RELION® PROTECTION AND CONTROL

620 series ANSI

Operation Manual

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Conformity

This product complies with the directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive 2014/30/EU) and concerning electrical equipment for use within specified voltage limits (Low-voltage directive 2014/35/EU). This conformity is the result of tests conducted by ABB in accordance with the product standards EN 50263 and EN 60255-26 for the EMC directive, and with the product standards EN 60255-1 and EN 60255-27 for the low voltage directive. The product is designed in accordance with the international standards of the IEC 60255 series and ANSI C37.90. This product complies with the UL 508 certification.

Safety information

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

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

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

National and local electrical safety regulations must always be followed.

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

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

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

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

Table of contents

Section 1 Introduction

1.1 This manual

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

1.2 Intended audience

This manual addresses the operator who operates the protection relay frequently.

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

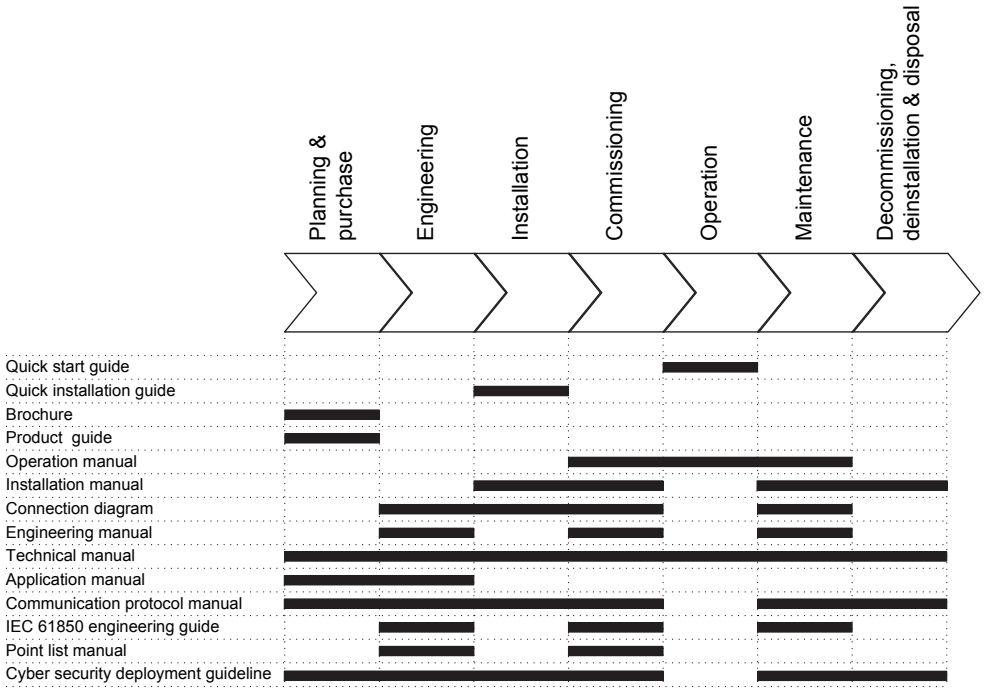

Figure 1: The intended use of documents during the product life cycle

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

1.3.2 Document revision history

Document revision/date	Product series version	History
A/2012-10-31	2.0	First release
B/2015-11-25	2.1	Content updated with release of REM620 Ver.2.1
C/2019-05-17	2.0 and 2.1	Content updated
D/2019-05-29	2.0 and 2.1	Content updated

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

1.3.3 Related documentation

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

1.4 Symbols and conventions

1.4.1 Symbols

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

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

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

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

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

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

1.4.2 Document conventions

A particular convention may not be used in this manual.

- Abbreviations and acronyms are spelled out in the glossary. The glossary also contains definitions of important terms.
- Push button navigation in the LHMI menu structure is presented by using the push button icons.
  To navigate between the options, use and .
- Menu paths are presented in bold.
  Select **Main menu/Settings**.
- WHMI menu names are presented in bold.
  Click **Information** in the WHMI menu structure.
- LHMI messages are shown in Courier font.
  To save the changes in nonvolatile memory, select `Yes` and press .
- Parameter names are shown in italics.
  The function can be enabled and disabled with the *Operation* setting.
- Parameter values are indicated with quotation marks.
  The corresponding parameter values are "Enabled" and "Disabled".
- Input/output messages and monitored data names are shown in Courier font.
  When the function picks up, the `PICKUP` output is set to TRUE.
- Dimensions are provided both in inches and mm. If it is not specifically mentioned, the dimension is in mm.

1.4.3 Functions, codes and symbols

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

Table 1: Functions included in the relays

Function	IEC 61850	IEC 60617	ANSI/C37.2 -2008		
			REF620	REM620	RET620
Protection					
Three-phase non-directional overcurrent protection, low stage, instance 1	PHLPTOC1	3I> (1)	51P	51P	51P (1)
Three-phase non-directional overcurrent protection, low stage, instance 2	PHLPTOC2	3I> (2)			51P (2)
Three-phase non-directional overcurrent protection, low stage, instance 3	PHLPTOC3	3I> (3)			51P (3)
Three-phase non-directional overcurrent protection, high stage, instance 1	PHHPTOC1	3I>> (1)	50P-1	50P-1[1)]	50P-1 (1)
Three-phase non-directional overcurrent protection, high stage, instance 2	PHHPTOC2	3I>> (2)	50P-2	50P-2[2)]	50P-2 (1)
Three-phase non-directional overcurrent protection, high stage, instance 3	PHHPTOC3	3I>> (3)			50P-1 (2)
Table continues on next page					

Function	IEC 61850	IEC 60617	ANSI/C37.2 -2008		
			REF620	REM620	RET620
Three-phase non-directional overcurrent protection, high stage, instance 4	PHHPTOC4	3I>> (4)			50P-2 (2)
Three-phase non-directional overcurrent protection, high stage, instance 5	PHHPTOC5	3I>> (5)			50P-1 (3)
Three-phase non-directional overcurrent protection, high stage, instance 6	PHHPTOC6	3I>> (6)			50P-2 (3)
Three-phase non-directional overcurrent protection, instantaneous stage, instance 1	PHIPTOC1	3I>>> (1)	50P-3		
Three-phase non-directional long time overcurrent protection, lower stage, instance 1	PHLTPTOC1	3I> (3)	51LT		
Three-phase directional overcurrent protection, low stage, instance 1	DPHLPDOC1	3I> -> (1)	67/51P		67/51P(1)
Three-phase directional overcurrent protection, low stage, instance 2	DPHLPDOC2	3I> -> (2)			67/51P(2)
Three-phase directional overcurrent protection, high stage, instance 1	DPHHPDOC1	3I>> -> (1)	67/50P-1		
Three-phase directional overcurrent protection, high stage, instance 2	DPHHPDOC2	3I>> -> (2)	67/50P-2		
Non-directional earth-fault protection, low stage, instance 1	EFLPTOC1	Io> (1)	51G	51G	51G
Non-directional earth-fault protection, low stage, instance 2	EFLPTOC2	Io> (2)	51N-1		51N (1)
Non-directional earth-fault protection, low stage, instance 3	EFLPTOC3	Io> (3)			51N (2)
Non-directional earth-fault protection, low stage, instance 4	EFLPTOC4	Io> (4)	50SEF		51N (3)
Non-directional earth-fault protection, high stage, instance 1	EFHPTOC1	Io>> (1)	50G-1	50G-1[1)]	50G
Non-directional earth-fault protection, high stage, instance 2	EFHPTOC2	Io>> (2)	50G-2	50G-2[2)]	
Non-directional earth-fault protection, high stage, instance 3	EFHPTOC3	Io>> (3)	50N-1		50N-1 (1)
Non-directional earth-fault protection, high stage, instance 4	EFHPTOC4	Io>> (4)	50N-2		50N-1 (2)
Non-directional earth-fault protection, high stage, instance 5	EFHPTOC5	Io>> (5)			50N-1 (3)
Non-directional earth-fault protection, instantaneous stage, instance 1	EFIPTOC1	Io>>>(1)	50G-3		
Non-directional earth-fault protection, instantaneous stage, instance 2	EFIPTOC2	Io>>>(2)	50N-3		
Directional earth-fault protection, low stage, instance 1	DEFLPDEF1	Io> -> (1)	67/51N	67/51N	67/51N(1)
Directional earth-fault protection, low stage, instance 2	DEFLPDEF2	Io> -> (2)			67/51N(2)
Directional earth-fault protection, high stage, instance 1	DEFHPDEF1	Io>> -> (1)	67/50N-1		
Directional earth-fault protection, high stage, instance 2	DEFHPDEF2	Io>> -> (2)	67/50N-2		
Three-phase directional power protection, instance 1	DPSRDIR1	I1-> (1)	32P-1		32P(1)
Three-phase directional power protection, instance 2	DPSRDIR2	I1-> (2)			32P(2)
Ground directional power protection, instance 1	DNZSRDIR1	I2 ->, Io-> (1)	32N-1		32N(1)
Ground directional power protection, instance 2	DNZSRDIR2	I2 ->, Io-> (2)			32N(2)
Phase distance protection, instance 1	PHDSTPDIS1	Z<	21P	21P[3)]	
Negative-sequence overcurrent protection, instance 1	NSPTOC1	I2> (1)	46-1		46 (1)
Negative-sequence overcurrent protection, instance 2	NSPTOC2	I2> (2)	46-2		46 (2)
Negative-sequence overcurrent protection, instance 3	NSPTOC3	I2> (3)			46 (3)
Phase discontinuity protection	PDNSPTOC1	I2/I1>	46PD		
Residual overvoltage protection, instance 1	ROVPTOV1	Uo> (1)	59G	59G	59G
Residual overvoltage protection, instance 2	ROVPTOV2	Uo> (2)	59N-1 (1)	59N	59N(1)
Residual overvoltage protection, instance 3	ROVPTOV3	Uo> (3)	59N-1 (2)		59N(2)
Three-phase undervoltage protection, instance 1	PHPTUV1	3U< (1)	27-1 (1)	27-1[1)]	27-1 (1)
Three-phase undervoltage protection, instance 2	PHPTUV2	3U< (2)	27-2 (1)	27-2[2)]	27-2 (1)
Three-phase undervoltage protection, instance 3	PHPTUV3	3U< (3)	27-1 (2)		27-1 (2)
Three-phase undervoltage protection, instance 4	PHPTUV4	3U< (4)	27-2 (2)		27-2 (2)
Three-phase overvoltage protection, instance 1	PHPTOV1	3U> (1)	59-1 (1)	59-1[1)]	59-1 (1)
Three-phase overvoltage protection, instance 2	PHPTOV2	3U> (2)	59-2 (1)	59-2[2)]	59-2 (1)
Three-phase overvoltage protection, instance 3	PHPTOV3	3U> (3)	59-1 (2)		59-1 (2)

Table continues on next page

Function	IEC 61850	IEC 60617	ANSI/C37.2 -2008		
			REF620	REM620	RET620
Three-phase overvoltage protection, instance 4	PHPTOV4	3U> (4)	59-2 (2)		59-2 (2)
Three-phase remnant undervoltage protection, instance 1 (source 1)	REMPTUV1	3U< (1)		27R[3)]	
Positive-sequence undervoltage protection, instance 1	PSPTUV1	U1< (1)		27PS	
Negative-sequence overvoltage protection, instance 1	NSPTOV1	U2> (1)	47-1 (1)	47-1[1)]	47-1 (1)
Negative-sequence overvoltage protection, instance 2	NSPTOV2	U2> (2)	47-2 (1)	47-2[2)]	47-2 (1)
Negative-sequence overvoltage protection, instance 3	NSPTOV3	U2> (3)	47-1 (2)		47-1 (2)
Negative-sequence overvoltage protection, instance 4	NSPTOV4	U2> (4)	47-2 (2)		47-2 (2)
Frequency protection, instance 1	FRPFRQ1	f>/f<,df/dt (1)	81-1	81-1[1)]	81-1(1)
Frequency protection, instance 2	FRPFRQ2	f>/f<,df/dt (2)	81-2	81-2[2)]	81-2(1)
Frequency protection, instance 3	FRPFRQ3	f>/f<,df/dt (3)			81-1(2)
Frequency protection, instance 4	FRPFRQ4	f>/f<,df/dt (4)			81-2(2)
Voltage per hertz protection, instance 1	OEPVPH1	U/f> (1)	24	24-1[3)]	24-1(1)
Voltage per hertz protection, instance 2	OEPVPH2	U/f> (2)		24-2[3)]	24-2(1)
Voltage per hertz protection, instance 3	OEPVPH3	U/f> (3)			24-1(2)
Voltage per hertz protection, instance 4	OEPVPH4	U/f> (4)			24-2(2)
Three-phase directional overpower protection, instance 1	DOPPDPR1	P> (1)		32O-1[3)]	
Three-phase directional overpower protection, instance 2	DOPPDPR2	P> (2)		32O-2[3)]	
Three-phase directional overpower protection, instance 3	DOPPDPR3	P> (3)		32O-3[3)]	
Three-phase directional underpower protection, instance 1	DUPPDPR1	P< (1)		32U-1[3)]	
Three-phase directional underpower protection, instance 2	DUPPDPR2	P< (2)		32U-2[3)]	
Three-phase thermal protection for feeders, cables and distribution transformers	T1PTTR1	3Ith>F	49F		
Three-phase thermal overload protection for power transformers, two time constants	T2PTTR1	3Ith>T			49T (1)
Negative-sequence overcurrent protection for motors, instance 1	MNSPTOC1	I2>M (1)		46M-1	
Negative-sequence overcurrent protection for motors, instance 2	MNSPTOC2	I2>M (2)		46M-2	
Loss of phase, instance 1	PHPTUC1	3I< (1)	37-1		37 (1)
Loss of phase, instance 2	PHPTUC2	3I< (2)			37 (2)
Loss of phase, instance 3	PHPTUC3	3I< (3)			37 (3)
Loss of load supervision, instance 1	LOFLPTUC1	3I< (1)		37M-1	
Loss of load supervision, instance 2	LOFLPTUC2	3I< (2)		37M-2	
Phase current sets summing function	CMSUM1	CSUM	CSUM		
Three-phase measurement switching	VMSWI1	VSWI	VSWI		
Motor load jam protection, instance 1	JAMPTOC1	Ist> (1)		51LR-1[1)]	
Motor load jam protection, instance 2	JAMPTOC2	Ist> (2)		51LR-2[2)]	
Motor start-up supervision	STTPMSU1	Is2t n<		66/51LRS	
Phase reversal protection	PREVPTOC1	I2>>		46R	
Thermal overload protection for motors	MPTTR1	3Ith>M		49M	
Motor differential protection	MPDIF1	3dI>M		87M	
High-impedance differential protection, instance 1	HIPDIF1	dHi> (1)		87A[3)]	
High-impedance differential protection, instance 2	HIPDIF2	dHi> (2)		87B[3)]	
High-impedance differential protection, instance 3	HIPDIF3	dHi> (3)		87C[3)]	
Stabilized and instantaneous differential protection for 3W transformers	TR3PTDF1	3dI>3W			87T
Numerical stabilized low impedance restricted earth-fault protection	LREFPNDF1	dIoLo>	87LOZREF	87LOZREF[3)]	87LOZREF (2)
Circuit breaker failure protection, instance 1	CCBRBRF1	3I>/Io>BF (1)	50BF-1	50BF	50BF (1)
Circuit breaker failure protection, instance 2	CCBRBRF2	3I>/Io>BF (2)	50BF-2		50BF (2)

Table continues on next page

Function	IEC 61850	IEC 60617	ANSI/C37.2 -2008		
			REF620	REM620	RET620
Circuit breaker failure protection, instance 3	CCBRBRF3	3I>/Io>BF (3)			50BF (3)
Three-phase inrush detector, instance 1	INRPHAR1	3I2f>	INR		
Master trip, instance 1	TRPPTRC1	Master Trip (1)	86/94-1	86/94-1	86/94-1
Master trip, instance 2	TRPPTRC2	Master Trip (2)	86/94-2	86/94-2	86/94-2
Master trip, instance 3	TRPPTRC3	Master Trip (3)	86/94-3	86/94-3[2)]	86/94-3
Master trip, instance 4	TRPPTRC4	Master Trip (4)		86/94-4[2)]	
Master trip, instance 5	TRPPTRC5	Master Trip (5)		86/94-5[2)]	
Master trip, instance 6	TRPPTRC6	Master Trip (6)		86/94-6[2)]	
Master trip, instance 7	TRPPTRC7	Master Trip (7)		86/94-7[2)]	
Master trip, instance 8	TRPPTRC8	Master Trip (8)		86/94-8[2)]	
Arc protection, instance 1	ARCSARC1	ARC (1)	AFD-1	AFD-1	AFD-1(1)
Arc protection, instance 2	ARCSARC2	ARC (2)	AFD-2	AFD-2	AFD-2(2)
Arc protection, instance 3	ARCSARC3	ARC (3)	AFD-3	AFD-3	AFD-3(3)
High-impedance fault detection	PHIZ1	PHIZ1	HIZ		
Cable fault detection	RCFD1	CFD	CFD		
Load shedding and restoration, instance 1	LSHDPFRQ1	UFLS/R (1)	81LSH-1		81LSH-1(1)
Load shedding and restoration, instance 2	LSHDPFRQ2	UFLS/R (2)	81LSH-2		81LSH-2(1)
Load shedding and restoration, instance 3	LSHDPFRQ3	UFLS/R (3)			81LSH-3(1)
Load shedding and restoration, instance 4	LSHDPFRQ4	UFLS/R (4)			81LSH-4(1)
Load shedding and restoration, instance 5	LSHDPFRQ5	UFLS/R (5)			81LSH-1(2)
Load shedding and restoration, instance 6	LSHDPFRQ6	UFLS/R (6)			81LSH-2(2)
Load shedding and restoration, instance 7	LSHDPFRQ7	UFLS/R (7)			81LSH-3(2)
Load shedding and restoration, instance 8	LSHDPFRQ8	UFLS/R (8)			81LSH-4(2)
RTD based thermal protection, instance 1	MAPGAPC1	ThA> ThB>(1)		38-1	38-1
RTD based thermal protection, instance 2	MAPGAPC2	ThA> ThB>(2)		38-2	38-2
RTD based thermal protection, instance 3	MAPGAPC3	ThA> ThB>(3)		38-3	38-3
RTD based thermal protection, instance 4	MAPGAPC4	ThA> ThB>(4)		38-4	
RTD based thermal protection, instance 5	MAPGAPC5	ThA> ThB>(5)		38-5	
RTD based thermal protection, instance 6	MAPGAPC6	ThA> ThB>(6)		38-6	
RTD based thermal protection, instance 7	MAPGAPC7	ThA> ThB>(7)		38-7	
RTD based thermal protection, instance 8	MAPGAPC8	ThA> ThB>(8)		38-8[2)]	
RTD based thermal protection, instance 9	MAPGAPC9	ThA> ThB>(9)		38-9[2)]	
RTD based thermal protection, instance 10	MAPGAPC10	ThA> ThB>(10)		38-10[2)]	
RTD based thermal protection, instance 11	MAPGAPC11	ThA> ThB>(11)		38-11[2)]	
RTD based thermal protection, instance 12	MAPGAPC12	ThA> ThB>(12)		38-12[2)]	
RTD based thermal protection, instance 13	MAPGAPC13	ThA> ThB>(13)		38-13[2)]	
RTD based thermal protection, instance 14	MAPGAPC14	ThA> ThB>(14)		38-14[2)]	
RTD based thermal protection, instance 15	MAPGAPC15	ThA> ThB>(15)		38-15[2)]	
RTD based thermal protection, instance 16	MAPGAPC16	ThA> ThB>(16)		38-16[2)]	
RTD based thermal protection, instance 17	MAPGAPC17	ThA> ThB>(17)		38-17[2)]	

