RELION® 670 SERIES
670 series
Version 2.1 IEC
Engineering manual
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This product complies with the directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive 2004/108/EC) and concerning electrical equipment for use within specified voltage limits (Low-voltage directive 2006/95/EC). This conformity is the result of tests conducted by ABB in accordance with the product 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.
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Section 1 Introduction

1.1 This manual

The engineering manual contains instructions on how to engineer the IEDs using the various tools available within the PCM600 software. The manual provides instructions on how to set up a PCM600 project and insert IEDs to the project structure. The manual also recommends a sequence for the engineering of protection and control functions, LHMI functions as well as communication engineering for IEC 60870-5-103, IEC 61850, DNP3, LON and SPA.

1.2 Intended audience

This manual addresses system and project engineers involved in the engineering process of a project, and installation and commissioning personnel, who use technical data during engineering, installation and commissioning, and in normal service.

The system engineer must have a thorough knowledge of protection and/or control systems, protection and/or control equipment, protection and/or control functions and the configured functional logics in the IEDs. The installation and commissioning personnel must have a basic knowledge of handling electronic equipment.
1.3 Product documentation

1.3.1 Product documentation set

Figure 1: The intended use of manuals throughout the product lifecycle

The engineering manual contains instructions on how to engineer the IEDs using the various tools available within the PCM600 software. The manual provides instructions on how to set up a PCM600 project and insert IEDs to the project structure. The manual also recommends a sequence for the engineering of protection and control functions, LHMI functions as well as communication engineering for IEC 60870-5-103, IEC 61850, DNP3, LON and SPA.

The installation manual contains instructions on how to install the IED. The manual provides procedures for mechanical and electrical installation. The chapters are organized in the chronological order in which the IED should be installed.

The commissioning manual contains instructions on how to commission the IED. The manual can also be used by system engineers and maintenance personnel for assistance during the testing phase. The manual provides procedures for the checking of external circuitry and energizing the IED, parameter setting and configuration as well as verifying settings by secondary injection. The manual describes the process of testing an IED in a substation which is not in service. The chapters are organized in the chronological order in which the IED should be commissioned. The relevant procedures may be followed also during the service and maintenance activities.

The operation manual contains instructions on how to operate the IED once it has been commissioned. The manual provides instructions for the monitoring, controlling and setting of the IED. The manual also describes how to identify disturbances and how to view calculated and measured power grid data to determine the cause of a fault.
The application manual contains application descriptions and setting guidelines sorted per function. The manual can be used to find out when and for what purpose a typical protection function can be used. The manual can also provide assistance for calculating settings.

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

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

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

The cyber security deployment guideline describes the process for handling cyber security when communicating with the IED. Certification, Authorization with role based access control, and product engineering for cyber security related events are described and sorted by function. The guideline can be used as a technical reference during the engineering phase, installation and commissioning phase, and during normal service.

### 1.3.2 Document revision history

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<td>January 2016</td>
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<td>March 2019</td>
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### 1.3.3 Related documents

#### Documents related to REB670

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### 1.4 Document symbols and conventions

#### 1.4.1 Symbols

- **The electrical warning icon** indicates the presence of a hazard which could result in electrical shock.

- **The warning icon** indicates the presence of a hazard which could result in personal injury.

- **The caution hot surface icon** indicates important information or warning about the temperature of product surfaces.

- **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. It is important that the user fully complies with all warning and cautionary notices.

### 1.4.2 Document conventions

- Abbreviations and acronyms in this manual are spelled out in the glossary. The glossary also contains definitions of important terms.
- Push button navigation in the LHMI menu structure is presented by using the push button icons.
  For example, to navigate between the options, use ▲ and ▼.
- HMI menu paths are presented in bold.
  For example, select **Main menu/Settings**.
- LHMI messages are shown in Courier font.
  For example, to save the changes in non-volatile memory, select Yes and press ☑️.
- Parameter names are shown in italics.
  For example, the function can be enabled and disabled with the *Operation* setting.
- Each function block symbol shows the available input/output signal.
  - the character ^ in front of an input/output signal name indicates that the signal name may be customized using the PCM600 software.
  - the character * after an input signal name indicates that the signal must be connected to another function block in the application configuration to achieve a valid application configuration.
- Dimensions are provided both in inches and millimeters. If it is not specifically mentioned then the dimension is in millimeters.

### 1.5 IEC61850 edition 1 / edition 2 mapping

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Section 2  Engineering tool set

2.1 Introduction

The structure of a monitoring and control system for electrical substations has a principle structure as shown in Figure 2. It contains a number of IEDs for the various purposes.

It can be subdivided in the three main parts:

- Bay level IEDs
- Station communication
- Station level IEDs

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

Each IED type and version has its own connectivity package module used in PCM600.

PCM600 communicates with the bay IEDs via an Ethernet connection. The connection allows to reading and writing all configuration data needed for proper operation from or to the IED. The IEDs have communication interfaces for protocols and media used for station communication. IEC 61850 communication files for a bay IED or a complete station can be exported from PCM600 to station engineering tools for engineering of station communication between bay IEDs and station IEDs.

A PC with PCM600 can be connected to any IED within a station using the Ethernet connection.

The Ethernet connection can then later also be used for service and maintenance purposes. The connection is also used to handle disturbance records in COMTRADE format from protection IEDs using the IEC 61850 file transfer or FTP.

The IEDs of today are designed on the concept of the IEC 61850 standard. This is mainly given for the organization of functions represented by an equivalent logical node in the IEC 61850 standard. The mapping between the logical node data model in the IED, following the structure and rules in part 7 of the IEC 61850 standard, and the function blocks in an IED configuration is given in the IEC 61850 communication protocol manual.
The same IEC 61850–based concept is also used for the DNP3 protocol. The signals used or delivered by a function block are automatically generated and available for station communication. This concept allows a very efficient cost saving signal engineering.

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

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

The applications can be organized in:

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

This manual is valid for PCM600 supporting the IED series product ver.2.1.

### 2.2 IED engineering process

PCM600 is used for various tasks in the IED engineering process. See Figure 3:

- **IED engineering management**
  - Organizing the bay IEDs in the structure of the substation by defining voltage levels and bays below the substation. A PCM600 project can have only one substation.
  - Configuring the IED functions (for example protection and control functions and LHMI functions) by using the Application Configuration tool.
  - Configuring the parameters and setting values for the IED itself and for the process functionality by using the Parameter Setting tool.
  - Drawing single line diagrams and do the link to dynamic process values by using the Graphical Display Editor tool. The single line diagrams are shown on the LHMI on the bay IED.
  - Configuring connections between the application configuration function blocks and physical hardware input and outputs by using the Signal Matrix tool or the Application Configuration tool.

- **Communication engineering**
  - IEC 61850 station communication engineering can be done in two ways, with a separate tool, IET600 or with the PCM600 built in IEC 61850 configuration tool. PCM600 interacts with IET600 by importing and exporting SCL files. The built in tool can be used for small projects including ABB IEDs only. To engineer communication between ABB IED’s and third party devices it’s recommended to use IET600.
  - Organizing GOOSE messages received is done by using the Signal Matrix tool.
  - Communication engineering for the DNP3 protocol by using the Communication Management tool.

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

- **Service management**
• Monitoring selected signals of an IED for commissioning or service purposes by using the Signal Monitoring tool.
• Listing all actual existing IED internal events by using the Event Viewer tool.
• Listing all actual pending process events as they are stored in the IED internal disturbance report event list by using the Event Viewer tool.

Figure 3: Organization of PCM600 in different management tasks

Additional functionality to manage the project and to organize the user rights:
• PCM600 user management
  • Organizing users with their rights, profile and password to use the different tools and activities within the tools.
  • Defining allowed activities for the user profiles to use tools in PCM600.
• IED user management
  • Organizing users with their rights, profile and password to read and write files of the IED. See the Cyber security deployment guideline for more information.
  • Defining allowed activities for the user profiles to use the read and write function.
• Central account management
  • Configuration of the central account server, deployment and management of IED certificates. See the Cyber security deployment guideline for more information.
  • Defining allowed activities for the user profiles to use the read and write function.

Once the engineering of the IED is done, the results must be written to the IED. Conversely some parts of the engineering information can be uploaded from the IED for various purposes.

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

The IP addresses of the different ports are not allowed to belong to same subnet.
Section 3  Engineering process

3.1  Workflow

Figure 4:  IED engineering workflow

The described sequence in Figure 4 is a proposal based on practical experience and dependencies of the steps. It is possible to do a different sequence based on the available information at the time the project is started. This means that several iterations may be needed to finish the project.

- Setting up the PCM600 project
  - Build the plant structure according to the substation structure.
For performance reasons, do not insert more than 40 IEDs in one PCM600 project. Larger projects can be divided into several PCM600 projects.

- Insert an IED in plant structure which can be done in many ways. By inserting the IED in online mode where the configuration is read from the physical IED, by inserting an IED in offline mode, by importing a *.pcmi file or by selecting an IED template from the template library (*pcmt).
- Rename the IED objects in PCM600 to the projects definitions.
- Set the IEC61850 technical key (or use the default one from PCM600).

- **ACT Application configuration**
  - Configure the protection or control function for example for a transformer application as requested.
  - Save the configuration made with ACT to make the interfaces and signals available for other engineering tools within PCM600, for example for PST.

- **PST Parameter setting and configuration**
  - Check the configuration parameters of the physical IED for communication channels, CT and VT conversion values of the transformer module, for example.
  - Check and adjust if needed the setting values for example for:
    - Presentation parameters for local HMI.
    - Settings for protection or control functions.
    - Number of setting groups.

- **GDE Single line diagram configuration**
  - Create a single line diagram.
  - Include measurements when needed.
  - Link the dynamic elements to functions created in ACT, for example a breaker object to the switch function.

- **Local HMI engineering**
  - Include and engineer the function blocks for LHMI element groups with ACT and SMT.
  - Define the LED behavior with PST.
  - Configure the LEDs with ACT and SMT.

- **Communication protocol engineering**
  - The engineering steps are protocol dependent.
  - Use the communication management tool (CMT) for DNP3 engineering.
  - Use the IET600 station configuration tool or the PCM600 IEC 61850 Configuration tool for IEC 61850 engineering.
  - See the application manual for other protocols (LON, SPA, IEC103).
Section 4 Setting up a project

4.1 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.

4.2 Installing Connectivity packages

A Connectivity package contains the complete description of the IED data signals, parameters and protocol addresses for a certain IED type and version. Several types of IEDs can be managed in one PCM600 project, thus the corresponding Connectivity package has to be installed on the PC. Connectivity Packages and Connectivity Package Updates are managed in the Update Manager.

PCM600 must be installed before the connectivity packages can be installed.

PCM600 version 2.7 or newer must be used with the 2.1 version of the IED. The Connectivity package used with PCM600 2.7 and the 2.1 version of the IED must be of version 3.1.0.0.

A Connectivity package for a specific IED type and version is divided in two parts. The IED Connectivity package base module is common for all IEDs. The IED specific module is separate for each type of IED.

Installing the IED Connectivity package

The Connectivity package is available on the CD that was distributed along with the IED. The user manuals for all IEDs are contained in a separate installation package Relion 670 v.2.1 series User Documentation. This package must be installed to access manuals for a specific IED type in PCM600.

Procedure

1. Close PCM600 before running the IED connectivity package installation.
2. Install the IED series Connectivity package base.
3. Select and install the IED modules as required.
4. Install the documentation.
Installing 670 2.1.5 (or lower) version of the Connectivity package on top of the
670 3.1.0.0 Connectivity package will corrupt the Connectivity package
installation. To work around this, uninstall all the Connectivity packages
(starting from the lowest version first), and then install the 670 3.1.0.0
Connectivity package freshly again. Because of parallel Connectivity package
support, 670 3.1.0.0 Connectivity package will background install 670 3.0.1.0,
670 2.1.6 and 670 2.1.5 Connectivity packages.

4.3 Setting technical key

Both a physical IED and an IED object in PCM600 have a technical key. The purpose of the
technical key is to prevent download of a configuration to wrong IED. The technical key in the
IED and PCM600 must be the same, otherwise it is not possible to download a configuration.
Each IED in a PCM600 project must have a unique technical key. It is therefore not possible to
set the same technical key for several IEDs in the same PCM600 project.

For details on technical key settings, see Naming conventions for IEC 61850

The technical key property in PCM600 corresponds to the IED name attribute in
SCL files. Avoid changing the IED name attribute outside PCM600, because
data in PCM600 might be lost when importing SCL files.

When using PCM600 for writing to the IED, it is important that the LHMI is not
in a menu position where settings can be made. Only one active transaction,
from LHMI or PCM600, is allowed at any one time.

When writing a configuration to the IED, PCM600 checks the mismatch between the IED object
in PCM600 and the physical IED technical key, if any. For communication between the IED and
PCM600, the technical key must be the same. Users have the option to read the technical key
from the IED and update it to PCM600 or write the PCM600 technical key to the IED. The user
can also define an own technical key. The error message displayed due to mismatch between
PCM600 and IED technical key is shown in Figure 5.

Figure 5: Error message due to mismatch between PCM600 and IED technical key

Be sure that the IED object in PCM600 has the same IP address as the physical
IED, which is intended to be connected through the technical key concept.
The technical key for an IED object in PCM600 can also be changed in the Object properties window.

1. Select the IED in the Plant Structure.
2. Right-click and select Set Technical Key, see Figure 6.

A dialog window opens to inform about the technical key concept.
3. Click OK in the dialog window.
   The technical key is read from the IED and the technical key editor window opens, see Figure 7.
Figure 7: PCM600: Technical key editor

Using the Technical Key Editor the following selections are possible.

