

RELION® PROTECTION AND CONTROL

REX610

Engineering Manual





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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 frame of the protection relay has to be carefully earthed.



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



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



Whenever changes are made in the protection relay, 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 protection relays using the different tools in PCM600. The manual provides instructions on how to set up a PCM600 project and insert relays 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 the application, protection and control equipment and the configured functional logic in the relays. The installation and commissioning personnel must have a basic knowledge of handling electronic equipment.

1.3

Product documentation

1.3.1

Product documentation set

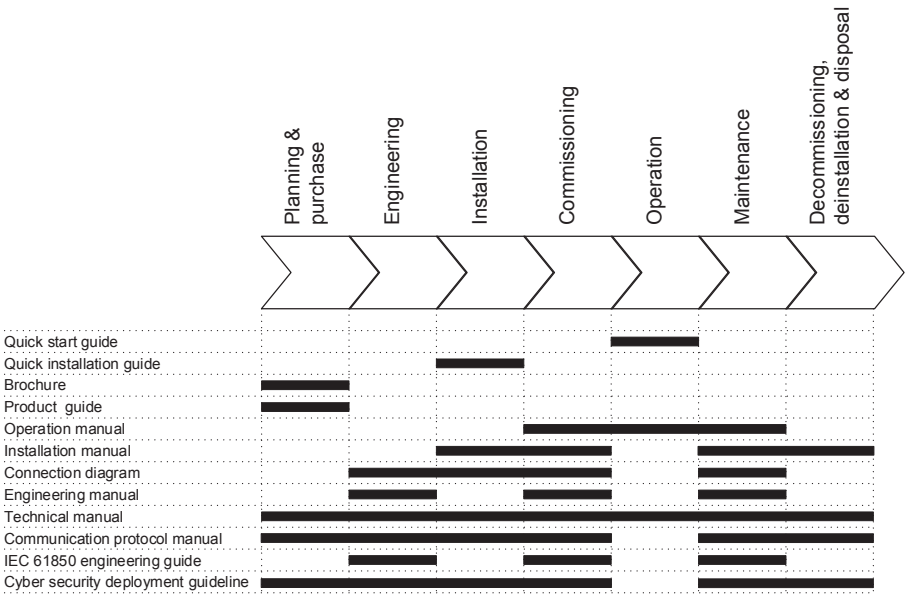


Figure 1: The intended use of documents during the product life cycle

1.3.2

Document revision history

Document revision/date	Product version	History
A/2022-04-21	1.0	First release

1.3.3

Related documentation

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

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 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 .
- Menu paths are presented in bold.
Select **Main menu/Settings**.
- LHMI messages are shown in Courier font.
To save the changes in nonvolatile 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".
- Input/output messages and monitored data names are shown in Courier font.
When the function starts, the `START` output is set to `TRUE`.
- Values of quantities are expressed with a number and an SI unit. The corresponding imperial units may be given in parentheses.
- This document assumes that the parameter setting visibility is "Advanced".
- A functional earth terminal is indicated in figures with the symbol .
- Equipment protected throughout by double insulation or reinforced insulation (equivalent to class II of IEC 61140) is indicated in figures with the symbol .

1.4.3

Functions, codes and symbols

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

Table 1: *Functions included in the relay*

Function	IEC 61850	IEC 60617	IEC-ANSI
Protection			
Three-phase non-directional overcurrent protection, low stage	PHLPTOC	3I>	51P-1
Three-phase non-directional overcurrent protection, high stage	PHHPTOC	3I>>	51P-2
Three-phase non-directional overcurrent protection, instantaneous stage	PHIPTOC	3I>>>	50P
Three-phase directional overcurrent protection, low stage	DPHLPDOC	3I> ->	67P/51P-1
Three-phase directional overcurrent protection, high stage	DPHHPDOC	3I>> ->	67P/51P-2
Non-directional earth-fault protection, low stage	EFLPTOC	Io>	51G/51N-1
Non-directional earth-fault protection, high stage	EFHPTOC	Io>>	51G/51N-2
Non-directional earth-fault protection, instantaneous stage	EFIPTOC	Io>>>	50G/50N
Directional earth-fault protection, low stage	DEFLPDEF	Io> ->	67G/N-1 51G/N-1
Directional earth-fault protection, high stage	DEFHPDEF	Io>> ->	67G/N-1 51G/N-2
Three-phase inrush detector	INRPHAR	3I2f>	68HB
Three-phase thermal protection for feeders, cables and distribution transformers	T1PTTR	3Ith>F	49F
Negative-sequence overcurrent protection	NSPTOC	I2>M	46M
Phase discontinuity / Single phasing protection for motor	PDNSPTOC	I2/I1>	46PD
Loss of phase, undercurrent	PHPTUC	3I<	37
Three-phase undervoltage protection	PHPTUV	3U<	27
Three-phase overvoltage protection	PHPTOV	3U>	59
Residual overvoltage protection	ROVPTOV	Uo>	59G/59N
Circuit breaker failure protection	CCBRBRF	3I>/Io>BF	50BF
Master trip	TRPPTRC	Master Trip	94/86
Multipurpose protection	MAPGAPC	MAP	MAP
Control			
Circuit-breaker control	CBXCBBR	I <-> O CB	52
Disconnecter position indication	DCSXSWI	I <-> O DC	29DS
Earthing switch position indication	ESSXSWI	I <-> O ES	29GS
Autoreclosing	DARREC	O -> I	79
Condition monitoring and supervision			
Trip circuit supervision	TCSSCBR	TCS	TCM
Table continues on next page			

Function	IEC 61850	IEC 60617	IEC-ANSI
Fuse failure supervision	SEQSPVC	FUSEF	VCM, 60
Circuit-breaker condition monitoring	SSCBR	CBCM	52CM
Current circuit supervision	CCSPVC	MCS 3I	CCM
Measurement			
Three-phase current measurement	CMMXU	3I	IA, IB, IC
Residual current measurement	RESCMMXU	Io	IG
Sequence current measurement	CSMSQI	I1, I2, I0	I1, I2, I0
Three-phase voltage measurement	VMMXU	3U	VA, VB, VC
Residual voltage measurement	RESVMMXU	Uo	VG/VN
Traditional LED indication			
Programmable LED control	LED	LED	LED
Logging functions			
Disturbance recorder (common functionality)	RDRE	DR	DFR
Disturbance recorder, analog channels 1...8	A1RADR	A1RADR	A1RADR
Disturbance recorder, binary channels 1...32	B1RBDR	B1RBDR	B1RBDR
Communication protocols			
IEC 61850-8-1 MMS	MMSLPRT	MMSLPRT	MMSLPRT
IEC 61850-8-1 GOOSE	GSELPRT	GSELPRT	GSELPRT
Modbus protocol	MBSLPRT	MBSLPRT	MBSLPRT

Section 2 Relay engineering process

PCM600 is used for various tasks in the protection relay engineering process.

- Relay engineering management
 - Organizing the bay protection relays in the structure of the substation by defining voltage levels and bays below the substation. PCM600 manages the project.
 - Configuring the protection relay functions (for example, protection and control functions) by using the Application Configuration tool.
 - Configuring the parameters and setting values for the protection relay itself and for the process functions by using the Parameter Setting tool.
 - Configuring connections between the application configuration function blocks and physical hardware inputs and outputs by using the Signal Matrix tool or the Application Configuration tool.
- Communication management
 - IEC 61850 station communication engineering is done using the internal IEC 61850 Configuration tool or a separate system engineering tool such as IET600. PCM600 interacts with system engineering tools, such as IET600, by importing and exporting SCL files.
 - Configuring the GOOSE receiving data connections to the protection relay's application configuration function blocks by using the Application Configuration tool and the Signal Matrix tool.
 - Configuring protocol data mapping for Modbus with the Communication Management tool.
- Record management
 - Generating overviews on the available (disturbance) recordings in all connected protection relays by using the Disturbance Handling tool.
 - Manually reading the recording files (in the COMTRADE format) from the protection relays 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 a protection relay for commissioning or service purposes by using the Signal Monitoring tool and Event Viewer tool (including audit trail).

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 protection relay is finished, the results must be written to the protection relay.

REX610 has a rear Ethernet port and a front USB port. Relay engineering can be done using both these ports. The relay supports two power-up modes, one using the auxiliary supply on the rear and another by USB. When powered up by USB, the relay works with limited functionality. The relay engineering can be done when powered up by USB. For a list of the tools supported by the rear and front ports, see [Table 2](#).

2.1

Monitoring and control system structure

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



The maximum size of a project is 180 devices. However, in order to maintain good performance and usability of the tool, it is recommended to divide one big project into multiple smaller PCM600 projects.

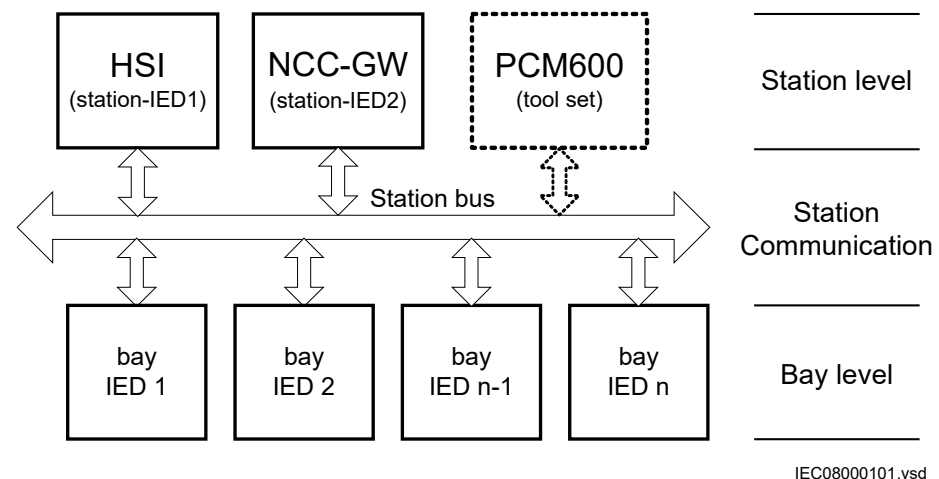


Figure 2: Principle structure of a monitoring and control system for a substation

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

- Bay level devices
- Station communication
- Station level devices

All three parts require specific engineering and configuration.

A plant structure is used to identify each device in its location within the substation organization. The plant structure is a logical image of the substation and the bays within the substation. The organization structure for the devices 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 device identification.

- Project
- Substation = name of the substation
- Voltage level = identifies to which grid type or part the device 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 device and two protection relays

2.2

Workflow

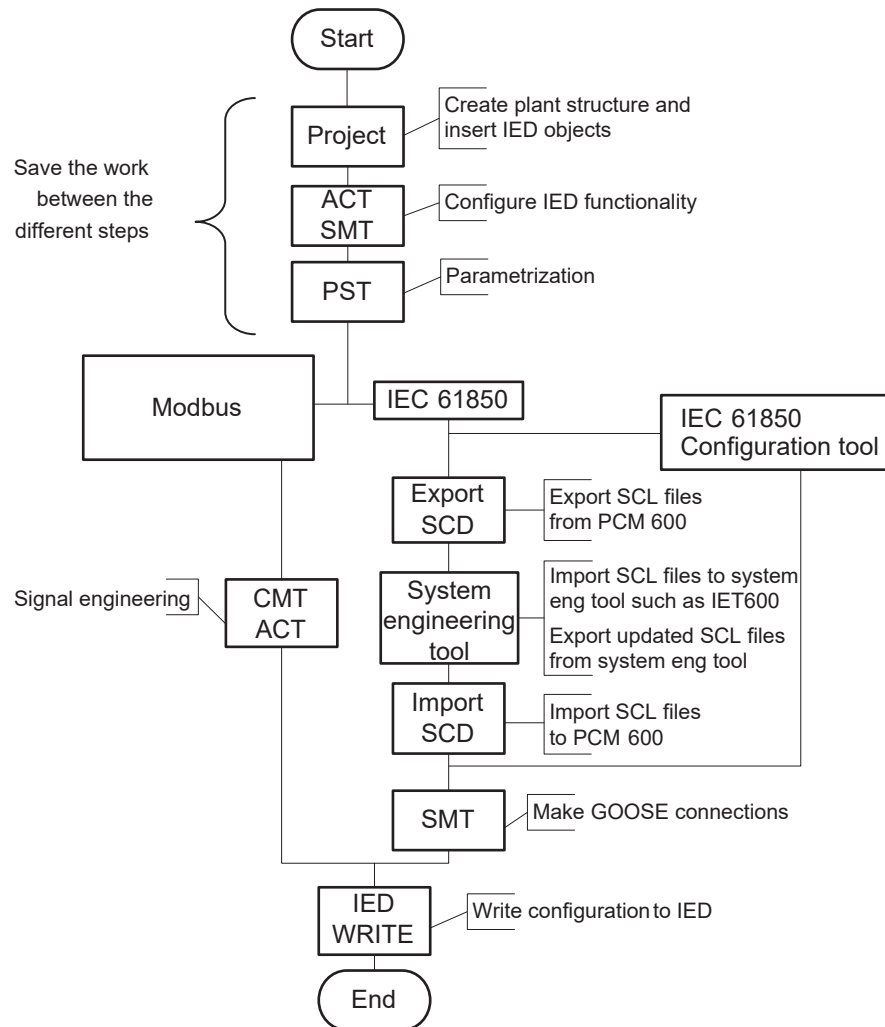


Figure 3: *Protection relay engineering workflow proposal based on practical experience and dependencies of the steps*

It is possible to follow a different 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 maximum size of a project is 180 IEDs. However, in order to maintain good performance and usability of the tool, it is

recommended to divide one big project into multiple smaller PCM600 projects.

- To add a protection relay to a project, a suitable Connectivity package is needed. Protection relays can be added either while connected or disconnected or through other means such as an IED template.
- IED objects are uniquely named within the PCM600 project.

Application configuration in the Application Configuration tool

- Protection and control functions can be configured as needed.
- 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

- Configuration parameters such as CT and VT conversion values of the transformer module are checked by the tool.
- If needed, the setting values are checked and adjusted with the Parameter Setting tool.

LHMI engineering

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

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. Either IEC 61850 Configuration tool or separate engineering tools are required for configuring horizontal and vertical communication.
- The Communication Management tool is used for other protocols; for example Modbus.



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



The protection relay supports engineering from both the front and the rear port. For details, see [Table 2](#).

Table 2: **Tools support**

Tools	Rear port (FTP)	Front port (USB power-up or AUX)
Common Write (CRW)	Yes	Yes
Common Read (CRW)	Yes	Yes
Parameter Setting tool (PST)	Yes	Yes ¹⁾
Set Technical Key	Yes	Yes
Event Viewer (EVT)	Yes	No
Disturbance Handling Tool (DHT)	Yes	Yes
Signal Monitoring Tool (MON)	Yes	No
User management Tool (UMT)	Yes	No
Communication management tool (CMT)	Yes	No
Online Order Code Read (Configuration Wizard)	Yes	Yes
IED Compare Tool (ICT)	Yes	No
Firmware Update Tool (FUT)	Yes	No
Life Cycle Traceability Tool (LCT)	Yes	No

1) PST read and PST write are supported. PST write with read back feature is not supported.

2.3 Configuring relay with USB port

The USB communication must be enabled both in the relay and in PCM600.

1. On the LHMI, set the *Enable USB* parameter to "True" via **Configuration/System** for communicating with USB from PCM600.
User credentials are required to activate USB communication on the LHMI when *Remote override* in the relay is set to "False". User credentials are not required to activate USB communication on the LHMI when *Remote override* in the relay is set to "True".
2. Ensure only one relay is connected to the PC via USB when connected to the front port.
3. Ensure the drive is available in the PC after USB connection with the relay (no external drivers' installation needed).

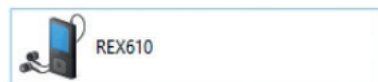


Figure 4: **IED USB drive in PC**

4. Select USB in the configuration wizard and follow the same steps as when configuring relay in rear port.

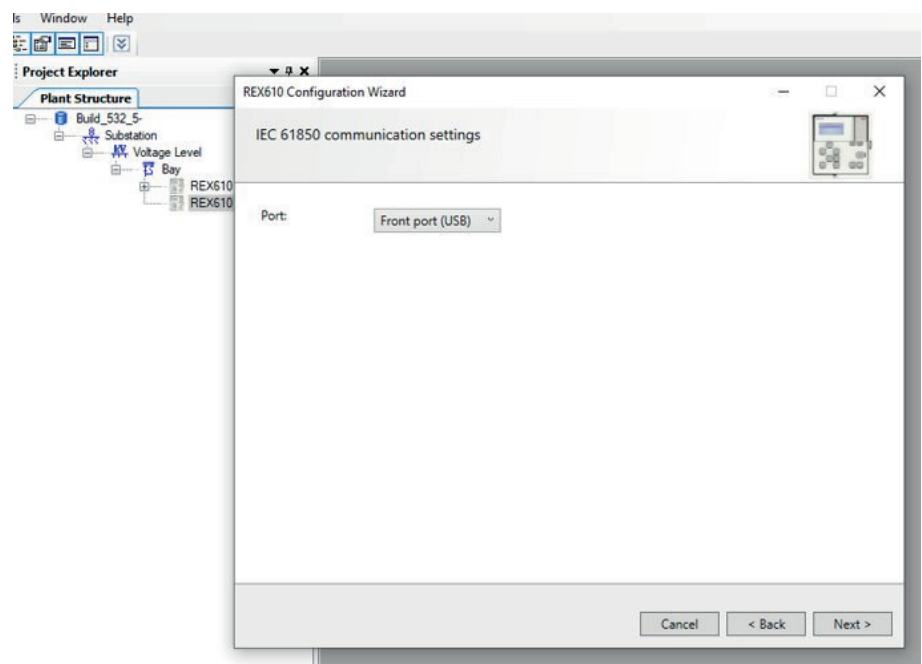


Figure 5: Configuration wizard

5. Right-click the IED and select **Communication Port** to activate a communication port.

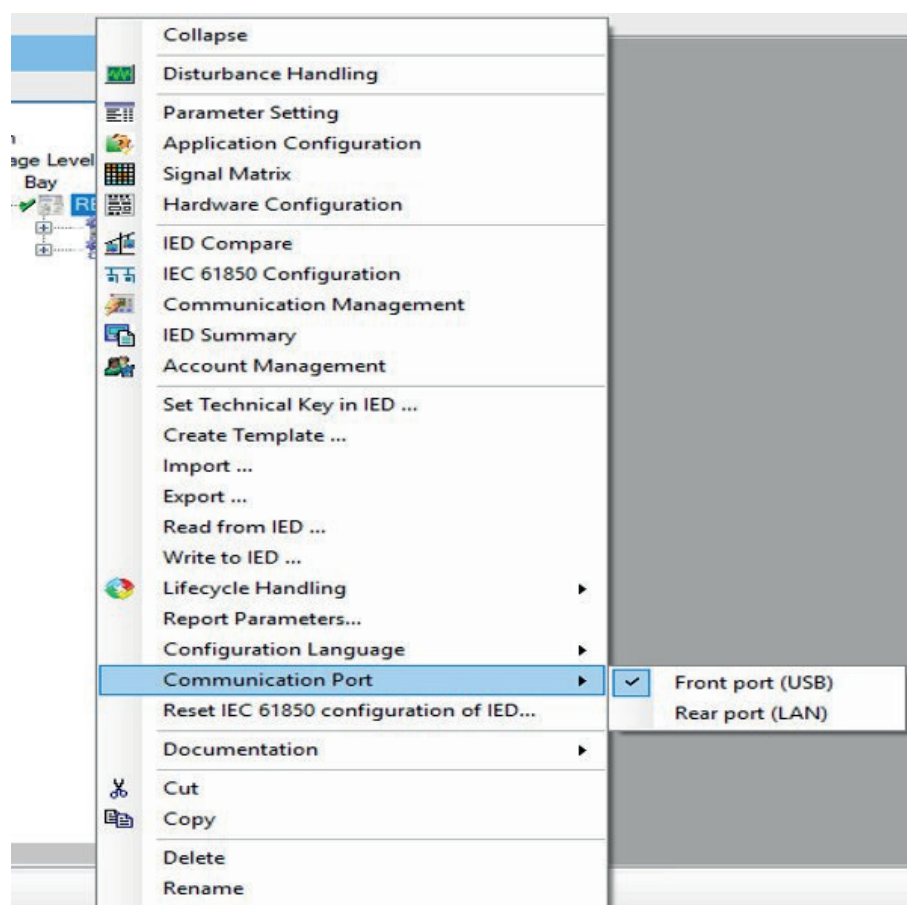


Figure 6: Selecting the communication port

The selected communication port is displayed next to **Selected Port** on the **Object Properties** window.

Object Properties	
<div> <div> <div></div> <div></div> <div></div> </div> <div> <div></div> <div></div> <div></div> </div> </div>	
▼ [000] Appearance	
Caption	REX610
Description	Protection and Control REX610
▼ [003] Composition Code	
CompositionCode	REX6101GNNANNNA
▼ [020] Addresses	
Selected Port	Front port (USB)
▼ [100] SCL Information	
Configuration Version	A
Manufacturer	ABB
SCL data model	Edition 2
Technical Key	Test
▼ [300] Configuration Version	
Last modified	7/20/2021 11:16 AM
System	IN-L-7345684
Version	33

Figure 7: Viewing the selected port in object properties (front port)

Object Properties	
<div> <div> <div></div> <div></div> <div></div> </div> <div> <div></div> <div></div> <div></div> </div> </div>	
▼ [000] Appearance	
Caption	REX610
Description	Protection and Control REX610
▼ [003] Composition Code	
CompositionCode	REX6101GNNANNNA
▼ [020] Addresses	
IP Address	127.0.0.1
Selected Port	Rear port (LAN)
▼ [100] SCL Information	
Configuration Version	A
Manufacturer	ABB
SCL data model	Edition 2
Technical Key	Test
▼ [300] Configuration Version	
Last modified	7/20/2021 11:16 AM
System	IN-L-7345684
Version	33

Figure 8: Viewing the selected port in object properties (rear port)



IP address is not available when *Communication Port* is set to "Front Port (USB)".

