RELION® 630 SERIES

Power Management PML630/Compact Load-Shedding Solution

Product Guide

Contents

1. Description

PML630 is a power management device that provides comprehensive load-shedding solution for the power network in an industrial plant. It protects the plant against blackouts and power source outages due to system disturbances. PML630 is a member of ABB's Relion® product family and a part of its 630 series characterized by their functional scalability and flexible configurability.

PML630 complies to IEC 61850 and offers seamless connectivity with Relion 630, 620 and 615 series protection relays, RIO600 IO units and COM600 to realize the load-shedding functionality. The device uses GOOSE and MMS communication profiles for I/O data exchange with other Relion product family protection relays and COM600 series products.

2. Power management systems

Power Management Systems (PMS) is essential for a safe, efficient and reliable operation of a power system within an industrial complex. The PMS functionality suite includes load-shedding, generator control, power sharing, network synchronization and power restoration.

PMS solutions protect and optimize the stability of industrial systems against disturbances by ensuring power sharing between generators when the industrial power system is islanded from the grid. These solutions also ensure that the generators meet the required power demand when the network is grid-connected. By ensuring fast acting load-shedding action, generator tripping can be avoided and thereby facilitating possible islanding of the network.

PMS solutions are suitable for industrial power networks.

- With captive power generation - islanded or grid-connected
- With substantial and critical loads
- With unstable grid connectivity
- Without grid connectivity

The PMS functionality suite is applicable in various industrial segments. Some of the industrial segments are Oil and Gas, Marine, Pulp and Paper, Metals, Minerals, Building automation, Infrastructure, Food and Beverage. In power utilities, load-shedding application is particularly relevant.

3. Load-shedding

Load-shedding is required when the electrical load demand exceeds the capacity of available power sources subsequent to the loss of power sources or network disintegration. The load-shedding system has to ensure the availability of electrical power to all essential and, most importantly, critical loads in the plant. This is achieved by switching off the non-essential loads in case of a lack of power in the electrical network or parts of the electrical network (subnetwork or island).

The load-shedding functionality can also be deployed in industrial power networks with sole dependency on the utility networks.

The lack of electrical power can be caused by a loss of generation capacity or power grid connectivity or the tie line feeding power to the plant.

Based on the shortfall of available power in the power network, the load-shedding action initiated by the system ensures that only identified loads are shed, system is stable after load-shedding and impact on the associated plant operation is minimal. The system allows flexibility to select or deselect the load feeders to be load-shed at any point in time during plant operation.

Furthermore, the load-shedding function should not operate if the situation in the power network does not necessitate such an action. Thus, it has to be accurate and selective.

4. Application

PML630 provides system level protection to small or medium-sized industrial systems from the system disturbances. The device supports different modes of load-shedding functions.

- Fast load-shedding
- Slow (overload or maximum demand violation-based) load-shedding
- Manual load-shedding
- Underfrequency load-shedding as a backup to fast and slow load-shedding

A network power deficit occurs when a power source such as a generator or a grid transformer trips. There could also be a power shortage when a network becomes isolated due to trip of a bus coupler or a bus tie breaker. The fast load-shedding function protects the power network during a power deficit.

The fast load-shedding function takes corrective action before the system frequency [1] drop and provides faster and accurate load-shedding action based on the power balance calculations and defined priorities. Thus, the function also contributes towards faster improvement of the frequency profile of the system.

The slow load-shedding function prevents the tripping of a power source during an overload condition. The slow (overload) load-shedding function triggers the load-shedding and resets the overload condition by acting faster than the dedicated overload protection function for the power sources. The overload situation can arise due to the overcurrent detection in a generator or grid transformer, or maximum demand violation at the power grid incomer for a specified period of time. Based on the amount of the overload, the slow load-shedding function determines the required load to be shed and uses the power

[1] A frequency-based load-shedding scheme, at the feeder level, acts based on the frequency drop caused by a power deficit. It triggers the shedding of loads based on the preset rate of change of the frequency or the discreet frequency value settings in their respective devices. It can sometimes result in excessive load-shedding.

balance calculations for arriving at the load-shedding priority and to initiate the load-shedding action.

Using the manual load-shedding function, the load-shedding of multiple load feeders can be initiated based on priorities or the required total power relief.

The underfrequency-based load-shedding function detects frequency decay and activates the shedding mechanism described for fast and manual load-shedding functions.

All load-shedding functions can be active concurrently.

5. Communication

PML630 only supports the IEC 61850 substation communication standard and its GOOSE and MMS communication profiles.

PML630 is optimized to interoperate with REF615, REG615, REM615, RET615, REF620, REM620, RET620, REF630, REG630, REM630, RET630, RIO600 and COM600S or COM600F. All the load-shedding operational and control information is exchanged over IEC 61850 GOOSE and MMS. Other ABB IEC 61850 devices, such as Relion 670/650 series intelligent electronic devices (IEDs) and AC800M, and HMI systems like MicroSCADA, System 800xA, can also be integrated into the solution cluster. However, PML630 can also be made to interoperate with any non-ABB or third-party IEC 61850 devices, provided they are able to meet the functional requirements for load-shedding.

Disturbance files in COMTRADE file format can also be accessed using the IEC 61850 standard's MMS file transfer services or any standard protocol like FTP. PML630 exchanges analog and binary signal information with the mentioned devices and IO units (horizontal communication) using the GOOSE profile. It meets the GOOSE performance requirements for tripping applications (Type 1A, performance class 1) like load-shedding in distribution substations, as defined by the IEC 61850 standard. PML630 can also interoperate with other IEC 61850-compliant devices, tools and systems and simultaneously report events to five different clients on the IEC 61850 station bus. It is connected to Ethernet-based communication systems via the RJ-45 connector (10/100BASE-TX) or the fibre-optic multimode LC connector (100BASE-FX).

The GOOSE communication profile for load-shedding offers several advantages.

- Minimal or no hardwiring between panels
  - Substation LAN can be used as the transmission medium of binary and analog process data between devices.
  - Less I/O hardware in devices
  - Lesser maintenance costs (due to lesser wiring diagrams, terminal blocks and connections)
  - Better predictability in the system or functionality verification
- Fast and reliable station bus for data transfer offered by Ethernet LAN technology
- Fast performance enabled by GOOSE.
  - No need for additional signal processing, for example, intermediate interposing relays, filtering and flutter suppressions in binary signal transfer.
  - Much faster binary signal transfer between devices than with conventional hardwiring
  - High performance
- Supervision of signals being transferred over GOOSE for data integrity (based on, for example, quality and communication status)

6. Network architecture for cPMS load-shedding Configuration A

The integrated approach with PML630, 620, 630 or 615 series feeder protection relays, RIO600 IO units and COM600S or COM600F to realize load-shedding power management solution is designated as cPMS (Compact Power Management System) load-shedding Configuration A. The cPMS load-shedding Configuration A is also a functionality feature in PML630.

The load-shedding network architecture consists of devices, their functional organization and inter-device communication.

PML630 performs load-shedding actions based on the binary and measurement data it receives from the protection relays or IO unit (RIO600) associated with generator feeders, grid transformer feeders, motor or load feeders, bus coupler feeders and bus tie feeders.

Using RIO600, non-IEC 61850 based feeders can be easily adapted for the load-shedding functionality. All the binary IO signals and the transducer inputs can be connected to RIO600. Furthermore, the data exchange between PML630 and RIO600 is based on GOOSE like 630 and 615 series protection relays.

After making a decision to take load-shedding action, PML630 sends shedding commands to motor or load feeders through their respective devices. The load-shed commands, when issued through the Relion protection relays or RIO600, can either be used to directly trip the circuit breaker or extended using auxiliary relays.

COM600 series product monitors and controls the load-shedding and substation operations. This is realized over the IEC 61850 MMS communication between COM600S or COM600F and PML630 and feeder protection relays. Since RIO600 supports only GOOSE, it may be appropriate to have the GOOSE communication association between RIO600 and COM600S or COM600F.

The load-shedding functionality information can be exchanged with any external system using the communication gateway features of COM600S or COM600F. See the COM600S or COM600F product documentation for more details.

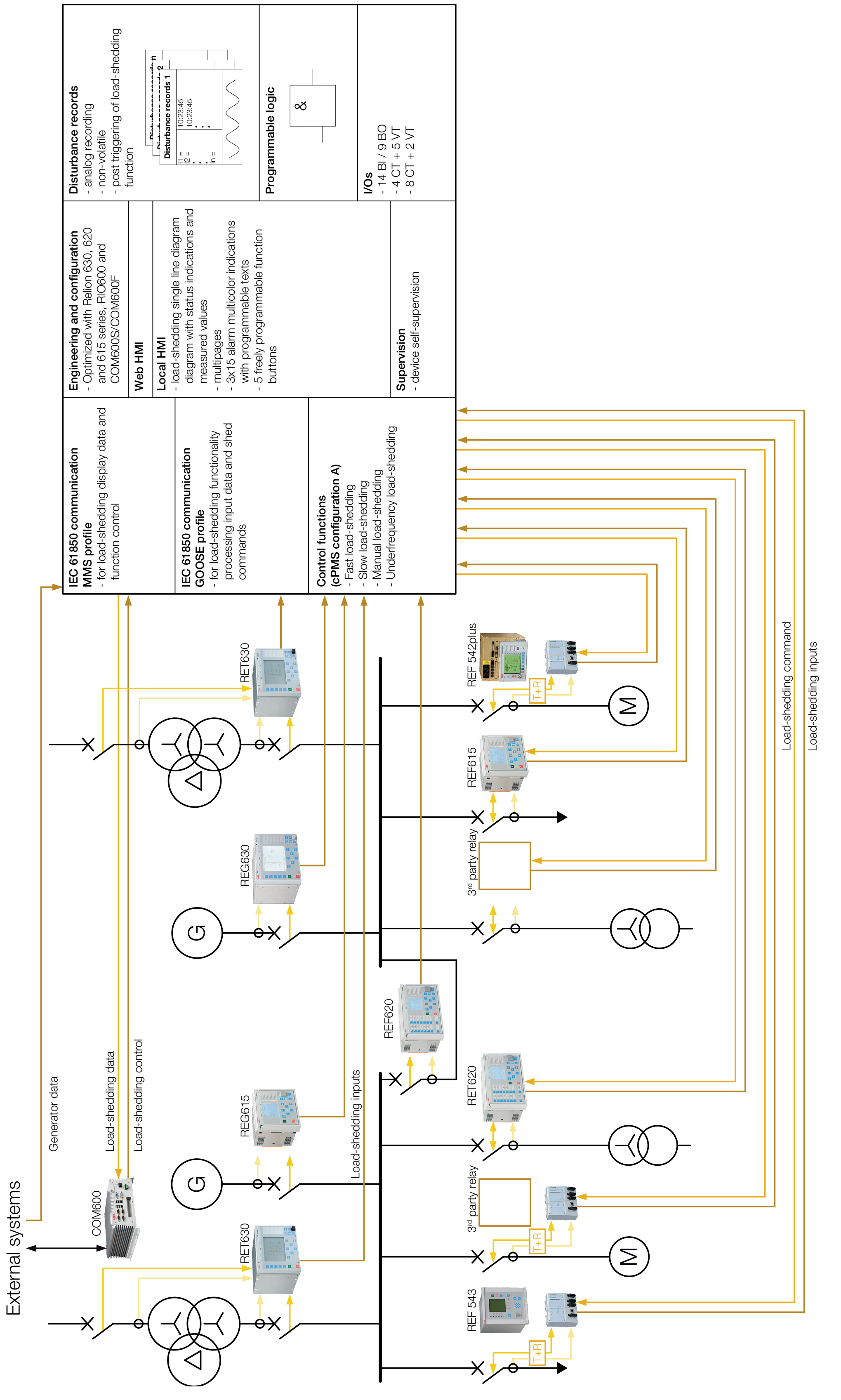

Figure 1. cPMS load-shedding Configuration A functionality overview

7. Terminology

The terminology in a cPMS load-shedding Configuration A solution is described using an example of a simple power network.

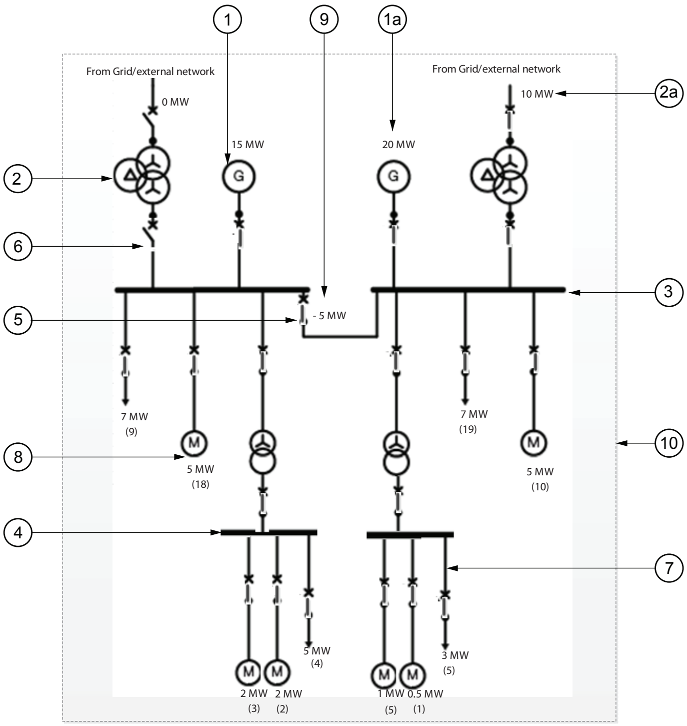

Figure 2. Terminology

1	Power source - Generator
1a	Generator Available Power (capacity)
2	Power source - Grid transformer
2a	Grid Available Power (power limit)
3	Power busbars with power sources and loads
4	Load busbars with only load feeders
5	Network circuit breaker (critical circuit breaker)
6	Power source circuit breaker (critical circuit breaker)
7	Load-shedding feeder or load-shedding group
8	Load-shedding priority for load feeder
9	Power flow direction
10	Power network area (under PML630's load-shedding responsibility)

8. Power network configuration support in cPMS load-shedding Configuration A

PML630 can support power networks certain configurations.

- Six generators
- Two power grid utility connectivity (tie or transformer feeder)
- Six single busbars
- Four subnetworks with power sources

The grid feeder 1 can be connected to the power busbar 1 and the grid feeder 2 can be connected to the power busbar 1 or 2.

