RELION® 670 SERIES
670 series
Version 2.1 ANSI
Operation manual
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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 2004/108/EC) and concerning electrical equipment for use within specified voltage limits (Low-voltage directive 2006/95/EC). This conformity is the result of tests conducted by ABB 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 and ANSI C37.90.
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Section 1 Introduction

1.1 This manual

The operation manual contains instructions on how to operate the IED once it has been commissioned. The manual provides instructions for the monitoring, controlling and setting of the IED. 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 IED on a daily basis.

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

1.3.1 Product documentation set

The engineering manual contains instructions on how to engineer the IEDs using the various tools available within the PCM600 software. The manual provides instructions on how to set up a PCM600 project and insert IEDs to the project structure. The manual also recommends a sequence for the engineering of protection and control functions, LHMI functions as well as communication engineering for IEC 60870-5-103, IEC 61850, DNP3, LON and SPA.

The installation manual contains instructions on how to install the IED. The manual provides procedures for mechanical and electrical installation. The chapters are organized in the chronological order in which the IED should be installed.

The commissioning manual contains instructions on how to commission the IED. The manual can also be used by system engineers and maintenance personnel for assistance during the testing phase. The manual provides procedures for the checking of external circuitry and energizing the IED, parameter setting and configuration as well as verifying settings by secondary injection. The manual describes the process of testing an IED in a substation which is not in service. The chapters are organized in the chronological order in which the IED should be commissioned. The relevant procedures may be followed also during the service and maintenance activities.
The operation manual contains instructions on how to operate the IED once it has been commissioned. The manual provides instructions for the monitoring, controlling and setting of the IED. 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.

The application manual contains application descriptions and setting guidelines sorted per function. The manual can be used to find out when and for what purpose a typical protection function can be used. The manual can also provide assistance for calculating settings.

The technical manual contains operation principle descriptions, and lists function blocks, logic diagrams, input and output signals, setting parameters and technical data, sorted per function. The manual can be used as a technical reference during the engineering phase, installation and commissioning phase, and during normal service.

The communication protocol manual describes the communication protocols supported by the IED. The manual concentrates on the vendor-specific implementations.

The point list manual describes the outlook and properties of the data points specific to the IED. The manual should be used in conjunction with the corresponding communication protocol manual.

The cyber security deployment guideline describes the process for handling cyber security when communicating with the IED. Certification, Authorization with role based access control, and product engineering for cyber security related events are described and sorted by function. The guideline can be used as a technical reference during the engineering phase, installation and commissioning phase, and during normal service.

### Document revision history

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### Related documents

#### Documents related to REB670

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1.4 Document 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 hot surface icon indicates important information or warning about the temperature of product surfaces.

Class 1 Laser product. Take adequate measures to protect the eyes and do not view directly with optical instruments.

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. It is important that the user fully complies with all warning and cautionary notices.

1.4.2 Document conventions

- Abbreviations and acronyms in this manual 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.
  For example, to navigate between the options, use ↑ and ↓.
- HMI menu paths are presented in bold.
  For example, select **Main menu/Settings**.
- LHMI messages are shown in Courier font.
  For example, to save the changes in non-volatile memory, select Yes and press ↵.
- Parameter names are shown in italics.
  For example, the function can be enabled and disabled with the *Operation* setting.
- Each function block symbol shows the available input/output signal.
  - the character ^ in front of an input/output signal name indicates that the signal name may be customized using the PCM600 software.
  - the character * after an input signal name indicates that the signal must be connected to another function block in the application configuration to achieve a valid application configuration.
- Dimensions are provided both in inches and millimeters. If it is not specifically mentioned then the dimension is in millimeters.
Section 2  Safety information

2.1  Symbols on the product

All warnings must be observed.

Read the entire manual before doing installation or any maintenance work on the product. All warnings must be observed.

Class 1 Laser product. Take adequate measures to protect your eyes and do not view directly with optical instruments.

Do not touch the unit in operation. The installation shall take into account the worst case temperature.

2.2  Warnings

Observe the warnings during all types of work related to the product.

Only electrically skilled persons with the proper authorization and knowledge of any safety hazards are allowed to carry out the electrical installation.

National and local electrical safety regulations must always be followed. Working in a high voltage environment requires serious approach to avoid human injuries and damage to equipment.

Do not touch circuitry during operation. Potentially lethal voltages and currents are present.
Always use suitable isolated test pins when measuring signals in open circuitry. Potentially lethal voltages and currents are present.

Never connect or disconnect a wire and/or a connector to or from an IED during normal operation. Hazardous voltages and currents are present that may be lethal. Operation may be disrupted and IED and measuring circuitry may be damaged.

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

Always connect the IED to protective ground, regardless of the operating conditions. This also applies to special occasions such as bench testing, demonstrations and off-site configuration. This is class 1 equipment that shall be grounded.

Never disconnect the secondary connection of current transformer circuit without short-circuiting the transformer’s secondary winding. Operating a current transformer with the secondary winding open will cause a massive potential build-up that may damage the transformer and may cause injuries to humans.

Never remove any screw from a powered IED or from a IED connected to powered circuitry. Potentially lethal voltages and currents are present.

Take adequate measures to protect the eyes. Never look into the laser beam.

The IED with accessories should be mounted in a cubicle in a restricted access area within a power station, substation or industrial or retail environment.

### 2.3 Caution signs

Whenever changes are made in the IED, measures should be taken to avoid inadvertent tripping.
The IED contains components which are sensitive to electrostatic discharge. ESD precautions shall always be observed prior to touching components.

Always transport PCBs (modules) using certified conductive bags.

Do not connect live wires to the IED. Internal circuitry may be damaged.

Always use a conductive wrist strap connected to protective ground when replacing modules. Electrostatic discharge (ESD) may damage the module and IED circuitry.

Take care to avoid electrical shock during installation and commissioning.

Changing the active setting group will inevitably change the IEDs operation. Be careful and check regulations before making the change.

Avoid touching the enclosure of the coupling capacitor REX061 unit and the shunt resistor REX062 unit. The surface may be hot during normal operation. The temperature can rise 50°C in REX061 and 65°C in REX062 above the ambient temperature.

### 2.4 Note signs

Observe the maximum allowed continuous current for the different current transformer inputs of the IED. See technical data.
Section 3 Environmental aspects

3.1 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 IED.

Operational reliability and long life time have been assured 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.

3.2 Disposing of the IED

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 an IED or its parts contact a local waste handler who is authorized and specialized in disposing electronic waste. These handlers can sort the material by using dedicated sorting processes and dispose of the product according to the local requirements.

Table 1: Materials of the IED parts

<table>
<thead>
<tr>
<th>IED</th>
<th>Parts</th>
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<tbody>
<tr>
<td>Unit</td>
<td>Metallic plates, parts and screws</td>
<td>Steel</td>
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<tr>
<td></td>
<td>Plastic parts</td>
<td>PC&lt;sup&gt;1)&lt;/sup&gt;, LCP&lt;sup&gt;2)&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>LHMI display module</td>
<td>Various</td>
</tr>
<tr>
<td>Package</td>
<td>Box</td>
<td>Cardboard</td>
</tr>
<tr>
<td>Attached material</td>
<td>Manuals</td>
<td>Paper</td>
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</tbody>
</table>

1) Polycarbonate
2) Liquid crystal polymer
Section 4 Overview

4.1 Local HMI

Figure 2: Local human-machine interface

The LHMI of the IED contains the following elements:
- Keypad
- Display (LCD)
- LED indicators
- Communication port for PCM600

The LHMI is used for setting, monitoring and controlling.

### 4.1.1 Display

The LHMI includes a graphical monochrome liquid crystal display (LCD) with a resolution of 320 x 240 pixels. The character size can vary.

The display view is divided into four basic areas.

![Display layout](image)

*Figure 3: Display layout*

1. Path
2. Content
3. Status
4. Scroll bar (appears when needed)
- The path shows the current location in the menu structure. If the path is too long to be shown, it is truncated from the beginning, and the truncation is indicated with three dots.
- The content area shows the menu content.
- The status area shows the current IED time, the user that is currently logged in and the object identification string which is settable via the LHMI or with PCM600.
- If text, pictures or other items do not fit in the display, a vertical scroll bar appears on the right. The text in content area is truncated from the beginning if it does not fit in the display horizontally. Truncation is indicated with three dots.

![Menu configuration]

**Figure 4: Truncated path**

The number after : (colon sign) at the end of the function instance, for example, 1 in SMAI1:1, indicates the number of that function instance.

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

The function key button panel shows on request what actions are possible with the function buttons. Each function button has a LED indication that can be used as a feedback signal for the function button control action. The LED is connected to the required signal with PCM600.
Figure 5: Function button panel
The indication LED panel shows on request the alarm text labels for the indication LEDs. Three indication LED pages are available.

Figure 6: Indication LED panel
The function button and indication LED panels are not visible at the same time. Each panel is shown by pressing one of the function buttons or the Multipage button. Pressing the ESC button clears the panel from the display. Both panels have a dynamic width that depends on the label string length.

4.1.2 LEDs
The LHMI includes three protection status LEDs above the display: Normal, Pickup and Trip.
There are 15 programmable indication LEDs on the front of the LHMI. Each LED can indicate three states with the colors: green, yellow and red. The texts related to each three-color LED are divided into three panels and can be browsed with the Multipage button.

There are 3 separate panels of LEDs available. The 15 physical three-color LEDs in one LED group can indicate 45 different signals. Altogether, 135 signals can be indicated since there are three LED groups. The LEDs are lit according to priority, with red being the highest and green the lowest priority. For example, if on one panel there is an indication that requires the green LED to be lit, and on another panel there is an indication that requires the red LED to be lit, the red LED takes priority and is lit. The LEDs can be configured with PCM600 and the operation mode can be selected with the LHMI or PCM600.

Information panels for the indication LEDs are shown by pressing the Multipage button. Pressing that button cycles through the three pages. A lit or un-acknowledged LED is indicated with a highlight. Such lines can be selected by using the Up/Down arrow buttons. Pressing the Enter key shows details about the selected LED. Pressing the ESC button exits from information pop-ups as well as from the LED panel as such.

The Multipage button has a LED. This LED is lit whenever any LED on any panel is lit. If there are un-acknowledged indication LEDs, then the Multipage LED blinks. To acknowledge LEDs, press the Clear button to enter the Reset menu (refer to description of this menu for details).

There are two additional LEDs which are next to the control buttons and . They can, for example, represent the status of a circuit breaker. The LEDs are controlled by the function block OPENCLOSE_LED which must be configured to show the status of the breaker.

### 4.1.3 Keypad

The LHMI keypad contains push-buttons which are used to navigate in different views or menus. The push-buttons are also used to acknowledge alarms, reset indications, provide help and switch between local and remote control mode.

