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This product includes software developed by the OpenSSL Project for use in the OpenSSL Toolkit. (http://www.openssl.org/) This product includes cryptographic software written/developed by: Eric Young (eay@cryptsoft.com) and Tim Hudson (tjh@cryptsoft.com).

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Conformity

This product complies with the directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive 2004/108/EC) and concerning electrical equipment for use within specified voltage limits (Low-voltage directive 2006/95/EC). This conformity is the result of tests conducted by ABB in accordance with the product 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, as well as communication engineering for IEC 61850.

1.1.1  Presumptions for Technical Data

The technical data stated in this document are only valid under the following circumstances:

1. Main current transformers with 1 A or 2 A secondary rating are wired to the IED 1 A rated CT inputs.
2. Main current transformer with 5 A secondary rating are wired to the IED 5 A rated CT inputs.
3. CT and VT ratios in the IED are set in accordance with the associated main instrument transformers. Note that for functions which measure an analogue signal which do not have corresponding primary quantity the 1:1 ratio shall be set for the used analogue inputs on the IED. Example of such functions are: HZPDIF, ROTIPHIZ and STTIPHIZ.
4. Parameter $I_{\text{Base}}$ used by the tested function is set equal to the rated CT primary current.
5. Parameter $U_{\text{Base}}$ used by the tested function is set equal to the rated primary phase-to-phase voltage.
6. Parameter $S_{\text{Base}}$ used by the tested function is set equal to:
   - $\sqrt{3} \times I_{\text{Base}} \times U_{\text{Base}}$
7. The rated secondary quantities have the following values:
   - Rated secondary phase current $I_r$ is either 1 A or 5 A depending on selected TRM.
   - Rated secondary phase-to-phase voltage $U_r$ is within the range from 100 V to 120 V.
   - Rated secondary power for three-phase system $S_r = \sqrt{3} \times U_r \times I_r$
8. For operate and reset time testing, the default setting values of the function are used if not explicitly stated otherwise.
9. During testing, signals with rated frequency have been injected if not explicitly stated otherwise.

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, as well as communication engineering for IEC 61850.

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 station 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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### 1.3.3 Related documents

#### Documents related to REB650

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### 650 series manuals

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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 IEC 61850 edition 1 / edition 2 mapping

Function block names are used in ACT and PST to identify functions. Respective function block names of Edition 1 logical nodes and Edition 2 logical nodes are shown in the table below.

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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 four main parts:

- Bay level IEDs
- Station communication
- Station level IEDs
- Process bus level

![Diagram showing the structure of a monitoring and control system for a substation.](IEC08000101-2-en.vsdex)

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

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

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 on the station bus 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 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 time saving signal engineering.

The engineering of the used communication protocols is a separate task and an addition to the engineering of 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 Relion 670/650 series product ver.2.2.

## 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 Ethernet ports, Routes and Merging units using the Ethernet configuration tool.
  - 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 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 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 on the IED are not allowed to belong to the 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 IEC 61850 technical key (or use the default one from PCM600).

- **ECT Ethernet configuration**
  - Configure the access points, routes and merging units
  - Check and adjust if needed the setting values for example for:
    - Operation of the access points
    - Redundant communication on the access points
    - Route for communication of devices in different subnetworks
    - Operation of merging unit receivers.

- **ACT Application configuration**
  - 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.
  - Check and adjust the setting values if needed for example for:
    - Presentation parameters for local HMI.
    - Settings for 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). 

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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 2.8 or newer must be used with the 2.2 version of the IED. The Connectivity package used with PCM600 2.8 and the 2.2 version of the IED must be of version 2.2.

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 media that was distributed along with the IED. The user manuals for all IEDs are contained in a separate installation package Relion 650 v.2.2 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.

4.3 Setting technical key

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

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.
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 6: PCM600: Set technical key menu at IED level**

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

**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 IEC 61850 Edition 1 and 55 characters for IEC 61850 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 transport layer used within the station or to the NCC.

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

Each IED has an RJ-45 Ethernet interface connector on the front. The front Ethernet connector is recommended to 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.
- A 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

Communication between the IED and PCM600 is enabled from the LHMI. The IP address and the corresponding communication subnetwork mask must be set via the Ethernet configuration tool (ECT) 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.

DHCP is available for the front port, and a device connected to it can thereby obtain an automatically assigned IP address via the local HMI path Main menu/Configuration/Communication/Ethernet configuration/Front port/DHCP.

Alternatively 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/TCP-IP configuration/ETHFRNT:1Main menu/Configuration/Communication/Ethernet configuration/AP_FRONT.
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.

If an IED is equipped with optical LC interface, a converter between RJ-45 and LC is needed.

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

![Figure 8: Select: Search programs and files](IEC13000057-1-en.vsd)

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

**Figure 9:**  Click *View network connections*

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

**Figure 10:**  Right-click *Local Area Connection* and select **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 12. The IP address must be different from the IP address chosen for the IED.

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 PCM600 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 different installations of PCM600.

### Creating a new project

**Procedure**

1. Select *File* and *Open/Manage Project* ... to see the projects that are currently available in the PCMDBases.
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 13.
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 = voltage level in substation
4. Bay = bay within the voltage level
5. IED = IED in the bay.

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.
structure by selecting the elements from the context menu. Rename the level after insertion using the Rename possibility or the Object Properties. Figure 14 shows the start of a project with two IEDs placed but still not renamed.

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

Procedure to build a plant structure:
• Right-click 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 15.

• 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.

![Diagram of plant structure](image)

Figure 15: PCM600: IEC 61850 signal designation concept

### 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 IEC 61850 to Edition 2 or the other way around. You can also convert a .pcmi file 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.

![Change SCL Version dialog](image)

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.

   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 16) indicates that communication between the IED object in PCM600 and the physical IED is established.
Import a template IED from a *.pcmt file available in the template library.
Import a pre-configured IED available as a *.pcmt file.

Inserting an IED in online mode

An IEC 61850 edition 2 mode cannot be inserted in an IEC 61850 edition 1 project and vice versa.

Procedure:

1. Right-click the Bay and select New and application type of IED.
2. Select the IED type to insert.
3. Select the Online Configuration mode, see Figure 18.
4. Select the IED Communication protocol, see Figure 19.

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

6. Cross-check that the IED whose IP address has been inserted, has been detected online by PCM600, see Figure 16.
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 21**.

![Figure 21: PCM600: IED Version detection](IEC15000453-1-en.vsd)

**Figure 21: PCM600: IED Version detection**

The IEC 61850 protocol edition 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.

SCL versions can be changed only if option 'Allow changing SCL version of an IED configuration' is selected from options in Tools menu and only if one IED is present 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 22**.

