Copyright

This document and parts thereof must not be reproduced or copied without written permission from ABB, and the contents thereof must not be imparted to a third party, nor used for any unauthorized purpose.

The software and hardware described in this document is furnished under a license and may be used or disclosed only in accordance with the terms of such license.

This product includes software developed by the OpenSSL Project for use in the OpenSSL Toolkit. (http://www.openssl.org/) This product includes cryptographic software written/developed by: Eric Young (eay@cryptsoft.com) and Tim Hudson (tjh@cryptsoft.com).

Trademarks

ABB and Relion are registered trademarks of the ABB Group. All other brand or product names mentioned in this document may be trademarks or registered trademarks of their respective holders.

Warranty

Please inquire about the terms of warranty from your nearest ABB representative.
Disclaimer

The data, examples and diagrams in this manual are included solely for the concept or product description and are not to be deemed as a statement of guaranteed properties. All persons responsible for applying the equipment addressed in this manual must satisfy themselves that each intended application is suitable and acceptable, including that any applicable safety or other operational requirements are complied with. In particular, any risks in applications where a system failure and/or product failure would create a risk for harm to property or persons (including but not limited to personal injuries or death) shall be the sole responsibility of the person or entity applying the equipment, and those so responsible are hereby requested to ensure that all measures are taken to exclude or mitigate such risks.

This document has been carefully checked by ABB but deviations cannot be completely ruled out. In case any errors are detected, the reader is kindly requested to notify the manufacturer. Other than under explicit contractual commitments, in no event shall ABB be responsible or liable for any loss or damage resulting from the use of this manual or the application of the equipment.
Conformity

This product complies with the directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive 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.
Table of contents

Section 1

Introduction...............................................................................................................5
1.1 This manual......................................................................................................... 5
1.2 Intended audience.......................................................................................... 5
1.3 Product documentation.................................................................................. 6
1.3.1 Product documentation set.......................................................................... 6
1.3.2 Document revision history........................................................................... 7
1.3.3 Related documents...................................................................................... 7
1.4 Document symbols and conventions............................................................. 9
1.4.1 Symbols....................................................................................................... 9
1.4.2 Document conventions.............................................................................. 10

Section 2

Safety information................................................................................................11
2.1 Symbols on the product.................................................................................. 11
2.2 Warnings......................................................................................................... 11
2.3 Caution signs................................................................................................. 12

Section 3

Environmental aspects.........................................................................................15
3.1 Sustainable development............................................................................ 15
3.2 Disposing of the IED.................................................................................... 15

Section 4

Overview.................................................................................................................17
4.1 Local HMI...................................................................................................... 17
4.1.1 Display...................................................................................................... 18
4.1.2 LEDs....................................................................................................... 20
4.1.3 Keypad..................................................................................................... 21
4.1.4 Local HMI functionality.......................................................................... 24
4.1.4.1 Protection and alarm indication......................................................... 24
4.1.4.2 Parameter management................................................................. 25
4.1.4.3 Front communication................................................................. 26
4.1.4.4 Single-line diagram....................................................................... 26
4.2 Authorization................................................................................................. 27
4.3 Communication.............................................................................................. 29
4.4 PCM600 tool................................................................................................. 30
4.4.1 Connectivity packages........................................................................... 30

Section 5

Using the HMI....................................................................................................... 31
5.1 Using the local HMI....................................................................................... 31
5.1.1 On-screen keyboard................................................................................ 31
5.1.2 Logging on............................................................................................... 32
5.1.3 Logging off............................................................................................. 34
5.1.4 Turning the display backlight on............................................................ 34
5.1.5 Selecting local or remote use................................................................. 34
# Table of contents

## Section 6 IED operation ................................................................. 47
6.1 Normal operation...................................................................... 47
  6.2 Disturbance identification.................................................. 47
    6.2.1 Disturbance recording triggering................................. 48
    6.2.2 Disturbance record analysis......................................... 48
    6.2.3 Disturbance reports..................................................... 48
    6.2.4 IED self-supervision................................................... 48
    6.2.5 Non-operative functions............................................. 48
6.3 IED parameterization............................................................ 49
  6.3.1 IED settings for IED functionality.................................. 49
  6.3.2 IED settings for different operating conditions.............. 49

## Section 7 Operating procedures .................................................. 51
7.1 Monitoring................................................................................ 51
  7.1.1 Indications................................................................. 51
    7.1.1.1 Using auto-indication messages.............................. 51
    7.1.1.2 Monitoring alarm data.......................................... 52
    7.1.1.3 Monitoring an internal IED fault............................ 53
7.1.2 Measured and calculated values........................................ 53
  7.1.2.1 Measured values....................................................... 53
  7.1.2.2 Using the local HMI for monitoring.......................... 53
7.1.3 Recorded data..................................................................... 54
  7.1.3.1 Creating disturbance recordings............................... 54
  7.1.3.2 Monitoring disturbance recorder data....................... 54
  7.1.3.3 Controlling and reading disturbance recorder data....... 55
7.1.4 Remote monitoring.......................................................... 56
  7.1.4.1 Monitoring the IED remotely..................................... 56

## 5.1.6 Identifying the device.......................................................... 35
5.1.7 Adjusting the display contrast.......................................... 35
5.1.8 Changing the local HMI language...................................... 36
5.1.9 Navigating in the menu..................................................... 36
5.1.9.1 Menu structure......................................................... 36
5.1.9.2 Scrolling the display.................................................. 36
5.1.9.3 Changing the default view.......................................... 37
5.1.10 Using function buttons................................................... 37
5.1.11 Using the single-line diagram........................................ 38
5.1.12 Browsing setting values................................................ 39
5.1.13 Editing values............................................................... 40
  5.1.13.1 Editing numerical values....................................... 40
  5.1.13.2 Editing string values............................................. 42
  5.1.13.3 Editing enumerated values.................................... 43
  5.1.13.4 Changing time settings in LHMI............................ 43
5.1.14 Saving settings............................................................... 43
5.1.15 Clearing and acknowledging.......................................... 44
5.1.16 Using the local HMI help................................................ 44

