Relion® 670 series

Line distance protection REL670 2.0
Product guide

Power and productivity
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Contents

1. Application

REL670 is used for the protection, control and monitoring of overhead lines and cables in solidly earthed networks. The IED can be used up to the high voltage levels. It is suitable for the protection of heavily loaded lines and multi-terminal lines where the requirement for tripping is one-, two- and/or three-phase. The IED is also suitable as back-up protection of power transformers, reactors and so on.

The full scheme distance protection provides protection of power lines with high sensitivity and low requirement on remote end communication. The five zones have fully independent measuring and setting which gives high flexibility for all types of lines. Load encroachment and adaptive reach compensation are included.

The modern technical solution offers fast operating time of typically 1.5 cycles.

The REL670 also includes an alternative for used on not solidly earthed networks. It includes Phase Preference Logic to select and trip only one line at cross-country faults.

The autorecloser for single-, two-, and/or three-phase tripping and autoreclosing includes priority features for multi-breaker arrangements. It co-operates with the synchrocheck function with high-speed or delayed reclosing.

A high impedance differential protection can be used to protect T-feeders or line reactors.

High set instantaneous phase and earth overcurrent, four step directional or non-directional delayed phase and earth overcurrent, sensitive earth fault for not direct earthed systems, thermal overload and two step under and overvoltage protection are examples of the available functions allowing the user to fulfill any application requirement.

The distance phase and earth fault protection, and the directional earth overcurrent protection can communicate with remote end in any teleprotection communication scheme. With the included remote communication, following the IEEE C37.94 standard, 6 x 32 channels for intertrip and binary signals are available per LDCM communication module in the communication between the IEDs.

The IED can also be provided with full bay control and interlocking functionality including co-operation with the synchrocheck function to allow integration of the main or back-up control.

Out of Step function is available to separate power system sections close to electrical centre at occurring out of step.

REL670 can be used in applications with the IEC 61850-9-2LE process bus with up to three Merging Units (MU). Each MU has eight analogue channels, normally four current and four voltages. Conventional and Merging Unit channels can be mixed freely in your application.

The advanced logic capability, where the user logic is prepared with a graphical tool, allows special applications such as automatic opening of disconnectors in multi-breaker arrangements, closing of breaker rings, load transfer logics and so on. The graphical configuration tool with delay mode, ensures simple and fast testing and commissioning.

Disturbance recording and fault locator are available to allow independent post-fault analysis after primary disturbances.

Communication via optical connections ensures immunity against disturbances.

Five packages have been defined for following applications:

- Single-breaker (double or single bus) with three phase tripping for high ohmic and resonance earthed systems (A21)
- Single-breaker (double or single bus) with three phase tripping (A31)
- Single-breaker (double or single bus) with single phase tripping (A32)
- Multi-breaker (one-and a half or ring) with three phase tripping (B31)
- Multi-breaker (one-and a half or ring) with single phase tripping (B32)

Optional functions are not configured but a maximum configuration with all optional functions are available as template in the graphical configuration tool. Analog inputs and binary input/output signals are pre-defined for basic use. Other signals may be required by each particular application.

Add binary I/O boards as required for the application when ordering.

"Basic IED functions"

