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ABB Oy
Distribution Automation
P.O. Box 699
FI-65101 Vaasa, Finland
Telephone: +358 10 2211
Facsimile: +358 10 22 41094
http://www.abb.com/substationautomation
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.

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This product complies with the directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Council 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 a test conducted by ABB in accordance with Article 10 of the directive in agreement with the product standards EN 50263 and EN 60255-26 for the EMC directive, and with the product standards EN 60255-6 and EN 60255-27 for the low voltage directive. The IED is designed in accordance with the international standards of the IEC 60255 series.
Safety information

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

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

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

National and local electrical safety regulations must always be followed.

The frame of the device has to be carefully earthed.

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

The device contains components which are sensitive to electrostatic discharge. Unnecessary touching of electronic components must therefore be avoided.
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- Sustainable development
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  - Standard configurations
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Section 1 Introduction

1.1 This manual

Operation Manual contains instructions on how to operate the IED during normal service once it has been commissioned. The manual can be used to find out how to handle disturbances or how to view calculated and measured network data in order 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

Engineering Manual contains instructions on how to engineer the IED products. The manual provides instructions on how to use the different tools for IED engineering. It also includes instructions on how to handle the tool component available to read disturbance files from the IEDs on the basis of the IEC 61850 definitions. It further introduces the diagnostic tool components available for IED products and the PCM600 tool.

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 protection IED should be installed.

Commissioning Manual contains instructions on how to commission the IED. The manual can also be used as a reference during periodic testing. The manual provides procedures for energizing and checking of external circuitry, setting and configuration as well as verifying settings and performing directional tests. The chapters are organized in the chronological order in which the IED should be commissioned.
Operation Manual contains instructions on how to operate the IED during normal service once it has been commissioned. The manual can be used to find out how to handle disturbances or how to view calculated and measured network data in order to determine the cause of a fault.

Service Manual contains instructions on how to service and maintain the IED. The manual also provides procedures for de-energizing, de-commissioning and disposal of the IED.

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 be used when calculating settings.

Technical Manual contains application and functionality 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 manuals describe the different communication protocols supported by the IED. The manuals concentrate on vendor-specific implementations.

The Point List Manual describes the outlook and properties of the data points specific to the IED. This manual should be used in conjunction with the corresponding Communication Protocol Manual.

All manuals are not available yet.

1.3.2 Document revision history

<table>
<thead>
<tr>
<th>Document revision/date</th>
<th>Product version</th>
<th>History</th>
</tr>
</thead>
<tbody>
<tr>
<td>A/20.12.2007</td>
<td>1.0</td>
<td>First release</td>
</tr>
<tr>
<td>B/08.02.2008</td>
<td>1.0</td>
<td>Content updated</td>
</tr>
<tr>
<td>C/02.07.2008</td>
<td>1.1</td>
<td>Content updated to correspond to the product version</td>
</tr>
</tbody>
</table>

The latest revision of the document can be downloaded from the ABB web site [http://www.abb.com/substationautomation](http://www.abb.com/substationautomation)
1.3.3 Related documentation

<table>
<thead>
<tr>
<th>Name of the document</th>
<th>Document ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application Manual</td>
<td>1MRS756378</td>
</tr>
<tr>
<td>Modbus Communication Protocol Manual</td>
<td>1MRS756468</td>
</tr>
<tr>
<td>Installation Manual</td>
<td>1MRS756375</td>
</tr>
<tr>
<td>Technical Manual</td>
<td>1MRS756377</td>
</tr>
</tbody>
</table>

1.4 Document symbols and conventions

1.4.1 Safety indication symbols

This publication includes the following icons that point out safety-related conditions or other important information:

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

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

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

- **The information icon** alerts the reader to relevant 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 should be understood that operation of damaged equipment could, under certain operational conditions, result in degraded process performance leading to personal injury or death. Therefore, comply fully with all warning and caution notices.
1.4.2 Document conventions

The following conventions are used for the presentation of material:

- Abbreviations in this manual are spelled out in the section "Glossary". In addition, the section contains descriptions on several terms.
- Push button navigation in the HMI 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 as follows:
  Select Main menu/Configuration/HMI.
- Menu names are shown in bold in WHMI, for example:
  Click Information in the WHMI menu structure.
- HMI messages are shown in Courier font, for example:
  To save the changes in non-volatile memory, select Yes and press \( \mathbb{E} \).
- Parameter names are shown in italics, for example:
  The function can be enabled and disabled with the Operation setting.
- Parameter values are indicated with quotation marks, for example:
  The corresponding parameter values are "On" and "Off".
- IED input/output messages and monitored data names are shown in Courier font, for example:
  When the function starts, the START output is set to TRUE.

1.4.3 Functions, codes and symbols

<table>
<thead>
<tr>
<th>Table 1: Functions included in the REF615 standard configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>Three-phase non-directional overcurrent protection, low stage</td>
</tr>
<tr>
<td>Three-phase non-directional overcurrent protection, high stage, instance 1</td>
</tr>
<tr>
<td>Three-phase non-directional overcurrent protection, high stage, instance 2</td>
</tr>
<tr>
<td>Three-phase non-directional overcurrent protection, instantaneous stage</td>
</tr>
<tr>
<td>Arc protection</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Non-directional earth-fault protection, low stage</td>
</tr>
<tr>
<td>Non-directional earth-fault protection, low stage</td>
</tr>
<tr>
<td>Non-directional earth-fault protection, high stage</td>
</tr>
<tr>
<td>Non-directional earth-fault protection, instantaneous stage</td>
</tr>
<tr>
<td>Directional earth-fault protection, low stage, instance 1</td>
</tr>
</tbody>
</table>

Table continues on next page
<table>
<thead>
<tr>
<th>Function</th>
<th>IEC 61850</th>
<th>IEC 61617</th>
<th>IEC-ANSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Directional earth-fault protection, low stage, instance 2</td>
<td>DEFLPDEF2</td>
<td>I₁p → ~ (2)</td>
<td>67N-1 (2)</td>
</tr>
<tr>
<td>Directional earth-fault protection, high stage</td>
<td>DEFPDEF1</td>
<td>I₁p &gt;&gt; → IEF</td>
<td>67N-2</td>
</tr>
<tr>
<td>Transient/Intermittent earth-fault protection</td>
<td>INTPTEF1</td>
<td>I₁p → IEF</td>
<td>67NIEF</td>
</tr>
<tr>
<td>Non-directional earth-fault protection, high stage (calculated I₀ current)</td>
<td>EFHPTOC1</td>
<td>I₁p &gt;&gt;</td>
<td>50N-2</td>
</tr>
<tr>
<td>Negative-sequence overcurrent protection, instance 1</td>
<td>NSPTOC1</td>
<td>I₂ (1)</td>
<td>46 (1)</td>
</tr>
<tr>
<td>Negative-sequence overcurrent protection, instance 2</td>
<td>NSPTOC2</td>
<td>I₂ (2)</td>
<td>46 (2)</td>
</tr>
<tr>
<td>Phase discontinuity</td>
<td>PDNSPTOC1</td>
<td>I₁/I₁p</td>
<td>46PD</td>
</tr>
<tr>
<td>Three-phase inrush detector</td>
<td>INRPHAR1</td>
<td>3I₂p&gt;</td>
<td>68</td>
</tr>
<tr>
<td>Three-phase thermal protection for feeders, cables and distribution transformers</td>
<td>T1PTTR1</td>
<td>3Ith&gt;</td>
<td>49F</td>
</tr>
<tr>
<td>Autoreclosure</td>
<td>DARREC1</td>
<td>O → I</td>
<td>79</td>
</tr>
<tr>
<td>Circuit breaker failure protection</td>
<td>CCBRBRF1</td>
<td>3I/I₀&gt;BF</td>
<td>51BF/51NBF</td>
</tr>
<tr>
<td>Master Trip</td>
<td>TRPPTRC1</td>
<td>Master Trip (1)</td>
<td>94/86 (1)</td>
</tr>
<tr>
<td>Master Trip</td>
<td>TRPPTRC2</td>
<td>Master Trip (2)</td>
<td>94/86 (2)</td>
</tr>
<tr>
<td>Trip circuit supervision, instance 1</td>
<td>TCSSCBR1</td>
<td>TCS (1)</td>
<td>TCM (1)</td>
</tr>
<tr>
<td>Trip circuit supervision, instance 2</td>
<td>TCSSCBR2</td>
<td>TCS (2)</td>
<td>TCM (2)</td>
</tr>
<tr>
<td>Disturbance recorder</td>
<td>RDRE1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Circuit breaker condition monitoring</td>
<td>SSCBR1</td>
<td>CBCM</td>
<td>CBCM</td>
</tr>
<tr>
<td>Three-phase current measurement</td>
<td>CMMXU1</td>
<td>3I</td>
<td>3I</td>
</tr>
<tr>
<td>Sequence current measurement</td>
<td>CSMSQI1</td>
<td>I₁, I₂, I₀</td>
<td>I₁, I₂, I₀</td>
</tr>
<tr>
<td>Residual current measurement</td>
<td>RESCMMXU1</td>
<td>I₀</td>
<td>I₀</td>
</tr>
<tr>
<td>Residual voltage measurement</td>
<td>RESVMMXU1</td>
<td>U₀</td>
<td>V₀</td>
</tr>
</tbody>
</table>
Section 2  Environmental aspects

2.1  Sustainable development

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

The choice of the materials and the suppliers has been made according to the EU RoHS directive (2002/95/EC). This directive limits the use of hazardous substances which are the following:

<table>
<thead>
<tr>
<th>Substance</th>
<th>Proposed maximum concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead - Pb</td>
<td>0,1%</td>
</tr>
<tr>
<td>Mercury - Hg</td>
<td>0,1%</td>
</tr>
<tr>
<td>Cadmium - Cd</td>
<td>0,01%</td>
</tr>
<tr>
<td>Hexavalent Chromium Cr (VI)</td>
<td>0,1%</td>
</tr>
<tr>
<td>Polybrominated biphenyls - PBB</td>
<td>0,1%</td>
</tr>
<tr>
<td>Polybrominated diphenyl ethers - PBDE</td>
<td>0,1%</td>
</tr>
</tbody>
</table>

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.

2.2  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 cast-off IEDs or its parts, contact the local enterprisers who are authorized and specialized in handling...
electrical/electronics waste. These partners can sort the material by using dedicated sorting processes and dispose the product according to the local requirements.