Section 6 IED operation ......................................................................................... 47
  6.1 Normal operation...................................................................... 47
  6.2 Disturbance identification................................................... 47
    6.2.1 Disturbance recording triggering................................. 48
    6.2.2 Disturbance record analysis......................................... 48
    6.2.3 Disturbance reports..................................................... 48
    6.2.4 IED self-supervision................................................... 48
    6.2.5 Non-operative functions............................................. 48
  6.3 IED parameterization............................................................ 49
    6.3.1 IED settings for IED functionality................................ 49
    6.3.2 IED settings for different operating conditions.............. 49

Section 7 Operating procedures ............................................................................. 51
  7.1 Monitoring................................................................................ 51
    7.1.1 Indications................................................................. 51
      7.1.1.1 Using auto-indication messages.............................. 51
      7.1.1.2 Monitoring alarm data.......................................... 52
      7.1.1.3 Monitoring an internal IED fault............................ 53
    7.1.2 Measured and calculated values.................................... 53
      7.1.2.1 Measured values....................................................... 53
      7.1.2.2 Using the local HMI for monitoring.......................... 53
  7.1.3 Recorded data..................................................................... 54
    7.1.3.1 Creating disturbance recordings............................... 54
    7.1.3.2 Monitoring disturbance recorder data....................... 54
    7.1.3.3 Controlling and reading disturbance recorder data....... 55
  7.1.4 Remote monitoring.......................................................... 56
    7.1.4.1 Monitoring the IED remotely..................................... 56
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

![Diagram of product documentation lifecycle]

Figure 1: The intended use of manuals throughout the product lifecycle

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, as well as communication engineering for IEC 61850.

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.

### 1.3.2 Document revision history

<table>
<thead>
<tr>
<th>Document revision/date</th>
<th>History</th>
</tr>
</thead>
<tbody>
<tr>
<td>~ /May 2017</td>
<td>First release</td>
</tr>
<tr>
<td>A/October 2017</td>
<td>Information updated</td>
</tr>
<tr>
<td>B/March 2018</td>
<td>2.2 Maintenance release 1</td>
</tr>
<tr>
<td>C/June 2018</td>
<td>Added new functions and resolved bugs</td>
</tr>
<tr>
<td>D/November 2018</td>
<td>Added harmonic, delta, and PSTPDIF functions</td>
</tr>
</tbody>
</table>

### 1.3.3 Related documents

#### Documents related to REB670

<table>
<thead>
<tr>
<th>Document numbers</th>
<th>Document numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application manual</td>
<td>1MRK 505 370-UEN</td>
</tr>
<tr>
<td>Commissioning manual</td>
<td>1MRK 505 372-UEN</td>
</tr>
<tr>
<td>Product guide</td>
<td>1MRK 505 373-BEN</td>
</tr>
<tr>
<td>Technical manual</td>
<td>1MRK 505 371-UEN</td>
</tr>
<tr>
<td>Type test certificate</td>
<td>1MRK 505 373-TEN</td>
</tr>
</tbody>
</table>

#### Documents related to REC670

<table>
<thead>
<tr>
<th>Document numbers</th>
<th>Document numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application manual</td>
<td>1MRK 511 401-UEN</td>
</tr>
<tr>
<td>Commissioning manual</td>
<td>1MRK 511 403-UEN</td>
</tr>
<tr>
<td>Product guide</td>
<td>1MRK 511 404-BEN</td>
</tr>
<tr>
<td>Technical manual</td>
<td>1MRK 511 402-UEN</td>
</tr>
<tr>
<td>Type test certificate</td>
<td>1MRK 511 404-TEN</td>
</tr>
</tbody>
</table>
### Documents related to RED670

<table>
<thead>
<tr>
<th>Document Type</th>
<th>Document Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application manual</td>
<td>1MRK 505 376-UEN</td>
</tr>
<tr>
<td>Commissioning manual</td>
<td>1MRK 505 378-UEN</td>
</tr>
<tr>
<td>Product guide</td>
<td>1MRK 505 379-BEN</td>
</tr>
<tr>
<td>Technical manual</td>
<td>1MRK 505 377-UEN</td>
</tr>
<tr>
<td>Type test certificate</td>
<td>1MRK 505 379-TEN</td>
</tr>
</tbody>
</table>

### Documents related to REG670

<table>
<thead>
<tr>
<th>Document Type</th>
<th>Document Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application manual</td>
<td>1MRK 502 071-UEN</td>
</tr>
<tr>
<td>Commissioning manual</td>
<td>1MRK 502 073-UEN</td>
</tr>
<tr>
<td>Product guide</td>
<td>1MRK 502 074-BEN</td>
</tr>
<tr>
<td>Technical manual</td>
<td>1MRK 502 072-UEN</td>
</tr>
<tr>
<td>Type test certificate</td>
<td>1MRK 502 074-TEN</td>
</tr>
</tbody>
</table>

### Documents related to REL670

<table>
<thead>
<tr>
<th>Document Type</th>
<th>Document Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application manual</td>
<td>1MRK 506 369-UEN</td>
</tr>
<tr>
<td>Commissioning manual</td>
<td>1MRK 506 371-UEN</td>
</tr>
<tr>
<td>Product guide</td>
<td>1MRK 506 372-BEN</td>
</tr>
<tr>
<td>Technical manual</td>
<td>1MRK 506 370-UEN</td>
</tr>
<tr>
<td>Type test certificate</td>
<td>1MRK 506 372-TEN</td>
</tr>
</tbody>
</table>

### Documents related to RET670

<table>
<thead>
<tr>
<th>Document Type</th>
<th>Document Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application manual</td>
<td>1MRK 504 163-UEN</td>
</tr>
<tr>
<td>Commissioning manual</td>
<td>1MRK 504 165-UEN</td>
</tr>
<tr>
<td>Product guide</td>
<td>1MRK 504 166-BEN</td>
</tr>
<tr>
<td>Technical manual</td>
<td>1MRK 504 164-UEN</td>
</tr>
<tr>
<td>Type test certificate</td>
<td>1MRK 504 166-TEN</td>
</tr>
</tbody>
</table>

### Documents related to RES670

<table>
<thead>
<tr>
<th>Document Type</th>
<th>Document Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application manual</td>
<td>1MRK 511 407-UEN</td>
</tr>
<tr>
<td>Commissioning manual</td>
<td>1MRK 511 409-UEN</td>
</tr>
<tr>
<td>Product guide</td>
<td>1MRK 511 410-BEN</td>
</tr>
<tr>
<td>Technical manual</td>
<td>1MRK 511 408-UEN</td>
</tr>
<tr>
<td>Type test certificate</td>
<td>1MRK 511 410-TEN</td>
</tr>
</tbody>
</table>