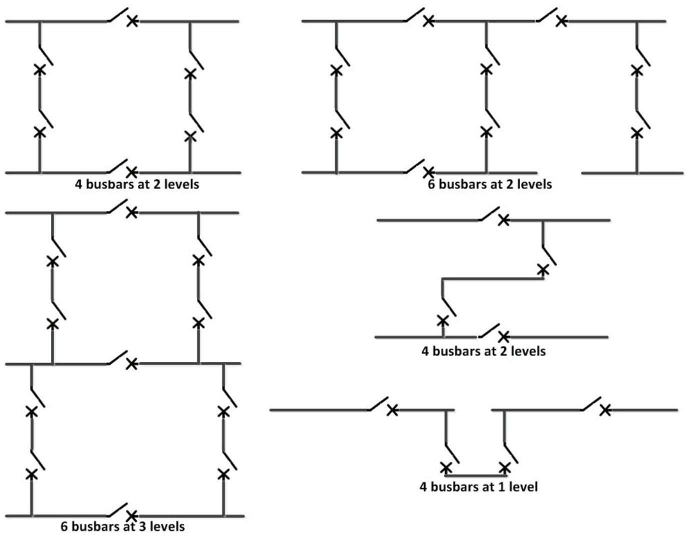

Figure 3. Typical busbar configurations (not preconfigured)

PML630 can support a power network under certain conditions.

- 23 critical circuit breakers consisting of eight power source circuit breakers and 15 equivalent bus coupler/bus tie network circuit breakers. For example, two circuit breakers at either end of a bus tie feeder are considered as a single equivalent bus tie feeder.
- 60 sheddable loads or load-shedding groups arranged across six busbars (four power busbars and two load busbars) with individual load-shedding priorities.
- 10 sheddable loads or load-shedding groups in a single busbar.
- 19 user-assignable load priorities.

A load-shedding group can be considered if the number of load feeders connected to a busbar exceeds 10. The maximum recommended number of feeders under a load-shedding group is three.

9. Configuration flexibility

The configuration aspects provide flexibility in the allocation of power sources (grid transformers and generators) depending on the project requirements.

Connectivity from a power network to a utility grid or other power networks can be achieved through the grid 1 or grid 2 power sources.

If the number of loads in a bus bar exceeds 10 and the number of busbars is less than six, an additional busbar with a virtual bus coupler (permanently closed status) can be configured. The load feeders can be distributed across the two bus bars.

Additional binary and arithmetic logic can be realized for tailoring the load-shedding functionality towards customer-specific requirements.

10. Network configuration for cPMS load-shedding Configuration B

When the power network configuration exceeds the limits defined for PML630 in Configuration A, an additional PML630 device can be configured in a peer-to-peer fashion, thereby dividing the network into sectors called power network areas. Hence, each PML630 is responsible for the load-shedding action in its respective area, based on the power source capabilities and the inter-power network area connectivity status. The coordination of the load-shedding actions between the PML630 devices is achieved by suitable parametrization. This arrangement of multiple PML630 devices in a peer-to-peer fashion is designated as cPMS load-shedding Configuration B.

The PML630 devices communicate with each other over IEC 61850 GOOSE.

Likewise, the cPMS load-shedding Configuration B is also a feature in PML630. The Configuration B is always built up over and above the Configuration A and hence the latter is a prerequisite.

The maximum recommended number of PML630 devices in the peer-to-peer mode in a Configuration B is three.

The power network areas are connected to each other through their grid 1 or grid 2 feeder connection points.

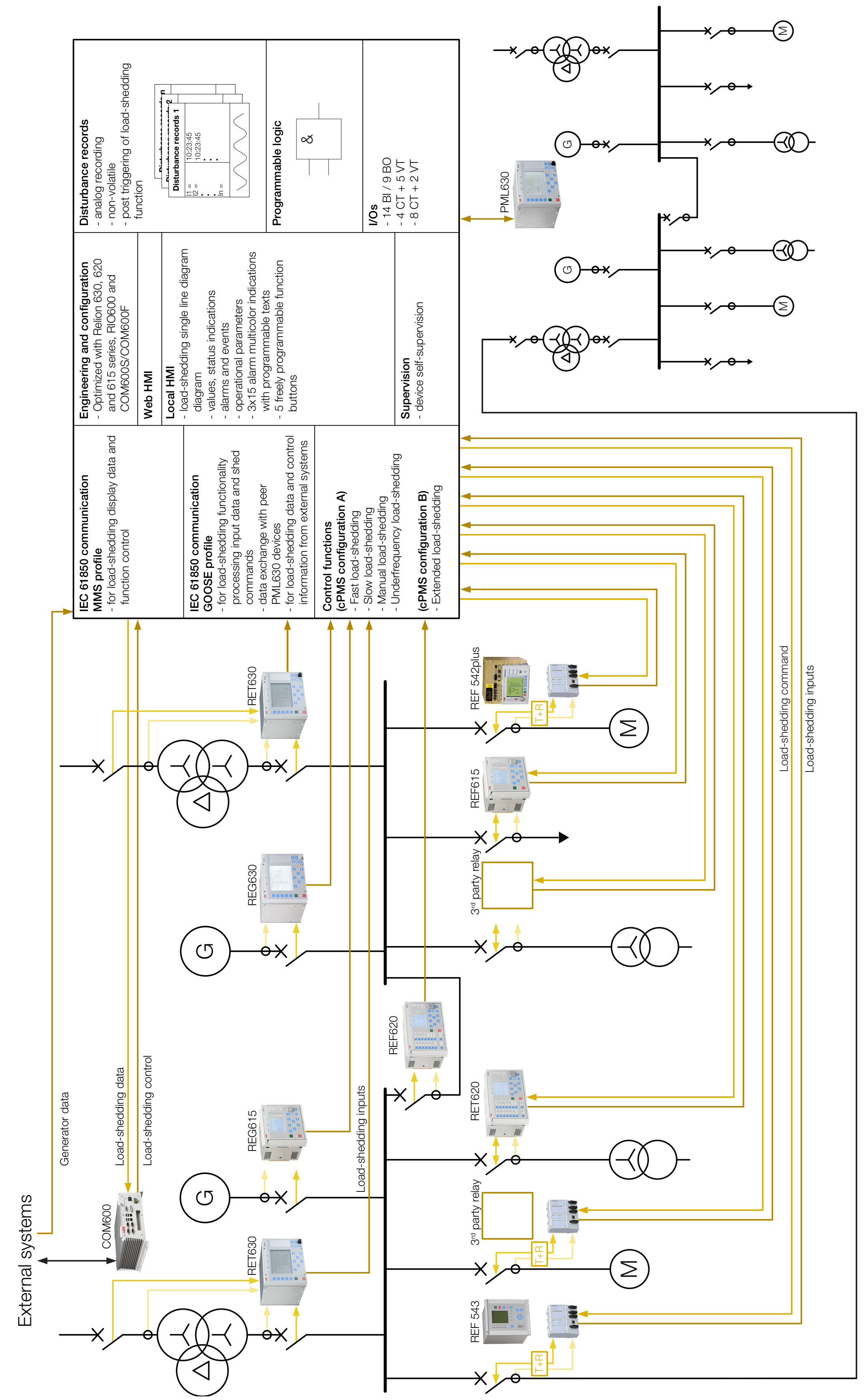

Figure 4. cPMS load-shedding Configuration B functionality overview

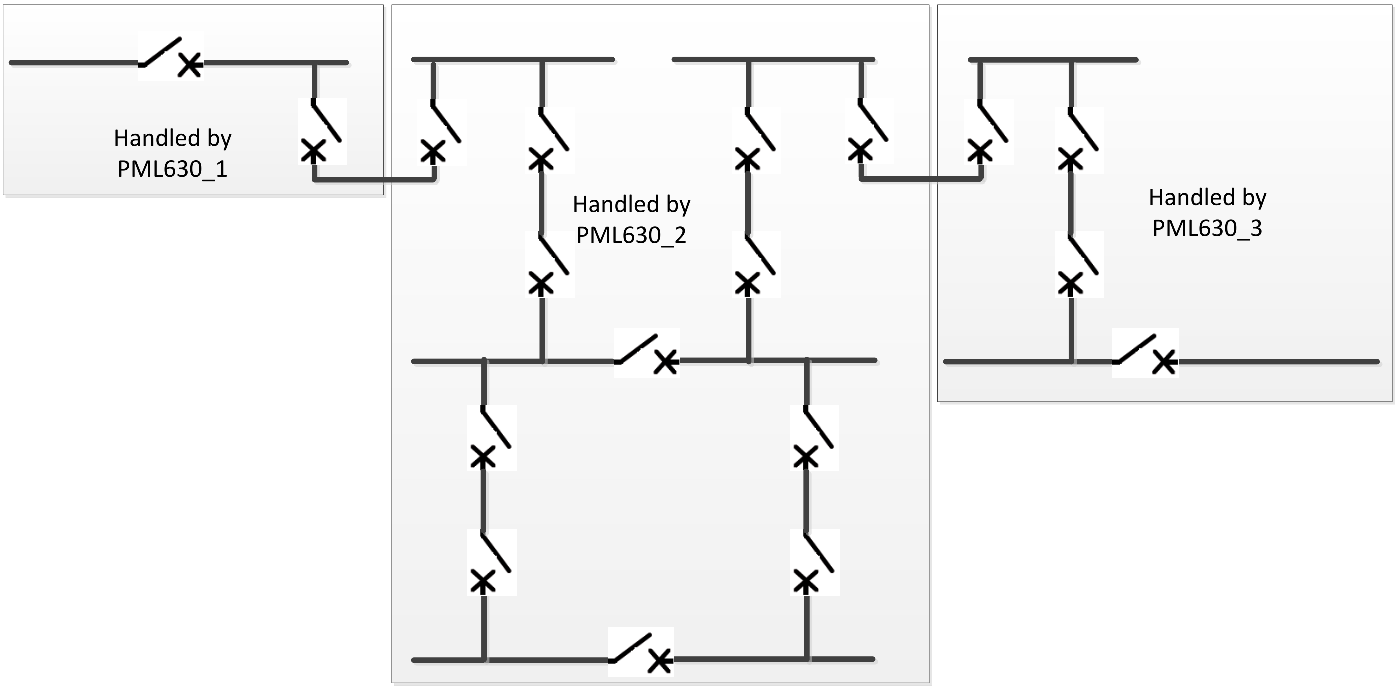

Figure 5. Busbar arrangement

11. Communication architecture support

In a cPMS load-shedding configuration A with the maximum number of feeders, PML630 can be simultaneously associated with almost 100 devices (8 power source devices, 60 load feeder devices, 30 tie feeder breaker devices, 1 COM600 series product, 1 external controller such as AC800M) in cPMS load-shedding configuration A and additionally 2 devices (peer PML630 devices) in cPMS load-shedding configuration B. This is based on the assumption of one device (630, 620 or 615 series or RIO600) per feeder and COM600 IEC 61850 proxy server [1].

The feeder devices can further be classified into eight power source devices, 15 or more equivalent network circuit breaker [2] devices and at least 60 load feeder devices configured as standalone loads or in load-shedding groups. For configurations of about 40 devices, COM600S or COM600F can be used for station automation and load-shedding HMI functions. For configurations exceeding 40 devices, MicroSCADA (SYS600) can be used for substation automation HMI function and COM600S or COM600F for load-shedding HMI function.

In such a situation, the COM600S or COM600F web page displays can be configured to be accessed from the MicroSCADA (SYS600) workplace. The COM600S or COM600F displays for load-shedding are automatically configured during the PML630 configuration process.

In case COM600S or COM600F is not opted as the HMI, then all the load-shedding process displays need to be configured manually in the MicroSCADA (SYS600) or 800xA (Aspect Server) HMI nodes. Parameter setting for manual load-shedding and reporting of binary information from RIO600 unit requires IEC 61850 GOOSE handling in the HMI.

In a redundant configuration, two PML630 devices with identical configurations can execute the load-shedding functionality independently. All feeder devices are configured to communicate simultaneously with both PML630 devices over IEC 61850 GOOSE.

12. System protection and control functions

Network topology determination

In Configuration A, PML630 acquires the status of all the power source and network circuit breakers in its own power network area and determines the subnetwork arrangements (1...4). Accordingly, the busbars are allocated to a particular subnetwork.

[1] Used for manual load-shedding

[2] A tie feeder has two circuit breakers on either ends controlled by two protection relays

If the busbar 3 is connected to the busbar 1, it is a part of the subnetwork 1. Similarly, if the busbar 4 is connected to the busbar 2, it is a part of the subnetwork 2. If all of them are connected together, the busbars 2,3 and 4 belong to the subnetwork 1. This information is displayed in the subnetwork display page on COM600S or COM600F.

In Configuration B, when an adjacent area is connected through the remote-end tie feeder circuit breaker to the power network area under consideration, the information from the adjacent area is considered for the load-shedding calculations by its PML630 device. In case the tie feeder opens, the power networks are automatically moved into the Configuration A mode by their respective PML630 devices.

One subnetwork within a power network area (under one PML630) can be in the Configuration B mode when it is connected to the adjacent power network area (controller by another PML630), while another isolated subnetwork can be in the Configuration A mode.

Fast load-shedding for Configuration A

The fast load-shedding function protects the network during a power deficit. A network power deficit occurs when a generator, a grid transformer, a bus coupler or a bus tie feeder circuit breaker trips. The fast load-shedding function can monitor a maximum of four independent power networks. During the power deficit in one of the networks, PML630 performs power balance calculations and arrives at a load-shedding priority. It issues shedding commands to the loads with priority less than or equal to the calculated priority.

In case of the cPMS load-shedding Configuration B, each PML630 considers the spinning reserve information from the adjacent power network area (sent by the peer PML630) and considers the same available power values along with the power sources from its own power network area for the overall power balance calculations.

In Figure 6 configuration example, when AB, AC, BD and CD connections are open, four subnetworks or power networks are formed and when they are closed, a single subnetwork is formed.

