Relion® Protection and Control

670 series 2.0 IEC
Operation Manual

Power and productivity
for a better world™

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Conformity

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

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Section 1 Introduction

1.1 This manual

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

1.2 Intended audience

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

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

1.3 Product documentation

1.3.1 Product documentation set

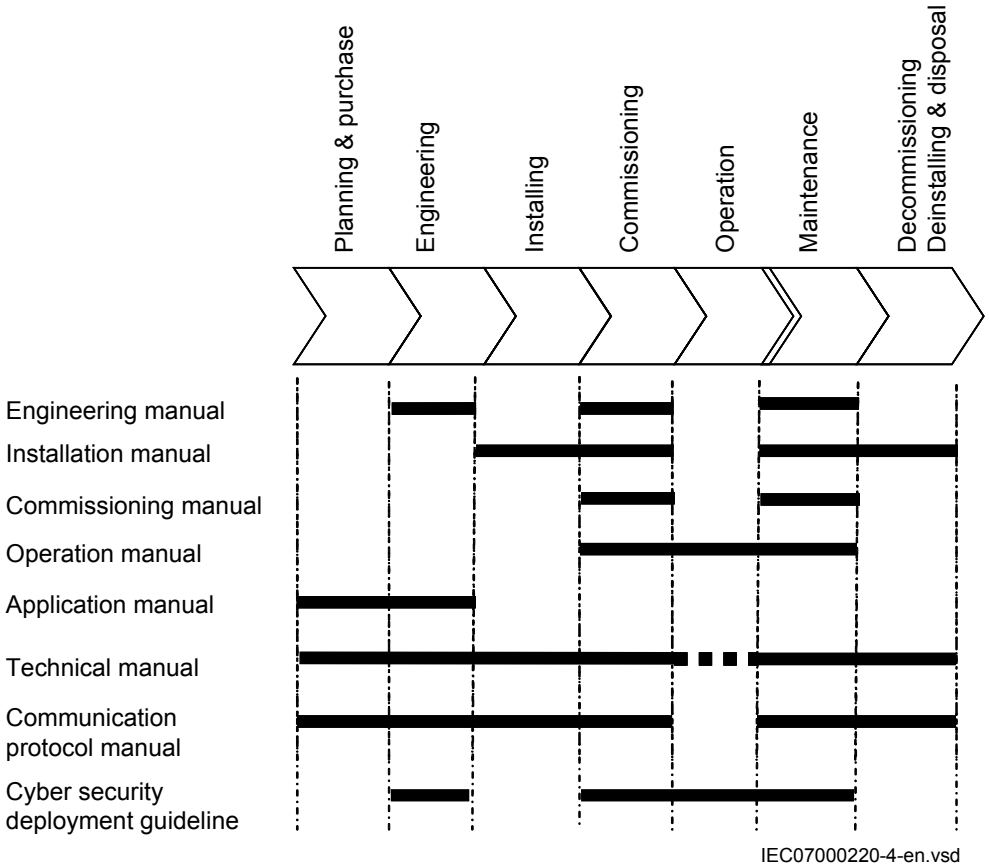


Figure 1: The intended use of manuals throughout the product lifecycle

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

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

configuration as well as verifying settings by secondary injection. The manual describes the process of testing an IED in a substation which is not in service. The chapters are organized in the chronological order in which the IED should be commissioned. The relevant procedures may be followed also during the service and maintenance activities.

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

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

The technical manual contains 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 the communication protocols supported by the IED. The manual concentrates on the vendor-specific implementations.

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

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

1.3.2 Document revision history

Document revision/date	History
-/May 2014	First release

1.3.3 Related documents

Documents related to REB670	Identify number
Application manual	1MRK 505 302-UEN
Commissioning manual	1MRK 505 304-UEN
Product guide	1MRK 505 305-BEN
Technical manual	1MRK 505 303-UEN
Type test certificate	1MRK 505 305-TEN

Documents related to REC670	Identify number
Application manual	1MRK 511 310-UEN
Commissioning manual	1MRK 511 312-UEN
Product guide	1MRK 511 313-BEN
Technical manual	1MRK 511 311-UEN
Type test certificate	1MRK 511 313-TEN

Documents related to RED670	Identify number
Application manual	1MRK 505 307-UEN
Commissioning manual	1MRK 505 309-UEN
Product guide	1MRK 505 310-BEN
Technical manual	1MRK 505 308-UEN
Type test certificate	1MRK 505 310-TEN

Documents related to REG670	Identify number
Application manual	1MRK 502 051-UEN
Commissioning manual	1MRK 502 053-UEN
Product guide	1MRK 502 054-BEN
Technical manual	1MRK 502 052-UEN
Type test certificate	1MRK 502 054-TEN

Documents related to REL670	Identify number
Application manual	1MRK 506 338-UEN
Commissioning manual	1MRK 506 340-UEN
Product guide	1MRK 506 341-BEN
Technical manual	1MRK 506 339-UEN
Type test certificate	1MRK 506 341-TEN

Documents related to RET670	Identify number
Application manual	1MRK 504 138-UEN
Commissioning manual	1MRK 504 140-UEN
Product guide	1MRK 504 141-BEN
Technical manual	1MRK 504 139-UEN
Type test certificate	1MRK 504 141-TEN

670 series manuals	Identify number
Operation manual	1MRK 500 118-UEN
Engineering manual	1MRK 511 308-UEN
Installation manual	1MRK 514 019-UEN
Communication protocol manual, IEC 60870-5-103	1MRK 511 304-UEN
Communication protocol manual, IEC 61850 Edition 1	1MRK 511 302-UEN
Communication protocol manual, IEC 61850 Edition 2	1MRK 511 303-UEN
Communication protocol manual, LON	1MRK 511 305-UEN
Communication protocol manual, SPA	1MRK 511 306-UEN
Accessories guide	1MRK 514 012-BEN
Cyber security deployment guideline	1MRK 511 309-UEN
Connection and Installation components	1MRK 513 003-BEN
Test system, COMBITEST	1MRK 512 001-BEN

1.4 Document symbols and conventions

1.4.1 Symbols

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

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

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

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

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

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

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

1.4.2 Document conventions

- Abbreviations and acronyms in this manual are spelled out in the glossary. The glossary also contains definitions of important terms.
- Push button navigation in the LHMI menu structure is presented by using the push button icons.
  For example, to navigate between the options, use ↑ and ↓.
- HMI menu paths are presented in bold.
  For example, select **Main menu/Settings**.
- LHMI messages are shown in Courier font.
  For example, to save the changes in non-volatile memory, select `Yes` and press ↵.
- Parameter names are shown in italics.
  For example, the function can be enabled and disabled with the *Operation* setting.
- Each function block symbol shows the available input/output signal.
  - the character ^ in front of an input/output signal name indicates that the signal name may be customized using the PCM600 software.
  - the character * after an input/output signal name indicates that the signal must be connected to another function block in the application configuration to achieve a valid application configuration.
- Logic diagrams describe the signal logic inside the function block and are bordered by dashed lines.

- Signals in frames with a shaded area on their right hand side represent setting parameter signals that are only settable via the PST or LHMI.
- If an internal signal path cannot be drawn with a continuous line, the suffix -int is added to the signal name to indicate where the signal starts and continues.
- Signal paths that extend beyond the logic diagram and continue in another diagram have the suffix ”-cont.”

1.4.3 Functions included in 670 series IEDs

Table 1: Main protection functions

IEC 61850 or function name	ANSI	Description
Differential protection		
BBP3PH4B	87B	Busbar differential protection, 2 zones, three phase/4 bays Package including functions BUTPTRC_B1-BUTPTRC_B4, BCZTPDIF, BZNTPDIF_A, BZNTPDIF_B, BZITGGIO, BUTSM4
BBP3PH8B	87B	Busbar differential protection, 2 zones, three phase/8 bays Package including functions BUTPTRC_B1-BUTPTRC_B8, BCZTPDIF, BZNTPDIF_A, BZNTPDIF_B, BZITGGIO, BUTSM8
BBP1PH12B	87B	Busbar differential protection, 2 zones, single phase/12 bays Package including functions BUSPTRC_B1-BUSPTRC_B12, BCZSPDIF, BZNSPDIF_A, BZNSPDIF_B, BZISGGIO, BUSSM12
BBP1PH24B	87B	Busbar differential protection, 2 zones, single phase/24 bays Package including functions BUSPTRC_B1-BUSPTRC_B24, BCZSPDIF, BZNSPDIF_A, BZNSPDIF_B, BZISGGIO, BUSSM24
BDCGAPC	87B	Status of primary switching object for busbar protection zone selection
T2WPDIF	87T	Transformer differential protection, two winding
T3WPDIF	87T	Transformer differential protection, three winding
HZPDIF	87	1Ph High impedance differential protection
GENPDIF	87G	Generator differential protection
REFPDIF	87N	Restricted earth fault protection, low impedance
L3CPDIF	87L	Line differential protection, 3 CT sets, 23 line ends
L6CPDIF	87L	Line differential protection, 6 CT sets, 35 line ends
LT3CPDIF	87LT	Line differential protection 3 CT sets, with inzone transformers, 23 line ends
LT6CPDIF	87LT	Line differential protection 6 CT sets, with inzone transformers, 35 line ends
LDLPSCH	87L	Line differential coordination function
LDRGFC	11REL	Additional security logic for differential protection
Impedance protection		
ZMQAPDIS, ZMQPDIS	21	Distance protection zone, quadrilateral characteristic
ZDRDIR	21D	Directional impedance quadrilateral
ZMCPDIS, ZMCAPDIS	21	Distance measuring zone, quadrilateral characteristic for series compensated lines
ZDSRDIR	21D	Directional impedance quadrilateral, including series compensation
FDPSPDIS	21	Phase selection, quadrilateral characteristic with fixed angle
Table continues on next page		

IEC 61850 or function name	ANSI	Description
ZMHPDIS	21	Full-scheme distance protection, mho characteristic
ZMMPDIS, ZMMAPDIS	21	Fullscheme distance protection, quadrilateral for earth faults
ZDMRDIR	21D	Directional impedance element for mho characteristic
ZDARDIR		Additional distance protection directional function for earth faults
ZSMGAPC		Mho Impedance supervision logic
FMPSPDIS	21	Faulty phase identification with load enchroachment
ZMRPDIS, ZMRAPDIS	21	Distance protection zone, quadrilateral characteristic, separate settings
FRPSPDIS	21	Phase selection, quadrilateral characteristic with settable angle
ZMFPDIS	21	High speed distance protection
ZMFCPDIS	21	High speed distance protection for series compensated lines
ZMCAPDIS		Additional distance measuring zone, quadrilateral characteristic
ZMRPSB	68	Power swing detection
PSLPSCH		Power swing logic
PSPPPAM	78	Pole slip/out-of-step protection
OOSPPAM	78	Out-of-step protection
ZCVPSOF		Automatic switch onto fault logic, voltage and current based
LEXPDIS	40	Loss of excitation
PPLPHIZ		Phase preference logic
ROTIPHIZ	64R	Sensitive rotor earth fault protection, injection based
STTIPHIZ	64S	100% stator earth fault protection, injection based
ZGVPDIS	21	Underimpedance protection for generators and transformers

Table 2: Backup protection functions

IEC 61850 or function name	ANSI	Description
Current protection		
PHPIOC	50	Instantaneous phase overcurrent protection
OC4PTOC	51_67	Four step phase overcurrent protection
PH4SPTOC	51	Four step single phase overcurrent protection
EFPIOC	50N	Instantaneous residual overcurrent protection
EF4PTOC	51N_67N	Four step residual overcurrent protection
NS4PTOC	46I2	Four step directional negative phase sequence overcurrent protection
SDEPSDE	67N	Sensitive directional residual over current and power 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
CCRBRF	50BF	Breaker failure protection
CCSRBRF	50BF	Breaker failure protection, single phase version

Table continues on next page

IEC 61850 or function name	ANSI	Description
STBPTOC	50STB	Stub protection
CCPDSC	52PD	Pole discordance protection
GUPPDUP	37	Directional underpower protection
GOPPDOP	32	Directional overpower protection
BRCPTOC	46	Broken conductor check
CBPGAPC		Capacitor bank protection
NS2PTOC	46I2	Negative sequence time overcurrent protection for machines
AEGPVOC	50AE	Accidental energizing protection for synchronous generator
VRPVOC	51V	Voltage restrained overcurrent protection
GSPTTR	49S	Stator overload protection
GRPTTR	49R	Rotor overload 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
VDCPTOV	60	Voltage differential protection
STEFPHIZ	59THD	100% Stator earth fault protection, 3rd harmonic based
LOVPTUV	27	Loss of voltage check
PAPGAPC	27	Radial feeder protection
Frequency protection		
SAPTUF	81	Underfrequency protection
SAPTOF	81	Overfrequency protection
SAPFRC	81	Rate-of-change frequency protection
FTAQFVR	81A	Frequency time accumulation protection
Multipurpose protection		
CVGAPC		General current and voltage protection

Table 3: Control and monitoring functions

IEC 61850 or function name	ANSI	Description
Control		
SESRSYN	25	Synchrocheck, energizing check, and synchronizing
SMBRREC	79	Autorecloser
TR1ATCC	90	Automatic voltage control for tap changer, single control
TR8ATCC	90	Automatic voltage control for tap changer, parallel control
TCMYLTC	84	Tap changer control and supervision, 6 binary inputs
TCLYLTC	84	Tap changer control and supervision, 32 binary inputs
SLGAPC		Logic Rotating Switch for function selection and LHMI presentation
Table continues on next page		

IEC 61850 or function name	ANSI	Description
VSGAPC		Selector mini switch
DPGAPC		Generic communication function for Double Point indication
SPC8GAPC		Single Point Generic Control 8 signals
AUTOBITS		AutomationBits, command function for DNP3.0
SINGLECMD		Single command, 16 signals Command function block for LON and SPA
VCTRSEND		Horizontal communication via GOOSE for VCTR
GOOSEVCTRRCV		Horizontal communication via GOOSE for VCTR
I103CMD		Function commands for IEC 60870-5-103
I103GENCMD		Function commands generic for IEC 60870-5-103
I103POSCMD		IED commands with position and select for IEC 60870-5-103
I103IEDCMD		IED commands for IEC 60870-5-103
I103USRCMD		Function commands user defined for IEC 60870-5-103
Apparatus control and interlocking		
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 disconnector
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		Switch controller
RESIN1		Reservation input 1
RESIN2		Reservation input 2
POS_EVAL		Evaluation of position indication
QCRSV		Bay reservation
QCBAY		Apparatus control Function for handling the status of Local/Remote switch
LOCREM		Handling of LRswitch positions
LOCREMCTRL		LHMI control of PSTO Function for handling Internal Local/Remote switch
Secondary system supervision		
Table continues on next page		