Some tool operations are not supported when the relay is connected using the front port. In such cases, the tool displays “The operation is not supported using front port USB connection” in the output window.

Date and Time	Category	User	Object	Message
23-03-2021 15:08:57.857	Warning	ABB - System Admins...	REX610	The operation is not supported using front port usb communication.

Figure 9: Operation not supported with USB front port connection

Section 3 PCM600

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

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

The whole substation configuration can be controlled and different tasks and functions can be performed with the individual tool components. PCM600 can operate with many different topologies, depending on the project needs.

PCM600 is used to conduct complete engineering and configuration activities needed for the bay-level protection relays.

Connectivity packages are separate software packages that provide type and version information to PCM600 and assist the tool with communications.

PCM600 communicates with devices over Ethernet using either IEC 61850 or the FTP/FTPS protocols. This communication allows PCM600 to configure and monitor the devices. In addition to IEC 61850, the devices have optional communication protocols and hardware to connect to station engineering tools. PCM600 provides the ability to export the configuration of the devices or an entire substation in a standard file format which enables station engineering in separate IEC 61850 system configuration tools.

A PC with PCM600 can be connected to any REX610 protection relay within a station by using the Ethernet connection. The connection can be used for service and maintenance purposes and to handle disturbance records from the protection relays.

REX610 also supports one-to-one connection using the front USB port. This port can be used for service and maintenance purposes.

The modern protection relays are designed using the concept of the IEC 61850 standard. This is mainly visible in how functions within the protection relay are modelled and how the protection relay is represented in the substation. The logical nodes follow the structure and rules defined in part 7 of the standard.

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

As PCM600 can be used for different purposes throughout the protection relay life cycle, a set of tools is available for different applications.

The applications can be organized into groups.

- Relay engineering
- Communication engineering
- Record management
- Device monitoring and diagnostic
- User management



For more information, see the PCM600 documentation.

3.1 Connectivity packages

A connectivity package is a software component that consists of executable code and data which enable system tools to communicate with a protection relay. Connectivity packages are used to create configuration structures in PCM600.

A connectivity package includes all the data which is used to describe the protection relay. For example, it contains a list of the existing parameters, data format used, units, setting range, access rights and visibility of the parameters. In addition, it contains code which allows the software packages that use the connectivity package to properly communicate with the protection relay.

3.2 PCM600 and relay connectivity package version

- Protection and Control IED Manager PCM600 Ver.2.11 or later
- REX610 Connectivity Package Ver.1.0 or later



Download connectivity packages from the ABB Web site abb.com/mediumvoltage or directly with Update Manager in PCM600.

3.2.1 Installing connectivity packages

- Install connectivity packages either by running the installer which can be downloaded on the ABB Website or by using Update Manager when a network connection is available.



Download connectivity packages from the ABB Web site abb.com/mediumvoltage or directly with Update Manager in PCM600.

3.2.1.1

Installing connectivity packages by using the connectivity package installer

1. Close PCM600.
2. Run the **ABB IED Connectivity Package REX610 Ver. n.msi** installer. (n = version number)
3. To install the connectivity package, follow the steps in the connectivity package installation wizard.

3.2.1.2

Installing connectivity packages by using Update Manager

1. In PCM600, click **Help** and select **Update Manager**.
Run Update Manager with administrator rights.

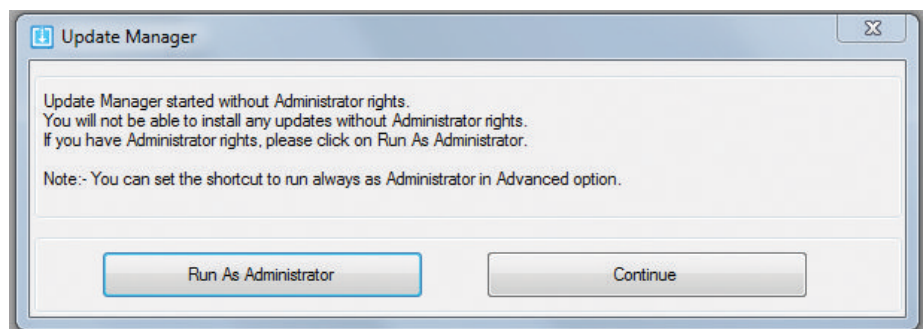


Figure 10: Running Update Manager as an administrator

2. Select **Get Connectivity Packages** from the menu on the left column.
3. Select all the required connectivity packages.
4. Click **Download and Install**.
The status bar shows the installation status.

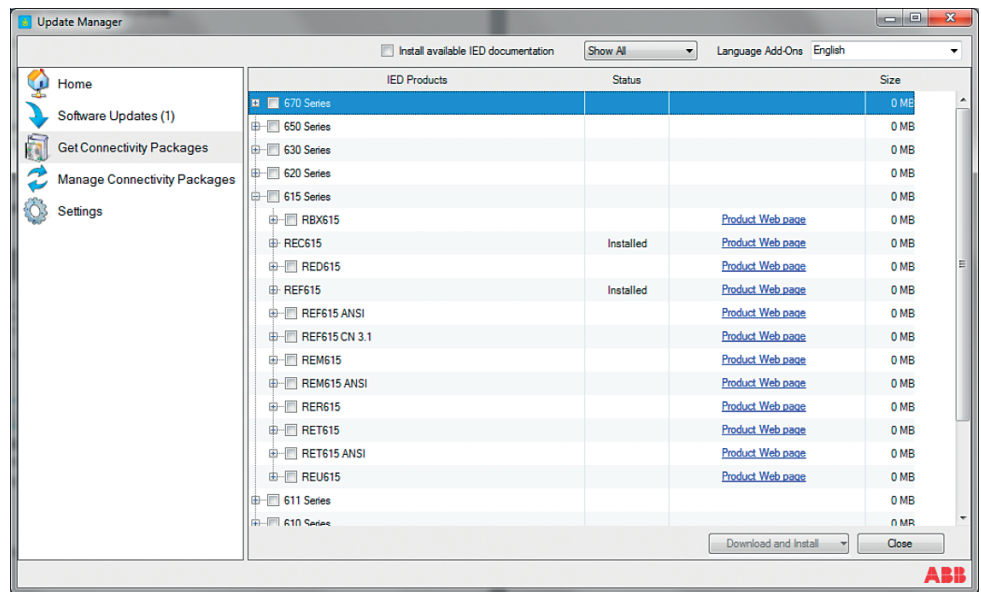


Figure 11: Selecting the connectivity packages

3.2.2

Activating connectivity packages

The relay connectivity package has to be installed before it can be activated in Update Manager.

1. Select **Manage Connectivity Packages** from the menu on the left column to access the installed connectivity packages.
2. Browse the tree structure to find the correct product.
3. Select the connectivity package version from the drop-down list beside the product name.



Always use the latest version of the connectivity package.

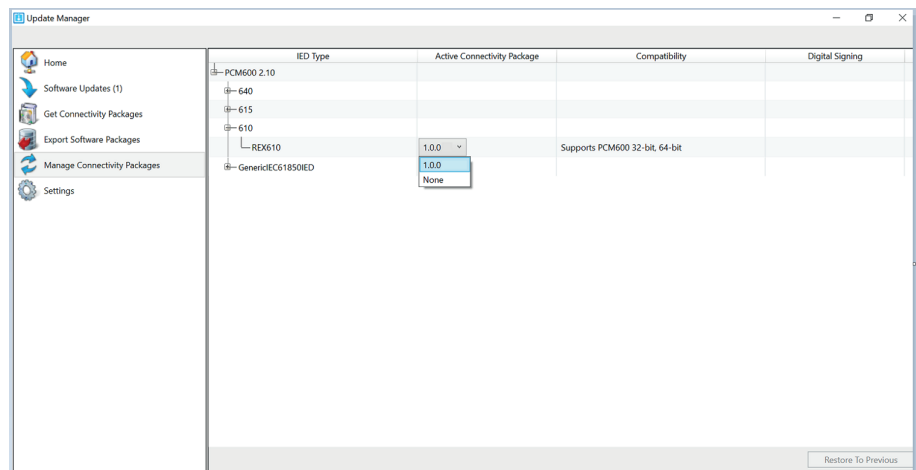


Figure 12: Selecting the connectivity package versions

PCM600 recognizes the installed connectivity packages during start-up, and the corresponding IED types are available in PCM600 when starting a new project.

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.

Regardless of the protocol used in installation for each project, it is possible to have Edition 1 and Edition 2 relays configured in the same PCM600 project. The PCM600 project's SCL edition is the highest SCL edition relay in the project. If IEC 61850 is not used for the station bus, either version can be applied. The protection relay's IEC 61850 version is by default Edition 2.

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 Technical key

Both a physical IED and an IED object in PCM600 have a technical key. The technical key in the protection relay 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 protection relay is delivered with a factory default technical key. The validation of the technical keys between PCM600 and the protection relay does not occur if the protection relay 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 protection relay and PCM600. The technical key can be read from the protection relay and updated to PCM600, or the PCM600 technical key can be written to the protection relay. Alternatively, a user-defined technical key can be defined.

When writing a configuration to the protection relay, PCM600 checks for 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 through the technical key concept.



Change the technical key for an IED object in the **Object Properties** dialog box in PCM600.

If factory setting restoration is performed on the device, ensure a configuration is written to the relay before setting the technical key.

3.4.1 IEC 61850 naming conventions to identify an IED

This section is only valid when the IEC 61850 standard is used for station bus communication. 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 IEC 61850-6, 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. The name is a relative identification within a hierarchy of objects. The maximum characters allowed for a technical key is 60 for IEC 61850 Edition 2 projects.
- User-oriented textual designation is contained in the *desc* attribute. Attributes are not allowed to contain carriage return, line feed, tab, greater than, less than, double quotes or ampersand characters. The semantics of *desc* must also be relative within an object hierarchy. The maximum length is 100.

PCM600 takes care of these two possibilities. The two possible signal designations are available per object in the Object Properties for all the 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, a short form should be used, 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, the Bay SCL Technical Key part is Q03 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.

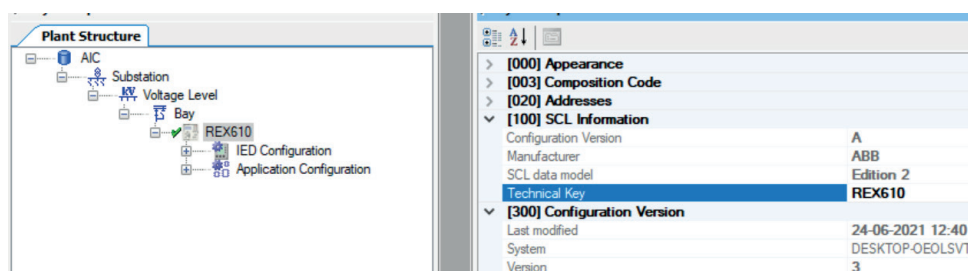


Figure 13: PCM600: IEC 61850 signal designation concept (online configuration)

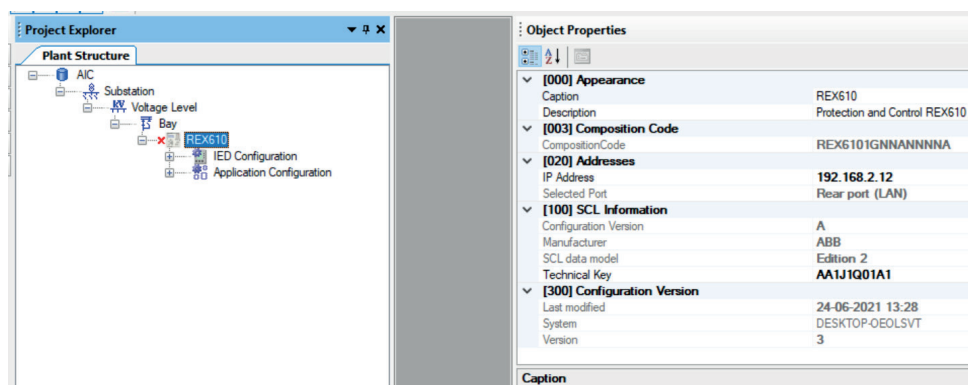


Figure 14: PCM600: IEC 61850 signal designation concept (offline configuration)

The created technical key for the full path name of the IED would be:
AA1J1Q03A1.

- AA1 = substation in the project
- J1 = voltage level from 20 to 30 kV
- Q03 = the third bay in the voltage level
- A1 = first IED in the bay Q03

3.4.2

Setting the technical key



The maximum length of technical key is 28 characters for Edition 1 and 60 characters for Edition 2.

1. In the **Plant Structure** view, right-click the IED and select **Set Technical Key in IED**.

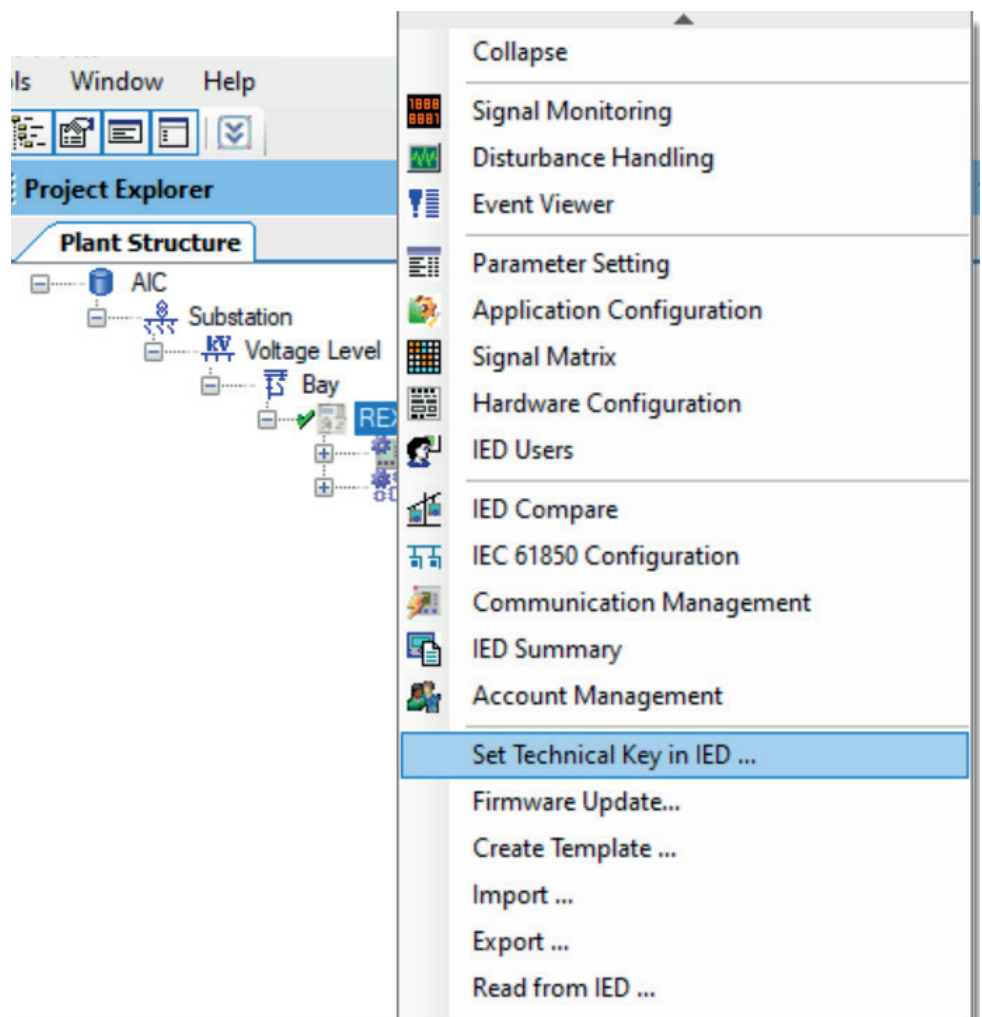


Figure 15: PCM600: Setting the technical key on the IED level

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

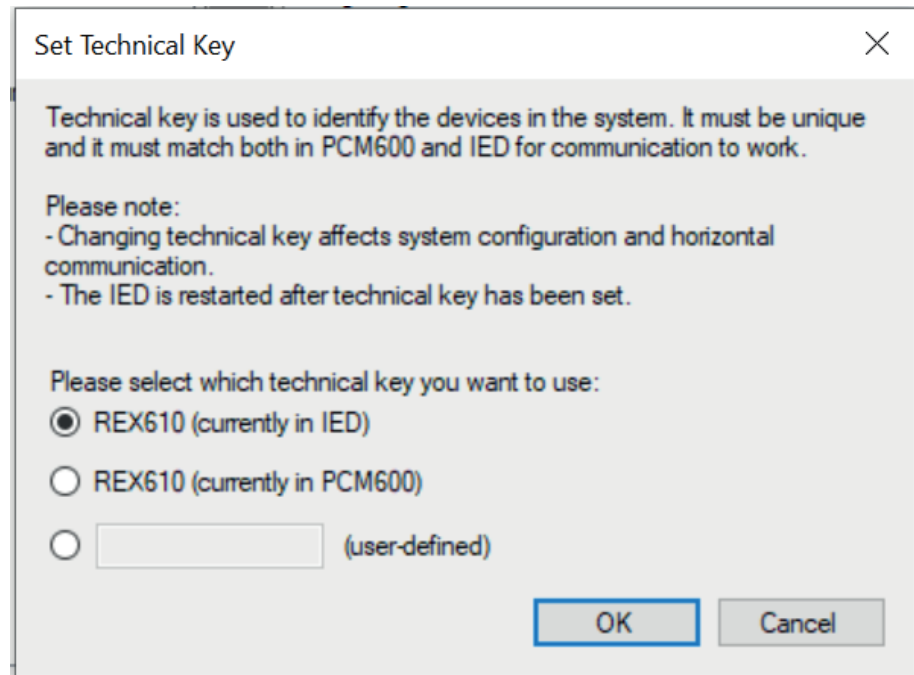


Figure 16: Setting the technical key

2. In **Set Technical Key** dialog box, select the technical 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
3. 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. An error message is displayed if this happens.

3.5

Communication between PCM600 and the protection relay

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

Each protection relay has an Ethernet interface connector on the rear and a USB interface connector on the front. Both connectors can be used for communication with PCM600.

Communication over Ethernet (rear port) is done using either IEC 61850 or FTP/FTPS. Communication over the front port USB is done over Media Transfer Protocol (MTP).

When an Ethernet-based station protocol is used for rear port communication, 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 protection relay.

- Direct point-to-point link between PCM600 and the protection relay's front port. When communicating over the front port USB, IP is not relevant and by default this is seen as 0.0.0.0.
 - Indirect link via station LAN or from remote via network
1. If needed, the IP address for the protection relay 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 protection relays' IP addresses in the PCM600 project are configured for each protection relay to match the IP addresses of the physical IEDs (rear port).
 4. Technical keys of the IEDs in PCM600 project are configured for each protection relay to match the technical keys of the physical IEDs.

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

Table 3: *Ports that must be open in the firewall for different protocols*

Protocol	TCP port
File Transfer Protocol (FTP and FTPS)	20, 21
IEC 61850	102
Simple Network Time Protocol (SNTP)	123
Modbus TCP	502

If there is an abrupt disconnection (removing of the communication cable) during an ongoing FTP/FTPS session, it takes 15–20 minutes for a fresh session to be successfully established.

3.5.1

Setting up IP addresses

The IP address and the corresponding subnet mask can be set via LHMI for the rear Ethernet interface in the protection relay. Each Ethernet interface has a default factory IP address when the complete protection relay is delivered.

1. Set the IP address for the protection relay's rear port and the corresponding subnet mask via the LHMI path **Configuration/Communication/Ethernet/Rear port**.

Table 4: *Default IP address for the rear port and the corresponding subnet mask*

IP address	Subnet mask
192.168.2.10	255.255.255.0

3.6 IED Firmware Update

The firmware update tool is used for updating the relay's system firmware and adding display languages to the relay. Update packages are provided by Customer Support. The firmware update is done locally when the relay is connected to the network or directly using USB.

It is recommended to take a backup of the relay configuration before starting the update. This can be done by using the common read feature in PCM600 from a relay connected to the network or via the front port. The user needs to be authorized before using PCM600. User credentials are asked if the default administrator password has been changed. For firmware and language update, users with the system update right are allowed.

3.6.1 Prerequisites for firmware update

1. If the rear port is used, ping test the relay to check for healthy network connection.



If the front port is used, ensure only one relay is connected to the PC via USB.

2. Create a REX610 instance with PCM600.
3. Set the IP address of the REX610 instance to be the same as the relay's IP address to continue with the rear port.
A green check mark on the left of the REX610 instance indicates successful connection.

