RELION® 650 SERIES
650 series
Version 2.1
Operation manual
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This product includes software developed by the OpenSSL Project for use in the OpenSSL Toolkit. (http://www.openssl.org/) This product includes cryptographic software written/developed by: Eric Young (eay@cryptsoft.com) and Tim Hudson (tjh@cryptsoft.com).

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Conformity

This product complies with the directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive 2004/108/EC) and concerning electrical equipment for use within specified voltage limits (Low-voltage directive 2006/95/EC). This conformity is the result of tests conducted by ABB in accordance with the product standard EN 60255-26 for the EMC directive, and with the product standards EN 60255-1 and EN 60255-27 for the low voltage directive. The product is designed in accordance with the international standards of the IEC 60255 series.
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Section 1  Introduction

1.1  This manual

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

1.2  Intended audience

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

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

1.3.1 Product documentation set

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

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

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

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

The operation manual contains instructions on how to operate the IED once it has been commissioned. The manual provides instructions for the monitoring, controlling and setting of the IED. The manual also describes how to identify disturbances and how to view calculated and measured power grid data to determine the cause of a fault.
The application manual contains application descriptions and setting guidelines sorted per function. The manual can be used to find out when and for what purpose a typical protection function can be used. The manual can also provide assistance for calculating settings.

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

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

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

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

### 1.3.2 Document revision history

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### 1.3.3 Related documents

#### Documents related to REB650

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### 1.4 Document symbols and conventions

#### 1.4.1 Symbols

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

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

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

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

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

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

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

Although warning hazards are related to personal injury, it is necessary to understand that under certain operational conditions, operation of damaged equipment may result in degraded process performance leading to personal injury or death. It is important that the user fully complies with all warning and cautionary notices.
1.4.2 Document conventions

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

2.1  Symbols on the product

All warnings must be observed.

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

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

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

2.2  Warnings

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

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

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

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

Always use suitable isolated test pins when measuring signals in open circuitry. Potentially lethal voltages and currents are present.
Never connect or disconnect a wire and/or a connector to or from a IED during normal operation. Hazardous voltages and currents are present that may be lethal. Operation may be disrupted and IED and measuring circuitry may be damaged.

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

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

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

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

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

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

2.3 Caution signs

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

The IED contains components which are sensitive to electrostatic discharge. ESD precautions shall always be observed prior to touching components.
Always transport PCBs (modules) using certified conductive bags.

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

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

Take care to avoid electrical shock during installation and commissioning.

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

### 2.4 Note signs

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

3.1 Sustainable development

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

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

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

3.2 Disposing of the IED

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

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

Table 1: Materials of the IED parts

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

1) Polycarbonate
2) Liquid crystal polymer
Section 4  Using the HMI

4.1  Using the local HMI

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

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

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

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

Figure 2:  Saving changes animation

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

4.1.1  On-screen keyboard

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

Figure 3:  On-screen keyboard

- To insert a character navigate to the desired character in the middle three key rows with ↖️, ↘️, ← and →️ and confirm each character with ↘️.
- To delete a character press ⌘️ or use the Backspace key on the on-screen keyboard.
- To clear a whole string press ⌘️ and then backspace.
4.1.2 Logging on

1. Press \( \text{\#} \) to activate the login procedure.
   The login is also activated when attempting a password-protected operation.

2. Press \( \text{\#} \) to activate the User field.
   If CAM is activated an on-screen keyboard is shown.

3. Type in the user name using the on-screen keyboard.
   You can end user name editing at any time by pressing \( \text{\#} \) while the user field is focused
   (or navigate to the OK button and press \( \text{\#} \)), or press \( \text{ESC} \) (or navigate to the Cancel
   button and press \( \text{\#} \)) to abort the login attempt.
   If CAM is not activated select the user by scrolling with \( \text{\#} \) and \( \text{\#} \)
   and press \( \text{\#} \) to confirm.

![Selecting the user name]

4. Select \( \text{OK} \) on the on-screen keyboard and press \( \text{\#} \) to stop editing the user name.

5. Press \( \text{\#} \) to select the Password field and press \( \text{\#} \) to activate it.
   An on-screen keyboard is shown.
   Each added character is shown for a short time, then hidden with an asterisk character ‘*’
   to enhance security. You can end password editing at any time by pressing \( \text{\#} \) while the
   password field is focused (or navigate to the OK button and press \( \text{\#} \)) to attempt to
   login, or press \( \text{ESC} \) (or navigate to the Cancel button and press \( \text{\#} \)) to abort the login
   attempt.
   When the cursor is moved, the newly selected character is shown for a short time.

![Password keyboard]

6. Type in the password using the on-screen keyboard.
Passwords are case sensitive.

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

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

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

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

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

The logon dialog appears if the attempted operation requires another level of user rights.

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

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

1. Press \[\text{Log on}\].
2. To confirm logoff, select Yes and press \[\text{Log off}\].

4.1.4 Turning the display backlight on

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

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

If the panel has not been used for a predefined timeout period, the backlight is switched off. The user is logged out from the current user level after the display backlight has turned off. The factory default for display timeout is 10 minutes. The minimum is 1 minute.

