Relion® Protection and Control

615 series
Operation Manual

Power and productivity
for a better world™

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Conformity

This product complies with the directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive 2004/108/EC) and concerning electrical equipment for use within specified voltage limits (Low-voltage directive 2006/95/EC). This conformity is the result of tests conducted by ABB in accordance with the product standards EN 50263 and EN 60255-26 for the EMC directive, and with the product standards EN 60255-6 and EN 60255-27 for the low voltage directive. The IED is designed in accordance with the international standards of the IEC 60255 series.

Safety information

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

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

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

National and local electrical safety regulations must always be followed.

The frame of the IED 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 IED case internals may contain high voltage potential and touching these may cause personal injury.

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

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

Table of contents

Section 1 Introduction

1.1 This manual

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

1.2 Intended audience

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

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

1.3 Product documentation

1.3.1 Product documentation set

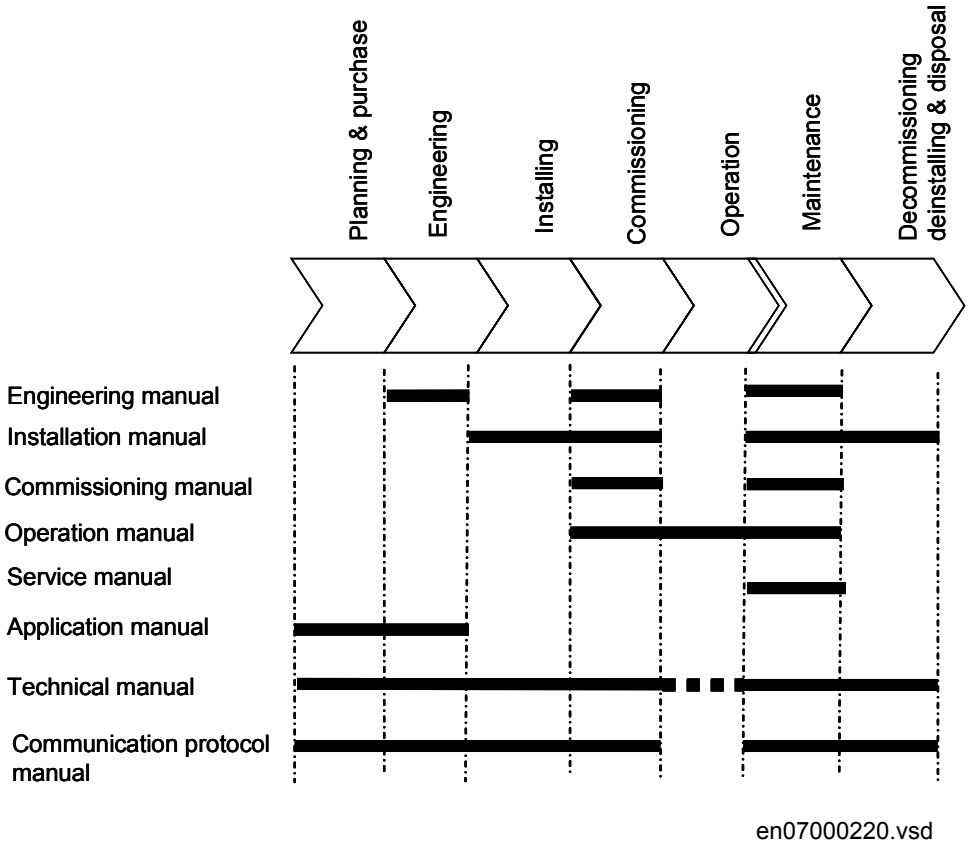


Figure 1: The intended use of manuals in different lifecycles

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

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

Commissioning Manual contains instructions on how to commission the IED. The manual can also be used as a reference during periodic testing. The manual provides procedures for energizing and checking of external circuitry, setting and configuration as well as verifying settings and performing directional tests. The

chapters are organized in chronological order in which the IED should be commissioned.

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

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

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

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

Communication Protocol Manual describes a communication protocol supported by the IED. The manual concentrates on vendor-specific implementations.

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

Some of the manuals are not available yet.

1.3.2 Document revision history

Document revision/date	Product series version	History
A/04.03.2009	2.0	First release
B/03.07.2009	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 Document symbols and conventions

1.4.1 Safety indication symbols

This publication includes icons that point out safety-related conditions or other important information.

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

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

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

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

1.4.2 Document conventions

- Abbreviations and acronyms in this manual are spelled out in Glossary. Glossary also contains definitions of important terms.
- Push button navigation in the LHMI menu structure is presented by using the push button icons, for example:

To navigate between the options, use  and  .

- HMI menu paths are presented in bold, for example:
  Select **Main menu/Information**.
- Menu names are shown in bold in WHMI, for example:
  Click **Information** in the WHMI menu structure.
- LHMI messages are shown in Courier font, for example:
  To save the changes in non-volatile memory, select `Yes` and press  .
- Parameter names are shown in italics, for example:
  The function can be enabled and disabled with the *Operation* setting.
- Parameter values are indicated with quotation marks, for example:
  The corresponding parameter values are "On" and "Off".
- IED input/output messages and monitored data names are shown in Courier font, for example:
  When the function starts, the `START` output is set to TRUE.

1.4.3 Functions, codes and symbols

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

Table 1: Functions included in standard configurations

Function	IEC 61850	IEC 60617	IEC-ANSI
Protection			
Three-phase non-directional overcurrent protection, low stage	PHLPTOC1	3I> (1)	51P-1 (1)
	PHLPTOC2	3I> (2)	51P-1 (2)
Three-phase non-directional overcurrent protection, high stage	PHHPTOC1	3I>> (1)	51P-2 (1)
	PHHPTOC2	3I>> (2)	51P-2 (2)
Three-phase non-directional overcurrent protection, instantaneous stage	PHIPTOC1	3I>>> (1)	50P/51P (1)
	PHIPTOC2	3I>>> (2)	50P/51P (2)
Three-phase directional overcurrent protection, low stage	DPHLPDOC1	3I> → (1)	67-1 (1)
	DPHLPDOC2	3I> → (2)	67-1 (2)
Three-phase directional overcurrent protection, high stage	DPHHPDOC1	3I>> →	67-2
Non-directional earth-fault protection, low stage	EFLPTOC1	I_0> (1)	51N-1 (1)
	EFLPTOC2	I_0> (2)	51N-1 (2)
Non-directional earth-fault protection, high stage	EFHPTOC1	I_0>> (1)	51N-2 (1)
	EFHPTOC2	I_0>> (2)	51N-2 (2)
Non-directional earth-fault protection, instantaneous stage	EFIPTOC1	I_0>>>	50N/51N
Directional earth-fault protection, low stage	DEFLPDEF1	I_0> → (1)	67N-1 (1)

Table continues on next page

Function	IEC 61850	IEC 60617	IEC-ANSI
	DEFLPDEF2	I_0> → (2)	67N-1 (2)
Directional earth-fault protection, high stage	DEFHPDEF1	I_0>> →	67N-2
Transient / intermittent earth-fault protection	INTRPTEF1	I_0> → IEF	67NIEF
Non-directional (cross-country) earth fault protection, using calculated I_0	EFHPTOC1	I_0>>	51N-2
Negative-sequence overcurrent protection	NSPTOC1	I_2> (1)	46 (1)
	NSPTOC2	I_2> (2)	46 (2)
Phase discontinuity protection	PDNSPTOC1	I_2/I_1>	46PD
Residual overvoltage protection	ROVPTOV1	U_0> (1)	59G (1)
	ROVPTOV2	U_0> (2)	59G (2)
	ROVPTOV3	U_0> (3)	59G (3)
Three-phase undervoltage protection	PHPTUV1	3U< (1)	27 (1)
	PHPTUV2	3U< (2)	27 (2)
	PHPTUV3	3U< (3)	27 (3)
Three-phase overvoltage protection	PHPTOV1	3U> (1)	59 (1)
	PHPTOV2	3U> (2)	59 (2)
	PHPTOV3	3U> (3)	59 (3)
Positive-sequence undervoltage protection	PSPTUV1	U1<	47U+
Negative-sequence overvoltage protection	NSPTOV1	U2>	47O-
Three-phase thermal protection for feeders, cables and distribution transformers	T1PTTR1	3Ith>F	49F
Three-phase thermal overload protection for power transformers, two time constants	T2PTTR1	3Ith>T	49T
Negative-sequence overcurrent protection for motors	MNSPTOC1	I2>M (1)	46M (1)
	MNSPTOC2	I2>M (2)	46M (2)
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	PREVPTOC	I_2>>	46R
Thermal overload protection for motors	MPTTR1	3Ith>M	49M
Binary signal transfer	BSTGGIO1	BST	BST
Stabilized and instantaneous differential protection for 2W-transformers	TR2PTDF1	3dI>T	87T
Line differential protection and related measurements, stabilized and instantaneous stages	LNPLDF1	3dI>L	87L
Numerical stabilized low impedance restricted earth-fault protection	LREFPNDF1	dI0Lo>	87NL
High impedance based restricted earth-fault protection	HREFPDIF1	dI_0Hi>	87NH
Circuit breaker failure protection	CCBRBRF1	3I>/I_0>BF	51BF/51NBF

Table continues on next page

Function	IEC 61850	IEC 60617	IEC-ANSI
Three-phase inrush detector	INRPHAR1	3I2f>	68
Master trip	TRPPTRC1	Master Trip (1)	94/86 (1)
	TRPPTRC2	Master Trip (2)	94/86 (2)
Arc protection	ARCSARC1	ARC (1)	50L/50NL (1)
	ARCSARC2	ARC (2)	50L/50NL (2)
	ARCSARC3	ARC (3)	50L/50NL (3)
Control			
Circuit-breaker control	CBXCBR1	I ↔ O CB	I ↔ O CB
Disconnector position indication	DCSXSWI1	I ↔ O DC (1)	I ↔ O DC (1)
	DCSXSWI2	I ↔ O DC (2)	I ↔ O DC (2)
	DCSXSWI3	I ↔ O DC (3)	I ↔ O DC (3)
Earthing switch indication	ESSXSWI1	I ↔ O ES	I ↔ O ES
Emergergency startup	ESMGAPC1	ESTART	ESTART
Auto-reclosing	DARREC1	O → I	79
Tap changer position indication	TPOSSLTC1	TPOSM	84M
Condition monitoring			
Circuit-breaker condition monitoring	SSCBR1	CBCM	CBCM
Trip circuit supervision	TCSSCBR1	TCS (1)	TCM (1)
	TCSSCBR2	TCS (2)	TCM (2)
Current circuit supervision	CCRDIF1	MCS 3I	MCS 3I
Fuse failure supervision	SEQRFUF1	FUSEF	60
Protection communication supervision	PCSRTPC1	PCS	PCS
Motor runtime counter	MDSOPT1	OPTS	OPTM
Measurement			
Disturbance recorder	RDRE1	-	-
Three-phase current measurement	CMMXU1	3I	3I
	CMMXU2	3I(B)	3I(B)
Sequence current measurement	CSMSQI1	I_1, I_2, I_0	I_1, I_2, I_0
Residual current measurement	RESCMMXU1	I_0	I_n
	RESCMMXU2	I_0(B)	I_n(B)
Three-phase voltage measurement	VMMXU1	3U	3U
Residual voltage measurement	RESVMMXU1	U_0	V_n
Sequence voltage measurement	VSMSQI1	U_1, U_2, U_0	U_1, U_2, U_0
Three-phase power and energy measurement	PEMMXU1	P, E	P, E

Section 2 Environmental aspects

2.1 Sustainable development

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

The choice of 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 Disposing of the IED

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

All parts used in this product are recyclable. When disposing cast-off IEDs or its parts, contact the local entrepreneurs who are authorized and specialized in

handling electrical/electronics waste. These partners can sort the material by using dedicated sorting processes and dispose of the product according to the local requirements.

Table 3: Materials of the IED parts

IED	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 plate	Steel
Package	Box	Cardboard
Attached material	Manuals	Paper

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

Section 3 615 series overview

3.1 Overview

615 series is a product family of IEDs designed for protection, control, measurement and supervision of utility substations and industrial switchgear and equipment. The design of the IEDs has been guided by the IEC 61850 standard for communication and interoperability of substation automation devices.

The IEDs feature draw-out-type design with a variety of mounting methods, compact size and ease of use. Depending on the product, optional functionality is available at the time of order for both software and hardware, for example, autoreclosure and additional I/Os.

The 615 series IEDs support a range of communication protocols including IEC 61850 with GOOSE messaging, Modbus®, DNP3 and IEC 60870-5-103.

3.2 Local HMI

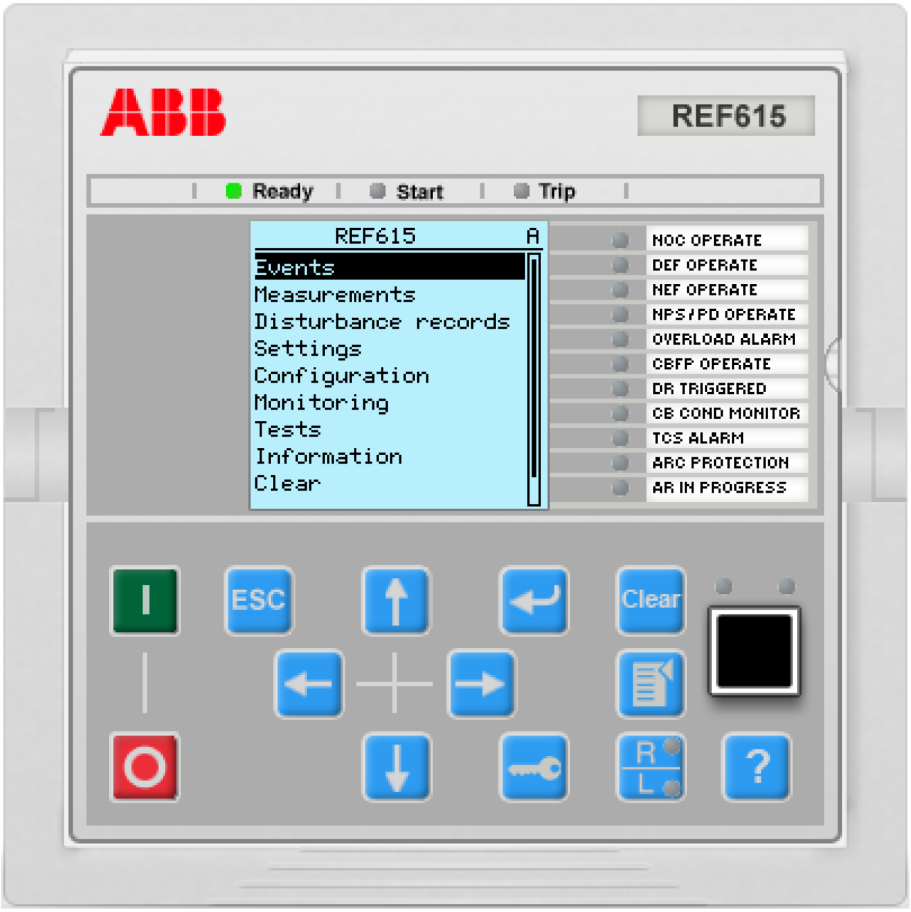


Figure 2: LHMI

The LHMI of the IED contains the following elements:

- Display
- Buttons
- LED indicators
- Communication port

The LHMI is used for setting, monitoring and controlling.

3.2.1 LCD

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

Table 4: Characters and rows on the view

Character size	Rows in view	Characters on row
Small, mono-spaced (6x12 pixels)	5 rows 10 rows with large screen	20
Large, variable width (13x14 pixels)	4 rows 8 rows with large screen	min 8

The display view is divided into four basic areas.

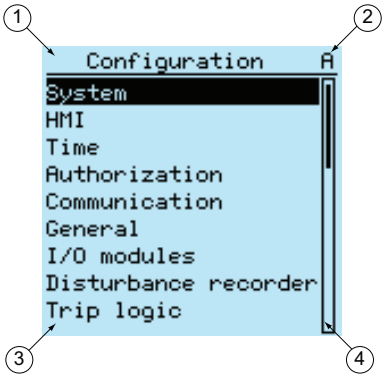


Figure 3: Display layout

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 11 matrix programmable alarm LEDs on front of the LHMI. The LEDs can be configured with PCM600 and the operation mode can be selected with the LHMI, WHMI or PCM600.