Table 3: Materials of the IED parts

<table>
<thead>
<tr>
<th>IED</th>
<th>Parts</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case</td>
<td>Metallic plates, parts and screws</td>
<td>Steel</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></td>
<td>Electronics plug in module</td>
<td>Various</td>
</tr>
<tr>
<td>Plug-in unit</td>
<td>Electronics plug in modules</td>
<td>Various</td>
</tr>
<tr>
<td></td>
<td>Electronics front panel module</td>
<td>Various</td>
</tr>
<tr>
<td></td>
<td>Plastic parts</td>
<td>PC, PBT&lt;sup&gt;3&lt;/sup&gt;, LCP, PA&lt;sup&gt;4&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Metallic plate</td>
<td>Steel</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
3) Polybutylene terephthalate
4) Polyamide
Section 3 REF615 overview

3.1 Overview

REF615 is a native IEC 61850 feeder protection relay for selective short-circuit, overcurrent and earth-fault protection. It is applicable to all types of radial isolated neutral networks, resistant earthed networks and compensated networks. REF615 is part of a product family that will cover main protection applications for utility and industry customers.

The IED features draw-out-type design, compact size and ease of use. Depending on the IED variant, the protection functions may include:

• Three-phase non-directional overcurrent protection, 4 stages
• Double earth-fault protection (cross-country earth-fault protection)
• Non-directional earth-fault, 3 stages
• Non-directional sensitive earth-fault
• Directional earth-fault protection, 3 stages
• Transient/intermittent earth-fault protection
• Negative-phase-sequence protection, 2 stages
• Phase discontinuity
• Three-phase transformer inrush detector
• Three-phase thermal overload, lines and cables
• Circuit breaker failure protection
• Electrically latched lockout relay

Depending on the IED variant, the optional functions may include:

• Auto-reclose
• Arc protection, three lens sensors for arc detection

3.2 Product version history

<table>
<thead>
<tr>
<th>IED version</th>
<th>Release date</th>
<th>Product history</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>20.12.2007</td>
<td>Product released</td>
</tr>
<tr>
<td>1.1</td>
<td>02.07.2008</td>
<td>• IRIG-B</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Support for parallel protocols added: IEC 61850 and Modbus</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• X130 BIO added: optional for variants B and D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• CB interlocking functionality enhanced</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• TCS functionality in HW enhanced</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Non-volatile memory added</td>
</tr>
</tbody>
</table>
### 3.3 Operation functionality

#### 3.3.1 Standard configurations

The IED is available with four alternative standard configurations. The table indicates the functions supported by the different IED configurations.

<table>
<thead>
<tr>
<th>Standard configuration functionality</th>
<th>Overcurrent and directional earth-fault protection</th>
<th>Overcurrent and non-directional earth-fault protection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Std. conf. (FE01)</td>
<td>Std. conf. (FE02)</td>
</tr>
<tr>
<td>Protection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Three-phase non-directional overcurrent, low-set stage</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Three-phase non-directional overcurrent, high-set stage, instance 1</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Three-phase non-directional overcurrent, high-set stage, instance 2</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Three-phase non-directional overcurrent, instantaneous stage</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Directional earth-fault, low-set stage, instance 1</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Directional earth-fault, low-set stage, instance 2</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Directional earth-fault, high-set stage</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Double earth-fault protection (cross-country earth-fault)</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Transient/intermittent earth-fault</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Non-directional earth-fault, low-set stage</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Non-directional earth-fault, high-set stage</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Non-directional earth-fault, instantaneous stage</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Non-directional sensitive earth-fault</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Negative-sequence overcurrent, instance 1</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Negative-sequence overcurrent, instance 2</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Phase discontinuity</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

Table continues on next page
### 3.3.2 Optional functions

The optional functions available in the IED are:

- Arc protection
- Auto-reclosing
- Modbus TCP/IP or RTU/ASCII

---

<table>
<thead>
<tr>
<th>Thermal overload</th>
<th>●</th>
<th>●</th>
<th>●</th>
<th>●</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circuit breaker failure protection</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Three-phase inrush current detection</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Arc protection with three sensors</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

**Control**

| Circuit breaker control with basic interlocking<sup>1</sup> | ● | ● | ● | ● |
| Circuit breaker control with extended interlocking<sup>2</sup> | - | ● | - | ● |
| Auto-reclosing of one circuit breaker | ○ | ○ | ○ | ○ |

**Supervision and Monitoring**

| Circuit breaker condition monitoring | - | ● | - | ● |
| Trip-circuit supervision of two trip circuits | ● | ● | ● | ● |

**Measurement**

| Transient disturbance recorder | ● | ● | ● | ● |
| Three-phase current measurement | ● | ● | ● | ● |
| Current sequence components | ● | ● | ● | ● |
| Residual current measurement | ● | ● | ● | ● |
| Residual voltage measurement | ● | ● | - | - |

<sup>1</sup> **Basic interlocking functionality**: Closing of the circuit breaker can be enabled by a binary input signal. The actual interlocking scheme is implemented outside the relay. The binary input serves as a “master interlocking input” and when energized, it enables circuit breaker closing.

<sup>2</sup> **Extended interlocking functionality**: The circuit breaker interlocking scheme is implemented in the relay configuration, based on primary equipment position information (via binary inputs) and the logical functions available. The signal matrix tool of PCM600 can be used for modifying the interlocking scheme to suit the application.

● = Included, ○ = Optional at the time of the order
3.4 Physical hardware

The IED consists of two main parts: plug-in unit and case. The plug-in unit content depends on the ordered functionality.

<table>
<thead>
<tr>
<th>Main unit</th>
<th>Content options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plug-in unit</td>
<td>HMI</td>
</tr>
<tr>
<td></td>
<td>CPU module</td>
</tr>
<tr>
<td></td>
<td>Auxiliary power/ binary output module (slot X100)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>AI module (slot X120)</td>
<td>Option 1:</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Option 2:</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>BI/O module (slot X110)</td>
<td>7 BIs</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Case</td>
<td>Optional BI/O module (slot X130)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>AI module interface connectors</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Auxiliary power/binary output module interface connectors</td>
</tr>
<tr>
<td></td>
<td>BI/O module interface connectors</td>
</tr>
<tr>
<td></td>
<td>Communication module</td>
</tr>
</tbody>
</table>

1) The analog input module option depends on the selected standard configuration.
2) The 0.2/1A input is normally used in applications requiring sensitive earth-fault protection and featuring core-balance current transformers.

The rated input levels are selected in the IED software for phase current, residual current and residual voltage. The binary input thresholds 18...176 V DC are selected by adjusting the IED’s parameter settings.

The additional BI/O module in slot X110 is included in the IED with standard configurations B and D. The optional BI/O module in slot X130 is available for configurations B and D.

The connection diagrams of different hardware modules are presented in the Application manual.
See the Installation Manual for more information about the case and the plug-in unit.

3.5 LHMI

The LHMI of the IED contains the following elements:

- Display
- Buttons
- LED indicators
- Communication port

The LHMI is used for setting, monitoring and controlling.
3.5.1 LCD

The LHMI includes a graphical LCD that supports two character sizes. The character size depends on the selected language.

The amount of characters and rows fitting the view depends on the character size:

<table>
<thead>
<tr>
<th>Character size</th>
<th>Rows in view</th>
<th>Characters on row</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small, mono-spaced (6x12 pixels)</td>
<td>5 rows</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>10 rows with large screen</td>
<td></td>
</tr>
<tr>
<td>Large, variable width (13x14 pixels)</td>
<td>4 rows</td>
<td>min 8</td>
</tr>
<tr>
<td></td>
<td>8 rows with large screen</td>
<td></td>
</tr>
</tbody>
</table>

The display view is divided into four basic areas:

1 Header
2 Icon
3 Content
4 Scroll bar (appears when needed)

- The header area at the top of the display view shows the current location in the menu structure.
- The icon area at the upper right corner of the display shows the current action or user level. Current action is indicated by the following characters:
  - U: Font/Firmware is being updated
  - S: Parameters are being stored
  - !: Warning and/or indication

Current user level is indicated by the following characters:
• V: Viewer
• O: Operator
• E: Engineer
• A: Administrator

• The content area with four rows shows the menu content. With larger character size, the content area has only three rows.
• If the menu contains more rows than the display can show at a time, a scroll bar appears on the right.

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

3.5.2 LEDs

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

There are also 11 matrix programmable alarm LEDs on front of the LHMI. The LEDs can be configured with PCM600 and the operation mode can be selected with the LHMI.

3.5.3 Keypad

The LHMI keypad consists of push buttons which are used to navigate in different views or menus. With push buttons you can give open or close commands to, for example, circuit breakers, disconnectors and switches. The push buttons are also used to acknowledge alarms, reset indications, provide help and switch between local and remote control mode.

![Figure 3: LHMI keypad with object control, navigation and command push buttons and RJ-45 communication port](image)

1. Close
2. Open
3. Escape
4. Left
Object control

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

As a default, breaker 1 is always the first to be controlled. If other controllable objects are available, the user can select them in the control menu.

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Close</td>
<td>Closing the selected object.</td>
</tr>
<tr>
<td>Open</td>
<td>Opening the selected object.</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.
### Navigation push buttons

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
</table>
| ESC  | • Leaving setting mode without saving the values.  
• Cancelling certain actions.  
• Adjusting the display contrast in combination with \( \uparrow \) or \( \downarrow \).  
• Changing the language in combination with \( \uparrow \).  
• Running the display test in combination with \( \uparrow \).  
• Deleting a character in combination with \( \uparrow \) when editing a string  
• Inserting a space in combination with \( \uparrow \) when editing a string. |
| Enter| • Entering parameter setting mode.  
• Confirming a new value of a setting parameter. |
| Up   | • Moving up and down in menus.  
• Scrolling active digits of a parameter when entering a new setting value. |
| Down | • Moving left and right in menus.  
• Changing the active digit of a parameter when entering a new setting value. |
| Key  | • Activating the authorization procedure, when the user is not logged in.  
• Logging out, when the user is currently logged in. |

### Command push buttons

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
</table>
| Menu | • Moving directly to the Main Menu, if currently in default view or in any menu.  
• 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 context sensitive help messages. |

### 3.5.4 LHMI functionality

#### 3.5.4.1 Protection and alarm indication

**Protection indicators**

Protection indicator LEDs are called Ready, Start and Trip.
### Table 8: Ready LED

<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>Blinking</td>
<td>Internal fault has occurred or the IED is in test mode. Internal faults are accompanied by an indication message.</td>
</tr>
</tbody>
</table>

### Table 9: Start LED

<table>
<thead>
<tr>
<th>LED state</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off</td>
<td>Normal operation.</td>
</tr>
</tbody>
</table>
| On        | A protection function has started and an indication message is displayed.  
            | • If several protection functions start within a short time, the last start is indicated on the display. |
| Blinking  | A protection function is blocked.               |
|           | • The blocking indication disappears when the blocking is removed or when the protection function is reset. |

### Table 10: Trip LED

<table>
<thead>
<tr>
<th>LED state</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off</td>
<td>Normal operation.</td>
</tr>
</tbody>
</table>
| On        | A protection function has tripped and an indication message is displayed.  
            | • The trip indication is latching and must be reset via communication or by pressing [image].  
            | • If several protection functions trip within a short time, the last trip is indicated on the display. |

### Alarm indicators

The 11 matrix programmable LEDs are used for alarm indication.

