ABB

RELION® PROTECTION AND CONTROL

611 series
Operation Manual

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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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Conformity

This product complies with the directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive 2014/30/EU) and concerning electrical equipment for use within specified voltage limits (Low-voltage directive 2014/35/EU). This conformity is the result of tests conducted by 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.

Safety information

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

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

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

National and local electrical safety regulations must always be followed.

The frame of the protection relay has to be carefully earthed.

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

The protection relay contains components which are sensitive to electrostatic discharge. Unnecessary touching of electronic components must therefore be avoided.

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

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Section 1 Introduction

1.1 This manual

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

1.2 Intended audience

This manual addresses the operator, who operates the protection relay 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
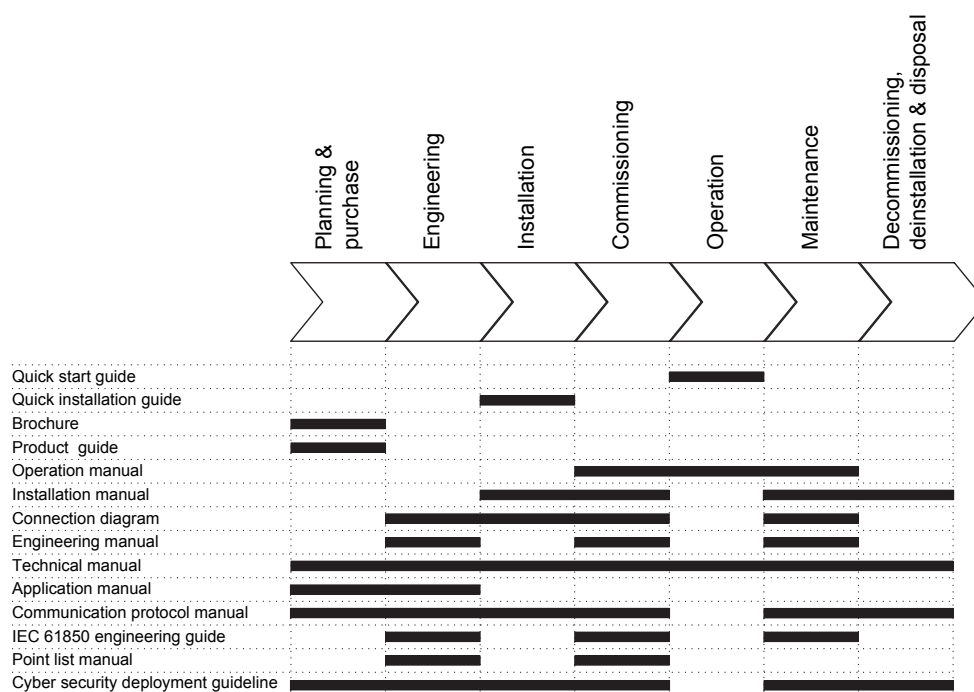
Figure 1:   The intended use of manuals in different lifecycles

> Product series- and product-specific manuals can be downloaded from the ABB Web site http://www.abb.com/relion.

1.3.2 Document revision history

Document revision/date	Product series version	History
A/2011-11-18	1.0	First release
B/2016-02-22	2.0	Content updated to correspond to the product series version
C/2019-04-10	2.0	Content updated

> Download the latest documents from the ABB Web site http://www.abb.com/substationautomation.

1.3.3 Related documentation

Product series- and product-specific manuals can be downloaded from the ABB Web site http://www.abb.com/substationautomation.

1.4 Symbols and conventions

1.4.1 Symbols

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

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

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

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

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

Although warning hazards are related to personal injury, it is necessary to understand that under certain operational conditions, operation of damaged equipment may result in degraded process performance leading to personal injury or death. Therefore, comply fully with all warning and caution notices.

1.4.2 Document conventions

A particular convention may not be used in this manual.

- Abbreviations and acronyms are spelled out in the glossary. The glossary also contains definitions of important terms.
- Push button navigation in the LHMI menu structure is presented by using the push button icons.

To navigate between the options, use ⬆ and ⬇.
- Menu paths are presented in bold.
  Select **Main menu/Settings**.
- WHMI menu names are presented in bold.
  Click **Information** in the WHMI menu structure.
- LHMI messages are shown in Courier font.

  To save the changes in nonvolatile memory, select `Yes` and press ↵.
- Parameter names are shown in italics.
  The function can be enabled and disabled with the *Operation* setting.
- Parameter values are indicated with quotation marks.
  The corresponding parameter values are "On" and "Off".
- Input/output messages and monitored data names are shown in Courier font.
  When the function starts, the `START` output is set to TRUE.
- This document assumes that the parameter setting visibility is "Advanced".

1.4.3 Functions, codes and symbols

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

Table 1: Functions included in the relays

Function	IEC 61850	IEC 60617	IEC-ANSI
Protection			
Three-phase non-directional overcurrent protection, low stage, instance 1	PHLPTOC1	3I> (1)	51P-1 (1)
Three-phase non-directional overcurrent protection, high stage, instance 1	PHHPTOC1	3I>> (1)	51P-2 (1)
Three-phase non-directional overcurrent protection, high stage, instance 2	PHHPTOC2	3I>> (2)	51P-2 (2)
Three-phase non-directional overcurrent protection, instantaneous stage, instance 1	PHIPTOC1	3I>>> (1)	50P/51P (1)
Non-directional earth-fault protection, low stage, instance 1	EFLPTOC1	Io> (1)	51N-1 (1)
Non-directional earth-fault protection, low stage, instance 2	EFLPTOC2	Io> (2)	51N-1 (2)
Non-directional earth-fault protection, high stage, instance 1	EFHPTOC1	Io>> (1)	51N-2 (1)
Non-directional earth-fault protection, instantaneous stage	EFIPTOC1	Io>>>	50N/51N
Three-phase directional overcurrent protection, low stage, instance 1	DPHLPDOC1	3I> -> (1)	67-1(1)
Three-phase directional overcurrent protection, low stage, instance 2	DPHLPDOC2	3I> -> (2)	67-1(2)
Table continues on next page			

Function	IEC 61850	IEC 60617	IEC-ANSI
Three-phase directional overcurrent protection, high stage, instance 1	DPHHPDOC1	3I>> -> (1)	67-2(1)
Directional earth-fault protection, low stage, instance 1	DEFLPDEF1	Io> -> (1)	67N-1 (1)
Directional earth-fault protection, low stage, instance 2	DEFLPDEF2	Io> -> (2)	67N-1 (2)
Directional earth-fault protection, high stage	DEFHPDEF1	Io>> ->	67N-2
Transient/intermittent earth-fault protection	INTRPTEF1	Io> -> IEF	67NIEF
Non-directional (cross-country) earth fault protection, using calculated Io	EFHPTOC1	Io>> (1)	51N-2 (1)
Negative-sequence overcurrent protection, instance 1	NSPTOC1	I2> (1)	46 (1)
Negative-sequence overcurrent protection, instance 2	NSPTOC2	I2> (2)	46 (2)
Negative-sequence overcurrent protection for machines, instance 1	MNSPTOC1	I2>M (1)	46M (1)
Negative-sequence overcurrent protection for machines, instance 2	MNSPTOC2	I2>M (2)	46M (2)
Phase discontinuity protection	PDNSPTOC1	I2/I1>	46PD
Residual overvoltage protection, instance 1	ROVPTOV1	Uo> (1)	59G (1)
Residual overvoltage protection, instance 2	ROVPTOV2	Uo> (2)	59G (2)
Residual overvoltage protection, instance 3	ROVPTOV3	Uo> (3)	59G (3)
Three-phase undervoltage protection, instance 1	PHPTUV1	3U< (1)	27(1)
Three-phase undervoltage protection, instance 2	PHPTUV2	3U< (2)	27(2)
Three-phase undervoltage protection, instance 3	PHPTUV3	3U< (3)	27(3)
Three-phase overvoltage protection, instance 1	PHPTOV1	3U> (1)	59(1)
Three-phase overvoltage protection, instance 2	PHPTOV2	3U> (2)	59(2)
Three-phase overvoltage protection, instance 3	PHPTOV3	3U> (3)	59(3)
Positive-sequence undervoltage protection, instance 1	PSPTUV1	U1< (1)	47U+(1)
Positive-sequence undervoltage protection, instance 2	PSPTUV2	U1< (2)	47U+(2)
Negative-sequence overvoltage protection, instance 1	NSPTOV1	U2> (1)	47O-(1)
Negative-sequence overvoltage protection, instance 2	NSPTOV2	U2> (2)	47O-(2)
Frequency protection, instance 1	FRPFRQ1	f>/f<,df/dt (1)	81(1)
Table continues on next page			

Function	IEC 61850	IEC 60617	IEC-ANSI
Frequency protection, instance 2	FRPFRQ2	f>/f<,df/dt (2)	81(2)
Three-phase thermal protection for feeders, cables and distribution transformers	T1PTTR1	3Ith>F	49F
Loss of load supervision	LOFLPTUC1	3I<	37
Motor load jam protection	JAMPTOC1	Ist>	51LR
Motor start-up supervision	STTPMSU1	Is2t n<	49,66,48,51LR
Phase reversal protection	PREVPTOC1	I2>>	46R
Thermal overload protection for motors	MPTTR1	3Ith>M	49M
Circuit breaker failure protection	CCBRBRF1	3I>/Io>BF	51BF/51NBF
Three-phase inrush detector	INRPHAR1	3I2f>	68
Master trip, instance 1	TRPPTRC1	Master Trip (1)	94/86 (1)
Master trip, instance 2	TRPPTRC2	Master Trip (2)	94/86 (2)
High-impedance differential protection for phase A, instance 1	HIAPDIF1	dHi>(1)	87(1)
High-impedance differential protection for phase B, instance 2	HIBPDIF1	dHi>(2)	87(2)
High-impedance differential protection for phase C, instance 3	HICPDIF1	dHi>(3)	87(3)
Switch onto fault	CBPSOF1	SOTF	SOTF
Other			
Input switch group	ISWGAPC	ISWGAPC	ISWGAPC
Output switch group	OSWGAPC	OSWGAPC	OSWGAPC
Selector	SELGAPC	SELGAPC	SELGAPC
Minimum pulse timer (2 pcs)	TPGAPC	TP	TP
Minimum pulse timer (2 pcs, second resolution), instance 1	TPSGAPC	TPS (1)	TPS (1)
Move (8 pcs), instance 1	MVGAPC	MV (1)	MV (1)
Control			
Circuit-breaker control	CBXCBR1	I <-> O CB	I <-> O CB
Emergency start-up	ESMGAPC1	ESTART	ESTART
Autoreclosing	DARREC1	O -> I	79
Condition monitoring and supervision			
Trip circuit supervision, instance 1	TCSSCBR1	TCS (1)	TCM (1)
Trip circuit supervision, instance 2	TCSSCBR2	TCS (2)	TCM (2)
Runtime counter for machines and devices	MDSOPT1	OPTS	OPTM
Phase segregated CT supervision function for phase A, instance 1	HZCCASPVC1	MCS 1I(1)	MCS 1I(1)
Phase segregated CT supervision function for phase B, instance 2	HZCCBSPVC1	MCS 1I(2)	MCS 1I(2)
Phase segregated CT supervision function for phase C, instance 3	HZCCCSPVC1	MCS 1I(3)	MCS 1I(3)
Table continues on next page			

Function	IEC 61850	IEC 60617	IEC-ANSI
Logging			
Disturbance recorder	RDRE1	DR (1)	DFR(1)
Fault recorder	FLTRFRC1	-	FR
Measurement			
Three-phase current measurement, instance 1[1]	CMMXU1	3I	3I
Sequence current measurement	CSMSQI1	I1, I2, I0	I1, I2, I0
Residual current measurement, instance 1	RESCMMXU1	Io	In
Three-phase voltage measurement, instance 1	VMMXU1	3U	3U
Three-phase voltage measurement, instance 2	VMMXU2	3U(B)	3U(B)
Sequence voltage measurement, instance 1	VSMSQI1	U1, U2, U0	U1, U2, U0
Residual voltage measurement	RESVMMXU1	Uo	Vn
Frequency measurement, instance 1	FMMXU1	f	f
Three-phase power and energy measurement, instance 1	PEMMXU1	P, E	P, E

1) In REB611, CMMXU is used for measuring differential phase currents

Section 2 Environmental aspects

2.1 Sustainable development

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

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

Table 2: *Maximum concentration values by weight per homogeneous material*

Substance	Proposed maximum concentration
Lead - Pb	0.1%
Mercury - Hg	0.1%
Cadmium - Cd	0.01%
Hexavalent Chromium Cr (VI)	0.1%
Polybrominated biphenyls - PBB	0.1%
Polybrominated diphenyl ethers - PBDE	0.1%

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 Disposal of a protection relay

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

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

Table 3:   *Materials of the protection relay parts*

Protection relay	Parts	Material
Case	Metallic plates, parts and screws	Steel
	Plastic parts	PC[1], LCP[2]
	Electronics plug in module	Various
Plug-in unit	Electronics plug in modules	Various
	Electronics LHMI module	Various
	Plastic parts	PC, PBT[3], LCP, PA[4]
	Metallic parts	Aluminium
Package	Box	Cardboard
Attached material	Manuals	Paper

1) Polycarbonate
2) Liquid crystal polymer
3) Polybutylene terephthalate
4) Polyamide

Section 3 611 series overview

3.1 Overview

The 611 series is part of ABB's Relion® product family. The 611 series protection relays offer functionality within basic protection and control configurations. There are product variants for feeder, motor, busbar and voltage protection applications. The relays, characterized by their compactness and withdrawable-unit design, are designed for most utility substations and industrial power systems including radial, looped and meshed distribution networks that may also involve distributed power generation.

The 611 series relays support the Edition 1 and Edition 2 versions of the IEC 61850 standard for communication and interoperability of substation automation devices, including fast GOOSE messaging. The 611 series relays are able to use IEC 61850 and Modbus® communication protocols simultaneously. The relays also support the parallel redundancy protocol PRP and the high-availability seamless redundancy HSR protocol. IEEE 1588 v2 is available for high-accuracy time synchronization in all variants with an optional redundant Ethernet communication module.

3.2 Local HMI

The LHMI is used for setting, monitoring and controlling the protection relay. The LHMI comprises the display, buttons, LED indicators and communication port.
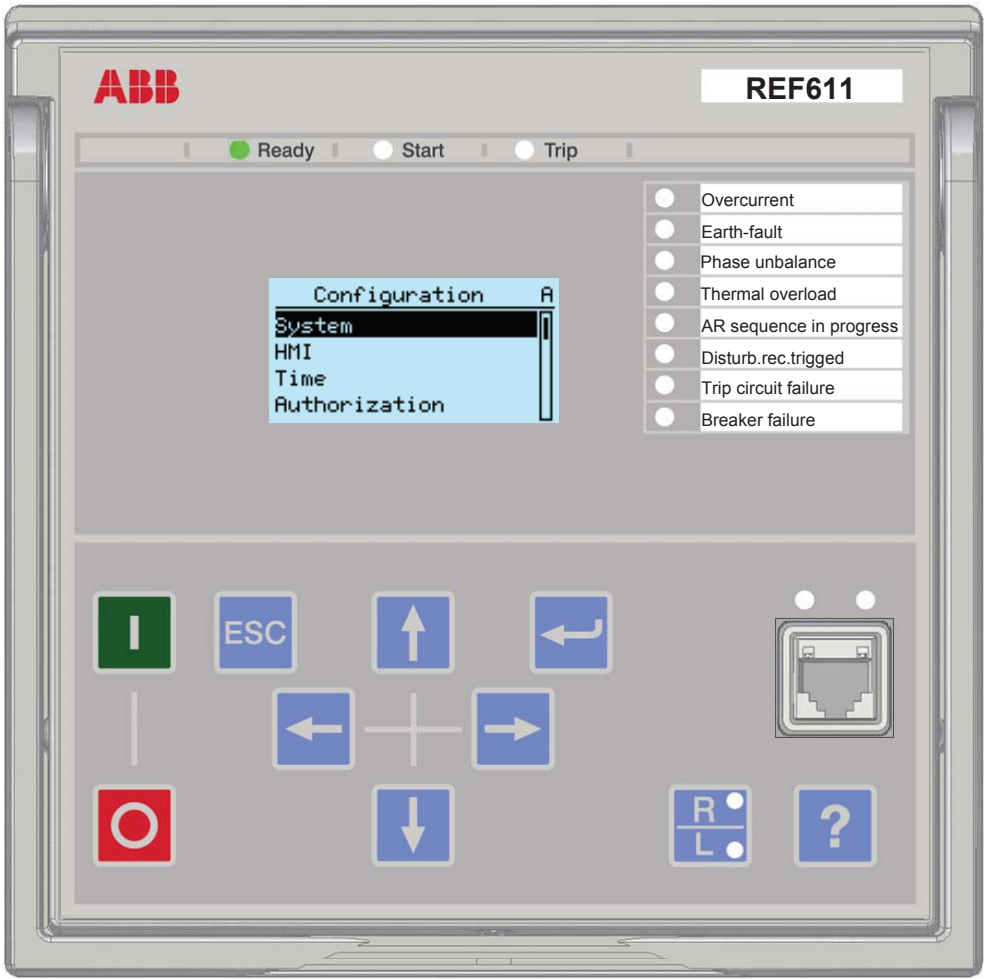
Figure 2:   Example of the LHMI

3.2.1   Display

The LHMI includes a graphical display that supports two character sizes. The character size depends on the selected language. The amount of characters and rows fitting the view depends on the character size.

Table 4:   Small display

Character size[1]	Rows in the view	Characters per row
Small, mono-spaced (6 × 12 pixels)	5	20
Large, variable width (13 × 14 pixels)	3	8 or more

1)   Depending on the selected language

The display view is divided into four basic areas.

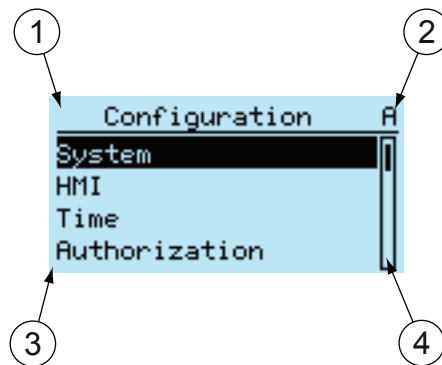*Figure 3:* *Display layout*

1   Header

2   Icon

3   Content

4   Scroll bar (displayed when needed)

- The header area at the top of the display view shows the current location in the menu structure.
- The icon area at the upper right corner of the display shows the current action or user level.
  Current action is indicated by the following characters.

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

  Current user level is indicated by the following characters.

  - V: Viewer
  - O: Operator
  - E: Engineer
  - A: Administrator
- The content area shows the menu content.
- If the menu contains more rows than the display can show at a time, a scroll bar is displayed on the right.

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

3.2.2   LEDs

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

There are also 8 programmable LEDs on front of the LHMI. The LEDs can be configured with the LHMI, WHMI or PCM600.

3.2.3 Keypad

The LHMI keypad contains push buttons which are used to navigate in different views or menus. With the push buttons you can give open or close commands to one object in the primary circuit, for example, a circuit breaker, a contactor or a disconnector. The push buttons are also used to acknowledge alarms, reset indications, provide help and switch between local and remote control mode.
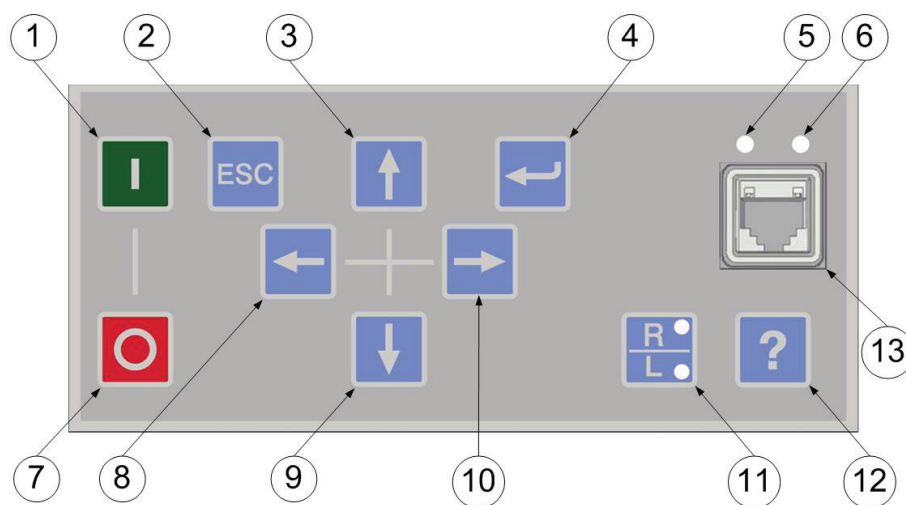

Figure 4:   *LHMI keypad with object control, navigation and command push buttons and RJ-45 communication port*

1 Close

2 Escape

3 Up

4 Enter

5 Uplink LED

6 Communication LED

7 Open

8 Left

9 Down

10 Right

11 Remote/Local

12 Help

13 Communication port

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.

Table 5:   *Object control push buttons*

Name	Description
CLOSE Close	Closing the object.
OPEN Open	Opening the object.

Navigation

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

Table 6:   *Navigation push buttons*

Name	Description
ESC ESC	• Leaving setting mode without saving the values. • Cancelling certain actions. • Adjusting the display contrast in combination with ↑ or ↓. • Changing the language in combination with ‹. • Inserting a space in combination with ↵ when editing a string. • Clearing indications and LEDs. The first three-second press clears the indications. The second three-second press clears the programmable LEDs. Requires appropriate user rights.
↵ Enter	• Entering parameter setting mode. • Confirming a new value of a setting parameter.
↑ Up ↓ Down	• Moving up and down in menus. • Scrolling active digits of a parameter when entering a new setting value.
‹ Left › Right	• Moving left and right in menus. • Changing the active digit of a parameter when entering a new setting value. • Deleting a character when editing a string by pressing ‹. • Logging out, when the user is currently logged in. Press ‹ for three seconds in the main menu.

Commands

Table 7:   *Command push buttons*

Name	Description
R/L (R over 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.
HELP Help	Showing context sensitive help messages.

3.2.4   Local HMI functionality

3.2.4.1   Protection and alarm indication

Protection indicators

The protection indicator LEDs are Ready, Start and Trip.

Table 8:   *Ready LED*

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

Table 9:   *Start LED*

LED state	Description
Off	Normal operation.
On	A protection function has started and an indication message is displayed. • If several protection functions start within a short time, the last start is indicated on the display.
Flashing	A protection function is blocked or the protection relay is in the test and blocked mode. • The blocking indication disappears when the blocking is removed or when the protection function is reset.

Table 10:   *Trip LED*

LED state	Description
Off	Normal operation.
On	A protection function has tripped and an indication message is displayed. • The trip indication is latching and must be reset via communication. • If several protection functions trip within a short time, the last trip is indicated on the display.

Alarm indicators

The 8 matrix programmable LEDs are used for alarm indication.

Table 11:   *Alarm indications*

LED state	Description
Off	Normal operation. All activation signals are off.
On	• Non-latched mode: activation signal is still on. • Latched mode: activation signal is still on, or it is off but has not been acknowledged. • Latched flashing mode: activation signal is still on but has been acknowledged.
Flashing	• Non-latched flashing mode: activation signal is still on. • Latched flashing mode: activation signal is still on, or it is off but has not been acknowledged.

3.2.4.2   Parameter management

The LHMI is used to access the relay parameters. Three types of parameters can be read and written.

• Numerical values
• String values
• Enumerated values

Numerical values are presented either in integer or in decimal format with minimum and maximum values. Character strings can be edited character by character. Enumerated values have a predefined set of selectable values.

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

> Changing the value of certain relay parameters affects the visibility or range of other parameters in the menu. This indicates which parameters or parameter values become obsolete due to the change.

The relay changes the visibility or range of these parameters immediately even before the changed values have been committed.

Some parameters may be hidden because the function is off or the setting visibility is set to "basic" instead of "advanced".