- use the existing technical key in the IED
- use the existing technical key defined for the IED object in PCM600 or
- set a user defined technical key, which changes the technical key for both the physical IED and IED object in PCM600.

The maximum technical key length is 25 characters for Edition 1 and 55 characters for Edition 2.

4. Click OK to confirm the selection.

   It is not possible to set a user defined name or select the Technical key in IED if the value is the same as already given to another IED object in the PCM600 project. A dialog window opens if this is the case.

4.4 Setting up communication between PCM600 and the IED

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

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

Each IED has an RJ-45 Ethernet interface connector on the front. The front Ethernet connector shall be used for communication with PCM600.

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

To connect PCM600 to the IED, two basic variants must be considered.

- Direct point-to-point link between PCM600 and the IED front port. The front port can be seen as a service port.
- Indirect link via a station LAN or from remote via a network.

The physical connection and the IP address must be configured in both cases to enable communication.

The communication procedures are the same in both cases.
1. If needed, set the IP address for the IEDs.
2. Set up the PC or workstation for a direct link (point-to-point), or
3. Connect the PC or workstation to the LAN/WAN network.
4. Configure the IED IP addresses in the PCM600 project for each IED to match the IP addresses of the physical IEDs.

**Setting up IP addresses**

The IP address and the corresponding communication subnetwork mask must be set via the LHMI for each available Ethernet interface in the IED. Each Ethernet interface has a default factory IP address when the IED is delivered. The IP address and the subnetwork mask might have to be reset when an additional Ethernet interface is installed or an interface is replaced.

- The default IP address for the IED front port is 10.1.150.3 and the corresponding subnetwork mask is 255.255.255.0, which can be set via the local HMI path **Main menu/Configuration/Communication/Ethernet configuration/FRON**:1.

**Setting up the PC or workstation for point-to-point access to IEDs front port**

An ethernet cable (max 2 m length) with RJ-45 connectors is needed to connect two physical Ethernet interfaces together without a hub, router, bridge or switch in between.

![Diagram](image)

**Figure 8:** Point-to-point link between IED and PCM600

The following description is an example valid for standard PCs using Microsoft Windows operating system. The example is taken from a Laptop with one Ethernet interface.

Administrator rights are required to change the PC communication setup. It is automatically detected that Tx signals from the IED are received on the Tx pin on the PC. Thus, a straight (standard) Ethernet cable can be used.

1. Select **Search programs and files** in the **Start menu** in Windows.
Figure 9: Select: Search programs and files

2. Type **View network connections** and click on the **View network connections** icon.
3. Right-click and select **Properties**.

4. Select the TCP/IPv4 protocol from the list of configured components using this connection and click **Properties**.
Figure 12: Select the TCP/IPv4 protocol and open Properties

5. Select **Use the following IP address** and define **IP address** and **Subnet mask** if the front port is used and if the **IP address** is not set to be obtained automatically by the IED, see Figure 13. The IP address must be different from the IP address chosen for the IED.

Figure 13: Select: Use the following IP address

6. Use the **ping** command to verify connectivity with the IED.
7. Close all open windows and start PCM600.
The PC and IED must belong to the same subnetwork for this set-up to work.

Setting up the PC to access the IED via a network

The same method is used as for connecting to the front port.

The PC and IED must belong to the same subnetwork for this set-up to work.

4.5 Project managing in PCM600

It is possible to:

- Open existing projects
- Import projects
- Create new projects
- Export projects
- Delete projects
- Rename projects
- Copy and paste projects
- Back up projects
- Migrate projects from one product version to another

It is possible to open projects created in previous versions of PCM to the current version, but the opposite is not possible.

Extension of the exported project file is *.pcmp and those files are only used for exporting and importing the projects between PCM600s.

Creating a new project

Procedure

1. Select File and Open/Manage Project ... to see the projects that are currently available in the PCMDatabases.
2. Open Projects on my computer.
3. Click the icon New Project. To create new project currently open projects and object tools shall be closed.
4. The New Project window opens, see Figure 14.
Figure 14: PCM600: Create a new project window

5. Name the project and include a description (optional) and click Create.
6. PCM600 sets up a new project that will be listed under Projects on my computer.

4.6 Building a plant structure

The plant structure is used to identify each IED in its location within the substation organization. It is a geographical image of the substation and the bays within the substation. The organization structure for the IEDs may differ from the structure of the primary equipment in the substation. In PCM600 it is possible to set up a hierarchical structure of five levels for the IED identification.

Build up the plant structure according to the project requirements. PCM600 offers several levels to build the hierarchical order from Center down to the IEDs in a bay.

The following levels are available:

1. Project = project name
2. Substation = name of the substation
3. Voltage Level = grid type or part in the substation the IED belongs to
4. Bay = bay within the voltage level
5. IED = selection of the IED used in the bay. Several IEDs are possible within a bay, for example one control IED and two protection IEDs.
Once a plant structure is built, the name of each level in the structure should be renamed by the names/identifications used in the grid. Use the right mouse button to build the plant structure by selecting the elements from the context menu. Rename the level after insertion using the Rename possibility or the Object Properties. Figure 15 shows the start of a project with two IEDs placed but still not renamed.

Figure 15: PCM600: Set up a plant structure

The plant structure corresponds to the complete grid including the needed IEDs.

Procedure to build a plant structure:

- Right-click on the plant structure, select New and Create from Template ..., or
- Right-click on the plant structure, select New, General and select either IED Group or Substation.
- Click View in the menu bar and select Object Types. Select the needed elements and drag and drop them into the plant structure. Close the window if it does not close automatically.

### 4.6.1 IEC 61850 naming conventions to identify an IED

This section is only valid when the IEC 61850 standard is used for station bus communication. According to the IEC 61850–6 clause 8.4, the SCL model allows two kinds of project designation in the object properties.

- A technical key is used on engineering drawings and for signal identifications. The technical key is used within SCL for referencing other objects. Observe that name is a relative identification within a hierarchy of objects. The maximum number of characters allowed for a technical key is 25 for Edition 1 and 55 for Edition 2.
- A user-oriented textual designation is contained in the attribute desc. Attributes cannot contain carriage return, line feed or tab characters. The semantics of desc must also be relative within an object hierarchy.

PCM600 takes care of these two possibilities. The two possible signal designations are available per object in the object properties for all hierarchical levels beginning with the station as the highest level.
The technical key is automatically generated based on the rules and type specifications of IEC 61346 and the extended definitions done for substations by a technical committee. The technical key is shown in the Object Properties under SCL Technical Key or Technical Key.

- The station level is predefined by "AA1", where 1 is the index.
- The voltage level is predefined by "J1", where 1 is the index.
- The bay level is predefined by "Q01", where 01 is the index.
- The IED is predefined by "A1", where 1 is the index.

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

For all practical engineering purposes (both towards the IED and towards the 61850 engineering process), the user should keep the default SCL technical key. However, it is possible, for example due to company naming policies, to rename the SCL technical key for the station level, voltage level, bay level and IED level using the Object properties window as shown in Figure 16.

- The station level has been renamed as "DMSTAT"
- The voltage level has been renamed as "C1"
- The bay level has been renamed as "Q1"
- The IED has been renamed as "SB1"

The renamed full path name of the technical key for the IED would be DMSTATC1Q1SB1.

![Figure 16: PCM600: IEC 61850 signal designation concept](image-url)
4.6.2 Changing the SCL version of an IED

You can change the SCL version of an IED in PCM600 from Edition 1 of IEC61850 to Edition 2 or the other way around. You can also convert a .pcmi file to from Edition 1 to Edition 2 or the other way around.

It is not possible to mix Edition 1 and Edition 2 IEDs in the same PCM600 project. Therefore, it is possible to change the SCL version only when there is one IED in the project.

1. Enable SCL version changing in PCM600.
   1.1. Select **Tools/Options...**
   1.2. In **Options/IEC 61850 Configuration**, open the **Miscellaneous** tab.
   1.3. Check **Allow changing SCL version of an IED configuration**.
   1.4. Click **OK** to exit.

2. In a project that has no IEDs, right-click the bay and select **Import...** to insert the IED from a .pcmi file.

3. Right-click the IED and select **Change SCL Version** and **IEC61850 Edition 1** or **IEC61850 Edition 2**.
   The **Change SCL Version** dialog opens.

4. Click **Yes** to confirm the edition change.
   **Changing SCL Version** dialog opens and shows the conversion progress. When the conversion is complete, the **Change SCL Version** dialog opens.

5. Close the dialog by clicking **OK**.

6. Right-click the IED and select **Export...** to save the converted IED in a .pcmi file.

4.7 Inserting an IED

The context menu or the **Object Types** view shows the available IEDs possible to insert on the bay level in the plant structure according to the installed connectivity package.

On the bay level in the plant structure it is possible to:

- Insert an IED in **Online mode** or in **Offline mode**:
  - **Online mode**: when the IED is already connected to PCM600 and the communication is established, PCM600 can read the configuration directly from the physical IED. This is useful when an order-specific IED is used. The order configuration is written to the IED at the factory, and can be accessed by PCM600. The housing type, the used overlay version for local HMI and the IO boards included in the IED will be read from the IED directly.
  - **Offline mode**: when the physical IED is not available or not connected to PCM600, the engineering steps are done without any synchronization with the IED. The offline configuration in PCM600 can be synchronized with the physical IED at a later state by connecting the IED to PCM600.

The green check mark (as shown in [Figure 17](#)) indicates that communication between the IED object in PCM and the physical IED is established.
Figure 17: Plant structure with pingable IED

- Import a template IED available in the template library as a *.pcmt file.
- Import a pre-configured IED available as a *.pcmi file.

Inserting an IED in online mode

An Ed2 node cannot be inserted in an Ed1 project and vice versa.

Procedure:
Figure 18: IED insertion in online mode

1. Right-click the Bay and select New and application type of IED.
2. Select the IED type to insert.

   It is also possible to drag an IED from the Object Types window to the Bay level.

3. Select the Online Configuration mode, see Figure 19.

Figure 19: PCM600: Configuration mode selection wizard

4. Select the IED Communication protocol, see Figure 20.
5. Select the port and insert the IP address of the physical IED to configure, see Figure 21.

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

   The user cannot scan data from the IED or proceed further if the IED is not online or if the IP address is not correct.

7. Click the Scan option to scan/read the IED Type and IED Version for the IED that is online, see Figure 22.
Figure 22: PCM600: IED Version detection

The IED version can be changed later in the Plant Structure view by right-clicking on the IED and selecting Change SCL Version if it is the only IED in the plant structure.

8. Click Next to open the Housing Selection Page. The IED housing type and display type are detected and displayed as shown in Figure 23.

Figure 23: PCM600: IED housing and display type detection

9. The Setup Complete Page dialog shows the summary of the IED Type, IED Version, IP Address of IED and Order Number, see Figure 24. It is possible to Cancel the insertion or confirm the configuration and do the insertion with Finish.

Figure 24: PCM600: IED Setup completion wizard

It is not possible to go back and do any modifications in the setup complete page. If an error is detected, the insertion has to be canceled and the IED has to be inserted again.
When the online configuration is completed, it is advised to read the configuration from the IED to ensure that the IED object in PCM600 has the same configuration data as the physical IED.

**Inserting an IED in offline mode**

Working in offline mode has an advantage compared to online mode in that one can start preparing configuration even though the IED is not available. Setting up an IED in offline mode is almost similar to inserting it in online mode. However, in offline mode it is not necessary to type the correct IP address in the Communication port and IP address dialog.

The version information needs to be selected from the drop down menu as shown in **Figure 25**

![Figure 25: PCM600: IED Version selection](IEC09000741-4-en.vsd)

**Figure 25: PCM600: IED Version selection**

![Figure 26: PCM600: IED Order code selection](IEC09000716-2-en.vsd)

**Figure 26: PCM600: IED Order code selection**

**Inserting an IED from the template library**

An IED in the plant structure can be exported as a template (*.pcmt). The user can build up a template library with all the exported IED templates. It is possible to insert an IED from the template library to create a new IED in the plant structure. Change the IP address and the name that corresponds to the physical IED after a template IED has been imported.

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

Procedure to insert a template IED
1. Right-click the Bay in the plant structure.
2. Select New and Create from Template ... to open the Create New Object from Template window, see Figure 27.

![Create New Object from Template](image)

**Figure 27:** PCM600: Selecting an IED from the template library

3. Select the IED from the list of available IEDs.
4. Click the icon in the right column of the list of available templates to open the Template Properties. Verify the template information, see Figure 28 and click Close to close the window.

![Template Properties](image)

**Figure 28:** PCM600: IED Template Properties

5. Click Delete Template to delete the template, click Import Template to import a template from the selection window or click Create to insert the selected IED to the bay, see Figure 27.
It is possible to insert more than one IED from the Create New Object from Template window and the selection window remains open until the user clicks Close.

Inserting a pre-configuration

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

Options for inserting a pre-configuration:

- Use the pre-configuration that has been ordered together with the IED.
- Create your own configuration, export the configuration as *.pcmi file and use it to configure other IEDs.
- Use a pre-configuration from the Connpack DVD if more than one pre-configurations exist for the IED.

Procedure to insert a pre-configuration

Because Ed1 and Ed 2 templates are incompatible, convert an Ed1 template to Ed2 before you insert it.

1. Right-click the bay and select Import ... to select the IED configuration file (*.pcmi), see Figure 29.

2. Import the *.pcmi file from the bay level in the plant structure.
3. Click OK to insert the new IED object in the plant structure.
4. Modify the configuration according to the needed application.
5. Write the configuration to the IED.

