

RELION® PROTECTION AND CONTROL

REX615

Operation Manual





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Conformity

This product complies with following directive and regulations.

Directives of the European parliament and of the council:

- Electromagnetic compatibility (EMC) Directive 2014/30/EU
- Low-voltage Directive 2014/35/EU
- RoHS Directive 2011/65/EU
- RoHS Directive (EU) 2015/863 amending Annex II

UK legislations:

- Electromagnetic Compatibility Regulations 2016
- Electrical Equipment (Safety) Regulations 2016
- The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012

These conformities are the result of tests conducted by the third-party testing in accordance with the product standard EN / BS EN 60255-26 for the EMC directive / regulation, and with the product standards EN / BS EN 60255-1 and EN / BS EN 60255-27 for the low voltage directive / safety regulation.

The product is designed in accordance with the international standards of the IEC 60255 series.

Safety information



Dangerous voltages can occur on the connectors, even though the auxiliary voltage has been disconnected.



Non-observance can result in death, personal injury or substantial property damage.



Only a competent electrician is allowed to carry out the electrical installation.



National and local electrical safety regulations must always be followed.



The frame of the protection relay has to be carefully earthed.



When the plug-in unit has been detached from the case, do not touch the inside of the case. The relay case internals may contain high voltage potential and touching these may cause personal injury.



The protection relay contains components which are sensitive to electrostatic discharge. Unnecessary touching of electronic components must therefore be avoided.



Whenever changes are made in the protection relay, measures should be taken to avoid inadvertent tripping.

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1 Introduction

1.1 This manual

The operation manual contains instructions on how to operate the protection relay once it has been commissioned. The manual provides instructions for monitoring, controlling and setting the relay. The manual also describes how to identify disturbances and how to view calculated and measured power grid data to determine the cause of a fault.

1.2 Intended audience

This manual addresses the operator, who operates the protection relay on a daily basis.

The operator must be trained in and have a basic knowledge of how to operate protection equipment. The manual contains terms and expressions commonly used to describe this kind of equipment.

1.3 Product documentation

1.3.1 Product documentation set

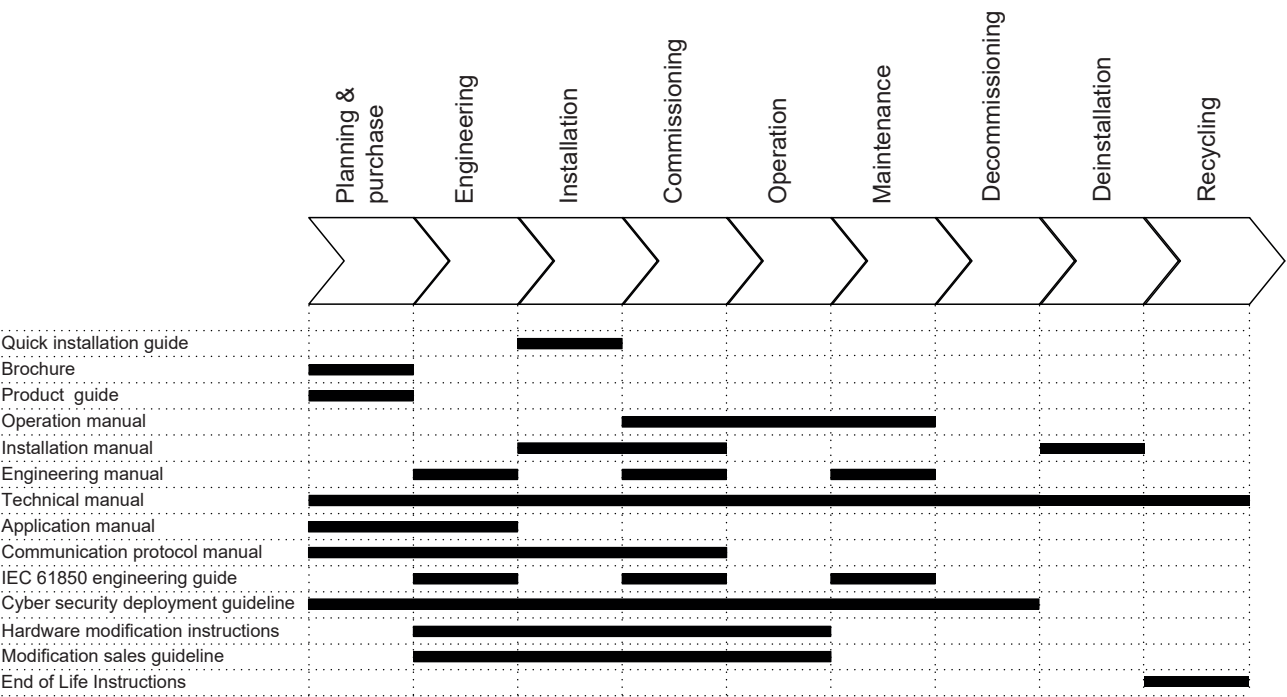


Figure 1: The intended use of documents during the product life cycle

1.3.2 Document revision history

Document revision/date	Product release	History
A/2024-03-05	PCL1	First release
B/2025-10-29	PCL1	Content updated
C/2026-02-25	PCL2	Content updated to correspond to the product connectivity level
D/2026-05-18	PCL3	Content updated to correspond to the product connectivity level

1.3.3 Related documentation



Download the latest documents from the ABB Web site www.abb.com/medium-voltage.

1.4 Symbols and conventions

1.4.1 Symbols



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



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



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



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



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

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

1.4.2 Document conventions

A particular convention may not be used in this manual.

- Abbreviations and acronyms are spelled out in the glossary. The glossary also contains definitions of important terms.
- Push-button navigation in the LHMI menu structure is presented by using the push-button icons.

To navigate between the options, use  and .

- Menu paths are presented in bold.
- Select **Main menu > Settings**.
- LHMI messages are shown in Courier font.

To save the changes in nonvolatile memory, select *Yes* and press .

- Parameter names are shown in italics.

The function can be enabled and disabled with the *Operation* setting.

- Parameter values are indicated with quotation marks.

The corresponding parameter values are "On" and "Off".

- Input/output messages and monitored data names are shown in Courier font.

When the function starts, the *START* output is set to TRUE.

- This document assumes that the parameter setting visibility is "Advanced".
- Values of quantities are expressed with a number and an SI unit. The corresponding imperial units may be given in parentheses.

- Protective earthing is indicated in figures with the symbol .

2 Environmental aspects

2.1 Sustainable development

Sustainability has been taken into account from the beginning of the product design including the pro-environmental manufacturing process, long life time, operation reliability and disposing of the device.

The choice of materials and suppliers has been made according to the EU RoHS directive (2011/65/EU) and EU RoHS Directive (2015/863/EU). These directives limit the use of hazardous substances.

Operational reliability and long life time have been ensured with extensive testing during the design and manufacturing processes. Moreover, long life time is supported by maintenance and repair services as well as by the availability of spare parts.

Design and manufacturing have been done under a certified environmental system. The effectiveness of the environmental system is constantly evaluated by an external auditing body. We follow environmental rules and regulations systematically to evaluate their effect on our products and processes.

A life cycle assessment has been done according to ISO 14040 and ISO 14044 to analyze the environmental impacts of the product throughout its entire lifecycle. The results are available in the environmental product declaration (EPD) according to ISO 14025, and this also includes a description of the constituent materials.

2.2 Disposal of a device

Before disposal, the protection relay needs to be decommissioned, and all sensitive information needs to be deleted from the relay. Instructions how to securely take the product out of use are available in the cyber security deployment guideline. After decommissioning the relay can be de-installed according to the installation manual.

End of life instructions are provided to show how to safely dismantle the relay and enable responsible recycling and disposal. Definitions and regulations of hazardous materials are country-specific and change when the knowledge of materials increases.

3 REX615 overview

3.1 Overview

REX615 is a product family of relays designed for protection, control, measurement and supervision of utility substations and industrial switchgear and equipment. The design of the relay has been guided by the IEC 61850 standard for communication and interoperability of substation automation devices.

The relays feature a draw-out-type design with a variety of mounting methods, compact size and ease of use. REX615 offers two different relay size variants, standard and wide. Relay size variant and module content can be selected according to application needs. Relay application functionality can be selected independently from the selected hardware content according to the protection application needs.

The REX615 relays support a range of communication protocols including IEC 61850 with Edition 2.1 support, process bus according to IEC 61850-9-2 LE or IEC 61869-9, IEC 60870-5-103, IEC 60870-5-104, Modbus® and DNP3. Profibus DPV1 communication protocol is supported by using the protocol converter SPA-ZC 302.

3.2 Local HMI

The LHMI is used for setting, monitoring and controlling the protection relay. The LHMI comprises the display, buttons, LED indicators and communication port.



Figure 2: Standard size LHMI

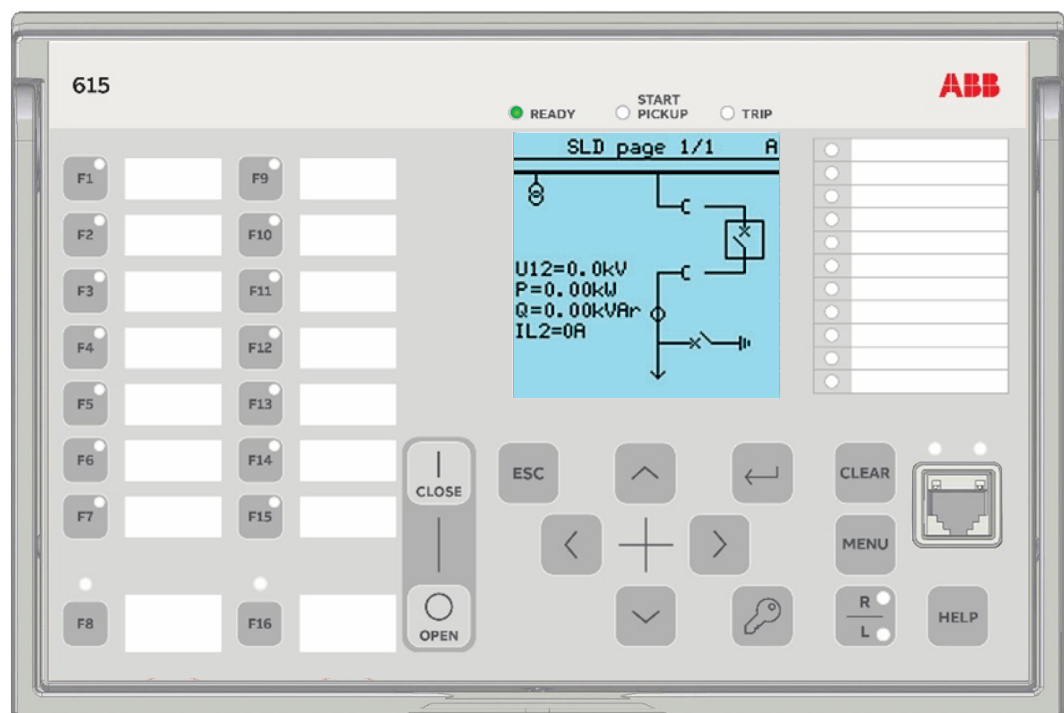


Figure 3: Wide size LHMI

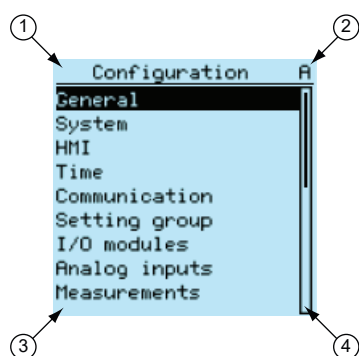
3.2.1 Display

The LHMI includes a graphical display that supports two character sizes. The character size depends on the selected language. The amount of characters and rows fitting the view depends on the character size.

Table 1: Display

Character size ⁵	Rows in the view	Characters per row
Small, mono-spaced (6 × 12 pixels)	10	20
Large, variable width (13 × 14 pixels)	7	8 or more

The display view is divided into four basic areas.



1 Header

2 Icon

3 Content

4 Scroll bar (displayed when needed)

Figure 4: Display layout

- The header area at the top of the display view shows the current location in the menu structure
- The icon area at the upper right corner of the display shows the first character of username logged in LHMI when local override is set to False, otherwise logged in username first character is not shown

Current action is indicated by the following characters:

- S: Parameters are being stored
- !: Warning and/or indication
- The content area shows the menu content.
- If the menu contains more rows than the display can show at a time, a scroll bar is displayed on the right.

The display is updated either cyclically or based on changes in the source data such as parameters or events.

3.2.2 LEDs

The LHMI includes three protection indicators above the display: Ready, Start/Pickup and Trip.

The local HMI includes 11 programmable LEDs. These LEDs can be configured to show alarms and indications as needed by PCM600 graphical configuration tool. The LEDs include two separately controllable colors, red and green, making one LED able to indicate better the different states of the monitored object.

3.2.3 Keypad

The LHMI keypad contains push buttons which are used to navigate in different views or menus. With the push buttons you can give open or close commands to objects in the primary circuit, for example, a circuit breaker, a contactor or a disconnecter. The push buttons are also used to acknowledge alarms, reset indications, provide help and switch between local and remote control mode.

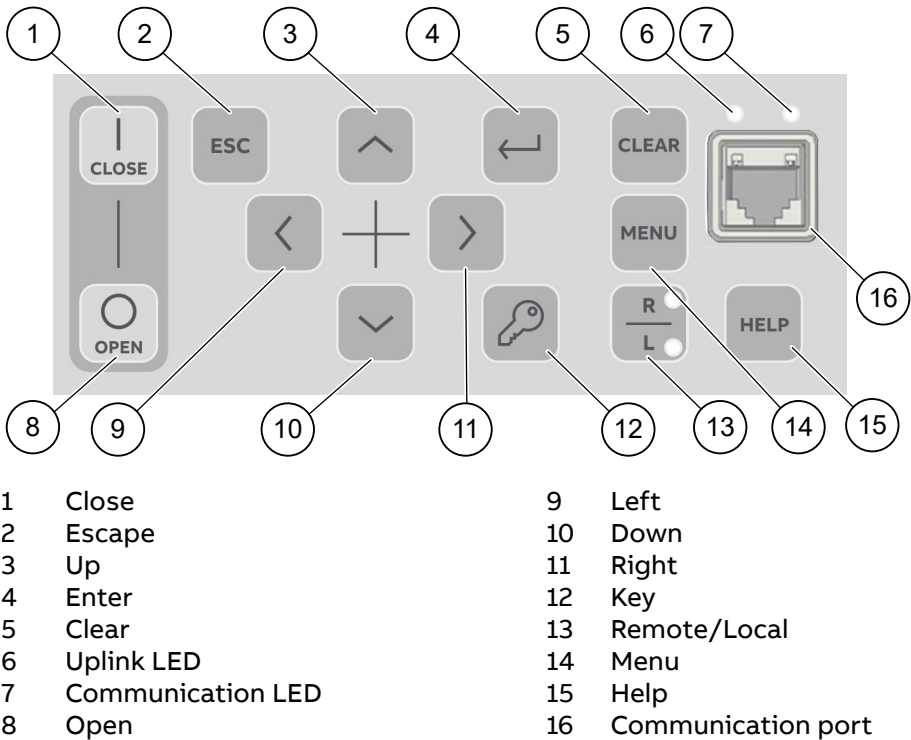


Figure 5: LHMI keypad with object control, navigation and command push buttons and RJ-45 communication port

Object control

If the control position of the protection relay is set to local with the R/L button, the relay can be controlled using the object control buttons.

Table 2: Object control push buttons

Name	Description
 Close	Closing the object.
 Open	Opening the object.

Navigation

The arrow buttons are used for navigation. To scroll information, press the arrow button several times or simply keep it pressed down.

Table 3: Navigation push buttons

Name	Description
 ESC	- Leaving setting mode without saving the values. - Cancelling certain actions. - Adjusting the display contrast in combination with  or . - Changing the language in combination with . - Running the display test in combination with . - Deleting a character in combination with  when editing a string. - Inserting a space in combination with  when editing a string.
 Enter	- Entering parameter setting mode. - Confirming a new value of a setting parameter.
 Up  Down	- Moving up and down in menus. - Scrolling active digits of a parameter when entering a new setting value.
 Left  Right	- Moving left and right in menus. - Changing the active digit of a parameter when entering a new setting value.
 Key	- Activating the authorization procedure, when the user is not logged in. - Logging out, when the user is currently logged in.

Commands**Table 4: Command push buttons**

Name	Description
 Menu	- Moving directly to main menu, if currently in any other menu. - Moving between main menu, measurements and single-line diagram views.
 R/L	Changing the control position (remote or local) of the device. When the R LED is lit, remote control is enabled and local control disabled.

Table continues on the next page

Name	Description
	- When the L LED is lit, local control is enabled and remote control disabled. - When the L and R LEDs are lit, both remote and local control are enabled. - When none of the LEDs are lit, both control positions are disabled.
 Clear	- Activating the Clear/Reset view. - Clearing indications and LEDs. The first three-second press clears the indications. The second three-second press clears the programmable LEDs. Requires appropriate user rights.
 Help	Showing context sensitive help messages.

3.2.4 Programmable push buttons with LEDs

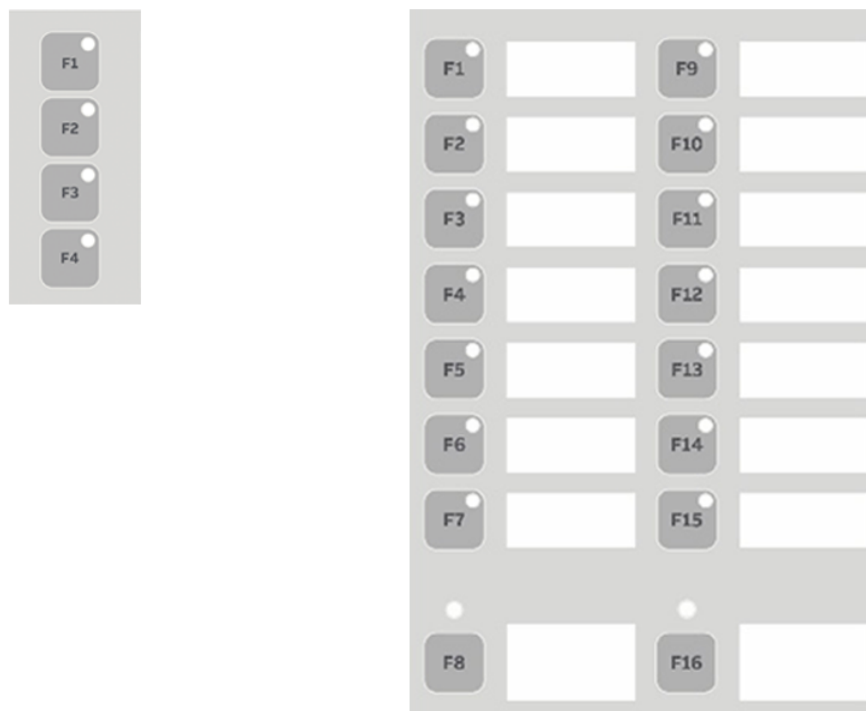


Figure 6: Programmable push buttons with LEDs for standard (4 buttons) and wide (16 buttons) units

The relay also includes configurable manual push buttons (4 buttons in standard, 16 buttons in wide), which can freely be configured by the PCM600 graphical configuration tool.

These buttons can be configured to control the relay's internal features for example changing setting group, trigger disturbance recordings and changing operation modes for functions or to control relay's external equipment, for example opening or closing the equipment, via relay's binary outputs.

These buttons also include a small indication LED for each button. This LED is freely configurable, making it possible to use push button LEDs to indicate button activities or as additional indication/alarm LEDs in addition to the 11 programmable LEDs.

3.2.5 Local HMI functionality

3.2.5.1 Protection and alarm indication

Protection indicators

The protection indicator LEDs are Ready, Start/Pickup and Trip.

Table 5: Ready LED

LED state	Description
Off	Auxiliary supply voltage is disconnected.
On	Normal operation.
Flashing	Internal fault has occurred or the protection relay is in test mode. Internal faults are accompanied by an indication message.

Table 6: Start/Pickup LED

LED state	Description
Off	Normal operation.
On	A protection function has started and an indication message is displayed. If several protection functions start within a short time, the last start is indicated on the display.
Flashing	A protection function is blocked or the protection relay is in the test and blocked mode. The blocking indication disappears when the blocking is removed or when the protection function is reset.

Table 7: Trip LED

LED state	Description
Off	Normal operation.
On	A protection function has tripped and an indication message is displayed. - The trip indication is latching and must be reset via communication or by pressing . - If several protection functions trip within a short time, the last trip is indicated on the display.

Alarm indicators

The 11 matrix programmable LEDs are used for alarm indication. All the programmable LEDs on the LHMI have two colors, green and red. For each LED, the different colors are individually controllable. The default color for alarm is red. The green color can indicate, for example, normal status or normal operation.

Table 8: Alarm indications

LED state	Description
Off	Normal operation. All activation signals are off.
On	- Non-latched mode: activation signal is still on. - Latched mode: activation signal is still on, or it is off but has not been acknowledged. - Latched flashing mode: activation signal is still on but has been acknowledged.
Flashing	- Non-latched flashing mode: activation signal is still on. - Latched flashing mode: activation signal is still on, or it is off but has not been acknowledged.

3.2.5.2

Parameter management

The LHMI is used to access the relay parameters. Three types of parameters can be read and written.

- Numerical values
- String values
- Enumerated values

Numerical values are presented either in integer or in decimal format with minimum and maximum values. Character strings can be edited character by character. Enumerated values have a predefined set of selectable values.



Changing the function block on or off affects the visibility of its parameters in the menu.



Changing the value of certain relay parameters affects the visibility or range of other parameters in the menu. This indicates which parameters or parameter values become obsolete due to the change. The relay changes the visibility or range of these parameters immediately even before the changed values have been committed.



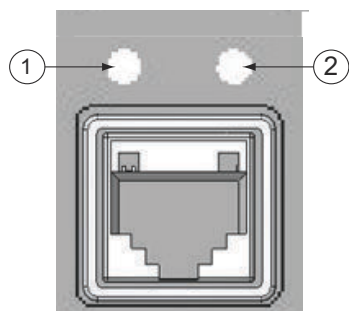
Some parameters may be hidden because the function is off or the setting visibility is set to “basic” instead of “advanced”.

3.2.5.3

Front communication

The RJ-45 port in the LHMI enables front communication. Two LEDs are located above the communication port.

- The green uplink LED on the left is lit when the cable is successfully connected to the port.
- The yellow communication LED on the right flashes when the protection relay communicates with the connected device.



1 Uplink LED

2 Communication LED

Figure 7: RJ-45 communication port and indication LEDs

The front port IP address and the corresponding subnet mask can be set via the LHMI. The front port has a factory default IP address 192.168.0.254, and it also provides DHCP server to assign an IP address for the connected computer.

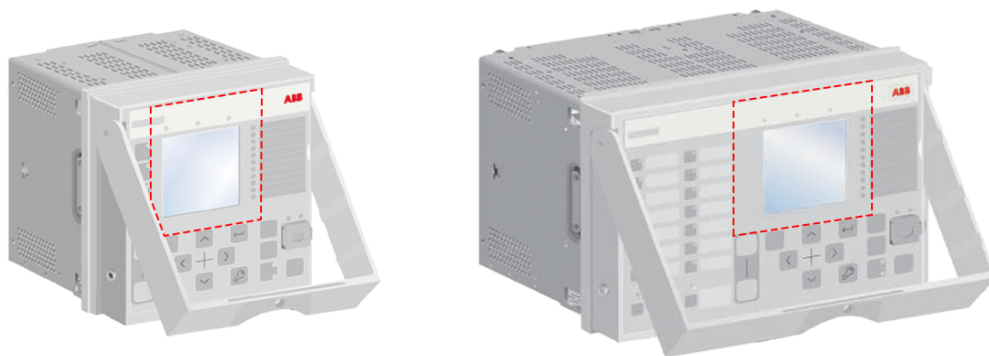
3.2.6

Handling LHMI

- More information about plug-in unit handling can be found in REX615 Quick installation guide.



It is not allowed to push or touch the screen during the plug-in unit handling.

*Figure 8: An area that is not allowed to be pushed or touched during the plug-in unit handling*

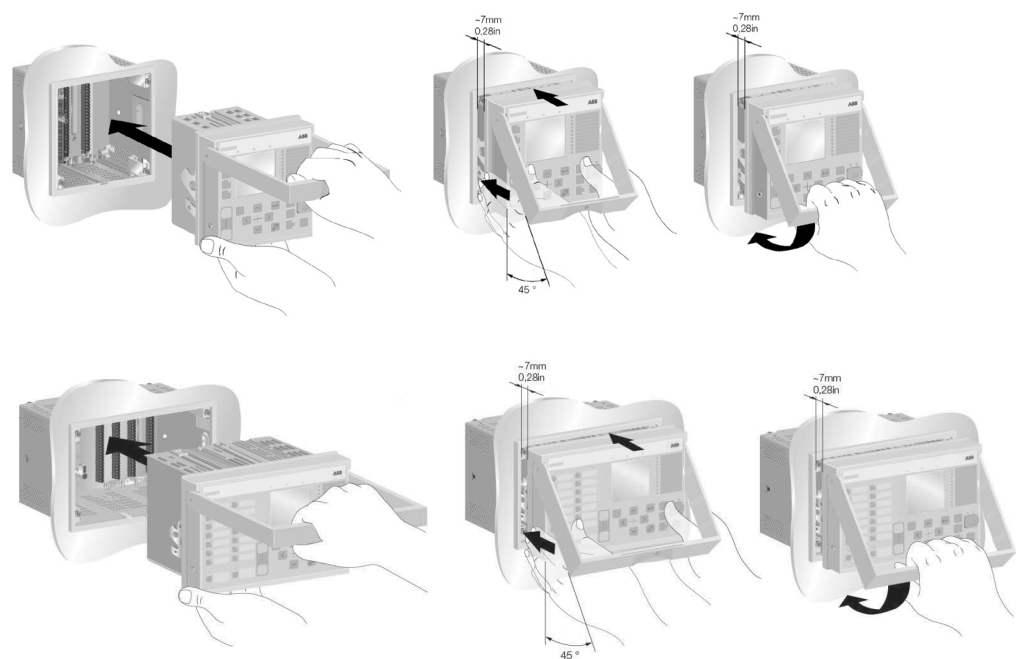


Figure 9: Example of hand positions when handling the plug-in unit

3.3 Web HMI

The WHMI allows secure access to the protection relay via a Web browser. The Web server is forced to take a secured (HTTPS) connection to WHMI using TLS encryption. The WHMI is verified with Google Chrome, Mozilla Firefox and Microsoft Edge.



WHMI is disabled by default. To enable the WHMI, select **Main Menu > Configuration > HMI > Web HMI mode** via the LHMI. Reboot the protection relay for the change to take effect.

WHMI offers several functions.

Table 9: Web HMI main groups and submenus

Main groups	Submenus	Description
Dashboard		Used to see an overview of the protection relay including status, measurements, single-line diagram and latest events
Device	Monitoring Information Self-supervision Single Line Diagram Goose and SMV	Used to navigate to monitoring, information, self-supervision, single-line diagram, Goose and SMV or clear pages

Table continues on the next page

Main groups	Submenus	Description
	Clear Change Password About	
Measurements	Measurements Phasor Diagrams	Used to navigate to the measurements or phasor diagrams
Recordings	Events Disturbance records Fault records Load Profile Record	Used to view the events, disturbance records, fault records and load profile records
Import/Export	Report Summary Import/Export Set- tings Parameter List	Used to export a parameter list or a report summary, and to import and export settings
Parameters		Used to view the menu tree structure for the protection relay's setting parameters
Language selection		Used to change the language
Logout		Used to end the session

The menu tree structure on the WHMI is almost identical to the one on the LHMI.

The screenshot displays the REX615 Web HMI interface. The top navigation bar includes links for Dashboard, Device, Measurements, Recordings, Import/Export, and Parameters. The left sidebar shows 'Device status' (Ready, Start, Trip) and 'Led Status' (Programmable LEDs LED 1 to LED 11). The main content area is divided into three sections: 'Measurements' (a table with columns for Description and Value), 'Latest Events' (a table with columns for Date & Time, Function, Description, and Event), and 'Single line diagram' (a schematic diagram). The 'About' section in the bottom right corner provides information about the device, including the Bay name (AA111Q01A1), Software version (6.2_B.58), and Setting visibility (Advanced).

DESCRIPTION	VALUE
IL1-A:1	0.0
IL2-A:1	0.0
IL3-A:1	2.0
Io-A:1	0.0
U12-kV:1	0.000
U23-kV:1	0.000
U31-kV:1	0.000

DATE & TIME	FUNCTION	DESCRIPTION	EVENT
11.03.2026 11:48:48:171	PHQVVR1	START	False
11.03.2026 11:48:48:171	PHQVVR1	MAXDUOPR	True
11.03.2026 11:47:49:756	X1/X16 port Ethernet c...	CHILLV	True
11.03.2026 11:47:41:923	Device	Boot up reason	Aux Power
11.03.2026 11:47:28:942	Device	Warning	Power down det.
11.03.2026 11:47:28:935	Device	Warning	All ok
11.03.2026 11:47:24:841	Control LLN0	LR state	Off
11.03.2026 11:47:22:940	Control LLN0	LR state	Remote
11.03.2026 11:47:21:940	Control LLN0	LR state	Local

Figure 10: Example view of the Web HMI

The WHMI can be accessed locally and remotely.

- Locally by connecting the laptop to the protection relay via the front communication port.
- Remotely over LAN/WAN.

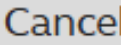
3.3.1 Command buttons

Command buttons can be used to edit parameters and control information via the WHMI.

Table 10: Command buttons

Name	Description
 Enable Edit	Enabling parameter editing
 Disable Edit	Disabling parameter editing
	Filtering the parameter list view
	Displays a tooltip with parameter information
Write to Relay	Writing parameters to the protection relay
 Refresh Values	Refreshing parameter values
 Print	Printing out parameters
Store Changes	Storing changes to protection relay's nonvolatile flash memory
Reject Changes	Rejecting changes
 Store or Reject Changes	Opening a dialog to confirm or discard changes to the parameters
	Indication that there are unsaved parameter changes. Clicking it opens a dialog to confirm or discard the changes.
<	Going to the previous event page
>	Going to the next event page
Clear from Relay	Clearing events
 Trigger Recording	Triggering the disturbance recorder manually
 Export	Saving values to TXT or CSV file format
Freeze	Freezing the values so that updates are not displayed
Continue	Receiving continuous updates to the monitoring view

Table continues on the next page

Name	Description
 Clear	Deleting the disturbance record(s)
	Saving the disturbance record files
 Clear All	Clearing all fault records
 Import Settings	Importing settings
 Export Settings	Exporting settings
 Refresh	Refreshing the parameter list view
Select Reference	Selecting reference phasor
 Change	Changing the password
 Cancel	Canceling the password change
	Logging out

3.4 Station communication

Operational information and control functions are available through a wide range of communication protocols, including IEC 61850 Edition 2, IEC 61850-9-2 LE, IEC 60870-5-103, IEC 60870-5-104, Modbus® and DNP3. Full IEC 61850 communication capabilities — such as horizontal communication between relays — are enabled exclusively through IEC 61850.

The relay provides support for two independent physical networks when communication modules with three Ethernet ports (COM8...COM10, COM15...COM18, COM31...34 and COM37) are used. These two networks can be assigned separate IP address ranges, allowing clear separation of operational traffic — for example, one network dedicated to SCADA/dispatching and the other to engineering or maintenance access.

In addition to the two physical network interfaces, the relay supports up to five VLAN interfaces, which operate as logical communication interfaces within Network1. VLAN interfaces can be used to segment traffic as needed into logically separated Ethernet networks.

Only one interface default route can be configured in the device. To support more complex communication architectures, the relay also allows configuration of

up to 10 additional static routes, enabling traffic to be directed toward specific destination networks in addition to the interface default route.

The IEC 61850 protocol forms a central part of the relay's protection and control functionality and is fully based on standardized data modelling. The relay supports both Edition 1 and Edition 2 of the standard. With Edition 2, the relay offers enhanced functionality for modern substation automation and improved interoperability. Flexible Product Naming (FPN) is supported, enabling customized adaptation of the IEC 61850 data model to project-specific naming conventions.

3.5 PCM600 tool

Protection and Control IED Manager PCM600 offers all the necessary functionality to work throughout all stages of the protection relay life cycle.

- Planning
- Engineering
- Commissioning
- Operation and disturbance handling
- Functional analysis

The whole substation configuration can be controlled and different tasks and functions can be performed with the individual tool components. PCM600 can operate with many different topologies, depending on the customer needs.



For more information, see the PCM600 documentation.

3.5.1 Connectivity packages

A connectivity package is a software component that consists of executable code and data which enables system tools to communicate with a protection relay. Connectivity packages are used to create configuration structures in PCM600. The latest PCM600 and connectivity packages are backward compatible with older protection relay versions.

A connectivity package includes all the data which is used to describe the protection relay. For example, it contains a list of the existing parameters, data format used, units, setting range, access rights and visibility of the parameters. In addition, it contains code which allows software packages that use the connectivity package to properly communicate with the protection relay. It also supports localization of text even when it is read from the protection relay in a standard format such as COMTRADE.

Update Manager is a tool that helps in defining the right connectivity package versions for different system products and tools. Update Manager is included with the products that use connectivity packages.

3.5.2 PCM600 and relay connectivity package version

- Protection and Control IED Manager PCM600 Ver 2.14 HF2 or later

- REX615 Connectivity Package Ver. 6.2.0 or later



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

3.5.3 Modification Sales

Modification Sales is a concept that provides modification support for already delivered relays. Under Modification Sales it is possible to modify both the hardware and software capabilities of the existing relay. The same options are available as when a new relay variant is configured and ordered from the factory: it is possible to add new hardware modules into empty slots, change the type of the existing modules within the slots or add software functions by adding application and, if necessary, add-on packages. If it is needed to use the possibilities provided by the Modification Sales concept, please contact your local ABB unit.

4 Using the HMI

4.1 Using the local HMI

To use the LHMI, logging in and authorization are required. Password authorization is disabled by default and can be enabled via the LHMI.



To enable password authorization, select **Configuration > Authorization > Passwords**. Set the *Local override* parameter to “False”.

4.1.1 Logging in to local HMI

1.  Press  to activate the login procedure.
2. Acknowledge the login banner notification if displayed.

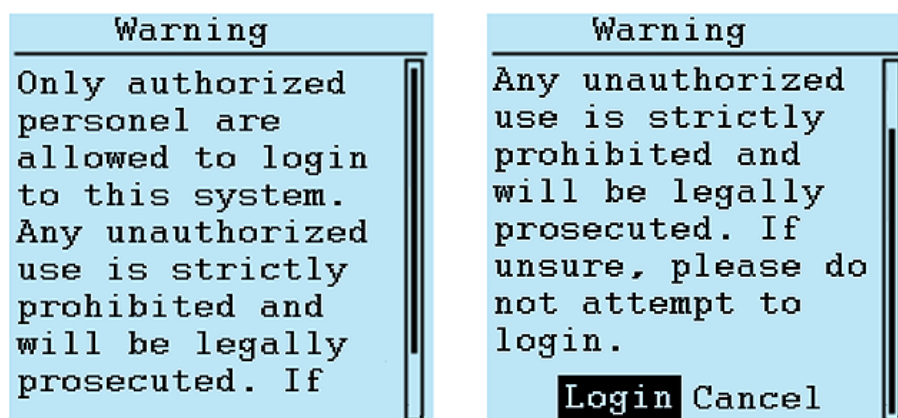


Figure 11: Sample notification on LHMI display



User Editable login banner provides a way to display a definitive warning to any possible intruders that may want to access your system that certain types of activity are illegal, but at the same time, it also advises the authorized and legitimate users of their obligations relating to acceptable use of the computerized or networked environment(s) as is required by IEC 62443-4-2 Component Requirement 1.12 System use notification. There is no login banner text defined by default.