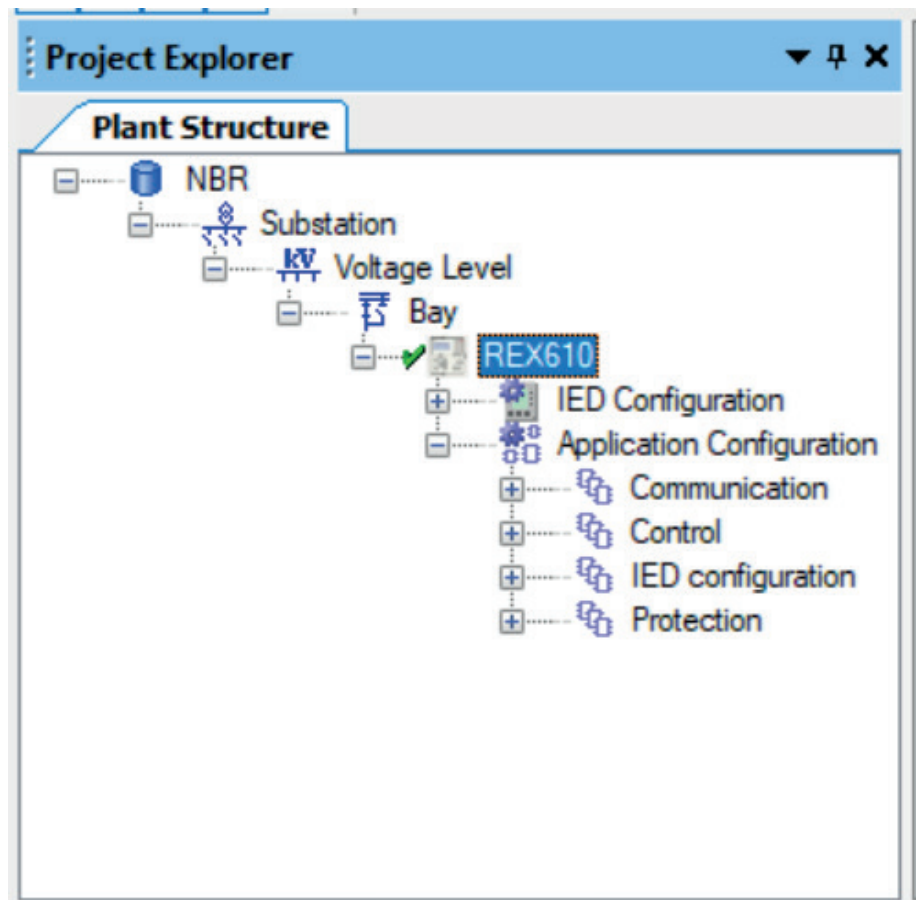


Figure 17: Checking the system connectivity

4. Clear the logs in PCM600.

3.6.2 Updating firmware or language

1. In PCM600, right-click the REX610 instance and select **Firmware Update**.

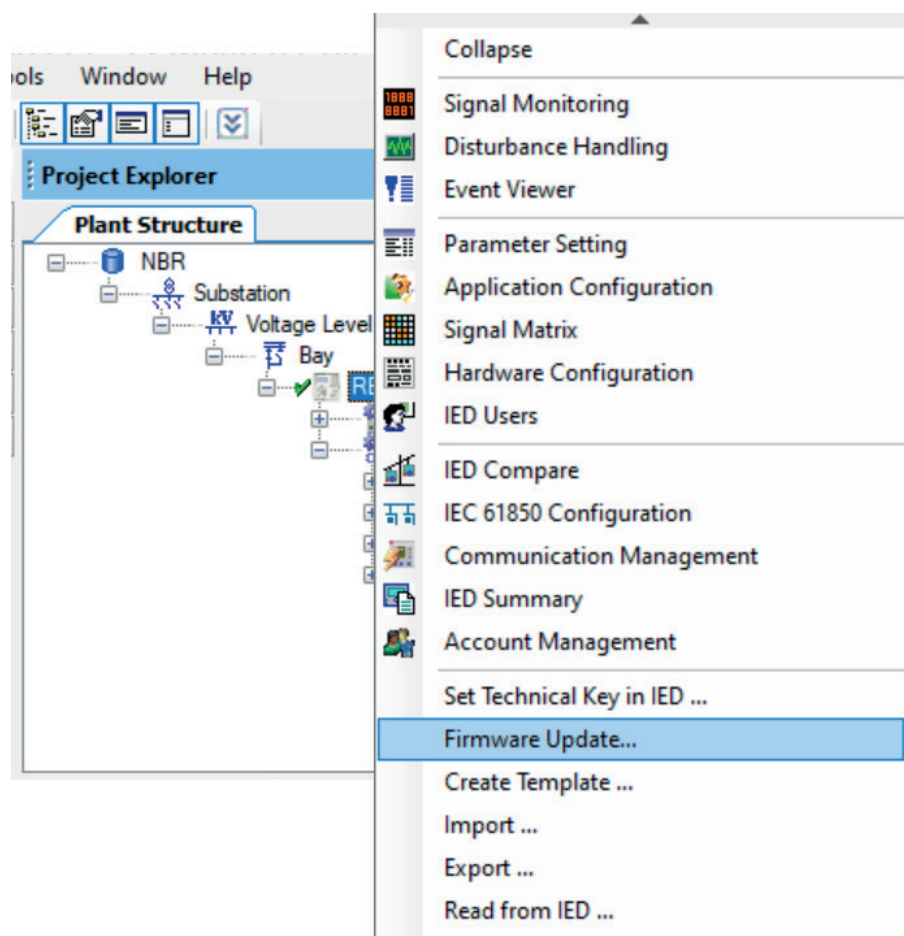


Figure 18: Selecting firmware update

2. User information wizard page opens, click **Next**.
3. Check the relay information and click **Next**.
4. Select the package type and click **Next**.

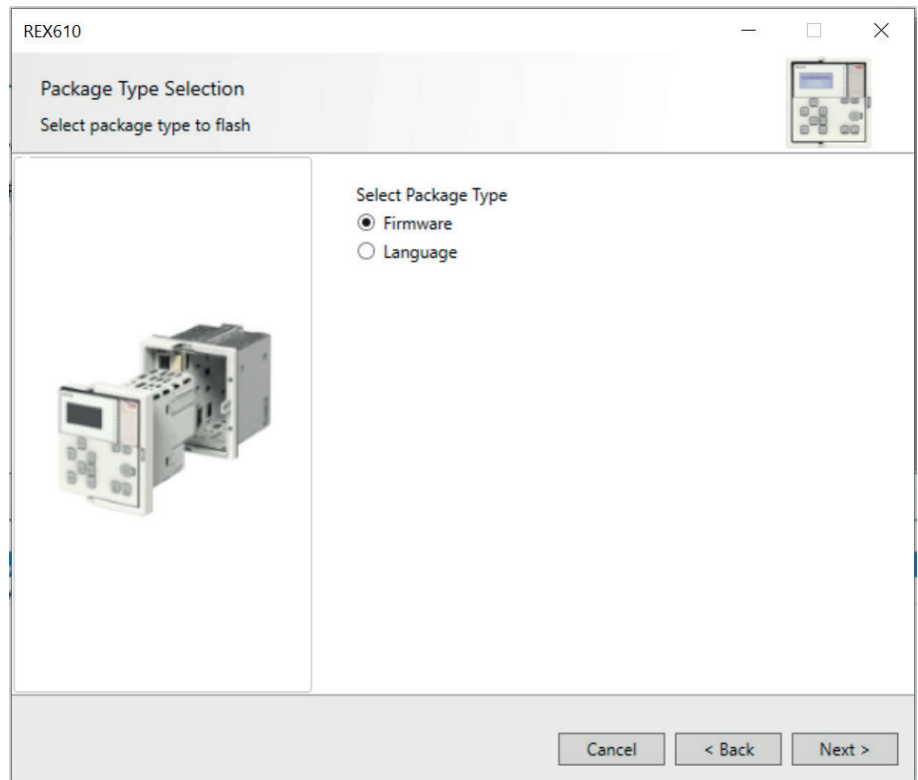


Figure 19: Selecting the package type

5. Select the package file.
 - If firmware update is selected, browse for the package file with format REX610_V_X_X_X.cab , where X is the major, middle, minor number of package versions.
 - If language update is selected, browse for the package file with format Lang_XXXX.zip, where XXXX is the language of the package.
6. Check the package file information and click **Next**.
7. Acknowledge on LHMI to confirm the firmware update.

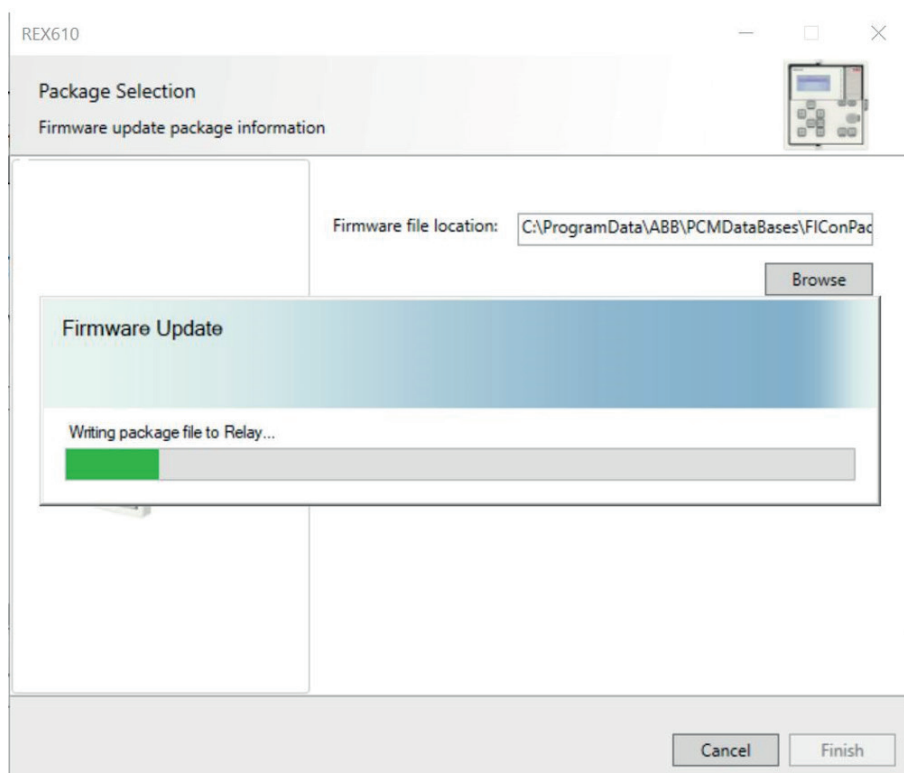


Figure 20: Firmware update progress bar

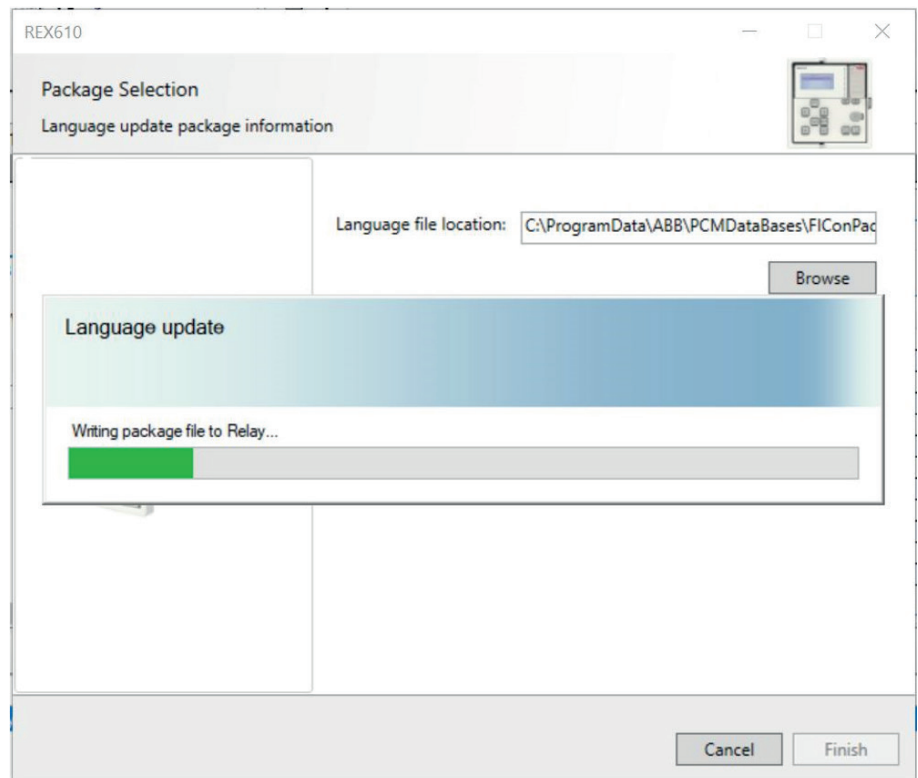


Figure 21: Language update progress bar

8. When the package has been updated, click **Finish** in the confirmation dialog.

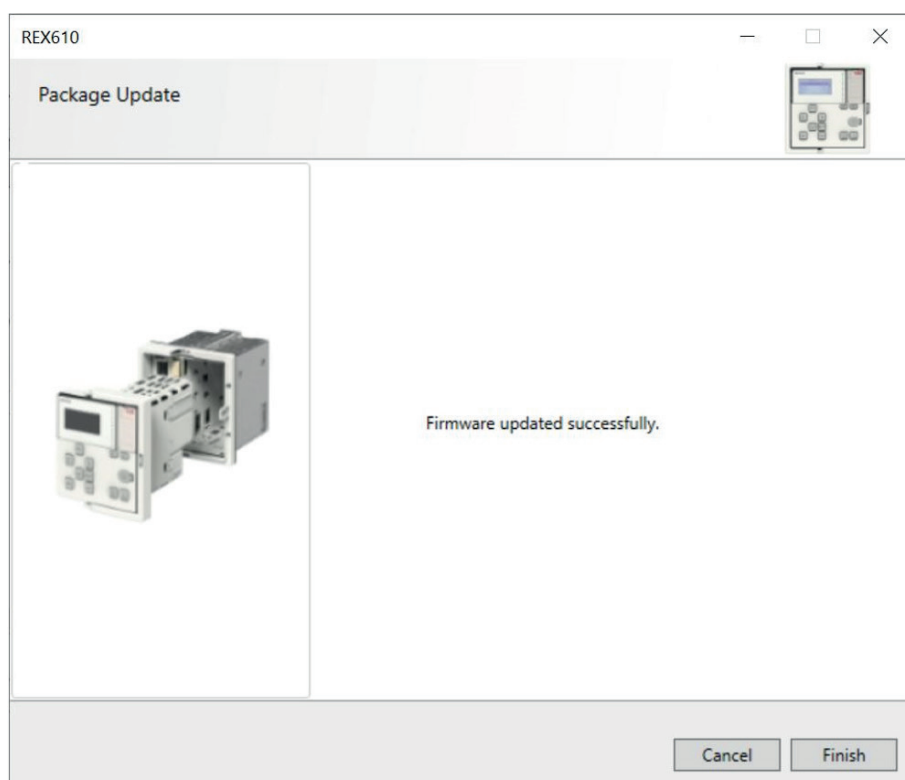


Figure 22: Firmware updated successfully

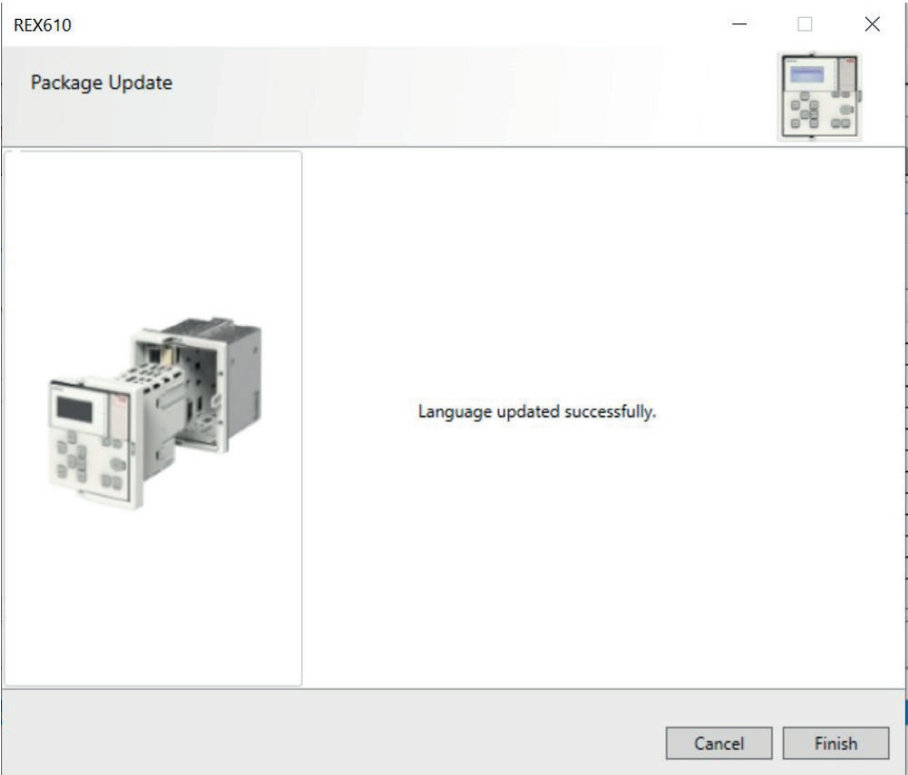


Figure 23: *Language updated successfully*

Section 4 Setting up a project

4.1 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. Click **New Project**.
5. If there are currently projects or object tools open, a confirmation dialog box opens.
 - Click **Yes** to close the open projects. A **Create New Project** dialog box opens.

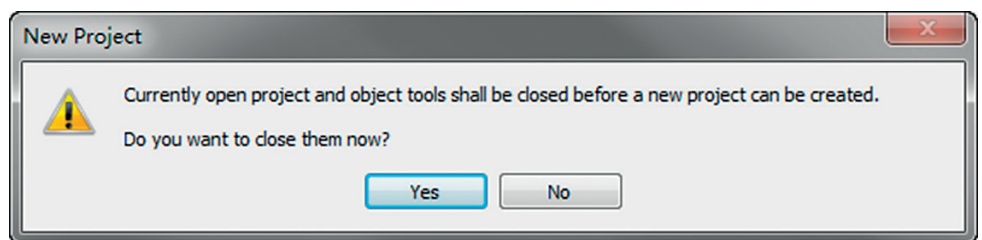


Figure 24: *New Project dialog box*

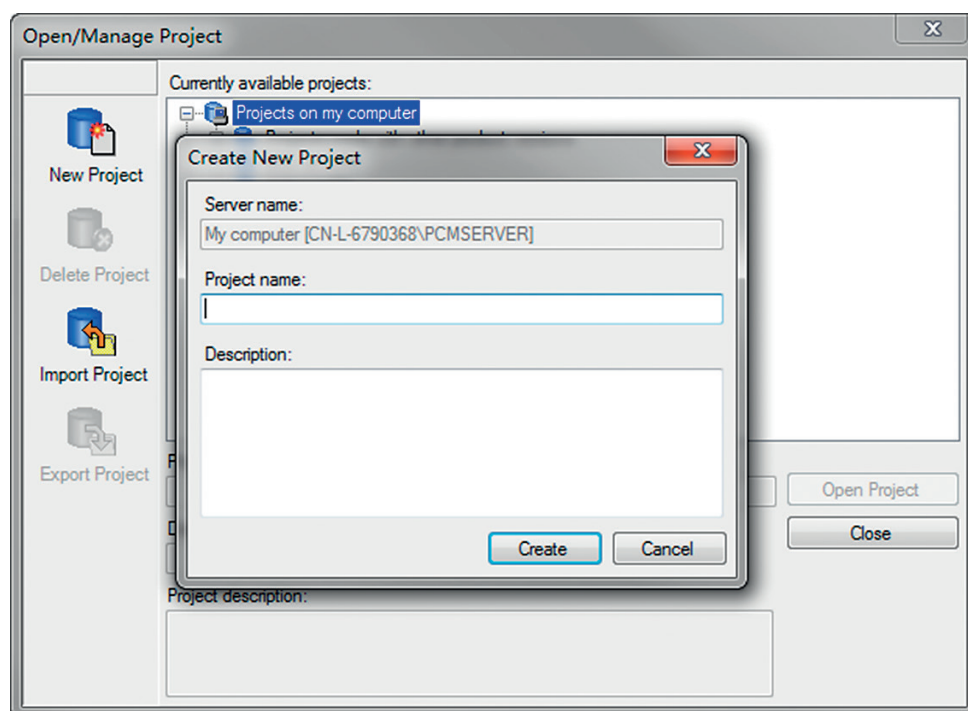


Figure 25: Creating a new project

6. In the **Project Name** box, give a name for the project.



The project name must be unique.

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**.

4.2

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 one of the alternative ways.

- Right-click the **Plant Structure** view, point to **New** and select **Create from Template**.
 - Right-click the **Plant Structure** view, point to **New** and select **General** and select the element either **IED Group** or **Substation**.
2. On the **View** menu, select **Object Types**.
 3. Select the needed elements and drag them into the plant structure.

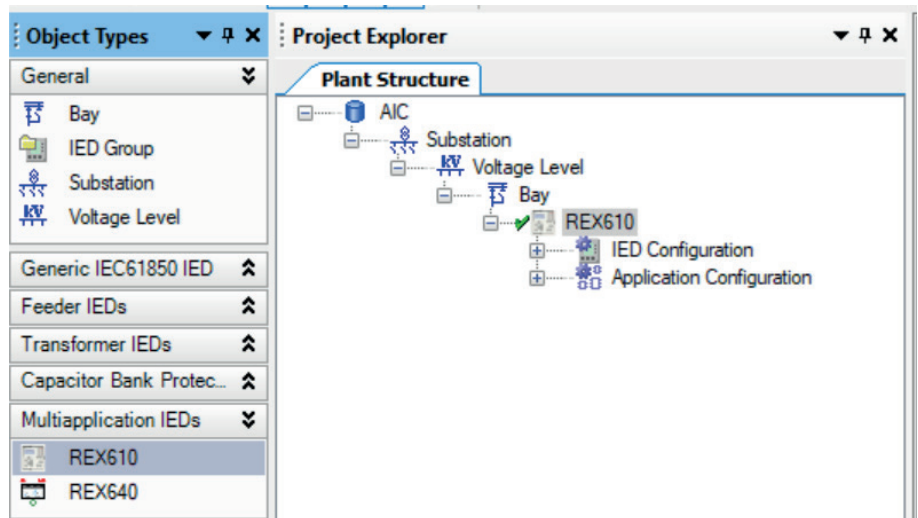


Figure 26: The start of a project with IEDs placed but not renamed

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.