3.2.4.3 Front communication

The RJ-45 port in the LHMI enables front communication. Two LEDs are located 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 flashes when the protection relay communicates with the connected device.
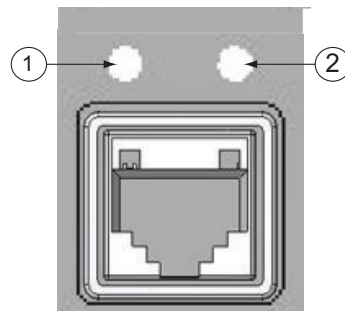
Figure 5:   *RJ-45 communication port and indication LEDs*

1   Uplink LED

2   Communication LED

When a computer is connected to the protection relay, the relay'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.

3.3 Web HMI

The WHMI allows secure access to the protection relay via a Web browser. When the *Secure Communication* parameter in the protection relay is activated, the Web server is forced to take a secured (HTTPS) connection to WHMI using TLS encryption.The WHMI is verified with Internet Explorer 8.0, 9.0, 10.0 and 11.0.

> WHMI is enabled by default. To disable the WHMI, select **Main Menu/Configuration/HMI/Web HMI mode** via the LHMI. Reboot the protection relay for the change to take effect.

WHMI offers several functions.

- Programmable LEDs and event lists
- System supervision
- Parameter settings
- Measurement display
- Disturbance records
- Fault records
- Phasor diagram
- Signal configuration
- Importing/Exporting parameters
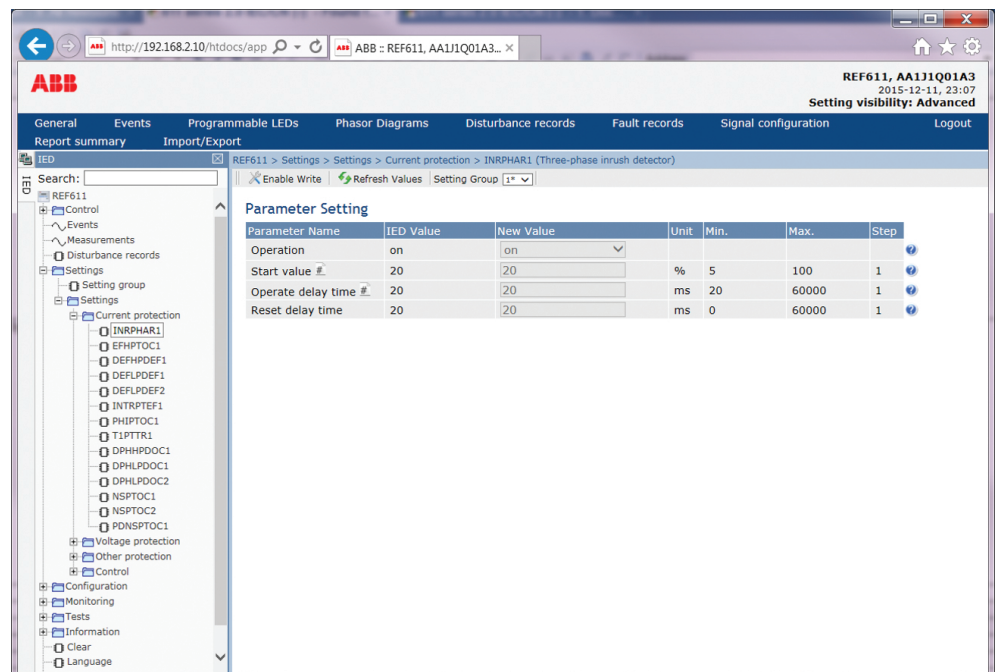- Report summary

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

Figure 6:   *Example view of the WHMI*

The WHMI can be accessed locally and remotely.

- Locally by connecting the laptop to the protection relay via the front communication port.
- Remotely over LAN/WAN.

3.3.1 Command buttons

Command buttons can be used to edit parameters and control information via the WHMI.

Table 12: Command buttons

Name	Description
✕ Enable Write	Enabling parameter editing
✕ Disable Write	Disabling parameter editing
⬇ Write to IED	Writing parameters to the protection relay
⟳ Refresh Values	Refreshing parameter values
🖨 Print	Printing out parameters
📥 Commit	Committing changes to protection relay's nonvolatile flash memory
✕ Reject	Rejecting changes
❓	Showing context sensitive help messages
⊗	Error icon
✕ Clear events	Clearing events
⟳ Manual trigger	Triggering the disturbance recorder manually
💾 Save	Saving values to TXT or CSV file format
‖ Freeze	Freezing the values so that updates are not displayed
▶ Continue	Receiving continuous updates to the monitoring view
✕ Delete	Deleting the disturbance record
✕ Delete all	Deleting all disturbance records
⬇	Saving the disturbance record files
🗋 View all	Viewing all fault records
✕ Clear records	Clearing all fault records
Import Settings	Importing settings
Export Settings	Exporting settings
Table continues on next page	

Name	Description
Select all	Selecting all
Clear all	Clearing all selections
Refresh	Refreshing the parameter list view

3.4 Authorization

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

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

User authorization is disabled by default for the LHMI and can be enabled with the *Local override* parameter via the LHMI path **Main Menu/Configuration/Authorization/Passwords**. WHMI always requires authentication.

Table 13:   *Predefined user categories*

Username	User rights
VIEWER	Read only access
OPERATOR	• Selecting remote or local state with R/L (only locally) • Changing setting groups • Controlling • Clearing indications
ENGINEER	• Changing settings • Clearing event list • Clearing disturbance records • Changing system settings such as IP address, serial baud rate or disturbance recorder settings • Setting the protection relay to test mode • Selecting language
ADMINISTRATOR	• All listed above • Changing password • Factory default activation

For user authorization for PCM600, see PCM600 documentation.

3.4.1 Audit trail

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

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

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

Audit trail events related to user authorization (login, logout, violation remote and violation local) are defined according to the selected set of requirements from IEEE 1686. The logging is based on predefined user names or user categories. The user audit trail events are accessible with IEC 61850-8-1, PCM600, LHMI and WHMI.

Table 14:   Audit trail events

Audit trail event	Description
Configuration change	Configuration files changed
Firmware change	Firmware changed
Firmware change fail	Firmware change failed
Attached to retrofit test case	Unit has been attached to retrofit case
Removed from retrofit test case	Removed from retrofit test case
Setting group remote	User changed setting group remotely
Setting group local	User changed setting group locally
Control remote	DPC object control remote
Control local	DPC object control local
Test on	Test mode on
Test off	Test mode off
Reset trips	Reset latched trips (TRPPTRC*)
Setting commit	Settings have been changed
Time change	Time changed directly by the user. Note that this is not used when the protection relay is synchronised properly by the appropriate protocol (SNTP, IRIG-B, IEEE 1588 v2).
View audit log	Administrator accessed audit trail
Login	Successful login from IEC 61850-8-1 (MMS), WHMI, FTP or LHMI.
Logout	Successful logout from IEC 61850-8-1 (MMS), WHMI, FTP or LHMI.
Table continues on next page	

Audit trail event	Description
Password change	Password changed
Firmware reset	Reset issued by user or tool
Audit overflow	Too many audit events in the time period
Violation remote	Unsuccessful login attempt from IEC 61850-8-1 (MMS), WHMI, FTP or LHMI.
Violation local	Unsuccessful login attempt from IEC 61850-8-1 (MMS), WHMI, FTP or LHMI.

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

To expose the audit trail events through Event list, define the *Authority logging* level parameter via **Configuration/ Authorization/Security**. This exposes audit trail events to all users.

Table 15:   *Comparison of authority logging levels*

Audit trail event	Authority logging level					
	None	Configuration change	Setting group	Setting group, control	Settings edit	All
Configuration change		●	●	●	●	●
Firmware change		●	●	●	●	●
Firmware change fail		●	●	●	●	●
Attached to retrofit test case		●	●	●	●	●
Removed from retrofit test case		●	●	●	●	●
Setting group remote			●	●	●	●
Setting group local			●	●	●	●
Control remote				●	●	●
Control local				●	●	●
Test on				●	●	●
Test off				●	●	●
Reset trips				●	●	●
Setting commit					●	●
Time change						●
View audit log						●
Login						●
Table continues on next page						

Audit trail event	Authority logging level					
Logout						•
Password change						•
Firmware reset						•
Violation local						•
Violation remote						•

3.5 Communication

The protection relay supports a range of communication protocols including IEC 61850 and Modbus®. Operational information and controls are available through these protocols. However, some communication functionality, for example, horizontal communication between the protection relays, is only enabled by the IEC 61850 communication protocol.

The IEC 61850 communication implementation supports all monitoring and control functions. Additionally, parameter settings, disturbance recordings and fault records can be accessed using the IEC 61850 protocol. Disturbance recordings are available to any Ethernet-based application in the IEC 60255-24 standard COMTRADE file format. The protection relay can send and receive binary signals from other devices (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 protection relay meets the GOOSE performance requirements for tripping applications in distribution substations, as defined by the IEC 61850 standard.

The protection relay 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 protection relay can be connected to Ethernet-based communication systems via the RJ-45 connector (100Base-TX) or the fiber-optic LC connector (100Base-FX). An optional serial interface is available for RS-485 communication.

3.5.1 Self-healing Ethernet ring

For the correct operation of self-healing loop topology, it is essential that the external switches in the network support the RSTP protocol and that it is enabled in the switches. Otherwise, connecting the loop topology can cause problems to the network. The protection relay itself does not support link-down detection or RSTP. The ring recovery process is based on the aging of the MAC addresses, and the link-up/link-down events can cause temporary breaks in communication. For a better performance of the self-healing loop, it is recommended that the external switch

furthest from the protection relay loop is assigned as the root switch (bridge priority = 0) and the bridge priority increases towards the protection relay loop. The end links of the protection relay loop can be attached to the same external switch or to two adjacent external switches. A self-healing Ethernet ring requires a communication module with at least two Ethernet interfaces for all protection relays.
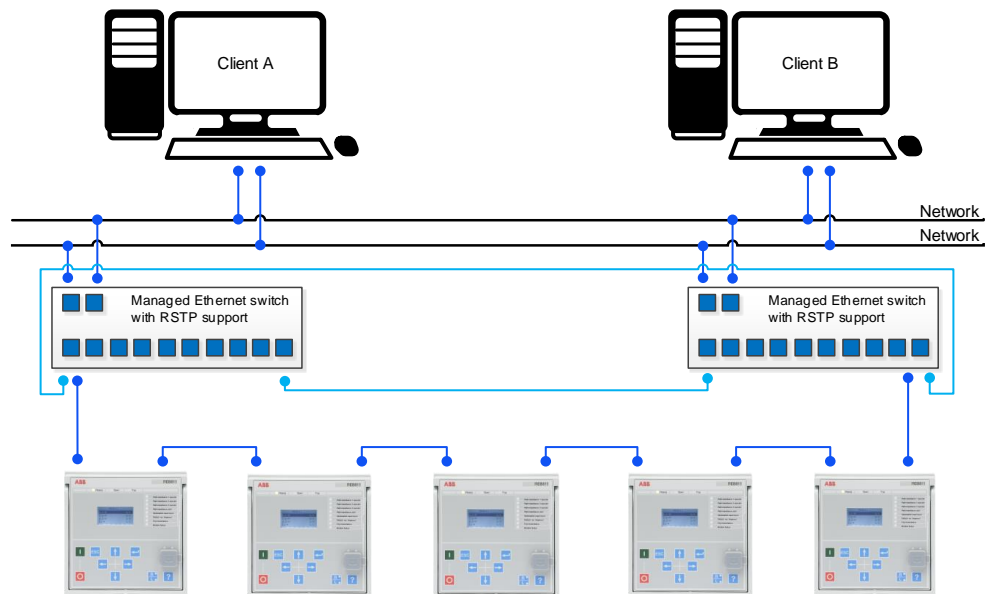

Figure 7:   *Self-healing Ethernet ring solution*

3.5.2   Ethernet redundancy

IEC 61850 specifies a network redundancy scheme that improves the system availability for substation communication. It is based on two complementary protocols defined in the IEC 62439-3:2012 standard: parallel redundancy protocol PRP and high-availability seamless redundancy HSR protocol. Both protocols rely on the duplication of all transmitted information via two Ethernet ports for one logical network connection. Therefore, both are able to overcome the failure of a link or switch with a zero-switchover time, thus fulfilling the stringent real-time requirements for the substation automation horizontal communication and time synchronization.

PRP specifies that each device is connected in parallel to two local area networks. HSR applies the PRP principle to rings and to the rings of rings to achieve cost-effective redundancy. Thus, each device incorporates a switch element that forwards frames from port to port. The HSR/PRP option is available for all 611 series protection relays.

> IEC 62439-3:2012 cancels and replaces the first edition published in 2010. These standard versions are also referred to as IEC 62439-3

Edition 1 and IEC 62439-3 Edition 2. The protection relay supports
IEC 62439-3:2012 and it is not compatible with IEC 62439-3:2010.

PRP

Each PRP node, called a double attached node with PRP (DAN), is attached to two
independent LANs operated in parallel. These parallel networks in PRP are called
LAN A and LAN B. The networks are completely separated to ensure failure
independence, and they can have different topologies. Both networks operate in
parallel, thus providing zero-time recovery and continuous checking of redundancy to
avoid communication failures. Non-PRP nodes, called single attached nodes (SANs),
are either attached to one network only (and can therefore communicate only with
DANs and SANs attached to the same network), or are attached through a redundancy
box, a device that behaves like a DAN.
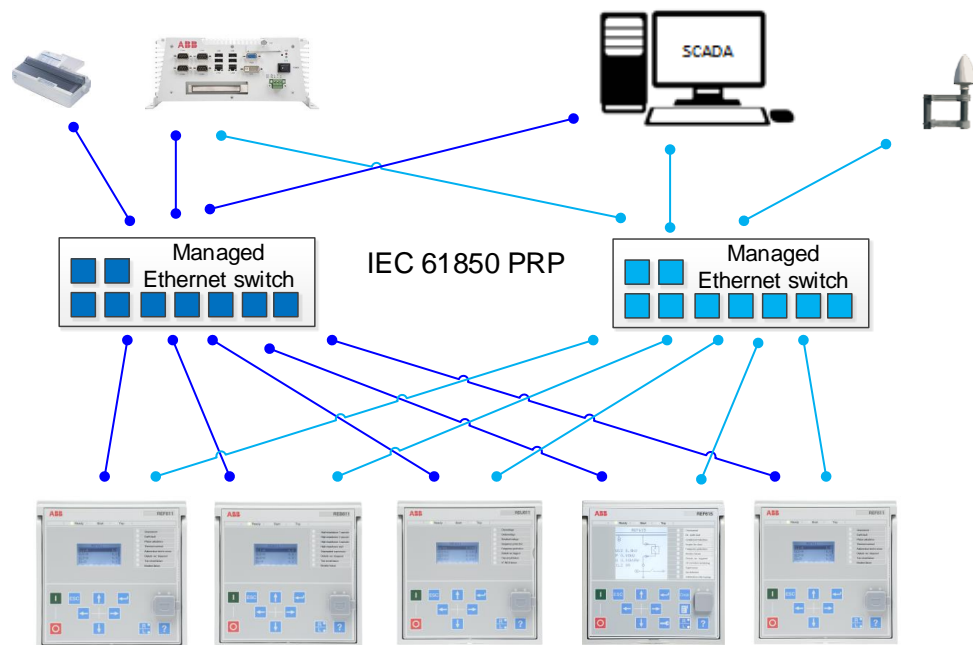
Figure 8:   *PRP solution*

In case a laptop or a PC workstation is connected as a non-PRP node to one of the PRP
networks, LAN A or LAN B, it is recommended to use a redundancy box device or an
Ethernet switch with similar functionality between the PRP network and SAN to
remove additional PRP information from the Ethernet frames. In some cases, default
PC workstation adapters are not able to handle the maximum-length Ethernet frames
with the PRP trailer.

There are different alternative ways to connect a laptop or a workstation as SAN to a
PRP network.

- Via an external redundancy box (RedBox) or a switch capable of connecting to PRP and normal networks
- By connecting the node directly to LAN A or LAN B as SAN
- By connecting the node to the protection relay's interlink port

HSR

HSR applies the PRP principle of parallel operation to a single ring, treating the two directions as two virtual LANs. For each frame sent, a node, DAN, sends two frames, one over each port. Both frames circulate in opposite directions over the ring and each node forwards the frames it receives, from one port to the other. When the originating node receives a frame sent to itself, it discards that to avoid loops; therefore, no ring protocol is needed. Individually attached nodes, SANs, such as laptops and printers, must be attached through a "redundancy box" that acts as a ring element. For example, a 615 or 620 series protection relay with HSR support can be used as a redundancy box.
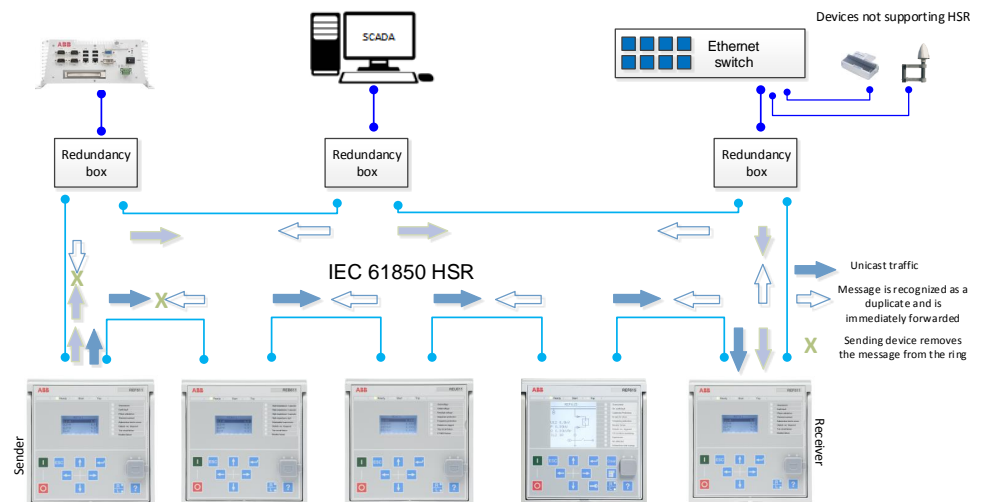
Figure 9:   *HSR solution*

3.5.3   Secure communication

The protection relay supports secure communication for WHMI and file transfer protocol. If the *Secure Communication* parameter is activated, protocols require TLS based encryption method support from the clients. In this case WHMI must be connected from a Web browser using the HTTPS protocol and in case of file transfer the client must use FTPS.

> As a factory default, *Secure Communication* is "ON".

3.6 PCM600 tool

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

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

The whole substation configuration can be controlled and different tasks and functions can be performed with the individual tool components. PCM600 can operate with many different topologies, depending on the customer needs.

For more information, see the PCM600 documentation.

3.6.1 Connectivity packages

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

A connectivity package includes all the data which is used to describe the protection relay. For example, it contains a list of the existing parameters, data format used, units, setting range, access rights and visibility of the parameters. In addition, it contains code which allows software packages that use the connectivity package to properly communicate with the protection relay. It also supports localization of text even when it is read from the protection relay in a standard format such as COMTRADE.

Update Manager is a tool that helps in defining the right connectivity package versions for different system products and tools. Update Manager is included with the products that use connectivity packages.

3.6.2 PCM600 and relay connectivity package version

- Protection and Control IED Manager PCM600 Ver.2.7 or later
- REB611 Connectivity Package Ver.2.0 or later
- REF611 Connectivity Package Ver.2.0 or later
- REM611 Connectivity Package Ver.2.0 or later
- REU611 Connectivity Package Ver.2.0 or later

Download connectivity packages from the ABB Web site
http://www.abb.com/substationautomation or directly with Update
Manager in PCM600.

Section 4   Using the HMI

4.1   Using the local HMI

To use the LHMI, logging in and authorization are required. Password authorization is disabled by default and can be enabled via the LHMI.

> To enable password authorization, select **Main menu/ Configuration/Authorization/Passwords**. Set the *Local override* parameter to "False".

4.1.1   Logging in

1. Press ⟨ or ⟩ or ↵ to activate the login procedure.
2. Press ↑ or ↓ to select the user level.

```
        Login
━━━━━━━━━━━━━━━━━━━━━
Select User
=VIEWER
```
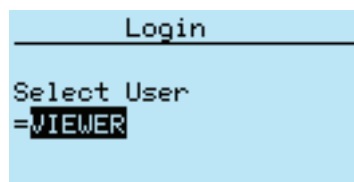
Figure 10:   *Selecting access level*

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

    •   Activate the digit to be entered with ⟨ and ⟩.
    •   Enter the character with ↑ and ↓.

```
        VIEWER
━━━━━━━━━━━━━━━━━━━━━
Enter password:
=***1
```
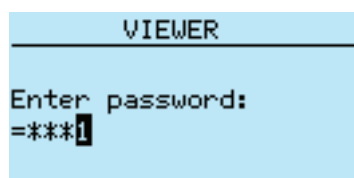
Figure 11:   *Entering password*

5. Press ↵ to confirm the login.

    •   To cancel the procedure, press ESC.
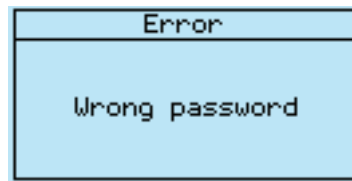
Figure 12:   *Error message indicating wrong password*

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

4.1.2   Logging out

An automatic logout occurs 30 seconds after the backlight timeout.

1. Press 〈 for three seconds in the main menu.
2. To confirm logout, select `Yes` and press ↵.
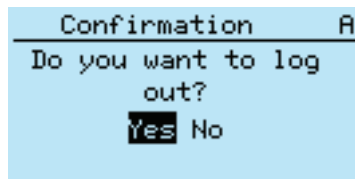
Figure 13:   *Logging out*

- To cancel logout, press ESC.

4.1.3   Turning the display backlight on

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

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

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

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

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

4.1.4 Selecting local or remote use

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

• Press $\boxed{\frac{R}{L}}$ 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 neither of the LEDs is lit, both control positions are disabled.
   • When the L and R LEDs are lit, both remote and local control are enabled.

By default, the control position cannot be local and remote simultaneously. See the technical manual for more information on local and remote control.

To control the protection relay, log in with the appropriate user rights.

4.1.5 Identifying the device

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

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

1. Select **Main menu/Information**.
2. Select a submenu with ↑ and ↓.
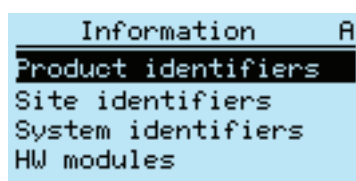
Figure 14:   Selecting a submenu

3.   Enter the submenu with ⟩ .

4.   Browse the information with ⬆ and ⬇ .
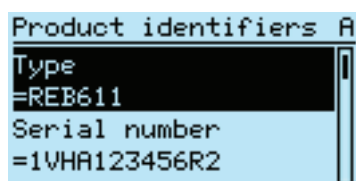
Figure 15:   Protection relay information

4.1.5.1   Identifying relay's IEC 61850 version

The relay's IEC 61850 version information identifies if the relay is configured as Edition 1 or Edition 2 device.

1.   Select **Main menu/Information/System identifiers**.

2.   Enter the submenu with ⟩ .
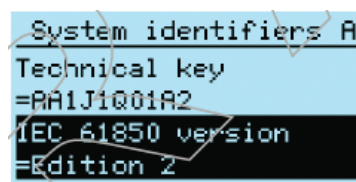
Figure 16:   Identifying IEC 61850 version

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 ᴇꜱᴄ and ⬆ .
*   To decrease the contrast, press simultaneously ᴇꜱᴄ and ⬇ .

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

4.1.7   Changing the local HMI language

1. Select **Main menu/Language** and press ⏎ .
2. Change the language using ↑ or ↓ .
3. Press ⏎ to confirm the selection.
4. Commit the changes.
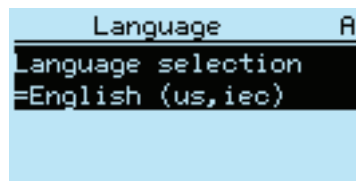
Figure 17:   *Changing the LHMI language*

> To change the language using a shortcut, press `ESC` and `<` simultaneously anywhere in the menu.