3. Input the username with keymaps.

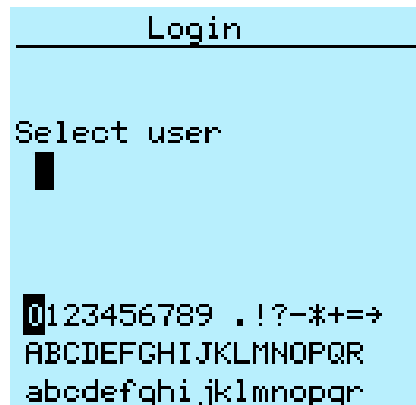


Figure 12: Input username

4. Confirm the selection with .
5. Input the password when prompted with keymaps.



Figure 13: Entering password

6. Press  to confirm the login.
 - To remove one character from left side of the cursor, press .
 - To cancel the procedure, press .

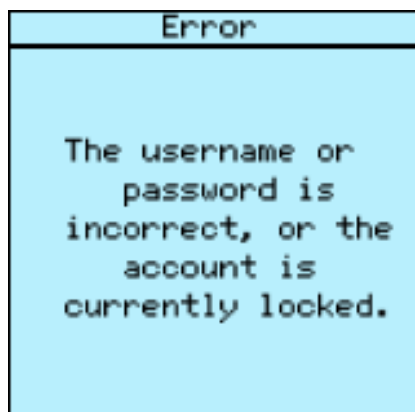


Figure 14: Error message indicating failed login

7. Press  and  to select user role.

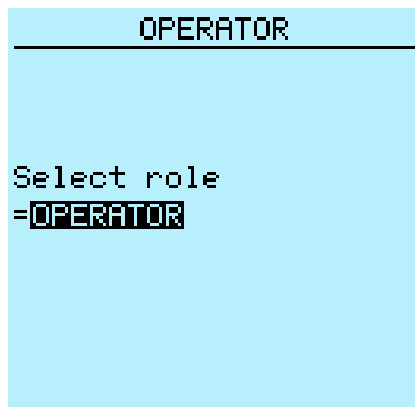


Figure 15: Selecting OPERATOR role

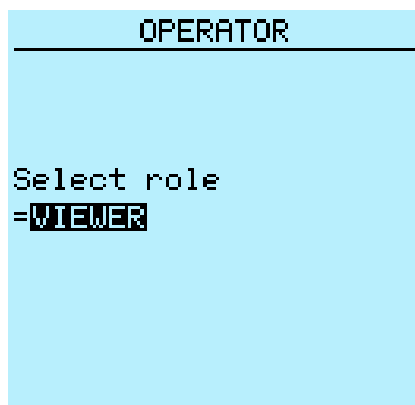


Figure 16: Selecting VIEWER role



Role select is only available when user has more than one role configured.

8. Press  to confirm the role.



The first character of the username logged in is shown on the display's upper right corner in the icon area.



When local override is disabled, user can navigate through SLD, Measurements and Main menu pages without logging in.



When the user tries to edit some parameter or to enter Settings or Configuration menus, a login dialog is shown asking for credentials.

4.1.1.1

Managing a forgotten local HMI password

OTP can be used to restore forgotten ADMINISTRATOR password. ADMINISTRATOR can reset the passwords of the users via PCM600. Support should be contacted in case ADMINISTRATOR password is forgotten.

Support advises REX615 LHMI user how to active OTP reset functionality and reset ADMINISTRATOR password.

1. Navigate via LHMI to the view where ADMINISTRATOR password should be entered.
2. Do not enter the password but press and hold down  button at least five seconds.
3. OTP ticket will be displayed on LHMI.
4. Provide to support all information given on the LHMI OTP view.

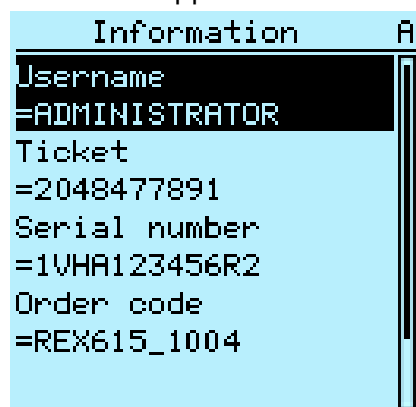


Figure 17: The LHMI OTP view

5. Support generates corresponding OTP value and provides it to the customer.
6. Navigate via LHMI to the view where ADMINISTRATOR password (OTP generated) can be entered.
7. Enter the generated OTP.
8. When OTP has been entered Relay will reset ADMINISTRATOR password to default value If OTP value was correct.
9. User can now login as ADMINISTRATOR using default password and create new password for ADMINISTRATOR.

4.1.2 Logging out of local HMI

An automatic logout occurs according to the HMI timeout parameter.

1. Press  for manual logout.
2. To confirm logout, select Yes and press .

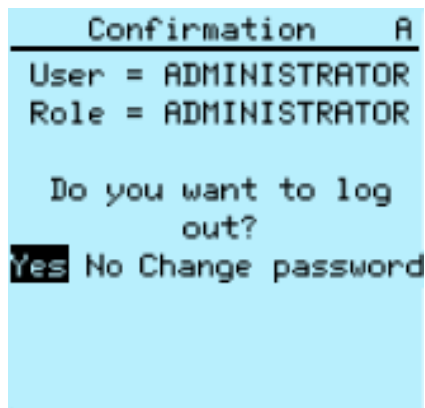


Figure 18: Logging out

- To cancel logout, press .

4.1.2.1 Changing a password in LHMI

Local override needs to be disabled to change a password in LHMI.

1. Press  for manual logout.
2. Select "Change password" and press  to select option.

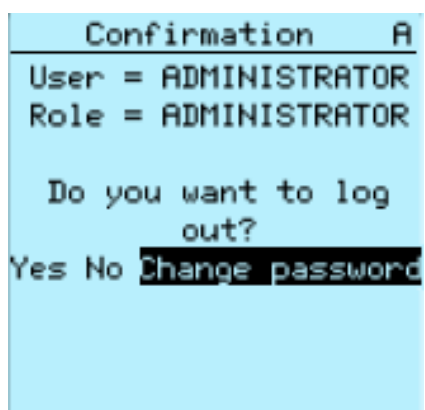


Figure 19: Selecting change password

3. Input the new password when prompted with keymap.

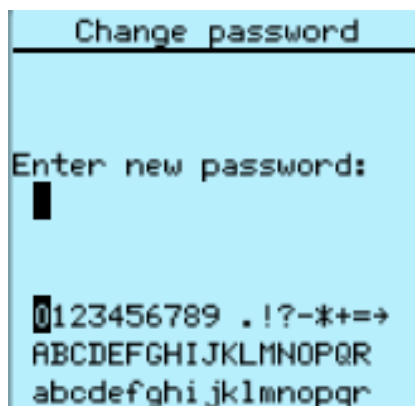


Figure 20: Entering a new password

4. Press  to confirm inputted password and activate change.

To cancel the procedure, press .

To remove one character from left side of the cursor, press .

4.1.3 Turning the display backlight on

The display backlight is normally off. It turns on during the display test at power up.

- To turn on the backlight manually, press any LHMI push button.
The backlight turns on and the panel is ready for further operations.

If the panel has not been used for a predefined timeout period, the backlight is switched off.



Change the backlight timeout period in **Main menu > Configuration > HMI > Backlight timeout.**

4.1.4 Selecting local or remote use

The control position of the protection relay can be changed with the R/L button. In local position primary equipment, such as circuit breakers or disconnectors, can be controlled via the LHMI. In remote position, control operations are possible only from a higher level, that is from a control center.

- Press  for two seconds.
 - When the L LED is lit, local control is enabled and remote control disabled.
 - When the R LED is lit, remote control is enabled and local control disabled.
 - When neither of the LEDs is lit, both control positions are disabled.

- When the L and R LEDs are lit, both remote and local control are enabled.



By default, the control position cannot be local and remote simultaneously. See the technical manual for more information on local and remote control.



To control the protection relay, log in with the appropriate user rights.

4.1.5 Identifying the device in local HMI

The Information menu includes detailed information about the device, such as revision and serial number.

1. Select **Main menu > Information**.

2. Select a submenu with  and .

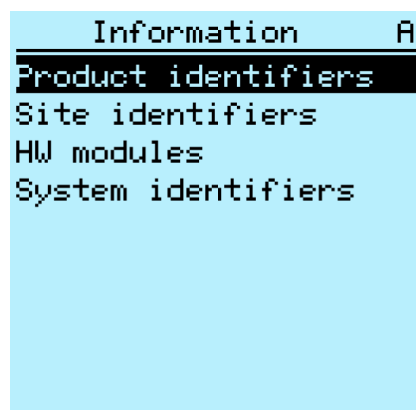


Figure 21: Selecting a submenu

3. Enter the submenu with .

4. Browse the information with  and .

```
Product identifiers A
Type
=REX615
Product version
=1
Serial number
=1XXXXXXXXXXXX
Production date
=29.08.2023 0:00:00...
```

Figure 22: Protection relay information

4.1.5.1 Identifying relay's IEC 61850 version

The relay's IEC 61850 version information identifies if the relay is configured as Edition 1 or Edition 2 device.

1. Select **Main menu > Information > System identifiers.**
2. Enter the submenu with .

```
System identifiers A
Technical key
=BAY1
IEC 61850 version
=Edition 2.1
Engineering model
=ABB
```

Figure 23: Identifying IEC 61850 version

4.1.6 Adjusting the display contrast

Adjust the display contrast anywhere in the menu structure to obtain optimal readability.

- To increase the contrast, press simultaneously  and .
- To decrease the contrast, press simultaneously  and .

The selected contrast value is stored in the non-volatile memory if you are logged in and authorized to control the protection relay. After an auxiliary power failure, the contrast is restored.

4.1.7 Changing the local HMI language

1. Select **Main menu > Language** and press .
2. Change the language using  or .
3. Press  to confirm the selection.
4. Commit the changes.



Figure 24: Changing the LHMI language



To change the language using a shortcut, press  and  simultaneously anywhere in the menu.

4.1.8 Changing display symbols

Use the keypad to switch between the display function block symbols IEC 61850, IEC 60617, ANSI and CHINESE.

1. Select **Main Menu > Configuration > HMI > FB naming convention** and press .
2. Change the display symbols with  or .
3. Press  to confirm the selection.



The relay WHMI view has to be refreshed or Logout/Login must be performed if the WHMI display symbols are changed. With the LHMI, the change takes effect immediately.

4.1.9 Changing setting visibility

The basic settings contain the most used parameters. The advanced settings contain all parameters.

1. Select **Main Menu > Configuration > HMI > Setting visibility** and press .
2. Change the setting visibility with  or  to select which parameters are shown.
 - Basic
 - Advanced
3. Press  to confirm the selection.

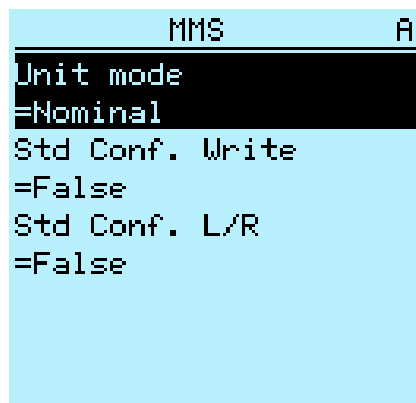


Figure 25: Viewing basic parameters

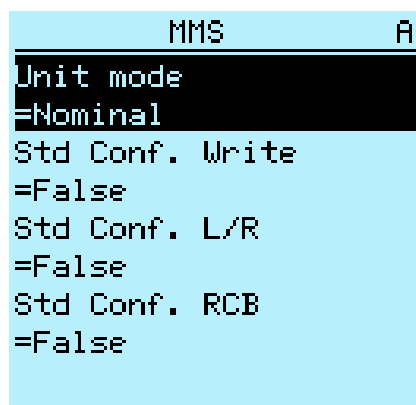


Figure 26: Viewing advanced parameters

4.1.10 Navigating in the menu

Navigate the menus and change the display views on the screen with the keypad.

- To navigate between main menu, measurements and single-line diagram, press



- To move up or down in a menu, press or .
- To move downwards in the menu tree, press .
- To move upwards in the menu tree, press .
- To enter setting mode, press .
- To leave setting mode without saving, press .

4.1.10.1 Menu structure

The Main menu contains main groups which are divided further into more detailed submenus.

- Control
- Events
- Measurements
- Disturbance records
- Settings
- Configuration
- Monitoring
- Tests
- Information
- Clear
- Language

4.1.10.2 Scrolling the display

If a menu contains more rows than the display can show at a time, a scroll bar is displayed on the right.

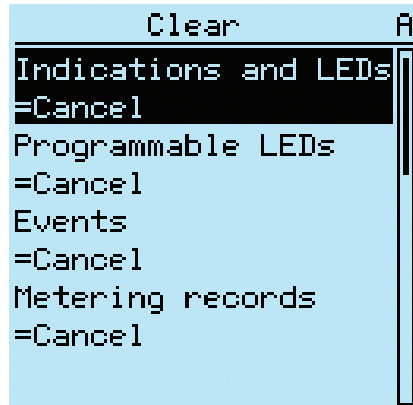


Figure 27: Scroll bar on the right

- To scroll the view upwards, press .
- To scroll the view downwards, press .
- To jump from the last row to the first row, press  again.
- Press  to jump from the first row to the last row.
- To scroll parameter names and values that do not fit the screen, press .
- Press  once to return to the beginning.

4.1.10.3 Changing the default view

The default view of the display is **Measurements** unless set otherwise.

1. Select **Main menu > Configuration > HMI > Default view** and press .
2. Change the default view with  or .
3. Press  to confirm the selection.

4.1.11 Viewing single-line diagram

The single-line diagram is created with PCM600.

- Select **Main menu > Control > SLD** to view the single-line diagram or press  to navigate between main menu, measurement and single-line diagram.



Select the single-line diagram for the default view in **Main menu > Configuration > HMI > Default view**.



When single-line diagram is selected as the default view, the first single-line diagram page is shown when the default view is entered. The single-line diagram page can be changed using the left and right push buttons.

4.1.11.1

Changing single-line diagram symbol formats

1. Select **Main menu > Configuration > HMI > SLD symbol format** and press .
2. Change symbol format with  or .
3. Press  to confirm the selection.

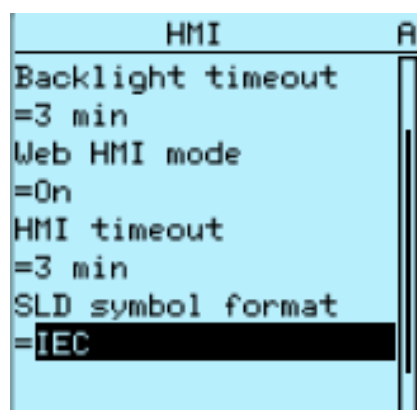


Figure 28: Selecting IEC as single-line diagram symbol format

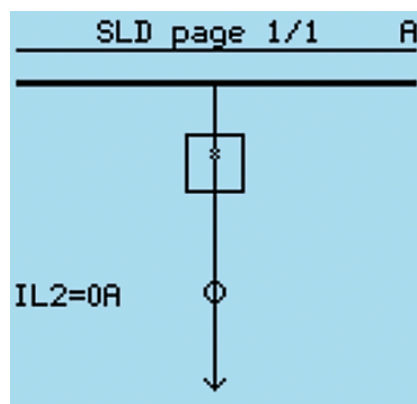


Figure 29: Single-line diagram with one breaker and IEC symbols

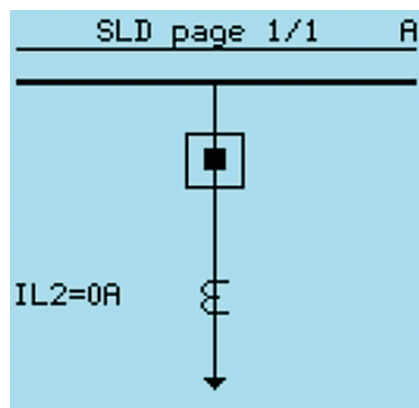


Figure 30: Single-line diagram with one breaker and ANSI symbols

4.1.12 Browsing setting values

1. Select **Main menu** > **Settings** > **Settings** and press .
2. Select the setting group to be viewed with  or .

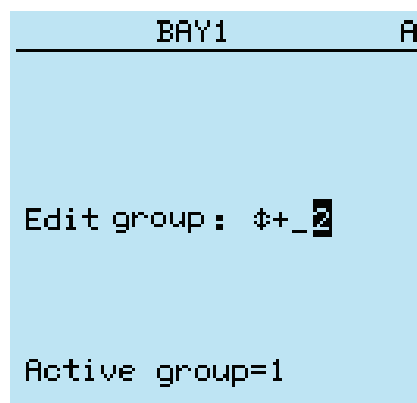


Figure 31: Selecting a setting group

3. Press  to confirm selection.

4. To browse the settings, scroll the list with  and  and to select a submenu press . To move back to the list, press .

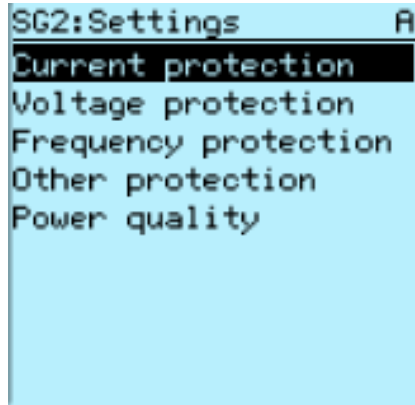


Figure 32: Example of submenus in the Settings menu



Some parameters may be hidden because the function is off or the setting visibility is set to “basic” instead of “advanced”.

4.1.13

Editing values

To edit values, log in with the appropriate user rights.

- Changing the function block on or off affects to the visibility of its parameters in the menu. Setting function block off hides the function parameters. When changing function block on or off the parameters' visibility changes immediately.



Commit the settings for the activation of the function.

- Changing the value of certain relay parameters affects the visibility or range of other parameters in the menu. This indicates which parameters or parameter values become obsolete due to the change. The relay changes the visibility or range of these parameters immediately.



Commit the settings for the activation of the function.

4.1.13.1

Editing numerical values

- Select **Main menu** > **Settings** and then a setting.
The last digit of the value is active.
 - When the symbol in front of the value is ↑, the active value can only be increased.
 - When the symbol is ↓, the active value can only be decreased.

- When the symbol in front of the value is $\updownarrow$, the active value can either be increased or decreased.

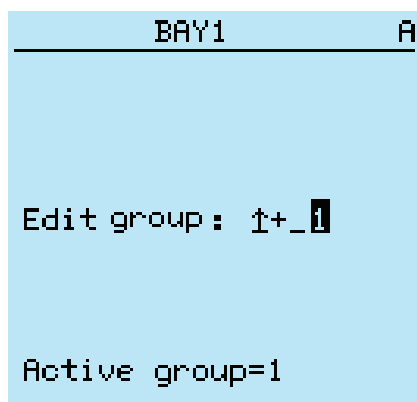


Figure 33: Last digit is active and it can only be increased

2. Press  to increase or  to decrease the value of an active digit.
One press increases or decreases the value by a certain step. For integer values, the change is 1, 10, 100 or 1000 (...) depending on the active digit. For decimal values, the change can be fractions 0.1, 0.01, 0.001 (...) depending on the active digit.



For parameters with defined steps, digits smaller than the step value cannot be edited.

3. Press  or  to move the cursor to another digit.
4. To select the minimum or maximum value, select the arrow symbol in front of the value.
 - To set the value to the maximum, press .
 - To set the value to the minimum, press .

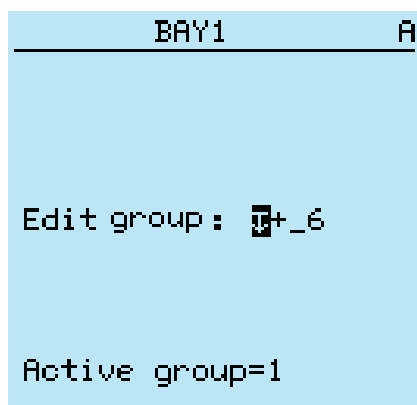


Figure 34: Arrow symbol is active, the value is set to the maximum

After pressing , the previous value can be restored by pressing  once, and vice versa. Another press of  or  sets the value to the lower or higher limit. The symbol in front of the value is ↕, when the previous value is shown.



Figure 35: Restoring the previous value

4.1.13.2 Editing string values

1. Activate the setting mode and select a setting.
When editing string values, the cursor moves to the first character.
2. Press  or  to change the value of an active character.
One press changes the value by one step.
3. Press  or  to move the cursor to another character.
 - To insert characters or space, press simultaneously  and .
 - To delete characters, press simultaneously  and .

4.1.13.3 Editing enumerated values

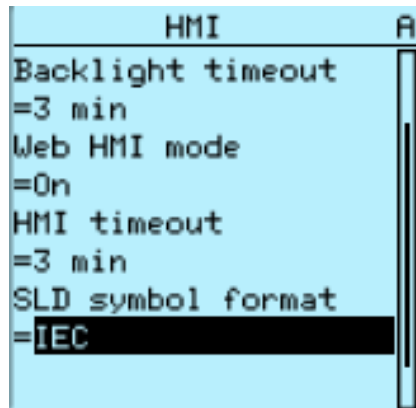


Figure 36: Example of editing enumerated values

1. Activate the setting mode and select a setting.
When editing an enumerated value, the selected value is shown inverted.
2. Press  or  to change the value of an active enumerated value.
One press changes the enumerated value by one step in the parameter specific order.

4.1.14 Committing settings

Editable values are stored either in RAM or in non-volatile flash memory. Values stored in flash memory are in effect also after reboot.

Some parameters have an edit-copy. If editing is cancelled, the values with an edit-copy are immediately restored to the original value. The values without an edit-copy, such as string values, are restored to the original value only after a reboot even though the edited value is not stored in the flash memory.

1. Press  to confirm any changes.
2. Press  to move upwards in the menu tree or  to enter the Main Menu.
3. To save the changes in non-volatile memory, select **Yes** and press .

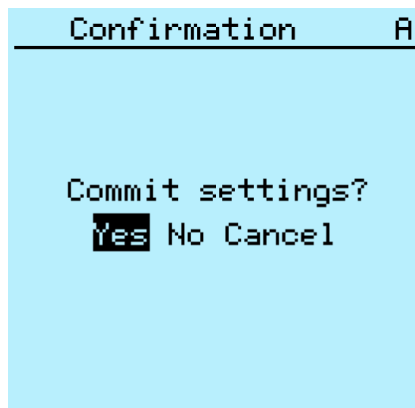


Figure 37: Confirming settings

- To exit without saving changes, select **No** and press .
 - If the parameter has an edit-copy, the original parameter value is restored.
 - If the parameter does not have an edit-copy, the edited parameter value remains visible until the protection relay is rebooted. However, the edited value is not stored in non-volatile memory and the reboot restores the original value.
- To cancel saving settings, select **Cancel** and press .



After certain parameters are changed, the protection relay has to be restarted.

4.1.15 Clearing and acknowledging

The Clear button is used to reset, acknowledge or clear all messages and indications, including LEDs and latched outputs as well as registers and recordings. Press the Clear button to activate a selection menu, and select the wanted clearance or reset function. Events and alarms assigned to programmable LEDs are cleared with the Clear button as well.

1. Press  to activate the Clear view.

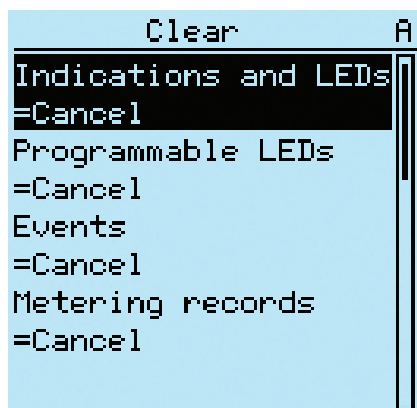


Figure 38: Clear view

2. Select the item to be cleared with  or .
3. Press , change the value with  or  and press  again. The item is now cleared.
4. Repeat steps 2 and 3 to clear other items.



Use the  button as a shortcut for clearing. If you keep the button pressed, after 3 seconds there is a yes/no confirmation to clear indications. If you continue to keep the  button pressed for 3 more seconds, there is a yes/no confirmation to clear programmable LEDs and if you still keep the  button pressed for 2 more seconds after this, there is a yes/no confirmation to clear all.

4.1.16 Using the local HMI help

1. Press  to open the help view.
2. Scroll the text with  or  if the help text exceeds the display area.
3. To close the help, press .

4.2 Using the Web HMI

WHMI is disabled by default, and can be activated in the protection relay configuration. As secure communication is enabled by default, the WHMI must be accessed from a Web browser using the HTTPS protocol. Three simultaneous WHMI sessions are supported.

1. To enable the WHMI, select **Main menu > Configuration > HMI > Web HMI mode**.
2. Reboot the relay for the change to take effect.
3. Log in with the proper user rights to use the WHMI.



To establish a remote WHMI connection to the protection relay, contact the network administrator to check the company rules for IP and remote connections.

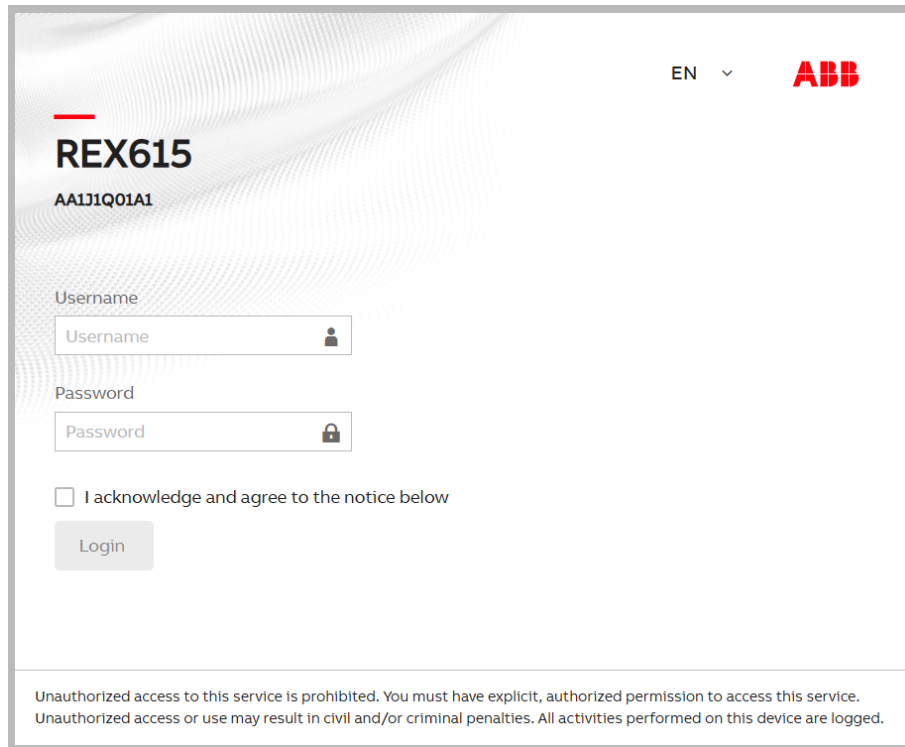


Disable the Web browser proxy settings or make an exception to the proxy rules to allow the protection relay's WHMI connection, for example, by including the relay's IP address in **Internet Options > Connections > LAN Settings > Advanced > Exceptions**.

4.2.1 Logging in to Web HMI

1. Open a supported web browser.
2. Type the protection relay's IP address in the address bar and press ENTER.
3. Type the username and password.

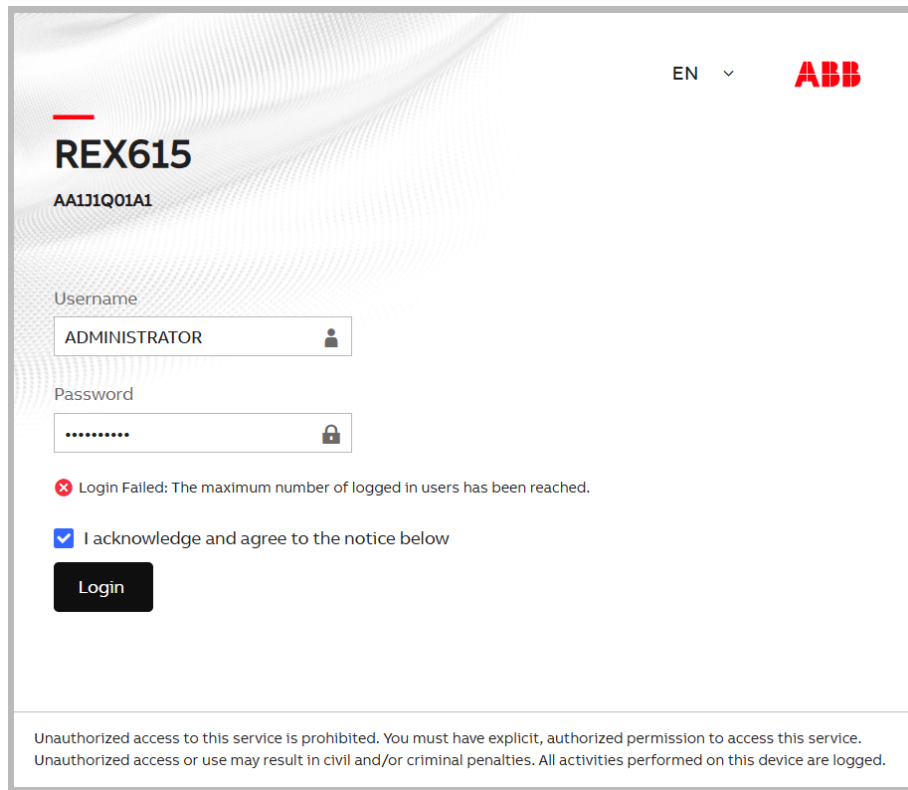
4. Check the “I acknowledge and agree to the notice below” box if it is shown.



The login dialog for the REX615 device (AA1J1Q01A1) features a clean, modern interface. At the top right, the language is set to 'EN' with a dropdown arrow, and the ABB logo is displayed. The device name 'REX615' and its ID 'AA1J1Q01A1' are prominently shown. Below this, there are input fields for 'Username' and 'Password', each with a corresponding icon (a person for username and a lock for password). A checkbox labeled 'I acknowledge and agree to the notice below' is positioned above a 'Login' button. At the bottom, a small text box contains a legal disclaimer: 'Unauthorized access to this service is prohibited. You must have explicit, authorized permission to access this service. Unauthorized access or use may result in civil and/or criminal penalties. All activities performed on this device are logged.'

Figure 39: Login dialog with user-configurable legal text and acknowledgement checkbox

5. If logging in fails because all sessions are used, an error message is shown on the login page.



The screenshot shows the login interface for the REX615 device. At the top right, there is a language selector set to 'EN' and the ABB logo. The device name 'REX615' and its identifier 'AA1J1Q01A1' are displayed. Below this, there are input fields for 'Username' (containing 'ADMINISTRATOR') and 'Password' (masked with dots). A red error message with a cross icon states: 'Login Failed: The maximum number of logged in users has been reached.' Below the error message is a checked checkbox for 'I acknowledge and agree to the notice below' and a 'Login' button. At the bottom, a disclaimer states: 'Unauthorized access to this service is prohibited. You must have explicit, authorized permission to access this service. Unauthorized access or use may result in civil and/or criminal penalties. All activities performed on this device are logged.'

Figure 40: Web HMI error message

6. Select the role if an additional view opens.

This view opens if there are several user roles configured.

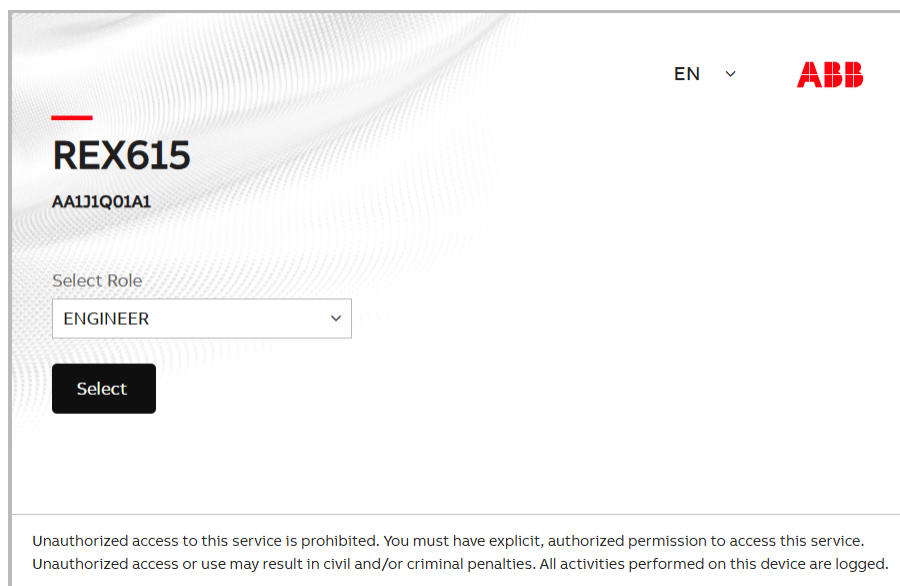


Figure 41: Selecting user role

The progress indicator is displayed until the WHMI opens and the dashboard view is shown.



It is recommended to disable the auto-complete feature, which is usually enabled by default, in the Web browser to prevent the usernames and passwords from being stored in the browser's cache.

4.2.1.1

Managing a forgotten Web HMI password

OTP can be used to restore forgotten ADMINISTRATOR password. ADMINISTRATOR can reset the passwords of the users via PCM600. OTP functionality in REX615 is available only via front port by WHMI. Support should be contacted in case ADMINISTRATOR password is forgotten. Use either default 192.168.0.254 or custom LHMI ip address.

1. Support gives URL to OTP page: https://ip_address/otp.html
2. User types https://ip_address/otp.html in browser.

- 3. OTP related information page will be displayed as below.

EN

ABB

REX615 - AA1J1Q01A1

One Time Password

Username

Username

Password (OTP)

Password (OTP)

Reset

Username:

ADMINISTRATOR

Ticket:

1979495903

Serial number:

1VHA123456R2

Order code:

REX615_1004

Figure 42: OTP related information page

- 4. User sends the information back to support
- 5. Support generates OTP and sends OTP to customer
- 6. User enters ADMINISTRATOR as username and OTP value.

EN

ABB

REX615 - AA1J1Q01A1

One Time Password

Username

ADMINISTRATOR

Password (OTP)

.....