4.3 Inserting of an IED

The context menu or the **Object Types** view shows the available 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 either offline or online IED
- Import a template IED that is available in the template library as a .pcmt file
- Import a preconfigured IED available as a .pcmi file



PCM600 uses two kinds of IED files: .pcmt and .pcmi. Both files include the complete IED configuration but their usage differs. The .pcmt files are always accessed through the PCM600 template manager while the .pcmi files are meant for sharing the IED

instances between different PCM600 users enabling quick import/export directly from the plant structure context menu.

4.3.1 Inserting an IED in online mode

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

When the protection relay is already connected to PCM600, PCM600 can read the order number directly from the relay. It is possible to read the full configuration from the relay by using the **Read from IED** function.

1. In the **Plant Structure** view, right-click the bay, point to **New**, point to the relay application area such as **Mutiapplication IEDs** and select the protection relay type to be inserted.



Alternatively, drag an IED from the **Object Types** view to the bay level.

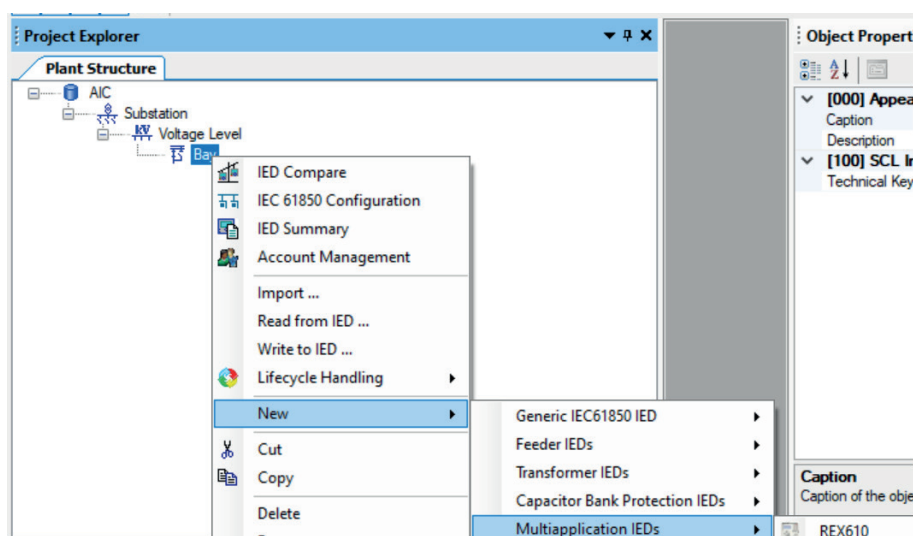


Figure 27: Selecting the protection relay type

2. On the **Configuration mode selection** page, select **Online configuration** and click **Next**.

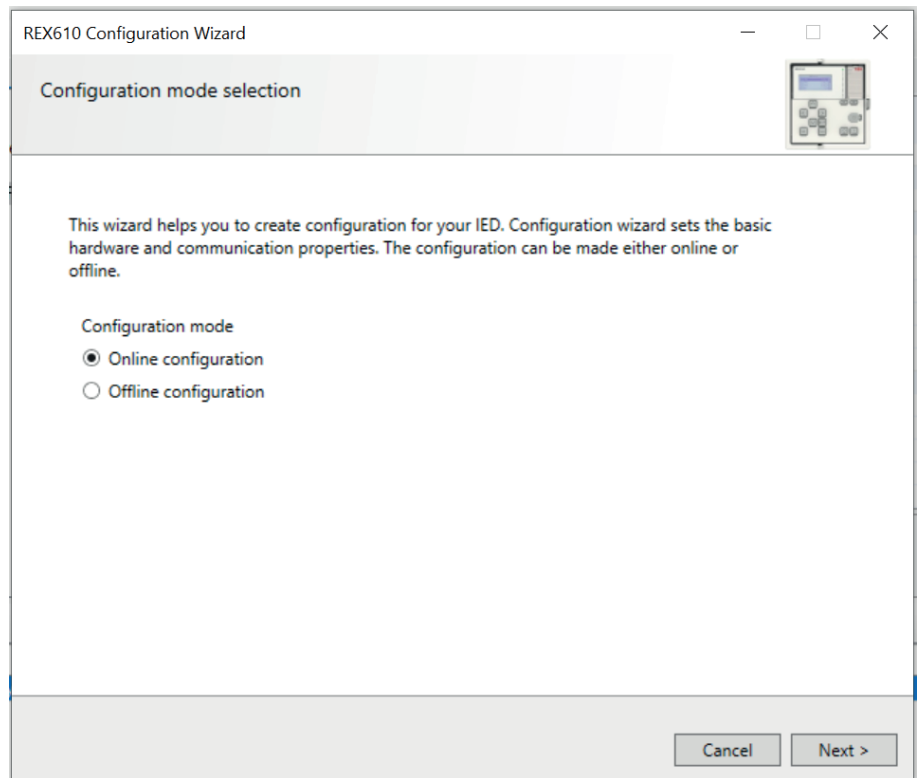


Figure 28: Configuration mode selection

3. On the **Communication protocol** page, select the communication protocol from the **IED Protocol** list and click **Next**.

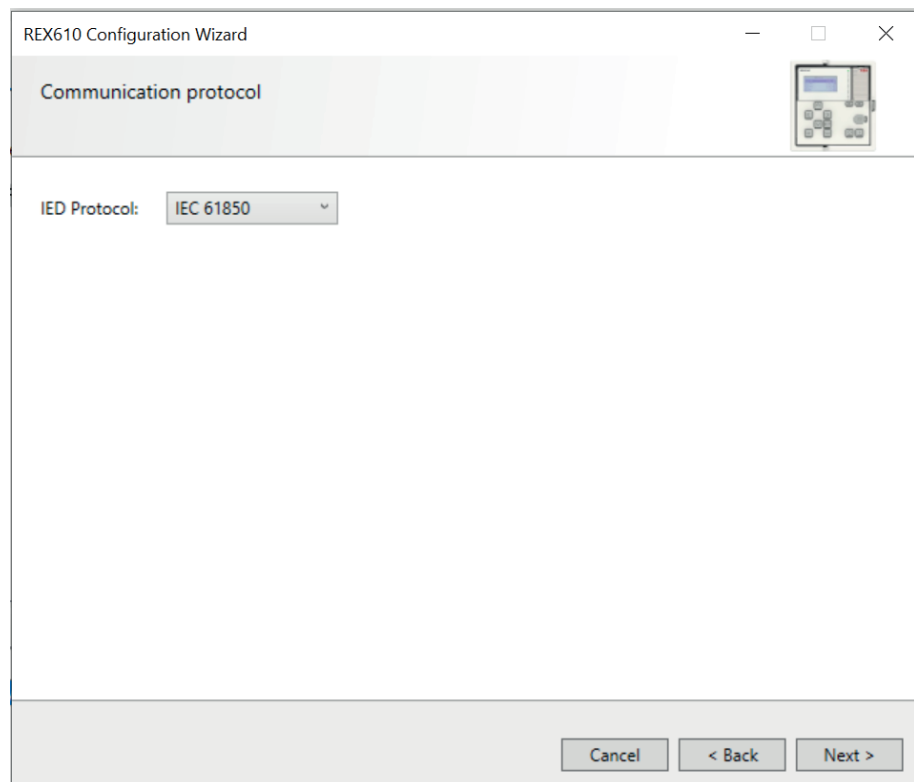
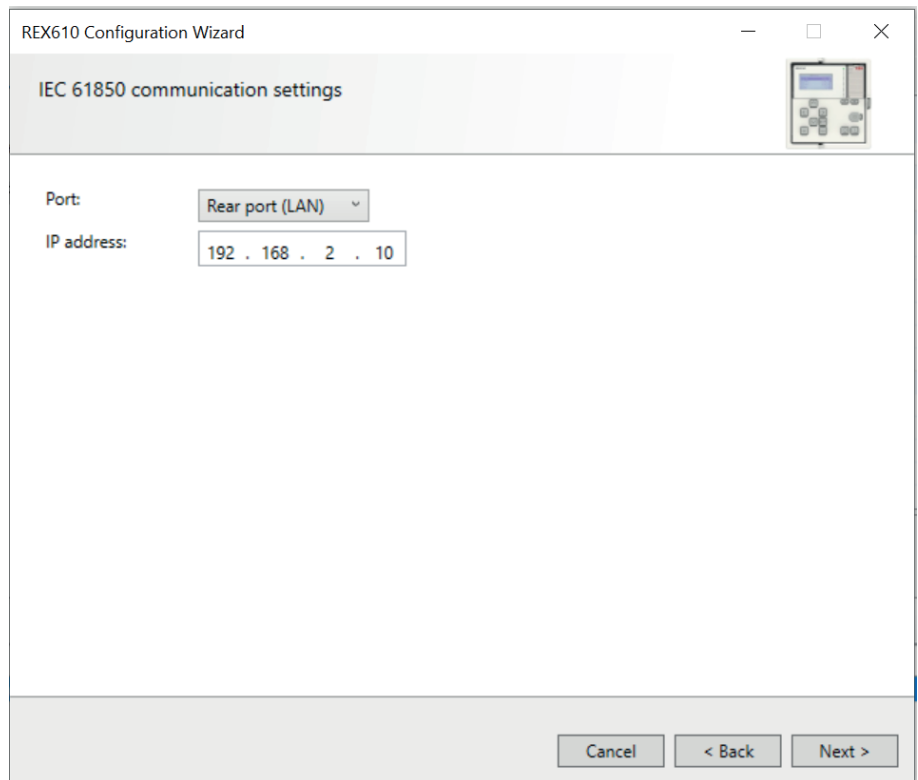


Figure 29: Communication protocol selection

4. On the **IEC 61850 communication settings** page, select the port from the **Port** list.
 - If the rear port is selected, type the correct IP address (of the physical protection relay to be configured) to the **IP address** box.



The screenshot shows a software window titled "REX610 Configuration Wizard". Inside, there is a tab labeled "IEC 61850 communication settings". Below the tab, there are two configuration fields: "Port:" with a dropdown menu currently showing "Rear port (LAN)", and "IP address:" with a text box containing "192 . 168 . 2 . 10". At the bottom right of the window, there are three buttons: "Cancel", "< Back", and "Next >". A small icon of the REX610 device is visible in the top right corner of the settings area.

Figure 30: Communication port and IP address

Communication configuration is now defined.

5. On the **IEC 61850 communication settings** page, select the USB port and click **Next**.

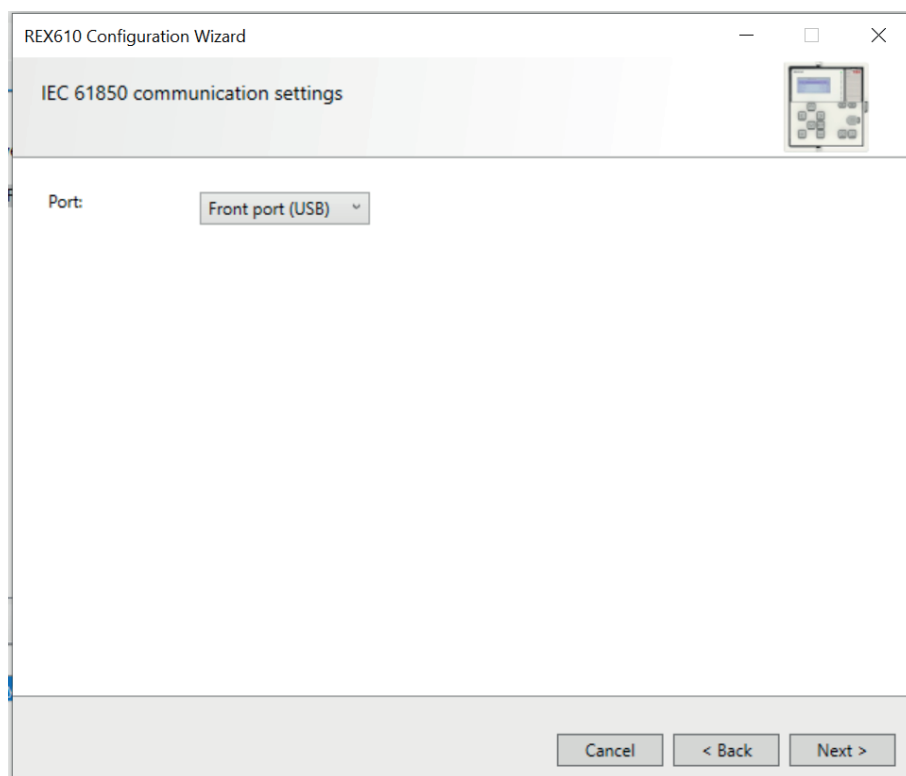


Figure 31: USB port selection

6. On the **Product version detection** page, select the product version.

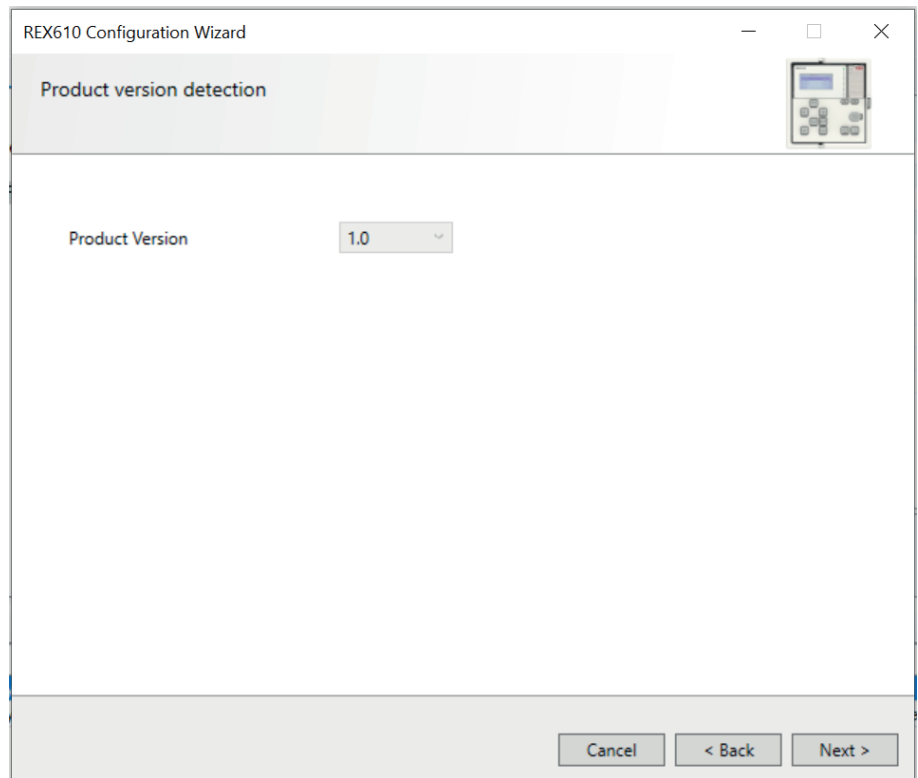


Figure 32: Product version selection

7. On **Composition code detection** page, click **Next**.

REX610 Configuration Wizard

Composition code detection page

Composition Code: REX610 1G A B A N N N N A

Composition code selection

Product	REX610	Multiapplication IED
Language	1G	English, Global
Current inputs	A	4 currents - compression type
Voltage inputs	B	4 voltages
Communication	A	Serial RS 485 and Ethernet 100Base TX (RJ45)
Arc protection	N	No arc protection
Reserved	N	Reserved for future use
Reserved	N	Reserved for future use
Reserved	N	Reserved for future use
Hardware version	A	Hardware version A

Cancel < Back Next >

Figure 33: Composition code detection page

8. On the **Version selection** page, select the IEC 61850 version and click **Next**.

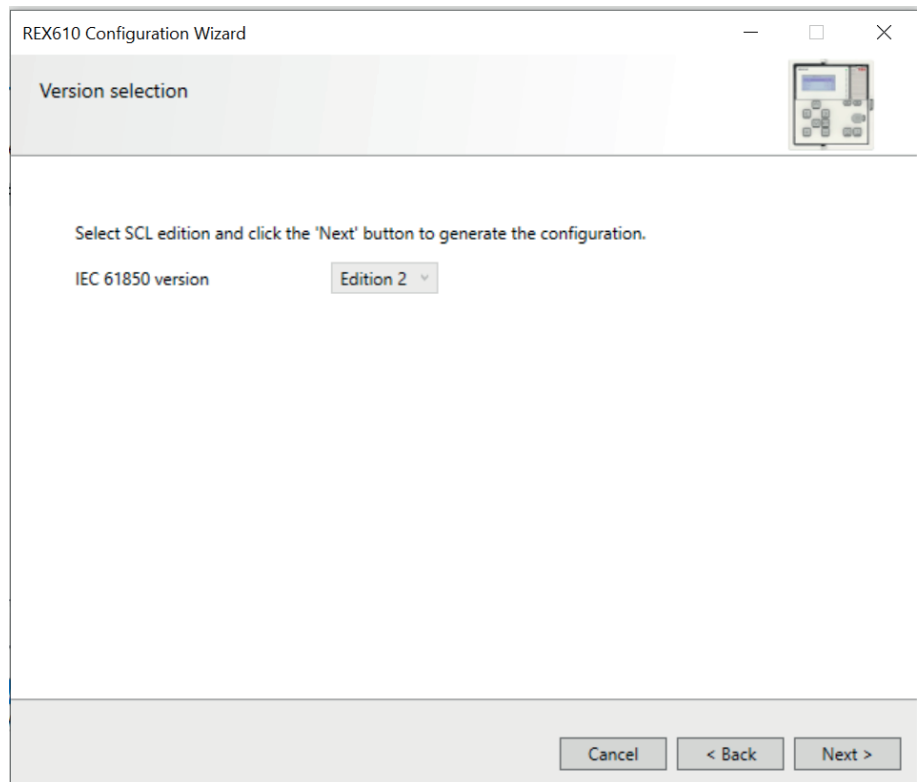


Figure 34: Version selection page



Regardless of the protocol used in the installation for each project, the IEC 61850 version must be selected when adding the first protection relay to the plant structure. After the initial selection all protection relays in the plant structure, use version Edition 2.

9. The **Summary** page shows the summary of the protection relay's IED type, version, IP address and the selected order number. Click **Finish** to confirm the configuration and conduct the insertion.

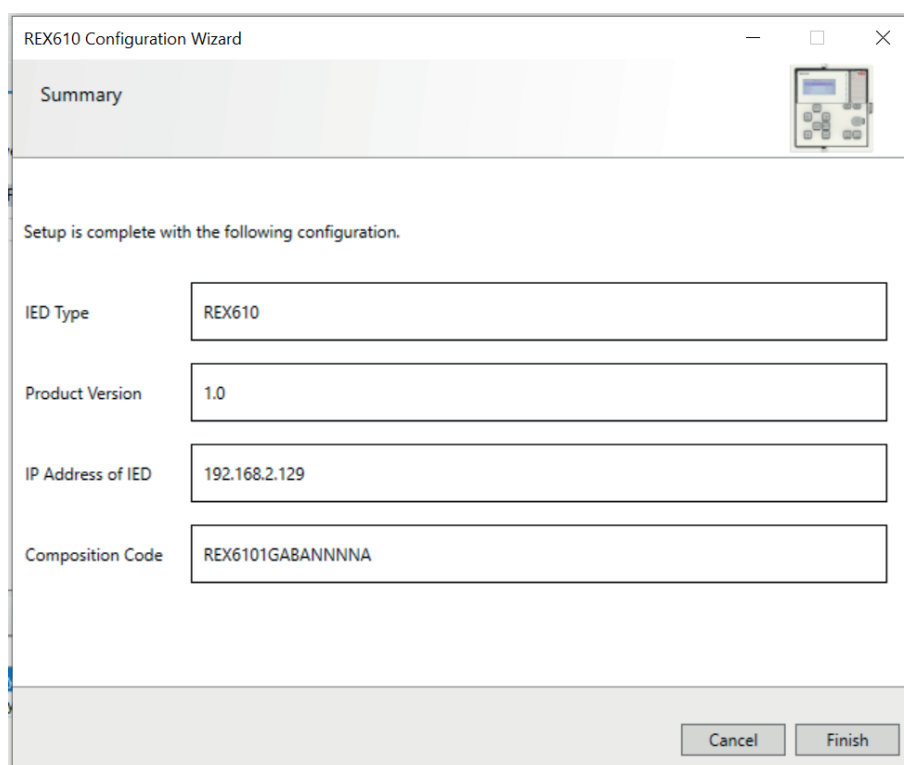


Figure 35: Summary page



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



If an error is found on the **Summary** page, it is not possible to go back and make modifications. If an error is detected, cancel the insertion by clicking **Cancel** and insert the IED again.

10. From the **Plant structure** view, check that PCM600 has turned online the IED that was inserted to the bay level.



Data cannot be scanned from the protection relay and proceeding is prevented if the IED is not online or if the IP address is not correct.

4.3.2 Inserting an IED in offline mode

When the protection relay is not available or is not connected to PCM600, engineering can be done offline. The offline configuration in PCM600 can be written to the protection relay later when it is connected.

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 protection relay is not available.

1. In the **Plant Structure** view, right-click the bay, point to **New**, point to the relay application area such as **Multiapplication IEDs** and select the protection relay type to be inserted.



Alternatively, drag an IED from the **Object Types** view to the bay level.

