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eVD4
Breaker Integrated Protection RBX615
Engineering Manual

Power and productivity
for a better world™

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Conformity

The IED is designed in accordance with the international standards of the IEC 60255 series, EMC Directive 2004/108/EC and MV circuit breaker standard IEC 62271-100.

Safety information

Dangerous voltages can occur on the connectors, even though the auxiliary voltage has been disconnected.

Non-observance can result in death, personal injury or substantial property damage.

Only a competent electrician is allowed to carry out the electrical installation.

National and local electrical safety regulations must always be followed.

The frames of the IED and of the HMI have to be carefully earthed.

When the plug-in unit has been detached from the docking unit, do not touch the inside of the DU. The IED DU internals may contain high voltage potential and touching these may cause personal injury.

The IED contains components which are sensitive to electrostatic discharge. Unnecessary touching of electronic components must therefore be avoided.

Whenever changes are made in the IED, measures should be taken to avoid inadvertent tripping.

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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 61850 and other supported protocols.

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

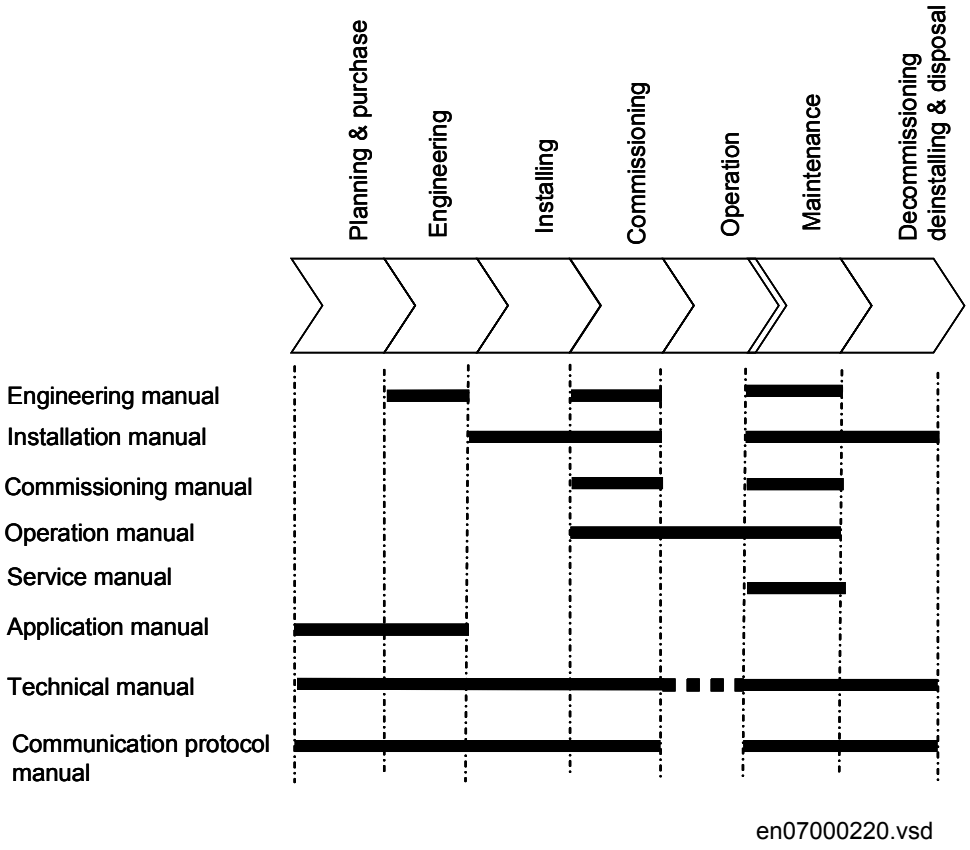


Figure 1: The intended use of manuals in different lifecycles

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 61850 and other supported protocols.

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 troubleshooting manual contains quick answers to frequently asked questions about the IED use. The manual provides instant solutions to the problems that the end used might face while using the IED, both at commissioning and during the eVD4 life.

The service manual contains instructions on how to service and maintain the IED. The manual also provides procedures for de-energizing, de-commissioning and disposal of the IED.

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

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

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

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

Some of the manuals are not available yet.

1.3.2 Document revision history

Document revision/date	Product series version	History
A/2010-12-22	1.0	First release
B/2011-12-13	2.0	Content updated to correspond to the product series version

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

1.3.3 Related documentation

1.4 Symbols and conventions

1.4.1 Symbols

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

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

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

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

1.4.2 Document conventions

A particular convention may not be used in this manual.

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

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

- Parameter values are indicated with quotation marks.
  The corresponding parameter values are "On" and "Off".
- IED input/output messages and monitored data names are shown in Courier font.
  When the function starts, the `START` output is set to TRUE.

1.4.3 Functions, codes and symbols

All available functions are listed in the table. All of them may not be applicable to all product variants.

Table 1: Functions included in standard configurations

Function	IEC 61850	IEC 60617	IEC-ANSI
Protection			
Three-phase non-directional overcurrent protection, low stage	PHLPTOC1	3I> (1)	51P-1 (1)
Three-phase non-directional overcurrent protection, high stage	PHHPTOC1	3I>> (1)	51P-2 (1)
	PHHPTOC2	3I>> (2)	51P-2 (2)
Three-phase non-directional overcurrent protection, instantaneous stage	PHIPTOC1	3I>>> (1)	50P/51P (1)
Three-phase directional overcurrent protection, low stage	DPHLPDOC1	3I> → (1)	67-1 (1)
	DPHLPDOC2	3I> → (2)	67-1 (2)
Three-phase directional overcurrent protection, high stage	DPHHPDOC1	3I>> →	67-2
Non-directional earth-fault protection, low stage	EFLPTOC1	I0> (1)	51N-1 (1)
	EFLPTOC2	I0> (2)	51N-1 (2)
Non-directional earth-fault protection, high stage	EFHPTOC1	I0>> (1)	51N-2 (1)
Non-directional earth-fault protection, instantaneous stage	EFIPTOC1	I0>>> (1)	50N/51N (1)
Directional earth-fault protection, low stage	DEFLPDEF1	I0> → (1)	67N-1 (1)
	DEFLPDEF2	I0> → (2)	67N-1 (2)
Directional earth-fault protection, high stage	DEFHPDEF1	I0>> →	67N-2
Negative-sequence overcurrent protection	NSPTOC1	I2> (1)	46 (1)
	NSPTOC2	I2> (2)	46 (2)
Phase discontinuity protection	PDNSPTOC1	I2/I1>	46PD
Residual overvoltage protection	ROVPTOV1	U0> (1)	59G (1)
	ROVPTOV2	U0> (2)	59G (2)
	ROVPTOV3	U0> (3)	59G (3)
Three-phase undervoltage protection	PHPTUV1	3U< (1)	27 (1)
	PHPTUV2	3U< (2)	27 (2)
	PHPTUV3	3U< (3)	27 (3)

Table continues on next page

Function	IEC 61850	IEC 60617	IEC-ANSI
Three-phase overvoltage protection	PHPTOV1	3U> (1)	59 (1)
	PHPTOV2	3U> (2)	59 (2)
	PHPTOV3	3U> (3)	59 (3)
Positive-sequence undervoltage protection	PSPTUV1	U1<	47U+
Negative-sequence overvoltage protection	NSPTOV1	U2>	47O-
Three-phase thermal protection for feeders, cables and distribution transformers	T1PTTR1	3Ith>F	49F
Negative-sequence overcurrent protection for motors	MNSPTOC1	I2>M (1)	46M (1)
	MNSPTOC2	I2>M (2)	46M (2)
Loss of load supervision	LOFLPTUC1	3I<	37
Motor load jam protection	JAMPTOC1	Ist>	51LR
Motor start-up supervision	STTPMSU1	Is2t n<	49,66,48,51 LR
Phase reversal protection	PREVPTOC	I2>>	46R
Thermal overload protection for motors	MPTTR1	3Ith>M	49M
Circuit breaker failure protection	CCBRBRF1	3I>/I0>BF	51BF/ 51NBF
Three-phase inrush detector	INRPHAR1	3I2f>	68
Protection trip conditioning	TRPPTRC1	Master Trip (1)	94/86 (1)
	TRPPTRC2	Master Trip (2)	94/86 (2)
Control			
Fixed circuit-breaker control	FCBXCBR1	I ↔ O CB	I ↔ O CB
Withdrawable circuit-breaker control	WCBXCBR1	I ↔ O CB	I ↔ O CB
Earthing switch indication	ESSXSWI1	I ↔ O ES	I ↔ O ES
Earthing switch control	MESXSWI1	I ↔ O ES	I ↔ O ES
Truck control	TRXSWI	I ↔ O DC	I ↔ O DC
H-bridge control	HBGAPC1	HBC	HBC
	HBGAPC2	HBC	HBC
Emergency startup	ESMGAPC1	ESTART	ESTART
Auto-reclosing	DARREC1	O → I	79
Condition monitoring			
Circuit-breaker condition monitoring	ESSCBR1	CBCM	CBCM
Current circuit supervision	CCRDIF1	MCS 3I	MCS 3I
Coil switch supervision (open)	OCSSCBR1	TCS (Open)	TCM (Open)
Coil switch supervision (close)	CCSSCBR1	TCS (Close)	TCM (Close)
Fuse failure supervision	SEQRFUF1	FUSEF	60
Motor runtime counter	MDSOPT1	OPTS	OPTM
Measurement			
Disturbance recorder	RDRE1	-	-
Three-phase current measurement	CMMXU1	3I	3I

Table continues on next page

Function	IEC 61850	IEC 60617	IEC-ANSI
Sequence current measurement	CSMSQI1	I1, I2, I0	I1, I2, I0
Residual current measurement	RESCMMXU1	I0	In
Three-phase voltage measurement	VMMXU1	3U	3U
Residual voltage measurement	RESVMMXU1	U0	Vn
Sequence voltage measurement	VSMSQI1	U1, U2, U0	U1, U2, U0
Three-phase power and energy measurement	PEMMXU1	P, E	P, E
Sensor temperature	VDSTMP	VDTS	VDTM

Section 2 IED engineering process

PCM600 is used for various tasks in the IED engineering process.

- IED engineering management
  - Organizing the bay IEDs in the structure of the substation by defining voltage levels and bays below the substation. PCM600 manages the project.
  - Configuring the IED functions (for example, protection and control functions) by using the Application Configuration tool.
  - Configuring the parameters and setting values for the IED itself and for the process functions by using the Parameter Setting tool.
  - Drawing single-line diagrams and making links to dynamic process values by using the Graphical Display Editor. The single-line diagrams are displayed in 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.

- Communication management
  - IEC 61850 station communication engineering is done with a separate tool, for example, CCT600. PCM600 interacts with CCT600 by importing and exporting SCL files.
  - Configuring the GOOSE receive data connections to the IED's application configuration function blocks.
  - Configuring protocol data mapping with the Communication Management tool for the supported protocols.

- Disturbance record management
  - Generating overviews on the available (disturbance) recordings in all connected protection IEDs by using the Disturbance Handling tool.
  - Manually reading the recording files (in the COMTRADE format) from the protection IEDs by using the Disturbance Handling tool or automatically by using the PCM600 Scheduler.
  - Managing recording files with the Disturbance Handling tool.
  - Creating recording file content overview reports for fast evaluation with assistance of the Disturbance Handling tool.

- Service management
  - Monitoring the selected signals of an IED for commissioning or service purposes by using the Signal Monitoring tool.

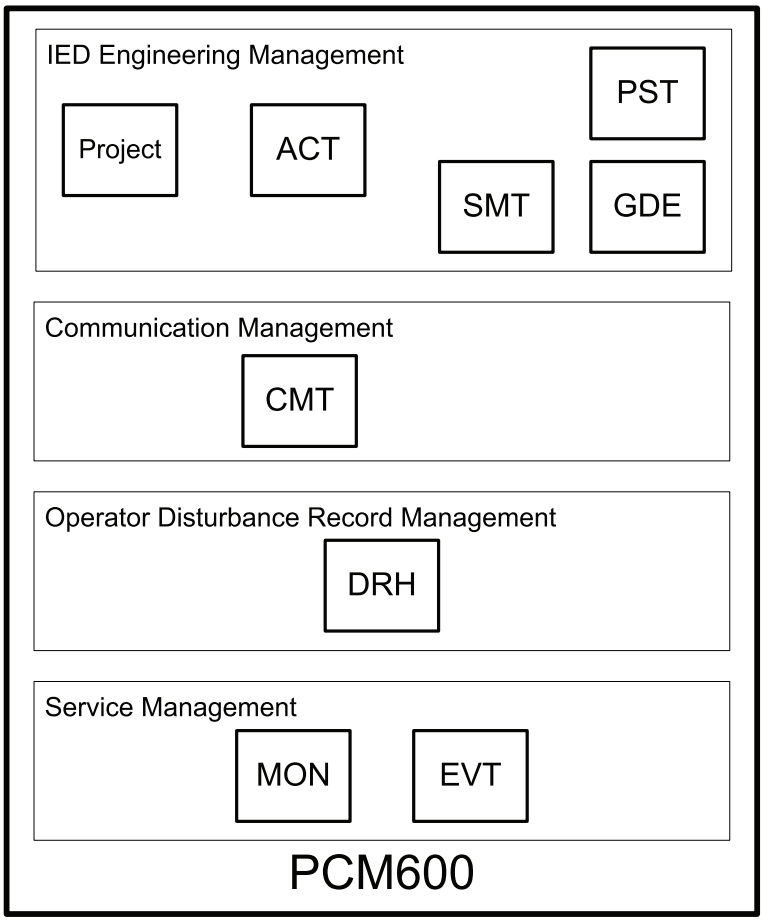


Figure 2: Organization of PCM600 in different management tasks

There are also additional functions for managing projects and organizing user rights.

- PCM600 user management
  - Organizing users regarding their rights, profiles and passwords to use different tools and functions in the tools.
  - Defining allowed activities for user profiles to use tools in PCM600.

Once the engineering of the IED is finished, the results must be written to the IED.

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

2.1 Monitoring and control system structure

The monitoring and control system for electrical substations contains a number of IEDs for various purposes.

The number of IEDs in one PCM600 project is limited. An error message is displayed if you exceed the limit. Divide larger projects into several PCM600 projects.

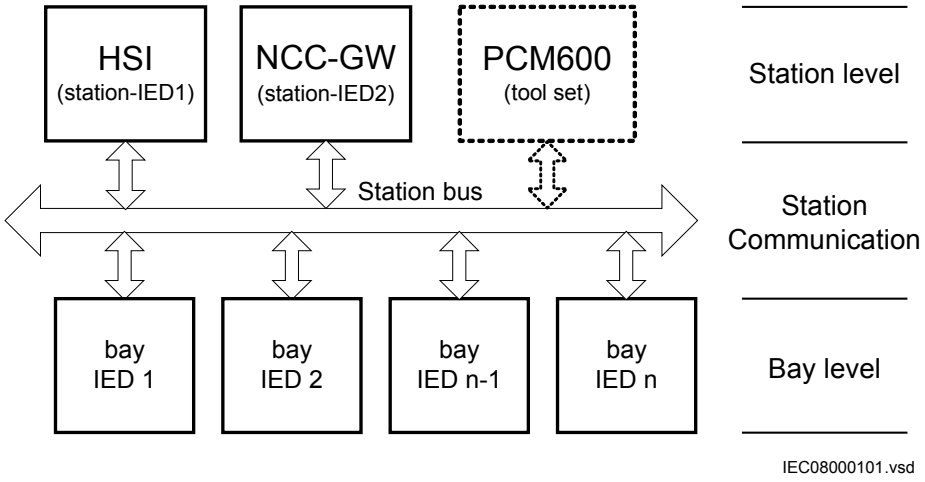


Figure 3: Principle structure of a monitoring and control system for a substation

The monitoring and control system can be divided into three main parts.

- Bay level IEDs
- Station communication
- Station level IEDs

All three parts require specific engineering and configuration.

The plant structure is used to identify each IED in its location within the substation organization. Plant structure is a logical 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.

- Project
- Substation = name of the substation
- Voltage level = identifies to which grid type or part the IED belongs in the substation
- Bay = bay within the voltage level
- IED = the selection of the IED that is used in the bay; it is possible to insert several IEDs within a bay, for example, one control IED and two protection IEDs

2.2 Preconfigurations concept

The RBX615 is a configurable device but it is offered with optional factory-made application, called preconfigurations, that contain protection, control, supervision and measurement function blocks and default logical connections. The preconfigurations contribute to faster commissioning and less engineering of the IED. The product also includes the preconfiguration specific default single-line diagram.

Current and voltage channels for protection and measurement functions are fixed and cannot be reassigned with Signal Matrix or Application Configuration in PCM600.

The single-line diagram consists of an application-specific general arrangement of a single-line diagram that includes position indications and the selection of controllable objects and measurements.

The content of the preconfiguration depends on the intended power system application. The standard configurations also have selectable options, which are selected when ordering the IED. Some of the options are related to the IED hardware.

The preconfigurations can be used as such, but they can also be modified by using PCM600. The standard preconfiguration itself can be modified or extended by using the Application Configuration tool, the Signal Matrix tool and the Communication Configuration tools. The single-line diagram can also be modified with Graphical Display Editor.

Some of the preconfigurations offer very wide functionality in means of number of different functions available as part of the product configuration. It is possible to use all of the offered functions at the same time.

However, if unused function blocks are removed from the preconfiguration with the Application Configuration, more resources in the IED can be used for other purposes, for example :

- More advanced user application logic with Application Configuration
- Extensive use of GOOSE sending and receiving
- Increasing the amount of data reported for 61850 clients

In case the configuration capacity of the IED is exceeded, the relay will enter to IRF error state at the bootup.

2.3 Workflow

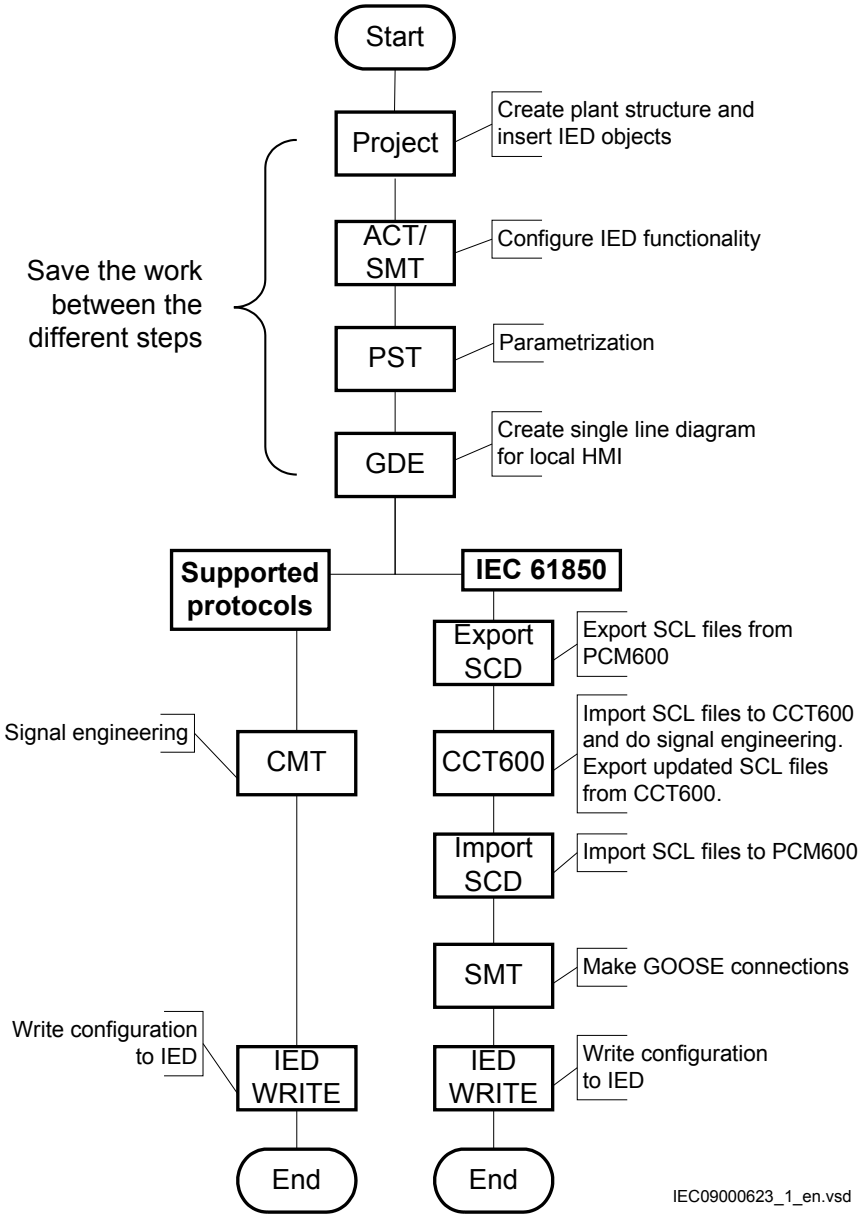


Figure 4: IED engineering workflow proposal based on practical experience and dependencies of the steps

It is possible to make a different kind of a sequence based on the information available at the time when the project is started. This means that several iterations may be needed to complete the project.

