RELION® 630 SERIES

Power Management PML630/Compact Load-Shedding Solution

Engineering Manual

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Table of contents

Section 1 Introduction

1.1 This manual

The engineering manual contains instructions to engineer the devices for the load-shedding power management functionality using PCM600. The manual provides instructions on how to set up a PCM600 project and insert devices to the project structure and also recommends a sequence for engineering of the devices' LHMI functions and IEC 61850 communication engineering.

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 good knowledge of the load-shedding functionality, protection and control equipment and the configured functional logic in the devices. The installation and commissioning personnel must have a basic knowledge of handling electronic equipment.

1.3 Product documentation

1.3.1 Product documentation set

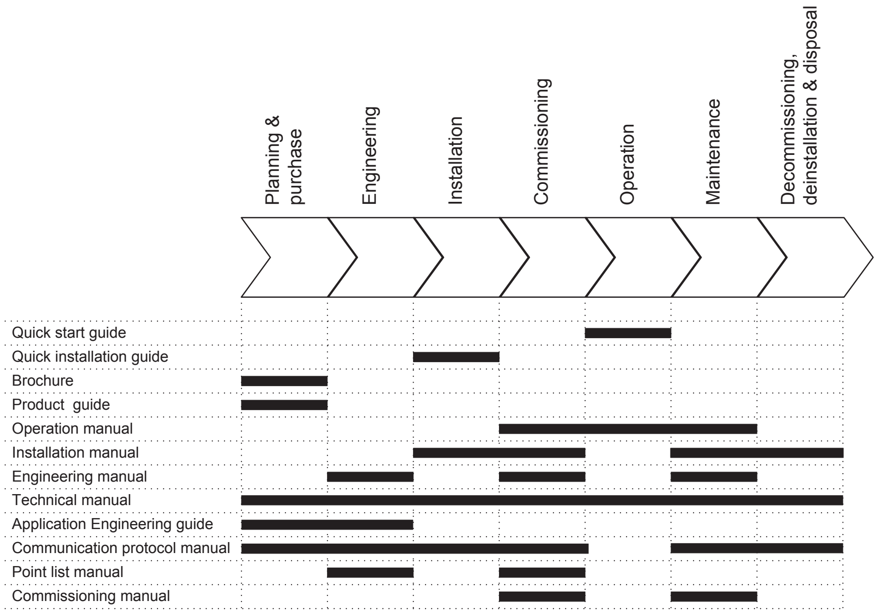


Figure 1: The intended use of documents during the product life cycle

See the 630 series documentation for installation and commissioning manuals. The PML630 documentation set includes only application engineering guide, engineering manual, IEC 61850 communication protocol manual, IEC 61850 point list manual, operation manual and technical manual.

1.3.2 Document revision history

Document revision/date	Product version	History
A/2011-05-04	1.1	First release
B/2011-11-03	1.1.1	Content updated to correspond to the product series version
C/2012-03-29	1.1.2	Content updated to correspond to the product series version
D/2013-10-14	1.2	Content updated to correspond to the product series version
E/2016-08-29	1.2.1	Content updated to correspond to the product series version
F/2019-08-12	1.2.1	Content updated

1.3.3 Related documentation

Name of the document	Document ID
Application Engineering Guide	1MRS757394
IEC 61850 Communication Protocol Manual	1MRS757260
IEC 61850 Point List Manual	1MRS757261
Operation Manual	1MRS757183
Technical Manual	1MRS757256

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

1.4 Symbols and conventions

1.4.1 Symbols

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

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

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

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

1.4.2 Document conventions

A particular convention may not be used in this manual.

- Abbreviations and acronyms are spelled out in the glossary. The glossary also contains definitions of important terms.
- Push button navigation in the LHMI menu structure is presented by using the push button icons.
  To navigate between the options, use  and .
- Menu paths are presented in bold.
  Select **Main menu/Settings**.
- WHMI menu names are presented in bold.
  Click **Information** in the WHMI menu structure.
- LHMI messages are shown in Courier font.
  To save the changes in nonvolatile memory, select `Yes` and press .
- Parameter names are shown in italics.
  The function can be enabled and disabled with the *Operation* setting.
- The ^ character in front of an input or output signal name in the function block symbol given for a function, indicates that the user can set an own signal name in PCM600.
- The * character after an input or output signal name in the function block symbol given for a function, indicates that the signal must be connected to another function block in the application configuration to achieve a valid application configuration.

1.4.3 Functions, codes and symbols

Table 1: Functions included in the device

Functionality	IEC 61850
Generic process I/O	
Single point control (8 signals)	SPC8GGIO[1)]
Double point indication	DPGGIO[1)]
Single point indication	SPGGIO[1)]
Generic measured value	MVGGIO[1)]
Event counter	CNTGGIO[1)]
Monitoring	
Measured value limit supervision	MVEXP[1)]
Station battery supervision	SPVNZBAT[1)]
Power management (load-shedding)	
Critical circuit breaker	NCBDCSWI
Contingency based load-shedding core function	LSCACLS
Busbar-wise sheddable loads data	LDMMXU
Busbar-wise load feeders load-shedding command	LSPTRC
Power source	PSCSWI
Subnetwork supervision	SNWRCLS
Network power source	NPMMXU
Table continues on next page	

Functionality	IEC 61850
Information exchange between peer PML630s	PPLSGGIO[2)]
Disturbance recorder functions	
Analog channels 1-10 (samples)	A1RADR
Analog channel 11-20 (samples)	A2RADR
Analog channel 21-30 (samples)	A3RADR[1)]
Analog channel 31-40 (calc. val.)	A4RADR[1)]
Binary channel 1-16	B1RBDR
Binary channel 17-32	B2RBDR
Binary channel 33-48	B3RBDR
Binary channel 49-64	B4RBDR[1)]
Disturbance recorder	DRRDRE
Multipurpose functions	
Position evaluate	POS_EVAL[1)]
Double point indication	DPGGIO[1)]
Multipurpose analog protection	MAPGAPC[1)]
Station communication (GOOSE)	
Binary receive	GOOSEBINRCV
Double point receive	GOOSEDPRCV
Integer receive	GOOSEINTRCV
Measured value receive	GOOSEMVRCV
Single point receive	GOOSESPRCV

1) The function is not used by default. However, it is kept enabled in the Application Configuration tool for instantiation in any additional logic other than features offered by the PML630 connectivity package.
2) The PPLSGGIO function block is instantiated only when the cPMS - LS Configuration B is selected in the configuration wizard of PML630.

Section 2 Engineering tool set

2.1 Introduction

The station automation system comprises of IEDs for various purposes. The system can be classified into the following categories:

- Bay level IEDs
  Feeder IEDs comprising protection, control, monitoring and metering IEDs
- Station level IEDs
  COM600 and PML630 power management load-shedding controller
- Station communication
  The station communication is based on IEC 61850 and thus, all IEDs interoperate/exchange data using the GOOSE and MMS communication profiles.

From the load-shedding functionality perspective, PML630 is a system level IED.

In the load-shedding solution context, COM600 is used as an HMI protocol gateway to external plant control systems.

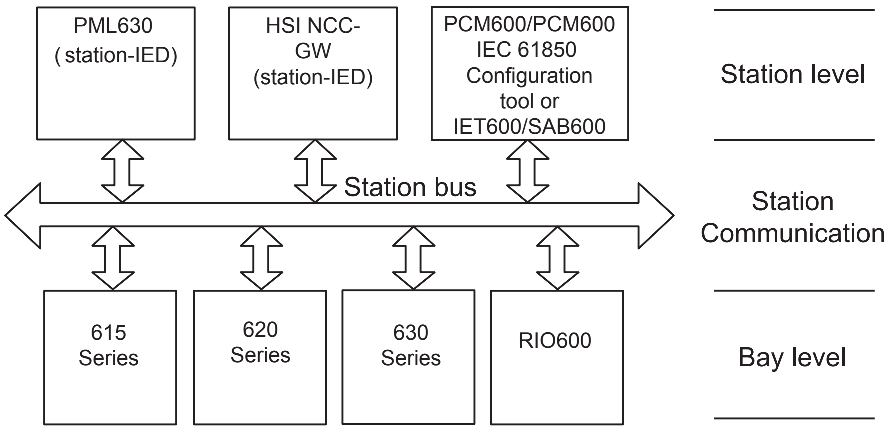


Figure 2: Common structure of a monitoring and control system for a substation

All three parts require specific engineering and configuration. PCM600 is used to perform engineering and configuration of bay level and station level IEDs. PCM600 version 2.5 (or later) supports IEC 61850 station level communication engineering. Alternatively, IET600 can also be used for station communication. COM600 is configured using SAB600.

Product type and version specific engineering data required by PCM600 to configure the load-shedding IED and feeder IEDs for power management, protection and control engineering are given in the respective IED connectivity packages.

PCM600 communicates with the IEDs via an Ethernet connection. The connection allows to read and write the configuration data needed for IED operation. The IEDs have communication interfaces for protocols and media used for station communication. Bay IED station communication files can be exported from PCM600 to IET600; these files are used for station communication between bay and station IEDs.

A PC with PCM600 can be connected to any IED within a substation using an Ethernet connection. Ethernet connection is used for service and maintenance purposes.

The modern-day IEDs are designed on the concept of the IEC 61850 standard. This is mainly given for the organization of functions represented by equivalent logical nodes in the IEC 61850 standard. See the IEC 61850 parameter list for the available logical nodes in the IED, following the structure and rules in part 7 of the IEC 61850 standard in an IED configuration.

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

The applications can be organized into groups.

- IED product engineering
- IED system monitoring
- IED product diagnostic

This manual is valid for PCM600 supporting the PML630 product.

2.2 IED engineering process

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

Though PML630 is a station level IED, it is represented as a bay level IED in PCM600.

- IED engineering management

- Organizing the IED in the structure of the substation by defining voltage levels and bays below the substation. A PCM600 project can have only one substation.
- Configuring the IED functions (for example load-shedding function and LHMI functions) using the Application Configuration tool.

Each network area supported with cPMS - LS Configuration B application has separate PCM600/IET600 and SAB600 projects. The station and project naming convention follow the naming of the respective electrical network or process area in their projects, for example, Electrical network area - 1.

The IED does not belong to a specific voltage level and bay, hence a generic naming convention can be used to represent the IED in PCM600, for example, voltage level can be named as PM (Power Management) and bay can be named as LS (Load-Shedding).

- Configuring the parameters and setting values for the IED itself and for the load-shedding functionality using the Parameter Setting tool.
- Extending the key load-shedding single-line diagram by adding additional elements and linking them to dynamic process values by using the Graphical Display Editor tool. The single-line diagrams are shown on the LHMI on the bay IED.

- Communication management
    - IEC 61850 station communication engineering using the IEC 61850 Configuration Engineering tool provided with the PCM600 version 2.5 or later or IET600. Preparing an IED for communication engineering using PCM600.
    - Organising GOOSE messages and configuring connections between the application configuration function blocks and incoming GOOSE inputs is done by using the Signal Matrix tool.
- Disturbance record management
    - Generating overviews about the available (disturbance) recordings in load-shedding IED by using the Disturbance Handling tool.
    - Manually reading the recording files (in COMTRADE format) from the load-shedding IED 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 post load-shedding analysis with the 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 and process events by using the Event Viewer tool.

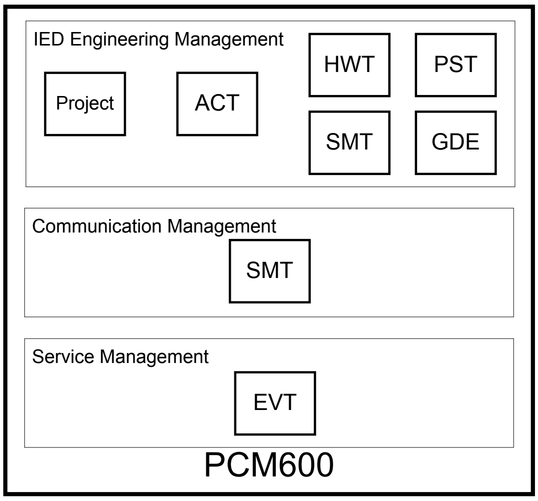


Figure 3: Organization of PCM600 in different management tasks

Additional functionality is provided 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.
  - This functionality defines the activities allowed 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.
  - Defining allowed activities for the user profiles to use the read and write function.

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

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

Section 3 Engineering process

PML630 load-shedding controller handles the load-shedding functionality depending on the size of substation or plant of an electrical network. An electrical network can be classified into various definitions.

- 6 generators/utility grid transformers
- 2 external network connectivity (tie line or grid transformers) and 6 bus bars
- 15 network breakers
- 60 load shed groups (10 loads/load groups per busbar)

The load-shedding function is handled by PML630 along with the supporting IEDs like Relion® 615, 620 or 630 series, RIO600 and COM600.

This is referred to as cPMS - LS Configuration A (for load-shedding power management function).

Multiple PML630 IEDs are needed to handle load-shedding for an extended network if the electrical network exceeds the defined size. In such cases, each network segment is assigned its own PML630 (and associated supporting IEDs) that is responsible for load-shedding functionality in that designated area.

In a network segment, PML630 exchanges information with the adjacent area's PML630 IED, related to its own area. This is to consider the overall power system data while doing load-shedding in its own area. Such a configuration is referred to as cPMS - LS Configuration B (for load-shedding power management function).

3.1 Workflow for cPMS - LS Configuration A

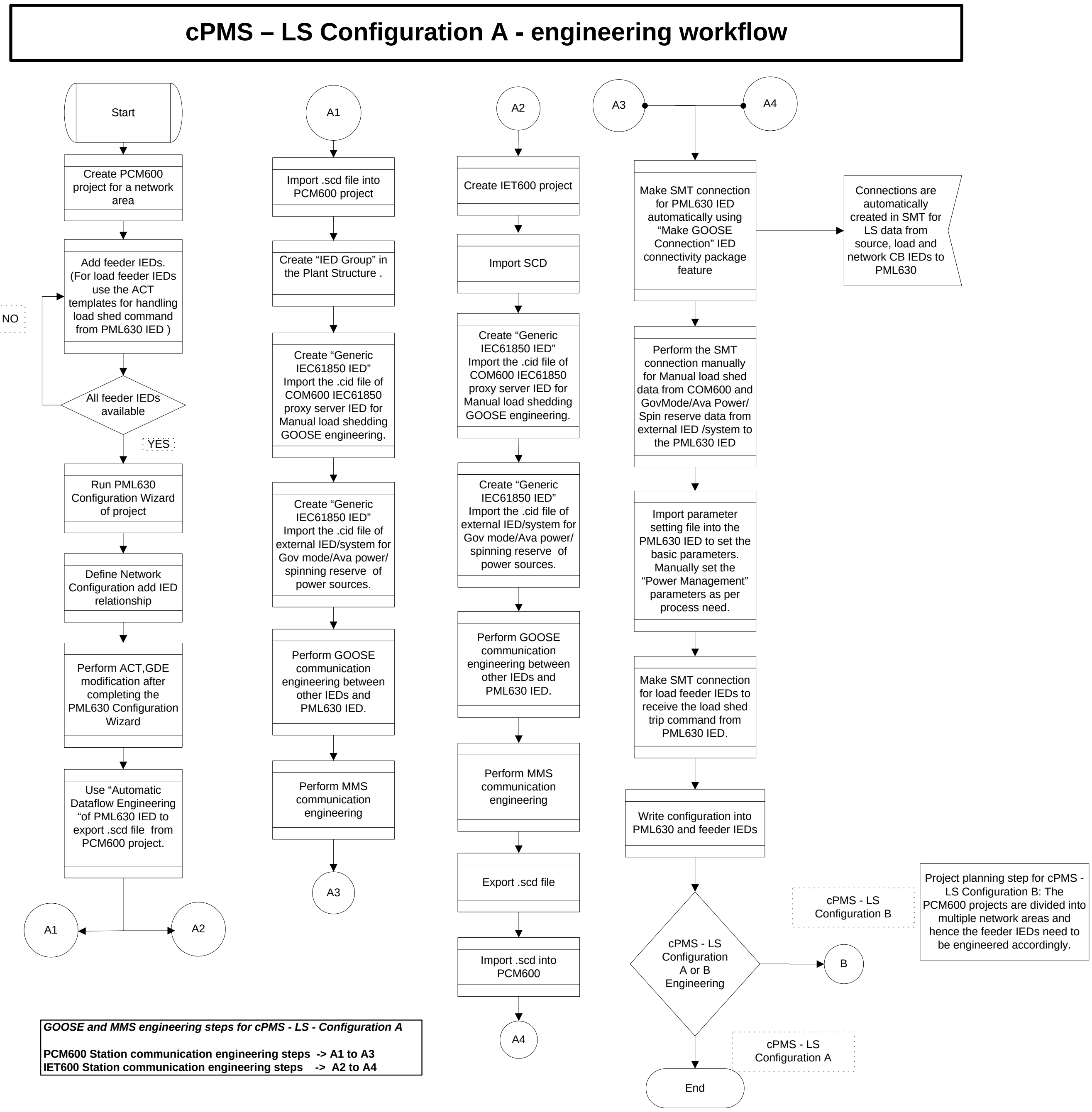


Figure 4: IED engineering workflow for cPMS - LS Configuration A

Governor mode and available power/spinning reserve for sources can be set as an IED parameter or can be configured as an incoming GOOSE information from an external IED/system. The external IED/

system can be added into IET600/PCM600 project and updated with their .cid files. Subscribe the IED to receive the data over GOOSE from the external IED/system.

Manual load-shedding is configured by defining the load priority or load power value to be shed for each subnetwork.
However, COM600 can send this data on GOOSE communication to the load-shedding IED. The IEC 61850 proxy server configuration engineering needs to be done in SAB600 and download the configuration to COM600. Once the configuration is complete follow the steps as mentioned below.

- Export the .cid file of COM600 IEC 61850 proxy server from the SAB600 project.
- Create a new IED in the IET600/PCM600 project.
- Update the IED with the .cid file.
- Subscribe the IED to receive the data over GOOSE from COM600.

See the SAB600 engineering procedure to configure GOOSE for the manual load-shedding feature.

3.2 Workflow for cPMS - LS Configuration B

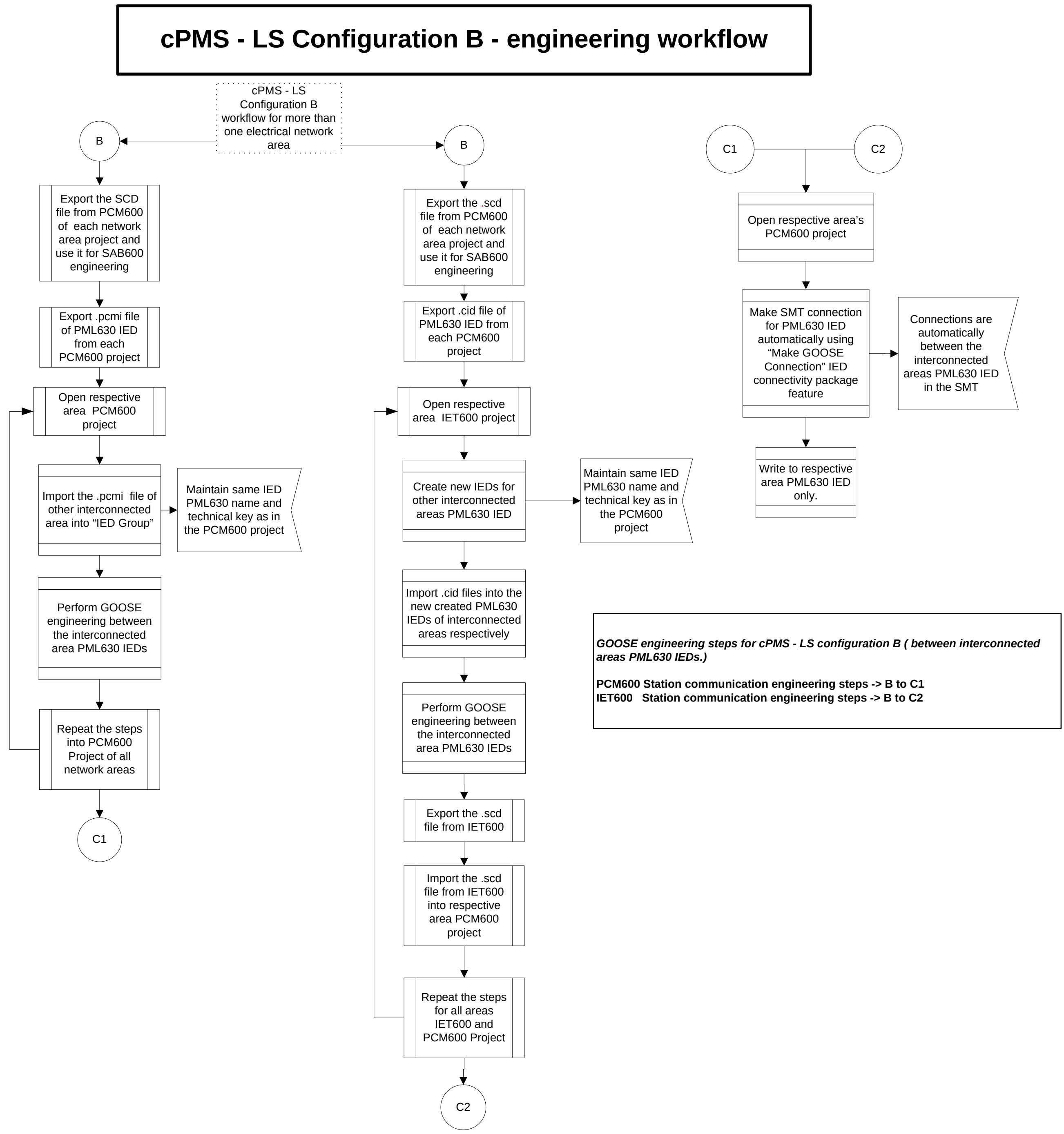


Figure 5: IED engineering workflow for cPMS - LS Configuration B

Engineering workflow for cPMS - LS Configuration A should be completed for each electrical network area before starting the engineering workflow for cPMS - LS Configuration B.

Each network area supported with cPMS - LS Configuration B application must have separate PCM600/IET600 and SAB600 projects.

Setting up the PCM600 project

- Build the plant structure according to the electrical network area/substation structure.

  See the PCM600 documentation for the recommended size of a project. Larger projects can be divided into several PCM600 projects.

- Protection and control engineering of all the feeder IEDs should be finished before the engineering for the load-shedding IED starts.
- The IED is created in online or offline mode. Follow the configuration wizard workflow and select the electrical network configuration, as per the single-line diagram. Complete the wizard with **Finish** button to create the IED instance.

Application configuration in the Application Configuration tool

- The application configuration is created automatically for the selected configuration. Check the Application Configuration tool (ACT) for the selected instances of functions.
- The configuration made in the Application Configuration tool is saved to make the interfaces and signals available for the engineering tools like the Parameter Setting tool within PCM600.

Parameter setting and configuration in the Parameter Setting tool

- Check the configuration parameters of the physical IED for communication channels.
- The Parameter Setting tool (PST) changes the setting values for power management function according to the project configuration.
- Once the configuration wizard is finished, import the parameter setting file, provided with IED connectivity package, to set the IED basic parameters for event configuration, LHMI function keys usage and disturbance recorder settings.

Single-line diagram configuration in the Graphical Display Editor

- The single-line diagram is created in the Graphical Display Editor (GDE) automatically, when the configuration wizard is completed. Rearrange the components, if required, to match the system representation.

Local HMI engineering

- The function key and LED behaviour is defined with the Parameter Setting tool.
- The function keys and LEDs are defined with the Application Configuration tool.
    - Once the configuration wizard is complete and the IED is instantiated, the function key, event on LHMI of the IED, disturbance recorder and LEDs configuration is done automatically. Necessary function blocks are a part of the **PML630LSAddlogicConfigA** and **PML630LSAddlogicConfigB** ACT pages. The parameter setting file provided with connectivity package should be imported manually to configure the parameters of these function blocks.

Communication protocol engineering

- A station Configuration tool, for example, IET600, is used for horizontal and vertical communication.
- PCM600 Version 2.5 or later supports the IEC 61850 Configuration tool that can also be used for horizontal and vertical communication.

For configuring the horizontal and vertical communication, see the IEC 61850 communication engineering chapter.

The IED restarts automatically for the changes to take effect after changing the parameters marked with! (on LHMI), IEC 61850 data model and user management settings.

Section 4 Setting up a project

4.1 PCM600 operates on 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 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. A connectivity package is managed in a separate tool called Update Manager.

PCM600 must be installed before installing the connectivity packages.

A connectivity package for a specific IED type and version is available as an installable file.

4.2.1 Installing connectivity packages

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

Download connectivity packages from the ABB Web site http://www.abb.com/substationautomation or directly with Update Manager in PCM600.

4.2.1.1 Installing connectivity packages by using the connectivity package installer

1. Close PCM600.
2. Run the **ABB IED Connectivity Package PML630 Ver. n.msi** installer.
   (n = version number)
3. To install the connectivity package, follow the steps in the connectivity package installation wizard.

4.2.1.2 Installing connectivity packages by using the Update Manager

1. In PCM600, click **Help** and select **Update Manager**.
2. Select **Show All Available Updates** from the drop-down list in the top left corner.
3. Browse for the required connectivity package.
4. Click **Download**.
5. Click **Install** when the download is complete and follow the steps in the installation wizard.

4.2.2 Activating installed connectivity packages

Activate the appropriate connectivity package in Update Manager after the installation. Update Manager shows the IEDs that are compatible with the installed PCM600 version.

1. Open **Update Manager** from the **Start** menu.
2. Select the **ABB IED Connectivity Package PML630 Ver. n** (*n* = version number).
   It is recommended to always use the latest version of the connectivity package.
   Activate the ABB IED Connectivity Package

Figure 6: Activating the connectivity package

PCM600 recognizes the installed connectivity package(s) during start-up and the corresponding IED types are available in PCM600 when starting a new project.

4.3 Setting up communication between PCM600 and the IED

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

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

Each IED has an Ethernet interface connector on the front and on the rear side. Both Ethernet connectors can 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.

For the connection of PCM600 to the IED, two basic variants have to be considered.

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

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

The communication procedures are the same in both cases.

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

Setting up IP addresses

The IP address and the corresponding mask can be set via the LHMI for each available Ethernet interface in the IED. Each Ethernet interface has a default factory IP address when the complete IED is delivered.

- The default IP address for the IED front port is 192.168.0.254 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/Front port**.
- The default IP address for the IED rear port is 192.168.2.10 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/LAN1**.

The front and rear port IP addresses cannot belong to the same subnet or communication will fail. It is recommended to change the IP address of the front port if the front and rear port are set to the same subnet.

Setting up the point-to-point access to IEDs front port

The IED front port is a standard Ethernet interface with DHCP server functionality. When a PC is connected to the front port, the DHCP server automatically assigns the IP address from the same subnetwork.

See the operating system manual for details on how to obtain the IP address automatically.

1. Connect the PC network adapter to the IED front port.
2. Wait until the operating system automatically acquires the network address.
3. Check that the front port connector green status LED is lit.
4. Ping the IED to verify that the connection is correctly established. The default IP address of the front port is 192.168.0.254.

Use Ethernet crossover cables only for point-to-point connections. Modern network adapters contain logic for automatic detection if they are connected directly to another network adapter using a regular Ethernet cable.

Setting up the PC to access the IED via a network

This task depends on the used LAN/WAN network. The PC and the IED must belong to the same subnetwork.

For cPMS - LS configurations A and B, the subnet mask of all IEDs, COM600 and PCM600/SAB600 engineering PC can be set as 255.255.255.0.
For example, for electrical network area 1 network setup, all devices' IP addresses can be set as 192.168.1.x series.
For example, for electrical network area 2 network setup, all devices' IP addresses can be set as 192.168.2.x series.
The purpose is to avoid the IP address conflict between the devices located in different electrical network areas.

4.4 Project management in PCM600

Many project management operations are possible in PCM600.

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

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

4.4.1 Creating a new project

1. On the **File** menu, select **Open/Manage Project** to see the projects that are currently available in the PCMDataBases.
2. Open **Projects on my computer**.
3. Click the icon **New Project**.
   To create a new project, currently open projects and object tools shall be closed.
   The **New Project window** opens.

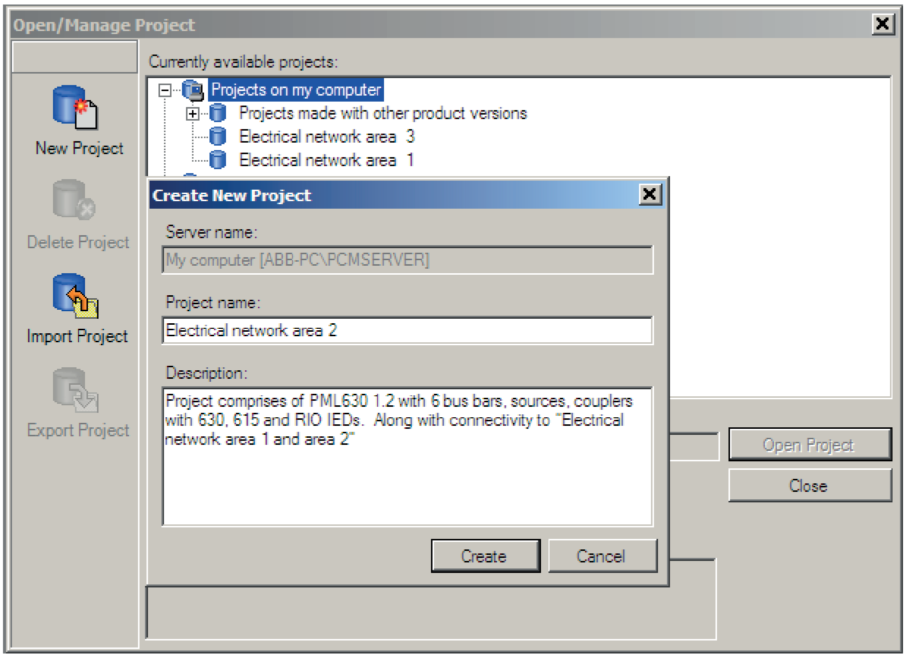


Figure 7: Create New Project window

4. Name the project and include a description (optional) and click **Create**. PCM600 sets up a new project that is listed under **Projects on my computer**.

4.5 Building a plant structure

The plant structure is used to identify the location of the IED within the substation. 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 IED identification.

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

1. Level 1 = Project name
2. Level 2 = Name of the electrical network segment/area or process area
3. Level 3 = Voltage level, identifies the grid type or part in the substation the IED belongs to
4. Level 4 = Bay level, the bay within the specified voltage level
5. Level 5 = IED instance, selection of the IED which is used in the bay. Several IEDs are possible within a bay, for example, one control IED and two protection IEDs.

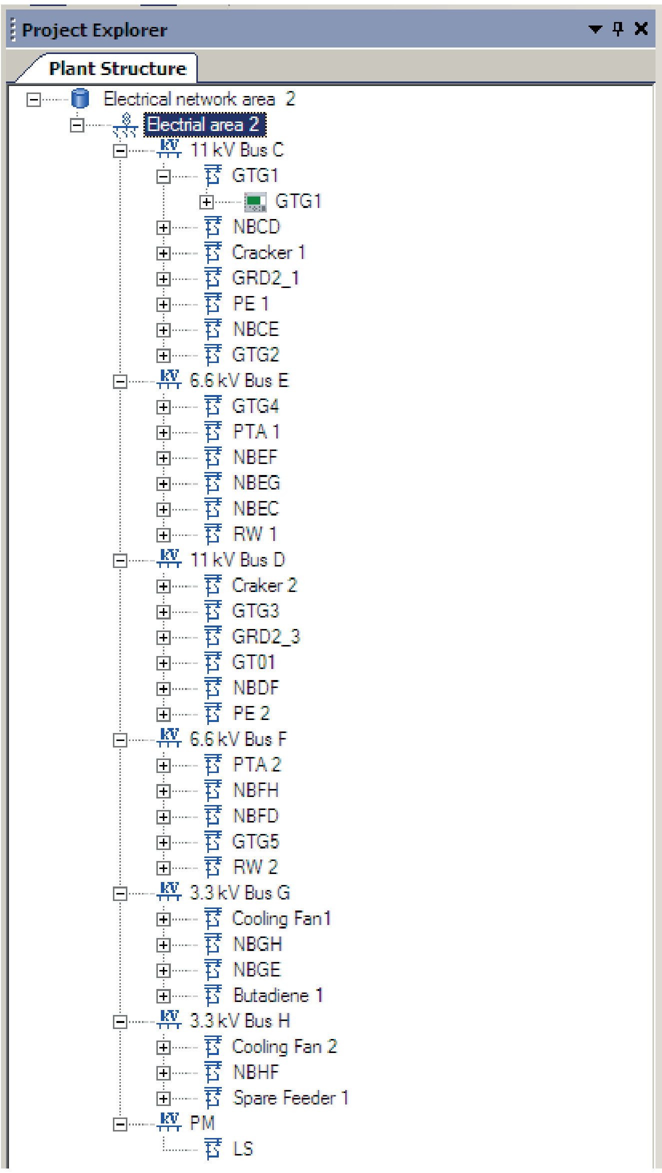


Figure 8: PCM600: Set up a plant structure

Level 2 is optional, all other levels are mandatory to identify an IED.

Once a plant structure is built, the identification should be renamed by the names/identifications used in the project/substation. Use the right mouse button to build the plant structure and to rename the elements, by selecting the elements from the context menu. Rename the level after insertion using the **Rename** possibility or the **Object Properties** window.

1. Create a new plant structure in one of the alternative ways.

- Right-click in **Plant Structure** and then select **New/Create from Template**.
- Right-click in **Plant Structure** and then select **New/General** and select one of the elements **IED Group** or **Substation**.

2. On the menu bar, click **View** and then select **Object Types**. Select the needed elements and drag them to **Plant Structure**. Close the window if it does not close automatically.

4.5.1 Creating IED object in PCM600

The IED object is created in an existing project in PCM600 using **Substation/Voltage Level/Bay**

.

Though the IED functions as a station level device, it is instantiated under the bay level in PCM600. The feeder IEDs must be configured before configuring the IED.

1. Right-click the **Bay** node in **Plant Structure**.
2. Select **New/Power Management IEDs/PML630**.

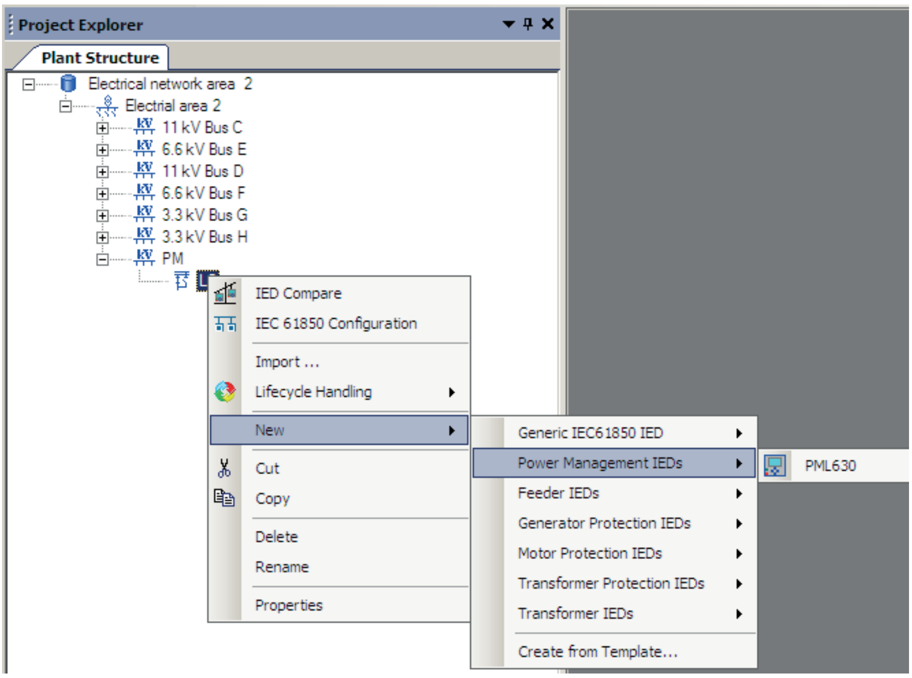


Figure 9: Menu navigation for the IED object creation

3. Click the **PML630** IED.
   PML630 Configuration Wizard opens.

4. Select **Online Configuration** and click **Next**.

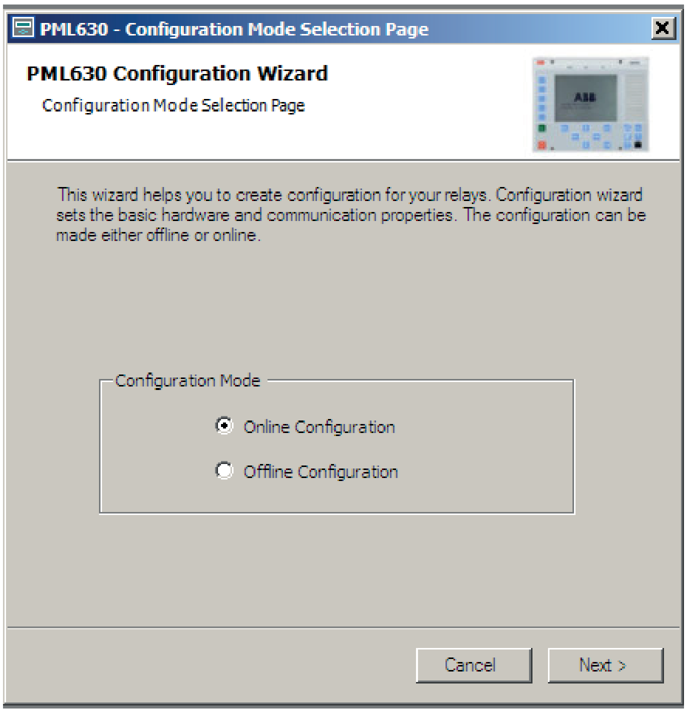


Figure 10: Configuration Mode Selection page

5. Click **Next** in the **Communication protocol selection page** window.

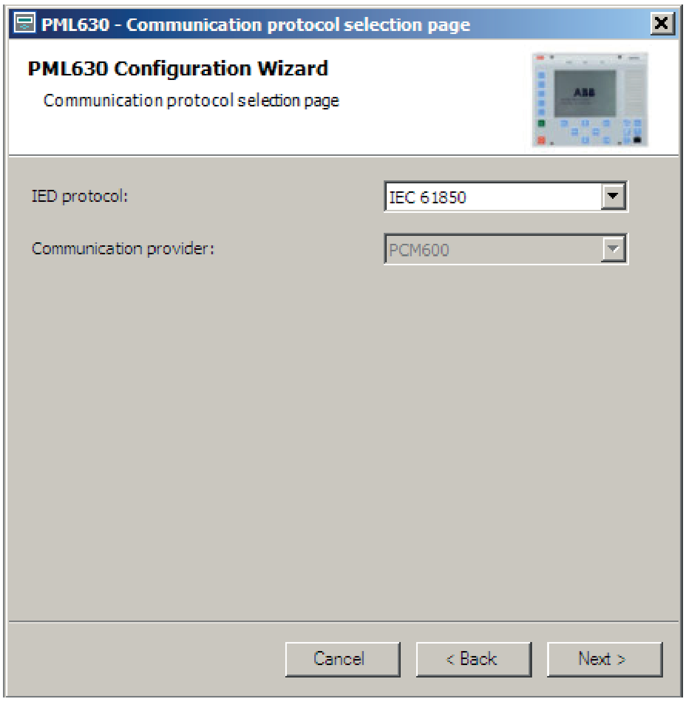


Figure 11: Communication protocol selection page

6. Select the port access as **Front Port** for the front port or **LAN** for the back port.

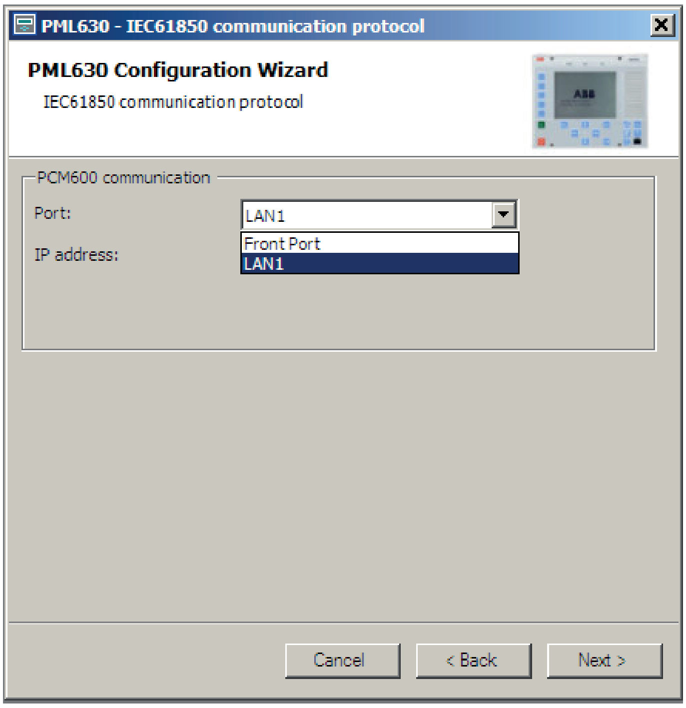


Figure 12: Port selection

7. Enter the IP address and click **Next** in the **IEC 61850 communication protocol** window.

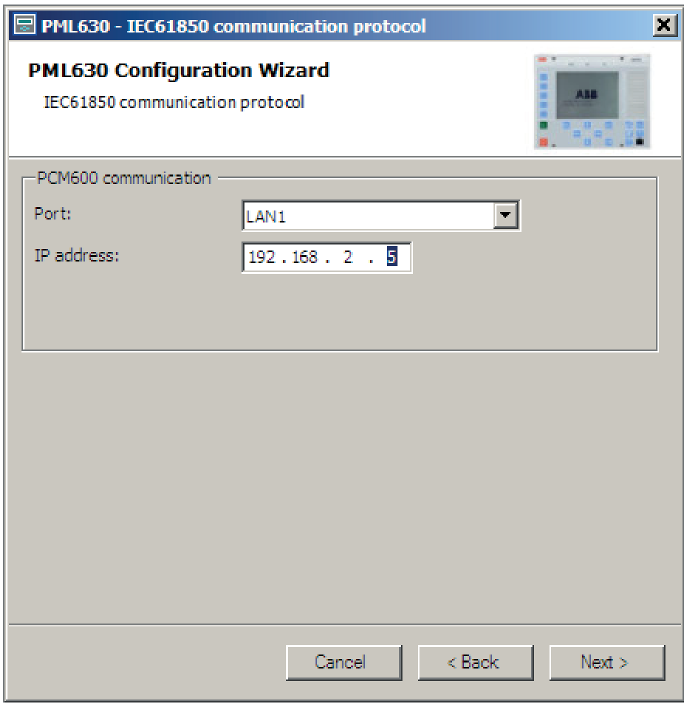


Figure 13: IP address selection for the IED

8. Click **Scan** and then click **Next** in the **Version Selection Page** window.

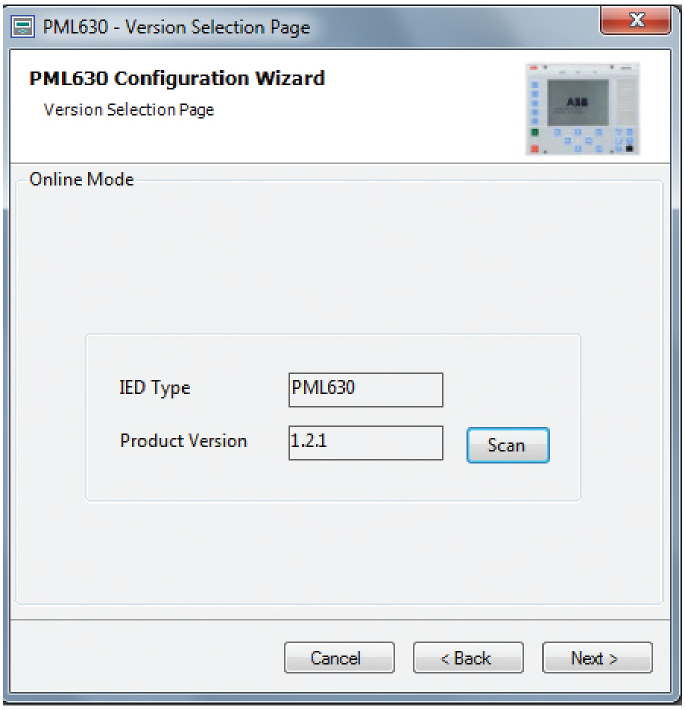


Figure 14: Version Selection Page

9. In **Order Code Detection Page**, click **Scan** and verify that the order code detected by the Configuration Wizard corresponds to the actual hardware configuration of the IED and click **Next**.

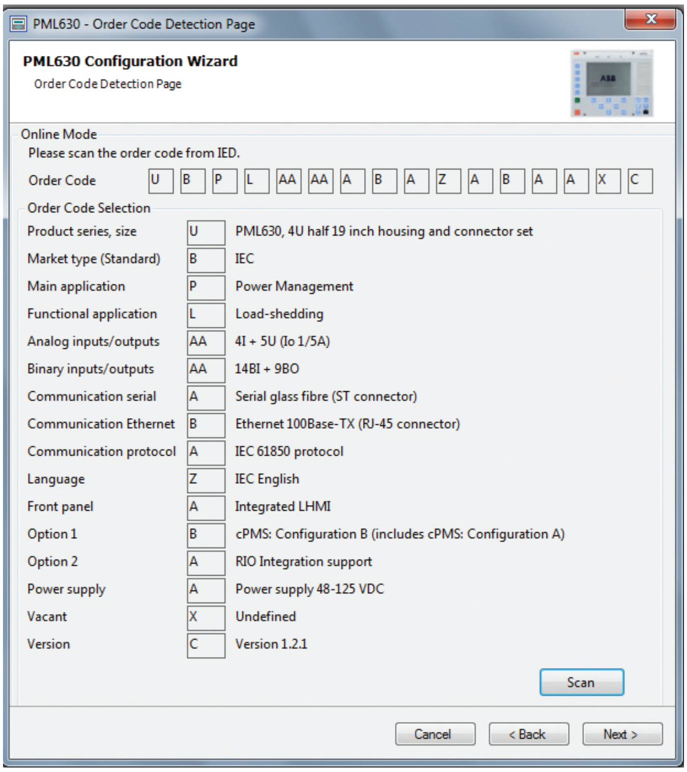


Figure 15: Order Code Detection Page

4.5.2 Defining the load-shedding network

The IED object is created in an existing project in PCM600 using **Substation/Voltage Level/Bay**. Define the load-shedding network on the tabbed pages of the configuration wizard.

4.5.2.1 Selecting the load-shed configuration

1. In PML630 Configuration Wizard, click the **Select Network** tab.
2. Select the required load shed configuration.

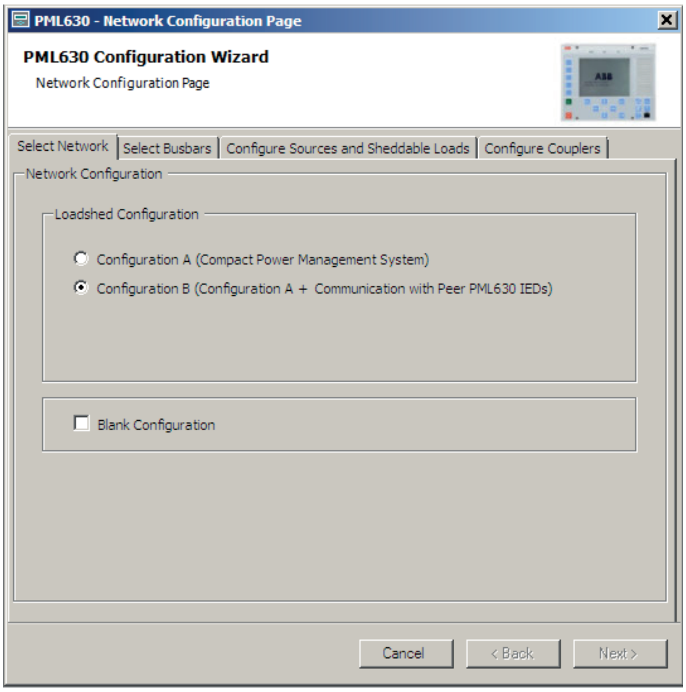


Figure 16: Network configuration selection

Based on the order code of the IED, the configuration option is enabled in the **Network Configuration** page in the wizard.

If **Option 1 – A** (cPMS - LS Configuration A) is defined in the **Order Code Detection Page**, only configuration A is enabled for selection in the **Network Configuration Page**.

If **Option 1 – B** (cPMS - LS Configuration B; includes cPMS-LS Configuration A) is defined in the **Order Code Detection Page**, both configurations A and B are enabled for selection in the **Network Configuration Page**.

If **Option 2 - A** (RIO integration support) is defined in the **Order Code Detection Page**, the **Configuration wizard** allows to select the feeder IEDs supported with RIO600 IED types for load-shedding application, else RIO600 IED's selection is disabled in the **Configuration Wizard**.

Based on the selection in the further Configuration Wizard, necessary function blocks are instantiated in the Application Configuration tool.

4.5.2.2 Adding busbars

The IED Connectivity Package supports three levels of busbars. Select the level based on the required project configuration.

1. In PML630 Configuration Wizard, click the **Select Busbars** tab.
2. Select the busbar from **List of Busbars** and click >>.
3. In the **Add Busbar** dialog box, select the busbar level and give the busbar name as required, and then click **Save.**

Select the busbar level to match the system representation.

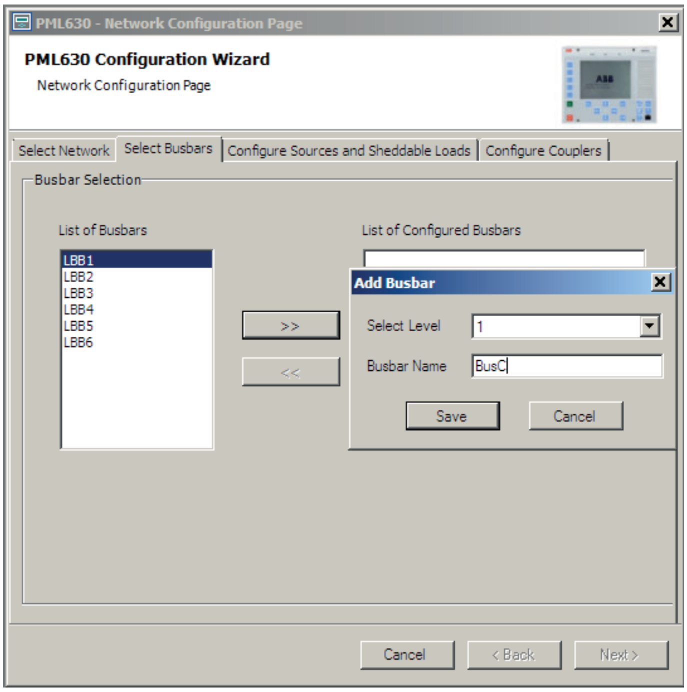


Figure 17: Network Configuration Page with the Select Busbars tab open

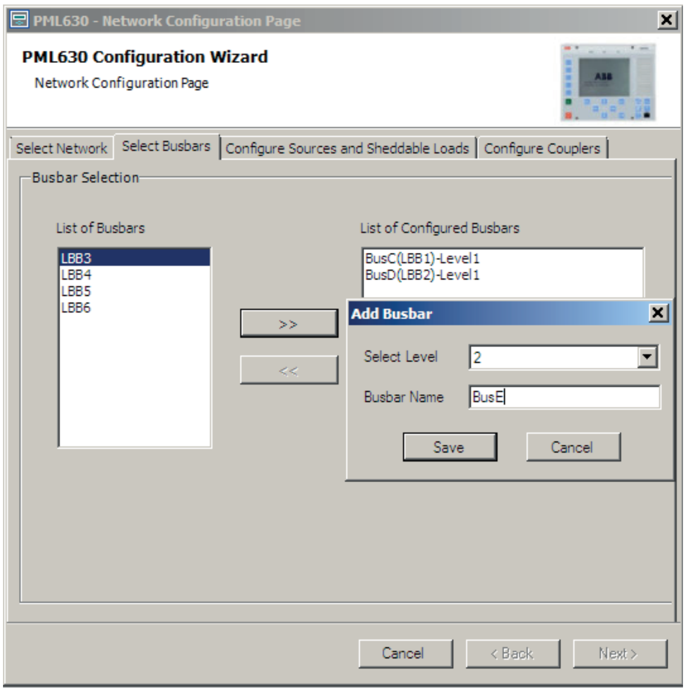


Figure 18: Select busbar level and name

Repeat the previous step for all the required busbars.

4.5.2.3 Adding power sources and sheddable loads

1. In PML630 Configuration Wizard, click the **Configure Source and Sheddable Load** tab.

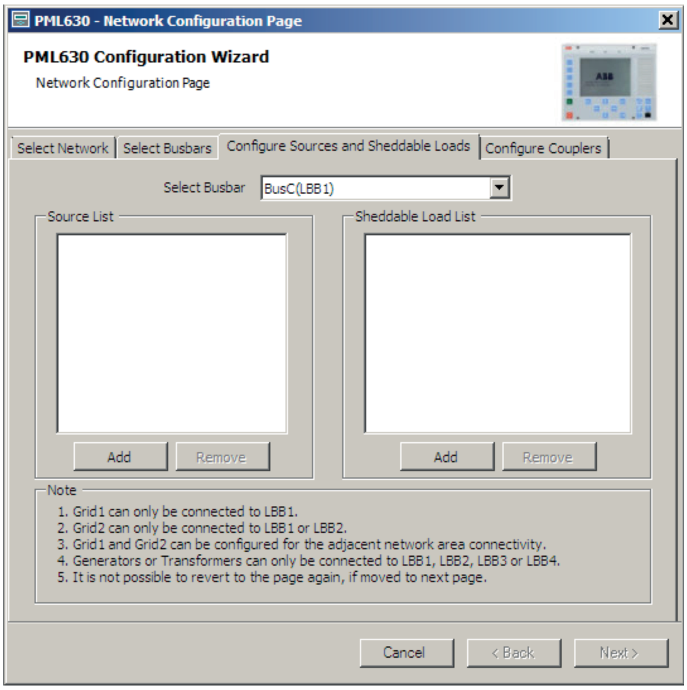


Figure 19: Network Configuration Page with the Configure Sources and Sheddable Loads tab open

2. Click **Add** below the **Source List** section to add a power source feeder.

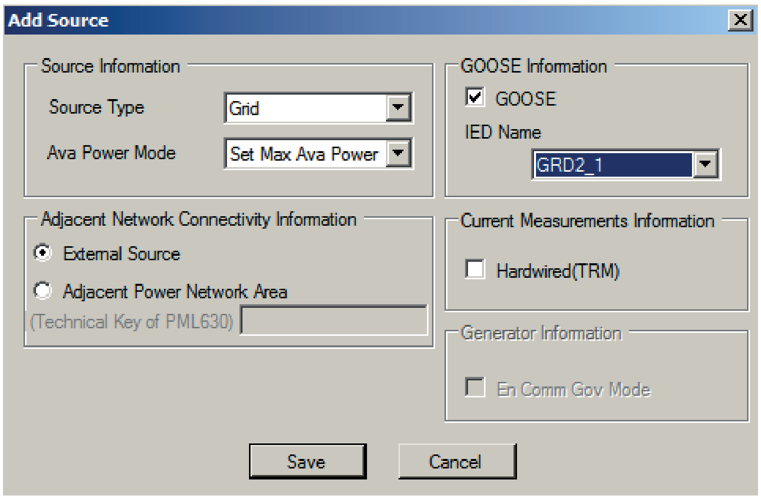


Figure 20: Add Source page

3. Select **GOOSE** to enable the **IED Name** box.
4. Select the **Source Type** in the **Source Information** section and the **IED Name** associated with the power source feeder.

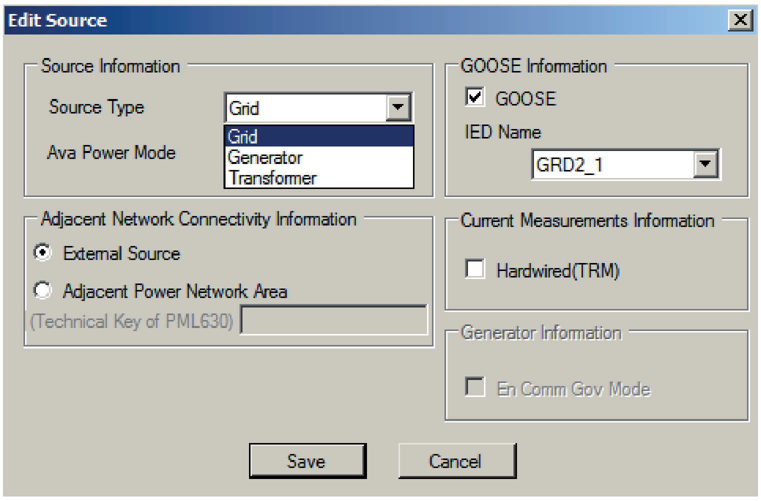


Figure 21: Selecting the source type

Three types (**Source Types**) of power source feeders can be configured.

- The **Grid** power source is the public utility grid tie-line or simply an external power source (which can also be a connection to an adjacent power network, that is, an inter-tie feeder).
  - First grid (Grid 1) power source type can be assigned to LBB1.
  - Second grid (Grid 2) power source type can be assigned to LBB1 or LBB2.
- The **Generator** power source type is a generator.
- The **Transformer** power source type is an external source or a public utility incoming grid transformer.

In cPMS - LS Configuration B, the **Adjacent Network Area** connectivity can be configured with **Source Type** as *Grid* only.

5. Set the available power and governor mode information for the power source feeder from PCM600/PST or accept it from an external IED/system.

   5.1. Select the source type **Generator**.

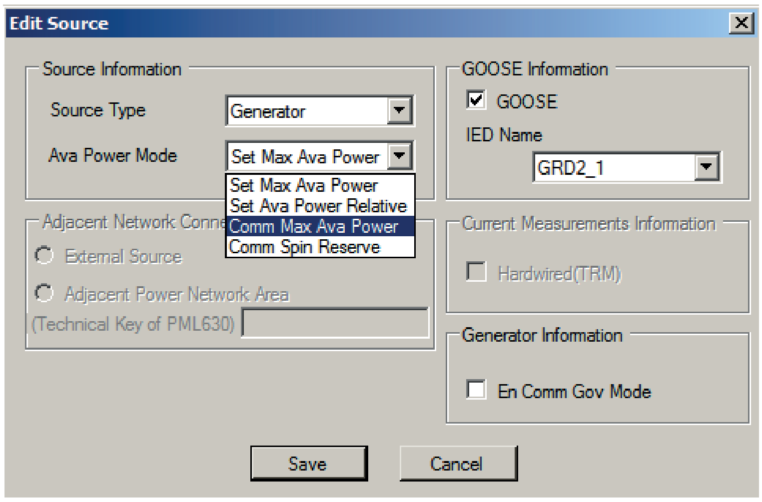


Figure 22: Available power mode selection and governor mode selection

If **Source Type** is **Generator**, it is possible to receive the governor mode information for communication from any external IED or system using GOOSE communication. To facilitate this, select **En Comm Gov Mode**.

Ava Power Mode selection has four options.

- **Set Max Ava Power**
  Maximum available power of the source is considered from the parameter setting in the IED.
- **Set Ava Pow Relative**
  Maximum available power of the source is considered as percentage of the active/running power, as set in the *Ava power relative* parameter setting in the IED.
- **Comm Max Ava Power**
  Maximum available power of the source is the GOOSE communication data from any other IED/ source external IED/system.
- **Comm Spin Reserve**
  Maximum available power of the source is the sum of active/running power of that source and spinning reserve GOOSE data external IED/ system.

The communication engineering and SMT connection for the communicated governor mode, **Comm Max Ava Power/Comm Spin Reserve** has to be done manually. This external IED/system should be configured as a generic IEC 61850 IED.

Additional engineering steps are required to add the 3rd party IED/AC800M into the PCM600 project.

5.2. Select the source type **Grid** and define **Adjacent Network Connectivity Information**.

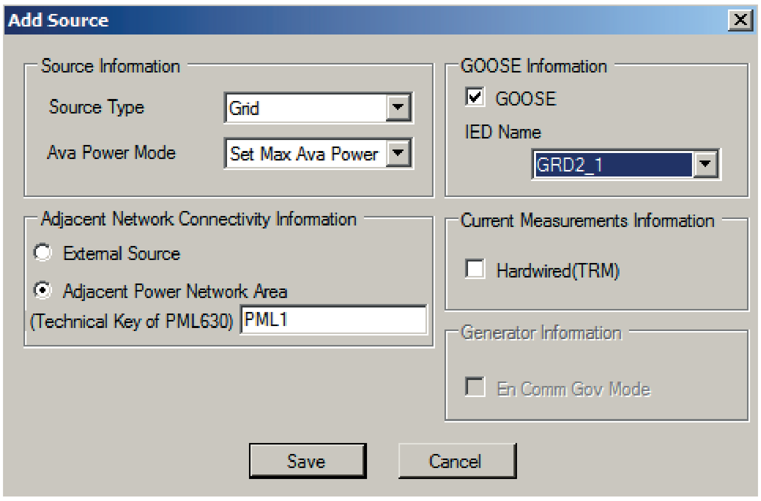


Figure 23: Adjacent network connectivity information selection for the source type Grid

Select **Adjacent Power Network Area** in the **Adjacent Network Connectivity Information** section if the **Grid** power source is an interconnection between the two electrical network areas (IED order code is **Configuration B**). Also provide the technical key of the other interconnected network area load-shedding IED.

Select **External Source** in the **Adjacent Network Connectivity Information** section if the **Grid** power source is an external source that is not connected with external utility or grid (IED order code is **Configuration A**).

Additional engineering steps are required to add the Adjacent Network Area load-shedding IED into the PCM600 project.

5.3. Select the source type **Grid/Transformer** and then select the **Current Measurement Information**.
This selection is applicable only when the current information needed for the grid transformer overload-based load-shedding is to be considered from the analog input module (TRM-Card of the IED).

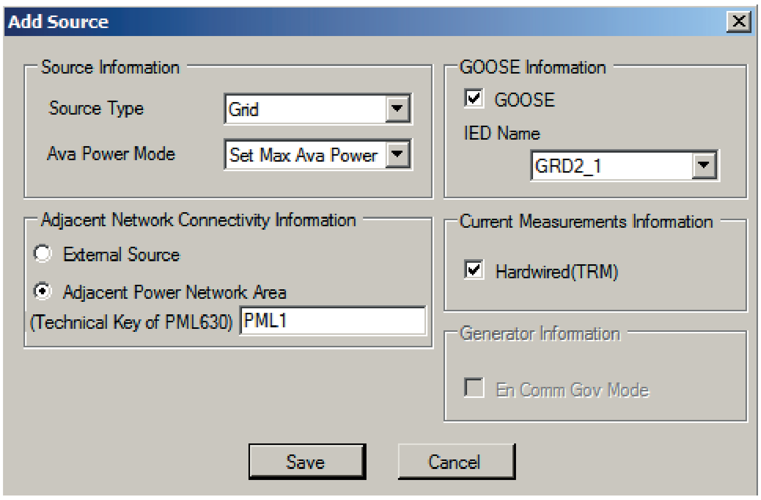


Figure 24: Current measurement information for the source type - Grid/Transformer

IED hardware TRM card of type 4I/5U allows the configuration of three-phase currents (from CT connections) for one grid transformer.
IED hardware TRM card of type 8I/2U allows the configuration of three-phase currents (from CT connections) for two Grid Transformers.

If ABB station automation system is based on IEC 61850 then the load-shedding solution comprises of a combination of IED and other Relion® 615, 620 and 630 series (REF/RET/REM and REG630).

If non-IEC 61850 feeders or bays exists along with the IEC 61850 based 615/620/630 series IEDs, then RIO600 Ver. 1.2 or later with DI, DO and AI modules are used. The field IOs is hardwired to the RIO600 modules. Based on the IEC 61850 GOOSE, RIO600 communicates with the PML630 IED.

In the **GOOSE Information** section, **GOOSE** and **IED Name** are not selected if the feeder IEDs and RIOs are not instantiated before the IED engineering.

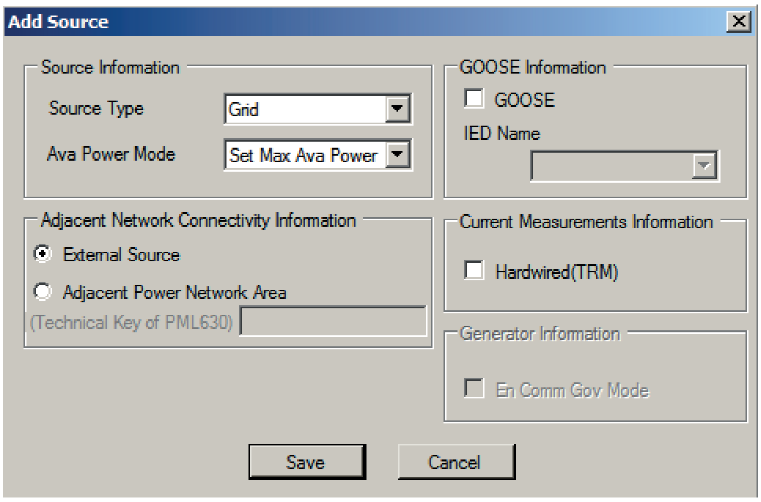


Figure 25: Feeder IEDs not instantiated before the IED engineering in PCM600

6. Click **Add** below the **Sheddable Load List** section to add loads

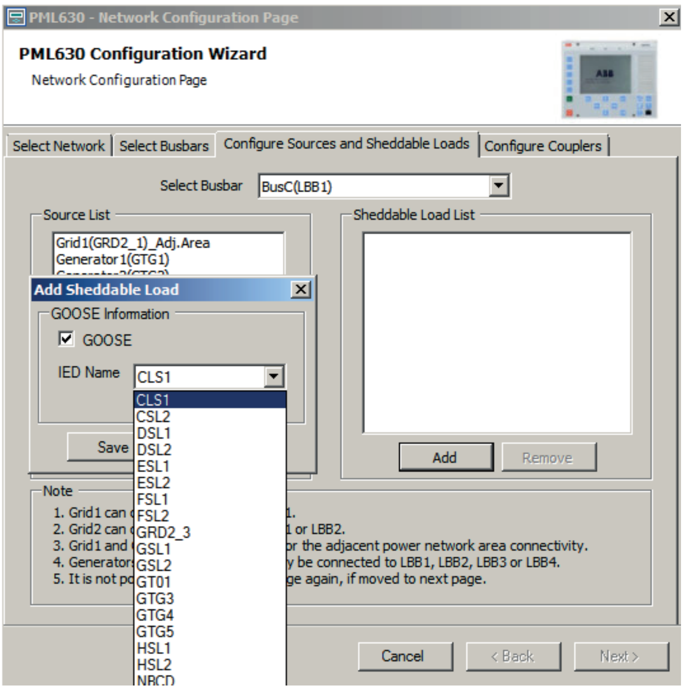


Figure 26: Configure Sheddable load for BusC(LBB1)

The IED Name must be entered, by selecting, if the load feeder is involved in load-shedding and its feeder IED sends GOOSE information to the PML630 IED. Click **Save** to add load. Repeat the previous step to add more sheddable loads.

The sheddable loads instantiation sequence is from left to right in a busbar. The left-most feeder is the first feeder assigned to the busbar. The shed command allocation is automatically done in this sequence.

Ten load feeders can be assigned to a busbar. If there are more load feeders involved in load-shedding, the load-shed groups needs to be configured.

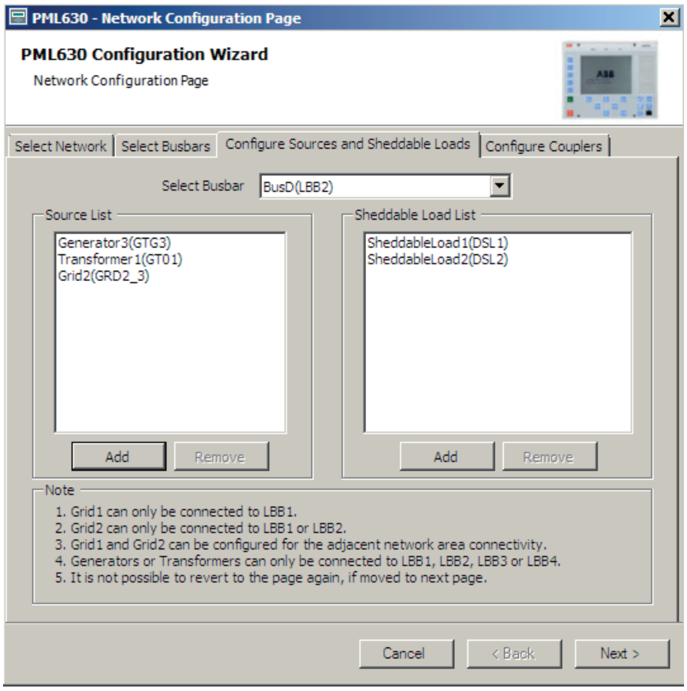


Figure 27: Configured sheddable loads for BusD(LBB2)

7. Repeat this procedure for all the busbars configured in the previous step.
8. Repeat above step for all the loads connected to the busbar.

PML630 Ver.1.2.1 supports ANSI/CN protection relays of the 615 and 620 series, REG615 and RIO600 Ver.1.2 or later in addition to the IEC protection relays mentioned in this section.

4.5.2.4 Configuring couplers, tie-lines and virtual circuit breakers

1. In PML630 Configuration Wizard, click the **Coupler Configuration** tab. This tab is to configure **Coupler**, **Tie-Line** and **Virtual Circuit Breaker**.

   Do not click the **Next** button without completing the coupler configuration. If clicked, repeat the entire configuration procedure for the IED.

2. Select **Primary Busbar** and **Secondary Busbar** from the **Select Connecting Busbars**.
3. Select **Coupler IED Name** and click **Save**.
   The coupler is added to the **Configured Couplers** list.

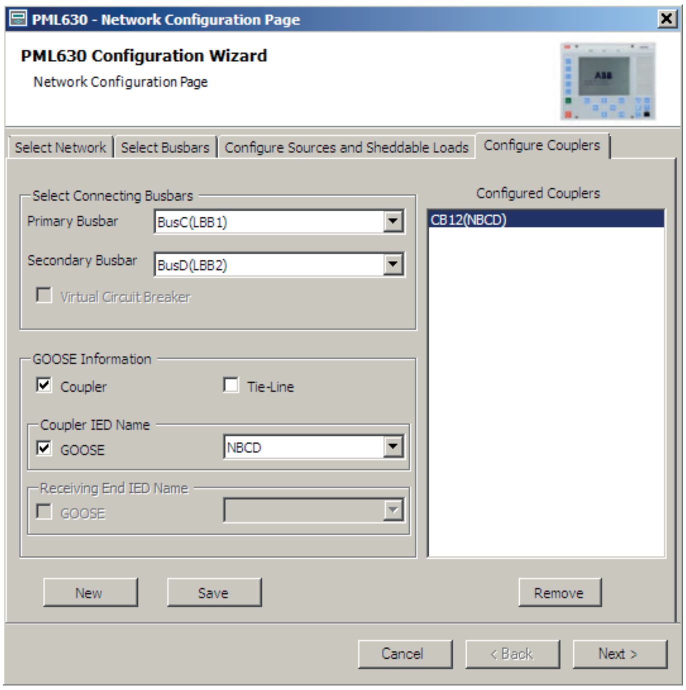


Figure 28: Configuring bus couplers

Enter the specific **Coupler IED Name** for the IED that sends the GOOSE information to the IED for **Coupler** configuration.

Enter the specific **Sending End IED Name** and **Receiving End IED Name** for the IEDs that send the GOOSE information to the IED for **Tie-Line** configuration.

4. Repeat the step for all the bus couplers.

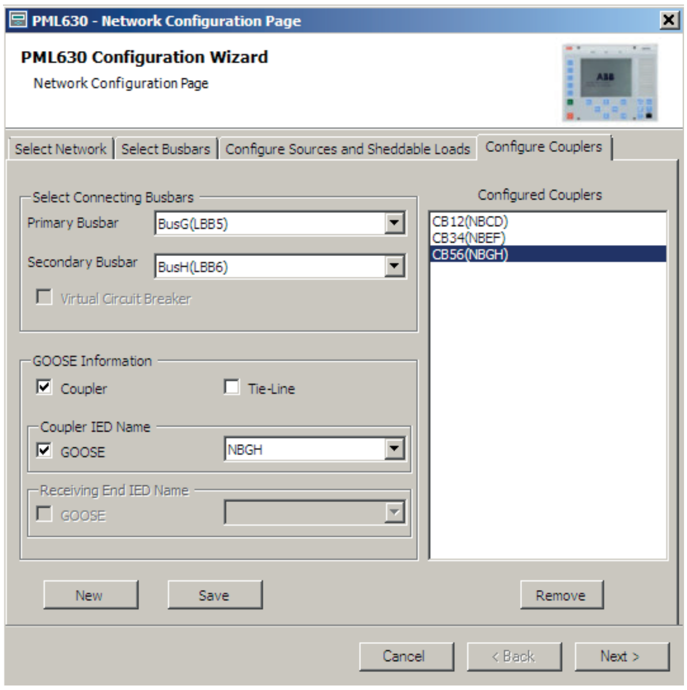


Figure 29: Coupler Configuartion

5. Configure **Virtual Circuit Breaker**, if one load busbar is virtually separated into two busbars in the configuration.
   - Uncheck the **Coupler** selection to enable **Virtual Circuit Breaker** selection, then select **Virtual Circuit Breaker** and click **Save**.

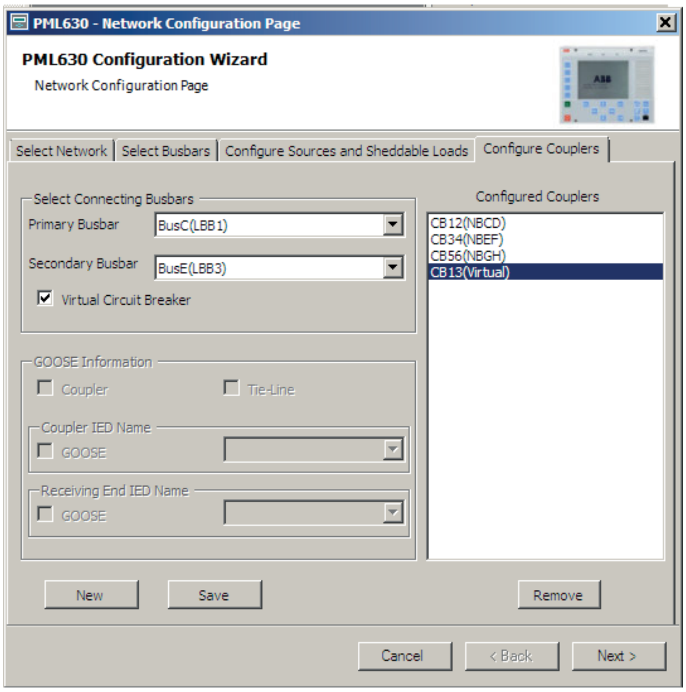


Figure 30: Virtual circuit-breaker configuration

For **Virtual Circuit Breaker** configuration, **IED Name** selection is disabled.

GOOSEPWRSRCRCV function block is not instantiated for the **Virtual Circuit Breaker** feeder.

6. Repeat the step for all the tie feeders.
7. Click **Next** to move to the **Setup Complete** page.

4.5.2.5 Completing the setup

When the load-shedding network configuration is done, complete the setup following the wizard steps.

- Click **Finish** in the **Setup Complete Page window** to create **PML630** object.

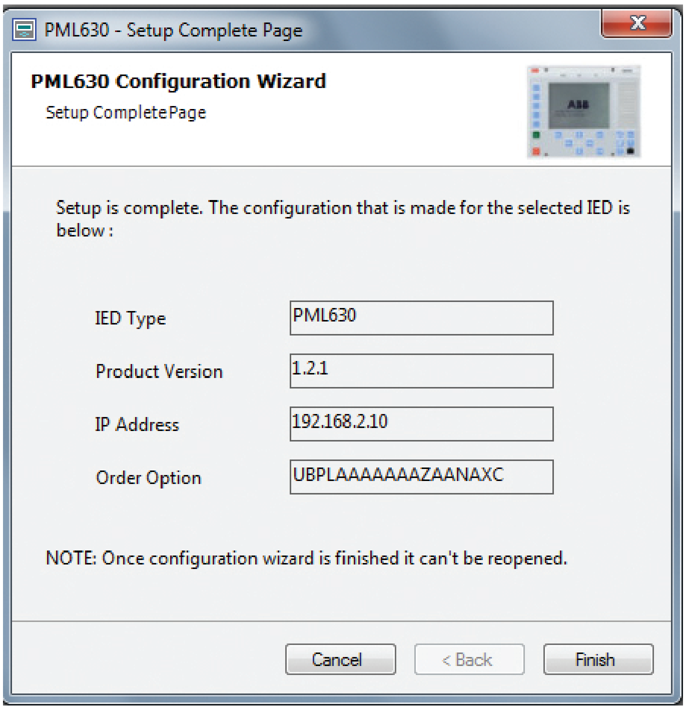


Figure 31: Setup Complete Page

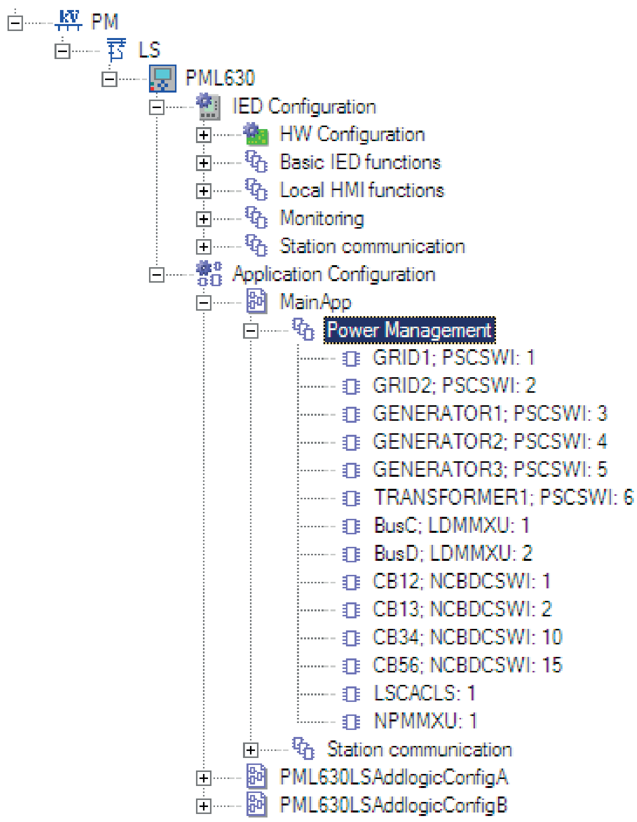


Figure 32: PCM600 showing the created PML630 object

The load-shedding function logic blocks are instantiated and the connection between the function blocks are established automatically in the Application Configuration tool.

The key load-shedding network diagram is configured with busbar, generator and grid transformer automatically in the Graphical Display Editor tool.

Perform Automatic Dataflow Engineering to include IEC 61850 information emanating from IED to feeder IEDs (on GOOSE communication profile) and COM600 (on MMS communication profile) for substation and load-shedding functionality. This information is available in an SCD file.

IEC 61850 communication configuration for MMS and GOOSE are created automatically for the IED and can be viewed in IET600.

4.5.3 Engineering with the IEC 61850 configuration tool of PCM600

External IED or system can provide the information as governor mode, *Comm Max Ava Power* or *Comm Spin Reserve* to the IED for the sources.

Similarly, manual load-shedding is configured by defining the load priority or in terms of load power to be shed for each subnetwork. This manual load shed data can be configured to be sent by the COM600 IEC 61850 Proxy server IED over GOOSE communication to the load-shedding IED.

1. Export the .cid/.icd file for the external IED or system and COM600 IEC 61850 Proxy Server.
2. Right-click **Project in PCM600**, point to **New**, point to **General** and select **IED Group**.

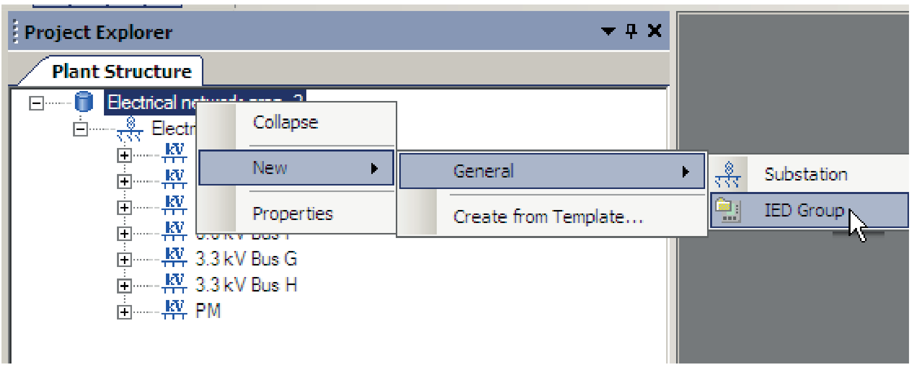


Figure 33: Add the IED Group to the PCM600 project

3. Right-click **IED Group**, point to **New**, point to **Generic IEC 61850 IED** and select **IEC 61850 IED**.

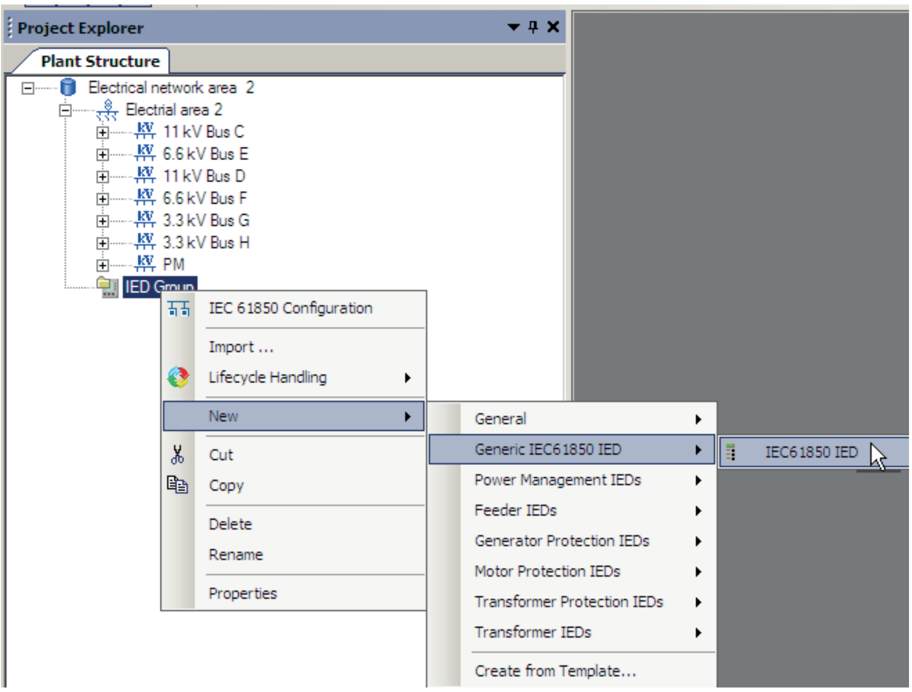


Figure 34: Create the Generic IEC 61850 IED

4. Select the communication port and IP address for the external IED or system or COM600 IEC 61850 proxy server IED.

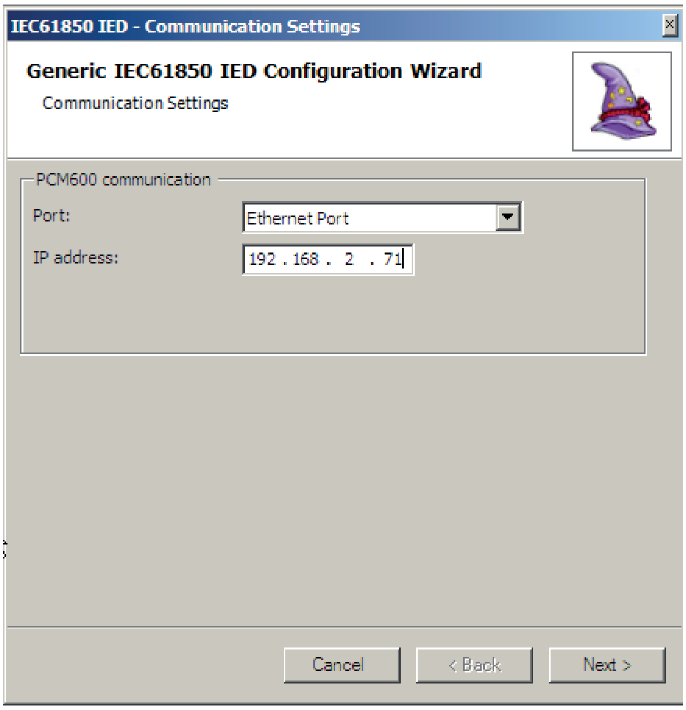


Figure 35: Communication port and IP address

5. In the **Communication Setting** page, click **Next** to go to the **Configuration Complete** page.

Figure 36: Configuration Complete page for Generic IEC 61850 IED

6. In the **Configuration Complete page**, click **Finish** to create the Generic IEC 61850 IED.

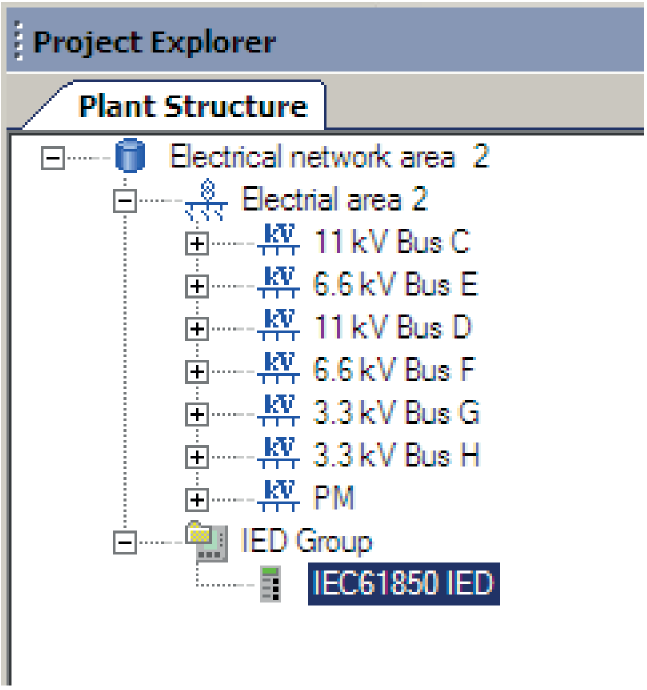


Figure 37: Generic IEC 61850 IED

7. Right-click **IEC 61850 IED** and select **Import** to import the .cid/.icd file.

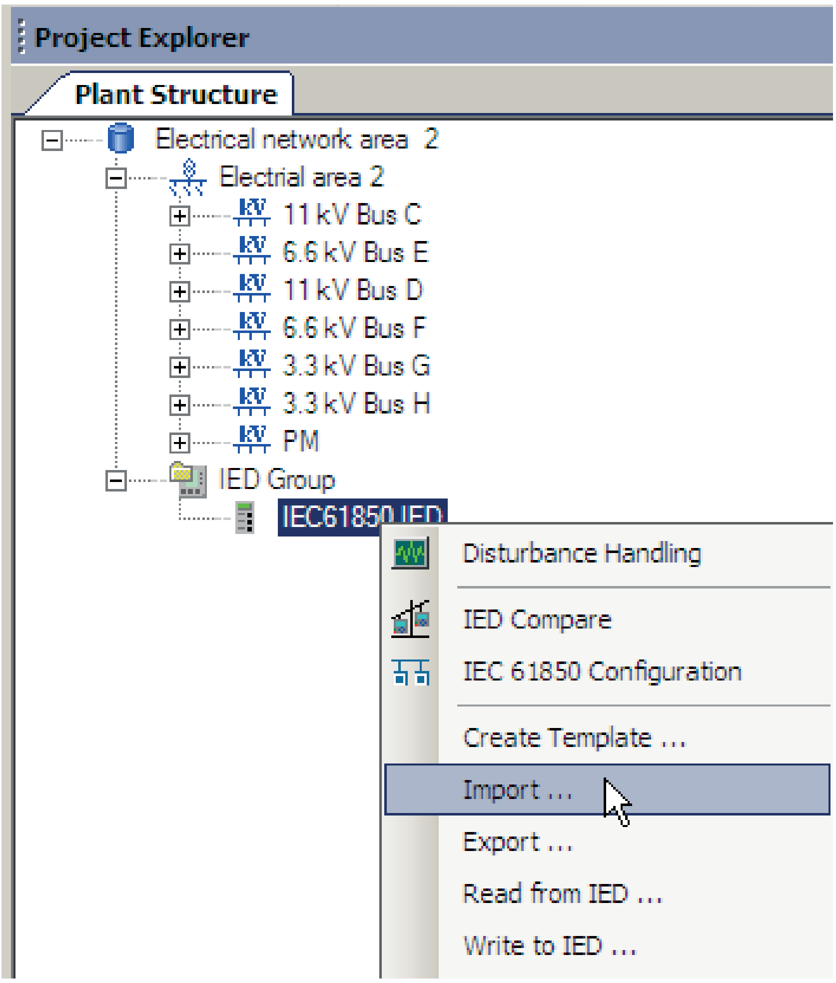


Figure 38: Select Import on the Generic IEC 61850 IED

8. In the **Information** dialog box, click **OK** to proceed.

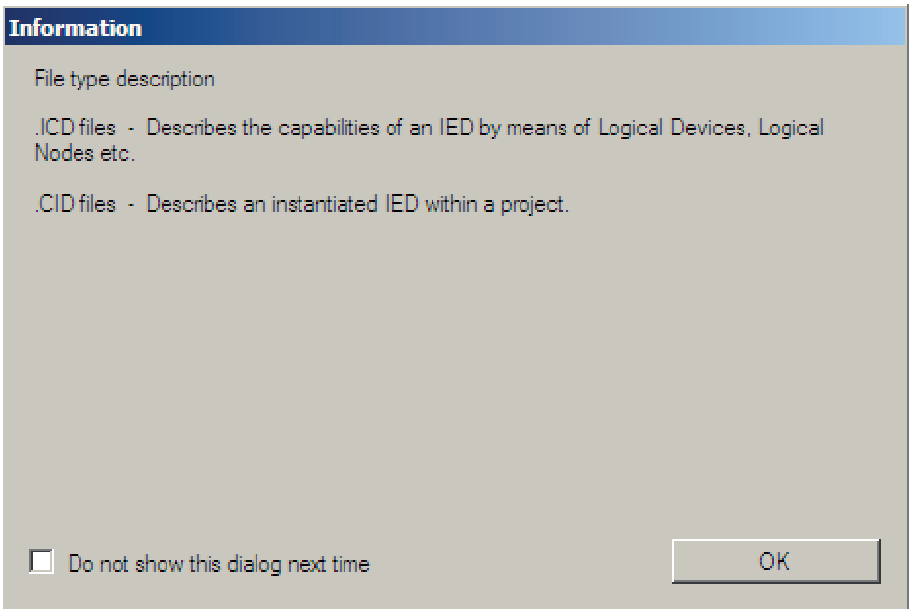


Figure 39: Proceed to import the .cid or .icd file

9. Select the .icd file and click **Open**.

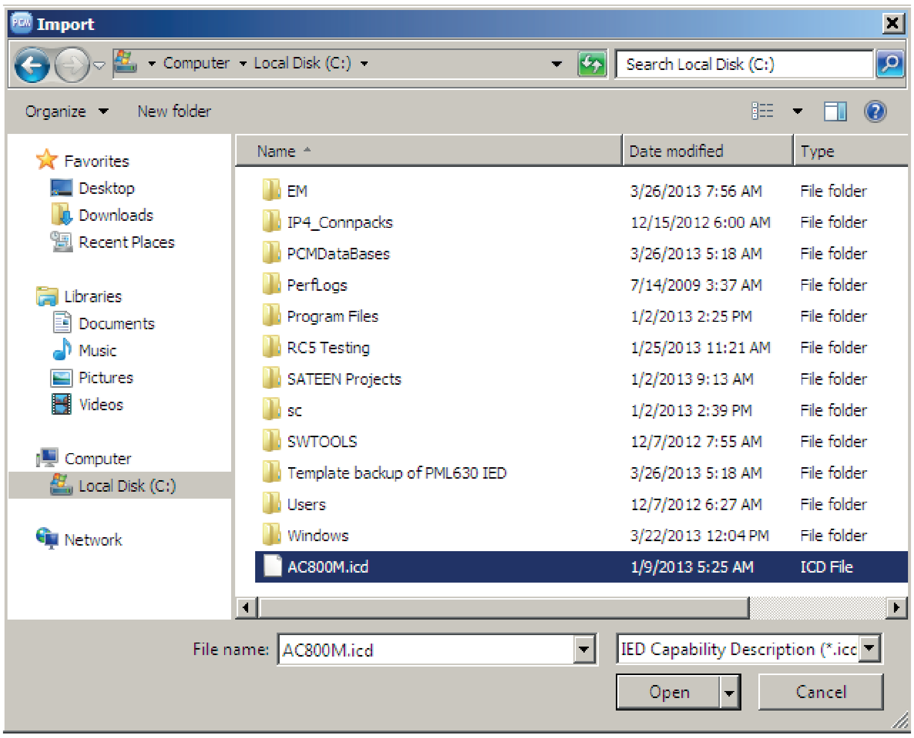


Figure 40: Select the .icd/.cid file

10. Select the correct options in the **SCL Import** dialog box and click **Import**.

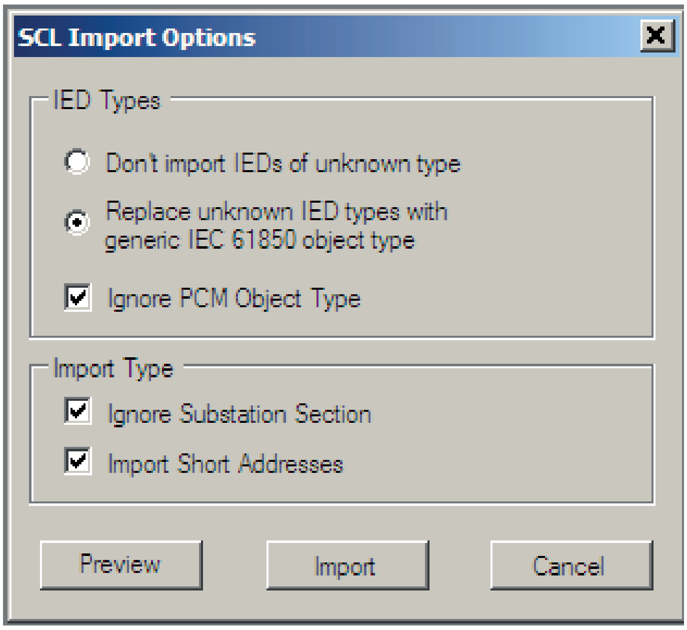


Figure 41: SCL import options

While importing the SCL file, IEC 61850 GOOSE communication can cause SCL error to the PCM600 project if any of these options are not selected.