IEC 61850 or function name	ANSI	Description
CCSSPVC	87	Current circuit supervision
FUFSPVC		Fuse failure supervision
VDSPVC	60	Fuse failure supervision based on voltage difference
Logic		
SMPPTRC	94	Tripping logic
TMAGAPC		Trip matrix logic
ALMCALH		Logic for group alarm
WRNCALH		Logic for group warning
INDCALH		Logic for group indication
AND		Configurable logic blocks, AND
OR		Configurable logic blocks, OR
INV		Configurable logic blocks, inverter
PULSETIMER		Configurable logic blocks, PULSETIMER
GATE		Configurable logic blocks, controllable gate
TIMERSET		Configurable logic blocks, timer
XOR		Configurable logic blocks, exclusive OR
LLD		Configurable logic blocks, LLD
SRMEMORY		Configurable logic blocks, set-reset memory
RSMEMORY		Configurable logic blocks, reset-set memory
ANDQT		Configurable logic blocks Q/T, ANDQT
ORQT		Configurable logic blocks Q/T, ORQT
INVERTERQT		Configurable logic blocks Q/T, INVERTERQT
XORQT		Configurable logic blocks 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
BTIGAPC		Boolean 16 to Integer conversion with Logic Node representation
IB16		Integer to Boolean 16 conversion
ITBGAPC		Integer to Boolean 16 conversion with Logic Node representation
TIGAPC		Delay on timer with input signal integration
TEIGAPC		Elapsed time integrator with limit transgression and overflow supervision
Monitoring		
Table continues on next page		

IEC 61850 or function name	ANSI	Description
CVMMXN, CMMXU, VMMXU, CMSQI VMSQI, VNMMXU		Measurements
AISVBAS		Function block for service value presentation of secondary analog inputs
SSIMG	63	Gas medium supervision
SSIML	71	Liquid medium supervision
SSCBR		Circuit breaker condition monitoring
EVENT		Event function Function for event reporting for LON and SPA
DRPRDRE, A1RADR-A4RADR, B1RBDR-B6RBDR		Disturbance report
SPGAPC		Generic communication function for Single Point indication
SP16GAPC		Generic communication function for Single Point indication 16 inputs
MVGAPC		Generic communication function for Measured Value
BINSTATREP		Logical signal status report
RANGE_XP		Measured value expander block
LMBRFLO		Fault locator
I103MEAS		Measurands for IEC 60870-5-103
I103MEASUSR		Measurands user defined signals for IEC 60870-5-103
I103AR		Function status auto-recloser for IEC 60870-5-103
I103EF		Function status earth-fault for IEC 60870-5-103
I103FLTPROT		Function status fault protection for IEC 60870-5-103
I103IED		IED status for IEC 60870-5-103
I103SUPERV		Supervison status for IEC 60870-5-103
I103USRDEF		Status for user defiend signals for IEC 60870-5-103
L4UFCNT		Event counter with limit supervision
Metering		
PCFCNT		Pulse-counter logic
ETPMMTR		Function for energy calculation and demand handling
System protection and control		
SMAIHPAC		Multipurpose filter

Table 4: Station communication functions

IEC 61850 or function name	ANSI	Description
Station communication		
SPA		SPA communication protocol
ADE		LON communciation protocol
PROTOCOL		Operation selection between SPA and IEC 60870-5-103 for SLM
CHSERRS485		DNP3.0 for TCP/IP and EIA-485 communication protocol
Table continues on next page		

IEC 61850 or function name	ANSI	Description
DNPFREC		DNP3.0 fault records for TCP/IP and EIA-485 communication protocol
IEC61850-8-1		Parameter setting function for IEC 61850
GOOSEINTLKRCV		Horizontal communication via GOOSE for interlocking
GOOSEBINRCV		Goose binary receive
GOOSEDPRCV		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
GOOSESPRCV		GOOSE function block to receive a single point value
GOOSEVCTRCONF		GOOSE VCTR configuration for send and receive
VCTRSEND		Horizontal communication via GOOSE for VCTR
GOOSEVCTRRCV		Horizontal communication via GOOSE for VCTR
MULTICMDRCV, MULTICMDSND		Multiple command and transmit
FRONT, LANABI, LANAB, LANCDI, LANCD		Ethernet configuration of links
MU1_4I_4U MU2_4I_4U MU3_4I_4U MU4_4I_4U MU5_4I_4U MU6_4I_4U		Process bus communication IEC 61850-9-2
PRP		Duo driver configuration
Scheme communication		
ZCPSCH	85	Scheme communication logic for distance or overcurrent protection
ZC1PPSCH	85	Phase segregated Scheme communication logic for distance protection
ZCRWPSCH	85	Current reversal and weak-end infeed logic for distance protection
ZC1WPSCH	85	Current reversal and weak-end infeed logic for phase segregated communication
ZCLCPSCH		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
Direct transfer trip		
LAPPGAPC	37_55	Low active power and power factor protection
COUVGAPC	59_27	Compensated over- and undervoltage protection
SCCVPTOC	51	Sudden change in current variation
LCCRPTRC	94	Carrier receive logic
LCNSPTOV	47	Negative sequence overvoltage protection
LCZSPTOV	59N	Zero sequence overvoltage protection
LCNSPTOC	46	Negative sequence overcurrent protection
LCZSPTOC	51N	Zero sequence overcurrent protection
LCP3PTOC	51	Three phase overcurrent
LCP3PTUC	37	Three phase undercurrent

Table 5: Basic IED functions

IEC 61850 or function name	Description
INTERRSIG	Self supervision with internal event list
SELFSUPEVLST	Self supervision with internal event list
TIMESYNCHGEN	Time synchronization module
SYNCHBIN, SYNCHCAN, SYNCHCMPPS, SYNCHLON, SYNCHPPH, SYNCHPPS, SYNCHSNTP, SYNCHSPA, SYNCHCMPPS	Time synchronization
TIMEZONE	Time synchronization
DSTBEGIN, DSTENABLE, DSTEND	GPS time synchronization module
IRIG-B	Time synchronization
SETGRPS	Number of setting groups
ACTVGRP	Parameter setting groups
TESTMODE	Test mode functionality
CHNGLCK	Change lock function
SMBI	Signal matrix for binary inputs
SMBO	Signal matrix for binary outputs
SMMI	Signal matrix for mA inputs
SMAI1 - SMAI20	Signal matrix for analog inputs
3PHSUM	Summation block 3 phase
ATHSTAT	Authority status
ATHCHCK	Authority check
AUTHMAN	Authority management
FTPACCS	FTP access with password
SPACOMMMAP	SPA communication mapping
SPATD	Date and time via SPA protocol
DOSFRNT	Denial of service, frame rate control for front port
DOSLANAB	Denial of service, frame rate control for OEM port AB
DOSLANCD	Denial of service, frame rate control for OEM port CD
DOSSCKT	Denial of service, socket flow control
GBASVAL	Global base values for settings
PRIMVAL	Primary system values
ALTMS	Time master supervision
ALTIM	Time management
ALTRK	Service tracking
ACTIVLOG	Activity logging parameters
Table continues on next page	

IEC 61850 or function name	Description
FSTACCS	Field service tool access via SPA protocol over ethernet communication
PCMACCS	IED Configuration Protocol
SECALARM	Component for mapping security events on protocols such as DNP3 and IEC103
DNPGEN	DNP3.0 communication general protocol
DNPGENTCP	DNP3.0 communication general TCP protocol
CHSEROPT	DNP3.0 for TCP/IP and EIA-485 communication protocol
MSTSER	DNP3.0 for serial communication protocol
OPTICAL103	IEC 60870-5-103 Optical serial communication
RS485103	IEC 60870-5-103 serial communication for RS485
IEC61850-8-1	Parameter setting function for IEC 61850
HORZCOMM	Network variables via LON
LONSPA	SPA communication protocol
LEDGEN	General LED indication part for LHMI

Section 2 Safety information

2.1 Symbols on the product

All warnings must be observed.

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

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

2.2 Warnings

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

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

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

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

Always use suitable isolated test pins when measuring signals in open circuitry. Potentially lethal voltages and currents are present.

Never connect or disconnect a wire and/or a connector to or from a IED during normal operation. Hazardous voltages and currents are present that may be lethal. Operation may be disrupted and IED and measuring circuitry may be damaged.

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

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

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

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

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

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

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

The IED contains components which are sensitive to electrostatic discharge. ESD precautions shall always be observed prior to touching components.

Always transport PCBs (modules) using certified conductive bags.

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

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

Take care to avoid electrical shock during installation and commissioning.

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

Avoid touching the enclosure of the coupling capacitor REX061 unit and the shunt resistor REX062 unit. The surface may be hot during normal operation. The temperature can rise 50°C in REX061 and 65°C in REX062 above the ambient temperature.

Section 3 Environmental aspects

3.1 Sustainable development

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

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

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

3.2 Disposing of the IED

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

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

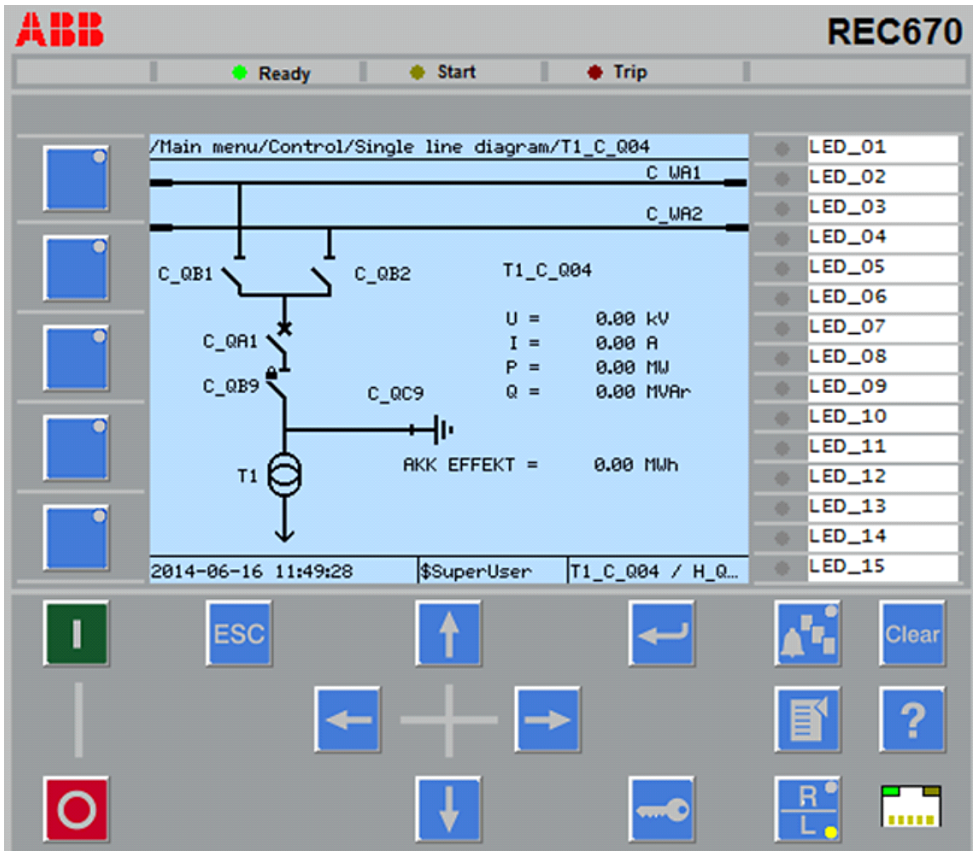
Table 6: Materials of the IED parts

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 4 670 series overview

4.1 Local HMI



IEC13000239-1-en.vsd

Figure 2: Local human-machine interface

The LHMI of the IED contains the following elements:

- Display (LCD)
- Buttons
- LED indicators
- Communication port for PCM600

The LHMI is used for setting, monitoring and controlling.

4.1.1 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.

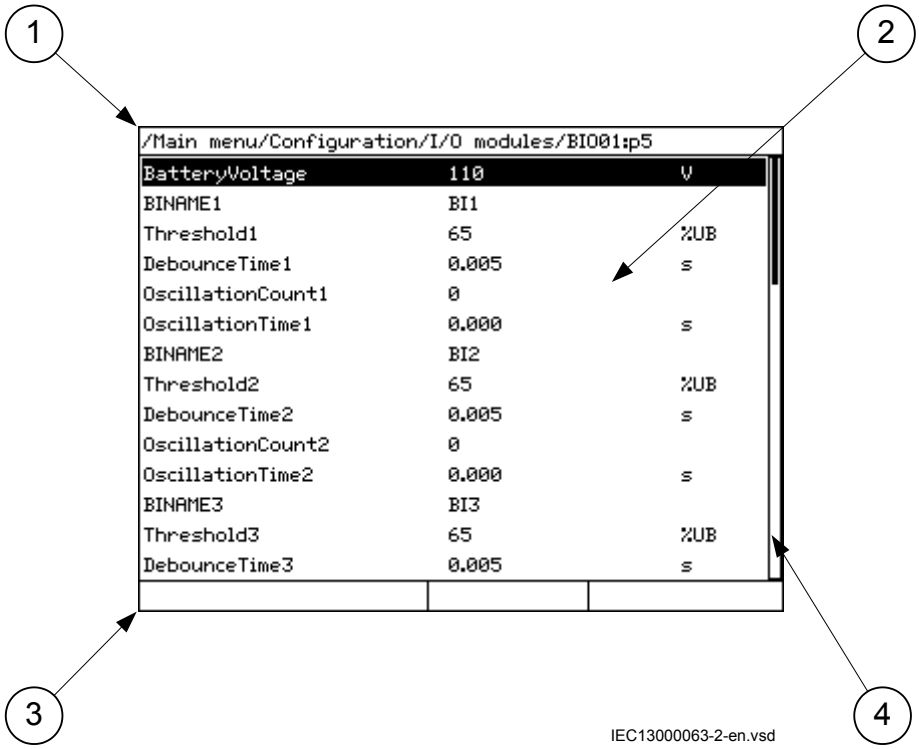


Figure 3: Display layout

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.