Setting up a PCM600 project

- The plant structure is built according to the substation structure.

The number of IEDs in one PCM600 project is limited. An error message is displayed if you exceed the limit. Divide larger projects into several PCM600 projects.

- The IED is created in offline or online mode. In both cases a suitable IED connectivity package is used. Additionally, a project template can be used for the IED creation.
- The IED objects in PCM600 are renamed uniquely according to the project definitions.

Application configuration in the Application Configuration tool

- The protection or control function is configured, for example, for a feeder, as requested.
- The configuration made in the Application Configuration tool is saved to make the interfaces and signals available for other engineering tools within PCM600, for example, for the Parameter Setting tool.

Parameter setting and configuration in the Parameter Setting tool

- The configuration parameters of the physical IED for communication channels and the CT and VT conversion values of the transformer module, for example, are checked.
- If needed, the setting values are checked and adjusted with the Parameter Setting tool.

Single-line diagram configuration in the Graphical Display Editor

- A single-line diagram of the switching devices in a bay is created.
- Measurements are included when needed.
- The dynamic elements are linked to the functions created in the Application Configuration tool; for example, a breaker object is linked to the circuit breaker control function.

LHMI engineering

- The LED behavior is defined with Parameter Setting.
- The LEDs are configured with Application Configuration.

Communication protocol engineering

- The communication engineering details are protocol dependent.
- The connectivity package creates the IEC 61850 configuration for vertical communication automatically and it is directly suitable, in most cases, for IEC

61850 client configuration. A station configuration tool, for example CCT600, is used for horizontal communication.

- The Communication Management tool is used for other protocols; for example, Modbus.

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

Section 3 PCM600 tool

Protection and Control IED Manager PCM600 offers all the necessary functionality to work throughout all stages of the IED life cycle.

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

With the individual tool components, you can perform different tasks and functions and control the whole substation. PCM600 can operate with many different topologies, depending on the customer needs.

PCM600 is used to conduct complete engineering and configuration activities needed for the 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 provided in an IED connectivity package.

PCM600 communicates with the bay IEDs via an Ethernet connection. The connection allows to read and write 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. Bay IED IEC 61850 station communication files can be exported from PCM600 to the station engineering tools for engineering of station communication between the bay IEDs and station IEDs.

A PC with PCM600 can be connected to any 615 series IED within a station by using the Ethernet connection. The Ethernet connection can later be used also for service and maintenance purposes. In addition, the connection is used to handle disturbance records from the protection IEDs using the IEC 61850 file transfer.

The modern-day IEDs 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. See the IEC 61850 parameter list for the available logical nodes in the IED, following the structure and rules in part 7 of the IEC 61850 standard in an IED configuration.

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 into groups.

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

For more information, see PCM600 documentation.

3.1 Connectivity packages

Connectivity package is a collection of software and information related to a specific protection and control terminal providing system products and tools to connect and interact with the IED. Connectivity packages are used to create configuration structures in PCM600. The latest PCM600 and connectivity packages are backward compatible with older IED versions.

Update Manager is a tool that helps in defining the right connectivity package versions for different system products and tools. Update Manager is included in products supporting the connectivity concept.

In addition to other products supporting the connectivity concept, the connectivity packages for PCM600 contain a description of IED's internal parameters and their properties (such as data format, unit, setting range, visibility and access rights) as well as software components that adapt the IED-specific interfaces to the standard interfaces of system products and tools, such as IED-specific dispatchers for tools. This means that there is a protocol-specific adaptation for the parameter setting and disturbance handling tool components, for example, disturbance recorder reading according to COMTRADE. The description texts can be translated into other languages as well.

3.2 PCM600 and IED connectivity package version

- Protection and Control IED Manager PCM600 Ver. 2.4 or later
- ABB IED Connectivity Package ECB Ver. 1.0 or later

Download connectivity packages from the ABB web site http://www.abb.com/substationautomation

3.3 PCM600 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.

With PCM600, it is possible to do various tasks.

- Open existing projects
- Import projects
- Create new projects
- Export projects
- Delete projects
- Rename projects
- Copy and paste projects

The extension of the exported project file is .pcmp. The files are only used for exporting and importing projects between PCM600s.

3.4 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 IEC 61850.

Each IED has an Ethernet interface connector on the front and optionally on the rear side as well. The Ethernet connector can be used for communication with PCM600.

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

Two basic variants have to be considered for the connection between PCM600 and the IED.

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

1. If needed, the IP address for the IEDs is set.
2. A PC or workstation is set up for a direct link (point-to-point), or the PC or workstation is connected to the LAN/WAN network.
3. The IED IP addresses in the PCM600 project are configured for each IED to match the IP addresses of the physical IEDs.

For successful IED engineering and usage, check the workstation firewall TCP and UDP port configurations, especially for IEC 61850 and FTP. Other protocols are not used for engineerging and/or they are optional.

Table 2: Ports that must be open in the firewall for different protocols

Protocol	TCP port
File Transfer Protocol (FTP)	20, 21
IEC 61850	102
Web Server HTTP	80
Simple Network Time Protocol (SNTP)	123
Modbus TCP	502

Section 4 Setting up a project

4.1 Installing connectivity packages

1. Close PCM600.
2. Run the **ABB IED Connectivity Package eCBConnPack.msi** installer.
3. To install the connectivity package, follow the steps in the connectivity package installation software guide.

4.2 Activating 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.

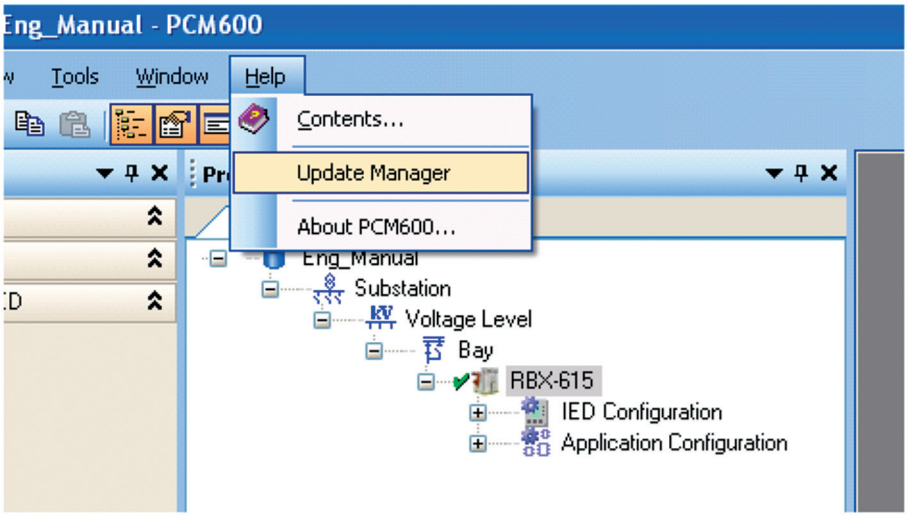


Figure 5: Help menu – Update Manager

The **Update Manager** shows the IEDs that are compatible with the installed PCM600 version.

2. Select **ABB IED Connectivity Package eCB**.
Always use the latest version of the connectivity package.

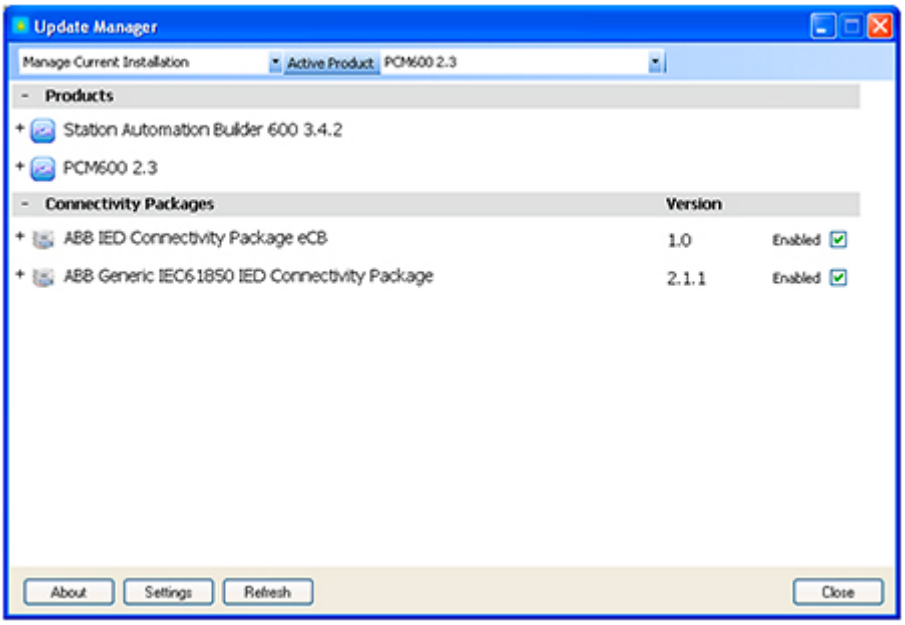


Figure 6: Activating the connectivity package

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 PCM and the IED

4.3.1 Setting up IP addresses

The IP address and the corresponding subnet mask can be set via 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 factory IP address is not given when an additional Ethernet interface is installed or when an interface is replaced.

The IED *front port* IP address is fixed to 192.168.0.254 and it cannot be modified.

1. Set the default IP address for the IED *rear port* and the corresponding subnet mask via the LHMI path: **Configuration/Communication/Ethernet/Rear port**.

Default IP address for the IED rear port	Corresponding subnet mask

192.168.2.10	255.255.0.0

Communication fails if the IP addresses of the front and the rear port belong to the same subnet.

4.3.2 Setting up the PC or workstation for point-to-point access to the local HMI's front port

This instruction is an example that applies to standard PCs using the Microsoft Windows operating system. A laptop with one Ethernet interface is used in the example.

Administrator rights are required to change the PC communication setup.

The IED's DHCP server for the front port assigns an IP address for the computer. The computer must be configured to obtain its IP address automatically.

1. With an Ethernet cable, connect two physical Ethernet interfaces together without a hub, router, bridge or switch in between.
   Use standard straight-through or crossover Ethernet cables. The minimum length for the cable is 2 m. The connector type is RJ-45.

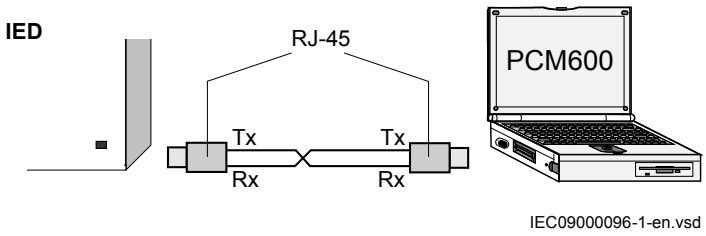


Figure 7: Point-to-point link between the IED and PCM600 using a cross-over Ethernet cable

2. From the **Start** menu, select **Settings/Network Connections**.

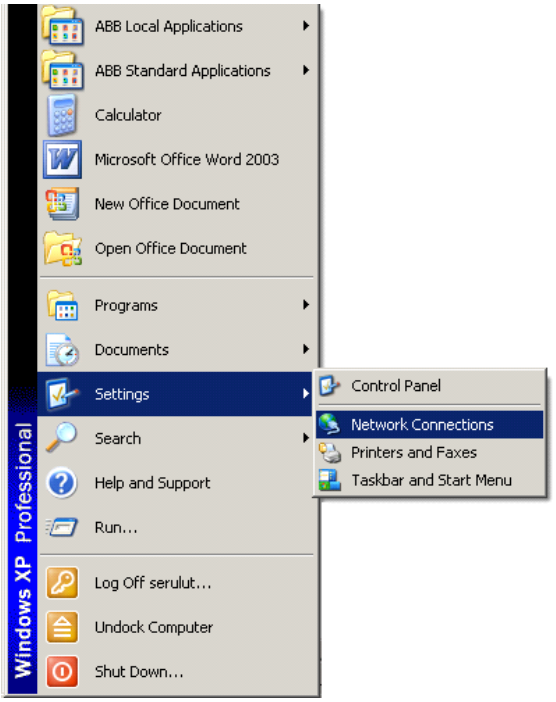


Figure 8: Selecting network connections

The **Network connections** dialog box is displayed.

3. Right-click the **Local Area Connection** and select **Properties**.

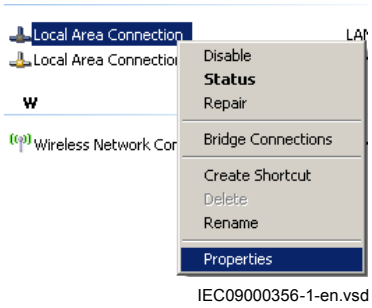
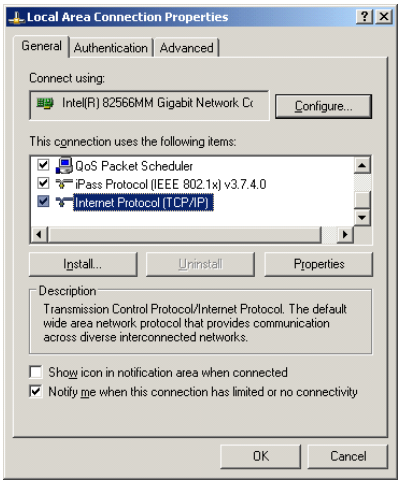


Figure 9: Selecting local area connection properties

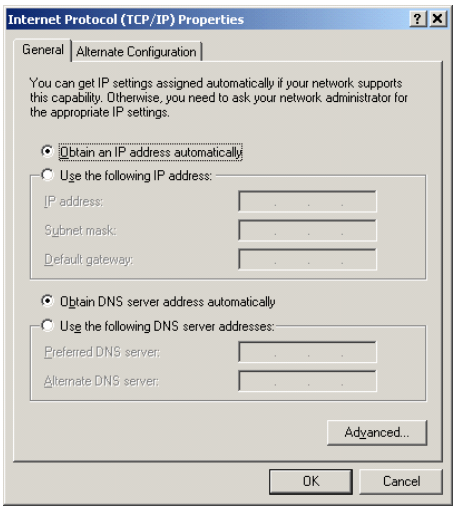
The **Local Area Connection Properties** dialog box is displayed.



IEC09000357-1-en.vsd

Figure 10: Local Area Connection Properties

4. From the list of configured components, select **Internet Protocol (TCP/IP)** using this connection and click **Properties**.
   The **Internet Protocol (TCP/IP) Properties** dialog box is displayed.



IEC09000358-1-en.vsd

Figure 11: TCP/IP settings

5. Click **Obtain an IP address automatically** and **OK**.
6. Close all open dialog boxes and start PCM600.

4.4 Creating a new project

1. Start PCM600.
2. To see the projects that are currently available in the PCM databases, select **File/Open/Manage Project** on the menu bar.
   The **Open/Manage Project** window is displayed.
3. Click **Projects on my computer**.
4. If there are currently any projects or object tools open, close them.
5. Click **New Project**.
   The **Create New Project** dialog box opens.

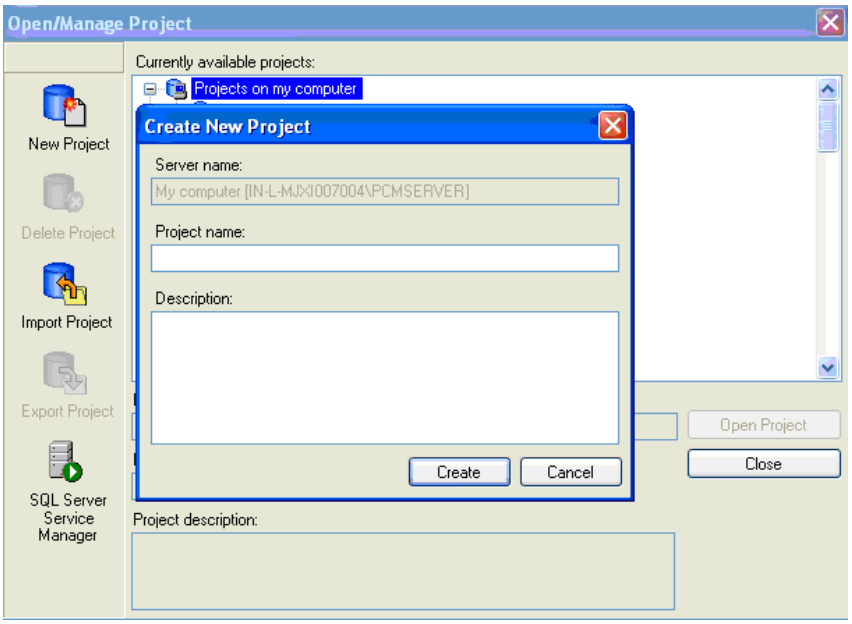


Figure 12: Creating a new project

6. In the **Project Name** box, give a name for the project.
7. Optionally, write a description of the project in the **Description** box.
8. Click **Create**.

PCM600 sets up a new project that is listed under **Projects on my computer**.

4.5 Building the plant structure

Building a plant structure is useful when a complete grid with an essential number of IEDs has to be built.

1. Create a new plant structure.
   - In the **Plant Structure** view, right-click and select **New/ Create from Template**.
   - In the **Plant Structure** view, right-click and select **New/ General** and select the element: either **IED Group** or **Substation**.
2. On the menu bar, click **View/ Object Types**.
3. Select the needed elements and drag-and-drop them into the plant structure.

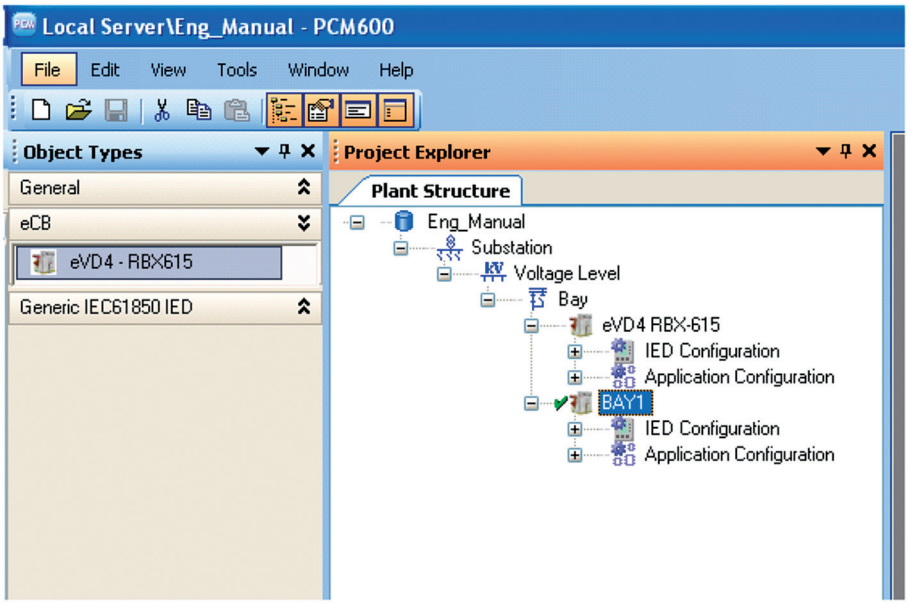


Figure 13: The start of a project with IEDs placed but not renamed

4. Rename each level in the structure by the names/identifications used in the grid.
   - Right-click the level and select **Rename**.
   - Rename the levels in the **Object Properties** view.

4.6 Inserting an IED

The context menu or the **Object Types** view shows the available 615 series IEDs that can be inserted, on the bay level, into the plant structure according to the installed connectivity package.

It is possible to do various tasks in the plant structure.

- Insert an IED to offline mode or online mode
- Import a template IED that is available in the template library as a .pcmt file

From the plant structure it is possible to see whether the inserted IED is in the offline or online mode. A red cross in front of the IED symbol indicates an offline mode, a green tick indicates online mode.