The keypad also contains programmable push-buttons that can be configured either as menu shortcut or control buttons.
Figure 7: LHMI keypad with object control, navigation and command push-buttons and RJ-45 communication port

1...5 Function button
6 Close
7 Open
8 Escape
9 Left
10 Down
11 Up
12 Right
13 Key
14 Enter
15 Remote/Local
16 Uplink LED
17 Not in use
18 Multipage
19 Menu
20 Clear
21 Help
Object control

If the control position of the IED is set to local with the R/L button, the controlled objects can be opened and closed using the object control buttons.

Object to be controlled is selected from the single line diagram.

Table 2: Object control push-buttons

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Close</td>
<td>Closing the object. The LED indicates the current object state.</td>
</tr>
<tr>
<td>Open</td>
<td>Opening the object. The LED indicates the current object state.</td>
</tr>
</tbody>
</table>

Navigation

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

Table 3: Navigation push-buttons

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESC</td>
<td>• Leaving setting mode without saving the values. • Cancelling certain actions. • Adjusting the display contrast in combination with ↑ or ↓. • Running the display test in combination with . • Deleting a character in combination with when editing a string. • Inserting a space in combination with when editing a string.</td>
</tr>
<tr>
<td>Enter</td>
<td>• Entering parameter setting mode. • Confirming a new value of a setting parameter. • Confirming selection in dialogs and alarm panel.</td>
</tr>
<tr>
<td>Up</td>
<td>• Moving up and down in menus. • Selecting objects in the SLD. • Moving selection in dialogs and alarm panel. • Scrolling active digits of a parameter when entering a new setting value.</td>
</tr>
<tr>
<td>Down</td>
<td>• Moving left and right in menus. • Selecting pages in the SLD. • Changing the active digit of a parameter when entering a new setting value.</td>
</tr>
<tr>
<td>Left</td>
<td>• Activating the authorization procedure, when the user is not logged in. • Logging out, when the user is currently logged in.</td>
</tr>
<tr>
<td>Right</td>
<td></td>
</tr>
</tbody>
</table>
Commands

Table 4: Command push-buttons

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
</table>
| Menu | • Moving directly to Main menu, if currently in any other menu or view.  
     | • Moving to the default view, if currently in Main menu. |
| R/L  | Changing the control position (remote or local) of the device.  
     | • When the R LED is lit, remote control is enabled and local control disabled.  
     | • When the L LED is lit, local control is enabled and remote control disabled.  
     | • When none of the LEDs are lit, both control positions are disabled. |
| Clear| • Activating the Clear/Reset view. |
| Help | Showing the help menu. |
| Multipage | Opening alarm panel and selecting alarm page from the view. |

Function buttons

Table 5: Function buttons

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function button</td>
<td>Executing the defined function: OFF, menu short cut or binary control.</td>
</tr>
</tbody>
</table>

4.1.4 Local HMI functionality

4.1.4.1 Protection and alarm indication

Protection indicators

The protection indicator LEDs are Normal, Pickup and Trip.

Table 6: Normal LED (green)

<table>
<thead>
<tr>
<th>LED state</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off</td>
<td>Auxiliary supply voltage is disconnected.</td>
</tr>
<tr>
<td>On</td>
<td>Normal operation.</td>
</tr>
<tr>
<td>Flashing</td>
<td>Internal fault has occurred.</td>
</tr>
</tbody>
</table>
Table 7: PickUp LED (yellow)

<table>
<thead>
<tr>
<th>LED state</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off</td>
<td>Normal operation.</td>
</tr>
<tr>
<td>On</td>
<td>A protection function has picked up and an indication message is displayed. The pick up indication is latching and must be reset via communication, LHMI or binary input on the LEDGEN component. To open the reset menu on the LHMI, press .</td>
</tr>
<tr>
<td>Flashing</td>
<td>The IED is in test mode and protection functions are blocked, or the IEC61850 protocol is blocking one or more functions. The indication disappears when the IED is no longer in test mode and blocking is removed. The blocking of functions through the IEC61850 protocol can be reset in Main menu/Test/Reset IEC61850 Mod. The yellow LED changes to either On or Off state depending on the state of operation.</td>
</tr>
</tbody>
</table>

Table 8: Trip LED (red)

<table>
<thead>
<tr>
<th>LED state</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off</td>
<td>Normal operation.</td>
</tr>
<tr>
<td>On</td>
<td>A protection function has tripped. An indication message is displayed if the auto-indication feature is enabled in the local HMI. The trip indication is latching and must be reset via communication, LHMI or binary input on the LEDGEN component. To open the reset menu on the LHMI, press .</td>
</tr>
<tr>
<td>Flashing</td>
<td>Configuration mode.</td>
</tr>
</tbody>
</table>

**Alarm indicators**

The 15 programmable three-color LEDs are used for alarm indication. An individual alarm/status signal, connected to any of the LED function blocks, can be assigned to one of the three LED colors when configuring the IED.

Table 9: Alarm indications

<table>
<thead>
<tr>
<th>LED state</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off</td>
<td>Normal operation. All activation signals are off.</td>
</tr>
</tbody>
</table>
| On        | • Follow-S sequence: The activation signal is on.  
            • LatchedColl-S sequence: The activation signal is on, or it is off but the indication has not been acknowledged.  
            • LatchedAck-F-S sequence: The indication has been acknowledged, but the activation signal is still on.  
            • LatchedAck-S-F sequence: The activation signal is on, or it is off but the indication has not been acknowledged.  
            • LatchedReset-S sequence: The activation signal is on, or it is off but the indication has not been acknowledged. |
| Flashing  | • Follow-F sequence: The activation signal is on.  
            • LatchedAck-F-S sequence: The activation signal is on, or it is off but the indication has not been acknowledged.  
            • LatchedAck-S-F sequence: The indication has been acknowledged, but the activation signal is still on. |
4.1.4.2 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.

4.1.4.3 Front communication

The RJ-45 port in the LHMI enables front communication.

- The green uplink LED on the left is lit when the cable is successfully connected to the port.
- The yellow LED is not used; it is always off.

Figure 8: RJ-45 communication port and green indicator LED

1 RJ-45 connector
2 Green indicator LED

The default IP address for the IED front port is 10.1.150.3 and the corresponding subnetwork mask is 255.255.255.0. It can be set through the local HMI path Main menu/Configuration/Communication/Ethernet configuration/Front:1.

Do not connect the IED front port to a LAN. Connect only a single local PC with PCM600 to the front port. It is only intended for temporary use, such as commissioning and testing.

4.1.4.4 Single-line diagram
4.2 Authorization

User roles with different user rights are predefined in the IED. It is recommended to use user defined users instead of the predefined built-in users.

The IED users can be created, deleted and edited only with PCM600. One user can belong to one or several user roles. By default, the users in Table 10 are created in the IED, and when creating new users, the predefined roles from Table 11 can be used.

At delivery, the IED user has full access as SuperUser until users are created with PCM600.

Table 10: Default users

<table>
<thead>
<tr>
<th>User name</th>
<th>User rights</th>
</tr>
</thead>
<tbody>
<tr>
<td>SuperUser</td>
<td>Full rights, only presented in LHMI. LHMI is logged on by default until other users are defined</td>
</tr>
<tr>
<td>Guest</td>
<td>Only read rights, only presented in LHMI. LHMI is logged on by default when other users are defined (same as VIEWER)</td>
</tr>
<tr>
<td>Administrator</td>
<td>Full rights. Password: Administrator. This user has to be used when reading out disturbances with third party FTP-client</td>
</tr>
</tbody>
</table>

Table 11: Predefined user roles according to IEC 62351-8

<table>
<thead>
<tr>
<th>User roles</th>
<th>Role explanation</th>
<th>User rights</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIEWER</td>
<td>Viewer</td>
<td>Can read parameters and browse the menus from LHMI</td>
</tr>
<tr>
<td>OPERATOR</td>
<td>Operator</td>
<td>Can read parameters and browse the menus as well as perform control actions</td>
</tr>
<tr>
<td>ENGINEER</td>
<td>Engineer</td>
<td>Can create and load configurations and change settings for the IED and also run commands and manage disturbances</td>
</tr>
</tbody>
</table>
### User roles

<table>
<thead>
<tr>
<th>User roles</th>
<th>Role explanation</th>
<th>User rights</th>
</tr>
</thead>
<tbody>
<tr>
<td>INSTALLER</td>
<td>Installer</td>
<td>Can load configurations and change settings for the IED</td>
</tr>
<tr>
<td>SECADM</td>
<td>Security administrator</td>
<td>Can change role assignments and security settings. Can deploy certificates.</td>
</tr>
<tr>
<td>SECAUD</td>
<td>Security auditor</td>
<td>Can view audit logs</td>
</tr>
<tr>
<td>RBACMNT</td>
<td>RBAC management</td>
<td>Can change role assignment</td>
</tr>
<tr>
<td>ADMINISTRATOR</td>
<td>Administrator rights</td>
<td>Sum of all rights for SECADM, SECAUD and RBACMNT</td>
</tr>
</tbody>
</table>

This User role is vendor specific and not defined in IEC 62351–8

### Changes in user management settings do not cause an IED reboot.

### After three consecutive failed login attempts the user will be locked out for ten minutes before a new attempt to log in can be performed. This time is settable 10 minutes to 60 minutes.

### The PCM600 tool caches the login credentials after successful login for 15 minutes. During that time no more login will be necessary.

### Table 12: Authority-related IED functions

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authority status ATHSTAT</td>
<td>This function is an indication function block for user logon activity. User denied attempt to log-on and user successful logon are reported.</td>
</tr>
</tbody>
</table>
| Authority check ATHCHCK | To safeguard the interests of our customers, both the IED and the tools that are accessing the IED are protected, by means of authorization handling. The authorization handling of the IED and the PCM600 is implemented at both access points to the IED:  
  - local, through the local HMI  
  - remote, through the communication ports  
  The IED users can be created, deleted and edited only in the CAM server. |
| Authority management AUTHMAN | This function enables/disables the maintenance menu. It also controls the maintenance menu log on time out. |

For more information on Authority management AUTHMAN, Authority status ATHSTAT, and Authority check ATHCHCK functions, see Chapter Basic IED functions in technical manual.
At delivery, the IED has a default user defined with full access rights. PCM600 uses this default user to access the IED. This user is automatically removed in IED when users are defined via the IED Users tool in PCM600.

Default User ID: Administrator
Password: Administrator

It is strongly recommended to define users via the IED Users tool in PCM600.

Only characters A - Z, a - z and 0 - 9 shall be used in user names. User names are not case sensitive. For passwords see the Password policies in PCM600.

See the Cyber security guideline for information on cyber security.