Description of configuration A21

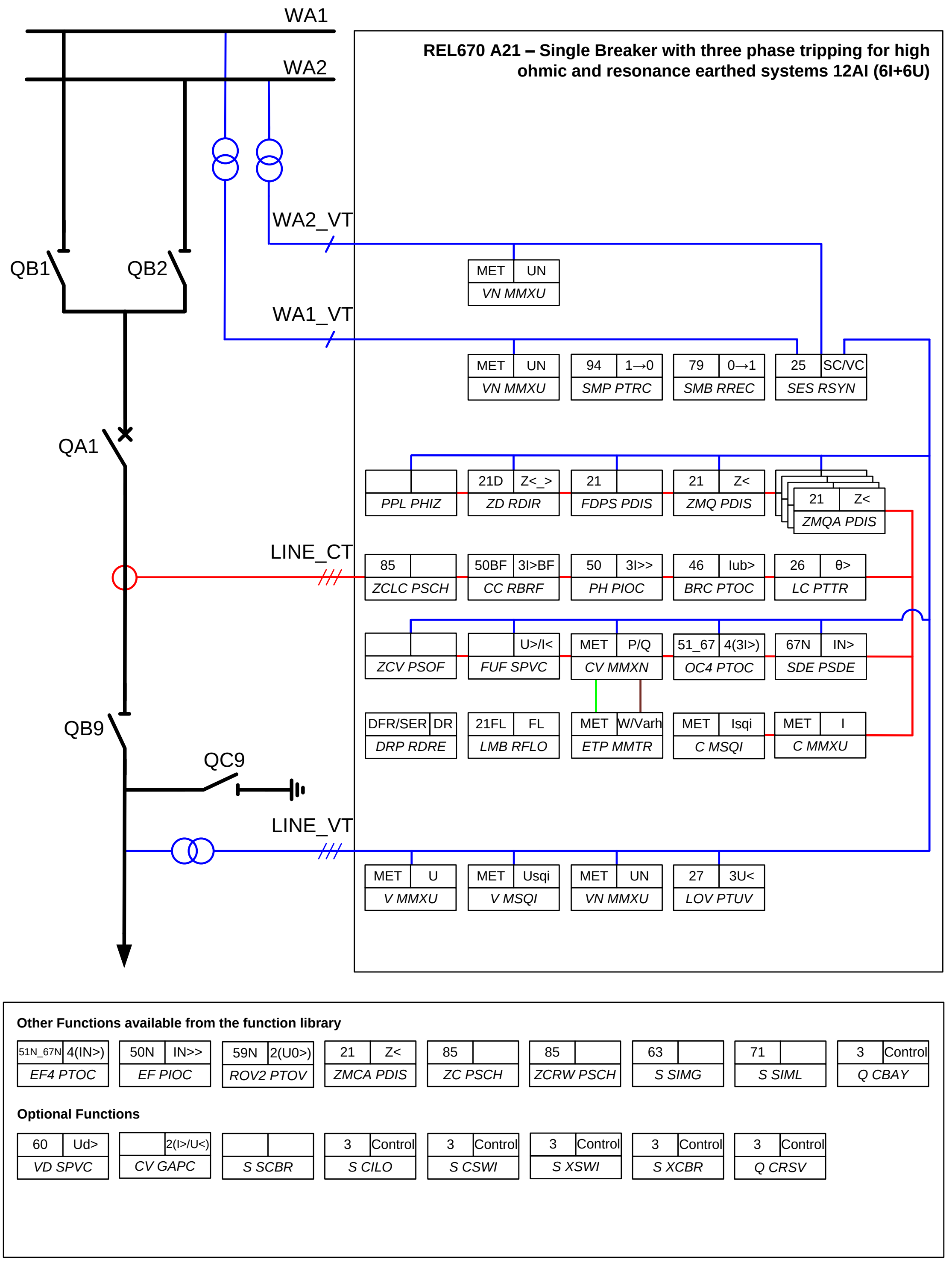


Figure 1. Configuration diagram for configuration A21

Description of configuration A31

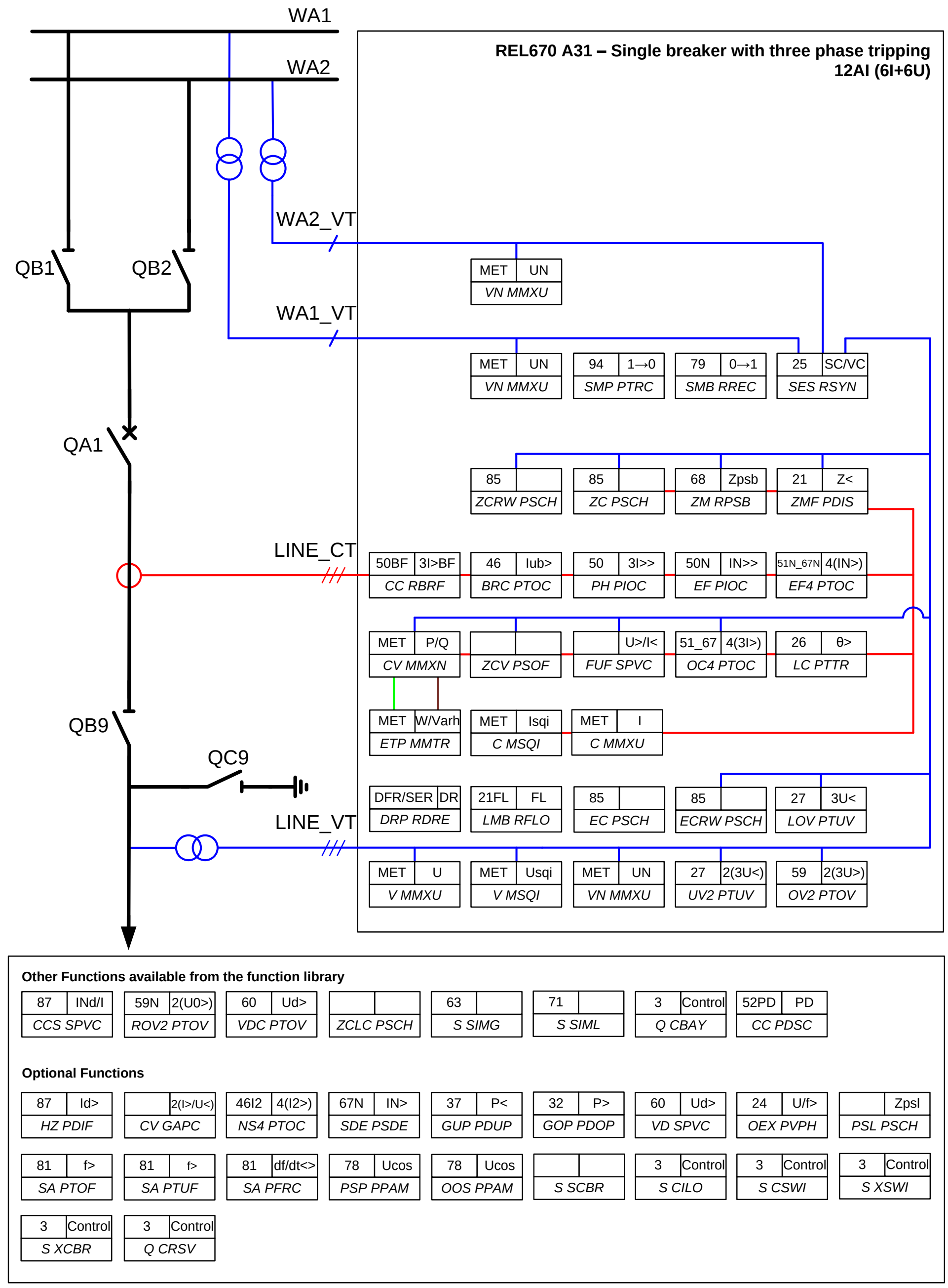


Figure 2. Configuration diagram for configuration A31

Description of configuration A32

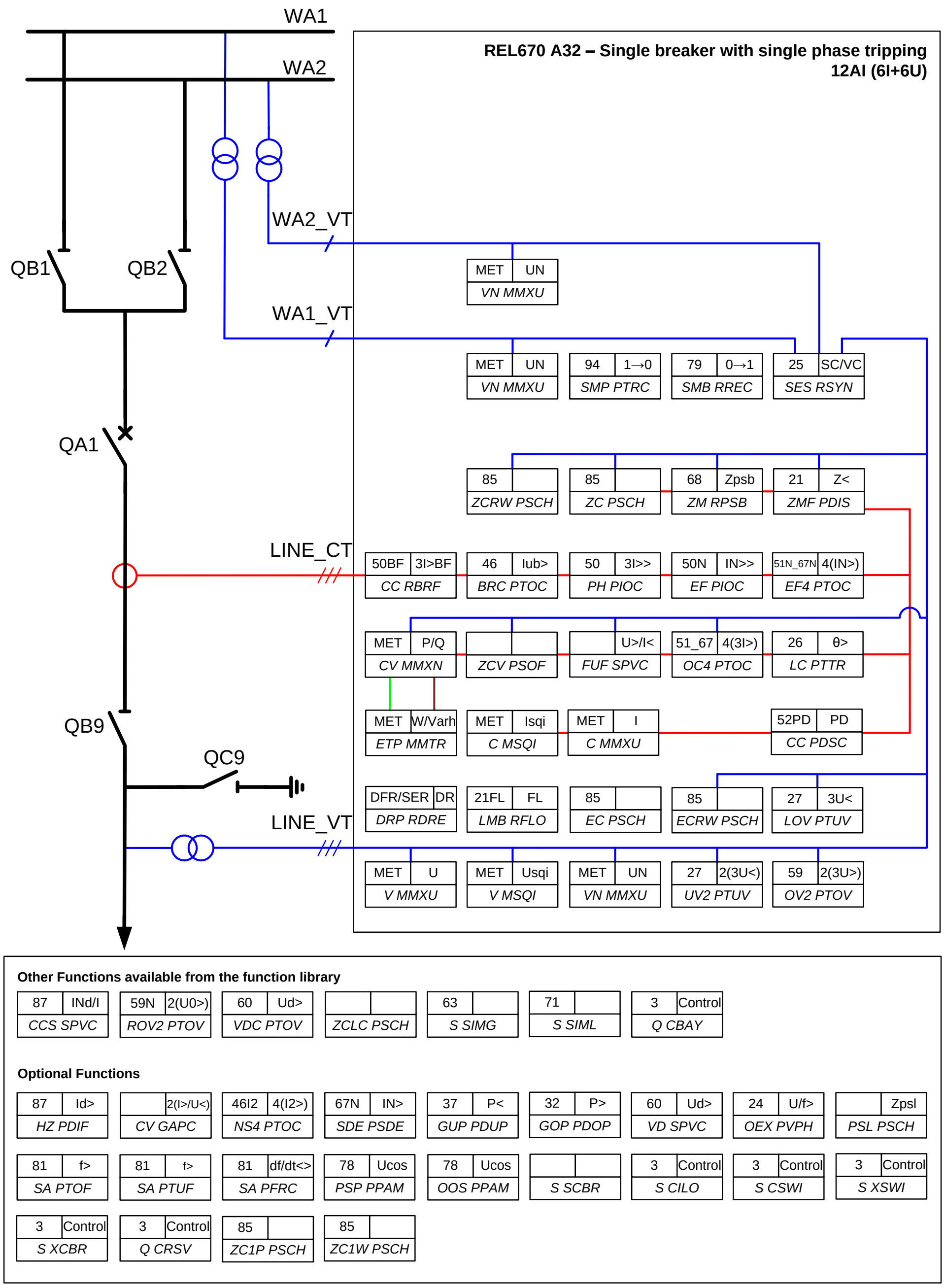


Figure 3. Configuration diagram for configuration A32

