ABB

RELION® PROTECTION AND CONTROL

REX610
Operation Manual

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Conformity

This product complies with the directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive 2014/30/EU) and concerning electrical equipment for use within specified voltage limits (Low-voltage directive 2014/35/EU). This conformity is the result of tests conducted by the third party testing laboratory KEMA in accordance with the product standard EN 60255-26 for the EMC directive, and with the product standards EN 60255-1 and EN 60255-27 for the low voltage directive. The product is designed in accordance with the international standards of the IEC 60255 series.

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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Section 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 frequently.

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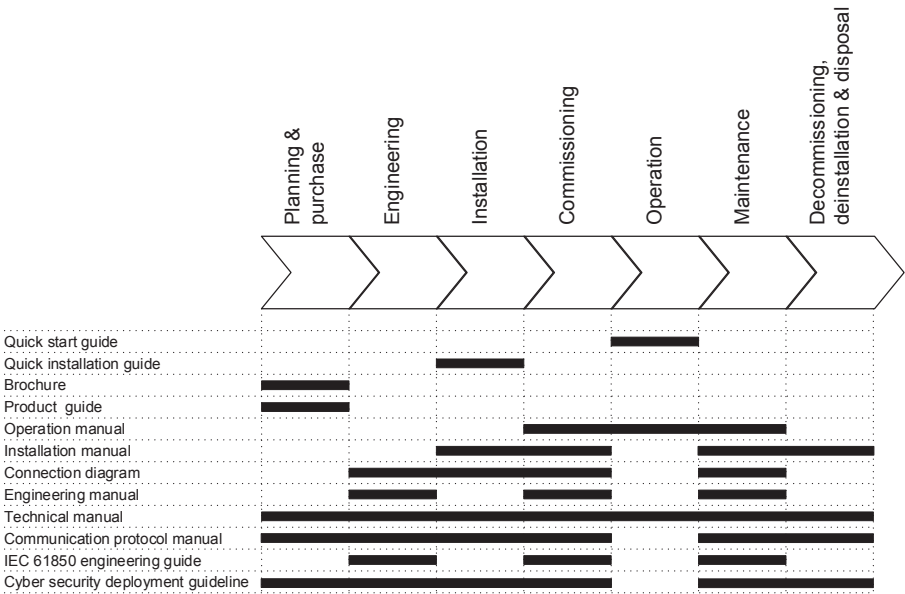
Figure 1:   The intended use of documents during the product life cycle

1.3.2 Document revision history

Document revision/date	Product version	History
A/2022-04-21	1.0	First release

1.3.3 Related documentation

Download the latest documents from the ABB Web site abb.com/mediumvoltage.

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 $\wedge$ and $\vee$.
- 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 $\leftarrow$.
- 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.
- Values of quantities are expressed with a number and an SI unit. The corresponding imperial units may be given in parentheses.

- This document assumes that the parameter setting visibility is "Advanced".
- A functional earth terminal is indicated in figures with the symbol ⏚.
- Equipment protected throughout by double insulation or reinforced insulation (equivalent to class II of IEC 61140) is indicated in figures with the symbol ▢.

1.4.3 Functions, codes and symbols

All available functions are listed in the table. All of them may not be applicable to all products.

Table 1: Functions included in the relay

Function	IEC 61850	IEC 60617	IEC-ANSI
Protection			
Three-phase non-directional overcurrent protection, low stage	PHLPTOC	3I>	51P-1
Three-phase non-directional overcurrent protection, high stage	PHHPTOC	3I>>	51P-2
Three-phase non-directional overcurrent protection, instantaneous stage	PHIPTOC	3I>>>	50P
Three-phase directional overcurrent protection, low stage	DPHLPDOC	3I> ->	67P/51P-1
Three-phase directional overcurrent protection, high stage	DPHHPDOC	3I>> ->	67P/51P-2
Non-directional earth-fault protection, low stage	EFLPTOC	Io>	51G/51N-1
Non-directional earth-fault protection, high stage	EFHPTOC	Io>>	51G/51N-2
Non-directional earth-fault protection, instantaneous stage	EFIPTOC	Io>>>	50G/50N
Directional earth-fault protection, low stage	DEFLPDEF	Io> ->	67G/N-1 51G/N-1
Directional earth-fault protection, high stage	DEFHPDEF	Io>> ->	67G/N-1 51G/N-2
Three-phase inrush detector	INRPHAR	3I2f>	68HB
Three-phase thermal protection for feeders, cables and distribution transformers	T1PTTR	3Ith>F	49F
Negative-sequence overcurrent protection	NSPTOC	I2>M	46M
Phase discontinuity / Single phasing protection for motor	PDNSPTOC	I2/I1>	46PD
Loss of phase, undercurrent	PHPTUC	3I<	37
Three-phase undervoltage protection	PHPTUV	3U<	27
Three-phase overvoltage protection	PHPTOV	3U>	59
Table continues on next page			

Function	IEC 61850	IEC 60617	IEC-ANSI
Residual overvoltage protection	ROVPTOV	Uo>	59G/59N
Circuit breaker failure protection	CCBRBRF	3I>/Io>BF	50BF
Master trip	TRPPTRC	Master Trip	94/86
Multipurpose protection	MAPGAPC	MAP	MAP
Control			
Circuit-breaker control	CBXCBR	I <-> O CB	52
Disconnector position indication	DCSXSWI	I <-> O DC	29DS
Earthing switch position indication	ESSXSWI	I <-> O ES	29GS
Autoreclosing	DARREC	O -> I	79
Condition monitoring and supervision			
Trip circuit supervision	TCSSCBR	TCS	TCM
Fuse failure supervision	SEQSPVC	FUSEF	VCM, 60
Circuit-breaker condition monitoring	SSCBR	CBCM	52CM
Current circuit supervision	CCSPVC	MCS 3I	CCM
Measurement			
Three-phase current measurement	CMMXU	3I	IA, IB, IC
Residual current measurement	RESCMMXU	Io	IG
Sequence current measurement	CSMSQI	I1, I2, I0	I1, I2, I0
Three-phase voltage measurement	VMMXU	3U	VA, VB, VC
Residual voltage measurement	RESVMMXU	Uo	VG/VN
Traditional LED indication			
Programmable LED control	LED	LED	LED
Logging functions			
Disturbance recorder (common functionality)	RDRE	DR	DFR
Disturbance recorder, analog channels 1…8	A1RADR	A1RADR	A1RADR
Disturbance recorder, binary channels 1...32	B1RBDR	B1RBDR	B1RBDR
Communication protocols			
IEC 61850-8-1 MMS	MMSLPRT	MMSLPRT	MMSLPRT
IEC 61850-8-1 GOOSE	GSELPRT	GSELPRT	GSELPRT
Modbus protocol	MBSLPRT	MBSLPRT	MBSLPRT

Section 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 protection relay.

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

Table 2:   Maximum concentration values by weight per homogeneous material

Substance	Proposed maximum concentration	In %
Lead - Pb	<1000 ppm (RoHS3)	0.001
Mercury - Hg	<1000 ppm (RoHS3)	0.001
Cadmium - Cd	<100 ppm (RoHS3)	0.0001
Hexavalent Chromium Cr (VI)	<1000 ppm (RoHS3)	0.001
Polybrominated biphenyls - PBB	<1000 ppm (RoHS3)	0.001
Polybrominated diphenyl ether - PBDE	<1000 ppm (RoHS3)	0.001

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.

2.2   Disposal of a protection relay

Definitions and regulations of hazardous materials are country-specific and change when the knowledge of materials increases. The materials used in this product are typical for electric and electronic devices.

All parts used in this product are recyclable. When disposing of a protection relay or its parts contact a local waste handler who is authorized and specialized in disposing of electronic waste. These handlers can sort the material by using dedicated sorting processes and dispose of the product according to the local requirements.

Table 3:   Materials of the protection relay parts

Protection relay	Parts	Material
Case	Metal plates, parts and screws	Steel
	Hard plastic parts	Polycarbonate, REACH and RoHS compliant
	Soft plastic parts	Silicone (UL94 HB) Thermoplastic elastomer
	Electronics modules in case	Various
Plug-in unit	Electronic plug-in modules	Various
	Electronics HMI module	Various
	Hard plastic parts	Polycarbonate, REACH and RoHS compliant
	Soft plastic parts	Silicone (UL94 HB) Thermoplastic elastomer
	Metal plates, parts and screws	Steel
Package	Box	Cardboard
Attached material	Manuals	Paper

Section 3   REX610 overview

3.1   Overview

REX610 is a freely configurable all-in-one protection relay that covers the full range of basic power distribution applications, without forgoing simplicity. The small number of variants translates into easy ordering, setup, use and maintenance. Although rich in functionality, REX610 represents a cost-effective choice. The fully modular hardware, unlocking all available functionality, and continuous access to new developments allow easy and flexible customization, modification and adaptation to changing protection and communication requirements at any time.

REX610 is a member of the renowned Relion$^{®}$ protection and control family of relays, building on ABB's strong heritage of freely configurable multifunctional relays and many proven protection algorithms.