### Documents related to RER670

<table>
<thead>
<tr>
<th>Document Type</th>
<th>Document Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application manual</td>
<td>1MRK 506 375-UEN</td>
</tr>
<tr>
<td>Commissioning manual</td>
<td>1MRK 506 377-UEN</td>
</tr>
<tr>
<td>Product guide</td>
<td>1MRK 506 378-BEN</td>
</tr>
<tr>
<td>Technical manual</td>
<td>1MRK 506 376-UEN</td>
</tr>
<tr>
<td>Type test certificate</td>
<td>1MRK 506 378-TEN</td>
</tr>
</tbody>
</table>
### 1.4 Document symbols and conventions

#### 1.4.1 Symbols

![Electrical Warning Icon]

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

![Warning Icon]

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

![Caution Hot Surface Icon]

The caution hot surface icon indicates important information or warning about the temperature of product surfaces.

![Class 1 Laser Product]

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

![Caution Icon]

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 \( \uparrow \) and \( \downarrow \).
- 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 \( \text{Enter} \).
- 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.

![Warning symbol]

Read the entire manual before doing installation or any maintenance work on the product.

![Warning symbol]

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

![Warning symbol]

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

![Warning symbol]

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.

![Warning symbol]

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.

![Warning symbol]

Do not touch circuitry during operation. Potentially lethal voltages and currents are present.

![Warning symbol]

Always use suitable isolated test pins when measuring signals in open circuitry. Potentially lethal voltages and currents are present.

![Warning symbol]
Never connect or disconnect a wire and/or a connector to or from a 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 earth, 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 earthed.

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 earth 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.
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>
<thead>
<tr>
<th>IED</th>
<th>Parts</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit</td>
<td>Metallic plates, parts and screws</td>
<td>Steel and aluminum</td>
</tr>
<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>Unit</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>
</tr>
</tbody>
</table>

1) Polycarbonate  
2) Liquid crystal polymer
### Section 4  Overview

#### 4.1 Local HMI

![Local Human-Machine Interface](EC00002R-3-en.png)

**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 amount of characters and rows fitting the view depends on the character size and the view that is shown.

The display view is divided into four basic areas.

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.
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.
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](IEC13000240-1-en.vsd)

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 status LEDs above the display: Ready, Start 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 ![I](Image 1) and ![O](Image 2). These LEDs can indicate the status of two arbitrary binary signals by configuring the OPENCLOSE_LED function block. For instance, OPENCLOSE_LED can be connected to a circuit breaker to indicate the breaker open/close status on the LEDs.
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: OPENCLOSE_LED connected to SXCBR
Figure 8: 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 Down</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>Left Right</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>Key</td>
<td>• Activating the authorization procedure, when the user is not logged in. • Logging out, when the user is currently logged in.</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 Ready, Start and Trip.

The yellow and red status LEDs are configured in the disturbance recorder function, DRPRDRE, by connecting a start or trip signal from the actual function to a BxRBDR binary input function block using the PCM600 and configure the setting to Off, Start or Trip for that particular signal.

Table 6: Ready 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: Start 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 started and an indication message is displayed. The start 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>
<tr>
<td>On</td>
<td>• Follow-S sequence: The activation signal is on.</td>
</tr>
<tr>
<td></td>
<td>• LatchedColl-S sequence: The activation signal is on, or it is off but the indication has not been acknowledged.</td>
</tr>
<tr>
<td></td>
<td>• LatchedAck-F-S sequence: The indication has been acknowledged, but the activation signal is still on.</td>
</tr>
<tr>
<td></td>
<td>• LatchedAck-S-F sequence: The activation signal is on, or it is off but the indication has not been acknowledged.</td>
</tr>
<tr>
<td></td>
<td>• LatchedReset-S sequence: The activation signal is on, or it is off but the indication has not been acknowledged.</td>
</tr>
<tr>
<td>Flashing</td>
<td>• Follow-F sequence: The activation signal is on.</td>
</tr>
<tr>
<td></td>
<td>• LatchedAck-F-S sequence: The activation signal is on, or it is off but the indication has not been acknowledged.</td>
</tr>
<tr>
<td></td>
<td>• LatchedAck-S-F sequence: The indication has been acknowledged, but the activation signal is still on.</td>
</tr>
</tbody>
</table>

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 9: RJ-45 communication port and green indicator LED](image)

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 255.255.254.0. It can be set through the local HMI path **Main menu/Configuration/Communication/Ethernet configuration/Front port/AP_FRONT**.

Ensure not to change the default IP address of the IED.

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>
<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>
</tbody>
</table>
### User roles

<table>
<thead>
<tr>
<th>Role</th>
<th>Role explanation</th>
<th>User rights</th>
</tr>
</thead>
<tbody>
<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

### User Management Settings

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 login can be performed. This time is settable 10 minutes to 60 minutes.

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

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
For user management, see Cyber security deployment guideline.

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/UCA 61850-9-2LE, SPA, IEC 60870-5-103, LON, DNP3, C37.118 and IEEE1344.

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 inter-operates 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 LC connector, that is 100BASE-FX)</td>
<td>IEC 61850, FTP, C37.118, IEEE1344, PTP, HSR, PRP, SNTP</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, PTP 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 PCM600 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 11: 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.

- To insert a character navigate to the desired character in the middle three key rows with 
  ↑↓←→ and confirm each character with 
- To delete a character press 
- To clear a whole string press 

Figure 12: On-screen keyboard
### 5.1.2 Logging on

1. Press \( \text{Login button} \) to activate the login procedure. The login is also activated when attempting a password-protected operation.
2. Press \( \text{User field button} \) 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 \( \text{OK button} \) while the user field is focused (or navigate to the OK button and press \( \text{OK button} \)), or press \( \text{Cancel button} \) to abort the login attempt. If CAM is not activated select the user by scrolling with \( \text{Up button} \) and \( \text{Down button} \) and press \( \text{Confirm button} \) to confirm.