Ordered default configurations are not locked. The user can use any of the available default configurations for a particular product type as a base to create an own configuration. The only requirement is that all needed hardware and software options are available.

It is possible to give the inserted IED in the plant structure a user-defined name. Be sure to only use characters a-z, A-Z, 0-9 and _. Do not use space character in IED names.
4.7.1 Setting IED IP address in the project

There are two alternatives to set the IP address of the IED object in PCM600. The IED object in PCM600 must have the same IP address and subnetwork mask as the front or rear port on the physical IED to which the PC is connected. The IP address of the physical IED’s front and rear port cannot be set from PCM600 but only from the LHMI.

- Via the first window of the wizard when including a new IED in a project, see Figure 30.

![Figure 30: Alternative 1: IP address via the first Wizard window](image)

- Via the IP address property of the IED in the Object Properties window, see Figure 31.

![Figure 31: Alternative 2: IP address via the IED Object Properties window](image)

Procedure

1. Select the IED to enter the IP address.
2. Open the Object Properties window.
3. Place the cursor on the IP address row and enter the IP address.

The used alternative depends on the time at which the IP address is available.
Section 5 Protection and control engineering

5.1 Creating an application configuration with ACT

5.1.1 Overview

ACT is used to create the application configuration for an IED. The application configuration is built up with function blocks.

Function blocks are dedicated for different functionality, for example:

- Preprocessing blocks
- Control related functions
- Protection related functions
- Monitoring functions
- Communication

For detailed information about function blocks see the technical manual and the application manual.

SMBIs and SMBOs are still available in PCM600 but the user does not have to use them anymore. Instead, the user can connect the function block inputs and outputs directly to the hardware channels.

Some function blocks are mapped as logical nodes according to the IEC 61850 standard. Other function blocks are not mapped as logical nodes, for example:

- Logical gates
- Timers
The basic general features of the Application configuration tool ACT:

- Organization of an application configuration
  - Organize an application configuration into a number of logical parts (MainApplication).
  - Organize a MainApplication over a number of pages.

- Features to program an application configuration:
  - Insert function blocks, make connections and create variables.
  - Include the hardware IO channels directly in the application configuration.
  - Set function blocks and signal visibility to SMT and PST.

SMT is not supporting signals of integer type or group signals. So, even if these types of signals are set as visible for SMT, they will not be shown in SMT.

- Document the application configuration, for example to make printouts.
- Test the application configuration online.
- Save application configurations as templates in an application library to reuse them in other IEDs.
- Validate the application configuration during the configuration process on demand and while writing the application configuration to the IED.

For instructions on how to perform the different tasks in PCM600, see PCM600 online help.

### 5.1.2 Function blocks

- Function blocks are the main elements of an application configuration. They are designed for a various number of functions and organized in type groups. The different function block types are shown in the Object Types View. Figure 33 presents an overview of the main parts that are relevant for function blocks.
- Set user defined names for function blocks and signals marked with blue text.

Signals that have a user defined name created in ACT, will only be visible in PST if the IED configuration is written to the IED and read back to PCM600. Otherwise the default signal name is shown in PST.

Do not use other characters than a-z, A-Z, 0-9 and _ when setting user defined names for signals and function blocks, since other characters might not display properly in local HMI. Also avoid using space character.

- Set IEC or/and ANSI naming style.
- Lock function blocks.
- Set visibility for execution order, cycle time and instance number.
- Manage signals, for example hide, show and rearrange.
- Invert Boolean inputs and Boolean outputs.

Mandatory signals must be connected.
Figure 33: ACT: Function block overview

1. Connection(s)
2. User defined function block name
3. Function block, selected (red)
4. Mandatory signal (indicated by a red triangle if not connected)
5. Function block name
6. Function block, locked (red)
7. ANSI symbol
8. Inverted output
9. Hardware, binary output channel
10. Hardware, analog input channel
11. User defined signal name
12. Hardware, binary input channel
13. Execution order
14. Cycle time
15. Instance number
16. Inverted input
17. Signal description note

5.1.3 Signals and signal management

A function block has set of input and output signals.

A function block can contain more signals than needed in that application part. A signal that is not used in a particular application is possible to hide in the function block view in ACT. It is not necessary to connect all inputs and outputs at a function block. If not connected, the signals always have a default value. The default value can be seen when hover over the signal with the mouse.

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

Boolean input and output signals may need to be inverted to fulfill the logic. ACT supports to add the inversion logic to a binary signal.
The input signal on glue logic function blocks can only be inverted if a glue logic function block with lower execution order in the same cycle time is available. Similarly, the output signal can only be inverted if a glue logic function block with higher execution order in the same cycle time is available. Up to two input signals and two output signals can be inverted for glue logic blocks in the same cycle time.

Even though current is injected to the IED and the IED is connected to PCM600 in online mode, the signal value in ACT is shown as zero.

All not mandatory input signals have a default value that will be used when not connected.

### 5.1.4 Function block execution parameters

Three function block execution parameters influence the runtime execution of the function block within the application configuration:

- **Execution Order**
- **Cycle Time**
- **Instance Number**

Each time a new function block is selected, one or more of these parameters become available for selection from the drop down lists in ACT depending on the function block type. The **Cycle Time** may be predefined to one value with certain functions. The **Instance Number** is a counter for the total possible number of function blocks of that type used within an application configuration.

**Execution Order** and **Instance Number** are given in the list as a selectable pair predefined within a product. **Figure 34** shows an example how the drop down list could look like.

![Figure 34: ACT: function block organization parameters](IEC09000720-2-en.vsd)

A minus sign in front of the cycle time, for example -200ms, indicates that the application is time driven, otherwise the application is analog data driven. Analog data driven applications require sample values from Analog input modules - in case the physical module is broken, applications are not executed. Time driven applications are executed periodically regardless of the status of the analog signal processing.

The **Cycle Time** can be selected to 1, 3, 8 or 100 ms for certain functions (for example SMAI). Depending on the function block and IED type, one or more possibilities may be available.
If used, 3PHSUM must have the same cycle time as SMAI.

The combination *Execution Order, Instance Number* is predefined by ABB. Mainly for basic logic function blocks like for example AND, OR, a set of combinations spread over the full range of execution orders is available. This gives the possibility to select a combination which fits to the execution order range needed in that application part.

**Application configuration cycle time and execution order organization**

The application execution within the IEDs is organized in three time classes, see Figure 35.

![Figure 35: ACT: Possible MainApplication cycle times](image)

For the same time point, faster cycle times are executed first.

A function block that is placed after a function block in the execution flow must have the same or a higher cycle time and/or execution order. See Figure 36.

![Figure 36: Cycle time and execution order](image)

A function block type can be defined to be a member of one or several cycle times. A function block instance can be set only to one cycle time.
Figure 37: ACT: Concept of Execution order sequence

In the conceptual MainApplication example in Figure 37, the execution order of the main function block in the execution order group 2 defines the execution orders needed in group 1 and 3. The preceding logic done with function blocks in group 1 must have a lower execution order than the ones in group 2. The following function blocks in group 3 must have a higher execution order than the main function block in group 2.

5.1.5 Configuration parameters

5.1.6 Connections and variables

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

Rules and methods to do connections:

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

It is possible to search and replace variable names in ACT.

Connection validation

A connection is only useful and possible between two signals of the same data type, see Figure 38.
5.1.7 Hardware channels

Hardware channels can only be connected to a function block input or output. A hardware connection can be established in ACT or SMT. When a hardware channel is connected a graphical symbol appears in ACT, see Figure 39. The connection is also represented in SMT with a cross mark. Hardware channels are always visible in SMT.

Supported hardware channels are:

- Binary input channels
- Binary output channels
- Analog input channels

A hardware input channel can be used as often as it is needed. A hardware binary output channel is taken from the list of available channels when a new channel is requested. That prevents for using a hardware binary output channel twice. As an example, see Figure 39.
5.1.8 Validation

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

- During creating the logic while doing a connection or placing a function block.
- On demand by starting the validation.
- When writing the application configuration into the IED.

Validation when creating the application configuration

Validation is made when creating the application configuration, for example:

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

Validation on demand

To check the validity of an application configuration, click the ‘Validate Configuration’ icon in the toolbar. ACT will check the application configuration for formal correctness. Found problems are qualified in:

- Warnings, marked by a yellow warning icon
  - Example: A variable connected to an output signal that is not connected.
  - Example: If the user connects output from higher execution order function to inputs of lower execution order function.
- Errors, marked by a red circle with a cross
  - Example: A mandatory input signal that is not connected.
Warnings will not prevent writing to the IED. Errors have to be corrected before writing the application configuration to the IED. An application configuration can be saved and ACT can be closed with open errors, but not written to the IED, see Figure 40.

These problems are listed in the Output View under the Tab Application Configuration. A double-click in the error or warning row will navigate to the MainApplication>Page>Area where the problems are identified.

Figure 40: ACT: Validation on demand

Validation when writing to the IED

When writing the application configuration to the IED an automatic validation is performed. The validation is the same as the manually demanded validation. Errors will abort the writing.

5.2 Setting configuration and setting parameters in PST

Configuration parameters and settings parameters are changeable either from LHMI or from PST in PCM600.

Note that the some parameters are only visible in PST and some are only visible on LHMI.

A common write from PCM600 to the IED, where parameters are changed in PST, will overwrite any parameter changes made locally from LHMI.

To export parameters from PST, both XRIIO and CSV formats are supported.

All variables listed and shown in the parameter list can be sorted into two groups:

- Configuration parameter or
- Setting parameter
Configuration parameter

A configuration parameter specifies an operation mode of an application function or of the IED. These are basic configurations, which are normally configured only once and then settled. The IED configures itself at start-up according to the given configuration parameter values.

Setting parameter

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

Setting group

Nearly all settings used by the IED for the protection application functions are organized in a group of settings. Up to six setting groups can be configured with different values. The IED supports the selection of a setting group at runtime.

IED parameters organization

The organization of the parameters in a tree structure is visible in the plant structure by expanding the setting tree. For each function, the parameters are organized in basic and advanced groups. The advanced settings are used for application optimization.

During a common write both the basic and advanced settings are written to the IED.

5.2.1 Graphical Parameter Setting Tool

The Graphical Parameter Setting Tool (GPST) is a tool in PCM600 that is used to present parameter settings in a graphical user interface. GPST is a part of the Parameter Setting Tool (PST), the settings are done in PST and can be presented in GPST.

GPST is available for distance protection functions:

<table>
<thead>
<tr>
<th>Function</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance protection zone, quadrilateral characteristic</td>
<td>ZMQPDIS, ZMQAPDIS</td>
</tr>
<tr>
<td>Distance measuring zone, quadrilateral characteristic for series compensated lines</td>
<td>ZMCQPDIS, ZMCAPDIS</td>
</tr>
<tr>
<td>Fullscheme distance protection, mho characteristic</td>
<td>ZMHPPDIS</td>
</tr>
<tr>
<td>Fullscheme distance protection, quadrilateral for earth faults</td>
<td>ZMMPDIS, ZMMAPDIS</td>
</tr>
<tr>
<td>Distance protection zone, quadrilateral characteristic, separate settings</td>
<td>ZMRPDIS, ZMRAPDIS</td>
</tr>
<tr>
<td>High speed distance protection, quadrilateral and mho</td>
<td>ZMPDIS</td>
</tr>
<tr>
<td>High speed distance protection for series compensated lines, quadrilateral and mho</td>
<td>ZMFCPDIS</td>
</tr>
<tr>
<td>Underimpedance protection for generators and transformers</td>
<td>ZGVPDIS</td>
</tr>
<tr>
<td>Power swing detection</td>
<td>ZMRPSB</td>
</tr>
<tr>
<td>Phase selection, quadrilateral characteristic with fixed angle</td>
<td>FDPSPDIS</td>
</tr>
<tr>
<td>Phase selection, quadrilateral characteristic with settable angle</td>
<td>FRPSPDIS</td>
</tr>
<tr>
<td>Faulty phase identification with load encroachment</td>
<td>FMPSDPS</td>
</tr>
</tbody>
</table>

For more information on GPST, see the online help for PCM600.
5.3 Connecting signals in SMT

SMT is used to do cross references, see Figure 41:

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

**Figure 41: SMT: Operation principles**

A binary input channel can be connected to one or several function block inputs, see Figure 42. If a binary input channel is connected to several different function blocks in ACT, the connection will appear as glue logic in SMT.

A binary output channel can only be activated from one function block output. If it should be activated from more than one function block output, glue logic has to be used. Glue logic means inserting a logical gate (OR and AND blocks) between the function blocks and the binary output channel. This can be engineered in SMT.
Connections made in SMT are automatically shown in ACT. Connections made in ACT are automatically shown in SMT.

It is possible to group and collapse hardware channels in SMT to get a better overview.

**Figure 42: SMT Connection between binary input channels to binary input signals**

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

- Binary Inputs
- Binary Outputs
- Analog Inputs
- Functions
- GOOSE Receive
Section 6   Local HMI engineering

6.1   LED and function key engineering

6.1.1   Local HMI engineering process

Figure 43 shows the different steps of the engineering process of the local HMI (LHMI) and their relative order.

- Application Configuration tool with possible assistance of Signal Matrix tool
  - To use the function keys and LEDs on LHMI it is necessary to insert the corresponding special function blocks for these operation element groups.
  - The function blocks for the LEDs are organized as single function block per LED but indexed to the group identification, for example GRP1_LED3 (indication LED 3 in virtual LED group 1).
  - The function blocks for the LHMI are visible by default for the Parameter Setting tool.
  - Use the Application Configuration tool to connect binary input signals from application functions to LED function blocks.
- Parameter Setting tool
The operation mode of the function keys and LEDs is defined in the Parameter Setting tool.