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Function	IEC 61850	IEC 60617	ANSI/C37.2 -2008		
			REF620	REM620	RET620
RTD based thermal protection, instance 18	MAPGAPC18	ThA>ThB>(18)		38-18[2]	
Out of step	OOSRPSB1	φ>		78[3]	
Power factor, instance 1	MPUPF1	PF< (1)		55-1[3]	
Power factor, instance 2	MPUPF2	PF< (2)		55-2[3]	
Three-phase underexcitation protection, instance 1	UEXPDIS1	X< (1)		40[3]	
Control					
Circuit-breaker control, instance 1	CBXCBR1	I <-> O CB (1)	52-1	52	52 (1)
Circuit-breaker control, instance 2	CBXCBR2	I <-> O CB (2)	52-2		52 (2)
Circuit-breaker control, instance 3	CBXCBR3	I <-> O CB (3)			52 (3)
Emergency start-up	ESMGAPC1	ESTART		62EST	
Autoreclosing, instance 1	DARREC1	O -> I (1)	79-1		
Autoreclosing, instance 2	DARREC2	O -> I (2)	79-2		
Synchronism and energizing check, instance 1	SECRSYN1	SYNC (1)	25-1	25[3]	
Synchronism and energizing check, instance 2	SECRSYN2	SYNC (2)	25-2		
Synchronism and energizing check, instance 3	SECRSYN3	SYNC (3)	25-3		
Condition monitoring					
Circuit-breaker condition monitoring, instance 1	SSCBR1	CBCM (1)	52CM-1	52CM	52CM (1)
Circuit-breaker condition monitoring, instance 2	SSCBR2	CBCM (2)	52CM-2		52CM (2)
Circuit-breaker condition monitoring, instance 3	SSCBR3	CBCM (3)			52CM (3)
Trip circuit supervision, instance 1	TCSSCBR1	TCS (1)	TCM-1	TCM-1	TCM-1
Trip circuit supervision, instance 2	TCSSCBR2	TCS (2)	TCM-2	TCM-2	TCM-2
Trip circuit supervision, instance 3	TCSSCBR3	TCS (3)			TCM-3
Current circuit supervision	CCRDIF1	MCS 3I	CCM	CCM	
Advanced current circuit supervision for transformers	CTSRCTF1	MCS 3I, I2			MCS 3I, I2
Fuse failure supervision, instance 1	SEQRFUF1	FUSEF (1)	60-1	60	60 (1)
Fuse failure supervision, instance 2	SEQRFUF2	FUSEF (2)	60-2		60 (2)
Runtime counter for machines and devices, instance 1	MDSOPT1	OPTS (1)		OPTM-1	
Runtime counter for machines and devices, instance 2	MDSOPT2	OPTS (2)		OPTM-2	
Measurement					
Three-phase current measurement, instance 1	CMMXU1	3I	IA, IB, IC	IA, IB, IC	IA, IB, IC (1)
Three-phase current measurement, instance 2	CMMXU2	3I(B)		IA, IB, IC (2)	IA, IB, IC (2)
Three-phase current measurement, instance 3	CMMXU3	3I(C)			IA, IB, IC (3)
Sequence current measurement, instance 1	CSMSQI1	I1, I2, I0	I1, I2, I0	I1, I2, I0	I1, I2, I0 (1)
Sequence current measurement, instance 2	CSMSQI2	I1, I2, I0 (B)		I1, I2, I0 (2)	I1, I2, I0 (2)
Sequence current measurement, instance 3	CSMSQI3	I1, I2, I0 (C)			I1, I2, I0 (3)
Residual current measurement, instance 1	RESCMMXU1	Io	IG	IG	IG
Three-phase voltage measurement, instance 1	VMMXU1	3U	VA, VB, VC	VA, VB, VC	VA, VB, VC (1)
Three-phase voltage measurement, instance 2	VMMXU2	3U (B)	VA, VB, VC (2)		VA, VB, VC (2)
Residual voltage measurement, instance 1	RESVMMXU1	Uo	VG	VG	VG
Residual voltage measurement, instance 2	RESVMMXU2	Uo(B)			VG
Sequence voltage measurement, instance 1	VSMSQI1	U1, U2, U0	V1, V2, V0	V1, V2, V0	V1, V2, V0 (1)
Sequence voltage measurement, instance 2	VSMSQI2	U1, U2, U0 (B)	V1, V2, V0 (2)		V1, V2, V0 (2)
Three-phase power and energy measurement, instance 1	PEMMXU1	P, E	P, E	P, E	P, E (1)
Three-phase power and energy measurement, instance 2	PEMMXU2	P, E (B)			P, E (2)
Current total demand distortion, instance 1	CMHAI1	PQM3I(1)	PQI-1		
Voltage total harmonic distortion, instance 1	VMHAI1	PQM3U(1)	PQVPH-1		

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Function	IEC 61850	IEC 60617	ANSI/C37.2 -2008		
			REF620	REM620	RET620
Voltage total harmonic distortion, instance 2	VMHAI2	PQM3U(2)	PQVPH-2		
Voltage variation, instance 1	PHQVVR1	PQ 3U<>(1)	PQSS-1		
Voltage unbalance, instance 1	VSQVUB1	PQMUBU(1)	PQVUB-1		
Voltage unbalance, instance 2	VSQVUB2	PQMUBU(2)	PQVUB-2		
Load profile, instance 1	LDPMSTA1	LoadProf	LoadProf	LoadProf	LoadProf
Frequency measurement, instance 1	FMMXU1	f	f	f	f
Frequency measurement, instance 2	FMMXU2	f			f
Single-phase power and energy measurement, instance 1	SPEMMXU1	SP, SE	SP, SE	SP, SE	SP, SE (1)
Single-phase power and energy measurement, instance 2	SPEMMXU2	SP, SE(B)			SP, SE (2)
Tap changer position indication	TPOSSLTC1	TPOSM			84T
Other					
Minimum pulse timer (2 pcs), instance 1	TPGAPC1	TP (1)	TP-1	TP-1	TP-1
Minimum pulse timer (2 pcs), instance 2	TPGAPC2	TP (2)	TP-2	TP-2	TP-2
Minimum pulse timer (2 pcs), instance 3	TPGAPC3	TP (3)	TP-3	TP-3	TP-3
Minimum pulse timer (2 pcs), instance 4	TPGAPC4	TP (4)	TP-4	TP-4	TP-4
Minimum pulse timer (2 pcs, second resolution), instance 1	TPSGAPC1	TPS (1)	62CLD-1	TPS (1)[3)]	
Minimum pulse timer (2 pcs, second resolution), instance 2	TPSGAPC2	TPS (2)	62CLD-3	TPS (2)[3)]	
Minimum pulse timer (2 pcs, minute resolution), instance 1	TPMGAPC1	TPM (1)	62CLD-2	TPM (1)[3)]	
Minimum pulse timer (2 pcs, minute resolution), instance 2	TPMGAPC2	TPM (2)	62CLD-4	TPM (2)[3)]	
Pulse timer (8 pcs), instance 1	PTGAPC1	PT (1)	PT-1	PT-1	PT-1
Pulse timer (8 pcs), instance 2	PTGAPC2	PT (2)	PT-2	PT-2	PT-2
Time delay off (8 pcs), instance 1	TOFGAPC1	TOF (1)	TOF-1	TOF-1	TOF-1
Time delay off (8 pcs), instance 2	TOFGAPC2	TOF (2)	TOF-2	TOF-2	TOF- 2
Time delay off (8 pcs), instance 3	TOFGAPC3	TOF (3)	TOF-3	TOF-3	TOF-3
Time delay off (8 pcs), instance 4	TOFGAPC4	TOF (4)	TOF-4	TOF-4	TOF- 4
Time delay on (8 pcs), instance 1	TONGAPC1	TON (1)	TON -1	TON -1	TON -1
Time delay on (8 pcs), instance 2	TONGAPC2	TON (2)	TON -2	TON -2	TON -2
Time delay on (8 pcs), instance 3	TONGAPC3	TON (3)	TON -3	TON -3	TON -3
Time delay on (8 pcs), instance 4	TONGAPC4	TON (4)	TON -4	TON -4	TON -4
Set reset (8 pcs), instance 1	SRGAPC1	SR (1)	SR-1	SR-1	SR-1
Set reset (8 pcs), instance 2	SRGAPC2	SR (2)	SR-2	SR-2	SR-2
Set reset (8 pcs), instance 3	SRGAPC3	SR (3)	SR-3	SR-3	SR-3
Set reset (8 pcs), instance 4	SRGAPC4	SR (4)	SR-4	SR-4	SR-4
Move (8 pcs), instance 1	MVGAPC1	MV (1)	MV-1	MV-1	MV-1
Move (8 pcs), instance 2	MVGAPC2	MV (2)	MV-2	MV-2	MV-2
Move (8 pcs), instance 3	MVGAPC3	MV (3)	MV-3	MV-3	MV-3
Move (8 pcs), instance 4	MVGAPC4	MV (4)	MV-4	MV-4	MV-4
Move (8 pcs), instance 5	MVGAPC5	MV (5)	MV-5	MV-5	MV-5
Move (8 pcs), instance 6	MVGAPC6	MV (6)	MV-6	MV-6	MV-6
Move (8 pcs), instance 7	MVGAPC7	MV (7)	MV-7	MV-7	MV-7
Move (8 pcs), instance 8	MVGAPC8	MV (8)	MV-8	MV-8	MV-8
Move (8 pcs), instance 9	MVGAPC9	MV (9)		MV-9[2)]	
Move (8 pcs), instance 10	MVGAPC10	MV (10)		MV-10[2)]	
Generic control points, instance 1	SPCGGIO1	SPC(1)	CNTRL-1	CNTRL-1	CNTRL-1
Generic control points, instance 2	SPCGGIO2	SPC(2)	CNTRL-2	CNTRL-2	CNTRL-2
Generic control points, instance 3	SPCGGIO3	SPC(3)	CNTRL-3	CNTRL-3	CNTRL-3
Remote generic control points, instance 1	SPCRGGIO1	SRCR(1)	RCNTRL-1	RCNTRL-1	RCNTRL-1

Table continues on next page

Function	IEC 61850	IEC 60617	ANSI/C37.2 -2008		
			REF620	REM620	RET620
Local generic control points, instance 1	SPCLGGIO1	SPCL(1)	LCNTRL-1	LCNTRL-1	LCNTRL-1
Generic up-down counters, instance 1	UDFCNT1	CTR(1)	CTR-1	CTR-1	CTR-1
Generic up-down counters, instance 2	UDFCNT2	CTR(2)	CTR-2	CTR-2	CTR-2
Generic up-down counters, instance 3	UDFCNT3	CTR(3)	CTR-3	CTR-3	CTR-3
Generic up-down counters, instance 4	UDFCNT4	CTR(4)	CTR-4	CTR-4	CTR-4
Generic up-down counters, instance 5	UDFCNT5	CTR(5)	CTR-5	CTR-5	CTR-5
Generic up-down counters, instance 6	UDFCNT6	CTR(6)	CTR-6	CTR-6	CTR-6
Generic up-down counters, instance 7	UDFCNT7	CTR(7)	CTR-7	CTR-7	CTR-7
Generic up-down counters, instance 8	UDFCNT8	CTR(8)	CTR-8	CTR-8	CTR-8
Generic up-down counters, instance 9	UDFCNT9	CTR(9)	CTR-9	CTR-9	CTR-9
Generic up-down counters, instance 10	UDFCNT10	CTR(10)	CTR-10	CTR-10	CTR-10
Generic up-down counters, instance 11	UDFCNT11	CTR(11)	CTR-11	CTR-11	CTR-11
Generic up-down counters, instance 12	UDFCNT12	CTR(12)	CTR-12	CTR-12	CTR-12
Programmable buttons (16 buttons), instance 1	FKEYGGIO1	FKEY	FKEY	FKEY	FKEY
Logging functions					
Disturbance recorder	RDRE1	DR	DFR	DFR	DFR
Fault recorder	FLTMSTA	FR	FR	FR	FR
Sequence event recorder	SER	SER	SER	SER	SER
Fault location	DRFLO	DRFLO	FLO		

1) Instance has been renamed in 620 series Ver.2.1 ANSI
2) Instance has been added in 620 series Ver 2.1 ANSI
3) Function has been added in 620 series Ver.2.1 ANSI

Section 2 Environmental aspects

2.1 Sustainable development

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

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

Table 2: Maximum concentration values by weight per homogeneous material

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

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

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

2.2 Disposal of a protection relay

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

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

Table 3: Materials of the protection relay parts

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

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

Section 3 620 series overview

3.1 Overview

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

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

The 620 series protection relays support a range of communication protocols including IEC 61850 with GOOSE messaging, Modbus® and DNP3.

3.2 Local HMI

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

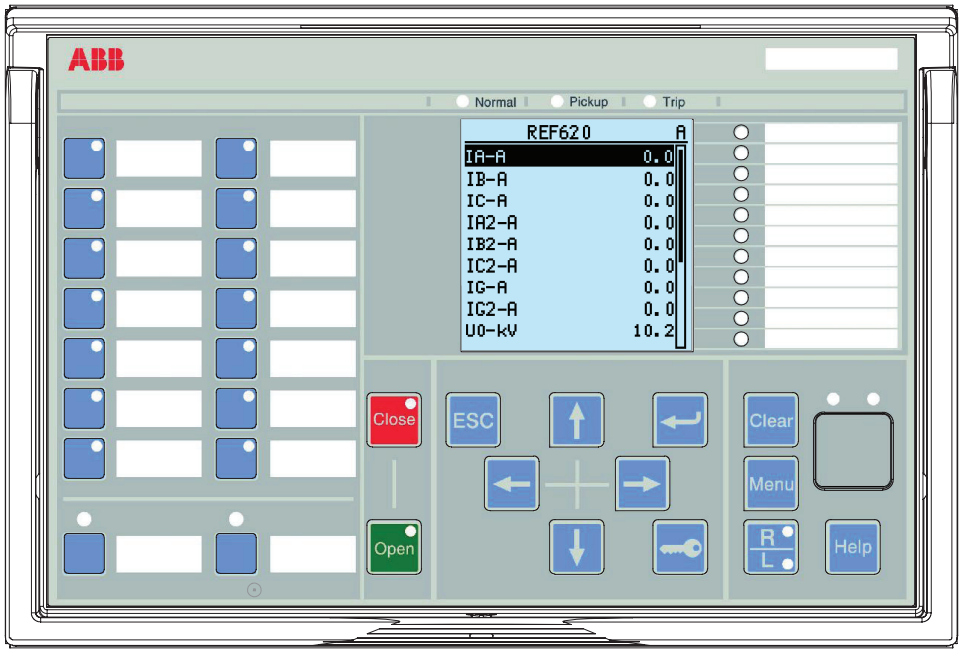


Figure 2: Example of the LHMI

3.2.1 Display

The LHMI includes a graphical display that supports one character size. The character size depends on the selected language.

Table 4: Large display

Character size[1)]	Rows in the view	Characters per row
Small, mono-spaced (6 × 12 pixels)	10	20

1) Depending on the selected language

The display view is divided into four basic areas.

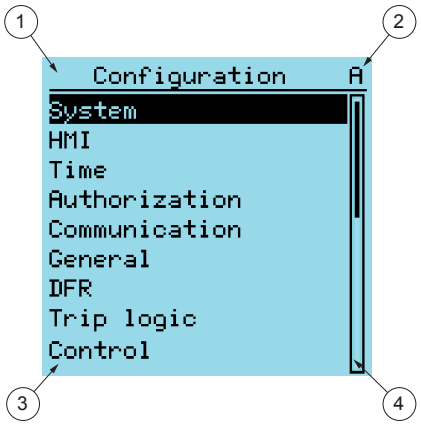


Figure 3: Display layout

1 Header
2 Icon
3 Content
4 Scroll bar (displayed when needed)

- The header area at the top of the display view shows the current location in the menu structure.
- The icon area at the upper right corner of the display shows the current action or user level.
  Current action is indicated by the following characters:
  - U: Font/Firmware is being updated
  - S: Parameters are being stored
  - !: Warning and/or indication

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

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

3.2.2 LEDs

The LHMI includes three protection indicators above the display: Normal, Pickup and Trip.

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

There are two additional LEDs which are embedded into the control buttons 

and 

. They represent the status of the selected breaker n (CBXCBRn).

3.2.3 Keypad

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

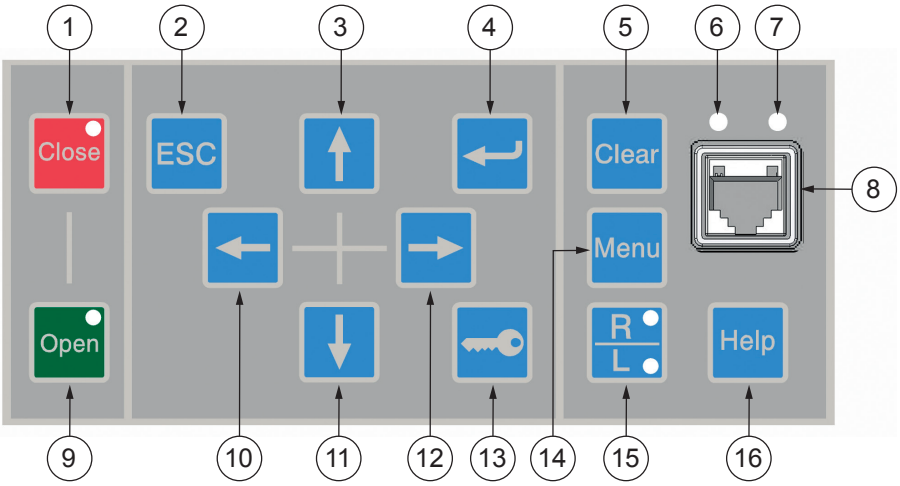


Figure 4: LHMI keypad with object control, navigation and command push buttons and RJ-45 communication port

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

Object control

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

Table 5: Object control push buttons

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

Navigation

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

Table 6: Navigation push buttons

Name	Description
ESC ESC	• Leaving setting mode without saving the values. • Cancelling certain actions. • Adjusting the display contrast in combination with ↑ or ↓. • Changing the language in combination with ←. • Running the display test in combination with Menu. • Deleting a character in combination with Clear when editing a string. • Inserting a space in combination with ↵ when editing a string.
↵ Enter	• Entering parameter setting mode. • Confirming a new value of a setting parameter.
↑ Up ↓ Down	• Moving up and down in menus. • Scrolling active digits of a parameter when entering a new setting value.
← Left → Right	• Moving left and right in menus. • Changing the active digit of a parameter when entering a new setting value.
Key	• Activating the authorization procedure, when the user is not logged in. • Logging out, when the user is currently logged in.

Commands

Table 7: Command push buttons

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

3.2.4 Programmable push buttons with LEDs

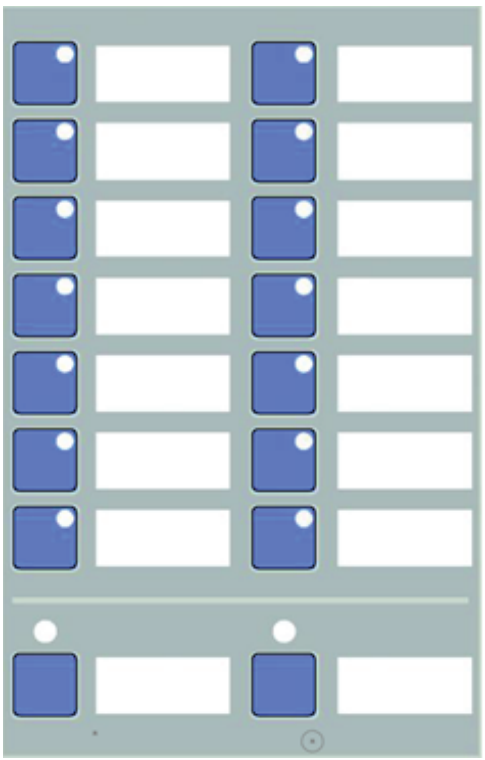


Figure 5: Programmable push buttons with LEDs

The LHMI keypad on the left side of the protection relay contains 16 programmable push buttons with red LEDs.

The buttons and LEDs are freely programmable, and they can be configured both for operation and acknowledgement purposes. That way, it is possible to get acknowledgements of the executed actions associated with the buttons. This combination can be useful, for example, for quickly selecting or changing a setting group, selecting or operating equipment, indicating field contact status or indicating or acknowledging individual alarms.

The LEDs can also be independently configured to bring general indications or important alarms to the operator's attention.

The lowest two buttons with LEDs on top are typically used for hot-line tag for the emergency operation of the circuit controlled by the protection relay.

To provide a description of the button function, it is possible to insert a paper sheet behind the transparent film next to the button.

3.2.5 Local HMI functionality

3.2.5.1 Protection and alarm indication

Protection indicators

The protection indicator LEDs are Normal, Pickup and Trip.

Table 8: Normal LED

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

Table 9: Pickup LED

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

Table 10: Trip LED

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

Alarm indicators

The 11 matrix programmable LEDs are used for alarm indication.

Table 11: Alarm indications

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

3.2.5.2 Parameter management

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

- Numerical values
- String values
- Enumerated values

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

3.2.5.3 Front communication

The RJ-45 port in the LHMI enables front communication. Two LEDs are located above the communication port.

- The green uplink LED on the left is lit when the cable is successfully connected to the port.
- The yellow communication LED on the right flashes when the protection relay communicates with the connected device.

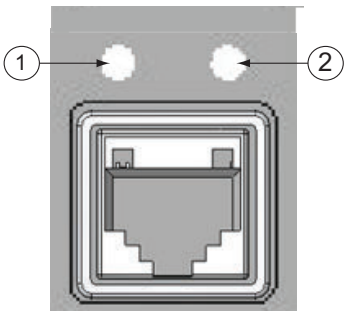


Figure 6: RJ-45 communication port and indication LEDs

1 Uplink LED
2 Communication LED

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

3.3 Web HMI

The WHMI allows secure access to the protection relay via a Web browser. The supported Web browser versions are Internet Explorer 9.0, 10.0 and 11.0.

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

Control operations are not allowed by WHMI.

WHMI offers several functions.