The display returns to the default view and all unconfirmed operations, for example parameter editing and breaker selection are cancelled.

To cancel logoff, press \[\text{ESC}\].

4.1.5 Identifying the device

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

1. Select Main menu/Diagnostics/IED Status/Product identifiers.
2. Select a submenu with \[\text{Up}\] and \[\text{Down}\].
3. Enter the submenu with ↗.
4. Browse the information with ↑ and ↓.

4.1.6 Adjusting the display contrast

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

* To increase the contrast, press simultaneously and ▼.
* To decrease the contrast, press simultaneously and ▲.

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

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

4.1.7 Navigating in the menu

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

* To move to the Main menu or default view, press ▼.
* To move up or down in a menu, press ↑ or ↓.
* To move downwards in the menu tree, press →.
* To move upwards in the menu tree, press ←.
* To enter setting mode, press ◼.
* To leave setting mode without saving, press ESC.

4.1.7.1 Menu structure

The Main menu contains main groups which are divided further into more detailed submenus.
• Events
• Measurements
• Disturbance records
• Settings
• Configuration
• Diagnostics
• Test
• Clear
• Authorization (only if authority is activated)

4.1.7.2 Scrolling the display

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

- 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.

4.1.7.3 Changing the default view

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

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

4.1.8 Browsing setting values

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

   ![Figure 12: Selecting the setting group number](IEC13000241-1-en.vsd)

3. Press ↑ or ↓ to select the setting group number.
4. Press → to confirm the setting group selection and ↓ to return to the Edit setting group dialog.
5. Press ← to select Yes and to view the setting group values.
   - Press ← or → to select No and ← to exit.
6. To browse the settings, scroll the list with ↑ and ↓ and to select a setting press →. To move back to the list, press ←.

Figure 14: Selecting settings
The content of the list depends on the functions configured with PCM600.

4.1.9 Editing values

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

4.1.9.1 Editing numerical values

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

   Figure 15: Last digit is active and it can be increased or decreased

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

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

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

4. To select the minimum or maximum value, select the arrow symbol in front of the value.
   • To set the value to the maximum, press ↑.
   • To set the value to the minimum, press ↓.

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

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

   Figure 16: Restoring the previous value
4.1.9.2 Editing string values

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

1. Activate the setting mode and select a setting.
   When editing string values, the cursor moves to the first character.
2. Press \[→\] to open the editor.
   An on-screen keyboard is shown on the HMI.

3. Press \[↑\] or \[↓\] to select the edited string and press \[←\] or \[→\] to move the cursor.

4. Edit the string using the on-screen keyboard.
5. Select \[OK\] on the on-screen keyboard or press \[ESC\] while the string editing field is focused to accept the entered string is accepted and the editing dialog is closed.

4.1.9.3 Editing enumerated values

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

4.1.9.4 Changing time settings in LHMI

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

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

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

![Save changes?](image)

Figure 17: Confirming settings

- To exit without saving changes, select No and press \[\].
- To cancel saving settings, select Cancel and press \[\].

Pressing Cancel in the Save changes dialog closes only the Save changes dialog box, but the IED remains in editing mode. All the changes applied to any setting are not lost and the user can continue to change settings. To leave the change setting mode, select No or Yes in the Save changes dialog.

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

4.1.11 Clearing and acknowledging

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

1. Press \[\] to activate the Clear view.
The content of the Clear menu depends on the configuration configured with PCM600.
2. Select the item to be cleared with \[\] or \[\].
3. Press \[\] select OK to confirm the selection or Cancel to cancel the selection, and press \[\].
4. Repeat steps 2 and 3 to clear other items.

4.1.12 Using the local HMI help

1. Press \[\] to open the help view.
2. Scroll the text with \[\] or \[\] if the help text exceeds the display area.
3. To close the help, press \[\].
The help dialog is also closed when the display timeout expires.

<table>
<thead>
<tr>
<th>Main menu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
</tr>
<tr>
<td>Events</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Gen. help</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>How to use the keys</td>
</tr>
<tr>
<td>Alarm : Cycle through alarm pages</td>
</tr>
<tr>
<td>Clear : Go to clear menu</td>
</tr>
<tr>
<td>Menu : Toggle between main menu / default menu</td>
</tr>
<tr>
<td>? : Show help</td>
</tr>
<tr>
<td>Te : Change command operator</td>
</tr>
<tr>
<td>Cm-L : Execute / enter</td>
</tr>
<tr>
<td>La : Log on dialog</td>
</tr>
<tr>
<td>Esc : Exit / discard</td>
</tr>
<tr>
<td>1 : Close selected switch</td>
</tr>
</tbody>
</table>

**Figure 18:** Help menu
Section 5  IED operation

5.1  Normal operation

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

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

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

For more information, see PCM600 documentation.

5.2  Disturbance identification

Further actions to be taken to identify the disturbance:

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

Document the disturbance before clearing the information from the IED.

