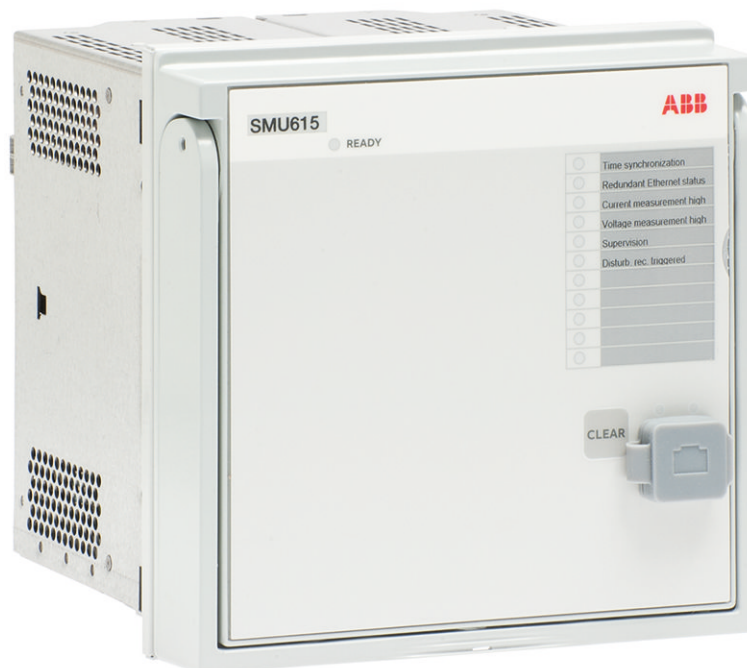


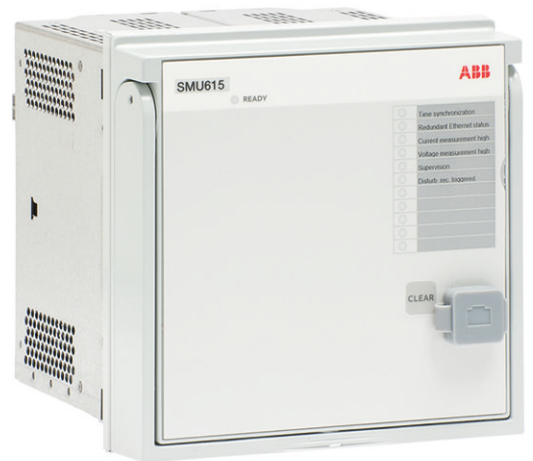
RELION®

Substation Merging Unit

SMU615

Engineering Manual





Document ID: 1MRS758408

Issued: 2019-05-17

Revision: B

Product version: 1.0

© Copyright 2019 ABB. All rights reserved

Copyright

This document and parts thereof must not be reproduced or copied without written permission from ABB, and the contents thereof must not be imparted to a third party, nor used for any unauthorized purpose.

The software or hardware described in this document is furnished under a license and may be used, copied, or disclosed only in accordance with the terms of such license.

Trademarks

ABB and Relion are registered trademarks of the ABB Group. All other brand or product names mentioned in this document may be trademarks or registered trademarks of their respective holders.

Warranty

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

www.abb.com/substationautomation

Disclaimer

The data, examples and diagrams in this manual are included solely for the concept or product description and are not to be deemed as a statement of guaranteed properties. All persons responsible for applying the equipment addressed in this manual must satisfy themselves that each intended application is suitable and acceptable, including that any applicable safety or other operational requirements are complied with. In particular, any risks in applications where a system failure and/or product failure would create a risk for harm to property or persons (including but not limited to personal injuries or death) shall be the sole responsibility of the person or entity applying the equipment, and those so responsible are hereby requested to ensure that all measures are taken to exclude or mitigate such risks.

This product has been designed to be connected and communicate data and information via a network interface which should be connected to a secure network. It is the sole responsibility of the person or entity responsible for network administration to ensure a secure connection to the network and to take the necessary measures (such as, but not limited to, installation of firewalls, application of authentication measures, encryption of data, installation of anti virus programs, etc.) to protect the product and the network, its system and interface included, against any kind of security breaches, unauthorized access, interference, intrusion, leakage and/or theft of data or information. ABB is not liable for any such damages and/or losses.

This document has been carefully checked by ABB but deviations cannot be completely ruled out. In case any errors are detected, the reader is kindly requested to notify the manufacturer. Other than under explicit contractual commitments, in no event shall ABB be responsible or liable for any loss or damage resulting from the use of this manual or the application of the equipment.

Conformity

This product complies with the directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive 2014/30/EU) and concerning electrical equipment for use within specified voltage limits (Low-voltage directive 2014/35/EU). This conformity is the result of tests conducted by ABB in accordance with the product standard EN 60255-26 for the EMC directive, and with the product standards EN 60255-1 and EN 60255-27 for the low voltage directive. The product is designed in accordance with the international standards of the IEC 60255 series.

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 merging unit 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 merging unit case internals may contain high voltage potential and touching these may cause personal injury.



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



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

Table of contents

Section 1	Introduction.....	5
	This manual.....	5
	Intended audience.....	5
	Product documentation.....	6
	Product documentation set.....	6
	Document revision history.....	6
	Related documentation.....	6
	Symbols and conventions.....	6
	Symbols.....	6
	Document conventions.....	7
	Functions, codes and symbols.....	7
Section 2	Merging unit engineering process.....	11
	Monitoring and control system structure.....	12
	Application configuration concept.....	13
	Workflow.....	14
Section 3	PCM600 tool.....	17
	Connectivity packages.....	18
	PCM600 and merging unit's connectivity package version.....	18
	Installing connectivity packages by using the connectivity package installer.....	18
	Activating connectivity packages.....	19
	PCM600 projects.....	20
	Technical key.....	20
	IEC 61850 naming conventions to identify an IED.....	21
	Setting the technical key.....	23
	Communication between PCM600 and the merging unit.....	26
	Setting up IP addresses.....	27
	IED Update.....	27
	Prerequisites for local and remote updates.....	28
	Updating firmware or language.....	28
Section 4	Setting up a project.....	31
	Creating a new project.....	31
	Building the plant structure.....	32
	Inserting an IED.....	33
	Inserting an IED in online mode.....	34
	Inserting an IED in offline mode.....	42
	Inserting an IED from the template directory.....	44

Inserting an IED by importing a .pcmi file.....	46
Setting the IED IP address in a project.....	47
COM600S project.....	49
Selecting communication port for configuration.....	50
Importing an SMU615 merging unit in a COM600S project.....	50
Using Web HMI.....	53
Managing IED users.....	54
PCM600 project's IEC 61850 version identification.....	56
Section 5 Protection and control engineering.....	57
Application Configuration tool.....	57
Function blocks.....	58
Signals and signal management.....	59
Function block execution parameters.....	60
Execution order and feedback loops.....	61
Configuration parameters.....	62
Connections and variables.....	62
Hardware channels.....	63
Online monitoring.....	64
Validation.....	65
Validation when creating an application configuration.....	65
Validation on demand.....	65
Validation when writing to the merging unit.....	66
Parameter Setting tool.....	66
Configuration parameter.....	67
Setting parameter.....	67
Parameter import and export.....	67
Parameter organization.....	68
Signal Matrix tool.....	68
IED Compare.....	70
Starting IED Compare.....	71
IED Compare tool interface.....	71
TEST_MODE and control blocking examples.....	72
TEST_MODE blocking example.....	73
Control blocking example.....	73
Section 6 LHMI engineering.....	75
HMI event filtering.....	75
Starting HMI event filtering.....	76
Setting visibility of HMI events.....	76
Searching events.....	77
Saving event filter configuration.....	77
Section 7 IEC 61850 communication engineering.....	79

IEC 61850 protocol references and pre-conditions.....	79
IEC 61850 interface.....	79
IEC 61850 interface in the merging unit.....	82
GOOSE data exchange.....	82
Function view for IEC 61850 in PCM600.....	83
Station configuration description file types.....	84
IEC 61850 engineering process.....	84
Exporting SCL files from PCM600.....	86
Exporting SCD files.....	86
Exporting ICD or CID files.....	88
Engineering vertical and horizontal communication.....	89
Importing SCL files to PCM600.....	91
Importing SCD files.....	92
Importing ICD or CID files.....	93
Writing communication configuration to the IED.....	94
Section 8 Glossary.....	97

Section 1 Introduction

1.1 This manual

The engineering manual contains instructions on how to engineer the merging units using the different tools in PCM600. The manual provides instructions on how to set up a PCM600 project and insert merging units 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 merging units. The installation and commissioning personnel must have a basic knowledge of handling electronic equipment.

1.3

Product documentation

1.3.1

Product documentation set

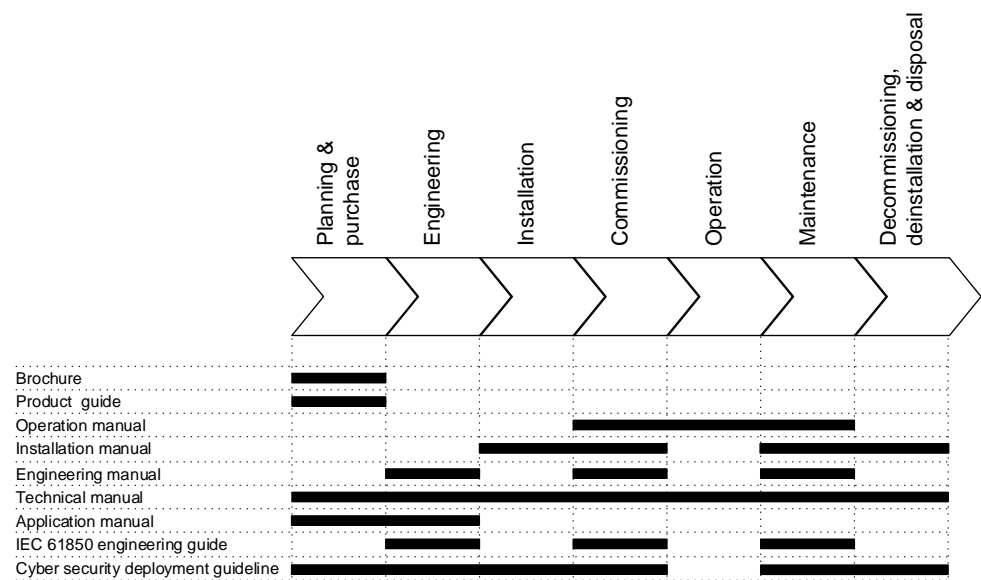


Figure 1: The intended use of documents during the product life cycle

1.3.2

Document revision history

Document revision/date	Product version	History
A/2017-09-26	1.0	First release
B/2019-05-17	1.0	Content updated

1.3.3

Related documentation



Contact ABB for information on SMU615 related documentation.

1.4

Symbols and conventions

1.4.1

Symbols



The caution icon indicates important information or warning related to the concept discussed in the text. It might indicate the presence of

a hazard which could result in corruption of software or damage to equipment or property.



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



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

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

1.4.2 Document conventions

A particular convention may not be used in this manual.

- Abbreviations and acronyms are spelled out in the glossary. The glossary also contains definitions of important terms.
- Menu paths are presented in bold.
Select **Main menu/Settings**.
- 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.
- This document assumes that the parameter setting visibility is "Advanced".

1.4.3 Functions, codes and symbols

Table 1: *Functions included in the merging unit*

Function	IEC 61850	IEC 60617	IEC-ANSI
Measurement			
Disturbance recorder	RDRE1	DR (1)	DFR (1)
Three-phase current measurement	CMMXU1	3I (1)	3I (1)
Sequence current measurement	CSMSQI1	I1, I2, I0 (1)	I1, I2, I0 (1)
Residual current measurement	RESCMMXU1	Io (1)	In (1)
Three-phase voltage measurement	VMMXU1	3U (1)	3V (1)
Table continues on next page			

Function	IEC 61850	IEC 60617	IEC-ANSI
Sequence voltage measurement	VSMSQI1	U1, U2, U0 (1)	V1, V2, V0 (1)
Three-phase power and energy measurement	PEMMXU1	P, E (1)	P, E (1)
Frequency measurement	FMMXU1	f (1)	f (1)
IEC 61850-9-2 LE sampled value sending	SMVSENDER	SMVSENDER	SMVSENDER
Condition monitoring and supervision			
Circuit-breaker condition monitoring	SSCBR1	CBCM (1)	CBCM (1)
Trip circuit supervision	TCSSCBR1	TCS (1)	TCM (1)
	TCSSCBR2	TCS (2)	TCM (2)
Current circuit supervision	CCSPVC1	MCS 3I (1)	MCS 3I (1)
Fuse failure supervision	SEQSPVC1	FUSEF (1)	60 (1)
Arc detection	ARCDSARC1	ARCD (1)	AFD (1)
	ARCDSARC2	ARCD (2)	AFD (2)
	ARCDSARC3	ARCD (3)	AFD (3)
Control			
Circuit-breaker control	CBXCBR1	I <-> O CB (1)	I <-> O CB (1)
Disconnecter control	DCXSWI1	I <-> O DCC (1)	I <-> O DCC (1)
	DCXSWI2	I <-> O DCC (2)	I <-> O DCC (2)
Earthing switch control	ESXSWI1	I <-> O ESC (1)	I <-> O ESC (1)
Disconnecter position indication	DCSXSWI1	I <-> O DC (1)	I <-> O DC (1)
	DCSXSWI2	I <-> O DC (2)	I <-> O DC (2)
Earthing switch indication	ESSXSWI1	I <-> O ES (1)	I <-> O ES (1)
Other			
Minimum pulse timer (2 pcs)	TPGAPC1	TP (1)	TP (1)
	TPGAPC2	TP (2)	TP (2)
	TPGAPC3	TP (3)	TP (3)
	TPGAPC4	TP (4)	TP (4)
Minimum pulse timer (2 pcs, second resolution)	TPSGAPC1	TPS (1)	TPS (1)
Minimum pulse timer (2 pcs, minute resolution)	TPMGAPC1	TPM (1)	TPM (1)
Pulse timer (8 pcs)	PTGAPC1	PT (1)	PT (1)
	PTGAPC2	PT (2)	PT (2)
Time delay off (8 pcs)	TOFGAPC1	TOF (1)	TOF (1)
	TOFGAPC2	TOF (2)	TOF (2)
	TOFGAPC3	TOF (3)	TOF (3)
	TOFGAPC4	TOF (4)	TOF (4)
Table continues on next page			

Function	IEC 61850	IEC 60617	IEC-ANSI
Time delay on (8 pcs)	TONGAPC1	TON (1)	TON (1)
	TONGAPC2	TON (2)	TON (2)
	TONGAPC3	TON (3)	TON (3)
	TONGAPC4	TON (4)	TON (4)
Set-reset (8 pcs)	SRGAPC1	SR (1)	SR (1)
	SRGAPC2	SR (2)	SR (2)
	SRGAPC3	SR (3)	SR (3)
	SRGAPC4	SR (4)	SR (4)
Move (8 pcs)	MVGAPC1	MV (1)	MV (1)
	MVGAPC2	MV (2)	MV (2)
Generic control point (16 pcs)	SPCGAPC1	SPC (1)	SPC (1)
	SPCGAPC2	SPC (2)	SPC (2)
Master trip	TRPPTRC1	Master Trip (1)	94/86 (1)
	TRPPTRC2	Master Trip (2)	94/86 (2)
	TRPPTRC3	Master Trip (3)	94/86 (3)
	TRPPTRC4	Master Trip (4)	94/86 (4)
	TRPPTRC5	Master Trip (5)	94/86 (5)

Section 2 Merging unit engineering process

PCM600 is used for various tasks in the merging unit engineering process.

- Merging unit engineering management
 - Organizing the bay merging units in the structure of the substation by defining voltage levels and bays below the substation. PCM600 manages the project.
 - Configuring the merging unit functions (for example, control functions) by using the Application Configuration tool.
 - Configuring the parameters and setting values for the merging unit 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.
 - Configuring the events shown on the WHMI using the HMI Event Filtering tool.
- Communication management
 - IEC 61850 station communication engineering is done using the internal IEC 61850 Configuration tool or the separate IET600. PCM600 interacts with IET600 by importing and exporting SCL files.
 - Configuring the GOOSE receiving data connections to the merging unit's application configuration function blocks by using the Application Configuration tool and the Signal Matrix tool.
 - Configuring the sampled values (process bus) between the devices using the Application Configuration tool and IEC 61850 Configuration tool.
- Record management
 - Generating overviews on the available (disturbance) recordings in all connected merging units by using the Disturbance Handling tool.
 - Manually reading the recording files (in the COMTRADE format) from the merging units 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 merging unit 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 merging unit is finished, the results must be written to the merging unit.

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

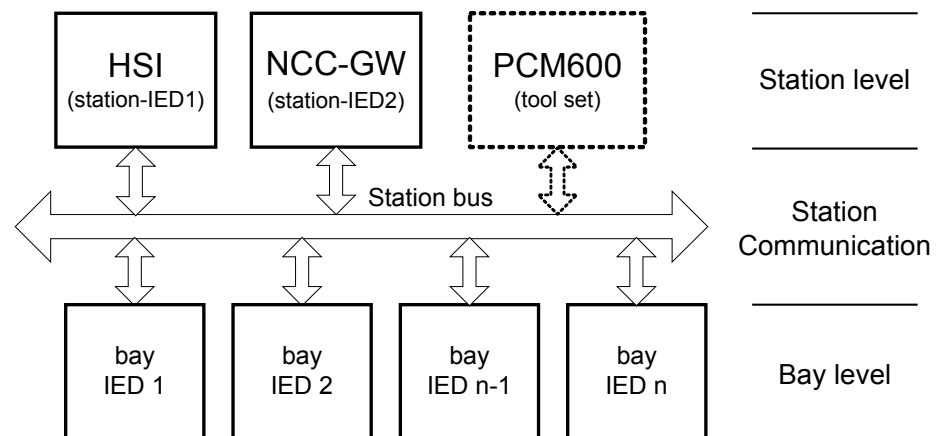
2.1

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.



IEC08000101.vsd

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 merging units

2.2

Application configuration concept

Every merging unit developed for the protection of medium voltage applications has predefined application-specific software called application configuration that contains control, supervision and measurement function blocks and default logical connections. For more information, see the application manual.

The application configuration software consists of connections between an application's functions developed according to the needs of a particular functional application. The inputs and outputs are similarly assigned to a default set of connections such as position indication and Master trip. The alarm LEDs are assigned to default connections based on the order number.



Current and voltage channels for measurement functions are fixed as a part of application configuration and cannot be reassigned with Signal Matrix or Application Configuration in PCM600.

The content of the application configuration depends on the intended functional application. The application configurations also have selectable software options, which are selected when ordering the merging unit. Some of the software options are related to the merging unit hardware.

The application configurations can be used as is, but they can also be modified by using PCM600. The application configuration itself can be modified or extended by

using Application Configuration, Signal Matrix and the communication configuration tools.