- Programmable LEDs and event lists
- System supervision
- Parameter settings
- Measurement display
- DFR records
- Phasor diagram
- Single-line diagram

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

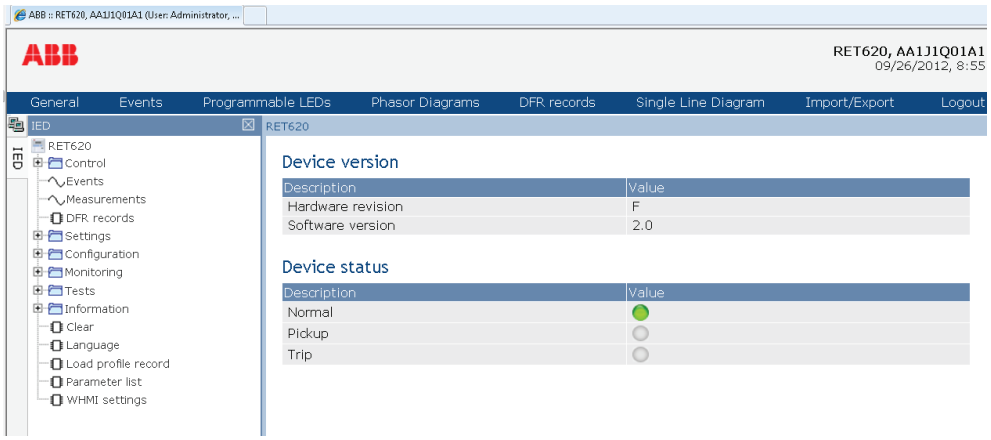


Figure 7: Example view of the WHMI

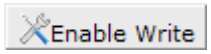
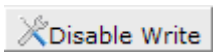
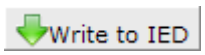
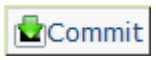
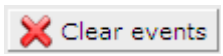
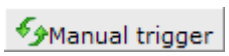
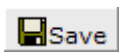
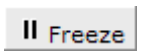
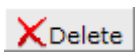
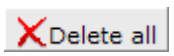
The WHMI can be accessed locally and remotely.

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

3.3.1 Command buttons

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

Table 12: Command buttons

Name	Description
	Enabling parameter editing.
	Disabling parameter editing.
	Writing parameters to the protection relay.
	Refreshing parameter values.
	Printing out parameters.
	Committing changes to protection relay's nonvolatile flash memory.
	Rejecting changes.
	Showing context sensitive help messages.
	Error icon.
	Clearing events.
	Triggering the DFR manually.
	Saving values to CSV file format.
	Freezing the values so that updates are not displayed.
	Receiving continuous updates to the monitoring view.
	Deleting the DFR.
	Deleting all DFRs.
	Uploading part one of a DFR.
	Uploading part two of a DFR.

3.4 Authorization

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

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

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

Table 13: Predefined user categories

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

For user authorization for PCM600, see PCM600 documentation.

3.4.1 Audit trail

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

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

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

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

Table 14: Audit trail events

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

Audit trail event	Description
Audit overflow	Too many audit events in the time period
Violation remote	Unsuccessful login attempt from IEC 61850-8-1 (MMS), WHMI, FTP or LHMI.
Violation local	Unsuccessful login attempt from IEC 61850-8-1 (MMS), WHMI, FTP or LHMI.

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

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

Table 15: Comparison of authority logging levels

Audit trail event	Authority logging level					
	None	Configuration change	Setting group	Setting group, control	Settings edit	All
Configuration change		•	•	•	•	•
Firmware change		•	•	•	•	•
Setting group remote			•	•	•	•
Setting group local			•	•	•	•
Control remote				•	•	•
Control local				•	•	•
Test on				•	•	•
Test off				•	•	•
Reset trips				•	•	•
Setting commit					•	•
Time change						•
View audit log						•
Login						•
Logout						•
Password change						•

Table continues on next page

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

3.5 Communication

The protection relay supports different communication protocols: IEC 61850, Modbus® and DNP3 Level 2 - all using TCP/IP. DNP3 and Modbus also support serial communication. Operational information and controls are available through these protocols. However, some communication functionality, for example, horizontal communication between the protection relays, is only enabled by the IEC 61850 communication protocol.

The protection relay utilizes Ethernet communication extensively for different purposes. The exact services depend on the ordered product variant and enabled functionality.

Table 16: TCP and UDP ports used for different services

Service	Port
IEC 61850	102
MODBUS	x
DNP	x
FTP	x
HTTP	x

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

The protection relay can support five simultaneous clients. If PCM600 reserves one client connection, only four client connections are left, for example, for IEC 61850, DNP3 and Modbus. Only one DNP3 client can be supported at a time.

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

3.5.1 Self-healing Ethernet ring

For the correct operation of self-healing loop topology, it is essential that the external switches in the network support the RSTP protocol and that it is enabled in the switches. Otherwise, connecting the loop topology can cause problems to the network. The protection relay itself does not support link-down detection or RSTP. The ring recovery process is based on the aging of the MAC addresses, and the link-up/link-down events can cause temporary breaks in communication. For a better performance of the self-healing loop, it is recommended that the external switch furthest from the protection relay loop is assigned as the root switch (bridge priority = 0) and the bridge priority increases towards the protection relay loop. The end links of the protection relay loop can be attached to the same external switch or to two adjacent external switches. A self-healing Ethernet ring requires a communication module with at least two Ethernet interfaces for all protection relays.

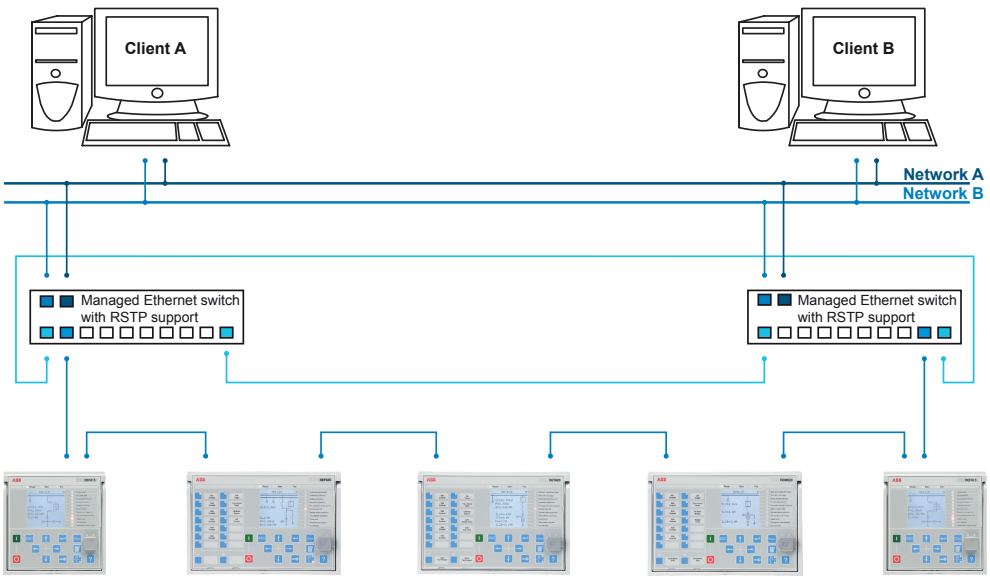


Figure 8: Self-healing Ethernet ring solution

3.5.2 Ethernet redundancy

This chapter is applicable to REM620 Ver.2.1 only.

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

PRP specifies that each device is connected in parallel to two local area networks. HSR applies the PRP principle to rings and to the rings of rings to achieve cost-effective redundancy. Thus, each device incorporates a switch element that forwards frames from port to port. The HSR/PRP option is available in REM620 Ver.2.1 only.

IEC 62439-3:2012 cancels and replaces the first edition published in 2010. These standard versions are also referred to as IEC 62439-3 Edition 1 and IEC 62439-3 Edition 2. The protection relay supports IEC 62439-3:2012 and it is not compatible with IEC 62439-3:2010.

PRP

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

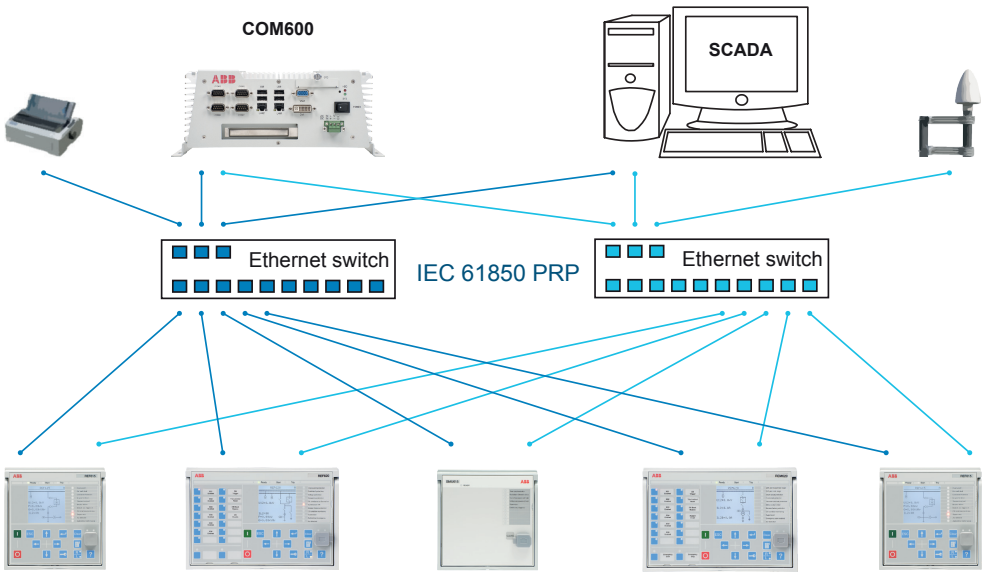


Figure 9: PRP solution

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

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

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

Take care to ensure that the ports marked "LAN A" and "LAN B" are used when implementing PRP. Some communication options offer a third port which should not be used for redundant Ethernet connectivity.

In a PRP network, the installer should ensure that all of the LAN A ports are connected to the same switch and that all of the LAN B ports are connected to a different switch.

HSR

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

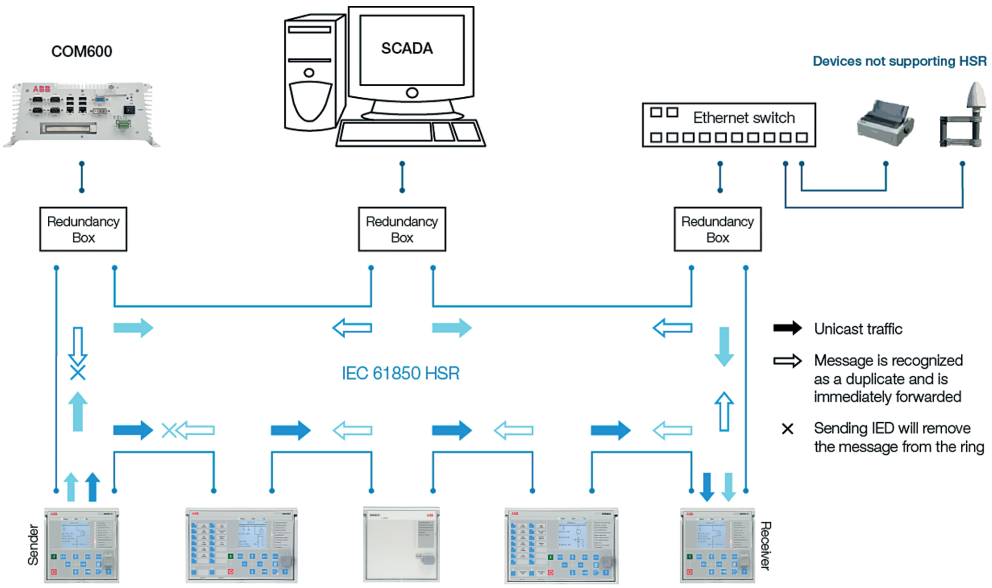


Figure 10: HSR solution

LAN A of one device should connect to LAN B in the next device in the ring. Do not connect LAN A to LAN A or LAN B to LAN B.

3.6 PCM600 tool

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

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

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

The system settings must be set before a new PCM600 project is started. For more information, see PCM600 documentation.

3.6.1 Connectivity packages

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

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

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

3.6.2 PCM600 and relay connectivity package version

- Protection and Control IED Manager PCM600 Ver.2.6 or later
- IED Connectivity Package REF620 ANSI Ver.2.0 or later
- IED Connectivity Package REM620 ANSI Ver.2.1 or later
- IED Connectivity Package RET620 ANSI Ver.2.0 or later

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

Section 4 Using the HMI

4.1 Using the local HMI

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

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

4.1.1 Logging in

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

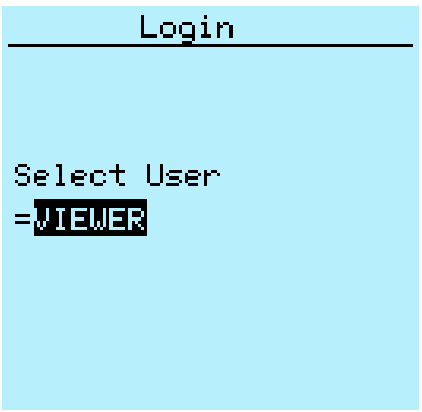


Figure 11: Selecting access level

3. Confirm the selection with .
4. Enter the password when prompted digit by digit.
   - Activate the digit to be entered with and .
   - Enter the character with and .

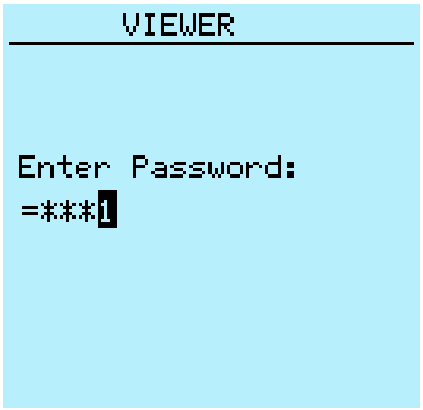


Figure 12: Entering password

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

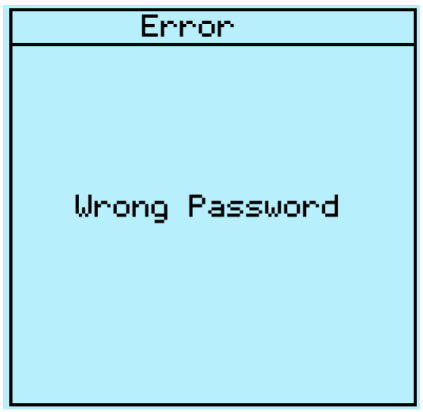


Figure 13: Error message indicating wrong password

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

4.1.2 Logging out

An automatic logout occurs 30 seconds after the backlight timeout.

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

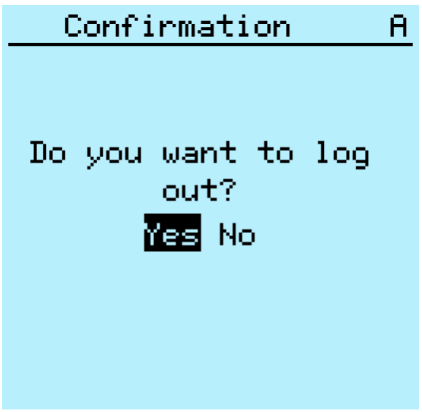


Figure 14: Logging out

- To cancel logout, press ESC.

4.1.3 Turning the display backlight on

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

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

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

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

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

4.1.4 Selecting local or remote use

The control position of the protection relay can be changed with the R/L button. In local position primary equipment, such as circuit breakers or disconnectors, can be controlled

via the LHMI. In remote position, control operations are possible only from a higher level, that is from a control center.

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

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

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

4.1.5 Identifying the device

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

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

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

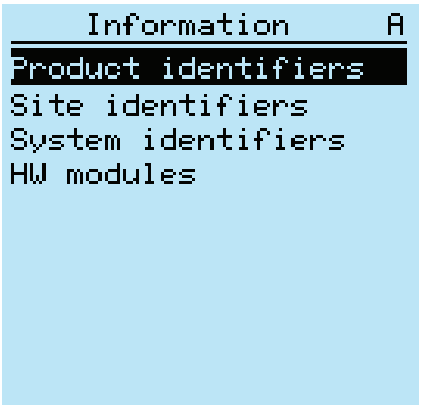


Figure 15: Selecting a submenu

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

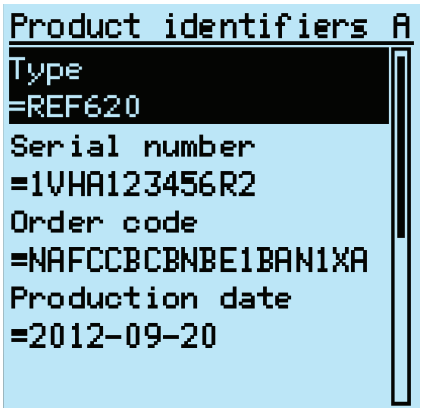


Figure 16: Protection relay information

4.1.6 Adjusting the display contrast

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

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

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

4.1.7 Changing the local HMI language

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

Figure 17: Changing the LHMI language

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

4.1.8 Changing display symbols

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

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

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

4.1.9 Navigating in the menu

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

- To navigate between main menu, measurements and single-line diagram, press Menu.
- To move up or down in a menu, press  or  .
- To move downwards in the menu tree, press  .
- To move upwards in the menu tree, press  .
- To enter setting mode, press  .
- To leave setting mode without saving, press ESC.

4.1.9.1 Menu structure

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

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

4.1.9.2 Scrolling the display

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

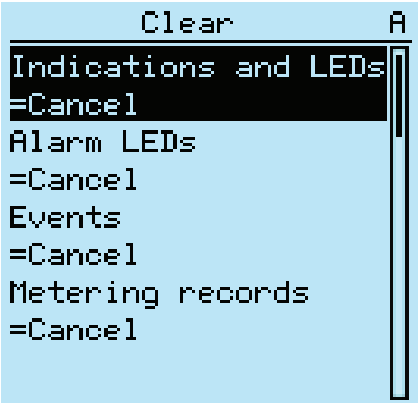


Figure 18: Scroll bar on the right

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

4.1.9.3 Changing the default view

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

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

4.1.10 Viewing single-line diagram

The single-line diagram is created with PCM600. The single-line diagram is active only when the large screen is used.Upon startup, SLD page 1 is set as the default page.

- Select **Main menu/Control/SLD** to view the single-line diagram or press Menu to navigate between main menu, measurement and single-line diagram.

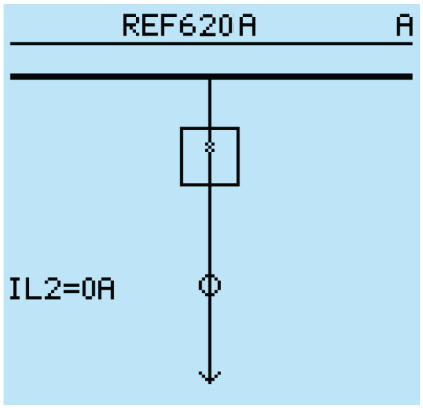


Figure 19: Single-line diagram with one breaker and IEC symbols

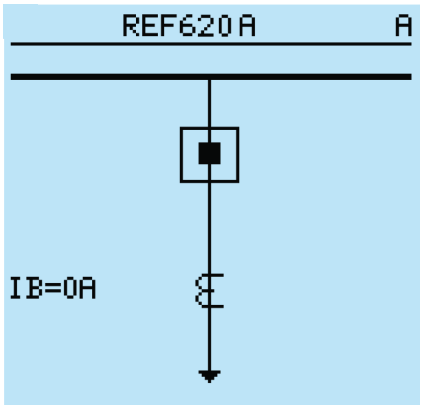


Figure 20: Single-line diagram with one breaker and ANSI symbols

Select the single-line diagram for the default view in **Main menu/Configuration/HMI/Default view**.

4.1.10.1 Changing single-line diagram symbol formats

1. Select **Main menu/Configuration/HMI/SLD symbol format** and press .
2. Change symbol format with or .
3. Press to confirm the selection.

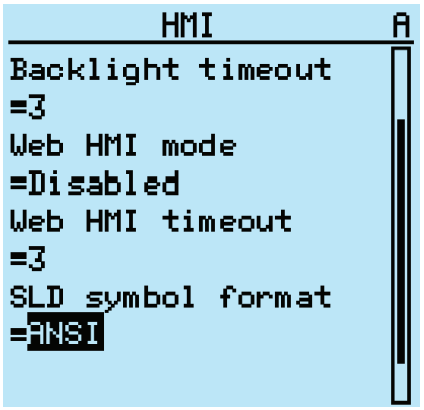


Figure 21: Selecting ANSI as single-line diagram symbol format

4.1.11 Browsing setting values

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

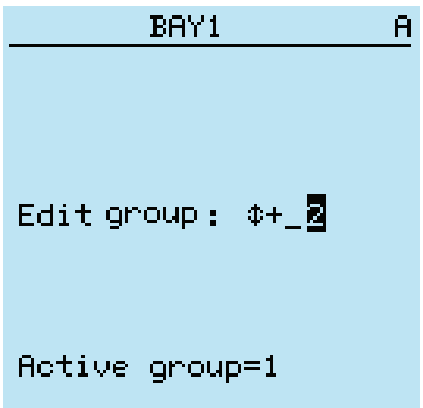


Figure 22: Selecting a setting group

3. Press ↵ to confirm selection.
4. To browse the settings, scroll the list with ↑ and ↓ and to select a submenu press →. To move back to the list, press ←.