3.2.3 Keypad

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

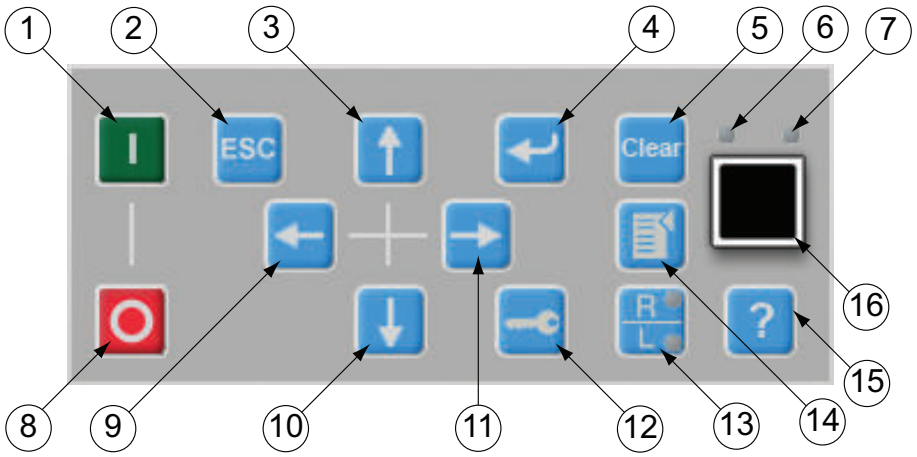


Figure 4: LHMI keypad with object control, navigation and command push-buttons and RJ-45 communication port

1 Close
2 Escape
3 Up
4 Enter
5 Clear
6 Uplink LED
7 Communication LED
8 Open
9 Left
10 Down
11 Right
12 Key
13 Remote/Local
14 Menu
15 Help
16 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	Closing the object.
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 ←. • Running the display test in combination with ☰. • Deleting a character in combination with Clear when editing a string. • Inserting a space in combination with ↵ when editing a string.
↵ 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.
Key	• Activating the authorization procedure, when the user is not logged in. • Logging out, when the user is currently logged in.

Commands

Table 7: Command push-buttons

Name	Description
☰ Menu	• Moving directly to Main menu, if currently in any other menu or view. • Moving to the default view, if currently in Main menu.
R L R/L	Changing the control position (remote or local) of the device. • When the R LED is lit, remote control is enabled and local control disabled. • When the L LED is lit, local control is enabled and remote control disabled. • When none of the LEDs are lit, both control positions are disabled.
Clear Clear	• Activating the Clear/Reset view. • Clearing indications and LEDs. The first three-second press clears the indications. The second three-second press clears the alarm LEDs. Requires appropriate user rights.
? Help	Showing context sensitive help messages.

3.2.4 LHMI functionality

3.2.4.1 Protection and alarm indication

Protection indicators

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 IED 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. • 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 or by pressing Clear. • If several protection functions trip within a short time, the last trip is indicated on the display.

Alarm indicators

The 11 matrix programmable LEDs are used for alarm indication.

Table 11: Alarm indications

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 IED 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.

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 IED communicates with the connected device.

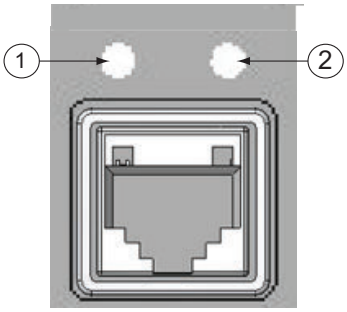


Figure 5: RJ-45 communication port and indication LEDs

1 Uplink LED
2 Communication LED

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

3.3 Web HMI

The WHMI enables the user to access the IED via a web browser. The supported web browser version is Internet Explorer 7.0 or later.

WHMI is disabled by default. To enable the WHMI, select **Main Menu/Configuration/HMI/Web HMI mode** via the LHMI. Reboot the IED for the change to take effect.

WHMI offers several functions.

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

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

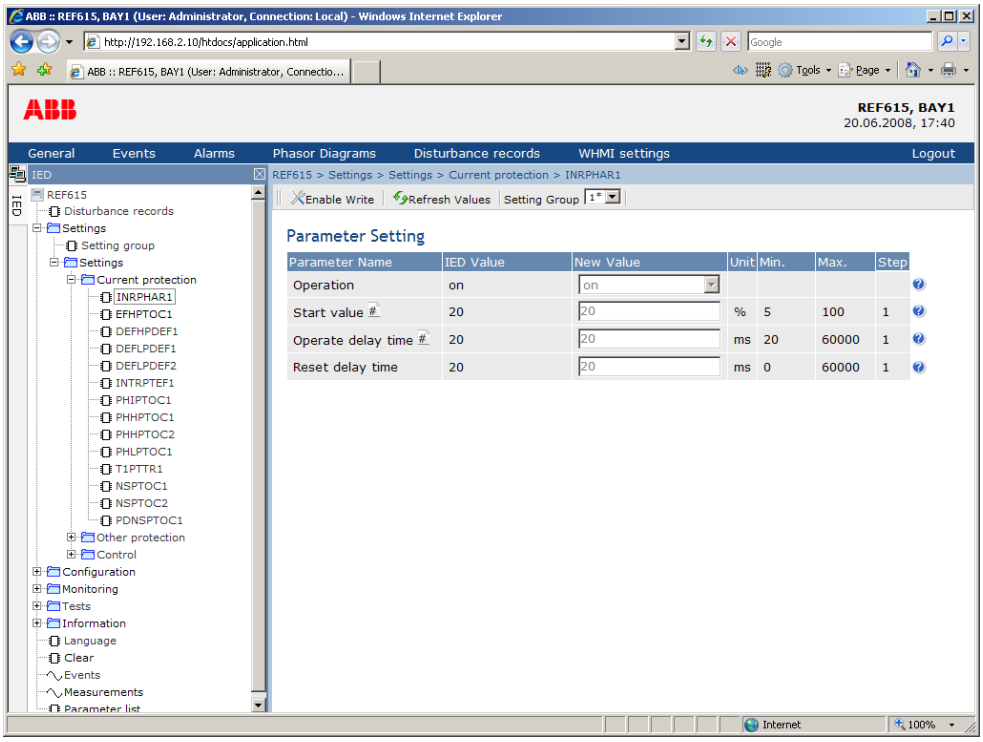


Figure 6: Example view of the WHMI

The WHMI can be accessed locally and remotely.

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

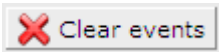
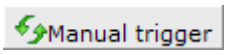
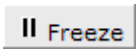
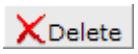
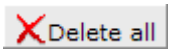
3.3.1 Command buttons

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 IED.
Refresh Values	Refreshing parameter values.
Print	Printing out parameters.
Commit	Committing changes to IED's non-volatile flash memory.

Table continues on next page

Name	Description
	Rejecting changes.
	Showing context sensitive help messages.
	Clearing events.
	Triggering the disturbance recorder manually.
	Saving values to CSV file format.
	Freezing the values so that updates are not displayed.
	Receiving continuous updates to the monitoring view.
	Deleting the disturbance record.
	Deleting all disturbance records.
	Uploading part one of a disturbance record.
	Uploading part two of a disturbance record.

3.4 Authorization

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

The default passwords can be changed with Administrator user rights.

User authorization is disabled by default for LHMI and can be enabled either via the LHMI or the WHMI **Main Menu/ Configuration/Authorization**. WHMI always requires authentication.

Table 13: Predefined user categories

Username	User rights
VIEWER	Read only access
OPERATOR	• Selecting remote or local state with  (only locally) • Changing setting groups • Controlling • Clearing alarm and indication LEDs and textual 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 IED to test mode • Selecting language
ADMINISTRATOR	• All listed above • Changing password • Factory default activation

For user authorization for PCM600, see PCM600 documentation.

3.5 Communication

The IED supports a range of communication protocols including IEC 61850, IEC 60870-5-103, Modbus® and DNP3. Operational information and controls are available through these protocols.

The IEC 61850 communication implementation supports all monitoring and control functions. Additionally, parameter setting and disturbance file records can be accessed using the IEC 61850 protocol. Disturbance files are available to any Ethernet-based application in the standard COMTRADE format. Further, the IED can send and receive binary signals from other IEDs (so called horizontal communication) using the IEC61850-8-1 GOOSE profile, where the highest performance class with a total transmission time of 3 ms is supported. The IED meets the GOOSE performance requirements for tripping applications in distribution substations, as defined by the IEC 61850 standard. The IED can simultaneously report events to five different clients on the station bus.

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

All communication connectors, except for the front port connector, are placed on integrated optional communication modules. The IED can be connected to Ethernet-based communication systems via the RJ-45 connector (100BASE-TX).

3.6 PCM600 tool

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

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

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

For more information, see PCM600 documentation.

3.6.1 Connectivity packages

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

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

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

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

3.6.2 PCM600 and IED connectivity package version

- Protection and Control IED Manager PCM600 Ver. 2.0 SP2 or later
- RED615 Connectivity Package Ver. 2.5 or later
- REF615 Connectivity Package Ver. 2.5 or later
- REM615 Connectivity Package Ver. 2.5 or later
- RET615 Connectivity Package Ver. 2.5 or later

Download connectivity packages from the ABB web site http://www.abb.com/substationautomation

Section 4 Using the HMI

4.1 Using the local HMI

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

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

4.1.1 Logging in

1. Press to activate the login procedure.
2. Press or to select the user level.

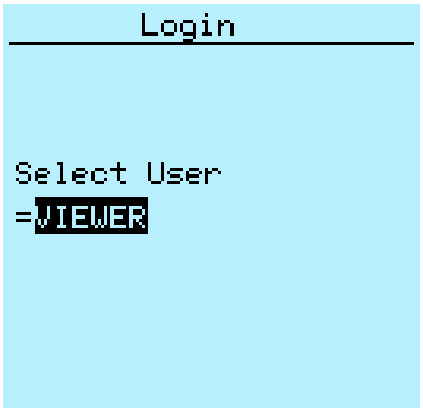


Figure 7: Selecting access level

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 .

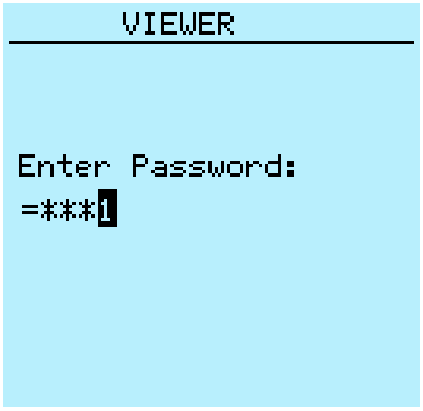


Figure 8: Entering password

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

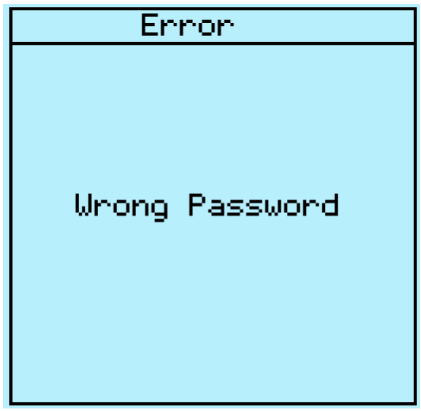


Figure 9: Error message indicating wrong password

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

4.1.2 Logging out

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

1. Press .
2. To confirm logout, select `Yes` and press .

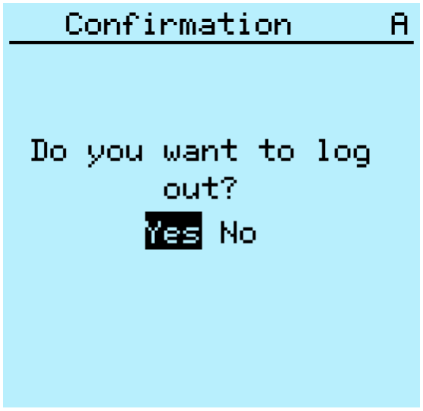


Figure 10: Logging out

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

- Press 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.

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

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

4.1.5 Identifying the device

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

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

1. Select **Main menu/Information**.
2. Select a submenu with and .

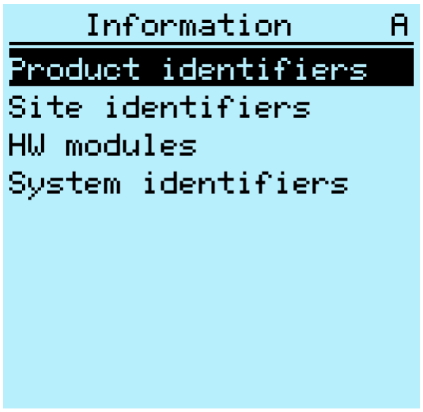


Figure 11: Selecting a submenu

3. Enter the submenu with .
4. Browse the information with and .

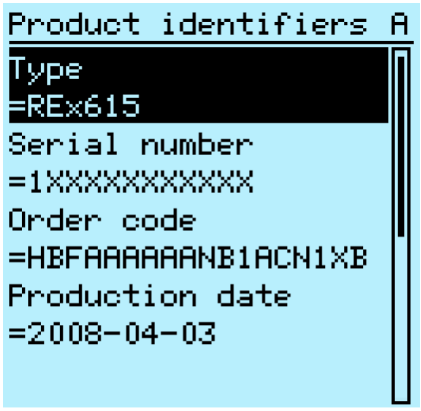


Figure 12: IED information

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

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

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 13: 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

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

4.1.9 Navigating in the menu

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

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

4.1.9.1 Menu structure

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

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

4.1.9.2 Scrolling the LCD view

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

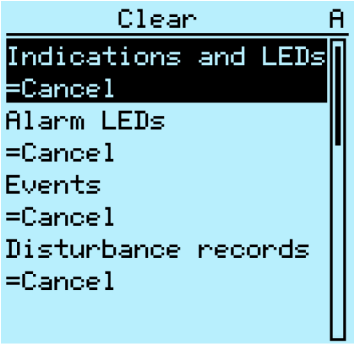


Figure 14: Scroll bar on the right

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

4.1.9.3 Changing the default view

The default view of the display is **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.

4.1.10 Browsing setting values

1. Select **Main menu/Settings/Settings** and press .
2. Select the setting group to be viewed with or .

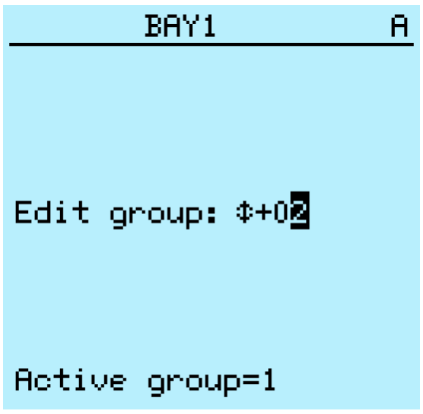


Figure 15: Selecting a setting group

3. Press to confirm selection.
4. To browse the settings, scroll the list with and and to select a setting press . To move back to the list, press .

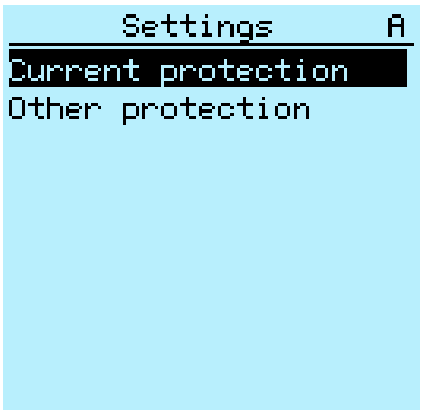


Figure 16: Setting alternatives in the selected setting group

4.1.11 Editing values

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

4.1.11.1 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 ↑, increase the active value.
   - When the symbol is ↓, decrease the active value.
   - When the symbol in front of the value is ↕, either increase or decrease the active value.