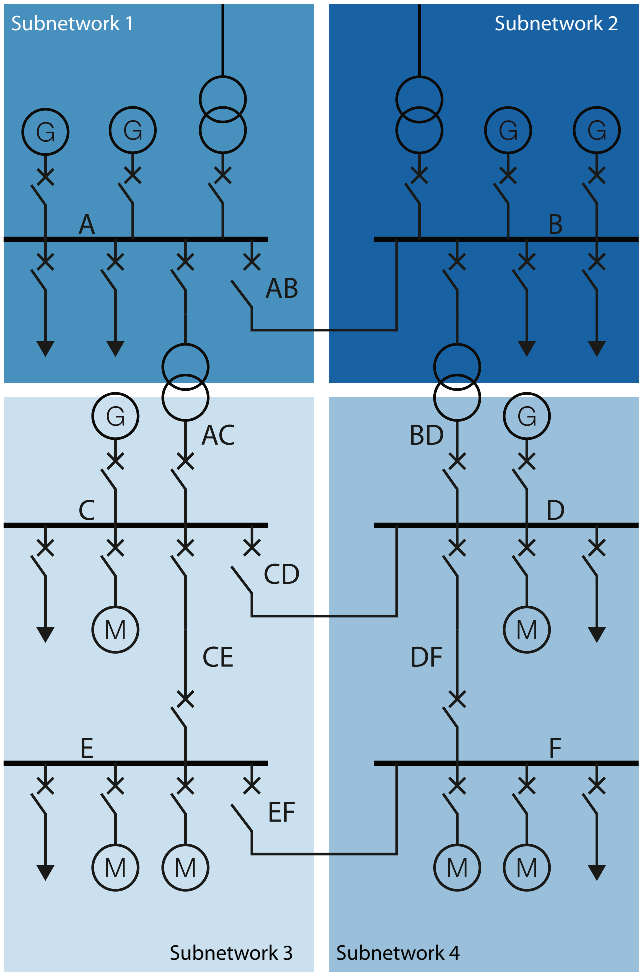

Figure 6. **Example of subnetwork formation in a power network area for cPMS load-shedding Configuration A**

In cPMS load-shedding Configuration A, the fast load-shedding function monitors the available power from the power sources based on their capability against the power consumption and performs the power balance calculation for each subnetwork using the following equation.

(*ΣPower available from generators including spinning reserve* + *ΣPower utility connection capacity*) ≥ (*ΣPower actual from generators* + *ΣPower actual drawn from grid*) + *ΣPower of inhibited* (*system or operator*) *or non-sheddable loads*)

For the power balance calculation in cPMS load-shedding Configuration B, ensure conformity with the following equation.

(*ΣPower available from generators including spinning reserve* + *ΣPower spinning reserve from generators from connected adjacent area* + *ΣPower utility connection capacity*) ≥ (*ΣPower actual from generators* + *ΣPower actual drawn from grid* + *ΣPower of inhibited* (*system or operator*) *or non-sheddable loads*)

If the above conditions are not met, load-shedding is initiated.

ΣPower available from generators = ΣPower actual generated + Σspinning reserve
ΣPower utility connection capacity = ΣPower actually drawn from grid + Σadditional drawing limit (*based on contractual conditions*)

- $\Sigma P_{spinning\ reserve}$ is the total reserve capacity of all the generators in the subnetwork. This depends on the ambient temperature and the capability of a generator and its working mode. The generator (governor) working mode and capability information can be either set as parameters or acquired from an external device or system over IEC 61850 GOOSE [1].
- $\Sigma P_{actual\ from\ generators}$ and $\Sigma P_{drawn\ from\ grid}$ equal the load consumption in the subnetwork.
- $\Sigma P_{inhibited\ loads}$ is the total power consumption of the load feeders that do not participate in the load-shedding due to intended operator action or an automatic system action or not configured for load-shedding or an overall difference between the power measurements from the sources and the loads.

PML630's fast load-shedding function performs actions in the power network cPMS load-shedding Configuration A.

- Builds subnetwork-wise dynamic load tables and power network information for display in COM600S or COM600F.

PML630 identifies certain events as critical signals for initiating the power balance calculation.

- Opening of a generator feeder or a grid transformer feeder circuit breaker
- Opening of a bus coupler feeder or a tie line (network) circuit breaker in its own power network area or from the (remote-end tie feeder circuit breaker) adjacent power network area.
- Protection lockout function operation of a critical circuit breaker.
- Lockout function operation of a generator turbine.
- External input-based trigger that reflects an abnormal situation like undervoltage condition. The external trigger is effective only when there is power deficit in the subnetwork like the other fast-load shed triggers.

The spinning reserve sharing during the power export conditions at the grid 1 or grid 2 feeders can be based on the criticality and the strength of the power network area to which power is exported.

- If one power network area exports power to an adjacent power network area, the load-shedding can be configured to be done in the strong power network based on the available power and thus continuing the power export.
- If the recipient power network area has sufficient capability, the load-shedding can be configured to be done in that power network area itself depending on the available power.

Fast load-shedding for Configuration B

Coordination between peer PML630 devices

In Configuration B, the spinning reserve power sharing and the load-shedding action information across the power network areas are exchanged between the peer PML630 devices.

The spinning reserve power is always shared by the peer PML630 devices with each other and their individual power balance calculations always consider the spinning reserve based on the tie line status across the power network areas.

The load-shedding action behavior can be automatically handled by the PML630 device depending on the system information or it can be parameterized depending on the prevailing system conditions.

- The load-shedding sharing action behavior in a Configuration B with two peer PML630 devices controlling the adjacent (interconnected) power network areas is automatically handled and the parametrized values are not considered.
- If a load-shedding action completed by a PML630 device in its area is inadequate (when more load relief is required), it conveys the balance load-shedding information to the adjacent area's PML630 device to shed the loads in its power area based on assigned priorities.
- In a 3-peer PML630 Configuration B, the parametrization is only effective for the PML630_2 as it is connected to the two external network areas. The PML630_1 and PML630_3 devices coordination occurs only with PML630_2 device and it is handled automatically.
  While the load-shedding action behavior of the PML630_1 and PML630_3 devices is identical to the 2-peer PML630 Configuration B situation, the PML630_2 can share its balance load-shedding values information with its peer PML630 devices. The sharing can be done on the 50-50% or 0-100% or 100-0% basis. The PML630_1 and PML630_3 initiate the shedding action in their respective power network areas based on the sharing value information. Sharing of load-shedding action is not supported between PML630_1 and PML630_3.

Slow load-shedding

The slow load-shedding function reduces the overload on a power source and reduces the power demand on the utility tie

[1] Another alternative is the COM600's protocol gateway feature to access generator information from external systems.

line to an acceptable level based on the parameter settings. It is termed as slow load-shedding because the overload detection is a slow process compared to a contingency like a power source protection operation followed by circuit breaker trip.

The overload detection is available for all eight power sources based on the three phase low stage overcurrent protection (PHLPTOC) function (identical to the function that is implemented in 630 series), with flexibility in curve selection and parameter selection. The 3-phase currents are acquired over IEC 61850 GOOSE from the respective power source devices. For the grid 1 and grid 2 feeders (when configured for external grid connectivity), there is an option to acquire the currents locally to the slow load-shedding function by extending CT wiring to PML630.

The 8CT/2VT connections can be used for two power sources.

PML630 requires adequate coordination with the power source feeder device's PHLPTOC function for early overload detection and effective activation of the slow load-shedding functionality. It is also possible to get an external overload signal (for example, thermal overcurrent start) to trigger the slow load-shedding function for any power source. The external overload signal should be configured to be sent from the power source device to PML630 over IEC 61850 GOOSE.

The overload detection based on a maximum demand exceeding beyond a certain time limit and is available for all the power sources even though it is more applicable for two power sources (grid connectivity feeder).

The method for reduction or elimination of the overload condition on the power source can be parametrized and should be decided based on the project requirements.

The actual permitted overload can be defined for each power source, and load can be shed accordingly. This results in load reduction on that specific power source based on the set parameter.

Alternatively, based on the actual permitted overload and the subsequent power balance calculation activation, the load-shedding can be initiated in the associated subnetwork.

The overload trigger for a power source is generated periodically as long as the overload conditions prevail, implying that loads can be shed in multiple shedding actions.

The slow load-shedding mode is only effective within one power network area (under a PML630 device) and cannot be extended across the power network areas (other PML630 devices) like fast load-shedding in Configuration B.

An overload condition in a subnetwork causes a negative power balance situation. This event can be used to trigger the fast load-shedding using its external trigger feature. The result of the power balance calculation leads to load-shedding in that subnetwork.

Manual load-shedding

The function can be used to obtain any preemptive power relief in any of the active subnetworks in a PML630 device's own power network area.

The needed power relief can be defined in the form of the load priority up to which loads have to be shed or alternatively in terms of the actual power.

The shedding priority or a power and a manual trigger can be set as parameters or acquired from an external device or system or from COM600S or COM600F to PML630 over IEC 61850 GOOSE. When entered as a priority, load-shedding commands are issued to load feeders with a priority lower than and equal to the priority entered by the operator. When entered as a power value, an equivalent load-shedding priority is calculated in such a way that the actual amount of load-shedding at least equals or is higher than the defined value.

The manual load-shedding feature can also be used in new ways using the external manual load-shedding trigger feature. For instance, a time-based load-shedding can be achieved by connecting an external timer output to PML630 device as a hardwired input or through RIO600. On activation of the timer, load-shedding can be activated simultaneously in all the subnetworks based on the priority or the power definition. When a load-shedding priority is identified for load-shedding, all the constituent load feeders associated with that priority will receive load-shedding commands.

The manual load-shedding mode is only effective within one power network area (under a PML630 device) and cannot be extended across the power network areas (other PML630 devices) like fast load-shedding in Configuration B.

An overload condition in a subnetwork causes a negative power balance situation. This event can be used to trigger the fast load-shedding using its external trigger feature. The power balance calculation will result in load-shedding in that subnetwork.

Frequency-based load-shedding

The system frequency can experience a sharp drop when a power source trips or a gradual drop when there is a gradual overload. The frequency-based load-shedding function is independent of the other load-shedding functions.

PML630 has provisions to support and perform load-shedding action during such conditions, based on the externally provided process data.

- The generic analog protection function (MAPGAPC) instances can be used to detect underfrequency conditions based on frequency data, subscribed over GOOSE from a device such as REU615. Since eight instances of the function are available, two instances can be assigned to each subnetwork as Stage 1 and Stage 2. In case of lower number of subnetworks, more instances

can be allocated to realize more underfrequency stages. While Stage 1's activation can be assigned to activate fast-load shedding based on power balance calculations, Stage 2 can be assigned to activate manual load-shedding based on priority or power definitions. The Stage 1 and Stage 2 activation outputs will act as the external triggers to the fast and manual load shedding functions respectively.
- The df/dt activation output from the REU615 can be connected as an external input trigger (GOOSE input or hardwired) to activate the fast load-shedding function. The load-shedding action will be in accordance to the power deficit situation.

Since the manual load-shedding is not affected by the blocked status of fast and slow load-shedding functions, the Stage 2 based activation can be considered as an independent backup to the fast-load shedding function.

If the critical signal for fast-load shedding is for some reason not received, Stage 1 detects the consequent frequency fall (due to inadequate power from generators or grid) and initiates load-shedding. Therefore, Stage 1 is also a backup for fast-load shedding.

If the detection of overload condition is not adequate enough for the power sources' slow load shed mechanism, the consequent frequency drop will be picked by the MAPGAPC function instances. In this manner, the underfrequency function is a backup to slow load-shedding as well.

Load-shedding priority assignment
All the loads or load-shedding groups participating in the load-shedding functionality are assigned a priority in the range of 1...19. The priority assignment is a part of the parametrization process.

The loads or load-shedding groups with the same priority assignment are combined automatically. The priority definition is common for all the load-shedding modes. The higher the priority number, the higher is the importance of the load feeder compared to any other load with a lower priority number. Load with priority 1 has the lowest assigned priority and the load with priority 19 has the highest assigned priority. The dedicated internal load priorities are reserved for the inhibited or non-sheddable loads due to operator or system conditions and for managing the measurement inaccuracies.

In case there are more than ten sheddable loads connected to a busbar, it is possible to combine the loads (maximum of three) in a load-shedding group and assign a common priority to the group. This implies that the load-shedding application considers the load-shedding group a single feeder, and the shedding commands are also sent to all the constituent feeders concurrently. The load-shed group handling application logic can be realized in 630 series relays and PML630, subject to logic block instances.

Load-shedding command handling in load feeder devices
Handling in 630, 620 and 615 series protection relays
The load-shedding command from the PML630 device is validated for the IEC 61850 data quality, communication status and test mode activation of PML630. The command is only passed through to activate the circuit breaker opening command channel when all the conditions are met.

Handling in RIO600 IO unit
The load-shedding command from the PML630 device is validated only for the IEC 61850 data quality. The command is extended to the binary output channel only when the IEC 61850 data quality is good (communication healthy, PML630 is not in test mode).

Load-shedding blocking
The load-shedding blocking feature can be used to block the load-shedding functionality. This is to prevent the fast and slow load-shedding modes from using incorrect system data for the load-shedding calculations. The load-shedding blocking can be effected automatically or manually.

Automatic blocking
The fast and slow load-shedding functions are blocked automatically in a subnetwork during certain system conditions.
- Communication failure between PML630 and the device associated with a power source circuit breaker
- Bad IEC 61850 data quality from the device associated with a power source circuit breaker
- Device associated with a power source circuit breaker is in the test mode
- Power source circuit breaker is in the intermediate position for longer than 200 ms or in an undefined state

The load-shedding functionality is blocked in all the subnetworks if any of the conditions is true for a network circuit breaker and its associated 630, 620 or 615 series protection relay. There is a provision through parametrization to override the blocking conditions. This is applied only when the cause of the blocking is known and ensures the availability of the fast and slow load-shedding functions.

Manual load-shedding can still be activated in any of the subnetworks when the fast or slow load-shedding functionality is blocked.

Manual blocking
The fast and slow load-shedding modes in a subnetwork can be blocked from the device's local or Web HMI or COM600S or COM600F.

The fast and slow load-shedding functions in all four subnetworks can be blocked from the local HMI of PML630. In such situation, the manual load-shedding action execution is still possible but only from LHMI or WHMI (and not from COM600S or COM600F).

Load-shedding blocking behavior in Configuration B
When the fast and slow load-shedding modes become blocked in the subnetwork connected to the adjacent power network area in a 2-peer PML630 Configuration B scenario, the adjacent power network area (subnetwork) goes automatically into the Configuration A mode. The PML630 device in the unblocked power network area discards the spinning reserve power from the peer PML630 device and considers its own grid capacity for the power balance calculations. Since the subnetworks are not disconnected physically, the grid 1 or 2 capacity setting can still be used and kept equal to the spinning reserve power or based on the capacity of the tie line.

If the load-shedding in 1 or 2 subnetworks (connected to the adjacent power area networks) in the power network area is controlled by PML630_2 device becomes blocked in a 3-peer PML630 device Configuration B scenario, the subnetworks in the adjacent power network areas controlled by the PML630_1 and the PML630_3 devices go into the Configuration A mode. However, if an interconnected subnetwork in the PML630_1 or PML630_3 device becomes blocked, the connected subnetworks in an adjacent power areas stay in the Configuration B mode.