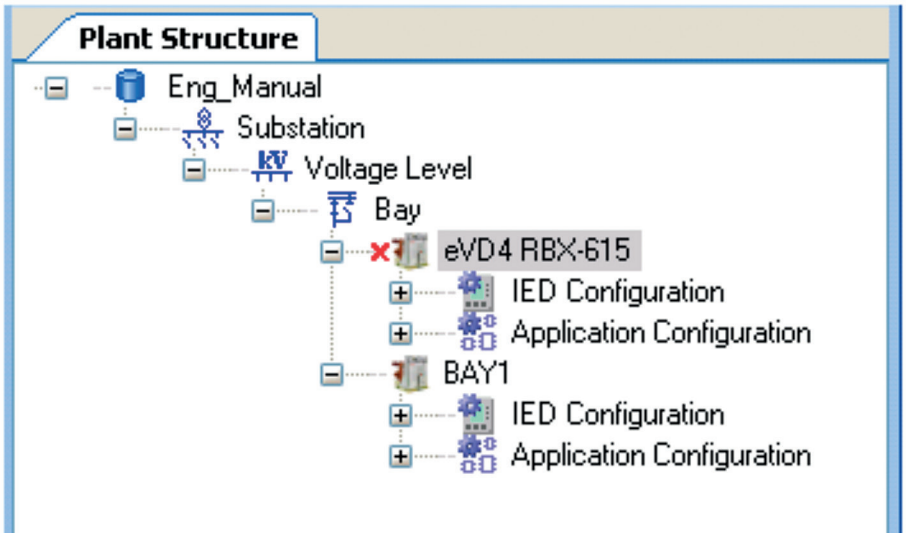


Figure 14: eVD4 RBX-615 is in offline mode

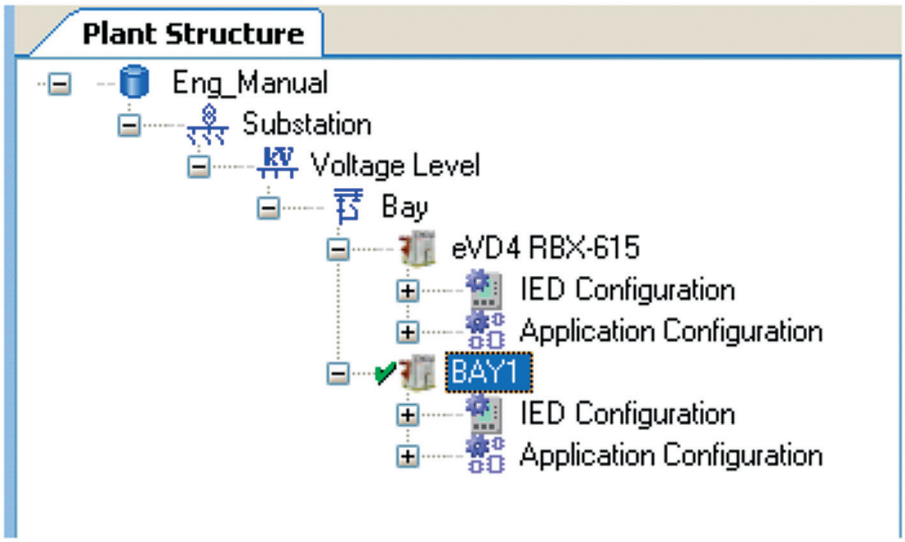


Figure 15: BAY1 is in online mode

4.6.1 Inserting an IED in 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 PCM600 is able to access it.

To set up an IED online, the IED must be connected to PCM600.

1. In the **Plant Structure** view, right-click the bay and from the list that appears, select **New/eCB/eVD4 – RBX615**.

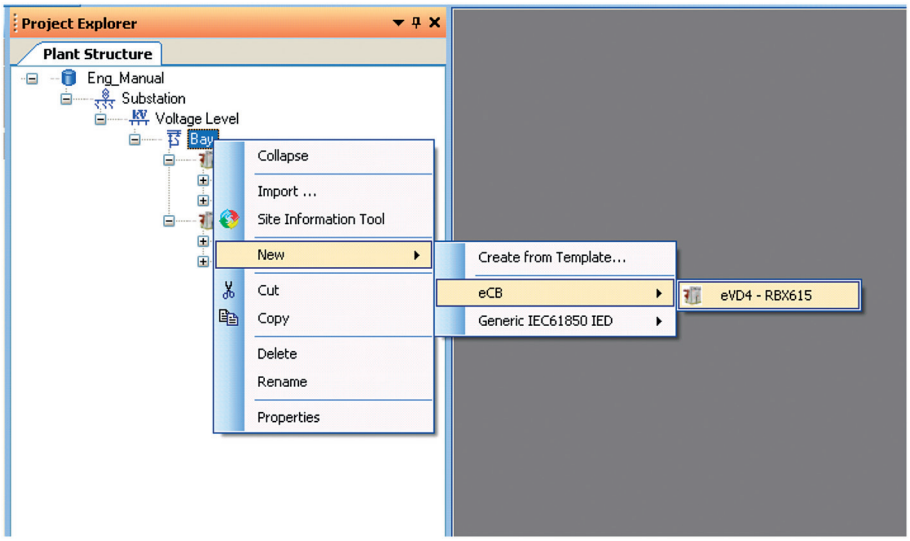


Figure 16: Selecting the IED type

You can also drag-and-drop an IED from the **Object Types** view to the bay level.

The **Configuration Mode Selection Page** dialog box opens.

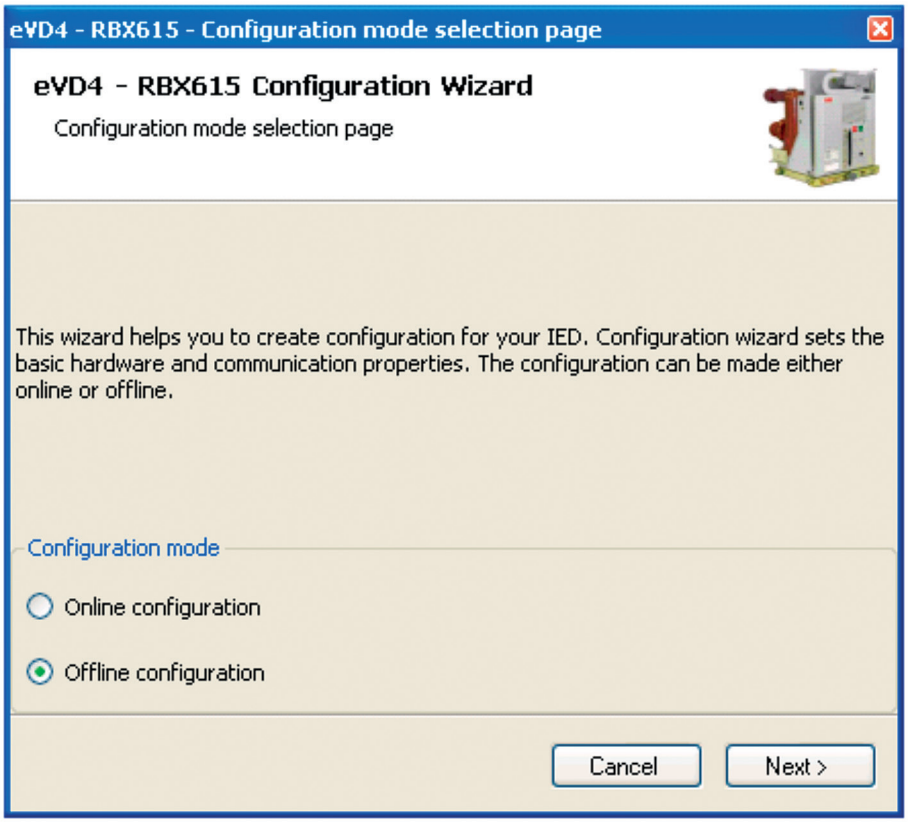


Figure 17: PCM600: Configuration mode selection

2. Select **Online Configuration** and click **Next**.
   The **Communication protocol selection page** is displayed.

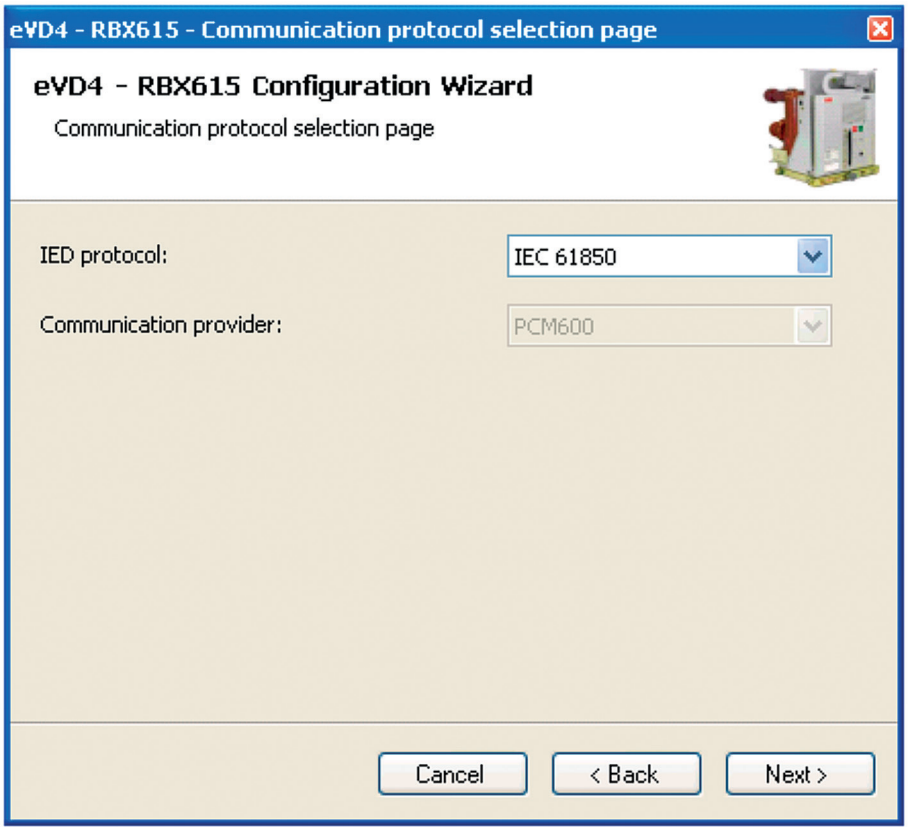


Figure 18: PCM600: Communication protocol selection

3. In the **IED protocol** list, select the IED communication protocol and click **Next**.
   The **Communication protocol** page is displayed.

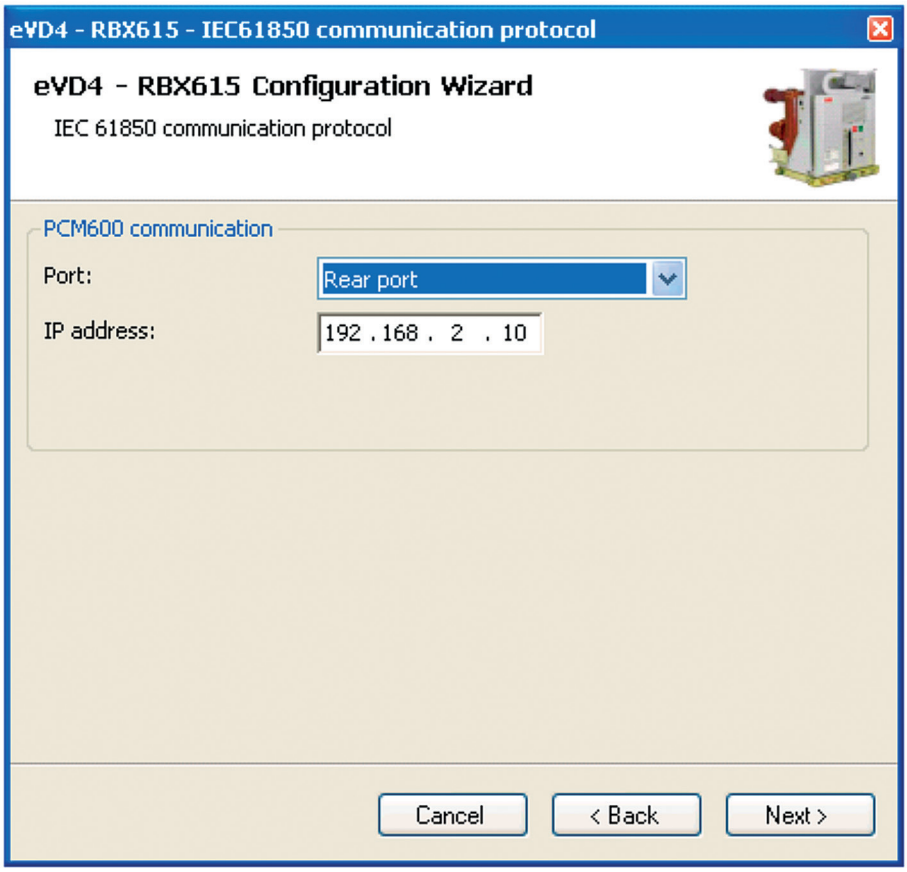


Figure 19: PCM600: Communication port and IP address

4. In the **Port** list, select the port.
   - If the rear port is selected, insert the correct IP address (of the physical IED to be configured) into the **IP address** box.

   Communication configuration is now defined.
5. Click **Next** in the Configuration Wizard.
   The **Composition code detection** page is displayed.

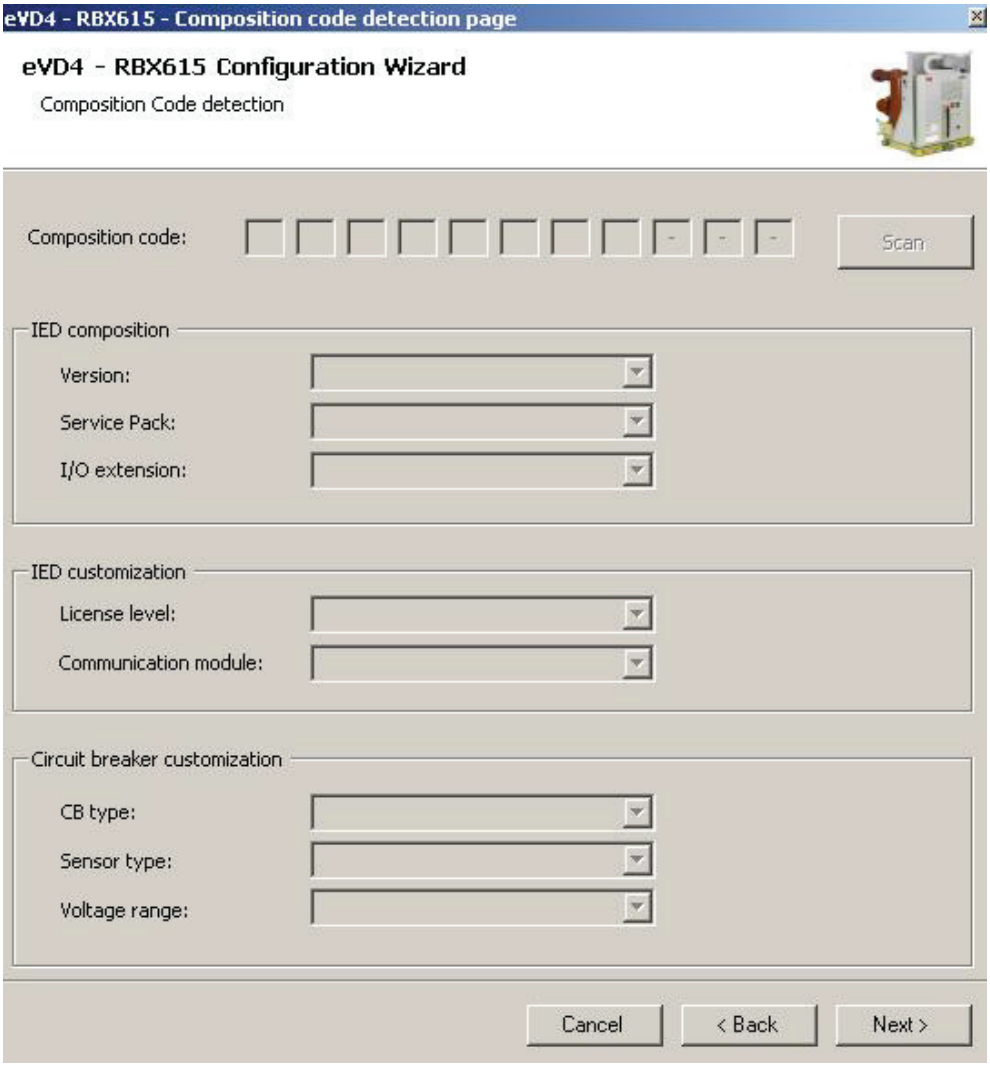


Figure 20: Composition selection page

6. Click **Scan** to scan/read the **Composition code** of the IED.
7. When the generation process is completed press **Next**.
   The **Setup Complete** page is displayed.

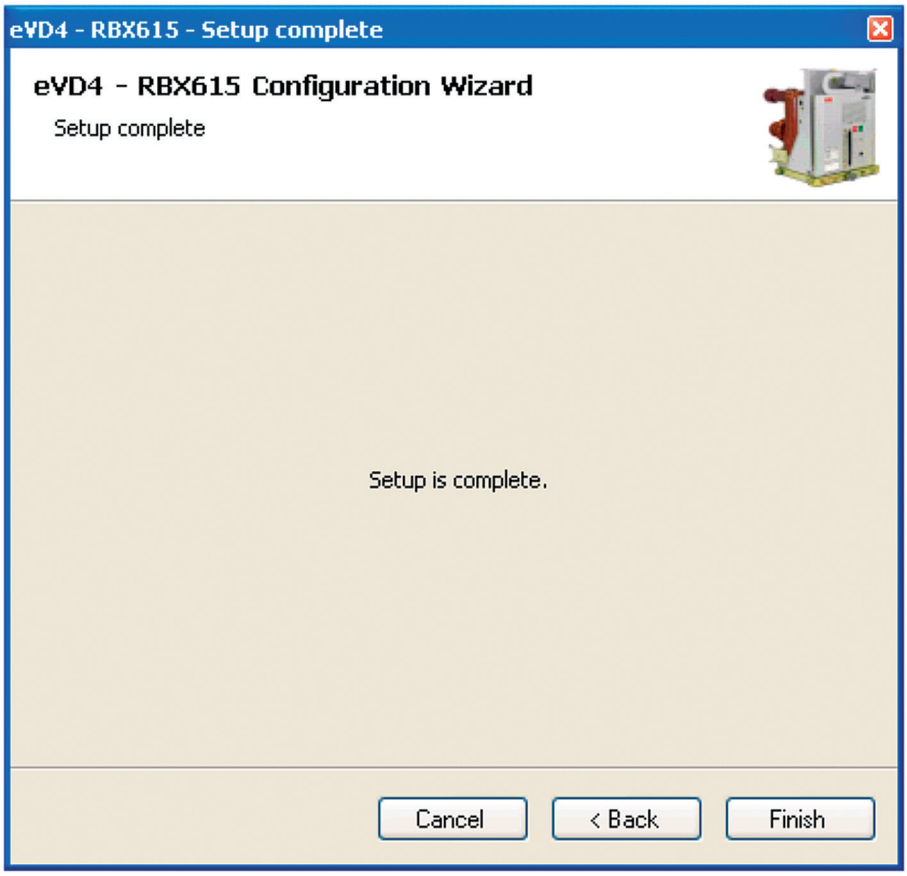


Figure 21: Setup complete page

To cancel the insertion, click **Cancel**.

8. Click **Finish** to confirm the configuration and conduct the insertion.

4.6.2 Inserting an IED in offline mode

When the physical IED is not available or not connected to PCM600, the engineering is done without any synchronization with the IED. The offline configuration in PCM600 can be synchronized with the physical IED later by connecting the IED to PCM600.

Working in the offline mode has an advantage compared to online mode in that the preparation for the configuration can be started even though the IED is not available.

1. In the **Plant Structure** view, right-click the bay and from the list that appears, select **New/eCB/eVD4 – RBX615**.
2. Select the IED type to be inserted.

You can also drag-and-drop an IED from the **Object Types** view to the bay level.

The **Configuration Mode Selection Page** dialog box opens.