![Figure 22: PCM600: IED housing and display type detection](IEC09000742-3-en.vsd)

**Figure 22: 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 Option**, see **Figure 23**. It is possible to **Cancel** the insertion or confirm the configuration and do the insertion with **Finish**.
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 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.
Figure 24: Insert an IED from the template library

2. Select New and Create from Template ... to open the Create New Object from Template window, see Figure 25.

Figure 25: 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 26 and click Close to close the window.
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 25.

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.

Importing a pre-configuration to template library

Pre-configurations in PCM600 are available as *.pcmt 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 to insert pre-configuration files:

- Use the pre-configuration that has been shipped together with the IED.
- Install the pre-configuration from the Connpack media.
- Download and install pre-configuration from Update Manager.

To insert a pre-configuration in to plant structure, see section Inserting an IED from the template library.

Because IEC 61850 edition 1 and IEC 61850 edition 2 templates are incompatible, convert an IEC 61850 edition 1 template to IEC 61850 edition 2 before you insert it.
Ordered pre-configurations are not locked. The user can use the available pre-configuration 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.

**Importing configuration to a template library**

Template configurations in PCM600 are available as *.pcmt files and include all information that is related to the IED object in PCM600.

Options to insert template configuration files:

- Install the template configuration from the Connpack media.
- Download and install the template configuration from Update Manager.

To insert the template configuration into a plant structure, see section [Inserting an IED from the template library](#).

Because IEC 61850 edition 1 and IEC 61850 edition 2 templates are incompatible, convert an IEC 61850 edition 1 template to IEC 61850 edition 2 before you insert it.

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.

- Via the first window of the wizard when including a new IED in a project, see [Figure 27](#).
Figure 27: Alternative 1: IP address via the first Wizard window

- Via the IP address property of the IED in the Object Properties window, see Figure 28.

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  Ethernet configuration tool

5.1  Introduction

The Ethernet configuration tool (ECT) is a configuration tool that provides the possibility to configure Access points, Merging units and Routes in a single place. The tool increases security and easy of use as it offers an overview of all configurations related to Ethernet communication, such as operation, IP addresses, redundant communications and which protocols allowed to run on the individual access points.

ECT validates the values entered for the IP-adress and the default gateway in the Access point-tab as well as the settings in the Merging unit-tab. For more information refer to the Application manual.

5.1.1  User interface

Access points

The Ethernet configuration tool consists of one tab for access point, one for merging unit and one for routing. The changes done during the session will be bolded until the tool is closed.

The protocols cannot be activated or deactivated from ECT, the tool only controls which protocols are allowed to run on the access point. For information on how to activate or deactivate the communication protocols, see the communication protocol manuals or cyber security deployment guideline.

To configure the access points and merging units in offline mode, first hardware configuration should be selected in Hardware Configuration Tool (HWT). In online mode all available access points and merging units will appear in ECT.

Figure 29:  Access point tab

This tab allows configuration of the access points, model access points in SCL, filter the protocols to be sent over each access point, and configure time synchronization for each access points. Each row in this tab corresponds to an access point. Access point 1 is the default access point and will be included in the SCL model by default. Changing settings in this tab will have impact on the SCL model.

The PTP VLAN tag is only valid for PTP time synchronization and it must have the same value in station clock and in the IED. The default value is set to 0.
Columns in this tab will vary based on IED capability and order-specification.

Table 2: Access point tab

<table>
<thead>
<tr>
<th>Column</th>
<th>Description</th>
<th>Read only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access point</td>
<td>Shows access point instance.</td>
<td>Yes</td>
</tr>
<tr>
<td>Description</td>
<td>Shows description of the access point</td>
<td>No</td>
</tr>
<tr>
<td>Operation</td>
<td>Enable/disable the access point operation.</td>
<td>No</td>
</tr>
<tr>
<td>Redundancy</td>
<td>Shows the redundancy mode. When HSR or PRP-0 or PRP-1 is selected, the next access point will be used as pair for redundancy hence the next access point row will be hidden in the tool.</td>
<td>No</td>
</tr>
<tr>
<td>Physical port A</td>
<td>Shows the physical port associated with the access point.</td>
<td>Yes</td>
</tr>
<tr>
<td>Physical port B</td>
<td>Shows the redundant physical port associated with the access point when PRP or HSR is activated.</td>
<td>Yes</td>
</tr>
<tr>
<td>Subnetwork</td>
<td>Shows the SCL subnetwork to which the access point is connected, can be changed. This column shows the SCL subnetworks available in the PCM600 project. SCL subnetworks can be created/deleted in Subnetworks tab of IEC 61850 Configuration tool in PCM600.</td>
<td>No</td>
</tr>
<tr>
<td>IP Address</td>
<td>Shows the IP address for the access point.</td>
<td>Yes</td>
</tr>
<tr>
<td>Subnetwork mask</td>
<td>Shows the Subnet mask of the access point.</td>
<td>No</td>
</tr>
<tr>
<td>Default gateway</td>
<td>Shows the Default gateway of the access point.</td>
<td>No</td>
</tr>
<tr>
<td>PCM600 access</td>
<td>Enable/Disable PCM600 communication on an access point.</td>
<td>No</td>
</tr>
<tr>
<td>MMS</td>
<td>Enable/Disable IEC 61850 MMS communication on an access point.</td>
<td>No</td>
</tr>
</tbody>
</table>

When changing this setting may have impact on the Application Configuration. Availability of Redundancy modes, HSR & PRP are based on hardware availability and order-specification.

When saving the ECT configuration, if redundancy mode (HSR, PRP-0 or PRP-1) is selected the redundant diagnostic function (RCHLCCH) is instantiated and if redundancy mode is None then the non redundant diagnostic function (SCHLCCH) is instantiated.

When saving the ECT configuration after selecting a subnetwork, ECT creates the access point in the SCL model, unselecting the subnetwork removes the access point from the SCL model.

For IEC 61850 Ed2 IEDs this column will be editable and for IEC 61850 Ed1 IEDs, this column will not be editable because in IEC 61850 Ed1 only one access point can be modelled SCL.