Load feeder inhibition
The load feeder inhibition feature is used to prevent the load-shedding functions from initiating opening commands to the inhibited load feeder. A load feeder inhibition can be achieved automatically or manually.

Automatic load feeder inhibition
A load feeder is inhibited automatically for load-shedding under certain conditions.

- Communication failure between a load feeder 630, 620 or 615 series protection relay or RIO600 IO unit and PML630
- Bad IEC 61850 data quality from a load feeder 630, 620 or 615 series protection relay or RIO600 IO unit
- Load feeder 630, 620 or 615 series protection relay or RIO600 IO unit in the test mode (also reflected in the IEC 61850 data quality)
- Based on an external input like a load circuit breaker trip circuit not healthy or in a racked-out condition

Manual load feeder inhibition
Manual load feeder inhibition can be performed from the PML630 device's local or Web HMI.

Load-shedding enabling and disabling in subnetworks
Load-shedding can be enabled or disabled in a subnetwork. However, the load-shedding block setting overrides individual subnetwork settings.

PML630 test mode behavior
The purpose of the test mode is to verify the load-shedding functionality until the load feeder 630, 620 or 615 series protection relays or RIO600 units.

PML630 and load feeder protection relays
When PML630 is put in the test mode from LHMI or WHMI, all the load-shedding functions are blocked. All the functions need to unblock to make them work again.

In this mode, the load-shedding command information (sent on IEC 61850 GOOSE) to the load feeder 630, 620 or 615 series protection relays or RIO600 units has a set test bit. In addition, a separate binary input is also sent together. On receipt of the load-shedding command with a set test bit and/or the dedicated PML630 device test mode information, the load feeder protection relay or IO unit blocks the load-shedding command from reaching the binary output channel.

Peer PML630 devices
When a PML630 device receives the power network information from another peer PML630 in the test mode, it can choose to consider the information or reject it.

When the adjacent power area network information is considered, the recipient PML630 also goes into test mode and runs in the Configuration B mode. If the load-shedding is activated by any of the PML630 devices, shedding commands are not issued to any of the load circuit breakers in the same power network area or other power network areas.

By rejecting it, the recipient PML630 device's subnetwork goes into the Configuration A mode until the peer PML630 device's test status changes to normal mode.

The selection to influence this behavior can be parameterized.

13. Load-shedding inputs and outputs

IEC 61850 GOOSE communication
The fast and slow load-shedding functions in PML630 require a fixed set of input data from the power source, load feeder 630, 620 or 615 series protection relays and RIO600 units.

- The REG630 or REG615 generator power source protection relay should be configured to send the active power, circuit breaker status, circuit breaker service position and protection trip information. If the generator power source also needs to be configured for slow (overload) load-shedding, the 3-phase currents need to be configured too.
- The RET630 and RET620 grid transformer protection relay is configured to send the three-phase currents, active power, circuit breaker status, circuit breaker service position and protection trip information.
- The REF630 and REF620 grid utility tie feeder power source or the network circuit breaker protection relay is configured to send the active power, circuit breaker status, circuit breaker service position and protection trip information.
- The REF630 or REM630 or RET630, REF620 or REM620 or RET620 and REF615 or REM615 or RET615 load feeder

protection relays are configured to send the active power and the circuit breaker status information.
- In case of RIO600 units that are associated with the power source, network circuit breakers and load feeders, the active power information passes through a power transducer as 4-20mA output and the RTD input module channel. The circuit breaker status is acquired through auxiliary relays like ABB RXMA1/2 and the binary input DIM8 module channels as two single-point inputs.
- RIO600 is configured to send the aforesaid information.
- The circuit breaker single-point status information are converted into double-point information in PML630.
- COM600S or COM600F, through its IEC 61850 proxy server, is configured to send the manual load-shedding priority and power information.

The binary data sets comprising the circuit breaker status and the digital input information are configured to be sent instantaneously over GOOSE with the lowest possible minimum time. Thus, the GOOSE message reaches the recipient PML630 device in the sending direction and the load feeder protection relays in the receiving direction typically in 10 ms.

Analog data sets comprising information such as active power and currents need to be configured with identical minimum and maximum times by emulating a cyclic behavior of transducer. Configuring faster analog signals can prove detrimental to the performance of the communication network.

Load-shedding command information sent from PML630 to the load feeder protection relay or the feeder IO unit is validated before released to trip the circuit breaker.

The validation checks include certain factors.

- IEC 61850 data validity from PML630
- Communication validity with PML630
- PML630 device test mode validity (that it is not in the test mode)
- Load feeder protection relay test mode validity (that it is not in the test mode)

The RIO600 IO unit's SCM module's high-speed, power outputs can be used to directly trip the load feeder's circuit breaker. Operating time of these outputs is <1 ms. Whereas, the RIO600 IO unit's DOM module channels do not have the capacity to be wired in the trip circuit and therefore, additional high capacity, fast-acting interposing relays like ABB RXMA1/2 need to be deployed to trip the load feeder circuit breaker.

IEC 61850 MMS communication

The load-shedding operational data sent to COM600 is displayed in the dedicated subnetwork and the single line displays standard alarm or the event lists. PML630 also receives the load-shedding control actions, manual load-shedding command and load-shedding reset commands from COM600S or COM600F.

PML630 sends the load-shedding operational data to COM600.

For six generators and two grid tie or grid transformers

- Measurement information
  - Available power
  - Active power
  - Available power on percentage of the active power
  - Actual demand
  - Maximum demand value above which demand-based load-shedding is started
  - Overload amount
  - Maximum power with the slow load-shedding trigger
  - Maximum current of the three-phase inputs
  - Elapsed time of the overcurrent-based slow load-shedding
  - Maximum current setting for overcurrent-based slow load-shedding
  - Total time after which current-based slow load-shedding trigger generated
  - Actual calculated demand energy of source
  - Must be load-shed power from adjacent network area through the grid 1 or grid 2 feeder (load-shedding sharing)
  - Spinning reserve power from the adjacent network area through the grid 1 or grid 2 feeder
- Status information
  - Fast load-shedding start
  - Fast load-shedding operation
  - Overcurrent-based slow load-shedding start
  - Overcurrent-based slow load-shedding operate
  - Circuit breaker position (open or closed)
  - Single or multiple basic function setting changes
  - Load-shedding blocking is bypassed for power source
  - Slow load-shedding mode information (overcurrent or maximum demand or overcurrent & maximum demand or disabled)
  - Slow load-shedding trigger inhibited or disabled for power source
  - Load-shedding blocked due to the power source
  - Generator governor mode information
  - Load-shedding trigger inhibited or disabled from the power source
  - Load-shedding triggered from the power source
  - Overcurrent-based slow load-shedding reset
  - Maximum demand operation alarm
  - Maximum demand reset
  - Subnetwork number

For six busbars

- Measurement data
  - Total active power from the sheddable loads (1...10)
  - Load-shedding trip command for the sheddable loads (1...10)
- Status information

- Load circuit breaker position (open or closed)
- Load-shedding inhibition status for load (1…10)
- Load feeder priority (1…10)
- Single or multiple basic function setting changes
- Subnetwork number

For 15 network circuit breakers

- Measurement information
  - Total active power flow
- Status information
  - Position (open or closed)
  - Load-shedding blocked due to the network circuit breaker
  - Load-shedding blocking bypassed
  - Load-shedding triggered from the network circuit breaker
  - Single or multiple basic function setting changes
  - Virtual circuit breaker setting enabled for the network circuit breaker
  - Subnetwork number

For four subnetworks

- Measurement information
  - Accumulated load against priority 1…19
  - Total available power (sum of power values from all the generators and the grid tie or transformers inclusive)
  - Total running load from the power sources
  - Total sheddable load (sum of sheddable loads)
  - Power imbalance (spinning reserve power)
  - Effective power difference considering the spinning reserve from adjacent network area (difference of load value between actual shedding and required shedding)
  - Required load-shedding (minimum load value that must be shed to establish power balance)
  - Actual load-shedding (load value of the calculated shedding priority)
  - Power difference (difference of the load value between actual shedding and required shedding)
  - Manual load to be shed in kW
  - Load inhibition by operator
  - Load inhibition by system
  - Load mismatch
  - Total value of non-sheddable loads

- Status information
  - Load-shedding block status
  - Load-shedding operation
  - Fast or slow or manual or extended from the adjacent power network area; Configuration B mode load-shedding operation
  - Calculated shedding priority record 1
  - Calculated shedding priority record 2
  - Calculated shedding priority record 3
  - Manual load-shedding priority status
  - Negative power balance status
  - Status (active or inactive)
  - Status (enable or disable)
  - Slow load-shedding block status
  - Load-shedding reset command status
  - Load-shedding counter reset command status
  - Manual load-shedding command status

Common load-shedding data

- Status information
  - General load-shedding function start (Fast or slow or manual or extended from the adjacent power network area; Configuration B mode)
  - General load-shedding function operation (Fast or slow or manual or extended from the adjacent power network area; Configuration B mode)
  - General slow load-shedding start
  - General slow load-shedding operation
  - Fast load-shedding start
  - Disturbance recorder memory used alarm
  - Disturbance recorder record cleared status
  - Disturbance recorder files made status
  - Disturbance recorder process start status
  - PML630 device test mode status
  - Fast load-shedding counter value
  - Manual load-shedding behavior (Priority setting or kW setting or priority input or kW input or priority setting active due to the bad quality of input or kW setting active due to the bad quality of input or manual load-shedding disabled)
  - Single or multiple basic core function setting changes
  - load-shedding data (encoded) for the adjacent network area PML630 device; Configuration B
  - Subnetwork load-shedding blocked due to interconnected circuit breaker in the adjacent power network area; Configuration B
  - Circuit breaker status of the interconnected tie feeder with the adjacent power network area; Configuration B
  - Subnetwork load-shedding blocked in the adjacent power network area; Configuration B
  - Error in received load-shedding data from the adjacent network area device; Configuration B
  - Error in sending load-shedding data to the adjacent network area device; Configuration B
  - Device in test mode information; Configuration B

COM600S or COM600F provides the load-shedding control actions to PML630.
- Fast load-shedding - overall and individual subnetwork load-shedding reset command
- Slow load-shedding - IDMT-based reset command
- Manual load-shedding - command for every subnetwork

Hardwired Inputs and Outputs
The additional hardware IO configuration for PML630 comprises two types of analog boards. The analog boards are a mandatory part of the PML630 device order code as the boot

process of a 630 series protection relay depends on the presence of the analog card.

The 4CT/5VT card's analog channels can be used to connect the currents from one grid power source.

- A card with four current transformer and five voltage transformer channels is the default variant when the 3–phase currents for the grid 1 or 2 transformer slow load-shedding functionality are acquired over IEC 61850 GOOSE from the respective RET630 or RET620 or RET615 protection relays.
- PML630 order code also includes an analog card option equipped with six phase current inputs (three inputs for the grid 1 transformer HV/LV side and the other three inputs for the grid 2 transformer HV/LV side) for slow (overload-based) load-shedding. The phase current inputs are rated for 1/5 A. The voltage inputs are not used.
- There are 14 binary inputs and nine binary outputs as part of the communication board and the power supply module respectively. The binary I/Os are not used by default. However, they can be configured and used in the application logic if required.

Table 1. Analog input options

Analog input configuration	CT (1/5 A)	VT
AA	4	5
AB	8	2

Table 2. Binary input/output options

Binary input configuration	BI	BO
AA	14	9

Interface of cPMS load-shedding Configuration A
The COM600S or COM600F gateway function can be used to send and receive information, if needed, with any 3rd party system like DCS based on MODBUS-TCP (slave) or OPC (server).

External HMI systems
Since PML630 supports the IEC 61850 standard, any IEC 61850 client like MicroSCADA or 800xA Connect or Aspect Server can be configured to display load-shedding process information in a similar manner to COM600S or COM600F.

External controllers or systems
An external controller such as AC800M running the generator control functionality can be configured to send the dynamic power capability (spinning reserve) information to the PML630 device based on IEC 61850 GOOSE.

Alternatively, the external controller or system can be configured to send such information to COM600S or COM600F that would further relay the information to PML630 over IEC 61850 GOOSE.

For large industrial plants such as refineries, an external plant-wide load-shedding system based on, for example, AC800M can work in a coordinated mode with multiple PML630 devices in the downstream process plant substations (with local power generation).

Based on the plant-wide event, the external controller can calculate the plant-wide load-shedding priorities and communicate them to the PML630 device along with the load-shedding activation inputs to all the subnetworks. Using PML630 device's feature to accept the manual load-shedding priorities and trigger on IEC 61850 GOOSE for four subnetworks, the plant-wide priorities can be translated to the local load-shedding commands.

In certain conditions such as disconnection or communication failure, the PML630 device can work independently as the local process area load-shedding controller. By having a downstream, the PML630 device can also handle any overloading of the interconnecting (incoming) transformers to the downstream process area.

Alternatively, if the local process area fast and slow load-shedding modes are blocked, the local PML630 can still accept the load-shedding priorities through the external trigger or the priorities channel.

The external load-shedding controller can selectively inhibit loads or load-shedding groups depending on the operational conditions of the process.

Direct load-shedding activation by external system
Any generic process event, which gets activated much before consequent electrical network actions, can be generated by an external system and sent to the PML630 device in order to trigger the priority calculations and activate load-shedding.

14. Disturbance recording

The disturbance recording function collects subnetwork information and load-shedding information after a load-shedding trigger event occurs. The device is equipped with a disturbance recorder with 20 analog signal channels. Out of the 20 analog channels, only 8 channels are used to record the load-shedding data.

- Subnetwork 1 or 2 or 3 or 4 load-shedding priority
- Subnetwork 1 or 2 or 3 or 4 effective power balance

A power source outage or the opening of a network circuit breaker generates an internally generated binary event that is mapped in the IEC 61850 model of the device as the load-shedding start signal. The recording from the analog signal channels of a disturbance recorder is triggered by the load-shedding start signal. This indicates the initiation of the power balance calculations.

Initiation of the power balance calculations does not imply the operation of the fast or slow load-shedding function, since it depends on the available power in the subnetwork. A negative power deficit due to a power source outage in the power network or the opening of a network circuit breaker activates the PML630 device to issue the load-shedding commands.