4.3 Communication

The IED supports the following communication protocols: IEC 61850-8-1, IEC 61850–9–2LE, SPA, IEC 60870-5-103, LON and DNP3.

REB670 IED do not support IEC 61850–9–2LE communication protocol.

All operational information and controls are available through these protocols. However, some communication functionality, for example, horizontal communication between the IEDs, is only enabled by the IEC 61850-8-1 communication protocol (GOOSE) and as Network Variables on LON.

The serial communication follows the EIA-485 standard and is intended to be used in multi-point communication.

Disturbance files are accessed using the IEC 61850, IEC 60870-5-103, DNP, SPA, LON or FTP protocols. The disturbances are in COMTRADE format. The IED can send binary signals to other IEDs (so called horizontal communication) using the IEC 61850-8-1 GOOSE (Generic Object Oriented Substation Event) profile or through LON network variables. Binary GOOSE messaging can, for example, be employed for protection and interlocking-based protection schemes.

The IED meets the GOOSE performance requirements for tripping applications in transmission substations, as defined by the IEC 61850 standard. Further, the IED supports the sending and receiving of analog values using GOOSE messaging. Analog GOOSE messaging enables fast transfer of analog measurement values over the station bus.

The IED interoperates with other IEC 61850 compliant IEDs, tools and systems and simultaneously reports events to eight different clients on the IEC 61850 station bus. For a system using DNP3 over TCP/IP, events can be sent to four different masters. For systems using IEC 60870-5-103 IED can be connected to one master in a station bus with star-topology.

The IED has a number of communication ports which support different protocols:
<table>
<thead>
<tr>
<th>Communication media</th>
<th>Protocols supported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethernet (fiber-optic multimode ST connector, i.e. 100BASE-FX)</td>
<td>IEC 61850, DNP3, FTP</td>
</tr>
<tr>
<td>Optical Serial port (glass with ST-connector, or plastic with HFBR Snap-in connector)</td>
<td>IEC 60870-5-103, DNP3, SPA</td>
</tr>
<tr>
<td>Optical LON port (glass with ST-connector, or plastic with HFBR Snap-in connector)</td>
<td>LON</td>
</tr>
<tr>
<td>RS485</td>
<td>IEC 60870-5-103, DNP3</td>
</tr>
</tbody>
</table>

The IED supports GPS, IRIG-B, PPS, SNTP or Binary time synchronization methods with a time-stamping resolution of 1 ms or better. Alternative time synchronization methods are LON, SPA, DNP or IED 60870-5-103.

4.4 PCM600 tool

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

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

When using PCM600 for writing to the IED, ensure that the LHMI is not in a menu position where settings can be made. Only one active transaction, from LHMI or PCM600, is allowed at a time.

With the individual tool components, you can perform different tasks and functions and control the whole substation. PCM600 can operate with many different topologies, depending on the customer needs.

For more information, see PCM600 documentation.

4.4.1 Connectivity packages

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

A connectivity package includes all of the data which is used to describe the IED, for example, it contains a list of the existing parameters, data format used, units, setting range, access rights and visibility of the parameter. In addition, it contains code which allows software packages that consume the connectivity package to properly communicate with the IED. It also allows for localization of text even when its read from the IED in a standard format such as COMTRADE.
Update Manager is a tool that helps in defining the right connectivity package versions for different system products and tools. Update Manager is included with products that use connectivity packages. Update Manager is a part of PCM and is delivered with it.
Section 5  Using the HMI

5.1 Using the local HMI

At delivery, logging on is not required and the user has full access until users and passwords are created with PCM600 and written into the IED or Centralized Account Management is enabled.

Commands, changing parameter values and resetting indications, for example, are actions requiring password when the password protection is activated. Reading information on the LHMI is always allowed without password.

Utility security policies and practical consideration should always be taken on the feasibility of using passwords. In emergency situations, the use of passwords could delay urgent actions. On the other hand when security issues must be met, the two factors must be seriously considered.

Do not switch off the auxiliary power supply to the IED before changes, for example, setting parameter or local/remote control state changes are saved.

Figure 10: Saving changes animation
Parameter saving is indicated by an animation in the lower right of the screen. As long as this animation is shown, saving is in progress.

5.1.1 On-screen keyboard

The on-screen keyboard is a three-row button pad where all the visual ASCII characters are selectable buttons. The editing location is marked with a cursor.

Figure 11: On-screen keyboard
• To insert a character navigate to the desired character in the middle three key rows with ↑, ↓, ← and → and confirm each character with →.
• To delete a character press Del or use the Backspace key on the on-screen keyboard.
• To clear a whole string press ESC and then Del.

5.1.2 Logging on

1. Press → to activate the login procedure. The login is also activated when attempting a password-protected operation.
2. Press → to activate the User field.
   If CAM is activated an on-screen keyboard is shown.
3. Type in the user name using the on-screen keyboard.
   You can end user name editing at any time by pressing → while the user field is focused (or navigate to the OK button and press →), or press Del (or navigate to the Cancel button and press →) to abort the login attempt.
   If CAM is not activated select the user by scrolling with ↑ and ↓, and press → to confirm.

4. Select OK on the on-screen keyboard and press → to stop editing the user name.
5. Press ↓ to select the Password field and press → to activate it. An on-screen keyboard is shown.

Each added character is shown for a short time, then hidden with an asterisk character ‘*’ to enhance security. You can end password editing at any time by pressing → while the password field is focused (or navigate to the OK button and press →) to attempt to login, or press Del (or navigate to the Cancel button and press →) to abort the login attempt. When the cursor is moved, the newly selected character is shown for a short time.
6. Type in the password using the on-screen keyboard.

<table>
<thead>
<tr>
<th>Log on</th>
</tr>
</thead>
<tbody>
<tr>
<td>User:</td>
</tr>
<tr>
<td>Password:</td>
</tr>
<tr>
<td>OK</td>
</tr>
</tbody>
</table>

![Figure 13: Entering the password](IEC12000157-3-en.vsd)

Passwords are case sensitive.

Only characters A - Z, a - z and 0 - 9 shall be used in user names. User names are not case sensitive. For passwords see the Password policies in PCM600.

7. Select **OK** on the on-screen keyboard and press **Esc** to stop editing the password.

8. Select **OK** in the *Log on* dialog and press **Esc** to confirm the login, or press **Esc** or **Cancel** to cancel the procedure.

If the login fails, a message is displayed on the display.

![Figure 14: Error message indicating an incorrect password](IEC12000158 .vsdx)

If a false password is entered three times, the login is blocked for that ID and the following message is displayed:

![Figure 15: Error message indicating blocked ID](IEC13000283-1-en.vsd)
The logon dialog appears if the attempted operation requires another level of user rights.

Once a user is created and written into the IED, login is possible with the password assigned in the tool. If there is no user created, an attempt to login causes the display to show a corresponding message.

**Figure 16: No user defined**

### 5.1.3 Logging off

The user is automatically logged off after the display timeout. The IED returns to a state where only reading is enabled. Manual logoff is also possible.

1. Press \[ \rightarrow \].
2. To confirm logoff, select Yes and press \[ \rightarrow \].

**Figure 17: Logging off**

- To cancel logoff, press \[ ESC \].

### 5.1.4 Turning the display backlight on

The display backlight is normally off. It turns on 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 after the display backlight has turned off. The factory default for display timeout is 10 minutes. The minimum is 1 minute.

The display returns to the default view and all unconfirmed operations, for example parameter editing and breaker selection are cancelled.
5.1.5 Selecting local or remote use

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

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

The control position cannot be simultaneously local and remote but it can be disabled when neither of the positions is active.

To control the IED, log in with the appropriate user rights.

5.1.6 Identifying the device

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

1. Select Main menu/Diagnostics/IED Status/Product identifiers.
2. Select a submenu with ▼ and ▲.
3. Enter the submenu with ➩. 
4. Browse the information with ↑ and ↓.

5.1.7 Adjusting the 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 ↓.

The display contrast is not stored in any memory if changed using the keys from local HMI. After an auxiliary power failure, the display contrast is restored to set value for parameter ContrastLevel.

Set the parameter ContrastLevel via Main menu/Configuration/HMI/Screen/SCREEN:1 to permanently change the display contrast.

5.1.8 Changing the local HMI language

1. Select Main menu/Language/LANGUAGE:1 and press ➩.
2. Change the language using ↑ or ↓.
3. Press ➩ to confirm the selection.
4. Commit the changes.
5.1.9 Navigating in the menu

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.

5.1.9.1 Menu structure

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

- Control
- Events
- Measurements
- Disturbance records
- Settings
- Configuration
- Diagnostics
- Test
- Clear
- Authorization (only if authority is activated)
- Language

5.1.9.2 Scrolling the display

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

![Scroll bar on the right](IEC13000292-1-en.vsd)

Figure 20: 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.

5.1.9.3 Changing the default view

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

1. Select **Main menu/Configuration/HMI/Screen/SCREEN:1** and press →.
2. Change the default view with ↑ or ↓.
3. Press ← to confirm the selection.

5.1.10 Using function buttons

The function buttons can be configured either as menu shortcuts or control buttons. The buttons are functional only when the function button panel is visible.

1. Press any function button to open the function button panel. On the first press of a button, the panel opens but no other action is taken.

   ![Function button panel]

   *Figure 21: Function button panel*

2. Press the wanted function button.
   - Press the wanted function button to jump to a certain menu item. The menu opens immediately upon pressing the button.
   - Press the wanted function button for at least 0.5 s to initiate a control signal. The action is taken once.
To repeat the action, press the button again. If the button is pressed less than 0.5 s, no action is taken.

3. Press \( \text{B} \) to close the function button panel.
   The panel is also closed after pressing a function button configured for a menu shortcut.

The function buttons are configured with PCM600.

**5.1.11 Using the single-line diagram**

The single-line diagram is created with PCM600.

1. Select **Main menu/Control/Single line diagram**.
   The single-line diagram view is displayed.

   ![Single-line diagram](image)

   *Figure 22: Example of a single-line diagram*

2. Select an object with \( \uparrow \) or \( \downarrow \).
   Selection of an object is indicated with a square border that moves when \( \uparrow \) and \( \downarrow \) are used.
   Switch objects can have additional icons that present the switch object states.
   - \( \text{!} \) = Switch object is in substituted state.
   - \( \text{!} \) = Switch object is interlocked.

3. Press \( \text{O} \) to select open or \( \text{C} \) to select close the object.
4. Confirm the control operation in the dialog that opens.
5. To move between the single-line diagram pages, press \( \text{s} \) or \( \text{t} \).

Select the single-line diagram for the default view in **Main menu/Configuration/HMI/Screen/SCREEN:1/DefaultScreen**.
5.1.12 Browsing setting values

1. Select Main menu/Settings/IED Settings and press ➡.
2. Press ↑ and then ➡ to activate the setting group number selection.