4.1.8   Changing display symbols

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

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

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

4.1.9   Changing setting visibility

The basic settings contain the most used parameters. The advanced settings contain all parameters.

1. Select **Main Menu/Configuration/HMI/Setting visibility** and press ↵.
2. Change the setting visibility with ↑ or ↓ to select which parameters are shown.

   • Basic
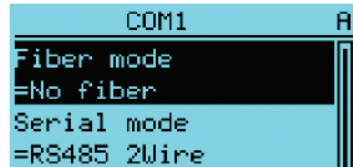   • Advanced

3. Press ↵ to confirm the selection.

Figure 18:   *Viewing basic parameters*

4.1.10   Navigating in the menu

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

- To move up or down in a menu, press ↑ or ↓.
- To move downwards in the menu tree, press ❭.
- To move upwards in the menu tree, press ❬.
- To enter setting mode, press ↵.
- To leave setting mode without saving, press ESC.

4.1.10.1   Menu structure

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

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

4.1.10.2 Scrolling the display

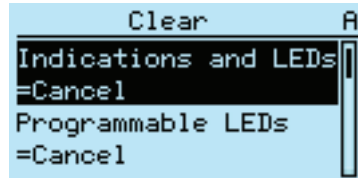If a menu contains more rows than the display can show at a time, a scroll bar is displayed on the right.

Figure 19:   *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.

4.1.10.3 Changing the default view

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

1. Select **Main menu/Configuration/HMI/Default view** and press ↵.
2. Change the default view with ⬆ or ⬇.
3. Press ↵ to confirm the selection.

4.1.11 Browsing setting values

1. Select **Main menu/Settings/Settings** and press ❯.
2. Select the setting group to be viewed with ⬆ or ⬇.
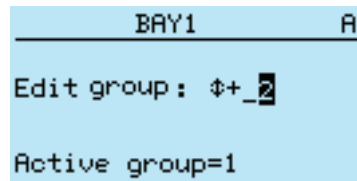
Figure 20:   Selecting a setting group

3. Press ⏎ to confirm selection.
4. To browse the settings, scroll the list with ↑ and ↓ and to select a submenu press 〉. To move back to the list, press 〈.
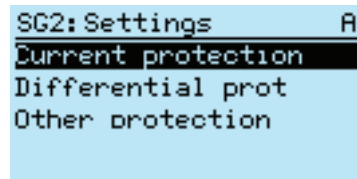
Figure 21:   Example of submenus in the Settings menu

4.1.12   Editing values

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

> ℹ Changing the function block on or off affects to the visibility of its parameters in the menu. Setting function block off hides the function parameters. When changing function block on or off the parameters' visibility changes immediately. Commit the settings for the activation of the function.

> ℹ Changing the value of certain relay parameters affects the visibility or range of other parameters in the menu. This indicates which parameters or parameter values become obsolete due to the change. The relay changes the visibility or range of these parameters immediately. Commit the settings for the activation of the function.

4.1.12.1   Editing numerical values

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

- When the symbol in front of the value is ↑, the active value can only be increased.
- When the symbol is ↓, the active value can only be decreased.
- When the symbol in front of the value is ↕, the active value can either be increased or decreased.

```
_____BAY1_____A___

Edit group: ↑+_1

Active group=1
```
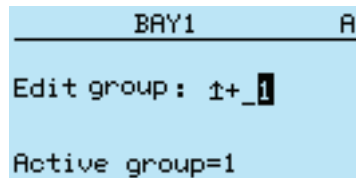
Figure 22:   Last digit is active and it can only be increased

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

> **i**   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 ⬇.

```
_____BAY1_____A___

Edit group: ↓+_5

Active group=1
```
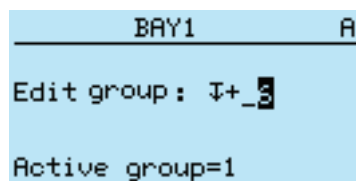
Figure 23:   Arrow symbol is active, the value is set to the maximum

After pressing ⬆, the previous value can be restored by pressing ⬇ once, and vice versa. Another press of ⬇ or ⬆ sets the value to the lower or higher limit. The symbol in front of the value is ↕, when the previous value is shown.
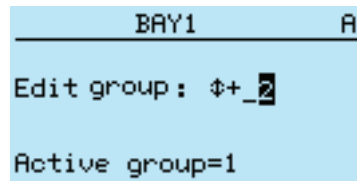
Figure 24:   *Restoring the previous value*

4.1.12.2   Editing string values

1.   Activate the setting mode and select a setting.
     When editing string values, the cursor moves to the first character.
2.   Press ⬆ or ⬇ to change the value of an active character.
     One press changes the value by one step.
3.   Press ⟩ to move the cursor to the right. Press ⟨ to delete the character on the
     left side of the cursor.

4.1.12.3   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.

4.1.13   Committing settings

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

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

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

Confirmation   A
Commit settings?
Yes No Cancel
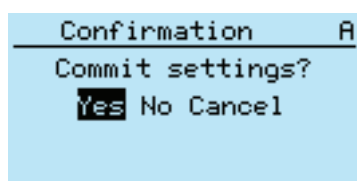
Figure 25:   *Confirming settings*

- To exit without saving changes, select `No` and press ⏎.

  - If the parameter has an edit-copy, the original parameter value is restored.
  - If the parameter does not have an edit-copy, the edited parameter value remains visible until the protection relay is rebooted. However, the edited value is not stored in non-volatile memory and the reboot restores the original value.

- To cancel saving settings, select `Cancel` and press ⏎.

> After certain parameters are changed, the protection relay has to be restarted.

4.1.14   Clearing and acknowledging

The Clear view is used to reset, acknowledge or clear all messages and indications, including LEDs and latched outputs as well as registers and recordings. Events and alarms assigned to programmable LEDs are cleared in the Clear view as well.

1. Select **Main menu/Clear** to activate the clear menu.

    Clear   A
    Indications and LEDs
    =Cancel
    Programmable LEDs
    =Cancel
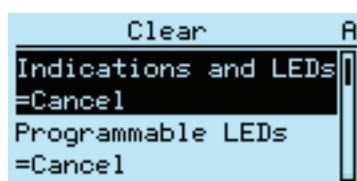
Figure 26:   *Clear view*

2. Select the item to be cleared with ⬆ or ⬇.
3. Press ⏎, change the value with ⬆ or ⬇ and press ⏎ again.
    The item is now cleared.
4. Repeat steps 2 and 3 to clear other items.

Use the ESC button as a shortcut for clearing. The first three-second press clears the indications. The second three-second press clears the programmable LEDs.

4.1.15 Using the local HMI help

1. Press HELP 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 ESC.

4.2 Using the Web HMI

WHMI is enabled by default. As secure communication is enabled by default, the WHMI must be accessed from a Web browser using the HTTPS protocol.

If the WHMI was previously disabled, it can be enabled again via the LHMI.

1. To enable the WHMI, select **Main menu/Configuration/HMI/Web HMI mode** via the LHMI.
2. Reboot the relay for the change to take effect.
3. Log in with the proper user rights to use the WHMI.

To establish a remote WHMI connection to the protection relay, contact the network administrator to check the company rules for IP and remote connections.

Disable the Web browser proxy settings or make an exception to the proxy rules to allow the protection relay's WHMI connection, for example, by including the relay's IP address in **Internet Options/ Connections/LAN Settings/Advanced/Exceptions**.

4.2.1 Logging in

1. Open Internet Explorer.
2. Type the protection relay's IP address in the Address bar and press ENTER.
3. Type the username with capital letters.
4. Type the password.
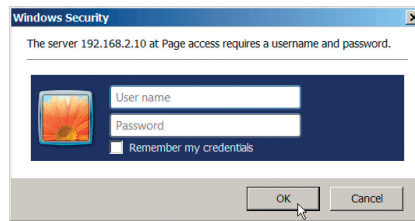
Figure 27:   Entering username and password to use the WHMI

5.   Click **OK**.
     The language file starts loading and the progress bar is displayed.

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**.

•   To log out manually, click **Logout** on the menu bar.

4.2.3   Identifying device

The Information menu includes detailed information about the device, for example, revision and serial number.

1.   Click the **Information** menu in the left navigation bar.
2.   Click a submenu to see the data.
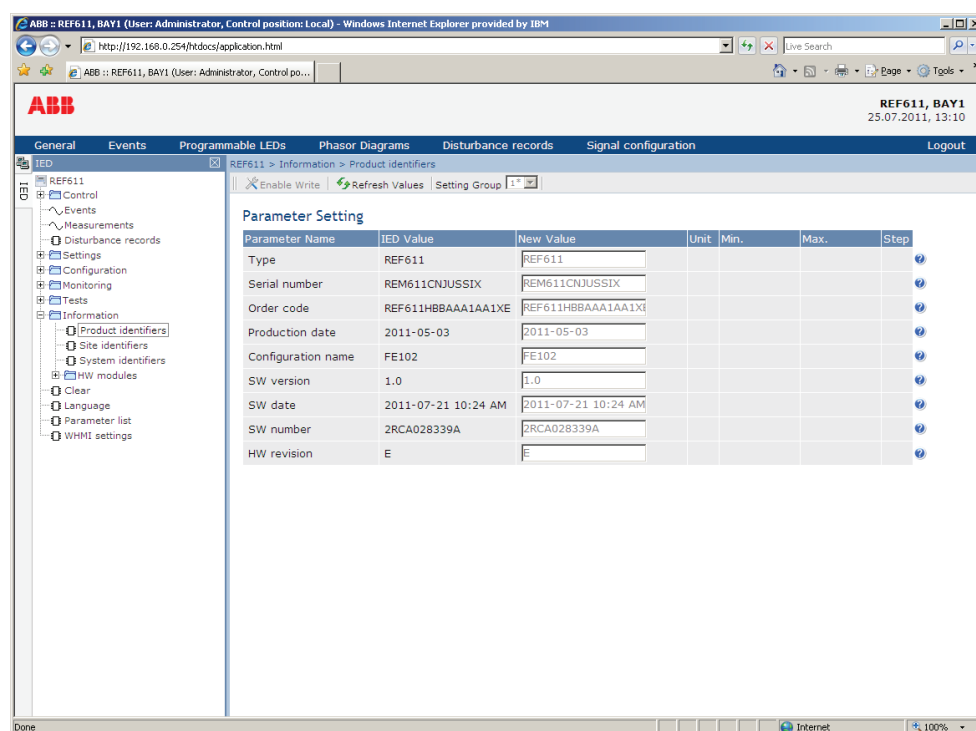
Figure 28:   *Device information*

4.2.4   Navigating in menus

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

- Use the menu bar to access different views.

  - The **General** view shows the protection relay version and status.
  - The **Events** view contains a list of events produced by the application configuration.
  - The **Programmable LEDs** view shows the status of programmable LEDs.
  - The **Phasor diagrams** view shows phasor diagrams.
  - The **Disturbance records** view shows the list of disturbance records.
  - **Signal configuration**
  - **Logout** ends the session.
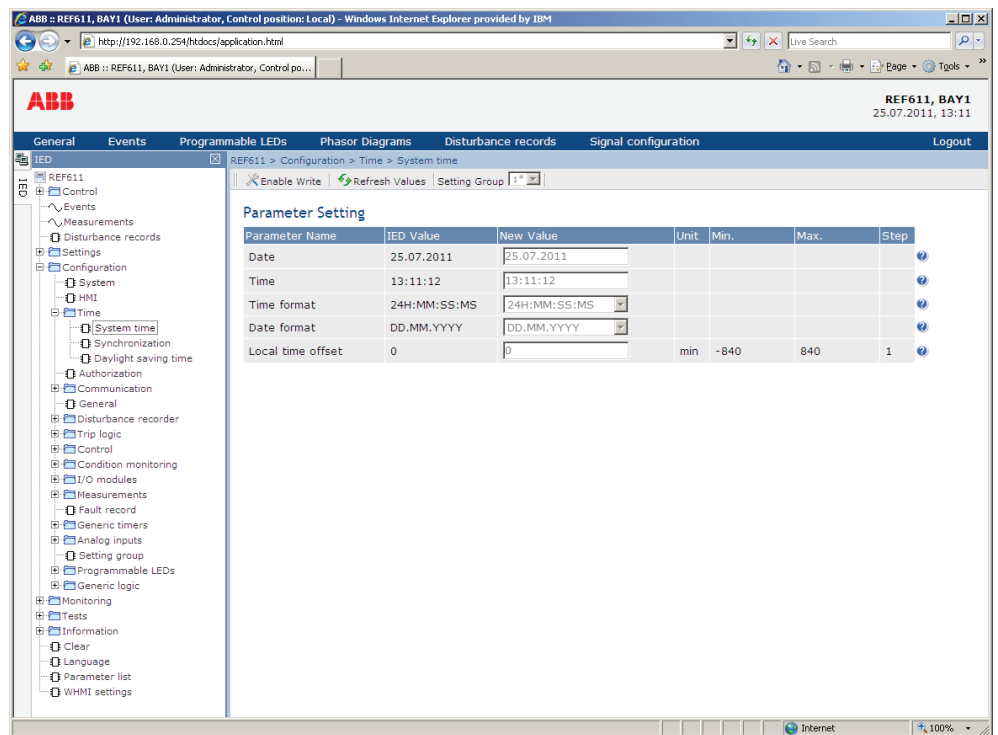
Figure 29:   Navigating in Web HMI menus

4.2.4.1   Menu structure

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

- Control
- Events
- Measurements
- Disturbance records
- Settings
- Configuration
- Monitoring
- Tests
- Information
- Clear
- Language
- Parameter list
- WHMI settings

4.2.5 Showing parameters

Some function blocks have a function-specific On/Off setting. When the function setting is "Off", all settings are hidden and when the function setting is "On", all settings are visible based on the other visibility and hiding rules.

> Switch a function block on or off via the *Operation* parameter under the required function block.
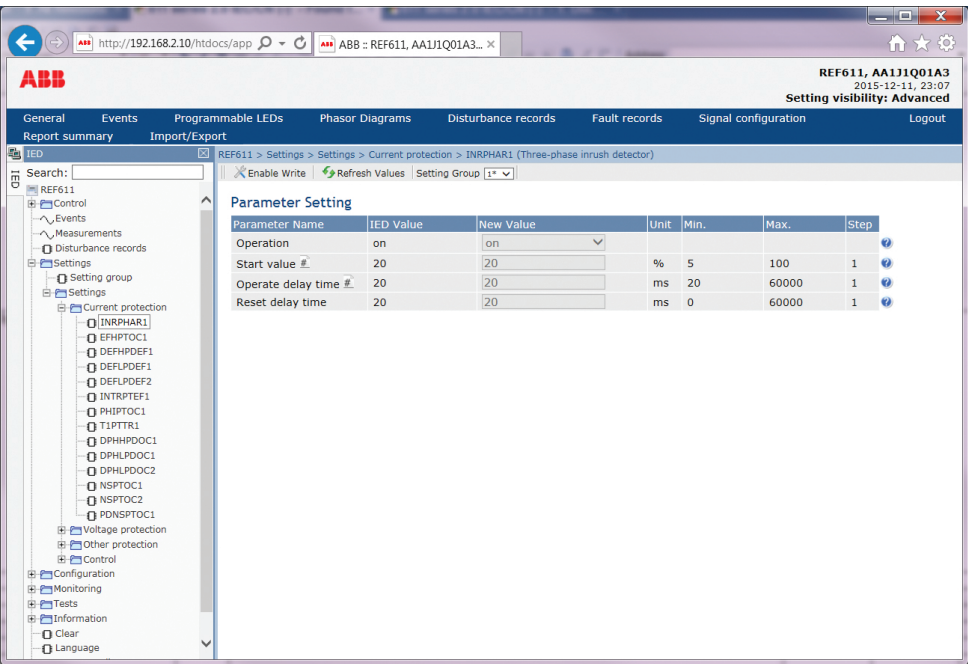
Figure 30:   *Function block On*
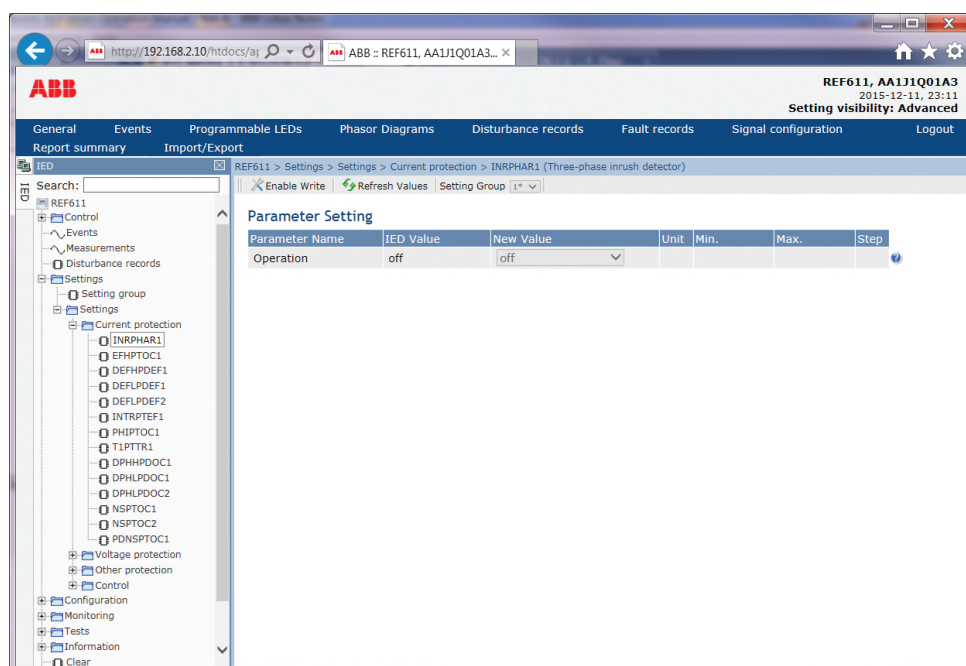
Figure 31:   Function block Off

The Parameter list page offers filtering functionality where only chosen parameters are displayed, saved or printed. There are various options for filtering.

- Enabled settings hides settings of disabled function blocks.
- Writable settings displays only writable settings. This option is checked by default.
- Basic settings displays only basic settings.
- Setting group displays only settings of the selected setting group. With "All" selected, all setting groups are displayed.

Options can be combined. For example, with the Enabled settings and Writable settings selected, only enabled and writable settings are displayed. If none of the options is selected, all settings are displayed.

> The values "Basic" or "Advanced" of the *Setting visibility* parameter in **Main Menu/Configuration/HMI** have no effect on the Parameter list page. This page has its own Basic settings option which can be used to hide or show the advanced settings on the Parameter list page.
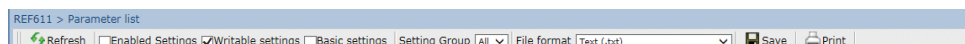
Figure 32:   Parameter list filter

1.   Click **Parameter list** in the left navigation bar.
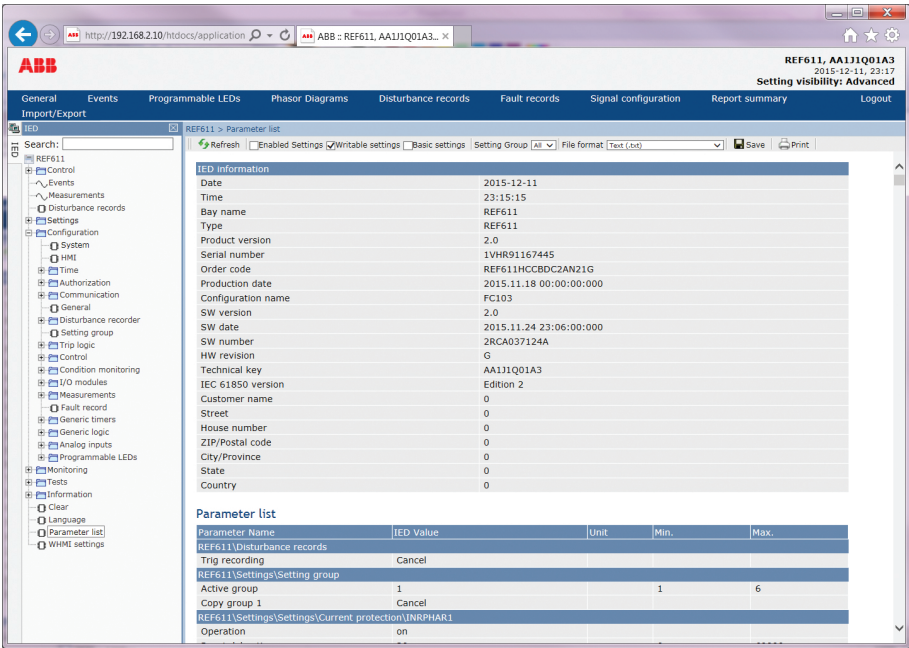
Figure 33:   Displaying parameters

2.   Select only those settings that are wanted to be shown and click **Refresh**. If
     nothing is selected, all settings are shown.
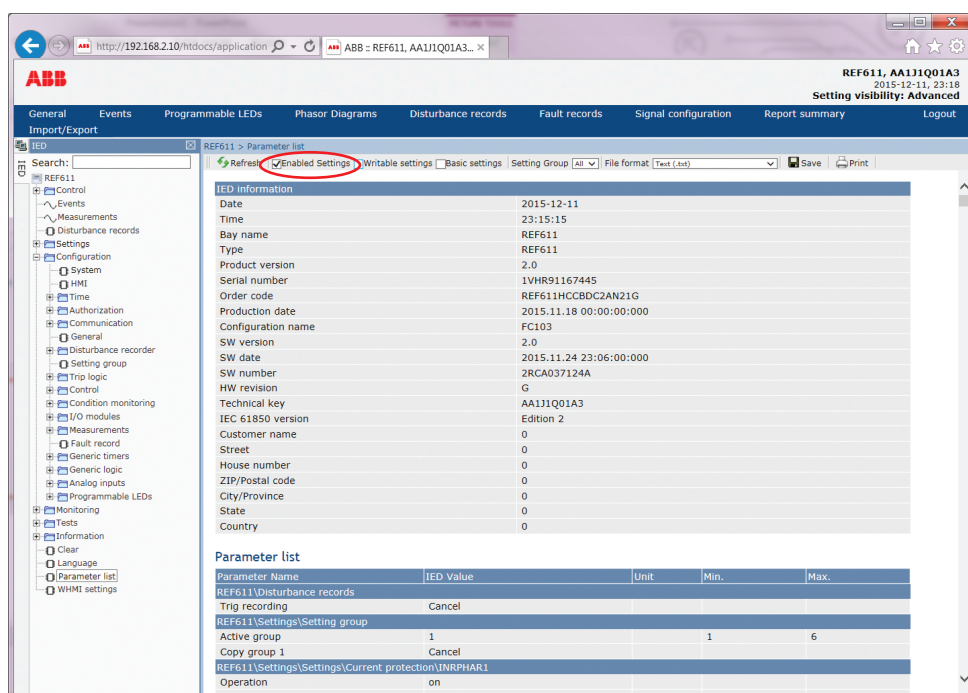
Figure 34:   Enabled settings

3. Select text (.txt) or comma separated values (.csv) file format and click **Save** to save the settings.
4. Click **Print** to print all the selected parameters.

4.2.6   Editing values

1. Select a menu in the left navigation bar.
2. Click a submenu to see function blocks.
3. Click a function block to see the setting values.
4. Click **Enable Write**.