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

5.2.1  Disturbance recording triggering

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

5.2.2  Disturbance record analysis

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

5.2.3 Disturbance reports

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

For more information, see PCM600 documentation.

5.2.4 IED self-supervision

The IED self-supervision handles internal run-time fault situations.

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

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

The IED records IED status data and events.

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

5.2.5 Non-operative functions

functions can be non-operative if:

• function is not turned on, that is, $\text{Operation} = \text{Off}$.
• function is set to a non-operative state by IEC 61850.
5.3 IED parameterization

IED parameters are set via the LHMI or PCM600. The IED's settings need to be verified before the IED is connected to a system.

- Document all changes to parameter settings.

- For more information, see PCM600 documentation.

5.3.1 IED settings for IED functionality

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

After completing the editing of setting group values, the new values are activated. The user can either commit the edited values or discard them.

5.3.2 IED settings for different operating conditions

IED settings can be designed for various operation conditions by defining different setting values to different setting groups. The active setting group can be changed by the IED application or manually via the LHMI or PCM600.
Section 6  Operating procedures

6.1  Monitoring

6.1.1  Indications

6.1.1.1  Monitoring an internal IED fault

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

<table>
<thead>
<tr>
<th>Item</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal fail</td>
<td>Off</td>
</tr>
<tr>
<td>Internal warning</td>
<td>Off</td>
</tr>
<tr>
<td>Time synch</td>
<td>Ready</td>
</tr>
<tr>
<td>Real time clock</td>
<td>Ready</td>
</tr>
<tr>
<td>Application</td>
<td>Ready</td>
</tr>
<tr>
<td>Runtime execution</td>
<td>Ready</td>
</tr>
<tr>
<td>IEC61850</td>
<td>Ready</td>
</tr>
<tr>
<td>DINP3</td>
<td>Ready</td>
</tr>
<tr>
<td>PGM1</td>
<td>Ready</td>
</tr>
<tr>
<td>BTH3</td>
<td>Ready</td>
</tr>
<tr>
<td>BTH4</td>
<td>Ready</td>
</tr>
<tr>
<td>ICM15</td>
<td>Ready</td>
</tr>
<tr>
<td>NUM30</td>
<td>Ready</td>
</tr>
<tr>
<td>SLM30</td>
<td>Ready</td>
</tr>
</tbody>
</table>

Figure 19: Fault indication

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

6.1.2  Recorded data

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

- Disturbance records
- Events
6.1.2.1 Creating disturbance recordings

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

Set the DRPRDRE Operation to On via LHMI or PCM600 and at least one channel has to be connected. To make the setting, select Main menu/Settings/IED Settings and then Monitoring/Disturbance report/DisturbanceReport/ DRPRDRE:1.

1. Select Main menu/Disturbance records.
2. Select Manual Trig with or .
3. Press to execute manual triggering.

Figure 20: Manual triggering

The disturbance recorder is now triggered.

6.1.2.2 Monitoring disturbance recorder data

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

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

4. To select a category and view the items under it, press ↑ or ↓ and then →.

### 6.1.2.3 Controlling and reading disturbance recorder data

Disturbance recorder data can be controlled and read with PCM600.

For more information, see PCM600 documentation.
### 6.1.2.4 Monitoring events

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

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

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

### 6.1.3 Remote monitoring

The IED supports comprehensive remote monitoring.

#### 6.1.3.1 Monitoring the IED remotely

Use the PCM600 tool to operate the IED remotely.

- Analyze disturbance record data.
- Create disturbance records.
- Monitor IED values.

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

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

6.1.4.1 Through fault monitoring tool

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

Starting the through fault monitoring tool

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

1. Right click on the Plant Structure of an IED.
2. Select the Through Fault Monitoring from the context menu as shown in Figure 24.

![Figure 24: Starting the through fault monitoring tool](image)

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

User interface

The through fault monitoring tool consists of Through Fault Monitoring tab. The tab contains two sets of table; an overview of all individual through fault events and detailed report of a selected through fault event, as shown in Figure 25.
Figure 25: Through fault monitoring tool

Through fault reports table

The through fault reports table is an overview of fault reports. It displays the available fault reports from the IED. It is possible to select a specific through fault and create a list view for that specific through fault. The through fault reports table contains the latest 100 records per function block instance.

Figure 26: Through fault reports table

As shown in Figure 26, the through fault reports table consist of Instance number, Fault number, and Date and time columns respectively.

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

In case of 2-winding transformers:
- The Winding 3 column is hidden and not shown in the report overview table.
- The Winding 3 related data will have zero values corresponding to General and Name columns.

---

**Figure 27: Selected through fault report data table**

---

Reading through fault reports from the IED
To read the through fault reports from the IED, perform either one of the following:
- Select the IED menu and click on the Read through fault reports option.
- Click on the Read through fault reports button on the tool bar.

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

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

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

1. Select the function block instance from the Through fault monitoring function selection combo box as shown in Figure 29.

2. Select the IED menu and click on Clear through fault reports option as shown in Figure 30.

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

![Confirm clear through fault reports](image1)

**Figure 31:** Confirm clear through fault reports

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

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

**Exporting through fault reports files**

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

1. Click on the export reports option from the tool bar to export report files from the IED. A confirmation message appears upon exporting the through fault reports files from an IED.

