Process Power Manager 5

Library for 800xA
PMS 5.6.5 Synchronization Library
Manual

Version 5.6-5

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PMS 5.6.5 Synchronization Library Manual

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About This User Manual

General

This User Manual provides the configuration information for the Synchronization control modules that are part of the PMS Library. The information in this manual is directed towards the project engineers.

The user should be familiar with the Control IT for AC 800M/C and Operate IT environment.

Document Conventions

Microsoft Windows conventions are normally used for the standard presentation of material when entering text, key sequences, prompts, messages, menu items, screen elements, and so on.

The following conventions are used for the presentation of material:

- The words in names of screen elements (for example, the title in the title bar of a window, the label for a field in a dialog box) are initially capitalized.
- Capital letters are used for the name of a keyboard key if it is labelled on the keyboard. For example, press the ENTER key.
- Lowercase letters are used for the name of a keyboard key that is not labelled on the keyboard. For example, the space bar, comma key, and so on.
- Press CTRL+C indicates that you must hold down the CTRL key while pressing the C key (to copy a selected object in this case).
- The names of push and toggle buttons are boldfaced. For example, click **OK**.
- The names of menus and menu items are boldfaced. For example, the **File** menu.
- The following convention is used for menu operations: MenuName > MenuItem > CascadedMenuItem. For example: choose **File** > **New** > **Type**.
- The **Start** menu name always refers to the Start menu on the Windows Task Bar.
- System prompts/messages are shown in the Courier font, and user responses/input in boldfaced Courier font. For example, if you enter a value out of range, the following message is displayed:

  ```
  Entered value is not valid. The value must be 0 to 30.
  ```

- You may be instructed to enter the string TIC132 in a field. The string is shown as follows in the procedure:

  `TIC132`

- Variables are shown in italics:

  IOPar.Govmode8.value

- Faceplate tabs are boldfaced:

  AVR Mode handler

Warning, Caution, Information, and Tip Icons

This publication includes **Warning**, **Caution**, and **Information** if/where appropriate to point out safety related or other important information. It also includes **Tip** to point out useful hints to the reader. The corresponding symbols should be interpreted as follows:

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

Warning icon indicates the presence of a hazard which could result in *personal injury*.

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/property*.

Information icon alerts the reader to pertinent facts and conditions.

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, and **Caution** hazards are associated with equipment or property damage, it should be understood that operation of damaged equipment could, under certain operational conditions, result in degraded process performance leading to personal injury or death. Therefore, comply fully with all **Warning** and **Caution** notices.

Terminology

Table 1 lists terms used in this document and associated with the Process Power Manager 5. The reader should be familiar with these terms before proceeding further in this user manual.

Table 1 Terminology

Term	Description
AC 800M/C Connect	Name of the connection/integration between Control IT for AC 800M/C and Operate IT. The following software packages are included under this name: - Aspect System for AC 800M/C - Graphics Object Type Library for AC 800M/C
Aspect	A description of some properties of an Aspect Object. Some examples of aspects are name, circuit diagram, process display and control logic.
Aspect Object	A computer representation of a real object, such as a pump, a valve, an order or a virtual object, such as a service or an object type. An Aspect Object is described by its aspects and these aspects are organized in structures.
Aspect System for AC 800M/C	One part of the AC 800M/C Controller Integration product (the other part is the Graphics Type Library for AC 800M/C, see below). Gives access to the controllers AC 800M, AC 800C and Advant Controller 250, by mirroring all functions in the controllers and their I/O to Operate IT Process Portal from Control Builder Professional.
Connectivity Server	Provides the integration between the Operate IT system and a controller or a device capable of sourcing data.
Contingency	An electrical network within the plant consists of at least one load busbar to which loads, generation and the public grid can be connected. Several of these electrical networks can exist at the same time within the plant electrical network. Each combination is called a contingency.

Term	Description
Control Builder M	Name of the Control Builder M software products. Available in three versions: Control Builder Basic, Control Builder Standard and Control Builder Professional. These are fully integrated Windows 2000 Professional / Windows XP applications for efficient configuration and programming of the ABB controllers AC 800M, AC 800C and Advant Controller 250.
Control Builder Professional	The powerful programming version of the Control Builder M software.
Control Builder Project Explorer	The name of the project navigator in the Control Builder M software, which is used to navigate through, create or modify an automation project.
Control IT for AC 800M/C	The name of the collection of ABB hardware and software products for AC 800M/C.
Control Network	Product name of the ABB network between AC 800M/C controllers, tools and Operator workplaces.
Critical breaker	A breaker the position of which determines the electrical network configuration.
Display Element	A graphical element, which illustrates an object (motor, regulator etc.). In general, clicking on the element will show a faceplate for supervision and control of the object.
Droop mode (PMS-level)	In this mode the generator is running in manual control, the adjustment of speed is operated from operator station by using UP/DOWN keys. Machine behaviour is according to the droop line.
Electrical network	A combination of components such as load busbars, generators, transformers and cables connected electrically. A network contains at least one load busbar.
Faceplate	A configurable type of graphic interface normally used by operators for process supervision and control.
Graphics Type Library for AC 800M/C	One part of the AC 800M/C Controller Integration product (the other part is the Aspect System for AC 800M/C, see above). Graphic aspects such as display elements, faceplates and dialogs are available for use in Operate IT Workplace. The graphic aspects correspond to the types delivered in the Control Builder library.
HSI	Human System Interface.
Instance	An individual description of the type. Every instance has the characteristics defined by the type, but each instance has its own individual behaviour.
I/O	Input / Output signals.
IP	Internet Protocol.
Island	A network with no connections to the public grid. An Island contains at least power generation and load components.
ISO mode (PMS-level)	Isochronous mode. An automatic mode for the speed governor. This mode is only allowed when a machine is not grid connected. For islanded networks, only one machine can be “master of frequency”.
IT	Information Technologies.
LVS	Low Voltage Switchgear.
MCC	Motor Control Centre.

Term	Description
MMS	Manufacturing Message Specification. Specifies the structure of messages used for industrial communication (manufacturing, process robotics, etc.). This is the application layer used within MAP (Manufacturing Automation Protocol), a specification for open communication based on the OSI model. MMS for AC 800M/C is a protocol used in ABB Control Network communication.
MVAr mode (PMS-level)	A manual setpoint mode for the AVR. An operator must issue the MVAr setpoint.
MW mode (PMS-level)	A manual setpoint mode for the governor. The MW setpoint must be issued by an operator.
Object	Objects represent the combination of data and associated procedures (operations that can be applied to the data) are represented. Objects represent significant elements or functions in the process control/process automation domain. Combining these objects creates applications.
OLE	Object Linking and Embedding.
OPC	OLE for Process Control. The Control IT for AC 800M/C software contains an OPC Server for AC 800M/C.
Operate IT	The name of the collection of ABB products for daily operation and supervision of an automated process. These products provide an environment for different user categories, such as engineers, operators and maintenance personnel.
P-control / Q-control mode (PMS-level)	Automatic setpoint modes for the active/reactive power control scheme of a plant. The PQ control algorithm calculates the MW/MVAr setpoints, which are distributed to the generators' governor and AVR.
Plant Explorer	The name of the project or plant navigator in the Operate IT workplace for creating the Aspect Objects that are used for assembling the various components of the plant. Can also be used for browsing and searching the structures of the plant.
PMS	Power Management System.
PPM	Process Power Manager
Process Panel	The name of the ABB product for local process monitoring and control. The key functionality is presentation of process information (numerical, text or graphical) on local operator or process panels including functional control keys.
Process Portal A	The name of the ABB product for process monitoring and control. The key functionality is presentation of process graphics, usage of faceplates, presentation of trends, and presentation of alarms.
Structure	A hierarchical tree organization of Aspect Objects that describes the dependencies between the real objects. An Aspect Object can exist in multiple structures, e.g. both in a functional structure and in a location structure.
Synchronoscope	An instrument for indication of the "in phase" condition of a reference supply (busbar) and a synchronizing supply (generator) to determine the correct moment for circuit breaker closure.
System Extension	A plug-in software package, which provides the Operate IT system with extended functions and properties.
Type	A general description of a unit that defines the behaviour of an individual unit called Instance. See also Instance.

Term	Description
Voltage mode (PMS-level)	An automatic mode for the AVR of a generator. This mode is only allowed when a machine is not grid connected. For islanded networks, only one machine can be “master of voltage”.

Related Documentation

Related documentation includes, but is not limited to, the table below. Other ABB 800xA documentation may also be relevant when configuring an 800xA Process Power Manager.

Table 2 Related Documentation

Document ID	Title
3BNP100234-0390	PMS Library 5.6-5 Release Notes
3BNP100234-0391	PMS Library 5.6-5 Circuit Breaker Control
3BNP100234-0392	PMS Library 5.6-5 Generator Control
3BNP100234-0393	PMS Library 5.6-5 Transformer Control
3BNP100234-0394	PMS Library 5.6-5 Loadshedding
3BNP100234-0395	PMS Library 5.6-5 Power Control
3BNP100234-0396	PMS Library 5.6-5 Restart & Reacceleration
3BNP100234-0397	PMS Library 5.6-5 Report Data Collector
3BNP100234-0398	PMS Library 5.6-5 Synchronization
3BSE037410	Administration and Security

Target Audience

This user manual is primarily intended for technical sales personnel, application, system engineers and maintenance personnel within ABB, external users and customers.

This user manual does not contain last-minute product information and updates which might affect functionality and/or performance. For information on last revisions, late changes and restrictions the user shall refer to document *Release Notes.*

Some graphics have been carried over from previous loadshedding manuals, hence Windows frames, and aspect names, library versions, etc. might be different than in current 800xA and PMS version. (e.g. PG2 suffix in aspect names is no longer present, etc.)

Compatibility

For compatibility with previous versions of the product, refer to the *Release Notes*.

System Security

The supplier of automation systems, based on PMS libraries, is responsible for the system integrity and security. We strongly recommend that strict password policies are applied.

Reference is made to document *Administration and Security*. The whole manual must be carefully consulted, with special attention given to *Security Planning* and *Security Configurations* for guidelines regarding system security, user authentication, and password policies and setting up audit trails.

Section 1 Introduction

The synchronization function in the PMS Library is based on the control module type *pmsSNSyncSuperv*. The control module supervises up to 15 energized networks and can provide synchronization across dedicated circuit breakers (synchronize-able breakers) interacting with relevant breakers, generators and synchronizing equipment (e.g. ABB Synchrotact).

The synchronization feature interacts with control modules from other libraries:

- ***pmsTopologyDet (****pmsMatrixLib)*
- ***pmsCBSynchM*** *(pmsCBLib)*
- ***pmsGenM*** *(pmsGenLib)*

The synchronization feature can handle up to:

- 10 synchronize-able circuit breakers
- 15 generators participating in synchronization
- 15 subnetworks

Section 2 Function

2.1 General

The *pmsSNSynchSuperv* module collects synch requests from synchronize-able circuit breakers, provides selection of relevant generators and subsequently interacts with a synchronizing devise to initiate synchronization across the selected circuit breaker.

The synchronization process requires the voltage level, frequency and phase on both sides of the circuit breaker to be equal before the breaker is allowed to close. To achieve synchronization, one side of the circuit breaker (defined as the variable side, U-Var) is adjusting the voltage and frequency, by means of a participating generator, to be the same as the voltage and frequency on the other side of the circuit breaker (defined as the reference side, U-Ref).

A typical synchronization process is based on the following field equipment:

- Synchronizing device, e.g. ABB Synchrotact
- Circuit breaker selection relays
- Generator selection relays or external selection code
- U-Var/U-Ref exchange relay

2.2 Features

2.2.1 Network determination

The control module pmsTopologyDet supervises the network configuration of the plant and determine the contingencies that are energized, based on the feedback position of the critical breakers.

2.2.2 Selection relays for Circuit Breakers

Up to 10 circuit breakers can be interfaced with one pmsSNSyncSuperv control module. The following interactions are provided to the operator:

- activation of circuit breaker selection relay
- feedback monitoring from the selected relay

2.2.3 Frequency and Voltage measurements

The frequency and voltage measurements from the U-Var and U-Ref side of the circuit breaker can be monitored and validated compared to the network determination. If there are inconsistencies (e.g. spurious powered bus or spurious dead bus), alarms will be raised and the synchronization process will be cancelled.

2.2.4 Selection relays for Generators

Up to 15 generators can be interfaced with one pmsSNSyncSuperv control module. The following interactions are provided to the operator:

- activation of generator selection relay(s)
- feedback monitoring from the selected relay(s)

2.2.5 Exchange relay for U-Var/U-Ref side

When synchronizing two island networks, the pmsSNSyncSuperv control module can detect if it is required to activate a relay for interchanging the measurements from the variable/reference side of the circuit breaker, so that it will correctly be applied to the synchronizing device. The following features are supported:

- automatic activation of exchange relay
- feedback monitoring from the exchange relay

2.2.6 Signal interface with Synchronizing Device

The pmsSNSyncSuperv control module can monitor the signal interface to/from the synchronizing device for proper response throughout the phases of the synchronization. The following signals are supported:

2.2.6.1 Feedback signals from the Synchronizing device:

- Local/Remote point of control (the device is in Local or Remote control)
- Ready (the device can be started)
- Operate (the device has started)
- Error (the device has a failure)

2.2.6.2 Command signals to the Synchronizing device:

- Start (the device is requested to begin the synchronizing operation)
- Stop (the device is requested to terminate the synchronizing operation)
- Parameter sets (the device is requested to activate a predefined parameter set, depending on the characteristics of the selected generator(s))

2.2.7 Governor/AVR mode handling for Generators

When a generator is selected on the U-Var side of the circuit breaker, it will participate in the synchronization process by adjusting the frequency and/or voltage of the variable side. The control module pmsSNSyncSuperv will influence the modes of the governor and AVR in the following way:

- The selected generator(s) will be set in droop mode for governor and droop mode for the AVR, to receive the raise/lower pulses according to the adjustments dictated by the synchronizing device.
- The generators that run parallel to the selected machine(s) are set in MW mode for the governor and PF mode for the AVR, to avoid MW/MVAr transfer between the generators.
- After the synchronizing session is completed, all governors and AVRs will return to their previous modes.

The pmsSNSyncSuperv module does not check if the previous modes are viable for the new electrical contingency. For example; one should not reinstate ISO mode in if a connection to Grid has been established. This is done by the pmsCMM (Central Mode Manager) found in both pmsPQSmallLib and pmsPQLargeLib.

2.2.8 Status indication for synchronization in progress and for U-VAR/U-REF side

The control module pmsSNSyncSuperv will provide an indication that the synchronization sequence is in progress and it will also present the identity numbers of the variable and reference side of the selected circuit breaker.

2.2.9 Time-out of synchronization session

The duration of the synchronization session is compared to a configurable time-out setting and when the period has elapsed, the control module pmsSNSyncSuperv will raise an alarm and cancel the software sequence.

2.2.10 Alarm & Event handling during the synchronizing process

Critical operational changes that affect the synchronization sequence are recorded and presented in Alarm and Event lists.

2.2.11 Optional direct operation of the synchronization sequence

The module pmsSNSyncSuperv automatically controls the interaction with the pmsCBSyncM and the pmsGenM control modules at certain steps of the synchronization software sequence. Alternatively, there is an option to allow direct operation of all the necessary steps (i.e. select a circuit breaker, select the generator(s), start or stop the synchronization device, etc.).

2.3 Synchronizing device

The synchronizing device is an essential equipment for the synchronizing process with facilities for:

- measuring voltage, frequency and phase angle on both sides of a circuit breaker
- increase/decrease output commands for adjusting the voltage and frequency of one side of the breaker (U-Var) against the other side (U-Ref)
- synchro-check relay for safe closure operation of the circuit breaker
- close relay for direct closure of the circuit breaker
- monitoring signals for status and operation of the synchronization process
- local panel with facilities for manual operation (e.g. push-buttons, synchronoscope, measurement instruments)

2.4 Circuit breaker selection relays

Selection relays are required when multiple circuit breaker closure is supported by the same synchronizing device. A panel shall provide selector switches and relays for routing the proper U-Var/U-Ref measurements from each selected breaker to the synchronizing device. It should be possible to activate the relays both locally (by selector switches) and remotely (via the control system).

2.5 Generator selection relays

If a selection of multiple generators shall receive increase/decrease commands for voltage and frequency adjustments, selection relays or external selection (routing) code is required to direct the commands to the correct AVR(s) and Governor(s). The generators may be selected from a list of available generators presented in the faceplate of *pmsSNSynchsuperv.*

A panel with selector switches and relays, or external selection code, must be configured to route the increase/decrease commands to the proper generator(s). It should be possible to activate the relays, or external selection code, both locally and remotely.

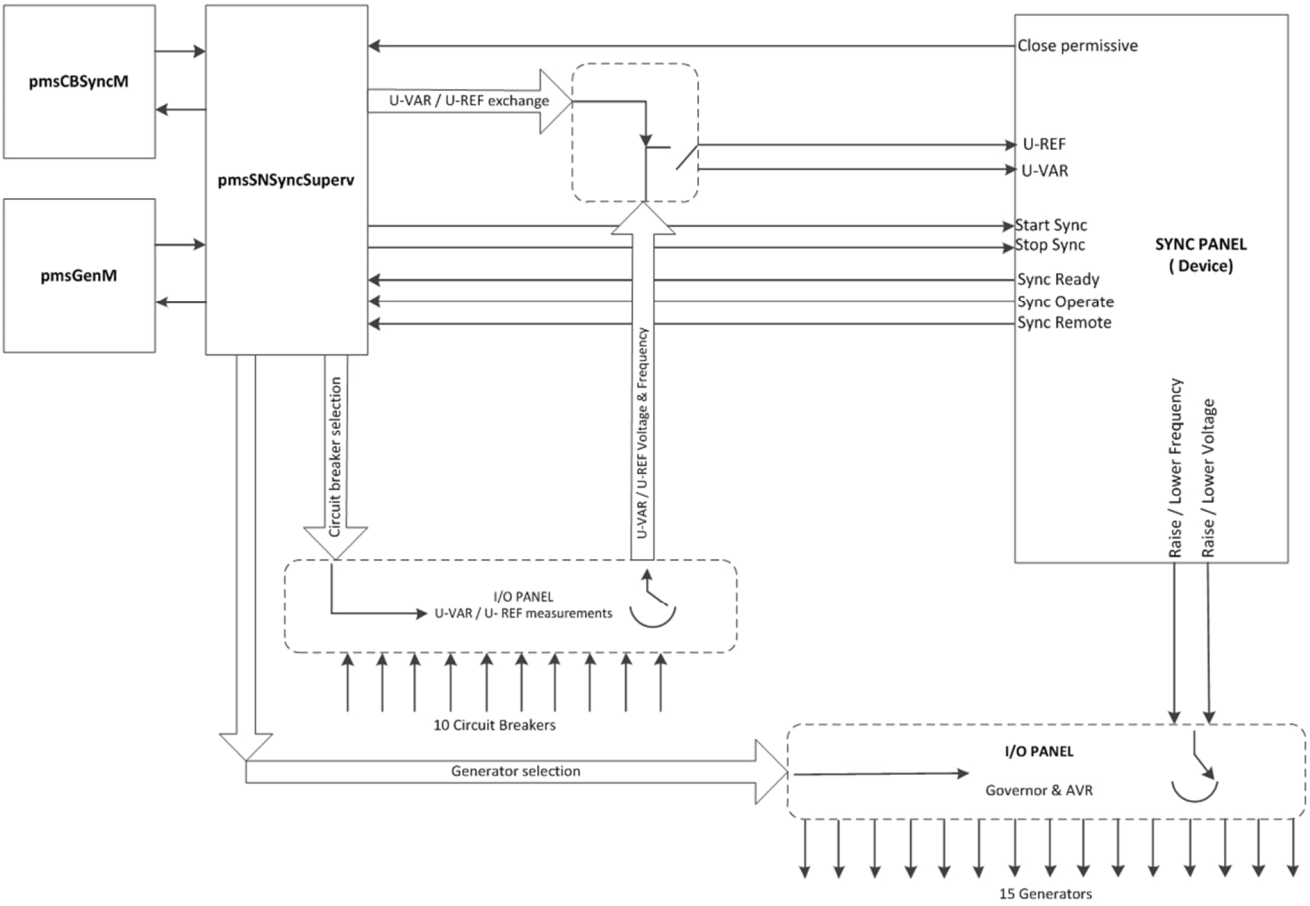


Figure 1 Overview of the synchronization system

2.6 U-Var/U-Ref exchange relay

When the selected circuit breaker is connecting two energized busbars (e.g. a bus-coupler) where either side can be the U-Var or U-Ref, a relay is normally installed for exchanging the reference and variable side. The purpose of the exchange relay is to swap the measurements applied to the synchronizing equipment, depending on the side of the bus that the selected generator(s) is connected to.

The circuit breaker must be closed, automatically or manually, through the synchronizing device. The close command output must always be routed through a synch-check relay.

In the case of an automatic closure, the synchronizing device shall pass the command to the synch-check relay automatically which subsequently releases the command to close the breaker when frequency, voltage and phase-angle match, i.e. a synchro-check function.

For manual synchronization, the synchronizing device will receive a manual close release request. The signal is passed to the synch-check relay which releases the close command at the right moment, closing the breaker when voltage, frequency and phase-angle match.

Section 3 Matrix library

3.1 General

All PMS library features depends on live network determination. This is provided by the following modules in *pmsMatrixLib*:

- ***pmsBusCon***
  - Creates a digital representation of a de-energized electrical plant configuration.
- ***pmsTopologyDet***
  - Combines the de-energized plant interpretation with actual critical breaker status and thus provides a digital representation of energized networks.

3.2 Introduction pmsBusCon

The *pmsBusConn* module detects the de-energized electrical plant configuration based on user input derived from the single line diagram. The input is done via faceplate.

The digital representation of the single line diagram is available to the *pmsTopologyDet* module via *MatrixIndex,* a structured data type for up to 160 circuit breakers.

Figure 2 Control module pmsBusConn

Table 3 Parameter configuration for pmsBusConn control module

Parameter	Direction	Significance
Reset	Input	IN: Clear index numbers, output *MatrixIndex* is cleared when TRUE
MatrixIndex	Output	OUT: Calculated index numbers, represents the de-energized electrical plant

3.3 Detailed Engineering

3.3.1 Network determination

As an example we shall configure the simple single line diagram shown below

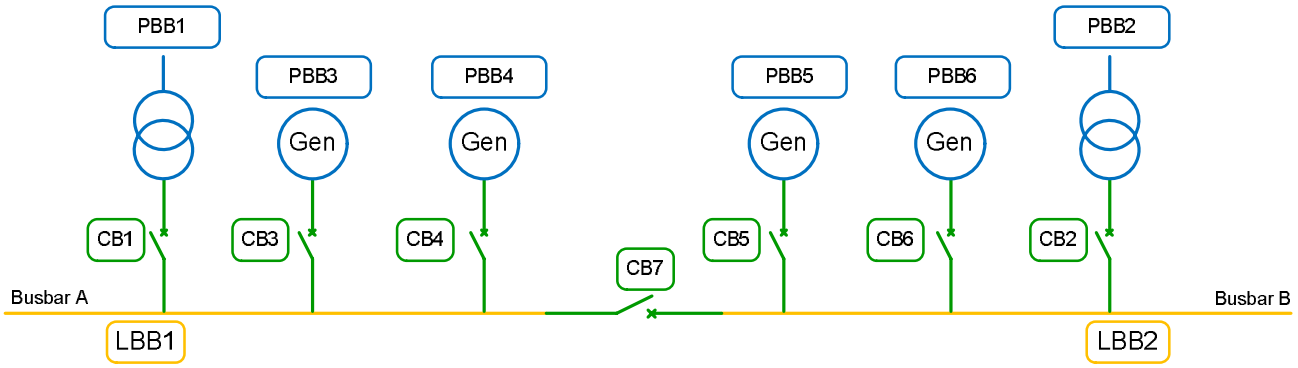


Figure 3 Simple single line diagram

1. Assign numbers to the single line diagram with labels according to the following rules:
    a. Assign generators and grid connections to the available 35 PBB identifiers. PBB1 to PBB4 is reserved for the grid connections if necessary. E.g. if there is only one grid connection, it must be assigned to PBB1, PBB2 is then first generator, and so on.
    b. Assign busbars to the available 35 LBB identifiers. Single loads, substation types, generators and grids must be directly connected to the load busbars.
    c. Critical breakers interconnect identified PBBs and LBBs shall have identities starting from CB01 up to maximum CB160.
2. Instantiate *pmsBusConn* and *pmsTopologyDet.*
3. Use the faceplate of the pmsBusConn, to enter busbar numbers that each CB interconnects.
    a. According to Figure 2 the bus-coupler CB7 interconnects LBB1 and LBB2. Enter this into the faceplate of pmsBusConn, as shown in Figure 4.

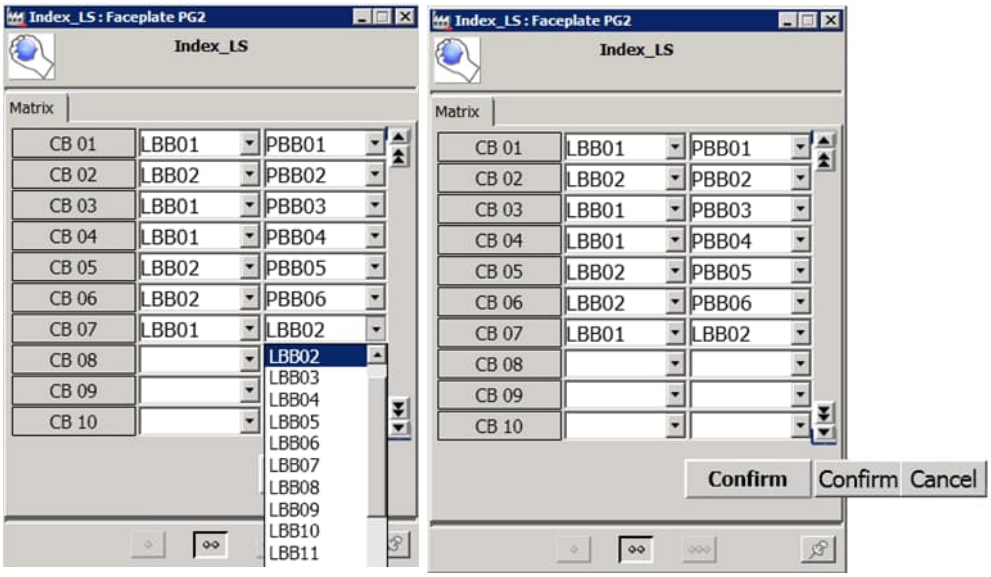


Figure 4 pmsBusConn faceplate

The digital representation of the de-energized electrical plant configuration available from *pmsBusCon* on output parameter *MatrixIndex*. The datatype is *CBIndex*.

Table 4 Parameter configuration for matrix index numbers (CBIndex)

Parameter	Parameter direction	Description
CBIndex.CB001_Index1	Input	Matrix number Index1 for CB01
CBIndex.CB001_Index2	Input	Matrix number Index2 for CB01
CBIndex.CB002_Index1	Input	Matrix number Index1 for CB02
CBIndex.CB002_Index2	Input	Matrix number Index2 for CB02
. . .		Matrix numbers Index1,2 for CB03-CB159
CBIndex.CB160_Index1	Input	Matrix number Index1 for CB160
CBIndex.CB160_Index2	Input	Matrix number Index2 for CB160

The *MatrixIndex* needs to execute once to be established. It is thus sufficient to execute *pmsBusCon* on demand as long as the CBIndex variable is cold made retain.

Some users choose to hardcoding established MatrixIndes data.

Matrix indexes shall not be changed online, but requires a warm download.

3.4 Introduction pmsBusCon

The *pmsTopologyDet* module reads the de-energized network representation and combine it with circuit breaker positions to determine existing energized network topologies (i.e. contingencies).

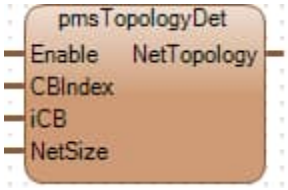


Figure 5 Control module pmsBusConn

Table 5 Parameter configuration for pmsBusConn control module

Parameter	Direction	Significance
Enable	Input	IN: Execute module when TRUE
CBIndex	Input	IN: Structured datatype, input from pmsBusCon output MatrixIndex
iCB	Input	IN: Structured datatype, contains critical breaker status
NetSize	Input	IN: Setting to avoid unnecessary code execution, can reduce cyclic load
NetTopology	Output	OUT: Digital representation of momentary live network topologies

3.5 Detailed Engineering

3.5.1 Network supervision

Energized electrical topologies are supervised by monitoring critical breaker status via the *iCB* parameter. The feedback signals are *BoolIO* data types and can be connected to digital input signals. This parameter is a structured data type with the feedback signals (i.e. CI, OI, SP and LO) for up to 160 circuit breakers.

Table 6 Parameter configuration for critical breaker position (iCB)

Parameter	Direction	Description
iCB.CB001.CI	Input	CB01 feedback signal “closed”
iCB.CB001.OI	Input	CB01 feedback signal “open”
iCB.CB001.SP	Input	CB01 feedback signal “test/racked-out”
iCB.CB001.LO	Input	CB01 feedback signal “lock-out”
iCB.CB002.CI	Input	CB02 feedback signal “closed”
iCB.CB002.OI	Input	CB02 feedback signal “open”
iCB.CB002.SP	Input	CB02 feedback signal “test/racked-out”
iCB.CB002.LO	Input	CB02 feedback signal “lock-out”
. . .	Input	CB03-CB159 feedback signals
iCB.CB160.CI	Input	CB160 feedback signal “closed”
iCB.CB160.OI		CB160 feedback signal “open”
iCB.CB160.SP	Input	CB160 feedback signal “test/racked-out”
iCB.CB160.LO	Input	CB160 feedback signal “lock-out”

The breaker is considered closed if feedback is according to Table 7.

Table 7 Feedback signals for a critical breaker position (iCB)

Parameter	Direction	Value	Description
iCB.CBxxx.CI.Value	Input	true	This signal monitors the closed position of the breaker. The limit switch for the closed indication of the breaker must report that there is a confirmed “closed” position.
iCB.CBxxx.OI.Value	Input	false	This signal monitors the open position of the breaker. The limit switch for the open indication of the breaker must report that there is no confirmed “open” position.
iCB.CBxxx.SP.Value	Input	true	This signal monitors if the breaker is in service. A feedback signal from the breaker must report that the breaker is not “racked-out” and not in “test” position.
iCB.CBxxx.LO.Value	Input	false	This signal monitors if the breaker is tripped. A feedback signal from the breaker must report that the breaker does not receive a trip command from a “lock-out” relay.

Loadshedding requires fastest possible critical breaker status update. We thus recommend that relevant IO is connected directly to the iCB structure, or via fast executing external code in case two physical breakers are combined into one critical breaker.

The output of *pmsTopologyDet* is made available to other PMS functions, via the output parameter *NetTopology*. This parameter is a structured data type which contains the topology of all 35 possible subnetworks, as shown in Table 8.

Table 8 Parameter configuration for network topology (NetTopology)

Parameter	Parameter direction	Description
NetTopology.PBB01	Input	Number for the subnetwork that the PBB01 belongs to.
. .	Input	Similar numbers for PBB02-PBB34.
NetTopology.PBB35	Input	Number for the subnetwork that the PBB35 belongs to.
NetTopology.BB01	Input	Subnetwork number of switchgear BB01.
. .		Similar numbers of switchgear for BB02-BB34.
NetTopology.BB35	Input	Subnetwork number of switchgear BB35.
CB_opened	Output	Parameter is set to true for one scan when one of the critical breakers is tripped.
RefreshNet	Output	Parameter is set to true for one scan when one of the critical breakers changes its position.
NoActiveSN	Output	Number of active subnetworks in the plant.

Section 4 Synchronization library

4.1 General

The synchronization library, *pmsSNLib* contains the following control modules:

- ***pmsCBSN*** – multiplexing interface for up to 10 synchronize-able circuit breakers
- ***pmsGenSN*** – multiplexing interface for up to 15 generators
- ***pmsSNSyncSuperv*** – main control module for synchronizing supervision
- ***pmsSimSynchrotact*** – simple control module simulating ABB Synchrotact interaction

4.2 Introduction – pmsCBSN

The pmsCBSN control module is handling the interface from up to 10 circuit breaker modules pmsCBSyncM. A block presentation of the module is shown in Figure 6. The parameters are briefly described in Table 9.

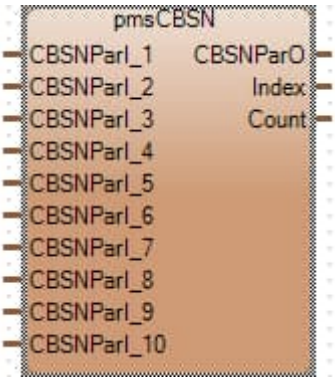


Figure 6 Control module pmsCBSN

Table 9 Parameters for pmsCBSN control module

Parameter	Direction	Description
CBSNParI_1… CBSNParI_10	Input	Each input parameter is a structured data type for receiving the components of *CBSynPar* from 10 different pmsCBSyncM control modules.
CBSNParO	Output	A structured data type for filtering one of the 10 incoming *CBSNParI_1…CBSNParI_10* data.
Index	Output	The identity number for the selected pmsCBSyncM control module.
Count	Output	The count number of the selected pmsCBSyncM control modules.

4.3 Detailed Engineering – pmsCBSN

The control module pmsCBSN multiplexes data from up to 10 different pmsCBSyncM control modules. The features of the pmsCBSN module are:

- **Parameters *CBSynPar* from 10 pmsCBSyncM control modules**

  The parameters *CBSynPar* from up to 10 different pmsCBSyncM modules can be processed with one pmsCBSN control module.

- **Index number from the selected pmsCBSyncM module**

  Index number (configured for each pmsCBSyncM control module) of selected circuit breaker for synchronization, is an output from the pmsCBSN control module.

- **Count number of the selected pmsCBSyncM modules**

  When more than one circuit breaker is selected for synchronization, the count number will be calculated by the pmsCBSN control module.

4.3.1 Parameters CBSynPar from 10 pmsCBSyncM control modules

The output parameter *CBSynPar* of the circuit breaker module shall be interconnected to the input *CBSynPar* of the *pmsCBSN control* module.

When more than one circuit breakers are interfaced by the same synchronization module, the *CBSNParI_1… CBSNParI_10* must be utilized to collect the data from the different breakers. Depending on the selected breaker, the output parameter *CBSNParO* will contain the data from one of the relevant *CBSNParI_1… CBSNParI_10* inputs.

Table 10 Parameters pmsCBSNParI_1… pmsCBSNParI_10

Parameter	Description
CBSNParI_1.MBBA	Input from 1st circuit breaker - Bus bar configuration number for the variable side of the circuit breaker.
CBSNParI_1.MBBB	Input from 1st circuit breaker - Bus bar configuration number for the reference side of the circuit breaker.
CBSNParI_1.SyncType	Input from 1st circuit breaker - Configuration number for the circuit breaker (generator, grid, network).
CBSNParI_1.SynIndex	Input from 1st circuit breaker - Configuration number for the circuit breaker Index.
. . .	Input from circuit breakers 2 – 9.
CBSNParI_10.MBBA	Input from 10th circuit breaker - Bus bar configuration number for the variable side of the circuit breaker.
CBSNParI_10.MBBB	Input from 10th circuit breaker - Bus bar configuration number for the reference side of the circuit breaker.
CBSNParI_10.SyncType	Input from 10th circuit breaker - Configuration number for the circuit breaker (generator, grid, network).
CBSNParI_10.SynIndex	Input from 10th circuit breaker - Configuration number for the circuit breaker Index.

4.3.2 Index number from the selected pmsCBSyncM module

The output parameter *Index* shall present the identity number of the selected breaker (*pmsCBSyncM:Index*). This output is not required to be further connected to another software module. It can be used for information and validation of the application configuration.

When more than one circuit breaker is selected, the parameter Index will show value -1.

4.3.3 Count number of the selected pmsCBSyncM modules

The pmsCBSN control module is monitoring how many circuit breakers are being selected for the synchronization process. This is reflected in the output parameter *Count*. This output is not required to be further connected to another software module.

When *Count* >1, the synchronization process will be cancelled.

4.4 Introduction – pmsGNSN

The pmsGNSN control module is handling the interface from up to 15 generator modules pmsGenM. A block presentation of the module is shown Figure 7. The parameters are briefly described in Table 11.

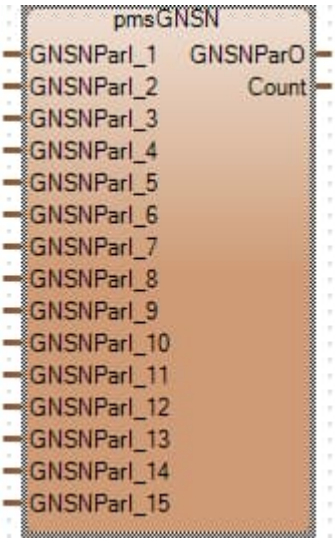


Figure 7 Control module pmsGNSN

Table 11 Parameters for pmsGNSN control module

Parameter	Direction	Description
GNSNParI_1… GNSNParI_15	Input	Each input parameter is a structured data type for receiving the components of *GNSynPar* from 15 different pmsGenM control modules.
GNSNParO	Output	A structured data type for filtering one of the 15 incoming *GNSNParI_1…GNSNParI_15* data.
Count	Output	The count number indicates how many pmsGenM control modules are selected.

4.5 Detailed Engineering – pmsGNSN

The control module pmsGNSN works as switchboard function for processing the data from up to 15 different pmsGenM control modules. The features of the pmsGNSN module are:

- **Parameters *GNSynPar* from 15 pmsGenM control modules**

  The parameters *GNSynPar* from up to 15 different pmsGenM modules can be processed with one pmsGNSN control module.

- **Count number of the selected pmsGenM modules**

  The count number will be calculated by the *pmsGNSN* control module. This will indicate the number of generator sets that have been selected to participate in the synchronization process (refer to Figure 12).

4.5.1 Parameters GNSynPar from 15 pmsGenM control modules

The output parameter *GNSynPar* of the generator module shall be interconnected to the input *GNSynPar* of the pmsGNSN control module.

When more than one generators are interfaced by the same synchronization module, the *GNSNParI_1…GNSNParI_15* must be utilized to collect the data from the different generators. Depending on the selected generator, the output parameter *GNSNParO* will contain the data from the relevant *GNSNParI_1…GNSNParI_15* inputs.

Table 12 Parameters pmsGNSNParI_1… pmsGNSNParI_15

Parameter	Description
GNSNParI_1.GenIDFB.Gen1	Input from 1st generator - Index of selected generator
GNSNParI_1.SyncUnavailable.Gen1	Input from 1st generator - Available flags for participation.
. . .	Input from generators 2 - 14.
GNSNParI_15.GenIDFB.Gen15	Input from 15th generator - Index of selected generator.
GNSNParI_15.SyncUnavailable.Gen15	Input from 15th generator - Available flags for participation.

4.5.2 Count number of the selected pmsGenM modules

The pmsGNSN control module is monitoring how many generators have been selected for the synchronization process. This is reflected in the output parameter *Count*. This output is not required to be further connected to another software module. It can be used for information and validation of the application configuration.

4.6 Introduction – pmsSNSynchSuperv

The pmsSNSyncSuperv control module is included in the *pmsSNLib library*. A block presentation of the control module is shown in Figure 8.

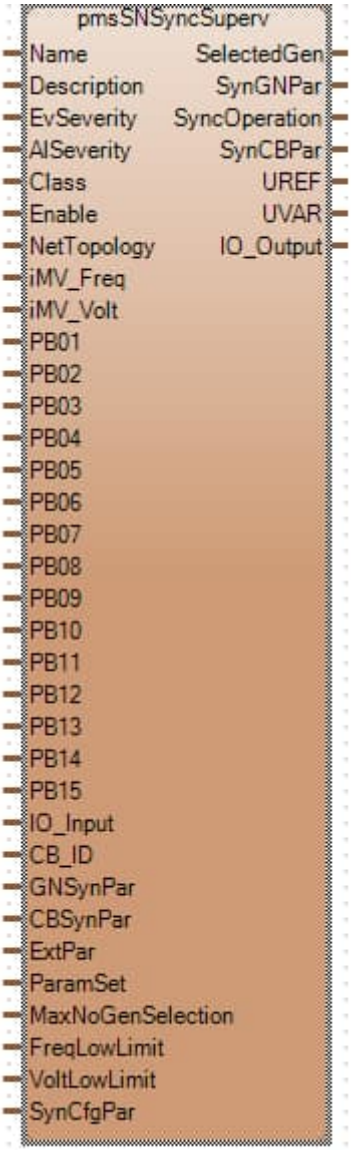


Figure 8 Control module pmsSNSyncSuperv

Table 13 Parameters of the control module pmsSNSyncSuperv

Parameter	Direction	Significance
Name	Input	Name of the object (e.g. synchronizing equipment tag). With the name upload tool of the process portal, this property will be used for identifying the object in the 800xA system. The name will be used for grouping the alarms and events and identifying the faceplate of an object. The name must be unique in the project.

Parameter	Direction	Significance
Description	Input	Description of the object (e.g. synchronizing cabinet information). With the name upload tool of the process portal, this property will be used for identifying the object in the 800xA system.
EvSeverity	Input	Event severity. The event severity can be used for filtering the event list. Range 1-1000.
AlSeverity	Input	Alarm severity. The alarm severity can be used for filtering the alarm list. Range 1-1000.
Class	Input	Alarm and Event Class. This parameter can be used for grouping objects to appear in separate alarm/event lists. Range 1-9999.
Enable	Input	If TRUE the control module is executed.
NetTopology	Input	Structured parameter: Network Configuration Matrix from pmsTopologyDet.
iMV_Freq	Input	Measurements for busbar frequency on both sides of the circuit breaker. This parameter is a structured data type.
iMV_Volt	Input	Measurements for busbar voltage on both sides of the circuit breaker. This parameter is a structured data type.
PB01…PB15	Input	Power Bus bar type identification for the network determination. 1 = Generator, 2= Grid. NOTE: Only PB01 and PB02 can be assigned with value = 2.
IO_Input	Input	Input signals for monitoring the status and feedbacks from the Synchronizing equipment and the field relays.
CB_ID	Input	Identity assignment for the CBs monitored by the Synchronizing equipment.
GNSynPAr	Input	Interface from Generator control module. Interface input signals received from pmsGenM module (Index, unavailable, etc.) This parameter is a structured data type.
CBSynPar	Input	Interface from Circuit Breaker control module. Interface input signals received from pmsCBSyncM module (mode set, etc.). This parameter is a structured data type.
ExtPar	Input	External parameters for application interaction. With this parameter it is possible to block the participation and the selection of the generator. The parameter set utilized by the synchronization equipment, depending on the generators participating in the synchronization process, can be defined using this parameter.
ParamSet	Input	Assignment of the parameter set utilized by the synchronization equipment, depending on the generator participating in the synchronization process.

Parameter	Direction	Significance
MaxNoGenSelection	Input	Assignment of the maximum number of generator sets that are allowed to participate in adjusting of frequency/voltage, on the Variable side of a network circuit breaker, during the synchronization process.
FreqLowLimit	Input	Frequency low limit value for spurious dead or powered bus condition.
VoltLowLimit	Input	Voltage low limit value for spurious dead or powered bus condition.
SynCfgPar	Input	Configuration parameter for selection relays time-out settings and circuit breaker names for event messages.
SelectedGen	Output	Indication of the generators that have been selected to participate in the synchronization process from the pmsSNSyncSuperv faceplate tab Main.
SynGNPAr	Output	Interface to Generator control module. Interface output signals send to the pmsGenM module (mode set, etc.) This parameter is a structured data type.
SyncOperation	Output	Indication that the synchronization control module is initiated and interacting with the Synchronizing equipment.
SynCBPar	Output	Interface to Circuit Breaker control module. Interface output signals sent to the pmsCBSyncM module (operate, cancel, etc.) This parameter is a structured data type.
UREF	Output	Indication of the busbar identity being the Reference side during the synchronization process.
UVAR	Output	Indication of the power busbar identity being the Variable side during the synchronization process.
IO_Output	Output	Output signals for commands to the Synchronizing equipment and the field relays.

For the spurious dead or powered bus detection to work, it is necessary that both limits FreqLowLimit and VoltLowLimit have a value unequal zero. If any of them are equal zero no test or restrictions for starting synchronisation are made.

4.7 Detailed Engineering

4.7.1 Selection relays for Circuit Breakers

The control module *pmsSNSyncSuperv* can supervise up to 10 circuit breaker relays for selection in the synchronization process. Each relay must be assigned with an identity number matching the *Index* parameter of a pmsCBSyncM circuit breaker module.

The circuit breaker relay identities are configured via the *CB_ ID* parameter. This parameter is a structured data type and receives up to 10 index numbers (one index number per pmsCBSyncM control module), as shown in Table 14.