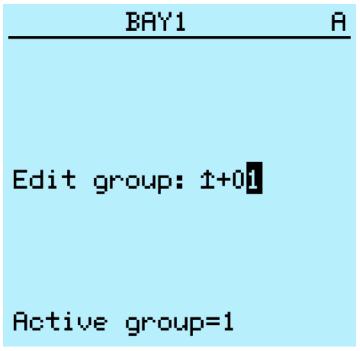


Figure 17: Last digit is active and it can only be increased

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.

   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 ↓.

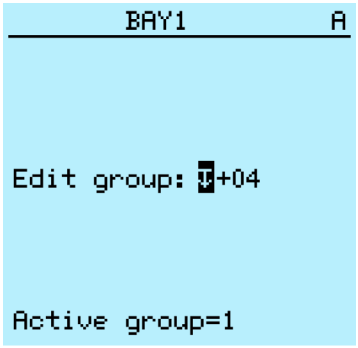


Figure 18: Arrow symbol is active, the value is set to the maximum

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.

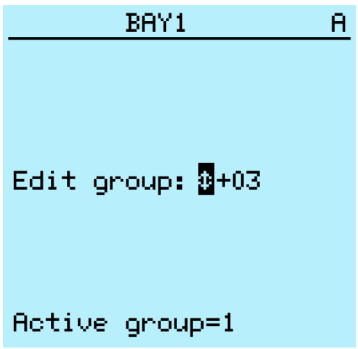


Figure 19: Restoring the previous value

4.1.11.2 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 ← or → to move the cursor to another character.
   - To insert characters or space, press simultaneously ESC and ↵.
   - To delete characters, press simultaneously ESC and Clear.

4.1.11.3 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.

4.1.12 Committing settings

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

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

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

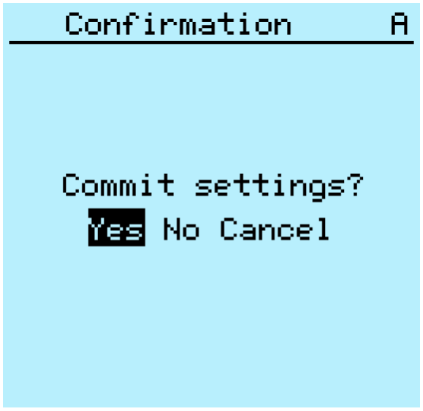


Figure 20: Confirming settings

- 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 you reboot the IED. 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 . The value returns to editing mode.

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

4.1.13 Clearing and acknowledging

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

1. Press Clear to activate the Clear view.

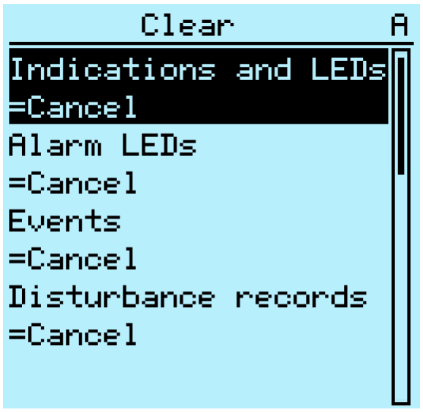


Figure 21: Clear view

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 Clear button as a shortcut for clearing. The first three-second press clears the indications. The second three-second press clears the alarm LEDs.

4.1.14 Using the local HMI help

1. Press ? to open the help view.
2. Scroll the text with ↑ or ↓ if the help text exceeds the display area.
3. To close the help, press ESC.

4.2 Using the Web HMI

WHMI is disabled by default. Log in with the proper user rights to use the WHMI.

1. To enable the WHMI, select **Main menu/Configuration/HMI/Web HMI mode** via the LHMI.
2. Reboot the IED for the change to take effect.

4.2.1 Logging in

1. Enter the username with capital letters.
2. Enter the password.
3. Click **OK**.

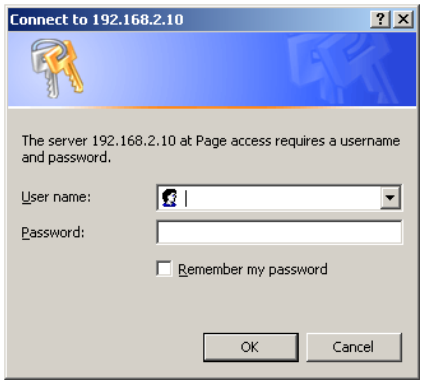


Figure 22: Entering username and password to use the WHMI

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.