The presented text labels on the LCD for LHMI keys and LEDs.

Graphical Display Editor with assistance of the Application Configuration tool, for example

- to make the single line diagram of the primary process part.
- to make the dynamic links for the apparatus.
- to make the dynamic links for measurements.

### Application Configuration tool and local HMI function blocks

See the *Technical Manual* for more information on function blocks.

The LHMI provides a set of special function blocks to be utilized in the Application Configuration tool:

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

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

*Figure 44* describes the basic LHMI and the operation element groups. These are the 15 LEDs and their belonging text elements on the LCD [A]. They are operated by keys [a] and [b].

The other group is the five function keys with their IEDs and the corresponding text elements on the LCD [B].
Figure 44: Local HMI: Placement of local HMI operation elements

Function block LEDGEN
- Handles an external acknowledge signal as source to acknowledge the LEDs.
- Generates an additional pulse for general purposes whenever the LEDs are acknowledged by the operator.
- Generates a pulse whenever a new LED signal occurs. It may be used to trigger an acoustical alarm.
- Handles timers $t_{\text{Reset}}$ and $t_{\text{Max}}$ for the LED operation mode 'LatchedReset-S'.

Function block GRP1_LED1 to GRP3_LED15
- The 15 LEDs on the right side of the LCD can indicate in total 45 alarms, warnings or other signals to the operator. They are organized in three groups 1 to 3.
- Each signal group belongs to one function block.
- Each LED illuminates in one of the three colors: RED, YELLOW or GREEN.
- The organization of flashing, acknowledgment and group selection is done directly between the function blocks and the basic LHMI keys, the ‘Multifunction’ key [a] to toggle between the three groups or the ‘Clear’ key [b] to acknowledge or reset the LEDs.
- Only the programming of the signals is needed for the LEDs.
- The operation mode of the LEDs is defined in the Parameter Setting tool.

Function block FNKEYMD1 to 5
Every function key has its own FNKEYMD function block.
The 5 function keys on the left side of the LCD [B] can be used to process demands.
The function block handles the signal for the LED included in the key as input signals.
The LED signal of the key is independent of the key function and must be programmed to process demands.
The function block handles the operators command when the key is pressed as output signal.
The functions are activated whenever a key is pressed for the first time. The corresponding text elements for the five keys appear on the left side of the LCD. No execution of the function is done. So the first push is used to activate the presentation only.
The next key push is handled as activate function and the output signal of the function block is set.
The operation mode of the function key is defined in the Parameter Setting tool (pulse, toggle).

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

The function key can operate as:

- **Pulsed signal**
  - Each push forces a pulse of a configured time.
  - The pulse time can be set in the Parameter Setting tool.
  - The default pulse time is 200 ms.

- **Toggle signal**
  - Each push changes the state of the signal: OFF-ON-OFF-ON-OFF...
  - The default position after power up or reset is OFF.

- **Menu shortcut**
  - When pressing a key configured for that purpose, the function key panel is hidden and the LHMI opens directly in the configured menu.

<table>
<thead>
<tr>
<th>Function key 1 FNKEYMD: 1</th>
<th>Node</th>
<th>Off</th>
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</thead>
<tbody>
<tr>
<td>Pulse Time</td>
<td>Off</td>
<td>0001</td>
</tr>
<tr>
<td>LabelOn</td>
<td>Fused</td>
<td>18 character(s)</td>
</tr>
<tr>
<td>LabelOff</td>
<td>LCD_FN1_OFF</td>
<td>18 character(s)</td>
</tr>
</tbody>
</table>

**Figure 45:** LHMI: Function key operation mode
The LEDs have a number of different operation modes, see **Figure 46.**

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

- Follow-S
  - The LED illumination follows the status of the signal. The LED illuminates steady (S).
- Follow-F
  - The LED illumination follows the status of the signal. The LED illuminates flashing (F).
- LatchedAck-F-S
  - The LED latches the signal change OFF-ON and flashes (F) until it is acknowledged.
  - When the signal is still ON at the time the signal is acknowledged, the LED changes to steady (S) mode.
  - When the signal has already changed to OFF before the time it is acknowledged, the LED turns to OFF.
- LatchedAck-S-F
  - The same as LatchedAck-F-S but the LED starts with steady state and flashes after acknowledgment.
- LatchedColl-S
  - The LED illuminates in all cases in steady mode only
  - The LED latches a signal change from OFF-ON until it is acknowledged by the operator.
  - The LED stays in steady mode when it is reset and the signal is still in ON state.
  - The LED is OFF only after the signal has changed to OFF state AND it is reset by the operator via ‘Clear’ operation.
- LatchedReset-S
  - This mode is used for all LEDs that are used to indicate a disturbance. The LEDs will stay in the last state after the disturbance run time until they are reset after a defined time.
  - The timers are set in the Parameter Setting tool in the function block LEDGEN.

<table>
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<tr>
<th>LEDs:</th>
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</thead>
<tbody>
<tr>
<td>Alarm group 1</td>
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<tr>
<td>GRP1.LED1: 1</td>
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</tr>
<tr>
<td>s'</td>
<td></td>
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<tr>
<td>SequenceType</td>
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<td>LabelDiff</td>
<td>Follow-S</td>
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<tr>
<td>LabelRed</td>
<td>LatchedAck-F-S</td>
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<tr>
<td>LabelYellow</td>
<td>LatchedColl-S</td>
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<tr>
<td>LabelGreen</td>
<td>LatchedReset-S</td>
</tr>
<tr>
<td>GRP1.LED2: 1</td>
<td></td>
</tr>
</tbody>
</table>

Figure 46: LHMI: LED operation mode
6.1.2 LED operation modes

The SequenceType parameter enables each LED to operate in one out of six different modes.

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

**LED operation mode Follow-S**

![LED operation mode Follow-S](IEC08000395.vsd)

**Figure 47: LHMI: LED operation mode Follow-S**

In the Follow-S mode, the LED adopts a steady behavior. It is lit on a binary On signal and switched off on a binary Off signal. See Figure 47 for details.

**LED operation mode Follow-F**

![LED operation mode Follow-F](IEC08000396.vsd)

**Figure 48: LHMI: LED operation mode Follow-F**

In the Follow-F mode, the LED starts flashing when receiving a steady binary On signal. At other times it is unlit. See Figure 48. This mode may be used to indicate that a tap changer or Petersen coil is moving.
LED operation mode LatchedAck-F-S

The LatchedAck-F-S mode is used to indicate unconfirmed alarms or warnings. On a binary On signal (steady or pulse), the LED enters a flashing state. If acknowledged and if the signal is still On, the LED transitions into a steady state. If the signal at this point is Off, the LED is switched off (for this color). See Figure 49 for details.

Each LED has one binary input for each of the colors: red, yellow and green representing high, medium and low priority respectively. Each priority also applies to the presentation of the state (acknowledged or unacknowledged) of each color. Excluding Off signals, the presentation of a state of higher priority always overrides the presentation of any state of lower priority.

See Figure 50 and Figure 51 for these two principles.
LED operation mode LatchedAck-S-F

The LatchedAck-S-F mode operates in a similar manner as the LatchedAck-F-S mode. However, on receiving a binary *On* signal, the LED enters a steady lit state. When acknowledged and the signal remains *On*, it starts flashing.

LED operation mode LatchedColl-S

A LED operating in the LatchedColl-S mode enters a steady lit state on receiving a binary *On* signal. The LED remains lit even if the signal immediately transitions to *Off* (pulse). When acknowledged, the LED is switched off, unless the attached signal remains *On*. See Figure 52 for details.
LED operation mode LatchedReset-S

The LatchedReset-S mode is designed for multi-signal disturbance monitoring. For this reason, the General LED indication function block (LEDGEN) has two parameters: tRestart and tMax. Both are timers used to determine the end of a disturbance window.

A disturbance window starts when a LED receives a binary On signal. The LED then enters a steady lit state. At the point where all signals, related to the LEDs in this particular mode, are Off, the timer tRestart is triggered. This timer is common for all LEDs and when it elapses, the disturbance window ends.

The second timer, tMax, starts whenever a LED is lit. If there are no activities until tMax elapses, tRestart is triggered. This means that the disturbance window eventually ends even if a signal remains On for a long time. See Figure 53.

Figure 53: LHMI: LED operation mode LatchedReset-S

Figure 54: LHMI LED operation mode LatchedReset-S / 2
6.2 Single-line diagram engineering

Phase angles are shown in radians in the single line diagram view, but in degrees in other views on the LHMI.

6.2.1 Concept description to present and generate diagrams in graphical display editor

Additional concept information to use GDE, see Figure 55:

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

![GDE: Screen image with active GDE](image)

Figure 55: GDE: Screen image with active GDE

1. Object type library window
2. HMI display window pages
3. IED HMI display window

Procedure

1. Start GDE to open a presentation of the tool.
2. GDE has a object type library window on the left side of the display.
3. The presentation is empty when no page exists for the IED.

Display window and sequence order

It is important to link correctly between the HMI display page and the corresponding bay that is presented as a single line diagram on this HMI page.

Rules to handle HMI pages:
• Several single line diagrams can be created for one bay.
• The IED supports one bay.
• The sequence order of the HMI pages in the Graphical Display Editor starts from left to right.
• Measurements and the single line diagram can be shown on the page in any possible order and placement.
• All symbol objects, for example apparatus, text and measurement, on the HMI page must be linked to the correct function block in the application configuration in order to present the correct process values.

Object types

The Graphical Display Editor window contains some panes that include drawing symbols or elements to create a single line diagram, measurements and texts on a page. Click on the name bar of the selected element to open the pane.

The object types shows the symbols either in ANSI standard or in IEC standard. The standard is selected by the drop down list box located on top of the display window.

When changing to the other symbol standard, GDE closes the object type window, changes the symbols according to the selected new standard and redraws the single line diagram in the display window.

Select the different panes and their symbols to become familiar with the available symbols.

Measurements (Measurands) are presented in one format that explains itself when selected. Select the format and drop it in the drawing area. Use the object properties to make adaptations.

Special symbols for dynamic text

In the text pane the object types contains a set of special symbols to present text that depends on the status of variables. A set of three symbols is either valid for a double bit information or for a list of up to 32 different inputs. The corresponding function blocks in ACT are of type xxxGAPC.

• Dynamic Text or Indication button is used when a position shall be monitored on single line diagram, Figure 56
• Select Button is used when the functions shall be manoeuvred from a single line diagram.

![Figure 56: GDE: Dynamic Text symbols](IEC08000127-2-en.vsdx)

The standard (IEC or ANSI) for the symbols and the selection of the font size for the text elements can be changed using the icons and drop down on top of the page window.
HMI display raster layout and text font selection

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

The text can be presented in two different font sizes:
- UniCode characters (6 x 12 pixels)
- UniCode characters (13 x 14 pixels)

The total size of the presented white area (page) represents the visible part of the local HMI display without header and foot-line.

The visible display for a single line diagram is organized in a raster of 13 x 8 (columns x rows). Each symbol presented by 24 x 24 pixels included by the drag and drop method must be dropped in a raster box. The apparatus object name can be placed in all four directions around the symbol. The name is part of the apparatus object.

Handling text

The raster switches when text is selected in a raster of 45 x 15 (columns x rows). One raster box is the placeholder for one character. A text element must be placed in the position of the raster. The signal name can changed either by double click or via the property window. Unit and scaling of the signal can only be changed via the property window.

Select and toggle Show Texts using the IED Fonts to get a view how it will look like later on the real HMI display.

Doing Link to draw lines

The line width has to fit to the line width used for the symbols. The standard size is 2. Choose the line width in a selection box placed in the upper area above the page. A line that is not connected to a symbol may be done in any line width in the range 1 - 5. But it needs to be simple connection points to be drawn.

For the procedure to draw lines when the apparatus symbols are placed, see Figure 57.

1. Place the apparatus or transformer symbols by drag and drop in a raster box.
2. Place the connections symbols by drag and drop in a raster box.
3. Center the mouse pointer on the center of a connection point; visible in two triangles if not connections are made, otherwise two circles at the endpoints of a line, to draw a line.
4. Click to start and move the mouse pointer to the destination connection point. Center once again the mouse pointer and click to drop the line.
5. Draw all line elements that are necessary.