3.1.1   Product version history

Product version	Product history
1.0	Product released

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:   *Example of the 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 4:   *Display*

Character size[1]	Rows in the view	Characters per row
Small, mono-spaced (6 × 12 pixels)	5	20

1)   Depending on the selected language

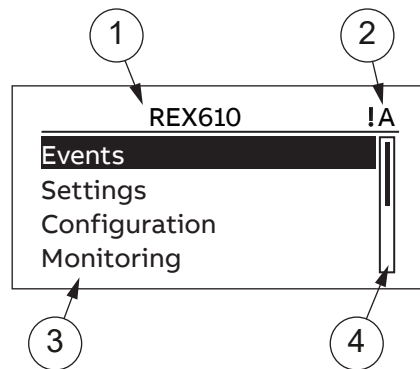The display view is divided into four basic areas.

Figure 3:   *Display layout*

1   Header

2   Icon

3   Content

4   Scroll bar (displayed when needed)

- 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 current action or user level.
  Current action is indicated by the following characters:

  - U: Font/Firmware is being updated
  - S: Parameters are being stored
  - !: Warning and/or indication

  Current user level is indicated by the following characters:

  - V: Viewer
  - O: Operator
  - E: Engineer
  - A: Administrator
- 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 in the upper-right corner: Ready, Start and Trip.

There are 10 matrix programmable LEDs on front of the LHMI. The LEDs can be configured with PCM600 and the operation mode can be selected with the LHMI or PCM600.

3.2.3 Keypad

The LHMI keypad contains push buttons which are used to navigate in different views or menus. Using the push buttons, open or close commands can be given to objects in the primary circuit, for example, a circuit breaker. The push buttons are also used to acknowledge alarms and reset indications.
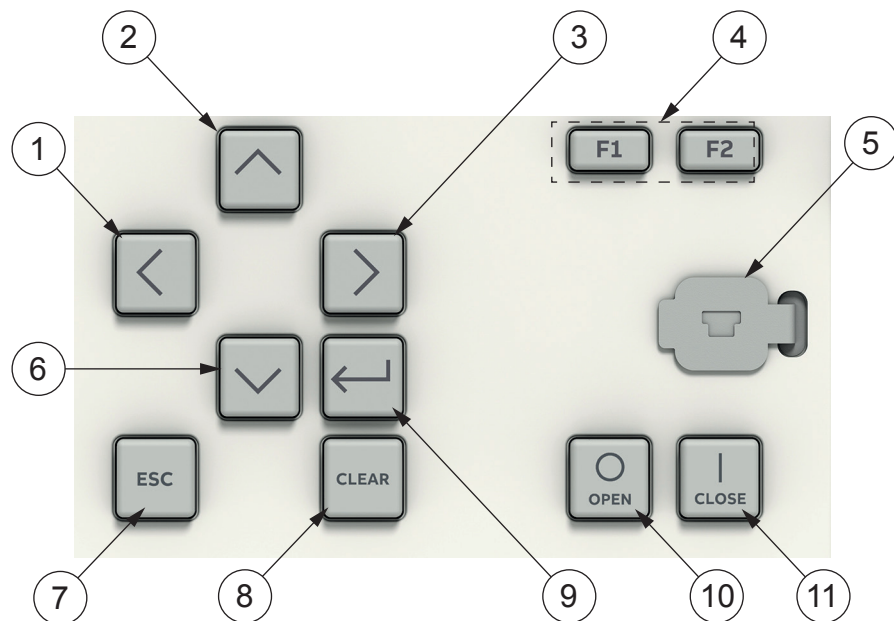

Figure 4:   *LHMI keypad*

1   Left

2   Up

3   Right

4   Function keys

5   Communication port

6   Down

7   Escape

8   Clear

9   Enter

10   Open

11   Close

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 5:   *Object control push buttons*

Name	Description
CLOSE Close	Closing the object.
OPEN 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 6:   *Navigation push buttons*

Name	Description
ESC ESC	• Logging off user when pressed continuously for 3 seconds. • 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 CLEAR when editing a string. • Inserting a space in combination with ↵ when editing a string.
↵ Enter	• Initiating authorization, that is logging in, on default screen (measurement screen or menu screen) provided that local override is false. • 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.

Commands

Table 7:   *Command push buttons*

Name	Description
CLEAR Clear	• Activating the Clear/Reset view. • Clearing indications and LEDs: a three-second press clears trip LEDs and a six-second press clears the programmable LEDs. Requires appropriate user rights.

3.2.4 Local HMI functionality

3.2.4.1 Protection and alarm indication

Protection indicators

The protection indicator LEDs are Ready, Start and Trip.

Table 8:   *Ready LED*

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

Table 9:   *Start 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, or the protection relay is in the blocked mode. • The blocking indication disappears when the blocking is removed or when the protection function is reset.

Table 10:   *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 CLEAR. • If several protection functions trip within a short time, the last trip is indicated on the display.

Alarm indicators

The 10 matrix programmable LEDs are used for alarm indication.

Table 11:   *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.

3.2.4.2   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.

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

> ℹ️ 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. In PCM600 the setting visibility can be switched between "basic" and "advanced" but this is not supported on the LHMI.

3.2.4.3   Front communication

The protection relay supports a USB front port (micro USB type B) that can be used to communicate with the relay or to power it up. The USB can be enabled via **Configuration/System/Enable USB**.

A micro USB type B cable can be used to connect to the relay. If auxiliary power is connected to the relay, the USB port works as a communication port. If auxiliary

power is not connected, the relay powers up from the USB. In this mode, the relay has limited functionality such as reading and writing configuration and settings.

For more information on the functionality supported, see the technical manual. See the engineering manual for details on how to work with PCM600 over the USB front port.

3.3 Authorization

Four factory default user accounts have been predefined, each with different rights and default passwords. The roles for these four user accounts are the same as the username.

- VIEWER
- OPERATOR
- ENGINEER
- ADMINISTRATOR

The default passwords in the protection relay delivered from the factory can be changed with Administrator user rights or by the users themselves.

Each protection relay supports four roles and eight user accounts. Each user can be mapped to only one role.

IED Users in PCM600 is used to manage the local user accounts.

- User accounts can be created under any role.
- 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.
- The user accounts' password can be changed by the users from IED Users or from the LHMI.
- Administrator can reset the user passwords.

The user account information is written to the protection relay from IED Users in PCM600. The user account information is securely maintained in a local database in the protection relay.

Any user logging into the protection relay from LHMI or PCM600 (FTPS/USB) is authenticated based on the user account information and this user's rights are defined by the user's role.

Table 12:   *Default user roles*

Role	Description
VIEWER	Viewing what objects are present in the logical device
OPERATOR	Viewing what objects are present in the logical device Performing control operations such as opening or closing the circuit breaker
ENGINEER	Viewing what objects are present in the logical device Making parameter setting and configuration changes in addition to having full access to the data sets and files
ADMINISTRATOR	Superset of all the roles

Table 13 describes the default mapping of all the user rights associated with all the roles in the protection relay. This mapping can be modified according to the user requirements.

Table 13:   *Default roles-to-rights mapping*

Rights/Roles	ADMINISTRATOR	ENGINEER	OPERATOR	VIEWER
Settings & Configuration	Read/Write	Read/Write	Read	Read
Settings Group Handling	Read/Write	Read	Read/Write	Read
Control Operations	Read/Write	Read	Read/Write	Read
Record Handling	Read/Write	Read/Write	Read	Read
Test Mode	Read/Write	Read/Write	Read	Read
System Update	Read/Write	Read	Read	Read
User Management	Read/Write	Read	Read	Read

User account information can be exported from IED Users in PCM600 to an encrypted file which can be imported into another protection relay.

> User authorization is disabled by default for the LHMI and can be enabled with the *Local override* parameter via the menu path **Configuration/Authorization/Passwords**. When the *Local override* parameter is set to "False", Local User Account Management comes into use.

> For user authorization for PCM600, see PCM600 documentation.

> The Administrator user shall not be allowed to delete the last ADMINISTRATOR user and itself. FTP/FTPS logins are done by entering the username and password; there is no role selection

required. The highest role for the username is automatically selected by the protection relay. Performing the Restore Factory settings operation in IED Users in PCM600 restores user accounts to the factory user accounts.

3.3.1 Audit trail

The protection relay offers a large set of event-logging functions. Critical system and protection relay security-related events are logged to a separate nonvolatile audit trail for the administrator.

Audit trail is a chronological record of system activities that allows the reconstruction and examination of the sequence of system and security-related events and changes in the protection relay. Both audit trail events and process related events can be examined and analyzed in a consistent method with the help of Event List in LHMI and Event Viewer in PCM600.

The protection relay stores 2048 audit trail events to the nonvolatile audit trail. Additionally, 1024 process events are stored in a nonvolatile event list. Both the audit trail and event list work according to the FIFO principle. Nonvolatile memory is based on a memory type which does not need battery backup nor regular component change to maintain the memory storage.

Audit trail events related to user authorization (login, logout) are defined according to the selected set of requirements from IEEE 1686. The logging is based on predefined user names or user categories. The user audit trail events are accessible from Event Viewer in PCM600.