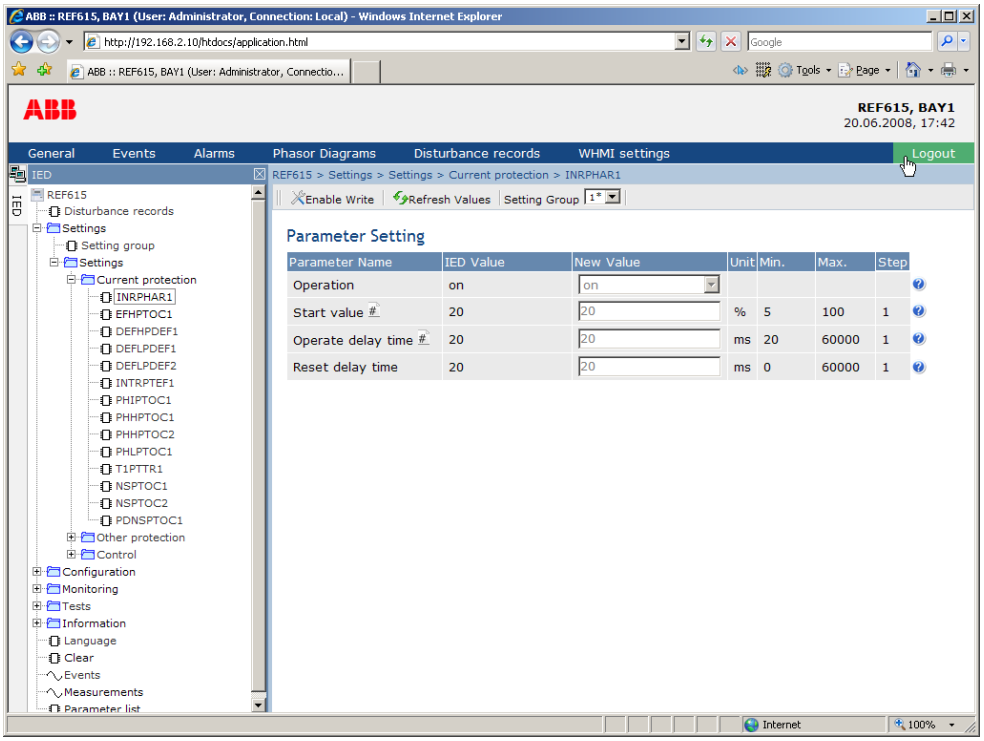


Figure 23: WHMI logout

4.2.3 Identifying the device

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

1. Click **Information** in the WHMI menu structure.
2. Click a submenu to see the data.

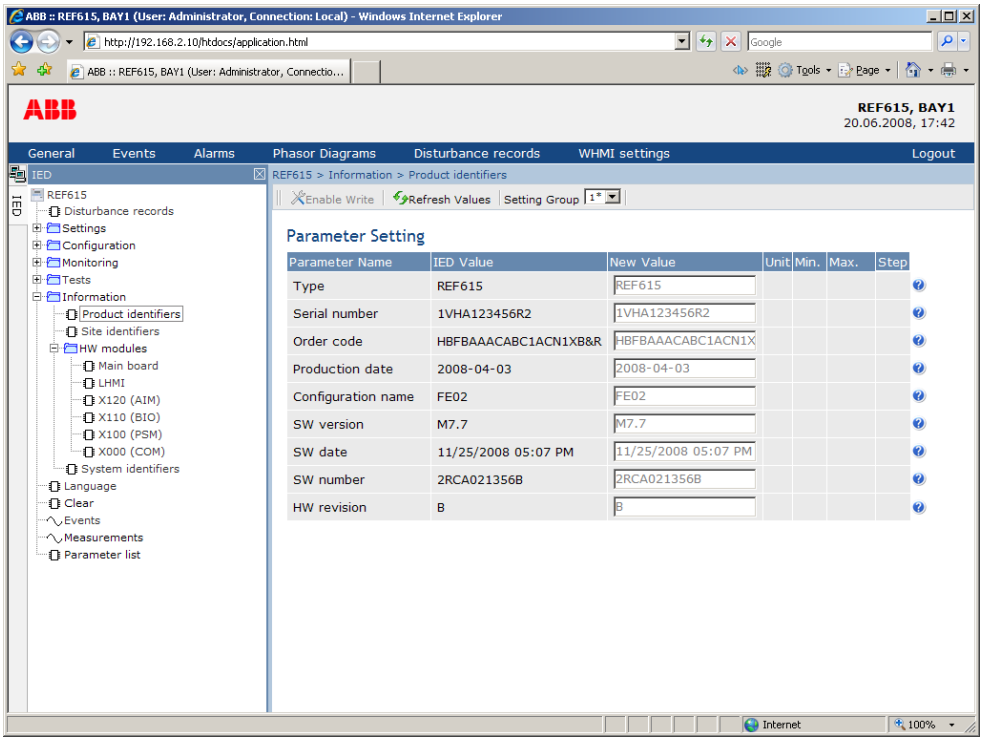


Figure 24: Device information

4.2.4 Navigating in the menu

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

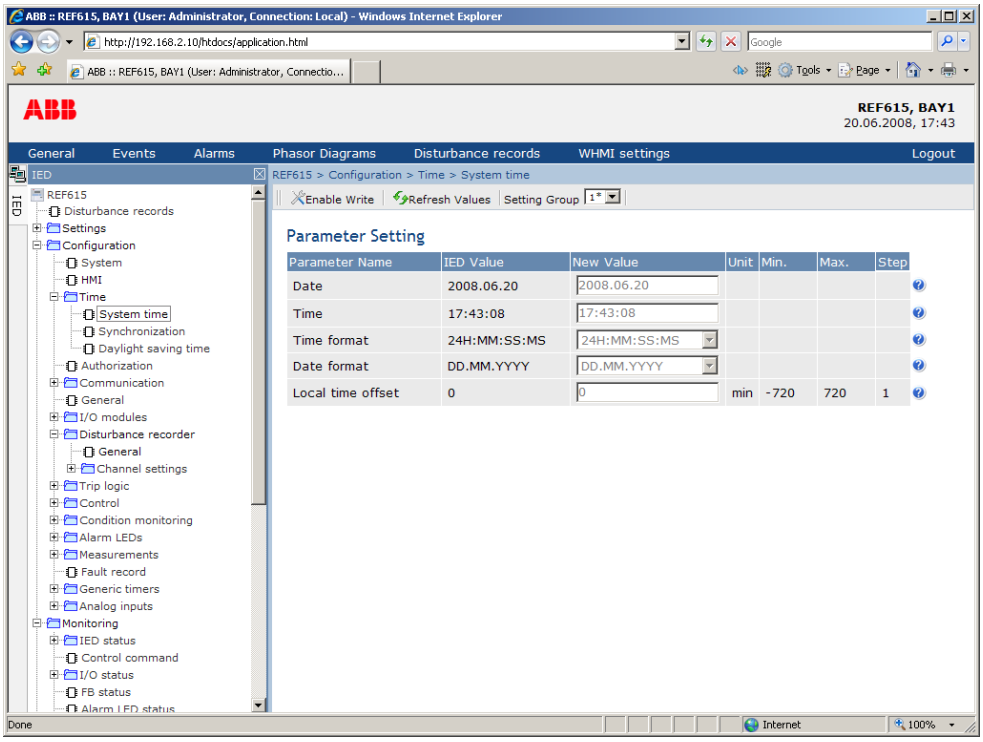


Figure 25: Navigating in the WHMI menus

4.2.4.1 Menu structure

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

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

4.2.5 Showing all parameters

1. Click **Parameter list** in the main menu.

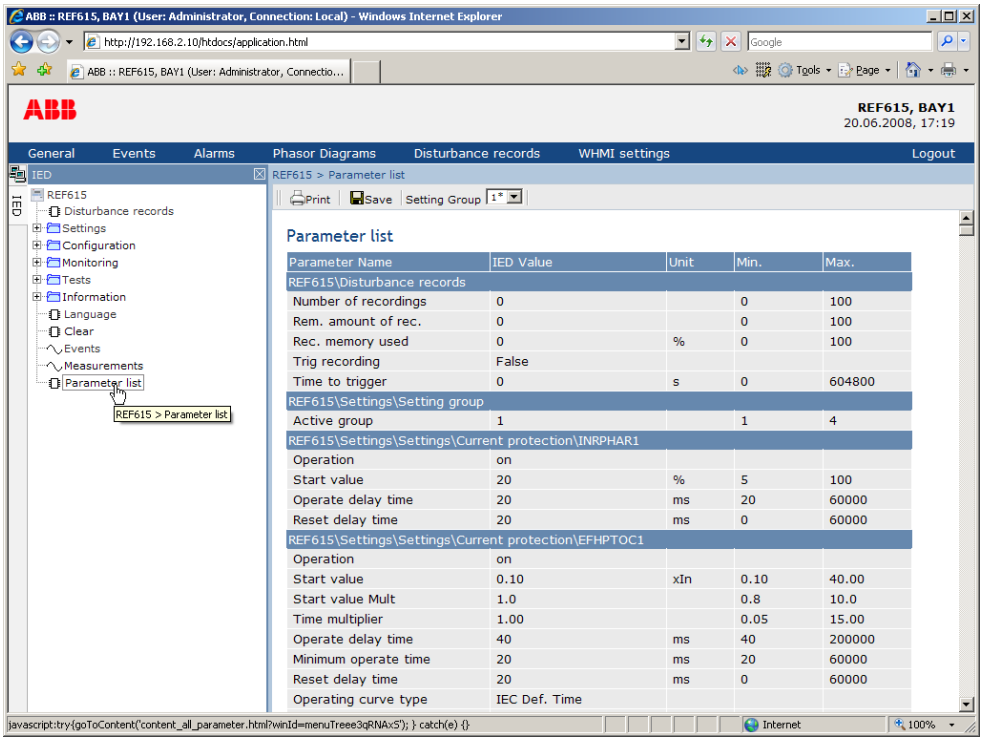


Figure 26: Show all parameters

2. Click **Print** to print out all parameters on paper.

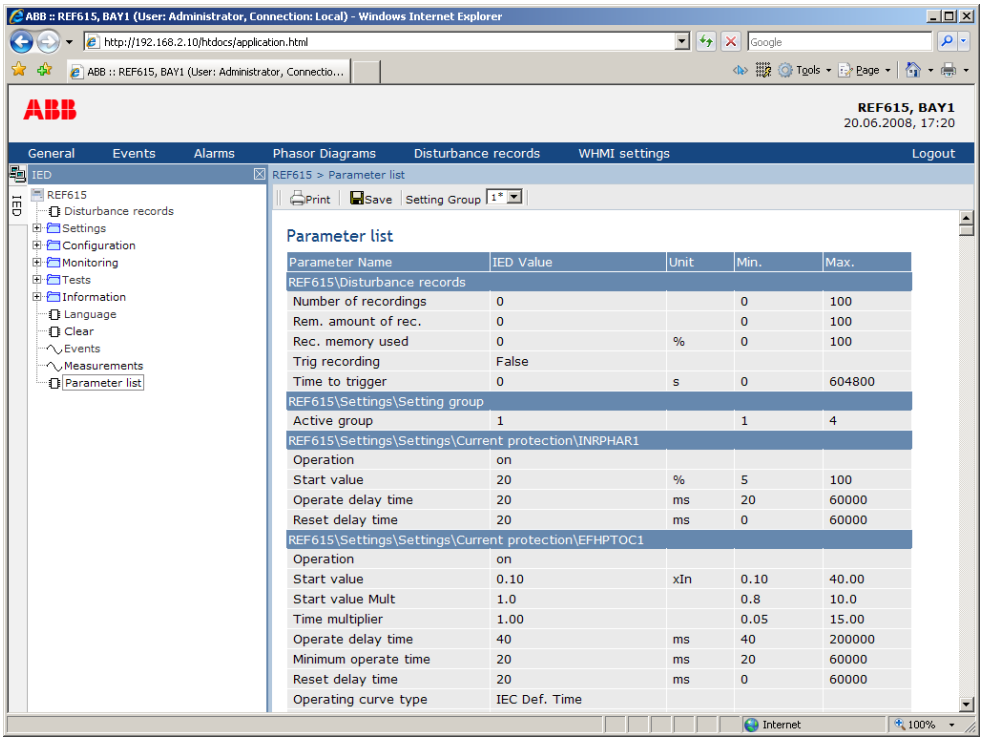


Figure 27: All parameters listed

3. Click **Save** to save all parameters in CSV file format.

4.2.6 Editing values

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

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

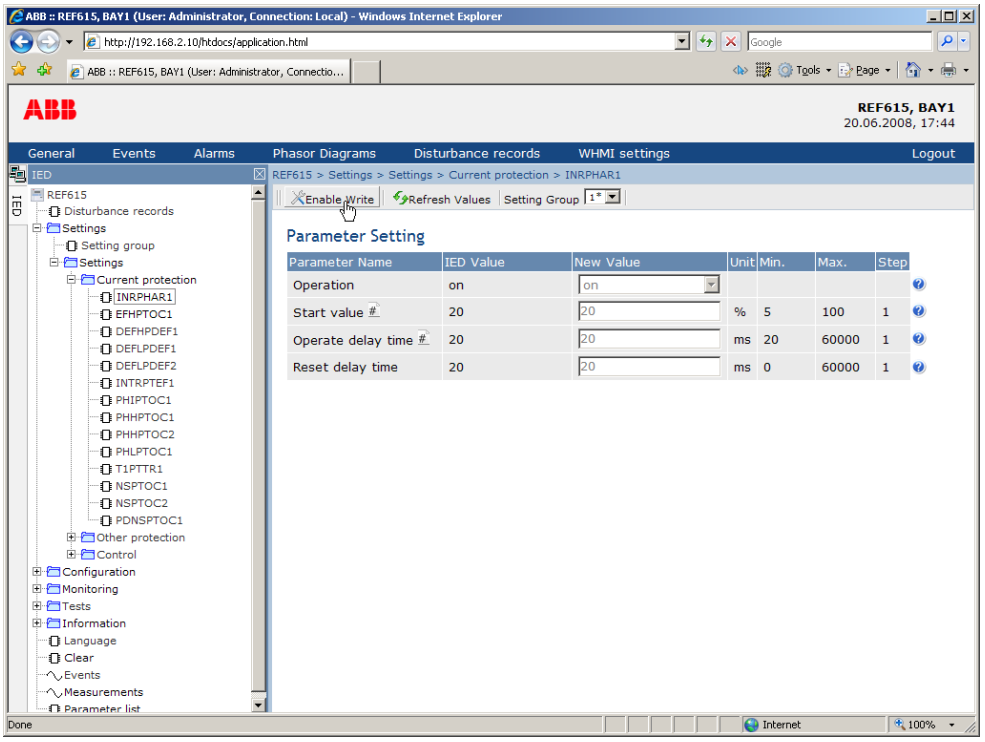


Figure 28: Enable writing to edit a value

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 #.

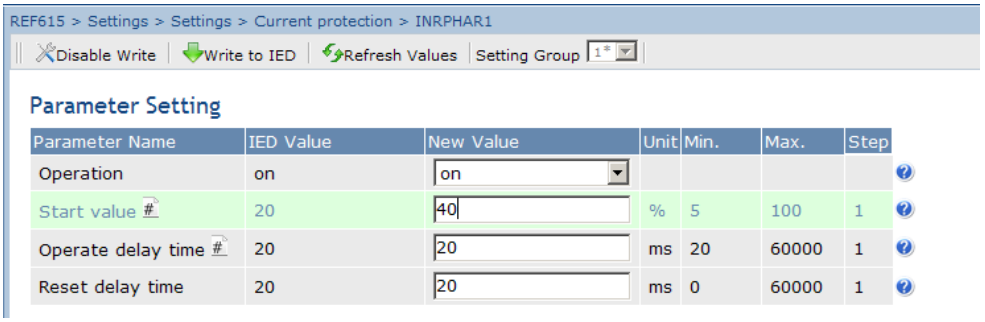


Figure 29: Editing a value

- 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.

Figure 30: Warning indicating that the entered value is incorrect

- If writing values fails, a warning dialog box is displayed.

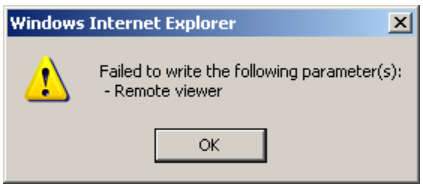


Figure 31: Warning indicating that the values were not written to the IED

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

4.2.7 Committing settings

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

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

1. Click **Write to IED** after editing parameter values to put the values into IED's database for use.

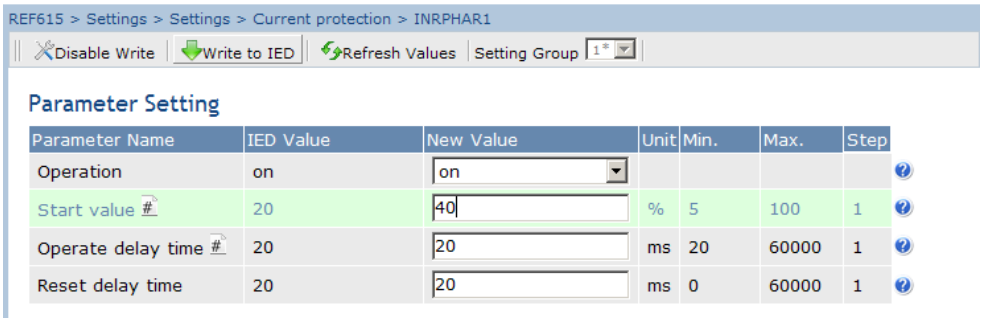


Figure 32: Writing values to IED

The values are not stored to the flash memory.

2. Click **Commit** to write the values to the flash memory.

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

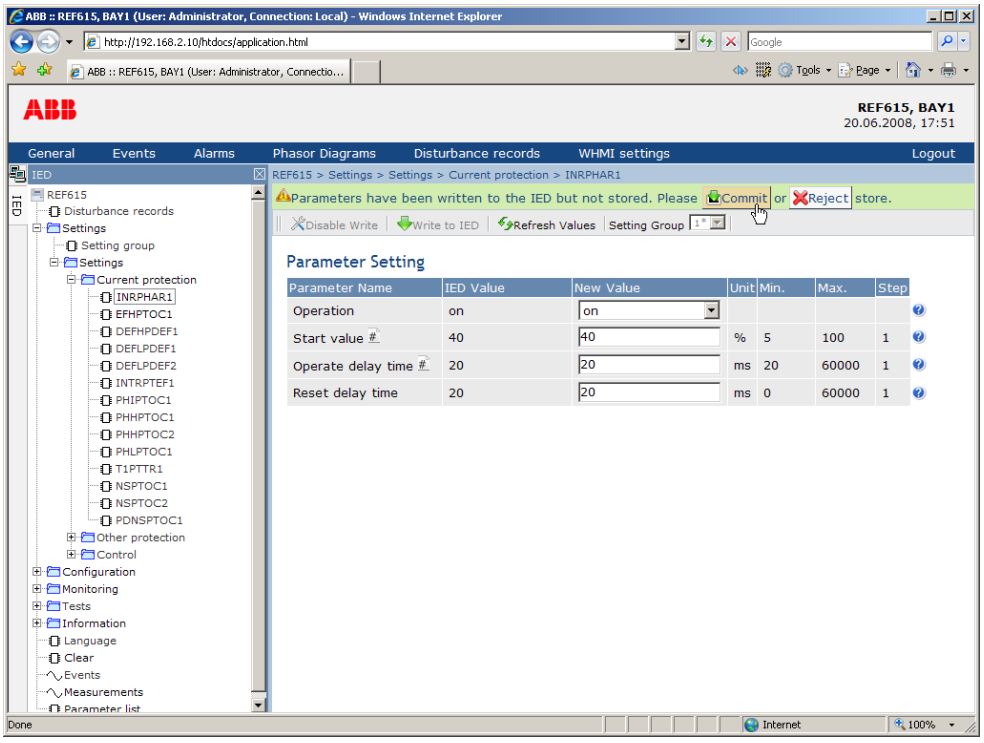


Figure 33: Committing changes

Committing values will take 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

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

1. Click the **Clear** menu.

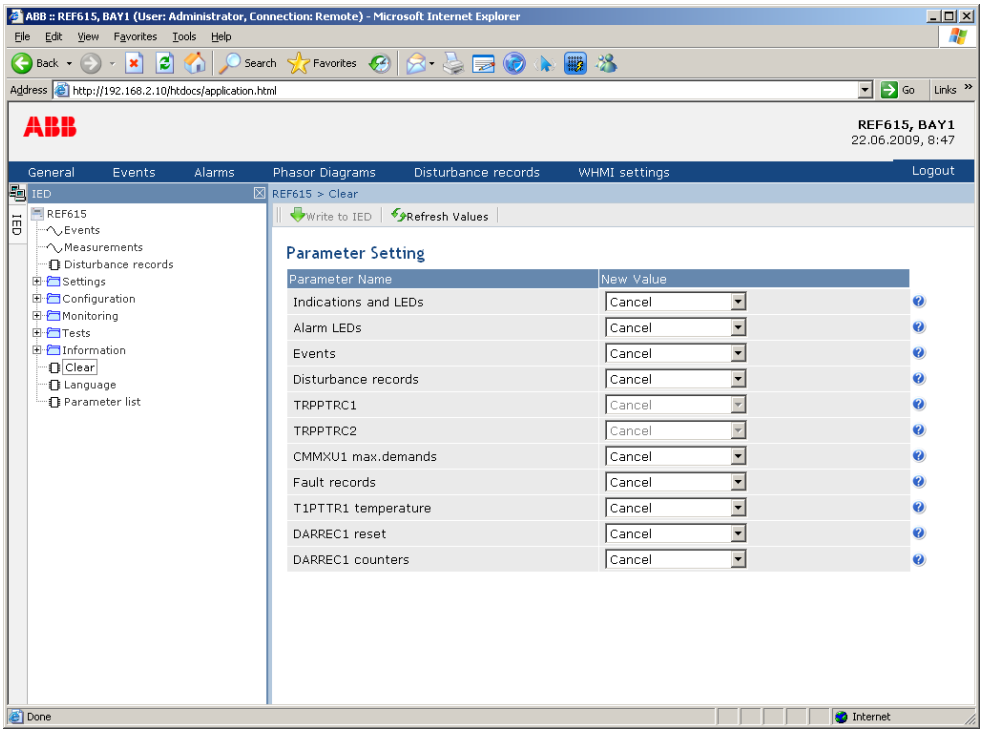


Figure 34: Selecting clear menu

2. In the **New Value** box, click **Clear** to select the item to be cleared.
3. Click **Write to IED**.
4. Click **Reject**.

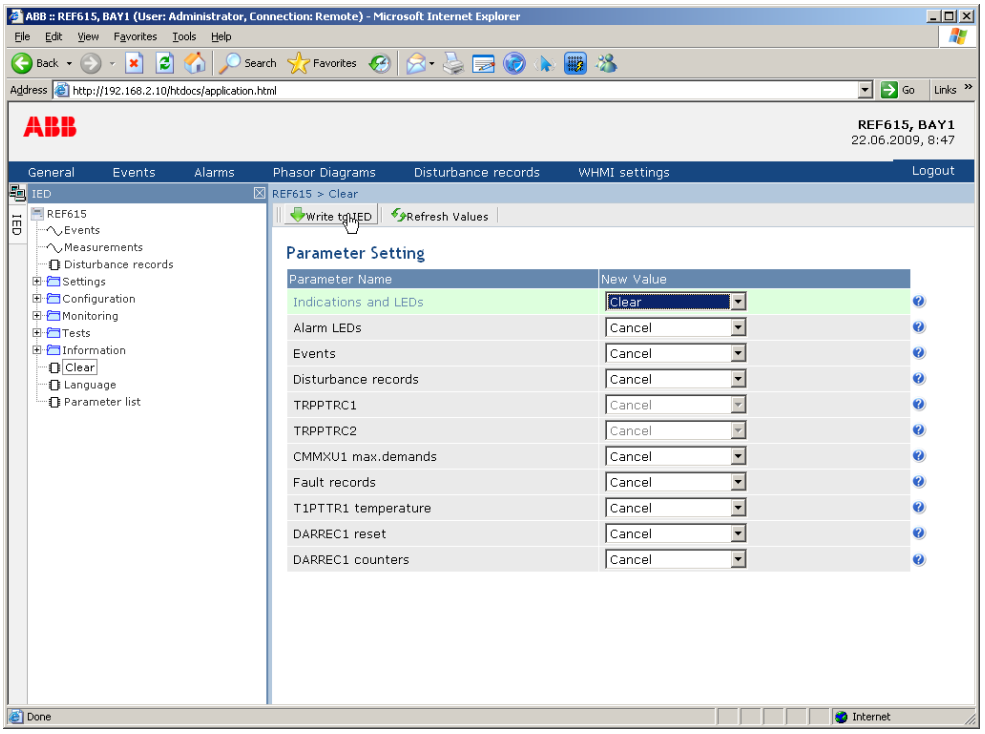


Figure 35: Clearing indications and LEDs

4.2.9 Selecting the alarm view

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

- Click **Alarms** in the menu bar.

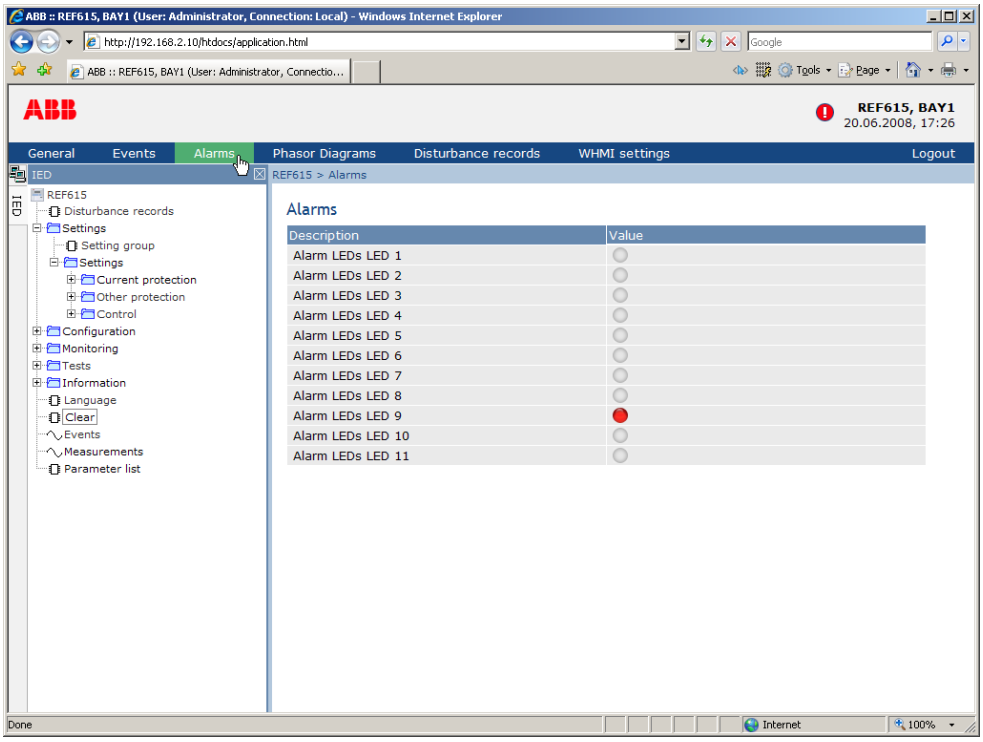


Figure 36: Monitoring alarms

4.2.10 Selecting the event view

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

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

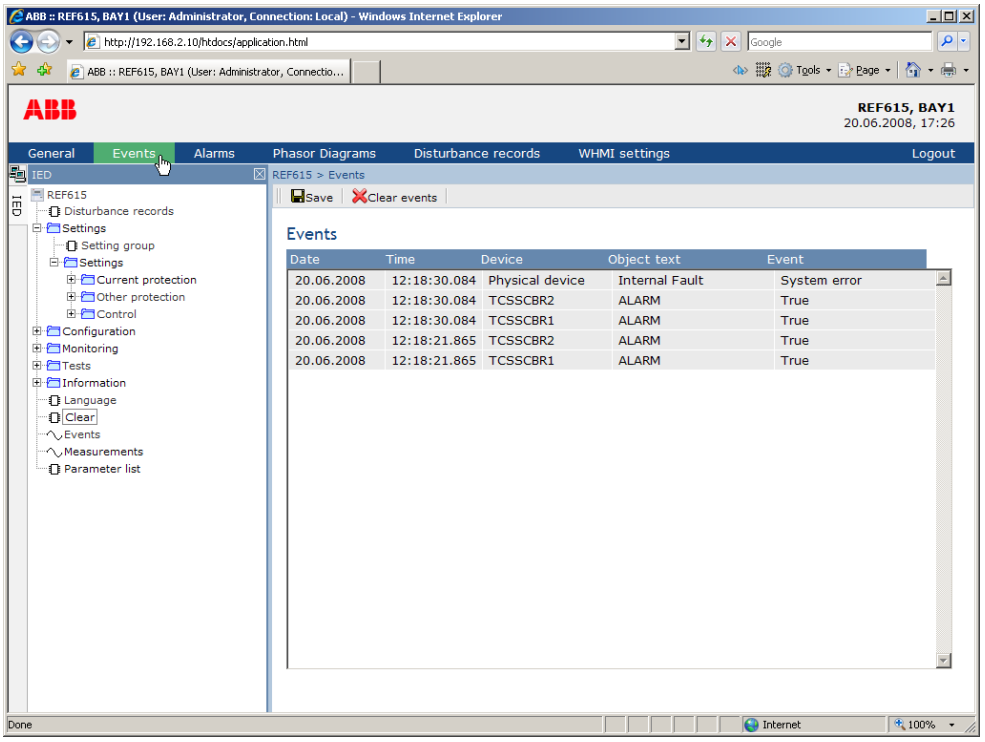


Figure 37: Monitoring events

2. Click **Save** to save the events in CSV file format.
   The CSV file can be opened with a spreadsheet program such as OpenOffice.org Calc or Microsoft Excel.
3. Click **Clear events** to clear all events from the IED.