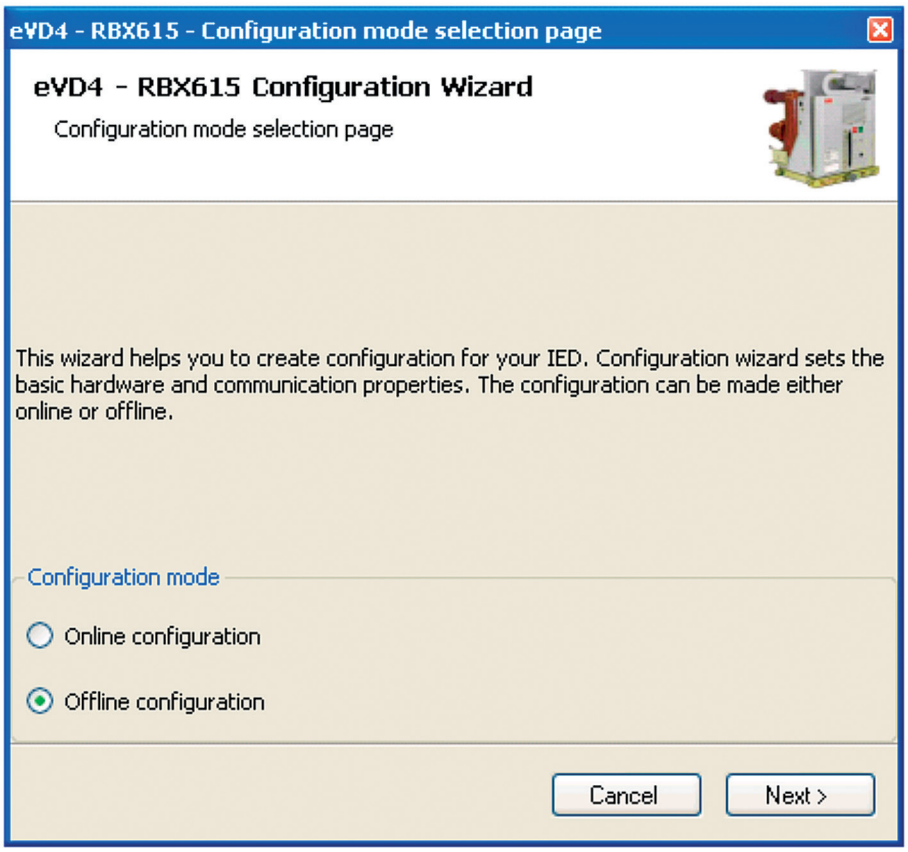


Figure 22: PCM600: Configuration Mode Selection Wizard

3. Select **Offline Configuration** and click **Next**.
   Setting up an IED in the offline mode is similar as in the online mode; however, with offline mode it is not necessary to type the correct IP address in the **Communication port and IP address** dialog box.
4. Select the composition code of the IED.

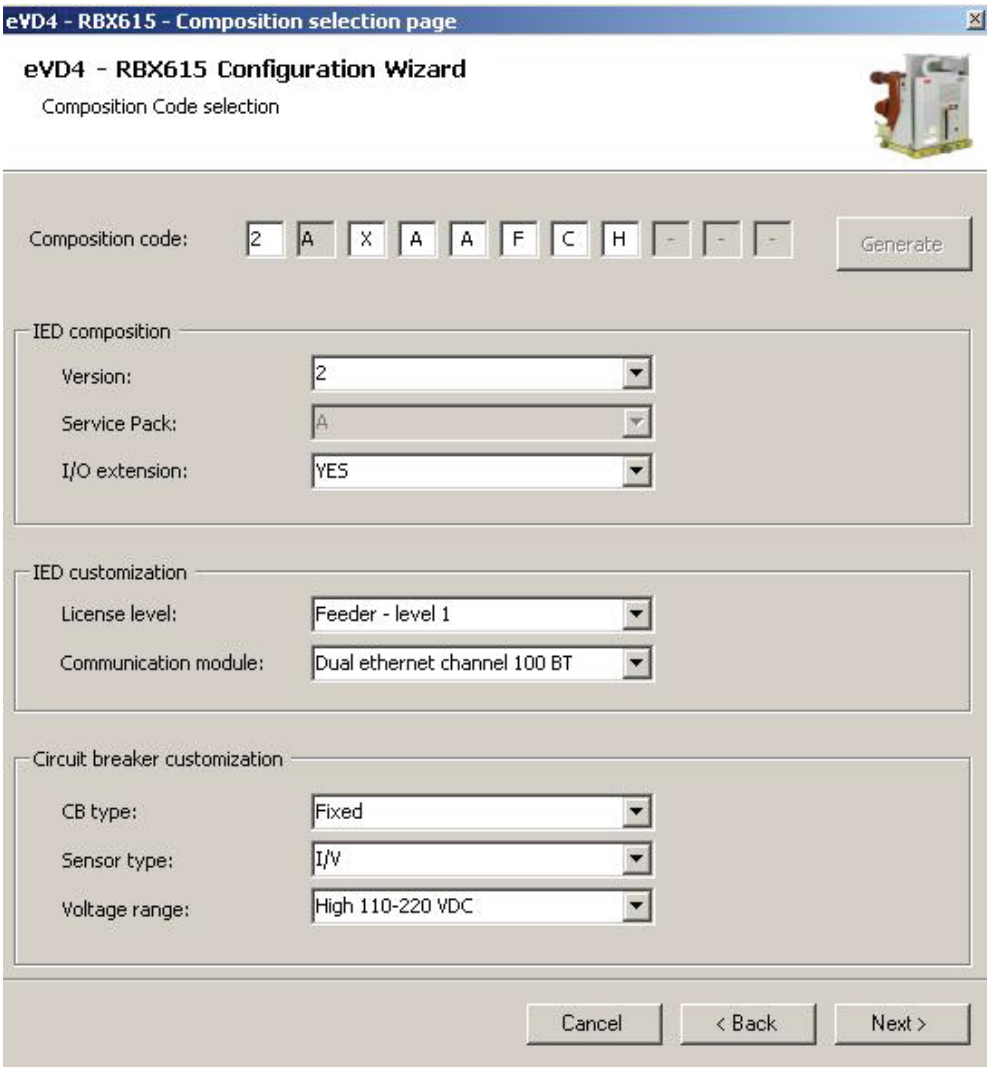


Figure 23: IED composition code selection

Ensure that the composition code is correct.

5. Click **Finish** to confirm the configuration and conduct the insertion.

4.6.3 Inserting an IED from the template directory

An IED in the plant structure can be exported as a template (.pcmt file). The template library can be build up of all the exported IED templates.

It is also possible to insert an IED from the template library to create a new IED in the plant structure. After a template IED has been imported, the IP address, the name and the technical key that corresponds to the physical IED have to be changed.

You can insert a template IED only when the bay is selected in the plant structure.

1. In the **Plant structure** view, select the bay, right-click and select **New/ Create from template**.
   The **Create New Object from Template** dialog box opens.

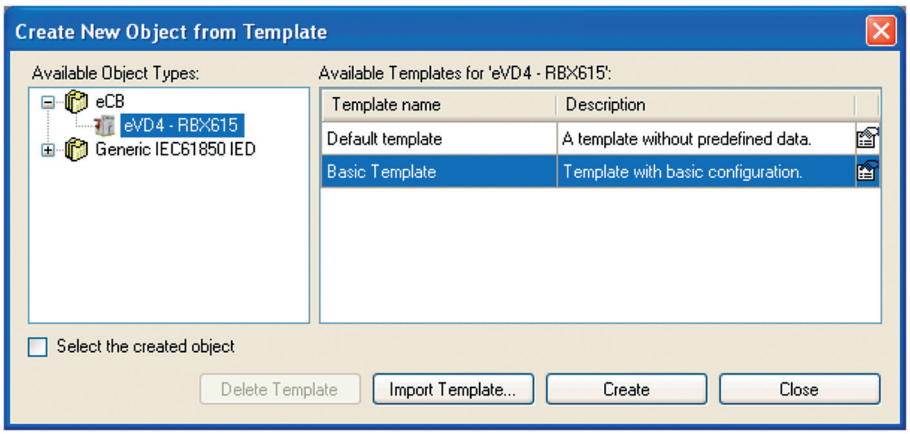


Figure 24: PCM600: selecting an IED from the template library

2. Select the eCB from the list of available IEDs.
3. Click the icon on the right column in the list of available templates.
   The **Template Properties** dialog box opens.

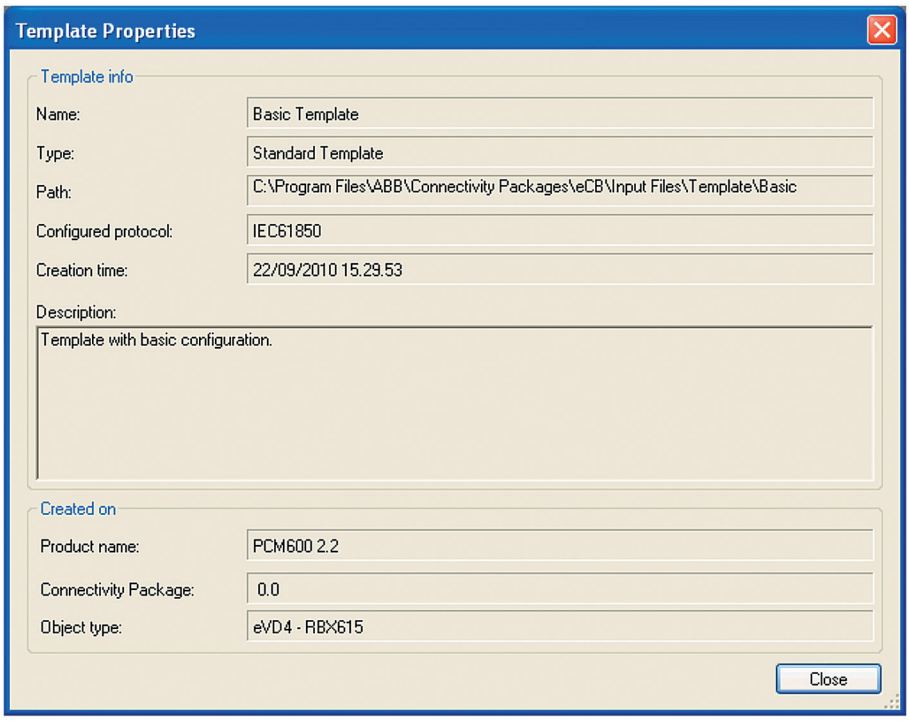


Figure 25: PCM600: template information

4. Check and verify the template information and click **Close** to close the window. The **Create New Object from Template** dialog box is displayed.
5. You can now delete, import or create a template by clicking the corresponding button.
   - To delete the selected template, click **Delete Template**.
   - To import a template from the selection window, click **Import Template**.
   - To insert the selected IED to the bay, click **Create**.

   It is possible to insert more than one IED from the **Create New Object from Template** dialog box. The dialog box remains open until you click **Close**.
6. Click **Close** when you are finished.

4.7 Setting the IED IP address in a project

The IED object in PCM600 must have the same IP address and subnet mask as the front or rear port of the physical IED to which the PC is connected. The IP address of the physical IED's front and rear port can be set only in LHMI, not in PCM600.

In PCM600, there are two alternatives to set the IP address of an IED object.

- On the first page of the wizard when including a new IED into a project.
- In the **IP address** box of the IED's **Object Properties** dialog box.

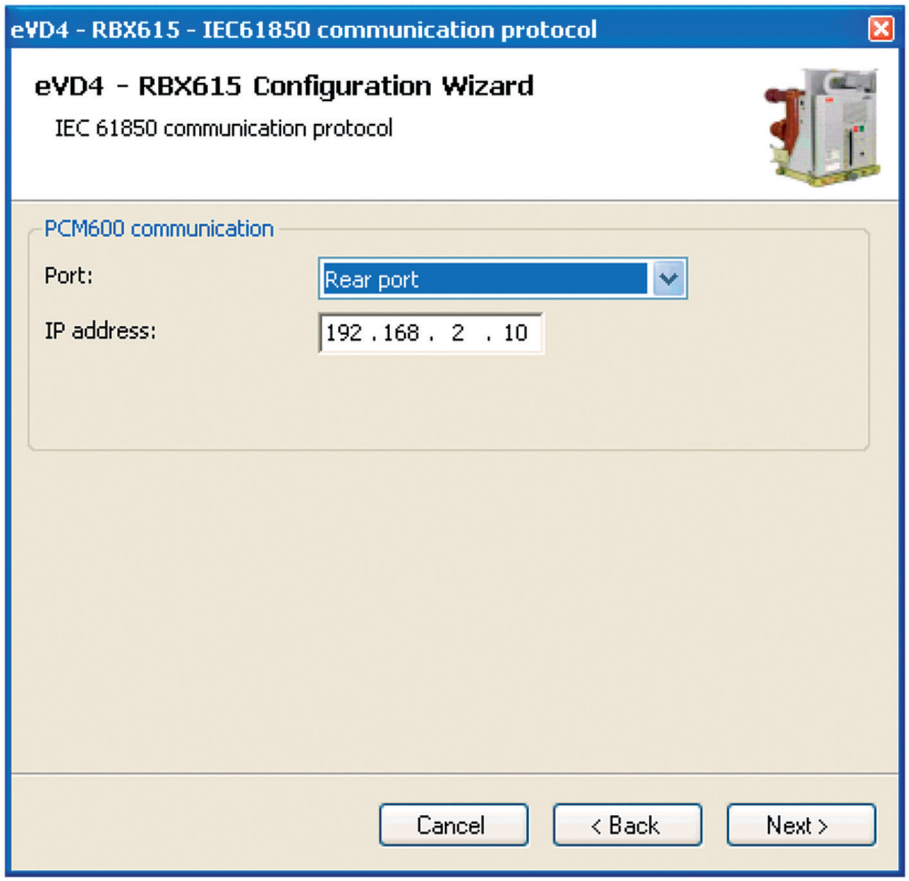


Figure 26: Alternative 1: setting the IP address on the first wizard page

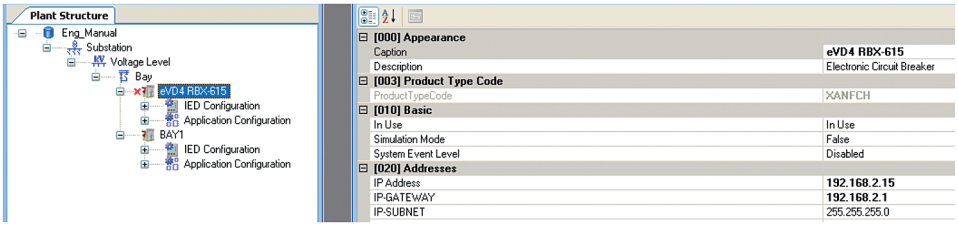


Figure 27: Alternative 2: setting the IP address in IED's Object Properties

The used alternative depends on the time at which the IP address is available. Entering the IP address via the IED **Object Properties** dialog box is possible at any time.

1. In the **Plant Structure** view, select the IED to which the IP address is to be entered.
2. Select **View/Object Properities** on the menu bar.

Object Properties dialog box is opened.

3. Type in the IP address to the **IP Address** row.

4.8 Technical key

Both a physical IED and an IED object in PCM600 have a technical key. The purpose of the technical key is to prevent a configuration download to a wrong IED. The technical key in the IED and PCM600 must be the same, otherwise it is not possible to download a configuration.

Each IED in a PCM600 project must have a unique technical key. Therefore, it is not possible to set the same technical key for several IEDs in the same PCM600 project.

The IED is delivered with a factory default technical key. The validation of the technical keys between PCM600 and the IED does not occur if the IED contains the factory default technical key.

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 may get lost when importing the SCL files.

The technical key must be the same for the communication between the IED and PCM600. The technical key can be read from the IED and updated to PCM600, or the PCM600 technical key can be written to the IED. Alternatively, a separate technical key can be defined.

It is not possible to write a configuration to IED if the there is a mismatch between the IED object and the physical IED technical key.

Ensure that the IED object in PCM600 has the same IP address as the physical IED that is intended to be connected.

You can change the technical key for an IED object in the **Object Properties** dialog box in PCM600.

4.8.1 IEC 61850 naming conventions to identify an IED

The IEC 61850 naming conventions to identify an IED are 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 designations in the object properties: a technical key and a user-oriented textual designation.

Technical key is used in engineering drawings and for signal identifications. This is contained in the attribute name as an identification of each object. If the value is used as a 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 to other objects. Note that the name is a relative identification within a hierarchy of objects.

User-oriented textual designation is contained in the *desc* attribute. Attributes are not allowed to contain carriage return, line feed or tab characters. The semantics of *desc* must also be relative within an object hierarchy.

PCM600 takes care of the 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 assigned for substations by a technical committee. The technical key is shown in the **Object Properties** dialog box 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 as the name used by the project. To minimize the word length, take a short form because this name is used also in the transmitted messages to identify the events, for example.
- The voltage level. In the example it is 20 kV and J1 is selected from the list below **SCL Technical Key** in the **Object Properties** dialog box.
- The bay and the IED are appended with the coding defined in the IEC 61346 standard and the substation definition lists. In the example, Bay SCL Technical Key part is Q01 and IED is A1.

The user-oriented textual designation is visible in the **Plant structure** view for each object. It is the name given by default or changed by using the **Rename** function.

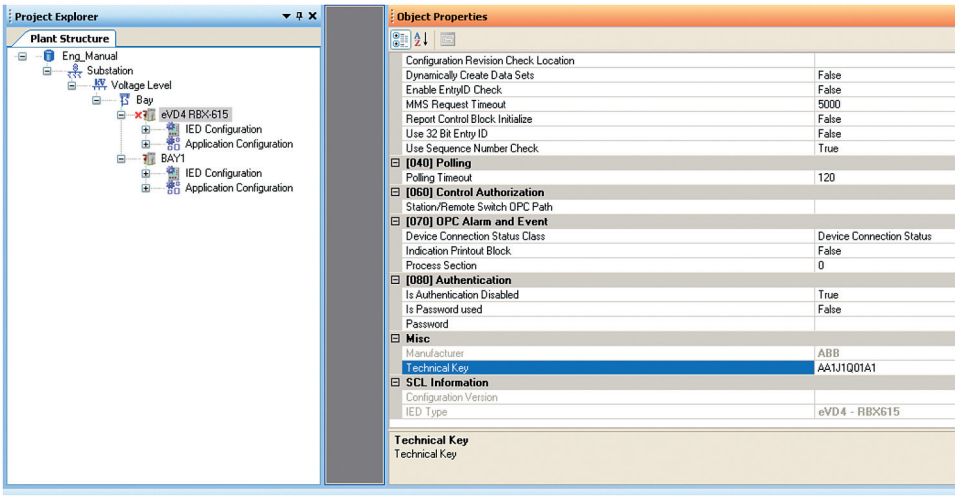


Figure 28: PCM600: IEC 61850 signal designation concept

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

- AA1 = substation in the project
- J1 = voltage level from 20 to 30 kV
- Q01= the third bay in the voltage level
- A1 = first IED in the bay Q01

4.8.2 Setting the technical key

1. Select the IED in the **Plant Structure** view and right-click.
2. From the list that opens, select **Set Technical Key in IED**.