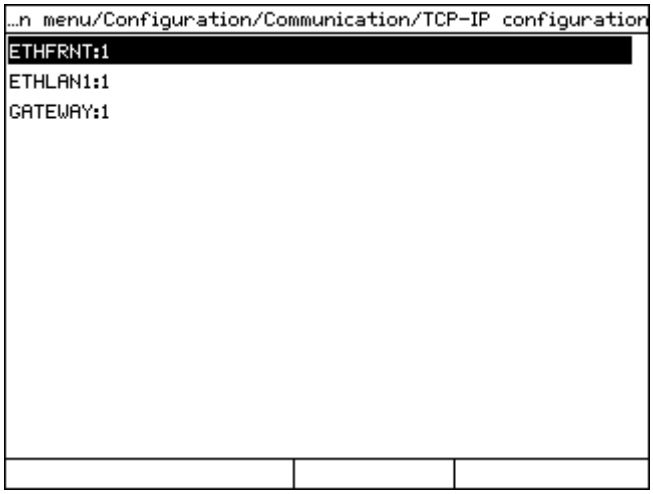


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Figure 4: Truncated path

The number after the function instance, for example `ETHFRNT:1`, 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.

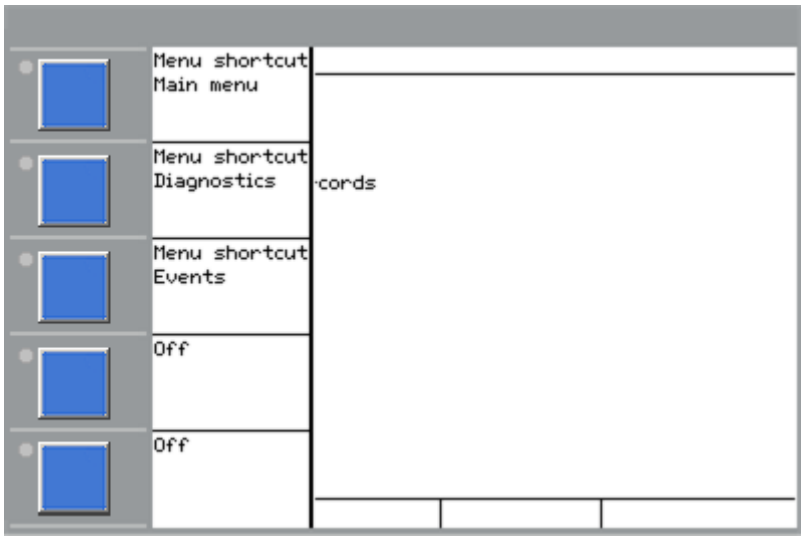

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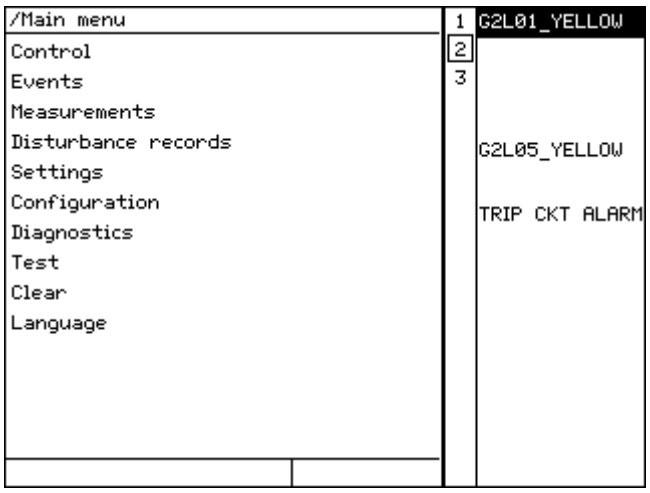
Figure 5: Function button panel

The alarm LED panel shows on request the alarm text labels for the alarm LEDs. Three alarm LED pages are available.



IEC13000240-1-en.vsd

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.

4.1.2 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 are lit according to priority, with red being the highest and green the lowest priority. For example, if on one page there is an indication that requires the green LED to be lit, and on another page there is an indication that requires the red LED to be lit, the red LED takes priority and is lit. The LEDs can be configured with PCM600 and the operation mode can be selected with the LHMI or PCM600.

Information pages for the alarm LEDs are shown by pressing the Multipage button. Pressing that button cycles through the three pages. A lit or un-acknowledged LED is indicated with a highlight. Such lines can be selected by using the Up / Down arrow buttons. Pressing the Enter key shows details about the selected LED. Pressing the ESC button exits from information pop-ups as well as from the LED panel as such.

The Multipage button has a LED. This LED is lit whenever any LED on any page is lit. If there are un-acknowledged alarm LEDs, then the Multipage LED blinks. To acknowledge LEDs, press the Clear button to enter the Reset menu (refer to description of this menu for details).

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

4.1.3 Keypad

The LHMI keypad contains push-buttons which are used to navigate in different views or menus. 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.

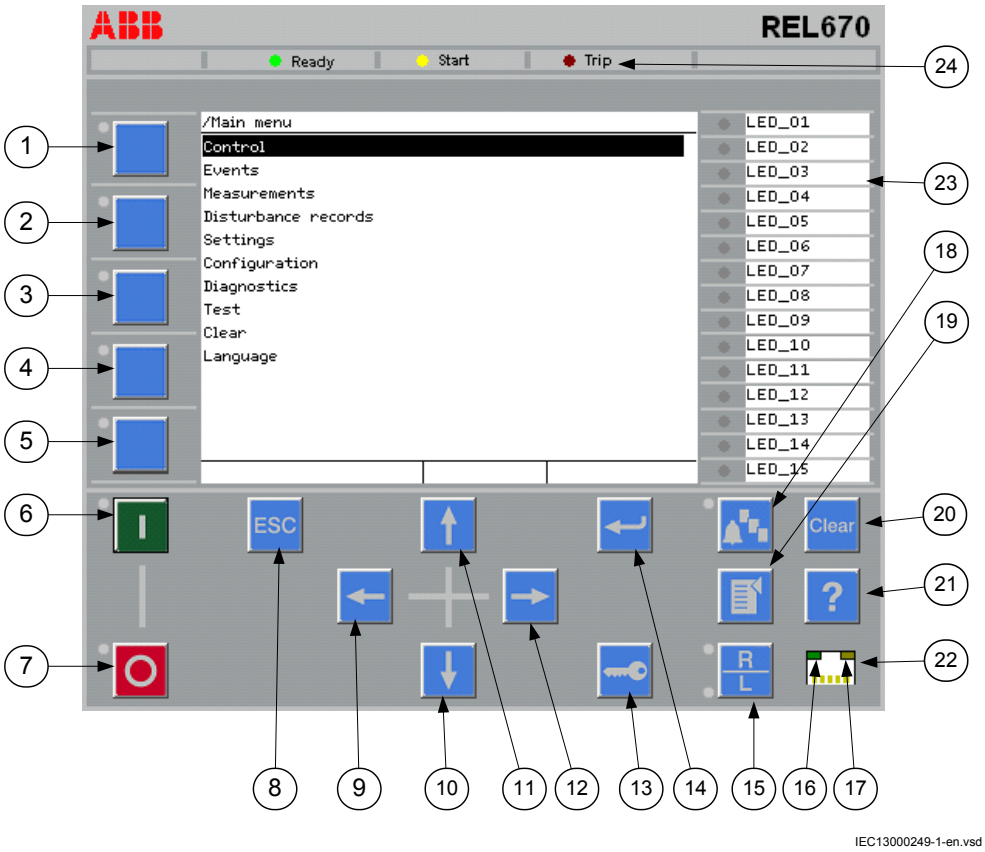


Figure 7: LHMI keypad with object control, navigation and command push-buttons and RJ-45 communication port

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

23 Programmable alarm LEDs

24 Protection status LEDs

Object control

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

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

Table 7: Object control push-buttons

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

Navigation

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

Table 8: Navigation push-buttons

Name	Description
ESC	• Leaving setting mode without saving the values. • Cancelling certain actions. • Adjusting the display contrast in combination with or . • Running the display test in combination with . • Deleting a character in combination with Clear when editing a string. • Inserting a space in combination with when editing a string.
Enter	• Entering parameter setting mode. • Confirming a new value of a setting parameter. • Confirming selection in dialogs and alarm panel.
Up Down	• 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	• 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	• Activating the authorization procedure, when the user is not logged in. • Logging out, when the user is currently logged in.

Commands

Table 9: Command push-buttons

Name	Description
Menu	• Moving directly to Main menu, if currently in any other menu or view. • Moving to the default view, if currently in Main menu.
R/L	Changing the control position (remote or local) of the device. • When the R LED is lit, remote control is enabled and local control disabled. • When the L LED is lit, local control is enabled and remote control disabled. • When none of the LEDs are lit, both control positions are disabled.
Clear	• Activating the Clear/Reset view.
Help	Showing the help menu.
Multipage	Opening alarm panel and selecting alarm page from the view.

Function buttons

Table 10: Function buttons

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

4.1.4 Local HMI functionality

4.1.4.1 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. The yellow and red status LEDs are configured in the disturbance recorder function, DRPRDRE, by connecting a start or trip signal from the actual function to a BxRBDR binary input function block using the PCM600 and configure the setting to *Off*, *Start* or *Trip* for that particular signal.

Table 11: Ready LED (green)

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

Table 12: Start LED (yellow)

LED state	Description
Off	Normal operation.
On	A protection function has started and an indication message is displayed. The start indication is latching and must be reset via communication, LHMI or binary input on the LEDGEN component. To open the reset menu on the LHMI, press Clear.
Flashing	The IED is in test mode and protection functions are blocked, or the IEC61850 protocol is blocking one or more functions. The indication disappears when the IED is no longer in test mode and blocking is removed. The blocking of functions through the IEC61850 protocol can be reset in **Main menu/Test/Reset IEC61850 Mod**. The yellow LED changes to either On or Off state depending on the state of operation.

Table 13: Trip LED (red)

LED state	Description
Off	Normal operation.
On	A protection function has tripped. An indication message is displayed if the auto-indication feature is enabled in the local HMI. The trip indication is latching and must be reset via communication, LHMI or binary input on the LEDGEN component. To open the reset menu on the LHMI, press Clear.

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 14: Alarm indications

LED state	Description
Off	Normal operation. All activation signals are off.
On	• 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	• 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.

4.1.4.2 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.

4.1.4.3 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.
- The yellow LED is not used; it is always off.

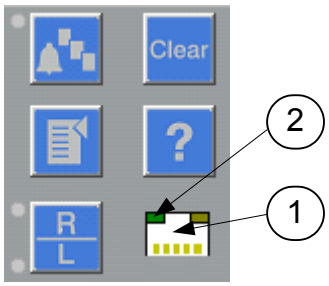


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Figure 8: RJ-45 communication port and green indicator LED

1 RJ-45 connector
2 Green indicator LED

The default IP address for the IED front port is 10.1.150.3 and the corresponding subnetwork mask is 255.255.255.0. It can be set through the local HMI path **Main menu/Configuration/Communication/Ethernet configuration/FRONT:1**.

Do not connect the IED front port to a LAN. Connect only a single local PC with PCM600 to the front port. It is only intended for temporary use, such as commissioning and testing.

4.1.4.4 Single-line diagram

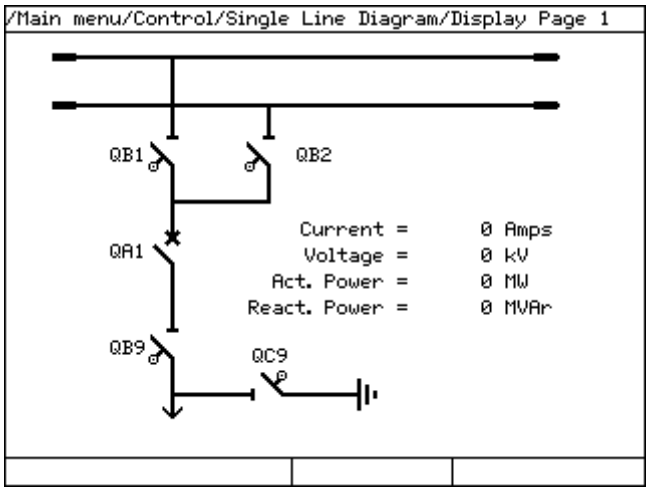

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Figure 9: Example of a single-line diagram

4.2 Authorization

The user roles with different user 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 roles. By default, the users in Table 1 are created in the IED, and when creating new users, the predefined roles from Table 16 can be used.

At delivery, the IED user has full access as SuperUser until users are created with PCM600.

Table 15: Default users

User name	User rights
Superuser	Full rights, only presented in LHMI. LHMI is logged on by default until other users are defined
Guest	Only read rights, only presented in LHMI. LHMI is logged on by default when other users are defined (same as VIEWER)
Administrator	Full rights. Password: Administrator. This user has to be used when reading out disturbances with third party FTP-client.

Table 16: Predefined user roles according to IEC 62351-8

User roles	Role explanation	User rights
VIEWER	Viewer	Can read parameters and browse the menus from LHMI
OPERATOR	Operator	Can read parameters and browse the menus as well as perform control actions
ENGINEER	Engineer	Can create and load configurations and change settings for the IED and also run commands and manage disturbances
INSTALLER	Installer	Can load configurations and change settings for the IED
SECADM	Security administrator	Can change role assignments and security settings
SECAUD	Security auditor	Can view audit logs
RBACMNT	RBAC management	Can change role assignment

Changes in user management settings do **not** cause an IED reboot.

After three consecutive failed login attempts the user will be locked out for ten minutes before a new attempt to log in can be performed. This time is settable 10 minutes to 60 minutes.

The PCM600 tool caches the login credentials after successful login for 15 minutes. During that time no more login will be necessary.