![Figure 13: Selecting the user name](IEC12000161-3-en.vsd)

4. Select \( \text{OK} \) on the on-screen keyboard and press \( \text{OK button} \) to stop editing the user name.
5. Press \( \text{Password field button} \) to select the Password field and press \( \text{Activate button} \) 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 \( \text{Cancel button} \) while the password field is focused (or navigate to the OK button and press \( \text{OK button} \)) to attempt to login, or press \( \text{Cancel button} \) (or navigate to the Cancel button and press \( \text{Cancel button} \)) to abort the login attempt.

When the cursor is moved, the newly selected character is shown for a short time.

![Password input](IEC15000061-3-en.vsd)

6. Type in the password using the on-screen keyboard.
Figure 14: Entering the password

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 to stop editing the password.

8. Select OK in the Log on dialog and press or Cancel to confirm the login, or press or Cancel to cancel the procedure. If the login fails, a message is displayed on the display.

Figure 15: Error message indicating an incorrect password

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

Figure 16: Error message indicating blocked ID

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 17: 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 $\text{Log off}$.
2. To confirm logoff, select $\text{Yes}$ and press $\text{ESC}$.

![Figure 18: Logging off](attachment:IEC12000159-3-en.vsd)

* To cancel logoff, press $\text{ESC}$.

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.

Change the backlight timeout period in $\text{Main menu/Configuration/HMI/Screen/SCREEN:1/DisplayTimeout}$.

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 $\text{R/L}$.
  - 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 ↓.

![Main menu/Diagnostics/IED status](image)

*Figure 19: Selecting a submenu*

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 → and ↑.
- To decrease the contrast, press simultaneously → 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 to the Main menu or default view, press ↓.
- To move up or down in a menu, press ↑ or ↓.
- To move downwards in the menu tree, press ←.
- To move upwards in the menu tree, press →.
- To enter setting mode, press ←.
- To leave setting mode without saving, press 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.
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.
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 \textit{ESC} 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.

\section*{5.1.11 Using the single-line diagram}

The single-line diagram is created with PCM600.

1. Select \textit{Main menu/Control/Single line diagram}. The single-line diagram view is displayed.
Figure 23: Example of a single-line diagram

2. Select an object with ↑ or ↓.

Selection of an object is indicated with a square border that moves when ↑ and ↓ are used.

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 select open or  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 ← or →.

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.

<table>
<thead>
<tr>
<th>Edit setting group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setting groups:</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
</tbody>
</table>

Figure 24: 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.
Section 5
Using the HMI

**Figure 25: 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 ←.

**Figure 26: 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.
Figure 27: Last digit is active and it can be increased or decreased

2. Press \( \uparrow \) to increase or \( \downarrow \) 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 \( \leftarrow \) or \( \rightarrow \) 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 \( \uparrow \).
   * To set the value to the minimum, press \( \downarrow \).

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 \( \uparrow \), the previous value can be restored by pressing \( \downarrow \) once, and vice versa. Another press of \( \uparrow \) or \( \downarrow \) sets the value to the lower or higher limit. The symbol in front of the value is \( \uparrow \), 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.
2. Press \( \text{Previous} \) to open the editor. An on-screen keyboard is shown on the HMI.
3. Editing can be aborted at any time by pressing \( \text{Cancel} \) or by using the Cancel button on the on-screen keyboard.
4. Press \( \text{Up} \) or \( \text{Down} \) to select the edited string and press \( \text{Previous} \) or \( \text{Next} \) to move the cursor.
4. Edit the string using the on-screen keyboard.
5. Select OK on the on-screen keyboard or press left 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:1) the change will take affect immediately. To confirm the new setting press enter. 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 enter to confirm any changes.
2. Press ↑ or ↓ 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 enter.

* To exit without saving changes, select No and press left.
* To cancel saving settings, select Cancel and press left.

Figure 29: Confirming settings
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 to activate the Clear view.

   ![Clearing and acknowledging](IEC13000236-1-en.vsd)

   **Figure 30: 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 to open the help view.

2. Scroll the text with ↑ or ↓ if the help text exceeds the display area.

3. To close the help, press ➔.

   The help dialog is also closed when the display timeout expires.
### Figure 31: Help menu

<table>
<thead>
<tr>
<th>Key</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>How to use the keys</td>
</tr>
<tr>
<td>S</td>
<td>Alarm: Cycle through alarm pages</td>
</tr>
<tr>
<td>C</td>
<td>Clear: Go to clear menu</td>
</tr>
<tr>
<td>M</td>
<td>Menu: Toggle between main menu / default menu</td>
</tr>
<tr>
<td>?</td>
<td>Show help</td>
</tr>
<tr>
<td>R/L</td>
<td>Change command operator</td>
</tr>
<tr>
<td>Ch</td>
<td>Execute / enter</td>
</tr>
<tr>
<td>Key</td>
<td>Log on dialog</td>
</tr>
<tr>
<td>ESC</td>
<td>Exit / discard</td>
</tr>
<tr>
<td>1</td>
<td>Close selected switch</td>
</tr>
</tbody>
</table>
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: Ready, Start and Trip. During normal operation, the Ready LED is steady green.

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

<table>
<thead>
<tr>
<th>LED</th>
<th>State</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start LED</td>
<td>Yellow, steady</td>
<td>Protection started</td>
</tr>
<tr>
<td>Trip LED</td>
<td>Red, steady</td>
<td>Protection operated</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 Disturbance recording triggering

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

6.2.2 Disturbance record analysis

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

For more information, see PCM600 documentation.

6.2.3 Disturbance reports

PCM600 can be used for creating reports of disturbance 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 Ready LED.

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

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

The IED records IED status data and events.

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

6.2.5 Non-operative functions

Protection and control functions can be non-operative if:

- function is not turned on, that is, Operation = Off.
- function is connected to bad or lost input data from MU.
- function is set to a non-operative state by IEC 61850.
Non-operative functions, functions that are blocked due to bad or lost data from MU and functions set to a non-operative state by IEC 61850 are listed on the LHMI under **Main menu/Test/Function overview**.