### Table 11: Alarm indications

<table>
<thead>
<tr>
<th>LED state</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off</td>
<td>Normal operation. All alarms are OFF.</td>
</tr>
</tbody>
</table>
| On        | • Non-latched mode: alarm is still on.  
            | • Latched mode: alarm is still on or it is off but has not been acknowledged.  
            | • Latched blinking mode: alarm is still on but has been acknowledged. |
| Blinking  | • Non-latched blinking mode: alarm is still on.  
            | • Latched blinking mode: alarm is still on or it is off but has not been acknowledged. |
3.5.4.2 Parameter management

The LHMI enables you to access the IED parameters. It is possible to read and write three types of parameters:

- 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.

3.5.4.3 Front communication

The RJ-45 port in the LHMI enables front communication. There are two LEDs above the communication port:

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

![Uplink Communication LED](image)

Figure 4: RJ-45 communication port and indication LEDs

When a computer is connected to the IED, the IED's DHCP server for the front interface assigns an IP address to the computer. The fixed IP address for the front port is 192.168.0.254.

3.6 WHMI

The WHMI enables the user to access the IED via a web browser.

WHMI is disabled by default and can be enabled via the LHMI Main Menu/Configuration/HMI/Web HMI mode. You must reboot the IED for the change to take effect.
WHMI offers the following functions:

- Alarm indications and event lists
- System supervision
- Parameter settings
- Measurement display
- Phasor diagram

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

![Figure 5: Example view of the WHMI](image)

The WHMI can be accessed:

- Locally by connecting your laptop to the IED via the front communication port.
- Remotely through the Internet or over LAN/WAN.

### 3.6.1 Command buttons

Command buttons can be used to edit parameters and control information via the WHMI.
### Table 12: Command buttons

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Close this dialog</td>
<td>Preventing automatic logout.</td>
</tr>
<tr>
<td>Enable Write</td>
<td>Enabling parameter editing.</td>
</tr>
<tr>
<td>Disable Write</td>
<td>Disabling parameter editing.</td>
</tr>
<tr>
<td>Write to IED</td>
<td>Writing parameters to the IED.</td>
</tr>
<tr>
<td>Refresh Values</td>
<td>Refreshing parameter values.</td>
</tr>
<tr>
<td>Print</td>
<td>Printing out parameters.</td>
</tr>
<tr>
<td>Commit</td>
<td>Committing changes to IED's non-volatile flash memory.</td>
</tr>
<tr>
<td>Reject</td>
<td>Rejecting changes.</td>
</tr>
<tr>
<td>Clear events</td>
<td>Clearing events.</td>
</tr>
<tr>
<td>Save</td>
<td>Saving values to CSV file format.</td>
</tr>
<tr>
<td>Freeze</td>
<td>Freezing the values so that updates are not displayed.</td>
</tr>
</tbody>
</table>

### 3.7 Authorization

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

The default passwords can be changed with Administrator user rights.

User authorization is disabled by default for LHMI and can be enabled either via the LHMI or the WHMI [Main Menu/Configuration/Authorization](#). WHMI always requires authentication.
### Table 13: Predefined user categories

<table>
<thead>
<tr>
<th>Username</th>
<th>User rights</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIEWER</td>
<td>Read only access</td>
</tr>
<tr>
<td>OPERATOR</td>
<td>• Selecting remote or local state with <img src="remote.png" alt="remote" /> (only locally)</td>
</tr>
<tr>
<td></td>
<td>• Changing setting groups</td>
</tr>
<tr>
<td></td>
<td>• Controlling</td>
</tr>
<tr>
<td></td>
<td>• Clearing alarm and indication LEDs and textual indications</td>
</tr>
<tr>
<td>ENGINEER</td>
<td>• Changing settings</td>
</tr>
<tr>
<td></td>
<td>• Clearing event list</td>
</tr>
<tr>
<td></td>
<td>• Clearing disturbance records</td>
</tr>
<tr>
<td></td>
<td>• Changing system settings such as IP address, serial baud rate or disturbance recorder settings</td>
</tr>
<tr>
<td></td>
<td>• Setting the IED to test mode</td>
</tr>
<tr>
<td></td>
<td>• Selecting language</td>
</tr>
<tr>
<td>ADMINISTRATOR</td>
<td>• All listed above</td>
</tr>
<tr>
<td></td>
<td>• Changing password</td>
</tr>
</tbody>
</table>

For user authorization for PCM600, see PCM600 documentation.

### 3.8 Communication

The IED supports two different communication protocols: IEC 61850 and Modbus®. Operational information and controls are available through these protocols. However, some communication functionality, for example, horizontal communication between the IEDs and parameters setting, is only enabled by the IEC 61850 communication protocol.

The IEC 61850 communication implementation supports all monitoring and control functions. Additionally, parameter setting and disturbance file records can be accessed using the IEC 61850-8-1 protocol. Further, the IED can send and receive binary signals from other IEDs (so called horizontal communication) using the IEC 61850-8-1 GOOSE profile, where the highest performance class with a total transmission time of 3 ms is supported. The IED can simultaneously report to five different IEC 61850-8-1 clients.

The IED can support five simultaneous clients. If PCM600 reserves one client connection, only four client connections are left, for example, for IEC 61850 and Modbus.

All communication connectors, except for the front port connector, are placed on integrated optional communication modules. The IED can be connected to Ethernet-based communication systems via the RJ-45 connector (100BASE-TX) or the fibre-
optic LC connector (100BASE-FX). If connection to a RS-485 network is required, the 10-pin screw-terminal connector can be used.

3.9 PCM600 configuration 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

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 customer needs.

For more information, refer to PCM600 documentation.

3.9.1 Connectivity packages

Connectivity package is a collection of software and information related to a specific protection and control terminal providing system products and tools to connect and interact with the IED.

Connectivity Package Manager is a tool that helps the user to define the right connectivity package versions for different system products and tools. Connectivity Package Manager is included in products supporting the connectivity concept.

Use the connectivity packages to create configuration structure in PCM600. In addition to other products supporting connectivity concept, the connectivity packages for PCM600 contain:

- Description of IED's internal parameters and their properties such as data format, unit, setting range, visibility and access rights. The description texts can be translated into other languages as well.
- Software components that adapt the IED-specific interfaces to the standard interfaces of system products and tools such as IED-specific dispatchers for tools. This means that there is a protocol-specific adaptation for the parameter setting
and disturbance handling tool components, for example disturbance uploading according to COMTRADE.

### 3.9.2 PCM600 and IED connectivity package version

Supported tools:

- Protection and Control IED Manager PCM600 Ver. 2.0 SP1 or later
- REF615 Connectivity Package Ver. 1.2
  - Parameter Setting Tool
  - Disturbance Handling Tool
  - Signal Monitoring Tool
  - Signal Matrix Tool
  - Communication Management Tool

The necessary connectivity packages can be downloaded from the ABB web site [http://www.abb.com/substationautomation](http://www.abb.com/substationautomation)
Section 4 Using HMI locally or via web interface

4.1 Using LHMI

You must be logged in and authorized to use the LHMI. Password authorization is disabled by default and can be enabled either via the LHMI or WHMI.

To enable password authorization, select Main Menu/Configuration/Authorization/Local override. Set the parameter to False.

4.1.1 Logging in

Log in to use the LHMI:

1. Press any key except for to activate the login procedure.
2. Press or to select the user level.
3. Confirm the selection with .
4. Enter the prompted password digit by digit.


- Activate the digit to be entered with ← and →.
- Enter the character with ↑ and ↓.

![Viewer](image)

Figure 7: Entering password

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

![Error](image)

Figure 8: Error message indicating wrong password

The user level you are logged into shows on the LCD's upper right corner in the icon area.

4.1.2 Logging out

The user is automatically logged out 30 seconds after the backlight timeout.

Manual logout is also possible:

1. Press ←.
2. To confirm logout, select Yes and press ←.
4.1.3 Turning display backlight on

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

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

If the panel has not been used for a predefined timeout period, the backlight is switched off. The user is logged out from the current user level 30 seconds after the display backlight has turned off.

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

You can change the backlight timeout period in Main Menu/Configuration/HMI/Backlight timeout.

4.1.4 Selecting local or remote use

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

To change the IED's control position:

- Press for two seconds.
  - When the L LED is lit, local control is enabled and remote control disabled.
  - When the R LED is lit, remote control is enabled and local control disabled.
  - When none of the LEDs are 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.
You must be logged in and authorized to control the IED.

4.1.5 Identifying the device

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

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

To view the device information:

1. Select **Main Menu/Information**.
2. Select a submenu with ↑ and ↓.
   
   ![Image](Figure 10: Selecting submenu)

3. Enter the submenu with →.
4. Browse the information with ↑ and ↓.
   
   ![Image](Figure 11: IED information)

4.1.6 Adjusting display contrast

To obtain optimal readability, you can adjust the display contrast. The contrast can be adjusted anywhere in the menu structure.
• To increase the contrast, press simultaneously and .
• To decrease the contrast, press simultaneously and .

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

4.1.7 Changing LHMI language

To change the LHMI language:

1. Select Main Menu/Language and press .
2. Change the language with or .
3. Press to confirm the selection.
4. Commit the changes.

You can change the language also by pressing simultaneously and .

4.1.8 Changing display symbols

To switch between the display symbols IEC 61850, IEC 61617 and IEC-ANSI:

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

The IED has to be rebooted if the WHMI display symbols are changed. With the LHMI, the change takes effect immediately.
4.1.9 Navigating in the menu

You can 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.

4.1.9.1 Menu structure

The Main Menu contains the following main groups:

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

Main groups are divided further into more detailed submenus.

4.1.9.2 Scrolling the LCD view

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

```
Monitoring
IEO status
Control
I/O status
FB status
```

*Figure 13: Scroll bar on the right*

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

4.1.9.3  
Changing the default view

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

To change the default view:

2. Change the default view with ↑ or ↓.
3. Press → to confirm the selection.

4.1.10  
Browsing setting values

To browse setting values:

1. Select Main Menu/Settings/Settings and press →.
2. Select the setting group to be viewed with ↑ or ↓.

3. Press → to confirm selection.
4. To browse the settings, scroll the list with ↑ and ↓ and to select a setting press →. To move back to the list, press ←.
4.1.11 Editing values

You must be logged in and authorized to edit values.

4.1.11.1 Editing numerical values

To edit numerical values:

1. Select **Main Menu/Settings** and then a setting.
   When you start editing numerical values, the last digit is active.
   - When the symbol in front of the value is \( \uparrow \), you can only increase the active value.
   - When the symbol is \( \downarrow \) you can only decrease the active value.
   - When the symbol in front of the value is \( \leftrightarrow \), you can either increase or decrease the active value.

   ![Figure 16: Last digit is active and it can only be increased](image)

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. Additionally, for decimal values, the change can be fractions 0.1, 0.01, 0.001 (...) depending on the active digit.