Table 17: Authority-related IED functions

Function	Description
Authority status ATHSTAT	This function is an indication function block for user log-on activity. User denied attempt to log-on and user successful log-on are reported.
Authority check ATHCHCK	To safeguard the interests of our customers, both the IED and the tools that are accessing the IED are protected, by means of authorization handling. The authorization handling of the IED and the PCM600 is implemented at both access points to the IED: • local, through the local HMI • remote, through the communication ports The IED users can be created, deleted and edited only with PCM600 IED user management tool.
Authority management AUTHMAN	This function enables/disables the maintenance menu. It also controls the maintenance menu log on time out.

For more information on Authority management AUTHMAN, Authority status ATHSTAT, and Authority check ATHCHCK functions, see Chapter Basic IED functions in technical manual.

4.3 Communication

The IED supports the following communication protocols: IEC 61850-8-1, IEC 61850–9–2LE, SPA, IEC 60870-5-103, LON and DNP3.

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

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, IEC 60870-5-103, DNP, SPA, LON or FTP protocols. The disturbances are in 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 or through LON network variables. 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 transmission 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.

The IED interoperates with other IEC 61850 compliant IEDs, tools and systems and simultaneously reports events to eight 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.

The IED has a number of communication ports which support different protocols:

Communication media	Protocols supported
Ethernet (fiber-optic multimode ST connector, i.e. 100BASE-FX)	IEC 61850, DNP3, FTP
Optical Serial port (glass with ST-connector, or plastic with HFBR Snap-in connector)	IEC 60870-5-103, DNP3, SPA
Optical LON port (glass with ST-connector, or plastic with HFBR Snap-in connector)	LON
RS485	IEC 60870-5-103, DNP3

The IED supports GPS, IRIG-B, PPS, SNTP or Binary time synchronization methods with a time-stamping resolution of 1 ms or better. Alternative time synchronization methods are LON, SPA, DNP or IED 60870-5-103.

4.4 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.

4.4.1 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 the existing parameters, data format used, units, setting range, 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. Update Manager is a part of PCM and is delivered with it.

4.5 Cyber security guidelines

4.5.1 Predefined user roles

There are different roles of users that can access or operate different areas of the IED and tool functionalities.

Ensure that the user logged on to the IED has the required access 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:

- X= Full access rights
- R= Only reading rights
- - = No access rights

Table 18: Predefined user roles according to IEC 62351-8

Access rights	VIEWER	OPERATOR	ENGINEER	INSTALLER	SECADM	SECAUD	RBACMNT
Config – Basic	-	-	X	X	-	-	-
Config – Advanced	-	-	X	X	-	-	-
FileTransfer – Tools	-	-	X	X	-	-	-
UserAdministration	-	-	-	-	X	-	X
Setting – Basic	R	-	X	X	-	-	-
Setting – Advanced	R	-	X	X	-	-	-
Control – Basic	-	X	X	-	-	-	-
Control – Advanced	-	X	X	-	-	-	-
IEDCmd – Basic	-	X	X	-	-	-	-
IEDCmd – Advanced	-	-	X	-	-	-	-
FileTransfer – Limited	-	X	X	X	X	X	X
DB Access normal	-	X	X	X	X	X	X
Audit log read	-	-	-	-	-	X	-
Setting – Change Setting Group	-	X	X	X	-	-	-
Security Advanced	-	-	-	-	-	X	-

Table 19: Access rights explanation

Access rights	Explanation
Config – Basic	Configuration – Basic is intended for engineers that only adapt an existing configuration e.g. the I/O-Configuration using SMT
Config – Advanced	Configuration – Advanced is intended for engineers that do the whole application engineering and using e.g. ACT
FileTransfer – Tools	FileTransfer – Tools is used for some configuration files for the configuration and shall have the same value as Config – Advanced
UserAdministration	UserAdministration is used to handle user management e.g. adding new user
Setting – Basic	Setting – Basic is used for basic settings e.g. control settings and limit supervision
Setting – Advanced	Setting – Advanced is used for the relay engineer to set settings e.g. for the protection functions
Control – Basic	Control – Basic is used for a normal operator without possibility to bypass safety functions e.g. interlock or synchro-check bypass
Control – Advanced	Control – Advanced is used for an operator that is trusted to do process commands that can be dangerous
IEDCmd – Basic	IEDCmd – Basic is used for commands to the IED that are not critical e.g. Clear LEDs, manual triggering of disturbances
IEDCmd – Advanced	IEDCmd – Advanced is used for commands to the IED that can hide information e.g. Clear disturbance record
FileTransfer – Limited	FileTransfer - Limited is used for access to disturbance files e.g. through FTP
DB Access normal	Database access for normal user. This is needed for all users that access data from PCM
Audit log read	Audit log read allows reading the audit log from the IED
Setting – Change Setting Group	Setting – Change Setting Group is separated to be able to include the possibility to change the setting group without changing any other setting
Security Advanced	Security Advanced is the privilege required to do some of the more advanced security-related settings

IED users can be created, deleted and edited only with the IED Users tool within PCM600. From the LHMI, no users can be created nor changed.

At delivery, the IED has a default user defined with full access rights. PCM600 uses this default user to access the IED. This user is automatically removed in IED when users are defined via the IED Users tool in PCM600.

Default User ID: Administrator

Password: Administrator

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

First user created must be appointed the role SECADM to be able to write users, created in PCM600, to the IED.

In order to allow the IED to communicate with PCM600 when users are defined via the IED Users tool, the access rights “UserAdministration” and “FileTransfer — Limited” must be applied to at least one user.

4.5.2 Communication ports and services

The port security guideline cannot suggest concrete products for a secure system setup. This must be decided within the specific project, requirements and existing infrastructure.

To set up a firewall the following table summarizes the ports used in the 670 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 can be opened as described in the comment column in the table. Front refers to the physical front port. On the rear side of the IED there are two network interfaces, one is labeled LAN AB, and the other is labeled LAN CD. The protocol availability on these ports is configurable.

ABB recommends using common security measures, like firewalls, up to date anti virus software, etc. to protect the IED and the equipment around it.

Table 20: Available ports

Port	Protocol	Default state	Front	LAN AB	LAN CD	Service	Comment
21	TCP	open	OFF	OFF	OFF	FTP	File transfer protocol
21	TCP	open	ON	ON	ON	FTPS	FTP with explicit SSL
102	TCP	closed	OFF	OFF	OFF	IEC 61850 (MMS)	MMS communication
123	UDP	closed	OFF	OFF	OFF	SNTP	Enabled when IED is configured as SNTP master.
7001	TCP	closed	OFF	OFF	OFF	FST (SPA on TCP/IP)	SPA protocol on TCP/IP used by FST (Field Service Tool)
2102	TCP	open	ON	ON	ON	PCM Access (IED configuration protocol)	IED configuration protocol
20 000	TCP	closed	OFF	OFF	OFF	DNP3.0	DNP3.0 DNP communication only
20 000	UDP	closed	OFF	OFF	OFF	DNP3.0	DNP3.0 DNP communication only

In addition to FTP, SPA, and IED configuration protocol, the 670 series supports two Ethernet++ substation automation++ communication protocols, which are IEC 61850 and DNP3.0. These communication protocols are enabled by configuration. This means that the port is closed and unavailable if the configuration of the 670 series does not contain a communication line of the protocol. If a protocol is configured, the corresponding port is open all the time.

See the 670 series technical manual and the corresponding protocol documentation on how to configure a certain communication protocol for the 670 series.

There are some restrictions and dependencies:

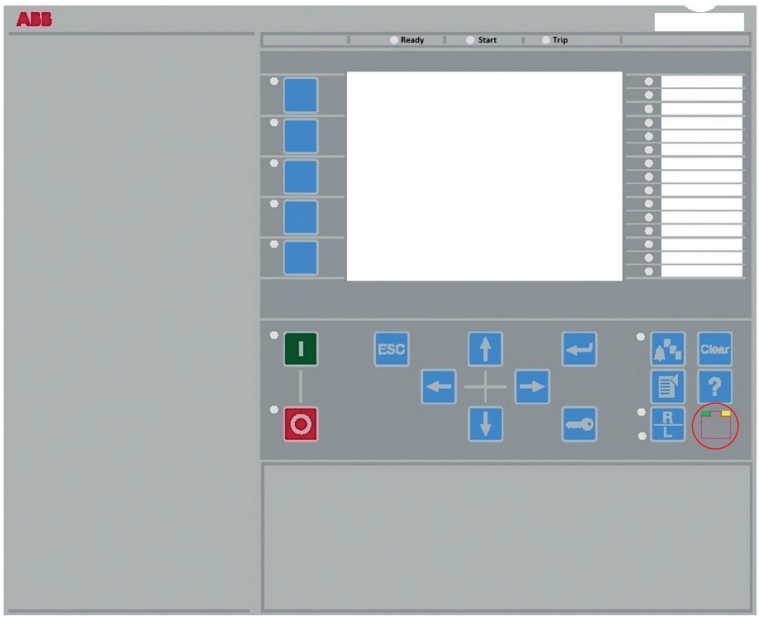
- The port used for IEC 61850 (default TCP port 102) is fixed and cannot be changed.
- The ports used for DNP3 are configurable. The communication protocol DNP3 could operate on UDP (default port 20 000) or TCP (default port 20 000). It is defined in the configuration which type of Ethernet communication is used. Only one type is possible at a time.
- The port used for FTP (default TCP port 21) can be changed in the IED if needed by a 3rd party FTP client.

If the FTP port is changed PCM600 cannot be used since it is not possible to configure it to use other IP-ports than port 21 for FTP.

Two ports are used by PCM600. For configuration and parameter settings, the IP port for a proprietary ODBC protocol is used (TCP port 2102) and the port is fixed and cannot be changed. For Field service tool, the IP port for a proprietary SPA protocol is used (TCP port 7001) and the port is fixed and cannot be changed.

IP routing is not possible via any of the physical interfaces.

Some IP ports are not possible to use in all physical interfaces.



IEC13000267-2-en.psd

Figure 10: Ethernet port used for PCM600 only, front view

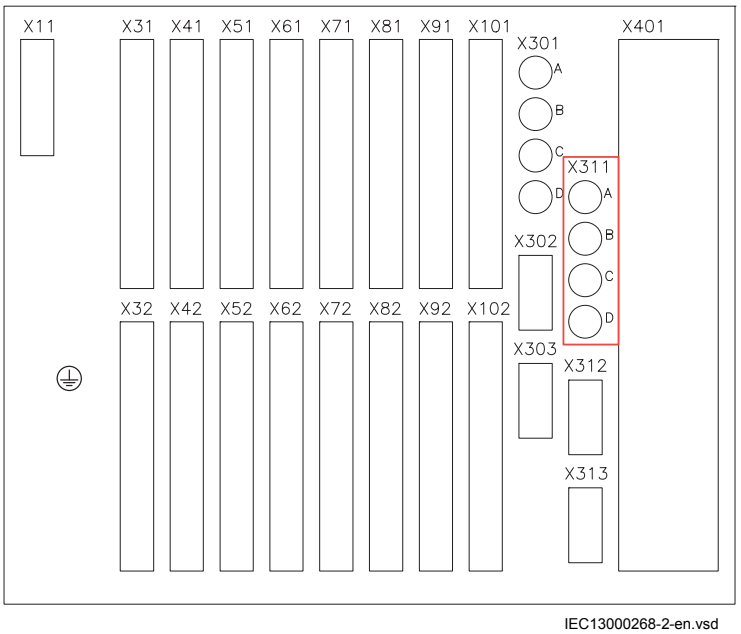


Figure 11: Optical ethernet ports, position X311, rear view

Section 5 Using the HMI

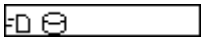
5.1 Using the local HMI

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.



IEC13000282-1-en.vsd

Figure 12: Saving changes animation

5.1.1 Logging on

1. Press to activate the logon procedure.
   The logon is also activated when attempting a password-protected operation.
2. Press to activate the User field.

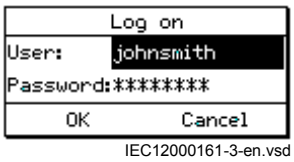


Figure 13: Selecting the user name

3. Select the user name by scrolling with ↑ and ↓, and press ↵ to confirm.
4. Press ↓ to select the Password field and press ↵ to activate it.
   A virtual keyboard opens.

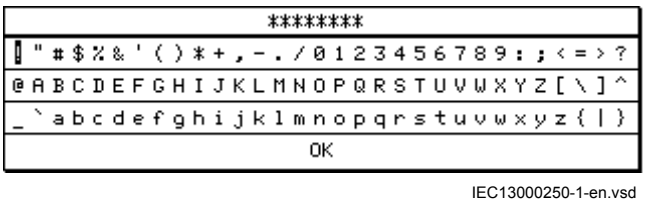


Figure 14: Virtual keyboard

This editor is a three-row button pad where all the visual ASCII characters are selectable buttons. Each added character is shown for a short time, then hidden with a hash character '*' to enhance security. You can abort password editing at any time by pressing ESC (required to restart editing, for example, if a wrong character is entered). To attempt logon, navigate to the OK button and press editing, or press ESC, or use the Cancel button to abort the logon attempt.

5. Navigate to the desired character one by one with ↑, ↓, ← and → and confirm each character with ↵. This terminates password editing and forwards the resulting password string to the password dialogue.

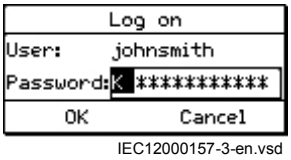
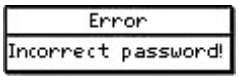


Figure 15: Entering the password

Passwords are case sensitive.

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

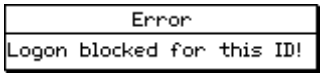
6. Select **OK** on the virtual keyboard and press ↵ to stop editing the password.
7. Select **OK** in the **Log on** dialog and press ↵ to confirm the logon, or press ESC to cancel the procedure.
   If the logon fails, a message is displayed on the display.



IEC12000158-2-en.vsd

Figure 16: Error message indicating an incorrect password

If a false password is entered too many times, the logon is blocked for that ID and the following message is displayed:

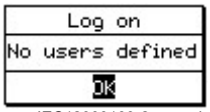


IEC13000283-1-en.vsd

Figure 17: Error message indicating blocked ID

The logon dialog appears 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.



