Relion® Protection and Control

620 series
Operation Manual

Power and productivity
for a better world™

ABB

Document ID: 1MAC306723-MB
Issued: 10/09/2015
Revision: C
Product version: 1.2

Copyright

Disclaimer

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

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

Conformity

This product complies with the directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive 2004/108/EC) and concerning electrical equipment for use within specified voltage limits (Low-voltage directive 2006/95/EC). This conformity is the result of tests conducted by ABB in accordance with the product 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 relay is designed in accordance with the international standards of the IEC 60255 series and ANSI C37.90.

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 relay has to be carefully grounded.

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

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

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

Table of contents

Section 1   Introduction

1.1   This manual

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

1.2   Intended audience

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

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

1.3 Product documentation

1.3.1 Product documentation set
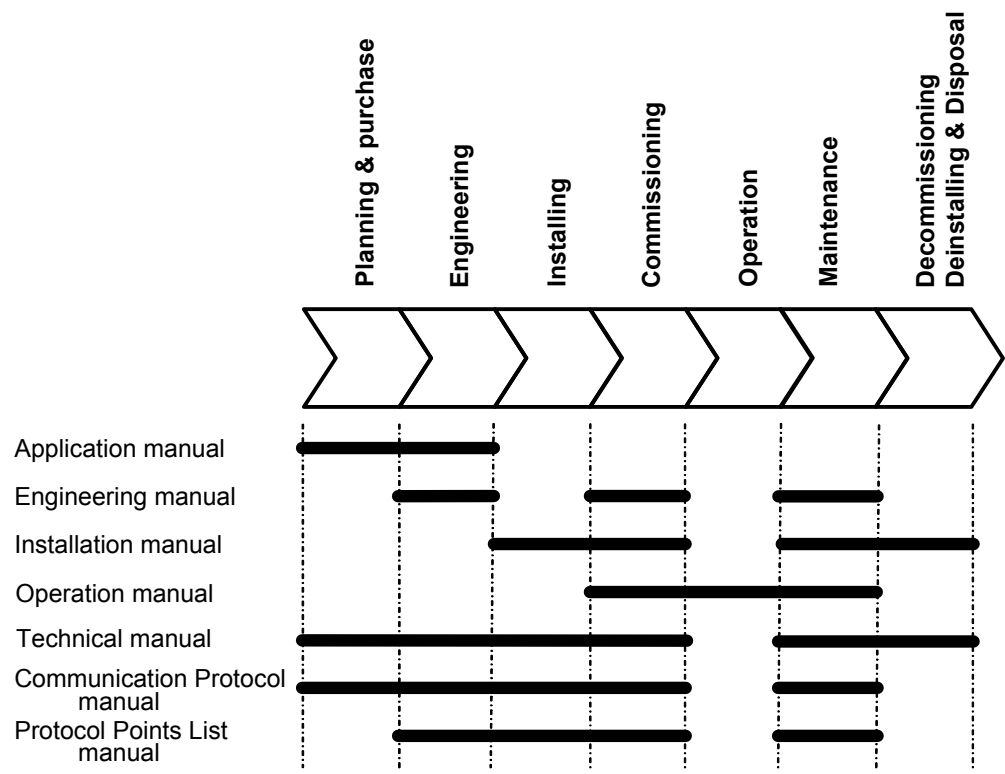
Figure 1:   *The intended use of manuals in different lifecycles*

The engineering manual contains instructions on how to engineer the relays using the different tools in PCM600. The manual provides instructions on how to set up a PCM600 project and insert relays to the project structure. The manual also recommends a sequence for engineering of protection and control functions, LHMI functions as well as communication engineering for IEC 61850 and DNP3.

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

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

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

The technical manual contains application and functionality descriptions and lists function blocks, logic diagrams, input and output signals, setting parameters and technical data

sorted per function. The manual can be used as a technical reference during the engineering phase, installation and commissioning phase, and during normal service.

The communication protocol manual describes a communication protocol supported by the relay. The manual concentrates on vendor-specific implementations. The point list manual describes the outlook and properties of the data points specific to the relay. The manual should be used in conjunction with the corresponding communication protocol manual.

1.3.2 Document revision history

Document revision/date	Product series version	History
A/11/23/2010	1.0	First release
B/10/31/2011	1.1	Content updated to correspond to the product series version
C/10/09/2015	1.2	Content updated

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

1.3.3 Related documentation

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

1.4 Symbols and conventions

1.4.1 Safety indication symbols

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

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

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

The information icon alerts the reader 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 Manual conventions

Conventions used in relay manuals. A particular convention may not be used in this manual.

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

  To navigate between the options, use ⬆ and ⬇.
- HMI menu paths are presented in bold, for example:

  Select **Main menu > Settings**.
- 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 "Enabled" and "Disabled".
- Relay input/output messages and monitored data names are shown in Courier font, for example:

  When the function picks up, the `PICKUP` output is set to TRUE.
- Dimensions are provided both in inches and mm. If it is not specifically mentioned then the dimension is in mm.
- Analog inputs to protection functions are shown in the technical manual for clarity however these inputs and connections do not appear in the application logic. The connection of these analog signals is fixed internally to the corresponding function blocks and cannot be altered by users

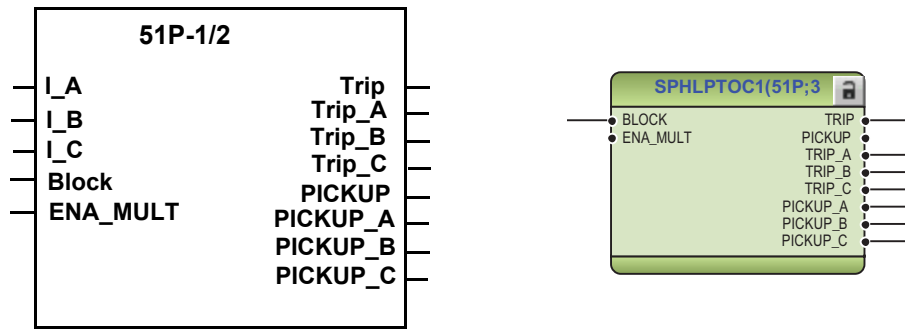**Function block**

Figure 2:   *Function block as it appears in the manual (left) and in the ACT (right)*

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:   RER620 functions, codes and symbols

Function	IEC61850	IEC60617	ANSI/C37.2
Current Protection			
Single-phase non-directional time overcurrent protection with 1-ph trip option, low stage	SPHLPTOC1	3I>(1)	51P
Single-phase non-directional time overcurrent protection with 1-ph trip option, high stage 1	SPHLPTOC2	3I>(2)	50P-1
Single-phase non-directional time overcurrent protection with 1-ph trip option, high stage 2	SPHHPTOC1	3I>>(1)	50P-2
Single-phase non-directional instantaneous overcurrent protection with 1-ph trip option	SPHIPTOC1	3I>>>(1)	50P-3
Non-directional time overcurrent ground-fault protection, low stage	XEFLPTOC2	Io>(2)	51N
Non-directional time overcurrent ground-fault protection, high stage 1	XEFLPTOC3	Io>(3)	50N-1
Non-directional time overcurrent ground-fault protection, high stage 2	XEFHPTOC3	Io>>(3)	50N-2
Non-directional instantaneous time overcurrent ground-fault protection	XEFIPTOC2	Io>>>(2)	50N-3
Non-directional sensitive earth-fault	EFLPTOC3	Io>(3)	50SEF
Negative sequence non-directional time overcurrent protection 1	XNSPTOC1	I2 >(1)	46-1
Negative sequence non-directional time overcurrent protection 2	XNSPTOC2	I2 >(2)	46-2
Phase discontinuity protection	PDNSPTOC1	I2/I1>	46PD
Three-phase inrush detector	INPHAR	3I2f >	INR
Directional Protection			
Single-phase directional overcurrent protection, low stage 1	SDPHLPDOC1	3I >->(1)	67/51P-1
Single-phase directional overcurrent protection, low stage 2	SDPHLPDOC2	3I >->(2)	67/51P-2
Directional ground-fault protection, low stage 1	XDEFLPDEF1	Io>->(1)	67/51N-1
Directional ground-fault protection, low stage 2	XDEFLPDEF2	Io>->(2)	67/51N-2
Cold Load Timers			
Cold load timer 1 Phase A (in seconds)	TPSGAPC1	TPS(1)	62CLD-1
Cold load timer 2 Phase A (in minutes)	TPMGAPC1	TPM(1)	62CLD-2
Cold load timer 1 Phase B (in seconds)	TPSGAPC2	TPS(2)	62CLD-3
Cold load timer 2 Phase B (in minutes)	TPMGAPC2	TPM(2)	62CLD-4
Cold load timer 1 Phase C (in seconds)	TPSGAPC3	TPS(3)	62CLD-5
Cold load timer 2 Phase C (in minutes)	TPMGAPC3	TPM(3)	62CLD-6
Voltage Protection			
Single-phase overvoltage 1, source 1 low stage	SPHPTOV1	3U >(1)	59-1
Single-phase overvoltage 2, source 1 high stage	SPHPTOV2	3U >(2)	59-2
Single-phase overvoltage 3, source 2 low stage	SPHPTOV3	3U >(3)	59-3
Single-phase undervoltage 1, source 1 low stage	SPHPTUV1	3U <(1)	27-1
Single-phase undervoltage 2, source 1 high stage	SPHPTUV2	3U <(2)	27-2
Single-phase undervoltage 3, source 2 low stage	SPHPTUV3	3U <(3)	27-3
Positive sequence overvoltage protection, source1	PSPTOV1	U1>(1)	59PS-1
Positive sequence overvoltage protection, source 2	PSPTOV2	U1>(2)	59PS-2
Negative sequence overvoltage protection, source1	NSPTOV1	U2>(1)	47
Negative sequence overvoltage protection, source 2	NSPTOV2	U2>(2)	47-2
Zero sequence overvoltage protection, source1	ROVPTOV1	Uo>(1)	59N-1
Zero sequence overvoltage protection, source 2	ROVPTOV2	Uo>(2)	59N-2

Function	IEC61850	IEC60617	ANSI/C37.2
Frequency Protection			
Underfrequency, Overfrequency, Frequency rate of change, Source 1, Stage 1	FRPFRQ1	f</f>,df/dt(1)	81-1
Underfrequency, Overfrequency, Frequency rate of change, Source 1, Stage 2	FRPFRQ2	f</f>,df/dt(2)	81-2
Load Shed & Restoration, Source 1, Stage 1	LSHDPFRQ1	UFLS/R(1)	81S-1
Load Shed & Restoration, Source 1, Stage 2	LSHDPFRQ2	UFLS/R(2)	81S-2
Other Protection			
High Impedance Fault Detector	PHIZ1	PHIZ1	HIZ
Circuit breaker failure protection	SCCBRBRF1	3I>/Io>BF	50BFT
Circuit breaker close failure protection	SCCBRBCF1	SCCBRBCF1	50BFC
Directional positive sequence power protection	DPSRDIR1	P>->	32P
Directional negative/zero sequence power protection	DNZSRDIR1	Q>->	32N
Control			
Autoreclosing, 1ph and/or 3ph	SDARREC1	O -> I	79
Synch-check/voltage check (Source 1 is defined as bus, Souce 2 as line)	SECRSYN1	SYNC	25
Circuit Breaker 1 (3 state inputs / 3 control outputs)	SCBXCBR1	I<->O CB	52
Loop control	DLCM	LCM	LCM
Supervision and Monitoring			
CB condition monitoring	SPSCBR1	CBCM	52CM
Fuse failure supervision, Source 1	SEQRFUF1	FUSEF	60
Measurement			
Three-phase current	CMMXU1	3I	IA,IB,IC
Demand metering, Max/Min metering	CMSTA1		
Sequence current	CSMSQI1	I1,I2,I0	I1, I2, I0
Ground current	RESCMMXU1	Io	IG
Three-phase voltage, Source 1	VMMXU1	3U	VA,VB,VC
Three-phase voltage, Source 2	VMMXU2	3U(B)	VA,VB,VC(2)
Sequence voltages, Source 1	VSMSQI1	U1,U2,U0	V1,V2,V0
Sequence voltages, Source 2	VSMSQI2	U1,U2,U0(B)	V1,V2,V0(2)
Single and Three-phase power, Power factor and three phase energy, Source 1	APEMMXU1	P,SP,E	P,SP,E
Frequency, Source 1	FMMXU1	f	f
Recorders			
Digital fault recorder (DFR)	RDRE	DR	DFR
Sequence of Events (SER)	SER	SER	SER
Fault Recorder	FLTMSTA	FLTMSTA	FLTMSTA
Fault Locator (FLOC)	DRFLO1	FLO	FLO
Other Functions			
Battery voltage, current. Test the battery	ZBAT1	UPS	UPS
Universal Power Drive	XGGIO115	X115(UPD)	X115(UPD)
Programmable buttons (16 buttons)	FKEYGGIO1	FKEYGGIO1	FKEYGGIO1
Move function block (8 outputs)	MVGAPC1	MVGAPC1	MVGAPC1
Move function block (8 outputs)	MVGAPC2	MVGAPC2	MVGAPC2

Function	IEC61850	IEC60617	ANSI/C37.2
Pulse timer (8 timers)	PTGAPC1	PTGAPC1	PTGAPC1
Pulse timer (8 timers)	PTGAPC2	PTGAPC2	PTGAPC2
Generic control points (16 outputs)	SPCGGIO1	SPCGGIO1	SPCGGIO1
Generic control points (16 outputs)	SPCGGIO2	SPCGGIO2	SPCGGIO2
Set reset flip flops (8 outputs)	SRGAPC1	SRGAPC1	SRGAPC1
Set reset flip flops (8 outputs)	SRGAPC2	SRGAPC2	SRGAPC2
Time delay off timers (8 timers)	TOFGAPC1	TOFGAPC1	TOFGAPC1
Time delay off timers (8 timers)	TOFGAPC2	TOFGAPC2	TOFGAPC2
Time delay on timers (8 timers)	TONGAPC1	TONGAPC1	TONGAPC1
Time delay on timers (8 timers)	TONGAPC2	TONGAPC2	TONGAPC2
Multipurpose generic up-down counter	UDFCNT1	UDFCNT1	UDFCNT1
Multipurpose generic up-down counter	UDFCNT2	UDFCNT2	UDFCNT2
Multipurpose generic up-down counter	UDFCNT3	UDFCNT3	UDFCNT3
Multipurpose generic up-down counter	UDFCNT4	UDFCNT4	UDFCNT4
Multipurpose generic up-down counter	UDFCNT5	UDFCNT5	UDFCNT5
Multipurpose generic up-down counter	UDFCNT6	UDFCNT6	UDFCNT6
Multipurpose generic up-down counter	UDFCNT7	UDFCNT7	UDFCNT7
Multipurpose generic up-down counter	UDFCNT8	UDFCNT8	UDFCNT8
Multipurpose generic up-down counter	UDFCNT9	UDFCNT9	UDFCNT9
Multipurpose generic up-down counter	UDFCNT10	UDFCNT10	UDFCNT10
Multipurpose generic up-down counter	UDFCNT11	UDFCNT11	UDFCNT11
Multipurpose generic up-down counter	UDFCNT12	UDFCNT12	UDFCNT12

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 relay.

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

Table 2:   Maximum concentration values by weight per homogeneous material

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

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

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

2.2   Disposing of the relay

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

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

Table 3:   Materials of the relay parts

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

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

Section 3   620 series overview

3.1   Overview

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

The relays 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 620 series relays support a range of communication protocols including IEC 61850 with GOOSE messaging, Modbus®, DNP3, PG&E 2179 and IEC 101/104.

3.2   Local HMI

Figure 3:   *LHMI*

The LHMI of the relay 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.

Table 4: Characters and rows on the view

Character size	Rows in view	Characters on row
Large, variable width (13x14 pixels)	4 rows 8 rows with large screen	min 8

The display view is divided into four basic areas.
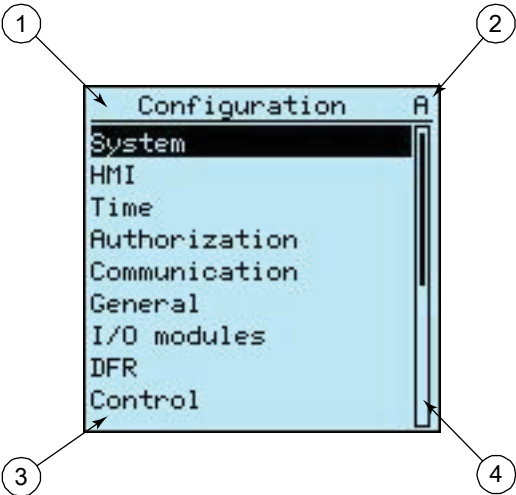
Figure 4: Display layout

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: Normal, Pickup 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.

There are two additional LEDs which are embedded into the control buttons and . They represent the status of the circuit breaker.

3.2.3 Keypad

The LHMI keypad contains push-buttons which are used to navigate in different views or menus. With the push-buttons you can give open or close commands to one 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.
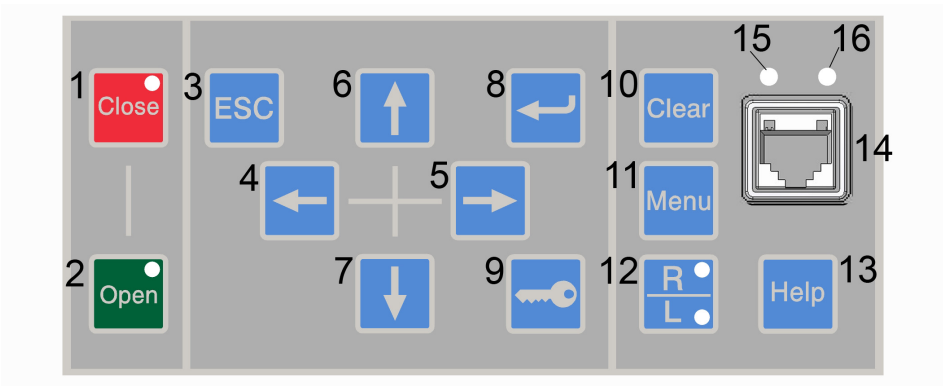
Figure 5:   *LHMI keypad with object control, navigation and command push-buttons and RJ-45 communication port*

1 Close
2 Open
3 Escape
4 Left
5 Right
6 Up
7 Down
8 Enter
9 Key
10 Clear
11 Menu
12 Remote/Local
13 Help
14 Communication port
15 Uplink LED
16 Communication LED

Object control

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

Table 5:   *Object control push-buttons*

Name	Description
Close	Closing the object. The LED indicates the current object state.
Open	Opening the object. The LED indicates the current object state.

