



Relion® Protection and Control

650 series Operation Manual



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Conformity

This product complies with the directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive 2004/108/EC) and concerning electrical equipment for use within specified voltage limits (Low-voltage directive 2006/95/EC). This conformity is the result of tests conducted by ABB in accordance with the product standards EN 50263 and EN 60255-26 for the EMC directive, and with the product standards EN 60255-1 and EN 60255-27 for the low voltage directive. The product is designed in accordance with the international standards of the IEC 60255 series.

Safety information



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



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



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



National and local electrical safety regulations must always be followed.



The frame of the IED has to be carefully earthed.



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



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

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Section 1 Introduction

1.1 This manual

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

1.2 Intended audience

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

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

1.3 Product documentation

1.3.1 Product documentation set

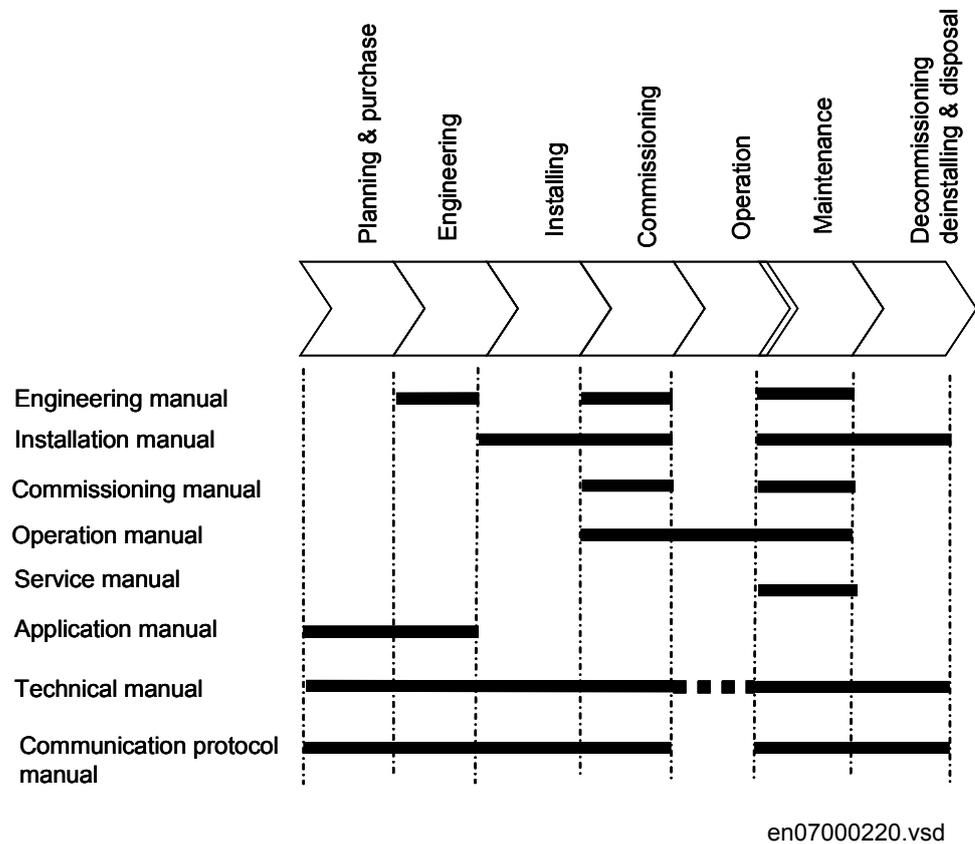


Figure 1: The intended use of manuals in different lifecycles

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

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

The commissioning manual contains instructions on how to commission the IED. The manual can also be used by system engineers and maintenance personnel for assistance during the testing phase. The manual provides procedures for checking of external circuitry and energizing the IED, parameter setting and configuration as

well as verifying settings by secondary injection. The manual describes the process of testing an IED in a substation which is not in service. The chapters are organized in chronological order in which the IED should be commissioned.

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

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

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 IED. The manual concentrates on vendor-specific implementations.

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

1.3.2 Document revision history

Document revision/date	History
A/December 2013	Minor corrections made

1.3.3 Related documents

Documents related to REB650	Identity number
Application manual	1MRK 505 276-UEN
Technical manual	1MRK 505 277-UEN
Commissioning manual	1MRK 505 278-UEN
Product Guide, configured	1MRK 505 279-BEN
Type test certificate	1MRK 505 279-TEN
Application notes for Circuit Breaker Control	1MRG006806

Documents related to REL650	Identity number
Application manual	1MRK 506 329-UEN
Technical manual	1MRK 506 330-UEN
Commissioning manual	1MRK 506 331-UEN
Product Guide, configured	1MRK 506 332-BEN
Type test certificate	1MRK 506 332-TEN
Application notes for Circuit Breaker Control	1MRG006806
Documents related to RET650	Identity number
Application manual	1MRK 504 128-UEN
Technical manual	1MRK 504 129-UEN
Commissioning manual	1MRK 504 130-UEN
Product Guide, configured	1MRK 504 131-BEN
Type test certificate	1MRK 504 131-TEN
Application notes for Circuit Breaker Control	1MRG006806
Documents related to REC650	Identity number
Application manual	1MRK 511 262-UEN
Technical manual	1MRK 511 263-UEN
Commissioning manual	1MRK 511 264-UEN
Product Guide	1MRK 511 265-BEN
Type test certificate	1MRK 511 265-TEN
Documents related to REG650	Identity number
Application manual	1MRK 502 042-UEN
Technical manual	1MRK 502 043-UEN
Commissioning manual	1MRK 502 044-UEN
Product Guide	1MRK 502 045-BEN
Type test certificate	1MRK 502 045-TEN
Rotor Earth Fault Protection with Injection Unit RXTTE4 and REG670	1MRG001910
Application notes for Circuit Breaker Control	1MRG006806
Documents related to REQ650	Identity number
Application manual	1MRK 505 280-UEN
Technical manual	1MRK 505 281-UEN
Commissioning manual	1MRK 505 282-UEN
Product Guide	1MRK 505 283-BEN
Type test certificate	1MRK 505 283-TEN
Application notes for Circuit Breaker Control	1MRG006806
650 series manuals	Identity number
Communication protocol manual, DNP3	1MRK 511 257-UEN
Communication protocol manual, IEC 61850-8-1	1MRK 511 258-UEN
Communication protocol manual, IEC 60870-5-103	1MRK 511 259-UEN
Cyber Security deployment guidelines	1MRK 511 268-UEN
Point list manual, DNP3	1MRK 511 260-UEN

Table continues on next page

650 series manuals	Identity number
Engineering manual	1MRK 511 261-UEN
Operation manual	1MRK 500 095-UEN
Installation manual	1MRK 514 015-UEN

1.4 Symbols and conventions

1.4.1 Symbols



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



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



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



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



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

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

1.4.2 Document conventions

A particular convention may not be used in this manual.

- Abbreviations and acronyms 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.
To navigate between the options, use  and .
- HMI menu paths are presented in bold.
Select **Main menu/Settings**.
- LHMI messages are shown in Courier font.
To save the changes in non-volatile memory, select *Yes* and press .
- Parameter names are shown in italics.
The function can be enabled and disabled with the *Operation* setting.
- The ^ character in front of an input or output signal name in the function block symbol given for a function, indicates that the user can set an own signal name in PCM600.
- The * character after an input or output signal name in the function block symbol given for a function, indicates that the signal must be connected to another function block in the application configuration to achieve a valid application configuration.

1.4.3 Functions included in 650 series IEDs

Table 1: Main protection functions

IEC 61850 / Function block name	ANSI	Function description
Differential protection		
T2WPDIF	87T	Transformer differential protection, two winding
T3WPDIF	87T	Transformer differential protection, three winding
REFPDIF	87N	Restricted earth fault protection, low impedance
HZPDIF	87	1Ph High impedance differential protection
GENPDIF	87G	Generator differential protection
Impedance protection		
ZQMPDIS	21	Five-zone distance protection, Quadrilateral and Mho characteristic
FDPSPDIS	21	Phase selection with load encroachment, quadrilateral characteristic
FMPSPDIS	21	Faulty phase identification with load encroachment for mho
ZDARDIR	21	Additional distance protection directional function for earth faults
ZDNRRDIR	21	Directional impedance quadrilateral and mho
PPLPHIZ		Phase preference logic
ZMRPSB	68	Power swing detection
ZCVPSOF		Automatic switch onto fault logic, voltage-and current-based
ZGCPDIS	21G	Underimpedance protection for generators and transformers
LEXPDIS	40	Loss of excitation
OOSPPAM	78	Out-of-step protection
LEPDIS		Load encroachment

Table 2: Backup protection functions

IEC 61850 / Function block name	ANSI	Function description
Current protection		
PHPIOC	50	Instantaneous phase overcurrent protection
SPTPIOC	50	Instantaneous phase overcurrent protection
OC4PTOC	51/67	Four-step phase overcurrent protection
OC4SPTOC	51/67	Four-step phase overcurrent protection
EFPIOC	50N	Instantaneous residual overcurrent protection
EF4PTOC	51N/67N	Four-step directional residual overcurrent protection
SDEPSDE	67N	Sensitive directional residual overcurrent and power protection
UC2PTUC	37	Time-delayed two-step undercurrent protection
LCPTTR	26	Thermal overload protection, one time constant, Celsius
LFPTTR	26	Thermal overload protection, one time constant, Fahrenheit
TRPTTR	49	Thermal overload protection, two time constants
CCRBFR	50BF	Breaker failure protection
CSPRBRF	50BF	Breaker failure protection
STBPTOC	50STB	Stub protection
CCRPLD	52PD	Pole discordance protection
BRCPTOC	46	Broken conductor check
GUPPDUP	37	Directional underpower protection
GOPPDOP	32	Directional overpower protection
DNSPTOC	46	Negative sequence-based overcurrent function
AEGGAPC	50AE	Accidental energizing protection for synchronous generator
NS2PTOC	46I2	Negative-sequence time overcurrent protection for machines
VR2PVOC	51V	Voltage-restrained time overcurrent protection
Voltage protection		
UV2PTUV	27	Two-step undervoltage protection
OV2PTOV	59	Two-step overvoltage protection
ROV2PTOV	59N	Two-step residual overvoltage protection
OEXPVPH	24	Overexcitation protection
LOVPTUV	27	Loss-of-voltage check
STEFPHIZ	59THD	100% Stator earth fault protection, 3rd harmonic based
Frequency protection		
SAPTUF	81	Underfrequency function
SAPTOF	81	Overfrequency function
SAPFRC	81	Rate-of-change frequency protection

Table 3: Control and monitoring functions

IEC 61850 / Function block name	ANSI	Function description
Control		
SESRSYN	25	Synchrocheck, energizing check and synchronizing
SMBRREC	79	Autorecloser
STBRREC	79	Autorecloser
SCILO	3	Logical node for interlocking
BB_ES	3	Interlocking for busbar earthing switch
A1A2_BS	3	Interlocking for bus-section breaker
A1A2_DC	3	Interlocking for bus-section disconnecter
ABC_BC	3	Interlocking for bus-coupler bay
BH_CONN	3	Interlocking for 1 1/2 breaker diameter
BH_LINE_A	3	Interlocking for 1 1/2 breaker diameter
BH_LINE_B	3	Interlocking for 1 1/2 breaker diameter
DB_BUS_A	3	Interlocking for double CB bay
DB_BUS_B	3	Interlocking for double CB bay
DB_LINE	3	Interlocking for double CB bay
ABC_LINE	3	Interlocking for line bay
AB_TRAFO	3	Interlocking for transformer bay
SCSWI		Switch controller
SXCBR		Circuit breaker
SXSWI		Circuit switch
POS_EVAL		Evaluation of position indication
SELGGIO		Select release
QCBAY		Bay control
LOCREM		Handling of LR-switch positions
LOCREMCTRL		LHMI control of PSTO
TR8ATCC	90	Automatic voltage control for tap changer, parallel control
TCMYLTC	84	Tap changer control and supervision, 6 binary inputs
SLGGIO		Logic-rotating Switch for function selection and LHMI presentation
VSGGIO		Selector mini switch extension
DPGGIO		IEC61850 generic communication I/O functions double point
SPC8GGIO		Single-point generic control 8 signals
AUTOBITS		AutomationBits, command function for DNP3.0
I103CMD		Function commands for IEC60870-5-103
I103IEDCMD		IED commands for IEC60870-5-103
I103USRCMD		Function commands user defined for IEC60870-5-103
I103GENCMD		Function commands generic for IEC60870-5-103
I103POSCMD		IED commands with position and select for IEC60870-5-103
Table continues on next page		

IEC 61850 / Function block name	ANSI	Function description
Secondary system supervision		
CCSRDIF	87	Current circuit supervision
SDDRFUF		Fuse failure supervision
TCSSCBR		Breaker close/trip circuit monitoring
Logic		
SMPPTRC	94	Tripping logic
SPTPTRC	94	Tripping logic
TMAGGIO		Trip matrix logic
OR		Configurable logic blocks, OR
INVERTER		Configurable logic blocks, Inverter
PULSETIMER		Configurable logic blocks, PULSETIMER
GATE		Configurable logic blocks, Controllable gate
XOR		Configurable logic blocks, exclusive OR
LOOPDELAY		Configurable logic blocks, loop delay
TimerSet		Configurable logic blocks, timer
AND		Configurable logic blocks, AND
SRMEMORY		Configurable logic blocks, set-reset memory
RSMEMORY		Configurable logic blocks, reset-set memory
ANDQT		Configurable logic Q/T, ANDQT
ORQT		Configurable logic Q/T, ORQT
INVERTERQT		Configurable logic Q/T, INVERTERQT
XORQT		Configurable logic Q/T, XORQT
SRMEMORYQT		Configurable logic Q/T, set-reset with memory
RSMEMORYQT		Configurable logic Q/T, reset-set with memory
TIMERSETQT		Configurable logic Q/T, settable timer
PULSETIMERQT		Configurable logic Q/T, pulse timer
INVALIDQT		Configurable logic Q/T, INVALIDQT
INDCOMBSPQT		Configurable logic Q/T, single-indication signal combining
INDEXTSPQT		Configurable logic Q/T, single-indication signal extractor
FXDSIGN		Fixed-signal function block
B16I		Boolean 16 to Integer conversion
B16FCVI		Boolean 16 to Integer conversion with logic node representation
IB16A		Integer to Boolean 16 conversion
IB16FCVB		Integer to boolean 16 conversion with logic node representation
Monitoring		
CVMMXN		Measurements
CMMXU		Phase current measurement
VMMXU		Phase-phase voltage measurement
Table continues on next page		