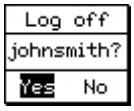
IEC12000160-2-en.vsd

Figure 18: No user defined

5.1.2 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 .



IEC12000159-3-en.vsd

Figure 19: Logging off

- To cancel logoff, press .

5.1.3 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 10 minutes. The minimum is 1 minute.

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

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

5.1.4 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, such as from a substation control system or a remote 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.

5.1.5 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 ↓.

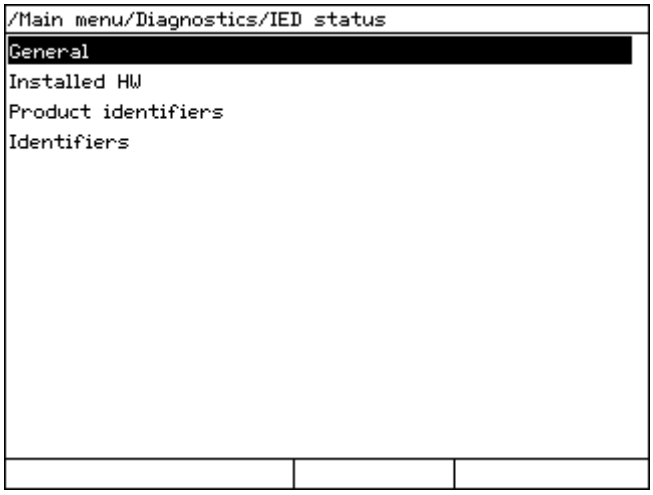


Figure 20: Selecting a submenu

3. Enter the submenu with →.
4. Browse the information with ↑ and ↓.

5.1.6 Adjusting the display contrast

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

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

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

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

5.1.7 Changing the local HMI language

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

5.1.8 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 ESC.

5.1.8.1 Menu structure

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

- Control
- Events
- Measurements
- Disturbance records
- Settings
- Configuration
- Diagnostics
- Test
- Clear
- Authorization (only if authority is activated)
- Language

5.1.8.2 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/Analog modules/TRM_6I_6U:p40
NAMECH1              CH1(I)
ChannelType1         CurrentProtection
RatedTrans1          1.0                A
CTStarPoint1         ToObject
CTsec1               1                  A
CTprim1              3000               A
NAMECH2              CH2(I)
ChannelType2         CurrentProtection
RatedTrans2          1.0                A
CTStarPoint2         ToObject
CTsec2               1                  A
CTprim2              3000               A
NAMECH3              CH3(I)
ChannelType3         CurrentProtection
```

IEC13000292-1-en.vsd

Figure 22: 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.

5.1.8.3 Changing the default view

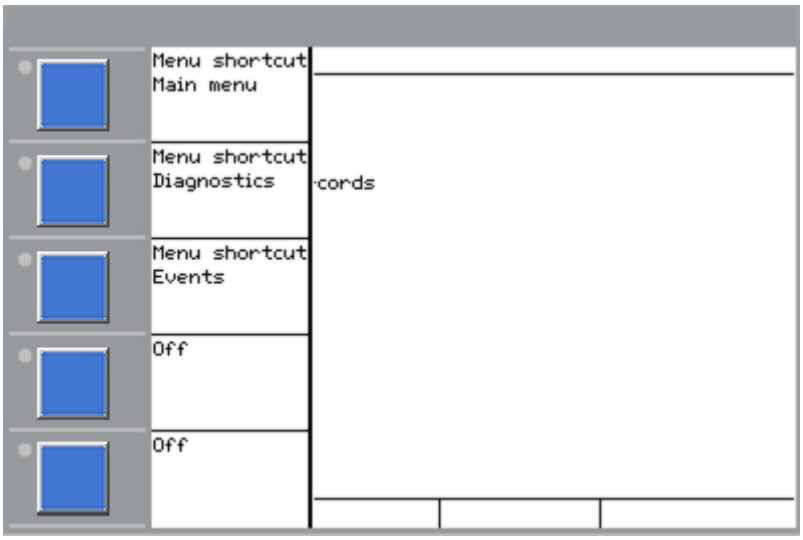
The default view of the display is **Main menu** unless set otherwise.

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

5.1.9 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.



IEC13000281-1-en.vsd

Figure 23: Function button panel

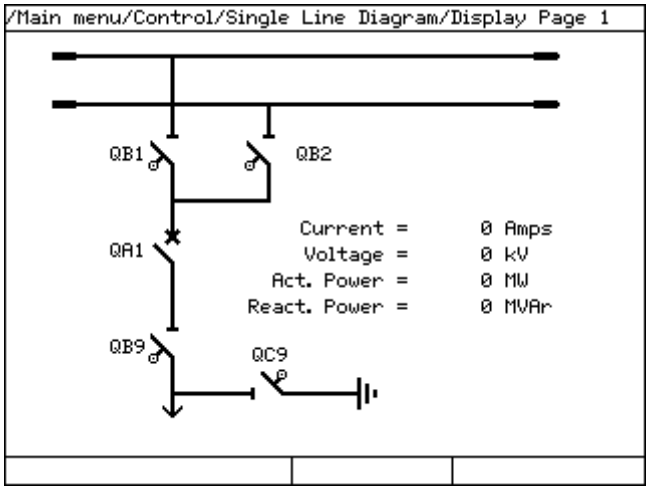
2. Press the wanted function button.
   - Press the wanted function button to jump to a certain menu item.
     The menu opens immediately upon pressing the button.
   - Press the wanted function button for at least 0.5 s to initiate a control signal. The action is taken once.
     To repeat the action,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

5.1.10 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.



IEC13000244-1-en.vsd

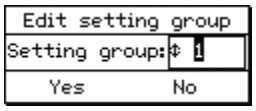
Figure 24: Example of a single-line diagram

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 I 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/SCREEN:1/DefaultScreen**.

5.1.11 Browsing setting values

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

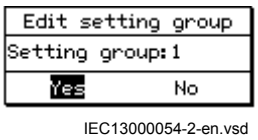


IEC13000241-1-en.vsd

Figure 25: Selecting the setting group number

3. Press ↑ or ↓ to select the setting group number.

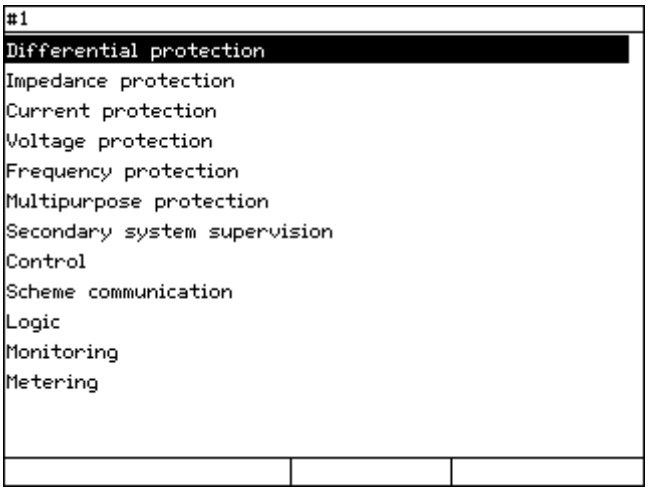
4. Press ↵ to confirm the setting group selection and ↓ to return to the Edit setting group dialog.
5. Press ↵ to select `Yes` and to view the setting group values.
   - Press ← or → to select `No` and ↵ to exit.



IEC13000054-2-en.vsd

Figure 26: 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 ←.



IEC13000265-1-en.vsd

Figure 27: Selecting settings

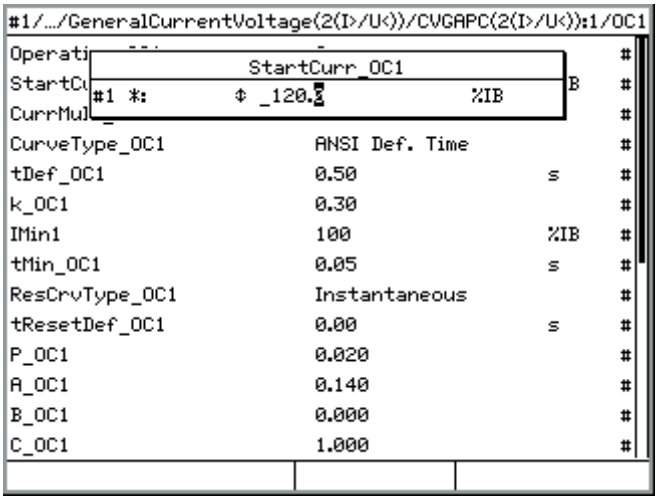
The content of the list depends on the pre-configuration or on the functions configured with PCM600.

5.1.12 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.

5.1.12.1 Editing numerical values

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



IEC13000285-1-en.vsd

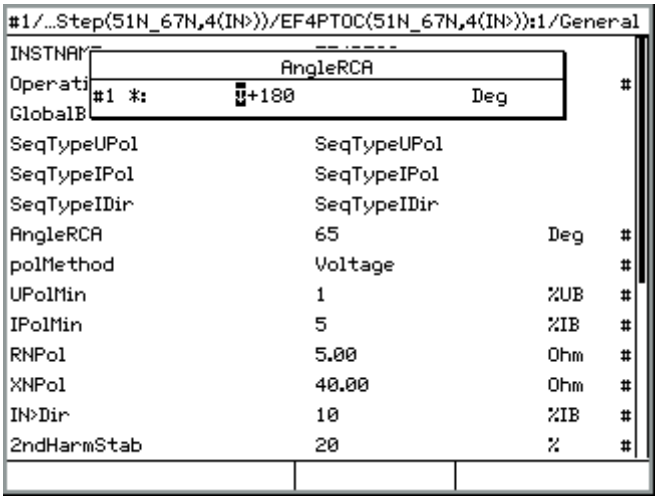
Figure 28: Last digit is active and it can be increased or decreased

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

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

3. Press ← or → to move the cursor to another digit.
4. To select the minimum or maximum value, select the arrow symbol in front of the value.
   - To set the value to the maximum, press ↑.
   - To set the value to the minimum, press ↓.

   If the value is already at either end value (minimum or maximum), it requires two presses to change it to the opposite end value.
   After pressing ↑, the previous value can be restored by pressing ↓ once, and vice versa. Another press of ↓ or ↑ sets the value to the lower or higher limit. The symbol in front of the value is ↕, when the previous value is shown.



IEC13000284-1-en.vsd

Figure 29: Restoring the previous value

5.1.12.2 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 ESC and ↵.
   - To delete characters, press simultaneously ESC and Clear.

PCM600 supports Unicode characters.

5.1.12.3 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.

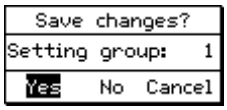
5.1.12.4 Changing time settings in LHMI

If there is a need to change the time setting in the LHMI (**Main menu/ Configuration/Time/System time/SYSTEMTIME:1**) the change will take affect immediately. To confirm the new setting press . To remove the change, press ESC.

5.1.13 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 .



IEC13000245-1-en.vsd

Figure 30: Confirming settings

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

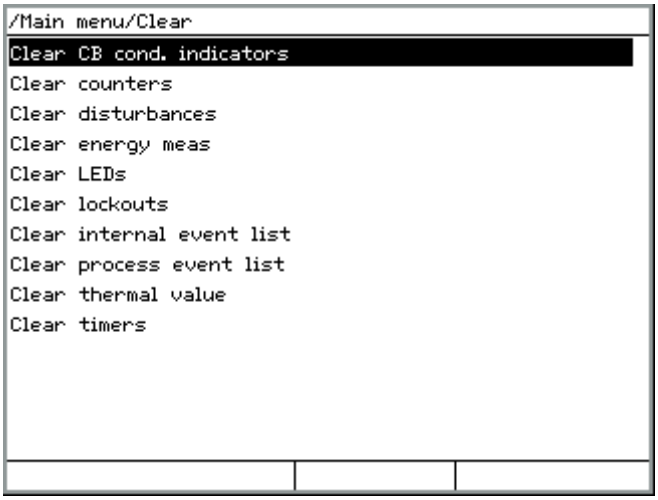
Pressing `Cancel` in the Save changes dialog closes only the Save changes dialog box, but the IED remains in editing mode. All the changes applied to any setting are not lost and the user can continue to change settings. To leave the change setting mode, select `No` or `Yes` in the Save changes dialog.

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

5.1.14 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.



IEC13000236-1-en.vsd

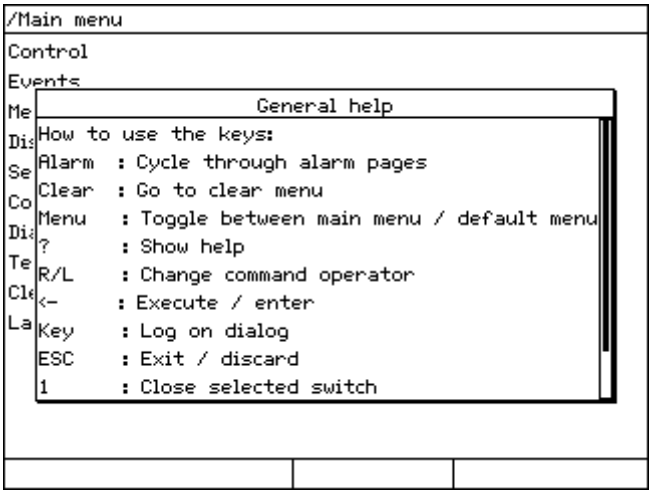
Figure 31: Clear view

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.

5.1.15 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.



IEC13000065-2-en.vsd

Figure 32: Help menu

Section 6 IED operation

6.1 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.

6.2 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 21: 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.

6.2.1 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.

6.2.2 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.

6.2.3 Disturbance reports

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

For more information, see PCM600 documentation.

6.2.4 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.

6.3 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.

6.3.1 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.

6.3.2 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 7 Operating procedures

7.1 Monitoring

7.1.1 Indications

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

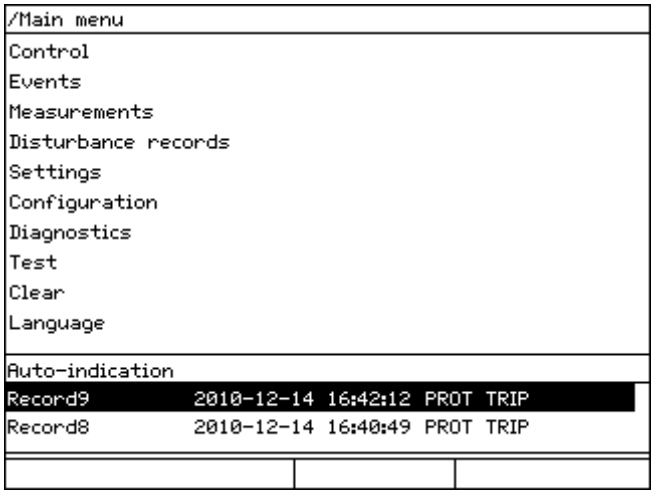
- Three indicator LEDs with fixed functionality: Ready, Start and Trip
- 15 programmable three-color alarm LEDs which can present 45 virtual LED states
  - For each on state LED color and for the LED off state, texts can be programmed with PCM600 and via LHMI. These texts are displayed on the LHMI.
-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

7.1.1.1 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/SCREEN:1/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 ESC to close the auto-indication message without clearing it or press Clear to activate the Clear view and to clear messages.



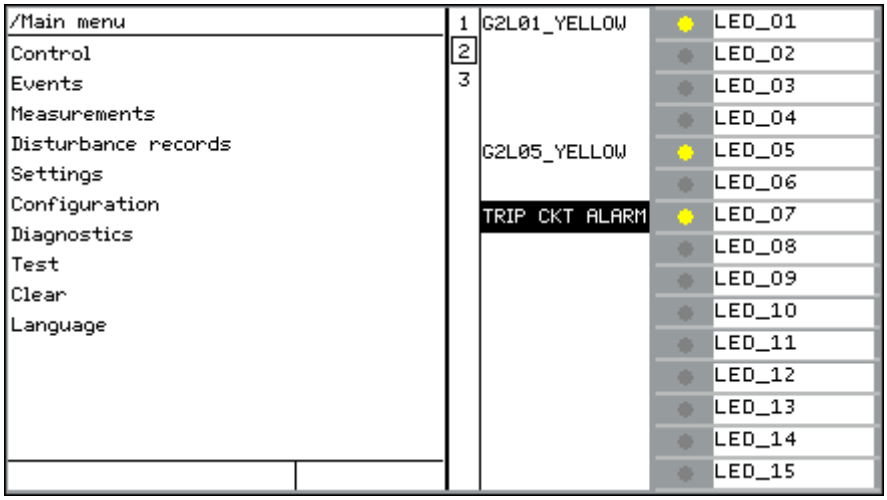
IEC13000237-1-en.vsd

Figure 33: Auto-indication message

7.1.1.2 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.
   Press or ESC to close the dialog box.
4. Press ESC to close the alarm view.
5. Press Clear to activate the Clear view and to clear alarms.



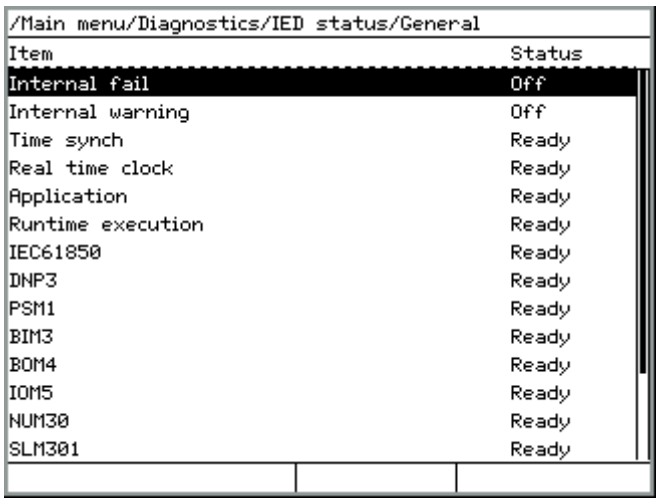
IEC13000248-1-en.vsd

Figure 34: Alarm data

7.1.1.3 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.



IEC13000247-1-en.vsd

Figure 35: Fault indication

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

7.1.2 Measured and calculated values

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

7.1.2.1 Measured values

Measured values can be accessed through the LHMI.

7.1.2.2 Using the local HMI for monitoring

If the LHMI displays ––– instead of a measured float value, it means that the value is invalid and out of range

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 ↓.

7.1.3 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.

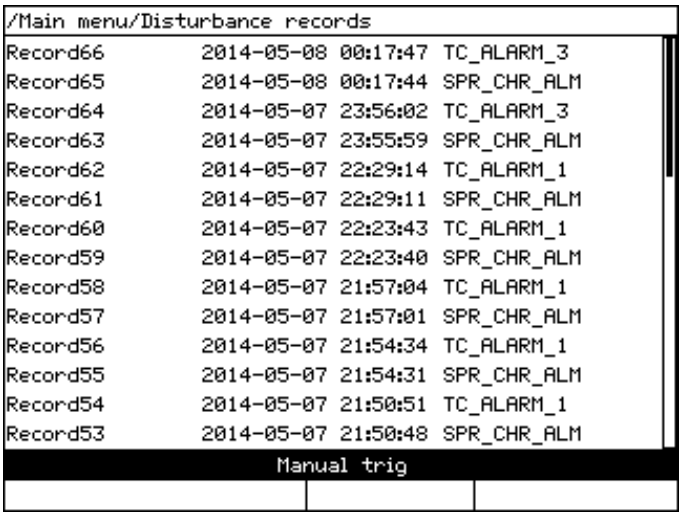
- Disturbance records
- Events

7.1.3.1 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. To make the setting, select **Main menu/Settings/IED Settings** and then **Monitoring/ Disturbance report/DisturbanceReport/DRPRDRE:1**.

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



IEC13000261-1-en.vsd

Figure 36: Manual triggering

The disturbance recorder is now triggered.

7.1.3.2 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        2014-05-08 00:17:47 TC_ALARM_3
Record65        2014-05-08 00:17:44 SPR_CHR_ALM
Record64        2014-05-07 23:56:02 TC_ALARM_3
Record63        2014-05-07 23:55:59 SPR_CHR_ALM
Record62        2014-05-07 22:29:14 TC_ALARM_1
Record61        2014-05-07 22:29:11 SPR_CHR_ALM
Record60        2014-05-07 22:23:43 TC_ALARM_1
Record59        2014-05-07 22:23:40 SPR_CHR_ALM
Record58        2014-05-07 21:57:04 TC_ALARM_1
Record57        2014-05-07 21:57:01 SPR_CHR_ALM
Record56        2014-05-07 21:54:34 TC_ALARM_1
Record55        2014-05-07 21:54:31 SPR_CHR_ALM
Record54        2014-05-07 21:50:51 TC_ALARM_1
Record53        2014-05-07 21:50:48 SPR_CHR_ALM
                    Manual trig
```