Figure 57: GDE: Drawing a line
### 6.2.2 Supported single-line diagram symbols

Table 2: Supported symbols

<table>
<thead>
<tr>
<th>Category</th>
<th>IEC Symbol Name</th>
<th>IEC Symbol Definitions</th>
<th>ANSI Y32.2/IEEE 315 Symbol Definitions</th>
<th>Function Block Type</th>
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<th>ANSI Y32.2/IEEE 315 Symbol Definitions</th>
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<td>SCSWI, VSGAPC</td>
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<td>Isolator indication only, 11 = Undefined</td>
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<td>Switchgear</td>
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<td>Isolator motor-operated, 10 = Closed</td>
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<tr>
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<td></td>
<td>SCSWI, VSGAPC</td>
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<tr>
<td></td>
<td>Breaker, 01 = Open</td>
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<td></td>
<td>Breaker, 10 = Closed</td>
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<td></td>
<td>Breaker, 11 = Undefined</td>
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<thead>
<tr>
<th>Category</th>
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<th>ANSI Y32.2/IEEE 315 Symbol Definitions</th>
<th>Function Block Type</th>
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<tr>
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<td>Breaker indication only, 10 = Closed</td>
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<tr>
<td>Switchgear</td>
<td>Truck breaker, 00 = Middle position</td>
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<td>SXSWI, SXCBR</td>
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<td>Truck breaker, 10 = Closed</td>
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<td>Truck breaker, 11 = Undefined</td>
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<tr>
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<td>SCSVWI, VSGAPC</td>
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<td>Breaker2, 11 = Undefined</td>
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<td>Breaker2 indication only, 10 = Closed</td>
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<tr>
<td></td>
<td>Breaker2 indication only, 11 = Undefined</td>
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<td>Switchgear</td>
<td>Disconnector circuit breaker, 00 = Middle position</td>
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<td>SCSWI, VSGAPC</td>
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<td></td>
<td>Disconnector circuit breaker, 01 = Open</td>
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<td>Disconnector circuit breaker, 10 = Closed</td>
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<td>Disconnector circuit breaker, 11 = Undefined</td>
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<td>XXX</td>
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<td>Select button, 11 = Undefined</td>
<td>XXX</td>
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### 6.2.3 Bay configuration engineering

A page with a single line diagram and measurements contains active living objects. The object values are updated by the IED periodically (measurement) or in case of an event. Once the symbols are placed on the HMI page they must be linked to the corresponding function block in the application configuration, which protects or controls the object that the symbol on the HMI page represents.

**Creating a complete HMI display page**

Procedure:

1. Make a sketch how to present the single line diagram.
2. Place the apparatus, transformer and other symbols that are needed for the single line diagram into the raster boxes.
3. Add connection points where needed.
4. Link the apparatus symbols with line elements.
5. Adjust the text symbols while writing to north, east, south or west. Use the object property window to do it.
6. Place measurements when needed.
7. Edit the name, unit and number of decimals of the measurements.
8. Select each object that has a dynamic link and do the link to the corresponding process object, see Figure 58.
9. Check to select the correct function block. Function blocks of the same type can have different instance numbers.
10. Validate that all links are done. Unlinked objects are greyed out.
11. Save the complete picture.
12. Repeat the steps for all pages when more than one is needed.
13. Write the display configuration to IED from the GDE tool.
Linking process objects

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

Three tools are involved for the described steps:

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

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

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

Procedure

1. Right-click the apparatus symbol and select Select Input Signal. A list of engineered switch control application function blocks opens, see Figure 59.
2. Select the switch control application function block that corresponds to the selected apparatus.
3. Right-click the measurement symbol and select Select Input Signal. A list of the engineered measurement application function blocks opens.
4. Select the measurement application function block that corresponds to the selected symbol.
The number of order in the selection window of the process objects corresponds to the number given in the PST tree and to the application function block in ACT.

Only those apparatus and measurements are shown that are configured in the application configuration program.

The single line diagram screen can display different values, with the help of the dynamic text fields. Please remember that these values are displayed by default in SI units (for example - active power is displayed in W). Modify the **Scale Factor** in the object properties (see Figure 61) to display values in more readable units (for example MW). Be sure to write the proper unit under the **Unit Text** field.
As the function delivers angles in radians, a scale factor of $180/\pi \approx 57.3$ shall be used to display the angle in degrees.

![Object Properties](image)

**Figure 61**: GDE: Object properties window for unit change

### 6.3 Events and indications

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

Detailed information about disturbance report subfunctions is found in the technical manual.
Section 7  IEC 61850 communication engineering

7.1  IEC 61850 interface in the IED and tools

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

7.1.1  Function view for IEC 61850 in PCM600

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

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

7.1.2  IEC 61850 interface in IED

See Figure 62 for a principle view of the IEC 61850 logical node concept in the IED.
IEC 61850 has as a concept for the identification of all signals for communication that belong to a function by a logical node as a placeholder. All signal information in command and monitoring direction, which belongs to a function, is available within the logical node.

Whenever a function block is instantiated in ACT, PCM600 automatically generates the corresponding logical node data. In Figure 62 this is shown by two parts per function block. The upper part is the visible function block in ACT and the lower part is the logical node data for the function block.

7.1.2.1 GOOSE data exchange

The IEC 61850 protocol supports a method to directly exchange data between two or more IEDs. This method is described in the IEC 61850–7–2 clause 15. The concept is based on sending a multicast over the Ethernet. Whoever needs the information detects the telegram by its source address and will read the telegram and deals with it. The telegrams are multicast sent and not acknowledged by the receiver.
When a GOOSE message is to be sent is defined by configuring the data set with the defined trigger option and the GOOSE control block (GoCB). This engineering process is done in the IET600 station configuration tool. The task involves configuring lists with the signal, value and quality (data attributes) that belong to the GOOSE message dataset.

In the opposite direction the standard only defines the IED as a receiver of the GOOSE message. How the GOOSE input signals are handled must be defined in the IED application configuration. The SCD file generated by the IET600 (or any other station configuration tool) contains these GOOSE data sets as input data. The input data must be connected to a GOOSE receive function block (GOOSEBINRCV and GOOSEINTLKRCV) in SMT.

If the quality of the value is needed in the receiver IED, the quality must be included in the GOOSE data set. The receiver side will connect this automatically and if the quality is not in the data set, a warning message will occur in PCM.

### 7.1.3 Station configuration description file types

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

- **ICD = IED Capability Description**

  The IED name in an exported .icd file is always named TEMPLATE.

  - Capability description of the IED in logical nodes and their data. No information about communication configuration, for example, is included.
  - An IED is already extended by default data sets. They are predefined by ABB. Changes or additional data sets, for example, have to be done with the IET600 station configuration tool.

- **SCD = Station Configuration Description**
• Complete configuration description of all IEDs in a station and the full engineering of process signals and communication structure is included. This includes all needed data sets and all control blocks.

• CID = Configured IED Description
  • The CID file contains the information needed to configure just one specific IED.

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

7.2 IEC 61850 engineering procedure

7.2.1 IEC 61850 protocol references and pre-conditions

To engineer the IEC 61850 protocol interface for the IED, the following additional manuals or knowledge of their contents is required.

• Knowledge of the IEC 61850 engineering process as described in the IEC 61850 standard.
• The IEC 61850 conformance documents for the IED to be engineered.
• The Technical reference manual describes function blocks defined as logical nodes.
• IEC 61850 Data objects list for the IED.

7.2.2 Sequence for engineering of IEC 61850 protocol

The IEC 61850 standard defines the complete part needed for information communication in a substation. This can be split into the following parts:

• Description of the substation part including the used logical nodes
• Description of the IEDs with their logical nodes
• Description of the communication network
• Description of the engineering process

For more details please refer to the IEC 61850 standards. In the following description it is assumed that PCM600 together with IET600 is used as system configuration tool.

A short form of a typical sequence is shown in Figure 64 when a complete station is exported as a SCD file.

1. Export SCL files from PCM600. In the scenario in Figure 64 it is a SCD file. Other SCL file types are possible to export.
2. Configure horizontal and vertical communication in the IET600 station configuration tool.
3. Import SCL files to PCM600 project. In the scenario in Figure 64 it is the updated SCD file.
7.3 Exporting SCL files from PCM600

The pre-condition for exporting SCL files from PCM600 is that IEDs included in the project are configured. The hardware interface, for example the IP address, must be selected and configured. Station communication has to be activated in the IED, that is, the IEC61850-8-1 setting Operation must be set to On.

7.3.1 Exporting SCD files

Procedure for exporting SCD files from PCM600:

1. Select the sub-station in the plant structure (see Figure 65).
2. Right-click on the sub-station, and select Export ....
3. Select a location to store the SCD file with a chosen name.
4. The SCL Export Options window opens (see Figure 66).

5. Click Export to export the SCD file to your chosen location.

7.3.2 Exporting ICD or CID files

Procedure for selecting the export type when an IED is selected in the plant structure:

1. Right-click on the IED in the plant structure and select Export to open the Export window.
2. Select the type of file to export from the Save as type drop down list (see Figure 67):
   • 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.
3. The SCL Export Options window opens (see Figure 68).
4. Select Export Private Sections, Export As SCL Template or Include Goose Sending IEDs, and click Export. Options in the SCL Export Options window are only available when an ICD file is exported.

Figure 67: IEC 61850: Export IED file type selection

Figure 68: IEC 61850: Export IED file Options

7.4 Engineering of vertical and horizontal communication in IET600

For IEC 61850 engineering, a separate system configuration tool may be needed with PCM600 (for example, when using other than ABB IEDs).

Procedure for vertical engineering using IET600:
1. Create a project in IET600.
2. Import the SCD file exported from PCM600.

   All data sets, report control blocks and GOOSE control blocks must be located at LDO/LLN0. There are limitations regarding the maximum number of data sets, number of entries in a data set and the number of report control blocks that can be used.

3. Add and/or reconfigure data sets. The configured IED includes a number of predefined data sets, but it is possible to add additional data sets and/or reconfigure default data sets according to the requirements.
Reporting data sets only contain data intended to be used by vertical clients, for example MicroSCADA or RTU560.

4. Configure report control blocks for each data set used in vertical communication. Pre-configured IEDs include predefined report control blocks which can be reconfigured. If additional control blocks are needed, it is possible to add them according to requirements.

Up to 8 vertical clients can be configured.

5. Connect the report control blocks to vertical clients.

The vertical client must belong to the same sub-network as the IEDs.


Please see the IET600 user manual for additional information about vertical and horizontal station communication engineering.

Procedure for horizontal engineering using IET600:

1. Create a project in IET600.
2. Import the SCD file exported from PCM600.

All data sets, report control blocks and GOOSE control blocks must be located at LD0/LLN0. There are limitations regarding the maximum number of data sets, number of entries in a data set and the number of report control blocks that can be used.

3. Create a GOOSE data set for the sending IED. Define the content of the data set according to the requirements.

The data set for GOOSE contains signals on the data attribute or FCDA levels. The latter is also known as structured GOOSE.

Data for one signal can only be included in one GOOSE data set. The data set for GOOSE cannot be empty.

4. Create a GOOSE control block and connect it to the GOOSE data set. Check parameters for GOOSE control block, for example MinTime and MaxTime, and update as required.
5. Connect the GOOSE control block to receiving IEDs that subscribe GOOSE data.
7.5 Importing SCL files to PCM600

PCM600 is able to import SCD, ICD and CID files.

7.5.1 Importing SCD files

Procedure to import an SCD file to PCM600:

1. Select the sub-station in the plant structure.
2. Right-click on the sub-station and select Import ...
3. Select the file and start the import.
4. An SCL Import Options window opens to enable you to configure import handling (see Figure 69):

![SCL Import Options](image)

Figure 69: IEC 61850: Import SCD file

4.1. Select Ignore Substation Section to ignore the sub-station section in the SCD file during import.
4.2. Select Don’t import IEDs to disable the import of unknown IED types (for example third-party IEDs).
4.3. Select Replace unknown IED types with generic IEC 61850 object type to replace unknown IED types with IED type “Generic IEC 61850 IED”. Use this option if you need to import third-party IEDs into PCM600.
4.4. Select Ignore PCM Object Type if the IED type is modified outside PCM600.
4.5. Click Import.

5. Configure how to receive data from sending IEDs:

5.1. In SMT, configure connections between signals the server is sending and the GOOSE receive function blocks.

If a client is defined for GOOSE receive, at least one cross in SMT is required to write the configuration to the IED.
It is important to set Operation to On for all configured GOOSE receiving function blocks.

7.5.2 Importing ICD or CID files

Procedure to import an ICD or CID file:

1. Select an IED in the plant structure.
2. Right-click on the IED and select Import ...
3. Select the file to be imported.
4. An SCL Import Options window opens to enable you to configure import handling (see Figure 70):
   4.1. Select Ignore Substation Section to ignore the sub-station section in the chosen file during import.
   4.2. Select Don’t import IEDs ... to disable the import of unknown IED types (for example third-party IEDs).
   4.3. Select Replace unknown ... to replace unknown IED types with IED type “Generic IEC 61850 IED”. Use this option if you need to import third-party IEDs into PCM600.
   4.4. Select Ignore PCM Object Type if the IED type is modified outside PCM600.
   4.5. Click Import.

![Figure 70: IEC 61850: SCL Import option](image)

7.6 Writing IEC 61850 communication configuration to an IED

When a changed IEC 61850 communication configuration is written to an IED, the user is asked to update the communication configuration:
1. Click **Yes** in the **Update Communication** window to update the communication configuration in the IED.
2. Click **No** in the **Update Communication** window to keep the existing communication configuration in the IED.

*Figure 71: Update communication configuration window in PCM600*
Section 8 IEC 60870-5-103 communication engineering

8.1 Engineering in PCM600

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

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

See the Communication protocol manual for IEC 60870-5-103 for more information about the IEC 60870-5-103 implementation in the IED series.

8.1.1 Settings for RS485 and optical serial communication

General settings

SPA, DNP and IEC 60870-5-103 can be configured to operate on the SLM optical serial port while DNP and IEC 60870-5-103 only can utilize the RS485 port. A single protocol can be active on a given physical port at any time.

Two different areas in the HMI are used to configure the IEC 60870-5-103 protocol.