The Default Gateway address should be within the subnetwork of the access point that is defined by the subnetwork mask.
### Column Description Read only

<table>
<thead>
<tr>
<th>Column</th>
<th>Description</th>
<th>Read only</th>
</tr>
</thead>
<tbody>
<tr>
<td>GOOSE</td>
<td>Enable/Disable IEC 61850 GOOSE communication on an access point.</td>
<td>No</td>
</tr>
<tr>
<td>DNP 3.0</td>
<td>Enable/Disable DNP 3.0 protocol on an access point.</td>
<td>No</td>
</tr>
<tr>
<td>FTP</td>
<td>Enable/Disable File Transfer Protocol on an access point.</td>
<td>No</td>
</tr>
<tr>
<td>FST access</td>
<td>Enable/Disable Field Service Tool access on an access point.</td>
<td>No</td>
</tr>
<tr>
<td>SNTP Server</td>
<td>Enable/Disable SNTP server communication on an access point.</td>
<td>No</td>
</tr>
<tr>
<td>PTP(IEEE 1588)</td>
<td>Precision Time protocol on an access point.</td>
<td>No</td>
</tr>
<tr>
<td>PTP VLAN tag</td>
<td>PTP VLAN identifier.</td>
<td>No</td>
</tr>
</tbody>
</table>

The columns that are updated during a partial write are highlighted when holding the pointer over the partial write button. The highlighted columns will be written to the IED but not synchronized towards SCL.

Changing an IED's IEC 61850 configuration from IEC 61850 edition 2 to IEC 61850 edition 1 will remove the Access points that are modelled in SCL except the default Access point and also if the redundancy is modelled then it will also be removed.

### Merging units

<table>
<thead>
<tr>
<th>Access points</th>
<th>Merging units</th>
<th>Routes</th>
</tr>
</thead>
<tbody>
<tr>
<td>MU</td>
<td>Name</td>
<td>AP connection</td>
</tr>
<tr>
<td>9201</td>
<td>MU1</td>
<td>AP1:Station bus</td>
</tr>
<tr>
<td>9202</td>
<td>MU2</td>
<td>None</td>
</tr>
<tr>
<td>9203</td>
<td>MU3</td>
<td>None</td>
</tr>
<tr>
<td>9204</td>
<td>MU4</td>
<td>None</td>
</tr>
</tbody>
</table>

![Figure 30: Merging units tab](IEC17000042-1-en.vsdx)

Access points should be configured before configuring merging units. This tab allows configuring of the reception of data from merging units. Each row in this tab corresponds to a merging unit. Changing settings in this tab will not have any impact on the SCL model. The IED can be configured to receive IEC 61850–9–2E sample value streams from merging units.

This tab's availability will be based on order-specification.
Migration of merging unit configuration from 650 2.0/2.1 to 2.2 series is not supported. From 650 2.2 series onwards, merging unit modules can be created/deleted from the merging unit tab of ECT, not from HWT.

Table 3: Merging units tab

<table>
<thead>
<tr>
<th>Column</th>
<th>Description</th>
<th>Read only</th>
</tr>
</thead>
<tbody>
<tr>
<td>MU</td>
<td>Merging unit instance.</td>
<td>Yes</td>
</tr>
<tr>
<td>Name</td>
<td>Name of the merging unit.</td>
<td>No</td>
</tr>
<tr>
<td>AP connection</td>
<td>Associates Merging unit with the access point. This column shows the access points that are available.</td>
<td>No</td>
</tr>
<tr>
<td>Sample value ID</td>
<td>Sample value ID of the stream.</td>
<td>No</td>
</tr>
</tbody>
</table>

Changing this setting may have impact on Application Configuration. When saving the ECT configuration after associating a merging unit to an access point creates the merging unit reception module in the background and removing association removes the merging unit reception module. These modules will appear in the plant structure in HW configuration section and will be available in ACT and SMT.

The combination of associating merging units to access points mentioned below is invalid.

For Merging units 9201 to 9204, if any four of the merging units are associated to one access point and the remaining merging units are assigned to different access points it will become an invalid configuration.

Figure 31: Example of invalid configuration
Routes

This tab allows configuration of the routing of data packets. Each row in this tab corresponds to a Route. Changing settings in this tab will not have any impact on the SCL model.

Table 4: Routes tab

<table>
<thead>
<tr>
<th>Column</th>
<th>Description</th>
<th>Read only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route</td>
<td>Route instance.</td>
<td>Yes</td>
</tr>
<tr>
<td>Name</td>
<td>Name of the route.</td>
<td>No</td>
</tr>
<tr>
<td>Operation</td>
<td>Enable/disable the route operation.</td>
<td>No</td>
</tr>
<tr>
<td>Gateway IP address</td>
<td>Gateway IP address of the route.</td>
<td>No</td>
</tr>
<tr>
<td>Destination IP address</td>
<td>Destination IP address of the route.</td>
<td>No</td>
</tr>
<tr>
<td>Destination subnet mask</td>
<td>Destination subnetwork mask of the route.</td>
<td>No</td>
</tr>
</tbody>
</table>

For routing, Gateway IP address should be within the subnetwork of the access point.

5.2 Starting the Ethernet configuration tool

The tool can be started the from the IED level in the Plant Structure window in PCM600.

1. Right click on the IED.
2. Select Ethernet configuration from the menu.
Section 6  Protection and control engineering

6.1  Creating an application configuration with ACT

6.1.1  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:

• Control related functions
• Monitoring functions
• Communication

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

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
Figure 33: Examples of function blocks with and without monitoring and commands

1 Function blocks without communication
2 Function blocks with communication only
3 Function blocks with monitoring and commands

LN The logical node of the function block

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.

6.1.2 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 34 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 34: 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

6.1.3 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. Similar, the output signal can only be inverted if a glue logic function block with higher execution order in the same cycle time is available. Up to two input signals and two output signals can be inverted for glue logic blocks in the same cycle time.

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

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

### 6.1.4 Conditional blocking functionality

Functions can be blocked by loss of analog data, for example if a IEC/UCA 61850-9-2LE source malfunctions. Figure 35 shows an example where MU1 malfunctions, and all function blocks connected to that 3-phase group get blocked as a result, this is also known as conditional blocking functionality.

![Diagram of function blocking](IEC6000049-2-en.vsdx)

Figure 35: An example of function blocking

### 6.1.5 Function block execution parameters

Three function block execution parameters have influence on the runtime execution of the function block within the application configuration.

- Execution Order
- Cycle Time
- Instance Number
Each time a new function block is selected, 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 36 shows an example how the drop down list could look like.

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 different values for certain functions. Depending on the function block and IED type, one or more possibilities may be available.

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 different classes, see Figure 37.

---

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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 38.

Figure 38: Cycle time and execution order
A function block type can be defined to be a member of one or several cycle times. A function block instance can be set only to one cycle time.

Figure 39: ACT: Concept of Execution order sequence
In the conceptual MainApplication example in Figure 39, 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.