![Export reports confirmation window](image2)

**Figure 33:** Export reports confirmation window
The through fault reports are exported into PCMDatabases folder as shown in Figure 34.

6.1.4.2 Through fault monitoring using local HMI

The list of saved through fault reports those are grouped based on the instance can be found on the local HMI under Main menu/Measurements/Through fault reports. The reports list contains date and time of the through fault and the latest report is displayed first. As shown in Figure 35, the local HMI mapped inputs can be displayed by entering each through fault report.
An instance specific clear option is provided to delete all the through fault reports from local HMI.

**Through fault monitoring report handling**

The through fault monitoring creates fault report for each through fault event. The through fault information is stored in a zipped .xml file in the IED under flash/frep folder. Each instance can have maximum 100 reports. Information in the through fault report is grouped into four sections; the general section and other three sections containing individual winding and phase-wise through fault data. The outputs given as ‘general data’ and ‘winding wise for all phases’ in the through fault monitoring report are shown in Table 2.

**Table 2: Through fault monitoring report outputs**

<table>
<thead>
<tr>
<th>General data</th>
<th>Winding wise for all phases</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Test mode status</td>
<td>• Number of faults</td>
</tr>
<tr>
<td>• Fault duration in seconds</td>
<td>• Event wise maximum peak current W1</td>
</tr>
<tr>
<td>• Overall number of faults</td>
<td>• Event wise RMS current</td>
</tr>
<tr>
<td>• Event wise maximum peak current W1</td>
<td>• Event wise $I^2t$</td>
</tr>
<tr>
<td>• Event wise maximum peak current W2</td>
<td>• Event wise $I^2t$ in % of set limit</td>
</tr>
<tr>
<td>• Event wise maximum peak current W3</td>
<td>• Delta $I^2t$ compared to prior fault</td>
</tr>
<tr>
<td>• Event wise RMS current W1</td>
<td>• Cumulative maximum peak current W1</td>
</tr>
<tr>
<td>• Event wise RMS current W2</td>
<td>• Cumulative $I^2t$ in % of set limit</td>
</tr>
<tr>
<td>• Event wise RMS current W3</td>
<td>• Event wise RMS voltage L1</td>
</tr>
<tr>
<td>• Event wise $I^2t$ in % of set limit</td>
<td>(The winding is based on the input connection to U3P)</td>
</tr>
<tr>
<td>• Cumulative maximum peak current W1</td>
<td>• Event wise RMS voltage L2</td>
</tr>
<tr>
<td>• Cumulative maximum peak current W2</td>
<td>(The winding is based on the input connection to U3P)</td>
</tr>
<tr>
<td>• Cumulative maximum peak current W3</td>
<td>• Event wise RMS voltage L3</td>
</tr>
<tr>
<td>• Cumulative $I^2t$ in % of set limit</td>
<td>(The winding is based on the input connection to U3P)</td>
</tr>
<tr>
<td>• Multiple faults warning</td>
<td>• Cumulative $I^2t$ in % of set limit</td>
</tr>
</tbody>
</table>

In case of 2-winding transformers:

- The Winding 3 section is excluded from the report
- The Winding 3 information under general section will have zero values

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

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

**6.2 Resetting the IED**

**6.2.1 Clearing and acknowledging via the local HMI**

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

1. Press ![image](image.png) to activate the Clear view.
All the items that can be cleared are shown.
The content of the Clear menu depends on the configuration configured with PCM600.

2. Select the item to be cleared with \( \uparrow \) or \( \downarrow \).
3. Press \( \text{OK} \), select OK to confirm the selection or Cancel to cancel the selection.
4. To clear other items, repeat the steps.

6.3 Changing the IED functionality

6.3.1 Defining the setting group

Do not switch off the auxiliary power supply to the IED before changes. For example, when setting parameter changes are saved.

6.3.1.1 Activating a setting group

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

1. Select Main menu/Settings/Active setting group/SETGRPS:1 and press \( \text{OK} \).

```
<table>
<thead>
<tr>
<th>ActiveSetGrp</th>
<th>SettingGroup1</th>
</tr>
</thead>
<tbody>
<tr>
<td>MaxNoSetGrp</td>
<td>1</td>
</tr>
</tbody>
</table>
```

**Figure 36: Active setting group**

2. Select the setting group with \( \uparrow \) or \( \downarrow \).
3. Press \( \text{OK} \) to confirm the selection or \( \text{Cancel} \) to cancel.
4. Commit the settings.

Remember to document the changes you make.
6.3.1.2 Browsing and editing setting group values

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

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

   **Figure 37:** Selecting a setting group for editing

2. Press ➔ on the Setting group line in the dialog box to activate selection mode.

3. Select the wanted setting group with ↑ or ↓ and press ➔.

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

   **Figure 38:** Changing the setting group

4. Select Yes in the dialog, and press ➔ to continue. The current setting group is displayed on the left in the header.

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

   ![Selecting the function category](IEC13000241-1-en.vsd)

   **Figure 39:** Selecting the function category

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

7. To select a function block, press ➔.

   ![Function block settings](IEC13000241-1-en.vsd)

   **Figure 40:** Function block settings

   The # character on the right indicates that the parameter belongs to a setting group.