Reset

Username:

ADMINISTRATOR

Ticket:

1979495903

Serial number:

1VHA123456R2

Order code:

REX615_1004

Figure 43: Entering ADMINISTRATOR as username and OTP value

7. In case password was reset successfully following message is shown:

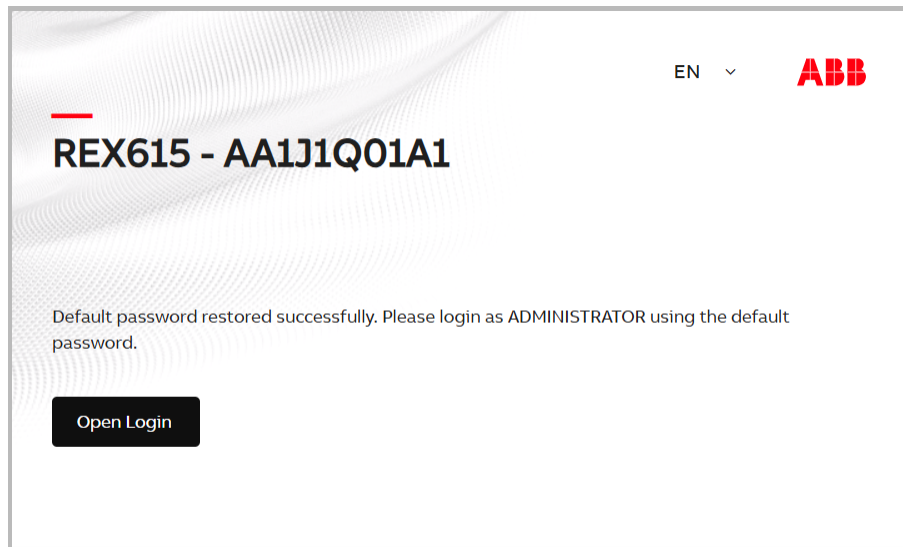


Figure 44: Password restored successfully message

8. If password reset failed error message is displayed as below:

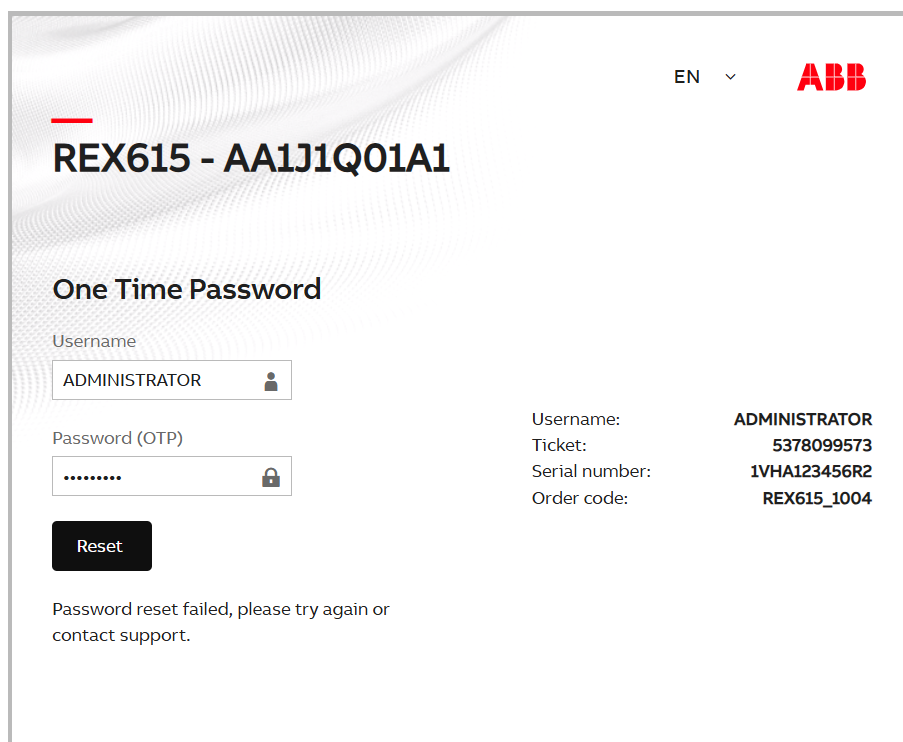


Figure 45: Password reset failed message

9. User shall check that correct OTP password is entered or contact support.

4.2.2 Logging out of Web HMI

The user is logged out after session timeout. By default, the timeout duration is three minutes. The timeout can be set in **Main menu > Configuration > HMI > HMI timeout**.

-  To log out manually, click **Logout** on the menu bar.

4.2.3 Navigating in menus

The menu bar contains main groups which are divided further into more detailed submenus. Refer to [Table 9](#) for more information.

- Use the menu bar to access different views.

4.2.4 Identifying device in Web HMI

The Information menu includes detailed information about the device, for example, revision and serial number.

1. Select **Device** on the menu bar.
2. Select **Information**
3. Click a submenu to see the data.

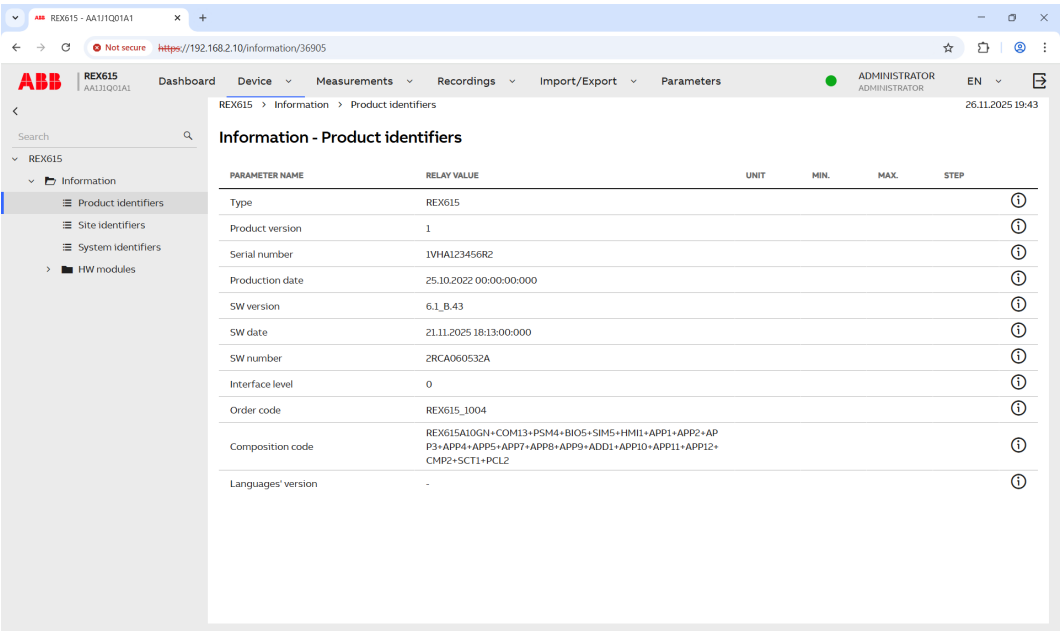


Figure 46: Viewing device information

4.2.5 Viewing dashboard

The Dashboard view is active automatically after logging in to WHMI and provides an overview of the protection relay including, the device status, measurements, single-line diagram, programmable LEDs status and the latest events.

- Select **Dashboard** on the menu bar to view the dashboard.

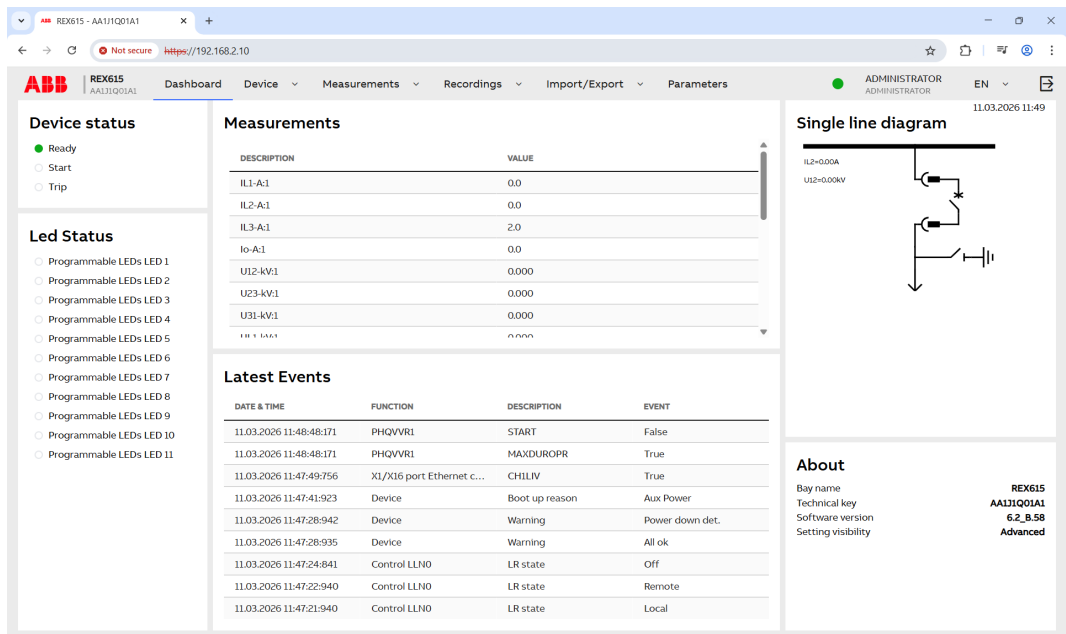


Figure 47: Viewing dashboard

4.2.6 Viewing self-supervision

1. Select **Device** on the menu bar.
2. Select **Self-Supervision**. The Self-Supervision view shows currently active internal faults and warnings.



Figure 48: Self-supervision: one internal fault is currently active

4.2.7 Changing language

The active language of the Web server session is indicated in the caption of the menu bar button.

1. Click the active language button to view all available languages.
2. Select the language from the drop-down list.

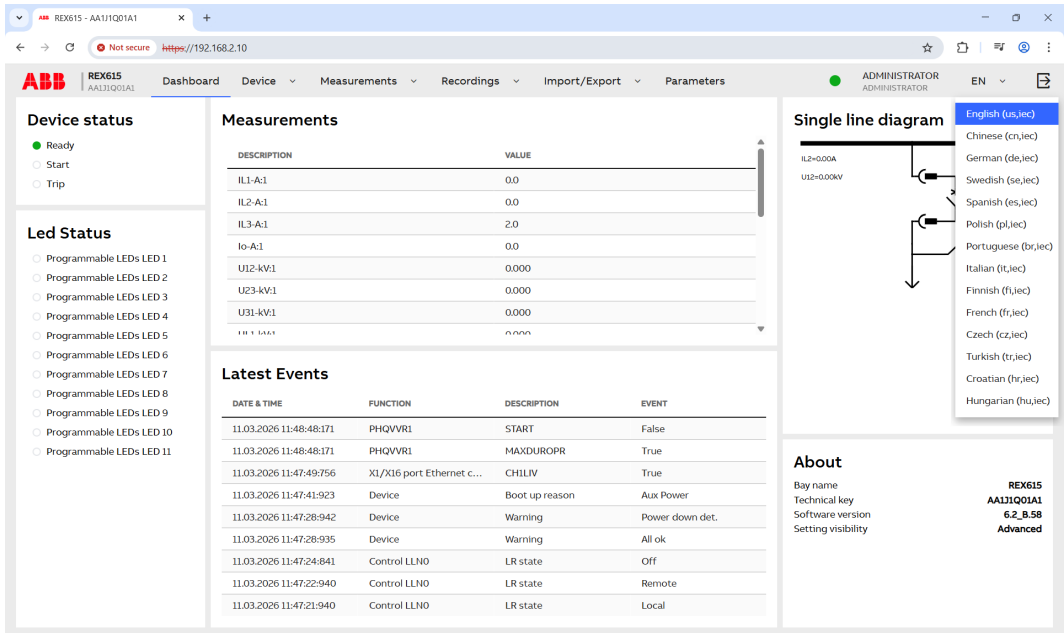


Figure 49: Changing language

4.2.8 Changing password in Web HMI

1. Select **Device** on the menu bar.

2. Select **Change Password** from the drop-down list.

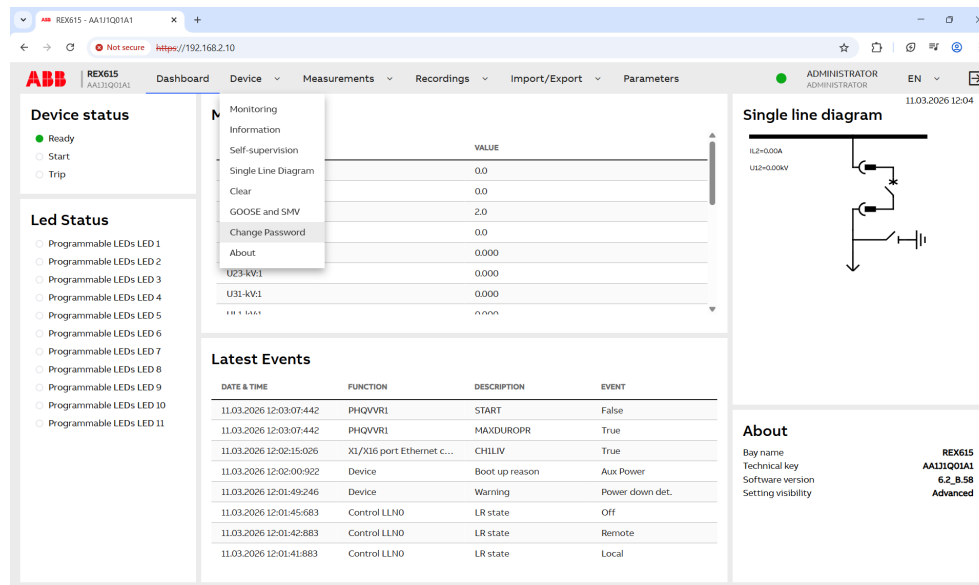


Figure 50: Selecting **Change Password**

This action will prompt the password modification dialog. Within this dialog, users must input their current password and set a new password, confirming the new entry to ensure accuracy.

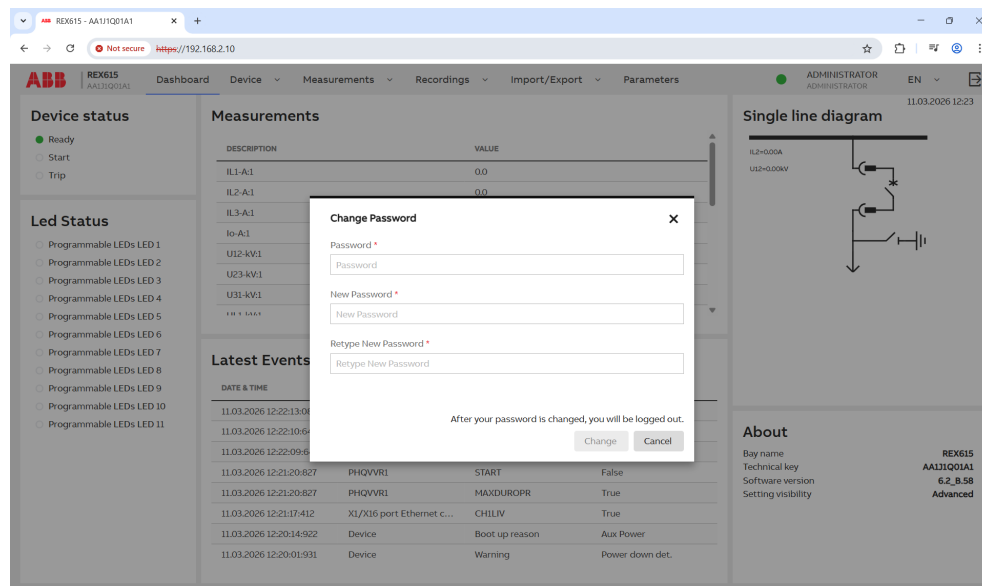


Figure 51: Password modification dialog

If the new password entries do not match, an error message will be displayed following the attempt to change the password.

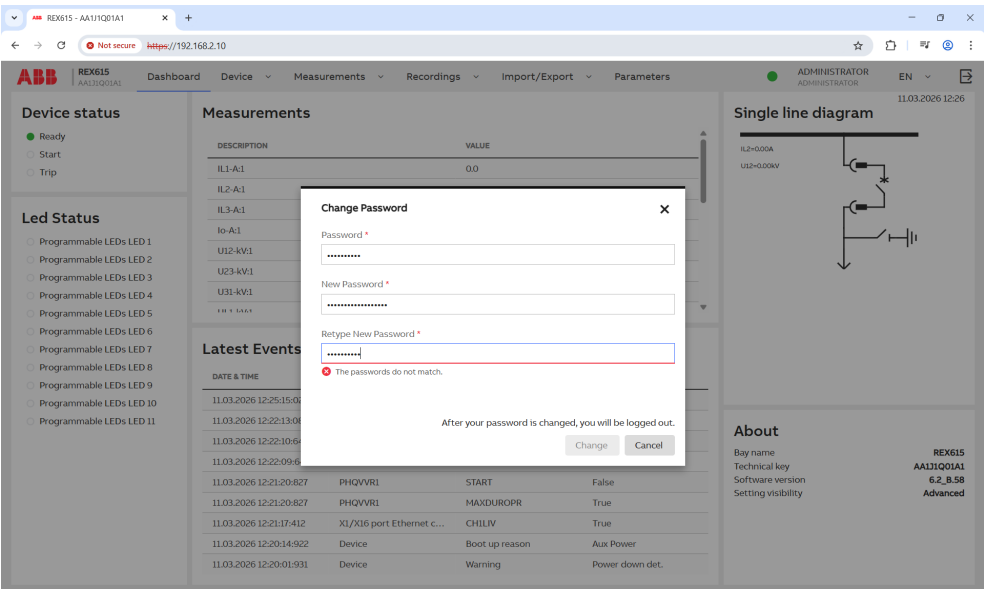


Figure 52: Password error message

Upon successful password change, the user will be automatically logged out.

4.2.9 Viewing monitoring

1. Select **Device** on the menu bar.
2. Select **Monitoring** from the drop-down list.
3. Select the monitored view from the left navigation bar.

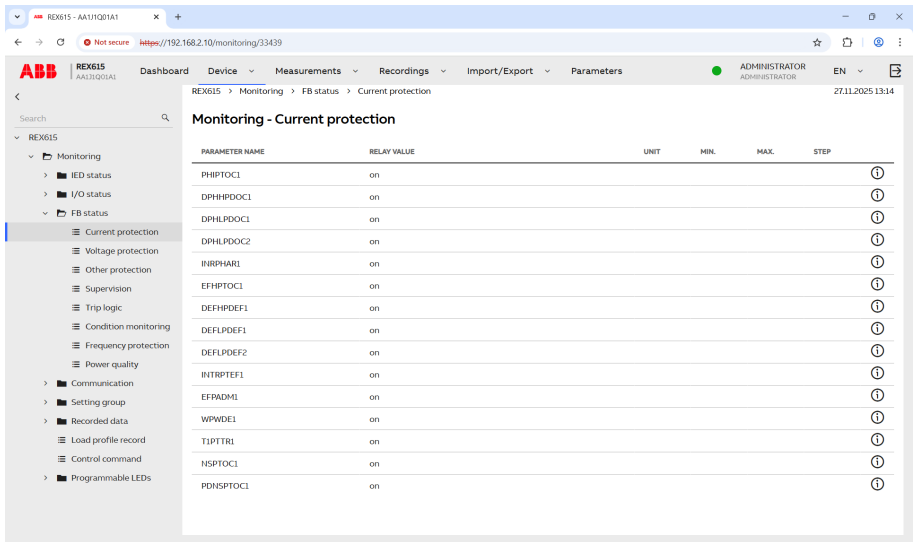


Figure 53: Monitoring data

4.2.10 Selecting single-line diagram

The single-line diagram is displayed on the dashboard and the Single Line Diagram page. All configured SLD pages are displayed next to each other in the WebHMI SLD page.

1. Select **Device** on the menu bar.
2. Select **Single Line Diagram** to view the single-line diagram page.

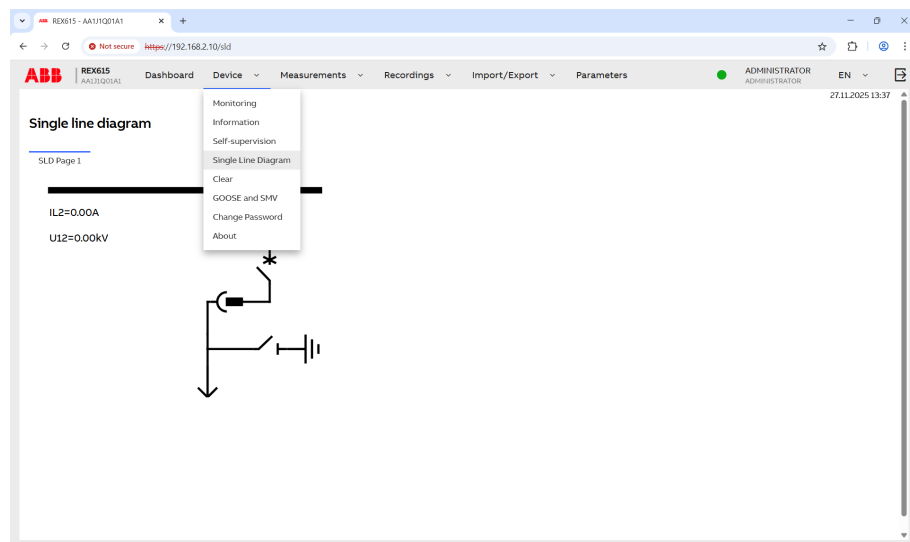


Figure 54: Viewing the single-line diagram with IEC symbols

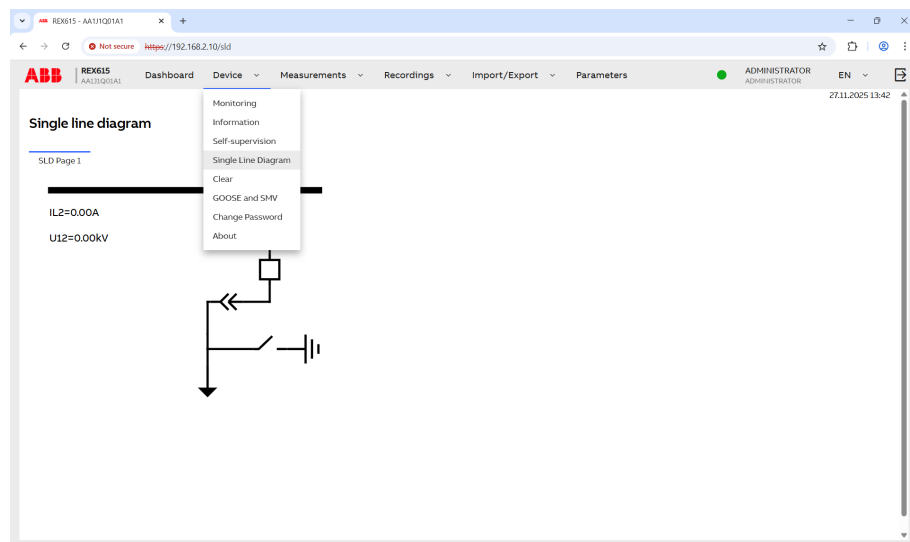


Figure 55: Viewing the single-line diagram with ANSI symbols

4.2.11 Viewing GOOSE and SMV

The Goose and SMV diagnostic page show data of senders and receivers in own tabs. The data set consists of value and quality attributes. The received or sent data have status indicators where green means all OK, yellow warning and red error.

1. Select **Device** on the menu bar.
2. Select **Goose and SMV** from the drop-down list.
3. Select appropriate tab to view data.

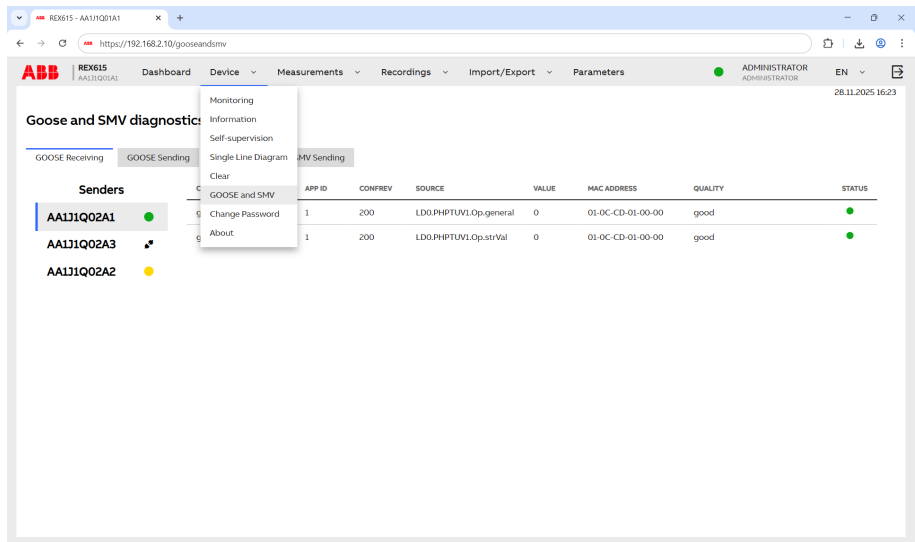


Figure 56: Navigating to Goose and SMV page

4.2.11.1 Goose Receiving

In this tab is shown GOOSE data that the relay subscribes from the Ethernet network. The left side of this page shows a list of devices that send GOOSE messages to the relay. These devices that publish data for the relay are defined in the relay configuration. The right side of the page shows the GOOSE data the relay receives from the network.

Goose and SMV diagnostics

GOOSE Receiving GOOSE Sending **SMV Receiving** SMV Sending

Senders	CONTROL BLOCK	APP ID	CONFREV	SOURCE	VALUE	MAC ADDRESS	QUALITY	STATUS
AA1J1Q02A1 ●	gcbGooseBinary	1	200	LD0.PHPTUV1.Op.general	0	01-0C-CD-01-00-00	good	●
AA1J1Q02A3 ●	gcbGooseBinary	1	200	LD0.PHPTUV1.Op.strVal	0	01-0C-CD-01-00-00	good	●
AA1J1Q02A2 ●								

Figure 57: Goose Receiving

4.2.11.2 Goose Sending

The GOOSE Sending tab shows the status of the relay's configured GOOSE control blocks and the values of the sent data. The left side of this page shows a list of the devices where the relay sends GOOSE messages. In the system there may be more devices, but these devices are according to relay configuration the ones subscribing the data from the relay. The right side of the page shows the GOOSE data that the relay sends to the network.

Goose and SMV diagnostics

GOOSE Receiving

GOOSE Sending

SMV Receiving

SMV Sending

Receivers	CONTROL BLOCK	APP ID	CONFREV	SOURCE	VALUE	MAC ADDRESS	QUALITY	STATUS
All	gcbgooseFromDesktop	2	200	LD0.PHPTUV2.Op.general	0	01-0C-CD-01-00-01	derived	
AA1J1Q02A1	gcbgooseFromDesktop	2	200	LD0.PHPTUV2.Op.t	27.12.2016 14:14:24.582	01-0C-CD-01-00-01	good	
AA1J1Q01A1	gcbgooseFromDesktop2	3	100	LD0.PHPTOV1.Op.general	0	01-0C-CD-01-00-02	good	
	gcbgooseFromDesktop2	3	100	LD0.PHPTOV1.Op.t	27.12.2016 14:14:24.582	01-0C-CD-01-00-02	good	

Figure 58: Goose Sending

4.2.11.3 SMV Receiving

In the SMV Receiving tab, check the sampled values data that the relay subscribes from the Ethernet network. The left side of this page shows a list of devices that send SMV messages to the relay. These devices that publish data for the relay are defined in the relay configuration. The right side of the page shows the SMV data that the relay receives from the network.

Goose and SMV diagnostics

GOOSE Receiving

GOOSE Sending

SMV Receiving

SMV Sending

Senders

AA1J1Q02A1

AA1J1Q02A3

AA1J1Q02A2

CONTROL BLOCK	APP ID	CONFREV	SOURCE	TRANSDUCER	VALUE	MAC ADDRESS	QUALITY	STATUS
gcbSmvBinary	1	200	LD0.PHPTUV1.Op.general	LD0.ILITCTRO	0	01-0C-CD-01-00-00	good	
gcbSmvBinary	1	200	LD0.PHPTUV1.Op.strVal	LD0.ILITCTR1	0	01-0C-CD-01-00-00	good	

Figure 59: SMV Receiving

4.2.11.4 SMV Sending

In the SMV Sending tab, check the status of the relay's configured SMV control blocks and the values of the sent IEC 61850-9-2 sampled value data. The left side of this page shows a list of the devices where the relay sends SMV messages. In the system there may be more devices, but these devices are according to relay configuration the ones subscribing the data from the relay. The right side of the page shows the SMV data the relay sends to the network.

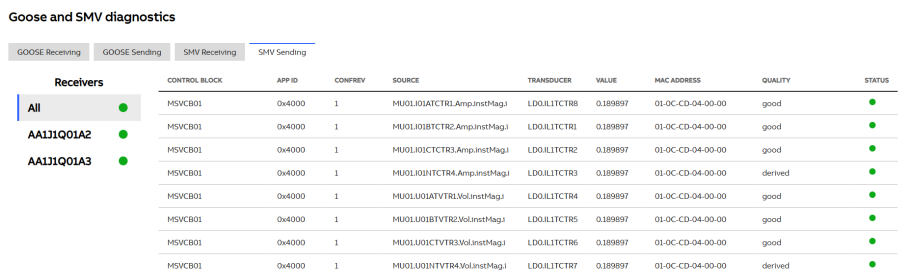


Figure 60: SMV Sending

4.2.12 Showing parameters

Some function blocks have a function-specific ON/OFF setting. When the function setting is "off", all settings are hidden and when the function setting is "on", all settings are visible based on the other visibility and hiding rules.

 Switch a function block on or off via the *Operation* parameter under the function block.

 The values "Basic" or "Advanced" of the *Setting visibility* parameter in **Configuration > HMI** have no effect on the Parameter List page. This page has its own Basic settings option which can be used to hide or show the advanced settings on the Parameter List page.

- 1. Select **Import/Export** on the menu bar.

2. Select **Parameter List** from the drop-down list.

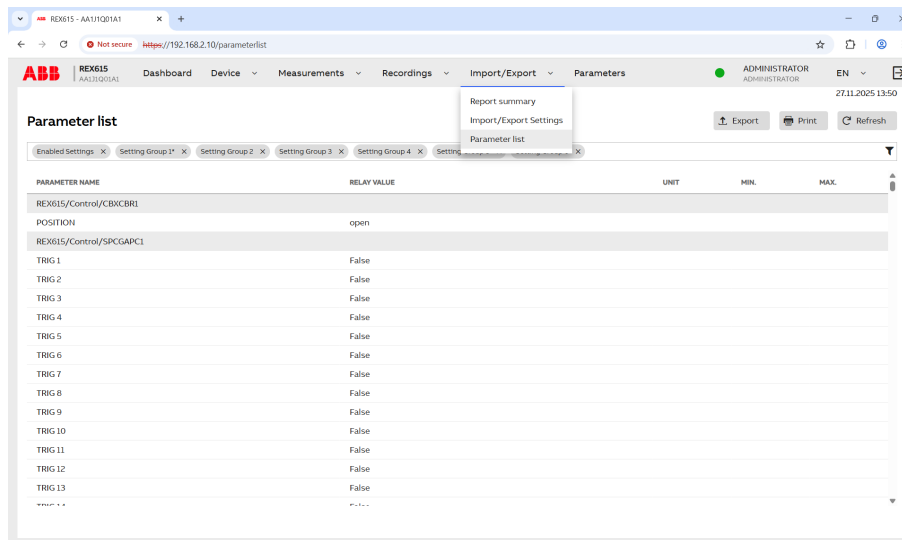


Figure 61: Displaying parameters

3.

Click the filter icon .

4. In the **multiselect dropdown filter**, select the settings that should be shown.

If none of the filter options (Enabled, Writable or Basic Settings) are selected, all of them are shown. The visibility of each setting group is determined by the selected setting group options.

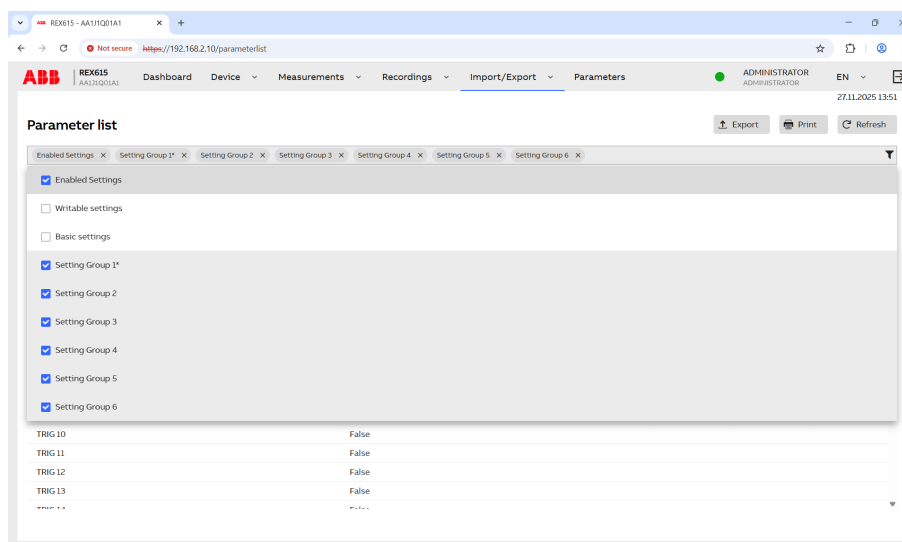


Figure 62: Enabling settings

The Parameter List page offers filtering functionality where only chosen parameters are displayed, saved or printed. There are various options for filtering.

- **Enabled Settings** hides settings of disabled function blocks. This option is checked by default.
- **Writable settings** displays only writable settings.

- **Basic settings** displays only basic settings.
 - **Setting group** displays only the settings of the selected setting group. Options can be combined. For example, with the **Enabled Settings** and **Writable settings** selected, only enabled and writable settings are displayed.
5. Click **Export** and select text (.txt) or comma separated values (.csv) file format to save the settings.
 6. Click **Print** to print all the selected parameters.

4.2.13 Editing values

1. Select **Parameters** on the menu bar.
2. Click a submenu in the left navigation bar to see the function blocks.
3. Click a function block to see the setting values.
4. Click **Enable Edit**.



If the edit mode is enabled accidentally, click **Disable Edit**. Editing cannot be disabled when a value has already been written to the protection relay. After clicking **Write to Relay**, if the parameter write is successful, the **Store or Reject Changes** button will appear. Clicking this button opens a dialog listing all the changes, where you can choose to **Store Changes**, **Reject Changes** or **Cancel**.

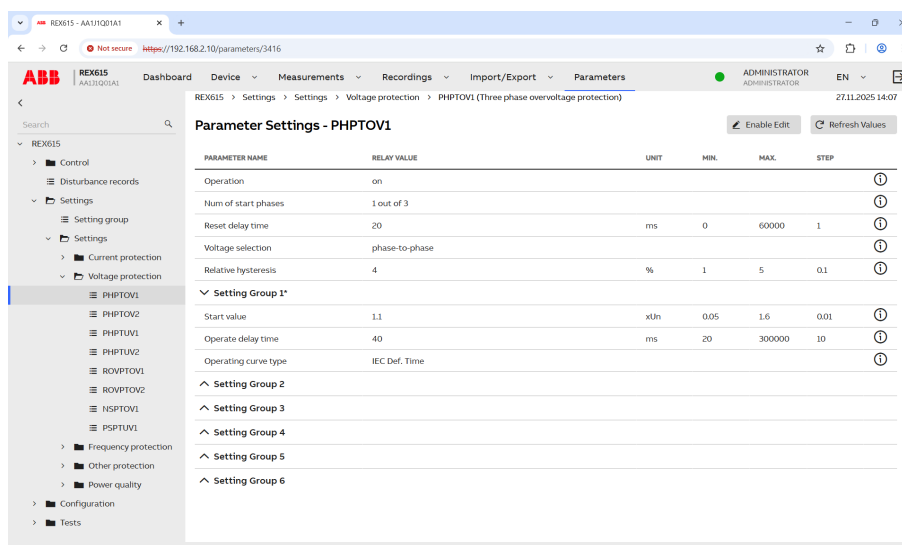


Figure 63: Enable writing to edit a value

All setting groups are listed on the page as collapsible rows, with the active setting group indicated by an asterisk (*). By default, only the active group or any groups that were previously expanded by the user are expanded, while all other groups remain collapsed.