- Replace unknown IED types with generic IEC 61850 object type
- Ignore PCM Object Type
- Ignore Substation Section
- Import Short Addresses

IET600 engineering tool can also be used for merging the .cid/.icd files of the external IED or system and COM600 IEC 61850 proxy server. While importing the SCD file into the PCM600 project, an IED Group with an external system IED and IEC 61850 proxy server IED is created automatically.

11. Right-click the **IED** under **IED Group** after importing the SCD file and select **IEC 61850 Configuration** to open station communication engineering tool.

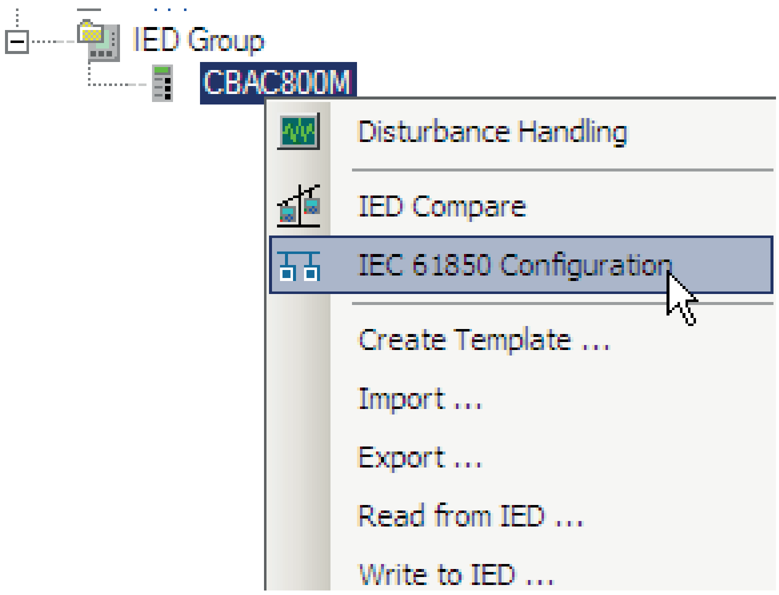


Figure 42: Open IEC 61850 Configuration tool

12. Subscribe the GOOSE control block of external IED or system or COM600 IEC 61850 proxy server IED to the PML630 IED.

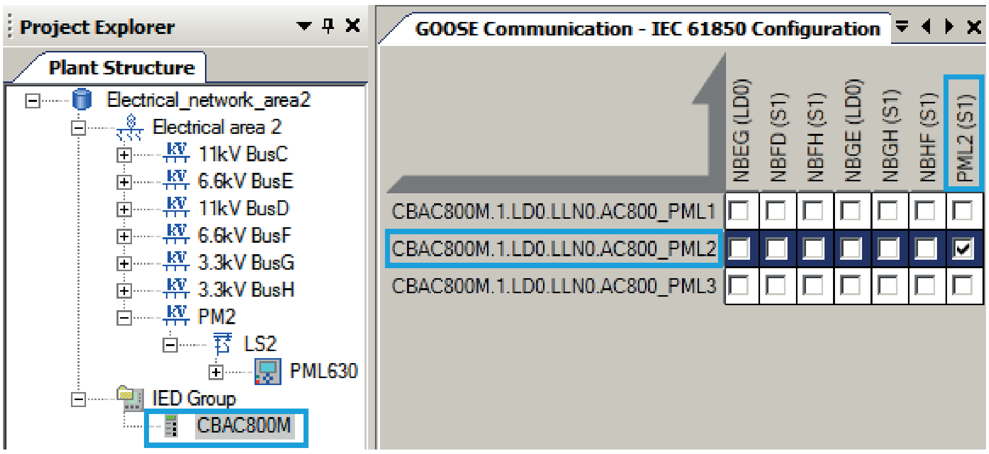


Figure 43: Subscribe the GOOSE control block to the PML630 IED

13. Signal matrix connections should be done manually in the PML630 IED.

4.5.4 Configuring adjacent network area load-shedding IED in PCM600

Once the other adjacent network area load-shedding IED PCM600 project configuration is complete, export the .PCMI file of the load-shedding IED. The exported .pcmi file of the load-shedding IED can be added to the IED group in this area

PCM600 project. The GOOSE communication engineering can be done between the load-shedding IED in the substation section and the load-shedding IED in the IED group.

1. Right-click **IED Group** and select **Import**.

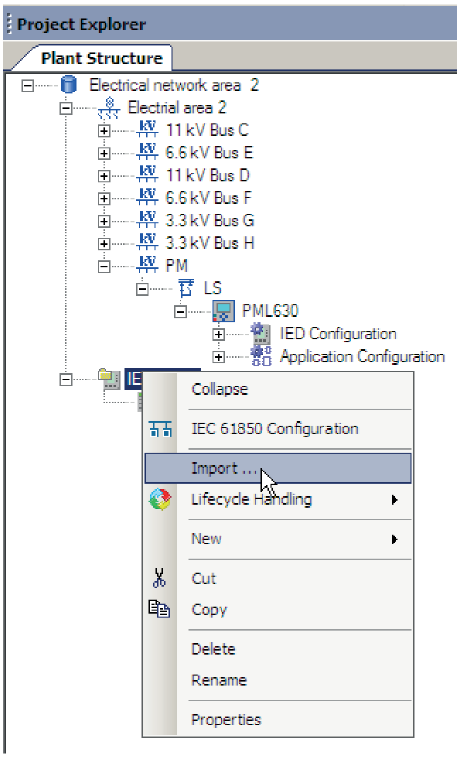


Figure 44: Import .pcmi into the IED Group

For example, **Electrical network area2** is connected to area 1 and area 3, so import the .pcmi files of IED from Electrical network area 1 and area 3 PCM600 project.

2. In the **Information** dialog box, click **OK** to select the .pcmi file.

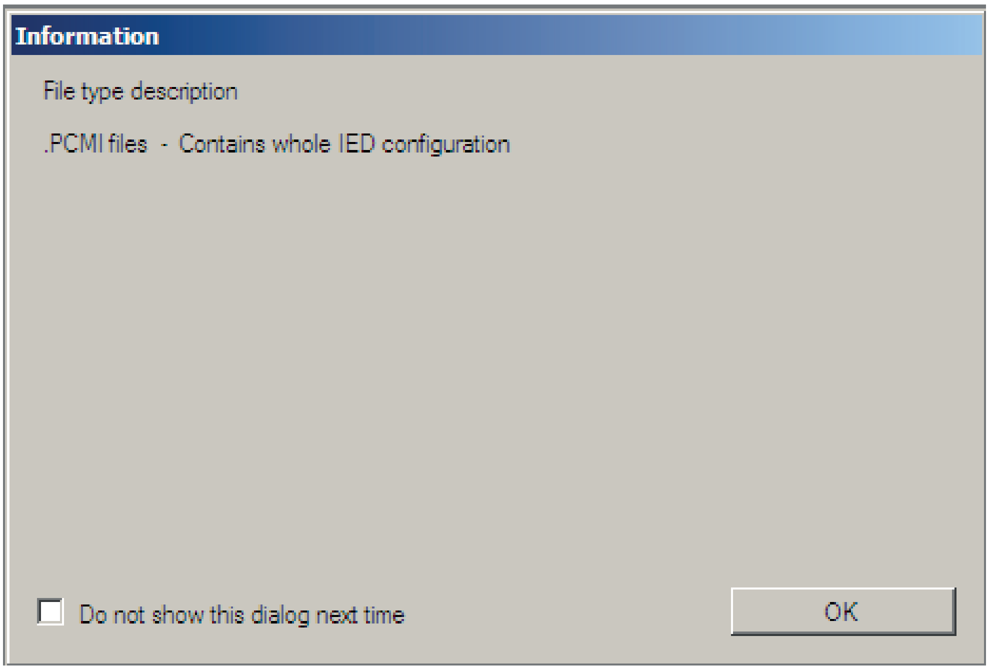


Figure 45: Click OK in the Information dialog box

3. Select the .pcmi file of network area 1 IED and click **Open**.

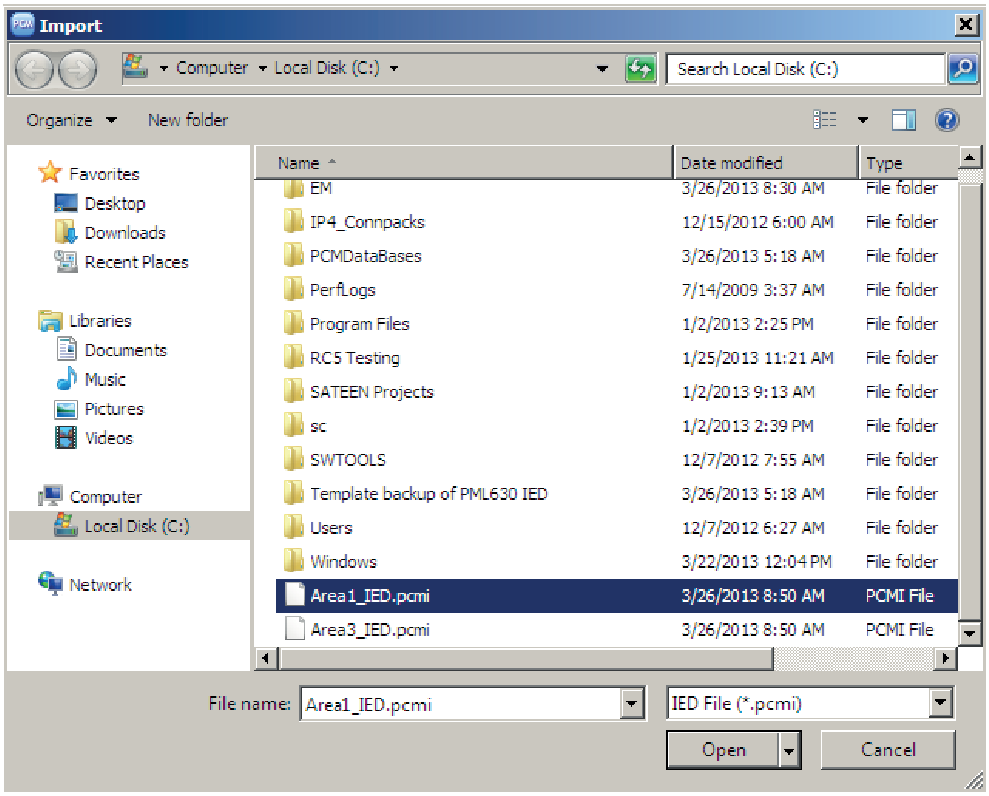


Figure 46: Select the .pcmi file

4. Import the .pcmi file of network area 2 IED.
5. Right-click the network area 1 IED and select **IEC 61850 Configuration** to open the tool for station communication engineering.

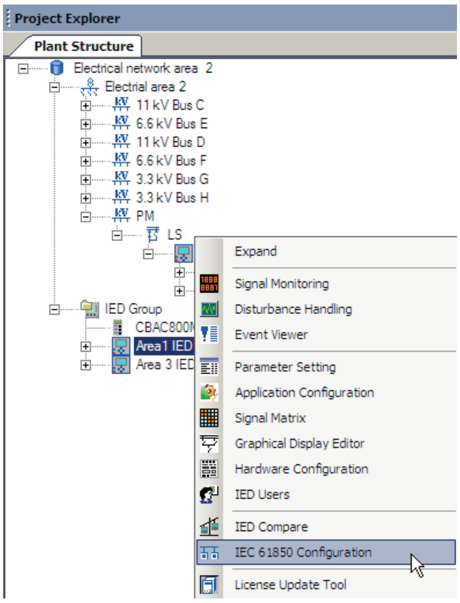


Figure 47: Open IEC 61850 Configuration tool

IET600 engineering tool can also be used for merging the .cid files of the adjacent network area IEDs. After importing the SCD file into the PCM600 project, **IED Group** with adjacent network area IEDs is created automatically.

While importing the SCL file, IEC 61850 GOOSE communication can cause SCL error to the PCM600 project if any of these options are not selected.

- Replace unknown IED types with generic IEC 61850 object type
- Ignore PCM Object Type
- Ignore Substation Section
- Import Short Addresses

6. Perform the GOOSE data subscription and publication between the inter-connected area PML630.

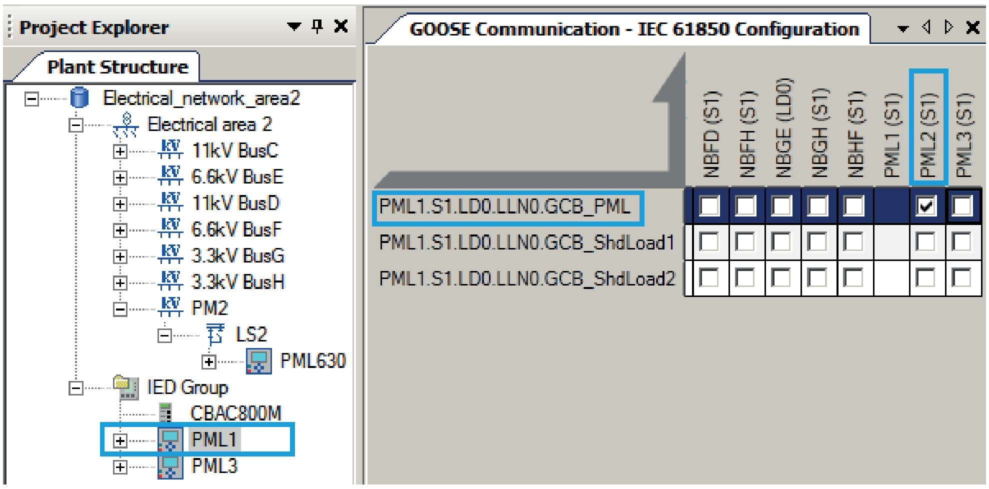


Figure 48: Subscribe Area 1 IED data to Area 2 IED

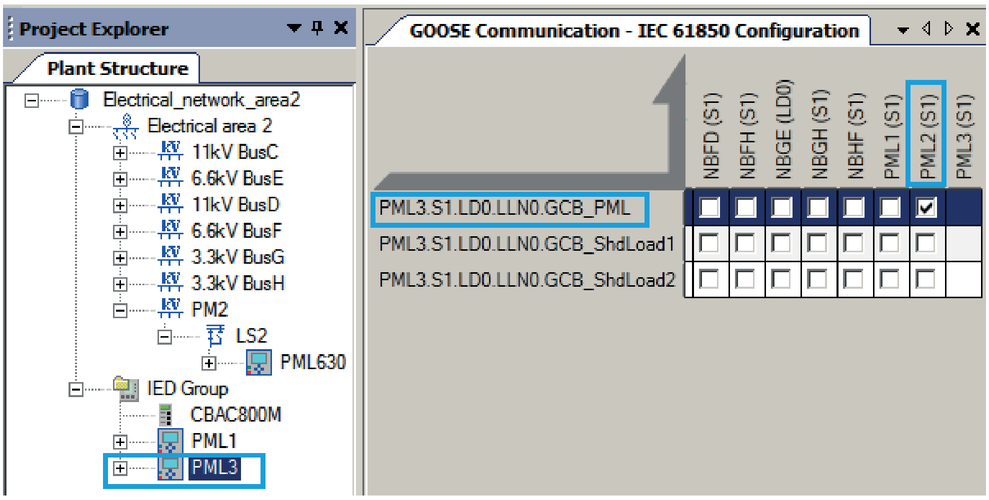


Figure 49: Subscribe Area 3 IED data to Area 2 IED

7. Right-click the network area 2 IED and select **Make GOOSE Connection** to perform signal matrix connection automatically.
8. Write the configurations for Electrical network area 2 IED from the project to complete the cPMS - LS Configuration B engineering workflow.
9. Repeat the above steps for Electrical network area 1 and area 3 PCM600 project.

4.5.5 IEC 61850 naming conventions to identify an IED

This section is 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 types of project designation in the object properties.

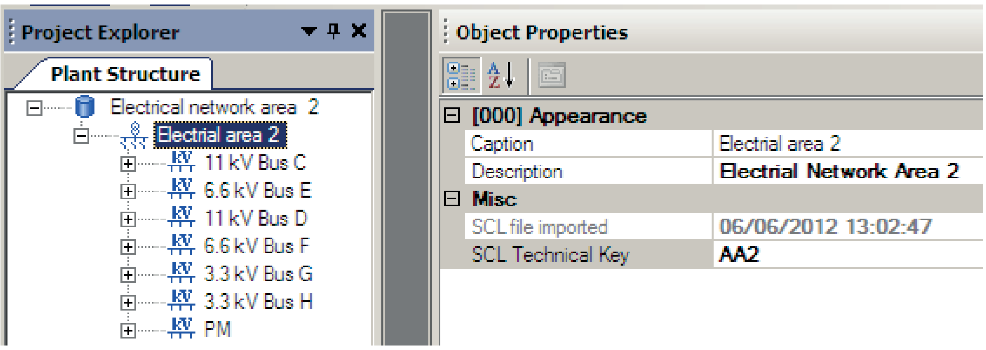
- A technical key is used on engineering drawings and for signal identifications. This is contained in the attribute name as identification of each object. If this value is used as reference to an object, it is contained in the attribute "name", starting with a string denoting the reference target object type and ending with the string **Name**. The technical key is used within SCL for referencing to other objects. The name is a relative identification within a hierarchy of objects.
- A user-oriented textual designation is contained in the attribute "desc". Attributes are not allowed to contain carriage return, line feed or tab characters. The semantics of "desc" must also be relative within an object hierarchy.

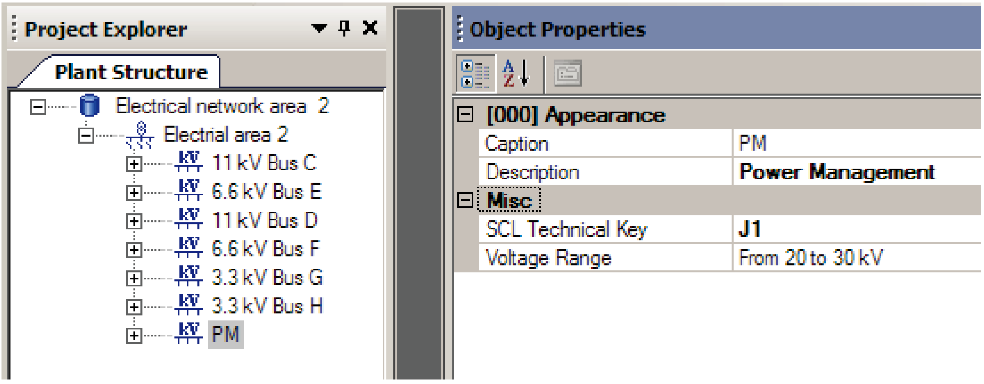
PCM600 is responsible for the above two possibilities. The two possible signal designations are available per object in the object properties for all hierarchical levels, beginning with the substation as the highest level.

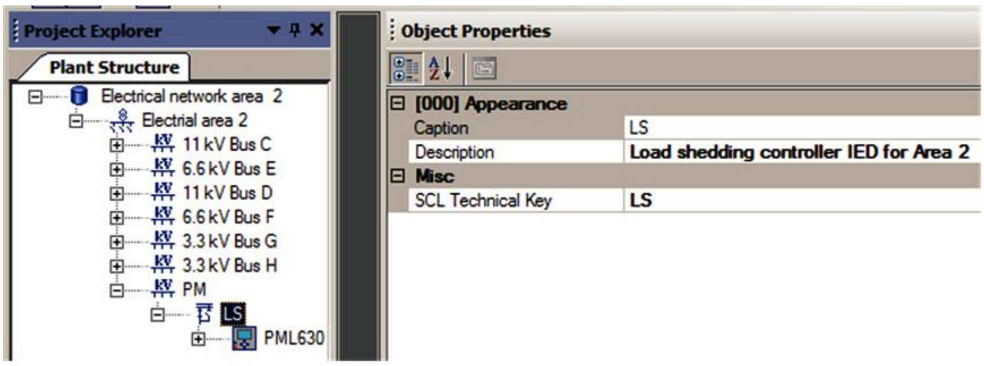
The technical key is automatically generated based on the rules and type specifications of IEC 61346 and the extended definitions made for substations by a technical committee. The technical key is shown in **Object Properties** under **SCL Technical Key** or **Technical Key**.

- **Station level**: The station is predefined by "AA2" where 2 is the index. To get the real station name that is used, it is possible to rename the "SCL Technical Key" for the station to the name used by the project. To minimize the word length, the acronym form should be used also in the messages transmitted to identify the events, for example. In Figure 50, Substation level SCL Technical key = AA2.
- **Voltage level**: In the example, voltage level is intended at 22 kV and hence the corresponding range is selected from the combo box and the corresponding SCL Technical Key is selected as J1.
  Though technically the Power Management functionality (load-shedding function in this case) is not associated with a particular voltage level, the above selection is done for the IED as the highest voltage level at which the load-shedding takes place is generally the voltage level associated with the IED.
- **Bay level** and **IED level**: The bay and the IED are appended with the coding defined in the IEC 61346 standard and the substation definition lists. In the example, Bay = LS, designating that the load-shedding functionality is designated under the "Power Management" "functionality". IED = PML630.

The user-oriented textual designation is visible in the plant structure for each object. It is the name given by default or changed via the **Rename** possibility. It is the name given by default or changed via the **Rename** possibility. See Figure 50, **Object Properties**, the row **Caption**.


Project Explorer
Plant Structure
Electrical network area 2
Electrial area 2
11 kV Bus C
6.6 kV Bus E
11 kV Bus D
6.6 kV Bus F
3.3 kV Bus G
3.3 kV Bus H
PM
Object Properties
[000] Appearance
Caption
Electrial area 2
Description
Electrial Network Area 2
Misc
SCL file imported
06/06/2012 13:02:47
SCL Technical Key
AA2


Project Explorer
Plant Structure
Electrical network area 2
Electrial area 2
11 kV Bus C
6.6 kV Bus E
11 kV Bus D
6.6 kV Bus F
3.3 kV Bus G
3.3 kV Bus H
PM
Object Properties
[000] Appearance
Caption
PM
Description
Power Management
Misc
SCL Technical Key
J1
Voltage Range
From 20 to 30 kV


Project Explorer
Plant Structure
Electrical network area 2
Electrial area 2
11 kV Bus C
6.6 kV Bus E
11 kV Bus D
6.6 kV Bus F
3.3 kV Bus G
3.3 kV Bus H
PM
LS
PML630
Object Properties
[000] Appearance
Caption
LS
Description
Load shedding controller IED for Area 2
Misc
SCL Technical Key
LS

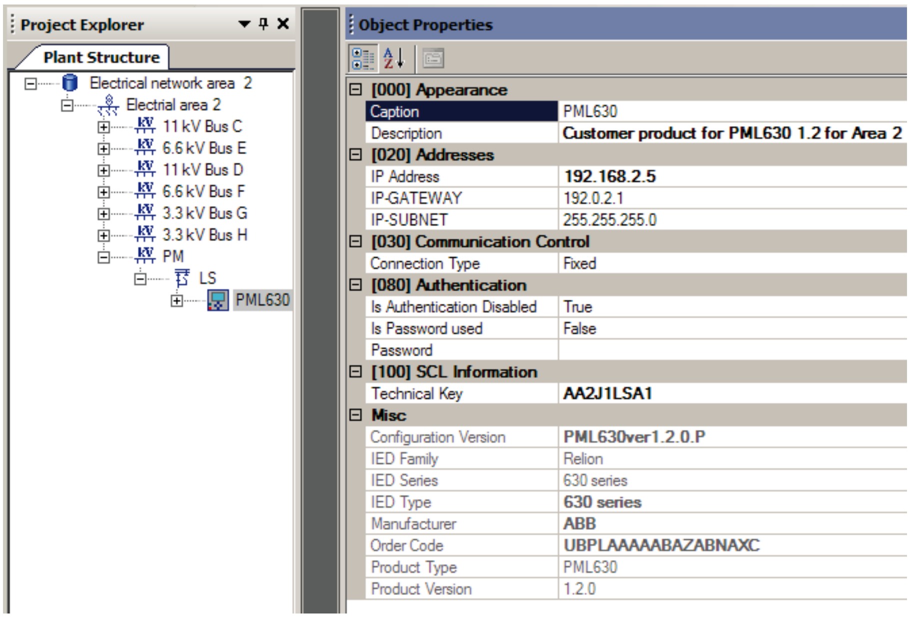


Figure 50: PCM600 : IEC 61850 signal designation concept

The created technical key for the full path name of the IED is:

- AA2J1LSA1
  - AA2 = Electrical Network Area 2 “AA2” SCL Technical key
  - J1 = Power Management - Voltage level “J1” SCL Technical key
  - Bay = Load-shedding - Bay “LS” SCL Technical key
  - PML630 = Customer product for PML630 1.2 for Area 2 “AA2J1LSA1” SCL Technical key

The technical key for the IED can be suitably derived based on the project naming conventions.

It is recommended to create a separate PCM600 project for each electrical network area, where more than one electrical network areas/ process areas are provided with PML630 in cPMS - LS Configuration B **Power Management** configuration option.
The AA1= SCL Tech Key has to be kept unique for each electrical network area. For example, electrical network area 1 as AA1, area 2 as AA2 and area 3 as AA3.

All the other bays in the project have to be created for the other feeder IEDs as per single-line diagram of the network area. PML630 has to be created at the end.

4.6 Setting technical key

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

The IED is delivered with a factory default technical key.

The technical key property in PCM600 corresponds to the IED name attribute in SCL files. The IED name attribute must not be changed outside PCM600, because data in PCM600 might be lost when importing SCL files.

The IED configuration wizard identifies feeder IEDs with the technical keys. Hence, it is recommended to use meaningful names for technical keys, for example, the name G1 can be assigned to the technical key of generator one feeder IED.

When writing a configuration to the IED, PCM600 checks for any mismatches between the IED object and the physical IED technical key. For communication between the IED and PCM600, the technical key must be the same. An option is available to read the technical key from the IED and update it to PCM600 or write the PCM600 technical key to the IED. A technical key can also be defined. An error message is displayed if there is any mismatch between PCM600 and the IED technical key.

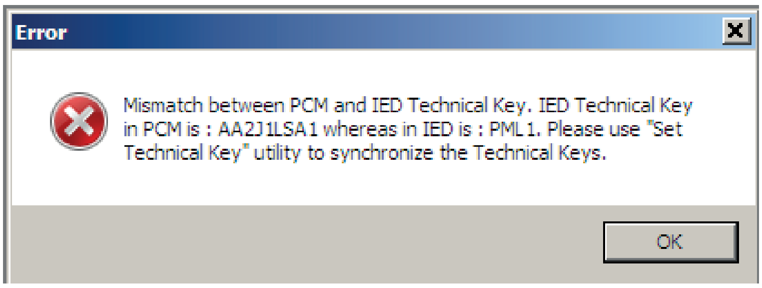


Figure 51: Error message generated due to mismatch between PCM600 and IED technical key

The IP address of the IED object in PCM600 and the physical IED which is intended to be connected through the technical key concept should be same.

The technical key for an IED object in PCM600 can also be changed in the **Object properties** window.

1. Select the **IED** in **Plant Structure**.
2. Right-click and select **Set Technical Key**.

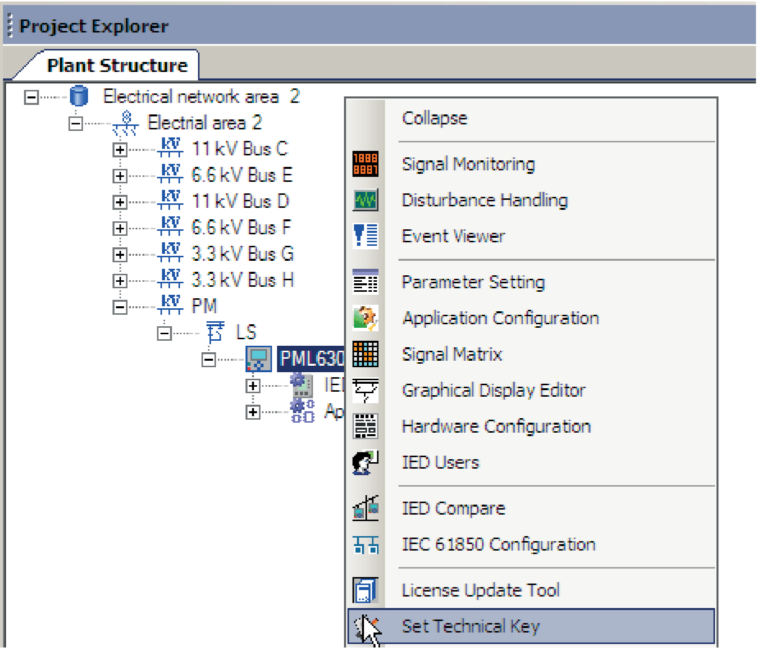


Figure 52: PCM600: Set technical key menu at IED level

The technical key concept message is displayed.

3. Click **OK** in the dialog box.
   The technical key is read from the IED and the technical key editor dialog box opens.

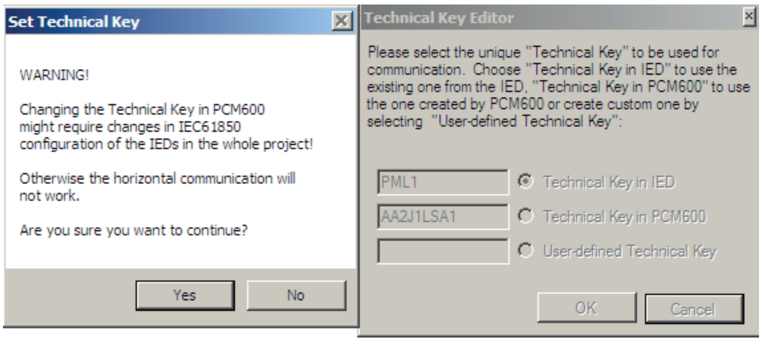


Figure 53: PCM600: Technical key editor

Select the desired options in the **Technical Key Editor** dialog box.

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

Do not use a technical key with more than 10 characters.

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

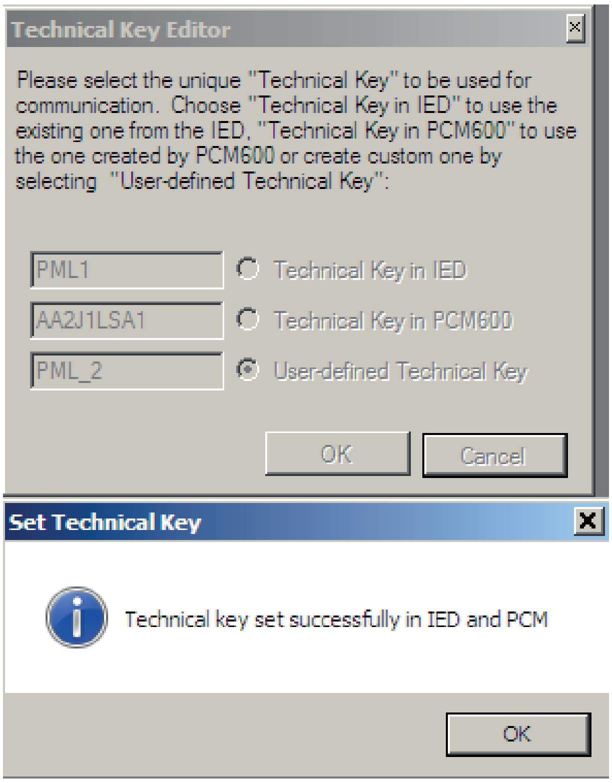


Figure 54: PCM600: Technical key in IED

4.7 Updating SCL private section

If the technical key of the PML630 IED is changed, it should also be reflected in the private section of PML630's SCL file to ensure that COM600 can pick the right section for WHMI. If a mismatch persists, load-shedding displays are not populated in COM600.

1. In the **Plant Structure** view, right click the PML630 IED and select **Update SCL Private Section** to update the technical key in the private section of the SCD file.

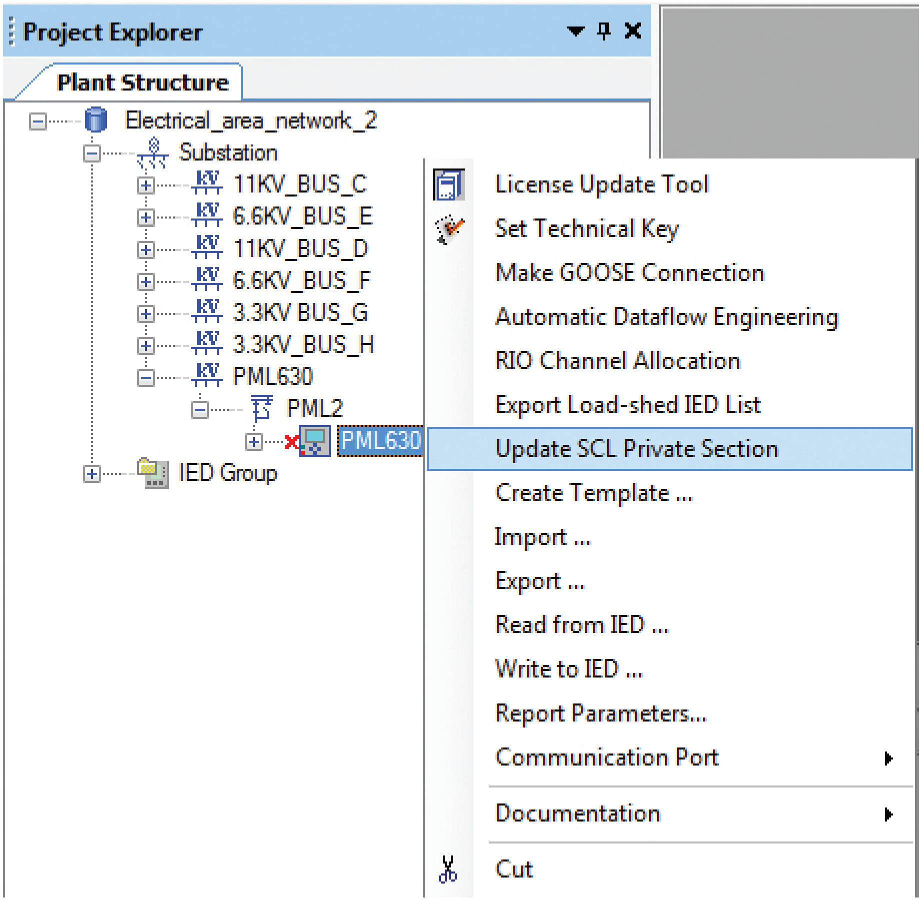


Figure 55: Selecting Update SCL Private Section

2. Select **Yes** to confirm the updating of the SCL private section.

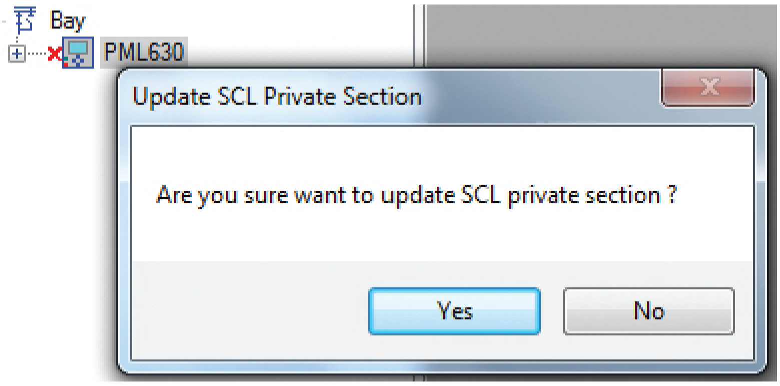


Figure 56: Confirming the update

On completion of the SCL private section update, the system confirms the action.

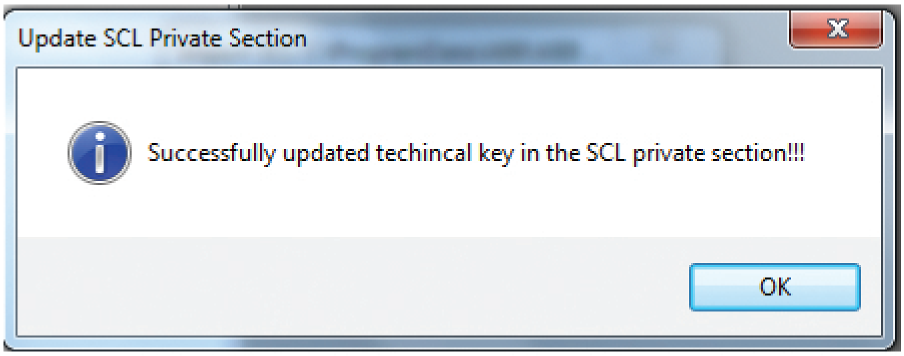


Figure 57: Completing the update successfully

The SCL private sections should be updated in certain situations.

- When the PML630 Technical Key of the PML630 instance is changed through Object properties.
- When the PML630 Technical Key of the PML630 instance is changed using “Set Technical Key” tool.
- After importing or copying the PML630 instance on substation level when a project specific PML630 Technical Key is defined.

The Update SCL Private Section tool does not support PML630 instances created or imported under the IED Group.

4.8 Using the IED in COM600 project - PML630

The IED connectivity package has built-in features to support the automatic configuration of the load-shedding process displays in COM600. After completing the cPMS - LS Configuration A engineering, the SCD file exported from PCM600 should be imported to SAB600.

It is not possible to access load-shedding subnetwork-wise displays in SAB600.

4.9 Configuring IEDs offline

1. Right-click the **Bay** node, point to **New**, point to **Power Management IEDs** and select **PML630**.

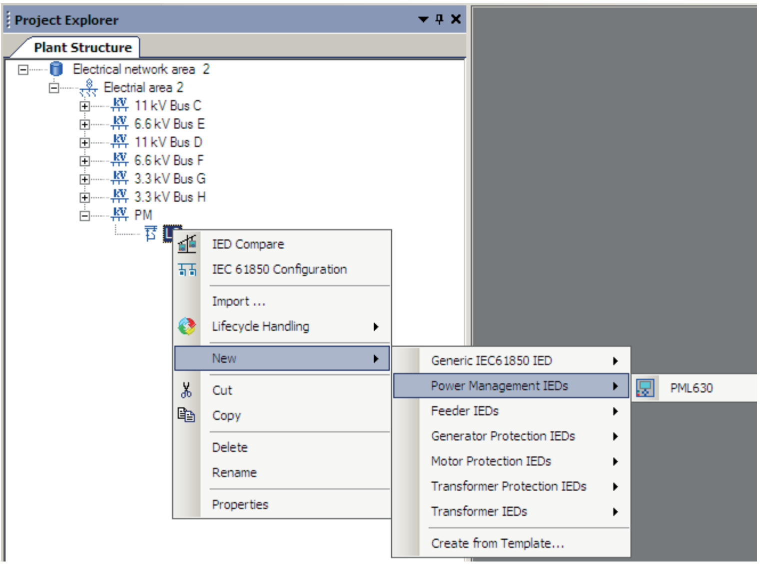


Figure 58: Menu navigation for the IED object creation

2. Click **PML630** IED.
   PML630 Configuration Wizard opens.
3. Select **Offline Configuration** in **Configuration Mode Selection Page** and click **Next**.

The **Configuration Mode** selection varies in the online and offline configuration. In the offline configuration, select the IED type, version and IED order code manually.

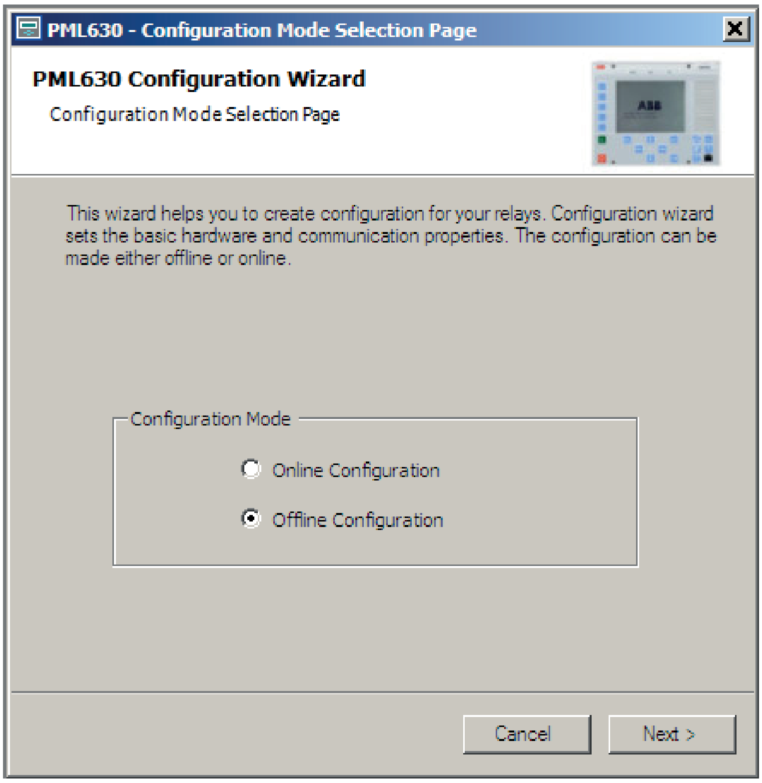


Figure 59: Configuration Mode Offline Configuration

The order selection must be done manually according to the project specifications or requirements.

If there is a mismatch between the offline order code selection and the actual IED configuration, the IED configuration from PCM600 cannot be downloaded into the IED.

4. In the **Communication Protocol Selection** page, click **Next**.

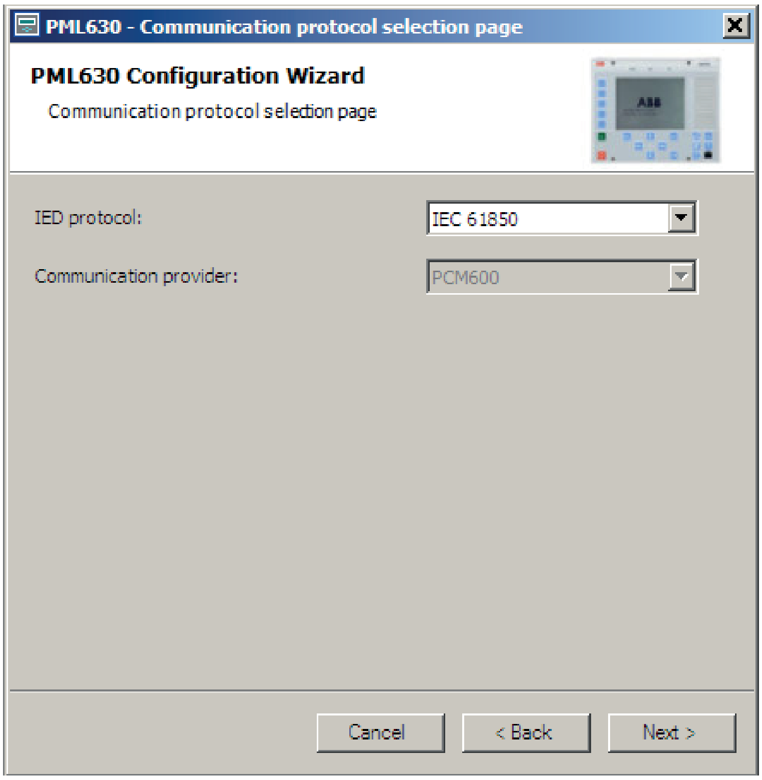


Figure 60: Communication protocol selection page

5. Select the port access as **Front Port** for the front port or **LAN1** for back port.

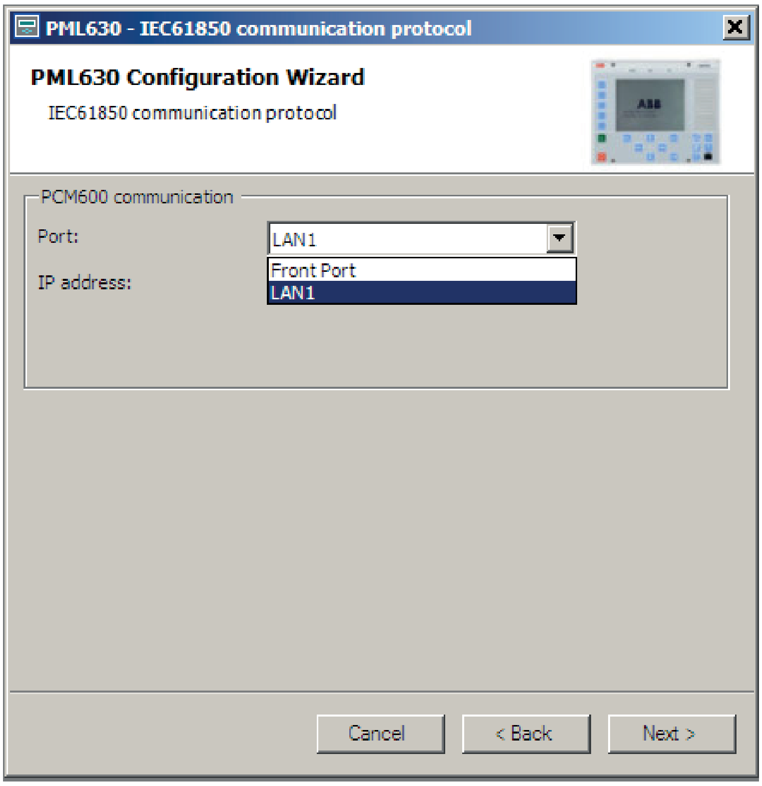


Figure 61: Port selection

6. In the **IEC 61850 Communication Protocol** page, type the IP address and click **Next**.

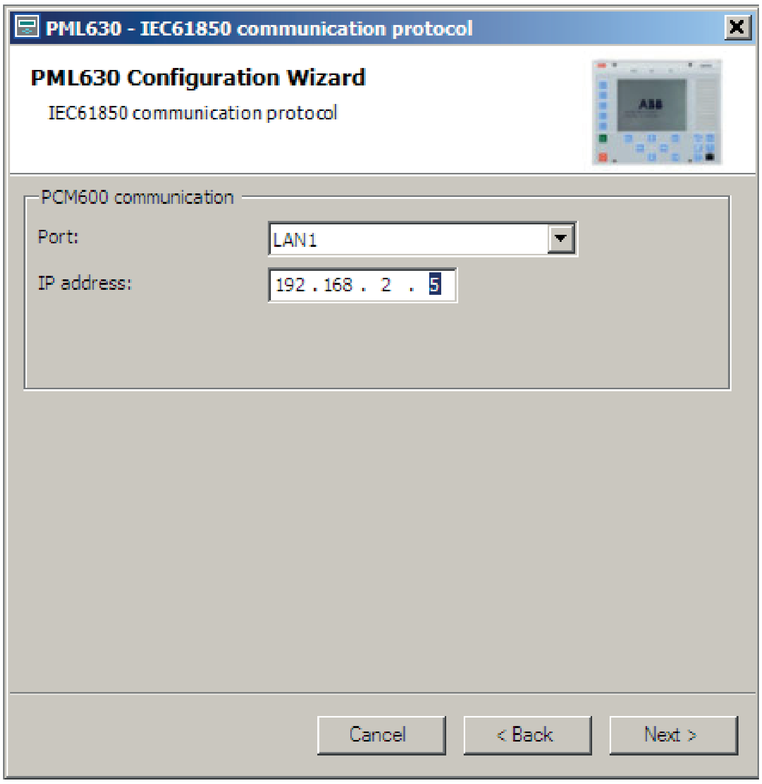


Figure 62: IP address selection for IED

For Ethernet communication, select the port as **LAN1** and the IP address of the IED should be unique.

7. Click **Next**.
8. In **Version Selection page**, click **Next**.

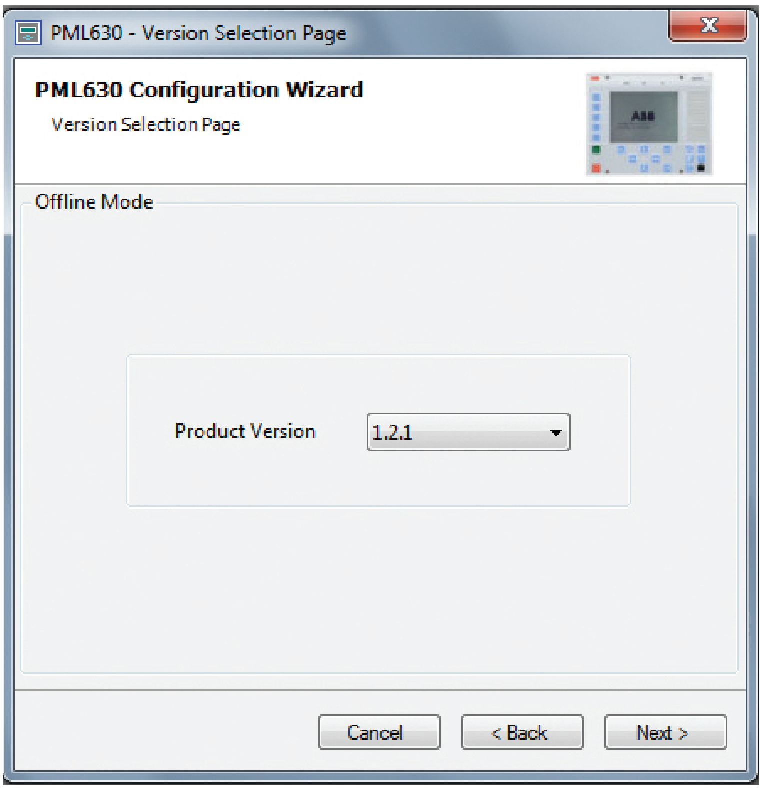


Figure 63: Version Selection Page

9. In **Order Code Selection page**, select the type of local HMI arrangement and Ethernet connection based on the project requirements, that is, for the desired power supply.

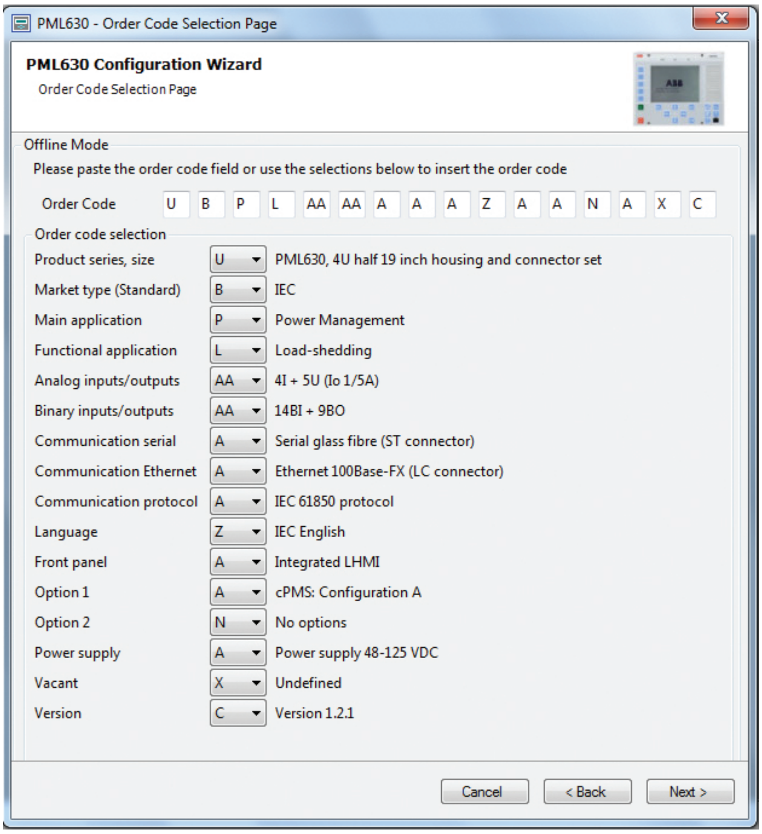


Figure 64: Order Code Selection Page

10. Click **Next**.
11. Define the load-shedding network and complete all the necessary steps.

4.10 Inserting IEDs from the template library

An IED in the plant structure can be exported as a template (*.pcmt). A template library can be built with the exported IED templates. It is possible to insert an IED from the template library to create a new IED in the plant structure.

A template library is created for reusing existing configurations in new projects. A template IED can only be inserted when the bay is selected in the plant structure.

1. Right-click the bay in the **Plant Structure** tab.

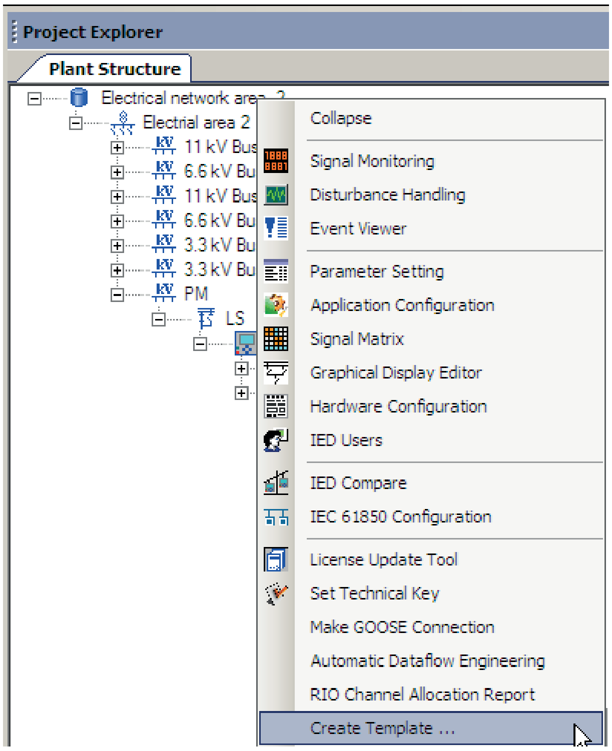


Figure 65: PCM600 : Selecting the bay in the plant structure

2. Select **New** and click **Create Template** to open the **Create New Object from Template** dialog box.

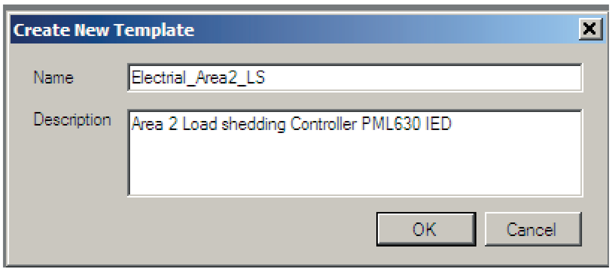


Figure 66: PCM600 : Creating the template

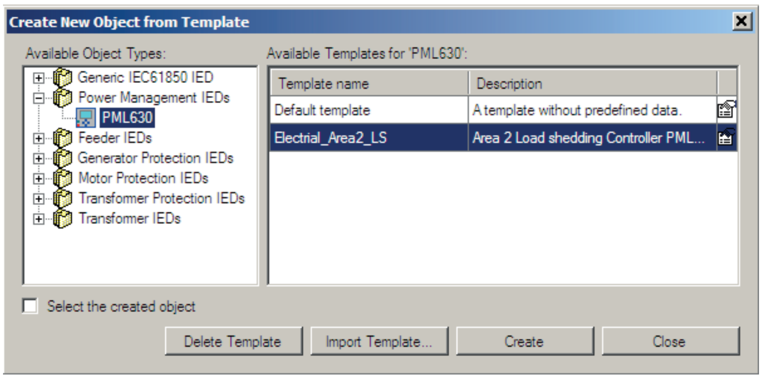


Figure 67: PCM600: Selecting IED from template library

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** dialog box. Verify the template information and click **Close** to close the dialog box.

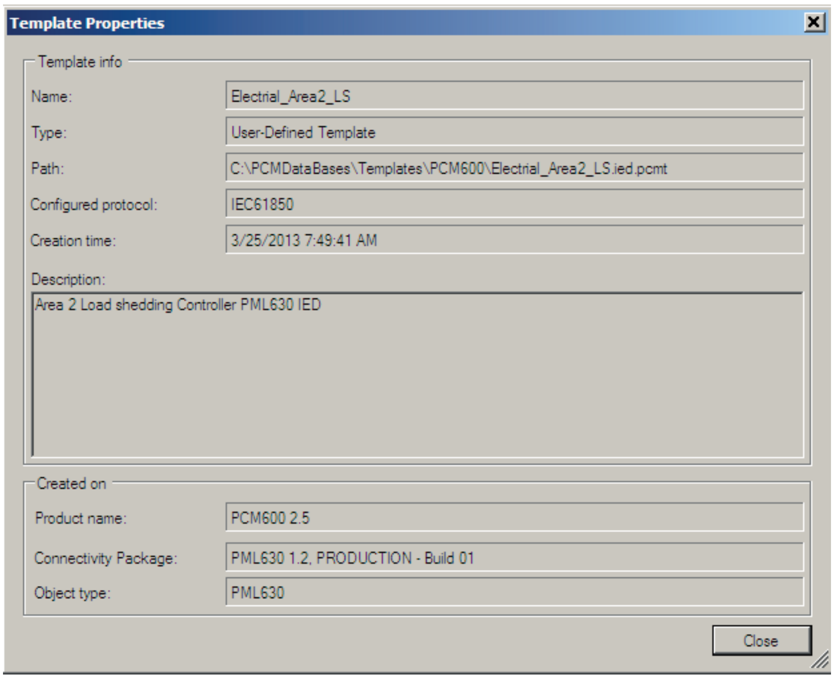


Figure 68: PCM600: IED Template Properties

5. Click **Delete Template** to delete the template or click **Import Template** to import a template from the selection dialog box or click **Create** to insert the selected IED to the bay.

It is possible to insert more than one IED from the **Create New Object from Template** dialog box and the selection window remains open until clicking **Close**.

4.11 Instantiating IED object without any configuration

The IED Connectivity Package provides an option to instantiate the IED object in the PCM600 project without any application logic configuration.

There are two possible scenarios where an IED instance can be created and configured.

- **Scenario 1:** An entire IED configuration can be uploaded from an existing or working IED.
  Further configuration changes, for example, addition of a busbar or power sources or a load feeder, can be introduced to download configuration and make a completely new IED configuration.
- **Scenario 2:** The entire load-shedding functionality is configured manually. This implies that the load-shedding logic is created manually similar to the application logic for other feeder IEDs like REF615/REM615/RET615 or REG630/REF630/REM630/RET630.

The IED configuration steps describe the IED configuration.

Scenario 1:

1. Instantiate an IED object in the PCM600 Plant Structure.
2. Start the configuration wizard and select the online mode.
3. Select IEC 61850 as the communication protocol.
4. Modify the default IP address by setting the actual IP address of the online IED.
5. Update the IED version.
6. Update the default order code with the actual order code from the online IED.
7. In **Network Configuration page**, select **Blank configuration** by clicking the check box.
   Once the above step is done, the **Loadshed Configuration** radio buttons are disabled.

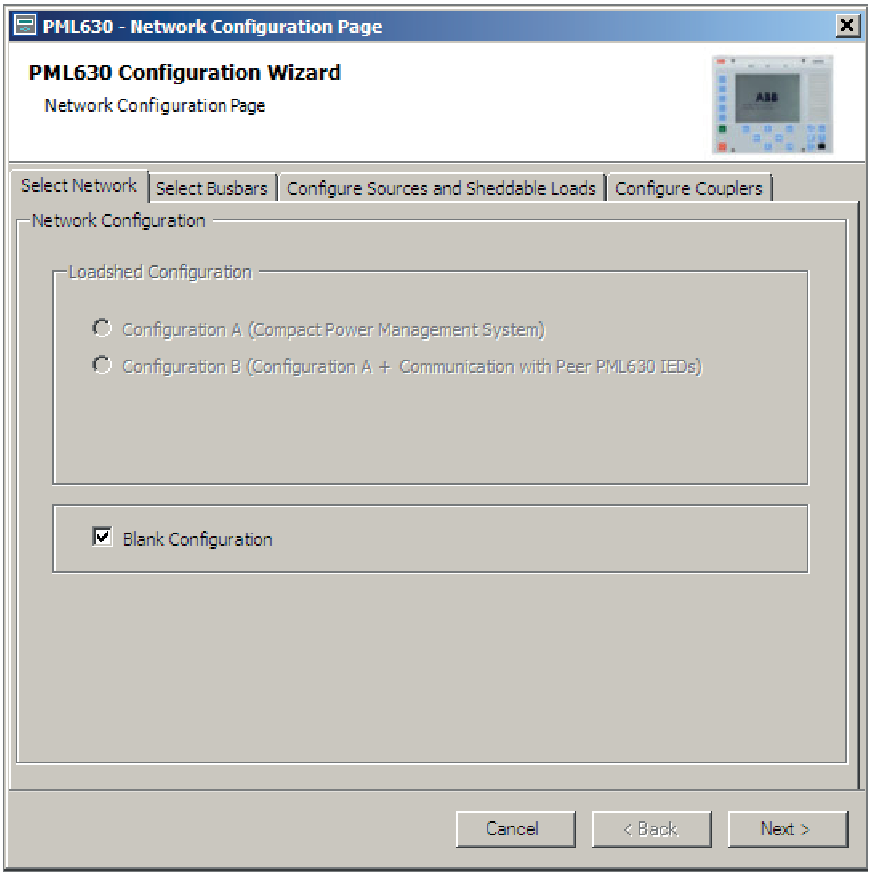


Figure 69: Blank configuration selection option

8. Click **Next** to skip additional network configuration steps.
9. Click **Finish** in **Setup Complete Page**.

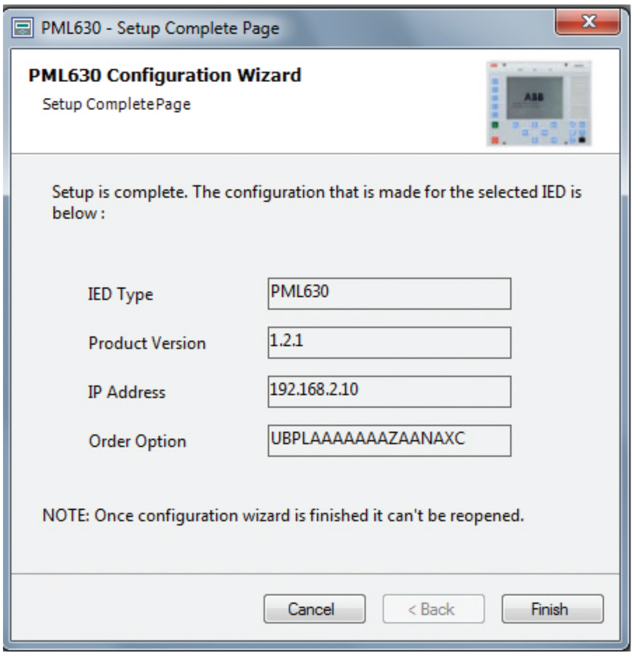


Figure 70: IED Setup completion page

10. The IED Connectivity Package creates an empty object type in the PCM600 without any application configuration content.

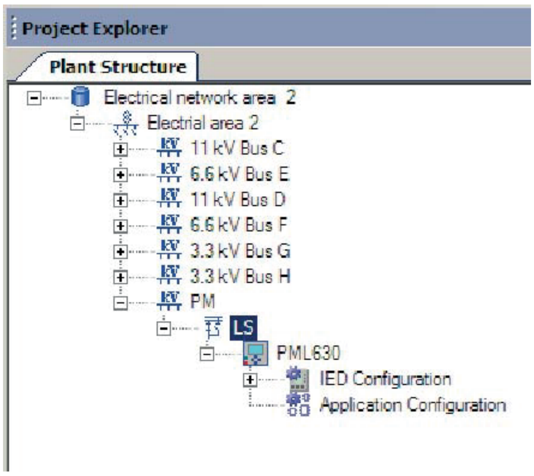


Figure 71: Empty Application Configuration section

11. Right-click the IED object and select **Read from IED** to upload the entire IED configuration.

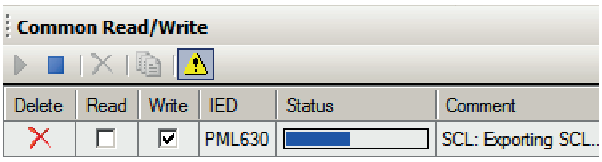


Figure 72: Downloading IED configuration

12. Open the Application Configuration tool after the IED configuration download. The load-shedding function blocks that were disabled for instantiation (when the network configuration was done with the configuration wizard) are now enabled.

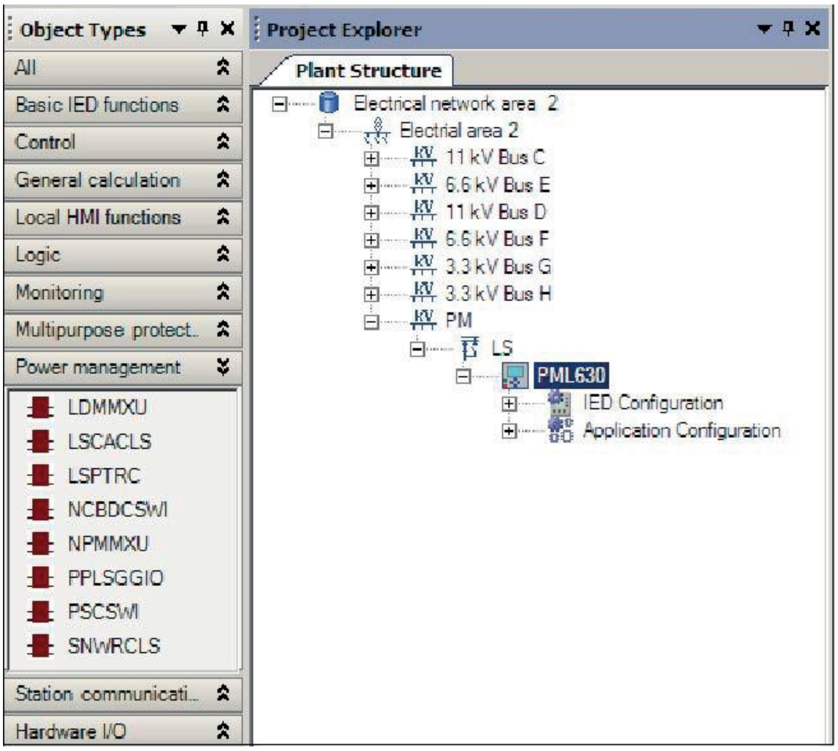


Figure 73: Load-shedding function blocks that can be instantiated

13. Drag function blocks from the object type window to the Application Configuration tool page. In the following example, the uploaded configuration from the IED already comprises four LDMMXU function block instances (corresponding to a four-busbar configuration). A dialog box appears when the fifth busbar LDMMXU function block instance is dragged to the Application Configuration page. It displays the maximum number of instances (six) that correspond to the maximum number of load busbars that are supported by the IED.

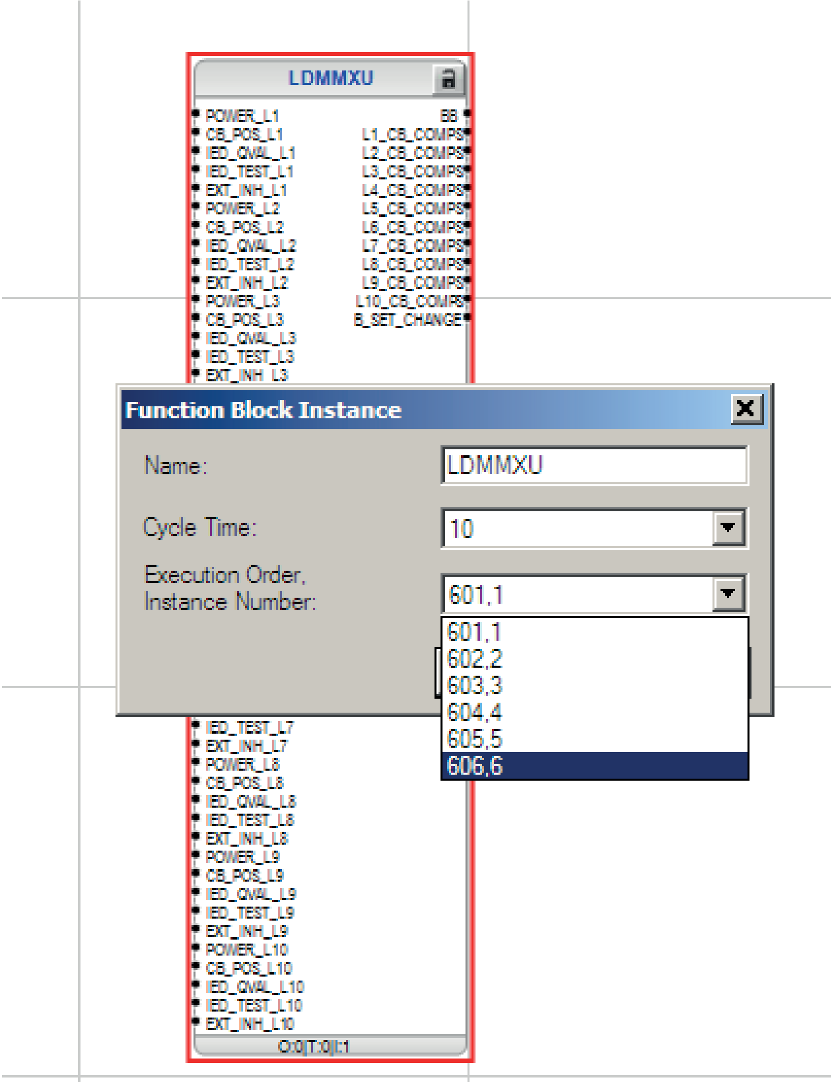


Figure 74: Number of instances of LDMMXU function blocks

14. Instantiate other load-shedding function blocks to extend the network configuration to, for example, six-busbar network and make the inter-function block connections manually, similar to any other IED configuration.

Once the network configuration is completed, the IED configuration can be exported and the IEC 61850 engineering completed in the IET600.

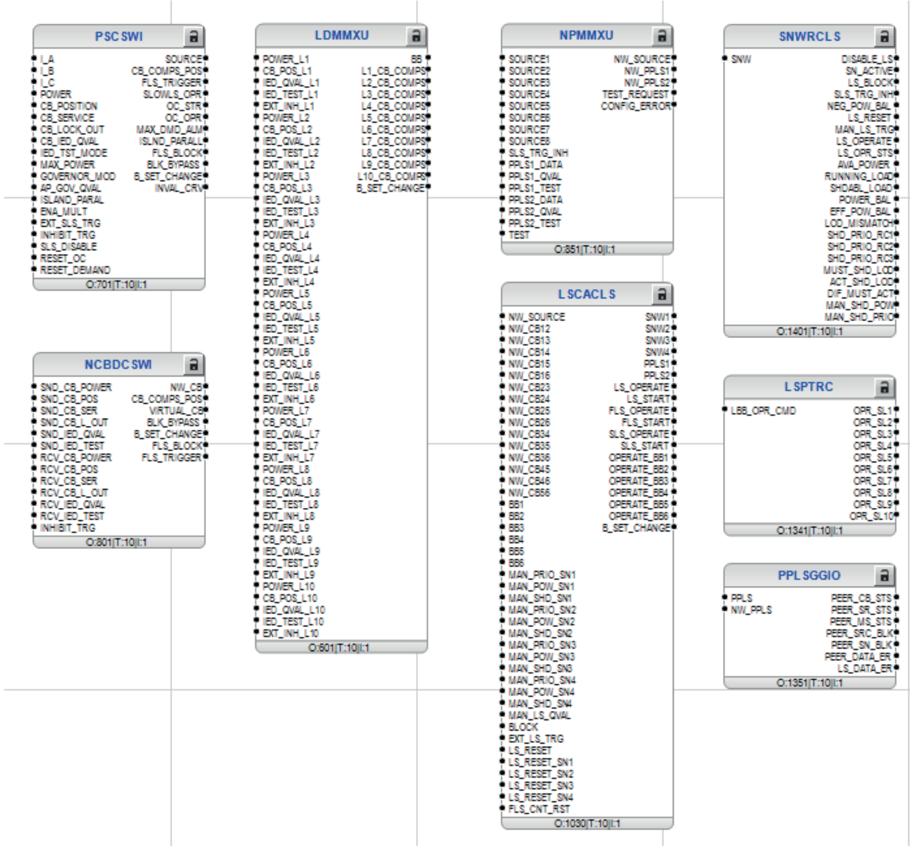


Figure 75: Manually inserted power management function blocks

15. Complete the remaining steps like automatic GOOSE connection and download the configuration into the IED.

Scenario 2:

1. Steps 1 to 10, as mentioned for Scenario 1, are applicable. Alternatively, the offline mode of IED configuration can also be selected.
2. The Application Configuration page is empty and hence, the entire load-shedding application has to be performed manually.
3. Step 15, as mentioned for Scenario 1, are applicable.

The COM600 automatic display and IEC 61850 automatic data flow configurations cannot be generated in Scenarios 1 (for the added part) and 2 (completely), as these are effective only when the configuration wizard runs through the load-shedding configuration (Network Configuration pages).

4.12 Interconnection between function blocks

After completing the configuration wizard steps, verify the created load-shedding logic.

1. Right-click the PML630 object and select **Application Configuration**.

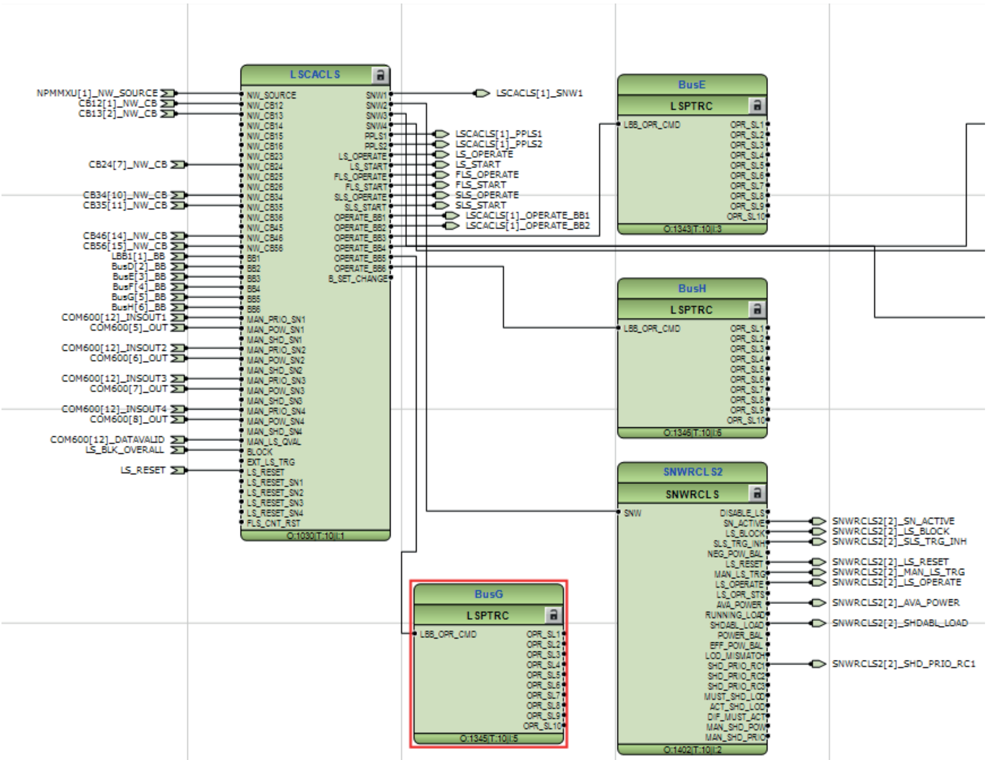


Figure 76: Load-shedding main application logic

Based on the configuration selected in the Configuration Wizard, the function blocks and their inter-connections are displayed in the Application Configuration tool.
The automatically created load-shedding logic must not be modified as, for example, deleting function blocks alter the connections for several reasons.

- Load-shedding function blocks cannot be instantiated in the Application Configuration tool.
- Once altered, connections are not done automatically.

In case the connections are altered and need to be restored, the License Update tool can be run to restore the connections.

2. If the load-shedding logic is modified, delete the existing IED configuration in the PCM600 project tree and rebuild it. Any additional logic can also be inserted

as per project-specific needs with the instantiable function blocks in the Application Configuration tool.

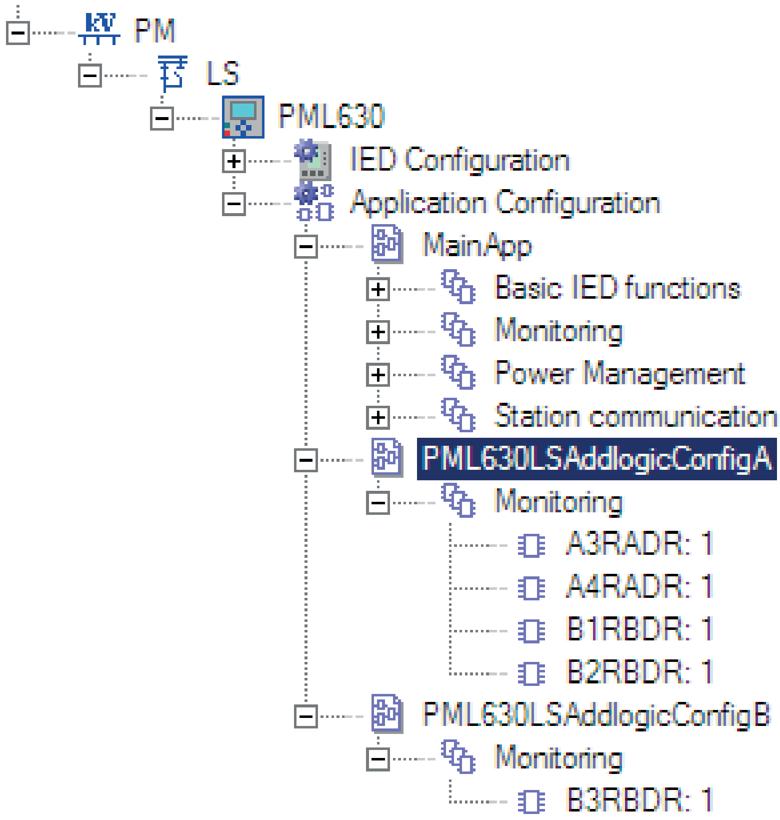


Figure 77: PCM600 : Application configuration pages

The PML630LSAddlogicConfigA and PML630LSAddlogicConfigB application pages for the LEDs, events in LHMI, function key configuration and disturbance record are created automatically.

- PML630LSAddlogicConfigA contains the above function blocks related to the cPMS - LS configuration A.
- PML630LSAddlogicConfigB contains the above function blocks related to the cPMS - LS configuration B.

The ACT connection of the function blocks in Addlogic ACT pages with power management function blocks in the main application pages is done automatically.

4.13 Creating load-shedding key single-line diagram in Graphical Display Editor

After completing the configuration wizard steps, the key load-shedding single-line diagram must be verified.

1. Right-click **PML630 Object Type** and select **Graphical Display Editor**. The network diagram as defined in the configuration wizard is displayed.

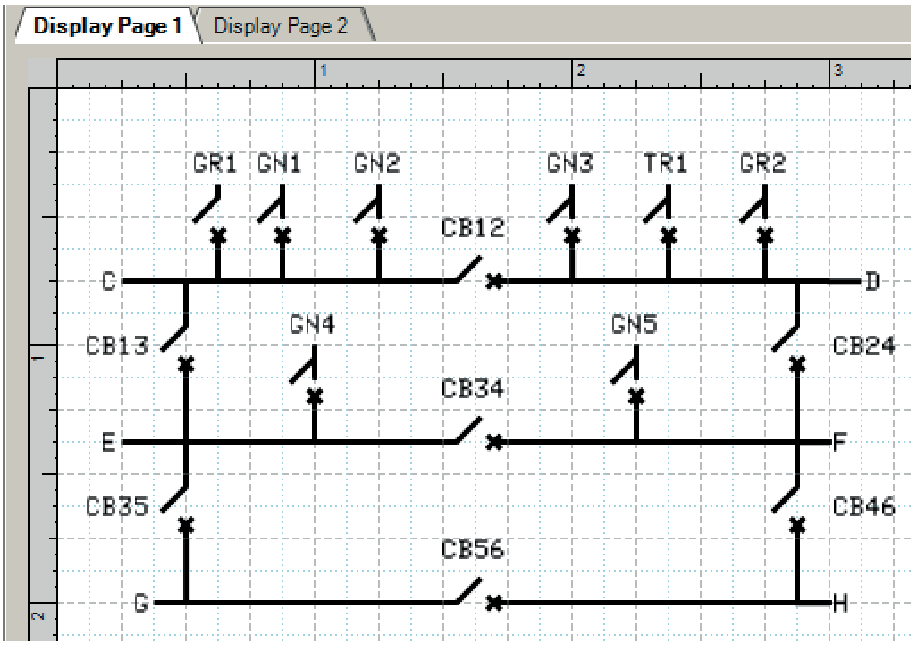


Figure 78: Graphical Display Editor: key load-shedding single-line diagram for a six-busbar configuration

The automatically created single-line diagram comprises of only busbars, power sources and critical circuit breakers (bus couplers, equivalent representation of tie feeders, source circuit breakers). When opened for the first time, the single-line diagram can be distorted. The distorted elements can be rearranged. Modification (for example, deletion and re-instantiation) of the automatically created load-shedding key single-line diagram objects is not possible, since the load-shedding display objects (circuit breakers) cannot be linked back to respective IEC 61850 information in Graphic Display Editor as they are not available for selection. Load circuit breaker indications can be included and connected to the respective circuit breakers.