8. To browse the settings, scroll the list with ↑ and ↓.

9. To edit the selected setting, press ➔.

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

   ![Changing the setting value](IEC13000241-1-en.vsd)

   **Figure 41:** Changing the setting value

10. Press ↑ or ↓ to change the value.

11. Confirm the change with ➔.
Section 7  Troubleshooting

7.1  Fault tracing

7.1.1  Identifying hardware errors

1. Check the module with an error.
   • Check the general IED status in Main menu/Diagnostics/IED status/General for a faulty hardware module.
   • Check the history of changes in internal event list in Main menu/Diagnostics/Internal events.
2. Inspect the IED visually.
   • Inspect the IED visually to find any physical error causes.
   • If you can find some obvious physical damage, contact ABB for repair or replacement actions.
3. Check whether the error is external or internal.
   • Check that the error is not caused by external origins.
   • Remove the wiring from the IED and test the input and output operation with an external test device.
   • If the problem remains, contact ABB for repair or replacement actions.

7.1.2  Identifying runtime errors

1. Check the error origin from IED's internal event list Main menu/Diagnostics/IED status/General.
2. Reboot the IED and recheck the supervision events to see if the fault has cleared.
3. In case of persistent faults, contact ABB for corrective actions.

7.1.3  Identifying blocked functions

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

7.1.4  Identifying communication errors

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

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

There are several different communication links on the product. First check that all communication ports that are used for communication are turned on.

1. the front communication port RJ-45.
   1.1. Check that the uplink LED is lit with a steady green light. The uplink LED is located on the LHMI above the RJ-45 communication port on the left. The port is used for direct electrical communication to a PC connected via a crossed-over Ethernet cable.
   1.2. Check the communication status of the front port via the LHMI in Main menu/Diagnostics/Communication/Ethernet status/Front port/FRONTSTATUS:1. Check that the LinkStatus value is 1, that is, the communication is working. When the value is 0, there is no communication link.

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

7.1.4.2 Checking the time synchronization

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

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

7.1.5 Diagnosing the IED status via the LHMI hint menu

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

The supported list of hints are as follows:

<table>
<thead>
<tr>
<th>Headline</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>GOOSE is configured on a disabled port</td>
<td>At least one of the access points configured for GOOSE is disabled. The port can be disabled either through changing the access point operation to off or by unchecking the GOOSE protocol from the access point in the Ethernet configuration in PCM600 or LHMI. Please enable GOOSE on access points: AP_FRONT, AP_1</td>
</tr>
</tbody>
</table>
7.2 Indication messages

7.2.1 Internal faults

Internal faults, the message associated with the fault is found in the internal event list in the LHMI menu Main menu/Diagnostics/Internal events. The message includes the date, time, description and signal state for the fault. The internal event list is not updated dynamically. The list is updated by leaving the Internal events menu and then selecting it again. The current status of the internal fault signals can also be checked via the LHMI in Main menu/Diagnostics/IED status.

Different actions are taken depending on the severity of the fault. If the fault is found to be permanent, the IED stays in internal fault mode. The IED continues to perform internal tests during the fault situation.

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

Table 4: Internal fault indications

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

7.2.2 Warnings

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

When a fault appears, record the fault indication message and state it when ordering service.
Table 5: Warning indications

<table>
<thead>
<tr>
<th>Warning indication</th>
<th>Additional information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warning IEC 61850 Error</td>
<td>IEC 61850 has not succeeded in some actions such as reading the configuration file, startup etc.</td>
</tr>
<tr>
<td>Warning GOOSE Error</td>
<td>One or more access point is not able to run GOOSE due to GOOSE being deactivated on the access point, or the access point being deactivated or failing.</td>
</tr>
</tbody>
</table>

7.2.3 Additional indications

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

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

Table 6: Additional indications

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

7.3 Correction procedures

7.3.1 Creating user accounts and setting and changing passwords

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

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

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

7.3.1.1 Changing the password from the LHMI

The password can only be changed for the active user.

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

7.3.2 Identifying IED application problems

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

- Check that the function is on.
- Check that the correct setting group (1 to 6) is activated.
- Check if the function is blocked.
- Check if the IED is in the test mode.
- Check the connections to trip and disturbance recorder functions.

7.3.2.1 Inspecting the wiring

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

- Check the actual state of the connected binary inputs.
  - In LHMI, select **Main menu/Test/Binary input values.** Then navigate to the board with the actual binary input to be checked.
  - Check the actual state of the connected binary inputs through PCM600, see PCM600 documentation.
- Measure output contacts using the voltage drop method of applying at least the minimum contact load given for the output relays in the technical data, for example 100 mA at 24 V AC/DC.