<table>
<thead>
<tr>
<th>Functions</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>operation OFF</td>
<td>0</td>
</tr>
<tr>
<td>Functions blocked</td>
<td>0</td>
</tr>
<tr>
<td>IEC 61850 status</td>
<td>0</td>
</tr>
</tbody>
</table>

### 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: Ready, Start 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 \[ \] to open the alarm view.
2. Press \[ \] or \[ \] to move between active alarms in the page, or press \[ \] to switch between the three alarm pages.
3. Press \[ \] to open a dialog box that shows more detailed information about the selected alarm.
4. Press \[ \] or \[ \] to close the dialog box.
5. Press \[ \] to close the alarm view.
6. Press \[ \] to activate the Clear view and to clear alarms.
7.1.3 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.

<table>
<thead>
<tr>
<th>Item</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal fault</td>
<td>Off</td>
</tr>
<tr>
<td>Internal warning</td>
<td>Off</td>
</tr>
<tr>
<td>Time synch</td>
<td>Ready</td>
</tr>
<tr>
<td>Real time clock</td>
<td>Ready</td>
</tr>
<tr>
<td>Application</td>
<td>Ready</td>
</tr>
<tr>
<td>Runtime execution</td>
<td>Ready</td>
</tr>
<tr>
<td>IEC61850</td>
<td>Ready</td>
</tr>
<tr>
<td>DHF3</td>
<td>Ready</td>
</tr>
<tr>
<td>PSN1</td>
<td>Ready</td>
</tr>
<tr>
<td>BM13</td>
<td>Ready</td>
</tr>
<tr>
<td>BM4</td>
<td>Ready</td>
</tr>
<tr>
<td>ICM5</td>
<td>Ready</td>
</tr>
<tr>
<td>NUM38</td>
<td>Ready</td>
</tr>
<tr>
<td>GLM38</td>
<td>Ready</td>
</tr>
</tbody>
</table>

**Figure 34: 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.

- Disturbance records
- Events

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 On 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 or .
3. Press to execute manual triggering.

![Figure 35: Manual triggering](IEC13000261-1-en.vsd)

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. All disturbance records are listed.
2. Scroll the view with or .
To view a specific disturbance record, press \( \text{enter} \). A list of detail categories is displayed.

![Figure 36: Monitoring disturbance recorder via the LHMI](image)

To select a category and view the items under it, press \( \text{up} \) or \( \text{down} \) and then \( \text{enter} \).

**7.1.3.3 Controlling and reading disturbance recorder data**

Disturbance 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 **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.

![](IEC13000264-1-en.vsd)

**Figure 38: 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 disturbance record data.
- Create disturbance records.
- Monitor IED values.

For more information, see PCM600 documentation.
7.1.5 Through fault monitoring report

Through fault reports can be viewed via the user interface using either the PCM tool or the local HMI. Additionally, the IED generates through fault reports those can be exported using multiple ways.

7.1.5.1 Through fault monitoring tool

The through fault monitoring report can be viewed using a specific tool known as through fault monitoring using PCM600 tool. This tool can store last 100 through faults and each through fault details can be viewed using this tool. The collected data can either be retrieved as a direct file transfer from the IED or be exported using PCM600 tool.

Starting the through fault monitoring tool

Proceed as follows to start the through fault monitoring tool from the IED level:

1. Right click on the Plant Structure of an IED.
2. Select the Through Fault Monitoring from the context menu as shown in Figure 39.

![Figure 39: Starting the through fault monitoring tool](image)

The through fault reports are read from the IED and the tool gets started. By default, fault reports related to the latest function instances are displayed.

User interface

The through fault monitoring tool consists of Through Fault Monitoring tab. The tab contains two sets of table; an overview of all individual through fault events and detailed report of a selected through fault event, as shown in Figure 40.
Through fault reports table
The through fault reports table is an overview of fault reports. It displays the available fault reports from the IED. It is possible to select a specific through fault and create a list view for that specific through fault. The through fault reports table contains the latest 100 records per function block instance.

As shown in Figure 41, the through fault reports table consist of Instance number, Fault number, and Date and time columns respectively.

- The Instance number column contains data related to the function block instance number.
- The Fault number column contains serial number of the fault reports.
- The Date and time column shows the date and time when the fault has occurred.
Selected through fault report data table
The report data table shows a detailed view of the selected through fault report. Based on the PTRSTHR function configuration, the windings columns are displayed. If the function is configured with two windings, Winding 1 and Winding 2 columns are displayed in the report data table. Based on the through fault reports data in the IED, visibility of the columns in the Report overview table are handled dynamically.

In case of 2-winding transformers:

- The Winding 3 column is hidden and not shown in the report overview table.
- The Winding 3 related data will have zero values corresponding to General and Name columns.

![Selected Through Fault Report Data](image)

Figure 42: Selected through fault report data table

Reading through fault reports from the IED
To read the through fault reports from the IED, perform either one of the following:

- Select the IED menu and click on the Read through fault reports option.
- Click on the Read through fault reports [button on the tool bar.

The through fault reports are read from the IED, and a confirmation dialog box appears.
In order to open the TFM tool successfully in PCM600, the configuration between the PCM600 tool and the IED should match. If the configuration is not same between the PCM600 tool and the IED, then read configuration from IED via Read from IED option in PCM600 need to be performed.

A warning message dialog box appears, if the through fault monitoring function is not configured in the IED.

Deleting through fault reports from the IED
In order to delete through fault reports from the IED via PCM600 at function block instance level, proceed as follows:

1. Select the function block instance from the Through fault monitoring function selection combo box as shown in Figure 44.

2. Select the IED menu and click on Clear through fault reports option as shown in Figure 45.

A confirmation dialog box appears.
3. Click on the Yes button to confirm the deletion. The through fault reports are deleted from the IED, and a confirmation dialog box appears.

In order to delete through fault reports for all function instances from an IED, select All option from the through fault monitoring selection combo box.

Authentication pop-up dialog box is displayed if external users (CAM/UAM) are defined in the IED. The roles with IEDCmd – Advanced right are allowed to clear through fault reports from an IED via PCM600.

Exporting through fault reports files
Proceed as follows to export through fault reports files from the IED via PCM600:

1. Click on the export reports option from the tool bar to export report files from the IED. A confirmation message appears upon exporting the through fault reports files from an IED.
The through fault reports are exported into PCMDataBases folder as shown in Figure 49.

7.1.5.2 Through fault monitoring using local HMI

The list of saved through fault reports those are grouped based on the instance can be found on the local HMI under Main menu/Measurements/Through fault reports. The reports list contains date and time of the through fault and the latest report is displayed first. As shown in Figure 50, the local HMI mapped inputs can be displayed by entering each through fault report.