3. Press \( \leftarrow \) or \( \rightarrow \) to move the cursor to another digit.

4. The minimum or maximum value can be set by selecting 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 \( \downarrow \).

   ![Figure 17: Arrow symbol is active, the value is set to the maximum](image)
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 $\downarrow$, when the previous value is shown.

Figure 18: Restoring the previous value

4.1.11.2 Editing string values

To edit string values consisting of UTF-8 characters:

1. Activate the setting mode and select a setting. When editing string values, the cursor moves to the first character.
2. Press $\leftarrow$ or $\rightarrow$ to change the value of an active character. One press changes the value by one step. The available UTF-8 character codes are 32...126 and 192...383.
3. Press $\uparrow$ or $\downarrow$ to move the cursor to another character.
   - To insert characters or space, press simultaneously ESC and $\leftarrow$.
   - To delete characters, press simultaneously ESC and $\rightarrow$.

4.1.11.3 Editing enumerated values

To edit enumerated values:

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

4.1.12 Committing settings

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

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

To store changes into non-volatile memory:

1. Press \( \text{confirm} \) to confirm any changes.
2. Press \( \text{up} \) to move upwards in the menu tree or \( \text{main menu} \) to enter the Main Menu.
3. To save the changes in non-volatile memory, select \( \text{Yes} \) and press \( \text{save} \).

![Figure 19: Confirming settings](image)

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

4.1.13 Clearing and acknowledging

You can reset, acknowledge or clear all messages and indications, including LEDs and latched outputs as well as registers and recordings, with the Clear button. Pressing the Clear button activates a selection menu, where you can choose which clearance or reset function you want to make. Events and alarms assigned to alarm LEDs are cleared with the Clear button as well.

To clear, reset or acknowledge messages and indications:

1. Press \( \text{clear} \) to activate the Clear view.

![Information icon](image)
2. Select the item to be cleared with ↑ or ↓.
3. Press ←, change the value from False to True with ↑ or ↓ and press ← again.
   The item is now cleared and the value changes back to False.
4. Repeat steps 2 and 3 to clear other items.

4.1.14 Using LHMI help

The LHMI help is used to get information from, for example, the selected view, menu or a single parameter.

To open the context sensitive help:

1. Press ?.
   The help view is displayed.
2. If the help text exceeds the display area, scroll the text with ↑ or ↓.
3. To close the help, press ESC.

4.2 Using WHMI

WHMI is disabled by default. To use it, you must enable it via the LHMI in Main Menu/Configuration/HMI/Web HMI mode. You must reboot the IED for the change to take effect.

You must be logged in and authorized to use the WHMI.

Using favorites in a web browser is not recommended. If you are unauthorized and select a favorite pointing to a WHMI page, you are redirected to the log in page. With authorization you are redirected to the startup page.

4.2.1 Logging in

Log in to use the WHMI:
1. Enter the username with capital letters.
2. Enter the password.
3. Click Log in.

![Figure 21: Entering username and password to use the WHMI](image)

### 4.2.2 Logging out

The user is logged out after session timeout. The timeout can be set in **Main Menu/Configuration/HMI/Web HMI timeout**. The red session timeout bar appears one minute before the timeout expires. You can prevent automatic logout by clicking Close this dialog.

![Figure 22: Session timeout](image)
• To log out manually, click **Logout** on the menu bar.

![WHMI logout](image)

**Figure 23:** WHMI logout

### 4.2.3 Identifying the device

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

To view the device information:
1. Click **Information** in the WHMI menu structure.
2. Click a submenu to see the data.

![Device Information](image)

**Figure 24: Device information**

### 4.2.4 Navigating in the menu

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

In the menu bar:

- The **General** view shows the IED version and status.
- The **Events** view contains a list of events produced by the application configuration.
- The **Alarms** view shows the status of alarm LEDs.
- The **Phasor diagrams** view shows phasor diagrams.
- The **Parameter list** view shows all parameters.
- The **WHMI settings** view contains user settings for the client, that is the web browser. WHMI settings include, for example, the client-specific setting for the WHMI language. Different users can use different languages when connecting to the same IED. The WHMI language selection is independent of the language selection for the LHMI.
- **Logout** ends the session.
4.2.4.1 Menu structure

The Main Menu contains the following main groups:

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

Main groups are divided further into more detailed submenus.

4.2.5 Showing all parameters

To view all parameters:

1. Click **Parameter list** in the menu bar.
Figure 26: Show all parameters

2. Click **Print** to print out all parameters on paper.
3. Click **Save** to save all parameters in CSV file format.

### 4.2.6 Editing values

To edit values via the WHMI:

1. Click the menu in the WHMI tree.
2. Click the submenu to see function blocks.
3. Click a function block to see the setting values.
4. Click **Enable Write**.

Some parameters, for example the IED test mode, cannot be set via the WHMI.
5. Edit the value.

- The minimum and maximum values for a parameter are shown in the Min. and Max. columns.
- Setting group values are indicated with *.

**Figure 28:** Enable writing to edit a value

The selected setting group is shown in the Setting Group drop-down box. The active setting group is indicated with an asterisk *

**Figure 29:** Editing value

- If the entered value is within the accepted value range, the selection is highlighted in green. If the value is out of range, the row is highlighted in red and a warning dialog box appears.
4.2.7 Committing settings

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

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

To store changes into non-volatile memory:

1. Click **Write to IED** after editing parameter values to put the values into IED’s database for use.
Figure 32: Writing values to IED

The values are not stored to the flash memory.

2. Click **Commit** to write the values to the flash memory.
   - Click **Reject** to cancel saving settings.
   - If the parameter has an edit-copy, the original parameter value is restored.
   - If the parameter does not have an edit-copy, the edited parameter value remains visible until you reboot the IED. However, the edited
value is not stored in non-volatile memory and thus the reboot
restores the original value.

Figure 33: Committing changes

Commencing values will take a few seconds.

If you only write values to the IED and then reboot, the old values
will resume in the IED as active values and the new values are lost.

4.2.8 Clearing and acknowledging

You can reset, acknowledge or clear all messages and indications, including LEDs
and latched outputs as well as registers and recordings, in the Clear menu.

To clear, reset or acknowledge messages and indications:

1. Click the Clear menu.
2. Click **Enable write**.
3. In the **New Value** box, click **True** to select the item to be cleared.
4. Click **Write to IED**.
5. Click **Reject**.

*Figure 34: Selecting clear menu*
4.2.9 Selecting alarm view

Alarm view shows the status of alarm LEDs. These are the same LEDs that are located on the upper right side of the LHMI panel.

To monitor the alarms:

- Click **Alarms** in the menu bar.
4.2.10 Selecting event view

The event view contains a list of events produced by the application configuration.

To monitor the events:

1. Click **Events** in the menu bar.
2. Click **Save** to save the events in CSV file format. The CSV file can be opened with a spreadsheet program such as OpenOffice.org Calc or Microsoft Excel.

3. Click **Clear events** to clear all events from the IED.

### 4.2.11 Selecting phasor diagrams

To view phasor diagrams:

1. Click **Phasor diagrams** in the menu bar.
Figure 38: Normal case with symmetrical phase currents

2. Toggle the diagram visibility by selecting it from the drop-down menu.
Figure 39: Toggling the diagram visibility

Visible diagrams are indicated with an asterisk *.

3. Change the size of the diagram by changing the zoom value.
4. Click **Freeze** to stop updating the phasor diagram. No updates will appear in the diagram. No updates will appear in the diagram.
Figure 41: The arrow extends outside the circle if the current value is too high

An SVG plugin is needed to view phasor diagrams.

### 4.2.12 Using WHMI help

With the WHMI help you can get information from, for example, a single parameter.

To open the context sensitive help:

1. Click 📒. The help dialog box is displayed.
2. To close the help dialog box, click **OK**.
Section 5  IED operation

5.1  Operation in normal case

The basic operation procedures in normal IED use situation are:

- Monitoring of measured values
- Checking the function setting parameters
- Checking the test data

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

For more information, refer to PCM600 documentation.

5.1.1  Function settings

To check the correct operation of the IED, check the function settings via the LHMI, WHMI or PCM600.

5.1.2  Test data

The IED's functions can be tested to ensure correct operation. After a specific test, you can analyze the results.

5.2  Disturbance case operation

The IED is designed to identify and indicate several types of disturbances. The main purpose of a protective IED is to identify power system disturbances and operate according to the disturbance to avoid damage for power system equipment and people. In other words, to disconnect the disturbance from the healthy network.

Many disturbance origins are permanent and cannot be automatically cleared. The IED then collects disturbance data for later analysis.

Only authorized and skilled personnel should analyze possible errors and decide on further action. Otherwise, stored important disturbance data can be permanently lost.
Some disturbances can be IED related, for example, external damage to hardware. The IED supervises internal faults and indicates them to ensure that the user can take the right corrective actions. Disturbance data can be read, managed and analyzed with PCM600.

For more information, refer to PCM600 documentation.

5.2.1 Disturbance case identification

Disturbances and their causes can be identified on the basis of indicator LEDs: Ready, Start and Trip. In normal operation case the Ready LED is steady green.

<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>Start LED</td>
<td>Yellow, blinking</td>
<td>Protection function blocked</td>
</tr>
<tr>
<td>Trip LED</td>
<td>Red, steady</td>
<td>Protections operated</td>
</tr>
<tr>
<td>Ready LED</td>
<td>Green, blinking</td>
<td>Internal faults</td>
</tr>
</tbody>
</table>

Further actions to be taken to identify the disturbance:

- Analyzing disturbance recordings
- Monitoring recorded data
- Reading internal events
- Finding available functions

5.2.2 Operation in tripping case

If a protection function trip is not cleared automatically, the cause of fault should be checked to identify needs for further actions.

Document the tripping case before clearing the information from the IED.

5.2.3 Internal IED errors

The IED monitors internal software and hardware errors. Internal error information is collected to the IED for later analysis. The main indication of an internal fault is a blinking green Ready LED.
Errors can be caused by external or internal events damaging the IED. Internal supervision functionality monitors different types of internal errors. These can be divided to hardware errors, runtime errors in application or operating system and communication errors. Further actions always depend on the cause of the errors.

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

Internal IED errors may be caused by:

- Hardware errors
- Runtime errors
- Communication errors

The IED records:

- IED self-supervision report
- Event list
- System registrations

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

### 5.2.4 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.

### 5.2.5 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 uploaded and analyzed, for example, with PCM600.

For more information, see PCM600 documentation.

### 5.2.6 Disturbance reports

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

Sometimes the cause of an application fault can be determined via the LHMI. Usually, this is not enough and a more detailed analysis of the application configuration is needed. This can be done with PCM600.

5.3.1 Application problem verification

The faulty operation of application functions is usually related to wrong configuration or incorrect wiring of the external voltage and currents or binary inputs.

5.4 IED parametrization

IED parameters are usually set with a parameter setting tool but it can also be done via the LHMI or WHMI.