2. On the **Configuration mode selection** page, select **Offline configuration** and click **Next**.

Setting up an IED in the offline mode is similar as in the online mode; however, with the offline mode it is not necessary to type the correct IP address in the **Communication port and IP address** dialog box.

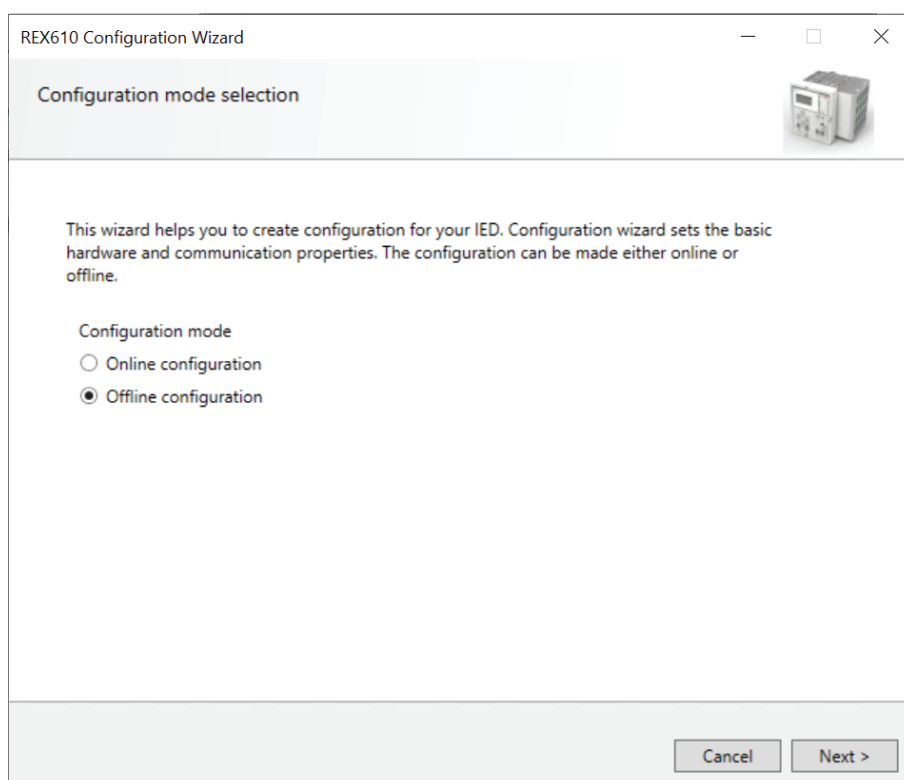


Figure 36: Configuration mode selection wizard

3. On the **IEC 61850 communication settings** page, select the USB port.

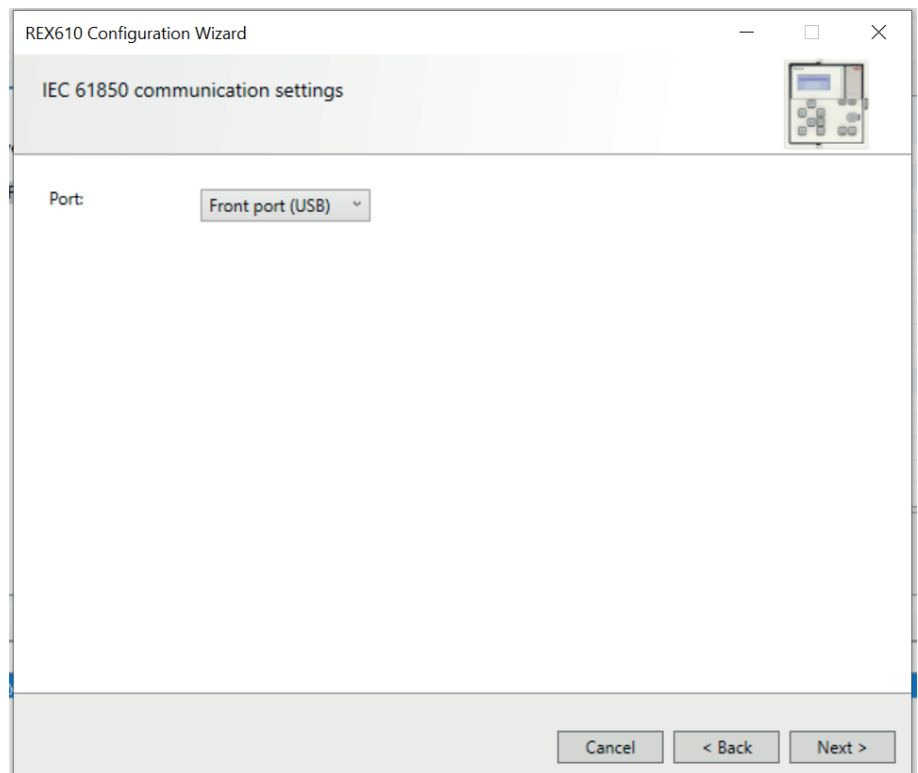


Figure 37: USB port selection

4. On **Composition code selection page**, select the correct composition codes and click **Next**.



Ensure that the composition code is correct. PCM600 verifies later that the composition code matches with the relay. If the composition code digits related to the configuration, I/O or version do not match with the relay, PCM600 does not allow writing the configuration to the device. If other digits in the composition code do not match, PCM600 informs about the mismatch with a dialog.

Configuration Item	Selected Value	Description
Product	REX610	Multiapplication IED
Language	1G	English, Global
Current inputs	A	4 currents - compression type
Voltage inputs	B	4 voltages
Communication	A	Serial RS 485 and Ethernet 100Base TX (RJ45)
Arc protection	N	No arc protection
Reserved	N	Reserved for future use
Reserved	N	Reserved for future use
Reserved	N	Reserved for future use
Hardware version	A	Hardware version A

Figure 38: Composition code selection

5. On the **Version Selection** page, select the IEC 61850 version and click **Next** to generate the functions.
6. The **Setup Complete Page** shows the summary of the IED type, version, IP address and the selected order number. Click **Finish** to confirm the configuration and conduct the insertion.

4.3.3

Inserting an IED from the template directory

IED templates can be used for replicating IEDs with the same order code in PCM600 projects. A template includes IED application configuration, communication protocol mappings and parameters. An IED in the plant structure can be exported as a template (.pcmt file). The template library can be built from 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 *Caption* in IED's **Object Properties** and the *Technical Key* that corresponds to the physical IED have to be changed.



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

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

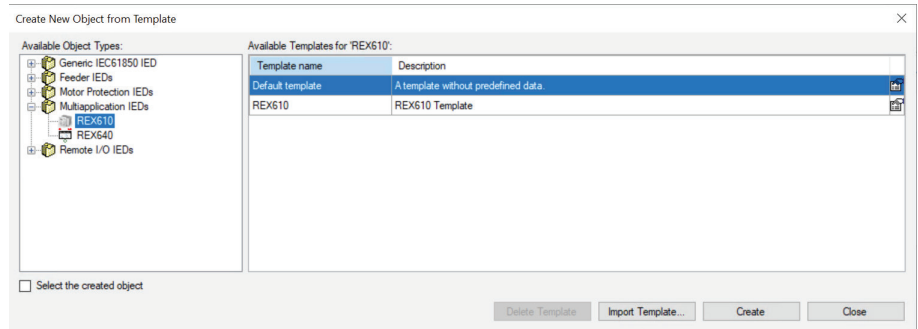


Figure 39: PCM600: Selecting an IED from the template library

2. Select the IED 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.

Template Properties

Template info

Name: REX610

Type: User-Defined Template

Creation time: 3/23/2021 9:26:28 PM

Protocol: IEC61850

Path: C:\PCMDatabases\Templates\PCM600\REX610.iied.pcmi

Description: REX610 Template

Created on

Product name: PCM600 2.10

Object type: REX610

Connectivity Package: ABB REX610 Connectivity Package

Close

Figure 40: PCM600: Template information

4. Check and verify the template information and click **Close** to close the dialog box.
The **Create New Object from Template** dialog box is displayed.
5. 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 **Close** is clicked.

6. Click **Close** when finished.

4.3.4

Inserting an IED by importing a .pcmi file

It is possible to create a new IED object in the plant structure by importing a .pcmi file.

1. In the **Plant Structure** view, right-click the bay and select **Import**.



A .pcmi file can be imported only when the bay is selected in the plant structure.

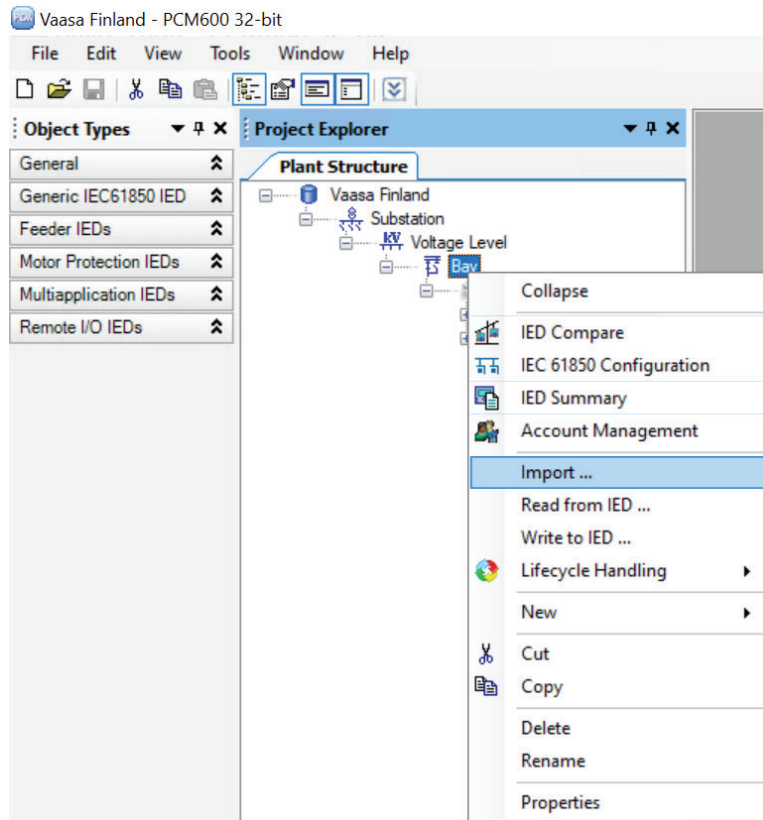


Figure 41: Importing IED configuration

2. In the **Import** dialog box, select the .pcmi file to be imported and click **Open**. After importing, the IED object is created in the plant structure.

After the .pcmi file has been imported, the IP address, the name and the technical key that correspond to the physical IED have to be changed.

4.4 Setting the IED IP address in a project

The IP address and subnet mask of the IED object in PCM600 must match the front and rear port of the protection relay (physical IED) to which the PC is connected. The IP address of the protection relay can only be set via the LHMI or Parameter Setting tool in PCM600. The PC and protection relay need to be on the same subnet.

There are two alternatives to set the IP address of an IED object in PCM600.

- 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.

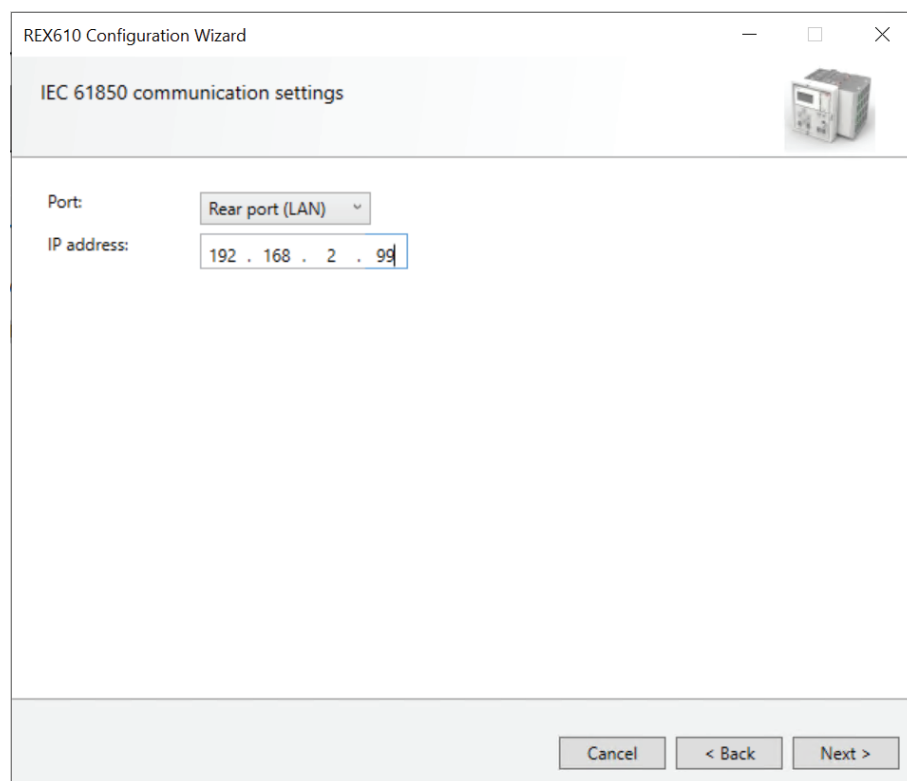


Figure 42: Alternative 1: Setting the IP address on the first wizard page

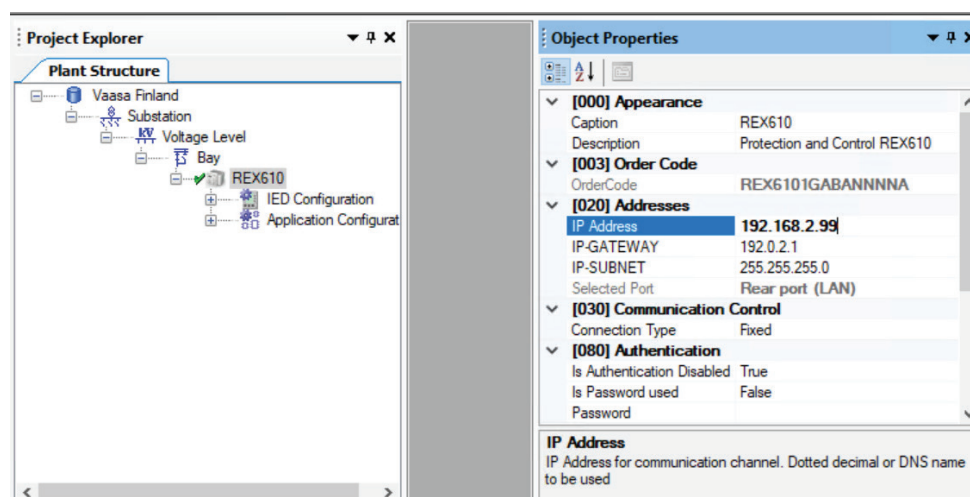


Figure 43: Alternative 2: Setting the IP address in IED's Object Properties dialog box

Choosing between the two ways depends on when the IP address is set. Typing the IP address via the IED's **Object Properties** dialog box is possible at any time while entering it via the configuration wizard can only be done when adding the IED object.

1. In the **Plant Structure** view, select the IED to which the IP address is to be entered.
2. On the **View** menu, select **Object Properties**.
Object Properties dialog box is opened.
3. Type in the IP address to the **IP Address** row.

4.5 Managing IED users

IED user authorization is disabled by default. IED user passwords can be changed on the LHMI and using the IED Users tool in PCM600.

The factory default passwords in the protection relay can be changed with Administrator user rights.



Local passwords can be changed only via the LHMI. Remote passwords can be changed via the LHMI or with PCM600.

1. Enable IED user authorization at **Main Menu/Configuration/Authorization/Passwords** on the LHMI.
2. Use the IED Users tool in PCM600 to manage the local user accounts.

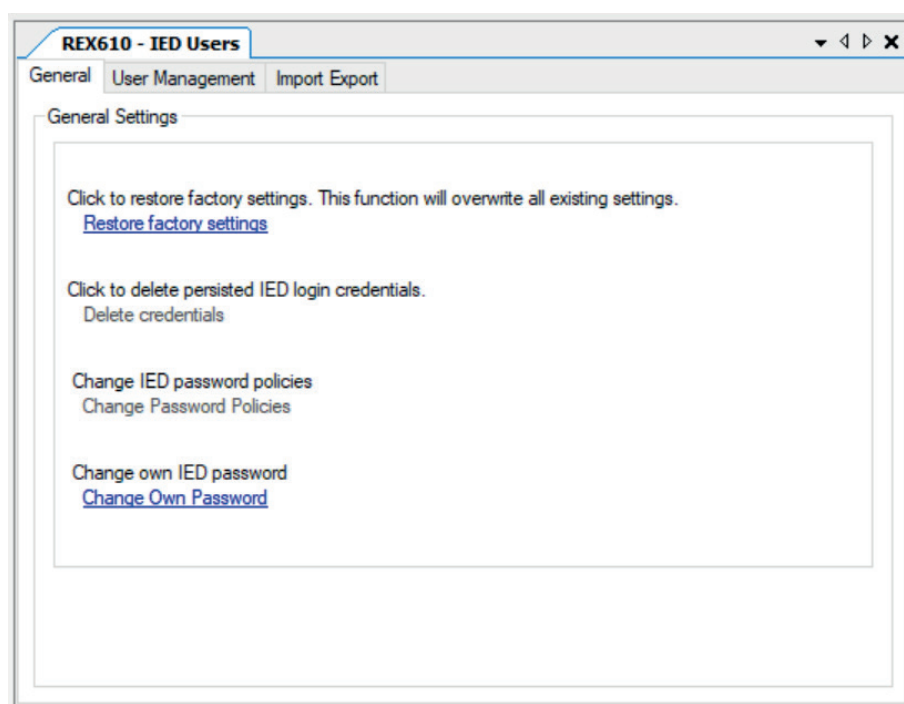


Figure 44: Managing local user accounts

- Click **Restore factory settings** to restore user management configuration (only with Administrator rights).
 - Click **Change Own Password** to change user account passwords.
3. Add or remove users on the **User Management** tab (only with Administrator rights).
User accounts can be created under any role.

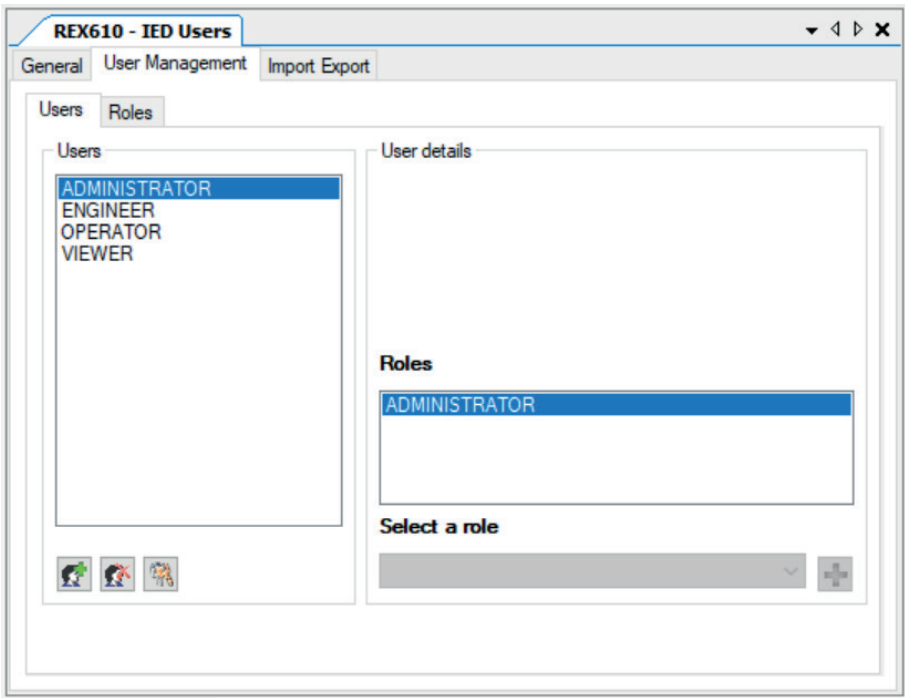


Figure 45: Adding or removing users



For more information on managing users, see the PCM600 documentation and the cyber security deployment guideline.

4.6 PCM600 project's IEC 61850 version identification

The IEC 61850 version of a PCM600 project can be identified from the Object Properties pane of the project.

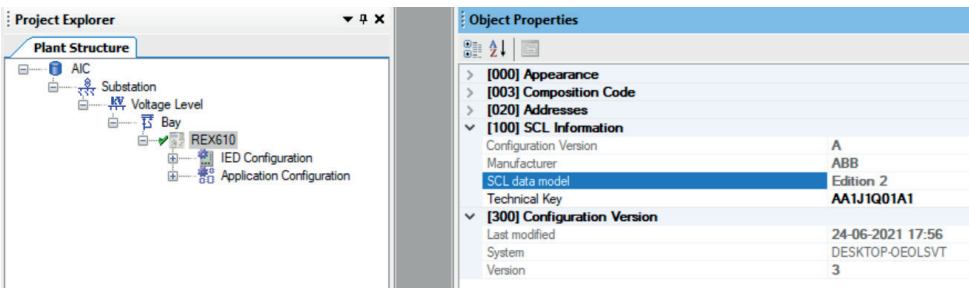


Figure 46: Project's IEC 61850 version

Section 5 Protection and control engineering

5.1 Application Configuration tool

Application Configuration tool is used to modify an application configuration for a protection relay and is based on IEC 61131-3 Function Block Diagrams.

The function blocks are dedicated to different functions.

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

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 IEC 61850 parameter list for more information.



If a function block is removed with Application Configuration, the function related data disappears from the menus as well as from the IEC 61850 data model, with the exception of some basic function blocks, which are mandatory and thus cannot be removed from the relay 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 Application Configuration tool include the ability to organize a configuration into several MainApplications as well as providing different application programming features.