2.3

Workflow

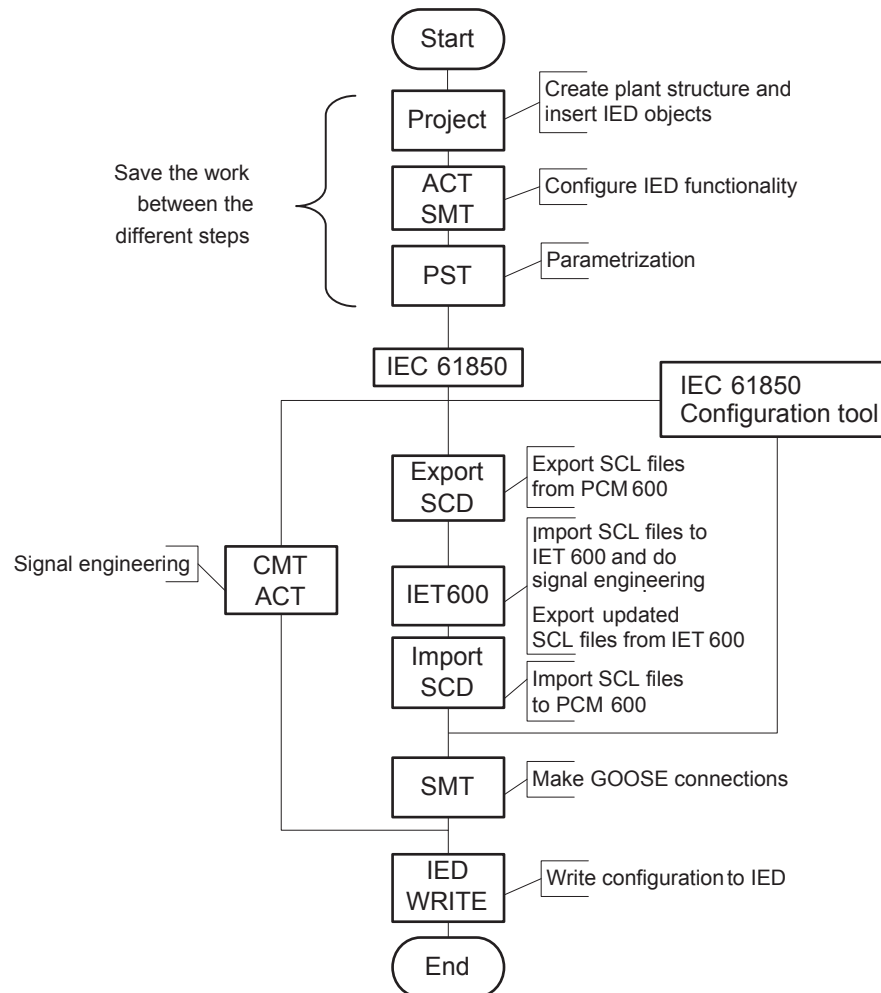


Figure 3: Merging unit engineering workflow proposal based on practical experience and dependencies of the steps

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 merging unit to a project, a suitable Connectivity package is needed. Merging units 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

- Merging unit 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 IET600 is needed for configuring horizontal and vertical communication.



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

Section 3 PCM600 tool

Protection and Control IED Manager PCM600 offers all the necessary functionality to work throughout all stages of the merging unit'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 customer needs.

PCM600 is used to conduct complete engineering and configuration activities needed for the bay level merging units.

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

PCM600 uses IEC 61850 over Ethernet to communicate with bay devices. This communication allows PCM600 to configure and monitor the devices. In addition to IEC 61850 the devices have optional communications 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 a merging unit within a station by using the Ethernet connection. The connection can also be used for service and maintenance purposes. In addition, the connection is used to handle disturbance records from the merging units.

The modern-day merging units are designed using the concept of the IEC 61850 standard. This is primarily in regards to how functions within the merging unit are modelled and how the merging unit is represented in the substation. See the IEC 61850 parameter list for the list of logical nodes available in the merging unit and observe how they follow the structure and rules as defined in part 7 of the standard.

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

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

The applications can be organized into groups.

- Merging unit engineering
- Communication engineering
- Record management
- Device monitoring and diagnostic



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 enables system tools to communicate with a merging unit. Connectivity packages are used to create configuration structures in PCM600. The latest PCM600 and connectivity packages are backward compatible with older merging unit versions.

A connectivity package includes all the data which is used to describe the merging unit, 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 software packages that use the connectivity package to properly communicate with the merging unit. It also supports localization of text even when its read from the merging unit in a standard format such as COMTRADE.

3.2 PCM600 and merging unit's connectivity package version

- Protection and Control IED Manager PCM600 2.7 or later
- SMU615 Connectivity Package Ver.1.0 or later



Contact ABB for information on the latest connectivity package.

3.2.1 Installing connectivity packages by using the connectivity package installer

1. Close PCM600.
2. Run the **ABB IED Connectivity Package SMU615 Ver. n.msi** installer which can be received from ABB.

(n = version number)

- To install the connectivity package, follow the steps in the connectivity package installation wizard.

3.2.2

Activating connectivity packages

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

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



Always use the latest version of the connectivity package.

- Click **Apply** to activate the connectivity package.

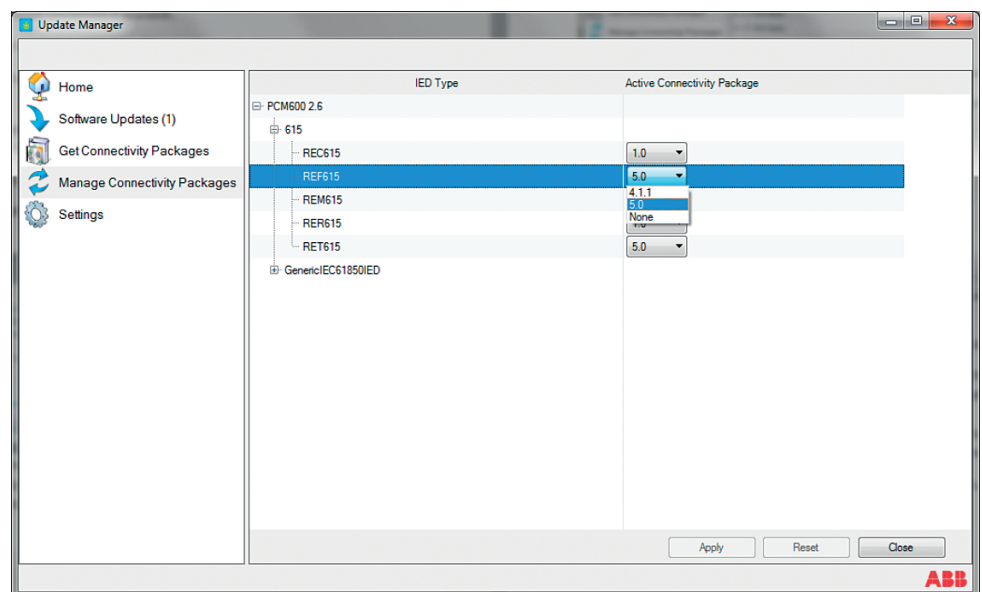


Figure 4: Selecting the connectivity package versions

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 the protocol used in installation for each project, the IEC 61850 version must be selected when adding the first IED to plant structure. After the initial selection, all IEDs in plant structure use the selected version, either Edition 1 or Edition 2. In case the IEC 61850 is not used for station bus, the default version can be applied. By default, the IEC 61850 version of PCM600 is Edition 1. The merging unit's IEC 61850 version is also by default Edition 1.

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 merging unit 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 merging unit is delivered with a factory default technical key. The validation of the technical keys between PCM600 and the merging unit does not occur if the merging unit 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 merging unit and PCM600. The technical key can be read from the merging unit and updated to PCM600, or the PCM600 technical key can be written to the merging unit. Alternatively, a user-defined technical key can be defined.

When writing a configuration to the merging unit, PCM600 checks for a mismatch between the IED object and the physical IED technical key.

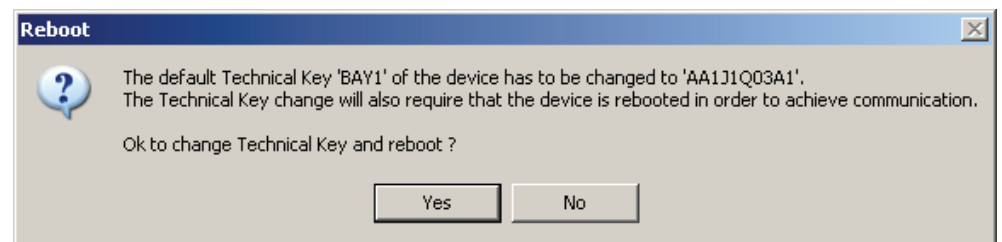


Figure 5: Reboot suggestion



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.

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 the 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 28 for IEC 61850 Edition 1 and 60 for 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.

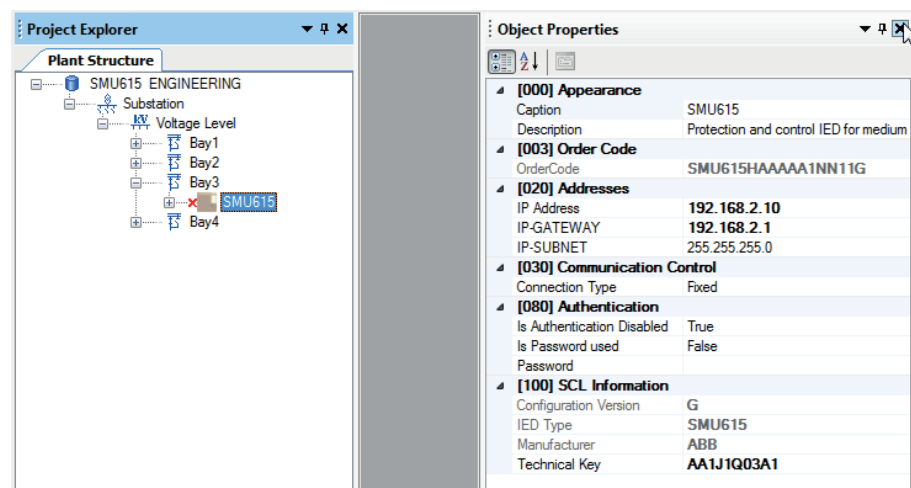


Figure 6: PCM600: IEC 61850 signal designation concept

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**.

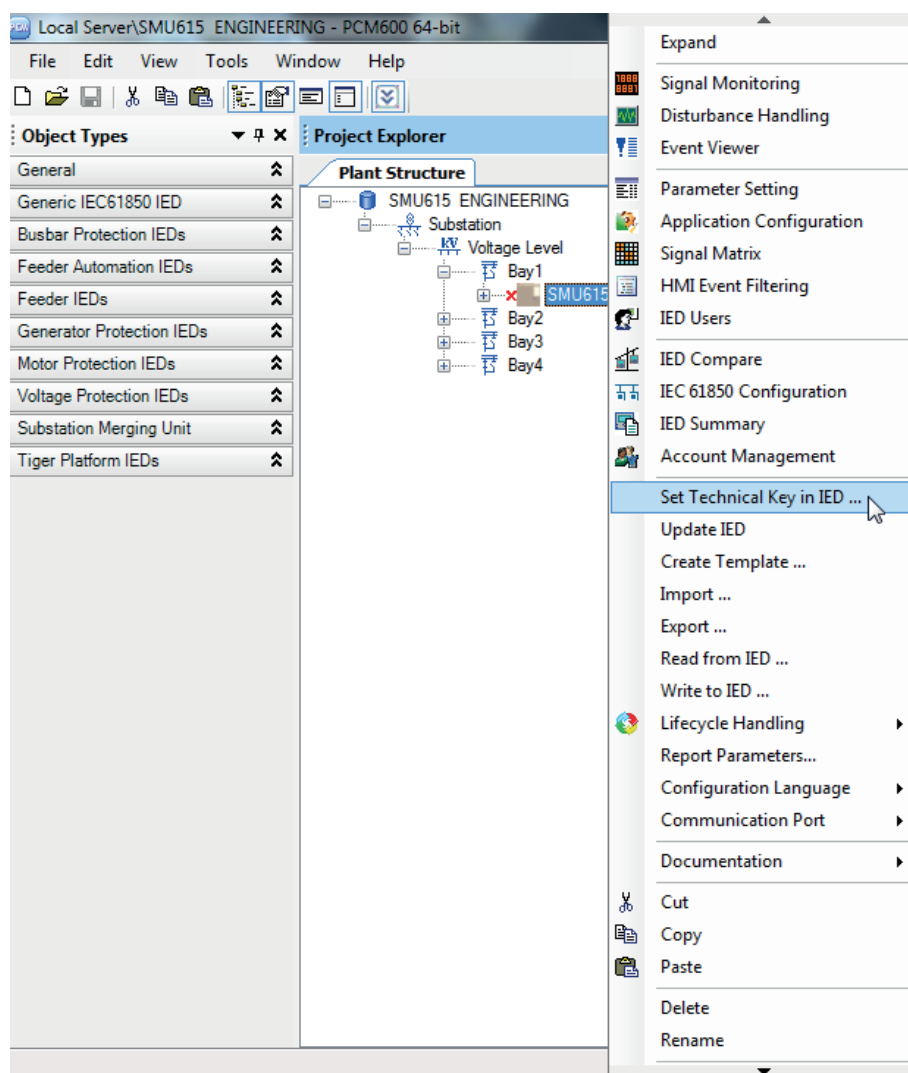


Figure 7: PCM600: Setting the technical key on the IED level

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

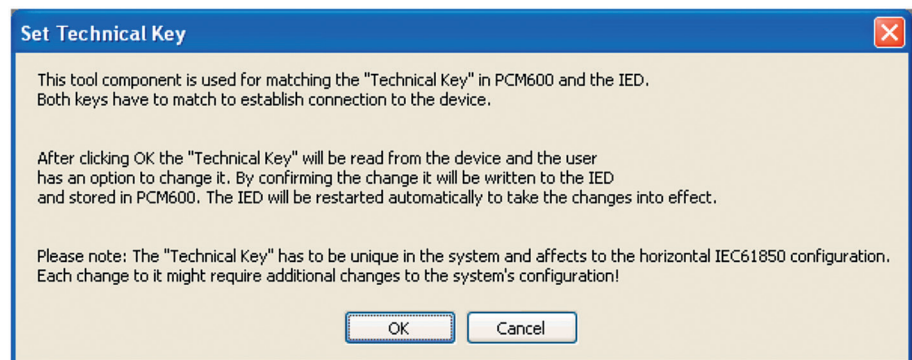


Figure 8: Technical key information

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

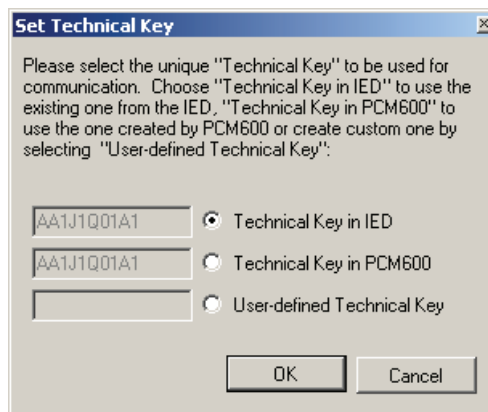


Figure 9: Setting the technical key

3. 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
4. Click **OK** to confirm the selection.



It is not possible to set a user-defined name or select the **Technical key in IED** if the value is the same as already given to another IED object in the PCM600 project. An error message is displayed if this happens.

3.5 Communication between PCM600 and the merging unit

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

All communication is done over Ethernet using either IEC 61850 or FTP/FTPS protocol.

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

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

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

- Direct point-to-point link between PCM600 and the merging unit's front port
 - Indirect link via station LAN or from remote via network
1. If needed, the IP address for the merging unit 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 merging units' IP addresses in the PCM600 project are configured for each merging unit to match the IP addresses of the physical IEDs.
 4. Technical keys of the IEDs in PCM600 project are configured for each merging unit to match the technical keys of the physical IEDs.

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

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

Protocol	TCP port
File Transfer Protocol (FTP and FTPS)	20, 21
IEC 61850	102
Web Server HTTP	80
Web server HTTPS	443
Simple Network Time Protocol (SNTP)	123

3.5.1 Setting up IP addresses

The IP address and the corresponding subnet mask can be set via WHMI for the rear Ethernet interface in the merging unit. Each Ethernet interface has a default factory IP address when the complete merging unit is delivered. The configured rear port IP address is preserved if a new communication card with Ethernet is installed or the communication card is replaced.



The merging unit's front port IP address is fixed to “192.168.0.254” and it cannot be modified.

1. Set the IP address for the merging unit's rear port and the corresponding subnet mask via the WHMI path **Configuration/Communication/Ethernet/Rear port**.

Table 3: *Default IP address for the rear port and the corresponding subnet mask*

IP address	Subnet mask
192.168.2.10	255.255.255.0



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



When using redundant Ethernet (HSR or PRP), configure all devices in the network before connecting cables to ports LAN A and LAN B. Avoid using the LAN A or LAN B ports on redundant communication modules while changing the *Redundant mode* parameter.

3.6 IED Update

The firmware update tool is used for patching the IED firmware and for adding or replacing additional languages to the IED. Update packages are provided by Customer Support. The update tool can be used either locally or remotely.

It is recommended to take a backup of the IED configuration before starting the update. This can be done by using the Read from IED function from the IED context menu in PCM600. The user needs to be authorized before using the tool. User credentials are asked if the default administrator password has been changed. Administrator or engineer credentials are needed for authorization.

3.6.1 Prerequisites for local and remote updates

Local update

- Use of the front port is recommended when updating locally. Remove the IED from the network especially with redundant network topologies (HSR/PRP).

Remote update

- Communication is recommended to be secured either by setting up a VPN connection or enabling secure communication in the IED via WHMI (**Configuration/Authorization/Remote Update**) while updating remotely.
- Remote update can be enabled in the IED either via the WHMI (**Configuration/Authorization/Security/Remote Update**) or by an administrator in the Parameter Setting tool in PCM600 (**IED Configuration/Configuration/Authorization/Remote Update**) to be able to update remotely. If the IED is in local control mode, remote update proceeds only after a confirmation is received from the user.
- Remote update has to be disabled manually after the update, if wanted.
- Remote update only works when the IED is connected from the rear port with a custom IP address.

3.6.2 Updating firmware or language

1. Select the update mode.
 - Firmware
 - Language
2. Select the update package and click **Next**.

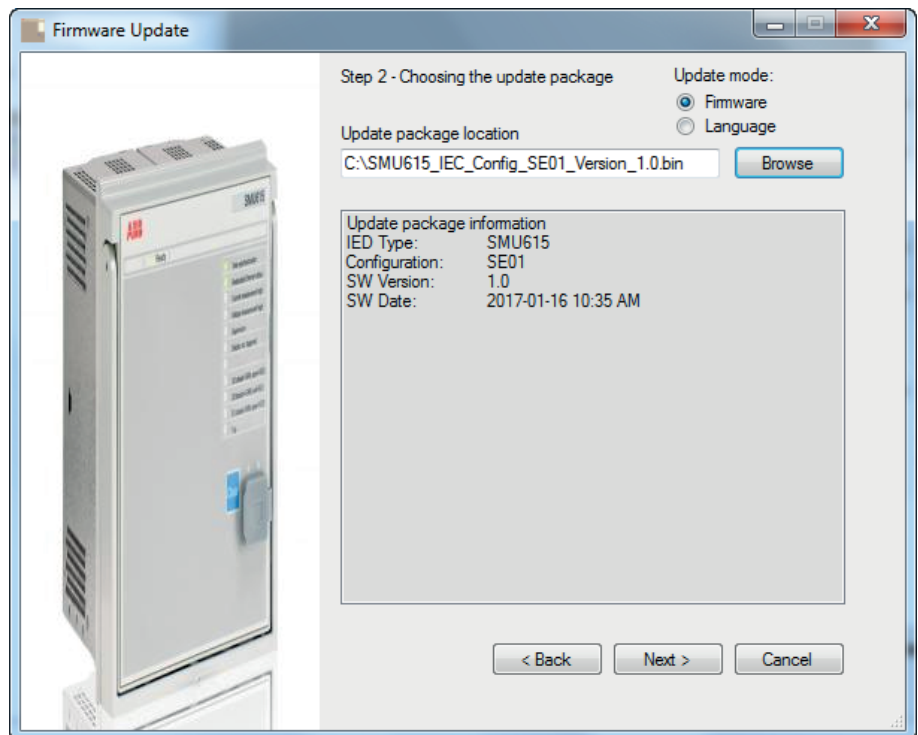


Figure 10: Choosing the update mode and package

3. Select the network interface controller, for example, the PC's integrated Ethernet communication card or an external Ethernet adapter, connected to the IED and click **OK**.

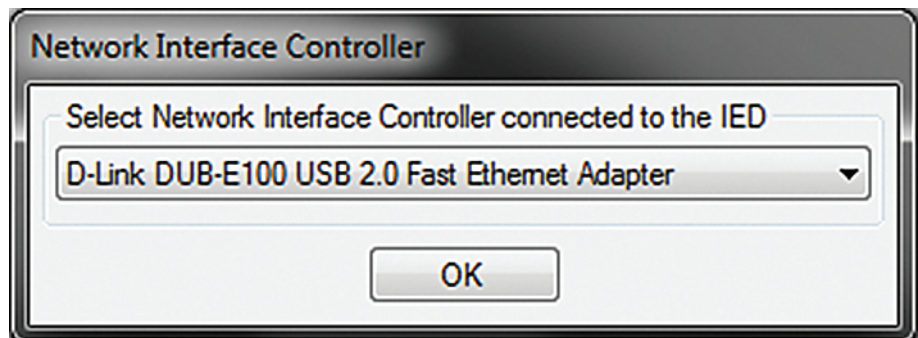


Figure 11: Selecting the network interface controller

4. When updating remotely, wait for 30 seconds for the local user confirmation before proceeding with the update.
 - IED use is allowed after the update is completed 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.