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.

For more information, see PCM600 documentation.

Document all changes to parameter settings.

5.4.1 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. Setting values can also be copied from one setting group to another.
5.4.2 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.
Section 6  Operating procedures

6.1  Monitoring

6.1.1  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
- 11 programmable alarm LEDs
- A text message on the display

6.1.1.1  Monitoring indication messages

Indication messages and tripping data are shown in a dialog box.

To monitor indication messages:

1. Read the indication message in the dialog box.
The message can indicate the starting or tripping of protection functions or an internal fault in the device.

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

![Figure 43: Indication message](image)

6.1.1.2  Monitoring internal IED fault

The blinking green LED indicates an internal IED fault. Internal IED fault messages are shown in a dialog box.
To monitor the latest fault indication:

1. Select **Main Menu/Monitoring/IED status/Self-supervision**.
2. Press ↑ or ↓ to scroll the view.

All internal IED fault messages are collected in C:\userlog.txt. The log file can be uploaded and viewed by the user. The timestamp of the fault is included in the log file.

### 6.1.1.3 Monitoring condition monitoring data

To access condition monitoring related data:

1. Select **Main Menu/Monitoring/I/O status/Condition monitoring**.
2. Press ↑ or ↓ to scroll the view.

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

### 6.1.2 Measured and calculated values

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

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

### 6.1.2.1 Measured values

Measured values can be accessed through the LHMI or WHMI.

**Table 15: Measured values**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IL1-A</td>
<td>Current measured on phase L1</td>
</tr>
<tr>
<td>IL2-A</td>
<td>Current measured on phase L2</td>
</tr>
<tr>
<td>IL3-A</td>
<td>Current measured on phase L3</td>
</tr>
<tr>
<td>IL1-dem-A</td>
<td>Current demand value on phase L1</td>
</tr>
</tbody>
</table>

Table continues on next page
### 6.1.2.2 Using LHMI for monitoring

To monitor measured and calculated values:

1. Select **Main Menu/Measurements**.
   - The list of IED’s basic measurements is shown.
2. Scroll the view with ↑ and ↓.

### 6.1.3 Recorded data

The IED is provided with intelligent and flexible functionality which collects different kinds of data, for example, in case of fault event. The data gives substantial information for the post fault analysis. These data include:

- Disturbance records
- Fault records
- Events

### 6.1.3.1 Creating disturbance recordings

Normally disturbance recordings are triggered by the IED applications.

To trigger a disturbance recording manually:

1. Select **Main Menu/Disturbance records**.
2. Select **Trig recording** with ↑ or ↓.
3. Press ↵, change the value from False to True with ↑ or ↓ and press ↵ again. The disturbance recorder is now triggered.

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IL2-dem-A</td>
<td>Current demand value on phase L2</td>
</tr>
<tr>
<td>IL3-dem-A</td>
<td>Current demand value on phase L3</td>
</tr>
<tr>
<td>I₀-A</td>
<td>Measured earth-fault current</td>
</tr>
<tr>
<td>Ng-Seq-A</td>
<td>Negative phase sequence</td>
</tr>
<tr>
<td>Ps-Seq-A</td>
<td>Positive phase sequence</td>
</tr>
<tr>
<td>Zro-Seq-A</td>
<td>Zero phase sequence</td>
</tr>
<tr>
<td>U₀-kV</td>
<td>Measured residual voltage</td>
</tr>
</tbody>
</table>
6.1.3.2 Monitoring disturbance recorder data

Individual disturbance recordings must be uploaded from the IED with appropriate software such as PCM600 to monitor disturbance recorder data. All disturbance recordings can be found from the C:\COMTRADE directory.

To monitor the state of the disturbance recorder via the LHMI:

1. Select Main Menu/Disturbance records.
2. All the disturbance recorder information is listed. To view the following items, scroll the list with ▲ or ▼:
   - Number of recordings currently in IED memory
   - Remaining amount of recordings that can fit into the available recording memory
   - Recording memory used in percentage value
   - If the periodic triggering functionality is used, the time to trigger which indicates the remaining time to next periodic triggering of the disturbance recorder.

6.1.3.3 Controlling and uploading disturbance recorder data

Disturbance recorder data can be controlled and read with PCM600.

For more information, see PCM600 documentation.
6.1.3.4 Monitoring fault records

To monitor fault records:

1. Select **Main Menu/Monitoring/Recorded data**.
2. To navigate between the fault records, press ↑ and ↓.
3. To enter or exit a submenu, press ← or →.

![Figure 47: Monitoring fault records](image)

6.1.3.5 Monitoring events

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

To monitor events:

1. Select **Main Menu/Events**.
2. Press ← to view the first event.
   - Date, time, device description, object description and event text elements of the event are shown.
3. Press ↑ or ↓ to scroll the view.

![Figure 48: Monitoring events](image)

6.1.4 Remote monitoring

The IED supports comprehensive remote monitoring.
6.1.4.1 Operating IED remotely

With the PCM600 tool you can:

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

For more information, refer to PCM600 documentation.

6.2 Controlling

6.2.1 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 you are authorized to access control operations.

As a default, breaker 1 is always the first to be controlled. If other controllable objects are available, the user can select them in the control menu:

1. Select Main menu/Control.
   The list of controllable objects is shown.
2. Enter the password when prompted.
3. Select an object with ↑ or ↓ and press →.
   The object is selected and is ready to be controlled.
4. Press → to open or ↓ to close the object.

![Selecting object](image)

Figure 49: Selecting object

5. To confirm the operation, select Yes and press →.
Figure 50: Opening circuit breaker

- To cancel the operation, select No and press .

Figure 51: Cancelling operation

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

6.3 Resetting IED

6.3.1 Clearing and acknowledging via LHMI

You can reset, acknowledge or clear all messages and indications, including LEDs and latched outputs as well as registers and recordings, with the Clear button. Pressing the Clear button activates a selection menu, where you can choose which clearance or reset function you want to make. You can also clear events and alarms assigned to alarm LEDs with the Clear button.

To clear, reset or acknowledge messages and indications:

1. Press to activate the Clear view.
   All the items that can be cleared are shown:
   - Indications and LEDs
   - Alarm LEDs
   - Recorded data
   - Events
• Disturbance records
• Temperature functions
• Trip lockout functions

![Clear view](image)

Figure 52: Clear view

2. Select the item to be cleared with ↑ or ↓.
3. Press ⇁, change the value from False to True with ↑ or ↓ and press ⇁ again. The item is now cleared and the value changes back to False.
4. Repeat steps 2 and 3 to clear other items.

6.4 Changing IED functionality

6.4.1 Creating blockings

PCM600 can be used for creating blockings.

For more information, refer to PCM600 documentation.

6.4.2 Selecting test mode

The test mode can be activated using the LHMI. The green Ready LED will be blinking to indicate that the test mode is activated.

To activate or deactivate the test mode:

1. Select Main Menu/Tests/IED test/Test mode and press ⇁.
Figure 53: Entering test mode

2. Select Test off or Test on with ↑ or ↓.
3. Press ← to confirm the selection.

If you do not cancel the test mode, it remains on and the Ready LED remains blinking. Test mode does not retain if the IED is reset.

6.4.3 Connecting to trip and disturbance recorder functions

PCM600 can be used for connecting trip and disturbance recorder functions.

For more information, refer to PCM600 documentation.

6.4.4 Defining channel settings

To monitor the settings for each channel of the disturbance recorder:

1. Select Main Menu/Configuration/Disturbance recorder/Channel settings.
2. Press ↑ or ↓ to scroll the view.
3. To change channel settings, press ←.

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

6.4.5 Defining setting group

6.4.5.1 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 by the IED application or manually from the menu.

To change the active setting group via the LHMI:
1. Select **Main Menu/Settings/Setting group/Active group** and press.

![Figure 54: Active setting group](image)

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

![Figure 55: Selecting active setting group](image)

4. Commit the settings.

   ![i](image) Remember to document the changes you make.

### 6.4.5.2 Selecting a setting group for editing

To select a setting group:

1. Select **Main Menu/Settings/Edit setting group**.
2. Select the setting group to be edited with ► or ◄.
3. Press to confirm the selection.
4. Edit the settings.
6.4.5.3 Browsing and editing setting group values

To browse setting group values:

1. Select Main Menu/Settings/Settings and press →.
2. Select the setting group to be viewed with ↑ or ↓ and press ← to confirm the selection.

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

The setting group values are indicated with #.
6. To select a setting group value, press \[\text{ }\] and to edit the value press \[\text{ }\].

![Setting group parameter](image1)

**Figure 58: Setting group parameter**

6. To select a setting group value, press \[\text{ }\] and to edit the value press \[\text{ }\].

![Selecting setting group value](image2)

**Figure 59: Selecting setting group value**

Only values within the selected setting group can be changed.

7. Press \[\uparrow\] or \[\downarrow\] to change the value and \[\text{ }\] to confirm the selection.

![Editing setting group value](image3)

**Figure 60: Editing setting group value**

The active setting group is indicated with an asterisk *.

### 6.4.6 Activating LEDs

To change the Alarm LED mode:

1. Select **Main Menu/Configuration/Alarm LEDs** and press \[\text{ }\].
2. Select an Alarm LED with \[\uparrow\] or \[\downarrow\].
3. Press \[\text{ }\] to confirm the selection and to change the Alarm LED mode.
4. Press \[\uparrow\] or \[\downarrow\] to change the value and enter to confirm the selection.

For more information, refer to PCM600 documentation.
Section 7

Troubleshooting

7.1 Fault tracing

7.1.1 Identifying hardware errors

Most hardware errors are caused by external events which physically damage the IED's hardware. Probable causes are, for example, overvoltage, spikes and short circuits which damage one or several of IED's physical inputs or outputs. Human errors can also cause damage during installation or operation. As a consequence, one or several physical cards, inputs or outputs may stop operating due to the damage.

To identify hardware errors:

1. Check the module with error.
   You can check the IED supervision events in Main Menu/Monitoring/IED status/Self-supervision for the hardware module with error.
2. Inspect the IED visually
   - Inspect the IED visually to find the 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.

7.1.2 Identifying runtime errors

Runtime errors may be caused by component failures or software problems. Application errors are sometimes caused by measurement data flow problems like missing samples from measurement data stream.

Some errors are cleared automatically but sometimes, for example in case of a component failure, proper corrective actions are needed.

To identify runtime errors:
1. Check the error origin from IED’s supervision events **Main Menu/Monitoring/IED status/Self-supervision**.
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.

### 7.1.3 Identifying communication errors

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

To identify communication errors:

1. Check the operation of the communication link.
2. Check the time synchronization. On the LHMI, this can be done by navigating from **Main Menu/Monitoring/IED status/Time synchronization**.
3. In case of persistent faults originating from IED’s internal faults such as component breakdown, contact ABB for repair or replacement actions.

### 7.1.4 Checking communication LEDs

There are two LEDs on the LHMI above the RJ-45 communication port.