Description of configuration B31

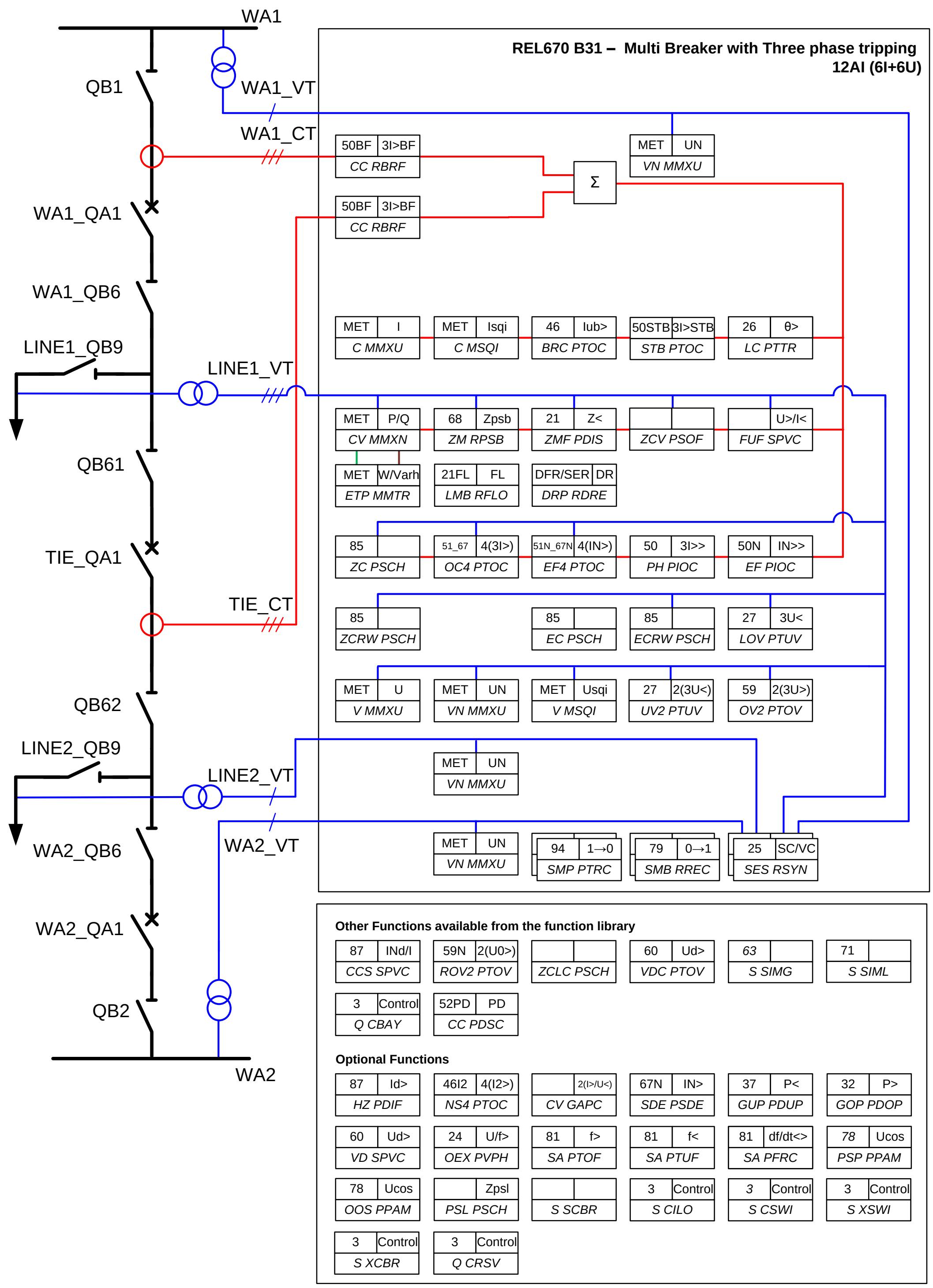


Figure 4. Configuration diagram for configuration B31

Description of configuration B32

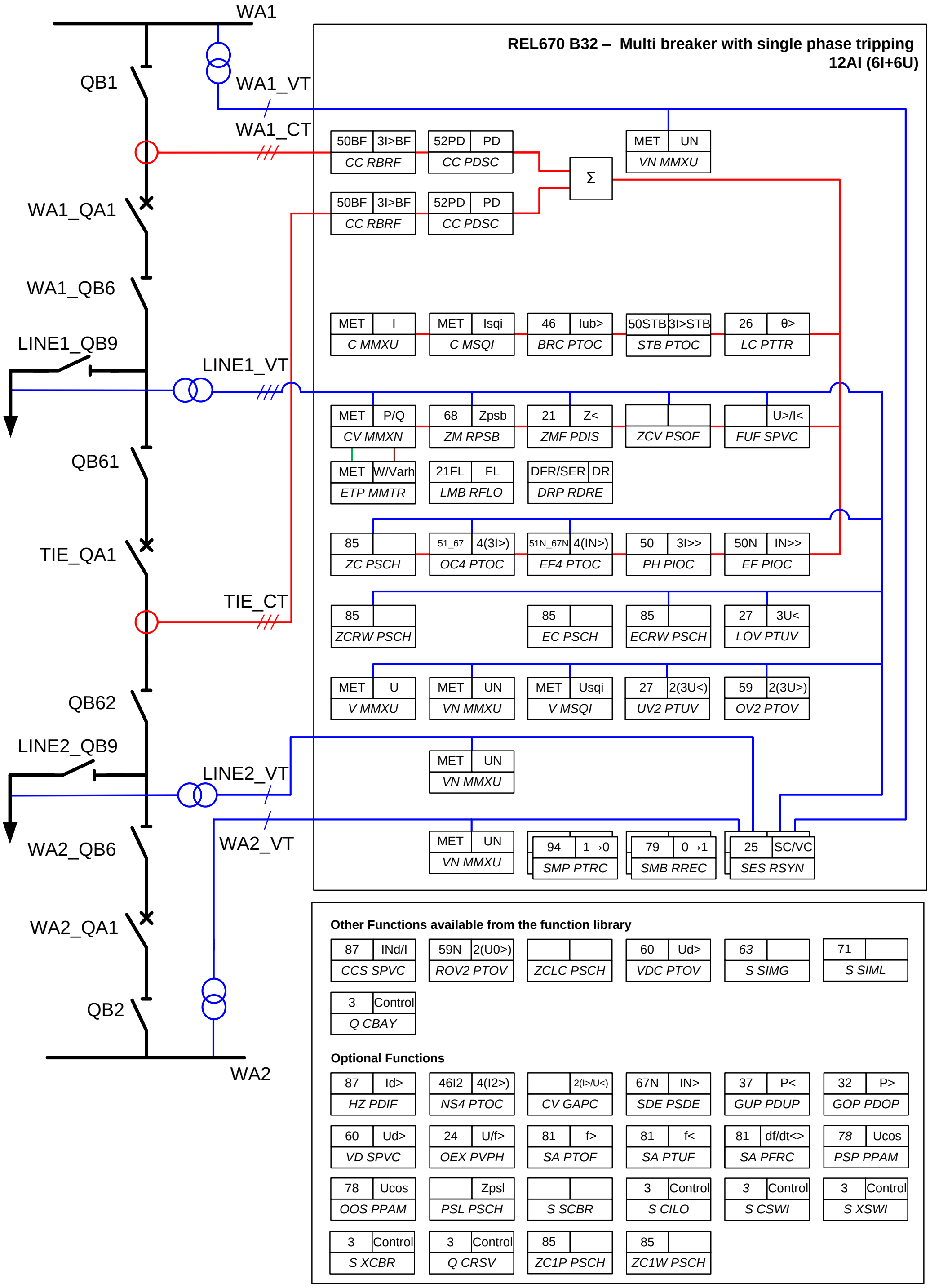


Figure 5. Configuration diagram for configuration B32

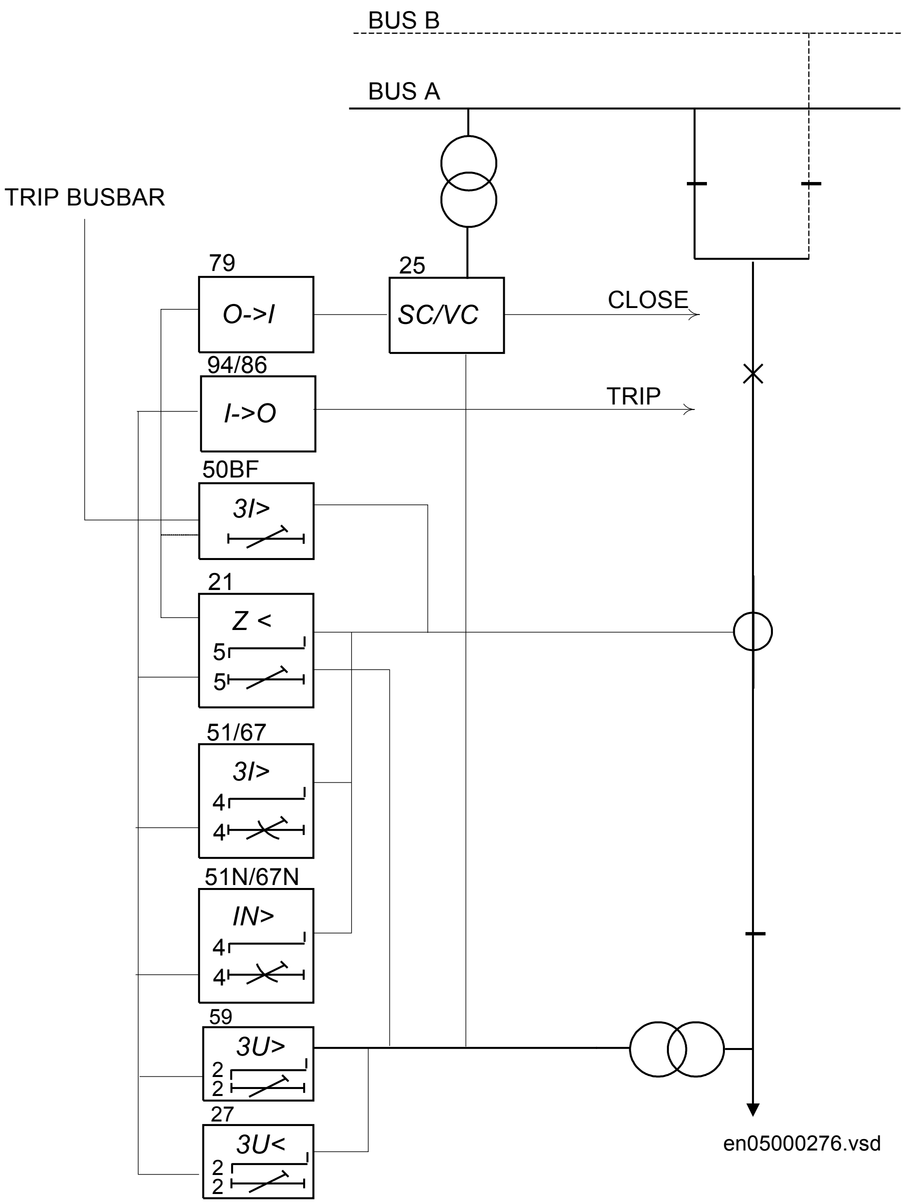