The disturbance recorder function provides the values of an available power, a load and a priority in each subnetwork before and after the load-shedding calculation initiation. This helps in ascertaining the power situation in the subnetworks before and after the load-shedding start event.

PML630 can record the shedding priorities of the recent and the last two load-shedding actions in every subnetwork.

The disturbance recorder and the Start LED on the device's front panel user interface are both activated by the load-shedding start signal.

Handling for double busbar configuration

PML630 handles single busbar-based network configurations inherently. However, a double busbar-based network can be accommodated using adaptations in configuration and additional engineering steps involving logic creation. The supported power network can be:

- 2 generators
- 2 grid transformers
- 3 double busbars
- 6 outgoing transformer or tie feeders and bus couplers
- 30 sheddable loads or load-shedding groups

For a double busbar configuration, the power source and load feeder protection relays can only be based on the 630 series only.

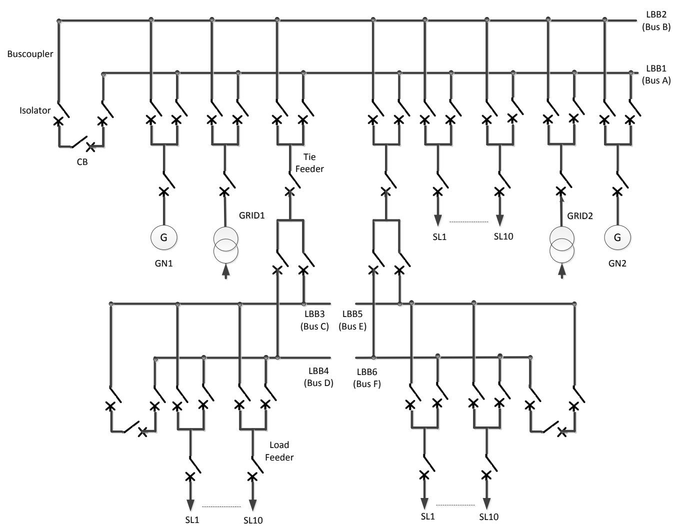

Figure 7. Example of a simple double busbar configuration (Configuration A)

15. Event log

PML630 features an event log which enables logging of event information. The event log can be configured to log information according to user pre-defined criteria including device signals. To collect sequence-of-events (SoE) information, the device incorporates a non-volatile memory with a capacity of storing 1000 events with associated time stamps and user definable event texts. The non-volatile memory retains its data also in case the device temporarily loses its auxiliary supply. The event log facilitates detailed pre- and post-fault analyses of faults and disturbances.

The SoE information can be accessed locally via the user interface on the device's front panel or remotely via the communication interface of the device. The information can further be accessed, either locally or remotely, using the web-browser based user interface.

The logging of communication events is determined by the used communication protocol and the communication engineering. The communication events are automatically sent to station automation and SCADA systems once the required communication engineering has been done.

16. Load-shedding performance

All load-shedding application functions are executed at a 10 ms cycle time. Therefore, the conservative performance of the fast load-shedding function in PML630 is up to 20 ms; earliest guaranteed execution being within 10 ms. The performance time is measured from the moment when a trigger event, such as an outage or a protection operation, reaches PML630 to the moment when the load-shedding commands are issued.

However, the total performance of end-to-end performance of the cPMS load-shedding solution configuration A depends on various factors.

- HW binary input and output activation times in feeder protection relays
- GOOSE transmission times between the protection relays (maximum ~10 ms for Relion 615, 620, and 630 series)
- Application function cycle times in the feeder protection relays
- PML630 device load-shedding logic execution time
- External trip contact operation time

The end-to-end performance of the configuration A is achieved within 60 ms [1]. In case of Configuration B, the load-shedding action in power network area 2 due to a contingency in power network area 1 is achieved within 90 ms [1] . Depending on the circuit breaker opening time, the overall performance times can be ascertained. When the load feeder circuit is based on ABB MV circuit breaker, the open time is about 50 ms.

17. Redundancy

The 630 series family does not support communication or device-level redundancy. To adapt the PML630 to work in a redundant communication network with other redundant devices such as 615 and 620 series, an external redundancy box is needed. With such unit, PML630 can be used in a network supporting High Availability Seamless Redundancy (HSR) or Parallel Redundancy Protocol (PRP).

A 100% redundant and independent PML630 device with identical configuration to the main PML630 device can work together to achieve load-shedding device-level redundancy.

For additional information, contact ABB DA-Supportline.

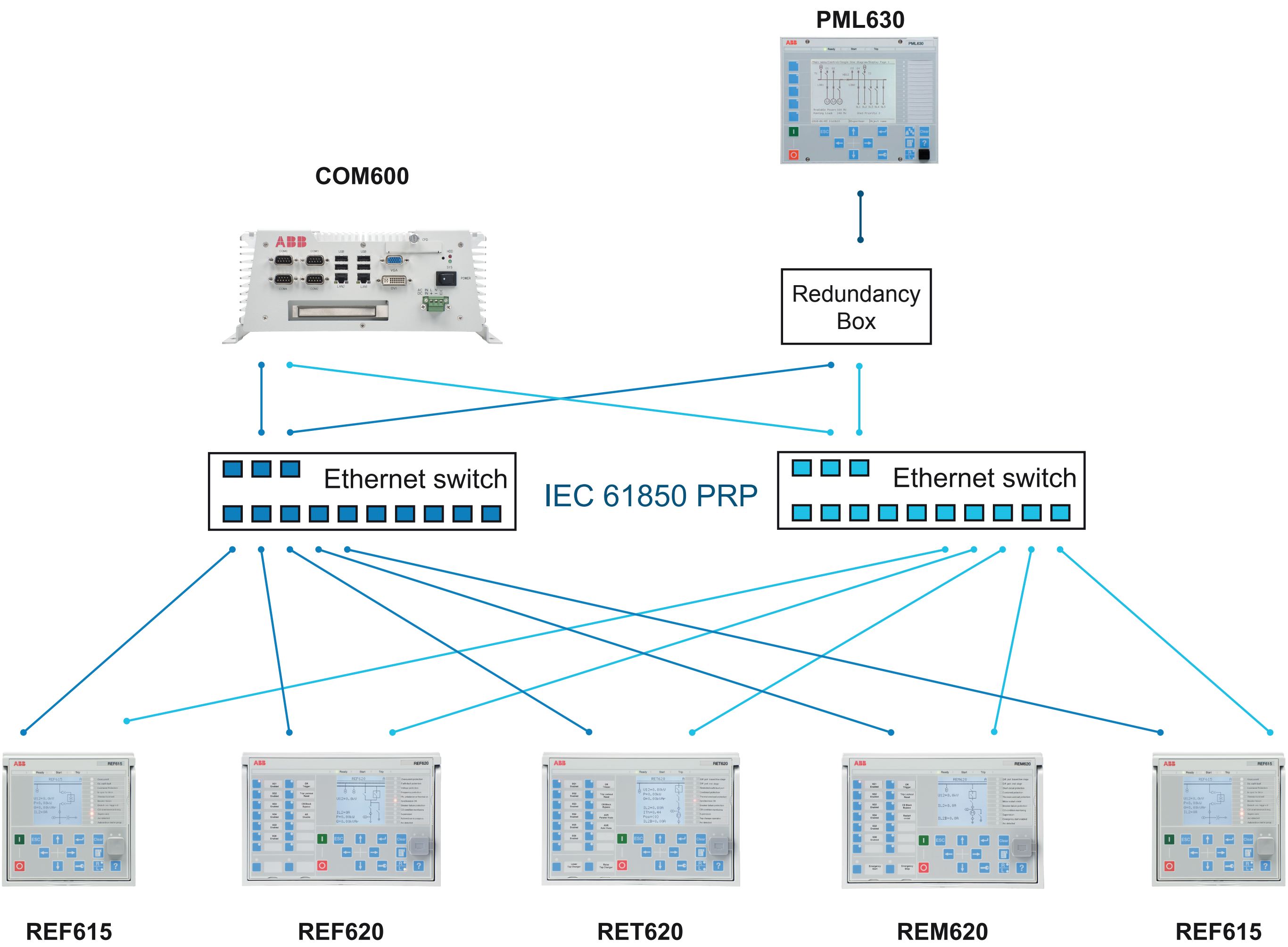

Figure 8. cPMS load-shedding Configuration A: PRP configuration

[1] This figure is conservative and is subject to substation communication network traffic conditions.

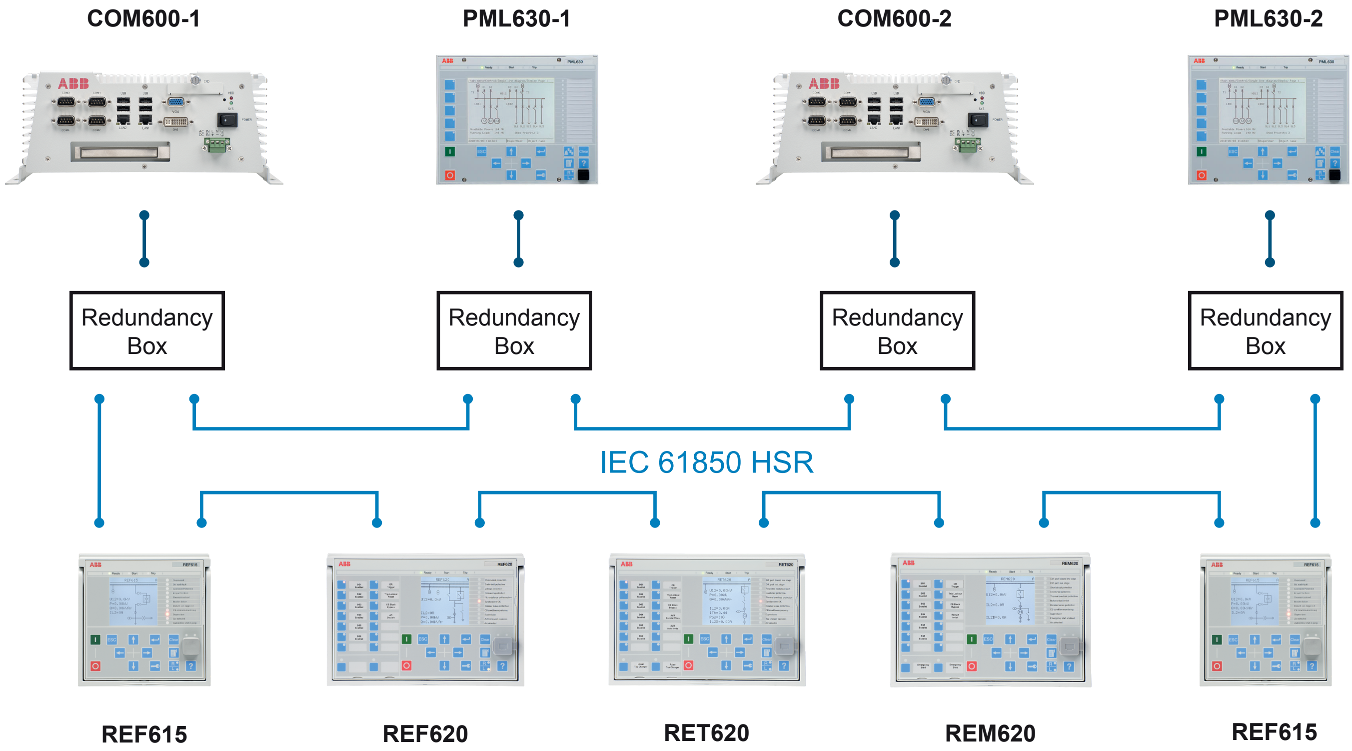

Figure 9. cPMS load-shedding Configuration A: HSR configuration (full redundancy)

18. Self-supervision

The device’s built-in self-supervision system continuously monitors the state of the device hardware and the operation of the device software. Any fault or malfunction detected is used for alerting the operator.

Self-supervision events are saved into an internal event list which can be accessed locally via the user interface on the device's front panel. The event list can also be accessed using the Web-browser based user interface or PCM600.

19. Access control

To protect the device from unauthorized access and to maintain information integrity, the device is provided with an authentication system including user management. Using the IED User Management tool in the Protection and Control IED Manager PCM600, an individual password is assigned to each user by the administrator. Further, the user name is associated to one or more of the four available user groups: System Operator, Protection Engineer, Design Engineer and User Administrator. The user group association for each individual user enables the use of the device according to the profile of the user group.

20. Time synchronization

The device supports the Ethernet-based SNTP and IRIG-B-based [1] time synchronization methods with the time-stamping resolution of 1 ms. This information can be accessed in the COM600 device alarms and the event display pages.

21. Integration into switchgear

The 630, 620 and 615 series protection relays can be directly mounted in a medium-voltage metal-clad switchgear. Additionally, the COM600 hardware is based on the ruggedized mechanics with no moving parts subject to wear and tear. Thus, the compact and robust design is well adapted for harsh environments in a substation. The visualization display unit associated with COM600S or COM600F can be based on a COTF industrial-grade touch panel.

Therefore, the entire cPMS load-shedding cluster can be mounted in the medium-voltage switchgear.

This ensures that the load-shedding power management system uses the same infrastructure as the medium-voltage switchgear and protection and control system.