IEC 61850 / Function block name	ANSI	Function description
CMSQI		Current sequence component measurement
VMSQI		Voltage sequence measurement
VNMMXU		Phase-neutral voltage measurement
AISVBAS		Function block for service values presentation of the analog inputs
TM_P_P2		Function block for service value presentation of primary analog inputs 600TRM
AM_P_P4		Function block for service value presentation of primary analog inputs 600AIM
TM_S_P2		Function block for service value presentation of secondary analog inputs 600TRM
AM_S_P4		Function block for service value presentation of secondary analog inputs 600AIM
CNTGGIO		Event counter
DRPRDRE		Disturbance report
AxRADR		Analog input signals
BxRBDR		Binary input signals
SPGGIO		IEC61850 generic communication I/O functions
SP16GGIO		IEC61850 generic communication I/O functions 16 inputs
MVGGIO		IEC61850 generic communication I/O functions
MVEXP		Measured value expander block
LMBRFLO		Fault locator
SPVNZBAT		Station battery supervision
SSIMG	63	Insulation gas-monitoring function
SSIML	71	Insulation liquid-monitoring function
SSCBR		Circuit breaker condition monitoring
I103MEAS		Measurands for IEC60870-5-103
I103MEASUSR		Measurands user defined signals for IEC60870-5-103
I103AR		Function status auto-recloser for IEC60870-5-103
I103EF		Function status earth-fault for IEC60870-5-103
I103FLTPROT		Function status fault protection for IEC60870-5-103
I103IED		IED status for IEC60870-5-103
I103SUPERV		Supervision status for IEC60870-5-103
I103USRDEF		Status for user defiend signals for IEC60870-5-103
Metering		
PCGGIO		Pulse counter logic
ETPMTR		Function for energy calculation and demand handling

Table 4: *Designed to communicate*

IEC 61850 / Function block name	ANSI	Function description
Station communication		
IEC61850-8-1		IEC61850 communication protocol
DNPSE DNPGEN RS485DNP DNPFC CH1TCP - CH4TCP OPTICALDNP MSTSERIAL MST1TCP - MST4TCP RS485GEN OPTICALPROT RS485PROT		DNP3.0 for serial communication EIA485 DNP3.0 for TCP/IP communication protocol DNP3.0 for EIA-485 communication protocol DNP3.0 fault records for TCP/IP communication protocol DNP3.0 for TCP/IP communication protocol DNP3.0 for TCP/IP communication protocol DNP3.0 for optical RS-232 communication protocol DNP3.0 for serial communication protocol RS485 Operation selection for optical serial Operation selection for RS485
DNPFC		DNP3.0 fault records for TCP/IP communication protocol
GOOSEINTLKRCV		Horizontal communication via GOOSE for interlocking
GOOSEBINRCV		GOOSE binary receive
GOOSEVCTRCONF		GOOSE VCTR configuration for send and receive
VCTRSEND		Voltage control sending block for GOOSE
GOOSEVCTRRCV		Voltage control receiving block for GOOSE
ETHFRNT ETHLAN1 GATEWAY		Ethernet configuration of front port, LAN1 port and gateway
GOOSEDPKCV		GOOSE function block to receive a double point value
GOOSEINTRCV		GOOSE function block to receive an integer value
GOOSEMVRCV		GOOSE function block to receive a measurand value
GOOSESPKCV		GOOSE function block to receive a single point value
Scheme communication		
ZCPSCH	85	Scheme communication logic with delta based blocking scheme signal transmit
ZCRWPSCH	85	Current reversal and weak end infeed logic for distance protection
ZCWSPSCH	85	Current reversal and weak end infeed logic for distance protection
ZCLCPLAL		Local acceleration logic
ECPSCH	85	Scheme communication logic for residual overcurrent protection
ECRWPSCH	85	Current reversal and weak end infeed logic for residual overcurrent protection

Table 5: *Basic IED functions*

IEC 61850 / Function block name	Function description
Basic functions included in all products	
INTERRSIG	Self-supervision with internal event list
SELSUPEVLST	Self-supervision with internal event list
TIMESYNCHGEN	Time synchronization
SNTP	Time synchronization
Table continues on next page	

IEC 61850 / Function block name	Function description
DTSBEGIN	Time synchronization
DTSEND	Time synchronization
TIMEZONE	Time synchronization
IRIG-B	Time synchronization
SETGRPS	Setting group handling
ACTVGRP	Parameter setting groups
TESTMODE	Test mode functionality
CHNGLCK	Change lock function
ATHSTAT	Authority status
ATHCHCK	Authority check
TERMINALID	IED identifiers
PRODINF	Product information
PRIMVAL	Primary system values
SMAI_20_1 - SMAI_20_12	Signal Matrix for analog inputs
3PHSUM	Summation block 3 phase
GBASVAL	Global base values for settings
DOSFRNT	Denial of service, frame rate control for front port
DOSLAN1	Denial of service, frame rate control for LAN1 port
DOSSCKT	Denial of service, socket flow control

Section 2 Environmental aspects

2.1 Sustainable development

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

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

Table 6: *Maximum concentration values by weight per homogeneous material*

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

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

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

2.2 Disposing of the IED

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

All parts used in this product are recyclable. When disposing of an IED or its parts contact a local waste handler who is authorized and specialized in disposing

electronic waste. These handlers can sort the material by using dedicated sorting processes and dispose of the product according to the local requirements.

Table 7: Materials of the IED parts

IED	Parts	Material
Unit	Metallic plates, parts and screws	Steel
	Plastic parts	PC ¹⁾ , LCP ²⁾
	LHMI display module	Various
Package	Box	Cardboard
Attached material	Manuals	Paper

- 1) Polycarbonate
- 2) Liquid crystal polymer

Section 3 650 series overview

3.1 Local HMI

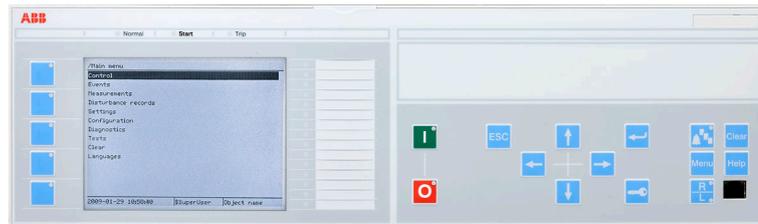


Figure 2: Local human-machine interface

The LHMI of the IED contains the following elements:

- Display (LCD)
- Buttons
- LED indicators
- Communication port

The LHMI is used for setting, monitoring and controlling.

3.1.1 Display

The LHMI includes a graphical monochrome display with a resolution of 320 x 240 pixels. The character size can vary. The amount of characters and rows fitting the view depends on the character size and the view that is shown.

The display view is divided into four basic areas.

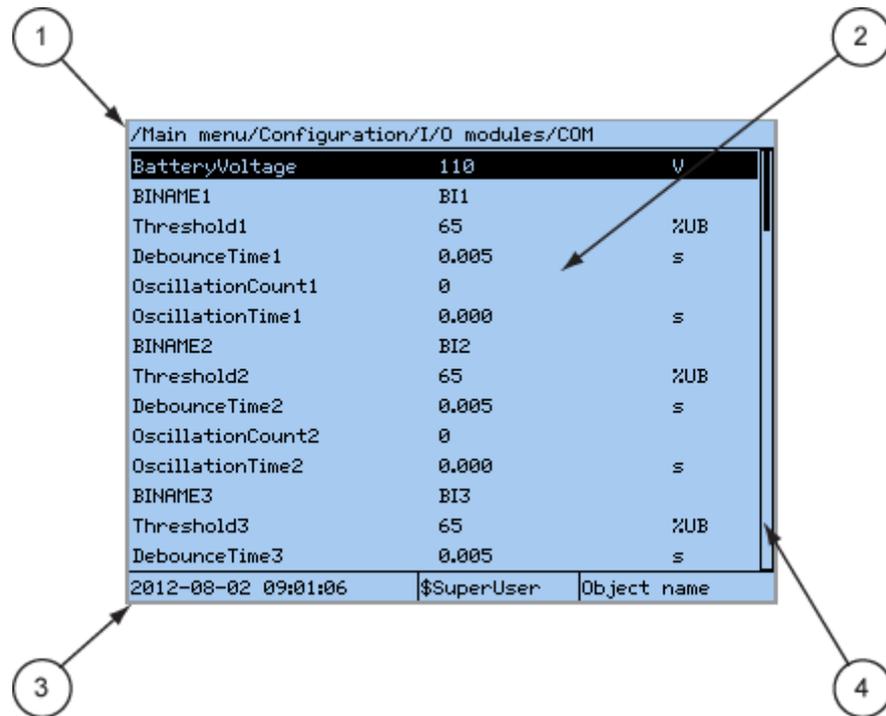


Figure 3: Display layout

- 1 Path
- 2 Content
- 3 Status
- 4 Scroll bar (appears when needed)

- The path shows the current location in the menu structure. If the path is too long to be shown, it is truncated from the beginning, and the truncation is indicated with three dots.
- The content area shows the menu content.
- The status area shows the current IED time, the user that is currently logged in and the object identification string which is settable via the LHMI or with PCM600.
- If text, pictures or other items do not fit in the display, a vertical scroll bar appears on the right. The text in content area is truncated from the beginning if it does not fit in the display horizontally. Truncation is indicated with three dots.

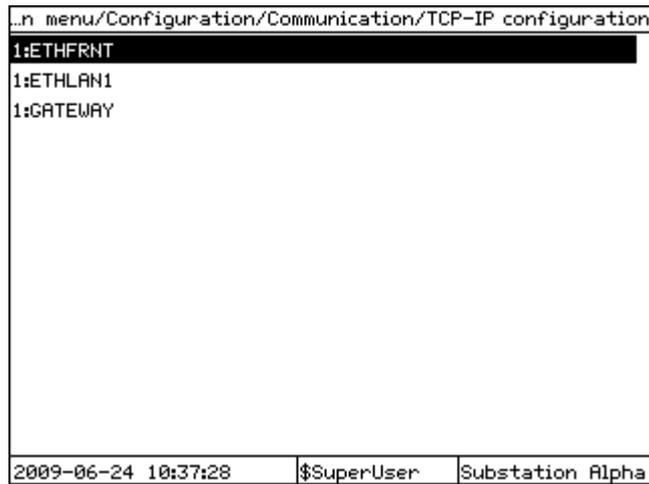


Figure 4: Truncated path

The number before the function instance, for example 1 : ETHFRNT, indicates the instance number.

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

The function button panel shows on request what actions are possible with the function buttons. Each function button has a LED indication that can be used as a feedback signal for the function button control action. The LED is connected to the required signal with PCM600.

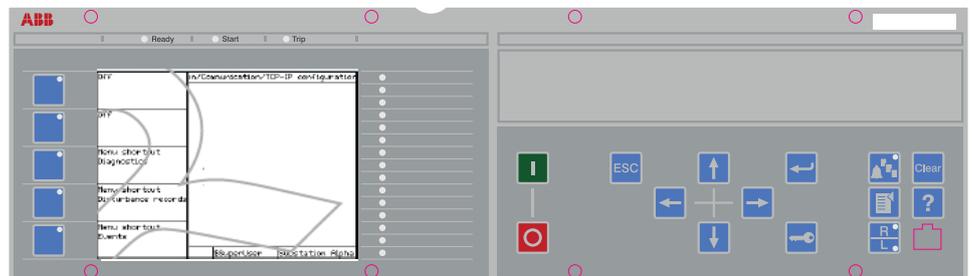


Figure 5: Function button panel

The alarm LED panel shows on request the alarm text labels for the alarm LEDs.

/Main menu	1	G2L01_YELLOW
Control	2	
Events	3	
Measurements		
Disturbance records		G2L05_YELLOW
Settings		
Configuration		
Diagnostics		TRIP CKT ALARM
Tests		
Clear		
Languages		
2009-06-24 10:41:24	\$SuperUser	

Figure 6: Alarm LED panel

The function button and alarm LED panels are not visible at the same time. Each panel is shown by pressing one of the function buttons or the Multipage button. Pressing the ESC button clears the panel from the display. Both the panels have dynamic width that depends on the label string length that the panel contains.

3.1.2

LEDs

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

There are 15 programmable alarm LEDs on the front of the LHMI. Each LED can indicate three states with the colors: green, yellow and red. The alarm texts related to each three-color LED are divided into three pages and can be browsed with the Multipage button.

There are 3 separate pages of LEDs available. The 15 physical three-color LEDs in one LED group can indicate 45 different signals. Altogether, 135 signals can be indicated since there are three LED groups. The LEDs can be configured with PCM600 and the operation mode can be selected with the LHMI or PCM600.

3.1.3

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, disconnecter or an earthing switch. The push-buttons are also used to acknowledge alarms, reset indications, provide help and switch between local and remote control mode.

The keypad also contains programmable push-buttons that can be configured either as menu shortcut or control buttons.

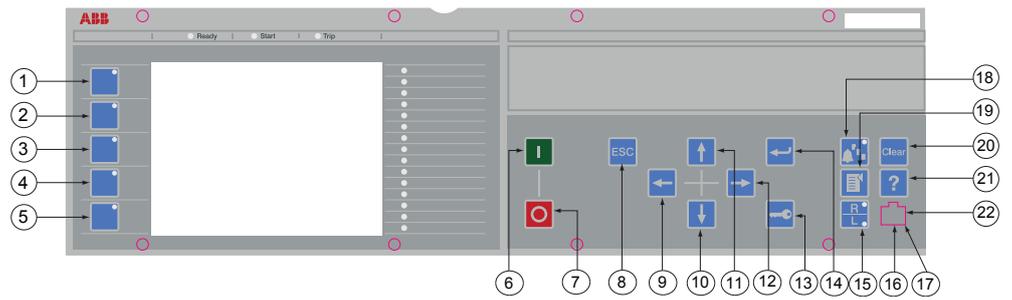


Figure 7: LHM keypad with object control, navigation and command push-buttons and RJ-45 communication port

- 1...5 Function button
- 6 Close
- 7 Open
- 8 Escape
- 9 Left
- 10 Down
- 11 Up
- 12 Right
- 13 Key
- 14 Enter
- 15 Remote/Local
- 16 Uplink LED
- 17 Not in use
- 18 Multipage
- 19 Menu
- 20 Clear
- 21 Help
- 22 Communication port

Object control

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

Object to be controlled is selected from the single line diagram.