6.1.6 Configuration parameters
6.1.7 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 40.

![Connection validation](IEC08000304-2-en.vsd)

*Figure 40: ACT: Warning message by signal mismatch for a connection*

6.1.8 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 41. 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

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 41.
6.1.9 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.
These warnings can be accepted to avoid checking the warnings every time the application is validated.

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 42.

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 42: 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.

6.2 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 write from PCM600 to the IED, where parameters are changed in PST, will overwrite any parameter changes made locally from LHMI unless a read from the IED was performed prior to changing any parameters in PCM600.

To export parameters from PST, both XRO 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 take immediate effect when changed.

Setting group
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 write both the basic and advanced settings are written to the IED.

6.2.1 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>Parameter Description</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under impedance protection for generators and transformers</td>
<td>ZGTPDIS</td>
</tr>
<tr>
<td>Distance protection, quadrilateral characteristic</td>
<td>ZRPDIS</td>
</tr>
<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>ZMCPDIS, ZMCAPDIS</td>
</tr>
<tr>
<td>Fullscheme distance protection, mho characteristic</td>
<td>ZMHPDIS</td>
</tr>
<tr>
<td>Fullscheme distance protection, quadrilateral for earth faults</td>
<td>ZMPDIS, 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>ZMFPDIS</td>
</tr>
<tr>
<td>High speed distance protection for series compensated lines, quadrilateral and mho</td>
<td>ZMFCPDIS</td>
</tr>
<tr>
<td>Directional impedance element for mho characteristic</td>
<td>ZDMRDIR</td>
</tr>
<tr>
<td>Directional impedance quadrilateral</td>
<td>ZRDWM</td>
</tr>
<tr>
<td>Directional impedance quadrilateral, including series compensation</td>
<td>ZDSRDWM</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>FDPSBD</td>
</tr>
<tr>
<td>Phase selection, quadrilateral characteristic with settable angle</td>
<td>FRPSBD</td>
</tr>
<tr>
<td>Faulty phase identification with load encroachment</td>
<td>FMPSPD</td>
</tr>
</tbody>
</table>

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For more information on GPST, see the online help for PCM600.

6.3 Connecting signals in SMT

SMT is used to connect the application to I/O, binary, and GOOSE, see Figure 43:

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

Figure 43: SMT: Operation principles

A binary input channel can be connected to one or several function block inputs, see Figure 44. If several binary inputs are connected to the same function block in SMT, the connection will appear as glue logic in SMT and ACT.

Figure 44: SMT Connection between binary input channels to binary input signals

A function block output can be connected to one or several binary output channels, see Figure 45. 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.

Figure 45: Binary output channel connection
Connections made in SMT are automatically shown in ACT and vice versa.

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

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

The possible sheets are:

- Binary Inputs
- Binary Outputs
- GOOSE Receive
Section 7  Local HMI engineering

7.1  LED and function key engineering

7.1.1  Local HMI engineering process

Figure 46 shows the different steps of the engineering process of the local HMI (LHMI) and their relative order.

Figure 46: LHMI: Engineering process flowchart

- Application Configuration tool with possible assistance of Signal Matrix tool
  - To use the function keys and LEDs on LHMI it is 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 47 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 LEDs and the corresponding text elements on the LCD [B].
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.
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 programed to process demands.
The function block handles the operators command when the key is pressed as output signal.
The functions are activated whenever a key is pressed 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</th>
<th>FNKEYMD 1: 1</th>
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</thead>
<tbody>
<tr>
<td>Node</td>
<td>Off</td>
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<td>PulseTime</td>
<td>Off</td>
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<tr>
<td>LabelOn</td>
<td>Toggle</td>
</tr>
<tr>
<td>LabelOff</td>
<td>LCD_FN1_OFF</td>
</tr>
</tbody>
</table>

Figure 48: LHMI: Function key operation mode

The LEDs have a number of different operation modes, see Figure 49:

- 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>
<thead>
<tr>
<th>LED:</th>
<th>Alarm group 1</th>
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<tr>
<td>GRP1_LED1</td>
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</table>

<table>
<thead>
<tr>
<th>Sequence Type</th>
<th>Follow-S</th>
<th>Follow-F</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>LabelDiff</th>
<th>18 character(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LabelRed</td>
<td>LatchedAck-F-S</td>
</tr>
<tr>
<td>LabelYellow</td>
<td>LatchedColl-S</td>
</tr>
<tr>
<td>LabelGreen</td>
<td>GRP1_LED2: 1</td>
</tr>
</tbody>
</table>

Figure 49: LHMI: LED operation mode
### 7.1.2 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

![Follow-S Diagram](IEC08000395.vsd)

*Figure 50: 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 50* for details.

#### LED operation mode Follow-F

![Follow-F Diagram](IEC08000396.vsd)

*Figure 51: 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 51*. 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 52 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 53 and Figure 54 for these two principles.
Figure 54: LHMI LED operation mode LatchedAck-F-S Prio / 2

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 55 for details.
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 56.

![Figure 56: LHMI: LED operation mode LatchedReset-S](IEC08000400.vsd)

Figure 57: LHMI LED operation mode LatchedReset-S / 2
7.2 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.

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

Additional concept information to use GDE, see Figure 58:

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

![Figure 58: GDE: Screen image with active GDE](image)

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 59
• Select Button is used when the functions shall be manoeuvred from a single line diagram.

Figure 59: GDE: Dynamic Text symbols

The standard (IEC or ANSI) for the symbols and the selection of the font size for the text elements can be changed using the 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 60.

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.
7.2.2 Supported single-line diagram symbols