Table 14 Identity (index) for circuit breaker relays

Parameter	Description
CB_ID.CB1	Circuit breaker index number for 1st CB in synchronization scheme.
CB_ID.CB2	Circuit breaker index number for 2nd CB in synchronization scheme.
CB_ID.CB3	Circuit breaker index number for 3rd CB in synchronization scheme.
CB_ID.CB4	Circuit breaker index number for 4th CB in synchronization scheme.
CB_ID.CB5	Circuit breaker index number for 5th CB in synchronization scheme.
CB_ID.CB6	Circuit breaker index number for 6th CB in synchronization scheme.
CB_ID.CB7	Circuit breaker index number for 7th CB in synchronization scheme.
CB_ID.CB8	Circuit breaker index number for 8th CB in synchronization scheme.
CB_ID.CB9	Circuit breaker index number for 9th CB in synchronization scheme.
CB_ID.CB10	Circuit breaker index number for 10th CB in synchronization scheme.

The CB_ID is used as a cross-reference between the parameter Index of a pmsCBSyncM circuit breaker module and the corresponding selection relay.

4.7.2 Operator interface for Circuit Breaker selection

The faceplate view of the *pmsCBSyncM* control module type has two command buttons to start/stop the interaction with the *pmsSNSyncSuperv* module. When the button for initiating synchronization is operated, as shown in Figure 9, the input parameter *CBSynPar.SynIndex* shall receive the corresponding Index assigned to the *pmsCBSyncM* module. If this number is equal to one of the *CB_ID* components (e.g. *CB_ID.CB7*), the relevant component from the *IO_Output* parameter will be activated (e.g. *IO_Output.CB7.Value*). The output represents the request to energize a selection relay for the corresponding circuit breaker

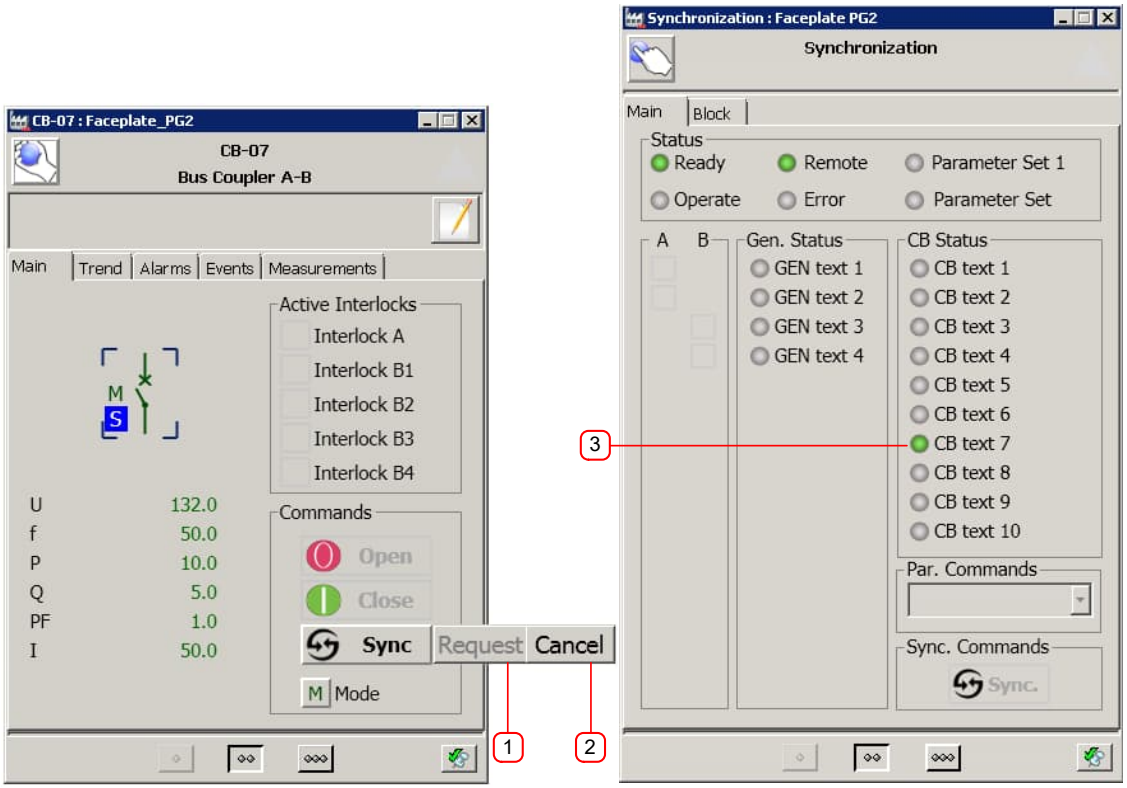


Figure 9 Synchronizing interaction from pmsCBSyncM faceplate and Main tab

Table 15 Synchronizing interaction from pmsCBSyncM faceplate and Main tab

Field	Item	Description
1	Push-button	Button to initiate the synchronization request
2	Push-button	Button to cancel (terminate) the synchronization request
3	Status box	Indication that the circuit breaker selection relay is activated

The feedback from activating a circuit breaker relay must be received via the parameter IO_Input.CB1 …CB10 (i.e. one digital input for each circuit breaker relay). If the feedback is not received within a configurable time-out setting, the control module pmsSNSyncSuperv will raise an alarm and the synchronization sequence will be cancelled. The time-out value is configured via the parameter SynCfgPar.SelCBTO and it is common for all the circuit breaker selection relays.

It is possible to change the descriptions (tag names) of the circuit breakers relays. This configuration is done via the tab Edit >Selection >CB Names from the extended faceplate view, as shown in Figure 10. A description must be entered in the text field followed by pressing the ENTER key. To hide a certain circuit breaker selection relay,

the corresponding text must be deleted and the field shall be left empty. A user with Application Engineer role can perform this configuration.

The configuration of the circuit breaker relay names is saved in the General Properties aspect of the pmsSNSyncSuperv object type in 800xA. It is important to take a backup of this aspect (e.g. by using the Import/Export tool from the 800xA Plant Explorer) after completing the configuration, in case there is a need to restore the settings.

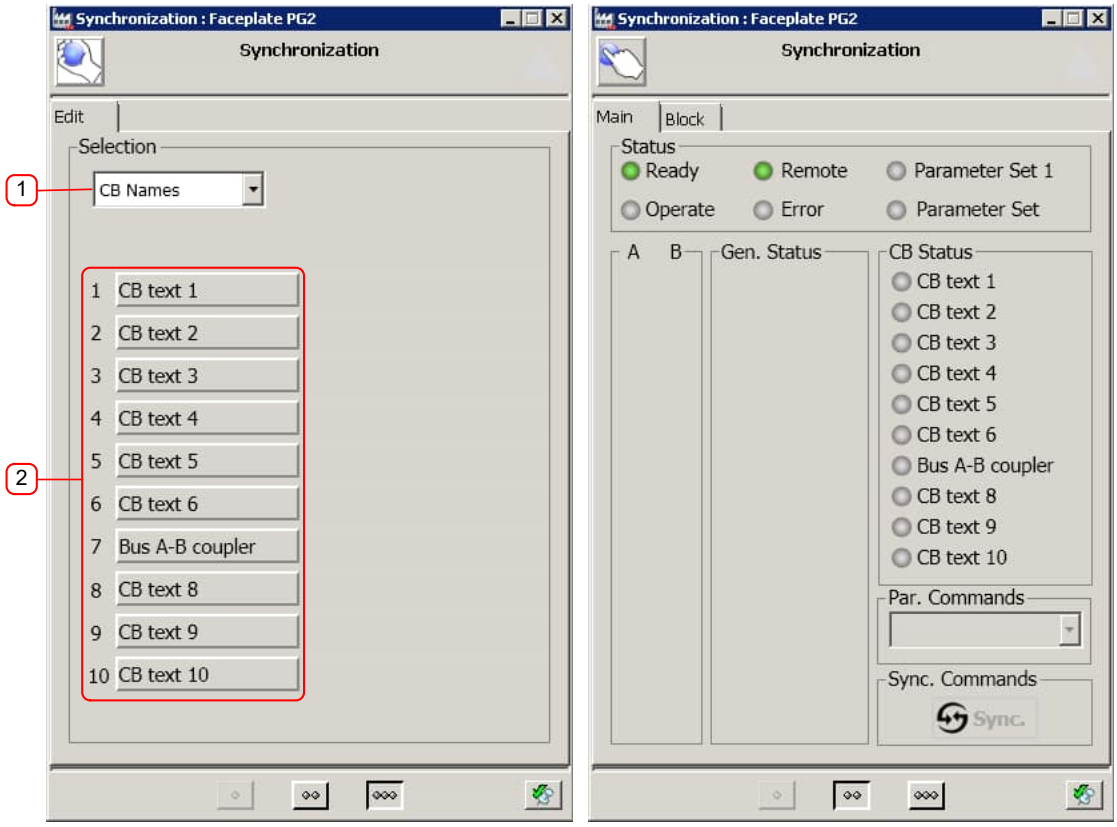


Figure 10 Faceplate tab Edit - CB Names

Table 16 Faceplate configuration for text description of circuit

Field	Indication	Item	Description
1	CB Names	Drop-down menu	When the option **CB Names** is selected the faceplate will show the text description input fields for the circuit breakers.
2	CB text 1…CB text 10	Text input fields	Text description. Empty field hides the CB Name from the faceplate tab **Main**.

When the configuration parameter SynCfgPar.DirectSyncOperation is true, the circuit breaker selection relays can be activated via check-boxes in the pmsSNSyncSuperv faceplate tab Main, as shown in Figure 11. This configuration is intended as an alternative operation method, where the pmsSNSyncSuperv control module is independent from the pmsCBSyncM and pmsGenM modules. The synchronization process will be executed according to the manual interaction from the faceplate buttons and not by the automatic sequence.

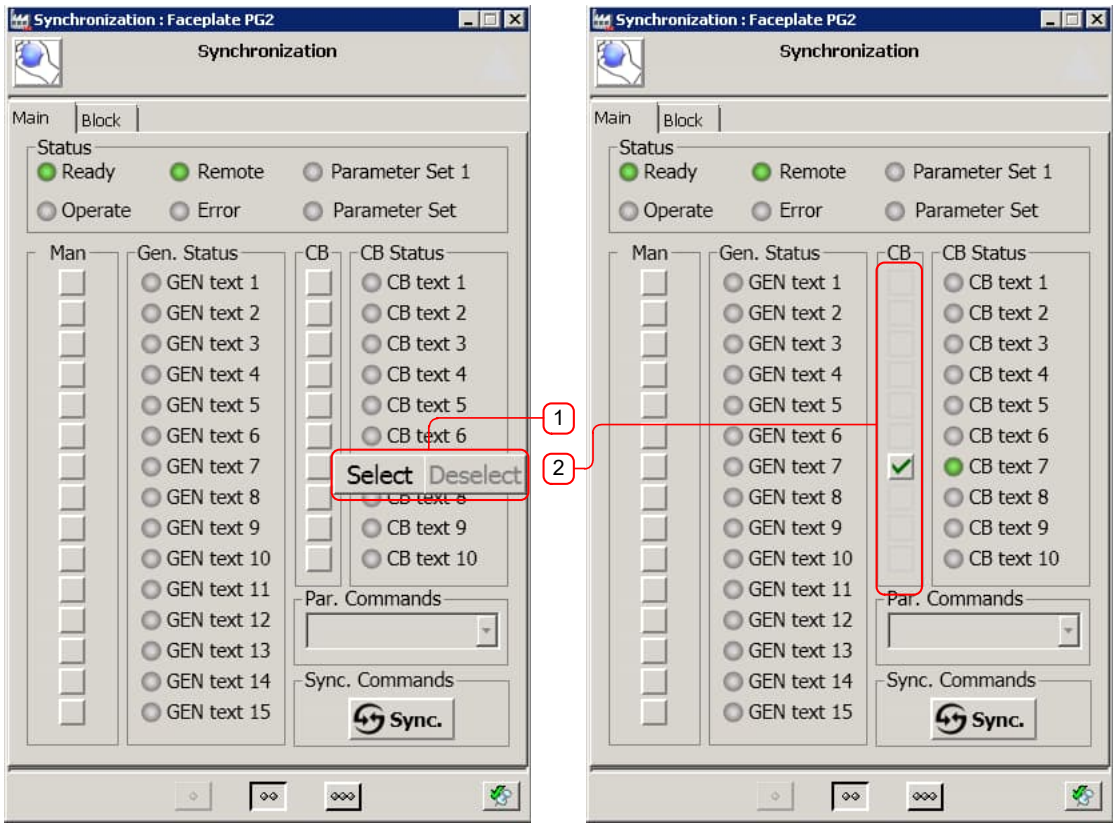


Figure 11 Direct circuit breaker selection

Table 17 Faceplate configuration for direct circuit breaker selection

Field	Indication	Item	Description
1	Selection menu	Push-button	If *SynCfgPar.DirectSyncOperation* = true, from the selection menu is possible to select or cancel the selection of a circuit breaker relay.
2	CB text 1…10	Check-boxes	If *SynCfgPar.DirectSyncOperation* = true, the selected check box will activate a circuit breaker selection relay.

When the parameter SynCfgPar.DirectSyncOperation is true, the visibility of the circuit breaker check-boxes listed in the faceplate tab Main is depending on the entered text via the tab Edit > Selection >CB Names (Figure 10) from the extended view of the faceplate. If an input text field is left empty, the corresponding circuit breaker will be hidden from the listed check-boxes.

After a circuit breaker relay has been selected all the other check boxes will be dimmed. In order to change the circuit breaker relay selection, first the current selected relay must be deselected.

4.7.3 Frequency and Voltage measurements

The control *module pmsSNSyncSuperv* can supervise the frequency and voltage measurements from the variable (U-Var) and the reference (U-Ref) side of the circuit breakers.

The measurements must be configured via the *iMV_Freq* and *iMV_Volt* parameters. The components of the parameters *iMV_Freq* and *iMV_Volt*, shown in Table 18 and

Table 19, refer to the busbar identities from the network determination matrix.

Table 18 Parameter configuration for Frequency measurements (iMV_Freq)

Parameter	Description
iMV_Freq.BB01.Value	Frequency measured value from bus PB01
iMV_Freq.BB02.Value	Frequency measured value from bus PB02
iMV_Freq.BB03.Value	Frequency measured value from bus PB03
.	Frequency measured values from bus PB04-PB14
iMV_Freq.BB15.Value	Frequency measured value from bus PB15
iMV_Freq.BB16.Value	Frequency measured value from bus LB01
iMV_Freq.BB17.Value	Frequency measured value from bus LB02
iMV_Freq.BB18.Value	Frequency measured value from bus LB03
.	Frequency measured values from bus LB04-LB34
iMV_Freq.BB50.Value	Frequency measured value from bus LB35

Table 19 Parameter configuration for Voltage measurements (iMV_Volt)

Parameter	Description
iMV_Volt.BB01.Value	Voltage measured value from bus PB01
iMV_Volt.BB02.Value	Voltage measured value from bus PB02
iMV_Volt.BB03.Value	Voltage measured value from bus PB03
.	Voltage measured values from bus PB04-PB14
iMV_Volt.BB15.Value	Voltage measured value from bus PB15
iMV_Volt.BB16.Value	Voltage measured value from bus LB01
iMV_Volt.BB17.Value	Voltage measured value from bus LB02
iMV_Volt.BB18.Value	Voltage measured value from bus LB03
.	Voltage measured values from bus LB04-LB34
iMV_Volt.BB50.Value	Voltage measured value from bus LB35

The measurements configured via the parameters iMV_Freq and iMV_Volt provide an additional check for validating the measurements applied directly (e.g. hardwired) on the synchronization device. The measurements are compared to the input parameters FreqLowLimit and VoltLowLimit and if a conflict is detected, an alarm will be raised and the synchronization sequence will be cancelled. The relevant alarms are described in Table 42 (items 1 and 2).
This function is enabled when the parameter SynCfgPar.DirectSyncOperation is false.

4.7.4 Selection Relays for Generators

The control module *pmsSNSyncSuperv* can supervise up to 15 generator relays for selection in the synchronization process. Each generator is defined via the network configuration matrix. For a generator to be represented as a power source, the value 1 shall be assigned to the parameters *PB01* to *PB15*, as shown in Table 20.

Table 20 Configuration of generators for network determination

Parameter	Description
PB01	PB01=1, for Generator with Index=1. PB01=2, for 1st Grid.
PB02	PB02=1, for Generator with Index=2. PB02=2, for 2nd Grid.
PB03	PB03=1, for Generator with Index=3
PB04	PB04=1, for Generator with Index=4
PB05	PB05=1, for Generator with Index=5
PB06	PB06=1, for Generator with Index=6
PB07	PB07=1, for Generator with Index=7
PB08	PB08=1, for Generator with Index=8
PB09	PB09=1, for Generator with Index=9
PB10	PB10=1, for Generator with Index=10
PB11	PB11=1, for Generator with Index=11
PB12	PB12=1, for Generator with Index=12
PB13	PB13=1, for Generator with Index=13
PB14	PB14=1, for Generator with Index=14
PB15	PB15=1, for Generator with Index=15

The parameters PB01 to PB15 are used as a cross-reference between the parameter Index of a pmsGenM generator module and the corresponding selection relay.

The maximum number of generator sets that can be selected to participate in adjusting the voltage/frequency on the variable side of a network breaker in the synchronization process cannot be higher than the value set for the parameter MaxNoGenSelection. When the value set for the MaxNoGenSelection parameter (e.g. MaxNoGenSelection = 2) has been reached, as shown in Figure 12, all the other generator check-boxes will be automatically dimmed, thus restricted from selection.

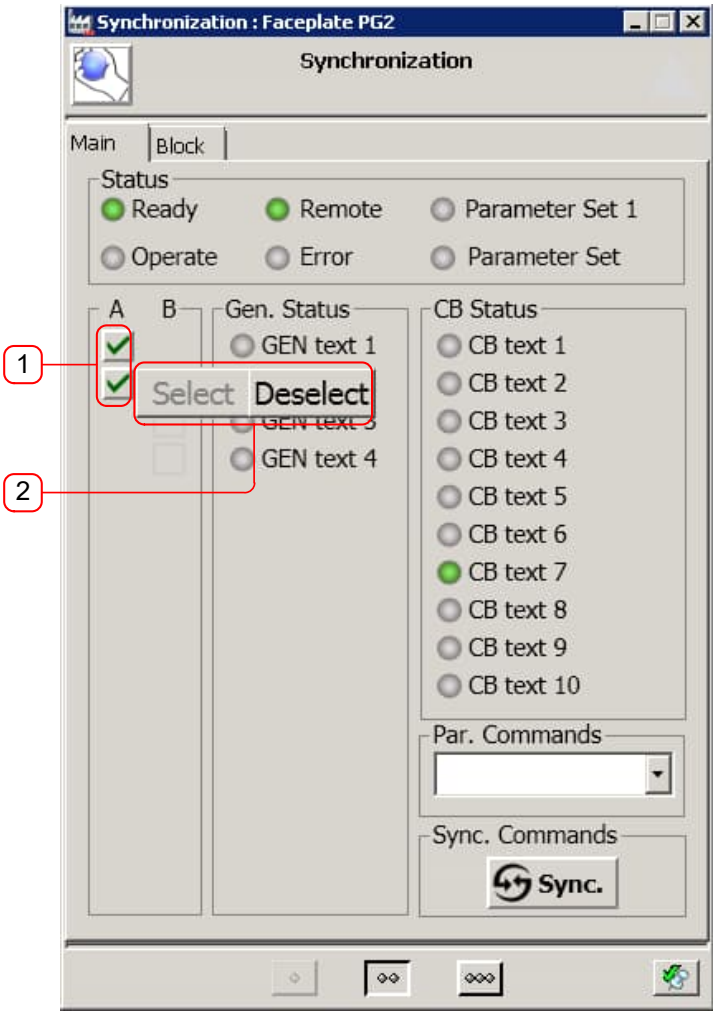


Figure 12 Faceplate tab Main - Generator selection

Table 21 Faceplate tab Main – Generator selection

Field	Item	Description
1	Check-box	Check mark indication for selection of the participating generators
2	Push button	Button for selection or cancel selection of a participating generator

When a generator is selected from the pmsSNSyncSuperv faceplate tab **Main**, as shown in Figure 13, (e.g. via the check-box for Generator 1, Generator 2), and the synchronization process has been started (from Sync. command button), the relevant output from the *IO_Output* parameter will be activated (e.g.*IO_Output.Gen1.Value*, *IO_Output.Gen2.Value*). This will activate the selection relays for the selected generators. This function is enabled when the parameter *SynCfgPar.DirectSyncOperation* is false.

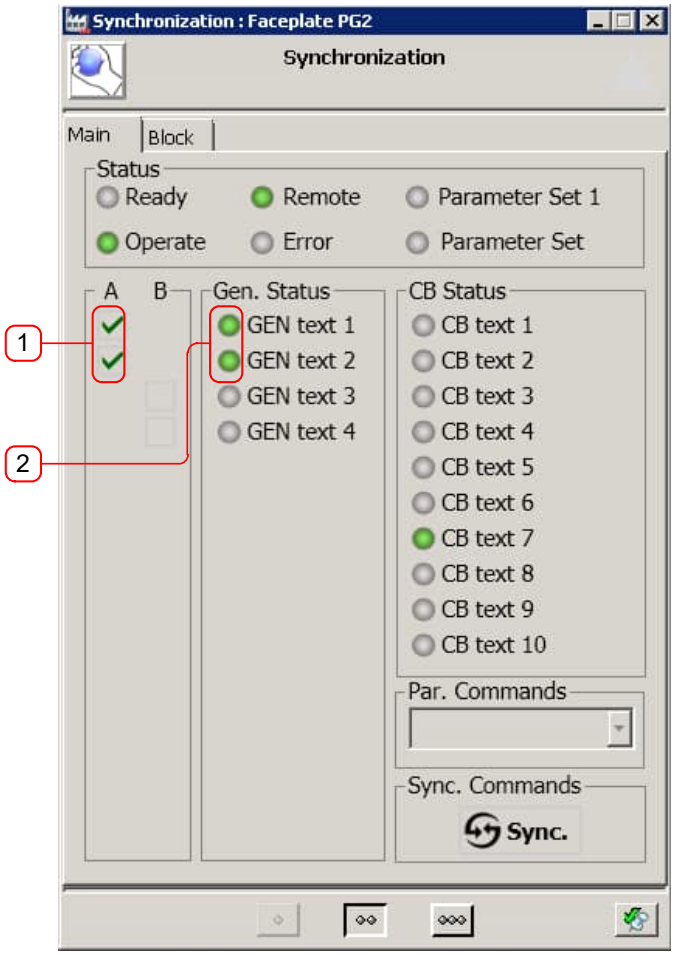


Figure 13 Faceplate tab Main – Generator selection relay active

Table 22 Faceplate tab GEN selection

Field	Item	Description
1	Checked mark	Indication for selection of the participating generator(s)
2	Status box	Indication that the requested generator selection relay is activated

The feedback from activating a generator selection relay must be received via the parameter *IO_Input.Gen1 …Gen15* (i.e. one digital input for each generator relay). If the feedback is not received within a configurable time-out setting, the control module pmsSNSyncSuperv will raise an alarm and the synchronization sequence will be cancelled. The time-out value is configured via the parameter *SynCfgPar.SelGenTO* and it is common for all the generator selection relays.

It is possible to change the descriptions (tag names) of the generator relays. This configuration is done via the tab Edit > Selection > Gen Names from the extended faceplate view, as shown in Figure 14. A description must be entered in the text field followed by the ENTER key. A user with Application Engineer role can perform this configuration.

The configuration of the generator relay names is saved in the General Properties aspect of the pmsSNSyncSuperv object type in 800xA. It is important to take a backup of this aspect (e.g. by using the Import/Export tool from the Plant Explorer) after completing the configuration, in case there is a need to restore the settings.

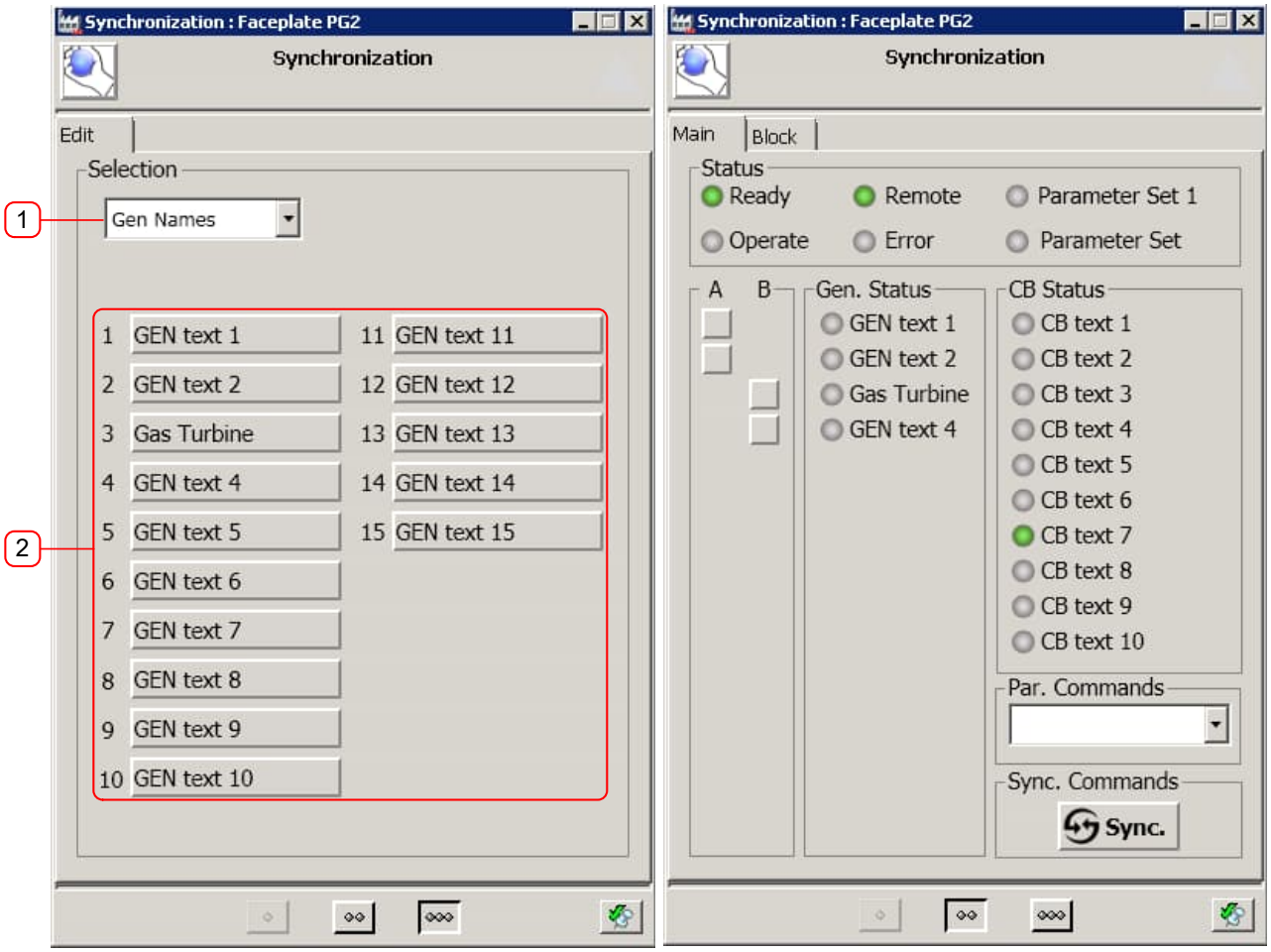


Figure 14 Faceplate tab Edit – GEN Names

Table 23 Faceplate configuration for text description of generator relays

Field	Indication	Item	Description
1	Gen Names	Drop-down menu	When the option **Gen Names** is selected the faceplate will show the text description input fields for the generators.
1	GEN text 1...GEN text 15	Text input fields	Text description.

The visibility of the generator check-boxes in the faceplate tab Main is depending on the following conditions:

4.7.4.1 Network determination

Depending on the physical location of a selected circuit breaker in the plant, the network determination function will list only the relevant generators in the faceplate.

4.7.4.2 Generator status

The following conditions will cause a generator to become unavailable for selection and participation in synchronization. The generator will not be listed in the faceplate tab **Main** and the configuration check-boxes in the faceplate tab **Block** will be disabled.

- local point of control for Governor or AVR
- mode reset function is active for Governor or AVR
- external mode is selected for Governor or AVR
- external mode reset is active for Governor or AVR
- external dimming of modes for Governor or AVR
- external dimming of direct adjust buttons for Governor or AVR

The parameter *GNSynPAr.SyncUnavailable.Gen1...Gen15* will receive the input for the unavailable generators from the interaction with the pmsGenM modules.

4.7.4.3 Faceplate configuration

It is possible to block a generator from being visible and/or selectable for synchronization by using the check-boxes from the faceplate tab Block, as shown in Figure 15.

- The check-box under the column Block Participation will prevent the generator from being listed in the faceplate. The Governor/AVR modes will not be influenced by the mode handling functionality described in section 4.7.7.
- The check-box under the column Block Selection will list the generator (either in column A or B, depending on the network determination) but it will appear dimmed and thus restricted for selection. The governor/AVR modes will be influenced by the mode handling functionality described in section 4.7.7.

The configuration of the check-boxes must be done prior to the initiation of the synchronization process. A user with Tune permission rights can perform this configuration.

When the parameter *GNSynPAr.SyncUnavailable.Gen1...Gen15* indicates that a certain generator is unavailable, the corresponding Block Participation check-box will be automatically selected and dimmed and the Block Selection check-box will be dimmed.

When the parameter *SynCfgPar.DirectSyncOperation* is true, the visibility of the generator check-boxes listed in the faceplate tab Main is depending on the entered text via the tab **Edit** > Selection > GEN Names (Figure 14). If an input text field is left empty, the corresponding generator will be hidden from the listed option-buttons.

4.7.4.4 Application logic

It is possible to configure the blocking settings by using the input parameter *ExtPar*:

- When the input parameter *ExtPar.ExtSelBlockGenParticipation* is true, the participation of the generators will be blocked if the respective values from the parameter *ExtPar.ExtCmdBlockGenParticipation.Gen1…Gen15* are set to true. While *ExtPar.ExtSelBlockGenParticipation* is true, the faceplate interaction (Figure 15, field 1) is disabled.
- After the parameter *ExtPar.ExtSelBlockGenParticipation* returns to false, the blocking settings will remain to their current values and the faceplate interaction (Figure 15, field 1) will be enabled.
- When the input parameter *ExtPar.ExtSelBlockGenSelection* is true, the selection of the generators will be blocked if the respective values from the parameter *ExtPar.ExtCmdBlockGenSelection.Gen1…Gen15* are set to true. While *ExtPar.ExtSelBlockGenSelection* is true, the faceplate interaction (Figure 15, field 2) is disabled.
- After the parameter *ExtPar.ExtSelBlockGenSelection* returns to false, the blocking settings will remain to their current values and the faceplate interaction (Figure 15, field 2) will be enabled.

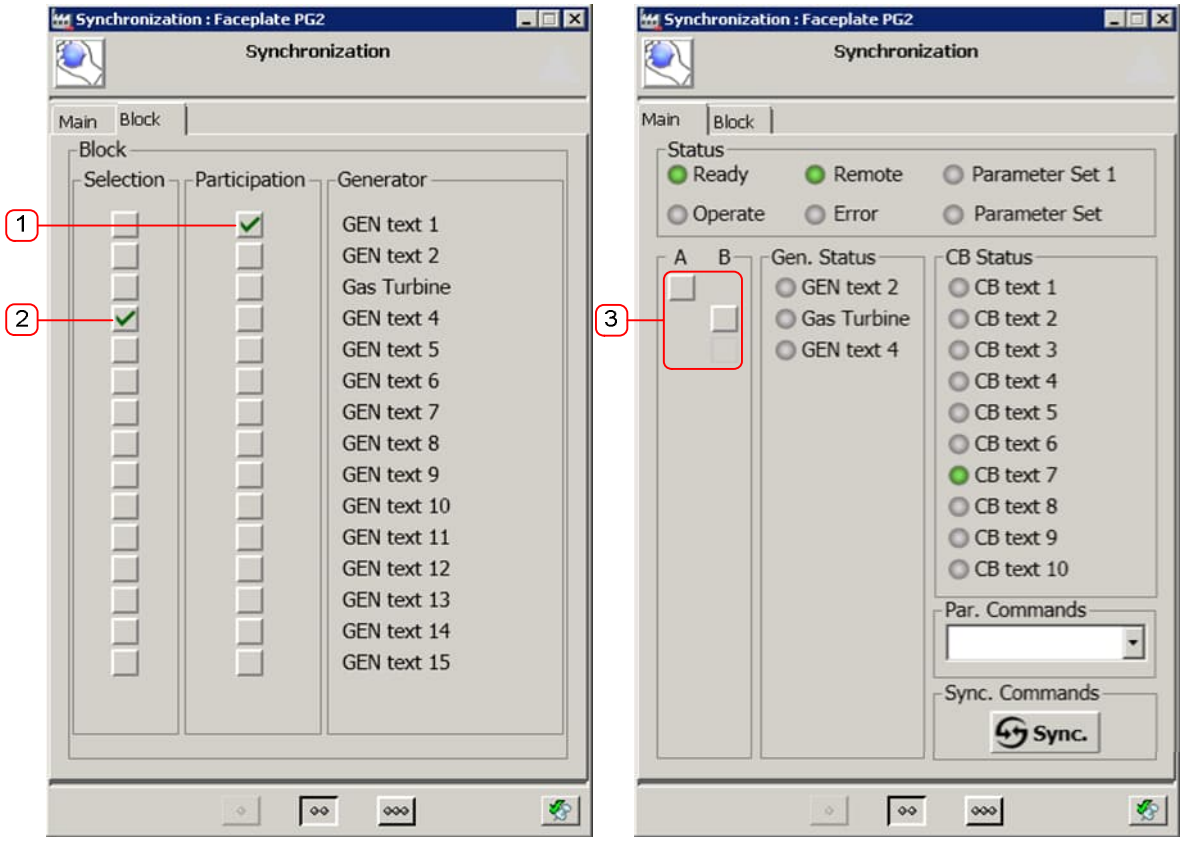


Figure 15 Faceplate tab Block and visibility of generators

Table 24 Faceplate configuration for blocking the generator selection

Field	Indication	Item	Description
1	Block Participation Gen1…Gen15	Check-box	When a check-box is marked, the generator will be hidden from the list. The mode change of the governor/AVR will not apply.
2	Block Selection Gen1…Gen15	Check-box	When a check-box is marked, the generator will be shown in the list, but it will be dimmed. The mode change will still apply.
3	Check-boxes for generator selection	Check-box	The Gen1 check-box is hidden, because the check-box for Block Participation Gen1 is marked. The Gen4 check-box is dimmed, because the check-box for Block Selection Gen4 is marked.

When the configuration parameter *SynCfgPar.DirectSyncOperation* is true, the generator selection relays can be activated via check-boxes in the faceplate tab Main, as shown in Figure 16. This configuration is intended as an alternative operation method, where the pmsSNSyncSuperv control module is independent from the pmsCBSyncM and pmsGenM modules. The synchronization process will be executed according to the manual interaction from the faceplate buttons and not by the automatic sequence.

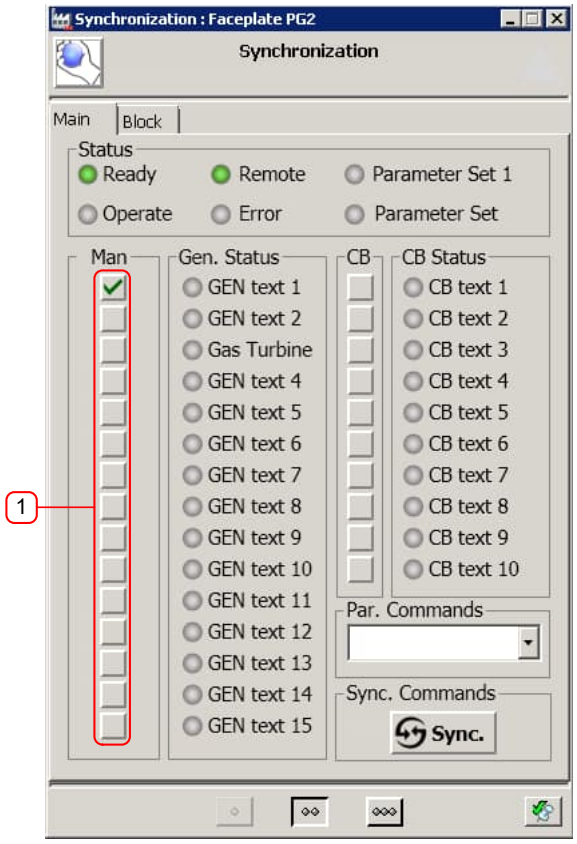


Figure 16 Direct generator selection

Table 25 Faceplate configuration for direct circuit breaker selection

Field	Indication	Item	Description
1	GEN text 1…15	Check-boxes	If *SynCfgPar.DirectSyncOperation* = true, the selected check-box will activate a generator relay when the synchronization process is started.

4.7.5 Exchange Relay for U-Var/U-Ref

The frequency and voltage measurements from the two sides of a circuit breaker are directed to the synchronizing device. In principle, the variable side (U-Var) and the reference side (U-Ref) for different types of circuit breakers is defined according to the drawing shown Figure 17.

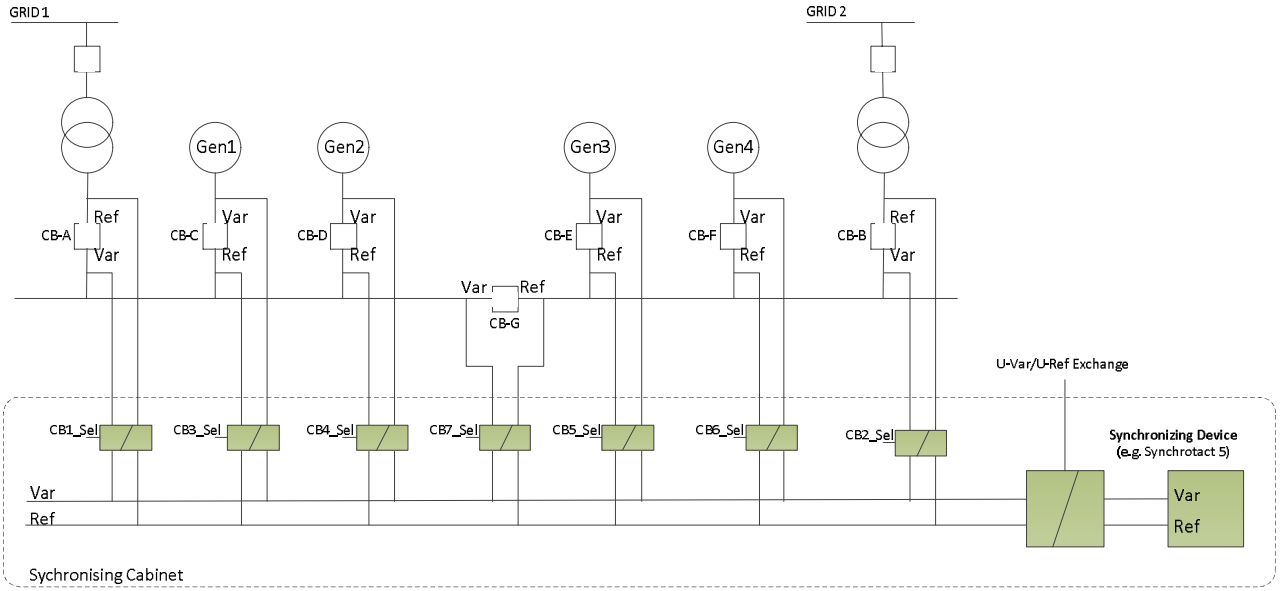


Figure 17 U-Var / U-Ref definition

Table 26 U-Var / U-Ref definition

Circuit breaker type	Circuit breaker tag	Definition of U-Var/U-Ref
Grid breaker	CB-A, CB-B	The grid side is the U-Ref, the busbar side is the U-Var.
Generator breaker	CB-C, CB-D, CB-E, CB-F	The generator side is the U-Var, the busbar side is the U-Ref.
Network breaker	CB-G	The left/top side is the U-Var, the right/down side is the U-Ref.

For network breakers (e.g. bus-couplers), the measurements applied to the synchronization equipment may need to be interchanged depending on the busbar where the participating generator(s) is connected. If a generator is physically connected to the side of the breaker defined as U-Ref, the measurements brought to the synchronizing device need to be swapped.

The control module pmsSNSyncSuperv will automatically activate the output parameter *IO_Output.VarRefEx.Value* for connection to an exchange relay, when a generator selected for synchronization is located on the reference side of a network breaker. This is shown in Figure 18, where a generator is selected from the faceplate tab Main. When one or more generators are selected from column B and the synchronization process is started, the dedicated exchange relay output will be activated.

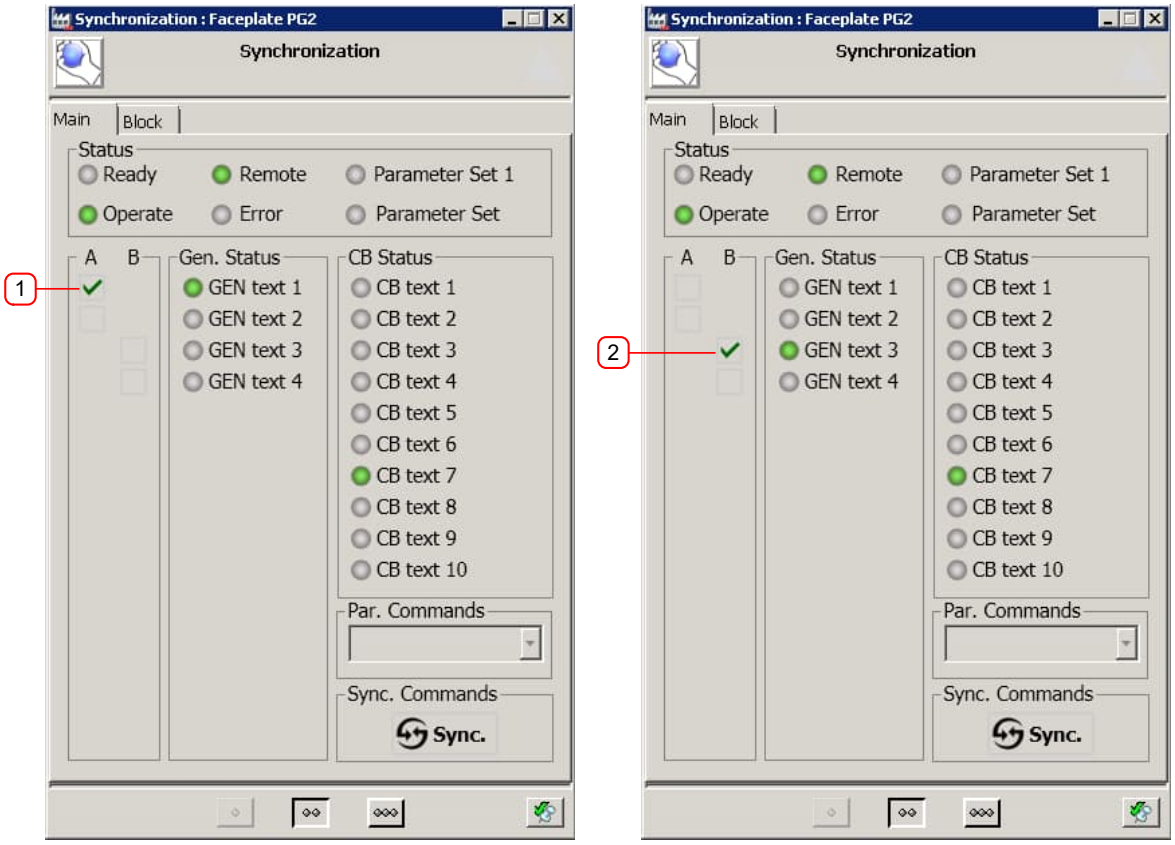


Figure 18 Exchange relay activation with GEN selection from B-column

Table 27. Exchange relay activation with GEN selection from B-column

Field	Item	Description
1	Check-box	A selected generator from the A-column will not activate the parameter *IO_Output.VarRefEx.Value.*
2	Check-box	A selected generator from the B-column will activate the parameter *IO_Output.VarRefEx.Value.*

The feedback from activating the exchange relay must be received via the parameter *IO_Input.VarRefEx*. If the feedback is not received within a configurable time-out setting, the control module pmsSNSyncSuperv will raise an alarm and the synchronization sequence will be cancelled. The time-out value is configured via the parameter *SynCfgPar.SelVarExTO*.