Table 8: Object control push-buttons

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

Navigation

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

Table 9: *Navigation push-buttons*

Name	Description
 ESC	<ul style="list-style-type: none"> Leaving setting mode without saving the values. Cancelling certain actions. Adjusting the display contrast in combination with  or . Changing the language in combination with  or . Running the display test in combination with . Deleting a character in combination with  when editing a string. Inserting a space in combination with  when editing a string.
 Enter	<ul style="list-style-type: none"> Entering parameter setting mode. Confirming a new value of a setting parameter. Confirming selection in dialogs and alarm panel.
 Up  Down	<ul style="list-style-type: none"> Moving up and down in menus. Selecting objects in the SLD. Moving selection in dialogs and alarm panel. Scrolling active digits of a parameter when entering a new setting value.
 Left  Right	<ul style="list-style-type: none"> Moving left and right in menus. Selecting pages in the SLD. Changing the active digit of a parameter when entering a new setting value.
 Key	<ul style="list-style-type: none"> Activating the authorization procedure, when the user is not logged in. Logging out, when the user is currently logged in.

Commands

Table 10: *Command push-buttons*

Name	Description
 Menu	<ul style="list-style-type: none"> 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. <ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Activating the Clear/Reset view.
 Help	Showing the help menu.
 Multipage	Opening alarm panel and selecting alarm page from the view.

Function buttons

Table 11: *Function buttons*

Name	Description
 Function button	Executing the defined function: OFF, menu short cut or binary control.

3.1.4 Local HMI functionality

3.1.4.1 Protection and alarm indication

Protection indicators

The protection indicator LEDs are Ready, Start and Trip.



The start and trip LEDs are configured via the disturbance recorder.

Table 12: *Ready LED (green)*

LED state	Description
Off	Auxiliary supply voltage is disconnected.
On	Normal operation.
Flashing	Internal fault has occurred.

Table 13: Start LED (yellow)

LED state	Description
Off	Normal operation.
On	<p>A protection function has started and an indication message is displayed.</p> <ul style="list-style-type: none"> The start indication is latching and must be reset via communication or by pressing .
Flashing	<p>A flashing yellow LED has a higher priority than a steady yellow LED. The IED is in test mode and protection functions are blocked.</p> <ul style="list-style-type: none"> The indication disappears when the IED is no longer in test mode and blocking is removed.

Table 14: Trip LED (red)

LED state	Description
Off	Normal operation.
On	<p>A protection function has tripped and an indication message is displayed.</p> <ul style="list-style-type: none"> The trip indication is latching and must be reset via communication or by pressing .

Alarm indicators

The 15 programmable three-color LEDs are used for alarm indication. An individual alarm/status signal, connected to any of the LED function blocks, can be assigned to one of the three LED colors when configuring the IED.

Table 15: Alarm indications

LED state	Description
Off	Normal operation. All activation signals are off.
On	<ul style="list-style-type: none"> Follow-S sequence: The activation signal is on. LatchedColl-S sequence: The activation signal is on, or it is off but the indication has not been acknowledged. LatchedAck-F-S sequence: The indication has been acknowledged, but the activation signal is still on. LatchedAck-S-F sequence: The activation signal is on, or it is off but the indication has not been acknowledged. LatchedReset-S sequence: The activation signal is on, or it is off but the indication has not been acknowledged.
Flashing	<ul style="list-style-type: none"> Follow-F sequence: The activation signal is on. LatchedAck-F-S sequence: The activation signal is on, or it is off but the indication has not been acknowledged. LatchedAck-S-F sequence: The indication has been acknowledged, but the activation signal is still on.

3.1.4.2 Parameter management

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

- Numerical values
- String values
- Enumerated values

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

3.1.4.3 Front communication

The RJ-45 port in the LHMI enables front communication.

- The green uplink LED on the left is lit when the cable is successfully connected to the port.

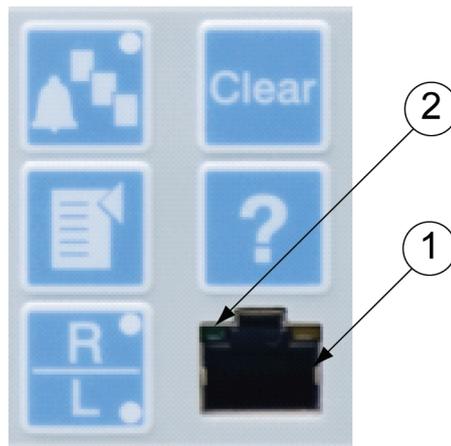


Figure 8: RJ-45 communication port and green indicator LED

- 1 RJ-45 connector
- 2 Green indicator LED

When a computer is connected to the IED front port with a crossed-over cable, the IED's DHCP server for the front interface assigns an IP address to the computer if *DHCP*Server = *On*. The default IP address for the front port is 10.1.150.3.



Do not connect the IED front port to a LAN. Connect only a single local PC with PCM600 to the front port.

3.1.4.4 Single-line diagram

Single-line diagram is used for bay monitoring and/or control. It shows a graphical presentation of the bay which is configured with PCM600.

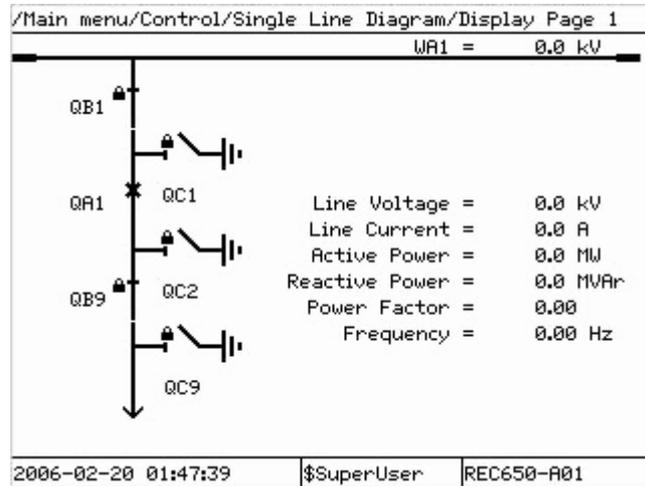


Figure 9: Single-line diagram example (REC650)

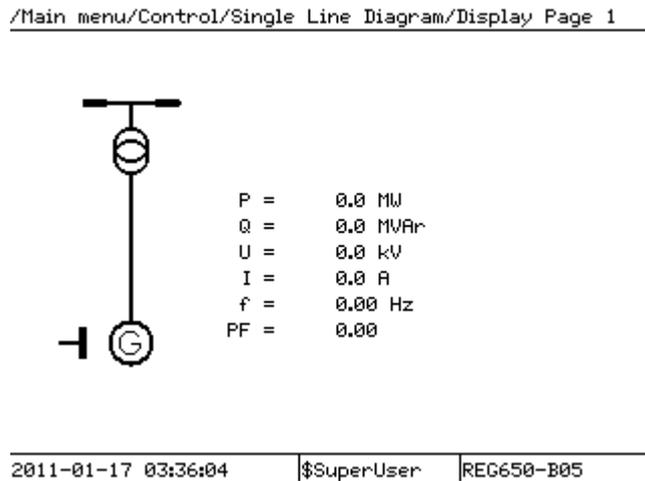


Figure 10: Single-line diagram example (REG650)

3.2 Authorization

The user categories with different access rights are predefined in the IED .

The IED users can be created, deleted and edited only with PCM600. One user can belong to one or several user categories.



At delivery, the IED user has full access as SuperUser until users are created with PCM600. Logging on is not required for the LHMI.

Table 16: *Predefined user categories*

User category	User rights
SystemOperator	Control from LHMI, no bypass
ProtectionEngineer	All settings
DesignEngineer	Application configuration
UserAdministrator	User and password administration
SuperUser	Full rights, only presented in LHMI. LHMI is default logged on until other users are defined
Guest	.Only read rights, only presented in LHMI. LHMI is default logged on when other users are defined



All changes in user management settings will cause an IED reboot.

3.3

Communication

The IED supports communication protocols IEC 61850-8-1, IEC 60870-5-103, DNP3 over TCP/IP and serial communication via RS485.

All operational information and controls are available through these protocols. However, some communication functionality, for example, horizontal communication (GOOSE) between the IEDs, is only enabled by the IEC 61850-8-1 communication protocol.

The serial communication follows the EIA-485 standard and is intended to be used in multi-point communication.

Disturbance files are accessed using the IEC 61850 or IEC 60870-5-103 protocols. Disturbance files are also available to any Ethernet based application in the standard COMTRADE format. The IED can send binary signals to other IEDs (so called horizontal communication) using the IEC 61850-8-1 GOOSE (Generic Object Oriented Substation Event) profile. Binary GOOSE messaging can, for example, be employed for protection and interlocking-based protection schemes. The IED meets the GOOSE performance requirements for tripping applications in distribution substations, as defined by the IEC 61850 standard. Further, the IED supports the sending and receiving of analog values using GOOSE messaging. Analog GOOSE messaging enables fast transfer of analog measurement values over the station bus, thus facilitating for example sharing of RTD input values, such as surrounding temperature values, to other IED applications. The IED interoperates with other IEC 61850 compliant IEDs, tools and systems and

simultaneously reports events to five different clients on the IEC 61850 station bus. For a system using DNP3 over TCP/IP, events can be sent to four different masters. For systems using IEC 60870-5-103 IED can be connected to one master in a station bus with star-topology.

All communication connectors, except for the front port connector, are placed on integrated communication modules. The IED is connected to Ethernet-based communication systems via the RJ-45 connector (10/100BASE-TX) or the fibre-optic multimode LC connector (100BASE-FX).

IEC 60870-5-103 is available from optical serial port where it is possible to use serial glass fibre (ST connector).

The IED supports SNTP, DNP3 and IRIG-B time synchronization methods with a time-stamping resolution of 1 ms.

IEC 60870-5-103 has time-stamping resolution of ± 5 ms.

The IED supports the following time synchronization methods with a timestamping resolution of 1 ms:

Ethernet communication based:

- SNTP (simple network time protocol)
- DNP3

With special time synchronization wiring:

- IRIG-B

3.4 PCM600 tool

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

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



When using PCM600 for writing to the IED, ensure that the LHMI is not in a menu position where settings can be made. Only one active transaction, from LHMI or PCM600, is allowed at a time.

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 the customer needs.



For more information, see PCM600 documentation.

3.4.1 Connectivity packages

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

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

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

3.4.2 PCM600 and IED connectivity package version

- Protection and Control IED Manager PCM600 Ver. 2.4 + Hotfix or later
- ABB 650 Series IED Connectivity Package Ver. 1.2.1 or later
- ABB REB650 1.2.1 Module Ver. 1.0 or later
- ABB REC650 1.2.1 Module Ver. 1.0 or later
- ABB REG650 1.2.1 Module Ver. 1.0 or later
- ABB REL650 1.2.1 Module Ver. 1.0 or later
- ABB REQ650 1.2.1 Module Ver. 1.0 or later
- ABB RET650 1.2.1 Module Ver. 1.0 or later



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

3.5 Cyber security guidelines

3.5.1 Predefined user roles

There are different levels (or roles) of users that can access or operate different areas of the IED and tools functionality. The predefined user roles are given in table below.



Be sure that the user logged on to the IED has the access required when writing particular data to the IED from PCM600. For more information about setting user access rights see the PCM600 documentation.

The meaning of the legends used in the table:

- R= Read
- W= Write
- - = No access rights

Table 17: *Predefined user roles*

Access rights	Guest	SuperUser	System Operator	Protection Engineer	Design Engineer	User Administrator
Basic setting possibilities (change setting group, control settings, limit supervision)	R	R/W	R/W	R/W	R/W	R
Advanced setting possibilities (for example protection settings)	R	R/W	R	R/W	R/W	R
Basic control possibilities (process control, no bypass)	R	R/W	R/W	R/W	R/W	R
Advanced control possibilities (process control including interlock trigg)	R	R/W	R/W	R/W	R/W	R
Basic command handling (for example clear LEDs, manual trigg)	R	R/W	R/W	R/W	R/W	R
Advanced command handling (for example clear disturbance record)	R	R/W	R	R/W	R/W	R
Basic configuration possibilities (I/O-configuration in SMT)	R	R/W	R	R	R/W	R
Advanced configuration possibilities (application configuration including SMT, GDE and CMT)	R	R/W	R	R	R/W	R
File loading (database loading from XML-file)	-	R/W	-	-	R/W	R/W
File dumping (database dumping to XML-file)	-	R/W	-	-	R/W	R/W
File transfer (FTP file transfer)	-	R/W	R/W	R/W	R/W	R/W
File transfer (limited) (FTP file transfer)	R	R/W	R/W	R/W	R/W	R/W
Database access for normal user	R	R/W	R/W	R/W	R/W	R/W
User administration (user management – FTP File Transfer)	R	R/W	R	R	R	R/W

The IED users can be created, deleted and edited only with the User Management Tool (UMT) within PCM600. The user can only Logon or Logoff on the local HMI on the IED, there are no users, groups or functions that can be defined on local HMI.

At delivery, the IED has a default user defined with full access rights. PCM600 use this default user to access the IED. This user will automatically be removed in IED when users are defined via User Management Tool (UMT) in PCM600.

Default User ID: Administrator

Password: Administrator



Only characters A - Z, a - z and 0 - 9 shall be used in user names and passwords.



First user created must be included in the UserAdministrator group to be able to write users, created in PCM600, to IED.

3.5.2

IP ports security guideline

The IP ports security guideline can not suggest concrete products for a secure system setup. This must be decided along the specific project, requirements and existing infrastructure. The required external equipment can be separated devices or devices that combine firewall, router and secure VPN functionality.