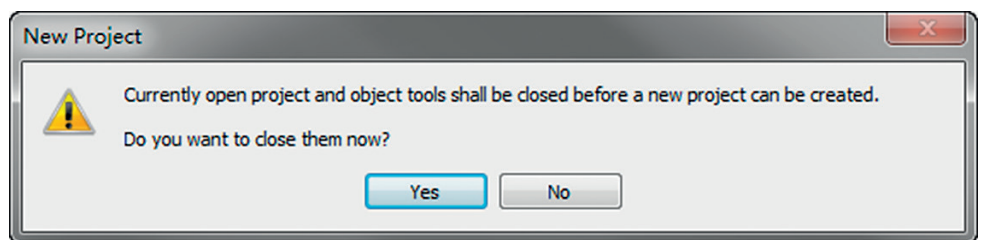


Figure 14: *New Project dialog box*

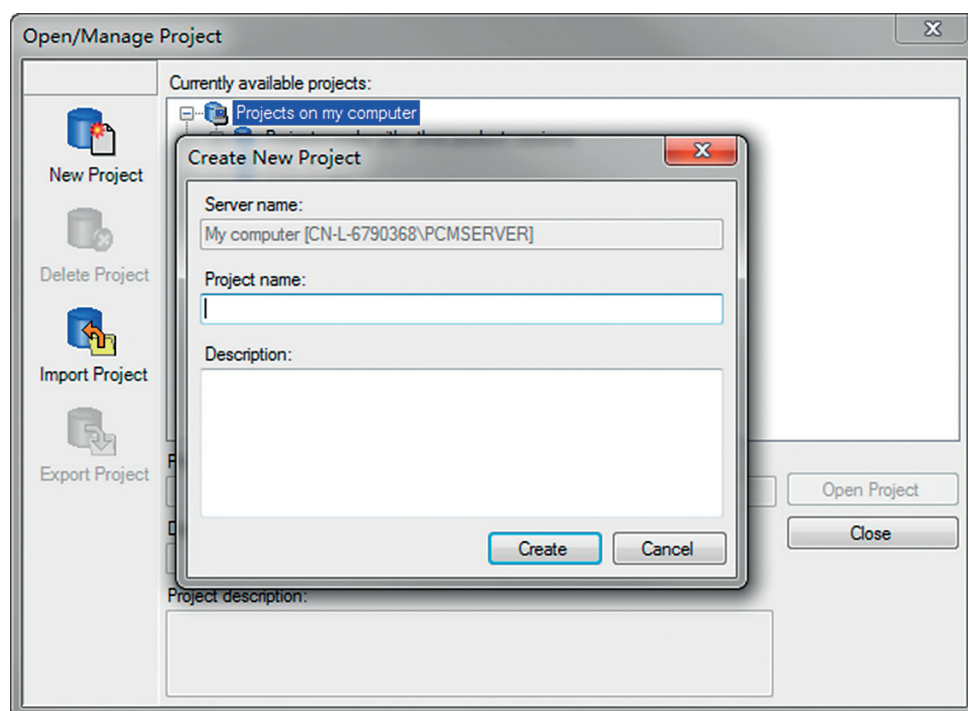


Figure 15: Creating a new project

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.

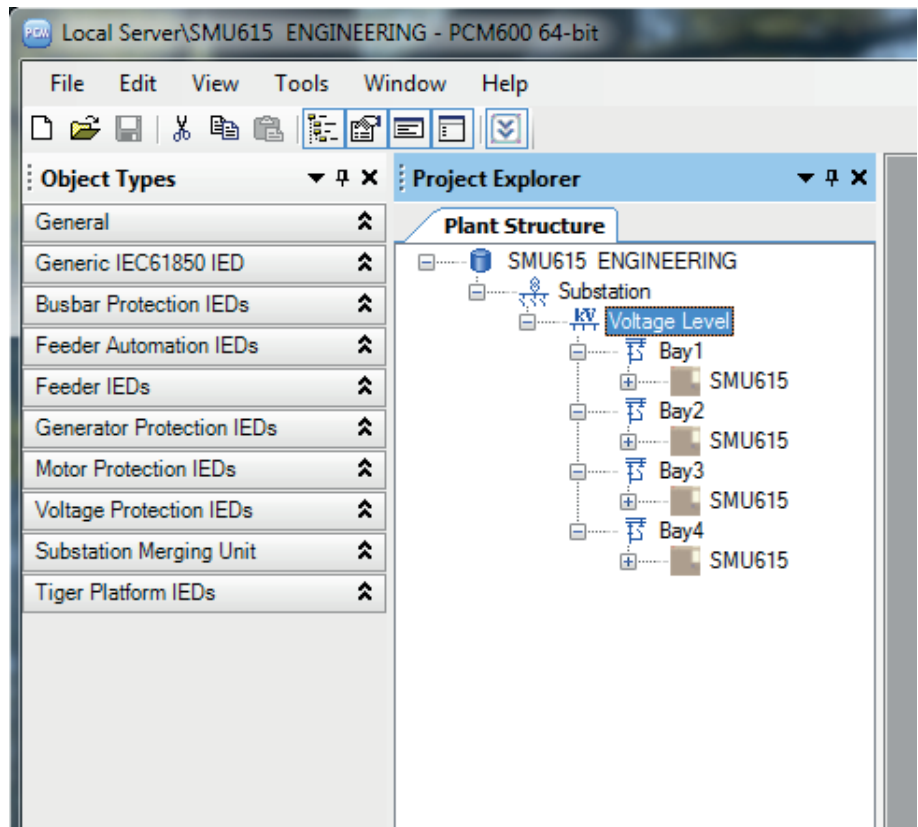


Figure 16: The start of a project with IEDs placed but not renamed

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 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.



IEC 61850 Edition 1 and Edition 2 IEDs cannot be used simultaneously in the same PCM600 project. The first inserted IED determines the IEC 61850 version for the whole project.

4.3.1

Inserting an IED in online mode

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

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

1. In the **Plant Structure** view, right-click the bay, point to **New**, point to the merging unit application area and select the merging unit type to be inserted.



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

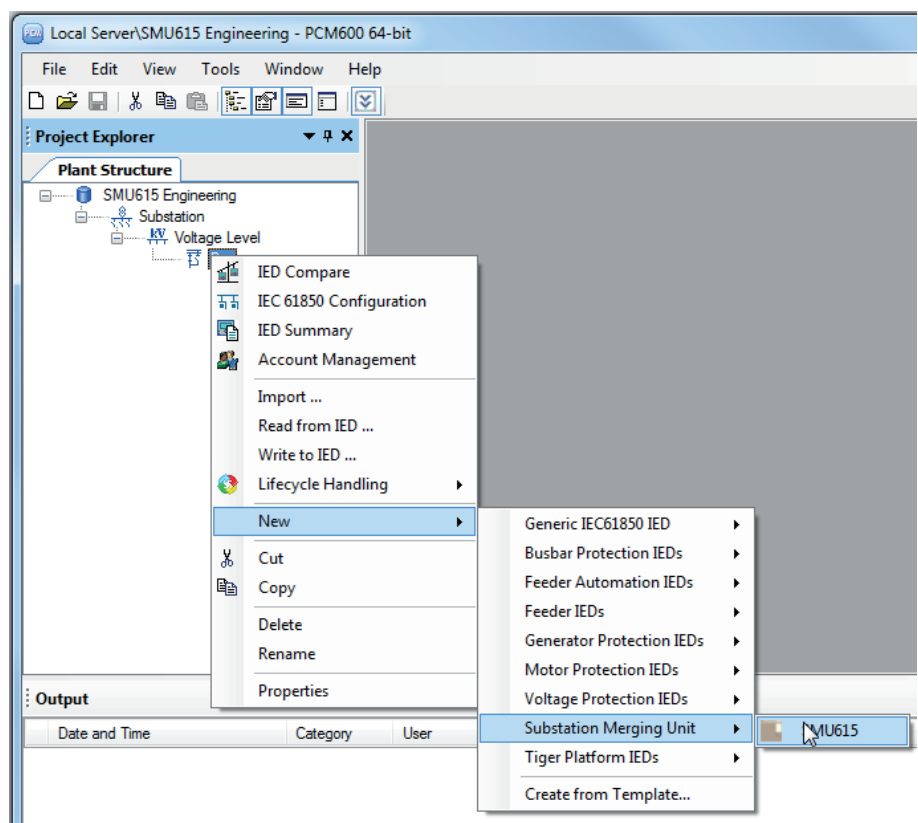


Figure 17: Selecting the merging unit type

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

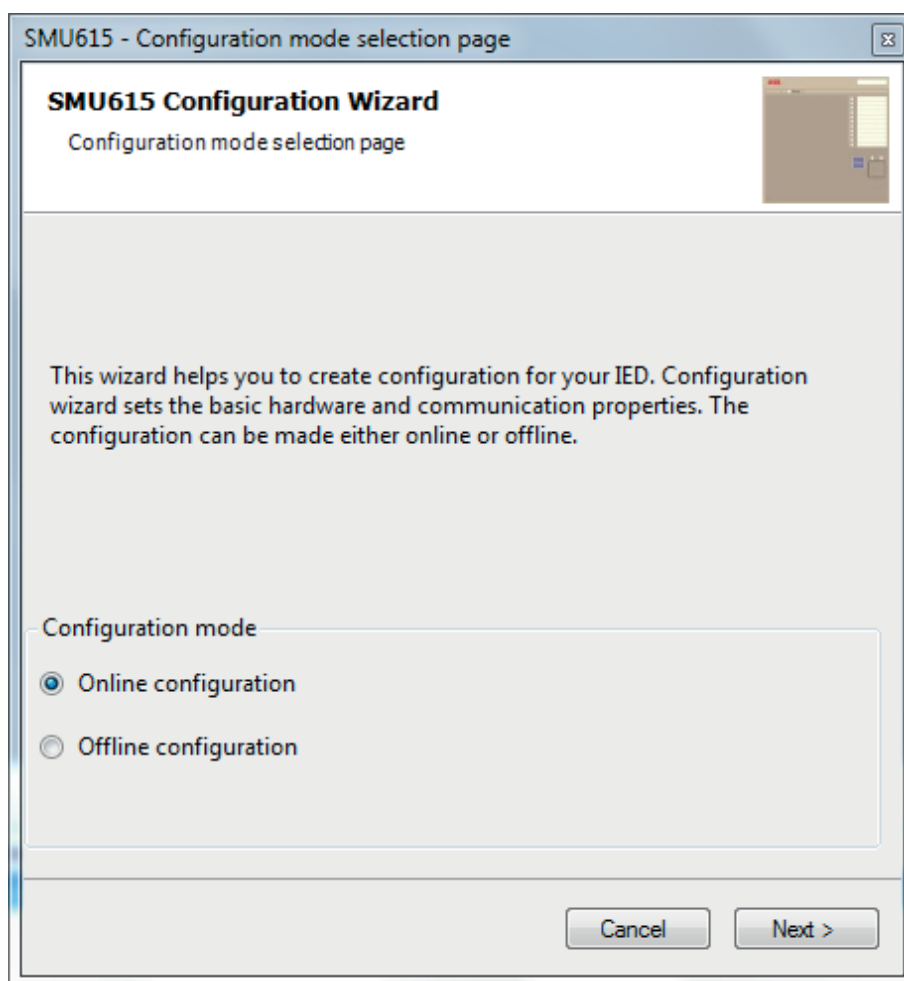


Figure 18: Configuration mode selection

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

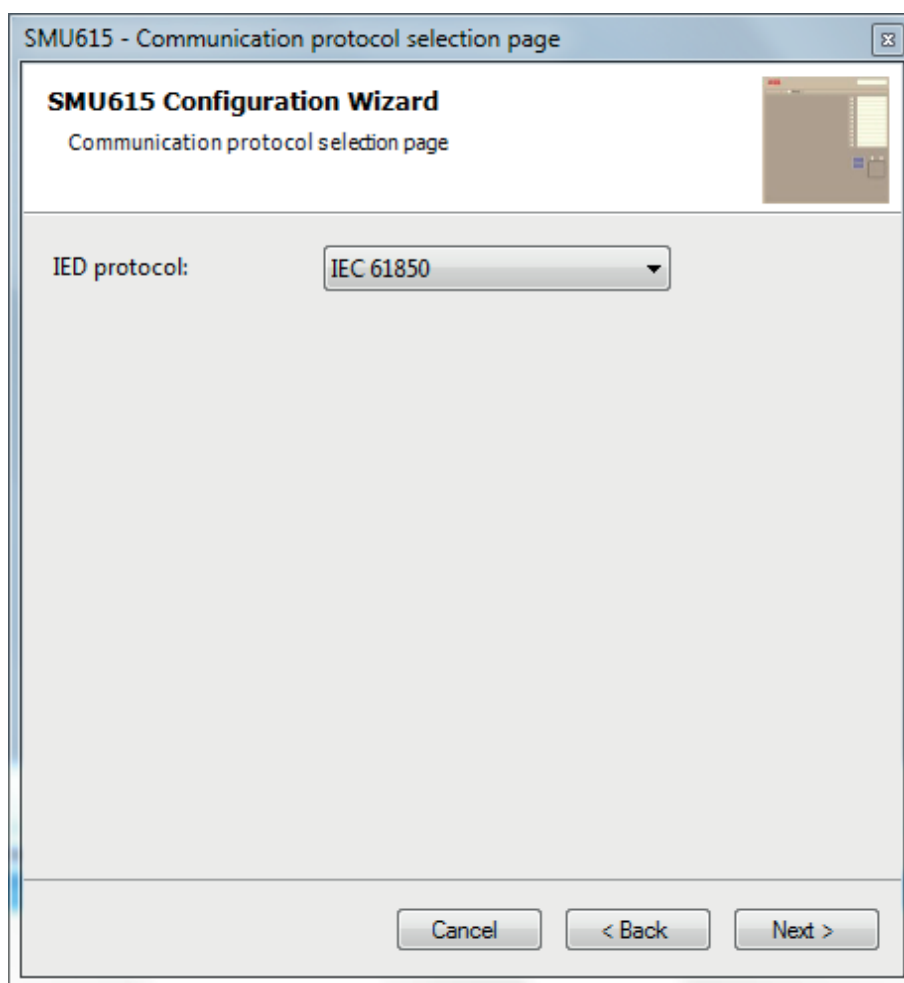


Figure 19: Communication protocol selection

4. On the **IEC61850 communication protocol** page, select the port from the **Port** list.
 - If the rear port is selected, type the correct IP address (of the physical merging unit to be configured) to the **IP address** box.

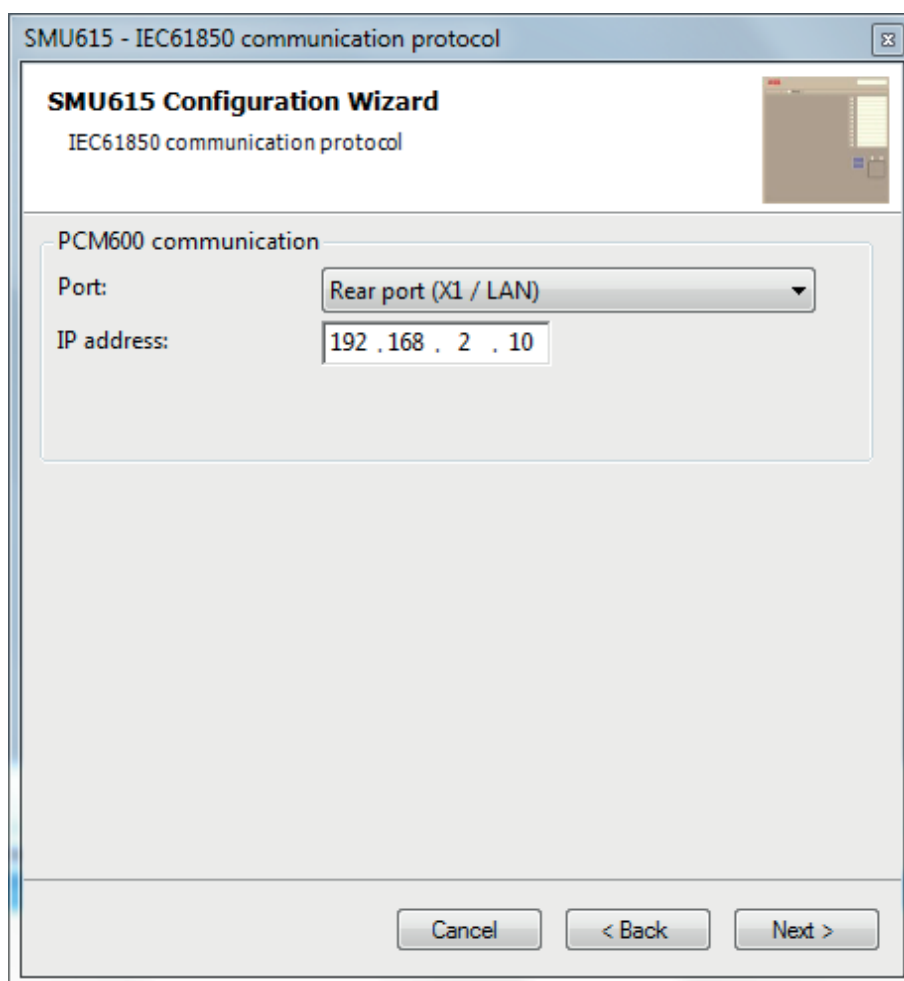


Figure 20: Communication port and IP address

Communication configuration is now defined.

5. Click **Next** to scan/read the order code of the merging unit.
6. On the **Order code detection page**, click **Next**.

SMU615 - Order code detection page

SMU615 Configuration Wizard
Order Code detection

Please input the order code to text boxes or use the selection below to insert the order code.