1. The port specific IEC 60870-5-103 protocol parameters are configured under:
   Main menu/Configuration/Communication/Station Communication/IEC6870-5-103/
   • <config-selector>
   • SlaveAddress
   • BaudRate
   • RevPolarity (optical channel only)
   • CycMeasRepTime
   • MasterTimeDomain
   • TimeSyncMode
   • EvalTimeAccuracy
   • EventRepMode
   • CmdMode
   • RepIntermediatePos

   <config-selector> is:
   • “OPTICAL103:1” for the optical serial channel on the SLM
   • “RS485103:1” for the RS485 port

2. The protocol to activate on a physical port is selected under:
   Main menu/Configuration/Communication/Station Communication/Port configuration/
   • RS485 port
• RS485PROT:1 (off, DNP, IEC103)
• SLM optical serial port
• PROTOCOL:1 (off, DNP, IEC103, SPA)

Figure 72: Settings for IEC 60870-5-103 communication

The general settings for IEC 60870-5-103 communication are the following:

- **SlaveAddress** and **BaudRate**: Settings for slave number and communication speed (baud rate).
  The slave number can be set to any value between 1 and 254. The communication speed, can be set either to 9600 bits/s or 19200 bits/s.
- **RevPolarity**: Setting for inverting the light (or not). Standard IEC 60870-5-103 setting is On.
- **CycMeasRepTime**: See I103MEAS function block for more information.
- **EventRepMode**: Defines the mode for how events are reported. The event buffer size is 1000 events.

**Event reporting mode**

If **EventRepMode** = *SeqOfEvent*, all GI and spontaneous events will be delivered in the order they were generated by BSW. The most recent value is the latest value delivered. All GI data from a single block will come from the same cycle.

If **EventRepMode** = *HiPriSpont*, spontaneous events will be delivered prior to GI event. To prevent old GI data from being delivered after a new spontaneous event, the pending GI event is modified to contain the same value as the spontaneous event. As a result, the GI dataset is not time-correlated.
Section 9  DNP3 communication engineering

9.1  Signal configuration user information

Basic knowledge about DNP3 and the used definitions are required to use CMT. See the DNP3 communication protocol manual for information on the DNP3 implementation in the IED.

CMT is a part of PCM600 and allows to configure the signals that are used to communicate with clients or master units for DNP3 protocols.

On the left window CMT organizes all available signals from the application configuration in containers that are preselected as signal types.

On the right window CMT provides containers that are selected by tabs. Each container represents one communication channel. The number of possible communication channels is IED type dependent. The IED uses TCP/IP as communication channel. DNP3 can be tunneled over TCP/IP. Serial communication over RS485 or optical is supported.

Use direction icons that are located between the windows to move all signals or a set of individual signals between the windows.

DNP3 signal types, index and default setting for classes are predefined in CMT. Adapt the signal configuration to project definitions. The signal type can not be modified due to the fact that the internal signal set up is fixed.

When the default configuration values are sufficient, the task is finished when all signal are moved according to the project requirements.

With the Save option, the signals are stored for the communication part of the IED according to the default selections.

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

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

9.2  Adding setting groups

In order to show for a DNP master which setting group is used, the procedure outlines here can be performed.

In this example, only setting groups one and two are used. The DNP master will get two binary inputs: the first is set if setting group one is used, the second is set if setting group two is used.

1. Configure ACTVGRP (Basic IED functions) and SP16GAPC (Monitoring) with the Application Configuration Tool (ACT).
To make it easier to recognize the signals for the active setting group, user-defined names are used.

2. Open the Communication Management Tool (CMT). Set the Signal Type to Binary Input Object, and choose the connection of the master for which the values should be presented.
3. Select the signals and move them into the DNP signal list of the master. DNP point zero and one of the Binary Input Objects are used for indicating the active setting group in this case.

9.3 Configuring DNP3 protocol signals

1. Save the actual project configuration in PCM600 to make all signals visible for CMT.
2. Right-click the IED in the plant structure and select Communication Management to start the Communication management tool.
3. Select the DNP3 protocol from the new window and click OK. Figure 78 presents the design of the two container windows, which open after the selection of DNP3.
   • The right window shows tabs for possible communication channels.
   • The left window has a drop down menu for signal selection and buttons for signal movement, see Figure 78.

Procedure to move signals:
1. Select one or several signals.
• Click in the list of signals to select one signal.
• Press Shift or Ctrl and several signals to select a set of signals.
• Right-click in the list of signals, select Select All from the context menu or press Ctrl + A to select all signals.

2. Press the blue arrow button to insert the selected signals into the configuration.
3. Press the green double arrow button to insert all signals into the configuration, see Figure 79.

4. Click the drop down list Signal Type: to select the other signal types for this channel.
5. Repeat to move signals for all signal types and save the selection.

Content changes in the DNP3 container are marked with a star at the end of the name, see Figure 80. The star indicates that changes in the container have to be saved before leaving CMT.

9.4 Setting DNP3 signal parameters

Two parameters per signal can be set for all signal types:

• The index of the signal
• The class configuration

Procedure to set the index of the signal:

1. Click the two inner arrows to sort signals to another index sequence, or select Set Index ... from the context menu to move one or a set of signals to another array, see Figure 81.
2. The selection window shows the number of signals selected, see Figure 82.

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

Procedure to set class configuration:

1. Click in the class field of the signal to change the class configuration.
2. The Select Class window opens.
3. Make the selection according to the definitions in the project and click OK to close the window and get the new configuration, see Figure 83.

9.4.1 Configuring DNP3 class

In DNP3 the user classifies the signals and defines those signals that are not member of any class. CMT has a default predefined organization of classes per signal type. In the master station the classes can be polled in sequences according to the demands in the project. Unsolicited reporting is possible as well.

Modify the organization of the classes for each signal individually.
Procedure

1. Click in the *Class* field of the signal. A new window *Select Class* opens where the user classifies the signal.
2. Select the signal classes and choose between *None* and 0 to 3 according to the project demands.
3. Click *OK* to set the signal classification.
4. Write to IED.
Section 10 Flexible product naming

10.1 IEC 61850 Structure Mapping Tool

IEC 61850 Structure Mapping Tool is used to manage the data model of IED, where one can change the IEDs IEC 61850 data model as per the requirement. This can be done by mapping the data model with customer specific data model. The IEC 61850 structure mapping tool is available only in FPN projects in PCM600. A PCM600 project can be converted into an FPN project by importing an FPN SCD file into it. FPN is supported for both IEC 61850 Edition 1 and IEC 61850 Edition 2.

FPN allows the use of standardized, predefined and IED-vendor independent templates for building and maintaining substations. Refer to the PCM600 online help for more detailed information about FPN.

10.1.1 User interface

Figure 84: Mapping Tool

1. Plant Structure
2. IEC 61850 Structure Mapping
3. Object Properties

Plant Structure

The data tree displays the Flexible Product Naming (FPN) IEDs, non-FPN IEDs and mapped IEDs under substation; internal IEDs under unassigned IEDs.

IEC 61850 structure Mapping

The IEC 61850 structure mapping list displays the FPN objects based on the current selection in the plant structure. The list may display either IEDs or data attributes. The FPN object’s name is displayed in the column on the left and the mapped PCM600 internal object name is displayed in the column on the right. The IEC 61850 structure mapping displays customer data structure and customer data attribute on the left; internal data structure and internal data attribute on the right.

Object Properties
Object properties window displays properties of objects currently selected in the FPN Mappings and Internal Data Attribute lists. The properties are read-only and cannot be modified by user.

### 10.1.1 Data Tree

The data tree displays the Flexible Product Naming (FPN) IEDs and their SCL data model down to data attribute level. The IEDs displayed in the data tree are filtered based on the current selection in the PCM plant structure.

### 10.1.2 FPN Mappings

The FPN mappings list displays the FPN objects based on the current selection in the data tree. The list may display either IEDs or data attributes. The FPN object’s name is displayed in the column on the left and the name of the mapped PCM internal object is displayed in the column on the right.

### 10.1.3 Internal Objects

Internal objects list displays the PCM internal objects. The list may display either IEDs or data attributes. When displaying the data attributes, the list will also contain information on how many times the PCM internal data attribute is mapped with an FPN data attribute.

### 10.1.4 Suggestions

The Suggestions list displays the PCM internal data attributes that the FPN Mapping Tool suggests to be mapped with the FPN data attribute currently selected in the FPN Mappings list.

### 10.1.5 Object Properties

Object properties window displays properties of objects currently selected in the FPN Mappings and Internal Objects lists. The properties are mostly read-only and cannot be modified by user.

### 10.2 IED and Signal Naming Convention

The names used for the internal objects can be defined to be either the names used in PCM600 or the names defined in the internal IEC 61850 model. To change the naming convention, select PCM600 naming style in use from options.

### 10.3 Starting the IEC 61850 Structure Mapping Tool

The tool can be started from any node from Substation to IED level.

1. Right click on one of the nodes.
2. Select Flexible Product Naming from the menu.
3. Click on IEC 61850 Structure Mapping.
   The FPN object’s name is displayed in the column on the left and the name of the mapped PCM600 internal object is displayed in the column on the right.
10.4 Filtering options

Displayed objects can be filtered using the filtering options on top of the object list.

- free text filter
- show/hide objects by status
- matching objects filter

Free text filter

The objects are filtered by free text, showing all the objects with a certain name.

Show/hide objects by status

The objects are filtered by status, showing only unmapped objects etc.

Matching objects filter

The “matching objects” is a user-configurable filter used to find the best possible matches for a selected FPN object from all available PCM internal objects. The desired filter criteria can be selected to match the objects.

History based filter

The FPN Mapping Tool learns from the data attribute mappings that the user is doing manually to show suggestions of PCM internal data attributes based on the currently selected FPN data attribute.
10.5 **Reporting and Printing**

The report consist of a cross-reference list of the IED and data attribute mappings. I.e. a table of all FPN objects together with the PCM600 internal objects they are mapped with.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Customer IED</th>
<th>Internal IED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical Key</td>
<td>FPN_CUSTOMER_IED</td>
<td>FPN_CUSTOMER_IED</td>
</tr>
<tr>
<td>Description</td>
<td>FPN_CUSTOMER_IED</td>
<td>FPN_CUSTOMER_IED</td>
</tr>
<tr>
<td>IED Type</td>
<td>7SJ82</td>
<td>670 series</td>
</tr>
<tr>
<td>Configuration Version</td>
<td>V07.00.15</td>
<td>REL670ver2.2.0</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>Customer</td>
<td>ABB</td>
</tr>
</tbody>
</table>

Table 4: Data Attribute Mappings

<table>
<thead>
<tr>
<th>Customer Data Attribute</th>
<th>Internal Data Attribute</th>
<th>Signal Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application/LLN0.Mod.origin.orCat [ST]</td>
<td>CTRULLN0.Beh.stVal [ST]</td>
<td></td>
</tr>
<tr>
<td>CB111.LLN0.Mod.stVal [ST]</td>
<td>CTRULLN0.Beh.stVal [ST]</td>
<td></td>
</tr>
<tr>
<td>CB 111.LLN0.Mod . t [ST]</td>
<td>CTRULLN0.Beh.t [ST]</td>
<td></td>
</tr>
</tbody>
</table>

10.6 **Undo and Redo**

It is possible to undo and redo actions made in the FPN Mapping Tool. The undo/redo functionality will be limited to the FPN Mapping Tool only. I.e. when the changes made in the tool are saved, the undo and redo stacks are cleared and it will not be possible to get back to the state prior to the save.

10.7 **IED mapping**

The first step in the IEC 61850 structure mapping is to map the real IEDs to the customer specific IEDs. IED mapping means that each server IED in the FPN model is mapped with a corresponding IED in the internal PCM600 model, that is, the real device in the substation. A server IED is an IED that has an access point containing a server. IED mapping does not map the data attributes between the IEDs unless the data attribute mapping is complete. IED mapping can be done in the PCM600 plant structure and in the IEC 61850 structure mapping tool.

10.7.1 **IED mapping in PCM600 Plant Structure**

**IED mapping**

IED mapping is done in plant structure by dragging and dropping a PCM600 IED from the Unassigned IEDs group on an FPN IED in the Substation. IED mapping status is indicated visually in the plant structure.

**Removing the IED mapping**

IED mapping is removed from the plant structure by dragging and dropping a mapped FPN IED onto the Unassigned IEDs group. The removed mapping will be indicated visually in the plant.
The PCM600 internal IED, with which the unmapped FPN IED was mapped, will appear back in the Unassigned IEDs group if it is not anymore mapped with any FPN IEDs.

### 10.7.2 IED mapping in the IEC 61850 Structure Mapping Tool

#### IED mapping

The tool will display all FPN IEDs and all PCM600 IEDs in separate lists. Mapping will be done by dragging and dropping the PCM600 IED on the right hand side to FPN IED on the left hand side. The tool indicates the mapping status visually.

Click save button of the IEC 61850 structure mapping tool to apply the mapping.

![Mapping of IEDs in IEC 61850 structure mapping tool](IEC15000090-2-en.vsdx)

**Figure 87:** Mapping of IEDs in IEC 61850 structure mapping tool

![Visual indication of the mapping](IEC15000091-2-en.vsdx)

**Figure 88:** Visual indication of the mapping

#### Removing the IED mapping

Removing IED mapping is done in the IEC 61850 Structure Mapping Tool by right-clicking the mapping and selecting the context menu option or pressing the Delete key. The tool indicates the mapping status visually.

Click save button of the IEC 61850 structure mapping tool to remove the mapping.

#### Data tree view

Data tree view consists of Customer Data Structure in the column on the left and the name of the mapped PCM600 Internal Data Structure in the column on the right.
Figure 89: Data tree view

Data attribute list view

Data attribute list view consists of Customer Data Attribute in the column on the left and the PCM600 Internal Data Attribute in the column on the right.

Figure 90: Data Attribute List view

Filters

Displayed objects can be filtered using the filtering options in the quick access Toolbar.