To setup an IP firewall the following table summarizes the IP ports used in the 650 series. The ports are listed in ascending order. The column “Default state” defines whether a port is open or closed by default. All ports that are closed by default are opened by configuration enabling.

Table 18: Available IP ports

Port	Protocol	Default state	Service	Comment
21	TCP	open	FTP	File transfer protocol
67	UDP	open	DHCP	Front port only
102	TCP	open	IEC 61850	MMS communication
7001	TCP	open	SPA	Proprietary for PCM600
2100	TCP	open	ODBC	Proprietary for PCM600
20 000	TCP	closed	DNP3	DNP3 DNP communication only
20 000	UDP	closed	DNP3	DNP3 DNP communication only

The 650 series supports two Ethernet communication protocols, these protocols are IEC61850 and DNP3/TCP. These communication protocols are enabled by configuration. This means that the IP port is closed and not available if the

configuration of the 650 series doesn't contain a communication line of the protocol. If a protocol is configured the corresponding IP port is open all the time.



See the 650 series technical manual and the corresponding protocol documentation on how to configure a certain communication protocol for the 650 series.

There are some restrictions and dependencies:

- The IP port used for file transfer (default port 21) is fixed and cannot be changed.
- The IP port used for DHCP (default port 67) between the IED and a computer is fixed and cannot be changed.
- The IP port used for IEC61850 (default port 102) is fixed and can not be changed.
- The IP ports used for DNP3 are configurable. The communication protocol DNP3 could operate on UDP (default port 20 000) or TCP (default port 20 000). It is defined in the configuration which type of Ethernet communication is used. Only one type is possible for a specific configuration.

Two ports are used by PCM600; for configuration and parameter settings the IP port for a proprietary ODBC protocol is used (port 2100), the port is fixed and cannot be changed. For monitoring events and clear commands the IP port for a proprietary SPA protocol is used (port 7001), the port is fixed and cannot be changed.

These security constraints are acceptable in limited local networks. For wide area networks in particular with connection to the Internet, the 650 series Ethernet communication must be protected against illegal access. This protection must be handled by external devices to setup a secure virtual private network (VPN).

All ports are available on all physical interfaces.

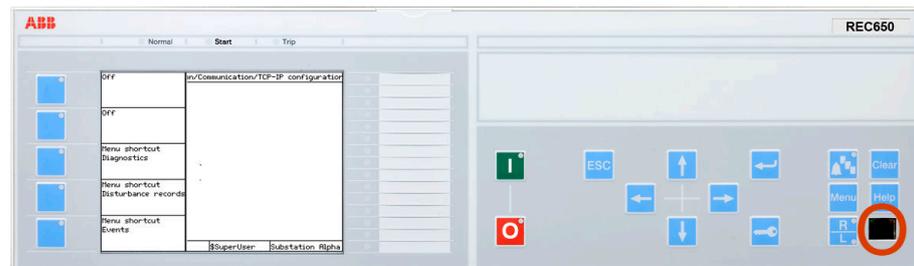
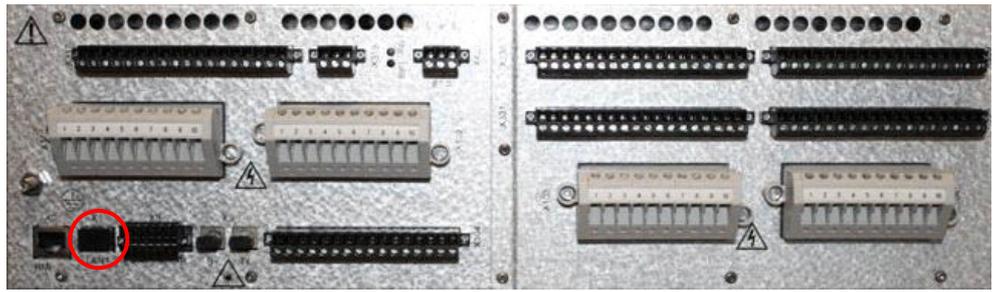


Figure 11: Ethernet port, front view



IEC12000171-1-en.vsd

Figure 12: Ethernet port, rear view

Section 4 Using the HMI

4.1 Using the local HMI

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

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



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



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

A mechanism for limiting the number of writings per time period is included in the IED to prevent the flash memory to be worn out due to too many writings. As a consequence it may take up to an hour to save changes. If the auxiliary power is interrupted before a change is saved, that change is lost.

4.1.1 Logging on

1. Press  to activate the logon procedure.
The logon is also activated when attempting a password-protected operation.
2. Select the user name by scrolling with  and .

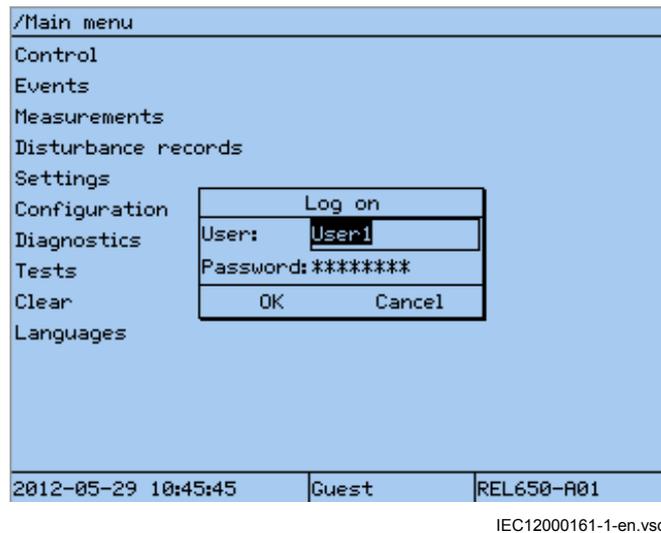


Figure 13: Selecting the user name

3. Enter the password when prompted digit by digit and select OK.
 - Activate the digit to be entered with and .
 - Enter the character with and .

Upper and lower case letters are also found by scrolling the 255 characters with and .

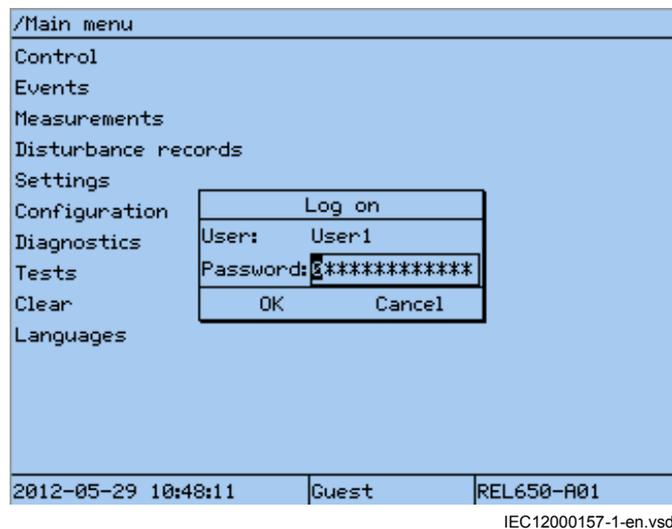


Figure 14: Entering the password



Passwords are case sensitive.



Only characters A - Z, a - z and 0 - 9 should be used in user names and passwords.

4. Press to confirm the logon or to cancel the procedure.
If the logon fails, a message is displayed on the display.

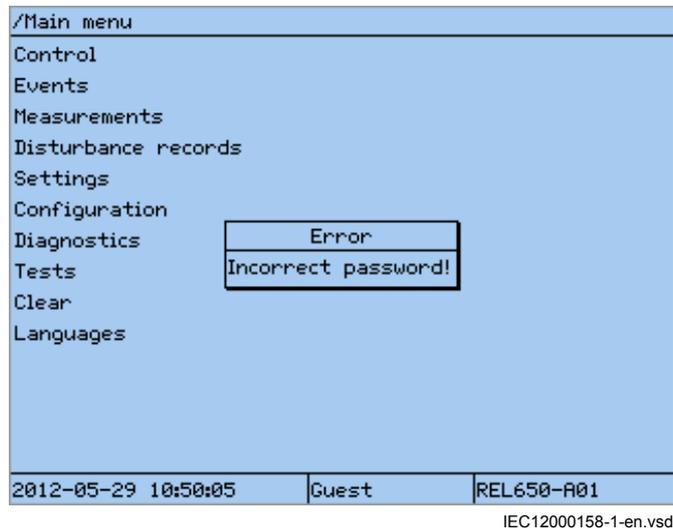


Figure 15: Error message indicating an incorrect password



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



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

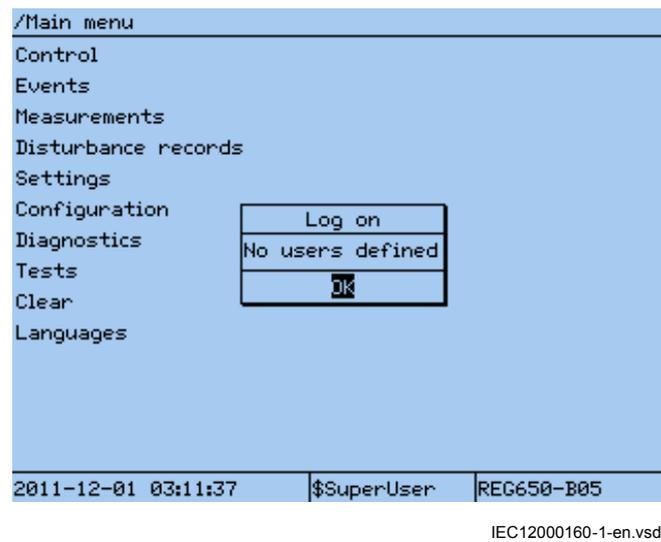


Figure 16: No user defined

4.1.2

Logging off

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

1. Press .
2. To confirm logoff, select Yes and press .

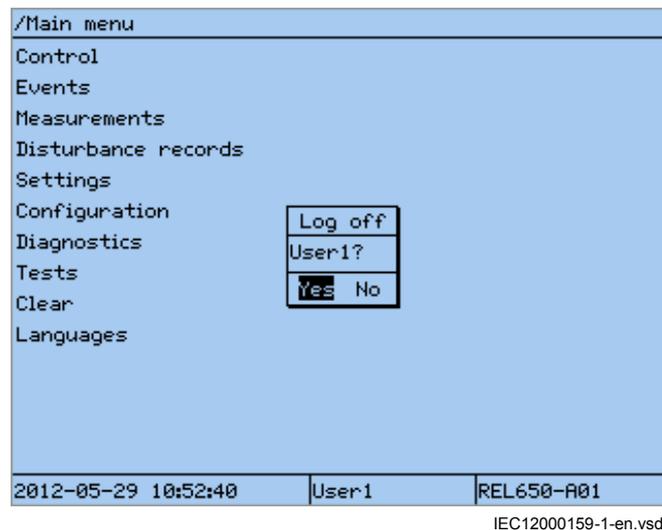


Figure 17: Logging off

- To cancel logoff, press .

4.1.3 Turning the display backlight on

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

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

If the panel has not been used for a predefined timeout period, the backlight is switched off. The user is logged out from the current user level after the display backlight has turned off. The factory default for display timeout is 60 minutes.

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



Change the backlight timeout period in **Main menu/Configuration/HMIScreen/1:SCREEN/DisplayTimeout**.

4.1.4 Selecting local or remote use

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

- Press .
 - When the L LED is lit, local control is enabled and remote control disabled.
 - When the R LED is lit, remote control is enabled and local control disabled.
 - When neither of the LEDs is lit, both control positions are disabled.



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



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

4.1.5 Identifying the device

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

1. Select **Main menu/Diagnostics/IED Status/Product identifiers**.
2. Select a submenu with  and .

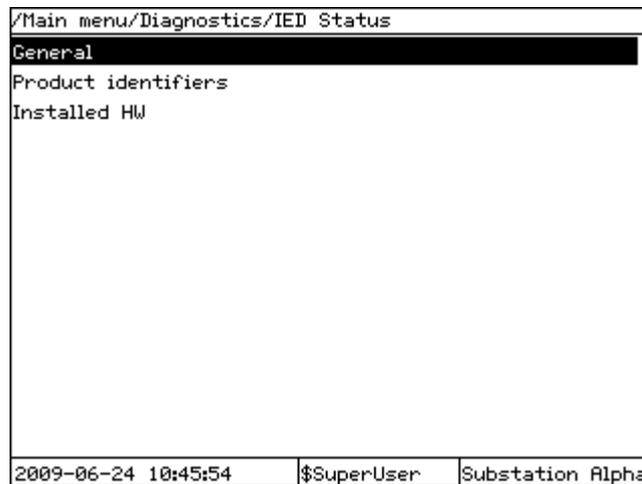


Figure 18: Selecting a submenu

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

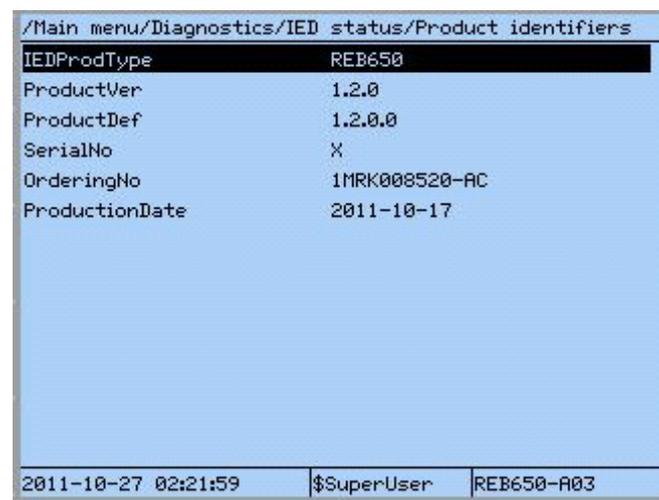


Figure 19: IED information

4.1.6 Adjusting the display contrast

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

- To increase the contrast, press simultaneously  and .
- To decrease the contrast, press simultaneously  and .



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

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

4.1.7 Changing the local HMI language

1. Select **Main menu/Languages/1:LANGUAGE** and press
2. Change the language using or .
3. Press to confirm the selection.
4. Commit the changes.