Order code

Order code Selection

Main Application	<input type="text" value="SMU"/>	Substation merging unit
Product	<input type="text" value="615"/>	615
Case	<input type="text" value="H"/>	Complete merging unit
Functional Apps	<input type="text" value="A"/>	Merging unit with analog inputs
Analog inputs, outputs	<input type="text" value="B"/>	3Is + 3Us + Io (Io 0.2/1A)
Binary inputs, outputs	<input type="text" value="A"/>	6BO
Communication Interface	<input type="text" value="A"/>	Ethernet 100Base TX (3xRJ45)
Communication protocol	<input type="text" value="A"/>	IEC 61850
Language	<input type="text" value="1"/>	English
Option 1	<input type="text" value="A"/>	Arc detection
Option 2	<input type="text" value="N"/>	None
Power supply	<input type="text" value="1"/>	48-250 Vdc; 100-240 Vac
Product version 1.0	<input type="text" value="1G"/>	Product version 1.0

Cancel < Back Next >

Figure 21: Order code detection

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

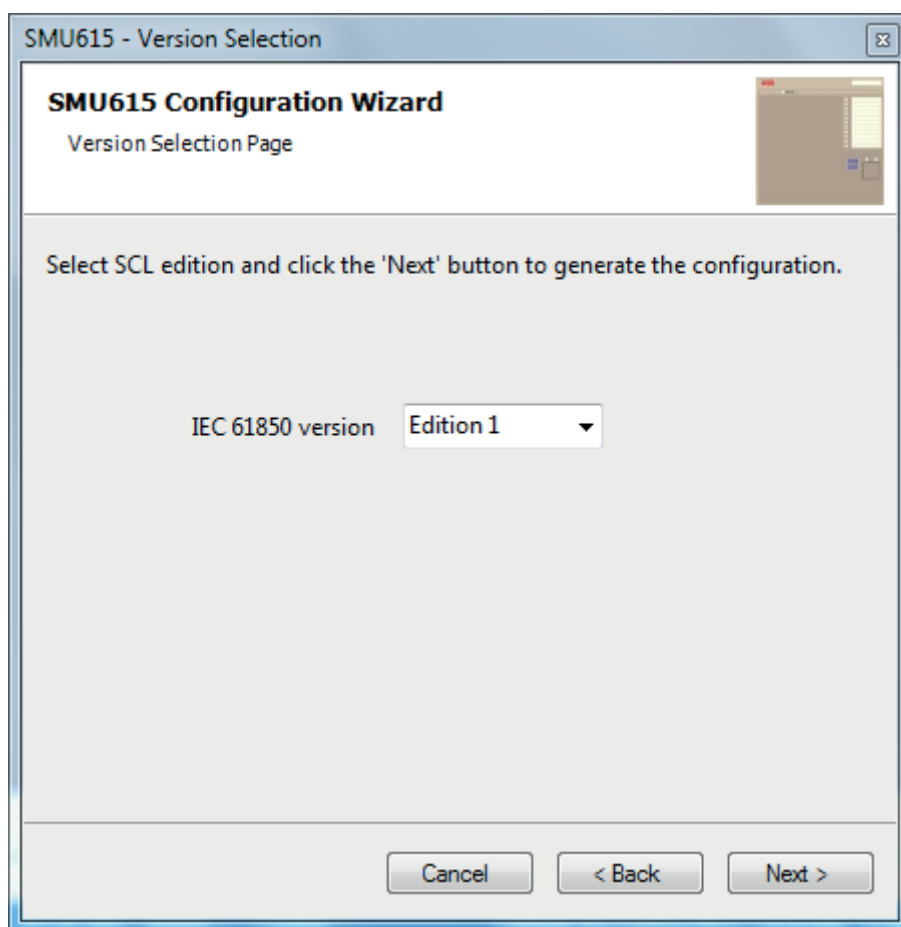
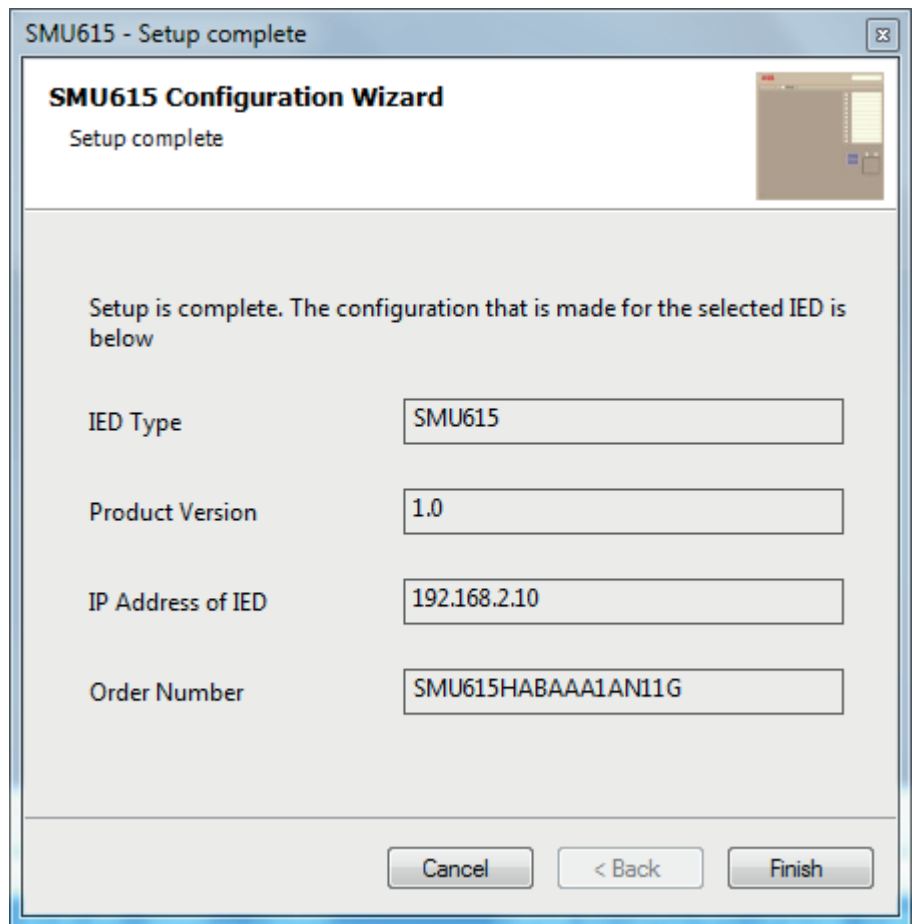


Figure 22: Version selection page



Regardless of the protocol used in the installation for each project, the IEC 61850 version must be selected when adding the first merging unit to the plant structure. After the initial selection all merging units in the plant structure use the selected version, either Edition 1 or Edition 2.

8. The **Setup complete** page shows the summary of the merging unit's IED type, version, IP address and the selected order number. Click **Finish** to confirm the configuration and conduct the insertion.



SMU615 - Setup complete

SMU615 Configuration Wizard
Setup complete

Setup is complete. The configuration that is made for the selected IED is below

IED Type	SMU615
Product Version	1.0
IP Address of IED	192.168.2.10
Order Number	SMU615HABAAA1AN11G

Cancel < Back Finish

Figure 23: Setup complete



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



If an error is found on the **Setup Complete 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.

- 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 merging unit 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 merging unit is not available or is not connected to PCM600, engineering can be done offline. The offline configuration in PCM600 can be written to the merging unit 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 merging unit is not available.

1. In the **Plant Structure** view, right-click the bay, point to **New**, point to the merging unit application area and select the merging unit 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.

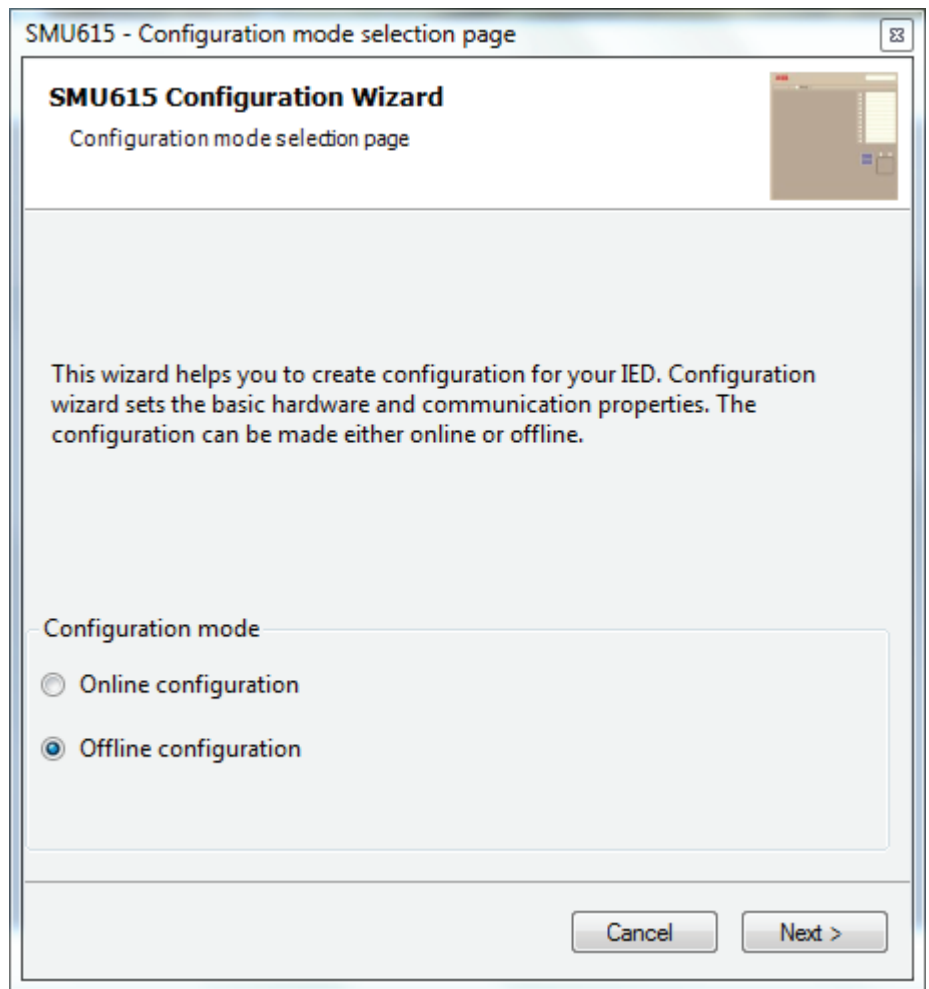


Figure 24: Configuration mode selection wizard

3. On the **Order Code selection** page, select the correct order codes and click **Next**.



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

Figure 25: Order code selection

4. On the **Configuration Selection Page**, select the configuration type and click **Next**.
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 same order code in PCM600 projects. 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.

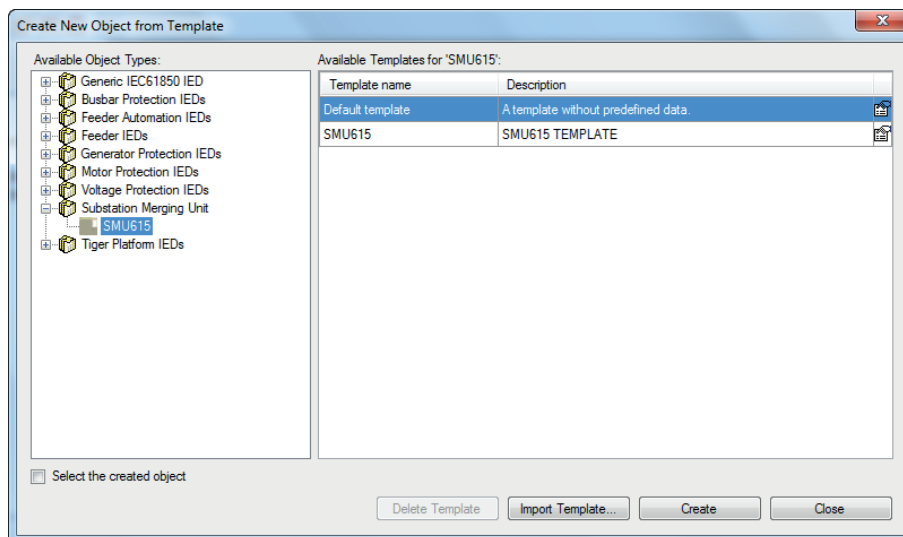


Figure 26: PCM600: Selecting an IED from the template library

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.

The image shows a 'Template Properties' dialog box with the following fields:

- Template info**
 - Name: SMU615
 - Type: User-Defined Template
 - Creation time: 3/24/2017 11:25:46 AM
 - Protocol: IEC61850
 - Path: C:\PCMDDataBases\Templates\PCM600\SMU615.ied.pcmi
 - Description: SMU615 TEMPLATE
- Created on**
 - Product name: PCM600 2.7
 - Object type: SMU615
 - Connectivity Package: SMU615 1.0, BETA 02 - Build 01

A 'Close' button is located at the bottom right of the dialog box.

Figure 27: 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.

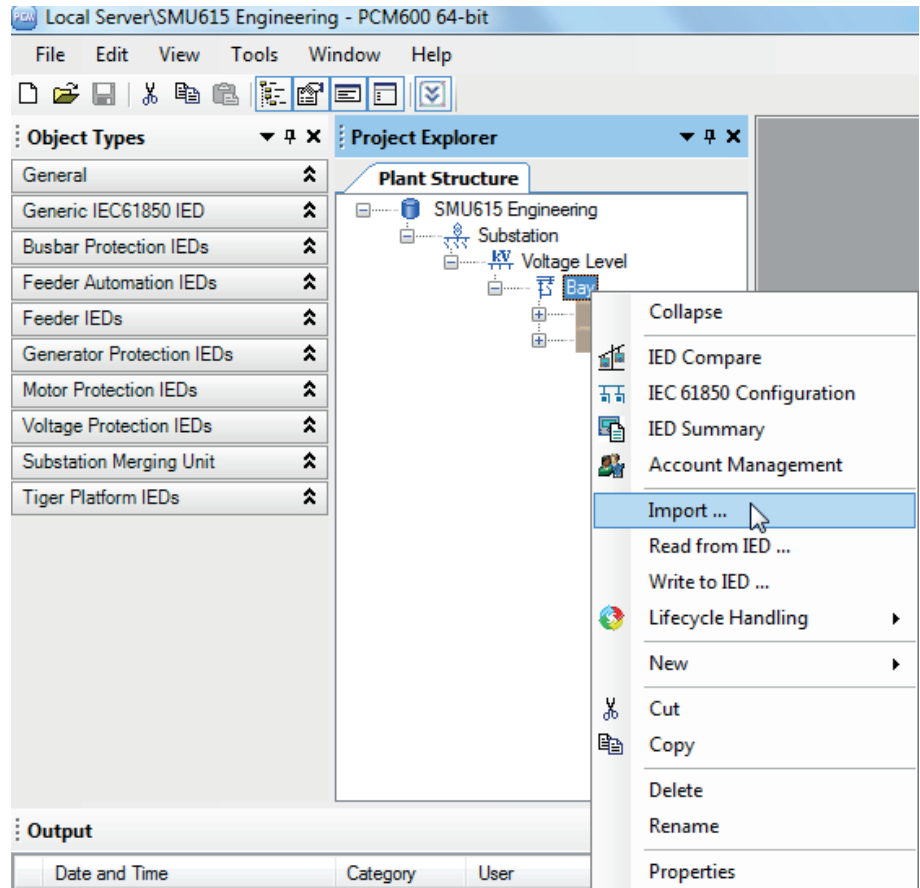


Figure 28: Importing IED configuration

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 merging unit (physical IED) to which the PC is connected. The IP address of the merging unit can only be set via the merging unit's front port or Parameter Setting tool in PCM600. The PC and merging unit 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.

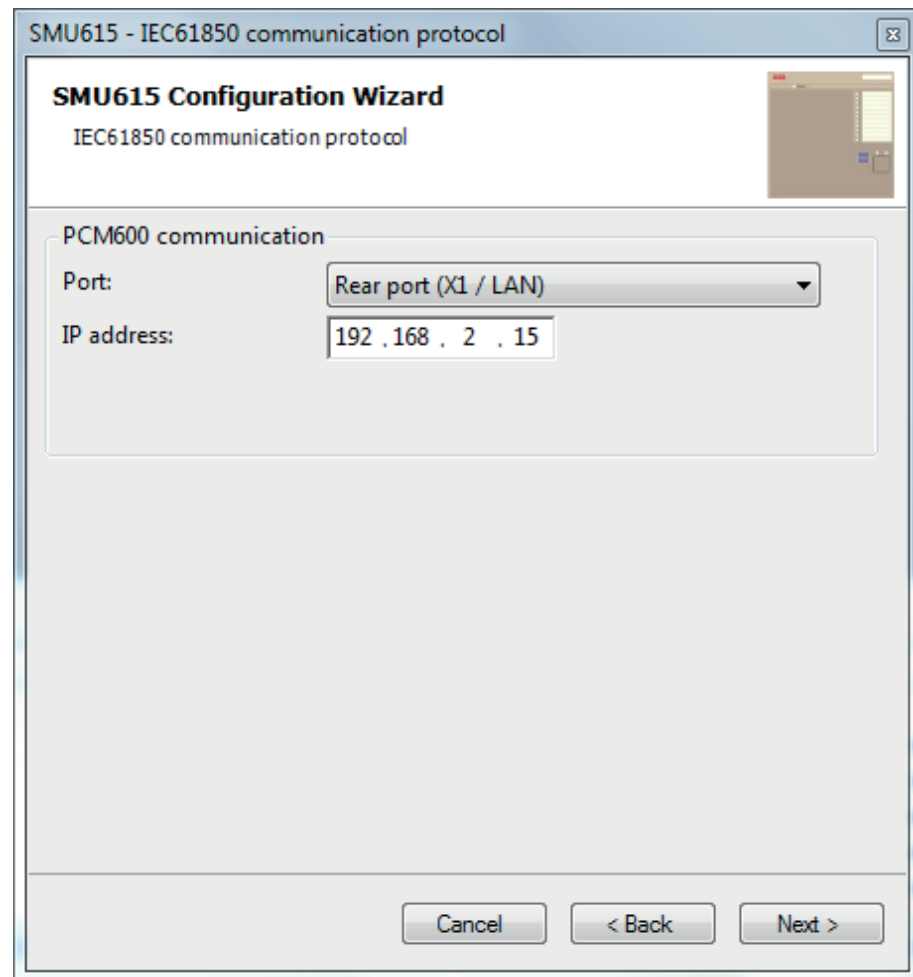


Figure 29: Alternative 1: Setting the IP address on the first wizard page

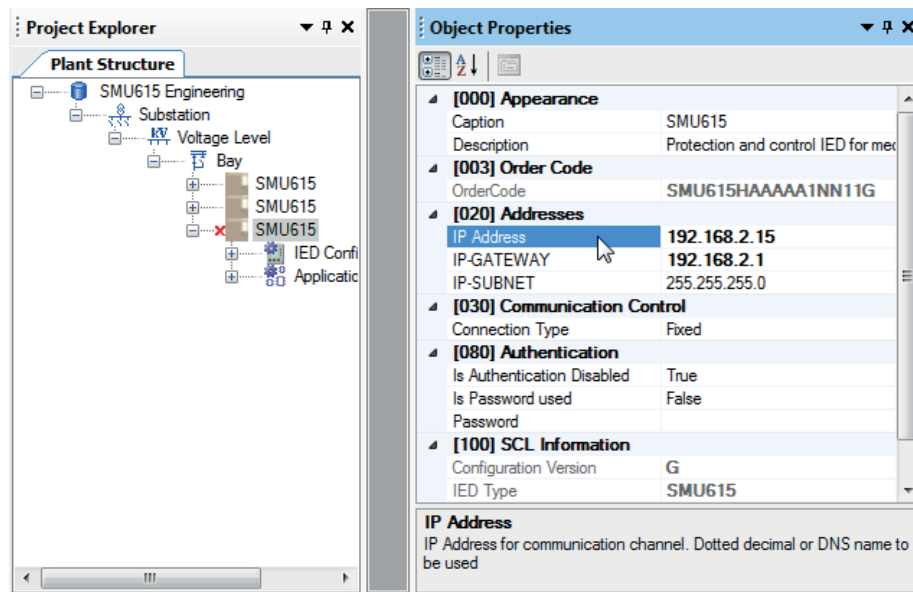


Figure 30: Alternative 2: Setting the IP address in IED's Object Properties dialog box

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 COM600S project

The SMU615 connectivity package supports SAB600. A merging unit is imported as a SMU615 device. It is also possible to import a full PCM600 project including several SMU615 devices to SAB600. In this case, PCM600 project information is imported to SAB600 using a SCD file.

The merging unit supports several functions in COM600S.

- Controlling the switchgear
- Monitoring the measured values
- Reading disturbance recordings
- Setting parameters

4.5.1 Selecting communication port for configuration

When a merging unit is configured to a PCM600 project, the connection between the merging unit and the tool can be established using a point-to-point link between the merging unit front port and the computer or by connecting the computer to the merging unit rear port over an Ethernet station bus. In PCM600, the front or rear communication port can be selected from the project structure.

When using the front port, DHCP server functionality must be activated in the computer network adapter settings to get the IP address from the merging unit. Alternatively, the computer network adapter IP address can be set manually to the same subnet range as the front port.

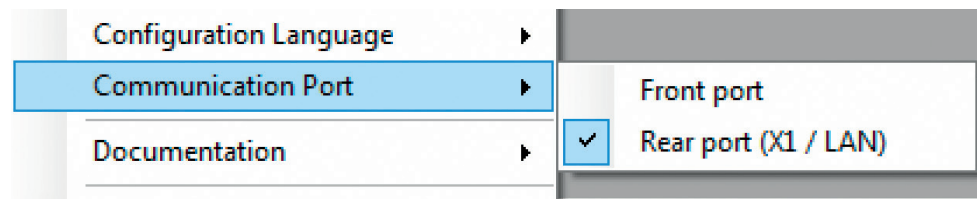


Figure 31: Communication port options

- Check that the settings are correct to ensure successful configuration access to the merging unit.
 - Computer port settings must match merging unit settings (IP address, subnet mask, DHCP).
 - Any firewall in the computer or in the network must pass required communication services.
 - When using the front port and switching the connection from the computer to another merging unit, it takes some time before the computer refreshes the merging unit's MAC address for front port IP address automatically. The MAC address can also be reset manually by clearing the computer ARP table.