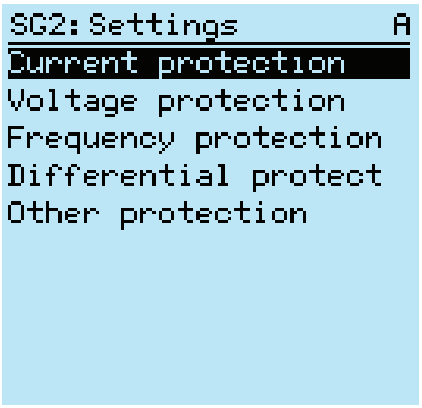


Figure 23: Example of submenus in the Settings menu

4.1.12 Editing values

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

4.1.12.1 Editing numerical values

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

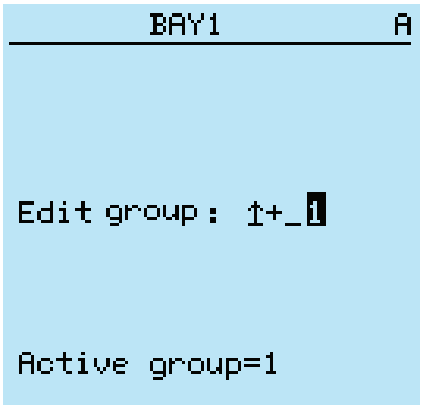


Figure 24: Last digit is active and it can only be increased

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

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

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

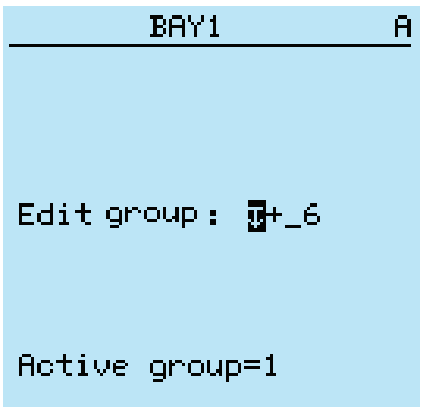


Figure 25: Arrow symbol is active, the value is set to the maximum

After pressing ↑, the previous value can be restored by pressing ↓ once, and vice versa. Another press of ↓ or ↑ sets the value to the lower or higher limit. The symbol in front of the value is ↕, when the previous value is shown.

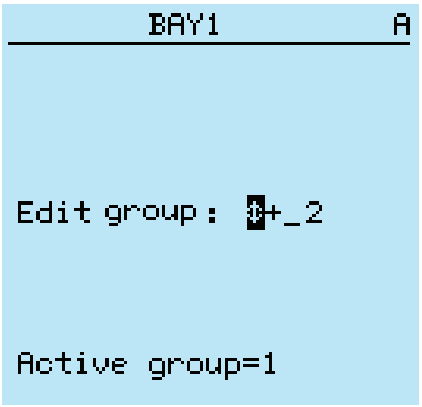


Figure 26: Restoring the previous value

4.1.12.2 Editing string values

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

4.1.12.3 Editing enumerated values

1. Activate the setting mode and select a setting.
   When editing an enumerated value, the selected value is shown inverted.
2. Press ↑ or ↓ to change the value of an active enumerated value.
   One press changes the enumerated value by one step in the parameter specific order.

4.1.13 Committing settings

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

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

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

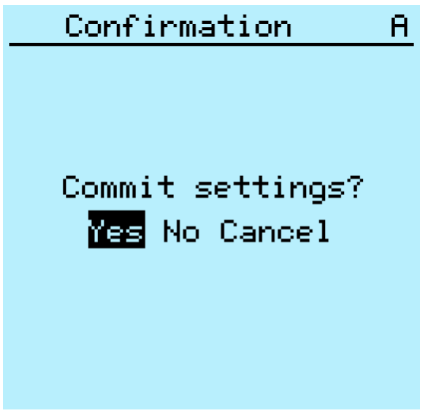


Figure 27: Confirming settings

- To exit without saving changes, select `No` and press .
  - If the parameter has an edit-copy, the original parameter value is restored.
  - If the parameter does not have an edit-copy, the edited parameter value remains visible until the protection relay is rebooted. However, the edited value is not stored in non-volatile memory and the reboot restores the original value.
- To cancel saving settings, select `Cancel` and press .

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

4.1.14 Clearing and acknowledging

The Clear 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 programmable LEDs are cleared with the Clear button as well.

1. Press Clear to activate the Clear view.

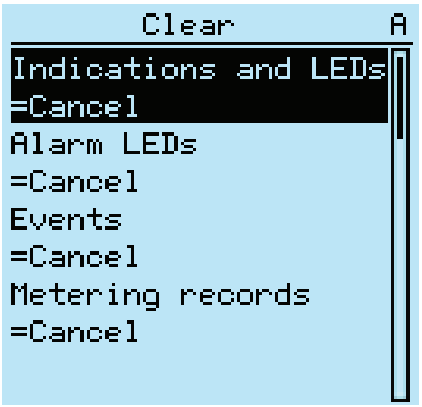


Figure 28: Clear view

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

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

4.1.15 Using the local HMI help

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

4.2 Using the Web HMI

WHMI is enabled by default.

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

4.2.1 Logging in

1. Open Internet Explorer.
2. Type the protection relay's IP address in the Address bar and press ENTER.
3. Type the username with capital letters.
4. Type the password.

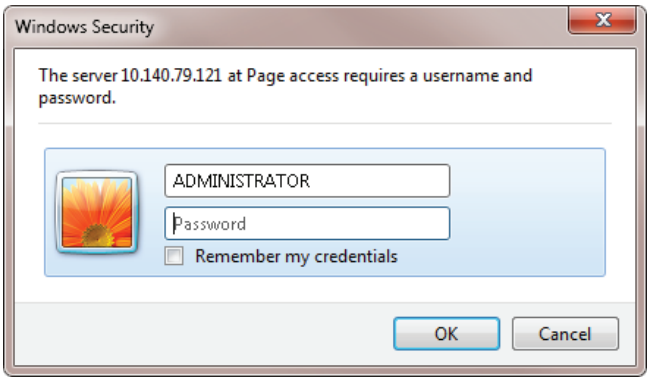


Figure 29: Entering username and password to use the WHMI

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

4.2.2 Logging out

The user is logged out after session timeout. The timeout can be set in **Main menu/Configuration/HMI/Web HMI timeout**.

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

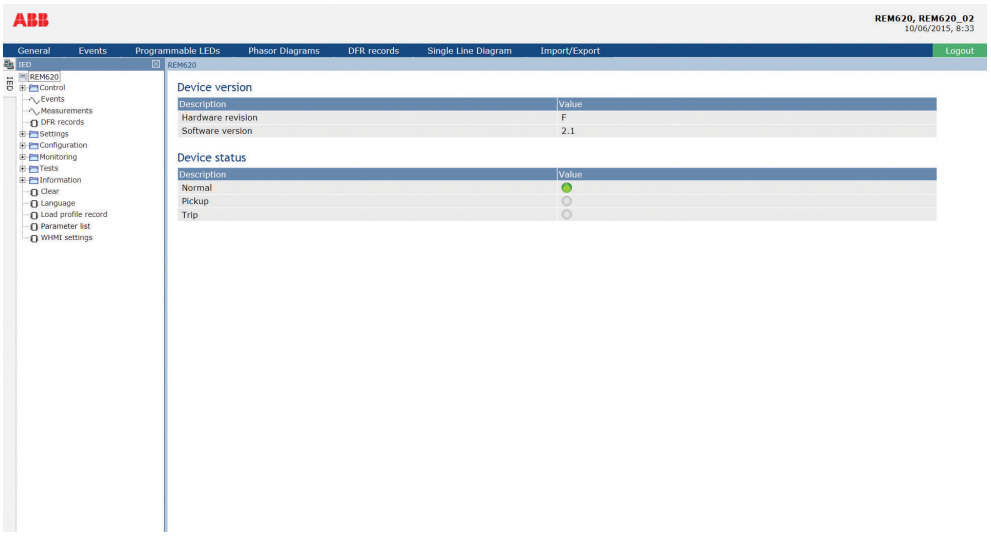


Figure 30: WHMI logout

4.2.3 Identifying device

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

1. Click the **Information** menu in the left navigation bar.
2. Click a submenu to see the data.

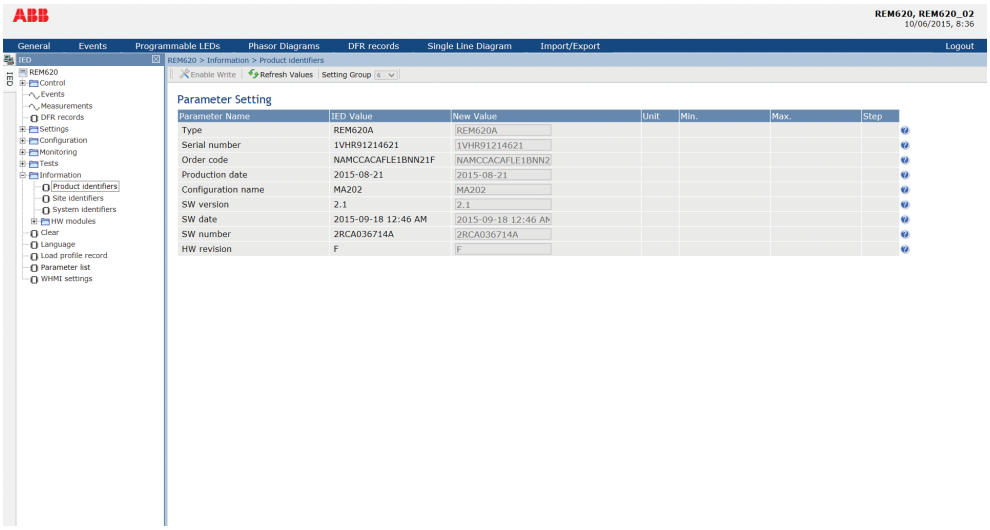


Figure 31: Device information

4.2.4 Navigating in menus

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

- Use the menu bar to access different views.
  - The **General** view shows the protection relay version and status.
  - The **Events** view contains a list of events produced by the application configuration.
  - The **Programmable LEDs** view shows the status of programmable LEDs.
  - The **Phasor diagrams** view shows phasor diagrams.
  - The **DFR records** view shows the list of disturbance records.
  - The **Single Line Diagram** view shows the single-line diagram.
  - **Logout** ends the session.

Figure 32: Navigating in Web HMI menus

4.2.4.1 Menu structure

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

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

4.2.5 Selecting single-line diagram

The single-line diagramis active only when the large screen is used.

- Select **Control/SLD** in the left navigation bar or click **Single Line Diagram** in the menu bar to view the single-line diagram.

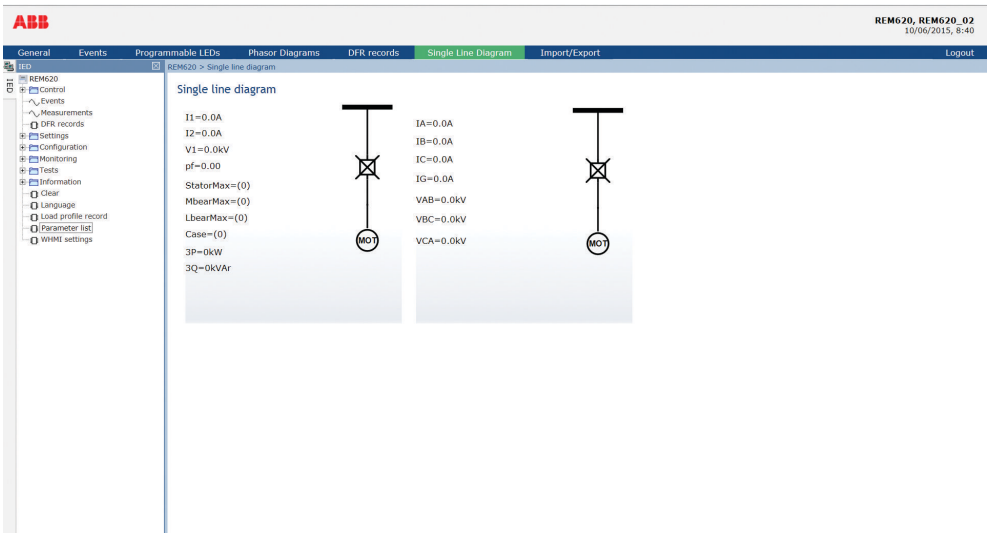


Figure 33: Viewing the single-line diagram with ANSI symbols

4.2.6 Showing parameters

1. Click **Parameter list** in the left navigation bar.

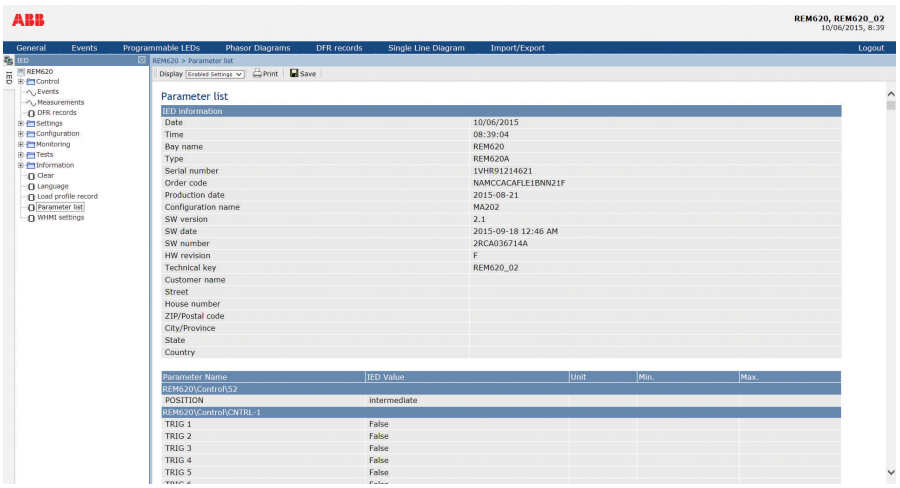


Figure 34: Displaying parameters

2. Select **Enabled Settings** or **All Settings** from the drop-down menu.

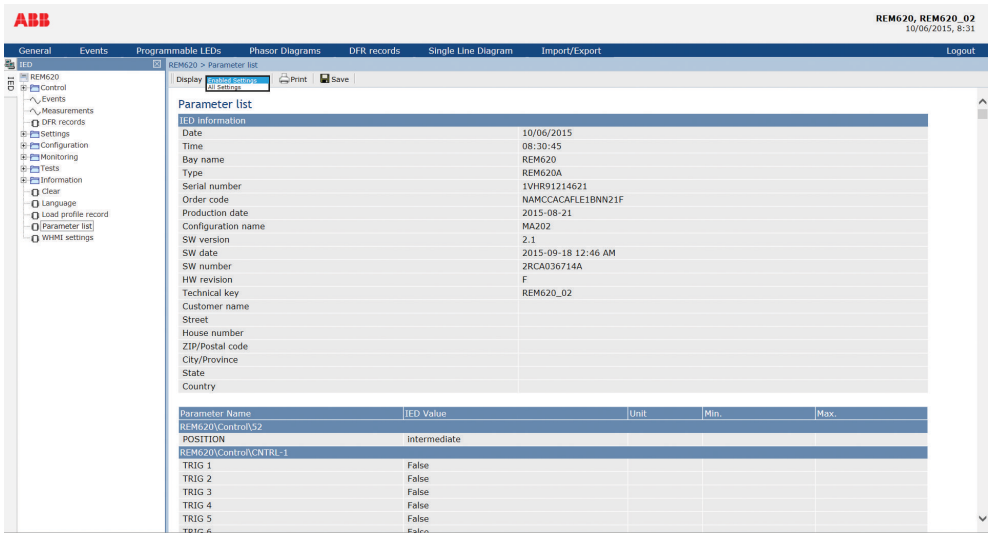


Figure 35: Enabled settings

3. Click **Save** to save selected parameters in the .csv file format.
4. Click **Print** to print all the selected parameters.

4.2.7 Editing values

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

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

Figure 36: Enable writing to edit a value

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

5. Edit the value.

   - The minimum and maximum values for a parameter are shown in the Min. and Max. columns.
   - Setting group values are indicated with #.

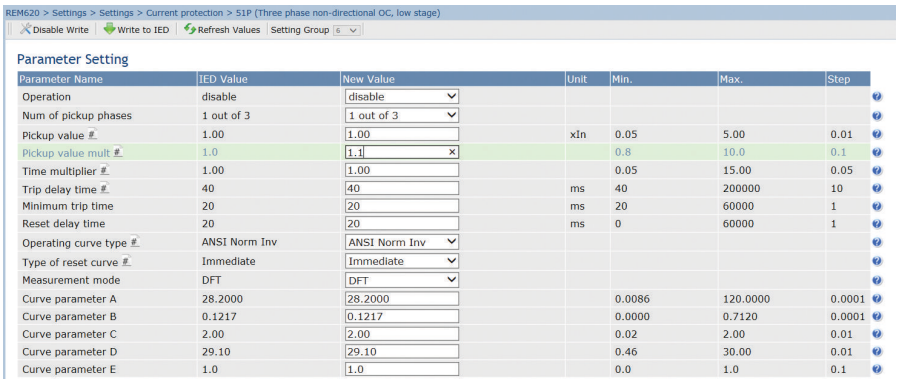


Figure 37: Editing a value

- If the entered value is within the accepted value range, the selection is highlighted in green. If the value is out of range, the row is highlighted in red and a warning dialog box is displayed. **Write to IED** is unavailable.

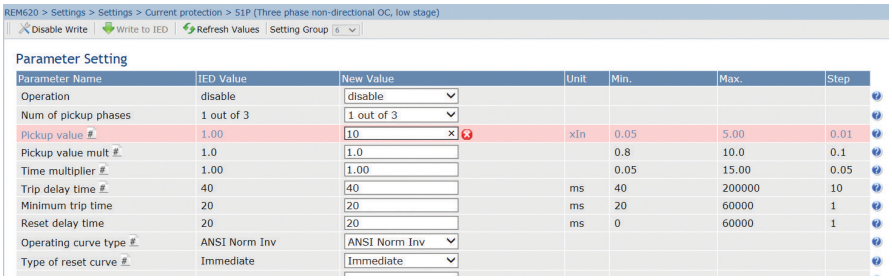


Figure 38: Warning indicating that the entered value is incorrect

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

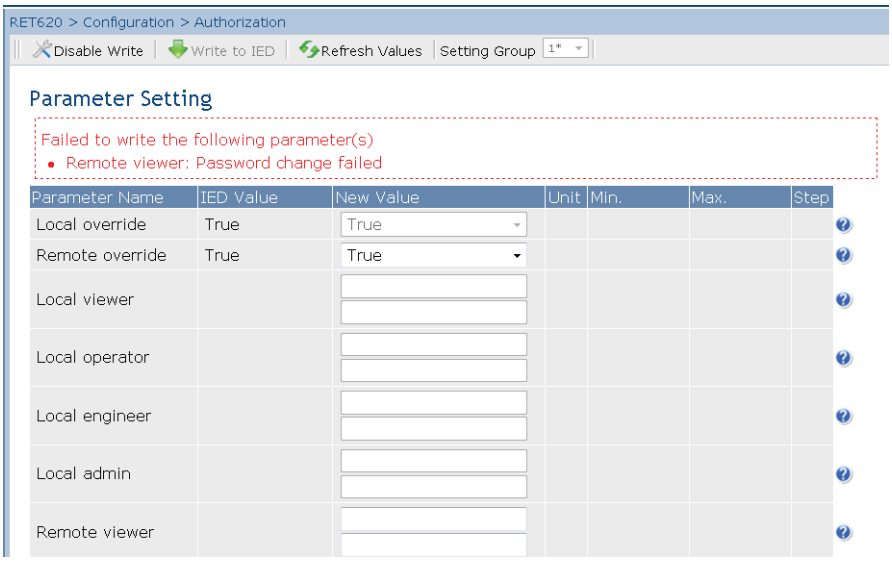


Figure 39: Warning indicating that the values were not written to the protection relay

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

4.2.8 Committing settings

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

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

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

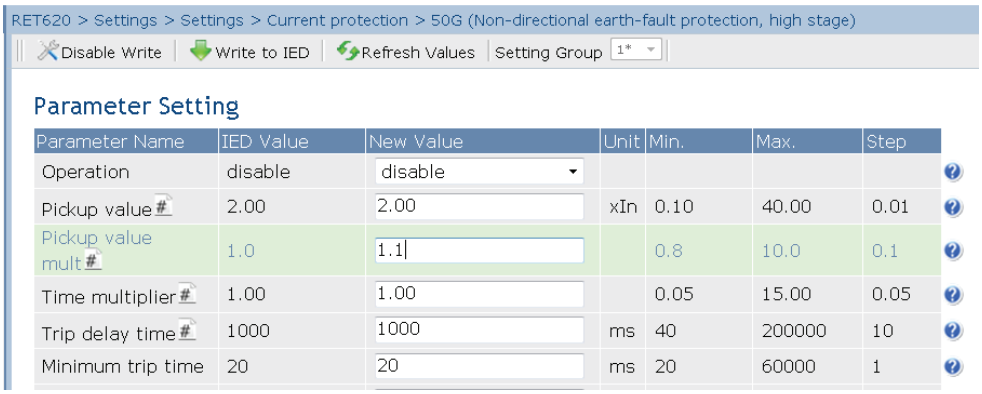


Figure 40: Writing values to protection relay

The values are not stored to the flash memory.

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

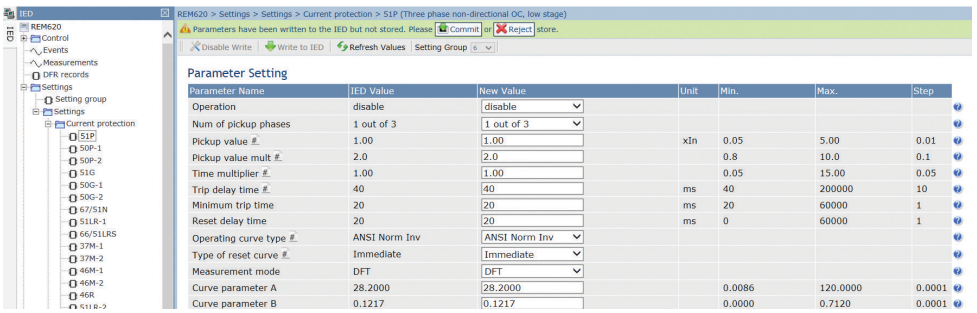


Figure 41: Committing changes

Committing values takes a few seconds.