- Organize 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: such as, make printouts
 - Save application configurations as templates in an application library to reuse them in other protection relays (Function blocks and related logic can be fully or partially reused depending on the functionality available in the other protection relay)
 - Validate the application configuration during the configuration process on demand and while writing the application configuration to the protection relay



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 groups according to type. The different function block types are shown in the **Object Types** view. Function block data can be modified with the Application Configuration tool.

- IEC 61850, ANSI or IEC 60617 symbol standard can be set.
- IEC or ANSI naming style can be set.
- Function blocks can be locked.
- Visibility for execution order, cycle time and instance number can be set.
- Signals can be managed.
- Boolean inputs and outputs can be inverted.

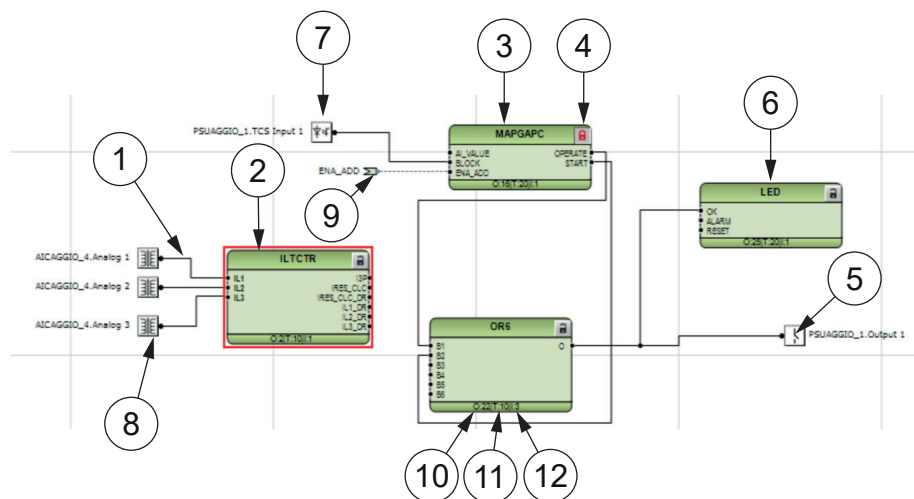


Figure 47: Application Configuration tool: function block overview

- 1 Connections
- 2 Function block, selected (red)
- 3 Function block name
- 4 Function block, locked
- 5 Hardware, binary output channel
- 6 Hardware, programmable LED
- 7 Hardware, binary input channel
- 8 Hardware, analog input channel
- 9 User-defined input variable
- 10 Execution order
- 11 Cycle time
- 12 Instance number

5.1.2 Signals and signal management

The 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.

Boolean input and output signals may need to be inverted to fulfil the logic. The Application Configuration tool supports the adding of inversion logic to a binary signal.

All input signals have a default value that is used when the signals are not connected in the configuration.

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 inserted, these parameters are shown in the Function Block Instance dialog box in the Application Configuration tool. The three parameters are selectable and not selectable depending on the function block type. The cycle time is 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.

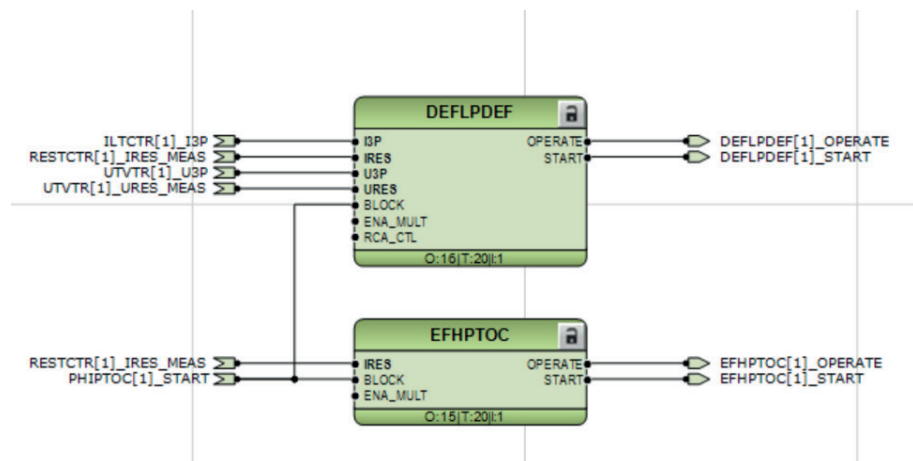


Figure 48: Application Configuration tool: an example of function block organization parameters

The *Cycle Time* is automatically set and it cannot be modified.



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

5.1.4

Execution order and feedback loops

It is possible to draw multi-layer configuration logic that contains feedback loops with the Application Configuration tool. The execution order of logic functions is calculated automatically in the Application Configuration tool, but the execution order can also be set manually. 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.



To perceive accurate time stamps from binary input signals to function blocks, direct logic connection should be used in the Application Configuration tool. Due to internal execution order,

time stamps may not be accurate if additional logic is used to connect priority signals to function blocks.

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.

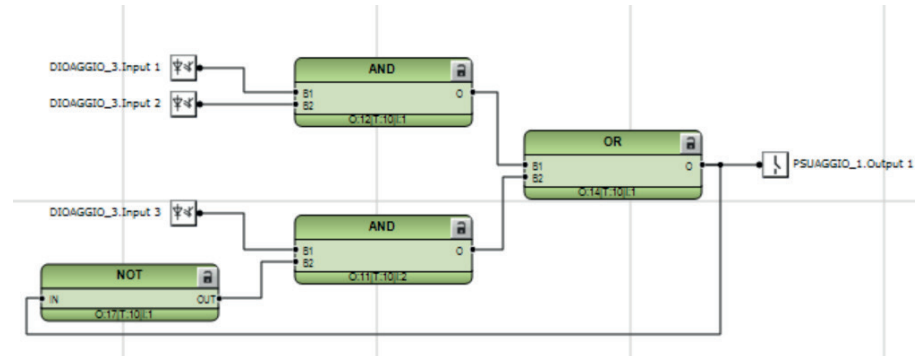


Figure 49: Feedback loop situation with automatically calculated execution orders

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.

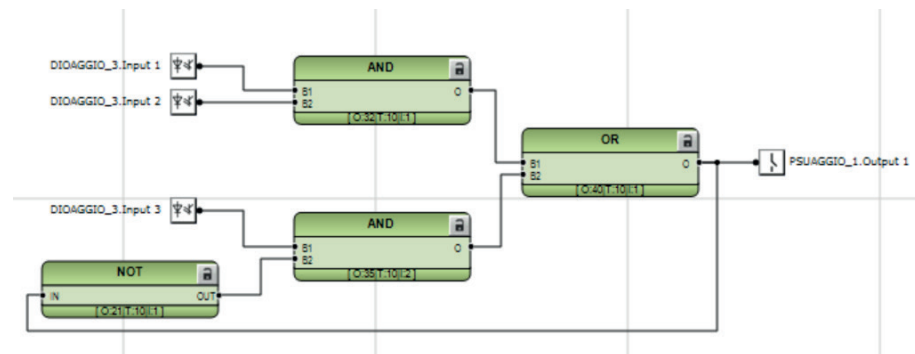


Figure 50: Feedback loop situation with manually fixed execution order for NOT port

Execution number can be changed by right-clicking the function and selecting **Change CycleTime ExecOrder**.

After manually defining the execution number, the function is no longer part of the automatic execution order calculation. The function can be included back to the automatic calculation by right-clicking the function and selecting **Include FB in calculation**.

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



It is possible to search and replace variable names in Application Configuration tool.



Connect the variables to a destination, for example to a function block or a hardware output channel. The connectivity package automatically removes the orphan variables which are not connected to any destination.

Connection validation

A connection is only useful or even possible between two signals of the same base attribute type.

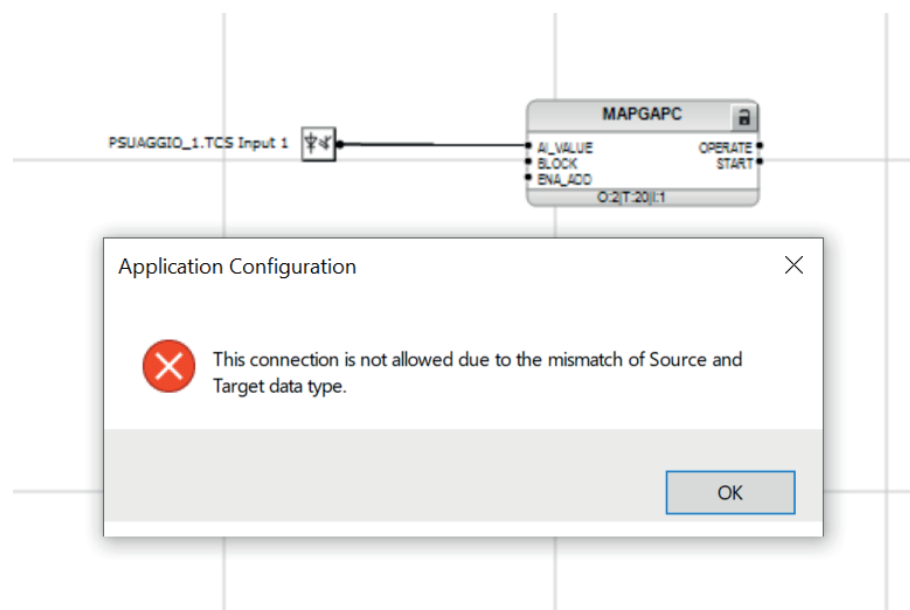


Figure 51: Application Configuration tool: an error message of a signal mismatch for a connection

5.1.7 Hardware channels

Hardware channels can only be connected to a function block input or output. A hardware connection can be established 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.

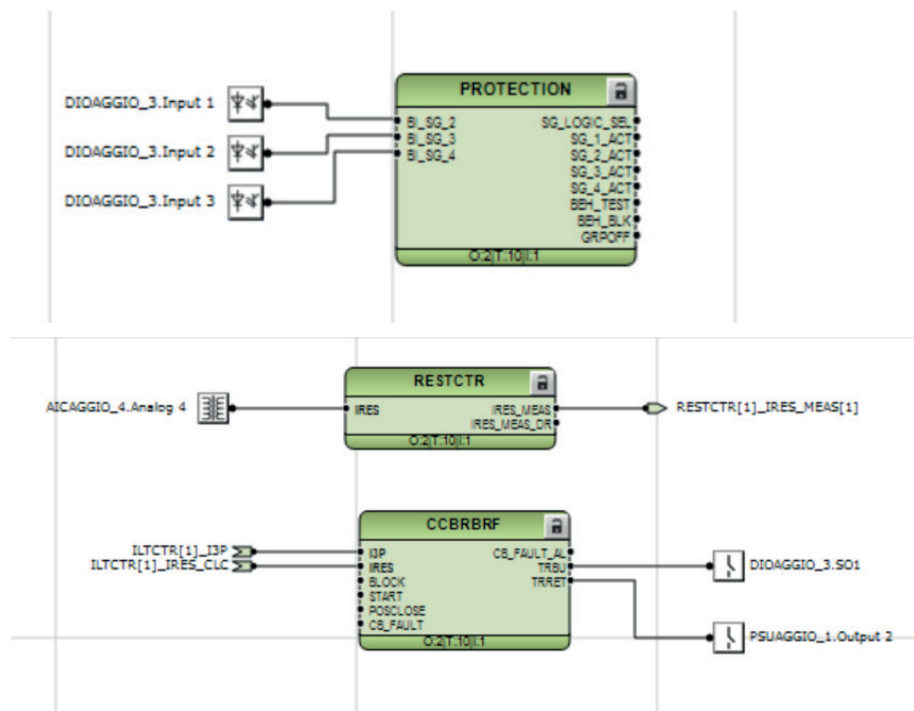


Figure 52: Application Configuration tool: HW signal channels

There are three types of supported hardware channels.

- Binary input channels
- Binary output channels
- Analog input 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 based on the rules that govern the creation of the application at three different times.

- 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 protection relay

5.1.8.1 Validation when creating an application configuration

Validation is made when creating the application configuration.

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

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 an output from a higher execution order function is connected 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 protection relay. However, errors must be corrected before writing the application configuration to the protection relay. The application configuration can be saved and the Application Configuration tool can be closed with open errors, but the application configuration cannot be written to the protection relay.

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 problem was identified.

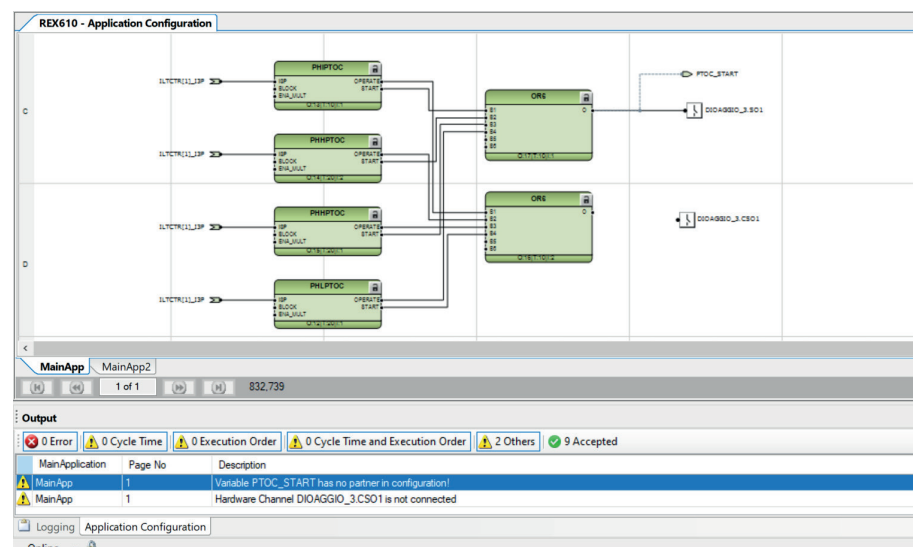


Figure 53: Application Configuration tool: validation on demand

5.1.8.3 Validation when writing to the protection relay

When writing the application configuration to the protection relay, an automatic validation is performed. The validation is the same as the manually demanded validation. Errors abort the writing.

5.1.9 Configuration load calculation

Connectivity package calculates an estimated application configuration load every time it is saved in the Application Configuration tool or while writing to the IED. This functionality prevents too complex configurations from being used and possibly risking IED protection functionality.

If the calculation result is more than 100%, the configuration is too large for the IED to handle and PCM600 prevents writing the configuration to the IED.

It is recommended to verify the configuration load also with an actual IED and actual settings when exceeding the calculation result of 90% or when using GOOSE on a larger scale.



The calculation result is only visible in PCM600 output window inside Logging tab.

Date and Time	Category	User	Object	Message
2/25/2022 1:41:11.222 PM	Fatal		REX610_122	Estimated configuration load is 100 %. This is not allowed. Estimated load can be decreased by removing some functionality with Application Configuration.

Figure 54: Configuration load result: an example of nearby maximum capacity

5.2 Parameter Setting tool

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



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



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

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

- Configuration parameters
- Setting parameters

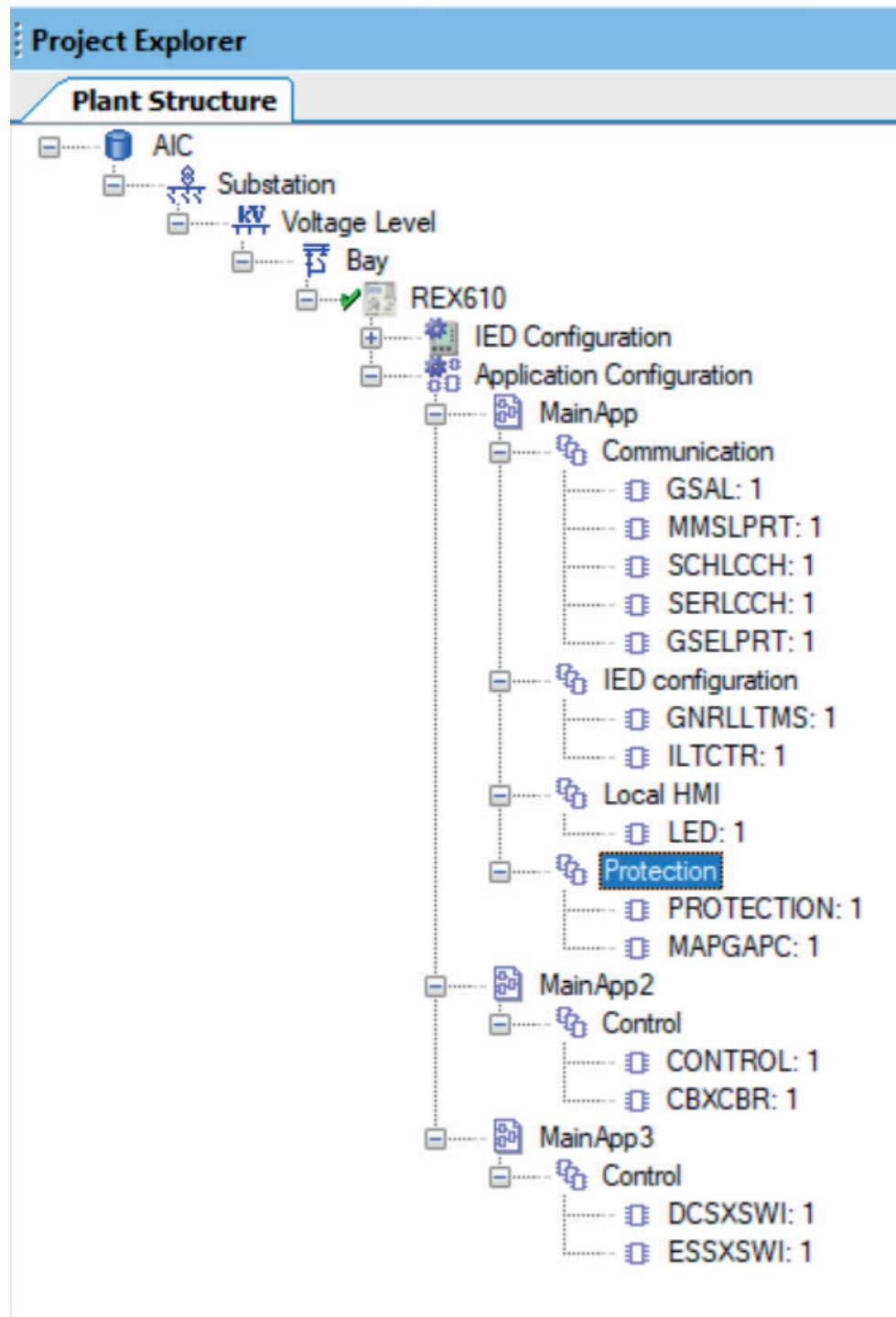


Figure 55: Plant structure in Parameter Setting

5.2.1 Configuration parameter

Configuration parameter specifies the operation mode of an application function or of the protection relay. These are basic configurations that are normally configured only once and then not modified again. The protection relay configures itself during start-up 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 protection relay at runtime.

5.2.3 Setting group

Nearly all settings used by the protection relay for protection application functions are organized into a group of settings. Up to four setting groups can be configured with different values.

The protection relay supports the selection of a setting group at runtime.

5.2.4 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 Application Configuration tool is used for adding or removing function blocks, for example, GOOSE receiving function blocks.

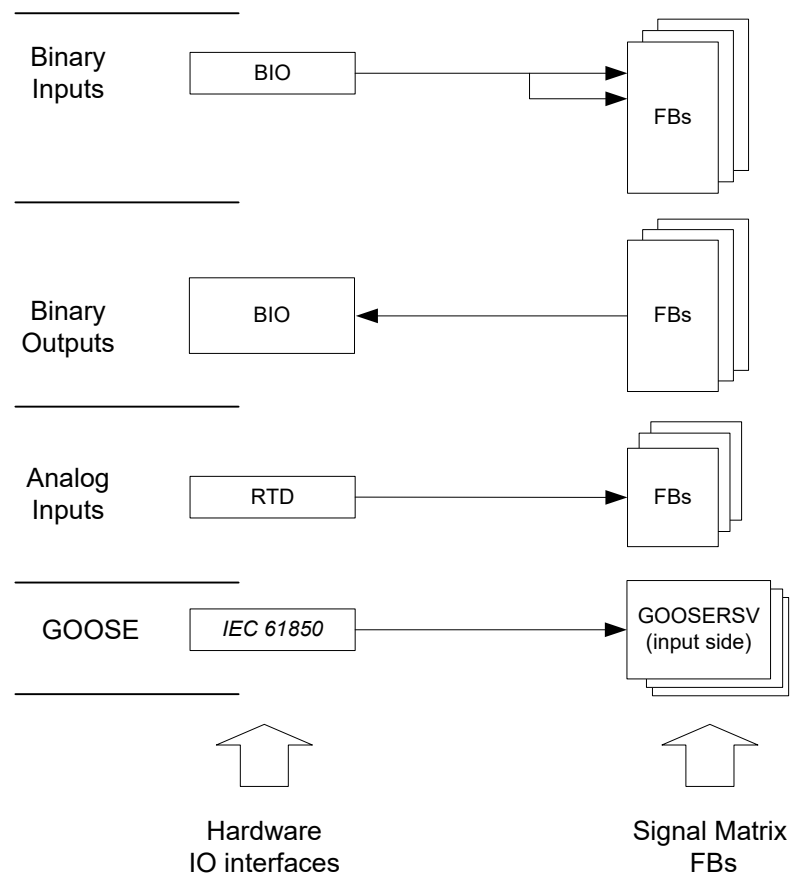


Figure 56: Signal Matrix: operation principles

A binary input channel can be connected to one or more function block inputs. If a binary input channel is connected to several different function blocks in the Application Configuration tool, the connection appears as glue logic in Signal Matrix.