5. Edit the value. The minimum, maximum and step values for a parameter are shown in the MIN., MAX. and STEP columns.

Parameter Settings - PHPTOV1

Write to RelayDisable EditRefresh Values

PARAMETER NAME	RELAY VALUE	UNIT	MIN.	MAX.	STEP	
Operation	on					
Num of start phases	1 out of 3					
Reset delay time	20	ms	0	60000	1	
Voltage selection	phase-to-phase					
Relative hysteresis	4.5	%	1	5	0.1	
Setting Group 1*						
Start value	1.12	xUn	0.05	1.6	0.01	
Operate delay time	40	ms	20	300000	10	
Operating curve type	IEC Def. Time					
Setting Group 2						
Setting Group 3						
Setting Group 4						
Setting Group 5						

Figure 64: Editing a value

If the entered value is within the accepted range, the input field is underlined in blue. If the value is out of range, the input field is underlined in red and error text is displayed. In this case **Write to Relay** is unavailable.

Parameter Settings - PHPTOV1

Write to RelayDisable EditRefresh Values

PARAMETER NAME	RELAY VALUE	UNIT	MIN.	MAX.	STEP	
Operation	on					
Num of start phases	1 out of 3					
Reset delay time	20	ms	0	60000	1	
Voltage selection	phase-to-phase					
Relative hysteresis	11.9	%	1	5	0.1	
Setting Group 1*						
Start value	2.00	xUn	0.05	1.6	0.01	
Operate delay time	40	ms	20	300000	10	
Operating curve type	IEC Def. Time					
Setting Group 2						
Setting Group 3						
Setting Group 4						

Figure 65: Error indicating that the entered value is incorrect

If writing values fails, an error message is displayed.

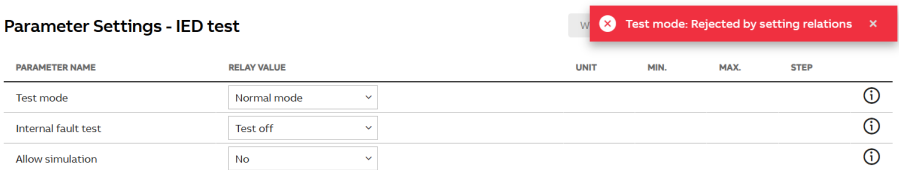


Figure 66: Error indicating that the values were not written to the protection relay

- 6. Commit the settings.

4.2.14 Committing settings

Editable values are stored either in RAM or a nonvolatile flash memory. The values stored in the flash memory are in effect also after a reboot.

Some parameters have an edit-copy. If writing is cancelled, the values with an edit-copy are immediately restored to the original value. The values without an edit-copy, such as string values, are restored to the original value only after a reboot even though the edited value is not stored in the flash memory.

- 1. After editing parameter values, click **Write to Relay** to put the values into the protection relay's database for use. The values are not stored to the flash memory.

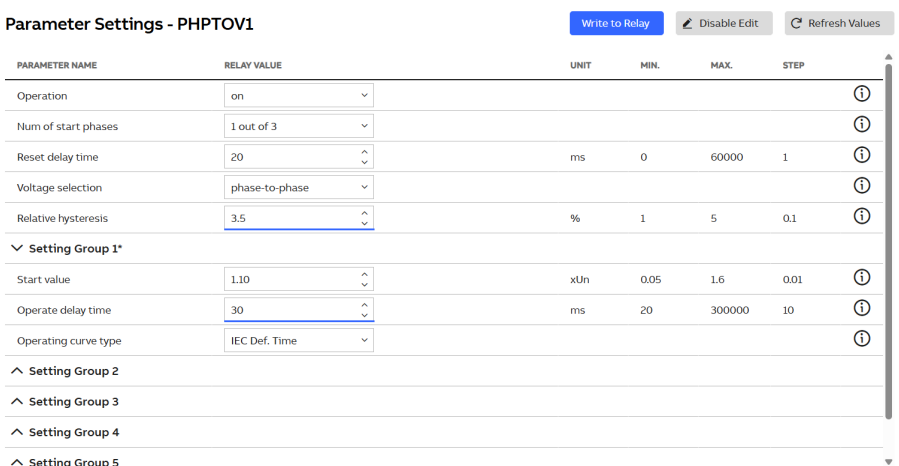


Figure 67: Writing values to the protection relay

- 2. Click **Store or Reject Changes** to open a dialog displaying the edited parameters.



There are three options **Store Changes**, **Reject Changes** and **Cancel** in the dialog box that opens. Clicking **Reject** exits the edit mode without storing the values to the nonvolatile memory. Clicking **Cancel** closes the dialog box and returns to parameter editing. When rejecting changes, if the parameter has an edit-copy, the original parameter value is restored. If the parameter does not have an edit-copy, the edited parameter value remains visible until the protection relay is rebooted. However, the edited value is not stored in the nonvolatile memory and thus the reboot restores the original value.

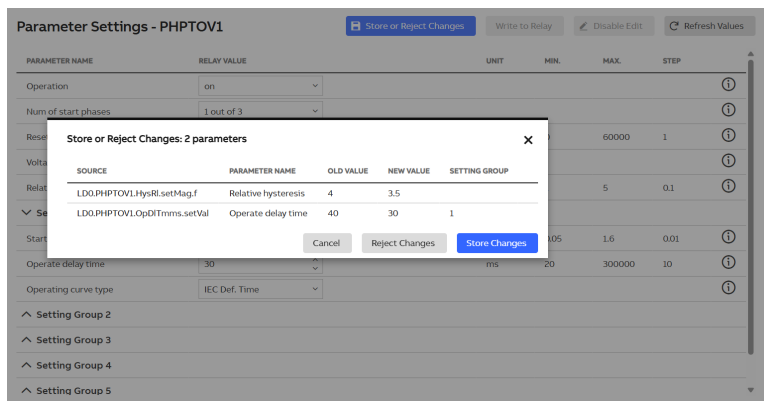


Figure 68: Storing or rejecting parameter changes



Storing values takes a few seconds.



If the values are not stored, they are not taken into use and they are lost after a reboot.

4.2.15 Clearing and acknowledging

Reset, acknowledge or clear all messages and indications, including LEDs and latched outputs as well as registers and recordings, in the Clear page.

- 1. Select **Device** on the menu bar.

2. Select **Clear** from the drop-down list.

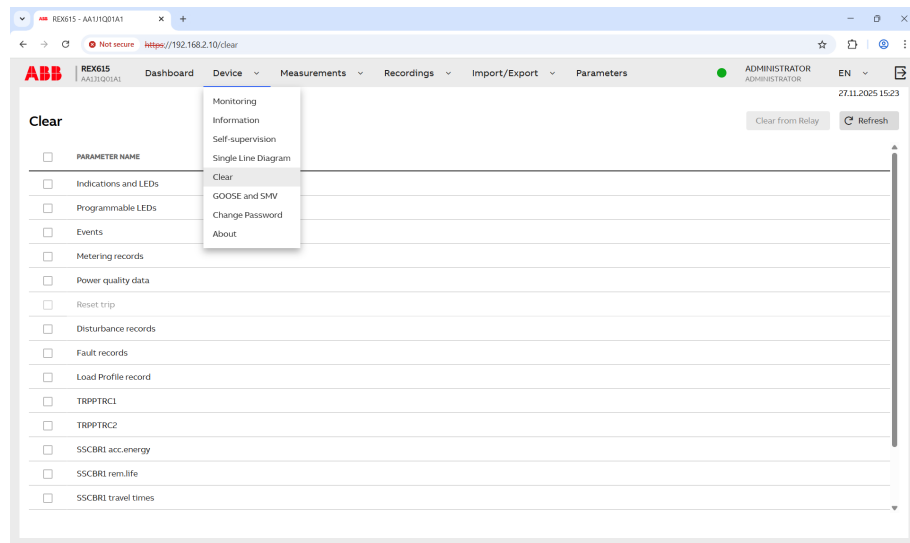


Figure 69: Opening the Clear page

3. Select the item to be cleared.

4. Click **Clear from Relay**.

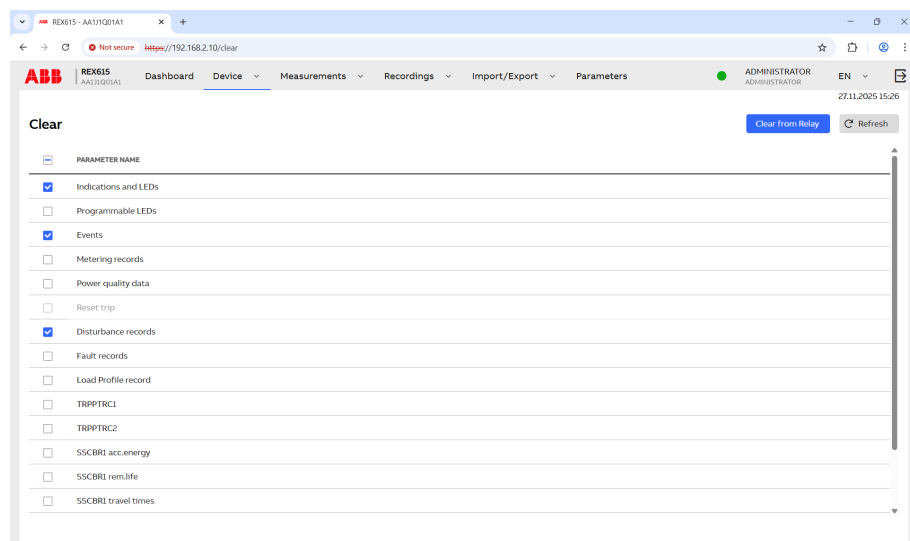


Figure 70: Clearing indications and LEDs

4.2.16 Accessing event view

The event view contains a list of events produced by the application configuration. Event list is updated automatically.

When the event page is opened, it initially displays up to 20 latest events. The number of events shown per page can be adjusted using the Row Count option located in the bottom-left corner of the page.

1. Select **Recordings** on the menu bar.

2. Select **Events** from the drop-down list.

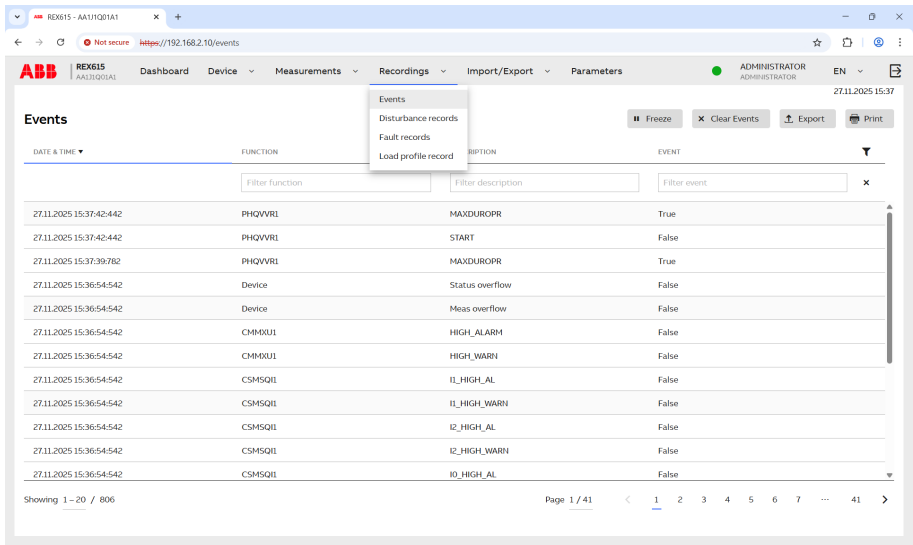


Figure 71: Monitoring events

- 3. Click **Freeze** to stop updating the event list.
- 4. Click **Date & Time** column header or select a page to view older events.

Clicking the **Date & Time** column header toggles between three sorting states: ascending order, descending order, and no sorting. By default, the events are sorted in descending order, displaying the most recent events first in the event list.

Using the pagination controls located in the bottom-right corner, users can navigate between pages either by clicking the Previous and Next buttons or by clicking specific page number.

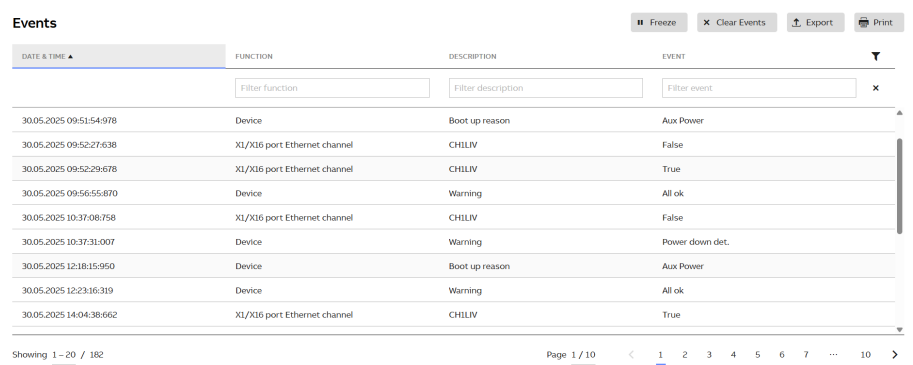


Figure 72: Displaying the oldest events first in the event list

5. Filter events using per-column filters

Displayed events can be filtered using per-column filters located directly below each column header. These filters are visible by default and can be easily shown or hidden by clicking the filter icon in the upper-right corner of the event list.

03.06.2025 15:04

Events

Freeze

Clear Events

Export

Print

DATE & TIME	FUNCTION	DESCRIPTION	EVENT	
	PHPTO	OP	Filter event	
31.05.2025 13:31:23.760	PHPTOV1	OPERATE	True	
31.05.2025 13:13:59.742	PHPTOV1	OPERATE	True	
31.05.2025 13:11:28.638	PHPTOV2	OPERATE	True	
31.05.2025 12:49:59.284	PHPTOV1	OPERATE	True	
31.05.2025 12:40:43.762	PHPTOV1	OPERATE	True	

Showing 1 - 195 / 195

Page 1 / 1

Figure 73: Filtering events

6. To save the events as .txt or .csv files, click **Export** and select the file format from the drop-down list.



The CSV file can be opened with a spreadsheet program such as OpenOffice.org Calc or Microsoft Excel.

7. Click **Clear Events** to clear all events from the protection relay.
8. Click **Print** to print all the selected events.

4.2.17 Accessing disturbance record view

Disturbance records are listed in the disturbance records view.

1. Select **Recordings** on the menu bar.

- 2. Select **Disturbance Records** from the drop-down list.

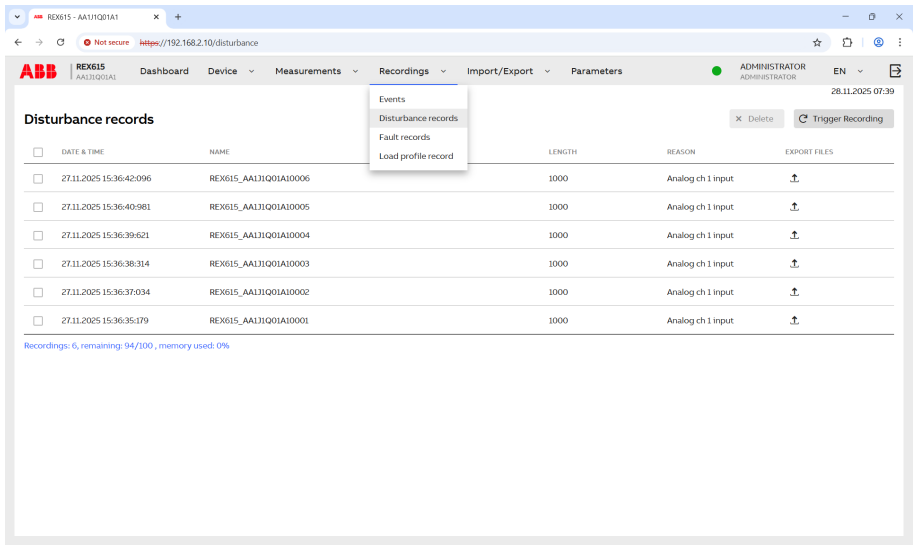


Figure 74: Viewing disturbance records

4.2.17.1 Saving disturbance records

- 1. Select **Recordings** on the menu bar.
- 2. Select **Disturbance Records** from the drop-down list.

3. To save the disturbance record file, click the export icon in the **Export Files** column of the record.

The CFF disturbance record file will begin downloading and the decompression process will start automatically.

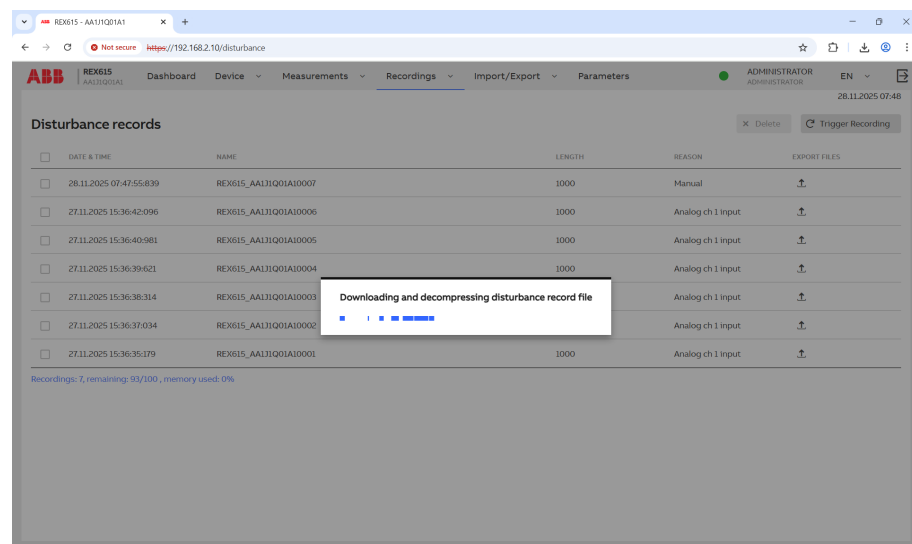


Figure 75: Saving a disturbance record



If prompted, give permission for file downloading depending on the used Web browser.

4. Open the disturbance record files with a suitable program.

4.2.17.2

Triggering disturbance recorder manually

1. Select **Recordings** on the menu bar.

2. Select **Disturbance Records** from the drop-down list.

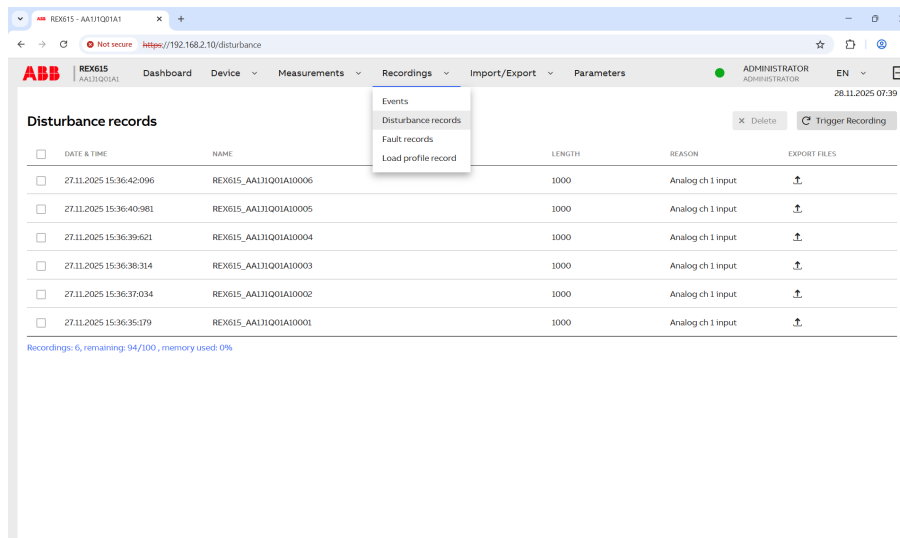


Figure 76: Selecting Disturbance Records

3. Click **Trigger Recording** to start a manual recording

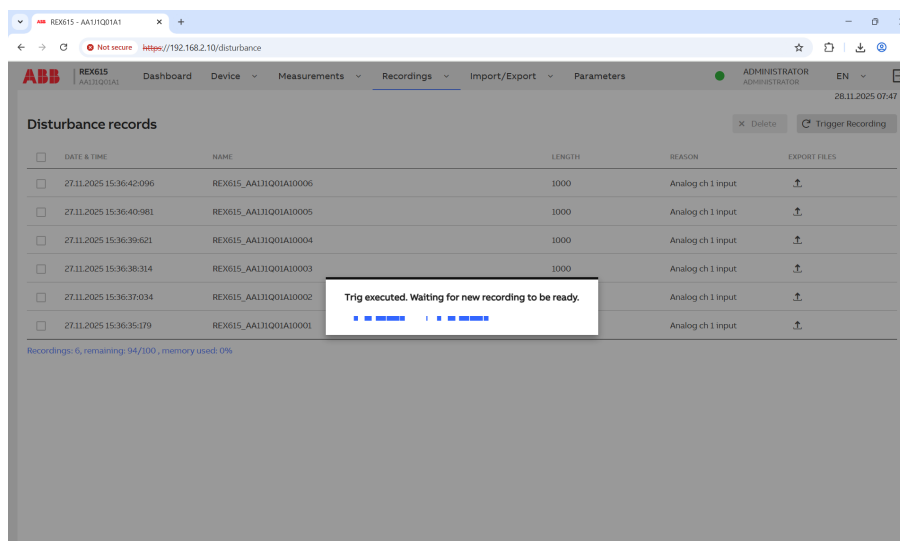


Figure 77: Triggering recording - progress bar

4.2.17.3 Deleting disturbance records

1. Select **Recordings** on the menu bar.
2. Select **Disturbance Records** from the drop-down list.
3. Delete records in one of the alternative ways.
 - Select all and click **Delete** to delete all records.
 - Select one or more recordings and click **Delete** to delete the selected records.

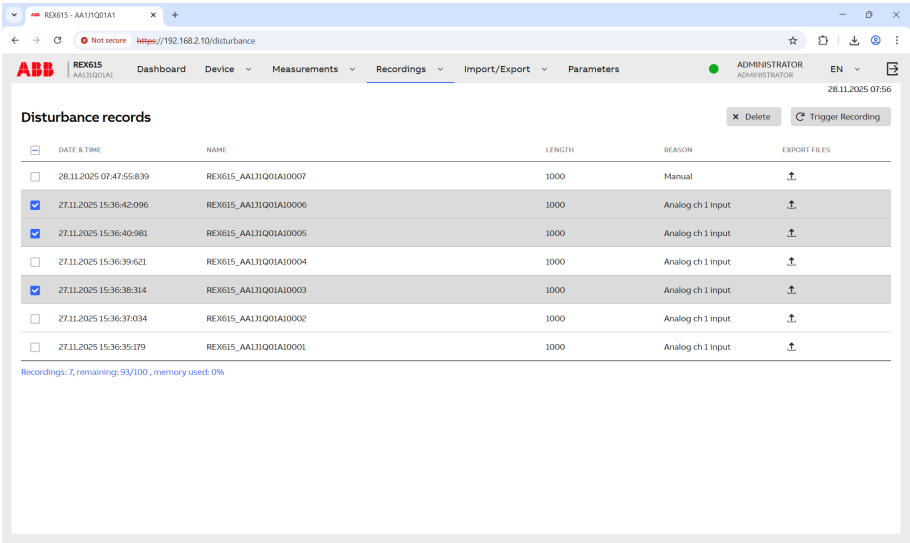


Figure 78: Deleting disturbance records

4.2.18 Measurements and phasor diagrams

4.2.18.1 Viewing measurements

1. Select **Measurements** on the menu bar.
2. Select **Measurements** from the drop-down list.

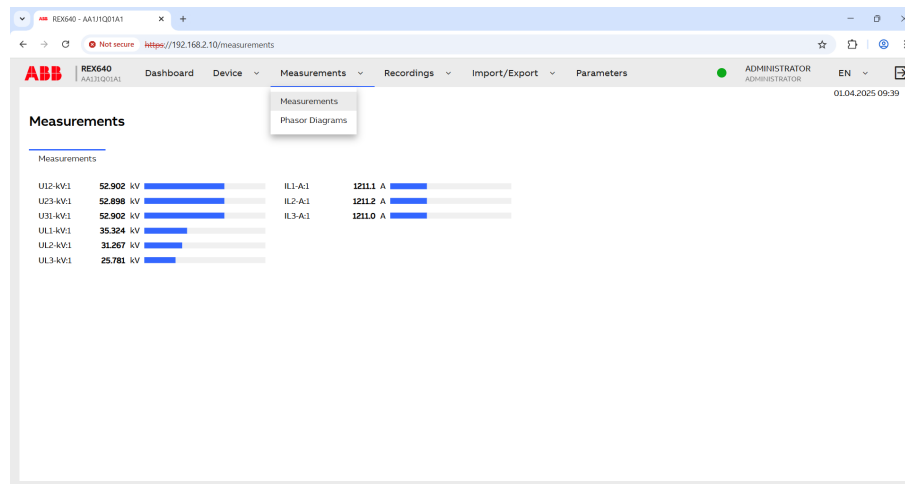


Figure 79: Viewing measurements



Measurements are also displayed in the Dashboard view.

4.2.18.2 Viewing phasor diagrams

1. Select **Measurements** on the menu bar.

2. Select **Phasor Diagrams** from the drop-down list.

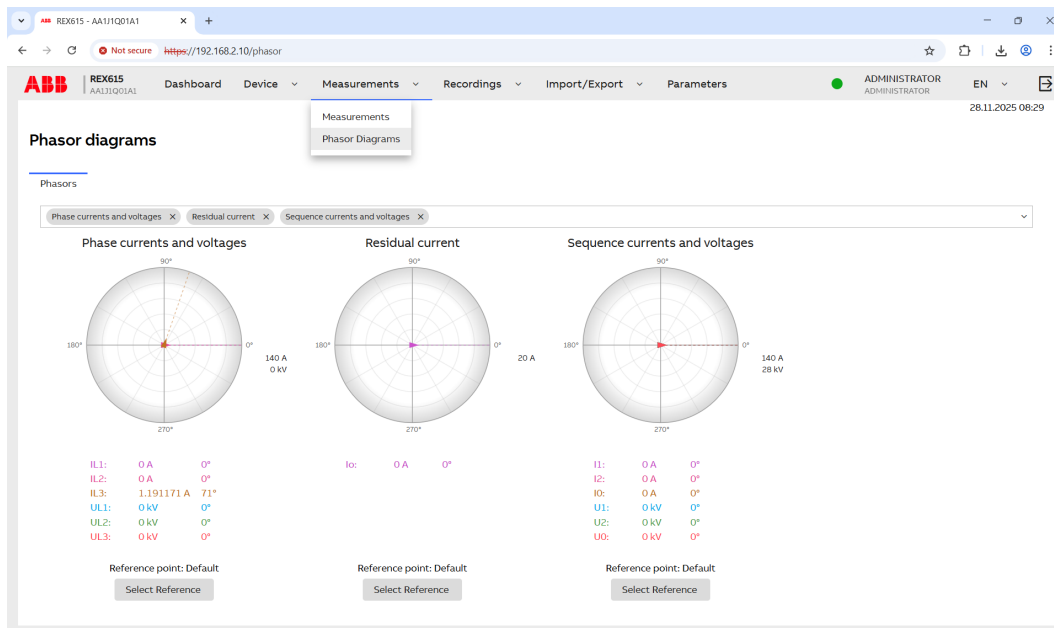


Figure 80: Monitoring phasors

3. Phasors can be shown or hidden on the **Phasor Diagrams** page by selecting or deselecting them from the multi-select dropdown list.

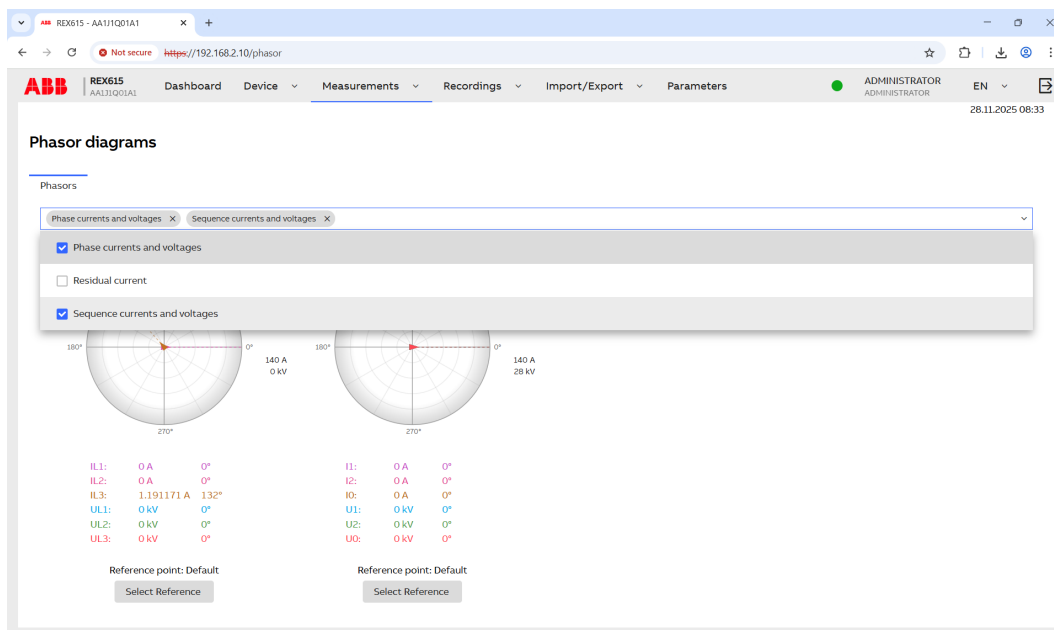


Figure 81: Selecting the phasor

- Click the **Select Reference** button to select a reference phasor for each phasor diagram, then click **OK**.

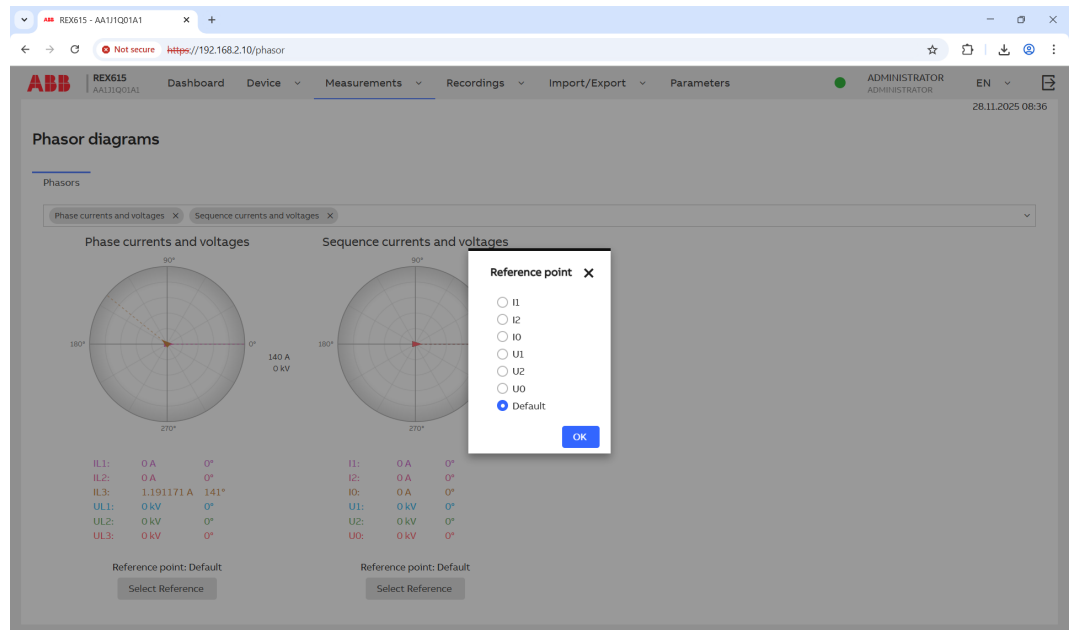


Figure 82: Selecting the reference phasor

4.2.19 Viewing fault records

- Select **Recordings** on the menu bar.
- Select **Fault Records** from the drop-down list to view a list of all available fault records.
- Click a record from the **Fault records** list to open the fault record details.
- To save the records as .txt or .csv files, select the format from the **Export** drop-down list.
 - When the fault record details view is shown, only the shown fault record is saved.
 - When fault record list view is shown, all fault records are saved.
- To clear all fault records from the relay, click **Clear All**. This can be done only when the fault record list view is shown.
- To print all fault records, click **Print** when the fault record list view is shown.

7. To print only one record, open it and click **Print**.

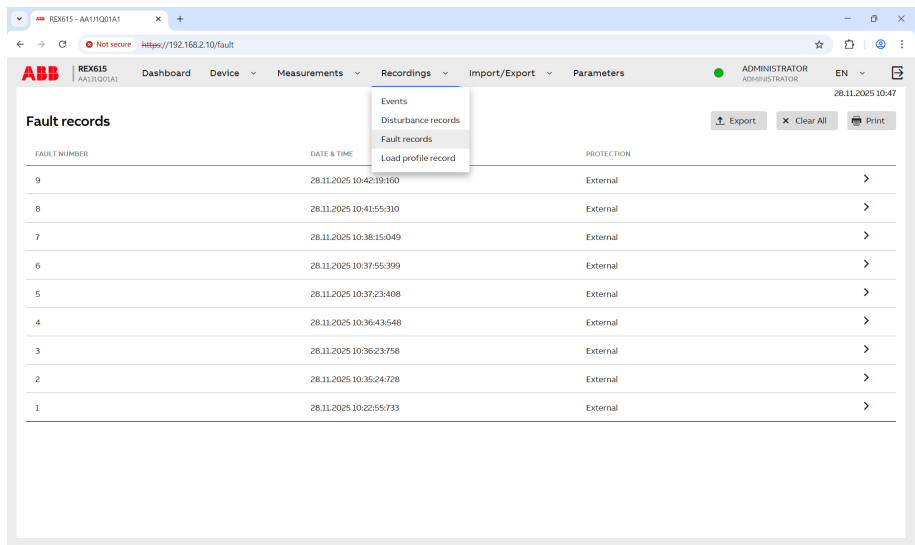


Figure 83: Fault record list view

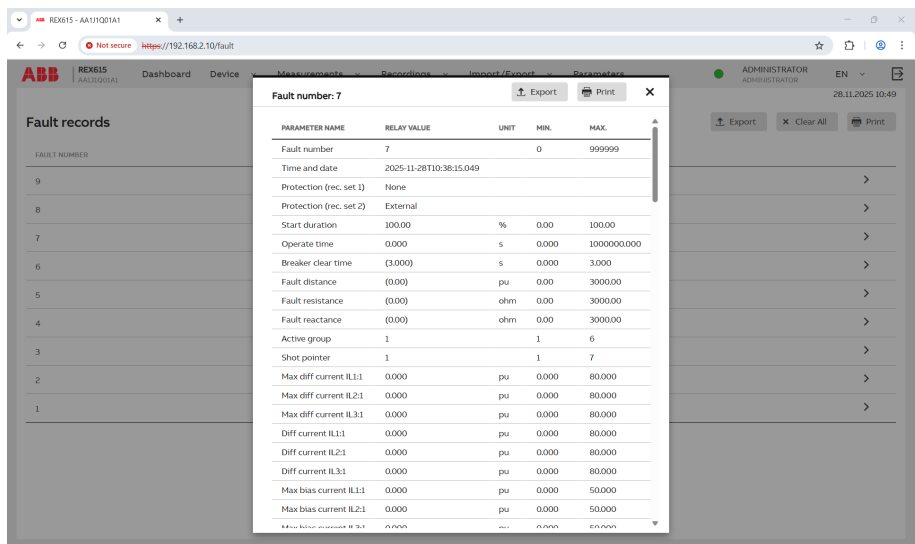


Figure 84: Fault record details view

4.2.20 Exporting load profile records

1. Select **Recordings** on the menu bar.
2. Select **Load Profile Record** from the drop-down list.
3. To export the load profile record files, click the export icon in the **Export Files** column.
Both load profile record files CFG and DAT are saved at once in one zip package.
4. Extract the CFG and DAT files into the same folder on the computer.