4.7.6 Signal interface with Synchronizing Device

4.7.6.1 Remote, Ready, Operate, Error

The faceplate tab **Main** presents the status signals from the synchronizing device, as shown in Figure 19. These digital input signals are configured via the *IO_Input* parameter of the control module, as shown in Table 28.

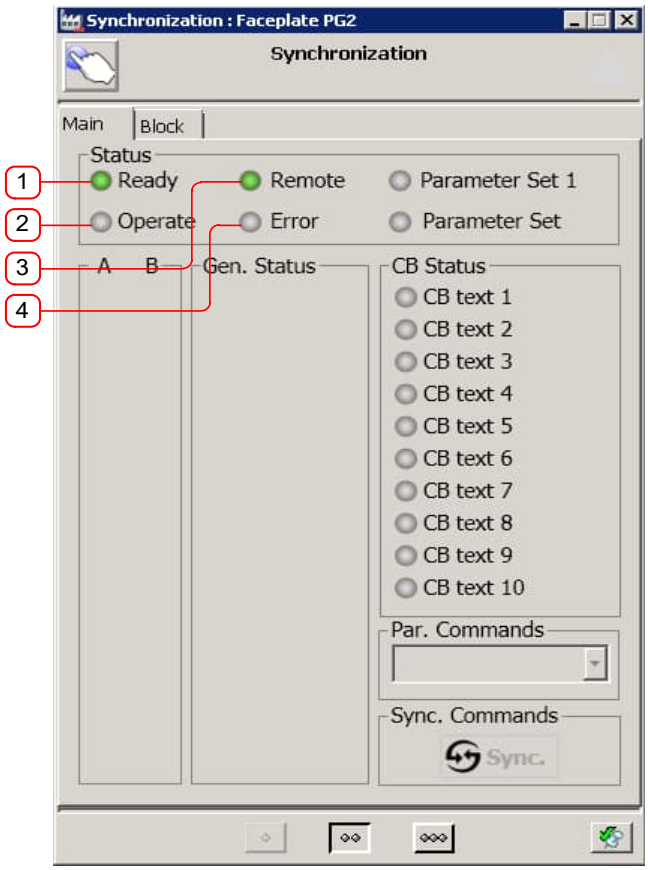


Figure 19 Faceplate tab Main – Sync device status

Table 28 Parameter configuration for Status signals

Field	Indication	Parameter	Description
1	Sync Ready	*IO_Input.SyncReady1.Value*	If parameter is TRUE, the sync device is not operating (i.e. stand-by) and it is ready to be started.
2	Sync Operate	*IO_Input.SyncOperate1.Value*	If parameter is TRUE, the sync device is operating (i.e. active) and it can be stopped.
3	Sync Remote	*IO_Input.Remote.Value*	If parameter is FALSE, the sync device is in Local point of control.
4	Sync Error	*IO_Input.SyncError1.Value*	If parameter is TRUE, the sync device is reporting a failure.

When the synchronizing device is controlled remotely (i.e. *IO_Input.Remote.Value* = true) the synchronizing equipment must be in Auto operating mode thus allowing the automatic synchronization from a remote location.

When the synchronizing device is controlled locally (i.e. *IO_Input.Remote.Value* = false) or when it reports a failure (i.e. *IO_Input.SyncError1.Value* = true), the pmsSNSyncSuperv control module will cancel the software sequence and all selection relays will be deactivated.

It is possible to change the descriptions (tag names) of the status signals. This configuration is done via the NLS aspect in **Plant Explorer under Library Structure > Preferences & Customizations > pms_NLS > pmsSNLib_PG2 > NLS_pmsSNLib_PG2**, as it is described in Table 29.

The descriptions can be changed from English language to another language by modifying the text description of the relevant Resource Id.

Table 29 Description configuration for sync device status

No.	Indication	NLS Resource (Resource Id)	Description
1	Sync Ready	NLSID_pmsReady	Text input for Sync Ready status description
2	Sync Operate	NLSID_pmsOperate	Text input for Sync Operate status description
3	Sync Remote	NLSID_pmsRemote	Text input for Sync Remote status description
4	Sync Error	NLSID_pmsError	Text input for Sync Error status description

4.7.6.2 Start, Stop

The start and stop command signals to the synchronizing device are issued from the faceplate tab **Main**, as shown in Figure 20. The digital output signals are configured via the *IO_Output* parameter of the control module, as shown Table 30.

Table 30 Parameter configuration for Start/Stop commands

No	Command	Parameter	Description
1	Start Sync	*IO_Output.SyncStart.Value*	When parameter is TRUE the sync device is requested to start.
2	Stop Sync	*IO_Output.SyncStop.Value*	When parameter is TRUE the sync device is requested to stop.

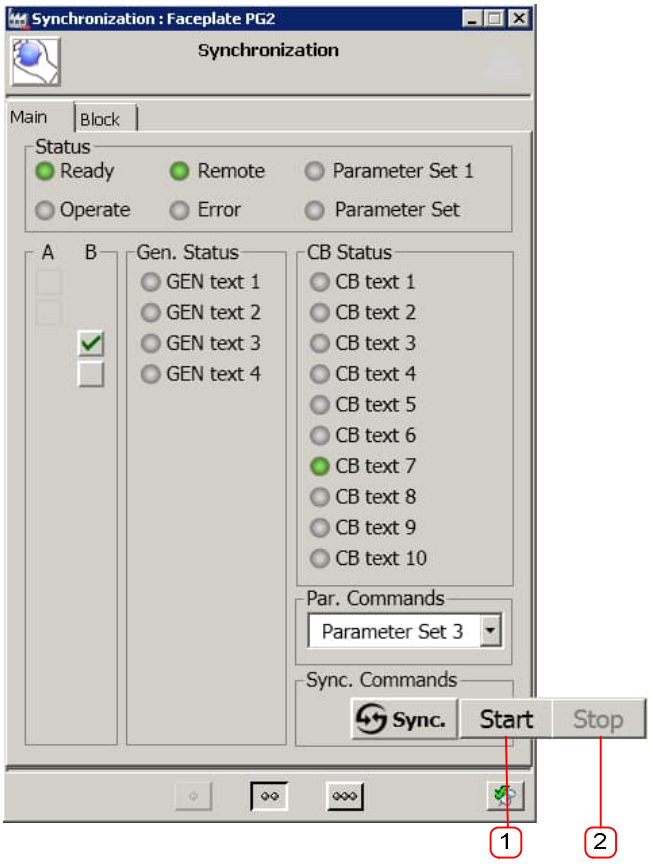


Figure 20 Faceplate tab Main - Commands (Start, Stop)

Table 31 Faceplate configuration for Start, Stop commands

Field	Indication	Item	Description
1	Start Sync icon	Push-button	The Start sync button is enabled for operation when *IO_Input.SyncReady1.Value* = true, *IO_Input.SyncRemote.Value* = true and a circuit breaker selection relay is active.
2	Stop Sync icon	Push-button	The Stop sync button is enabled for operation when *IO_Input.SyncOperate1.Value* = true.

The synchronization sequence is initiated by the pmsSNSyncSuperv control module under the following conditions.

- A feedback from a circuit breaker selection relay is received and the dead bus detection function is enabled (refer to parameter set 1 in paragraph Parameter Sets).
- A feedback from a circuit breaker selection relay is received and the start synchronization command from the pmsSNSyncSuperv faceplate tab Main is issued.

Start command remains active (IO_Output.SyncStart.Value = true) until operate feedback is received (IO_Input.SyncOperate1.Value = true), confirms that the operation has started.

When the synchronization sequence is initiated, the pmsSNSyncSuperv control module will automatically issue a stop command when

- A time-out for dead bus detection has elapsed (refer to parameter set 1 in paragraph Parameter Sets).
- A generator selection is deactivated and the corresponding parameter set is reset (refer to parameter sets 2-7 in paragraph Parameter Sets).
- The selected circuit breaker has been successfully closed and the synchronization sequence has ended.

Stop command remain active (IO_Output.SyncStop.Value = true) until ready feedback is received (IO_Input.SyncReady1.Value = true), confirms that the operation has stopped.

The feedback from activating the start and stop commands must be received via the parameters *IO_Input.SyncStart and IO_Input.SyncStop*, respectively. If the feedback is not received within a configurable time, the control module *pmsSNSyncSuperv* will raise an alarm and the synchronization sequence will be cancelled. The time-out value is configured via the parameters *SynCfgPar.SelSyncStartTO* (for the Start command) and *SynCfgPar.SelSyncStopTO* (for the Stop command).

When the synchronization sequence in progress (*IO_Input.SyncOperate1.Value* = true), the selection options (e.g. Generator selection) from the faceplate tab Main are not available, as it is shown in Figure 21. This is to prevent any selection change while the synchronization process is in progress.

This function is available when the parameter *SynCfgPar.DirectSyncOperation* is false.

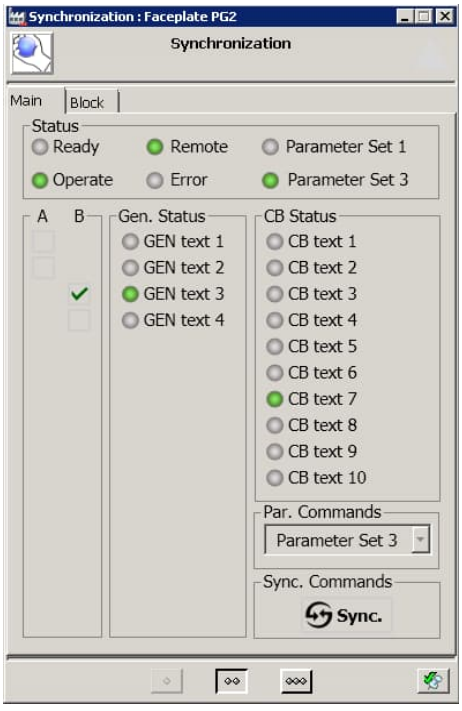


Figure 21 Faceplate tab Main – Synchronization in progress

It is possible to change the descriptions of the start/stop commands. This configuration is done via the NLS aspect in Plant Explorer under **Library Structure > Preferences & Customizations > pms_NLS > pmsSNLib_PG2 > NLS_pmsSNLib_PG2**, as it is described in Table 32. The descriptions can be changed from English language to another language by modifying the text description of the relevant Resource Id.

Table 32 Tag names configuration for Start/Stop command buttons

No.	Push Button	NLS Resource (Resource Id)	Description
1	Sync Start	NLSID_pmsStartSynchronization	Text input for Sync Start command button
2	Sync Stop	NLSID_pmsStopSynchronization	Text input for Sync Stop command button

When the configuration parameter *SynCfgPar.DirectSyncOperation* is true, the synchronization Start and Stop commands can be activated from the faceplate, as shown in Figure 22, as long as the synchronizing device is in remote (*IO_Input.SyncRemote.Value* = true), This configuration is intended as an alternative operation method, where the pmsSNSyncSuperv control module is independent from the pmsCBSyncM and pmsGenM modules.

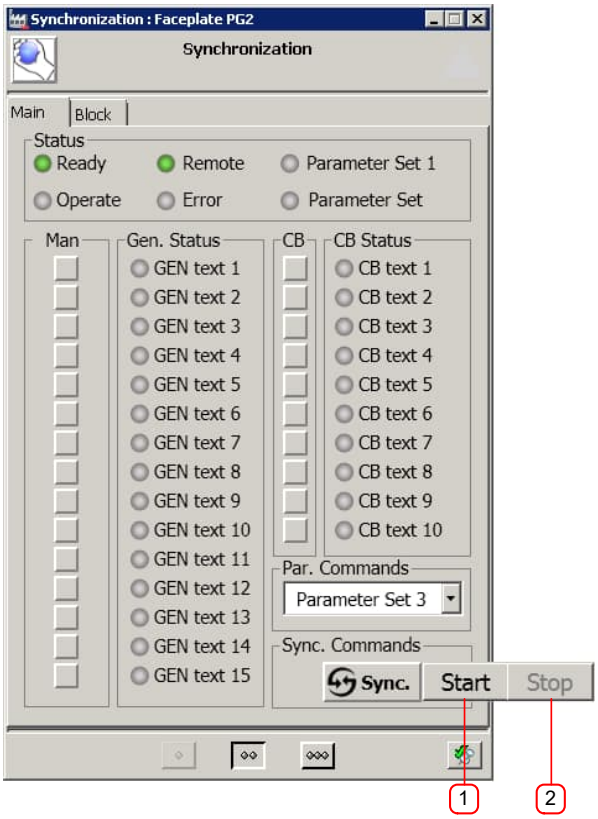


Figure 22 Start/stop commands

Table 33 Faceplate configuration for direct start/stop commands

Field	Indication	Item	Description
1	Start Sync icon	Push-button	If *SynCfgPar.DirectSyncOperation* = true, the start sync button is enabled for operation when *IO_Input.SyncReady1.Value* = true and *IO_Input.SyncRemote.Value* = true.
2	Stop Sync icon	Push-button	If *SynCfgPar.DirectSyncOperation* = true, the stop sync button is enabled for operation when *IO_Input.SyncOperate1.Value* = true and *IO_Input.SyncRemote.Value* = true.

The synchronization process will be executed according to the manual interaction from the faceplate buttons and not by the automatic sequence.

If the command for stop or start the synchronization process is activated (*IO_Input.SyncStart* and *IO_Input.SyncStop*) and the alarm generated by the absence of feedback from the synchronizing device is received (refer to the alarm description in paragraph Alarms) the output commands *IO_Output.SyncStart* and *IO_Output.SyncStop* are automatically reset.

4.7.6.3 Parameter Sets

The synchronizing devices often support different configuration settings (i.e. parameter sets), depending on the type of generator or generator groups that are selected for the synchronization process. These settings are a group of values which are stored on the programmable panel of the device. They affect important parameters of the synchronizing process, such as the pulse length for frequency and voltage adjustments, the breaker closing time, etc.

The control module pmsSNSyncSuperv supports 7 different parameter sets and the active parameter set selection relay is presented in the faceplate tab **Main**, as shown Figure 23.

The parameter set selection relay activation is included in the components of the *IO_Input* parameter, as shown in Table 35.

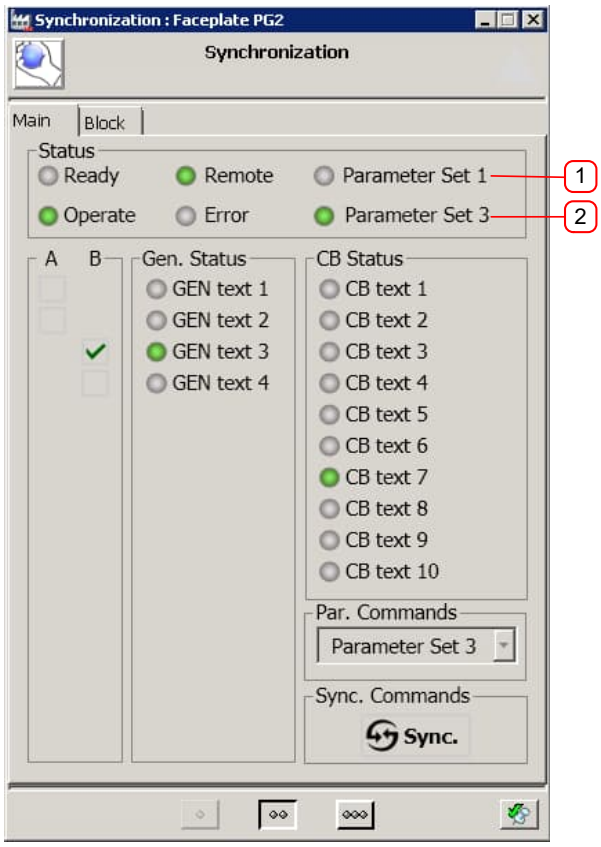


Figure 23 Faceplate tab Main - Status (Parameter Sets)

Table 34 Parameter configuration for parameter set indication

Field	Indication	Item	Description
1	Parameter Set 1	*IO_Input.ParamSet1.Value*	Indication of status for parameter set 1.
2	Parameter Set 2 …7	*IO_Input.ParamSet2 ...7.Value*	Indication of status for parameter set 2 …7

The feedback from activating a Parameter Set must be received via the parameters *IO_Input.ParamSet1.Value… IO_Input.ParamSet7.Value*. If the feedback is not received within a configurable time-out setting, the control module pmsSNSyncSuperv will raise an alarm and the synchronization sequence will be cancelled. The time-out value is configured via the parameters *SynCfgPar.SelParamSetTO* and it is common for all the parameter set commands.

The *IO_Intput.ParamSet1* is reserved for a dead bus or synchronous net condition, therefore the value 1 must not be assigned to any generator. The parameter set 1 will be activated for a configurable time period via the parameter *SynCfgPar.SyncCheck_TO*. This setting represents the time period to allow the synchronizing device to detect a dead bus or synchronous net condition and close the circuit breaker. When the time period has elapsed and the circuit breaker has not closed, the control module pmsSNSyncSuperv will continue with the synchronization sequence and present the list of available generators for selection.

The purpose of activating the parameter set 1 is to request the synchronizing device to check if the circuit breaker can be closed immediately, without going through the synchronization process. Such conditions may apply during a dead bus connection to an already energized network or when the frequency and voltage measurements are within tolerable values.

The synchronizing device is expected to rely on a synchro-check feature for a safe and reliable closing of the breaker, thus omitting the selection of the generator for measurement adjustments.

If the synchronizing device does not support the feature of dead bus detection, the parameter *SynCfgPar.SyncCheck_TO* must be set to 0d0h0m0s0ms and the ParamSet1 will be voided.

The commands to activate the digital output signals for each of the 7 different parameter sets are included in the components of the *IO_Output* parameter, as shown Table 35.

Table 35 Parameter configuration for parameter sets

No	Item	Description
1	*IO_Output.ParamSet1.Value*	Activate parameter set 1 selection relay.
2	*IO_Output.ParamSet2.Value*	Activate parameter set 2 selection relay.
3	*IO_Output.ParamSet3.Value*	Activate parameter set 3 selection relay.
4	*IO_Output.ParamSet4.Value*	Activate parameter set 4 selection relay.
5	*IO_Output.ParamSet5.Value*	Activate parameter set 5 selection relay.
6	*IO_Output.ParamSet6.Value*	Activate parameter set 6 selection relay.
7	*IO_Output.ParamSet7.Value*	Activate parameter set 7 selection relay.

Configuration of which parameter set shall be activated can be done from application code or via the pmsSNSyncSuperv control module faceplate tab **Main.** The pmsSNSyncSuperv control module can handle single and multiple generator set selection.

The parameter *MaxNoGenSelection* must be assigned with a dint number corresponding with the maximum number of generators allowed to participate in the synchronization process. This feature is relevant for the synchronization of network circuit breakers (i.e. bus coupler).

It is possible to change the descriptions (tag names) of the parameter set selection relays. This configuration is done via the tab **Edit** > Selection > Parameter Set from the extended faceplate view, as shown in Figure 24. A description must be entered in the text field followed by the ENTER key. A user with Application Engineer role can perform this configuration.

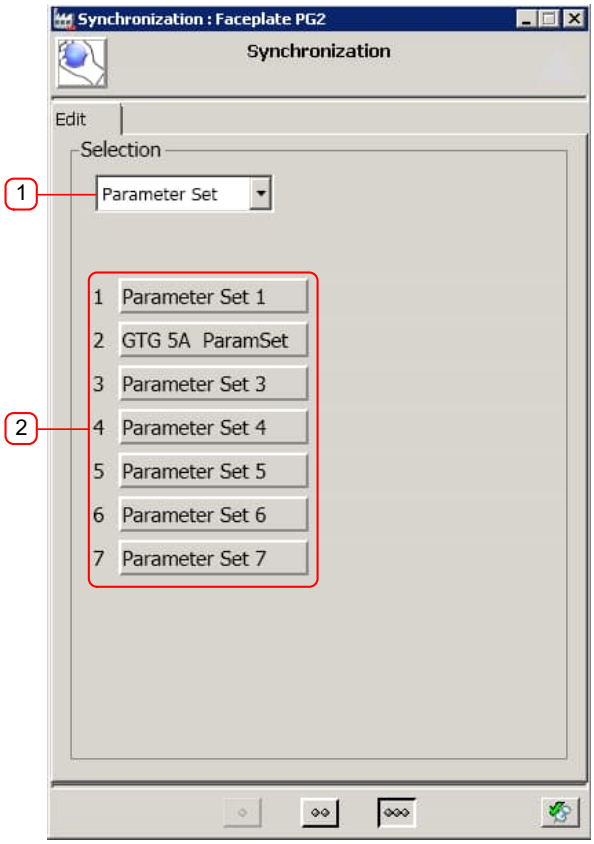


Figure 24 Faceplate tab Edit - Parameter Set names

Table 36 Faceplate configuration for text description of generator relays

Field	Indication	Item	Description
1	Parameter Set	Drop-down menu	When the option Parameter Set is selected the faceplate will show the text description input fields for the parameter sets.
2	Parameter Set 1...7	Text input fields	Text description.

The configuration of the parameter set relay names is saved in the General Properties aspect of the pmsSNSyncSuperv object type in 800xA. It is important to take a backup of this aspect (e.g. by using the Import/Export tool from the Plant Explorer) after completing the configuration, in case there is a need to restore the settings.

It is possible to identify the generator sets that have been selected to participate in the synchronization process via the pmsSNSyncSuperv control module faceplate tab Main from the parameter SelectedGen.Gen1…Gen15. This can be used in the application logic to define the generator selection configuration when the parameter set is selected from the parameter ExtPar.

4.7.6.4 Parameter Sets - single generator selection

The configuration, of which parameter set shall be activated, when single generator selection is applicable, is done via the *ParamSet* parameter, as shown Table 37. The components *ParamSet.Gen1…Gen15* must be assigned with a dint number 2, 3, 4, 5, 6 or 7. Based on this number, the corresponding parameter set 2-7 will be activated via the digital output signals *IO_Output.ParamSet2.Value* … *IO_Output.ParamSet7.Value*, when the relevant generator is selected.

Table 37 Parameter configuration for ParamSet

Parameter	Description
ParamSet.TRF	Shall not be used.
ParamSet.TRF2	Shall not be used.
ParamSet.Gen1	Parameter set 2-7, when the generator 1 is selected.
ParamSet.Gen2	Parameter set 2-7, when the generator 2 is selected.
ParamSet.Gen3	Parameter set 2-7, when the generator 3 is selected.
ParamSet.Gen4	Parameter set 2-7, when the generator 4 is selected.
ParamSet.Gen5	Parameter set 2-7, when the generator 5 is selected.
ParamSet.Gen6	Parameter set 2-7, when the generator 6 is selected.
ParamSet.Gen7	Parameter set 2-7, when the generator 7 is selected.
ParamSet.Gen8	Parameter set 2-7, when the generator 8 is selected.
ParamSet.Gen9	Parameter set 2-7, when the generator 9 is selected.
ParamSet.Gen10	Parameter set 2-7, when the generator 10 is selected.
ParamSet.Gen11	Parameter set 2-7, when the generator 11 is selected.
ParamSet.Gen12	Parameter set 2-7, when the generator 12 is selected.
ParamSet.Gen13	Parameter set 2-7, when the generator 13 is selected.
ParamSet.Gen14	Parameter set 2-7, when the generator 14 is selected.
ParamSet.Gen15	Parameter set 2-7, when the generator 15 is selected.
ParamSet.NumberOfGrids	Shall not to be used.

MaxNoGenSelection parameter must be set to value 1 indicating that the single generator selection is applicable in the synchronization process. If the M*axNoGenSelection* is set to a value higher than 1 the parameter set selection from the parameter *ParamSet* will not be applicable.

It is possible to externally select the parameter set that needs to be activated by setting the input parameter *ExtPar.ExtParamSelection* to true and *ExtPar.ExtSelectParamSetID* to a dint number 2, 3, 4, 5, 6 or 7. Based on this number, the corresponding parameter set 2-7 will be activated via the digital output signals *IO_Output.ParamSet2.Value* … *IO_Output.ParamSet7.Value*.

4.7.6.5 Parameter Sets - multiple generator selection

When multiple generator selection is applicable the parameter set selection relay activation can be done directly from the pmsSNSyncSuperv faceplate tab **Main** as shown in Figure 25.

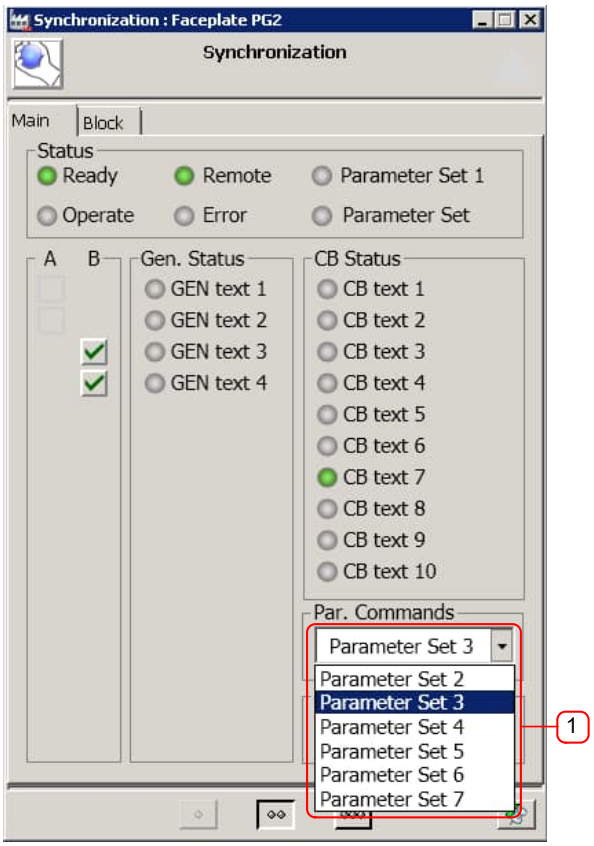


Figure 25 Faceplate tab Main - Parameter Set commands

Table 38 Parameter set commands configuration

Field	Indication	Item	Description
1	Parameter Set selection	Drop down menu	Selection list to choose the parameter set that is necessary to be activated on the sync device in the synchronization process. Available when the parameter *MaxNoGenSelection* is > 1.

The visibility of each of the parameter sets in the drop down menu listed in the faceplate tab **Main** is depending on the entered text via the tab **Edit** > Selection > Parameter Set, as shown in Figure 24. If an input text field is left empty, the corresponding parameter set will be hidden from the listed available parameter sets.

MaxNoGenSelection parameter must be set to a dint value higher than 1 indicating that the multiple generator selection is applicable in the synchronization process. If the *MaxNoGenSelection* is not set to a value higher than 1 the parameter set selection from the parameter faceplate tab Main will not be applicable.

I t is possible to externally select the parameter set that needs to be activated by setting the input parameter *ExtPar.ExtParamSelection* to true and *ExtPar.ExtSelectParamSetID* to a dint number 2, 3, 4, 5, 6 or 7. Based on this number, the corresponding parameter set 2-7 will be activated via the digital output signals *IO_Output.ParamSet2.Value* … *IO_Output.ParamSet7.Value*. When the parameter *ExtPar.ExtParamSelection* is true the parameter set selection drop-down menu from the faceplate **Main** tab will be automatically dimmed, thus restricted from selection.

The parameter selection drop-down menu can be hidden from the faceplate **Main** tab by setting the *ExtPar.ExtHideParamCmds* parameter to true.

4.7.6.6 Close Permissive

The control module pmsSNSyncSuperv can affect the visibility of the direct close command button in the pmsCBSyncM faceplate, which is by default dimmed when the position of breaker is open. When the synchronization session is initiated from the command button in the pmsCBSyncM faceplate, the pmsSNSyncSuperv module will monitor the input parameter *IO_Input.ClosePermissive* and if the value is true, the close command button will be enabled for operation, as shown in Figure 26.

The parameter *IO_Input.ClosePermissive* should be used as an alternative method for bypassing the synchronization sequence, if the parameter Set 1 is not supported by the synchronizing device.

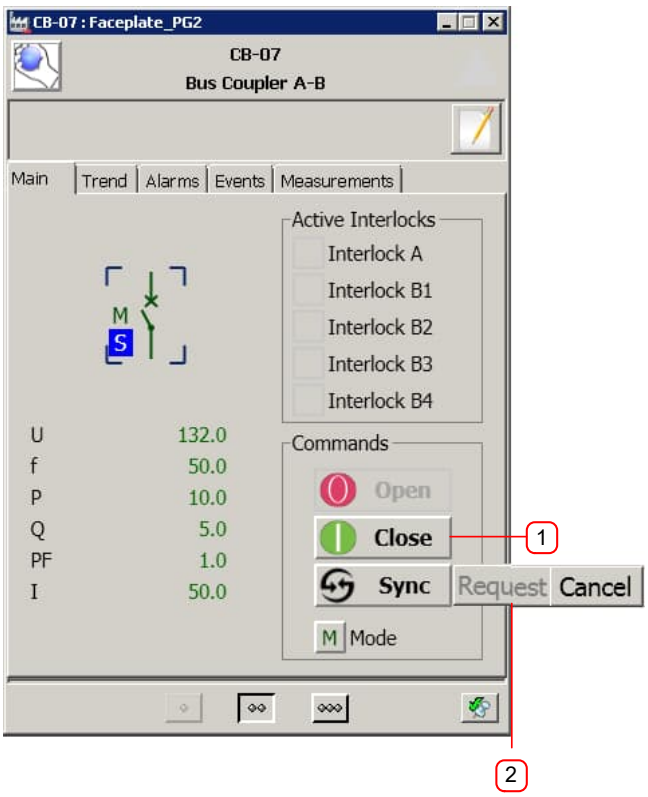


Figure 26 Close permissive and pmsCBSyncM faceplate

Table 39 Close permissive and pmsCBSyncM faceplate

Field	Indication	Item	Description
1	Close command	Push-button	When the *IO_Input.ClosePermissive.Value* = true and the synchronization is in progress, the direct close command button will be enabled.
2	Initiates sync command	Push-button	Request to initiate the synchronization software in the pmsSNSyncSuperv module.

4.7.7 Generator mode handling

The control module pmsSNSyncSuperv affects the Governor and AVR modes on the generators which are connected to the U-Var side of the selected circuit breaker in the following way:

- The selected generator(s) will be set in droop mode for governor and droop mode for the AVR, to receive the raise/lower pulses according to the adjustments dictated by the synchronizing device.
- The generators that run parallel to the selected machine(s) are set in MW mode for the governor and PF mode for the AVR, to avoid MW/MVAr transfer between the generators. Exceptions apply if a generator is unavailable, as described in section Selection Relays for Generators.
- After the synchronizing session is completed, all governors and AVRs will return to their previous modes.

When a selection is made from the available generators listed in the pmsSNSyncSuperv faceplate, the parameter *SynGNPar.ModeSet.Gen1…Gen15* will interact with the control module pmsGenM to change the governor and AVR modes.

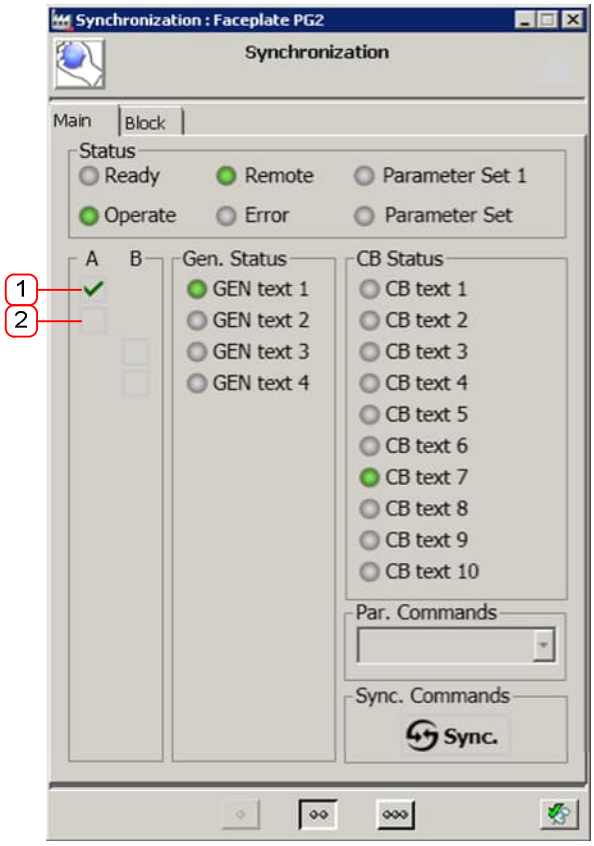


Figure 27 Governor and AVR mode handling (pmsSNSyncSuperv faceplate)

Table 40 Governor and AVR mode handling (pmsSNSyncSuperv faceplate)

Field	Indication	Item	Description
1	Gen1	Check-box	The Governor and AVR mode of the selected generator will be set to Droop/Droop.
2	Gen2	Check-box	The Governor and AVR mode of the generator in parallel with the selected machine, will be set to MW/PF.

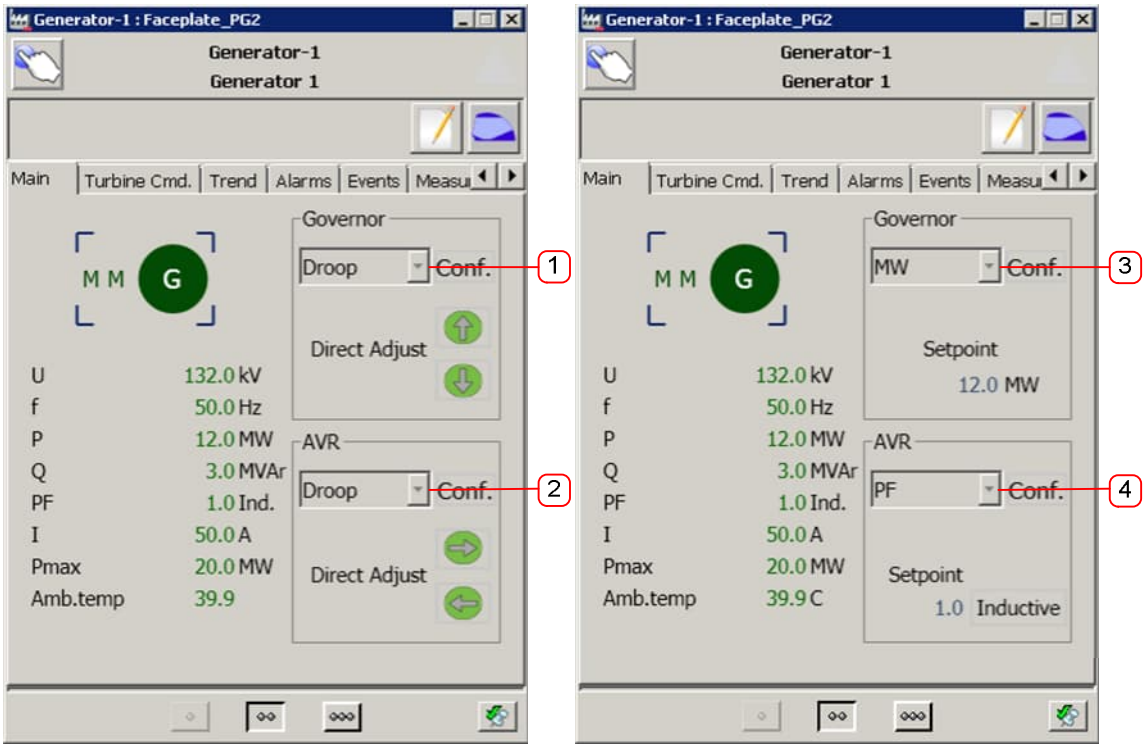


Figure 28 Governor and AVR mode handling (pmsGenM faceplate)

Table 41 Governor and AVR mode handling (pmsGenM faceplate)

Field	Indication	Item	Description
1	Gov Droop	Text field	The Governor mode of the selected generator is set to Droop.
2	AVR Droop	Text field	The AVR mode of the selected generator is set to Droop.
3	Gov MW	Text field	The Governor mode of the generator on the same side as the selected machine is set to MW. Refer to section Selection Relays for Generators for the mode handling exceptions when a generator becomes unavailable for participation.
4	AVR PF	Text field	The AVR mode of the generator on the same side as the selected machine is set to PF. Refer to section Selection Relays for Generators for the mode handling exceptions when a generator becomes unavailable for participation.

4.7.8 Indication of synchronization in progress

The control module pmsSNSyncSuperv is providing a software indication that the synchronization sequence is in progress. When a circuit breaker is selected for synchronization via the pmsCBSyncM faceplate or when a direct operation is performed from the pmsSNSyncSuperv faceplate, the Boolean output parameter *SyncOperation* will be set to true.

4.7.9 Indication of Variable/Reference side

The control module pmsSNSyncSuperv is providing a software indication of the busbar identity numbers assigned to the variable and reference side of a selected circuit breaker, according to the network determination. When a circuit breaker is selected for synchronization via the pmsCBSyncM faceplate, the double integer output parameters *UREF* and *UVAR* will be set to the PB/LB identity numbers, according to the network matrix configuration.

4.7.10 Synchronization time-out

The control module pmsSNSyncSuperv is monitoring the time period of the synchronization session. When the operation is in progress (i.e. *SyncOperation* = true) and the configuration time parameter *SynCfgPar.SyncCancelTO* has elapsed, an alarm will be raised and the synchronization sequence will be cancelled.

It is possible to override the synchronization time-out feature, by setting the parameter *SynCfgPar.SyncCancelTO* to 0d0h0m0s0ms.

4.7.11 Alarms

The control module pmsSNSyncSuperv shall monitor the alarm conditions and will generate the alarm messages, as described in Table 42.

Table 42 Alarm configuration

No.	Description	Alarm condition	Alarm message (Resource Id)
1	Spurious dead bus.	When the network determination detects a contingency on any side of the breaker with power sources connected and frequency measurement<*FreqLowLimit* or voltage measurement<*VoltLowLimit*.	NLSID_SpurDB
2	Spurious powered bus.	When the network determination detects a contingency on any side of the breaker with no power sources connected and frequency measurement>*FreqLowLimit* or voltage measurement>*VoltLowLimit*.	NLSID_SpurPow
3	Feedback from multiple circuit breaker selection relays.	When the feedback *IO_Input.CB1…C10* is received from more than one circuit breaker selection relays.	NLSID_TwoCBSel
4	Feedback from multiple generator selection relays.	When the feedback *IO_Input.Gen1…Gen15* is received from more than the maximum allowed generator selection relays.	NLSID_MaxGenSel
5	No feedback from circuit breaker selection relay.	When the feedback *IO_Input.CB1…C10* is not received after a circuit breaker selection relay *IO_Output.CB1…C10* is activated.	NLSID_cCBFeedback

No.	Description	Alarm condition	Alarm message (Resource Id)
6	No feedback from generator selection relay.	When the feedback *IO_Input.Gen1…Gen15* is not received after a generator selection relay *IO_Output.Gen1…Gen15* is activated.	NLSID_cGenFeedback
7	Spurious energized circuit breaker selection relay.	When the feedback *IO_Input.CB1…C10* is received from a circuit breaker selection relay without a synchronization session in progress.	NLSID_SpurCBSel
8	Spurious energized generator selection relay.	When the feedback *IO_Input.Gen1…Gen15* is received from a generator selection relay without a synchronization session in progress.	NLSID_SpurGenSel
9	No feedback from the synchronizing device.	When the proper feedback is not received after the following commands to the synchronizing device: Parameter set: *IO_Output.ParamSet1…ParamSet7* Sync Start command: *IO_Output.SyncStart* Sync Stop command: *IO_Output.SyncStop* Var/Ref exchange command: *IO_Output.VarRefEx.*	NLSID_SyncFeedback
10	Error from synchronizing device.	When the *IO_Input.SyncError1.Value* = true.	NLSID_SyncError1
11	Multiple circuit breaker request.	A request for synchronization is received from more than one pmsCBSyncM faceplate command buttons.	NLSID_MultiCBSyncReq
12	Synchronizing session timed out.	The synchronization session has reached the time-out period of *SynCfgPar.SyncCancelTO*.	NLSID_SyncTimeout

The text messages (i.e. in Alarm List) for the above alarms are configurable via the Alarm and Event Translator aspect in Plant Explorer under **Library Structure > Preferences & Customizations > PMS_Alarm&Event.** These messages can be changed from English language to another language by modifying the relevant Resource Id (i.e. NLSID_….) to a desired message (a text string up to 60 characters).

4.7.12 Events

The control module pmsSNSyncSuperv shall monitor the event conditions and will generate the event messages, as described in Table 43.

Table 43 Event configuration

No	Description	Event condition	Event message (Resource Id)
1	Circuit breaker selection relay feedback	When any feedback *IO_Input.CB1…C10* is activated or deactivated.	NLSID_SyncSelectionRelay + SynCfgPar.NameSyncCB01 +NLSID_On … NLSID_SyncSelectionRelay +SynCfgPar.NameSyncCB10 +NLSID_On (or NLSID_Off)
2	Generator selection relay feedback	When any feedback *IO_Input.Gen1…Gen15* is activated or deactivated.	NLSID_SyncSelectionRelay +NLSID_GEN1Sel +NLSID_On NLSID_SyncSelectionRelay +NLSID_GEN2Sel +NLSID_On … NLSID_SyncSelectionRelay +NLSID_GEN15Sel +NLSID_On (or NLSID_Off)
3	Parameter Set feedback	When *IO_Input.ParamSet1…7* is activated or deactivated.	NLSID_SyncSelectionRelay +NLSID_Param1 +NLSID_On NLSID_SyncSelectionRelay +NLSID_Param2 +NLSID_On … NLSID_SyncSelectionRelay +NLSID_Param7 +NLSID_On (or NLSID_Off)
4	Sync Ready feedback	When *IO_Input.SyncReady1* is activated or deactivated.	NLSID_SyncReady1 +NLSID_On (or NLSID_Off)
5	Sync Operate feedback	When *IO_Input.SyncOperate1* is activated or deactivated.	NLSID_SyncStart1 +NLSID_On (or NLSID_Off)
6	Remote feedback	When *IO_Input.Remote* is activated or deactivated.	NLSID_Remote +NLSID_On (or NLSID_Off)
7	Error feedback	When *IO_Input.Error1* is activated or deactivated.	NLSID_Error1 +NLSID_On (or NLSID_Off)
8	Close Permissive feedback	When *IO_Input.ClosePermissive* is activated or deactivated.	NLSID_ClosePermissive +NLSID_On (or NLSID_Off)
9	U-Var/U-Ref exchange relay feedback	When *IO_Input.VarRefEx* is activated or deactivated.	NLSID_UVarRef +NLSID_On (or NLSID_Off)

The text messages (i.e. in Event List) for the above events are configurable via the Alarm and Event Translator aspect in Plant Explorer under **Library Structure > Preferences & Customizations > PMS_Alarm&Event.** These messages can be changed from English language to another language by modifying the relevant Resource Id (i.e. NLSID_….) to a desired message (a text string up to 60 characters).

4.7.13 Required I/O

An overview of the required I/O is listed in Table 44, Table 45 and Table 46, with respect to significance when setting up the interface connections for the synchronization control module. The description “mandatory” implies that the internal logic of the control modules requires data from the variable in order to function properly. The description “optional” implies that the internal logic of the control modules can also handle data from the variable, but it could be omitted without affecting the functionality of the module.

Table 44 Significance iMV_Freq, iMV_Volt components (analogue inputs)

Field	IO_Input	Importance	Description
1	*iMV_Freq.BB01*	Optional	Frequency PB01.
2	*iMV_Freq.BB02*	Optional	Frequency PB02.
3	*iMV_Freq.BB03… BB15*	Optional	Frequency PB03-PB15.
4	*iMV_Freq.BB16*	Optional	Frequency LB01.
5	*iMV_Freq.BB17*	Optional	Frequency LB02.
6	*iMV_Freq.BB18… BB50*	Optional	Frequency LB03-PB35.
7	*iMV_Volt.BB01*	Optional	Voltage PB01.
8	*iMV_Volt.BB02*	Optional	Voltage PB02.
9	*iMV_Volt.BB03… BB15*	Optional	Voltage PB03-PB15.
10	*iMV_Volt.BB16*	Optional	Voltage LB01.
11	*iMV_Volt.BB17*	Optional	Voltage LB02.
12	*iMV_Volt.BB18… BB50*	Optional	Voltage LB03-PB35.