> **i** Some parameters, for example the Web HMI mode, cannot be set via the WHMI.
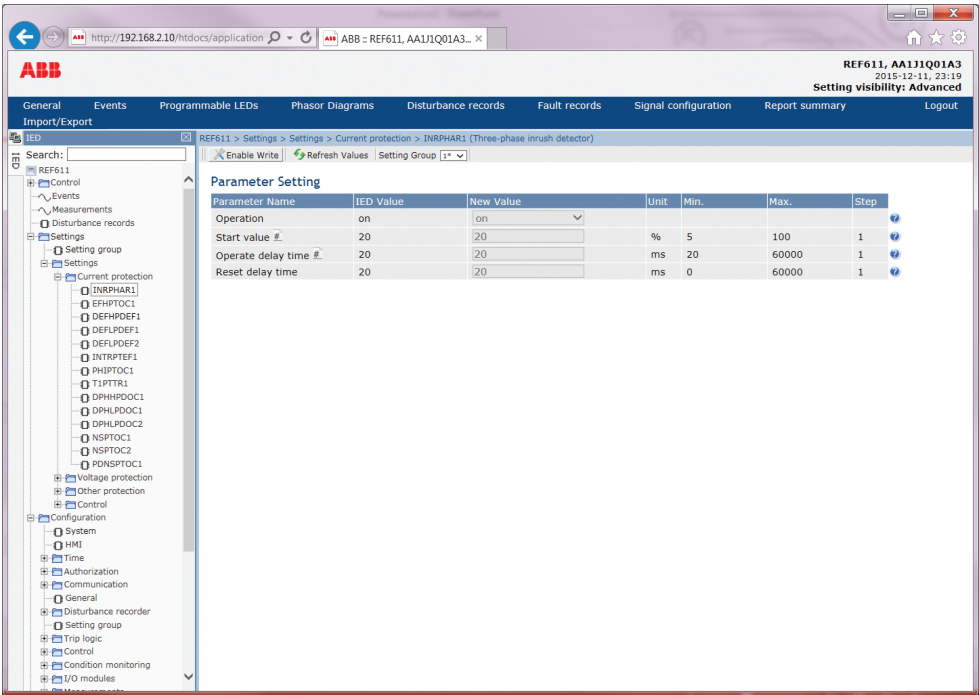
Figure 35:   Enable writing to edit a value

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

5.   Edit the value.

•   The minimum, maximum and step values for a parameter are shown in the Min., Max. and Step columns.

•   Setting group values are indicated with #.
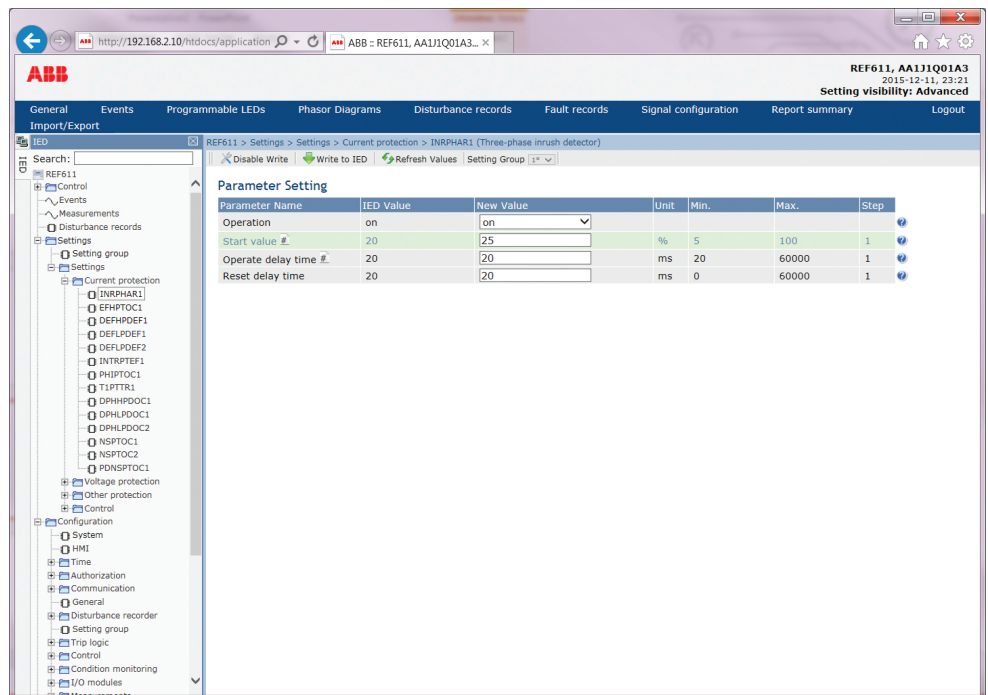
Figure 36: Editing a value

- 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 is displayed. **Write to IED** is unavailable.
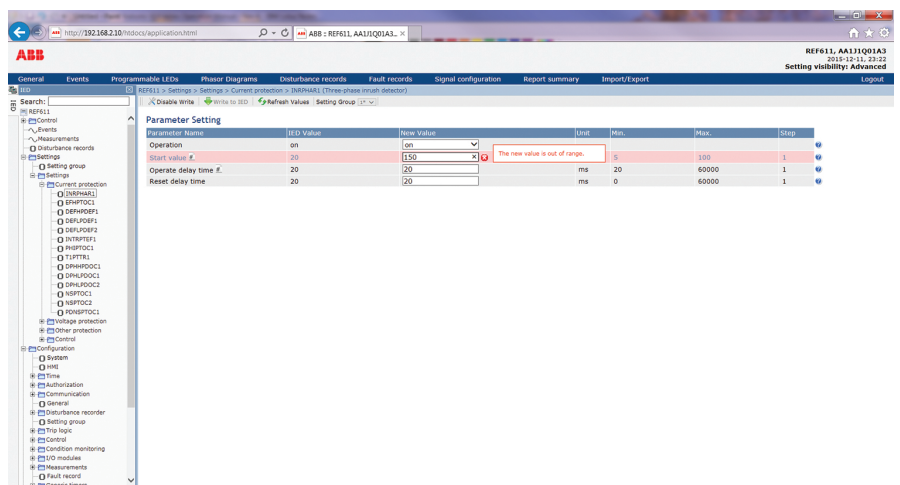
Figure 37: Warning indicating that the entered value is incorrect

- If writing values fails, a warning dialog box is displayed.
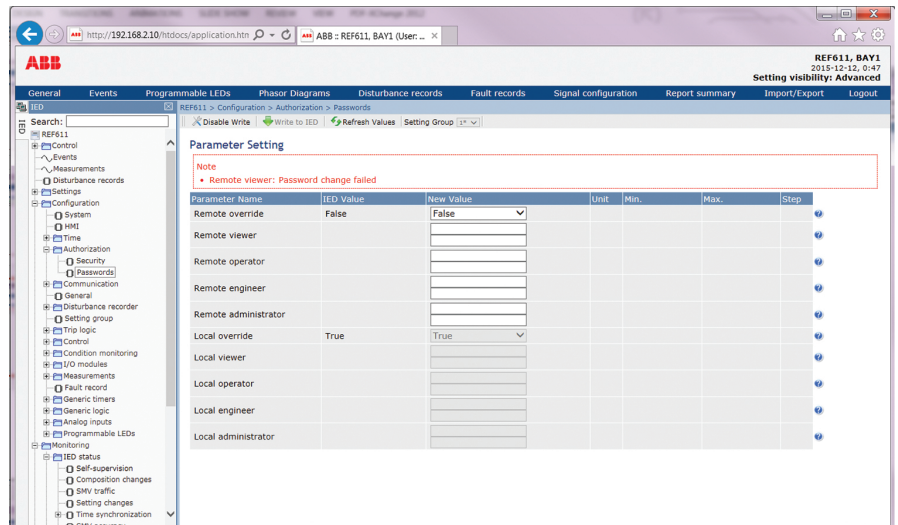
Figure 38:   *Warning indicating that the values were not written to the IED*

If writing is enabled accidentally, click **Disable Write**. **Disable Write** cannot be selected when a value has already been written to the protection relay. After clicking **Write to IED**, click either **Commit** or **Reject**.

4.2.7   Committing settings

Editable values are stored either in RAM or a nonvolatile flash memory. Values stored in the flash memory are in effect also after a reboot.

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

1. Click **Write to IED** after editing parameter values to put the values into protection relay's database for use.
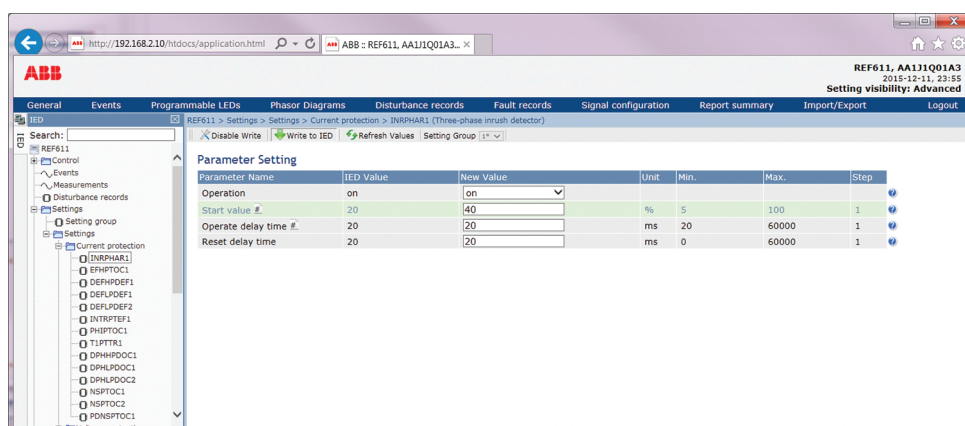
Figure 39:   Writing values to protection relay

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 the protection relay is rebooted. However, the edited value is not stored in the nonvolatile memory and thus the reboot restores the original value.
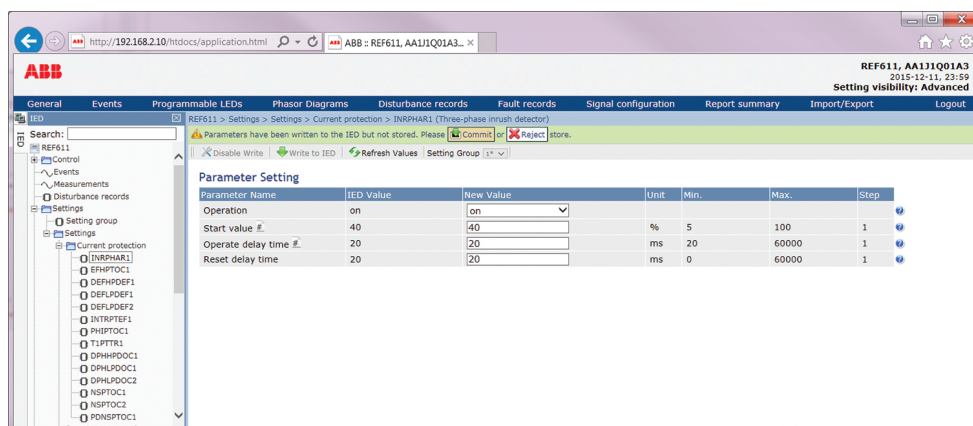
Figure 40:   Committing changes

Committing values takes a few seconds.

> If the values are not committed, they are not taken into use and they are lost after a reboot.

4.2.8 Clearing and acknowledging

All messages and indications, including LEDs and latched outputs as well as registers and recordings, can be reset, acknowledged or cleared using the Clear menu.

1. Click **Clear** in the left navigation bar.
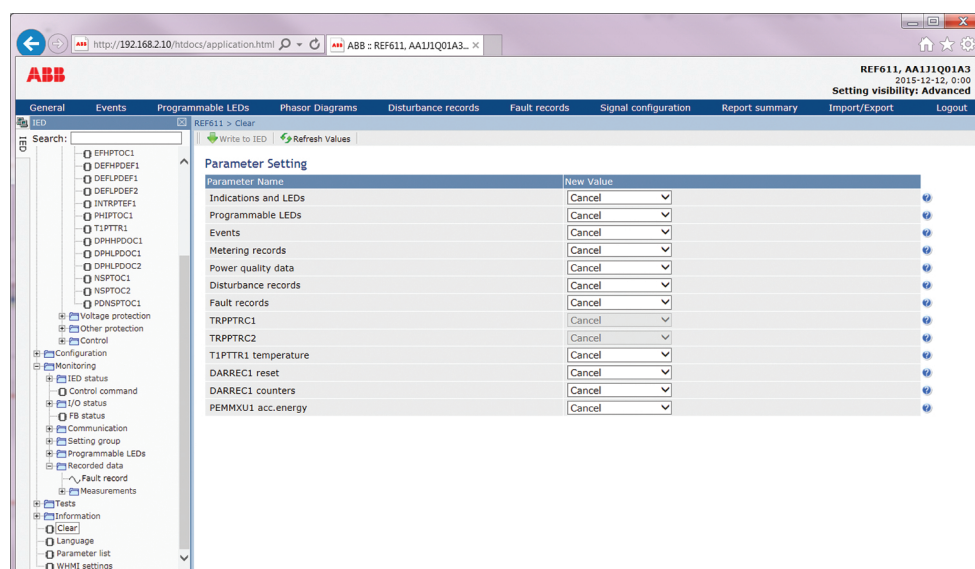
Figure 41:   Selecting clear menu

2. In the **New Value** list, select **Clear** to choose the item to be cleared.
3. Click **Write to IED**.
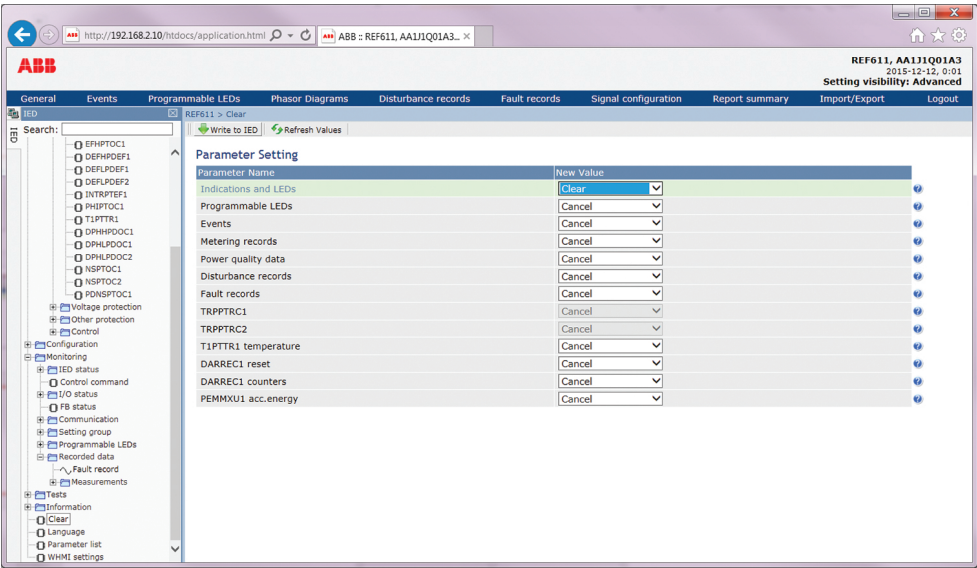
Figure 42:   Clearing indications and LEDs

4.2.9   Selecting programmable LEDs view

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

•   Click **Programmable LEDs** on the menu bar.
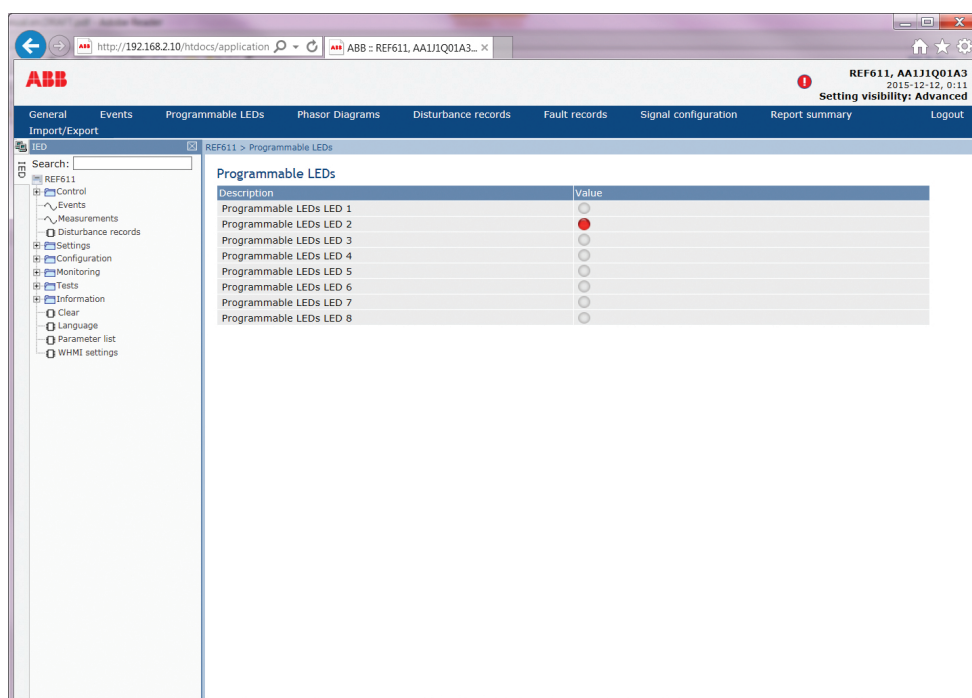
Figure 43:   Monitoring programmable LEDs

4.2.10   Selecting event view

The event view contains a list of events produced by the application configuration. When the event page is opened, it displays up to 100 latest events at one time. The event list is updated automatically.

1.   Click **Events** on the menu bar.

Figure 44:   Monitoring events

2.   Click **Freeze** to stop updating the event list.
3.   Select a page from the drop-down list to view older events or select **View all** to
      show all events on the same page.

Figure 45:   Events view

4.   To save the events in TXT or CSV file formats, select the file format from the
      drop-down list and click **Save**.

> 💡 The CSV file can be opened with a spreadsheet program such as OpenOffice.org Calc or Microsoft Excel.

5. Click **Clear events** to clear all events from the protection relay.
6. Click **Print** to print all the selected events.

4.2.11 Selecting disturbance records view

Disturbance records are listed in the disturbance records view.

- Click **Disturbance records** on the menu bar.
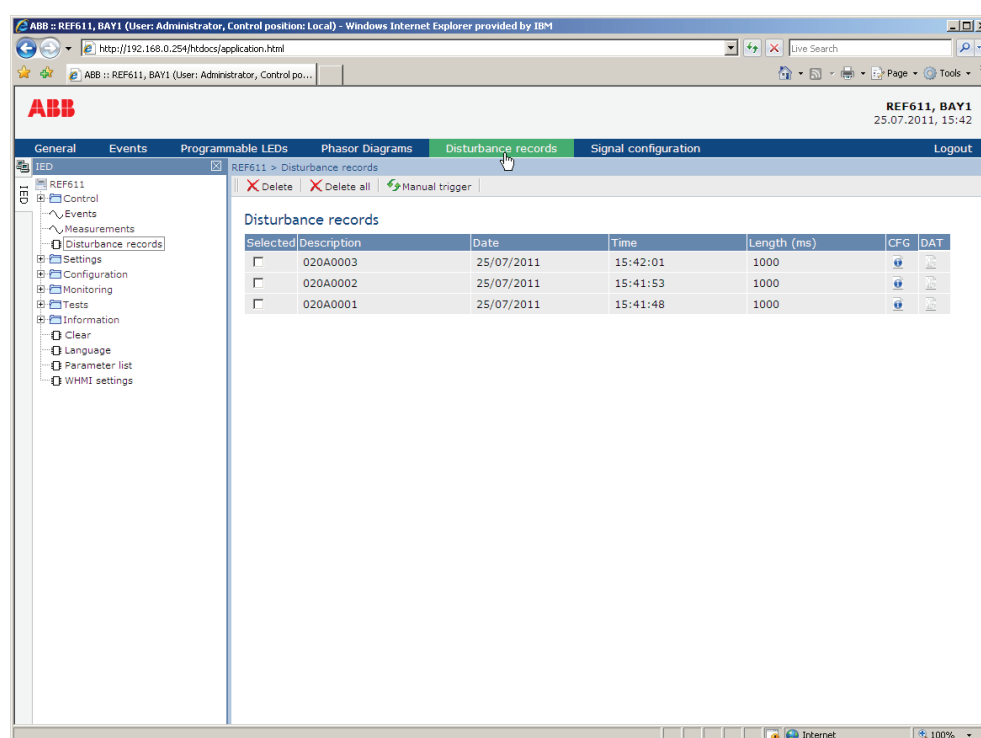
Figure 46:   Selecting disturbance records view

4.2.11.1 Saving disturbance records

1. Click **Disturbance records** on the menu bar.
2. To save the disturbance record files, click the icon in the **Download Files** column of the record.
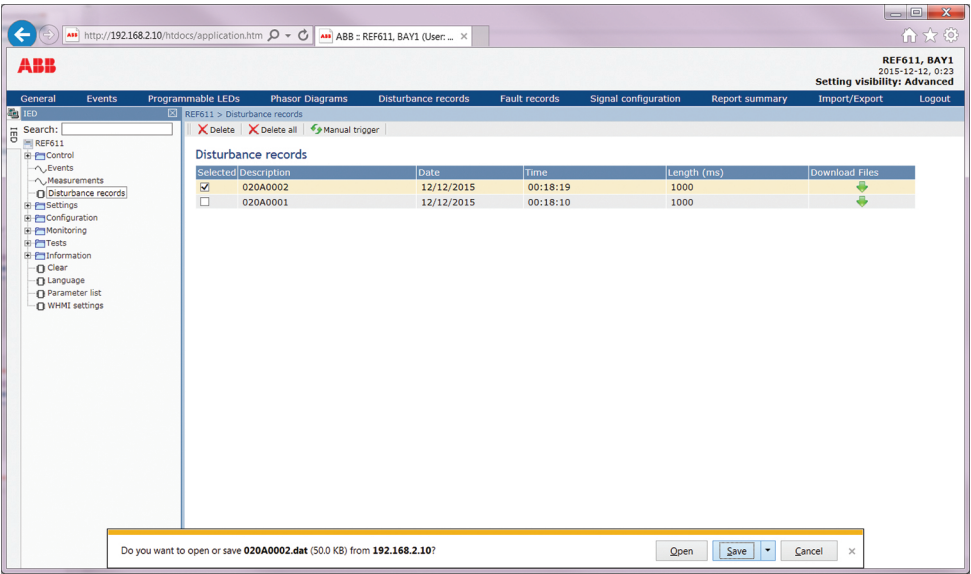
Figure 47:   Saving a disturbance record

3.   Open the disturbance record files with a suitable program.

4.2.11.2   Triggering disturbance recorder manually

1.   Click **Disturbance records** on the menu bar.
2.   Click **Manual trigger**.
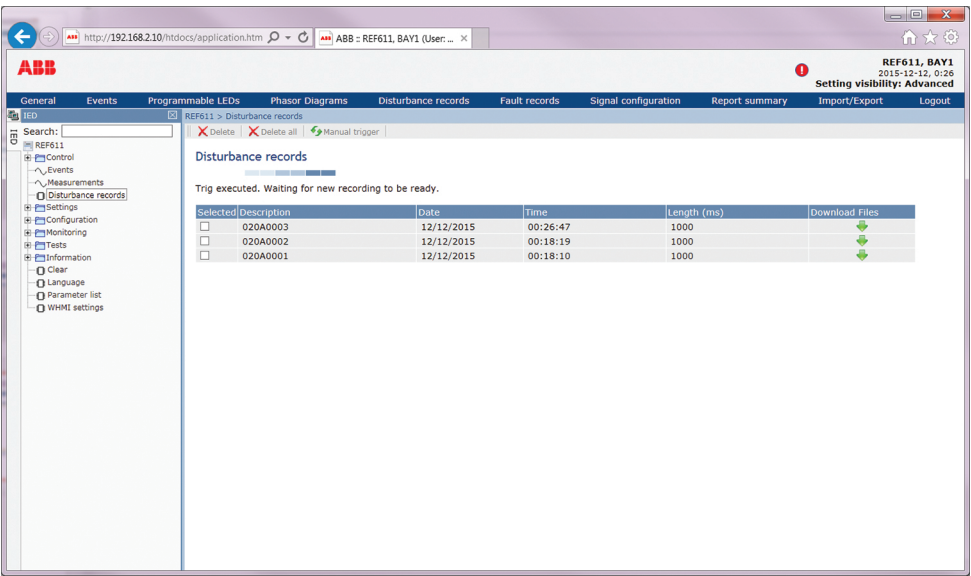
Figure 48:   Manual triggering

4.2.11.3 Deleting disturbance records

1. Click **Disturbance records** on the menu bar.
2. Delete records.

   • Click **Delete all** to delete all records.
   • Select one or more recordings and click **Delete** to delete selected records.
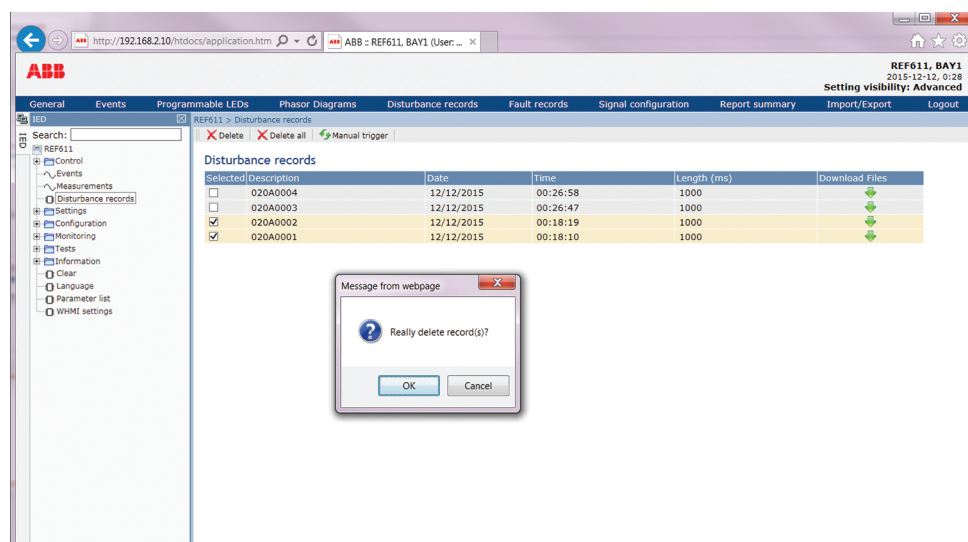
Figure 49:   Deleting disturbance records

3. Click **OK** to confirm or **Cancel** to cancel the deletion.

4.2.12 Selecting phasor diagrams

Install or enable the SVG plugin to view the phasor diagrams, if
needed.