- To verify communication, check that both LEDs are lit.

<table>
<thead>
<tr>
<th>LED</th>
<th>Communication ok</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uplink</td>
<td>Steady green light</td>
</tr>
<tr>
<td>Comm</td>
<td>Blinking yellow light</td>
</tr>
</tbody>
</table>

### 7.1.5 Running the display test

A short display test is always run, when auxiliary voltage is connected to the device. You can also run the display test manually:

- Press simultaneously `esc` and `6`.  
The LEDs are tested by turning them on simultaneously. The LCD shows a set of patterns so that all the pixels are activated. After the test, the display returns to normal state.

7.2 Indication messages

7.2.1 Internal faults

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

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

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

The internal fault code indicates the type of internal IED fault. When a fault appears, document the code and state it when ordering the service.

![Internal Fault Message](image)

Figure 61: Fault indication

Table 17: Internal fault indications and codes

<table>
<thead>
<tr>
<th>Fault indication</th>
<th>Fault code</th>
<th>Additional information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Fault System error</td>
<td>2</td>
<td>An internal system error has occurred.</td>
</tr>
<tr>
<td>Internal Fault File system error</td>
<td>7</td>
<td>A file system error has occurred.</td>
</tr>
<tr>
<td>Internal Fault Test</td>
<td>8</td>
<td>Internal fault test activated manually by the user.</td>
</tr>
<tr>
<td>Internal Fault SW watchdog error</td>
<td>10</td>
<td>Watchdog reset has occurred too many times within an hour.</td>
</tr>
<tr>
<td>Internal Fault SO-relay(s),X100</td>
<td>43</td>
<td>Faulty Signal Output relay(s) in card located in slot X100.</td>
</tr>
</tbody>
</table>

Table continues on next page
<table>
<thead>
<tr>
<th>Fault indication</th>
<th>Fault code</th>
<th>Additional information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Fault SO-relay(s),X110</td>
<td>44</td>
<td>Faulty Signal Output relay(s) in card located in slot X110.</td>
</tr>
<tr>
<td>Internal Fault SO-relay(s),X130</td>
<td>46</td>
<td>Faulty Signal Output relay(s) in card located in slot X130.</td>
</tr>
<tr>
<td>Internal Fault PO-relay(s),X100</td>
<td>53</td>
<td>Faulty Power Output relay(s) in card located in slot X100.</td>
</tr>
<tr>
<td>Internal Fault PO-relay(s),X110</td>
<td>54</td>
<td>Faulty Power Output relay(s) in card located in slot X110.</td>
</tr>
<tr>
<td>Internal Fault PO-relay(s),X130</td>
<td>56</td>
<td>Faulty Power Output relay(s) in card located in slot X130.</td>
</tr>
<tr>
<td>Internal Fault Light sensor error</td>
<td>57</td>
<td>Faulty ARC light sensor input(s).</td>
</tr>
<tr>
<td>Internal Fault Conf. error,X000</td>
<td>62</td>
<td>Card in slot X000 is wrong type.</td>
</tr>
<tr>
<td>Internal Fault Conf. error,X100</td>
<td>63</td>
<td>Card in slot X100 is wrong type or does not belong to the original composition.</td>
</tr>
<tr>
<td>Internal Fault Conf. error,X110</td>
<td>64</td>
<td>Card in slot X110 is wrong type, is missing or does not belong to the original composition.</td>
</tr>
<tr>
<td>Internal Fault Conf. error,X120</td>
<td>65</td>
<td>Card in slot X120 is wrong type, is missing or does not belong to the original composition.</td>
</tr>
<tr>
<td>Internal Fault Conf. error,X130</td>
<td>66</td>
<td>Card in slot X130 is wrong type, is missing or does not belong to the original composition.</td>
</tr>
<tr>
<td>Internal Fault Card error,X000</td>
<td>72</td>
<td>Card in slot X000 is faulty.</td>
</tr>
<tr>
<td>Internal Fault Card error,X100</td>
<td>73</td>
<td>Card in slot X100 is faulty.</td>
</tr>
<tr>
<td>Internal Fault Card error,X110</td>
<td>74</td>
<td>Card in slot X110 is faulty.</td>
</tr>
<tr>
<td>Internal Fault Card error,X120</td>
<td>75</td>
<td>Card in slot X120 is faulty.</td>
</tr>
<tr>
<td>Internal Fault Card error,X130</td>
<td>76</td>
<td>Card in slot X130 is faulty.</td>
</tr>
<tr>
<td>Internal Fault LHMI module</td>
<td>79</td>
<td>LHMI module is faulty. The fault indication may not be seen on the LHMI during the fault.</td>
</tr>
<tr>
<td>Internal Fault RAM error</td>
<td>80</td>
<td>Error in the RAM memory on the CPU card.</td>
</tr>
<tr>
<td>Internal Fault ROM error</td>
<td>81</td>
<td>Error in the ROM memory on the CPU card.</td>
</tr>
<tr>
<td>Internal Fault EEPROM error</td>
<td>82</td>
<td>Error in the EEPROM memory on the CPU card.</td>
</tr>
<tr>
<td>Internal Fault FPGA error</td>
<td>83</td>
<td>Error in the FPGA on the CPU card.</td>
</tr>
<tr>
<td>Internal Fault RTC error</td>
<td>84</td>
<td>Error in the RTC on the CPU card.</td>
</tr>
</tbody>
</table>
7.2.2 Warnings

Further, a fault indication message, which includes text *Warning* with additional text, a code, date and time, is shown on the LHMI to indicate the fault type. If more than one type of fault occur at the same time, indication of the latest fault appears on the LCD. The fault indication message can be manually cleared.

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

![Warning](image)

*Figure 62: Warning*

<table>
<thead>
<tr>
<th>Warning indication</th>
<th>Warning code</th>
<th>Additional information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warning</td>
<td>10</td>
<td>A watchdog reset has occurred.</td>
</tr>
<tr>
<td>Watchdog reset</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power down det.</td>
<td>11</td>
<td>The auxiliary supply voltage has dropped too low.</td>
</tr>
<tr>
<td>IEC61850 error</td>
<td>20</td>
<td>Error when building the IEC 61850 data model.</td>
</tr>
<tr>
<td>Modbus error</td>
<td>21</td>
<td>Error in the Modbus communication.</td>
</tr>
<tr>
<td>DNP3 error</td>
<td>22</td>
<td>Error in the DNP3 communication.</td>
</tr>
<tr>
<td>Dataset error</td>
<td>24</td>
<td>Error in the Data set(s).</td>
</tr>
<tr>
<td>Report cont. error</td>
<td>25</td>
<td>Error in the Report control block(s).</td>
</tr>
<tr>
<td>GOOSE contr. error</td>
<td>26</td>
<td>Error in the GOOSE control block(s).</td>
</tr>
<tr>
<td>SCL config error</td>
<td>27</td>
<td>Error in the SCL configuration file or the file is missing.</td>
</tr>
<tr>
<td>Logic error</td>
<td>28</td>
<td>Too many connections in the configuration.</td>
</tr>
<tr>
<td>SMT logic error</td>
<td>29</td>
<td>Error in the SMT connections.</td>
</tr>
<tr>
<td>GOOSE input error</td>
<td>30</td>
<td>Error in the GOOSE connections.</td>
</tr>
<tr>
<td>GOOSE rec. error</td>
<td>32</td>
<td>Error in the GOOSE message receiving.</td>
</tr>
</tbody>
</table>

Table continues on next page
### Warning indications

<table>
<thead>
<tr>
<th>Warning indication</th>
<th>Warning code</th>
<th>Additional information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warning</td>
<td>33</td>
<td>Analog channel configuration error.</td>
</tr>
<tr>
<td>AFL error</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unack card comp.</td>
<td>40</td>
<td>A new composition has not been acknowledged/accepted.</td>
</tr>
<tr>
<td>ARC1 cont. light</td>
<td>85</td>
<td>A continuous light has been detected on the ARC light input 1.</td>
</tr>
<tr>
<td>ARC2 cont. light</td>
<td>86</td>
<td>A continuous light has been detected on the ARC light input 2.</td>
</tr>
<tr>
<td>ARC3 cont. light</td>
<td>87</td>
<td>A continuous light has been detected on the ARC light input 3.</td>
</tr>
</tbody>
</table>

### 7.2.3 LED and display messages

Usually when a LED is lit, an indication is shown on the LHMI and event 10 is generated.

### 7.3 Corrections procedures

#### 7.3.1 Rebooting software

To reboot the software:

1. Select **Main Menu/Configuration/General** and press **↵**.
2. Change the value from **False** to **True** with ↑ or ↓ button and press **↵**.

#### 7.3.2 Setting password

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

The password can be set to write mode with engineer or operator rights but the changes to the password are not saved.

To set a password via the LHMI:

1. Select **Main Menu/Configuration/Authorization**.
2. Select the password to be reset with ↑ or ↓.
3. Press **↵**, change the password with ↑ or ↓ and press **↵** again.
4. Repeat steps 2 and 3 to set the rest of the passwords.
7.3.3 Identifying IED application problems

To identify application problems:

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

7.3.3.1 Inspecting wiring

The physical inspection of wiring connections often reveals the wrong connection for phase currents or voltages. However, even though the phase current connections to IED terminals might be correct, wrong polarity of one or more measurement transformers can cause problems. To verify this problem:

1. Check the current or voltage measurements and their phase information from Main Menu/Measurements/Load – primary values.
2. Check that the phase information and phase shift between phases is correct.
3. Correct the wiring if needed.

7.3.3.2 Inspecting configuration connection

The user can sometimes make wrong connections for applications in the ACT. The user might, for example, connect a wrong binary input to an application function. Thus, the IED includes a software testing functionality to force any binary input to active or inactive state. To verify the problem:

1. Activate Main Menu/Tests/IED test /Test mode.
3. Check the function operation from Main Menu/Monitoring/I/O status/Function output values.
4. Check and correct the product configuration, if the input does not create the expected action.

7.3.3.3 Sample data interruptions

Occasionally IEDs can receive corrupted or faulty measurement data during runtime. In these cases the operation system halts the corresponding application execution until the correct data are received. In case of permanent faults, the measurement chain shall be checked to remove the origin of the faulty measurement data.
In case of persistent faults originating from IED's internal faults, contact ABB for repair or replacement actions.
Section 8 Commissioning

8.1 Commissioning checklist

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

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

8.2 Checking installation

8.2.1 Checking the power supply

Check that the auxiliary supply voltage remains within the permissible input voltage range under all operating conditions. Check that the polarity is correct.
8.2.2 Checking CT circuits

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

- Primary injection test to verify the current ratio of the CT, the correct wiring up to the protection IED and correct phase sequence connection (that is L1, L2, L3.)
- Polarity check to prove that the predicted direction of secondary current flow is correct for a given direction of primary current flow. This is an essential test for the proper operation of the directional function, protection or measurement in the IED.
- CT secondary loop resistance measurement to confirm that the current transformer secondary loop dc resistance is within specification and that there are no high resistance joints in the CT winding or wiring.
- CT excitation test to ensure that the correct core in the CT is connected to the IED. Normally only a few points along the excitation curve are checked to ensure that there are no wiring errors in the system, for example due to a mistake in connecting the CT's measurement core to the IED.
- Check the earthing of the individual CT secondary circuits to verify that each three-phase set of main CTs is properly connected to the station earth and only at one electrical point.
- Insulation resistance check.