5. Open the load profile record COMTRADE files with a suitable program.



Open the load profile files, for example, with the Wavewin tool included in PCM600.

4.2.21 Importing and exporting of settings

The relay's setting parameters can be imported and exported in the XRIO file format.



When importing parameters to PCM600 via an XRIO file generated by the WHMI, some Ethernet communication and HMI-related parameters may be skipped during import. Check the Output window of PCM600 for such parameters and manually update those if needed.

4.2.21.1 Exporting settings

The relay's setting parameters can be exported in XRIO file format.

1. Select **Import/Export** on the menu bar.
2. Select **Import/Export Settings** from the drop-down list.
3. Click **Export Settings**. The export file includes all parameters except status parameters and parameters writable only in LHMI.

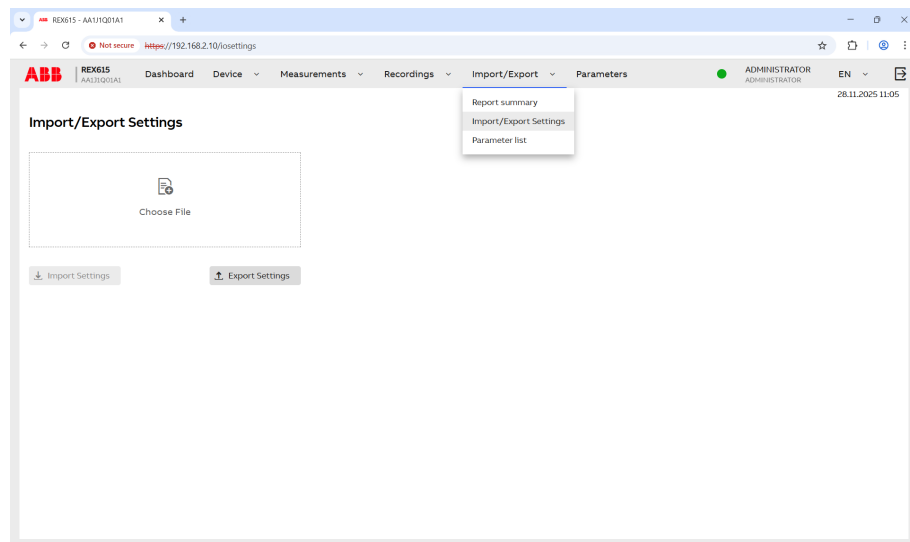


Figure 85: Exporting settings

4.2.21.2 Importing settings

The parameter export and import function can be used, for example, when the protection relay's parameters are set using the WHMI instead of PCM600. The protection relay's settings engineered with PCM600 can be exported to XRIO files and imported to the WHMI. The WHMI can be used to write the settings to the protection relays. The WHMI can also be used to read the protection relay's setting parameters and to export those to files, which can be used by PCM600. WHMI imports all parameters from the import file except lockable and read-only parameters.



The XRIO file name supports only characters A-Z, a-z and 0-9.



The exporting and importing of settings is sensitive to the protection relay content. Settings are exported and imported for one protection relay at a time. The export files of a specific protection relay can be exchanged between PCM600, WHMI and the actual physical protection relay. To avoid errors and to efficiently manage the exporting and importing of settings, for example, in a substation with several relays, ensure that the names of the export files identify the relay to which the file should be imported.



Ensure that the correct settings are imported to the correct relay. Wrong settings may cause the relay to malfunction.

1. Select **Import/Export** on the menu bar.
2. Select **Import/Export Settings** from the drop-down list.
3. Click **Choose File** and choose the file to be imported.

Import/Export Settings

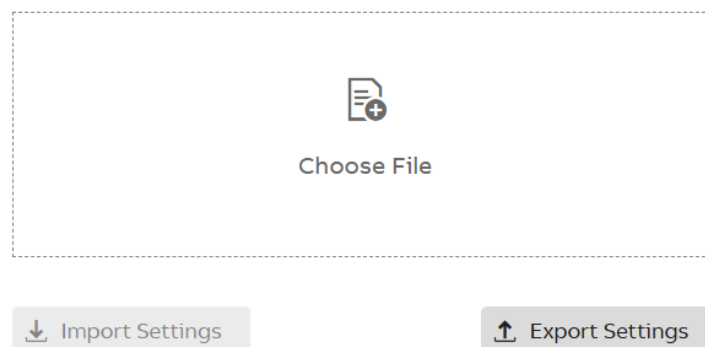


Figure 86: Selecting the settings to be imported

4. Click **Import Settings**. Wait until the file transfer is complete.

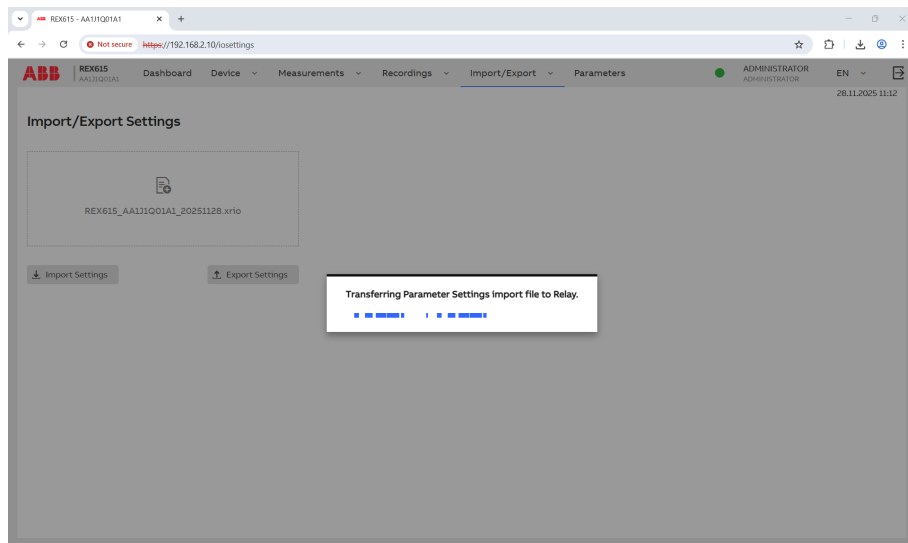


Figure 87: Importing settings

- Click **Store** to commit the imported settings to the relay. Wait until the import is complete.



Click **Cancel** to cancel the import. Both the WHMI and the relay revert to the settings in use prior to the import.

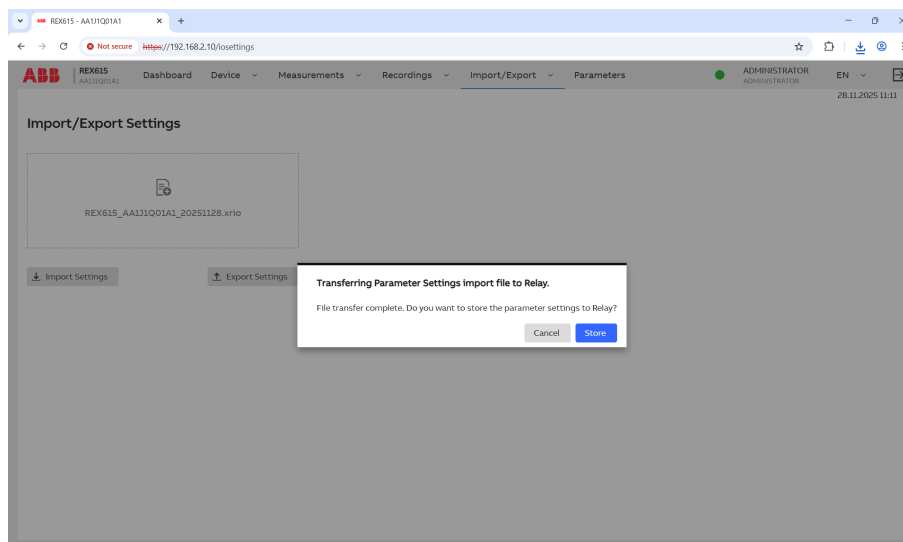


Figure 88: Writing parameter settings

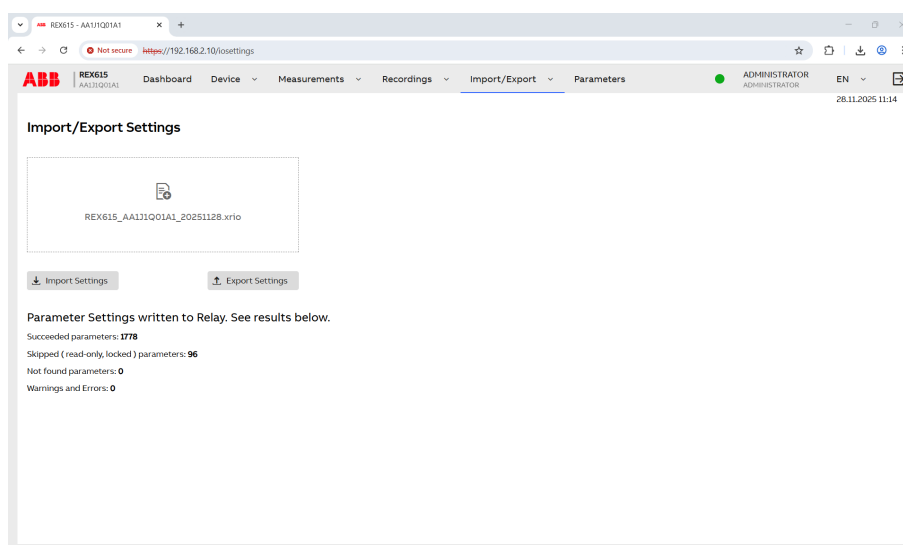


Figure 89: Parameter settings written to relay

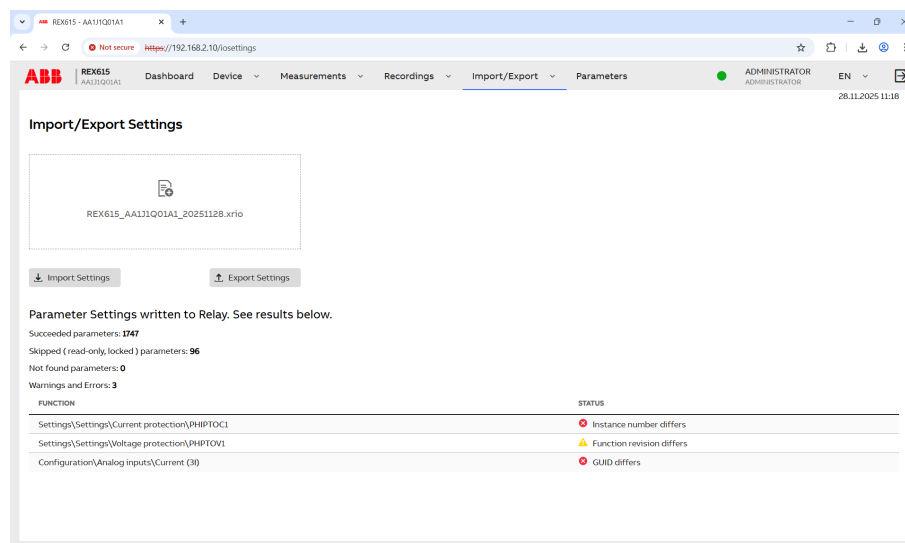


Figure 90: Summary of Errors and Warnings during settings import



Only editable parameters are written to the relay during the import. If part of the import fails, the faulty parameters are listed separately.

4.2.22 Exporting report summary

The Report Summary page allows exporting protection relay recordings, logs, parameters and the SNMP MIB package. Events, fault records and the parameter list are saved in TXT format. The saved files contain all events, fault records and settings.

Disturbance records are saved in CFF format, and load profile record files are saved in CFG and DAT formats. The SNMP MIB package is exported as a ZIP.

1. Select **Import/Export** on the menu bar.
2. Select **Report Summary** from the drop-down list.
3. Select the items to be exported.

- 4. Click **Export** to export the .zip file with the selected files.

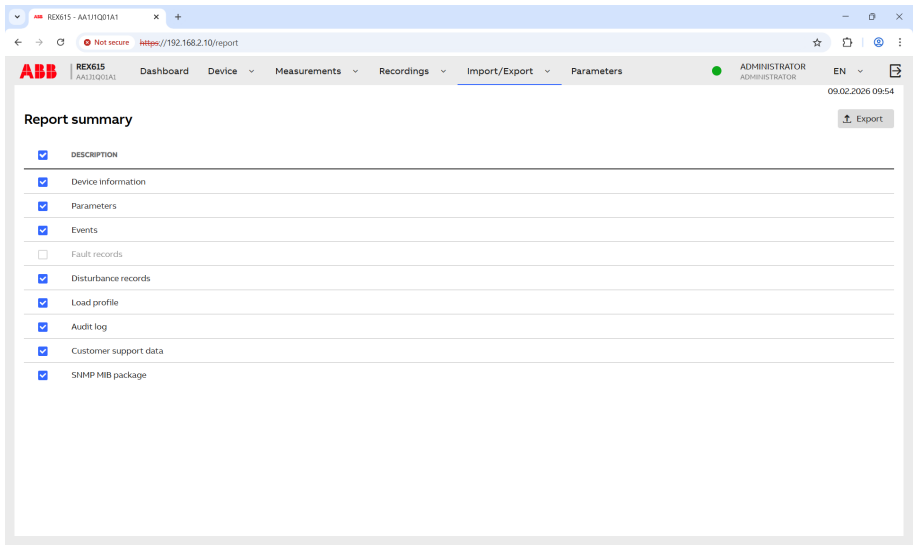


Figure 91: Report Summary page

4.2.23 Viewing Parameter Details

The context-sensitive information icon on WebHMI settings page provides details about parameters.

- Hover over the  icon to display a tooltip with more information about the parameter.

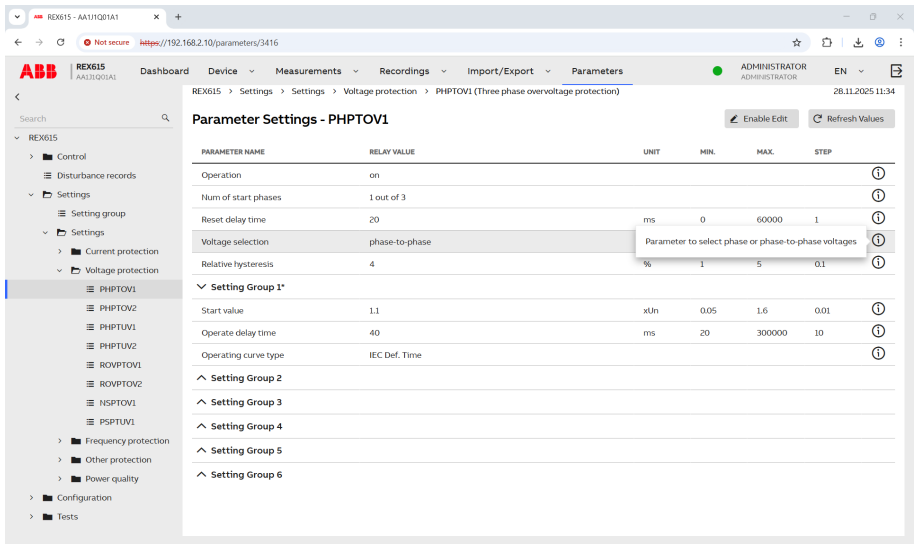


Figure 92: Viewing parameter details

4.2.24 Viewing SNMP monitored data

The SNMP monitoring values can be found under **Device > Monitoring > Communication > Protocols > SNMPLPRT1**.

When the SNMP service is running, all monitored values are displayed.

If the service is off, only the SNMP status is shown.

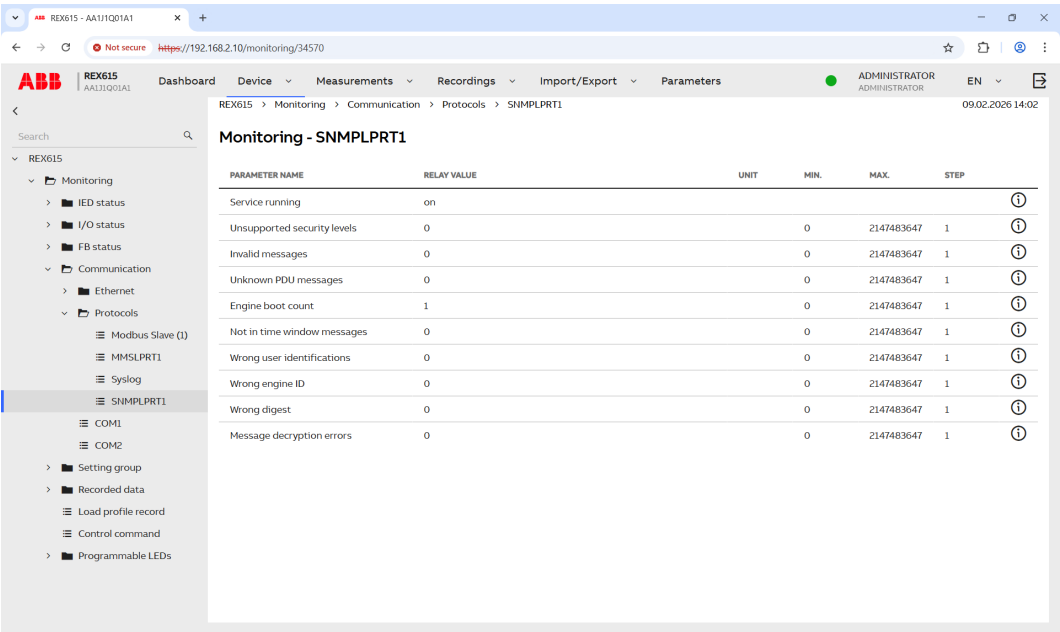


Figure 93: SNMP service on

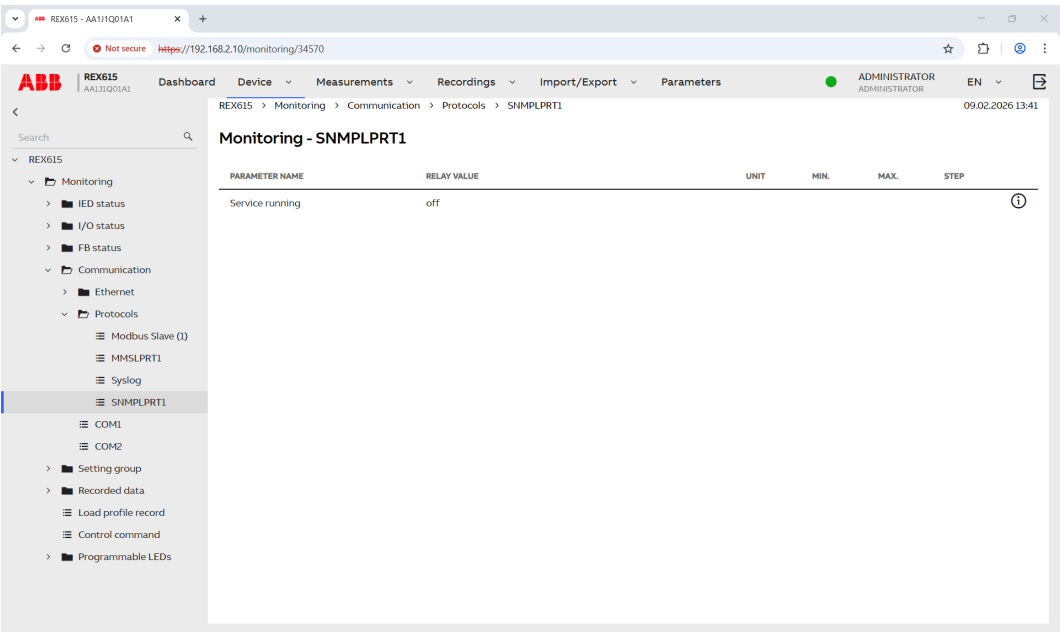


Figure 94: SNMP service off

A list of SNMP monitoring parameters is provided in the table below.

Table 11: SNMP monitoring parameters

Parameter	Description
Service running	SNMP service status
Unsupported security levels	Number of times agent has been queried with wrong security level
Invalid messages	Number of invalid messages received
Unknown PDU messages	Amount of unknown PDU handler messages received
Engine boot count	Amount of engine boots have been counted
Not in time window messages	Amount of messages received outside of available time window
Wrong user identifications	Amount of times wrong user credentials are used
Wrong engine ID	Amount of data with wrong engine ID received
Wrong digest	Amount of wrong digests received for credentials
Message decryption errors	Amount of errors with decryption issues

5 Operating procedures

5.1 Monitoring

5.1.1 Indications

The operation of the protection relay can be monitored via three different indications on the LHMI.

- Three indicator LEDs with fixed functionality: Ready, Start/Pickup and Trip
- 11 programmable LEDs
- Information on the display

5.1.1.1 Monitoring indication messages

Indication messages and tripping data are shown in a dialog box. Only one dialog box can be shown at a time, therefore the relay has internal priority for indication messages and tripping data. Internal fault and warning messages have always higher priority than start or trip information. Trip information has always higher priority than start information.

1. Read the indication message in the dialog box.

The message can indicate the starting or tripping of protection functions or an internal fault in the device.

- 2.

Press  to close the indication message without clearing it or press  to activate the Clear view and to clear messages.

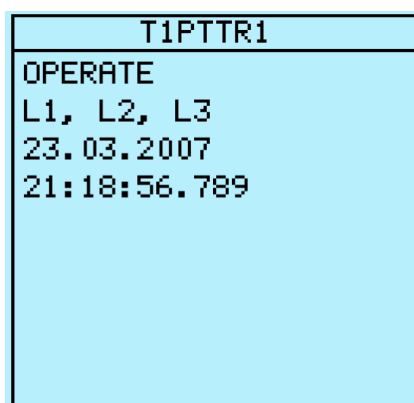


Figure 95: Indication message

5.1.1.2 Monitoring an internal relay fault

The flashing green LED indicates an internal relay fault. Internal relay fault messages are shown in a dialog box. Only one dialog box can be shown at a time, therefore the relay has internal priority for indication messages and tripping data. Internal fault has always higher priority than a warning.



See the troubleshooting section for more details.

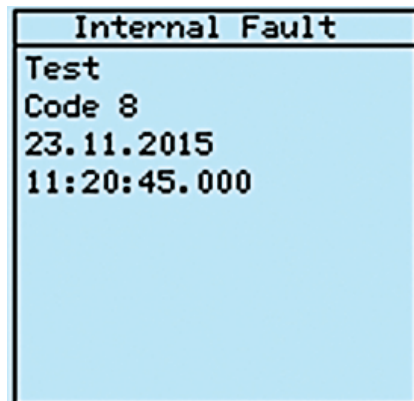


Figure 96: Fault indication

1. Select **Main menu > Monitoring > IED status > Self-supervision** to monitor the latest fault indication.
2. Press  or  to scroll the view.

5.1.1.3 Monitoring condition monitoring data

1. Select **Main menu > Monitoring/I/O status > Condition monitoring**.
2. Press  or  to scroll the view.
3. Press  to enter or  to exit a submenu.

With PCM600 the user can map output signals from condition monitoring related function blocks to the appropriate destinations.

5.1.2 Measured and calculated values

Measurement view in **Main Menu > Measurements** shows the momentary actual values for various power system measurements.

All values show the momentary measurement value and some include demand values calculated from a set period.



Invalid or questionable measurement values are presented in parentheses.

5.1.2.1 Measured values

Measured values can be accessed through the LHMI, WHMI or PCM600.

Table 12: Examples of the measured values

Indicator	Description
IL1-A	Current measured on phase L1
IL2-A	Current measured on phase L2
IL3-A	Current measured on phase L3
I_0 -A	Measured earth-fault current
U_0 -kV	Measured residual voltage
U12-kV	Measured phase-to-phase voltage U12
U23-kV	Measured phase-to-phase voltage U23
U31-kV	Measured phase-to-phase voltage U31
f-Hz	Measured frequency
S-MVA	Total apparent power
P-MW	Total active power
Q-MVar	Total reactive power
PF	Average power factor
Ng-Seq-A	Negative-phase-sequence current
Ps-Seq-A	Positive-phase-sequence current
Zro-Seq-A	Zero-phase-sequence current
Ng-Seq-kV	Negative-phase-sequence voltage
Ps-Seq-kV	Positive-phase-sequence voltage
Zro-Seq-kV	Zero-phase-sequence voltage

5.1.2.2 Using the local HMI for monitoring

1. Select **Main menu** > **Measurements** to monitor measured and calculated values. The list of protection relay's basic measurements is shown.

2. Scroll the view with  and .



Value will be presented within parenthesis if its data quality is not good i.e. device is in Test mode, connection to source is not good or time synchronization is bad.

5.1.3 Recorded data

The protection relay is provided with intelligent and flexible functionality that collects different kinds of data. The recorded data gives substantial information for post fault analysis.

- Disturbance records

- Fault records
- Events
- Load profile record

5.1.3.1 Creating disturbance recordings

Normally disturbance recordings are triggered by the protection relay applications but the recording can also be triggered manually.

1. Select **Main menu > Disturbance records.**
2. Select **Trig recording** with  or .
3. Press , change the value with  or  and press  again.

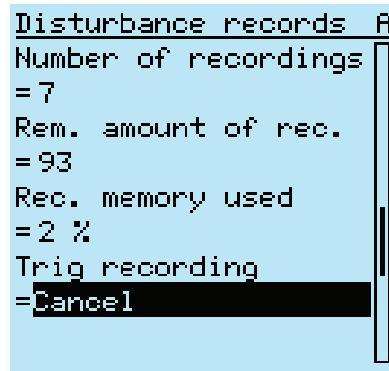


Figure 97: Changing the value

The disturbance recorder is now triggered.

5.1.3.2 Monitoring disturbance recorder data

Upload individual disturbance recordings from the protection relay with the PCM600 software to monitor disturbance recorder data.

1. Select **Main menu > Disturbance records.**
All the disturbance recorder information is listed.
 2. Scroll the view with  or .
- The following items are listed in the view:
- Number of recordings currently in the protection relay's memory.
 - Remaining amount of recordings that fit into the available recording memory.
 - Recording memory used in percentage.
 - If the periodic triggering function is used, the time to trigger which indicates the remaining time to the next periodic triggering of the disturbance recorder.

```

Disturbance records A
Number of recordings
=7
Rem. amount of rec.
=93
Rec. memory used
=2 %
Trig recording
=Cancel

```

Figure 98: Monitoring disturbance recorder via the LHMI

5.1.3.3 Controlling and reading of disturbance recorder data

Disturbance recorder data can be controlled and read with PCM600. It can also be read via WHMI.



For more information, see the PCM600 documentation.

5.1.3.4 Monitoring fault records

Timestamps of the fault records are shown as a list. The first fault record is the newest.

1. Select **Main Menu > Monitoring > Recorded data > Fault record**.

2. To navigate between the fault records, press  and .

3. To enter or exit the record data, press  or . Press the  further from there to view the data.

```

Fault record A
07.11.2009 10:58
05.11.2009 09:50
04.11.2009 11:16
04.11.2009 10:38
01.11.2009 12:30
01.11.2009 11:11
01.11.2009 10:20
28.10.2009 08:30
27.10.2009 11:50

```

Figure 99: Monitoring fault records

5.1.3.5 Monitoring events

Event view contains a list of events produced by the application configuration. Each event takes one view area. The header area shows the currently viewed event index and the total amount of the events. The most recent event is always first.



The HMI Event Filtering tool can be used to configure the event visibility in the LHMI.

1. Select **Main Menu > Events**.

2.



Press to view the first event.

Date, time, device description, object description and event text elements of the event are shown.

3.



Press or to scroll the view.

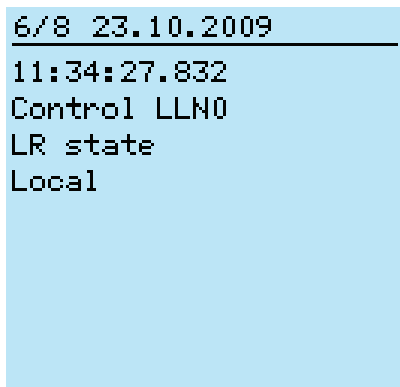


Figure 100: Monitoring events

5.1.3.6 Monitoring and saving load profile record

- Monitor the recording memory usage of the load profile via **Main menu > Monitoring > Load profile record**.
- Save and analyze the load profile record with PCM600.

5.1.4 Remote monitoring

The protection relay supports comprehensive remote monitoring.

5.1.4.1 Monitoring protection relays remotely

Use the PCM600 tool and WHMI to operate the protection relay remotely.

- Read maintenance record and version log.
- Analyze disturbance record data.
- Create disturbance records.

- Monitor protection relay values.



For more information, see the PCM600 documentation.

5.2 Controlling

5.2.1 Controlling with single-line diagram

In the single-line diagram view, controllable objects can be opened and closed.



To control the protection relay, logging in and authorization are required.

5.2.1.1 Controlling circuit breaker, disconnectors and earthing switch

1. Select the object with  or  if it is not already selected.

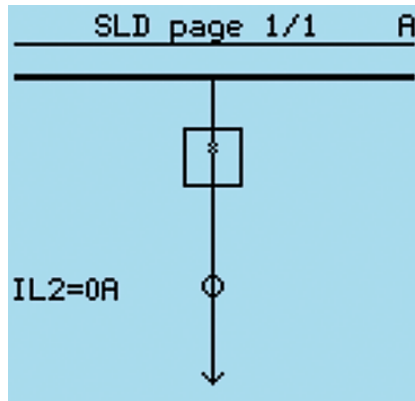


Figure 101: Single-line diagram with one breaker and IEC symbols

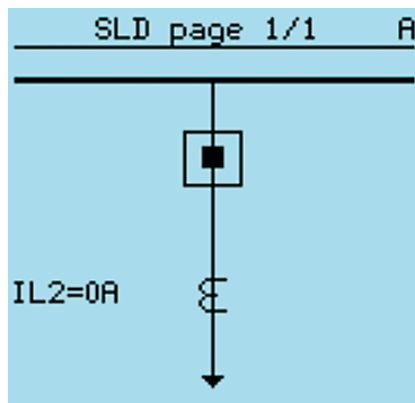


Figure 102: Single-line diagram with one breaker and ANSI symbols

The selected object is indicated with a square border that moves when  or  are used. Switch object can have additional  icon when the object is interlocked.

2. Press  to open or  to close the selected object.
3. Press  or  to select Yes if you want to operate, or select No if you don't want to operate.
4. Activate selection by pressing  or press  to cancel.

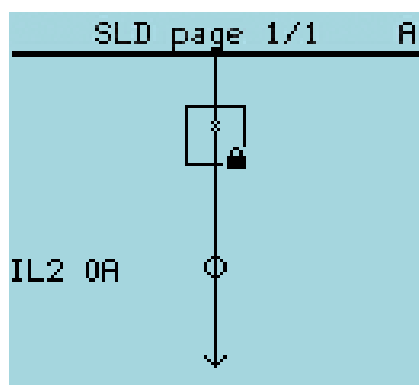


Figure 103: Interlocking example on Single-Line diagram with one breaker and IEC symbols

5.2.1.2 Controlling SLD buttons

Buttons are controlled with the Open and Close buttons like any other controllable single-line diagram objects.

1. Select the button with  and  if it is not already selected.

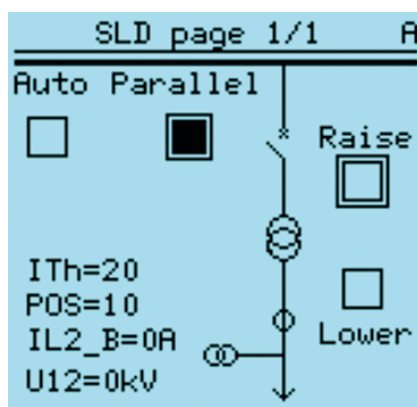


Figure 104: Single-line diagram with several buttons. The Parallel button is in "On" state and the Raise button is selected and it is currently in "Off" state

The selected button has a square around it.

2. Press  or  to control the selected button.



The control position of the protection relay affects the controlling SLD buttons. Depending on the parameter settings, the protection relay may have to be in local state for the control to succeed.

5.2.1.3 Controlling single-line diagram tap changer

1. Select the tap changer with  or  if it is not already selected.
The selected object has a square around it.
2. Press  to start controlling the tap changer.

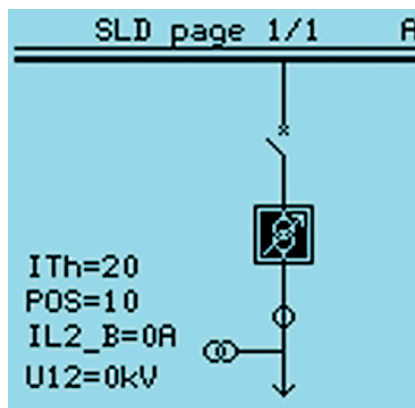


Figure 105: Single-line diagram with tap changer symbol. Inverted tap changer symbol indicates that it can be controlled using arrow keys.

3. Use  and  to raise or lower the tap changer position.
4. Press  to end the controlling.

5.2.2 Controlling via the control menu

The primary equipment can be controlled via the LHMI with the Open and Close buttons when the protection relay is set to the local-control mode and accessing the control operations is authorized.

1. Press  to open or  to close the object.

- If there are several controllable objects, select the object with  and 
and press  to confirm the selection.

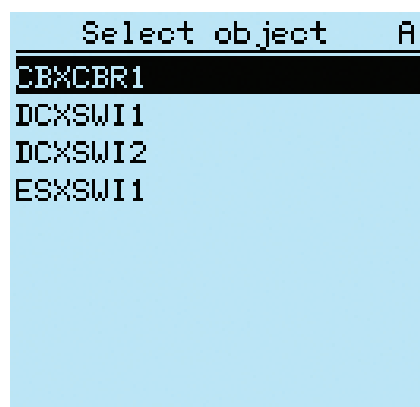


Figure 106: Selecting a controlled object

2.

To confirm the operation, select **Yes** and press .

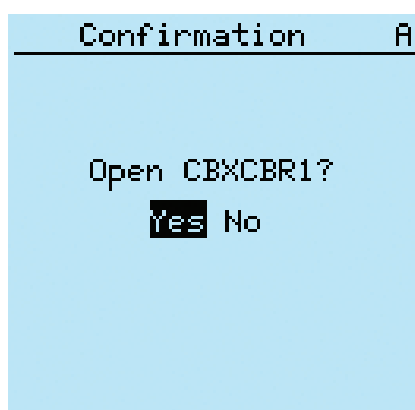


Figure 107: Opening a circuit breaker

•

To cancel the operation, select **No** and press .

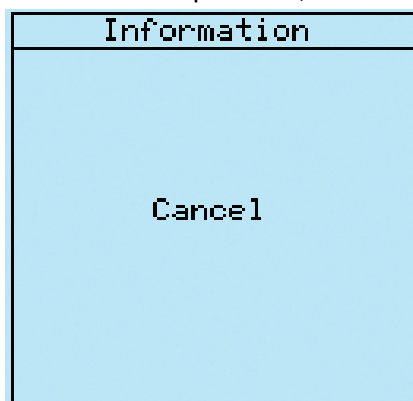


Figure 108: Cancelling operation



The time between selecting the object and giving a control command is restricted by an adjustable time-out. When an object is selected, the control command has to be given within this time.



With default configurations it is possible to control a breaker open even when the breaker is in an intermediate state.