1. Click **Phasor diagrams** on the menu bar.
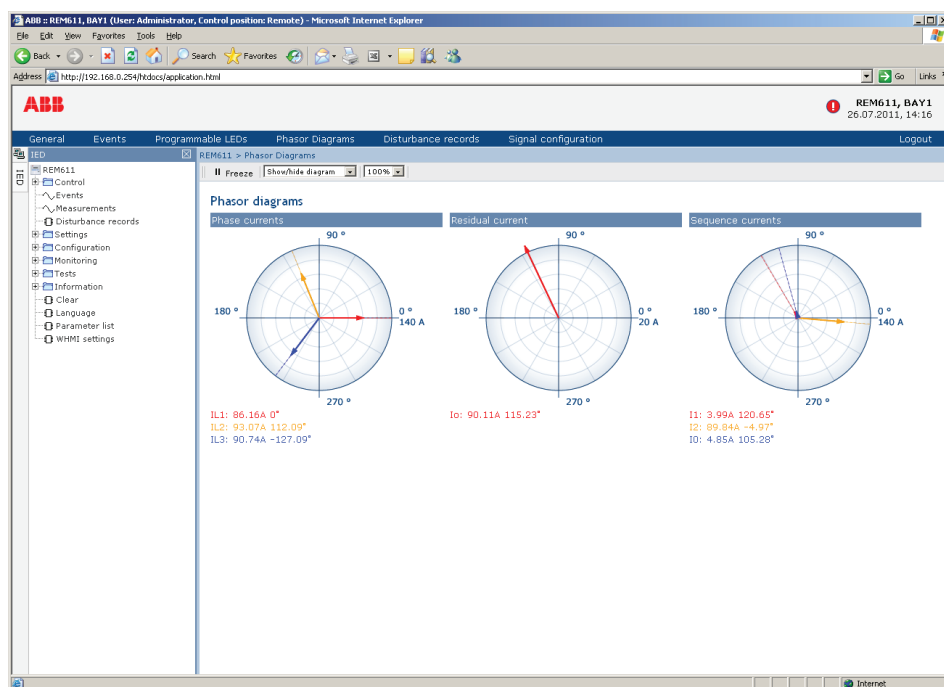
Figure 50:   Monitoring phasors

2.   Toggle the diagram visibility by selecting the diagram from the drop-down menu.
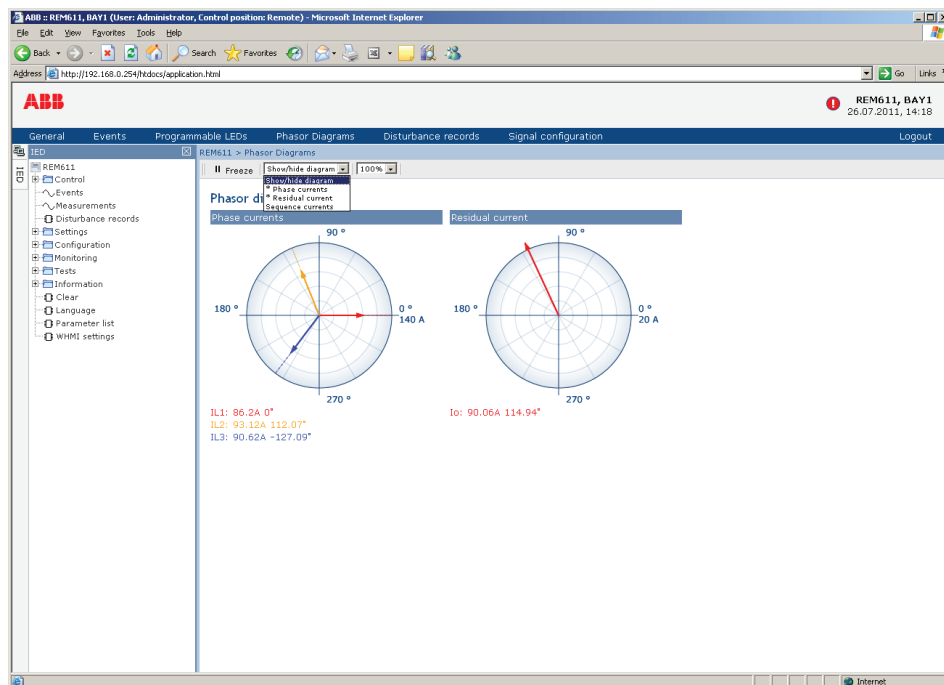
Figure 51:   Toggling the diagram visibility

Visible diagrams are indicated with an asterisk *.
3. Change the size of the diagram by changing the zoom value.
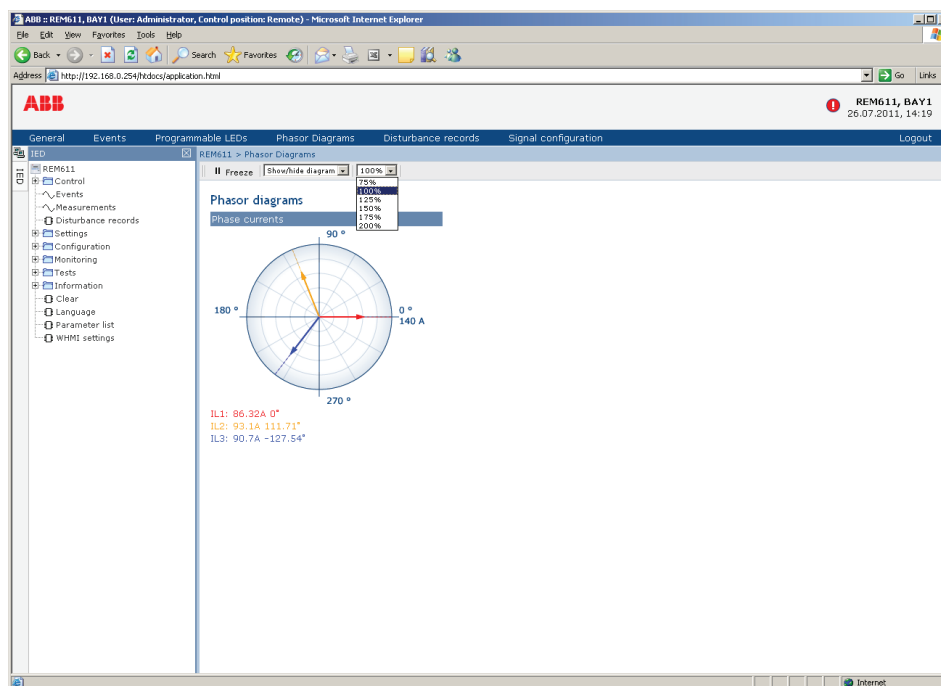
Figure 52:   Zooming the diagram

4. Click **Freeze** to stop updating the phasor diagram.
    No updates are displayed in the diagram.
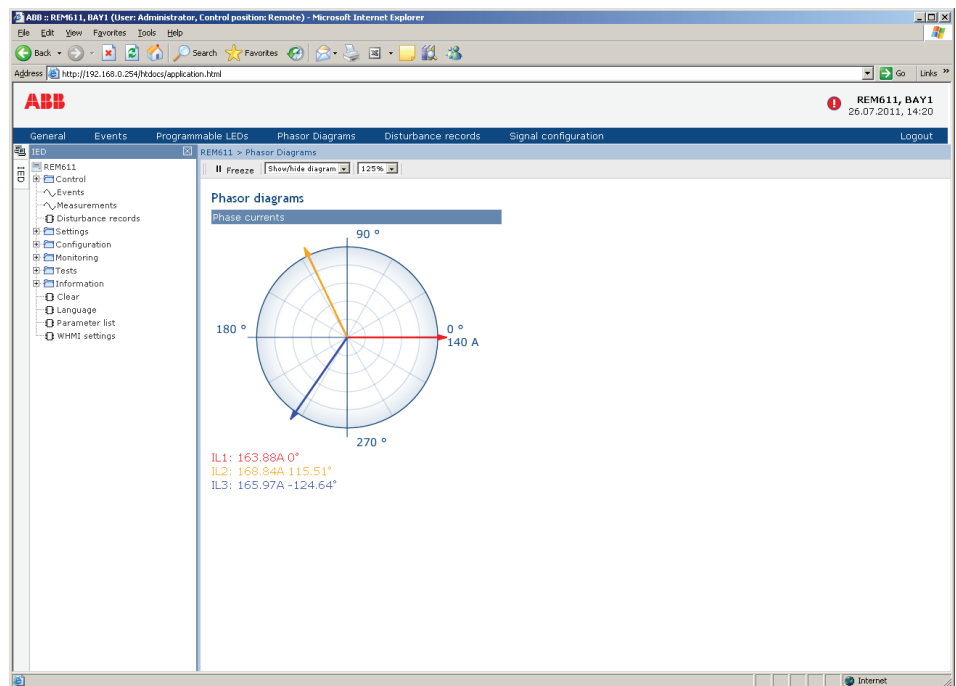
Figure 53: *The arrow extends outside the circle if the current value is too high*

4.2.13 Selecting fault records

1. Fom the main menu, select **Monitoring/Recorded data/Fault record** or click **Fault records** on the menu bar to view a list of all available fault records.
2. Click a record from the **Fault records** list to open the fault record details view.
3. To go back to the list view, click **Fault records** on the menu bar or click the **View all** button.
4. To save the records in TXT or CSV file formats, select the format from the **File format** drop-down list and click **Save**.

   • When the fault record details view is shown, only the shown fault record is saved.
   • When fault record list view is shown, all fault records are saved.

5. To clear all fault records from the protection relay, click **Clear records**. This can be done only when the fault record list view is shown.
6. To print all fault records, click **Print** when the fault record list view is shown.
7. To print only one record, open it in the details view and click **Print**.
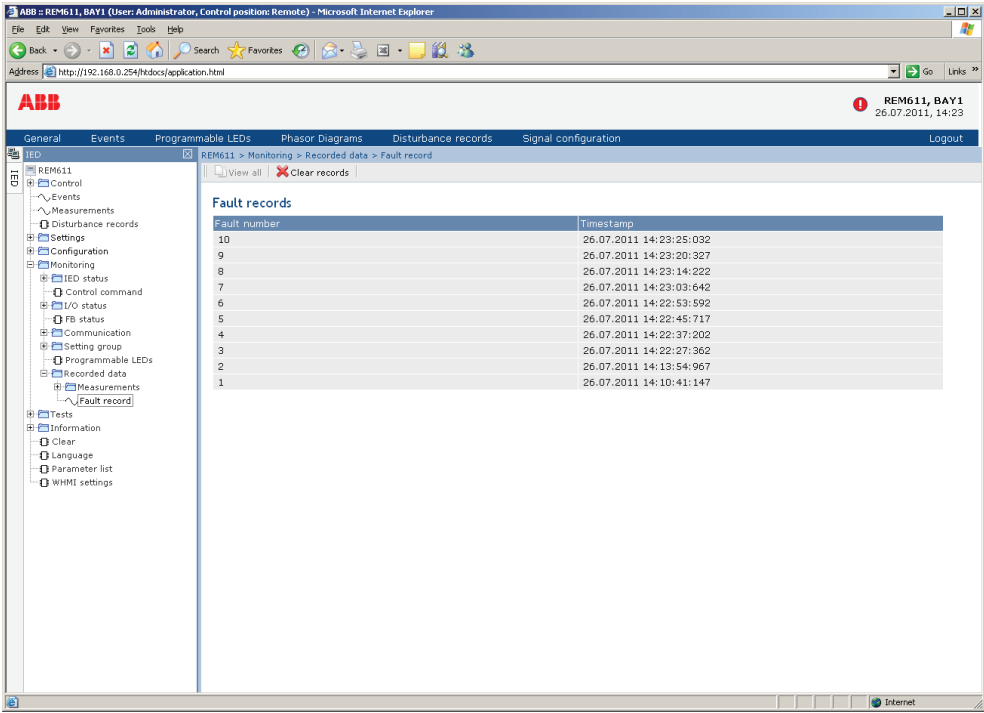
Figure 54:   *Fault record list view*
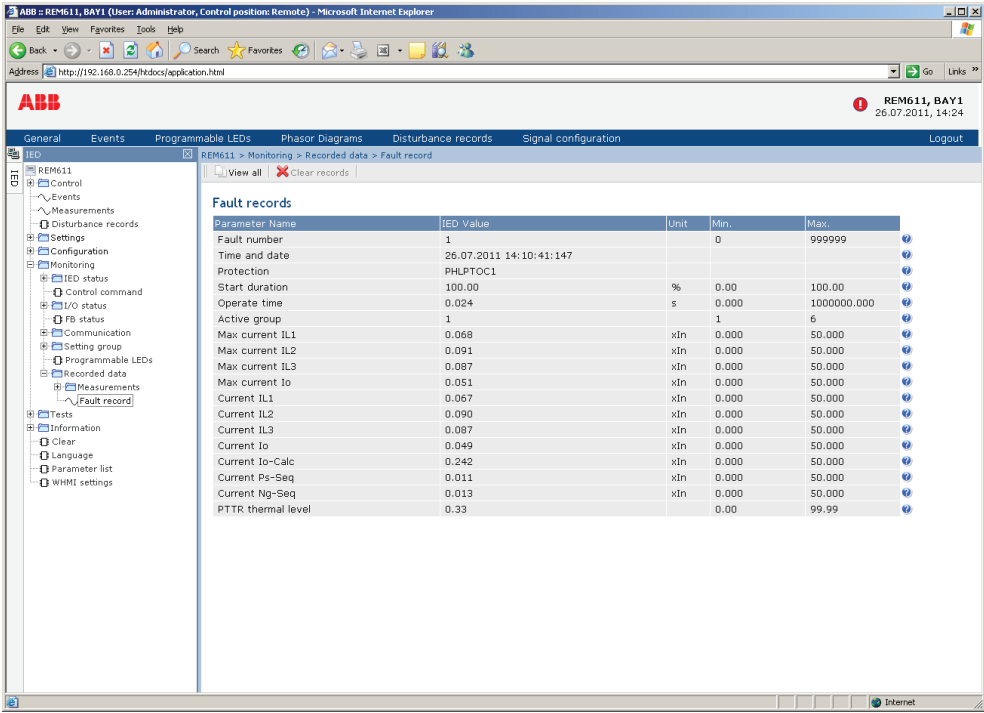
Figure 55:   *Fault record details view*

4.2.14   Selecting signal configuration

The signal configuration view provides an easy tool to manage the application configuration, simplifying the configuration work. The signal configuration is done with three switch group functions including input switch group ISWGAPC, output switch group OSWGAPC and selector switch group SELGAPC.

1. Click **Signal configuration** on the menu bar to open the overview page.
   The switch groups used in the protection relay are categorized into four logical groups.

   - Binary inputs
   - GOOSE
   - Internal signals
   - Binary outputs and LEDs

   Each group is represented by an area enclosed in a rectangle with a general description text.
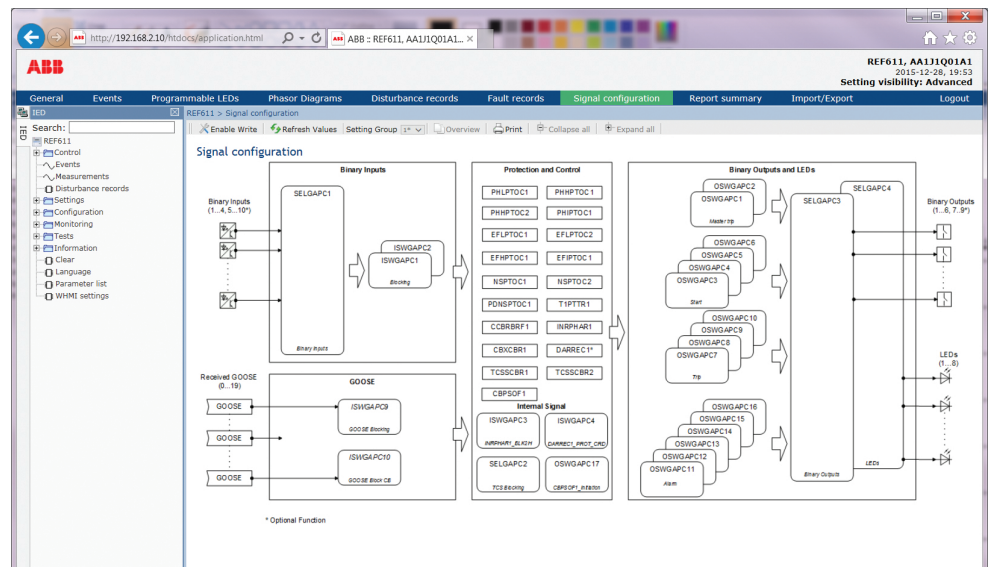
Figure 56:   *Overview*

2. Click the corresponding area to view a specific logical group.
   The switch groups included in the logical group are shown as a matrix view on the respective page. This view allows to change or map the connections from binary inputs to functions, GOOSE signals to functions, functions to functions, functions to binary outputs and functions to LEDs through corresponding switch group functions.
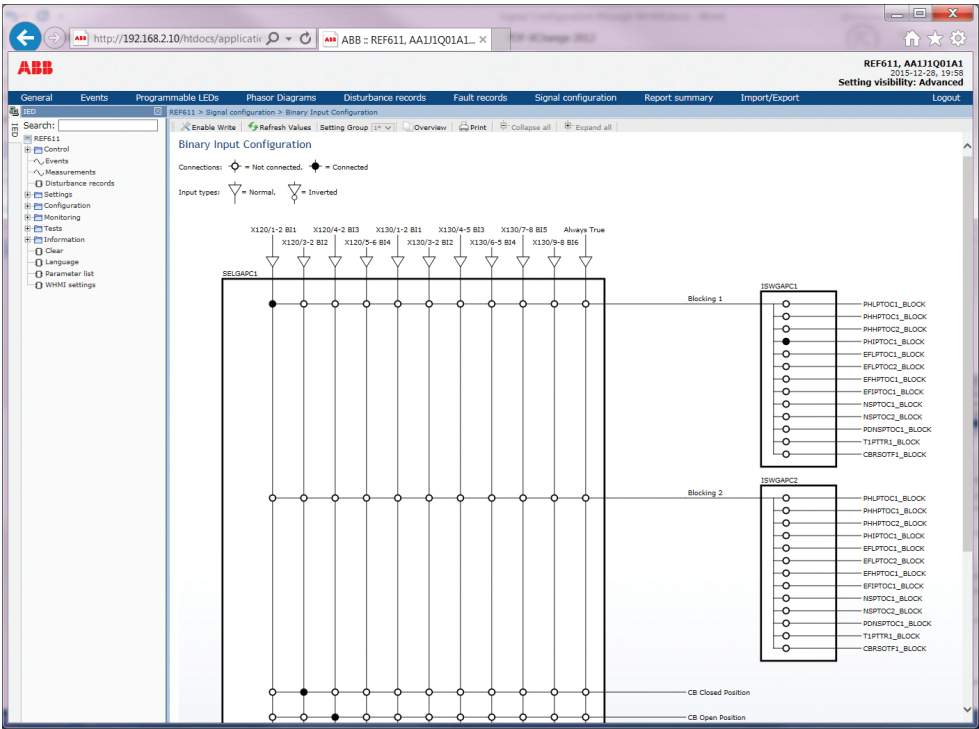
Figure 57:   Binary input configuration
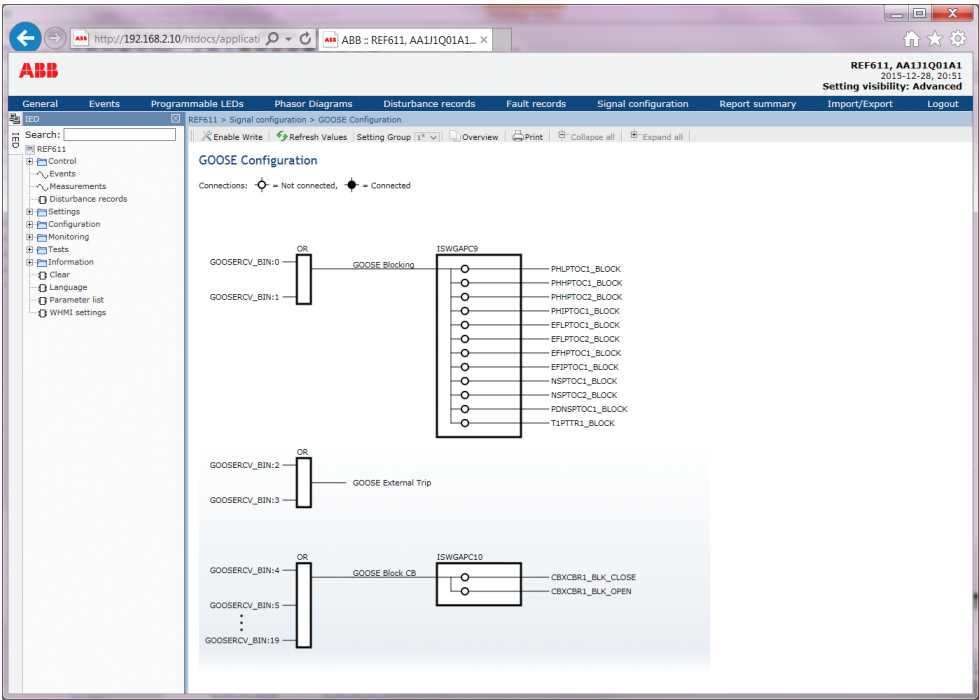
Figure 58:   GOOSE configuration
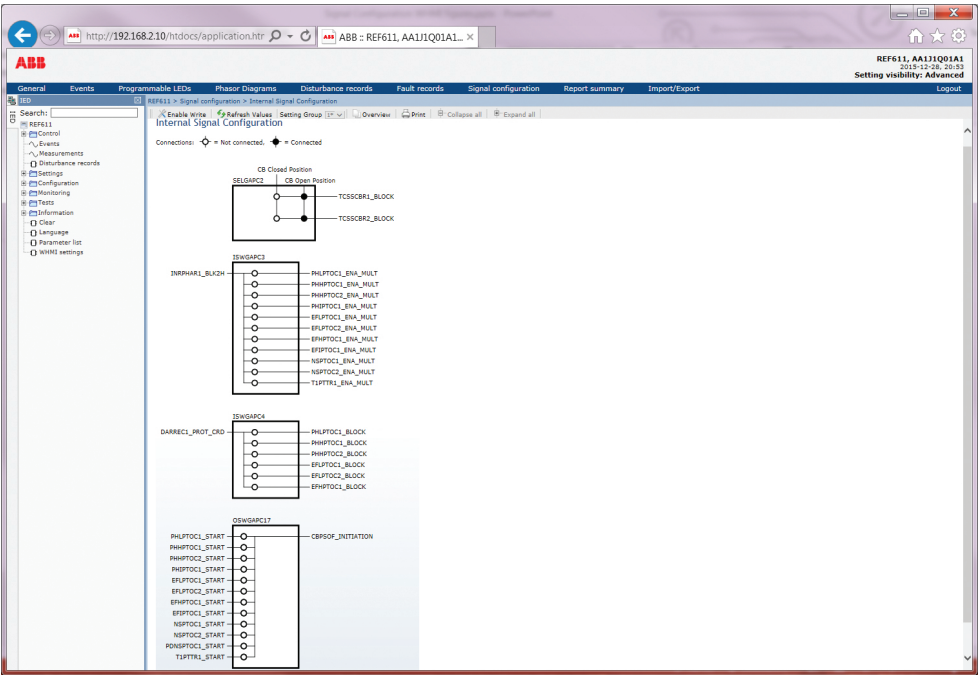
Figure 59:   *Internal signal configuration*
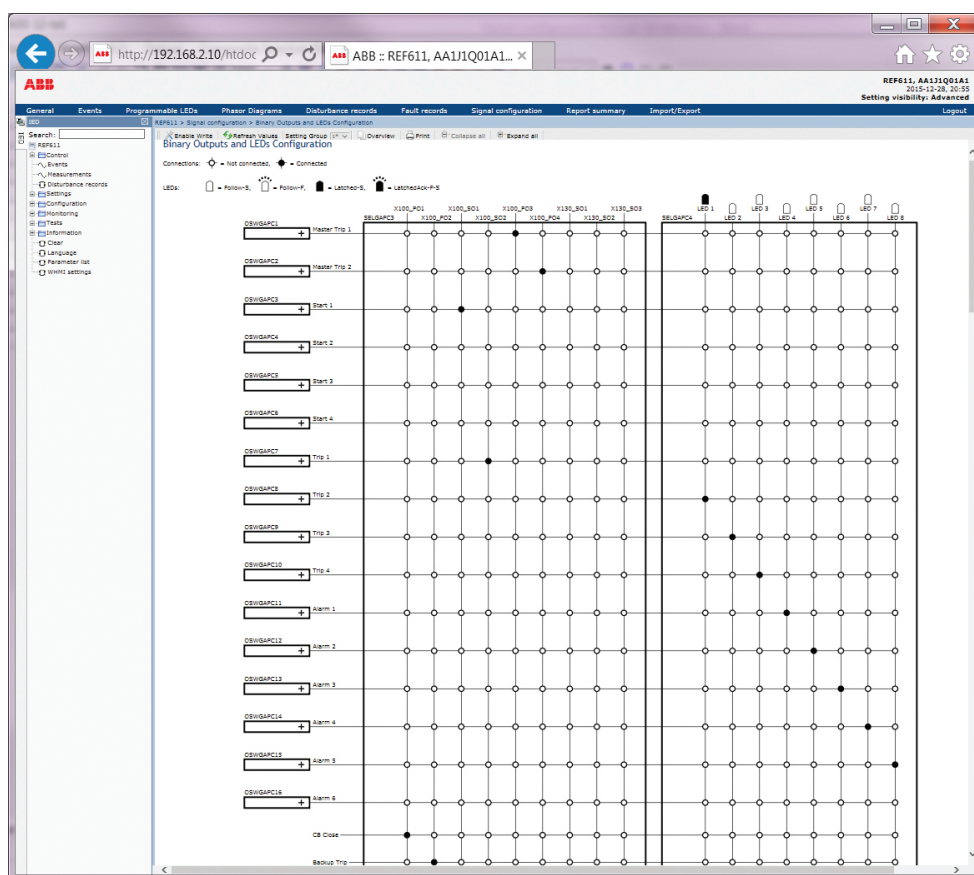
Figure 60:   Binary outputs and LEDs configuration