IEC13000262-1-en.vsd

Figure 37: 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      2014-05-08 00:17:47.583
General information
Event recording
Trip values
```

IEC13000263-1-en.vsd

Figure 38: Disturbance record data categories

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

7.1.3.3 Controlling and reading disturbance recorder data

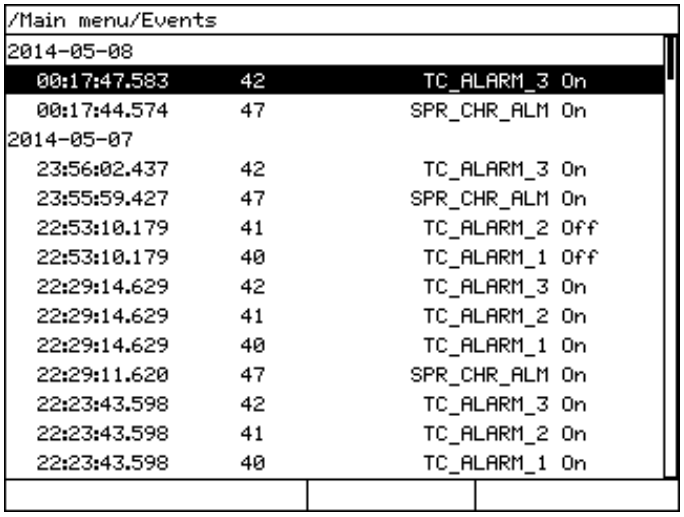
Disturbance recorder data can be controlled and read with PCM600.

For more information, see PCM600 documentation.

7.1.3.4 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/SCREEN:1/ EvListSrtOrder**.

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



IEC13000264-1-en.vsd

Figure 39: Monitoring events

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

7.1.4 Remote monitoring

The IED supports comprehensive remote monitoring.

7.1.4.1 Monitoring the IED remotely

Use the PCM600 tool to operate the IED remotely.

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

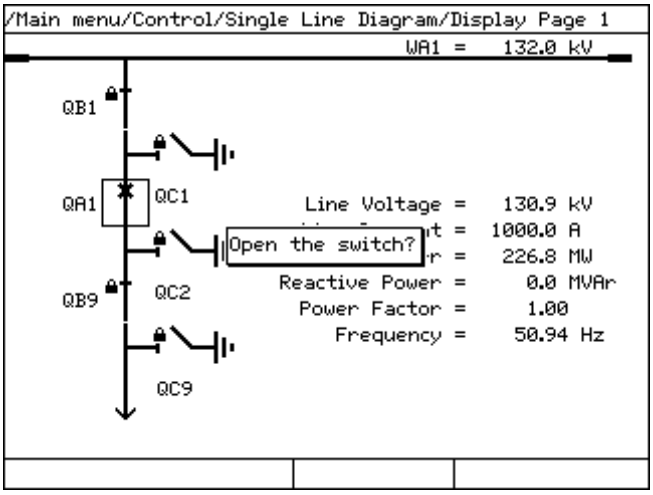
For more information, see PCM600 documentation.

7.2 Controlling

7.2.1 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 configured to the SLD.
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 I to select close the object.
4. Press ↵ to confirm the operation.



IEC10000340-3-en.vsd

Figure 40: Opening a circuit breaker

- Press ESC to cancel the operation.

5. Press ← or → to move between single-line diagram pages.

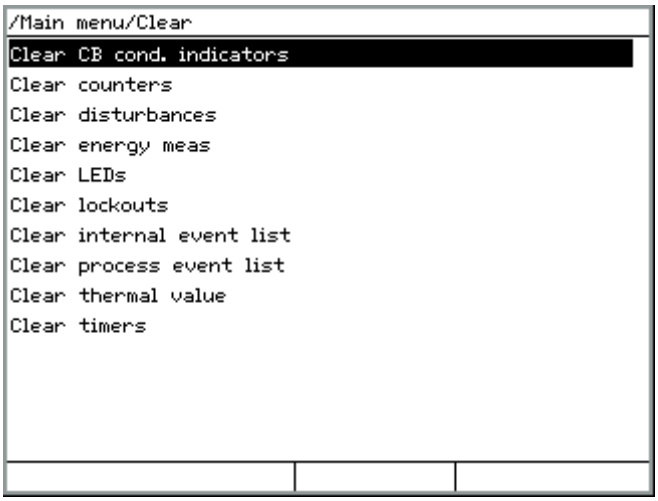
The time between selecting the object and giving a control command is restricted by an adjustable timeout [(set by the parameter *tSelect* for each object)]. When an object is selected, the control command has to be given within this time.

7.3 Resetting the IED

7.3.1 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.



IEC13000236-1-en.vsd

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.

7.4 Changing the IED functionality

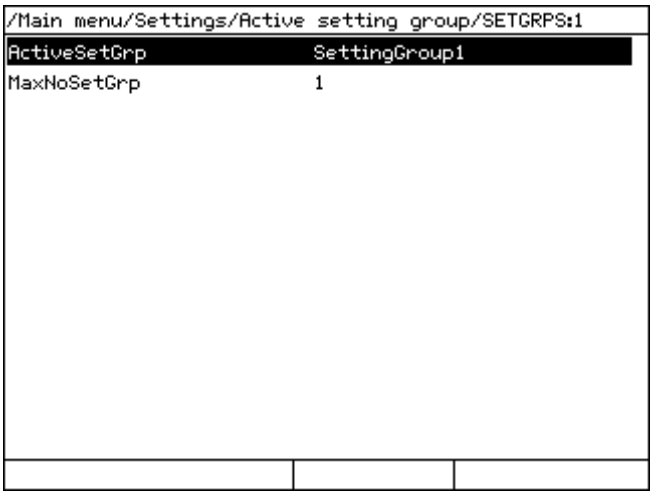
7.4.1 Defining the setting group

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.

7.4.1.1 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 manually from the menu or by the PCM600 tool.

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



IEC13000235-1-en.vsd

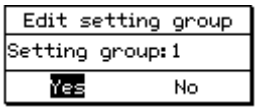
Figure 42: Active setting group

2. Select the setting group with or .
3. Press to confirm the selection or ESC to cancel.
4. Commit the settings.

Remember to document the changes you make.

7.4.1.2 Browsing and editing setting group values

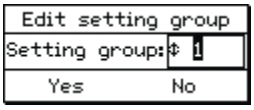
1. Select **Main menu/Settings/IED Settings** and press ➡.
   Setting group 1 is the default setting group to be edited.



IEC13000054-2-en.vsd

Figure 43: Selecting a setting group for editing

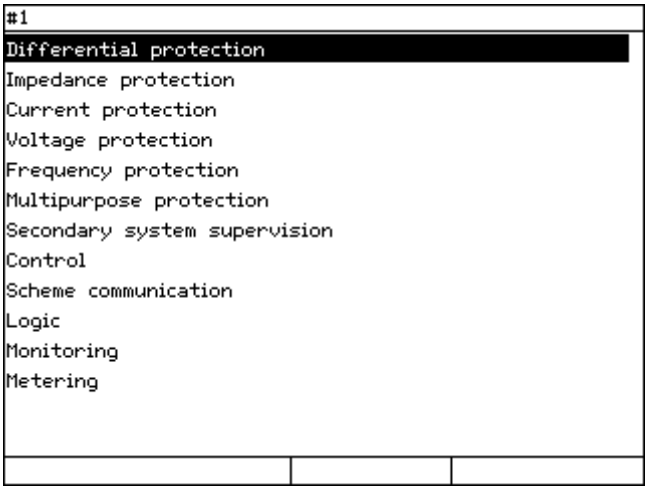
2. Press ↵ on the `Setting group` line in the dialog box to activate selection mode.
3. Select the wanted setting group with ↑ or ↓ and press ↵.



IEC13000241-1-en.vsd

Figure 44: 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.



IEC13000265-1-en.vsd

Figure 45: 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 →.