4.5.2 Importing an SMU615 merging unit in a COM600S project

1. Create a PCM600 project including several IEDs.

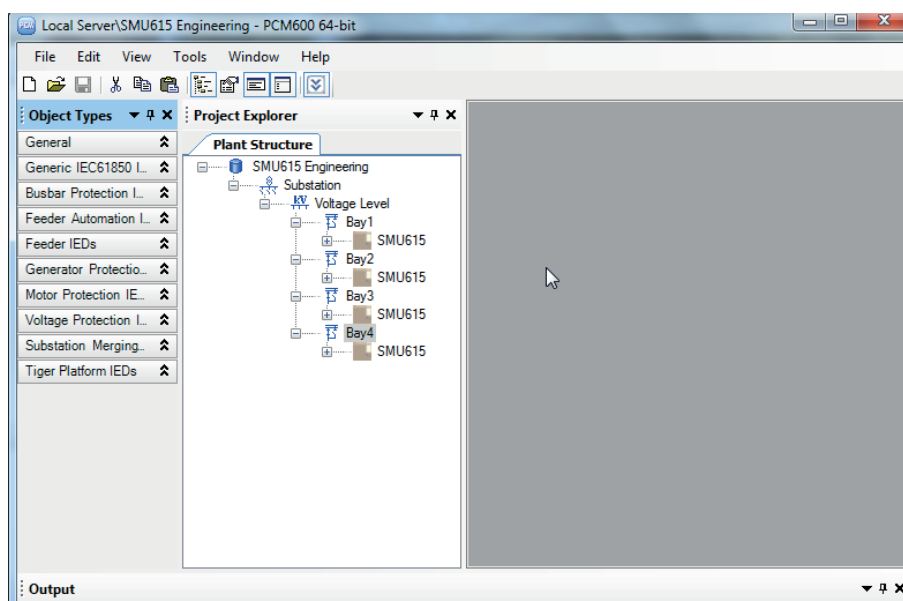


Figure 32: Creating a PCM600 project including several IEDs

2. Export the SCD file from PCM600.
In the **Plant structure** view, select the substation, right-click and select **Export**.

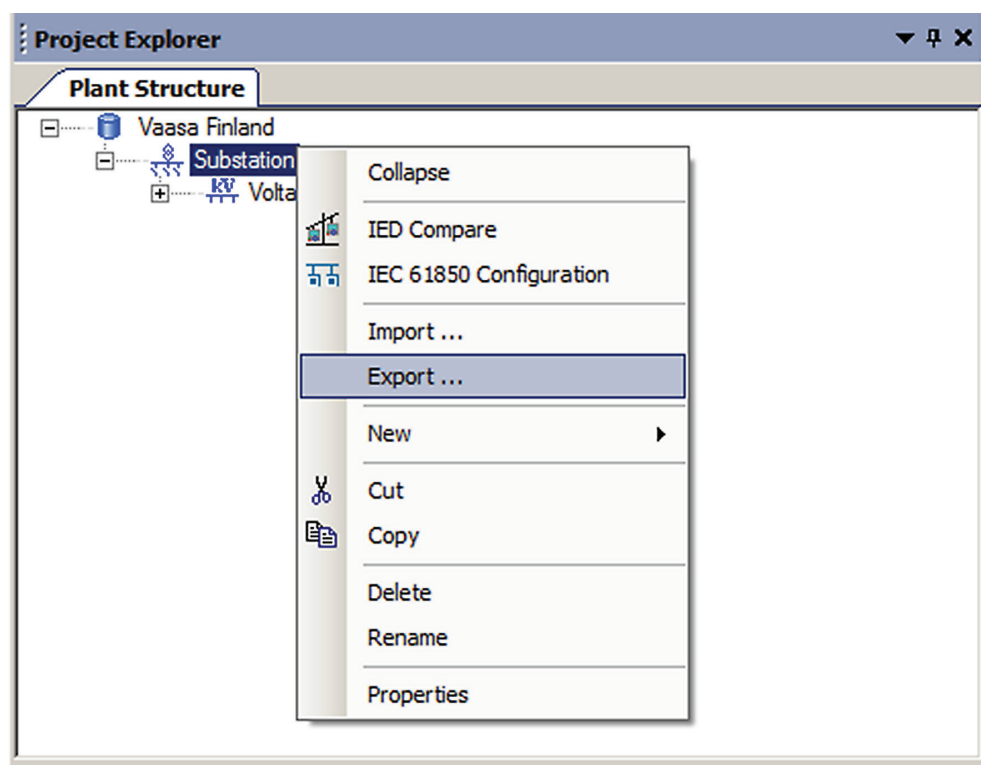


Figure 33: Exporting SCD file from PCM600 and importing it to SAB600

3. Import the SCD configuration into the SAB600 project.

In the **Project Explorer** view, right-click the IEC61850 OPC Server object and select **SCL Import**.

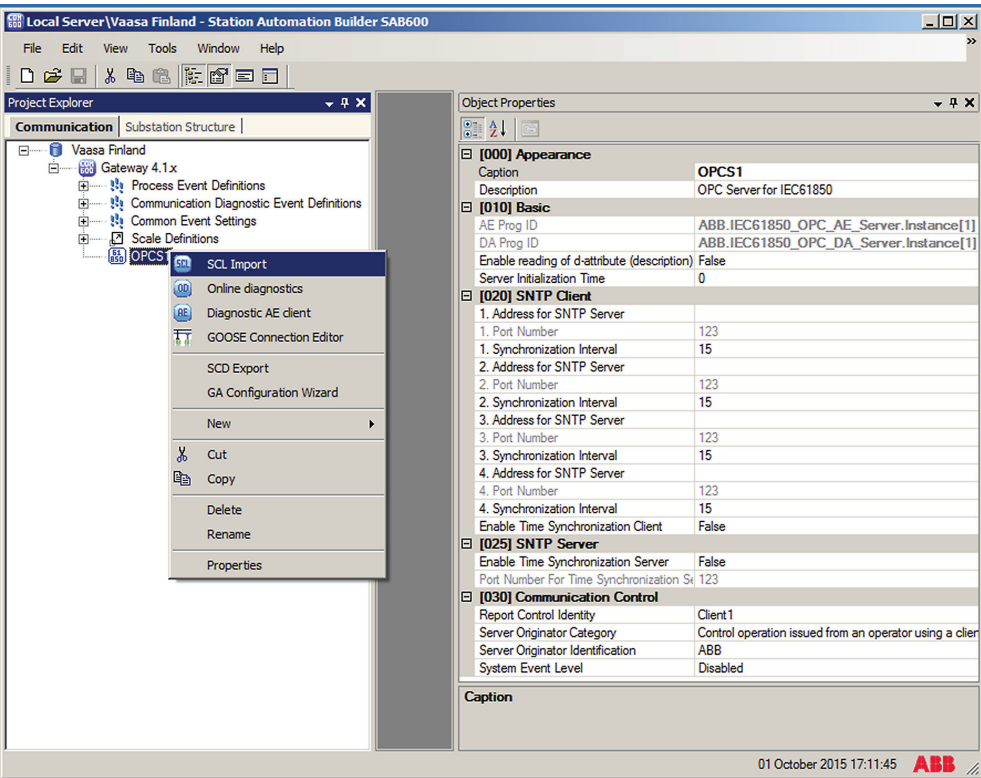


Figure 34: Importing the SCD configuration into the SAB600 project

- 4. In the **SCL Import** view, click **Select File** to select the SCD file exported from PCM600.

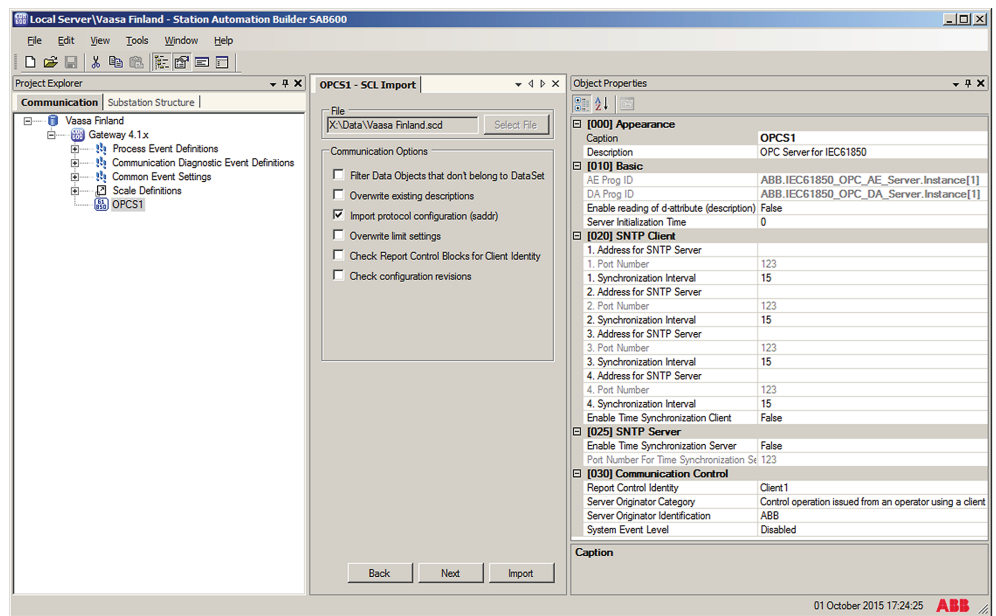


Figure 35: Creating a new IED into SAB600 project

5. Check the default settings in the **SCL Import** view and change the settings if they are not suitable.
The default settings in the **SCL Import** dialog should be correct in most cases.
6. Click **Import** to import the SCD file.
7. Check the IP address on the IEC 61850 subnetwork and change it if needed.
When the SCD file is directly exported from PCM600, it uses the IP address of the PCM600 computer, not the COM600S.

The communication towards the merging units is now ready. For information on how to finalize the single-line diagram and enable parameter setting through COM600S HMI, see COM600S documentation.

4.6

Using Web HMI

- As secure communication is enabled by default, access the WHMI from a Web browser using the HTTPS protocol.



To establish a remote WHMI connection to the merging unit, contact the network administrator to check the company rules for IP and remote connections.



Disable the Web browser proxy settings or make an exception to the proxy rules to allow the merging unit's WHMI connection, for

example, by including the merging unit's IP address in **Internet Options/Connections/LAN Settings/Advanced/Exceptions**.

For more information on the WHMI, see the operation manual.

4.7 Managing IED users

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



Local passwords can be changed only via the merging unit's front port. Remote passwords can be changed via the merging unit's front port WHMI, rear port WHMI or with PCM600.

1. Enable IED user authorization at **Main Menu/Configuration/Authorization/Passwords** in WHMI.
2. Use the IED Users tool in PCM600 to change the passwords. This tool cannot be used to add or change users.

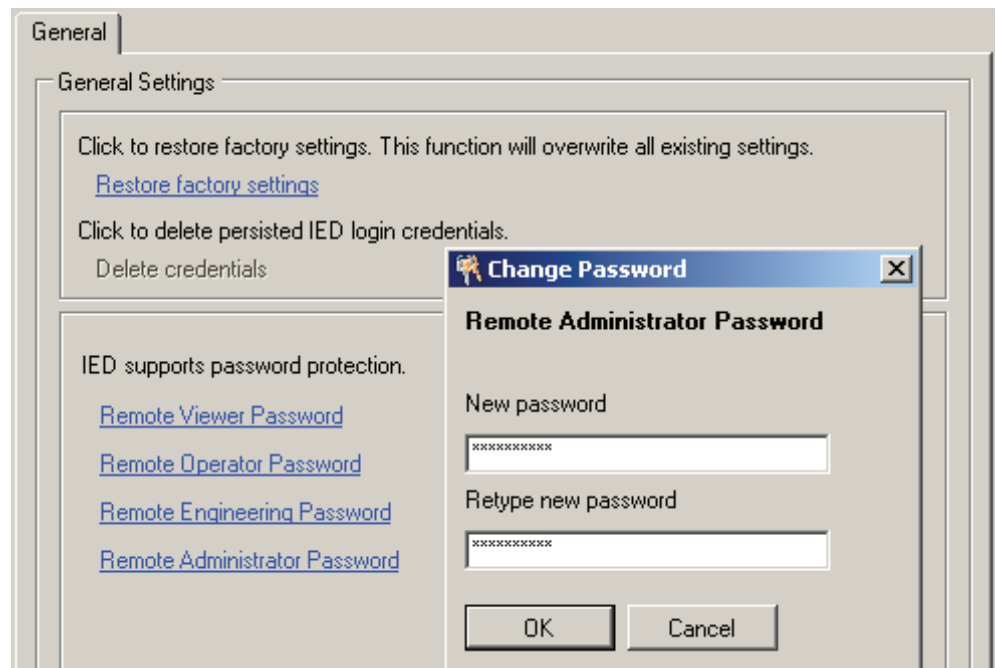
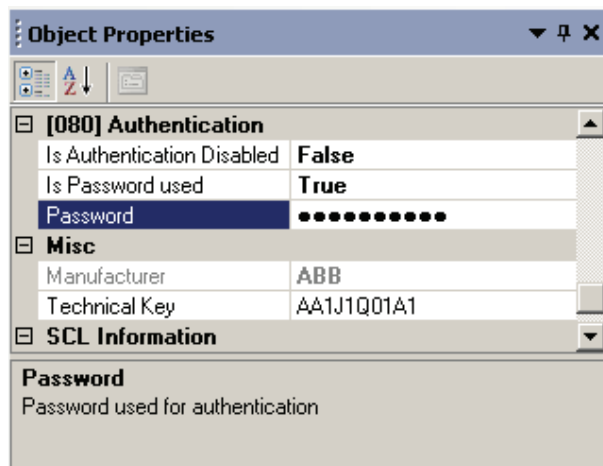


Figure 36: Changing the password using the IED User Management tool

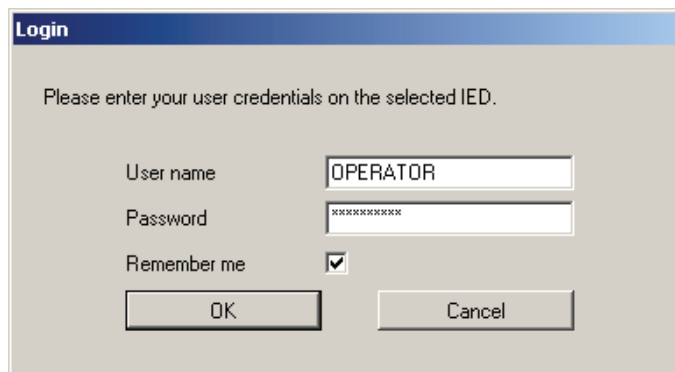
3. Set the object property values in PCM600 to make the communication between the IED and PCM600 work, if the remote authentication has been enabled.

Table 4: *Object properties to change*

Object Properties field	Value
Is Authentication Disabled	False
Is Password used	True
Password	Write the correct password

**Figure 37:** *Object properties*

When communicating with the merging unit with PCM600 tools and with the merging unit's authentication enabled, the merging unit username and password must be given when prompted. When setting the technical key, the username and password must be given twice.

**Figure 38:** *User login*

If the PCM600 authentication has been enabled in PCM600 System Settings, a merging unit user can be linked to the current PCM600 user by selecting the Remember me check box in the Login dialog. After that, the user credentials are no longer asked

at tool communication as logging in PCM600 also provides the authentication credentials to the merging unit.

4.8 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.

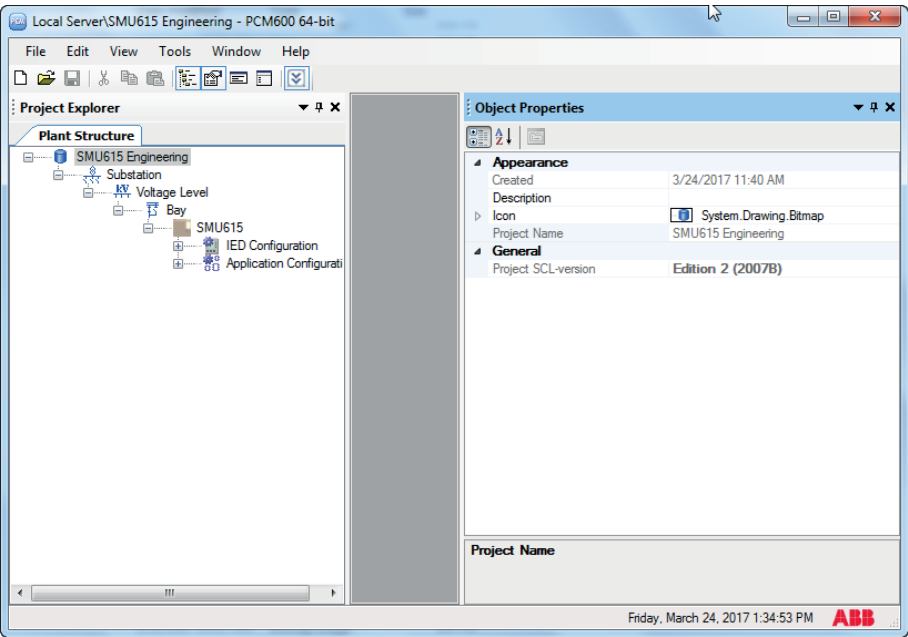


Figure 39: Project's IEC 61850 version

To change the IEC 61850 version Edition 1 of an IED to Edition 2, the configuration has to be written to the IED from a PCM600 project that has the IEC 61850 version Edition 2. A dialog box notifies on the difference of the versions.

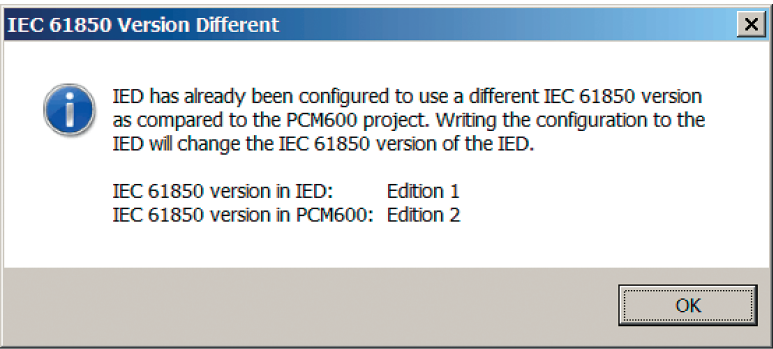


Figure 40: IEC 61850 version change

Section 5 Protection and control engineering

5.1 Application Configuration tool

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

The function blocks are dedicated to different functions.

- Control related functions
- Supervision 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 merging unit 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 merging units (Function blocks and related logic can be fully or partially reused depending on the functionality available in the other merging unit)
- Validate the application configuration during the configuration process on demand and while writing the application configuration to the merging unit



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.

- User-defined names can be given for function blocks and signals.



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



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

- 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.

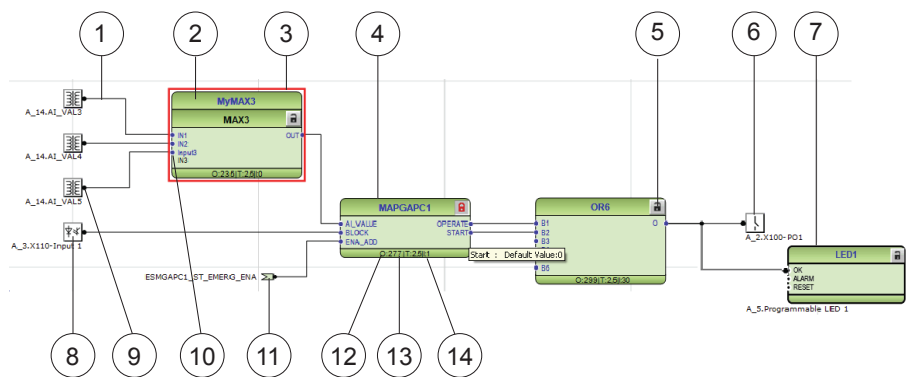


Figure 41: Application Configuration tool: function block overview

- 1 Connection(s)
- 2 User-defined function block name
- 3 Function block, selected (red)
- 4 Function block name
- 5 Function block, locked
- 6 Hardware, binary output channel
- 7 Hardware, programmable LED
- 8 Hardware, binary input channel
- 9 Hardware, analog input channel
- 10 User-defined signal name
- 11 User-defined input variable
- 12 Execution order
- 13 Cycle time
- 14 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.