Table 14:   *Audit trail events*

Event ID	Audit trail event	Description
1110	Login	Successful login from LHMI and PCM600
1210	Logout	Successful logout from LHMI, PCM600 or IEC 61850
1130	Login failure	Login failed for using the wrong user credentials
13200	Configuration transfer	Configuration transferred successfully to the device
1380	Parameter change	Parameter changed successfully
1460	Parameter change fail	Parameter change failed
1520	Software update	Software updated successfully
1610	Software update fail	Software update failed
2210	Password change	User password changed successfully
2220	Password change fail	User password change failed
5270	System startup	Software reset
6110	Test on	Test mode started
Table continues on next page		

Event ID	Audit trail event	Description
6120	Test off	Test mode ended
6130	Control operation	Control operation performed successfully
5120	Reset trips	Latched trips reset

PCM600 Event Viewer can be used to view the audit trail events and process related events. Audit trail events are visible through dedicated Security events view. Since only the administrator has the right to read audit trail, authorization must be used in PCM600. The audit trail cannot be reset, but PCM600 Event Viewer can filter data.

3.4 Station communication

Operational information and controls are available through a wide range of communication protocols including IEC 61850 and Modbus®. Full communication capabilities, for example, horizontal communication between the relays, are only enabled by IEC 61850.

The IEC 61850 protocol is a core part of the relay as the protection and control application is fully based on standard modelling. The relay supports Edition 2 version of the standard. With Edition 2 support, the relay has the latest functionality modelling for substation applications and the best interoperability for modern substations.

3.5 PCM600

Protection and Control IED Manager PCM600 offers all the necessary functionality to work throughout all stages of the protection relay's 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 project 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 enable system tools to communicate with a protection relay. Connectivity packages are used to create configuration structures in PCM600.

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 the software packages that use the connectivity package to properly communicate with the protection relay.

3.5.2 PCM600 and relay connectivity package version

- Protection and Control IED Manager PCM600 Ver.2.11 or later
- REX610 Connectivity Package Ver.1.0 or later

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

3.6 Modification Sales

Modification Sales is a concept that provides modification support for already delivered relays. Under Modification Sales it is possible to add protection functions by adding a hardware module. 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 or change the type of the existing modules within the slots.

Section 4   Using local HMI

4.1   Logging in

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 **Main menu/ Configuration/Authorization/Passwords**. Set the *Local override* parameter to "False".

1. Press ↵ to activate the login procedure.
2. Press ⌃ or ⌄ to enter the username character by character.

```
            Login
    _____

    Select user
    =VIEWER
```

Figure 5:   Selecting access level

3. Confirm the selection with ↵.
4. Enter the password when prompted character by character.

> Special characters are not allowed.

- Activate the digit to be entered with ⟨ and ⟩.
- Enter the character with ⌃ and ⌄.

```
              VIEWER
   ─────────────────────────
   Enter password:
   =***1
```
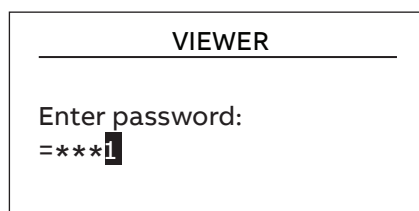
Figure 6:   *Entering password*

5.   Press ↵ to confirm the login.
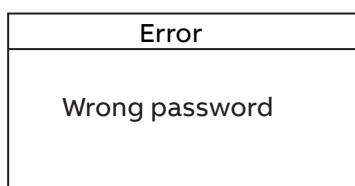
-     To cancel the procedure, press ESC .

```
   ┌─────────────────────────┐
   │          Error          │
   ├─────────────────────────┤
   │                         │
   │     Wrong password      │
   │                         │
   └─────────────────────────┘
```

Figure 7:   *Error message indicating wrong password*

The current user level is shown on the display's upper right corner in the icon area.

When local override is disabled, the Login page is shown in case of any LHMI activity.

4.2   Logging out

An automatic logout occurs 30 seconds after the backlight timeout.

1.   Press ESC continuously for 3 seconds.
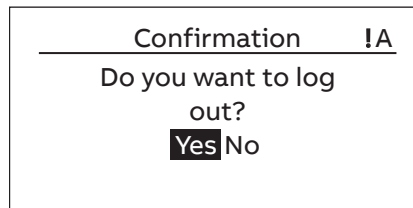2.   To confirm logout, select Yes and press ↵.

```
┌─────────────────────────────┐
│   Confirmation        !A    │
│─────────────────────────────│
│     Do you want to log      │
│           out?              │
│        [Yes] No             │
│                             │
│                             │
└─────────────────────────────┘
```

Figure 8:   *Logging out*

•   To cancel logout, press [ESC].

4.3   Turning 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. The user is logged out from the current user level 30 seconds after the display backlight has turned off.

The display returns to the default view and all unconfirmed operations such as parameter editing and breaker selection are cancelled.

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

4.4   Identifying device

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

The protection relay information is shown on the display for a few seconds when the device starts. The same information is also found in the protection relay menu.

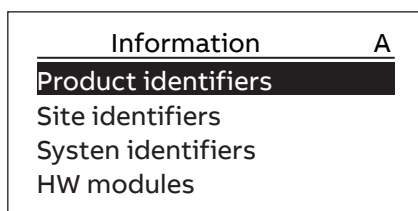1.   Select **Main menu/Information**.
2.   Select a submenu with ︿ and ﹀.

```
         Information        A
Product identifiers
Site identifiers
Systen identifiers
HW modules
```

Figure 9:   *Selecting a submenu*

3.   Enter the submenu with ⟩ .
4.   Browse the information with ⌃ and ⌄ .


```
Product identifiers    A
Type
=REX610
Product version
=1.0.0
```
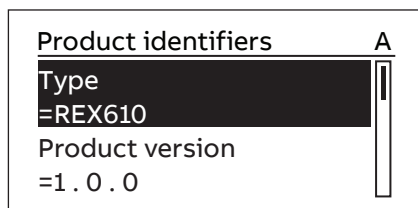
Figure 10:   *Protection relay information*

4.4.1   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.

ℹ️   The first version of the protection relay supports only Edition 2.

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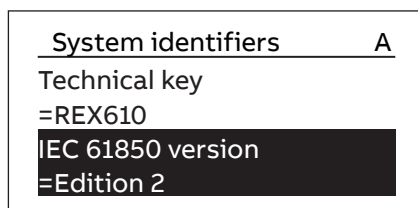


```
  System identifiers      A
Technical key
=REX610
IEC 61850 version
=Edition 2
```

Figure 11:   *Identifying IEC 61850 version*

4.4.2 Identifying relay's composition code

The relay's composition code identifies the relay composition based on the hardware modules present in the relay.

1. Select **Main menu/Information/Product Identifiers**.
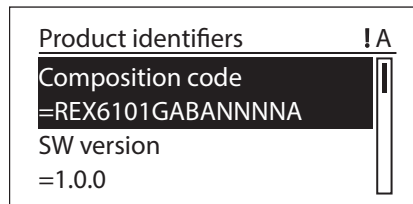2. Enter the submenu with ⟩ .

```
Product identifiers        ! A
Composition code
=REX6101GABANNNNA
SW version
=1.0.0
```

Figure 12:   Composition code

4.5 Configuring SD card

SD card is supported in the relay. It should be formatted in FAT32 format.

1. Select **Main menu/Configuration**.
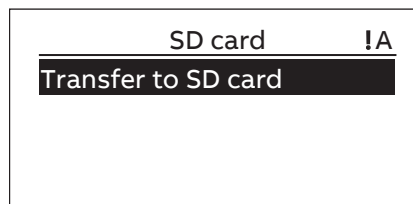2. Enter the submenu with ⟩ to transfer disturbance records to the SD card.

```
              SD card        ! A
Transfer to SD card
```

Figure 13:   SD card

4.6 Adjusting display contrast

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

*   To increase the contrast, press simultaneously ᴇꜱᴄ and ⌃ .
*   To decrease the contrast, press simultaneously ᴇꜱᴄ and ⌄ .

4.7 Changing 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.

```
        Language          A
Language selection
=English (us, iec)


```
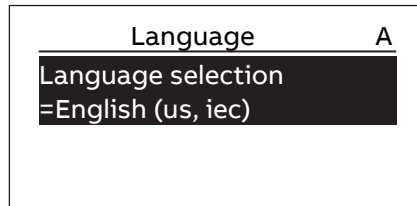
Figure 14:   Changing the local HMI language

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

4.8 Changing display symbols

Use the keypad to switch between the display symbols IEC 61850, IEC 60617 and IEC-ANSI.

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

```
        HMI               A
FB naming convention
=IEC61850
Default view
=Main menu
```
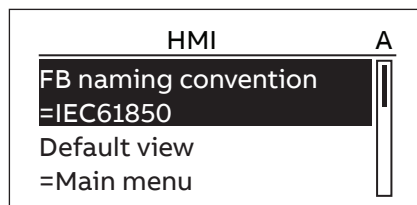
Figure 15:   Changing the function block naming convention

The change in LHMI display symbols takes effect immediately without the need to reboot the protection relay.

4.9 Navigating in menus

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

- 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 ESC.

4.9.1 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

4.9.2 Scrolling display

If a menu contains more rows than the display can show at a time, a scroll bar is displayed on the right.
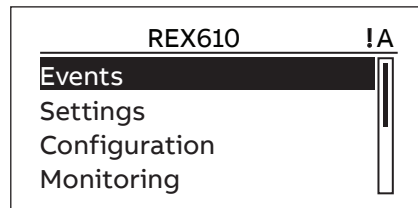
Figure 16:   Scroll bar on the right

- 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.