2. Rearrange the objects in the **Graphical Display Editor** page to match the system representation.
The network diagram can be extended with **Symbol Library**.

The peer area connectivity needs to be configured in Graphical Display Editor manually for the GR1 and GR2 by the user as per the network connectivity to the other electrical network area.

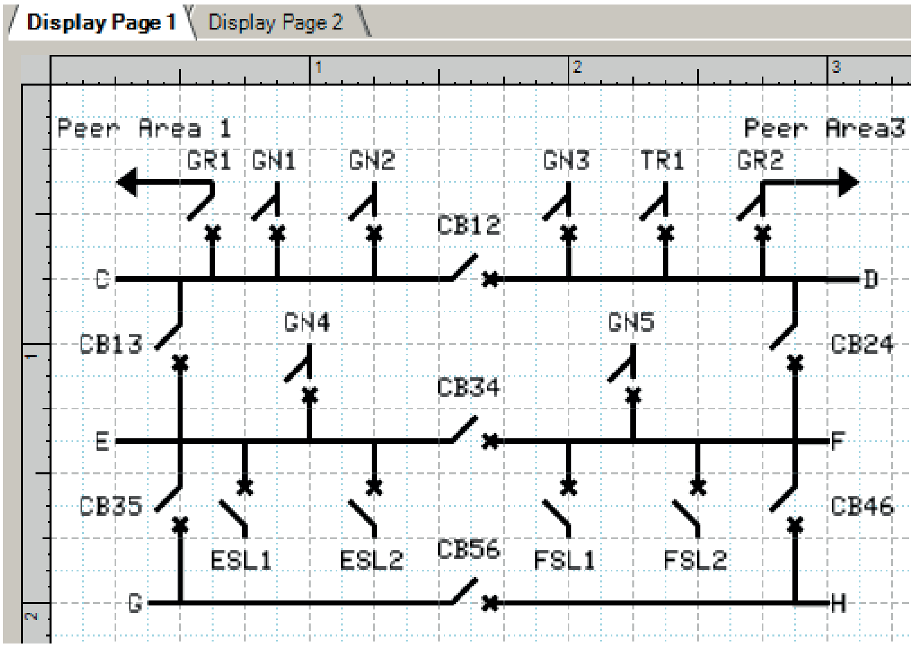


Figure 79: Graphical Display Editor: extended single-line diagram

3. Associate each load feeder IED with its IEC 61850 status input information data point in the IED.

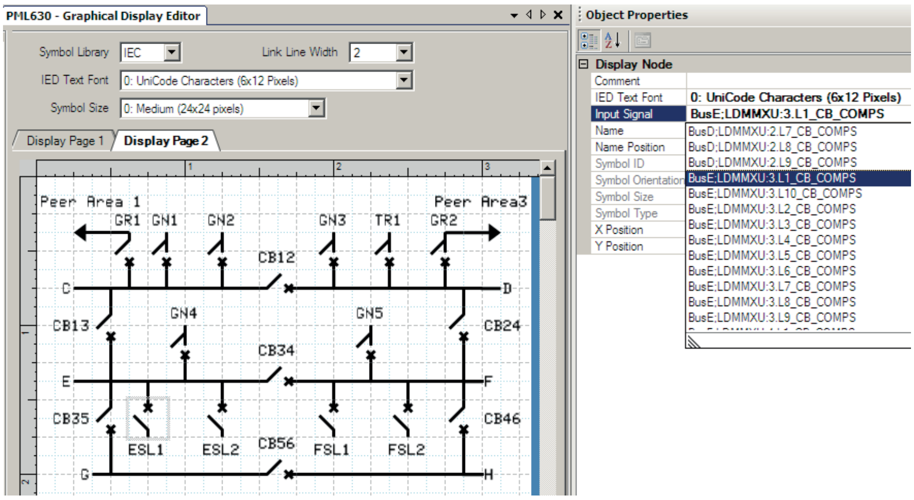


Figure 80: *Graphical Display Editor: extended single-line diagram with additional load feeder representation and peer area network connectivity*

4. If needed, introduce symbols such as generator and transformer and associate them with the power source representation.

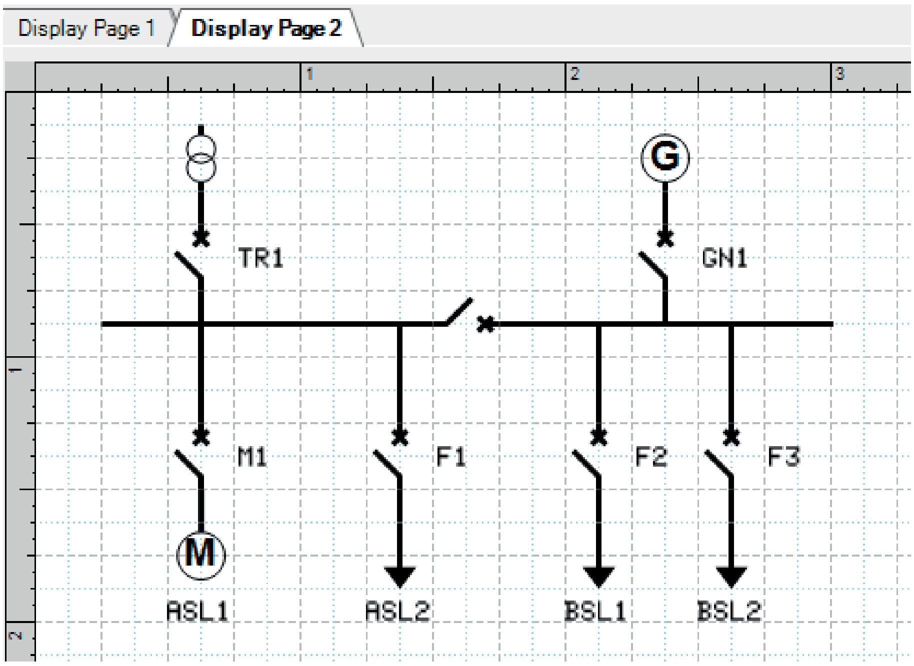


Figure 81: *Graphical Display Editor: extended single-line diagram with generator and transformer symbols*

If the PML630 IED is reconfigured using License Update Tool after rearranging the single-line diagram in Graphical Display Editor, the rearrangement in Graphical Display Editor needs to be repeated.

4.14 IED reconfiguration

The IED Connectivity Package allows to reconfigure the load-shedding configuration by re-launching the configuration wizard on launching of the License Update tool (LUT). On user confirmation at the end of reconfiguration activity, the License Update tool recreates the entire configuration based on the changes made in the Network Configuration and Order code pages.

The IED Connectivity Package retains all the configurations done prior to the reconfiguration activity. Hence, do not re-enter all the information entered during the first iteration of the IED configuration. It also allows to reject the introduced modifications. The IED reconfiguration is required under the following cases.

- Network configuration change
  - Addition or modification of the existing busbar assignment, for example, level, names.
  - Addition of a new load feeder to a busbar
  - Modification of an existing load feeder's assignment to a busbar
  - Addition of a new power source to a busbar
  - Modification of an existing power source's assignment to a busbar
  - Addition of a new bus coupler or a tie feeder to a busbar
  - Selecting or removing the already selected information of virtual circuit breaker configuration for the couplers
  - Modification of an existing bus coupler or a tie feeder's assignment to a busbar
- Load-shedding logic in the Application Configuration tool
  - Restoration of the automatically created function blocks deleted inadvertently
  - Restoration of the automatically created connection(s) between function blocks deleted inadvertently
- Regeneration of the automatically created key single-line diagram for Graphic Display Editor
- Regeneration of the load-shedding displays section in the IEC 61850 configuration file (SCD/CID) of the IED
- Upgrade of load-shedding functionality in future
- Upgrade of load-shedding configuration option in future from cPMS - LS Configuration A to cPMS - LS Configuration B
- Change of IED hardware, if applicable in future

Any changes done in the configuration or hardware with the LUT tool reinstantiate the load-shedding application logics and set the default load-shedding parameters for the power management function blocks. Therefore, it is recommended to take the complete backup of the parameter setting tools and restore it with the parameter setting import tool in PCM600.
As the power management function blocks are reinstantiated after the completion of LUT tool, IEC 61850 references also changes. It can change the data object contents in the data sets and configuration revision of the GOOSE and MMS control blocks. Hence, it is recommended to export the .SCD file with the Automatic Dataflow Engineering tool and use it for SAB600 configuration again. Also verify the GOOSE data in the input sections of all the IEDs in the PCM600 project and rewrite the configurations.

4.14.1 Reconfiguring IEDs

1. To begin IED reconfiguration, right-click the PML630 Object type and select **License Update Tool**.

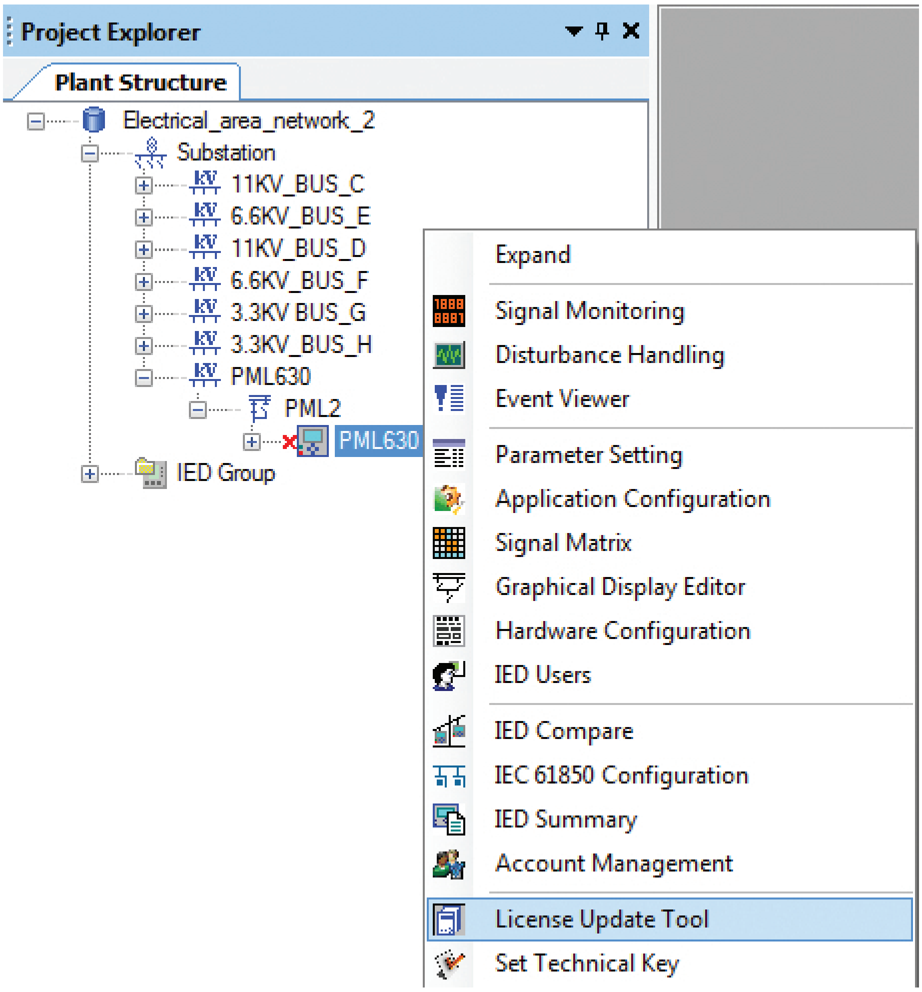


Figure 82: License Update Tool

2. Select **License Update Tool**. A dialog box appears to prompt for the taking of a backup of the current.

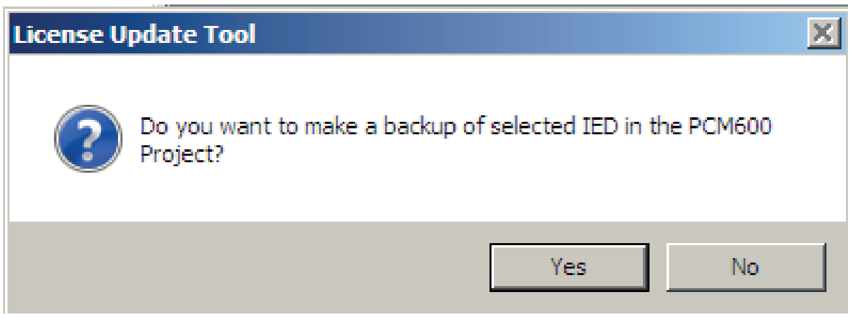


Figure 83: Configuration backup prompt from LUT

3. Click **Yes** to save the IED configuration as a .pcmi (template) file.

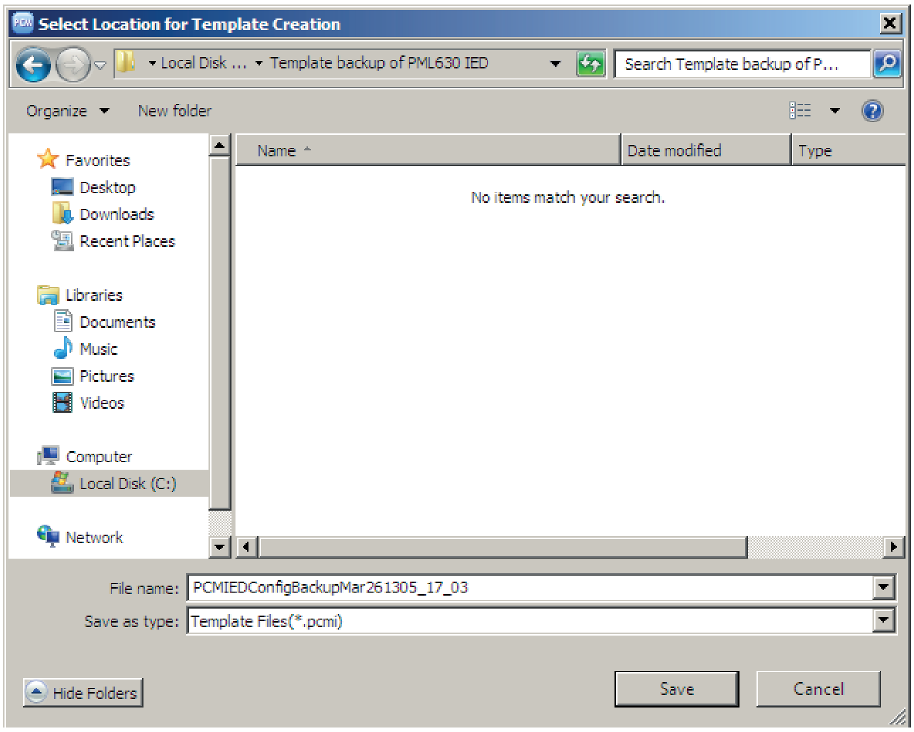


Figure 84: Saving the IED template file

- While running the License Update tool for any changes in HW or network configuration, it is required to take the backup of the IED, SCD file and the parameter setting file exported from the IED.
- IED connpack reinstantiates all the power management functions again, therefore, the configuration revision of the MMS data set can change. Reimport the new SCD file into the SAB600 project.
- The power management function blocks are reinstantiated with the default parameter settings for the functions, therefore, reimport the exported parameter setting file and verify the parameters for the power management functions.
- Make the changes again in the LHMI displays with the Graphic Display Èditor as the previous changes are lost after running the License Update tool. This is because at present there is no provision available in PCM600 to take section-wise or selective backups of the IED configuration.

4. Click **Save**. A progress bar appears, indicating the progress of the current IED configuration backup process.

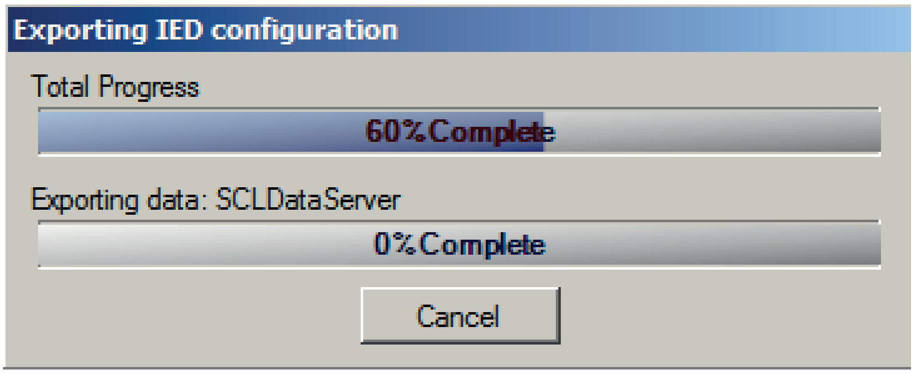


Figure 85: IED template file export progress bar

On completion of the export of the IED configuration file or when the current IED configuration is decided not to be saved, the selection page under License Update Mode appears, similar to the one when the Configuration Wizard is launched.

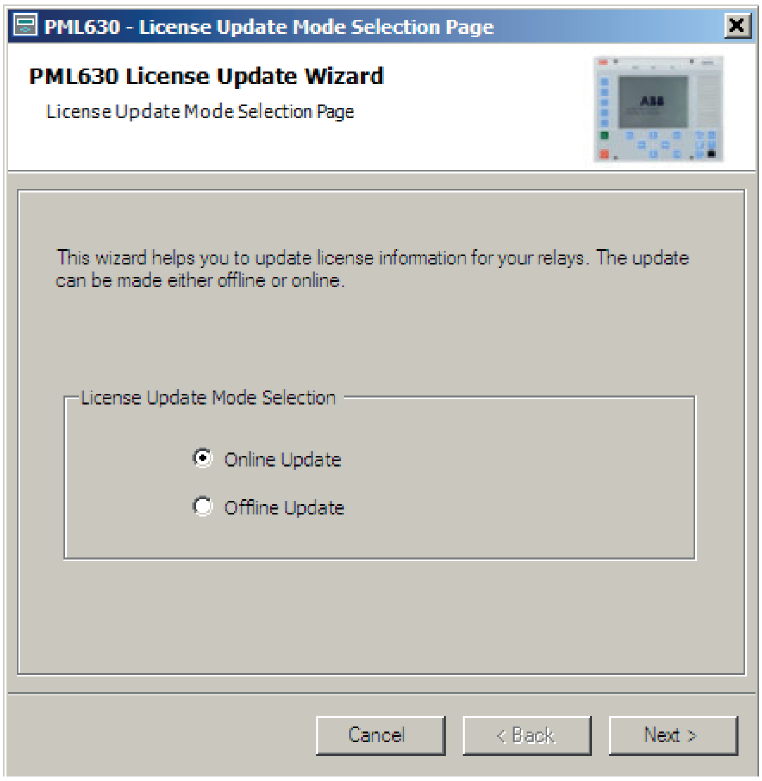


Figure 86: License Update tool mode Selection Page

5. Select the update to be done in the IED online or offline modes.
6. Click **Next** on the **License Update Wizard** to open **Order Code Selection** page, where the modification of the IED hardware and software options is possible to generate a change in the order code.

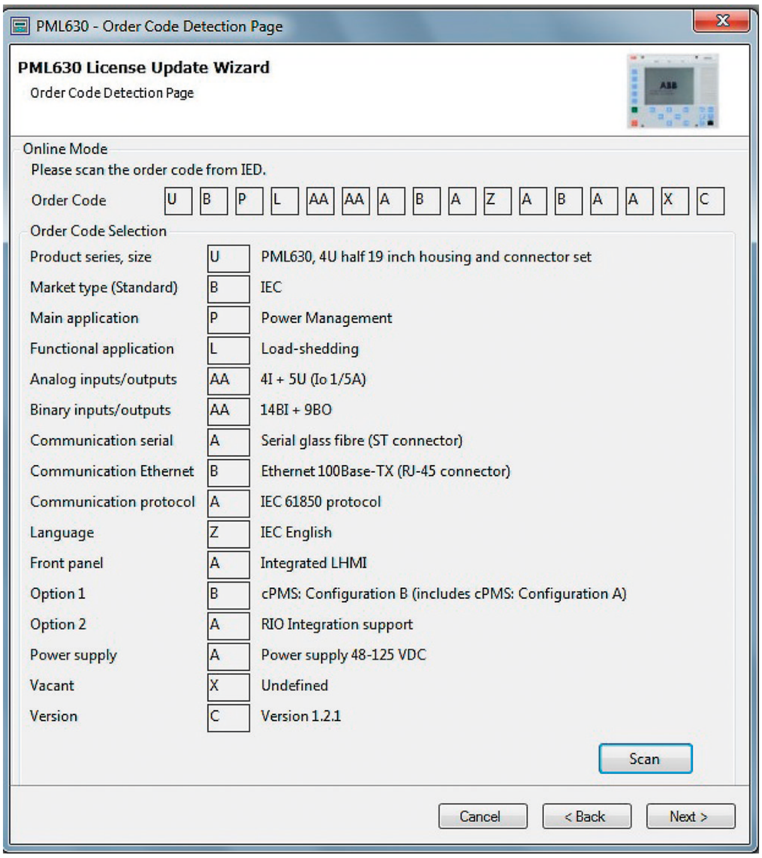


Figure 87: Order selection page

Changing Order Option 2 - A (RIO Integration support) to N should not be done by the user. A warning message displays saying that network configuration is lost if the load-shedding configuration is changed. Click **OK** to proceed, else click **Cancel**. That is, License Update tool does not support to remove or downgrade the RIO integration support, the complete configuration in wizard needs to be redone and older configuration cannot be saved.

7. Click **Next**. This action prompts the load-shedding functionality license update dialog box to appear, where the load-shedding network configuration can be upgraded.

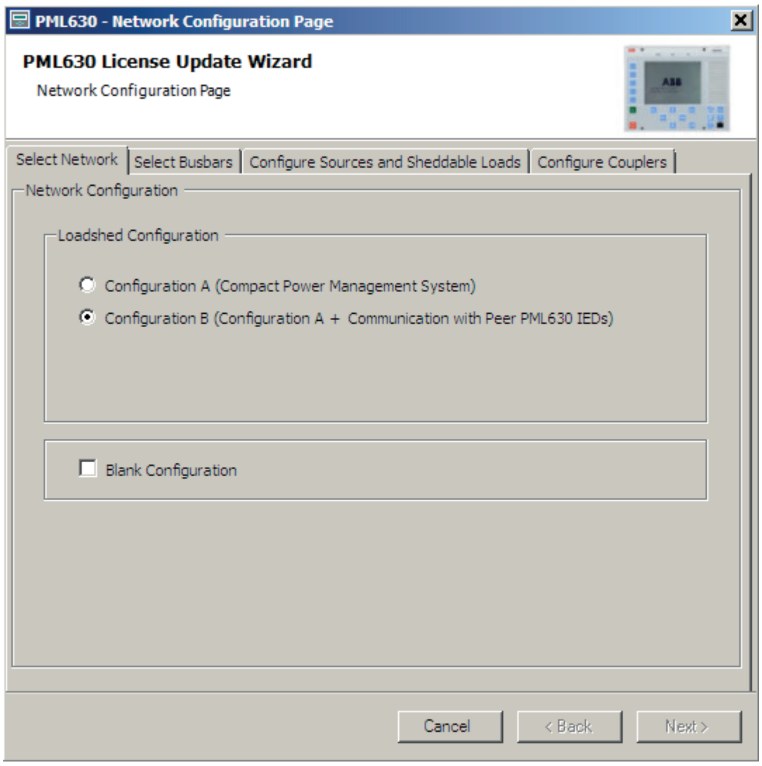


Figure 88: Load-shedding network configuration page

8. Make additions or modifications as needed for the load-shedding functionality related to load feeders, power sources, network circuit breakers and busbars.

Change of Loadshed Configuration option from Configuration B to Configuration A should not be done by the user. A warning message displays saying that network configuration is lost if the load-shedding configuration is changed. Click **OK** to proceed, else click **Cancel**. If Configuration A is changed to Configuration B, first remove loads\Sources\coupler before removing the already configured busbars.

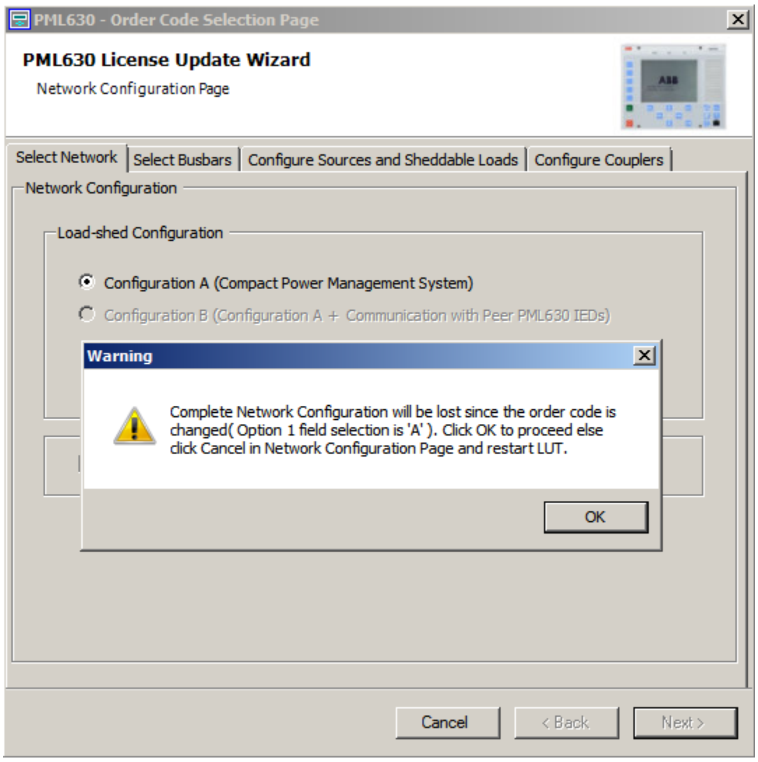


Figure 89: Warning message while downgrading the cPMS Configuration B to A

An example to add a load feeder.

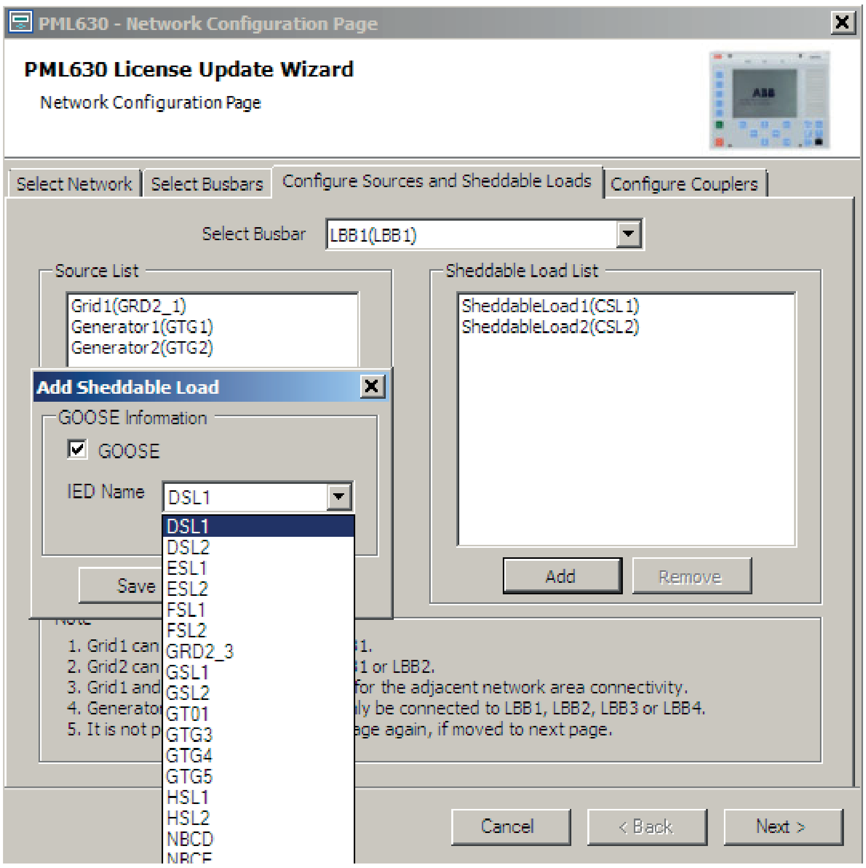


Figure 90: Adding network component (Load) in PML630 License Update Wizard

9. Click **Next**. The updated license code appears.

Adding network components does not influence the order code.

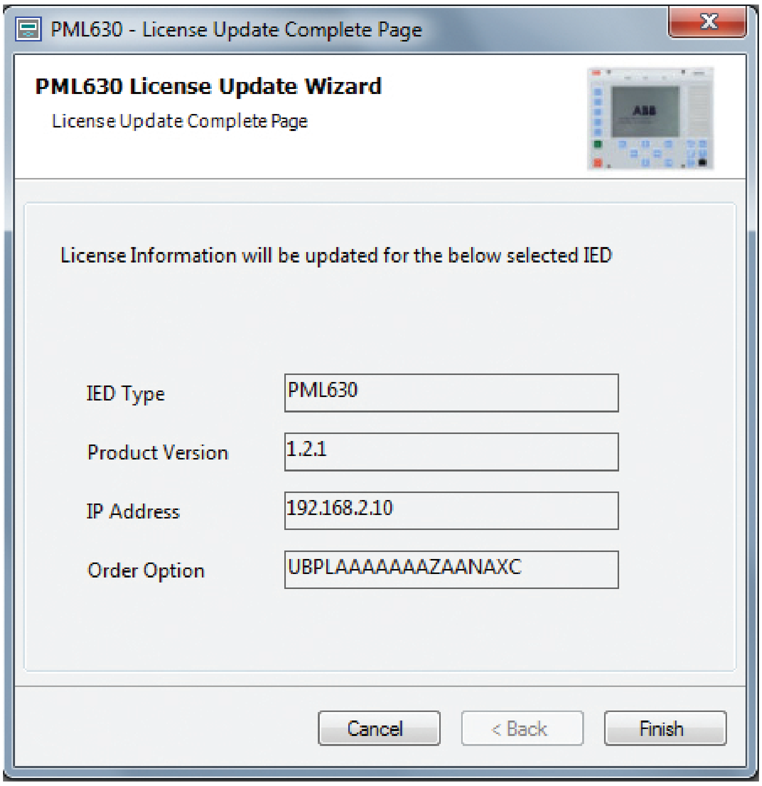


Figure 91: License update complete page

10. Click **Finish** to complete the reconfiguration process with the changes considered.
11. Click **Cancel** to reverse the changes done in the **Network Configuration** page or **Order Code Detection** page.
    The IED Connectivity Package does not affect any change in the IED configuration and, thus, ignores the changes.

Precautions to be taken while using LUT

- Some of the changes made with the License Update tool for the load-shedding network configuration need multiple procedures before the configuration is downloaded into the IED and failing of performing the procedures may result in incorrect IED behaviour.
- It is assumed that the feeders' IEDs are not deleted from the PCM600 structure.
- The changes and their impacts are described in Table 2.

Case 2 can have unconnected function blocks in Application Configuration tool.

Table 2: Changes in the load-shedding network configuration and their impact

Case	Intent Impact	IEC 61850 datasets of IED (config. rev)	Power Management PST corrections (Default setting are applied after running LUT)	IET600 Engg.		SMT Config.		SLD in GDE	SAB 600
				MMS	GOOSE	Feeder IED	IED		
1	Add load feeder	Yes	Yes	Yes	Yes	Yes	Yes	No[1]	Yes
2	Delete load feeder	No	Yes	No	No	No	No	No	Yes
3	Swap load feeders from one busbar to another	Yes	Yes	Yes	Yes	Yes	Yes	No[1]	Yes
4	Swap power source feeders from one busbar to another	Yes	Yes	Yes	Yes	-	No	Yes	Yes
5	Delete busbar	No	Yes	Yes	Yes	No	No	Yes	Yes
6	Change busbar levels	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
7	Change of order codes (power supply, LHMI arrangement and Ethernet connectivity type)	NA	Yes	NA	NA	NA	NA	Yes	Yes
8	Modification of Source Type and Adjacent Network Connectivity information.	Yes	Yes	No	Yes	No	Yes	Yes	Yes
9	Selecting or removing the already selected current measurement information.	No	Yes	No	No	No	No	Yes	Yes
10	Selecting or removing the already selected information for various Source Type for Available power mode - *Ava Pow Mode* selection or governor mode - *En Comm Gov Mode* selection for sources.	Yes	Yes	No	Yes	No	Yes	Yes	Yes
11	Selecting or removing the already selected information for Virtual Circuit Breaker configuration for couplers	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes

1) If the load feeder is included or removed in the SLD

- It may take some time to complete the License Update tool activity, especially after making the changes in the load-shedding network configuration as the Configuration Wizard performs the IED load-shedding configuration again.
- Before running the License Update tool changes involving non-load-shedding network elements, export the project .scd file (from the IED object) as a backup. After completion of License Update tool, re-import the .scd file in the project. Once done, check that the Signal Matrix tool connections are intact. Without taking the backup of the .scd file, the Signal Matrix tool connections for load feeders (load-shedding commands received in IED) may be lost.

4.15 Configuration of load-shedding groups and PCM600 project handling

Ideally the engineering and configuration of all feeder IEDs are already done before the commencement of the IED configuration.

Multiple load feeders are grouped together to form load-shedding groups in certain conditions.

- When the sheddable feeder IED count in a busbar exceeds 10 (This is because the IED only handles a maximum of 10 priorities in a busbar)
- When the electrical network is big and thus comprises of IEDs that cannot be handled in a single PCM600 project

By grouping load feeder IEDs, the number of load feeder 615, 620 and 630 series IEDs communicating directly with the IED is decreased. A load-shedding group comprises of a maximum of three load feeders IEDs.

Another reason is to optimize the PCM600 project sizes that could be significantly large when configurations are attempted to be engineered under the same project in PCM600. This could result in performance issues related to PCM600. Hence, to manage a higher number of loads per busbar and PCM600 project size, a split in the PCM600 projects is necessary and may be unavoidable.

All feeder IEDs with the same shedding priority (as per plant processes) in each busbar are grouped into a single entity (group), and an IED from this group is assigned as the representative load. This feeder IED communicates the cumulative power value of this group to the IED. The feeder IEDs in this group do not communicate with the IED directly, and are termed as dependent loads. However, load-shedding commands from the IED are extended directly to the representative load and dependent loads.

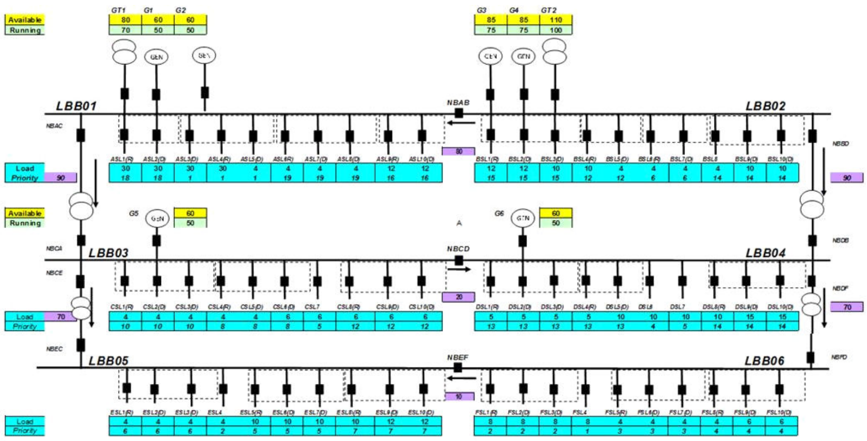


Figure 92: Example of six-busbar configuration

This network comprises of two grid transformers, six generators, six busbars, 60 loads/load-shedding groups connected across six busbars and 11 network circuit breakers (bus couplers/tie feeders).

Though the loads in every busbar are only 10, the above network has 79 IEDs that need to be directly associated with the IED.

The current limitations in PCM600 prevent the engineering of 200 IEDs in a single project.

The load-shedding group adaptations is also needed when the number of loads under a busbar increases beyond the current limit of 10.

In a busbar LBB03 network that comprises of generator G5, network circuit breaker NBCA and 10 sheddable loads. Load feeders CSL1, CSL2 and CSL3 have the same load-shedding priority (10) (process-wise) and hence included in a single load-shedding group. The IEDs belonging to the same group are enclosed and identified by a dashed rectangle.

Similarly CSL4, CSL5 and CSL6 form the second load-shedding group (priority 8) and CSL8, CSL9 and CSL10 form the third group (priority 12). One independent load feeder CSL7 has the priority 5 that is not a part of any load-shedding group. Similarly, such an arrangement is carried out for all five other busbars. An example of such load-shedding group is presented under busbar LBB01.

While the ASL4 load feeder is referred to as representative load (RL), the ASL3 and ASL5 load feeders are referred to as dependent loads (DL). All the feeders under a load-shedding group have the same priorities.

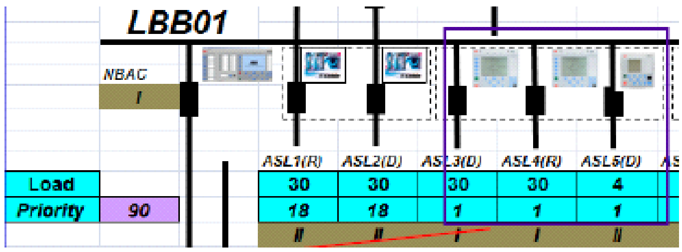


Figure 93: Load-shedding group arrangement

The IED that is not a part of a load-shedding group is referred to as an independent load (IL).

In LBB03, for example, all representative loads (CSL1, CSL4, CSL8) and independent load (CSL7) besides G5- (generator), NBCA-, NBCE- and NBCD - related (tie feeders and bus couplers) IEDs need to communicate directly with the IED. The IED issues independent shedding commands to the representative loads and independent load. Dependent loads communicate with their respective representative load within the load-shedding group. They send power value and circuit breaker status data to the respective representative load using the IEC 61850 GOOSE communication profile. Representative load combines this data with its own data using a customized logic. This logic should be included in feeder IEDs (REM/REF/RET) 615, 620 and 630 series.

Only an REF630/RET630/REM630 1.1 IED can be assigned to be a representative load, whereas an dependent load can be an (REF/REM/RET) 615, 620 and 630 series version 1.0.

Input data handling at representative load

The logic in the representative load includes several aspects.

- The logic to receive the circuit breaker position of the two dependent loads. The logic also includes the validation of GOOSE data and conversion to one-bit value for switching of power value.
- The logic to convert the two-bit representative load circuit breaker position information to one-bit.
- The logic to receive the power values of the two dependent loads. The logic also includes the validation of data based on GOOSE and one-bit circuit breaker status, logic for summation of power values of dependent loads and representative load. Summationed power values is send to the IED.
- Combined circuit breaker position status of representative load and two dependent loads after conversion to two-bit status information is send to the IED.

If the representative load is in Test mode, the entire load-shedding group (including representative loads) becomes inhibited for load-shedding.

Command handling and distribution of commands to dependent loads at representative load

Besides the representative loads and independent loads, the IED sends load-shedding commands also directly to REF630/RET630/REM630-based dependent loads. However, for (REF/REM/RET) 615 and 620 series-based dependent loads, the load-shedding command is routed through the representative load.

This difference in handling between 630 series and 615/620 series is due to the current limitations in the latter to handle its own test mode condition in the Application Configuration tool.

Only REF630/RET630/REM630 1.1 version IEDs can play the role of representative loads. This is because only they have the capability to receive Analog GOOSE needed to receive power values from dependent loads.

PCM600 project configuration

The configuration for the above six-busbar network arrangement is divided in the manner as described below.

The main project consists of all the power sources under busbars LBB01..04, all the representative loads under LBB01...06, independent loads under LBB01..06 and the IED. In other words, the main project comprises of all the feeder IEDs communicating directly with the IED.

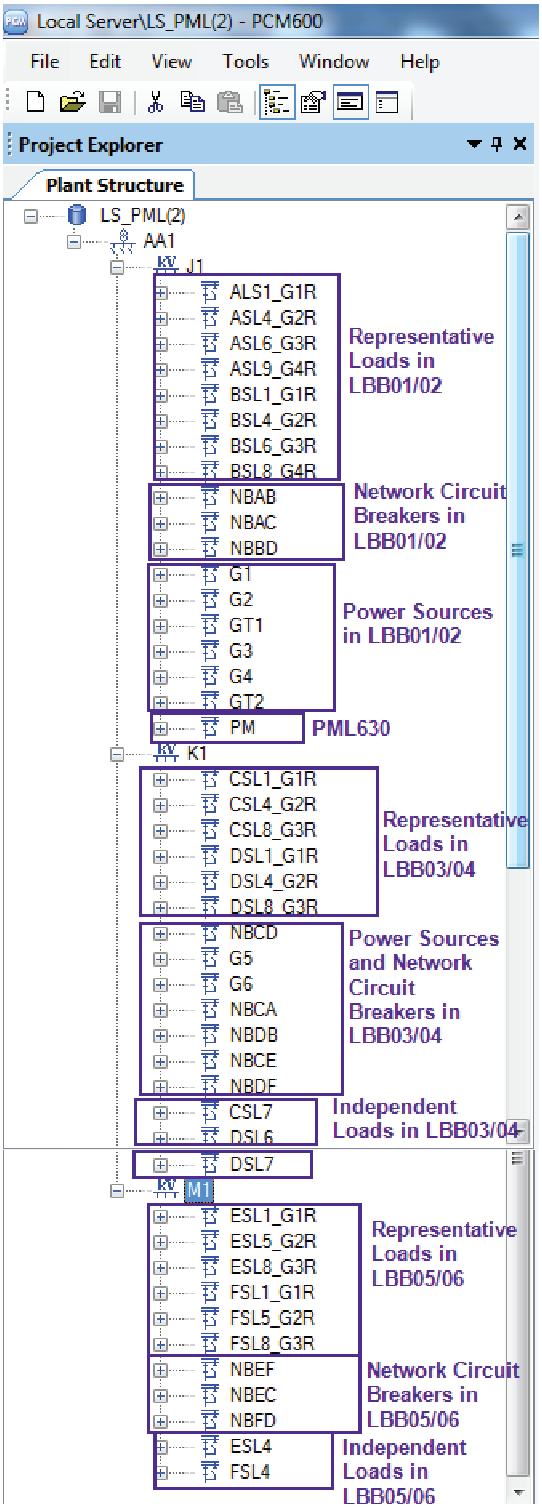


Figure 94: Main project tree structure

The subprojects (typically one per busbar) comprise of dependent loads, representative loads and the IED. In other words, all the load feeder IEDs belonging to various load-shedding groups are included in the subproject. The IED is also included in the all the subprojects as it is directly associated with representative loads to ensure inter-project (main and subproject) configuration consistency.

In this example, there are six such subprojects for LBB01...06.

The subproject composition can be decided but the modularity and PCM600 limitations must be considered.

The IED group, as shown in Figure 95, should not be deleted, as it is needed to keep the SCL structure of the project intact.

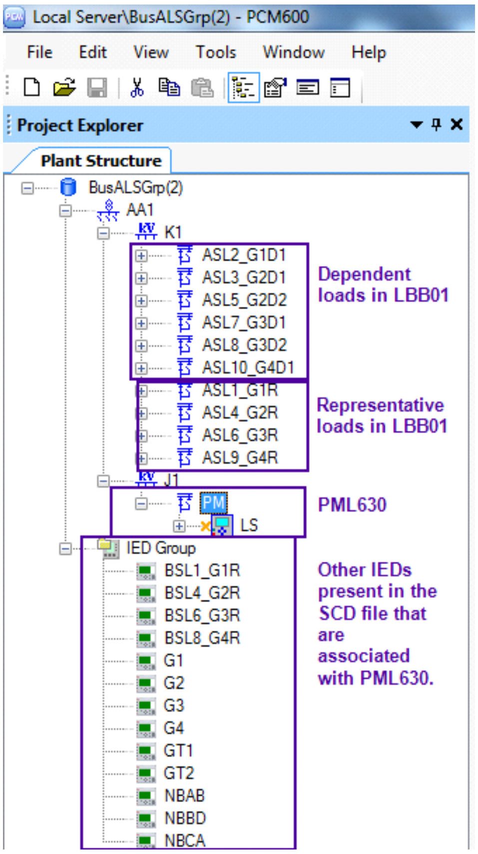


Figure 95: Subproject for LBB01 configuration details

Considerations for configuration download

After completing the engineering for the entire network, the configurations related to power sources, network circuit breakers and independent loads can be downloaded in the respective IEDs from the PCM600. The IED configuration can also be downloaded from the main project.

The representative load configurations should not be downloaded from the main project.

The configurations for all the representative loads and dependent loads should be downloaded from the subprojects.

IEC 61850 GOOSE communication parameters setting should be identical in the main and subprojects for the IED and representative load in IET600.

No additional logic engineering is required in the IED for load-shedding group configuration as the IED notices only the representative load and not the dependent loads.

4.16 Load-shedding group handling engineering

Projects involving big network configurations and load-shedding groups require main project engineering and subproject engineering.

4.16.1 Engineering main projects

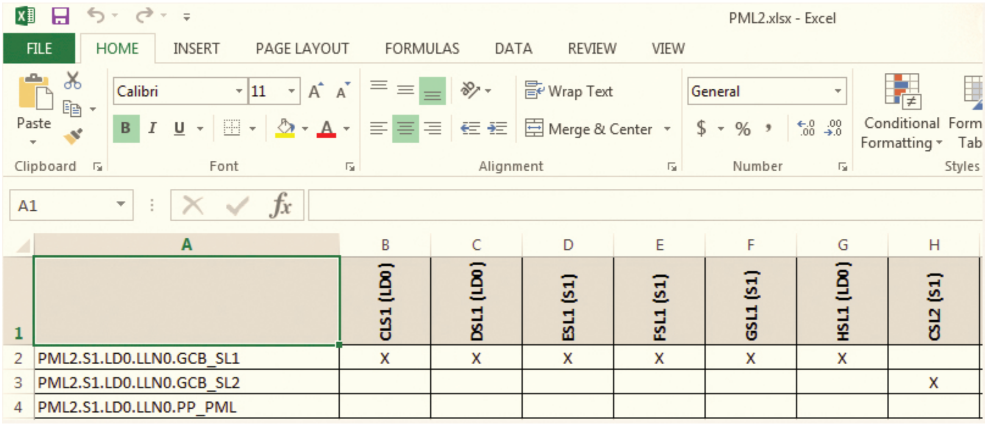
Projects involving big network configurations and load shedding groups require main project engineering.

1. Configure representative load feeder IEDs, independent load IEDs, power source IEDs and IED in the main project.
2. Perform IET600 Engineering for load shedding functionality.
3. Import the main project .scd file into PCM600 and complete the Signal Matrix tool configuration for the IED and feeder IEDs.
4. Export the IED template files (.pcmi) of PML630 and all representative loads.
5. Export the IED .cid file. This file also comprises of all representative loads.
6. The independent load IEDs, power source IEDs and IED configurations are ready to downloading to the respective IEDs.

4.16.2 Automatic DataFlow engineering

From PCM600 Ver.2.6 onwards, GOOSE subscription for sheddable loads has to be manually configured in the IEC 61850 Configuration tool. To ensure ease of engineering, an Excel sheet with a similar look and feel as the IEC 61850 Configuration tool is exported at given location after the Automatic DataFlow Engineering action.

While the sheddable loads appear in the first column, the list of GOOSE Control Blocks from PML630 appear in the first row. Each sheddable load has a subscription mark to a particular GCB in accordance with the configuration done in the PML630 Configuration wizard.



	CLS1 (LD0)	DSL1 (LD0)	ESL1 (S1)	FSL1 (S1)	GSL1 (S1)	HSL1 (LD0)	CSL2 (S1)
PML2.S1.LD0.LLN0.GCB_SL1	X	X	X	X	X	X	
PML2.S1.LD0.LLN0.GCB_SL2							X
PML2.S1.LD0.LLN0.PP_PML							

Figure 96: Exported sheddable load list

4.16.3 Engineering subprojects

Projects involving big network configurations and load-shedding groups require subproject engineering.

1. Create the subproject for LBB01.
2. Add and engineer all the dependent load IEDs.
3. Import the PCMI files of PML630 and representative loads , exported from the main project.
4. Export the .scd file.
5. Create a new IET600 project and import the .scd file.
6. Import the IED .cid file into IET600.
7. Perform IET600 Engineering for data exchange between representative load and dependent loads. The GOOSE data flow configuration for the representative loads comprises of both dependent loads and PML630 (load-shedding commands).
8. Generate the LBB01 SCD file and import into the PCM600 LBB01 subproject. Select **Ignore Substation section** in PCM600.
9. Make the Signal Matrix tool configuration for representative load and dependent loads.
10. The configurations of representative load and dependent loads are ready for downloading to the respective IEDs.

The subproject engineering steps are repeated for the remaining busbars LBB02 to LBB06.

4.17 Exporting IED lists using connectivity package

The IED connectivity package provides a feature to export an IED list that consolidates the properties of the IEDs configured in the load-shedding functionality. This feature is available only on completion of the configuration wizard steps. The following IED details are made available on clicking the export IED list utility.

- Position in PCM600 project plant structure
- Type
- Configuration version
- Technical key
- Order/composition code
- Feeder type for load-shedding

The following steps describe the actions to export such an IED list.

1. Right-click the IED and select **Export IED List**.

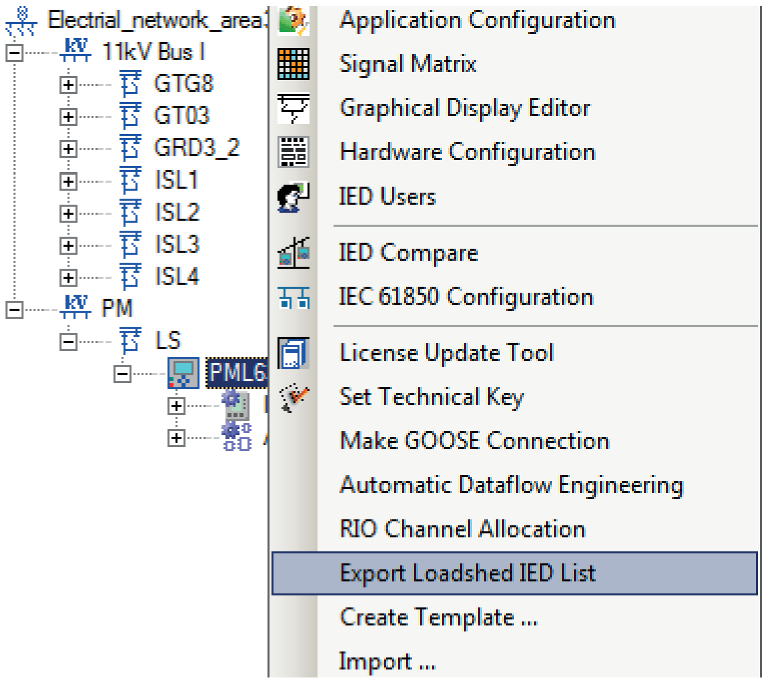


Figure 97: Select Export IED list

2. Save the IED list at the desired location in the engineering station or network server.

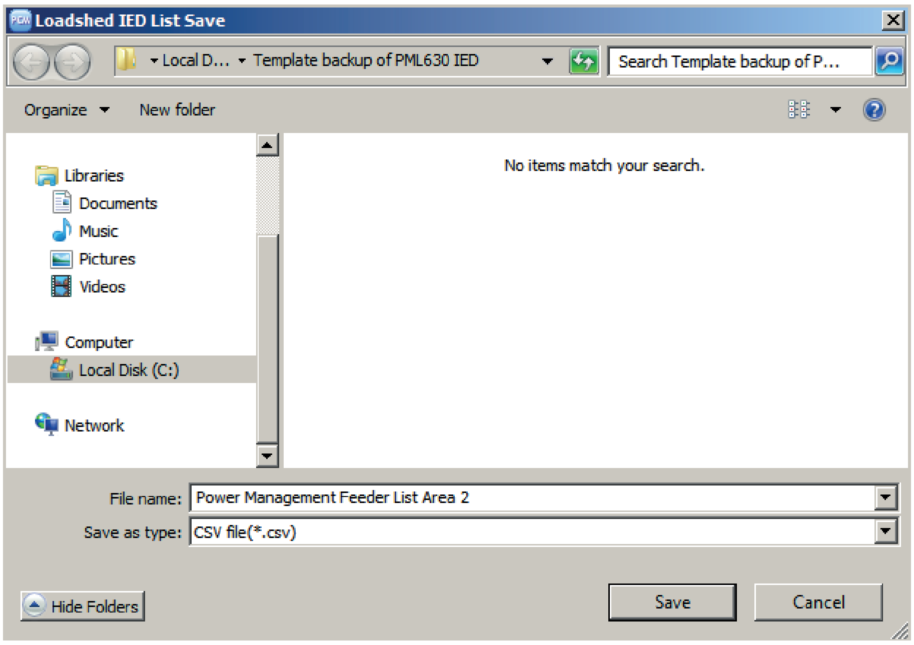


Figure 98: Save the load-shed IED list

3. Open the IED list file to view its content.

Feeder IED List for PML630 :-					
Substation/VoltageLevel/Bay	IED Type	Configuration Version	IED Technical Key	Order/ Composition Code	Feeder Type for Load-shedding
Electrical area 2/11kV BusC/GRD2_1	REF630	REF630ver1.2.0.10	GRD2_1	SBFDABABAAAZANNAXC	C(LBB1)-Grid1- Adj.Area
Electrical area 2/11kV BusC/GTG1	REG630	REG630ver1.2.0.10	GTG1	SBGAABAAAAAZAZNAXC	C(LBB1)-Generator1
Electrical area 2/11kV BusC/GTG2	REG630	REG630ver1.2.0.10	GTG2	SBGAABAAAAAZAZNAXC	C(LBB1)-Generator2
Electrical area 2/11kV BusC/Cracker1	REF615	D	CLS1	HBFFAFAGABC3BAA2XD	C(LBB1)-SheddableLoad1
Electrical area 2/11kV BusC/PE1	REF630	REF630ver1.1.0.1	CSL2	SBFNABABAACZAZNAXB	C(LBB1)-SheddableLoad2
Electrical area 2/11kV BusD/GTG3	REG630	REG630ver1.2.0.10	GTG3	SBGAABAAAAAZAZNAXC	D(LBB2)-Generator3
Electrical area 2/11kV BusD/GT01	REF620	F	GT01	NBFNAANNABC1BNN1XF	D(LBB2)-Transformer1
Electrical area 2/11kV BusD/GRD2_3	REF630	REF630ver1.2.0.10	GRD2_3	SBFDABABAAAZANNAXC	D(LBB2)-Grid2- Adj.Area
Electrical area 2/11kV BusD/Cracker2	REF620	F	DSL1	NBFNAANNABC1BNN1XF	D(LBB2)-SheddableLoad1
Electrical area 2/11kV BusD/PE2	REM615	E	DSL2	HBMCAEAGNBA1BBN1XE	D(LBB2)-SheddableLoad2
Electrical area 2/6.6kV BusE/GTG4	REG630	REG630ver1.2.0.10	GTG4	SBGAABAAAAAZAZNAXC	E(LBB3)-Generator4
Electrical area 2/6.6kV BusE/PTA1	REF630	REF630ver1.0.0.0	ESL1	SBFNABABAABZAZNAXA	E(LBB3)-SheddableLoad1
Electrical area 2/6.6kV BusE/RW1	REM630	REM630ver1.1.0.1	ESL2	SBMNAAAAAAAZNNNAXB	E(LBB3)-SheddableLoad2
Electrical area 2/6.6kV BusF/GTG5	RIO600	C	GTG5	AA-AA-LACCAADDA----------	F(LBB4)-Generator5
Electrical area 2/6.6kV BusF/PTA2	REF630	REF630ver1.2.0.10	FSL1	SBFNABABAACZAZNAXC	F(LBB4)-SheddableLoad1
Electrical area 2/6.6kV BusF/RW2	REM620	F	FSL2	NBMNAANNABC1BNN1XF	F(LBB4)-SheddableLoad2
Electrical area 2/3.3kV BusG/Cooling	REF630	REF630ver1.1.0.1	GSL1	SBFNABABAACZAZNAXB	G(LBB5)-SheddableLoad1
Electrical area 2/3.3kV BusG/Butadie	REM615	D	GSL2	HBMCAEAGNBA1BBN1XD	G(LBB5)-SheddableLoad2
Electrical area 2/3.3kV BusH/Cooling	RIO600	C	HSL1	AA-AA-LACCAADDAB-A------	H(LBB6)-SheddableLoad1
Electrical area 2/3.3kV BusH/SpareFe	REM615	D	HSL2	HBMCAEAGNBA1BBN1XD	H(LBB6)-SheddableLoad2
Electrical area 2/11kV BusC/NBCD	REF630	REF630ver1.1.0.1	NBCD	SBFNABACAACZAZNAXB	CB12 - Sending
Electrical area 2/6.6kV BusE/NBEF	RIO600	C	NBEF	AA-AA-LACCAADDA----------	CB34 - Sending
Electrical area 2/3.3kV BusG/NBGH	REF630	REF630ver1.1.0.1	NBGH	SBFNABACAACZAZNAXB	CB56 - Sending
Electrical area 2/11kV BusC/NBCE	RET630	RET630ver1.2.0.10	NBCE	SBTAAAABAAAZANNAXC	CB13 - Sending
Electrical area 2/6.6kV BusE/NBEC	RET630	RET630ver1.2.0.10	NBEC	SBTAAAABAAAZANNAXC	CB13 - Receiving
Electrical area 2/11kV BusD/NBDF	RET630	RET630ver1.2.0.10	NBDF	SBTAAAABAAAZANNAXC	CB24 - Sending
Electrical area 2/6.6kV BusF/NBFD	RET630	RET630ver1.2.0.10	NBFD	SBTAAAABAAAZANNAXC	CB24 - Receiving
Electrical area 2/6.6kV BusE/NBEG	RET620	F	NBEG	NBTNAANNABC1BNN1XF	CB35 - Sending
Electrical area 2/3.3kV BusG/NBGE	RET620	F	NBGE	NBTNAANNABC1BNN1XF	CB35 - Receiving
Electrical area 2/6.6kV BusF/NBFH	RET630	RET630ver1.2.0.10	NBFH	SBTAAAABAAAZANNAXC	CB46 - Sending
Electrical area 2/3.3kV BusH/NBHF	RET630	RET630ver1.2.0.10	NBHF	SBTAAAABAAAZANNAXC	CB46 - Receiving
Electrical area 2/PM2/LS2	PML630	PML630ver1.2.0.0	PML2	UBPLABAAABAZABAAXC	ConfigB

Figure 99: Feeder IED list

The IED list is not possible to be generated in case of a blank PML630 IED configuration. If attempted, an error message appears.

Figure 100: Export IED list for blank load-shedding IED

In case of **Configuration B**, the adjacent power network area's load-shedding IED appears in the PCM600 project as a part of the IED Group. The adjacent network area's IED list should be exported from the respective area's PCM600 project.

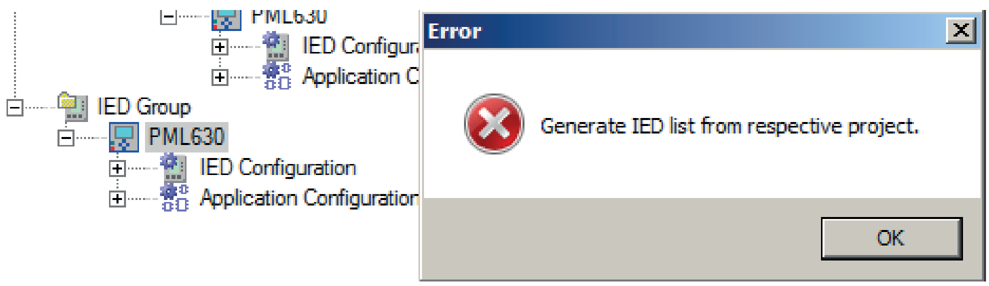


Figure 101: Export load-shed IED list for adjacent network area load-shedding IED

4.18 RIO600 channel allocation details

Additional tool is included in the load-shedding IED connectivity package, as RIO channel allocation.

The channel allocations in the RIO600 IED for the power management load-shedding functionality are defined for each type of feeder bay (Power source - Grid/ Transformer/Generator, network circuit breaker - Bus coupler and Load feeder -

sheddable loads). Also the input - DIM module, output - DOM module and analog input - RTD module positions are also defined for the RIO600 IED.

It is recommended to follow the recommendations as mentioned in the **RIO Channel Allocation** details.

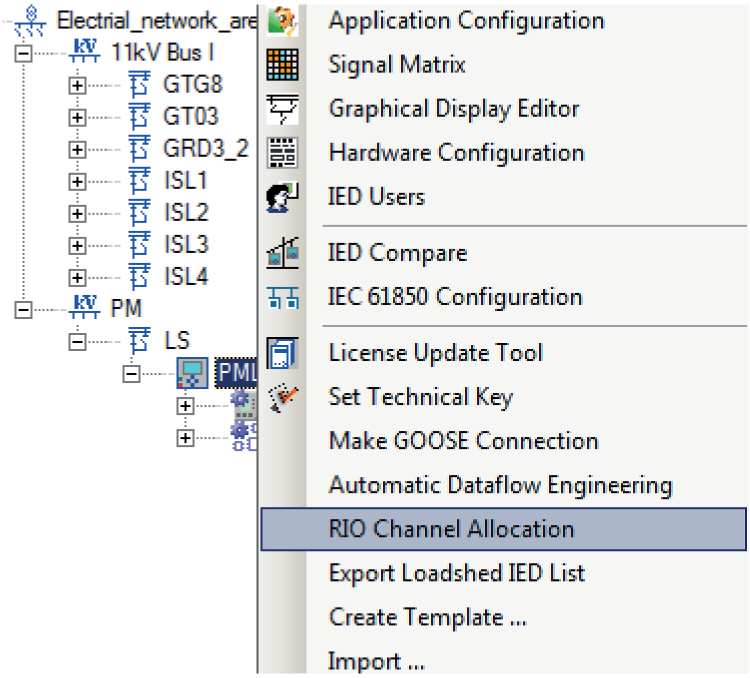
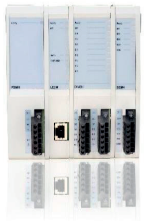


Figure 102: RIO channel allocation details

Right-click the IED and select **RIO Channel Allocation**.

RIO600 modules channel allocation in IO modules for load shedding solution



RIO600 Ver.1.2

Element Type	Signal Type	DIM	RTD	DIM/RTD Position
Grid transformer/ Generation and Bus Coupler/ Tie-line breaker	Circuit breaker open	DIM8GGIO1.Ind1	-	1
	Circuit breaker close	DIM8GGIO1.Ind2	-	1
	Protection trip	DIM8GGIO1.Ind3	-	1
	Circuit breaker in service position	DIM8GGIO1.Ind4	-	1
	Circuit breaker power	-	RTDGGIO2.AnIn1	2

Element Type	Signal Type	DIM	RTD	DOM	DIM/RTD/DOM Position
Load feeder	Circuit breaker open	DIM8GGIO1.Ind1	-	-	1
	Circuit breaker close	DIM8GGIO1.Ind2	-	-	1
	RIO600 error indication	DIM8GGIO1.Ind3	-	-	1
	Load feeder power	-	RTDGGIO2.AnIn1	-	2
	Load shed trip command			DOMGGIO3.SPCSO1	3
	RIO600 error activation			DOMGGIO3.SPCSO4 (Made as an indication at DIM card channel 3)	3

Note: RIO600 IEDs should be configured as follows

1. DIM module shall only be configured at position 1.
2. RTD module shall only be configured at position 2.
3. DOM module shall be configured at any position except position 1 and 2.
4. DOM module SMT connection shall be done manually.
5. DOM module channel 4 shall be configured for IRF of RIO600 and hardwired to DIM module channel 3.

RIO600 Ver.1.6 and later

Element Type	Signal Type	SCM/DIM	RTD	SCM/DIM/ RTD Position
Grid transformer/ Generation and Bus Coupler/ Tie-line breaker	Circuit breaker open	SCMHGGIO1.Ind1/ DIM8GGIO1.Ind1	-	Any
	Circuit breaker close	SCMHGGIO1.Ind2/ DIM8GGIO1.Ind2	-	Any
	Protection trip	SCMHGGIO1.Ind3/ DIM8GGIO1.Ind3	-	Any
	Circuit breaker in service position	SCMHGGIO1.Ind4/ DIM8GGIO1.Ind4	-	Any
	Circuit breaker power	-	RTDGGIO1.AnIn1	Any

Element Type	Signal Type	SCM/DIM	RTD	DOM	SCM/RTD/DOM Position
Load feeder	Circuit breaker open	SCMHGGIO1.Ind1/ DIM8GGIO1.Ind1	-	-	Any
	Circuit breaker close	SCMHGGIO1.Ind2/ DIM8GGIO1.Ind2	-	-	Any
	RIO600 error indication	SCMHGGIO1.Ind3/ DIM8GGIO1.Ind3	-	-	Any
	Load feeder power	-	RTDGGIO1.AnIn1	-	Any
	Load shed trip command			DOMGGIO1.SPCSO1/ SCMHGGIO1.SPCSO1	Any
	RIO600 error activation			DOMGGIO1.SPCSO4/ SCMHGGIO1.SPCSO4 (Made as an indication at SCM/DIM card channel 3)	Any

Note: RIO600 IEDs should be configured as follows

1. SCM/RTD/DOM/DIM modules can be configured at any position.
2. User must select high voltage (hardware type) and 4I4O (application type) If SCM module is used.
3. SCM module have the highest priority over DIM module if both are available in the same stack.
4. In the absence of SCM module, available first instance of DIM8 module will be used.
5. If the first instance of any module is not available in the stack, next immediate available instance will be used.
6. High voltage variant of modules have the highest priority than the low voltage variants.
7. DOM module SMT connection shall be done manually.
8. DOM module channel 4 shall be configured for IRF of RIO600 and hardwired to SCM/DIM module channel 3.

ABB

Figure 103: RIO600 channel allocation report

RIO channel allocation details from the load-shedding IED tool set is accessible only if the RIO600 IEDs are configured as power source/bus coupler or sheddable loads in the IED configuration wizard.

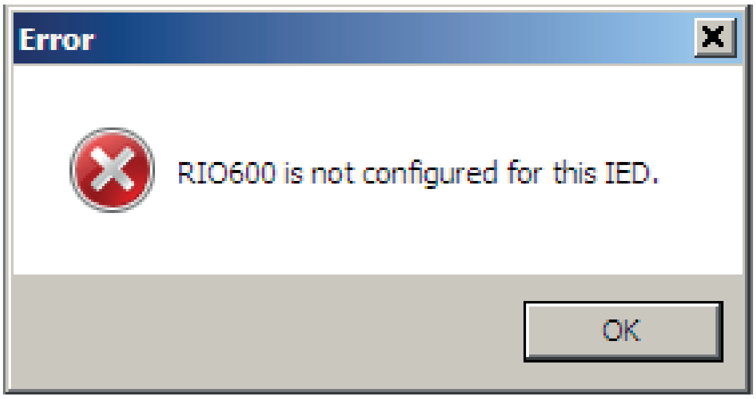


Figure 104: RIO600 is not configured for this IED

Section 5 Power management engineering

5.1 Creating an application configuration using Application Configuration tool

5.1.1 Overview

Application Configuration tool is used to create the application configuration for an IED. The application configuration is built up with function blocks. Function blocks are dedicated to different functions.

- Monitoring
- Communication
- Preprocessing

Some function blocks are mapped as logical nodes as per IEC 61850 standard. See the IEC 61850 Communication Protocol manual for more information.

Logical gates and timers are not mapped as logical nodes.

Though the load-shed logic is created automatically, the user can still use the Application Configuration tool to make additional logic, if necessary, as per project configuration/requirements.

The Application Configuration tool contains features for organizing and programming an application configuration.

- Coordinating application configuration into multiple logical parts in multiple pages
- Inserting function blocks - Configuration wizard automatically inserts function blocks for the IED, however certain function blocks, for example, AND, OR can be instantiated.
- Making connections - Configuration wizard automatically inserts function blocks for the IED.
- Creating variables
- Setting function blocks and signal visibility to Signal Matrix tool
- Documenting the application configuration

- Testing the application configuration online
- Saving application configuration as a template in an application library for reuse in IEDs
- Validating the application configuration during the configuration process on demand and write the configuration to the IED

Signal Matrix tool does not support group signals. These signals are hidden in the Signal Matrix tool.

See the PCM600 online help for procedures to accomplish different tasks in PCM600.

5.1.2 Function blocks

Function blocks are the basic elements of an application configuration. They are designed to represent functions and are organized in type groups. Different function block types are displayed in the **Object Types** view. Function block data can be modified using the Application Configuration tool.

Do not use characters other than a-z, A-Z, 0-9 or _ when setting user defined names for signals and function blocks. Avoid using the space character in function names. Follow IEC 61850 symbol standard and IEC 61850 naming style.

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

Several operations are possible in a function block.

- Setting user-defined names for function blocks and signals (marked in blue color)
- Setting IEC 61850 symbol standard
- Setting IEC naming style
- Locking function blocks
- Setting visibility for execution order, cycle time and instance number
- Managing signals, for example hiding, showing and rearranging
- Inverting input and output Boolean signals

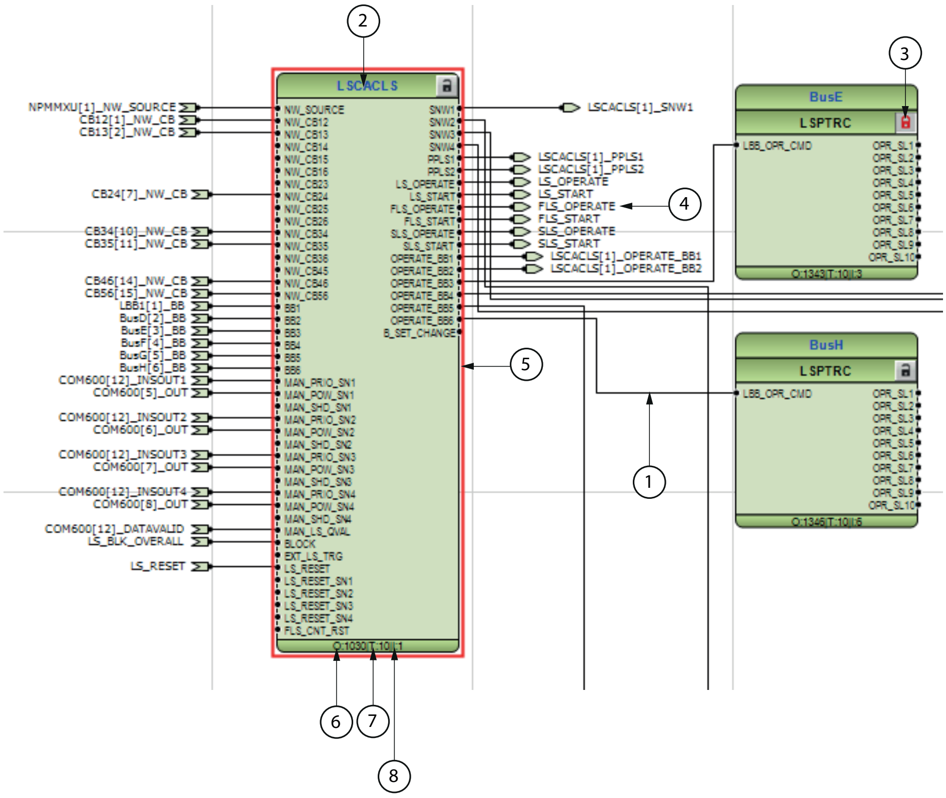


Figure 105: Application Configuration tool: Function block overview

1 Connection(s)
2 User defined function block name
3 Function block, locked (red)
4 User defined signal name
5 Function block, selected (red)
6 O: Execution order
7 T: Cycle time
8 I: Instance number

5.1.3 Signals and signal management

The input and output signals are arranged on the left and right sides of a function block. Application part in the function block contains these signals, unused signals are hidden for better visibility and connection routing.

The input signals 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. Upto two input signals and two output signals can be inverted for glue logic blocks in the same cycle time.

When the function block input is not connected the Application Configuration tool displays the default value of all signals.

5.1.4 Function block execution parameters

The function block parameters *Execution Order*, *Cycle Time* and *Instance Number* determine the runtime execution of the function block in the application configuration. These parameters are optionally set for each new function block in the Application Configuration tool.

Each time a function block is added in the Application Configuration tool, the execution parameters are set from the **Function Block Instance** dialog box.

The *Cycle Time* setting options are 3, 5, 10, 100 or 200 ms. The availability of these options depend on the function block type and the 630 series product.

All IED specific functions have an unalterable preset *Cycle Time* of 10 ms.

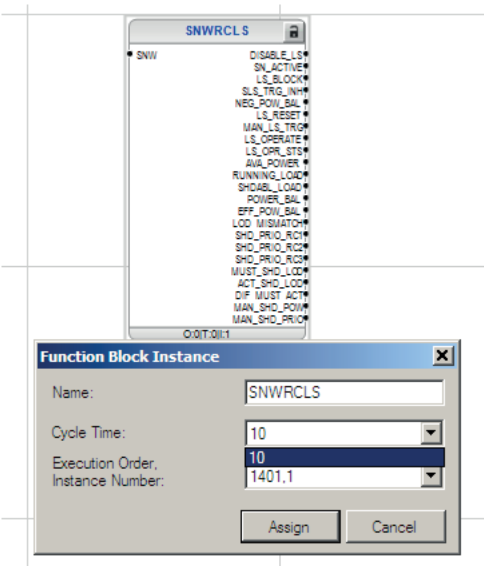


Figure 106: Cycle Time

A –ve *Cycle Time* indicates a time driven application and a +ve *Cycle Time* indicates an analogue data driven application. Analog data driven applications require sample values from analog input modules.

Time driven applications are executed periodically regardless of the status of the analog signal processing.

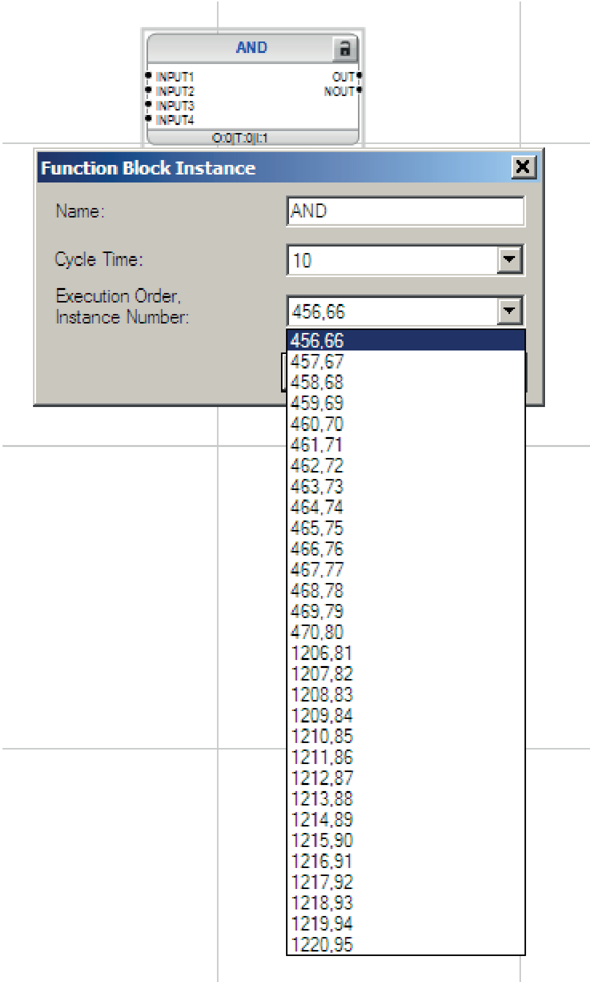


Figure 107: Application Configuration tool: function block organization parameters

Instance Number is a counter for the total number of function blocks of the selected type used within an application configuration.

The combination of *Execution Order* and *Instance Number* is predefined. Depending on the application requirement, select a suitable combination from the *Function Block Instance* dialog box.

Application configuration cycle time and execution order organization

The application execution within the 630 series products is organized in four time classes.

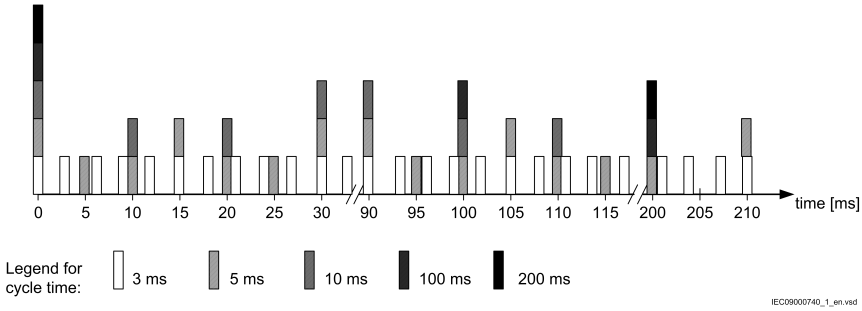


Figure 108: Application Configuration tool: Possible MainApplication cycle times

For the same time point, faster *Cycle Time* is executed first.

The function block with the preceding *Execution Order* must have the lowest *Cycle Time* in a configuration. The *Execution Order* of all subsequent function blocks must be the same or higher than the previous function blocks.

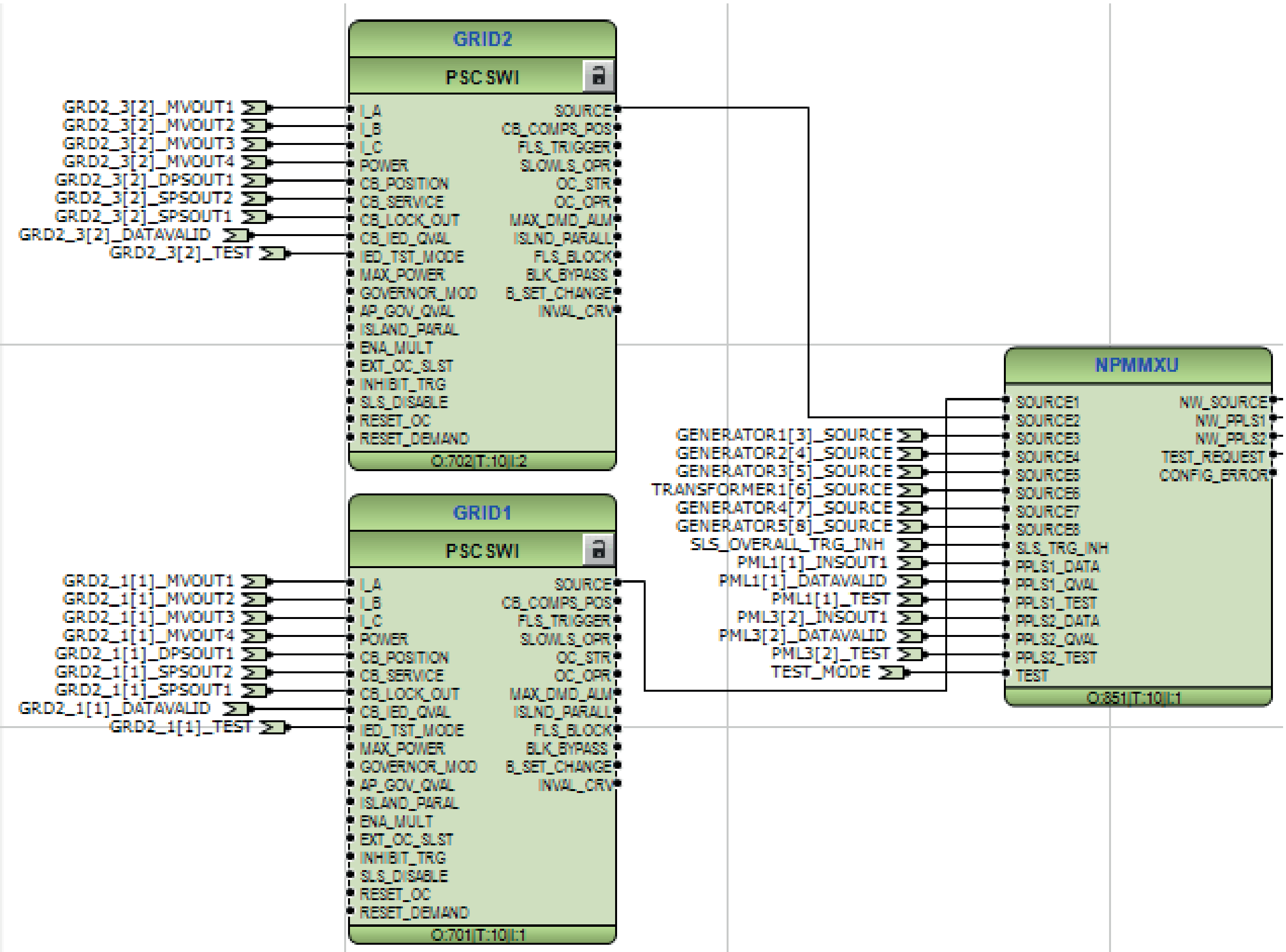


Figure 109: Cycle time and execution order

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*.

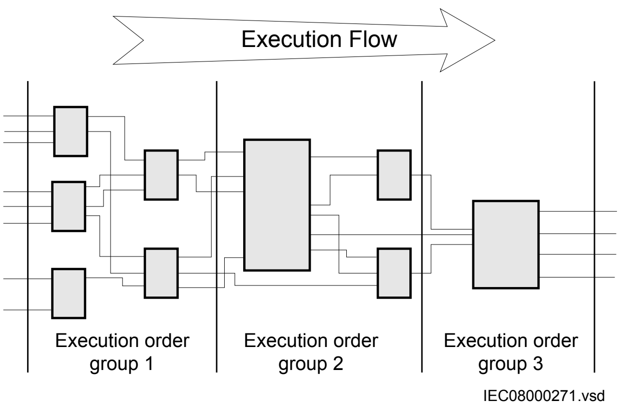


Figure 110: Application Configuration tool: Concept of Execution order sequence

The *Execution Order* of the main function block in the *Execution Order* group 2 defines the *Execution Order*s needed in group 1 and 3. The preceding logic done with function blocks in group 1 must have a lower *Execution Order* than the ones in group 2. The following function blocks in group 3 must have a higher *Execution Order* than the main function block in group 2.

5.1.5 Creating additional IED logic

5.1.5.1 LED indication logic

The IED LHMI contains Start and Trip LED indications on the top part of the LHMI. Besides, the IED includes a set of 13 programmable LEDs on the right side of the LHMI. These LEDs are effectively used for load-shedding indications.

Table 3: cPMS - LS Configuration A LED indications

LED	Indication
Start LED	General load-shedding start (initiation of power balance calculations)
Trip LED	General load-shedding operation (power balance calculations) resulting in load-shedding command initiation to feeder IEDs
GRP1_LED 1	• Fast load-shedding module activation (Red indication pin) • Fast load-shedding module start (Yellow indication pin)
GRP1_LED 2	• Slow load-shedding module activation (Red indication pin) • Slow load-shedding module start (Yellow indication pin)
GRP1_LED 3	Spare
GRP1_LED 4	SubNetwork 1 load-shedding block (Red indication)
GRP1_LED 5	SubNetwork 2 load-shedding block (Red indication)
GRP1_LED 6	SubNetwork 3 load-shedding block (Red indication)
GRP1_LED 7	SubNetwork 4 load-shedding block (Red indication)
GRP1_LED 8	SubNetwork 1 slow load-shedding block/inhibited (Red indication)
GRP1_LED 9	SubNetwork 2 slow load-shedding block/inhibited (Red indication)
GRP1_LED 10	SubNetwork 3 slow load-shedding block/inhibited (Red indication)
GRP1_LED 11	SubNetwork 4 slow load-shedding block/inhibited (Red indication)
GRP1_LED 12	SubNetwork 1 load-shed operated (Red indication)
GRP1_LED 13	SubNetwork 2 load-shed operated (Red indication)
GRP1_LED 14	SubNetwork 3 load-shed operated (Red indication)
GRP1_LED 15	SubNetwork 4 load-shed operated (Red indication)

Table 4: cPMS - LS Configuration B LED indications

LED	Indication
Start LED	General load-shedding start (initiation of power balance calculations)
Trip LED	General load-shedding operation (power balance calculations) resulting in load-shed command initiation to feeder IEDs
GRP2_LED 1	• GR1 connected network area Remote CB Close (Green indication) • GR1 connected network area Remote CB Open (Off)
GRP2_LED 2	GR1 connected network area IED data error (Red indication)
GRP2_LED 3	GR1 connected network area SN LS block due to Remote CB (Red indication)
GRP2_LED 4	GR1 connected network area SN LS block (Red indication)
Table continues on next page	

LED	Indication
GRP2_LED 5	• GR2 connected network area Remote CB Close (Green indication) • GR2 connected network area Remote CB Open (Off)
GRP2_LED 6	GR2 connected network area IED data error (Red indication)
GRP2_LED 7	GR2 connected network area SN LS block due to Remote CB (Red indication)
GRP2_LED 8	GR2 connected network area SN LS block (Red indication)

Internal variables for representing the signals are created in PCM600 and assigned to the output pins of load-shed function blocks.

See the application engineering guide for more details.

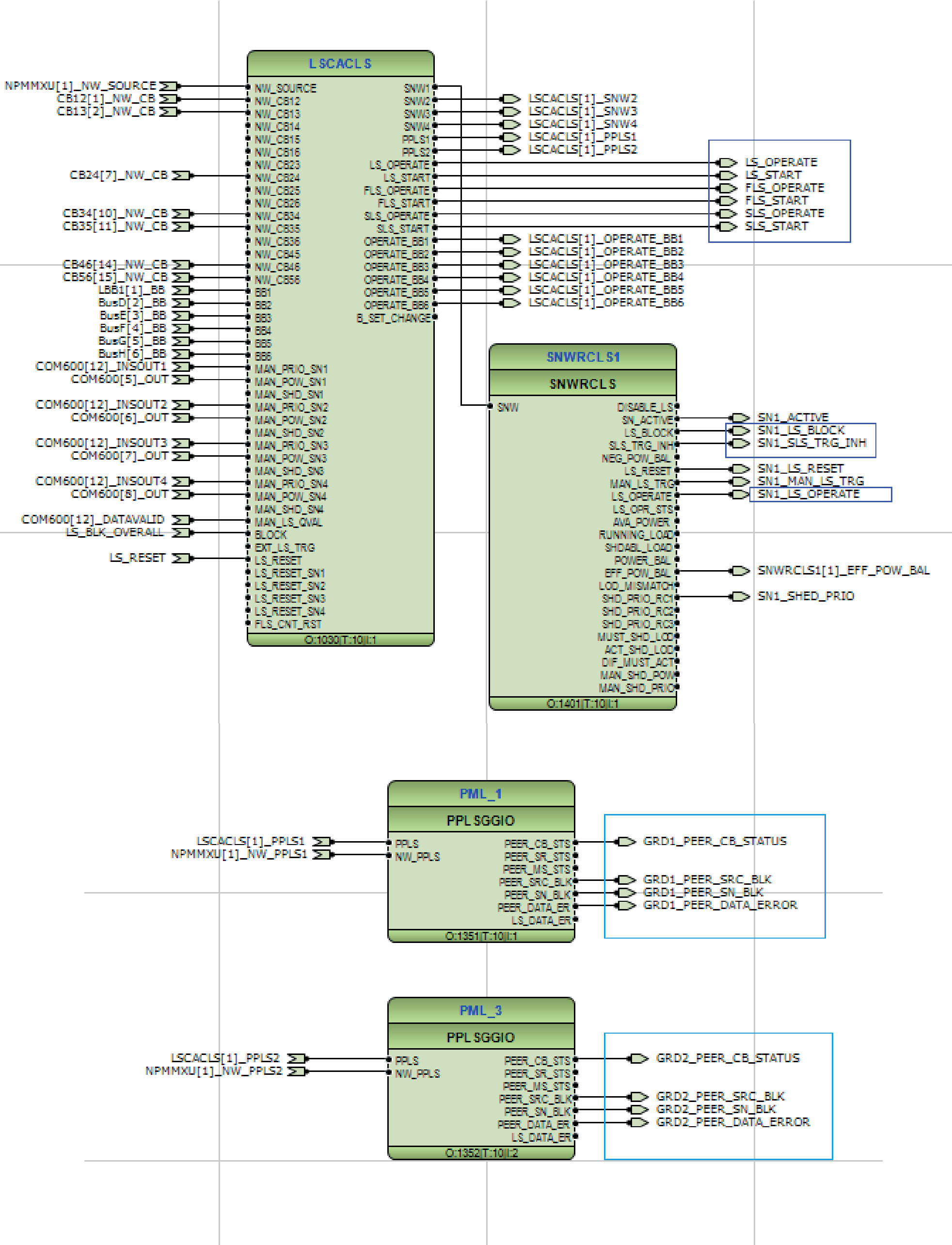


Figure 111: LED indication logic: internal variables

These variables are connected to the LED function blocks.