![Edit setting group](IEC13000241-1-en.vsd)

**Figure 23: Selecting the setting group number**

3. Press ↑ or ↓ to select the setting group number.
4. Press ➡ to confirm the setting group selection and ↓ to return to the Edit setting group dialog.
5. Press ➡ to select Yes and to view the setting group values.
   - Press ← or → to select No and → to exit.

![Edit setting group](IEC13000054-2-en.vsd)

**Figure 24: Selecting a setting group**

6. To browse the settings, scroll the list with ↑ and ↓ and to select a setting press ➡. To move back to the list, press ←.

![Selecting settings](IEC13000265-1-en.vsd)

**Figure 25: Selecting settings**

The content of the list depends on the pre-configuration or on the functions configured with PCM600.
5.1.13 Editing values

- To edit values, log in with the appropriate user rights. If the user rights are not sufficient for editing values, the login dialog opens.

5.1.13.1 Editing numerical values

1. Select **Main menu/Settings** and then a setting. The last digit of the value is active.

![Image of numerical settings](image)

**Figure 26**: Last digit is active and it can be increased or decreased

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

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

3. Press ← or → to move the cursor to another digit.

4. To select the minimum or maximum value, select the arrow symbol in front of the value.

    - To set the value to the maximum, press ↑
    - To set the value to the minimum, press ↓

If the value is already at either end value (minimum or maximum), it requires two presses to change it to the opposite end value. 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.
5.1.13.2 Editing string values

Unicode characters that are not found on the on-screen keyboard can be used if the string is edited in PCM600. This string can be shown and edited on the HMI but if a character that is not found on the on-screen keyboard is deleted it cannot be retrieved using the HMI.

1. Activate the setting mode and select a setting.
   When editing string values, the cursor moves to the first character.
2. Press \text{\textarrowleft} to open the editor.
   An on-screen keyboard is shown on the HMI.
3. Press \text{\textarrowup} or \text{\textarrowdown} to select the edited string and press \text{\textarrowleft} or \text{\textarrowright} to move the cursor.

Editing can be aborted at any time by pressing \text{\textastern} or by using the Cancel button on the on-screen keyboard.
4. Edit the string using the on-screen keyboard.
5. Select OK on the on-screen keyboard or press while the string editing field is focused to accept the entered string is accepted and the editing dialog is closed.

5.1.13.3 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.

5.1.13.4 Changing time settings in LHMI

If there is a need to change the time setting in the LHMI (Main menu/Configuration/Time/System time/SYSTEMTIME) the change will take affect immediately. To confirm the new setting press . To remove the change, press ESC.

5.1.14 Saving settings

Editable values are stored in the non-volatile flash memory. Most of the parameter changes take effect immediately after storing, but some parameter changes require application restart. Values stored in the flash memory remain in effect after reboot as well.

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

Figure 28: Confirming settings

- To exit without saving changes, select No and press .
- To cancel saving settings, select Cancel and press .
Pressing Cancel in the Save changes dialog closes only the Save changes dialog box, but the IED remains in editing mode. All the changes applied to any setting are not lost and the user can continue to change settings. To leave the change setting mode, select No or Yes in the Save changes dialog.

After changing the parameters marked with !, the IED restarts automatically for the changes to take effect.

### 5.1.15 Clearing and acknowledging

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

1. Press the Clear button to activate the Clear view.

   ![Clear menu](IEC13000236-1-en.vsd)

   **Figure 29:** Clear view

   The content of the Clear menu depends on the configuration configured with PCM600.

2. Select the item to be cleared with ↑ or ↓.

3. Press →, select OK to confirm the selection or Cancel to cancel the selection, and press →.

4. Repeat steps 2 and 3 to clear other items.
5.1.16 Using the local HMI help

1. Press \[ \text{Shift} \] to open the help view.
2. Scroll the text with \[ \text{Up} \] or \[ \text{Down} \] if the help text exceeds the display area.
3. To close the help, press \[ \text{ESC} \].

The help dialog is also closed when the display timeout expires.

\[ \text{Main menu} \]

<table>
<thead>
<tr>
<th>Control</th>
<th>Events</th>
<th>General help</th>
</tr>
</thead>
<tbody>
<tr>
<td>Me : How to use the keys:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Di : Alarm : Cycle through alarm pages</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Se : Clear : Go to clear menu</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Co : Menu : Toggle between main menu / default menu</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Di : ? : Show help</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Te : R/L : Change command operator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cl : \text{&lt;-} : Execute / enter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>La : Key : Log on dialog</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ESC : Exit / discard</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 : Close selected switch</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 30: Help menu**
Section 6  IED operation

6.1  Normal operation

In a normal IED 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 PCM600 documentation.

6.2  Disturbance identification

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

For the LEDs to operate, the disturbance recorder has to be defined in the configuration.

Table 13: Disturbance indications

<table>
<thead>
<tr>
<th>LED</th>
<th>State</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pickup LED</td>
<td>Yellow, steady</td>
<td>Protection picked up</td>
</tr>
<tr>
<td>Trip LED</td>
<td>Red, steady</td>
<td>Protection tripped</td>
</tr>
</tbody>
</table>

Further actions to be taken to identify the disturbance:

- Checking alarm LEDs
- Reading event history
- Checking fault records
- Analyzing disturbance recordings

Document the disturbance before clearing the information from the IED.
Only authorized and skilled personnel should analyze possible errors and decide on further actions. Otherwise, stored disturbance data can be lost.

### 6.2.1 DFR recording triggering

DFR recordings are normally triggered by IED applications when they detect fault events. DFR 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.

### 6.2.2 DFR record analysis

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

For more information, see PCM600 documentation.

### 6.2.3 DFR reports

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

For more information, see PCM600 documentation.

### 6.2.4 IED self-supervision

The IED self-supervision handles internal run-time fault situations. The main indication of an internal fault is a flashing green Normal 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 IED records IED status data and events.

Document all the recorded data from the IED before resetting the tripping and IED lockout functions.
6.3 IED parameterization

IED 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 IED’s settings need to be verified before the IED is connected to a system.

- Document all changes to parameter settings.

- For more information, see PCM600 documentation.

6.3.1 IED settings for IED 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.

6.3.2 IED settings for different operating conditions

IED 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 IED application or manually via the LHMI or PCM600.
Section 7 Operating procedures

7.1 Monitoring

7.1.1 Indications

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

- Three indicator LEDs with fixed functionality: Normal, Pickup and Trip
- 15 programmable three-color alarm LEDs which can present 45 virtual LED states
  - For each on state LED color and for the LED off state, texts can be programmed with PCM600 and via LHMI. These texts are displayed on the LHMI.
- An auto-indicating message on the display.

7.1.1.1 Using auto-indication messages

Auto-indication messages are shown in a dialog box that is displayed when the disturbance recorder is triggered. The indication dialog box shows a list of current disturbance recordings one by one. To scroll the dialog, use ↑ and ↓.

To activate the auto-indication message function, the disturbance recorder function has to be activated and properly configured. Check also that the setting Main menu/Configuration/HMI/Screen/SCREEN:1/AutoIndicationDRP is set to On.

1. Read the auto-indication message in the dialog box. The message contains the same information that is available for disturbance recordings.
2. Press → to see more detailed information.
3. Press ← to close the auto-indication message without clearing it or press → to activate the Clear view and to clear messages.
### 7.1.1.2 Monitoring alarm data

Active alarms are indicated by the alarm LEDs and the LED in the Multipage button. The alarms are configured with PCM600. The alarm type and information depend on the application configuration.

1. Press \[\text{[ ]}\] to open the alarm view.
2. Press \[\text{< up> or < down}>\] to move between active alarms in the page, or press \[\text{< left> or < right>}\] to switch between the three alarm pages.
3. Press \[\text{< left>}\] to open a dialog box that shows more detailed information about the selected alarm.
   - Press \[\text{< left> or < right>}\] to close the dialog box.
4. Press \[\text{< enter>}\] to clear the alarm view.
5. Press \[\text{< enter>}\] to activate the Clear view and to clear alarms.
7.1.1.3 Monitoring an internal IED fault

The flashing green LED indicates an internal IED fault. The fault messages are found in the LHMI menu.

1. Select **Main menu/Diagnostics/Internal events** or **IED status** to monitor the latest fault indication.
2. Press ↑ or ↓ to scroll the view.

---

**Figure 32: Alarm data**

**Figure 33: Fault indication**
The internal event list is not updated dynamically. To update the list, leave the Internal events menu and then select it again.

7.1.2 Measured and calculated values

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

7.1.2.1 Measured values

Measured values can be accessed through the LHMI.

7.1.2.2 Using the local HMI for monitoring

If the LHMI displays --- instead of a measured float value, it means that the value is invalid and out of range.

1. Select Main menu/Measurements to monitor measured and calculated values. The list of IED’s basic measurements is shown.
2. Scroll the view with ↑ and ↓.

7.1.3 Recorded data

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

- DFR records
- Events
- Load profile record

7.1.3.1 Creating disturbance recordings

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

Set the DRPRDRE Operation to Enabled via LHMI or PCM600 and at least one channel has to be connected. To make the setting, select Main menu/Settings/IED Settings and then Monitoring/Disturbance report/DisturbanceReport/DRPRDRE:1.
1. Select **Main menu/Disturbance records**.
2. Select **Manual Trig** with 
3. Press \( \text{or} \) \( \) \( \) to execute manual triggering.

<table>
<thead>
<tr>
<th>Record</th>
<th>Date/Time</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Record66</td>
<td>2014-05-08 08:17:47</td>
<td>TC_ALARM_3</td>
</tr>
<tr>
<td>Record65</td>
<td>2014-05-08 08:17:44</td>
<td>SPR_CHR_ALM</td>
</tr>
<tr>
<td>Record64</td>
<td>2014-05-07 23:56:02</td>
<td>TC_ALARM_3</td>
</tr>
<tr>
<td>Record63</td>
<td>2014-05-07 23:55:59</td>
<td>SPR_CHR_ALM</td>
</tr>
<tr>
<td>Record62</td>
<td>2014-05-07 22:29:14</td>
<td>TC_ALARM_1</td>
</tr>
<tr>
<td>Record61</td>
<td>2014-05-07 22:29:11</td>
<td>SPR_CHR_ALM</td>
</tr>
<tr>
<td>Record60</td>
<td>2014-05-07 22:23:43</td>
<td>TC_ALARM_1</td>
</tr>
<tr>
<td>Record59</td>
<td>2014-05-07 22:23:40</td>
<td>SPR_CHR_ALM</td>
</tr>
<tr>
<td>Record58</td>
<td>2014-05-07 21:57:04</td>
<td>TC_ALARM_1</td>
</tr>
<tr>
<td>Record57</td>
<td>2014-05-07 21:57:01</td>
<td>SPR_CHR_ALM</td>
</tr>
<tr>
<td>Record56</td>
<td>2014-05-07 21:54:34</td>
<td>TC_ALARM_1</td>
</tr>
<tr>
<td>Record55</td>
<td>2014-05-07 21:54:31</td>
<td>SPR_CHR_ALM</td>
</tr>
<tr>
<td>Record54</td>
<td>2014-05-07 21:50:51</td>
<td>TC_ALARM_1</td>
</tr>
<tr>
<td>Record53</td>
<td>2014-05-07 21:50:48</td>
<td>SPR_CHR_ALM</td>
</tr>
</tbody>
</table>

![Figure 34: Manual triggering](image)

The disturbance recorder is now triggered.