Table 45 Significance of IO_Input components (digital inputs)

Field	IO_Input	Importance	Description
1	*IO_Input.CB1*	Mandatory	Feedback from selection relay for CB1.
2	*IO_Input.CB2 … CB10*	Optional	Feedback from selection relays for CB2-CB10. Required depending on the applicable circuit breakers.
3	*IO_Input.Gen1*	Mandatory	Feedback from selection relay for Gen1.
4	*IO_Input.Gen2 … Gen15*	Optional	Feedback from selection relays for Gen2-Gen15. Required depending on the applicable generators.
5	*IO_Input.SyncReady1*	Mandatory	Feedback from synchronizing device for Ready status.
6	*IO_Input.SyncOperate1*	Mandatory	Feedback from synchronizing device for Operate status
7	*IO_Input.SyncError1*	Optional	Feedback from synchronizing device for Error status.
8	*IO_Input.ParamSet1*	Optional	Feedback from synchronizing device for ParamSet1. Required for dead bus feature.
9	*IO_Input.ParamSet2*	Mandatory	Feedback from synchronizing device for ParamSet2
10	*IO_Input.ParamSet3… ParamSet7*	Optional	Feedback from synchronizing device for ParamSet3-7. Required depending on the applicable parameter sets.
11	*IO_Input.VarRefEx*	Optional	Feedback from exchange relay. Required for network breakers.
12	*IO_Input.ClosePermissive*	Optional	Feedback from synchronizing device for direct closing.
13	*IO_Input.Remote*	Mandatory	Feedback from synchronizing device for Remote status

Table 46 Significance of IO_Output components (digital outputs)

Field	IO_Input	Importance	Description
1	*IO_Output.CB1*	Mandatory	Command for selection relay CB1.
2	*IO_Output.CB2… CB10*	Optional	Command for selection relay CB2-CB10. Required depending on the applicable circuit breakers.
3	*IO_Output.Gen1*	Mandatory	Command for selection relay Gen1.
4	*IO_Output.Gen2 … Gen15*	Optional	Command for selection relays Gen2-Gen15. Required depending on the applicable generators.
5	*IO_Output.SyncStart*	Mandatory	Command for starting the synchronizing device.
6	*IO_Output.SyncStop*	Mandatory	Command for stopping the synchronizing device.
7	*IO_Output.ParamSet1*	Optional	Command for activating the dead bus detection feature
8	*IO_Output.ParamSet2*	Mandatory	Command for activating the parameter set for a selected generator.
9	*IO_Output.ParamSet3… ParamSet7*	Optional	Command for activating the parameter sets depending on the applicable generators.
10	*IO_Output.VarRefEx*	Optional	Command for activating the exchange relay. Required for network breakers.

4.8 Operation

The operational steps required to perform the synchronization procedure are described in the following sections. The text remark “optional” indicates that a feature may be omitted.

4.8.1 Synchronization with supervision of pmsCBSyncM/pmsGenM modules

The steps described in this section apply when the control module pmsSNSyncSuperv is configured to supervise the pmsCBSyncM and pmsGenM control modules. This is a typical case where the synchronization functionality is fully integrated with the generator and circuit breaker objects available in the pmsGenLib and pmsCBLib libraries respectively.

STEP 1:

Initiating the synchronization process for closing a circuit breaker (refer to Figure 9).

Operation:	Result:	Comment:
- The faceplate aspect of the circuit breaker module pmsCBSyncM is called up and the synchronization request command button is operated from the main faceplate view.	- The output for the circuit breaker selection relay is activated. - The output for starting the synchronizing device is activated. - The output for parameter set 1 is activated (optional). - The output for stopping the synchronizing device is activated if parameter set 1 is deactivated (optional).	- The feedback that the selected circuit breaker relay is activated must be received within a preconfigured time setting. The hardware engineering of the selection relay panel and the synchronizing panel must ensure that, when a breaker is selected, the proper voltage and frequency measurements from the two sides of the breaker (U-Var and U-Ref) shall be sent to the synchronizing equipment. - The feedback that the synchronizing device is operating shall deactivate the start output. - If the synchronizing equipment supports the dead bus or synchronous network detection and parameter set 1 is implemented, the feedback that the parameter set 1 is activated must be received within a preconfigured time setting. The synchronizing equipment must ensure that the parameter set 1 shall initiate the check for dead bus or synchronous network in order to issue a direct close command to the circuit breaker without performing voltage/frequency adjustments. - The parameter set 1 output will remain activated for a preconfigured time setting, thus allowing the synchronizing device to close the circuit breaker. If the circuit breaker has not closed after the defined time has elapsed, the parameter set 1 output will be deactivated and the stop command will be issued to set the device in idle status. If the synchronizing equipment does not support the parameter set 1 but can detect a dead bus condition, the close command button in the pmsCBSyncM faceplate can be enabled for operation, when a “permissive” input is received.

STEP 2:

Selecting the generator(s) that will be required to participate in the process of adjusting the voltage/frequency on the variable side of the circuit breaker (refer to Figure 12).

Operation:	Result:	Comment:
- The faceplate of the pmsSNSyncSuperv control module is called up and the generator(s) will be selected from the list presented in the **Main** tab. If the parameter set 1 is implemented, the list of available generators will be presented when the time period for the direct closure has elapsed. If the parameter set 1 is not applicable, the generators will be presented right after performing step 1.	- The generator(s) that has been selected will have the relevant check-box marked, indicating the selection that has been made.	- When a generator breaker is selected for synchronizing a generator to a bus bar, the faceplate tab **Main** will present for selection only the specific generator. - When a network breaker is selected for synchronizing, the faceplate tab **Main** will present the available generators on both sides of the respective circuit breaker. The maximum number of generators that can be selected to participate in the sync process is equal to the value of the parameter *MaxNoGenSelection*.

STEP 3 (Optional):

Selecting the parameter set that will be activated on the synchronizing device.

Operation:	Result:	Comment:
- The faceplate of the pmsSNSyncSuperv control module is called up and parameter set will be selected from the drop-down menu presented in the faceplate **Main** tab. If the parameter set will be selected from application code the drop-down menu will be automatically dimmed/hidden (refer to paragraph Parameter Sets).	- The parameter set that will be activated on the synchronizing device, when the synchronization process is started, is now selected.	- When the sync process is started the relevant parameter set selection relay will be activated on the synchronizing device.

STEP 4:

Proceeding with the command for starting the synchronization (refer to Figure 20).

Operation:	Result:	Comment:
- The faceplate of the pmsSNSyncSuperv control module is called up and the synch start command is issued from the **Main** tab.	- The output for the generator selection relay(s) is activated. - The output for a parameter set (2-7) is activated. - The output for starting the synchronizing device is activated. - The governor and AVR modes for the selected generator are both changed to Droop. - The governor and AVR modes for the generators running in parallel with the selected generator are changed to MW (for governor) and PF (for AVR).	- The feedback that the selected generator relay(s) is activated must be received within a preconfigured time setting. The feedback that a parameter set (2-7) is activated must be received within a preconfigured time setting. The software parameterization of the synchronizing equipment must ensure that the parameter set 2-7 shall reflect the selected generator(s). When the output for starting the synchronizing device is activated, the hardware design must ensure that the respective synchronizing equipment is in Auto operating mode, thus allowing the automatic synchronization from a remote location. - The feedback that the synchronizing device is operating shall deactivate the start output. - The mode change for the governor and AVR is forced on the pmsGenM modules while the synchronization is in progress. When the synchronization is terminated (either by a breaker closure or by cancelling the operation), the governor and AVR will return to their previous modes. The hardware engineering of the selection relay panel and the synchronizing panel must ensure that, when one or more generators are selected, the raise/lower commands for the voltage and frequency adjustments shall be directed from the synchronizing equipment to the proper generator(s).

STEP 5:

Terminating the synchronization process (refer to Figure 9)

Operation:	Result:	Comment:
- The faceplate of the circuit breaker module pmsCBSyncM is called up and the synchronization cancel command button is operated from the main faceplate view	- The output for stopping the synchronizing device is activated. - All outputs for selection relays are deactivated.	- The feedback that the synchronizing device is ready shall deactivate the stop output. The synchronization process can be terminated automatically, if the time-out feature is configured or when the synchronizing equipment reports an error (optional).

When a generator breaker is selected for synchronizing a generator to a busbar, the faceplate tab **Main** will only present the specific generator, as shown in Figure 29.

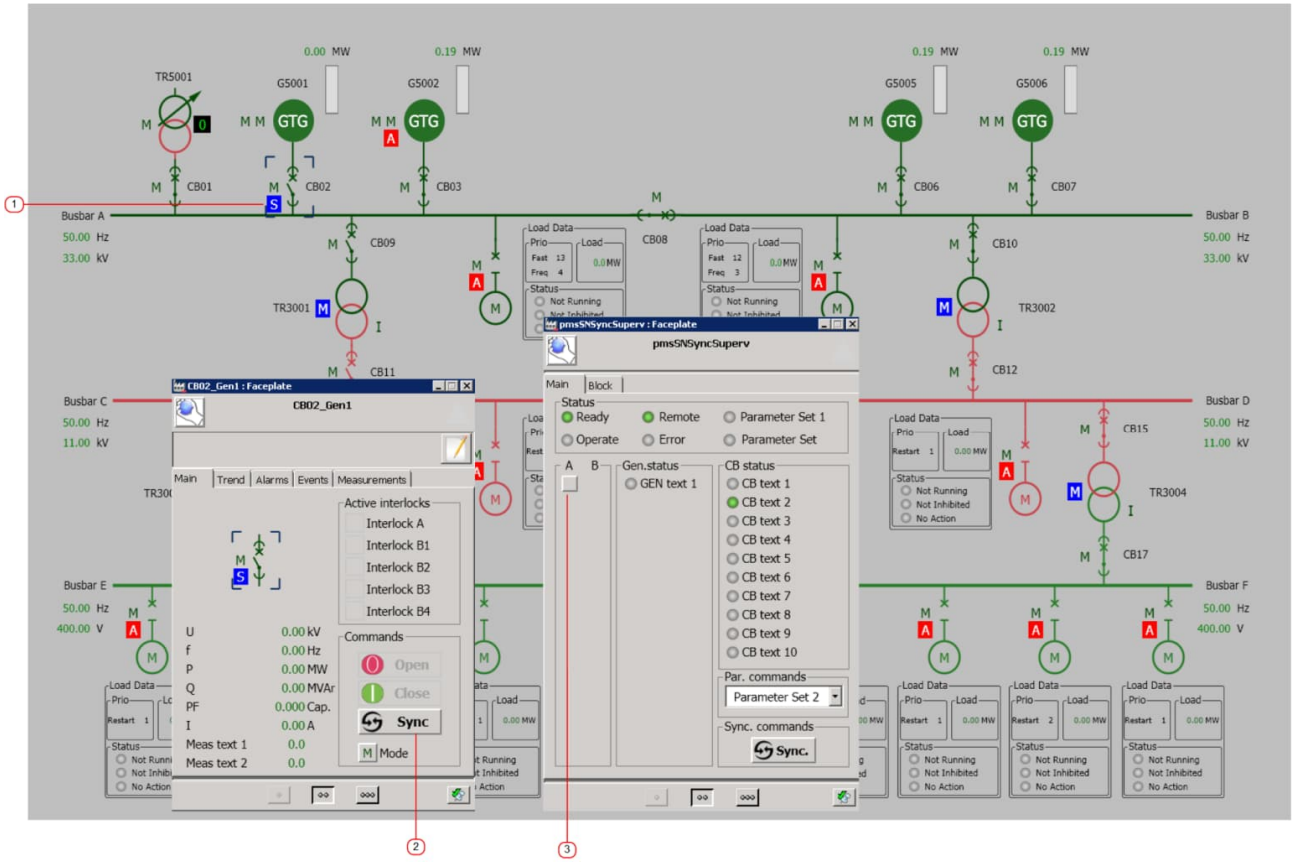


Figure 29 Generator selection list for a generator breaker

Table 47 Generator selection list for a generator breaker

Field	Indication	Description
1	Circuit breaker graphical icon	Graphic element for calling up the faceplate aspect of the pmsCBSyncM circuit breaker (refer to STEP 1 in section Synchronization with supervision of pmsCBSyncM/pmsGenM modules).
2	Faceplate command button	Command to initiate the synchronization procedure in pmsSNSyncSuperv (refer to STEP 4 in section Synchronization with supervision of pmsCBSyncM/pmsGenM modules).
3	Faceplate check-box	Command to select a generator for adjusting frequency/voltage (refer to STEP 2 in section Synchronization with supervision of pmsCBSyncM/pmsGenM modules).

When a grid circuit breaker is selected for synchronizing a plant network to a grid, the faceplate tab **Main** will present the generators that are connected to the variable side of the selected breaker, as shown in Figure 30.

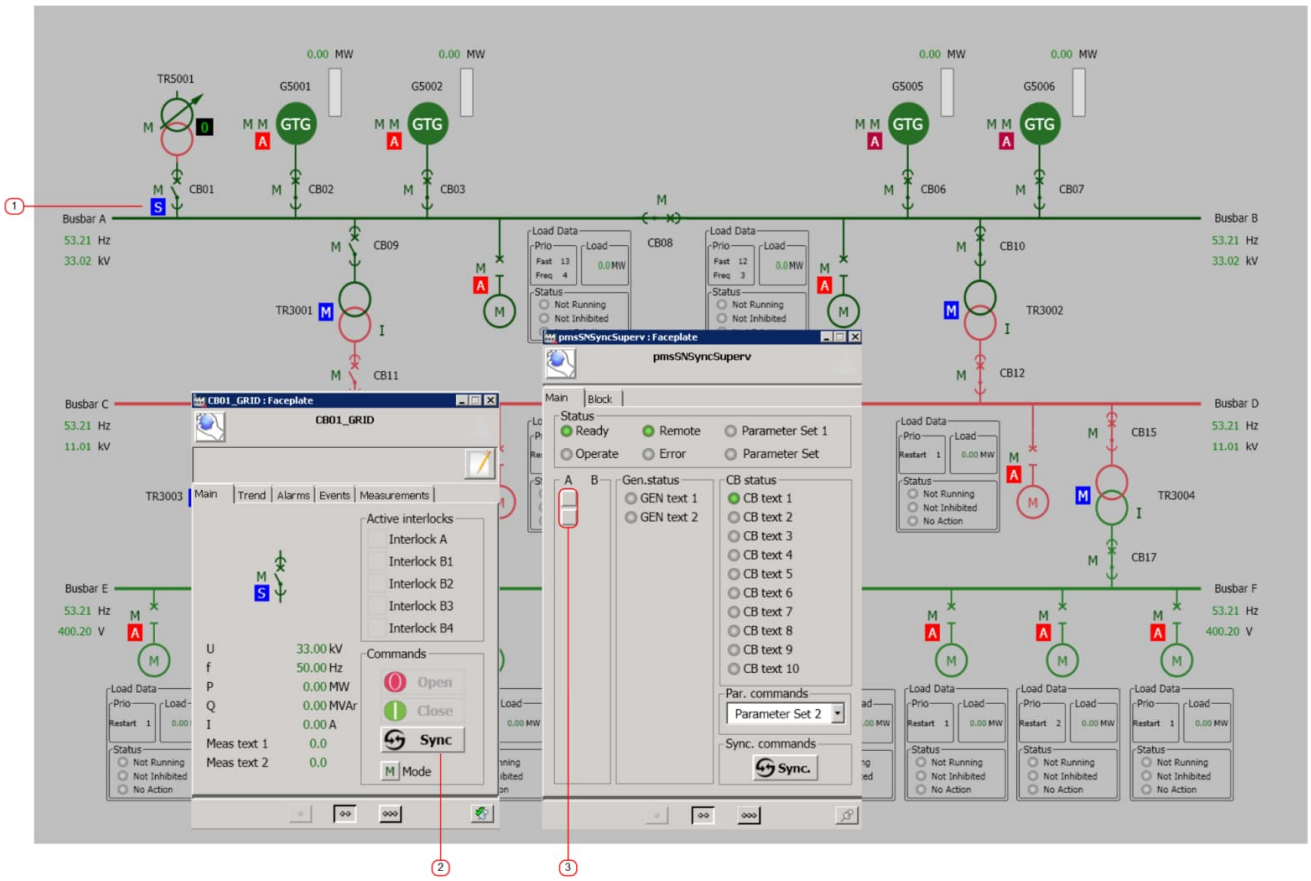


Figure 30 Generator selection list for a grid breaker

Table 48 Generator selection list for a grid breaker

Field	Indication	Description
1	Circuit breaker graphical icon	Graphic element for calling up the faceplate aspect of the pmsCBSyncM circuit breaker (refer to STEP 1 in section Synchronization with supervision of pmsCBSyncM/pmsGenM modules).
2	Faceplate command button	Command to initiate the synchronization procedure in pmsSNSyncSuperv (refer to STEP 4 in section Synchronization with supervision of pmsCBSyncM/pmsGenM modules).
3	Faceplate option-buttons	Commands to select a generator for adjusting frequency/voltage (refer to STEP 2 in section Synchronization with supervision of pmsCBSyncM/pmsGenM modules).

When a network breaker is selected for synchronizing two islanded busbars, the faceplate tab **Main** will present the generators connected to both sides of the breaker, as shown in Figure 31.

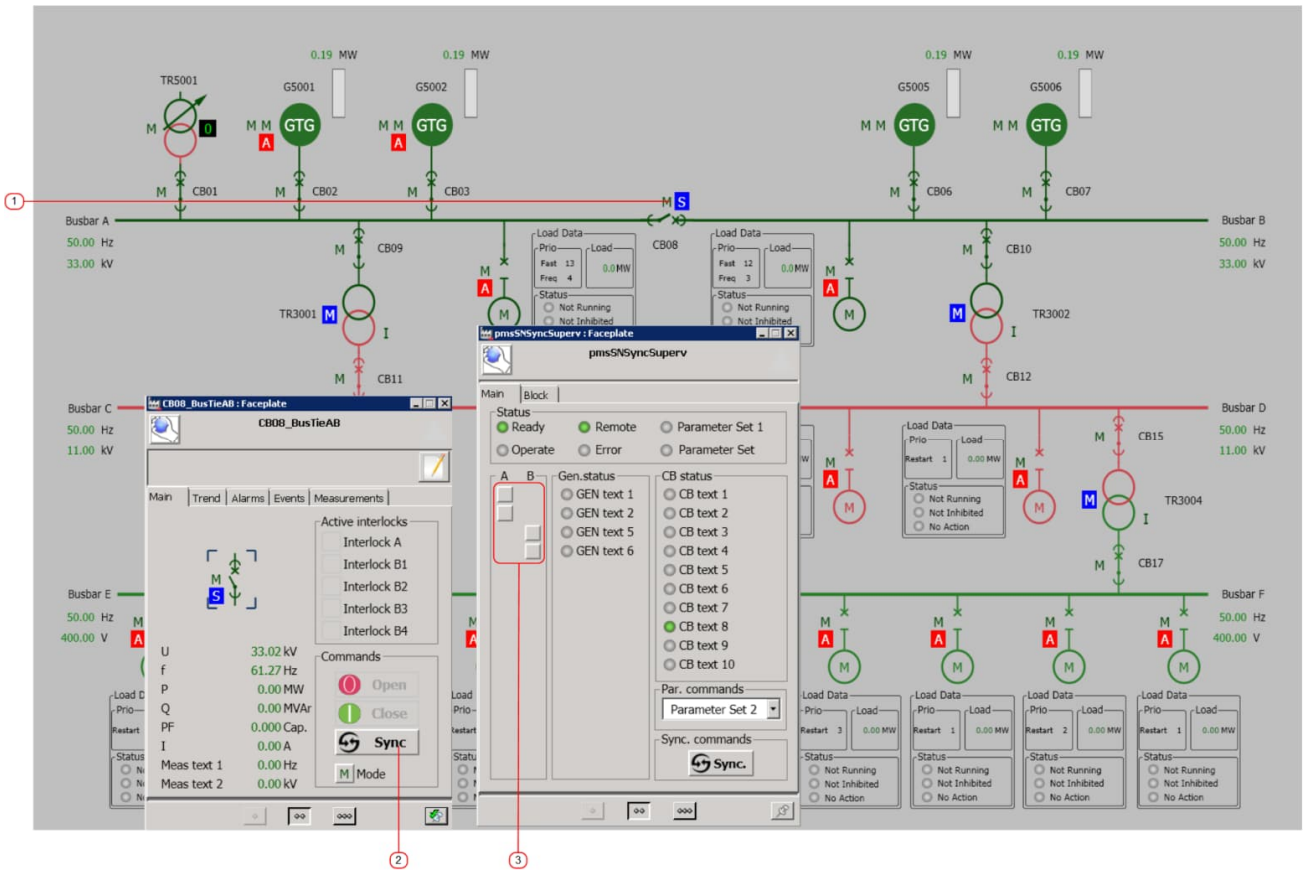


Figure 31 Generator selection list for a network breaker (bus-tie)

Table 49 Generator selection list for a network breaker (bus-tie)

Field	Indication	Description
1	Circuit breaker graphical icon	Graphic element for calling up the faceplate aspect of the pmsCBSyncM circuit breaker (refer to STEP 1 in section Synchronization with supervision of pmsCBSyncM/pmsGenM modules).
2	Faceplate command button	Command to initiate the synchronization procedure in pmsSNSyncSuperv (refer to STEP 1 in section Synchronization with supervision of pmsCBSyncM/pmsGenM modules).
3	Faceplate check-boxes	Commands to select a generator for adjusting frequency/voltage (refer to STEP 2 in section Synchronization with supervision of pmsCBSyncM/pmsGenM modules). The A-column reflects the variable side (U-Var) of a circuit breaker according to the hardware configuration. If a generator is selected from the B-column, the exchange relay will be activated for swapping the U-Var/U-Ref measurements applied to the synchronizing device.

4.8.2 Synchronization independent from pmsCBSyncM/pmsGenM modules

The steps described in this section apply when the pmsSNSyncSuperv is configured with no interaction with the pmsCBSyncM and pmsGenM modules. This alternative is used when the synchronization functionality requires to be implemented as a stand-alone feature without integration with the generator and circuit breaker objects.

STEP 1: Selecting a circuit breaker (refer to Figure 11).

Operation:	Result:	Comment:
The faceplate of the synchronization module pmsSNSyncSuperv is called up and a circuit breaker is selected from the **Main** tab.	The output for the circuit breaker selection relay is activated.	The feedback that the selected circuit breaker relay is activated must be received within a preconfigured time setting. The hardware engineering of the selection relay panel and the synchronizing panel must ensure that, when a breaker is selected, the proper voltage and frequency measurements from the two sides of the breaker (U-Var and U-Ref) shall be applied to the synchronizing equipment.

STEP 2: Selecting a generator (refer to Figure 16).

Operation:	Result:	Comment:
The faceplate of the synchronization module pmsSNSyncSuperv is called up and the generator(s) selected from the **Main** tab.	The generator(s) that has been selected will have the relevant check-box marked, indicating the selection that has been made.	The maximum number of generators that can be selected to participate in the synchronization process is equal to the value assigned to the parameter *MaxNoGenSelection*. The number of the generators selected must not be higher than the value set for the parameter *MaxNoGenSelection*.

STEP 3 (Optional): Selecting the parameter set that will be activated on the sync device (refer to Figure 25).

Operation:	Result:	Comment:
The faceplate of the pmsSNSyncSuperv control module is called up and parameter set will be selected from the drop-down menu presented in the **Main** tab. If the parameter set will be selected from application code the drop-down menu will be automatically dimmed/hidden (refer to Parameter Sets).	The parameter set that will be activated on the synchronizing device when the synchronization process is started has been selected.	When the sync process is started the relevant parameter set selection relay will be activated on the synchronizing device.

STEP 4: Starting the synchronizing device (refer to Figure 22).

Operation:	Result:	Comment:
The faceplate of the synchronization module pmsSNSyncSuperv is called up and the synch start command is issued from the **Main** tab.	The output for the generator selection relay is activated. The output for a parameter set (2-7) is activated.	The feedback that the selected generator relay is activated must be received within a preconfigured time setting. The feedback that a parameter set (2-7) is activated must be received within a preconfigured time setting. The software parameterization of the synchronizing equipment must ensure that the parameter set 2-7 shall reflect the selected generator. The hardware engineering of the selection relay panel and the synchronizing panel must ensure that, when a generator is selected, the raise/lower commands for the voltage and frequency adjustments shall be directed from the synchronizing equipment to the proper generator.

STEP 5: Stopping the synchronizing device (refer to Figure 22).

Operation:	Result:	Comment:
The faceplate of the synchronization module pmsSNSyncSuperv is called up and the Stop command is operated.	The output for stopping the synchronizing device is activated (when the Stop command is issued). The outputs for the selection relays are deactivated.	The feedback that the synchronizing device is operating shall deactivate the start output. The feedback that the synchronizing device is ready shall deactivate the stop output.

Section 5 Relations

5.1 Related Control Modules

The relation between the pmsSNSyncSuperv control module and the pmsCBSyncM and pmsGenM modules is shown in Figure 32.

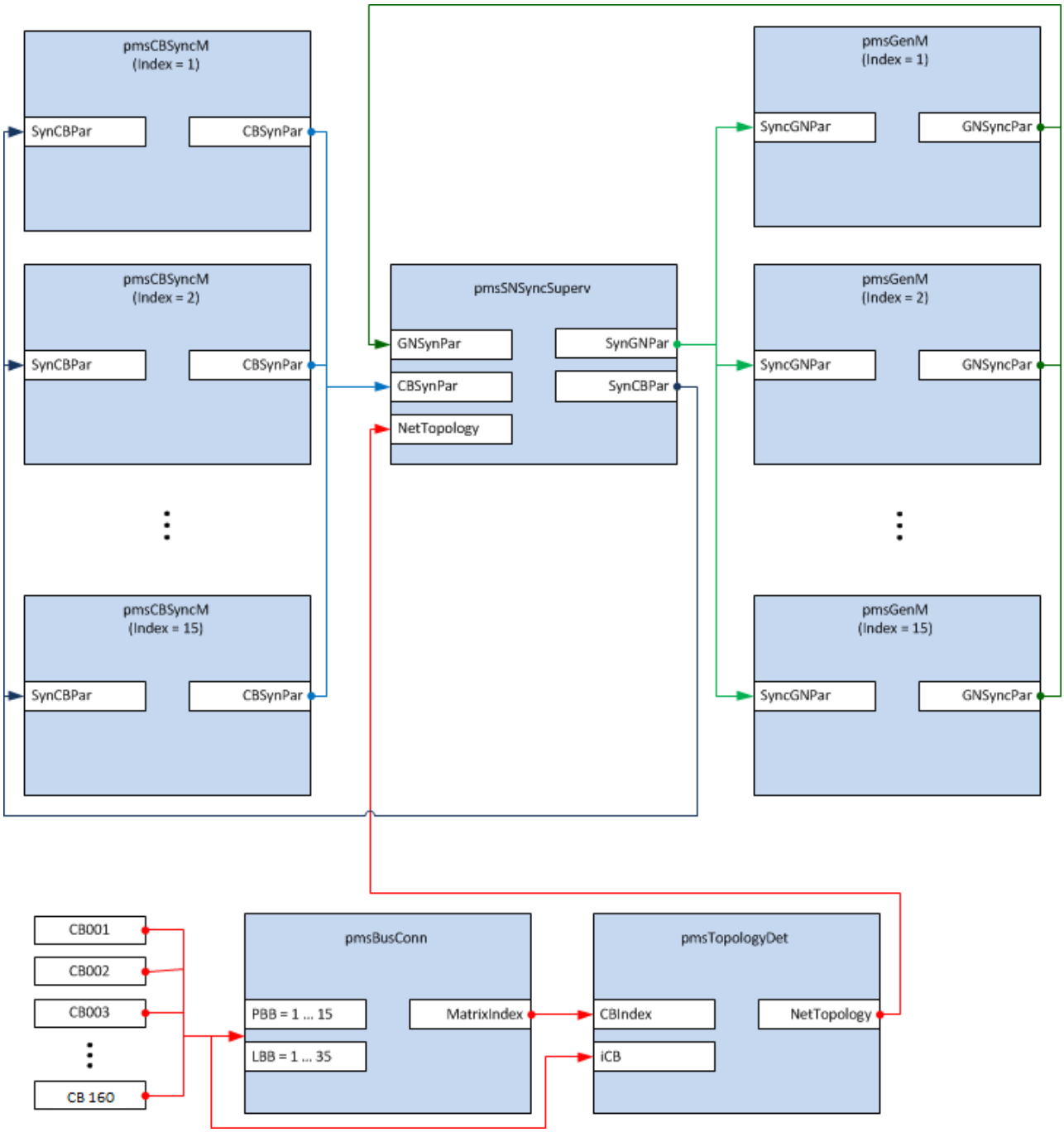


Figure 32 Interconnection between pmsSNSyncSuperv and other modules in PMS

5.2 All modules in one application

When the pmsGenM, pmsCBSyncM and the pmsSNSyncSuperv modules are implemented in one application, the interconnection between the modules is established by global variables. A configuration overview is shown in Figure 33.

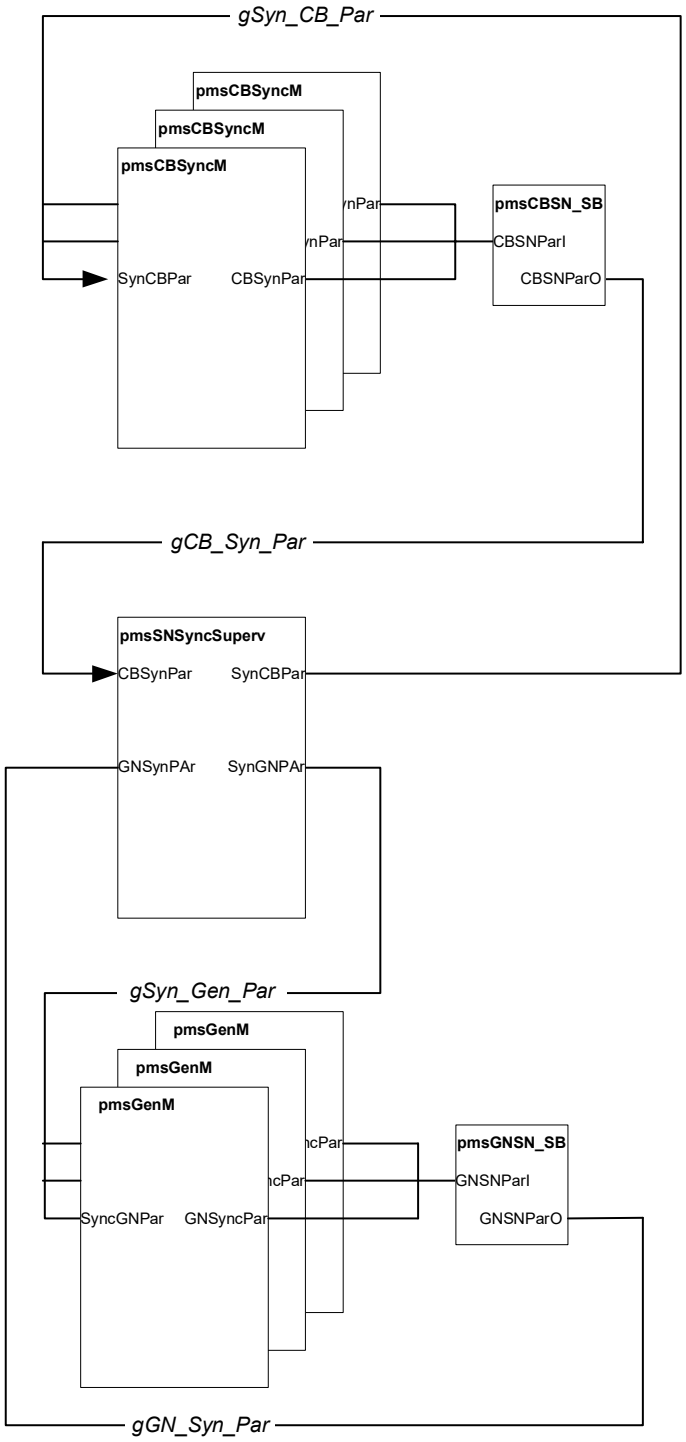


Figure 33 Interconnection of related modules in one application

5.3 Modules distributed over several applications

When the pmsGenM, pmsCBSyncM and the pmsSNSyncSuperv modules are implemented in different applications, interconnection is established by using MMS communication and access variables. A configuration overview is shown Figure 34.

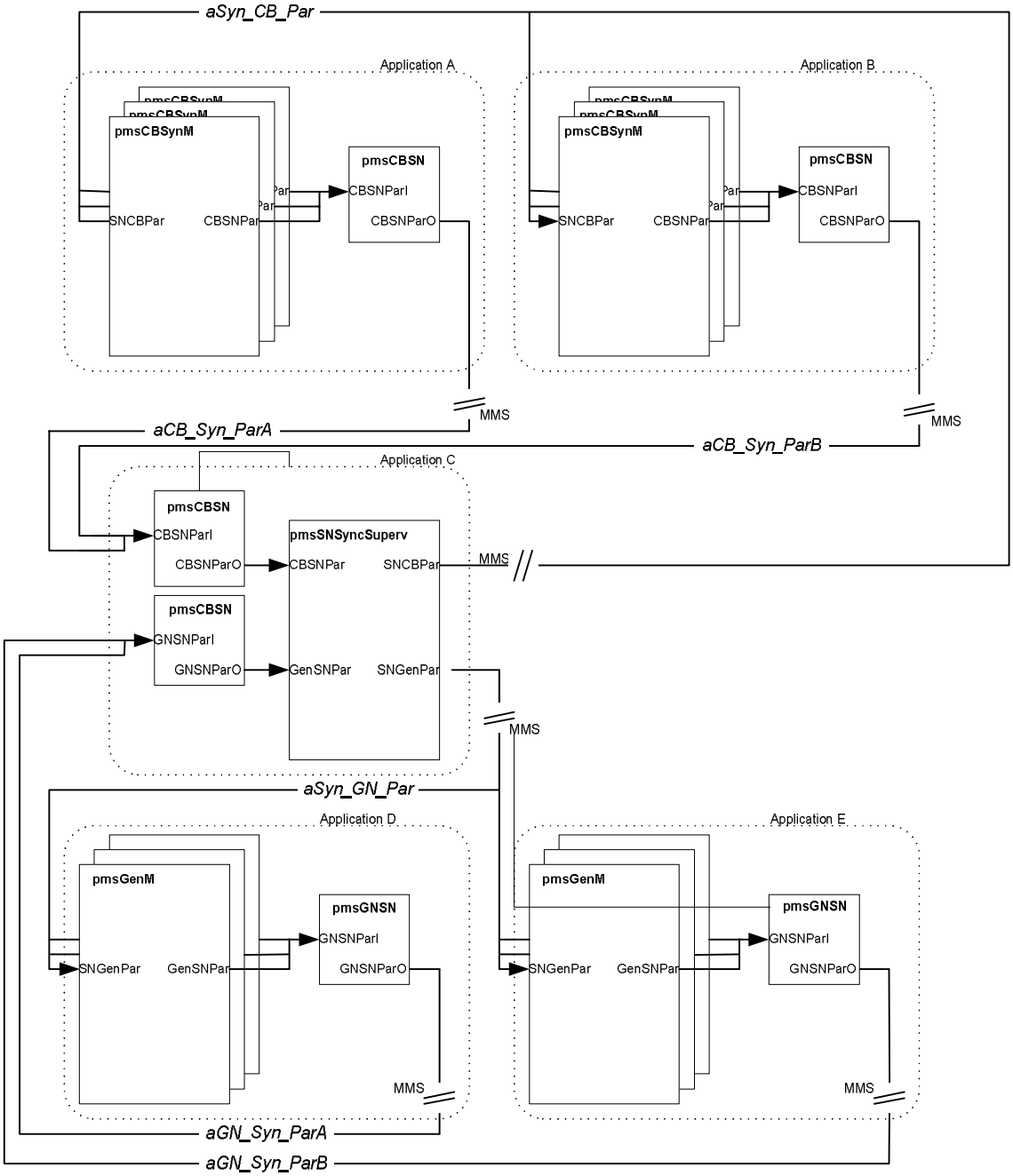


Figure 34 Interconnection of related modules in more than one application

Section 6 Capacity & Performance

Table 50 Firmware version downloaded in AC800M controllers

Unit	Firmware version
PM866	FW866 5.1.48.40 2010-07-02 (BasicHwLib 5.1-0)
PM891	FW891 5.1.48.40 2010-07-02 (BasicHwLib 5.1-0)

6.1 Heap utilization

6.1.1 pmsSNSyncSuperv

Table 51 Heap utilization of pmsSNSyncSuperv in AC800M controller

	First instance	2nd and following instances
Heap utilization(MB) in PM866	0.202	0.174
Heap utilization(MB) in PM891	0.212	0.182

6.1.2 pmsGNSN

Table 52 Heap utilization of pmsCBSN in AC800M controller

	First instance	2nd and following instances
Heap utilization(MB) in PM866	0.013	0.004
Heap utilization(MB) in PM891	0.011	0.005

6.2 Execution Time

6.2.1 pmsSNSyncSuperv

Table 53 Execution time of pmsSNSyncSuperv in AC800M controller

Execution time (ms)	Notes
5 ms	For one instance in PM866
1 ms	For one instance in PM891

6.2.2 pmsGNSN

Table 54 Execution time of pmsGNSN in AC800M controller

Execution time (ms)	Notes
<0.01 ms	For one instance in PM866
<0.005 ms	For one instance in PM891

6.2.3 pmsCBSN

Table 55 Execution time of pmsCBSN in AC800M controller

Execution time (ms)	Notes
<0.01 ms	For one instance in PM866
<0.005 ms	For one instance in PM891

Section 7 Application Notes

A configuration example of the synchronization software will be described in the following sections. The single line diagram in Figure 35 will be used as a basis for the example.

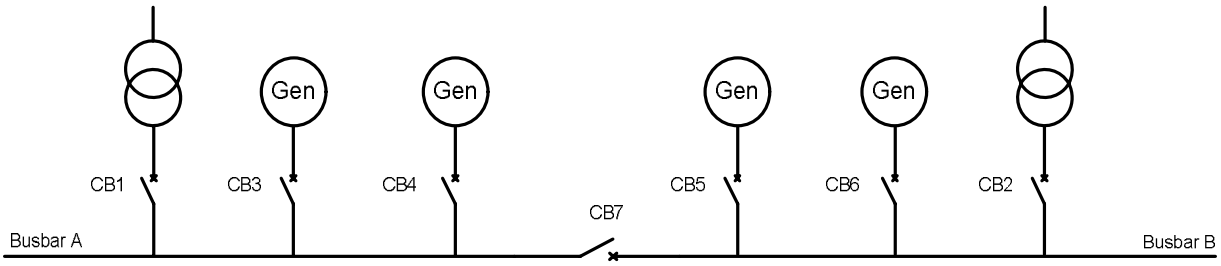


Figure 35 Example of Single Line Diagram

This configuration example will assume that the following circuit breakers are included in the synchronization scheme as shown in Figure 35:

- Incomers from Grid 1 and Grid 2.
- Generator breakers from G1, G2, G3 and G4.
- Bus-coupler between bus sections A-B.

7.1 Project structure

A PMS project configured with the Control Builder M Professional is shown in Figure 36. The examples described in the following sections will be based on this project structure.

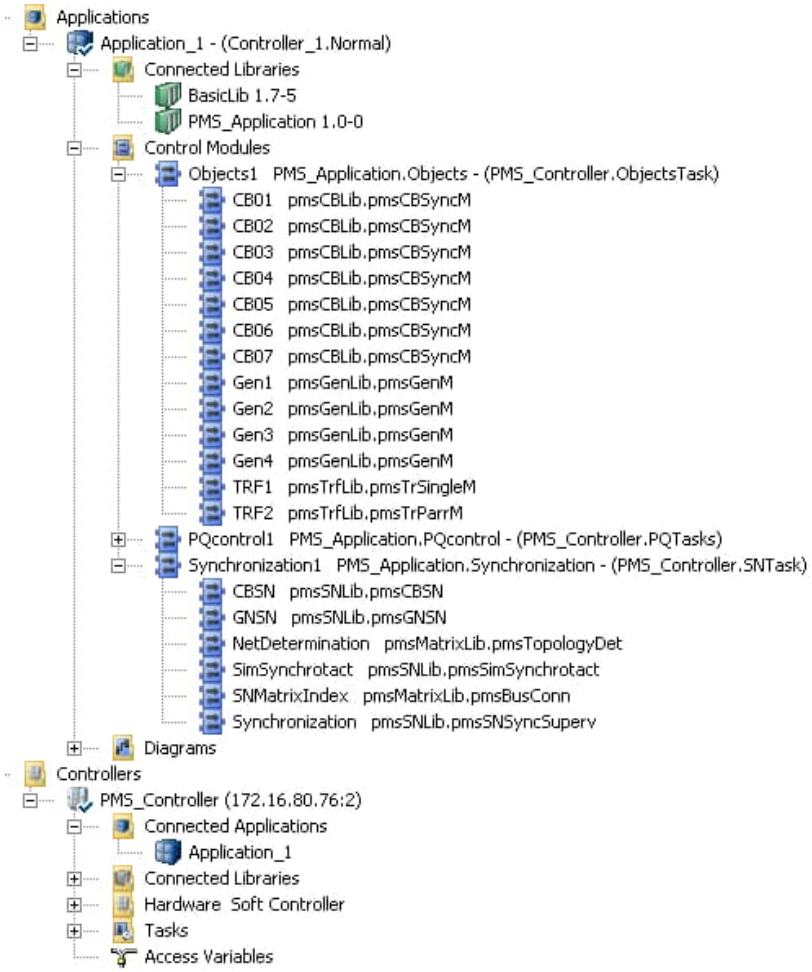


Figure 36 Example of project structure

7.2 Network determination

The first task in configuring the network matrix, is to assign unique identity numbers for all network components (i.e. power busbars, load busbars and circuit breakers):

- Power busbars (PB01 to PB15): The power busbars must be identified starting from the grid connections. The grid connections are defined with the identity PB01 and PB02. If grid connections are not applicable for a certain plant, then PB01 and PB02 shall be configured for generators. The power busbars for the generators must start from identity PBx, where x is 1 + Number of grid connections in the plant. If the plant has 2 grid connections then the first generator must start from identity PB03.
- Load busbars (LB01 to LB35): The load busbars with shed items and connections to power busbars must be identified first. The load busbars of a substation configuration type are not required to be given an identity number.
- Circuit breakers (CB01 to CB160): The circuit breakers that determine if a busbar is connected to an energized network must be identified. The circuit breakers that connect a load to a busbar are not required to be given an identity number.

The assignment of identities for the network example is shown in Figure 37. The power busbars are marked with red background colour, the load busbars with green background colour and the circuit breakers with orange background colour.

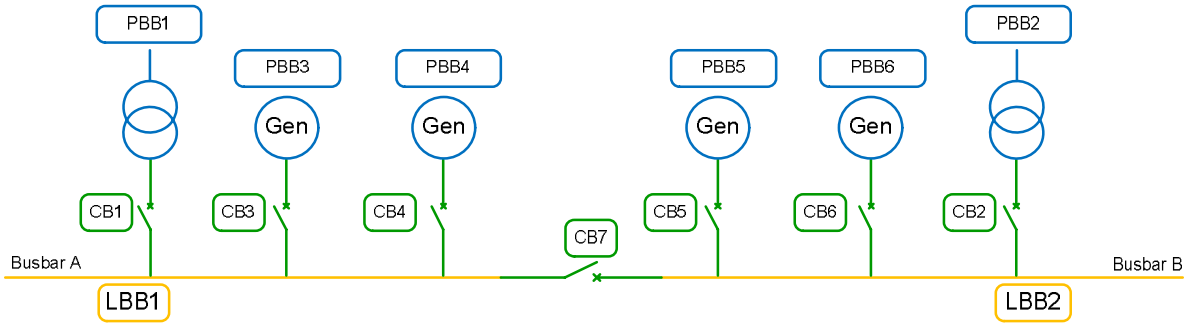


Figure 37 Example of network determination

7.3 Configuration of circuit breaker and generator objects

The synchronization function supports software connections with the circuit breaker modules (pmsCBSyncM) and the generator modules (pmsGenM). The following sections will describe the configuration of these objects for the synchronization application.

7.3.1 Application code for pmsCBSyncM control modules

The control modules pmsCBSyncM are instantiated under a library structure named *Objects*, as shown in Figure 38.

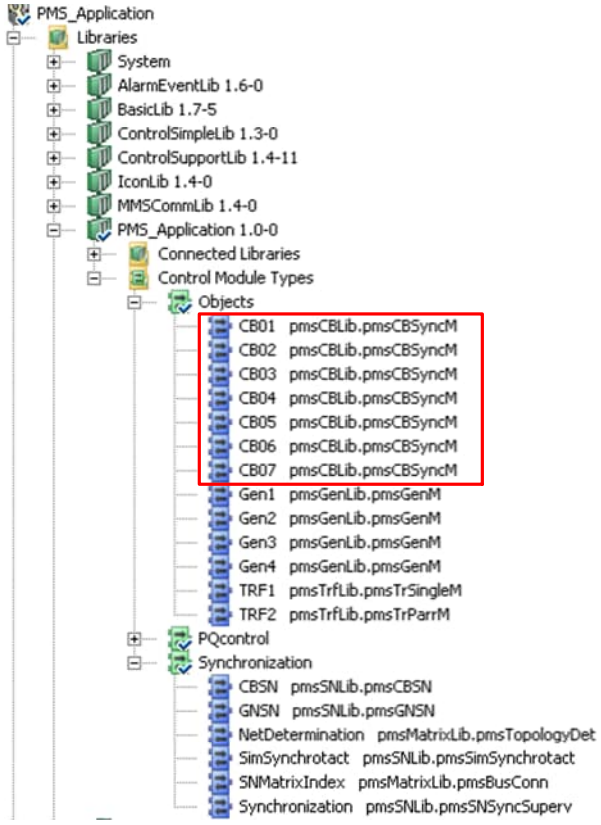


Figure 38 Example of pmsCBSyncM instances used in synchronization

To connect the parameters of the instances it is recommended to create an application specific data type. The example in Figure 39 shows the data type named *pmsNode1*. The necessary components for the parameter connections to the pmsCBSyncM modules are shown with a red frame.