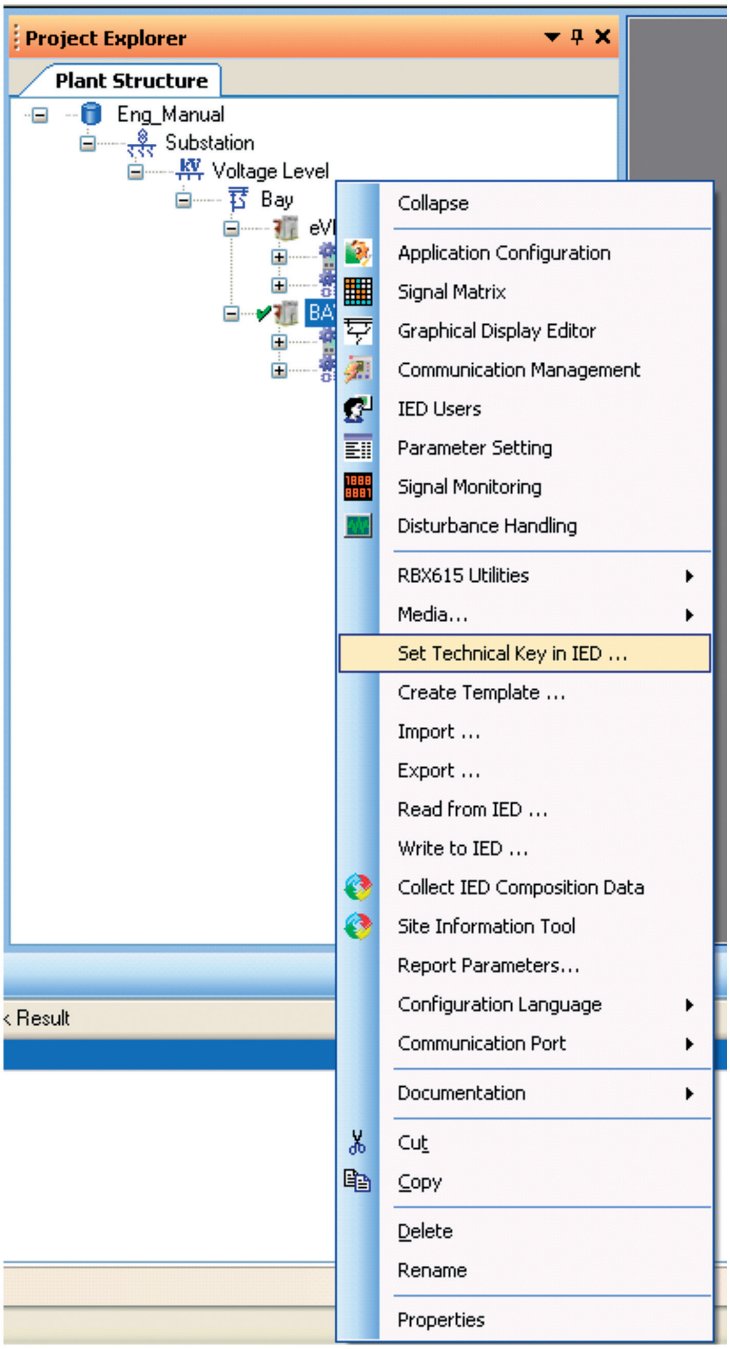


Figure 29: PCM600: Setting the technical key on the IED level

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

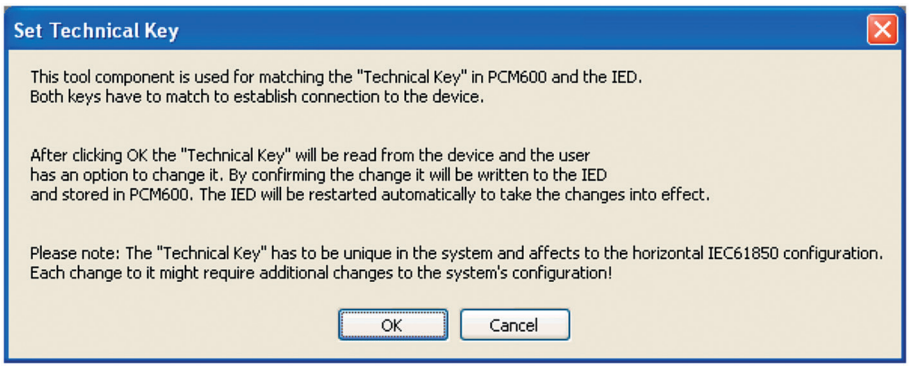


Figure 30: Techical key information

3. Click **OK**.
   The technical key is read from the IED and the **Set Technical Key** dialog box opens.

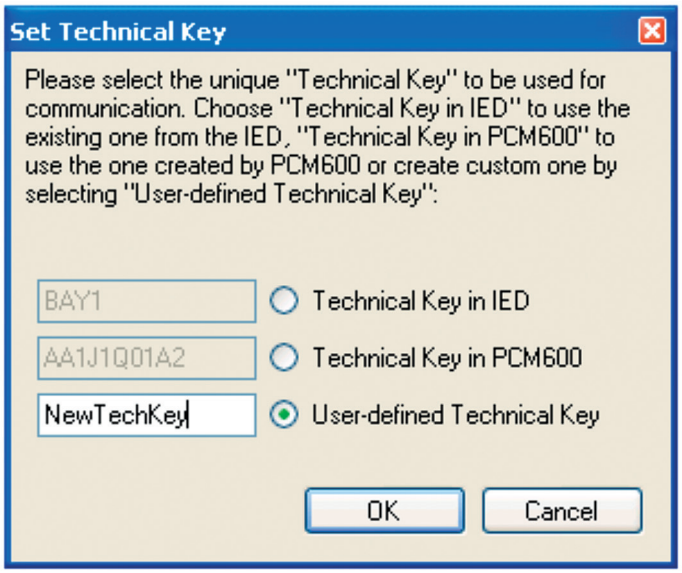


Figure 31: Setting the technical key

4. In **Set Technical Key** dialog box, select the techical key to be used. There are three alternatives.
   - Use the existing technical key in the IED
   - Use the existing technical key defined for the IED object in PCM600
   - Set a user-defined technical key, which changes the technical key for both the physical IED and IED object in PCM600

   Do not use a technical key that has more than 10 characters.

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. In that kind of a situation, a dialog box opens informing of the situation.

Section 5 Protection and control engineering

5.1 Application Configuration tool

Application Configuration tool is used to modify an application configuration for an IED. The application configuration is built of function blocks.

The function blocks are dedicated to different functions.

- Control related functions
- Protection related functions
- Monitoring functions
- Communication
- Logic functions

For more information on the function blocks, see the technical manual.

Most function blocks are mapped as logical nodes according to the IEC 61850 standard. See the 61850 parameter list for more information.

If a function block is removed with Application Configuration, the function related data disappears from the menus, with the exception of some basic function blocks, which are mandatory and thus cannot be removed from the IED configuration by removing them from the Application Configuration.

Other function blocks are not mapped as logical nodes; for example, logical gates.

The basic features of the Application Configuration tool include organizing of an application configuration as well as different application configuration programming features.

- Organizating an application configuration
  - Organize an application configuration into a number of logical parts (MainApplication)
  - Organize a MainApplication over a number of pages
- Features for programming an application configuration
  - Insert function blocks, make connections and create variables
  - Include the hardware I/O channels directly to the application configuration
  - Calculate the execution order automatically by clicking **Calculate execution order** on the toolbar.

- Document the application configuration: for example, make printouts
- 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.

5.1.1 Function blocks

Function blocks are the main elements of an application configuration. They are designed for a various number of functions and organized into type groups. The different function block types are shown in the **Object Types** view. Function block data can be modified with the Application Configuration tool.

- Set user-defined names for function blocks and signals marked with blue text.

Signals that have a user-defined name created with the Application Configuration tool are only visible in the Parameter Setting tool if the IED configuration is written to the IED and read back to PCM600. Otherwise, the default signal name is shown in the Parameter Setting tool.

If possible, set the user-defined name to a signal before connecting the signal to other function blocks.

- 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.

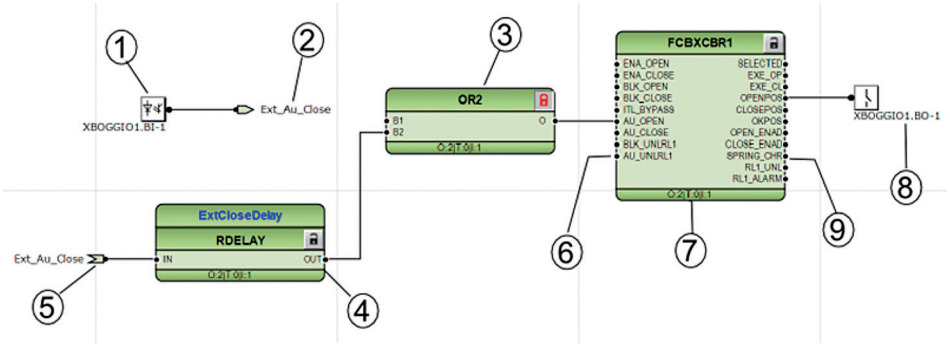


Figure 32: Application Configuration tool: function block overview

1. Hardware, binary input channel
2. User-defined signal name
3. Function block, locked (red)
4. User-defined function block name
5. User-defined signal name
6. Function block inputs
7. Execution order, cycle time
8. Hardware, binary output channel
9. Function block outputs

5.1.2 Signals and signal management

Function block has a set of input and output signals. The placement of function block signals is from left to right. Input signals are placed on the left and output signals on the right.

Function blocks can contain more signals than needed in that application part. Unused signals can be hidden to get a clear picture.

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

All input signals have a default value that is used when not connected.

5.1.3 Function block execution parameters

Three function block execution parameters have an 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 must be selected from the lists in the **Application Configuration** tool. Depending on the function block type, some of the three parameters are selectable and some not. 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 the application configuration.

The **Execution Order** and **Instance Number** are a combination that is predefined within a product. It is possible to select a pair out of the list.

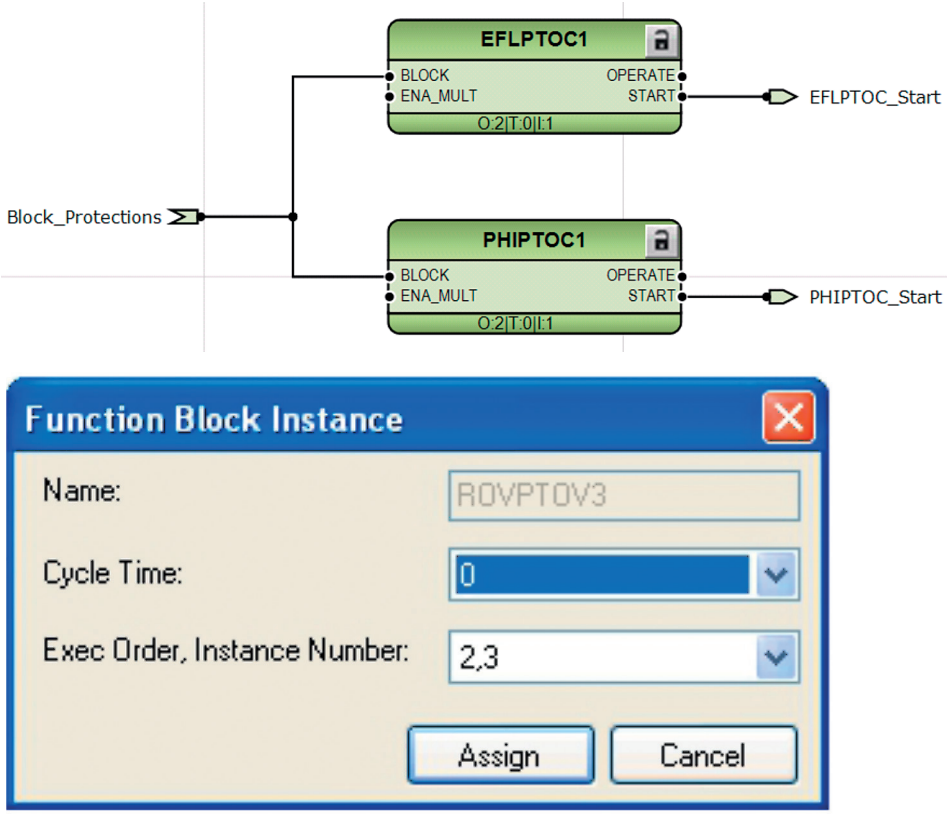


Figure 33: Application Configuration tool: an example of function block

For eVD4 the **Cycle Time** is always equal to 0 since the correct cycle time is automatically selected according to the frequency of the network IED is connected to.

To automatically calculate the execution order, click **Calculate Execution Order** on the tool bar.

5.1.4 Execution order and feedback loops

With the Application Configuration tool it is possible to draw multi-layer configuration logic that contains feedback loops. The execution order of logic functions is calculated automatically in the Application Configuration tool, but the execution order can be set manually also. If the automatically calculated value causes the function to be executed one task cycle time after the other logic functions in the same loop, the execution order number can be set manually to prevent delays, for example, in output activation.

The following example shows a simple situation where the execution order causes one cycle time delay if the NOT port is executed in the order determined by the automatic calculation.

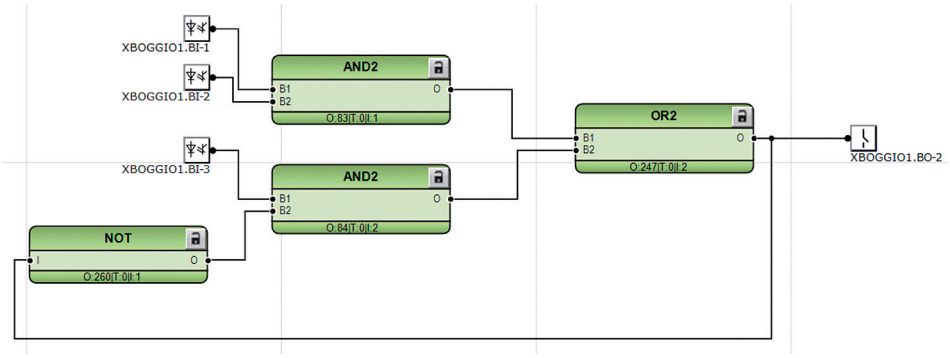


Figure 34: Feedback loop situation with automatically calculated execution orders

To change the execution order, right-click the function block and select **Change Cycle Time ExecOrder**. When the window opens, set the desired value.

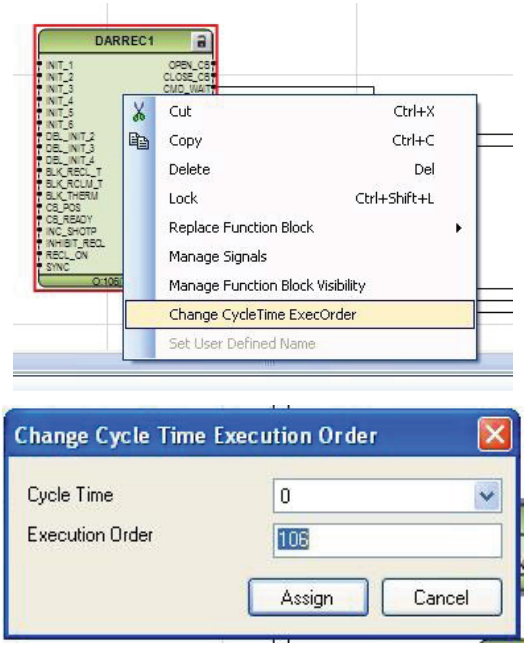


Figure 35: Changing the default execution order

By setting a smaller execution number than in the AND port to where the NOT port is connected, it is possible to fix the execution order of all functions in a loop so that they are handled in the same task.

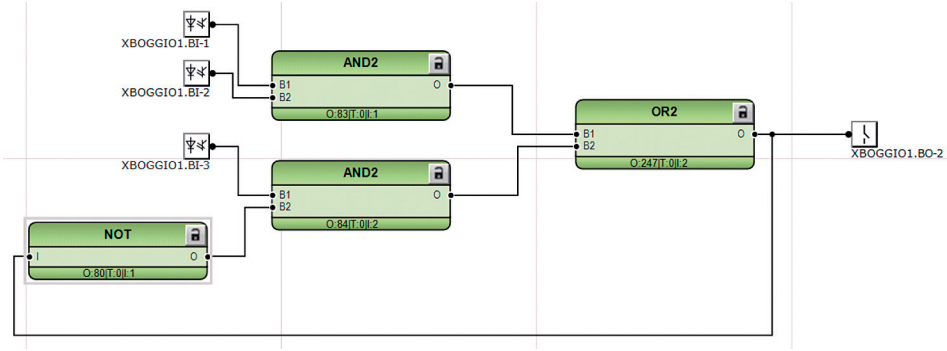


Figure 36: Feedback loop situation with manually fixed execution order for NOT port

Once the execution order has been manually changed, the system will disable the automatic calculation of the execution order for that logic function. To restore it right click on the block and select the "**Include FB in calculation**" option.

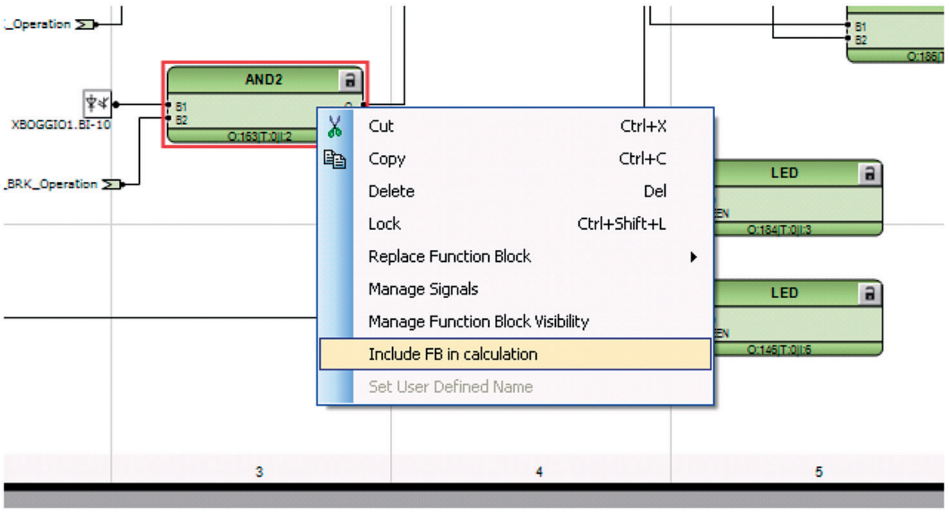


Figure 37: Restoring the automatic execution order calculation for a function block

5.1.5 Configuration parameters

Configuration parameters can be viewed and set with the Parameter Setting tool.

5.1.6 Connections and variables

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

There are rules and methods for making connections.

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

5.1.7 Hardware channels

Hardware channels can only be connected to a function block input or output. A hardware connection can be established with the Application Configuration tool or Signal Matrix tool.

When a hardware channel is connected, a graphical symbol appears in the Application Configuration tool. The connection is also displayed in the Signal Matrix tool with a cross mark. Hardware channels are always visible in the Signal Matrix tool.

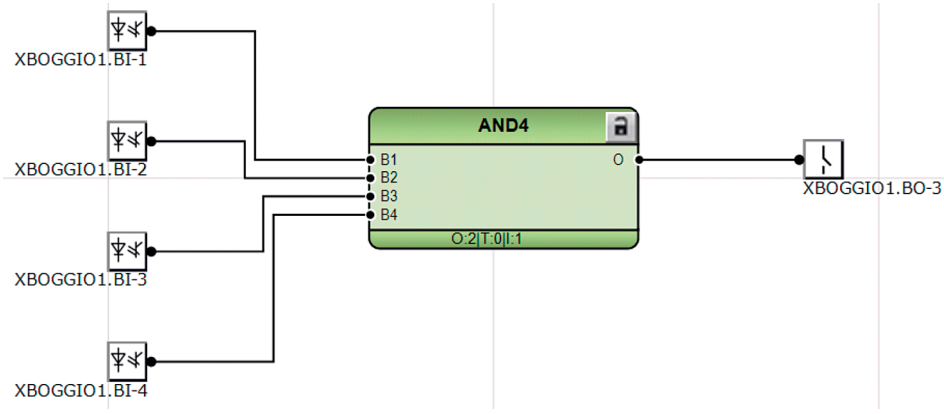


Figure 38: Application Configuration tool: HW signal channels

There are three types of supported hardware channels.

- Binary input channels
- Binary output channels

Hardware input channel can be used as often as needed. A hardware binary output channel is taken from the list of available channels when a new channel is requested. This prevents using the same hardware binary output channel twice.

5.1.8 Validation

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

- During the logic creation, while making a connection or placing a function block
- On demand by starting the validation
- When writing the application configuration to the IED

5.1.8.1 Validation when creating an application configuration

Validation is made when creating the application configuration preventing the user from making a connection between two input or two output signals.

5.1.8.2 Validation on demand

The validity of an application configuration can be checked by clicking **Validate Configuration** in the toolbar. The Application Configuration tool checks the application configuration for formal correctness. The found problems are divided into warnings and errors.

- Warnings, marked with a yellow warning icon

- Example: a variable connected to an output signal that is not connected
- Example: if the user connects an output from a higher execution order function to inputs of lower execution order function

- Errors, marked with a red circle with a cross
  - Example: unconnected hardware output

Warnings do not prevent writing to the IED. However, errors must be corrected before writing the application configuration to the IED. The application configuration can be saved and the Application Configuration tool can be closed with open errors, but not written to the IED.

These problems are listed in the **Output** view under the **Application Configuration** tab. Double-clicking the error or warning row navigates to the **MainApplication/ Page/ Area**, where the problems are identified.