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

4.2.9 Clearing and acknowledging

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

1. Click **Clear** in the left navigation bar.

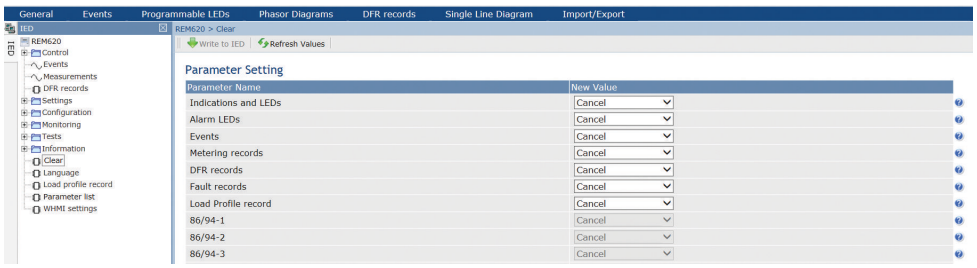


Figure 42: Selecting clear menu

2. In the **New Value** list, select **Clear** to choose the item to be cleared.
3. Click **Write to IED**.

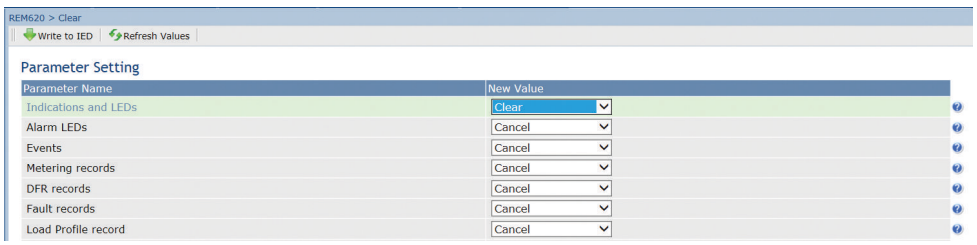


Figure 43: Clearing indications and LEDs

4.2.10 Selecting programmable LEDs view

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

- Click **Programmable LEDs** on the menu bar.

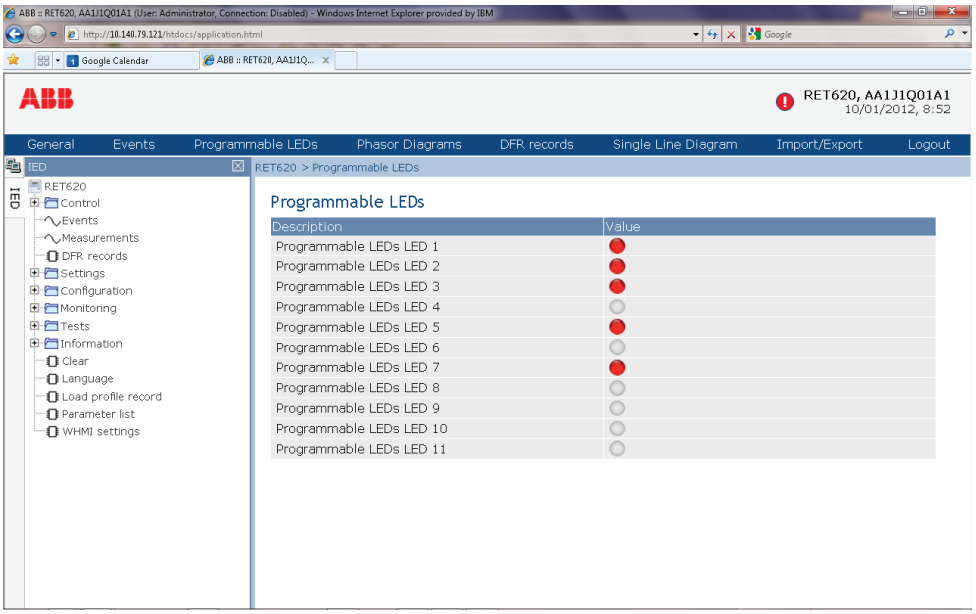


Figure 44: Monitoring alarms

4.2.11 Selecting event view

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

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

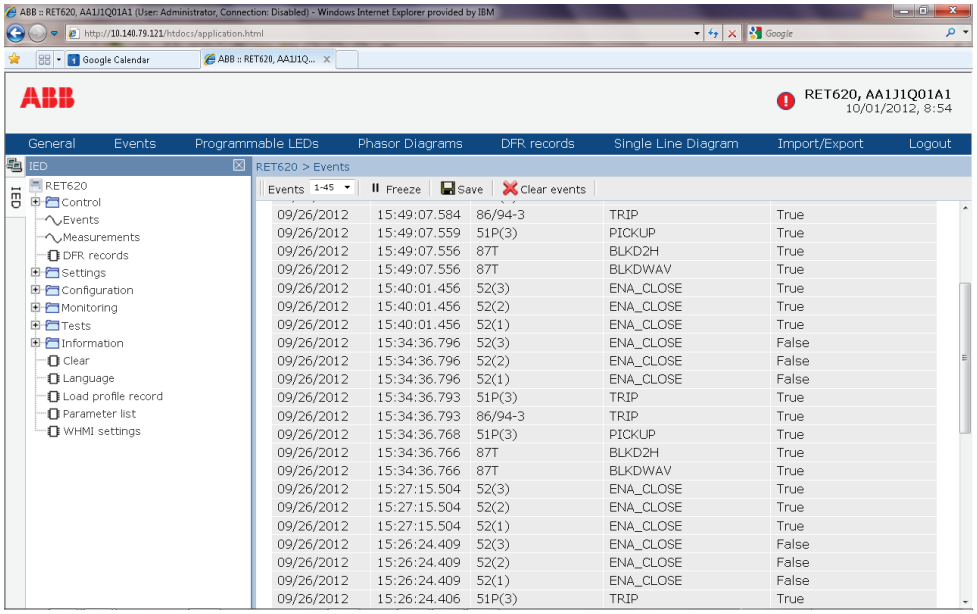


Figure 45: Monitoring events

2. Click **Freeze** to stop updating the event list.
3. Select a page from the drop-down list to view older documents.
4. To save the events in the CSV file format, click **Save** and copy the CSV content to text editor and save in the CSV file format.

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

5. Click **Clear events** to clear all events from the protection relay.

4.2.12 Selecting DFR records view

DFR records are listed in the DFR records view.

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

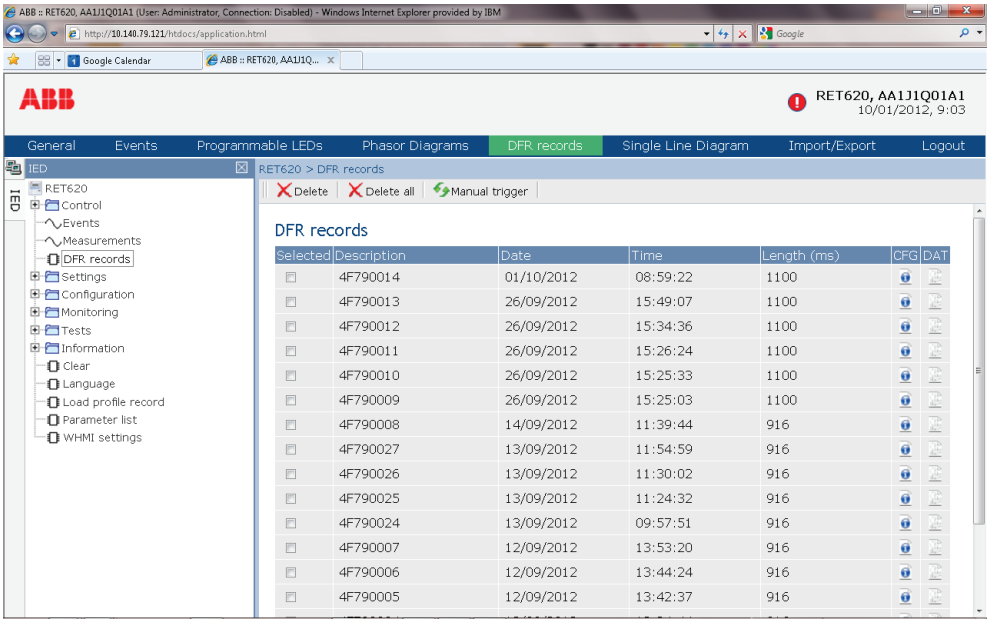


Figure 46: Selecting DFR records view

4.2.12.1 Uploading DFR records

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

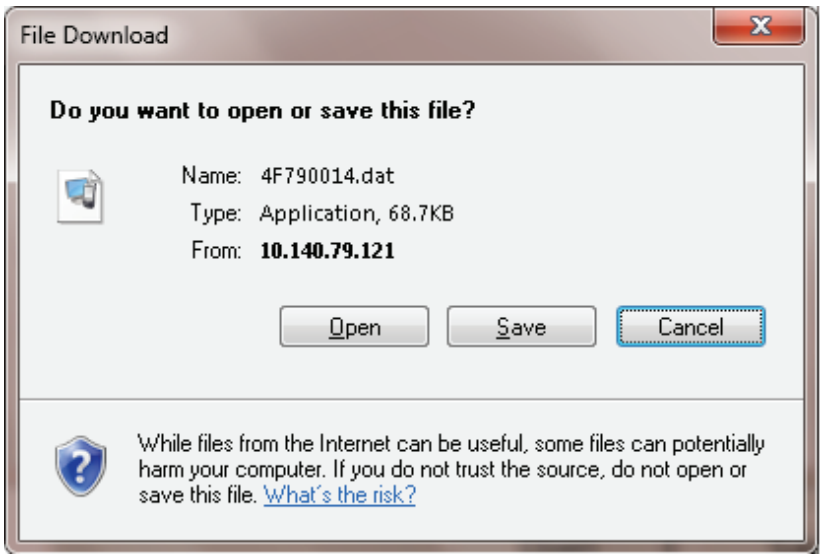


Figure 47: Uploading a DFR record

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

4.2.12.2 Triggering DFR recorder manually

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

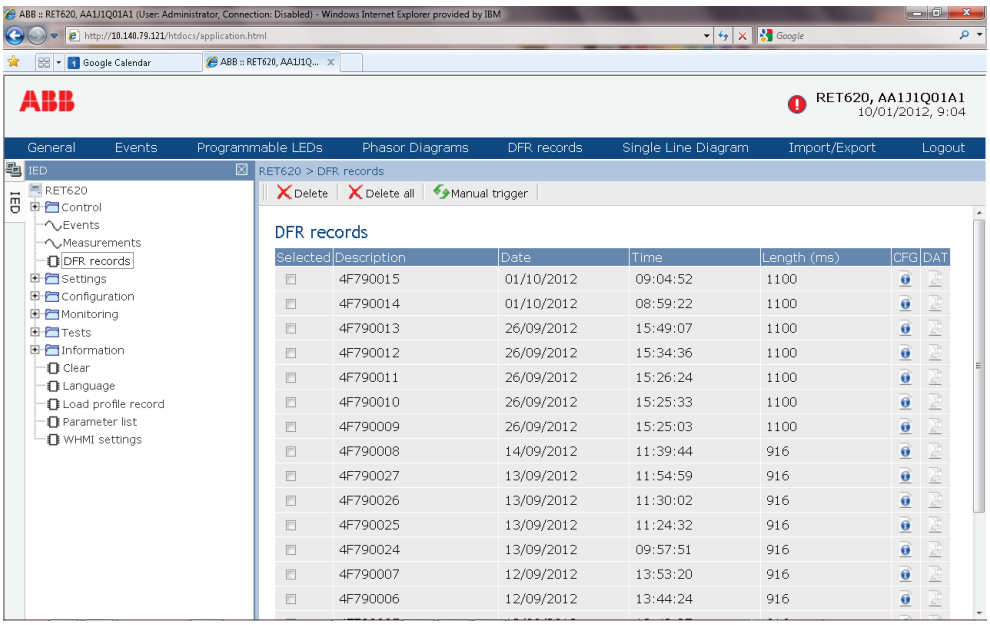


Figure 48: Manual triggering

4.2.12.3 Deleting DFR records

1. Click **DFR records** on the menu bar.
2. Delete records.
   - Click **Delete all** to delete all records.
   - Select one or more recordings and click **Delete** to delete selected records.

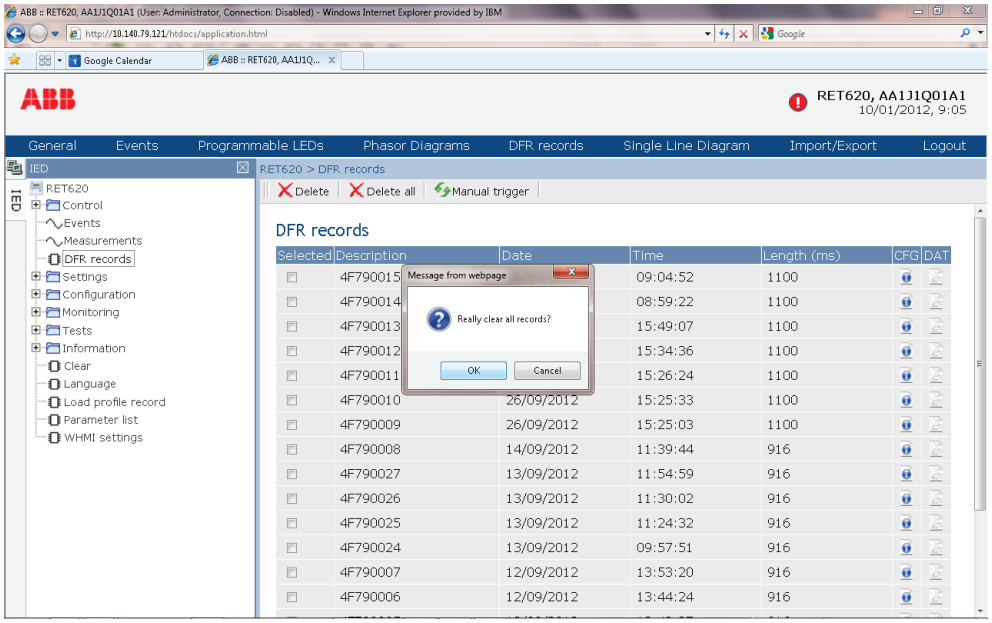


Figure 49: Deleting DFR records

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

4.2.13 Selecting phasor diagrams

Internet Explorer version 9.0 requires an SVG plugin to view the phasor diagrams whereas Internet Explorer versions 10.0 and 11.0 do not require any additional plugins for SVG support. Contact the factory for support on getting the plugin.

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

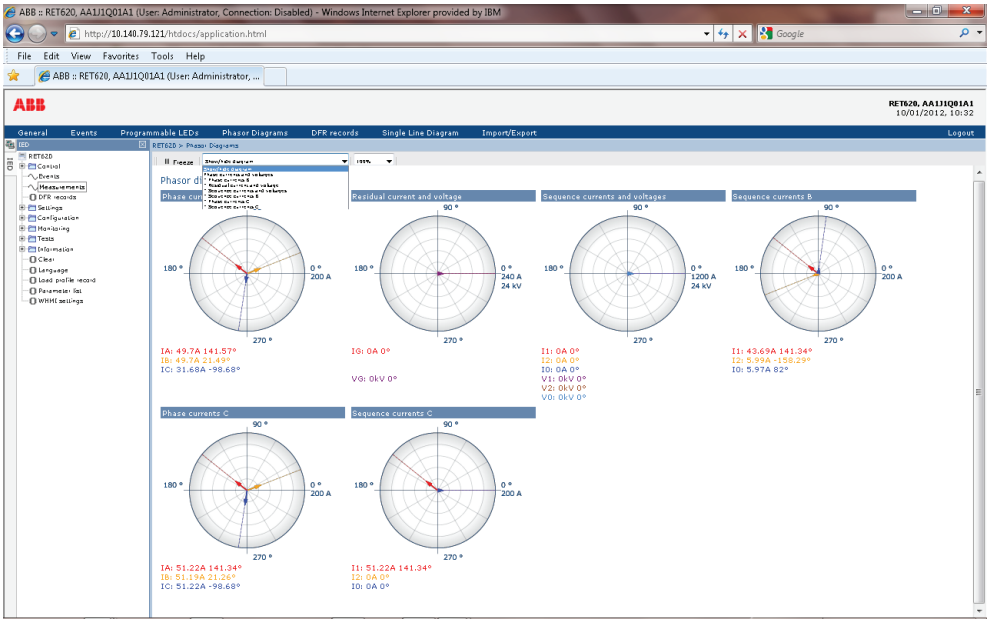


Figure 50: Monitoring phasors

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

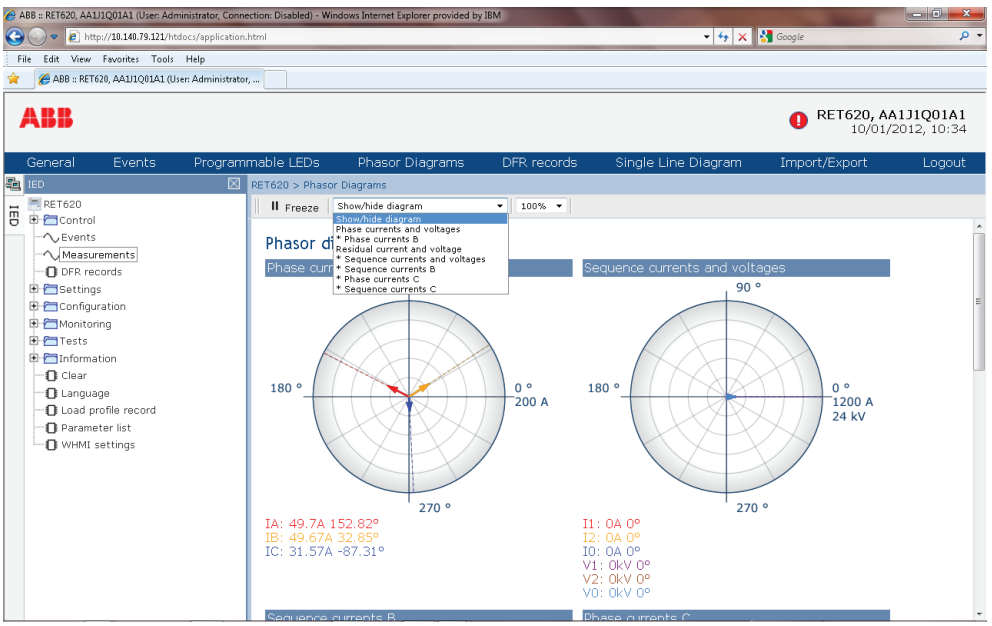


Figure 51: Toggling the diagram visibility

Visible diagrams are indicated with an asterisk *.

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

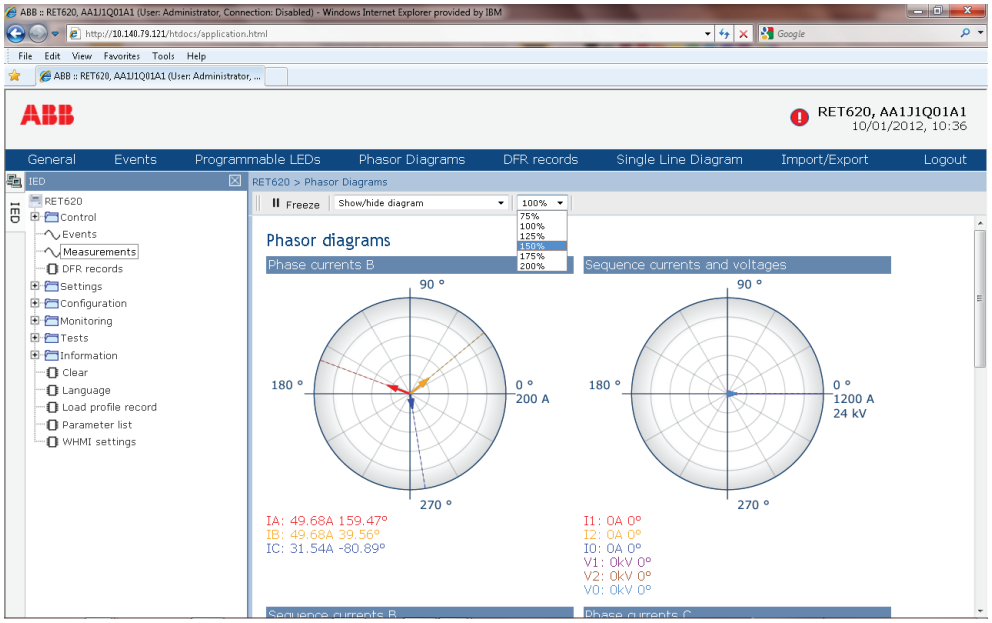


Figure 52: Zooming the diagram

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

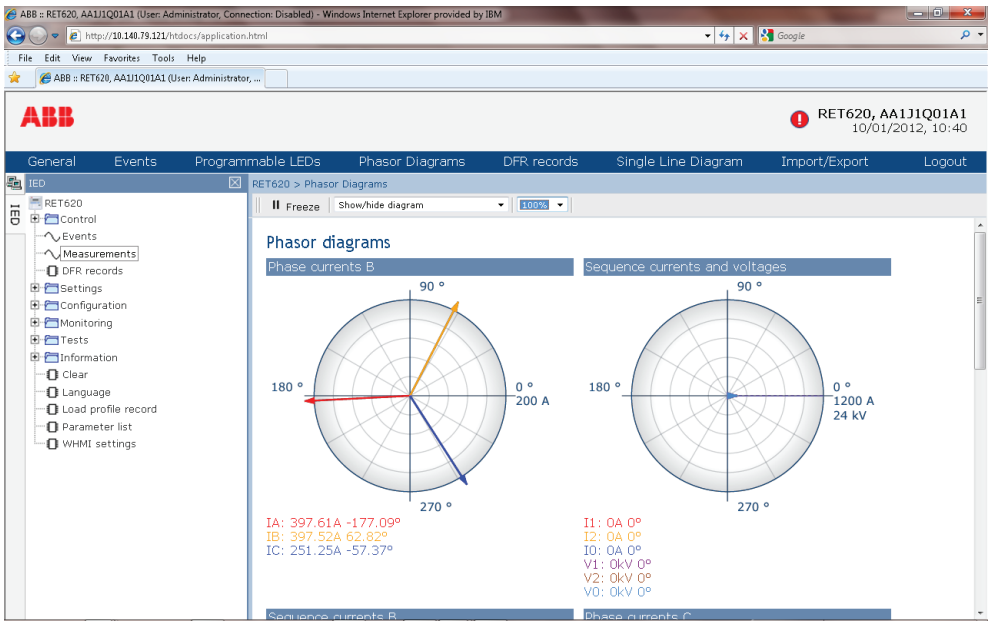


Figure 53: The arrow extends outside the circle if the current value is too high

4.2.14 Selecting fault records

- Select from the main menu **Monitoring/Recorded data/Fault record** to view a list of all available fault records.
  The newest fault record is first on the list. The fault records list is updated automatically.