```
#1/Current/EF4PTOC(51N_67N,4IN>)/EF4PTOC:1/General
INSTNAME            EF4PTOC
Operation           On                    #
GlobalBaseSel       1
SeqTypeUPol         22
SeqTypeIPol         23
SeqTypeIDir         122
EnaDir              Enable                #
AngleRCA            65            Deg     #
polMethod           Voltage               #
UPolMin             1             %UB     #
IPolMin             5             %IB     #
RPol                5.00          ohm     #
XPol                40.00         ohm     #
I>Dir               10            %IB     #
```

IEC13000055-2-en.vsd

Figure 46: 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 *.

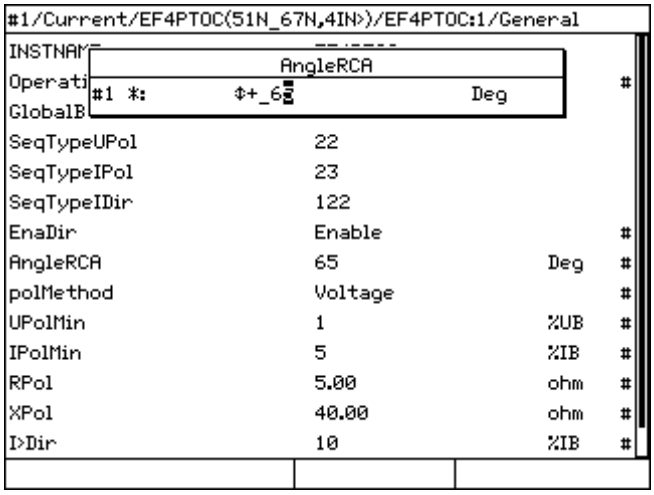


Figure 47: Changing the setting value

10. Press ↑ or ↓ to change the value.
11. Confirm the change with ↵.

7.4.2 Activating LEDs

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

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

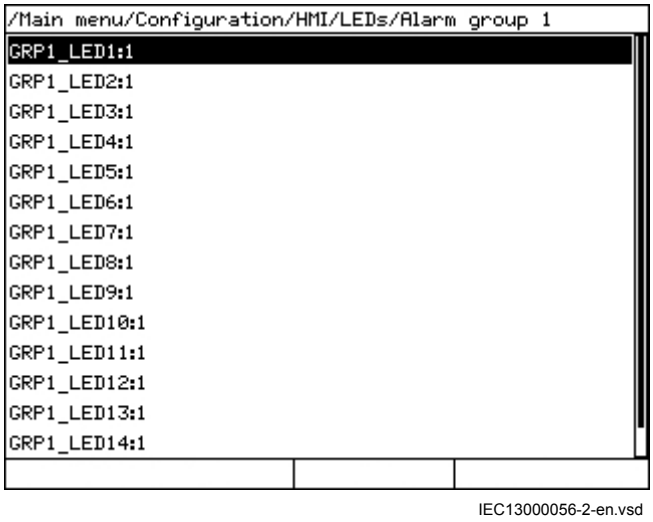


Figure 48: Alarm groups

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 8 REX060 injection unit LHMI

8.1 REX060 injection unit HMI (REG670 only)

8.1.1 Injection unit REX060

The injection unit REX060 is used to inject voltage and current signals to the generator or motor stator and rotor circuits. REX060 generates two square wave signals with different frequencies for injection into the stator and rotor circuits respectively. The response from the injected voltage and currents are then measured by the REX060 unit and amplified to a level suitable for the analog voltage inputs of IED.

For local operation, the REX060 unit is provided with a control panel on the front.

Local operation shall only be performed according to the operation regulations set up by the relevant operation authority of the plant.

8.1.2 REX060 start up sequence

When the injection unit REX060 is energized, the ABB logotype is shown followed by current REX060 revision status. When the start up sequence is completed, the main menu (normal display content) is shown. The duration of the start up sequence is a few seconds.

8.1.3 REX060 Front panel controls

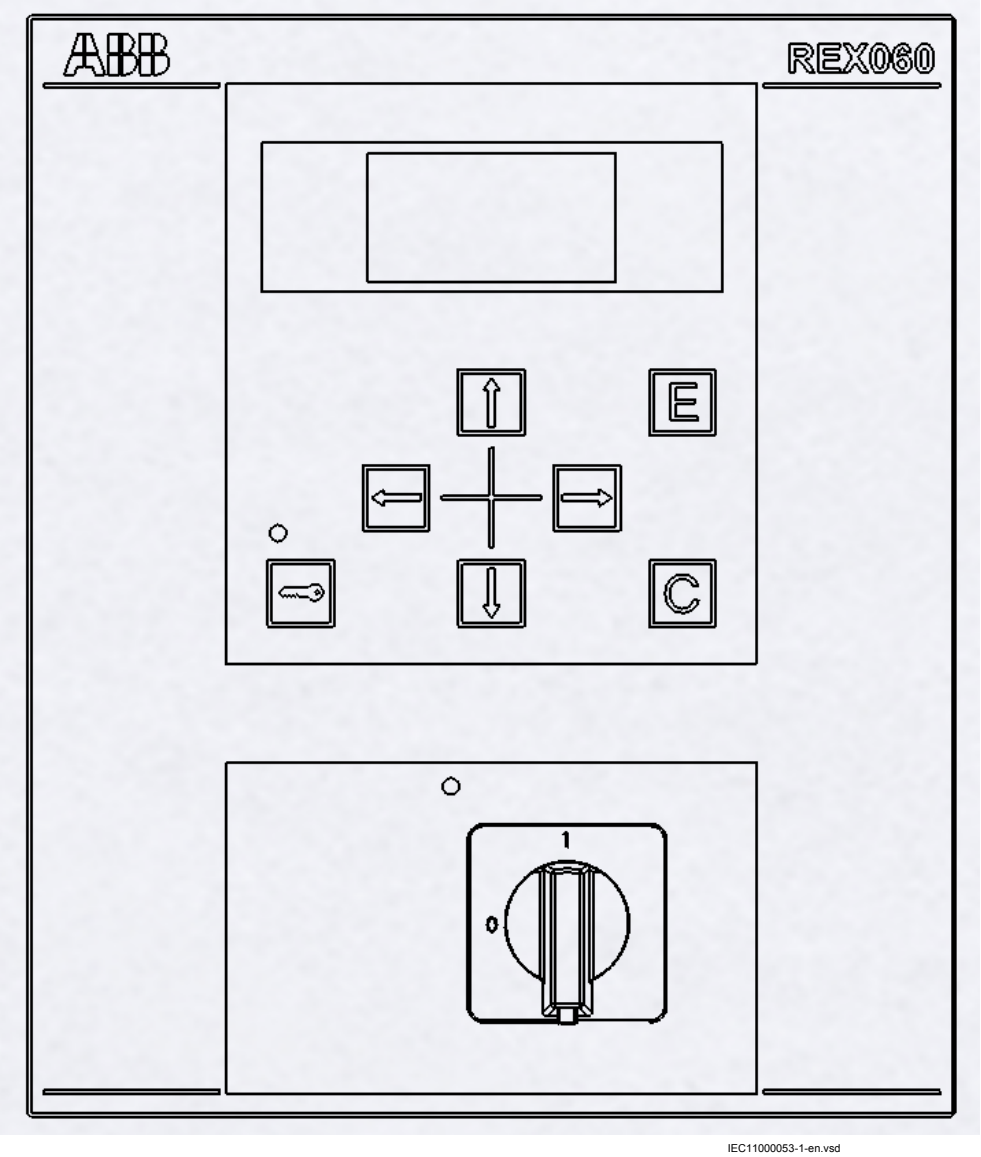
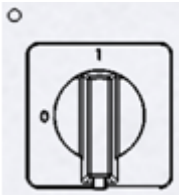
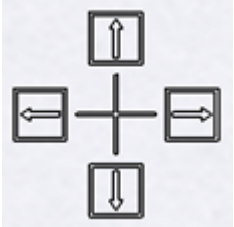


Figure 49: REX060 front panel

Table 22: HMI keys on the front of the injection unit REX060

Key	Function
	The Injection switch enables injection at rotor and stator 2 s after switching on. A LED indicates that the injection switch is set to enable injection. The injection switch can be padlocked in off position in order to cut-off both injection signals.
	The Key-lock button enables/disables the keypad. Hold the Key-lock button for a period of 1.2 s to 4 s to lock or unlock the keys. A key-lock LED indicates when the keypad is unlocked.
	• Moves the cursor in the direction of the arrows • When the cursor is in the value change state, pressing the up button increases the value and pressing the down button decreases the value.
	Pressing the clear button cancels changes that have not been stored.
	Pressing the enter button stores the changed value. If the value is outside range, the limit value is stored.

8.1.4 Display

On the front of the enclosure there is a backlit LCD.

- 6 x 12 pixel characters
- Graphical LCD 128 x 64 pixels

In figure 50 the content of the display is shown for a REX060 with one SIM and one RIM module. Row 1 contains mains frequency information. Row 2-3 contains stator information and row 4-5 rotor information. Column 1 (empty) gives status, column 2 and 3 are informative and column 4 contains variables, settable by the keypad.

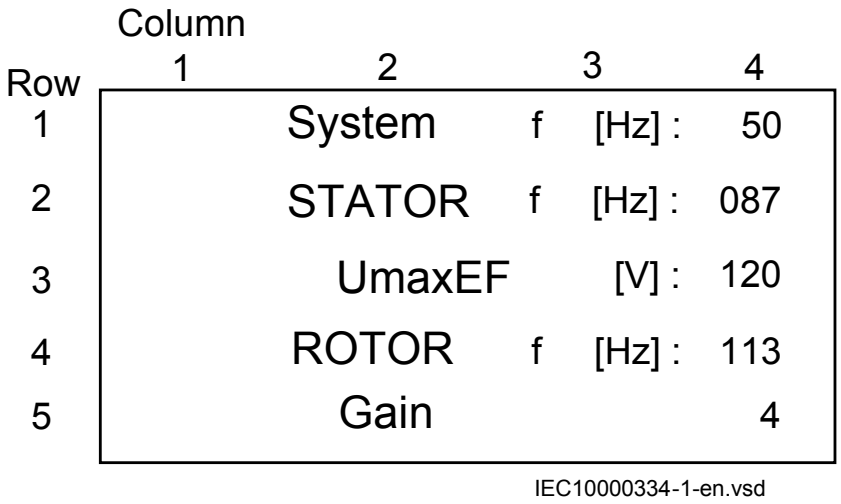


Figure 50: Display content in normal operation

Column 1 (status column) symbols

Table 23: Status symbols and their description

Status symbol	Description of the status	Priority
	Over voltage occurred, injection is blocked. This can occur on both X61/62 and X81/82 (Stator & Rotor) simultaneously or on either of them. The symbol is displayed in the status column (column 1) in row 2 for X61/62 and in row 4 for X81/82. The injection is blocked until a manual reset of the blocking occurs.	1
	Injection blocked by the injection switch. The symbol is displayed in the status column (column 1) and is always shown in both row 2 and 4.	2 Over voltage blocked status overrides displaying of this status
ø	Injection blocked by binary input. Blocked injection will be shown in the status column (column 1) depending on binary in status. This can occur on both X61/62 then shown in row 2 and X81/82 then shown in row 4 (Stator & Rotor) simultaneously or on ether of them.	3 Injection switch and over voltage blocked overrides displaying of this status
	Analog output saturation. This status is set when the analog signal, current and or voltage, to REG670 IED is too high and may thereby be incorrect due to saturation in amplifier stage. Saturation status will be shown in the status column (column 1) in row 3 or 5 depending on the saturation occurrence	Not applicable

Backlight is on for 30 seconds after pressing any button. Backlight activation by pressing any button does not cause any other action than turning on the backlight.

8.1.5 How to set frequency and voltage and current gain factors

Frequency, current and voltage gain for the stator and/or rotor can be set and stored from the injection unit HMI. If a value is out of range, the limit value is stored. The display shows the latest stored settings.

The settings are stored in non-volatile memory, which means that they remain stored in case IED is powered off.

8.1.5.1 Setting system frequency

Frequency can be set to either 50 or 60 Hz.

1. Use the Up and Down button to select frequency.
2. Store the new frequency by pressing the Enter button, or clear the last stored frequency by pressing the Clear button.

8.1.5.2 Setting stator and rotor injection frequency

Frequency can be set as integer in range 50 to 250 Hz for a stator and 75 to 250 Hz for a rotor.

1. Use the keypad to navigate to stator or rotor frequency (row 2 or 4)
2. Press E to enter value change state
3. Use the Up and Down button to select frequency
4. Store the new frequency by pressing the E (Enter) button, or clear the chosen frequency by pressing the C (Clear) button

8.1.5.3 Selecting rotor gain

Default (gain factor 3) is the recommended level, where a defined effect of worst case single fault at exciter circuit is allowed. A higher gain factor (4) may cause saturation in case of single fault in exciter circuit. A lower gain factor may be needed if the degree of disturbance is high. Change from default value only if requested by ICT tool during calibration procedure.

Select rotor gain factor according to the table below.

Table 24: Rotor gain

Gain factor	Note
1	Extreme
2	Enhanced
3	Default
4	Reduced

8.1.5.4 Selecting stator gain

Stator gain factor for both voltage and current depends on the highest voltage that may occur at the injection point of VT or DT. That voltage depends on the VT/DT ratio and the stator rated primary voltage.

Select gain factor in accordance with highest voltage that may occur at the injection point. See *Technical manual* for exact formulas depending on particular injection arrangement.

Table 25: Stator gain

UmaxEF [V]	Note
240	
200	
160	Default value
up to 120	

8.1.5.5 Resetting overvoltage

Stator and rotor injection output is protected against voltages exceeding maximum operating range (10% of rated VT/DT) by a relay blocking the injection circuit. This blocking is controlled by measuring the stator and/or rotor voltage, and remains blocked until manually reset. The blocking remains in the non-volatile memory when the IED is powered off.

Overvoltage blocking is indicated by a symbol shown in Table 23.

Resetting procedure:

1. Power off the REX060.
2. Press and hold the C and Key-lock buttons.
3. Power on the REX060 and wait until the status indication *Over-voltage* (symbol) disappears from the display.
4. Release the C and Key-lock buttons.

REX060 stator and rotor overvoltage protection of injection circuit

Both rotor and stator have two levels of protection, injection circuit interruption controlled by the voltage sense input and a fuse for over-current protection. The voltage controlled interruption, overvoltage, will normally occur prior to interruption by fuse and the reset sequence is described above. A blown fuse requires module disassembling to replace the fuse (F 4 A 250 V for stator and F 160 mA 250 V for rotor). However, if this occurs it is recommended to identify the reason for the over-current and take necessary actions to reduce the current before restarting the unit. The problem must be outside the injection unit since this unit cannot provide enough energy to blow the fuse.

REX062 input protection

REX062 limits overvoltage by a varistor at the injection output to stator. Normally , REX060 will interrupt the injection circuit in case of excessive over-current in the injection chain. Fuse within REX062 is an additional protection in case of failure within REX062 during over-voltage condition.

A blown REX062 fuse requires a module disassembling to replace the fuse (F 6.3 A 250 V). However, if this occurs it is recommended to identify the reason for the over-current and do needed actions to reduce the current.

Section 9 Troubleshooting

9.1 Fault tracing

9.1.1 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.

9.1.2 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.

9.1.3 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.

9.1.3.1 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/Diagnostics/Communication/Front port/DOSFRNT:1**.
   Check that the *LINKUP* value is 1, that is, the communication is working. When the value is 0, there is no communication link.
2. Check the communication status of the X311 rear ports via the LHMI in **Main menu/Diagnostics/Communication/OEM port LAN AB/ DOSLANAB:2** and **Main menu/Diagnostics/Communication/OEM port LAN CD/DOSLANCD:3**.
   The X311 communication ports on the rear side of the IED are for optical Ethernet via ST connectors.
   - Check that the *LINKUP* value is 1, that is, the communication is working. When the value is 0, there is no communication link.

9.1.3.2 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*.

9.1.4 Running the display test

You can run the display test in either of the following ways:

- Select **Main menu/Test/LED test**.
- Press simultaneously ESC 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.

9.2 Indication messages

9.2.1 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 26: Internal fault indications

Fault indication	Additional information
Internal Fail Real Time Clock Error	Hardware error with the real time clock.
Internal Fail Runtime Exec. Error	One or more of the application threads are not working properly.
Internal Fail SW Watchdog Error	This signal will be activated when the terminal has been under too heavy load for at least 5 minutes.
Internal Fail Runtime App Error	One or more of the application threads are not in an expected state.
Internal Fail IEC 61850 Error	IEC 61850 has not succeeded in some actions such as reading the configuration file or start-up.
Internal Fail DNP3 Error	An error in DNP3 communication has occurred.
Internal Fail PSM1-Error	A PSM card error has occurred. The instance number is shown as part of the fault indication, such as 1 in this example.
Internal Fail BIM3-Error	A binary-in-module error has occurred. The instance number is shown as part of the fault indication, such as 3 in this example.
Internal Fail BOM4-Error	A binary-out-module error has occurred. The instance number is shown as part of the fault indication, such as 4 in this example.
Internal Fail IOM5-Error	A in/out-module error has occurred. The instance number is shown as part of the fault indication, such as 5 in this example.