Figure 20: Changing the LHMI language



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

4.1.8 Navigating in the menu

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

- To move to the Main menu or default view, press .
- To move up or down in a menu, press or .
- To move downwards in the menu tree, press .

- To move upwards in the menu tree, press .
- To enter setting mode, press .
- To leave setting mode without saving, press .

4.1.8.1

Menu structure

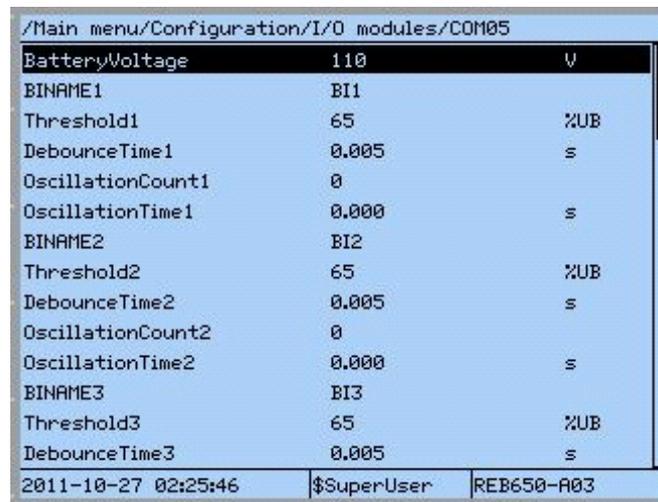
The Main menu contains main groups which are divided further into more detailed submenus.

- Control
- Events
- Measurements
- Disturbance records
- Settings
- Configuration
- Diagnostics
- Tests
- Clear
- Languages

4.1.8.2

Scrolling the display

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



/Main menu/Configuration/I/O modules/COM05		
BatteryVoltage	110	V
BINAME1	BI1	
Threshold1	65	%UB
DebounceTime1	0.005	s
OscillationCount1	0	
OscillationTime1	0.000	s
BINAME2	BI2	
Threshold2	65	%UB
DebounceTime2	0.005	s
OscillationCount2	0	
OscillationTime2	0.000	s
BINAME3	BI3	
Threshold3	65	%UB
DebounceTime3	0.005	s
2011-10-27 02:25:46 \$SuperUser REB650-A03		

Figure 21: 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.

4.1.8.3 Changing the default view

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

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

4.1.9 Using function buttons

The function buttons can be configured either as menu shortcuts or control buttons. The buttons are functional only when the function button panel is visible.

1. Press any function button to open the function button panel.
On the first press of a button, the panel opens but no other action is taken.

Off	on/Communication/TCP-IP configuration	
Off		
Menu shortcut Diagnostics		
Menu shortcut Disturbance records		
Menu shortcut Events		
	\$SuperUser	Substation Alpha

Figure 22: Function button panel

2. Press the wanted function button.
 - Press the wanted function button to jump to a certain menu item.
The menu opens immediately upon pressing the button.
 - Press the wanted function button for at least 0.5 s to initiate a control signal. The action is taken once.
To repeat the action, press the button again. If the button is pressed less than 0.5 s, no action is taken.
3. Press  to close the function button panel.
The panel is also closed after pressing a function button configured for a menu shortcut.

The function buttons are configured with PCM600.



For more information, see PCM600 documentation.

4.1.10 Using the single-line diagram

The single-line diagram is created with PCM600.

1. Select **Main menu/Control/Single line diagram**.
The single-line diagram view is displayed.

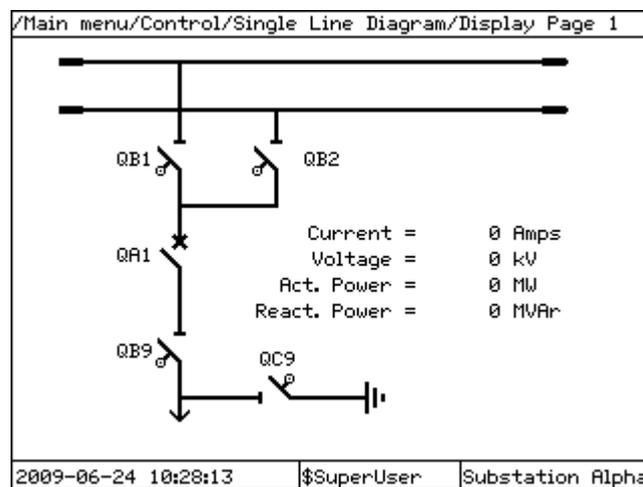


Figure 23: Example of a single-line diagram

2. Select an object with or .
Selection of an object is indicated with a square border that moves when and are used.
Switch objects can have additional icons that present the switch object states.
 - = Switch object is in substituted state.
 - = Switch object is interlocked.
3. Press to select open or to select close the object.
4. Confirm the control operation in the dialog that opens.
5. To move between the single-line diagram pages, press or .



Select the single-line diagram for the default view in **Main menu/Configuration/HMI/Screen/1:SCREEN/DefaultScreen**.

4.1.11 Browsing setting values

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

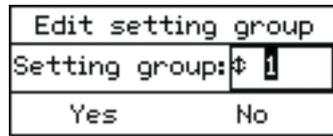


Figure 24: Selecting the setting group number

3. Press  or  to select the setting group number.
4. Press  to confirm the setting group selection and  to return to the Edit setting group dialog.
5. Press  to select Yes and to view the setting group values.
 - Press  or  to select No and  to exit.

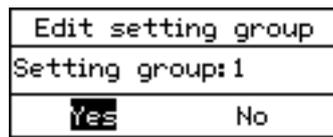


Figure 25: Selecting a setting group

6. To browse the settings, scroll the list with  and  and to select a setting press . To move back to the list, press .



Figure 26: Setting alternatives in the selected setting group

The content of the list depends on the pre-configuration or on the functions configured with PCM600.

4.1.12 Editing values

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

4.1.12.1 Editing numerical values

- Select **Main menu/Settings** and then a setting.
The last digit of the value is active.
 - When the symbol in front of the value is ↑, the active value can only be increased.
 - When the symbol is ↓, the active value can only be decreased.
 - When the symbol in front of the value is ⇅, the active value can either be increased or decreased.

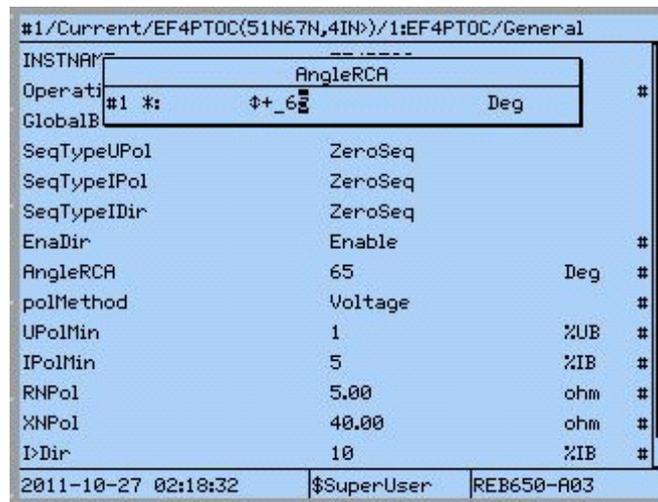


Figure 27: Last digit is active and it can be increased or decreased

- 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.

- Press or to move the cursor to another digit.
- 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 .

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 \updownarrow , when the previous value is shown.

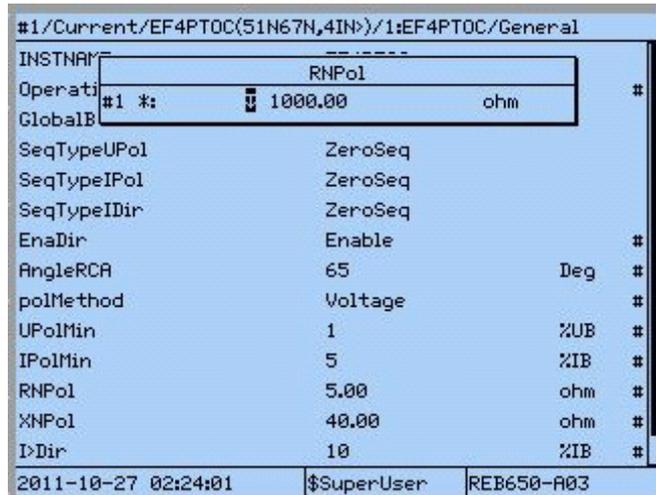


Figure 28: Restoring the previous value

4.1.12.2

Editing string values

1. Activate the setting mode and select a setting.
When editing string values, the cursor moves to the first character.
2. Press  or  to change the value of an active character.
One press changes the value by one step.
3. Press  or  to move the cursor to another character.
 - To insert characters or space, press simultaneously  and .
 - To delete characters, press simultaneously  and .



PCM600 supports Unicode characters.

4.1.12.3

Editing enumerated values

1. Activate the setting mode and select a setting.

- When editing an enumerated value, the selected value is shown inverted.
2. Press  or  to change the value of an active enumerated value. One press changes the enumerated value by one step in the parameter specific order.

4.1.12.4 Changing time settings in LHMI

If there is a need to change the time setting in the LHMI (**Main menu/Configuration/Time**) the change will take affect immediately. To confirm the new setting press . To remove the change, press .

4.1.13 Saving settings

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

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

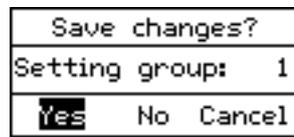


Figure 29: Confirming settings

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



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



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

4.1.14 Clearing and acknowledging

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

1. Press **Clear** to activate the Clear view.

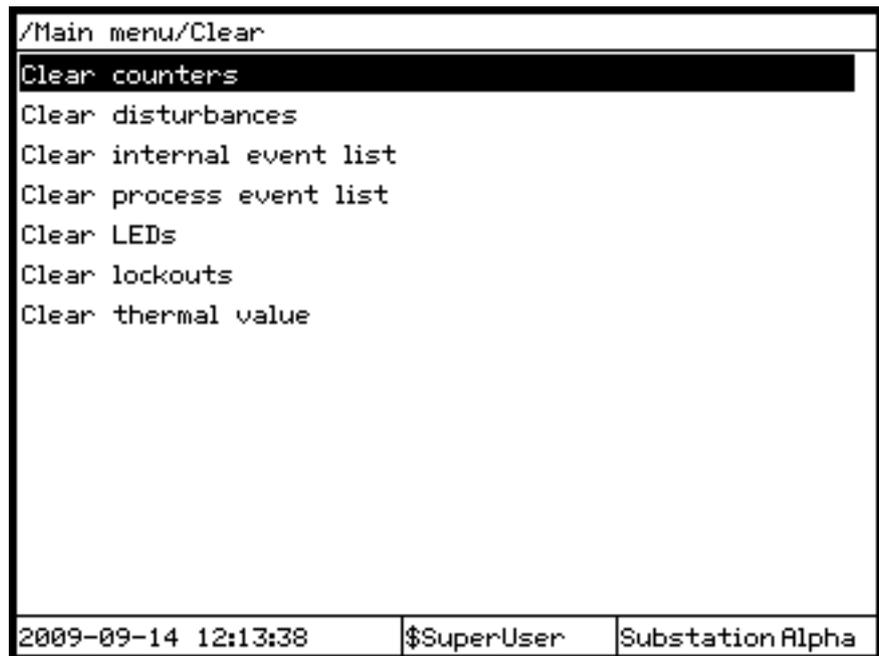


Figure 30: Clear view

The content of the Clear menu depends on the configuration configured with PCM600.

2. Select the item to be cleared with **↑** or **↓**.
3. Press **→**, select OK to confirm the selection or Cancel to cancel the selection, and press **←**.
4. Repeat steps 2 and 3 to clear other items.

4.1.15 Using the local HMI help

1. Press **?** to open the help view.
2. Scroll the text with **↑** or **↓** if the help text exceeds the display area.
3. To close the help, press **ESC**.
The help dialog is also closed when the display timeout expires.

Section 5 IED operation

5.1 Normal operation

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

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

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



For more information, see PCM600 documentation.

5.2 Disturbance identification

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

For the LEDs to operate, the disturbance recorder has to be defined in the configuration.

Table 19: *Disturbance indications*

LED	State	Description
Start LED	Yellow, steady	Protection started
Trip LED	Red, steady	Protection operated

Further actions to be taken to identify the disturbance:

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



Document the disturbance before clearing the information from the IED.



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

5.2.1 Disturbance recording triggering

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

5.2.2 Disturbance record analysis

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



For more information, see PCM600 documentation.

5.2.3 Disturbance reports

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



For more information, see PCM600 documentation.

5.2.4 IED self-supervision

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

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



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

The IED records IED status data and events.



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

5.3 IED parameterization

IED parameters are set via the LHMI or PCM600.

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



Document all changes to parameter settings.



For more information, see PCM600 documentation.



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

A mechanism for limiting the number of writings per time period is included in the IED to prevent the flash memory to be worn out due to too many writings. As a consequence it may take up to an hour to save changes. If the auxiliary power is interrupted before a change is saved, that change is lost.

5.3.1 IED settings for IED functionality

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

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

5.3.2 IED settings for different operating conditions

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

Section 6 Operating procedures

6.1 Monitoring

6.1.1 Indications

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

- Three indicator LEDs with fixed functionality: Ready, Start and Trip
- 15 programmable three-color alarm LEDs which can present 45 virtual LED states
 - For each on state LED color and for the LED off state, texts can be programmed with PCM600 and via LHMI. These texts are displayed on the LHMI.
- An auto-indicating message on the display.

6.1.1.1 Using auto-indication messages

Auto-indication messages are shown in a dialog box that is displayed when the disturbance recorder is triggered. The indication dialog box shows a list of current disturbance recordings one by one. To scroll the dialog, use  and .



To activate the auto-indication message function, the disturbance recorder function has to be activated and properly configured. Check also that the setting **Main menu/Configuration/HMI/Screen/1:SCREEN1/AutoIndicationDRP** is set to *On*.

1. Read the auto-indication message in the dialog box. The message contains the same information that is available for disturbance recordings.
2. Press  to see more detailed information.
3. Press  to close the auto-indication message without clearing it or press  to activate the Clear view and to clear messages.