Figure 49: PCMDataBases folder

Figure 50: Local HMI through fault report view
An instance specific clear option is provided to delete all the through fault reports from local HMI.

Through fault monitoring report handling
The through fault monitoring creates fault report for each through fault event. The through fault information is stored in a zipped .xml file in the IED under flash/frep folder. Each instance can have maximum 100 reports. Information in the through fault report is grouped into four sections; the general section and other three sections containing individual winding and phase-wise through fault data. The outputs given as ‘general data’ and ‘winding wise for all phases’ in the through fault monitoring report are shown in Table 14.

Table 14: Through fault monitoring report outputs

<table>
<thead>
<tr>
<th>General data</th>
<th>Winding wise for all phases</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Test mode status</td>
<td>• Number of faults</td>
</tr>
<tr>
<td>• Fault duration in seconds</td>
<td>• Event wise maximum peak current</td>
</tr>
<tr>
<td>• Overall number of faults</td>
<td>• Event wise RMS current</td>
</tr>
<tr>
<td>• Event wise maximum peak current W1</td>
<td>• Event wise ( I^2t )</td>
</tr>
<tr>
<td>• Event wise maximum peak current W2</td>
<td>• Event wise ( I^2t ) in % of set limit</td>
</tr>
<tr>
<td>• Event wise maximum peak current W3</td>
<td>• Delta ( I^2t ) compared to prior fault</td>
</tr>
<tr>
<td>• Event wise RMS current W1</td>
<td>• Cumulative maximum peak current</td>
</tr>
<tr>
<td>• Event wise RMS current W2</td>
<td>• Cumulative maximum peak current</td>
</tr>
<tr>
<td>• Event wise RMS current W3</td>
<td>• Cumulative ( I^2t )</td>
</tr>
<tr>
<td>• Event wise ( I^2t ) in % of set limit</td>
<td>• Cumulative ( I^2t ) in % of set limit</td>
</tr>
</tbody>
</table>

In case of 2-winding transformers:
- The Winding 3 section is excluded from the report
- The Winding 3 information under general section will have zero values

Each report is created with a unique identifier. For example, the second through fault report of the first instance will have report identifier as frep_1_2.zip. The first digit in the identifier indicates the instance number and the second digit represents the report number.

The through fault report can be read using the FTP client, PCM600 tool or via IEC61850 MMS file transfer.

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 ↑ or ↓.
Selection of object is indicated with a square border that moves when and are used.
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 select open or to select close the object.
4. Press to confirm the operation.

![Single Line Diagram]

**Figure 51:** Opening a circuit breaker

* 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 to activate the Clear view.
   All the items that can be cleared are shown.
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.
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.

Do not switch off the auxiliary power supply to the IED before changes. For example, when setting parameter 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 ▼.
2. Select the setting group with ↑ or ↓.
3. Press → to confirm the selection or ← 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.

Figure 54: 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 →.

Figure 55: Changing the setting group

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.
To browse the function blocks, scroll the list with \[\uparrow\] and \[\downarrow\]. Function blocks available depend on the application configuration. To move back to the list, press \[\leftarrow\].

To select a function block, press \[\rightarrow\].

8. To browse the settings, scroll the list with \[\uparrow\] and \[\downarrow\].

9. To edit the selected setting, press \[\rightarrow\].

- 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 *.
### 7.4.2 Activating LEDs

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

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

![Figure 59: Alarm groups](IEC13000056-2-en.vsd)

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

![REX060 front panel diagram]

Figure 60: REX060 front panel
Table 15: 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>
</tbody>
</table>
| ![Cursor Movement Arrows](image) | - Moves the cursor in the direction of the arrows  
- When the cursor is in the value change state, pressing the up button increases the value and pressing the down button decreases the value. |
| ![Clear Button](image) | Pressing the clear button cancels changes that have not been stored. |
| ![Enter Button](image) | Pressing the enter button stores the changed value. If the value is outside range, the limit value is stored. |

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 61 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.
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.
### 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 16.

**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, REX062 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 blocked functions

1. Check the list of blocked functions from the LHMI under Main menu/Diagnostics/IED status/Function overview.
2. Check the settings for the 9-2LE receiver and associated cabling.
3. In case of persistent faults, contact ABB for corrective actions.

9.1.4  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.
9.1.4.1 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 on the LHMI 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/Ethernet status/Front port/FrontStatus:1**. Check that the **LinkStatus** 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 rear ports via the LHMI in **Main menu/Diagnostics/Communication/Ethernet status/Access points**. The communication ports on the rear side of the IED are for optical Ethernet via ST connectors.
   - Check that the **LinkStatus** value is 1, that is, the communication is working. When the value is 0, there is no communication link.

9.1.4.2 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 **Ready** when the synchronization is in order.

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

9.1.5 Running the display test

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

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

9.1.6 Diagnosing the IED status via the LHMI hint menu

In order to help the user, there is an LHMI page labeled ‘Hints’. This page is located under **Main menu/Diagnostics/IED status/Hints**. For each activated hint there is a headline. From the headline view, an explanation page can be entered, giving the user more information and hints about the particular topic.

For example, if there is a configuration to use IEC 61850 9–2 analog data, but no data arrives on the access point, then the IED will use substituted data and most protection functions will...
be blocked. This condition will be indicated with a sub-menu under Hints, where details about this condition are shown. The Hint menu is a way to assist the user in troubleshooting.

The Hint menu is currently only available in English. All the entries are in English, regardless of which language is selected.