Internal Fail NUM30-Error	A NUM card error has occurred. The instance number is shown as part of the fault indication, such as 30 in this example.
Internal Fail SLM301-Error	A SLM card error has occurred. The instance number is shown as part of the fault indication, such as 301 in this example.

9.2.2 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 27: 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.

9.2.3 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 28: Additional indications

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

9.3 Correction procedures

9.3.1 Changing and setting the password

The password can only be set with PCM600.

For more information, see PCM600 documentation.

9.3.2 Identifying IED application problems

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

- Check that the function is on.
- Check that the correct setting group (1 to 6) is activated.
- Check if the function is blocked.
- Check if the IED is in the test mode.
- Check the measurement values.
- Check the connections to trip and disturbance recorder functions.
- Check the TRM channel settings.
- Check the cycle time of the SMAI block.
- Check the DFT reference of the SMAI block.

9.3.2.1 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 values**.
- 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/3 phase analog group/SMAIn:1** (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/Test/Binary input values**. Then navigate to the board with the actual binary input to be checked.
  - Check the actual state of the connected binary inputs through PCM600, see PCM600 documentation.
- Measure output contacts using the voltage drop method of applying at least the minimum contact load given for the output relays in the technical data, for example 100 mA at 24 V AC/DC.

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

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

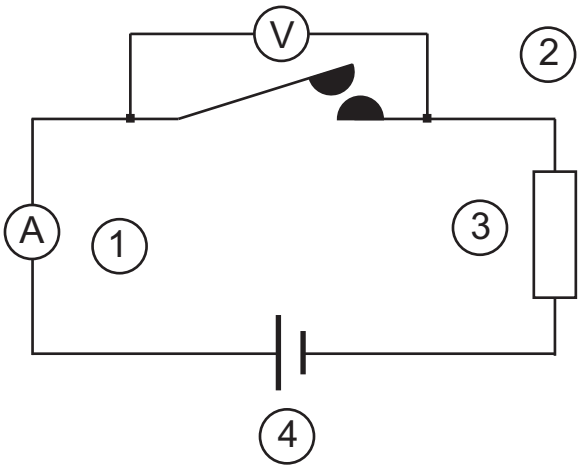


Figure 51: Testing output contacts using the voltage drop method

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

- To check the status of the output circuits driving the output relay via the LHMI, select **Main menu/Test/Binary output values** and then navigate to the board with the actual binary output to be checked.
- Test and change the relay state manually.
  1. To set the IED to test mode, select **Main menu/Test/IED test mode/ TESTMODE:1** and set the parameter *TestMode* to *On*.
  2. To operate or force the output relay to operate, select **Main menu/Test/ Forcing/Binary output values** and then navigate to the board with the actual binary output relay to be operated/forced.
  3. Select the BOn to be operated/forced and use and or to operate the actual output relay.
     Each BOn 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 10 Glossary

AC	Alternating current
ACC	Actual channel
ACT	Application configuration tool within PCM600
A/D converter	Analog-to-digital converter
ADBS	Amplitude deadband supervision
ADM	Analog digital conversion module, with time synchronization
AI	Analog input
ANSI	American National Standards Institute
AR	Autoreclosing
ASCT	Auxiliary summation current transformer
ASD	Adaptive signal detection
ASDU	Application service data unit
AWG	American Wire Gauge standard
BBP	Busbar protection
BFOC/2,5	Bayonet fibre optic connector
BFP	Breaker failure protection
BI	Binary input
BIM	Binary input module
BOM	Binary output module
BOS	Binary outputs status
BR	External bistable relay
BS	British Standards
BSR	Binary signal transfer function, receiver blocks
BST	Binary signal transfer function, transmit blocks
C37.94	IEEE/ANSI protocol used when sending binary signals between IEDs
CAN	Controller Area Network. ISO standard (ISO 11898) for serial communication
CB	Circuit breaker
CBM	Combined backplane module

CCITT	Consultative Committee for International Telegraph and Telephony. A United Nations-sponsored standards body within the International Telecommunications Union.
CCM	CAN carrier module
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
COM	Command
COMTRADE	Standard Common Format for Transient Data Exchange format for Disturbance recorder according to IEEE/ANSI C37.111, 1999 / IEC60255-24
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
COT	Cause of transmission
CPU	Central processing unit
CR	Carrier receive
CRC	Cyclic redundancy check
CROB	Control relay output block
CS	Carrier send
CT	Current transformer
CU	Communication unit
CVT or CCVT	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 Std 1815-2012
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	Electromotive force
EMI	Electromagnetic interference
EnFP	End fault protection
EPA	Enhanced performance architecture
ESD	Electrostatic discharge
F-SMA	Type of optical fibre connector
FAN	Fault number
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
FUN	Function type
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

GSAL	Generic security application
GTM	GPS Time Module
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
ICT	Installation and Commissioning Tool for injection based protection in REG670
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 60870-5-103	Communication standard for protection equipment. A serial master/slave protocol for point-to-point communication
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
IOM	Binary input/output module
Instance	When several occurrences of the same function are available in the IED, they are referred to as instances of that function. One instance of a function is identical to another of the same kind but has a different number in the

	IED user interfaces. The word "instance" is sometimes defined as an item of information that is representative of a type. In the same way an instance of a function in the IED is representative of a type of function.
IP	1. Internet protocol. The network layer for the TCP/IP protocol suite widely used on Ethernet networks. IP is a connectionless, best-effort packet-switching protocol. It provides packet routing, fragmentation and reassembly through the data link layer. 2. Ingression protection, according to IEC 60529
IP 20	Ingression protection, according to IEC 60529, level 20
IP 40	Ingression protection, according to IEC 60529, level 40
IP 54	Ingression protection, according to IEC 60529, level 54
IRF	Internal failure signal
IRIG-B:	InterRange Instrumentation Group Time code format B, standard 200
ITU	International Telecommunications Union
LAN	Local area network
LIB 520	High-voltage software module
LCD	Liquid crystal display
LDCM	Line differential communication module
LDD	Local detection device
LED	Light-emitting diode
LNT	LON network tool
LON	Local operating network
MCB	Miniature circuit breaker
MCM	Mezzanine carrier module
MIM	Milli-ampere module
MPM	Main processing module
MVAL	Value of measurement
MVB	Multifunction vehicle bus. Standardized serial bus originally developed for use in trains.
NCC	National Control Centre
NOF	Number of grid faults
NUM	Numerical module
OCO cycle	Open-close-open cycle
OCP	Overcurrent protection

OEM	Optical Ethernet module
OLTC	On-load tap changer
OTEV	Disturbance data recording initiated by other event than start/ pick-up
OV	Overvoltage
Overreach	A term used to describe how the relay behaves during a fault condition. For example, a distance relay is overreaching when the impedance presented to it is smaller than the apparent impedance to the fault applied to the balance point, that is, the set reach. The relay “sees” the fault but perhaps it should not have seen it.
PCI	Peripheral component interconnect, a local data bus
PCM	Pulse code modulation
PCM600	Protection and control IED manager
PC-MIP	Mezzanine card standard
PMC	PCI Mezzanine card
POR	Permissive overreach
POTT	Permissive overreach transfer trip
Process bus	Bus or LAN used at the process level, that is, in near proximity to the measured and/or controlled components
PSM	Power supply module
PST	Parameter setting tool within PCM600
PT ratio	Potential transformer or voltage transformer ratio
PUTT	Permissive underreach transfer trip
RASC	Synchrocheck relay, COMBIFLEX
RCA	Relay characteristic angle
RISC	Reduced instruction set computer
RMS value	Root mean square value
RS422	A balanced serial interface for the transmission of digital data in point-to-point connections
RS485	Serial link according to EIA standard RS485
RTC	Real-time clock
RTU	Remote terminal unit
SA	Substation Automation
SBO	Select-before-operate
SC	Switch or push button to close
SCL	Short circuit location

SCS	Station control system
SCADA	Supervision, control and data acquisition
SCT	System configuration tool according to standard IEC 61850
SDU	Service data unit
SLM	Serial communication module.
SMA connector	Subminiature version A, A threaded connector with constant impedance.
SMT	Signal matrix tool within PCM600
SMS	Station monitoring system
SNTP	Simple network time protocol – is used to synchronize computer clocks on local area networks. This reduces the requirement to have accurate hardware clocks in every embedded system in a network. Each embedded node can instead synchronize with a remote clock, providing the required accuracy.
SOF	Status of fault
SPA	Strömberg Protection Acquisition (SPA), a serial master/ slave protocol for point-to-point communication
SRY	Switch for CB ready condition
ST	Switch or push button to trip
Starpoint	Neutral point of transformer or generator
SVC	Static VAr compensation
TC	Trip coil
TCS	Trip circuit supervision
TCP	Transmission control protocol. The most common transport layer protocol used on Ethernet and the Internet.
TCP/IP	Transmission control protocol over Internet Protocol. The de facto standard Ethernet protocols incorporated into 4.2BSD Unix. TCP/IP was developed by DARPA for Internet working and encompasses both network layer and transport layer protocols. While TCP and IP specify two protocols at specific protocol layers, TCP/IP is often used to refer to the entire US Department of Defense protocol suite based upon these, including Telnet, FTP, UDP and RDP.
TEF	Time delayed earth-fault protection function
TM	Transmit (disturbance data)
TNC connector	Threaded Neill-Concelman, a threaded constant impedance version of a BNC connector

TP	Trip (recorded fault)
TPZ, TPY, TPX, TPS	Current transformer class according to IEC
TRM	Transformer Module. This module transforms currents and voltages taken from the process into levels suitable for further signal processing.
TYP	Type identification
UMT	User management tool
Underreach	A term used to describe how the relay behaves during a fault condition. For example, a distance relay is underreaching when the impedance presented to it is greater than the apparent impedance to the fault applied to the balance point, that is, the set reach. The relay does not “see” the fault but perhaps it should have seen it. See also Overreach.
UTC	Coordinated Universal Time. A coordinated time scale, maintained by the Bureau International des Poids et Mesures (BIPM), which forms the basis of a coordinated dissemination of standard frequencies and time signals. UTC is derived from International Atomic Time (TAI) by the addition of a whole number of "leap seconds" to synchronize it with Universal Time 1 (UT1), thus allowing for the eccentricity of the Earth's orbit, the rotational axis tilt (23.5 degrees), but still showing the Earth's irregular rotation, on which UT1 is based. The Coordinated Universal Time is expressed using a 24-hour clock, and uses the Gregorian calendar. It is used for aeroplane and ship navigation, where it is also sometimes known by the military name, "Zulu time." "Zulu" in the phonetic alphabet stands for "Z", which stands for longitude zero.
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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