[1] Inter-Range Instrumentation Group - Time Code Format B with special time synchronization wiring

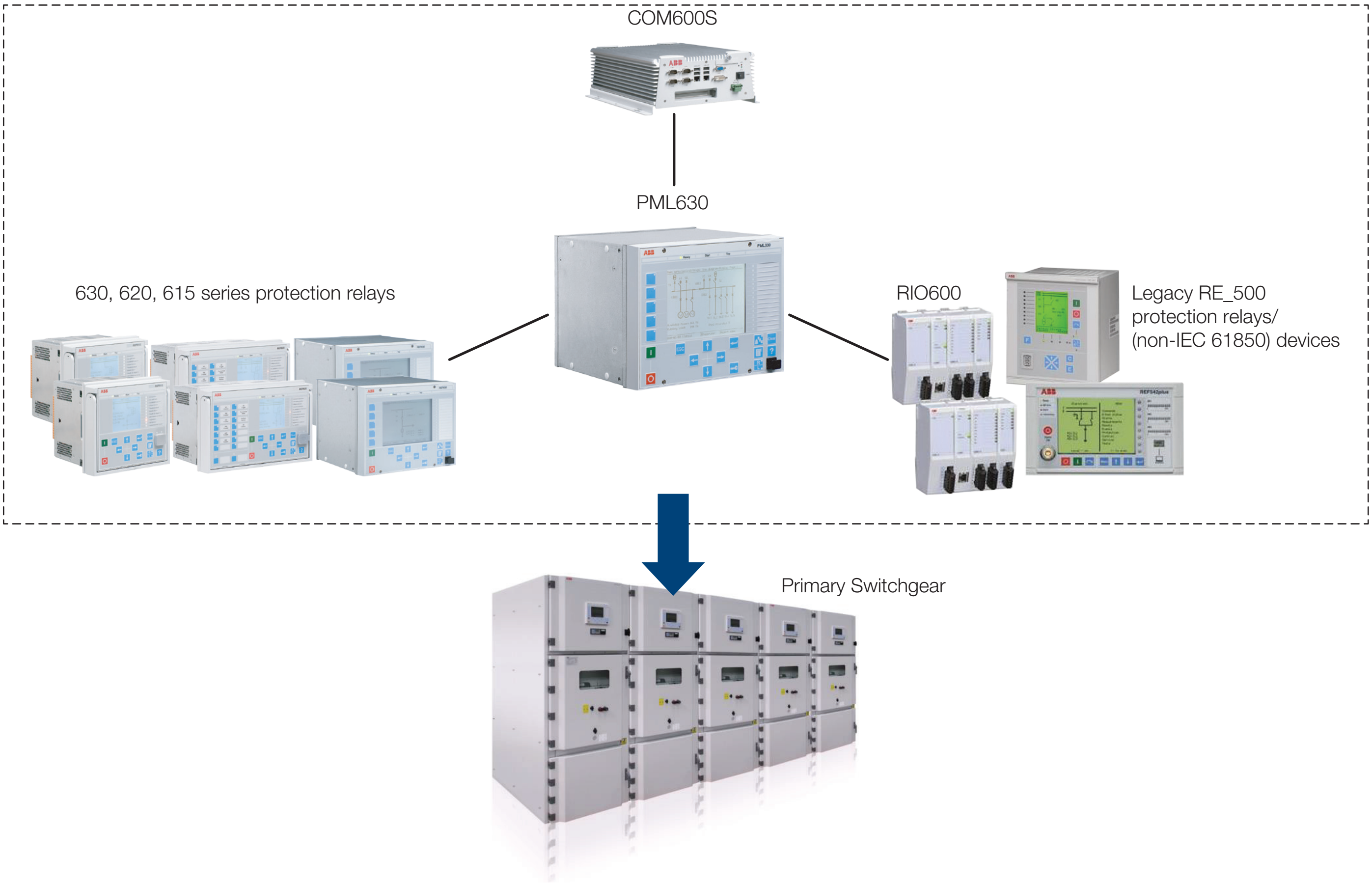

Figure 10. cPMS load solution combined with medium voltage switchgear

22. Technical data

Table 3. Dimensions (4U, half 19")

Description	Value
Width	220 mm
Height	177 mm
Depth	249.5 mm
Weight box	6.2 kg
Weight LHMI	1.0 kg

Table 4. Power supply

<table>
<tr><th>Description</th><th>600PSM03</th><th>600PSM02</th></tr>
<tr><td rowspan="2">U_{aux}nominal</td><td>100, 110, 120, 220, 240 V AC, 50 and 60 Hz</td><td rowspan="2">48, 60, 110, 125 V DC</td></tr>
<tr><td>110, 125, 220, 250 V DC</td></tr>
<tr><td rowspan="2">U_{aux}variation</td><td>85...110% of U_n (85...264 V AC)</td><td rowspan="2">80...120% of U_n (38.4...150 V DC)</td></tr>
<tr><td>80...120% of U_n (88...300 V DC)</td></tr>
<tr><td>Maximum load of auxiliary voltage supply</td><td colspan="2">35 W</td></tr>
<tr><td>Ripple in the DC auxiliary voltage</td><td colspan="2">Max 15% of the DC value (at frequency of 100 Hz)</td></tr>
<tr><td>Maximum interruption time in the auxiliary DC voltage without resetting the device</td><td colspan="2">50 ms at U_{aux}</td></tr>
<tr><td>Power supply input must be protected by an external miniature circuit breaker</td><td colspan="2">For example, type S282 UC-K.
The rated maximum load of aux voltage which is given as 35 watts. Depending on the voltage used, select a suitable MCB based on the respective current. Type S282 UC-K has a rated current of 0.75 A at 400 V AC.</td></tr>
</table>

Table 5. Energizing inputs

Description		Value	
Rated frequency		50/60 Hz	
Operating range		Rated frequency ± 5 Hz	
Current inputs	Rated current, I_n	0.1/0.5 A[1)]	1/5 A[2)]
	Thermal withstand capability:		
	• Continuously	4 A	20 A
	• For 1 s	100 A	500 A
	• For 10 s	25 A	100 A
	Dynamic current withstand:		
	• Half-wave value	250 A	1250 A
	Input impedance	<100 mΩ	<20 mΩ
Voltage inputs	Rated voltage, U_n	100 V AC/ 110 V AC/ 115 V AC/ 120 V AC	
	Voltage withstand:		
	• Continuous	425 V AC	
	• For 10 s	450 V AC	
	Burden at rated voltage	<0.05 VA	

1) Residual current
2) Phase currents or residual current

Table 6. Binary inputs

Description	Value
Operating range	Maximum input voltage 300 V DC
Rated voltage	24...250 V DC
Current drain	1.6...1.8 mA
Power consumption/input	<0.3 W
Threshold voltage	15...221 V DC (parametrizable in the range in steps of 1% of the rated voltage)
Threshold accuracy	±3.0%
Ripple in the DC auxiliary voltage	Max 15% of the DC value (at frequency of 100 Hz)

Table 7. Signal output and IRF output

IRF relay change over - type signal output relay	
Description	**Value**
Rated voltage	250 V AC/DC
Continuous contact carry	5 A
Make and carry for 3.0 s	10 A
Make and carry 0.5 s	15 A
Breaking capacity when the control-circuit time constant L/R<40 ms, at U< 48/110/220 V DC	≤0.5 A/≤0.1 A/≤0.04 A
Minimum contact load	100 mA at 24 V AC/DC

Table 8. Ethernet interfaces

Ethernet interface	Protocol	Cable	Data transfer rate
LAN1 (X1)	TCP/IP protocol	Fibre-optic cable with LC connector or shielded twisted pair CAT 5e cable or better	100 MBits/s

Table 9. LAN (X1) fibre-optic communication link

Wave length	Fibre type	Connector	Permitted path attenuation[1)]	Distance
1300 nm	MM 62.5/125 μm or MM 50/125 μm glass fibre core	LC	<7.5 dB	2 km

1) Maximum allowed attenuation caused by connectors and cable together

Table 10. X4/IRIG-B interface

Type	Protocol	Cable
Screw terminal, pin row header	IRIG-B	Shielded twisted pair cable Recommended: CAT 5, Belden RS-485 (9841- 9844) or Alpha Wire (Alpha 6222-6230)

Table 11. X9 Optical serial interface characteristics

Wave length	Fibre type	Connector	Permitted path attenuation	Distance
820 nm	MM 62.5/125	ST	4 dB/km	1000 m
820 mm	MM 50/125	ST	4 dB/km	400 m
660 mm	1 mm	Snap-in		10 m

Table 12. Degree of protection of flush-mounted device

Description	Value
Front side	IP 40
Rear side, connection terminals	IP 20

Table 13. Degree of protection of the LHMI

Description	Value
Front and side	IP 42

Table 14. Environmental conditions

Description	Value
Operating temperature range	-25...+55ºC (continuous)
Short-time service temperature range	-40...+85ºC (<16 h) Note: Degradation in MTBF and HMI performance outside the temperature range of -25...+55ºC
Relative humidity	<93%, non-condensing
Atmospheric pressure	86...106 kPa
Altitude	up to 2000 m
Transport and storage temperature range	-40...+85ºC

Table 15. Environmental tests

Description	Type test value	Reference
Dry heat test (humidity <50%)	• 96 h at +55ºC • 16 h at +85ºC	IEC 60068-2-2
Cold test	• 96 h at -25ºC • 16 h at -40ºC	IEC 60068-2-1
Damp heat test, cyclic	• 6 cycles at +25…55°C, Rh >93%	IEC 60068-2-30
Storage test	• 96 h at -40ºC • 96 h at +85ºC	IEC 60068-2-1 IEC 60068-2-2

Table 16. Electromagnetic compatibility tests

Description	Type test value	Reference
100 kHz and 1 MHz burst disturbance test		IEC 61000-4-18, level 3 IEC 60255-22-1
• Common mode	2.5 kV	
• Differential mode	1.0 kV	
3 MHz, 10 MHz and 30 MHz burst disturbance test		IEC 61000-4-18 IEC 60255-22-1, class III
• Common mode	2.5 kV	
Electrostatic discharge test		IEC 61000-4-2, level 4 IEC 60255-22-2 IEEE C37.90.3.2001
• Contact discharge	8 kV	
• Air discharge	15 kV	
Radio frequency interference tests		
• Conducted, common mode	10 V (rms), f=150 kHz...80 MHz	IEC 61000-4-6 , level 3 IEC 60255-22-6
• Radiated, pulse-modulated	10 V/m (rms), f=900 MHz	ENV 50204 IEC 60255-22-3
• Radiated, amplitude-modulated	10 V/m (rms), f=80...2700 MHz	IEC 61000-4-3, level 3 IEC 60255-22-3
Fast transient disturbance tests		IEC 61000-4-4 IEC 60255-22-4, class A
• All ports	4 kV	
Surge immunity test		IEC 61000-4-5, level 3/2 IEC 60255-22-5
• Communication	1 kV line-to-earth	
• Binary inputs, voltage inputs	2 kV line-to-earth 1 kV line-to-line	
• Other ports	4 kV line-to-earth, 2 kV line-to-line	
Power frequency (50 Hz) magnetic field		IEC 61000-4-8
• 1...3 s	1000 A/m	
• Continuous	300 A/m	
Pulse magnetic field immunity test	1000 A/m 6.4/16 μs	IEC 61000-4-9
Damped oscillatory magnetic field immunity test		IEC 61000-4-10
• 2 s	100 A/m	
• 1 MHz	400 transients/s	
Power frequency immunity test	Binary inputs only	IEC 60255-22-7, class A IEC 61000-4-16
• Common mode	300 V rms	
• Differential mode	150 V rms	
Conducted common mode disturbances	15 Hz...150 kHz Test level 3 (10/1/10 V rms)	IEC 61000-4-16

Table 16. Electromagnetic compatibility tests, continued

Description	Type test value	Reference
Voltage dips and short interruptions	30%/10 ms 60%/100 ms 60%/1000 ms >95%/5000 ms	IEC 61000-4-11
Electromagnetic emission tests		EN 55011, class A IEC 60255-25
• Conducted, RF-emission (mains terminal)		
0.15...0.50 MHz	< 79 dB(µV) quasi peak < 66 dB(µV) average	
0.5...30 MHz	< 73 dB(µV) quasi peak < 60 dB(µV) average	
• Radiated RF-emission		
30...230 MHz	< 40 dB(µV/m) quasi peak, measured at 10 m distance	
230...1000 MHz	< 47 dB(µV/m) quasi peak, measured at 10 m distance	

Table 17. Insulation tests

Description	Type test value	Reference
Dielectric tests:		IEC 60255-5 IEC 60255-27
• Test voltage	2 kV, 50 Hz, 1 min 500 V, 50 Hz, 1 min, communication	
Impulse voltage test:		IEC 60255-5 IEC 60255-27
• Test voltage	5 kV, 1.2/50 μs, 0.5 J 1 kV, 1.2/50 μs, 0.5 J, communication	
Insulation resistance measurements		IEC 60255-5 IEC 60255-27
• Isolation resistance	>100 MΩ, 500 V DC	
Protective bonding resistance		IEC 60255-27
• Resistance	<0.1Ω, 4 A, 60 s	

Table 18. Mechanical tests

Description	Reference	Requirement
Vibration tests (sinusoidal)	IEC 60068-2-6 (test Fc) IEC 60255-21-1	Class 1
Shock and bump test	IEC 60068-2-27 (test Ea shock) IEC 60068-2-29 (test Eb bump) IEC 60255-21-2	Class 1
Seismic test	IEC 60255-21-3 (method A)	Class 1

Table 19. Product safety

Description	Reference
LV directive	2006/95/EC
Standard	EN 60255-27 (2005) EN 60255-1 (2009)

Table 20. EMC compliance

Description	Reference
EMC directive	2004/108/EC
Standard	EN 50263 (2000) EN 60255-26 (2007)

Table 21. RoHS compliance

Description
Complies with RoHS directive 2002/95/EC

Functions inherited from 630 series

Table 22. Multipurpose analog protection (MAPGAPC)

Characteristic	Value
Operate time accuracy	±1.0% of the set value or ±20 ms

Table 23. Multipurpose analog protection (MAPGAPC) main settings

Parameter	Function	Value (Range)	Step
Operation mode	MAPGAPC	Over Under	-
Start value	MAPGAPC	-10000.0...10000.0	0.1
Start value Add	MAPGAPC	-100.0...100.0	0.1
Operate delay time	MAPGAPC	0.00...200.00 s	0.01

Table 24. Station battery supervision (SPVNZBAT)

Characteristic	Value
Operation accuracy	±1.0% of the set value
Operate time accuracy	±1.0% of the set value or ±40 ms

Table 25. Three-phase current measurement (CMMXU)

Characteristic	Value
Operation accuracy	At the frequency $f = f_n$
	±0.5% or ±0.002 × I_n (at currents in the range of 0.01...4.00 × I_n)
Suppression of harmonics	DFT: -50 dB at $f = n \times f_n$, where n = 2, 3, 4, 5,… RMS: No suppression

Power management functions

Table 26. Application functions used in cPMS load-shedding

Application function	Description
PSCSWI	Power source handling
NPMMXU	Network power source measurement
LDMMXU	Busbar-wise load feeder measurement
NCBDCSWI	Network circuit breaker handling
LSCACLS	Load-shedding core
SNWLRCS	Subnetwork monitoring
PPLSGGIO (only configuration B)	Peer PML630 data sharing
LSPTRC	Load-shedding trip command