The supported list of hints are as follows:

**Table 19: Hint menu**

<table>
<thead>
<tr>
<th>Headline</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incorrect setting of SyncLostMode</td>
<td>There are two explanations possible:</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
|                                               | *SyncLostMode* is set to *Block*, no time source is configured to achieve the required accuracy. Unless a high accuracy time source is selected, the function dependent on high time accuracy will be blocked.  
|                                               |  
|                                               | *SyncLostMode* is set to *BlockOnLostUTC*, but there is no UTC capable synch source (GPS, IRIG-B) used. Unless a UTC capable time source is selected, the function dependent on high time accuracy will be blocked.  
| Sampled value substituted                      | `<Access Point><Hardware Module Identifier><svID>`  
|                                               | Where the Hardware Module Identifier is the same as given in PCM600, e.g. API: MU1_9201 svID: <ABB_MU0101>                                                                                                   |
| Time diff: IED vs Sampled value               | `<Access Point><Hardware Module Identifier><svID>`  
|                                               | Where the Hardware Module Identifier is the same as given in PCM600, e.g. API: MU1_9201 svID: <ABB_MU0101>                                                                                                   |
| Frequency diff: IED vs Sampled value          | `<Access Point><Hardware Module Identifier><svID>`  
|                                               | Where the Hardware Module Identifier is the same as given in PCM600, e.g. API: MU1_9201 svID: <ABB_MU0101>                                                                                                   |
| Wrong cycle time for PMU report              | Wrong cycle time on SMAI or 3PHSUM block connected to Phasor Report block. The SMAI or 3PHSUM block should have the same cycle time as that of Phasor Report.                                                |
| PMU not connected to 3ph output              | The PMU phasor report input(s) must be connected to the 3ph output of SMAI or 3PHSU.                                                                                                                                                  |
| Invalid value set for PMU Parameters          | There are two explanations possible:                                                                                                                                                                         |
|                                               |  
|                                               | Check if the following parameters are set correctly on PMUREPORT: *ReportRate* or *SvcClass* or parameter PRIMVAL:1:FrequencySel is not set as 50Hz / 60Hz.  
|                                               |  
|                                               | Check if the following parameters are set correctly on PMUREPORT: *ReportRate* or *SvcClass* or **RptTimetag** or parameter PRIMVAL:1:FrequencySel is not set as 50Hz / 60Hz.  
| Invalid phase angle reference                 | The selected *PhaseAngleRef* corresponds to an analog channel that is not configured. Please configure a valid reference channel.                                                                                   |
| GOOSE is configured on a disabled port        | At least one of the access points configured for GOOSE is disabled. The port can be disabled either through changing the access point operation to off or by unchecking the GOOSE protocol from the access point in the Ethernet configuration in PCM600 or LHMI. Please enable GOOSE on access points: AP_FRONT, AP_1 |

Table continues on next page
### 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 20: Internal fault indications**

<table>
<thead>
<tr>
<th>Fault indication</th>
<th>Additional information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Fail</td>
<td></td>
</tr>
<tr>
<td>Real Time Clock Error</td>
<td>Hardware error with the real time clock.</td>
</tr>
<tr>
<td>Internal Fail</td>
<td></td>
</tr>
<tr>
<td>Runtime Exec. Error</td>
<td>One or more of the application threads are not working properly.</td>
</tr>
<tr>
<td>Internal Fail</td>
<td></td>
</tr>
<tr>
<td>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>
</tbody>
</table>

Table continues on next page
### 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 21: 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 GOOSE Error</td>
<td>One or more access point is not able to run GOOSE due to GOOSE being deactivated on the access point, or the access point being deactivated or failing.</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 22: 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 \[\text{Log OFF}\].
2. Select Change Password and press \[\leftarrow\] to confirm.

3. Enter a new password using the on-screen keyboard. To cancel password change, press \[\text{Cancel}\].

### 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 disturbance recorder 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).

![Warning]

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.

![Warning]

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.
Figure 62: 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 On.
  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 BOOn to be operated/forced and use ← and ↑ or ↓ to operate the actual output relay.

Each BOOn 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 Off after completing these tests. The Start 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