5.2.3 Controlling with the closing delay

Close delay mode and *Close delay* need to be set to be able to control objects with the closing delay.

The closing operation from the LHMI can be delayed by a predefined period of time.

1. Press  to close the selected object.
 - If there are several controllable objects, select the object and press  to confirm the selection.
2. To confirm the operation, select *Yes* and press .
 - After the control operation is confirmed, the delay is activated.
 - Cancel the control by pressing any key when the delay is active.

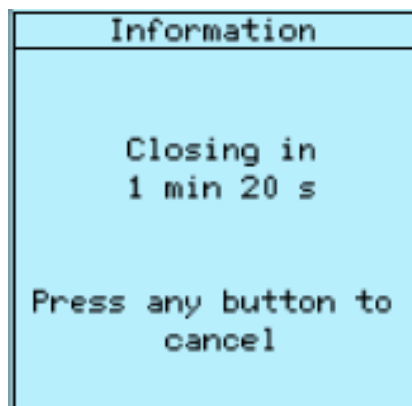


Figure 109: Delay view



When the delay is activated, it is recommended not to change any closing delay parameters in the WHMI during the delayed time as it affects the delayed circuit breaker closing. If the delayed circuit breaker closing fails, the LHMI status shows *Select timeout* or *Status only*.



The display backlight stays on for the delay also if the backlight timeout is shorter than the closing delay.

5.2.4 Controlling with the opening delay

Open delay mode and *Open delay* parameters need to be set to be able to control objects with the opening delay. The opening operation from the LHMI can be delayed by a predefined period of time.

1.

Press  to open the selected object.

•

If there are several controllable objects, select the object with  and  until desired object is selected.

2.

To confirm the operation, select *Yes* and press .

- After the control operation is confirmed, the delay is activated.
- Cancel the control by pressing any key while the delay is active.

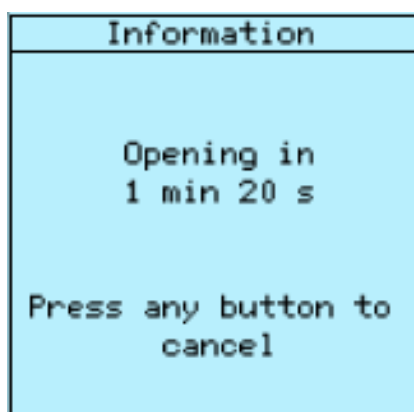


Figure 110: Delay view for opening



When the delay is activated, it is recommended not to change opening delay parameters in the WHMI during the delayed time as it affects the delayed circuit breaker closing. If the delayed circuit breaker controlling fails, the LHMI status shows *Select timeout* or *Status only*.



The display backlight stays on for the delay also if the backlight timeout is shorter than the control delay.

5.2.5 Changing visibility of function key texts

The LHMI keypad on the left side of the protection relay contains four function keys with red LEDs. They can be freely configured both for operation and acknowledgement purposes to get acknowledgements of the executed actions associated with the buttons. The LEDs can also be independently configured to bring general indications or important alarms to the operator's attention.

The function keys can be used, for example, for quickly selecting or changing a setting group, selecting or operating equipment, indicating field contact status or indicating or acknowledging individual alarms.

Each function key has editable descriptions for the LED ON and OFF states.

1. Log in as OPERATOR, ENGINEER or ADMINISTRATOR roles to use the function keys.
2. Select **Main Menu > Configuration > Function key text visibility** and press .
3. Change the visibility of function key texts on the LHMI with  or .
 - a) True: The first function key press activates the function key description view and the subsequent key presses change the state. The display returns to previous view 30 seconds after the last key press or when is pressed.
 - b) False: The function key changes the state immediately.
4. Press  to confirm the selection.

BAY1	A
F1: Function key 1	on
F2: Function key 2	off
F3: Function key 3	off
F4: Function key 4	off

Figure 111: Viewing the function key descriptions

5.3 Resetting protection relay

5.3.1 Clearing and acknowledging via the local HMI

All messages and indications, including LEDs and latched outputs as well as registers and indications, including recordings can be reset, acknowledged or cleared with the Clear button. Pressing the Clear button activates a menu for selecting the wanted clearing or reset function. Events and alarms assigned to programmable LEDs can also be cleared with the Clear button.

1.



Press to activate the Clear view.

All the items that can be cleared are shown.

- Indications and LEDs
- Programmable LEDs
- Events
- Metering records
- Power quality data
- Disturbance records
- Fault records
- Load profile record
- Acc. energy of circuit breaker condition monitoring, three-phase power and energy measurement and single-phase power and energy measurement
- Rem. life of circuit breaker condition monitoring
- Travel times of circuit breaker condition monitoring
- Spr. charge time of circuit breaker condition monitoring
- Temperature of three-phase thermal protection for feeders, cables and distribution transformers, and thermal overload protection for motors
- Reset of autoreclosing and cable fault detection
- Operation time of runtime counter for machines and devices
- Counters for autoreclosing and motor startup supervision
- Master trip
- Clear All

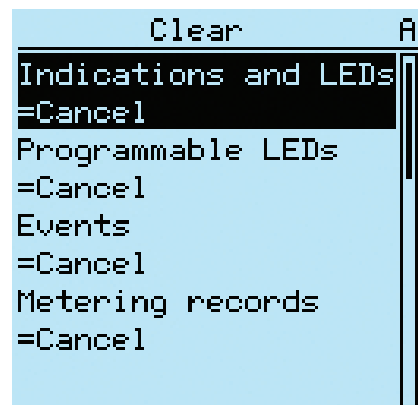


Figure 112: Clear view

2.

Select the item to be cleared with or .

3.

Press , change the value with or and press again. The item is now cleared.

4. Repeat the steps to clear other items.



Use the  button as a shortcut for clearing. The first three-second press clears the indications. The second three-second press clears the programmable LEDs.

5.4 Changing protection relay functionality

5.4.1 Defining the setting group

5.4.1.1 Activating a setting group

Protection relay settings are planned in advance for different operation conditions by calculating setting values to different setting groups. The active setting group can be changed by the protection relay application or manually from the menu.

1. Select **Main menu > Settings > Setting group > Active group** and press .

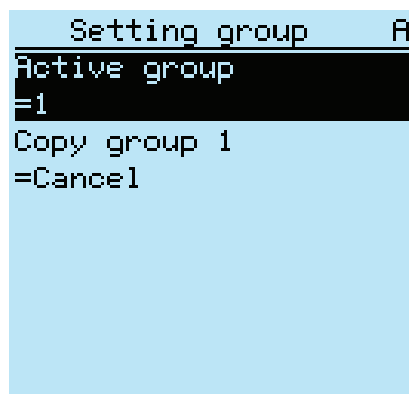


Figure 113: Active setting group

2. Select the setting group with  or .

3. Press  to confirm the selection or  to cancel.

```

Setting group  A
Active group
=i+_1
Copy group 1
=Cancel

```

Figure 114: Selecting the active setting group

4. Commit the settings.



Remember to document the changes you make.

5.4.1.2

Copying a setting group

Setting group 1 can be copied to another group or to all available groups.

1. Select **Main menu > Settings > Setting group > Copy group 1** and press .
2. Change the options with  or  and press  to confirm the selection.

```

Setting group  A
Active group
=1
Copy group 1
=Copy 1 into 6

```

Figure 115: Copying setting group 1 into 6

5.4.1.3

Browsing and editing setting group values

1. Select **Main menu > Settings > Settings** and press .

2. Select the setting group to be viewed with  or  and press  to confirm the selection.



Figure 116: Selecting a setting group

3. To browse the settings, scroll the list with  and  and to select a setting press .

4. To browse different function blocks, scroll the list with  and  and to select a function block press . To move back to the list, press . The function block list is shown in the content area of the display. On the left in the header, you see the current setting group, and on the right the menu path.

5. To browse the parameters, scroll the list with  and  and to select a parameter, press .

The setting group values are indicated with #.

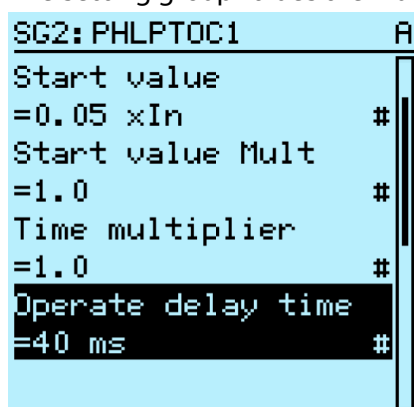


Figure 117: Setting group parameter

6.

To select a setting group value, press  and to edit the value press .

```
SG2: Operate delay... A
*[1]=40 ms
[2]=40 ms
[3]=40 ms
[4]=40 ms
[5]=40 ms
[6]=40 ms
```

Figure 118: Selecting the setting group value

Only values within the selected setting group can be changed.

7.

Press  or  to change the value and  to confirm the selection.

```
SG2: Operate delay... A
*[1]=40 ms
[2]=1+___40 ms
[3]=40 ms
[4]=40 ms
[5]=40 ms
[6]=40 ms
```

Figure 119: Editing the setting group value

The active setting group is indicated with an asterisk *.



Switching the *Operation* parameter of a function block on or off restarts all control and protection functions.

5.4.2 Activating programmable LEDs

1. Select **Main menu > Configuration > Programmable LEDs**.

2.

Select a programmable LED with  or .

3. Press  to enter the selection and  to change the programmable LED mode.

4. Change the mode with  or  and press  to confirm the selection.



See the technical manual for details on LED configuration.

5.4.3 Setting autscroll delay

Autoscroll delay parameter sets the delay of scrolling down measurements view if it is set as default view and the user is logged out. Autoscroll is active if the delay value is not zero.

1. Select **Main menu > Configuration > HMI > Autoscroll delay** and press .
2. Select delay time with  or .
3. Press  to confirm the selection.

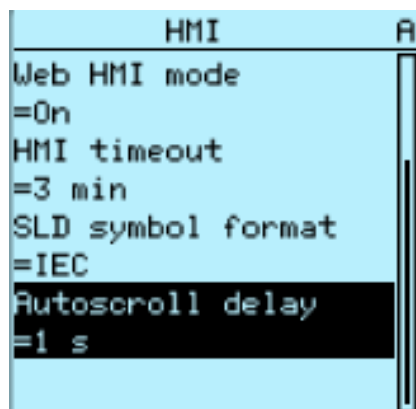


Figure 120: Autoscroll delay

5.4.4 Changing the control operation delay

5.4.4.1 Changing the close delay mode

1. Select **Main menu > Configuration > Control > LHMI > Close delay mode** and press .
2. Select the delay mode with  and .

3. Press  to confirm the selection.

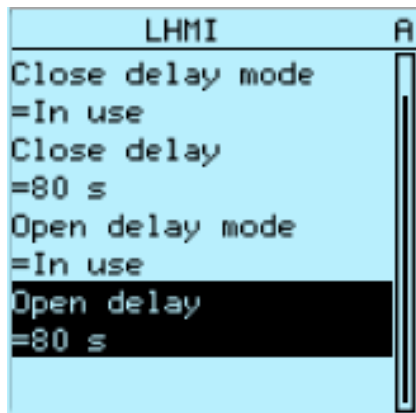


Figure 121: Changing the close delay mode



Use delayed control only in the local control mode.

5.4.4.2 Changing the closing delay

1. Select **Main menu > Configuration > Control > LHMI > Close delay** and press .
2. Select the delay time with  and .
3. Press  to confirm the selection.

5.4.4.3 Changing the open delay mode

1. Select **Main menu > Configuration > Control > LHMI > Open delay mode** and press .
2. Select the delay mode with  and .
3. Press  to confirm the selection.

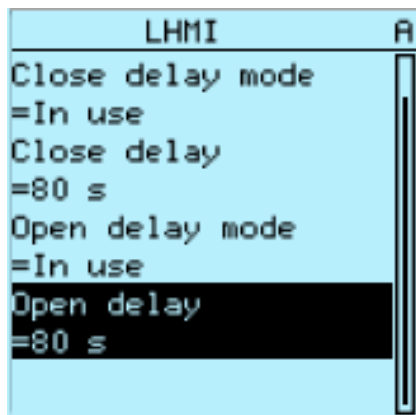


Figure 122: Changing the close delay mode



Use delayed control only in the local control mode.

5.4.4.4

Changing the opening delay

1. Select **Main menu > Configuration > Control > LHMI > Open delay** and press



- 2.

Select the delay time with  and .

- 3.

Press  to confirm the selection.

6 Troubleshooting

6.1 Fault tracing

6.1.1 Identifying hardware errors

1. Check the module with an error.
Check the relay supervision events in **Main menu > Monitoring > IED status > Self-supervision** for a faulty hardware module.
2. Inspect the protection relay visually.
 - Inspect the protection relay visually to find any physical error causes.
 - If you can find some obvious physical damage, contact ABB for repair or replacement actions.
3. Check whether the error is external or internal.
 - Check that the error is not caused by external origins.
 - Remove the wiring from the protection relay and test the input and output operation with an external test device.
 - If the problem remains, contact ABB for repair or replacement actions.

6.1.2 Identifying runtime errors

1. Check the error origin from the protection relay's supervision events **Main menu > Monitoring > IED status > Self-supervision**.
2. Reboot the protection relay and recheck the supervision events to see if the fault has cleared.
3. In case of persistent faults, contact ABB for corrective actions.

6.1.3 Identifying communication errors

Communication errors are normally communication interruptions or synchronization message errors due to communication link breakdown.

- In case of persistent faults originating from protection relay's internal faults such as component breakdown, contact ABB for repair or replacement actions.

6.1.3.1 Checking front communication link operation

- To verify front communication, check that both LEDs above the RJ-45 communication port are lit.

Table 13: Front communication LEDs

LED	Communication ok
Uplink	Steady green light
Communication	Flashing yellow light

6.1.3.2 Checking time synchronization

- Check the time synchronization via LHMI in **Main menu > Monitoring > IED status > Time synchronization**.

6.1.4 Reading internal log files

When contacting ABB customer service, be prepared to send the relay's internal log files for investigation. The files can be read via the WHMI's Exporting report summary, see [Chapter 4.2.22 Exporting report summary](#).

6.1.5 Running the display test

A short display test is always run, when auxiliary voltage is connected to the protection relay. The display test can also be run manually.

- Press simultaneously  and .
- All the LEDs are tested by turning them on simultaneously. The display shows a set of patterns so that all the pixels are activated. After the test, the display returns to normal state.



Clear any indications on the display before running the display test manually.

6.2 Indication messages

6.2.1 Internal faults

When an internal relay fault is detected, relay protection operation is disabled, the green Ready LED begins to flash and the self-supervision output contact is activated.



Internal fault indications have the highest priority on the LHMI. None of the other LHMI indications can override the internal fault indication.

An indication about the fault is shown as a message on the LHMI. The text `Internal Fault` with an additional text message, a code, date and time, is shown to indicate the fault type.

Different actions are taken depending on the severity of the fault. The protection relay tries to eliminate the fault by restarting. After the fault is found to be permanent, the protection relay stays in the internal fault mode. All other output contacts are released and locked for the internal fault. The protection relay continues to perform internal tests during the fault situation.

If an internal fault disappears, the green Ready LED stops flashing and the protection relay returns to the normal service state.

The self-supervision signal output operates on the closed-circuit principle. Under normal conditions, the protection relay is energized and the contact gaps 3-5 in slot X100 is closed. If the auxiliary power supply fails or an internal fault is detected, the contact gaps 3-5 are opened.

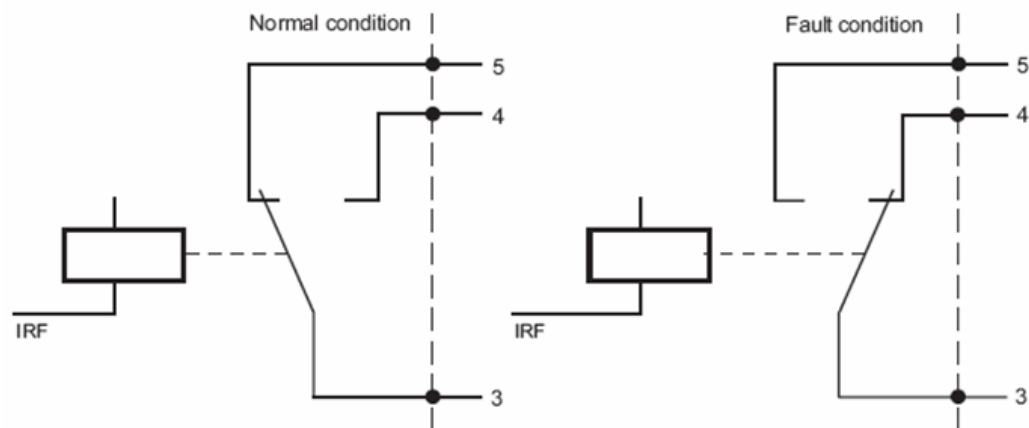


Figure 123: Output contact

The internal fault code indicates the type of internal relay fault. When a fault appears, the code must be recorded so that it can be reported to ABB customer service.

Table 14: Internal fault indications and codes

Fault indication	Fault code	Additional information	Fast self-recovery attempt (# of attempts)	Slow 10 min self-recovery (# of attempts)	Immediate permanent IRF-mode	Action in permanent fault state
Internal Fault System error	2	Start up error: HW/SW mismatch	No	No	Yes	If relay SW has just been updated, redo it. If not recovered, contact your nearest ABB representative to check the next possible corrective action.
Internal Fault System error	2	Start up or runtime error: Data bus error, CPU module	Yes (2)	Yes (3)	No	Restart the relay. If recovered by restarting, continue relay normal operation. If not recovered by restarting, replace the relay, most probably hardware failure in CPU module.
Internal Fault System error	2	Start up error: SCL file missing	No	No	Yes	Do factory restore or rewrite configuration using PCM600.

Table continues on the next page

Fault indication	Fault code	Additional information	Fast self-recovery attempt (# of attempts)	Slow 10 min self-recovery (# of attempts)	Immediate permanent IRF-mode	Action in permanent fault state
Internal Fault System error	2	Start up error: Missing order number	No	No	Yes	Do factory restore. If not recovered, contact your nearest ABB representative to check the next possible corrective action.
Internal Fault System error	2	Start up error: FPGA HW error, CPU module	Yes (2)	Yes (3)	No	Restart the relay. If recovered by restarting, continue relay normal operation. If not recover by restarting, replace the relay, most probably hardware failure in CPU module.
Internal Fault System error	2	Start up error: FPGA image corrupted, CPU module	Yes (2)	Yes (3)	No	Restart the relay or if relay SW has just been updated, redo it. If recovered by restarting, continue relay normal operation. If not recovered by restarting or redoing SW update, replace the relay, most probably hardware failure in CPU module.
Internal Fault System error	2	Runtime error: CPU internal fault	Yes (2)	Yes (3)	No	Restart the relay. If recovered by restarting, continue relay normal operation. If not recover by restarting, replace the relay, most probably hardware failure in CPU module.
Internal Fault File system error	7	Start up error or runtime error: file system error	Yes (2)	Yes (3)	No	Restart the relay. If recovered by restarting, continue relay normal operation. If not recover by restarting, replace the relay, most probably hardware failure in CPU module.
Internal Fault Test	8	Internal fault test activated manually by the user.	No	No	-	Just check the "Internal fault test" -setting parameter position, if relay is in test mode
Internal Fault SW watchdog error	10	Start up error: Watchdog reset has occurred too many times within an hour. Note! This is different indication than Warning code 10: Watchdog reset	No	No	Yes	Restart the relay. If recovered by restarting, continue relay normal operation. If not recover by restarting, replace the relay.
Internal Fault SO-relay(s),X105	40	Runtime error: Faulty Signal Output relay(s) in card located in slot X105.	Yes (2)	Yes (3)	No	Check wirings. Restart the relay. If recovered by restarting, continue relay normal operation. If not recover by restarting, exchange the hardware module in slot X105.
Internal Fault SO-relay(s),X115	41	Runtime error: Faulty Signal Output relay(s) in card located in slot X115.	Yes (2)	Yes (3)	No	Check wirings. Restart the relay. If recovered by restarting, continue relay normal operation. If not recover by restarting, exchange the hardware module in slot X115.
Internal Fault SO-relay(s),X100	43	Runtime error: Faulty Signal Output relay(s) in card located in slot X100.	Yes (2)	Yes (3)	No	Check wirings. Restart the relay. If recovered by restarting, continue relay normal operation. If not recover by restarting, exchange the hardware module in slot X100.
Internal Fault SO-relay(s),X110	44	Runtime error: Faulty Signal Output relay(s) in card located in slot X110. Runtime error:	Yes (2)	Yes (3)	No	Check wirings. Restart the relay. If recovered by restarting, continue relay normal operation. If not recover by restarting, exchange the hardware module in slot X110.
Internal Fault SO-relay(s),X120	45	Runtime error: Faulty Signal Output relay(s) in card located in slot X120.	Yes (2)	Yes (3)	No	Check wirings. Restart the relay. If recovered by restarting, continue relay normal operation. If not recover by restarting,

Table continues on the next page

Fault indication	Fault code	Additional information	Fast self-recovery attempt (# of attempts)	Slow 10 min self-recovery (# of attempts)	Immediate permanent IRF-mode	Action in permanent fault state
						exchange the hardware module in slot X120.
Internal Fault SO-relay(s),X130	46	Runtime error: Faulty Signal Output relay(s) in card located in slot X130.	Yes (2)	Yes (3)	No	Check wirings. Restart the relay. If recovered by restarting, continue relay normal operation. If not recover by restarting, exchange the hardware module in slot X130.
Fault in PO-relay(s) attached to X105	50	Runtime error: Faulty Power Output relay(s) in card located in slot X105.	Yes (2)	Yes (3)	No	Check wirings. Restart the relay. If recovered by restarting, continue relay normal operation. If not recover by restarting, exchange the hardware module in slot X105.
Fault in PO-relay(s) attached to X115	51	Runtime error: Faulty Power Output relay(s) in card located in slot X115.	Yes (2)	Yes (3)	No	Check wirings. Restart the relay. If recovered by restarting, continue relay normal operation. If not recover by restarting, exchange the hardware module in slot X115.
Internal Fault PO-relay(s),X100	53	Runtime error: Faulty Power Output relay(s) in card located in slot X100.	Yes (2)	Yes (3)	No	Check wirings. Restart the relay. If recovered by restarting, continue relay normal operation. If not recover by restarting, exchange the hardware module in slot X100.
Internal Fault PO-relay(s),X110	54	Runtime error: Faulty Power Output relay(s) in card located in slot X110.	Yes (2)	Yes (3)	No	Check wirings. Restart the relay. If recovered by restarting, continue relay normal operation. If not recover by restarting, exchange the hardware module in slot X110.
Internal Fault PO-relay(s),X120	55	Runtime error: Faulty Power Output relay(s) in card located in slot X120.	Yes (2)	Yes (3)	No	Check wirings. Restart the relay. If recovered by restarting, continue relay normal operation. If not recover by restarting, exchange the hardware module in slot X120.
Internal Fault PO-relay(s),X130	56	Runtime error: Faulty Power Output relay(s) in card located in slot X130.	Yes (2)	Yes (3)	No	Check wirings. Restart the relay. If recovered by restarting, continue relay normal operation. If not recover by restarting, exchange the hardware module in slot X130.
Internal Fault Light sensor error	59	Runtime error: Faulty ARC light sensor input(s).	Yes (2)	Yes (3)	No	Check wirings. Restart the relay. If recovered by restarting, continue relay normal operation. If not recover by restarting, exchange the communication module including ARC inputs in slot X000.
Internal Fault Conf. error,X105	60	Start up error: Card in slot X105 is wrong type, is missing, does not belong to original configuration or card firmware is faulty.	No	No	Yes	Check that the card in slot X105 is proper type and properly installed. Check that the plug-in unit is properly installed and plug-in unit handle is properly fixed to closed position. Then restart the relay. If does not recover by restarting, it is hardware module failure most likely. Exchange the hardware module in slot X105.
Internal Fault Conf. error,X115	61	Start up error: Card in slot X115 is wrong type, is missing, does not belong to original configuration or card firmware is faulty.	No	No	Yes	Check that the card in slot X115 is proper type and properly installed. Check that the plug-in unit is properly installed and plug-in unit handle is properly fixed to closed position. Then restart the relay. If does not recover by restarting, it is hardware module failure most likely. Exchange the hardware module in slot X115.

Table continues on the next page

Fault indication	Fault code	Additional information	Fast self-recovery attempt (# of attempts)	Slow 10 min self-recovery (# of attempts)	Immediate permanent IRF-mode	Action in permanent fault state
Internal Fault Conf. error,X000	62	Start up error: Card in slot X000 is wrong type, is missing, does not belong to original configuration or card firmware is faulty.	No	No	Yes	"Check that the communication card in slot X000 is proper type and properly installed. Check that the plug-in unit is properly installed and plug-in unit handle is properly fixed to closed position. Then restart the relay. If does not recover by restarting, it is hardware module failure most likely. Exchange the communication module in slot X000. In some rare cases also communication storm may cause this. Detach the ethernet communication cable(s) from the communication module and reboot the relay. If not recover,exchange the communication module in slot X000. "
Internal Fault Conf. error,X100	63	Start up error: Card in slot X100 is wrong type, is missing, does not belong to original configuration or card firmware is faulty.	No	No	Yes	"Check that the card in slot X100 is proper type and properly installed. Check that the plug-in unit is properly installed and plug-in unit handle is properly fixed to closed position. Then restart the relay. If does not recover by restarting, it is hardware module failure most likely. Exchange the hardware module in slot X100."
Internal Fault Conf. error,X110	64	Start up error: Card in slot X110 is wrong type, is missing, does not belong to original configuration or card firmware is faulty.	No	No	Yes	"Check that the card in slot X110 is proper type and properly installed. Check that the plug-in unit is properly installed and plug-in unit handle is properly fixed to closed position. Then restart the relay. If does not recover by restarting, it is hardware module failure most likely. Exchange the hardware module in slot X110."
Internal Fault Conf. error,X120	65	Start up error: Card in slot X120 is wrong type, is missing, does not belong to original configuration or card firmware is faulty.	No	No	Yes	"Check that the card in slot X120 is proper type and properly installed. Check that the plug-in unit is properly installed and plug-in unit handle is properly fixed to closed position. Then restart the relay. If does not recover by restarting, it is hardware module failure most likely. Exchange the hardware module in slot X120."
Internal Fault Conf. error,X130	66	Start up error: Card in slot X130 is wrong type, is missing, does not belong to original configuration or card firmware is faulty.	No	No	Yes	"Check that the card in slot X130 is proper type and properly installed. Check that the plug-in unit is properly installed and plug-in unit handle is properly fixed to closed position. Then restart the relay. If does not recover by restarting, it is hardware module failure most likely. Exchange the hardware module in slot X130."
Internal Fault Card error,X105	70	Card in slot X105 is faulty.	Yes (2)	Yes (3)	No	Exchange the hardware module in slot X105.
Internal Fault Card error,X115	71	Card in slot X115 is faulty.	Yes (2)	Yes (3)	No	Exchange the hardware module in slot X115.
Internal Fault Card error,X000	72	Card in slot X000 is faulty.	Yes (2)	Yes (3)	No	"Check the plug-in unit connector pins in the card by detaching the plug-in unit. If pins are OK, exchange the communication module in slot X000. In some rare cases also communication storm may cause this. Detach the ethernet communication cable(s) from the communication module and reboot the relay. If not recover,exchange the communication module in slot X000. "

Table continues on the next page

Fault indication	Fault code	Additional information	Fast self-recovery attempt (# of attempts)	Slow 10 min self-recovery (# of attempts)	Immediate permanent IRF-mode	Action in permanent fault state
Internal Fault Card error,X100	73	Card in slot X100 is faulty.	Yes (2)	Yes (3)	No	Exchange the hardware module in slot X100.
Internal Fault Card error,X110	74	Card in slot X110 is faulty.	Yes (2)	Yes (3)	No	Exchange the hardware module in slot X110.
Internal Fault Card error,X120	75	Card in slot X120 is faulty.	Yes (2)	Yes (3)	No	Exchange the hardware module in slot X120.
Internal Fault Card error,X130	76	Card in slot X130 is faulty.	Yes (2)	Yes (3)	No	Check the plug-in unit connector pins in the card by detaching the plug-in unit. If pins are OK, exchange the hardware module in slot X130.
Internal Fault LHMI module	79	Runtime error: LHMI LCD error. The fault indication may not be seen on the LHMI during the fault.	Yes (2)	Yes (3)	No	Restart the relay. If recovered by restarting, continue relay normal operation. If not recover by restarting, check LHMI connection cable and connection to be properly fixed. If then not recovered by restarting, exchange the LHMI module.
Internal Fault RAM error	80	Runtime error: Error in the RAM memory on the CPU module.	Yes (2)	Yes (10)	No	If recovered by restarting, continue relay normal operation. If not recover by restarting, replace the relay, most probably hardware failure in CPU module.
Internal Fault ROM error	81	Runtime error: Error in the ROM memory on the CPU module.	Yes (2)	Yes (3)	No	Restart the relay. If recovered by restarting, continue relay normal operation. If not recover by restarting, replace the relay, most probably hardware failure in CPU module.
Internal Fault EEPROM error	82	Start up error: Error in the EEPROM memory on the CPU module.	No	No	Yes	Restart the relay. If recovered by restarting, continue relay normal operation. If not recover by restarting, replace the relay, most probably hardware failure in CPU module.
Internal Fault EEPROM error	82	Start up error: CRC check failure in the EEPROM memory on boot-up on the CPU module.	Yes (2)	Yes (3)	No	Restart the relay. If recovered by restarting, continue relay normal operation. If not recover by restarting, replace the relay, most probably hardware failure in CPU module.
Internal Fault FPGA error	83	Runtime error: Error in the FPGA on the CPU module.	Yes	Yes (3)	No	Restart the relay. If recovered by restarting, continue relay normal operation. If not recover by restarting, replace the relay, most probably hardware failure in CPU module.
Internal Fault RTC error	84	Start up error: Error in the RTC on the CPU module.	Yes	Yes (3)	No	Restart the relay. If recovered by restarting, continue relay normal operation. If not recover by restarting, replace the relay, most probably hardware failure in CPU module.
Internal Fault RTD card error,X105	90	Runtime error: RTD card located in slot X105 may have permanent fault. Temporary error has occurred too many times within a short time.	Yes (2)	Yes (3)	No	Restart the relay. If recovered by restarting, continue relay normal operation. If not recover by restarting, exchange the RTD hardware module in slot X105.
Internal Fault RTD card error,X130	96	Runtime error: RTD card located in slot X130 may have permanent fault. Temporary error has occurred too many	Yes	Yes (3)	No	Restart the relay. If recovered by restarting, continue relay normal operation. If not recover by restarting, exchange the hardware module in slot X130.

Table continues on the next page

Fault indication	Fault code	Additional information	Fast self-recovery attempt (# of attempts)	Slow 10 min self-recovery (# of attempts)	Immediate permanent IRF-mode	Action in permanent fault state
		times within a short time.				
Internal Fault COM card error	116	Runtime error: Error in the COM card.	Yes	Yes (3)	No	Restart the relay. If recovered by restarting, continue relay normal operation. If not recover by restarting, exchange the communication module in slot X000.

For further information on internal fault indications, see the operation manual.

6.2.2 Warnings

Warnings are indicated with the text **Warning** additionally provided with the name of the warning, a numeric code and the date and time on the LHMI. The warning indication message can be manually cleared.



If a warning appears, record the name and code so that it can be provided to ABB customer service.

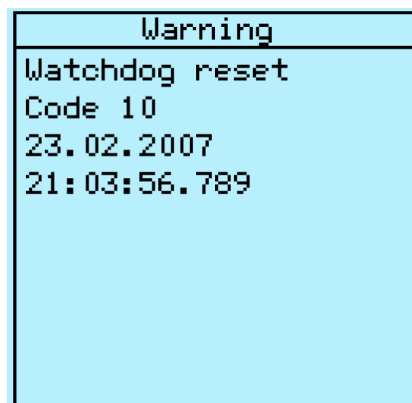


Figure 124: Warning

Table 15: Warning indications and codes

Warning indication	Warning code	Additional information
Warning Watchdog reset	10	A watchdog reset has occurred.
Warning Power down det.	11	The auxiliary supply voltage has dropped too low.
Warning IEC61850 error	20	Error when building the IEC 61850 data model.
Warning	21	Error in the Modbus communication.

Table continues on the next page

Warning indication	Warning code	Additional information
Modbus error		
Warning DNP3 error	22	Error in the DNP3 communication.
Warning Dataset error	24	Error in the Data set(s).
Warning Report cont. error	25	Error in the Report control block(s).
Warning GOOSE contr. error	26	Error in the GOOSE control block(s).
Warning SCL config error	27	Error in the SCL configuration file or the file is missing.
Warning Logic error	28	Too many connections in the configuration.
Warning SMT logic error	29	Error in the SMT connections.
Warning GOOSE input error	30	Error in the GOOSE connections.
ACT error	31	Error in the ACT connections.
Warning GOOSE Rx. error	32	Error in the GOOSE message receiving.
Warning AFL error	33	Analog channel configuration error.
Warning SMV config error	34	Error in the SMV configuration.
Warning Comm. channel down	35	Redundant Ethernet (HSR/PRP) communication interrupted.
Warning Unack card comp	40	A new composition has not been acknowledged/accepted.
Warning Protection comm.	50	Error in protection communication.
Warning ARC1 cont. light	85	A continuous light has been detected on the ARC light input 1.

Table continues on the next page

Warning indication	Warning code	Additional information
Warning ARC2 cont. light	86	A continuous light has been detected on the ARC light input 2.
Warning ARC3 cont. light	87	A continuous light has been detected on the ARC light input 3.
Warning RTD card error,X105	90	Temporary error occurred in RTD card located in slot X105.
Warning RTD card error,X110	94	Temporary error occurred in RTD card located in slot X110.
Warning RTD card error,X130	96	Temporary error occurred in RTD card located in slot X130.
Warning RTD meas. error,X105	100	Measurement error in RTD card located in slot X105.
Warning RTD meas. error,X110	104	Measurement error in RTD card located in slot X110.
Warning RTD meas. error,X130	106	Measurement error in RTD card located in slot X130.
SNMP Config warning	-58	The SNMP service was not started due to invalid configuration file. Try to write the SNMP configuration to the device again, contact customer support with details of the configuration if the issue persists.
Internal warning	-59	The SNMP service has unexpectedly stopped or failed to start. Try to write the SNMP configuration to the device again or restart the device, contact customer support if the issue persists or keeps re-appearing.

6.3 Correction procedures

6.3.1 Rebooting the software

1. Select **Main menu** > **Configuration** > **General** > **Software reset** and press .
2. Change the value with  or  and press .

6.3.2 Restoring factory settings

In case of configuration data loss or any other file system error that prevents the protection relay from working properly, the whole file system can be restored to the original factory state. All default settings and configuration files stored in the factory are restored. Only the administrator can restore the factory settings.

1. Select **Main menu** > **Configuration** > **General** > **Factory setting** and press .
2. Set the value with  or  and press .
3. Confirm by selecting **Yes** with  or  and press .

The protection relay restores the factory settings and restarts. Restoring takes 1...3 minutes. Confirmation of restoring the factory settings is shown on the display a few seconds, after which the relay restarts.



Avoid the unnecessary restoring of factory settings, because all the parameter settings that are written earlier to the relay will be overwritten with the default values. During normal use, a sudden change of the settings can cause a protection function to trip.



Restoring factory setting also moves relay configuration to factory default. End user must download the real end-user configuration to relay after the factory restore action.

6.3.3 Setting passwords

IED Users in PCM600 is used to manage user accounts.

User accounts can be created under any default roles (VIEWER, OPERATOR, ENGINEER and ADMINISTRATOR) or additional roles (INSTALLER, SECADM, SECAUD and RBACMNT). Only Administrator can create user accounts and update the roles-to-rights mapping. Administrator needs to share the default password generated for the user account by the tool with the users and recommend the user to change the password.