4.9.3   Changing default view

The default view of the display is Main menu unless set otherwise.

1.   Select **Main menu/Configuration/HMI/Default view** and press ↵.
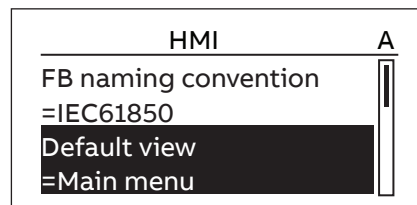
Figure 17:   Changing the default view

2.   Change the default view with ⌃ or ⌄.
3.   Press ↵ to confirm the selection.

4.10   Browsing setting values

1.   Select **Main menu/Settings/Settings** and press ⟩.
2.   Select the setting group to be viewed with ⌃ or ⌄.

```
┌──────────────────────────────────┐
│      REX610              !A       │
│   ──────────────                 │
│                                  │
│   Edit group:  ↕+ 2              │
│                                  │
│   Active group=1                 │
│                                  │
└──────────────────────────────────┘
```
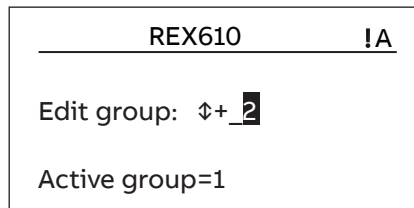
Figure 18:   *Selecting a setting group*

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 ⟨ .

```
┌──────────────────────────────────┐
│  SG2: Settings          !A       │
│  ─────────────                   │
│  Current protection              │
│  Voltage protection              │
│  Other protection                │
│                                  │
│                                  │
└──────────────────────────────────┘
```
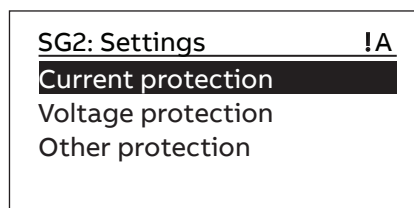
Figure 19:   *Example of submenus in the Settings menu*

> ℹ Some parameters may be hidden because the function is off .

4.11   Editing values

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

> ℹ 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.

> ℹ 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.

4.11.1 Editing numerical values

1. 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 ↕, the active value can either be increased or decreased.

```
┌─────────────────────────────────┐
│       REX610          !A        │
│  ────────────────────           │
│                                 │
│  Edit group:   ↕ + 1            │
│                                 │
│  Active group=1                 │
└─────────────────────────────────┘
```

Figure 20:   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.

   > ℹ️ 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 ⌄.

```
┌─────────────────────────────────┐
│       REX610          !A        │
│  ────────────────────           │
│                                 │
│  Edit group:   ↕ + 4            │
│                                 │
│  Active group=1                 │
└─────────────────────────────────┘
```

Figure 21:   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.

```
┌─────────────────────────────────┐
│       REX610            !A       │
│  ─────────────────              │
│                                 │
│  Edit group:  ↕+_2              │
│                                 │
│  Active group=1                 │
│                                 │
└─────────────────────────────────┘
```
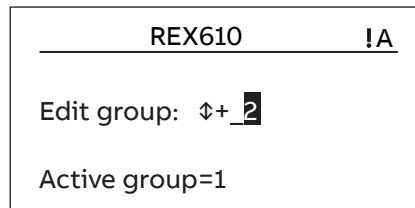
Figure 22:   Restoring the previous value

4.11.2   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 ESC and ↵.
     •   To delete characters, press simultaneously ESC and CLEAR.

4.11.3   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.

4.12   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 MENU to enter the Main Menu.
3. To save the changes in non-volatile memory, select Yes and press ⏎.

```
┌─────────────────────────────────┐
│   Confirmation          !A      │
│  ───────────────────────        │
│  Commit settings?               │
│   Yes  No  Cancel               │
│                                 │
│                                 │
└─────────────────────────────────┘
```
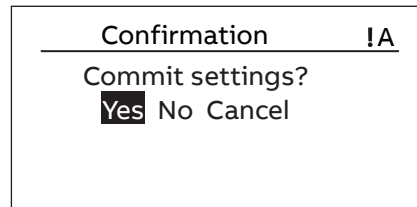
Figure 23:   Confirming settings

-   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.

4.13   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 CLEAR to activate the Clear view.
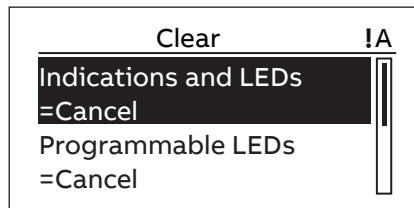
Figure 24:   *Clear view*

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 CLEAR button as a shortcut for clearing. A three-second press clears trip LEDs and a six-second press clears the programmable LEDs.

Section 5   Protection relay operation

5.1   Normal operation

In a normal protection relay use situation, the basic operation includes monitoring and checking procedures.

- Monitoring measured values
- Checking object states
- Checking function setting parameters
- Checking events and alarms

All basic operations can be performed via the LHMI or with PCM600.

> For more information, see the PCM600 documentation.

5.2   Disturbance identification

Disturbances and their causes can be identified by indicator LEDs: Ready, Start and Trip. During normal operation, the Ready LED is steady green.

Table 15:   Disturbance indications

LED	State	Description
Start LED	Yellow, steady	Protection started
Trip LED	Red, steady	Protection operated
Ready LED	Green, flashing	Internal fault

Further actions to be taken to identify the disturbance:

- Checking programmable LEDs
- Reading event history
- Analyzing disturbance recordings

> Document the disturbance before clearing the information from the protection relay.

Only authorized and skilled personnel should analyze possible errors and decide on further actions. Otherwise, stored disturbance data can be lost.

5.2.1 Disturbance recording triggering

Disturbance recordings are normally triggered by protection relay applications when they detect fault events. Disturbance recordings can also be triggered manually or periodically. The manual trigger generates an instant disturbance report. Use this function to get a snapshot of the monitored signals.

5.2.2 Disturbance record analysis

The protection relay collects disturbance records of fault events which are set to trigger the disturbance recorder. Disturbance data is collected and stored for later viewing and analysis. The disturbance recorder data can be read and analyzed with PCM600.

For more information, see the PCM600 documentation.

5.2.3 Disturbance reports

PCM600 can be used for creating reports of disturbance recorder data.

For more information, see the PCM600 documentation.

5.2.4 Relay self-supervision

The relay self-supervision handles internal run-time fault situations. The main indication of an internal fault is a flashing green Ready LED.

Internal faults can be divided to hardware errors, run-time errors in the application or operating system and communication errors. Further actions always depend on the cause of the error.

Only authorized and skilled personnel should analyze the errors and decide on further actions.

The protection relay records system registrations, relay status data and events.

Document all the recorded data from the protection relay before resetting the tripping and relay lockout functions.

5.3 Relay parametrization

Protection relay parameters are set via the LHMI 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.

5.3.1 Settings for relay functionality

Function settings can be edited one by one by navigating to the individual setting values, for example via the LHMI. The values in other setting groups should be known before editing a certain setting value.

After completing the editing of setting group values, the new values are activated. The user can either commit the edited values or discard them. Setting values can also be copied from one setting group to another.

5.3.2 Settings for different operating conditions

Protection relay settings can be designed for various operation conditions by defining different setting values to different setting groups. The active setting group can be changed by the relay application or manually via the LHMI or PCM600.

Section 6   Operating procedures

6.1   Monitoring

6.1.1   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 and Trip
- 10 programmable LEDs
- Information on the display

6.1.1.1   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 [ESC] to close the indication message without clearing it or press [CLEAR] to activate the Clear view and to clear messages.

```
        T1PTTR1
OPERATE
L1, L2, L3
23. 03. 2007
21:18:56. 789



```

Figure 25:   Indication message

6.1.1.2   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.

i   See the troubleshooting section for more details.

```
┌──────────────────────────┐
│      Internal Fault      │
├──────────────────────────┤
│ Test                     │
│ Code  00. 01. 08. 008. 19│
│ 20. 01. 2021             │
│ 22: 20: 34. 690          │
└──────────────────────────┘
```

Figure 26:   *Fault indication*

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

6.1.1.3   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.

6.1.2   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.

i   Invalid or questionable measurement values are presented in
      parentheses.

6.1.2.1   Measured values

Measured values can be accessed through the LHMI.

Table 16:   *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
NgSeq-A	Negative-phase-sequence current
Ps-Seq-A	Positive-phase-sequence current
Zr-Seq-A	Zero-phase-sequence current

6.1.2.2   Using 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 ⌄.

6.1.3   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
- Events

6.1.3.1   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.

```
Disturbance records        !A
Number of recordings
=4
Rem. amount of rec.
=96
```
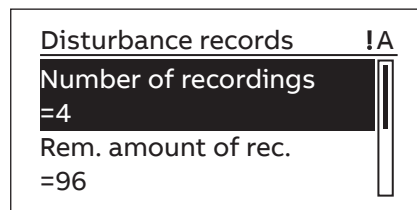
Figure 27:   Changing the value

The disturbance recorder is now triggered.