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	• 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 Clear 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	Changing the control position (remote or local) of the device. • When the R LED is lit, remote control is enabled and local control disabled. • When the L LED is lit, local control is enabled and remote control disabled. • When none of the LEDs are lit, both control positions are disabled.
Clear	• Activating the Clear/Reset view. • 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   Local HMI functionality

3.2.4.1   Protection and alarm indication

Protection indicators

The protection indicator LEDs are Normal, Pickup and Trip.

Table 8:   Normal LED

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

Table 9:   Pickup LED

LED state	Description
Off	Normal operation.
On	A protection function has picked up and an indication message is displayed. • If several protection functions pick up within a short time, the last pickup 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 relay parameters. Three types of parameters can be read and written.

• Numerical values

• String values

• Enumerated values

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

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 relay communicates with the connected device.

Figure 6:   *RJ-45 communication port and indication LEDs*
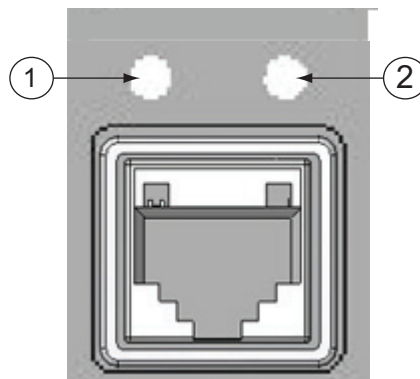
1 Uplink LED

2 Communication LED

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

3.3 Web HMI

The WHMI enables the user to access the relay via a web browser. The supported web browser versions are Internet Explorer 9.0, 10.0 and 11.0.

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

WHMI offers several functions.

- Alarm indications and event lists
- System supervision
- Parameter settings

- • Measurement display
- • Oscillographic records
- • Phasor diagram

The menu tree structure on the WHMI is almost identical to the one on the LHMI.
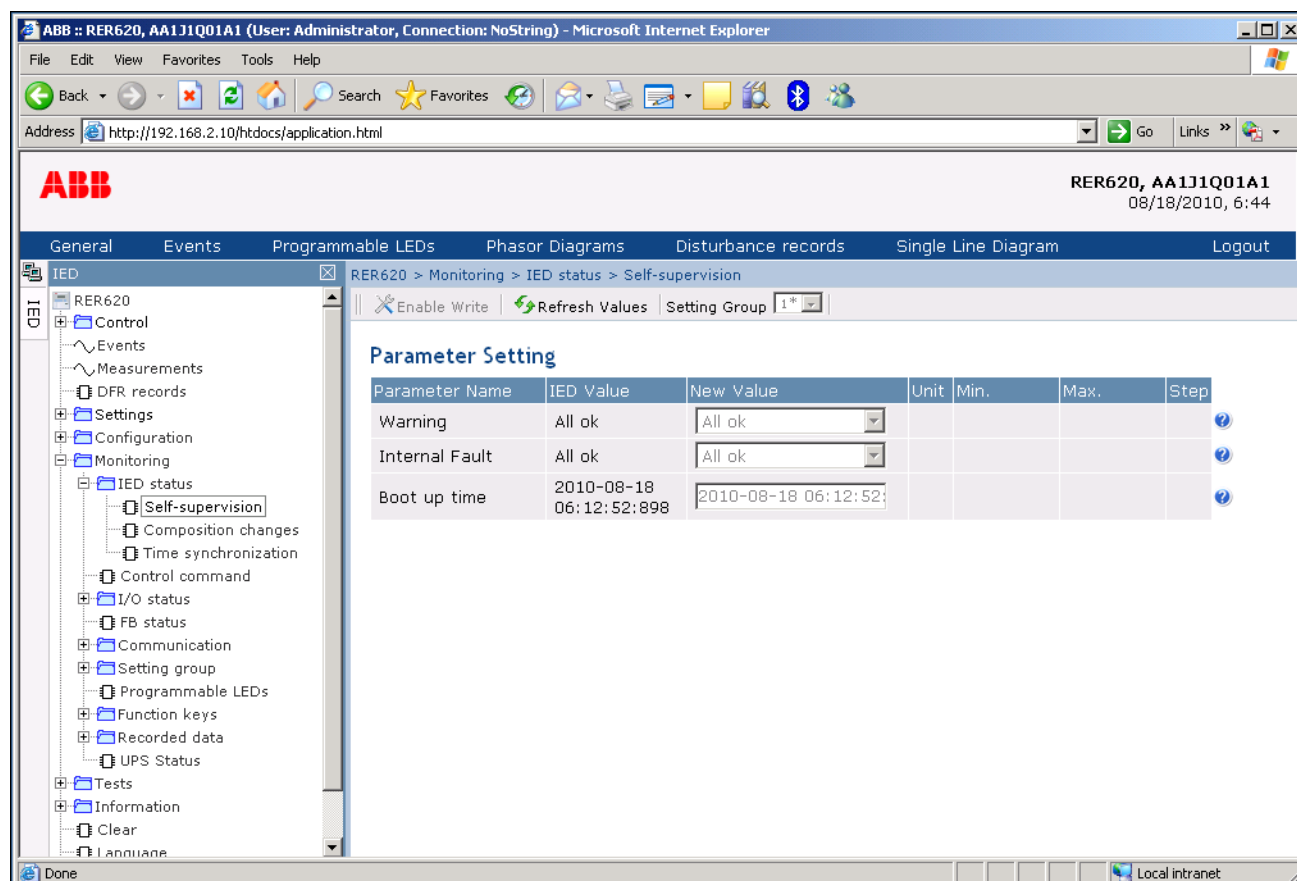
Figure 7:   *Example view of the WHMI*

The WHMI can be accessed locally and remotely.
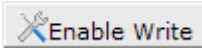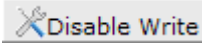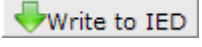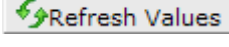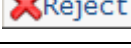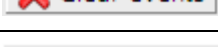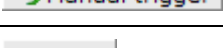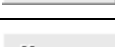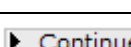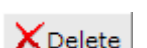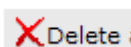
- • Locally by connecting your laptop to the relay via the front communication port.
- • Remotely over LAN/WAN.

3.3.1   Command buttons

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

Table 12:   Command buttons

Name	Description
Enable Write	Enabling parameter editing.
Disable Write	Disabling parameter editing.
Write to IED	Writing parameters to the relay.
Refresh Values	Refreshing parameter values.
Print	Printing out parameters.
Commit	Committing changes to relay's non-volatile flash memory.
Reject	Rejecting changes.
(help icon)	Showing context sensitive help messages.
Clear events	Clearing events.
Manual trigger	Triggering the DFR manually.
Save	Saving values to CSV file format.
Freeze	Freezing the values so that updates are not displayed.
Continue	Receiving continuous updates to the monitoring view.
Delete	Deleting the DFR.
Delete all	Deleting all DFRs.
(icon)	Uploading part one of a DFR.
(icon)	Uploading part two of a DFR.

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 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 DFRs • Changing system settings such as IP address, serial baud rate or DFR settings • Setting the relay 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 relay supports different communication protocols: IEC 61850 with GOOSE messaging, Modbus®, DNP3, IEC 60870-5-101, and IEC 60870-5-104 all using TCP/IP. DNP3 and Modbus also support serial communication. PG&E2179 protocol is supported in serial communication. Operational information and controls are available through these protocols.

The IEC 61850 communication implementation supports all monitoring and control functions. Additionally, parameter setting and DFR records can be accessed using the IEC 61850 protocol. Oscillographic files are available to any Ethernet-based application in the standard COMTRADE format. Further, the relay can send and receive binary signals from other relays (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 relay meets the GOOSE performance requirements for tripping applications in distribution substations, as defined by the IEC 61850 standard. The relay can simultaneously report events to five different clients on the station bus.

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

3.6   PCM600 tool

Protection and Control relay Manager PCM600 offers all the necessary functionality to work throughout all stages of the relay 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

A 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 relay.

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 structures in PCM600. In addition to other products supporting the connectivity concept, the connectivity packages for PCM600 contain:

- Description of relay'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 relay-specific interfaces to the standard interfaces of system products and tools such as relay-specific dispatchers for tools. This means that there is a protocol-specific adaptation for the parameter setting and disturbance handling tool components, for example DFR file uploading according to COMTRADE.

3.6.2   PCM600 and relay connectivity package version

- Protection and Control relay Manager PCM600 Ver. 2.6 or later
- Relay Connectivity Package RER620 Ver. 1.2 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 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.
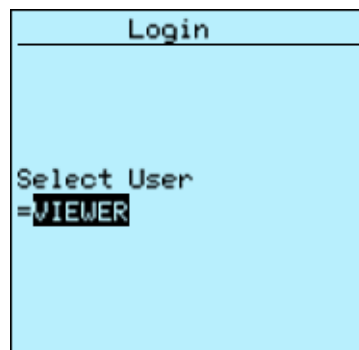
Figure 8:   *Selecting access level*

3.   Confirm the selection with ↵.

4. Enter the password when prompted digit by digit.

- Activate the digit to be entered with ← and →.

- Enter the character with ↑ and ↓.

```
VIEWER




Enter Password:
=***1
```

Figure 9:   Entering password

5. Press ↵ to confirm the login.

- To cancel the procedure, press ESC.

```
Error



Wrong Password
```
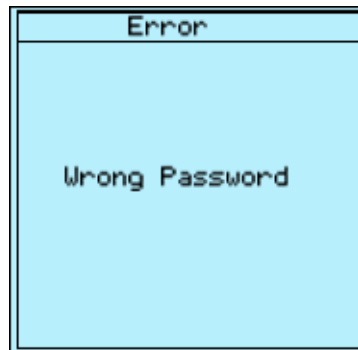
Figure 10:   Error message indicating wrong password

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 ↵.
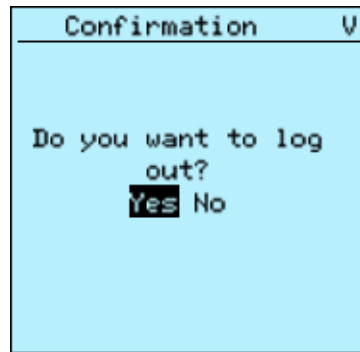
Figure 11: *Logging out*

- To cancel logout, press .

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

- Press 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 relay, log in with the appropriate user rights.

4.1.5 Identifying the device

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

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

1. Select **Main menu > Information**.

2. Select a submenu with ⬆ and ⬇.
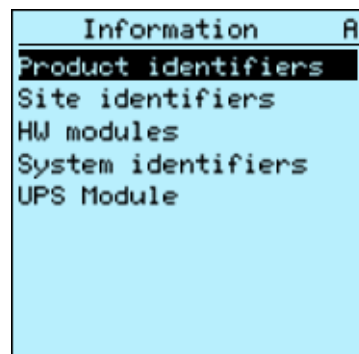
Figure 12: *Selecting a submenu*

3. Enter the submenu with ➡.

4. Browse the information with ⬆ and ⬇.
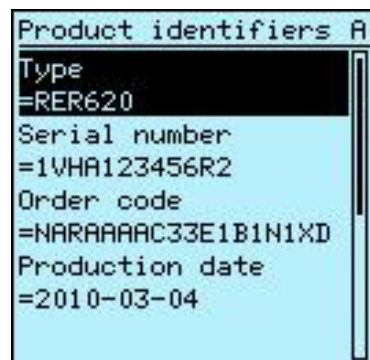
Figure 13: *relay information*

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 relay. After an auxiliary power failure, the contrast is restored.

4.1.7 Changing the local HMI language

1. Select **Main menu > Language** and press ↵ .

2. Change the language using ↑ or ↓ .

3. Press ↵ to confirm the selection.

4. Commit the changes.
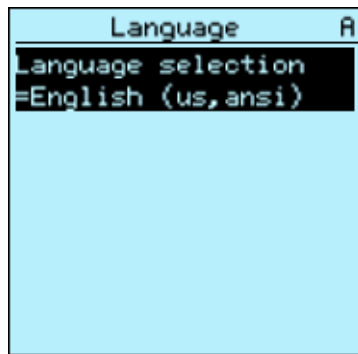
Figure 14: *Changing the LHMI language*

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 and 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 relay 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 [Menu].

- 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
- FB status
- Tests
- Function tests
- Information
- Clear
- Language
- Control
- SLD

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.
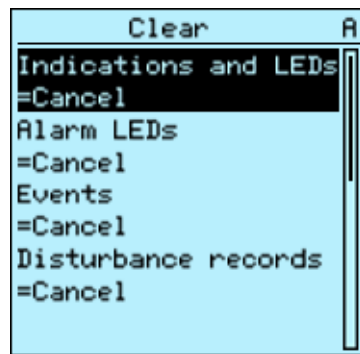
Figure 15: Scroll bar on the right

- 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 .
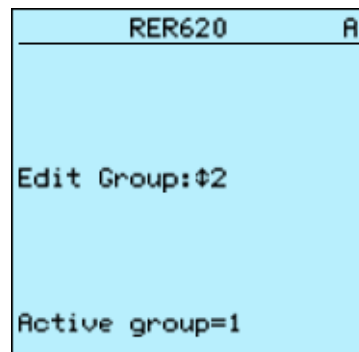
Figure 16: *Selecting a setting group*

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 [←].
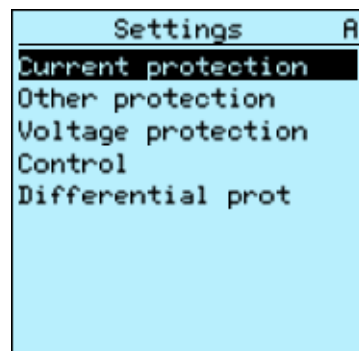
Figure 17: *Setting alternatives in the selected setting group*

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.
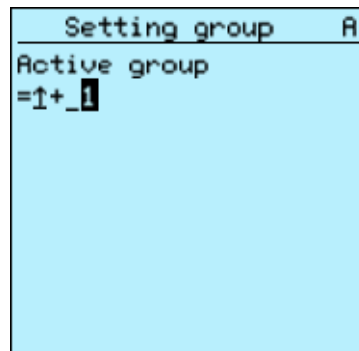
Figure 18: *Last digit is active and it can only be increased*

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 ⬇️.
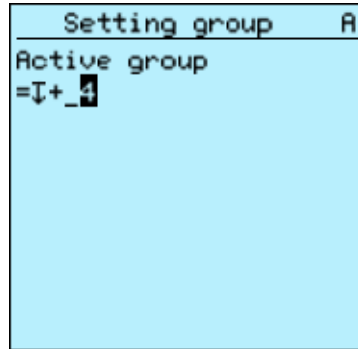
Figure 19: *Arrow symbol is active, the value is set to the maximum*

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.
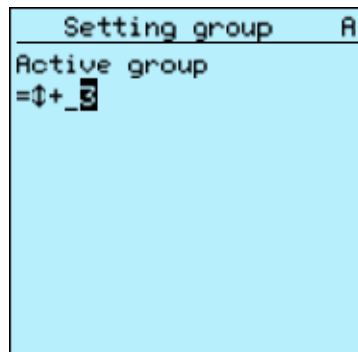
Figure 20: *Restoring the previous value*

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 Menu to enter the Main Menu.

3. To save the changes in non-volatile memory, select `Yes` and press ↵.
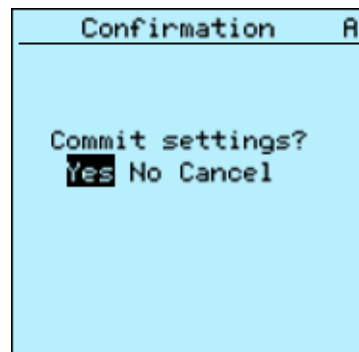
Figure 21: *Confirming settings*

- 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 relay. 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 relay 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 to activate the Clear view.
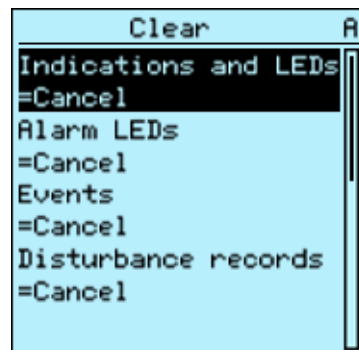
Figure 22: *Clear view*

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 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 .