### 7.1.3.2 Monitoring disturbance recorder data

Read individual disturbance recordings from the IED with the PCM600 software to monitor disturbance recorder data.

1. Select **Main menu/Disturbance records**.
2. All disturbance records are listed.
3. Scroll the view with \( \text{or} \) \( \) \( \) \( \) \( \) \( \) \( \).
3. To view a specific disturbance record, press \rightarrow. A list of detail categories is displayed.

4. To select a category and view the items under it, press \uparrow or \downarrow and then \rightarrow.

7.1.3.3 Controlling and uploading DFR recorder data

DFR recorder data can be controlled and read with PCM600.

For more information, see PCM600 documentation.
7.1.3.4 Monitoring events

The event view contains a list of events produced by the application configuration. The events are grouped by day, and each event takes one line. Select the order of events with the setting **Main menu/Configuration/HMI/Screen/SCREEN:1/EvListSrtOrder**.

1. Select **Main menu/Events**.
2. Press the button to open the event list.
   - Events are shown grouped by date.
   - Time, channel, signal name and value of the event are shown.
3. Press or to scroll the view.

![Monitoring events](image)

**Figure 37: Monitoring events**

The event list is not updated dynamically. To update the list, leave the Events menu and then select it again.

7.1.4 Remote monitoring

The IED supports comprehensive remote monitoring.

7.1.4.1 Monitoring the IED remotely

Use the PCM600 tool to operate the IED remotely.

- Analyze DFR data.
- Create DFR records.
- Monitor IED values.
For more information, see PCM600 documentation.

7.2 Controlling

7.2.1 Controlling circuit breakers and disconnectors

The primary equipment can be controlled via the LHMI with the Open and Close buttons when the IED is set to local control mode and the user is authorized to access control operations.

1. Select **Main menu/Control/Single line diagram**.
The SLD displays all controllable objects configured to the SLD.
2. Select an object with 
   Selection of object is indicated with a square border that moves when 
   Switch objects can have additional icons that present the switch object states.
   - Switch object is in substituted state.
   - Switch object is interlocked.
3. Press 
   to open or 
   to close the object.
4. Press 
   to confirm the operation.
   - Press 
     to cancel the operation.
5. Press 
   or 
   to move between single-line diagram pages.

The time between selecting the object and giving a control command is restricted by an adjustable timeout ([set by the parameter tSelect for each object]). When an object is selected, the control command has to be given within this time.
7.3 Resetting the IED

7.3.1 Clearing and acknowledging via the local HMI

Use the Clear button to reset, acknowledge or clear all messages and indications, including LEDs and latched outputs as well as registers and recordings. Pressing the Clear button activates a view for selecting the reset function. Events and alarms assigned to alarm LEDs can also be cleared with the Clear button.

1. Press \( \text{Clear} \) to activate the Clear view.
   All the items that can be cleared are shown.

   ![](image)

   **Figure 39: Clear view**
   The content of the Clear menu depends on the configuration configured with PCM600.

   2. Select the item to be cleared with \( \uparrow \) or \( \downarrow \).

   3. Press \( \text{OK} \), select OK to confirm the selection or Cancel to cancel the selection.

   4. To clear other items, repeat the steps.

7.4 Changing the IED functionality

7.4.1 Defining the setting group

Do not switch off the auxiliary power supply to the IED before changes, for example, setting parameter or local/remote control state changes are saved.
### 7.4.1.1 Activating a setting group

IED settings are planned in advance for different operation conditions by calculating setting values to different setting groups. The active setting group can be changed manually from the menu or by the PCM600 tool.

1. Select **Main menu/Settings/Active setting group/SETGRPS:1** and press .

\[
\begin{array}{|c|c|}
\hline
\text{ActiveSetGrp} & \text{SettingGroup1} \\
\hline
\text{MaxNoSetGrp} & 1 \\
\hline
\end{array}
\]

*Figure 40: Active setting group*

2. Select the setting group with ↑ or ↓.
3. Press ← to confirm the selection or Esc to cancel.
4. Commit the settings.

Remember to document the changes you make.

### 7.4.1.2 Browsing and editing setting group values

1. Select **Main menu/Settings/IED Settings** and press →. Setting group 1 is the default setting group to be edited.

\[
\begin{array}{|c|}
\hline
\text{Edit setting group} \\
\text{Setting group:1} \\
\text{EC} & \text{No} \\
\hline
\end{array}
\]

*Figure 41: Selecting a setting group for editing*

2. Press ← on the Setting group line in the dialog box to activate selection mode.
3. Select the wanted setting group with ↑ or ↓ and press →.
4. Select Yes in the dialog, and press → to continue. The current setting group is displayed on the left in the header.

5. Select the application function category in the list with ↑ or ↓, and press → to see the function blocks in that category. Categories available in the list depend on the configuration configured with PCM600.

6. To browse the function blocks, scroll the list with ↑ and ↓. Function blocks available depend on the application configuration. To move back to the list, press ←.

7. To select a function block, press →.
8. To browse the settings, scroll the list with ✈ and ❌.

9. To edit the selected setting, press ✈.  
   • In case of a parameter that is not part of a setting group, the parameter is activated for editing.
   • In case of a setting group parameter, the editing dialog shows the value of the setting in all available setting groups, but the user can edit only the value in the selected setting group. The active setting group is marked with an asterisk *.

10. Press ✈ or ❌ to change the value.

11. Confirm the change with ❌.
7.4.2 Activating LEDs

To activate the LEDs, they must be configured with PCM600.

1. Select **Main menu/Configuration/HMI/LEDs** and press ➡.

   ![LED Configuration](IEC13000056-2-en.vsd)

   **Figure 46: Alarm groups**

   The list can contain three alarm groups at the maximum. The amount of groups depends on the amount of LEDs taken into use.

2. Select an alarm group with ↑ or ↓ and press ➡.

3. Select an Alarm LED with ↑ or ↓.

4. Press ➡ to confirm the selection and to change the Alarm LED mode.

5. Press ↑ or ↓ to change the value and ➡ to confirm the selection.

   For more information, see PCM600 documentation.
Section 8  REX060 injection unit LHMI

8.1  REX060 injection unit HMI (REG670 only)

8.1.1  Injection unit REX060

The injection unit REX060 is used to inject voltage and current signals to the generator or motor stator and rotor circuits. REX060 generates two square wave signals with different frequencies for injection into the stator and rotor circuits respectively. The response from the injected voltage and currents are then measured by the REX060 unit and amplified to a level suitable for the analog voltage inputs of IED.

For local operation, the REX060 unit is provided with a control panel on the front.

Local operation shall only be performed according to the operation regulations set up by the relevant operation authority of the plant.

8.1.2  REX060 start up sequence

When the injection unit REX060 is energized, the ABB logotype is shown followed by current REX060 revision status. When the start up sequence is completed, the main menu (normal display content) is shown. The duration of the start up sequence is a few seconds.
8.1.3 REX060 Front panel controls

**Figure 47:** REX060 front panel
Table 14:  HMI keys on the front of the injection unit REX060

<table>
<thead>
<tr>
<th>Key</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="Image" alt="Injection Switch" /></td>
<td>The Injection switch enables injection at rotor and stator 2 s after switching on. A LED indicates that the injection switch is set to enable injection. The injection switch can be padlocked in off position in order to cut-off both injection signals.</td>
</tr>
<tr>
<td><img src="Image" alt="Key-lock Button" /></td>
<td>The Key-lock button enables/disables the keypad. Hold the Key-lock button for a period of 1.2 s to 4 s to lock or unlock the keys. A key-lock LED indicates when the keypad is unlocked.</td>
</tr>
<tr>
<td><img src="Image" alt="Cursor Move" /></td>
<td>• Moves the cursor in the direction of the arrows&lt;br&gt;• When the cursor is in the value change state, pressing the up button increases the value and pressing the down button decreases the value.</td>
</tr>
<tr>
<td><img src="Image" alt="Clear Button" /></td>
<td>Pressing the clear button cancels changes that have not been stored.</td>
</tr>
<tr>
<td><img src="Image" alt="Enter Button" /></td>
<td>Pressing the enter button stores the changed value. If the value is outside range, the limit value is stored.</td>
</tr>
</tbody>
</table>

### 8.1.4 Display

On the front of the enclosure there is a backlit LCD.

- 6 x 12 pixel characters
- Graphical LCD 128 x 64 pixels

In figure 48 the content of the display is shown for a REX060 with one SIM and one RIM module. Row 1 contains mains frequency information. Row 2-3 contains stator information and row 4-5 rotor information. Column 1 (empty) gives status, column 2 and 3 are informative and column 4 contains variables, settable by the keypad.
### Column 1 (status column) symbols

#### Table 15: Status symbols and their description

<table>
<thead>
<tr>
<th>Status symbol</th>
<th>Description of the status</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>✨</td>
<td>Over voltage occurred, injection is blocked. This can occur on both X61/62 and X81/82 (Stator &amp; Rotor) simultaneously or on either of them. The symbol is displayed in the status column (column 1) in row 2 for X61/62 and in row 4 for X81/82. The injection is blocked until a manual reset of the blocking occurs.</td>
<td>1</td>
</tr>
<tr>
<td>⚪️</td>
<td>Injection blocked by the injection switch. The symbol is displayed in the status column (column 1) and is always shown in both row 2 and 4.</td>
<td>2</td>
</tr>
<tr>
<td>🔄</td>
<td>Injection blocked by binary input. Blocked injection will be shown in the status column (column 1) depending on binary in status. This can occur on both X61/62 then shown in row 2 and X81/82 then shown in row 4 (Stator &amp; Rotor) simultaneously or on ether of them.</td>
<td>3</td>
</tr>
<tr>
<td>⚠️</td>
<td>Analog output saturation. This status is set when the analog signal, current and or voltage, to REG670 IED is too high and may thereby be incorrect due to saturation in amplifier stage. Saturation status will be shown in the status column (column 1) in row 3 or 5 depending on the saturation occurrence</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>

Backlight is on for 30 seconds after pressing any button. Backlight activation by pressing any button does not cause any other action than turning on the backlight.
8.1.5 How to set frequency and voltage and current gain factors

Frequency, current and voltage gain for the stator and/or rotor can be set and stored from the injection unit HMI. If a value is out of range, the limit value is stored. The display shows the latest stored settings.