Table 5: 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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<td>Junction</td>
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<td>Busbar junction</td>
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<td>Current transformer</td>
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<td>Measuring transformers</td>
<td>Voltage transf. 2 windings</td>
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<td>Transformer 3 windings</td>
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Table continues on next page
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<thead>
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<th>Category</th>
<th>IEC Symbol Name</th>
<th>IEC Symbol Definitions</th>
<th>ANSI Y32.2/IEEE 315 Symbol Definitions</th>
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<td>SCSWI, VSGAPC</td>
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<td>Isolator, 11 = Undefined</td>
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<td>Switchgear</td>
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<td>SCSWI, SXSWI, DPGAPC, VSGAPC</td>
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</tr>
<tr>
<td>Switchgear</td>
<td>Breaker indication only, 00 = Middle position</td>
<td></td>
<td></td>
<td>SCSWI, SXCBR, DPGAPC, VSGAPC</td>
</tr>
<tr>
<td></td>
<td>Breaker indication only, 01 = Open</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Breaker indication only, 10 = Closed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Breaker indication only, 11 = Undefined</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table continues on next page
<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>
</tr>
</thead>
<tbody>
<tr>
<td>Switchgear</td>
<td><strong>Truck breaker, 00 = Middle position</strong></td>
<td><img src="image1" alt="Symbol" /></td>
<td><img src="image2" alt="Symbol" /></td>
<td>SXSWI, SXCBR</td>
</tr>
<tr>
<td></td>
<td><strong>Truck breaker, 01 = Open</strong></td>
<td><img src="image3" alt="Symbol" /></td>
<td><img src="image4" alt="Symbol" /></td>
<td>SXSWI, SXCBR</td>
</tr>
<tr>
<td></td>
<td><strong>Truck breaker, 10 = Closed</strong></td>
<td><img src="image5" alt="Symbol" /></td>
<td><img src="image6" alt="Symbol" /></td>
<td>SXSWI, SXCBR</td>
</tr>
<tr>
<td></td>
<td><strong>Truck breaker, 11 = Undefined</strong></td>
<td><img src="image7" alt="Symbol" /></td>
<td><img src="image8" alt="Symbol" /></td>
<td>SXSWI, SXCBR</td>
</tr>
<tr>
<td>Switchgear</td>
<td><strong>Isolator2, 00 = Middle position</strong></td>
<td><img src="image9" alt="Symbol" /></td>
<td><img src="image10" alt="Symbol" /></td>
<td>SXSWI, VSGAPC</td>
</tr>
<tr>
<td></td>
<td><strong>Isolator2, 01 = Open</strong></td>
<td><img src="image11" alt="Symbol" /></td>
<td><img src="image12" alt="Symbol" /></td>
<td>SXSWI, VSGAPC</td>
</tr>
<tr>
<td></td>
<td><strong>Isolator2, 10 = Closed</strong></td>
<td><img src="image13" alt="Symbol" /></td>
<td><img src="image14" alt="Symbol" /></td>
<td>SXSWI, VSGAPC</td>
</tr>
<tr>
<td></td>
<td><strong>Isolator2, 11 = Undefined</strong></td>
<td><img src="image15" alt="Symbol" /></td>
<td><img src="image16" alt="Symbol" /></td>
<td>SXSWI, VSGAPC</td>
</tr>
<tr>
<td>Switchgear</td>
<td><strong>Isolator2 indication only, 00 = Middle position</strong></td>
<td><img src="image17" alt="Symbol" /></td>
<td><img src="image18" alt="Symbol" /></td>
<td>SXSWI, SXSWI, DPGAPC, VSGAPC</td>
</tr>
<tr>
<td></td>
<td><strong>Isolator2 indication only, 01 = Open</strong></td>
<td><img src="image19" alt="Symbol" /></td>
<td><img src="image20" alt="Symbol" /></td>
<td>SXSWI, SXSWI, DPGAPC, VSGAPC</td>
</tr>
<tr>
<td></td>
<td><strong>Isolator2 indication only, 10 = Closed</strong></td>
<td><img src="image21" alt="Symbol" /></td>
<td><img src="image22" alt="Symbol" /></td>
<td>SXSWI, SXSWI, DPGAPC, VSGAPC</td>
</tr>
<tr>
<td></td>
<td><strong>Isolator2 indication only, 11 = Undefined</strong></td>
<td><img src="image23" alt="Symbol" /></td>
<td><img src="image24" alt="Symbol" /></td>
<td>SXSWI, SXSWI, DPGAPC, VSGAPC</td>
</tr>
<tr>
<td>Switchgear</td>
<td><strong>Breaker2, 00 = Middle position</strong></td>
<td><img src="image25" alt="Symbol" /></td>
<td><img src="image26" alt="Symbol" /></td>
<td>SXSWI, VSGAPC</td>
</tr>
<tr>
<td></td>
<td><strong>Breaker2, 01 = Open</strong></td>
<td><img src="image27" alt="Symbol" /></td>
<td><img src="image28" alt="Symbol" /></td>
<td>SXSWI, VSGAPC</td>
</tr>
<tr>
<td></td>
<td><strong>Breaker2, 10 = Closed</strong></td>
<td><img src="image29" alt="Symbol" /></td>
<td><img src="image30" alt="Symbol" /></td>
<td>SXSWI, VSGAPC</td>
</tr>
<tr>
<td></td>
<td><strong>Breaker2, 11 = Undefined</strong></td>
<td><img src="image31" alt="Symbol" /></td>
<td><img src="image32" alt="Symbol" /></td>
<td>SXSWI, VSGAPC</td>
</tr>
<tr>
<td>Switchgear</td>
<td><strong>Breaker2 indication only, 00 = Middle position</strong></td>
<td><img src="image33" alt="Symbol" /></td>
<td><img src="image34" alt="Symbol" /></td>
<td>SXSWI, SXCBR, DPGAPC, VSGAPC</td>
</tr>
<tr>
<td></td>
<td><strong>Breaker2 indication only, 01 = Open</strong></td>
<td><img src="image35" alt="Symbol" /></td>
<td><img src="image36" alt="Symbol" /></td>
<td>SXSWI, SXCBR, DPGAPC, VSGAPC</td>
</tr>
<tr>
<td></td>
<td><strong>Breaker2 indication only, 10 = Closed</strong></td>
<td><img src="image37" alt="Symbol" /></td>
<td><img src="image38" alt="Symbol" /></td>
<td>SXSWI, SXCBR, DPGAPC, VSGAPC</td>
</tr>
<tr>
<td></td>
<td><strong>Breaker2 indication only, 11 = Undefined</strong></td>
<td><img src="image39" alt="Symbol" /></td>
<td><img src="image40" alt="Symbol" /></td>
<td>SXSWI, SXCBR, DPGAPC, VSGAPC</td>
</tr>
</tbody>
</table>