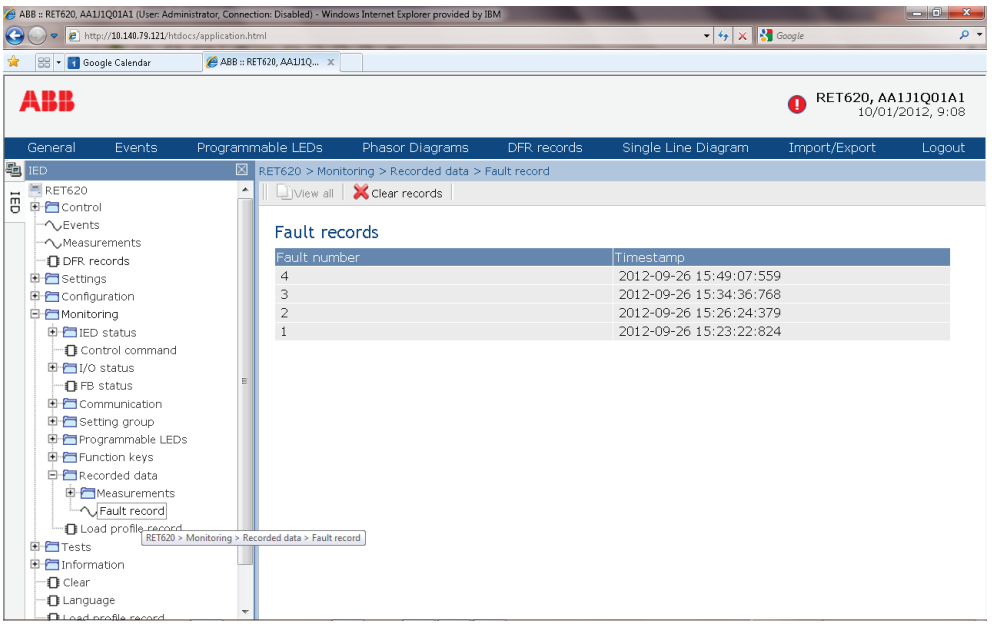


Figure 54: Fault records

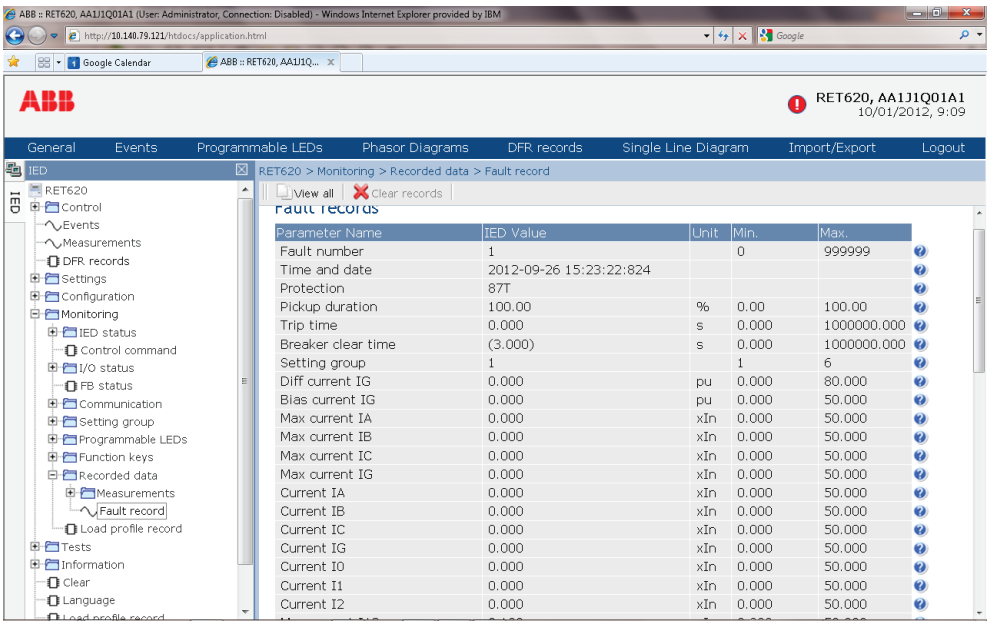


Figure 55: Fault record parameters

4.2.15 Using Web HMI help

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

- Move the mouse over the to display the help dialog box.

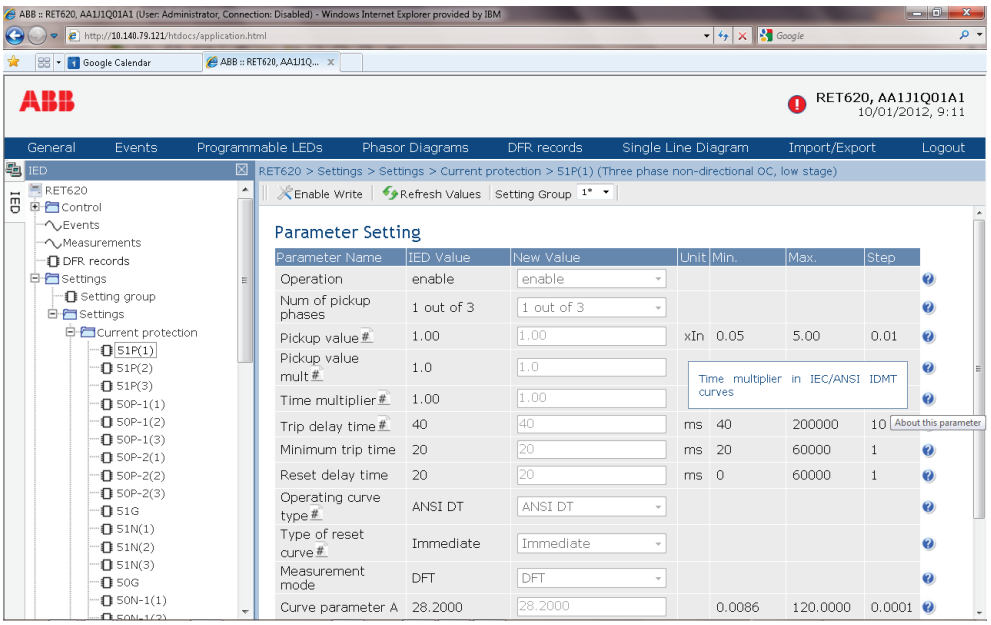


Figure 56: Opening the WHMI help

Section 5 Protection relay operation

5.1 Normal operation

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

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

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

For more information, see the PCM600 documentation.

5.2 Disturbance identification

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

Table 17: Disturbance indications

LED	State	Description
Pickup LED	Yellow, steady	Protection picked up
Pickup LED	Yellow, flashing	Protection function blocked
Trip LED	Red, steady	Protection tripped
Normal LED	Green, flashing	Internal fault

Further actions to be taken to identify the disturbance:

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

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

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

5.2.1 DFR recording triggering

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

5.2.2 DFR record analysis

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

For more information, see the PCM600 documentation.

5.2.3 DFR reports

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

For more information, see the PCM600 documentation.

5.2.4 Relay self-supervision

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

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

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

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

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

5.3 Relay parametrization

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

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

Document all changes to parameter settings.

For more information, see the PCM600 documentation.

5.3.1 Settings for relay functionality

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

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

5.3.2 Settings for different operating conditions

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

Section 6 Operating procedures

6.1 Monitoring

6.1.1 Indications

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

- Three indicator LEDs with fixed functionality: Normal, Pickup and Trip
- 11 programmable LEDs
- Information on the display

6.1.1.1 Monitoring indication messages

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

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

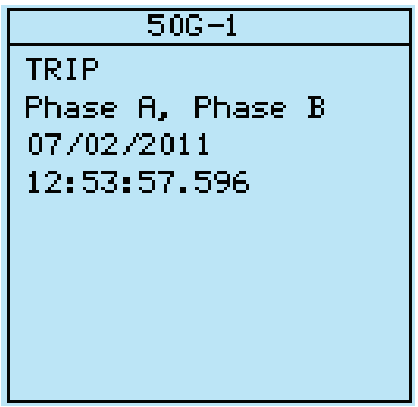


Figure 57: Indication message

6.1.1.2 Monitoring an internal relay fault

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

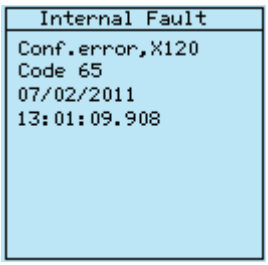


Figure 58: Fault indication

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

6.1.1.3 Monitoring condition monitoring data

1. Select **Main menu/Monitoring/I/O status/Condition monitoring**.
2. Press ↑ or ↓ to scroll the view.
3. Press → to enter or ← to exit a submenu.

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

6.1.2 Measured and calculated values

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

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

6.1.2.1 Measured values

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

Measured values available in the protection relay depend on the chosen functionality, relay type and variant.

Table 18: Measured values

Indicator	Description
IA-A	Measured current amplitude phase A
IB-A	Measured current amplitude phase B
IC-A	Measured current amplitude phase C
IA2-A	Measured current amplitude phase A
IB2-A	Measured current amplitude phase B
IC2-A	Measured current amplitude phase C
I1-A	Measured positive sequence current
I2-A	Measured negative-sequence current
I0-A	Measured zero-sequence current
I1B-A	Measured positive-sequence current
I2B-A	Measured negative-sequence current
I0B-A	Measured zero-sequence current
f-Hz	Measured frequency
IA3	Measured current phase A
IB3	Measured current phase B
IC3	Measured current phase C
I1C	Calculated positive sequence current
I2C	Calculated negative sequence current
I0C	Calculated zero sequence current
Therm-Lev	Thermal level of protected object
IA-diff	Measured differential current amplitude phase IA
IB-diff	Measured differential current amplitude phase IB
IC-diff	Measured differential current amplitude phase IC
IA-bias	Measured bias current amplitude phase IA
IB-bias	Measured bias current amplitude phase IB
IC-bias	Measured bias current amplitude phase IC
PF	Average power factor
P-kW	Active power, magnitude of instantaneous value
S-kVA	Apparent power, magnitude of instantaneous value
Q-kVAr	Reactive power, magnitude of instantaneous value
PF2	Power factor, magnitude of instantaneous value

Table continues on next page

Indicator	Description
P2-kW	Active power, magnitude of instantaneous value
S2-kVA	Apparent power, magnitude of instantaneous value
Q2-kVAr	Reactive power, magnitude of instantaneous value
IG-A	Measured residual current
VG-kV	Measured residual voltage
PFA	Power factor, magnitude of instantaneous value, phase A
PFB	Power factor, magnitude of instantaneous value, phase B
PFC	Power factor, magnitude of instantaneous value, phase C
PA-kW	Active power, magnitude of instantaneous value, phase A
PB-kW	Active power, magnitude of instantaneous value, phase B
PC-kW	Active power, magnitude of instantaneous value, phase C
SA-kVA	Apparent power, magnitude of instantaneous value, phase A
SB-kVA	Apparent power, magnitude of instantaneous value, phase B
SC-kVA	Apparent power, magnitude of instantaneous value, phase C
QA-kVAr	Reactive power, magnitude of instantaneous value, phase A
QB-kVAr	Reactive power, magnitude of instantaneous value, phase B
QC-kVAr	Reactive power, magnitude of instantaneous value, phase C
PFA2	Power factor, magnitude of instantaneous value, phase A
PFB2	Power factor, magnitude of instantaneous value, phase B
PFC2	Power factor, magnitude of instantaneous value, phase C
PA2-kW	Active power, magnitude of instantaneous value, phase A
PB2-kW	Active power, magnitude of instantaneous value, phase B
PC2-kW	Active power, magnitude of instantaneous value, phase C
SA2-kVA	Apparent power, magnitude of instantaneous value, phase A
SB2-kVA	Apparent power, magnitude of instantaneous value, phase B
SC2-kVA	Apparent power, magnitude of instantaneous value, phase C
QA2-kVAr	Reactive power, magnitude of instantaneous value, phase A
QB2-kVAr	Reactive power, magnitude of instantaneous value, phase B
QC2-kVAr	Reactive power, magnitude of instantaneous value, phase C
VAB-kV	Measured phase-to-phase voltage amplitude phase AB
VBC-kV	Measured phase-to-phase voltage amplitude phase BC
VCA-kV	Measured phase-to-phase voltage amplitude phase CA
VAB2-kV	Measured phase-to-phase voltage amplitude phase AB
VBC2-kV	Measured phase-to-phase voltage amplitude phase BC
VCA2-kV	Measured phase-to-phase voltage amplitude phase CA
V1-kV	Measured positive-sequence voltage

Table continues on next page

Indicator	Description
V2-kV	Measured negative-sequence voltage
V0-kV	Measured zero-sequence voltage
V1B-kV	Measured positive-sequence voltage
V2B-kV	Measured negative-sequence voltage
V0B-kV	Measured zero-sequence voltage

6.1.2.2 Using the local HMI for monitoring

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

6.1.3 Recorded data

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

- DFR records
- Fault records
- Events
- Load profile record

6.1.3.1 Creating digital fault records

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

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

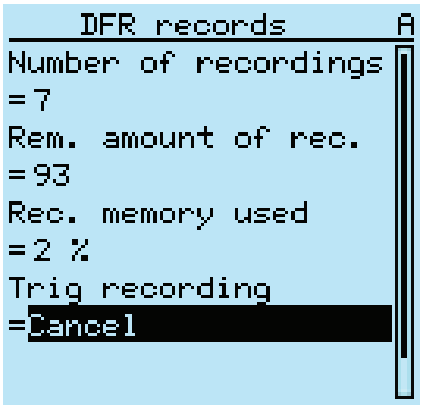


Figure 59: Changing the value

The DFR recorder is now triggered.

6.1.3.2 Monitoring DFR data

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

1. Select **Main menu/DFR records**.
   All the DFR information is listed.
2. Scroll the view with  or  .
   The following items are listed in the view:
   - Number of recordings currently in the protection relay's memory.
   - Remaining amount of recordings that fit into the available recording memory.
   - Recording memory used in percentage.
   - If the periodic triggering function is used, the time to trigger which indicates the remaining time to the next periodic triggering of the DFR.

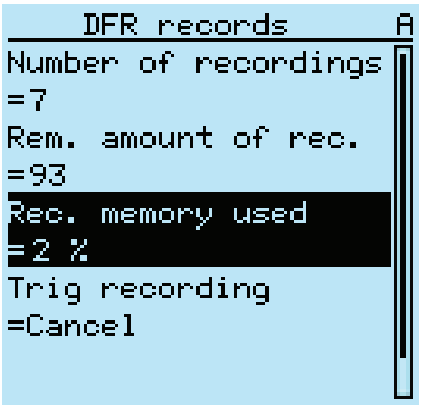


Figure 60: Monitoring DFR via the LHMI

6.1.3.3 Controlling and uploading of DFR recorder data

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

For more information, see the PCM600 documentation.

6.1.3.4 Monitoring fault records

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

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

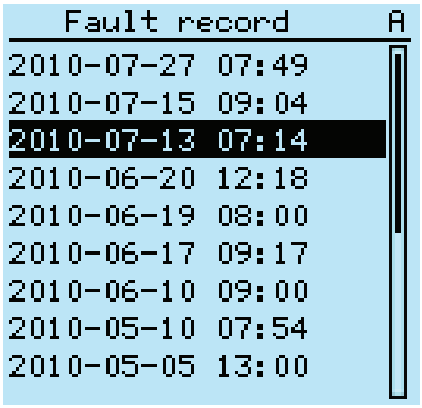


Figure 61: Monitoring fault records

6.1.3.5 Monitoring events

Event view contains a list of events produced by the application configuration. Each event takes one view area. The header area shows the currently viewed event index and the total amount of the events. The most recent event is always first.

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

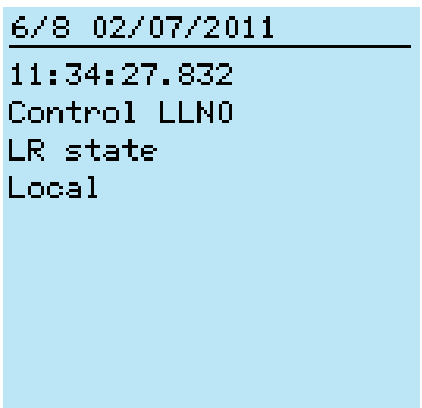


Figure 62: Monitoring events

6.1.3.6 Monitoring and uploading load profile record

- Monitor the recording memory usage of the load profile via **Main menu/ Monitoring/Load profile record**.
- Upload and analyze the load profile record with PCM600.

6.1.4 Remote monitoring

The protection relay supports comprehensive remote monitoring.

6.1.4.1 Monitoring protection relays remotely

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

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

For more information, see the PCM600 documentation.

6.2 Controlling

6.2.1 Controlling with single-line diagram

In the single-line diagram view, controllable objects can be opened and closed.

To control the protection relay, logging in and authorization are required.

6.2.1.1 Controlling circuit breaker, disconnectors and earthing switch

1. Select the object with or if it is not already selected.

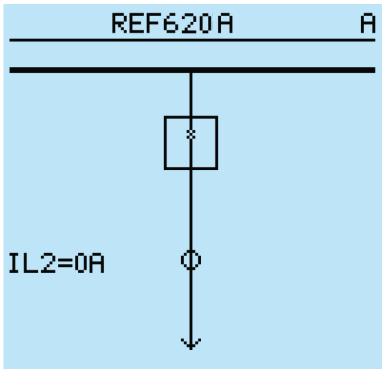


Figure 63: Single-line diagram with one breaker and IEC symbols

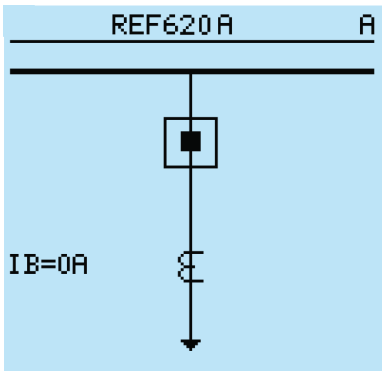


Figure 64: Single-line diagram with one breaker and ANSI symbols

The selected object has a square around it.

2. Press Open to open or Close to close the selected object.
3. Select `Yes` and press ↵ to confirm.

6.2.1.2 Controlling SLD buttons

Buttons are controlled with the Open and Close buttons like any other controllable single-line diagram objects.

1. Select the button with ↑ and ↓ if it is not already selected.
   The selected button has a square around it.
2. Press Open or Close to control the selected button.

The control position of the protection relay affects the controlling SLD buttons. Depending on the parameter settings, the protection relay may have to be in local state for the control to succeed.

6.2.2 Controlling via the control menu

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

1. Press Open to open or Close to close the object.
   - If there are several controllable objects, select the object with ↑ and ↓ and press ↵ to confirm the selection.