Figure 91: Filters

Free text filter

The objects are filtered by free text, showing all the objects with a certain name in both Data Structure level and Data Attribute level.
Show/hide objects by status
The objects are filtered by status, showing only selected objects in Data Structure level and Data Attribute level.

Enable and disable type filters
Objects in the FPN can be filtered using additional filtering options available in the quick access menu.

10.7.3 Excluding IED from Mapping
FPN IEDs that cannot or does not need to be mapped can be excluded from the mapping concept. Excluded IEDs will be ignored when determining whether or not the mapping of all IEDs is complete. IEDs can be excluded in the FPN mapping tool by selecting the IEDs to exclude, right-clicking and selecting the exclude option from the context menu. IED can be excluded directly in the PCM600 plant structure by right-clicking the IED and selecting the excluded option from the context menu.

FPN IEDs can be included back to the mapping concept in the FPN mapping tool by selecting the IEDs to include, right-clicking and selecting the include option from the context menu. FPN IED can be included back to the mapping concept directly in the PCM600 plant structure by right-clicking the IED and selecting the include option from the context menu.

10.8 Data Attribute Mapping
Data attribute mapping means that each FPN data attribute in the FPN model is mapped with a corresponding data attribute in the internal PCM600 model, that is, the real device in the substation.

The mapping status is indicated visually. It can be seen what FPN data attribute is mapped to what PCM600 internal data attribute and how many FPN data attributes are mapped to a PCM600 internal data attribute.

Data attribute mapping is complete when all data attributes of the FPN IED, which are not excluded from the mappings, are mapped with a PCM600 internal data attribute. The data attribute mapping must be complete in order to be able to write to IED.

Data attribute mapping is broken if any of the data attributes - FPN or PCM600 internal - that are mapped, does not exist in the SCL database.

When performing data attribute mapping, understand the following visual signs:

- Completely mapped
- Not mapped
- Broken mapping
- Partially mapped
- Object is excluded from the mappings
All data attributes in the FPN model must be mapped or excluded, otherwise write to IED fails.

10.8.1 Data Attribute Level Mapping

The IEC 61850 Structure Mapping Tool displays the FPN data attributes and PCM600 internal data attributes in separate lists. The mapping is done by dragging and dropping the FPN data attribute onto a PCM600 internal data attribute.

The mapping is removed by right clicking and selecting remove from the context menu or by clicking the Delete key while the mapping is selected.

![Data attribute level mapping](image)

**Figure 92: Data attribute level mapping**

10.8.2 Data Object Level Mapping

Data attribute mapping can be created on the data object level in one of the alternative ways.

- Drag a data object from the customer data structure onto a data object in the internal data structure
- Drag a data object from the internal data structure onto a data object in the customer data structure.

![Completed data object mapping](image)

**Figure 93: Completed data object mapping**

10.8.3 Logical Node Level Mapping

Data attribute mapping can be created on the logical node level in one of the alternative ways.

- Drag a logical node from the customer data structure on a logical node in the internal data structure.
- Drag a logical node from the internal data structure on a logical node in the customer data structure.
10.8.4 Excluding Data Attributes from Mapping

Data attributes can be excluded by selecting the data attributes to exclude, right-clicking and selecting the exclude option from the context menu. It is possible to exclude all unmapped data attributes from the mapping at once by right-clicking and selecting the exclude all option.

The data attributes that are excluded from the mapping will not be excluded from the model. Excluded mappings will be ignored when determining if an IED mapping is complete.

It is crucial to set a value to the excluded data attributes before initiating the mapping.

10.8.5 Setting the data attribute value

The data attribute value can be set by editing the Value field in the Object Properties window. For enum type of data attributes there is a list of available values to select. For numeric and string type data attributes the value can be entered directly in the Value field.
10.9 Creating Template

It is possible to create a template of an IED’s data attribute mapping and store it for reuse. The template contains description of the data attribute mapping between two IED SCL models.

All mapping templates created in PCM600 are stored in a template library. The template library is not specific to certain PCM600 project, but it is common for all projects. Templates in the library can be managed in the following ways.

- Delete selected templates
- Export templates
  - A single or multiple template files can be exported.
- Import templates
  - A single or multiple template files can be imported.
  - If a template being imported already exists in the library, user will be prompted whether to override the existing one.
- Export project’s templates
  - When PCM600 project is exported, all templates used in the project will be automatically included in the exported PCMP file.
- Import project’s templates
  - When PCM600 project is imported, all templates included in the imported PCMP file will be automatically imported into the template library.
  - If a template being imported already exists in the library it will be overridden.

The mapping templates are also used by IET600 to translate the internal data references in the signal library to the FPN references, because IET600 needs to know what template to use to resolve the internal data references.

Create template for each IED mapping.
10.9.1 Exporting FPN templates

1. Right click on the PCM600 plant structure.
2. Select Manage Mapping Templates under Flexible Product Naming in the menu.
3. Select the templates to export and click Export.

4. Select the folder where to export the templates and click OK.

10.9.2 Creating a Mapping Template

Data attribute mapping templates can be created from mapped IEDs. If the template is created from an incompletely mapped IED, an information dialog will be shown. User can select an option to not show the dialog again. The dialog can be resumed afterwards from the PCM600 Options menu.

The template can be created either from the IEC 61850 structure mapping tool or from the PCM600 plant structure. The required template information has to be filled in before it can be created.

10.9.3 Applying Mapping Template on IED

The template can be selected from a list consisting of all available templates. The FPN IED must be mapped with a PCM600 internal IED before the template can be applied.

The template can be applied either in the IEC 61850 structure mapping tool or in the PCM600 plant structure. In the IEC 61850 structure mapping tool, the template can be applied to one or several IEDs at once. In the plant structure the template can be applied on one IED at a time by right clicking on an IED or on all IEDs under a bay by right clicking on the bay.
## Section 11  Glossary