6.1.3.2   Monitoring disturbance recorder data

Disturbance recordings can be uploaded from the protection relay with PCM600 to monitor disturbance recorder data. Individual disturbance recordings can be viewed.

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
Rec. memory used
=0 %
Trig recording
=Cancel
```
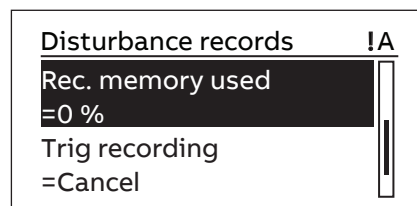
Figure 28:   Monitoring disturbance recorder via the LHMI

6.1.3.3   Controlling and reading of disturbance recorder data

Disturbance recorder data can be controlled and read with PCM600. Disturbance records are stored in the internal memory and storage can be extended using the SD card. Later the data can be accessed using PCM600 or a COMTRADE reader tool.

For more information, see the PCM600 documentation.

6.1.3.4   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.

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.

1/78 20. 01. 2021
_____

22: 27: 54. 742
GNRLLTMSI
Synch source
SNTP primary
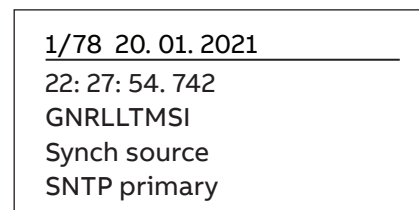
Figure 29:   Monitoring events

6.1.4   Remote monitoring

The protection relay supports remote monitoring.

6.1.4.1   Monitoring protection relays remotely

Use PCM600 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.

6.1.5   Monitoring SD card memory

SD card memory can be monitored to ensure there is sufficient space in the SD card to enable copying of disturbance records to the SD card when necessary.

1. Select **Main menu/Monitoring/SD card**.
2. Scroll the view with ⌃ or ⌄ to check the remaining SD card memory.

```
      SD card          !A
Mounted
=No
Memory remaining
=0 MB
```
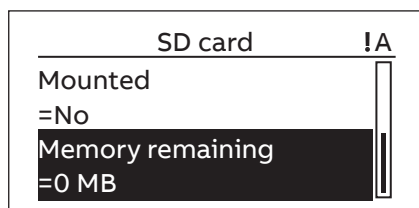
Figure 30:   Monitoring SD card memory

6.2   Controlling

6.2.1   Controlling via 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.

```
       Select object         A
CBXCBR1
```
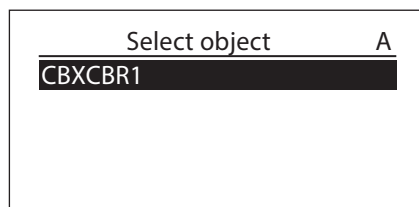
Figure 31:   Selecting a controlled object

2. To confirm the operation, select Yes and press ↵.

```
       Confirmation           A
       Open CBXCBR1?
             Yes No
```
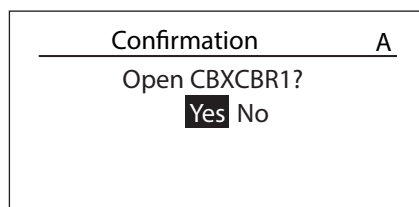
Figure 32:   Opening a circuit breaker

•   To cancel the operation, select No and press ↵.

```
┌─────────────────────────────┐
│        Information           │
├─────────────────────────────┤
│                             │
│          Cancel             │
│                             │
│                             │
└─────────────────────────────┘
```
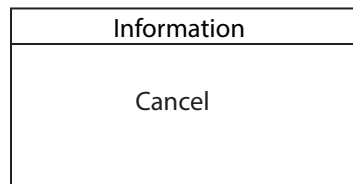
Figure 33:   *Cancelling operation*

- If the control operation is not successful, the Control failed message appears. This can happen, for example, if opening is not enabled before the open command is executed. More details can be seen via **Control/Monitoring/Control command/Command response**.

```
┌─────────────────────────────┐
│        Information           │
├─────────────────────────────┤
│                             │
│       Control failed        │
│                             │
│                             │
└─────────────────────────────┘
```
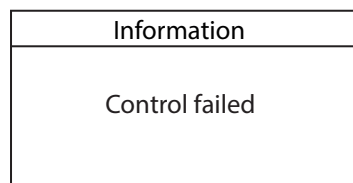
Figure 34:   *Control failed message*

> **i** 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.

6.2.2   Controlling with 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.

```
┌─────────────────────────┐
│       Information        │
│        Closing in        │
│           17 s           │
│     Press any button to  │
│        cancel close      │
└─────────────────────────┘
```

Figure 35:   *Delay view*

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

6.3   Resetting protection relay

6.3.1   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 ⬚CLEAR to activate the Clear view.
     All the items that can be cleared are shown.

     - Indications and LEDs
     - Programmable LEDs
     - Events
     - Disturbance records
     - Acc. energy of circuit breaker condition monitoring
     - 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 transformer
     - Reset of autoreclosing
     - Counters for autoreclosing
     - Master trip

```
           Clear            A
 Indications and LEDs
 =Cancel
 Programmable LEDs
 =Cancel
```
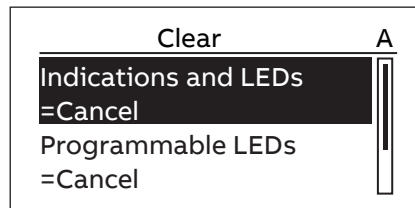
Figure 36:   *Clear view*

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 CLEAR button as a shortcut for clearing. A three-second press
> clears trip LEDs and a six-second press clears the programmable
> LEDs.

6.4   Changing protection relay functionality

6.4.1   Defining the setting group

6.4.1.1   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 ↵ .

```
         Setting group      !A
 Active group
 =1
 Copy group 1
 =Cancel
```
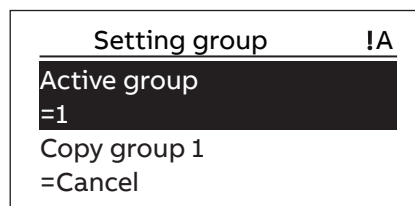
Figure 37:   *Active setting group*

2.   Select the setting group with ⌃ or ⌄ .
3.   Press ↵ to confirm the selection or ESC to cancel.

```
        Setting group          !A
   _____
   Active group
   = ⇧ + _1
   Copy group 1
   =Cancel
```
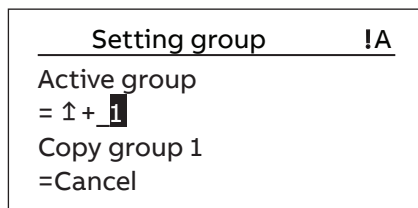
Figure 38:   Selecting the active setting group

4.   Commit the settings.

> Remember to document the changes made.

6.4.1.2   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 4
```
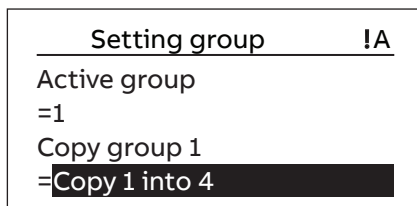
Figure 39:   Copying setting group 1 into 4

6.4.1.3   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.

```
┌─────────────────────────────────────┐
│           REX610          !A         │
│   ─────────────                      │
│                                      │
│   Edit group:  ↕+ 2                  │
│                                      │
│   Active group=1                     │
└─────────────────────────────────────┘
```
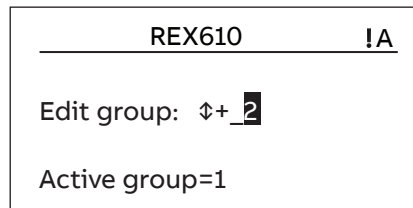
Figure 40:   Selecting a setting group

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 #.

```
┌─────────────────────────────────────┐
│   SG1: PHIPTOC1           !A         │
│   Num of start phases          ▓     │
│   =1 out of 3                  ▓     │
│   Start value                  ▓     │
│   =1. 00 xln              #    ▓     │
└─────────────────────────────────────┘
```
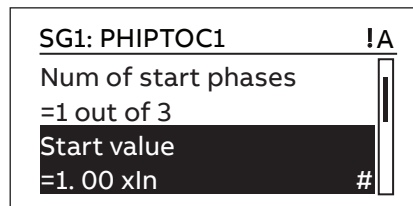
Figure 41:   Setting group parameter

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

```
┌─────────────────────────────────────┐
│   SG1: Start value        !A         │
│  *[1]=1. 00 xln                      │
│   [2]=1. 00 xln                      │
│   [3]=1. 00 xln                      │
│   [4]=1. 00 xln                      │
└─────────────────────────────────────┘
```
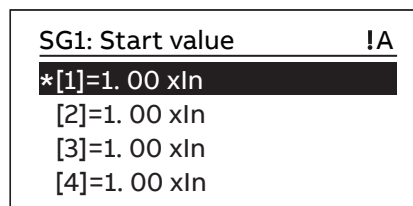
Figure 42:   Selecting the setting group value

Only values within the selected setting group can be changed.