Table 27. Network power source measurement (PSCSWI) main settings

Parameter	Function	Value (Range)	Step
Start value	PSCSWI	0.05...5.00	0.01
Start value Mult	PSCSWI	0.8...10.0	0.1
Time multiplier	PSCSWI	0.05...15.00	-
Operating curve type	PSCSWI	ANSI Ext. inv. ANSI Very inv. ANSI Norm. inv. ANSI Mod. inv. ANSI Def. Time L.T.E. inv. L.T.V. inv. L.T. inv. IEC Norm. inv. IEC Very inv. IEC inv. IEC Ext. inv. IEC S.T. inv. IEC L.T. inv. IEC Def. Time Programmable RI type RD type	-
Operate delay time	PSCSWI	0.04...200.00	0.01
Block override	PSCSWI	No IED test mode Quality bad CB close Quality bad CB open CB Interm or invalid All yes	-
Maximum Ava power	PSCSWI	0.0...999999.9	0.1
Governor mode	PSCSWI	Droop MW ISO P-Control Optimize Base load Peak load	-
Slow load shed mode	PSCSW	Disable OC & Ext Trg Max Dmd Trg OC Max Dmd Ext Trg	-
Maximum power SLS	PSCSWI	0.0...999999.9	0.1
Maximum demand	PSCSWI	0.0...999999.9	0.1
CB Interm time	PSCSWI	0...500	10
Ava power mode	PSCSWI	Set Max Ava power Set Ava Pow relative Comm Max Ava power Comm spin reserve	-
Ava power relative	PSCSWI	100.00...400.00	1

Table 27. Network power source measurement (PSCSWI) main settings, continued

Parameter	Function	Value (Range)	Step
Demand interval	PSCSWI	1 min 5 min 10 min 15 min 30 min 180 min 60 min	-
En Ov load Amnt shed	PSCSWI	No Yes	-
Power Cfg export Mod	PSCSWI	Pow & Ava Pow No Chg Pow & Ava Pow Zero	-
Base value Sel phase	PSCSWI	Phase Grp 1 Phase Grp 2 Phase Grp 3	-
Curve parameter A	PSCSWI	0.0086...120.0000	0.0001
Curve parameter B	PSCSWI	0.0000...0.7120	0.0001
Curve parameter C	PSCSWI	0.02...2.00	0.01
Curve parameter D	PSCSWI	0.46...30.00	0.01
Curve parameter E	PSCSWI	0.0...1.0	0.1
Reset delay time	PSCSWI	0.000...60.000	0.020
Minimum operate time	PSCSWI	0.040...60.000	0.040

Table 28. Network power source measurement (NPMMXU) main settings

Parameter	Function	Value (Range)	Step
Grid1...2 connectivity	NPMMXU	External source Peer substation	-
Ov Curr Trg interval	NPMMXU	0.00...3.00	0.01
Extended LS sharing	NPMMXU	Half Half Zero full Full zero	-
Disable test request	NPMMXU	No Yes	-

Table 29. Busbar-wise load feeder measurement (LDMMXU) main settings

Parameter	Function	Value (Range)	Step
Priority L1...L10	LDMMXU	1...19	1
Inhibit L1...L10	LDMMXU	Inactive Active	-

Table 30. Network circuit breaker handling (NCBDCSWI) main settings

Parameter	Function	Value (Range)	Step
Block override	NCBDCSWI	No IED test mode Quality bad CB close Quality bad CB open CB Interm or invalid All yes	-
CB Pow consider	NCBDCSWI	Sending end IED Receiving end IED	-
Snd CB Interm time	NCBDCSWI	0...500	10
Rcv CB Interm time	NCBDCSWI	0...500	10

Table 31. Load-shedding core (LSCACLS) main settings

Parameter	Function	Value (Range)	Step
Disable LS SubNetw	LSCACLS	Yes No	-
Enable LS SubNetw1...4	LSCACLS	No Yes	-
SubNetw1...4 Man Prio	LSCACLS	0...19	1
SubNetw1...4 Man Pow	LSCACLS	0.0...999999.9	0
Operation	LSCACLS	Off On	-
SubNetw Abs offset	LSCACLS	-1000.00...1000.00	0.01
SubNetw Rel offset	LSCACLS	-100.0...100.0	1.0
Man load shed mode	LSCACLS	Disable manual LS SN Man Prio setting SN Man Pow setting SN Man Prio input SN Man Pow input	-

Table 32. Supported load-shedding functions

Functions	Description	PML630: Configuration A	PML630: Configuration B
Fast load-shedding function	Load-shedding action based on a contingency situation is triggered by the activation of the protection function or outage of a generator or grid transformer or tie feeder or a change in the network configuration (for local power network area).	x	x
Slow load-shedding function	Load-shedding action based on the operation of the overcurrent detection function for the generator or grid transformer power source or maximum demand violation on the grid tie line (for local power network area).	x	x
Manual load-shedding function	Load-shedding action based on the operator action by definition of the load-shedding priority or by the desired amount of the required load power relief (for local power network area).	x	x
Extended load-shedding function	Fast load-shedding action triggered by PML630 and accepted by PML630 in the affected power network area from the adjacent power network area when the load-shedding action in that area is insufficient, that is, lesser than the calculated value, and needs to be extended.		x

Table 33. Power system network elements with functions based on single busbar

Functions based on single busbar	Power system network elements							
					Busbars (max 6)			
	Generators/ Transformers	Grid connectivity (grid transformers)	Bus coupler/tie feeders	Load feeders/ groups	Power busbars	Load busbars	Subnetworks	External power network area connectivity
Fast load-shedding based on power balance and contingency activation	6	2	15	60	4	6	4	2
Slow load-shedding based on overload	6	2		60	4	6	4	
Slow load-shedding based on maximum demand violation at grid connection points	6	2		60	2	6	4	
Manual load-shedding based on priority or power				60	4	6	4	
Underfrequency load-shedding (using fast or manual load-shedding 'channel')				60	4	6	4	

Table 34. Power system network elements with functions based on double busbar

Functions based on double busbar (for entire network)	Power system network elements							
					Busbars (max 3)			
	Generators/ Transformers	Grid connectivity (grid transformers)	Bus coupler/ tie feeders	Load feeders/ groups	Power busbars	Load busbars	Subnetworks	External power network area connectivity
Fast load-shedding based on power balance and contingency activation	2	2	3 bus couplers/ 3 tie feeders	30	2	3	2	
Slow load-shedding based on overload	2	2		30	2	3	2	
Slow load-shedding based on maximum demand violation at grid connection points	2	2 [1)]		30	1	3	2	
Manual load-shedding based on priority or power				30	2	3	2	
Underfrequency load-shedding (using fast or manual load-shedding 'channel')				30	2	3	2	

1) Depending on bus connectivity

23. Front panel user interface

The 630 series devices can be ordered with a detached front panel user interface (HMI). An integrated HMI is available for 4U high housing. The local HMI includes a large graphical monochrome LCD with a resolution of 320 x 240 pixels (width x height). The amount of the characters and the rows fitting the view depends on the character size as the characters' width and height may vary.

15 programmable alarm LEDs can indicate 45 alarms. The local HMI offers full front panel user interface functionality with the menu navigation, menu views and operational data. In addition, the local HMI is configured automatically using PCM600 (as a part of the device configuration steps) to display the key load-shedding single-line diagram. The single-line diagram view displays the status of the critical circuit breakers like generator, grid transformer circuit breakers, network circuit breakers (bus couplers and equivalent tie feeder representation) and busbar arrangements. Additional representation like load feeders, generator and grid transformer can also be configured over and above the key load-shedding single-line diagram.

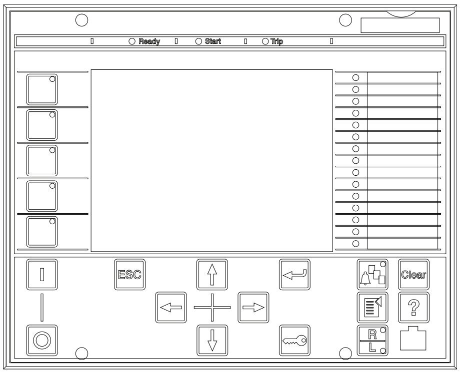

Figure 11. Local user interface

24. Mounting methods

The mounting methods for the PML630 device are identical to the 630 series protection relays. With appropriate mounting accessories, the standard case for the 630 series protection relays can be flush-mounted, semi-flush-mounted or wall-mounted. A detachable HMI is intended for optimized mounting in a medium-voltage metal-clad switchgear, thus reducing wiring between the low-voltage compartment and the panel door. Furthermore, the protection relays can be mounted in any standard 19” instrument cabinet with the 19” rack-mounting accessories.

There are different kinds of mounting methods.

- Flush mounting
- Semi-flush mounting
- Overhead or ceiling mounting
- 19” rack mounting
- Wall mounting
- Door mounting of the local HMI, protection relay case mounted in the low-voltage compartment of the switchgear

For more information on different mounting options, see the 630 series installation manual 1MRS755958 and the quick installation guide 1MRS757518.

25. Selection and ordering data

The device type and serial number label identify the load-shedding controller device. The label is placed on the side of the device case. The device labels include a set of smaller labels, one label for each module in the device. The module labels state the type and serial number of each module.

The order code consists of a string of codes generated from the hardware and software modules of the device. The ordering key information in the tables is to be used for generating the order code when ordering PML630.

U B P L A B A A A B A Z A B A A X C

#	Description	
1	**Device**	
	PML630, 4U half 19" housing & connector set	U
2	**Standard**	
	IEC	B
3	**Main application**	
	Power management	P
4	**Functional application**	
	Load shedding	L
5-6	**Analog inputs/outputs**	
	4I (I_0 1/5 A) + 5U	AA
	8 I (I_0 1/5A) + 2U	AB
7-8	**Binary inputs/outputs**	
	14BI + 9BO	AA
9	**Communication (Serial)**[1]	
	Serial glass fibre (ST connector); not used	A
10	**Communication (Ethernet)**	
	Ethernet 100Base-FX (LC connector)	A
	Ethernet 100Base-TX (RJ-45 connector)	B
11	**Communication protocol**	
	IEC 61850	A
12	**Language**	
	IEC English	Z
13	**Front panel**	
	Integrated HMI	A
	Detached HMI, 5 m cable	F
14	**Option 1**	
	Configuration A	A
	Configuration B (Configuration A + peer-to-peer communication and functionality handling)	B
15	**Option 2**	
	RIO600 integration support	A
	None	N
16	**Power supply**	
	Power supply 48-125 VDC	A
	Power supply 110-250 VDC, 100-240 VAC	B
17	**Reserved**	
	Undefined	X
18	**Version**	
	Version 1.2.1	C

1) (Not used)

Example code: UBPLAAAAAAAZAANAXC

Your ordering code:

Digit (#)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Code																		

Figure 12. Ordering key for PML630

Table 35. Order codes classified into eight major variants

Variant	Feature	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	Configuration A (for greenfield stations with Relion® 615, 620 or 630 series)	U	B	P	L	A	A	A	A	A	A/B	A	Z	A/F	A	N	A/B	X	C
2	Variant 1 + 8 CT card for current measurements for power sources' overload detection (slow load-shedding)	U	B	P	L	A	B	A	A	A	A/B	A	Z	A/F	A	N	A/B	X	C
3	Variant 1 + RIO600 integration for brownfield stations (for non-IEC 61850 or non-ABB installations)	U	B	P	L	A	A	A	A	A	A/B	A	Z	A/F	A	A	A/B	X	C
4	Variant 1 + 8 CT card for current measurements for power sources' overload detection (slow load-shedding) + RIO600 integration for brownfield stations (for non-IEC 61850 or non-ABB installations)	U	B	P	L	A	B	A	A	A	A/B	A	Z	A/F	A	A	A/B	X	C
5	Configuration B for peer PML630 device connectivity + Variant 1	U	B	P	L	A	A	A	A	A	A/B	A	Z	A/F	B	N	A/B	X	C
6	Variant 5 + 8 CT card for current measurements for power sources' overload detection (slow load-shedding)	U	B	P	L	A	B	A	A	A	A/B	A	Z	A/F	B	N	A/B	X	C
7	Variant 5 + RIO600 integration for brownfield stations (for non-IEC 61850 or non-ABB installations)	U	B	P	L	A	A	A	A	A	A/B	A	Z	A/F	B	A	A/B	X	C
8	Variant 5 + 8 CT card for current measurements for power sources' overload detection (slow load-shedding) + RIO600 integration for brownfield stations (for non-IEC 61850 or non-ABB installations)	U	B	P	L	A	B	A	A	A	A/B	A	Z	A/F	B	A	A/B	X	C

Order codes for the devices in the cPMS load-shedding solution

The recommended minimum level of order codes for the various device types in the solution cluster.

Table 36. Device order codes

Type	Order code
REF630	Any combination is compatible; last (18th digit) cannot be A.
REG630	Any combination is compatible.
REM630	Any combination is compatible; last (18th digit) cannot be A.
RET630	Any combination is compatible; last (18th digit) cannot be A.
REF620	Any combination is compatible; 9th and 10th digits cannot be AN, BN, NN. 11th digit cannnot be B, D, E and 18th digit has to be XF.
REM620	Any combination is compatible; 9th and 10th digits cannot be AN, BN, NN. 11th digit cannnot be B, D, E and 18th digit has to be XF.
RET620	Any combination is compatible; 9th and 10th digits cannot be AN, BN, NN. 11th digit cannnot be B, D, E and 18th digit has to be XF.
REF615	Any combination is compatible; 9th and 10th digits cannot be AN, BN, NN. 11th digit cannnot be B, D, E and 18th digit cannot be C.
REG615	Any combination is compatible; 9th and 10th digits cannot be AN, BN, NN. 11th digit cannot be B,D,E.
REM615	Any combination is compatible; 9th and 10th digits cannot be AN, BN, NN. 11th digit cannnot be B, D, E and 18th digit cannot be C.
RET615	Any combination is compatible; 9th and 10th digits cannot be AN, BN, NN. 11th digit cannnot be B, D, E and 18th digit cannot be C.
RIO600 (generator feeder)	Position 1: RTD4 (MOD600ARTD4), Position 2: DIM8 (MOD600ADIM8H) Configuration code (AB-LACCAADDA or AA-LACCBADDA)
RIO600 (grid transformer feeder)	Position 1: RTD4 (MOD600ARTD4), Position 2: DIM8 (MOD600ADIM8H) Configuration code (AB-LACCAADDA or AA-LACCBADDA)
RIO600 (network circuit breaker feeder)	Position 1: RTD4 (MOD600ARTD4), Position 2: DIM8 (MOD600ADIM8H) Configuration code (AB-LACCAADDA or AA-LACCBADDA)
RIO600 (load feeder)	Position 1: RTD4 (MOD600ARTD4), Position 2: DIM8 (MOD600ADIM8H), Position 3: DOM4 (MOD600ADOM4R) or SCM8H/L: MOD600ASCM8H/MOD600ASCM8L
COM600S or COM600F	9th digit cannot be S, N (R mandatory). 14th digit cannot be N (P is recommended when manual load-shedding is opted for; G is recommended to monitor IEC 61850 GOOSE traffic). 12th digit should be mandatory E or later.