A binary output channel can only be activated from one function block output. If it is activated from more than one function block output, the glue logic has to be used.

Glue logic means inserting a logical gate (OR and AND blocks) between the binary input and the function blocks or between the function blocks and the binary output channel. This can be engineered with the Signal Matrix tool.



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

		PSUAGGIO_1		DIOAGGIO_3	DIOAGGIO_3					
		TCS Input 1	TCS Input 2	- DIOAGGIO_3	Input 1	Input 2	Input 3	Input 4	Input 5	Input 6
- CBXCBBR(I<->O CB):1	POSOPEN									X
CBXCBBR(I<->O CB):1	POSCLOSE								X	
	ENA_OPEN									
	ENA_CLOSE									
	BLK_OPEN									
	BLK_CLOSE									
	AU_OPEN									
	AU_CLOSE									
	TRIP									
	SYNC_OK									
	SYNC_ITL_BYP									

		PSUAGGIO_1	DIOAGGIO_3	DIOAGGIO_3			
		Output 1	Output 2	SO1	SO2	CSO1	CSO2
- CBXCBBR(I<->O CB):1	SELECTED						
CBXCBBR(I<->O CB):1	EXE_OP	X					
	EXE_CL		X				
	OP_REQ						
	CL_REQ						
	OPENPOS						
	CLOSEPOS						
	OKPOS						
	OPEN_ENAD						
	CLOSE_ENAD						

Figure 57: Signal Matrix: a connection between binary input channels to binary input signals

The Signal Matrix tool has a separate sheet for each possible combination.

- Binary inputs
- Binary outputs
- Analog inputs
- GOOSE

5.4 IED Compare

IED Compare is used to compare the IED configurations of two IEDs of the same type. It generates a text report which lists the differences between the IED configurations. IED Compare provides an option to compare an IED configuration

stored in PCM600, IED or .pcmi file. IED Compare can compare certain types of IED configurations and parameters.

- Application configuration
- Display configuration
- GOOSE receive configuration
- Parameters



Application comparison also compares the system function blocks.



Display comparison compares two display pages with a delta of two pixels.



Detailed instructions are shown in PCM600 documentation.

5.4.1

Starting IED Compare

- Start **IED Compare** in the shortcut menu in plant structure.
 1. In the PCM600 plant structure, right-click **Substation, Voltage level, Bay** or **IED**.
 2. Select **IED Compare**.
- Start **IED Compare** from the PCM600 main menu.
 1. Select **Substation, Voltage level, Bay** or **IED** in the PCM600 plant structure.
 2. On the PCM600 menu bar, point to **Tools** and select **IED Compare**.

5.4.2

IED Compare tool interface

The comparison report shows differences in the configuration of two IEDs. Hardware, application, display, GOOSE and parameter configuration differences are grouped and listed under the corresponding headings.

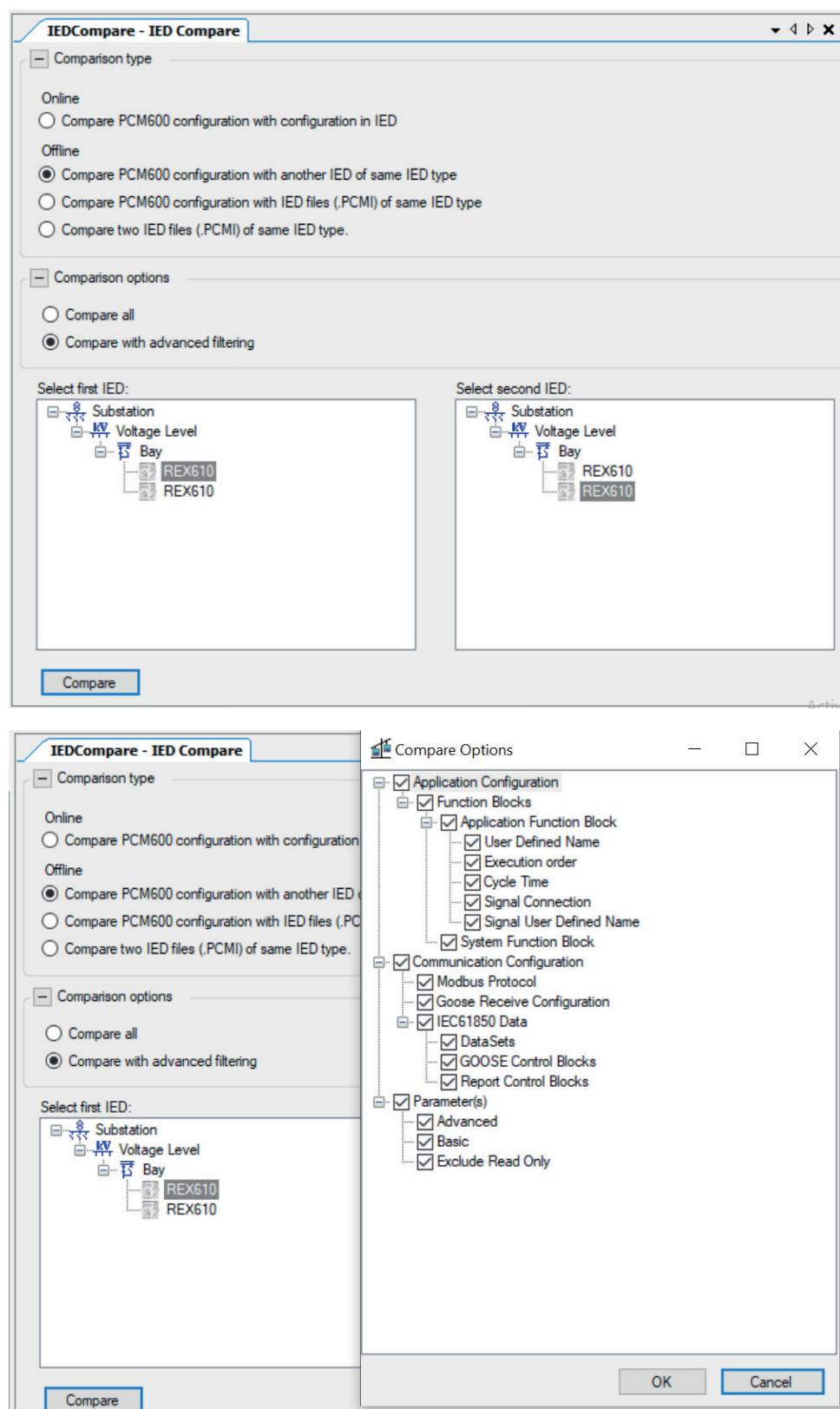


Figure 58: Compare options

Each configuration group can be expanded or collapsed by clicking the plus (+) or minus (-) button next to it in the result grid.

The reports must be read from left to right row-wise.

Compare PCM600 configuration with another IED of same IED type			
	Configuration Group	REX610 (AA1J1Q01A1)	REX610 (AA1J1Q01A2)
▶ +	Application Configuration		
–	Communication Configuration		
		No differences found	
–	GOOSE Receive Configuration		
		No differences found	
–	IEC61850 Configuration		
		No differences found	
–	Parameter(s)		
		No differences found	

Figure 59: Compare report

Table 5: Acronyms used in a report

Acronym	Description
DA	Data attribute
DO	Data object
IED	Intelligent electronic device
LN	Logical node
SIG	Signal

5.5 Protection and control blocking examples

All of the relay's logical nodes are set with *Test mode*. *Test mode* is selected through one common parameter via the HMI path **Tests/IED test**. By default, *Test mode* can only be set locally through LHMI. *Test mode* is also available via IEC 61850 communication (LD0.LLN0.Mod).

Table 6: Test mode

Test mode	Description	Protection BEH_BLK
Normal mode	Normal operation	FALSE
IED blocked	Protection working as in "Normal mode" but ACT configuration can be used to block physical outputs to process. Control function commands blocked.	TRUE
IED test	Protection working as in "Normal mode" but protection functions are working in parallel with test parameters.	FALSE
IED test and blocked	Protection working as in "Normal mode" but protection functions are working in parallel with test parameters. ACT configuration can be used to block physical outputs to process. Control function commands blocked.	TRUE

The mode of all logical nodes located under CTRL logical device are set with *Control mode*. *Control mode* is selected via the HMI or PCM600 path **Configuration/Control/General**. By default, *Control mode* can only be set locally through LHMI. *Control mode* inherits its value from *Test mode* but *Control mode* "On", "Blocked" and "Off" can also be independently set. *Control mode* is also available via IEC 61850 communication (CTRL.LLN0.Mod).

Table 7: *Control mode*

Control mode	Description	Control BEH_BLK
On	Normal operation	FALSE
Blocked	Control function commands blocked	TRUE
Off	Control functions disabled	FALSE

According to IEC 61850, the physical outputs to process should be blocked when device is set to blocked or test blocked mode. The usage depends heavily on the actual ACT configuration. In the protection blocking example the main trip from TRPPTRC1 is blocked, and in the control blocking example the CBXCBR1 is blocked. Both comply to the IEC 61850. In real applications some of PTRC's might also be used for signalling purposes (GOOSE) and blocking and interlocking via IO.

5.5.1

Protection blocking example

The physical outputs to process can be blocked with "IED blocked" and "IED test and blocked" modes. If physical outputs need to be blocked, the application configuration must block signals or function blocks that affect primary apparatuses. Blocking scheme needs to use the BEH_BLK output of the PROTECTION function block.

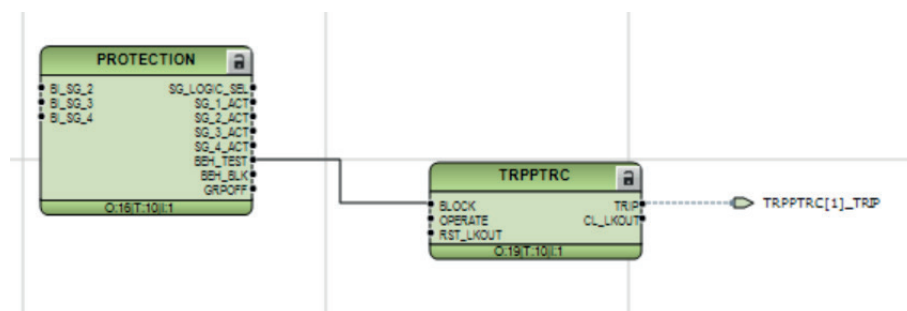


Figure 60: *Master trip TRPPTRC blocked using Protection function block BEH_BLK output*

5.5.2

Control blocking example

The physical outputs to process can be blocked with "Blocked" mode. If physical outputs need to be blocked, the application configuration must block signals or

function blocks that affect primary apparatuses. Blocking scheme needs to use BEH_BLK output of CONTROL function block.

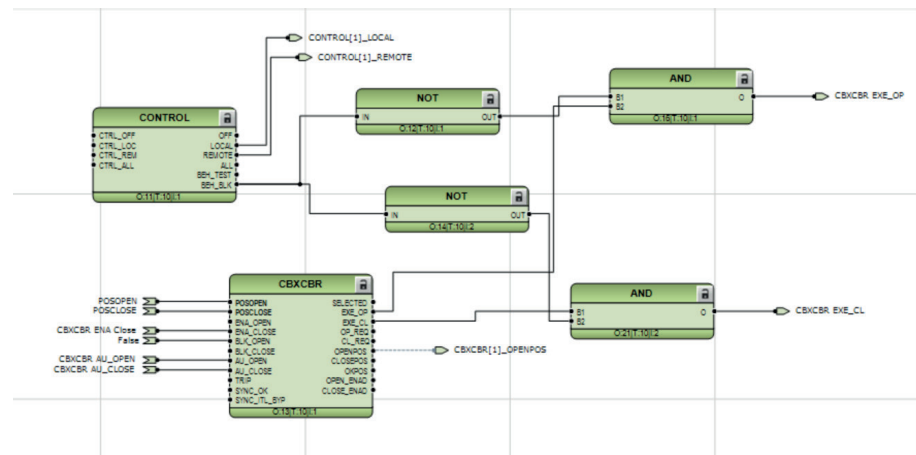


Figure 61: Circuit breaker control CBXCBR1 blocked using Protection function block BEH_BLK output

Section 6 IEC 61850 communication engineering

6.1 IEC 61850 protocol references and pre-conditions

To engineer the IEC 61850 protocol interface for the protection relay, 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 protection relay to be engineered
- The IEC 61850 parameter list

6.2 IEC 61850 interface



REX610 supports only IEC 61850 Edition 2. For more information on the implementation of IEC 61850 in protection relays, see IEC 61850 engineering guide and conformance documents.

6.2.1 IEC 61850 interface in the protection relay

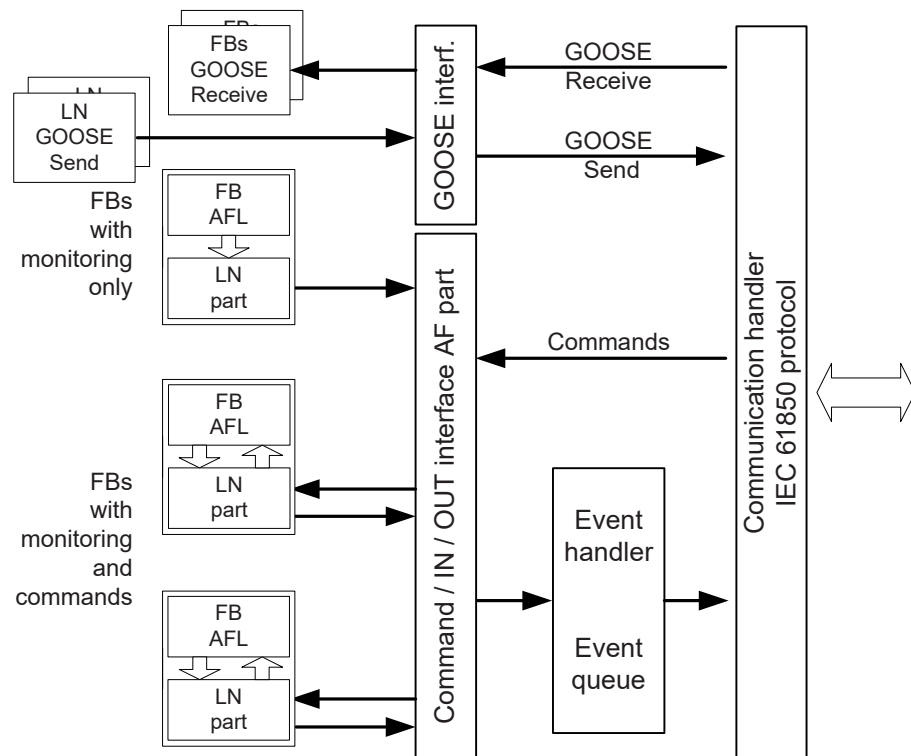


Figure 62: IEC 61850 communication interface principle

IEC 61850 provides a method for identifying all signals that belong to a function. These signals are identified through the logical nodes representing the functions. All signal information for commands and monitoring are available in logical nodes.

Whenever a function block is instantiated in the Application Configuration tool, PCM600 automatically generates the corresponding logical node data.

6.2.1.1 GOOSE data exchange

The IEC 61850 protocol supports a method to directly exchange data between two or more devices (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 handles it. The telegrams are multicast sent and not acknowledged by the receiver.

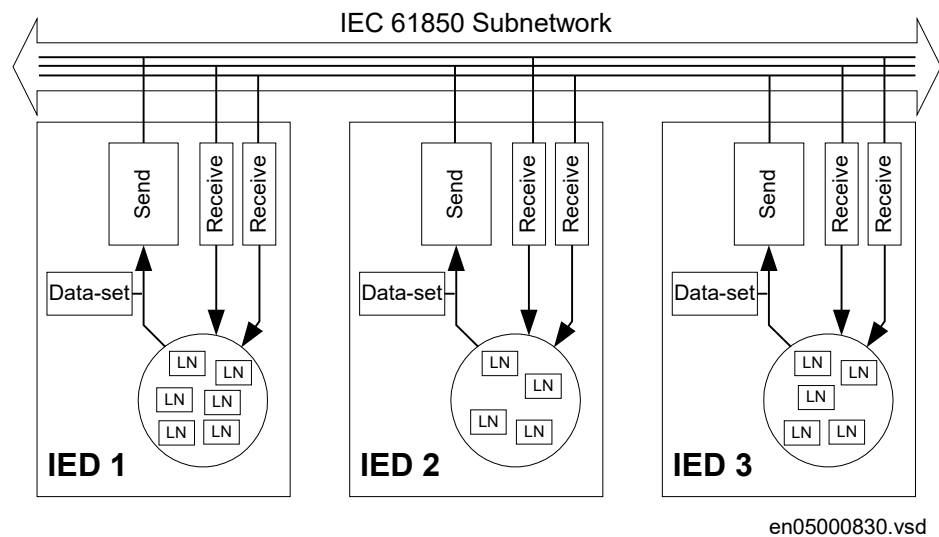


Figure 63: IEC 61850: Horizontal communication principle, an example of three IEDs where each IED communicates with all others

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, IEC 61850 Configuration tool or a system engineering tool such as IET600. The task involves configuring lists with the signal, value and quality (data attributes or data objects) 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 device's application configuration. The SCL data generated by the IEC 61850 Configuration tool or IET600 (or any other station configuration tool) contains the GOOSE data sets as input data. The input data must be connected to a GOOSE receive function blocks in the Signal Matrix tool.

6.2.2

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 IEC 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.

6.2.3 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 report control blocks predefined by ABB. Adding or editing data sets should be done with IEC 61850 Configuration tool or any other system engineering tool such as IET600.
- 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.
- IID = Instantiated IED description
 - The IID file contains a complete IED configuration, like the CID file. The IID file can include references to other devices which are not present in the file. The IID file is meant for transferring configuration data from IED configuration tool to a system configuration tool.



The uploading of IEC 61850 communication configuration is not supported when reading a configuration from an online IED. The PCM600 project works as a repository for the IEC 61850 configuration.

6.3 IEC 61850 engineering process

The IEC 61850 standard defines how information is communicated 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 an SCL file from PCM600, the tool builds a default substation structure and creates 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 IET600 are used as the system configuration tools. Another option is to use the IEC 61850 Configuration tool inside PCM600. In that case the SCL file export and import operations (steps 1 and 3) are not needed.

1. SCL files are exported from PCM600. In this case, an 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, IEC 61850 Configuration tool or IET600.
3. SCL files are imported to a PCM600 project. In this case, it is the updated SCD file.

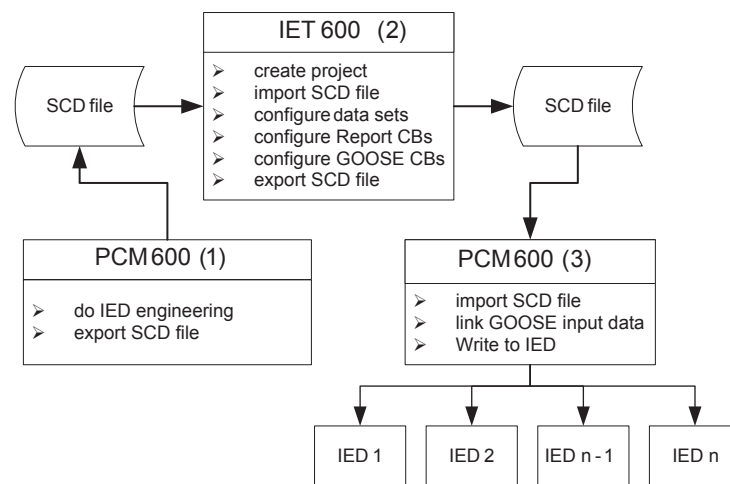


Figure 64: IEC 61850: signal engineering procedure flow when a complete station is exported as an SCD file

6.3.1

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.

6.3.1.1

Exporting SCD files

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

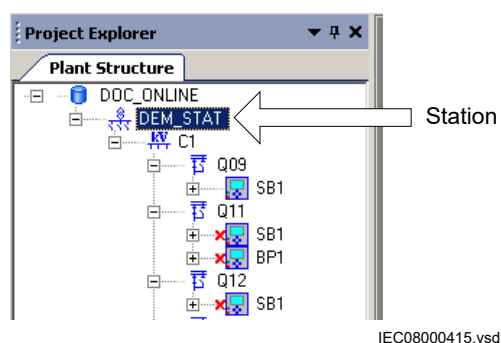


Figure 65: IEC 61850: selecting the station

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.