7. Press ⌃ or ⌄ to change the value and ↵ to confirm the selection.

```
┌─────────────────────────────────────┐
│ SG1: Operate delay ...          !A   │
│ *[1]= ⇕ +_ _ _ _█0 ms               │
│   [2]=20 ms                          │
│   [3]=20 ms                          │
│   [4]=20 ms                          │
└─────────────────────────────────────┘
```
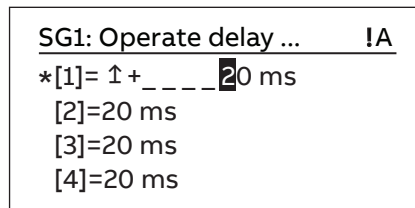
Figure 43:   Editing the setting group value

The active setting group is indicated with an asterisk * .

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

6.4.2 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.

> **i** See the technical manual for details on LED configuration.

6.4.3 Setting autoscroll 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 44:   Autoscroll delay

Section 7   Troubleshooting

7.1   Fault tracing

7.1.1   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.
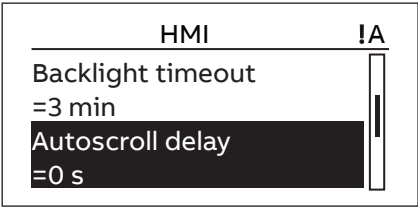
   - Check that the error is not caused by external origins.
   - Remove the wiring from the protection relay and test the input and output operation with an external test device.
   - If the problem remains, contact ABB for repair or replacement actions.

7.1.2   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.

7.1.3   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.

7.1.3.1   Checking front communication link operation

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

LED	Communication ok
Uplink	Steady green light
Communication	Flashing yellow light

Table 17:   *Front communication LEDs*

7.1.3.2   Checking time synchronization

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

7.1.4   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 [ESC] 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.

7.2   Self-supervision

The protection relay's extensive self-supervision system continuously supervises the relay's software, hardware and certain external circuits. It handles the run-time fault situation and informs the user about a fault via the LHMI, the relay's main unit power module Ready LED and through the communication channels. The target of the self-supervision is to safeguard the relay's reliability by increasing both dependability and security. The dependability can be described as the relay's ability to operate when required. The security can be described as the relay scheme's ability to refrain from operating when not required. The dependability is increased by letting the system operators know about the problem, giving them a chance to take the necessary actions as soon as possible. The security is increased by preventing the relay from making false decisions, such as issuing false control commands.

There are two types of fault indications.

- Internal faults
- Warnings

Warnings are indications of less severe situations which can also be caused by external reasons such as a missing relay configuration.

The self-supervision page is available under **Main menu/Monitoring/Self-supervision node**. The self-supervision page has the Internal fault and Warning indications. In normal operation, `ALL OK` is displayed for the Internal fault and Warning indications. The self-supervision also controls the status of IRF output relay. The IRF output relay is energized under normal conditions and de-energized under internal fault conditions.
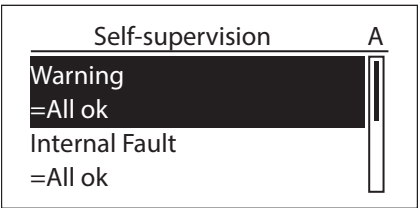
```
      Self-supervision      A
Warning
=All ok
Internal Fault
=All ok
```

Figure 45:   Relay self-supervision status on local HMI

In addition, the boot reason is available in the audit trail events in Event Viewer in PCM600 under the Security events.

7.2.1 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.

> **i** 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.

```
      Self-supervision      !A
Warning
=All ok
Internal Fault
=DIO card error
```
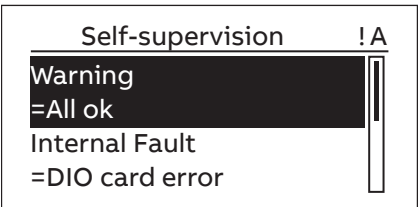
Figure 46:   Internal fault in LHMI self-supervision page

If an internal fault disappears, the green Ready LED stops flashing and the protection relay returns to the normal service state. The fault indication message remains on the display until manually cleared.

The self-supervision signal output operates on the closed-circuit principle.

- Normal conditions with empty application configuration

    - DIO2001 pins 16 and 17 are closed, pins 16 and 18 are open.

- Normal conditions with application configuration

    - DIO2001 pins 16 and 17 are open, pins 16 and 18 are closed.

- USB powered with or without application configuration

    - DIO2001 pins 16 and 18 are closed, pins 16 and 17 are open.
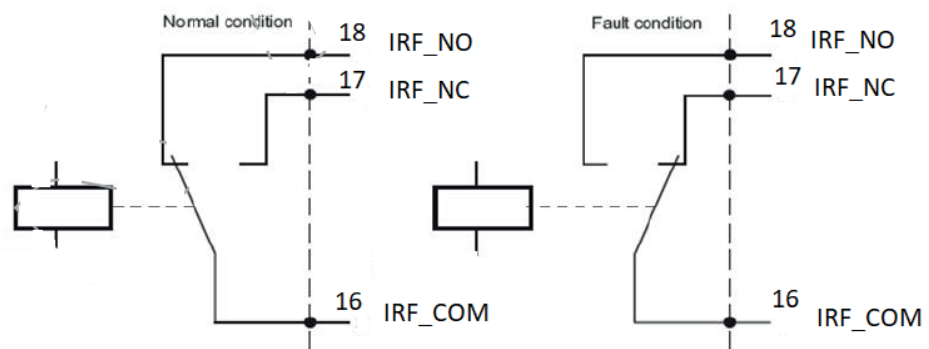
Figure 47:   *Output contact*

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.

The display code format for internal faults is `aa.bb.cc.ddd.ee`.

- `aa`: Reserved for future
- `bb`: Error domain

    - `1`: HW error
    - `2`: Runtime error
    - `3`: Communication error

- `cc`: Component

    - Range 0...11

- `ddd`: Error category
- `ee`: Offset

- Range 0...255

```
┌─────────────────────────────────┐
│         Internal Fault          │
├─────────────────────────────────┤
│ Test                            │
│ Code  00. 01. 08. 008. 19       │
│ 20. 01. 2021                    │
│ 22: 20: 34. 690                 │
└─────────────────────────────────┘
```

Figure 48:   Fault indication

Table 18:   Internal fault indications and codes

Fault indication	Error category	Additional information
File system error	7	A file system error has occurred
Test	8	Internal fault test activated by the user
USB powered	12	Device powered with USB
RAM error	80[1]	Memory error
ROM error	81	Failure in internal NV memory
PSU traceability invalid	160	Invalid PSU card traceability data
DIO traceability invalid	161	Invalid DIO card traceability data
AIU traceability invalid	162	Invalid AIU card traceability data
AIC traceability invalid	163	Invalid AIC card traceability data
HMI traceability invalid	164	Invalid HMI card traceability data
Product traceability invalid	165	Invalid product traceability data
LHMI LCD error	166	Failure in LCD detection
AIU card error	171	Error in the AIU card
DIO card error	172	Error in the DIO card
AIC card error	173	Error in the AIC card
Firmware update error	175[1]	Software update failed
CPU exception	176[1]	CPU exception
HW config mismatch	177	Mismatch between the HW configuration and the HW cards connected to the relay
System Boot up failure	179[1]	Error during system bootup
HMI Card error	181	Error in the HMI card
RTC Error	182	Error in the RTC
Device Resource error	183	IRF triggered One of the mandatory files missing
COM failure	184[1]	COM failure
ADC Error	185[1]	Analog samples missing

1) Used for software simulation

7.2.2   Warnings

In case of a warning, the protection relay continues to operate except for those protection functions possibly affected by the fault, and the green Ready LED remains lit as during normal operation.

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.

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

The display code format for the warning codes is `aa.bb.cc.ddd.ee`.

- `aa`: Reserved for future
- `bb`: Error domain
  - `1`: HW error
  - `2`: Runtime error
  - `3`: Communication error
- `cc`: Component
  - Range 0...11
- `ddd`: Warning category
- `ee`: Offset
  - Range 0...255

```
        Warning
Watchdog reset
Code 00.02.03.010.61
20.1.2021
22:20:34.690
```

Figure 49:   *Warning*

Table 19:   *Warning indications and codes*

Warning indication	Warning category	Additional information
System	2	Error in file operations
Watchdog reset	10	Watch dog reset has occurred
Power down det.	11	Auxiliary supply voltage dropped too low
Modbus warning	21	Error in Modbus communication
Dataset error	24	Error in data set(s)
Table continues on next page		

Warning indication	Warning category	Additional information
Report cont. Error	25[1]	IEC report error
SCL config error	27	Error in SCL configuration file or the file is missing
Logic warning	28	Too many connections in the configuration
SMT connect error	29	Error in SMT connections
GOOSE input warning	30[1]	Error in GOOSE connections
ACT Config. mismatch	37	Configuration mismatch
SDcard mount Warn	156	SD card mount error
PSU.data.invalid	160[1]	PSU traceability warning
DIO.data.invalid	161[1]	DIO traceability warning
AIU.data.invalid	162[1]	AIU traceability warning
AIC.data.invalid	163[1]	AIC traceability warning
HMI.data.invalid	164[1]	HMI traceability warning
LHMI keyscan error	169[1]	Keyscan error
GOOSE receive error	170	Error in GOOSE message receiving
GOOSE publish error	171[1]	Error in GOOSE publish
SDcard memory full	172	SD card memory is full
Device Cert. Expired	173	Device certificate expired
SDcard error	174	Error in SD card
SNTP error	175	Error in the SNTP module
Internal voltage error	176[1]	Voltage error detected
Inter. humidity sensor error	177	Error in internal humidity sensor
Inter. temp. sensor error	178	Error in internal temperature sensor
Access Errx	179	Setting write failure
Config. not available	181	Error in ACT connections/ACT Configuration not available
SCL validation warning	182	Failure in SCL file validation
MMS report warning	183[1]	MMS report warning
MMS service warning	184[1]	MMS service warning

1) Used for software simulation

7.3 Correction procedures

7.3.1 Rebooting the software

1. Select **Main menu/Configuration/General/Software reset** and press ↵.
2. Change the value with ⌃ or ⌄ and press ↵.

7.3.2   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 stored in the factory are restored. As the device has no configuration, the warning `Config. not available` is displayed.