4.2   Using the Web HMI

WHMI is enabled 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 relay 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**.
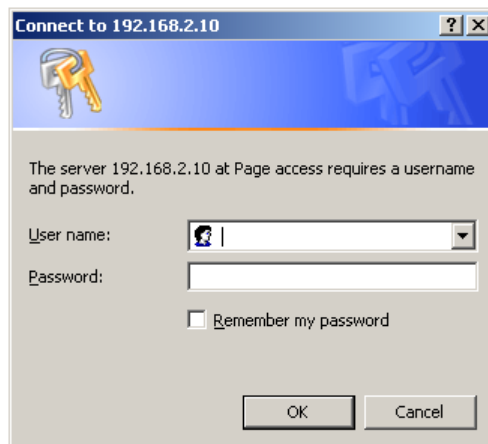
Figure 23:   *Entering username and password to use the WHMI*

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**.
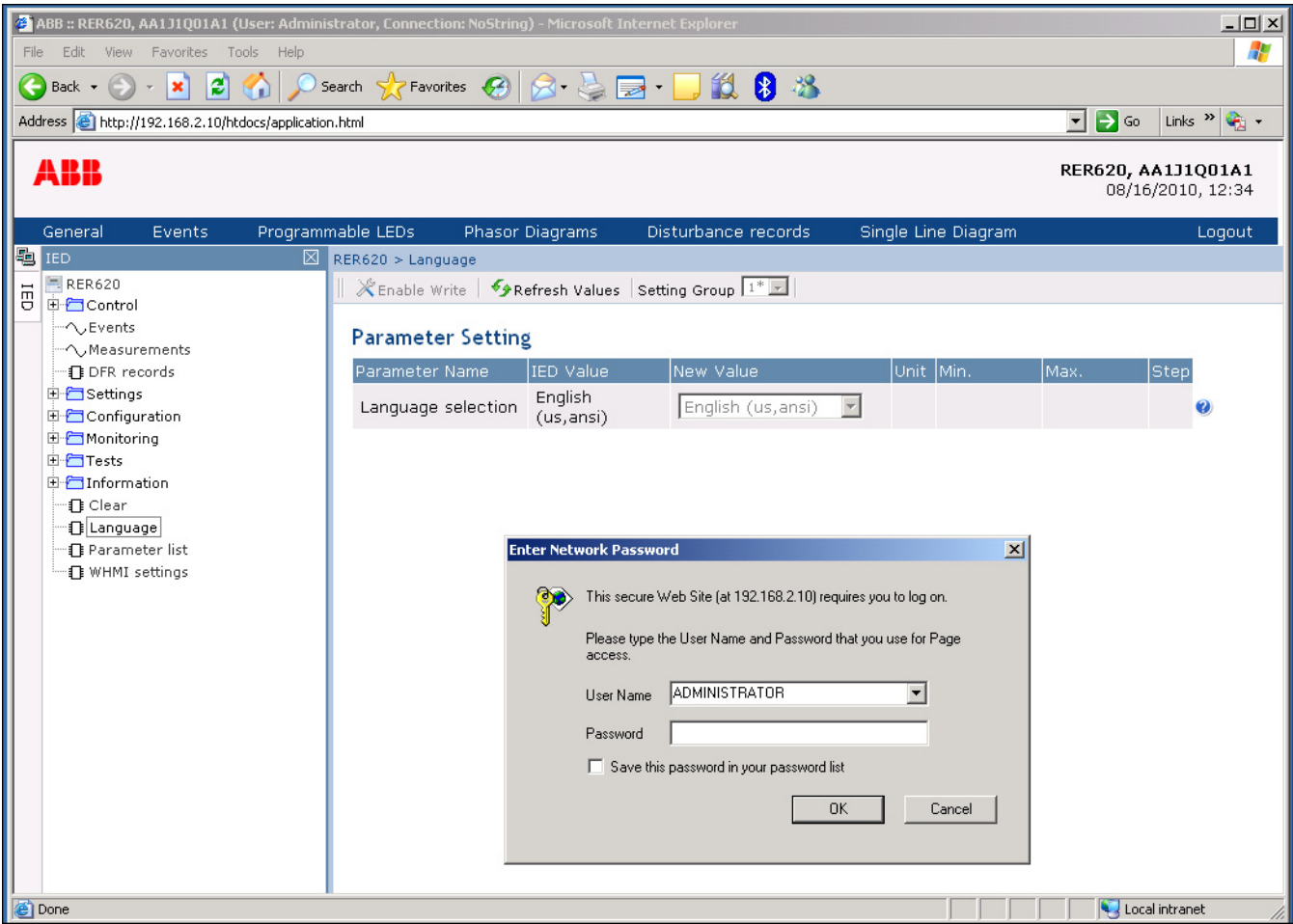
Figure 24: *Session timeout*

• To log out manually, click **Logout** on the menu bar.
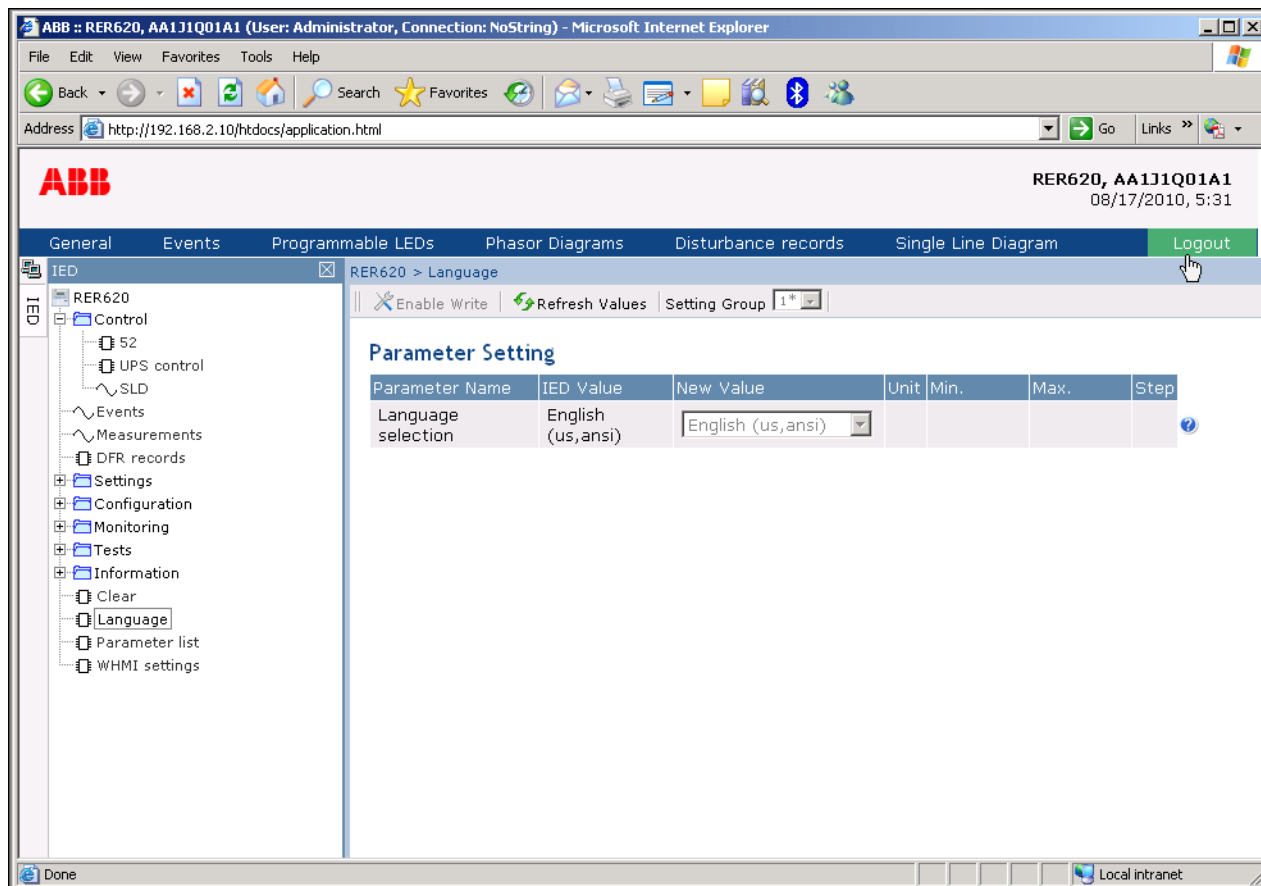
Figure 25:   *WHMI logout*

4.2.3   Identifying the device

The relay 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.
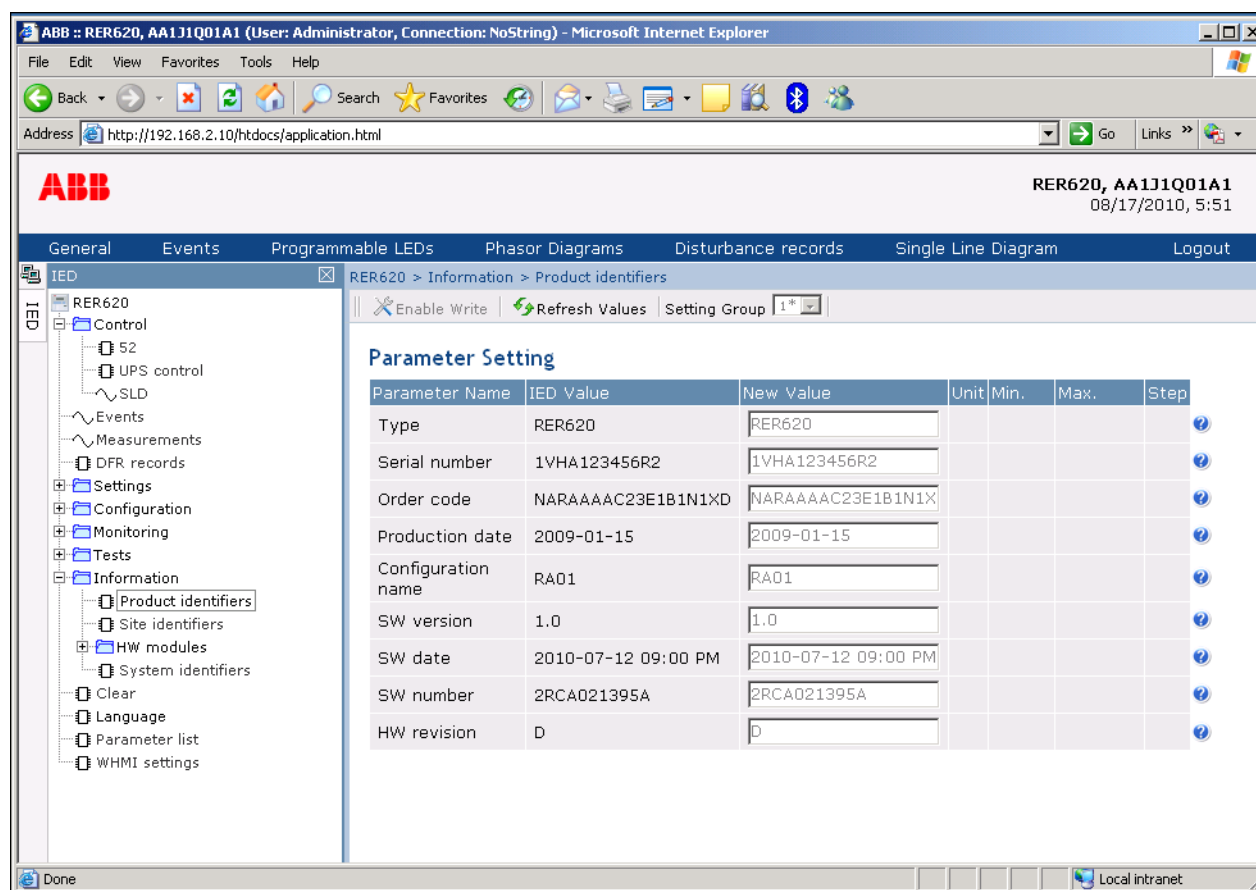
Figure 26:   *Device information*

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 relay 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 DFR **records** view shows the list of disturbance records.
- The **WHMI settings** view contains user settings for the web client. WHMI settings include, for example, the client-specific setting for the WHMI language. Different users can use different languages when connecting to the same relay. The WHMI language selection is independent of the language selection for the LHMI.
- **Logout** ends the session.
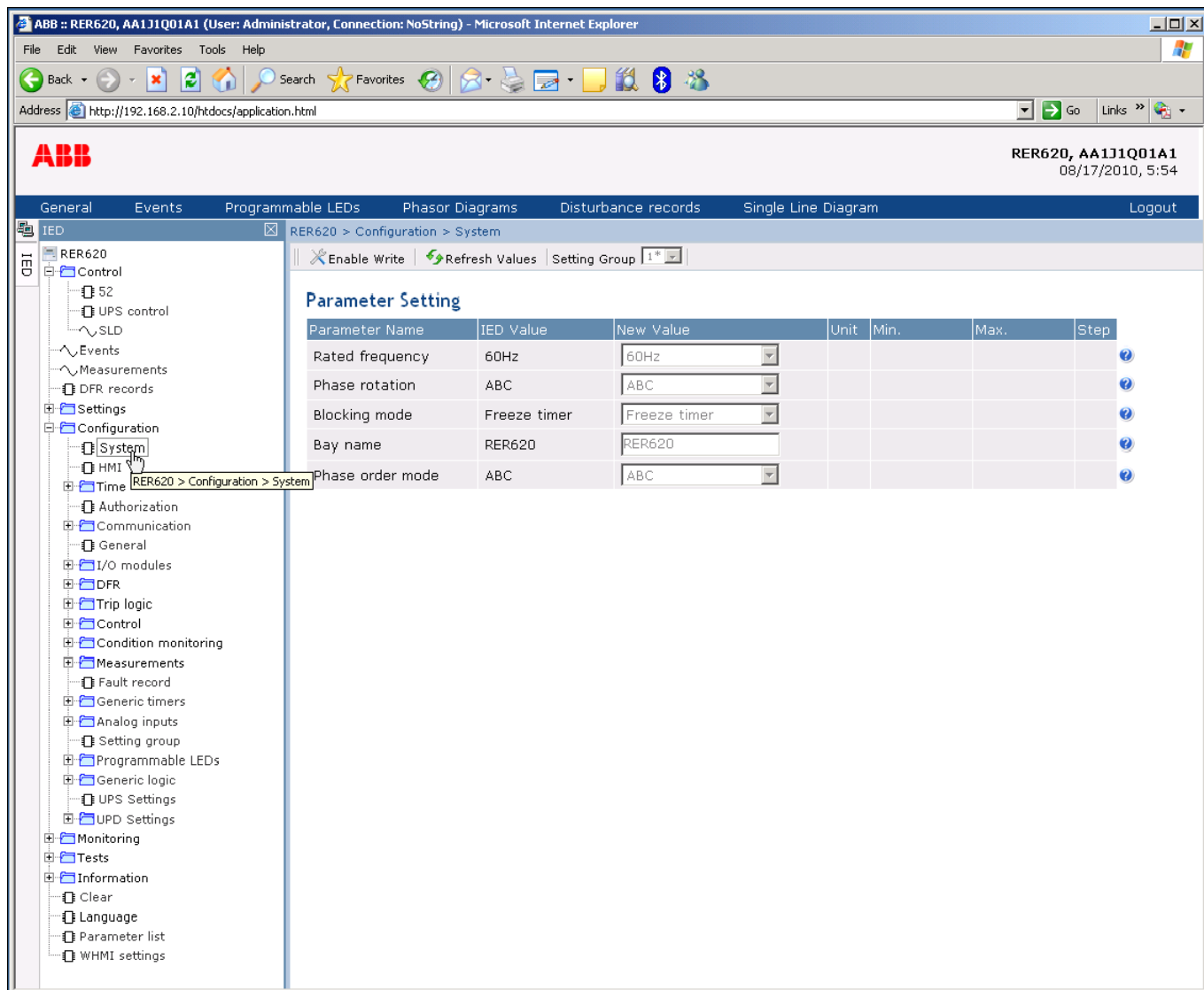
Figure 27:   *Navigating in the WHMI menus*

4.2.4.1   Menu structure

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

- Events
- Measurements
- DFR records
- Settings
- Configuration
- Monitoring
- Tests
- Information

- Clear
- Language
- Parameter list

4.2.5 Showing all parameters

1. Click **Parameter list** in the main menu.
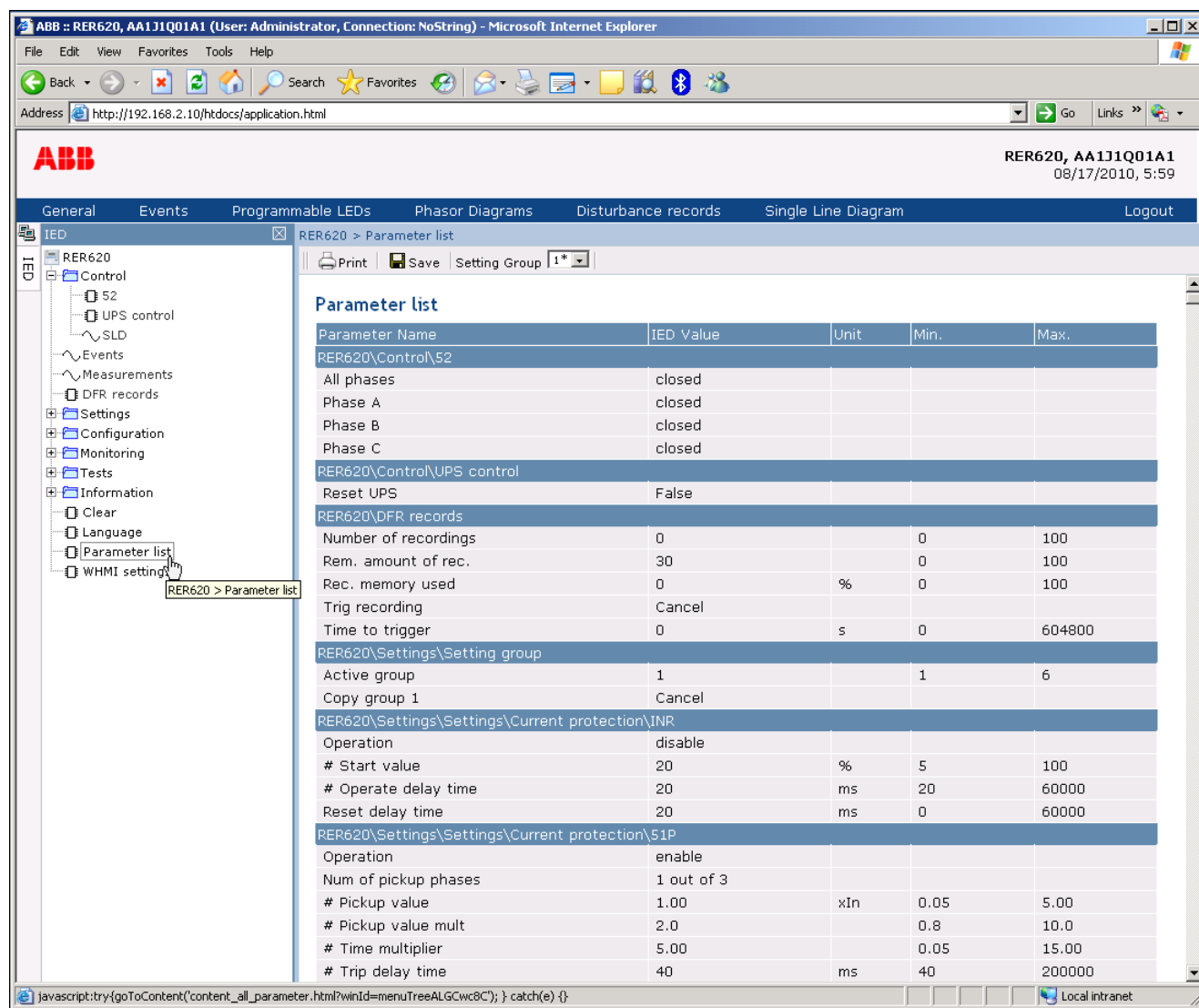
Figure 28:   *Show all parameters*