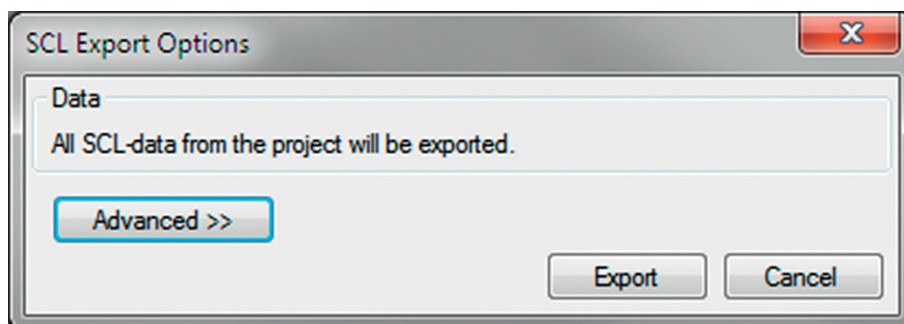


Figure 66: IEC 61850: selecting the SCL export option

5. Change the SCL file version by clicking the **Advanced** button, if required by the receiving configuration tool.

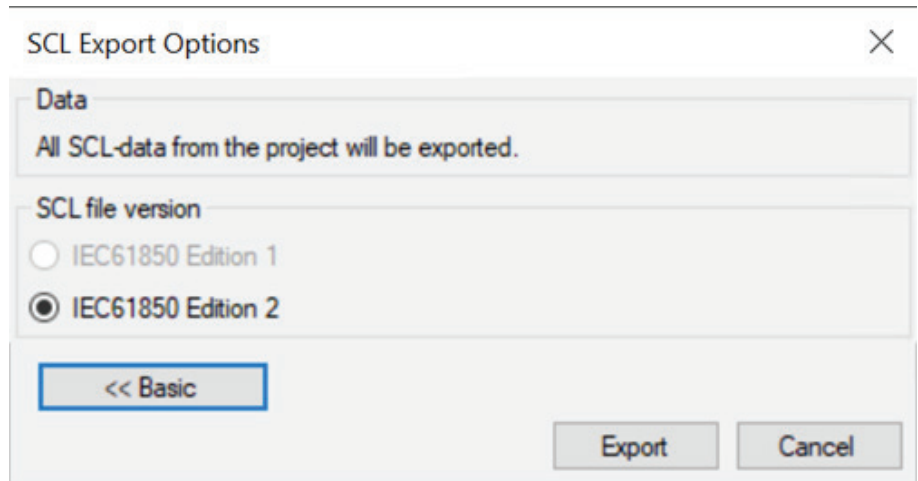


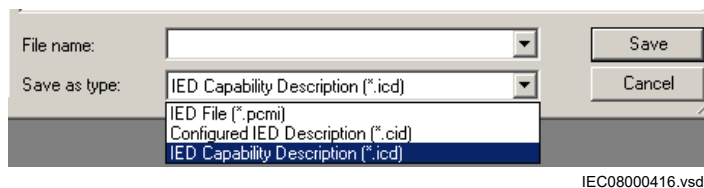
Figure 67: Export options of SCL

6. Click **Export** to generate the SCD file.
A progress window shows the ongoing export of the station.

6.3.1.2

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



IEC08000416.vsd

Figure 68: IEC 61850: export IED file type selection

4. Click **Save**.
The **SCL Export Options** dialog box opens.
5. Select the export options.

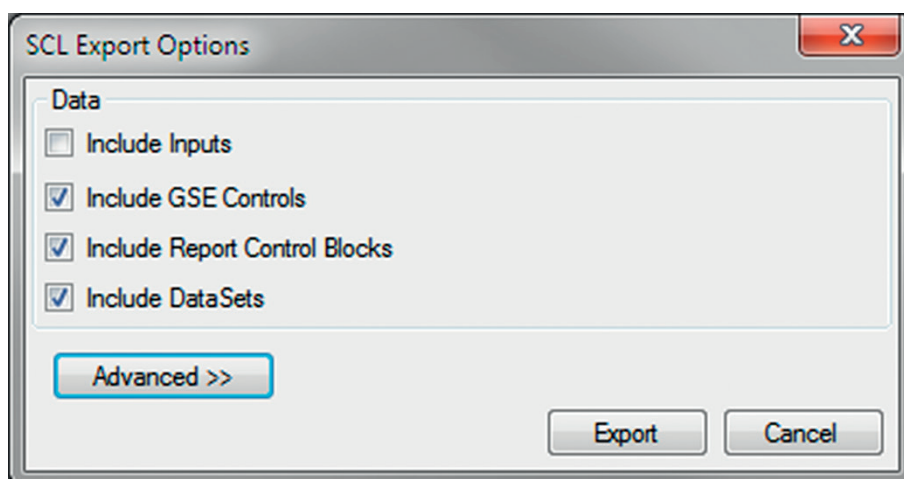


Figure 69: IEC 61850: export options for ICD files

6. Change the SCL file version by clicking the **Advanced** button, if required by the receiving configuration tool.

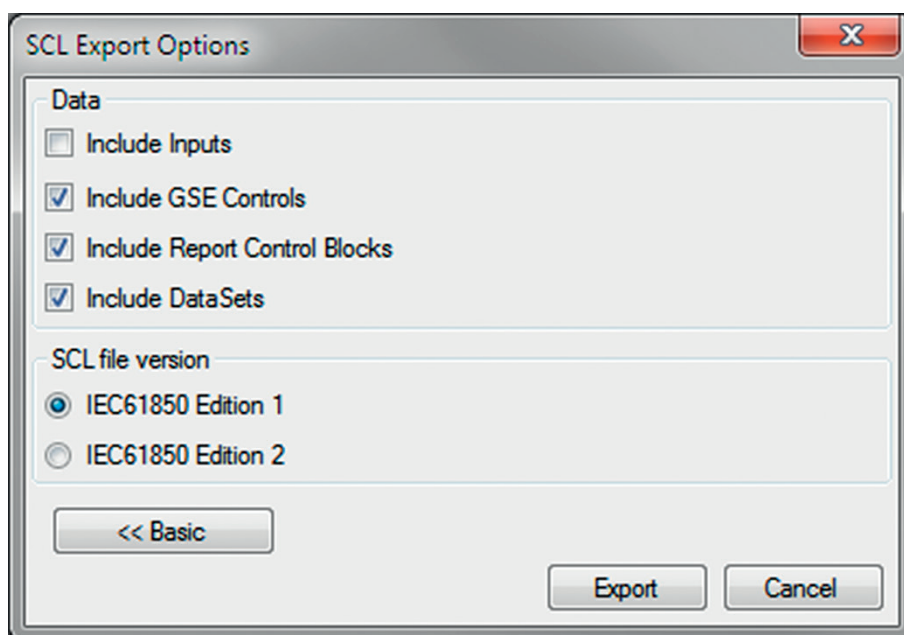


Figure 70: SCL export options

7. Click **Export**.

6.3.2 Engineering vertical and horizontal communication

For IEC 61850 engineering, a separate system configuration tool needs to be used with PCM600.

1. Create a project in IET600. ^[1]
2. Import the SCD file created by PCM600. ^[1]
3. Conduct vertical communication engineering (monitoring direction).
 - 3.1. Configure and/or reconfigure the default data sets.



Data sets meant for vertical reporting can only contain data on the data object level, not on the data attribute level.



The data set for GOOSE can contain signals on the data attribute or data object level. Data object level GOOSE entries can only be received of the following CDC types: SPS, SPC, ACD, ACT, DPS, DPC, INC, INS, ENC and ENS.

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



Up to five report clients can be configured.

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



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

- 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. Export the updated SCD file. ^[1]



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

[1] Applicable when using IET600

6.3.3 Importing SCL files to PCM600

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

To be able to import an SCD file at station level, the option IED 61850 configuration engineering mode enabled has to be cleared in PCM600.

1. On the **Tools** menu, select **Options** and click **IEC 61850 Configuration**.
2. Clear the option **IED 61850 configuration engineering mode enabled** and click **OK**.

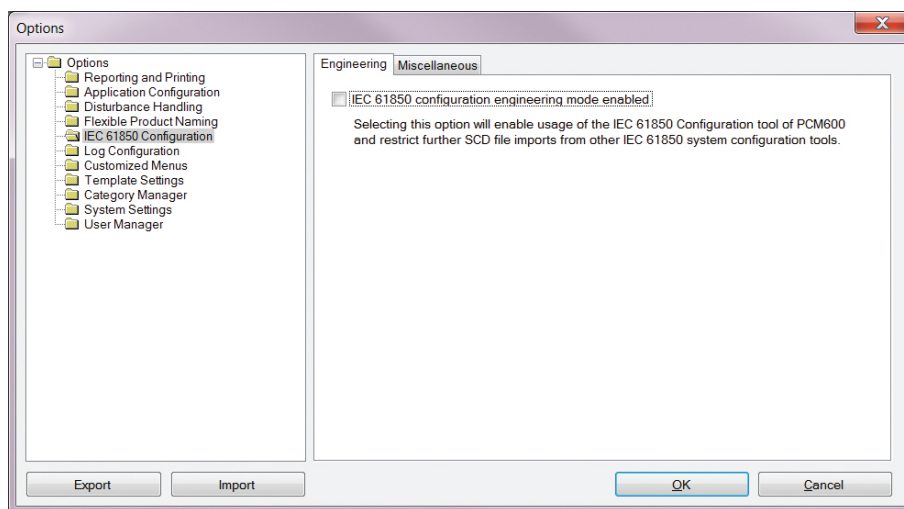


Figure 71: Enabling SCD file import at station level

If the IED 61850 configuration engineering mode is enabled, SCD files cannot be imported and an error message is shown.

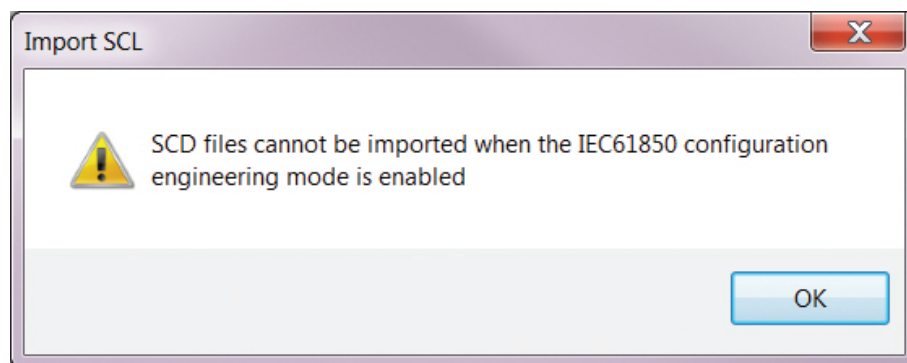


Figure 72: Error message when SCD files cannot be imported

6.3.3.1

Importing SCD files

To be able to import an SCD file at station level, the option IED 61850 configuration engineering mode enabled has to be cleared in PCM600.

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, querying how the file should be handled during the import.

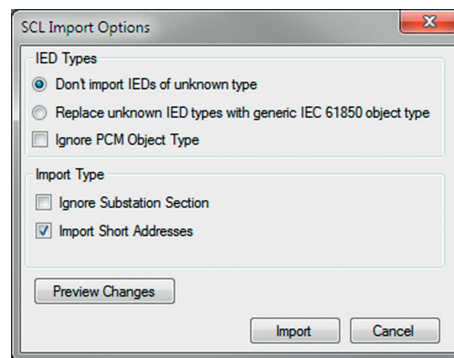


Figure 73: SCL Import Options

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 PCM600. This option can be used, for example, when third party IEDs are included in the system and the SCD file sends GOOSE messages to ABB IEDs included in the project.
 - 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**.

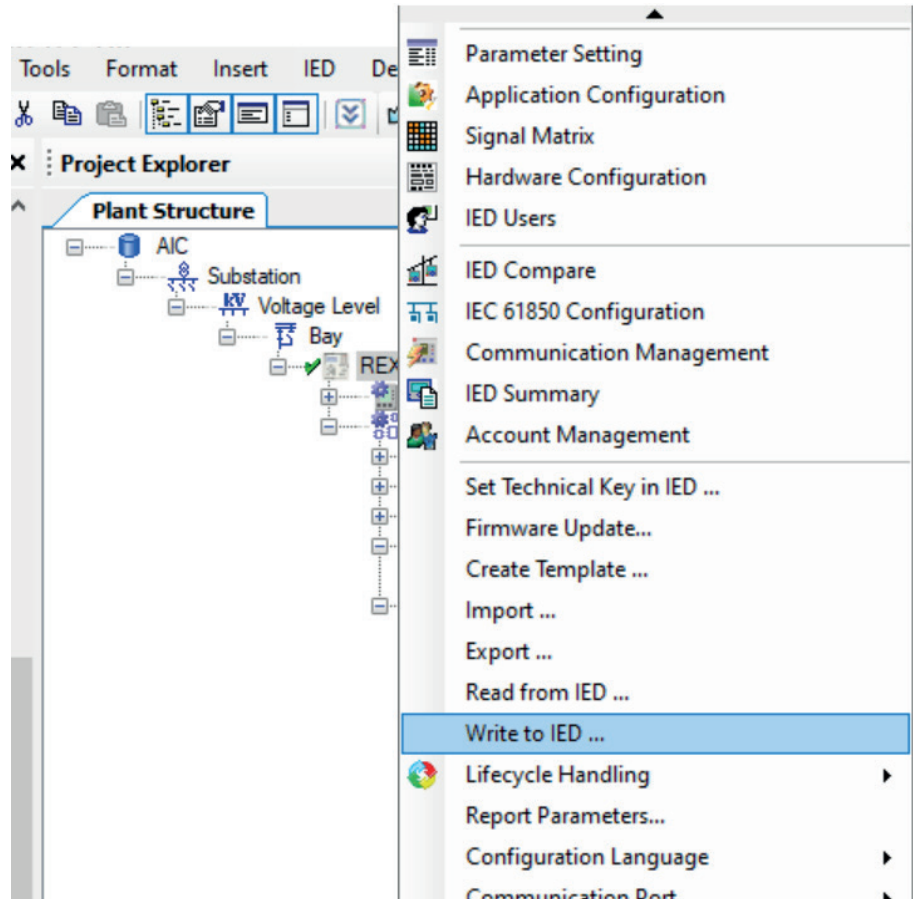


Figure 74: Common write menu



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

6.3.3.2 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.

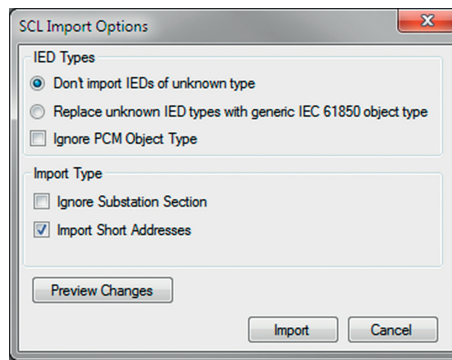


Figure 75: SCL Import Options

- **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.

6.3.4

Writing communication configuration to the IED

IEC 61850 communication depends on the proper communication configuration in all IEDs that communicate via IEC 61850.

It is possible to make a configuration change in one IED, without affecting the horizontal communication (GOOSE) engineering between IEDs. For example, when the Application Configuration tool configuration is changed, but no changes are done to the instantiation or deletion of functions that represent a logical node.

When a changed configuration is written to the protection relay, the horizontal communication configuration needs to be updated.

1. Select which configuration part to include in writing.
 - Select **GOOSE** to update the GOOSE configuration part in the IED.
 - Select **Process bus (IEC 61850-9-2)** to update the IEC 61850-9-2 configuration part in the IED.
2. Select whether or not to update the configuration.

-
- Click **Continue** to update the selected communication configuration part(s) in the IED. The options can be left unselected. In this case, other parts of the configuration are updated.
 - Click **Cancel** to cancel the whole writing operation.

6.3.5

Adding or removing hardware cards

A hardware module can be added or removed using the supported hardware modules in the optional card space. The optional hardware modules can also be replaced with other supported hardware modules in the slot. A hardware configuration change in Hardware Configuration of PCM600 also updates the composition code in PCM600 Object properties.

1. In the **Plant Structure** view, right-click the IED and select **Hardware Configuration**.

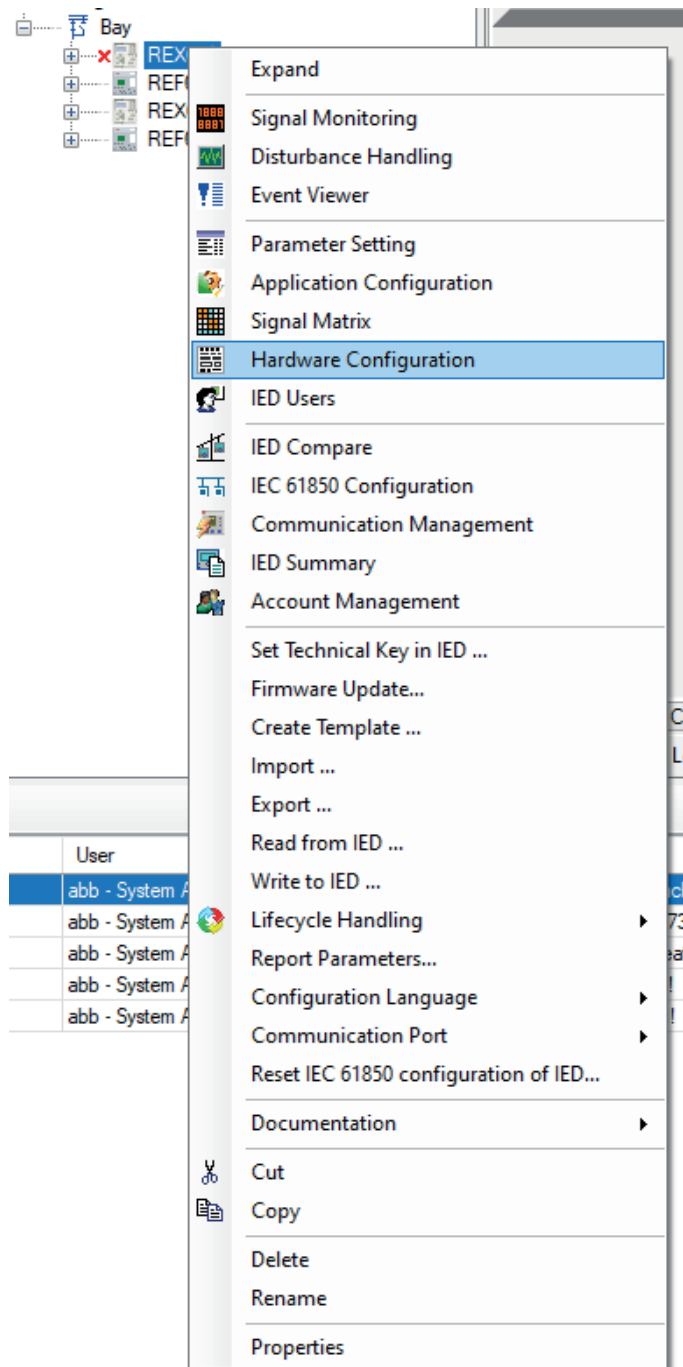


Figure 76: Opening Hardware Configuration

2. Add or remove cards.

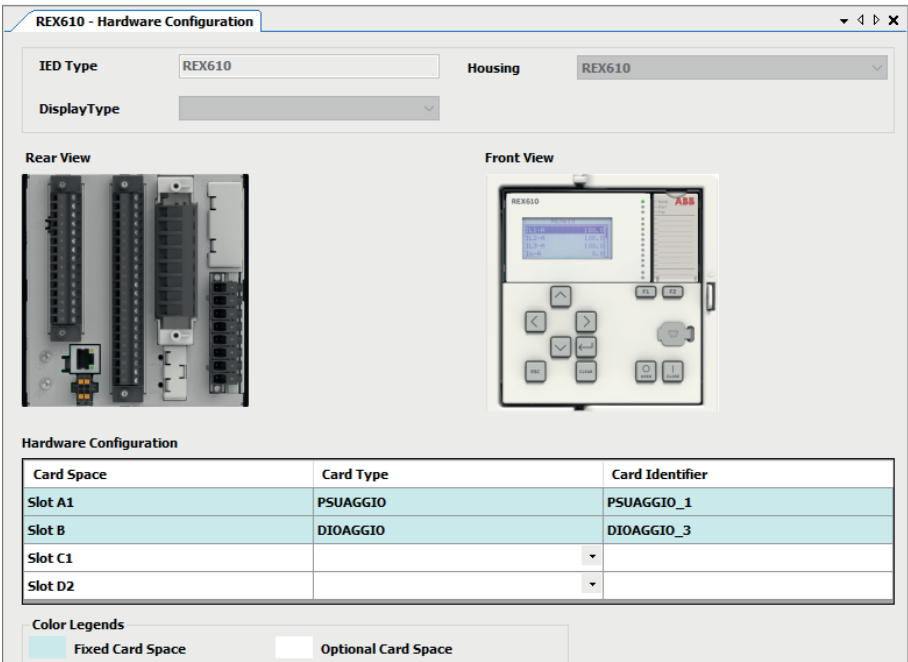


Figure 77: Adding or removing hardware cards

- Add or replace a hardware module by selecting the applicable cards in the **Card Type** column to match with the IED hardware cards.
 - Remove a hardware module by removing the option available in the optional card space for the slot.
3. When applicable, update the application configuration to write valid configuration to the IED.



Fixed card space cannot be changed in the Hardware Configuration tool. Modifications are allowed in the optional card space only. For more information on the Hardware Configuration tool, see the PCM600 documentation. See the installation manual for instructions on how to safely add or remove hardware in the relay.

Section 7 Glossary

ACT	1. Application Configuration tool in PCM600 2. Trip status in IEC 61850
ANSI	American National Standards Institute
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
DA	Data attribute
DHT	Disturbance Handling tool in PCM600
DO	Data object
EMC	Electromagnetic compatibility
Ethernet	A standard for connecting a family of frame-based computer networking technologies into a LAN
EVT	Event Viewer tool in PCM600
Firmware	System software or hardware that has been written and stored in a device's memory that controls the device
FTP	File transfer protocol
FTPS	FTP Secure
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
IET600	Integrated Engineering Toolbox

IID	Instantiated IED description
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
LN	Logical node
MON	Signal Monitoring tool in PCM600
MTP	Media transfer protocol
NCC	Network control center
PCM600	Protection and Control IED Manager
PST	1. Parameter Setting tool in PCM600 2. Product Selection Tool
SCD	Substation configuration description
SCL	XML-based system configuration description language defined by IEC 61850
SI	Sensor input
SMT	Signal Matrix tool in PCM600
SNTP	Simple Network Time Protocol
Subnet mask	A set of four numbers used to create IP address numbers that are used only within a particular network, subnet
TCP	Transmission Control Protocol
UDP	User datagram protocol
USB	Universal serial bus
VT	Voltage transformer
WAN	Wide area network



ABB Distribution Solutions

P.O. Box 699

FI-65101 VAASA, Finland

Phone +358 10 22 11

abb.com/mediumvoltage