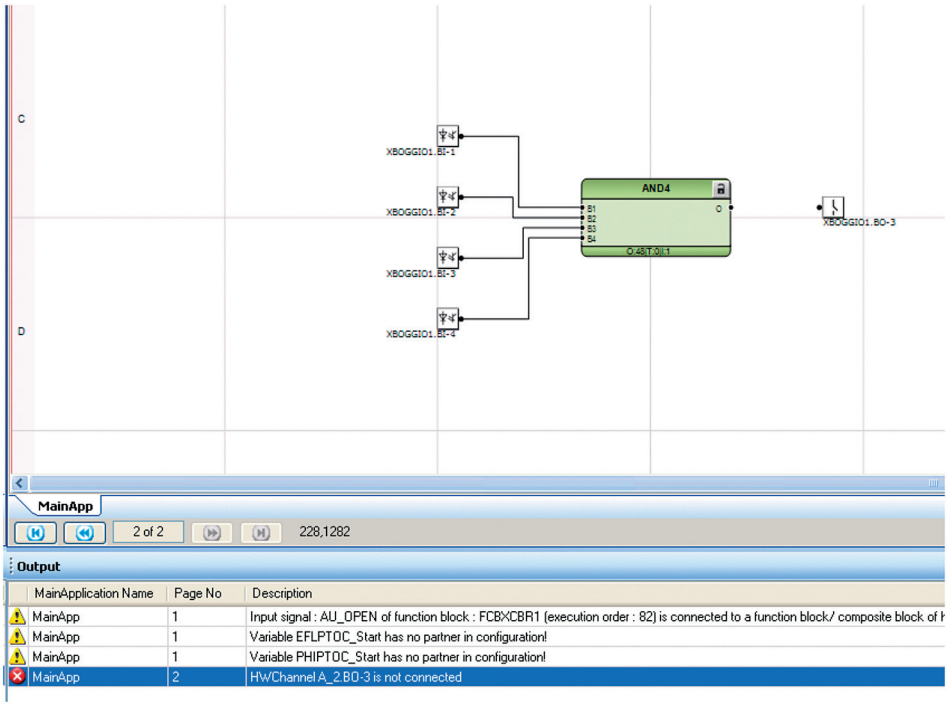


Figure 39: Application Configuration tool: validation on demand

5.1.8.3 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 abort the writing.

5.2 Parameter Setting tool

Configuration parameters and settings parameters can be changed with LHMI, WHMI or with the Parameter Setting tool in PCM600.

Some parameters are only visible in the Parameter Setting tool and some only in LHMI.

A common writing from PCM600 to the IED, where parameters are changed in the Parameter Setting tool, overwrites any parameter changes made locally with LHMI.

All variables listed and displayed in the parameter list can be sorted into two groups.

- Configuration parameters
- Setting parameters

5.2.1 Configuration parameter

Configuration parameter specifies the operation mode of an application function or of the IED. These are basic configurations that are normally configured only once and then settled. The IED configures itself during startup according to the given configuration parameter values.

5.2.2 Setting parameter

Setting parameter (short form: “setting”) is a parameter that can be changed in the IED at runtime.

5.2.3 Setting group

Nearly all settings used by the IED for protection application functions are organized into 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.

5.2.4 IED parameter organization

The organization of parameters into a tree structure becomes visible in the **Plant Structure** by expanding the setting tree.

5.3 Signal Matrix tool

The Signal Matrix tool is used to make cross-references between the physical I/O signals and function blocks and for the GOOSE signal input engineering.

The Signal Matrix tool cannot be used for adding or removing function blocks, for example, GOOSE receive function blocks. The Application Configuration tool is used for this kind of operations.

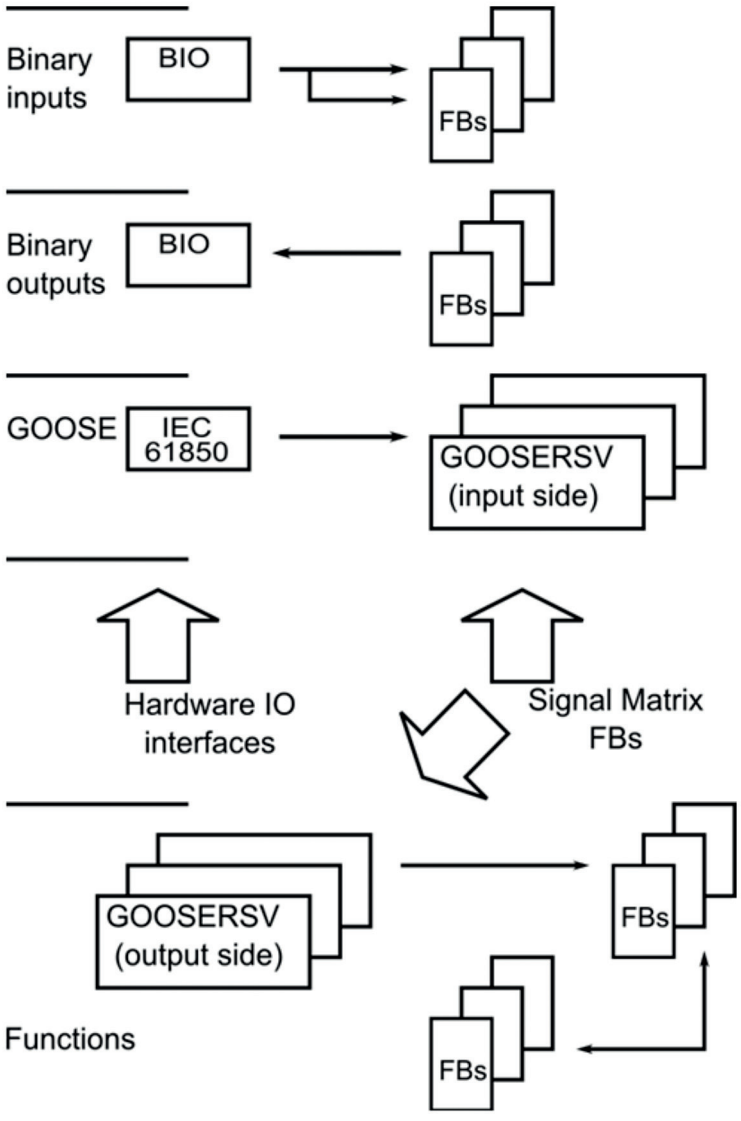


Figure 40: Signal Matrix tool: operation principles

A binary input channel can be connected to one or several function block inputs.

A binary output channel can only be activated from one function block output.

Connections made with the Signal Matrix tool are automatically also shown in the Application Configuration tool.

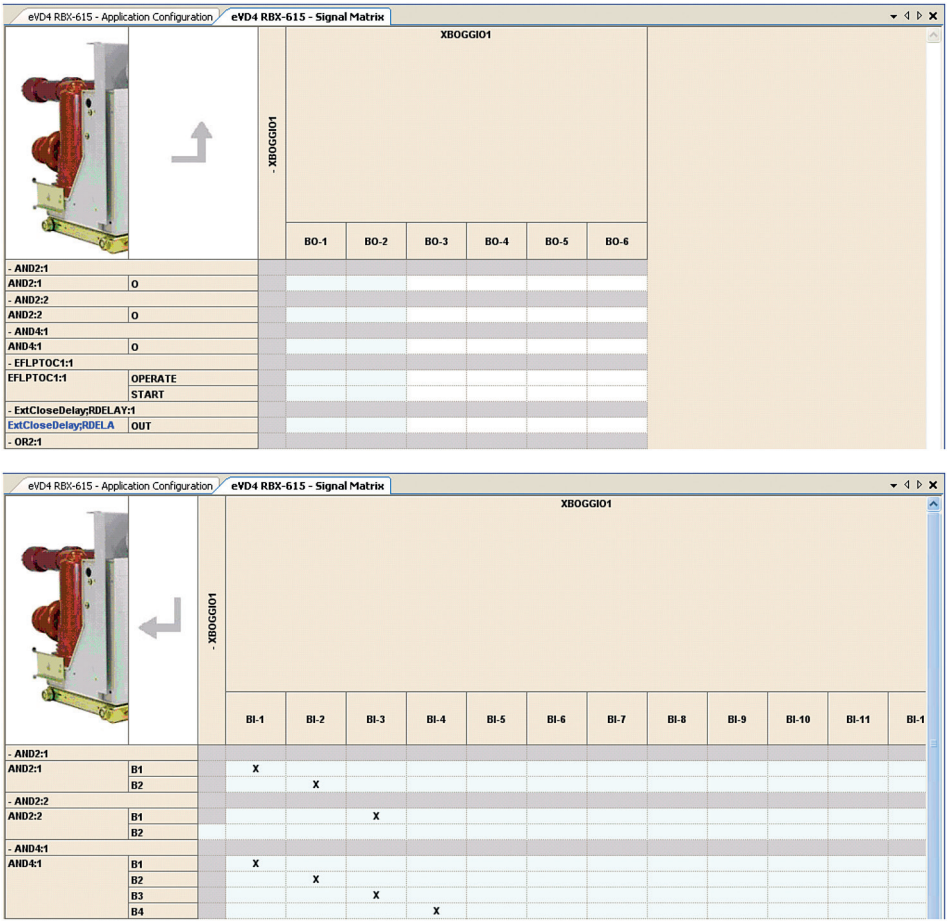


Figure 41: Signal Matrix tool: a connection between binary input channels to binary input signals

Depending on the IED capability, the Signal Matrix tool has a separate sheet for each possible combination.

The possible sheets are:

- Binary inputs
- Binary outputs
- GOOSE

Section 6 LHMI engineering

For information on LED operation modes supported by 615 series, see technical manual.

6.1 Single-line diagram engineering

A single-line diagram of the IED can be designed by using the Graphical Display Editor tool of PCM600. The single-line diagram is modelled according to the IEC61850 standard in the Graphical Display Editor.

6.1.1 Diagrams in Graphical Display Editor

The Graphical Display Editor is used for various tasks.

- HMI display raster layouts
- Adding static text
- Adding measurands
- Adding busbars
- Adding symbols onto display page
- Drawing lines (creating a link)

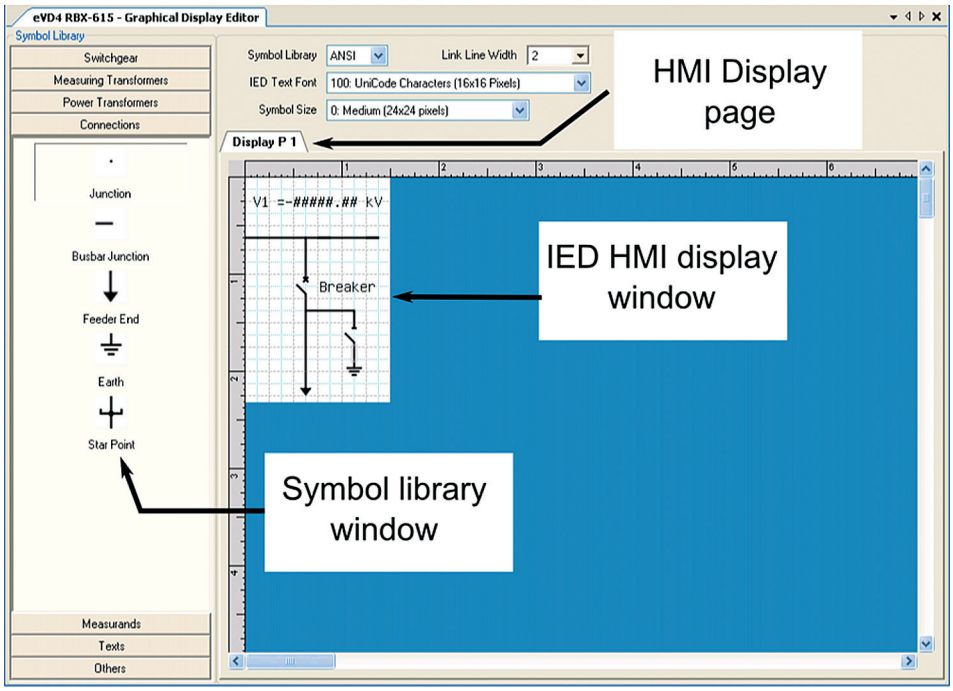


Figure 42: Graphical Display Editor: an active view

The Graphical Display Editor has a fixed symbol library window on the left side of the view. The presentation is empty when no page exists for the IED. A default single-line diagram presentation is displayed if standard configurations are used.

6.1.1.1 Display window and sequence order

Writing display configuration to IED shows all symbols in the IED's single-line diagram view.

There are rules for handling the HMI pages.

- IED supports one bay with one single-line diagram.
- Measurements and the single-line diagram can be displayed on the page in any possible order and placement.
- All symbol objects, for example apparatus 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.

6.1.1.2 Symbol library

The **Symbol Library** view contains panes that include drawing symbols or elements for creating a single-line diagram, measurements and texts onto a page. Panes can be opened by clicking the name bar of the selected element.

The library shows the symbols either in the ANSI standard or IEC standard. The standard is selected from the list located on top of the window.

When changing to another library standard, Graphical Display Editor changes the symbols according to the selected new standard and redraws the single-line diagram in the window.

To change the symbol format used in the IED, select **Main menu/ Configuration/HMI/SLD symbol format** and choose IEC or ANSI.

To become familiar with the available symbols, select the different panes and their symbols.

6.1.1.3 Supported single-line diagram symbols

Table 3: Single-line diagram symbols

Description	IEC representation	ANSI representation
Isolator — Intermediate position		
Isolator – Open position		
Isolator – Closed position		
Isolator – Bad (faulty) position		
Isolator motor operated – Intermediate position		
Isolator motor operated – Open position		
Isolator motor operated – Closed position		
Isolator motor operated – Bad (faulty) position		
Circuit breaker – Intermediate position		
Circuit breaker – Open position		
Circuit breaker – Closed position		

Table continues on next page

Description	IEC representation	ANSI representation
Circuit breaker – Bad (faulty) position		
Truck – Intermediate position		
Truck – Open position		
Truck – Closed position		
Truck – Bad (faulty) position		
Current transformer		
Voltage transformer		
Power transformer (2 windings)		
Power transformer (3 windings)		
Autotransformer		
Feeder end		
Earth symbol		
Star Point		
Capacitor		
Surge arrestor		
Reactor		
Motor		
Table continues on next page		

Description	IEC representation	ANSI representation
Generator		
Coil		
Fuse		
Resistor		
Fieldwinding		
Rectifier		
Earthing transformer		

6.1.1.4 HMI display raster layout and text font selection

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

The text can be presented in UniCode characters (8 x 16 pixel and 16 x 16). The total size of the presented white area (page) represents the visible part of the LHMI display without the header line.

The visible display for a single-line diagram is organized in a raster of 12 x 18 (columns x rows). Each symbol (presented in 24 x 24 pixels) included in the drag-and-drop method must be dropped into a raster box.

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 without the assistance of **Snap to Grid** and manually change the position coordinates.

6.1.1.5 Text handling

The raster switches when text is selected in a raster of 9 x 14 (columns x rows). 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 by double-clicking the symbol or via the **Object Properties** view.

6.1.1.6 Adding static text

1. Place a **Static Text** object into a raster box by dragging-and-dropping.

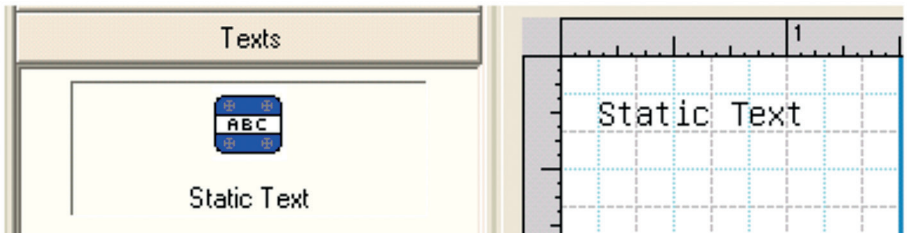


Figure 43: Adding a static text field into a LHMI view

2. Edit the text in the **Name** field in the **Object Properties** view, or alternatively double-click the text to edit it.

6.1.1.7 Adding a measurand

1. Place a **Measurand** object into a raster box by dragging-and-dropping.

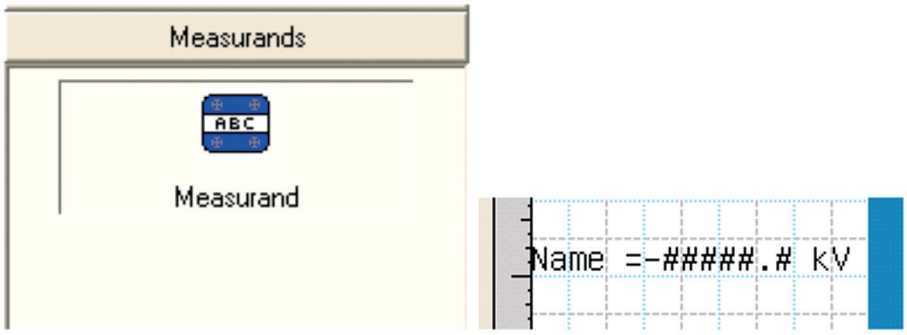


Figure 44: Adding a measurand object to an LHMI view

2. In the **Objects Properties** view, edit the name, unit and the number of decimals. **Unit text** specifies the default text used for the measurement's unit. If **Unit text** is not empty, the unit in the IED is updated dynamically and the unit from the Graphical Display Editor is used by default. If the **Unit text** is empty in the Graphical Display Editor, no unit is shown. The *Scale factor* parameter is not used.

6.1.1.8 Adding symbols into a display page

1. Prepare the body of the single-line diagram by locating symbols to the wanted positions on the display.
2. Place the apparatus or transformer symbols into a raster box by dragging-and-dropping.
3. Place the connection symbols into a raster box by dragging-and-dropping.
4. Place the junction points when a bended connection is needed
5. Use the coordinates in the **Object Properties** windows for adjusting the placement.

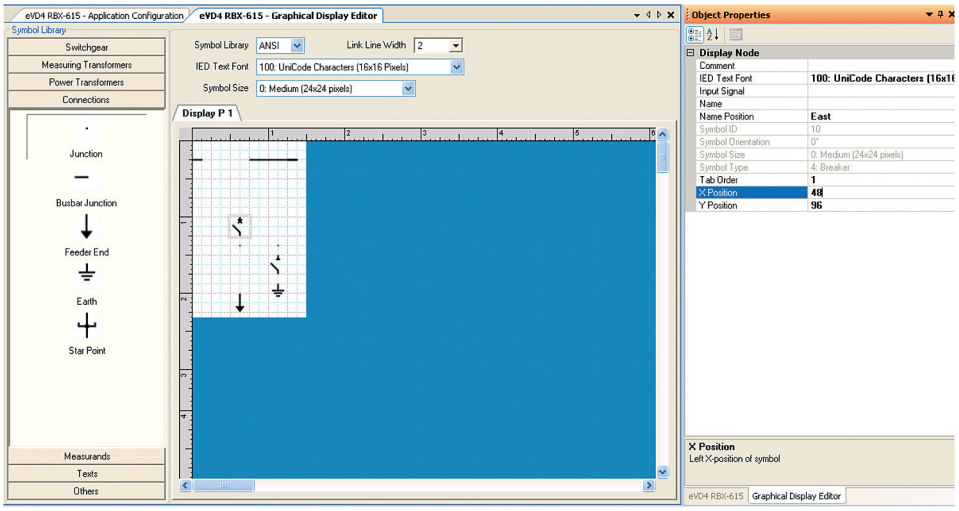


Figure 45: Graphical Display Editor: adding single-line diagram symbols into display page

6.1.1.9 Drawing lines to create links

After the apparatus symbols are placed, lines can be drawn to create links.

1. Click **Link** to enable direct line drawing.
2. To draw a line, center the mouse pointer on the center of the connection point (visible in two circles at the end points of a line).
3. Click to start and move the mouse pointer to the destination connection point.
4. Center the mouse pointer once again and click to drop the line.

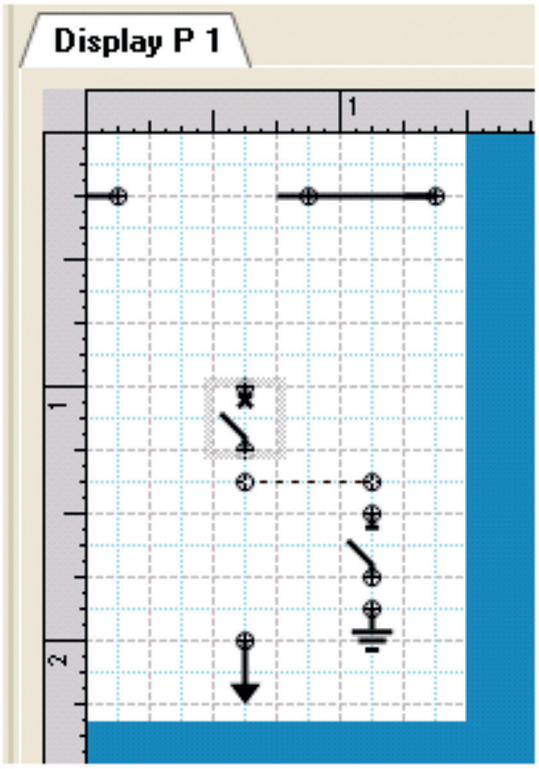


Figure 46: Graphical Display Editor: drawing a line between symbols

5. Draw all line elements that are necessary.
6. To finish the line drawing, click **Select** on the menu bar.

6.1.2 Bay configuration engineering

A view 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.