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

Figure 29:   *Settings group*

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 relay test mode, cannot be set via the WHMI.
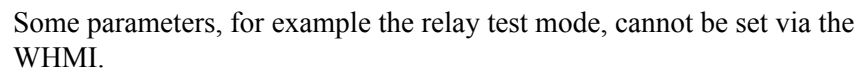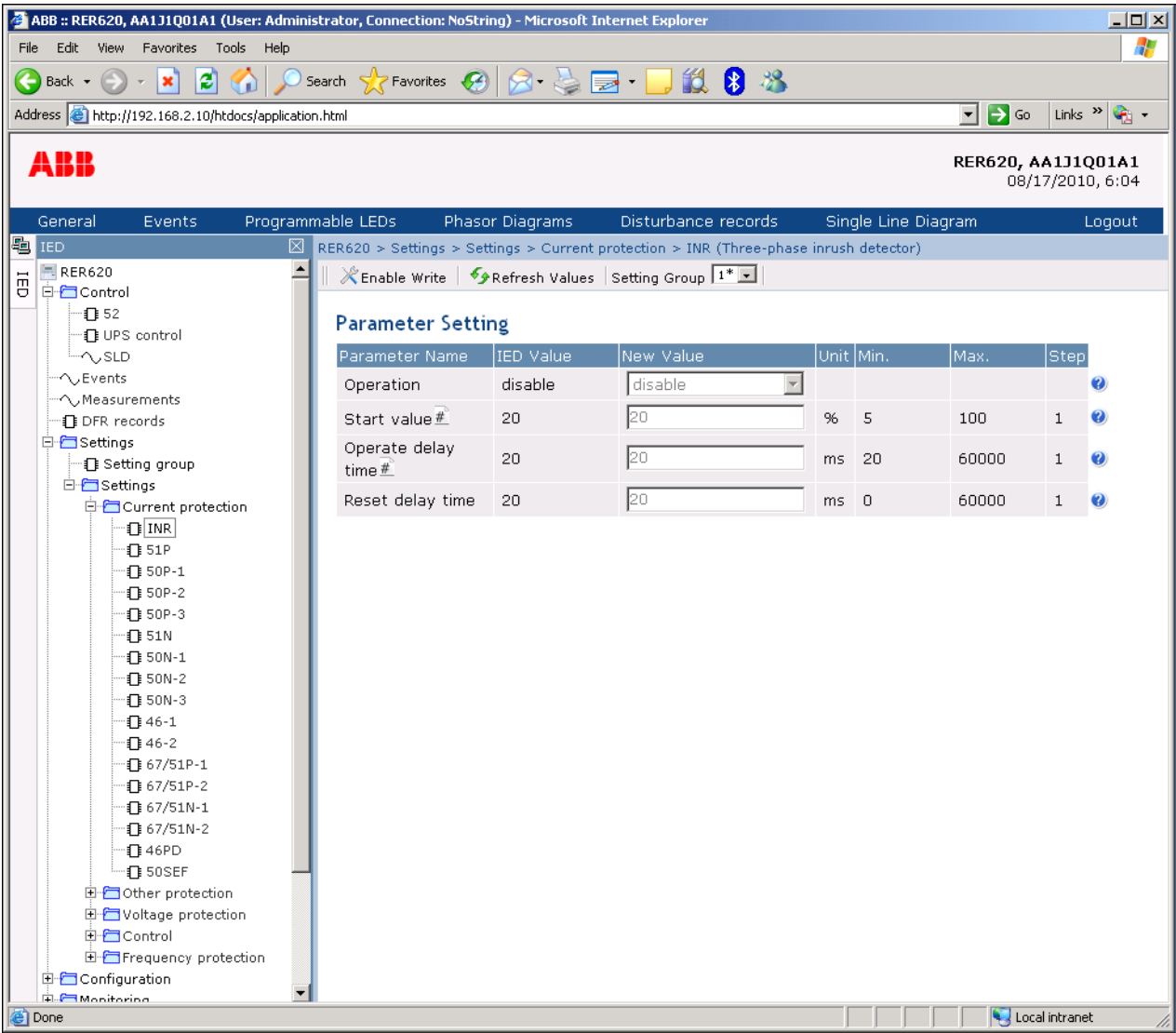
Figure 30:   *Enable writing to edit a value*

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 and maximum values for a parameter are shown in the Min. and Max. columns.

- Setting group values are indicated with .

Figure 31:   *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 32:   *Warning indicating that the entered value is incorrect*

- If writing values fails, a warning dialog box is displayed.
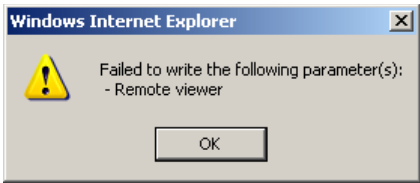
Figure 33:   *Warning indicating that the values were not written to the relay*

If writing is enabled accidentally, click **Disable Write**. **Disable Write** cannot be selected, when a value has already been written to the relay. After clicking **Write to relay**, 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 relay** after editing parameter values to put the values into relay's database for use.

RER620 > Settings > Settings > Current protection > INR (Three-phase inrush detector)

✕ Disable Write ⬇ Write to IED 🔄 Refresh Values Setting Group 1* ▾

Parameter Setting

Parameter Name	IED Value	New Value	Unit	Min.	Max.	Step	
Operation	disable	disable ▾					❓
Start value #	20	20	%	5	100	1	❓
Operate delay time #	20	2000	ms	20	60000	1	❓
Reset delay time	20	20	ms	0	60000	1	❓

Figure 34:   *Writing values to relay*

The values are not stored to the flash memory.

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

RER620 > Settings > Settings > Current protection > INR (Three-phase inrush detector)

⚠ Parameters have been written to the IED but not stored. Please 💾 Commit or ✕ Reject store.

✕ Disable Write ⬇ Write to IED 🔄 Refresh Values Setting Group 1* ▾

Parameter Setting

Parameter Name	IED Value	New Value	Unit	Min.	Max.	Step	
Operation	disable	disable ▾					❓
Start value #	20	20	%	5	100	1	❓
Operate delay time #	2000	2000	ms	20	60000	1	❓
Reset delay time	20	20	ms	0	60000	1	❓

Figure 35:   *Committing changes*

ℹ Committing values will take a few seconds.

ℹ 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.
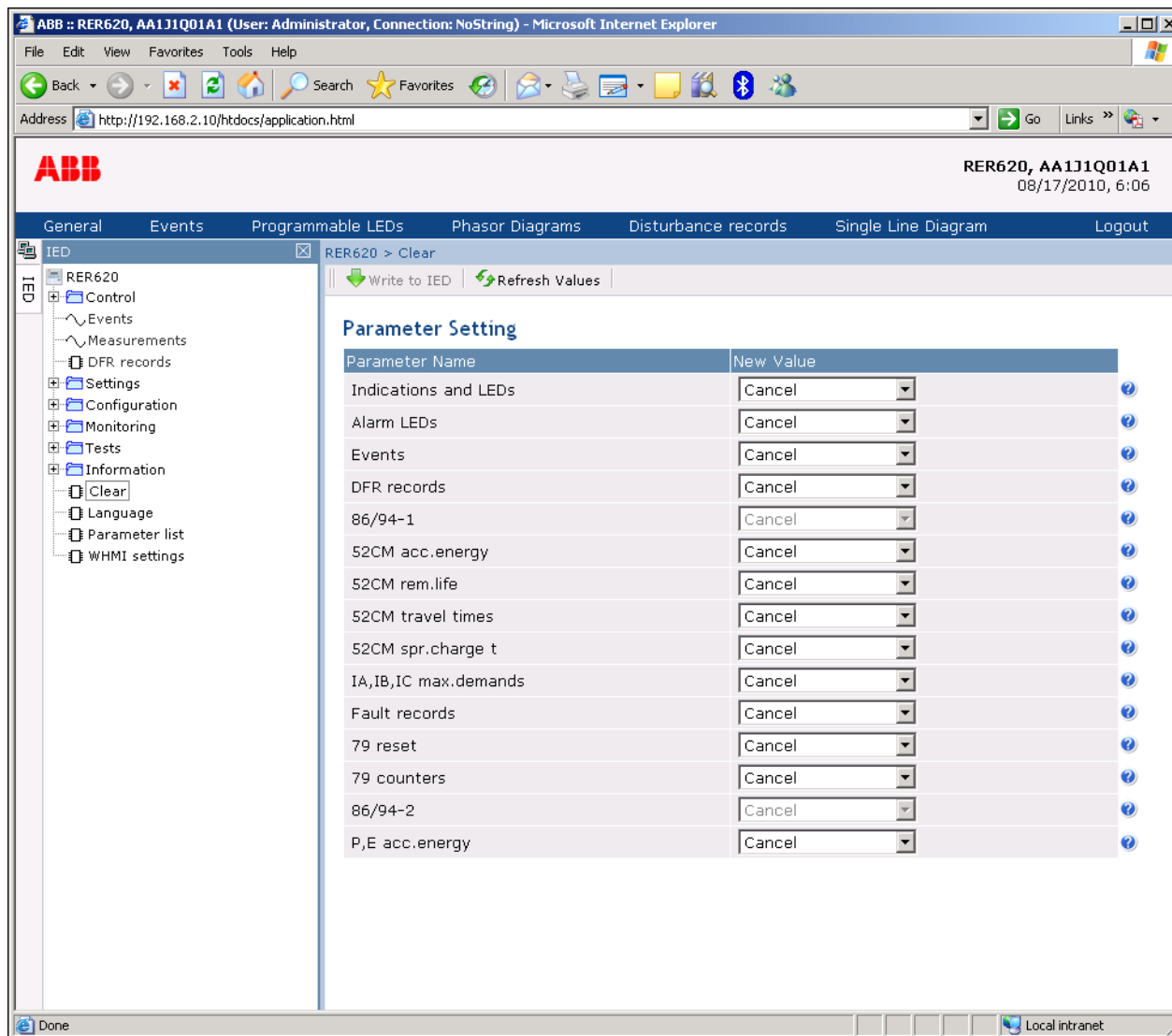
Figure 36:   *Selecting clear menu*

2.   In the **New Value** box, click **Clear** to select the item to be cleared.

3.   Click **Write to relay**.

4.   Click **Reject**.
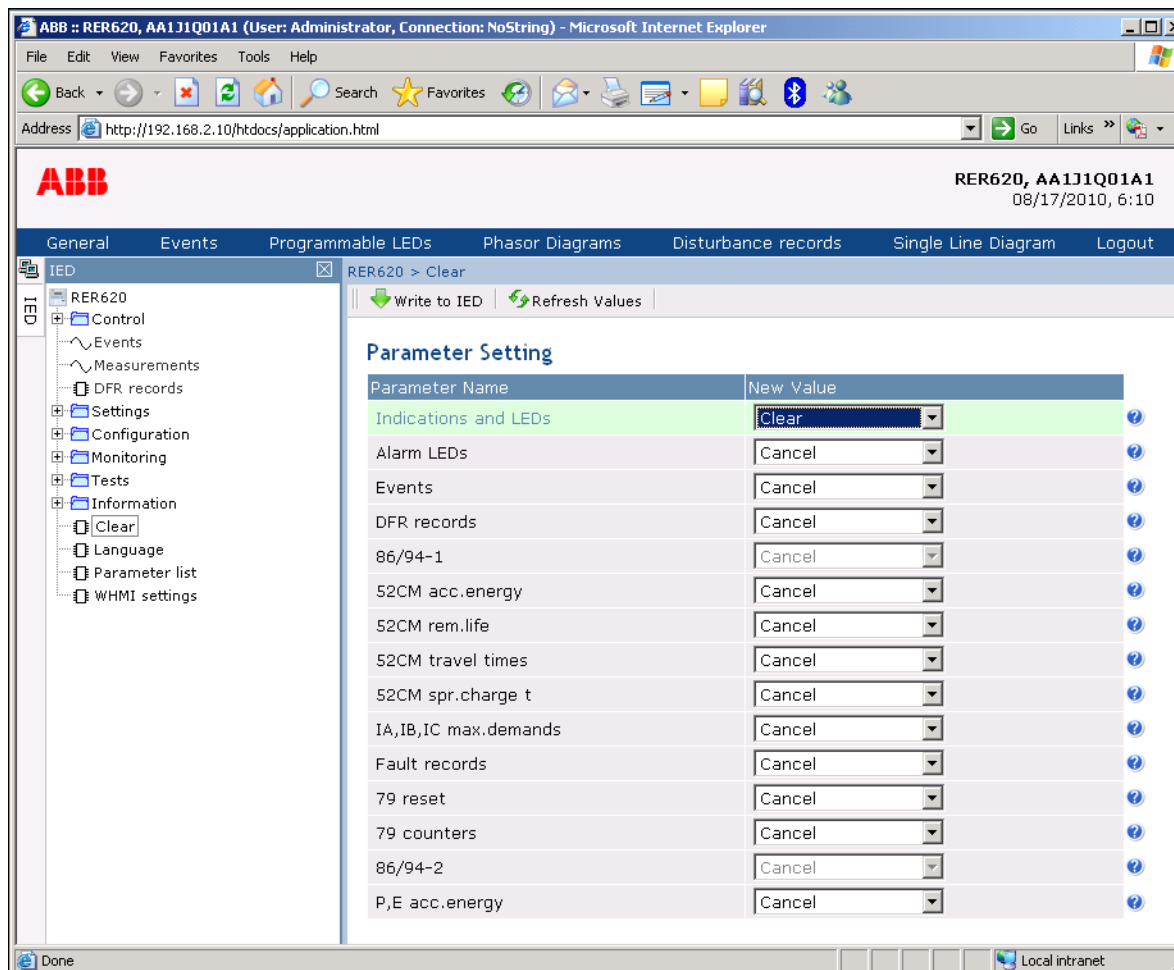
Figure 37: *Clearing indications and LEDs*

4.2.9 Selecting the programmable-LED view

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

• Click **Programmable LEDs** in the menu bar.
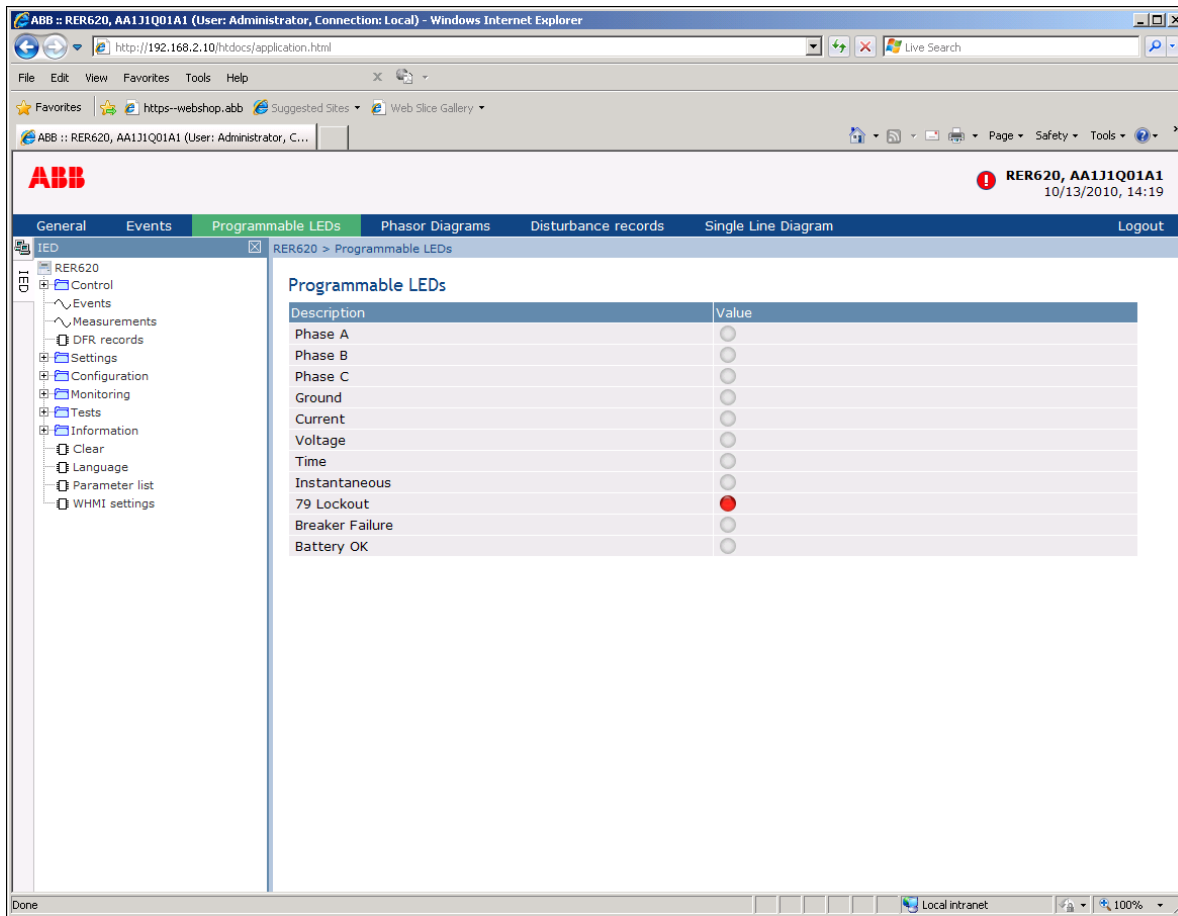
Figure 38: *Monitoring programmable LEDs*