Figure 6. The single breaker packages for single- and three phase tripping typical arrangement for one protection sub-system is shown here.

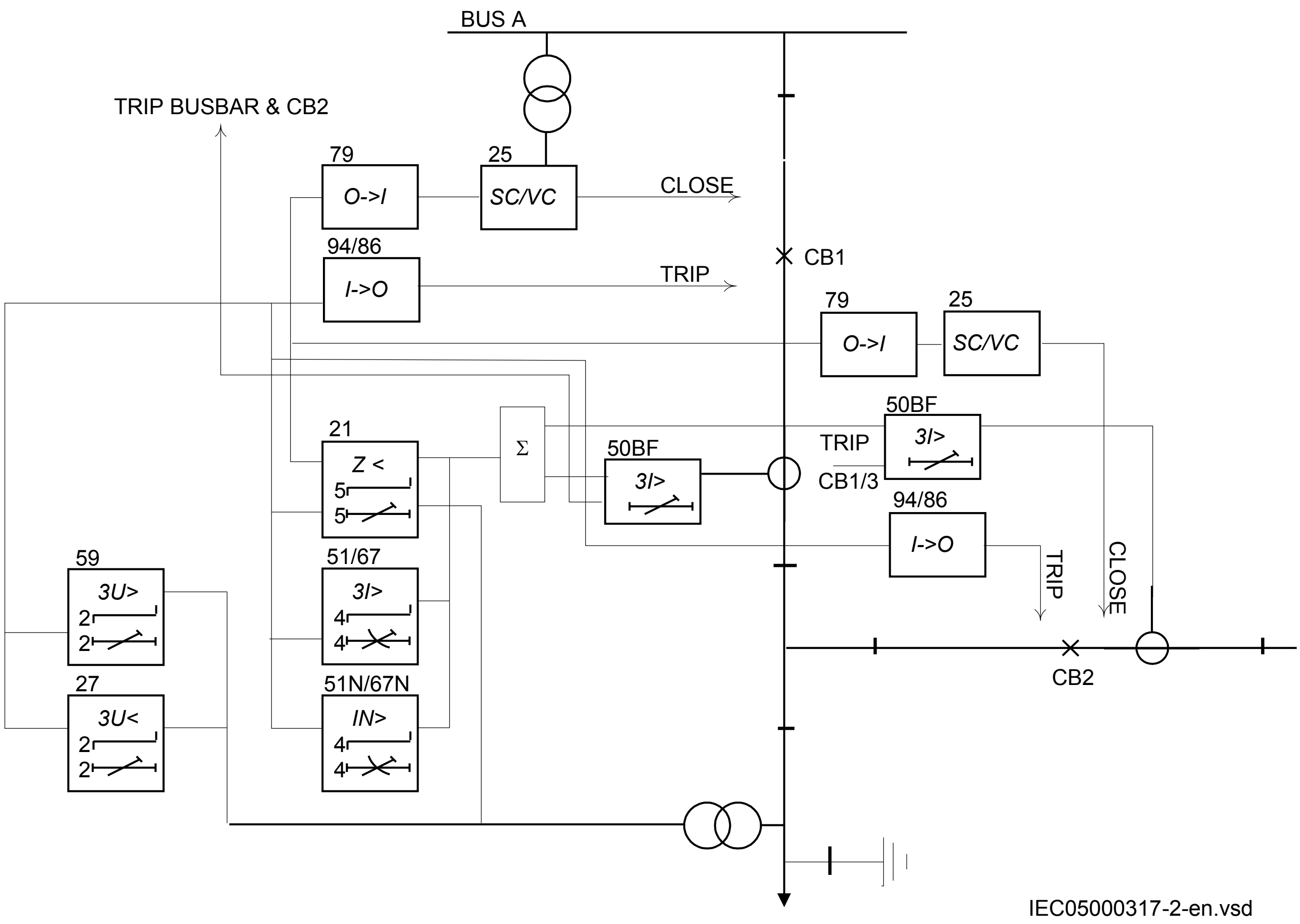


Figure 7. The multi breaker packages for single- and three phase tripping typical arrangement for one protection sub-system is shown here. Auto-reclose, Synchrocheck and Breaker failure functions are included for each of the two breakers.