If the administrator password is lost, contact ABB's technical customer support to retrieve the administrator level access.

6.3.4 Identifying relay application problems

- Check that the function is on.
- Check the blocking.
- Check the mode.
- Check the measurement value.
- Check the connection to trip and disturbance recorder functions.
- Check the channel settings.

6.3.4.1 Inspecting wiring

The physical inspection of wiring connections often reveals the wrong connection for phase currents or voltages. However, even though the phase current or voltage connections to protection relay terminals might be correct, wrong polarity of one or more measurement transformers can cause problems.

- Check the current or voltage measurements and their phase information from **Main menu > Measurements**.
- Check that the phase information and phase shift between phases is correct.
- Correct the wiring if needed.
- Check the actual state of the connected binary inputs from **Main menu > Monitoring > I/O status > Binary input values**.
- Test and change the relay state manually in **Main menu > Tests > Binary outputs**.

6.3.4.2 Sample data interruptions

Occasionally protection relays can receive corrupted or faulty measurement data during runtime. In these cases the operation system halts the corresponding application execution until correct data is received. In case of permanent faults, the measurement chain should be checked to remove the origin of the faulty measurement data.



In case of persistent faults originating from protection relay's internal faults, contact ABB for repair or replacement actions.

7 Commissioning

7.1 Commissioning checklist

Familiarize yourself with the protection relay and its functionality before you start the commissioning work.

- Ensure that you have all the needed station drawings such as single line and wiring diagrams.
- Ensure that your version of the technical manual applies to the protection relay version you test.
- Ensure that your setting software and connectivity packages work with the protection relay version you test.
- Find out if you need any additional software.
- Ensure that you have the relay settings either on paper or in electronic format. The settings and logic should be well documented.
- Inspect the settings to ensure that they are correct.
- Ensure that you have the correct cable to connect your PC to the protection relay's communication port. The RJ-45 port supports any CAT 5 Ethernet cable but the recommendation is STP.
- Test your PC's communication port before you go to the site.
- Find out who to contact if you have trouble and make sure you have a means to contact them.
- Find out who is responsible for the settings.
- Ensure that you have with you the proper test equipment and all needed connection cables.
- Ensure that the owner of the switchgear familiarizes you with the work site and any special aspects of it.
- Ensure that you know how to operate in emergency situations. Find out where the first aid and safety materials and exit routes are.



Ensure that self-supervision is not indicating active internal faults before starting commissioning work.

7.2 Checking the installation

7.2.1 Checking power supply

- Check that the auxiliary supply voltage remains within the permissible input voltage range under all operating conditions.
- Check that the polarity is correct before powering the protection relay.

7.2.2 Checking CT circuits



Check that the wiring is in strict accordance with the supplied connection diagram.

The CTs must be connected in accordance with the terminal diagram provided with the protection relay, both with regards to phases and polarity. The following tests are recommended for every primary CT or CT core connected to the protection relay.

- Primary injection test to verify the current ratio of the CT, the correct wiring up to the protection relay and correct phase sequence connection (that is L1, L2, L3.)
- Polarity check to prove that the predicted direction of the secondary current flow is correct for a given direction of the primary current flow. This is an essential test for the proper operation of the directional function, protection or measurement in the protection relay.
- CT secondary loop resistance measurement to confirm that the current transformer secondary loop DC resistance is within specification and that there are no high resistance joints in the CT winding or wiring.
- CT excitation test to ensure that the correct core in the CT is connected to the protection relay. Normally only a few points along the excitation curve are checked to ensure that there are no wiring errors in the system, for example, due to a mistake in connecting the CT's measurement core to the protection relay.
- CT excitation test to ensure that the CT is of the correct accuracy rating and that there are no short circuited turns in the CT windings. Manufacturer's design curves should be available for the CT to compare the actual results.
- Earthing check of the individual CT secondary circuits to verify that each three-phase set of main CTs is properly connected to the station earth and only at one electrical point.
- Insulation resistance check.
- Phase identification of CT shall be made.



Both the primary and the secondary sides must be disconnected from the line and the protection relay when plotting the excitation characteristics.



If the CT secondary circuit is opened or its earth connection is missing or removed without the CT primary being de-energized first, dangerous voltages may be produced. This can be lethal and cause damage to the insulation. The re-energizing of the CT primary should be prohibited as long as the CT secondary is open or unearthed.

7.2.3 Checking VT circuits

Check that the wiring is in strict accordance with the supplied connection diagram.



Correct possible errors before continuing to test the circuitry.

Test the circuitry.

- Polarity check

- VT circuit voltage measurement (primary injection test)
- Earthing check
- Phase relationship
- Insulation resistance check

The polarity check verifies the integrity of circuits and the phase relationships. The polarity must be measured as close to the protection relay as possible to ensure that most of the wiring is also checked.

The primary injection test verifies the VT ratio and the wiring all the way from the primary system to the protection relay. Injection must be performed for each phase-to-neutral circuit and each phase-to-phase pair. In each case, voltages in all phases and neutral are measured.

7.2.4 Checking binary input and output circuits

7.2.4.1 Checking binary input circuits

- Preferably, disconnect the binary input connector from the binary input cards.
- Check all the connected signals so that both the input level and the polarity are in accordance with the protection relay specifications.



Do not use AC voltage. Binary inputs are rated for DC voltage only.

7.2.4.2 Checking binary output circuits

- Preferably, disconnect the binary output connector from the binary output cards.
- Check all connected signals so that both load and voltage are in accordance with the protection relay specifications.

7.3 Authorizations

7.3.1 User authorization

There are four predefined user accounts in the relay that can be accessed through LHMI and WHMI.

Passwords are settable for user accounts in all roles. Only the following characters are accepted.

- Numbers 0-9
- Letters a-z, A-Z
- Space
- Special characters !"#\$%&'()*+,-./:;<=>?@[\\]^_`{|}~

By default, the password policies in the protection relay are as follows:

- Minimum password length: 6
- Maximum password length: 20
- Minimum uppercase characters: 0
- Minimum numeric: 0
- Minimum special characters: 0

The protection relays are delivered from the factory with default passwords. It is required to change the default passwords.

Table 16: Predefined users, their passwords and roles

Username	Password	Predefined role
VIEWER	remote0001	VIEWER
OPERATOR	remote0002	OPERATOR
ENGINEER	remote0003	ENGINEER
ADMINISTRATOR	remote0004	ADMINISTRATOR

Table 17: Predefined user categories

Username	User rights
VIEWER	Read only access
OPERATOR	• Selecting remote or local state with  (only locally) • Changing setting groups • Controlling • Clearing indications
ENGINEER	• Changing settings • Clearing event list • Clearing disturbance records • Changing system settings such as IP address, serial baud rate or disturbance recorder settings • Setting the protection relay to test mode • Selecting language
ADMINISTRATOR	• All listed above • Changing password • Factory default activation

The following enforcing rules of the password policies can be customized in IED Users in PCM600.

- Option of enabling or disabling password policies (disabling sets default policies as described above)
- Minimum password length
- Use of uppercase characters
- Use of lowercase characters
- Use of numbers
- Use of special characters

It is required to login as an Administrator in PCM600 in order to change the password policies.

Each user can change their own password, but only Administrator can reset the passwords of other users.

On Factory restore, factory default usernames, passwords and password policies are restored.



For user authorization for PCM600, see the PCM600 documentation.



Policy change and configuration is not allowed when the protection relay is in offline mode in PCM600.



If the last ADMINISTRATOR password is lost, contact ABB's technical customer support to retrieve the administrator level access.

7.4 Setting protection relay and communication

7.4.1 Setting the communication between protection relays and PCM600

The communication between the protection relay and PCM600 is independent of the used communication protocol within the substation or to the NCC. It can be seen as a second channel for communication.

The media is always Ethernet and communication is based on TCP/IP.

Each protection relay has an Ethernet front connector for PCM600 access. Depending on the station concept and the used station protocol, additional Ethernet interfaces may be available on the rear side of the protection relay. All Ethernet interfaces can be used to connect PCM600.

When an Ethernet based station protocol is used, the PCM600 communication can use the same Ethernet port and IP address. The protection relay is able to separate the information belonging to the PCM600 dialog.

To configure the physical connection and the IP addresses:

1. Set up or get the IP addresses of the protection relays.
2. Set up the PC for a direct link or connect the PC or workstation to the network.
3. Configure the IP addresses in the PCM600 project for each protection relay.
The addresses are used for communication between protection relays and PCM600.

7.4.1.1 Communication link options between PCM600 and protection relays

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

All communication is done over Ethernet using either IEC 61850 or the FTP/FTPS protocol.

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

Two basic variants have to be considered for the connection between PCM600 and the protection relay.

- Protection relays front port is being used for direct point-to-point link between PCM600 and the protection relay
 - Indirect link via station LAN or remotely via network
1. If needed, the IP address for the protection relay is set.
 2. A PC or workstation is set up for a direct link (point-to-point), or the PC or workstation is connected to the LAN/WAN network.
 3. The protection relays' IP addresses in the PCM600 project are configured to match the IP addresses of the physical IEDs.

4. Technical keys of the IEDs in the PCM600 project are configured to match the technical keys of the physical IEDs.

For successful protection relay engineering and usage, the workstation firewall TCP and UDP port configurations should be checked, especially for IEC 61850 and FTP. Other protocols are not used for engineering or they are optional.

Table 18: IP ports used by the relay

Port number	Type	Default state	Description
21	TCP	Open	Explicit FTP over TLS
22	TCP	Closed	SSH (HMI only, normally closed)
102	TCP	Open	IEC 61850
443	TCP	Open	Web server HTTPS
80	TCP	Closed	Traffic redirect to HTTPS port 443 TCP
123	UDP	Client service not active by default in relay	SNTP
502	TCP	Closed	Modbus TCP
2404	TCP	Closed	IEC 60870-5-104 TCP
20000	TCP	Closed	DNP3 TCP
20000	UDP	Closed	DNP3 UDP
1468	TCP	Closed	CAL
514	UDP	Closed	CAL
49220...49235	TCP	Closed	Ports open on demand for data transfer when FTP PASV command is given

7.4.2 Communication settings

The protection relay is provided with an RJ-45 front port on the LHMI. This connector is mainly used for configuration and setting purposes. The front and rear port IP addresses and the corresponding subnet masks can be set via the LHMI. The front port has a factory default IP address 192.168.0.254, and it also provides DHCP server to assign an IP address for the connected computer. The rear Ethernet interface has a factory default IP address 192.168.2.10 when the complete protection relay is delivered.

Different communication ports are available via optional communication modules. Ethernet RJ-45 and optical Ethernet LC are the two rear port Ethernet communication options. Rear port Ethernet is intended for station bus communication. Communication protocols used via Ethernet ports are IEC

61850-8-1, IEC 61850-9-2 LE, DNP3 TCP/IP, Modbus TCP/IP and IEC 60870-5-104. Optical ST-type glass fiber serial and RS-485/RS-232 twisted pair can also be used for rear port communication. Protocols available for serial communication are Modbus RTU/Modbus ASCII, DNP3 and IEC 60870-5-103.

Ethernet ports

The protection relay allows the use of a secondary IP address for the station ports on the communication modules COM8...COM10, COM15...COM18, COM31...34 and COM37. This secondary IP network is assigned to a single Ethernet port and can be used to make separate networks for different communication protocols or, for example, a separate service network for configuration purposes. Multicast station/bus communication, such as IEC 61850-9-2 LE sampled values and GOOSE, is only supported on the Network 1 interface. The parameters for setting the secondary IP network are located under **Configuration > Communication > Ethernet > Network 2 address**.

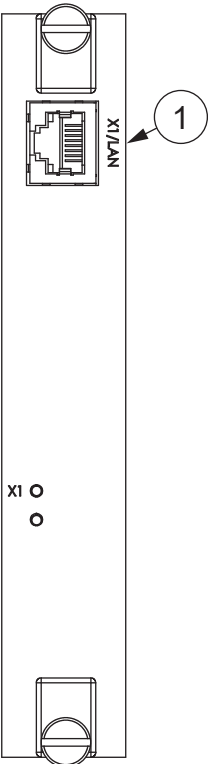
Table 19: Secondary IP address parameters

Parameter	Options	Description
Configuration/Communication/Ethernet/Network 2 address/ Enable	False (default)	Network 2 disabled
	TRUE	Network 2 enabled
Configuration/Communication/Ethernet/Network 2 address/IP address	0.0.0.0	IP address for Network 2
Configuration/Communication/Ethernet/Network 2 address/IP address	0.0.0.0	Subnet address for Network 2
Configuration/Communication/Ethernet/Network 2 address/MAC address	xx-xx-xx-xx-xx-xx	MAC address for Network 2

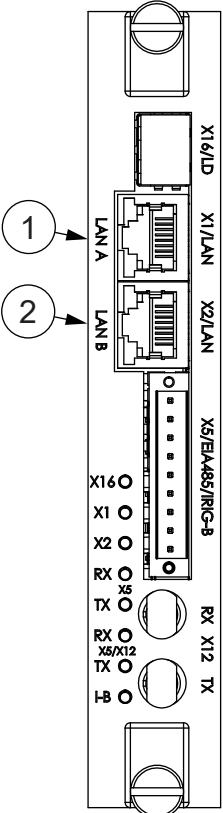
The IP address for Network 2 is disabled by default settings, and all Ethernet ports are assigned to the same IP address used in the Network 1 address menu **Configuration > Communication > Ethernet > Network 1**. If Network 2 is taken into use by the setting Enable="True" (requires reboot), the interlink port X3 of the COM module is assigned to this second network, using the IP address and subnet parameters in the Network 2 address menu **Configuration > Communication > Ethernet > Network 2 address**.



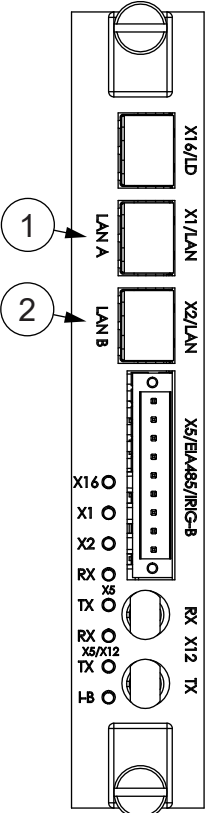
If the Network 2 interface is enabled, PTP time synchronization and SMV/GOOSE multicast are disabled for that port.



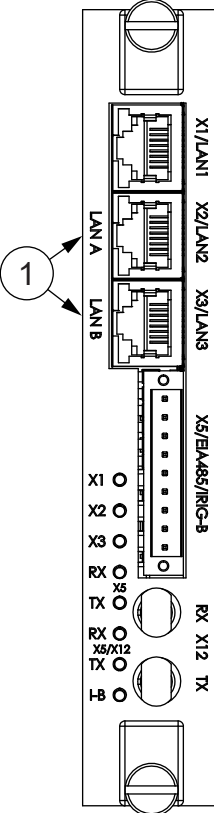
COM0001
RJ-45



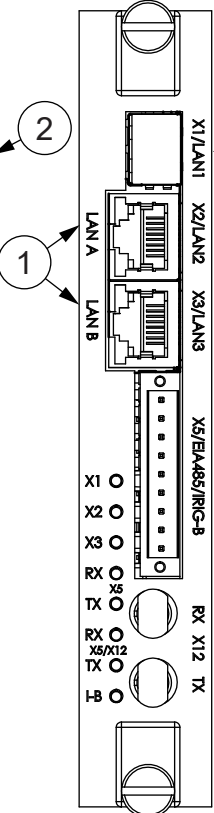
COM0008
COM0010



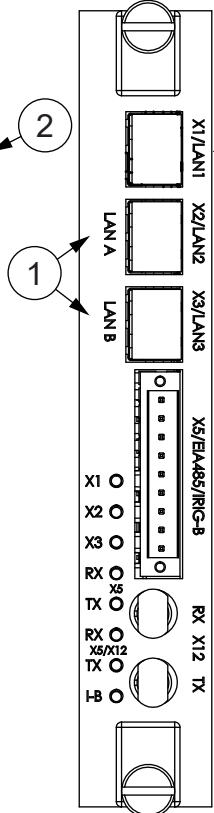
COM0009
COM0015



COM0016



COM0017



COM0018

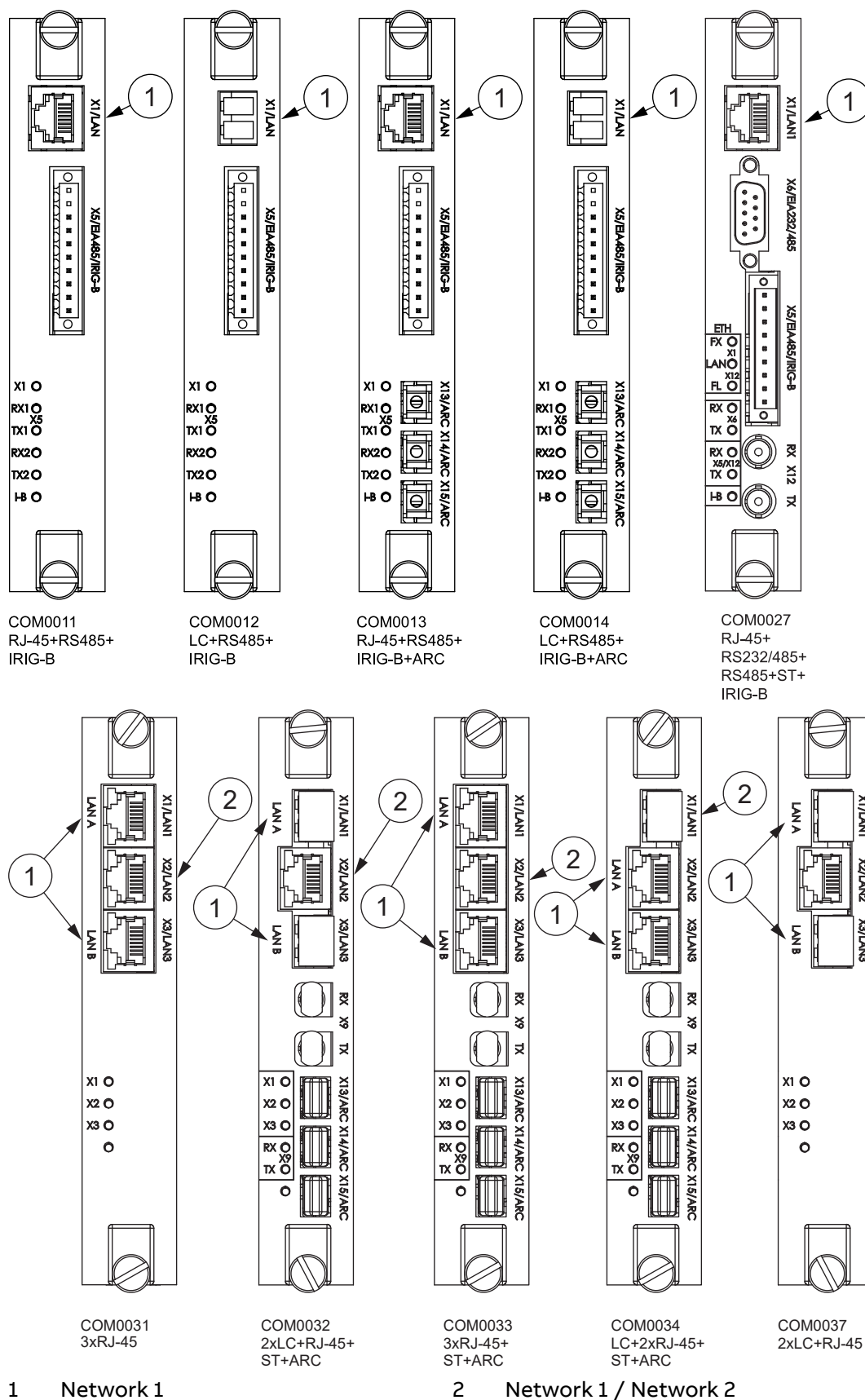


Figure 125: Ethernet modes with Network 1 and Network 2



If the protocol does not operate as expected, check that other serial protocols are not using the COM port.



Use the correct Ethernet connectors in the protection relay with redundant communication protocols like HSR and PRP. protection relays with HSR/PRP support have three Ethernet connectors and redundant Ethernet ports are marked as LAN A and LAN B. The third Ethernet port without any LAN marking works as an interlink port. Thus, an additional redundancy box is not needed. For example, laptops with PCM600 must be connected via a redundancy box to access a protection relay which is part of the HSR network.



The redundant communication module has three operation modes: “Normal”, “HSR” and “PRP”. The operation mode can be changed from communication settings.



For more information, see the communication protocol manuals and the technical manual.

7.4.2.1

Protocol control

It is possible to allow or block different protocols for different network interfaces in the protection relay using the parameters in **Configuration > Communication > Protocols > Network1**, **Configuration > Communication > Protocols > Network2** and **Configuration > Communication > Protocols > HMI Port**.

Table 20: Protocol control in the protection relay

Parameter	Options	Description
Configuration/Communication/Protocols/Network1/FTP	Off	Denies FTP and FTPS
	On	Allows FTP and FTPS
	Secure (Default)	Allows FTPS only
Configuration/Communication/Protocols/Network2/FTP	Off	Denies FTP and FTPS
	On	Allows FTP and FTPS
	Secure (Default)	Allows FTPS only
Configuration/Communication/Protocols/HMI Port/FTP	Off	Denies FTP and FTPS
	On	Allows FTP and FTPS
	Secure (Default)	Allows FTPS only
Configuration/Communication/Protocols/Network1/HTTPS	Off	Denies HTTPS
	On (Default)	Allows HTTPS
Configuration/Communication/Protocols/Network2/HTTPS	Off	Denies HTTPS
	On (Default)	Allows HTTPS
Configuration/Communication/Protocols/Network1/MMS	Off	Denies IEC 61850 MMS
	On (Default)	Allows IEC 61850 MMS
	Secure	Allows FTPS only
Configuration/Communication/Protocols/Network2/MMS	Off	Denies IEC 61850 MMS
	On (Default)	Allows IEC 61850 MMS

Table continues on the next page

Parameter	Options	Description
	Secure	Allows FTPS only
Configuration/Communication/Protocols/HMI Port/MMS	Off	Denies IEC 61850 MMS
	On (Default)	Allows IEC 61850 MMS
	Secure	Allows FTPS only
Configuration/Communication/Protocols/Network1/DNP	Off	Denies DNP3
	On (Default)	Allows DNP3
Configuration/Communication/Protocols/Network1/DNP VLAN1	Off	Denies DNP VLAN1
	On (Default)	Allows DNP VLAN1
Configuration/Communication/Protocols/Network1/DNP VLAN2	Off	Denies DNP VLAN2
	On (Default)	Allows DNP VLAN2
Configuration/Communication/Protocols/Network1/DNP VLAN3	Off	Denies DNP VLAN3
	On (Default)	Allows DNP VLAN3
Configuration/Communication/Protocols/Network1/DNP VLAN4	Off	Denies DNP VLAN4
	On (Default)	Allows DNP VLAN4
Configuration/Communication/Protocols/Network1/DNP VLAN5	Off	Denies DNP VLAN5
	On (Default)	Allows DNP VLAN5
Configuration/Communication/Protocols/Network2/DNP	Off	Denies DNP3
	On (Default)	Allows DNP3
Configuration/Communication/Protocols/Network1/Modbus	Off	Denies Modbus
	On (Default)	Allows Modbus
Configuration/Communication/Protocols/Network1/Modbus VLAN1	Off	Denies Modbus VLAN1
	On (Default)	Allows Modbus VLAN1
Configuration/Communication/Protocols/Network1/Modbus VLAN2	Off	Denies Modbus VLAN2
	On (Default)	Allows Modbus VLAN2
Configuration/Communication/Protocols/Network1/Modbus VLAN3	Off	Denies Modbus VLAN3
	On (Default)	Allows Modbus VLAN3
Configuration/Communication/Protocols/Network1/Modbus VLAN4	Off	Denies Modbus VLAN4
	On (Default)	Allows Modbus VLAN4
Configuration/Communication/Protocols/Network1/Modbus VLAN5	Off	Denies Modbus VLAN5
	On (Default)	Allows Modbus VLAN5
Configuration/Communication/Protocols/Network2/Modbus	Off	Denies Modbus
	On (Default)	Allows Modbus
Configuration/Communication/Protocols/Network1/IEC-60870-5-104	Off	Denies IEC 60870-5-104
	On (Default)	Allows IEC 60870-5-104
Configuration/Communication/Protocols/Network2/IEC-60870-5-104	Off	Denies IEC 60870-5-104
	On (Default)	Allows IEC 60870-5-104
Configuration/Communication/Protocols/Network1 VLAN/MMS VLAN1	Off	Denies MMS VLAN1
	On (Default)	Allows MMS VLAN1
Configuration/Communication/Protocols/Network1 VLAN/MMS VLAN2	Off	Denies MMS VLAN2
	On (Default)	Allows MMS VLAN2
Configuration/Communication/Protocols/Network1 VLAN/MMS VLAN3	Off	Denies MMS VLAN3

Table continues on the next page

Parameter	Options	Description
	On (Default)	Allows MMS VLAN3
Configuration/Communication/Protocols/Network1 VLAN/MMS VLAN4	Off	Denies MMS VLAN4
	On (Default)	Allows MMS VLAN4
Configuration/Communication/Protocols/Network1 VLAN/MMS VLAN5	Off	Denies MMS VLAN5
	On (Default)	Allows MMS VLAN5
Configuration/Communication/Protocols/Network1 VLAN/IEC-60870-5-104 VLAN1	Off	Denies IEC 60870-5-104 VLAN1
	On (Default)	Allows IEC 60870-5-104 VLAN1
Configuration/Communication/Protocols/Network1 VLAN/IEC-60870-5-104 VLAN2	Off	Denies IEC 60870-5-104 VLAN2
	On (Default)	Allows IEC 60870-5-104 VLAN2
Configuration/Communication/Protocols/Network1 VLAN/IEC-60870-5-104 VLAN3	Off	Denies IEC 60870-5-104 VLAN3
	On (Default)	Allows IEC 60870-5-104 VLAN3
Configuration/Communication/Protocols/Network1 VLAN/IEC-60870-5-104 VLAN4	Off	Denies IEC 60870-5-104 VLAN4
	On (Default)	Allows IEC 60870-5-104 VLAN4
Configuration/Communication/Protocols/Network1 VLAN/IEC-60870-5-104 VLAN5	Off	Denies IEC 60870-5-104 VLAN5
	On (Default)	Allows IEC 60870-5-104 VLAN5
Configuration/Communication/Protocols/Network1/SNMP	Off	Denies SNMP
	On (Default)	Allows SNMP
Configuration/Communication/Protocols/Network1/SNMP VLAN1	Off	Denies SNMP VLAN1
	On (Default)	Allows SNMP VLAN1
Configuration/Communication/Protocols/Network1/SNMP VLAN2	Off	Denies SNMP VLAN2
	On (Default)	Allows SNMP VLAN2
Configuration/Communication/Protocols/Network1/SNMP VLAN3	Off	Denies SNMP VLAN3
	On (Default)	Allows SNMP VLAN3
Configuration/Communication/Protocols/Network1/SNMP VLAN4	Off	Denies SNMP VLAN4
	On (Default)	Allows SNMP VLAN4
Configuration/Communication/Protocols/Network1/SNMP VLAN5	Off	Denies SNMP VLAN5
	On (Default)	Allows SNMP VLAN5
Configuration/Communication/Protocols/Network2/SNMP	Off	Denies SNMP
	On (Default)	Allows SNMP

7.4.2.2

Protocol write access rights

Write access rights are configurable for FTP, MMS, and HTTPS protocols in **Configuration > Authorization**. The write access parameters are used to narrow down services that allow setting changes on different network interfaces. Disabling the FTP and IEC 61850 MMS write access on Network 1 and 2 prevents the user

from updating the configuration to the protection relay from PCM600. Disabling the HTTPS write access prevents the user from writing setting changes from WHMI.

Table 21: Protocol write access in the protection relay

Parameter	Options	Description
Configuration/Authorization/Network1/FTP write access	Off	FTP write access denied for Network 1
	On (Default)	FTP write access allowed for Network 1
Configuration/Authorization/Network1/MMS write access	Off	IEC 61850 MMS write access denied for Network 1
	On (Default)	IEC 61850 MMS write access allowed for Network 1
Configuration/Authorization/Network1/HTTPS write access	Off	HTTPS write access denied for Network 1
	On (Default)	HTTPS write access allowed for Network 1
Configuration/Authorization/Network2/FTP write access	Off	FTP write access denied for Network 2
	On (Default)	FTP write access allowed for Network 2
Configuration/Authorization/Network2/MMS write access	Off	IEC 61850 MMS write access denied for Network 2
	On (Default)	IEC 61850 MMS write access allowed for Network 2
Configuration/Authorization/Network2/HTTPS write access	Off	HTTPS write access denied for Network 2
	On (Default)	HTTPS write access allowed for Network 2
Configuration/Authorization/HMI/FTP write access	Off	FTP write access denied for the HMI port
	On (Default)	FTP write access allowed for the HMI port
Configuration/Authorization/HMI/MMS write access	Off	IEC 61850 MMS write access denied for the HMI port
	On (Default)	IEC 61850 MMS write access allowed for the HMI port
Configuration/Authorization/Network1 VLAN/ VLAN1 FTP write access	Off	VLAN1 FTP write access denied for Network 1 VLAN
	On (Default)	VLAN1 FTP write access allowed for Network 1 VLAN
Configuration/Authorization/Network1 VLAN/ VLAN1 MMS write access	Off	VLAN1 FTP write access denied for Network 1 VLAN
	On (Default)	VLAN1 FTP write access allowed for Network 1 VLAN

Table continues on the next page

Parameter	Options	Description
Configuration/Authorization/Network1 VLAN/ VLAN1 HTTPS write access	Off	VLAN1 FTP write access denied for Network 1 VLAN
	On (Default)	VLAN1 FTP write access allowed for Network 1 VLAN
Configuration/Authorization/Network1 VLAN/ VLAN2 FTP write access	Off	VLAN2 FTP write access denied for Network 1 VLAN
	On (Default)	VLAN2 FTP write access allowed for Network 1 VLAN
Configuration/Authorization/Network1 VLAN/ VLAN2 MMS write access	Off	VLAN2 FTP write access denied for Network 1 VLAN
	On (Default)	VLAN2 FTP write access allowed for Network 1 VLAN
Configuration/Authorization/Network1 VLAN/ VLAN2 HTTPS write access	Off	VLAN2 FTP write access denied for Network 1 VLAN
	On (Default)	VLAN2 FTP write access allowed for Network 1 VLAN
Configuration/Authorization/Network1 VLAN/ VLAN3 FTP write access	Off	VLAN3 FTP write access denied for Network 1 VLAN
	On (Default)	VLAN3 FTP write access allowed for Network 1 VLAN
Configuration/Authorization/Network1 VLAN/ VLAN3 MMS write access	Off	VLAN3 FTP write access denied for Network 1 VLAN
	On (Default)	VLAN3 FTP write access allowed for Network 1 VLAN
Configuration/Authorization/Network1 VLAN/ VLAN3 HTTPS write access	Off	VLAN3 FTP write access denied for Network 1 VLAN
	On (Default)	VLAN3 FTP write access allowed for Network 1 VLAN
Configuration/Authorization/Network1 VLAN/ VLAN4 FTP write access	Off	VLAN4 FTP write access denied for Network 1 VLAN
	On (Default)	VLAN4 FTP write access allowed for Network 1 VLAN
Configuration/Authorization/Network1 VLAN/ VLAN4 MMS write access	Off	VLAN4 FTP write access denied for Network 1 VLAN
	On (Default)	VLAN4 FTP write access allowed for Network 1 VLAN
Configuration/Authorization/Network1 VLAN/ VLAN4 HTTPS write access	Off	VLAN4 FTP write access denied for Network 1 VLAN

Table continues on the next page

Parameter	Options	Description
	On (Default)	VLAN4 FTP write access allowed for Network 1 VLAN
Configuration/Authorization/Network1 VLAN/ VLAN5 FTP write access	Off	VLAN5 FTP write access denied for Network 1 VLAN
	On (Default)	VLAN5 FTP write access allowed for Network 1 VLAN
Configuration/Authorization/Network1 VLAN/ VLAN5 MMS write access	Off	VLAN5 FTP write access denied for Network 1 VLAN
	On (Default)	VLAN5 FTP write access allowed for Network 1 VLAN
Configuration/Authorization/Network1 VLAN/ VLAN5 HTTPS write access	Off	VLAN5 FTP write access denied for Network 1 VLAN
	On (Default)	VLAN5 FTP write access allowed for Network 1 VLAN



PCM600 is using FTP or FTPS protocol to communicate with the protection relay. If the FTP write access is disabled for a network PCM600 functionality is limited to support read operations only from Disturbance handling, Event viewer and Parameter Setting.



Enabling Network 2 IP address requires additional configuration in PCM600 to define IEC 61580 subnetworks. This configuration is done via Ethernet Configuration and IEC 61850 Configuration in PCM600.

Table 22: VLAN parameters

Parameter	Options	Description
Communication/Ethernet/Network1 VLAN/VLAN1-5 tagging mode	Tagged	VLAN1-5 Tagged
Communication/Ethernet/Network1 VLAN/VLAN1-5 id	100	VLAN tag identifier
Communication/Ethernet/Network1 VLAN/VLAN1-5 QoS	0	VLAN Quality of Service
Communication/Ethernet/Network1 VLAN/VLAN1-5 IP address	192.168.2.10	VLAN IP address
Communication/Ethernet/Network1 VLAN/VLAN1-5 subnet mask	255.255.255.0	VLAN Subnet mask
Communication/Ethernet/Network1 VLAN/VLAN1-5 default gw	0.0.0.0	VLAN Default gateway
Communication/Ethernet/IP routes/IP route 1-10 enabled	False (Default)	IP route 1-10 disabled
	True	IP Route 1-10 enabled

Table continues on the next page

Parameter	Options	Description
Communication/Ethernet/IP routes/Dst IP address 1-10	0.0.0.0	IP address for DST 1-10
Communication/Ethernet/IP routes/Dst subnet mask 1-10	255.255.255.0	Destination subnet mask
Communication/Ethernet/IP routes/Gw IP address 1-10	0.0.0.0	Gateway IP address
Communication/Ethernet/IP settings/IP MTU	1500	Internet Protocol Maximum Transmission Unit

7.4.2.3 Serial communication ports and drivers

Depending on the hardware configuration, the protection relay can be equipped with one or several UART-based serial communication ports. The communication ports can be either galvanic (RS-485, RS-232) or fiber optic. The protection relay uses serial ports and drivers as different types of serial communication protocol links.

Serial ports are called COM1, COM2 and so on, depending on the number of serial ports in the relay hardware configuration. Each COM port driver has its own setting parameters found via the LHMI in **Configuration > Communication > COMn** (n= 1,2,...).

Since the same protection relay usually supports a variety of different communication hardware options, all COM port driver setting parameters are not relevant for every communication hardware type.

Table 23: COM port parameters in different HW options

COM parameter	Values	Hardware options
Fiber mode	0 = No fiber	Used in the fiber optic mode only. Note that "No fiber " mode is the same as the galvanic mode.
	1 = Fiber light ON/loop	
	2 = Fiber light OFF/loop	
	3 = Fiber light ON/star	
	4 = Fiber light OFF/star	
Serial mode	0 = RS485 2wire	For galvanic modes. RS-type depends on the communication card used. Note that this setting parameter is relevant only if <i>Fiber mode</i> is set to "No Fiber".
	1 = RS485 4wire	
	2 = RS232 no handshake	
	3 = RS232 with handshake	
CTS Delay	0...60000 [ms]	RS232 mode only
RTS Delay	0...60000 [ms]	RS232 mode only
Baudrate	1 = 300	All modes
	2 = 600	
	3 = 1200	
	4 = 2400	
	5 = 4800	
	6 = 9600	
	7 = 19200	
	8 = 38400	

Table continues on the next page

¹ When fiber mode is used, the *Serial mode* parameter value must be "RS485 2wire".