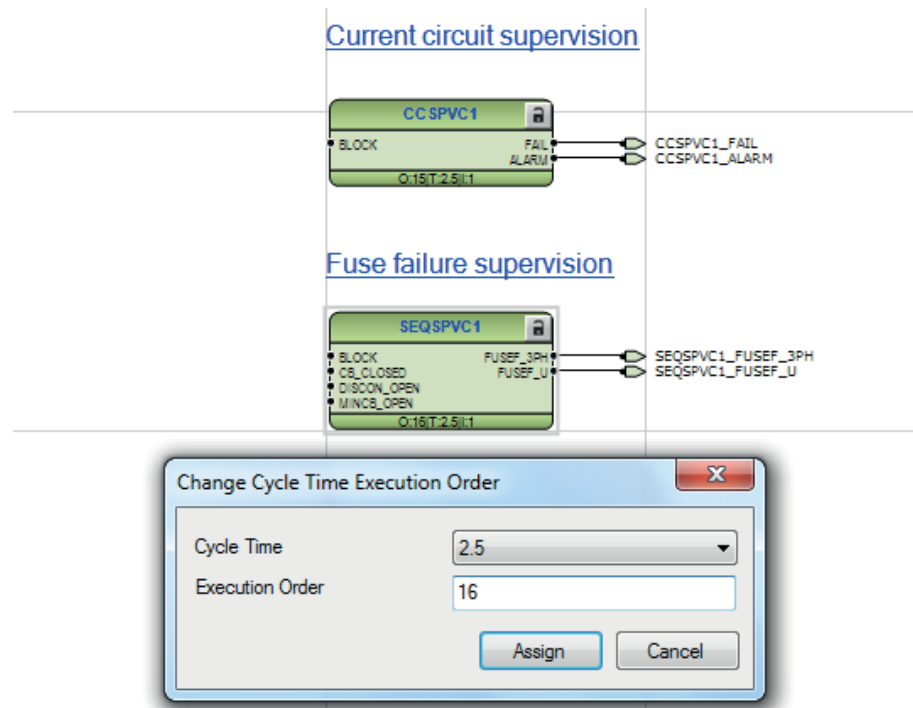


Figure 42: Application Configuration tool: an example of function block organization parameters

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.

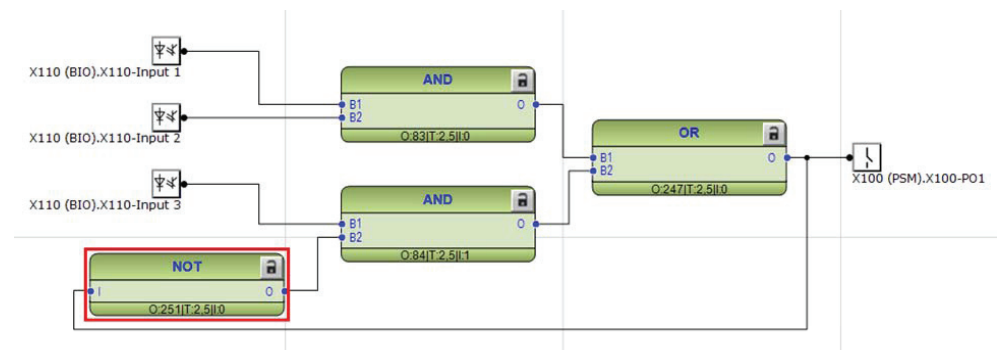


Figure 43: Feedback loop situation with automatically calculated execution orders

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.

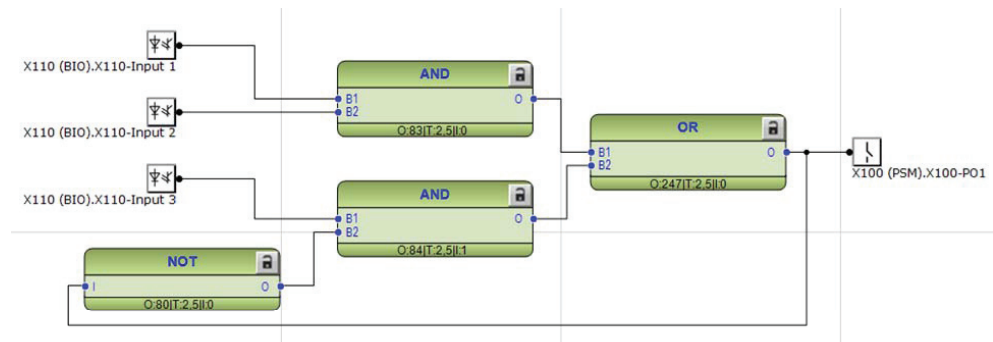


Figure 44: Feedback loop situation with manually fixed execution order for NOT port

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.

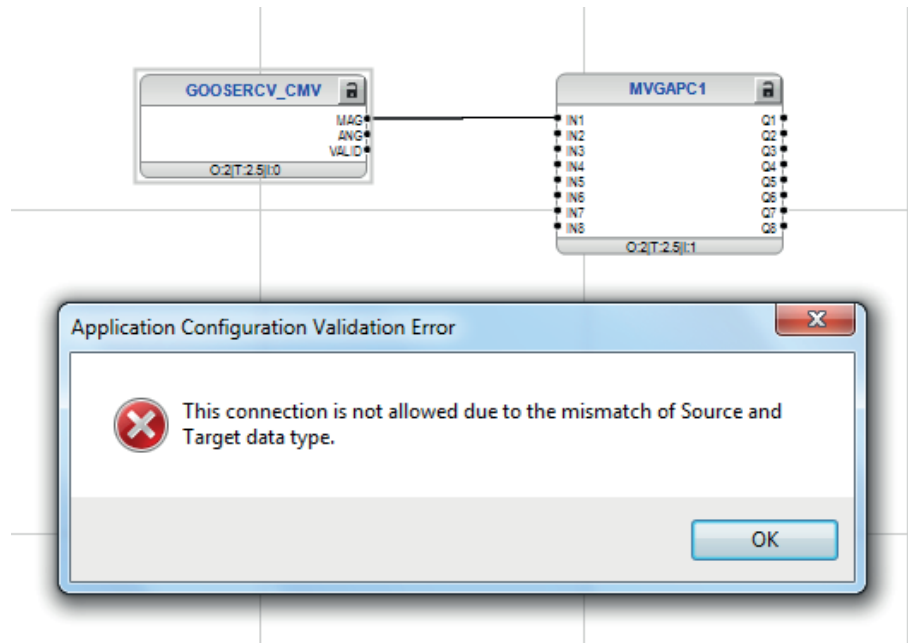


Figure 45: Application Configuration tool: an error message of a signal mismatch for a connection

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.

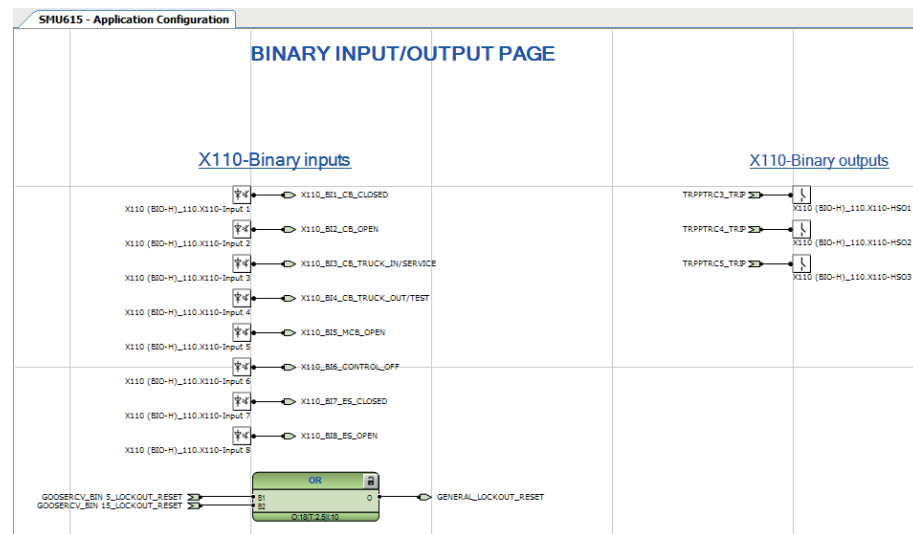


Figure 46: Application Configuration tool: HW signal channels

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

Online monitoring

The online monitoring enables the continuous monitoring of the signal or channel values in the configuration. In the “Online monitoring” mode, the configuration cannot be edited in the Application Configuration tool.

Online monitoring can be started by clicking the Work online button in the toolbar. If the application configurations in the IED and PCM600 are the same, the online monitoring starts. The online monitoring ends and the tool returns to the configuration mode if the Work Offline button is clicked.



Online monitoring cannot be started if the application configuration in IED and PCM600 are different.



In some cases when the function block input is directly mapped to the function block output, the input is internally forced to the correct value depending of the function block's settings. This kind of function block design is present in control blocks and tap changer.

5.1.9

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 merging unit

5.1.9.1

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

5.1.9.2

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 merging unit. However, errors must be corrected before writing the application configuration to the merging unit. 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 merging unit.

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.

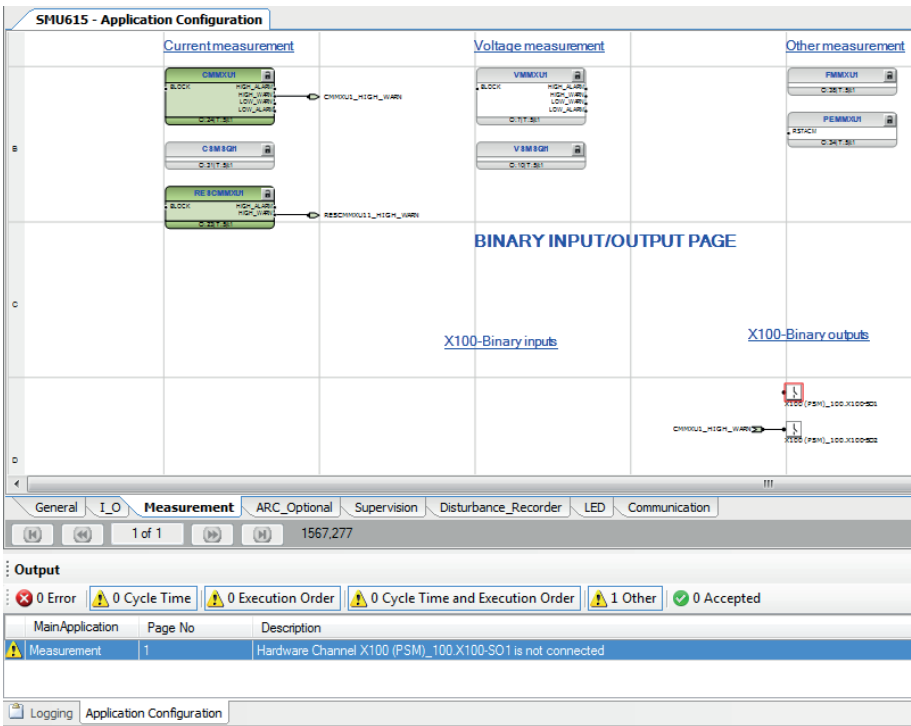


Figure 47: Application Configuration tool: validation on demand

5.1.9.3

Validation when writing to the merging unit

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

5.2

Parameter Setting tool

Configuration parameters and settings parameters can be changed via the merging unit's front port WHMI, rear port WHMI or with the Parameter Setting tool in PCM600.



Some parameters are only visible in the Parameter Setting tool and some only via the merging unit's front port WHMI.



A common writing from PCM600 to the merging unit, where parameters are changed in the Parameter Setting tool, overwrites any parameter changes made locally via the merging unit's front port WHMI.

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

- Configuration parameters
- Setting parameters

5.2.1 Configuration parameter

Configuration parameter specifies the operation mode of an application function or of the merging unit. These are basic configurations that are normally configured only once and then not modified again. The merging unit 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 merging unit at runtime.

5.2.3 Parameter import and export

The parameter export and import function can be utilized, for example, when the merging unit's parameters are set using the WHMI instead of PCM600. The merging unit settings engineered with PCM600 can be exported to XRIO files and imported to the WHMI. The WHMI can be used to write the settings to the merging units. The WHMI can also be used to read the merging unit setting parameters and to export those to files, which can be used by PCM600.



The exporting and importing of settings is sensitive to the merging unit's content. Settings are exported and imported for one merging unit at a time. The export files of a specific merging unit can be exchanged between PCM600, WHMI and the actual physical IED. To avoid errors and to efficiently manage the exporting and importing of settings, for example, in a substation with several merging units, ensure that the names of the export files identify the merging unit to which the file should be imported.

The parameter import/export functionality is available via the File menu when the Parameter Setting tool is open.

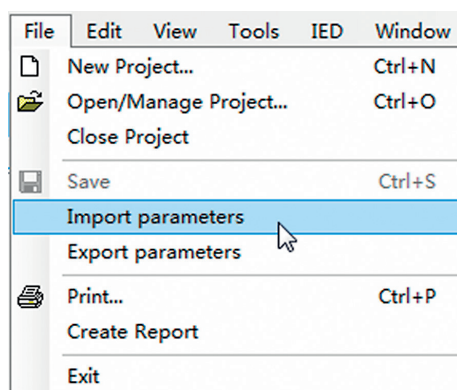


Figure 48: Parameter import/export

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.

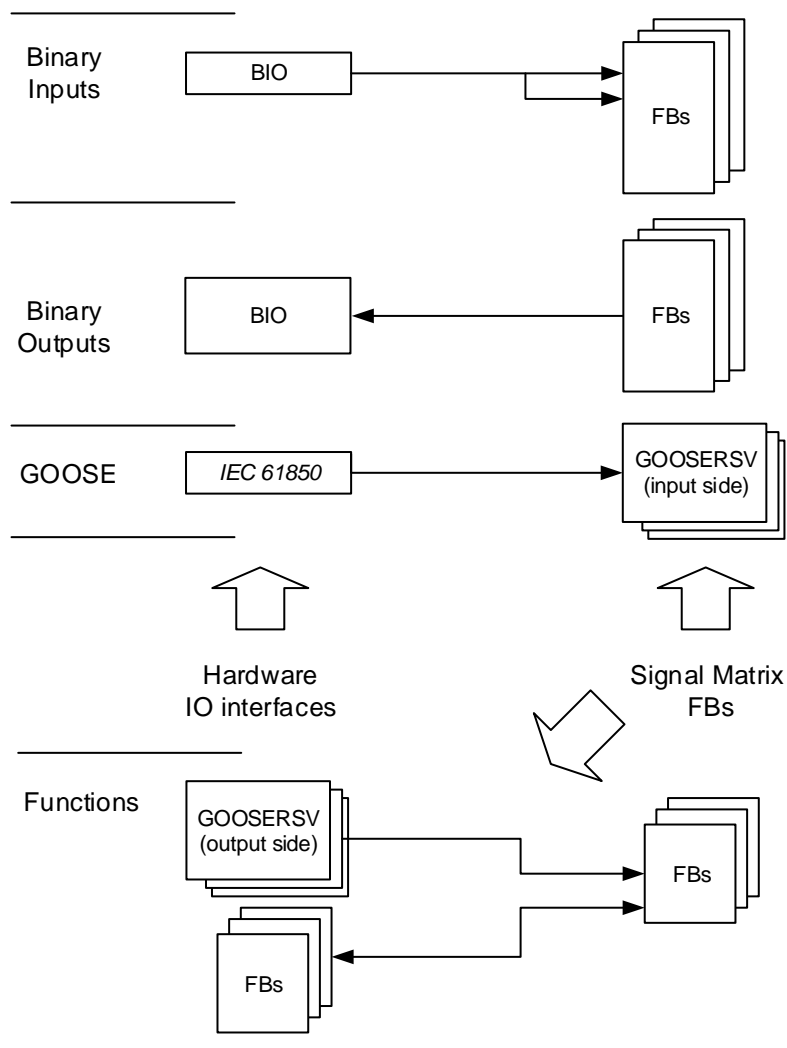


Figure 49: *Signal Matrix: operation principles*

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.

		X110 (BIO)							
		X110-Input 1	X110-Input 2	X110-Input 3	X110-Input 4	X110-Input 5	X110-Input 6	X110-Input 7	X110-Input 8
- CBXCBR1:1 CBXCBR1:1	POSOPEN								X
	POSCLOSE							X	
	ENA_OPEN								
	ENA_CLOSE								
	BLK_OPEN								
	BLK_CLOSE								

		X100 (PSM)					
		X100-PO1	X100-PO2	X100-SO1	X100-SO2	X100-PO3	X100-PO4
CBXCBR1:1	SELECTED						
	EXE_OP		X				
	EXE_CL	X					
	OPENPOS						
	CLOSEPOS						

Figure 50: 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
- Functions
- 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
- GOOSE receive configuration
- Parameters



Application comparison also compares the system function blocks.



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.

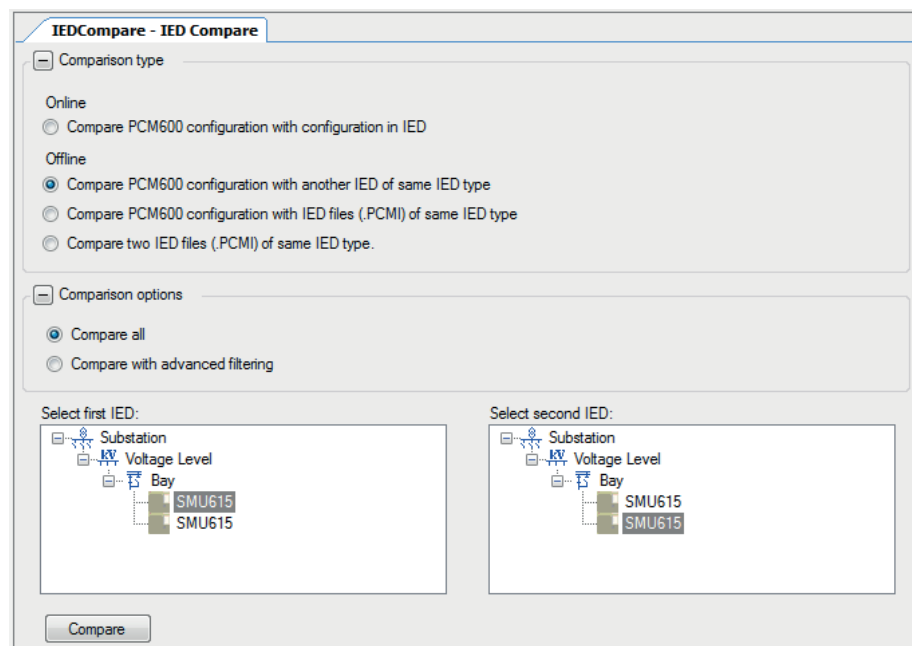


Figure 51: Compare options

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.

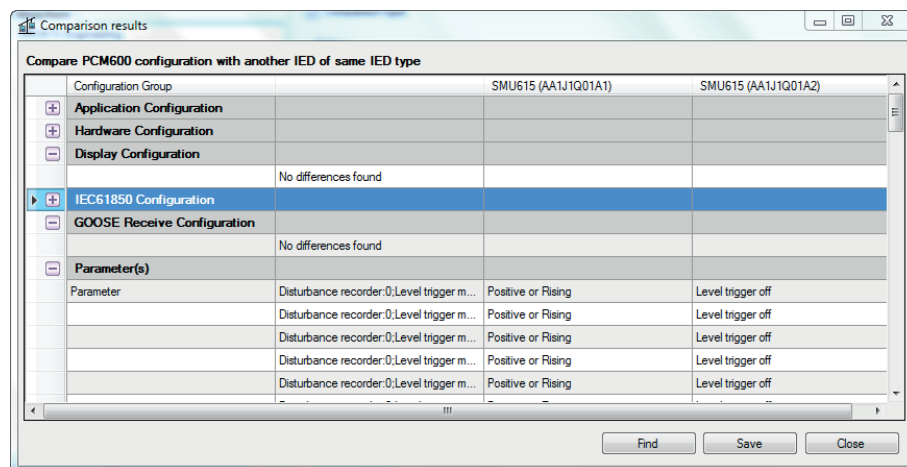


Figure 52: Compare report

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 TEST_MODE and control blocking examples

All of the merging unit'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 the merging unit's front port WHMI. *Test mode* is also available via IEC 61850 communication (LD0.LLN0.Mod).