2. Available functions

Main protection functions

2	= number of basic instances
0-3	= option quantities
3-A03	= optional function included in packages A03 (refer to ordering details)

IEC 61850	ANSI	Function description	Line Distance					
			REL670	REL670 (A21)	REL670 (A31)	REL670 (B31)	REL670 (A32)	REL670 (B32)
Differential protection								
HZPDIF	87	1Ph high impedance differential protection	0-3		3-A02	3-A02	3-A02	3-A02
LDRGFC	11REL	Additional security logic for differential protection	0-1					
Impedance protection								
ZMQPDIS, ZMQAPDIS	21	Distance protection zone, quadrilateral characteristic	1-5	5				
ZDRDIR	21D	Directional impedance quadrilateral	1-2	1				
ZMCAPDIS	21	Additional distance measuring zone, quadrilateral characteristic		1				
ZMCPDIS, ZMCAPDIS	21	Distance measuring zone, quadrilateral characteristic for series compensated lines	1-5					
ZDSRDIR	21D	Directional impedance quadrilateral, including series compensation	1-2					
FDPSPDIS	21	Phase selection, quadrilateral characteristic with fixed angle	2	2				
ZMHPDIS	21	Fullscheme distance protection, mho characteristic	1-5					
ZMMPDIS, ZMMAPDIS	21	Fullscheme distance protection, quadrilateral for earth faults	1-5					
ZDMRDIR	21D	Directional impedance element for mho characteristic	1-2					
ZDARDIR		Additional distance protection directional function for earth faults	1-2					
ZSMGAPC		Mho impedance supervision logic	1					
FMPSPDIS	21	Faulty phase identification with load enchroachment	2					
ZMRPDIS, ZMRAPDIS	21	Distance protection zone, quadrilateral characteristic, separate settings	1-5					
FRPSPDIS	21	Phase selection, quadrilateral characteristic with fixed angle	2					
ZMFPDIS	21	High speed distance protection	1		1	1	1	1
ZMFCPDIS	21	High speed distance protection for series compensated lines	1					
ZMRPSB	68	Power swing detection	0-1		1	1	1	1
PSLPSCH		Power swing logic	0-1		1-B03	1-B03	1-B03	1-B03
PSPPPAM	78	Pole slip/out-of-step protection	0-2		1-B22	1-B22	1-B22	1-B22
OOSPPAM	78	Out-of-step protection	0–1		1-B22	1-B22	1-B22	1-B22
ZCVPSOF		Automatic switch onto fault logic, voltage and current based	1	1	1	1	1	1
PPLPHIZ		Phase preference logic	0-1	1				

Back-up protection functions

IEC 61850	ANSI	Function description	Line Distance					
			REL670	REL670 (A21)	REL670 (A31)	REL670 (B31)	REL670 (A32)	REL670 (B32)
Current protection								
PHPIOC	50	Instantaneous phase overcurrent protection	0-3	1	1	1	1	1
OC4PTOC	51_67[1]	Four step phase overcurrent protection	0-3	1	1	1	1	1
EFPIOC	50N	Instantaneous residual overcurrent protection	0-3	1	1	1	1	1
EF4PTOC	51N 67N[2]	Four step residual overcurrent protection	0-3		1	1	1	1
NS4PTOC	46I2	Four step directional negative phase sequence overcurrent protection	0-2		1-C41	1-C41	1-C41	1-C41
SDEPSDE	67N	Sensitive directional residual overcurrent and power protection	0-1	1	1-C16	1-C16	1-C16	1-C16
LCPTTR	26	Thermal overload protection, one time constant, Celsius	0–2	1	1	1	1	1
LFPTTR	26	Thermal overload protection, one time constant, Fahrenheit	0–2	1	1	1	1	1
CCRBRF	50BF	Breaker failure protection	0-2	1	1	2	1	2
STBPTOC	50STB	Stub protection	0-1			1		1
CCPDSC	52PD	Pole discordance protection	0-2		1	2	1	2
GUPPDUP	37	Directional underpower protection	0-2		1-C17	1-C17	1-C17	1-C17
GOPPDOP	32	Directional overpower protection	0-2		1-C17	1-C17	1-C17	1-C17
BRCPTOC	46	Broken conductor check	1	1	1	1	1	1
VRPVOC	51V	Voltage restrained overcurrent protection	0-3					
Voltage protection								
UV2PTUV	27	Two step undervoltage protection	0-2		1	1	1	1
OV2PTOV	59	Two step overvoltage protection	0-2		1	1	1	1
ROV2PTOV	59N	Two step residual overvoltage protection	0-2	1	1	1	1	1
OEXPVPH	24	Overexcitation protection	0-1		1-D03	1-D03	1-D03	1-D03
VDCPTOV	60	Voltage differential protection	0-2		2	2	2	2
LOVPTUV	27	Loss of voltage check	1	1	1	1	1	1
PAPGAPC	27	Radial feeder protection	0-1					
Frequency protection								
SAPTUF	81	Underfrequency protection	0-2		2-E02	2-E02	2-E02	2-E02
SAPTOF	81	Overfrequency protection	0-2		2-E02	2-E02	2-E02	2-E02
SAPFRC	81	Rate-of-change frequency protection	0-2		2-E02	2-E02	2-E02	2-E02

IEC 61850	ANSI	Function description	Line Distance					
			REL670	REL670 (A21)	REL670 (A31)	REL670 (B31)	REL670 (A32)	REL670 (B32)
Multipurpose protection								
CVGAPC		General current and voltage protection	0-4	1	4-F01	4-F01	4-F01	4-F01
General calculation								
SMAIHPAC		Multipurpose filter	0-6					

1) 67 requires voltage
2) 67N requires voltage

Control and monitoring functions

IEC 61850	ANSI	Function description	Line Distance					
			REL670	REL670 (A21)	REL670 (A31)	REL670 (B31)	REL670 (A32)	REL670 (B32)
Control								
SESRSYN	25	Synchrocheck, energizing check and synchronizing	0-2	1	1	2	1	2
SMBRREC	79	Autorecloser	0-4	1	1B, 1-H04	2B, 2-H05	1B, 1-H04	2B, 2-H05
APC8	3	Apparatus control for single bay, max 8 apparatuses (1CB) incl. interlocking	0-1	1-H07	1-H07		1-H07	
APC15	3	Apparatus control for single bay, max 15 apparatuses (2CBs) incl. interlocking	0-1			1-H08		1-H08
QCBAY		Apparatus control	1	1	1	1	1	1
LOCREM		Handling of LRswitch positions	1	1	1	1	1	1
LOCREMCTRL		LHMI control of PSTO	1	1	1	1	1	1
SLGAPC		Logic rotating switch for function selection and LHMI presentation	15	15	15	15	15	15
VSGAPC		Selector mini switch	20	20	20	20	20	20
DPGAPC		Generic communication function for Double Point indication	16	16	16	16	16	16
SPC8GAPC		Single point generic control 8 signals	5	5	5	5	5	5
AUTOBITS		AutomationBits, command function for DNP3.0	3	3	3	3	3	3
SINGLECMD		Single command, 16 signals	4	4	4	4	4	4
I103CMD		Function commands for IEC 60870-5-103	1	1	1	1	1	1
I103GENCMD		Function commands generic for IEC 60870-5-103	50	50	50	50	50	50
I103POSCMD		IED commands with position and select for IEC 60870-5-103	50	50	50	50	50	50
I103IEDCMD		IED commands for IEC 60870-5-103	1	1	1	1	1	1
I103USRCMD		Function commands user defined for IEC 60870-5-103	1	1	1	1	1	1
Secondary system supervision								
CCSSPVC	87	Current circuit supervision	0-2		1	2	1	2
FUFSPVC		Fuse failure supervision	0-3	1	3	3	3	3
VDSPVC	60	Fuse failure supervision based on voltage difference	0-3	1-G03	1-G03	1-G03	1-G03	1-G03
Logic								
SMPPTRC	94	Tripping logic	1-6	6	6	6	6	6
TMAGAPC		Trip matrix logic	12	12	12	12	12	12
ALMCALH		Logic for group alarm	5	5	5	5	5	5
WRNCALH		Logic for group warning	5	5	5	5	5	5