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.
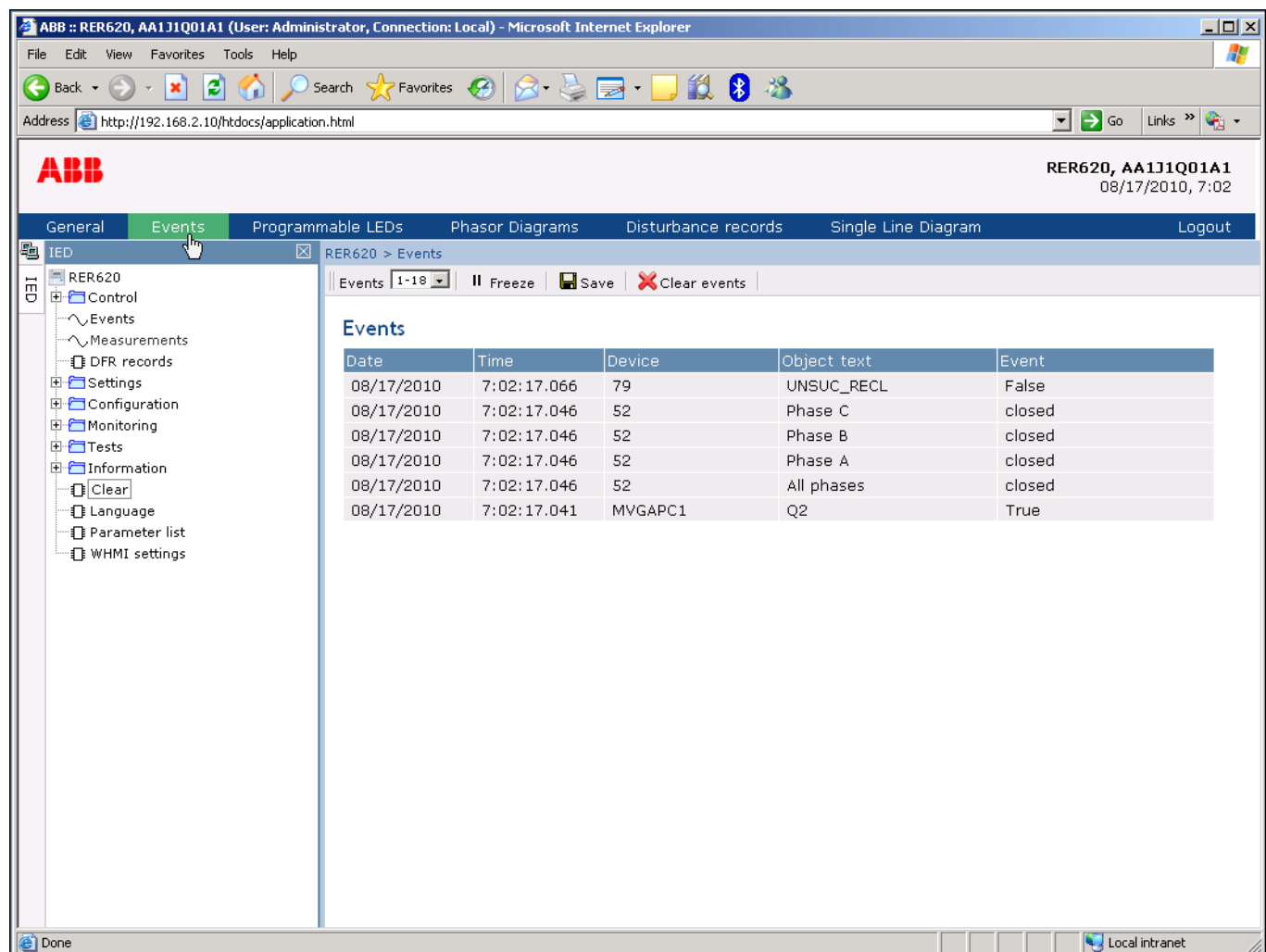
Figure 39: *Monitoring events*

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 relay.

4.2.11 Selecting the disturbance records view

Disturbance records are listed in the disturbance records view.

• Click **Disturgance records** on the menu bar.
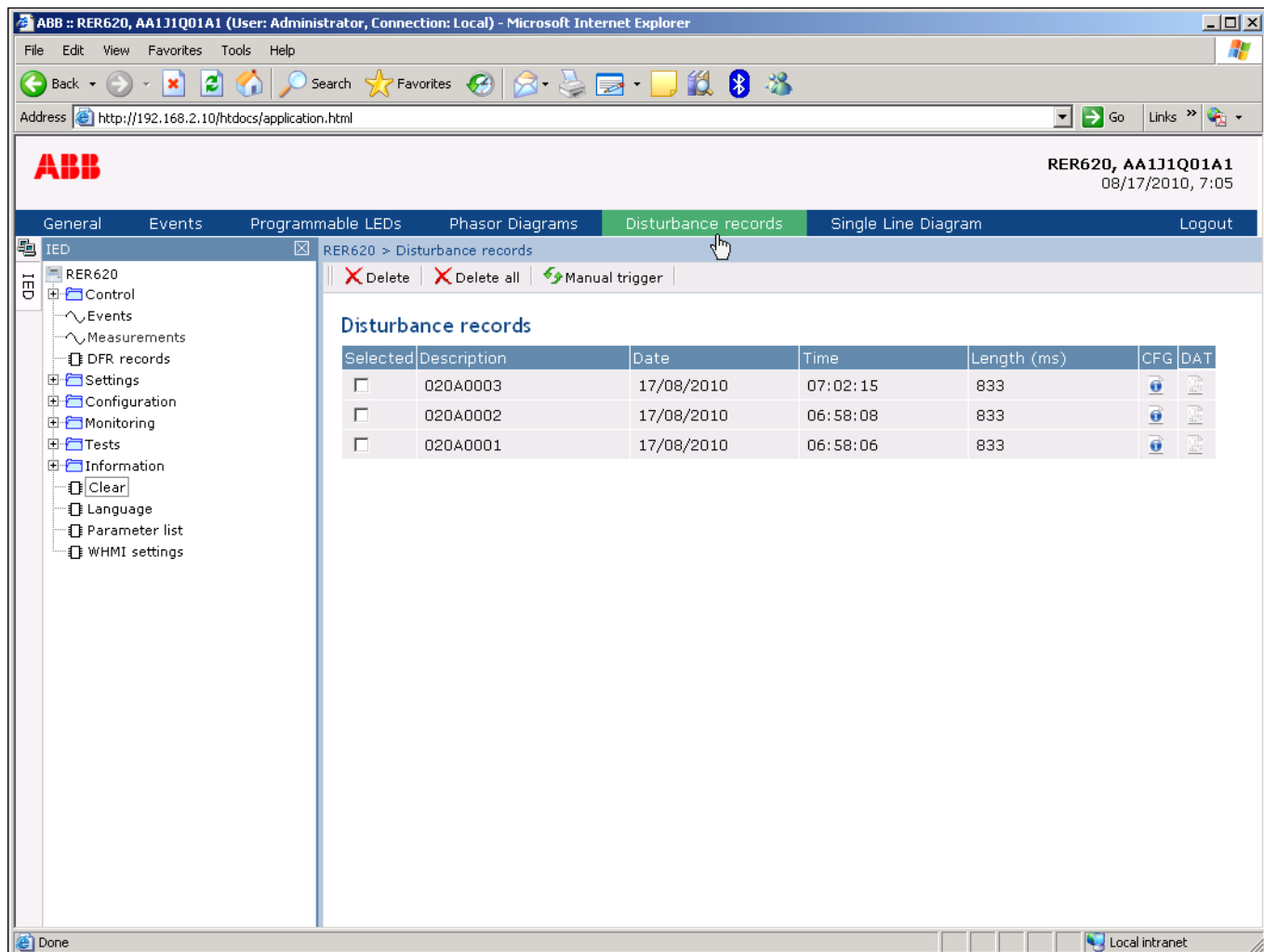
Figure 40: *Disturbance records view*

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.
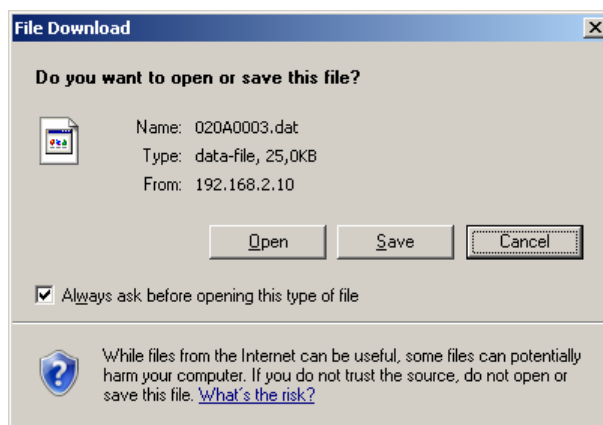
Figure 41: *Uploading a DFR record*

3.   Save both the files in the same folder on your computer.

4.   Open the DFR 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**.
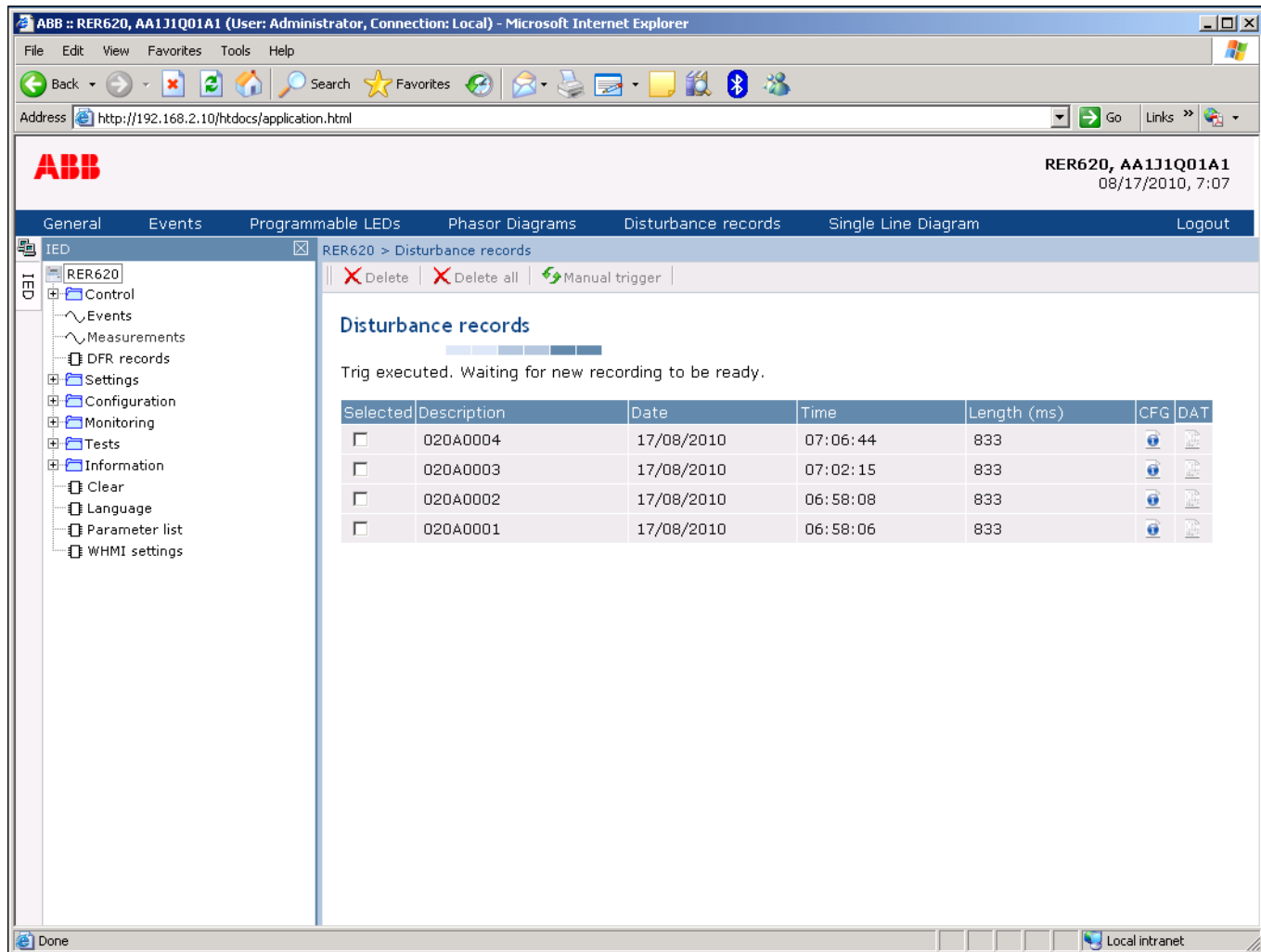
Figure 42:   *Manual triggering disturbance record*

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.
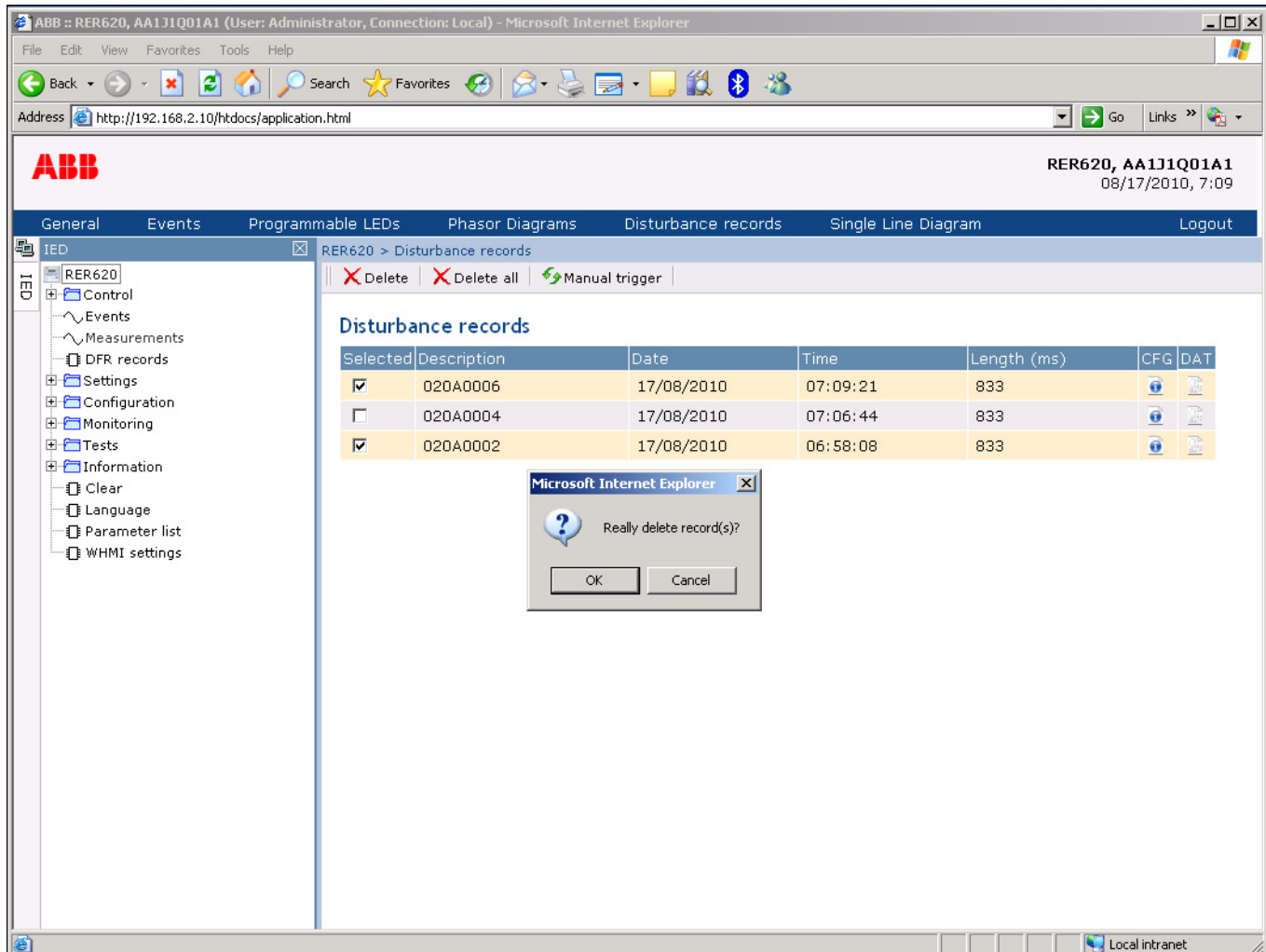
Figure 43:   *Deleting disturbance records*