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.

> ℹ️ 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.

7.3.3   Setting passwords

If user authorization is off or the user is logged in as an administrator, user passwords can be set via the LHMI or with PCM600.

> ℹ️ Local passwords can be changed only via the LHMI. Remote passwords can be changed via the LHMI or with PCM600.

1. Select **Main menu/Configuration/Authorization/Passwords**.
2. Select the password to be reset with ⌃ or ⌄.
3. Press ⏎, change the password with ⌃ or ⌄ and press ⏎ again.
4. Repeat steps 2 and 3 to set the rest of the passwords.

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

7.3.4 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.

7.3.4.1 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**.

7.3.4.2 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.

Section 8 Commissioning

8.1 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. A micro USB type B cable is also needed if you need to configure the relay from the front USB port.
- 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.

8.2 Checking the installation

8.2.1 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.

8.2.2   Checking CT circuits

> ℹ️ 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.

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

> ℹ️ 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.

8.2.3 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.

8.2.4 Checking binary input and output circuits

8.2.4.1 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.
  Binary inputs support also AC voltages.

8.2.4.2 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.

8.3 Authorizations

8.3.1 User authorization

The user categories have been predefined for the LHMI with different rights and default passwords.

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

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

There are default password policies in the protection relay.

- Minimum password length: 4
- Maximum password length: 8
- Minimum uppercase characters: 0
- Minimum numeric: 0
- Minimum special characters: 0

Table 20:   Predefined users, their passwords and roles

Username	Password	Predefined role
VIEWER	0001	VIEWER
OPERATOR	0002	OPERATOR
ENGINEER	0003	ENGINEER
ADMINISTRATOR	0004	ADMINISTRATOR

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

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

> User authorization is disabled by default and can be enabled via the LHMI path **Configuration/Authorization/Passwords**.

> User configuration change 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.

See the cyber security deployment guideline for more information
on configuring the user management. For user authorization for
PCM600, see the PCM600 documentation.

8.4 Setting protection relay and communication

8.4.1 Communication between PCM600 and the protection relay

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

Each protection relay has an Ethernet interface connector on the rear and a USB
interface connector on the front. Both connectors can be used for communication
with PCM600.

Communication over Ethernet (rear port) is done using either IEC 61850 or FTP/
FTPS. Communication over the front port USB is done over Media Transfer
Protocol (MTP).

When an Ethernet-based station protocol is used for rear port communication, 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.

- Direct point-to-point link between PCM600 and the protection relay's front
  port. When communicating over the front port USB, IP is not relevant and by
  default this is seen as 0.0.0.0.
- Indirect link via station LAN or from remote 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 for
   each protection relay to match the IP addresses of the physical IEDs (rear
   port).
4. Technical keys of the IEDs in PCM600 project are configured for each
   protection relay to match the technical keys of the physical IEDs.

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

Table 21: Ports that must be open in the firewall for different protocols

Protocol	TCP port
File Transfer Protocol (FTP and FTPS)	20, 21
IEC 61850	102
Simple Network Time Protocol (SNTP)	123
Modbus TCP	502

If there is an abrupt disconnection (removing of the communication cable) during an ongoing FTP/FTPS session, it takes 15–20 minutes for a fresh session to be successfully established.

8.4.1.1 Setting up IP addresses

The IP address and the corresponding subnet mask can be set via LHMI for the rear Ethernet interface in the protection relay. Each Ethernet interface has a default factory IP address when the complete protection relay is delivered.

1. Set the IP address for the protection relay's rear port and the corresponding subnet mask via the LHMI path **Configuration/Communication/Ethernet/ Rear port**.

Table 22: Default IP address for the rear port and the corresponding subnet mask

IP address	Subnet mask
192.168.2.10	255.255.255.0

8.4.2 Communication settings

The protection relay is provided with a USB port on the LHMI. This port is mainly used for configuration and setting purposes. The rear port IP address and the corresponding subnet masks can be set via the LHMI. The front port uses MTP for communicating with the connected computer. The rear Ethernet interface has a factory default IP address 192.168.2.10 when the complete protection relay is delivered.

Rear port Ethernet is intended for station bus communication. RS-485/RS-232 twisted pair can also be used for rear port communication. Protocol available for serial communication is Modbus RTU.

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

8.4.2.1 Serial communication ports and drivers

The protection relay can be equipped with one UART-based serial communication port. The communication port is a galvanic (RS-485, RS-232) port.

The serial port is called COM1. The COM port driver has its own setting parameters found via the LHMI in **Configuration/Communication/COM1**.

Table 23: COM port parameters

Parameter	Values (Range)	Unit	Step	Default	Description
Baudrate	1=300 2=600 3=1200 4=2400 5=4800 6=9600[1] 7=19200[1] 8=38400 9=57600 10=115200			6=9600	Baudrate
Serial mode	1=RS485 2Wire			1=RS485 2Wire	Serial mode
Reset counters	0=False 1=True			0=False	Resets counters

1) Recommended baud rate for optimum performance

8.4.2.2 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/COM1**.

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 COM channel

Parameter or counter	Description
LNKxLIV	TRUE whenever characters are received on the serial interface
CHxLIV	TRUE while complete link frames are received
Characters received	Counts all incoming non-erroneous characters. This counter operates regardless of whether the serial driver is set to detect a whole protocol link frame or just separate characters.
Table continues on next page	

Parameter or counter	Description
Parity errors	Counts the number of parity errors detected in characters received
Overrun errors	Counts the number of overrun errors detected in characters received
Framing errors	Counts the number of framing errors detected in characters received
Reset counter	Resets all counters to zero

8.4.2.3 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/Rear port**.
2. Define the settings for the Ethernet port.

   - IP address
   - Subnet mask
   - Default gateway of the optional rear port Ethernet connector

8.4.2.4 Defining serial port settings

1. Select **Main menu/Configuration/Communication/COM1**.
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.

```
          COM1              A
Serial mode
=RS485 2Wire
Baudrate
=9600
```
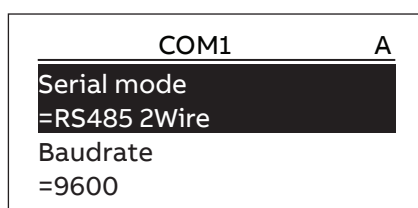
Figure 50:   Defining the serial port settings

8.4.2.5   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.

8.4.2.6   Connecting jumper connectors

> ℹ️ See the technical manual for details on jumper connectors.

8.4.3   Setting local HMI

8.4.3.1   Changing 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.

```
        Language              A
Language selection
=English (us, iec)


```
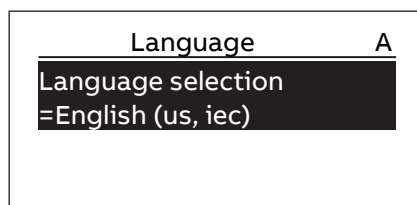
Figure 51:   *Changing the local HMI language*

> 💡 To change the language using a shortcut, press ᴱˢᶜ and ⟨ simultaneously anywhere in the menu.

8.4.3.2   Adjusting display contrast

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

*   To increase the contrast, press simultaneously ᴱˢᶜ and ∧.
*   To decrease the contrast, press simultaneously ᴱˢᶜ and ∨.

8.4.3.3 Changing display symbols

Use the keypad to switch between the display symbols IEC 61850, IEC 60617 and IEC-ANSI.

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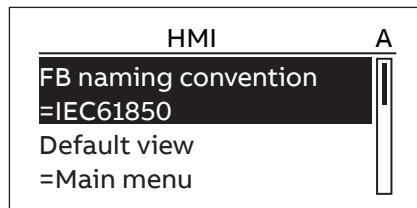3. Press ↵ to confirm the selection.

```
        HMI           A
FB naming convention  ▌
=IEC61850
Default view
=Main menu
```

Figure 52:   Changing the function block naming convention

ℹ️ The change in LHMI display symbols takes effect immediately without the need to reboot the protection relay.

8.4.3.4 Changing default view

The default view of the display is Main menu unless set otherwise.