3.   On the **Binary Outputs and LEDs Configuration** matrix view, click **Expand all** to see the expanded page for configuring individual OSWGAPC instances. Use the **Expand all** and **Collapse all** buttons to move from the **Binary Outputs and LEDs Configuration** overview page to the more detailed view and back.
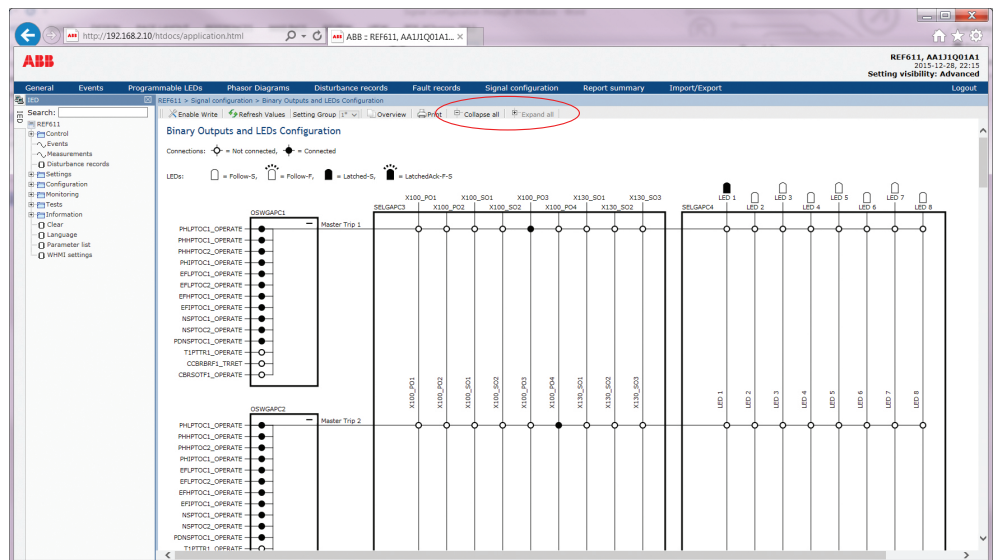
Figure 61:   *Binary outputs and LEDs configuration expanded view*

4.   Click **Enable Write** to edit field values.
Figure 62 shows an example view of updating or changing the input signal
configuration. One of the binary input channels has been mapped to one
blocking input of a protection function through input switch group ISWGAPC
and selector switch group SELGAPC functions.

- Click one of the input switch group ISWGAPC connection channel shown
  in green.
- Click and select the binary input in the selector switch group SELGAPC
  function shown in green.
- Write the connection setting to IED and refresh values.
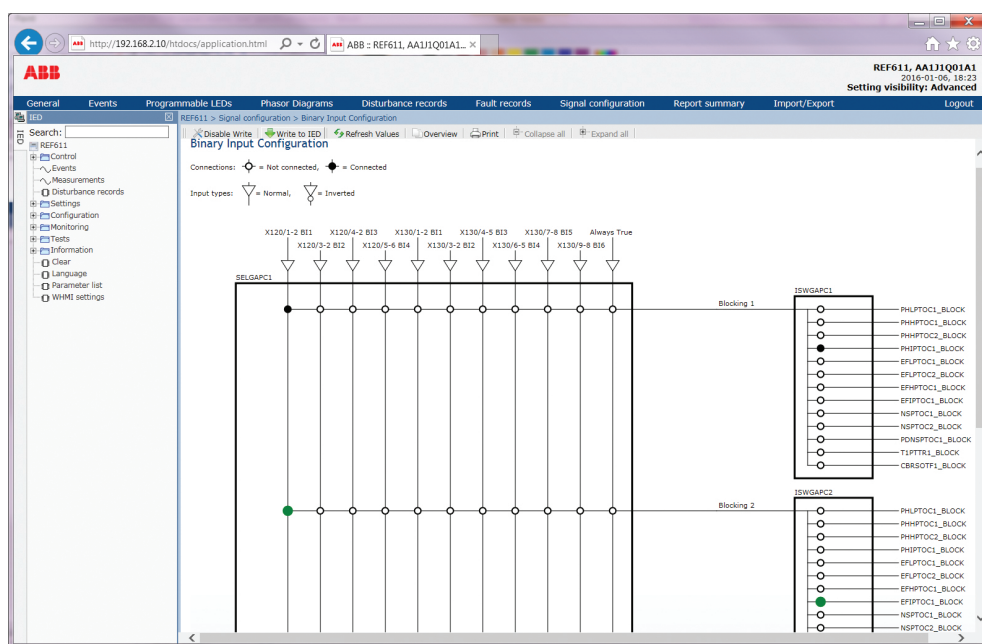
Figure 62:   Example view of changing binary input connections

For more information on editing field values, see the corresponding chapter.

4.2.15   Import and export of settings

Protection relay's setting parameters can be imported and exported in the XRIO file format.

4.2.15.1   Exporting settings

Relay setting parameters can be exported in XRIO file format.

1. Click **Import/Export** on the menu bar.
2. Click **Export Settings**. The export file includes all parameters except status parameters and parameters writable only in LHMI.
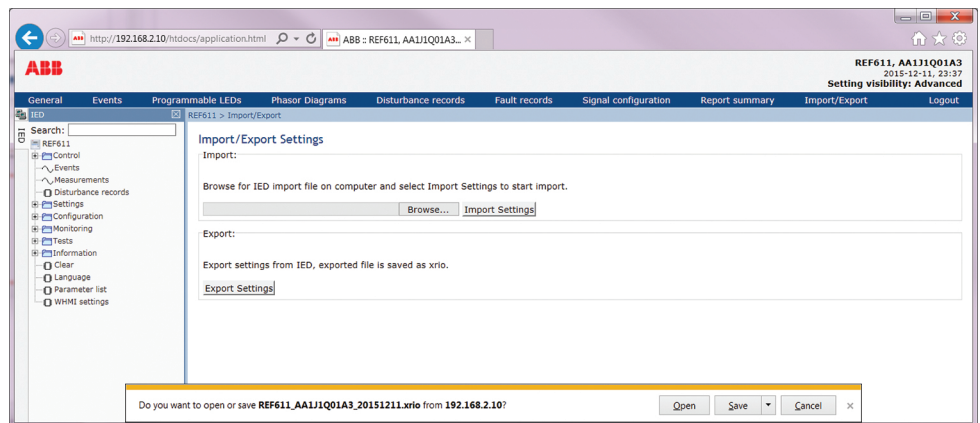
Figure 63:   *Exporting settings*

3.   Click **Save** to export the settings to the computer.

4.2.15.2   Importing settings

The parameter export and import function can be utilized, for example, when the relay parameters are set using the WHMI instead of PCM600. The relay settings engineered with PCM600 can be exported to XRIO files and imported to the WHMI. The WHMI can be used to write the settings to the protection relays. The WHMI can also be used to read the relay setting parameters and to export those to files, which can be used by PCM600. WHMI imports all parameters from the import file except lockable and read only parameters.

> The exporting and importing of settings is sensitive to the protection relay contents. Settings are exported and imported for one protection relay at a time. The export files of a specific protection relay can be exchanged between PCM600, WHMI and the actual physical protection relay. To avoid errors and to efficiently manage the exporting and importing of settings, for example, in a substation with several devices, ensure that the names of the export files identify the protection relay to which the file should be imported.

> Ensure that the correct settings are imported to the correct protection relay. Wrong settings may cause the protection relay to malfunction.

1.   Click **Import/Export** on the menu bar.
2.   Click **Browse** and choose the file to be imported.
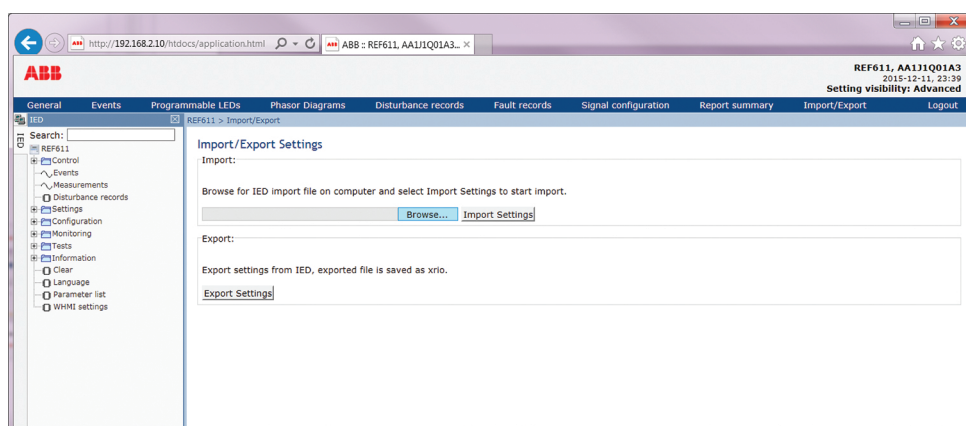
Figure 64:   *Browsing import settings*

3.   Click **Import Settings**.
Wait until the file transfer is complete.
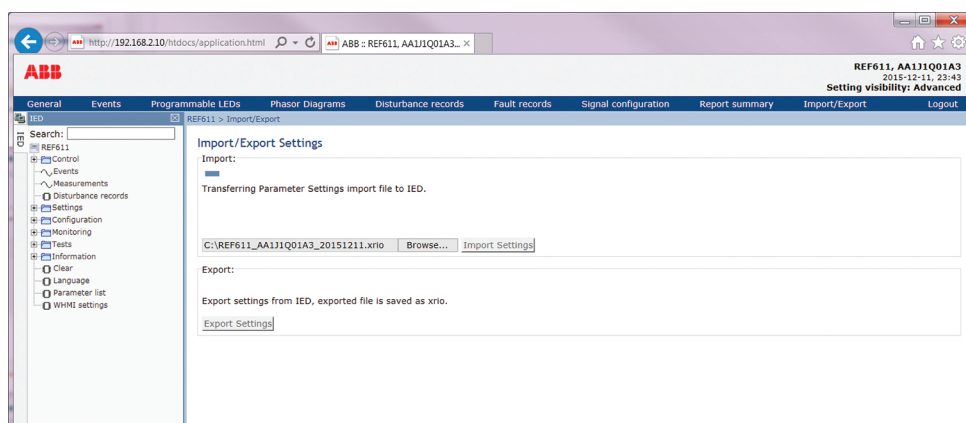
Figure 65:   *Importing settings*

4.   Click **OK** to commit the imported settings to the protection relay.
Wait until the import is complete.

-    Click **Cancel** to cancel the importing. Both the WHMI and the protection relay revert to the settings in use prior to the import.
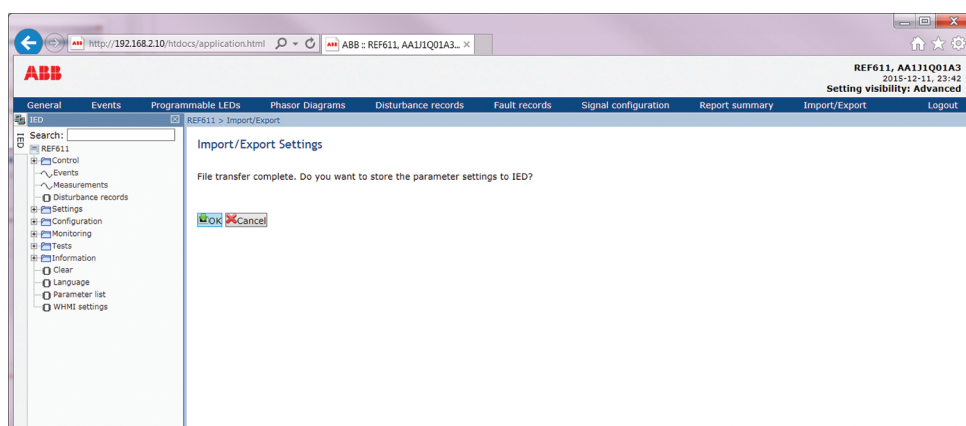
Figure 66:   *Writing parameter settings*
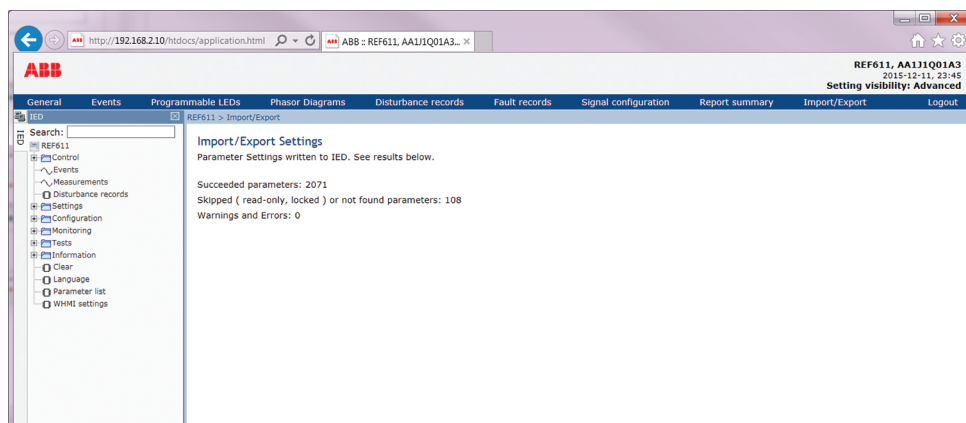
Figure 67:   *Parameter settings written to protection relay*

> Only editable parameters are written to the protection relay during the import. If part of the import fails, the faulty parameters are listed separately.

4.2.16   Exporting report summary

The Report summary page allows exporting events, fault records, disturbance records and the parameter list.Events, fault records and the parameter list are saved in TXT format. Saved files contain all events, fault records and settings.Disturbance records are saved in CFG and DAT formats.

1.   Click **Report summary** on the menu bar.
2.   Select the items to be exported.

Click **Select all** to select all items and click **Clear all** to clear all selections.

3. From the **Disturbance records** drop-down list, select the amount of records to be saved.

- All
- Last 1
- Last 10

4. Click **Save** to export the ZIP file with the selected files.
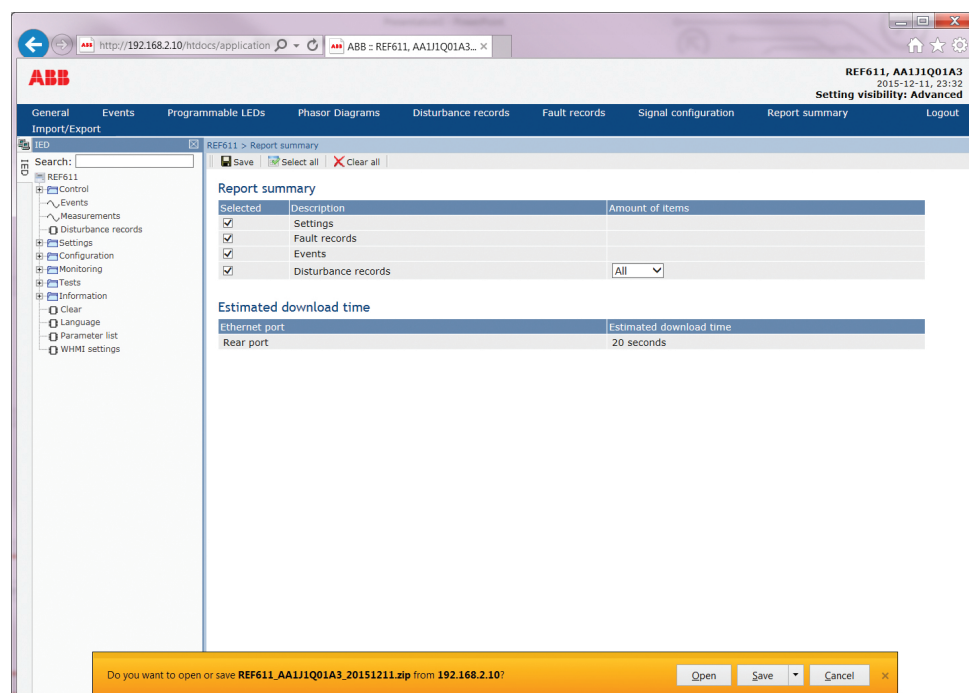
Figure 68:   *Report summary page*

4.2.17   Using Web HMI help

The context-sensitive WHMI help provides information on a single parameter, for example.

- Move the mouse over the 🔵 to display the help dialog box.
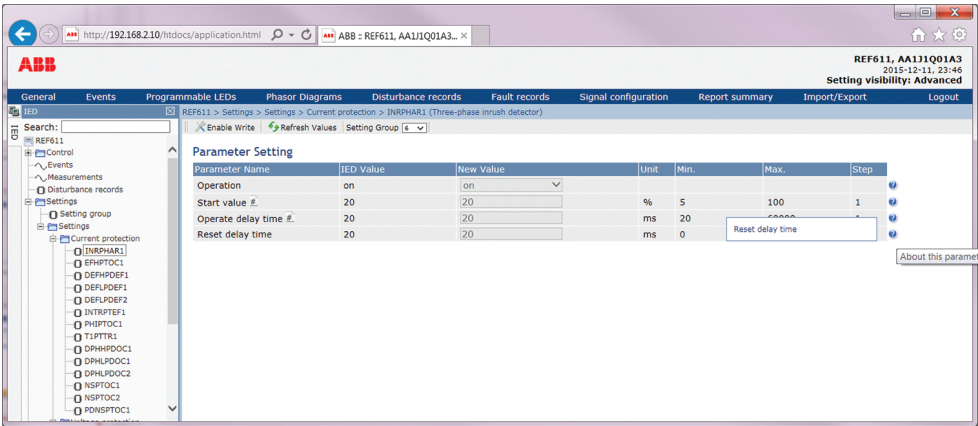
Figure 69:   Opening the WHMI help

Section 5   IED operation

5.1   Normal operation

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

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

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

For more information, see the PCM600 documentation.

5.2   Disturbance identification

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

Table 16:   Disturbance indications

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

Further actions to be taken to identify the disturbance:

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

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

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

5.2.1 Disturbance recording triggering

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

5.2.2 Disturbance record analysis

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

For more information, see the PCM600 documentation.

5.2.3 Disturbance reports

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

For more information, see the PCM600 documentation.

5.2.4 Relay self-supervision

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

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

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

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

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

5.3 Relay parametrization

Protection relay parameters are set via the LHMI, WHMI or PCM600.

Setting parameters need to be calculated according to the electrical network conditions and the electrical characteristics of the protected equipment. The protection relay's settings need to be verified before the protection relay is connected to a system.

Document all changes to parameter settings.

For more information, see the PCM600 documentation.

5.3.1 Settings for relay functionality

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

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

5.3.2 Settings for different operating conditions

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

Section 6   Operating procedures

6.1   Monitoring

6.1.1   Indications

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

- Three indicator LEDs with fixed functionality: Ready, Start and Trip
- 8 programmable LEDs
- Information on the display

6.1.1.1   Monitoring indication messages

Indication messages and tripping data are shown in a dialog box. Only one dialog box can be shown at a time, therefore the relay has internal priority for indication messages and tripping data. Internal fault and warning messages have always higher priority than start or trip information. Trip information has always higher priority than start information.