The settings are stored in non-volatile memory, which means that they remain stored in case IED is powered off.

8.1.5.1 Setting system frequency

Frequency can be set to either 50 or 60 Hz.

1. Use the Up and Down button to select frequency.
2. Store the new frequency by pressing the Enter button, or clear the last stored frequency by pressing the Clear button.

8.1.5.2 Setting stator and rotor injection frequency

Frequency can be set as integer in range 50 to 250 Hz for a stator and 75 to 250 Hz for a rotor.

1. Use the keypad to navigate to stator or rotor frequency (row 2 or 4)
2. Press E to enter value change state
3. Use the Up and Down button to select frequency
4. Store the new frequency by pressing the E (Enter) button, or clear the chosen frequency by pressing the C (Clear) button

8.1.5.3 Selecting rotor gain

Default (gain factor 3) is the recommended level, where a defined effect of worst case single fault at exciter circuit is allowed. A higher gain factor (4) may cause saturation in case of single fault in exciter circuit. A lower gain factor may be needed if the degree of disturbance is high. Change from default value only if requested by ICT tool during calibration procedure.

Select rotor gain factor according to the table below.

<table>
<thead>
<tr>
<th>Gain factor</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Extreme</td>
</tr>
<tr>
<td>2</td>
<td>Enhanced</td>
</tr>
<tr>
<td>3</td>
<td>Default</td>
</tr>
<tr>
<td>4</td>
<td>Reduced</td>
</tr>
</tbody>
</table>
8.1.5.4  Selecting stator gain

Stator gain factor for both voltage and current depends on the highest voltage that may occur at the injection point of VT or DT. That voltage depends on the VT/DT ratio and the stator rated primary voltage.

Select gain factor in accordance with highest voltage that may occur at the injection point. See *Technical manual* for exact formulas depending on particular injection arrangement.

<table>
<thead>
<tr>
<th>VmaxEF [V]</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>240</td>
<td></td>
</tr>
<tr>
<td>200</td>
<td></td>
</tr>
<tr>
<td>160</td>
<td>Default value</td>
</tr>
<tr>
<td>up to 120</td>
<td></td>
</tr>
</tbody>
</table>

8.1.5.5  Resetting overvoltage

Stator and rotor injection output is protected against voltages exceeding maximum operating range (10% of rated VT/DT) by a relay blocking the injection circuit. This blocking is controlled by measuring the stator and/or rotor voltage, and remains blocked until manually reset. The blocking remains in the non-volatile memory when the IED is powered off.

Overvoltage blocking is indicated by a symbol shown in Table 15.

Resetting procedure:

1. Power off the REX060.
2. Press and hold the C and Key-lock buttons.
3. Power on the REX060 and wait until the status indication Over-voltage (symbol) disappears from the display.
4. Release the C and Key-lock buttons.

**REX060 stator and rotor overvoltage protection of injection circuit**

Both rotor and stator have two levels of protection, injection circuit interruption controlled by the voltage sense input and a fuse for over-current protection. The voltage controlled interruption, overvoltage, will normally occur prior to interruption by fuse and the reset sequence is described above. A blown fuse requires module disassembling to replace the fuse (F 4 A 250 V for stator and F 160 mA 250 V for rotor). However, if this occurs it is recommended to identify the reason for the over-current and take necessary actions to reduce the current before restarting the unit. The problem must be outside the injection unit since this unit cannot provide enough energy to blow the fuse.

**REX062 input protection**
REX062 limits overvoltage by a varistor at the injection output to stator. Normally, REX060 will interrupt the injection circuit in case of excessive over-current in the injection chain. Fuse within REX062 is an additional protection in case of failure within REX062 during over-voltage condition.

A blown REX062 fuse requires a module disassembling to replace the fuse (F 6.3 A 250 V). However, if this occurs it is recommended to identify the reason for the over-current and do needed actions to reduce the current.
Section 9  Troubleshooting

9.1  Fault tracing

9.1.1  Identifying hardware errors

1. Check the module with an error.
   • Check the general IED status in Main menu/Diagnostics/IED status/General for a faulty hardware module.
   • Check the history of changes in internal event list in Main menu/Diagnostics/Internal events.

2. Inspect the IED visually.
   • Inspect the IED 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 IED and test the input and output operation with an external test device.
   • If the problem remains, contact ABB for repair or replacement actions.

9.1.2  Identifying runtime errors

1. Check the error origin from IED’s internal event list Main menu/Diagnostics/IED status/General.

2. Reboot the IED and recheck the supervision events to see if the fault has cleared.

3. In case of persistent faults, contact ABB for corrective actions.

9.1.3  Identifying communication errors

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

• Check the IEC61850 and DNP3 communication status in internal event list in Main menu/Diagnostics/IED Status/General.
• In case of persistent faults originating from IED’s internal faults such as component breakdown, contact ABB for repair or replacement actions.

9.1.3.1  Checking the communication link operation

There are several different communication links on the product. First check that all communication ports that are used for communication are turned on.
1. Check the front communication port RJ-45.
   1.1. Check that the uplink LED is lit with a steady green light. The uplink LED is located above the RJ-45 communication port on the left. The port is used for direct electrical communication to a PC connected via a crossed-over Ethernet cable.
   1.2. Check the communication status of the front port via the LHMI in **Main menu/Diagnostics/Communication/Front port/DOSFRNT:1**. Check that the **LINKUP** value is 1, that is, the communication is working. When the value is 0, there is no communication link.

2. Check the communication status of the X311 rear ports via the LHMI in **Main menu/Diagnostics/Communication/OEM port LAN AB/DOSLANAB:2** and **Main menu/Diagnostics/Communication/OEM port LAN CD/DOSLANCD:3**. The X311 communication ports on the rear side of the IED are for optical Ethernet via ST connectors.
   - Check that the **LINKUP** value is 1, that is, the communication is working. When the value is 0, there is no communication link.

### 9.1.3.2 Checking the time synchronization

- Select **Main menu/Diagnostics/IED status/General** and check the status of the time synchronization on **Time synch**. The **Time synch** value is **Normal** when the synchronization is in order.

   ![Note Icon]

   Note that the time synchronization source has to be activated. Otherwise the value is always **Normal**.

### 9.1.4 Running the display test

You can run the display test in either of the following ways:

- Select **Main menu/Test/LED test**.
- Press simultaneously **ESC** and **ENT**.

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.

### 9.2 Indication messages

#### 9.2.1 Internal faults

When the Ready LED indicates an internal fault by flashing, the message associated with the fault is found in the internal event list in the LHMI menu **Main menu/Diagnostics/Internal events**. The message includes the date, time, description and signal state for the fault. The internal event list is not updated dynamically. The list is updated by leaving the **Internal events** menu and then selecting it again. The current status of the internal fault signals can also be checked via the LHMI in **Main menu/Diagnostics/IED status**.
Different actions are taken depending on the severity of the fault. If the fault is found to be permanent, the IED stays in internal fault mode. The IED continues to perform internal tests during the fault situation.

When a fault appears, the fault indication message is to be recorded and stated when requesting support or service.

### Table 18: Internal fault indications

<table>
<thead>
<tr>
<th>Fault indication</th>
<th>Additional information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Fail Real Time Clock Error</td>
<td>Hardware error with the real time clock.</td>
</tr>
<tr>
<td>Internal Fail Runtime Exec. Error</td>
<td>One or more of the application threads are not working properly.</td>
</tr>
<tr>
<td>Internal Fail SW Watchdog Error</td>
<td>This signal will be activated when the terminal has been under too heavy load for at least 5 minutes.</td>
</tr>
<tr>
<td>Internal Fail Runtime App Error</td>
<td>One or more of the application threads are not in an expected state.</td>
</tr>
<tr>
<td>Internal Fail IEC 61850 Error</td>
<td>IEC 61850 has not succeeded in some actions such as reading the configuration file or start-up.</td>
</tr>
<tr>
<td>Internal Fail DNP3 Error</td>
<td>An error in DNP3 communication has occurred.</td>
</tr>
<tr>
<td>Internal Fail PSM1-Error</td>
<td>A PSM card error has occurred. The instance number is shown as part of the fault indication, such as 1 in this example.</td>
</tr>
<tr>
<td>Internal Fail BIM3-Error</td>
<td>A binary-in-module error has occurred. The instance number is shown as part of the fault indication, such as 3 in this example.</td>
</tr>
<tr>
<td>Internal Fail BOM4-Error</td>
<td>A binary-out-module error has occurred. The instance number is shown as part of the fault indication, such as 4 in this example.</td>
</tr>
<tr>
<td>Internal Fail IOM5-Error</td>
<td>An in/out-module error has occurred. The instance number is shown as part of the fault indication, such as 5 in this example.</td>
</tr>
<tr>
<td>Internal Fail NUM30-Error</td>
<td>A NUM card error has occurred. The instance number is shown as part of the fault indication, such as 30 in this example.</td>
</tr>
<tr>
<td>Internal Fail SLM301-Error</td>
<td>A SLM card error has occurred. The instance number is shown as part of the fault indication, such as 301 in this example.</td>
</tr>
</tbody>
</table>

### 9.2.2 Warnings

The warning message associated with the fault is found in the internal event list in the LHMI menu **Main menu/Diagnostics/Internal events**. The message includes the date, time, description and signal state for the fault. The current status of the internal fault signals can also be checked via the LHMI in **Main menu/Diagnostics/IED status/General**.

When a fault appears, record the fault indication message and state it when ordering service.
Table 19: Warning indications

<table>
<thead>
<tr>
<th>Warning indication</th>
<th>Additional information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warning IEC 61850 Error</td>
<td>IEC 61850 has not succeeded in some actions such as reading the configuration file, startup etc.</td>
</tr>
<tr>
<td>Warning DNP3 Error</td>
<td>Error in DNP3 communication.</td>
</tr>
</tbody>
</table>

9.2.3 Additional indications

The additional indication messages do not activate internal fault or warning.

The messages are listed in the LHMI menu under the event list. The signal status data is found under the IED status and in the internal event list.

Table 20: Additional indications

<table>
<thead>
<tr>
<th>Warning indication</th>
<th>Additional information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time Synch Error</td>
<td>Source of the time synchronization is lost or time system has made a time reset.</td>
</tr>
<tr>
<td>Settings Changed</td>
<td>Settings have been changed.</td>
</tr>
<tr>
<td>Setting Groups Changed</td>
<td>Setting group has been changed.</td>
</tr>
</tbody>
</table>

9.3 Correction procedures

9.3.1 Creating user accounts and setting and changing passwords

If Central Account Management is disabled in the IED, user account creation, initial password setting and password changing is done using PCM600.