The input 1 and input 2 terminals of B1RBDR block are used for load-shedding Start and Operate events. These signals are assigned to the Start and Trip LEDs of the IED. These signals are allocated to the B1RBDR function block and parameterized as Start and Trip respectively.

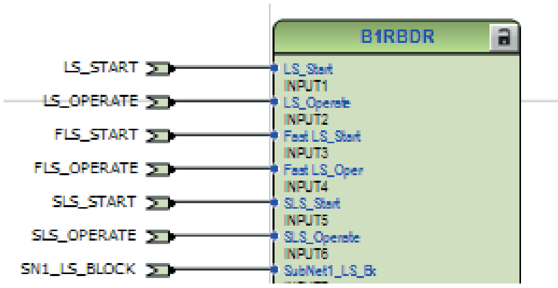


Figure 112: LED indication logic: Start and Trip LED configuration

Group / Parameter Name	IED Value	PC Value
B1RBDR: 1		
NAME1		INPUT1
Trigger operation 1		**On**
Set LED 1		**Start**
NAME2		INPUT2
Trigger operation 2		Off
Set LED 2		**Trip**

Figure 113: LED Engineering: Parameterization in B1RBDR

Based on the project configuration, the user can assign more LEDs, if required.

- Slow load-shedding start/operate for power source
- Subnetworks negative power balance

Based on the selection in the configuration wizard for the configuration option, the related configuration LED indication, LHMI events, function keys, and disturbance record function blocks are instantiated and the Application Configuration tool connection with main application (load-shedding application) is done automatically.

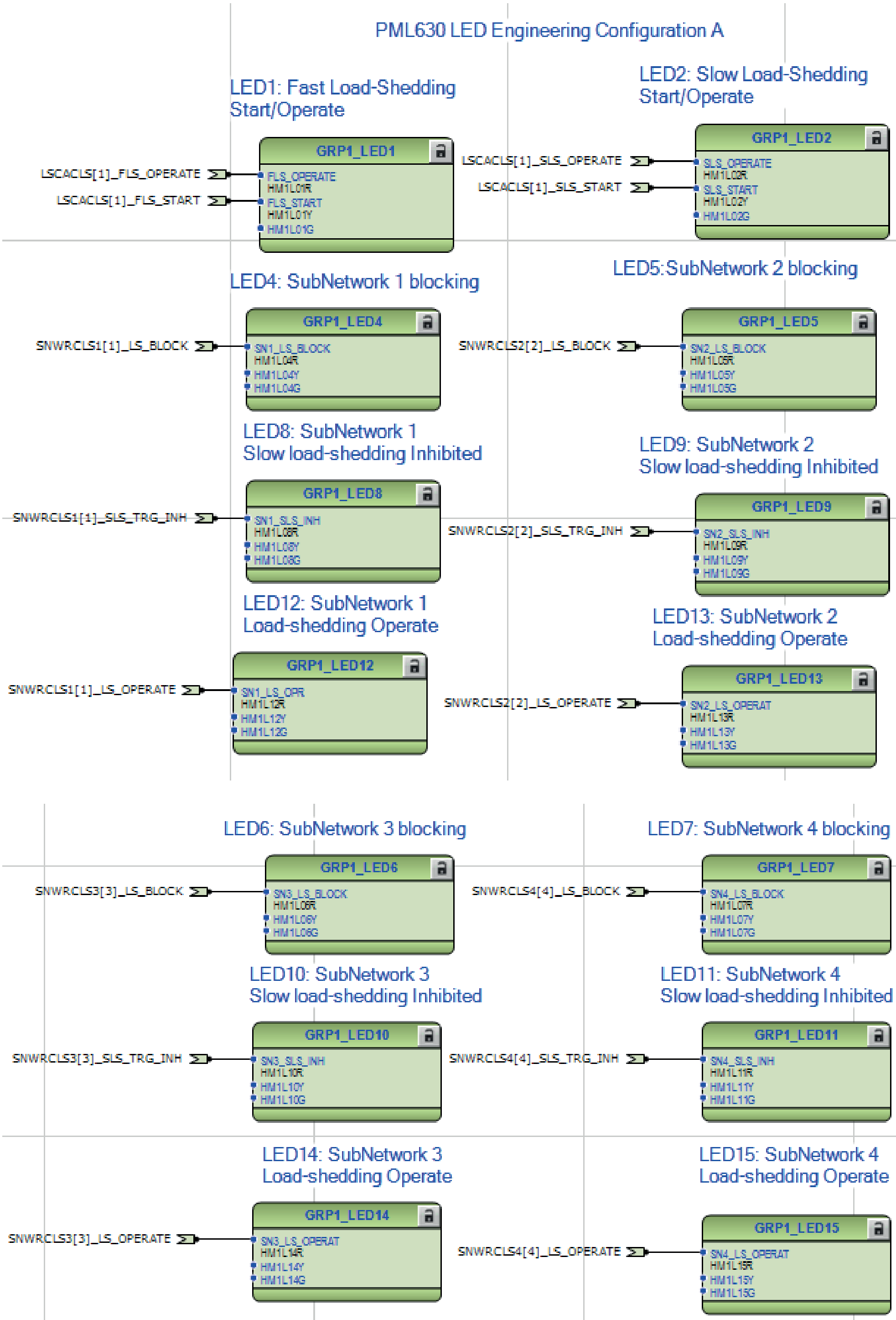


Figure 114: LED engineering cPMS - LS Configuration A

Figure 115: LED engineering cPMS - LS Configuration B

5.1.5.2 Local HMI event configuration

1. The BI1RBDR block, as instantiated for the Start and Trip LEDs, is also used to configure load-shedding events on the LHMI.

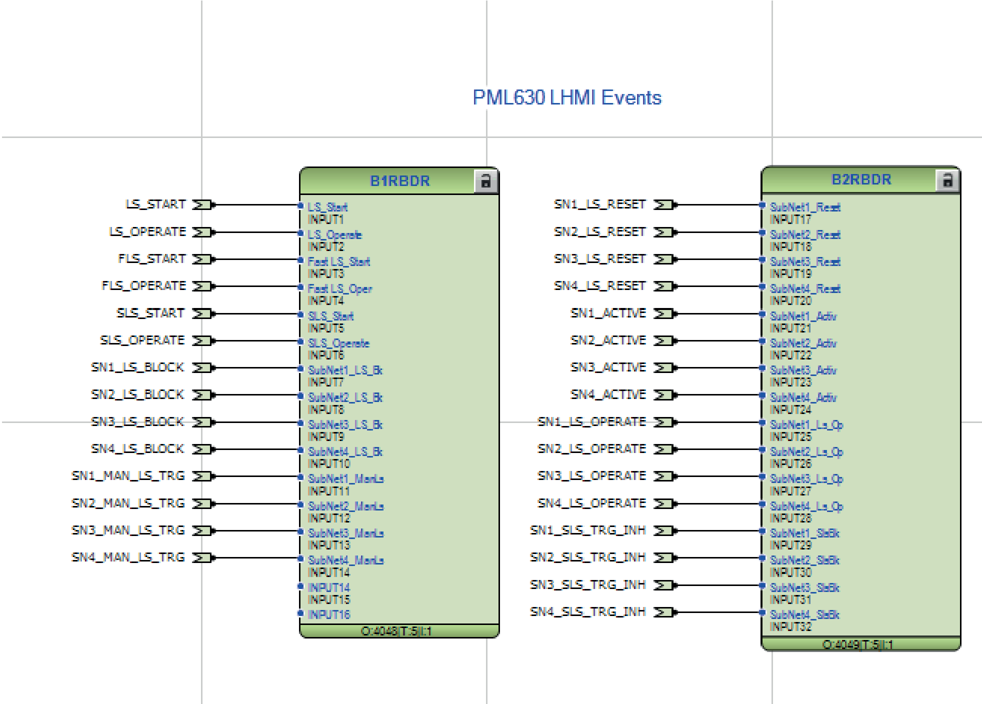


Figure 116: B1RBDR and B2RBDR signals for the IED events in cPMS - LS Configuration A

2. The signals configured for the LHMI LEDs are also used for LHMI events.
3. cPMS - LS Configuration A functionality-related necessary signals are configured as LHMI events, and assigned to B1RBDR and B2RBDR function blocks.
4. cPMS - LS Configuration B functionality-related necessary signals are configured as LHMI events, and assigned to B3RBDR function block.

Based on the project configuration, you can assign more LHMI events if required to the spare input pins of the B1RBDR and B3RBDR function blocks.

- Slow load-shedding start/operate for power source
- Subnetworks negative power balance

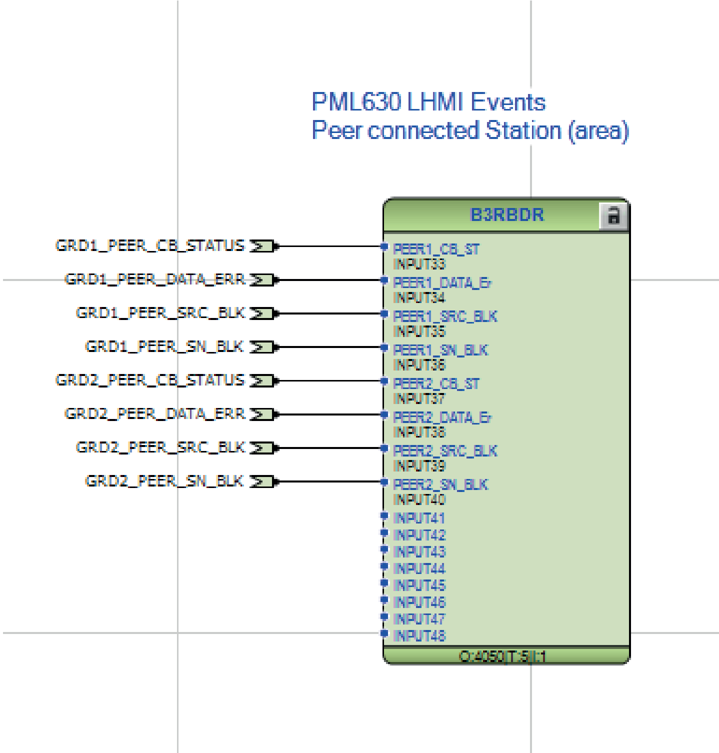


Figure 117: B3RBDR signals for the IED events in cPMS - LS Configuration B

See the application engineering guide for connection of variables between B1/B2/B3 RBDR function blocks and main load shed logic.

5.1.6 Load-shedding logic for feeder IEDs using Application Configuration tool

Every load feeder IED directly associated with the IED and participating in load-shedding activity requires a logic to handle the load-shedding command issued by the IED. The logic is created using the Application Configuration tool. A Binary GOOSE Receive block is created to receive the GOOSE command information from the IED. The load-shedding command data is verified for the data quality of the IED, test mode status of the IED and the load feeder IED before being passed onto to the binary output channel to open the circuit breaker.

The OUT1 pin of GOOSE Receive function block is connected to an AND gate where it is combined with a valid pin of the GOOSE input. The validated load-shedding command is combined with other circuit breaker trip or open operation signals including the protection operation and supervisory command from COM600 HMI or LHMI and connected to a physical binary output channel.

This logic is explained for all types of load feeders in the section Logic template import.

- REF/REM/RET630 1.0 based independent load or dependent load
- REF/REM/RET630 1.1 or later based independent load, representative or dependent load
- REF/REM/RET615 3.0 or later based independent load or dependent load. The logic templates for 615 and 620 series are identical. However, separate logic template files are provided in the connectivity package.

5.1.7 Configuring disturbance recorder

Disturbance recorder feature is useful in analyzing load-shedding data, pre-load-shedding event and post load-shedding event. To incorporate this feature, the IED needs to be configured with an additional logic using the Application Configuration tool.

The disturbance recorder function block, A4RADR, can accommodate ten analog channels. A maximum number of ten data signals can be connected from the load-shedding function block to the disturbance recorder function block. The disturbance recorder engineering is explained using an example. In this example, four channels from the core load-shedding function block are connected to the A4RADR function block.

- Subnetwork 1 Effective Power Balance
- Subnetwork 2 Effective Power Balance
- Subnetwork 3 Effective Power Balance
- Subnetwork 4 Effective Power Balance

Load-shedding start signal triggers the capture of the behavior of these four channels, that is, the Effective Power Balance (*EFF_POW_BAL*) is captured before and after load-shedding calculation initiation for each subnetwork. Load-shedding depends on the Effective Power Balance in the subnetwork and, hence, load-shedding calculation initiation may or may not result in load-shedding. This feature provides sufficient information to measure the subnetwork behavior before and after a load-shedding trigger.

1. PML630LSAddlogicConfigA ACT application page is instantiated once the configuration wizard is finished. It contains the logic function blocks needed to configure the disturbance recorder function. B1RBDR ,A3RADR and A4RADR functions are created and the signal connections are done from the main load-shedding application.

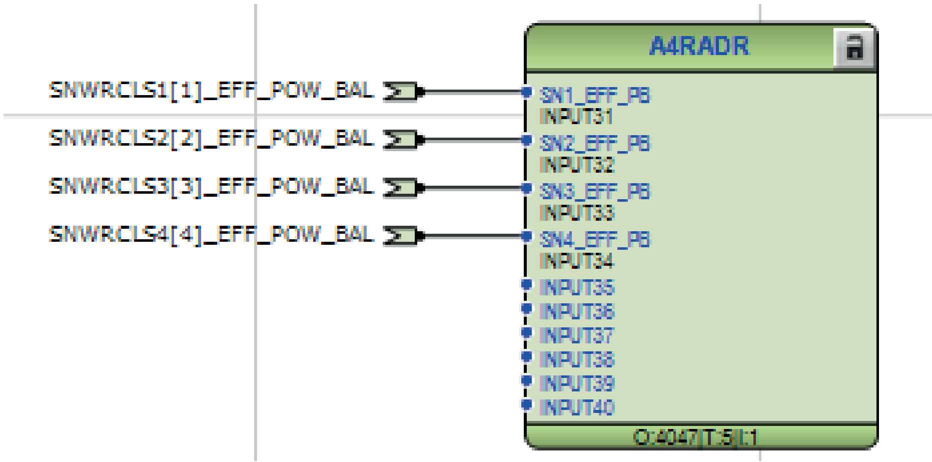


Figure 118: Disturbance recorder instantiation for SN-wise available power and load power

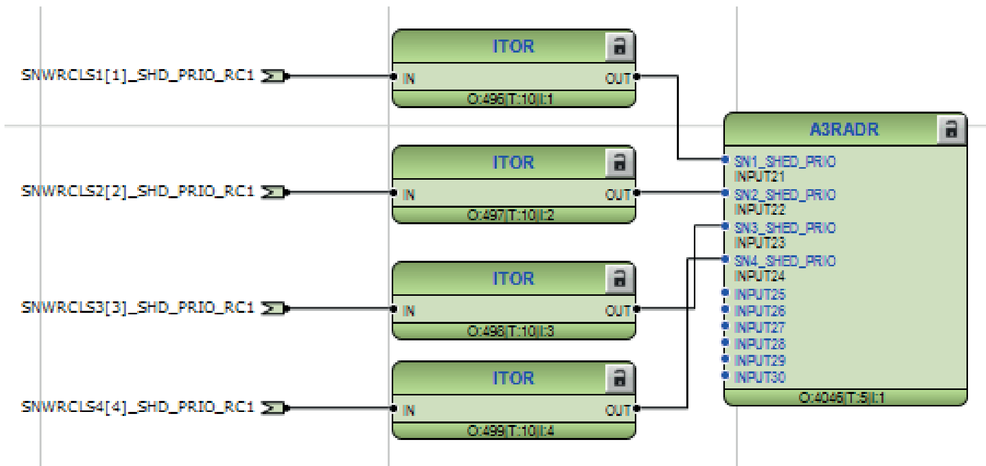


Figure 119: Disturbance recorder instantiation for SN-wise shed priority

2. Connect the variables to the SNWRCLS function block (one instance per subnetwork) for Effective Power balance and Shed priority. In Figure 120, `SNWLRCLS1[1]_ EFF_POW_BAL` represents the Effective Power Balance for Subnetwork 1. Also connect the `SNWLRCLS1[1]_SHD_PRIO_RC1` to ITOR function block for connecting to A3RADR.

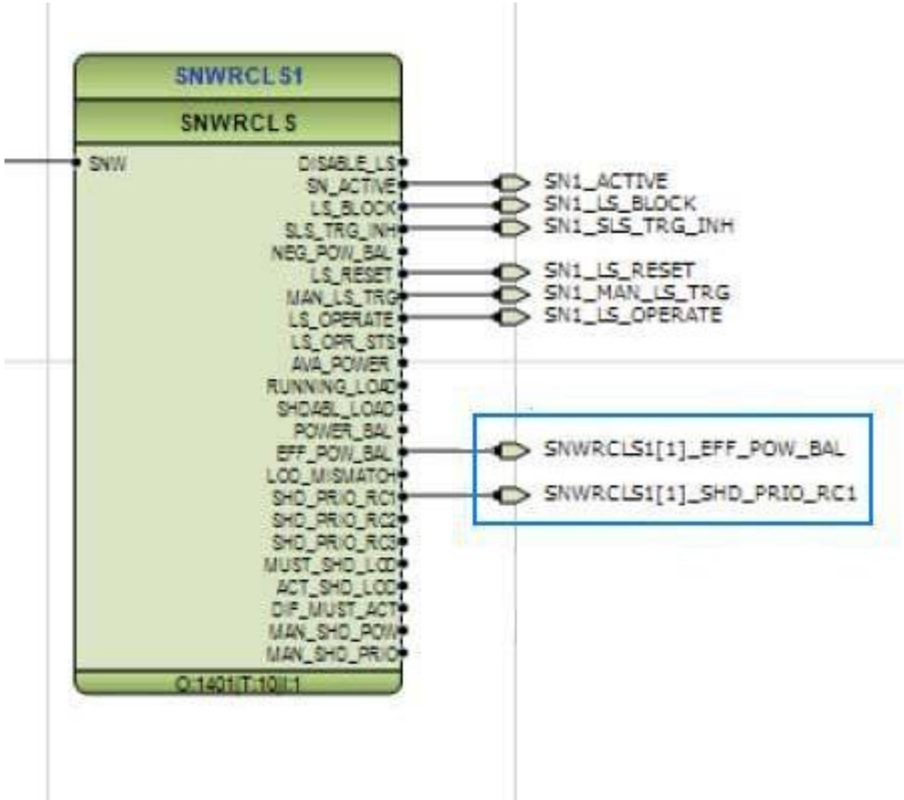


Figure 120: Subnetwork information for disturbance record

3. Complete this procedure for the maximum number of IED supported subnetworks.

IED supports the maximum of four subnetworks.

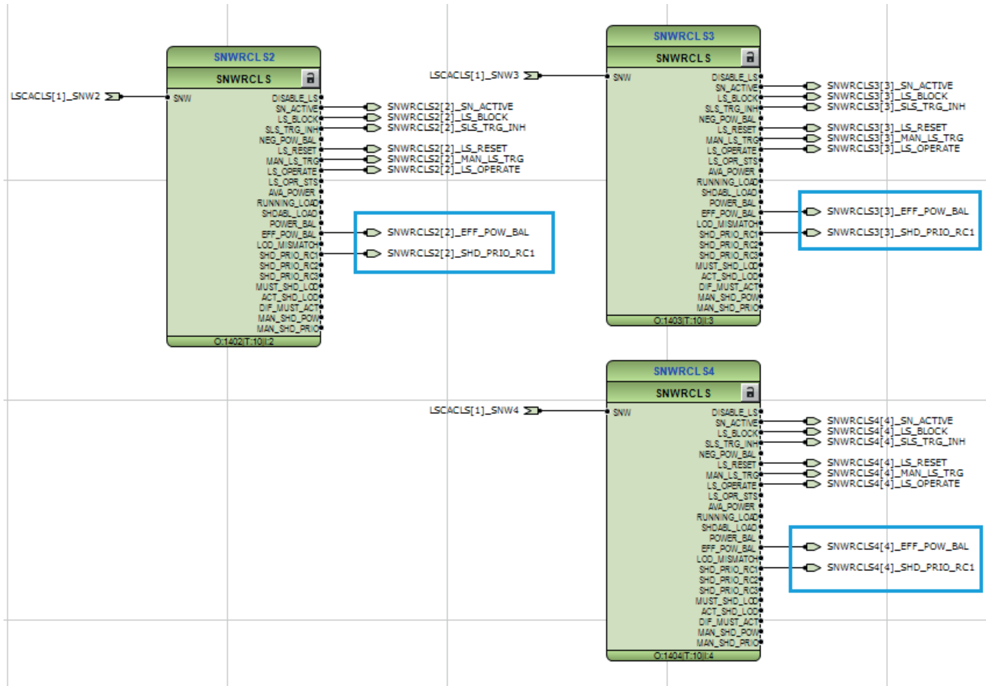


Figure 121: Subnetwork 2/3/4 information for disturbance record

4. The *LS_START* variable is connected to the *LS_START* pin of the LSCACLS function block.

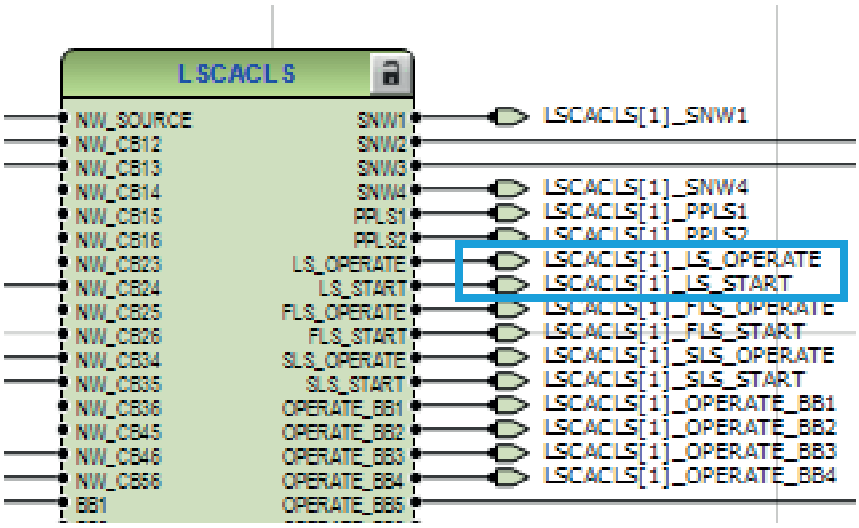


Figure 122: Function block connection details : LSCACLS

5. The B1RDBR function block and variables are also instantiated automatically. The *LS_START* variable is connected to the 1st Input.

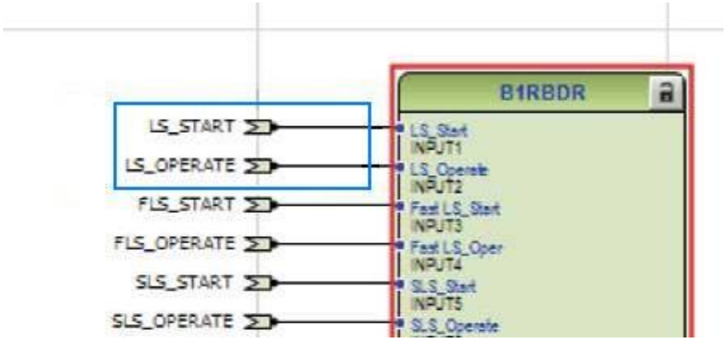


Figure 123: Function block connection details : B1RBDR

6. Parameterize the B1RBDR function block.

Group / Parameter Name	IED Value	PC Value
B1RBDR: 1		
NAME1		INPUT1
Trigger operation 1		**On**
Set LED 1		**Start**
NAME2		INPUT2
Trigger operation 2		Off
Set LED 2		**Trip**
NAME3		INPUT3

Figure 124: B1RBDR function block parameterization

The **Trigger** option for channel 1 is set to **ON** and the **Set LED1** is assigned the **PC Value** to **Start** .

7. Parameterize the A4RADR, by configuring the necessary channels (Operation channel 31 to Operation channel 38).

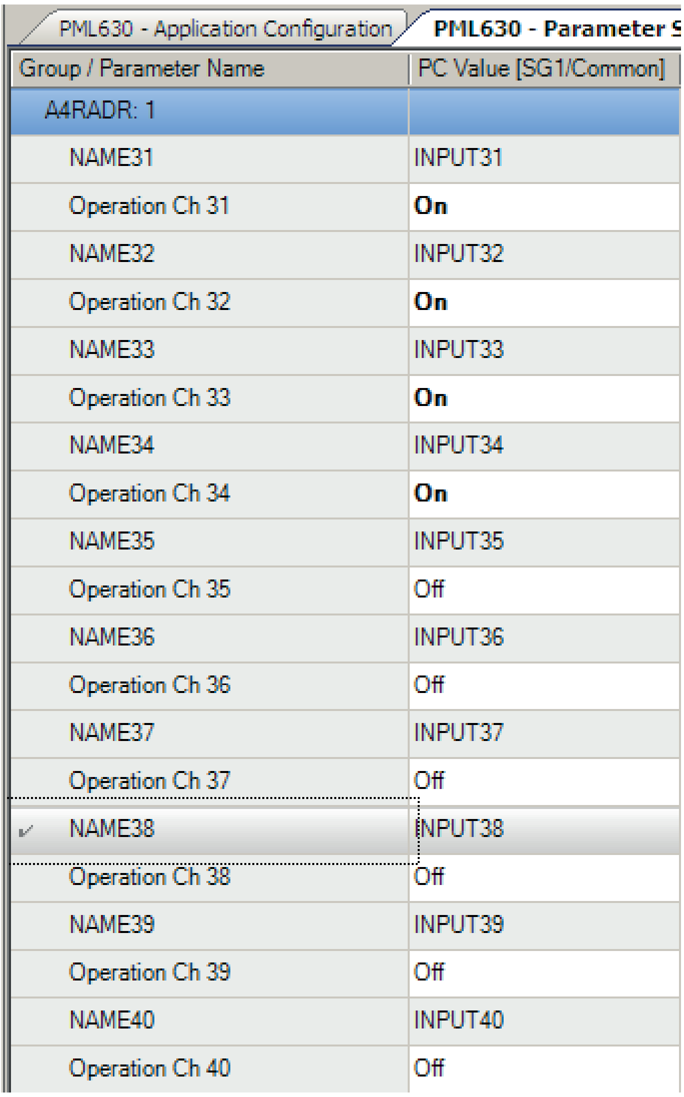


Figure 125: A4RADR function block parameterization

8. Parameterize the A3RADR, by configuring the necessary channels (Operation channel 21 to Operation channel 24).

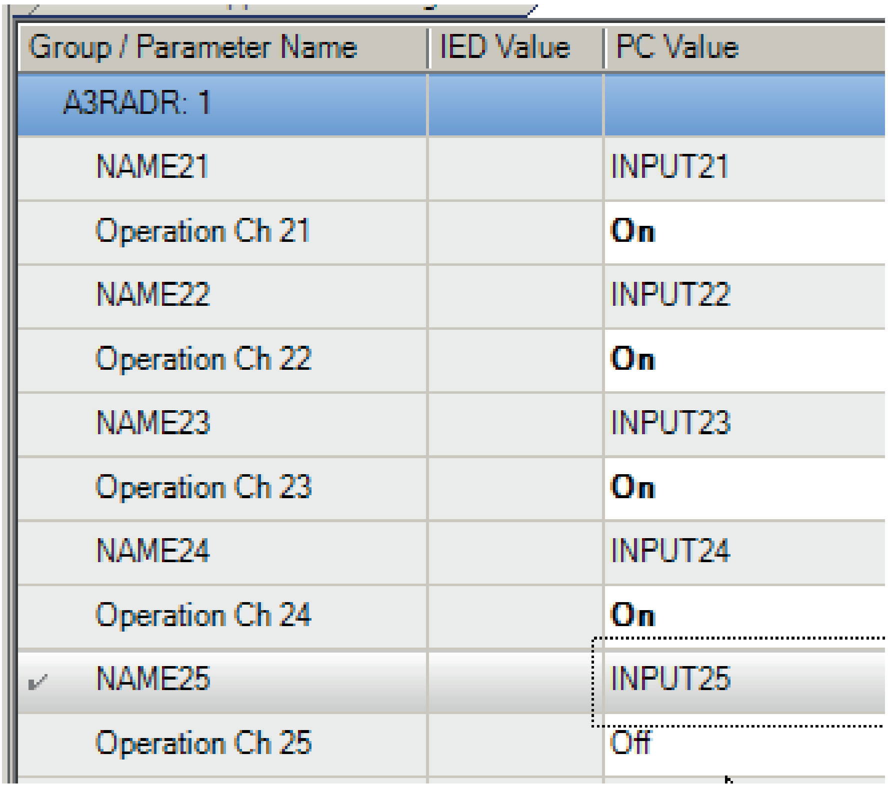


Figure 126: A3RADR function block parameterization

5.1.8 Logic templates import

Automatic engineering feature or functionality is one of the unique features being offered with the IED. It helps to handle the engineering and configuration process to avoid making errors and saving precious time during project execution.

One such feature is the Templates import that can be extensively used in the additional logic configuration of the IED and feeder IEDs. The Application Configuration tool has a feature to reuse the same logic in different IEDs in the same or different projects.

5.1.8.1 Available templates

A set of standardized logic for load-shedding functionality and other commonly used configuration files are available as a part of the IED Connectivity Package installation.

- Feeder IED logic
- IEC 61850 OPC Client ICD file
- PML630 logic
- PML630 parameters
- SAB600 project with Proxy IED
- Sample PML630 project

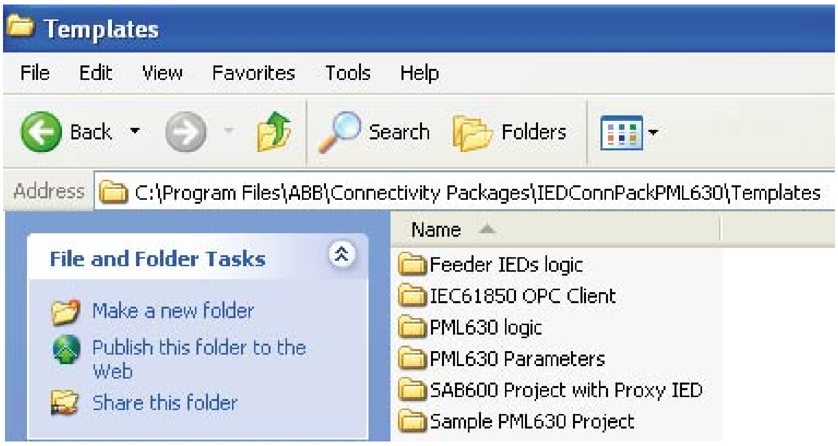


Figure 127: Template folders under IED Connectivity Package folders

Load feeder IED logic

These include additional load feeder logic needed to realize load-shedding functionality. The logic templates are broadly classified for the following load feeder types and their associated IED types.

- REF/REM/RET630 1.0 based independent load or dependent load
- REF/REM/RET630 1.1 or later based independent load, representative load or dependent load
- REF/REM/RET615 3.0 or later based independent load or dependent load
- REF/REM/RET620 2.0 based independent load or dependent load

Load feeder type templates are stored under the feeder IEDs logic folder.

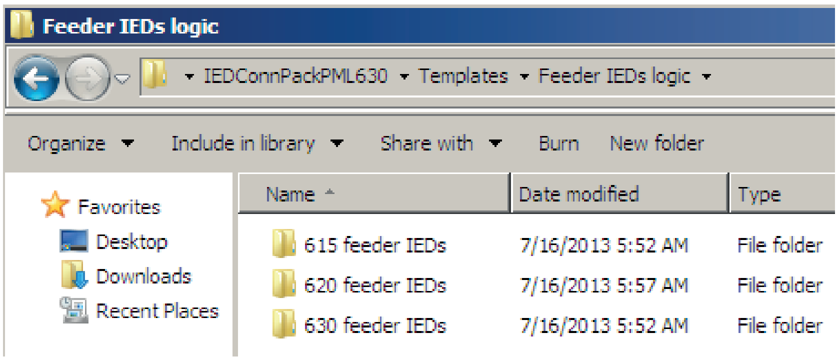


Figure 128: Feeder IEDs template folders under IED Connectivity Package folders

The 630 feeder IEDs folder comprises of the following template files.

- REF/REM/RET630 1.0 load-shed command handling, as independent load or dependent load
- REF/REM/RET630 1.1 or later load-shed command handling, as independent load or dependent load
- REF/REM/RET630 1.1 or later load-shed information and command handling, as representative load

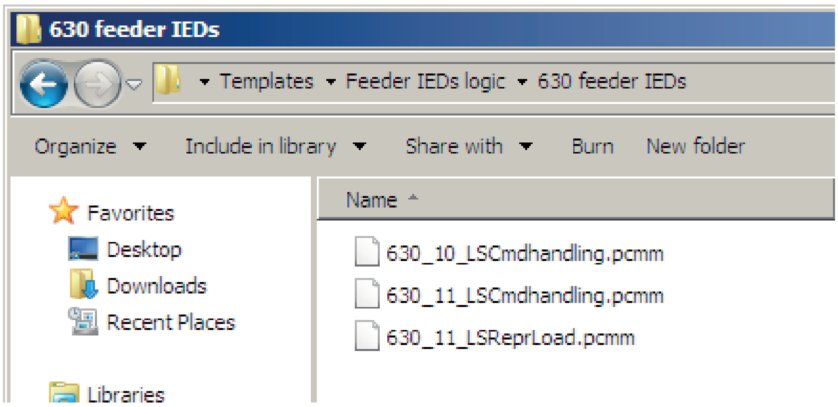


Figure 129: 630 feeder IEDs template files

The 615 feeder IEDs folder comprises of REF/REM/RET615 3.0 or later load-shedding command handling, as independent load or dependent load.

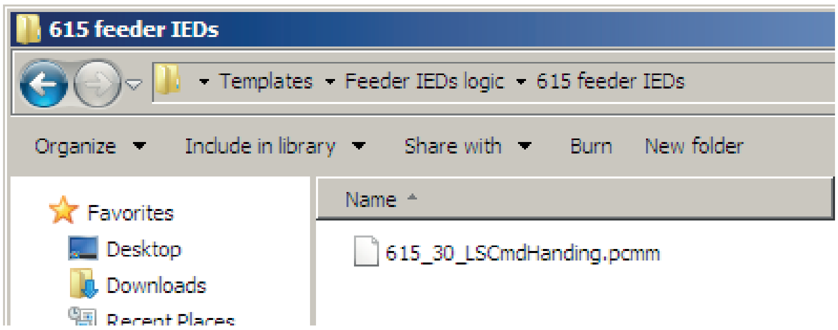


Figure 130: 615 feeder IEDs template files

The 620 feeder IEDs folder comprises of REF/REM/RET620 2.0 load-shedding command handling, as independent load or dependent load.

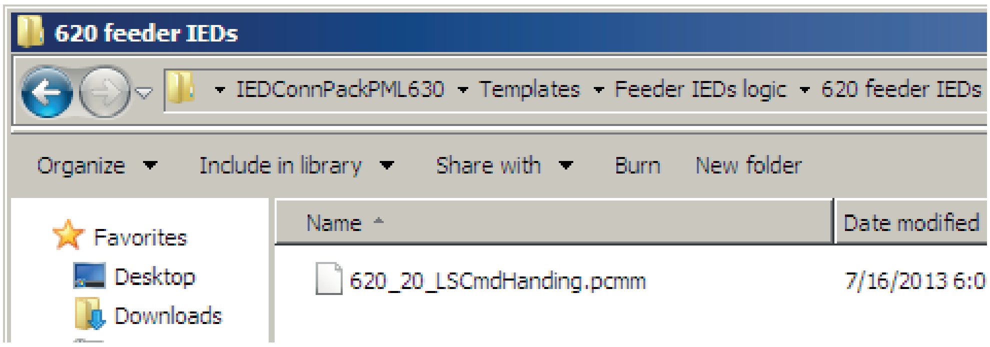


Figure 131: 620 feeder IEDs template files

Template import for 630 1.0 load feeder IEDs

The file "63010LSCmdhandling.pcmm" handles the load-shed commands intended to trip the load feeder (REF/REM/RET630 1.0) when sent from the PML630 to the load feeder (when it is an independent load or dependent load). The template includes the following logic.

- Load-shedding command receiving, command validation after considering data validity, PML630 test mode status and its own 630 1.0 IED test mode status.
- Test mode checks for feeder IED and IED are performed in order to ensure that load-shedding command information is not extended to trip the circuit breaker and have load-shedding indication only after validated command is received (when the feeder IED or IED are in test mode).
- When the load feeder IED itself is in test mode and when the load feeder is an independent load, then the load feeder is inhibited from load-shedding by PML630 and, the load-shedding command is never received. However, when the load feeder is a Dependent IED and it is in test mode, this additional check is needed to prevent trip of the load feeder (as dependent load feeder IED’s test mode is not passed onto the PML630 by the representative load IED).
- Two GOOSERCVBIN function blocks need to be used to receive GOOSE data for load-shedding command information and IED test mode status, as 630 1.0 GOOSERCVBIN function blocks cannot handle IEC 61850 quality (test mode).
- LED Engineering

Unlike a dependent load based on 615 and 620 series, a dependent load based on 630 1.0 IED can handle its test mode in Application Configuration tool and can handle load-shedding commands directly from the PML630 instead of routing the command through a 630 1.1 IED.

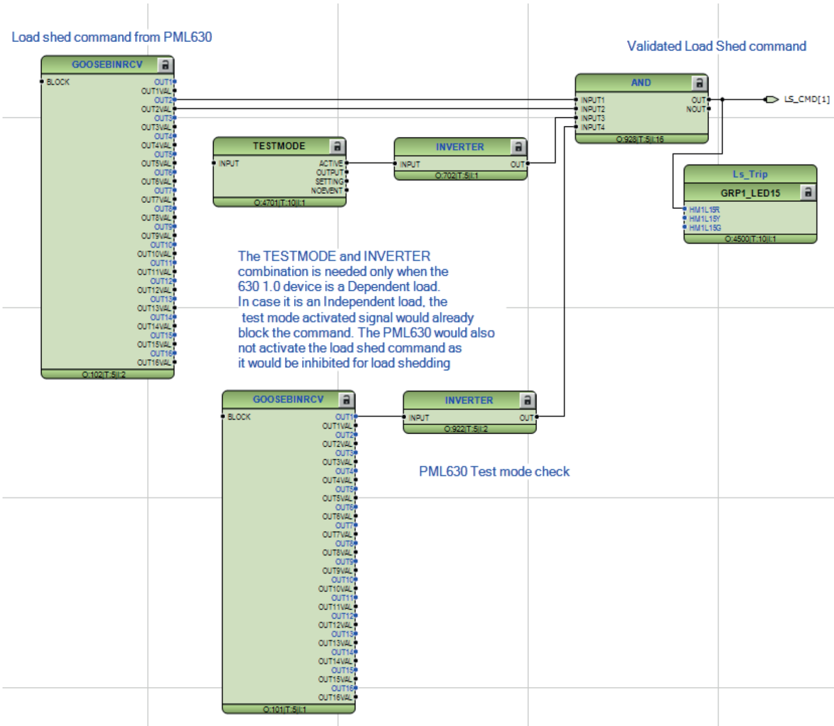


Figure 132: REF/REM/RET 630 1.0 IED load-shedding command handling template

Change of execution order or cycle time for any function block used in the load-shedding command handling template impacts the execution of load-shedding trip command and activation of digital output or activation of TRIP command output.

GOOSESPRCV, GOOSEBINRCV, AND and OR gates used in the template for load-shedding command logic must be 5 ms cyclic and execution order of all logical gates must be in incremental order from input function block (GOOSESPRCV/GOOSEBINRCV) function block until the TRPPTRC binary output contact activation.

Template import for 630 1.1 or later load feeder IEDs

The file "630_11_LSCmdhandling.pcmm" handles the load-shedding commands intended to trip the load feeder (REF/REM/RET630 1.1 or later).

- Load-shedding command receiving, command validation after considering data validity, PML630 test mode status and its own 630 1.1 IED test mode status.
- Test mode checks for feeder IED and IED are performed in order to ensure that load-shedding command information is not extended to trip the circuit breaker

and have load-shedding indication only after validated command is received (when the feeder IED or IED are in test mode).

- When the load feeder IED itself is in test mode and is an independent load, then the load feeder is inhibited from load-shedding by PML630 and the load-shedding command is never received. However, when the load feeder is a dependent IED and it is in test mode, this additional check is needed to prevent trip of the load feeder (as the dependent load feeder IED's test mode is not passed onto the PML630 by the representative load IED).
- A GOOSESPRCV function block is sufficient to receive GOOSE data for load-shedding command information and detect the IED test mode (IEC 61850 Quality) in the same message. The GOOSESPRCV function block is only available for the 630 1.1 IEDs.
- LED Engineering

Unlike a dependent load based on 615 3.0 IED, a dependent load based on 630 1.1 IED can handle its test mode in Application Configuration tool and can handle load-shedding commands directly from the PML630 instead of 'routing' the command through another 630 1.1 IED. (This refers to REF/REM/RET630 1.1 or later and REF/REM/RET630 1.1 or later only).

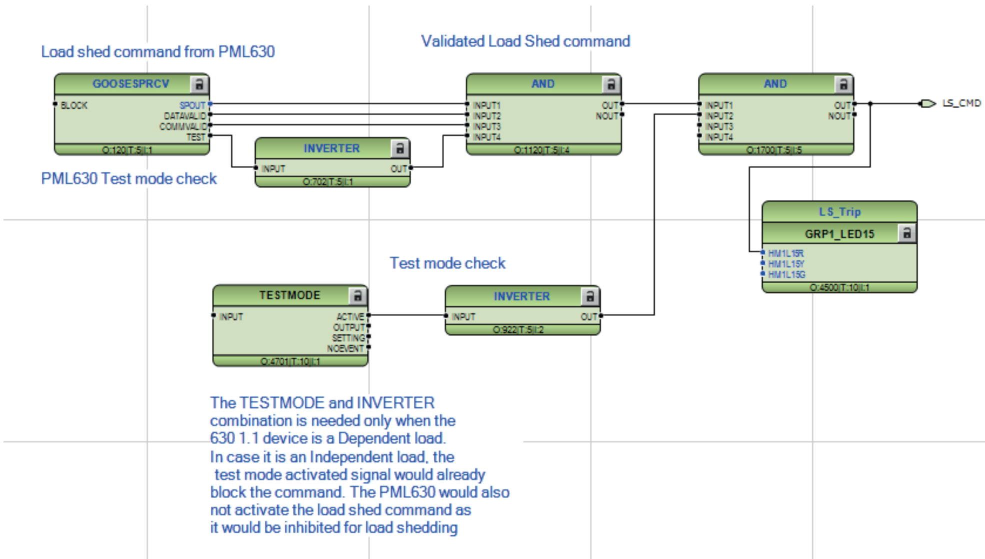


Figure 133: REF/REM/RET630 1.1 or later IED load-shedding command handling template

Change of execution order or cycle time for any function block used in the load-shedding command handling template impacts on the execution on load-shedding trip command and activation of digital output or activation of TRIP command output.

GOOSESPRCV/GOOSEBINRCV, AND and OR gates used in the template for load-shedding command logic must be 5 ms cyclic and execution order of all logical gates must be in incremental order from input function block (GOOSESPRCV/GOOSEBINRCV) function block until the TRPPTRC binary output contact activation.

Template import for 615 3.0 or later load feeder IEDs

The file "61530LSCmdhandling.pcmm" handles the load-shedding commands intended to trip the load feeder (REF/REM/RET615 3.0 or later) when sent from the PML630 to the load feeder (when it is an independent load) or sent by the representative load (REF/REM/RET630 1.1 or later) to the load feeder (when it is a dependent load). The template includes the logic.

- Load-shedding command receiving, command validation after considering data validity, PML630 test mode status.
- Test mode check for the IED is performed in order to ensure that load-shedding command information is not extended to trip the circuit breaker and have load-shedding indication only after validated command is received (when the IED is in test mode).
- When the load feeder IED itself is in test mode and is an independent load, then the load feeder will be inhibited from load-shedding by PML630 and the load-shedding command will never be received. However, when the load feeder is a dependent IED and it is in test mode, this additional check will be done in the Representative load logic (630 1.1 or later) in order to prevent trip of the load feeder (as the test mode is not passed onto the PML630 by the representative load IED).
- Two GOOSERCV_BIN function blocks need to be used to receive GOOSE data for load-shedding command information and IED test mode status, as 615 3.0 GOOSERCV_BIN function blocks cannot handle IEC 61850 Quality (test mode).
- The PML630 test mode handling logic is not needed for the dependent loads .
- LED Engineering

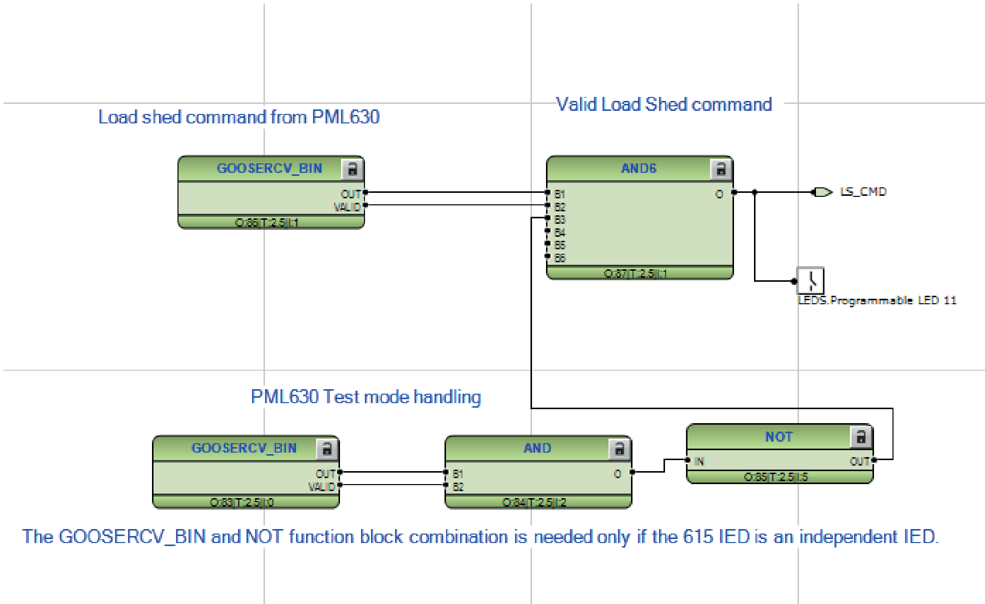


Figure 134: REF/REM/RET615 3.0 load-shedding command handling template

Change of execution order or cycle time for any function block used in the load-shedding command handling template impacts on the execution on load-shedding trip command and activation of digital output or activation of TRIP command output.

GOOSESPRCV/GOOSEBINRCV, AND and OR gates used in the template for load-shedding command logic must be 5 ms cyclic and execution order of all logical gates must be in incremental order from input function block (GOOSESPRCV/GOOSEBINRCV) function block until the TRPPTRC binary output contact activation.

620 series load-shedding command handling template is identical to the 615 series IED template.

Template import for 630 1.1/1.2 Representative load feeder IEDs

The file "630_11_LSReprLoad.pcmm" template file includes the measurement, circuit breaker status and load-shedding command handling for the load-shedding group. As mentioned in the earlier section ‘Load-shedding groups’ configuration and PCM600 project handling’, a representative load IED acts as a liaison between the IED and dependent load feeder IEDs. The template includes the following logic.

- Equivalent circuit breaker status determination considering status of the two dependent loads and representative load and IEC 61850 allocation for the equivalent circuit breaker status.

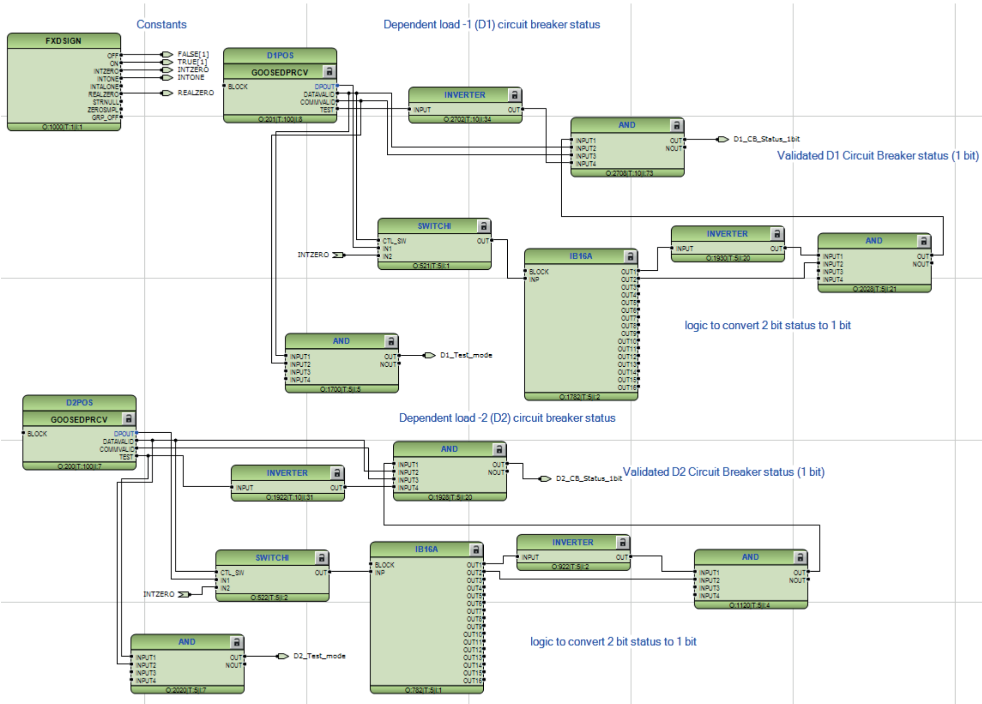


Figure 135: Equivalent circuit breaker status determination

- Power summation of two dependent loads and representative load and IEC 61850 allocation for the summated power.

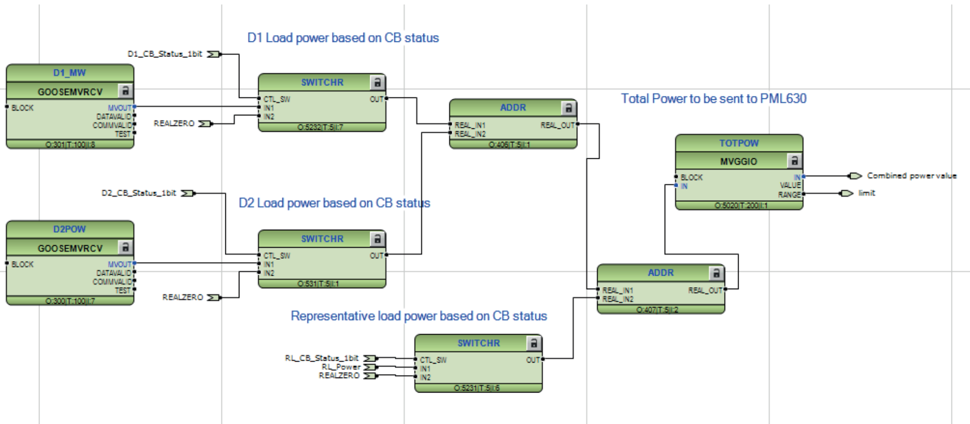
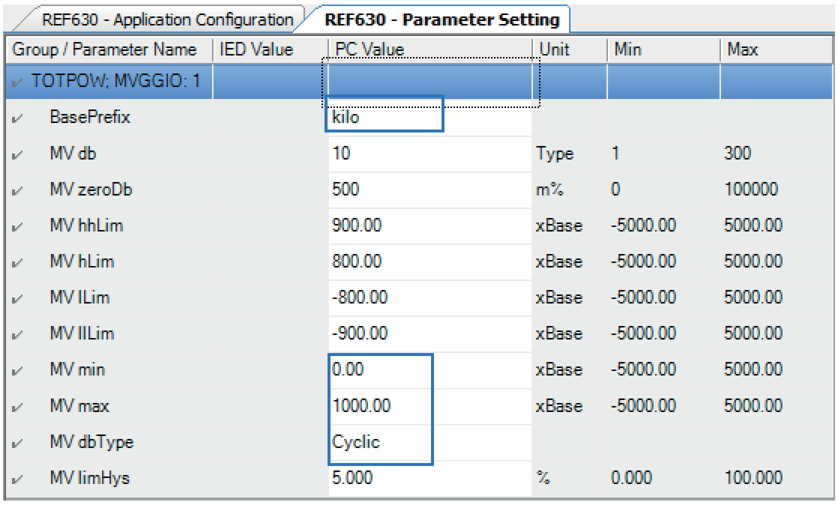


Figure 136: Summated power determination

- The summation feature is possible only because of the additional features implemented in the MVGGIO for the 630 1.1 IEDs. Because of this reason and the Analog GOOSE receiving capability, only 630 1.1 IEDs can be assigned as representative loads (these features are not available in 630 1.0, 615 3.0 or later and 620 series IEDs.

- The power summation is passed on to the MVGGIO function block that is responsible for making the signal available for IEC 61850 GOOSE communication. The necessary parameters are set in the PCM600 Parameter Setting tool.



REF630 - Application Configuration | REF630 - Parameter Setting

Group / Parameter Name	IED Value	PC Value	Unit	Min	Max
TOTPOW: MVGGIO: 1					
BasePrefix		kilo			
MV db		10	Type	1	300
MV zeroDb		500	m%	0	100000
MV hhLim		900.00	xBase	-5000.00	5000.00
MV hLim		800.00	xBase	-5000.00	5000.00
MV lLim		-800.00	xBase	-5000.00	5000.00
MV llLim		-900.00	xBase	-5000.00	5000.00
MV min		0.00	xBase	-5000.00	5000.00
MV max		1000.00	xBase	-5000.00	5000.00
MV dbType		Cyclic			
MV limHys		5.000	%	0.000	100.000

Figure 137: MVGGIO parameters

- The units of power can be set, for example, kilo. This unit should normally be same as the units of the power values that would have directly been sent to the PML630 by the independent load IEDs.
- The minimum value can be set as ‘0’ and the maximum can be the combined rated power value of representative load and the two dependent load feeders. In the figure above, ‘1000’ is set as the maximum limit.
- The MV dbType parameter can be selected as ‘Cyclic’ so that the IEC 61850 values are reported periodically (resulting in cyclic GOOSE information) to the PML630. The enabling of this parameter also effectively results in making the default values against *MVdb* and *MV zeroDb* parameters redundant. This is because the deadband values from the reporting of summated power of the representative load's and dependent load's IEDs to the PML630 are not needed. (as individual IED’s deadbands would already have been fixed). Similarly, as the summated power value from the representative load is not reported to the COM600, the power value limits (high-high, high, low and low-low) is not used. However, the default values can still be retained.

- Load-shedding command handling for representative load feeder and dependent load feeders (if 615 3.0 or later based IEDs)
  - Command validation is performed after considering data validity, PML630 test mode status and its own 630 1.1 or later IED test mode status.
  - Test mode checks for feeder IED and IED are performed in order to ensure that load-shedding command information is not extended to trip the circuit

breaker and have load-shedding indication only after validated command is received (when the feeder IED or IED are in test mode).

- When the representative load feeder IED itself is in test mode an independent load, then the load-shedding group will be inhibited from load-shedding by PML630 and the load-shedding command will never be received. However, when the dependent load feeder IED (615 3.0 or later) is in test mode, this additional check is needed to prevent trip of the dependent load feeder (as the dependent load feeder IED's test mode is not passed onto the PML630 by the representative load IED).
- A GOOSESPRCV function block is sufficient to receive GOOSE data for load-shedding command information and detect the IED test mode (IEC 61850 Quality) in the same message. The GOOSESPRCV function block is only available for the 630 1.1 IEDs.
- LED Engineering

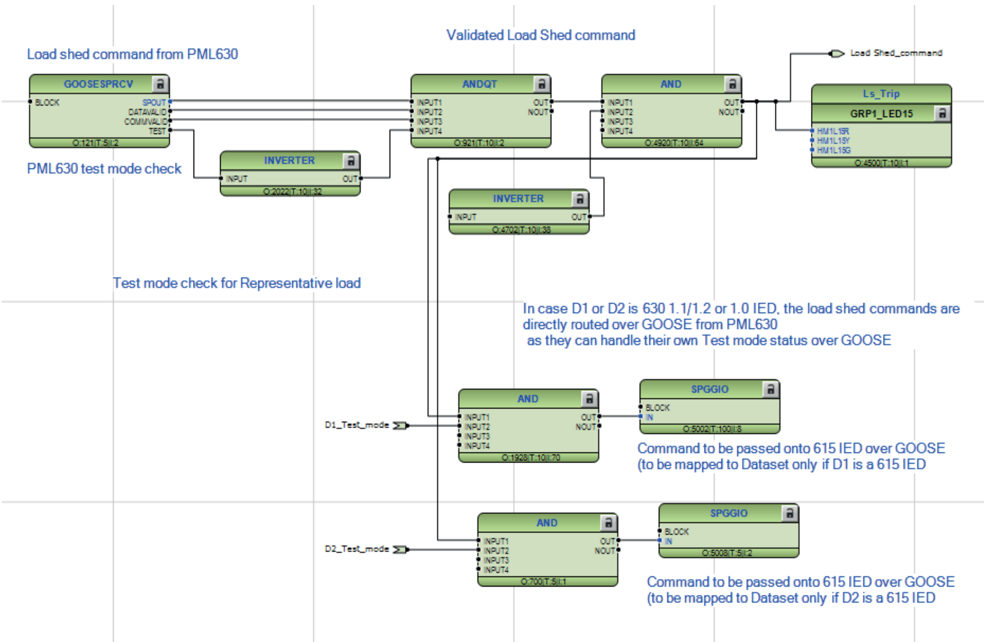


Figure 138: Representative load command handling logic

Additional IED logic

The PML630 logic folder comprises of the file *PML630LSAddlogicConfigA.pcmm* and *PML630LSAddlogicConfigB.pcmm* handles the following logic.

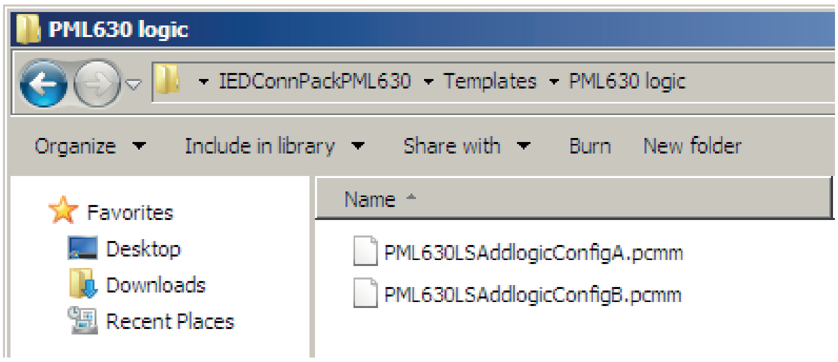


Figure 139: IED load-shedding additional logic handling template under Connectivity Package folder

- LED Engineering
- Disturbance recorder engineering
- LHMI events engineering
- LHMI function key assignment
- IED test mode handling
    - The IED test mode is needed for feeder IEDs (based on 620 2.0, 615 3.0 or later and 630 1.0) as their Binary GOOSE Receive function cannot handle GOOSE messages having Test bit activated in the IEC 61850 Quality information. In addition to the load-shedding command information, the IED test mode information also needs to be sent as GOOSE information to IEDs 620 2.0, 615 3.0 or later and 630 1.0 (REF/RET/REM) series based feeder IEDs.

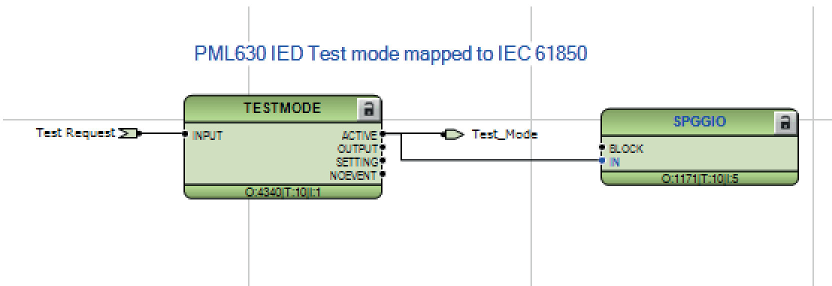


Figure 140: PML630 IED test mode mapped to IEC61850

The references to 620 2.0, 615 3.0 or later and 630 1.0 or 1.1 or later IEDs refers to REF/REM/RET.

Any user-defined logic can be saved as a template in the same folder (or as per user's choice) and can be reused later.

Take a backup of the additional IED logic page as a template before running LUT. This is because after running LUT, the connections done from the main application logic and the additional logic may get lost. The user may need to delete the additional IED logic page and re-import the saved template.

After running of LUT, the ‘Power Management’ and ‘Station Communication’ nodes underneath the ‘MainApp’ main node may get ‘displaced’ under ‘PML630LSAddlogicConfigA’ and ‘PML630LSAddlogicConfigB’. This does not affect the logic pages in the Application Configuration tool. In this situation, delete the additional IED logic page and then re-import the saved template.

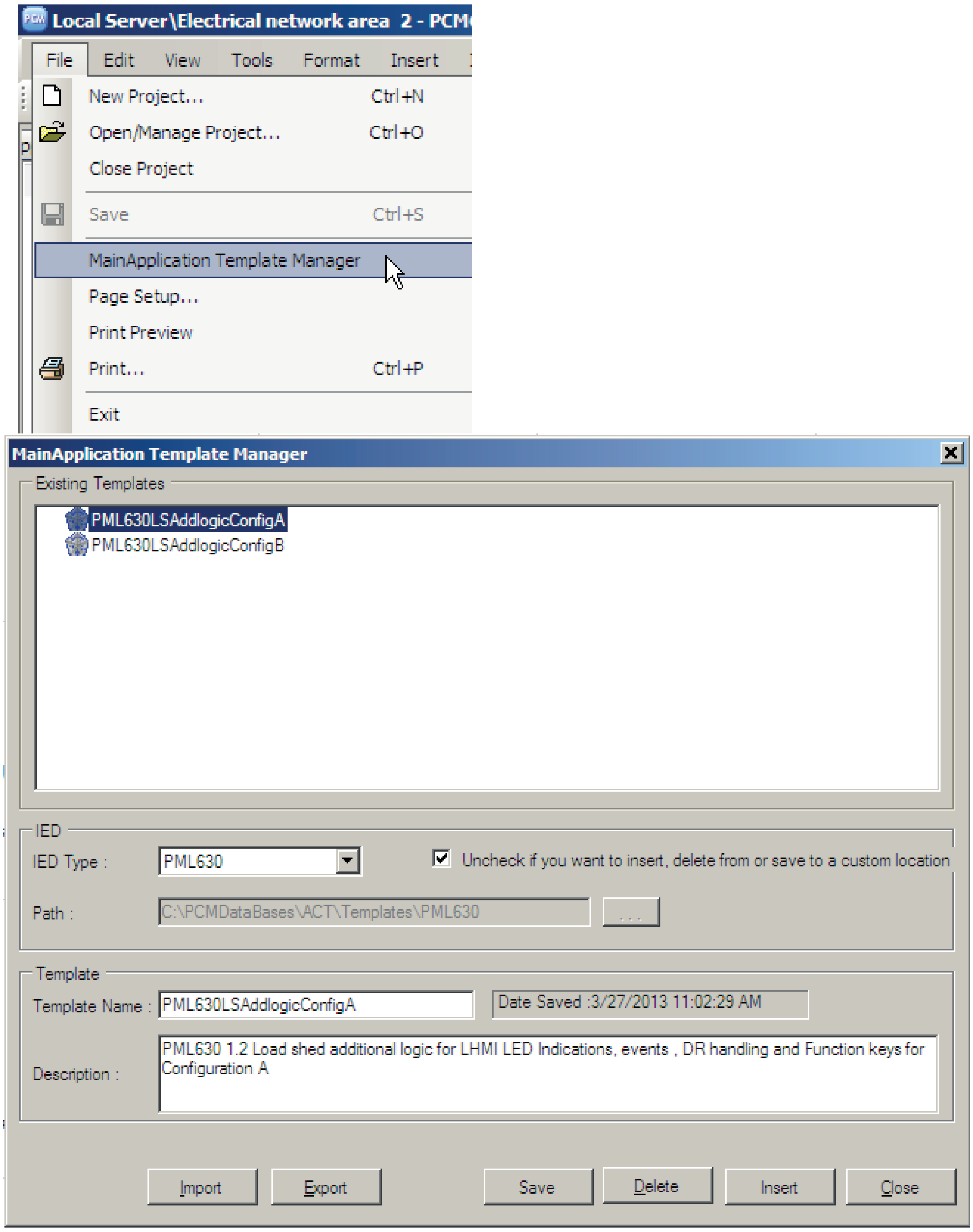


Figure 141: Saving user-defined template

5.1.8.2 Inserting a template

The IED and feeder IED templates have been included in the IED Connectivity Package installation for maximum reuse and error avoidance.

The pre-defined templates and possible new ones created are included for configuring other instances of IEDs and feeder IEDs. The templates are inserted along with existing logic in Application Configuration tool.

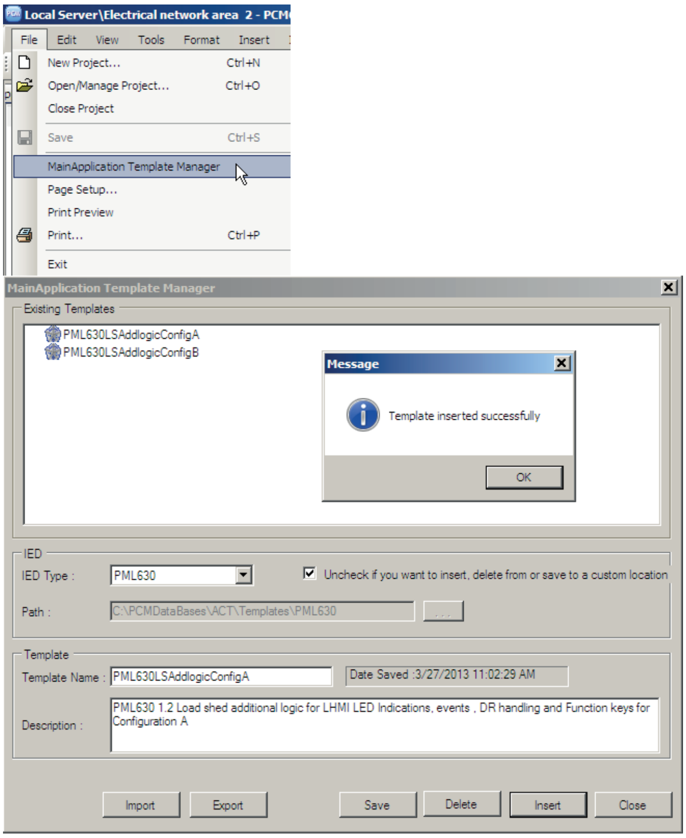


Figure 142: Inserting pre-defined template for IED from Connectivity Package directory

Connect the respective variables to the input pins of the Main application function blocks as the variables are already created and defined when the templates are inserted. Only dummy variables are assigned in the pre-defined templates.

Table 5: Templates available as a part of IED Connectivity Package

Template name	Description
PML630LSAddlogicConfigA	PML630 load-shedding additional logic for LHMI LED indications, events, DR handling and Function keys for Configuration A
PML630LSAddlogicConfigB	PML630 load-shedding additional logic for LHMI LED indications, events for Configuration B
615_30 LSCmdhandling	615 series Ver.3.0 or later versions load-shedding command handling template
620_20 LSCmdhandling	620 series Ver.2.0 load-shedding command handling template
630_10_LSCmdhandling	630 series Ver.1.0 load-shedding command handling logic
630_11_LSCmhandling	630 series Ver.1.1 or later version load-shedding command handling template
630_11_LSReprLoad	630 series Ver.1.1 or later version load feeder as a representative load template

5.1.9 Sample power management project

An example of a PCM600 and PML630 project with electrical network area 2 having connectivity to nearby two areas via external (utility) network connectivity (tie line or grid transformers).

Grid 2_1 is connected with the adjacent electrical network area 1 and Grid2_3 is connected with the adjacent electrical network area 3.

Electrical network area 2, equipped with the components, is included along with the Connectivity Package installation.

- 6 busbars
- 5 generators
- 2 external (utility) network connectivity (tie-line or grid transformers)
- 1 utility grid transformer
- 7 network circuit breakers
- 13 load feeders (12 individual loads and one load-shedding group)

To study and understand the IED configuration including load-shedding logic in the Application Configuration tool and parameterization using Parameter Setting tool, a sample PML630 project and an example of PCM600 are included along with the Connectivity Package installation.

This is a hypothetical electrical network as the number of loads are few in number and bus tie feeders are represented by a single circuit breaker.

In case of accidental deletion of a connection between function blocks in an actual project configuration for the IED, the sample project is referred to and affected function block connections are restored. Alternatively, use the License Update tool to restore the lost connections.

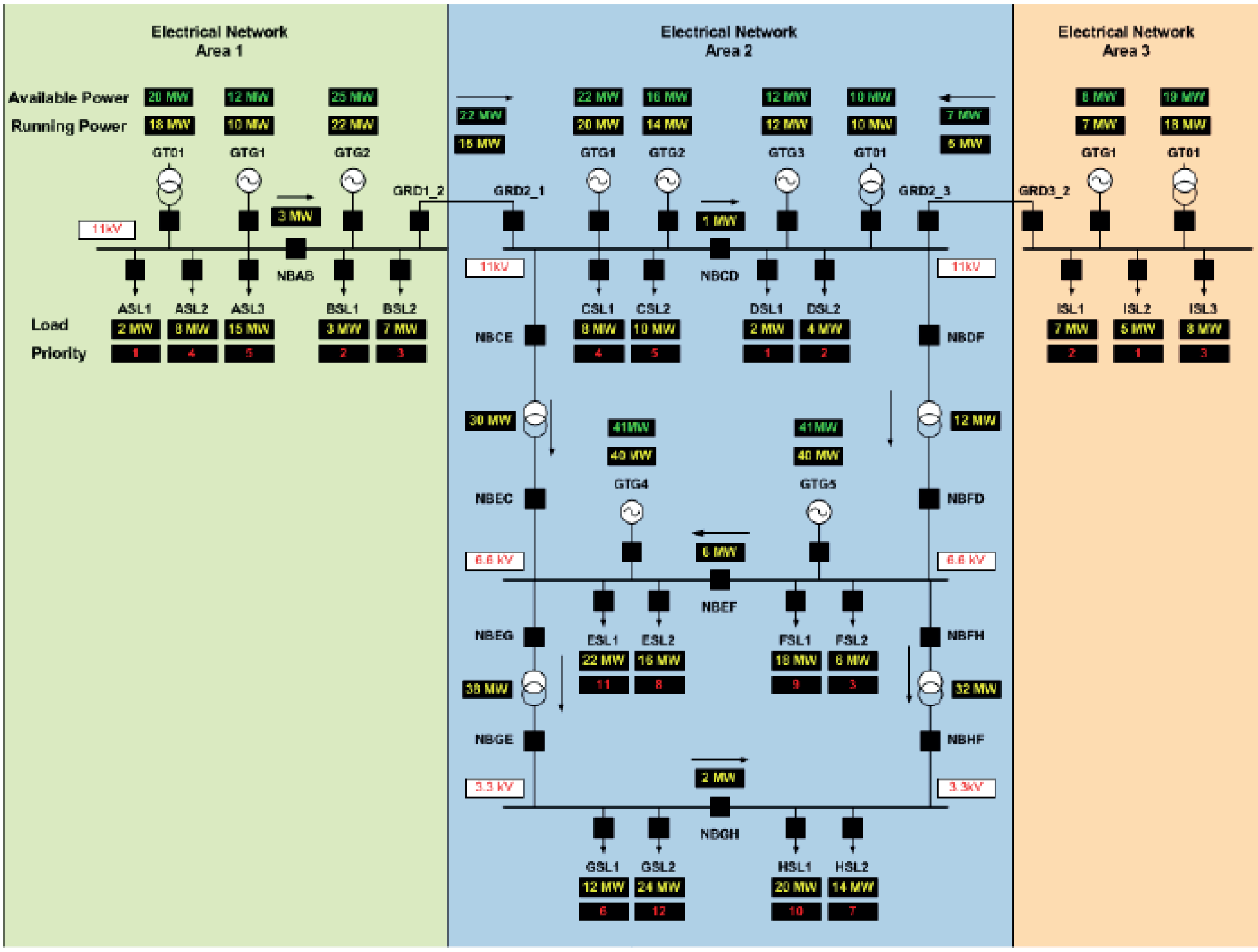


Figure 143: Sample project configuration

- The sample project is only for offline reference purposes.
- The sample project consists of other IEDs for each bay and the PML630 load-shedding IED. Make sure all necessary connectivity packages are pre-installed before importing the sample project into PCM600.
- The sample project may not work if downloaded in an IED.

The sample project is available under **Program Files/ABB/Connectivity Packages/IEDConnPackPML630/Templates/Sample PML630 project.**

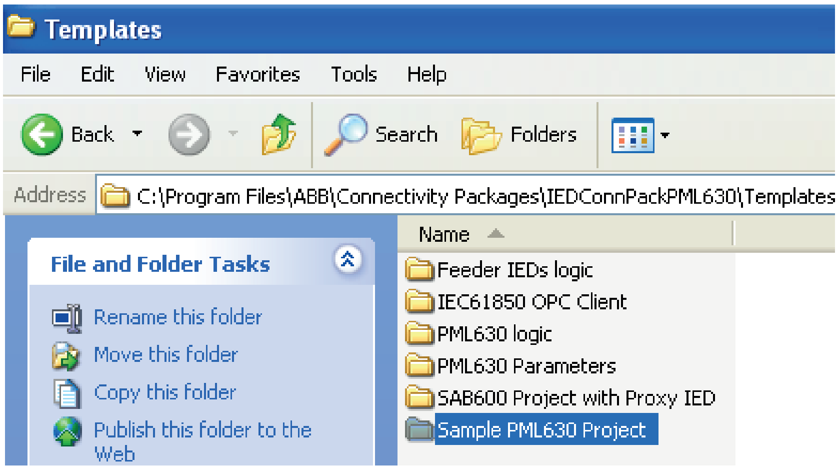


Figure 144: Sample IED project folder under IED Connectivity Package folders

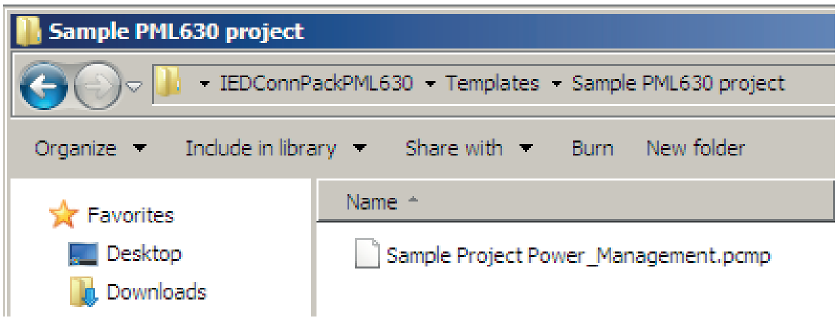
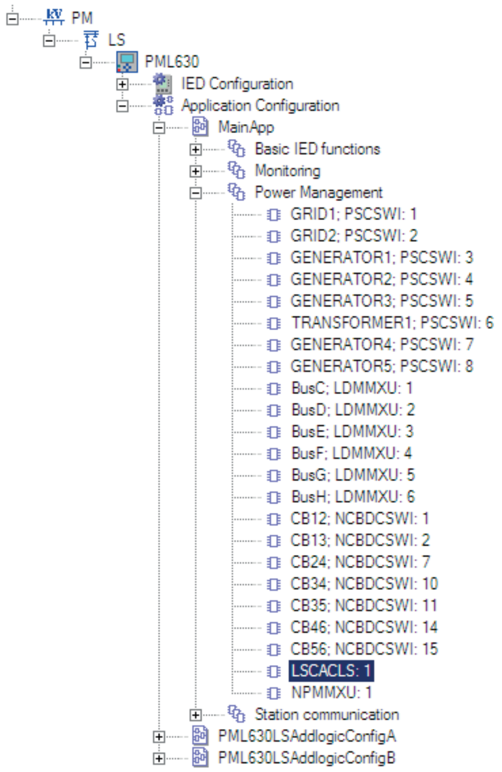


Figure 145: Sample IED project folder

The sample project is also used to refer the set parameters in the Parameter Setting tool.

5.1.10 Configuration parameters

The Parameter Setting tool is used to view and set configuration parameters, for example the parameters of the core load shedding function block LSCACLS.



Group / Parameter Name	IED Value [SG1/Common]	PC Value [SG1/Common]	Unit	Min	Max
LSCACLS: 1					
Disable LS SubNetw		No			
Enable LS SubNetw1		Yes			
Enable LS SubNetw2		Yes			
Enable LS SubNetw3		Yes			
Enable LS SubNetw4		Yes			
SubNetw1 Man Prio		0		0	19
SubNetw2 Man Prio		0		0	19
SubNetw3 Man Prio		0		0	19
SubNetw4 Man Prio		0		0	19
SubNetw1 Man Pow		0.0	kW	0.0	999999.9
SubNetw2 Man Pow		0.0	kW	0.0	999999.9
SubNetw3 Man Pow		0.0	kW	0.0	999999.9
SubNetw4 Man Pow		0.0	kW	0.0	999999.9

Figure 146: ACT: function block configuration parameter setting

- Save the IED application before doing parameter configuration, otherwise ACT shows an information window and asks to save the IED application.
- Select **Configuration Parameters** from the context menu.
- **Simple PST**, a new small tool window is shown above the tool window. **Simple PST** shows the name of the function block that must be configured, and the possible parameters to be configured.
- In the above figure, configure **Type**.
  The possible type values are shown as a note window when the mouse pointer selects **Type**.

- Check the actual default value and change the value in the **PC Value** field when necessary.
- Save (CTRL+S) the configuration value in **Simple PST**.
- The function block is now operating according to the configuration.
- Save the IED application to activate the changes for all tools.
- Close **Simple PST**.

5.1.11 Connections and variables

Input and output signals of a function block are linked using connections. Connection is established by dragging a line between the signals or by linking them using the variables.

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

Connection validation

A valid connection is only possible between two signals of the same base attribute type.

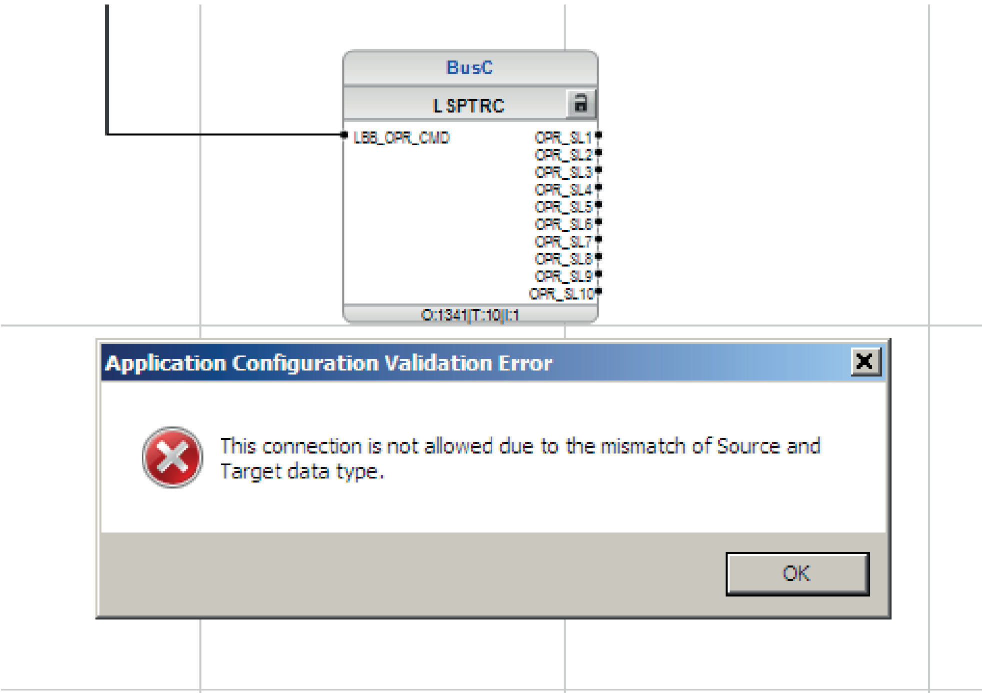


Figure 147: Application Configuration tool: Warning message by signal mismatch for a connection

5.1.12 Validation

Application Configuration tool validates application configuration in three levels.

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

Validation when creating the application configuration

Validation is performed when an application configuration is created, for example when a new connection is established between two function blocks. Error message is displayed in case of faulty connections.

- Connection between two input signals or two output signals
- Connection between two different data types, for example a binary output and an analog input

Validation on demand

Validation can be performed using the Validate Configuration icon in the toolbar. Errors and warnings 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.

- Warnings
  - Function block output signal connected to an unused variable
  - If the user connects output from higher execution order function to the input of the lower execution order function
- Errors
  - A mandatory input signal that is not connected

Warnings will not prevent writing to the IED. Errors have to be corrected before writing the application configuration to the IED. An application configuration can be saved and Application Configuration tool can be closed with open errors, but not written to the IED.

Validation when writing to the IED

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

5.2 Setting configuration and setting parameters in Parameter Setting tool

5.2.1 Setting parameters in Parameter Setting tool

Variables listed and displayed in the parameter list can be grouped as configuration and setting parameters. Configuration and setting parameters are set using the LHMI and Parameter Setting tool in PCM600. The LHMI and Parameter Setting tool-specific parameters are only visible in the LHMI and Parameter Setting tool.

A write from PCM600 to the IED operation using Common Read/ Write performed in the Parameter Setting tool overrides all parameters in the IED.

Parameters can be exported in XRIO (.xrio[1)]) format using Parameter Setting tool.

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 is a parameter that is changeable in the IED at runtime.

Setting group

The settings used by the IED for the protection application functions are organized in a group of settings. IED supports only one setting group.

IED parameters organization

The organization of the parameters in a tree structure is visible in the plant structure by expanding the setting tree.

See the technical manual for information on parameters like feeder load-shed priority, grid transformer/generator overload capability, generator modes, activation of GOOSE and so on.

5.2.2 Automatic parameter import

A set of common parameters needed for the IED are included as a part of the 'Templates' folder under the IED Connectivity Package.

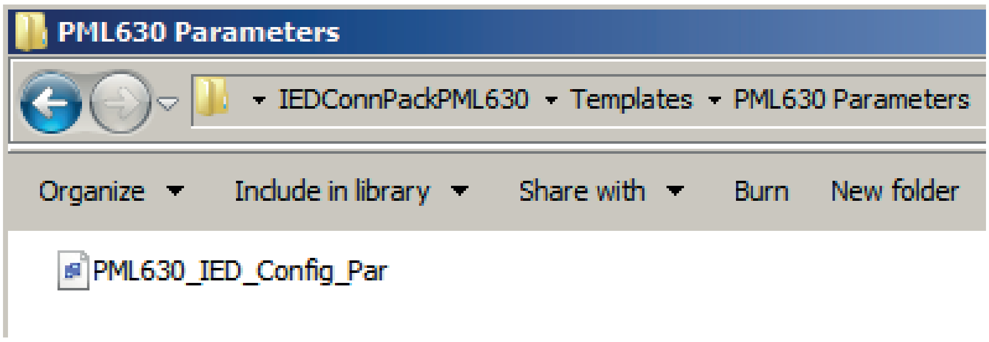


Figure 148: IED parameter file

Only the parameters pertaining to the IED Configuration section including LHMI LED configuration, Function keys assignment and so on and not the Power Management function are included in the parameter file.

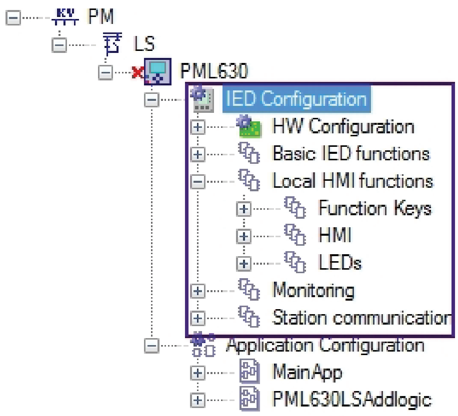


Figure 149: IED parameter file scope of coverage

The parameter file needs to be imported as soon as Configuration Wizard step is completed. If done so after doing the power management settings, the latter would be overwritten.

Section 6 Local HMI engineering

6.1 LED and function key engineering

6.1.1 Local HMI engineering process

The engineering process of the LED LHMI involves several steps. Figure 6.1.1 presents the pre-engineering step, the main steps in the engineering process and the required sequences.

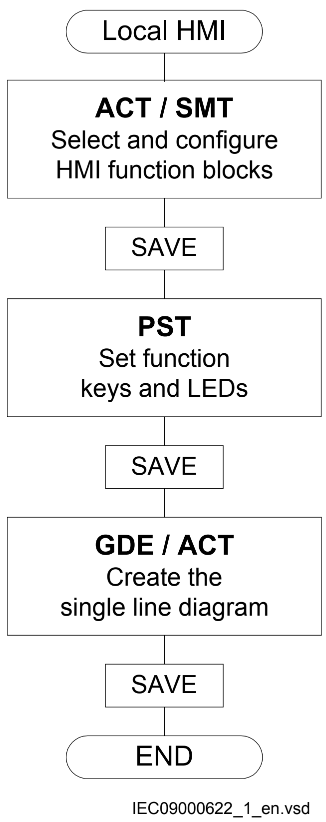


Figure 150: LHMI: Engineering process flowchart

- Application Configuration tool with possible assistance of the Signal Matrix tool

- To use the function keys and LEDs on LHMI it is needed 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 LHMI are visible by default for the Parameter Setting tool.
- Use the Application Configuration tool to connect start and trip signals from application functions to LED function blocks.

- Parameter Setting tool
    - The operation mode of the function keys and the LEDs is defined in the Parameter Setting tool.
    - The presented text labels on the display for the LHMI keys and LEDs.
- Graphical Display Editor with assistance of the Application Configuration tool
    - Making the single line diagram of the primary process part
    - Making the dynamic links for the apparatus
    - Making the dynamic links for measurements

6.1.1.1 Application Configuration tool and local HMI function blocks

A set of special function blocks is available for all the operation element groups on LHMI.

See the technical manual for more information about function blocks.

Different LHMI function blocks are available in Application Configuration tool.

- 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 151 describes the basic LHMI and the operation element groups. These are the 15 LEDs and the corresponding text elements on the display [A]. They are operated by the keys [a] and [b].

The other group is the five function keys with their IEDs and the corresponding text elements on the display [B].