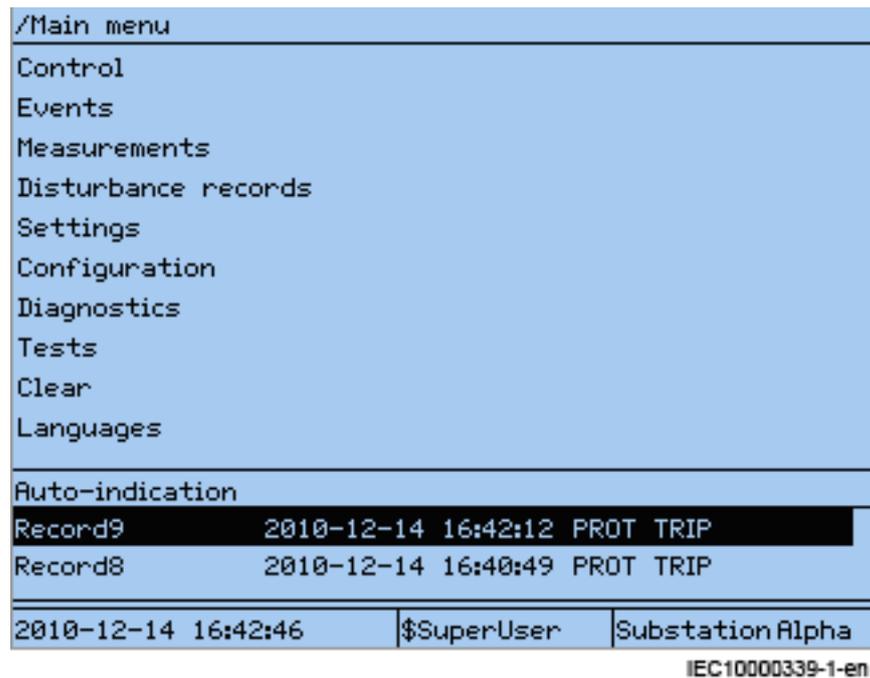


Figure 31: Auto-indication message

6.1.1.2 Monitoring alarm data

Active alarms are indicated by the alarm LEDs and the LED in the Multipage button. The alarms are configured with PCM600. The alarm type and information depend on the application configuration.

1. Press  to open the alarm view.
2. Press  or  to move between active alarms in the page, or press  to switch between the three alarm pages.
3. Press  to open a dialog box that shows more detailed information about the selected alarm.

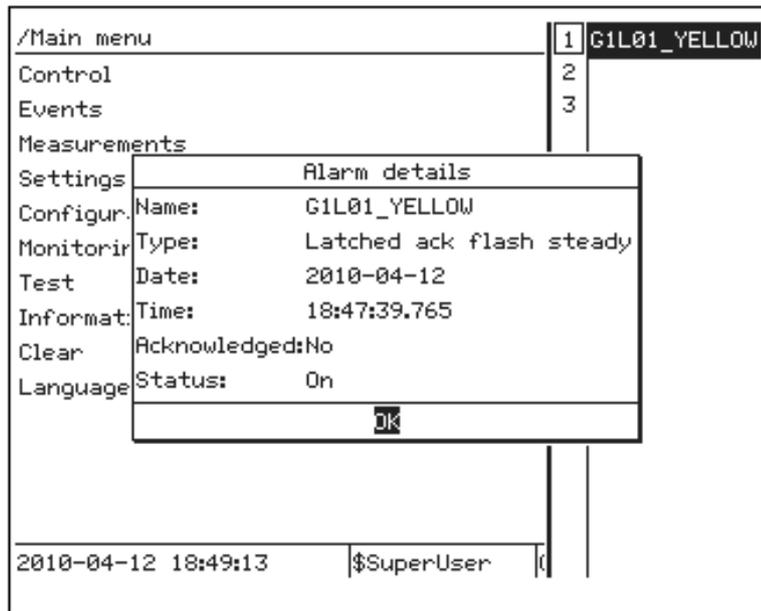


Figure 32: Alarm details

Press or to close the dialog box.

4. Press to close the alarm view.
5. Press to activate the Clear view and to clear alarms.

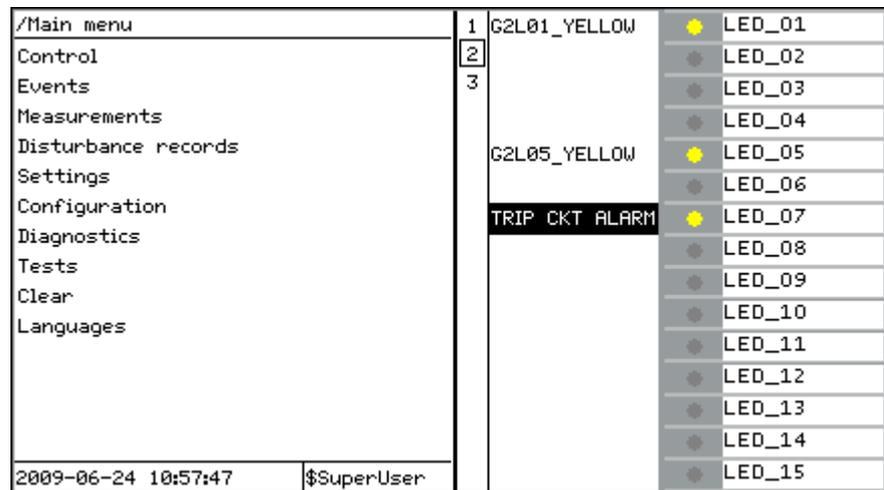


Figure 33: Alarm data

6.1.1.3 Monitoring an internal IED fault

The flashing green LED indicates an internal IED fault. The fault messages are found in the LHMI menu.

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

/Main menu/Diagnostics/IED status/General		
Item	Status	
Internal fail	Off	
Internal warning	Off	
Time synch	Ready	
Real time clock	Ready	
Application	Ready	
Runtime execution	Ready	
IEC61850	Ready	
DNP3	Ready	
TRM2	Ready	
BIO3	Ready	
BIO4	Ready	
COM1	Ready	
PSM1	Ready	
BIO5	Ready	
2009-06-24 10:26:42	\$SuperUser	Substation Alpha

Figure 34: Fault indication



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

6.1.1.4 Monitoring condition monitoring data

1. Select **Main menu/Diagnostics/IED status/General**.
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

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.

6.1.2.2 Using the local HMI for monitoring

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

6.1.3 Recorded data

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

- Disturbance records
- Events

6.1.3.1 Creating disturbance recordings

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



Set the DRPRDRE *Operation* to *On* via LHMI or PCM600 and at least one channel has to be connected.

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

/Main menu/Disturbance records		
Record66	2009-05-08 00:17:47	TC_ALARM_3
Record65	2009-05-08 00:17:44	SPR_CHR_ALM
Record64	2009-05-07 23:56:02	TC_ALARM_3
Record63	2009-05-07 23:55:59	SPR_CHR_ALM
Record62	2009-05-07 22:29:14	TC_ALARM_1
Record61	2009-05-07 22:29:11	SPR_CHR_ALM
Record60	2009-05-07 22:23:43	TC_ALARM_1
Record59	2009-05-07 22:23:40	SPR_CHR_ALM
Record58	2009-05-07 21:57:04	TC_ALARM_1
Record57	2009-05-07 21:57:01	SPR_CHR_ALM
Record56	2009-05-07 21:54:34	TC_ALARM_1
Record55	2009-05-07 21:54:31	SPR_CHR_ALM
Record54	2009-05-07 21:50:51	TC_ALARM_1
Record53	2009-05-07 21:50:48	SPR_CHR_ALM
Manual trig		
2009-05-08 00:57:16	Guest	Feeder

Figure 35: Manual triggering

The disturbance recorder is now triggered.

6.1.3.2 Monitoring disturbance recorder data

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

1. Select **Main menu/Disturbance records**.
All disturbance records are listed.
2. Scroll the view with  or .

/Main menu/Disturbance records		
Record66	2009-05-08 00:17:47	TC_ALARM_3
Record65	2009-05-08 00:17:44	SPR_CHR_ALM
Record64	2009-05-07 23:56:02	TC_ALARM_3
Record63	2009-05-07 23:55:59	SPR_CHR_ALM
Record62	2009-05-07 22:29:14	TC_ALARM_1
Record61	2009-05-07 22:29:11	SPR_CHR_ALM
Record60	2009-05-07 22:23:43	TC_ALARM_1
Record59	2009-05-07 22:23:40	SPR_CHR_ALM
Record58	2009-05-07 21:57:04	TC_ALARM_1
Record57	2009-05-07 21:57:01	SPR_CHR_ALM
Record56	2009-05-07 21:54:34	TC_ALARM_1
Record55	2009-05-07 21:54:31	SPR_CHR_ALM
Record54	2009-05-07 21:50:51	TC_ALARM_1
Record53	2009-05-07 21:50:48	SPR_CHR_ALM
Manual trig		
2009-05-08 00:59:12	Guest	Feeder

Figure 36: Monitoring disturbance recorder via the LHMI

3. To view a specific disturbance record, press .
A list of detail categories is displayed.

/Main menu/Disturbance records/Record66		
Recording number	66	2009-05-08 00:17:47.583
General information		
Indications		
Event recording		
Trip values		
2009-05-08 01:00:27	Guest	Feeder

Figure 37: Disturbance record data categories

- To select a category and view the items under it, press  or  and then .

6.1.3.3

Controlling and reading disturbance recorder data

Disturbance recorder data can be controlled and read with PCM600.



For more information, see PCM600 documentation.

6.1.3.4

Monitoring events

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

- Select **Main menu/Events**.
- Press  to open the event list.
Events are shown grouped by date.
Time, channel, signal name and value of the event are shown.
- Press  or  to scroll the view.

/Main menu/Events		
2009-05-08		
00:17:47.583	42	TC_ALARM_3 On
00:17:44.574	47	SPR_CHR_ALM On
2009-05-07		
23:56:02.437	42	TC_ALARM_3 On
23:55:59.427	47	SPR_CHR_ALM On
22:53:10.179	41	TC_ALARM_2 Off
22:53:10.179	40	TC_ALARM_1 Off
22:29:14.629	42	TC_ALARM_3 On
22:29:14.629	41	TC_ALARM_2 On
22:29:14.629	40	TC_ALARM_1 On
22:29:11.620	47	SPR_CHR_ALM On
22:23:43.598	42	TC_ALARM_3 On
22:23:43.598	41	TC_ALARM_2 On
22:23:43.598	40	TC_ALARM_1 On
2009-05-08 01:04:35	Guest	Feeder

Figure 38: Monitoring events



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

6.1.4 Remote monitoring

The IED supports comprehensive remote monitoring.

6.1.4.1 Monitoring the IED remotely

Use the PCM600 tool to operate the IED remotely.

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



For more information, see PCM600 documentation.

6.2 Controlling

6.2.1 Controlling circuit breakers and disconnectors

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

1. Select **Main menu/Control/Single line diagram**.
The SLD displays all controllable objects.
2. Select an object with  or .
Selection of object is indicated with a square border that moves when  and  are used.
Switch objects can have additional icons that present the switch object states.
 Switch object is in substituted state.
 Switch object is interlocked.
3. Press  to select open or  to select close the object.

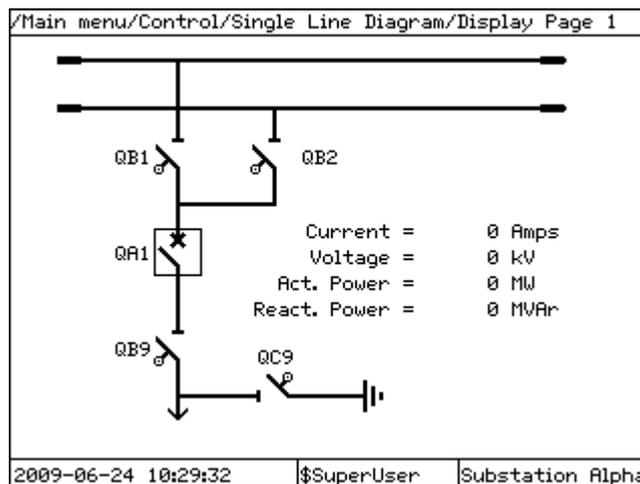


Figure 39: Selecting an object

4. Press  to confirm the operation.

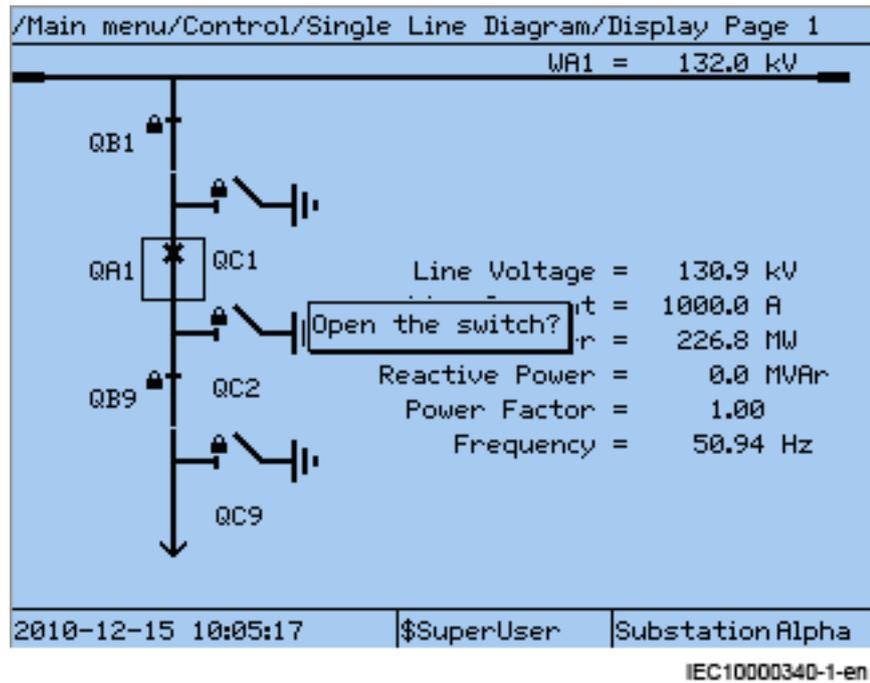


Figure 40: Closing a circuit breaker

- Press **ESC** to cancel the operation.
5. Press **←** or **→** to move between single-line diagram pages.