6.1.2.1 Creating a complete HMI display page

1. Make a sketch of 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 **Junction points** where needed.
4. Link the apparatus symbols with line elements.
5. In the **Object Properties** view, adjust the text symbols while writing to north, east, south or west.

6. Place measurements when needed.
7. Edit the name, unit and the number of the measurements' decimals.
8. Select each object that has a dynamic link and make the link to the corresponding process object.
9. Check that you have selected the correct function block.
   Function blocks of the same type can have different instance numbers.

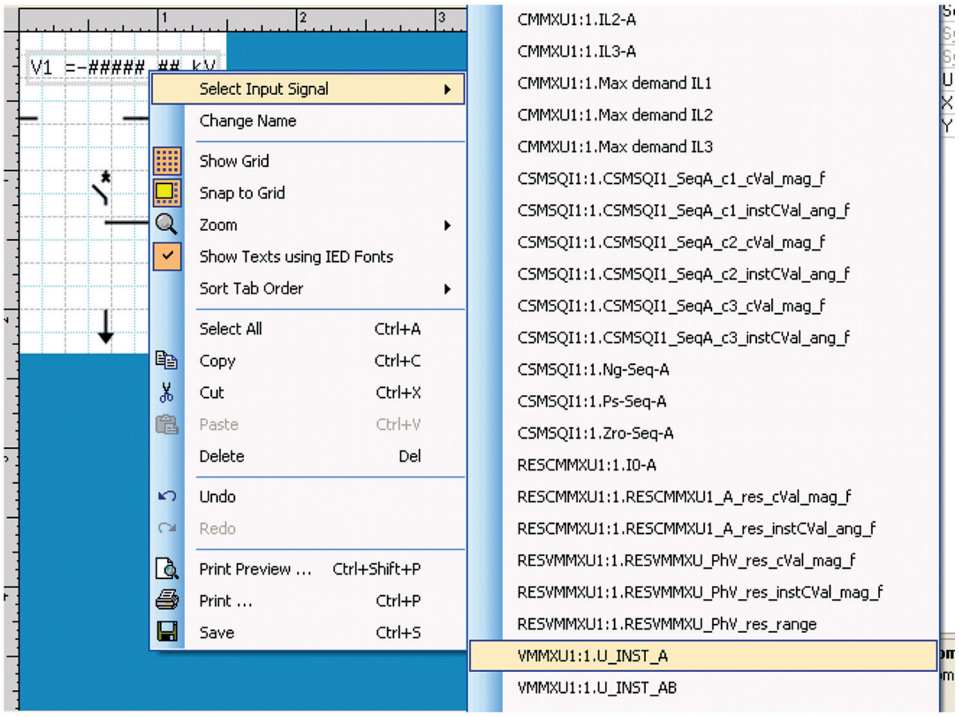


Figure 47: Graphical Display Editor: establishing a dynamic object link

10. Ensure that all links are done.
11. Save the complete picture.
12. Write to the IED.
13. Validate the single-line diagram on the IED.

6.1.2.2 Linking process objects

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

Three tools are involved in the described steps.

- Application Configuration tool for programming the application function block for the apparatus and/or measurements
- Parameter Setting tool for adapting the settings and/or configuration parameters of the application function block
- Graphical Display Editor for establishing the link to update 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

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

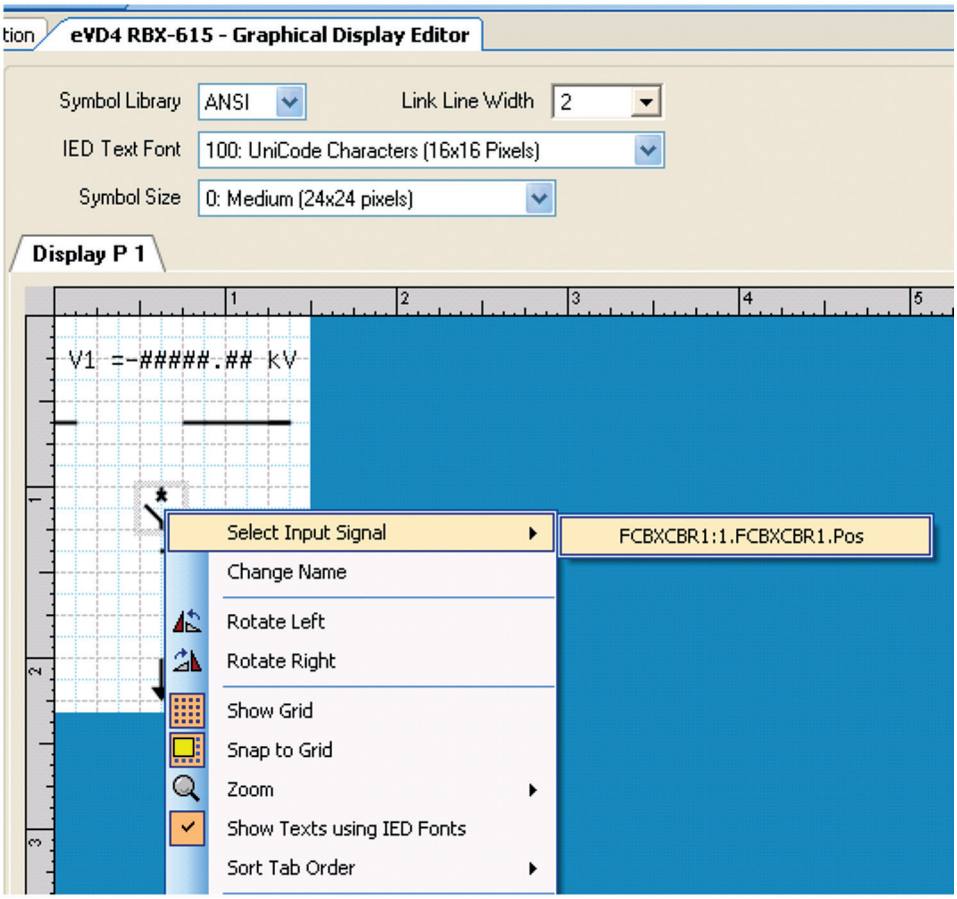


Figure 48: Graphical Display Editor: input signal selection

The ordering number in the selection window of the process objects corresponds to the number given in the Parameter Setting tool tree and to the application function block in the Application Configuration tool.
Only the apparatus and measurements that are configured in the application configuration program are displayed.

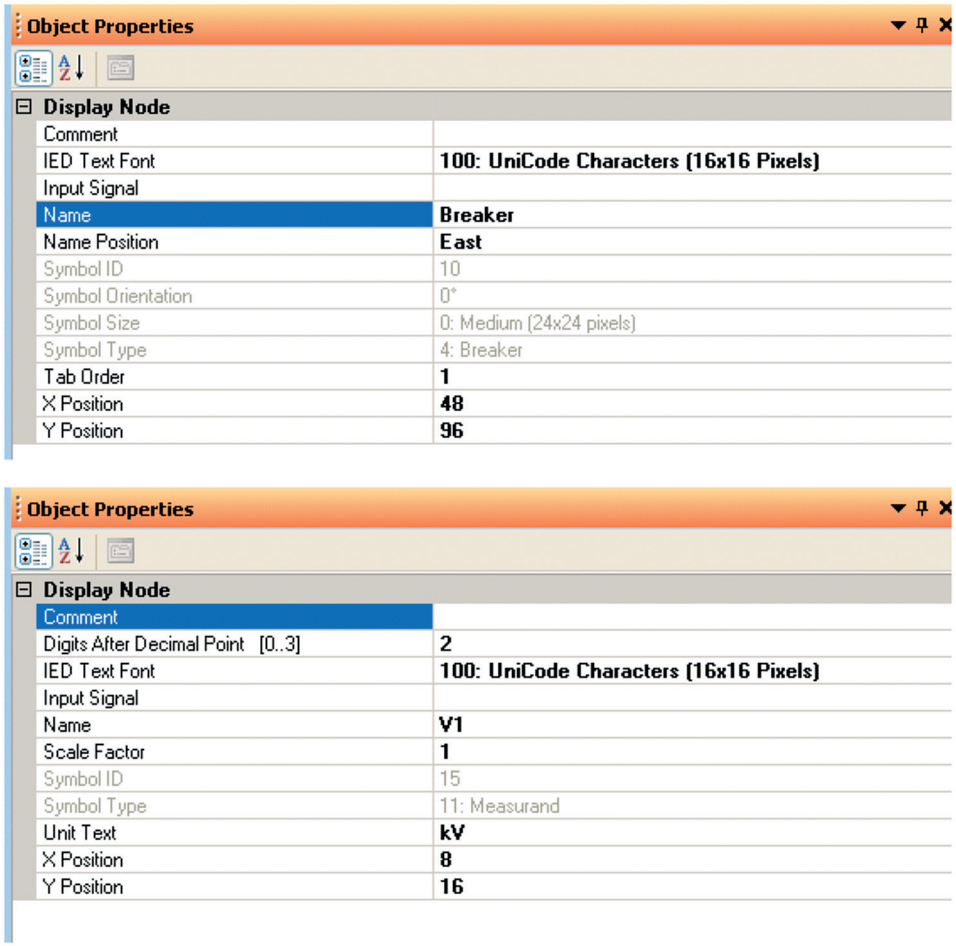


Figure 49: Graphical Display Editor: object properties view for text insertion

Section 7 IEC 61850 communication engineering

7.1 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 the function blocks defined as logical nodes
- The IEC 61850 engineering guide
- The IEC 61850 conformance documents for the IED to be engineered
- The IEC 61850 parameter list

7.2 IEC 61850 interface

For more information on the implementation of IEC 61850 in IEDs, see IEC 61850 engineering guide and conformance documents.

7.2.1 IEC 61850 interface in the IED

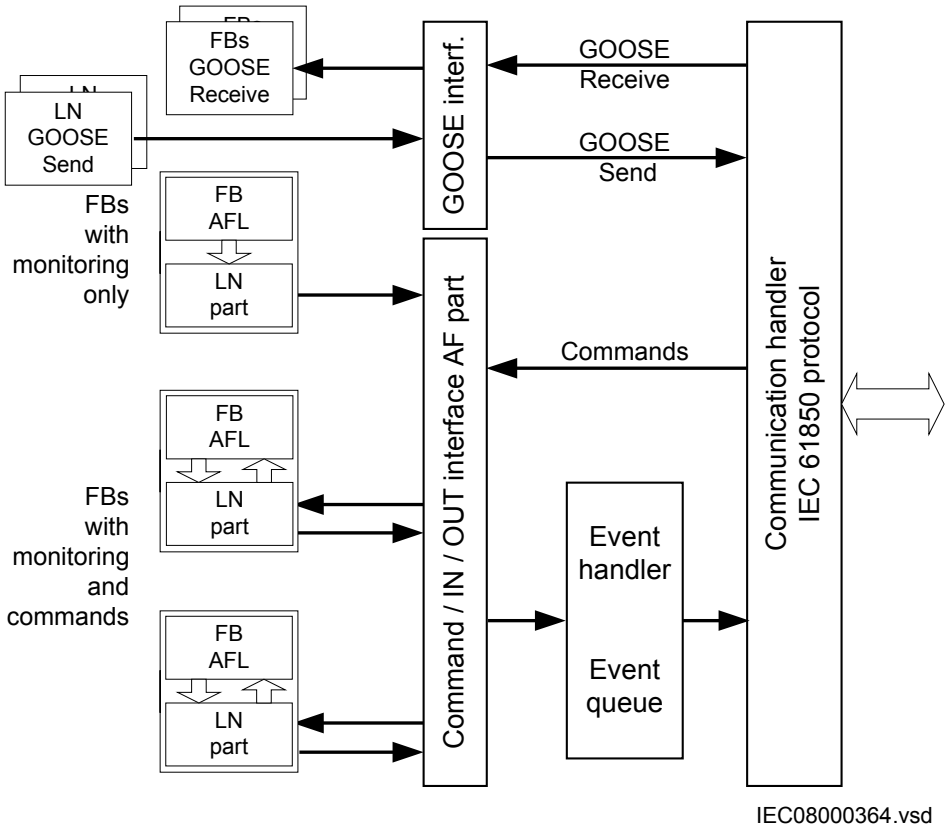


Figure 50: IEC 61850: communication interface principle

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

Whenever a function block is instantiated in the Application Configuration tool, PCM600 automatically generates the corresponding logical node data. In the figure above this is shown by two parts per function block. The upper part is the visible function block in the Application Configuration tool and the lower part is the logical node data for the function block.

7.2.1.1 GOOSE data exchange

The IEC 61850 protocol supports a method to directly exchange data between two or more IEDs. This method is described in the IEC 61850–7–2 clause 15.

The concept is based on sending a multicast over the Ethernet. Whoever needs the information, detects the telegram by its source address, reads the telegram and deals with it. The telegrams are multicast sent and not acknowledged by the receiver.

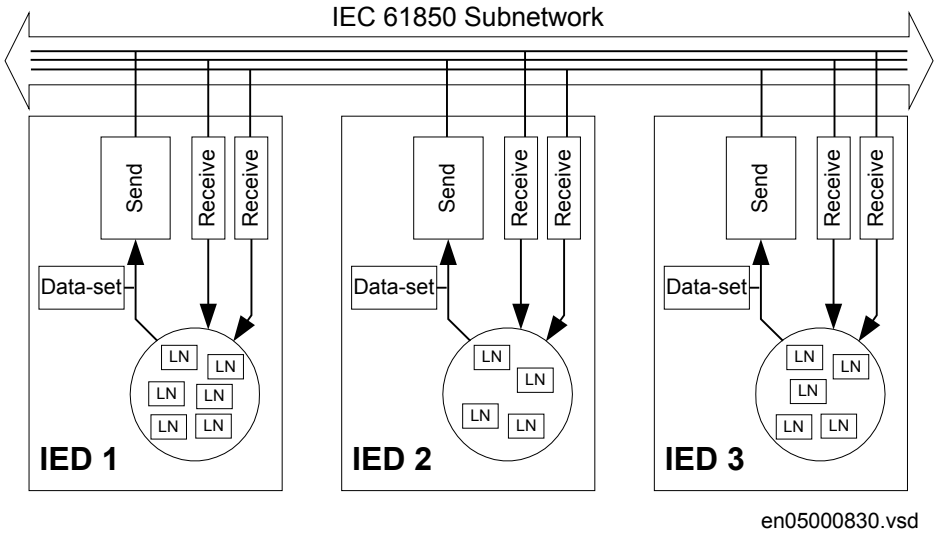


Figure 51: IEC 61850: horizontal communication principle, an example of three IEDs where each IED communicate with all others

When a GOOSE message is to be sent, it is defined by configuring the data set with the defined trigger option and GoCB. This engineering process is done in a station configuration tool, for example, CCT600. The task involves configuring lists with the signal, value and quality (data attributes) that belong to the GOOSE message data set.

In the opposite direction, the standard only defines the IED as a receiver of a GOOSE message. How the GOOSE input signals are handled must be defined in the IED application configuration. The SCD file generated by CCT600 (or any other station configuration tool) contains the GOOSE data sets as input data. The input data must be connected to the function block inputs in the Signal Matrix tool.

7.2.2 Function view for IEC 61850 in PCM600

The IED design is directly based on IEC 61850. Thus, the function blocks in PCM600 tool use IEC 61850 logical node naming for function blocks. This relation is automatically handled by the PCM600 tools.

The concept in the IED is such that the 61850 data for each function instance is available in the data model, even when the function is not used in the application. This means that it is not necessary to handle any instance information for the functions regarding IEC 61850.

7.2.3 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 the 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, for example, the communication configuration is included.
- An IED is already extended by default data sets and report control blocks. They are predefined by ABB. Changes or additional data sets, for example, have to be done with CCT600.

- SCD = Station configuration description
  - A complete configuration description of all IEDs in a station and the full engineering of process signals and communication structure is included. This includes all the needed data sets and control blocks.
- CID = configured IED description
  - The CID file contains the information needed for configuring one specific IED. The CID file contains the complete configuration description of one specific IED. This includes the configured IED name, communication part, data sets and all control blocks.

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

7.3 IEC 61850 engineering process

The IEC 61850 standard defines the complete part needed for information communication in a substation. The information communication can be divided into different 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

When exporting a SCL file from PCM600, the tool builds a default substation structure and creates default data sets and control blocks for vertical communication between the substation client and IEDs. For more information, see the IEC 61850 standards.

In the following example, it is assumed that PCM600 and CCT600 are used as the system configuration tools.

1. SCL files are exported from PCM600. In this case, a SCD file. It is also possible to export other SCL file types.
2. Horizontal and vertical communication is configured using the station configuration tool, for example, CCT600.
3. SCL files are imported to a PCM600 project. In this case, it is the updated SCD file.

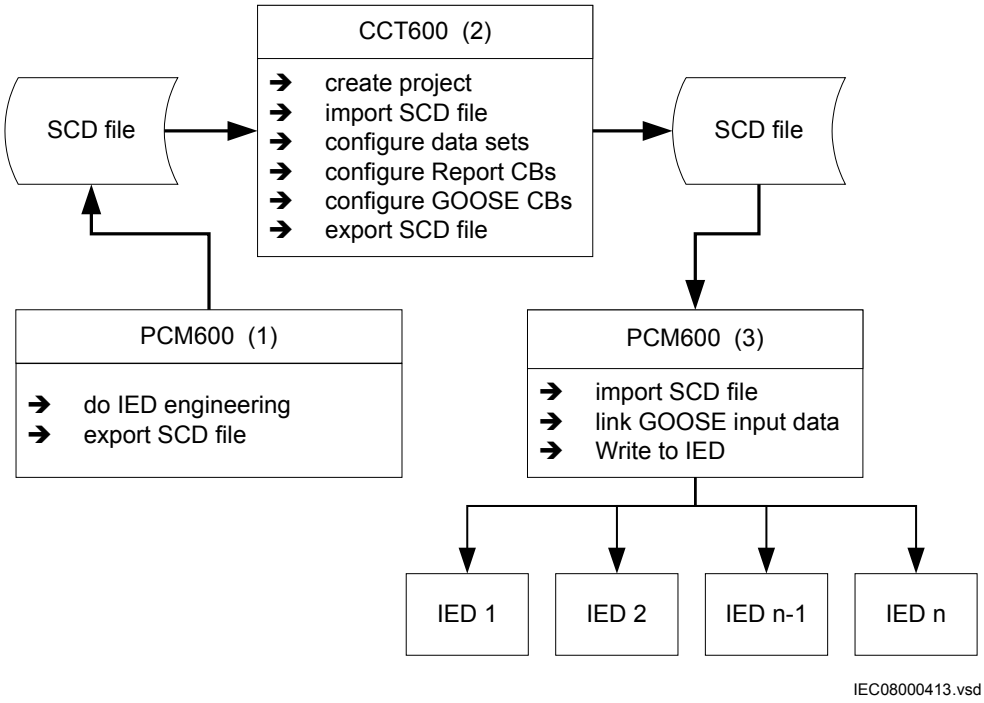


Figure 52: IEC 61850: signal engineering procedure flow when a complete station is exported as a SCD file

7.3.1 Exporting SCL files from PCM600

A pre-condition for exporting SCL files from PCM600 is that all IEDs in the project must be engineered in PCM600. The IEDs require unique name and IP addresses and they must be set according to the project definitions. IED configurations must be finalized as far as possible before starting the IEC 61850 configuration part.