Table continues on next page
<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>
</tr>
</thead>
<tbody>
<tr>
<td>Switchgear</td>
<td>Disconnector circuit breaker, 00 = Middle position</td>
<td></td>
<td></td>
<td>SCSWI, VSGAPC</td>
</tr>
<tr>
<td></td>
<td>Disconnector circuit breaker, 01 = Open</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Disconnector circuit breaker, 10 = Closed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Disconnector circuit breaker, 11 = Undefined</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switchgear</td>
<td>Disconnector circuit breaker indication only, 00 = Middle position</td>
<td></td>
<td></td>
<td>SCSWI, SXCBR, VSGAPC</td>
</tr>
<tr>
<td></td>
<td>Disconnector circuit breaker indication only, 01 = Open</td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Disconnector circuit breaker indication only, 10 = Closed</td>
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<tr>
<td></td>
<td>Disconnector circuit breaker indication only, 11 = Undefined</td>
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<td></td>
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<tr>
<td>Texts</td>
<td>Static text</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dynamic text</td>
<td></td>
<td></td>
<td>VSGAPC</td>
</tr>
<tr>
<td>Texts</td>
<td>Select button, 00 = Middle position</td>
<td></td>
<td></td>
<td>VSGAPC</td>
</tr>
<tr>
<td></td>
<td>Select button, 01 = Open</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Select button, 10 = Closed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Select button, 11 = Undefined</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Texts</td>
<td>Indication button, 00 = Middle position</td>
<td></td>
<td></td>
<td>VSGAPC</td>
</tr>
<tr>
<td></td>
<td>Indication button, 01 = Open</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Indication button, 10 = Closed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Indication button, 11 = Undefined</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Texts</td>
<td>Dynamic text (32 inputs)</td>
<td></td>
<td></td>
<td>SLGAPC</td>
</tr>
<tr>
<td>Texts</td>
<td>Select button (32 positions), 1 - 32</td>
<td></td>
<td></td>
<td>SLGAPC</td>
</tr>
<tr>
<td>Texts</td>
<td>Indication button (32 positions), 1 - 32</td>
<td></td>
<td></td>
<td>SLGAPC</td>
</tr>
</tbody>
</table>
7.2.3 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 61.
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.

![Diagram](image.png)

Figure 61: GDE: Establish a dynamic object link

Linking process objects

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

Three tools are involved for the described steps:

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

The following application function blocks are used to deliver the needed information:
- Switch controller (of type CSWI) for an apparatus.
- All configured function blocks with measurements (of type MMXU) for the measurements.
- 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 62.
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.

![Image of GDE: Input signal selection](IEC08000125-2-en.vsd)

**Figure 62: GDE: Input signal selection**

The number of order in the selection window of the process objects corresponds to the number given in the PST tree and to the application function block in ACT.

Only those apparatus and measurements are shown that are configured in the application configuration program.
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 64) 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 $180/\pi = 57.3$ shall be used to display the angle in degrees.

7.3 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 8  IEC 61850 communication engineering

8.1  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.

8.1.1  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.

8.1.2  Access points

An access point is an Ethernet communication interface for single or redundant station communication. Each access point is allocated with one physical Ethernet port, two physical Ethernet ports are allocated if redundant communication is activated for the access point.

![Access points, non redundant (left) and redundant communication (right)](image)

The IEC/UCA 61850-9-2LE process bus communication protocol enables an IED to communicate with devices providing measured values in digital format, commonly known as Merging Units (MU). The rear access points are used for the communication.

The merging units (MU) are called so because they can gather analog values from one or more measuring transformers, sample the data and send the data over process bus to other clients (or subscribers) in the system. Some merging units are able to get data from classical measuring transformers, others from non-conventional measuring transducers and yet others can pick up data from both types.

8.1.3  IEC 61850 interface in IED

See Figure 66 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 ACT, PCM600 automatically generates the corresponding logical node data. In Figure 66 this is shown by two parts per function block. The upper part is the visible function block in ACT Application Configuration tool and the lower part is the logical node data for the function block.

Horizontal data communication between IEDs is illustrated in Figure 67.

Figure 66: IEC 61850: Communication interface principle
8.1.3.1 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) in SMT.

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

8.1.4 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.

<table>
<thead>
<tr>
<th>SCL files</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICD = IED Capability Description</td>
<td>Capability description of the IED in logical nodes and their data. No station specific information e.g. about communication configuration is included. In an exported .icd file the IED name is always TEMPLATE.</td>
</tr>
<tr>
<td>SCD = Station Configuration Description</td>
<td>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.</td>
</tr>
<tr>
<td>CID = Configured IED Description</td>
<td>The CID file contains the information needed to configure just one specific IED.</td>
</tr>
</tbody>
</table>

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

8.2 IEC 61850 engineering procedure

8.2.1 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.

8.2.2 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 Integrated Engineering Tool (IET600) is used as system configuration tool.

A short form of a typical sequence is shown in Figure 69 when a complete station is exported as a SCD file.

1. Export SCL files from PCM600. In the scenario in Figure 69 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 69 it is the updated SCD file.

**Figure 69: IEC 61850: Signal engineering procedure flow**

### 8.3 Exporting SCL files from PCM600

The pre-condition for exporting SCL files from PCM600 is that all 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 IEC 61850-8-1 setting Operation must be set to On.

#### 8.3.1 Exporting SCD files

Procedure for exporting SCD files from PCM600:

1. Select the sub-station in the plant structure (see Figure 70).
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 71).

5. Select the data to be exported and the version of the IEC 61850 standard.

   PWC600 1.0 only supports IEC 61850 Edition 1.

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

8.3.2 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 72):
   • 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 73).
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 73**: IEC 61850: Export IED file Options

PWC600 1.0 only supports IEC 61850 Edition 1.

### 8.4 Easy GOOSE engineering in the application configuration tool

Easy GOOSE engineering enables configuration of GOOSE communication between two or more IEDs in a single tool, the application configuration tool (ACT). GOOSE datasets and GOOSE control blocks are created automatically when the configuration is done in ACT. Easy GOOSE engineering does not replace GOOSE engineering in the Signal Matrix Tool (SMT) or the IEC 61850 Engineering tool.

Easy GOOSE Engineering is supported for both IEC 61850 Edition 1 and IEC 61850 Edition 2 configured IEDs.
8.4.1 User interface

Connect to GOOSE dialog window

Select Sender IEDs
The Select sender IEDs list displays all IEDs in the PCM600 plant structure. The following IEDs will be grayed out in the list:
- The IEDs that do not support Easy GOOSE.
- The IEDs that do not belong to Receiver IED’s subnetwork

Recently Used IEDs
The Recently Used IEDs list displays the last three GOOSE subscribed IEDs in the PCM600 plant structure.

Sender IEDs
The Sender IEDs list displays all selected sender IEDs compatible data attributes that can be received for the selected receiving signal.
- Application Configuration: Application configuration tab displays all selected sender IEDs data attributes for signals that are visible in Application Configuration.
Figure 75: Application configuration tab in Connect to GOOSE dialog window

- **SCL Configuration**: SCL Configuration tab displays all selected sender IEDs IEC 61850 data attributes for signals that are not visible in Application Configuration.
In the Application Configuration tab, the Main Application, function block, signal, data attribute and IED name is considered in the filtering.

In the SCL Configuration tab, the logical device, logical node, data object and data attribute is considered in the filtering.

**Extended Mode**

Extended Mode is used to create multiple GOOSE connections without selecting an input signal in Application Configuration. For detailed information about Extended Mode functionality, see Section "Connect to GOOSE dialog window user interface – Extended Mode".