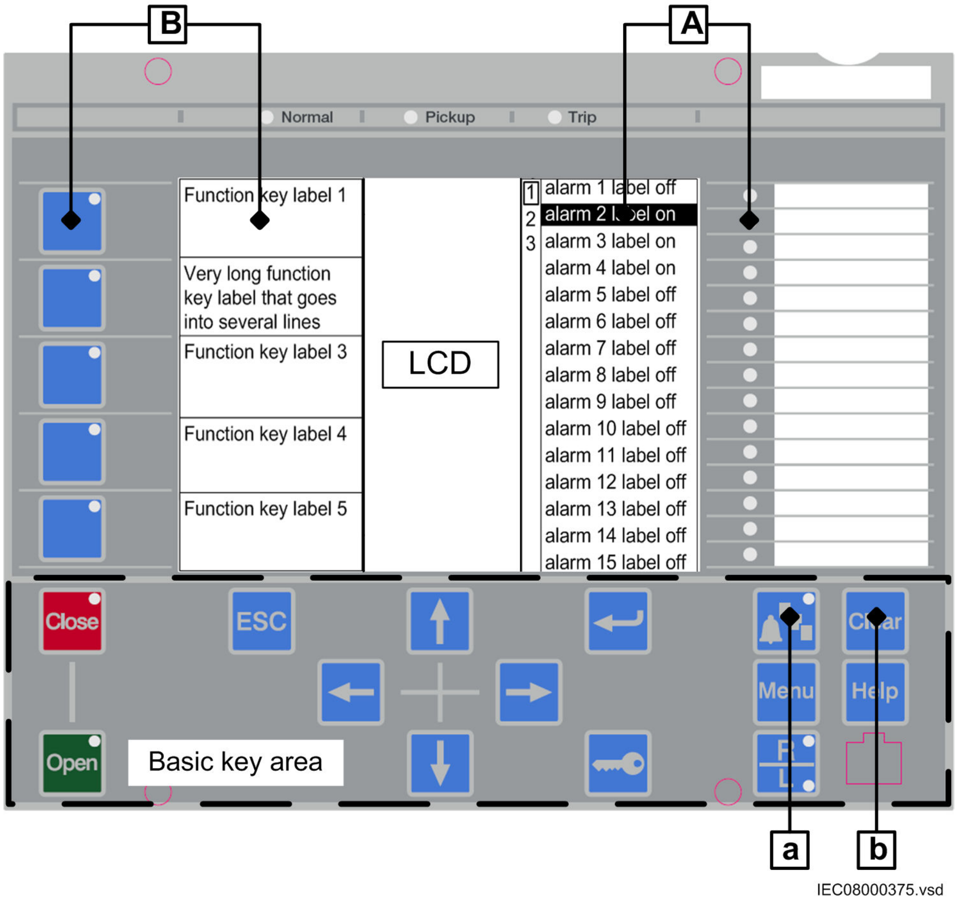


Figure 151: Local HMI: Placement of local HMI operation elements

The breaker control Open/Close and R/L keys are not used in PML630.

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 the timer *tReset* and *tMax* for the LED operation mode 'LatchedReset-S'.

Function block GRP1_LED1 to GRP3_LED15

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

Function block FNKEYMD1 to 5

- Every function key has an own FNKEYMD function block.
- The 5 function keys on the left side of the display [B] can be used to process demands.
- The function block handles the signal for the LED included in the key as input signals.
- The LED signal of the key is independent of the key function and must be programmed to process demands.
- The function block handles the operators command when the key is pressed as output signal.
- The functions are activated whenever a key is pressed the first time. The corresponding text elements for the five keys appear on the left side of the display. No execution of the function is done. So the first press is used to activate only the presentation.
- The next key press 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).

6.1.1.2 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 be used for different operations.

- Pulsed signal
    - Each press 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.

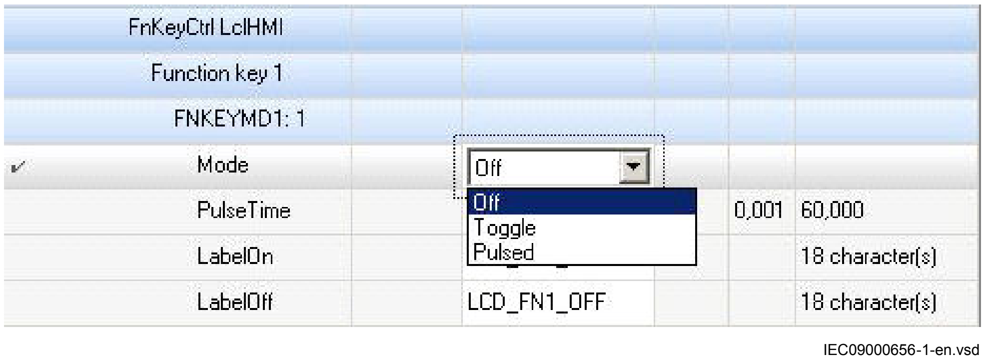


Figure 152: LHMI: Function key operation mode

6.1.1.3 Local HMI function key assignment

The LHMI function keys are assigned to perform certain commonly used user control functions. These are also available from the LHMI menu structure and/or the Parameter Setting tool. Certain user actions are assigned to the function keys.

- Load-shedding block command
- Slow load-shedding trigger inhibit for command
- Global (overall) load-shedding reset command

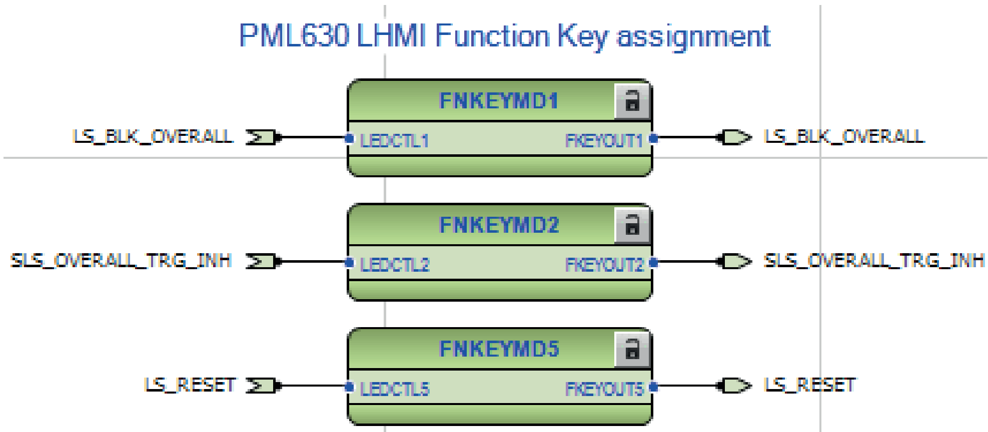


Figure 153: Logic for function keys assignment

The function keys also need to be parameterized using the Parameter Setting tool. The blocking actions are configured in the toggle mode and load-shedding reset action is configured in the pulse mode.

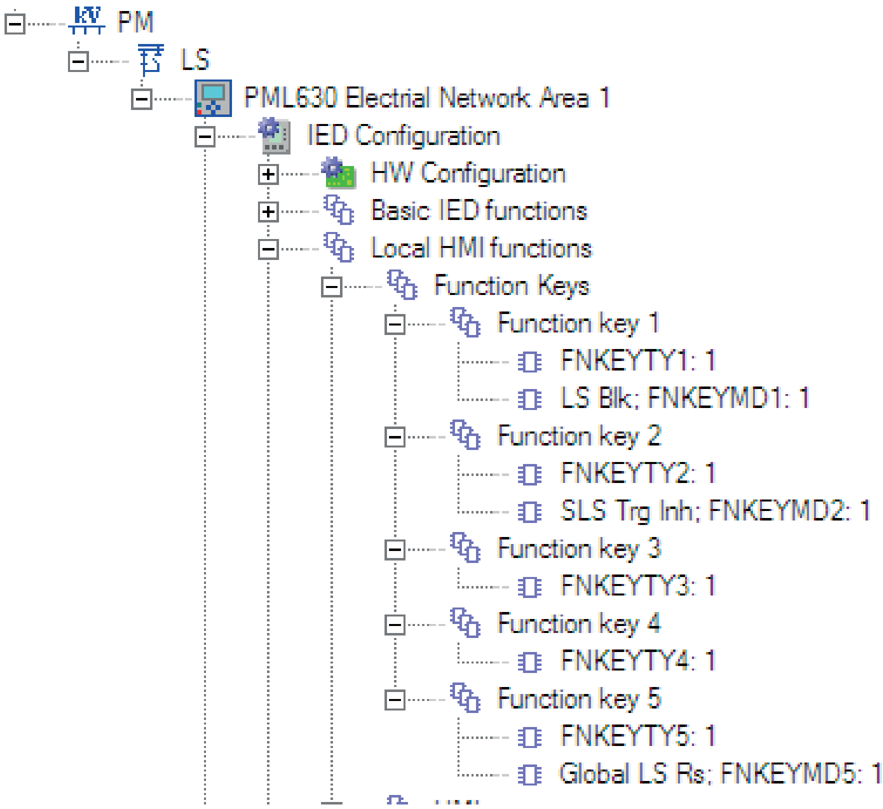


Figure 154: Parameter tree structure for functional keys

The generic parameters for the function keys FNKEYTY1, FNKEYTY3 to FNKEYTY5 are presented in the figures.

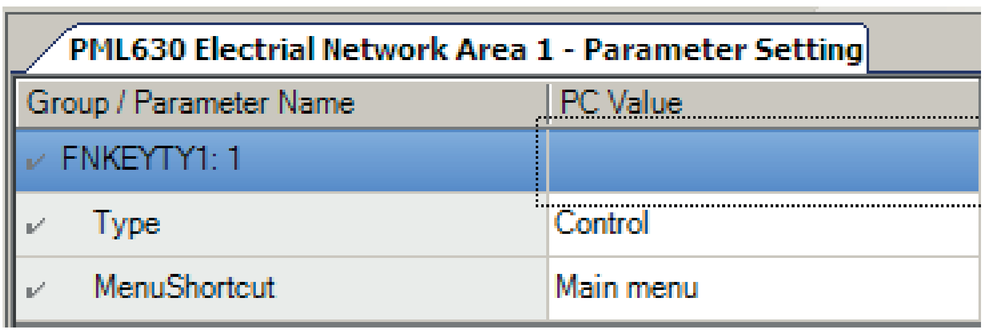


Figure 155: Generic function key parameter set

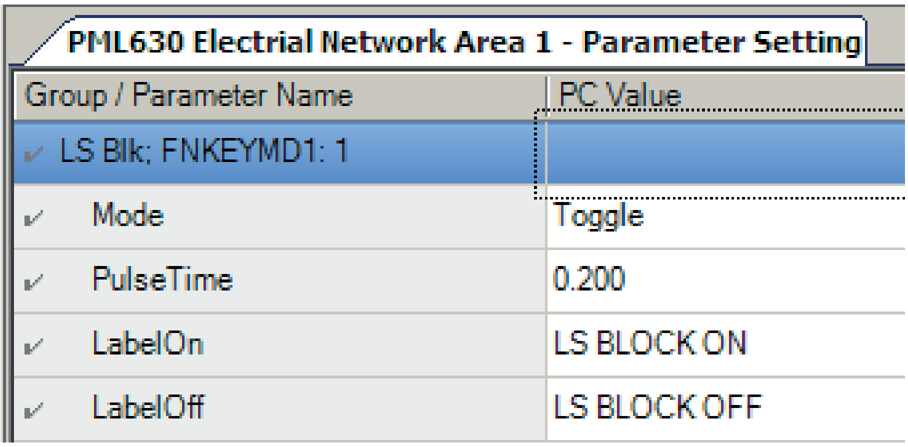


Figure 156: Function key 1 parameter set

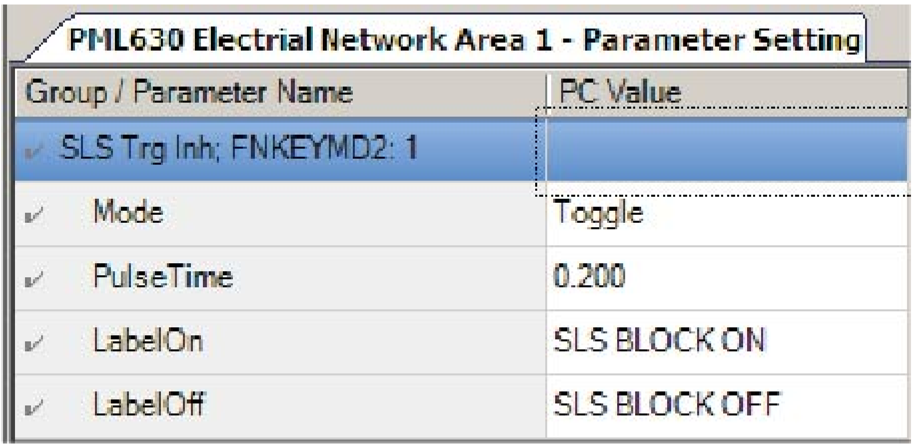


Figure 157: Function key 2 parameter set

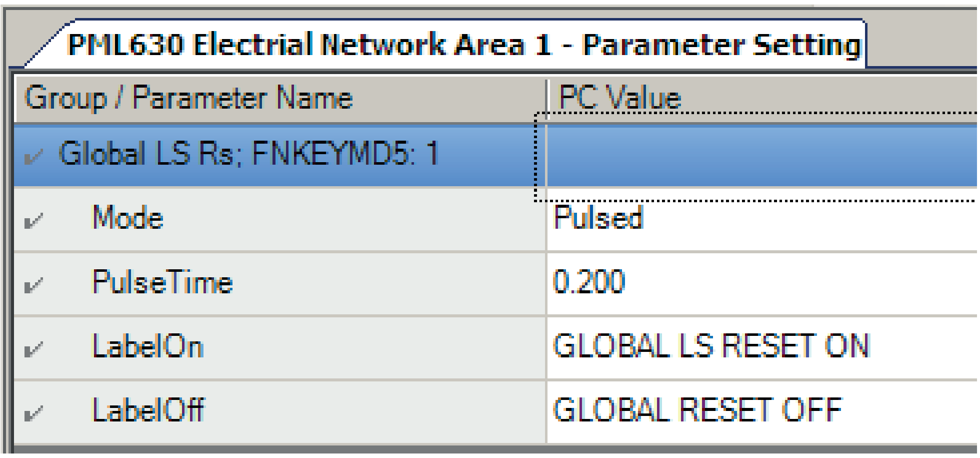


Figure 158: Function key-5 parameter set

The LEDs have a number of different operation modes, see Figure 159.

- General definitions
  - Each LED can illuminate in one of three colors: RED, YELLOW or GREEN.
  - Only one color is illuminated at a time.
  - The priority for illumination and the color is linked.
    - 1 = RED
    - 2 = YELLOW
    - 3 = GREEN
    - When RED and YELLOW are ON at the same time, the LED illuminates in RED.
  - The operator's acknowledgement for the LED signals is done for all three signals (RED, YELLOW and 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 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.

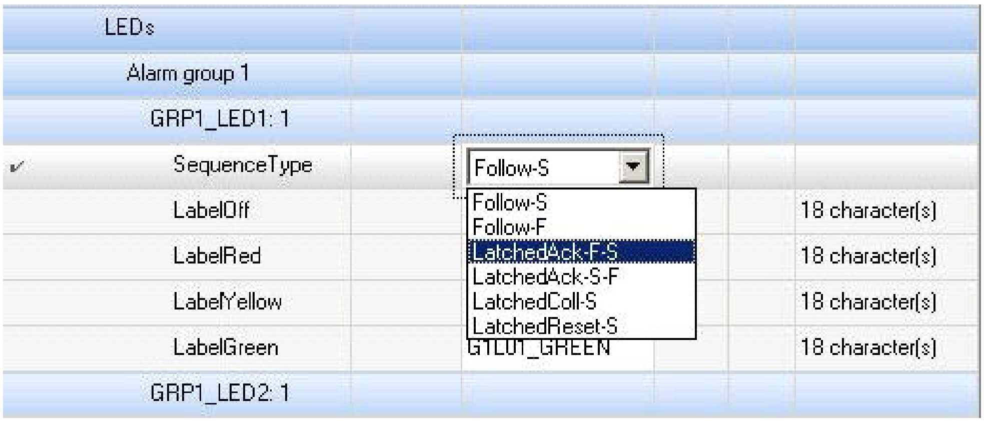


Figure 159: LHMI: LED operation mode

6.1.2 LED operation modes

Description of different operation modes for LEDs to be configured in Application Configuration tool and Parameter Setting tool.

Six operation modes are listed in the drop down menu in the Parameter Setting tool.

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

LED operation mode Follow-S

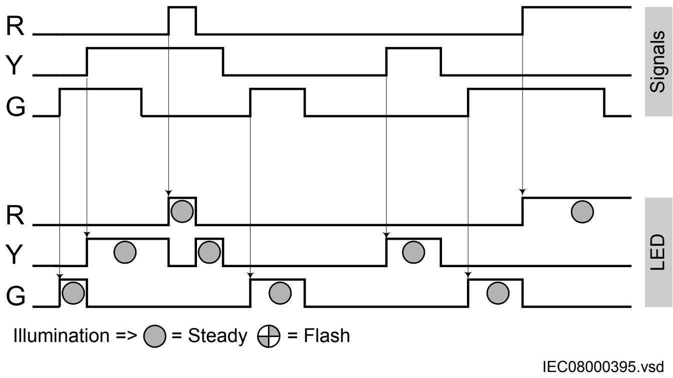


Figure 160: LHMI: LED operation mode Follow-S

Monitoring a signal with a LED is a simple mode, where the LED follows the signal state. More than one signal per LED can be used when applicable. See Figure 160 for the valid priority rules. The LED illuminates always in steady state.

LED operation mode Follow-F

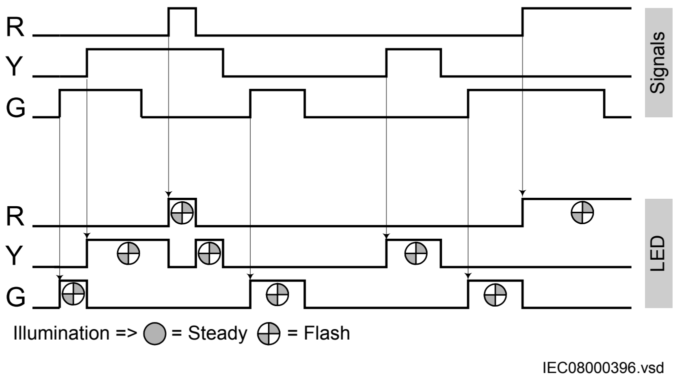


Figure 161: LHMI: LED operation mode Follow-F

This is the same mode as Follow-S but the LED illuminates flashing, see Figure 161. This mode may be used to indicate that a tap changer or Petersen coil is moving.

LED operation mode LatchedAck-F-S

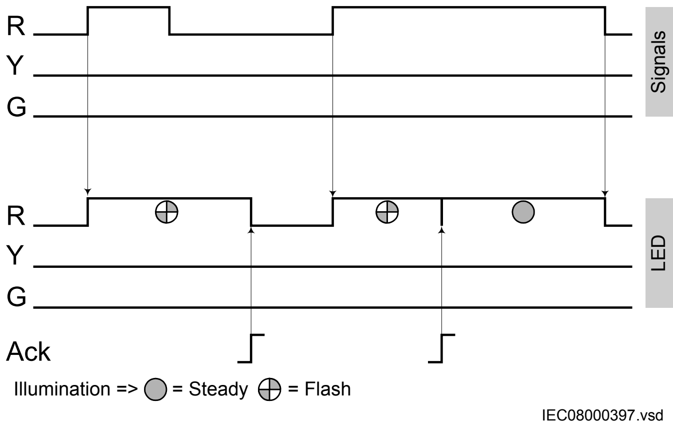


Figure 162: LHMI: LED operation mode LatchedAck-F-S / Base

The classical mode to indicate incoming alarms or warnings, which the operator has not seen since the last acknowledgement, is presented in Figure 162 as a basic operation mode. There are two possibilities for the operator to acknowledge.

- The signal is already gone when acknowledged, the LED turns OFF (at least for this color).
- The signal is still ON, the LED stays illuminated and changes to steady state.

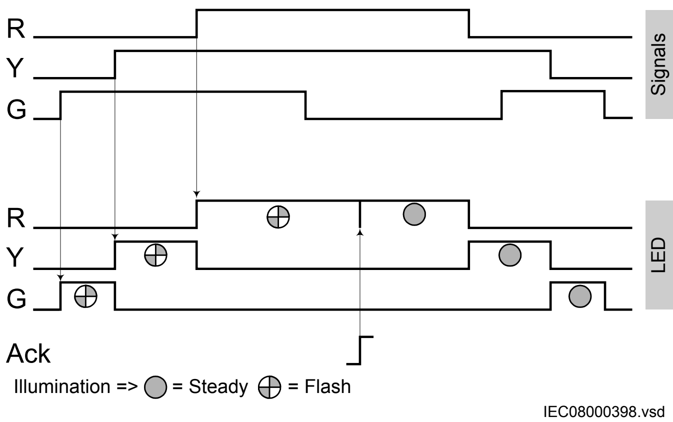


Figure 163: LHMI LED operation mode LatchedAck-F-S Ack Prio / 1

When more than one color is used the rules for priority are valid. There are two basic principles.

- Two or more signals are still ON when the LED is acknowledged.

    - All colors (signals) are acknowledged and they will illuminate in steady state.
    - Incoming additional signals with lower priority will illuminate when they become the highest priority in steady mode.
- One or more signals with higher priority are changing to ON after an acknowledgement.
    - The higher priority color (signal) will illuminate in flash mode.

See Figure 163 and Figure 164 for these two principles.

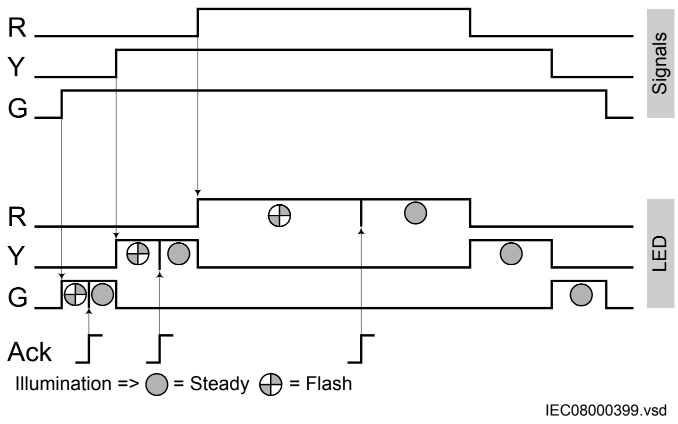


Figure 164: LHMI LED operation mode LatchedAck-F-S Prio / 2

LED operation mode LatchedAck-S-F

This operation mode operates exactly as the LatchedAck-F-S mode described above. The only difference is that the illumination mode is changed. Flash mode instead of steady mode and steady mode instead of flash mode.

LED operation mode LatchedColl-S

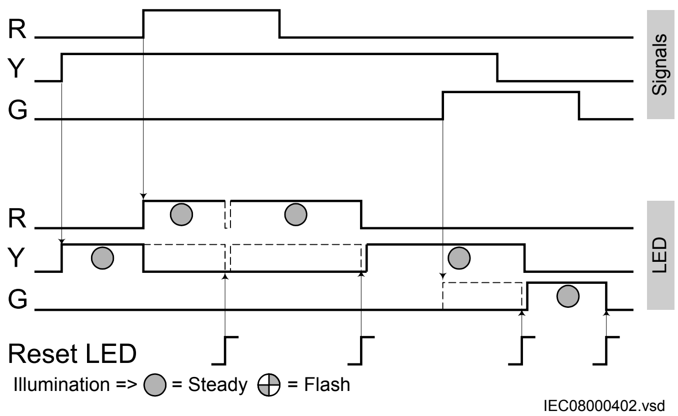


Figure 165: LHMI: LED operation mode LatchedColl-S

This mode catches a signal change to ON and the LED stays ON until the operator resets the LEDs for this group.

If the signal is still ON when a reset LED is done, the LED will illuminate again. This occurs when the application configuration accesses the signal again in the next cycle after reset. The thin dashed lines in Figure 165 shows the internal state of the LED following the signal and reset, when no higher prior signal is given.

The LED illuminates always in steady mode.

LED operation mode LatchedReset-S

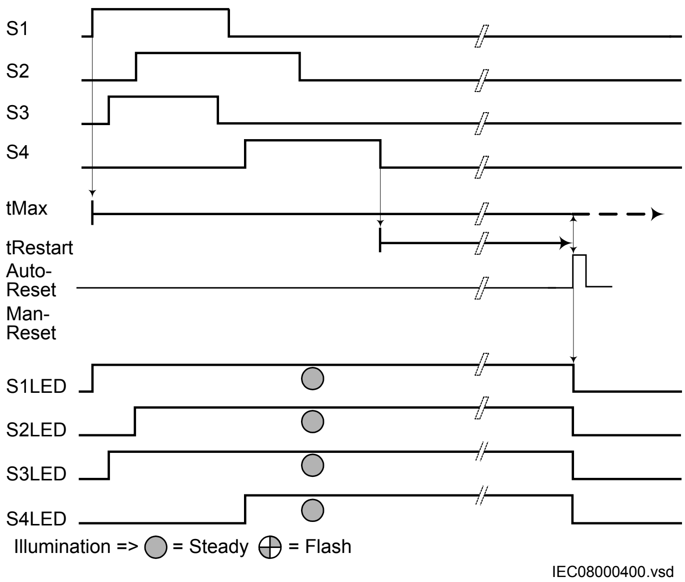


Figure 166: LHMI: LED operation mode LatchedReset-S

This mode is useful to monitor signals that are involved in case of a disturbance, see Figure 166. The signal state after the disturbance allows a fast overview about the disturbance. To get always the situation of the last occurred disturbance, the LEDs are reset after a predefined time (tReset). So this is the longest time a disturbance can be monitored by the LED situation.

In case a second disturbance occurs before the tReset time has elapsed, see Figure 167, the signals that are still ON at the end of tReset will return to ON with the next application configuration cycle after tReset. To clear these LEDs, a second timer tMax is used. TMax is started when the first signal of the disturbance changes to ON. tMax is stopped, when tReset could clear all LEDs.

A disturbance runs for a maximum of some seconds, while tReset can be in the range of 60 to 90 seconds.

The timer tReset and tMax are configured in Parameter Setting tool as part of the function block LEDGEN

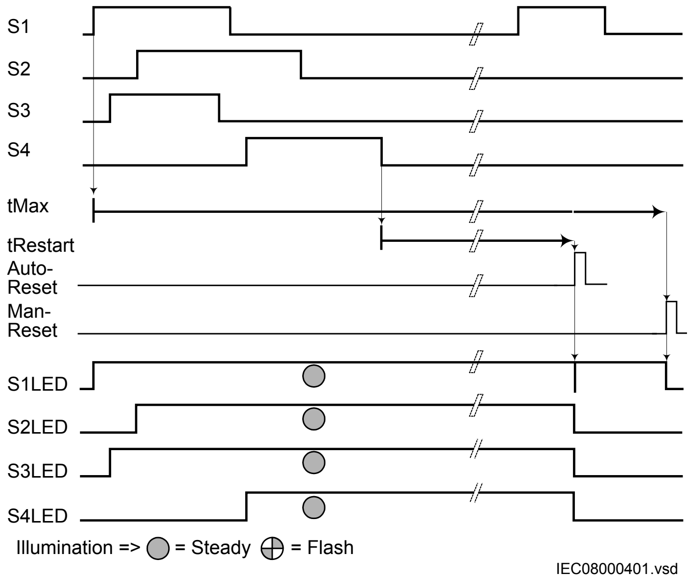


Figure 167: LHMI LED operation mode LatchedReset-S / 2

6.2 Single-line diagram engineering

The substation single-line diagram with, for example, breaker status and power values, can be created using the Graphical Display Editor.

The load-shedding network view of a substation is generated automatically at the end of the configuration wizard process. The load-shedding network view contains the source circuit breaker (generator, grid transformers) and the network circuit breaker (bus section and bus coupler) status.

6.2.1 Concept description to present and generate diagrams in Graphical Display Editor

For additional concept information to use Graphical Display Editor, see Figure 168.

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

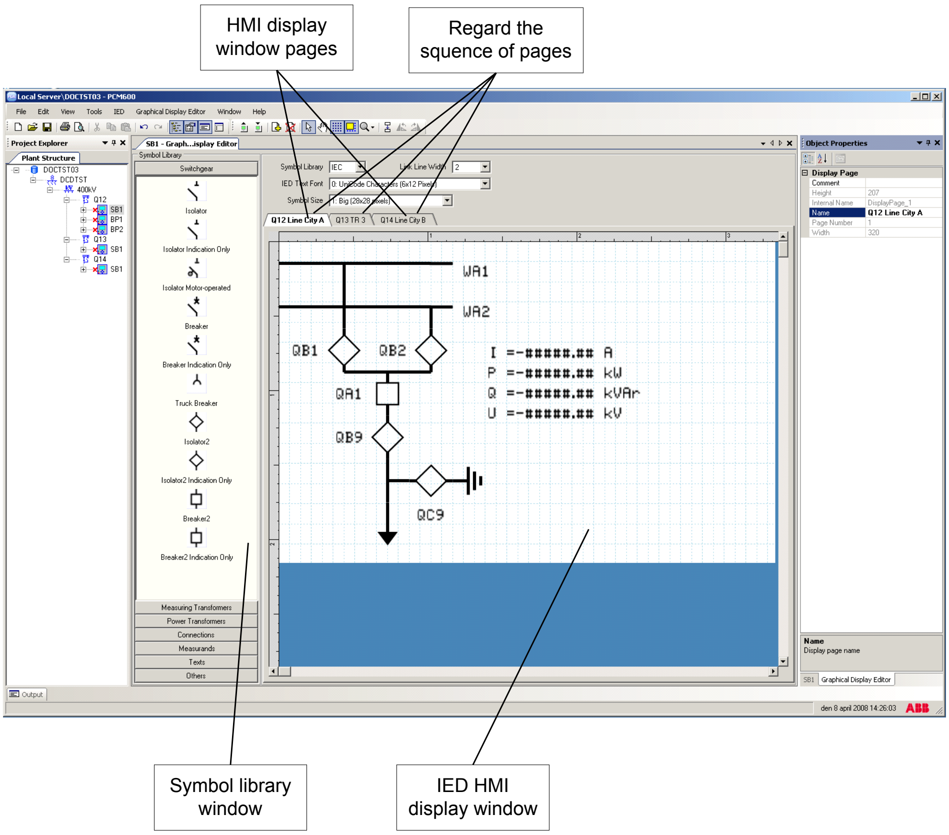


Figure 168: GDE: Screen image with active GDE

1. Start GDE to open a presentation of the tool.
2. GDE has a fixed symbol 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

- Several single line diagrams can be created for one bay.
- The IED supports one bay.
- The sequence order of the HMI pages in 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.

Symbol library

The symbol library 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 library 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 library standard, GDE closes the library windows, 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 symbol library 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 single bit information or for a list of up to 32 different inputs. The corresponding function blocks in ACT are of type VSGGIO and SLGGIO.

- Select **Dynamic Text** and **Indication** to present the text for the actual value of the function block, see Figure 169.
- Click **Select Button** to select the value.

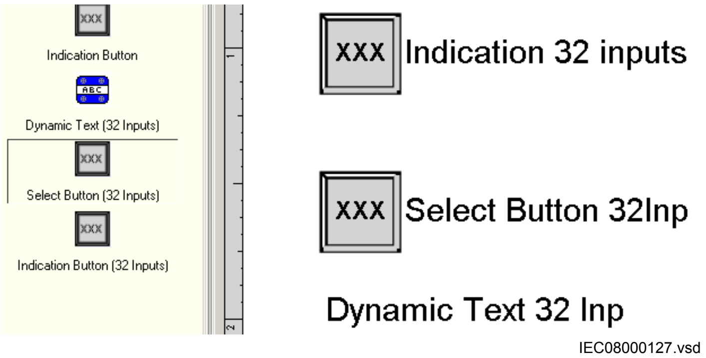


Figure 169: GDE: Dynamic Text symbols

The standard (IEC or ANSI) for the symbols and the selection of the font size for the text elements can be changed using the two selector boxes 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 pixel)
- UniCode characters (13 x 14 pixel)

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 icon *Snap to grid* must be enabled to place a symbol, for example an apparatus object. The description text for an apparatus object can be placed in all four directions around the symbol. The description is part of the symbol and the description can be placed even if the *Snap to Grid* is not enabled.

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 name and the unit of a measurement or text symbol can be changed either by double click the symbol or via the object 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 170.

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. Click the *Link* icon to enable direct line drawing.
4. Center the mouse pointer on the center of a connection point; visible in two circles at the endpoints of a line, to draw a line.
5. 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.
6. Draw all line elements that are necessary.
7. Click *Select* in the menu bar to finish the line drawing.

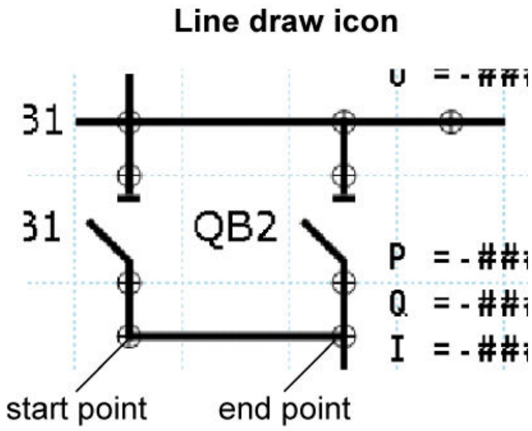


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Figure 170: GDE: Drawing a line

6.2.2 Supported single-line diagram symbols

Table 6: Supported symbols

IEC Symbol Name	Node Type	IEC Symbol Definitions	ANSI Y32.2/ IEEE 315 Symbol Definitions	Category
Junction	1			Connections
Busbar junction	2			Connections
Earth	10			Connections
Feeder end	21			Connections
Current transformer	5			Measuring transformers
Voltage transf. 2 windings	6			Measuring transformers
Measurand	11	ABC	ABC	Measurands
Capacitor	7			Others
Surge arrestor	8			Others
Generator	9	G	GEN	Others
Table continues on next page				

IEC Symbol Name	Node Type	IEC Symbol Definitions	ANSI Y32.2/ IEEE 315 Symbol Definitions	Category
Reactor	14			Others
Motor	15			Others
Coil	18			Others
Transformer 2 winding	16			Power transformers
Transformer 3 winding	17			Power transformers
Autotransformer	23			Power transformers
Isolator, 00 = middle position	3			Switchgear
Isolator, 01 = Open	3			Switchgear
Isolator, 10 = Closed	3			Switchgear
Isolator, 11 = Undefined	3			Switchgear
Breaker, 00 = Middle position	4			Switchgear
Breaker, 01 = Open	4			Switchgear
Breaker, 10 = Closed	4			Switchgear
Breaker, 11 = Undefined	4			Switchgear
Truck, 00 = Middle position	22			Switchgear
Truck, 01 = Open	22			Switchgear
Truck, 10 = Closed	22			Switchgear
Truck, 11 = Undefined	22			Switchgear
Isolator indication only, 00 = Middle position	25			Switchgear
Isolator indication only, 01 = Open	25			Switchgear
Isolator indication only, 10 = Closed	25			Switchgear

Table continues on next page

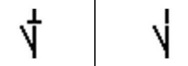
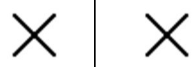
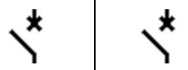
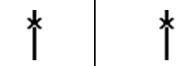
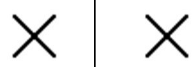
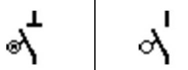
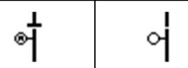
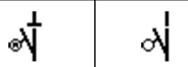
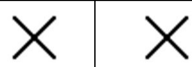
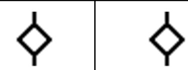
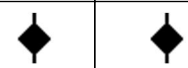
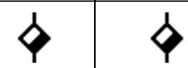
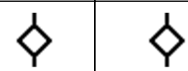
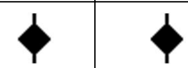
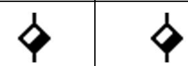
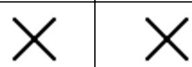
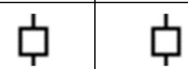
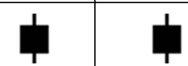
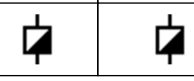
IEC Symbol Name	Node Type	IEC Symbol Definitions	ANSI Y32.2/ IEEE 315 Symbol Definitions	Category
Isolator indication only, 11 = Undefined	25			Switchgear
Breaker indication only, 00 = Middle position	26			Switchgear
Breaker indication only, 01 = Open	26			Switchgear
Breaker indication only, 10 = Closed	26			Switchgear
Breaker indication only, 11 = Undefined	26			Switchgear
Isolator motor operated, 00 = Middle position	27			Switchgear
Isolator motor operated, 01 = Open	27			Switchgear
Isolator motor operated, 10 = Closed	27			Switchgear
Isolator motor operated, 11 = Undefined	27			Switchgear
Isolator2, 00 = Middle position	32			Switchgear
Isolator2, 01 = Open	32			Switchgear
Isolator2, 10 = Closed	32			Switchgear
Isolator2, 11 = Undefined	32			Switchgear
Isolator2 indication only, 00 = Middle position	33			Switchgear
Isolator2 indication only, 01 = Open	33			Switchgear
Isolator2 indication only, 10 = Closed	33			Switchgear
Isolator2 indication only, 11 = Undefined	33			Switchgear
Breaker2, 00 = Middle position	34			Switchgear
Breaker2, 01 = Open	34			Switchgear
Breaker2, 10 = Closed	34			Switchgear
Breaker2, 11 = Undefined	34			Switchgear

Table continues on next page

IEC Symbol Name	Node Type	IEC Symbol Definitions	ANSI Y32.2/ IEEE 315 Symbol Definitions	Category
Breaker2 indication only, 00 = Middle position	35			Switchgear
Breaker2 indication only, 01 = Open	35			Switchgear
Breaker2 indication only, 10 = Closed	35			Switchgear
Breaker2 indication only, 11 = Undefined	35			Switchgear
Static text	0			Texts
Dynamic text	29			Texts
Select button, 00 = Middle position	30			Texts
Select button, 01 = Open	30			Texts
Select button, 10 = Closed	30			Texts
Select button, 11 = Undefined	30			Texts
Indication button, 00 = Middle position	31			Texts
Indication button, 01 = Open	31			Texts
Indication button, 10 = Closed	31			Texts
Indication button, 11 = Undefined	31			Texts

6.2.3 Bay configuration engineering

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

6.2.3.1 Creating a complete HMI display page

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 171.
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.
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.

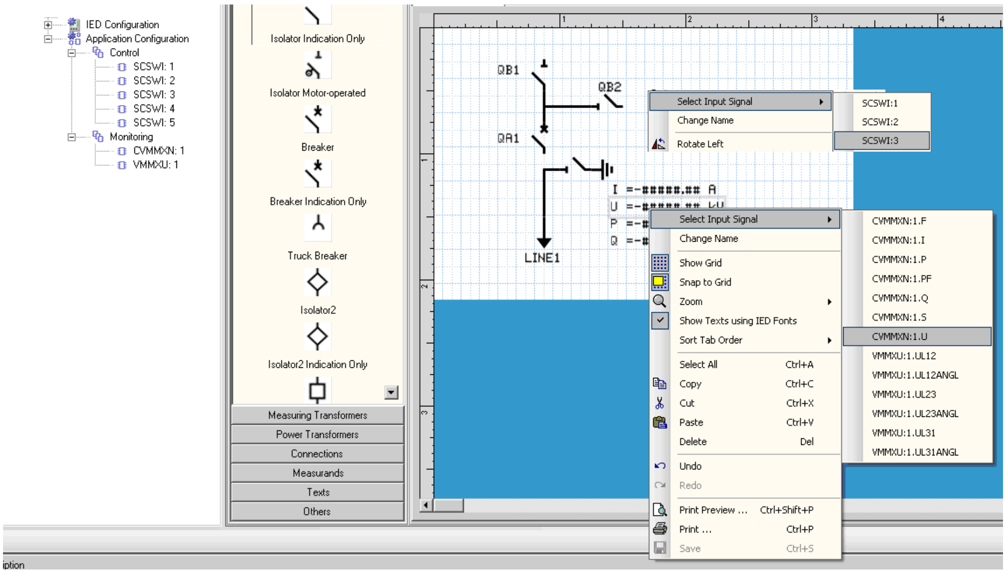


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Figure 171: GDE: Establish a dynamic object link

6.2.3.2 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.

1. Right-click the apparatus symbol and select **Select Input Signal**. A list of engineered switch control application function blocks opens, see Figure 172.
2. Select the switch control application function block that corresponds to the selected apparatus.
3. Right-click the measurement symbol and select **Select Input Signal**. A list of the engineered measurement application function blocks opens.
4. Select the measurement application function block that corresponds to the selected symbol.

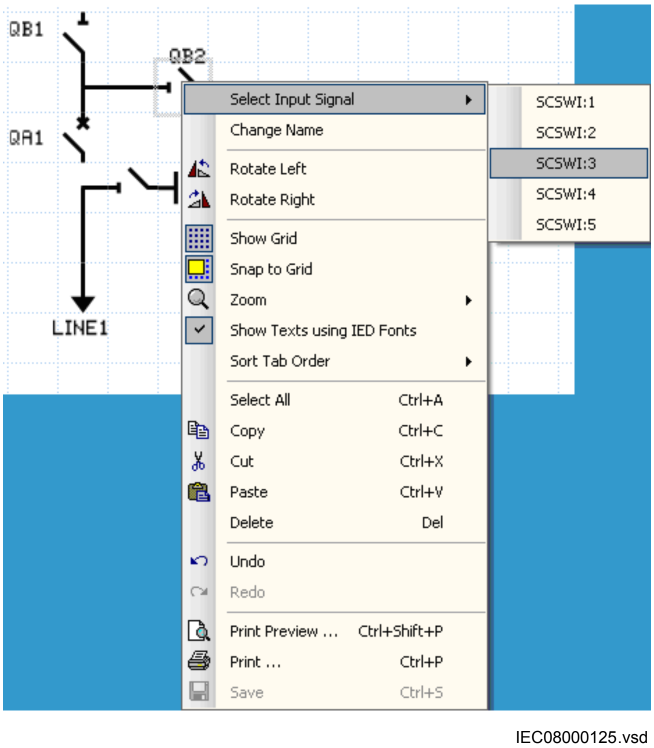
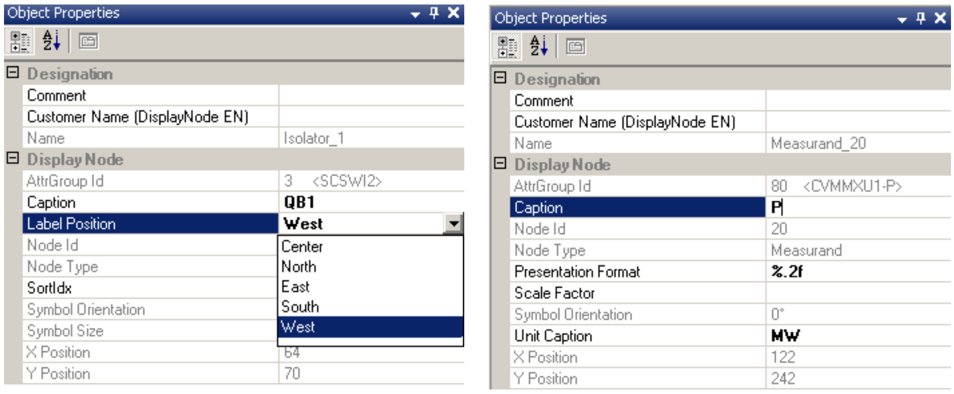


Figure 172: GDE: Input signal selection

The order number 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.

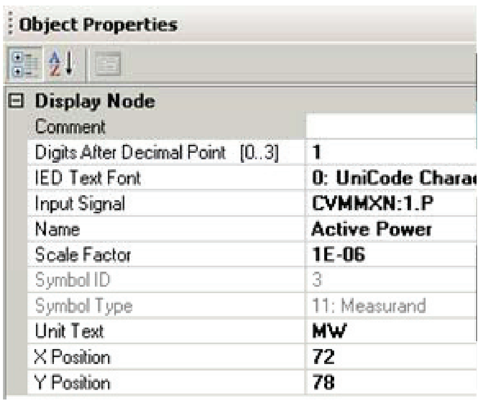


en05000611.vsd

Figure 173: GDE: Object properties windows for text insertion

The single-line diagram screen can display different values, with the help of the dynamic text fields. These values are displayed by default in SI units (for example, active power is displayed in W). Modify **Scale Factor** in the object properties (see Figure 174) 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



IEC10000174.vsd

Figure 174: GDE: Object properties window for unit change

6.3 Events and indications

To get IED events to the LHMI event list and indications for the Start and Trip protection indicator LEDs, the disturbance rerecorder needs to be engineered.

See the technical manual for more information on how to configure and set the binary signals of the disturbance recorder.

Section 7 IEC 61850 communication engineering

7.1 IEC 61850 interface in the IED and tools

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

7.1.1 Function view for IEC 61850 in PCM600

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

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

7.1.2 IEC 61850 interface in IED

See Figure 175 for a principle view of the IEC 61850 logical node concept in the IED.

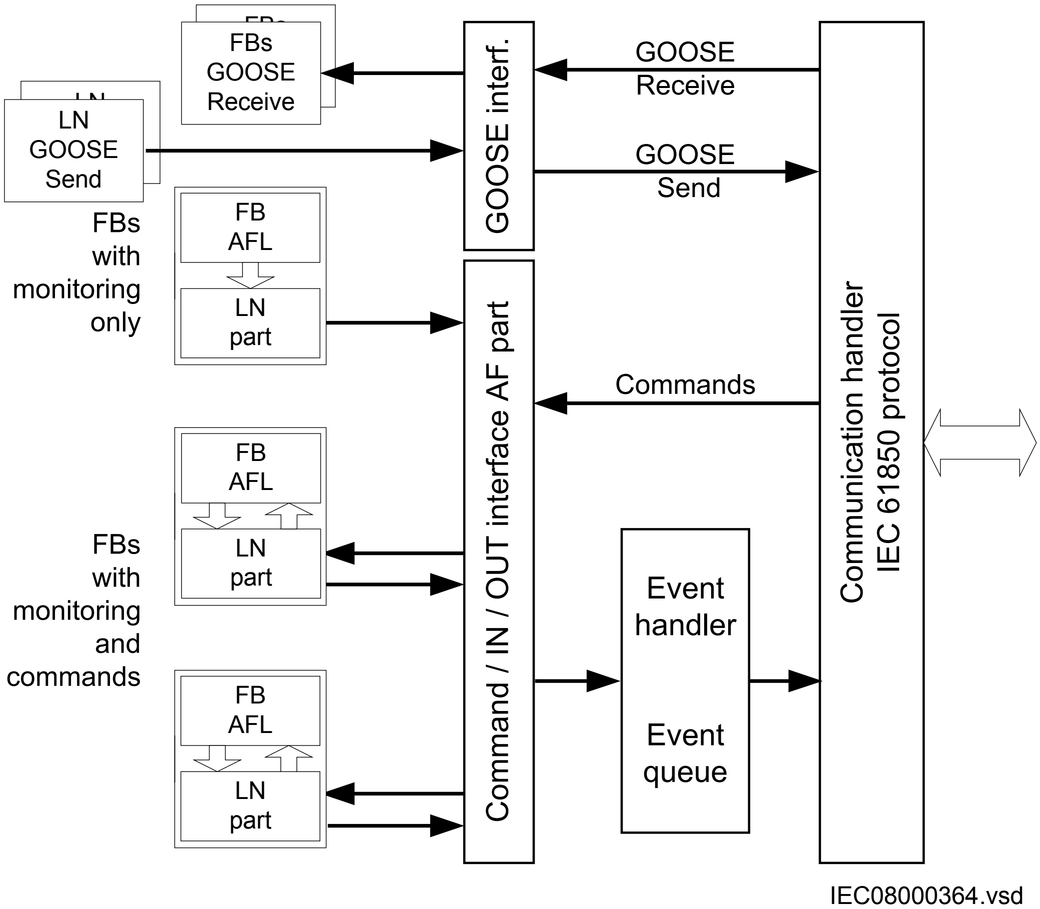


Figure 175: IEC 61850: Communication interface principle

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

Whenever a function block is instantiated in the Application Configuration tool, PCM600 automatically generates the corresponding logical node data. In Figure 175 this is shown by two parts per function block. The upper part is the visible function block in the Application Configuration tool and the lower part is the logical node data for the function block.

7.1.2.1 GOOSE data exchange

The IEC 61850's GOOSE communication profile supports direct data exchange between two or more IEDs. The concept is based on sending a multicast message over the Ethernet. This method is described in the IEC 61850-7-2 clause 15. The IEDs detect the required information from the telegram by its source address. Telegrams are send as multicast messages and are not acknowledged by the receiver.

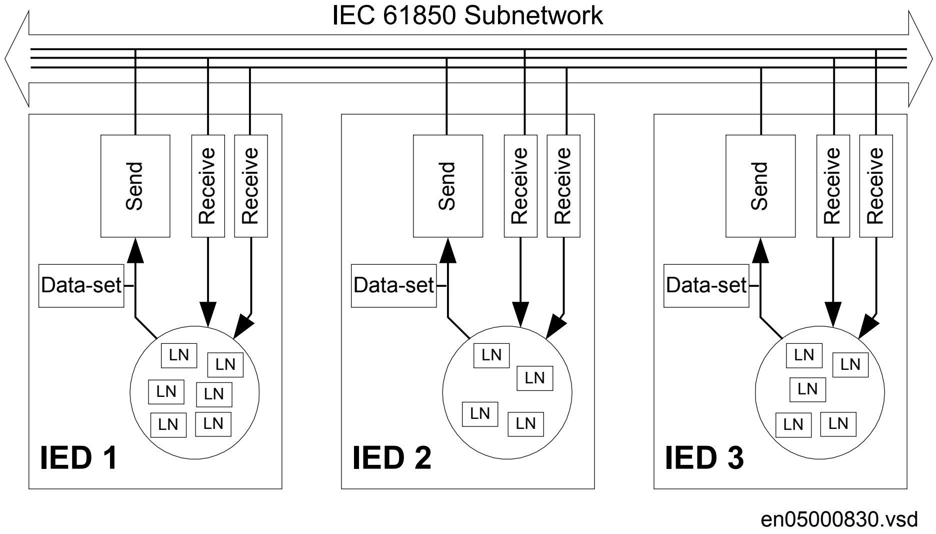


Figure 176: IEC 61850: Horizontal communication principle

Figure 176 shows an example with three IEDs where each one communicates with other IEDs.

GOOSE message is defined by configuring the data set and the GOOSE control block (GoCB). This engineering process is done in a station configuration tool, for example, IEC 61850 Configuration tool or IET600. The task involves configuring lists with the signal, value and quality (data attributes) that belong to the GOOSE message data set.

In the opposite direction, the standard only defines an IED as a receiver of a GOOSE message data set content. The handling of the GOOSE input signals must be defined in the IED application configuration. The SCL data generated by the IEC 61850 Configuration tool or IET600 (or any other station configuration tool) contains the GOOSE data sets as input data. The input data must be connected to a GOOSE receive function block such as GOOSEBINRCV/GOOSESPRCV/ GOOSEDPRCV/ GOOSEINTRCV/GOOSEMVRCV/GOOSEINTMVRCV/GOOSEPWRFDRRCV/ GOOSEPWRSRCRCV using SMT.

Some features, such as IEC 61850 Configuration tool (station communication engineering), are available in PCM600 2.5 or later only.

7.1.3 Station configuration description file types

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

- ICD = IED Capability Description

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

  - Capability description of the IED in logical nodes and their data. No information about communication configuration, for example, is included.
  - An IED is already extended by default data sets. They are predefined by ABB. Changes or additional data sets, for example, have to be done with IEC 61850 Configuration tool or IET600.
- SCD = Station Configuration Description
  - Complete configuration description of all IEDs in a station and the full engineering of process signals and communication structure is included. This includes all needed data sets and all control blocks.
- CID = Configured IED Description
  - The CID file contains the information needed to configure just one specific IED.

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

7.2 IEC 61850 engineering procedure

7.2.1 IEC 61850 protocol references and pre-conditions

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

- Knowledge of the IEC 61850 engineering process as described in the IEC 61850 standard.
- The Technical Manual describes function blocks defined as logical nodes.
- The IEC 61850 Communication Protocol Manual.
- The IEC 61850 conformance documents for the IED to be engineered.

7.2.2 System configuration using PCM600 and IET600

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

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

For more details, see the IEC 61850 standards. In the following description, it is assumed that PCM600 together with IET600 or the IEC 61850 Configuration tool inside PCM600 can be used as the system configuration tool.

7.2.2.1 Configuring cPMS - LS Configuration A using PCM600 and IET600

PCM600 is used for feeder IED engineering and load-shedding IED configuration. An SCD file is generated using the Automatic Dataflow Engineering tool in the IED connectivity package.

1. Import the SCD file generated from the PCM600 into IET600. Configure horizontal and vertical communication in IET600, and export the updated SCD file.
2. Import the updated SCD file from IET600 back into PCM600. Make association between information coming on GOOSE to the application logic for Feeder IEDs and the IED for load-shedding and Substation Automation functions.
3. Download the final configurations into the IEDs.
4. Import the SCD file from IET600 into SAB600. Make COM600 configuration in SAB600 and download into COM600.

The block/flow diagram describes the previous steps more elaborately.

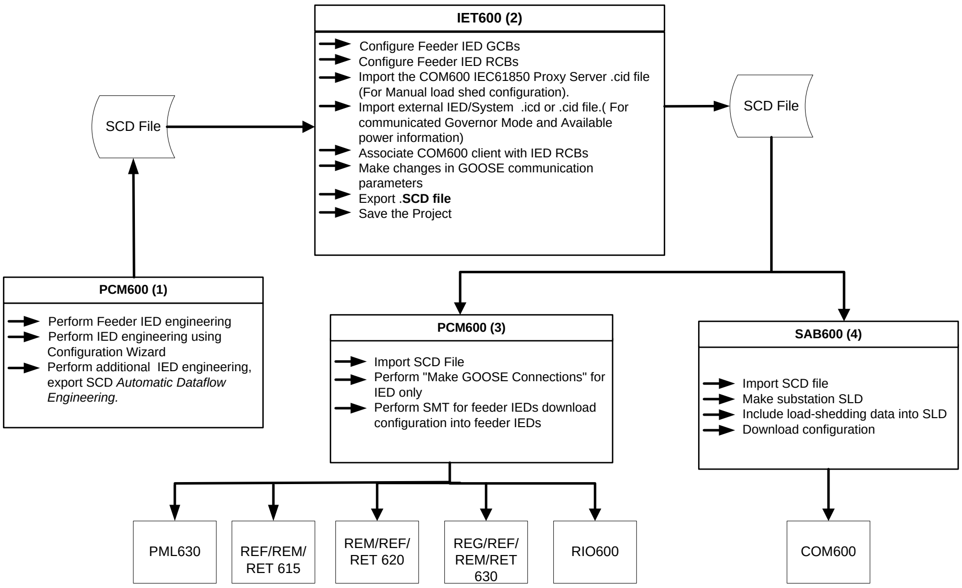


Figure 177: IEC 61850: Signal engineering procedure flow with IET600 for cPMS - LS Configuration A

7.2.2.2 Configuring cPMS - LS Configuration B using PCM600 and IET600

Configuration B comprises of some additional steps after the completion of Configuration A steps described previously.

1. Import .cid file of adjacent interconnected network area load-shedding IED into IET600.
2. Configure horizontal communication between the load-shedding IEDs and export updated SCD file.
3. Import the updated SCD file from IET600 into PCM600. Make association between information coming on GOOSE to the application logic between the adjacent network area's load-shedding IEDs.
4. Download the final configuration into the IED.

The block/flow diagram describes the previous steps more elaborately.

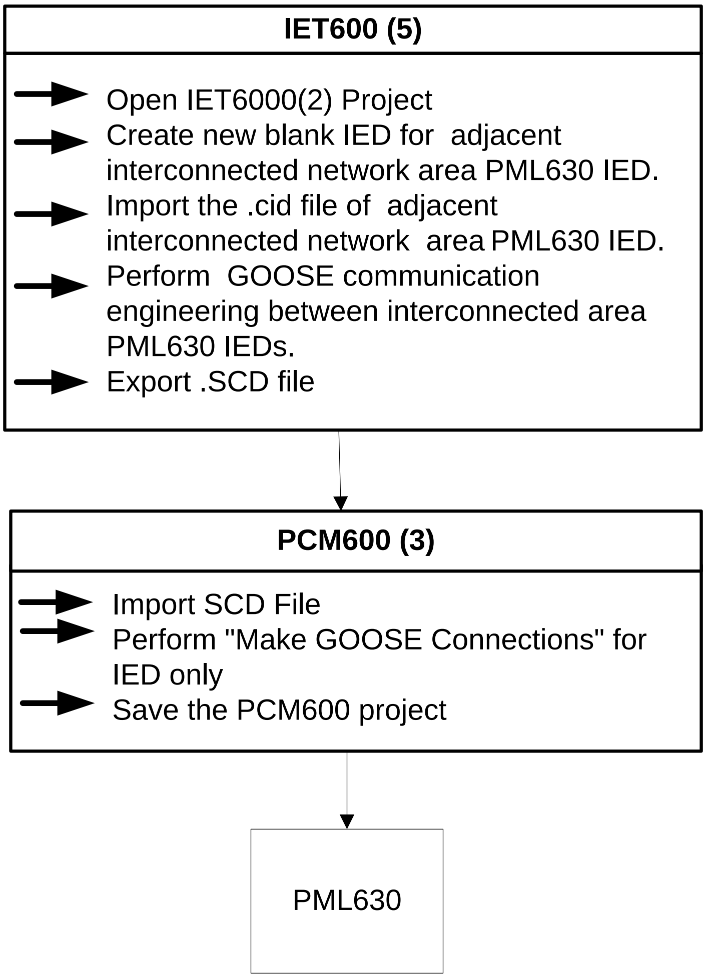


Figure 178: IEC 61850: Additional signal engineering procedure flow with IET600 for cPMS - LS configuration B

7.2.3 System configuration in PCM600

7.2.3.1 Configuring cPMS - LS configuration A using PCM600

1. Use the PCM600 (IED tool) for Feeder IED engineering and IED configuration. Generate the SCD file using the Automatic Dataflow Engineering tool in the IED connectivity package.
2. Re-import the SCD file exported with the Automatic Dataflow Engineering tool into PCM600.
3. Make association between information coming on GOOSE to the application logic for Feeder IEDs and the IED for load-shedding and Substation Automation functions. Export the updated SCD file.
4. Download the final configurations into the IEDs.
5. Import the SCD file from PCM600 into SAB600. Make COM600 configuration in SAB600 and download into COM600.

The block/flow diagram describes the previous steps more elaborately.

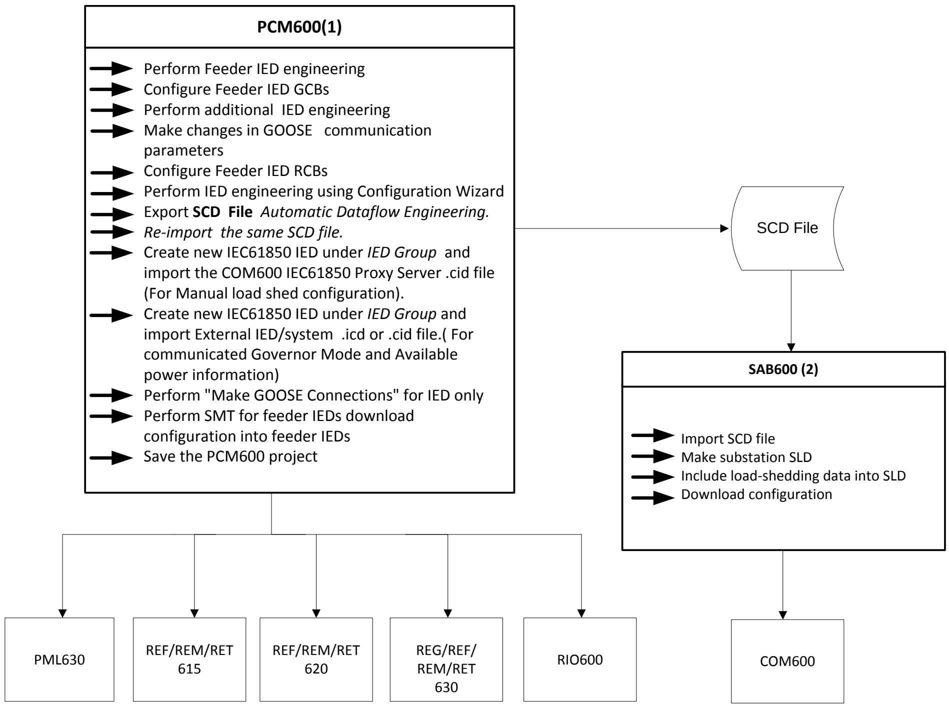


Figure 179: IEC 61850: Signal engineering procedure flow with PCM600 for cPMS - LS Configuration A

7.2.3.2 Configuring cPMS - LS Configuration B using PCM600

1. Import the .pcmi file of adjacent interconnected network area load-shedding IED.
2. Make association between information coming on GOOSE to the application logic between the adjacent network area IEDs for load-shedding.
3. Download the final configuration into the load-shedding IED.

The block/flow diagram describes the previous steps more elaborately.

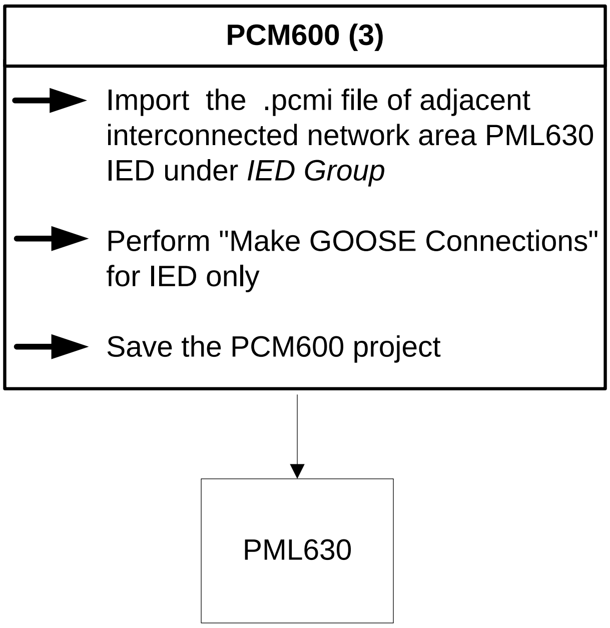


Figure 180: IEC 61850: Additional signal engineering procedure flow with PCM600 for cPMS - LS Configuration B

7.3 IEC 61850 Engineering workflow

7.3.1 IED engineering

The pre-condition for performing IED engineering is to complete the feeder IEDs engineering before configuring the IED.

- Engineering of feeder IEDs and the IED in the project are done using PCM600.
- The hardware interface, for example the communication port should be selected and configured.
- Set the user interface addresses according to protocol and project definitions.
- Activate the station communication port in the IED. Set the IEC61850-8-1 *Operation* setting to 'On'.

7.3.2 Exporting SCD file through Automatic Dataflow Engineering

After completing the configuration wizard steps and additional logic, PCM600 configuration should be configured for IEC 61850 system engineering using IET600 or PCM600.

1. Right-click the **PML630** object and select **Automatic Dataflow Engineering**.

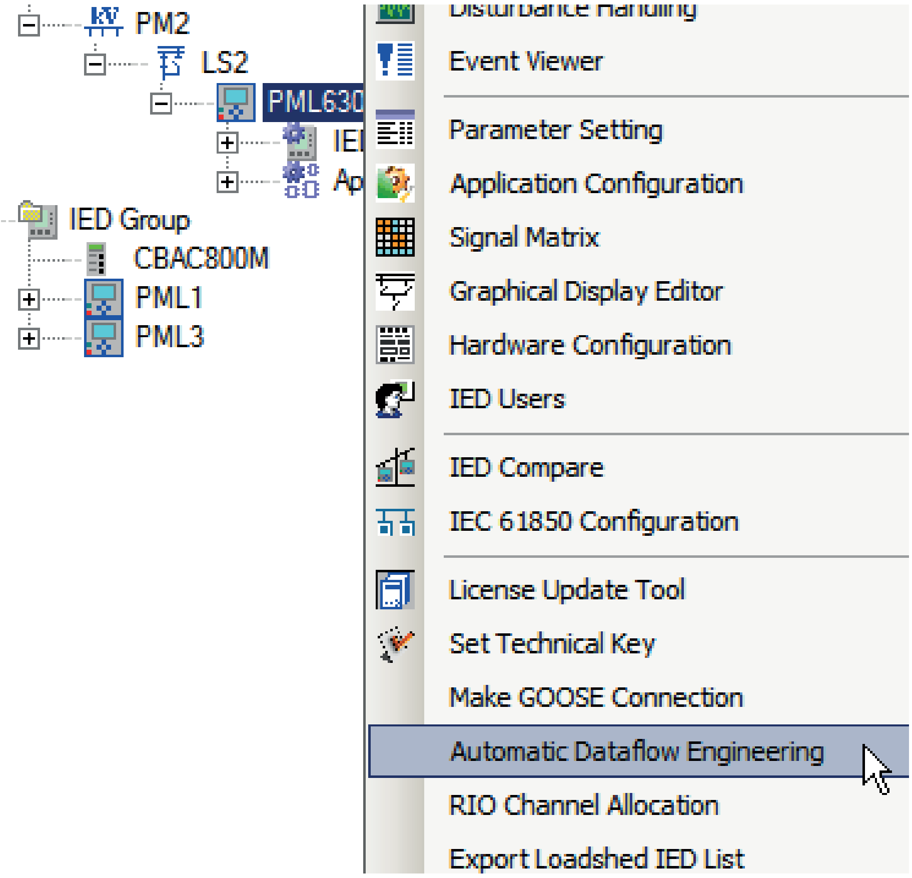


Figure 181: Automatic Dataflow Engineering selection

This selection creates GOOSE data sets and control blocks for information flow from the IED to other load feeder IEDs (REF/REM/RET - 615, 620 and 630 series and RIO600). The GOOSE data sets comprise of load shed command signals emanating from the IED to other load feeder IEDs.
This feature also creates MMS data sets and report control blocks for data flow from the IED to COM600. The MMS data sets comprise of measurements, indications, alarms and event data to be displayed on COM600 displays. This selection also includes the key single-line diagram information (as created automatically by the configuration wizard) in the IEC 61850 configuration of the IED.

2. Save the SCD file in the required location.

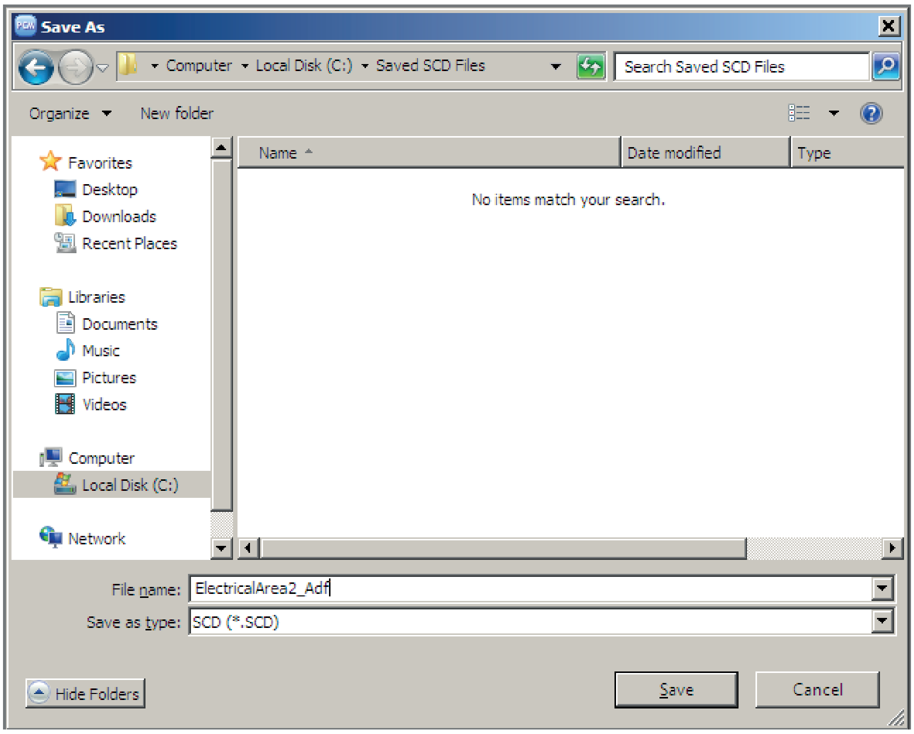


Figure 182: SCD export feature from the Automatic Dataflow Engineering tool

SCD file export from the substation level does not create the automated data sets and control blocks information. It is recommended to use the **Automatic Dataflow Engineering** tool every time after creation of new IED, run of LUT, and change of technical key of the IED.

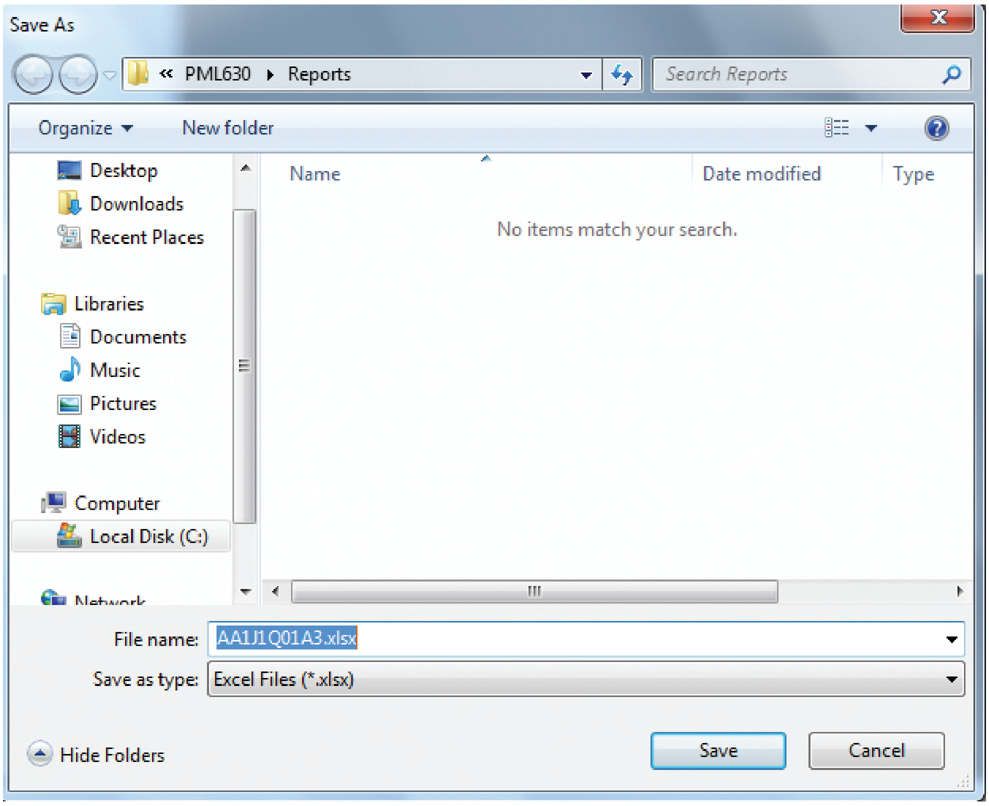


Figure 183: Sheddable Load list export from the Automatic Dataflow Engineering tool

7.3.3 Initiating IET600 engineering

1. On the **IET600** menu, click **Manage Projects**. Click **New** to **Create New Project**. In the **Project name** dialog box, type the name of the project, for example, Electrical_network_area2. Click **OK**.

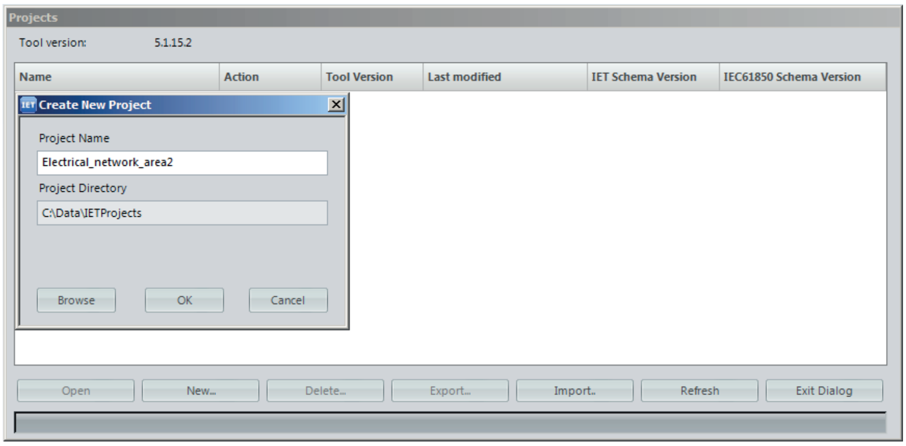


Figure 184: Create new project

New project is created with the specified name.

2. Right-click **Electrical_network_area2** and select **Import SCL file**.

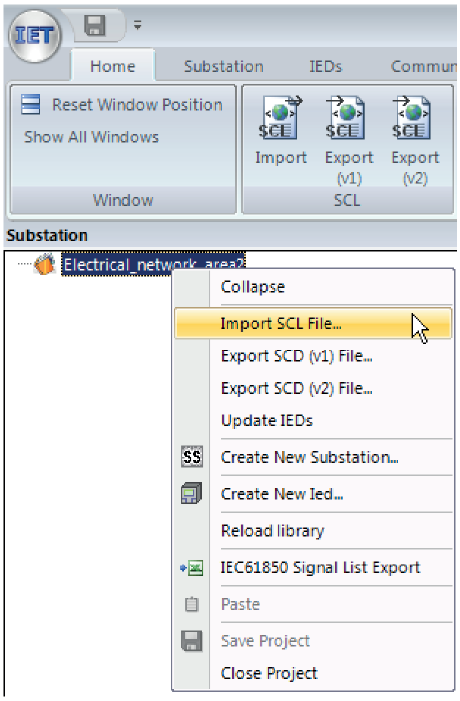


Figure 185: Import SCL file

The COM600 HMI client must be associated with the IED.

3. Right-click **Electrical_network_area2** and select **Create New Ied** for COM600 Client.
The **Create New IED** window opens.

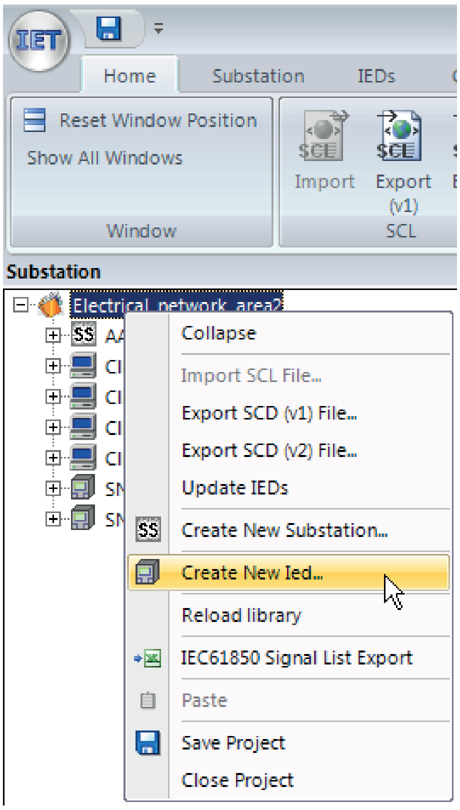


Figure 186: Create New IED for COM600 client

4. Enter the IED name in the **Name of the new** IED dialog box, for example, HSI and click **OK**. Right-click **HSI** and select **Update IED**.

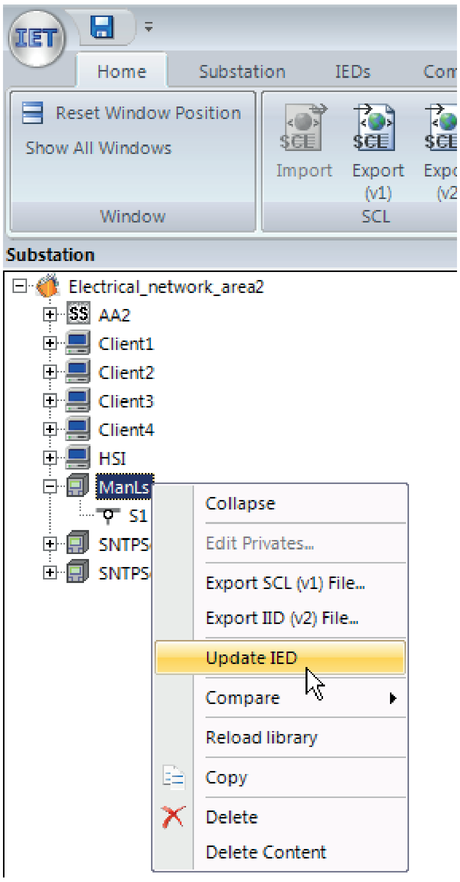


Figure 187: Update IED

An ICD file for IEC 61850 OPC client is included as a part of the Templates folder under the IED Connectivity package.

An ICD file is required when the cPMS configuration does not contain any 615 3.0 IEDs.

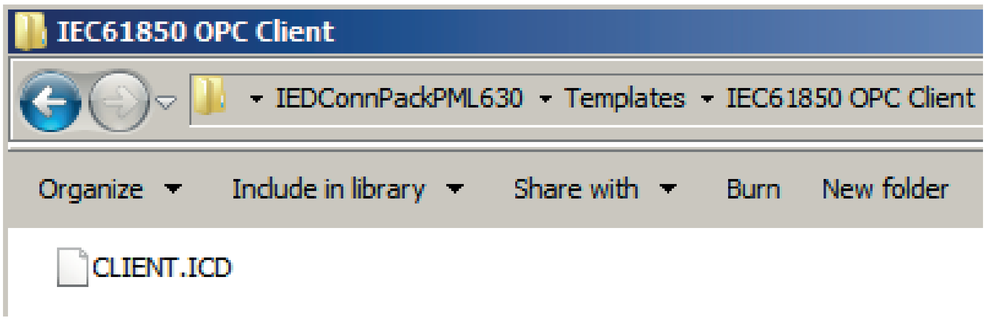


Figure 188: IEC 61850 OPC client ICD file for COM600

5. Import the **CLIENT.ICD** file for COM600 from the **IEC 61850 OPC Client** folder under the **IED Connectivity package**. Update IED and click **OK**.

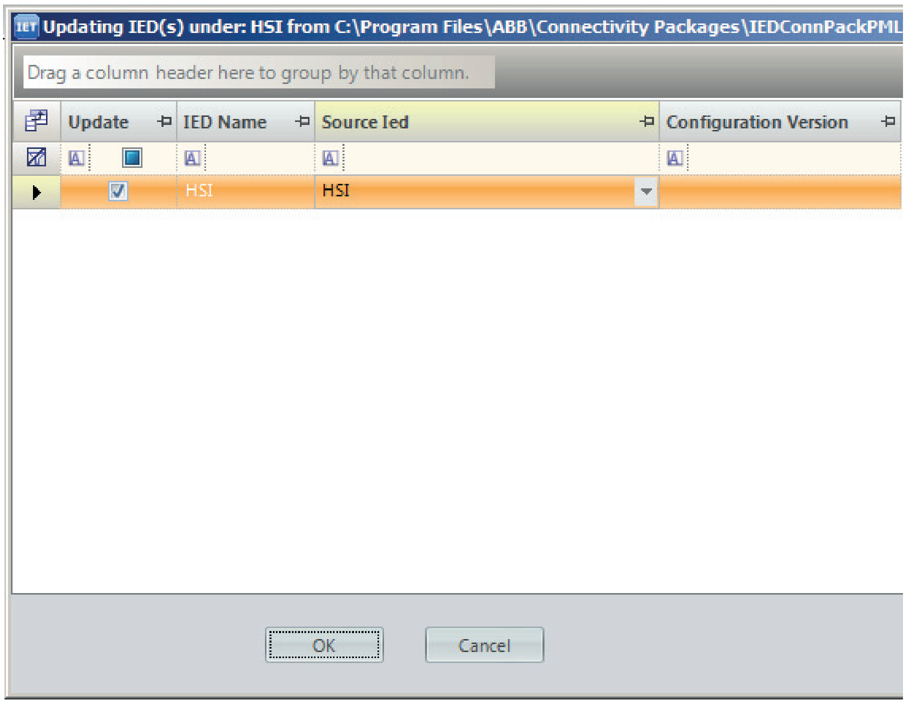


Figure 189: Update IED for HSI

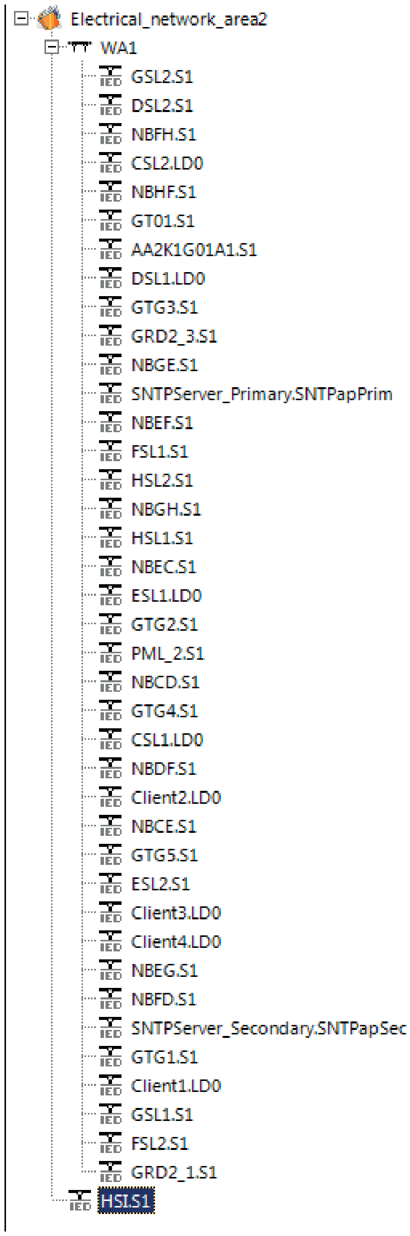


Figure 190: Default communication structure in IET600

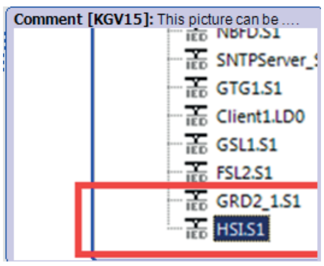


Figure 191: HSI dragged in WA1 communication structure

7.3.4 Communication engineering power source IEDs using IET600

Communication engineering for power source IED involves the creation of two data sets, for example, PML630_B and PML630_A. These data sets must contain status data and quality attributes. For power source IEDs, PML630_B must contain circuit breaker status, lock-out relay status and circuit breaker service position data with respective quality. Add additional signals including turbine trip and critical alarms signifying outage of power source when required. PML630_B sends binary data to the IED.

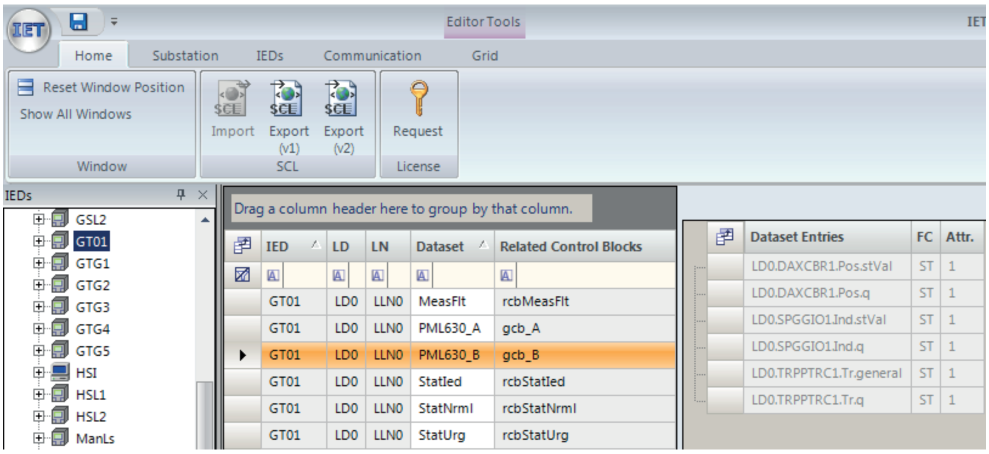


Figure 192: PML630_B data set for power source IEDs

For power source IEDs, PML630_A must contain power value status and quality attributes. The data sets of the grid transformer IED must be configured additionally for three-phase currents. PML630_A sends analog data (power value) to the IED. The data set must contain status value and quality attributes.

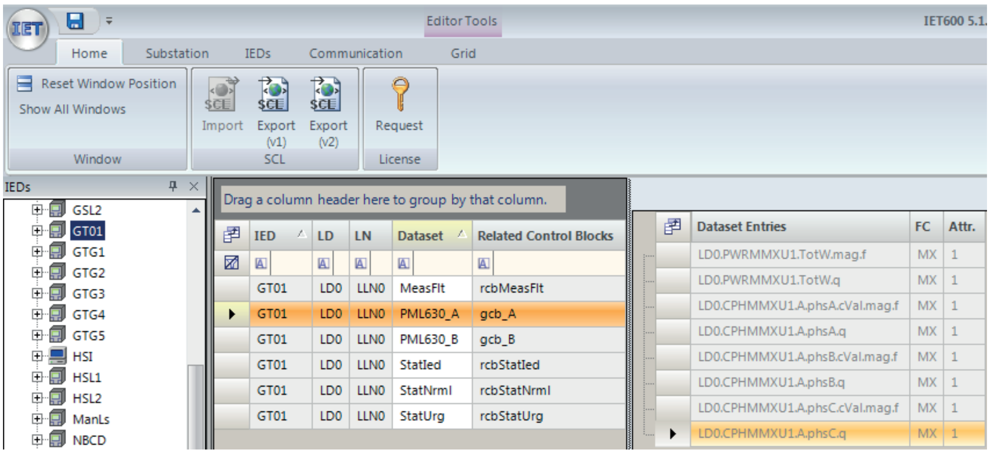


Figure 193: PML630_A data set for power source IEDs

A GOOSE control block gcb_B must be associated with this data set PML630_B, and GOOSE control block gcb_A must be associated with this data set PML630_A .

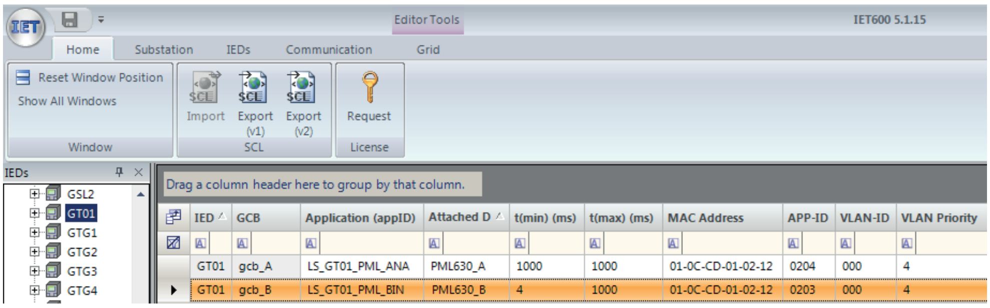


Figure 194: gcb_B and gcb_A control block information for power source IEDs

PML630 IED must be set as the subscribing IED for both data sets as GCB client.

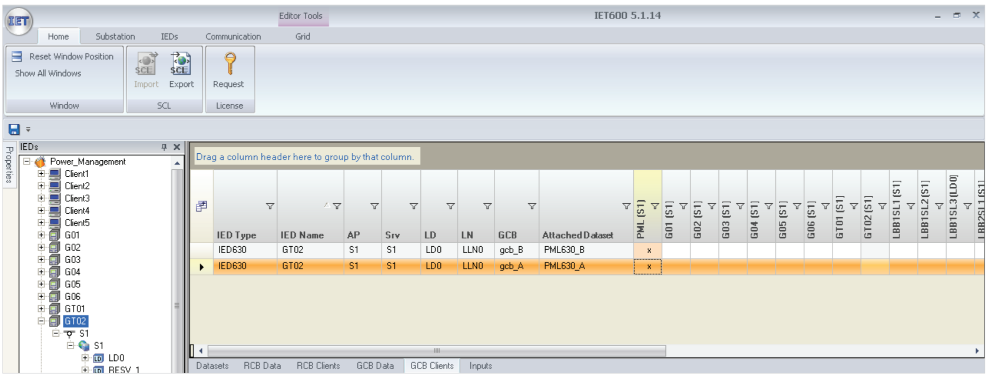


Figure 195: gcb_B and gcb_A control block subscribed for PML630

If any additional signals need to be configured from the power source IEDs to the IED, create additional data sets and GCBs in the power source IED section.