1. Read the indication message in the dialog box.
   The message can indicate the starting or tripping of protection functions or an internal fault in the device.
2. Press ESC to close the indication message without clearing it or press CLEAR to activate the Clear view and to clear messages.

```
            EFHPTOC1
  OPERATE
  L1,L2,L3
  30.06.2011
  11:48:11.687
```
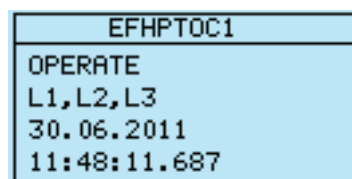
Figure 70:   *Indication message*

6.1.1.2   Monitoring an internal relay fault

The flashing green LED indicates an internal relay fault. Internal relay fault messages are shown in a dialog box. Only one dialog box can be shown at a time, therefore the

relay has internal priority for indication messages and tripping data. Internal fault has always higher priority than a warning.

> ℹ️ See the troubleshooting section for more details.

```
┌─────────────────────────┐
│ Internal Fault          │
├─────────────────────────┤
│ Conf.error,X120         │
│ Code 65                 │
│ 30.06.2011              │
│ 13:01:09.908            │
└─────────────────────────┘
```
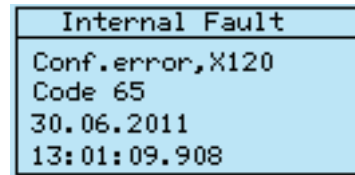
Figure 71:   Fault indication

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

6.1.1.3   Monitoring condition monitoring data

1. Select **Main menu/Monitoring/I/O status/Condition monitoring**.
2. Press ⬆ or ⬇ to scroll the view.
3. Press ＞ to enter or ＜ to exit a submenu.

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

6.1.2   Measured and calculated values

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

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

> ℹ️ Invalid or questionable measurement values are presented in parentheses.

6.1.2.1   Measured values

Measured values can be accessed through the LHMI, WHMI or PCM600.

Table 17:   *Examples of the measured values*

Indicator	Description
IL1-A	Current measured on phase L1
IL2-A	Current measured on phase L2
IL3-A	Current measured on phase L3
I_0-A	Measured earth-fault current
U_0-kV	Measured residual voltage
U12-kV	Measured phase-to-phase voltage U12
f-Hz	Measured frequency
S-MVA	Total apparent power
P-MW	Total active power
Q-MVar	Total reactive power
PF	Average power factor
Ng-Seq-A	Negative-phase-sequence current
Ps-Seq-A	Positive-phase-sequence current
Zro-Seq-A	Zero-phase-sequence current
Ng-Seq-kV	Negative-phase-sequence voltage
Ps-Seq-kV	Positive-phase-sequence voltage
Zro-Seq-kV	Zero-phase-sequence voltage

6.1.2.2   Using the local HMI for monitoring

1. Select **Main menu/Measurements** to monitor measured and calculated values. The list of protection relay's basic measurements is shown.
2. Scroll the view with ⬆ and ⬇.

6.1.3   Recorded data

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

- Disturbance records
- Fault records
- Events

6.1.3.1   Creating disturbance recordings

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

1. Select **Main menu/Disturbance records**.
2. Select **Trig recording** with ⬆ or ⬇.
3. Press ⏎, change the value with ⬆ or ⬇ and press ⏎ again.

```
Disturbance records  A
Trig recording
=Cancel
Time to trigger
=0s
```
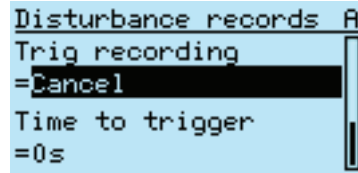
Figure 72:   Changing the value

The disturbance recorder is now triggered.

6.1.3.2 Monitoring disturbance recorder data

Upload individual disturbance recordings from the protection relay with the PCM600 software to monitor disturbance recorder data.

1. Select **Main menu/Disturbance records**.
   All the disturbance recorder information is listed.
2. Scroll the view with ⬆ or ⬇.
   The following items are listed in the view:

   • Number of recordings currently in the protection relay's memory.
   • Remaining amount of recordings that fit into the available recording memory.
   • Recording memory used in percentage.
   • If the periodic triggering function is used, the time to trigger which indicates the remaining time to the next periodic triggering of the disturbance recorder.

```
Disturbance records  A
Number of recordings
=2
Rem. amount of rec.
=61
```
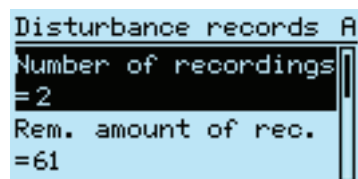
Figure 73:   Monitoring disturbance recorder via the LHMI

6.1.3.3 Controlling and reading of disturbance recorder data

Disturbance recorder data can be controlled and read with PCM600. It can also be read via WHMI.

For more information, see the PCM600 documentation.

6.1.3.4 Monitoring fault records

Timestamps of the fault records are shown as a list. The first fault record is the newest.

1. Select **Main Menu/Monitoring/Recorded data/Fault record**.
2. To navigate between the fault records, press ⬆ and ⬇.
3. To enter or exit a submenu, press 〉 or 〈.

```
Fault record      A
13.07.2011 07:14
10.06.2011 09:00
15.05.2011 07:54
05.05.2011 13:00
```
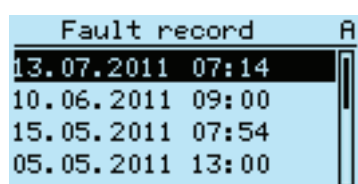
Figure 74:   Monitoring fault records

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.

The HMI Event Filtering tool can be used to configure the event visibility in the LHMI.

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

```
1/1 30.06.2011
11:34:27.132
Control LLN0
LR state
Local
```
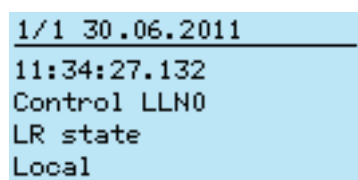
Figure 75:   Monitoring events

6.1.4 Remote monitoring

The protection relay supports comprehensive remote monitoring.

6.1.4.1 Monitoring protection relays remotely

Use the PCM600 tool and WHMI to operate the protection relay remotely.

- Read maintenance record and version log.
- Analyze disturbance record data.
- Create disturbance records.
- Monitor protection relay values.

> For more information, see the PCM600 documentation.

6.2 Controlling

6.2.1 Controlling via the control menu

The primary equipment can be controlled via the LHMI with the Open and Close buttons when the protection relay is set to the local-control mode and accessing the control operations is authorized.

1. Press ⊙ to open or ⏽ to close the object.

2. Enter the password when prompted.

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

```
Confirmation        A
    Open breaker?
    Yes No
```
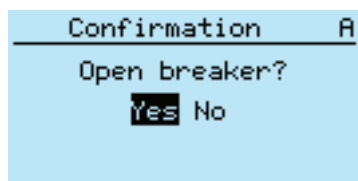
Figure 76:   Opening circuit breaker

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

```
┌─────────────────────────┐
│     Information          │
├─────────────────────────┤
│                         │
│       Cancel            │
│                         │
│                         │
└─────────────────────────┘
```
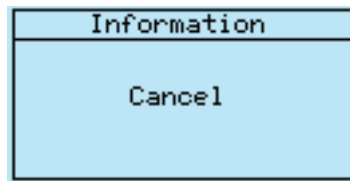
Figure 77:   Cancelling operation

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

With default configurations it is possible to control a breaker open even when the breaker is in an intermediate state.

6.2.2   Controlling with the closing delay

Close delay mode and *Close delay* need to be set to be able to control objects with the closing delay.

The closing operation from the LHMI can be delayed by a predefined period of time.

1.   Press [I CLOSE] to close the selected object.

   •   If there are several controllable objects, select the object and press ↵ to confirm the selection.

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

   •   After the control operation is confirmed, the delay is activated.
   •   Cancel the control by pressing any key when the delay is active.

```
┌─────────────────────────┐
│     Information          │
├─────────────────────────┤
│      Closing in          │
│      1 min 17 s          │
│  Press any button to     │
│    cancel close          │
│                         │
└─────────────────────────┘
```
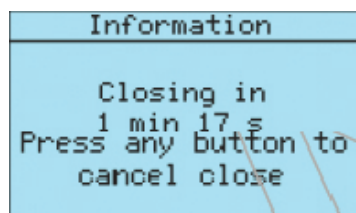
Figure 78:   Delay view

When the delay is activated, it is recommended not to change any closing delay parameters in the WHMI during the delayed time as it affects the delayed circuit breaker closing. If the

delayed circuit breaker closing fails, the LHMI status shows `Select timeout` or `Status only`.

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

6.3 Resetting IED

6.3.1 Clearing and acknowledging via the local HMI

All messages and indications, including LEDs and latched outputs as well as registers and indications, including recordings can be reset, acknowledged or cleared in the Clear view. Selecting **Main menu/Clear** activates the Clear menu for selecting the wanted clearance or reset function. Events and alarms assigned to programmable LEDs can also be cleared in the Clear menu.

1. Select **Main menu/Clear** to activate the **Clear** view.
   All the items that can be cleared are shown.

   - Indications and LEDs
   - Programmable LEDs
   - Events
   - Metering records
   - Disturbance records
   - Fault records
   - Temperature of three-phase thermal protection for feeders and thermal overload protection for motors
   - Reset of autoreclosing
   - Operation time of runtime counter for machines and devices
   - Counters for autoreclosing and motor start-up supervision
   - Master trip
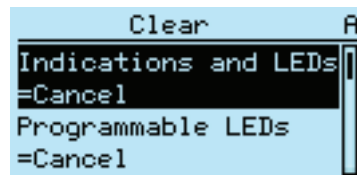
Figure 79:   Clear view

2. Select the item to be cleared with ⬆️ or ⬇️ .
3. Press ↵, change the value with ⬆️ or ⬇️ and press ↵ again.

The item is now cleared.

4. Repeat the steps to clear other items.

> Use the ESC button as a shortcut for clearing. The first three-second press clears the indications. The second three-second press clears the programmable LEDs.

6.4 Changing the IED functionality

6.4.1 Defining the setting group

6.4.1.1 Activating a setting group

Protection relay settings are planned in advance for different operation conditions by calculating setting values to different setting groups. The active setting group can be changed by the protection relay application or manually from the menu.

1. Select **Main menu/Settings/Setting group/Active group** and press ↵.

```
    Setting group      A
Active group
=1
Copy group 1
=Cancel
```

Figure 80:   Active setting group

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

```
    Setting group      A
Active group
=1+_1
Copy group 1
=Cancel
```

Figure 81:   Selecting the active setting group

4. Commit the settings.

> Remember to document the changes you make.

6.4.1.2 Copying a setting group

Setting group 1 can be copied to another group or to all available groups.

1. Select **Main menu/Settings/Setting group/Copy group 1** and press ⏎ .
2. Change the options with ⬆ or ⬇ and press ⏎ to confirm the selection.

```
  Setting group    A
Active group
=1
Copy group 1
=Copy 1 into 6
```
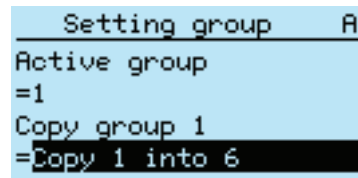
Figure 82:   Copying setting group 1 into 6

6.4.1.3 Browsing and editing setting group values

1. Select **Main menu/Settings/Settings** and press ❯ .
2. Select the setting group to be viewed with ⬆ or ⬇ and press ⏎ to confirm the selection.

```
     BAY1         A

Edit group: ↕+_2

Active group=1
```
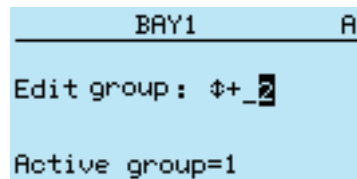
Figure 83:   Selecting a setting group

3. To browse the settings, scroll the list with ⬆ and ⬇ and to select a setting press ❯ .
4. To browse different function blocks, scroll the list with ⬆ and ⬇ and to select a function block press ❯ . To move back to the list, press ❮ .
   The function block list is shown in the content area of the display. On the left in the header, you see the current setting group, and on the right the menu path.
5. To browse the parameters, scroll the list with ⬆ and ⬇ and to select a parameter, press ❯ .
   The setting group values are indicated with #.
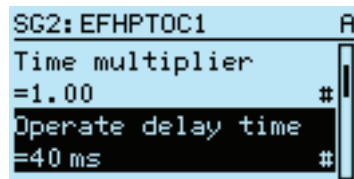
Figure 84:   Setting group parameter

6.   To select a setting group value, press ▷ and to edit the value press ⏎.
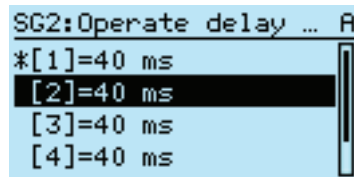
Figure 85:   Selecting the setting group value

Only values within the selected setting group can be changed.

7.   Press ↑ or ↓ to change the value and ⏎ to confirm the selection.
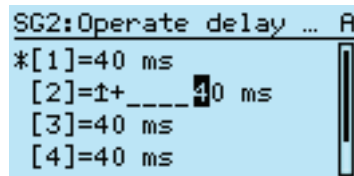
Figure 86:   Editing the setting group value

The active setting group is indicated with an asterisk * .

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

6.4.2   Activating programmable LEDs

1.   Select **Main menu/Configuration/Programmable LEDs.**
2.   Select a programmable LED with ↑ or ↓.
3.   Press ▷ to enter the selection and ⏎ to change the programmable LED mode.
4.   Change the mode with ↑ or ↓ and press ⏎ to confirm the selection.

See the technical manual for details on LED configuration.

6.4.3   Setting autoscroll delay

Autoscroll delay parameter sets the delay of scrolling down measurements view if it is set as default view and the user is logged out. Autoscroll is active if the delay value is not zero.

1. Select **Main menu/Configuration/ HMI/Autoscroll delay** and press ⏎ .
2. Select delay time with ⬆ or ⬇ .
3. Press ⏎ to confirm the selection.

```
         HMI           A
Web HMI timeout
=3 min
Autoscroll delay
=1 s
```
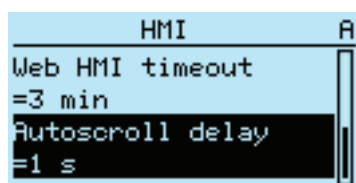
Figure 87:   Autoscroll delay

Section 7   Troubleshooting

7.1   Fault tracing

7.1.1   Identifying hardware errors

1. Check the module with an error.
    Check the relay supervision events in **Main menu/Monitoring/IED status/
    Self-supervision** for a faulty hardware module.
2. Inspect the protection relay visually.

    *   Inspect the protection relay visually to find any physical error causes.
    *   If you can find some obvious physical damage, contact ABB for repair or
        replacement actions.

3. Check whether the error is external or internal.

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

7.1.2   Identifying runtime errors

1. Check the error origin from the protection relay's supervision events **Main
    menu/Monitoring/IED status/Self-supervision**.
2. Reboot the protection relay and recheck the supervision events to see if the fault
    has cleared.
3. In case of persistent faults, contact ABB for corrective actions.

7.1.3   Identifying communication errors

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

*   In case of persistent faults originating from protection relay's internal faults such
    as component breakdown, contact ABB for repair or replacement actions.

7.1.3.1   Checking front communication link operation

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

Table 18:   *Front communication LEDs*

LED	Communication ok
Uplink	Steady green light
Communication	Flashing yellow light

7.1.3.2   Checking time synchronization

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

7.1.4   Running the display test

A short display test is always run, when auxiliary voltage is connected to the protection relay. The display test can also be run manually.

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

Clear any indications on the display before running the display test manually.

7.2   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 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 protection relay tries to eliminate the fault by restarting. After the fault is found to be permanent, the protection relay stays in the internal fault mode. All other output contacts are released and locked for the internal fault. The protection relay continues to perform internal tests during the fault situation.

The internal fault code indicates the type of internal relay fault. When a fault appears, the code must be recorded so that it can be reported to ABB customer service.
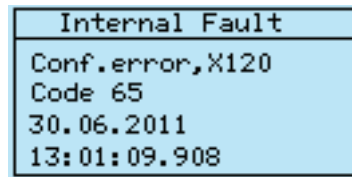
Figure 88:   *Fault indication*

Table 19:   *Internal fault indications and codes*

Fault indication	Fault code	Additional information
Internal Fault System error	2	An internal system error has occurred.
Internal Fault File system error	7	A file system error has occurred.
Internal Fault Test	8	Internal fault test activated manually by the user.
Internal Fault SW watchdog error	10	Watchdog reset has occurred too many times within an hour.
Internal Fault SO-relay(s),X100	43	Faulty Signal Output relay(s) in card located in slot X100.
Internal Fault SO-relay(s),X120	45	Faulty Signal Output relay(s) in card located in slot X120.
Internal Fault SO-relay(s),X130	46	Faulty Signal Output relay(s) in card located in slot X130.
Internal Fault PO-relay(s),X100	53	Faulty Power Output relay(s) in card located in slot X100.
Internal Fault PO-relay(s),X120	55	Faulty Power Output relay(s) in card located in slot X120.
Internal Fault PO-relay(s),X130	56	Faulty Power Output relay(s) in card located in slot X130.
Internal Fault Conf. error,X000	62	Card in slot X000 is wrong type, is missing, does not belong to original configuration or card firmware is faulty.
Internal Fault Conf. error,X100	63	Card in slot X100 is wrong type or does not belong to the original composition.
Internal Fault Conf. error,X120	65	Card in slot X120 is wrong type, is missing or does not belong to the original composition.
Internal Fault Conf.error,X130	66	Card in slot X130 is wrong type, is missing or does not belong to the original composition.
Internal Fault Card error,X000	72	Card in slot X000 is faulty.
Internal Fault Card error,X100	73	Card in slot X100 is faulty.
Table continues on next page		

Fault indication	Fault code	Additional information
Internal Fault Card error,X120	75	Card in slot X120 is faulty.
Internal Fault Card error,X130	76	Card in slot X130 is faulty.
Internal Fault LHMI module	79	LHMI module is faulty. The fault indication may not be seen on the LHMI during the fault.
Internal Fault RAM error	80	Error in the RAM memory on the CPU card.
Internal Fault ROM error	81	Error in the ROM memory on the CPU card.
Internal Fault EEPROM error	82	Error in the EEPROM memory on the CPU card.
Internal Fault FPGA error	83	Error in the FPGA on the CPU card.
Internal Fault RTC error	84	Error in the RTC on the CPU card.
Internal Fault COM card error	116	Error in the COM card.

7.2.2 Warnings

Warnings are indicated with the text `Warning` additionally provided with the name of the warning, a numeric code and the date and time on the LHMI. The warning indication message can be manually cleared.

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


```
       Warning
Watchdog reset
Code 10
10.06.2011
08:51:45.846
```

Figure 89:   Warning

Table 20:   Warning indications and codes

Warning indication	Warning code	Additional information
Warning Watchdog reset	10	A watchdog reset has occurred.
Warning Power down det.	11	The auxiliary supply voltage has dropped too low.
Warning IEC61850 error	20	Error when building the IEC 61850 data model.
Table continues on next page		

Warning indication	Warning code	Additional information
Warning Modbus error	21	Error in the Modbus communication.
Warning Dataset error	24	Error in the Data set(s).
Warning Report cont. error	25	Error in the Report control block(s).
Warning GOOSE contr. error	26	Error in the GOOSE control block(s).
Warning SCL config error	27	Error in the SCL configuration file or the file is missing.
Warning Logic error	28	Too many connections in the configuration.
Warning SMT logic error	29	Error in the SMT connections.
Warning GOOSE input error	30	Error in the GOOSE connections.
Warning GOOSE Rx. error	32	Error in the GOOSE message receiving.
Warning AFL error	33	Analog channel configuration error.
Warning Comm. channel down	35	Redundant Ethernet (HSR/PRP) communication interrupted.
Warning Unack card comp.	40	A new composition has not been acknowledged/accepted.
Warning Protection comm.	50	Error in protection communication.

7.3 Correction procedures

7.3.1 Rebooting the software

1. Select **Main menu/Configuration/General/Software reset** and press ⏎.
2. Change the value with ⬆ or ⬇ and press ⏎.

7.3.2 Restoring factory settings

In case of configuration data loss or any other file system error that prevents the protection relay from working properly, the whole file system can be restored to the original factory state. All default settings and configuration files stored in the factory are restored. Only the administrator can restore the factory settings.

1. Select **Main menu/Configuration/General/Factory setting** and press ⏎.
2. Set the value with ⬆ or ⬇ and press ⏎.
3. Confirm by selecting **Yes** with ⬆ or ⬇ and press ⏎.

The protection relay restores the factory settings and restarts. Restoring takes 1...3 minutes. Confirmation of restoring the factory settings is shown on the display a few seconds, after which the relay restarts.

> Avoid the unnecessary restoring of factory settings, because all the parameter settings that are written earlier to the relay will be overwritten with the default values. During normal use, a sudden change of the settings can cause a protection function to trip.

> Restoring factory settings also resets the IP address for the rear port and the corresponding subnet mask to the factory default settings.

> To restore factory settings from bootloader mode, press ESC + `>` simultaneously for 5 seconds.

7.3.3 Setting passwords

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

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

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

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

7.3.4 Identifying relay application problems

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

7.3.4.1 Inspecting wiring

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

- Check the current or voltage measurements and their phase information from **Main menu/Measurements**.
- Check that the phase information and phase shift between phases is correct.
- Correct the wiring if needed.
- Check the actual state of the connected binary inputs from **Main menu/ Monitoring/I/O status/Binary input values**.
- Test and change the relay state manually in **Main menu/Tests/Binary outputs**.

7.3.4.2 Sample data interruptions

Occasionally protection relays can receive corrupted or faulty measurement data during runtime. In these cases the operation system halts the corresponding application execution until correct data is received. In case of permanent faults, the measurement chain should be checked to remove the origin of the faulty measurement data.

In case of persistent faults originating from protection relay's internal faults, contact ABB for repair or replacement actions.

Section 8   Commissioning

8.1   Commissioning checklist

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

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

8.2   Checking the installation

8.2.1   Checking of 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 before powering the protection relay.

8.2.2 Checking CT circuits

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

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

- Primary injection test to verify the current ratio of the CT, the correct wiring up to the protection relay and correct phase sequence connection (that is L1, L2, L3.)
- Polarity check to prove that the predicted direction of the secondary current flow is correct for a given direction of the primary current flow. This is an essential test for the proper operation of the directional function, protection or measurement in the protection relay.
- CT secondary loop resistance measurement to confirm that the current transformer secondary loop DC resistance is within specification and that there are no high resistance joints in the CT winding or wiring.
- CT excitation test to ensure that the correct core in the CT is connected to the protection relay. Normally only a few points along the excitation curve are checked to ensure that there are no wiring errors in the system, for example, due to a mistake in connecting the CT's measurement core to the protection relay.
- CT excitation test to ensure that the CT is of the correct accuracy rating and that there are no short circuited turns in the CT windings. Manufacturer's design curves should be available for the CT to compare the actual results.
- Earthing check of the individual CT secondary circuits to verify that each three-phase set of main CTs is properly connected to the station earth and only at one electrical point.
- Insulation resistance check.
- Phase identification of CT shall be made.

> **i** Both the primary and the secondary sides must be disconnected from the line and the protection relay 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 cause damage to the insulation. The re-energizing of the CT primary should be prohibited as long as the CT secondary is open or unearthed.

8.2.3 Checking VT circuits

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

Correct possible errors before continuing to test the circuitry.

Test the circuitry.

- Polarity check
- VT circuit voltage measurement (primary injection test)
- Earthing check
- Phase relationship
- Insulation resistance check

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

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

8.2.4 Checking binary input and output circuits

8.2.4.1 Checking binary input circuits

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

Do not use AC voltage. Binary inputs are rated for DC voltage only.

8.2.4.2 Checking binary output circuits

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

8.3 Authorizations

8.3.1 User authorization

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

Passwords are settable for all predefined user categories. The LHMI password must be at least four and WHMI password at least nine characters. The maximum number of characters is 8 for the LHMI password and 20 for the WHMI password. Only the following characters are accepted.

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

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

Table 21:   Predefined user categories and default passwords

Username	LHMI password	WHMI password	User rights
VIEWER	0001	remote0001	Only allowed to view
OPERATOR	0002	remote0002	Authorized to make operations
ENGINEER	0003	remote0003	Allowed to change protection relay parameters, but no operation rights
ADMINISTRATOR	0004	remote0004	Full access

> ℹ️ For user authorization for PCM600, see PCM600 documentation.