**Select GOOSE Block and Signal dialog window**

This dialog window will provide a list of compatible GOOSE Receive function blocks and corresponding GOOSE input signals.
Figure 77: ACT: Select GOOSE Block and Signal

GOOSE Receive Blocks In Configuration

The GOOSE Receive Blocks in Configuration displays list of compatible GOOSE Receive function blocks which are already in the configuration.

New GOOSE Receive Blocks

The New GOOSE Receive Blocks displays list of compatible GOOSE Receive function blocks and corresponding GOOSE input signals which can be added to the configuration.

Search

Function block name and signal name are considered as filtering.

Extended mode

In the “Connect to GOOSE” dialog window, Extended Mode is selected to create multiple GOOSE connections directly without selecting an input signal in the Application Configuration.
Figure 78: ACT: Connect to GOOSE dialog window with Extended Mode

Receiver IED

Receiver IED list displays the Receiver IED Main Application, function block and signal data. Connection can be made at signal level and one connection per signal.

Search

Main Application name, function block name and signal name are considered as filtering.

8.4.2 Enable Easy GOOSE Engineering in PCM600

1. Select Tools/Options
2. In Options/Application Configuration, open the “Configuration” tab
3. Under the “GOOSE configuration” section, check “Allow configuring GOOSE in Application Configuration”.
4. Click “OK” to exit.
The “IEC 61850 configuration engineering mode enabled” option under Tools/Options/IEC 61850 Configuration/Engineering tab has to be checked to get the option above enabled.

8.4.3 Making GOOSE connections in the application configuration tool

GOOSE connections via Easy GOOSE can be created in two ways:

- via GOOSE receive functions
- via normal function blocks.

8.4.3.1 Create GOOSE connections via GOOSE receive functions

1. Select and right click on the input signal of the GOOSE Receive function, point to “Connect” and select the “GOOSE” option.
2. Under Select sender IEDs section, check sender IEDs that can be received on receiver signal.

3. Under Sender IEDs section, select needed data attribute in Application configuration tab (see Figure 75) and click on the “Connect” button. GOOSE connection will be added as shown in the Figure 81 below.

4. If SCL configuration data attributes needs to be connected, the needed data attribute shall be selected in the SCL configuration tab (see Figure 76). Click on the “Connect” button.
   For more information on SCL configuration data attributes, see Section “User interface”.
   In this case, the GOOSE connection will be added as shown in Figure 82 below.
8.4.3.2 Create GOOSE connections via normal function blocks

1. Select and right click on the input signal of a normal function block, point to “Connect” and select the “GOOSE” option.

2. Under Sender IEDs section, select needed data attribute in the Application configuration tab.

3. Click on the “Connect” button. The “Select GOOSE Block and Signal” dialog window opens. For detailed information about the “Select GOOSE Block and Signal” dialog refer to Section "User interface".

4. In the “Select GOOSE Block and Signal” dialog window, select needed GOOSE Input signal from either “GOOSE Receive Blocks In Configuration” or “New GOOSE Receive Blocks” section.

5. Click on the “Connect” button, the GOOSE connection will be added to the configuration as shown in Figure 84 below.
6. If SCL configuration data attributes needs to be connected the needed data attributes needs to be selected in the SCL configuration tab (See Figure 76).

   6.1. Click on the “Connect” button.
   6.2. Select the needed GOOSE input signal in the “Select GOOSE Block and Signal” dialog window.
   6.3. Click on the Connect button.

   In this case, GOOSE connection will be added as shown in Figure 85 below.

   **Figure 85:** ACT: GOOSE configuration on Receiver IED (left) and Sender IED (right) side

   Creation of GOOSE connections via normal function blocks is not supported for the GOOSEINTLKRCV function.

### 8.4.3.3 Connect to GOOSE dialog window user interface – Extended Mode

In the “Connect to GOOSE” dialog window, “Extended Mode” is selected to create multiple GOOSE connections directly without selecting an input signal in the Application Configuration.

1. Under “Receiver IED” section, select GOOSE Receive or normal function input signal.
2. Under “Sender IEDs” section, select and right click on data attribute in either Application Configuration or SCL Configuration tab
3. Click on Connect option.
The GOOSE connections will be added to the configuration. Refer to Figure 75, 76, 82 and 83 for GOOSE connections appearance in ACT.

8.4.3.4 Connecting to a IEC 61850 SCL data attribute from sending IED

When a GOOSE connection is created by selecting data attribute under "SCL Configuration" tab in the Connect to GOOSE dialog window (see Figure 76), a separate MainApp called GOOSESenderApp is created automatically and added to application configuration in the sender IED side. GOOSESenderApp contains the graphical representation of the IEC 61850 SCL data attributes for signals that are not visible in Application Configuration.

![GOOSESenderApp](IEC16000169-1-en.vsdx)

**Figure 86: ACT: GOOSESenderApp**

- GOOSE datasets and GOOSE control blocks are created automatically when the GOOSE configuration is done in ACT.
- If the sender IED and receiver IEDs do not belong to same subnetworks, GOOSE receiving is not possible.
- GOOSESenderApp MainApp cannot be copied or deleted in the Application Configuration.

8.4.3.5 Easy GOOSE engineering when GOOSE is configured via IEC 61850 configuration protocol

After enabling Easy GOOSE Engineering in PCM600 (see section "Enable Easy GOOSE Engineering in PCM600"), GOOSE can be configured either via the IEC 61850 configuration tool and the Signal matrix tool or via Easy GOOSE. When GOOSE is configured via the IEC 61850 configuration tool and Signal matrix tool, the GOOSE configuration is also added to the application configuration in the sender IED and the receiver IED as shown in Figure 81, 82, 84, and 85.

- When Easy GOOSE engineering is enabled in PCM600, GOOSE can be still be configured via IEC 61850 configuration tool and Signal Matrix Tool as well.
8.4.4 Deleting connections

The following connections cannot be deleted in ACT:

- GOOSE sending variable
- Link between the GOOSE sending variable and signal
- Function block to which the GOOSE sending variable is connected
- MainApp/Page containing the GOOSE sending variable.

8.4.5 Cut-Paste and Copy-Paste of ACT GOOSE variables

The GOOSE variables alone cannot be pasted. They can be cut or pasted only with the connected block.

Copying and pasting of GOOSE variables within the same IED is not allowed. If the GOOSE variable is copied along with the connected block, only the block is copied provided that the instance is available.

GOOSE variables and worksheets can be copied and pasted into other IEDs. However, the GOOSE sending variables are not copied. The receiving GOOSE variables are copied unless they are already present in the other IED.