The time between selecting the object and giving a control command is restricted by an adjustable timeout [(set by the parameter *tSelect* for each object)]. When an object is selected, the control command has to be given within this time.

6.3 Resetting the IED

6.3.1 Clearing and acknowledging via the local HMI

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

1. Press **Clear** to activate the Clear view.
All the items that can be cleared are shown.

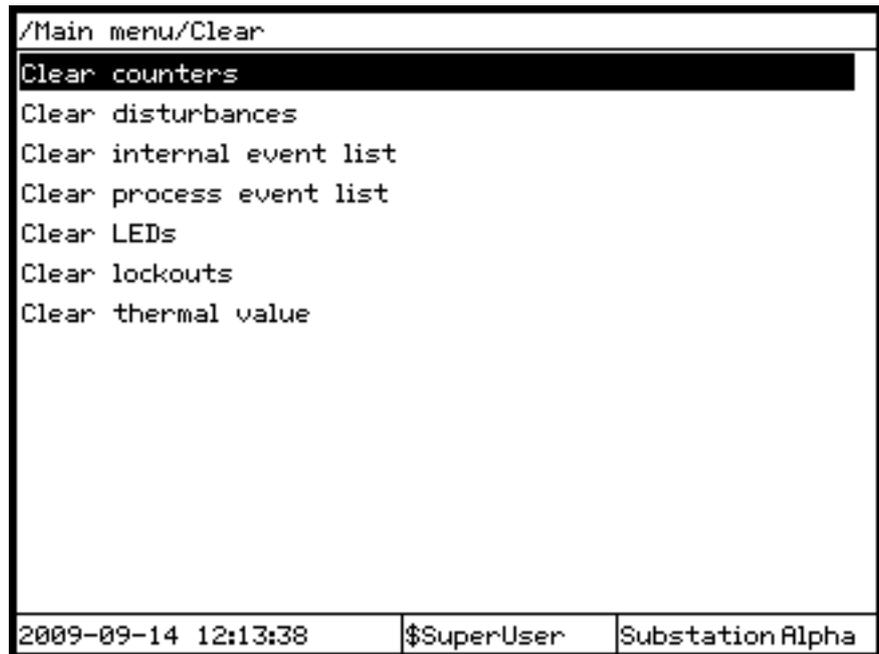


Figure 41: Clear view

The content of the Clear menu depends on the configuration configured with PCM600.

2. Select the item to be cleared with  or .
3. Press , select OK to confirm the selection or Cancel to cancel the selection.
4. To clear other items, repeat the steps.

6.4 Changing the IED functionality

6.4.1 Defining the setting group



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

A mechanism for limiting the number of writings per time period is included in the IED to prevent the flash memory to be worn out due to too many writings. As a consequence it may take up to an hour to save changes. If the auxiliary power is interrupted before a change is saved, that change is lost.

6.4.1.1 Activating a setting group

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

1. Select **Main menu/Settings/Activate setting group/1:SETGRPS** and press .



Figure 42: Active setting group

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

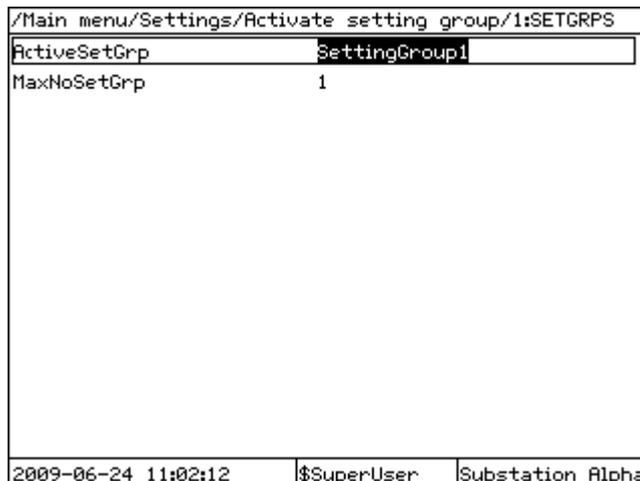


Figure 43: Selecting the active setting group

4. Commit the settings.



Remember to document the changes you make.

6.4.1.2 Browsing and editing setting group values

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

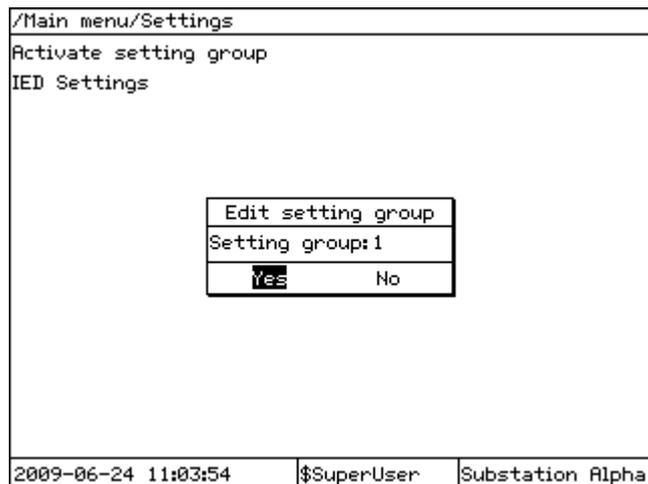


Figure 44: Selecting a setting group for editing

2. Press on the Setting group line in the dialog box to activate selection mode.
3. Select the wanted setting group with or and press .

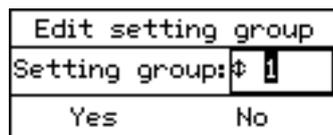


Figure 45: Changing the setting group

4. Select **Yes** in the dialog, and press to continue. The current setting group is displayed on the left in the header.
5. Select the application function category in the list with or , and press to see the function blocks in that category. Categories available in the list depend on the configuration configured with PCM600.

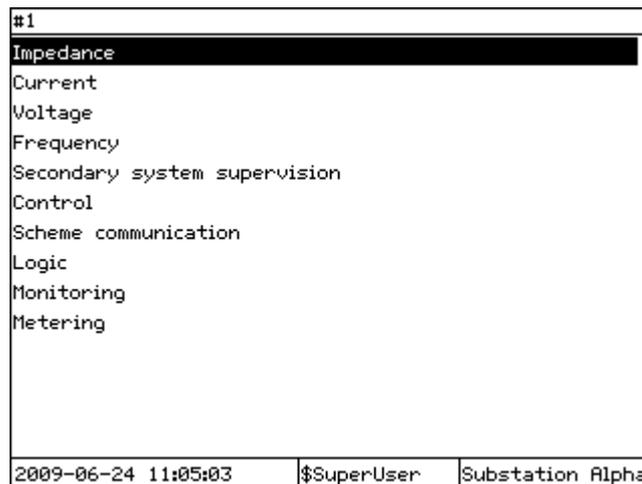


Figure 46: Selecting the function category

6. To browse the function blocks, scroll the list with and . Function blocks available depend on the application configuration. To move back to the list, press .
7. To select a function block, press .

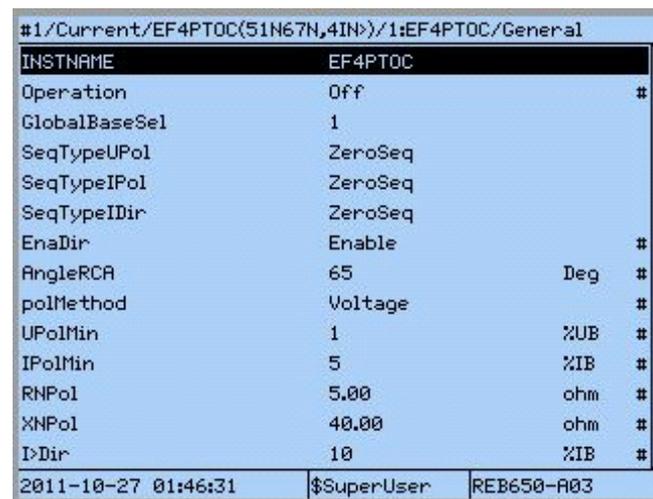


Figure 47: Function block settings

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

8. To browse the settings, scroll the list with and .
9. To edit the selected setting, press .
 - In case of a parameter that is not part of a setting group, the parameter is activated for editing.
 - In case of a setting group parameter, the editing dialog shows the value of the setting in all available setting groups, but the user can edit only

the value in the selected setting group. The active setting group is marked with an asterisk *.

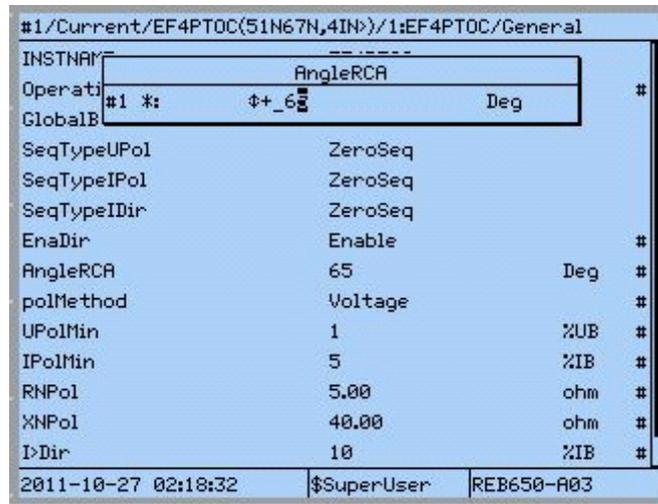


Figure 48: Changing the setting value

10. Press or to change the value.
11. Confirm the change with .

6.4.2 Activating LEDs

To activate the LEDs, they must be configured with PCM600.

1. Select **Main menu/Configuration/HMI/LEDs** and press .

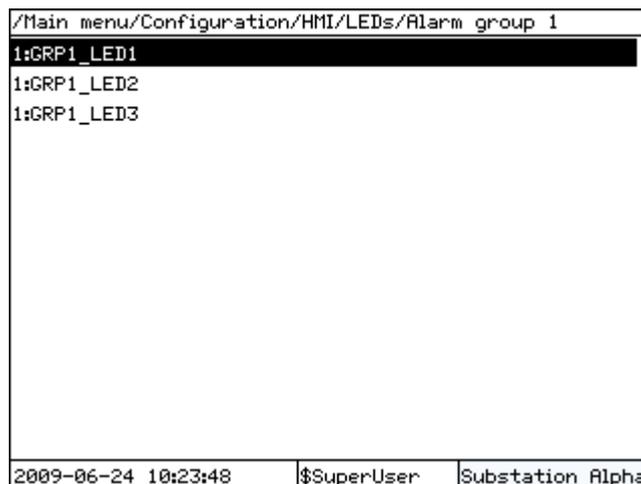


Figure 49: Alarm groups

The list can contain three alarm groups at the maximum. The amount of groups depends on the amount of LEDs taken into use.

2. Select an alarm group with  or  and press .
3. Select an Alarm LED with  or .
4. Press  to confirm the selection and to change the Alarm LED mode.
5. 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 general IED status in **Main menu/Diagnostics/IED status/General** for a faulty hardware module.
 - Check the history of changes in internal event list in **Main menu/Diagnostics/Internal Events**.
2. Inspect the IED visually.
 - Inspect the IED visually to find any physical error causes.
 - If you can find some obvious physical damage, contact ABB for repair or replacement actions.
3. Check whether the error is external or internal.
 - Check that the error is not caused by external origins.
 - Remove the wiring from the IED and test the input and output operation with an external test device.
 - If the problem remains, contact ABB for repair or replacement actions.

7.1.2 Identifying runtime errors

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

7.1.3 Identifying communication errors

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

- Check the IEC61850 and DNP3 communication status in internal event list in **Main menu/Diagnostics/IED Status/General**.
- In case of persistent faults originating from IED's internal faults such as component breakdown, contact ABB for repair or replacement actions.

7.1.3.1 Checking the communication link operation

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

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



The rear port connector X0 is used for connecting an external HMI to the IED. If the *LINKUP* value is 0 for front port, there is no communication link via port X0. Do not use rear port connector X0 if the IED is equipped with an LHMI.

2. Check the communication status of the rear port X1 via the LHMI in **Main menu/Test/Function status/Communication/1:DOSLAN1/Outputs**. The X1 communication port on the rear side of the IED is for optical Ethernet via LC connector or electrical via RJ-45 connector of the IEC 61850-8-1 station bus communication.
 - Check that the *LINKUP* value is 1, that is, the communication is working. When the value is 0, there is no communication link.

7.1.3.2 Checking the time synchronization

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



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

7.1.4 Running the display test

To run the display test, either use the push buttons or start the test via the menu.

- Select **Main menu/Tests/LED test**.
- Press  or simultaneously  and .

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

7.2 Indication messages

7.2.1 Internal faults

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

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

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

Table 20: *Internal fault indications*

Fault indication	Additional information
Internal Fault Real Time Clock Error	Hardware error with the real time clock.
Internal Fault Runtime Exec. Error	One or more of the application threads are not working properly.
Internal Fault SW Watchdog Error	This signal will be activated when the terminal has been under too heavy load for at least 5 minutes.
Internal Fault Runtime App Error	One or more of the application threads are not in an expected state.
Internal Fault File System Error	A file system error has occurred.
Internal Fault TRM-Error	A TRM card error has occurred. The instance number is displayed at the end of the fault indication.
Internal Fault COM-Error	A COM card error has occurred. The instance number is displayed at the end of the fault indication.
Internal Fault PSM-Error	A PSM card error has occurred. The instance number is displayed at the end of the fault indication.

7.2.2

Warnings

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

When a fault appears, record the fault indication message and state it when ordering service.

Table 21: *Warning indications*

Warning indication	Additional information
Warning IEC 61850 Error	IEC 61850 has not succeeded in some actions such as reading the configuration file, startup etc.
Warning DNP3 Error	Error in DNP3 communication.

7.2.3

Additional indications

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

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

Table 22: *Additional indications*

Warning indication	Additional information
Time Synch Error	Source of the time synchronization is lost or time system has made a time reset.
BATTERY1 Error	Auxiliary power is disconnected.
Settings Changed	Settings have been changed.
Setting Groups Changed	Setting group has been changed.