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.
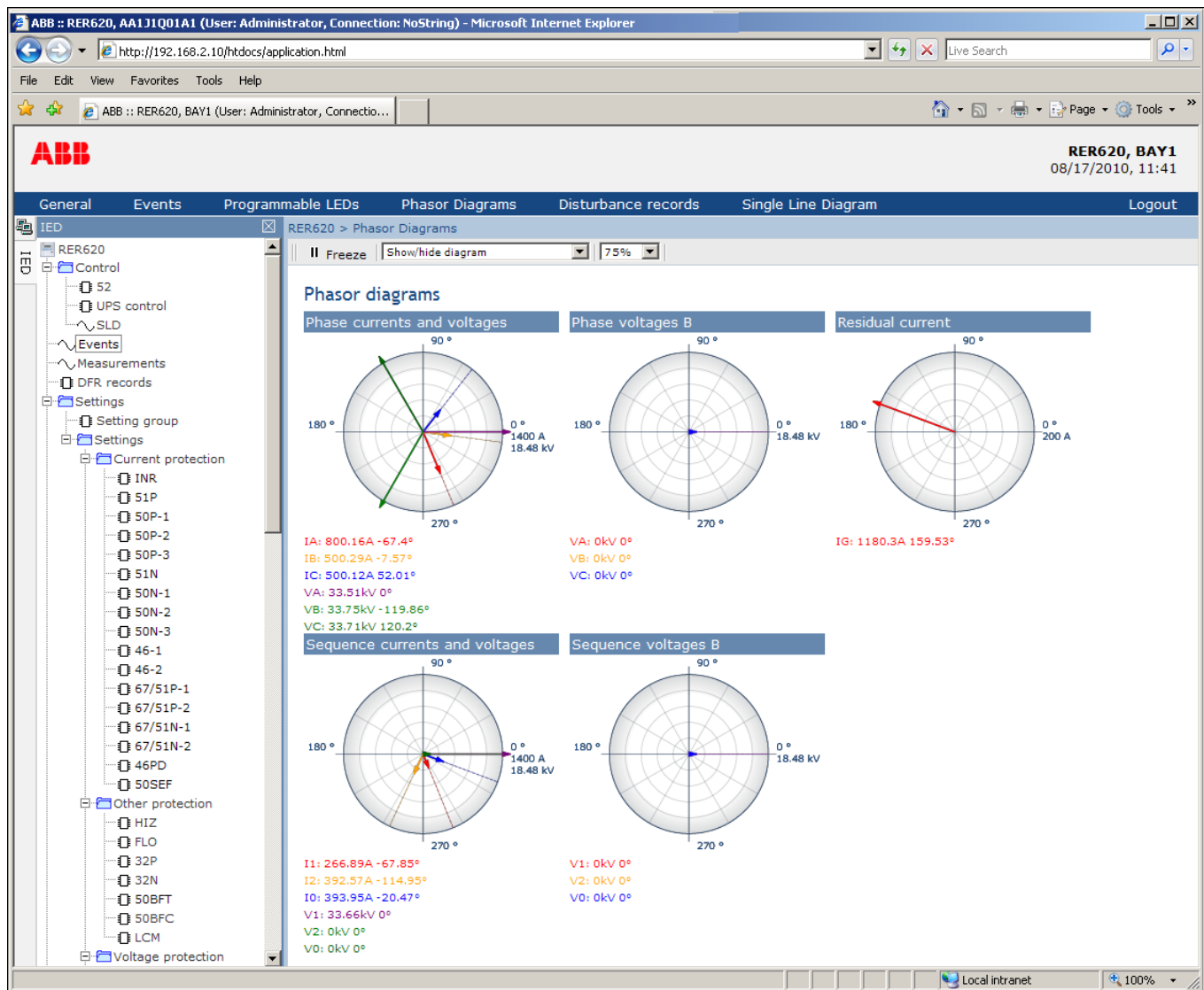
Figure 44:   *Normal case with symmetrical phase currents*

2.   Toggle the diagram visibility by selecting it from the drop-down menu.
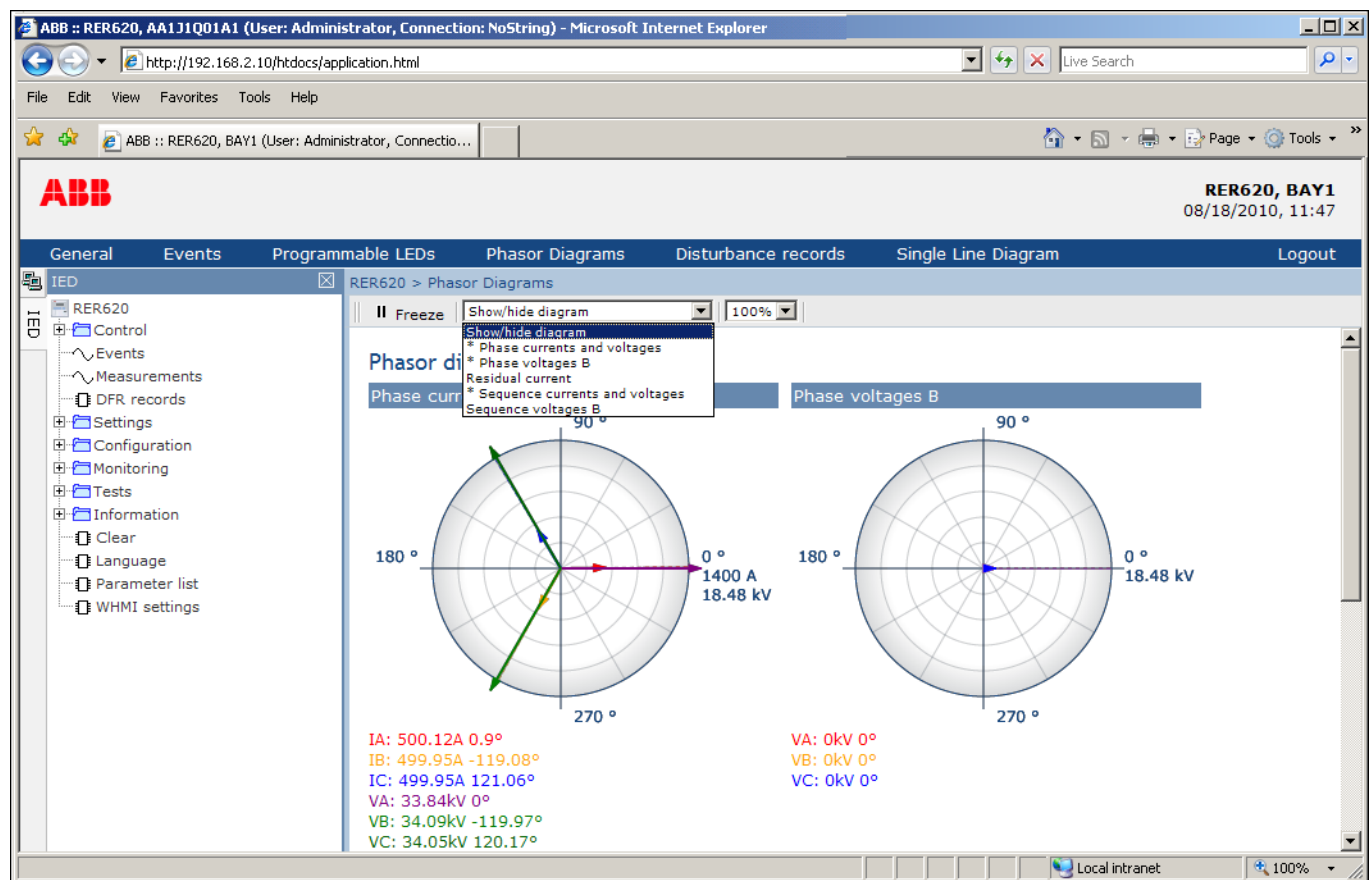
Figure 45: Toggling the diagram visibility

Visible diagrams are indicated with an asterisk *.

3. Change the size of the diagram by changing the zoom value.
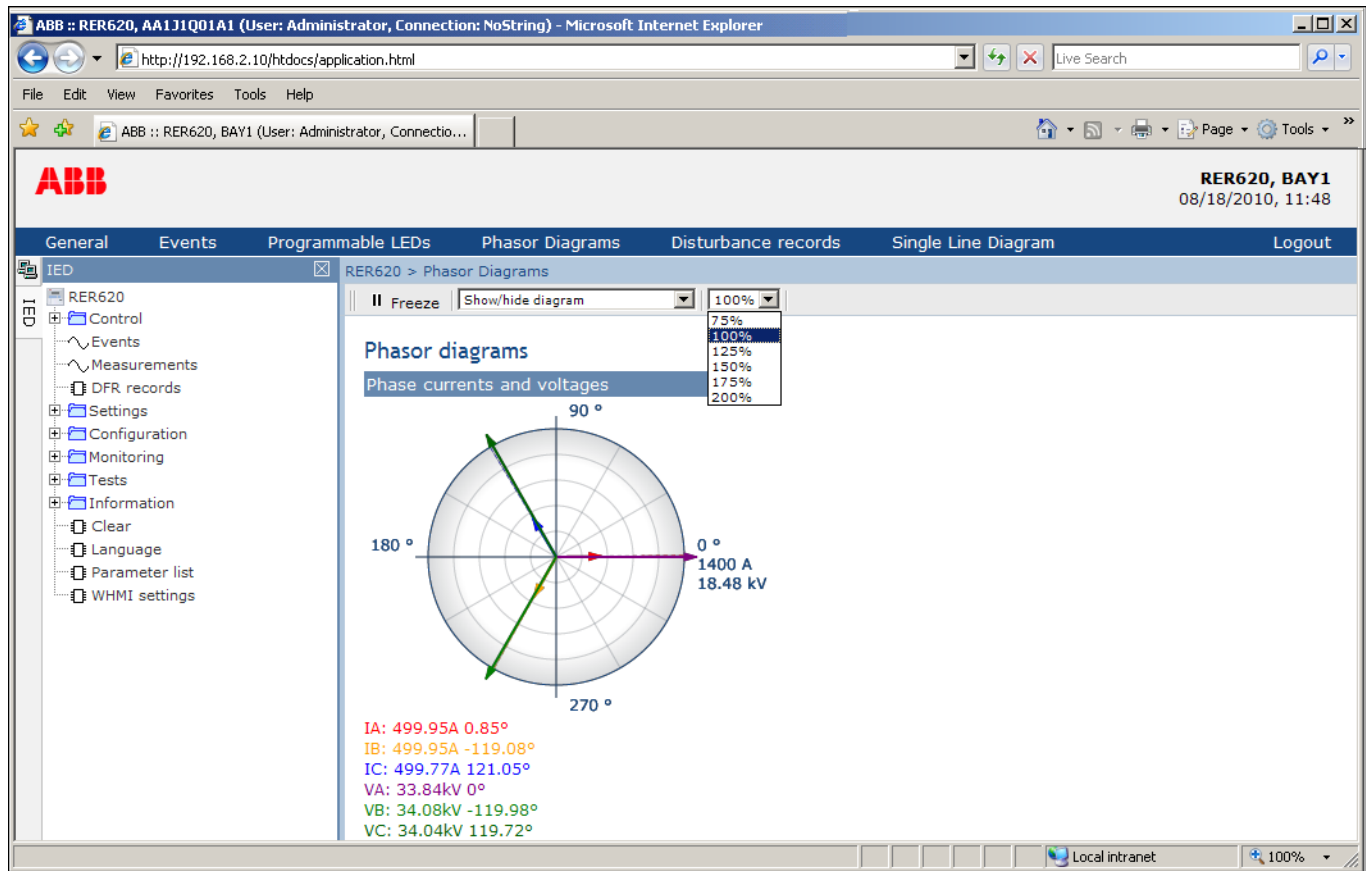
Figure 46:   *Zooming the diagram*

4.   Click **Freeze** to stop updating the phasor diagram.

No updates are displayed in the diagram.
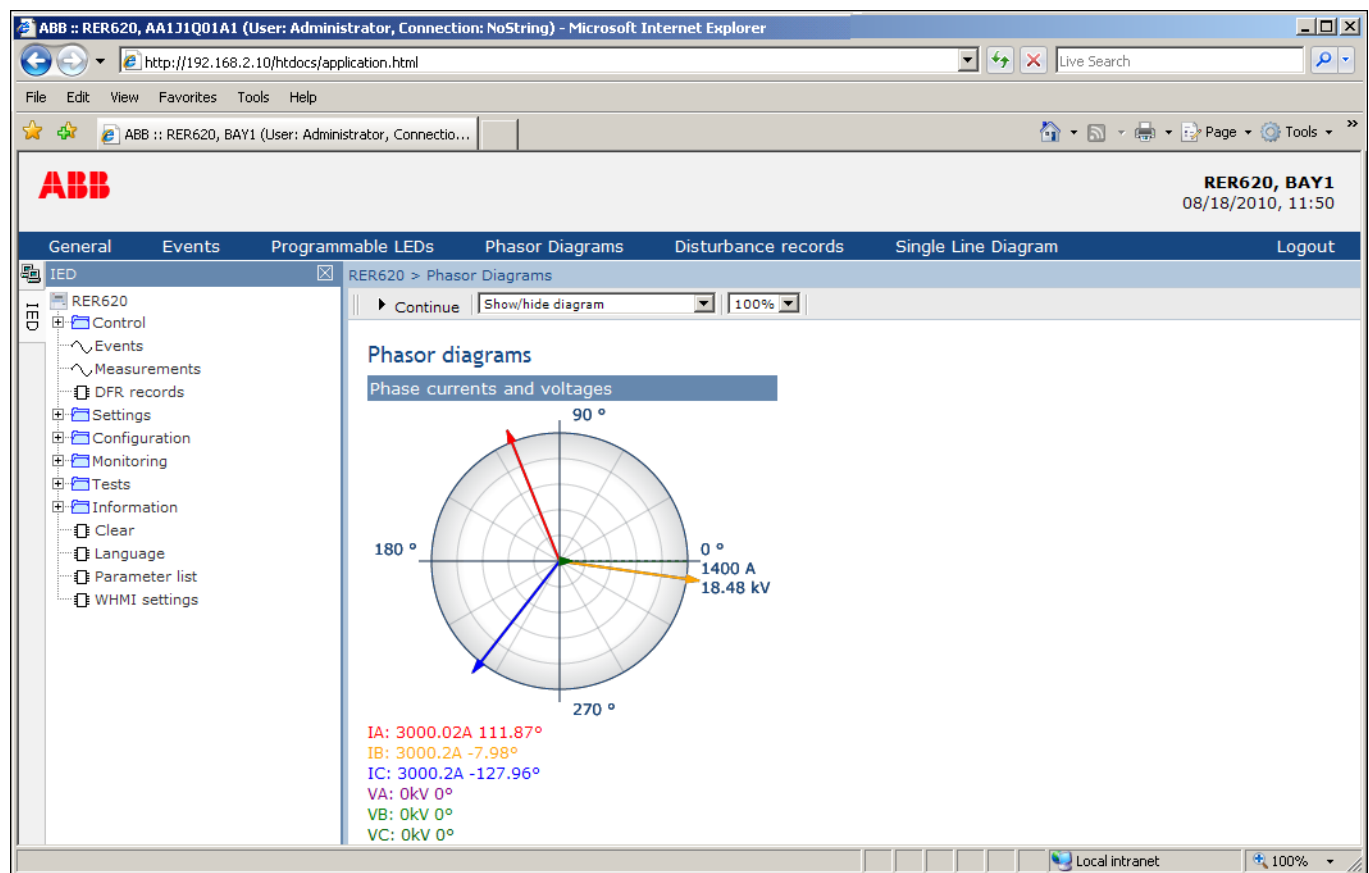
Figure 47:   *The arrow extends outside the circle if the current value is too high*

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.
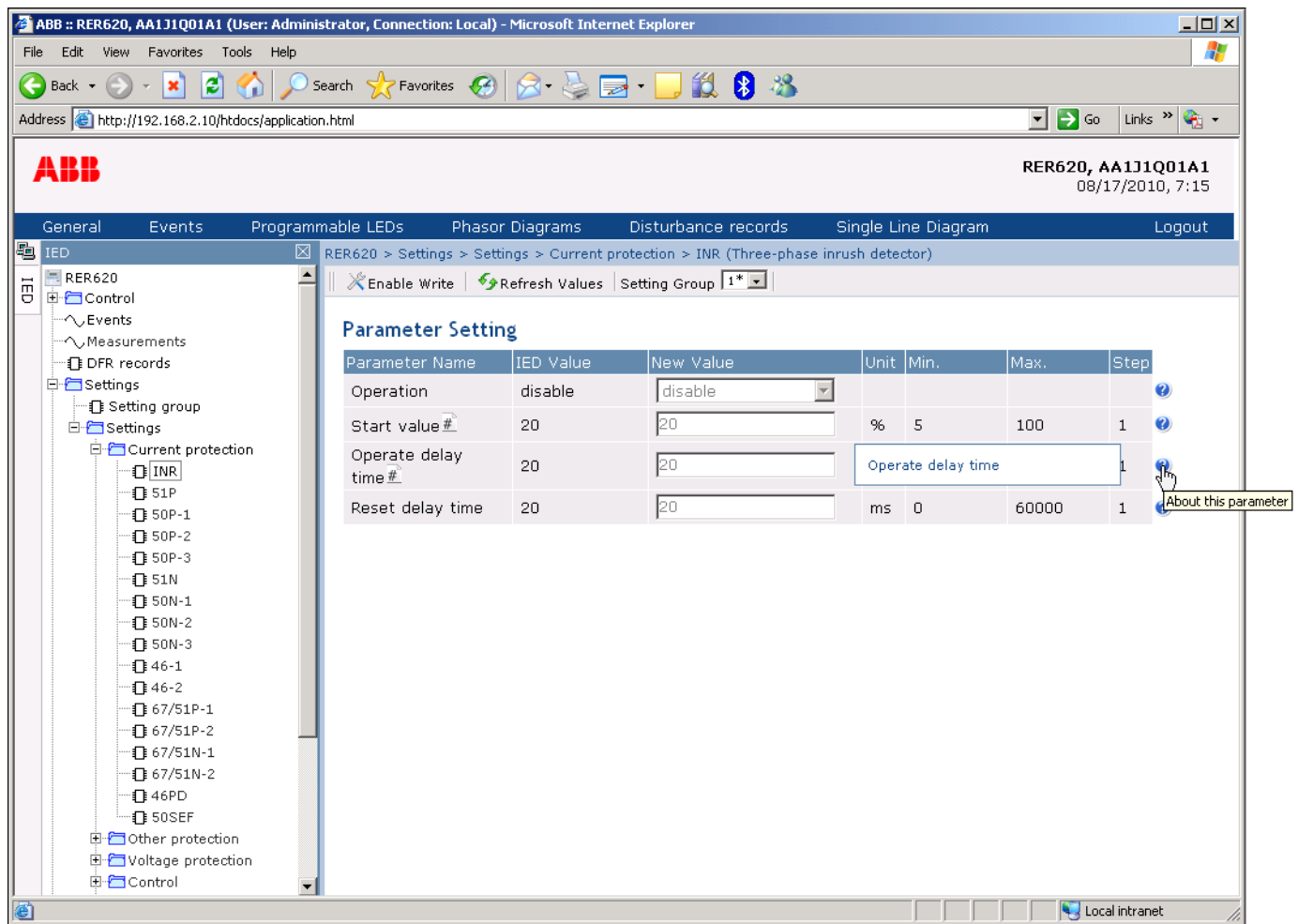
Figure 48:   *Opening the WHMI help*

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

Section 5 Relay Operation

5.1 Normal operation

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

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

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

For more information, see PCM600 documentation.