COM parameter	Values	Hardware options
	9 = 57600	
	10 = 115200 [bits/sec]	



In addition to setting the COM parameter, a communication card with many hardware options may also require changing the jumpers on the communication card.

Connection of a serial communication protocol to a specific serial port

The serial communication protocol (instance) settings include a setting parameter called *Serial port n* (n = protocol instance number). Setting options for this parameter are “COM1”, “COM2” and so on. The desired serial port for the protocol instance is selected through this parameter.



All link setting parameters are not found in the COM n settings. Additional link setting parameters are found in the setting parameter list of the used serial protocol, since some serial protocol standards allow changes in link parameters, while other protocol standards do not.

7.4.2.4

Serial link diagnostics and monitoring

Serial communication diagnostics and monitoring is divided between the serial link driver and the serial communication protocol. The lower level physical and protocol-independent aspects of the UART-based serial communication are monitored in the serial link driver. Diagnostic counters and monitoring values are found via the LHMI in **Monitoring > Communication > COM n** (n = 1,2,...).

Depending on the communication protocol, the serial driver software receives single characters or complete protocol frames, based on the frame start/stop characters or on timing.

Monitoring data for a COM channel can be divided into basic and detailed diagnostic counters.

Table 24: Monitoring data for a COM channel

Parameter	Range	Type	Description
Characters received	0...2147483646	Basic	Number of separate characters received.
Frames received	0...2147483646	Basic	Number of successfully received complete frames.
Frames discarded	0...2147483646	Basic	Number of frames discarded.
Frames transmitted	0...2147483646	Basic	Number of frames transmitted.
CD Lost	0...2147483646	Detailed	Number of carrier-detect signal lost during receive.
Collision	0...2147483646	Detailed	Number of collisions detected.
CTS Timeout	0...2147483646	Detailed	Number of clear-to-send signal timeout errors.

Table continues on the next page

¹ When fiber mode is used, the *Serial mode* parameter value must be “RS485 2wire”.

Parameter	Range	Type	Description
Transmission time-out	0...2147483646	Detailed	Number of transmission timeout errors.
Parity errors	0...2147483646	Detailed	Number of character parity errors detected.
Overrun errors	0...2147483646	Detailed	Number of character overrun errors detected.
Framing errors	0...2147483646	Detailed	Number of character overrun errors detected.
Link status	1		1 = Reset counters (by entering 1 the diagnostic counters are reset)

Whether all diagnostic counters are relevant depends on the communication hardware and communication protocol.

Table 25: Basic diagnostic counters

Counter	Function
Characters received	Counts all incoming non-erroneous characters. This counter operates regardless of if the serial driver is set to detect a whole protocol link frame or just separate characters.
Frames received	Counts all protocol specific non-erroneous frames received. Protocol-specific frames can be based on timing (for example, Modbus RTU) or on special start and stop characters (for example, Modbus ASCII).
Frames discarded	Counts all protocol-specific erroneous frames received. If the driver detects an error while receiving a frame, the frame is automatically discarded. This also means that the protocol in question will never receive a faulty frame from the driver. When this counter is increased, one of the detailed error counters is also incremented.
Frames transmitted	Counts all protocol-specific frames transmitted from the COM channel.

Table 26: Detailed error counters

Counter	Function
CD Lost	In RS-232 handshake mode, characters are to be received as long as Carrier Detect (CD) signal is active. This counter is incremented if the CD signal is lost during reception.
Collision	Counts transmission collisions. Used in RS-485 mode by some protocols where transmissions could collide. For example DNP3 unsolicited mode.
CTS Timeout.	In RS-232 handshake mode the Clear To Send (CTS) signal is not received as reply to this device Request To Send (RTS) signal.

Table continues on the next page

Counter	Function
Transmission timeout.	In RS-232 handshake mode. If the CTS signal goes inactive during transmission then the transmission is halted. Transmission will be resumed when CTS goes active again. The whole frame transmission must anyhow be ready within a specified time. If this timeout elapses then this counter is incremented. Result will be that the end of the frame is not being transmitted out.
Parity errors	Counts parity errors detected in characters.
Overrun errors	Counts overrun errors detected in characters.
Framing errors	Counts framing errors detected in characters

Table 27: Link status

Parameter	Function
Link status	Link status in write direction: By writing 1 to the parameter the diagnostic counters are reset to 0.
	Link status in monitoring direction: If the driver is in use by any communication protocol, the monitoring value shows 1. In other case, the value is 0.

7.4.2.5

Defining Ethernet port settings



Change the Ethernet port settings primarily via PCM600 to ensure that PCM600 is able to export a consistent configuration to SYS600. Ethernet port settings are recommended to be changed only when the device is stand-alone and properly configured.

1. Select **Main menu > Configuration > Communication > Ethernet > Network1 address** or **Configuration > Communication > Ethernet > Network2 address**.
2. Define the settings for the Ethernet port.
 - IP address
 - Subnet mask
 - Default gateway of the optional rear port Ethernet connector

7.4.2.6

Defining serial port settings

1. Select **Main menu > Configuration > Communication > COM1** or **COM2**.
2. Define the settings for the serial port.
It is possible to change the general serial communication parameters per port. Select fiber or galvanic mode with the proper baud rate, parity and delays depending on the system architecture and the selected physical communication port.

7.4.2.7 Setting communication protocol parameters

1. Select **Main menu > Configuration > Communication > <protocol>**.
2. Change the protocol specific settings.
Possible settings to be changed are, for example, the selected communication port, address and link mode.

7.4.2.8 Connecting jumper connectors



See the technical manual for details on jumper connectors.

7.4.3 Setting the local HMI

7.4.3.1 Changing the local HMI language

1. Select **Main menu > Language** and press .
2. Change the language using  or .
3. Press  to confirm the selection.
4. Commit the changes.



Figure 126: Changing the LHMI language



To change the language using a shortcut, press  and  simultaneously anywhere in the menu.

7.4.3.2 Adjusting the display contrast

Adjust the display contrast anywhere in the menu structure to obtain optimal readability.

- To increase the contrast, press simultaneously  and .
- To decrease the contrast, press simultaneously  and .

The selected contrast value is stored in the non-volatile memory if you are logged in and authorized to control the protection relay. After an auxiliary power failure, the contrast is restored.

7.4.3.3 Changing display symbols

Use the keypad to switch between the display function block symbols IEC 61850, IEC 60617, ANSI and CHINESE.

1. Select **Main Menu > Configuration > HMI > FB naming convention** and press



2. Change the display symbols with  or .

3. Press  to confirm the selection.



The protection relay has to be rebooted if the WHMI display symbols are changed. With the LHMI, the change takes effect immediately.

7.4.3.4 Changing single-line diagram symbol formats

1. Select **Main menu > Configuration > HMI > SLD symbol format** and press .
2. Change symbol format with  or .
3. Press  to confirm the selection.

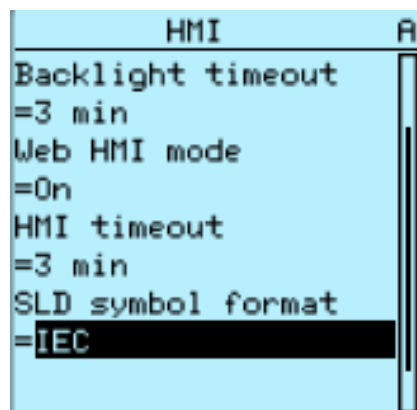


Figure 127: Selecting IEC as single-line diagram symbol format

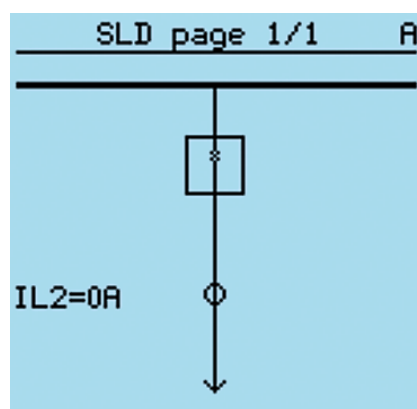


Figure 128: Single-line diagram with one breaker and IEC symbols

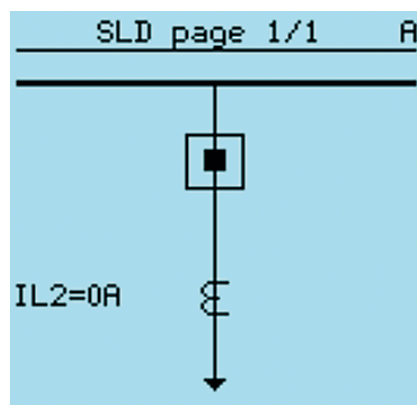


Figure 129: Single-line diagram with one breaker and ANSI symbols

7.4.3.5 Changing the default view

The default view of the display is **Measurements** unless set otherwise.

1. Select **Main menu > Configuration > HMI > Default view** and press .
2. Change the default view with  or .

3. Press  to confirm the selection.

7.4.3.6

Setting the system time and time synchronization

1. Select **Main menu > Configuration > Time > System time.**
2. Select the parameter with  or .
3. Press , change the value with  or  and press  again.
4. Repeat steps 2 and 3 to set the rest of the system time parameters.
5. Select **Main menu > Configuration > Time > Synchronization > Synch source** and press .
6. Select the time synchronization source with  or .
7. Press  to confirm the selection.

Setting daylight saving time

The protection relay can be set to determine the correct date for the DST shift every year. The UTC time is used to set the DST.

1. Set the *DST on day (weekday)* and *DST off day (weekday)* parameters to define on which week day the time shift occurs.

2. Set the *DST on date (day)*, *DST on date (month)* and *DST off date (month)* parameters to define on which month and week the time shift occurs.

The DST on/off date must precede the selected DST on/off day and be within the same week as the DST shift.

Table 28: Possible date values for DST change on Sunday

Day of the DST shift	DST on/off date (day)
First Sunday of the month	1
Second Sunday of the month	8
Third Sunday of the month	15
Fourth Sunday of the month	22
Last Sunday, if the month has 30 days	24
Last Sunday, if the month has 31 days	25

For example, if the DST is observed from the last Sunday in March to the last Sunday in October and the time shift occurs at 01:00 UTC, the setting parameters are the following.

DST on time (hours):	2 h
DST on time (minutes):	0 min
DST on date (day):	25
DST on date (month):	March
DST on day (weekday):	Sunday
DST off time (hours):	1 h
DST off time (minutes):	0 min
DST off date (day):	25
DST off date (month):	October
DST off day (weekday):	Sunday



Set the *DST on day (weekday)* and *DST off day (weekday)* to "reserved" to determine the exact date and time for the DST shift. Repeat the setting yearly, as the time for the DST shift is not on the same date every year.



To disable the DST, set the *DST in use* parameter to "False".

7.4.3.7 Setting up the indication timeout

Table 29: Configuration options

Option	IEC61850 parameter	Behavior
HMI > Indication enable	LD0.LDEV1.IndEna.setVal	Can be used to disable all indications globally. If disabled, hides Indication timeout parameter in menu. Range: Enable/Disable Default: Enable
HMI > Indication timeout	LD0.LDEV1.IndTms.setVal	Sets automatic indication timeout for events in seconds.

Option	IEC61850 parameter	Behavior
		Setting the value to 0, will not expire indications automatically. Range: 0 – 604800 (3600s = 1 hour, 86400s = 1 day, 604800s = 1 week) Default: 0

7.4.4 Setting protection relay parameters

7.4.4.1 Defining setting groups

Selecting a setting group for editing

1. Select **Main Menu > Settings > Edit setting group**.
2. Select the setting group to be edited with  or .
3. Press  to confirm the selection.
4. Edit the settings.



Figure 130: Selecting a setting group

Browsing and editing setting group values

1. Select **Main menu > Settings > Settings** and press .

2. Select the setting group to be viewed with  or  and press  to confirm the selection.

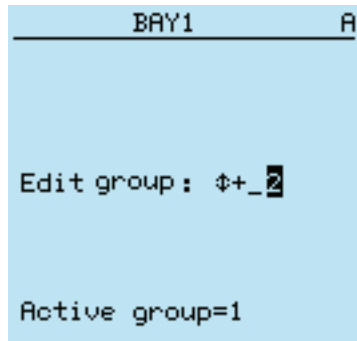


Figure 131: Selecting a setting group

3. To browse the settings, scroll the list with  and  and to select a setting press .

4. To browse different function blocks, scroll the list with  and  and to select a function block press . To move back to the list, press . The function block list is shown in the content area of the display. On the left in the header, you see the current setting group, and on the right the menu path.

5. To browse the parameters, scroll the list with  and  and to select a parameter, press .

The setting group values are indicated with #.

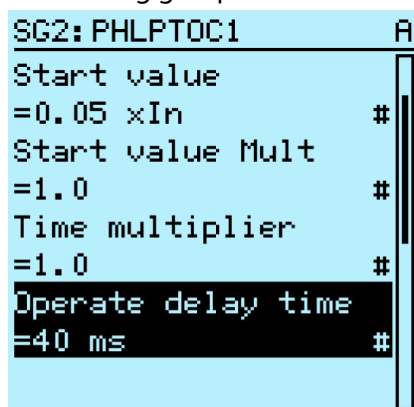


Figure 132: Setting group parameter

6.

To select a setting group value, press  and to edit the value press .

```
SG2: Operate delay... A
*[1]=40 ms
[2]=40 ms
[3]=40 ms
[4]=40 ms
[5]=40 ms
[6]=40 ms
```

Figure 133: Selecting the setting group value

Only values within the selected setting group can be changed.

7.

Press  or  to change the value and  to confirm the selection.

```
SG2: Operate delay... A
*[1]=40 ms
[2]=1+____ 40 ms
[3]=40 ms
[4]=40 ms
[5]=40 ms
[6]=40 ms
```

Figure 134: Editing the setting group value

The active setting group is indicated with an asterisk *.



Switching the *Operation* parameter of a function block on or off restarts all control and protection functions.

Activating a setting group

Protection relay settings are planned in advance for different operation conditions by calculating setting values to different setting groups. The active setting group can be changed by the protection relay application or manually from the menu.

1. Select **Main menu > Settings > Setting group > Active group** and press .

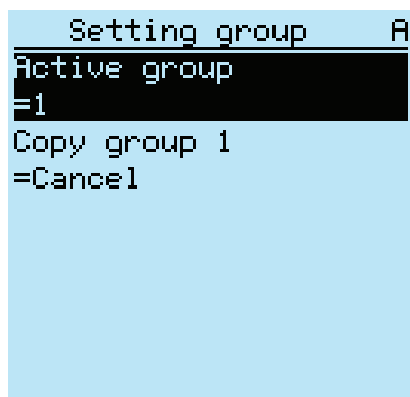


Figure 135: Active setting group

2. Select the setting group with  or .
3. Press  to confirm the selection or  to cancel.

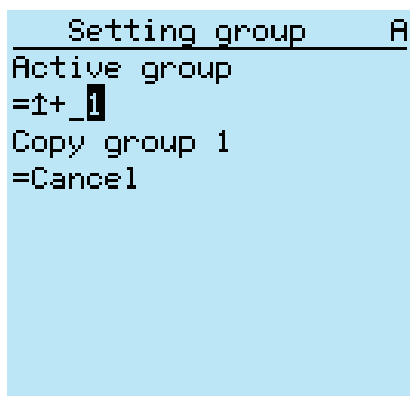


Figure 136: Selecting the active setting group

4. Commit the settings.



Remember to document the changes you make.

7.4.4.2

Relay parametrization

Protection relay parameters are set via the LHMI, WHMI or PCM600.

Setting parameters need to be calculated according to the electrical network conditions and the electrical characteristics of the protected equipment. The protection relay's settings need to be verified before the protection relay is connected to a system.



Document all changes to parameter settings.



For more information, see the PCM600 documentation.

7.4.4.3 Defining disturbance recorder channel settings

1. Select **Main Menu > Configuration > Disturbance recorder > Channel settings**.
2. Press  or  to select the wanted channel and parameter.
3. To change channel settings, press .

Each analog channel has an equal set of parameters and correspondingly, each binary channel has an equal set of parameters.

7.4.4.4 Configuring analog inputs

1. Select **Main Menu > Configuration > Analog inputs**.
2. Select the analog input to be configured with  or .
3. Press , change the value with  or  and press  again.
 - For CTs, the secondary current and primary current need to be set to the correct values.
 - For VTs, the secondary voltage and primary voltage need to be set to the correct values.

7.5 Testing protection relay operation

The protection relay has to be in the test mode before the digital outputs and certain output signals of protection and other functions can be activated.

7.5.1 Selecting the IED test mode

The test mode can be activated using the LHMI. The green Ready LED is flashing to indicate that the test mode is activated. By default, the test mode can only be changed from the LHMI. Activation by remote client is possible, see the technical manual.



The Ready LED also flashes if the protection relay detects a diagnostic failure. Check the test mode setting and the protection relay's IRF alarm contact status to find the reason for the failure.

The test mode is useful for simulated testing of functions and outputs without providing current inputs.

1.

Select **Main menu > Tests > IED test > Test mode** and press

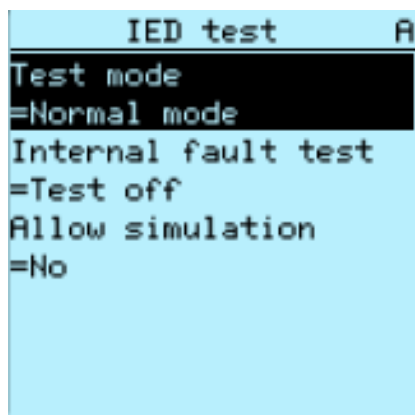


Figure 137: Entering test mode

2.

Select the test mode status with or .

3.

Press to confirm the selection.



If the test mode is not cancelled, it remains on and the Ready LED remains flashing.

7.5.2 Selecting function specific test mode

The test mode can be activated for individual protection functions independently of device level test mode parameter. Activation is done using *Operation* setting of the protection function. See technical manual for details about the functionality.

7.5.3 Testing the digital I/O interface

To activate or deactivate, for example, a digital output:

1. Select **Main menu > Tests > Binary outputs > X100 (PSM) > X100-PO1** and press



2. Select the value with or .

3. Press to confirm the selection.



If the optional BIO-module (X105, X110, X115, X130) is included in the protection relay, the menu path could also be **Main menu > Tests > Binary Outputs > X110 (BIO) > <binary output>**.

7.5.4 Testing functions

Activate or deactivate an output signal for protection or other function to test the function.

1. Select **Main Menu > Tests > Function tests > Current protection > <function**

block name> and press .

2. Select the output signal to be activated or deactivated with or and press .

3. To deactivate all output signals for the function, select Reset with or and press .

7.5.5 Selecting the internal fault test

The internal fault may be tested by using the LHMI. When enabling the test, the internal relay fault output contact is activated, the green Ready LED is flashing and internal fault test indication is shown on the LHMI. See the technical manual for the internal relay fault output contact location. The internal fault can only be activated by using the LHMI.



Differing from real internal fault situation, the other output contacts are not released and locked during the test. In other words, protection functions can operate and trip the outputs when the internal fault is tested.

1.

Select **Main menu > Tests > IED test > Internal fault test** and press .

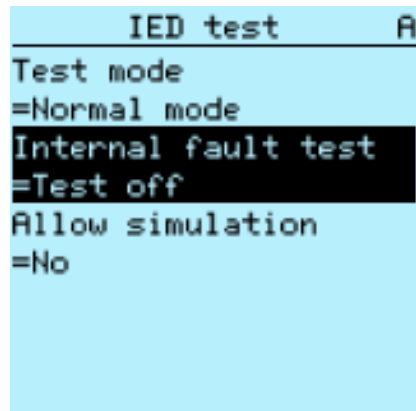


Figure 138: Internal fault test

2.

Select the value with  or .

3.

Press  to confirm the selection.

7.5.6

Selecting the IED blocked or IED test and blocked mode

The IED blocked mode and the IED test and blocked mode can be activated using the LHMI. The yellow Start LED flashes when the device is in the IED blocked or IED test and blocked mode. The green Ready LED flashes to indicate that the IED test and blocked mode is activated. By default, the test mode can only be changed from the LHMI. Activation by remote client is possible, see the technical manual.



The Ready LED also flashes if the IED detects a diagnostic failure. Check the test mode setting and the protection relay's IRF alarm contact status to find the reason of the failure.

The test mode can be used for simulated testing of functions and outputs without providing current inputs. The IED blocked mode can be used to block the physical outputs to the process.

1.

Select **Main menu > Tests > IED test > Test mode** and press .

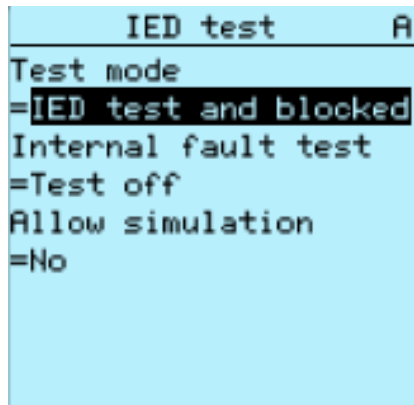


Figure 139: Entering IED blocked or IED test and blocked mode

2.

Select the test mode status with  or . Press  to confirm the selection.



If the IED blocked or IED test and blocked mode is not cancelled, it remains on and the Start and/or Ready LEDs remain flashing.

7.6 ABB Product Data Registration

The ABB Product Data Registration feature traces composition changes in the protection relay's SW or HW. Traceability allows better support and maintenance possibilities.

After a composition change, an LCT indication is seen on the LHMI at the protection relay startup. The PCM600 reads the changed data from the protection relay. Therefore a connection to the protection relay must be established first. Composition data can be read with PCM600 by enabling LCT during PCM600 installation and activating collection in PCM600 from 'Lifecycle Handling' menu. For detailed information see PCM600 online help.

The LCT indication is cleared in the same way as other indications. If composition data is not collected with PCM600, the indication reappears after protection relay's reboot.



If the LCT indication appears, update the protection relay composition to avoid information mismatch. The LCT indication does not affect the functionality of the protection relay.

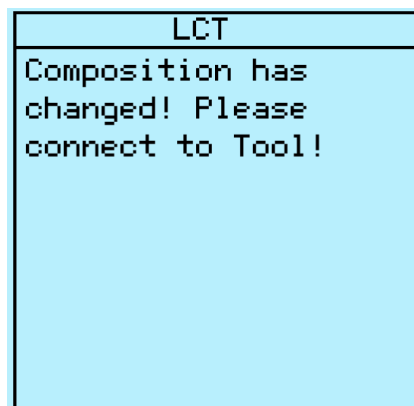


Figure 140: LCT indication

The number of composition changes can be seen from the *Composition changes* parameter in **Main Menu > Monitoring > IED status**.

8 Maintenance and Periodical Testing

8.1 Maintenance and Periodical Testing

The following sections are discussing selected aspects in regards the maintenance and periodical testing of REX615 Protection and control relay. The maintenance activities are here referred as specific actions, documented by the relay manufacturer, to be performed to the relay according to predefined time intervals. There are several factors influencing the optimum frequency of periodical testing, as well as the method of testing. Local legislation, insurance policy terms, customers' own maintenance practices, level of technology used in the installation and other similar issues certainly have an impact which is not possible to comprehensively cover here.

These sections do not discuss the personnel work safety related issues, nor the expected skill level of the testing and maintenance engineers or technicians. These are obviously of paramount importance but must be instructed and supervised by the party responsible.

8.1.1 Maintenance

REX615 protection and control relays do not require any specific periodical maintenance when installed and operated according to the manufacturer's instructions and within the specified environmental conditions. The relays shall be kept clean and free of dust and yearly visual check of installation's condition is recommended. Retightening of relay's screw type terminals is recommended after the first three to six months in use.

As a part of our quality assurance process, we constantly analyze the data from the installed base. In case a systematic anomaly would be identified, we will take specific actions. The actions are highly dependent on the nature of the anomaly and could include targeted maintenance advice for a dedicated relay batch, or it could be more general advisory based on the years of relay in operation.

As a part of our products' lifecycle support activities, we publish firmware updates offering functionality enhancements for the delivered units. The REX615 users are encouraged to visit the REX615 product page to check the latest firmware updates. Each firmware update includes a release note, describing the content, and a link that can be used to download the actual firmware package. Relay specific REX615 serial number is required for downloading. Depending on the firmware patch content and the evaluated criticality of it, the relay update can be performed soonest or as mostly done, during the periodical testing of the relay. Updating the relay firmware with a patch does not itself require relay retesting.

8.1.2 Periodical Testing

Precondition for efficient and successful periodical testing is that the installation has been comprehensively tested before it has entered the commercial use, the

documentation is up to date and test records from the pre-commissioning and commissioning tests are available. Periodical testing should not be seen as a reconfirmation of commission stage testing, but as a stage where the installation's possible impaired performance is detected, documented and also corrected.

REX615 protection and control relay is a vital part of the complete protection and control scheme, but it's not the only one. The other devices within the scheme shall be considered as well. Depending on the actual installation these might include all or just a part of the following list:

- Circuit breaker primary part
- Circuit breaker trip coils, one or several
- Measurement transformers or sensors and related wiring
- Arc flash detection sensors
- Other protection relay(s) as a part of the complete scheme
- Interpanel wiring
- Interpanel communication for binary and/or analogue signals
- DC auxiliary voltage supply
- Station level Scada/monitoring system
- Process control system
- Remote level Scada system

The following is mainly concentrating on the REX615 as a part of the overall system, but other devices will be shortly discussed where seen necessary.

8.1.2.1 Method of Testing

Important aspect in periodical testing is to secure that at the end of the testing all parts of the installation are restored to the original state. For example, if some test requires disconnecting relay voltage measurements from busbar voltage transformer secondary circuits, the connections must be reestablished at the end of that testing. It's highly recommended that the test engineer keeps a record of all possible temporary modifications within the installation, to help him/her to revert to the original set-up.

In general, a good rule is to perform the tests using a method which is as close as possible to the normal operational conditions of the installation. This is one way to reduce the risk of leaving some temporary connection or setting unrestored to original position at the end of the testing.

Periodical testing is performed with the protected feeder de-energized, circuit breaker truck withdrawn to test position or in case of a fixed circuit breaker, bus- and line-disconnectors in open position. In case the other feeders within the installation remain energized and supplying loads, it's important to isolate the relay under testing from the rest of the system to avoid accidentally sending upstream trip commands during the testing.

Protection relay periodical testing is normally carried out as secondary injection testing. The currents and voltages normally measured via sensors or instrument transformers are replaced with adjustable analogue signals from the test set. In case the installation is equipped with relay test blocks, the separation of the relay from the measurement and trip circuits happens automatically when the test adaptor is inserted into the test block.

If test blocks are not present, the connection point of the test set is the LV-compartment's terminal blocks. These terminal blocks typically offer the possibility to open the terminal mid bridge connection and that way separate the relay under

testing from the measurement and trip circuits. Each protection function is then tested one by one to confirm the functionality in respect of:

- start value level
- operate value level
- reset ratio value
- operate time, typically done with an infeed of 1,5 times the operate value setting

The results are compared to the setting values and the test records from the commissioning and the latest periodical test results. In case discrepancies outside the manufacturer's stated accuracy limits are found, the corresponding test shall be repeated. If the second test results are still outside the limits, deeper considerations are needed. If the deviation is considerable, recommendation is to replace the relay with a spare relay. In case of a slight deviation the operation until the next periodical test round can be considered.

The secondary test set will also introduce certain level of inaccuracies to the tests, especially if the test set has not been calibrated as per the manufacturer's instructions. As a final task for each protection function testing, it's highly recommended to do final operate test including the circuit breaker operation. In case the circuit breaker is equipped with two trip coils, the condition of both coils shall be verified.

During the testing of protection functions, the related measurements and events shall be verified from the local HMI. The verification, if possible, is recommended to be extended all the way to the upper-level systems like Scada or process control system.

When testing individual protection functions, there will be situations where some other protection function might interfere the testing of the selected one. REX615 HMI under menu "Tests" offers various support for testing activities. When the relay is returned to Normal mode, the functions will regain their original status automatically.

The correct function and the related external circuitry of IRF-relay (internal relay fault) output shall be checked. This can be performed using dedicated functionality in the HMI. Under the menu "Tests" there is a tab called "Internal fault test". By selecting position "test on", the IRF-relay will be de-energized, and the function of the related circuitry can be verified.

Arc flash sensors connected to REX615 relays must be tested by high intensity light like strong camera flash. This functionality will indicate if the connected sensor's or lens, optical circuit is intact.

8.1.2.2 Recommended Testing Intervals

The recommended periodical testing interval is between three and five years, depending on the following factors.

Installation environment

REX615 relays which are installed in harsh environments, we recommend applying the three years interval. The harsh conditions can be due to temperatures and/or humidity near to the maximum specified for the product, or it can be due to dust, salt, chemicals, or other corrosive agents.

Infrequent operations

If the relay has performed very few operations during the observation period, which is typical for spare feeders, we recommend applying the three years periodical

testing interval. The long inoperative time is not typically a problem for the relay, if the auxiliary power is turned on continuously, but it might be more problematic for the circuit breaker operation mechanism.

Frequent operations

When the relay performs several operations during the observation period, specially initiated by the protection functions, and the relay's performance during the faults are analyzed we recommend applying the five years periodical testing interval. The analyzing can be based on relay's events, fault records and disturbance records.

Utilization of relay's external and internal supervision features

REX615 contains several supervision features, both for relay's internal functionality and for relay's external circuitry. For external circuitry there are many supervision features. Whether the features are activated depends on the relay configuration and settings. It's highly recommended to take an advantage of these features, since they will cover a large part of the complete protection circuitry offering continuous supervision. The following features are included:

- Trip (and close) coil supervision
- Circuit breaker condition monitoring
- Motor operated disconnector supervision
- Current transformer secondary circuit supervision
- Fuse failure supervision
- Protection (point-to-point) communication supervision
- Station communication supervision

When in use and configured correctly, these supervision features will activate events and alarms, both on local HMI and on remote systems.

The protection relay's self-supervision function monitors the relay's performance and indicates possible problems on two levels: internal warnings and internal faults. Internal warnings effects only the concerned part of the relay's functionality, for other parts the relay will continue normal operation. The internal warnings are indicated as events and as alarms, if enabled in the configuration, on the HMI and on remote systems.

In case of internal faults, the relay operation will be disabled, IRF output relay will be de-energized and corresponding events and alarms issued. REX615 has a mechanism for recovering from internal fault situation by activating a controlled restart of the relay. Depending on the root cause, the restart can happen several times and if successfully the relay will resume full operational status.

When these supervision features are utilized and actions taken in case any of the supervision functions activates itself, we recommend applying the five years periodic testing interval.

8.1.2.3

Test Records

During pre-commissioning, commissioning, and periodical testing stages it is important to record the test cases and test results. The records shall be on such a detailed level that they can be used to detect any signs of protection performance deterioration during the years. The history shall be available for the technician performing the testing, and for a person evaluating and approving the test result.

9 Glossary

100BASE-FX	A physical medium defined in the IEEE 802.3 Ethernet standard for local area networks (LANs) that uses fiber optic cabling
100BASE-TX	A physical medium defined in the IEEE 802.3 Ethernet standard for local area networks (LANs) that uses twisted-pair cabling category 5 or higher with RJ-45 connectors
615 series	Series of numerical protection and control relays for protection and supervision applications of utility substations, and industrial switchgear and equipment
AC	Alternating current
ACT	1. Application Configuration tool in PCM600 2. Trip status in IEC 61850
ANSI	American National Standards Institute
CAT 5	A twisted pair cable type designed for high signal integrity
COMTRADE	Common format for transient data exchange for power systems. Defined by the IEEE Standard.
CPU	Central processing unit
CSV	Comma-separated values
CT	Current transformer
DAN	Doubly attached node
DC	1. Direct current 2. Disconnecter 3. Double command
DHCP	Dynamic Host Configuration Protocol
DNP3	A distributed network protocol originally developed by Westronic. The DNP3 Users Group has the ownership of the protocol and assumes responsibility for its evolution.
DPC	Double-point control
DST	Daylight-saving time
EEPROM	Electrically erasable programmable read-only memory
EMC	Electromagnetic compatibility
Ethernet	A standard for connecting a family of frame-based computer networking technologies into a LAN
FB	Function block
FIFO	First in, first out
Firmware	System software or hardware that has been written and stored in a device's memory that controls the device
FPGA	Field-programmable gate array

FTP	File transfer protocol
FTPS	FTP Secure
GOOSE	Generic Object-Oriented Substation Event
HMI	Human-machine interface
HSR	High-availability seamless redundancy
HTTPS	Hypertext Transfer Protocol Secure
HW	Hardware
IEC	International Electrotechnical Commission
IEC 60870-5-103	1. Communication standard for protective equipment 2. A serial master/slave protocol for point-to-point communication
IEC 61850	International standard for substation communication and modeling
IEC 61850-8-1	A communication protocol based on the IEC 61850 standard series
IEC 61850-9-2	A communication protocol based on the IEC 61850 standard series
IEC 61850-9-2 LE	Lite Edition of IEC 61850-9-2 offering process bus interface
IED	Intelligent electronic device
IEEE 1686	Standard for Substation Intelligent Electronic Devices' (IEDs') Cyber Security Capabilities
IP address	A set of four numbers between 0 and 255, separated by periods. Each server connected to the Internet is assigned a unique IP address that specifies the location for the TCP/IP protocol.
IRF	1. Internal fault 2. Internal relay fault
IRIG-B	Inter-Range Instrumentation Group's time code format B
LAN	Local area network
LC	Connector type for glass fiber cable, IEC 61754-20
LCD	Liquid crystal display
LCP	Liquid crystal polymer
LCT	Life cycle traceability
LE	Light Edition
LED	Light-emitting diode
LHMI	Local human-machine interface
MAC	Media access control
MMS	1. Manufacturing message specification 2. Metering management system
Modbus	A serial communication protocol developed by the Modicon company in 1979. Originally used for communication in PLCs and RTU devices.
Modbus ASCII	Modbus link mode. Character length 10 bits.
Modbus RTU	Modbus link mode. Character length 11 bits.
Modbus TCP/IP	Modbus RTU protocol which uses TCP/IP and Ethernet to carry data between devices

NCC	Network control center
PA	Polyamide
PBT	Polybutylene terephthalate
PC	1. Personal computer 2. Polycarbonate
PCM600	Protection and Control IED Manager
PRP	Parallel redundancy protocol
PTP	Precision Time Protocol
R/L	Remote/Local
RAM	Random access memory
RJ-45	Galvanic connector type
RoHS	Restriction of hazardous substances
ROM	Read-only memory
RS-232	Serial interface standard
RS-485	Serial link according to EIA standard RS485
RSTP	Rapid spanning tree protocol
RTC	Real-time clock
SAN	Single attached node
SCL	XML-based substation description configuration language defined by IEC 61850
Single-line diagram	Simplified notation for representing a three-phase power system. Instead of representing each of three phases with a separate line or terminal, only one conductor is represented.
SLD	Single-line diagram
SMT	Signal Matrix tool in PCM600
SMV	Sampled measured values
SNMP	Simple Network Management Protocol
SNTP	Simple Network Time Protocol
ST	Connector type for glass fiber cable
STP	Shielded twisted-pair
SVG	Scalable vector graphics
SW	Software
TCP/IP	Transmission Control Protocol/Internet Protocol
UTC	Coordinated universal time
VT	Voltage transformer
WAN	Wide area network
WHMI	Web human-machine interface
XRIO	eXtended Relay Interface by OMICRON



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