IEC 61850	ANSI	Function description	Line Distance					
			REL670	REL670 (A21)	REL670 (A31)	REL670 (B31)	REL670 (A32)	REL670 (B32)
INDCALH		Logic for group indication	5	5	5	5	5	5
AND, OR, INV, PULSETIMER, GATE, TIMERSET, XOR, LLD, SRMEMORY, RSMEMORY		Configurable logic blocks	40-420	40-420	40-420	40-420	40-420	40-420
ANDQT, ORQT, INVERTERQT, XORQT, SRMEMORYQT, RSMEMORYQT, TIMERSETQT, PULSETIMERQT, INVALIDQT, INDCOMBSPQT, INDEXTSPQT		Configurable logic blocks Q/T	0–1					
SLGAPC, VSGAPC, AND, OR, PULSETIMER, GATE, TIMERSET, XOR, LLD, SRMEMORY, INV		Extension logic package	0–1					
FXDSIGN		Fixed signal function block	1	1	1	1	1	1
B16I		Boolean 16 to Integer conversion	18	18	18	18	18	18
BTIGAPC		Boolean 16 to Integer conversion with Logic Node representation	16	16	16	16	16	16
IB16		Integer to Boolean 16 conversion	18	18	18	18	18	18
ITBGAPC		Integer to Boolean 16 conversion with Logic Node representation	16	16	16	16	16	16
TEIGAPC		Elapsed time integrator with limit transgression and overflow supervision	12	12	12	12	12	12
Monitoring								
CVMMXN, CMMXU, VMMXU, CMSQI, VMSQI, VNMMXU		Measurements	6	6	6	6	6	6
AISVBAS		Function block for service value presentation of secondary analog inputs	1	1	1	1	1	1
EVENT		Event function	20	20	20	20	20	20

IEC 61850	ANSI	Function description	Line Distance					
			REL670	REL670 (A21)	REL670 (A31)	REL670 (B31)	REL670 (A32)	REL670 (B32)
DRPRDRE, A1RADR, A2RADR, A3RADR, A4RADR, B1RBDR, B2RBDR, B3RBDR, B4RBDR, B5RBDR, B6RBDR		Disturbance report	1	1	1	1	1	1
SPGAPC		Generic communication function for Single Point indication	64	64	64	64	64	64
SP16GAPC		Generic communication function for Single Point indication 16 inputs	16	16	16	16	16	16
MVGAPC		Generic communication function for Measured Value	24	24	24	24	24	24
BINSTATREP		Logical signal status report	3	3	3	3	3	3
RANGE_XP		Measured value expander block	66	66	66	66	66	66
SSIMG	63	Gas medium supervision	21	21	21	21	21	21
SSIML	71	Liquid medium supervision	3	3	3	3	3	3
SSCBR		Circuit breaker monitoring	0-2	1-M11	1-M11	2-M12	1-M11	2-M12
LMBRFLO		Fault locator	1	1	1	1	1	1
I103MEAS		Measurands for IEC 60870-5-103	1	1	1	1	1	1
I103MEASUSR		Measurands user defined signals for IEC 60870-5-103	3	3	3	3	3	3
I103AR		Function status auto-recloser for IEC 60870-5-103	1	1	1	1	1	1
I103EF		Function status earth-fault for IEC 60870-5-103	1	1	1	1	1	1
I103FLTPROT		Function status fault protection for IEC 60870-5-103	1	1	1	1	1	1
I103IED		IED status for IEC 60870-5-103	1	1	1	1	1	1
I103SUPERV		Supervison status for IEC 60870-5-103	1	1	1	1	1	1
I103USRDEF		Status for user defiend signals for IEC 60870-5-103	20	20	20	20	20	20
L4UFCNT		Event counter with limit supervision	30	30	30	30	30	30
Metering								
PCFCNT		Pulse-counter logic	16	16	16	16	16	16
ETPMMTR		Function for energy calculation and demand handling	6	6	6	6	6	6

Communication

IEC 61850	ANSI	Function description	Line Distance					
			REL670	REL670 (A21)	REL670 (A31)	REL670 (B31)	REL670 (A32)	REL670 (B32)
Station communication								
LONSPA, SPA		SPA communication protocol	1	1	1	1	1	1
ADE		LON communication protocol	1	1	1	1	1	1
HORZCOMM		Network variables via LON	1	1	1	1	1	1
PROTOCOL		Operation selection between SPA and IEC 60870-5-103 for SLM	1	1	1	1	1	1
RS485PROT		Operation selection for RS485	1	1	1	1	1	1
RS485GEN		RS485	1	1	1	1	1	1
DNPGEN		DNP3.0 communication general protocol	1	1	1	1	1	1
DNPGENTCP		DNP3.0 communication general TCP protocol	1	1	1	1	1	1
CHSERRS485		DNP3.0 for EIA-485 communication protocol	1	1	1	1	1	1
CH1TCP, CH2TCP, CH3TCP, CH4TCP		DNP3.0 for TCP/IP communication protocol	1	1	1	1	1	1
CHSEROPT		DNP3.0 for TCP/IP and EIA-485 communication protocol	1	1	1	1	1	1
MST1TCP, MST2TCP, MST3TCP, MST4TCP		DNP3.0 for serial communication protocol	1	1	1	1	1	1
DNPFREC		DNP3.0 fault records for TCP/IP and EIA-485 communication protocol	1	1	1	1	1	1
IEC61850-8-1		Parameter setting function for IEC 61850	1	1	1	1	1	1
GOOSEINTLKRCV		Horizontal communication via GOOSE for interlocking	59	59	59	59	59	59
GOOSEBINRCV		Goose binary receive	16	16	16	16	16	16
GOOSEDPRCV		GOOSE function block to receive a double point value	64	64	64	64	64	64
GOOSEINTRCV		GOOSE function block to receive an integer value	32	32	32	32	32	32
GOOSEMVRCV		GOOSE function block to receive a measurand value	60	60	60	60	60	60
GOOSESPRCV		GOOSE function block to receive a single point value	64	64	64	64	64	64
MULTICMDRCV, MULTICMDSND		Multiple command and transmit	60/10	60/10	60/10	60/10	60/10	60/10