5.2 Disturbance identification

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

Table 14: Disturbance indications

LED	State	Description
Pickup LED	Yellow, steady	Protection picked up
Pickup LED	Yellow, flashing	Protection function blocked
Trip LED	Red, steady	Protection tripped
Normal 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 relay.

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

5.2.1 DFR record triggering

DFR recordings are normally triggered by relay applications when they detect fault events. DFR 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 DFR record analysis

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

For more information, see PCM600 documentation.

5.2.3 DFR reports

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

For more information, see PCM600 documentation.

5.2.4 Internal relay errors

The relay self-supervision handles internal run-time fault situations. The main indication of an internal fault is a flashing green Normal 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 relay records system registrations, relay status data and events.

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

5.3 Relay parametrization

Relay parameters are set via the LHMI, WHMI or PCM600.

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

Document all changes to parameter settings.

For more information, see PCM600 documentation.

5.3.1 Relay settings for relay functionality

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

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

5.3.2 Relay settings for different operating conditions

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

Section 6   Operating Procedures

6.1   Monitoring

6.1.1   Indications

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

- Three indicator LEDs with fixed functionality: Normal, Pickup and Trip
- 27 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 pickup 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.
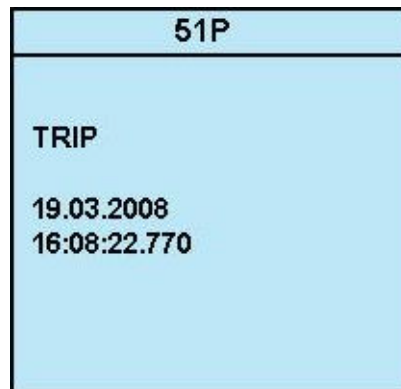
Figure 49:   Indication message

6.1.1.2   Monitoring an internal relay fault

The flashing green LED indicates an internal relay fault. Internal relay fault messages are shown in a dialog box.
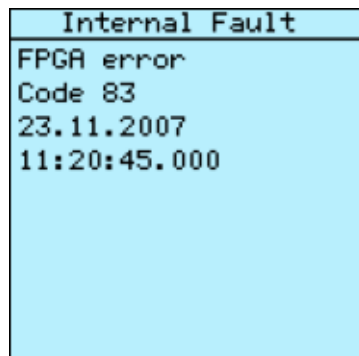
Figure 50: Fault indication

1.   Select **Main menu > Monitoring > relay 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 demand values calculated from a 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
IA-A	Current measured on phase A
IB-A	Current measured on phase B
IC-A	Current measure on phase C
IG-A	Ground current measured
VAB-kV	Phase to Phase AB voltage, Source 1
VBC-kV	Phase to Phace BC voltage, Source 1
VCA-kV	Phase to Phase CA voltage, Source 1
VAB2-kV	Phase to Phase AB voltage, Source 2
VBC2-kV	Phase to Phase BC voltage, Source 2
VCA2-kV	Phase to Phase CA voltage, Source 2
f-Hz	Frequency
S-kVA	Apparent Power
P-kW	Active Power
Q-kVAr	Reactive Power
PF	Power Factor
I2-A	Negative Sequence Current
I1-A	Positive Sequence Current
I0-A	Zero Sequence Current
V2-kV	Negative Sequence Voltage, Source 1
V1-kV	Positive Sequence Voltage, Source 1
V0-kV	Zero Sequence Voltage, Source 1
V2B-kV	Negative Sequence Voltage, Source 2
V1B-kV	Positive Sequence Voltage, Source 2
V0B-kV	Zero Sequence Voltage, Source 2

6.1.2.2   Using the local HMI for monitoring

1.   Select **Main menu** > **Measurements** to monitor measured and calculated values.
      The list of relay's basic measurements is shown.

2.   Scroll the view with and .

6.1.3   Recorded data

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

- DFR records
- Fault records
- Events

6.1.3.1 Creating digital fault records

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

1. Select **Main menu > DFR records**.

2. Select **Trig recording** with ⬆ or ⬇.

3. Press ↵, change the value with ⬆ or ⬇ and press ↵ again.
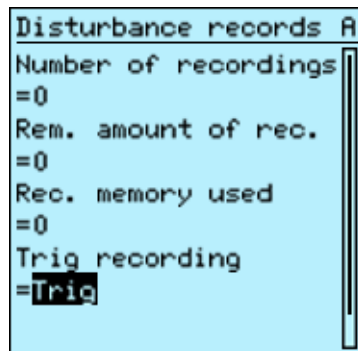
Figure 51: Changing the value

The DFR recorder is now triggered.

6.1.3.2 Monitoring DFR data

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

1. Select **Main menu > DFR records**.

All the DFR information is listed.

2. Scroll the view with ⬆ or ⬇.

The following items are listed in the view:
- Number of recordings currently in the relay 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 DFR.

```
Disturbance records A
Number of recordings
=0
Rem. amount of rec.
=0
Rec. memory used
=0
Trig recording
=Cancel
```
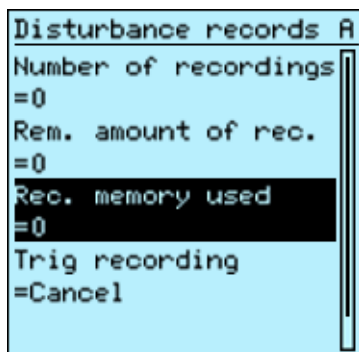
Figure 52: *Monitoring DFR via the LHMI*

6.1.3.3 Controlling and uploading DFR recorder data

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

ℹ️ 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 ⬅.
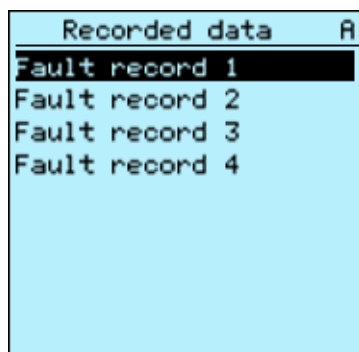
Figure 53: *Monitoring fault records*

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.
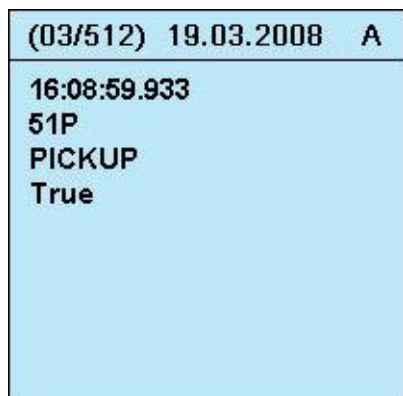
Figure 54: *Monitoring events*

6.1.4 Remote monitoring

The relay supports comprehensive remote monitoring.

6.1.4.1 Operating the relay remotely

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

- Read maintenance record and version log.

- Analyze DFR data.

- Create disturbance records.

- • Read relay 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 relay is set to local control mode and you are authorized to access control operations.

1. Press to open or to close the object.
2. Enter the password when prompted.
3. To confirm the operation, select `Yes` and press .
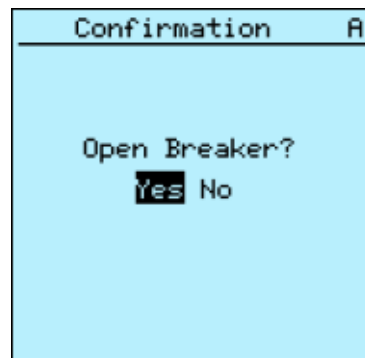
Figure 55: *Opening circuit breaker*

- To cancel the operation, select No and press ⏎.
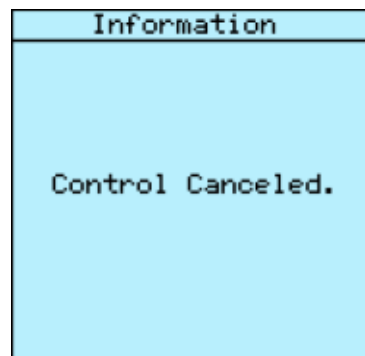
Figure 56: *Cancelling operation*

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 relay

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 ⬜ to activate the Clear view.

All the items that can be cleared are shown:
- Indications and LEDs

- Alarm LEDs

- Recorded data

- Events

- DFR records

- Temperature functions

- Trip lockout functions
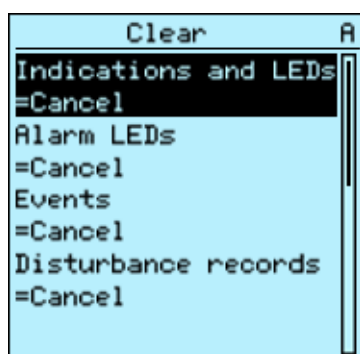
Figure 57: Clear view

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 ⬜ 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 relay functionality

6.4.1   Defining the setting group

6.4.1.1   Activating a setting group

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

1.   Select **Main menu > Settings > Setting group > Active group** and press ⏎.
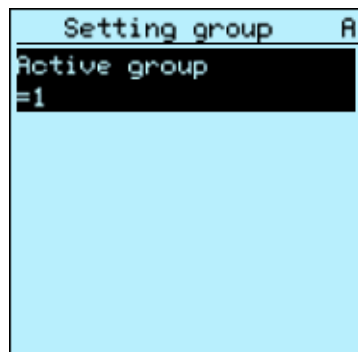
Figure 58:   *Active setting group*

2.   Select the setting group with or .
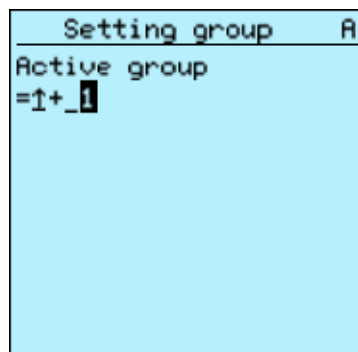
Figure 59:   *Selecting the active setting group*

3.   Press to confirm the selection or to cancel.

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.
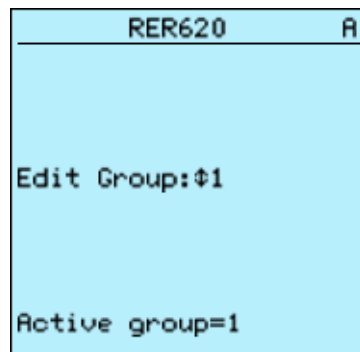
Figure 60: *Selecting a setting group*

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 #.
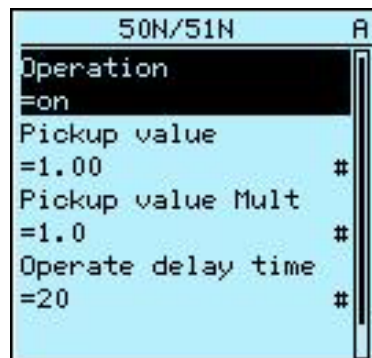
Figure 61: *Setting group parameter*

6. To select a setting group value, press ➡ and to edit the value press ↵ .
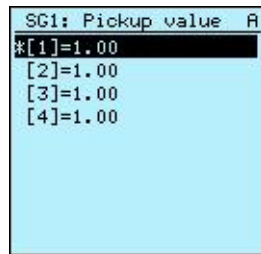
Figure 62:   *Selecting the setting group value*

Only values within the selected setting group can be changed.

7.   Press ⬆ or ⬇ to change the value and 🗒 to confirm the selection.
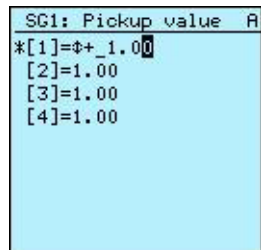
Figure 63:   *Editing the setting group value*

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 relay supervision events in **Main menu > Monitoring > relay status > Self-supervision** for a faulty hardware module.

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

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

7.1.2   Identifying runtime errors

1.   Check the error origin from the relay's supervision events **Main menu > Monitoring > relay status > Self-supervision**.

2.   Reboot the relay and recheck the supervision events to see if the fault has cleared.

3.   In case of persistent faults, contact ABB for corrective actions.

7.1.3   Identifying communication errors

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

- In case of persistent faults originating from relay'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 > relay status > Time synchronization**.

7.1.4   Running the display test

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

*   Press simultaneously ESC and Menu.

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

The internal fault code indicates the type of internal relay fault. When a fault appears, record the code so that it can be reported to ABB customer service.
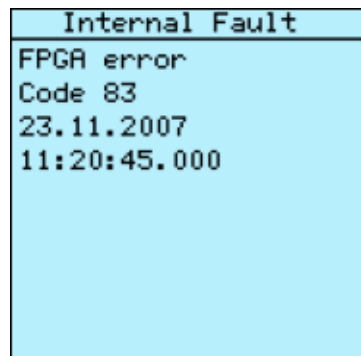
Figure 64: *Fault indication*

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 Supply voltage break	11	The auxiliary supply voltage has dropped to the failure level.
Internal fault Settings error	32	Settings error has occurred.
Internal Fault SO-relay(s),X105	40	Faulty Signal Output relay(s) in card located in slot X105.
Internal Fault SO-relay(s),X115	41	Faulty Signal Output relay(s) in card located in slot X115.
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),X120	45	Faulty Signal Output relay(s) in card located in slot X120.
Internal Fault SO-relay(s),X130	46	Faulty Signal Output relay(s) in card located in slot X130.
Internal Fault PO-relay(s),X105	50	Faulty Power Output relay(s) in card located in slot X105.
Internal Fault PO-relay(s),X115	51	Faulty Power Output relay(s) in card located in slot X115.
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),X120	55	Faulty Power Output relay(s) in card located in slot X120.
Internal Fault PO-relay(s),X130	56	Faulty Power Output relay(s) in card located in slot X130.
Internal Fault Light sensor error	57	Faulty ARC light sensor input(s).
Internal Fault Conf. error,X105	60	Card in slot X105 is wrong type.
Internal Fault Conf. error,X115	61	Card in slot X115 is wrong type.
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.

Fault indication	Fault code	Additional information
Internal Fault Conf. error,X130	66	Card in slot X130 is wrong type.
Internal Fault Card error,X105	70	Card in slot X105 is faulty.
Internal Fault Card error,X115	71	Card in slot X115 is faulty.
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.
Internal Fault UPD card error in X115	110	UPD card error in X115
Internal Fault UPD self-check fail in X115	111	UPD self-check fail in X115

7.2.2 Warnings

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

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

Figure 65:   *Warning*

Table 18:   Warning indications and codes

Warning indication	Warning code	Additional information
Warning Internal system warning	2	An internal system warning condition has occurred.
Warning Time synch error	5	A time synch error warning condition has occurred.
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 ACT error	31	ACT error
Warning GOOSE Tx/Rx error	32	Error in GOOSE message transmitting or receiving.
Warning AFL error	33	Error in AFL configuration
Warning Unack card comp.	40	A new composition has not been acknowledged/accepted.
Warning Protection comm.	50	Error in protection communication.
Warning UPD Voltage Low in X115	112	UPD Voltage Low in X115
Warning UPS Communication error in X115	113	UPS Communication error in X115
Warning UPS Command failure in X115	114	UPS Command failure in X115
Warning Breaker Operation Failure	115	Breaker Operation Failure, possibly due to incorrect setting for UPD or UPD profile setting.

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 relay from working properly, the whole file system can be restored to the original factory state. All default settings and configuration files stored in the factory are restored.

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

> **i**   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.

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

> 💡   For more information, see User authorization.

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 relay application problems

- Check that the function is on.
- Check the blocking.
- Check the mode.
- Check the measurement value.
- Check the connection to trip and DFR 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 or voltage connections to relay terminals might be correct, wrong polarity of one or more measurement transformers can cause problems.

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

7.3.4.2 Sample data interruptions

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

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

Section 8   Commissioning

8.1   Commissioning checklist

It is recommended that personnel familiarize themselves with the relay and its functionality before starting the commissioning work. It is most highly recommended to install communications software on the PC to be used during commissioning and test communications with an relay before going to the site.

Most utilities have a checklist used during the commissioning process. Such a list should include the following:

- All necessary station drawings such as single line and wiring diagrams
- The correct version of the technical manual for the relay version to be tested
- Setting software and connectivity packages that work with the relay version to be tested
- Identify and install any additional software required.
- Verified relay settings either on paper or in electronic format. Both settings and connection logic should be well documented
- The correct cable to connect a PC to the relay's communication port. The RJ-45 port supports any CAT 5 Ethernet cable but the recommended type is STP
- The name and phone number of a person to contact if there is trouble with operation or settings in the relay
- Proper test equipment and all necessary connection cables
- Obtain information about the switchgear at the work site and any special aspects of it
- Information on how to operate in emergency situations: first aid, safety materials, exit routes, etc.

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 before powering the relay.