8.4 Setting IED and communication

8.4.1 Setting the communication between protection relays and PCM600

The communication between the protection relay 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 media is always Ethernet and communication is based on TCP/IP.

Each protection relay 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 protection relay. 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 protection relay 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 protection relays.
2. Set up the PC for a direct link or connect the PC or workstation to the network.
3. Configure the IP addresses in the PCM600 project for each protection relay. The addresses are used for communication between protection relays and PCM600.

8.4.1.1 Communication link options between PCM600 and protection relays

Two options are available for the connection of PCM600 to the protection relay.

- Direct point to point link between PCM600 and the protection relay
- Indirect link via a station LAN or from remote via a network

Point to point link

The protection relay is provided with an RJ-45 connector on the LHMI. The front communication port is mainly used for configuration and setting purposes. The front communication port should not be connected to any Ethernet network.

The protection relay 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.

8.4.2 Communication settings

The protection relay is provided with an RJ-45 front port on the LHMI. This connector is mainly used for configuration and setting purposes. The rear port IP address and the corresponding subnet masks can be set via the LHMI. The front port uses a fixed IP address 192.168.0.254, and it also provides DHCP server to assign an IP address for the connected computer. The rear Ethernet interface has a factory default IP address 192.168.2.10 when the complete protection relay is delivered.

Different communication ports are available via optional communication modules. Ethernet RJ-45 and optical Ethernet LC are the two rear port Ethernet communication options. Rear port Ethernet is intended for station bus communication. Communication protocols used via Ethernet ports are IEC 61850-8-1 and Modbus TCP/IP. The RS-485 twisted pair is used for rear port communication. Modbus RTU/Modbus ASCII is the protocol available for serial communication.

> If the protocol does not operate as expected, check that other serial protocols are not using the COM port.

> Use the correct Ethernet connectors in the protection relay with redundant communication protocols like HSR and PRP. protection relays with HSR/PRP support have three Ethernet connectors and redundant Ethernet ports are marked as LAN A and LAN B. The third Ethernet port without any LAN marking works as an interlink port. Thus, an additional redundancy box is not needed. For example, laptops with PCM600 must be connected via a redundancy box to access a protection relay which is part of the HSR network.

> The redundant communication module has three operation modes: "Normal", "HSR" and "PRP". The operation mode can be changed from communication settings.

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

8.4.2.1 Serial communication ports and drivers

Depending on the hardware configuration, the protection relay can be equipped with one or several UART-based serial communication ports. The communication ports can be either galvanic (RS-485) or fiber optic. The protection relay uses serial ports and drivers as different types of serial communication protocol links.

Serial ports are called COM1, COM2 and so on, depending on the number of serial ports in the relay hardware configuration. Each COM port driver has its own setting parameters found via the LHMI in **Configuration/Communication/COMn** (n= 1,2, …).

Since the same protection relay usually supports a variety of different communication hardware options, all COM port driver setting parameters are not relevant for every communication hardware type.

Table 22:   COM port parameters in different HW options

COM parameter	Values	Hardware options[1]
Fiber mode	0 = No fiber	Used in the fiber optic mode only. Note that "No fiber " mode is the same as the galvanic mode.
	1 = Fiber light ON/loop	
	2 = Fiber light OFF/loop	
	3 = Fiber light ON/star	
	4 = Fiber light OFF/star	
Serial mode	0 = RS485 2wire	For galvanic modes. RS-type depends on the communication card used. Note that this setting parameter is relevant only if *Fiber mode* is set to "No Fiber".
	1 = RS485 4wire	
CTS Delay	0…60000 [ms]	RS232 mode only
RTS Delay	0…60000 [ms]	RS232 mode only
Baudrate	1 = 300	All modes
	2 = 600	
	3 = 1200	
	4 = 2400	
	5 = 4800	
	6 = 9600	
	7 = 19200	
	8 = 38400	
	9 = 57600	
	10 = 115200 [bits/sec]	

1) When fiber mode is used, the *Serial mode* parameter value must be "RS485 2wire".

In addition to setting the COM parameter, a communication card with many hardware options may also require changing the jumpers on the communication card.

Connection of a serial communication protocol to a specific serial port

The serial communication protocol (instance) settings include a setting parameter called *Serial port n* (n = protocol instance number). Setting options for this parameter are "COM1", "COM2" and so on. The desired serial port for the protocol instance is selected through this parameter.

> All link setting parameters are not found in the COMn settings. Additional link setting parameters are found in the setting parameter list of the used serial protocol, since some serial protocol standards allow changes in link parameters, while other protocol standards do not.

8.4.2.2 Serial link diagnostics and monitoring

Serial communication diagnostics and monitoring is divided between the serial link driver and the serial communication protocol. The lower level physical and protocol-independent aspects of the UART-based serial communication are monitored in the serial link driver. Diagnostic counters and monitoring values are found via the LHMI in **Monitoring/Communication/COMn** (n= 1,2,…).

Depending on the communication protocol, the serial driver software receives single characters or complete protocol frames, based on the frame start/stop characters or on timing.

Monitoring data for a COM channel can be divided into basic and detailed diagnostic counters.

Table 23:   *Monitoring data for a COM channel*

Parameter	Range	Type	Description
Characters received	0…2147483646	Basic	Number of separate characters received.
Frames received	0…2147483646	Basic	Number of successfully received complete frames.
Frames discarded	0…2147483646	Basic	Number of frames discarded.
Frames transmitted	0…2147483646	Basic	Number of frames transmitted.
CD Lost	0…2147483646	Detailed	Number of carrier-detect signal lost during receive.
Collision	0…2147483646	Detailed	Number of collisions detected.
CTS Timeout	0…2147483646	Detailed	Number of clear-to-send signal timeout errors.
Transmission timeout	0…2147483646	Detailed	Number of transmission timeout errors.
Parity errors	0…2147483646	Detailed	Number of character parity errors detected.
Table continues on next page			

Parameter	Range	Type	Description
Overrun errors	0…2147483646	Detailed	Number of character overrun errors detected.
Framing errors	0…2147483646	Detailed	Number of character overrun errors detected.
Link status	1		1 = Reset counters (by entering 1 the diagnostic counters are reset)

Whether all diagnostic counters are relevant depends on the communication hardware and communication protocol.

Table 24:   Basic diagnostic counters

Counter	Function
Characters received	Counts all incoming non-erroneous characters. This counter operates regardless of if the serial driver is set to detect a whole protocol link frame or just separate characters.
Frames received	Counts all protocol specific non-erroneous frames received. Protocol-specific frames can be based on timing (for example, Modbus RTU) or on special start and stop characters (for example, Modbus ASCII).
Frames discarded	Counts all protocol-specific erroneous frames received. If the driver detects an error while receiving a frame, the frame is automatically discarded. This also means that the protocol in question will never receive a faulty frame from the driver. When this counter is increased, one of the detailed error counters is also incremented.
Frames transmitted	Counts all protocol-specific frames transmitted from the COM channel.

Table 25:   Detailed error counters

Counter	Function
CD Lost	In RS-232 handshake mode, characters are to be received as long as Carrier Detect (CD) signal is active. This counter is incremented if the CD signal is lost during reception.
Collision	Counts transmission collisions. Used in RS-485 mode by some protocols where transmissions could collide. For example, DNP3 unsolicited mode.
CTS Timeout.	In RS-232 handshake mode the Clear To Send (CTS) signal is not received as reply to this device Request To Send (RTS) signal.
Table continues on next page	

Counter	Function
Transmission timeout.	In RS-232 handshake mode. If the CTS signal goes inactive during transmission then the transmission is halted. Transmission will be resumed when CTS goes active again. The whole frame transmission must anyhow be ready within a specified time. If this timeout elapses then this counter is incremented. Result will be that the end of the frame is not being transmitted out.
Parity errors	Counts parity errors detected in characters.
Overrun errors	Counts overrun errors detected in characters.
Framing errors	Counts framing errors detected in characters

Table 26:   *Link status*

Parameter	Function
Link status	Link status in write direction: By writing 1 to the parameter the diagnostic counters are reset to 0.
	Link status in monitoring direction: If the driver is in use by any communication protocol, the monitoring value shows 1. In other case, the value is 0.

8.4.2.3   Defining Ethernet port settings

> Change the Ethernet port settings primarily via PCM600 to ensure that PCM600 is able to export a consistent configuration to SYS600. Ethernet port settings are recommended to be changed only when the device is stand-alone and properly configured.

1. Select **Main menu/Configuration/Communication/Ethernet/Rear port**.
2. Define the settings for the Ethernet port.

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

8.4.2.4   Defining serial port settings

1. Select **Main menu/Configuration/Communication/COM1** or **COM2**.
2. Define the settings for the serial port.
   It is possible to change the general serial communication parameters per port. Select fiber or galvanic mode with the proper baud rate, parity and delays depending on the system architecture and the selected physical communication port.

8.4.2.5   Setting communication protocol parameters

1. Select **Main menu/Configuration/Communication/<protocol>**.
2. Change the protocol specific settings.
    Possible settings to be changed are, for example, the selected communication port, address and link mode.

8.4.2.6   Connecting jumper connectors

> See the technical manual for details on jumper connectors.

8.4.3   Setting the local HMI

8.4.3.1   Changing the local HMI language

1. Select **Main menu/Language** and press ↵.
2. Change the language using ↑ or ↓.
3. Press ↵ to confirm the selection.
4. Commit the changes.
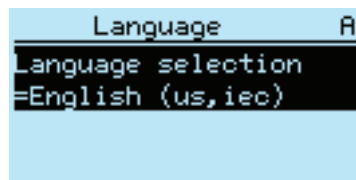
Figure 90:   *Changing the LHMI language*

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

8.4.3.2   Adjusting the display contrast

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

- To increase the contrast, press simultaneously ᴱˢᶜ and ↑.
- To decrease the contrast, press simultaneously ᴱˢᶜ and ↓.

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

8.4.3.3 Changing display symbols

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

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

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

8.4.3.4 Changing the default view

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

1. Select **Main menu/Configuration/HMI/Default view** and press ↵.
2. Change the default view with ↑ or ↓.
3. Press ↵ to confirm the selection.

8.4.3.5 Setting the system time and time synchronization

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

Setting daylight saving time
The protection relay can be set to determine the correct date for the DST shift every year. The UTC time is used to set the DST.

1. Set the *DST on day (weekday)* and *DST off day (weekday)* parameters to define on which week day the time shift occurs.
2. Set the *DST on date (day)*, *DST on date (month)* and *DST off date (month)* parameters to define on which month and week the time shift occurs.
   The DST on/off date must precede the selected DST on/off day and be within the same week as the DST shift.

Table 27:   Possible date values for DST change on Sunday

Day of the DST shift	DST on/off date (day)
First Sunday of the month	1
Second Sunday of the month	8
Third Sunday of the month	15
Fourth Sunday of the month	22
Last Sunday, if the month has 30 days	24
Last Sunday, if the month has 31 days	25

For example, if the DST is observed from the last Sunday in March to the last Sunday in October and the time shift occurs at 01:00 UTC, the setting parameters are the following.

DST on time (hours):	2 h
DST on time (minutes):	0 min
DST on date (day):	25
DST on date (month):	March
DST on day (weekday):	Sunday
DST off time (hours):	1 h
DST off time (minutes):	0 min
DST off date (day):	25
DST off date (month):	October
DST off day (weekday):	Sunday

Set the *DST on day (weekday)* and *DST off day (weekday)* to "reserved" 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 in use* parameter to "False".

8.4.4 Setting IED parameters

8.4.4.1 Defining setting groups

Selecting a setting group for editing

1. Select **Main Menu/Settings/Edit setting group**.
2. Select the setting group to be edited with ⬆ or ⬇.
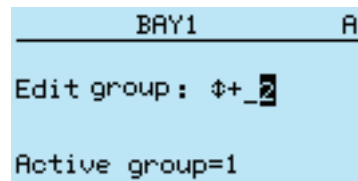3. Press ↵ to confirm the selection.
4. Edit the settings.

```
            BAY1          A
─────────────────────────────
Edit group:  ↕+_2

Active group=1
```

Figure 91:   Selecting a setting group

Browsing and editing setting group values

1. Select **Main menu/Settings/Settings** and press ❯.
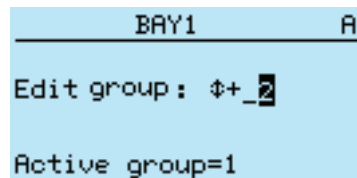2. Select the setting group to be viewed with ⬆ or ⬇ and press ↵ to confirm the selection.

```
            BAY1          A
─────────────────────────────
Edit group:  ↕+_2

Active group=1
```

Figure 92:   Selecting a setting group

3. To browse the settings, scroll the list with ⬆ and ⬇ and to select a setting press ❯.
4. To browse different function blocks, scroll the list with ⬆ and ⬇ and to select a function block press ❯. To move back to the list, press ❮.
   The function block list is shown in the content area of the display. On the left in the header, you see the current setting group, and on the right the menu path.
5. To browse the parameters, scroll the list with ⬆ and ⬇ and to select a parameter, press ❯.
   The setting group values are indicated with #.
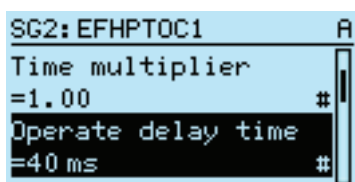
Figure 93:   Setting group parameter

6. To select a setting group value, press ⬦ and to edit the value press ↵.
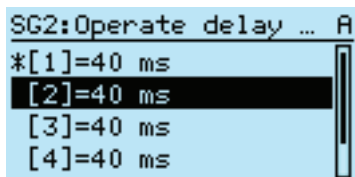
Figure 94:   Selecting the setting group value

Only values within the selected setting group can be changed.

7. Press ⬆ or ⬇ to change the value and ↵ to confirm the selection.
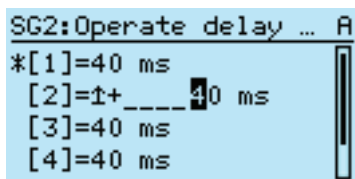
Figure 95:   Editing the setting group value

The active setting group is indicated with an asterisk * .

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

Activating a setting group

Protection relay settings are planned in advance for different operation conditions by calculating setting values to different setting groups. The active setting group can be changed by the protection relay application or manually from the menu.

1. Select **Main menu/Settings/Setting group/Active group** and press ↵.
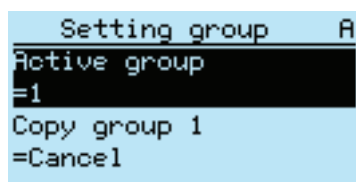
Figure 96:   *Active setting group*

2.   Select the setting group with ⬆ or ⬇ .
3.   Press ⏎ to confirm the selection or ᴱˢᶜ to cancel.
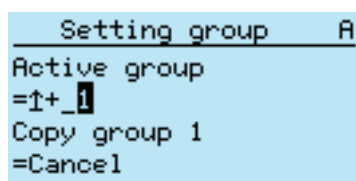
Figure 97:   *Selecting the active setting group*

4.   Commit the settings.

> 🛈   Remember to document the changes you make.

8.4.4.2   Relay parametrization

Protection relay parameters are set via the LHMI, WHMI or PCM600.

Setting parameters need to be calculated according to the electrical network conditions and the electrical characteristics of the protected equipment. The protection relay's settings need to be verified before the protection relay is connected to a system.

> 🛈   Document all changes to parameter settings.

> 🛈   For more information, see the PCM600 documentation.

8.4.4.3   Defining disturbance recorder channel settings

1. Select **Main Menu/Configuration/Disturbance recorder/Channel settings**.
2. Press ⬆ or ⬇ to select the wanted channel and parameter.
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.

8.4.4.4   Configuring analog inputs

1. Select **Main Menu/Configuration/Analog inputs**.
2. Select the analog input to be configured with ⬆ or ⬇.
3. Press ↵, change the value with ⬆ or ⬇ and press ↵ again.

   • For CTs, the secondary current and primary current need to be set to the correct values.
   • For VTs, the secondary voltage and primary voltage need to be set to the correct values.

8.5   Testing protection relay operation

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

8.5.1   Selecting the IED test mode

The test mode can be activated using the LHMI. The green Ready LED is flashing to indicate that the test mode is activated. By default, the test mode can only be changed from the LHMI. Activation by remote client is possible, see the technical manual.

> ℹ️ The Ready LED also flashes if the protection relay detects a diagnostic failure. Check the test mode setting and the protection relay's IRF alarm contact status to find the reason for the failure.

The test mode is useful for simulated testing of functions and outputs without providing current inputs.

1. Select **Main menu/Tests/IED test/Test mode** and press ↵.
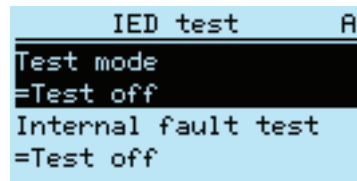
Figure 98:   Entering test mode

2.   Select the test mode status with ↑ or ↓.
3.   Press ↵ to confirm the selection.

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

8.5.2   Testing the digital I/O interface

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

1.   Select **Main menu/Tests/Binary outputs/X100 (PSM)/X100-PO1** and press ↵.
2.   Select the value with ↑ or ↓.
3.   Press ↵ to confirm the selection.

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

8.5.3   Testing functions

Activate or deactivate an output signal for protection or other function to test the function.

1.   Select **Main Menu/Tests/Function tests/Current protection/<function block name>** and press ↵.
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 ↵.

8.5.4 Selecting the internal fault test

The internal fault may be tested by using the LHMI. When enabling the test, the internal relay fault output contact is activated, the green Ready LED is flashing and internal fault test indication is shown on the LHMI. See the technical manual for the internal relay fault output contact location. The internal fault can only be activated by using the LHMI.

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

1. Select **Main menu/Tests/IED test/Internal fault test** and press ↵.

```
          IED test       A
Test mode
=Test on
Internal fault test
=Test off
```
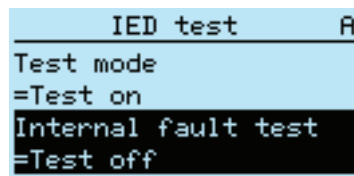
Figure 99:   Internal fault test

2. Select the value with ↑ or ↓.
3. Press ↵ to confirm the selection.

8.5.5 Selecting the IED blocked or IED test and blocked mode

The IED blocked mode and the IED test and blocked mode can be activated using the LHMI. The yellow Start LED flashes when the device is in the IED blocked or IED test and blocked mode. The green Ready LED flashes to indicate that the IED test and blocked mode is activated. By default, the test mode can only be changed from the LHMI. Activation by remote client is possible, see the technical manual.

> The Ready LED also flashes if the IED detects a diagnostic failure. Check the test mode setting and the protection relay's IRF alarm contact status to find the reason of the failure.

The test mode can be used for simulated testing of functions and outputs without providing current inputs. The IED blocked mode can be used to block the physical outputs to the process.

1. Select **Main menu/Tests/IED test/Test mode** and press ↵.
2. Select the test mode status with ↑ or ↓. Press ↵ to confirm the selection.

If the IED blocked or IED test and blocked mode is not cancelled, it remains on and the Start and/or Ready LEDs remain flashing.

8.6 ABB Product Data Registration

The ABB Product Data Registration feature traces composition changes in the protection relay's SW or HW. Traceability allows better support and maintenance possibilities.

After a composition change, an LCT indication is seen on the LHMI at the protection relay startup. The PCM600 reads the changed data from the protection relay. Therefore a connection to the protection relay must be established first. Composition data can be read with PCM600 by enabling LCT during PCM600 installation and activating collection in PCM600 from 'Lifecycle Handling' menu. For detailed information see PCM600 online help.

The LCT indication is cleared in the same way as other indications. If composition data is not collected with PCM600, the indication reappears after protection relay's reboot.

If the LCT indication appears, update the protection relay composition to avoid information mismatch. The LCT indication does not affect the functionality of the protection relay.
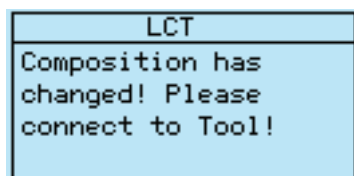
Figure 100: LCT indication

The number of composition changes can be seen from the *Composition changes* parameter in **Main Menu/Monitoring/IED status**.

Section 9   Glossary

100BASE-FX	A physical medium defined in the IEEE 802.3 Ethernet standard for local area networks (LANs) that uses fiber optic cabling
100BASE-TX	A physical medium defined in the IEEE 802.3 Ethernet standard for local area networks (LANs) that uses twisted-pair cabling category 5 or higher with RJ-45 connectors
AC	Alternating current
ANSI	American National Standards Institute
CAT 5	A twisted pair cable type designed for high signal integrity
COMTRADE	Common format for transient data exchange for power systems. Defined by the IEEE Standard.
CPU	Central processing unit
CSV	Comma-separated values
CT	Current transformer
DAN	Doubly attached node
DC	1. Direct current 2. Disconnector 3. Double command
DHCP	Dynamic Host Configuration Protocol
DPC	Double-point control
DST	Daylight-saving time
EEPROM	Electrically erasable programmable read-only memory
EMC	Electromagnetic compatibility
Ethernet	A standard for connecting a family of frame-based computer networking technologies into a LAN
FB	Function block
FIFO	First in, first out
Firmware	System software or hardware that has been written and stored in a device's memory that controls the device
FPGA	Field-programmable gate array
FTP	File transfer protocol
FTPS	FTP Secure

GOOSE	Generic Object-Oriented Substation Event	
HMI	Human-machine interface	
HSR	High-availability seamless redundancy	
HTTPS	Hypertext Transfer Protocol Secure	
HW	Hardware	
IEC	International Electrotechnical Commission	
IEC 61850	International standard for substation communication and modeling	
IEC 61850-8-1	A communication protocol based on the IEC 61850 standard series	
IED	Intelligent electronic device	
IEEE 1686	Standard for Substation Intelligent Electronic Devices' (IEDs') Cyber Security Capabilities	
IP	Internet protocol	
IP address	A set of four numbers between 0 and 255, separated by periods. Each server connected to the Internet is assigned a unique IP address that specifies the location for the TCP/IP protocol.	
IRF	1. Internal fault	
	2. Internal relay fault	
IRIG-B	Inter-Range Instrumentation Group's time code format B	
LAN	Local area network	
LC	Connector type for glass fiber cable, IEC 61754-20	
LCD	Liquid crystal display	
LCP	Liquid crystal polymer	
LCT	Life cycle traceability	
LED	Light-emitting diode	
LHMI	Local human-machine interface	
MAC	Media access control	
MMS	1. Manufacturing message specification	
	2. Metering management system	
Modbus	A serial communication protocol developed by the Modicon company in 1979. Originally used for communication in PLCs and RTU devices.	
Modbus ASCII	Link mode using 7-bit ASCII characters	
Modbus RTU	Link mode using 8-bit binary characters	
NCC	Network control center	

PA	Polyamide
PBT	Polybutylene terephthalate
PC	1. Personal computer
	2. Polycarbonate
PCM600	Protection and Control IED Manager
PRP	Parallel redundancy protocol
R/L	Remote/Local
RAM	Random access memory
REB611	Busbar and multipurpose differential protection and control relay
REF611	Feeder protection and control relay
REM611	Motor protection and control relay
REU611	Voltage protection and control relay
RJ-45	Galvanic connector type
RoHS	Restriction of hazardous substances
ROM	Read-only memory
RS-232	Serial interface standard
RS-485	Serial link according to EIA standard RS485
RSTP	Rapid spanning tree protocol
RTC	Real-time clock
SAN	Single attached node
SCL	XML-based substation description configuration language defined by IEC 61850
SMT	Signal Matrix tool in PCM600
SNTP	Simple Network Time Protocol
STP	Shielded twisted-pair
SVG	Scalable vector graphics
SW	Software
TCP/IP	Transmission Control Protocol/Internet Protocol
UTC	Coordinated universal time
VT	Voltage transformer
WAN	Wide area network
WHMI	Web human-machine interface
XRIO	eXtended Relay Interface by OMICRON

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