7.3.5 Communication engineering of network circuit breaker IEDs using IET600

Communication engineering for network circuit breaker (bus coupler and tie-line feeder) IED involves the creation of two data sets, for example, PML630_B and PML630_A. These data sets must contain status data and quality attributes. For power source IEDs, PML630_B must contain circuit breaker status, lock-out relay status and circuit breaker service position data with respective quality. Add additional signals including turbine trip and critical alarms signifying outage of network circuit breaker when required. PML630_B sends binary data to the IED.

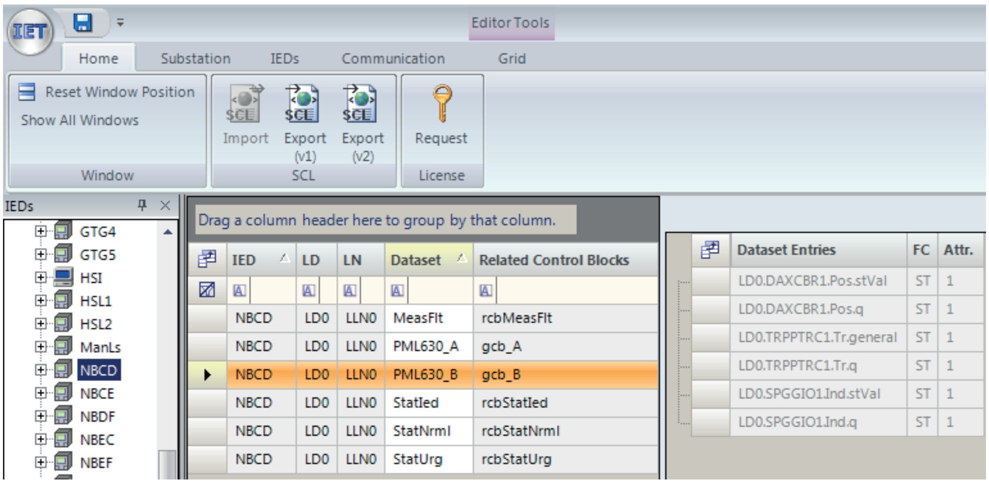


Figure 196: PML630_B data set for network circuit breaker IEDs

For network circuit breaker IEDs, PML630_A must contain power value status and quality attributes.

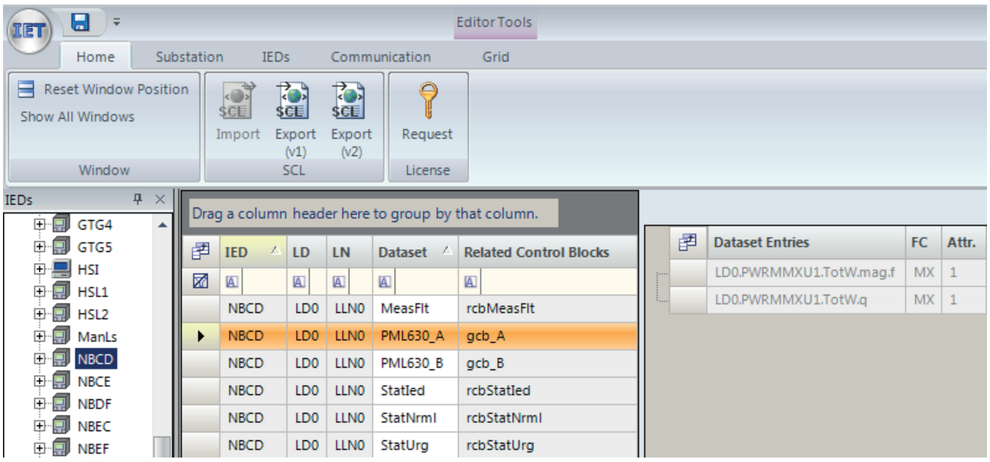


Figure 197:   PML630_A data set for network circuit breaker IEDs

A GOOSE control block gcb_B must be associated with this data set PML630_B,and GOOSE control block gcb_A must be associated with this data set PML630_A.

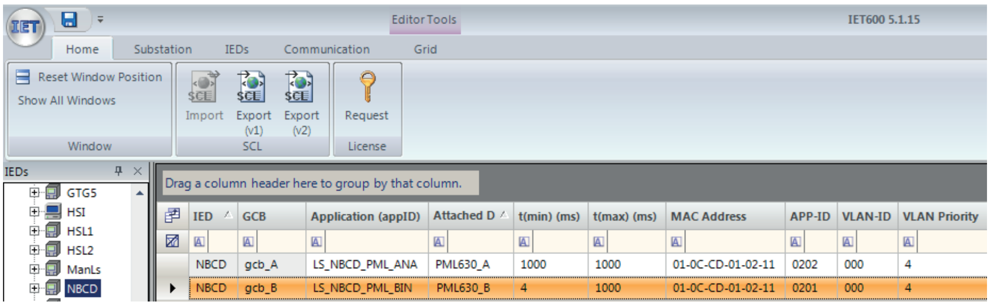


Figure 198:   gcb_B and gcb_A control block information for network circuit breaker IEDs

PML630 IED must be set as the subscribing IED for both data sets as GCB client.

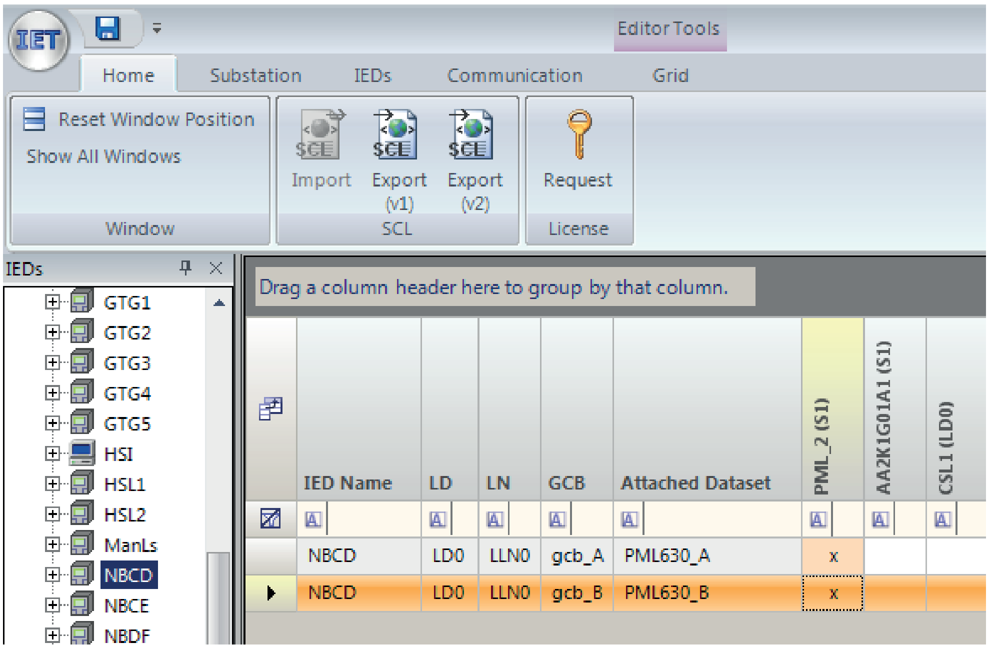


Figure 199: gcb_B and gcb_A control block subscribed for PML630

If any additional signals need to be configured from the network circuit breaker IEDs to the IED, create additional data sets and GCBs in the power source IED section.

7.3.6 Communication engineering of load feeder IEDs using IET600

Communication engineering for load feeder IED consists of two data sets, for example, PML630_B and PML630_A for each load feeder IED. These data sets must contain status data and quality attributes. For load feeder IEDs, PML630_B must contain circuit breaker status with quality. PML630_B must contain circuit breaker status and service position data.

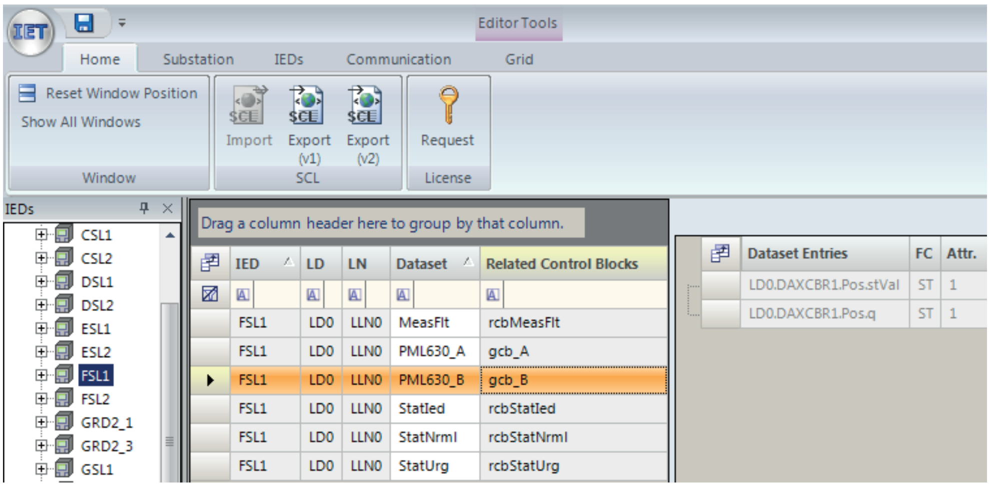


Figure 200: PML630_B data set for load feeder IEDs

PML630_A sends analog data (power value) to the IED. The data set must contain status value and quality attributes. A GOOSE control block gcb_A must be associated with this data set and the IED must be set as the subscribing IED.

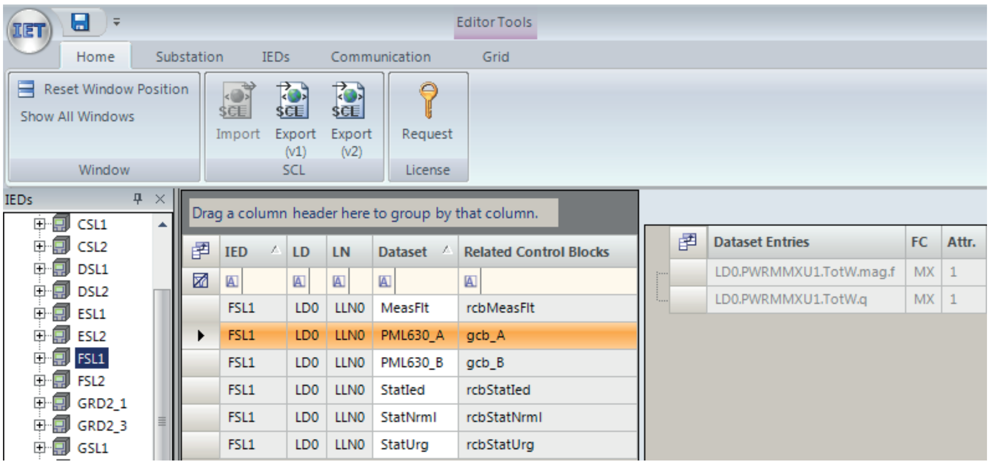


Figure 201: PML630_A data set for load feeder IEDs

A GOOSE control block gcb_B must be associated with this data set PML630_B and GOOSE control block gcb_A must be associated with this data set PML630_A.

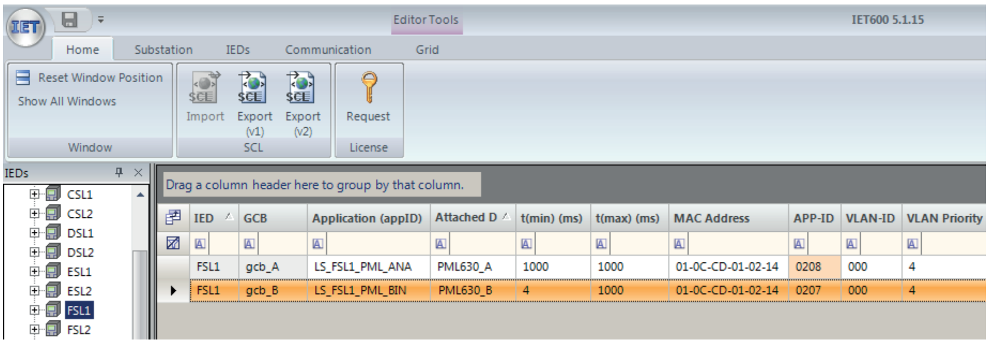


Figure 202: gcb_B and gcb_A control block information for load feeder IEDs

PML630 IED must be set as the subscribing IED for both data sets as GCB client.

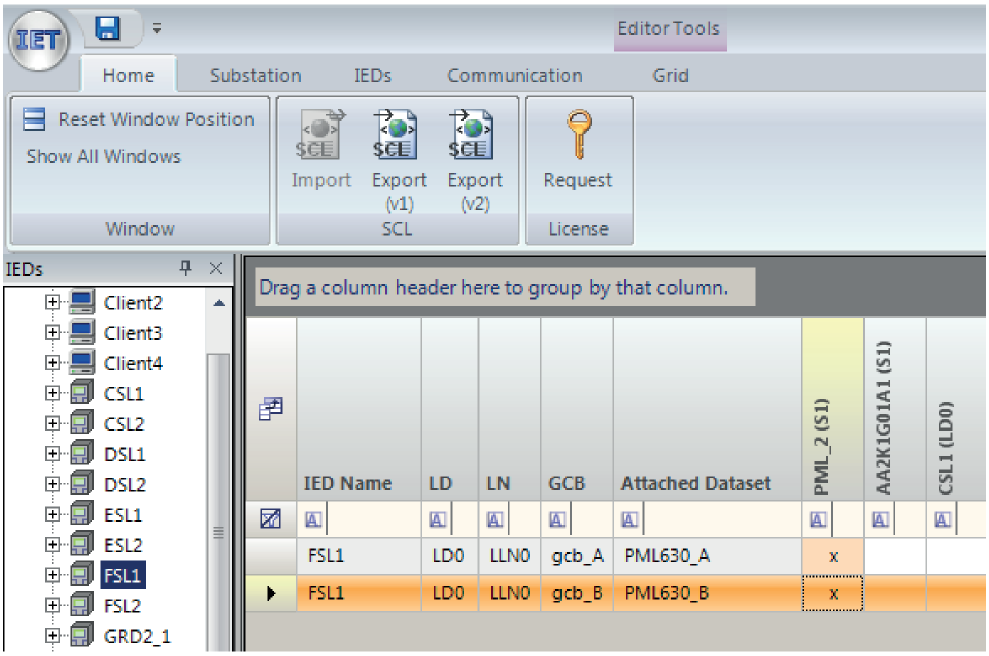


Figure 203: gcb_B and gcb_A control block subscribed for PML630

The GOOSE communication configuration is completed after subscribing the PML630 IED for all IEDs in the project. The PML630_B and PML630_A data set information is displayed as inputs in the PML630 IED.

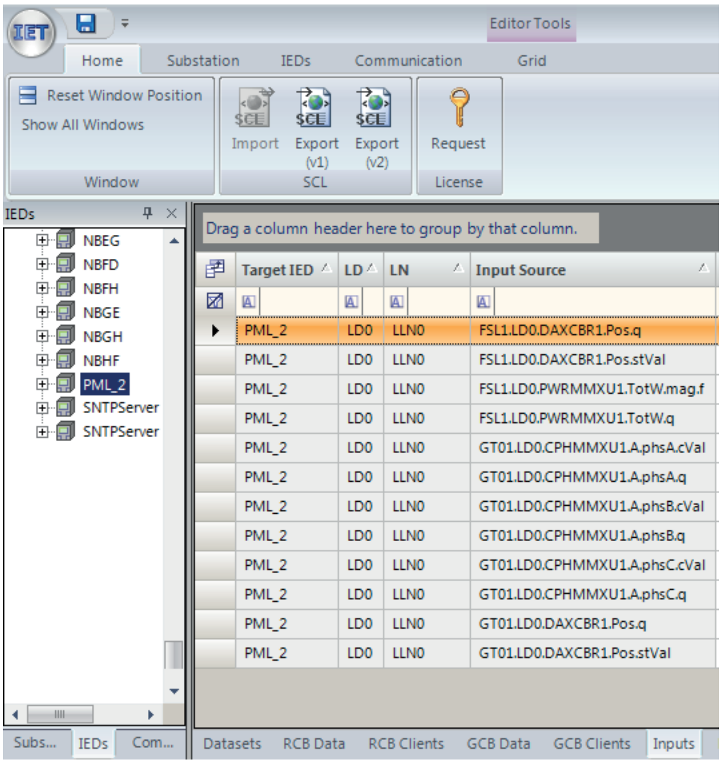


Figure 204: GOOSE input section for IED

The load shed trip command data for feeder IEDs, sent from PML630, is displayed as an input under the menu tree structure in the respective load feeder IED.

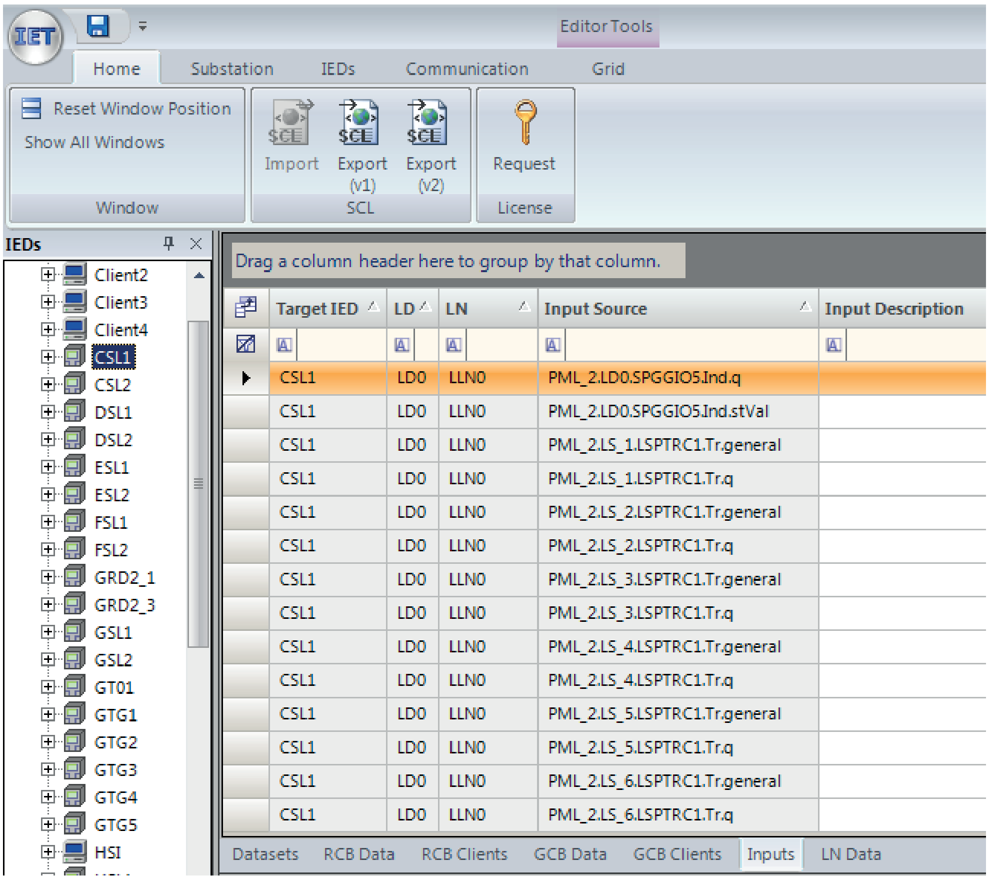


Figure 205: GOOSE input section for independent feeder IED

The IED GOOSE data sets are created automatically. Every feeder IED subscribes to not only its own load-shedding command information (designated as “3” in the Figure 206, in this case the first feeder in the sixth busbar), but also the other 5 busbars’ corresponding feeder IEDs’ load-shedding command information (LN LSPTRC1 instances under LS_1, LS_2, LS_3, LS_4 and LS_5 busbar logical devices). The feeder IED uses only its own command information in its load-shedding command handling application logic.

The IED’s test mode information is also required to be available for subscription for every feeder IED. This information is designated as “1” in Figure 206.

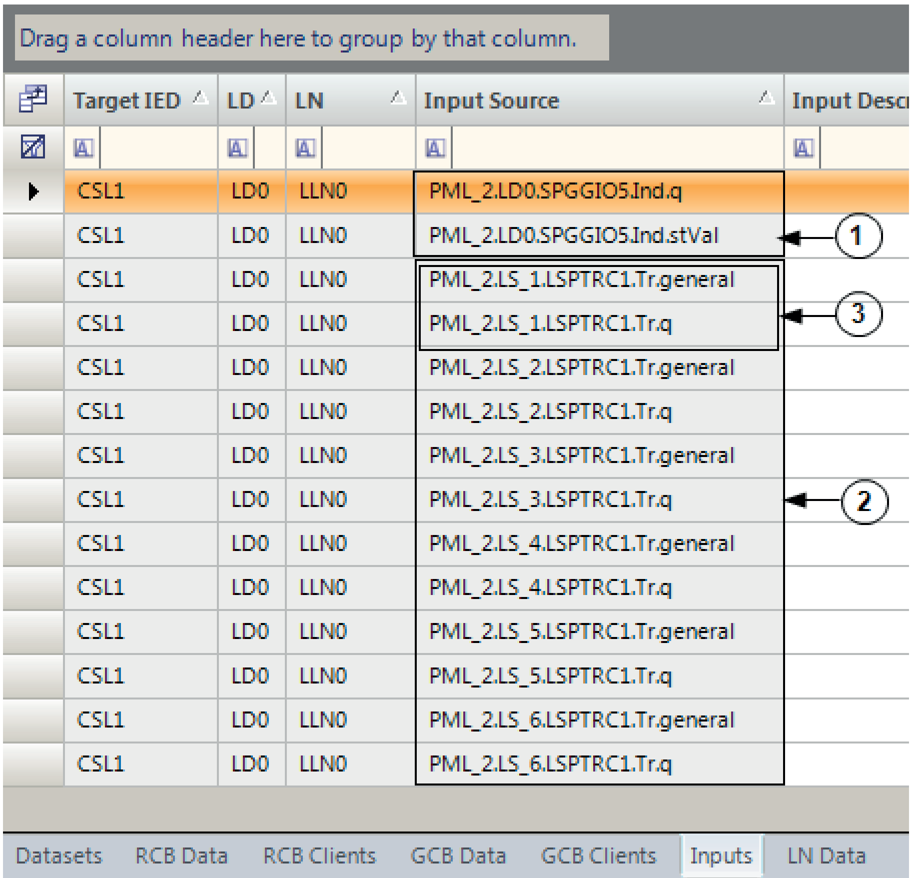


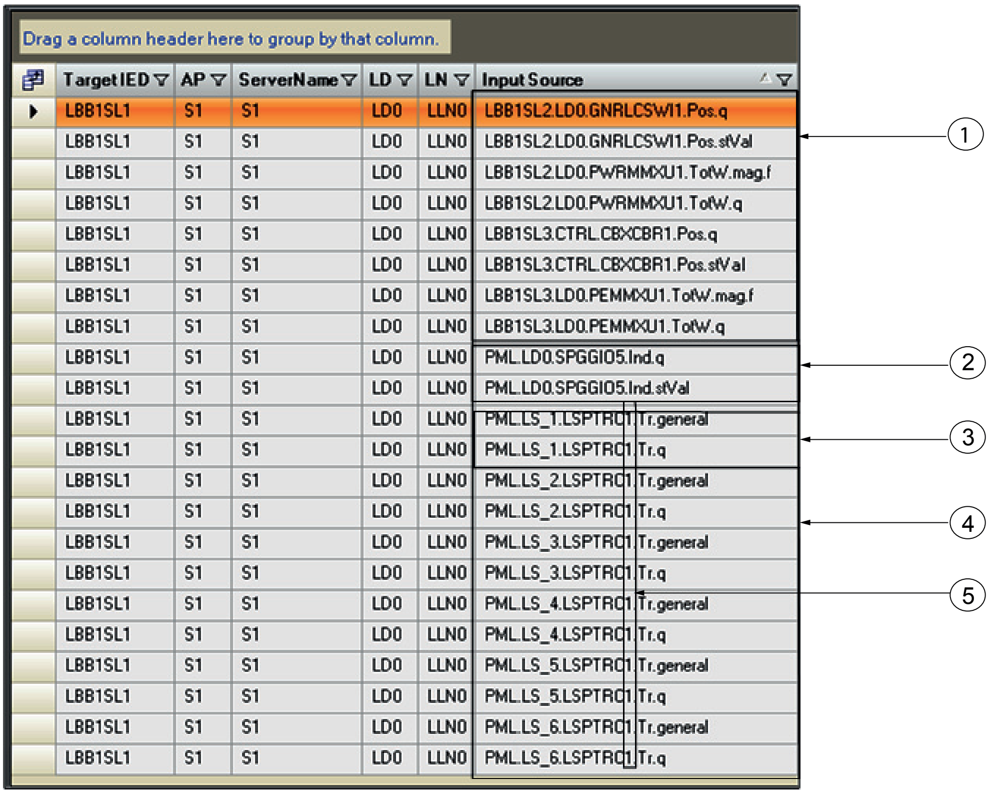
Figure 206: Independent load feeder IEDs GOOSE input section

1 PML630 IED test mode information

2 Feeder IED's own load-shedding command status information

3 Other busbar feeder IED's load-shedding command status information

Besides the above, in case the feeder IED is a representative load (the 1st feeder in the 1st bus bar) then the Dependable Loads’ circuit breaker status and power values also need to be feeder IED’s GOOSE Input (subscription) section. This is designated as “1”.



Drag a column header here to group by that column.

Target IED	AP	ServerName	LD	LN	Input Source
LBB1SL1	S1	S1	LD0	LLN0	LBB1SL2.LD0.GNRLCSWI1.Pos.q
LBB1SL1	S1	S1	LD0	LLN0	LBB1SL2.LD0.GNRLCSWI1.Pos.stVal
LBB1SL1	S1	S1	LD0	LLN0	LBB1SL2.LD0.PWRMMXU1.TotW.mag.f
LBB1SL1	S1	S1	LD0	LLN0	LBB1SL2.LD0.PWRMMXU1.TotW.q
LBB1SL1	S1	S1	LD0	LLN0	LBB1SL3.CTRL.CBXCBR1.Pos.q
LBB1SL1	S1	S1	LD0	LLN0	LBB1SL3.CTRL.CBXCBR1.Pos.stVal
LBB1SL1	S1	S1	LD0	LLN0	LBB1SL3.LD0.PEMMXU1.TotW.mag.f
LBB1SL1	S1	S1	LD0	LLN0	LBB1SL3.LD0.PEMMXU1.TotW.q
LBB1SL1	S1	S1	LD0	LLN0	PML.LD0.SPGGIO5.Ind.q
LBB1SL1	S1	S1	LD0	LLN0	PML.LD0.SPGGIO5.Ind.stVal
LBB1SL1	S1	S1	LD0	LLN0	PML.LS_1.LSPTRC1.Tr.general
LBB1SL1	S1	S1	LD0	LLN0	PML.LS_1.LSPTRC1.Tr.q
LBB1SL1	S1	S1	LD0	LLN0	PML.LS_2.LSPTRC1.Tr.general
LBB1SL1	S1	S1	LD0	LLN0	PML.LS_2.LSPTRC1.Tr.q
LBB1SL1	S1	S1	LD0	LLN0	PML.LS_3.LSPTRC1.Tr.general
LBB1SL1	S1	S1	LD0	LLN0	PML.LS_3.LSPTRC1.Tr.q
LBB1SL1	S1	S1	LD0	LLN0	PML.LS_4.LSPTRC1.Tr.general
LBB1SL1	S1	S1	LD0	LLN0	PML.LS_4.LSPTRC1.Tr.q
LBB1SL1	S1	S1	LD0	LLN0	PML.LS_5.LSPTRC1.Tr.general
LBB1SL1	S1	S1	LD0	LLN0	PML.LS_5.LSPTRC1.Tr.q
LBB1SL1	S1	S1	LD0	LLN0	PML.LS_6.LSPTRC1.Tr.general
LBB1SL1	S1	S1	LD0	LLN0	PML.LS_6.LSPTRC1.Tr.q

Figure 207: Representative load feeder IED's GOOSE Input section

1 Dependent load's (D1 and D2) circuit breaker status and power status/value information

2 PML630 IED test mode information

3 Feeder IED's load-shedding command status information

4 Other busbar feeder IED's load-shedding command status information

5 Feeder IED's position across all six busbars (PTRC instance)

In the example configuration, see Figure 208, SL1, SL2 and SL3 under busbar 1 are configured as a load-shedding group, with LBB1SL1 as the representative load (REF/REM/RET 630 1.1 or later), LBB1SL2 as dependent load 1 (REF630 1.0/RET630 1.0/REM630 1.0) and LBB1SL3 as dependent load 2. Feeder IED LBB1SL3 is a REF615 3.0 IED and has its load-shedding command information through the LBB1SL1 (typically a REF/REM/RET630 1.1 or later).

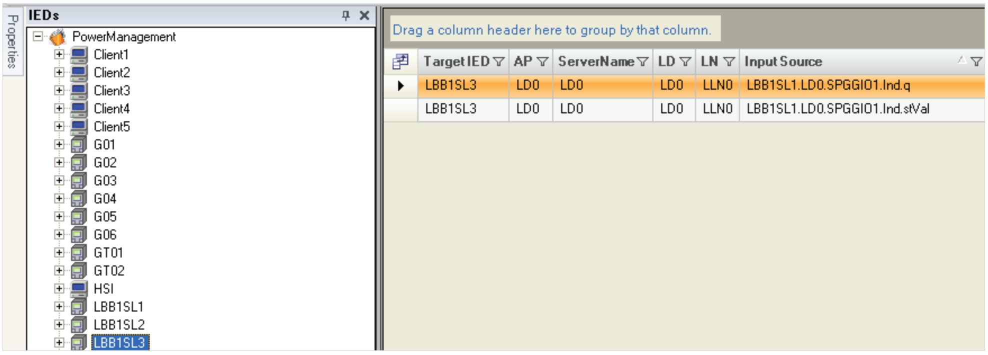


Figure 208: Dependent load 2 (REF615/RET615/REM615) feeder IED's GOOSE Input section

Feeder IED LBB1SL2 is a REF615 IED which contains load-shedding command information directly from the IED. It's GOOSE input section is identical to independent load feeder IED.

All subscribers IED's input section (GOOSE receive) should be verified for the necessary data objects/attributes to be received from the publisher IED before the final SCD export from IET600. In case the update does not happen automatically, redo the GCB client subscription using IET600 or PCM600's IEC 61850 Configuration tool.

7.3.7 RIO600 communication engineering using IET600

Feeders (Power Source, Network Circuit Breaker and Load Feeder) are supported with RIO600 IED. GOOSE control block creation and GCB Client subscription can be done using the IET600 tool.

By default, data sets are created in the RIO600 IED.

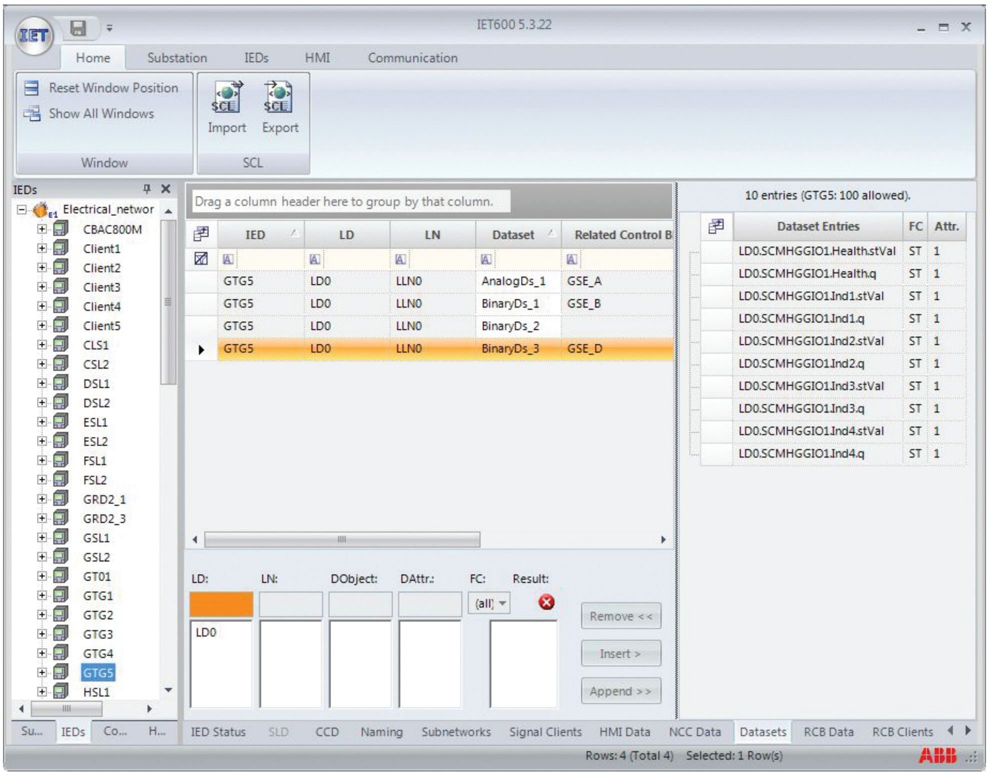


Figure 209: Default binary data set in RIO600

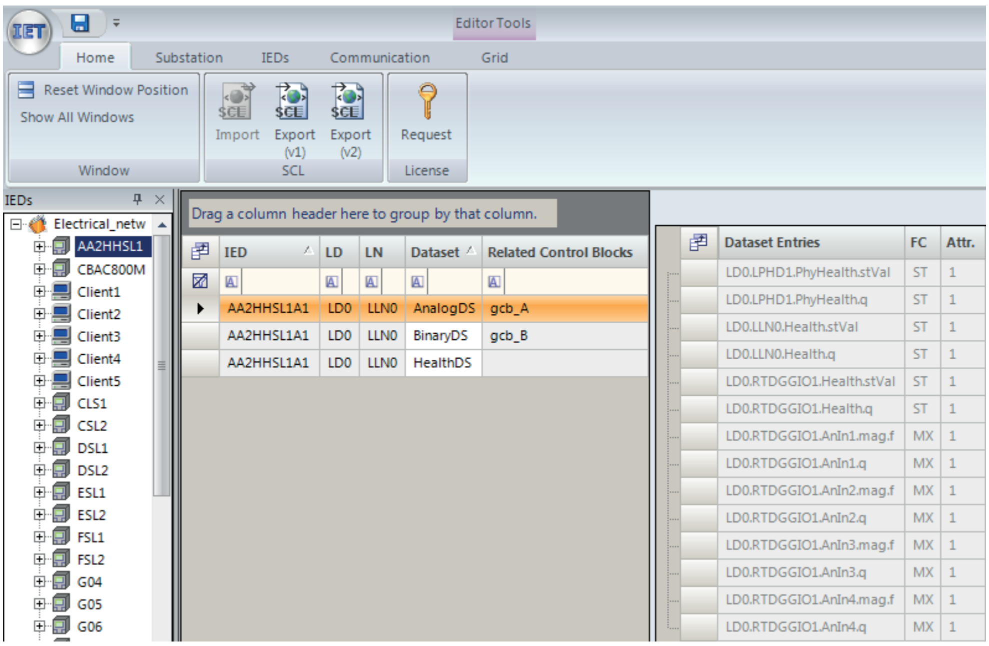


Figure 210: Default analog data set in RIO600

A GOOSE control block gcb_B must be associated with binary data set and gcb_A must be associated with analog data set.

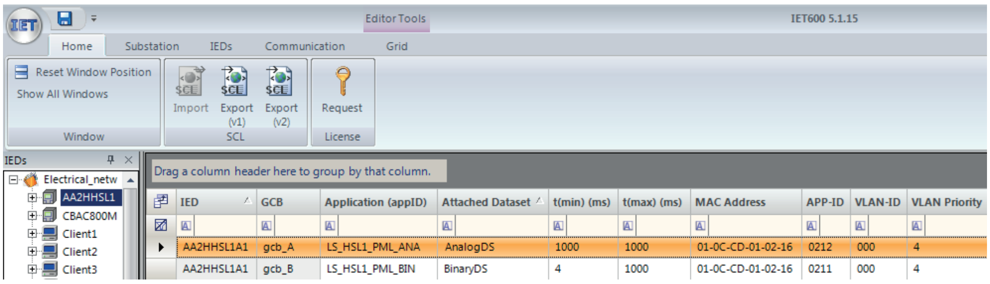


Figure 211: gcb_B and gcb_A control block information for RIO600

PML630 IED must be set as the subscribing IED for both data sets as GCB client.

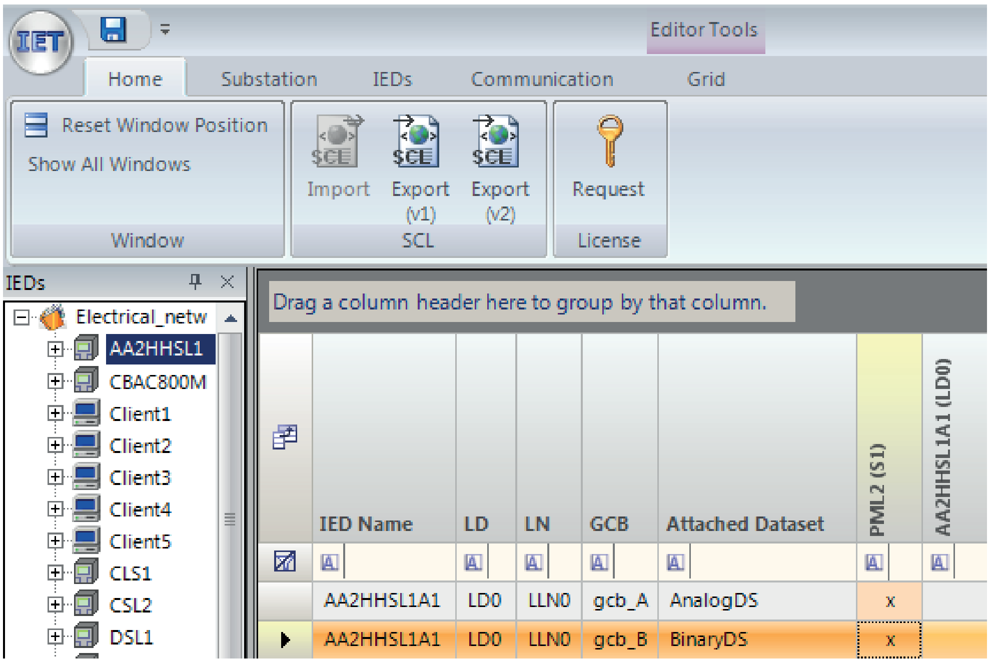


Figure 212: gcb_B and gcb_A control block subscribed for PML630

See the RIO600 channel allocation details for data objects needed for power source, network circuit breaker and load feeder IEDs.

7.3.8 Engineering manual load-shedding proxy IED and external IED/system communication using IET600

These engineering steps are needed when COM600 needs to send the data such as priority and amount load to be shed values to the load-shedding IED for manual load-shedding functionality or when external systems data is routed through COM600’s gateway feature.

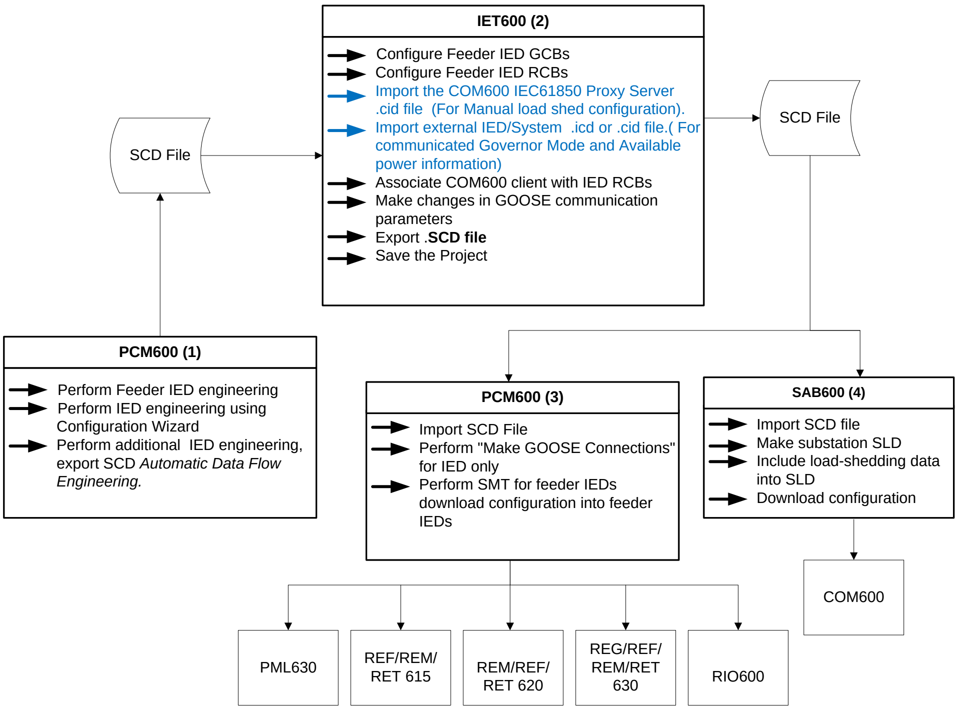


Figure 213: Engineering workflow – LS Configuration A

1. Export the proxy server IED .icd file from SAB600 project or use the standard Opc_Ied.cid file provided with the load-shedding IED connectivity package.
2. Create new blank IED in the IET600 project and import the .cid file.
3. Subscribe the manual load shed proxy IED data to the load-shedding IED.
4. Similar procedure can be followed if any external system data is to be sent to the load-shedding IED using COM600's gateway feature.
   For example, generator governor mode, maximum available power and spinning reserve information can be configured to be sent from an external IED/System or may be routed using COM600’s gateway feature. If so, a similar procedure can be adapted to configure the IEC 61850 compliant external IED/System.

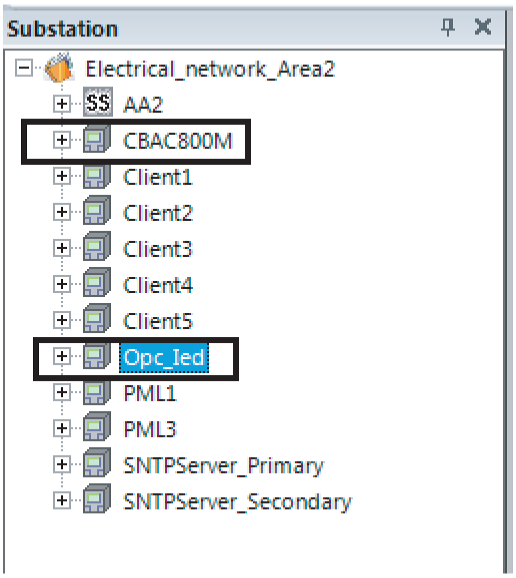


Figure 214: Manual LS (Opc_Ied) IED and external system IED (CBAC800M) in IET600

Eight integer controllable data points (INS) are included in the dataset for manual load shed feature. This includes four integer data points for the four subnetworks manual load shed priority and four integer data points for the load to be shed in (kW) for the four subnetworks.

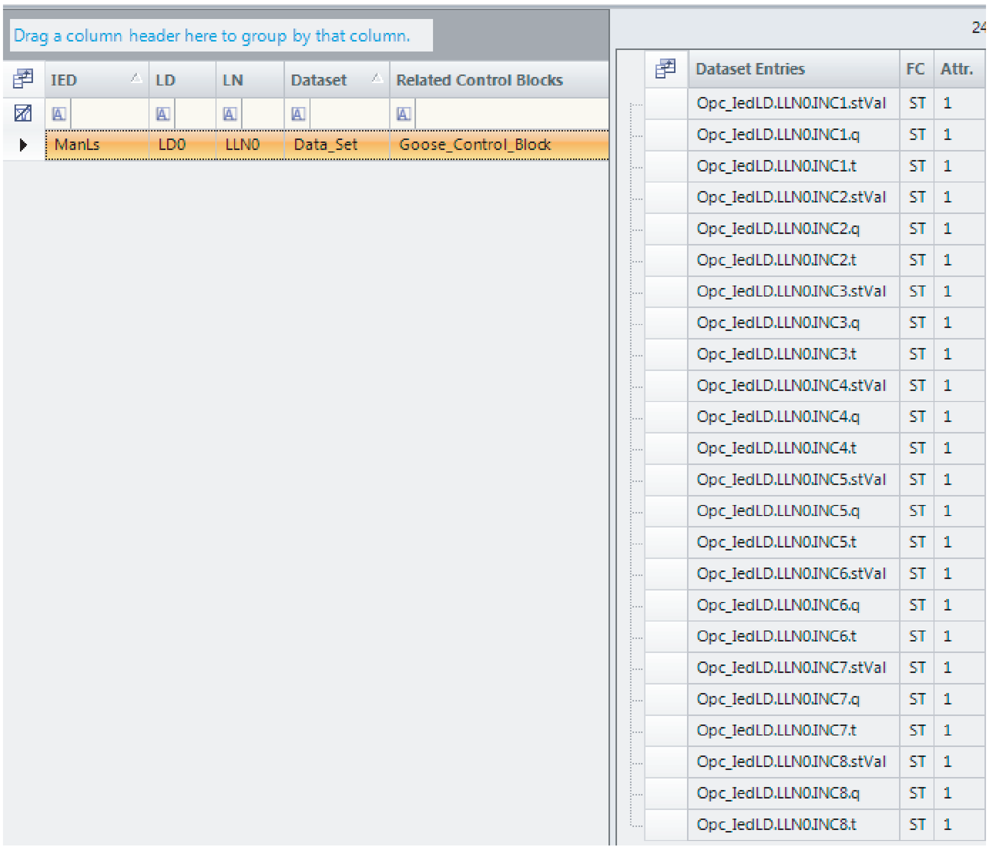


Figure 215: Manual LS proxy IED data sets

GOOSE control block parameters are set in the SAB600 project as per the recommendations in Table 15 for Multicast MAC address arrangement for cPMS - LS Configuration A.

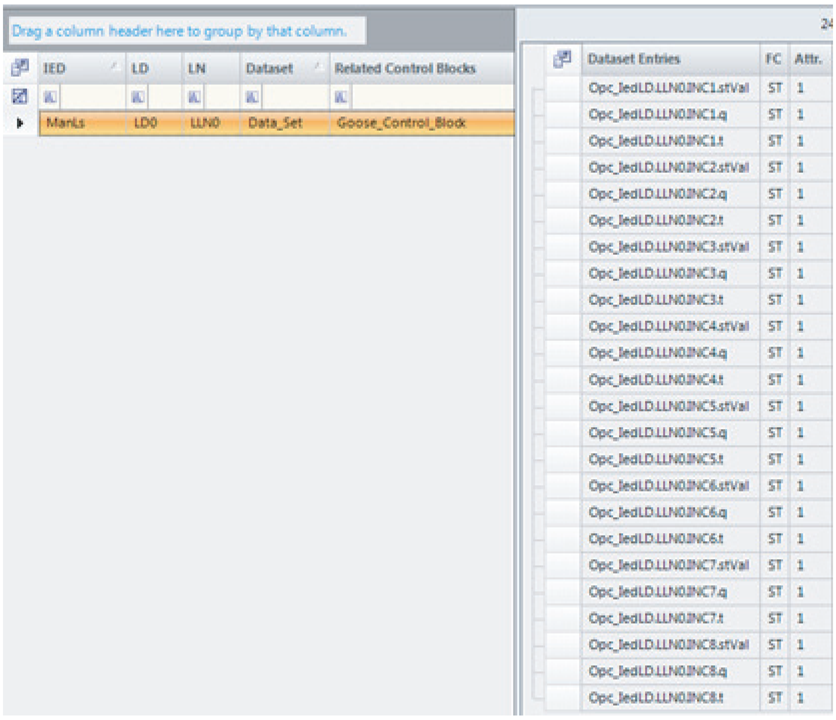


Figure 216: Manual LS proxy IED GCB

Subscribe the manual load shed GOOSE control block to the respective areas load-shedding IED. As an example, the data is subscribed to the network area 2 load-shedding IED (PML_2).

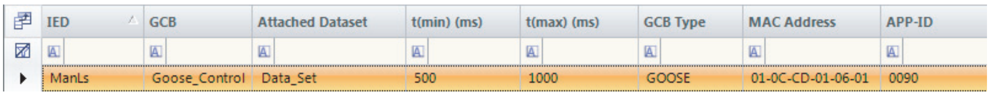


Figure 217: Subscribe manual load shed data to the load-shedding IED

7.3.9 Engineering adjacent network area load-shedding IED communication using IET600

Use IET600 to establish GOOSE communication between the adjacent network areas load-shedding IED.

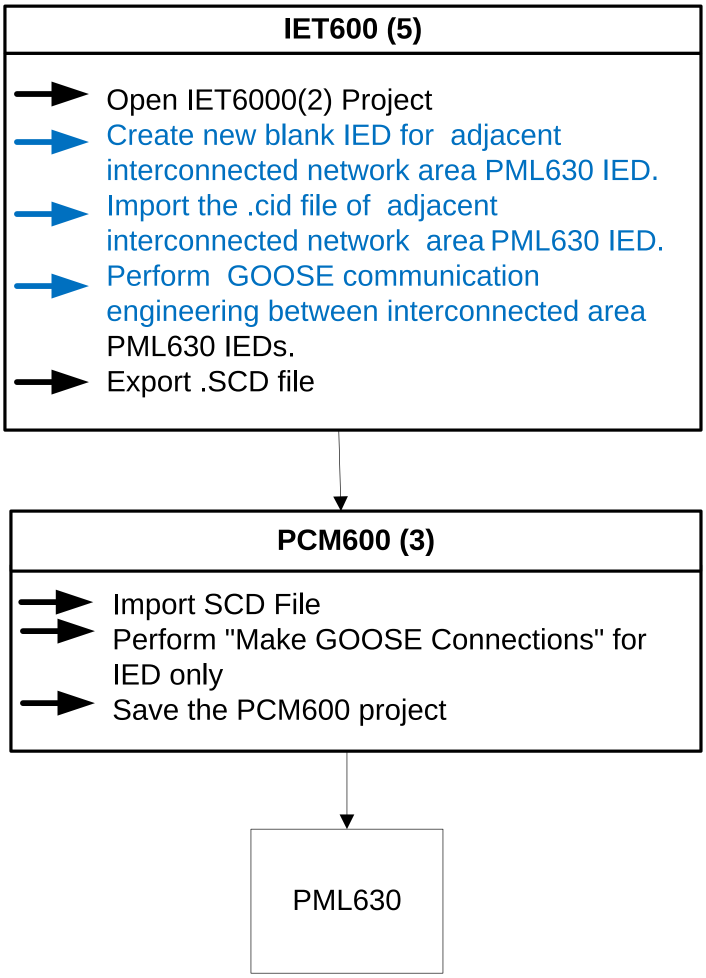


Figure 218: Engineering work flow LS Configuration B

1. Open the IET600 project of an electrical network area which was saved after the completion of cPMS-LS Configuration A.
2. Create the blank IED in the IET600 project.
3. Import the adjacent interconnected area load-shedding IED .cid file.
4. Subscribe the load shed data from adjacent network area load-shedding IED to this area load-shedding IED.
5. Export the .SCD file and save the IET600 project.

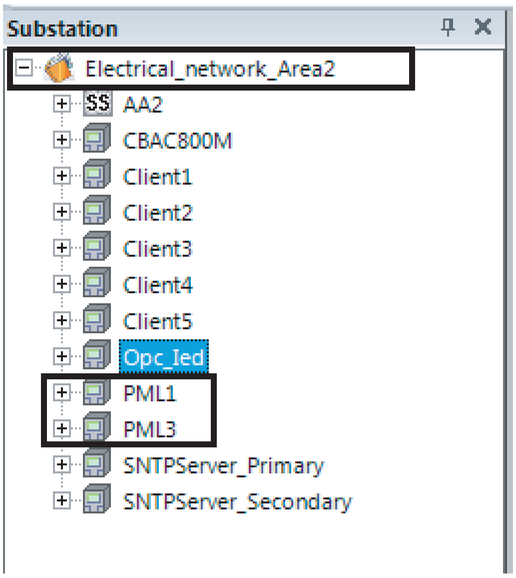


Figure 219: Adjacent network area 1 and 3 load-shedding IEDs added to the Electrical_network_area 2 IET600

The data set PP_PML of the network area 2 load-shedding IED contains the two integers. Load-shedding IED in area 2 sends the load shed data to the area1 and area 3 as PPLS_1 and PPLS_2 integer data objects respectively.

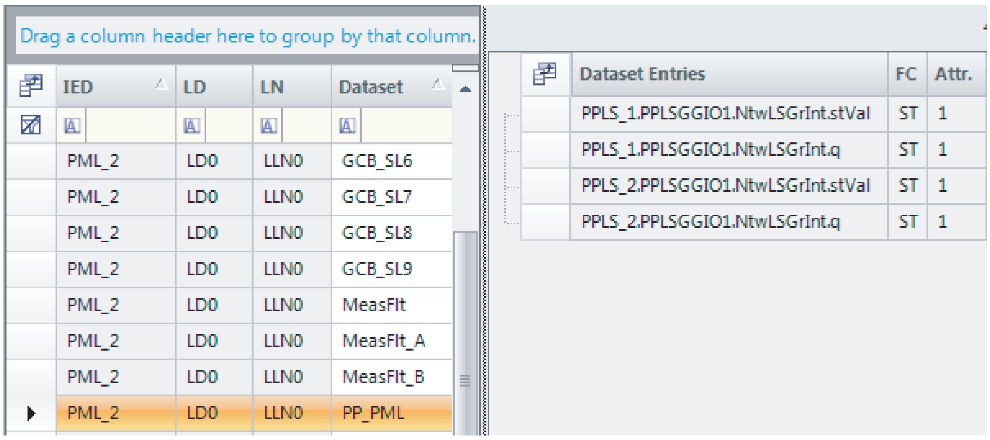


Figure 220: Data set contents of PP_PML for adjacent network area load-shedding IEDs

GOOSE control block parameters are set as per the recommendations in Table 16 for Multicast MAC address.

IED	GCB	Attached Dataset	t(min) (ms)	t(max) (ms)	GCB Type	MAC Address	APP-ID
PML2	GCB_ShdLoad1	GCB_SL1	4	1000	GOOSE	01-0C-CD-01-02-01	0221
PML2	GCB_ShdLoad2	GCB_SL2	4	1000	GOOSE	01-0C-CD-01-02-02	0222
PML2	GCB_PML	PP_PML	5	2000	GOOSE	01-0C-CD-01-02-0B	022B

Figure 221: GCB parameters for the load-shedding IED in area2

GOOSE control block of the area2 load-shedding IED data is subscribed by the two interconnected areas (that is, area1 and area3) load-shedding IEDs.

IED Name	LD	LN	GCB	Attached Dataset	PML1 (S1)	PML3 (S1)
PML2	LD0	LLN0	GCB_ShdLoad1	GCB_SL1		
PML2	LD0	LLN0	GCB_ShdLoad2	GCB_SL2		
PML2	LD0	LLN0	GCB_PML	PP_PML	x	x

Figure 222: Area2 load-shedding IED in LS Configuration B as a publisher

GOOSE control blocks of the load-shedding IEDs in area1 and area 3 are subscribed to the interconnected area (that is, area 2) load-shedding IED

IED Name	LD	LN	GCB	Attached Dataset	PML2 (S1)
PML1	LD0	LLN0	GCB_ShdLoad1	GCB_SL1	
PML1	LD0	LLN0	GCB_ShdLoad2	GCB_SL2	
PML1	LD0	LLN0	GCB_ShdLoad3	GCB_SL3	
PML1	LD0	LLN0	GCB_PML	PP_PML	x

IED Name	LD	LN	GCB	Attached Dataset	PML2 (S1)
PML3	LD0	LLN0	GCB_ShdLoad1	GCB_SL1	
PML3	LD0	LLN0	GCB_ShdLoad2	GCB_SL2	
PML3	LD0	LLN0	GCB_ShdLoad3	GCB_SL3	
PML3	LD0	LLN0	GCB_PML	PP_PML	x

Figure 223: Area2 load-shedding IED in LS Configuration B as a subscriber

7.3.10 Automatic GOOSE connection in Signal Matrix tool

The Signal Matrix tool is used for cross-referencing between GOOSE input signals and function blocks. The incoming GOOSE information from feeder IEDs (REF/REM/RET615 or 620 series IEDs, REF/REM/RET/REG630 and RIO600) should be cross-referenced or mapped to the function blocks of the IED.

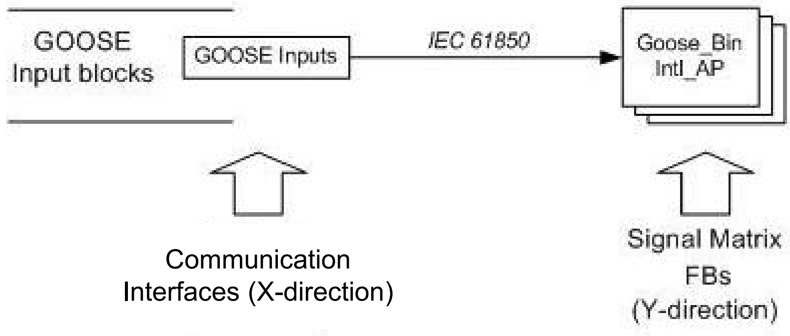


Figure 224: SMT: Operation principle

7.3.11 Initializing automatic GOOSE connection

Analog and binary GOOSE receive connections are performed automatically in the Signal Matrix tool, when the GOOSE subscription configuration is completed in the IET600 or PCM600 IEC 61850 Configuration tool.

1. Click IED Object in the **Plant Structure** and select **Make GOOSE Connection**.

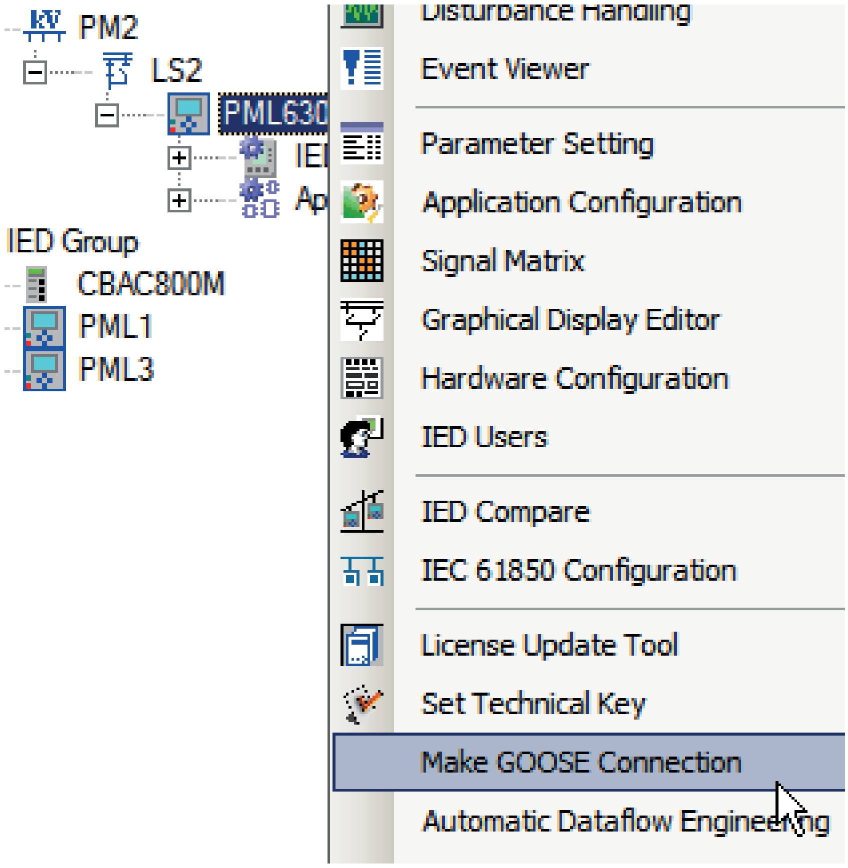


Figure 225: Initializing GOOSE connection

IED connectivity package performs GOOSE connection according to the selected configuration in the configuration wizard and displays process completion status.

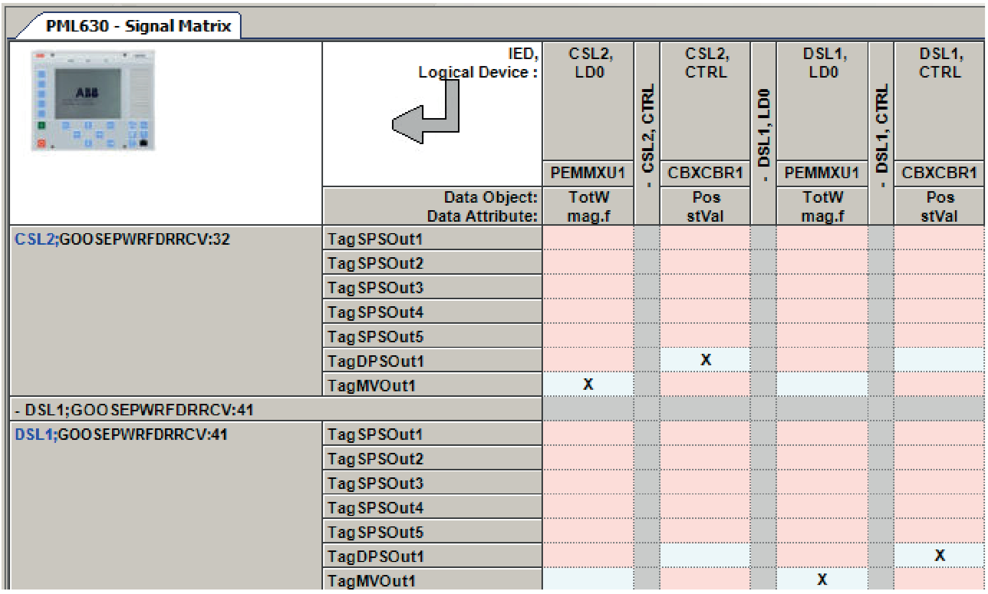


Figure 226: Signal Matrix tool connection for GOOSE receive

Connections performed in the Signal Matrix tool are displayed automatically in the Application Configuration tool.

The Signal Matrix tool includes a feature to group and collapse hardware channels for better visibility.

Depending on the IED capability, the Signal Matrix tool provides separate views for all possible combinations. The possible views are Binary Inputs, Binary Outputs, Analog Inputs and GOOSE Receive. In case of the IED, only **GOOSE Receive** tab is used as there are no direct binary inputs/outputs or analog inputs.

Based on the requirement for load-shedding functionality if certain GOOSE information are not configured in IET600, an error message is displayed.

Figure 227: Error message

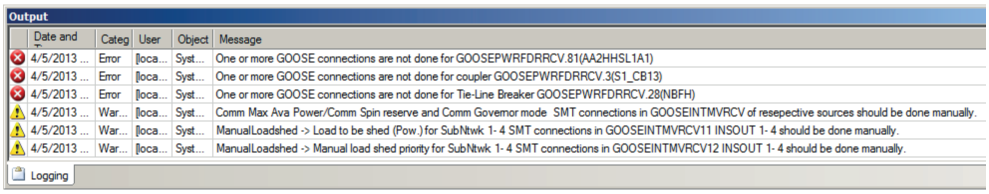


Figure 228: Log output window for error and warning messages after Make GOOSE Connection

This implies that the incoming GOOSE signals (to the IED) are not assigned automatically as they are not configured in the feeder IED GOOSE data sets. Configure the missing signals in the IET600 and re-import the SCD into PCM600.

Warning message appears in the PCM600 output window for configuring the signal matrix connections manually.

Manual load shed -> Load to be shed (Pow.) for SubNtwk 1-4 signal matrix connection in GOOSEINTMVRCV11 INSOUT 1-4 should be done manually.

Manual load shed -> Manual load shed priority for SubNtwk 1-4 signal matrix connection in GOOSEINTMVRCV12 INSOUT 1-4 should be done manually.

In case, the Comm Max Ava Power/Comm Spin Reserve and En CommGov Mode are opted to be received on communication for the sources in the configuration wizard of the IED, then signal matrix connection has to be done manually.

Re-verify the signal matrix connections for the load shed data exchange information between adjacent network area connected IEDs as per network configuration connectivity, in GOOSEINTMVRCV:1 and GOOSEINTMVRCV:2.

7.3.12 Information for automatic GOOSE connection

The IED connectivity package performs automatic GOOSE connection to link the incoming GOOSE data to the load-shedding logic in the Signal Matrix tool using GOOSE data in the IED Input section.

Table 7: GOOSE data for automatic GOOSE connection for 630 and 615 series based feeder IEDs

GOOSE data	Description
Pos.stVal	Position Information of sheddable load, bus coupler, grid or generator
TotW.mag.f	Power Information of sheddable load, bus coupler, grid or generator
Tr.general	Trip information of bus coupler, grid or generator
A.phsA.cVal.mag.f	Current Information of grid phase A
A.phsB.cVal.mag.f	Current Information of grid phase B
A.phsC.cVal.mag.f	Current Information of grid phase C
Ind.stVal	Bus coupler, grid or generator circuit breaker service position

Table 8: GOOSE data for automatic GOOSE connection for RIO600 based feeders

GOOSE data	Description
Ind1.stVa - Open Pos Ind2.stVal - Close Pos	Open and close position information of sheddable load, bus coupler, grid or generator
Ind3.sVal	Trip information of bus coupler, grid or generator
Ind4.sVal	Bus coupler, grid or generator circuit breaker service position
AnnIn1.mag.f	Power information of sheddable load, bus coupler, grid or generator

7.3.13 Communication engineering using Signal Matrix tool

Based on the position of the load feeder IEDs in the busbar (left most feeder is considered as the first load under the busbar), the incoming load-shedding command signal is assigned to the Binary GOOSE Receive block.

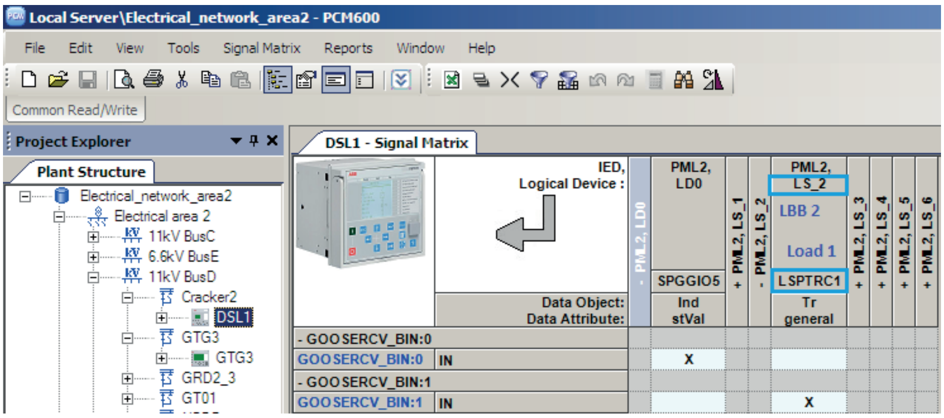


Figure 229: Signal Matrix tool for load feeder (the left-most load in a busbar)

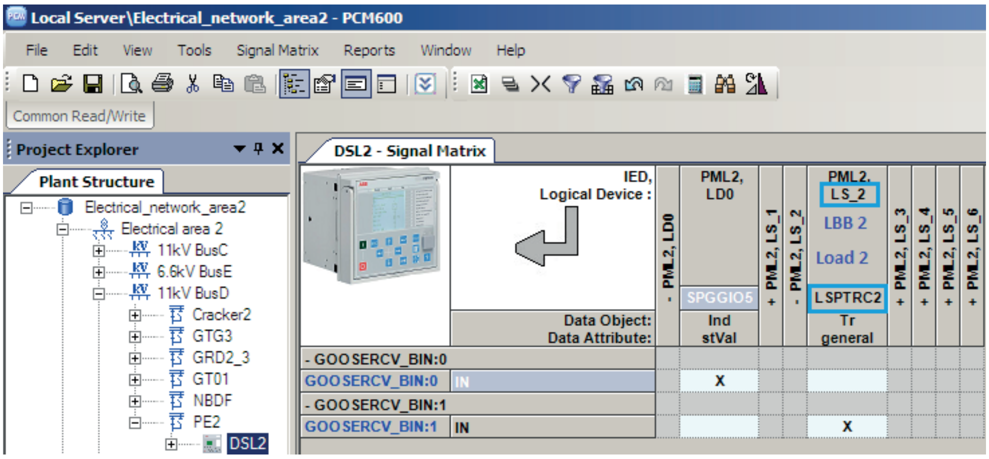


Figure 230: Signal Matrix tool configuration for second-most left load feeder on the busbar

GOOSESPRCV function block appears when the load feeder IED is REF/REM/RET630 1.1 or later.

GOOSEBINRCV function block appears when the load feeder IED is (REF/REM/RET) 615 3.0 or later and 620 2.0.

7.4 GOOSE communication engineering

Data sets and GCBs are created in power source (generator and grid transformer) IEDs, bus section/bus tie IEDs and shed load IEDs.

All feeder IEDs should be capable of sending data, as mentioned in the these tables, on GOOSE to the PML630 IED.

Table 9: Data set elements for PML630 in REG630/REF630/RET630/REM630

IED	Data set	Data object/attribute	Description
Generator source IED (REG630/REF630)	PML630_B	LD0.DAXCBR1.Pos.stVal	Circuit breaker position status
		LD0.DAXCBR1.Pos.q	Circuit breaker position quality
		LD0.TRPPTRC1.Tr.general	Lockout operation status
		LD0.TRPPTRC1.Tr.q	Lockout operation quality

Table continues on next page

IED	Data set	Data object/attribute	Description
		LD0.SPGGIO<Instance>.Ind.stVal	Circuit breaker service position status typically Instance = 7 is considered for Make GOOSE Connection
		LD0.SPGGIO<Instance>.Ind.q	Circuit breaker service position quality typically Instance = 7 is considered for Make GOOSE Connection
	PML630_A	LD0.PWRMMXU1.TotW.mag.f	Active (running) power value
		LD0.PWRMMXU1.TotW.q	Active (running) power quality
Grid transformer source IED (RET630)	PML630_B	LD0.DAXCBR1.Pos.stVal	Circuit breaker position status
		LD0.DAXCBR1.Pos.q	Circuit breaker position quality
		LD0.TRPPTRC1.Tr.general	Lockout operation status
		LD0.TRPPTRC1.Tr.q	Lockout operation quality
		LD0.SPGGIO<Instance>.Ind.stVal	Circuit breaker service position status typically Instance = 7 is considered for Make GOOSE Connection
		LD0.SPGGIO<Instance>.Ind.q	Circuit breaker service position quality typically Instance = 7 is considered for Make GOOSE Connection
	PML630_A	LD0.PWRMMXU1.TotW.mag.f	Active (running) power value
		LD0.PWRMMXU1.TotW.q	Active (running) power quality
		LD0.CPHMMXU1.A.phsA.cVal.mag.f	Phase A current value
		LD0.CPHMMXU1.A.phsA.q	Phase A current quality
		LD0.CPHMMXU1.A.phsB.cVal.mag.f	Phase B current value
		LD0.CPHMMXU1.A.phsB.q	Phase B current quality
		LD0.CPHMMXU1.A.phsC.cVal.mag.f	Phase C current value
		LD0.CPHMMXU1.A.phsC.q	Phase C current quality
Network breaker IED (REF630/RET630)	PML630_B	LD0.DAXCBR1.Pos.stVal	Circuit breaker position status
		LD0.DAXCBR1.Pos.q	Circuit breaker position quality
		LD0.TRPPTRC1.Tr.general	Lockout operation status
		LD0.TRPPTRC1.Tr.q	Lockout operation quality
		LD0.SPGGIO	Circuit breaker service position status typically Instance = 7 is considered for Make GOOSE Connection
		LD0.SPGGIO<Instance>.Ind.q	Circuit breaker service position quality typically Instance = 7 is considered for Make GOOSE Connection
	PML630_A	LD0.PWRMMXU1.TotW.mag.f	Active (running) power value
		LD0.PWRMMXU1.TotW.q	Active (running) power quality
Sheddable load IED (REF/REM630)	PML630_B	LD0.DAXCBR1.Pos.stVal	Circuit breaker position status
		LD0.DAXCBR1.Pos.q	Circuit breaker position quality
	PML630_A	LD0.PWRMMXU1.TotW.mag.f	Active (running) power value
		LD0.PWRMMXU1.TotW.q	Active (running) power quality

Table 10: Data set elements for PML630 in (REF/REM/RET) 615 IEC/ANSI and 620 Series IEC

IED	Data set	Data object/attribute	Description
Grid transformer source IED (RET615/RET620)	PML630_B	CTRL.CBXCBR1.Pos.stVal	Circuit breaker position status
		CTRL.CBXCBR1.Pos.q	Circuit breaker position quality
		LD0.TRPPTRC1.Tr.general	Lockout operation status
		LD0.TRPPTRC1.Tr.q	Lockout operation quality
		LD0.XGGIO110.Ind7.stVal	Circuit breaker service position status typically Instance = 7 is considered for Make GOOSE Connection
		LD0.XGGIO110.Ind7.q	Circuit breaker service position quality typically Instance = 7 is considered for Make GOOSE Connection
	PML630_A	LD0.PEMMXU1.TotW.mag.f	Active (running) power value
		LD0.PEMMXU1.TotW.q	Active (running) power quality
		LD0.CMMXU1.A.phsA.cVal.mag.f	Phase A current value
		LD0.CMMXU1.A.phsA.q	Phase A current quality
		LD0.CMMXU1.A.phsB.cVal.mag.f	Phase B current value
		LD0.CMMXU1.A.phsB.q	Phase B current quality
		LD0.CMMXU1.A.phsC.cVal.mag.f	Phase C current value
		LD0.CMMXU1.A.phsC.q	Phase C current quality
Network breaker IED (REF615/REF620)	PML630_B	CTRL.CBXCBR1.Pos.stVal	Circuit breaker position status
		CTRL.CBXCBR1.Pos.q	Circuit breaker position quality
		LD0.TRPPTRC1.Tr.general	Lockout operation status
		LD0.TRPPTRC1.Tr.q	Lockout operation quality
		LD0.XGGIO110.Ind7.stVal	Circuit breaker service position status typically Instance = 7 is considered for Make GOOSE Connection
		LD0.XGGIO110.Ind7.q	Circuit breaker service position quality typically Instance = 7 is considered for Make GOOSE Connection
	PML630_A	LD0.PEMMXU1.TotW.mag.f	Active (running) power value
		LD0.PEMMXU1.TotW.q	Active (running) power quality
Sheddable load IED (REF/REM615 or 620)	PML630_B	CTRL.CBXCBR1.Pos.stVal	Circuit breaker position status
		CTRL.CBXCBR1.Pos.q	Circuit breaker position quality
	PML630_A	LD0.PEMMXU1.TotW.mag.f	Active (running) power value
		LD0.PEMMXU1.TotW.q	Active (running) power quality

Table 11: Data set elements for PML630 in RIO600

IED	Data set	Data object/attribute	Description
Generator/Grid/ Transformer/Network breaker IED (RIO600)	BinaryDS	LD0.SCMHGGIO1.Ind1.stVal/ LD0.DIM8GGIO1.Ind1.stVal	Circuit breaker open position status
		LD0.SCMHGGIO1.Ind1.q/ LD0.DIM8GGIO1.Ind1.q	Circuit breaker open position quality
		LD0.SCMHGGIO1.Ind2.stVal/ LD0.DIM8GGIO1.Ind2.stVal	Circuit breaker closed position status
		LD0.SCMHGGIO1.Ind2.q/ LD0.DIM8GGIO1.Ind2.q	Circuit breaker closed position quality
		LD0.SCMHGGIO1.Ind3.stVal/ LD0.DIM8GGIO1.Ind3.stVal	Lockout operation status
		LD0.SCMHGGIO1.Ind3.q/ LD0.DIM8GGIO1.Ind3.q	Lockout operation quality
		LD0.SCMHGGIO1.Ind4.stVal/ LD0.DIM8GGIO1.Ind4.stVal	Circuit breaker service position status
		LD0.SCMHGGIO1.Ind4.q/ LD0.DIM8GGIO1.Ind4.q	Circuit breaker service position quality
	AnalogDS	LD0.RTDGGIO1.AnIn.mag.f/ LD0.RTDGGIO2.AnIn.mag.f	Active (Running) power value
		LD0.RTDGGIO2.AnIn.mag.q	Active (Running) power quality
Sheddable load IED (RIO600)	BinaryDS	LD0.SCMHGGIO1.Ind1.stVal/ LD0.DIM8GGIO1.Ind1.stVal	Circuit breaker open position status
		LD0.SCMHGGIO1.Ind1.q/ LD0.DIM8GGIO1.Ind1.q	Circuit breaker open position quality
		LD0.SCMHGGIO1.Ind2.stVal/ LD0.DIM8GGIO1.Ind2.stVal	Circuit breaker closed position status
		LD0.SCMHGGIO1.Ind2.q/ LD0.DIM8GGIO1.Ind2.q	Circuit breaker closed position quality
		LD0.SCMHGGIO1.Ind3.stVal/ LD0.DIM8GGIO1.Ind3.stVal	Card error status
		LD0.SCMHGGIO1.Ind3.q/ LD0.DIM8GGIO1.Ind3.q	Card error status quality
		LD0.RTDGGIO2.AnIn.mag.f	Active (Running) power value
		LD0.RTDGGIO2.AnIn.mag.q	Active (Running) power quality

Table 12: Data set elements in the IED for load-shedding trip commands to load feeder

IED	Data set	Data object/attribute	Description
PML630	GCB_SL1 (Data set for all sheddable loads 1 under all busbars)	LS_1.LSPTRC1.Tr.general	Load-shedding trip command for sheddable load 1 of busbar 1
		LS_1.LSPTRC1.Tr.q	Data quality status of load-shedding trip command for sheddable load 1 of busbar 1
		LS_2.LSPTRC1.Tr.general	Load-shedding trip command for sheddable load 1 of busbar 2
Table continues on next page			

IED	Data set	Data object/attribute	Description
		LS_2.LSPTRC1.Tr.q	Data quality status of load-shedding trip command for sheddable load 1 of busbar 2
		LS_3.LSPTRC1.Tr.general	Load-shedding trip command for sheddable load 1 of busbar 3
		LS_3.LSPTRC1.Tr.q	Data quality status of load-shedding trip command for sheddable load 1 of busbar 3
		LS_4.LSPTRC1.Tr.general	Load-shedding trip command for sheddable load 1 of busbar 4
		LS_4.LSPTRC1.Tr.q	Data quality status of load-shedding trip command for sheddable load 1 of busbar 4
		LS_5.LSPTRC1.Tr.general	Load-shedding trip command for sheddable load 1 of busbar 5
		LS_5.LSPTRC1.Tr.q	Data quality status of load-shedding trip command for sheddable load 1 of busbar 5
		LS_6.LSPTRC1.Tr.general	Load-shedding trip command for sheddable load 1 of busbar 6
		LS_6.LSPTRC1.Tr.q	Data quality status of load-shedding trip command for sheddable load 1 of busbar 6
		LD0.SPGGIO5.Ind.stVal	PML630 IED in test mode information. (To be added manually in the data set).
		LD0.SPGGIO5.Ind.q	PML630 IED in test mode information. (To be added manually in the data set).
	GCB_SL2 (Data set for all sheddable loads 2 under all busbars)	LS_1.LSPTRC2.Tr.general	Load-shedding trip command for sheddable load 2 of busbar 1
		LS_1.LSPTRC2.Tr.q	Data quality status of load-shedding trip command for sheddable load 2 of busbar 1
		LS_2.LSPTRC2.Tr.general	Load-shedding trip command for sheddable load 2 of busbar 2
		LS_2.LSPTRC2.Tr.q	Data quality status of load-shedding trip command for sheddable load 2 of busbar 2
		LS_3.LSPTRC2.Tr.general	Load-shedding trip command for sheddable load 2 of busbar 3
		LS_3.LSPTRC2.Tr.q	Data quality status of load-shedding trip command for sheddable load 2 of busbar 3
		LS_4.LSPTRC2.Tr.general	Load-shedding trip command for sheddable load 2 of busbar 4
		LS_4.LSPTRC2.Tr.q	Data quality status of load-shedding trip command for sheddable load 2 of busbar 4
		LS_5.LSPTRC2.Tr.general	Load-shedding trip command for sheddable load 2 of busbar 5

Table continues on next page

IED	Data set	Data object/attribute	Description
		LS_5.LSPTRC2.Tr.q	Data quality status of load-shedding trip command for sheddable load 2 of busbar 5
		LS_6.LSPTRC2.Tr.general	Load-shedding trip command for sheddable load 2 of busbar 6
		LS_6.LSPTRC2.Tr.q	Data quality status of load-shedding trip command for sheddable load 2 of busbar 6
		LD0.SPGGIO5.Ind.stVal	PML630 IED in test mode information. (To be added manually in the data set).
		LD0.SPGGIO5.Ind.q	PML630 IED in test mode information. (To be added manually in the data set).
	GCB_SL3 (Data set for all sheddable loads 3 under all busbars)	LS_1.LSPTRC3.Tr.general	Load-shedding trip command for sheddable load 3 of busbar 1
		LS_1.LSPTRC3.Tr.q	Data quality status of load-shedding trip command for sheddable load 3 of busbar 1
		LS_2.LSPTRC3.Tr.general	Load-shedding trip command for sheddable load 3 of busbar 2
		LS_2.LSPTRC3.Tr.q	Data quality status of load-shedding trip command for sheddable load 3 of busbar 2
		LS_3.LSPTRC3.Tr.general	Load-shedding trip command for sheddable load 3 of busbar 3
		LS_3.LSPTRC3.Tr.q	Data quality status of load-shedding trip command for sheddable load 3 of busbar 3
		LS_4.LSPTRC3.Tr.general	Load-shedding trip command for sheddable load 3 of busbar 4
		LS_4.LSPTRC3.Tr.q	Data quality status of load-shedding trip command for sheddable load 3 of busbar 4
		LS_5.LSPTRC3.Tr.general	Load-shedding trip command for sheddable load 3 of busbar 5
		LS_5.LSPTRC3.Tr.q	Data quality status of load-shedding trip command for sheddable load 3 of busbar 5
		LS_6.LSPTRC3.Tr.general	Load-shedding trip command for sheddable load 3 of busbar 6
		LS_6.LSPTRC3.Tr.q	Data quality status of load-shedding trip command for sheddable load 3 of busbar 6
		LD0.SPGGIO5.Ind.stVal	PML630 IED in test mode information. (To be added manually in the data set).
		LD0.SPGGIO5.Ind.q	PML630 IED in test mode information. (To be added manually in the data set).
	GCB_SL4 (Data set for all sheddable loads 4 under all busbars)	LS_1.LSPTRC4.Tr.general	Load-shedding trip command for sheddable load 4 of busbar 1

Table continues on next page

IED	Data set	Data object/attribute	Description
		LS_1.LSPTRC4.Tr.q	Data quality status of load-shedding trip command for sheddable load 4 of busbar 1
		LS_2.LSPTRC4.Tr.general	Load-shedding trip command for sheddable load 4 of busbar 2
		LS_2.LSPTRC4.Tr.q	Data quality status of load-shedding trip command for sheddable load 4 of busbar 2
		LS_3.LSPTRC4.Tr.general	Load-shedding trip command for sheddable load 4 of busbar 3
		LS_3.LSPTRC4.Tr.q	Data quality status of load-shedding trip command for sheddable load 4 of busbar 3
		LS_4.LSPTRC4.Tr.general	Load-shedding trip command for sheddable load 4 of busbar 4
		LS_4.LSPTRC4.Tr.q	Data quality status of load-shedding trip command for sheddable load 4 of busbar 4
		LS_5.LSPTRC4.Tr.general	Load-shedding trip command for sheddable load 4 of busbar 5
		LS_5.LSPTRC4.Tr.q	Data quality status of load-shedding trip command for sheddable load 4 of busbar 5
		LS_6.LSPTRC4.Tr.general	Load-shedding trip command for sheddable load 4 of busbar 6
		LS_6.LSPTRC4.Tr.q	Data quality status of load-shedding trip command for sheddable load 4 of busbar 6
		LD0.SPGGIO5.Ind.stVal	PML630 IED in test mode information. (To be added manually in the data set).
		LD0.SPGGIO5.Ind.q	PML630 IED in test mode information. (To be added manually in the data set).
	GCB_SL5 (Data set for all sheddable loads 5 under all busbars)	LS_1.LSPTRC5.Tr.general	Load-shedding trip command for sheddable load 5 of busbar 1
		LS_1.LSPTRC5.Tr.q	Data quality status of load-shedding trip command for sheddable load 5 of busbar 1
		LS_2.LSPTRC5.Tr.general	Load-shedding trip command for sheddable load 5 of busbar 2
		LS_2.LSPTRC5.Tr.q	Data quality status of load-shedding trip command for sheddable load 5 of busbar 2
		LS_3.LSPTRC5.Tr.general	Load-shedding trip command for sheddable load 5 of busbar 3
		LS_3.LSPTRC5.Tr.q	Data quality status of load-shedding trip command for sheddable load 5 of busbar 3
		LS_4.LSPTRC5.Tr.general	Load-shedding trip command for sheddable load 5 of busbar 4

Table continues on next page

IED	Data set	Data object/attribute	Description
		LS_4.LSPTRC5.Tr.q	Data quality status of load-shedding trip command for sheddable load 5 of busbar 4
		LS_5.LSPTRC5.Tr.general	Load-shedding trip command for sheddable load 5 of busbar 5
		LS_5.LSPTRC5.Tr.q	Data quality status of load-shedding trip command for sheddable load 5 of busbar 5
		LS_6.LSPTRC5.Tr.general	Load-shedding trip command for sheddable load 5 of busbar 6
		LS_6.LSPTRC5.Tr.q	Data quality status of load-shedding trip command for sheddable load 5 of busbar 6
		LD0.SPGGIO5.Ind.stVal	PML630 IED in test mode information. (To be added manually in the data set).
		LD0.SPGGIO5.Ind.q	PML630 IED in test mode information. (To be added manually in the data set).
	GCB_SL6 (Data set for all sheddable loads 6 under all busbars)	LS_1.LSPTRC6.Tr.general	Load-shedding trip command for sheddable load 6 of busbar 1
		LS_1.LSPTRC6.Tr.q	Data quality status of load-shedding trip command for sheddable load 6 of busbar 1
		LS_2.LSPTRC6.Tr.general	Load-shedding trip command for sheddable load 6 of busbar 2
		LS_2.LSPTRC6.Tr.q	Data quality status of load-shedding trip command for sheddable load 6 of busbar 2
		LS_3.LSPTRC6.Tr.general	Load-shedding trip command for sheddable load 6 of busbar 3
		LS_3.LSPTRC6.Tr.q	Data quality status of load-shedding trip command for sheddable load 6 of busbar 3
		LS_4.LSPTRC6.Tr.general	Load-shedding trip command for sheddable load 6 of busbar 4
		LS_4.LSPTRC6.Tr.q	Data quality status of load-shedding trip command for sheddable load 6 of busbar 4
		LS_5.LSPTRC6.Tr.general	Load-shedding trip command for sheddable load 6 of busbar 5
		LS_5.LSPTRC6.Tr.q	Data quality status of load-shedding trip command or sheddable load 6 of busbar 5
		LS_6.LSPTRC6.Tr.general	Load-shedding trip command for sheddable load 6 of busbar 6
		LS_6.LSPTRC6.Tr.q	Data quality status of load-shedding trip command for sheddable load 6 of busbar 6
		LD0.SPGGIO5.Ind.stVal	PML630 IED in test mode information. (To be added manually in the data set).
		LD0.SPGGIO5.Ind.q	PML630 IED in test mode information. (To be added manually in the data set).