Output relays, especially power output relays, are designed for breaking high currents. Due to this, layers of high resistance may appear on the surface of the contacts. Do not determine proper functionality of connectivity or contact resistance by measuring with a regular hand-held ohm meter.
Figure 42: Testing output contacts using the voltage drop method

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

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

Set the parameter TestMode to Off after completing these tests. The Start LED stops flashing when the relay is no longer in test mode.

An initially high contact resistance does not cause problems as it is reduced quickly by the electrical cleaning effect of fritting and thermal destruction of layers, bringing the contact resistance back to the mOhm range. As a result, practically the full voltage is available at the load.
## Section 8  Glossary

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC</td>
<td>Alternating current</td>
</tr>
<tr>
<td>ACC</td>
<td>Actual channel</td>
</tr>
<tr>
<td>ACT</td>
<td>Application configuration tool within PCM600</td>
</tr>
<tr>
<td>A/D converter</td>
<td>Analog-to-digital converter</td>
</tr>
<tr>
<td>ADBS</td>
<td>Amplitude deadband supervision</td>
</tr>
<tr>
<td>ADM</td>
<td>Analog digital conversion module, with time synchronization</td>
</tr>
<tr>
<td>AI</td>
<td>Analog input</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
</tr>
<tr>
<td>AR</td>
<td>Autoreclosing</td>
</tr>
<tr>
<td>ASCT</td>
<td>Auxiliary summation current transformer</td>
</tr>
<tr>
<td>ASD</td>
<td>Adaptive signal detection</td>
</tr>
<tr>
<td>ASDU</td>
<td>Application service data unit</td>
</tr>
<tr>
<td>AWG</td>
<td>American Wire Gauge standard</td>
</tr>
<tr>
<td>BBP</td>
<td>Busbar protection</td>
</tr>
<tr>
<td>BFOC/2,5</td>
<td>Bayonet fiber optic connector</td>
</tr>
<tr>
<td>BFP</td>
<td>Breaker failure protection</td>
</tr>
<tr>
<td>BI</td>
<td>Binary input</td>
</tr>
<tr>
<td>BIM</td>
<td>Binary input module</td>
</tr>
<tr>
<td>BOM</td>
<td>Binary output module</td>
</tr>
<tr>
<td>BOS</td>
<td>Binary outputs status</td>
</tr>
<tr>
<td>BR</td>
<td>External bistable relay</td>
</tr>
<tr>
<td>BS</td>
<td>British Standards</td>
</tr>
<tr>
<td>BSR</td>
<td>Binary signal transfer function, receiver blocks</td>
</tr>
<tr>
<td>BST</td>
<td>Binary signal transfer function, transmit blocks</td>
</tr>
<tr>
<td>C37.94</td>
<td>IEEE/ANSI protocol used when sending binary signals between IEDs</td>
</tr>
<tr>
<td>CAN</td>
<td>Controller Area Network. ISO standard (ISO 11898) for serial communication</td>
</tr>
<tr>
<td>CB</td>
<td>Circuit breaker</td>
</tr>
<tr>
<td>CBM</td>
<td>Combined backplane module</td>
</tr>
<tr>
<td>CCM</td>
<td>CAN carrier module</td>
</tr>
<tr>
<td>CCVT</td>
<td>Capacitive Coupled Voltage Transformer</td>
</tr>
<tr>
<td>Class C</td>
<td>Protection Current Transformer class as per IEEE/ ANSI</td>
</tr>
<tr>
<td>CMPPS</td>
<td>Combined megapulses per second</td>
</tr>
<tr>
<td>CMT</td>
<td>Communication Management tool in PCM600</td>
</tr>
<tr>
<td>Term</td>
<td>Description</td>
</tr>
<tr>
<td>------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>CO cycle</td>
<td>Close-open cycle</td>
</tr>
<tr>
<td>Codirectional</td>
<td>Way of transmitting G.703 over a balanced line. Involves two twisted pairs making it possible to transmit information in both directions</td>
</tr>
<tr>
<td>COM</td>
<td>Command</td>
</tr>
<tr>
<td>COMTRADE</td>
<td>Standard Common Format for Transient Data Exchange format for Disturbance recorder according to IEEE/ANSI C37.111, 1999 / IEC 60255-24</td>
</tr>
<tr>
<td>Contra-directional</td>
<td>Way of transmitting G.703 over a balanced line. Involves four twisted pairs, two of which are used for transmitting data in both directions and two for transmitting clock signals</td>
</tr>
<tr>
<td>COT</td>
<td>Cause of transmission</td>
</tr>
<tr>
<td>CPU</td>
<td>Central processing unit</td>
</tr>
<tr>
<td>CR</td>
<td>Carrier receive</td>
</tr>
<tr>
<td>CRC</td>
<td>Cyclic redundancy check</td>
</tr>
<tr>
<td>CROB</td>
<td>Control relay output block</td>
</tr>
<tr>
<td>CS</td>
<td>Carrier send</td>
</tr>
<tr>
<td>CT</td>
<td>Current transformer</td>
</tr>
<tr>
<td>CU</td>
<td>Communication unit</td>
</tr>
<tr>
<td>CVT or CCVT</td>
<td>Capacitive voltage transformer</td>
</tr>
<tr>
<td>DAR</td>
<td>Delayed autoreclosing</td>
</tr>
<tr>
<td>DARPA</td>
<td>Defense Advanced Research Projects Agency (The US developer of the TCP/IP protocol etc.)</td>
</tr>
<tr>
<td>DBDL</td>