7.3

Correction procedures

7.3.1

Changing and setting the password

The password can only be set with PCM600.



For more information, see PCM600 documentation.

7.3.2 Identifying IED application problems

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

- Check that the function is on.
- Check that the correct setting group (1 to 4) is activated.
- Check the blocking.
- Check the mode.
- Check the measurement value.
- Check the connection to trip and disturbance recorder functions.
- Check the channel settings.

7.3.2.1 Inspecting the wiring

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

- Check the current or voltage measurements and their phase information from **Main menu/Measurements/Analog primary values** or **Analog secondary voltages**.
- Check that the phase information and phase shift between phases is correct.
- Correct the wiring if needed.
 - Change the parameter *Negation* in **Configuration/Analog modules/3PhaseAnalogGroup/1:SMAI_20_n** (n= the number of the SMAI used).



Changing the *Negation* parameter is not recommended without special skills.

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



Output relays, especially power output relays, are designed for breaking high currents. Due to this, layers of high resistance may appear on the surface of the contacts. Do not determine

proper functionality of connectivity or contact resistance by measuring with a regular hand-held ohm meter.

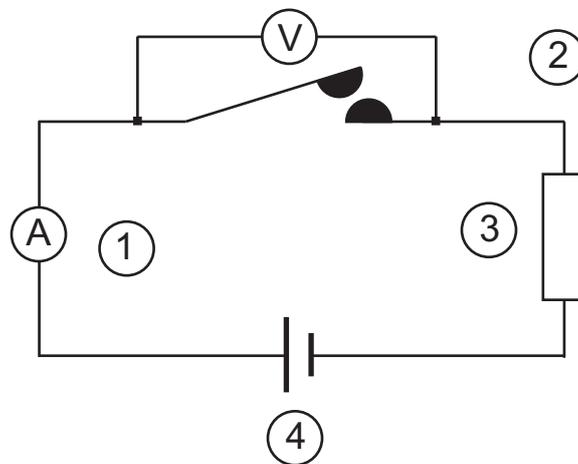


Figure 50: Testing output contacts using the voltage drop method

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

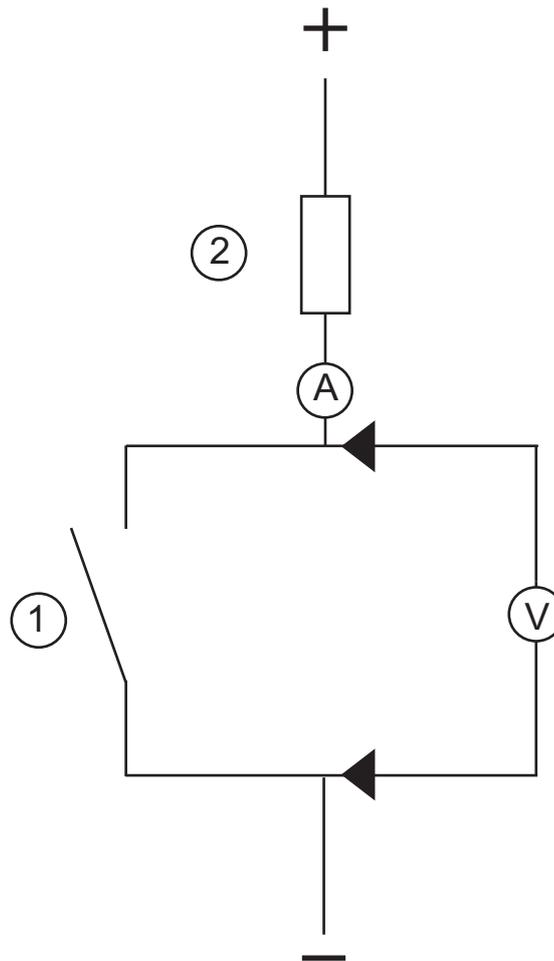


Figure 51: Testing a trip contact

- 1 Trip contact under test
- 2 Current limiting resistor

- To check the status of the output circuits driving the output relay via the LHMI, select **Main menu/Tests/Binary output values/Binary output modules** and then navigate to the board with the actual binary output to be checked.
- Test and change the relay state manually.
 1. To set the IED to test mode, select **Main menu/Tests/IED testmode1:TESTMODE/TestMode** and set the parameter to *On*.
 2. To operate or force the output relay to operate, select and then navigate to the board with the actual binary output relay to be operated/forced.
 3. Select the BOn_PO to be operated/forced and use  and  or  to operate the actual output relay.

Each BOn_PO is represented by two signals. The first signal in LHMI is the actual value 1 or 0 of the output, and in PCM600 a lit or dimmed

diode. The second signal is the status Normal or Forced. Forced status is only achieved when the BO is set to *Forced* or operated on the LHMI.



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

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

Section 8 Glossary

AC	Alternating current
ACT	Application configuration tool within PCM600
A/D converter	Analog-to-digital converter
ADBS	Amplitude deadband supervision
AI	Analog input
ANSI	American National Standards Institute
AR	Autoreclosing
ASCT	Auxiliary summation current transformer
ASD	Adaptive signal detection
AWG	American Wire Gauge standard
BI	Binary input
BOS	Binary outputs status
BR	External bistable relay
BS	British Standards
CAN	Controller Area Network. ISO standard (ISO 11898) for serial communication
CB	Circuit breaker
CCITT	Consultative Committee for International Telegraph and Telephony. A United Nations-sponsored standards body within the International Telecommunications Union.
CCVT	Capacitive Coupled Voltage Transformer
Class C	Protection Current Transformer class as per IEEE/ ANSI
CMPPS	Combined megapulses per second
CMT	Communication Management tool in PCM600
CO cycle	Close-open cycle
Codirectional	Way of transmitting G.703 over a balanced line. Involves two twisted pairs making it possible to transmit information in both directions
COMTRADE	Standard format according to IEC 60255-24
Contra-directional	Way of transmitting G.703 over a balanced line. Involves four twisted pairs, two of which are used for transmitting data in both directions and two for transmitting clock signals

CPU	Central processor unit
CR	Carrier receive
CRC	Cyclic redundancy check
CROB	Control relay output block
CS	Carrier send
CT	Current transformer
CVT	Capacitive voltage transformer
DAR	Delayed autoreclosing
DARPA	Defense Advanced Research Projects Agency (The US developer of the TCP/IP protocol etc.)
DBDL	Dead bus dead line
DBLL	Dead bus live line
DC	Direct current
DFC	Data flow control
DFT	Discrete Fourier transform
DHCP	Dynamic Host Configuration Protocol
DIP-switch	Small switch mounted on a printed circuit board
DI	Digital input
DLLB	Dead line live bus
DNP	Distributed Network Protocol as per IEEE/ANSI Std. 1379-2000
DR	Disturbance recorder
DRAM	Dynamic random access memory
DRH	Disturbance report handler
DSP	Digital signal processor
DTT	Direct transfer trip scheme
EHV network	Extra high voltage network
EIA	Electronic Industries Association
EMC	Electromagnetic compatibility
EMF	(Electric Motive Force)
EMI	Electromagnetic interference
EnFP	End fault protection
EPA	Enhanced performance architecture
ESD	Electrostatic discharge
FCB	Flow control bit; Frame count bit

FOX 20	Modular 20 channel telecommunication system for speech, data and protection signals
FOX 512/515	Access multiplexer
FOX 6Plus	Compact time-division multiplexer for the transmission of up to seven duplex channels of digital data over optical fibers
G.703	Electrical and functional description for digital lines used by local telephone companies. Can be transported over balanced and unbalanced lines
GCM	Communication interface module with carrier of GPS receiver module
GDE	Graphical display editor within PCM600
GI	General interrogation command
GIS	Gas-insulated switchgear
GOOSE	Generic object-oriented substation event
GPS	Global positioning system
HDLC protocol	High-level data link control, protocol based on the HDLC standard
HFBR connector type	Plastic fiber connector
HMI	Human-machine interface
HSAR	High speed autoreclosing
HV	High-voltage
HVDC	High-voltage direct current
IDBS	Integrating deadband supervision
IEC	International Electrical Committee
IEC 60044-6	IEC Standard, Instrument transformers – Part 6: Requirements for protective current transformers for transient performance
IEC 61850	Substation automation communication standard
IEC 61850–8–1	Communication protocol standard
IEEE	Institute of Electrical and Electronics Engineers
IEEE 802.12	A network technology standard that provides 100 Mbits/s on twisted-pair or optical fiber cable
IEEE P1386.1	PCI Mezzanine Card (PMC) standard for local bus modules. References the CMC (IEEE P1386, also known as Common Mezzanine Card) standard for the mechanics and the PCI specifications from the PCI SIG (Special Interest Group) for the electrical EMF (Electromotive force).

IEEE 1686	Standard for Substation Intelligent Electronic Devices (IEDs) Cyber Security Capabilities
IED	Intelligent electronic device
I-GIS	Intelligent gas-insulated switchgear
Instance	When several occurrences of the same function are available in the IED, they are referred to as instances of that function. One instance of a function is identical to another of the same kind but has a different number in the IED user interfaces. The word "instance" is sometimes defined as an item of information that is representative of a type. In the same way an instance of a function in the IED is representative of a type of function.
IP	<p>1. Internet protocol. The network layer for the TCP/IP protocol suite widely used on Ethernet networks. IP is a connectionless, best-effort packet-switching protocol. It provides packet routing, fragmentation and reassembly through the data link layer.</p> <p>2. Ingression protection, according to IEC standard</p>
IP 20	Ingression protection, according to IEC standard, level 20
IP 40	Ingression protection, according to IEC standard, level 40
IP 54	Ingression protection, according to IEC standard, level 54
IRF	Internal failure signal
IRIG-B:	InterRange Instrumentation Group Time code format B, standard 200
ITU	International Telecommunications Union
LAN	Local area network
LIB 520	High-voltage software module
LCD	Liquid crystal display
LDD	Local detection device
LED	Light-emitting diode
MCB	Miniature circuit breaker
MCM	Mezzanine carrier module
MVB	Multifunction vehicle bus. Standardized serial bus originally developed for use in trains.
NCC	National Control Centre
OCO cycle	Open-close-open cycle
OCP	Overcurrent protection
OLTC	On-load tap changer
OV	Over-voltage

Overreach	A term used to describe how the relay behaves during a fault condition. For example, a distance relay is overreaching when the impedance presented to it is smaller than the apparent impedance to the fault applied to the balance point, that is, the set reach. The relay “sees” the fault but perhaps it should not have seen it.
PCI	Peripheral component interconnect, a local data bus
PCM	Pulse code modulation
PCM600	Protection and control IED manager
PC-MIP	Mezzanine card standard
PMC	PCI Mezzanine card
POR	Permissive overreach
POTT	Permissive overreach transfer trip
Process bus	Bus or LAN used at the process level, that is, in near proximity to the measured and/or controlled components
PSM	Power supply module
PST	Parameter setting tool within PCM600
PT ratio	Potential transformer or voltage transformer ratio
PUTT	Permissive underreach transfer trip
RASC	Synchrocheck relay, COMBIFLEX
RCA	Relay characteristic angle
RFPP	Resistance for phase-to-phase faults
RFPE	Resistance for phase-to-earth faults
RISC	Reduced instruction set computer
RMS value	Root mean square value
RS422	A balanced serial interface for the transmission of digital data in point-to-point connections
RS485	Serial link according to EIA standard RS485
RTC	Real-time clock
RTU	Remote terminal unit
SA	Substation Automation
SBO	Select-before-operate
SC	Switch or push button to close
SCS	Station control system
SCADA	Supervision, control and data acquisition
SCT	System configuration tool according to standard IEC 61850

SDU	Service data unit
SMA connector	Subminiature version A, A threaded connector with constant impedance.
SMT	Signal matrix tool within PCM600
SMS	Station monitoring system
SNTP	Simple network time protocol – is used to synchronize computer clocks on local area networks. This reduces the requirement to have accurate hardware clocks in every embedded system in a network. Each embedded node can instead synchronize with a remote clock, providing the required accuracy.
SRY	Switch for CB ready condition
ST	Switch or push button to trip
Starpoint	Neutral point of transformer or generator
SVC	Static VAr compensation
TC	Trip coil
TCS	Trip circuit supervision
TCP	Transmission control protocol. The most common transport layer protocol used on Ethernet and the Internet.
TCP/IP	Transmission control protocol over Internet Protocol. The de facto standard Ethernet protocols incorporated into 4.2BSD Unix. TCP/IP was developed by DARPA for Internet working and encompasses both network layer and transport layer protocols. While TCP and IP specify two protocols at specific protocol layers, TCP/IP is often used to refer to the entire US Department of Defense protocol suite based upon these, including Telnet, FTP, UDP and RDP.
TNC connector	Threaded Neill-Concelman, a threaded constant impedance version of a BNC connector
TPZ, TPY, TPX, TPS	Current transformer class according to IEC
UMT	User management tool
Underreach	A term used to describe how the relay behaves during a fault condition. For example, a distance relay is underreaching when the impedance presented to it is greater than the apparent impedance to the fault applied to the balance point, that is, the set reach. The relay does not “see” the fault but perhaps it should have seen it. See also Overreach.
UTC	Coordinated Universal Time. A coordinated time scale, maintained by the Bureau International des Poids et Mesures (BIPM), which forms the basis of a coordinated dissemination of standard frequencies and time signals. UTC

is derived from International Atomic Time (TAI) by the addition of a whole number of "leap seconds" to synchronize it with Universal Time 1 (UT1), thus allowing for the eccentricity of the Earth's orbit, the rotational axis tilt (23.5 degrees), but still showing the Earth's irregular rotation, on which UT1 is based. The Coordinated Universal Time is expressed using a 24-hour clock, and uses the Gregorian calendar. It is used for aeroplane and ship navigation, where it is also sometimes known by the military name, "Zulu time." "Zulu" in the phonetic alphabet stands for "Z", which stands for longitude zero.

UV	Undervoltage
WEI	Weak end infeed logic
VT	Voltage transformer
X.21	A digital signalling interface primarily used for telecom equipment
3I_O	Three times zero-sequence current. Often referred to as the residual or the earth-fault current
3U_O	Three times the zero sequence voltage. Often referred to as the residual voltage or the neutral point voltage

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