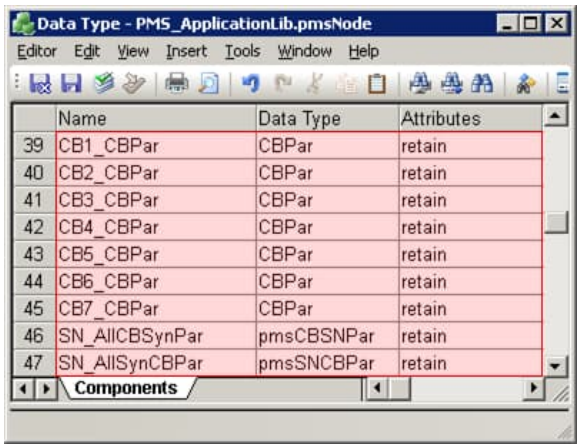
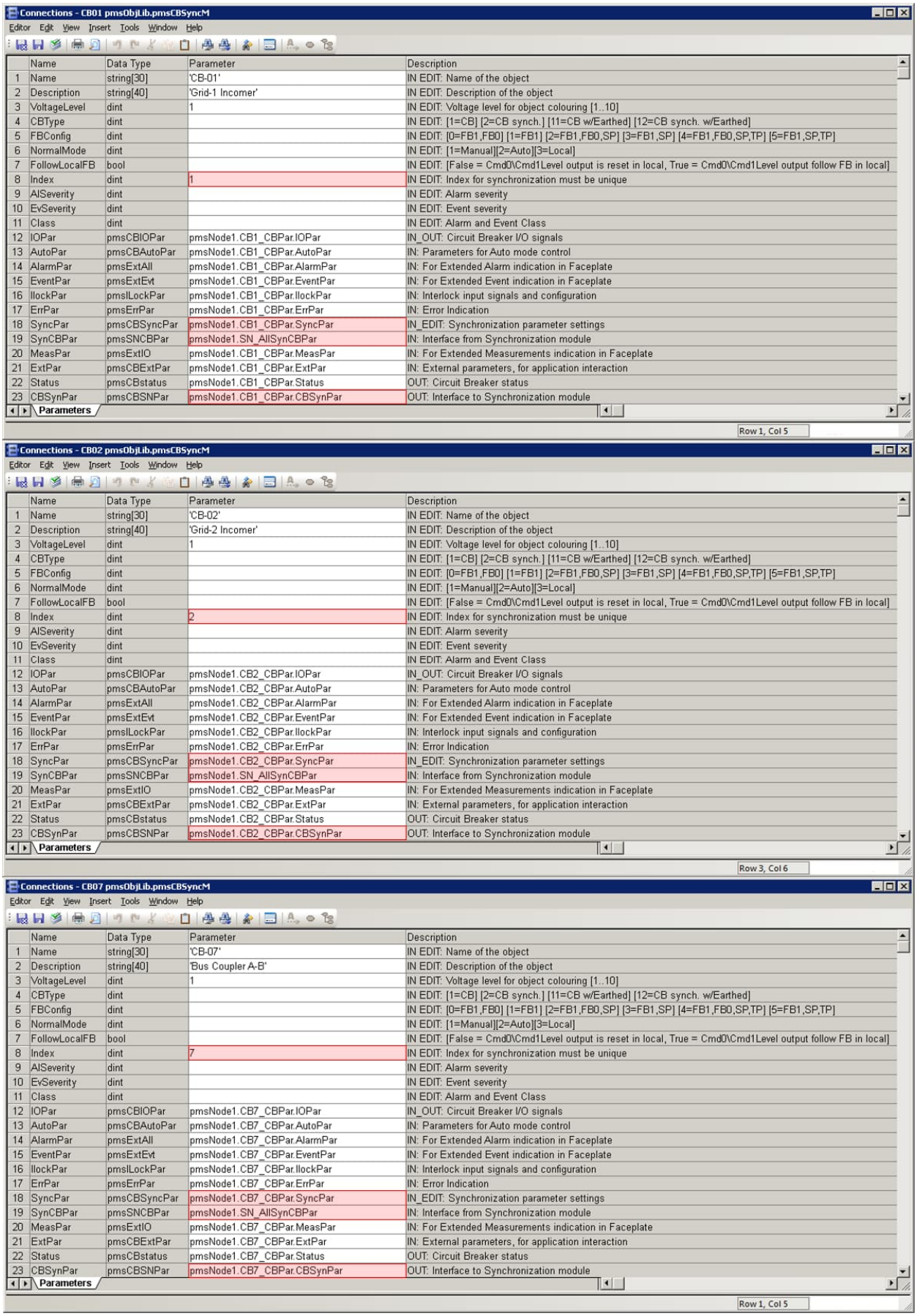


Figure 39 Example of data type components for the pmsCBSyncM instances

One control module of type pmsCBSyncM must be instantiated for each breaker included in the synchronization scheme. An example of the parameter connections is shown, in Figure 40.



Connections - CB01 pmsObjLib.pmsCBSyncM

Editor Edit View Insert Tools Window Help

	Name	Data Type	Parameter	Description
1	Name	string[30]	'CB-01'	IN EDIT: Name of the object
2	Description	string[40]	'Grid-1 Incomer'	IN EDIT: Description of the object
3	VoltageLevel	dint	1	IN EDIT: Voltage level for object colouring [1..10]
4	CBType	dint		IN EDIT: [1=CB] [2=CB synch.] [11=CB w/Earthed] [12=CB synch. w/Earthed]
5	FBConfig	dint		IN EDIT: [0=FB1,FB0] [1=FB1] [2=FB1,FB0,SP] [3=FB1,SP] [4=FB1,FB0,SP,TP] [5=FB1,SP,TP]
6	NormalMode	dint		IN EDIT: [1=Manual][2=Auto][3=Local]
7	FollowLocalFB	bool		IN EDIT: [False = Cmd0\Cmd1Level output is reset in local, True = Cmd0\Cmd1Level output follow FB in local]
8	Index	dint	1	IN EDIT: Index for synchronization must be unique
9	AlSeverity	dint		IN EDIT: Alarm severity
10	EvSeverity	dint		IN EDIT: Event severity
11	Class	dint		IN EDIT: Alarm and Event Class
12	IOPar	pmsCBIOPar	pmsNode1.CB1_CBPar.IOPar	IN_OUT: Circuit Breaker I/O signals
13	AutoPar	pmsCBAutoPar	pmsNode1.CB1_CBPar.AutoPar	IN: Parameters for Auto mode control
14	AlarmPar	pmsExtAll	pmsNode1.CB1_CBPar.AlarmPar	IN: For Extended Alarm indication in Faceplate
15	EventPar	pmsExtEvt	pmsNode1.CB1_CBPar.EventPar	IN: For Extended Event indication in Faceplate
16	IlockPar	pmsILockPar	pmsNode1.CB1_CBPar.IlockPar	IN: Interlock input signals and configuration
17	ErrPar	pmsErrPar	pmsNode1.CB1_CBPar.ErrPar	IN: Error Indication
18	SyncPar	pmsCBSyncPar	pmsNode1.CB1_CBPar.SyncPar	IN_EDIT: Synchronization parameter settings
19	SynCBPar	pmsSNCBPar	pmsNode1.SN_AllSynCBPar	IN: Interface from Synchronization module
20	MeasPar	pmsExtIO	pmsNode1.CB1_CBPar.MeasPar	IN: For Extended Measurements indication in Faceplate
21	ExtPar	pmsCBExtPar	pmsNode1.CB1_CBPar.ExtPar	IN: External parameters, for application interaction
22	Status	pmsCBstatus	pmsNode1.CB1_CBPar.Status	OUT: Circuit Breaker status
23	CBSynPar	pmsCBSNPar	pmsNode1.CB1_CBPar.CBSynPar	OUT: Interface to Synchronization module

Parameters

Row 1, Col 5

Connections - CB02 pmsObjLib.pmsCBSyncM

Editor Edit View Insert Tools Window Help

	Name	Data Type	Parameter	Description
1	Name	string[30]	'CB-02'	IN EDIT: Name of the object
2	Description	string[40]	'Grid-2 Incomer'	IN EDIT: Description of the object
3	VoltageLevel	dint	1	IN EDIT: Voltage level for object colouring [1..10]
4	CBType	dint		IN EDIT: [1=CB] [2=CB synch.] [11=CB w/Earthed] [12=CB synch. w/Earthed]
5	FBConfig	dint		IN EDIT: [0=FB1,FB0] [1=FB1] [2=FB1,FB0,SP] [3=FB1,SP] [4=FB1,FB0,SP,TP] [5=FB1,SP,TP]
6	NormalMode	dint		IN EDIT: [1=Manual][2=Auto][3=Local]
7	FollowLocalFB	bool		IN EDIT: [False = Cmd0\Cmd1Level output is reset in local, True = Cmd0\Cmd1Level output follow FB in local]
8	Index	dint	2	IN EDIT: Index for synchronization must be unique
9	AlSeverity	dint		IN EDIT: Alarm severity
10	EvSeverity	dint		IN EDIT: Event severity
11	Class	dint		IN EDIT: Alarm and Event Class
12	IOPar	pmsCBIOPar	pmsNode1.CB2_CBPar.IOPar	IN_OUT: Circuit Breaker I/O signals
13	AutoPar	pmsCBAutoPar	pmsNode1.CB2_CBPar.AutoPar	IN: Parameters for Auto mode control
14	AlarmPar	pmsExtAll	pmsNode1.CB2_CBPar.AlarmPar	IN: For Extended Alarm indication in Faceplate
15	EventPar	pmsExtEvt	pmsNode1.CB2_CBPar.EventPar	IN: For Extended Event indication in Faceplate
16	IlockPar	pmsILockPar	pmsNode1.CB2_CBPar.IlockPar	IN: Interlock input signals and configuration
17	ErrPar	pmsErrPar	pmsNode1.CB2_CBPar.ErrPar	IN: Error Indication
18	SyncPar	pmsCBSyncPar	pmsNode1.CB2_CBPar.SyncPar	IN_EDIT: Synchronization parameter settings
19	SynCBPar	pmsSNCBPar	pmsNode1.SN_AllSynCBPar	IN: Interface from Synchronization module
20	MeasPar	pmsExtIO	pmsNode1.CB2_CBPar.MeasPar	IN: For Extended Measurements indication in Faceplate
21	ExtPar	pmsCBExtPar	pmsNode1.CB2_CBPar.ExtPar	IN: External parameters, for application interaction
22	Status	pmsCBstatus	pmsNode1.CB2_CBPar.Status	OUT: Circuit Breaker status
23	CBSynPar	pmsCBSNPar	pmsNode1.CB2_CBPar.CBSynPar	OUT: Interface to Synchronization module

Parameters

Row 3, Col 6

Connections - CB07 pmsObjLib.pmsCBSyncM

Editor Edit View Insert Tools Window Help

	Name	Data Type	Parameter	Description
1	Name	string[30]	'CB-07'	IN EDIT: Name of the object
2	Description	string[40]	'Bus Coupler A-B'	IN EDIT: Description of the object
3	VoltageLevel	dint	1	IN EDIT: Voltage level for object colouring [1..10]
4	CBType	dint		IN EDIT: [1=CB] [2=CB synch.] [11=CB w/Earthed] [12=CB synch. w/Earthed]
5	FBConfig	dint		IN EDIT: [0=FB1,FB0] [1=FB1] [2=FB1,FB0,SP] [3=FB1,SP] [4=FB1,FB0,SP,TP] [5=FB1,SP,TP]
6	NormalMode	dint		IN EDIT: [1=Manual][2=Auto][3=Local]
7	FollowLocalFB	bool		IN EDIT: [False = Cmd0\Cmd1Level output is reset in local, True = Cmd0\Cmd1Level output follow FB in local]
8	Index	dint	7	IN EDIT: Index for synchronization must be unique
9	AlSeverity	dint		IN EDIT: Alarm severity
10	EvSeverity	dint		IN EDIT: Event severity
11	Class	dint		IN EDIT: Alarm and Event Class
12	IOPar	pmsCBIOPar	pmsNode1.CB7_CBPar.IOPar	IN_OUT: Circuit Breaker I/O signals
13	AutoPar	pmsCBAutoPar	pmsNode1.CB7_CBPar.AutoPar	IN: Parameters for Auto mode control
14	AlarmPar	pmsExtAll	pmsNode1.CB7_CBPar.AlarmPar	IN: For Extended Alarm indication in Faceplate
15	EventPar	pmsExtEvt	pmsNode1.CB7_CBPar.EventPar	IN: For Extended Event indication in Faceplate
16	IlockPar	pmsILockPar	pmsNode1.CB7_CBPar.IlockPar	IN: Interlock input signals and configuration
17	ErrPar	pmsErrPar	pmsNode1.CB7_CBPar.ErrPar	IN: Error Indication
18	SyncPar	pmsCBSyncPar	pmsNode1.CB7_CBPar.SyncPar	IN_EDIT: Synchronization parameter settings
19	SynCBPar	pmsSNCBPar	pmsNode1.SN_AllSynCBPar	IN: Interface from Synchronization module
20	MeasPar	pmsExtIO	pmsNode1.CB7_CBPar.MeasPar	IN: For Extended Measurements indication in Faceplate
21	ExtPar	pmsCBExtPar	pmsNode1.CB7_CBPar.ExtPar	IN: External parameters, for application interaction
22	Status	pmsCBstatus	pmsNode1.CB7_CBPar.Status	OUT: Circuit Breaker status
23	CBSynPar	pmsCBSNPar	pmsNode1.CB7_CBPar.CBSynPar	OUT: Interface to Synchronization module

Parameters

Row 1, Col 5

Figure 40 Example of parameter connections for the pmsCBSyncM instances

7.3.2 Connection of Index

The parameter *Index* in the pmsCBSyncM control module is a unique identity number which must be assigned to each circuit breaker included in the synchronization scheme.

The configuration example in Figure 40 shows the following index numbers assigned to the relevant circuit breakers:

Table 56 Example of Index numbers assigned to pmsCBSyncM modules

Control module name	Description	Index
CB-01	Grid-1 Incomer	1
CB-02	Grid-2 Incomer	2
CB-03	Generator 1 Incomer	3
CB-04	Generator 2 Incomer	4
CB-05	Generator 3 Incomer	5
CB-06	Generator 4 Incomer	6
CB-07	Bus Coupler A-B	7

Any double integer number can be assigned to the parameter Index of a circuit breaker, as long as it is unique among the pmsCBSyncM modules included in the synchronization scheme. In the example shown in Table 55, the index numbers are equal to the identity of the circuit breakers in the network determination, thus ensuring that they are unique.

7.3.2.1 Connection of SyncPar

The parameter *SyncPar* in the pmsCBSyncM control module shall be used for defining the variable and reference side (i.e. U-Var and U-Ref) of each circuit breaker in the synchronization scheme, according to the principle described in Figure 17. It is also used for assigning a configuration value for the type of the breaker (i.e. grid breaker, generator breaker or network breaker), according to the network topology. An example of the necessary application code is shown in Figure 41.

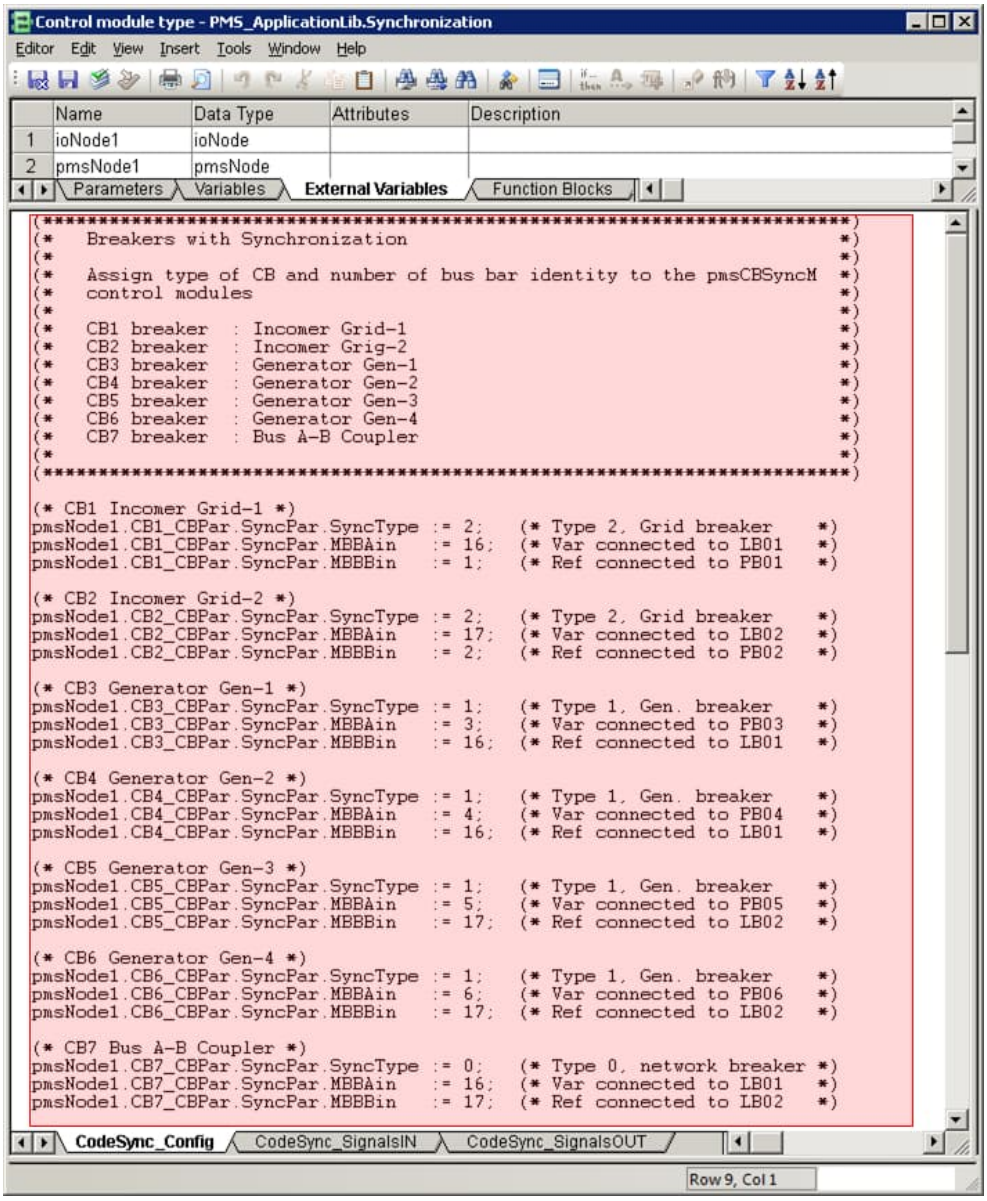


Figure 41 Example of application code for the parameter SyncPar in pmsCBSyncM module

7.3.2.2 Connection of SynCBPar

The parameter *SynCBPar* shall be used for receiving the necessary data, from the synchronization module pmsSNSyncSuperv, into the circuit breaker module pmsCBSyncM.

The configuration example in Figure 38 shows that the variable *pmsNode1.gSN_AllSynCBPar* is connected to the parameter *SynCBPar* for all the circuit breakers in the synchronization scheme. The same variable *pmsNode1.gSN_AllSynCBPar* shall also be connected to the parameter *SynCBPar* in the pmsSNSyncSuperv, as shown in Figure 42.

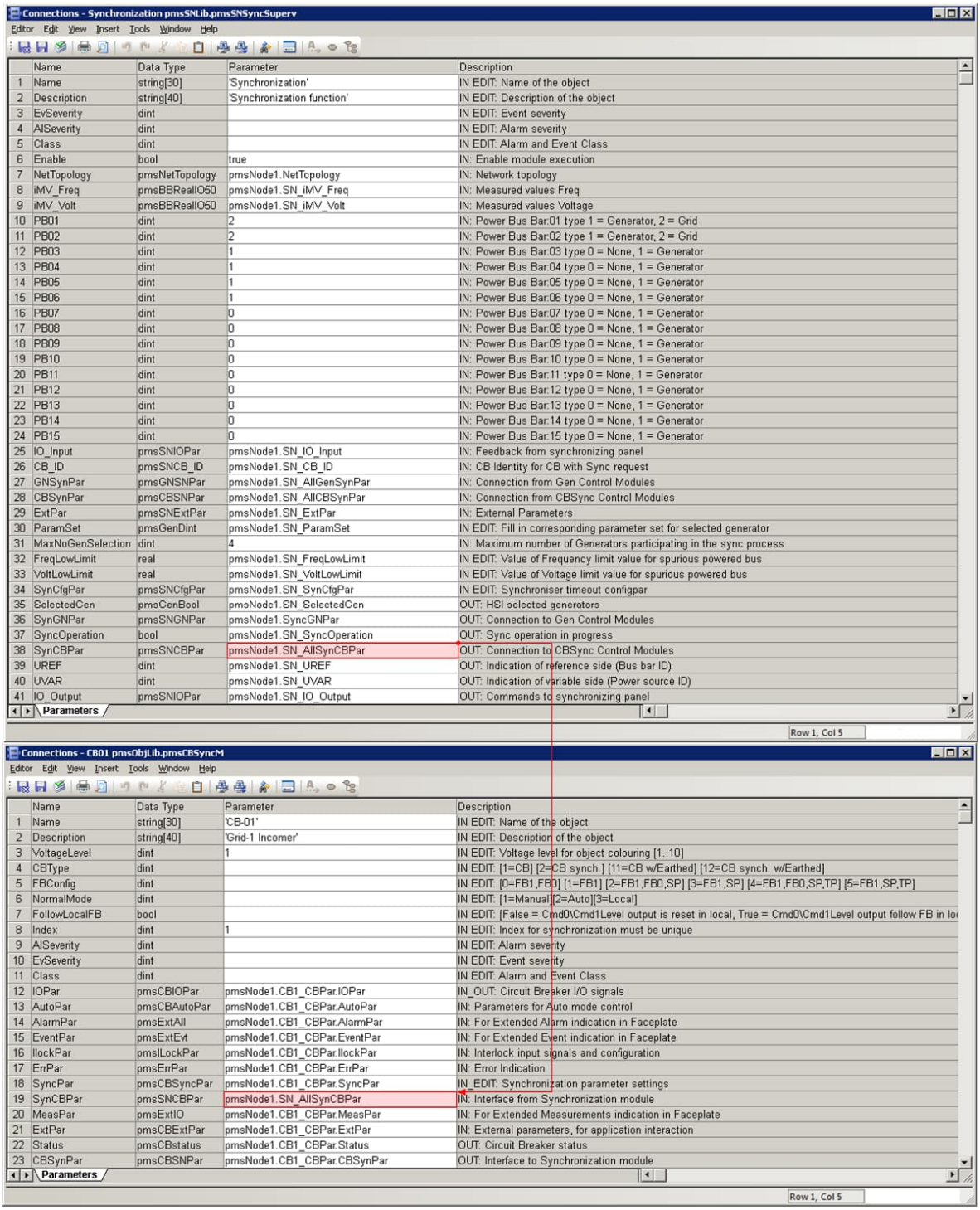


Figure 42 Example of SynCBPar parameter interconnection with pmsSNSyncSuperv

7.3.2.3 Connection of CBSynPar

The parameter *CBSynPar* shall be used for sending the necessary data from the circuit breaker modules pmsCBSyncM into the synchronization module pmsSNSyncSuperv.

The configuration example in Figure 40 shows that the following variables are connected to the *CBSynPar* parameter of the relevant circuit breakers in the synchronization scheme:

Table 57 Example of CBSynPar connections to pmsCBSyncM modules

Control module name	Description	Variable connected to CBSynPar
CB-01	Grid-1 Incomer	*pmsNode1.CB1_CBPar.CBSynPar*
CB-02	Grid-2 Incomer	*pmsNode1.CB2_CBPar.CBSynPar*
CB-03	Generator 1 Incomer	*pmsNode1.CB3_CBPar.CBSynPar*
CB-04	Generator 2 Incomer	*pmsNode1.CB4_CBPar.CBSynPar*
CB-05	Generator 3 Incomer	*pmsNode1.CB5_CBPar.CBSynPar*
CB-06	Generator 4 Incomer	*pmsNode1.CB6_CBPar.CBSynPar*
CB-07	Bus Coupler A-B	*pmsNode1.CB7_CBPar.CBSynPar*

The *CBSynPar* from up to 10 different circuit breakers shall be collected in a *pmsCBSN* control module, as shown in Figure 43. The output *CBSNParO* shall be further linked to the input parameter *CBSynPar* of the pmsSNSyncSuperv module.

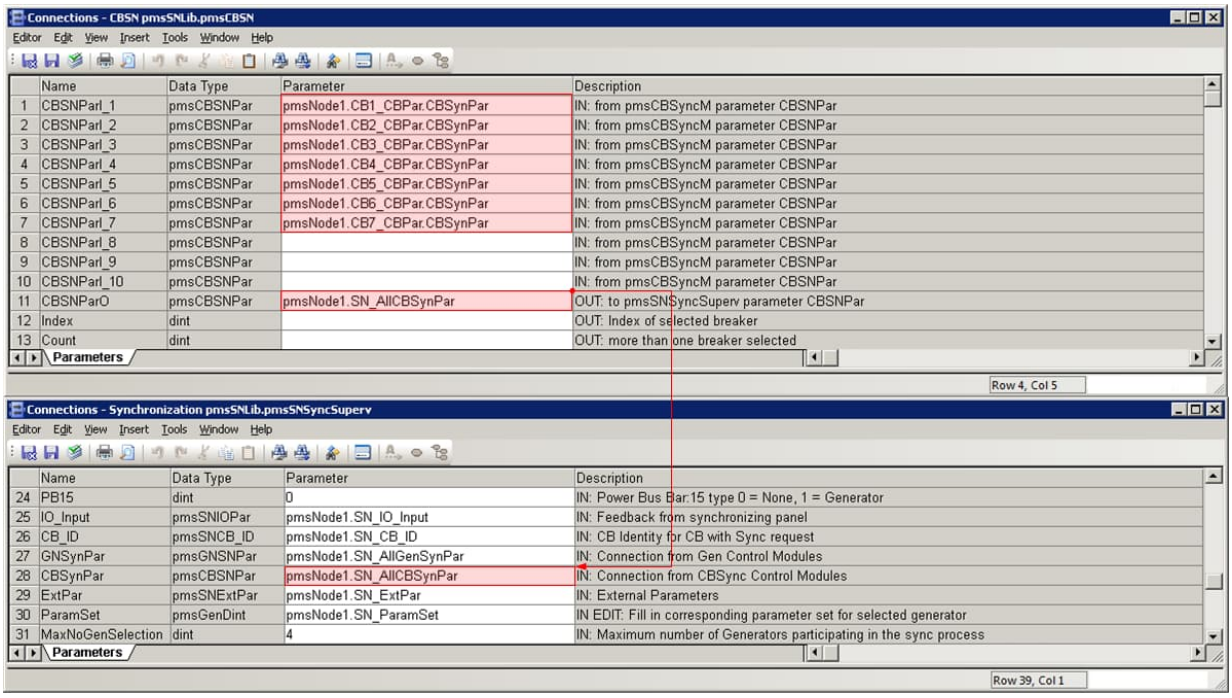


Figure 43 Example of SynCBPar parameter interconnection with pmsSNSyncSuperv

7.3.3 Application code for pmsGenM control modules

The control modules pmsGenM are instantiated under a library structure named *Objects*, as shown in Figure 44.

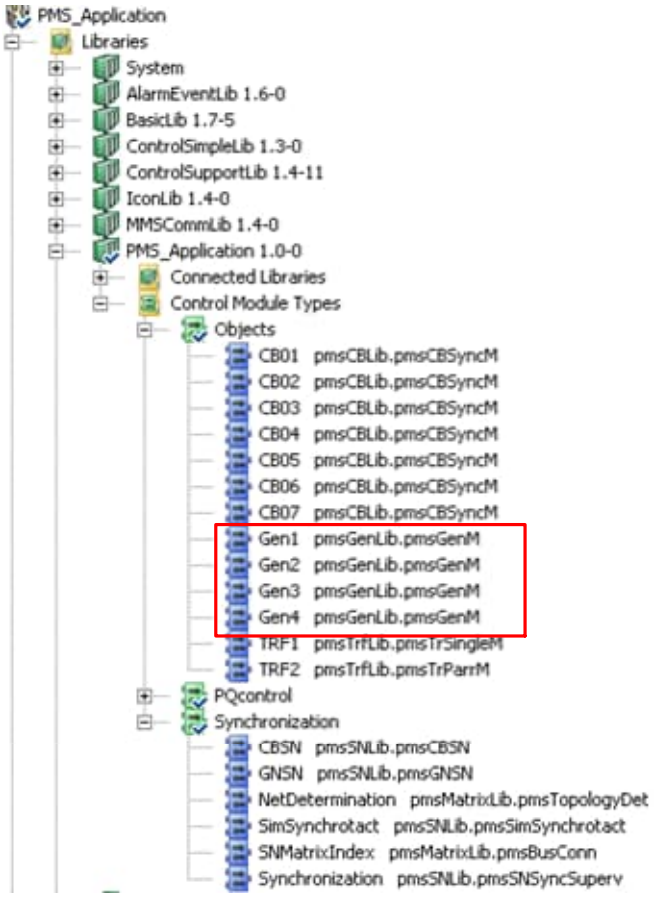
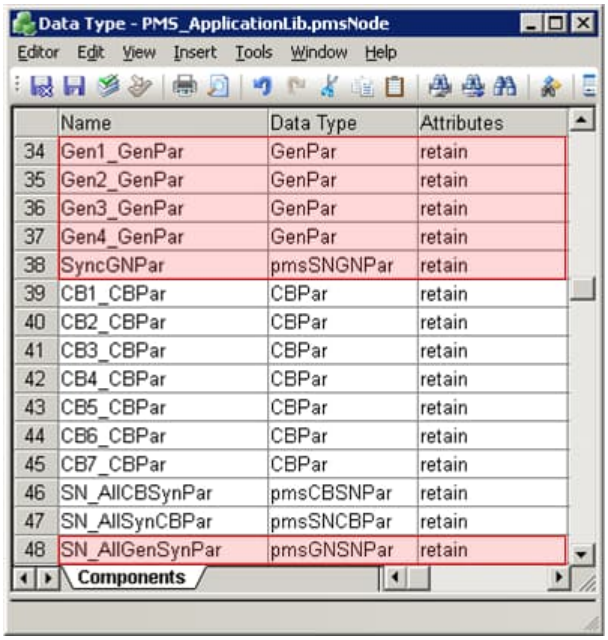


Figure 44 Example of pmsGenM instances used in synchronization

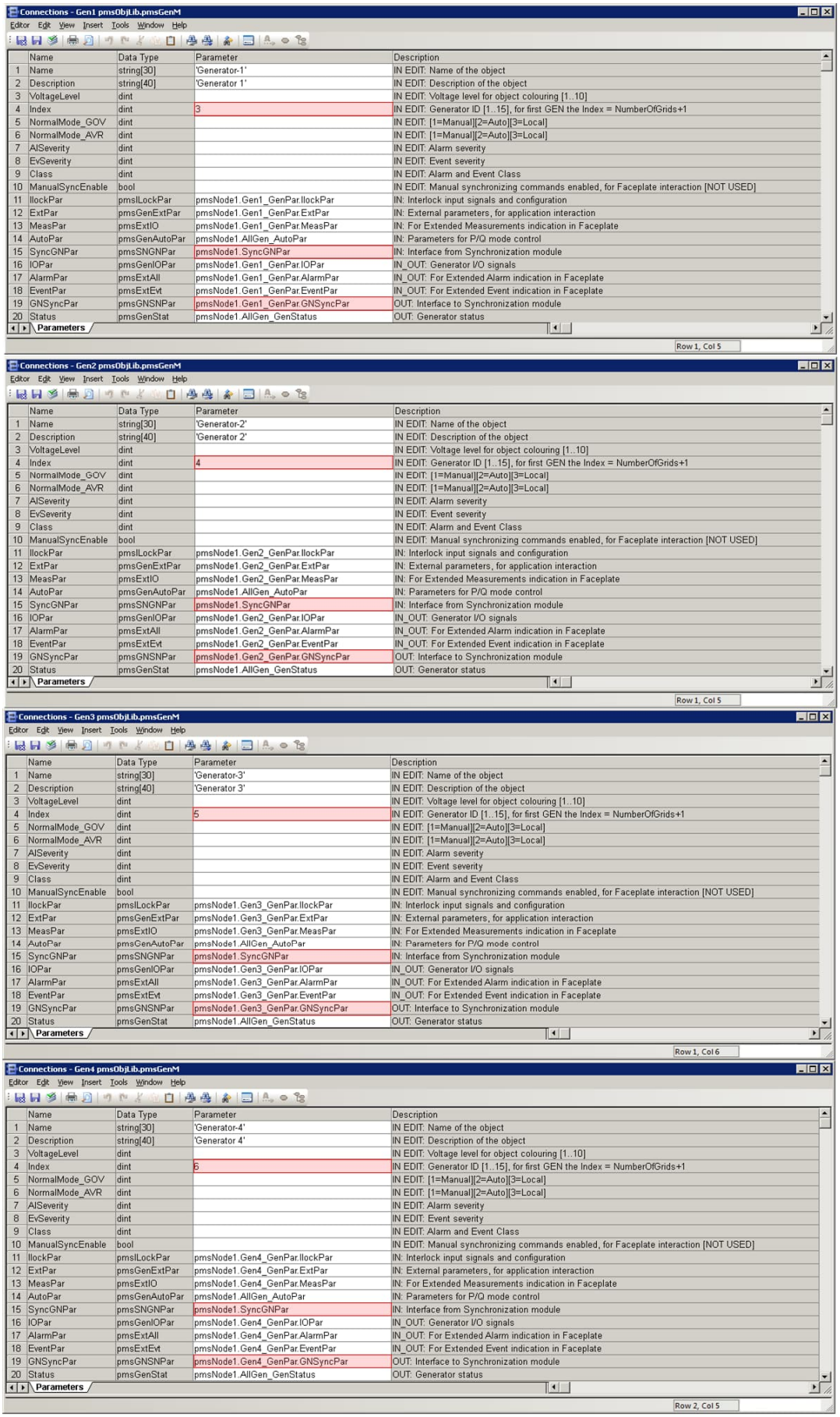
To connect the parameters of the instances it is recommended to create an application specific data type. The example in Figure 45 shows the data type named pmsNode1. The necessary components for the parameter connections to the pmsGenM modules are shown with a red frame.



	Name	Data Type	Attributes
34	Gen1_GenPar	GenPar	retain
35	Gen2_GenPar	GenPar	retain
36	Gen3_GenPar	GenPar	retain
37	Gen4_GenPar	GenPar	retain
38	SyncGNPar	pmsSNGNPar	retain
39	CB1_CBPar	CBPar	retain
40	CB2_CBPar	CBPar	retain
41	CB3_CBPar	CBPar	retain
42	CB4_CBPar	CBPar	retain
43	CB5_CBPar	CBPar	retain
44	CB6_CBPar	CBPar	retain
45	CB7_CBPar	CBPar	retain
46	SN_AllCBSynPar	pmsCBSNPar	retain
47	SN_AllSynCBPar	pmsSNCBPar	retain
48	SN_AllGenSynPar	pmsGNSNPar	retain

Figure 45 Example of data type components for the pmsGenM instances

One control module of type pmsGenM must be instantiated for each generator included in the synchronization scheme. An example of the parameter connections is shown, in Figure 46.



Connections - Gen1 pmsObjLib.pmsGenM

Editor Edit View Insert Tools Window Help

	Name	Data Type	Parameter	Description
1	Name	string[30]	'Generator-1'	IN EDIT: Name of the object
2	Description	string[40]	'Generator 1'	IN EDIT: Description of the object
3	VoltageLevel	dint		IN EDIT: Voltage level for object colouring [1..10]
4	Index	dint	3	IN EDIT: Generator ID [1..15], for first GEN the Index = NumberOfGrids+1
5	NormalMode_GOV	dint		IN EDIT: [1=Manual][2=Auto][3=Local]
6	NormalMode_AVR	dint		IN EDIT: [1=Manual][2=Auto][3=Local]
7	AlSeverity	dint		IN EDIT: Alarm severity
8	EvSeverity	dint		IN EDIT: Event severity
9	Class	dint		IN EDIT: Alarm and Event Class
10	ManualSyncEnable	bool		IN EDIT: Manual synchronizing commands enabled, for Faceplate interaction [NOT USED]
11	IlockPar	pmslLockPar	pmsNode1.Gen1_GenPar.IlockPar	IN: Interlock input signals and configuration
12	ExtPar	pmsGenExtPar	pmsNode1.Gen1_GenPar.ExtPar	IN: External parameters, for application interaction
13	MeasPar	pmsExtIO	pmsNode1.Gen1_GenPar.MeasPar	IN: For Extended Measurements indication in Faceplate
14	AutoPar	pmsGenAutoPar	pmsNode1.AllGen_AutoPar	IN: Parameters for P/Q mode control
15	SyncGNPar	pmsSNGNPar	pmsNode1.SyncGNPar	IN: Interface from Synchronization module
16	IOPar	pmsGenIOPar	pmsNode1.Gen1_GenPar.IOPar	IN_OUT: Generator I/O signals
17	AlarmPar	pmsExtAll	pmsNode1.Gen1_GenPar.AlarmPar	IN_OUT: For Extended Alarm indication in Faceplate
18	EventPar	pmsExtEvt	pmsNode1.Gen1_GenPar.EventPar	IN_OUT: For Extended Event indication in Faceplate
19	GNSyncPar	pmsGNSNPar	pmsNode1.Gen1_GenPar.GNSyncPar	OUT: Interface to Synchronization module
20	Status	pmsGenStat	pmsNode1.AllGen_GenStatus	OUT: Generator status

Parameters

Row 1, Col 5

Connections - Gen2 pmsObjLib.pmsGenM

Editor Edit View Insert Tools Window Help

	Name	Data Type	Parameter	Description
1	Name	string[30]	'Generator-2'	IN EDIT: Name of the object
2	Description	string[40]	'Generator 2'	IN EDIT: Description of the object
3	VoltageLevel	dint		IN EDIT: Voltage level for object colouring [1..10]
4	Index	dint	4	IN EDIT: Generator ID [1..15], for first GEN the Index = NumberOfGrids+1
5	NormalMode_GOV	dint		IN EDIT: [1=Manual][2=Auto][3=Local]
6	NormalMode_AVR	dint		IN EDIT: [1=Manual][2=Auto][3=Local]
7	AlSeverity	dint		IN EDIT: Alarm severity
8	EvSeverity	dint		IN EDIT: Event severity
9	Class	dint		IN EDIT: Alarm and Event Class
10	ManualSyncEnable	bool		IN EDIT: Manual synchronizing commands enabled, for Faceplate interaction [NOT USED]
11	IlockPar	pmslLockPar	pmsNode1.Gen2_GenPar.IlockPar	IN: Interlock input signals and configuration
12	ExtPar	pmsGenExtPar	pmsNode1.Gen2_GenPar.ExtPar	IN: External parameters, for application interaction
13	MeasPar	pmsExtIO	pmsNode1.Gen2_GenPar.MeasPar	IN: For Extended Measurements indication in Faceplate
14	AutoPar	pmsGenAutoPar	pmsNode1.AllGen_AutoPar	IN: Parameters for P/Q mode control
15	SyncGNPar	pmsSNGNPar	pmsNode1.SyncGNPar	IN: Interface from Synchronization module
16	IOPar	pmsGenIOPar	pmsNode1.Gen2_GenPar.IOPar	IN_OUT: Generator I/O signals
17	AlarmPar	pmsExtAll	pmsNode1.Gen2_GenPar.AlarmPar	IN_OUT: For Extended Alarm indication in Faceplate
18	EventPar	pmsExtEvt	pmsNode1.Gen2_GenPar.EventPar	IN_OUT: For Extended Event indication in Faceplate
19	GNSyncPar	pmsGNSNPar	pmsNode1.Gen2_GenPar.GNSyncPar	OUT: Interface to Synchronization module
20	Status	pmsGenStat	pmsNode1.AllGen_GenStatus	OUT: Generator status

Parameters

Row 1, Col 5

Connections - Gen3 pmsObjLib.pmsGenM

Editor Edit View Insert Tools Window Help

	Name	Data Type	Parameter	Description
1	Name	string[30]	'Generator-3'	IN EDIT: Name of the object
2	Description	string[40]	'Generator 3'	IN EDIT: Description of the object
3	VoltageLevel	dint		IN EDIT: Voltage level for object colouring [1..10]
4	Index	dint	5	IN EDIT: Generator ID [1..15], for first GEN the Index = NumberOfGrids+1
5	NormalMode_GOV	dint		IN EDIT: [1=Manual][2=Auto][3=Local]
6	NormalMode_AVR	dint		IN EDIT: [1=Manual][2=Auto][3=Local]
7	AlSeverity	dint		IN EDIT: Alarm severity
8	EvSeverity	dint		IN EDIT: Event severity
9	Class	dint		IN EDIT: Alarm and Event Class
10	ManualSyncEnable	bool		IN EDIT: Manual synchronizing commands enabled, for Faceplate interaction [NOT USED]
11	IlockPar	pmslLockPar	pmsNode1.Gen3_GenPar.IlockPar	IN: Interlock input signals and configuration
12	ExtPar	pmsGenExtPar	pmsNode1.Gen3_GenPar.ExtPar	IN: External parameters, for application interaction
13	MeasPar	pmsExtIO	pmsNode1.Gen3_GenPar.MeasPar	IN: For Extended Measurements indication in Faceplate
14	AutoPar	pmsGenAutoPar	pmsNode1.AllGen_AutoPar	IN: Parameters for P/Q mode control
15	SyncGNPar	pmsSNGNPar	pmsNode1.SyncGNPar	IN: Interface from Synchronization module
16	IOPar	pmsGenIOPar	pmsNode1.Gen3_GenPar.IOPar	IN_OUT: Generator I/O signals
17	AlarmPar	pmsExtAll	pmsNode1.Gen3_GenPar.AlarmPar	IN_OUT: For Extended Alarm indication in Faceplate
18	EventPar	pmsExtEvt	pmsNode1.Gen3_GenPar.EventPar	IN_OUT: For Extended Event indication in Faceplate
19	GNSyncPar	pmsGNSNPar	pmsNode1.Gen3_GenPar.GNSyncPar	OUT: Interface to Synchronization module
20	Status	pmsGenStat	pmsNode1.AllGen_GenStatus	OUT: Generator status

Parameters

Row 1, Col 6

Connections - Gen4 pmsObjLib.pmsGenM

Editor Edit View Insert Tools Window Help

	Name	Data Type	Parameter	Description
1	Name	string[30]	'Generator-4'	IN EDIT: Name of the object
2	Description	string[40]	'Generator 4'	IN EDIT: Description of the object
3	VoltageLevel	dint		IN EDIT: Voltage level for object colouring [1..10]
4	Index	dint	6	IN EDIT: Generator ID [1..15], for first GEN the Index = NumberOfGrids+1
5	NormalMode_GOV	dint		IN EDIT: [1=Manual][2=Auto][3=Local]
6	NormalMode_AVR	dint		IN EDIT: [1=Manual][2=Auto][3=Local]
7	AlSeverity	dint		IN EDIT: Alarm severity
8	EvSeverity	dint		IN EDIT: Event severity
9	Class	dint		IN EDIT: Alarm and Event Class
10	ManualSyncEnable	bool		IN EDIT: Manual synchronizing commands enabled, for Faceplate interaction [NOT USED]
11	IlockPar	pmslLockPar	pmsNode1.Gen4_GenPar.IlockPar	IN: Interlock input signals and configuration
12	ExtPar	pmsGenExtPar	pmsNode1.Gen4_GenPar.ExtPar	IN: External parameters, for application interaction
13	MeasPar	pmsExtIO	pmsNode1.Gen4_GenPar.MeasPar	IN: For Extended Measurements indication in Faceplate
14	AutoPar	pmsGenAutoPar	pmsNode1.AllGen_AutoPar	IN: Parameters for P/Q mode control
15	SyncGNPar	pmsSNGNPar	pmsNode1.SyncGNPar	IN: Interface from Synchronization module
16	IOPar	pmsGenIOPar	pmsNode1.Gen4_GenPar.IOPar	IN_OUT: Generator I/O signals
17	AlarmPar	pmsExtAll	pmsNode1.Gen4_GenPar.AlarmPar	IN_OUT: For Extended Alarm indication in Faceplate
18	EventPar	pmsExtEvt	pmsNode1.Gen4_GenPar.EventPar	IN_OUT: For Extended Event indication in Faceplate
19	GNSyncPar	pmsGNSNPar	pmsNode1.Gen4_GenPar.GNSyncPar	OUT: Interface to Synchronization module
20	Status	pmsGenStat	pmsNode1.AllGen_GenStatus	OUT: Generator status

Parameters

Row 2, Col 5

Figure 46 Example of parameter connections for the pmsGenM instances

7.3.3.1 Connection of Index

The parameter *Index* in the pmsGenM control module is a unique identity number which must be assigned to each generator according to the network determination (refer to section Network determination).