4.2.11 Selecting the disturbance record view

Disturbance records are listed in the disturbance records view.

- Click **Disturbance records** on the menu bar.

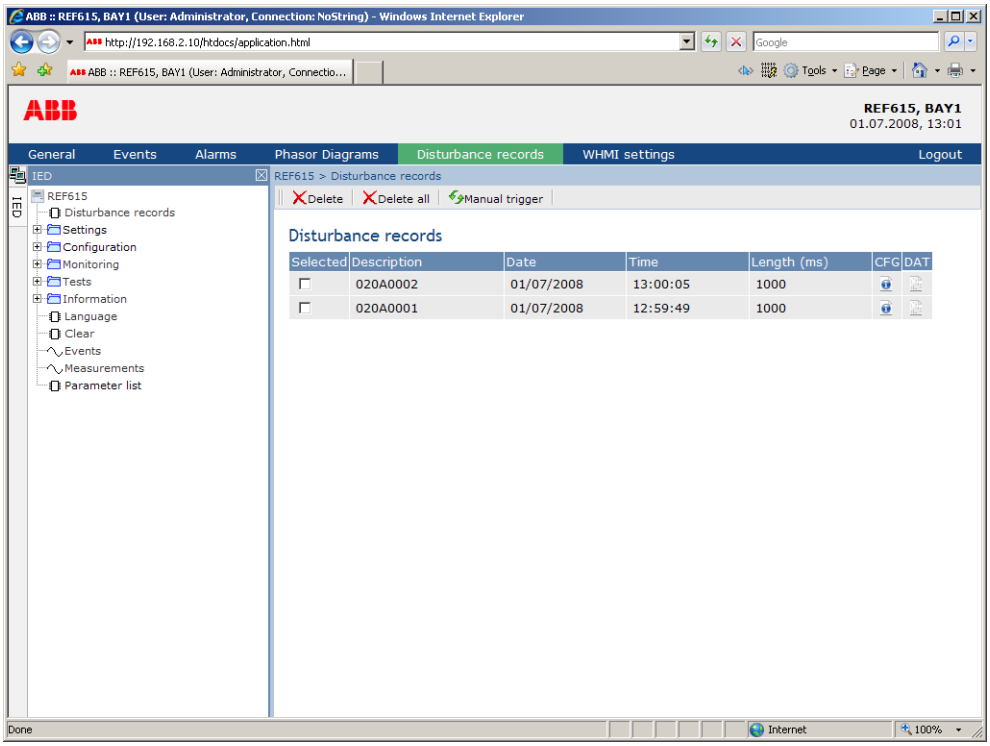


Figure 38: Disturbance record view

4.2.11.1 Uploading disturbance records

1. Click **Disturbance records** on the menu bar.
2. To upload a disturbance record, click the icons in the CFG and DAT columns of the record.

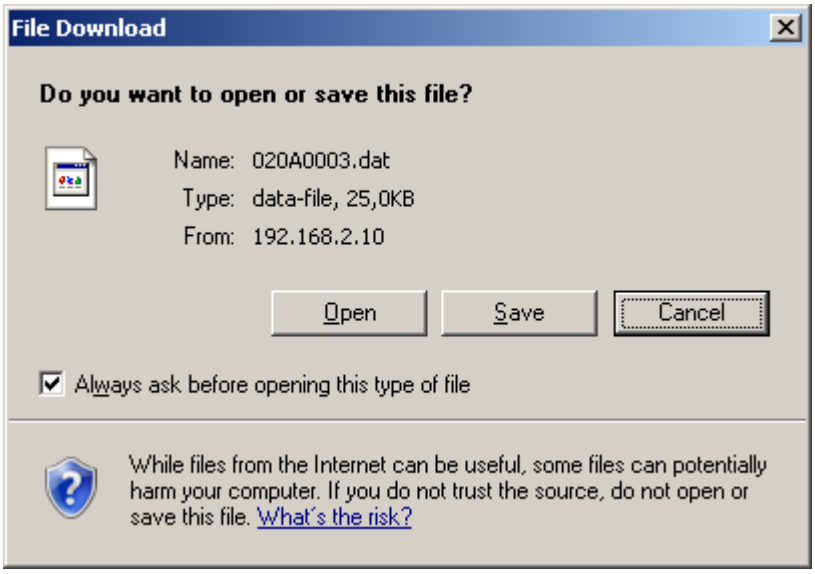


Figure 39: Uploading a disturbance record

3. Save both the files in the same folder on your computer.
4. Open the disturbance record files with a suitable program.

4.2.11.2 Triggering the disturbance recorder manually

1. Click **Disturbance records** on the menu bar.
2. Click **Manual trigger**.

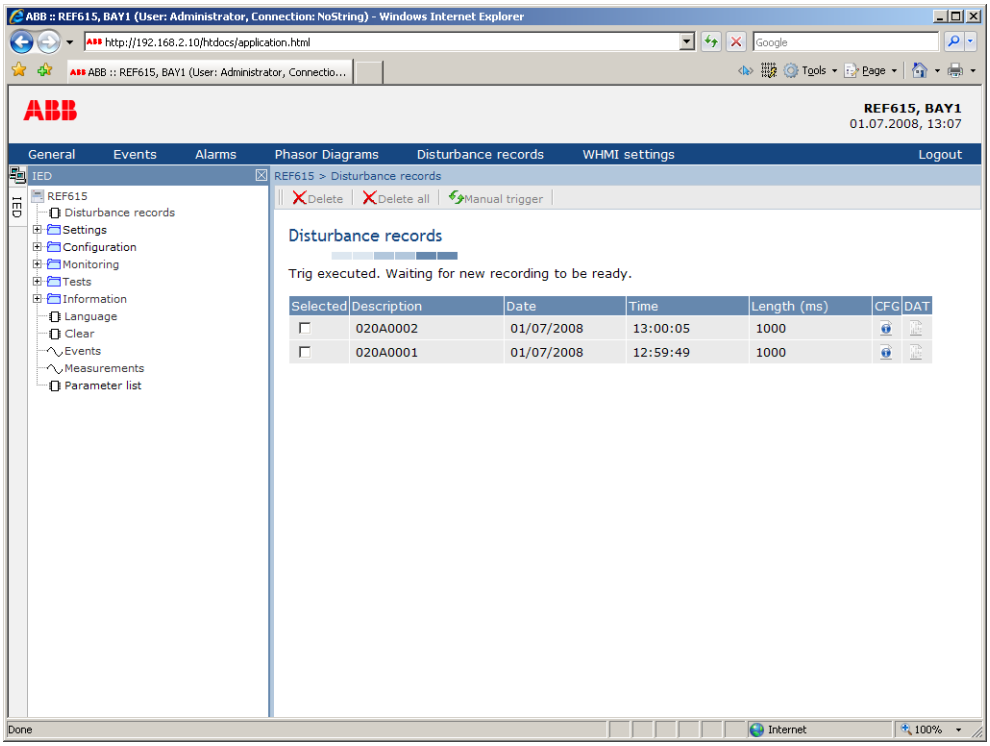


Figure 40: Manual triggering

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.

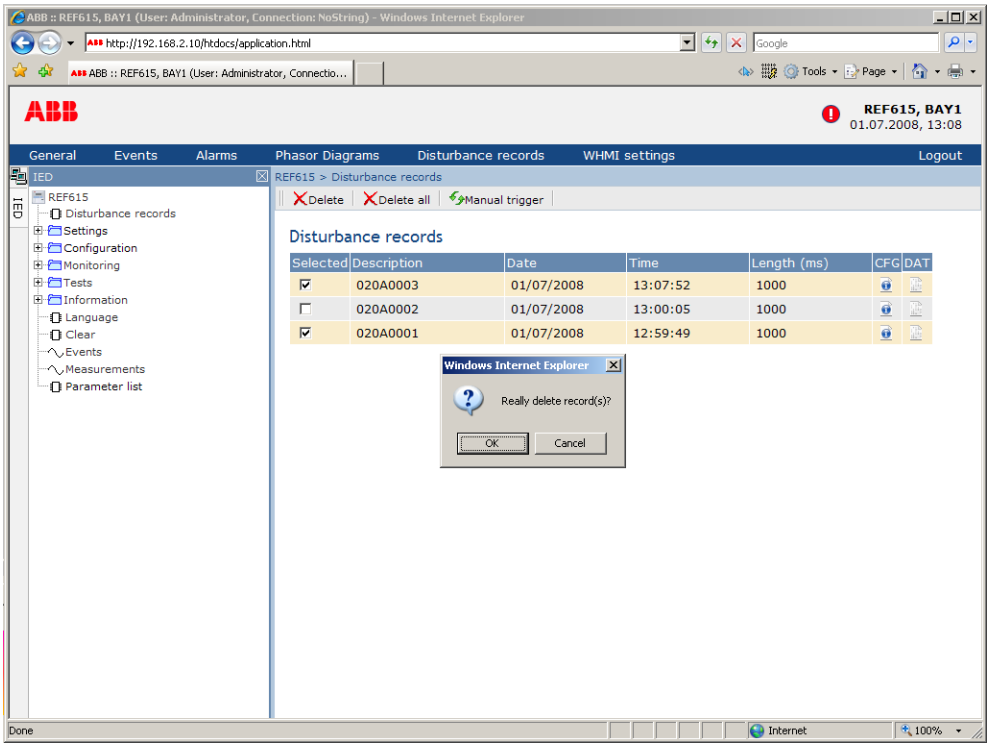


Figure 41: Deleting disturbance records

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

4.2.12 Selecting phasor diagrams

1. Click **Phasor diagrams** in the menu bar.

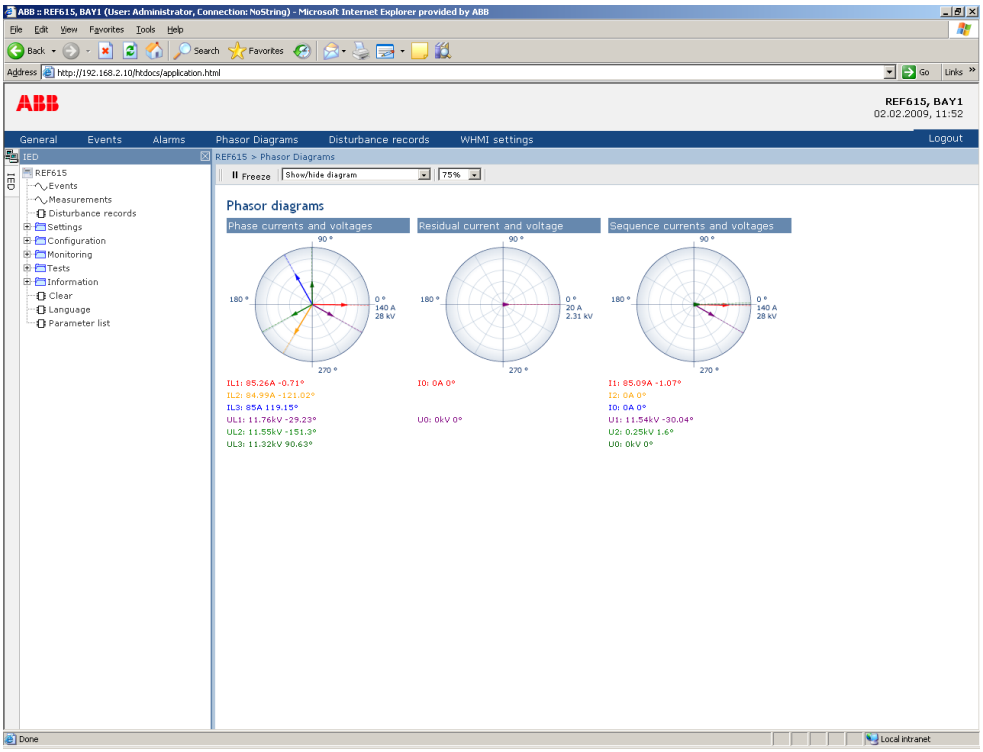


Figure 42: Monitoring phasors

2. Toggle the diagram visibility by selecting it from the drop-down menu.

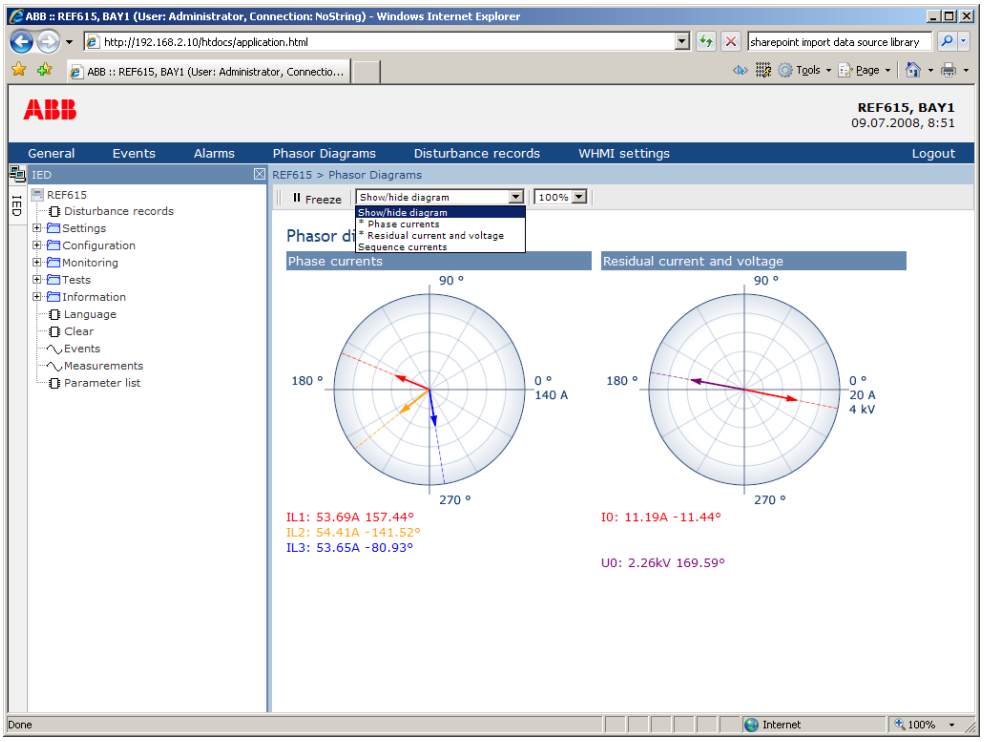


Figure 43: Toggling the diagram visibility

Visible diagrams are indicated with an asterisk *.