IEC 61850	ANSI	Function description	Line Distance					
			REL670	REL670 (A21)	REL670 (A31)	REL670 (B31)	REL670 (A32)	REL670 (B32)
FRONT, LANABI, LANAB, LANCDI, LANCD		Ethernet configuration of links	1	1	1	1	1	1
GATEWAY		Ethernet configuration of link one	1	1	1	1	1	1
OPTICAL103		IEC 60870-5-103 Optical serial communication	1	1	1	1	1	1
RS485103		IEC 60870-5-103 serial communication for RS485	1	1	1	1	1	1
AGSAL		Generic security application component	1	1	1	1	1	1
LD0LLN0		IEC 61850 LD0 LLN0	1	1	1	1	1	1
SYSLLN0		IEC 61850 SYS LLN0	1	1	1	1	1	1
LPHD		Physical device information	1	1	1	1	1	1
PCMACCS		IED Configuration Protocol	1	1	1	1	1	1
SECALARM		Component for mapping security events on protocols such as DNP3 and IEC103	1	1	1	1	1	1
FSTACCS		Field service tool access via SPA protocol over ethernet communication	1	1	1	1	1	1
ACTIVLOG		Activity logging parameters	1	1	1	1	1	1
ALTRK		Service Tracking	1	1	1	1	1	1
SINGLELCCH		Single ethernet port link status	1	1	1	1	1	1
PRPSTATUS		Dual ethernet port link status	1	1	1	1	1	1
		Process bus communication IEC 61850-9-2 [1)]						
PRP		IEC 62439-3 parallel redundancy protocol (only in F00)	0-1	1-P03	1-P03	1-P03	1-P03	1-P03
Remote communication								
		Binary signal transfer receive/transmit	6/36	6/36	6/36	6/36	6/36	6/36
		Transmission of analog data from LDCM	1	1	1	1	1	1
		Receive binary status from remote LDCM	6/3/3	6/3/3	6/3/3	6/3/3	6/3/3	6/3/3
Scheme communication								
ZCPSCH	85	Scheme communication logic for distance or overcurrent protection	0-1	1	1	1	1	1
ZC1PPSCH	85	Phase segregated scheme communication logic for distance protection	0-1				1-B05	1-B05
ZCRWPSCH	85	Current reversal and weak-end infeed logic for distance protection	0-1	1	1	1	1	1
ZC1WPSCH	85	Current reversal and weak-end infeed logic for phase segregated communication	0-1				1-B05	1-B05

IEC 61850	ANSI	Function description	Line Distance					
			REL670	REL670 (A21)	REL670 (A31)	REL670 (B31)	REL670 (A32)	REL670 (B32)
ZCLCPSCH		Local acceleration logic	1	1	1	1	1	1
ECPSCH	85	Scheme communication logic for residual overcurrent protection	0-1		1	1	1	1
ECRWPSCH	85	Current reversal and weak-end infeed logic for residual overcurrent protection	0-1		1	1	1	1
DTT		Direct transfer trip	0-1					

1) Only included for 9-2LE products

Basic IED functions

Table 1. Basic IED functions

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

Table 1. Basic IED functions, continued

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

3. Differential protection

1Ph High impedance differential protection HZPDIF

The 1Ph High impedance differential protection HZPDIF functions can be used when the involved CT cores have the same turns ratio and similar magnetizing characteristics. It utilizes an external CT secondary current summation by wiring. Actually all CT secondary circuits which are involved in the differential scheme are connected in parallel. External series resistor, and a voltage dependent resistor which are both mounted externally to the IED, are also required.

The external resistor unit shall be ordered under IED accessories in the Product Guide.

HZPDIF can be used to protect tee-feeders or busbars, reactors, motors, auto-transformers, capacitor banks and so on. One such function block is used for a high-impedance restricted earth fault protection. Three such function blocks are used to form three-phase, phase-segregated differential protection. Several function block instances (for example, six) can be available in a single IED.

Additional security logic for differential protection LDRGFC

Additional security logic for differential protection (LDRGFC) can help the security of the protection especially when the communication system is in abnormal status or for example when there is unspecified asymmetry in the communication link. It helps to reduce the probability for mal-operation of the protection. LDRGFC is more sensitive than the main protection logic to always release operation for all faults detected by the differential function. LDRGFC consists of four sub functions:

- Phase-to-phase current variation
- Zero sequence current criterion
- Low voltage criterion
- Low current criterion

Phase-to-phase current variation takes the current samples as input and it calculates the variation using the sampling value based algorithm. Phase-to-phase current variation function is major one to fulfill the objectives of the startup element.

Zero sequence criterion takes the zero sequence current as input. It increases the security of protection during the high impedance fault conditions.

Low voltage criterion takes the phase voltages and phase-to-phase voltages as inputs. It increases the security of protection when the three-phase fault occurred on the weak end side.

Low current criterion takes the phase currents as inputs and it increases the dependability during the switch onto fault case of unloaded line.

The differential function can be allowed to trip as no load is fed through the line and protection is not working correctly.

Features:

- Startup element is sensitive enough to detect the abnormal status of the protected system
- Startup element does not influence the operation speed of main protection
- Startup element would detect the evolving faults, high impedance faults and three phase fault on weak side
- It is possible to block the each sub function of startup element
- Startup signal has a settable pulse time

4. Impedance protection

Distance measuring zone, quadrilateral characteristic ZMQPDIS, ZMQAPDIS

The line distance protection is an up to five (depending on product variant) zone full scheme protection function with three fault loops for phase-to-phase faults and three fault loops for phase-to-earth faults for each of the independent zones. Individual settings for each zone in resistive and reactive reach gives flexibility for use as back-up protection for transformer connected to overhead lines and cables of different types and lengths.

ZMQPDIS together with Phase selection with load encroachment FDPSPDIS has functionality for load encroachment, which increases the possibility to detect high resistive faults on heavily loaded lines, as shown in figure8.

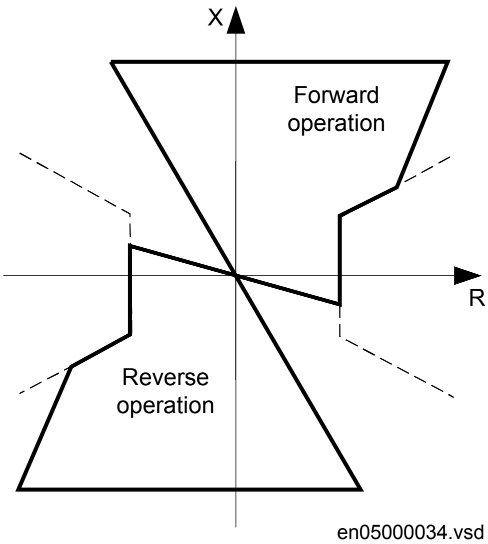


Figure 8. Typical quadrilateral distance protection zone with Phase selection with load encroachment function FDPSPDIS activated

The independent measurement of impedance for each fault loop together with a sensitive and reliable built-in phase selection makes the function suitable in applications with single-phase autoreclosing.

Built-in adaptive load compensation algorithm prevents overreaching of zone 1 at load exporting end at phase-to-earth faults on heavily loaded power lines.

The distance protection zones can operate independently of each other in directional (forward or reverse) or non-directional mode. This makes them suitable, together with different communication schemes, for the protection of power lines and cables in complex network configurations, such as parallel lines, multi-terminal lines.

Distance measuring zone, quadrilateral characteristic for series compensated lines ZMCPDIS, ZMCAPDIS

The line distance protection is a five zone full scheme protection with three fault loops for phase-to-phase faults and three fault loops for phase-to-earth fault for each of the independent zones. Individual settings for each zone resistive and reactive reach give flexibility for use on overhead lines and cables of different types and lengths.

Quadrilateral characteristic is available.