The configuration example in Figure 46 shows that the following index numbers are assigned to the relevant generators:

Table 58 Example of Index numbers assigned to pmsGenM modules

Control module name	Description	Index
GEN-1	Generator 1	3
GEN-2	Generator 2	4
GEN-3	Generator 3	5
GEN-4	Generator 4	6

The parameter Index of the pmsGenM modules depends on the identity PB01…PB15 assigned to each generator in the network determination and the total number of grid connections that are applicable for the plant: Index number = PBx + Number of grids.

In the example shown in Table 58, the index number 5 is assigned to the GEN-3, because the identity in the network determination from Figure 47 is PB03 and there are two grid connections in the plant (i.e. PBx = 3, Number of grids = 2, Index = 3+2).

7.3.3.2 Connection of SyncGNPar

The parameter *SyncGNPar* shall be used for receiving the necessary data from the synchronization module pmsSNSyncSuperv into the generator module pmsGenM.

The configuration example in Figure 46 shows that the variable *pmsNode1.gSN_AllSynGNPar* is connected to the parameter *SyncGNPar* for all the generators. The same variable *pmsNode1.gSN_AllSynGNPar* shall also be connected to the parameter *SynGNPAr* in the pmsSNSyncSuperv module, as shown in Figure 47.

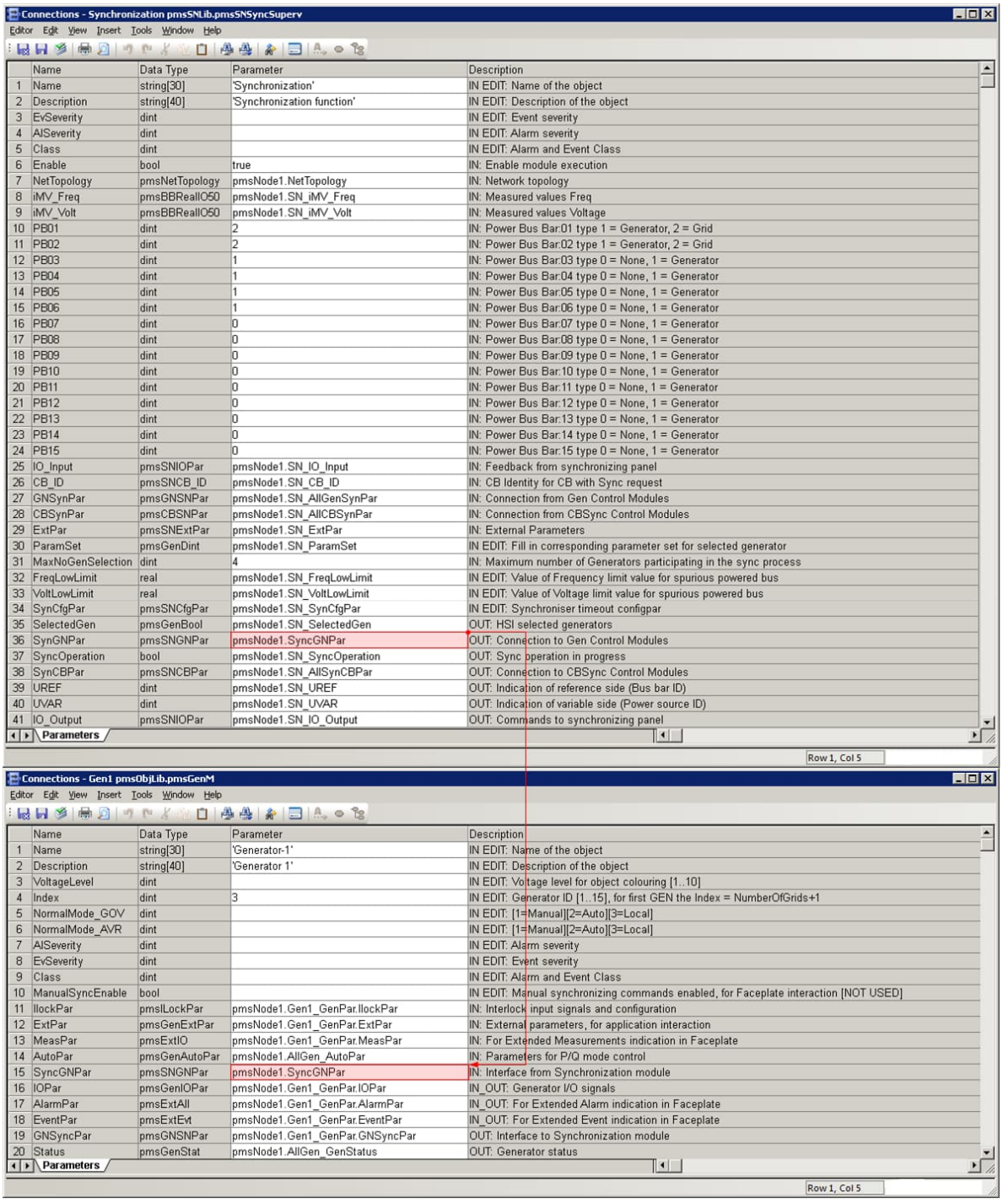


Figure 47 Example of SyncGNPar parameter interconnection with pmsSNSyncSuperv

7.3.3.3 Connection of GNSyncPar

The parameter *GNSyncPar* shall be used for sending the necessary data from the generator modules pmsGenM into the synchronization module pmsSNSyncSuperv.

The configuration example in Figure 46 shows the following variables connected to the *GNSyncPar* parameter of the relevant generators:

Table 59 Example of GNSyncPar connections to pmsGenM modules

Control module name	Description	Variable connected to CBSynPar
GEN-1	Generator 1	*pmsNode1.GEN1_GenPar.GNSyncPar*
GEN-2	Generator 2	*pmsNode1.GEN2_GenPar.GNSyncPar*
GEN-3	Generator 3	*pmsNode1.GEN3_GenPar.GNSyncPar*
GEN-4	Generator 4	*pmsNode1.GEN4_GenPar.GNSyncPar*

The *GNSyncPar*, from up to 15 different generators, shall be collected in a pmsGNSN control module, as shown in Figure 48 The output *GNSNParO* shall be further linked to the input parameter *GNSynPar* of the pmsSNSyncSuperv module.

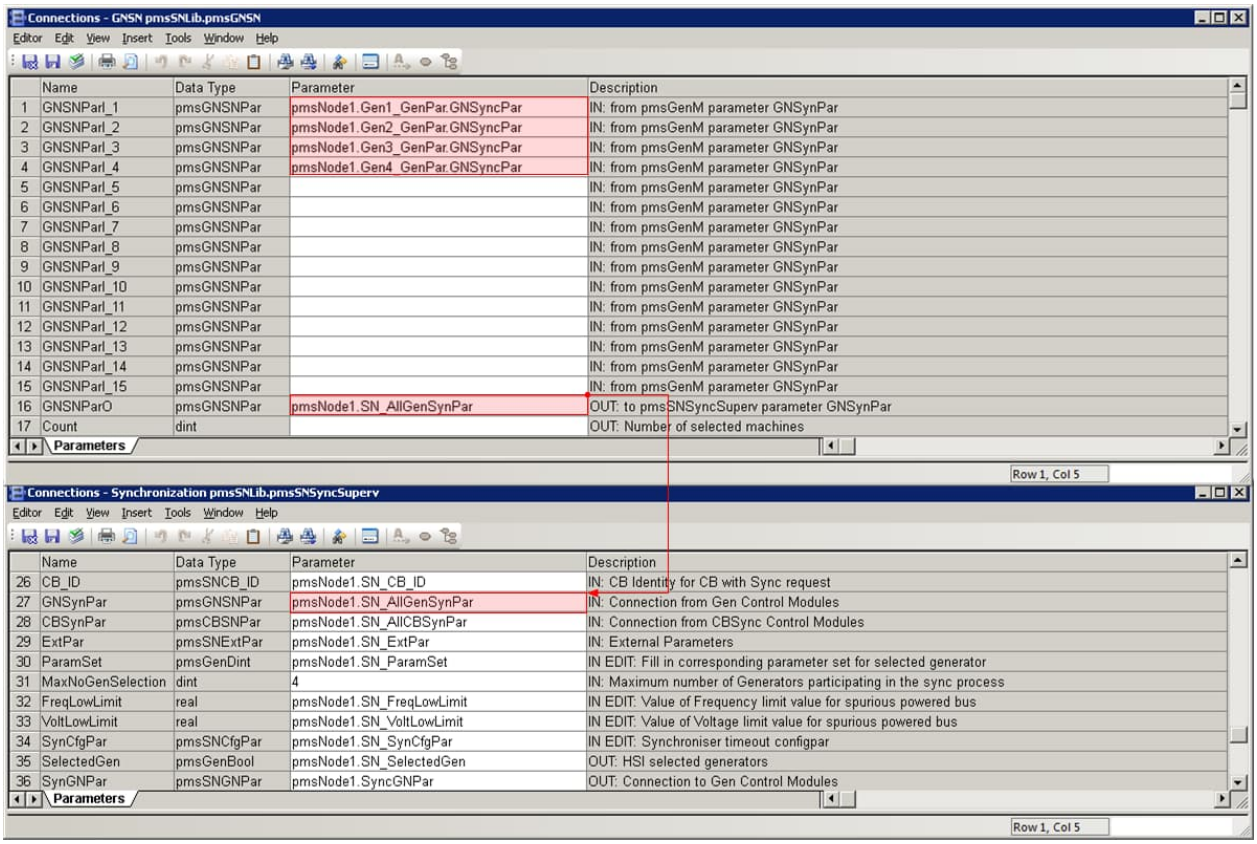


Figure 48 Example of GNSynPar parameter interconnection with pmsSNSyncSuperv

7.4 Configuration of synchronization objects

The following sections will describe the configuration of the pmsSNSyncSuperv control module type and the supporting module types; pmsCBSN and pmsGNSN which are required for the synchronization function.

7.4.1 Application code for pmsSNSyncSuperv control module

The example in Figure 49 shows a control module type *pmSNSyncSuperv* instantiated under the structure named *Synchronization*.

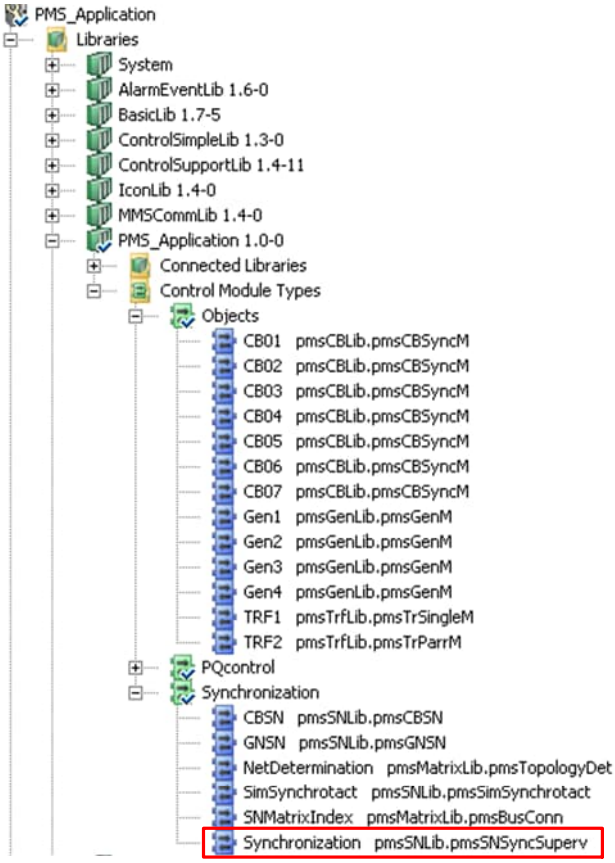
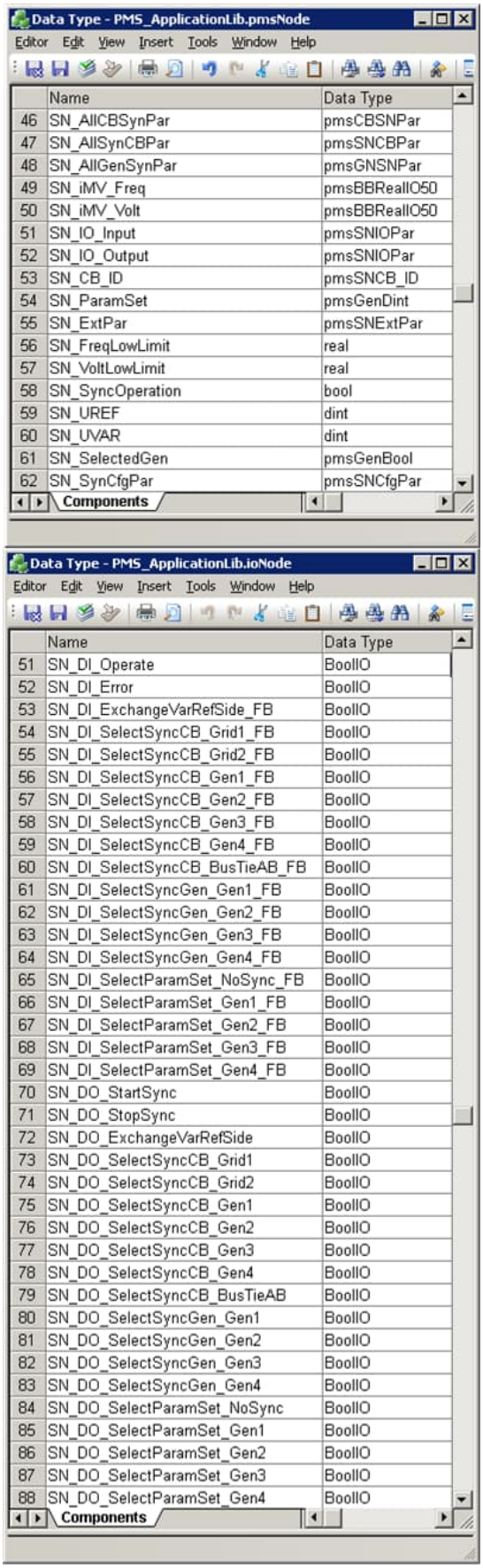


Figure 49 Example of pmsSNSyncSuperv control module type instance

To connect the parameters of the instance it is recommended to create two application specific data types; one that will contain the control module internal connection variables and one that will contain the I/O signal variables. The example in Figure 50 shows the data types named pmsNode1 and ioNode1.



Data Type - PMS_ApplicationLib.pmsNode

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	Name	Data Type
46	SN_AllCBSynPar	pmsCBSNPar
47	SN_AllSynCBPar	pmsSNCBPar
48	SN_AllGenSynPar	pmsGNSNPar
49	SN_iMV_Freq	pmsBBReallO50
50	SN_iMV_Volt	pmsBBReallO50
51	SN_IO_Input	pmsSNIOPar
52	SN_IO_Output	pmsSNIOPar
53	SN_CB_ID	pmsSNCB_ID
54	SN_ParamSet	pmsGenDint
55	SN_ExtPar	pmsSNExtPar
56	SN_FreqLowLimit	real
57	SN_VoltLowLimit	real
58	SN_SyncOperation	bool
59	SN_UREF	dint
60	SN_UVAR	dint
61	SN_SelectedGen	pmsGenBool
62	SN_SynCfgPar	pmsSNCfgPar

Components

Data Type - PMS_ApplicationLib.ioNode

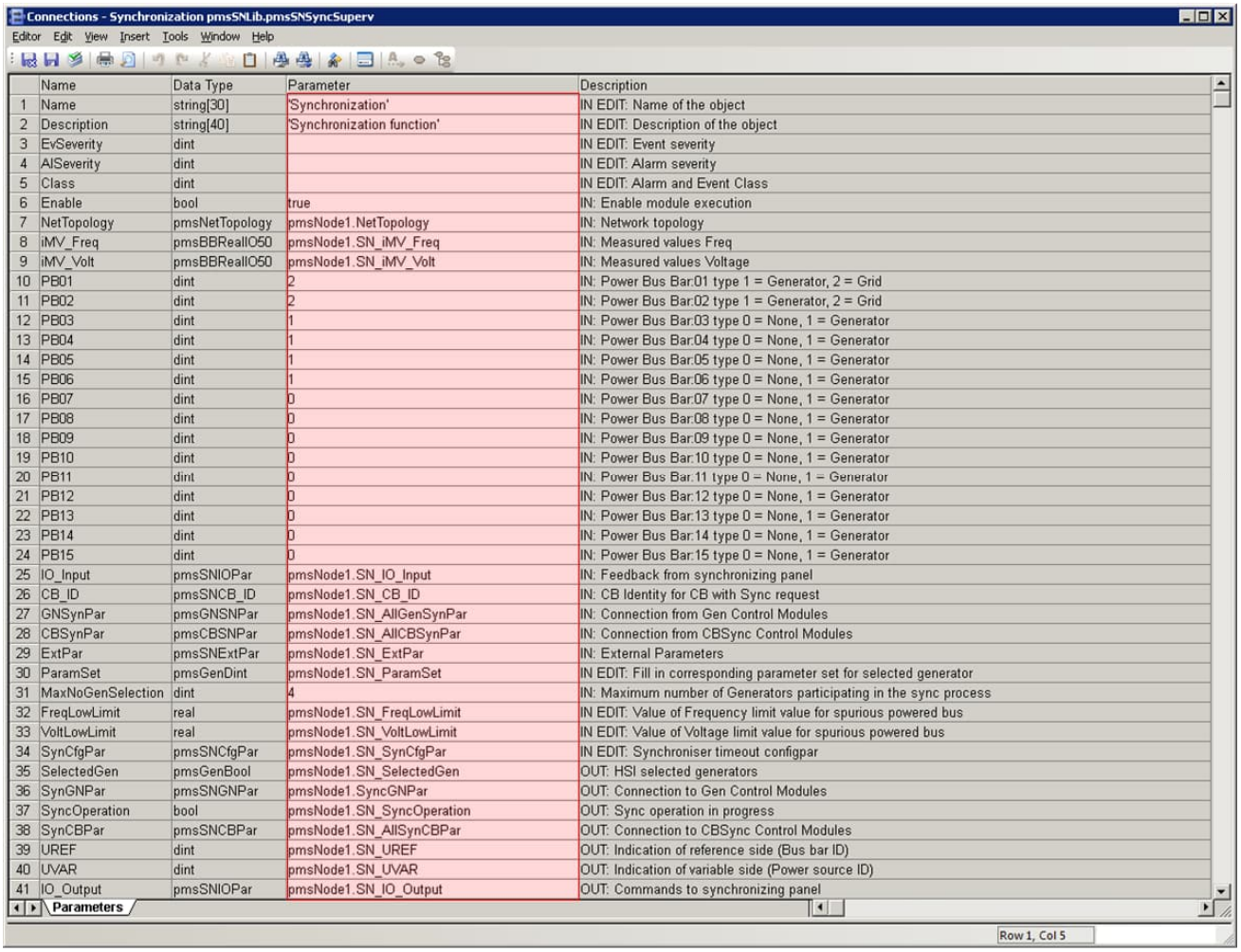
Editor Edit View Insert Tools Window Help

	Name	Data Type
51	SN_DI_Operate	BoolIO
52	SN_DI_Error	BoolIO
53	SN_DI_ExchangeVarRefSide_FB	BoolIO
54	SN_DI_SelectSyncCB_Grid1_FB	BoolIO
55	SN_DI_SelectSyncCB_Grid2_FB	BoolIO
56	SN_DI_SelectSyncCB_Gen1_FB	BoolIO
57	SN_DI_SelectSyncCB_Gen2_FB	BoolIO
58	SN_DI_SelectSyncCB_Gen3_FB	BoolIO
59	SN_DI_SelectSyncCB_Gen4_FB	BoolIO
60	SN_DI_SelectSyncCB_BusTieAB_FB	BoolIO
61	SN_DI_SelectSyncGen_Gen1_FB	BoolIO
62	SN_DI_SelectSyncGen_Gen2_FB	BoolIO
63	SN_DI_SelectSyncGen_Gen3_FB	BoolIO
64	SN_DI_SelectSyncGen_Gen4_FB	BoolIO
65	SN_DI_SelectParamSet_NoSync_FB	BoolIO
66	SN_DI_SelectParamSet_Gen1_FB	BoolIO
67	SN_DI_SelectParamSet_Gen2_FB	BoolIO
68	SN_DI_SelectParamSet_Gen3_FB	BoolIO
69	SN_DI_SelectParamSet_Gen4_FB	BoolIO
70	SN_DO_StartSync	BoolIO
71	SN_DO_StopSync	BoolIO
72	SN_DO_ExchangeVarRefSide	BoolIO
73	SN_DO_SelectSyncCB_Grid1	BoolIO
74	SN_DO_SelectSyncCB_Grid2	BoolIO
75	SN_DO_SelectSyncCB_Gen1	BoolIO
76	SN_DO_SelectSyncCB_Gen2	BoolIO
77	SN_DO_SelectSyncCB_Gen3	BoolIO
78	SN_DO_SelectSyncCB_Gen4	BoolIO
79	SN_DO_SelectSyncCB_BusTieAB	BoolIO
80	SN_DO_SelectSyncGen_Gen1	BoolIO
81	SN_DO_SelectSyncGen_Gen2	BoolIO
82	SN_DO_SelectSyncGen_Gen3	BoolIO
83	SN_DO_SelectSyncGen_Gen4	BoolIO
84	SN_DO_SelectParamSet_NoSync	BoolIO
85	SN_DO_SelectParamSet_Gen1	BoolIO
86	SN_DO_SelectParamSet_Gen2	BoolIO
87	SN_DO_SelectParamSet_Gen3	BoolIO
88	SN_DO_SelectParamSet_Gen4	BoolIO

Components

Figure 50 Example of application-defined data types for pmsSNSyncSuperv

An example of the parameter connections for the pmsSNSyncSuperv is shown in Figure 51.



Connections - Synchronization pmsSNLib.pmsSNSyncSuperv

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	Name	Data Type	Parameter	Description
1	Name	string[30]	'Synchronization'	IN EDIT: Name of the object
2	Description	string[40]	'Synchronization function'	IN EDIT: Description of the object
3	EvSeverity	dint		IN EDIT: Event severity
4	AlSeverity	dint		IN EDIT: Alarm severity
5	Class	dint		IN EDIT: Alarm and Event Class
6	Enable	bool	true	IN: Enable module execution
7	NetTopology	pmsNetTopology	pmsNode1.NetTopology	IN: Network topology
8	iMV_Freq	pmsBBRealIO50	pmsNode1.SN_iMV_Freq	IN: Measured values Freq
9	iMV_Volt	pmsBBRealIO50	pmsNode1.SN_iMV_Volt	IN: Measured values Voltage
10	PB01	dint	2	IN: Power Bus Bar.01 type 1 = Generator, 2 = Grid
11	PB02	dint	2	IN: Power Bus Bar.02 type 1 = Generator, 2 = Grid
12	PB03	dint	1	IN: Power Bus Bar.03 type 0 = None, 1 = Generator
13	PB04	dint	1	IN: Power Bus Bar.04 type 0 = None, 1 = Generator
14	PB05	dint	1	IN: Power Bus Bar.05 type 0 = None, 1 = Generator
15	PB06	dint	1	IN: Power Bus Bar.06 type 0 = None, 1 = Generator
16	PB07	dint	0	IN: Power Bus Bar.07 type 0 = None, 1 = Generator
17	PB08	dint	0	IN: Power Bus Bar.08 type 0 = None, 1 = Generator
18	PB09	dint	0	IN: Power Bus Bar.09 type 0 = None, 1 = Generator
19	PB10	dint	0	IN: Power Bus Bar.10 type 0 = None, 1 = Generator
20	PB11	dint	0	IN: Power Bus Bar.11 type 0 = None, 1 = Generator
21	PB12	dint	0	IN: Power Bus Bar.12 type 0 = None, 1 = Generator
22	PB13	dint	0	IN: Power Bus Bar.13 type 0 = None, 1 = Generator
23	PB14	dint	0	IN: Power Bus Bar.14 type 0 = None, 1 = Generator
24	PB15	dint	0	IN: Power Bus Bar.15 type 0 = None, 1 = Generator
25	IO_Input	pmsSNIOPar	pmsNode1.SN_IO_Input	IN: Feedback from synchronizing panel
26	CB_ID	pmsSNCB_ID	pmsNode1.SN_CB_ID	IN: CB Identity for CB with Sync request
27	GNSynPar	pmsGNSNPar	pmsNode1.SN_AllGenSynPar	IN: Connection from Gen Control Modules
28	CBSynPar	pmsCBSNPar	pmsNode1.SN_AllCBSynPar	IN: Connection from CBSync Control Modules
29	ExtPar	pmsSNExtPar	pmsNode1.SN_ExtPar	IN: External Parameters
30	ParamSet	pmsGenDint	pmsNode1.SN_ParamSet	IN EDIT: Fill in corresponding parameter set for selected generator
31	MaxNoGenSelection	dint	4	IN: Maximum number of Generators participating in the sync process
32	FreqLowLimit	real	pmsNode1.SN_FreqLowLimit	IN EDIT: Value of Frequency limit value for spurious powered bus
33	VoltLowLimit	real	pmsNode1.SN_VoltLowLimit	IN EDIT: Value of Voltage limit value for spurious powered bus
34	SynCfgPar	pmsSNCfgPar	pmsNode1.SN_SynCfgPar	IN EDIT: Synchroniser timeout configpar
35	SelectedGen	pmsGenBool	pmsNode1.SN_SelectedGen	OUT: HSI selected generators
36	SynGNPar	pmsSNGNPar	pmsNode1.SyncGNPar	OUT: Connection to Gen Control Modules
37	SyncOperation	bool	pmsNode1.SN_SyncOperation	OUT: Sync operation in progress
38	SynCBPar	pmsSNCBPar	pmsNode1.SN_AllSynCBPar	OUT: Connection to CBSync Control Modules
39	UREF	dint	pmsNode1.SN_UREF	OUT: Indication of reference side (Bus bar ID)
40	UVAR	dint	pmsNode1.SN_UVAR	OUT: Indication of variable side (Power source ID)
41	IO_Output	pmsSNIOPar	pmsNode1.SN_IO_Output	OUT: Commands to synchronizing panel

Parameters

Row 1, Col 5

Figure 51 Example of parameter connection in pmsSNSyncSuperv control module

7.4.1.1 Connection of CB

The index numbers required for the circuit breakers in the network determination shall be calculated by the control module type *pmsBusConn*. An example of this module is shown in Figure 52.

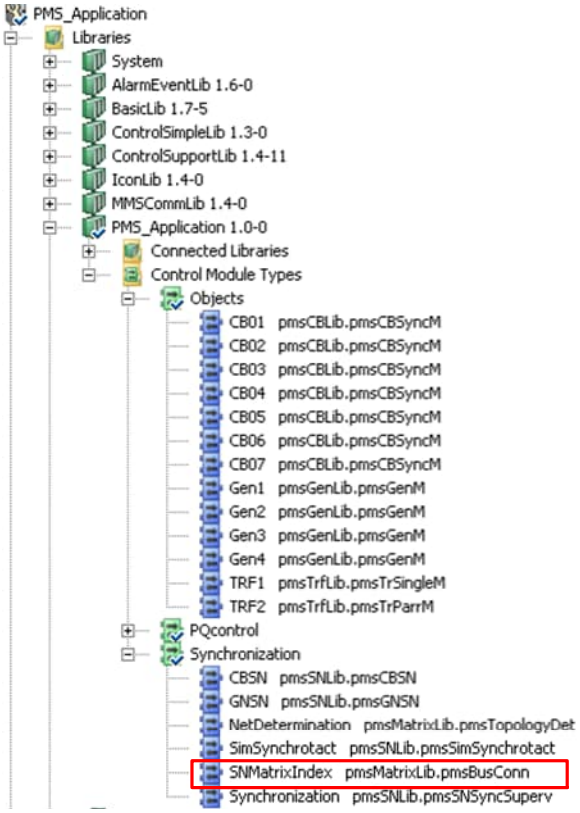

Figure 52 Example of pmsBusConn control module type instance

The faceplate aspect of the *pmsBusConn* module is shown in Figure 53 .This faceplate shall be utilized to assign the PBx and LBx identities for the circuit breakers of the network determination example presented in Figure 37.

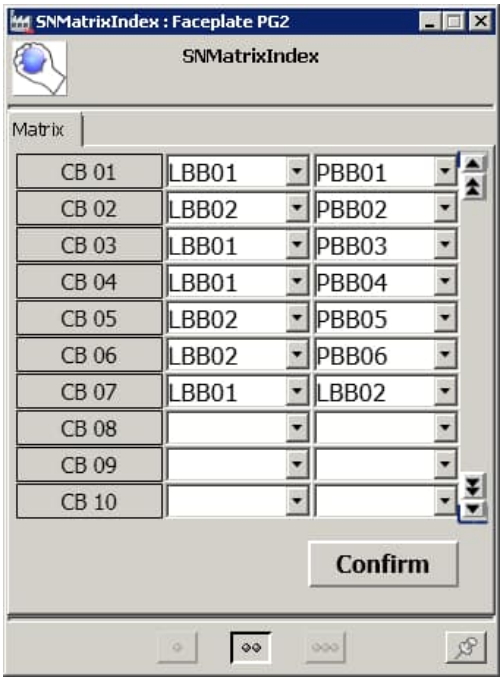

Figure 53 Example of pmsBusConn faceplate

A dropdown menu shall appear after a mouse-click on any of the cells inside the *pmsBusConn* faceplate. A busbar identity must be selected for each circuit breaker included in the network determination. The example in Figure 53shows that CB01 has been assigned with the identities LBB01 and PBB01, because according to the network example in Figure 37, the breaker CB01 is interconnecting bus LB01 with bus PB01.

When all circuit breakers are assigned with a pair of identities, the *pmsBusConn* control module will calculate the index numbers for each circuit breaker. The Figure 54 shows the output parameter *MatrixIndex*, in on-line mode, which shall contain the calculated index numbers for the configuration example in Figure 53.

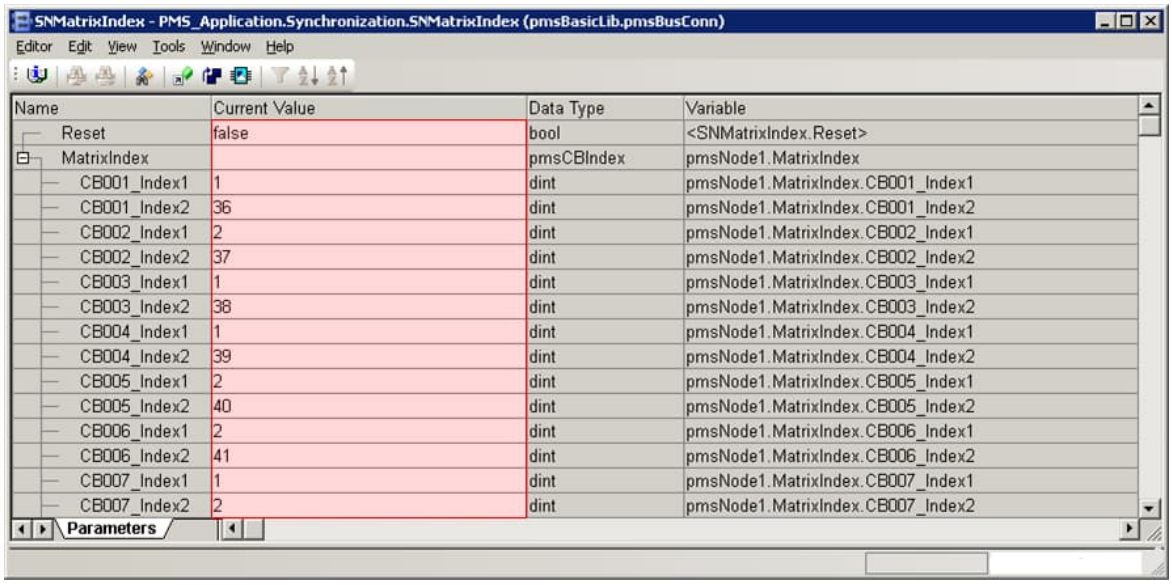

Figure 54 Example of parameter connections in pmsBusConn

The variable connected to the output parameter *MatrixIndex*, in the control module *pmsBusConn*, shall be further connected to the input parameter *CB* in the control module *pmsTopologyDet*. An example is shown in Figure 55.

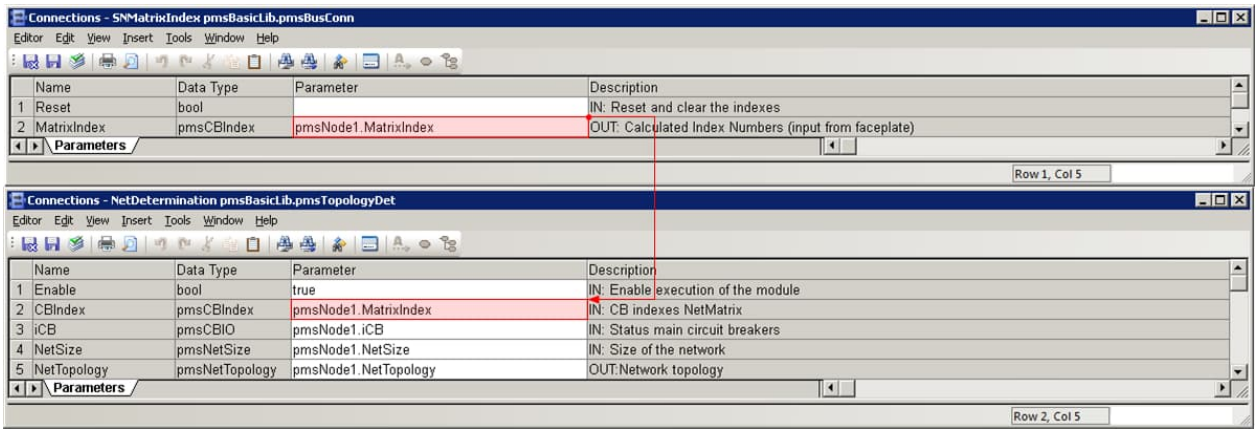

Figure 55 Example of CB parameter connection

7.4.1.2 Connection of iCB

The parameter *iCB* shall be used for connecting the physical position feedback signals of the circuit breakers identified for the network determination Figure 37. An example of the necessary application code is shown in Figure 56.

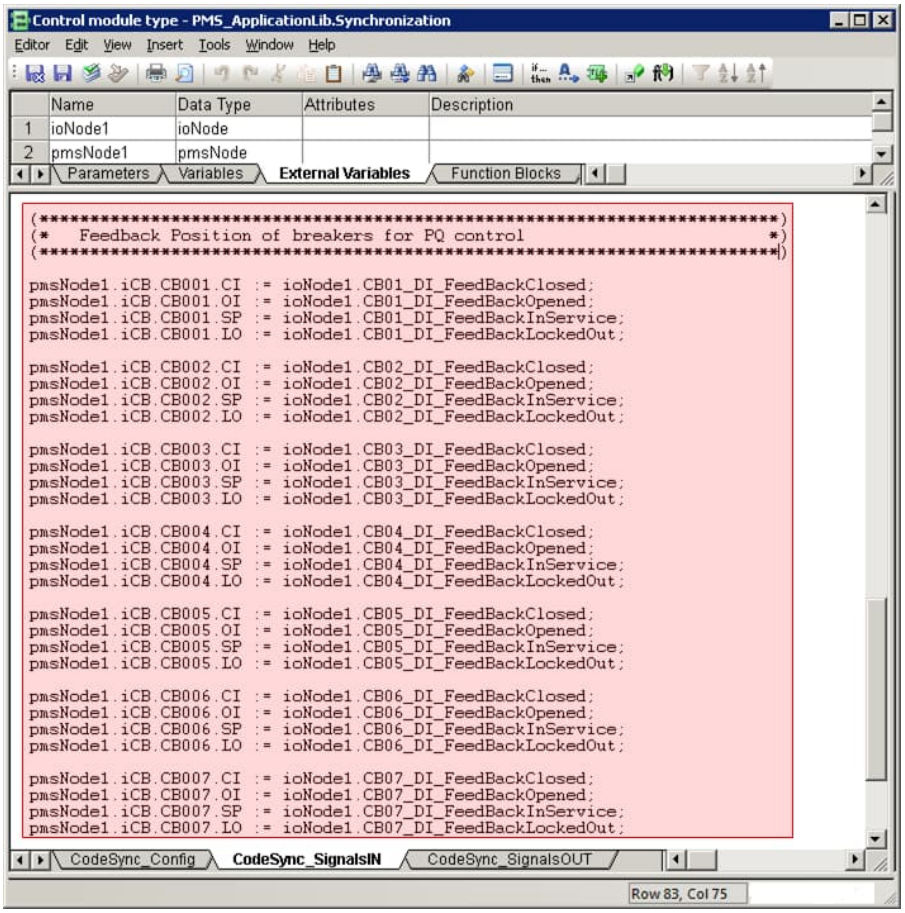

Figure 56 Example of application code for iCB connections

If the feedback signal for the service position of a circuit breaker (e.g. CB01) is not applicable for a specific project, it will still be required to permanently set the parameter *iCB.CB01.SP.Value* to true. If the feedback signal for the open position or the locked-out position of a circuit breaker (e.g. CB01) is not applicable for a specific project, the application code for the *iCB.CB01.OI* and *iCB.CB01.LO* can be omitted. The feedback signal for the closed position of a critical circuit breaker (e.g. CB01) is a minimum requirement for the network matrix and therefore the parameter *iCB.CB01.CI* must always be connected via application code.

If a generator or grid is connected to a busbar via several interconnections, the network determination can be simplified by reducing the number of busbars and merging the number of circuit breakers. This option may prove useful when the maximum number of breakers (i.e. 160) is exceeded for a plant.

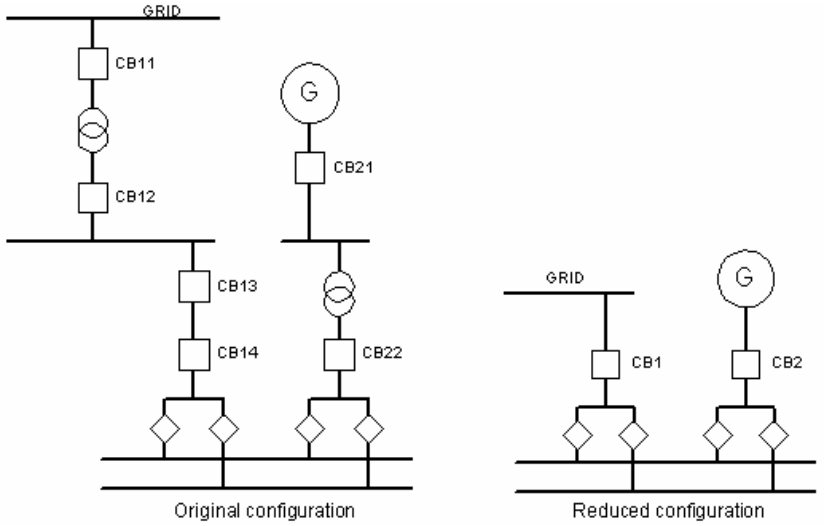

Figure 57 Example of reduced network determination

The following application code shall be used for combining the feedback positions from the circuit breakers shown in Figure 57:

```
 (* GRID *)
iCB.CB1.CI.Value   :=   CB11.IOPAR.CI.Value AND
                        CB12.IOPAR.CI.Value AND
                           CB13.IOPAR.CI.Value AND
                           CB14.IOPAR.CI.Value;

iCB.CB1.OI.Value   :=   CB11.IOPAR.OI.Value OR
                           CB12.IOPAR.OI.Value OR
                           CB13.IOPAR.OI.Value OR
                        CB14.IOPAR.OI.Value;

iCB.CB1.SP.Value  :=    CB11.IOPAR.SP.Value AND
                           CB12.IOPAR.SP.Value AND
                           CB13.IOPAR.SP.Value AND
                           CB14.IOPAR.SP.Value;
(* Gen 1 *)
iCB.CB2.CI.Value:=      CB21.IOPAR.CI.Value AND
                           CB22.IOPAR.CI.Value;

iCB.CB2.OI.Value:=      CB21.IOPAR.OI.Value OR
                        CB22.IOPAR.OI.Value;

iCB.CB2.SP.Value:=   CB21.IOPAR.SP.Value AND
                           CB22.IOPAR.SP.Value;
```

7.4.1.3 Connection of NetSize

The parameter *NetSize* shall be used to determine the maximum number of:

- circuit breakers
- power sources
- load busbars
- potential subnetworks
- grids

…used in the project. An example of the necessary application code is shown in Figure 58.

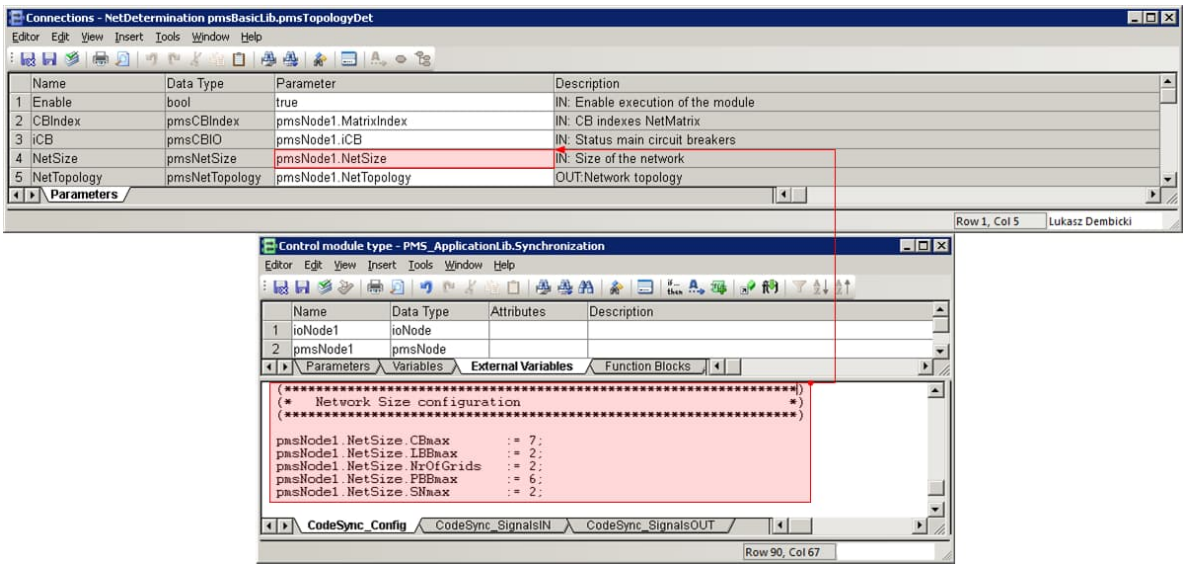

Figure 58 Example of Network Size configuration

NetworkSize parameter is a one time setting and should not be modified during runtime of the code depending on different conditions.

NetworkSize setting for load busbars (*LBBmax*) and subnetworks to be monitored (*SNmax*) should be set to same value in the network determination.

7.4.1.4 Connection of iMV_Freq and iMV_Volt

The parameters *iMV_Freq* and *iMV_Volt* shall be used for connecting the analogue frequency and voltage measurements from the variable and reference side of the circuit breaker. An example of the necessary application code is shown in Figure 59.