3. Change the size of the diagram by changing the zoom value.

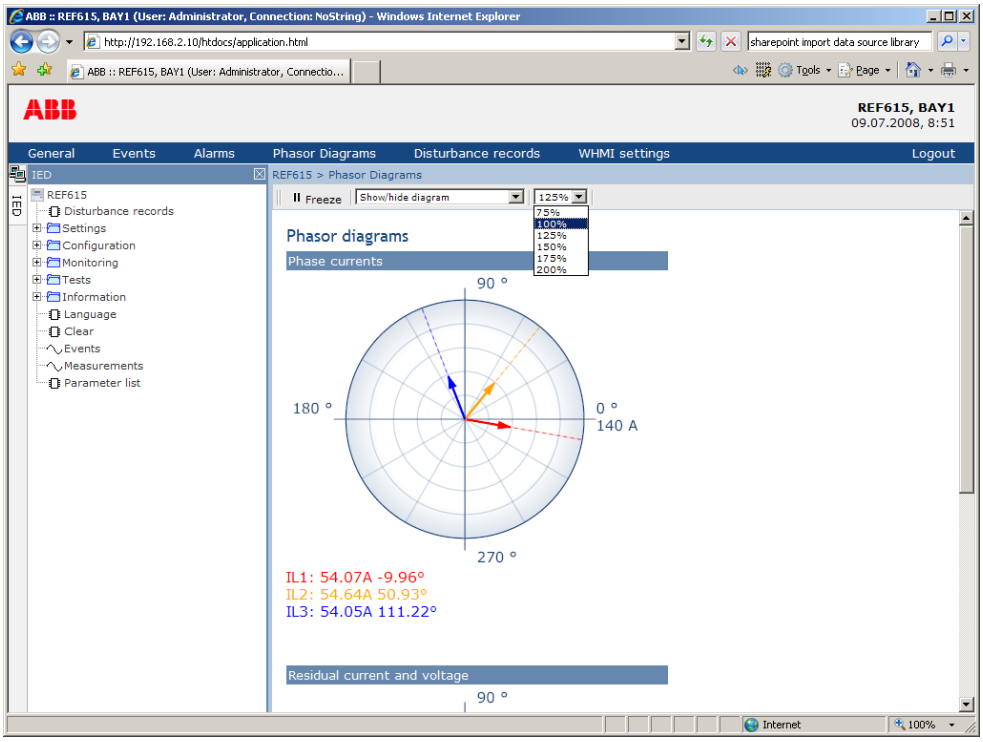


Figure 44: Zooming the diagram

4. Click **Freeze** to stop updating the phasor diagram.
No updates are displayed in the diagram.

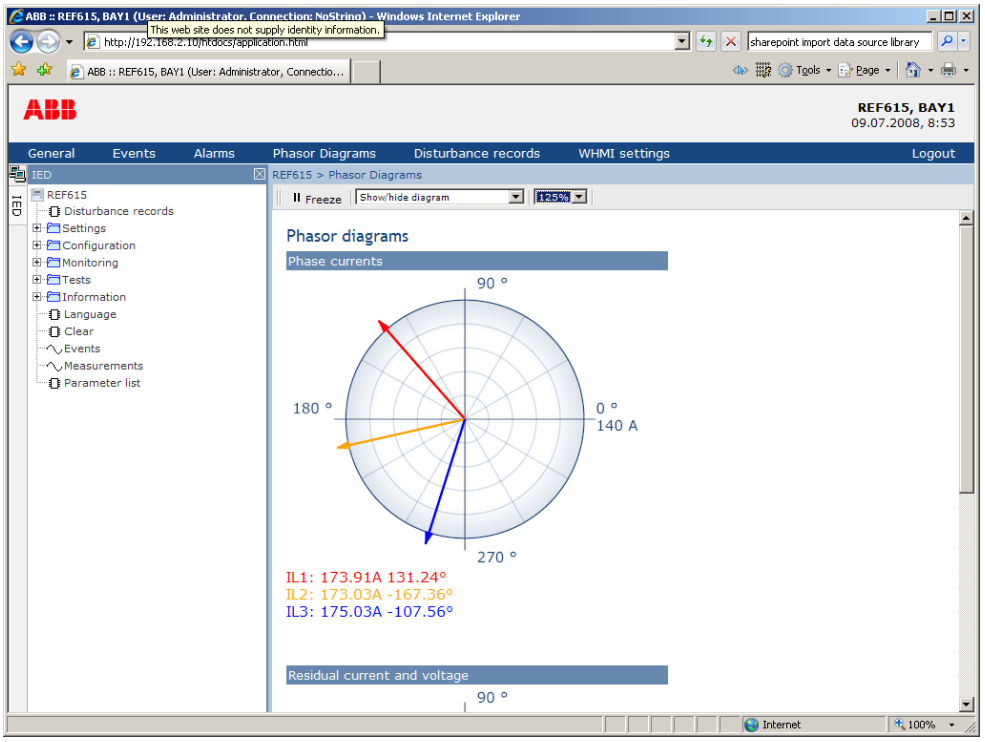


Figure 45: The arrow extends outside the circle if the current value is too high

Install an SVG plugin to view the phasor diagrams.

4.2.13 Using the Web HMI help

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

1. Click .
   The help dialog box is displayed.

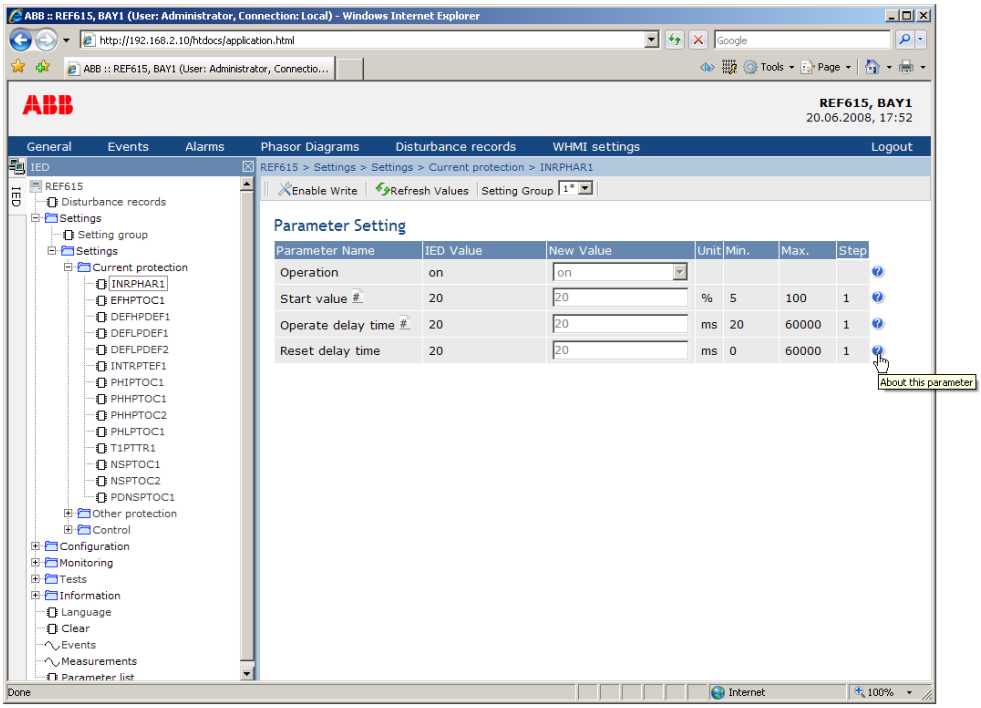


Figure 46: Opening the WHMI help

2. To close the help dialog box, click **OK**.

Section 5 IED operation

5.1 Normal operation

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

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

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

For more information, see PCM600 documentation.

5.2 Disturbance identification

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

Table 14: 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 alarm LEDs
- Reading event history
- Checking fault records
- Analyzing disturbance recordings

Document the disturbance before clearing the information from the IED.

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

5.2.1 Disturbance recording triggering

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

5.2.2 Disturbance record analysis

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

For more information, see PCM600 documentation.

5.2.3 Disturbance reports

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

For more information, see PCM600 documentation.

5.2.4 Internal IED errors

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

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

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

The IED records system registrations, IED status data and events.

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

5.3 IED parametrization

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

Document all changes to parameter settings.

For more information, see PCM600 documentation.

5.3.1 IED settings for IED functionality

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

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

5.3.2 IED settings for different operating conditions

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

Section 6 Operating procedures

6.1 Monitoring

6.1.1 Indications

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

- Three indicator LEDs with fixed functionality: Ready, Start and Trip
- 11 programmable alarm LEDs
- A text message on the display.

6.1.1.1 Monitoring indication messages

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

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.

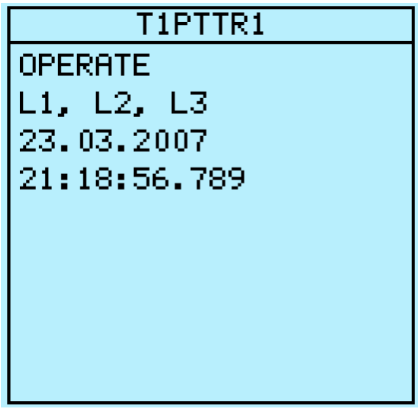


Figure 47: Indication message

6.1.1.2 Monitoring an internal IED fault

The flashing green LED indicates an internal IED fault. Internal IED fault messages are shown in a dialog box.

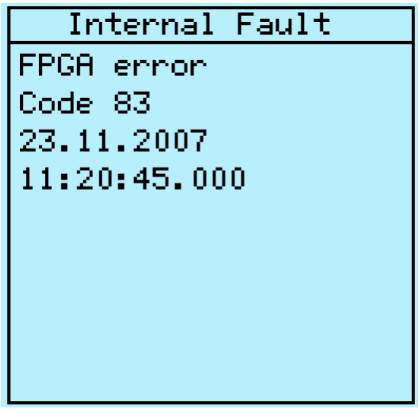


Figure 48: Fault indication

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.

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

6.1.2 Measured and calculated values

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

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

6.1.2.1 Measured values

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

Table 15: 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
U23-kV	Measured phase-to-phase voltage U23
U31-kV	Measured phase-to-phase voltage U31
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 IED's basic measurements is shown.
2. Scroll the view with  and  .

6.1.3 Recorded data

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

- Disturbance records
- Fault records
- Events

6.1.3.1 Creating disturbance recordings

Normally disturbance recordings are triggered by the IED 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.

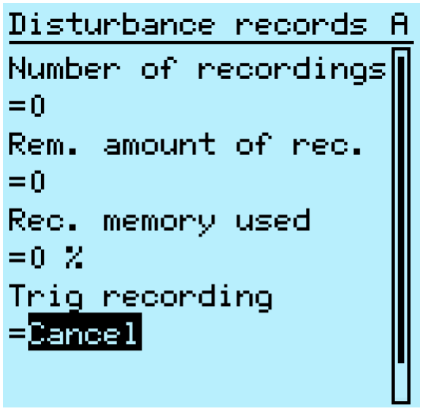


Figure 49: Changing the value

The disturbance recorder is now triggered.

6.1.3.2 Monitoring disturbance recorder data

Upload individual disturbance recordings from the IED 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 IED 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.

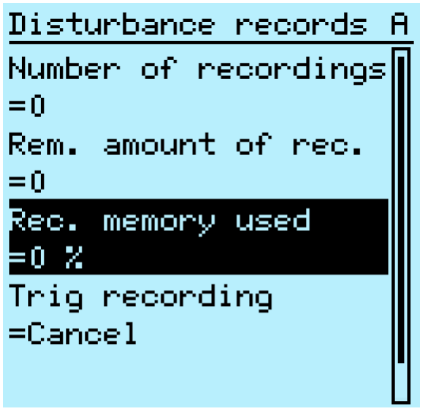


Figure 50: Monitoring disturbance recorder via the LHMI

6.1.3.3 Controlling and uploading disturbance recorder data

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

For more information, see PCM600 documentation.

6.1.3.4 Monitoring fault records

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

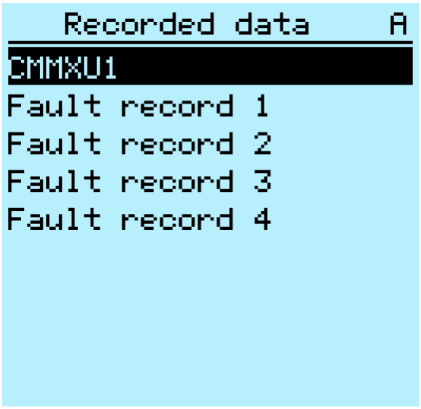


Figure 51: Monitoring fault records

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.

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

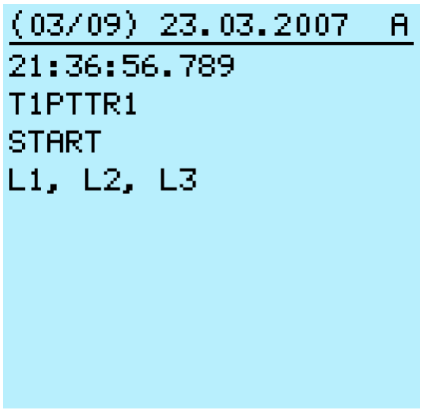


Figure 52: Monitoring events

6.1.4 Remote monitoring

The IED supports comprehensive remote monitoring.

6.1.4.1 Operating the IED remotely

Use the PCM600 tool and WHMI to operate the IED remotely.

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

For more information, see PCM600 documentation.

6.2 Controlling

6.2.1 Controlling circuit breakers or disconnectors

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

1. Press O to open or I to close the object.
2. Enter the password when prompted.
3. To confirm the operation, select Yes and press ↵.

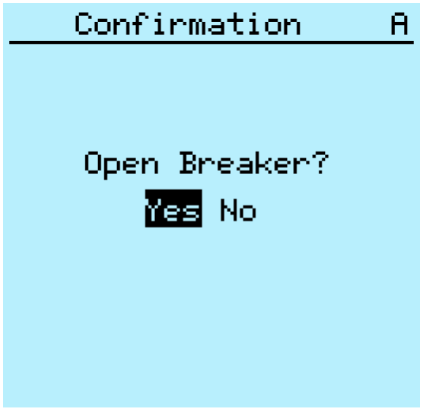


Figure 53: Opening circuit breaker

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

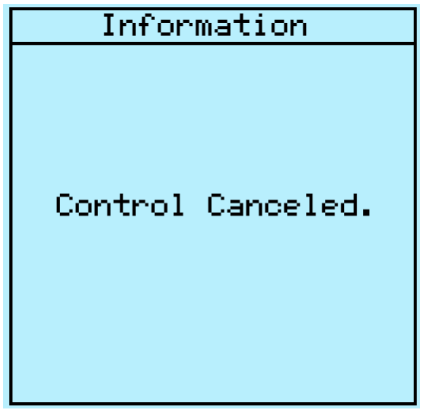


Figure 54: Cancelling operation

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.

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 recordings can be reset, acknowledged or cleared with the Clear button. Pressing the Clear button activates a menu for selecting the wanted clearance or reset function. Events and alarms assigned to alarm LEDs can also be cleared with the Clear button.

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

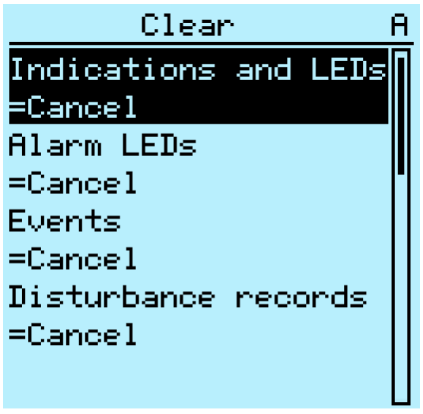


Figure 55: Clear view

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 Clear button as a shortcut for clearing. The first three-second press clears the indications. The second three-second press clears the alarm LEDs.