The positions that are not specifically mentioned in the above table can be selected as per the project requirements.

26. Accessories

Table 37. Mounting accessories

Item	Order number
Flush mounting kit for one 4U half 19” housing device	1KHL400040R0001
Semi-flush mounting kit for one 4U half 19” housing device	1KHL400444R0001
Wall-mounting kit (cabling towards the mounting wall) for one 4U half 19” housing device	1KHL400067R0001
Wall-mounting kit (cabling to the front) for one 4U half 19” housing device	1KHL400449R0001
19" rack mounting kit for one 4U half 19” housing device	1KHL400236R0001
19" rack mounting kit for two 4U half 19” housing devices	1KHL400237R0001

Table 38. Connector sets

Item	Order number
Connector set for one 4U half 19" housing device including analog input variant 4I + 5U (Io 1/5A), 5I + 4U (Io 0.1/0.5A) or 4I + 5U (Io 0.1/0.5A)	2RCA021735
Connector set for one 4U housing device including analog input variant 8I + 2U	2RCA023039

Table 39. Optional cables

Item	Order number
LHMI cable (5m)	2RCA025073P0005

27. Tools

PML630 is delivered without factory-made pre-configuration. The default parameter setting values can be changed from the front panel user interface, the web browser-based user interface (WebHMI) or the PCM600 tool in combination with the device-specific connectivity package.

PCM600 offers extensive device configuration functions such as application configuration, parametrization, signal configuration and IEC 61850 GOOSE communication configuration.

When the web browser-based user interface is used, the device can be accessed either locally or remotely with a web browser (IE 7.0 or later). For security reasons, the web browser-based user interface is disabled by default. The interface can be enabled with the PCM600 tool or from the front panel user interface. The functionality of the interface is by default limited to read-only, but can be configured to enable reading and writing access by means of PCM600 or the local HMI.

The device connectivity package is a collection of software and specific device information which enables system products and tools to connect and interact with the device. The connectivity packages reduce the risk of errors in the system integration, minimizing device configuration and setup times.

The configurability of the device ensures the easy adaptation of load-shedding functionality to any applicable industrial power network, thus adapting to the specific requirements in the project. An efficient and low-effort engineering procedure ensures automatic completion of certain engineering steps.

- Instantiation of function blocks and their interconnections to complete the load-shedding application logic
- Instantiation of additional logic for the LHMI events engineering, function key assignment, LED assignment, test mode handling and the disturbance record configuration for Configuration A
- Instantiation of additional logic for the LHMI LED assignment and the events engineering for Configuration B
- Generation of the load-shedding single-line diagram with user-configured busbar names for the local HMI
- IEC 61850 engineering and the GOOSE signal mapping, specific to the device
- Load-shedding display configuration for COM600 when used as an HMI
- Feeder device report (Excel) with details such as location in PCM600 substation tree structure, device type, configuration version, device technical key, order/

composition code, feeder type for load-shedding functionality
- Generation of MS Excel report containing details of the outgoing load feeder IEC 61850 GOOSE configuration to facilitate easy engineering.
- RIO600 module's (BI, BO, SCM and RTD) channel allocation for a power source, network circuit breaker and load feeder can be exported as a pdf file from the device connectivity package.

The PML630 connectivity package offers several additional features for engineering the cPMS load-shedding solution conveniently. These features include 630, 620 and 615 series device-based load feeder templates for load-shedding command handling, standard parameter set and a sample reference project. Extensive logic and general application function blocks from the 630 series have been included in the device connectivity package to further enable customizing possibilities.

All other devices like REG670 or 650 series, if used, need to be configured manually.

Table 40. Tools

Description	Version
PCM600	2.5 or later
Web browser	IE 8.0, IE 9.0 or IE 10.0
PML630 Connectivity Package	1.2.1

Table 41. Supported functions

Function	Web HMI	PCM600
Parameter setting	•	•
Disturbance handling	•	•
Signal monitoring	•	•
Event viewer	•	•
Alarm LED viewing	•	•
Hardware configuration	-	•
Signal matrix	-	•
Graphical display editor	-	•
IED configuration templates	-	•
Communication management	-	•
Disturbance record analysis	-	•
IED user management	-	•
User management	-	•
Creating/handling projects	-	•
Graphical application configuration	-	•
IEC 61850 communication configuration, incl. GOOSE	-	•
IED Compare	-	•

28. Supported ABB solutions

The 630 series protection and control devices together with COM600S or COM600F constitute a genuine IEC 61850 solution for a reliable power distribution in the utility and industrial power systems. To facilitate and streamline the system engineering, the devices are supplied with the connectivity packages containing a compilation of software and device-specific information, including single-line diagram templates, manuals and a full device data model including event and the parameter lists. By utilizing the connectivity packages, the devices can be readily configured via the PCM600 Protection and Control IED Manager and integrated with COM600S or COM600F or the MicroSCADA Pro network control and management system.

The 630 series devices offer support for the IEC 61850 standard, including also horizontal GOOSE messaging. Compared to the traditional hardwired interdevice signaling, a peer-to-peer communication over a switched Ethernet LAN offers an advanced and versatile platform for the power system protection. A fast software-based communication, continuous supervision of the integrity of the protection and communication system and inherent flexibility for reconfiguration and upgrades are among the distinctive features of the protection system approach enabled by the implementation of the IEC 61850 substation automation standard.

At the substation level, COM600S or COM600F utilizes the logic processor and the data content of the bay level devices to offer enhanced substation level functionality. COM600S or COM600F features the web browser-based HMI, providing a customizable graphical display for visualizing single-line mimic diagrams for the switchgear bay solutions. To enhance personnel safety, the web HMI also enables remote access to the substation devices and processes.

Furthermore, COM600S or COM600F can be used as a local data warehouse for the technical documentation of the substation and for the network data collected by the devices. The collected network data facilitates the extensive reporting and analyzing of network fault situations using the data historian and the event-handling features of COM600S or COM600F.

COM600S or COM600F also features a gateway functionality providing seamless connectivity between the substation devices and the network level control and management systems such as MicroSCADA Pro and System 800xA.

29. Terminal diagrams

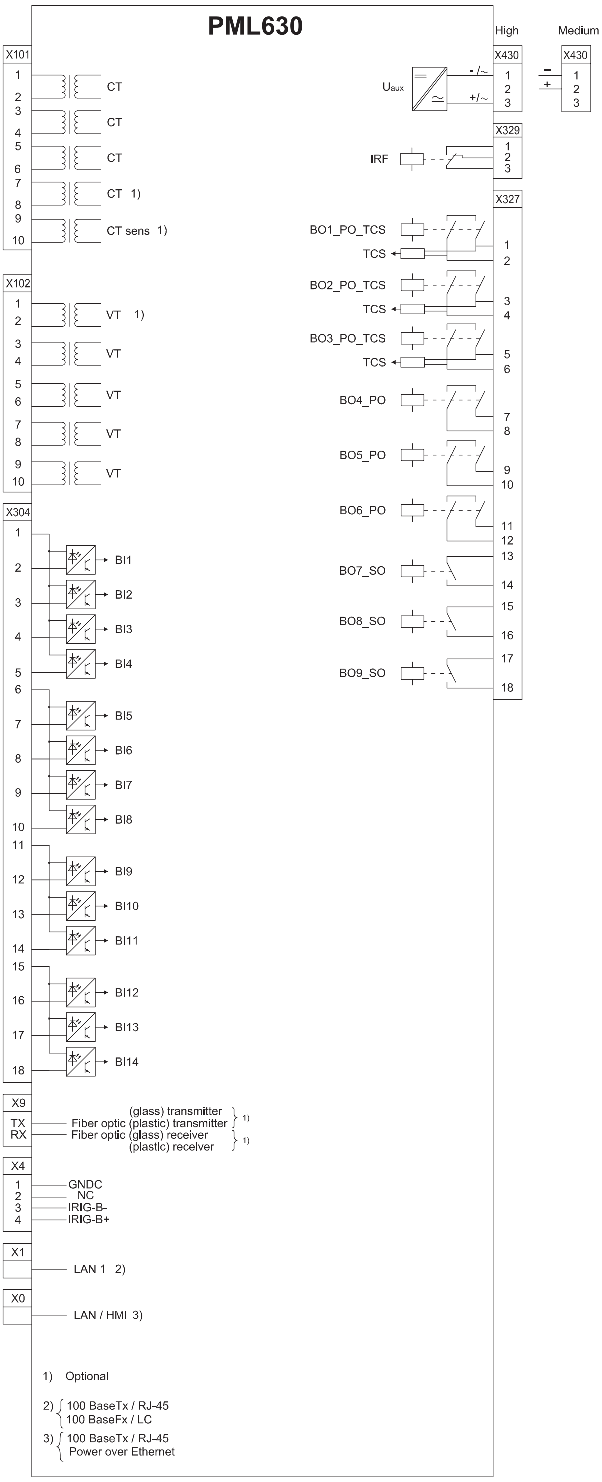

Figure 13. PML630 terminal diagram (4 CT, 5 VT)

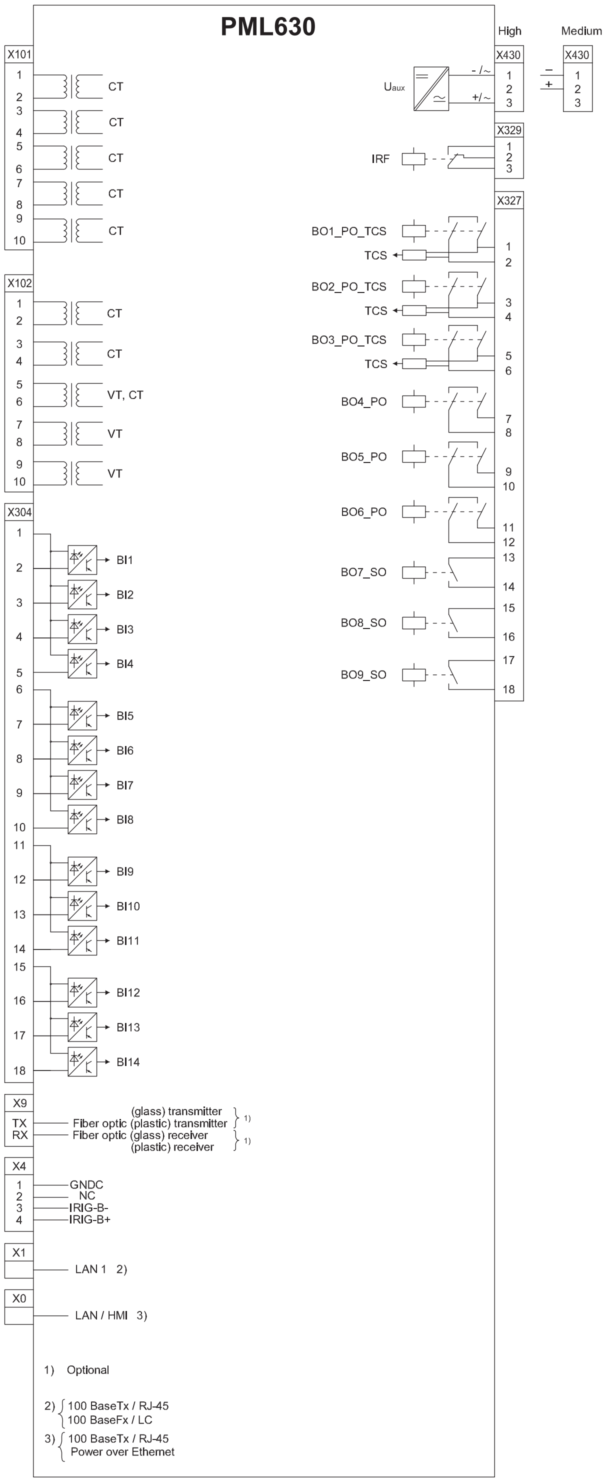

Figure 14. PML630 terminal diagram (8 CT, 2 VT)

30. References

The www.abb.com/substationautomation portal provides information on the entire range of distribution automation products and services.

The latest relevant information on the PML630 load-shedding controller is found on the product page. Scroll down the page to find and download the related documentation.

31. Functions, codes and symbols

Table 42. Functions included in the device

Functionality	IEC 61850
Generic process I/O	
Single point control (8 signals)	SPC8GGIO[1)]
Double point indication	DPGGIO[1)]
Single point indication	SPGGIO[1)]
Generic measured value	MVGGIO[1)]
Event counter	CNTGGIO[1)]
Monitoring	
Measured value limit supervision	MVEXP[1)]
Station battery supervision	SPVNZBAT[1)]
Power management (load-shedding)	
Critical circuit breaker	NCBDCSWI
Contingency based load-shedding core function	LSCACLS
Busbar-wise sheddable loads data	LDMMXU
Busbar-wise load feeders load-shedding command	LSPTRC
Power source	PSCSWI
Subnetwork supervision	SNWRCLS
Network power source	NPMMXU
Information exchange between peer PML630s	PPLSGGIO[2)]
Disturbance recorder functions	
Analog channels 1-10 (samples)	A1RADR
Analog channel 11-20 (samples)	A2RADR
Analog channel 21-30 (samples)	A3RADR[1)]
Analog channel 31-40 (calc. val.)	A4RADR[1)]
Binary channel 1-16	B1RBDR
Binary channel 17-32	B2RBDR
Binary channel 33-48	B3RBDR
Binary channel 49-64	B4RBDR[1)]
Disturbance recorder	DRRDRE
Multipurpose functions	
Position evaluate	POS_EVAL[1)]
Double point indication	DPGGIO[1)]
Multipurpose analog protection	MAPGAPC[1)]
Station communication (GOOSE)	
Binary receive	GOOSEBINRCV
Double point receive	GOOSEDPRCV

Table 42. Functions included in the device, continued

Functionality	IEC 61850
Integer receive	GOOSEINTRCV
Measured value receive	GOOSEMVRCV
Single point receive	GOOSESPRCV

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

32. Document revision history

Document revision/date	Product version	History
A/2011-05-04	1.1	First release
B/2011-11-03	1.1.1	Content updated to correspond to the product series version
C/2013-11-04	1.2	Content updated to correspond to the product series version
D/2016-08-29	1.2.1	Content updated to correspond to the product series version
E/2019-08-27	1.2.1	Content updated

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