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

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

8.2.3 Checking VT circuits

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

Do not continue before any errors are corrected.

Test the circuitry. The following tests are recommended:
• Polarity check
• VT circuit voltage measurement (primary injection test)
• Earthing check
• Phase relationship
• Insulation resistance check

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

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

8.2.4 Checking binary input and output circuits

8.2.4.1 Binary input circuits

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

8.2.4.2 Binary output circuits

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

8.3 Authorizations

8.3.1 User authorization

The user categories have been predefined for LHMI and WHMI, each with different rights and default passwords.

Passwords are settable. LHMI password must be at least four and WHMI password at least nine characters. Maximum number of characters is 20 for the WHMI password and 8 for the LHMI password. Only the following characters are accepted:

• Numbers 0-1
• Letters a-z, A-Z
• Space
• Special characters !"#$%&'()*+,-./:;<=>?@[\]^_`{|}~
User authorization is disabled by default and can be enabled either via the LHMI or WHMI Main Menu/Configuration/Authorization.

Table 19: Predefined user categories

<table>
<thead>
<tr>
<th>Username</th>
<th>LHMI password</th>
<th>WHMI password</th>
<th>User rights</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIEWER</td>
<td>0001</td>
<td>remote0001</td>
<td>Only allowed to view</td>
</tr>
<tr>
<td>OPERATOR</td>
<td>0002</td>
<td>remote0002</td>
<td>Authorized to make operations</td>
</tr>
<tr>
<td>ENGINEER</td>
<td>0003</td>
<td>remote0003</td>
<td>Allowed to change IED parameters, but no operation rights</td>
</tr>
<tr>
<td>ADMINISTRATOR</td>
<td>0004</td>
<td>remote0004</td>
<td>Full access</td>
</tr>
</tbody>
</table>

For user authorization for PCM600, see PCM600 documentation.

8.4 Using PCM600

8.4.1 Setting communication between IEDs and PCM600

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

The communication media is always Ethernet and the protocol is TCP/IP.

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

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

To configure the physical connection and the IP addresses:

1. Set up or get the IP addresses of the IEDs.
2. Set up the PC for a direct link or connect the PC or workstation to the network.
3. Configure the IED IP addresses in the PCM600 project for each IED. The addresses are used for communication by the OPC interface of PCM600.
8.4.1.1 Communication options

Two options are available for the connection of PCM600 to the IED:

• Direct point to point link between PCM600 and the IED
• Indirect link via a station LAN or from remote via a network

Point to point link

The IED is provided with an RJ-45 connector on the front panel. The connector is mainly for configuration and setting purposes. Any Ethernet cable can be used but the recommendation is STP.

The IED has a DHCP server for the front interface. The DHCP server assigns an IP address to the computer connected to the front interface. The computer's LAN interface has to be configured to obtain the IP address automatically.

LAN or WAN network

In TCP/IP networking, a LAN is often but not always implemented as a single IP subnet. A router connects LANs to a WAN. In IP networking, the router maintains both a LAN address and a WAN address. Design considerations for computer networks cover a wide range of topics including layout, capacity planning, and security. To some extent, the network configuration also depends on user preferences.

8.4.1.2 Setting communication parameters

The IP address and the corresponding mask can be set via the LHMI for the rear port. The front port uses a fixed IP address 192.168.0.254. The front port also uses DHCP.

Each Ethernet interface has a factory default IP address when the complete IED is delivered.

Setting front communication

To set up a standard PC with Microsoft Windows operating system for front communication:

1. To open Network Connections, click Start, point to Settings, click Control Panel, and then double-click Network Connections.
2. Double-click the connection that you want to configure, and then click Properties.
3. Select the TCP/IP protocol from the list of configured components using this connection and click Properties.
4. Select **Obtain an IP address automatically** and **Obtain DNS server address automatically**.
5. Close all open windows by clicking OK and start PCM600.

Administrator rights are requested to change the configuration as described above.

Setting rear communication
To set up a standard PC with Microsoft Windows operating system for rear communication:

1. To open Network Connections, click Start, point to Settings, click Control Panel, and then double-click Network Connections.
2. Double-click the connection that you want to configure, and then click Properties.
3. Select the TCP/IP protocol from the list of configured components using this connection and click Properties.
4. Choose **Use the following IP address**. Enter an IP address and a subnet mask. Make sure that the IP address is unique, that is not used by any other IED on the network.
5. Close all open windows by clicking OK and start PCM600.

Administrator rights are requested to change the configuration as described above.

**Setting IED's IP address in PCM600**

In PCM600 the IED's IP address can be defined either via the first window of the wizard by including a new IED in the project or by entering the IED's IP address in the Object Properties window.

To define the IP address via the Object Properties window:

1. Select the IED to which you want to define the IP address.
2. Open the Object Properties window.
3. Place the cursor in the IP Address row and enter the IP address.
The used method depends on the time at which the IP address is available. Defining IP address in the Object Properties windows allows changing the IP address at any time.

8.5 Setting IED and communication

8.5.1 Setting communication

The IED is provided with an RJ-45 connector on the front panel. The connector is mainly used for configuration and setting purposes. The fixed IP address for the front port is 192.168.0.254.

Different communication ports are available via optional communication modules. There are three options for rear port communication intended mainly for station level communication, that is station bus. The options are galvanic Ethernet (RJ-45), optical Ethernet (LC) and RS-485/RS-232 twisted pair. Communication protocols used via Ethernet ports are IEC 61850-8-1 and Modbus TCP/IP. Protocol available for RS-485/RS-232 serial port is Modbus RTU/Modbus ASCII.

You can set the following communication parameters:

- To define the settings for the Ethernet port, select **Main Menu/Configuration/Communication/Ethernet/Rear port**.
- To define the settings for RS-485/RS-232 serial port, select **Main Menu/Configuration/Communication/COM1** or **Main Menu/Configuration/Communication/COM2**.
- To define Modbus communication parameters, select **Main Menu/Configuration/Communication/Modbus**.

For more information, see Modbus Communication Protocol Manual and Technical Manual.

8.5.2 Setting LHMI

8.5.2.1 Changing LHMI language

To change the LHMI language:

1. Select **Main Menu/Language** and press ✪.
2. Change the language with or ✪.
3. Press ✪ to confirm the selection.
4. Commit the changes.
8.5.2.2 Adjusting display contrast

To obtain optimal readability, you can adjust the display contrast. The contrast can be adjusted anywhere in the menu structure.

- To increase the contrast, press simultaneously ‹ESC› and ‹↑›.
- To decrease the contrast, press simultaneously ‹ESC› and ‹↓›.

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

8.5.2.3 Changing display symbols

To switch between the display symbols IEC 61850, IEC 61617 and IEC-ANSI:

1. Select Main Menu/Configuration/HMI/FB naming convention and press ‹←›.
2. Change the display symbols with ‹↑› or ‹↓›.
3. Press ‹→› to confirm the selection.

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

8.5.2.4 Changing the default view

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

To change the default view:
1. Select **Main Menu/Configuration/HMI/Default view** and press →.
2. Change the default view with ↑ or ↓.
3. Press → to confirm the selection.

### 8.5.2.5 Setting system time and time synchronization

To edit the date and time and the time synchronization source:

1. Select **Main Menu/Configuration/Time/System time** and press →.
2. Select the parameter with ↑ or ↓.
3. Press →, change the value with ↑ or ↓ and press → again.
4. Repeat steps 2 and 3 to set the rest of the system time parameters.
5. Select **Main Menu/Configuration/Time/Synchronization/Synch source** and press →.
6. Set the time synchronization source to SNTP, Modbus or IRIG-B with ↑ or ↓.
7. Press → to confirm the selection.

If SNTP is used, the SNTP server’s IP address is set in **Main Menu/Configuration/Time/Synchronization/IP SNTP Primary** and **Main Menu/Configuration/Time/Synchronization/IP SNTP Secondary**.

### Setting daylight saving time

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

To define the DST shift:

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

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

#### Table 20: DST change on Sunday

<table>
<thead>
<tr>
<th>Day of the DST shift</th>
<th>DST on/off date</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Sunday of the month</td>
<td>1</td>
</tr>
<tr>
<td>Second Sunday of the month</td>
<td>8</td>
</tr>
<tr>
<td>Third Sunday of the month</td>
<td>15</td>
</tr>
<tr>
<td>Fourth Sunday of the month</td>
<td>22</td>
</tr>
<tr>
<td>Last Sunday, if the month has 30 days</td>
<td>24</td>
</tr>
<tr>
<td>Last Sunday, if the month has 31 days</td>
<td>25</td>
</tr>
</tbody>
</table>
For example, if the DST is observed from the last Sunday in March to the last Sunday in October and the time shift occurs at 01:00 UTC, the setting parameters are:

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>DST on time:</td>
<td>01:00</td>
</tr>
<tr>
<td>DST on date:</td>
<td>25.03</td>
</tr>
<tr>
<td>DST on day:</td>
<td>Sun</td>
</tr>
<tr>
<td>DST off time:</td>
<td>01:00</td>
</tr>
<tr>
<td>DST off date:</td>
<td>25.10</td>
</tr>
<tr>
<td>DST off day:</td>
<td>Sun</td>
</tr>
</tbody>
</table>

Set the DST on day and DST off day to "not in use" to determine the exact date and time for the DST shift. Repeat the setting yearly, as the time for the DST shift is not on the same date every year.

To disable the DST, set the DST offset parameter to "0 min".

8.5.3 Setting IED parameters

8.5.3.1 Defining setting groups

Selecting a setting group for editing

To select a setting group:

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

![Figure 68: Selecting a setting group](image)

Browsing and editing setting group values

To browse setting group values:
1. Select **Main Menu/Settings/Settings** and press ➡️.

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

![Figure 69: Selecting setting group](image)

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

4. To browse different function blocks, scroll the list with ↑ and ↓ and to select a function block press ➡️. To move back to the list, press ➡️.

   The function block list is shown in the content area of the display. On the left in the header, you see the current setting group, and on the right the menu path.

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

   The setting group values are indicated with #.

![Figure 70: Setting group parameter](image)

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

![Figure 71: Selecting setting group value](image)

   Only values within the selected setting group can be changed.

7. Press ↑ or ↓ to change the value and ➡️ to confirm the selection.
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 by the IED application or manually from the menu.