1. Select **Main menu/Configuration/HMI/Default view** and press ↵.

```
        HMI           A
FB naming convention  ▌
=IEC61850
Default view
=Main menu
```
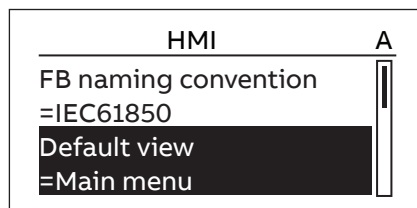
Figure 53:   Changing the default view

2. Change the default view with ⌃ or ⌄.
3. Press ↵ to confirm the selection.

8.4.3.5   Setting 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 25:   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

Table continues on next page

DST off date (day):	25
DST off date (month):	October
DST off day (weekday):	Sunday

> If *DST on day (weekday)* and *DST off day (weekday)* are set to "reserved", the exact day for the DST shift does not have to be set.

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

8.4.4   Setting protection relay parameters

8.4.4.1   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 $\wedge$ or $\vee$.
3.   Press $\hookleftarrow$ to confirm the selection.
4.   Edit the settings.

```
   REX610              !A
_____

Edit group:  ⇕+ 2

Active group=1
```

Figure 54:   *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 $\wedge$ or $\vee$ and press $\hookleftarrow$ to confirm the selection.

```
          REX610          !A
  ────────────

  Edit group:  ⇕+_2

  Active group=1
```
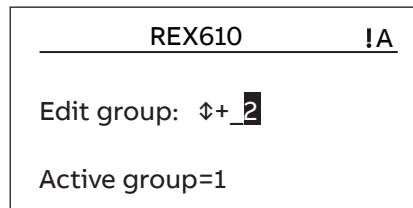
Figure 55:   Selecting a setting group

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 ⟩.
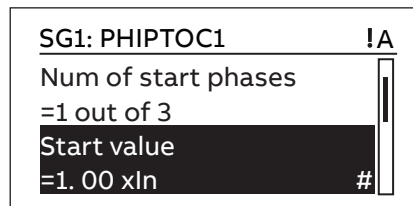   The setting group values are indicated with #.

```
  SG1: PHIPTOC1          !A
  Num of start phases
  =1 out of 3
  Start value
  =1. 00 xln            #
```

Figure 56:   Setting group parameter

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

```
  SG1: Start value       !A
  *[1]=1. 00 xln
   [2]=1. 00 xln
   [3]=1. 00 xln
   [4]=1. 00 xln
```
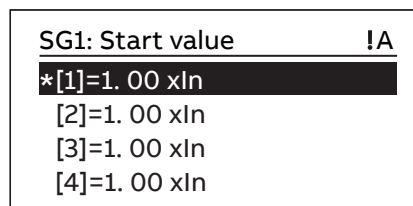
Figure 57:   Selecting the setting group value

Only values within the selected setting group can be changed.

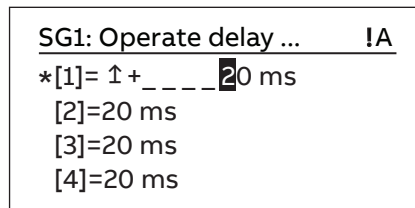7. Press ⌃ or ⌄ to change the value and ↵ to confirm the selection.

```
SG1: Operate delay ...      !A
*[1]= ⇕ +_ _ _ _ 2̲0 ms
  [2]=20 ms
  [3]=20 ms
  [4]=20 ms
```

Figure 58:   *Editing the setting group value*

The active setting group is indicated with an asterisk * .

> ℹ️ 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 ↵.
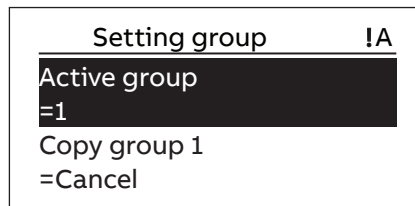
```
Setting group        !A
Active group
=1
Copy group 1
=Cancel
```

Figure 59:   *Active setting group*

2. Select the setting group with ⌃ or ⌄.
3. Press ↵ to confirm the selection or ESC to cancel.

```
Setting group        !A
Active group
= ⇕ + _1̲
Copy group 1
=Cancel
```
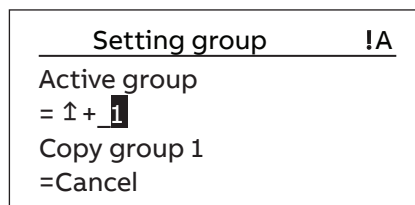
Figure 60:   *Selecting the active setting group*

4. Commit the settings.

Remember to document the changes made.

8.4.4.2 Relay parametrization

Protection relay parameters are set via the LHMI 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.

8.4.4.3 Defining disturbance recorder channel settings

1. Select **Main Menu/Configuration/Disturbance recorder**.
2. Select one of the alternatives.
   - **General**
   - **A1RADR**
   - **B1RBDR**
3. Press ⌃ or ⌄ to select the wanted channel and parameter.
4. 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.

8.4.4.4 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.

8.5 Testing of 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.

8.5.1 Changing control authority

Control authority must be set to "Local" to enable changing of test mode from the LHMI.

1. Select **Main menu/Configuration/Control/General/LR control** and press ↵.
2. Select the LR control status with ⌃ or ⌄.
3. Select **Setting based** and press ↵ to confirm the selection.
4. Select **Main menu/Configuration/Control/General/Control authority** and press ↵.
5. Select the Control authority status with ⌃ or ⌄.
6. Select **Local** and press ↵ to confirm the selection.

8.5.2 Selecting 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. The test mode can be changed from the LHMI if *Control authority* is set to "Local". Activation by remote client is possible, see the technical manual.

> ℹ️ 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 ↵.
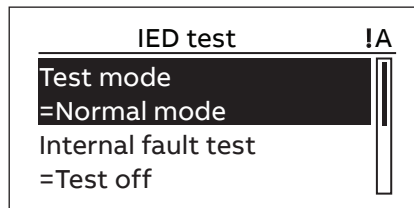
Figure 61:   *Entering test mode*

2.   Select the test mode status with $\wedge$ or $\vee$.

3.   Press $\hookleftarrow$ to confirm the selection.

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

8.5.3   Testing digital I/O interface

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

1.   Select **Main menu/Tests/Binary outputs/PSUAGGIO/<output>** and press $\hookleftarrow$.

2.   Select the value with $\wedge$ or $\vee$.

3.   Press $\hookleftarrow$ to confirm the selection.

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

8.5.4   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 $\hookleftarrow$.

2.   Select the output signal to be activated or deactivated with $\wedge$ or $\vee$ and press $\hookleftarrow$.

3.   To deactivate all output signals for the function, select `Reset` with $\wedge$ or $\vee$ and press $\hookleftarrow$.

8.5.5   Selecting 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 ↵.


```
         IED test            ! A
       ─────────────────────────
       Test mode
       =Normal mode
       Internal fault test
       =Test off
```
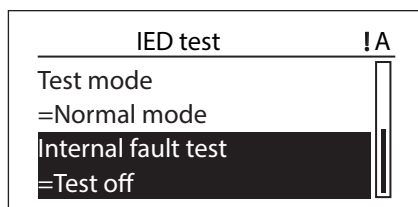
Figure 62:   *Internal fault test*

2. Select the value with ∧ or ∨.
3. Press ↵ to confirm the selection.

8.5.6   Selecting 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. The test mode can be changed from the LHMI if *Control authority* is set to "Local". 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 ↵.

IED test   **!** A

Internal fault test
=Test off
Remote test mode
=Off
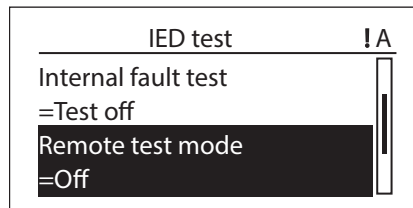
Figure 63:   Entering IED blocked or IED test and blocked mode

2.   Select the test mode status with ⌃ or ⌄. Press ⏎ to confirm the selection.

> ℹ️   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.

8.6   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.

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 number of composition changes can be seen from the *Composition changes* parameter in **Main Menu/Monitoring/IED status**. Composition changes increment for firmware updates and site information changes.

Section 9   Glossary

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.
CT	Current transformer
DC	1. Direct current
	2. Disconnector
	3. Double command
DST	Daylight-saving time
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
FTP	File transfer protocol
FTPS	FTP Secure
HMI	Human-machine interface
HW	Hardware
IEC	International Electrotechnical Commission
IEC 61850	International standard for substation communication and modeling
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
LAN	Local area network
LCD	Liquid crystal display
LED	Light-emitting diode
LHMI	Local human-machine interface
Modbus RTU	Link mode using 8-bit binary characters
MTP	Media transfer protocol
NCC	Network control center
PC	1. Personal computer
	2. Polycarbonate
PCM600	Protection and Control IED Manager
R/L	Remote/Local
RAM	Random access memory
RJ-45	Galvanic connector type
RoHS	Restriction of hazardous substances
RS-232	Serial interface standard
RS-485	Serial link according to EIA standard RS485
SI	Sensor input
SNTP	Simple Network Time Protocol
STP	Shielded twisted-pair
Subnet mask	A set of four numbers used to create IP address numbers that are used only within a particular network, subnet
SW	Software
TCP	Transmission Control Protocol
UART	Universal asynchronous receiver-transmitter
UDP	User datagram protocol
USB	Universal serial bus
UTC	Coordinated universal time
VT	Voltage transformer
WAN	Wide area network

ABB

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