Table continues on next page

IED	Data set	Data object/attribute	Description
	GCB_SL7 (Data set for all sheddable loads 7 under all busbars)	LS_1.LSPTRC7.Tr.general	Load-shedding trip command for sheddable load 7 of busbar 1
		LS_1.LSPTRC7.Tr.q	Data quality status of load-shedding trip command for sheddable load 7 of busbar 1
		LS_2.LSPTRC7.Tr.general	Load-shedding trip command for sheddable load 7 of busbar 2
		LS_2.LSPTRC7.Tr.q	Data quality status of load-shedding trip command for sheddable load 7 of busbar 2
		LS_3.LSPTRC7.Tr.general	Load-shedding trip command for sheddable load 7 of busbar 3
		LS_3.LSPTRC7.Tr.q	Data quality status of load-shedding trip command for sheddable load 7 of busbar 3
		LS_4.LSPTRC7.Tr.general	Load-shedding trip command for sheddable load 7 of busbar 4
		LS_4.LSPTRC7.Tr.q	Data quality status of load-shedding trip command for sheddable load 7 of busbar 4
		LS_5.LSPTRC7.Tr.general	Load-shedding trip command for sheddable load 7 of busbar 5
		LS_5.LSPTRC7.Tr.q	Data quality status of load-shedding trip command for sheddable load 7 of busbar 5
		LS_6.LSPTRC7.Tr.general	Load-shedding trip command for sheddable load 7 of busbar 6
		LS_6.LSPTRC7.Tr.q	Data quality status of load-shedding trip command for sheddable load 7 of busbar 6
		LD0.SPGGIO5.Ind.stVal	PML630 IED in test mode information. (To be added manually in the data set).
		LD0.SPGGIO5.Ind.q	PML630 IED in test mode information. (To be added manually in the data set).
	GCB_SL8 (Data set for all sheddable loads 8 under all busbars)	LS_1.LSPTRC8.Tr.general	Load-shedding trip command for sheddable load 8 of busbar 1
		LS_1.LSPTRC8.Tr.q	Data quality status of load-shedding trip command for sheddable load 8 of busbar 1
		LS_2.LSPTRC8.Tr.general	Load-shedding trip command for sheddable load 8 of busbar 2
		LS_2.LSPTRC8.Tr.q	Data quality status of load-shedding trip command for sheddable load 8 of busbar 2
		LS_3.LSPTRC8.Tr.general	Load-shedding trip command for sheddable load 8 of busbar 3

Table continues on next page

IED	Data set	Data object/attribute	Description
		LS_3.LSPTRC8.Tr.q	Data quality status of load-shedding trip command for sheddable load 8 of busbar 3
		LS_4.LSPTRC8.Tr.general	Load-shedding trip command for sheddable load 8 of busbar 4
		LS_4.LSPTRC8.Tr.q	Data quality status of load-shedding trip command for sheddable load 8 of busbar 4
		LS_5.LSPTRC8.Tr.general	Load-shedding trip command for sheddable load 8 of busbar 5
		LS_5.LSPTRC8.Tr.q	Data quality status of load-shedding trip command for sheddable load 8 of busbar 5
		LS_6.LSPTRC8.Tr.general	Load-shedding trip command for sheddable load 8 of busbar 6
		LS_6.LSPTRC8.Tr.q	Data quality status of load-shedding trip command for sheddable load 8 of busbar 6
		LD0.SPGGIO5.Ind.stVal	PML630 IED in test mode information. (To be added manually in the data set).
		LD0.SPGGIO5.Ind.q	PML630 IED in test mode information. (To be added manually in the data set).
	GCB_SL9 (Data set for all sheddable loads 9 under all busbars)	LS_1.LSPTRC9.Tr.general	Load-shedding trip command for sheddable load 9 of busbar 1
		LS_1.LSPTRC9.Tr.q	Data quality status of load-shedding trip command for sheddable load 9 of busbar 1
		LS_2.LSPTRC9.Tr.general	Load-shedding trip command for sheddable load 9 of busbar 2
		LS_2.LSPTRC9.Tr.q	Data quality status of load-shedding trip command for sheddable load 9 of busbar 2
		LS_3.LSPTRC9.Tr.general	Load-shedding trip command for sheddable load 9 of busbar 3
		LS_3.LSPTRC9.Tr.q	Data quality status of load-shedding trip command for sheddable load 9 of busbar 3
		LS_4.LSPTRC9.Tr.general	Load-shedding trip command for sheddable load 9 of busbar 4
		LS_4.LSPTRC9.Tr.q	Data quality status of load-shedding trip command for sheddable load 9 of busbar 4
		LS_5.LSPTRC9.Tr.general	Load-shedding trip command for sheddable load 9 of busbar 5
		LS_5.LSPTRC9.Tr.q	Data quality status of load-shedding trip command for sheddable load 9 of busbar 5
		LS_6.LSPTRC9.Tr.general	Load-shedding trip command for sheddable load 9 of busbar 6

Table continues on next page

IED	Data set	Data object/attribute	Description
		LS_6.LSPTRC9.Tr.q	Data quality status of load-shedding trip command for sheddable load 9 of busbar 6
		LD0.SPGGIO5.Ind.stVal	PML630 IED in test mode information. (To be added manually in the data set).
		LD0.SPGGIO5.Ind.q	PML630 IED in test mode information. (To be added manually in the data set).
	GCB_SL10 (Data set for all sheddable loads 10 under all busbars)	LS_1.LSPTRC10.Tr.general	Load-shedding trip command for sheddable load 10 of busbar 1
		LS_1.LSPTRC10.Tr.q	Data quality status of load-shedding trip command for sheddable load 10 of busbar 1
		LS_2.LSPTRC10.Tr.general	load-shedding trip command for sheddable load 10 of busbar 2
		LS_2.LSPTRC10.Tr.q	Data quality status of load-shedding trip command for sheddable load 10 of busbar 2
		LS_3.LSPTRC10.Tr.general	Load-shedding trip command for sheddable load 10 of busbar 3
		LS_3.LSPTRC10.Tr.q	Data quality status of load-shedding trip command for sheddable load 10 of busbar 3
		LS_4.LSPTRC10.Tr.general	Load-shedding trip command for sheddable load 10 of busbar 4
		LS_4.LSPTRC10.Tr.q	Data quality status of load-shedding trip command for sheddable load 10 of busbar 4
		LS_5.LSPTRC10.Tr.general	Load-shedding trip command for sheddable load 10 of busbar 5
		LS_5.LSPTRC10.Tr.q	Data quality status of load-shedding trip command for sheddable load 10 of busbar 5
		LS_6.LSPTRC10.Tr.general	Load-shedding trip command for sheddable load 10 of busbar 6
		LS_6.LSPTRC10.Tr.q	Data quality status of load-shedding trip command for sheddable load 10 of busbar 6
		LD0.SPGGIO5.Ind.stVal	PML630 IED in test mode information. (To be added manually in the data set).
		LD0.SPGGIO5.Ind.q	PML630 IED in test mode information. (To be added manually in the data set).

If a load-shedding feeder is the outgoing feeder to another voltage level (with another incomer and a bus coupler), it might be necessary to block the change over of the entire downstream load to the other incomer, that is, closure of the bus coupler circuit breaker. This can be achieved by issuing an auto change over inhibit command to the bus coupler. The load shed command to the upper voltage level outgoing feeder should also be sent to the bus coupler IED. This signal should be used as a deterrent to close the bus coupler circuit breaker. Hence, additional bus coupler feeder IEC 61850 engineering and logic engineering needs to be done, as necessary, by the user.

In case of cPMS - LS Configuration B (inter-connected electrical networks), the separate electrical network areas are monitored with the load-shedding IED. The data exchange the load-shedding IEDs are managed by GOOSE data sets as mentioned in Table 13. The required GOOSE data set and control block are created automatically by the IED ConnPack.

Table 13: Data set elements in the IED for load shed data exchange with adjacent network area IED

IED	Data set	Data object/attribute	Description
PML630	PP_PML	PPLS_1.PPLSGGIO1.NtwLSGrInt.stVal	Load-shedding data to adjacent network area connected with Grid1 source
		PPLS_1.PPLSGGIO1.NtwLSGrInt.q	Data quality status of load-shedding data to adjacent network area connected with Grid1 source
		PPLS_2.PPLSGGIO1.NtwLSGrInt.stVal	Load-shedding data to adjacent network area connected with Grid2 source
		PPLS_2.PPLSGGIO1.NtwLSGrInt.q	Data quality status of load-shedding data to adjacent network area connected with Grid2 source

7.4.1 Defining the GOOSE control block and GOOSE application with IET600

1. Select the IED in the IEDs section.

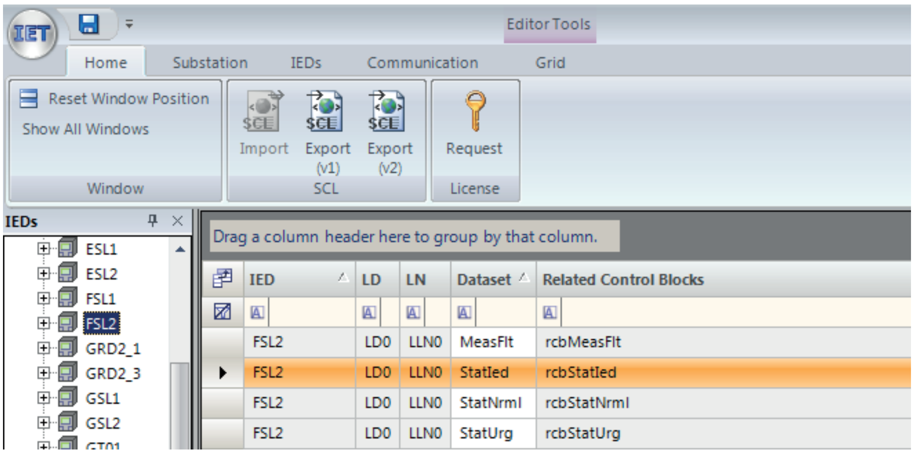


Figure 231: Select the IED, for example, FSL2

2. Click and open **GCB Data** window. Right-click the window and select **Insert new row** to create a GOOSE control block. Create a new GCB, for instance, gcb_A.

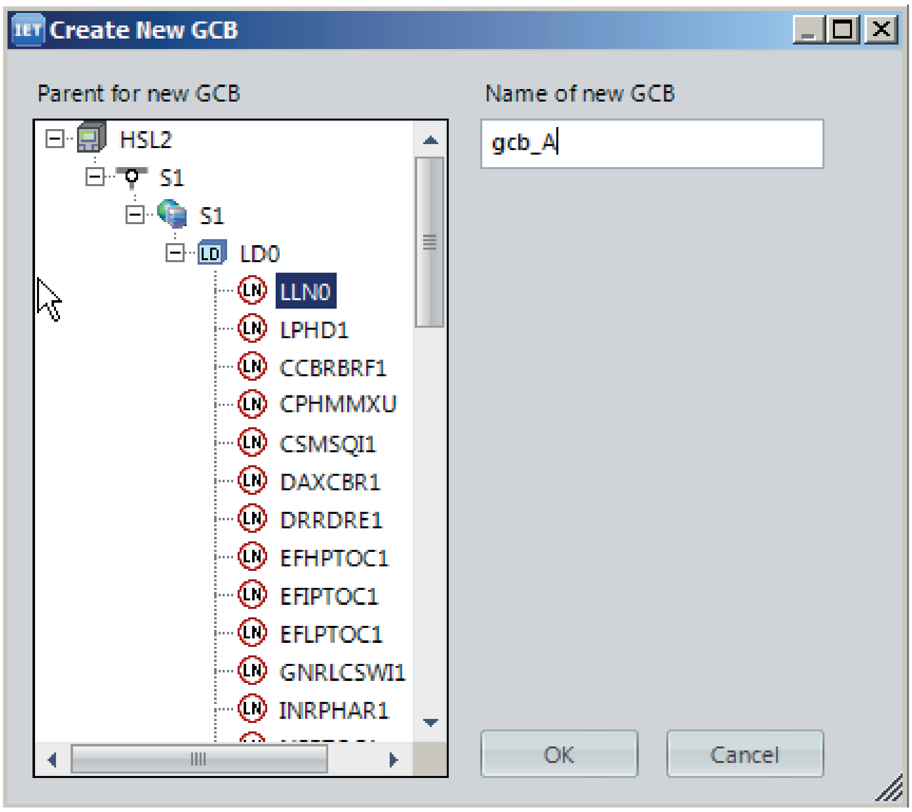


Figure 232: Creating a new GCB

3. Select the data set to associate to the new GCB.

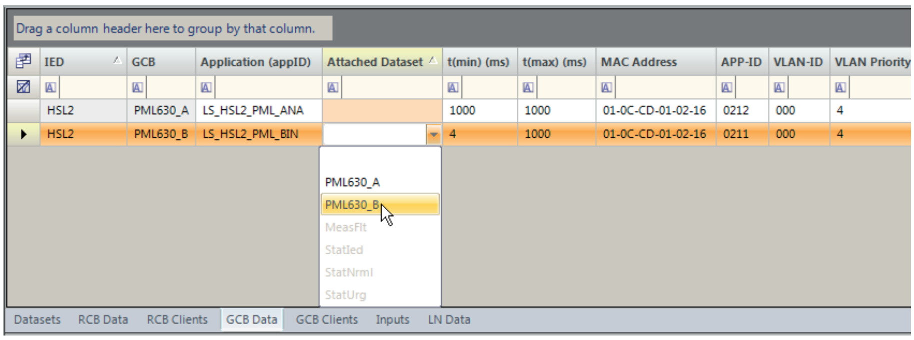


Figure 233: Associating the data set to GCB

4. Define the application identity (*appID/GoID*).

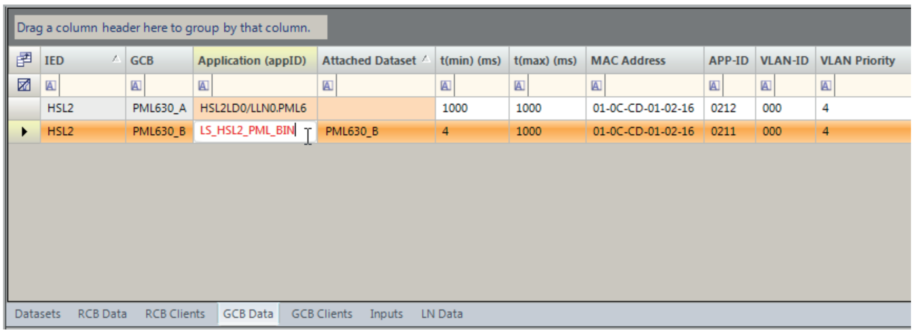


Figure 234: Application level (IEC 61850-7-2) GCB parameters, appID/GoID

5. Define the MAC Address and APP-ID address parameters.
6. Define t(min) and t(max) parameters in milliseconds.

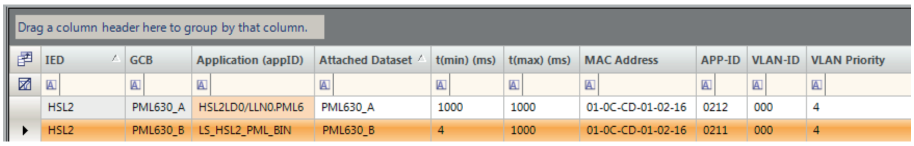


Figure 235: GOOSE control block and GOOSE application definition

Table 14: Link level IEC 61850-8-1 GCB parameters

MAC address elements	Range	Description
MAC address (GOOSE Multicast addresses)	01-0CCD- 01-00-00 to 01-0C-CD-01-01-FF.	The address receiving the specific GOOSE data.
APP-ID	0000 to 3FFF	*APP-ID* is unique HEX value for sending the *GoCB* within the system.
VLAN-ID /VLAN-PRIO Priority	Default VLAN-ID=0 and VLAN Priority=4	*VLAN-ID* and *VLAN-PRIORITY* properties can be used in the networks supporting virtual LANs.
MinTime	10 000ms (default value); 4ms	*MinTime* indicates the maximum response time in milliseconds for data change. The receiver uses this time to discard old messages.
MaxTime	10 000ms (default value); 1000ms	*MaxTime* indicates the background heartbeat cycle time in milliseconds. In the absence of data change, the IED re-sends the message with the heartbeat cycle to the receiver for detecting communication losses.

For (REF/REM/RET) 615 or 620 series IEDs, the *appID/GoID* field cannot be left blank.

7.4.2 GOOSE control block addressing for sending IEDs

The GOOSE control block addressing is important to control the GOOSE traffic flow in the substation network. Some filtering parameters need to be set carefully during the IET600 engineering step.

It is recommended that all GOOSE Control blocks for load-shedding application from all feeder IEDs belonging to a particular busbar can have the same multicast MAC address. Since the *APP-ID* is unique for every message, the APP-ID parameter can be unique for every Data set.

Table 15: Multicast MAC address for six-busbar Configuration A

Particular	Multicast MAC addresses	APP-ID for Binary data set	APP-ID for Analog data set
LBB1 feeder IED data for load-shedding	01-0C-CD-01-00-11	0011	0012
LBB2 feeder IED data for load-shedding	01-0C-CD-01-00-12	0013	0014
LBB3 feeder IED data for load-shedding	01-0C-CD-01-00-13	0015	0016
LBB4 feeder IED data for load-shedding	01-0C-CD-01-00-14	0017	0018
LBB5 feeder IED data for load-shedding	01-0C-CD-01-00-15	0019	001A
LBB6 feeder IED data for load-shedding	01-0C-CD-01-00-16	001B	001C
COM600 Opc_IED for Manual load-shedding	01-0C-CD-01-00-17	-	001D
PML630 (GCB_SL1 DataSet)	01-0C-CD-01-01-11	0111	-
PML630 (GCB_SL2 DataSet)	01-0C-CD-01-01-12	0112	-
PML630 (GCB_SL3 DataSet)	01-0C-CD-01-01-13	0113	-
PML630 (GCB_SL4 DataSet)	01-0C-CD-01-01-14	0114	-
PML630 (GCB_SL5 DataSet)	01-0C-CD-01-01-15	0115	-
PML630 (GCB_SL6 DataSet)	01-0C-CD-01-01-16	0116	-
PML630 (GCB_SL7 DataSet)	01-0C-CD-01-01-17	0117	-
PML630 (GCB_SL8 DataSet)	01-0C-CD-01-01-18	0118	-
PML630 (GCB_SL9 DataSet)	01-0C-CD-01-01-19	0119	-
PML630 (GCB_SL10 DataSet)	01-0C-CD-01-01-1A	011A	-

Table 16: Multicast MAC address for six-busbar Configuration B

Particular	Multicast MAC addresses	APP-ID for Binary data set	APP-ID for Analog data set
LBB1 feeder IED data for load-shedding	01-0C-CD-01-00-x1	00x1	0x02
LBB2 feeder IED data for load-shedding	01-0C-CD-01-00-x2	00x3	0x04
LBB3 feeder IED data for load-shedding	01-0C-CD-01-00-x3	00x5	0x06
LBB4 feeder IED data for load-shedding	01-0C-CD-01-00-x4	00x7	0x08
LBB5 feeder IED data for load-shedding	01-0C-CD-01-00-x5	00x9	00xA
LBB6 feeder IED data for load-shedding	01-0C-CD-01-00-x6	00xB	00xC
COM600 Opc_IED for Manual load-shedding	01-0C-CD-01-00-x7	-	00xD
PML630 (GCB_SL1 Data set)	01-0C-CD-01-01-x1	01x1	-
PML630 (GCB_SL2 Data set)	01-0C-CD-01-01-x2	01x2	-
PML630 (GCB_SL3 Data set)	01-0C-CD-01-01-x3	01x3	-
Table continues on next page			

Particular	Multicast MAC addresses	APP-ID for Binary data set	APP-ID for Analog data set
PML630 (GCB_SL4 Data set)	01-0C-CD-01-01-x4	01x4	-
PML630 (GCB_SL5 Data set)	01-0C-CD-01-01-x5	01x5	-
PML630 (GCB_SL6 Data set)	01-0C-CD-01-01-x6	01x6	-
PML630 (GCB_SL7 Data set)	01-0C-CD-01-01-x7	01x7	-
PML630 (GCB_SL8 Data set)	01-0C-CD-01-01-x8	01x8	-
PML630 (GCB_SL9 Data set)	01-0C-CD-01-01-x9	01x9	-
PML630 (GCB_SL10 Data set)	01-0C-CD-01-01-xA	01xA	-
PML630 (PP_PML Data set)	01-0C-CD-01-01-xB	-	01xB

To maintain the uniqueness of GOOSE Multicast address across different network areas in Config B, it is recommended to have an identification scheme as follows: the 11th character (left to right) can be designated as per the substation technical key identity (1,2,3) for area1, area2 and area3 respectively.
One proposal is to have all the GOOSE control blocks for the load-shedding application feeder IEDs from a busbar to have the same multicast MAC address. Since the *APP-ID* should be unique for every message, the parameter can be unique for every data set.

In Table 16, 'x' is recommended to be associated with the substation technical key of the PCM600 project.
In cPMS – LS Configuration A (a single power network area), it is recommended to keep the technical key as AA1. The 3rd character, the numeric part, that is, x = 1, is used in the data set names.
In case of cPMS - LS Configuration B (inter-connected power network areas), for the first power network area PCM600 project, the substation technical key is recommended as AA1 where x=1. For the second electrical network area PCM600 project, the substation technical key is recommended as AA2 where x=2. Similarly, for the 3rd power network area PCM600 project, the substation technical key is recommended as AA3 where x=3.

The 615 3.0 or later and 620 2.0 series IEDs do not recognize the *appID/GoID* parameters in the incoming GOOSE message and only perform the filtering based on MAC address and the APP-ID parameters. Therefore, it is necessary to have a unique MAC address and APP-ID for every GSE in case of a 615 3.0 or later and 620 2.0 series feeder IED.
For a 615 3.0 or later and 620 2.0 series based feeder IED, the user must ensure that the PML630 generated load-shedding GOOSE command information message's MAC address and APP-ID

parameters are not used in any other application like interlocking/ inter-trip based GSEs (configured in other sending IEDs). This would enable the 615 3.0 or later and 620 2.0 series IED to distinguish between the incoming GOOSE messages meant for the different applications.

The *appID/GoID* must be unique for every GOOSE control block. It is recommended to specify this parameter for (REF/REM/RET) 630 series Ver.1.x, REG630 1.2, (REF/REM/RET) 615 3.0 or later, 620 2.0 and REG670. This parameter is mandatory for 615 and 620 series.

Table 17 shows the possible *appID/GoID* designations for feeder IEDs and PML630. The designation format could be <Application>_<Sending IED>_<Receiving IED>_<Data type>.

Table 17: appID/GoID designation for GOOSE information from feeder IEDs to PML630

Feeder Type	IED/Data set	GoID designation
Generator feeder	G02/PML630_A	LS_G02_PML_ANA
	G02/PML630_B	LS_G02_PML_BIN
Grid transformer	GR1/PML630_A	LS_GR1_PML_ANA
	GR1/PML630_B	LS_GR1_PML_BIN
Network circuit breaker (Buscoupler / bus section)	NBAB/PML630_A	LS_NBAB_PML_ANA
	NBAB/PML630_B	LS_NBAB_PML_BIN
Load feeder	CSL1/PML630_A	LS_CSL1_PML_ANA
	CSL1/PML630_B	LS_CSL1_PML_BIN

The appID/GoIDs designation for the load-shedding commands from PML630 to load feeder IEDs can also be defined. These definitions are automatically done by the load-shedding IED connectivity package during the generation of SCD file from the automatic dataflow engineering utility.

Table 18: appID/GoID designation for GOOSE information from PML630 to feeder IEDs

Load shed commands	IED/Data set	appID/GoID designation
Sheddable loads ‘SL1’ under busbars LBB1…LBB6	PML630/GCB_SL1	LS_PML_BBSL1_BIN
Sheddable loads ‘SL2’ under busbars LBB1…LBB6	PML630/GCB_SL2	LS_PML_BBSL2_BIN
Sheddable loads ‘SL3’ under busbars LBB1…LBB6	PML630/GCB_SL3	LS_PML_BBSL3_BIN
Sheddable loads ‘SL4’ under busbars LBB1…LBB6	PML630/GCB_SL4	LS_PML_BBSL4_BIN
Sheddable loads ‘SL5’ under busbars LBB1…LBB6	PML630/GCB_SL5	LS_PML_BBSL5_BIN
Sheddable loads ‘SL6’ under busbars LBB1…LBB6	PML630/GCB_SL6	LS_PML_BBSL6_BIN

Table continues on next page

Load shed commands	IED/Data set	appID/GoID designation
Sheddable loads ‘SL7 under busbars LBB1…LBB6	PML630/GCB_SL7	LS_PML_BBSL7_BIN
Sheddable loads ‘SL8’ under busbars LBB1…LBB6	PML630/GCB_SL8	LS_PML_BBSL8_BIN
Sheddable loads ‘SL9’ under busbars LBB1…LBB6	PML630/GCB_SL9	LS_PML_BBSL9_BIN
Sheddable loads ‘SL10’ under busbars LBB1…LBB6	PML630/GCB_SL10	LS_PML_BBSL10_BIN

The *appID*/*GoID*s for cPMS-LS Configuration B are also done automatically by the load-shedding IED Connectivity Package during the generation of SCD file from the automatic dataflow engineering utility.

Table 19: appID/GoID designation for GOOSE infromation between inter-connected network area PML630 IEDs

Feeder Type	IED/Data set	GoID designation
PML630 IED	PP_PML	LS_DATA_PPLSGGIO

The analog GOOSE minimum and maximum time are recommended to be the same values, for example, 1000 msec or 2000 msec. In this manner, the analog GOOSE values are sent at cyclic intervals, emulating transducers.

A lower setting minimum time (4 or 10 msec) can overload the network with too many messages (as analog values are sent from feeder IEDs based on deadband violations, thresholds, for example). Besides, the load-shedding application does not need fast changing values.

7.5 Data set element information for MMS communication

Information from the load-shedding application needs to be reported to the COM600 HMI client. Therefore, the automatically created MMS data sets and RCBs from the automatic dataflow function from PCM600 need to be associated with the COM600 HMI Client IED identity.

Table 20: MMS data set elements for PML630

Data set	Data object (Data attributes)	Description
MeasFlt	PS_<1..8>.PSMMXU.AvaPwr.(mag.f/q/t)	Power source <1..8> Available power
	PS_<1..8>.PSMMXU.TotW(mag.f/q/t)	Power source <1..8> Active power
	PS_<1..8>.PSMMXU.AvaPct.(mag.f/q/t)	Power source <1..8> Available power on % of active power
	PS_<1..8>.PSMMXU.DmdPwr(mag.f/q/t)	Power source <1..8> Actual demand
	PS_<1..8>.PSMMXU.MaxDmdLS(mag.f/q/t)	Power source <1..8> Maximum demand value above which demand shed started
	PS_<1..8>.PSMMXU.OvLodPwr(mag.f/q/t)	Power source <1..8> Overload amount
	PS_<1..8>.PSMMXU.SLSMaxPwr(mag.f/q/t)	Power source <1..8> Maximum power with slow load-shedding trigger
	PS_<1..8>.PSPTOC.MaxA(mag.f/q/t)	Power source <1..8> Maximum current of three-phase inputs
	PS_<1..8>.PSPTOC.OvLodTm(mag.f/q/t)	Power source <1..8> Overcurrent-based slow load-shedding elapsed time
	PS_<1..8>.PSPTOC.SetMaxA(mag.f/q/t)	Power source <1..8> *Maximum current* setting for overcurrent-based slow load-shedding
	PS_<1..8>.PSPTOC.TotOvLodTm(mag.f/q/t)	Power source <1..8> Total time after which the current-based slow load-shedding trigger generated
	PS_<1..8>.PSMMTR.WhDmd(mag.f/q/t)	Power source <1..8> Actual calculated demand energy of source
	LD_<1..6>.LDMMXU<1..10>TotW(mag.f/q/t)	Busbar <1..6> Total active power from loads <1..10>
	NCBD_<index>.NCBDMMXU1.TotW.(mag.f/q/t)	Total Active power flow through network circuit breaker <12..16, 23..26, 34..36, 45..46, 56>
	SNW_<1..4>.SNWARCLS1.ALodPrio<1..19>.(mag.f/q/t)	Subnetwork <1..4> Accumulated load against Priority 1..19
	SNW_<1..4>.SNWLRCLS1.NtwAvaPwr(mag.f/q/t)	Subnetwork <1..4> Total available power (Sum of power values from all generators and grid transformers inclusive
	SNW_<1..4>.SNWLRCLS1.NtwTotLoad(mag.f/q/t)	Subnetwork <1..4> Total running load from the power sources
	SNW_<1..4>.SNWLRCLS1.NtwShdLod(mag.f/q/t)	Subnetwork <1..4> Sheddable load (total accumulated value of sheddable loads)
	SNW_<1..4>.SNWLRCLS1.NtwPwrImb(mag.f/q/t)	Subnetwork <1..4> Power balance (spinning reserve value of the subnetwork <1..4>)
	SNW_<1..4>.SNWLRCLS1.EffPwrImb(mag.f/q/t)	Subnetwork <1..4> Effective power difference considering the spiining reserve from adjacent network area (difference of load value between actually shed and must be shed)
	SNW_<1..4>.SNWLRCLS1.NtwMustLs(mag.f/q/t)	Subnetwork <1..4> Must load-shed (Load value that must be shed (at minimum) to establish power balance)
	SNW_<1..4>.SNWLRCLS1.NtwALodShd(mag.f/q/t)	Subnetwork <1..4> Actual load-shed (Load value of the calculated shed priority)
	SNW_<1..4>.SNWLRCLS1.NtwPwrDiff(mag.f/q/t)	Subnetwork <1..4> Power difference (difference of load value between actually shed and must be shed)
	SNW_<1..4>.SNWLRCLS1.ManLsPwr(mag.f/q/t)	Subnetwork <1..4> Manual load to be shed in kW
	SNW_<1..4>.SNWLRCLS1.NtwLodInhM(mag.f/q/t)	Subnetwork <1..4> Load inhibition by Operator (Load value that is inhibited from being shed by the operator)
	SNW_<1..4>.SNWLRCLS1.NtwLodInhS(mag.f/q/t)	Subnetwork <1..4> Load inhibition by the system (Load value that is inhibited from being shed by the system)
	SNW_<1..4>.SNWLRCLS1.NtwLodMm(mag.f/q/t)	Subnetwork <1..4> Load mismatch (Total value of non-sheddable loads)

Table continues on next page

Data set	Data object (Data attributes)	Description
	PPLS_<1..2>PPLSGGIO1.RxLSPwr(mag.f/q/t)	Received extended must be shed load power from the adjacent network area 1 or 2
	PPLS_<1..2>PPLSGGIO1.RxSpRsvPwr(mag.f/q/t)	Received spinning reserve power from the adjacent network area 1 or 2
	LD0.NPMMXU1.AvaPwrSrc1(mag.f/q/t)	Available power of source 1 from the network power source-based on LS configuration mode
	LD0.NPMMXU1.AvaPwrSrc2(mag.f/q/t)	Available power of source 2 from the network power source-based on LS configuration mode
	LD0.NPMMXU1.TotWSrc1(mag.f/q/t)	Active power of source 1 from the network power source-based on LS configuration mode
	LD0.NPMMXU1.TotWSrc2(mag.f/q/t)	Active power of source 2 from network power source-based on LS configuration mode
StarNrml	PS_<1..8>PSPTOC1.Str.(general/q/t)	Power source <1..8> overcurrent-based slow load-shedding start
	PS_<1..8>PSPTOC1.Op.(general/q/t)	Power source <1..8> overcurrent-based slow load-shedding operation
	PS_<1..8>PSACLS1.Str.(general/q/t)	Power source <1..8> Fast load-shedding start
	PS_<1..8>PSACLS1.Op.(general/q/t)	Power source <1..8> Fast load-shedding operation
	LSC_1.LSCGAPC1.Str.(general/q/t)	General load = shed function start (Fast /Slow/Manual/ Extended)
	LSC_1.LSCGAPC1.Op.(general/q/t)	General load-shedding function operation (Fast /Slow/ Manual/Extended)
	LSC_1.LSCGAPC2.Str.(general/q/t)	General slow load-shedding start
	LSC_1.LSCGAPC2.Op.(general/q/t)	General slow load-shedding operation
	LSC_1.LSCACLS1.Str.(general/q/t)	Fast load-shedding start
	LSC_1.LSCACLS1.Op.(general/q/t)	Fast load-shedding operation
	LS_<1..6>LSPTRC<1..10>.Tr.(general/q/t)	Load-shedding trip command for busbar <1..6> for sheddable loads <1..10>
	LD0_RDRE1.MemUsedAlm.(stVal/q/t)	Disturbance Recorder memory-used alarm
	LD0_RDRE1.RcdClr.(stVal/q/t)	Disturbance Recorder record clear status
	LD0_RDRE1.RcdMade.(stVal/q/t)	Disturbance Recorder files made status
	LD0_RDRE1.RcdStr.(stVal/q/t)	Disturbance Recorder process start status
	LD0.SPGGIO<Instance>.Ind.(stVal/q/t)	PML630 Test mode status, template import generates Instance 5
StatUrg	PS_<1..8>.PSCSWI1.Pos.(stVal/q/t)	Power source <1..8> circuit breaker position (Open/Close)
	PS_<1..8>.PSACLS1.BlkOvSt.(stVal/q/t)	Load-shed blocking is bypassed for the power sources <1..8>
	PS_<1..8>.PSACLS1.LSTrgInh.(stVal/q/t)	Load-shedding trigger inhibited/disabled power sources <1..8>
	PS_<1..8>.PSACLS1.SetChg.(stVal/q/t)	Power source <1..8> function one or many basic setting change
	PS_<1..8>.PSACLS1.SLSModSt.(stVal/q/t)	Power source <1..8> slow load-shedding mode information (Overcurrent/Maximum demand/Overcurrent & Maximum demand/Disabled)
	PS_<1..8>.PSACLS1.SLSTrgInh.(stVal/q/t)	Slow load-shedding trigger inhibited/disabled for power source <1..8>
	PS_<1..8>.PSMMXU1.BlkLS.(stVal/q/t)	Load-shedding blocked due to Power source <1..8>

Table continues on next page

Data set	Data object (Data attributes)	Description
	PS_<1..8>.PSMMXU1.EnaFactSL.(stVal/q/t)	
	PS_<1..8>.PSMMXU1.GovModVal.(stVal/q/t)	Power source <3..8> Generator governor mode information
	PS_<1..8>.PSMMXU1.LSTrg.(stVal/q/t)	Load-shedding triggered from the power source <1..8>
	PS_<1..8>.PSPTOC1.Rs.(stVal/q/t)	Power source <1..8> Overcurrent-based slow load-shedding reset
	PS_<1..8>.PSMMTR1.Alm.(stVal/q/t)	Power source <1..8> Maximum demand operation alarm
	PS_<1..8>.PSMMTR1.TmmDmdPer.(stVal/q/t)	
	PS_<1..8>.PSMMTR1.Rs.(stVal/q/t)	Power source <1..8> Maximum demand reset
	LD_<1..6>.LDCSWI<1..10>.Pos.(stVal/q/t)	Busbar <1..6> Load circuit breaker position (Open/Close)
	LD_<1..6>.LDMMXU<1..10>.InhLSSt.(stVal/q/t)	Busbar <1..6> Load-shedding inhibition status for load <1..10>
	LD_<1..6>.LDMMXU<1..10>.LodPrioSt.(stVal/q/t)	Busbar <1..6> Load feeder priority <1..10>
	LD_<1..6>.LDGGIO1.SetChg.(stVal/q/t)	Busbar <1..6> Load busbar function one or many basic setting change
	NCBD_<index>.NCBDCSWI1.Pos.(stVal/q/t)	Network circuit breaker <12..16, 23..26, 34..36, 45..46, 56> position (Open/Close)
	NCBD_<index>.NCBDCSWI1.BlkLS.(stVal/q/t)	Load-shedding blocked due to network circuit breaker <12..16, 23..26, 34..36, 45..46, 56>
	NCBD_<index>.NCBDCSWI1.BlkOvSt.(stVal/q/t)	Load-shed blocking is bypassed for the network circuit breaker <12..16, 23..26, 34..36, 45..46, 56>
	NCBD_<index>.NCBDCSWI1.LSTrg.(stVal/q/t)	Load-shedding triggered from the network circuit breaker <12..16, 23..26, 34..36, 45..46, 56>
	NCBD_<index>.NCBDCSWI1.SetChg.(stVal/q/t)	Network circuit breaker <12..16, 23..26, 34..36, 45..46, 56> function one or many basic setting change
	NCBD_<index>.NCBDCSWI1.VirCBEna.(stVal/q/t)	*Virtual circuit breaker* setting enabled for network circuit breaker <12..16, 23..26, 34..36, 45..46, 56>
	SNW_<1..4>.SNWLRCLS1.LSBlkSt.(stVal/q/t)	Subnetwork <1..4> Load-shedding block status
	SNW_<1..4>.SNWLRCLS1.LsOp.(stVal/q/t)	Subnetwork <1..4> Load-shedding operation
	SNW_<1..4>.SNWLRCLS1.LsOpSt.(stVal/q/t)	Subnetwork <1..4> Fast/Slow/Manual/Extended load-shedding operation
	SNW_<1..4>.SNWLRCLS1.LSPrioRcd1.(stVal/q/t)	Subnetwork <1..4> Calculated shed priority record 1
	SNW_<1..4>.SNWLRCLS1.LSPrioRcd2.(stVal/q/t)	Subnetwork <1..4> Calculated shed priority record 2
	SNW_<1..4>.SNWLRCLS1.LSPrioRcd3.(stVal/q/t)	Subnetwork <1..4> Calculated shed priority record 3
	SNW_<1..4>.SNWLRCLS1.ManPrioSet.(stVal/q/t)	Subnetwork <1..4> Manual load-shedding priority status
	SNW_<1..4>.SNWLRCLS1.NgPwrBalSt.(stVal/q/t)	Subnetwork <1..4> Negative power balance status
	SNW_<1..4>.SNWLRCLS1.NtwActSt.(stVal/q/t)	Subnetwork <1..4> Status (Active/Inactive)
	SNW_<1..4>.SNWLRCLS1.NtwEnaSt.(stVal/q/t)	Subnetwork <1..4> Status (Enable/Disable)
	SNW_<1..4>.SNWLRCLS1.SlwLSBlkSt.(stVal/q/t)	Subnetwork <1..4> Slow load-shed block status
	LSC_1.LSCACLS1.Ntw<1..4>Rs.(stVal/q/t)	Subnetwork <1..4> Load-shedding reset command status
	LSC_1.LSCACLS1.StrCntRs.(stVal/q/t)	Subnetwork <1..4> Load-shedding counter reset command status
	LSC_1.LSCRCLS1.FLSCnt.(stVal/q/t)	Fast load-shedding counter value

Table continues on next page

Data set	Data object (Data attributes)	Description
	LSC_1.LSCRCLS1.ManLSBeh.(stVal/q/t)	Manual load-shedding behaviour (*Priority* setting/*kw* setting/ Priority input/kW input/*Priority* setting active due to bad quality of input/*kW* setting active due to bad quality of input/ manual load-shedding disabled)
	LSC_1.LSCRCLS1.NtwNumBB<1..6>.(stVal/q/t)	Busbar <1..6> Subnetwork number
	LSC_1.LSCRCLS1.NtwNumCB<1..15>.(stVal/q/t)	Network circuit breaker <12..16, 23..26, 34..36, 45..46, 56> subnetwork number
	LSC_1.LSCRCLS1.NtwNumSrc<1..8>.(stVal/q/t)	Power source <1..8> subnetwork number
	LSC_1.LSCRCLS1.SetChg.(stVal/q/t)	Load-shedding core function one or more basic setting change
	LSC_1.LSCCCLS<1..4>.ManLSCmd.(stVal/q/t)	Manual load-shedding command status for subnetwork <1..4>
	PPLS_1.PPLSGGIO<1..2>.NtwLSGrInt.(stVal/q/t)	Load-shedding data (coded) for the adjacent network area IED
	PPLS_1.PPLSGGIO<1..2>.RxCBBlk.(stVal/q/t)	Subnetwork load-shedding blocked due to the inter-connected circuit breaker in the adjacent network area
	PPLS_1.PPLSGGIO<1..2>.RxCBSt.(stVal/q/t)	Adjacent network area inter-connected tie circuit breaker status
	PPLS_1.PPLSGGIO<1..2>.RxNtwBlk.(stVal/q/t)	Subnetwork load-shedding blocked in the adjacent network area
	PPLS_1.PPLSGGIO<1..2>.RxSigErr.(stVal/q/t)	Error in the received load-shedding data from adjacent network area IED
	PPLS_1.PPLSGGIO<1..2>.SigErr.(stVal/q/t)	Error in the sending load-shedding data to adjacent network area IED
	LD0.SPGGIO5.(stVal/q/t)	IED in test mode information

- All power values (magnitudes, float) are in kW.
- Once a data set contains roughly 100 Data Objects, a new MeasFlt data set instance (MeasFlt_A, MeasFlt_B and so on) is created automatically by PCM600.
- Network circuit breaker index: If equivalent circuit breaker is between busbars 4 and 6 (tie feeder), index is 46; in case of bus coupler between busbars 5 and 6, index is 56.
- Equivalent circuit breaker is the representation of 2 circuit breakers at either end of the tie feeder; see the IED technical manual.

7.5.1 Engineering MMS communication in IET600

1. Check the default data sets created using the automatic data flow feature in PCM600.

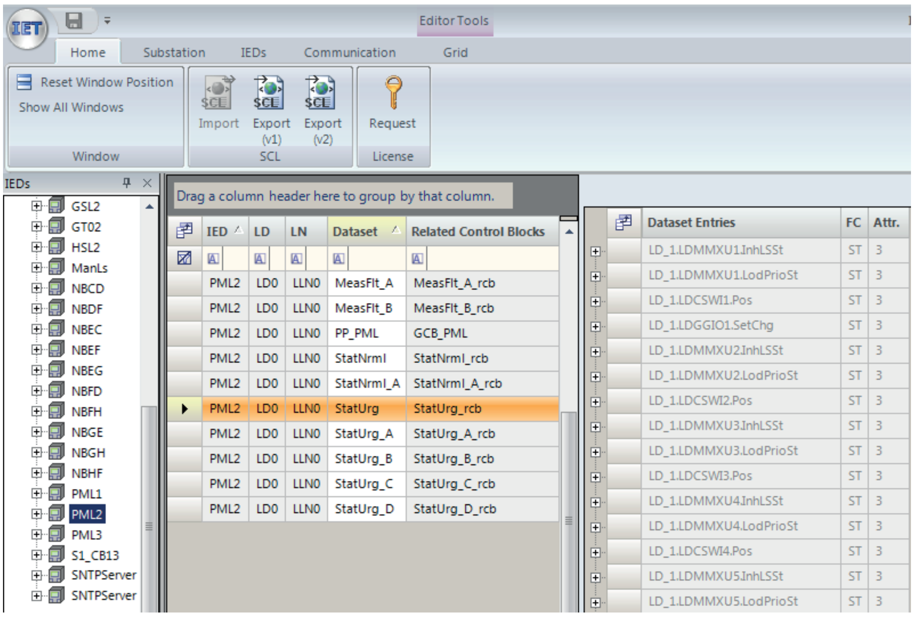


Figure 236: IED Data sets default contents in IET600

2. Include more information from the IED IEC 61850 structure in the existing data sets. Alternatively, new data sets can also be configured.

   The reporting data sets must contain only client-specific data, for example, event handling or measurement or alarm data.

3. Configure additional report control blocks, when needed, for each newly created data set.

   Maximum of five report clients can be configured for all IEDs.

4. Define the COM600 HMI client identity and link the client name to the report control blocks of the IED.

7.6 Report control engineering using IET600

1. Select the PML630 IED in the IED section of the IET600.
2. Select the **RCB Data** tab of the PML630 IED.
3. Check the existing MMS data sets and RCBs.

Drag a column header here to group by that column.

IED	LD	LN	RCB	Identifier (rptID)	Attached Dataset	Conf.Rev.	Buffered	Buffer T	Enable	DChg	QChg
PML2	LD0	LLN0	MeasFlt_rcb	PML2LD0/LLN0.MeasFlt_rcb	MeasFlt	1	☑	100	5	☑	☑
PML2	LD0	LLN0	MeasFlt_A_rcb	PML2LD0/LLN0.MeasFlt_A_rcb	MeasFlt_A	1	☑	100	5	☑	☑
PML2	LD0	LLN0	MeasFlt_B_rcb	PML2LD0/LLN0.MeasFlt_B_rcb	MeasFlt_B	1	☑	100	5	☑	☑
PML2	LD0	LLN0	StatNrml_rcb	PML2LD0/LLN0.StatNrml_rcb	StatNrml	1	☑	100	5	☑	☑
PML2	LD0	LLN0	StatNrml_A_rcb	PML2LD0/LLN0.StatNrml_A_rcb	StatNrml_A	1	☑	100	5	☑	☑
PML2	LD0	LLN0	StatUrg_rcb	PML2LD0/LLN0.StatUrg_rcb	StatUrg	1	☑	100	5	☑	☑
PML2	LD0	LLN0	StatUrg_A_rcb	PML2LD0/LLN0.StatUrg_A_rcb	StatUrg_A	1	☑	100	5	☑	☑
PML2	LD0	LLN0	StatUrg_B_rcb	PML2LD0/LLN0.StatUrg_B_rcb	StatUrg_B	1	☑	100	5	☑	☑
PML2	LD0	LLN0	StatUrg_C_rcb	PML2LD0/LLN0.StatUrg_C_rcb	StatUrg_C	1	☑	100	5	☑	☑
PML2	LD0	LLN0	StatUrg_D_rcb	PML2LD0/LLN0.StatUrg_D_rcb	StatUrg_D	1	☑	100	5	☑	☑

Figure 237: MMS data sets and RCB in IET600

4. Select the **RCB Clients** tab of the PML630 IED.
5. Subscribe the **HSI** client for existing RCBs.

Drag a column header here to group by that column.

IED Name	LD	LN	RCB	Attached Dataset	Client1 (LD0)	Client2 (LD0)	Client3 (LD0)	Client4 (LD0)	Client5 (LD0)
PML2									
PML2	LD0	LLN0	MeasFlt_rcb	MeasFlt	1	2	3	4	5
PML2	LD0	LLN0	MeasFlt_A_rcb	MeasFlt_A	1	2	3	4	5
PML2	LD0	LLN0	MeasFlt_B_rcb	MeasFlt_B	1	2	3	4	5
PML2	LD0	LLN0	StatNrml_rcb	StatNrml	1	2	3	4	5
PML2	LD0	LLN0	StatNrml_A_rcb	StatNrml_A	1	2	3	4	5
PML2	LD0	LLN0	StatUrg_rcb	StatUrg	1	2	3	4	5
PML2	LD0	LLN0	StatUrg_A_rcb	StatUrg_A	1	2	3	4	5
PML2	LD0	LLN0	StatUrg_B_rcb	StatUrg_B	1	2	3	4	5
PML2	LD0	LLN0	StatUrg_C_rcb	StatUrg_C	1	2	3	4	5
PML2	LD0	LLN0	StatUrg_D_rcb	StatUrg_D	1	2	3	4	5

Figure 238: RCB client subscription in IET600

All IED data sets, report control blocks and GOOSE control blocks should exist under LLN0.

A GOOSE data set should include unique data.

7.7 Importing SCD file into PCM600

The SCD file created from IET600 is imported into PCM600, for the final set of engineering to be done before downloading it into the IED and feeder IEDs.

1. Select the station in the **Plant Structure**.
2. Right-click the substation and select **Import**.

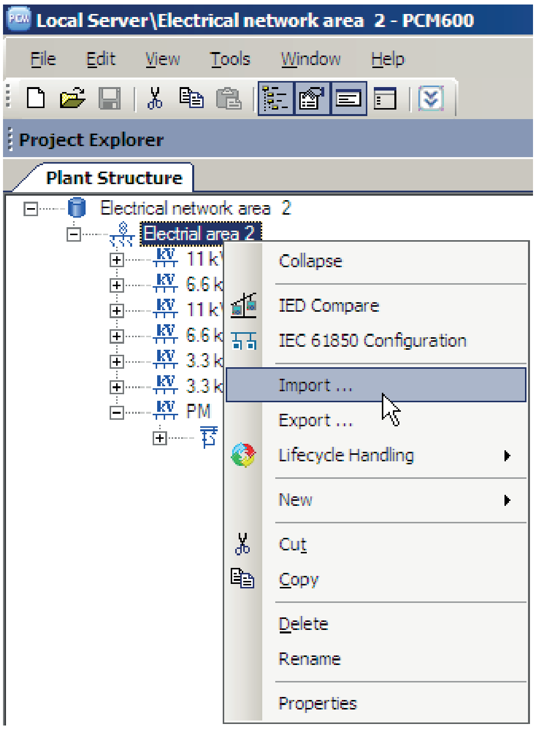


Figure 239: IEC 61850: Import SCD file

3. Select the file from the open standard window menu and select the options in **SCL Import Options**.

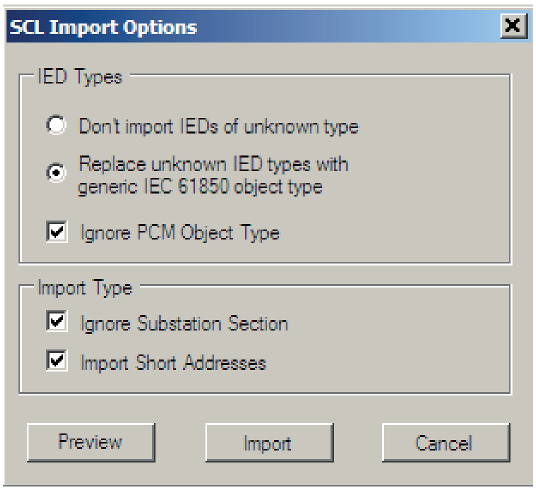


Figure 240: IEC 61850: Import SCD file

SCL data server error occurs in PCM600 project if the selections mentioned earlier are not done when importing the SCL file.

SCD file includes the .cid/.icd of external IED/system and COM600 IEC 61850 proxy server. These IEDs are unknown IED types which do not match with the PCM600 object type, and must be replaced with generic IEC 61850 object type.

While importing the SCD file into the PCM600 project, the IED Group is created automatically. This IED Group contains the external system/IED and IEC 61850 proxy server IED if the SCD file is exported from IET600.

The above selection is also valid when the external IED/system and/or COM600 IEC 61850 proxy server are created manually under the IED Group in PCM600.

7.8 Engineering the data flow using IEC 61850 Configuration in PCM600; alternative to IET600

PCM600's IEC 61850 Configuration tool component can also be used for GOOSE and client-server data flow engineering (MMS) IEDs in a substation.

1. On the **PCM600** menu bar, point to **Tools** and select **IEC 61850 Configuration**.

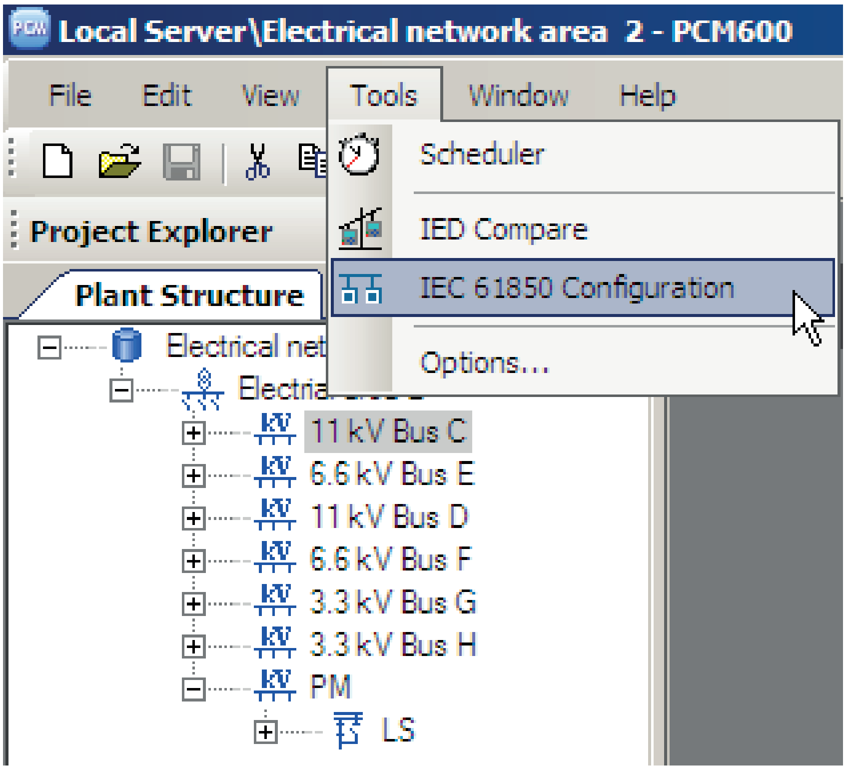


Figure 241: Open IEC 61850 Configuration from Tools menu

2. Changing the configuration mode
   Different parts of IEC 61850 configuration can be edited by selecting the configuration mode from the drop-down list on the **PCM600** tool bar.
   - Select **GOOSE Communication** from the drop-down list to edit the GOOSE configuration.
   - Select **Client-Server Communication** from the drop-down list to edit the client-server configuration.

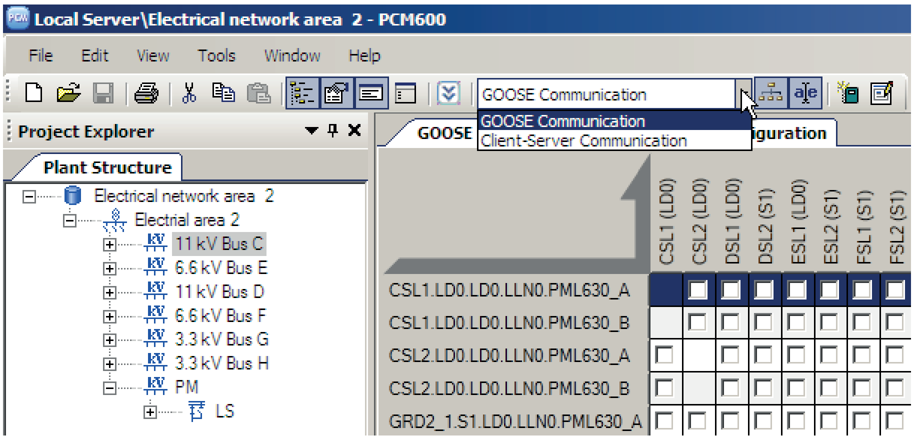


Figure 242: Select GOOSE Communication or Client-Server Communication

7.8.1 Engineering GOOSE communication using PCM600

An example of a GTG1 IED (REF630) generator 1 sending data to the load-shedding IED is described.

1. Select the GTG1IED to initiate the **GOOSE Communication - IEC61850 Configuration** window.
   GOOSE Communication - IEC61850 Configuration window has three tabs.
   - Select the **Data Sets** tab to edit the data sets.
   - Select the **GOOSE Controls** tab to edit the GOOSE control blocks.
   - Select the **Inputs** tab page to edit the GOOSE inputs.

   New objects can be created in the **Data Sets**, **GOOSE Controls** and **Report Controls** tabs.

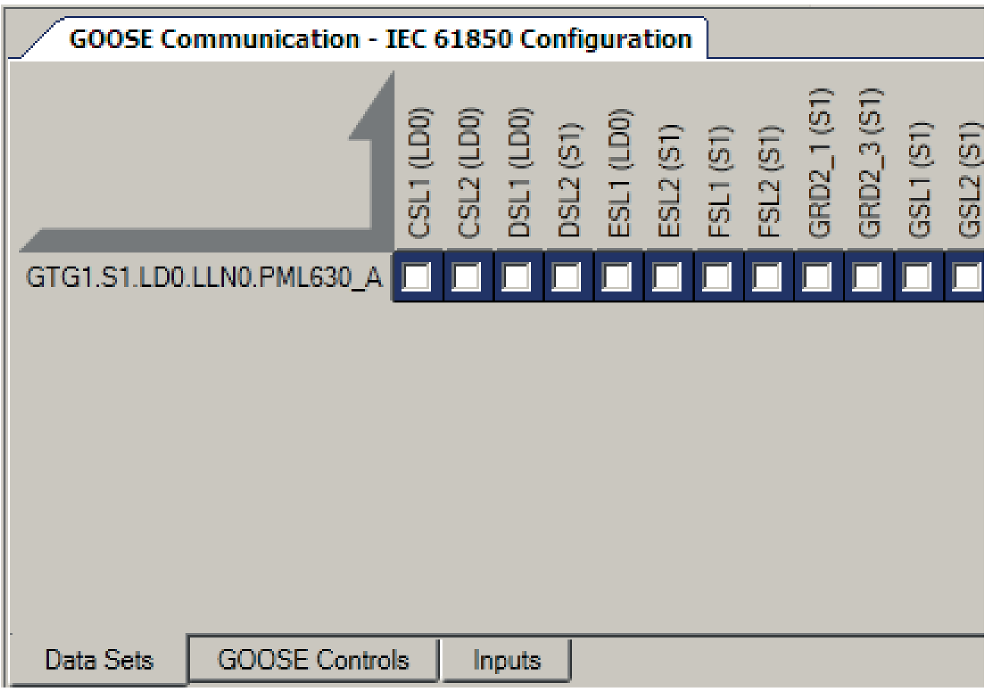


Figure 243: Three tabs in GOOSE Communication – IEC 61850 Configuration window

2. On the GTG1 Edit menu, click **New** to create data set. Enter the **Name** of the data set and click **OK**.

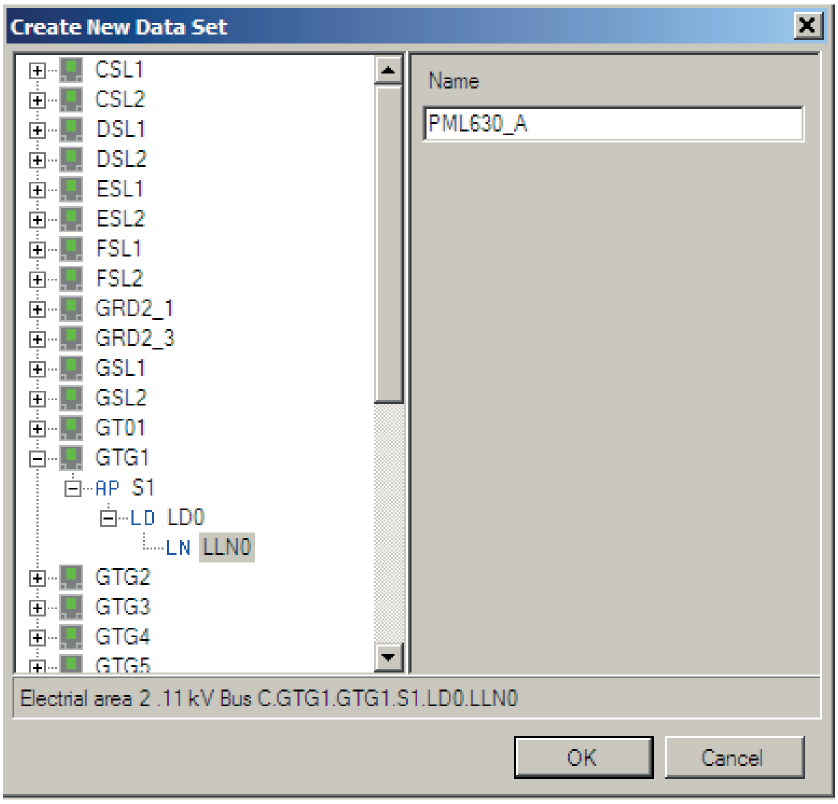


Figure 244: Create new data set

3. Right-click the data set created and select **Details** to edit or view the objects configured in the data set.
   - Select a logical device in the **LD** list.
   - Select a logical node in the **LN** list.
   - Select a data object in the **DO** list.
   - Click **OK** or press **ENTER** to apply the changes.

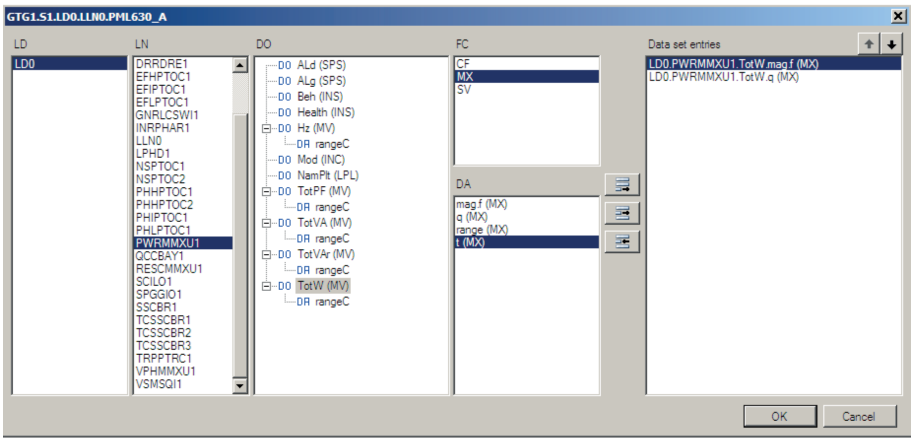


Figure 245: Data set details to edit the data objects

4. **Create New GOOSE Control** block in **GOOSE Control** tab, enter the **Name** of the GCB and associate with the data set. Click **OK**.

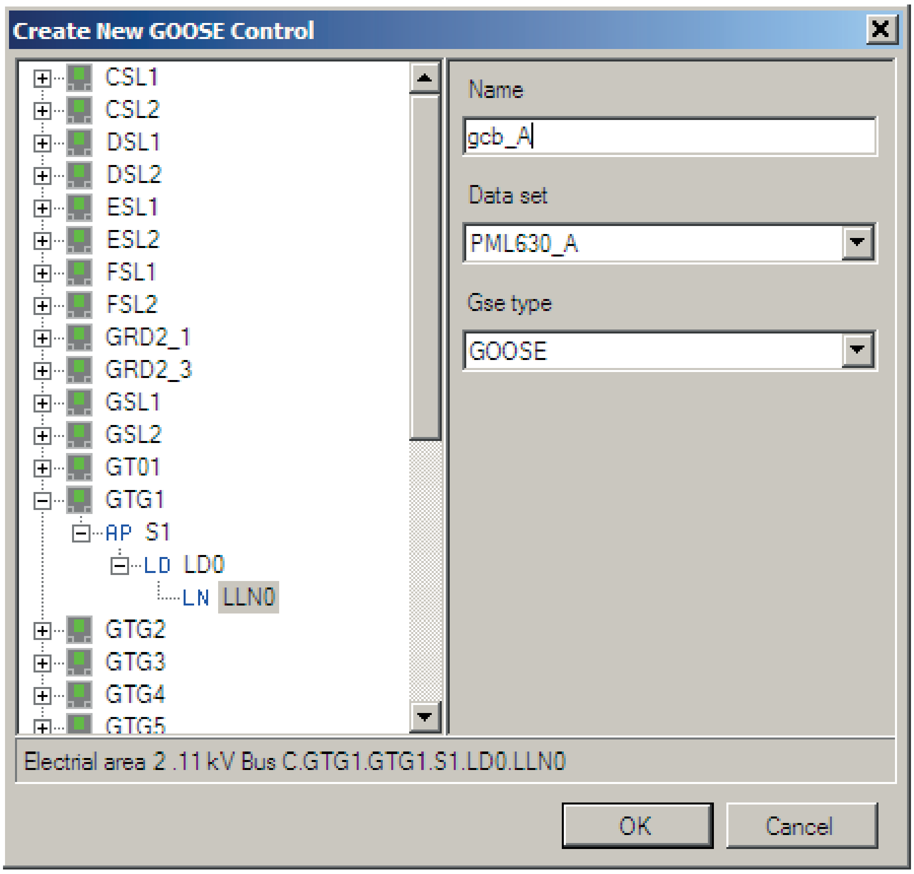


Figure 246: Create New GOOSE Control window

5. In the **Object Properties** window of selected GOOSE control block, define the *APPID*/*MAC Address*/*Max Time*/*Min Time* parameters as per the project configuration.

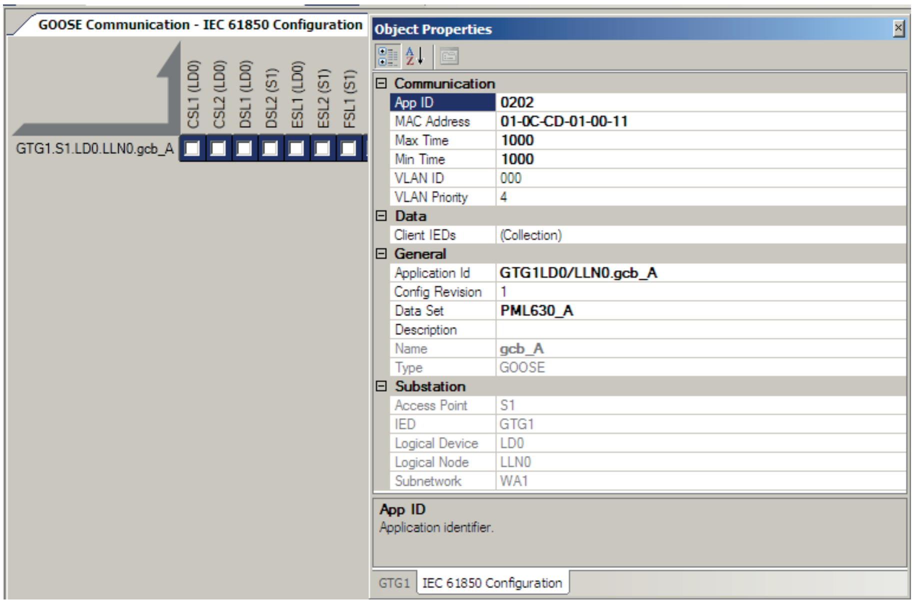


Figure 247: Object Properties window of selected GCB

For more information, see Table 15 and Table 16 for the multicast MAC address arrangement for cPMS - LS configuration A and B.

6. Subscribe the GOOSE control block of GTG1 IED to the load-shedding IED.

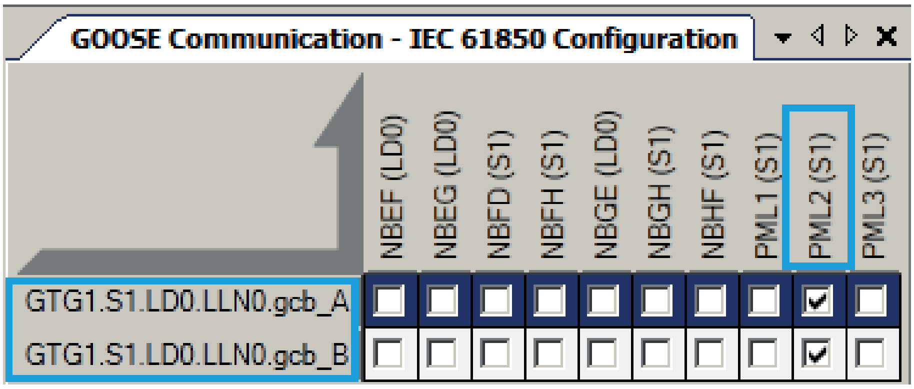


Figure 248: Select PML630 IED as subscriber for GCBs from feeder IEDs

7. Select the subscriber IED and check the **Inputs** tab in **GOOSE Communication - IEC 61850 Configuration** window

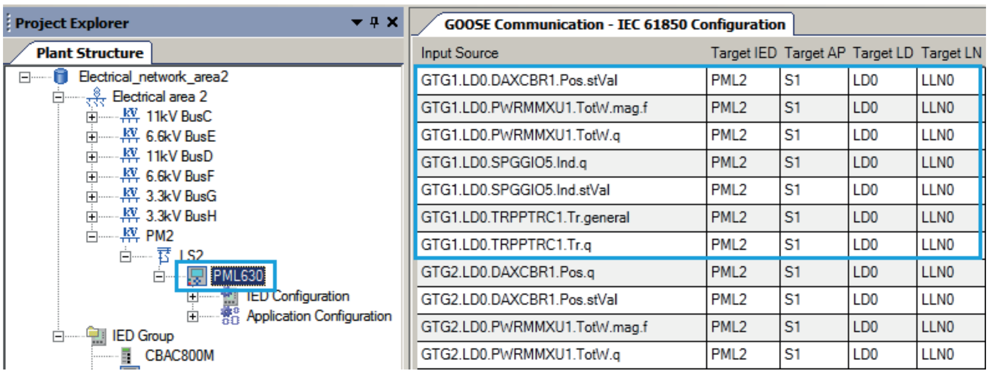


Figure 249: Inputs section in the subscriber IED

8. Repeat the procedure to create the data set and GOOSE control blocks for the data from other IEDs in the network to the IED.

Similar procedure should be followed for the GOOSE communication engineering between power sources, network circuit breaker, load feeder IEDs and the IED.

7.8.2 Engineering MMS communication using PCM600

An example of a bus coupler IED NBCD (REF630) sending data to the IED is described.

Client-Server Communication - IEC 61850 Configuration window has two tabs.

- Select the **Data Sets** tab to edit the data sets.
- Select the **Report Controls** tab to edit the report control blocks.

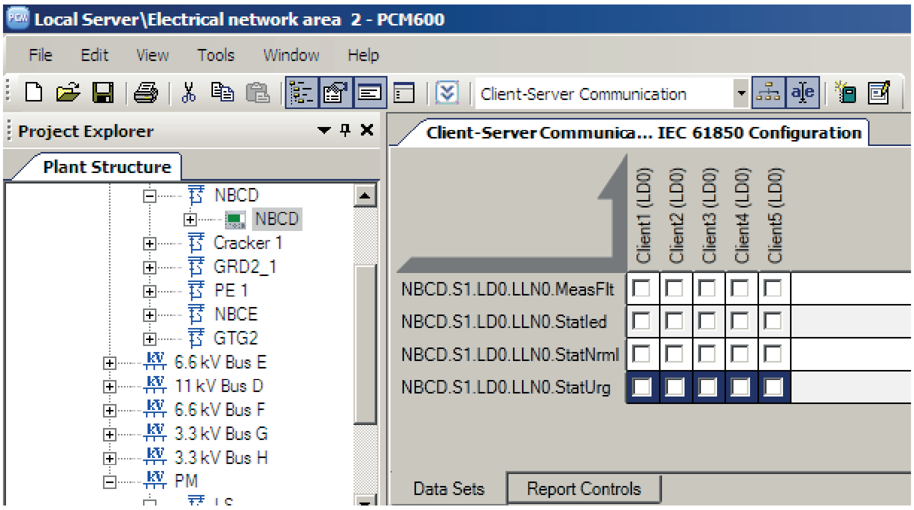


Figure 250: Two tabs in Client-Server Communication – IEC 61850 Configuration window

1. Create MMS data sets and **Create New Report Control** block in **Report Controls** tab, enter the **Name** of the RCB and associate with the data set. Click **OK**.

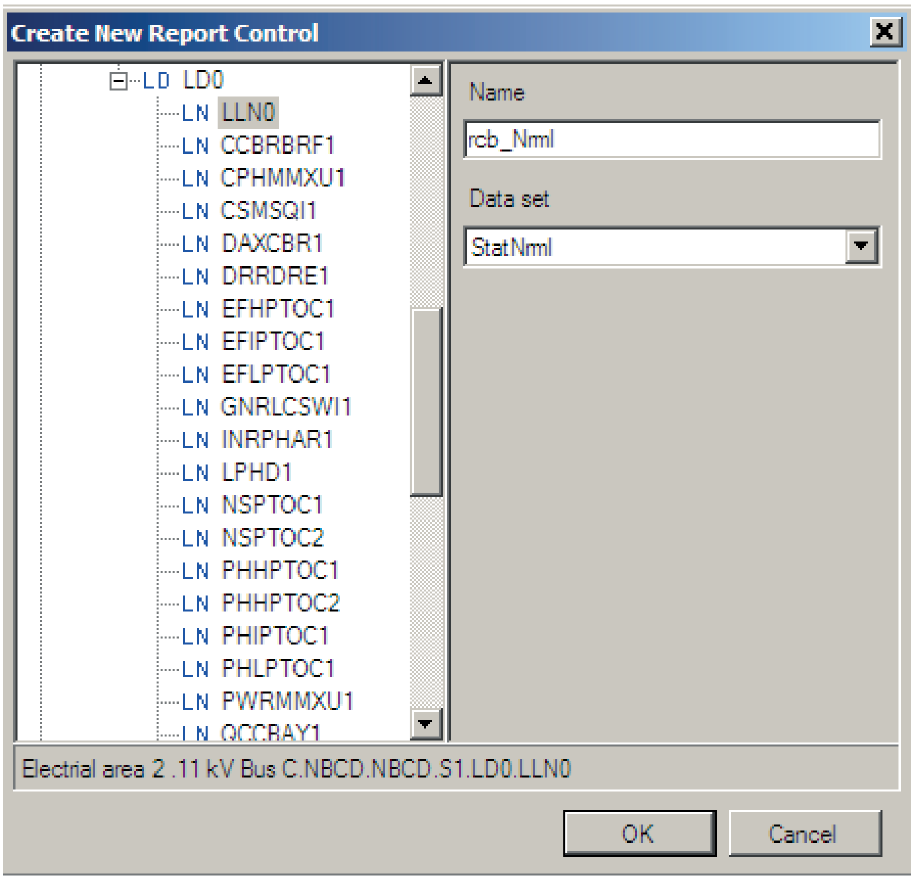


Figure 251: Create New Report Control window

2. In the **Object Properties** window of selected report control block, various report-related parameters can be set.

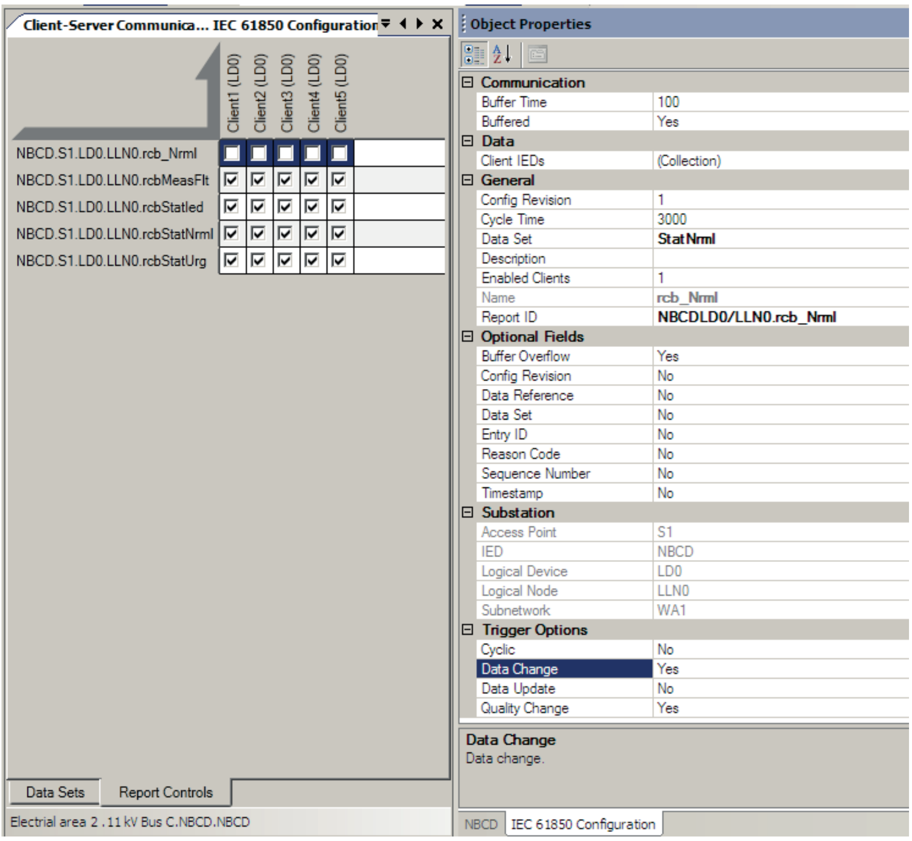


Figure 252: Object Properties window of selected RCB

3. Select HMI clients for the Report Control Block.

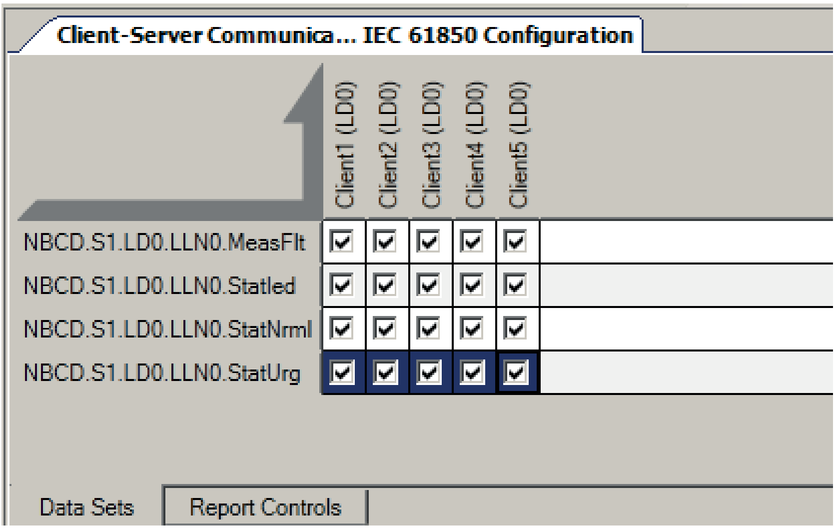


Figure 253: Select HMI clients

Similar procedure should be followed for the (MMS) communication engineering between power sources, network circuit breaker, load feeder IEDs, load-shedding IED and Client (HMI).

7.9 Writing communication configuration to IED and feeder IEDs

IEC 61850 communication depends on proper communication configuration in all IEDs that communicate via IEC 61850. It is not possible to read the communication configuration from the IED to PCM600.

However it is possible to make a configuration change in one IED, without affecting the communication engineering. For example, when the Application Configuration tool configuration is changed, but no changes are done for the instantiation or deletion of functions that represent a logical node.

When a changed configuration is written to the IED, the user is asked to update the communication configuration.

1. Select **Yes** in the **Update Communication** window to update the communication configuration part in the IED.
2. Click **No** in the **Update Communication** window to keep the communication configuration part in the IED. Other parts of the configuration will be updated.

If no changes have been done in the communication configuration part, click **No** in the **Update Communication** window.

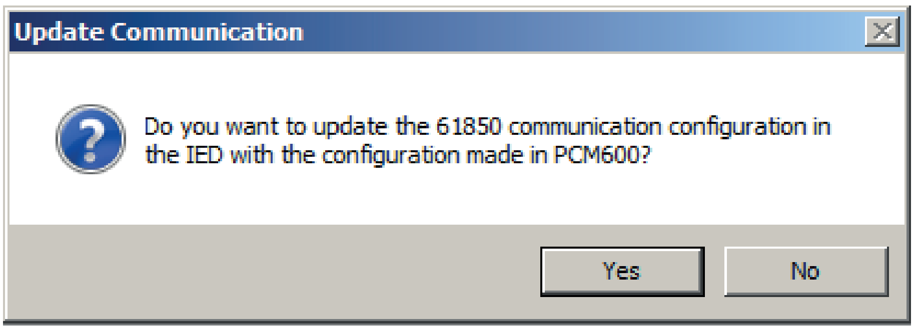


Figure 254: Update the communication configuration in the IED with the configuration made in PCM600

7.10 SAB600 engineering

Configuring the substation in a COM600 project is an important step for configuring the HMI functionality. After the SCL import, the substation structure is built automatically.

It is recommended to first create the IEC61850 proxy server OPC client IED for the manual load-shedding functionality in the SAB600 project. Export the .cid file of the configured proxy IED. Subscribe the manual load-shed data to PML630 IED using the IET600 tool or using the PCM600.

7.10.1 Configuring IEC61850 proxy server OPC client for manual load-shedding

1. Select the project name to add a gateway object in the **Communication** structure. Right-click the project name and then select **New/Communication/ Gateway**.

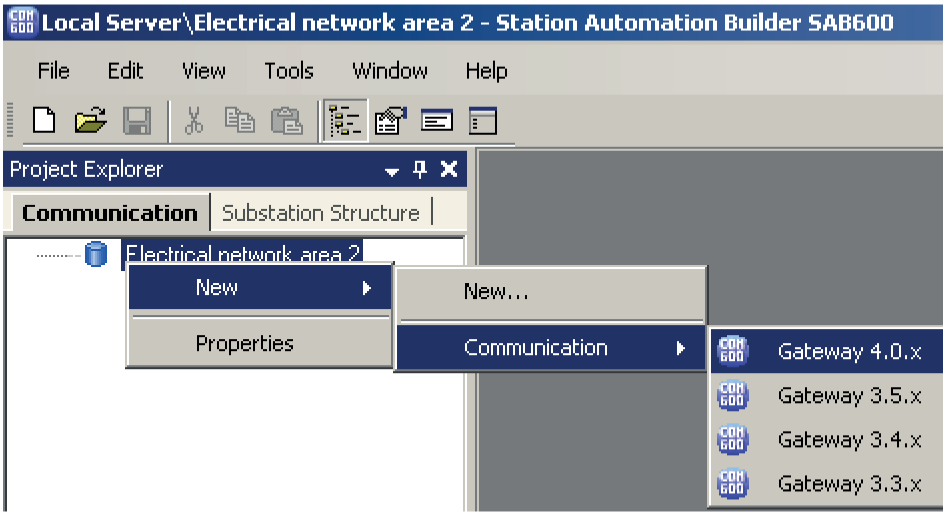


Figure 255: Adding a Gateway 4.0.x

2. Add an External OPC Server object.
   - Select the **Gateway** object in the **Communication** structure and right-click it.
   - Select **New/OPC/External OPC Server**. Rename the **External OPC Server** as **ManLsOPC**.

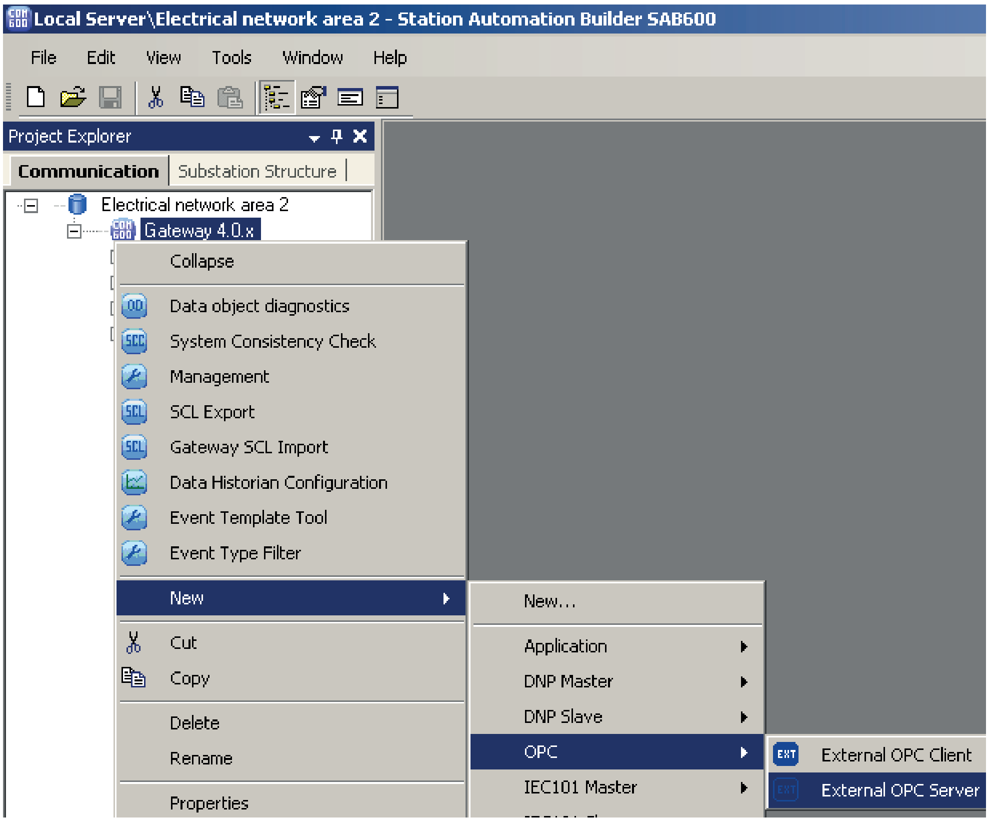


Figure 256: Add External OPC Server

3. Add an External OPC Subnetwork object
   - Select **External OPC Server** object. Right-click the **External OPC Server** object.
   - Select **New/New/OPC/External OPC Subnetwork**. Rename the **External OPC Subnetwork** as **Sn**.

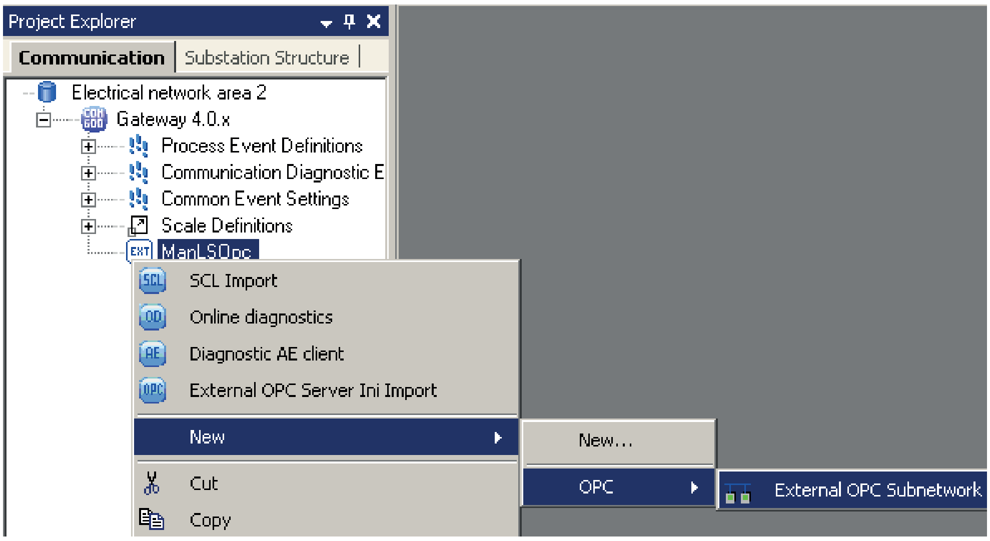


Figure 257: Add External OPC Subnetwork

4. Add an External OPC IED object.
   - Select a **Subnetwork** object. Right-click the **Subnetwork** object.
   - Select **New/OPC/External OPC IED**. Rename **External OPC IED** as **IED**.

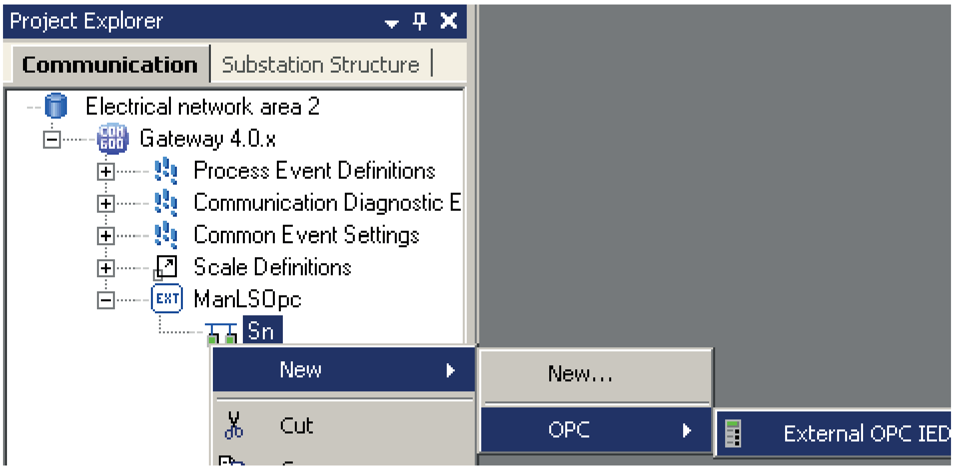


Figure 258: Add External OPC IED

5. Add Logical Device objects.
   - Select an **External OPC IED** object and right-click it.
   - Select **New/New/Communication/Logical Device**. Rename **Logical Device** as **LD**.