### 11.1 Glossary

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC</td>
<td>Alternating current</td>
</tr>
<tr>
<td>ACC</td>
<td>Actual channel</td>
</tr>
<tr>
<td>ACT</td>
<td>Application configuration tool within PCM600</td>
</tr>
<tr>
<td>A/D converter</td>
<td>Analog-to-digital converter</td>
</tr>
<tr>
<td>ADBS</td>
<td>Amplitude deadband supervision</td>
</tr>
<tr>
<td>ADM</td>
<td>Analog digital conversion module, with time synchronization</td>
</tr>
<tr>
<td>AI</td>
<td>Analog input</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
</tr>
<tr>
<td>AR</td>
<td>Autoreclosing</td>
</tr>
<tr>
<td>ASCT</td>
<td>Auxiliary summation current transformer</td>
</tr>
<tr>
<td>ASD</td>
<td>Adaptive signal detection</td>
</tr>
<tr>
<td>ASDU</td>
<td>Application service data unit</td>
</tr>
<tr>
<td>AWG</td>
<td>American Wire Gauge standard</td>
</tr>
<tr>
<td>BBP</td>
<td>Busbar protection</td>
</tr>
<tr>
<td>BFOC/2,5</td>
<td>Bayonet fiber optic connector</td>
</tr>
<tr>
<td>BFP</td>
<td>Breaker failure protection</td>
</tr>
<tr>
<td>BI</td>
<td>Binary input</td>
</tr>
<tr>
<td>BIM</td>
<td>Binary input module</td>
</tr>
<tr>
<td>BOM</td>
<td>Binary output module</td>
</tr>
<tr>
<td>BOS</td>
<td>Binary outputs status</td>
</tr>
<tr>
<td>BR</td>
<td>External bistable relay</td>
</tr>
<tr>
<td>BS</td>
<td>British Standards</td>
</tr>
<tr>
<td>BSR</td>
<td>Binary signal transfer function, receiver blocks</td>
</tr>
<tr>
<td>BST</td>
<td>Binary signal transfer function, transmit blocks</td>
</tr>
<tr>
<td>C37.94</td>
<td>IEEE/ANSI protocol used when sending binary signals between IEDs</td>
</tr>
<tr>
<td>CAN</td>
<td>Controller Area Network. ISO standard (ISO 11898) for serial communication</td>
</tr>
<tr>
<td>CB</td>
<td>Circuit breaker</td>
</tr>
<tr>
<td>CBM</td>
<td>Combined backplane module</td>
</tr>
<tr>
<td>CCM</td>
<td>CAN carrier module</td>
</tr>
<tr>
<td>CCVT</td>
<td>Capacitive Coupled Voltage Transformer</td>
</tr>
<tr>
<td>Class C</td>
<td>Protection Current Transformer class as per IEEE/ ANSI</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
</tr>
<tr>
<td>CMPPS</td>
<td>Combined megapulses per second</td>
</tr>
<tr>
<td>CMT</td>
<td>Communication Management tool in PCM600</td>
</tr>
<tr>
<td>CO cycle</td>
<td>Close-open cycle</td>
</tr>
<tr>
<td>Codirectional</td>
<td>Way of transmitting G.703 over a balanced line. Involves two twisted pairs making it possible to transmit information in both directions</td>
</tr>
<tr>
<td>COM</td>
<td>Command</td>
</tr>
<tr>
<td>COMTRADE</td>
<td>Standard Common Format for Transient Data Exchange format for Disturbance recorder according to IEEE/ANSI C37.111, 1999 / IEC 60255-24</td>
</tr>
<tr>
<td>Contra-directional</td>
<td>Way of transmitting G.703 over a balanced line. Involves four twisted pairs, two of which are used for transmitting data in both directions and two for transmitting clock signals</td>
</tr>
<tr>
<td>COT</td>
<td>Cause of transmission</td>
</tr>
<tr>
<td>CPU</td>
<td>Central processing unit</td>
</tr>
<tr>
<td>CR</td>
<td>Carrier receive</td>
</tr>
<tr>
<td>CRC</td>
<td>Cyclic redundancy check</td>
</tr>
<tr>
<td>CROB</td>
<td>Control relay output block</td>
</tr>
<tr>
<td>CS</td>
<td>Carrier send</td>
</tr>
<tr>
<td>CT</td>
<td>Current transformer</td>
</tr>
<tr>
<td>CU</td>
<td>Communication unit</td>
</tr>
<tr>
<td>CVT or CCVT</td>
<td>Capacitive voltage transformer</td>
</tr>
<tr>
<td>DAR</td>
<td>Delayed autoreclosing</td>
</tr>
<tr>
<td>DARPA</td>
<td>Defense Advanced Research Projects Agency (The US developer of the TCP/IP protocol etc.)</td>
</tr>
<tr>
<td>DBDL</td>
<td>Dead bus dead line</td>
</tr>
<tr>
<td>DBLL</td>
<td>Dead bus live line</td>
</tr>
<tr>
<td>DC</td>
<td>Direct current</td>
</tr>
<tr>
<td>DFC</td>
<td>Data flow control</td>
</tr>
<tr>
<td>DFT</td>
<td>Discrete Fourier transform</td>
</tr>
<tr>
<td>DHCP</td>
<td>Dynamic Host Configuration Protocol</td>
</tr>
<tr>
<td>DIP-switch</td>
<td>Small switch mounted on a printed circuit board</td>
</tr>
<tr>
<td>DI</td>
<td>Digital input</td>
</tr>
<tr>
<td>DLLB</td>
<td>Dead line live bus</td>
</tr>
<tr>
<td>DNP</td>
<td>Distributed Network Protocol as per IEEE Std 1815-2012</td>
</tr>
<tr>
<td>DR</td>
<td>Disturbance recorder</td>
</tr>
<tr>
<td>DRAM</td>
<td>Dynamic random access memory</td>
</tr>
<tr>
<td>DRH</td>
<td>Disturbance report handler</td>
</tr>
<tr>
<td>DSP</td>
<td>Digital signal processor</td>
</tr>
<tr>
<td>DTT</td>
<td>Direct transfer trip scheme</td>
</tr>
<tr>
<td>ECT</td>
<td>Ethernet configuration tool</td>
</tr>
<tr>
<td>EHV network</td>
<td>Extra high voltage network</td>
</tr>
<tr>
<td>EIA</td>
<td>Electronic Industries Association</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
</tr>
<tr>
<td>EMC</td>
<td>Electromagnetic compatibility</td>
</tr>
<tr>
<td>EMF</td>
<td>Electromotive force</td>
</tr>
<tr>
<td>EMI</td>
<td>Electromagnetic interference</td>
</tr>
<tr>
<td>EnFP</td>
<td>End fault protection</td>
</tr>
<tr>
<td>EPA</td>
<td>Enhanced performance architecture</td>
</tr>
<tr>
<td>ESD</td>
<td>Electrostatic discharge</td>
</tr>
<tr>
<td>F-SMA</td>
<td>Type of optical fiber connector</td>
</tr>
<tr>
<td>FAN</td>
<td>Fault number</td>
</tr>
<tr>
<td>FCB</td>
<td>Flow control bit; Frame count bit</td>
</tr>
<tr>
<td>FOX 20</td>
<td>Modular 20 channel telecommunication system for speech, data and protection signals</td>
</tr>
<tr>
<td>FOX 512/515</td>
<td>Access multiplexer</td>
</tr>
<tr>
<td>FOX 6Plus</td>
<td>Compact time-division multiplexer for the transmission of up to seven duplex channels of digital data over optical fibers</td>
</tr>
<tr>
<td>FPN</td>
<td>Flexible product naming</td>
</tr>
<tr>
<td>FTP</td>
<td>File Transfer Protocol</td>
</tr>
<tr>
<td>FUN</td>
<td>Function type</td>
</tr>
<tr>
<td>G.703</td>
<td>Electrical and functional description for digital lines used by local telephone companies. Can be transported over balanced and unbalanced lines</td>
</tr>
<tr>
<td>GCM</td>
<td>Communication interface module with carrier of GPS receiver module</td>
</tr>
<tr>
<td>GDE</td>
<td>Graphical display editor within PCM600</td>
</tr>
<tr>
<td>GI</td>
<td>General interrogation command</td>
</tr>
<tr>
<td>GIS</td>
<td>Gas-insulated switchgear</td>
</tr>
<tr>
<td>GOOSE</td>
<td>Generic object-oriented substation event</td>
</tr>
<tr>
<td>GPS</td>
<td>Global positioning system</td>
</tr>
<tr>
<td>GSAL</td>
<td>Generic security application</td>
</tr>
<tr>
<td>GSE</td>
<td>Generic substation event</td>
</tr>
<tr>
<td>GSM</td>
<td>GPS time synchronization module</td>
</tr>
<tr>
<td>GTM</td>
<td>GPS Time Module</td>
</tr>
<tr>
<td>HDLC protocol</td>
<td>High-level data link control, protocol based on the HDLC standard</td>
</tr>
<tr>
<td>HFBR connector type</td>
<td>Plastic fiber connector</td>
</tr>
<tr>
<td>HLV circuit</td>
<td>Hazardous Live Voltage according to IEC60255-27</td>
</tr>
<tr>
<td>HMI</td>
<td>Human-machine interface</td>
</tr>
<tr>
<td>HSAR</td>
<td>High speed autoreclosing</td>
</tr>
<tr>
<td>HSR</td>
<td>High-availability Seamless Redundancy</td>
</tr>
<tr>
<td>HV</td>
<td>High-voltage</td>
</tr>
<tr>
<td>HVDC</td>
<td>High-voltage direct current</td>
</tr>
<tr>
<td>ICT</td>
<td>Installation and Commissioning Tool for injection based protection in REG670</td>
</tr>
<tr>
<td>IDBS</td>
<td>Integrating deadband supervision</td>
</tr>
<tr>
<td>IEC</td>
<td>International Electrical Committee</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
</tr>
<tr>
<td>----------</td>
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</tr>
<tr>
<td>IEC 60044-6</td>
<td>IEC Standard, Instrument transformers – Part 6: Requirements for protective current transformers for transient performance</td>
</tr>
<tr>
<td>IEC 60870-5-103</td>
<td>Communication standard for protection equipment. A serial master/slide protocol for point-to-point communication</td>
</tr>
<tr>
<td>IEC 61850</td>
<td>Substation automation communication standard</td>
</tr>
<tr>
<td>IEC 61850–8-1</td>
<td>Communication protocol standard</td>
</tr>
<tr>
<td>IEEE</td>
<td>Institute of Electrical and Electronics Engineers</td>
</tr>
<tr>
<td>IEEE 802.12</td>
<td>A network technology standard that provides 100 Mbits/s on twisted-pair or optical fiber cable</td>
</tr>
<tr>
<td>IEEE P1386.1</td>
<td>PCI Mezzanine Card (PMC) standard for local bus modules. References the CMC (IEEE P1386, also known as Common Mezzanine Card) standard for the mechanics and the PCI specifications from the PCI SIG (Special Interest Group) for the electrical EMF (Electromotive force).</td>
</tr>
<tr>
<td>IEC 1686</td>
<td>Standard for Substation Intelligent Electronic Devices (IEDs) Cyber Security Capabilities</td>
</tr>
<tr>
<td>IED</td>
<td>Intelligent electronic device</td>
</tr>
<tr>
<td>IET600</td>
<td>Integrated engineering tool</td>
</tr>
<tr>
<td>I-GIS</td>
<td>Intelligent gas-insulated switchgear</td>
</tr>
<tr>
<td>IOM</td>
<td>Binary input/output module</td>
</tr>
<tr>
<td>Instance</td>
<td>When several occurrences of the same function are available in the IED, they are referred to as instances of that function. One instance of a function is identical to another of the same kind but has a different number in the IED user interfaces. The word “instance” is sometimes defined as an item of information that is representative of a type. In the same way an instance of a function in the IED is representative of a type of function.</td>
</tr>
<tr>
<td>IP</td>
<td>1. Internet protocol. The network layer for the TCP/IP protocol suite widely used on Ethernet networks. IP is a connectionless, best-effort packet-switching protocol. It provides packet routing, fragmentation and reassembly through the data link layer. 2. Ingress protection, according to IEC 60529</td>
</tr>
<tr>
<td>IP 20</td>
<td>Ingress protection, according to IEC 60529, level 20</td>
</tr>
<tr>
<td>IP 40</td>
<td>Ingress protection, according to IEC 60529, level 40</td>
</tr>
<tr>
<td>IP 54</td>
<td>Ingress protection, according to IEC 60529, level 54</td>
</tr>
<tr>
<td>IRF</td>
<td>Internal failure signal</td>
</tr>
<tr>
<td>IRIG-B:</td>
<td>InterRange Instrumentation Group Time code format B, standard 200</td>
</tr>
<tr>
<td>ITU</td>
<td>International Telecommunications Union</td>
</tr>
<tr>
<td>LAN</td>
<td>Local area network</td>
</tr>
<tr>
<td>LIB 520</td>
<td>High-voltage software module</td>
</tr>
<tr>
<td>LCD</td>
<td>Liquid crystal display</td>
</tr>
<tr>
<td>LDCM</td>
<td>Line data communication module</td>
</tr>
<tr>
<td>LDD</td>
<td>Local detection device</td>
</tr>
<tr>
<td>LED</td>
<td>Light-emitting diode</td>
</tr>
<tr>
<td>LNT</td>
<td>LON network tool</td>
</tr>
<tr>
<td>LON</td>
<td>Local operating network</td>
</tr>
<tr>
<td>MCB</td>
<td>Miniature circuit breaker</td>
</tr>
</tbody>
</table>
MCM  Mezzanine carrier module
MIM  Milli-ampere module
MPM  Main processing module
MVAL Value of measurement
MVB  Multifunction vehicle bus. Standardized serial bus originally developed for use in trains.
NCC  National Control Centre
NOF  Number of grid faults
NUM  Numerical module
OCO cycle  Open-close-open cycle
OCP  Overcurrent protection
OEM  Optical Ethernet module
OLTC  On-load tap changer
OTEV  Disturbance data recording initiated by other event than start/pick-up
OV  Overvoltage
Overreach  A term used to describe how the relay behaves during a fault condition. For example, a distance relay is overreaching when the impedance presented to it is smaller than the apparent impedance to the fault applied to the balance point, that is, the set reach. The relay “sees” the fault but perhaps it should not have seen it.
PCI  Peripheral component interconnect, a local data bus
PCM  Pulse code modulation
PCM600 Protection and control IED manager
PC-MIP  Mezzanine card standard
PELV circuit  Protected Extra-Low Voltage circuit type according to IEC60255-27
PMC  PCI Mezzanine card
POR  Permissive overreach
POTT  Permissive overreach transfer trip
Process bus  Bus or LAN used at the process level, that is, in near proximity to the measured and/or controlled components
PRP  Parallel redundancy protocol
PSM  Power supply module
PST  Parameter setting tool within PCM600
PTP  Precision time protocol
PT ratio  Potential transformer or voltage transformer ratio
PUTT  Permissive underreach transfer trip
RASC  Synchrocheck relay, COMBIFLEX
RCA  Relay characteristic angle
RISC  Reduced instruction set computer
RMS value  Root mean square value
RS422  A balanced serial interface for the transmission of digital data in point-to-point connections
RS485  Serial link according to EIA standard RS485
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
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</thead>
<tbody>
<tr>
<td>RTC</td>
<td>Real-time clock</td>
</tr>
<tr>
<td>RTU</td>
<td>Remote terminal unit</td>
</tr>
<tr>
<td>SA</td>
<td>Substation Automation</td>
</tr>
<tr>
<td>SBO</td>
<td>Select-before-operate</td>
</tr>
<tr>
<td>SC</td>
<td>Switch or push button to close</td>
</tr>
<tr>
<td>SCL</td>
<td>Short circuit location</td>
</tr>
<tr>
<td>SCS</td>
<td>Station control system</td>
</tr>
<tr>
<td>SCADA</td>
<td>Supervision, control and data acquisition</td>
</tr>
<tr>
<td>SCT</td>
<td>System configuration tool according to standard IEC 61850</td>
</tr>
<tr>
<td>SDU</td>
<td>Service data unit</td>
</tr>
<tr>
<td>SELV circuit</td>
<td>Safety Extra-Low Voltage circuit type according to IEC60255-27</td>
</tr>
<tr>
<td>SFP</td>
<td>Small form-factor pluggable (abbreviation) Optical Ethernet port (explanation)</td>
</tr>
<tr>
<td>SLM</td>
<td>Serial communication module.</td>
</tr>
<tr>
<td>SMA connector</td>
<td>Subminiature version A, A threaded connector with constant impedance.</td>
</tr>
<tr>
<td>SMT</td>
<td>Signal matrix tool within PCM600</td>
</tr>
<tr>
<td>SMS</td>
<td>Station monitoring system</td>
</tr>
<tr>
<td>SNTP</td>
<td>Simple network time protocol – is used to synchronize computer clocks on local area networks. This reduces the requirement to have accurate hardware clocks in every embedded system in a network. Each embedded node can instead synchronize with a remote clock, providing the required accuracy.</td>
</tr>
<tr>
<td>SOF</td>
<td>Status of fault</td>
</tr>
<tr>
<td>SPA</td>
<td>Strömberg Protection Acquisition (SPA), a serial master/slave protocol for point-to-point and ring communication.</td>
</tr>
<tr>
<td>SRY</td>
<td>Switch for CB ready condition</td>
</tr>
<tr>
<td>ST</td>
<td>Switch or push button to trip</td>
</tr>
<tr>
<td>Starpoint</td>
<td>Neutral point of transformer or generator</td>
</tr>
<tr>
<td>SVC</td>
<td>Static VAr compensation</td>
</tr>
<tr>
<td>TC</td>
<td>Trip coil</td>
</tr>
<tr>
<td>TCS</td>
<td>Trip circuit supervision</td>
</tr>
<tr>
<td>TCP</td>
<td>Transmission control protocol. The most common transport layer protocol used on Ethernet and the Internet.</td>
</tr>
<tr>
<td>TCP/IP</td>
<td>Transmission control protocol over Internet Protocol. The de facto standard Ethernet protocols incorporated into 4.2BSD Unix. TCP/IP was developed by DARPA for Internet working and encompasses both network layer and transport layer protocols. While TCP and IP specify two protocols at specific protocol layers, TCP/IP is often used to refer to the entire US Department of Defense protocol suite based upon these, including Telnet, FTP, UDP and RDP.</td>
</tr>
<tr>
<td>TEF</td>
<td>Time delayed earth-fault protection function</td>
</tr>
<tr>
<td>TLS</td>
<td>Transport Layer Security</td>
</tr>
<tr>
<td>TM</td>
<td>Transmit (disturbance data)</td>
</tr>
<tr>
<td><strong>TNC connector</strong></td>
<td>Threaded Neill-Concelman, a threaded constant impedance version of a BNC connector</td>
</tr>
<tr>
<td><strong>TP</strong></td>
<td>Trip (recorded fault)</td>
</tr>
<tr>
<td><strong>TPZ, TPY, TPX, TPS</strong></td>
<td>Current transformer class according to IEC</td>
</tr>
<tr>
<td><strong>TRM</strong></td>
<td>Transformer Module. This module transforms currents and voltages taken from the process into levels suitable for further signal processing.</td>
</tr>
<tr>
<td><strong>TYP</strong></td>
<td>Type identification</td>
</tr>
<tr>
<td><strong>UMT</strong></td>
<td>User management tool</td>
</tr>
<tr>
<td><strong>Underreach</strong></td>
<td>A term used to describe how the relay behaves during a fault condition. For example, a distance relay is underreaching when the impedance presented to it is greater than the apparent impedance to the fault applied to the balance point, that is, the set reach. The relay does not “see” the fault but perhaps it should have seen it. See also Overreach.</td>
</tr>
<tr>
<td><strong>UTC</strong></td>
<td>Coordinated Universal Time. A coordinated time scale, maintained by the Bureau International des Poids et Mesures (BIPM), which forms the basis of a coordinated dissemination of standard frequencies and time signals. UTC is derived from International Atomic Time (TAI) by the addition of a whole number of “leap seconds” to synchronize it with Universal Time 1 (UT1), thus allowing for the eccentricity of the Earth's orbit, the rotational axis tilt (23.5 degrees), but still showing the Earth's irregular rotation, on which UT1 is based. The Coordinated Universal Time is expressed using a 24-hour clock, and uses the Gregorian calendar. It is used for aeroplane and ship navigation, where it is also sometimes known by the military name, “Zulu time.” “Zulu” in the phonetic alphabet stands for “Z”, which stands for longitude zero.</td>
</tr>
<tr>
<td><strong>UV</strong></td>
<td>Undervoltage</td>
</tr>
<tr>
<td><strong>WEI</strong></td>
<td>Weak end infeed logic</td>
</tr>
<tr>
<td><strong>VT</strong></td>
<td>Voltage transformer</td>
</tr>
<tr>
<td><strong>X.21</strong></td>
<td>A digital signalling interface primarily used for telecom equipment</td>
</tr>
<tr>
<td><strong>3I₀</strong></td>
<td>Three times zero-sequence current. Often referred to as the residual or the earth-fault current</td>
</tr>
<tr>
<td><strong>3U₀</strong></td>
<td>Three times the zero sequence voltage. Often referred to as the residual voltage or the neutral point voltage</td>
</tr>
</tbody>
</table>