<td>Dead bus dead line</td>
</tr>
<tr>
<td>DBLL</td>
<td>Dead bus live line</td>
</tr>
<tr>
<td>DC</td>
<td>Direct current</td>
</tr>
<tr>
<td>DFC</td>
<td>Data flow control</td>
</tr>
<tr>
<td>DFT</td>
<td>Discrete Fourier transform</td>
</tr>
<tr>
<td>DHCP</td>
<td>Dynamic Host Configuration Protocol</td>
</tr>
<tr>
<td>DIP-switch</td>
<td>Small switch mounted on a printed circuit board</td>
</tr>
<tr>
<td>DI</td>
<td>Digital input</td>
</tr>
<tr>
<td>DLLB</td>
<td>Dead line live bus</td>
</tr>
<tr>
<td>DNP</td>
<td>Distributed Network Protocol as per IEEE Std 1815-2012</td>
</tr>
<tr>
<td>DR</td>
<td>Disturbance recorder</td>
</tr>
<tr>
<td>DRAM</td>
<td>Dynamic random access memory</td>
</tr>
<tr>
<td>DRH</td>
<td>Disturbance report handler</td>
</tr>
<tr>
<td>DSP</td>
<td>Digital signal processor</td>
</tr>
<tr>
<td>DTT</td>
<td>Direct transfer trip scheme</td>
</tr>
<tr>
<td>EHV network</td>
<td>Extra high voltage network</td>
</tr>
<tr>
<td>EIA</td>
<td>Electronic Industries Association</td>
</tr>
<tr>
<td>EMC</td>
<td>Electromagnetic compatibility</td>
</tr>
<tr>
<td>EMF</td>
<td>Electromotive force</td>
</tr>
<tr>
<td>EMI</td>
<td>Electromagnetic interference</td>
</tr>
<tr>
<td>Acronym</td>
<td>Definition</td>
</tr>
<tr>
<td>---------</td>
<td>------------</td>
</tr>
<tr>
<td>EnFP</td>
<td>End fault protection</td>
</tr>
<tr>
<td>EPA</td>
<td>Enhanced performance architecture</td>
</tr>
<tr>
<td>ESD</td>
<td>Electrostatic discharge</td>
</tr>
<tr>
<td>F-SMA</td>
<td>Type of optical fiber connector</td>
</tr>
<tr>
<td>FAN</td>
<td>Fault number</td>
</tr>
<tr>
<td>FCB</td>
<td>Flow control bit; Frame count bit</td>
</tr>
<tr>
<td>FOX 20</td>
<td>Modular 20 channel telecommunication system for speech, data and protection signals</td>
</tr>
<tr>
<td>FOX 512/515</td>
<td>Access multiplexer</td>
</tr>
<tr>
<td>FOX 6Plus</td>
<td>Compact time-division multiplexer for the transmission of up to seven duplex channels of digital data over optical fibers</td>
</tr>
<tr>
<td>FTP</td>
<td>File Transfer Protocol</td>
</tr>
<tr>
<td>FUN</td>
<td>Function type</td>
</tr>
<tr>
<td>G.703</td>
<td>Electrical and functional description for digital lines used by local telephone companies. Can be transported over balanced and unbalanced lines</td>
</tr>
<tr>
<td>GCM</td>
<td>Communication interface module with carrier of GPS receiver module</td>
</tr>
<tr>
<td>GDE</td>
<td>Graphical display editor within PCM600</td>
</tr>
<tr>
<td>GI</td>
<td>General interrogation command</td>
</tr>
<tr>
<td>GIS</td>
<td>Gas-insulated switchgear</td>
</tr>
<tr>
<td>GOOSE</td>
<td>Generic object-oriented substation event</td>
</tr>
<tr>
<td>GPS</td>
<td>Global positioning system</td>
</tr>
<tr>
<td>GSAL</td>
<td>Generic security application</td>
</tr>
<tr>
<td>GSE</td>
<td>Generic substation event</td>
</tr>
<tr>
<td>HDLC protocol</td>
<td>High-level data link control, protocol based on the HDLC standard</td>
</tr>
<tr>
<td>HFBR connector type</td>
<td>Plastic fiber connector</td>
</tr>
<tr>
<td>HMI</td>
<td>Human-machine interface</td>
</tr>
<tr>
<td>HSAR</td>
<td>High speed autoreclosuring</td>
</tr>
<tr>
<td>HV</td>
<td>High-voltage</td>
</tr>
<tr>
<td>HVDC</td>
<td>High-voltage direct current</td>
</tr>
<tr>
<td>IDBS</td>
<td>Integrating deadband supervision</td>
</tr>
<tr>
<td>IEC</td>
<td>International Electrical Committee</td>
</tr>
<tr>
<td>IEC 60044-6</td>
<td>IEC Standard, Instrument transformers – Part 6: Requirements for protective current transformers for transient performance</td>
</tr>
<tr>
<td>IEC 60870-5-103</td>
<td>Communication standard for protection equipment. A serial master.slave protocol for point-to-point communication</td>
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<tr>
<td>IEC 61850</td>
<td>Substation automation communication standard</td>
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<tr>
<td>IEC 61850–8–1</td>
<td>Communication protocol standard</td>
</tr>
<tr>
<td>IEEE</td>
<td>Institute of Electrical and Electronics Engineers</td>
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<tr>
<td>IEEE 802.12</td>
<td>A network technology standard that provides 100 Mbits/s on twisted-pair or optical fiber cable</td>
</tr>
<tr>
<td>IEEE P1386.1</td>
<td>PCI Mezzanine Card (PMC) standard for local bus modules. References the CMC (IEEE P1386, also known as Common Mezzanine Card)</td>
</tr>
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</table>
standard for the mechanics and the PCI specifications from the PCI SIG (Special Interest Group) for the electrical EMF (Electromotive force).