8.2.2   Checking CT circuits

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

- Primary injection test to verify the current ratio of the CT, the correct wiring up to the protection relay and correct phase sequence connection (that is A, B, C.)
- 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 relay.
- CT secondary loop resistance measurement to confirm that the current transformer secondary loop dc resistance is within specification and that there are no high resistance joints in the CT winding or wiring.
- CT excitation test to ensure that the correct core in the CT is connected to the relay. Normally only a few points along the excitation curve are checked to ensure that there are no wiring errors in the system, for example due to a mistake in connecting the CT's measurement core to the relay.
- CT excitation test to ensure that the CT is of the correct accuracy rating and that there are no short circuited turns in the CT windings. Manufacturer's design curves should be available for the CT to compare the actual results.
- Grounding check of the individual CT secondary circuits to verify that each three-phase set of main CTs is properly connected to the station ground 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 relay when plotting the excitation characteristics.

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

8.2.3   Checking VT circuits

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

> Do not continue before any errors are corrected.

Test the circuitry.

- Polarity check
- VT circuit voltage measurement (primary injection test)
- Grounding 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 to the relay as possible to ensure that most of the wiring is also checked.

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

8.2.4 Checking binary input and output circuits

8.2.4.1 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 relays 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 relay specifications.

8.2.5 Checking optical connections

Check that the Tx and Rx optical connections are correct.

A relay equipped with optical connections requires a minimum depth of 180 mm for plastic fiber cables and 275 mm for glass fiber cables. The allowed minimum bending radius has to be checked from the optical cable manufacturer.

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 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 relay 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 relays and PCM600

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

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

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

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

To configure the physical connection and the IP addresses:

1. Set up or get the IP addresses of the relays.
2. Set up the PC for a direct link or connect the PC or workstation to the network.
3. Configure the relay IP addresses in the PCM600 project for each relay. 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 relay.

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

Point to point link

The relay 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 it is recommended to use the shielded twisted pair cable.

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

LAN or WAN network

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

8.4.1.2 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 relay 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**.
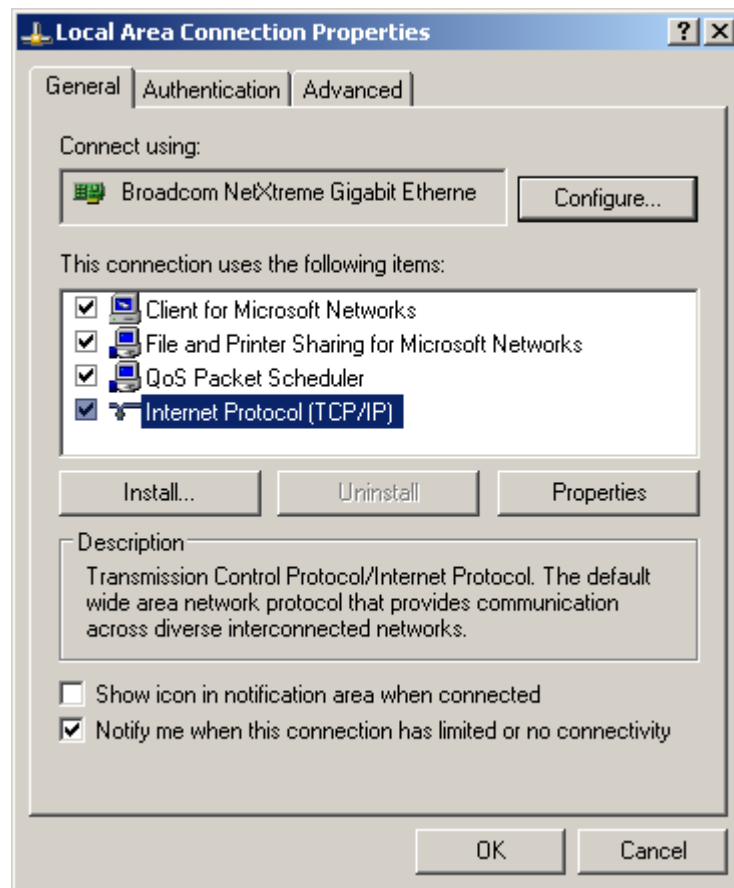
Figure 66: *Selecting TCP/IP protocol*

4.   Select **Obtain an IP address automatically** and **Obtain** DNS **server address automatically**.
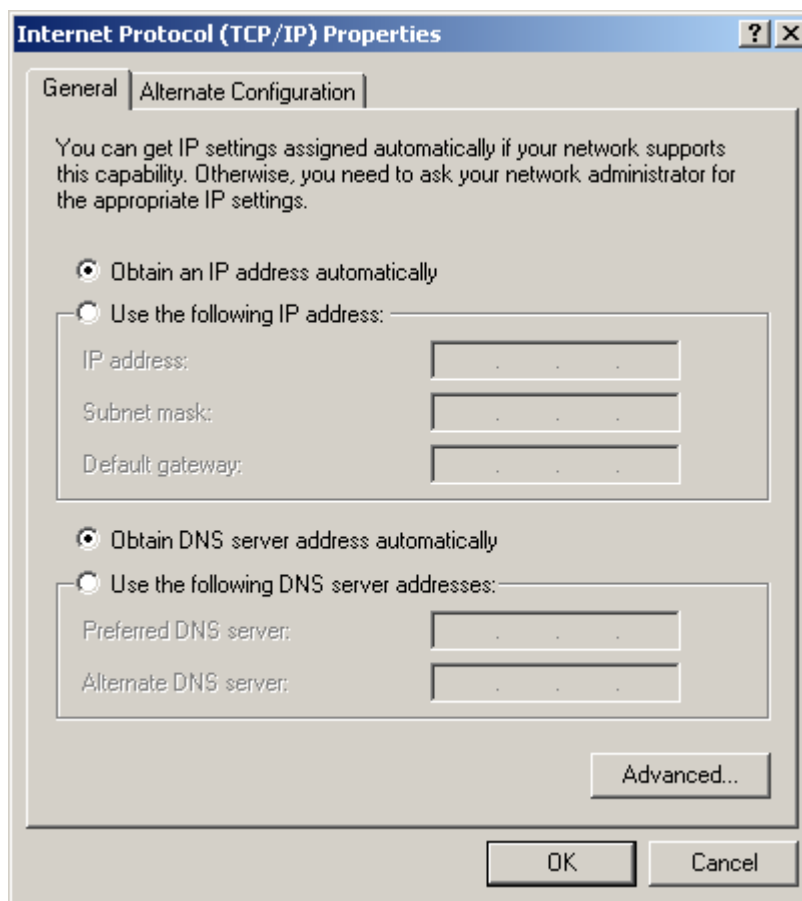
Figure 67: Obtaining IP address automatically

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**.
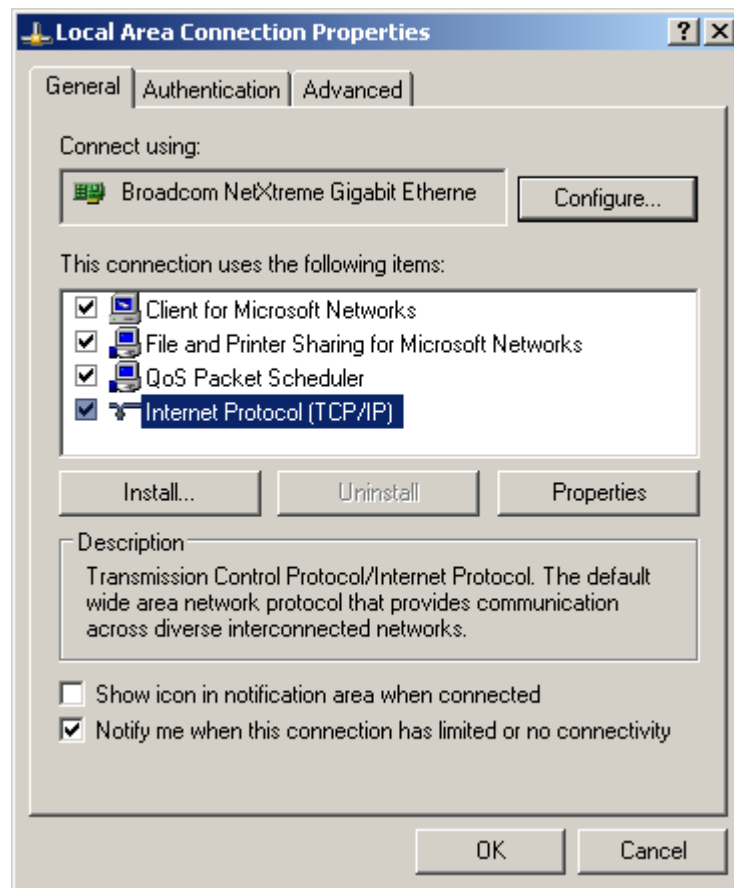
Figure 68: *Selecting TCP/IP protocol*

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 relay on the network.
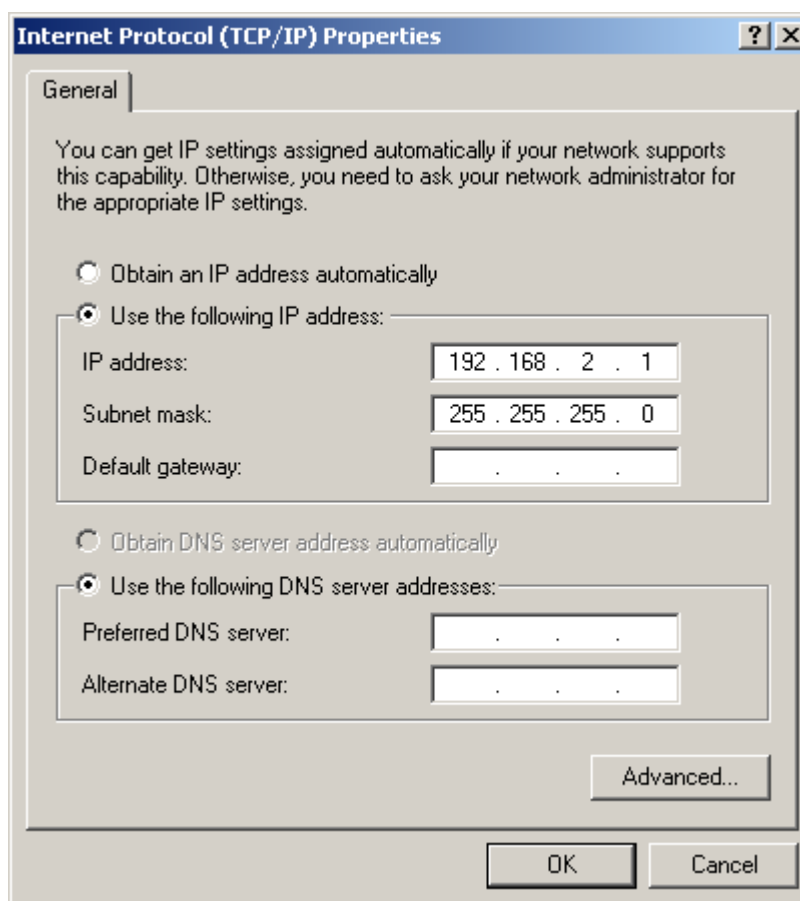
Figure 69:   *Setting IP address and subnet mask*

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

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

Setting relay's IP address in PCM600

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

1.   Select the relay 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 relay and communication

8.5.1 Communication settings

The relay 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. Ethernet RJ-45 and optical Ethernet LC are the two rear port Ethernet communication options. Rear port Ethernet is intended for station bus communication. Communication protocols used via Ethernet ports are IEC 61850-8-1, DNP3 TCP/IP and Modbus TCP/IP.

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

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

> 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.

8.5.1.1 Serial communication ports and drivers

Depending on the hardware configuration, the relay 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 relay uses serial ports and drivers as different types of serial communication protocol links.

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

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

Table 20:   COM port parameters in different HW options

COM parameter	Values	Hardware options
Serial mode	0 = RS485 2wire	For galvanic modes. RS-type depends on the communication card used.
	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]	

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 framing 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

The serial COM setting is not currently supported.

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 relay'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 relay 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.

a   Clear the browser of cached pages.

b   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 relay's technical manual to determine if the jumpers on the communication board are correct.

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

ℹ️ 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.
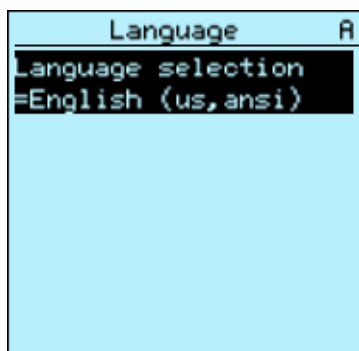
Figure 70: *Changing the LHMI language*

💡 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 relay. After an auxiliary power failure, the contrast is restored.

8.5.2.3 Changing display symbols

To switch between the display symbols IEC 61850 and 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.

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

1. Set the *DST on day* 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 relay parameters

8.5.3.1   Defining settings 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 71: *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.
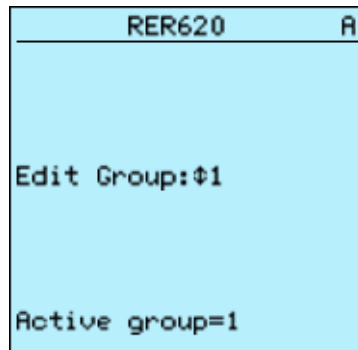
Figure 72: *Selecting a setting group*

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 #.
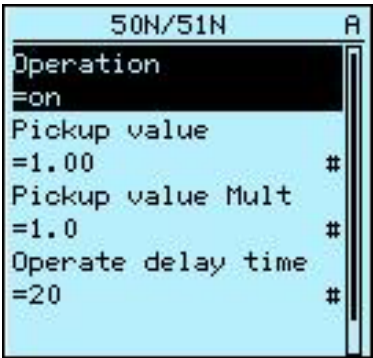
Figure 73: *Setting group parameter*

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

Figure 74: *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 75: *Editing the setting group value*

The active setting group is indicated with an asterisk * .

Activating a setting group

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

1. Select **Main menu > Settings > Setting group > Active group** and press ⏎.

    Figure 76: *Active setting group*

2. Select the setting group with ⬆ or ⬇.

3. Press ⏎ to confirm the selection or ESC to cancel.
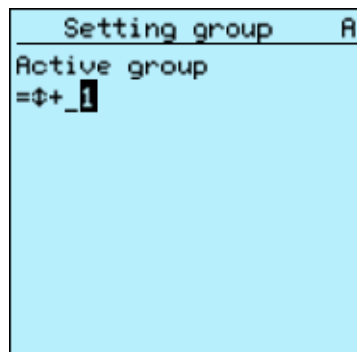

    Figure 77: *Selecting the active setting group*

4. Commit the settings.

    > Remember to document the changes you make.

8.5.3.2   Relay parametrization

Relay parameters are set via the LHMI, WHMI or PCM600.

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

Document all changes to parameter settings.

For more information, see PCM600 documentation.

8.5.3.3 Defining DFR channel settings

1. Select **Main Menu > Configuration > DFR > Channel settings**.

2. Press ⬆ or ⬇ to scroll the view.

3. To change channel settings, press ↵.
Analog channels are fixed except channel 4 which is selectable based on the Ground CT option.

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.

8.6 Testing relay operation

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

8.6.1 Selecting the test mode

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

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

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

1. Select **Main menu > Tests > relay test > Test mode** and press ↵.

Figure 78: Entering test mode
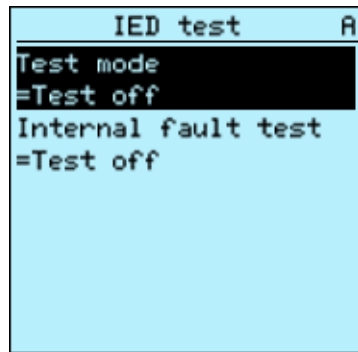
2.   Select the test mode status with ⬆ or ⬇.

3.   Press ↵ to confirm the selection.

ⓘ   If you do not cancel the test mode, it remains on and the Normal 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 relay, 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 Normal 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 > relay test > Internal fault test** and press ⏎.
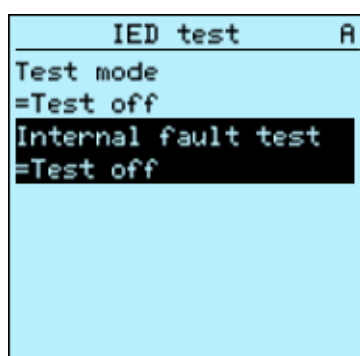
Figure 79:   *Internal fault test*

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 relay's SW or HW.

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

Figure 80:   *LCT indication*

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

Section 9   Glossary

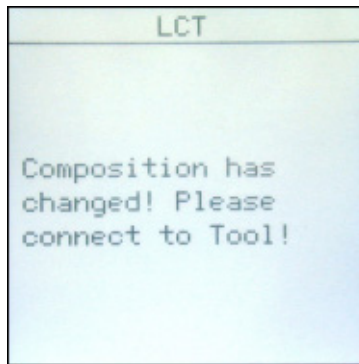|	
100BASE-FX	A physical media defined in the IEEE 802.3 Ethernet standard for local area networks (LANs) that uses fibre-optic cabling
100BASE-TX	A physical media defined in the IEEE 802.3 Ethernet standard for local area networks (LANs) that uses twisted-pair cabling category 5 or higher with RJ-45 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
CRC	Cyclical redundancy check
CSV	Comma-separated values
CT	Current transformer
DFR	Digital fault recorder
DHCP	Dynamic Host Configuration Protocol
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 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
relay	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 fiber 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 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 relay 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

RTC	Real-time clock
Rx	Receive/Received
SCL	Substation configuration language
SMT	Signal Matrix Tool in PCM600
STP	Shielded twisted-pair
SVG	Scalable vector graphics
SW	Software
TCP/IP	Transmission Control Protocol/Internet Protocol
Tx	Transmit/Transmitted
UTC	Coordinated universal time
VT	Voltage transformer
WAN	Wide area network
WHMI	Web human-machine interface

Contact us

ABB Inc.
Distribution Automation
4300 Coral Ridge Drive
Coral Springs, FL 33065, USA
Phone:+1 (800) 523-2620
Phone:+1 954-752-6700
Fax:+1 954 345-5329
www.abb.com/substationautomation

Power and productivity
for a better world™

ABB