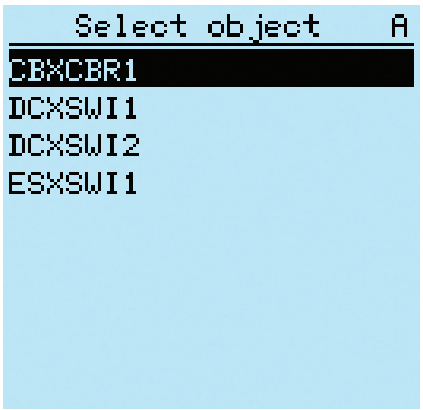


Figure 65: Selecting a controlled object

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

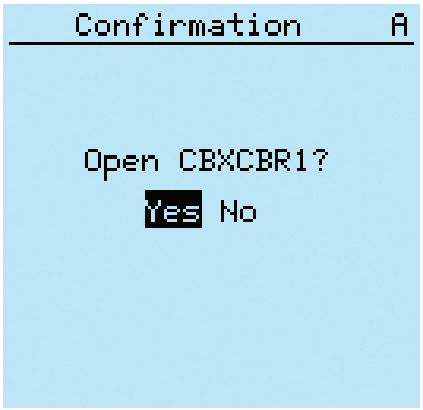


Figure 66: Opening a circuit breaker

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

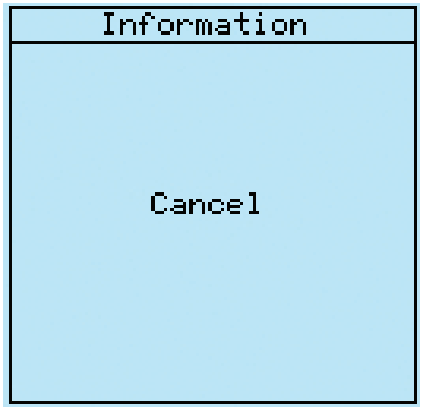


Figure 67: Cancelling operation

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

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

6.3 Resetting protection relays

6.3.1 Clearing and acknowledging via the local HMI

All messages and indications, including LEDs and latched outputs as well as registers and indications, including recordings can be reset, acknowledged or cleared with the Clear button. Pressing the Clear button activates a menu for selecting the wanted clearing or reset function. Events and alarms assigned to programmable LEDs can also be cleared with the Clear button.

1. Press Clear to activate the Clear view.
   All the items that can be cleared are shown.
   - Indications and LEDs
   - Programmable LEDs
   - Events
   - Metering records
   - Power quality data
   - DFR records
   - Fault records
   - Load profile record
   - Acc. energy of circuit breaker condition monitoring and three-phase power and energy measurement
   - Rem. life of circuit breaker condition monitoring
   - Travel times of circuit breaker condition monitoring
   - Spr. charge time of circuit breaker condition monitoring
   - Temperature of three-phase thermal protection for feeders, cables and distribution transformers, and thermal overload protection for motors
   - Reset of autoreclosing
   - Operation time of runtime counter for machines and devices
   - Counters for autoreclosing and motor startup supervision
   - Master trip

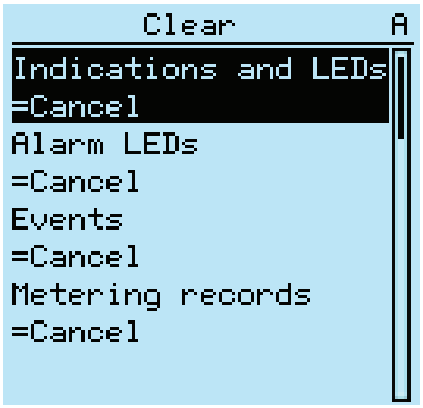


Figure 68: Clear view

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

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

6.4 Changing the protection relay functionality

6.4.1 Defining the setting group

6.4.1.1 Activating a setting group

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

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

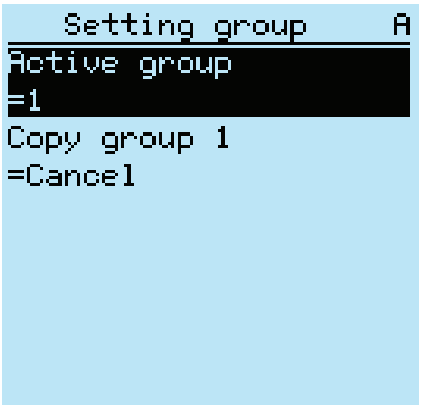


Figure 69: Active setting group

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

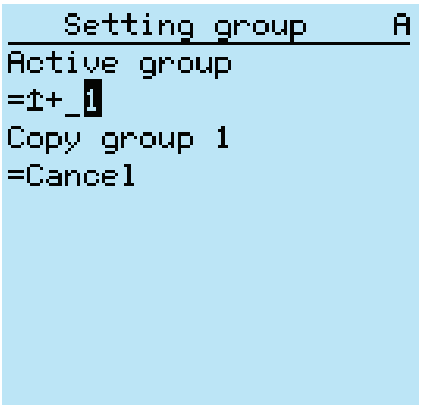


Figure 70: Selecting the active setting group

4. Commit the settings.

Remember to document the changes you make.

6.4.1.2 Copying a setting group

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

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

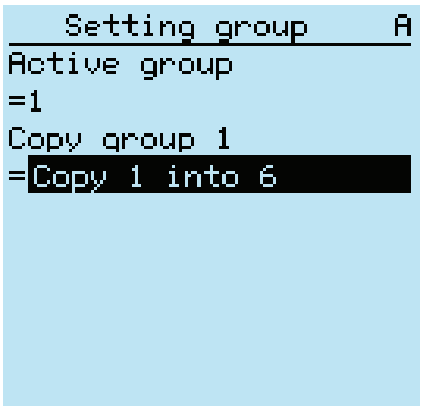


Figure 71: Copying setting group 1 into 6

6.4.1.3 Browsing and editing setting group values

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

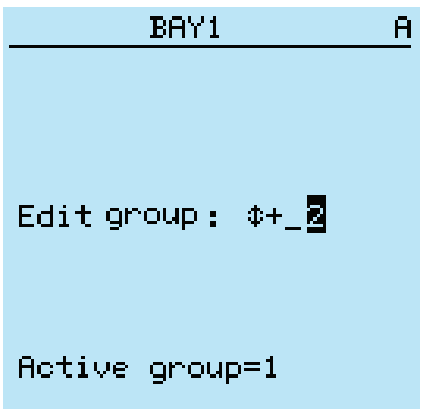


Figure 72: Selecting a setting group

3. To browse the settings, scroll the list with and and to select a setting press .

4. To browse different function blocks, scroll the list with ↑ and ↓ and to select a function block press →. To move back to the list, press ←.
   The function block list is shown in the content area of the display. On the left in the header, you see the current setting group, and on the right the menu path.
5. To browse the parameters, scroll the list with ↑ and ↓ and to select a parameter, press →.
   The setting group values are indicated with #.

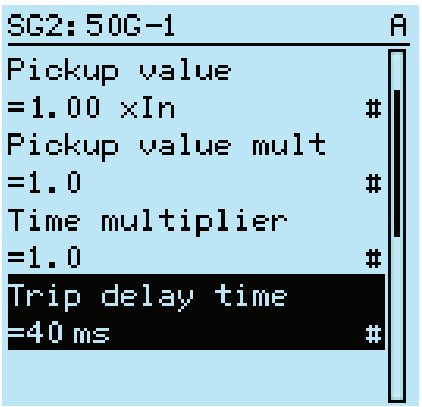


Figure 73: Setting group parameter

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

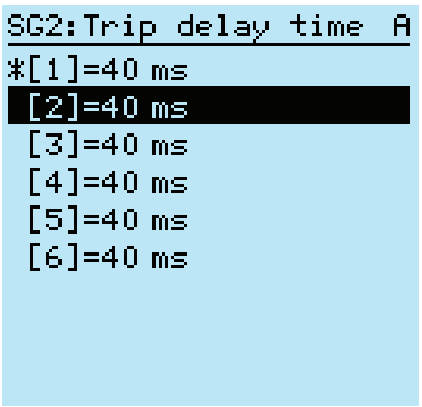


Figure 74: Selecting the setting group value

   Only values within the selected setting group can be changed.
7. Press ↑ or ↓ to change the value and ↵ to confirm the selection.

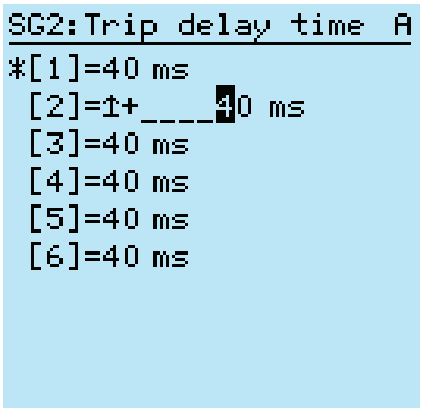


Figure 75: Editing the setting group value

The active setting group is indicated with an asterisk * .

6.4.2 Activating programmable LEDs

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

6.4.3 Setting autoscroll delay

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

1. Select **Main menu/Configuration/ HMI/Autoscroll delay** and press ↵ .
2. Select delay time with ↑ or ↓ .
3. Press ↵ to confirm the selection.

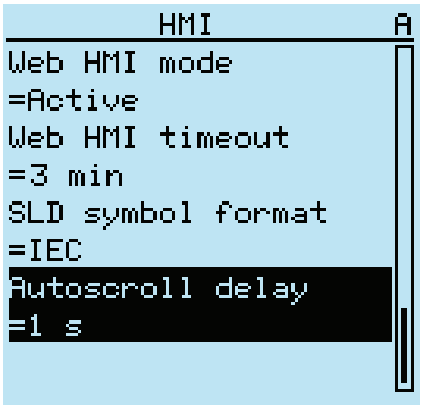


Figure 76: Autoscroll delay

Section 7 Troubleshooting

7.1 Fault tracing

7.1.1 Identifying hardware errors

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

7.1.2 Identifying runtime errors

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

7.1.3 Identifying communication errors

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

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

7.1.3.1 Checking front communication link operation

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

Table 19: Front communication LEDs

LED	Communication ok
Uplink	Steady green light
Communication	Flashing yellow light

7.1.3.2 Checking time synchronization

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

7.1.4 Running the display test

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

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

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

7.2 Indication messages

7.2.1 Internal faults

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

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

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

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

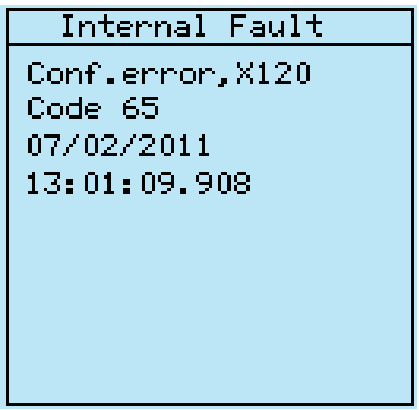


Figure 77: Fault indication

Table 20: Internal fault indications and codes

Fault indication	Fault code	Additional information
Internal Fault System error	2	An internal system error has occurred.
Internal Fault File system error	7	A file system error has occurred.
Internal Fault Test	8	Internal fault test activated manually by the user
Internal Fault SW watchdog error	10	Watchdog reset has occurred too many times within an hour.
Internal Fault SO-relay(s),X105	40	Faulty Signal Output relay(s) in card located in slot X105
Internal Fault SO-relay(s),X115	41	Faulty Signal Output relay(s) in card located in slot X115
Internal Fault SO-relay(s),X100	43	Faulty Signal Output relay(s) in card located in slot X100
Table continues on next page		

Fault indication	Fault code	Additional information
Internal Fault SO-relay(s),X110	44	Faulty Signal Output relay(s) in card located in slot X110
Internal Fault SO-relay(s),X120	45	Faulty Signal Output relay(s) in card located in slot X120
Internal Fault SO-relay(s),X130	46	Faulty Signal Output relay(s) in card located in slot X130
Internal Fault PO-relay(s),X105	50	Faulty Power Output relay(s) in card located in slot X105
Internal Fault PO-relay(s),X115	51	Faulty Power Output relay(s) in card located in slot X115
Internal Fault PO-relay(s),X100	53	Faulty Power Output relay(s) in card located in slot X100
Internal Fault PO-relay(s),X110	54	Faulty Power Output relay(s) in card located in slot X110
Internal Fault PO-relay(s),X120	55	Faulty Power Output relay(s) in card located in slot X120
Internal Fault PO-relay(s),X130	56	Faulty Power Output relay(s) in card located in slot X130
Internal Fault Light sensor error	57	Faulty ARC light sensor input(s)
Internal Fault Conf.error,X105	60	Card in slot X105 is wrong type
Internal Fault Conf.error,X115	61	Card in slot X115 is wrong type
Internal Fault Conf. error,X000	62	Card in slot X000 is wrong type
Internal Fault Conf. error,X100	63	Card in slot X100 is wrong type or does not belong to the original composition.
Internal Fault Conf. error,X110	64	Card in slot X110 is wrong type, is missing or does not belong to the original composition.
Internal Fault Conf. error,X120	65	Card in slot X120 is wrong type, is missing or does not belong to the original composition.
Internal Fault Conf.error,X130	66	Card in slot X130 is wrong type, is missing or does not belong to the original composition.
Internal Fault Card error,X105	70	Card in slot X105 is faulty.
Internal Fault Card error,X115	71	Card in slot X115 is faulty.
Internal Fault Card error,X000	72	Card in slot X000 is faulty.
Internal Fault Card error,X100	73	Card in slot X100 is faulty.

Table continues on next page

Fault indication	Fault code	Additional information
Internal Fault Card error,X110	74	Card in slot X110 is faulty.
Internal Fault Card error,X120	75	Card in slot X120 is faulty.
Internal Fault Card error,X130	76	Card in slot X130 is faulty.
Internal Fault LHMI module	79	LHMI module is faulty. The fault indication may not be seen on the LHMI during the fault.
Internal Fault RAM error	80	Error in the RAM memory on the CPU card.
Internal Fault ROM error	81	Error in the ROM memory on the CPU card.
Internal Fault EEPROM error	82	Error in the EEPROM memory on the CPU card.
Internal Fault FPGA error	83	Error in the FPGA on the CPU card.
Internal Fault RTC error	84	Error in the RTC on the CPU card.
Internal Fault RTD card error,X105	90	Card in slot X105 has RTD fault.
Internal Fault RTD card error,X110	94	Card in slot X110 has RTD fault.
Internal Fault RTD card error,X130	96	Card in slot X130 has RTD fault.

7.2.2 Warnings

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

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

Figure 78: Warning

Table 21: Warning indications and codes

Warning indication	Warning code	Additional information
Warning System warning	2	An internal system error has occurred.
Warning Watchdog reset	10	A watchdog reset has occurred.
Warning Power down det.	11	The auxiliary supply voltage has dropped too low.
Warning IEC61850 error	20	Error when building the IEC 61850 data model
Warning Modbus error	21	Error in the Modbus communication
Warning DNP3 error	22	Error in the DNP3 communication
Warning Dataset error	24	Error in the Data set(s)
Warning Report cont. error	25	Error in the Report control block(s)
Warning GOOSE contr. error	26	Error in the GOOSE control block(s)
Warning SCL config error	27	Error in the SCL configuration file or the file is missing
Warning Logic error	28	Too many connections in the configuration
Warning SMT logic error	29	Error in the SMT connections
Warning GOOSE input error	30	Error in the GOOSE connections
ACT error	31	Error in the ACT connections

Table continues on next page

Warning indication	Warning code	Additional information
Warning GOOSE Rx. error	32	Error in the GOOSE message receiving
Warning AFL error	33	Analog channel configuration error
Warning Unack card comp.	40	A new composition has not been acknowledged/accepted.
Warning Protection comm.	50	Error in protection communication
Warning ARC1 cont. light	85	A continuous light has been detected on the ARC light input 1.
Warning ARC2 cont. light	86	A continuous light has been detected on the ARC light input 2.
Warning ARC3 cont. light	87	A continuous light has been detected on the ARC light input 3.
Warning RTD card error,X105	90	Temporary error occurred in RTD card located in slot X105
Warning RTD card error,X110	94	Temporary error occurred in RTD card located in slot X110
Warning RTD card error,X130	96	Temporary error occurred in RTD card located in slot X130.
Warning RTD measurement error in X105	100	Measurement error in RTD card located in slot X105
Warning RTD measurement error in X110	104	Measurement error in RTD card located in slot X110
Warning RTD meas. error,X130	106	Measurement error in RTD card located in slot X130

7.3 Correction procedures

7.3.1 Rebooting the software

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

7.3.2 Restoring factory settings

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

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

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

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

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

7.3.3 Setting passwords

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

For more information, see User authorization.

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

7.3.4 Identifying relay application problems

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

7.3.4.1 Inspecting wiring

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

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

7.3.4.2 Sample data interruptions

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

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

Section 8 Commissioning

8.1 Commissioning checklist

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

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

8.2 Checking the installation

8.2.1 Checking of the power supply

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

8.2.2 Checking CT circuits

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

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

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

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

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

8.2.3 Checking VT circuits

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

Correct possible errors before continuing to test the circuitry.

Test the circuitry.

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

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

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

8.2.4 Checking binary input and output circuits

8.2.4.1 Checking binary input circuits

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

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

8.2.4.2 Checking binary output circuits

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

8.2.5 Checking optical connections

Check that the Tx and Rx optical connections are correct.

A relay equipped with optical connections requires a minimum depth of 180 mm (7.2 inches) for plastic fiber cables and 275 mm (10.9 inches) for glass fiber cables. Check the allowed minimum bending radius from the optical cable manufacturer.

8.3 Authorizations

8.3.1 User authorization

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

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

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

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

Table 22: Predefined user categories and default passwords

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

For user authorization for PCM600, see PCM600 documentation.

8.4 Using PCM600

8.4.1 Setting the communication between protection relays and PCM600

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

The media is always Ethernet and communication is based on TCP/IP.

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

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

To configure the physical connection and the IP addresses:

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

8.4.1.1 Communication link options between PCM600 and protection relays

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

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

Point to point link

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

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

LAN or WAN network

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

8.4.1.2 Setting communication parameters

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

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

Setting the front communication

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

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

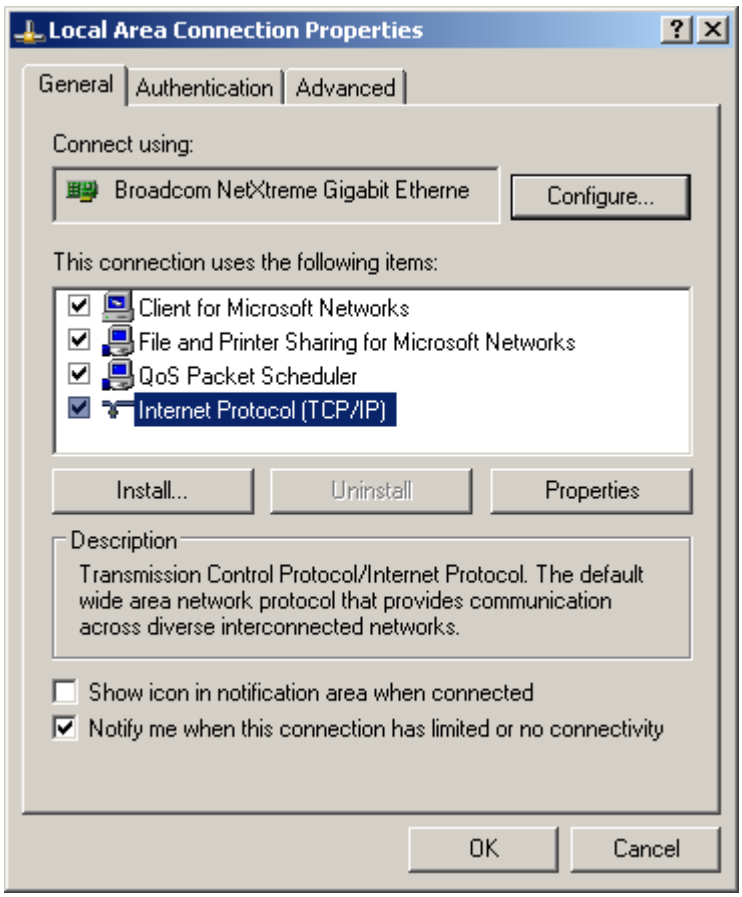


Figure 79: Selecting TCP/IP protocol

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

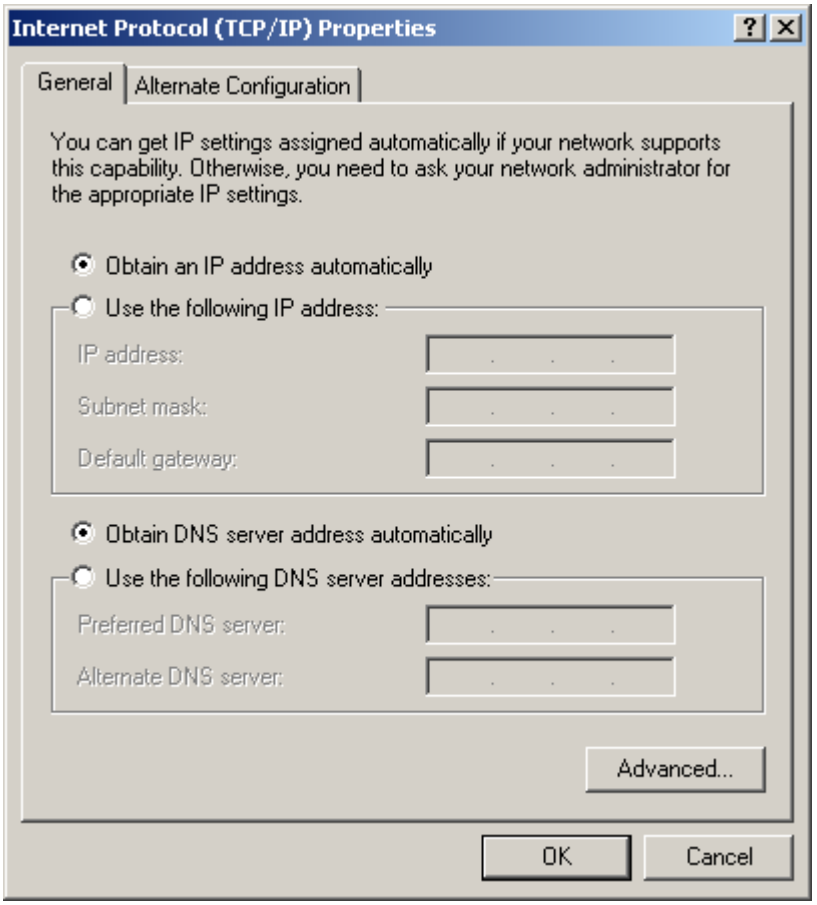


Figure 80: Obtaining IP address automatically

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

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

Setting the rear communication

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

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

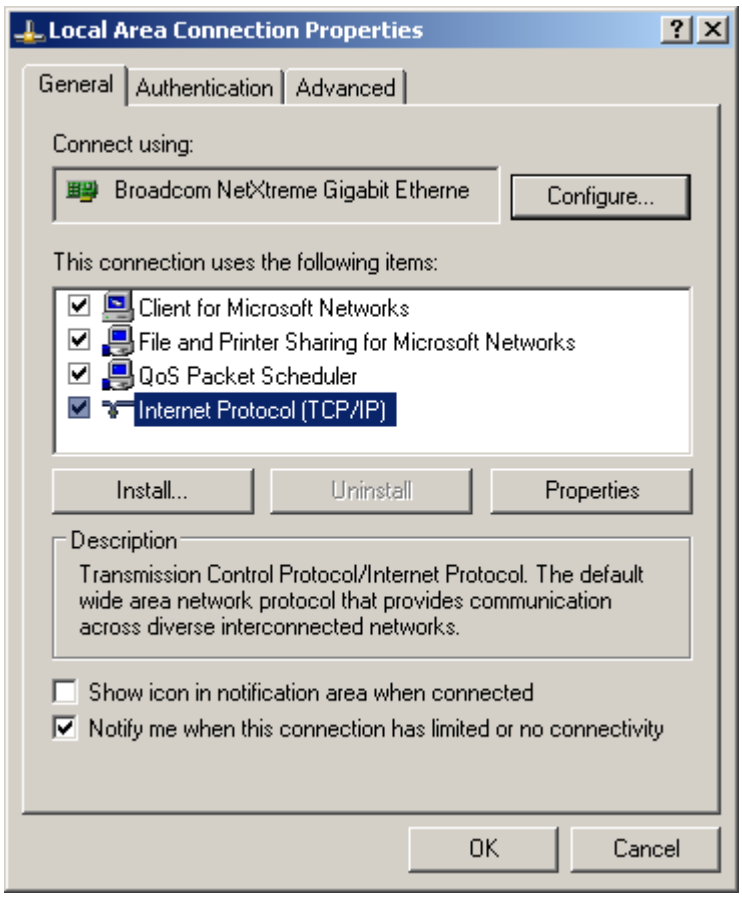


Figure 81: Selecting TCP/IP protocol

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

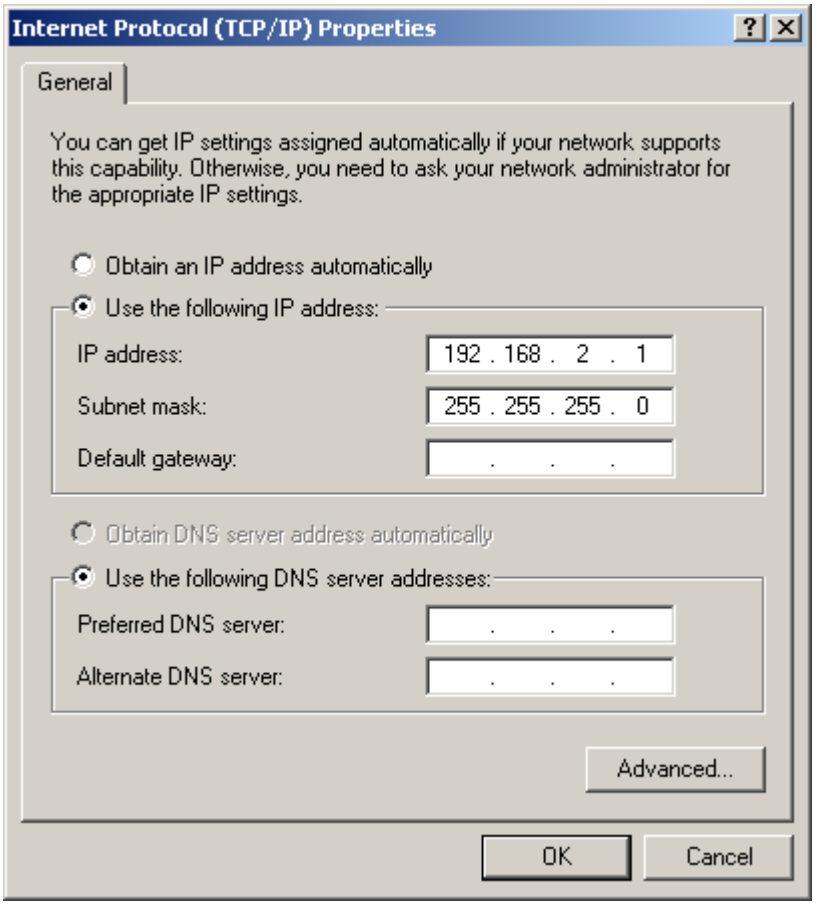


Figure 82: Setting IP address and subnet mask

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

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

Setting protection relay's IP address in PCM600

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

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

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

8.5 Setting protection relay and communication

8.5.1 Communication settings

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

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

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

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

For cyber security purposes, disable all unused communication protocols and ports.

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

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

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

8.5.1.1 Serial communication ports and drivers

Depending on the hardware configuration, the protection relay can be equipped with one or several UART-based serial communication ports. The communication ports can be either galvanic (RS-485, RS-232) or fiber optic. The protection relay uses serial ports and drivers as different types of serial communication protocol links.

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

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

Table 23: COM port parameters in different HW options

COM parameter	Values	Hardware options[1)]
Fiber mode	0 = No fiber	Used in the fiber optic mode only. Note that ”No fiber “ mode is the same as the galvanic mode.
	1 = Fiber light ON/loop	
	2 = Fiber light OFF/loop	
	3 = Fiber light ON/star	
	4 = Fiber light OFF/star	
Serial mode	0 = RS485 2wire	For galvanic modes. RS-type depends on the communication card used. Note that this setting parameter is relevant only if *Fiber mode* is set to “No Fiber”.
	1 = RS485 4wire	
	2 = RS232 no handshake	
	3 = RS232 with handshake	
CTS Delay	0…60000 [ms]	RS232 mode only
RTS Delay	0…60000 [ms]	RS232 mode only

Table continues on next page

COM parameter	Values	Hardware options[1)]
Baudrate	1 = 300	All modes
	2 = 600	
	3 = 1200	
	4 = 2400	
	5 = 4800	
	6 = 9600	
	7 = 19200	
	8 = 38400	
	9 = 57600	
	10 = 115200 [bits/sec]	

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

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

Connection of a serial communication protocol to a specific serial port

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

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

8.5.1.2 Serial link diagnostics and monitoring

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

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

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

Table 24: Monitoring data for a COM channel

Parameter	Range	Type	Description
Characters received	0…2147483646	Basic	Number of separate characters received.
Frames received	0…2147483646	Basic	Number of successfully received complete frames.
Frames discarded	0…2147483646	Basic	Number of frames discarded.
Frames transmitted	0…2147483646	Basic	Number of frames transmitted.
CD Lost	0…2147483646	Detailed	Number of carrier-detect signal lost during receive.
Collision	0…2147483646	Detailed	Number of collisions detected.
CTS Timeout	0…2147483646	Detailed	Number of clear-to-send signal timeout errors.
Transmission timeout	0…2147483646	Detailed	Number of transmission timeout errors.
Parity errors	0…2147483646	Detailed	Number of character parity errors detected.
Overrun errors	0…2147483646	Detailed	Number of character overrun errors detected.
Framing errors	0…2147483646	Detailed	Number of character overrun errors detected.
Link status	1		1 = Reset counters (by entering 1 the diagnostic counters are reset)

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

Table 25: Basic diagnostic counters

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

Table 26: Detailed error counters

Counter	Function
CD Lost	In RS-232 handshake mode, characters are to be received as long as Carrier Detect (CD) signal is active. This counter is incremented if the CD signal is lost during reception.
Collision	Counts transmission collisions. Used in RS-485 mode by some protocols where transmissions could collide. For example, DNP3 unsolicited mode.
CTS Timeout.	In RS-232 handshake mode the Clear To Send (CTS) signal is not received as reply to this device Request To Send (RTS) signal.
Transmission timeout.	In RS-232 handshake mode. If the CTS signal goes inactive during transmission then the transmission is halted. Transmission will be resumed when CTS goes active again. The whole frame transmission must anyhow be ready within a specified time. If this timeout elapses then this counter is incremented. Result will be that the end of the frame is not being transmitted out.
Parity errors	Counts parity errors detected in characters.
Overrun errors	Counts overrun errors detected in characters.
Framing errors	Counts framing errors detected in characters

Table 27: Link status

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

8.5.1.3 Defining Ethernet port settings

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

1. Select **Main menu/Configuration/Communication/Ethernet/Rear port**.
2. Define the settings for the Ethernet port.
   - IP address
   - Subnet mask
   - Default gateway of the optional rear port Ethernet connector

8.5.1.4 Defining serial port settings

The serial COM setting is not currently supported.

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

8.5.1.5 Setting communication protocol parameters

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

8.5.1.6 Connecting jumper connectors

See the technical manual for details on jumper connectors.

8.5.1.7 Communication checklist

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

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

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

8.5.2 Setting the local HMI

8.5.2.1 Changing the local HMI language

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

Figure 83: Changing the LHMI language

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

8.5.2.2 Adjusting the display contrast

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

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

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

8.5.2.3 Changing display symbols

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

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

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

8.5.2.4 Changing the default view

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

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

8.5.2.5 Setting the system time and time synchronization

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

Setting daylight saving time

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

1. Set the *DST on day* and *DST off day* parameters to define on which week day the time shift occurs.
2. Set the *DST on date* and *DST off date* parameters to define on which month and week the time shift occurs.

The DST on/off date must precede the selected DST on/off day and be within the same week as the DST shift.

Table 28: Possible date values for DST change on Sunday

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

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

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

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

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

8.5.3 Setting protection relay parameters

8.5.3.1 Defining setting groups

Selecting a setting group for editing

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

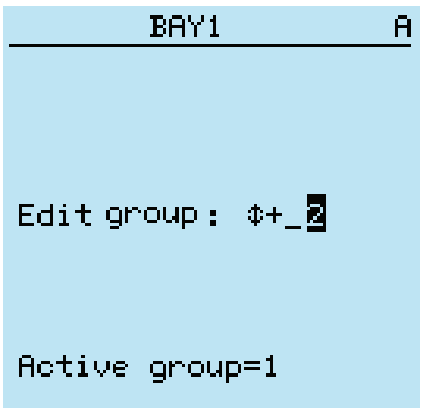


Figure 84: Selecting a setting group

Browsing and editing setting group values

1. Select **Main menu/Settings/Settings** and press →.
2. Select the setting group to be viewed with ↑ or ↓ and press ↵ to confirm the selection.

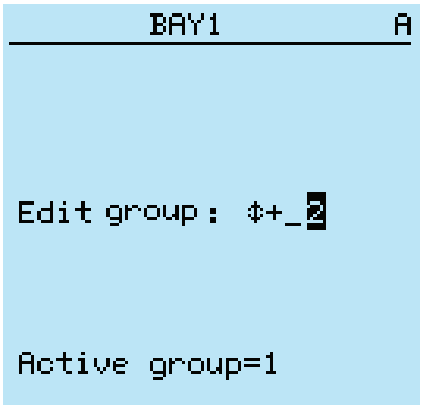


Figure 85: Selecting a setting group

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

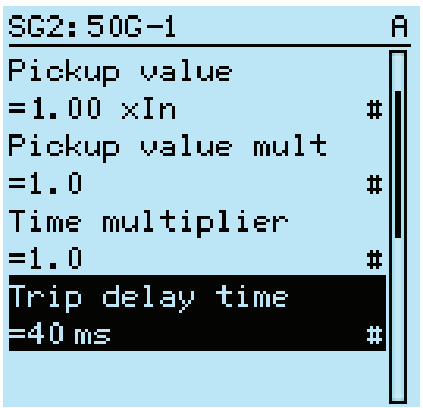


Figure 86: Setting group parameter

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

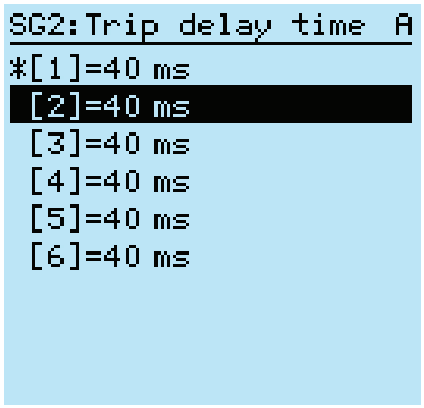


Figure 87: Selecting the setting group value

Only values within the selected setting group can be changed.

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

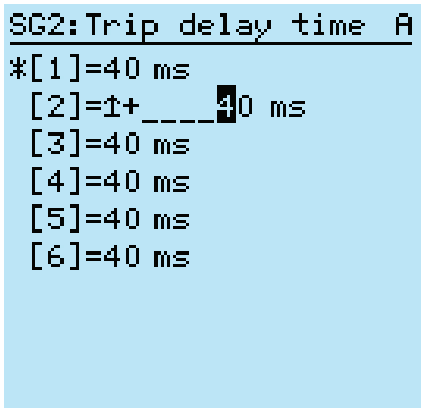


Figure 88: Editing the setting group value

The active setting group is indicated with an asterisk * .

Activating a setting group

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

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

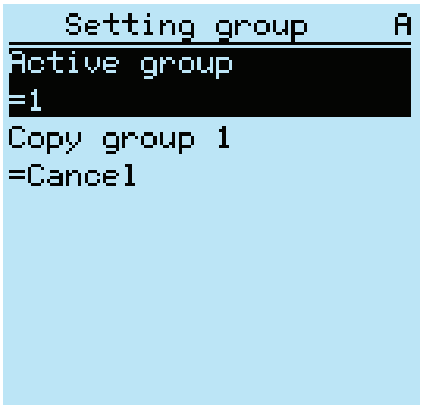


Figure 89: Active setting group

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

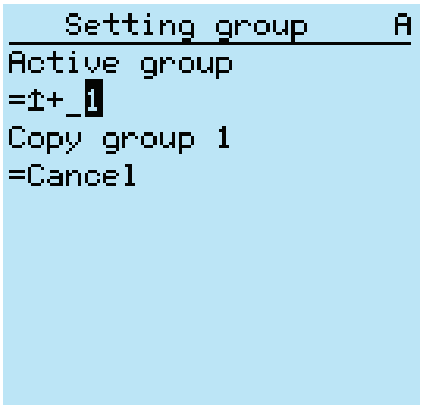


Figure 90: Selecting the active setting group

4. Commit the settings.

Remember to document the changes you make.

8.5.3.2 Relay parametrization

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

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

Document all changes to parameter settings.

For more information, see the PCM600 documentation.

8.5.3.3 Defining DFR channel settings

1. Select **Main Menu/Configuration/DFR/Channel settings**.
2. Press or to select the wanted channel and parameter.
3. To change channel settings, press .

Analog channels are fixed except channel 4 which is selectable based on the Ground CT option.

8.5.3.4 Configuring analog inputs

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

8.6 Testing protection relay operation

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

8.6.1 Selecting the test mode

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

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

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

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

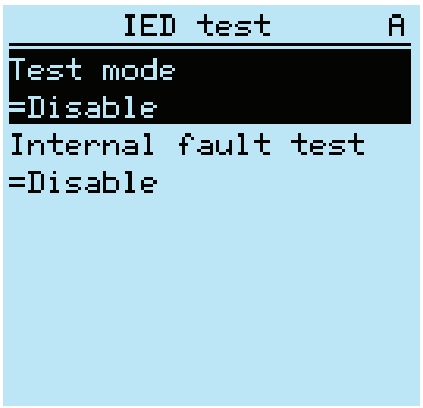


Figure 91: Entering test mode

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

If the test mode is not cancelled, it remains on and the Normal LED remains flashing.

8.6.2 Testing the digital I/O interface

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

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

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

8.6.3 Testing functions

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

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

8.6.4 Selecting the internal fault test

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

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

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

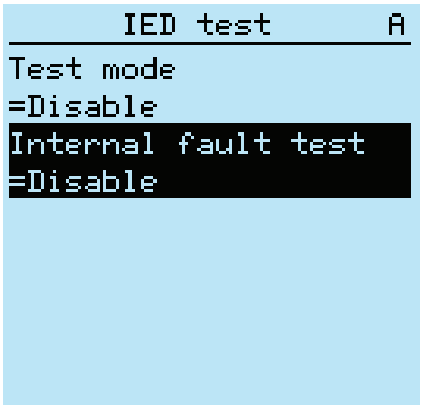


Figure 92: Internal fault test

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

8.7 ABB Product Data Registration

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

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

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

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

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

Section 9 Glossary

100BASE-FX	A physical medium defined in the IEEE 802.3 Ethernet standard for local area networks (LANs) that uses fiber optic cabling
100BASE-TX	A physical medium defined in the IEEE 802.3 Ethernet standard for local area networks (LANs) that uses twisted-pair cabling category 5 or higher with RJ-45 connectors
AC	Alternating current
ACT	1. Application Configuration tool in PCM600 2. Trip status in IEC 61850
ANSI	American National Standards Institute
ARP	Address Resolution Protocol
CAT 5	A twisted pair cable type designed for high signal integrity
COMTRADE	Common format for transient data exchange for power systems. Defined by the IEEE Standard.
CPU	Central processing unit
CRC	Cyclical redundancy check
CSV	Comma-separated values
CT	Current transformer
DAN	Doubly attached node
DC	1. Direct current 2. Disconnector 3. Double command
DFR	Digital fault recorder
DHCP	Dynamic Host Configuration Protocol
DNP3	A distributed network protocol originally developed by Westronic. The DNP3 Users Group has the ownership of the protocol and assumes responsibility for its evolution.
DNS	Domain Name System
DPC	Double-point control
DST	Daylight-saving time

EEPROM	Electrically erasable programmable read-only memory
EMC	Electromagnetic compatibility
Ethernet	A standard for connecting a family of frame-based computer networking technologies into a LAN
FB	Function block
FIFO	First in, first out
Firmware	System software or hardware that has been written and stored in a device's memory that controls the device
FPGA	Field-programmable gate array
FTP	File transfer protocol
GOOSE	Generic Object-Oriented Substation Event
HMI	Human-machine interface
HSR	High-availability seamless redundancy
HW	Hardware
IEC	International Electrotechnical Commission
IEC 61850	International standard for substation communication and modeling
IEC 61850-8-1	A communication protocol based on the IEC 61850 standard series
IED	Intelligent electronic device
IEEE 1686	Standard for Substation Intelligent Electronic Devices' (IEDs') Cyber Security Capabilities
IP	Internet protocol
IP address	A set of four numbers between 0 and 255, separated by periods. Each server connected to the Internet is assigned a unique IP address that specifies the location for the TCP/IP protocol.
IRF	1. Internal fault 2. Internal relay fault
IRIG-B	Inter-Range Instrumentation Group's time code format B
LAN	Local area network
LC	Connector type for glass fiber cable
LCD	Liquid crystal display
LCP	Liquid crystal polymer

LCT	Life cycle traceability
LED	Light-emitting diode
LHMI	Local human-machine interface
MAC	Media access control
MMS	1. Manufacturing message specification 2. Metering management system
Modbus	A serial communication protocol developed by the Modicon company in 1979. Originally used for communication in PLCs and RTU devices.
Modbus ASCII	Link mode using 7-bit ASCII characters
Modbus RTU	Link mode using 8-bit binary characters
Modbus TCP/IP	Modbus RTU protocol which uses TCP/IP and Ethernet to carry data between devices
NCC	Network control center
PA	Polyamide
PBT	Polybutylene terephthalate
PC	1. Personal computer 2. Polycarbonate
PCM600	Protection and Control IED Manager
PRP	Parallel redundancy protocol
R/L	Remote/Local
RAM	Random access memory
RJ-45	Galvanic connector type
RoHS	Restriction of hazardous substances
ROM	Read-only memory
RS-232	Serial interface standard
RS-485	Serial link according to EIA standard RS485
RSTP	Rapid spanning tree protocol
RTC	Real-time clock
RTD	Resistance temperature detector
Rx	Receive/Received
SAN	Single attached node

SCL	XML-based substation description configuration language defined by IEC 61850
Single-line diagram	Simplified notation for representing a three-phase power system. Instead of representing each of three phases with a separate line or terminal, only one conductor is represented.
SLD	Single-line diagram
SMT	Signal Matrix tool in PCM600
SNTP	Simple Network Time Protocol
STP	Shielded twisted-pair
Subnet mask	A set of four numbers used to create IP address numbers that are used only within a particular network, subnet
SVG	Scalable vector graphics
SW	Software
TCP	Transmission Control Protocol
TCP/IP	Transmission Control Protocol/Internet Protocol
Tx	Transmit/Transmitted
UDP	User datagram protocol
UL	Underwriters Laboratories
UTC	Coordinated universal time
VT	Voltage transformer
WAN	Wide area network
WHMI	Web human-machine interface

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