If Central Account Management is enabled in the IED, user account creation and initial password setting is done using the SDM600 server. Individual users can then change their passwords via PCM600 or the LHMI.

For more information, see PCM600 documentation or the Cyber security deployment guidelines.

9.3.1.1 Changing the password from the LHMI

The password can only be changed for the active user.

1. Press .
2. Select Change Password and press to confirm.
3. Enter a new password using the on-screen keyboard. To cancel password change, press ESC.

9.3.2 Identifying IED application problems

Navigate to the appropriate menu in the LHMI to identify possible problems.

- Check that the function is on.
- Check that the correct setting group (1 to 6) is activated.
- Check if the function is blocked.
- Check if the IED is in the test mode.
- Check the measurement values.
- Check the connections to trip and DFR functions.
- Check the TRM channel settings.
- Check the cycle time of the SMAI block.
- Check the DFT reference of the SMAI block.

9.3.2.1 Inspecting the 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 IED 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/Analog primary values or Analog secondary values.
- Check that the phase information and phase shift between phases is correct.
- Correct the wiring if needed.
  - Change the parameter Negation in Configuration/Analog modules/3 phase analog group/SMAIn:1 (n= the number of the SMAI used).

  Changing the Negation parameter is not recommended without special skills.

- Change the parameter in PCM600, see PCM600 documentation.
- Check the actual state of the connected binary inputs.
  - In LHMI, select Main menu/Test/Binary input values. Then navigate to the board with the actual binary input to be checked.
  - Check the actual state of the connected binary inputs through PCM600, see PCM600 documentation.
- Measure output contacts using the voltage drop method of applying at least the minimum contact load given for the output relays in the technical data, for example 100 mA at 24 V AC/DC.
Output relays, especially power output relays, are designed for breaking high currents. Due to this, layers of high resistance may appear on the surface of the contacts. Do not determine proper functionality of connectivity or contact resistance by measuring with a regular hand-held ohm meter.

![Diagram of output relay connections]

Figure 49: Testing output contacts using the voltage drop method

1. Contact current
2. Contact voltage drop
3. Load
4. Supply voltage

- To check the status of the output circuits driving the output relay via the LHMI, select **Main menu/Test/Binary output values** and then navigate to the board with the actual binary output to be checked.
- Test and change the relay state manually.
  1. To set the IED to test mode, select **Main menu/Test/IED test mode/TESTMODE:1** and set the parameter **TestMode to enable**.
  2. To operate or force the output relay to operate, select **Main menu/Test/Forcing/Binary output values** and then navigate to the board with the actual binary output relay to be operated/forced.
  3. Select the BOn to be operated/forced and use and or to operate the actual output relay. Each BOn is represented by two signals. The first signal in LHMI is the actual value 1 or 0 of the output, and in PCM600 a lit or dimmed diode. The second signal is the status Normal or Forced. Forced status is only achieved when the BO is set to Forced or operated on the LHMI.

Set the parameter **TestMode to disable** after completing these tests. The Pickup LED stops flashing when the relay is no longer in test mode.
An initially high contact resistance does not cause problems as it is reduced quickly by the electrical cleaning effect of fritting and thermal destruction of layers, bringing the contact resistance back to the mOhm range. As a result, practically the full voltage is available at the load.
Section 10  Glossary

AC  Alternating current
ACC  Actual channel
ACT  Application configuration tool within PCM600
A/D converter  Analog-to-digital converter
ADBS  Amplitude deadband supervision
ADM  Analog digital conversion module, with time synchronization
AI  Analog input
ANSI  American National Standards Institute
AR  Autoreclosing
ASCT  Auxiliary summation current transformer
ASD  Adaptive signal detection
ASDU  Application service data unit
AWG  American Wire Gauge standard
BBP  Busbar protection
BFOC/2,5  Bayonet fiber optic connector
BFP  Breaker failure protection
BI  Binary input
BIM  Binary input module
BOM  Binary output module
BOS  Binary outputs status
BR  External bistable relay
BS  British Standards
BSR  Binary signal transfer function, receiver blocks
BST  Binary signal transfer function, transmit blocks
C37.94  IEEE/ANSI protocol used when sending binary signals between IEDs
CAN  Controller Area Network. ISO standard (ISO 11898) for serial communication
CB  Circuit breaker
CBM  Combined backplane module
CCM  CAN carrier module
CCVT  Capacitive Coupled Voltage Transformer
<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class C</td>
<td>Protection Current Transformer class as per IEEE/ ANSI</td>
</tr>
<tr>
<td>CMPPS</td>
<td>Combined megapulses per second</td>
</tr>
<tr>
<td>CMT</td>
<td>Communication Management tool in PCM600</td>
</tr>
<tr>
<td>CO cycle</td>
<td>Close-open cycle</td>
</tr>
<tr>
<td>CODirectional</td>
<td>Way of transmitting G.703 over a balanced line. Involves two twisted pairs making it possible to transmit information in both directions</td>
</tr>
<tr>
<td>COM</td>
<td>Command</td>
</tr>
<tr>
<td>COMTRADE</td>
<td>Standard Common Format for Transient Data Exchange format for Disturbance recorder according to IEEE/ANSI C37.111, 1999 / IEC 60255-24</td>
</tr>
<tr>
<td>Contra-directional</td>
<td>Way of transmitting G.703 over a balanced line. Involves four twisted pairs, two of which are used for transmitting data in both directions and two for transmitting clock signals</td>
</tr>
<tr>
<td>COT</td>
<td>Cause of transmission</td>
</tr>
<tr>
<td>CPU</td>
<td>Central processing unit</td>
</tr>
<tr>
<td>CR</td>
<td>Carrier receive</td>
</tr>
<tr>
<td>CRC</td>
<td>Cyclic redundancy check</td>
</tr>
<tr>
<td>CROB</td>
<td>Control relay output block</td>
</tr>
<tr>
<td>CS</td>
<td>Carrier send</td>
</tr>
<tr>
<td>CT</td>
<td>Current transformer</td>
</tr>
<tr>
<td>CU</td>
<td>Communication unit</td>
</tr>
<tr>
<td>CVT or CCVT</td>
<td>Capacitive voltage transformer</td>
</tr>
<tr>
<td>DAR</td>
<td>Delayed autoreclosing</td>
</tr>
<tr>
<td>DARPA</td>
<td>Defense Advanced Research Projects Agency (The US developer of the TCP/IP protocol etc.)</td>
</tr>
<tr>
<td>DBDL</td>
<td>Dead bus dead line</td>
</tr>
<tr>
<td>DBLL</td>
<td>Dead bus live line</td>
</tr>
<tr>
<td>DC</td>
<td>Direct current</td>
</tr>
<tr>
<td>DFC</td>
<td>Data flow control</td>
</tr>
<tr>
<td>DFT</td>
<td>Discrete Fourier transform</td>
</tr>
<tr>
<td>DHCP</td>
<td>Dynamic Host Configuration Protocol</td>
</tr>
<tr>
<td>DIP-switch</td>
<td>Small switch mounted on a printed circuit board</td>
</tr>
<tr>
<td>DI</td>
<td>Digital input</td>
</tr>
<tr>
<td>DLLB</td>
<td>Dead line live bus</td>
</tr>
<tr>
<td>DNP</td>
<td>Distributed Network Protocol as per IEEE Std 1815-2012</td>
</tr>
<tr>
<td>DR</td>
<td>Disturbance recorder</td>
</tr>
<tr>
<td>DRAM</td>
<td>Dynamic random access memory</td>
</tr>
<tr>
<td>DRH</td>
<td>Disturbance report handler</td>
</tr>
<tr>
<td>DSP</td>
<td>Digital signal processor</td>
</tr>
<tr>
<td>DTT</td>
<td>Direct transfer trip scheme</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>ECT</td>
<td>Ethernet configuration tool</td>
</tr>
<tr>
<td>EHV network</td>
<td>Extra high voltage network</td>
</tr>
<tr>
<td>EIA</td>
<td>Electronic Industries Association</td>
</tr>
<tr>
<td>EMC</td>
<td>Electromagnetic compatibility</td>
</tr>
<tr>
<td>EMF</td>
<td>Electromotive force</td>
</tr>
<tr>
<td>EMI</td>
<td>Electromagnetic interference</td>
</tr>
<tr>
<td>EnFP</td>
<td>End fault protection</td>
</tr>
<tr>
<td>EPA</td>
<td>Enhanced performance architecture</td>
</tr>
<tr>
<td>ESD</td>
<td>Electrostatic discharge</td>
</tr>
<tr>
<td>F-SMA</td>
<td>Type of optical fiber connector</td>
</tr>
<tr>
<td>FAN</td>
<td>Fault number</td>
</tr>
<tr>
<td>FCB</td>
<td>Flow control bit; Frame count bit</td>
</tr>
<tr>
<td>FOX 20</td>
<td>Modular 20 channel telecommunication system for speech, data and protection signals</td>
</tr>
<tr>
<td>FOX 512/515</td>
<td>Access multiplexer</td>
</tr>
<tr>
<td>FOX 6Plus</td>
<td>Compact time-division multiplexer for the transmission of up to seven duplex channels of digital data over optical fibers</td>
</tr>
<tr>
<td>FPN</td>
<td>Flexible product naming</td>
</tr>
<tr>
<td>FTP</td>
<td>File Transfer Protocol</td>
</tr>
<tr>
<td>FUN</td>
<td>Function type</td>
</tr>
<tr>
<td>G.703</td>
<td>Electrical and functional description for digital lines used by local telephone companies. Can be transported over balanced and unbalanced lines</td>
</tr>
<tr>
<td>GCM</td>
<td>Communication interface module with carrier of GPS receiver module</td>
</tr>
<tr>
<td>GDE</td>
<td>Graphical display editor within PCM600</td>
</tr>
<tr>
<td>GI</td>
<td>General interrogation command</td>
</tr>
<tr>
<td>GIS</td>
<td>Gas-insulated switchgear</td>
</tr>
<tr>
<td>GOOSE</td>
<td>Generic object-oriented substation event</td>
</tr>
<tr>
<td>GPS</td>
<td>Global positioning system</td>
</tr>
<tr>
<td>GSAL</td>
<td>Generic security application</td>
</tr>
<tr>
<td>GSE</td>
<td>Generic substation event</td>
</tr>
<tr>
<td>HDLC protocol</td>
<td>High-level data link control, protocol based on the HDLC standard</td>
</tr>
<tr>
<td>HFBR connector type</td>
<td>Plastic fiber connector</td>
</tr>
<tr>
<td>HLV circuit</td>
<td>Hazardous Live Voltage according to IEC60255-27</td>
</tr>
<tr>
<td>HMI</td>
<td>Human-machine interface</td>
</tr>
<tr>
<td>HSAR</td>
<td>High speed autoreclosing</td>
</tr>
<tr>
<td>HSR</td>
<td>High-availability Seamless Redundancy</td>
</tr>
<tr>
<td>HV</td>
<td>High-voltage</td>
</tr>
<tr>
<td>HVDC</td>
<td>High-voltage direct current</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>ICT</td>
<td>Installation and Commissioning Tool for injection based protection in REG670</td>
</tr>
<tr>
<td>IDBS</td>
<td>Integrating deadband supervision</td>
</tr>
<tr>
<td>IEC</td>
<td>International Electrical Committee</td>
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<tr>
<td>IEC 60044-6</td>
<td>IEC Standard, Instrument transformers – Part 6: Requirements for protective current transformers for transient performance</td>
</tr>
<tr>
<td>IEC 60870-5-103</td>
<td>Communication standard for protection equipment. A serial master/slave protocol for point-to-point communication</td>
</tr>
<tr>
<td>IEC 61850</td>
<td>Substation automation communication standard</td>
</tr>
<tr>
<td>IEC 61850–8–1</td>
<td>Communication protocol standard</td>
</tr>
<tr>
<td>IEEE</td>
<td>Institute of Electrical and Electronics Engineers</td>
</tr>
<tr>
<td>IEEE 802.12</td>
<td>A network technology standard that provides 100 Mbits/s on twisted-pair or optical fiber cable</td>
</tr>
<tr>
<td>IEEE P1386.1</td>
<td>PCI Mezzanine Card (PMC) standard for local bus modules. References the CMC (IEEE P1386, also known as Common Mezzanine Card) standard for the mechanics and the PCI specifications from the PCI SIG (Special Interest Group) for the electrical EMF (Electromotive force).</td>
</tr>
<tr>
<td>IEEE 1686</td>
<td>Standard for Substation Intelligent Electronic Devices (IEDs) Cyber Security Capabilities</td>
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<tr>
<td>IED</td>
<td>Intelligent electronic device</td>
</tr>
<tr>
<td>IET600</td>
<td>Integrated engineering tool</td>
</tr>
<tr>
<td>I-GIS</td>
<td>Intelligent gas-insulated switchgear</td>
</tr>
<tr>
<td>IOM</td>
<td>Binary input/output module</td>
</tr>
<tr>
<td>Instance</td>
<td>When several occurrences of the same function are available in the IED, they are referred to as instances of that function. One instance of a function is identical to another of the same kind but has a different number in the IED user interfaces. The word “instance” is sometimes defined as an item of information that is representative of a type. In the same way an instance of a function in the IED is representative of a type of function.</td>
</tr>
</tbody>
</table>
| IP      | 1. Internet protocol. The network layer for the TCP/IP protocol suite widely used on Ethernet networks. IP is a connectionless, best-effort packet-switching protocol. It provides packet routing, fragmentation and reassembly through the data link layer.  
2. Ingression protection, according to IEC 60529 |
| IP 20   | Ingression protection, according to IEC 60529, level IP20- Protected against solid foreign objects of 12.5mm diameter and greater. |
| IP 40   | Ingression protection, according to IEC 60529, level IP40-Protected against solid foreign objects of 1mm diameter and greater. |
| IP 54   | Ingression protection, according to IEC 60529, level IP54-Dust-protected, protected against splashing water. |
| IRF     | Internal failure signal |
| IRIG-B: | InterRange Instrumentation Group Time code format B, standard 200 |
ITU International Telecommunications Union
LAN Local area network
LIB 520 High-voltage software module
LCD Liquid crystal display
LDCM Line data communication module
LDD Local detection device
LNT LON network tool
LON Local operating network
MCB Miniature circuit breaker
MCM Mezzanine carrier module
MIM Milli-ampere module
MPM Main processing module
MVAL Value of measurement
MVB Multifunction vehicle bus. Standardized serial bus originally developed for use in trains.
NCC National Control Centre
NOF Number of grid faults
NUM Numerical module
OCO cycle Open-close-open cycle
OCP Overcurrent protection
OEM Optical Ethernet module
OLTC On-load tap changer
OTEV Disturbance data recording initiated by other event than start/pick-up
OV Overvoltage
Overreach A term used to describe how the relay behaves during a fault condition. For example, a distance relay is overreaching when the impedance presented to it is smaller than the apparent impedance to the fault applied to the balance point, that is, the set reach. The relay “sees” the fault but perhaps it should not have seen it.
PCI Peripheral component interconnect, a local data bus
PCM Pulse code modulation
PCM600 Protection and control IED manager
PC-MIP Mezzanine card standard
PELV circuit Protected Extra-Low Voltage circuit type according to IEC60255-27
PMC PCI Mezzanine card
POR Permissive overreach
POTT Permissive overreach transfer trip
Process bus Bus or LAN used at the process level, that is, in near proximity to the measured and/or controlled components
<table>
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<tr>
<th>Abbreviation</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>PRP</td>
<td>Parallel redundancy protocol</td>
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<tr>
<td>PSM</td>
<td>Power supply module</td>
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<tr>
<td>PST</td>
<td>Parameter setting tool within PCM600</td>
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<tr>
<td>PTP</td>
<td>Precision time protocol</td>
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<tr>
<td>PT ratio</td>
<td>Potential transformer or voltage transformer ratio</td>
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<tr>
<td>PUTT</td>
<td>Permissive underreach transfer trip</td>
</tr>
<tr>
<td>RASC</td>
<td>Synchrocheck relay, COMBIFLEX</td>
</tr>
<tr>
<td>RCA</td>
<td>Relay characteristic angle</td>
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<tr>
<td>RISC</td>
<td>Reduced instruction set computer</td>
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<tr>
<td>RMS value</td>
<td>Root mean square value</td>
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<tr>
<td>RS422</td>
<td>A balanced serial interface for the transmission of digital data in point-to-point connections</td>
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<tr>
<td>RS485</td>
<td>Serial link according to EIA standard RS485</td>
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<tr>
<td>RTC</td>
<td>Real-time clock</td>
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<tr>
<td>RTU</td>
<td>Remote terminal unit</td>
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<tr>
<td>SA</td>
<td>Substation Automation</td>
</tr>
<tr>
<td>SBO</td>
<td>Select-before-operate</td>
</tr>
<tr>
<td>SC</td>
<td>Switch or push button to close</td>
</tr>
<tr>
<td>SCL</td>
<td>Short circuit location</td>
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<tr>
<td>SCS</td>
<td>Station control system</td>
</tr>
<tr>
<td>SCADA</td>
<td>Supervision, control and data acquisition</td>
</tr>
<tr>
<td>SCT</td>
<td>System configuration tool according to standard IEC 61850</td>
</tr>
<tr>
<td>SDU</td>
<td>Service data unit</td>
</tr>
<tr>
<td>SELV circuit</td>
<td>Safety Extra-Low Voltage circuit type according to IEC60255-27</td>
</tr>
<tr>
<td>SFP</td>
<td>Small form-factor pluggable (abbreviation) Optical Ethernet port (explanation)</td>
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</table>