Table 6: Test mode

Test mode	Description	TEST_MODE BEH_BLK
Normal mode	Normal operation	FALSE
IED blocked	Functions working as in "Normal mode" but ACT configuration can be used to block physical outputs to process. Control function commands blocked.	TRUE
IED test	Functions working as in "Normal mode" but in parallel with test parameters.	FALSE
IED test and blocked	Functions working as in "Normal mode" but 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 via the merging unit's front port WHMI. *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

5.5.1

TEST_MODE 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 TEST_MODE function block.

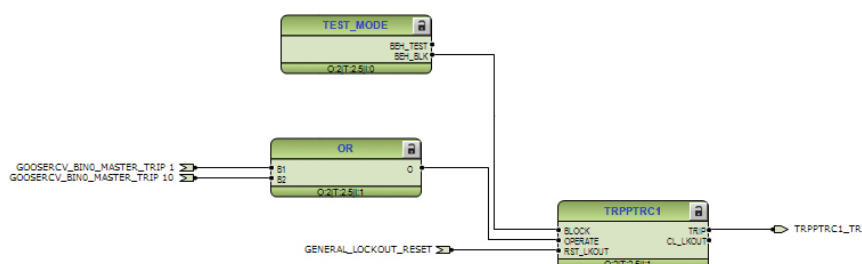


Figure 53: *Master trip TRPPTRC blocked using TEST_MODE function block BEH_BLK output*

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.

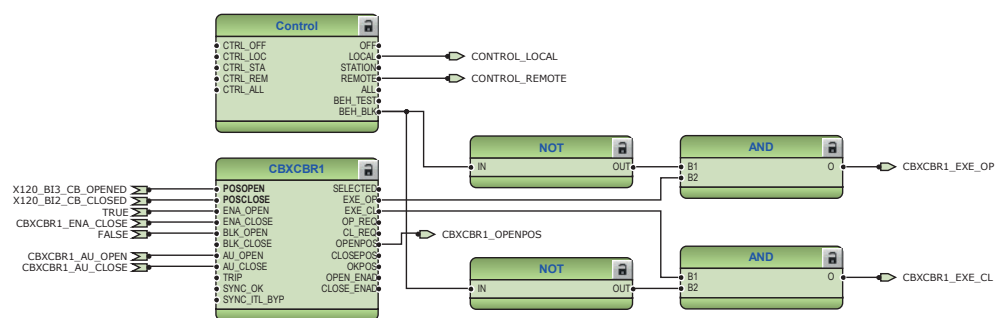


Figure 54: Circuit breaker control CBXCBR1 blocked using Protection function block BEH_BLK output

Section 6 LHMI engineering



For information on LED operation modes supported by the merging unit, see the technical manual.

6.1 HMI event filtering

HMI Event Filtering is a tool that helps in configuring visibility of events shown on the WHMI of the IED. This tool does not modify the actual events on the protocol level, it only modifies the event visibility on the WHMI.

The event tree view is used to modify the visibility of the events shown on the WHMI. Events in the tree view are structured in the same way as functions in the PCM600 plant structure.

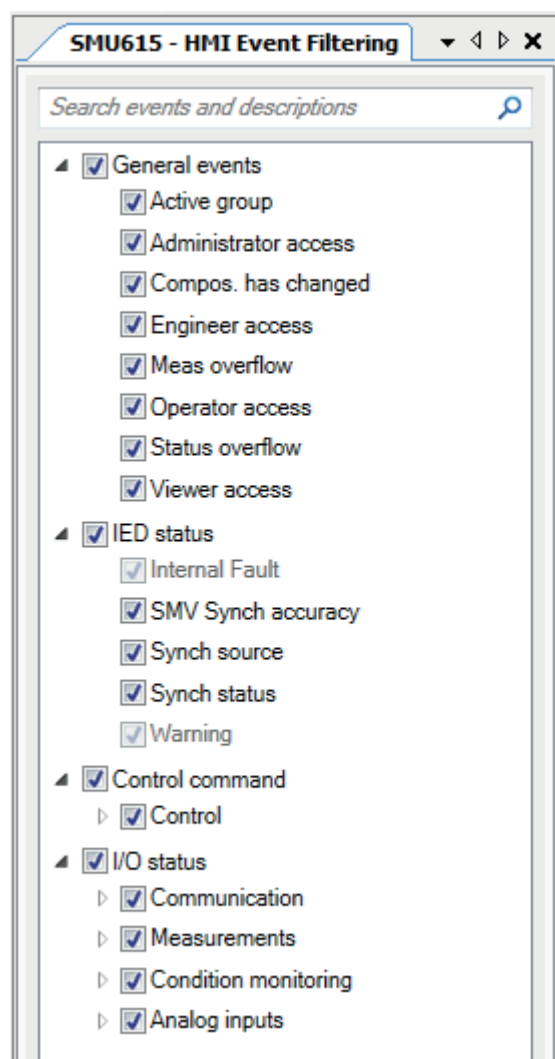


Figure 55: HMI event filtering interface

6.1.1 Starting HMI event filtering

Start HMI event filtering in one of the alternative ways.

- Right-click an IED and select **HMI Event Filtering**.
- On the **Tools** menu, click **HMI Event Filtering**.

6.1.2 Setting visibility of HMI events

1. Browse the event tree for the event.
Event nodes in the tree have more detailed description in the tool tip.
2. Select or clear the check box next to the event name to specify it's visibility.

- When the check box is cleared, the event is not visible on the WHMI.
- When the check box is selected, the event is visible on the WHMI.

The HMI visibility can also be modified for multiple events by selecting the check box of the parent node in the event tree view.

Some events in the event tree are read-only and cannot be modified. The read-only events appear dimmed in the user interface.

6.1.3 Searching events

HMI Event Filtering has search capabilities to quickly find wanted event from the event tree view. Use predefined search strings or type a search string manually. The event tree view is filtered using the search string.

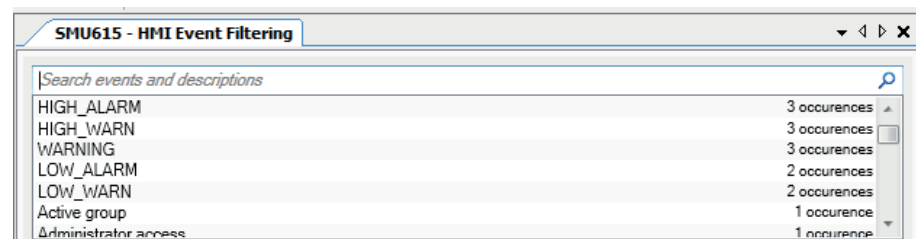


Figure 56: Searching events

- Search events using predefined search strings.
 1. Click the search text box shown on top of the event tree view. A drop-down list is shown with predefined search strings.
 2. Select the event name to be shown in the event tree. Event tree is filtered to show only events with the specified name.
- Search using custom search strings.
 1. Click the search text box shown on top of the event tree view.
 2. Type a custom search string in the search text box. The event tree is filtered to all matching events. Search functionality tries to match the given custom search string to the event name and description. Partial matches are also shown in the results view.
- To clear the search results, click the Clear button on the right side of the search text box or erase the search string.

6.1.4 Saving event filter configuration

Save the event filter configuration in one of the alternative ways.

- In the event tree view, select **File/Save**.
- Click the Save button on the toolbar.

Section 7 IEC 61850 communication engineering

7.1 IEC 61850 protocol references and pre-conditions

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

7.2 IEC 61850 interface



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

Table 8: Function blocks and IEC 61850 Edition 1 and Edition 2 Logical Nodes

Function	IEC 61850	Logical device	Logical nodes in Edition 2	Logical nodes in Edition 1
Control				
Circuit breaker control	CBXCBR	CTRL	CBCSWI CBCILO CBXCBR	CBCSWI CBCILO CBXCBR
Disconnecter control	DCXSWI	CTRL	DCCSWI DCCILO DCXSWI	DCCSWI DCCILO DCXSWI
Earthing switch control	ESXSWI	CTRL	ESCSWI ESCILO ESXSWI	ESCSWI ESCILO ESXSWI
Disconnecter position indication	DCSXSWI	CTRL	DCSXSWI	DCSXSWI
Earthing switch indication	ESSXSWI	CTRL	ESSXSWI	ESSXSWI
Condition monitoring				
Circuit-breaker condition monitoring	SSCBR1	LD0	SSCBR1 SPH1SCBR SPH2SCBR SPH3SCBR SSOPM SSIMG	SSCBR1
Table continues on next page				

Function	IEC 61850	Logical device	Logical nodes in Edition 2	Logical nodes in Edition 1
Trip circuit supervision	TCSSCBR	LD0	TCSSCBR	TCSSCBR
Current circuit supervision	CCSPVC	LD0	CCSPVC	CCRDIF
Fuse failure supervision	SEQSPVC	LD0	SEQSPVC	SEQRFUF
Arc detection	ARCDSARC	LD0	ARCDSARC	ARCDSARC
Measurement				
Disturbance recorder	RDRE	LD0	DR_LLNO RDRE_type RADR_type RBDR_type LPHD_M	DR_LLNO RDRE_type RADR_type RBDR_type LPHD_M
Three-phase current measurement	CMMXU	LD0	CMMXU CAVMMXU CMAMMXU CMIMMXU	CMMXU CMSTA
Phase sequence current measurement	CSMSQI	LD0	CSMSQI	CSMSQI
Residual current measurement	RESCMMXU	LD0	RESCMMXU RCVMMXU RCMAMMXU RCMIMMXU	RESCMMXU RESCMSTA
Three-phase voltage measurement	VMMXU	LD0	VMMXU VAVMMXU	VMMXU VMSTA
Phase sequence voltage measurement	VSMSQI	LD0	VSMSQI	VSMSQI
Three-phase power and energy measurement	PEMMXU	LD0	PEMMXU PEMMTR PEAVMMXU PEMAMMXU PEMIMMXU	PEMMXU PEMMTR PEMSTA
Frequency measurement	FMMXU	LD0	FMMXU	FMMXU
Instrument transformers and sensors				
Three-phase current transformer	ILTCTR	LD0	IL1TCTR IL2TCTR IL3TCTR	IL1TCTR IL2TCTR IL3TCTR
Three-phase voltage transformer	ULTVTR	LD0	UL1TVTR UL2TVTR UL3TVTR	UL1TVTR UL2TVTR UL3TVTR
Residual current transformer	RESTCTR	LD0	RESTCTR	RESTCTR
Communication				
IEC 61850-9-2 LE sampled value sending	SMVSENDER	MU01	LLNO LPHD1 I01ATCTR1 I01BTCTR2 I01CTCTR3 I01NTCTR4 U01ATVTR1 U01BTVTR2 U01CTVTR3 U01NTVTR4	LLNO LPHD1 I01ATCTR1 I01BTCTR2 I01CTCTR3 I01NTCTR4 U01ATVTR1 U01BTVTR2 U01CTVTR3 U01NTVTR4
Redundant Ethernet channel supervision	RCHLCCH	LD0	RCHLCCH	
Ethernet channel supervision	SCHLCCH	LD0	SCHLCCH	
Human machine interface	IHMI	LD0	IHMI	IHMI
Table continues on next page				

Function	IEC 61850	Logical device	Logical nodes in Edition 2	Logical nodes in Edition 1
General security application	GSAL	LD0	GSAL	GSAL
Time synchronization and local time	GNRLLTMS	LD0	GNRLLTMS ¹⁾ GNRLLTIM	GNRLLTMS
Controllable logic				
Minimum pulse timer	TPGAPC		TPGAPC	TPGAPC
Minimum pulse timer	TPSGAPC		TPSGAPC	TPSGAPC
Minimum pulse timer	TPMGAPC		TPMGAPC	TPMGAPC
Pulse timer	PTGAPC		PTGAPC	PTGAPC
Time delay off	TOFGAPC		TOFGAPC	TOFGAPC
Time delay on	TONGAPC		TONGAPC	TONGAPC
Set-reset	SRGAPC		SRGAPC	SRGAPC
Move	MVGAPC		MVGAPC	MVGAPC
Generic control point	SPCGAPC		SPCGAPC	SPCGGIO
Protocols				
IEC 61850	MMSLPRT	LD0	MMSLPRT	MMSGGIO
GOOSE	GSELPRT	LD0	GSELPRT	GSEGGIO
Hardware				
PSM (X100) card	X100 (PSM)	LD0	XGGIO100	XGGIO100
BIO (X110) card	X110 (BIO)	LD0	XGGIO110	XGGIO110
BIO (X110) high speed output	X110 (BIO-H)	LD0	XBGGIO110	XBGGIO110
AIM (X120) 4CT_3VT with sensitive Io	X120 (AIM2)	LD0	XAGGIO120	XAGGIO120
SIM (X130) 3Is_3Us with sensitive Io	X130 (SIM)	LD0	XSGGIO130	XSGGIO130
COM (X000) card	XGGIO90	LD0	XGGIO90	XGGIO90
LED indication control	LEDPTRC	LD0	LEDPTRC	LEDPTRC
Programmable LEDs	LED	LD0	LEDGGIO	LEDGGIO

1) IEC61850 Edition1 logical node is GNRLLTMM

7.2.1 IEC 61850 interface in the merging unit

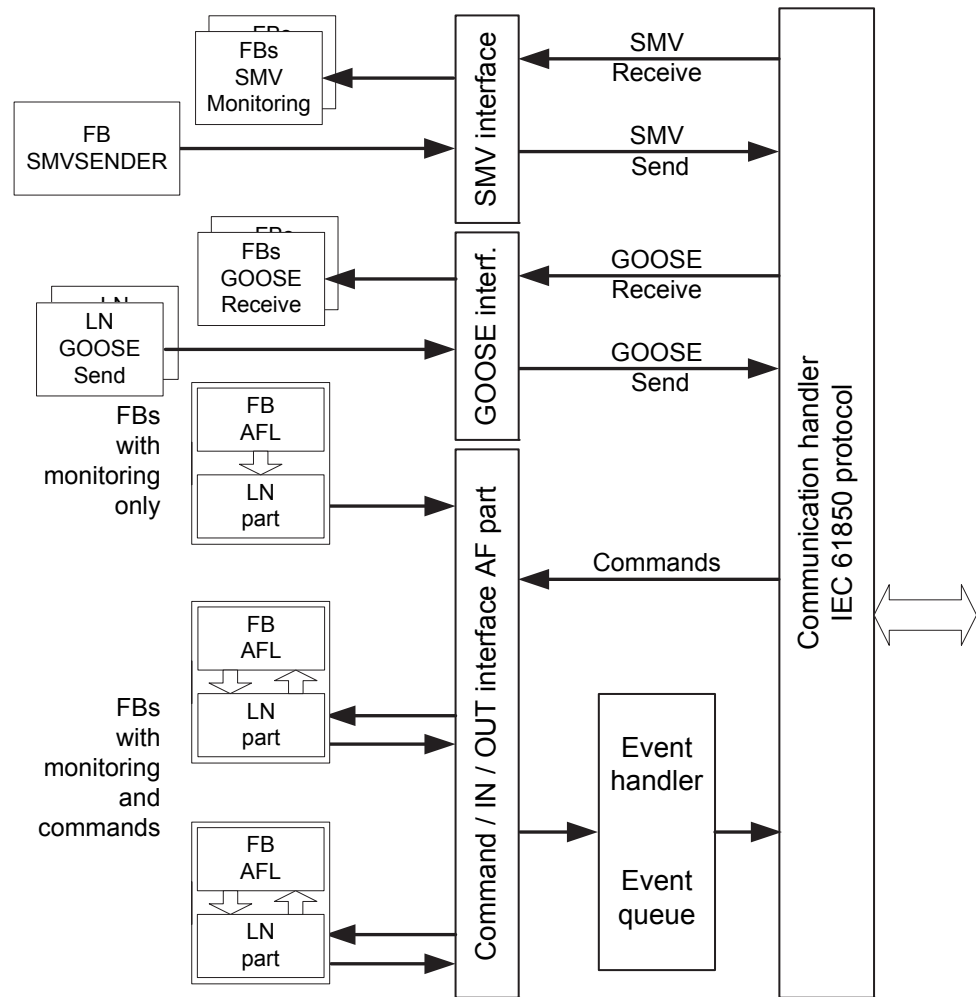


Figure 57: IEC 61850 communication interface principle

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.

7.2.1.1 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.

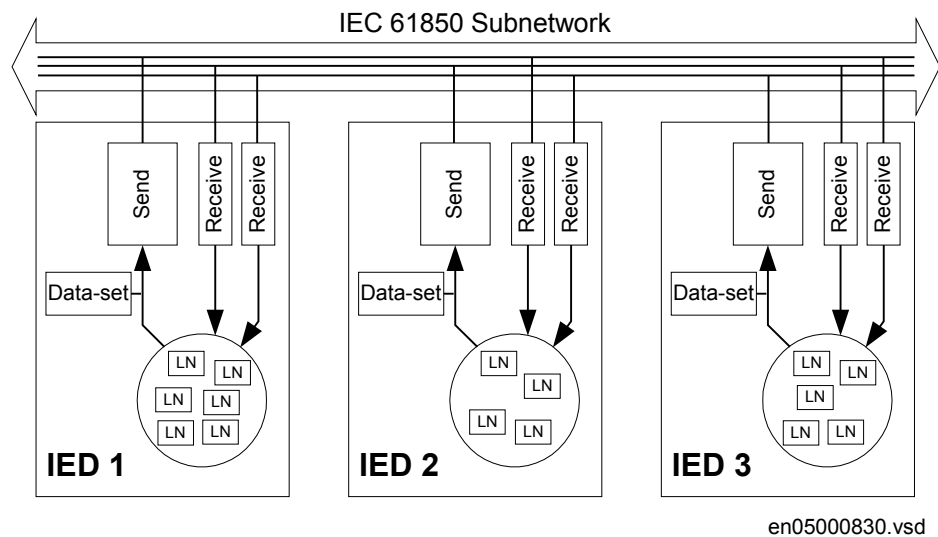


Figure 58: IEC 61850: Horizontal communication principle, an example of three IEDs where each IED communicates with all others

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 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.

7.2.2

Function view for IEC 61850 in PCM600

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

The concept in the IED is such that the 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.

7.2.3

Station configuration description file types

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

- ICD = IED capability description
 - Capability description of the IED in logical nodes and their data. No information about, for example, the communication configuration is included.
 - An IED is already extended by default data sets and report control blocks. They are predefined by ABB. Changes or additional data sets, for example, have to be done with IEC 61850 Configuration tool or 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.

7.3

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 default data sets and control blocks for vertical communication between the substation client and IEDs. For more information, see the IEC 61850 standards.

In the following example, it is assumed that PCM600 and 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, a SCD file. It is also possible to export other SCL file types.
2. Horizontal and vertical communication is configured using the station configuration tool, for example, IEC 61850 Configuration tool or IET600.
3. SCL files are imported to a PCM600 project. In this case, it is the updated SCD file.