6.4 Changing the IED functionality

6.4.1 Defining the setting group

6.4.1.1 Activating a setting group

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

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

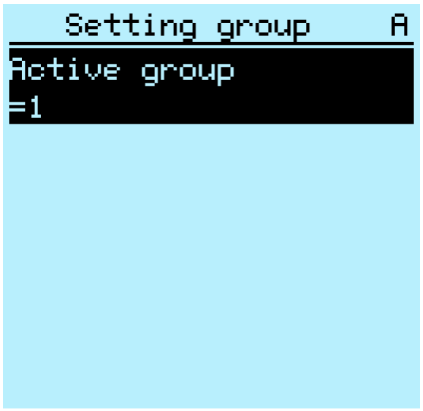


Figure 56: Active setting group

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

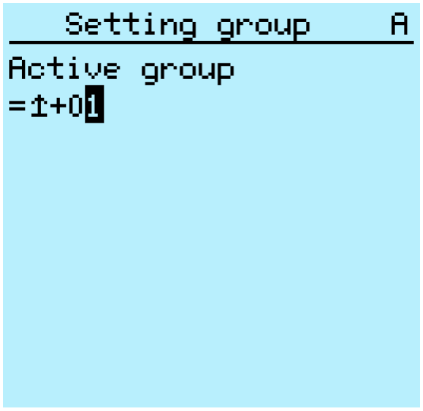


Figure 57: Selecting the active setting group

4. Commit the settings.

Remember to document the changes you make.

6.4.1.2 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.

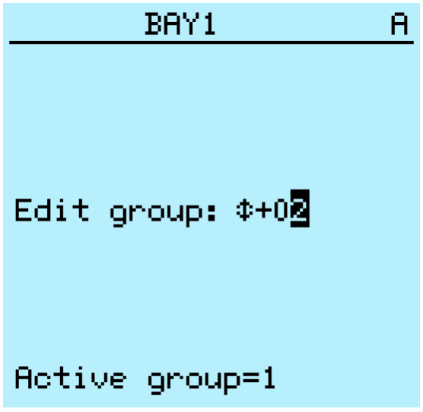


Figure 58: Selecting a setting group

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 #.

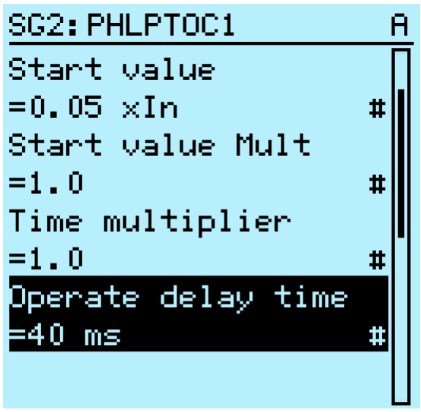


Figure 59: Setting group parameter

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

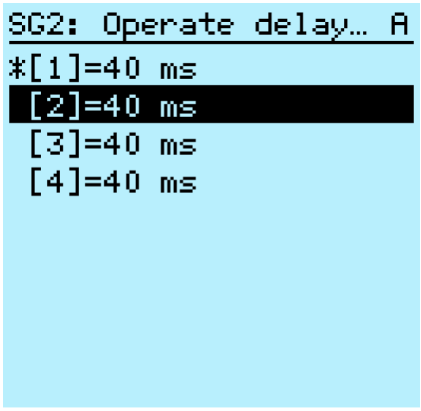


Figure 60: Selecting the setting group value

Only values within the selected setting group can be changed.

7. Press or to change the value and to confirm the selection.

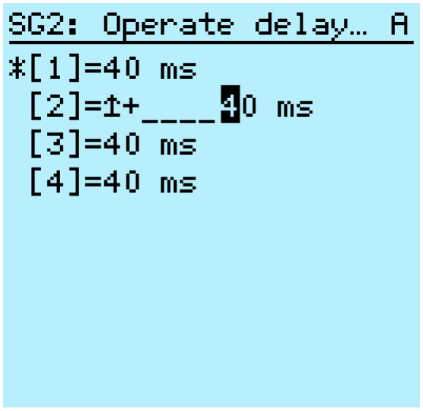


Figure 61: Editing the setting group value

The active setting group is indicated with an asterisk * .

6.4.2 Activating LEDs

1. Select **Main menu/Configuration/Alarm LEDs** and press →.
2. Select an Alarm LED with ↑ or ↓.
3. Press ↵ to confirm the selection and to change the Alarm LED mode.
4. Press ↑ or ↓ to change the value and ↵ to confirm the selection.

For more information, see PCM600 documentation.

Section 7 Troubleshooting

7.1 Fault tracing

7.1.1 Identifying hardware errors

1. Check the module with an error.
   Check the IED supervision events in **Main menu/Monitoring/IED status/Self-supervision** for a faulty hardware module.
2. Inspect the IED visually.
   - Inspect the IED visually to find the physical error causes.
   - If you can find some obvious physical damage, contact ABB for repair or replacement actions.
3. Check whether the error is external or internal.
   - Check that the error is not caused by external origins.
   - Remove the wiring from the IED and test the input and output operation with an external test device.
   - If the problem remains, contact ABB for repair or replacement actions.

7.1.2 Identifying runtime errors

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

7.1.3 Identifying communication errors

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

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

7.1.3.1 Checking the communication link operation

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

Table 16: Communication LEDs

LED	Communication ok
Uplink	Steady green light
Communication	Flashing yellow light

7.1.3.2 Checking the 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 IED. You can also run the display test manually.

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

7.2 Indication messages

7.2.1 Internal faults

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

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

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

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

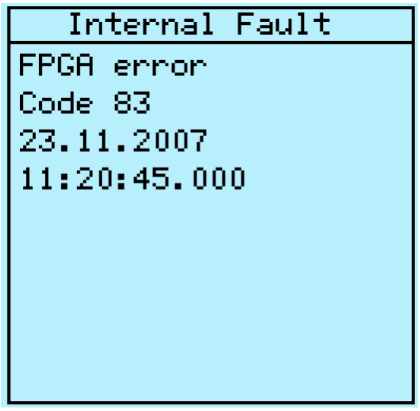


Figure 62: Fault indication

Table 17: 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),X110	44	Faulty Signal Output relay(s) in card located in slot X110.
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),X110	54	Faulty Power Output relay(s) in card located in slot X110.
Internal Fault PO-relay(s),X130	56	Faulty Power Output relay(s) in card located in slot X130.
Internal Fault Light sensor error	57	Faulty ARC light sensor input(s).
Internal Fault Conf. error,X000	62	Card in slot X000 is wrong type.
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,X110	64	Card in slot X110 is wrong type, is missing 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.

Table continues on next page

Fault indication	Fault code	Additional information
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.
Internal Fault Card error,X110	74	Card in slot X110 is faulty.
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.

7.2.2 Warnings

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

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

Figure 63: Warning

Table 18: 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.
Warning Modbus error	21	Error in the Modbus communication.
Warning DNP3 error	22	Error in the DNP3 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 Unack card comp.	40	A new composition has not been acknowledged/accepted.
Warning Protection comm.	50	Error in protection communication.

Table continues on next page

Warning indication	Warning code	Additional information
Warning ARC1 cont. light	85	A continuous light has been detected on the ARC light input 1.
Warning ARC2 cont. light	86	A continuous light has been detected on the ARC light input 2.
Warning ARC3 cont. light	87	A continuous light has been detected on the ARC light input 3.

7.2.3 LED and display messages

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

7.3 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 IED 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.

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 again

The IED 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 IED restarts.

Avoid 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.

7.3.3 Setting the password

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

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

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

7.3.4 Identifying IED 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 the wiring

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

- 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 IEDs 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 IED's internal faults, contact ABB for repair or replacement actions.

Section 8 Commissioning

8.1 Commissioning checklist

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

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

8.2 Checking the installation

8.2.1 Checking the power supply

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

8.2.2 Checking CT circuits

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

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

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

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

8.2.3 Checking VT circuits

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

Do not continue before any errors are corrected.

Test the circuitry. The following tests are recommended:

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

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

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

8.2.4 Checking binary input and output circuits

8.2.4.1 Binary input circuits

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

8.2.4.2 Binary output circuits

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

8.3 Authorizations

8.3.1 User authorization

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

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

- Numbers 0-1
- Letters a-z, A-Z
- Space
- Special characters !"#%&'()*+´-./:;<=>?@[\]^_`{|}~

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

Table 19: Predefined user categories

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 IED parameters, but no operation rights
ADMINISTRATOR	0004	remote0004	Full access

For user authorization for PCM600, see PCM600 documentation.

8.4 Using PCM600

8.4.1 Setting the communication between IEDs and PCM600

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

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

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

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

To configure the physical connection and the IP addresses:

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

8.4.1.1 Communication options

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

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

Point to point link

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

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

LAN or WAN network

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

8.4.1.2 Setting communication parameters

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

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

Setting the front communication

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

1. To open Network Connections, click **Start**, point to **Settings**, click **Control Panel**, and then double-click **Network Connections**.
2. Double-click the connection that you want to configure, and then click **Properties**.
3. Select the TCP/IP protocol from the list of configured components using this connection and click **Properties**.

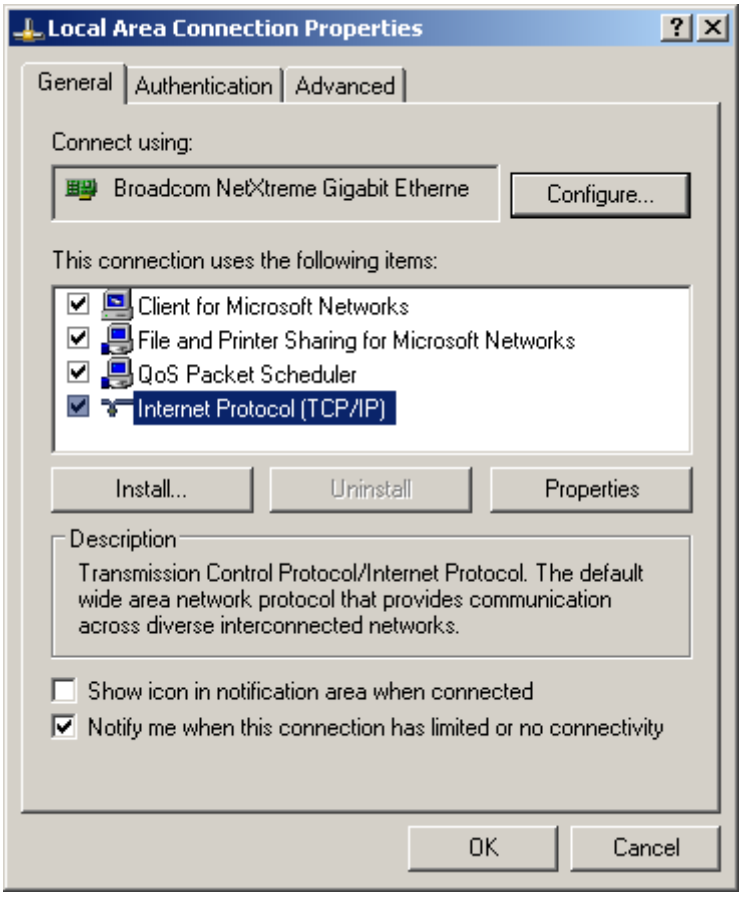


Figure 64: Selecting TCP/IP protocol

4. Select **Obtain an IP address automatically** and **Obtain DNS server address automatically**.

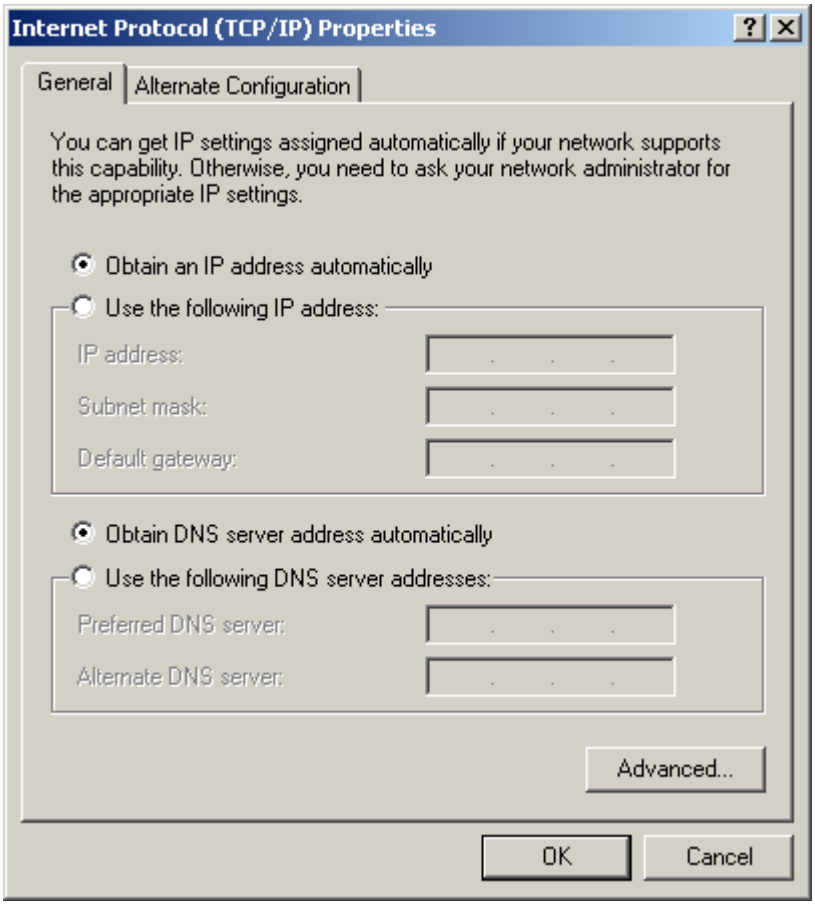


Figure 65: Obtaining IP address automatically

5. Close all open windows by clicking **OK** and start PCM600.

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

Setting the rear communication

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

1. To open Network Connections, click **Start**, point to **Settings**, click **Control Panel**, and then double-click **Network Connections**.
2. Double-click the connection that you want to configure, and then click **Properties**.
3. Select the TCP/IP protocol from the list of configured components using this connection and click **Properties**.

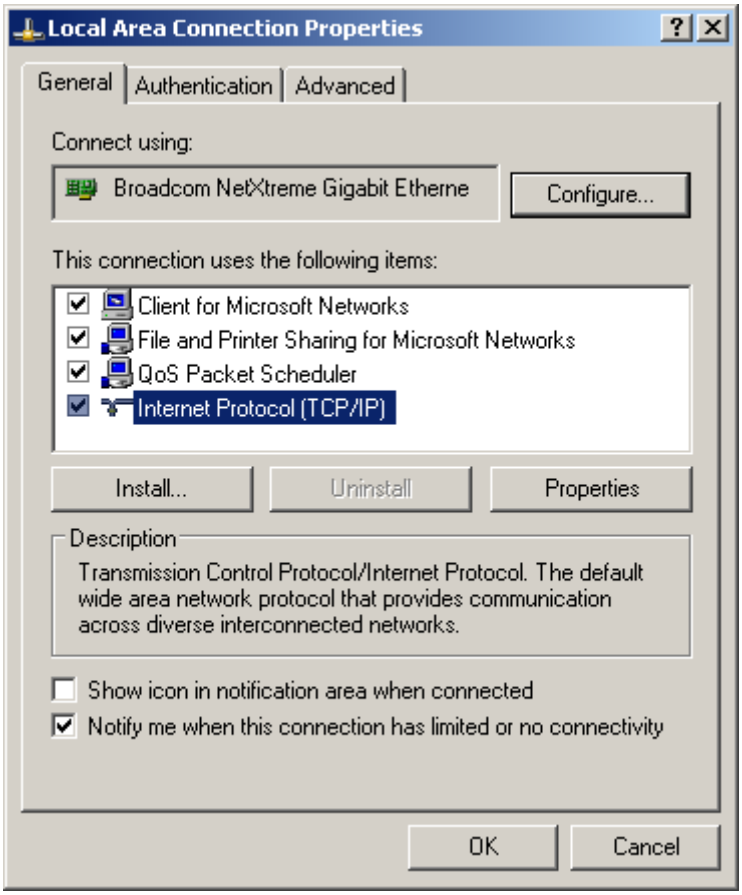


Figure 66: Selecting TCP/IP protocol

4. Choose **Use the following IP address**. Enter an IP address and a subnet mask. Make sure that the IP address is unique, that is not used by any other IED on the network.