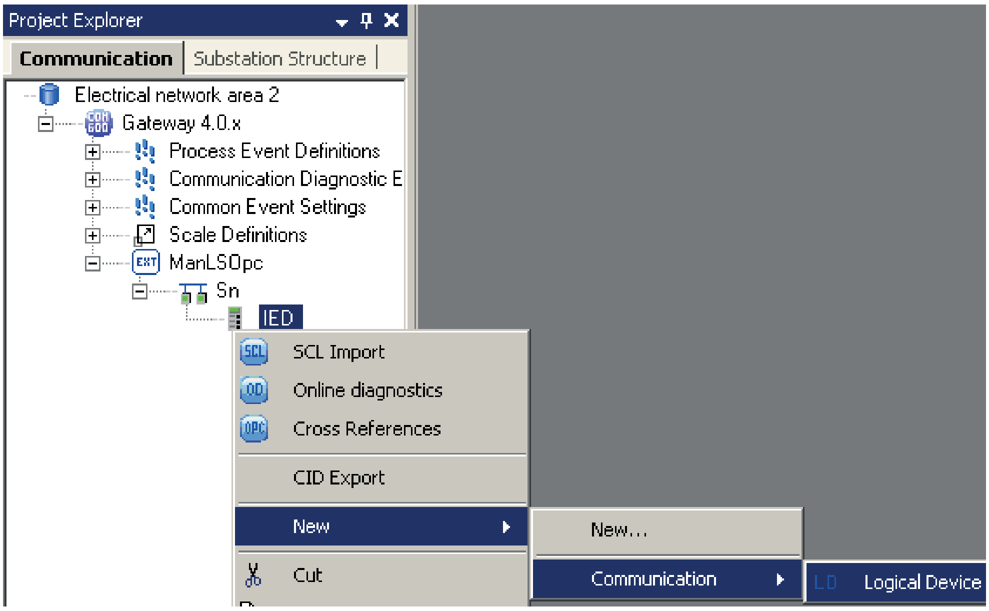


Figure 259: Add Logical Device

6. Add a Logical Node LLN0.
    - Select a **Logical Device** object and right-click it.
    - Add a **Logical Node** object. Select **New/Communication/LLN0**.
    - Rename the new object. The names of the **Logical Node** objects have to be unique.

There must be only one Logical Node 0 (LLN0) as a child object to a Logical Device object.

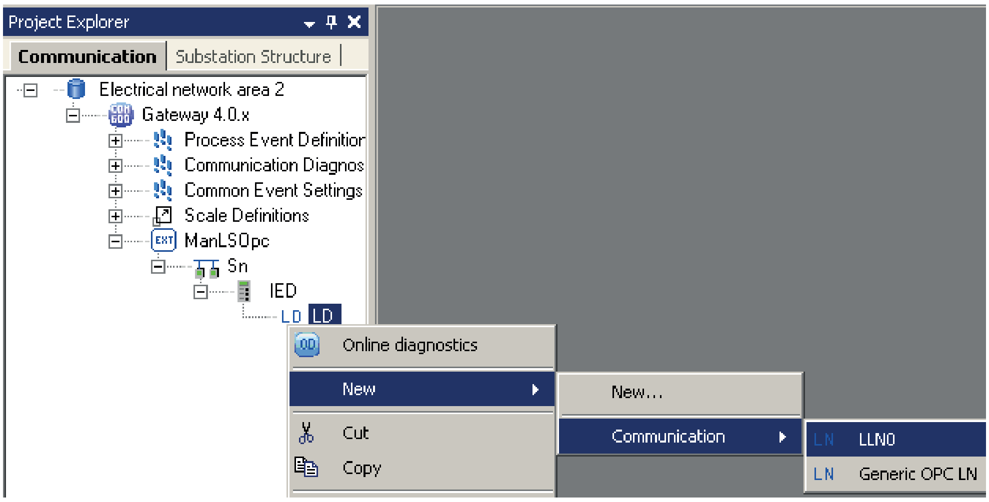


Figure 260: Add LLN0

7. Add the Integer controllable (INC) data points as child objects to LLN0. Select **New/Data objects/INC**. Rename each object as unique from INC1...INC8.

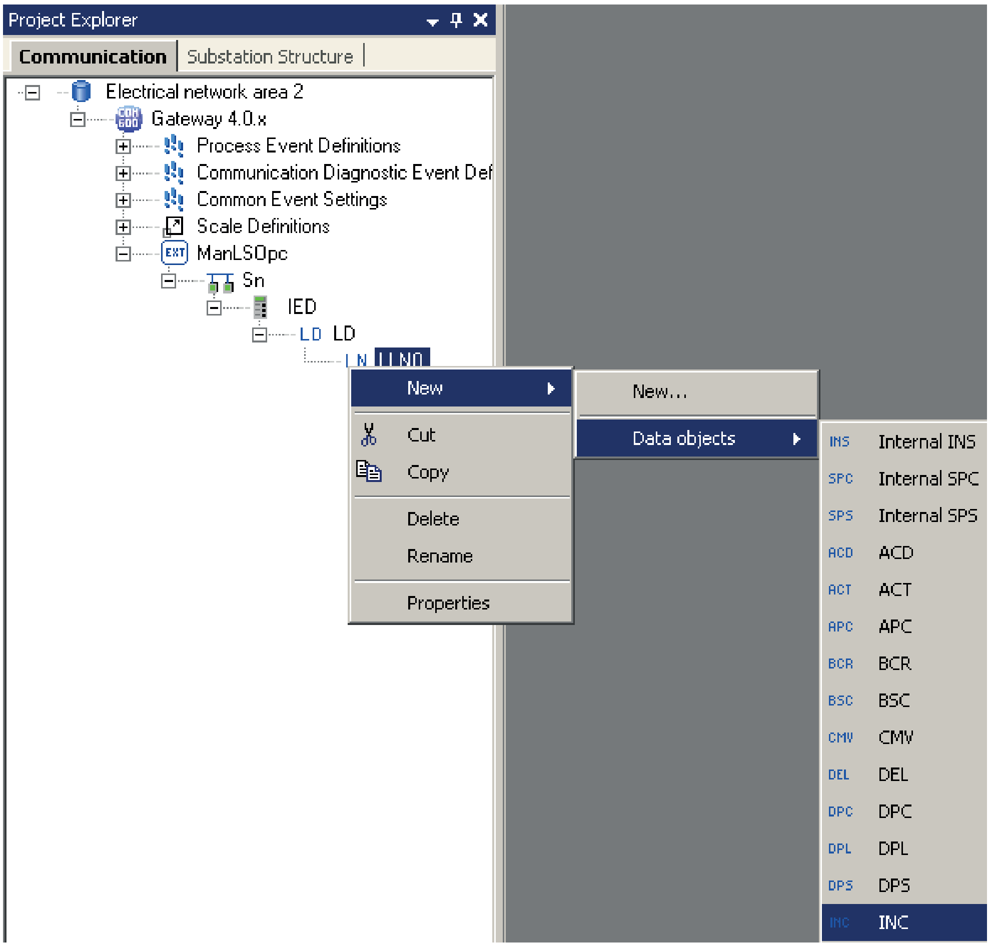


Figure 261: Add INC objects INC1..INC8

INC1..INC4 objects are configured for manual load-shedding. Load to be shed in kW for the subnetworks 1 .. 4 respectively. INC5..INC8 objects are configured for manual load-shedding priority for the subnetworks 1..4 respectively.

8. For each INC data object, select the **Control OPC Item Path** and **State OPC Item Path** in **Object properties** window as **Default** and click **OK**.

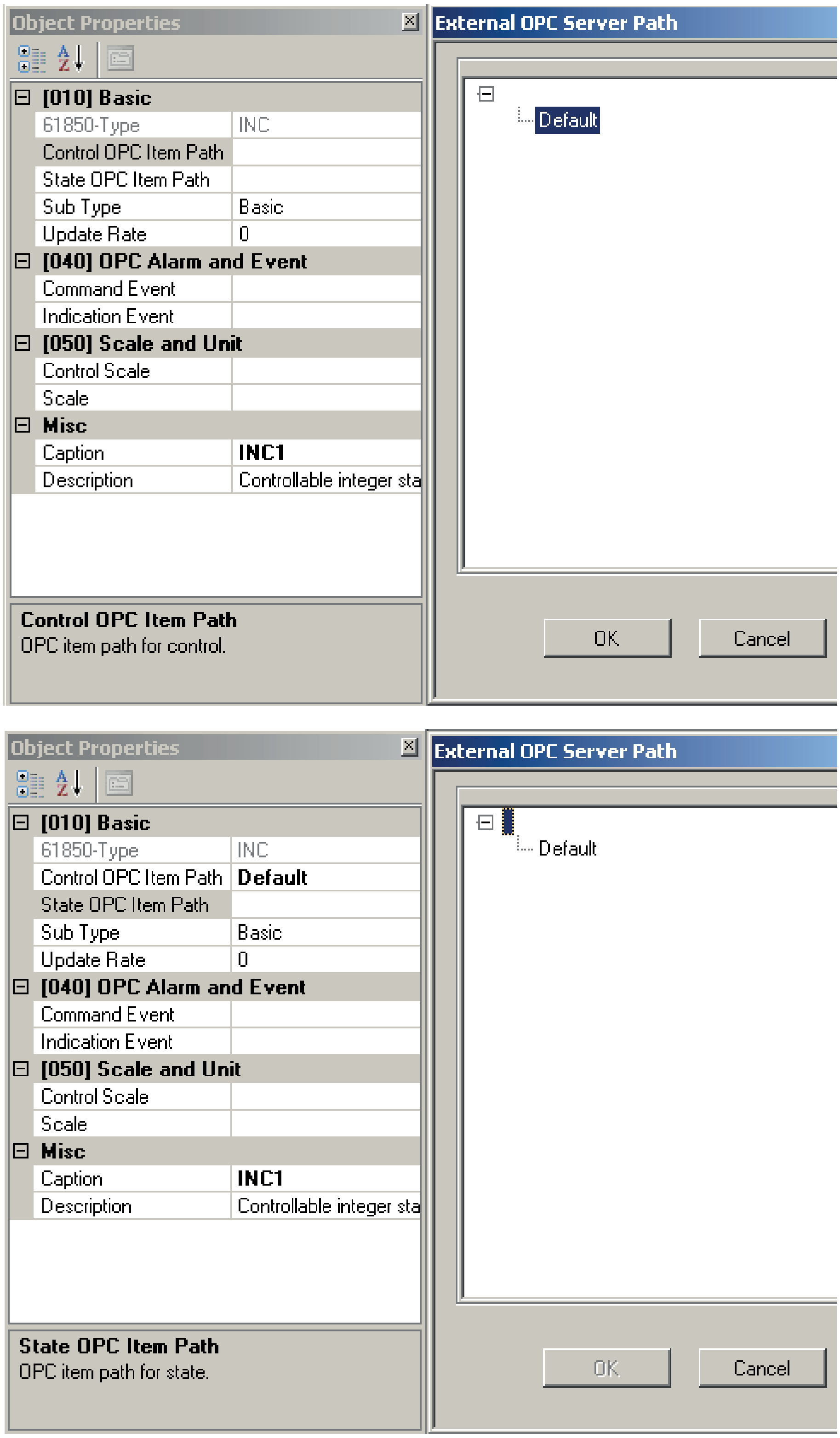


Figure 262: Assign OPC path for the INC data objects

9. Define **Command Event** and **Indication Event** property for each INC object.

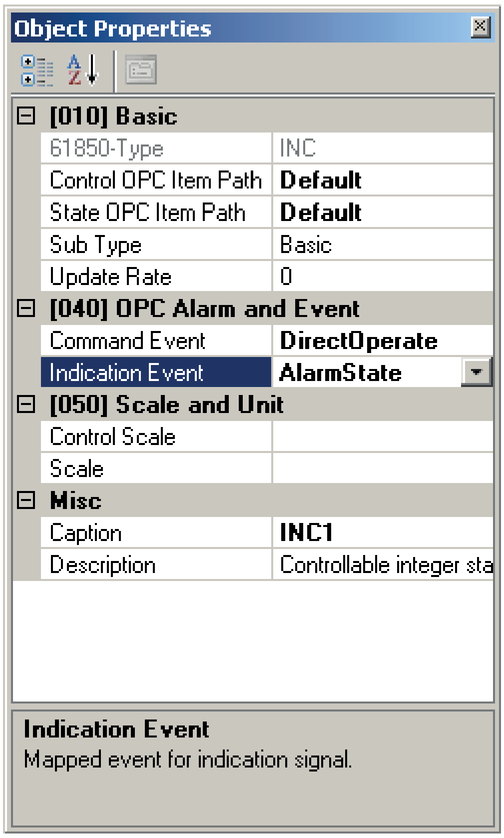


Figure 263: Define alarm and event property

10. Eight integer controllable data points, INC1...INC8.

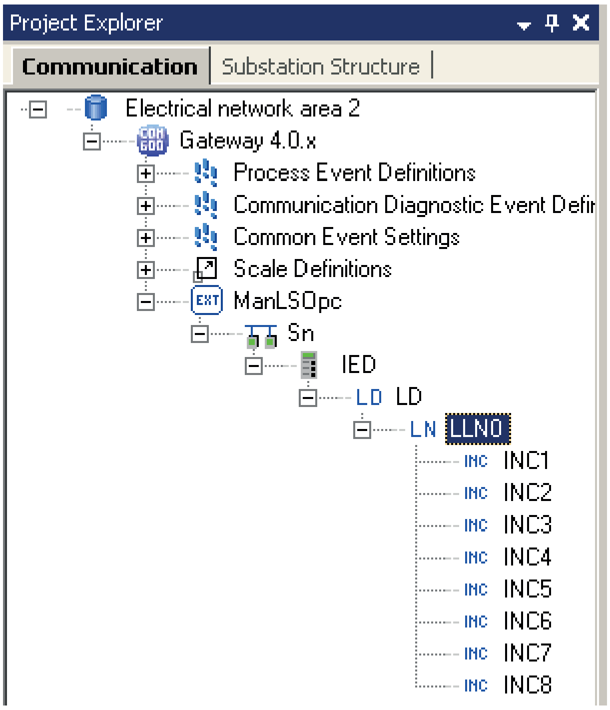


Figure 264: INC1...INC8 objects

11. Set the **Simulation Mode** as **True** for the External OPC IED.

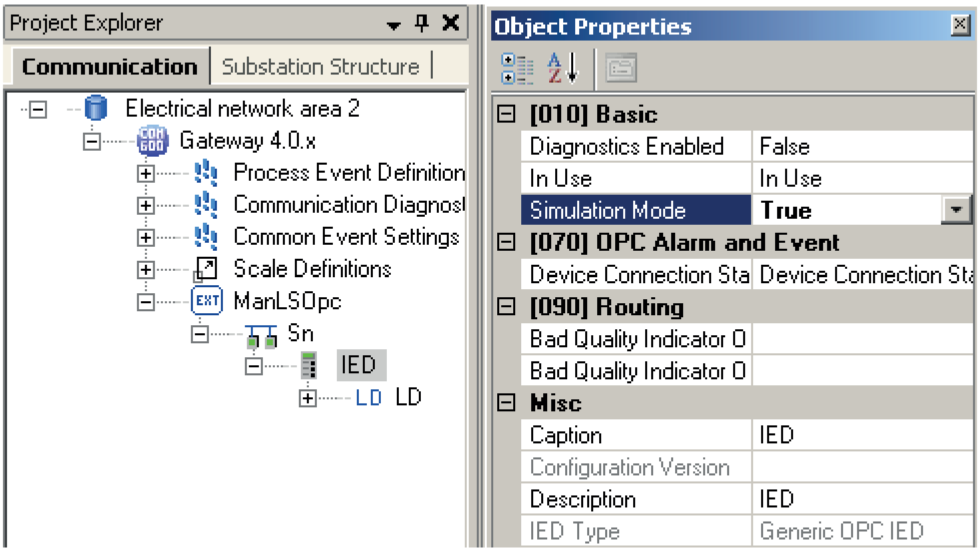


Figure 265: Simulation mode enabling

12. Select the gateway object to add the IEC 61850 Proxy Server OPC Client object in the **Communication** structure. Right-click the gateway object and select the server object, for example, **New/IEC61850/IEC 61850 Proxy Server OPC Client**. Rename the object as **Proxy**.

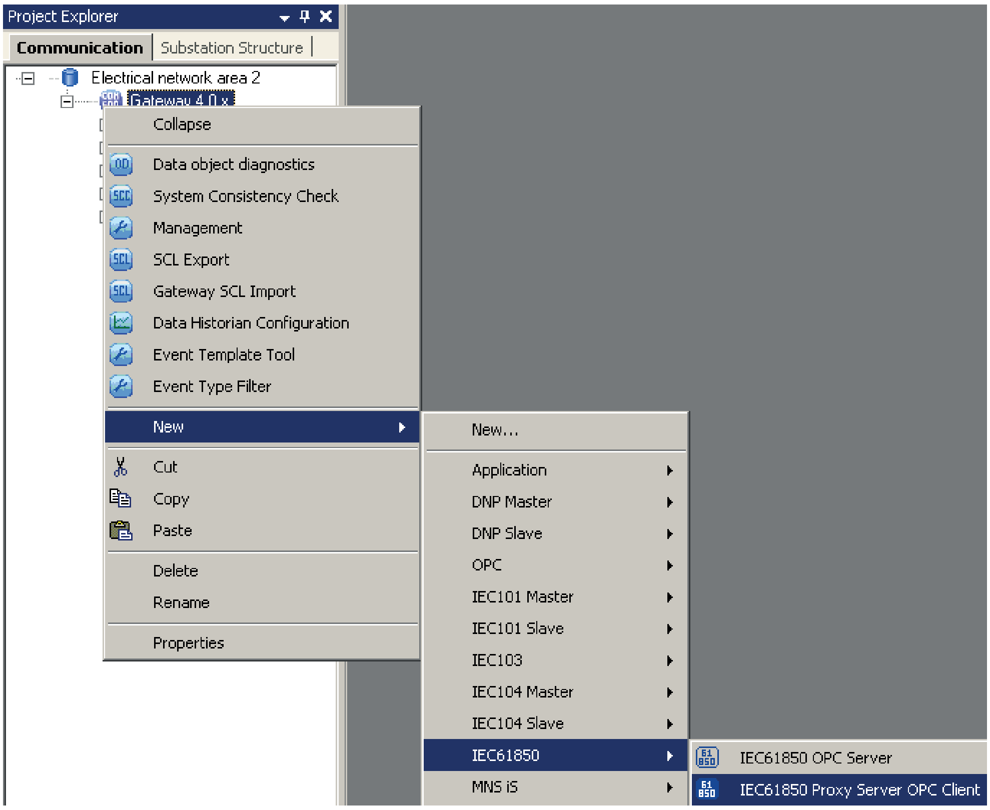


Figure 266: Add IEC61850 proxy server OPC client

13. Right-click the IEC 61850 Proxy Server OPC Client object and select **Proxy Config Tool**.

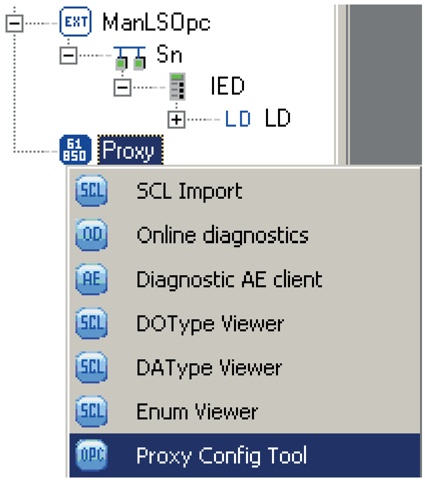


Figure 267: Use Proxy Config tool

14. Select the check boxes in the first column to add the LDs to the IEC61850 Proxy Server OPC Client configuration. Click **Apply** to create the configuration with the selected IEDs to the **Communication** structure.

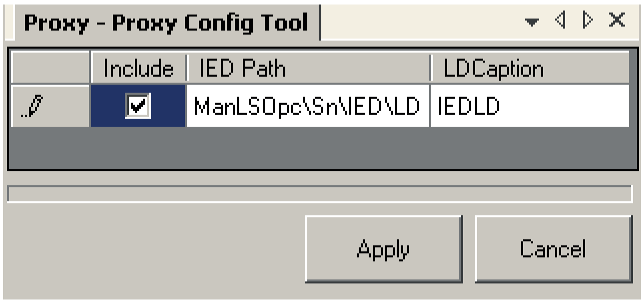


Figure 268: Proxy Configuration tool

The Proxy Configuration tool includes certain columns.

- **Include**: This column specifies if the LD is a part of the proxy configuration.
- **IED Path**: This column specifies the OPC path of the selected LD
- **LD Caption**: This column specifies the name of the referenced LD in the proxy configuration

15. Data Objects are created automatically in the Proxy IED. Rename the **IEC61850ProxySubnetwork** as **SubNtwk** and **IEC61850ProxyIED** as **Opc_Ied**.

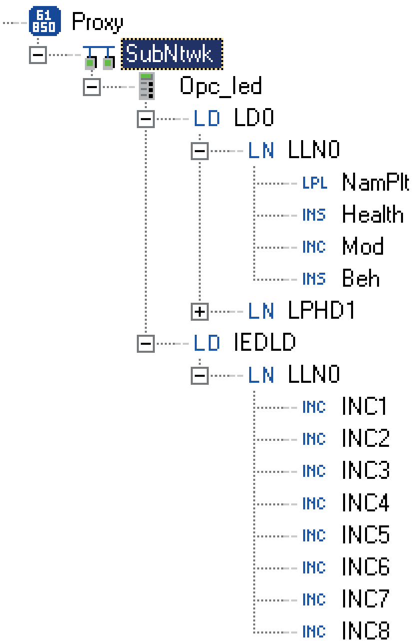


Figure 269: Data objects in proxy IED

16. Configure the data set to include the data objects INC1..INC8. Right-click **Opc_Ied/LD0/LLN0** and select **New/Communication/Data Set**.

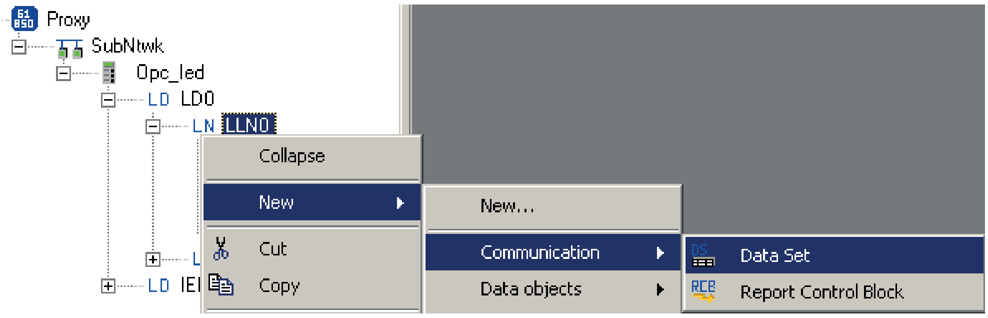


Figure 270: Create Data Set

17. The data set can be modified with the **Data set Editor**. Right-click the Data set object to open the **Data set Editor** and then select the **Data set Editor**. Select **Enable doName for GOOSE**. Drag the INC1..INC8 data objects under **IEDLD/LLN0** to **Data Set Editor** window and click **Apply**.

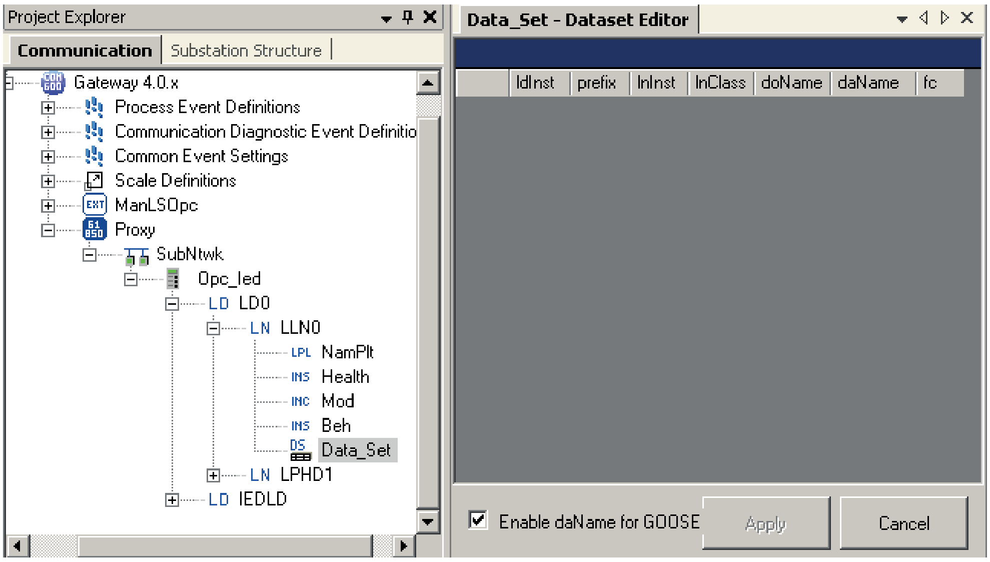
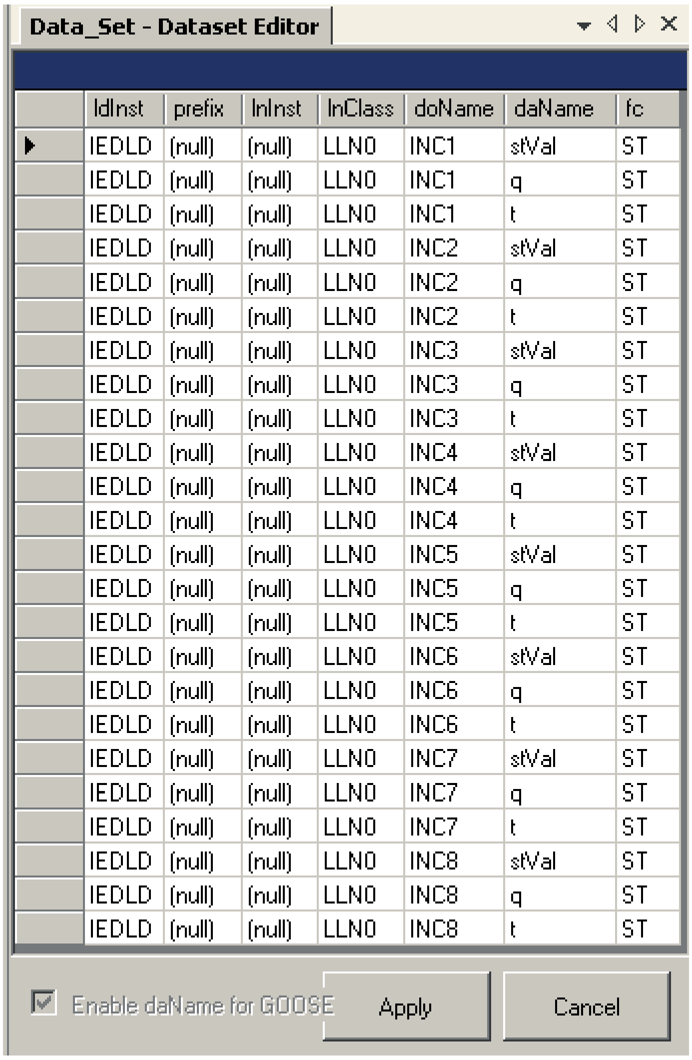


Figure 271: Data set Editor window


Data_Set - Dataset Editor

	ldInst	prefix	lnInst	lnClass	doName	daName	fc
▶	IEDLD	(null)	(null)	LLN0	INC1	stVal	ST
	IEDLD	(null)	(null)	LLN0	INC1	q	ST
	IEDLD	(null)	(null)	LLN0	INC1	t	ST
	IEDLD	(null)	(null)	LLN0	INC2	stVal	ST
	IEDLD	(null)	(null)	LLN0	INC2	q	ST
	IEDLD	(null)	(null)	LLN0	INC2	t	ST
	IEDLD	(null)	(null)	LLN0	INC3	stVal	ST
	IEDLD	(null)	(null)	LLN0	INC3	q	ST
	IEDLD	(null)	(null)	LLN0	INC3	t	ST
	IEDLD	(null)	(null)	LLN0	INC4	stVal	ST
	IEDLD	(null)	(null)	LLN0	INC4	q	ST
	IEDLD	(null)	(null)	LLN0	INC4	t	ST
	IEDLD	(null)	(null)	LLN0	INC5	stVal	ST
	IEDLD	(null)	(null)	LLN0	INC5	q	ST
	IEDLD	(null)	(null)	LLN0	INC5	t	ST
	IEDLD	(null)	(null)	LLN0	INC6	stVal	ST
	IEDLD	(null)	(null)	LLN0	INC6	q	ST
	IEDLD	(null)	(null)	LLN0	INC6	t	ST
	IEDLD	(null)	(null)	LLN0	INC7	stVal	ST
	IEDLD	(null)	(null)	LLN0	INC7	q	ST
	IEDLD	(null)	(null)	LLN0	INC7	t	ST
	IEDLD	(null)	(null)	LLN0	INC8	stVal	ST
	IEDLD	(null)	(null)	LLN0	INC8	q	ST
	IEDLD	(null)	(null)	LLN0	INC8	t	ST

Enable daName for GOOSE | Apply | Cancel

Figure 272: Add INC1 to INC8 to Data set Editor window

18. Create GOOSE Control Block and associate it with data set. Select **New/ GOOSE/Goose Control Block**.

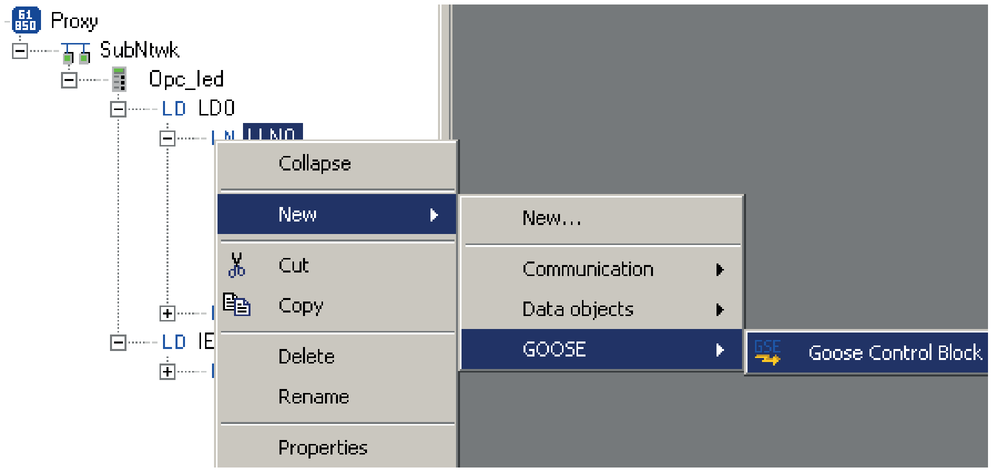


Figure 273: GOOSE Control Block creation

19. Define GOOSE Control Block parameters.

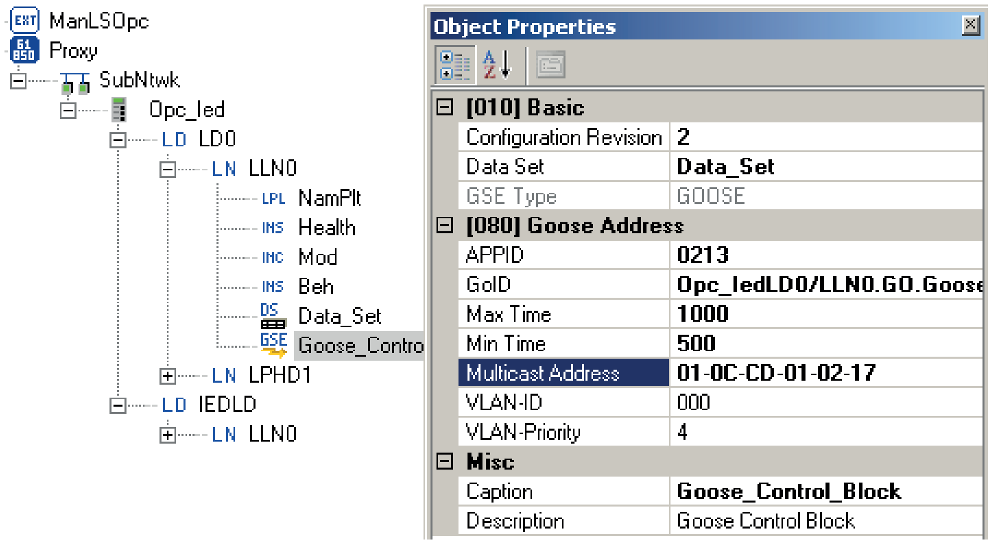


Figure 274: GCB parameters

Define *APPID*,*GoID*, *Max Time* and *Min Time* based on recommendations in Table 16.

20. Upload and reload configuration to COM600 and check the GOOSE send status on the COM600 web browser.

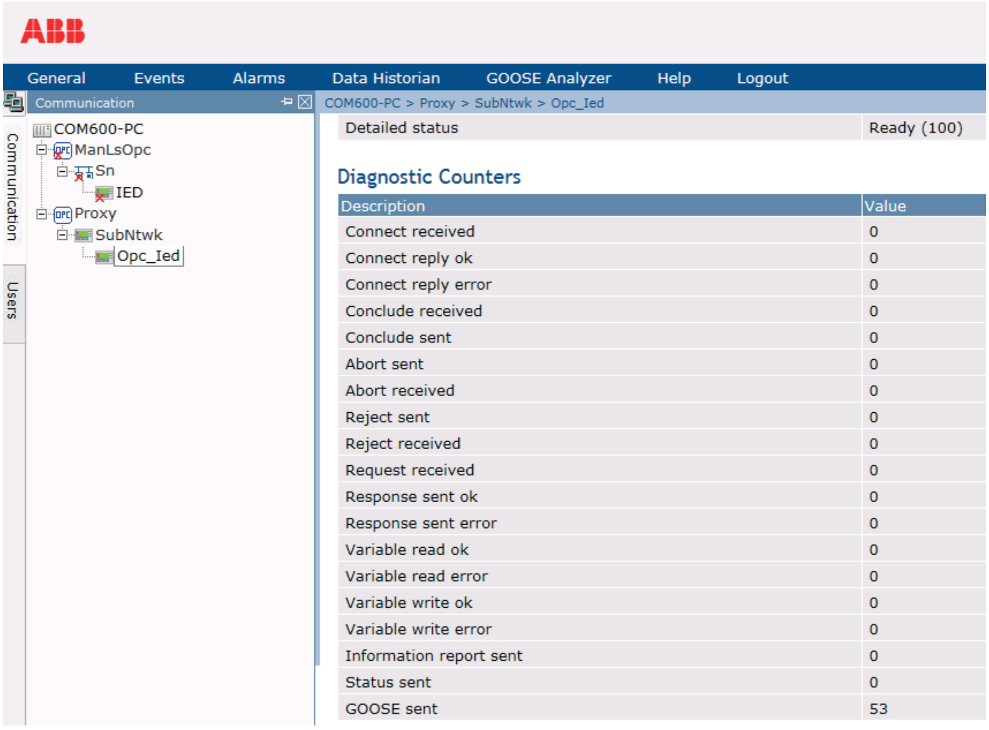


Figure 275: GOOSE sent status from the COM600

Default data quality of these objects is “BAD”. Start the **SOClient** in COM600 device and force the values to make the data quality "GOOD". See the application engineering guide for the use of SOClient.

21. Export the .cid file of proxy IED.

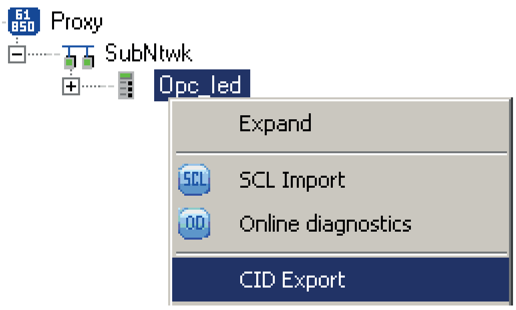


Figure 276: CID Export

The pre-configured SAB Project contains IEC61850ProxyIED. It is located at C:\Program Files \ABB\Connectivity packages \IEDConnPackPML630\Templates\SAB600 project with Proxy IED. Also Opc_Ied.cid is located at the same location.

However, the above SAB600 engineering steps for manual load-shedding are described if the configuration is done manually. Otherwise, the sample SAB600 project and Opc_Ied.cid file can be used as it is pre-configured.

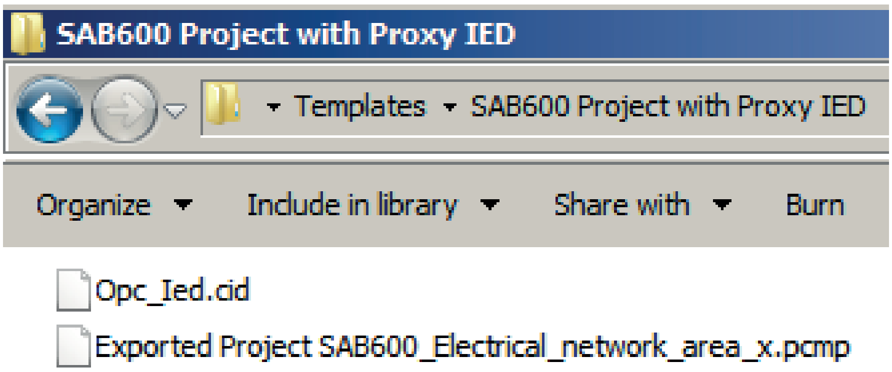


Figure 277: SAB Project with IEC61850ProxyIED

7.10.2 Configuring communication in SAB600

1. Import the SCL file.
   In **Project Explorer** view, click the **Communication** tab and then right-click the OPC server and select **SCL Import**.

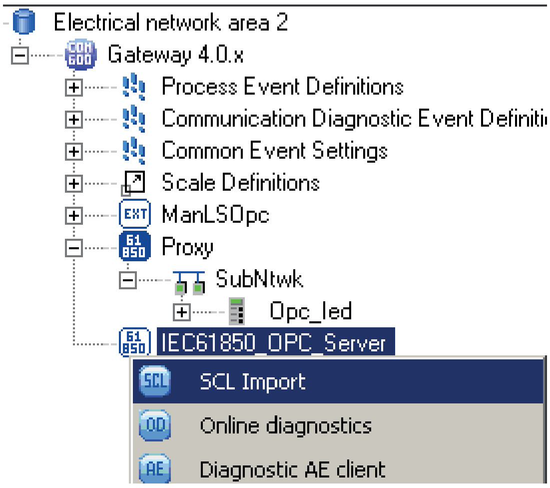


Figure 278: SCL Import

2. Click and **Select File**, browse for the SCL file to import and Click **Import**.

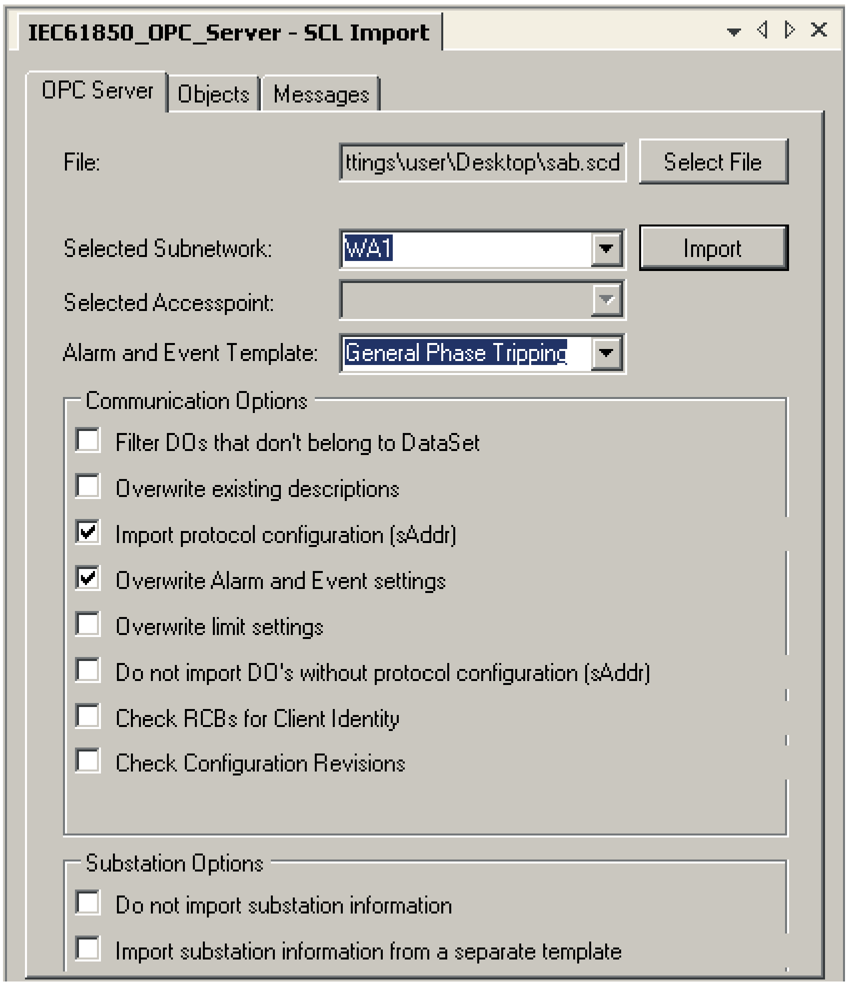


Figure 279: SCL file import

3. Set the IP address for the gateway.
   Right-click **Gateway** and then select **Properties**.
   In the **Object Properties** view, enter the IP address (COM600 IP address) in the **Remoting IP Address** field.

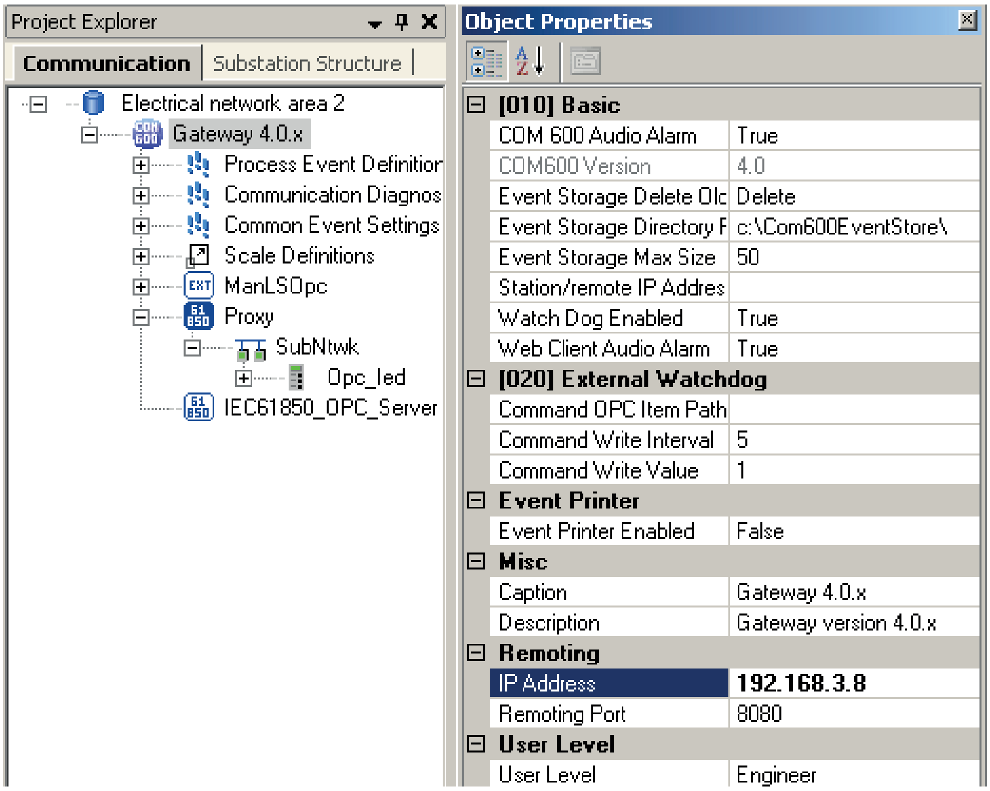


Figure 280: Gateway properties window

4. The **Communication** structure in SAB600 for after the .SCD file import.

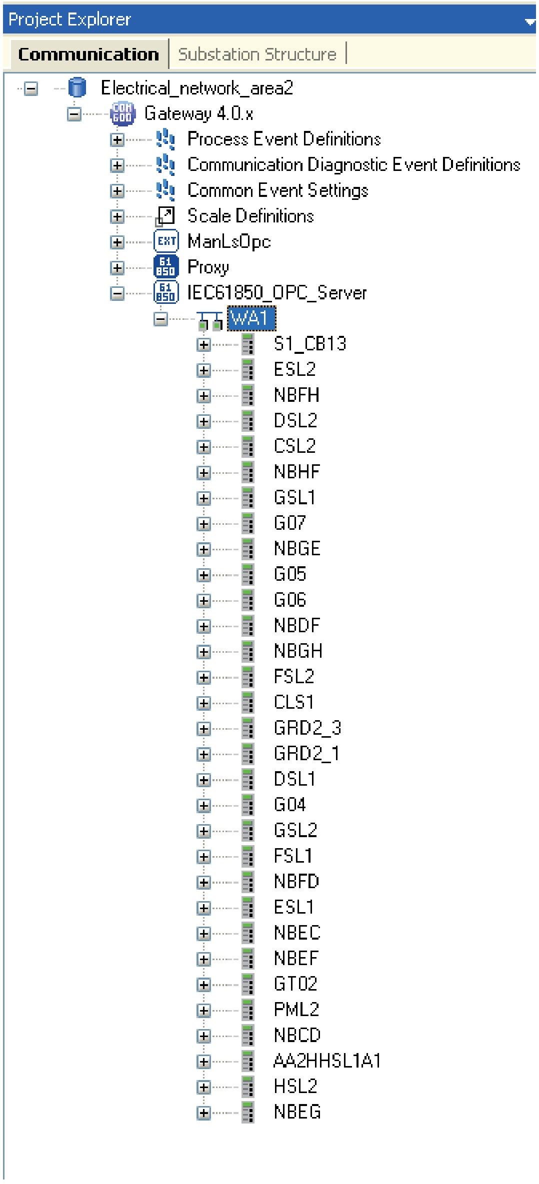


Figure 281: Communication structure in SAB600

7.10.3 Configuring the load-shedding single-line diagram in SAB600

1. Access the **Substation** structure in **SAB600**.
2. Create the bay SLD for every feeder IED.
3. Create the overall SLD by integrating the individual bay SLDs.
4. Right-click the **LS** bay under which the IED was engineered in PCM600 and access the **Data Connection** context menu.
5. Using the **Data Connection** feature, include the load feeder **LN LDMMXU** under the **LS** bay.

6. Right-click the **LS** bay and open the **SLD Editor**.
7. On the display surface, drag a **Measurement** text box object below the **Measurement** tab.
8. Select the power value by selecting the IED, LD, LN, DO and DA information and define the parameters, for example, unit name, description and decimals. This appears as first tab in the **Measurement** window.
9. Add another measurement under the same object.

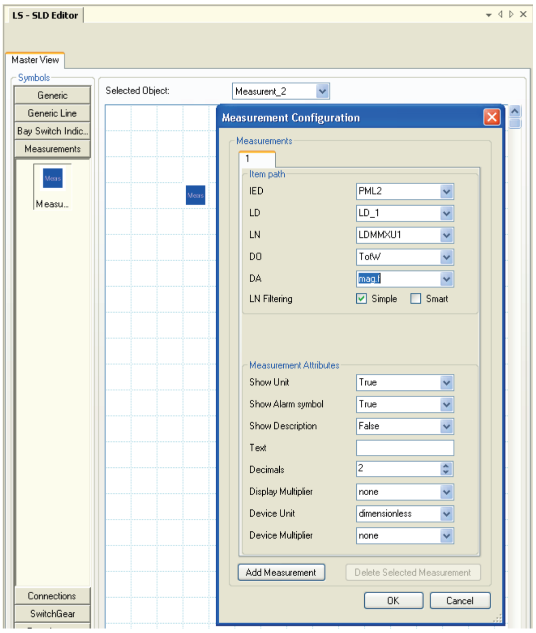


Figure 282: Measurement addition

10. Select the load feeder load-shedding priority information from the LN LDMMXU in the same way as the power value selection. This appears as the second tab in the **Measurement** window.

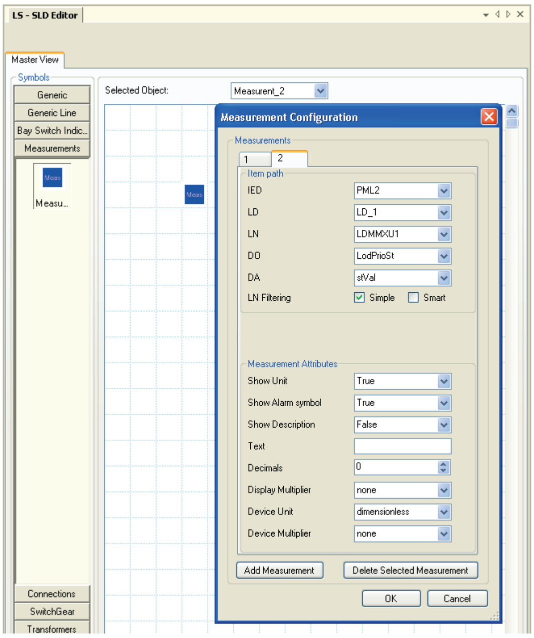


Figure 283: Load feeder load-shedding priority information

11. Check the SLD preview and the positioning of the **Measurement** text box object in the SLD.
12. Adjust the positioning in the display grid until the desired positioning is achieved.

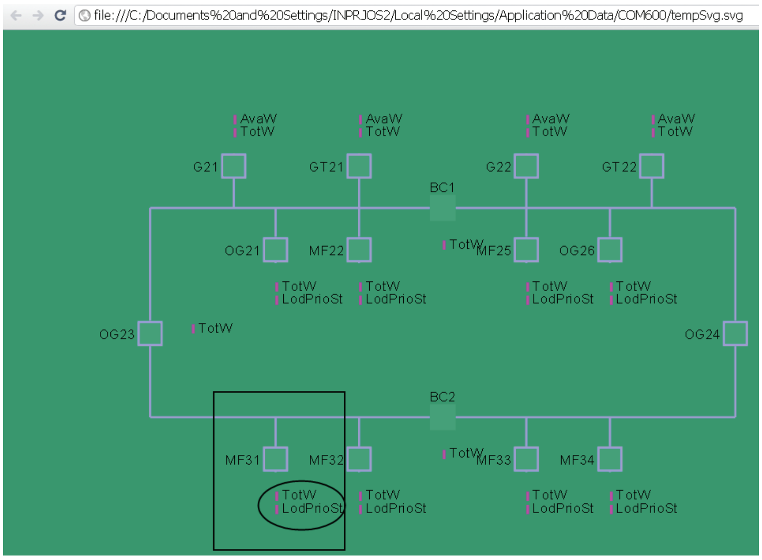


Figure 284: Adjusting the display grid

13. Open the **SLD Editor** at the voltage or substation level.
14. Observe the positioning of the **Measurement** text box object to be placed in the SLD.

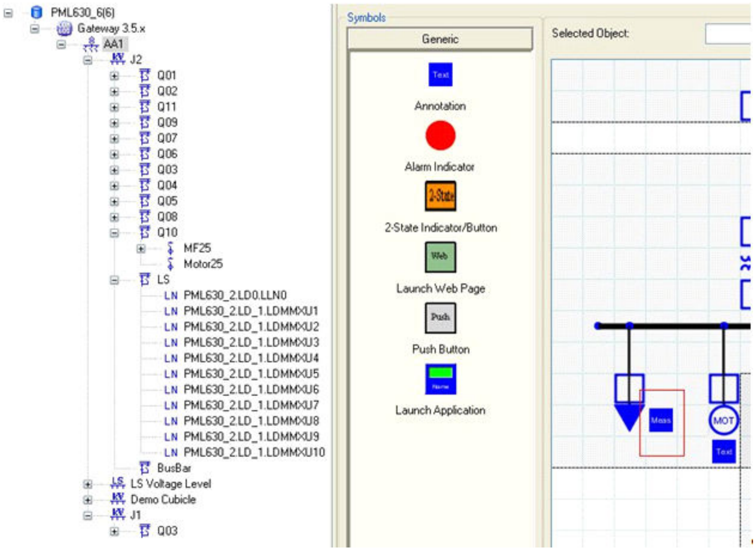


Figure 285: SLD Editor

15. Drag the slow load-shedding display element for the power sources 1...8 transformers (adjacent to the transformer symbols) in the Substation SLD.

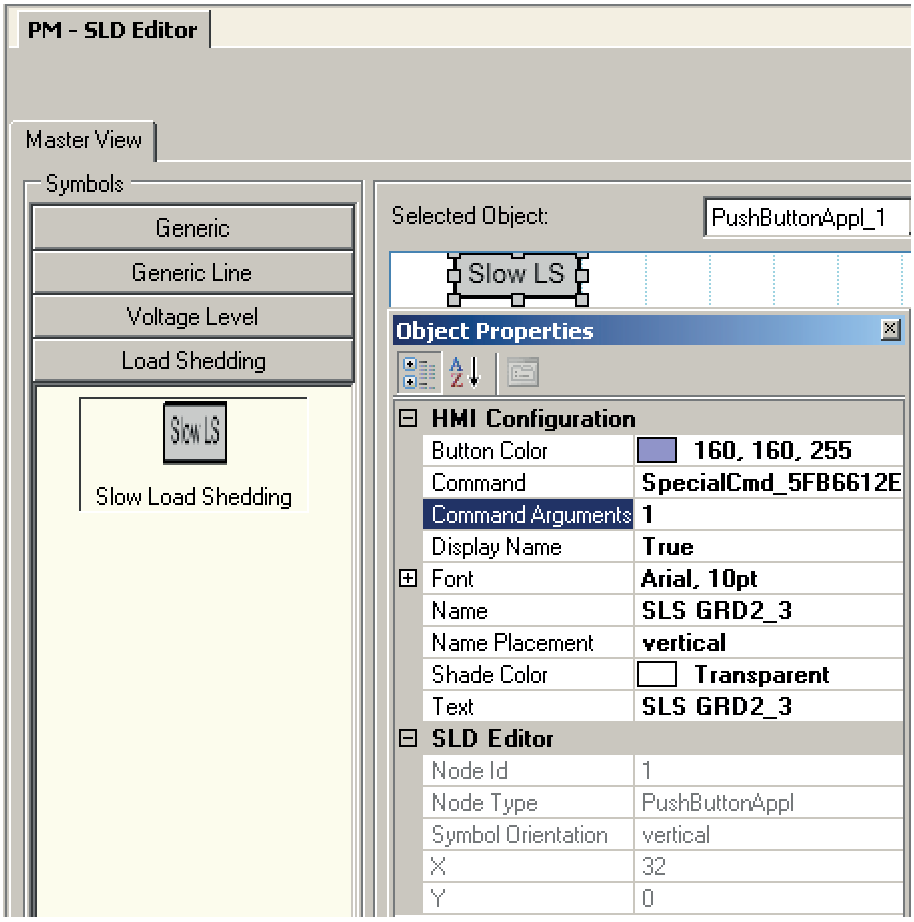


Figure 286: Slow load-shedding display element

Command Arguments property value should be set according to the power source (PSCSWI: I instance number). For example, to configure the slow load-shedding control panel for power source 5 (PSCSWI:5), the **Command Arguments** property value should be set as 5.

For more details, see the application engineering guide.

7.10.4 Downloading configuration in COM600

1. Right-click **Gateway** and select **Management** .

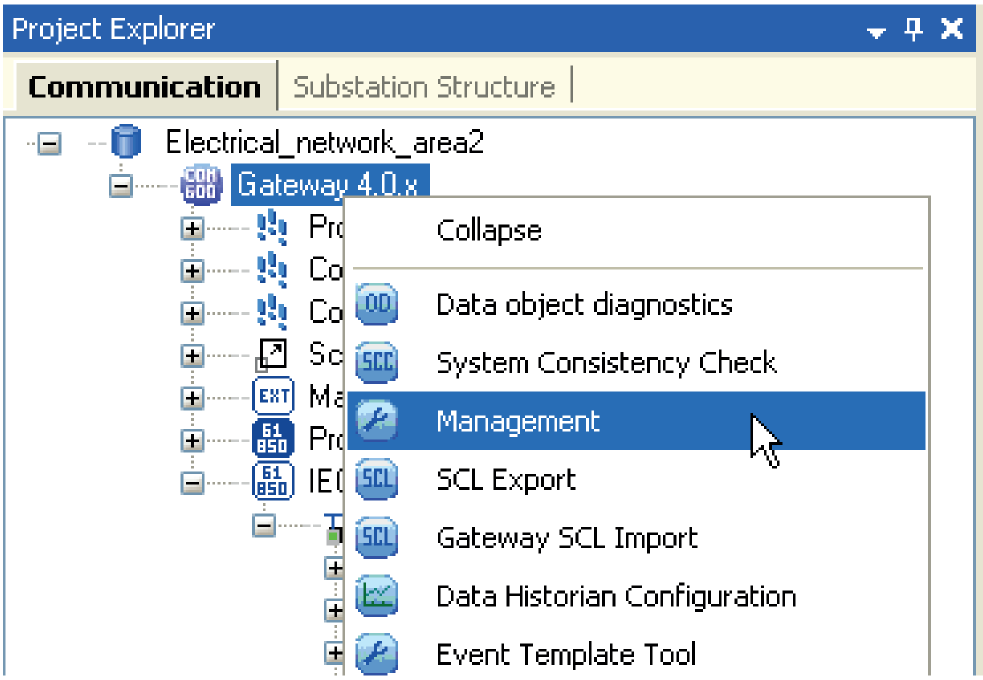


Figure 287: Configuration management

2. Select the **Reset** check box and then click **Update & reload configuration**.

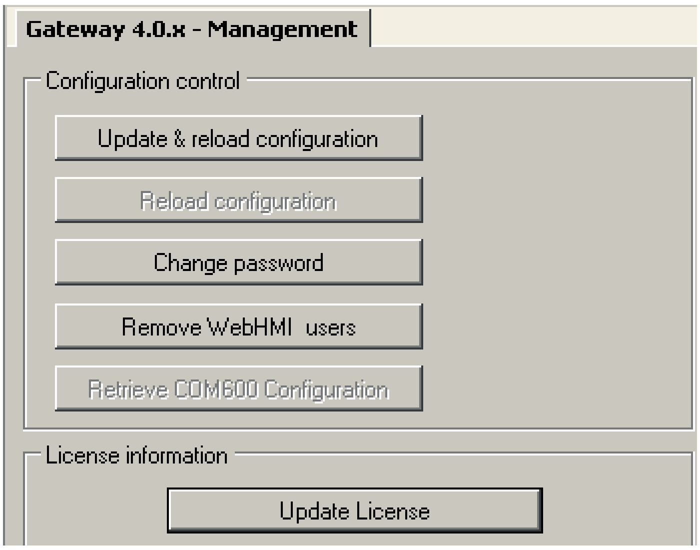


Figure 288: Update & reload configuration

Section 8 Configuration parameters in LoadShedding.ini file in COM600 device

After writing the configuration to the COM600, the PML630 specific load-shedding display pages are by default configured for cPMS - LS Configuration A and Configuration B.

The subnetwork displays (1..4) are created by default, while the **Peer PML Data Exchange** pages are created for the IED having connectivity to the two adjacent network areas. While the grid incomer 1 (GR1) is considered to be connected to adjacent area 1 and GR2 is considered to be connected to adjacent area 2.

However, the **Peer PML Data Exchange** pages based on the grid connectivity to the adjacent area and configuration parameters in the subnetwork display pages can be set or tuned by doing modifications to the load-shedding.ini file as explained in the below sections.

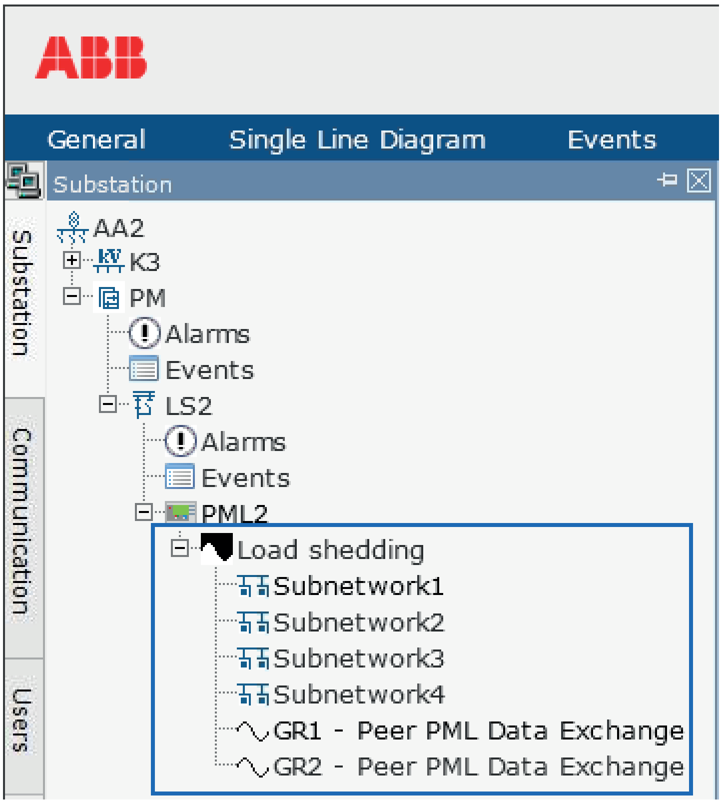


Figure 289: COM600 default Substation structure

COM600 supports display of only a single PML630 and hence the adjacent network area's PML630 is not displayed, even though its content might be present in the SCD file. Typically, each network area is expected to have its own COM600 HMI.

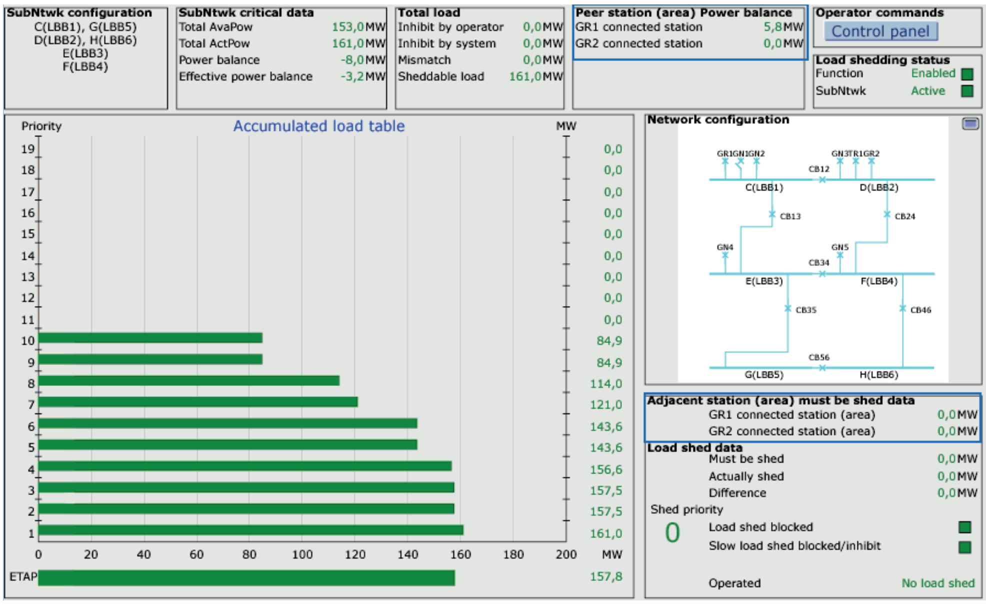


Figure 290: Subnetwork 1 and 2 page

8.1 Modification of LoadShedding.ini file based on network configuration

If the area has only one network area connectivity either with the GR1 or GR2, this is configured in the LoadShedding.ini file. After editing the file save the changes and restart the COM600 device. The related connectivity pages appear after the restart. Loadshedding.ini file is located in COM600.

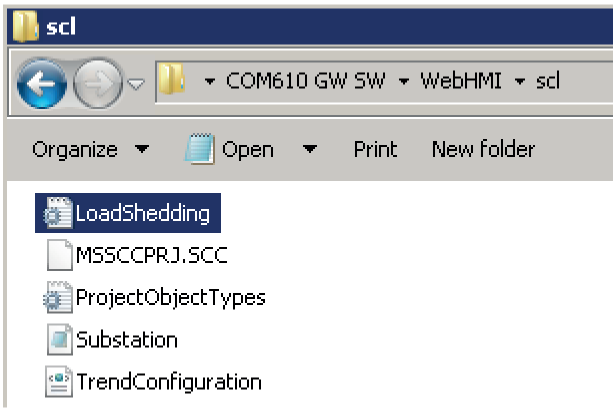


Figure 291: Figure 288: Loadshedding.ini file path

The following parameters in LoadShedding.ini file displays the relevant data exchange between PML630s from adjacent area to PML630 relevant for the current area. This data is represented in the in the load-shedding subnetwork pages.

GR1PeerConfiguration = 1

GR2PeerConfiguration = 1

These parameters are enabled (1) by default.

- If PML630 has connectivity with two adjacent network areas connected to the Grid 1 and Grid 2 power source respectively, *GR1PeerConfiguration* and *GR2PeerConfiguration* should be set as 1.
- If PML630 has connectivity with the adjacent network area connected to the Grid 1 power source only, *GR1PeerConfiguration* should be set as 1 and *GR2PeerConfiguration* is set as 0.
- If PML630 has connectivity with the adjacent network area connected to the Grid 2 power source only, *GR1PeerConfiguration* should be set as 0 and *GR2PeerConfiguration* is set as 1.
- If PML630 has no connectivity with the adjacent network area, both *GR1PeerConfiguration* and *GR2PeerConfiguration* should be set as 0.

8.2 Modification of LoadShedding.ini file for configuration parameters in subnetwork displays

The information in Subnetwork display pages can be configured by modifying the LoadShedding.ini.

Parameters in the LoadShedding.ini file are edited based on the real values in the network areas.

Table 21: Parameter description in the LoadShedding.ini file

Parameter name	Value	Description
MinValueX	0	Minimum value in the load table for sheddable load on x axis
MaxValueX	200	Maximum value in the load table for sheddable load on x axis
StepSizeX	20	The value step count determines where to put the labels and vertical bars for the load table
ALodPrioCount	19	The number of bars corresponding to (load priorities)
MultiplierHMI	M	The watt multiplier used in the HMI (load table and other measurement Values) M = MW and k= KW
MultiplierPML	k	The watt multiplier used internally in the PML device (load table and other measured values)
NumberOfDecimals	1	The number of decimals (load table and other measurement values)
BusbarNameFontSize BreakerNameFontSize	3 2	Font size for the busbar and breaker names font size in the network diagram.
PriorityMinVal PriorityMaxVal	1 19	Priority input range for the manual load-shedding dialog.
AmountOfLoadshedMinVal AmountOfLoadshedMaxVal	0 200000	Amount of load to be shed input range (kW) for the manual load-shedding dialog.
GooseOpcServerProgId	ABB.conn_OPC_DA_Server.Instance	Used for accessing GOOSE data (mapped to the OPC server via IEC61850 Proxy)
ManLsPriorityOutPutItemId ManLsAmountShedOutPutItemId	Sn\IED\LD\LLN0\INC5\ctlVal Sn\IED\LD\LLN0\INC1\ctlVal	[Subnetwork1] - Opc Item path
ManLsPriorityOutPutItemId ManLsAmountShedOutPutItemId	Sn\IED\LD\LLN0\INC6\ctlVal Sn\IED\LD\LLN0\INC2\ctlVal	[Subnetwork2] - Opc Item path
ManLsPriorityOutPutItemId ManLsAmountShedOutPutItemId	Sn\IED\LD\LLN0\INC7\ctlVal Sn\IED\LD\LLN0\INC3\ctlVal	[Subnetwork3] - Opc Item path
ManLsPriorityOutPutItemId ManLsAmountShedOutPutItemId	Sn\IED\LD\LLN0\INC8\ctlVal Sn\IED\LD\LLN0\INC4\ctlVal	[Subnetwork4] - Opc Item path

Restart of the COM600 devices is needed if the Load-shedding.ini file parameters are changed.

Section 9 Configuring REG670 as a generator source

IED connectivity package supports (REF/REM/RET) 615 and 620 series, (REG/REF/REM/RET) 630 series and RIO600 IEDs for the configuration wizard. However, it is possible to configure the REG670 IED as generator source using the configuration wizard with some additional engineering steps.

1. Include the REG670 .pcmi in the PCM600 project and include one more **630 series IED** as **Dummy Generator.**

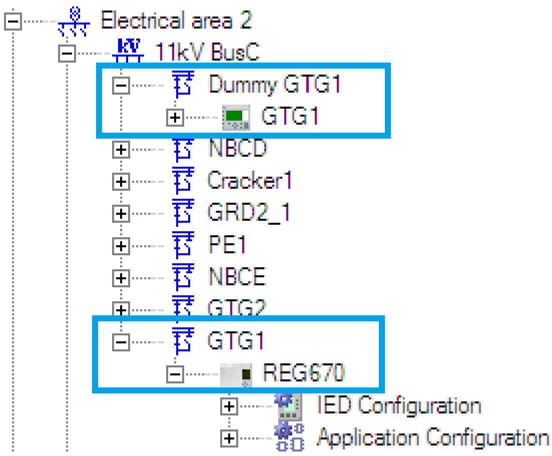


Figure 292: 630 as dummy GTG1 for REG670

2. Run the **Configuration Wizard** and select the **Dummy Generator IED** as generator source.
3. Finish the **Configuration Wizard.**
4. Subscribe the REG670 data to the PML630 IED.

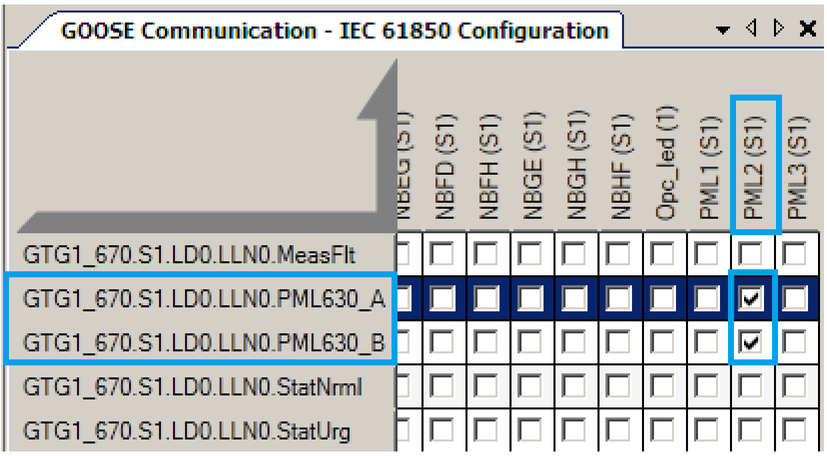


Figure 293: Subscribe REG670 GCB to PML630 IED

5. The **GOOSEPWRSRCRCV** function block (for generator) **Signal Matrix Connection** in the IED needs to be done manually.

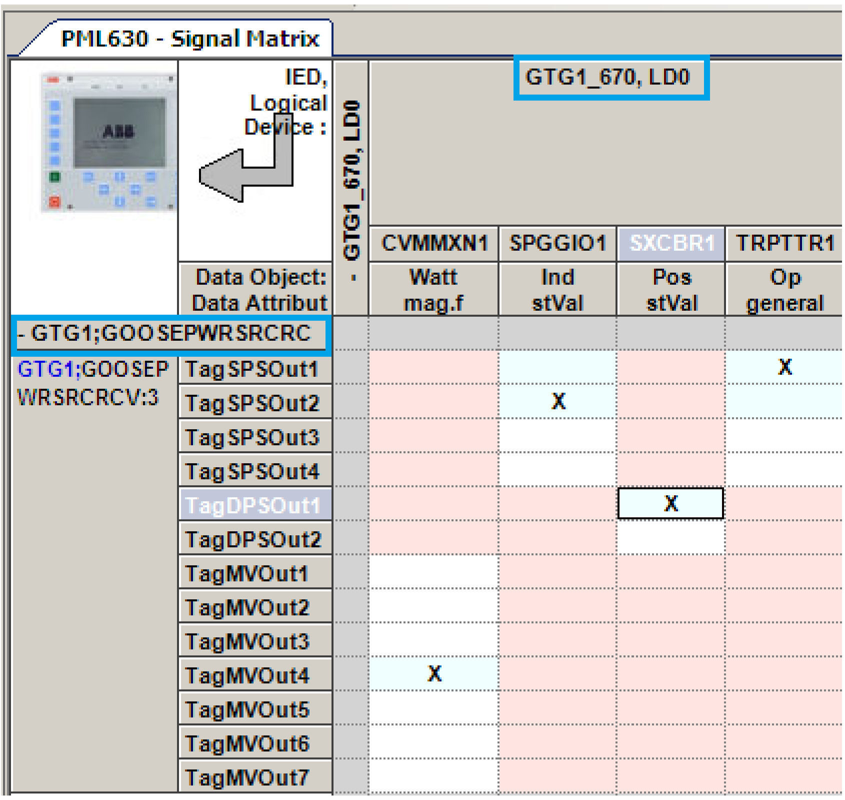


Figure 294: Signal matrix connections manually configured for REG670 GOOSE data

6. **630 series IED** as **Dummy Generator IED** in the PCM600 project is of no use for load-shedding application.

Section 10 Limitations

The IED connectivity package only supports single busbar configuration. However, with manual configuration engineering, the IED can also support double busbar configuration.

10.1 Handling of double busbar configurations using PML630

It is only possible to handle single busbar based configurations inherently using the PML630. However, it is also possible to handle a simple double busbar configuration (two mains with a tie) with some adaptation steps.

A sample configuration is shown in Figure 295. Consequently, the maximum system configuration is generally halved.

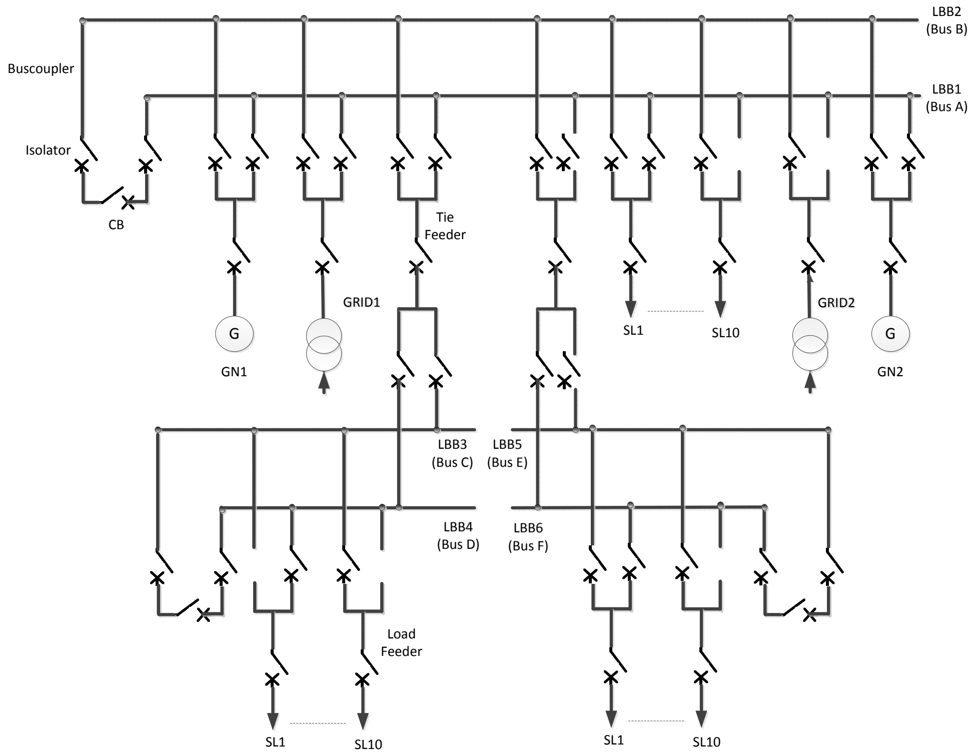


Figure 295: Example of a simple double busbar configuration (Configuration A)

- 2 generators or transformers
- 2 grid transformers
- 2 subnetworks
- 3 double busbars (2 power busbars and 3 load busbars)
- 10 load-shed groups per double busbar section
- 30 load-shed groups in total (10 load-shed groups * 3 load busbars)

In the above example, the remaining two double busbars LBB3-LBB4 and LBB5-LBB6 are load busbars (with no power sources) connected to the upstream double busbar section. Each double busbar can be allocated with ten load-shedding feeders or groups.

The IED connectivity package supports only single busbar configuration. However, a double busbar based network can be configured with additional adaptations and engineering steps.

Considering the above example, a double busbar configuration requires certain adaptations.

- Consideration of LBB1 as Bus A of double bus bar
- Consideration of LBB2 as Bus B of double bus bar
- Consideration of External grid source 1 and Generator/transformer 1 as single grid power source GRID1
- Consideration of Generator/transformer 2 and 3 as a single source GN1
- Consideration of Generator/transformer 4 and 5 as a single source GN2
- Consideration of External grid source 2 and Generator/transformer 6 as single grid power source GRID2
- Consolidated handling of the following information from all feeders connected to the double busbar, that is, power sources, bus section and outgoing feeders (tie and load feeders) in their respective feeder IEDs (Relion 630).
    - Isolator and circuit breaker status
    - Circuit breaker service position
    - Power value

This information depends on the active busbar, Bus A or B, and should be sent as an equivalent status to PML630.

- Modification of LHMI load-shedding subnetwork single-line diagram using Graphical Display Editor
- Consolidated load-shed command handling for load feeders in respective feeder IEDs (Relion 630)

Section 11 Appendix

Table 22: Engineering checklist

Checklist item	Macro steps for single PCM600 project based configurations	Step completed
cPMS - LS Configuration A		
PCM600 (1)		
1	Installation of appropriate PML630 Connectivity Package and IED Module in PCM600 machine.	Yes/No
2	Installation of appropriate feeder IEDs' Connectivity Packages, as per project configuration (REG630 1.2, REF630 1.0/1.1/1.2, RET630 1.0/1.1/1.2, REM630 1.0/1.1/1.2, REF615 3.0/4.0, RET615 3.0/4.0, REM615 3.0/4.0, REF620 1.2, REM620 1.2, RET6201.2, RIO600 and REG670 1.1 (optional)) in PCM600 machine.	Yes/No
PCM600 engineering (Part 1)		
4	All bays with correct pre-configurations done in PCM600 project. Usage of appropriate templates provided with PML630 Connectivity Package for load-shedding logic.	Yes/No
5	Load-shedding Groups: Usage of appropriate templates provided with PML630 Connectivity package.	Yes/No
6	Make connections between templates and template logic.	Yes/No
7	MVGGIO parameters settings done for *Representative Load* in the load-shedding group	Yes/No
8	Back up of the project taken without PML630.	Yes/No
9	New Bay and instantiate PML630 IED created.	Yes/No
10	Run Configuration Wizard or License Update Tool, as per Engineering manual.	Yes/No
11	Usage of appropriate template provided with PML630 Connectivity Package.	Yes/No
12	Make connections between templates and template logic.	Yes/No
13	SCD from the PML630 Automatic Dataflow Engineering feature exported.	Yes/No
IET600 Engineering (2)		
14	Import SCD file from PCM600 and IEC 61850 OPC Client ICD file (for COM600).	Yes/No
15	For all feeder IEDs except PML630, create Report Control Blocks to send circuit breaker position and protection trip status to COM600.	Yes/No
16	For all the load, network circuit breakers and power source feeder IEDs, create data sets PML630_A and PML630_B for analog data and binary respectively.	Yes/No
17	Include CB Position – status, quality (PML630_B) for load feeders.	Yes/No
18	Include Real power – status, quality (PML630_A) for load feeders.	Yes/No
19	Include CB Position – status, quality (PML630_B) for power source and network circuit breakers.	Yes/No
20	Include protection trip (Lockout) – status, quality (PML630_B) for power source and network circuit breakers.	Yes/No

Table continues on next page

Checklist item	Macro steps for single PCM600 project based configurations	Step completed
21	Include service position – status, quality (PML630_B) for power source and network circuit breakers.	Yes/No
22	Include Real Power – status, quality (PML630_A) for power source and network circuit breakers.	Yes/No
23	Include all three phase Currents – status, quality (PML630_A) only for the Grid Transformers.	Yes/No
24	Create GOOSE Control Blocks for all feeder IEDs, gcb_a corresponding to PML630_Adata set and gcb_b corresponding to PML630_B data set.	Yes/No
25	gcb_a parameters: tmin(1000 ms), tmax (1000ms), MACID, APPID, GoID set as per manual.	Yes/No
26	gcb_b parameters: tmin(4 ms), tmax (1000ms), MACID, APPID, GoID set as per manual.	Yes/No
27	Subscribe PML630 IED for all the feeder IEDs GCB.	Yes/No
28	Create Extenal IED /System and import the .cid or .icd file and subscribe the data to PML630 IED. This data inforamtion is Governor Mode and Available power information of power sources on communication to the PML630 IED.	Yes/No
29	Create Opc_Ied in the IET600 and import the .cid file exported from SAB 600 project and subscribe the manual load-shedding priority and load to be shed (kW) data to PML630 IED.	Yes/No
30	Subscribe *Representative load* feeder IED to all Dependent load feeder IED information.	Yes/No
31	All the load-shedding command GCBs(GCB_SLx) have load feeder IEDs subscribed automatically.	Yes/No
32	Subscribe the 615 3.0 and later version or 620 2.0 based load feeders to 'relayed' command information through *Representative load*	Yes/No
33	Set Client1 as COM600 IEC 61850 OPC server and set the all feeder IEDs and PML630's RCBs' Client LN identity to Client1.	Yes/No
34	Export the SCD from the IET600.	Yes/No
PCM600 engineering (Part 2)		
35	Import the IET600 exported SCD file.	Yes/No
36	Activate PML630's Make GOOSE Connection feature.	Yes/No
37	Verify all incoming GOOSE data from feeder IEDs are checked automatically against GOOSE Receive blocks.	Yes/No
38	Manually make Signal Matrix connections for load-shedding commands as GOOSE inputs into Representative, Independent load feeders IEDs and Dependent loads based on 630 1.0/1.1/1.2 IEDs).	Yes/No
39	Manually make Signal Matrix connections for load-shedding commands as GOOSE inputs into load feeders Dependent loads based on 615 3.0/4.0 IEDs).	Yes/No
40	Set GOOSESPRCV, GOOSEBINRCV function blocks to ON using PST to enable receipt of LS command.	Yes/No
41	Parameterize all load-shedding functionality functionblocks like PSCSWI, LDMMXU, NCBDCSWI, NPMMXU and LSCACLS.	Yes/No
42	Import default parameter set file to set all parameters like function keys, LHMI LEDs, WebHMI and so on.	Yes/No
43	Parameterize all non load-shedding functionality functions like B1/B2RBDR, A3RADR, A4RADR, DRRDRE and so on.	Yes/No
44	Synchronize time in all IEDs in the network.	Yes/No
Table continues on next page		

Checklist item	Macro steps for single PCM600 project based configurations	Step completed
45	Modify cramped key load-shedding SLD in GDE and add additional elements if necessary.	Yes/No
46	Write configurations into IEDs	Yes/No
SAB600 engineering		
47	Import SCD to the SAB600 exported from IET600 project.	Yes/No
48	Set IP setting and Client name of the COM600 in the IEC61850 OPC Server.	Yes/No
49	Set IP for SNTP server and enable SNTP time synchronization.	Yes/No
50	Upload and write to the COM600 once.	Yes/No
51	Add all the Data connections in all the bays for the GNRCSWI (circuit breaker) positions -> Switch Position – Open/Close Intermediate, Faulty Events for GNRLCSWI Pos , DAXCBR Pos (if applicable).	Yes/No
52	Add all the Data connections for the PML630.	Yes/No
53	Do the event configuration.	Yes/No
53 a	Trip from General – Yes – No event for -LS Operate per source, LS Operate per Network CB, LS operate, Subnetworkwise LS Operate, SLS Operate per source , SLS Operate Subnetwork-wise.	Yes/No
53 b	Start from General – Yes – No event for Slow LS Start per source, Slow LS Start Subnetwork-wise, LS Enable per Subnetwork, LS Start per source , LS Start per Network CB, LS start.	Yes/No
53 c	Blocking – Blocked – Not Blocked event for -LS Block, LS Block per source, LS Block per Nework CB, LS Block per subnetwork.	Yes/No
53 d	Alarm State – Active – Not active events for - Subnetwork-wise active, one or more basic setting change for PSCSWI,LDMMXU,NCBDCSWI and LSCACLS functions.	Yes/No
53 e	Direct operate – Operation Success – Operate Fail Events for - Manual LS Command Subnetwork-wise, LS Reset per Subnetwork and Global LS Reset.	Yes/No
54	Write to the COM600.	Yes/No
55	Open the Substation section of SAB600 and SLD Editor from the PML630 object and create the load-shedding SLD. Configure power flow and priority display objects and slow load-shedding operation objects for sources configured for slow load-shedding.	Yes/No
56	Again upload and reload Configuration.	Yes/No
57	COM600 device -Edit Load-shedding.ini file setting for priority load table, unit, multiplier, font sizes for bus bar and ciruit breaker names, manual load-shedding kw and priority based LD/LN information. Restart the COM600 device.	Yes/No
cPMS - LS configuration B		
58	Finish all network areas cPMS - LS configuration A Engineering flow. Export the .pcmi file of PML630 IED from each area project.	Yes/No
59	Open PCM600 project of area x and import the .pcmi of other interconnected area PML630 IED .pcmi file under the IED Group section.	Yes/No
60	Perform horizontal communication between the IEDs.	Yes/No
61	Write configuration to PML630 IED of its own network area from the same network area PCM600 project.	Yes/No

Table continues on next page

Checklist item	Macro steps for single PCM600 project based configurations	Step completed
62	Repeat steps 59 - 61 to each network area PCM600 project.	Yes/No
63	Set the NPMMXU *Grid connectivity to Peer connectivity* as per network configuration to the respective interconnected Grid 1 and Grid 2 in each area project and write the setting to IED.	Yes/No
64	Verify the *Spinning Reserve* data exchange and *Effective Power Balance* in each PML630 IED.	Yes/No

Section 12 Glossary

ACT	1. Application Configuration tool in PCM600 2. Trip status in IEC 61850
ANSI	American National Standards Institute
APPID	Application identifier
Attribute	Named element of data and of a specific type
CID	Configured IED description
COMTRADE	Common format for transient data exchange for power systems. Defined by the IEEE Standard.
Connectivity package	A collection of software and information related to a specific protection and control IED, providing system products and tools to connect and interact with the IED
cPMS	Compact power management solution
Data attribute	Defines the name, format, range of possible values and representation of values while being communicated
Data set	The content basis for reporting and logging containing references to the data and data attribute values
DHCP	Dynamic Host Configuration Protocol
EMC	Electromagnetic compatibility
Ethernet	A standard for connecting a family of frame-based computer networking technologies into a LAN
GDE	Graphical Display Editor in PCM600
GoCB	GOOSE control block
GoID	GOOSE control block-specific identifier
GOOSE	Generic Object-Oriented Substation Event
HMI	Human-machine interface
Horizontal communication	Peer-to-peer communication
ICD	IED capability description
IEC	International Electrotechnical Commission
IEC 61850	International standard for substation communication and modeling
IED	Intelligent electronic device

IET600	Integrated Engineering Toolbox
IP	Internet protocol
IP address	A set of four numbers between 0 and 255, separated by periods. Each server connected to the Internet is assigned a unique IP address that specifies the location for the TCP/IP protocol.
LAN	Local area network
LED	Light-emitting diode
LHMI	Local human-machine interface
Logical node	Also known as LN. The smallest part of a function that exchanges data. An LN is an object defined by its data and methods.
MMS	1. Manufacturing message specification 2. Metering management system
PC	1. Personal computer 2. Polycarbonate
PCM600	Protection and Control IED Manager
PST	1. Parameter Setting tool in PCM600 2. Product Selection Tool
RIO600	Remote I/O unit
SAB600	Substation automation builder tool
SCD	Substation configuration description
SCL	XML-based substation description configuration language defined by IEC 61850
SMT	Signal Matrix tool in PCM600
Station	Network node or a device connected to a network
TCP/IP	Transmission Control Protocol/Internet Protocol
Unicode	16-bit character encoding standard
WAN	Wide area network
WHMI	Web human-machine interface

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