8.4.6 GOOSE Online Monitoring

Click Work online on the toolbar in ACT for Online Monitoring for the GOOSE sending signals and receiving signals. The sending or receiving GOOSE variable shows the value being sent or received over GOOSE.

8.5 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 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. 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.

8.6 Importing SCL files to PCM600

PCM600 is able to import SCD, ICD and CID files.
8.6.1 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 87):

![SCL Import Options window](image)

**Figure 87: 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 ... 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.
8.6.2 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 88):
   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 88: IEC 61850: SCL Import option](image)

8.7 Writing IEC 61850 communication configuration to an IED

After changing any aspect of IEC 61850 communication the updated configuration needs to be written to the IED. This is done through a full Write to IED... from the context menu or the Tools menu.

During the write process, 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 89: Update communication configuration window in PCM600
Section 9  IEC 60870-5-103 communication engineering

9.1  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.

9.1.1  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 additionally 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/IEC60870-5-103/
   •  <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 90: 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 10  DNP3 communication engineering

10.1  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.

10.2  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.
10.3 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 96 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 96.

**Figure 96: CMT: Container window design when selecting DNP3 protocol**

Procedure to move signals:

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

2. Press the blue arrow button to insert the selected signals into the configuration.
3. Press the green double arrow button to insert all signals into the configuration, see Figure 97.

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 98. The star indicates that changes in the container have to be saved before leaving CMT.

**Figure 97: CMT: Move buttons**

**Figure 98: CMT: Marker to indicate changes in the container**
10.4 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 99.

2. The selection window shows the number of signals selected, see Figure 100.

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 101.
10.4.1 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 11 Flexible product naming

11.1 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.

11.1.1 User interface

![Mapping Tool Diagram]

Figure 102: 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.

11.1.2 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.

11.2 Importing the System Configuration Description file

Before starting the IEC 61850 Structure Mapping Tool, enable the option Import as Flexible Product Naming SCD.

System Configuration Description (SCD) file can only be imported only at the substation level.

1. Right click on a substation level.
2. Select and click Import from the Menu.
3. Browse and select the SCD file.
4. Click Open to open the file.
The imported SCD file will replace the Internal IED from original substation structure and push it to unassigned IEDs folder.

![Diagram showing Plant Structure with Flexible product naming and Substation nodes]

**Figure 105: Unassigned IEDs**

Importing the FPN SCD file will convert the project into a FPN project and the conversion is irreversible.

FPN projects does not support Easy Goose Engineering.

### 11.3 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.
11.4 IEC 61850 Structure Mapping

11.4.1 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.

11.4.1.1 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 structure. 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.

11.4.1.2 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.

Figure 107: Mapping of IEDs in IEC 61850 structure mapping tool

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

Figure 108: 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.

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 109: 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.

![Data Attribute List view](IEC17000026-1-en.vsdx)

Figure 110: Data Attribute List view

Filters

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

![Filters](IEC17000027-1-en.vsdx)

Figure 111: 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.

11.4.2 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.

### 11.4.2.1 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 112: Data attribute level mapping*

### 11.4.2.2 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.
### 11.4.2.3 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.

### 11.4.2.4 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.

### 11.5 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.

![Figure 116: Setting the data attribute value](IEC15000132.vsdx)

Value cannot be set for all types of data attributes, for example, quality and timestamp values cannot be edited.

### 11.6 Validation

Once the FPN mapping is complete, all mapping can be validated in three ways using the validate option available in quick access menu

1. Validate All
2. Validate Current
3. Validate Selected

![Figure 117: Validate mapping](IEC17000029-1-en.vsdx)
11.7 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.

11.7.1 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.

11.7.2 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.

11.7.3 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.

11.8 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 6: Table 3. IED mappings.

<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>IEDType</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 7: 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>
### Section 12  Glossary

#### 12.1 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>CMPPS</td>
<td>Combined megapulses per second</td>
</tr>
<tr>
<td><strong>Abbreviation</strong></td>
<td><strong>Definition</strong></td>
</tr>
<tr>
<td>------------------</td>
<td>----------------</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>EMC</td>
<td>Electromagnetic compatibility</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</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>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>IDBS</td>
<td>Integrating deadband supervision</td>
</tr>
<tr>
<td>IEC</td>
<td>International Electrical Committee</td>
</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/slave protocol for point-to-point communication</td>
</tr>
<tr>
<td>IEC 61850</td>
<td>Substation automation communication standard</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
</tr>
<tr>
<td>----------</td>
<td>-------------</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>IEEE 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. Ingression protection, according to IEC 60529</td>
</tr>
<tr>
<td>IP 20</td>
<td>Ingression protection, according to IEC 60529, level 20</td>
</tr>
<tr>
<td>IP 40</td>
<td>Ingression protection, according to IEC 60529, level 40</td>
</tr>
<tr>
<td>IP 54</td>
<td>Ingression 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>
<tr>
<td>MCM</td>
<td>Mezzanine carrier module</td>
</tr>
<tr>
<td>MPM</td>
<td>Main processing module</td>
</tr>
<tr>
<td>MVAL</td>
<td>Value of measurement</td>
</tr>
<tr>
<td>MVB</td>
<td>Multifunction vehicle bus. Standardized serial bus originally developed for use in trains.</td>
</tr>
</tbody>
</table>
NCC  National Control Centre
NOF  Number of grid faults
NUM  Numerical module
OCO cycle  Open-close-open cycle
OCP  Overcurrent protection
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
RTC  Real-time clock
RTU  Remote terminal unit
SA  Substation Automation
SBO  Select-before-operate
SC  Switch or push button to close
SCL  Short circuit location
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<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>TNC connector</td>
<td>Threaded Neill-Concelman, a threaded constant impedance version of a BNC connector</td>
</tr>
<tr>
<td>TP</td>
<td>Trip (recorded fault)</td>
</tr>
<tr>
<td>TPZ, TPY, TPX, TPS</td>
<td>Current transformer class according to IEC</td>
</tr>
<tr>
<td>TRM</td>
<td>Transformer Module. This module transforms currents and voltages taken from the process into levels suitable for further signal processing.</td>
</tr>
</tbody>
</table>
**TYP**  Type identification

**UMT**  User management tool

**Underreach**  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.

**UTC**  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.

**UV**  Undervoltage

**WEI**  Weak end infeed logic

**VT**  Voltage transformer

**$3I_0$**  Three times zero-sequence current. Often referred to as the residual or the earth-fault current

**$3U_0$**  Three times the zero sequence voltage. Often referred to as the residual voltage or the neutral point voltage