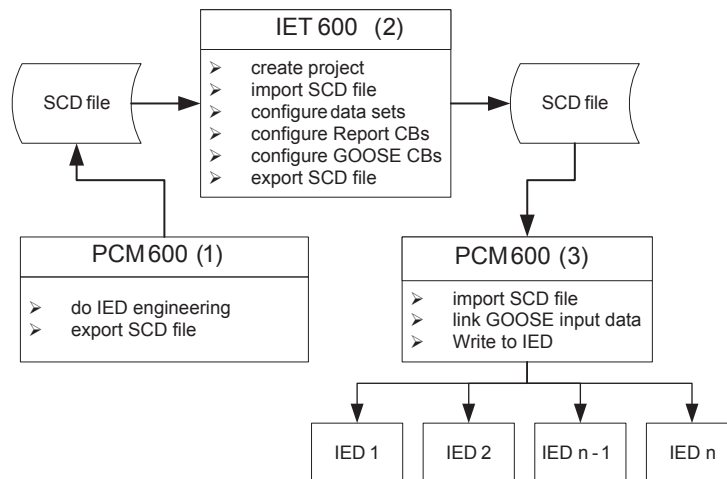


Figure 59:

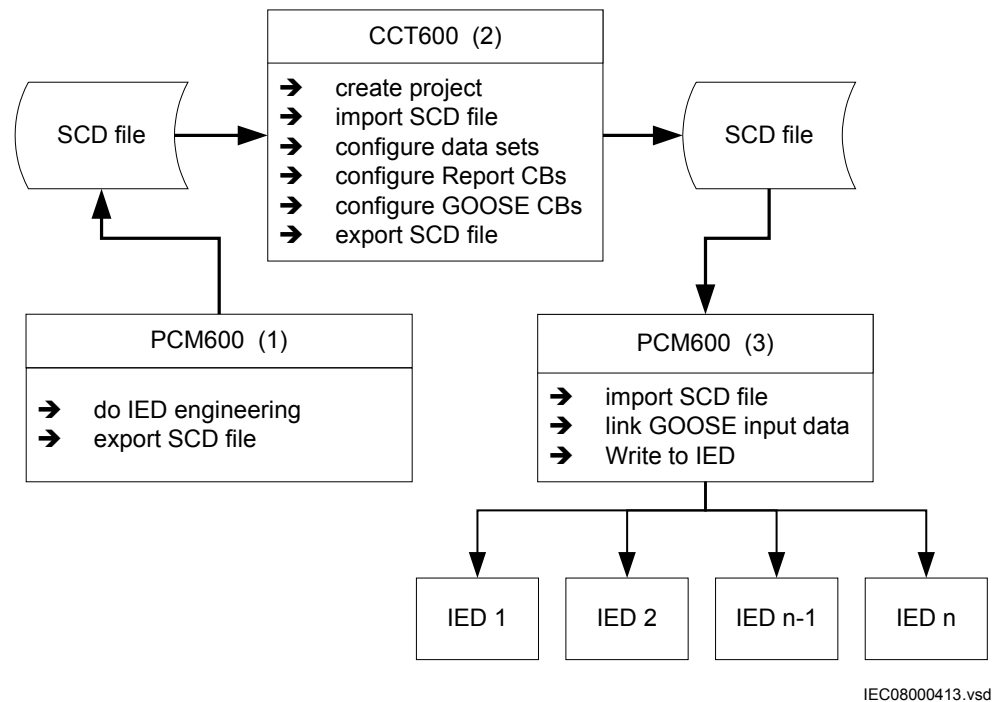


Figure 60: IEC 61850: Signal engineering procedure flow when a complete station is exported as a SCD file

7.3.1

Exporting SCL files from PCM600

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

7.3.1.1

Exporting SCD files

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

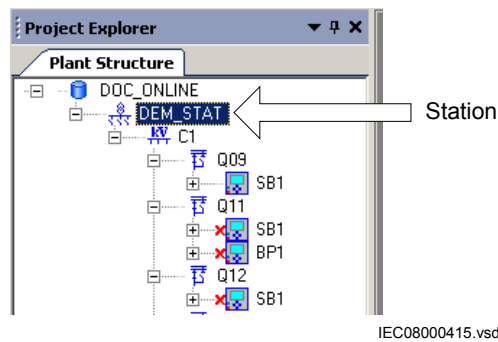


Figure 61: IEC 61850: selecting the station

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.

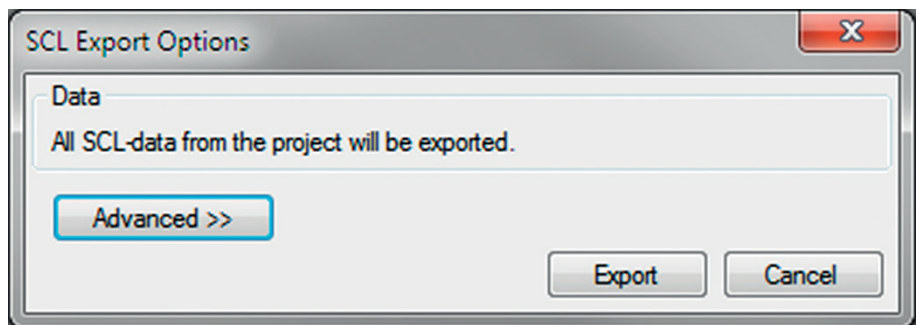


Figure 62: IEC 61850: selecting the SCL export option

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

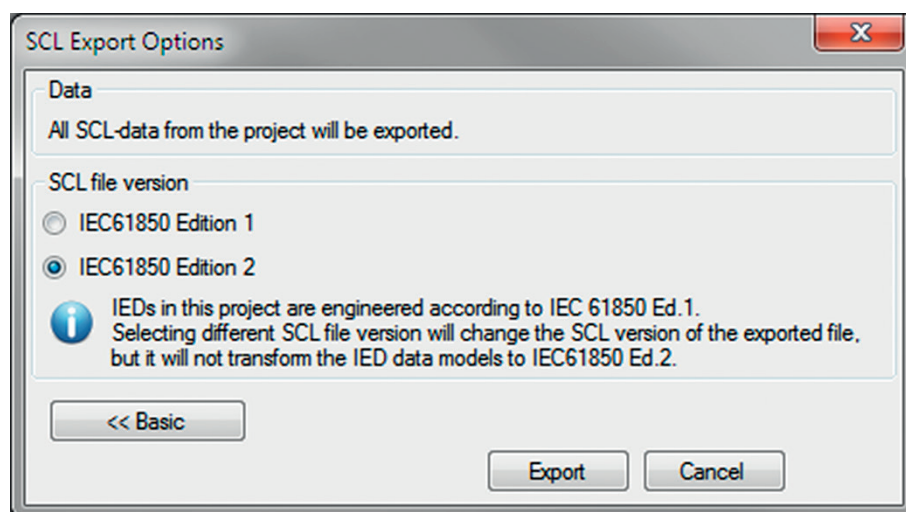


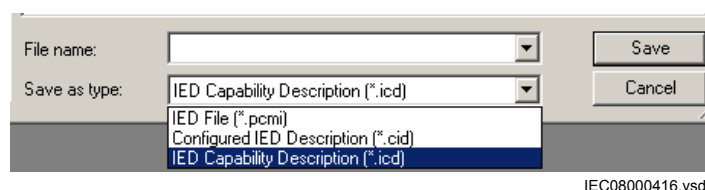
Figure 63: Export options of SCL

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

7.3.1.2

Exporting ICD or CID files

1. Select the IED in the **Plant Structure** view.
2. Right-click the IED and select **Export...**
The **Export** dialog box opens.
3. From the **Save as type** list, select the type of file to export.
 - Configured IED description (.cid) for the IEC 61850 structure as needed for the IED at runtime
 - IED capability description (.icd) for the IEC 61850 structure



IEC08000416.vsd

Figure 64: IEC 61850: export IED file type selection

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

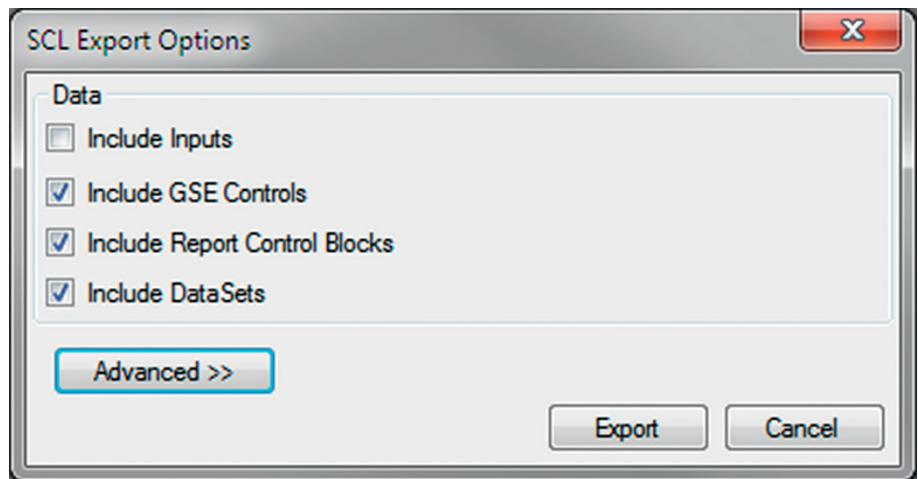


Figure 65: IEC 61850: export options for ICD files

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

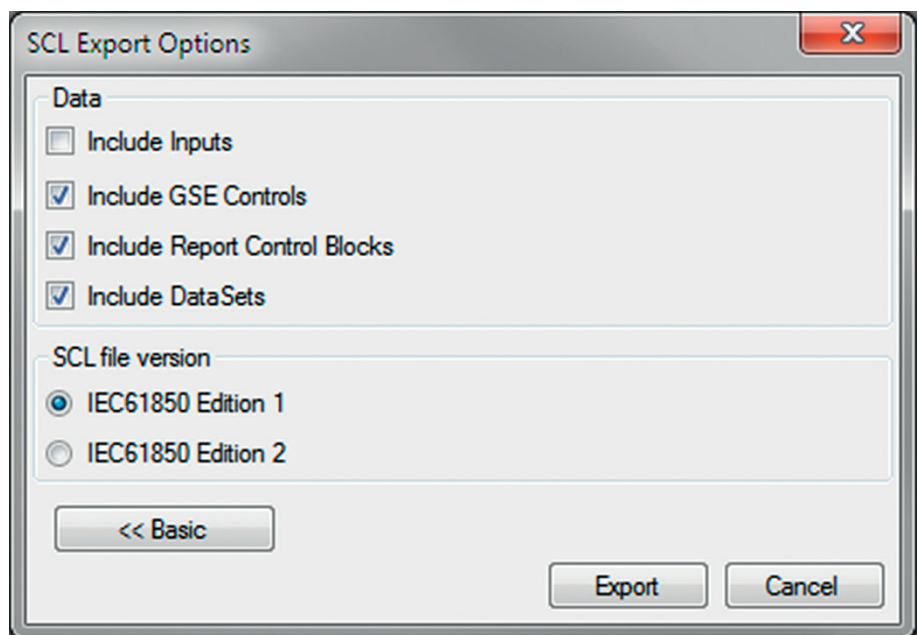


Figure 66: SCL export options

7. Click **Export**.

7.3.2

Engineering vertical and horizontal communication

For IEC 61850 engineering a separate system configuration tool is needed to be used with PCM600. In PCM600 Ver.2.4 the recommended tool is IET600, which is also included in the PCM600 Engineering Pro installation package. In PCM600 Ver.2.5 or

later the recommended tool for smaller projects is the IEC 61850 Configuration tool. For larger projects it is recommended to use IET600, which is available as a standalone tool.

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. Check the default data sets.
 - 3.2. 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.

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



Up to 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

7.3.3 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**.

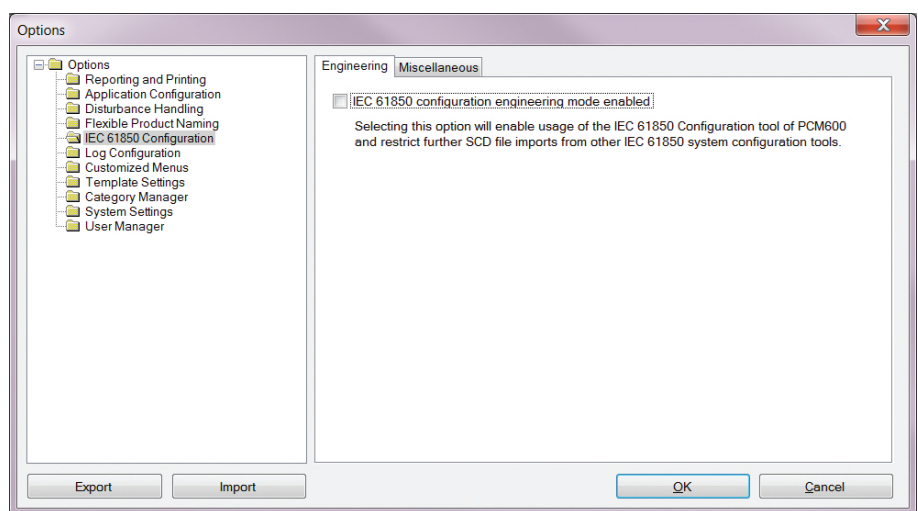


Figure 67: Enabling SCD file import at station level

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

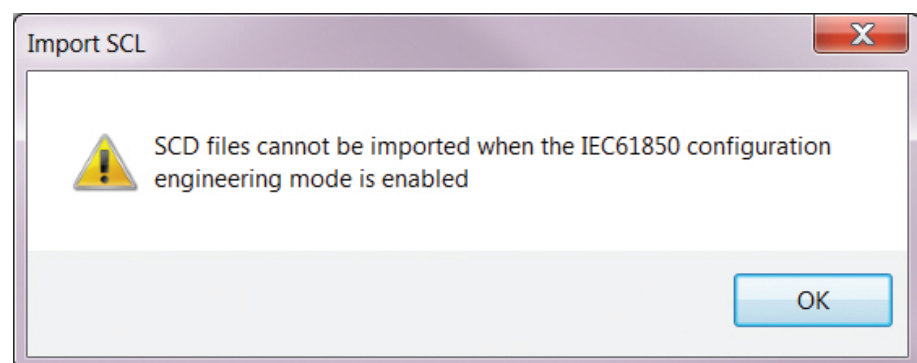


Figure 68: Error message when SCD files cannot be imported

7.3.3.1

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.

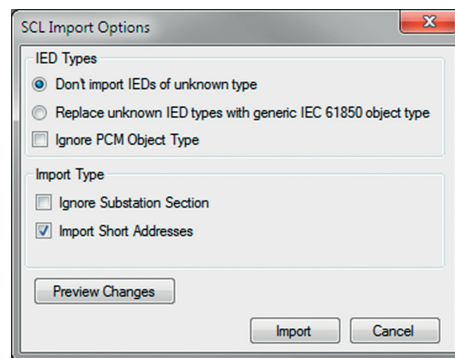


Figure 69: SCL Import Options

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**.

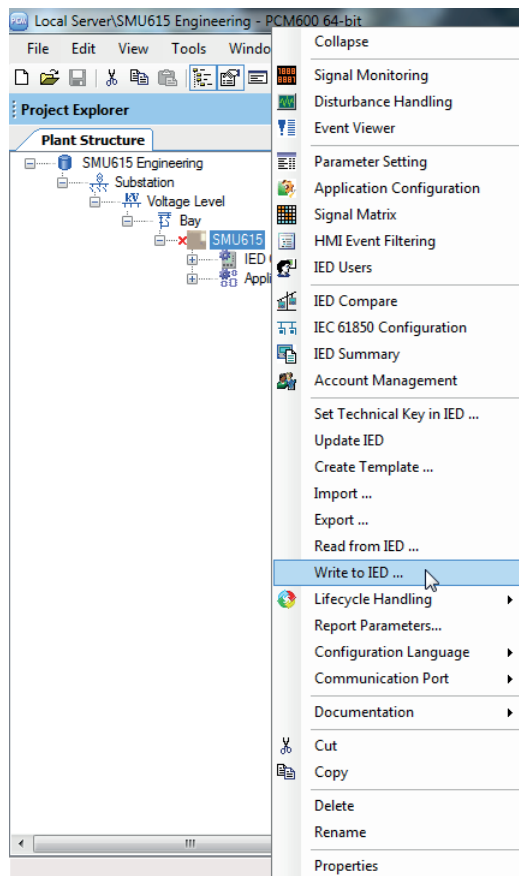


Figure 70: Common write menu



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

7.3.3.2 Importing ICD or CID files

1. Select an existing IED to import IEC 61850 files.
2. From the **Files of type** list, select the file type of IEC 61850 to be imported (ICD or CID).
The **SCL Import Option** dialog box opens.
3. In the **SCL Import Option** dialog box, select how the file is to be handled during the import.

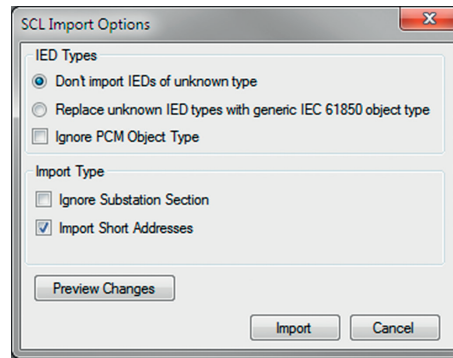


Figure 71: SCL Import Options

- **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.

7.3.4

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 or IEC 61850-9-2 LE) 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 merging unit, the horizontal communication configuration needs to be updated.

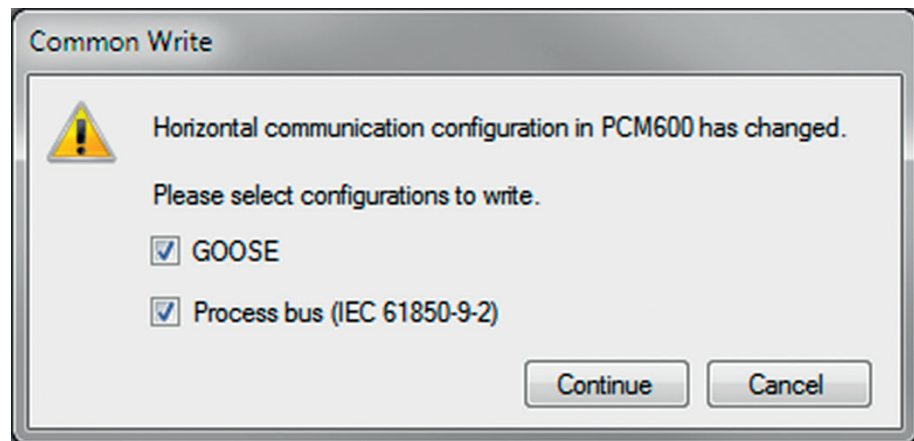


Figure 72: Updating the communication configuration in the IED with the configuration made in PCM600

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.

Section 8 Glossary

ACT	1. Application Configuration tool in PCM600 2. Trip status in IEC 61850
ANSI	American National Standards Institute
ARP	Address Resolution Protocol
BIO	Binary input and output
CID	Configured IED description
CMT	Communication Management tool in PCM600
COM600S	Substation Management Unit. An all-in-one communication gateway, automation platform and user interface solution for utility and industrial distribution substations.
COMTRADE	Common format for transient data exchange for power systems. Defined by the IEEE Standard.
Connectivity package	A collection of software and information related to a specific protection and control IED, providing system products and tools to connect and interact with the IED
CT	Current transformer
DA	Data attribute
DHCP	Dynamic Host Configuration Protocol
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
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
HSR	High-availability seamless redundancy

HTTPS	Hypertext Transfer Protocol Secure
HW	Hardware
I/O	Input/output
ICD	IED capability description
IEC	International Electrotechnical Commission
IEC 61850	International standard for substation communication and modeling
IEC 61850-9-2 LE	Lite Edition of IEC 61850-9-2 offering process bus interface
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	Internet protocol
IP address	A set of four numbers between 0 and 255, separated by periods. Each server connected to the Internet is assigned a unique IP address that specifies the location for the TCP/IP protocol.
LAN	Local area network
LED	Light-emitting diode
LHMI	Local human-machine interface
LN	Logical node
MAC	Media access control
MON	Signal Monitoring tool in PCM600
NCC	Network control center
PCM600	Protection and Control IED Manager
PRP	Parallel redundancy protocol
PSM	Power supply module
PST	1. Parameter Setting tool in PCM600 2. Product Selection Tool
SAB600	Substation automation builder tool
SCD	Substation configuration description
SCL	XML-based substation description configuration language defined by IEC 61850

SMT	Signal Matrix tool in PCM600
SMU615	Substation merging unit
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
VPN	Virtual Private Network
VT	Voltage transformer
WAN	Wide area network
WHMI	Web human-machine interface
XRIO	eXtended Relay Interface by OMICRON



ABB Distribution Solutions
Distribution Automation

P.O. Box 699

FI-65101 VAASA, Finland

Phone +358 10 22 11

www.abb.com/mediumvoltage

www.abb.com/substationautomation