IEEE 1686
Standard for Substation Intelligent Electronic Devices (IEDs) Cyber Security Capabilities

IED
Intelligent electronic device

I-GIS
Intelligent gas-insulated switchgear

IOM
Binary input/output module

Instance
When several occurrences of the same function are available in the IED, they are referred to as instances of that function. One instance of a function is identical to another of the same kind but has a different number in the IED user interfaces. The word “instance” is sometimes defined as an item of information that is representative of a type. In the same way an instance of a function in the IED is representative of a type of function.

IP
1. Internet protocol. The network layer for the TCP/IP protocol suite widely used on Ethernet networks. IP is a connectionless, best-effort packet-switching protocol. It provides packet routing, fragmentation and reassembly through the data link layer.
2. Ingression protection, according to IEC 60529

IP 20
Ingression protection, according to IEC 60529, level 20

IP 40
Ingression protection, according to IEC 60529, level 40

IP 54
Ingression protection, according to IEC 60529, level 54

IRF
Internal failure signal

IRIG-B:
InterRange Instrumentation Group Time code format B, standard 200

ITU
International Telecommunications Union

LAN
Local area network

LIB 520
High-voltage software module

LCD
Liquid crystal display

LDCM
Line differential communication module

LDD
Local detection device

LED
Light-emitting diode

LNT
LON network tool

LON
Local operating network

MCB
Miniature circuit breaker

MCM
Mezzanine carrier module

MPM
Main processing module

MVAL
Value of measurement

MVB
Multifunction vehicle bus. Standardized serial bus originally developed for use in trains.

NCC
National Control Centre

NOF
Number of grid faults

NUM
Numerical module

OCO cycle
Open-close-open cycle

OCP
Overcurrent protection

OEM
Optical Ethernet module
OLTC
On-load tap changer

OTEV
Disturbance data recording initiated by other event than start/pick-up

OV
Overvoltage

Overreach
A term used to describe how the relay behaves during a fault condition. For example, a distance relay is overreaching when the impedance presented to it is smaller than the apparent impedance to the fault applied to the balance point, that is, the set reach. The relay “sees” the fault but perhaps it should not have seen it.

PCI
Peripheral component interconnect, a local data bus

PCM
Pulse code modulation

PCM600
Protection and control IED manager

PC-MIP
Mezzanine card standard

PMC
PCI Mezzanine card

POR
Permissive overreach

POTT
Permissive overreach transfer trip

Process bus
Bus or LAN used at the process level, that is, in near proximity to the measured and/or controlled components

PSM
Power supply module

PST
Parameter setting tool within PCM600

PT ratio
Potential transformer or voltage transformer ratio

PUTT
Permissive underreach transfer trip

RASC
Synchrocheck relay, COMBIFLEX

RCA
Relay characteristic angle

RISC
Reduced instruction set computer

RMS value
Root mean square value

RS422
A balanced serial interface for the transmission of digital data in point-to-point connections

RS485
Serial link according to EIA standard RS485

RTC
Real-time clock

RTU
Remote terminal unit

SA
Substation Automation

SBO
Select-before-operate

SC
Switch or push button to close

SCL
Short circuit location

SCS
Station control system

SCADA
Supervision, control and data acquisition

SCT
System configuration tool according to standard IEC 61850

SDU
Service data unit

SLM
Serial communication module.

SMA connector
Subminiature version A, A threaded connector with constant impedance.

SMT
Signal matrix tool within PCM600

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

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>UV</td>
<td>Undervoltage</td>
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<tr>
<td>WEI</td>
<td>Weak end infeed logic</td>
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<tr>
<td>VT</td>
<td>Voltage transformer</td>
</tr>
<tr>
<td>3I₀</td>
<td>Three times zero-sequence current. Often referred to as the residual or the earth-fault current</td>
</tr>
<tr>
<td>3U₀</td>
<td>Three times the zero sequence voltage. Often referred to as the residual voltage or the neutral point voltage</td>
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