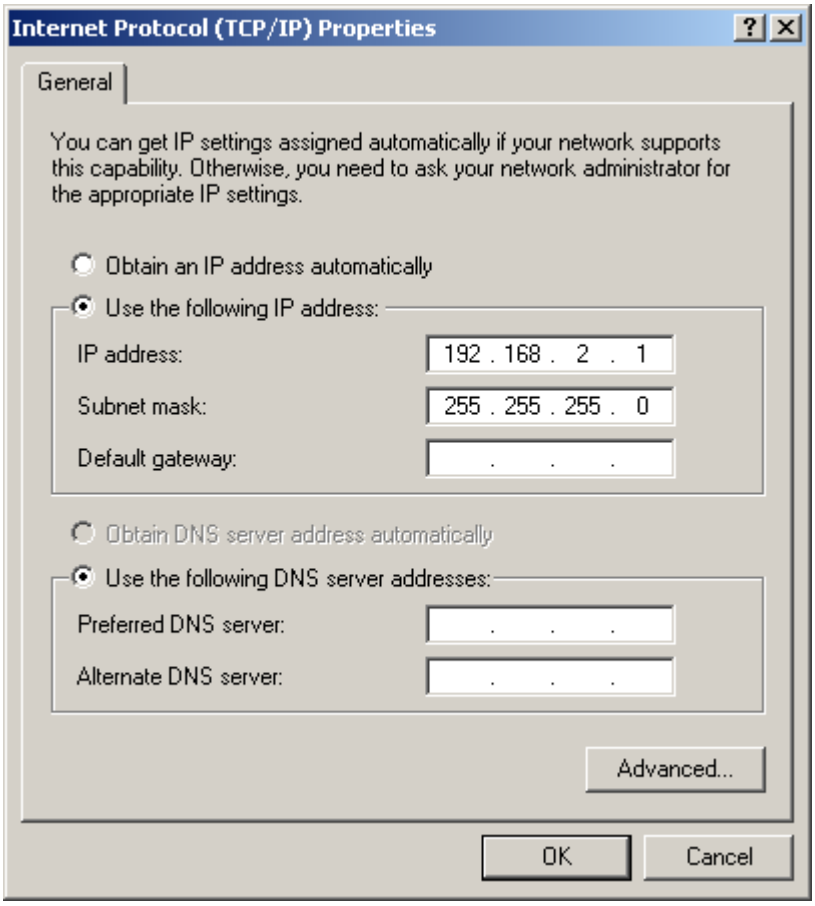


Figure 67: Setting IP address and subnet mask

5. Close all open windows by clicking **OK** and start PCM600.

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

Setting IED's IP address in PCM600

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

1. Select the IED to which you want to define the IP address.
2. Open the Object Properties window.
3. Place the cursor in the IP Address row and enter the IP address.

The used method depends on the time at which the IP address is available. Defining IP address in the Object Properties windows allows changing the IP address at any time.

8.5 Setting IED and communication

8.5.1 Communication settings

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

Different communication ports are available via optional communication modules. There are four options for rear port communication intended mainly for station level communication, that is station bus. The options are galvanic Ethernet (RJ-45), optical Ethernet (LC), optical ST-type glass fibre serial and RS-485/RS-232 twisted pair. Communication protocols used via Ethernet ports are IEC 61850-8-1, Modbus TCP/IP and DNP3 TCP/IP. Protocols available for serial communication are Modbus RTU/Modbus ASCII, DNP3 and IEC 60870-5-103.

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

8.5.1.1 Serial communication ports and drivers

Depending on the hardware configuration, the IED can be equipped with one or several UART-based serial communication ports. The communication ports can be either galvanic (RS-485, RS-232) or fibre-optic. The IED 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 IED 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 IED usually supports a variety of different communication hardware options, all COM port driver setting parameters are not relevant for every communication hardware type.

Table 20: 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	

Table continues on next page

COM parameter	Values	Hardware options[1)]
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	
	2 = RS232 no handshake	
	3 = RS232 with handshake	
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. Select the desired serial port for the protocol instance 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.

8.5.1.2 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 21: 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.
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 22: 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 23: 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.
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 24: 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.

8.5.1.3 Defining Ethernet port settings

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

8.5.1.4 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 fibre or galvanic mode with the proper baud rate, parity and delays depending on the system architecture and the selected physical communication port.

8.5.1.5 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.

8.5.1.6 Connecting jumper connectors

See the technical manual for details on jumper connectors.

8.5.1.7 Communication checklist

1. Check the physical connections.
2. After the settings are changed, allow them to be stored in NVRAM (!S on LHMI).
   Reboot the unit to allow the setting changes to take effect in DNP3.
3. If the WHMI connection is missing, enable the IED's WHMI setting and prevent the Web browser from attempting to use a proxy **Internet Options/ Connections/LAN Settings/Advanced/Exceptions** (for example 192.168.*.*;).
4. Ping the unit.
   Verify that the IED has been correctly configured to accept messages with the master's IP address, DNP3 address, and so on.
5. Use the LHMI to enable the WHMI configuration if a ping response is received from the unit but the WHMI does not respond.
   5.1. Clear the browser of cached pages.
   5.2. Logout and log back in.
6. Install a TCP packet sniffer to see what is happening on the network.
7. Clear the ARP table.
8. See the IED's technical manual to determine if the jumpers on the communication board are correct.

DNP3 protocol ignores any parity setting in the COM settings group; DNP3 is defined as an 8 bit/no parity protocol with a 16-bit CRC every 16 bytes. This provides better error detection than parity.

8.5.2 Setting the local HMI

8.5.2.1 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 68: Changing the LHMI language

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

8.5.2.2 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 IED. After an auxiliary power failure, the contrast is restored.

8.5.2.3 Changing display symbols

To switch between the display symbols IEC 61850, IEC 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 IED has to be rebooted if the WHMI display symbols are changed. With the LHMI, the change takes effect immediately.

8.5.2.4 Changing the default view

The default view of the display is **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.

8.5.2.5 Setting the system time and time synchronization

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

Setting the daylight saving time

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

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

Table 25: DST change on Sunday

Day of the DST shift	DST on/off date
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:

DST on time:	01:00
DST on date:	25.03
DST on day:	Sun
DST off time:	01:00
DST off date:	25.10
DST off day:	Sun

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

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

8.5.3 Setting IED parameters

8.5.3.1 Defining setting groups

Selecting a setting group for editing

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

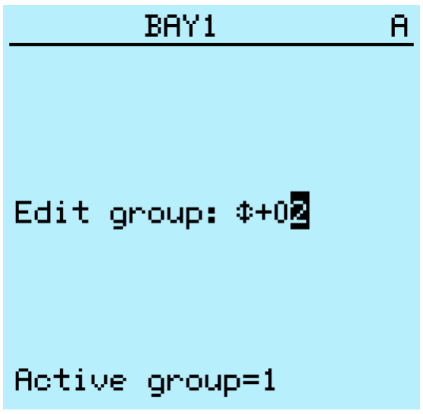


Figure 69: Selecting a setting group

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.

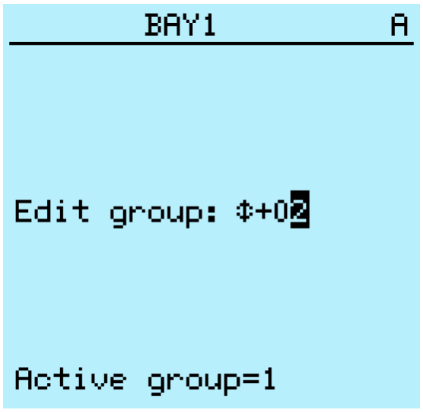


Figure 70: Selecting a setting group

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 #.

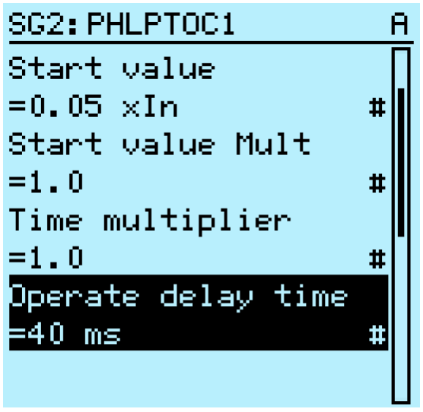


Figure 71: Setting group parameter

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

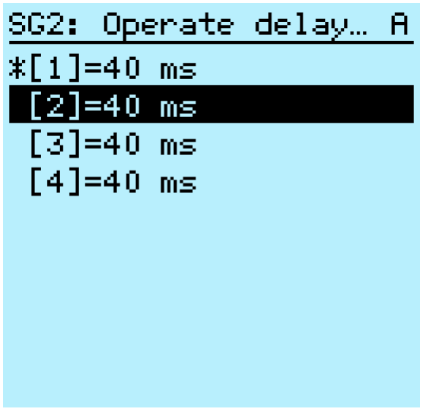


Figure 72: Selecting the setting group value

Only values within the selected setting group can be changed.

7. Press ↑ or ↓ to change the value and ↵ to confirm the selection.

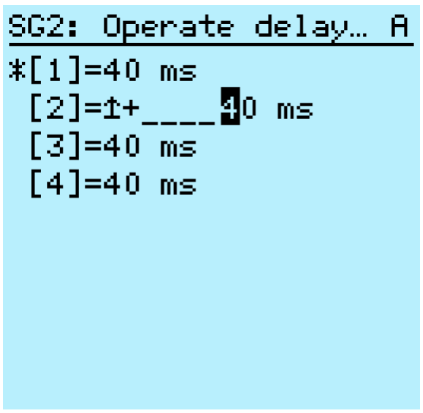


Figure 73: Editing the setting group value

The active setting group is indicated with an asterisk * .

Activating a setting group

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

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

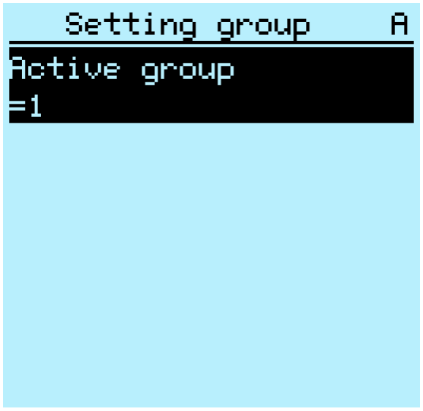


Figure 74: Active setting group

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

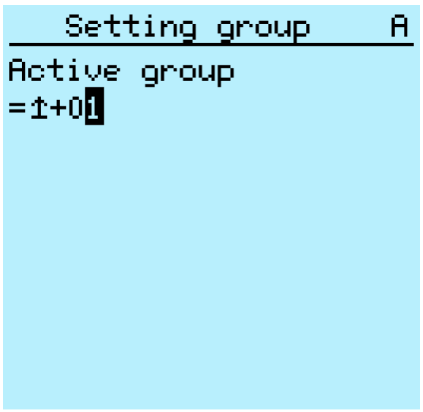


Figure 75: Selecting the active setting group

4. Commit the settings.

Remember to document the changes you make.

8.5.3.2 IED parametrization

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

Document all changes to parameter settings.

For more information, see PCM600 documentation.

8.5.3.3 Defining disturbance recorder channel settings

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

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

8.5.3.4 Configuring analog inputs

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

8.6 Testing IED operation

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

8.6.1 Selecting the test mode

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

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

1. Select **Main menu/Tests/IED test/Test mode** and press .

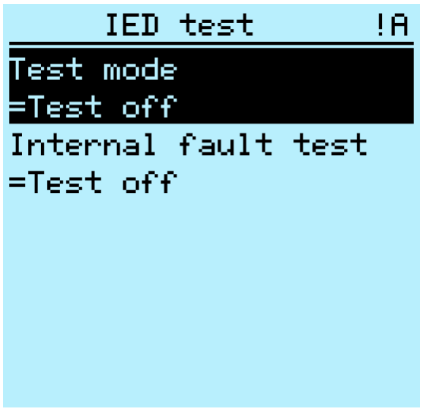


Figure 76: Entering test mode

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

If you do not cancel the test mode, it remains on and the Ready LED remains flashing.

8.6.2 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-Output 1** and press .
2. Select the value with or .
3. Press to confirm the selection.

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

8.6.3 Testing functions

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

1. Select **Main Menu/Tests/Function tests/Current protection/PHLPTOC** and press .
2. Select the output signal to be activated or deactivated with or and press .
3. To deactivate all output signals for the function, select `Reset` with or and press .

8.6.4 Selecting 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 will be blinking and internal fault test indication is shown on the LHMI. See Technical Manual for internal relay fault output contact location.

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

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

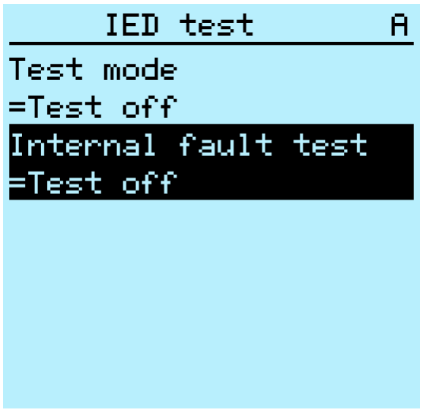


Figure 77: Internal fault test

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

8.7 ABB Product Data Registration

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

After a composition change, an LCT indication is seen on the LHMI at the IED start-up. At this point, PCM600 should be connected to the IED as it reads the changed data from the IED. The LCT indication is cleared in the same way as other indications. If PCM600 is not connected to the IED, the indication is seen again after the IED's reboot.

Figure 78: 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-TX	A physical media 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
ANSI	American National Standards Institute
ARP	Address Resolution Protocol
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.
Connectivity Package Manager	Software that helps the user to define right connectivity package versions for different applications and tools
CPU	Central processing unit
CSV	Comma-separated values
CT	Current transformer
DHCP	Dynamic Host Configuration Protocol
DMS	Distribution Management System
DNP3	A distributed network protocol originally developed by Westronic. The DNP3 Users Group has the ownership of the protocol and assumes responsibility for its evolution.
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
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
GOOSE	Generic Object Oriented Substation Event
HMI	Human-machine interface
HW	Hardware

IEC	International Electrotechnical Commission
IEC 60870-5-103	Communication standard for protective equipment; A serial master/slave protocol for point-to-point communication
IEC 61850	International standard for substation communication and modelling
IEC 61850-8-1	A communication protocol based on the IEC 61850 standard series and a standard for substation modelling
IED	Intelligent electronic device
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.
LAN	Local area network
LC	Connector type for glass fibre cable
LCD	Liquid crystal display
LCP	Liquid crystal polymer
LCT	Life cycle traceability
LED	Light-emitting diode
LHMI	Local human-machine interface
Modbus	A serial communication protocol developed by the Modicon company in 1979. Originally used for communication in PLCs and RTU devices.
Modbus ASCII	Modbus link mode. Character length 10 bits.
Modbus RTU	Modbus link mode. Character length 11 bits.
Modbus TCP/IP	Modbus RTU protocol which uses TCP/IP and Ethernet to carry data between devices
NCC	Network control center
OPC	Object linking and embedding for process control
PA	Polyamide
PBT	Polybutylene terephthalate
PC	Personal computer; Polycarbonate
PCM600	Protection and Control IED Manager
R/L	Remote/Local
RAM	Random access memory
RJ-45	Galvanic connector type

RoHS	Restriction of the use of certain hazardous substances in electrical and electronic equipment
ROM	Read-only memory
RS-232	Serial interface standard
RS-485	Serial link according to EIA standard RS485
RTC	Real-time clock
SCADA	Supervision, control and data acquisition
SCL	Substation configuration language
SMT	Signal Matrix Tool in PCM600
ST	Connector type for glass fibre cable
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

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