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC</td>
<td>Alternating current</td>
</tr>
<tr>
<td>ACC</td>
<td>Actual channel</td>
</tr>
<tr>
<td>ACT</td>
<td>Application configuration tool within PCM600</td>
</tr>
<tr>
<td>A/D converter</td>
<td>Analog-to-digital converter</td>
</tr>
<tr>
<td>ADBS</td>
<td>Amplitude deadband supervision</td>
</tr>
<tr>
<td>ADM</td>
<td>Analog digital conversion module, with time synchronization</td>
</tr>
<tr>
<td>AI</td>
<td>Analog input</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
</tr>
<tr>
<td>AR</td>
<td>Autoreclosing</td>
</tr>
<tr>
<td>ASCT</td>
<td>Auxiliary summation current transformer</td>
</tr>
<tr>
<td>ASD</td>
<td>Adaptive signal detection</td>
</tr>
<tr>
<td>ASDU</td>
<td>Application service data unit</td>
</tr>
<tr>
<td>AWG</td>
<td>American Wire Gauge standard</td>
</tr>
<tr>
<td>BBP</td>
<td>Busbar protection</td>
</tr>
<tr>
<td>BFOC/2,5</td>
<td>Bayonet fiber optic connector</td>
</tr>
<tr>
<td>BFP</td>
<td>Breaker failure protection</td>
</tr>
<tr>
<td>BI</td>
<td>Binary input</td>
</tr>
<tr>
<td>BIM</td>
<td>Binary input module</td>
</tr>
<tr>
<td>BOM</td>
<td>Binary output module</td>
</tr>
<tr>
<td>BOS</td>
<td>Binary outputs status</td>
</tr>
<tr>
<td>BR</td>
<td>External bistable relay</td>
</tr>
<tr>
<td>BS</td>
<td>British Standards</td>
</tr>
<tr>
<td>BSR</td>
<td>Binary signal transfer function, receiver blocks</td>
</tr>
<tr>
<td>BST</td>
<td>Binary signal transfer function, transmit blocks</td>
</tr>
<tr>
<td>C37.94</td>
<td>IEEE/ANSI protocol used when sending binary signals between IEDs</td>
</tr>
<tr>
<td>CAN</td>
<td>Controller Area Network. ISO standard (ISO 11898) for serial communication</td>
</tr>
<tr>
<td>CB</td>
<td>Circuit breaker</td>
</tr>
<tr>
<td>CBM</td>
<td>Combined backplane module</td>
</tr>
<tr>
<td>CCM</td>
<td>CAN carrier module</td>
</tr>
<tr>
<td>CCVT</td>
<td>Capacitive Coupled Voltage Transformer</td>
</tr>
<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>
</tbody>
</table>
CO cycle Close-open cycle
Codirectional Way of transmitting G.703 over a balanced line. Involves two twisted pairs making it possible to transmit information in both directions
COM Command
COMTRADE Standard Common Format for Transient Data Exchange format for Disturbance recorder according to IEEE/ANSI C37.111, 1999 / IEC 60255-24
Contra-directional 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
COT Cause of transmission
CPU Central processing unit
CR Carrier receive
CRC Cyclic redundancy check
CROB Control relay output block
CS Carrier send
CT Current transformer
CU Communication unit
CVT or CCVT Capacitive voltage transformer
DAR Delayed autoreclosing
DARPA Defense Advanced Research Projects Agency (The US developer of the TCP/IP protocol etc.)
DBDL Dead bus dead line
DBLL Dead bus live line
DC Direct current
DFC Data flow control
DFT Discrete Fourier transform
DHCP Dynamic Host Configuration Protocol
DIP-switch Small switch mounted on a printed circuit board
DI Digital input
DLLB Dead line live bus
DNP Distributed Network Protocol as per IEEE Std 1815-2012
DR Disturbance recorder
DRAM Dynamic random access memory
DRH Disturbance report handler
DSP Digital signal processor
DTT Direct transfer trip scheme
ECT Ethernet configuration tool
EHV network Extra high voltage network
EIA Electronic Industries Association
EMC Electromagnetic compatibility
EMF Electromotive force
<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<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>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>
</tr>
<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>
</tbody>
</table>
IEC 61850–8–1  Communication protocol standard
IEEE  Institute of Electrical and Electronics Engineers
IEEE 802.12  A network technology standard that provides 100 Mbits/s on twisted-pair or optical fiber cable
IEEE P1386.1  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).
IEEE 1686  Standard for Substation Intelligent Electronic Devices (IEDs) Cyber Security Capabilities
IED  Intelligent electronic device
IET600  Integrated engineering tool
I-GIS  Intelligent gas-insulated switchgear
IOM  Binary input/output module
Instance  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.
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 20
IP 40  Ingression protection, according to IEC 60529, level 40
IP 54  Ingression protection, according to IEC 60529, level 54
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
LED  Light-emitting diode
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
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>MVB</td>
<td>Multifunction vehicle bus. Standardized serial bus originally developed for use in trains.</td>
</tr>
<tr>
<td>NCC</td>
<td>National Control Centre</td>
</tr>
<tr>
<td>NOF</td>
<td>Number of grid faults</td>
</tr>
<tr>
<td>NUM</td>
<td>Numerical module</td>
</tr>
<tr>
<td>OCO cycle</td>
<td>Open-close-open cycle</td>
</tr>
<tr>
<td>OCP</td>
<td>Overcurrent protection</td>
</tr>
<tr>
<td>OEM</td>
<td>Optical Ethernet module</td>
</tr>
<tr>
<td>OLTC</td>
<td>On-load tap changer</td>
</tr>
<tr>
<td>OTEV</td>
<td>Disturbance data recording initiated by other event than start/pick-up</td>
</tr>
<tr>
<td>OV</td>
<td>Overvoltage</td>
</tr>
<tr>
<td>Overreach</td>
<td>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.</td>
</tr>
<tr>
<td>PCI</td>
<td>Peripheral component interconnect, a local data bus</td>
</tr>
<tr>
<td>PCM</td>
<td>Pulse code modulation</td>
</tr>
<tr>
<td>PCM600</td>
<td>Protection and control IED manager</td>
</tr>
<tr>
<td>PC-MIP</td>
<td>Mezzanine card standard</td>
</tr>
<tr>
<td>PELV circuit</td>
<td>Protected Extra-Low Voltage circuit type according to IEC60255-27</td>
</tr>
<tr>
<td>PMC</td>
<td>PCI Mezzanine card</td>
</tr>
<tr>
<td>POR</td>
<td>Permissive overreach</td>
</tr>
<tr>
<td>POTT</td>
<td>Permissive overreach transfer trip</td>
</tr>
<tr>
<td>Process bus</td>
<td>Bus or LAN used at the process level, that is, in near proximity to the measured and/or controlled components</td>
</tr>
<tr>
<td>PRP</td>
<td>Parallel redundancy protocol</td>
</tr>
<tr>
<td>PSM</td>
<td>Power supply module</td>
</tr>
<tr>
<td>PST</td>
<td>Parameter setting tool within PCM600</td>
</tr>
<tr>
<td>PTP</td>
<td>Precision time protocol</td>
</tr>
<tr>
<td>PT ratio</td>
<td>Potential transformer or voltage transformer ratio</td>
</tr>
<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>
</tr>
<tr>
<td>RISC</td>
<td>Reduced instruction set computer</td>
</tr>
<tr>
<td>RMS value</td>
<td>Root mean square value</td>
</tr>
<tr>
<td>RS422</td>
<td>A balanced serial interface for the transmission of digital data in point-to-point connections</td>
</tr>
<tr>
<td>RS485</td>
<td>Serial link according to EIA standard RS485</td>
</tr>
<tr>
<td>RTC</td>
<td>Real-time clock</td>
</tr>
<tr>
<td>RTU</td>
<td>Remote terminal unit</td>
</tr>
<tr>
<td>SA</td>
<td>Substation Automation</td>
</tr>
<tr>
<td>SBO</td>
<td>Select-before-operate</td>
</tr>
<tr>
<td></td>
<td>Description</td>
</tr>
<tr>
<td>---</td>
<td>-------------</td>
</tr>
<tr>
<td>SC</td>
<td>Switch or push button to close</td>
</tr>
<tr>
<td>SCL</td>
<td>Short circuit location</td>
</tr>
<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>
</tbody>
</table>
| SFP | Small form-factor pluggable (abbreviation) 
Optical Ethernet port (explanation) |
| SLM | Serial communication module. |
| SMA connector | Subminiature version A, A threaded connector with constant impedance. |
| SMT | Signal matrix tool within PCM600 |
| SMS | Station monitoring system |
| SNTP | 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. |
| SOF | Status of fault |
| SPA | Strömberg Protection Acquisition (SPA), a serial master/slave protocol for point-to-point and ring communication. |
| SRY | Switch for CB ready condition |
| ST | Switch or push button to trip |
| Starpoint | Neutral 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 earth-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 earth-fault current

$3U_0$  Three times the zero sequence voltage. Often referred to as the residual voltage or the neutral point voltage