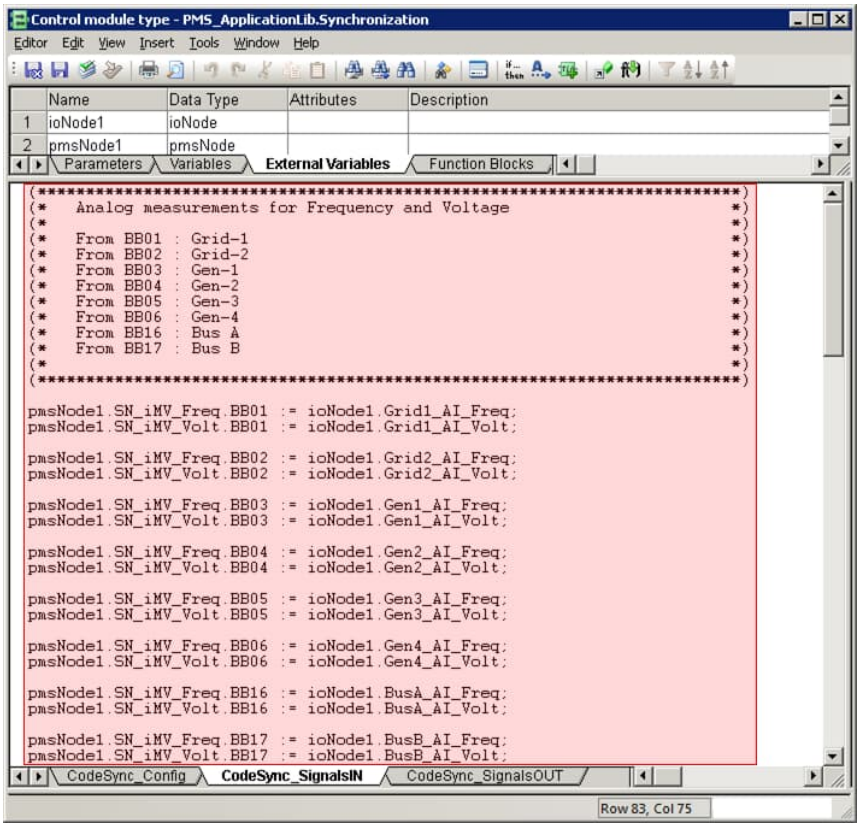

Figure 59 Example of application code for iMV_Freq and iMV_Volt

The example in Figure 59 shows that the variables pmsNode1.SN_iMV_Freq.BBxx and pmsNode1.SN_iMV_Volt.BBxx are receiving the frequency and voltage values from physical AI signals representing the field measurements.

The variables pmsNode1.SN_iMV_Freq and pmsNode1.SN_iMV_Volt shall be connected to the inputs iMV_Freq and iMV_Volt as shown in Figure 60.

Connections - Synchronization pmsSNLib.pmsSNSyncSuperv

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	Name	Data Type	Parameter	Description
1	Name	string[30]	'Synchronization'	IN EDIT: Name of the object
2	Description	string[40]	'Synchronization function'	IN EDIT: Description of the object
3	EvSeverity	dint		IN EDIT: Event severity
4	AlSeverity	dint		IN EDIT: Alarm severity
5	Class	dint		IN EDIT: Alarm and Event Class
6	Enable	bool	true	IN: Enable module execution
7	NetTopology	pmsNetTopology	pmsNode1.NetTopology	IN: Network topology
8	iMV_Freq	pmsBBRealIO50	pmsNode1.SN_iMV_Freq	IN: Measured values Freq
9	iMV_Volt	pmsBBRealIO50	pmsNode1.SN_iMV_Volt	IN: Measured values Voltage
10	PB01	dint	2	IN: Power Bus Bar:01 type 1 = Generator, 2 = Grid
11	PB02	dint	2	IN: Power Bus Bar:02 type 1 = Generator, 2 = Grid
12	PB03	dint	1	IN: Power Bus Bar:03 type 0 = None, 1 = Generator
13	PB04	dint	1	IN: Power Bus Bar:04 type 0 = None, 1 = Generator
14	PB05	dint	1	IN: Power Bus Bar:05 type 0 = None, 1 = Generator
15	PB06	dint	1	IN: Power Bus Bar:06 type 0 = None, 1 = Generator
16	PB07	dint	0	IN: Power Bus Bar:07 type 0 = None, 1 = Generator
17	PB08	dint	0	IN: Power Bus Bar:08 type 0 = None, 1 = Generator
18	PB09	dint	0	IN: Power Bus Bar:09 type 0 = None, 1 = Generator
19	PB10	dint	0	IN: Power Bus Bar:10 type 0 = None, 1 = Generator
20	PB11	dint	0	IN: Power Bus Bar:11 type 0 = None, 1 = Generator
21	PB12	dint	0	IN: Power Bus Bar:12 type 0 = None, 1 = Generator
22	PB13	dint	0	IN: Power Bus Bar:13 type 0 = None, 1 = Generator
23	PB14	dint	0	IN: Power Bus Bar:14 type 0 = None, 1 = Generator
24	PB15	dint	0	IN: Power Bus Bar:15 type 0 = None, 1 = Generator
25	IO_Input	pmsSNIOPar	pmsNode1.SN_IO_Input	IN: Feedback from synchronizing panel
26	CB_ID	pmsSNCB_ID	pmsNode1.SN_CB_ID	IN: CB Identity for CB with Sync request
27	GNSynPar	pmsGNSNPar	pmsNode1.SN_AllGenSynPar	IN: Connection from Gen Control Modules
28	CBSynPar	pmsCBSNPar	pmsNode1.SN_AllCBSynPar	IN: Connection from CBSync Control Modules
29	ExtPar	pmsSNExtPar	pmsNode1.SN_ExtPar	IN: External Parameters
30	ParamSet	pmsGenDint	pmsNode1.SN_ParamSet	IN EDIT: Fill in corresponding parameter set for selected generator
31	MaxNoGenSelection	dint	4	IN: Maximum number of Generators participating in the sync process
32	FreqLowLimit	real	pmsNode1.SN_FreqLowLimit	IN EDIT: Value of Frequency limit value for spurious powered bus
33	VoltLowLimit	real	pmsNode1.SN_VoltLowLimit	IN EDIT: Value of Voltage limit value for spurious powered bus
34	SynCfgPar	pmsSNCfgPar	pmsNode1.SN_SynCfgPar	IN EDIT: Synchroniser timeout configpar
35	SelectedGen	pmsGenBool	pmsNode1.SN_SelectedGen	OUT: HSI selected generators
36	SynGNPar	pmsSNGNPar	pmsNode1.SyncGNPar	OUT: Connection to Gen Control Modules
37	SyncOperation	bool	pmsNode1.SN_SyncOperation	OUT: Sync operation in progress
38	SynCBPar	pmsSNCBPar	pmsNode1.SN_AllSynCBPar	OUT: Connection to CBSync Control Modules
39	UREF	dint	pmsNode1.SN_UREF	OUT: Indication of reference side (Bus bar ID)
40	UVAR	dint	pmsNode1.SN_UVAR	OUT: Indication of variable side (Power source ID)
41	IO_Output	pmsSNIOPar	pmsNode1.SN_IO_Output	OUT: Commands to synchronizing panel

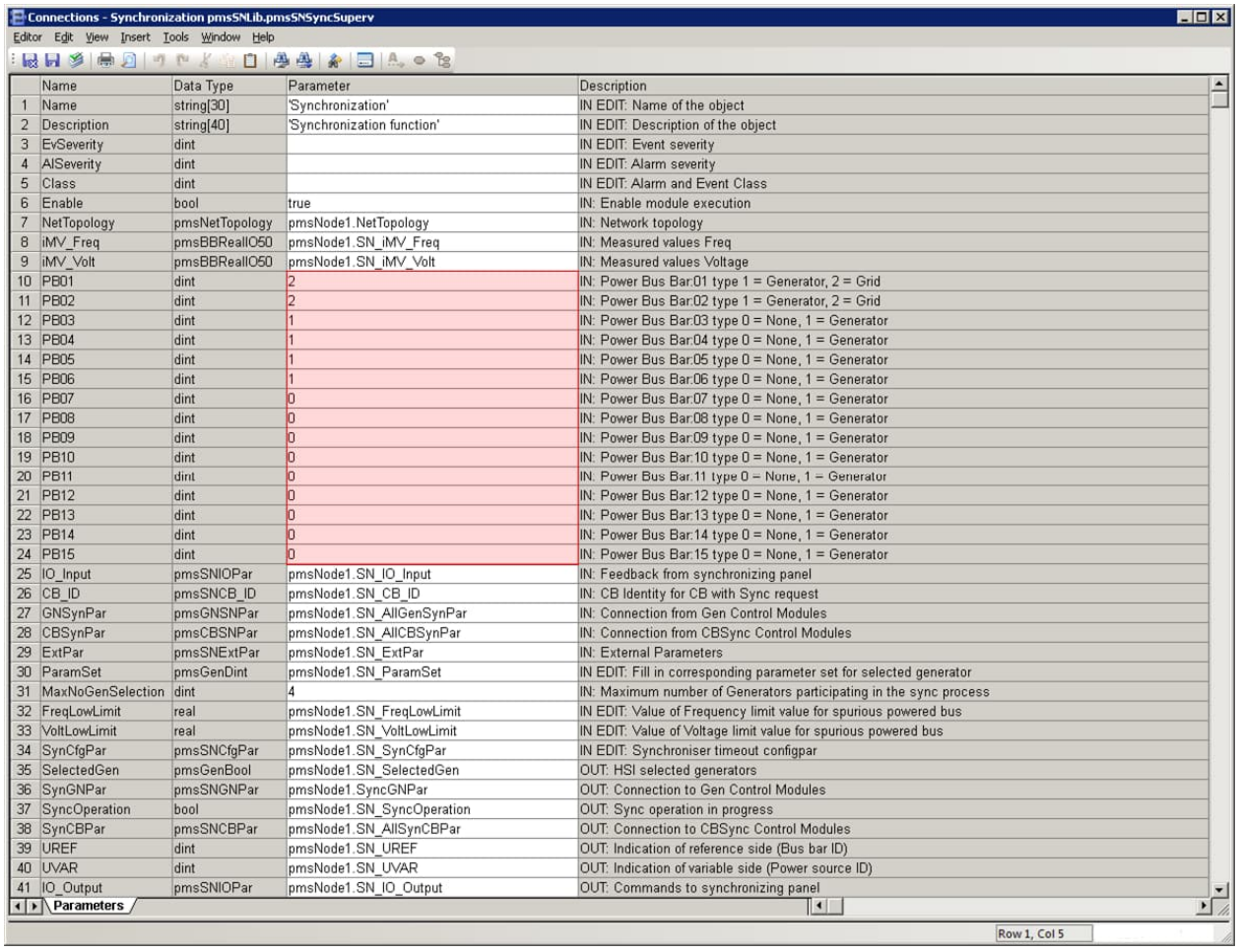
Parameters

Row 1, Col 5

Figure 60 Example of parameter connection iMV_Freq and iMV_Volt

7.4.1.5 Connection of PB01…PB15

The parameters *PB01…PB15* shall be used for configuring the power sources (generators and grid connections) included in the network determination. An example of the necessary connections is shown in Figure 61.



Connections - Synchronization pmsSNLib.pmsSNSyncSuperv

Editor Edit View Insert Tools Window Help

	Name	Data Type	Parameter	Description
1	Name	string[30]	'Synchronization'	IN EDIT: Name of the object
2	Description	string[40]	'Synchronization function'	IN EDIT: Description of the object
3	EvSeverity	dint		IN EDIT: Event severity
4	AlSeverity	dint		IN EDIT: Alarm severity
5	Class	dint		IN EDIT: Alarm and Event Class
6	Enable	bool	true	IN: Enable module execution
7	NetTopology	pmsNetTopology	pmsNode1.NetTopology	IN: Network topology
8	iMV_Freq	pmsBBRealIO50	pmsNode1.SN_iMV_Freq	IN: Measured values Freq
9	iMV_Volt	pmsBBRealIO50	pmsNode1.SN_iMV_Volt	IN: Measured values Voltage
10	PB01	dint	2	IN: Power Bus Bar:01 type 1 = Generator, 2 = Grid
11	PB02	dint	2	IN: Power Bus Bar:02 type 1 = Generator, 2 = Grid
12	PB03	dint	1	IN: Power Bus Bar:03 type 0 = None, 1 = Generator
13	PB04	dint	1	IN: Power Bus Bar:04 type 0 = None, 1 = Generator
14	PB05	dint	1	IN: Power Bus Bar:05 type 0 = None, 1 = Generator
15	PB06	dint	1	IN: Power Bus Bar:06 type 0 = None, 1 = Generator
16	PB07	dint	0	IN: Power Bus Bar:07 type 0 = None, 1 = Generator
17	PB08	dint	0	IN: Power Bus Bar:08 type 0 = None, 1 = Generator
18	PB09	dint	0	IN: Power Bus Bar:09 type 0 = None, 1 = Generator
19	PB10	dint	0	IN: Power Bus Bar:10 type 0 = None, 1 = Generator
20	PB11	dint	0	IN: Power Bus Bar:11 type 0 = None, 1 = Generator
21	PB12	dint	0	IN: Power Bus Bar:12 type 0 = None, 1 = Generator
22	PB13	dint	0	IN: Power Bus Bar:13 type 0 = None, 1 = Generator
23	PB14	dint	0	IN: Power Bus Bar:14 type 0 = None, 1 = Generator
24	PB15	dint	0	IN: Power Bus Bar:15 type 0 = None, 1 = Generator
25	IO_Input	pmsSNIOPar	pmsNode1.SN_IO_Input	IN: Feedback from synchronizing panel
26	CB_ID	pmsSNCB_ID	pmsNode1.SN_CB_ID	IN: CB Identity for CB with Sync request
27	GNSynPar	pmsGNSNPar	pmsNode1.SN_AllGenSynPar	IN: Connection from Gen Control Modules
28	CBSynPar	pmsCBSNPar	pmsNode1.SN_AllCBSynPar	IN: Connection from CBSync Control Modules
29	ExtPar	pmsSNExtPar	pmsNode1.SN_ExtPar	IN: External Parameters
30	ParamSet	pmsGenDint	pmsNode1.SN_ParamSet	IN EDIT: Fill in corresponding parameter set for selected generator
31	MaxNoGenSelection	dint	4	IN: Maximum number of Generators participating in the sync process
32	FreqLowLimit	real	pmsNode1.SN_FreqLowLimit	IN EDIT: Value of Frequency limit value for spurious powered bus
33	VoltLowLimit	real	pmsNode1.SN_VoltLowLimit	IN EDIT: Value of Voltage limit value for spurious powered bus
34	SynCfgPar	pmsSNCfgPar	pmsNode1.SN_SynCfgPar	IN EDIT: Synchroniser timeout configpar
35	SelectedGen	pmsGenBool	pmsNode1.SN_SelectedGen	OUT: HSI selected generators
36	SynGNPar	pmsSNGNPar	pmsNode1.SyncGNPar	OUT: Connection to Gen Control Modules
37	SyncOperation	bool	pmsNode1.SN_SyncOperation	OUT: Sync operation in progress
38	SynCBPar	pmsSNCBPar	pmsNode1.SN_AllSynCBPar	OUT: Connection to CBSync Control Modules
39	UREF	dint	pmsNode1.SN_UREF	OUT: Indication of reference side (Bus bar ID)
40	UVAR	dint	pmsNode1.SN_UVAR	OUT: Indication of variable side (Power source ID)
41	IO_Output	pmsSNIOPar	pmsNode1.SN_IO_Output	OUT: Commands to synchronizing panel

Parameters

Row 1, Col 5

Figure 61 Example of parameter connection PB01-PB15

The example in Figure 61 reflects the configuration of the power sources in the network determination example from Figure 37. The PB01 and PB02 are set to number 2 because they represent the grid connections, while the PB03 to PB06 are set to number 1 because they represent the generators. The rest of PB07 to PB15 are set to number 0 because they are not applicable for the specific network determination.

7.4.1.1 Connection of IO_Input and IO_Output

The parameters *IO_Input* and *IO_Output* shall be used for configuring the I/O interface signals with the synchronizing equipment. An example of the necessary connections is shown in Figure 62 and Figure 63.

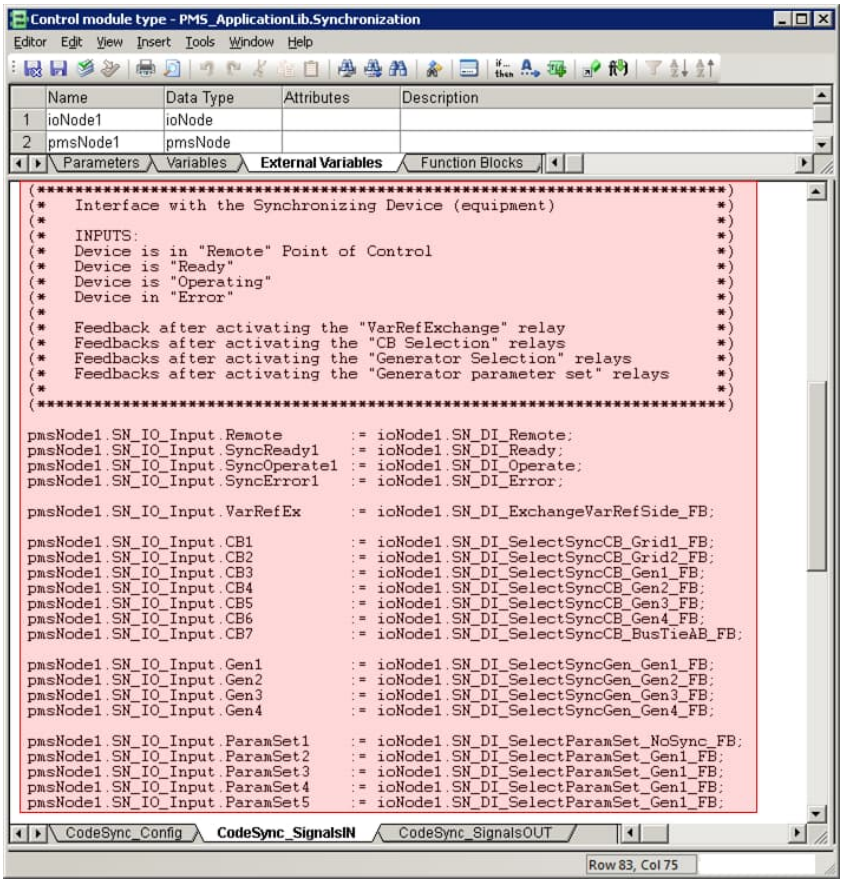


Figure 62 Example of application code for IO_Input parameter

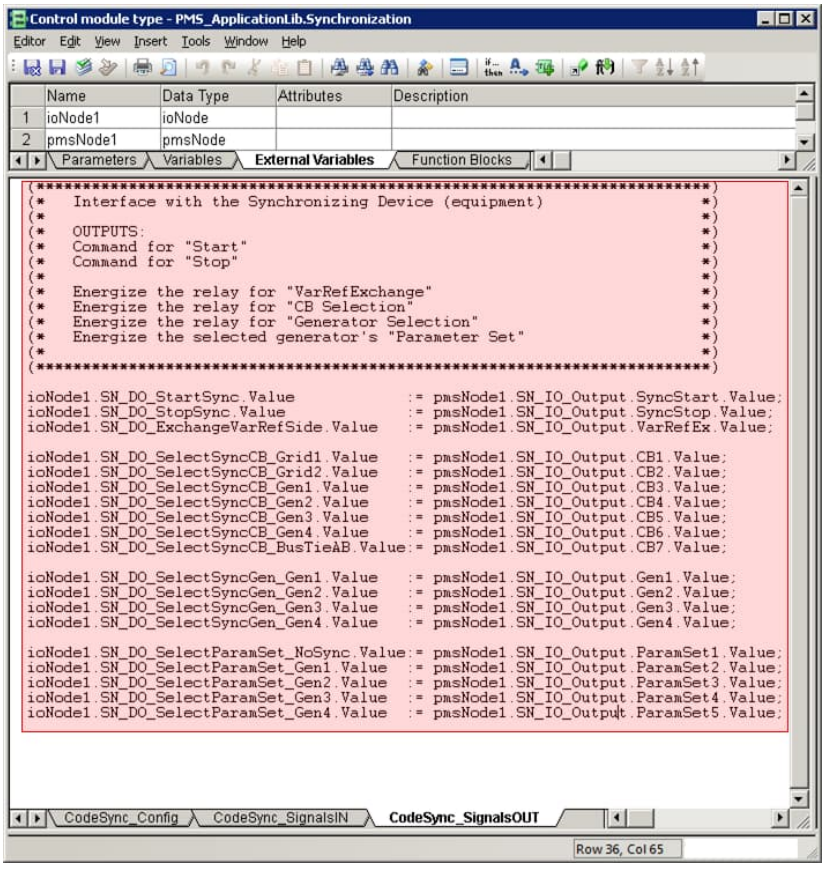
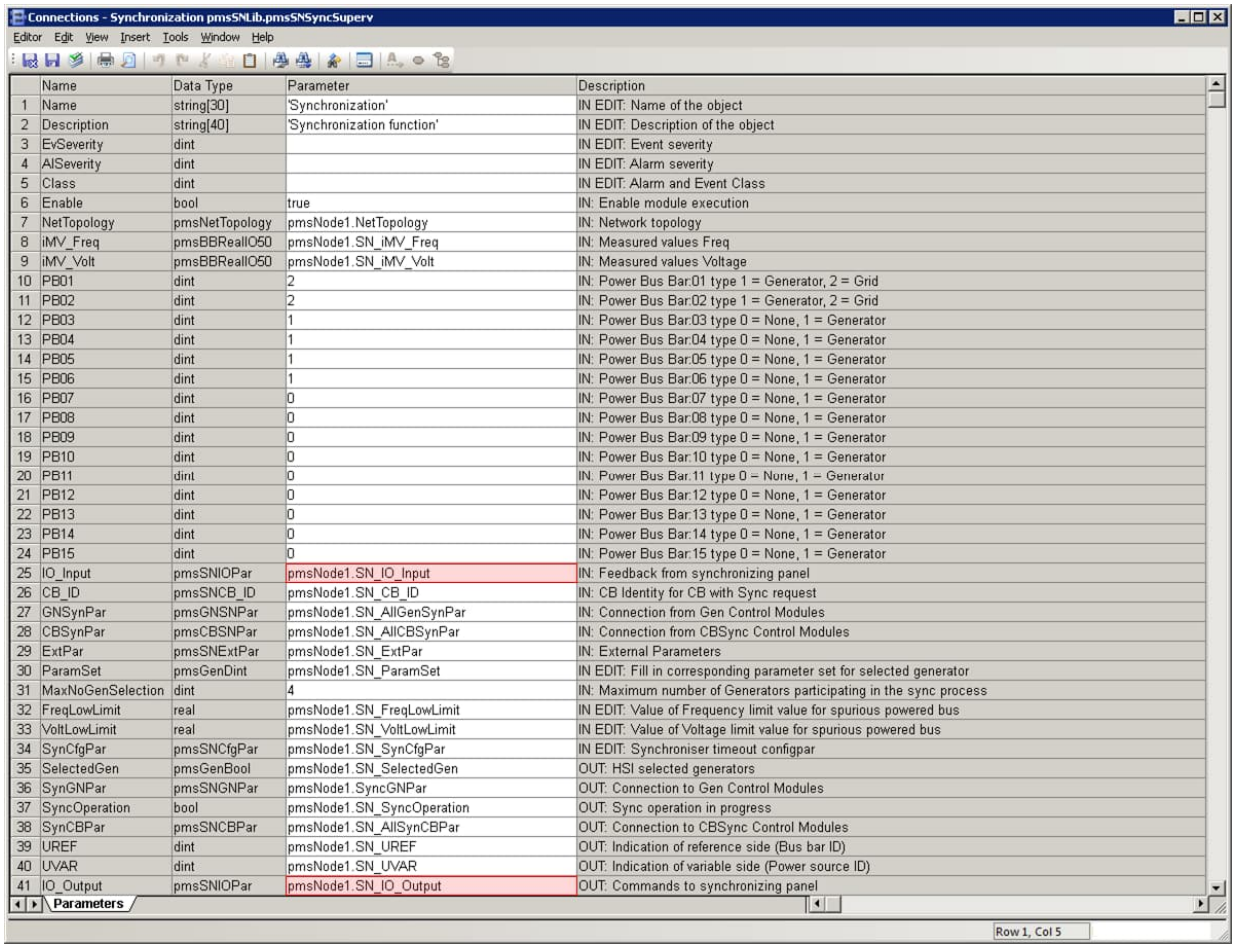


Figure 63 Example of application code for IO_Output parameter

The example in Figure 62 shows that the variables *pmsNode1.SN_IO_Input.xx* are receiving the feedback signals from DI signals representing the status of the synchronizing device and the field selection relays (refer to the comments in the structure text code).

The example in Figure 63 shows that the variables *pmsNode1.SN_IO_Output.xx* are sending the software commands to DO outputs representing the operation commands towards the synchronizing device and the field relays (refer to the comments in the structure text code).

The variables pmsNode1.*SN_IO_Input and pmsNode1.SN_IO_Output* shall be connected to the parameters *IO_Input and IO_Output*, as shown in Figure 64.



	Name	Data Type	Parameter	Description
1	Name	string[30]	'Synchronization'	IN EDIT: Name of the object
2	Description	string[40]	'Synchronization function'	IN EDIT: Description of the object
3	EvSeverity	dint		IN EDIT: Event severity
4	AlSeverity	dint		IN EDIT: Alarm severity
5	Class	dint		IN EDIT: Alarm and Event Class
6	Enable	bool	true	IN: Enable module execution
7	NetTopology	pmsNetTopology	pmsNode1.NetTopology	IN: Network topology
8	iMV_Freq	pmsBBRealIO50	pmsNode1.SN_iMV_Freq	IN: Measured values Freq
9	iMV_Volt	pmsBBRealIO50	pmsNode1.SN_iMV_Volt	IN: Measured values Voltage
10	PB01	dint	2	IN: Power Bus Bar:01 type 1 = Generator, 2 = Grid
11	PB02	dint	2	IN: Power Bus Bar:02 type 1 = Generator, 2 = Grid
12	PB03	dint	1	IN: Power Bus Bar:03 type 0 = None, 1 = Generator
13	PB04	dint	1	IN: Power Bus Bar:04 type 0 = None, 1 = Generator
14	PB05	dint	1	IN: Power Bus Bar:05 type 0 = None, 1 = Generator
15	PB06	dint	1	IN: Power Bus Bar:06 type 0 = None, 1 = Generator
16	PB07	dint	0	IN: Power Bus Bar:07 type 0 = None, 1 = Generator
17	PB08	dint	0	IN: Power Bus Bar:08 type 0 = None, 1 = Generator
18	PB09	dint	0	IN: Power Bus Bar:09 type 0 = None, 1 = Generator
19	PB10	dint	0	IN: Power Bus Bar:10 type 0 = None, 1 = Generator
20	PB11	dint	0	IN: Power Bus Bar:11 type 0 = None, 1 = Generator
21	PB12	dint	0	IN: Power Bus Bar:12 type 0 = None, 1 = Generator
22	PB13	dint	0	IN: Power Bus Bar:13 type 0 = None, 1 = Generator
23	PB14	dint	0	IN: Power Bus Bar:14 type 0 = None, 1 = Generator
24	PB15	dint	0	IN: Power Bus Bar:15 type 0 = None, 1 = Generator
25	IO_Input	pmsSNIOPar	pmsNode1.SN_IO_Input	IN: Feedback from synchronizing panel
26	CB_ID	pmsSNCB_ID	pmsNode1.SN_CB_ID	IN: CB Identity for CB with Sync request
27	GNSynPar	pmsGNSNPar	pmsNode1.SN_AllGenSynPar	IN: Connection from Gen Control Modules
28	CBSynPar	pmsCBSNPar	pmsNode1.SN_AllCBSynPar	IN: Connection from CBSync Control Modules
29	ExtPar	pmsSNExtPar	pmsNode1.SN_ExtPar	IN: External Parameters
30	ParamSet	pmsGenDint	pmsNode1.SN_ParamSet	IN EDIT: Fill in corresponding parameter set for selected generator
31	MaxNoGenSelection	dint	4	IN: Maximum number of Generators participating in the sync process
32	FreqLowLimit	real	pmsNode1.SN_FreqLowLimit	IN EDIT: Value of Frequency limit value for spurious powered bus
33	VoltLowLimit	real	pmsNode1.SN_VoltLowLimit	IN EDIT: Value of Voltage limit value for spurious powered bus
34	SynCfgPar	pmsSNCfgPar	pmsNode1.SN_SynCfgPar	IN EDIT: Synchroniser timeout configpar
35	SelectedGen	pmsGenBool	pmsNode1.SN_SelectedGen	OUT: HSI selected generators
36	SynGNPar	pmsSNGNPar	pmsNode1.SyncGNPar	OUT: Connection to Gen Control Modules
37	SyncOperation	bool	pmsNode1.SN_SyncOperation	OUT: Sync operation in progress
38	SynCBPar	pmsSNCBPar	pmsNode1.SN_AllSynCBPar	OUT: Connection to CBSync Control Modules
39	UREF	dint	pmsNode1.SN_UREF	OUT: Indication of reference side (Bus bar ID)
40	UVAR	dint	pmsNode1.SN_UVAR	OUT: Indication of variable side (Power source ID)
41	IO_Output	pmsSNIOPar	pmsNode1.SN_IO_Output	OUT: Commands to synchronizing panel

Figure 64 Example of parameter connection IO_Input and IO_Output

7.4.1.2 Connection of CB_ID

The parameter *CB_ID* shall be used for activating the circuit breaker selection relays, depending on the faceplate of the pmsCBSyncM module which is initiating the synchronization process (refer to Figure 9). An example of the necessary application code is shown in Figure 65.

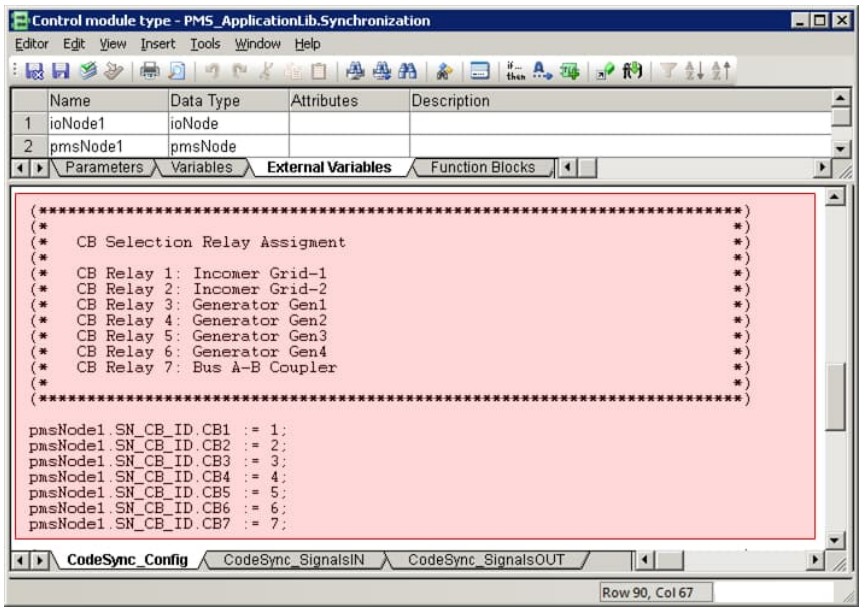
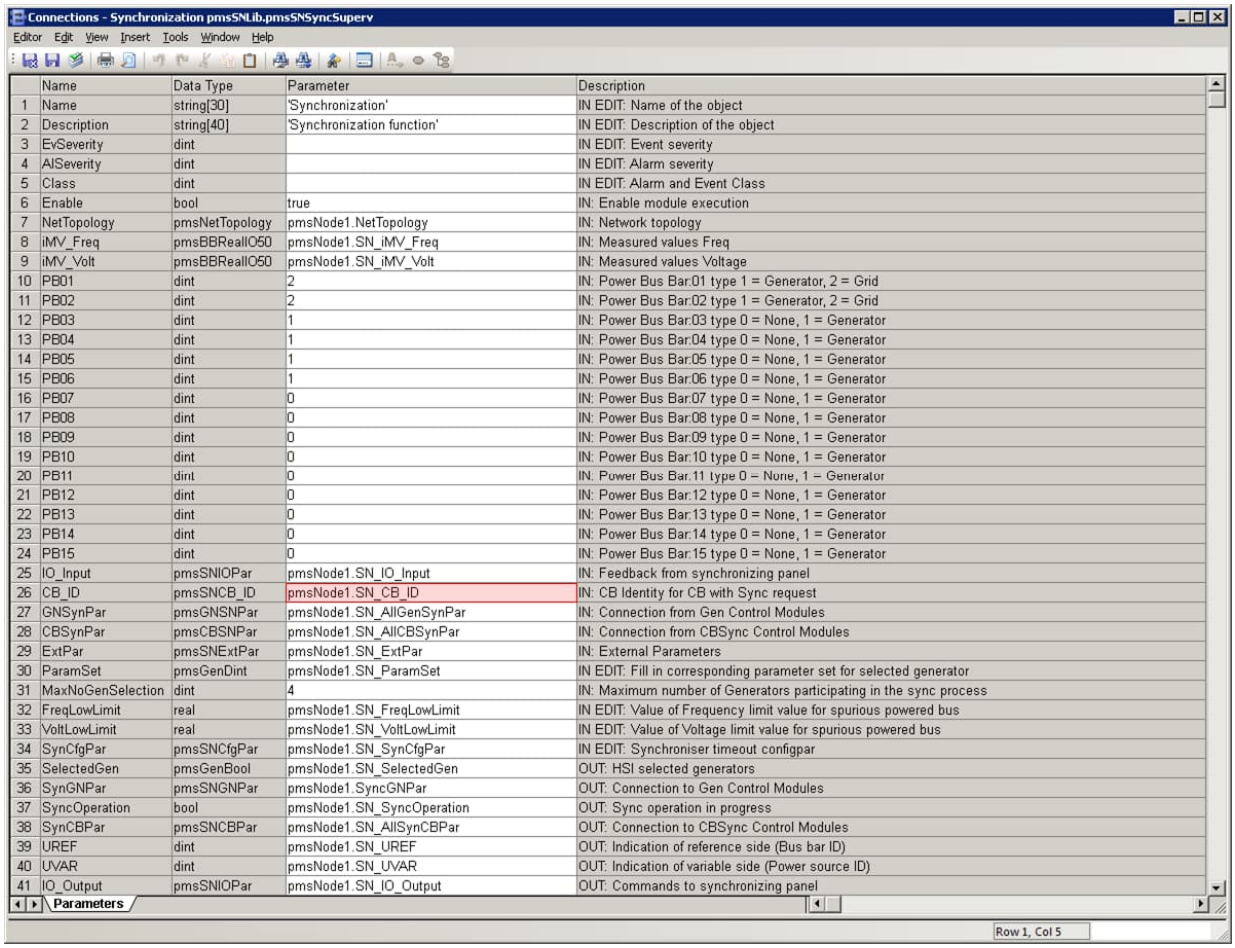


Figure 65 Example of application code for CB_ID parameter

The example in Figure 65 shows that the variables *pmsNode1.SN_CB_ID.CB1…CB8* are set to a value representing the index number of the circuit breakers in the synchronizing scheme (refer to Table 56). The variable *pmsNode1.SN_CB_ID* shall be connected to the parameter CB_ID, as shown in Figure 66.

According to the configuration example, when the circuit breaker with index 2 is selected for the synchronization, the variable *pmsNode1.SN_IO_Output.CB2.Value* will be set to true. The application code in Figure 63 shows that this variable will cause the selection relay for the Grid-2 breaker to be activated.



Connections - Synchronization pmsSNLib.pmsSNSyncSuperv

Editor Edit View Insert Tools Window Help

	Name	Data Type	Parameter	Description
1	Name	string[30]	'Synchronization'	IN EDIT: Name of the object
2	Description	string[40]	'Synchronization function'	IN EDIT: Description of the object
3	EvSeverity	dint		IN EDIT: Event severity
4	AlSeverity	dint		IN EDIT: Alarm severity
5	Class	dint		IN EDIT: Alarm and Event Class
6	Enable	bool	true	IN: Enable module execution
7	NetTopology	pmsNetTopology	pmsNode1.NetTopology	IN: Network topology
8	iMV_Freq	pmsBBRealIO50	pmsNode1.SN_iMV_Freq	IN: Measured values Freq
9	iMV_Volt	pmsBBRealIO50	pmsNode1.SN_iMV_Volt	IN: Measured values Voltage
10	PB01	dint	2	IN: Power Bus Bar:01 type 1 = Generator, 2 = Grid
11	PB02	dint	2	IN: Power Bus Bar:02 type 1 = Generator, 2 = Grid
12	PB03	dint	1	IN: Power Bus Bar:03 type 0 = None, 1 = Generator
13	PB04	dint	1	IN: Power Bus Bar:04 type 0 = None, 1 = Generator
14	PB05	dint	1	IN: Power Bus Bar:05 type 0 = None, 1 = Generator
15	PB06	dint	1	IN: Power Bus Bar:06 type 0 = None, 1 = Generator
16	PB07	dint	0	IN: Power Bus Bar:07 type 0 = None, 1 = Generator
17	PB08	dint	0	IN: Power Bus Bar:08 type 0 = None, 1 = Generator
18	PB09	dint	0	IN: Power Bus Bar:09 type 0 = None, 1 = Generator
19	PB10	dint	0	IN: Power Bus Bar:10 type 0 = None, 1 = Generator
20	PB11	dint	0	IN: Power Bus Bar:11 type 0 = None, 1 = Generator
21	PB12	dint	0	IN: Power Bus Bar:12 type 0 = None, 1 = Generator
22	PB13	dint	0	IN: Power Bus Bar:13 type 0 = None, 1 = Generator
23	PB14	dint	0	IN: Power Bus Bar:14 type 0 = None, 1 = Generator
24	PB15	dint	0	IN: Power Bus Bar:15 type 0 = None, 1 = Generator
25	IO_Input	pmsSNIOPar	pmsNode1.SN_IO_Input	IN: Feedback from synchronizing panel
26	CB_ID	pmsSNCB_ID	pmsNode1.SN_CB_ID	IN: CB Identity for CB with Sync request
27	GNSynPar	pmsGNSNPar	pmsNode1.SN_AllGenSynPar	IN: Connection from Gen Control Modules
28	CBSynPar	pmsCBSNPar	pmsNode1.SN_AllCBSynPar	IN: Connection from CBSync Control Modules
29	ExtPar	pmsSNExtPar	pmsNode1.SN_ExtPar	IN: External Parameters
30	ParamSet	pmsGenDint	pmsNode1.SN_ParamSet	IN EDIT: Fill in corresponding parameter set for selected generator
31	MaxNoGenSelection	dint	4	IN: Maximum number of Generators participating in the sync process
32	FreqLowLimit	real	pmsNode1.SN_FreqLowLimit	IN EDIT: Value of Frequency limit value for spurious powered bus
33	VoltLowLimit	real	pmsNode1.SN_VoltLowLimit	IN EDIT: Value of Voltage limit value for spurious powered bus
34	SynCfgPar	pmsSNCfgPar	pmsNode1.SN_SynCfgPar	IN EDIT: Synchroniser timeout configpar
35	SelectedGen	pmsGenBool	pmsNode1.SN_SelectedGen	OUT: HSI selected generators
36	SynGNPar	pmsSNGNPar	pmsNode1.SyncGNPar	OUT: Connection to Gen Control Modules
37	SyncOperation	bool	pmsNode1.SN_SyncOperation	OUT: Sync operation in progress
38	SynCBPar	pmsSNCBPar	pmsNode1.SN_AllSynCBPar	OUT: Connection to CBSync Control Modules
39	UREF	dint	pmsNode1.SN_UREF	OUT: Indication of reference side (Bus bar ID)
40	UVAR	dint	pmsNode1.SN_UVAR	OUT: Indication of variable side (Power source ID)
41	IO_Output	pmsSNIOPar	pmsNode1.SN_IO_Output	OUT: Commands to synchronizing panel

Parameters

Row 1, Col 5

Figure 66 Example of parameter connection CB_ID

7.4.1.3 Connection of GNSynPar and SynGNPAr

The parameters *GNSynPar* and *SynGNPAr* are described in Connection of SyncGNPar and section Connection of GNSyncPar . Refer to Figure 47 and Figure 48 for the relevant examples.

7.4.1.4 Connection of SyncOperation

The parameter *SyncOperation* is providing a Boolean indication that the synchronization session is in progress and the control module pmsSNSyncSuperv is active. It can be used in project specific application logic or in graphic displays for presenting the status of the synchronization function. An example of the necessary connection is shown in Figure 67.

Connections - Synchronization pmsSNLib.pmsSNSyncSuperv

Editor Edit View Insert Tools Window Help

	Name	Data Type	Parameter	Description
1	Name	string[30]	'Synchronization'	IN EDIT: Name of the object
2	Description	string[40]	'Synchronization function'	IN EDIT: Description of the object
3	EvSeverity	dint		IN EDIT: Event severity
4	AlSeverity	dint		IN EDIT: Alarm severity
5	Class	dint		IN EDIT: Alarm and Event Class
6	Enable	bool	true	IN: Enable module execution
7	NetTopology	pmsNetTopology	pmsNode1.NetTopology	IN: Network topology
8	iMV_Freq	pmsBBRealIO50	pmsNode1.SN_iMV_Freq	IN: Measured values Freq
9	iMV_Volt	pmsBBRealIO50	pmsNode1.SN_iMV_Volt	IN: Measured values Voltage
10	PB01	dint	2	IN: Power Bus Bar:01 type 1 = Generator, 2 = Grid
11	PB02	dint	2	IN: Power Bus Bar:02 type 1 = Generator, 2 = Grid
12	PB03	dint	1	IN: Power Bus Bar:03 type 0 = None, 1 = Generator
13	PB04	dint	1	IN: Power Bus Bar:04 type 0 = None, 1 = Generator
14	PB05	dint	1	IN: Power Bus Bar:05 type 0 = None, 1 = Generator
15	PB06	dint	1	IN: Power Bus Bar:06 type 0 = None, 1 = Generator
16	PB07	dint	0	IN: Power Bus Bar:07 type 0 = None, 1 = Generator
17	PB08	dint	0	IN: Power Bus Bar:08 type 0 = None, 1 = Generator
18	PB09	dint	0	IN: Power Bus Bar:09 type 0 = None, 1 = Generator
19	PB10	dint	0	IN: Power Bus Bar:10 type 0 = None, 1 = Generator
20	PB11	dint	0	IN: Power Bus Bar:11 type 0 = None, 1 = Generator
21	PB12	dint	0	IN: Power Bus Bar:12 type 0 = None, 1 = Generator
22	PB13	dint	0	IN: Power Bus Bar:13 type 0 = None, 1 = Generator
23	PB14	dint	0	IN: Power Bus Bar:14 type 0 = None, 1 = Generator
24	PB15	dint	0	IN: Power Bus Bar:15 type 0 = None, 1 = Generator
25	IO_Input	pmsSNIOPar	pmsNode1.SN_IO_Input	IN: Feedback from synchronizing panel
26	CB_ID	pmsSNCB_ID	pmsNode1.SN_CB_ID	IN: CB Identity for CB with Sync request
27	GNSynPar	pmsGNSNPar	pmsNode1.SN_AllGenSynPar	IN: Connection from Gen Control Modules
28	CBSynPar	pmsCBSNPar	pmsNode1.SN_AllCBSynPar	IN: Connection from CBSync Control Modules
29	ExtPar	pmsSNExtPar	pmsNode1.SN_ExtPar	IN: External Parameters
30	ParamSet	pmsGenDint	pmsNode1.SN_ParamSet	IN EDIT: Fill in corresponding parameter set for selected generator
31	MaxNoGenSelection	dint	4	IN: Maximum number of Generators participating in the sync process
32	FreqLowLimit	real	pmsNode1.SN_FreqLowLimit	IN EDIT: Value of Frequency limit value for spurious powered bus
33	VoltLowLimit	real	pmsNode1.SN_VoltLowLimit	IN EDIT: Value of Voltage limit value for spurious powered bus
34	SynCfgPar	pmsSNCfgPar	pmsNode1.SN_SynCfgPar	IN EDIT: Synchroniser timeout configpar
35	SelectedGen	pmsGenBool	pmsNode1.SN_SelectedGen	OUT: HSI selected generators
36	SynGNPar	pmsSNGNPar	pmsNode1.SyncGNPar	OUT: Connection to Gen Control Modules
37	SyncOperation	bool	pmsNode1.SN_SyncOperation	OUT: Sync operation in progress
38	SynCBPar	pmsSNCBPar	pmsNode1.SN_AllSynCBPar	OUT: Connection to CBSync Control Modules
39	UREF	dint	pmsNode1.SN_UREF	OUT: Indication of reference side (Bus bar ID)
40	UVAR	dint	pmsNode1.SN_UVAR	OUT: Indication of variable side (Power source ID)
41	IO_Output	pmsSNIOPar	pmsNode1.SN_IO_Output	OUT: Commands to synchronizing panel

Parameters

Row 1, Col 5

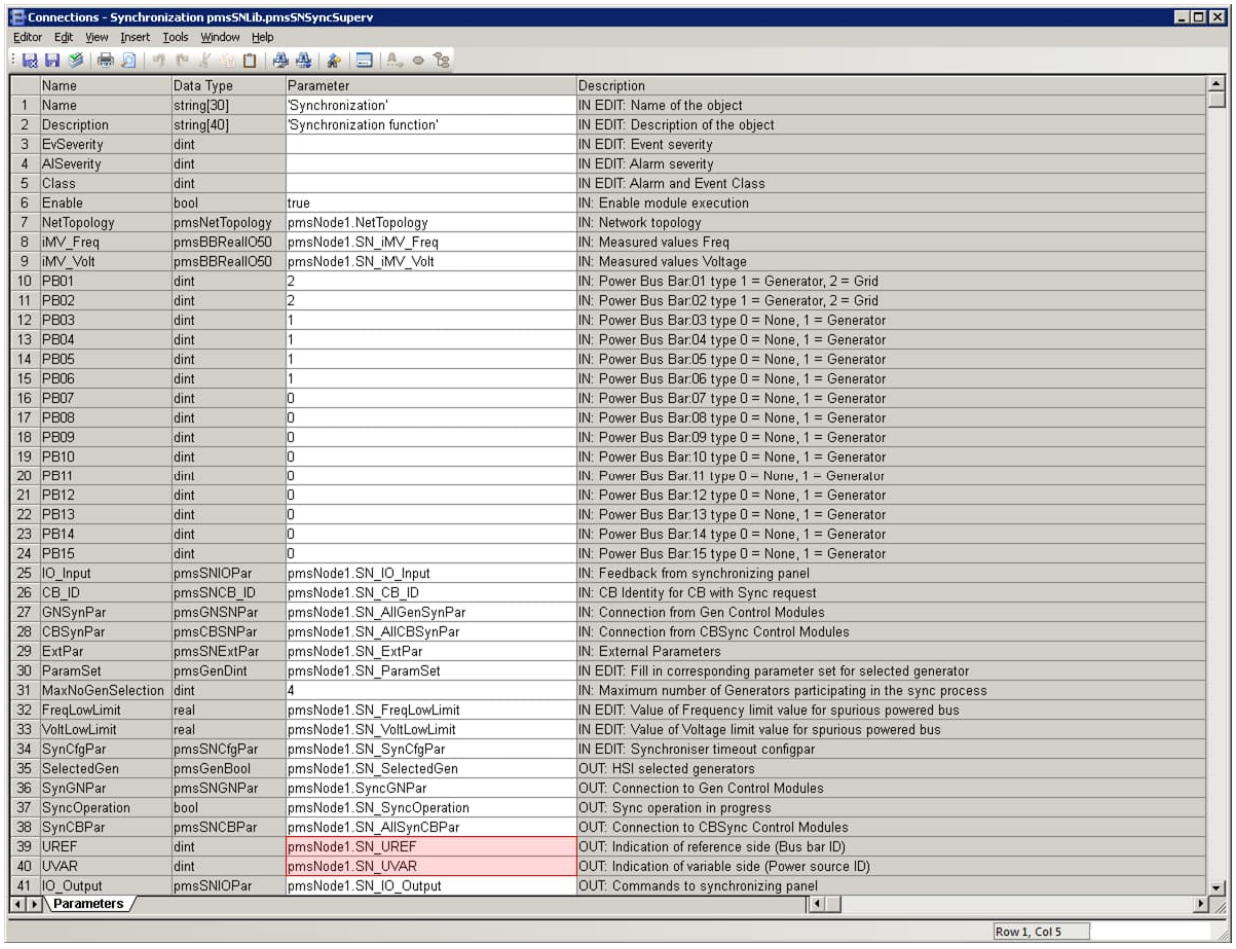
Figure 67 Example of parameter connection SyncOperation

7.4.1.5 Connection of CBSynPar and SynCBPar

The parameters *CBSynPar* and *SynCBPar* are described in section Connection of SynCBPar and section Connection of CBSynPar. Refer to Figure 42 and Figure 43 for the relevant examples.