To change the active setting group via the LHMI:

1. Select **Main Menu/Settings/Setting group/Active group** 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.
8.5.3.2 IED parametrization

IED parameters are usually set with a parameter setting tool but it can also be done via the LHMI or WHMI.

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.

For more information, see PCM600 documentation.

Document all changes to parameter settings.

8.5.3.3 Configuring analog inputs

To configure the CT and VT analog inputs:

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

8.6 Testing IED operation

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

8.6.1 Selecting test mode

The test mode can be activated using the LHMI. The green Ready LED will be blinking to indicate that the test mode is activated.

To activate or deactivate the test mode:

1. Select Main Menu/Tests/IED test/Test mode and press .
2. Select Test off or Test on with ↑ or ↓.
3. Press ↓ to confirm the selection.

If you do not cancel the test mode, it remains on and the Ready LED remains blinking. Test mode does not retain if the IED is reset.

8.6.2 Testing digital I/O interface

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

1. Select Main Menu/Tests/Binary Outputs/X100 (PSM)/X100-Output 1 and press ↓.
2. Select False or True with ↑ or ↓.
3. Press ↓ to confirm the selection.

If the optional BIO-module (X110) is included in the IED, the menu path could also be Main Menu/Tests/Binary Outputs/X110 (BIO1)/<binary output>.

8.6.3 Testing functions

To activate or deactivate an output signal for protection or other function:

1. Select Main Menu/Tests/Function tests/Current protection/PHLPTOC and press ↓.
2. Select the output signal to be activated or deactivated with ↑ or ↓ and press ↓.
3. To deactivate all output signals for the function, select Reset with ↑ or ↓ and press ↓.
8.6.4 Selecting internal fault test

The internal fault may be tested by using the LHMI. When enabling the test, the internal relay fault output contact is activated, the green Ready LED will be blinking and internal fault test indication is shown on the LHMI. See Technical Manual for internal relay fault output contact location.

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

To activate or deactivate internal fault test:


2. Select False or True with ↑ or ↓.

3. Press ✏️ to confirm the selection.

8.7 ABB Product Data Registration

The ABB Product Data Registration feature traces composition changes related to the IED's SW or HW.

After a composition change, an LCT indication is seen on the LHMI at the IED startup. At this point, PCM600 should be connected to the IED as it reads the changed data from the IED. The LCT indication is cleared in the same way as other indications. If PCM600 is not connected to the IED, the indication is seen again after the IED's reboot.
The number of composition changes can be seen from the Composition changes parameter in Main Menu/Monitoring/IED status.
# Section 9 Glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>100BASE-FX</td>
<td>A physical media defined in the IEEE 802.3 Ethernet standard for local area networks (LANs). 100BASE-FX uses fiber optic cabling.</td>
</tr>
<tr>
<td>100BASE-TX</td>
<td>A physical media defined in the IEEE 802.3 Ethernet standard for local area networks (LANs). 100BASE-TX uses twisted-pair cabling category 5 or higher with RJ-45 connectors.</td>
</tr>
<tr>
<td>ACT</td>
<td>Application Configuration Tool in PCM600</td>
</tr>
<tr>
<td>ACT</td>
<td>Trip status</td>
</tr>
<tr>
<td>AI</td>
<td>Analog input</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
</tr>
<tr>
<td>ASCII</td>
<td>American Standard Code for Information Interchange</td>
</tr>
<tr>
<td>BI</td>
<td>Binary input</td>
</tr>
<tr>
<td>BI/O</td>
<td>Binary input/output</td>
</tr>
<tr>
<td>CAT 5</td>
<td>A twisted pair cable type designed for high signal integrity</td>
</tr>
<tr>
<td>CB</td>
<td>Circuit breaker</td>
</tr>
<tr>
<td>COMTRADE</td>
<td>COMmon format for Transient Data Exchange for power systems. Defined by the IEEE Standard.</td>
</tr>
<tr>
<td>Connectivity</td>
<td>Software that helps the user to define right connectivity package versions for different applications and tools.</td>
</tr>
<tr>
<td>Package Manager</td>
<td></td>
</tr>
<tr>
<td>CPU</td>
<td>Central Processing Unit</td>
</tr>
<tr>
<td>CSV</td>
<td>Comma separated values</td>
</tr>
<tr>
<td>CT</td>
<td>Current transformer</td>
</tr>
<tr>
<td>DHCP</td>
<td>Dynamic Host Control Protocol allows devices joining the network to dynamically receive an IP address from the DHCP server that contains a pool of IP addresses.</td>
</tr>
<tr>
<td>DMS</td>
<td>Distribution Management System</td>
</tr>
<tr>
<td>DST</td>
<td>Daylight saving time</td>
</tr>
<tr>
<td>EEPROM</td>
<td>Electrically Erasable Programmable Read-Only Memory</td>
</tr>
<tr>
<td>Ethernet</td>
<td>A large, diverse family of frame-based computer networking technologies that operate at many speeds for LANs interconnecting computing devices. Ethernet is a trademark of Xerox Corporation, Inc. and defined in the</td>
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</tbody>
</table>
**IEEE 802.3** standard in which computers access the network through a CSMA/CD protocol.

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tr>
<td>FB</td>
<td>Function block.</td>
</tr>
<tr>
<td>Firmware</td>
<td>System software or hardware that has been written and stored in a device's memory that controls the device.</td>
</tr>
<tr>
<td>FPGA</td>
<td>Field Programmable Gate Array</td>
</tr>
<tr>
<td>GOOSE</td>
<td>Generic Object Oriented Substation Event</td>
</tr>
<tr>
<td>HMI</td>
<td>Human-machine interface</td>
</tr>
<tr>
<td>HW</td>
<td>Hardware</td>
</tr>
<tr>
<td>IEC</td>
<td>International Electrotechnical Commission</td>
</tr>
<tr>
<td>IEC 61850</td>
<td>International standard for substation communication and modelling.</td>
</tr>
<tr>
<td>IEC 61850-8-1</td>
<td>A communication protocol based on the IEC 61850 standard series and a standard for substation modelling.</td>
</tr>
<tr>
<td>IED</td>
<td>Intelligent Electronic Device</td>
</tr>
<tr>
<td>IP address</td>
<td>Internet protocol address is a set of four numbers between 0 and 255, separated by periods. Each server connected to the Internet is assigned a unique IP address that specifies a location for the TCP/IP protocol.</td>
</tr>
<tr>
<td>LAN</td>
<td>Local area network</td>
</tr>
<tr>
<td>LC</td>
<td>Connector type for glass fibre cable.</td>
</tr>
<tr>
<td>LCD</td>
<td>Liquid crystal display</td>
</tr>
<tr>
<td>LCP</td>
<td>Liquid crystal polymer</td>
</tr>
<tr>
<td>LCT</td>
<td>Life cycle traceability</td>
</tr>
<tr>
<td>LED</td>
<td>Light-emitting diode</td>
</tr>
<tr>
<td>LHMI</td>
<td>Local Human-Machine Interface</td>
</tr>
<tr>
<td>Modbus</td>
<td>A serial communication protocol developed by the Modicon company in 1979. Originally used for communication in PLCs and RTU devices.</td>
</tr>
<tr>
<td>Modbus ASCII</td>
<td>Modbus link mode. Character length 10 bits.</td>
</tr>
<tr>
<td>Modbus RTU</td>
<td>Modbus link mode. Character length 11 bits.</td>
</tr>
<tr>
<td>Modbus TCP/IP</td>
<td>Modbus RTU protocol which uses TCP/IP and Ethernet to carry data between devices.</td>
</tr>
<tr>
<td>NCC</td>
<td>Network control center</td>
</tr>
<tr>
<td>OPC</td>
<td>OLE (object linking and embedding) for process control</td>
</tr>
<tr>
<td>PA</td>
<td>Polyamide</td>
</tr>
<tr>
<td>PBT</td>
<td>Polybutylene terephthalate</td>
</tr>
<tr>
<td><strong>PC</strong></td>
<td>Personal Computer; Polycarbonate</td>
</tr>
<tr>
<td>------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td><strong>PCM600</strong></td>
<td>Protection and Control IED Manager</td>
</tr>
<tr>
<td><strong>PO</strong></td>
<td>Power output</td>
</tr>
<tr>
<td><strong>R/L</strong></td>
<td>Remote/Local</td>
</tr>
<tr>
<td><strong>RAM</strong></td>
<td>Random access memory</td>
</tr>
<tr>
<td><strong>REF615</strong></td>
<td>Feeder protection relay</td>
</tr>
<tr>
<td><strong>RJ-45</strong></td>
<td>Galvanic connector type.</td>
</tr>
<tr>
<td><strong>RoHS</strong></td>
<td>Restriction of the use of certain Hazardous Substances in electrical and electronic equipment.</td>
</tr>
<tr>
<td><strong>ROM</strong></td>
<td>Read Only Memory</td>
</tr>
<tr>
<td><strong>RS-232</strong></td>
<td>Serial interface standard.</td>
</tr>
<tr>
<td><strong>RS-485</strong></td>
<td>Serial link according to EIA standard RS485.</td>
</tr>
<tr>
<td><strong>RTC</strong></td>
<td>Real Time Clock</td>
</tr>
<tr>
<td><strong>RTU</strong></td>
<td>Remote Terminal Unit</td>
</tr>
<tr>
<td><strong>SCADA</strong></td>
<td>Supervision, control and data acquisition</td>
</tr>
<tr>
<td><strong>SCL</strong></td>
<td>Substation Configuration Language</td>
</tr>
<tr>
<td><strong>SMT</strong></td>
<td>Signal Matrix Tool</td>
</tr>
<tr>
<td><strong>SNTP</strong></td>
<td>Simple Network Time Protocol</td>
</tr>
<tr>
<td><strong>SO</strong></td>
<td>Signal output</td>
</tr>
<tr>
<td><strong>STP</strong></td>
<td>Shielded Twisted-Pair</td>
</tr>
<tr>
<td><strong>SVG</strong></td>
<td>Scalable Vector Graphics</td>
</tr>
<tr>
<td><strong>SW</strong></td>
<td>Software</td>
</tr>
<tr>
<td><strong>TCP/IP</strong></td>
<td>Transmission Control Protocol / Internet Protocol</td>
</tr>
<tr>
<td><strong>TCS</strong></td>
<td>Trip-circuit supervision</td>
</tr>
<tr>
<td><strong>UTC</strong></td>
<td>Universal Time Coordinated</td>
</tr>
<tr>
<td><strong>UTF-8</strong></td>
<td>8-bit Unicode Transformation Format that serializes a Unicode scalar value as a sequence of one to four bytes.</td>
</tr>
<tr>
<td><strong>VT</strong></td>
<td>Voltage transformer</td>
</tr>
<tr>
<td><strong>WAN</strong></td>
<td>Wide area network</td>
</tr>
<tr>
<td><strong>WHMI</strong></td>
<td>Web Human-Machine Interface</td>
</tr>
</tbody>
</table>