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<tr>
<td>SLM</td>
<td>Serial communication module.</td>
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<tr>
<td>SMA connector</td>
<td>Subminiature version A, A threaded connector with constant impedance.</td>
</tr>
<tr>
<td>SMT</td>
<td>Signal matrix tool within PCM600</td>
</tr>
<tr>
<td>SMS</td>
<td>Station monitoring system</td>
</tr>
<tr>
<td>SNTP</td>
<td>Simple network time protocol – is used to synchronize computer clocks on local area networks. This reduces the requirement to have accurate hardware clocks in every embedded system in a network. Each embedded node can instead synchronize with a remote clock, providing the required accuracy.</td>
</tr>
<tr>
<td>SOF</td>
<td>Status of fault</td>
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<tr>
<td>SPA</td>
<td>Strömberg Protection Acquisition (SPA), a serial master/slave protocol for point-to-point and ring communication.</td>
</tr>
<tr>
<td>SRY</td>
<td>Switch for CB ready condition</td>
</tr>
</tbody>
</table>
ST  Switch or push button to trip
Starpoint  Neutral/Wye point of transformer or generator
SVC  Static VAr compensation
TC  Trip coil
TCS  Trip circuit supervision
TCP  Transmission control protocol. The most common transport layer protocol used on Ethernet and the Internet.
TCP/IP  Transmission control protocol over Internet Protocol. The de facto standard Ethernet protocols incorporated into 4.2BSD Unix. TCP/IP was developed by DARPA for Internet working and encompasses both network layer and transport layer protocols. While TCP and IP specify two protocols at specific protocol layers, TCP/IP is often used to refer to the entire US Department of Defense protocol suite based upon these, including Telnet, FTP, UDP and RDP.
TEF  Time delayed ground-fault protection function
TLS  Transport Layer Security
TM  Transmit (disturbance data)
TNC connector  Threaded Neill-Concelman, a threaded constant impedance version of a BNC connector
TP  Trip (recorded fault)
TPZ, TPY, TPX, TPS  Current transformer class according to IEC
TRM  Transformer Module. This module transforms currents and voltages taken from the process into levels suitable for further signal processing.
TYP  Type identification
UMT  User management tool
Underreach  A term used to describe how the relay behaves during a fault condition. For example, a distance relay is underreaching when the impedance presented to it is greater than the apparent impedance to the fault applied to the balance point, that is, the set reach. The relay does not "see" the fault but perhaps it should have seen it. See also Overreach.
UTC  Coordinated Universal Time. A coordinated time scale, maintained by the Bureau International des Poids et Mesures (BIPM), which forms the basis of a coordinated dissemination of standard frequencies and time signals. UTC is derived from International Atomic Time (TAI) by the addition of a whole number of "leap seconds" to synchronize it with Universal Time 1 (UT1), thus allowing for the eccentricity of the Earth's orbit, the rotational axis tilt (23.5 degrees), but still showing the Earth's irregular rotation, on which UT1 is based. The Coordinated Universal Time is expressed using a 24-hour clock, and uses the Gregorian calendar. It is used for aeroplane and ship navigation, where it is also sometimes known by the military name, "Zulu time." "Zulu" in the phonetic alphabet stands for "Z", which stands for longitude zero.
UV  Undervoltage
WEI  Weak end infeed logic
VT  Voltage transformer
X.21  A digital signalling interface primarily used for telecom equipment

$3I_0$  Three times zero-sequence current. Often referred to as the residual or the ground-fault current

$3V_0$  Three times the zero sequence voltage. Often referred to as the residual voltage or the neutral point voltage