7.4.1.6 Connection of UREF and UVAR

The parameters *UREF* and *UVAR* are providing a numerical indication of the selected variable and reference side in the synchronization session. They can be used in project specific application logic or in graphic displays for presenting the variable and reference side. An example of the necessary connections is shown in Figure 68.


Connections - Synchronization pmsSNLib.pmsSNSyncSuperv

Editor Edit View Insert Tools Window Help

	Name	Data Type	Parameter	Description
1	Name	string[30]	'Synchronization'	IN EDIT: Name of the object
2	Description	string[40]	'Synchronization function'	IN EDIT: Description of the object
3	EvSeverity	dint		IN EDIT: Event severity
4	AlSeverity	dint		IN EDIT: Alarm severity
5	Class	dint		IN EDIT: Alarm and Event Class
6	Enable	bool	true	IN: Enable module execution
7	NetTopology	pmsNetTopology	pmsNode1.NetTopology	IN: Network topology
8	iMV_Freq	pmsBBRealIO50	pmsNode1.SN_iMV_Freq	IN: Measured values Freq
9	iMV_Volt	pmsBBRealIO50	pmsNode1.SN_iMV_Volt	IN: Measured values Voltage
10	PB01	dint	2	IN: Power Bus Bar:01 type 1 = Generator, 2 = Grid
11	PB02	dint	2	IN: Power Bus Bar:02 type 1 = Generator, 2 = Grid
12	PB03	dint	1	IN: Power Bus Bar:03 type 0 = None, 1 = Generator
13	PB04	dint	1	IN: Power Bus Bar:04 type 0 = None, 1 = Generator
14	PB05	dint	1	IN: Power Bus Bar:05 type 0 = None, 1 = Generator
15	PB06	dint	1	IN: Power Bus Bar:06 type 0 = None, 1 = Generator
16	PB07	dint	0	IN: Power Bus Bar:07 type 0 = None, 1 = Generator
17	PB08	dint	0	IN: Power Bus Bar:08 type 0 = None, 1 = Generator
18	PB09	dint	0	IN: Power Bus Bar:09 type 0 = None, 1 = Generator
19	PB10	dint	0	IN: Power Bus Bar:10 type 0 = None, 1 = Generator
20	PB11	dint	0	IN: Power Bus Bar:11 type 0 = None, 1 = Generator
21	PB12	dint	0	IN: Power Bus Bar:12 type 0 = None, 1 = Generator
22	PB13	dint	0	IN: Power Bus Bar:13 type 0 = None, 1 = Generator
23	PB14	dint	0	IN: Power Bus Bar:14 type 0 = None, 1 = Generator
24	PB15	dint	0	IN: Power Bus Bar:15 type 0 = None, 1 = Generator
25	IO_Input	pmsSNIOPar	pmsNode1.SN_IO_Input	IN: Feedback from synchronizing panel
26	CB_ID	pmsSNCB_ID	pmsNode1.SN_CB_ID	IN: CB Identity for CB with Sync request
27	GNSynPar	pmsGNSNPar	pmsNode1.SN_AllGenSynPar	IN: Connection from Gen Control Modules
28	CBSynPar	pmsCBSNPar	pmsNode1.SN_AllCBSynPar	IN: Connection from CBSync Control Modules
29	ExtPar	pmsSNExtPar	pmsNode1.SN_ExtPar	IN: External Parameters
30	ParamSet	pmsGenDint	pmsNode1.SN_ParamSet	IN EDIT: Fill in corresponding parameter set for selected generator
31	MaxNoGenSelection	dint	4	IN: Maximum number of Generators participating in the sync process
32	FreqLowLimit	real	pmsNode1.SN_FreqLowLimit	IN EDIT: Value of Frequency limit value for spurious powered bus
33	VoltLowLimit	real	pmsNode1.SN_VoltLowLimit	IN EDIT: Value of Voltage limit value for spurious powered bus
34	SynCfgPar	pmsSNCfgPar	pmsNode1.SN_SynCfgPar	IN EDIT: Synchroniser timeout configpar
35	SelectedGen	pmsGenBool	pmsNode1.SN_SelectedGen	OUT: HSI selected generators
36	SynGNPar	pmsSNGNPar	pmsNode1.SyncGNPar	OUT: Connection to Gen Control Modules
37	SyncOperation	bool	pmsNode1.SN_SyncOperation	OUT: Sync operation in progress
38	SynCBPar	pmsSNCBPar	pmsNode1.SN_AllSynCBPar	OUT: Connection to CBSync Control Modules
39	UREF	dint	pmsNode1.SN_UREF	OUT: Indication of reference side (Bus bar ID)
40	UVAR	dint	pmsNode1.SN_UVAR	OUT: Indication of variable side (Power source ID)
41	IO_Output	pmsSNIOPar	pmsNode1.SN_IO_Output	OUT: Commands to synchronizing panel

Parameters

Row 1, Col 5

Figure 68 Example of parameter connection UREF and UVAR

7.4.1.7 Connection of ParamSet

The *ParamSet* shall be used for activating the parameter sets utilized by the synchronization equipment, depending on the pmsGenM module which is participating in the synchronization process. An example of the necessary application code is shown in Figure 69.

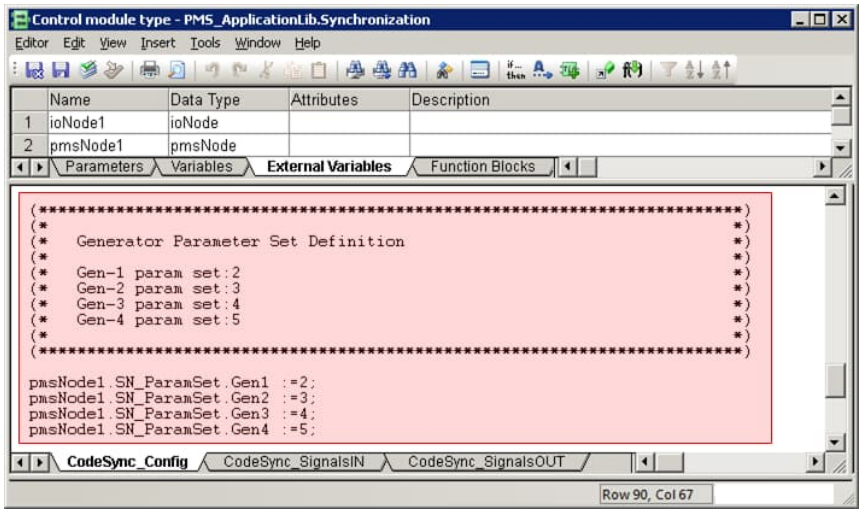
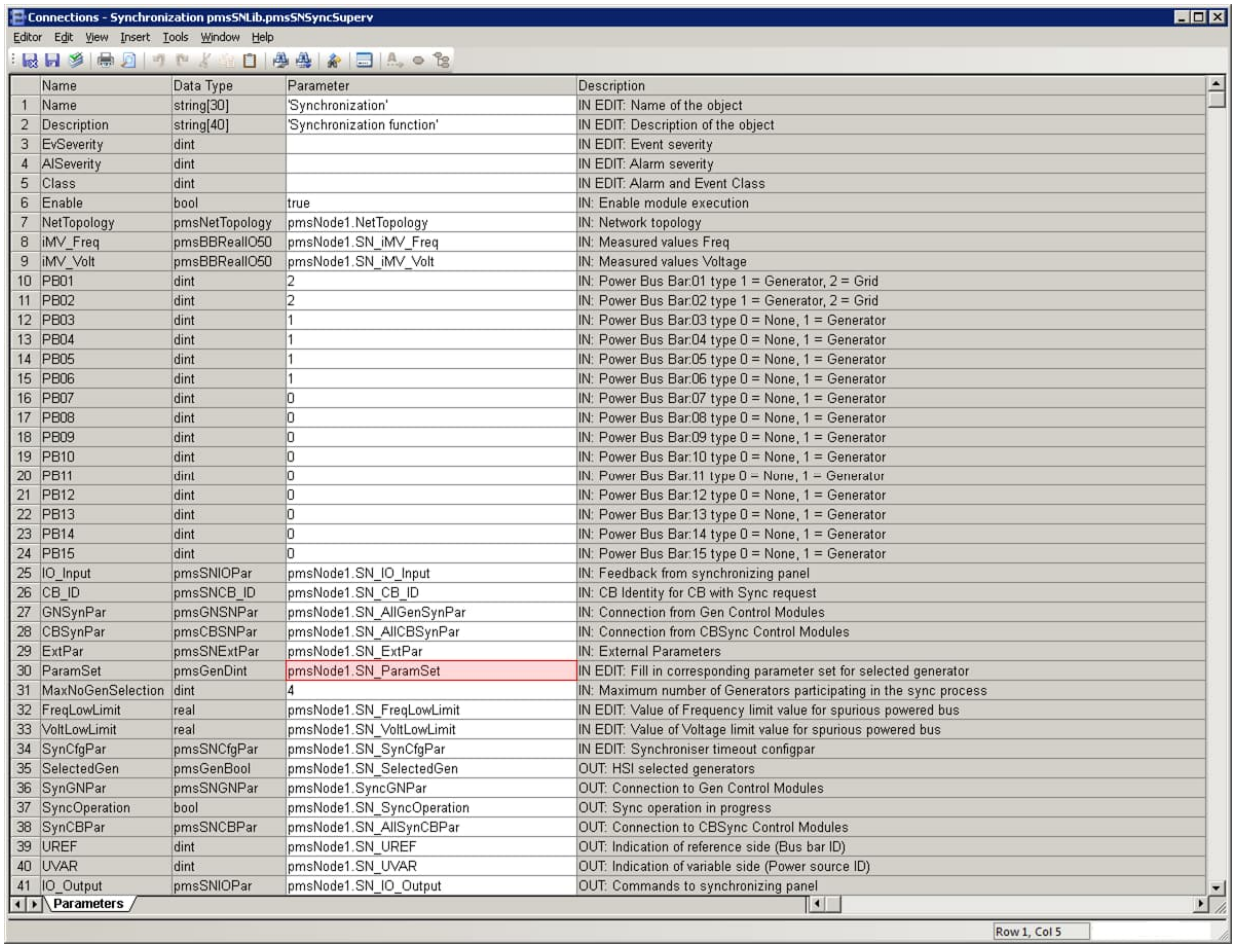


Figure 69 Example of application code for ParamSet parameter

The example in Figure 69 shows that the variables *pmsNode1.SN_ParamSet.Gen1…Gen4* are set to a value representing the desired parameter set. The variable *pmsNode1.SN_ParamSet* shall be connected to the parameter *ParamSet*, as shown in Figure 68.

According to the configuration example, when the generator 4 is selected for the synchronization, the variable *pmsNode1.SN_IO_Output.ParamSet5.Value* will be set to true. The application code in Figure 63 shows that this variable will cause the output for parameter set 5 to be activated.



Connections - Synchronization pmsSNLib.pmsSNSyncSuperv

Editor Edit View Insert Tools Window Help

	Name	Data Type	Parameter	Description
1	Name	string[30]	'Synchronization'	IN EDIT: Name of the object
2	Description	string[40]	'Synchronization function'	IN EDIT: Description of the object
3	EvSeverity	dint		IN EDIT: Event severity
4	AlSeverity	dint		IN EDIT: Alarm severity
5	Class	dint		IN EDIT: Alarm and Event Class
6	Enable	bool	true	IN: Enable module execution
7	NetTopology	pmsNetTopology	pmsNode1.NetTopology	IN: Network topology
8	iMV_Freq	pmsBBRealIO50	pmsNode1.SN_iMV_Freq	IN: Measured values Freq
9	iMV_Volt	pmsBBRealIO50	pmsNode1.SN_iMV_Volt	IN: Measured values Voltage
10	PB01	dint	2	IN: Power Bus Bar:01 type 1 = Generator, 2 = Grid
11	PB02	dint	2	IN: Power Bus Bar:02 type 1 = Generator, 2 = Grid
12	PB03	dint	1	IN: Power Bus Bar:03 type 0 = None, 1 = Generator
13	PB04	dint	1	IN: Power Bus Bar:04 type 0 = None, 1 = Generator
14	PB05	dint	1	IN: Power Bus Bar:05 type 0 = None, 1 = Generator
15	PB06	dint	1	IN: Power Bus Bar:06 type 0 = None, 1 = Generator
16	PB07	dint	0	IN: Power Bus Bar:07 type 0 = None, 1 = Generator
17	PB08	dint	0	IN: Power Bus Bar:08 type 0 = None, 1 = Generator
18	PB09	dint	0	IN: Power Bus Bar:09 type 0 = None, 1 = Generator
19	PB10	dint	0	IN: Power Bus Bar:10 type 0 = None, 1 = Generator
20	PB11	dint	0	IN: Power Bus Bar:11 type 0 = None, 1 = Generator
21	PB12	dint	0	IN: Power Bus Bar:12 type 0 = None, 1 = Generator
22	PB13	dint	0	IN: Power Bus Bar:13 type 0 = None, 1 = Generator
23	PB14	dint	0	IN: Power Bus Bar:14 type 0 = None, 1 = Generator
24	PB15	dint	0	IN: Power Bus Bar:15 type 0 = None, 1 = Generator
25	IO_Input	pmsSNIOPar	pmsNode1.SN_IO_Input	IN: Feedback from synchronizing panel
26	CB_ID	pmsSNCB_ID	pmsNode1.SN_CB_ID	IN: CB Identity for CB with Sync request
27	GNSynPar	pmsGNSNPar	pmsNode1.SN_AllGenSynPar	IN: Connection from Gen Control Modules
28	CBSynPar	pmsCBSNPar	pmsNode1.SN_AllCBSynPar	IN: Connection from CBSync Control Modules
29	ExtPar	pmsSNExtPar	pmsNode1.SN_ExtPar	IN: External Parameters
30	ParamSet	pmsGenDint	pmsNode1.SN_ParamSet	IN EDIT: Fill in corresponding parameter set for selected generator
31	MaxNoGenSelection	dint	4	IN: Maximum number of Generators participating in the sync process
32	FreqLowLimit	real	pmsNode1.SN_FreqLowLimit	IN EDIT: Value of Frequency limit value for spurious powered bus
33	VoltLowLimit	real	pmsNode1.SN_VoltLowLimit	IN EDIT: Value of Voltage limit value for spurious powered bus
34	SynCfgPar	pmsSNCfgPar	pmsNode1.SN_SynCfgPar	IN EDIT: Synchroniser timeout configpar
35	SelectedGen	pmsGenBool	pmsNode1.SN_SelectedGen	OUT: HSI selected generators
36	SynGNPar	pmsSNGNPar	pmsNode1.SyncGNPar	OUT: Connection to Gen Control Modules
37	SyncOperation	bool	pmsNode1.SN_SyncOperation	OUT: Sync operation in progress
38	SynCBPar	pmsSNCBPar	pmsNode1.SN_AllSynCBPar	OUT: Connection to CBSync Control Modules
39	UREF	dint	pmsNode1.SN_UREF	OUT: Indication of reference side (Bus bar ID)
40	UVAR	dint	pmsNode1.SN_UVAR	OUT: Indication of variable side (Power source ID)
41	IO_Output	pmsSNIOPar	pmsNode1.SN_IO_Output	OUT: Commands to synchronizing panel

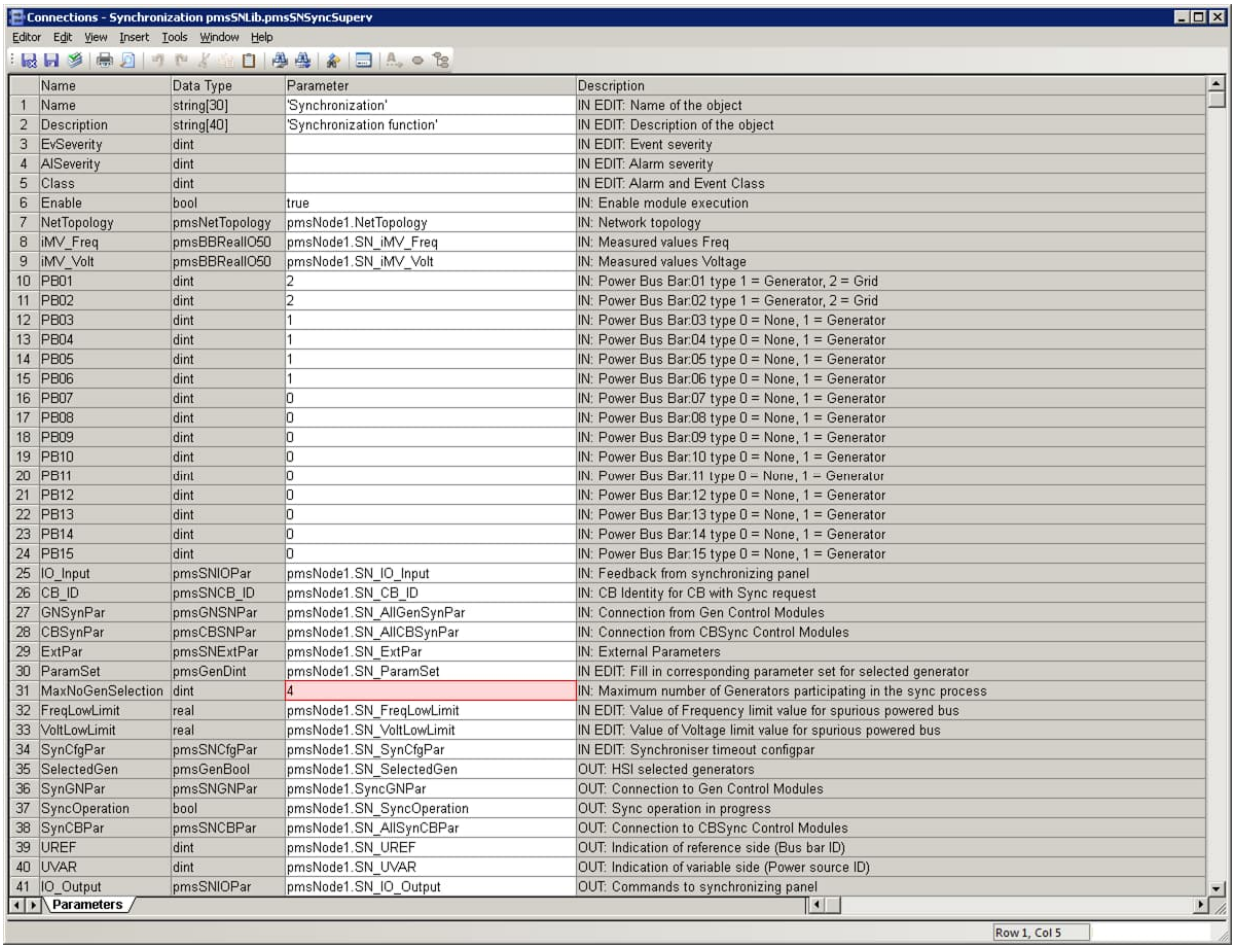
Parameters

Row 1, Col 5

Figure 70 Example of parameter connection ParamSet

7.4.1.8 Connection of MaxNoGenSelection

The parameter *MaxNoGenSelection* shall be used to configure the maximum allowed number of generators sets that can participate in adjusting of voltage/frequency in the synchronization process. This parameter is relevant for the synchronization of a network breaker (e.g. bus coupler) where more machines can participate in adjusting the voltage/frequency on the variable side of the breaker. An example of the necessary connections is shown in Figure 71.



	Name	Data Type	Parameter	Description
1	Name	string[30]	'Synchronization'	IN EDIT: Name of the object
2	Description	string[40]	'Synchronization function'	IN EDIT: Description of the object
3	EvSeverity	dint		IN EDIT: Event severity
4	AlSeverity	dint		IN EDIT: Alarm severity
5	Class	dint		IN EDIT: Alarm and Event Class
6	Enable	bool	true	IN: Enable module execution
7	NetTopology	pmsNetTopology	pmsNode1.NetTopology	IN: Network topology
8	iMV_Freq	pmsBBRealIO50	pmsNode1.SN_iMV_Freq	IN: Measured values Freq
9	iMV_Volt	pmsBBRealIO50	pmsNode1.SN_iMV_Volt	IN: Measured values Voltage
10	PB01	dint	2	IN: Power Bus Bar:01 type 1 = Generator, 2 = Grid
11	PB02	dint	2	IN: Power Bus Bar:02 type 1 = Generator, 2 = Grid
12	PB03	dint	1	IN: Power Bus Bar:03 type 0 = None, 1 = Generator
13	PB04	dint	1	IN: Power Bus Bar:04 type 0 = None, 1 = Generator
14	PB05	dint	1	IN: Power Bus Bar:05 type 0 = None, 1 = Generator
15	PB06	dint	1	IN: Power Bus Bar:06 type 0 = None, 1 = Generator
16	PB07	dint	0	IN: Power Bus Bar:07 type 0 = None, 1 = Generator
17	PB08	dint	0	IN: Power Bus Bar:08 type 0 = None, 1 = Generator
18	PB09	dint	0	IN: Power Bus Bar:09 type 0 = None, 1 = Generator
19	PB10	dint	0	IN: Power Bus Bar:10 type 0 = None, 1 = Generator
20	PB11	dint	0	IN: Power Bus Bar:11 type 0 = None, 1 = Generator
21	PB12	dint	0	IN: Power Bus Bar:12 type 0 = None, 1 = Generator
22	PB13	dint	0	IN: Power Bus Bar:13 type 0 = None, 1 = Generator
23	PB14	dint	0	IN: Power Bus Bar:14 type 0 = None, 1 = Generator
24	PB15	dint	0	IN: Power Bus Bar:15 type 0 = None, 1 = Generator
25	IO_Input	pmsSNIOPar	pmsNode1.SN_IO_Input	IN: Feedback from synchronizing panel
26	CB_ID	pmsSNCB_ID	pmsNode1.SN_CB_ID	IN: CB Identity for CB with Sync request
27	GNSynPar	pmsGNSNPar	pmsNode1.SN_AllGenSynPar	IN: Connection from Gen Control Modules
28	CBSynPar	pmsCBSNPar	pmsNode1.SN_AllCBSynPar	IN: Connection from CBSync Control Modules
29	ExtPar	pmsSNExtPar	pmsNode1.SN_ExtPar	IN: External Parameters
30	ParamSet	pmsGenDint	pmsNode1.SN_ParamSet	IN EDIT: Fill in corresponding parameter set for selected generator
31	MaxNoGenSelection	dint	4	IN: Maximum number of Generators participating in the sync process
32	FreqLowLimit	real	pmsNode1.SN_FreqLowLimit	IN EDIT: Value of Frequency limit value for spurious powered bus
33	VoltLowLimit	real	pmsNode1.SN_VoltLowLimit	IN EDIT: Value of Voltage limit value for spurious powered bus
34	SynCfgPar	pmsSNCfgPar	pmsNode1.SN_SynCfgPar	IN EDIT: Synchroniser timeout configpar
35	SelectedGen	pmsGenBool	pmsNode1.SN_SelectedGen	OUT: HSI selected generators
36	SynGNPar	pmsSNGNPar	pmsNode1.SyncGNPar	OUT: Connection to Gen Control Modules
37	SyncOperation	bool	pmsNode1.SN_SyncOperation	OUT: Sync operation in progress
38	SynCBPar	pmsSNCBPar	pmsNode1.SN_AllSynCBPar	OUT: Connection to CBSync Control Modules
39	UREF	dint	pmsNode1.SN_UREF	OUT: Indication of reference side (Bus bar ID)
40	UVAR	dint	pmsNode1.SN_UVAR	OUT: Indication of variable side (Power source ID)
41	IO_Output	pmsSNIOPar	pmsNode1.SN_IO_Output	OUT: Commands to synchronizing panel

Figure 71 Example of connection for MaxNoGenSelection

The Figure 71 presents an example where the parameter MaxNoGenSelection is assigned to the dint value 4. This indicates that maximum four generator sets can participate in the adjustment of voltage and frequency, on the variable side a of a network breaker network, during the synchronization process.

7.4.1.9 Connection of SelectedGen

The parameter *SelectedGen* provides an indication of which generator set(s) has been selected from the pmsSNSyncSuperv faceplate to participate in the synchronization process. An example of the necessary connections is shown in Figure 72.

Connections - Synchronization pmsSNLib.pmsSNSyncSuperv

Editor Edit View Insert Tools Window Help

	Name	Data Type	Parameter	Description
1	Name	string[30]	'Synchronization'	IN EDIT: Name of the object
2	Description	string[40]	'Synchronization function'	IN EDIT: Description of the object
3	EvSeverity	dint		IN EDIT: Event severity
4	AlSeverity	dint		IN EDIT: Alarm severity
5	Class	dint		IN EDIT: Alarm and Event Class
6	Enable	bool	true	IN: Enable module execution
7	NetTopology	pmsNetTopology	pmsNode1.NetTopology	IN: Network topology
8	iMV_Freq	pmsBBRealIO50	pmsNode1.SN_iMV_Freq	IN: Measured values Freq
9	iMV_Volt	pmsBBRealIO50	pmsNode1.SN_iMV_Volt	IN: Measured values Voltage
10	PB01	dint	2	IN: Power Bus Bar:01 type 1 = Generator, 2 = Grid
11	PB02	dint	2	IN: Power Bus Bar:02 type 1 = Generator, 2 = Grid
12	PB03	dint	1	IN: Power Bus Bar:03 type 0 = None, 1 = Generator
13	PB04	dint	1	IN: Power Bus Bar:04 type 0 = None, 1 = Generator
14	PB05	dint	1	IN: Power Bus Bar:05 type 0 = None, 1 = Generator
15	PB06	dint	1	IN: Power Bus Bar:06 type 0 = None, 1 = Generator
16	PB07	dint	0	IN: Power Bus Bar:07 type 0 = None, 1 = Generator
17	PB08	dint	0	IN: Power Bus Bar:08 type 0 = None, 1 = Generator
18	PB09	dint	0	IN: Power Bus Bar:09 type 0 = None, 1 = Generator
19	PB10	dint	0	IN: Power Bus Bar:10 type 0 = None, 1 = Generator
20	PB11	dint	0	IN: Power Bus Bar:11 type 0 = None, 1 = Generator
21	PB12	dint	0	IN: Power Bus Bar:12 type 0 = None, 1 = Generator
22	PB13	dint	0	IN: Power Bus Bar:13 type 0 = None, 1 = Generator
23	PB14	dint	0	IN: Power Bus Bar:14 type 0 = None, 1 = Generator
24	PB15	dint	0	IN: Power Bus Bar:15 type 0 = None, 1 = Generator
25	IO_Input	pmsSNIOPar	pmsNode1.SN_IO_Input	IN: Feedback from synchronizing panel
26	CB_ID	pmsSNCB_ID	pmsNode1.SN_CB_ID	IN: CB Identity for CB with Sync request
27	GNSynPar	pmsGNSNPar	pmsNode1.SN_AllGenSynPar	IN: Connection from Gen Control Modules
28	CBSynPar	pmsCBSNPar	pmsNode1.SN_AllCBSynPar	IN: Connection from CBSync Control Modules
29	ExtPar	pmsSNExtPar	pmsNode1.SN_ExtPar	IN: External Parameters
30	ParamSet	pmsGenDint	pmsNode1.SN_ParamSet	IN EDIT: Fill in corresponding parameter set for selected generator
31	MaxNoGenSelection	dint	4	IN: Maximum number of Generators participating in the sync process
32	FreqLowLimit	real	pmsNode1.SN_FreqLowLimit	IN EDIT: Value of Frequency limit value for spurious powered bus
33	VoltLowLimit	real	pmsNode1.SN_VoltLowLimit	IN EDIT: Value of Voltage limit value for spurious powered bus
34	SynCfgPar	pmsSNCfgPar	pmsNode1.SN_SynCfgPar	IN EDIT: Synchroniser timeout configpar
35	SelectedGen	pmsGenBool	pmsNode1.SN_SelectedGen	OUT: HSI selected generators
36	SynGNPar	pmsSNGNPar	pmsNode1.SyncGNPar	OUT: Connection to Gen Control Modules
37	SyncOperation	bool	pmsNode1.SN_SyncOperation	OUT: Sync operation in progress
38	SynCBPar	pmsSNCBPar	pmsNode1.SN_AllSynCBPar	OUT: Connection to CBSync Control Modules
39	UREF	dint	pmsNode1.SN_UREF	OUT: Indication of reference side (Bus bar ID)
40	UVAR	dint	pmsNode1.SN_UVAR	OUT: Indication of variable side (Power source ID)
41	IO_Output	pmsSNIOPar	pmsNode1.SN_IO_Output	OUT: Commands to synchronizing panel

Parameters

Row 1, Col 5

Figure 72 Example of connection SelectedGen

The parameter can be used for any external application logic needed for configuring the synchronization function.

7.4.1.10 Connection of FreqLowLimit and VoltLowLimit

The parameters *FreqLowLimit* and *VoltLowLimit* shall be used for configuring the alarm limit settings for the spurious dead bus and spurious powered bus alarms. An example of the necessary connections is shown in Figure 73.

Connections - Synchronization pmsSNLib.pmsSNSyncSuperv

Editor Edit View Insert Tools Window Help

	Name	Data Type	Parameter	Description
1	Name	string[30]	'Synchronization'	IN EDIT: Name of the object
2	Description	string[40]	'Synchronization function'	IN EDIT: Description of the object
3	EvSeverity	dint		IN EDIT: Event severity
4	AlSeverity	dint		IN EDIT: Alarm severity
5	Class	dint		IN EDIT: Alarm and Event Class
6	Enable	bool	true	IN: Enable module execution
7	NetTopology	pmsNetTopology	pmsNode1.NetTopology	IN: Network topology
8	iMV_Freq	pmsBBRealIO50	pmsNode1.SN_iMV_Freq	IN: Measured values Freq
9	iMV_Volt	pmsBBRealIO50	pmsNode1.SN_iMV_Volt	IN: Measured values Voltage
10	PB01	dint	2	IN: Power Bus Bar:01 type 1 = Generator, 2 = Grid
11	PB02	dint	2	IN: Power Bus Bar:02 type 1 = Generator, 2 = Grid
12	PB03	dint	1	IN: Power Bus Bar:03 type 0 = None, 1 = Generator
13	PB04	dint	1	IN: Power Bus Bar:04 type 0 = None, 1 = Generator
14	PB05	dint	1	IN: Power Bus Bar:05 type 0 = None, 1 = Generator
15	PB06	dint	1	IN: Power Bus Bar:06 type 0 = None, 1 = Generator
16	PB07	dint	0	IN: Power Bus Bar:07 type 0 = None, 1 = Generator
17	PB08	dint	0	IN: Power Bus Bar:08 type 0 = None, 1 = Generator
18	PB09	dint	0	IN: Power Bus Bar:09 type 0 = None, 1 = Generator
19	PB10	dint	0	IN: Power Bus Bar:10 type 0 = None, 1 = Generator
20	PB11	dint	0	IN: Power Bus Bar:11 type 0 = None, 1 = Generator
21	PB12	dint	0	IN: Power Bus Bar:12 type 0 = None, 1 = Generator
22	PB13	dint	0	IN: Power Bus Bar:13 type 0 = None, 1 = Generator
23	PB14	dint	0	IN: Power Bus Bar:14 type 0 = None, 1 = Generator
24	PB15	dint	0	IN: Power Bus Bar:15 type 0 = None, 1 = Generator
25	IO_Input	pmsSNIOPar	pmsNode1.SN_IO_Input	IN: Feedback from synchronizing panel
26	CB_ID	pmsSNCB_ID	pmsNode1.SN_CB_ID	IN: CB Identity for CB with Sync request
27	GNSynPar	pmsGNSNPar	pmsNode1.SN_AllGenSynPar	IN: Connection from Gen Control Modules
28	CBSynPar	pmsCBSNPar	pmsNode1.SN_AllCBSynPar	IN: Connection from CBSync Control Modules
29	ExtPar	pmsSNExtPar	pmsNode1.SN_ExtPar	IN: External Parameters
30	ParamSet	pmsGenDint	pmsNode1.SN_ParamSet	IN EDIT: Fill in corresponding parameter set for selected generator
31	MaxNoGenSelection	dint	4	IN: Maximum number of Generators participating in the sync process
32	FreqLowLimit	real	pmsNode1.SN_FreqLowLimit	IN EDIT: Value of Frequency limit value for spurious powered bus
33	VoltLowLimit	real	pmsNode1.SN_VoltLowLimit	IN EDIT: Value of Voltage limit value for spurious powered bus
34	SynCfgPar	pmsSNCfgPar	pmsNode1.SN_SynCfgPar	IN EDIT: Synchroniser timeout configpar
35	SelectedGen	pmsGenBool	pmsNode1.SN_SelectedGen	OUT: HSI selected generators
36	SynGNPar	pmsSNGNPar	pmsNode1.SyncGNPar	OUT: Connection to Gen Control Modules
37	SyncOperation	bool	pmsNode1.SN_SyncOperation	OUT: Sync operation in progress
38	SynCBPar	pmsSNCBPar	pmsNode1.SN_AllSynCBPar	OUT: Connection to CBSync Control Modules
39	UREF	dint	pmsNode1.SN_UREF	OUT: Indication of reference side (Bus bar ID)
40	UVAR	dint	pmsNode1.SN_UVAR	OUT: Indication of variable side (Power source ID)
41	IO_Output	pmsSNIOPar	pmsNode1.SN_IO_Output	OUT: Commands to synchronizing panel

Parameters

Row 1, Col 5

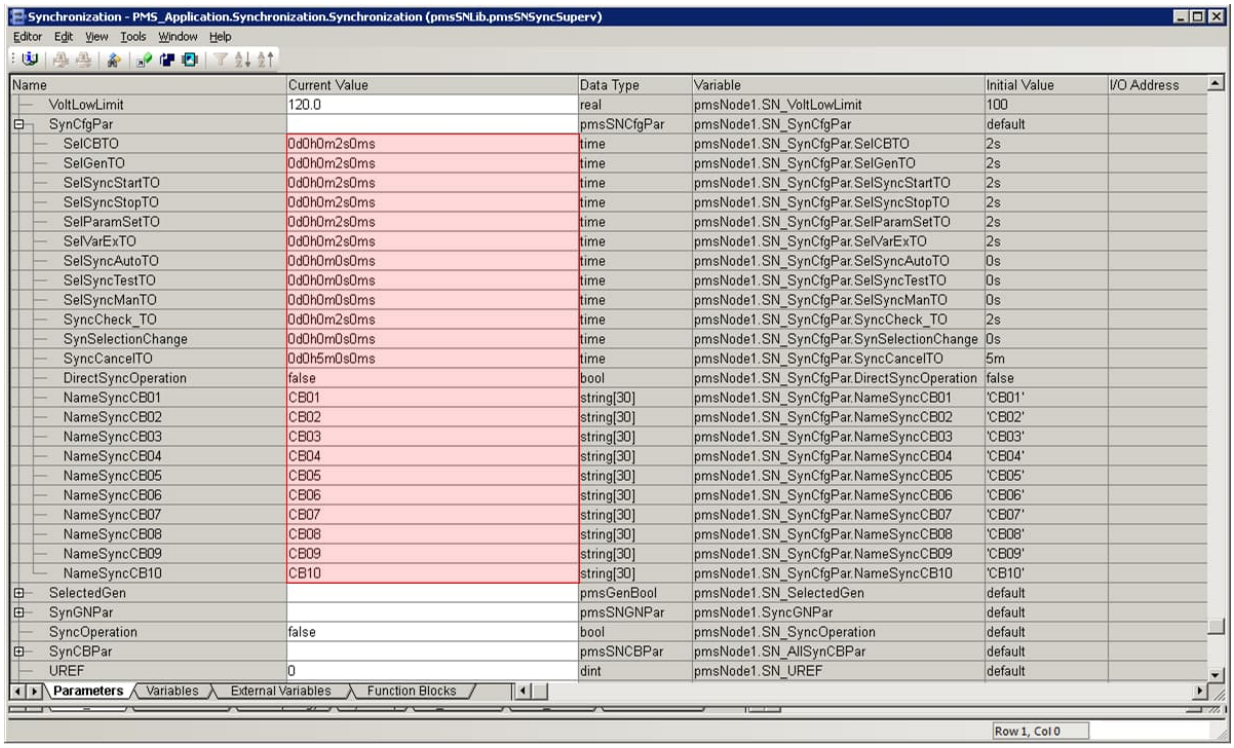
Figure 73 Example of connection FreqLowLimit and VoltLowLimit

The variables pmsNode1.SN_FreqLowLimit and pmsNode1.SN_VoltLowLimit, from the example in Figure 73, are configured with initial values of 40 and 110 (for frequency and voltage respectively) as shown in Figure 50. When the network determination detects a de-energized contingency with frequency>40Hz or voltage>110kV, the spurious powered bus alarm will be generated. When the network determination detects an energized contingency with frequency<40Hz or voltage<110kV, the spurious dead bus alarm will be generated.

To disable spurious dead bus and spurious powered bus alarms where project does not have frequency and voltage measurements, temporary setting iMV_Freq\Volt values for the busbars missing measurements will solve the problem. Caution is advised.

7.4.1.11 Connection of SynCfgPar

The parameter *SynCfgPar* shall be used for configuring time delay settings for the feedbacks received from the synchronization equipment and the selection relays. An example of the necessary settings is shown in Figure 74.



Name	Current Value	Data Type	Variable	Initial Value	I/O Address
VoltLowLimit	120.0	real	pmsNode1.SN_VoltLowLimit	100	
SynCfgPar		pmsSNCfgPar	pmsNode1.SN_SynCfgPar	default	
SelCBTO	0d0h0m2s0ms	time	pmsNode1.SN_SynCfgPar.SelCBTO	2s	
SelGenTO	0d0h0m2s0ms	time	pmsNode1.SN_SynCfgPar.SelGenTO	2s	
SelSyncStartTO	0d0h0m2s0ms	time	pmsNode1.SN_SynCfgPar.SelSyncStartTO	2s	
SelSyncStopTO	0d0h0m2s0ms	time	pmsNode1.SN_SynCfgPar.SelSyncStopTO	2s	
SelParamSetTO	0d0h0m2s0ms	time	pmsNode1.SN_SynCfgPar.SelParamSetTO	2s	
SelVarExTO	0d0h0m2s0ms	time	pmsNode1.SN_SynCfgPar.SelVarExTO	2s	
SelSyncAutoTO	0d0h0m0s0ms	time	pmsNode1.SN_SynCfgPar.SelSyncAutoTO	0s	
SelSyncTestTO	0d0h0m0s0ms	time	pmsNode1.SN_SynCfgPar.SelSyncTestTO	0s	
SelSyncManTO	0d0h0m0s0ms	time	pmsNode1.SN_SynCfgPar.SelSyncManTO	0s	
SyncCheck_TO	0d0h0m2s0ms	time	pmsNode1.SN_SynCfgPar.SyncCheck_TO	2s	
SynSelectionChange	0d0h0m0s0ms	time	pmsNode1.SN_SynCfgPar.SynSelectionChange	0s	
SyncCancelTO	0d0h5m0s0ms	time	pmsNode1.SN_SynCfgPar.SyncCancelTO	5m	
DirectSyncOperation	false	bool	pmsNode1.SN_SynCfgPar.DirectSyncOperation	false	
NameSyncCB01	CB01	string[30]	pmsNode1.SN_SynCfgPar.NameSyncCB01	'CB01'	
NameSyncCB02	CB02	string[30]	pmsNode1.SN_SynCfgPar.NameSyncCB02	'CB02'	
NameSyncCB03	CB03	string[30]	pmsNode1.SN_SynCfgPar.NameSyncCB03	'CB03'	
NameSyncCB04	CB04	string[30]	pmsNode1.SN_SynCfgPar.NameSyncCB04	'CB04'	
NameSyncCB05	CB05	string[30]	pmsNode1.SN_SynCfgPar.NameSyncCB05	'CB05'	
NameSyncCB06	CB06	string[30]	pmsNode1.SN_SynCfgPar.NameSyncCB06	'CB06'	
NameSyncCB07	CB07	string[30]	pmsNode1.SN_SynCfgPar.NameSyncCB07	'CB07'	
NameSyncCB08	CB08	string[30]	pmsNode1.SN_SynCfgPar.NameSyncCB08	'CB08'	
NameSyncCB09	CB09	string[30]	pmsNode1.SN_SynCfgPar.NameSyncCB09	'CB09'	
NameSyncCB10	CB10	string[30]	pmsNode1.SN_SynCfgPar.NameSyncCB10	'CB10'	
SelectedGen		pmsGenBool	pmsNode1.SN_SelectedGen	default	
SynGNPar		pmsSNGNPar	pmsNode1.SyncGNPar	default	
SyncOperation	false	bool	pmsNode1.SN_SyncOperation	default	
SynCBPar		pmsSNCBPar	pmsNode1.SN_AllSynCBPar	default	
UREF	0	dint	pmsNode1.SN_UREF	default	

Figure 74 Example of parameter connection SynCfgPar

The example in Figure 74 shows the variable *pmsNode1.SN_SynCfgPar* in on-line mode and the various configuration settings for the allowed time delay between issuing a command and receiving the respective feedback, for the direct synchronization feature and for the string names of the circuit breaker selection events.

Appendix A Revision table

Rev. ind.	*Page (P) / Chapter ©*	*Description*	*Date*
A		Initial document release for 5.6-5	2022.08.30/KAA

Contact us

ABB AS
PA Energy Industries
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ABB Oil and Gas

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