7.3.1.1 Exporting SCD files

1. Select the station in the **Plant Structure** view.

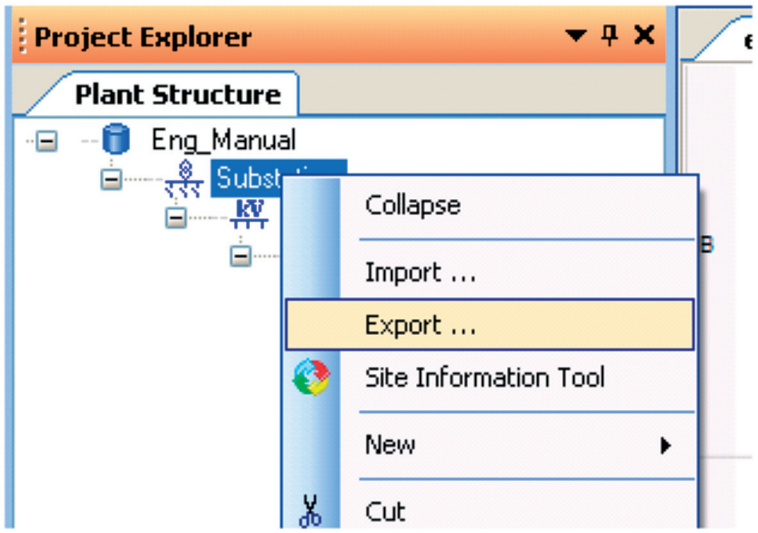


Figure 53: IEC 61850: selecting the station

2. Right-click the station and select **Export**.
3. From the open standard Windows dialog box, select the location to store the file and name it.
4. Click **Save**.
   The **SCL Export Options** dialog box opens.

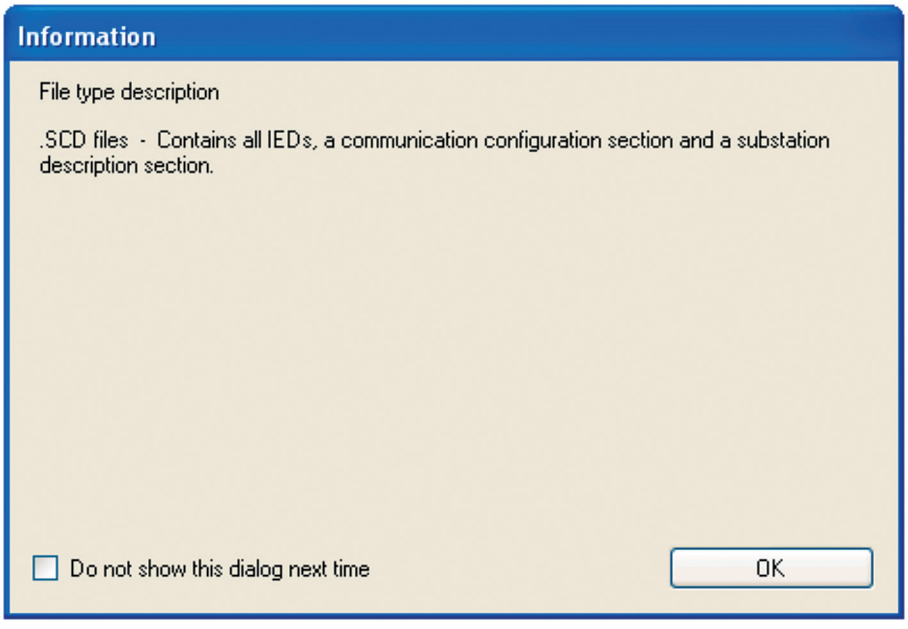


Figure 54: The export dialog box

5. Click **OK** to export the project to the SCD file. A progress window shows the ongoing export of the station.

7.3.1.2 Exporting ICD or CID files

1. Select the IED in the **Plant Structure** view.
2. Right-click the IED and select **Export...**
   The **Export** dialog box opens.
3. From the **Save as type** list, select the type of file to export.
   - 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

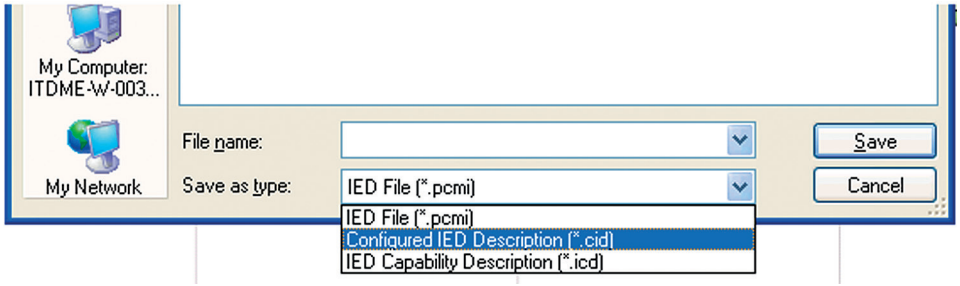


Figure 55: IEC 61850: export IED file type selection

4. Click **Save**.
   The **SCL Export Options** dialog box opens.
5. Select the exportation method.
   - **Export Private Sections**
   - **Export As SCL Template**
   - **Include Goose Sending IEDs**

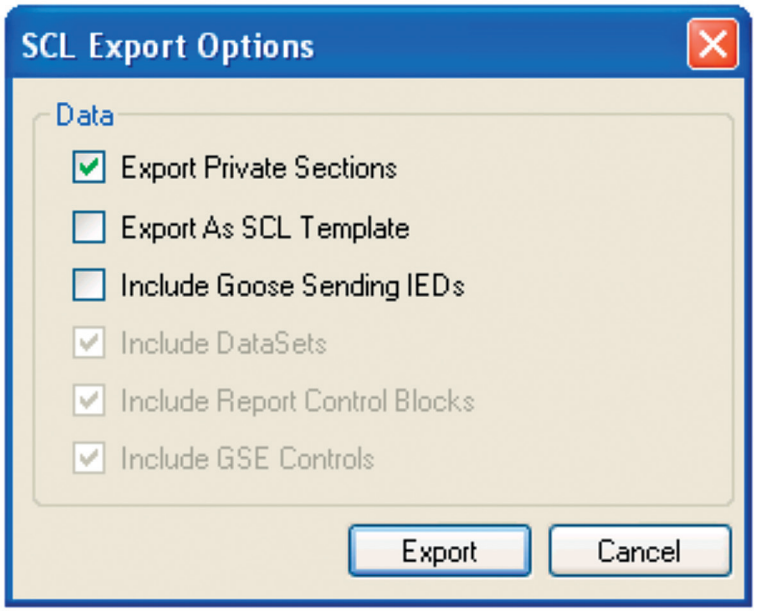


Figure 56: IEC 61850: export IED file options

6. Click **Export**.

7.3.2 Engineering vertical and horizontal communication in CCT600

1. Create a project in CCT600.
2. On the menu, select **Tools/ SCL Import/Export/ Import SCL File** to import the SCD file created by PCM600.

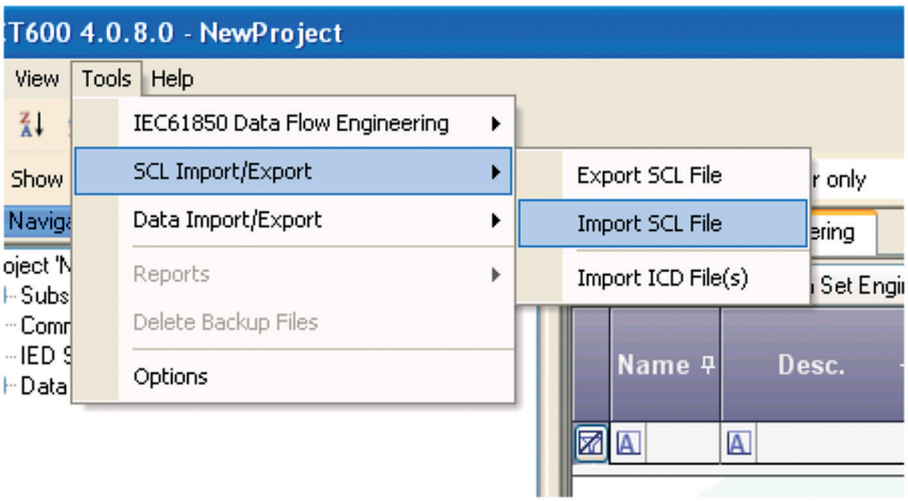


Figure 57: CCT600: importing an SCL file

3. Conduct vertical communication engineering (monitoring direction).

3.1. Check the default data sets.

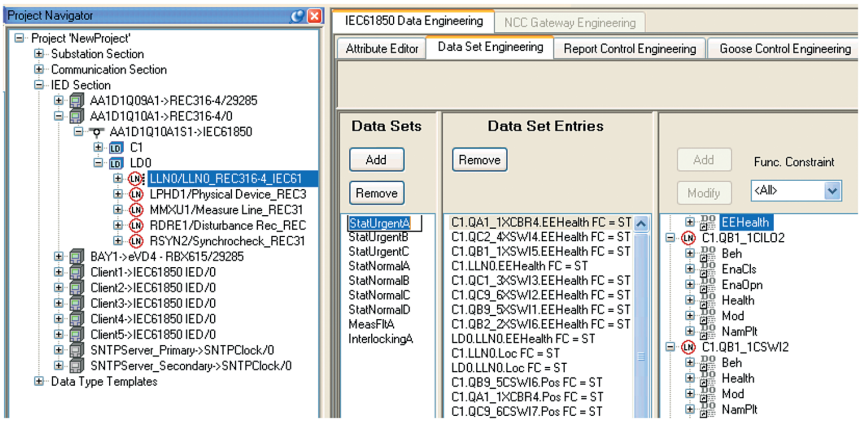


Figure 58: CCT600 data set default content

3.2. Configure and/or re-configure the default data sets.

Reporting data sets can 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.

3.3. Configure additional **Report Control Blocks** when needed for each data set used for vertical communication.

Up to five report clients can be configured.

3.4. Link the IED clients to the **Report Control Blocks**.

4. Conduct horizontal communication engineering.

4.1. Configure GOOSE control blocks for each data set configured for GOOSE messages.

One data must be included only once in the GOOSE data set.

4.2. Define the client IEDs for each GOOSE control block.

4.3. Link the IEDs to the GOOSE control block that is to receive the GOOSE control block.

5. Update the data flow.

6. Export the updated SCD file.

All data sets, **Report Control Blocks** and GOOSE control blocks must be located in LLN0.

7.3.3 Importing SCL files to PCM600

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

7.3.3.1 Importing SCD files

1. Select the station in the **Plant Structure** view.
2. Right-click the station and select **Import**.
3. From the open standard Windows menu, select the file to be imported and start the reading.
   The **SCL Import Options** dialog box opens, quering how the file should be handled during the import.

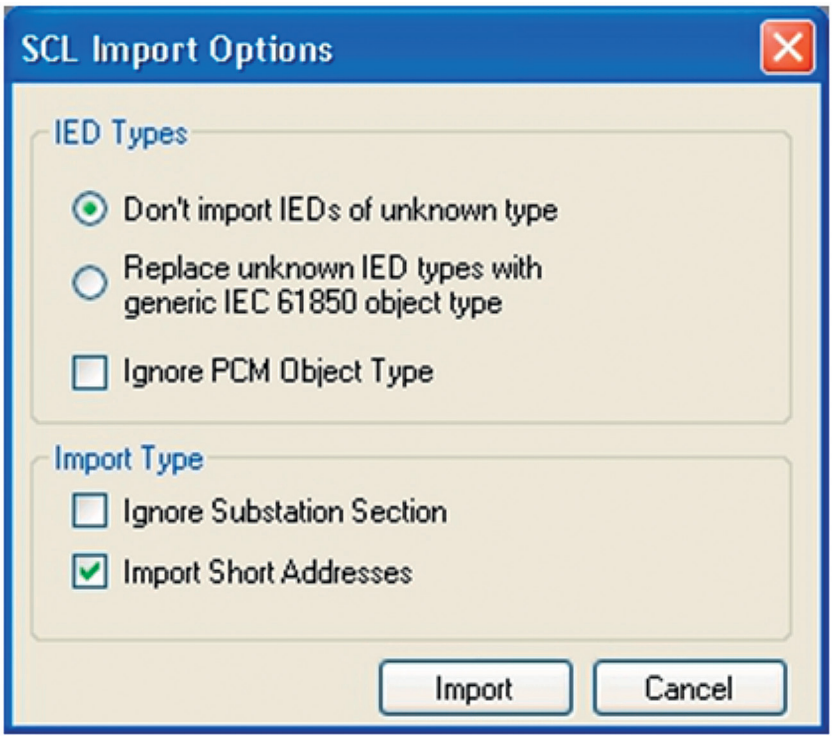


Figure 59: IEC 61850: importing a SCD file

4. In the **SCL Import Options** dialog box, select how to handle the file during the import.

- 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.
- Click **Replace unknown** if 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 into the plant structure, for example.
- Click **Ignore PCM Object Type** to update the IED object(s) in PCM600 from the IED type(s) in the SCD file, whether or not the IED type(s) in the SCD file matches the IED object(s) in PM600.
- Click **Ignore Substation Section** to not import the SSD file part of the SCD file.

5. Click **Import** when the file definition has been completed.
   A progress view displays the importing procedure.
6. Make connections from the sending IEDs to the receiving function blocks with the Signal Matrix tool.
   Make connections between the signals that the server is sending and the function blocks on the receiver's side.
7. Write the configuration to the IED.
   In the **Plant Structure** view, select the IED, right-click and select **Write to IED**.

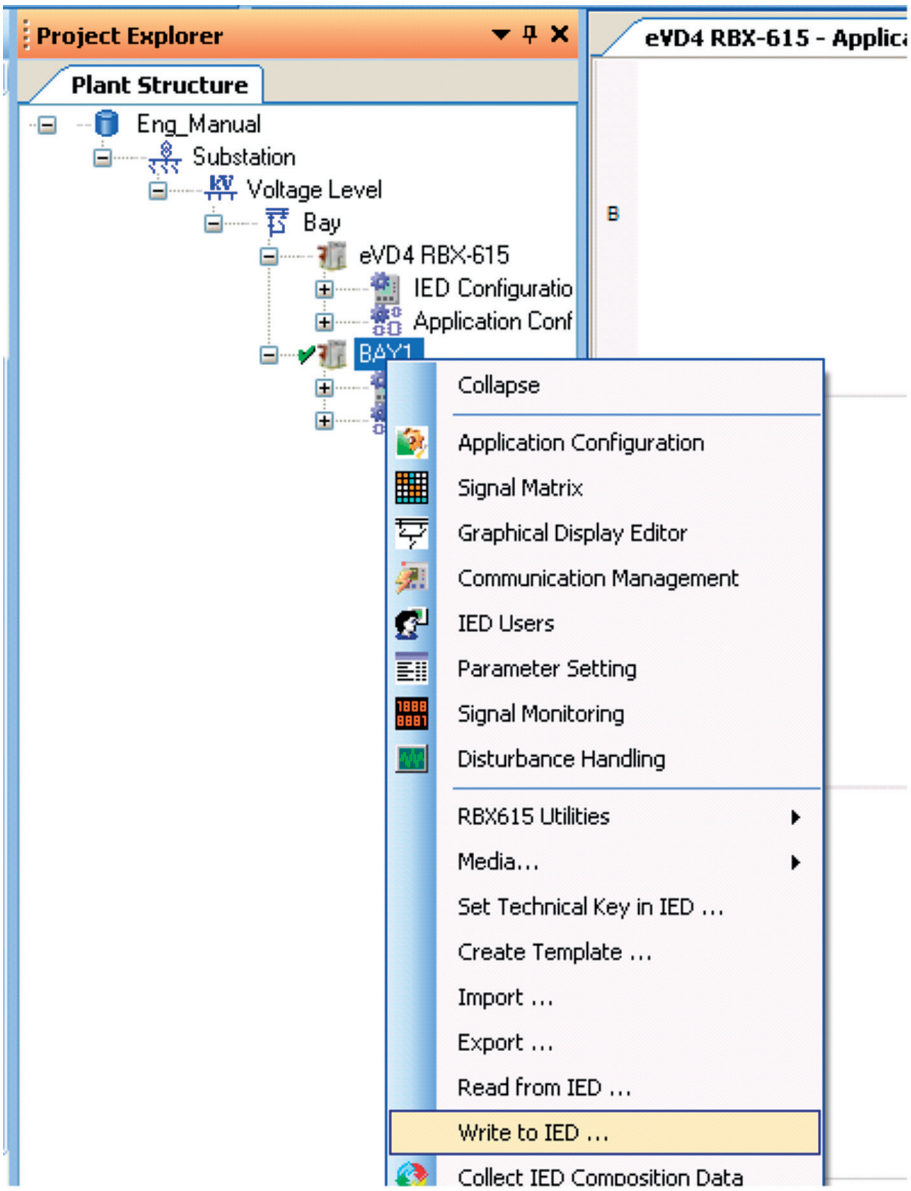


Figure 60: Common write menu

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

7.3.3.2 Importing ICD or CID files

1. Select an existing IED to import IEC 61850 files.
2. From the **Files of type** list, select the file type of IEC 61850 to be imported (ICD or CID).

The **SCL Import Option** dialog box opens.

3. In the **SCL Import Option** dialog box, select how the file is to be handled during the import.

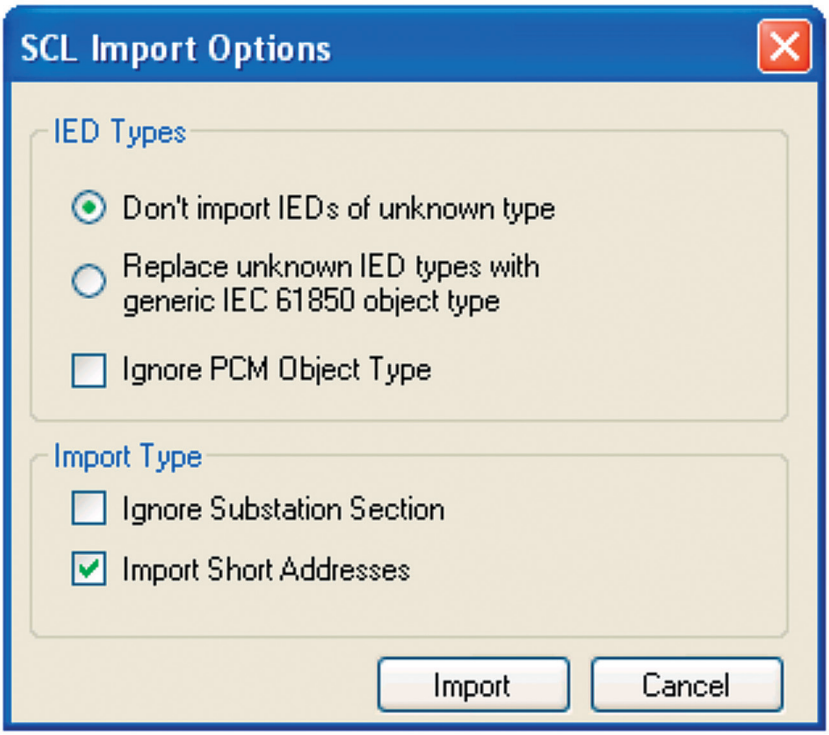


Figure 61: IEC 61850: SCL import options

- **Don't import** protects the existing IEDs in case the SCD file does not match the original configuration in PCM600.
- **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 into, for example, the plant structure.
- **Ignore PCM Object Type** updates the IED object(s) in PCM600 from the IED type(s) in the SCD file, discarding whether or not the IED type(s) in the SCD file matches the IED object(s) in PM600.
- **Ignore Substation Section** does not import the SSD file part of the SCD file.

4. Click **Import** when the definition has been completed.
A progress view displays the importing procedure.

Section 8 Glossary

615 series	Series of numerical IEDs for low-end protection and supervision applications of utility substations, and industrial switchgear and equipment
ACT	Application Configuration tool in PCM600; Trip status
ANSI	American National Standards Institute
CCT600	Communication Configuration tool in PCM600
CID	Configured IED description
CMT	Communication Management tool in PCM600
COMTRADE	Common format for transient data exchange for power systems. Defined by the IEEE Standard.
CT	Current transformer
DU	Docking unit
EMC	Electromagnetic compatibility
Ethernet	A standard for connecting a family of frame-based computer networking technologies into a LAN
FTP	File transfer protocol
GDE	Graphical Display Editor in PCM600
GoCB	GOOSE control block
GOOSE	Generic Object-Oriented Substation Event
HMI	Human-machine interface
HW	Hardware
I/O	Input/output
ICD	IED capability description
IEC	International Electrotechnical Commission
IEC 61850	International standard for substation communication and modeling
IED	Intelligent electronic device
Instance	Identical protection function blocks available in a standard configuration. By setting the application-specific parameters of an instance, a protection function stage can be established.
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
MV	Medium voltage
NCC	Network control center
PCM600	Protection and Control IED Manager
PST	Parameter Setting tool in PCM600
RJ-45	Galvanic connector type
SCD	Substation configuration description
SCL	XML-based substation description configuration language defined by IEC 61850
SMT	Signal Matrix tool in PCM600
TCP	Transmission Control Protocol
UDP	User datagram protocol
VT	Voltage transformer
WAN	Wide area network
WHMI	Web human-machine interface

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