ZMCPDIS function has functionality for load encroachment which increases the possibility to detect high resistive faults on heavily loaded lines.

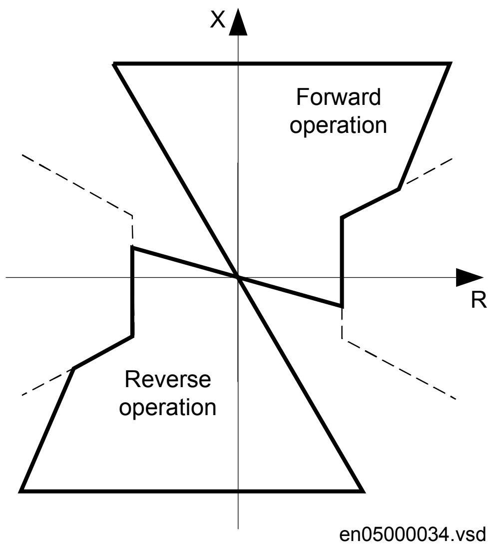


Figure 9. Typical quadrilateral distance protection zone with load encroachment function activated

The independent measurement of impedance for each fault loop together with a sensitive and reliable built in phase selection makes the function suitable in applications with single phase auto-reclosing.

Built-in adaptive load compensation algorithm for the quadrilateral function prevents overreaching of zone1 at load exporting end at phase to earth-faults on heavily loaded power lines.

The distance protection zones can operate, independent of each other, in directional (forward or reverse) or non-directional mode. This makes them suitable, together with different communication schemes, for the protection of power lines and cables in complex network configurations, such as parallel lines, multi-terminal lines.

Phase selection, quadrilateral characteristic with fixed angle FDPSPDIS

The operation of transmission networks today is in many cases close to the stability limit. Due to environmental considerations, the rate of expansion and reinforcement of the power system is reduced, for example, difficulties to get permission to build new power lines. The ability to accurately and reliably classify the different types of fault, so that single pole tripping and autoreclosing can be used plays an important role in this matter. Phase selection, quadrilateral characteristic with fixed angle FDPSPDIS is designed to accurately select the proper fault loop in the distance function dependent on the fault type.

The heavy load transfer that is common in many transmission networks may make fault resistance coverage difficult to achieve. Therefore, FDPSPDIS has a built-in algorithm for load encroachment, which gives the possibility to enlarge the resistive setting of both the phase selection and the measuring zones without interfering with the load.

The extensive output signals from the phase selection gives also important information about faulty phase(s), which can be used for fault analysis.

A current-based phase selection is also included. The measuring elements continuously measure three phase currents and the residual current and, compare them with the set values.

Full-scheme distance measuring, Mho characteristic ZMHPDIS

The numerical mho line distance protection is a five zone full scheme protection of short circuit and earth faults.

The five zones have fully independent measuring and settings, which gives high flexibility for all types of lines. Each zone is an individual function block available for independent configuration in ACT.

The IED can be used up to the highest voltage levels. It is suitable for the protection of heavily loaded lines and multi-terminal lines where the requirement for tripping is one-, two- and/or three-pole.

The independent measurement of impedance for each fault loop together with a sensitive and reliable phase selection makes the function suitable in applications with single phase autoreclosing.

Built-in selectable zone timer logic is also provided in the function.

Adaptive load compensation algorithm prevents overreaching at phase-to-earth faults on heavily loaded power lines, see Figure 10.

Load compensation algorithm prevents overreaching at phase-to-earth faults on heavily loaded power lines, see Figure 10. This Load encroachment characteristic is taken from the FMPSPDIS function.

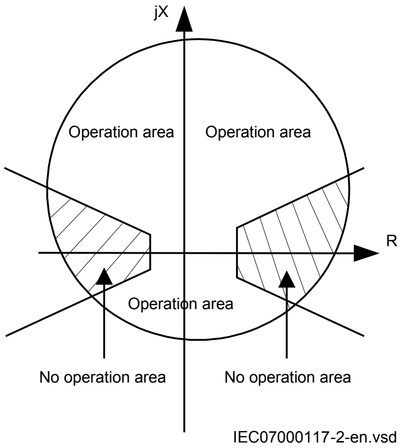


Figure 10. Load encroachment influence on the offset mho characteristic

The distance protection zones can operate, independent of each other, in directional (forward or reverse) or non-directional mode (offset). This makes them suitable, together with different communication schemes, for the protection of power lines and cables in complex network configurations, such as parallel lines, multi-terminal lines and so on.

The integrated control and monitoring functions offer effective solutions for operating and monitoring all types of transmission and sub-transmission lines.

Full-scheme distance protection, quadrilateral for earth faults ZMMPDIS, ZMMAPDIS

The line distance protection is an up to five (depending on product variant) zone full scheme protection function with three fault loops for phase-to-earth fault for each of the independent zones. Individual settings for each zone resistive and reactive reach give flexibility for use on overhead lines and cables of different types and lengths.

The Full-scheme distance protection, quadrilateral for earth fault functions have functionality for load encroachment, which increases the possibility to detect high resistive faults on heavily loaded lines , see Figure 8.

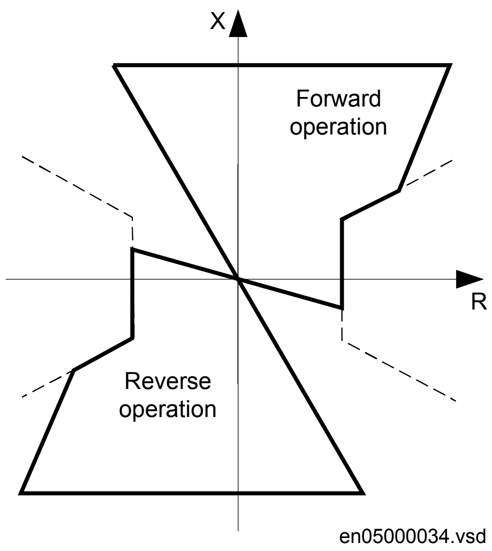


Figure 11. **Typical quadrilateral distance protection zone with Phase selection, quadrilateral characteristic with settable angle function FRPSPDIS activated**

The independent measurement of impedance for each fault loop together with a sensitive and reliable built in phase selection makes the function suitable in applications with single phase auto-reclosing.

The distance protection zones can operate, independent of each other, in directional (forward or reverse) or non-directional mode. This makes them suitable, together with different communication schemes, for the protection of power lines and cables in complex network configurations, such as parallel lines, multi-terminal lines.

Directional impedance element for Mho characteristic ZDMRDIR

The phase-to-earth impedance elements can be optionally supervised by a phase unselective directional function (phase unselective, because it is based on symmetrical components).

Mho impedance supervision logic ZSMGAPC

The Mho impedance supervision logic (ZSMGAPC) includes features for fault inception detection and high SIR detection. It also includes the functionality for loss of potential logic as well as for the pilot channel blocking scheme.

ZSMGAPC can mainly be decomposed in two different parts:

1. A fault inception detection logic
2. High SIR detection logic

Faulty phase identification with load encroachment FMPSPDIS

The ability to accurately and reliably classify different types of fault so that single phase tripping and autoreclosing can be used plays an important roll in today's power systems.

The phase selection function is design to accurately select the proper fault loop(s) in the distance function dependent on the fault type.

The heavy load transfer that is common in many transmission networks may in some cases interfere with the distance protection zone reach and cause unwanted operation. Therefore the function has a built in algorithm for load encroachment, which gives the possibility to enlarge the resistive setting of the measuring zones without interfering with the load.

The output signals from the phase selection function produce important information about faulty phase(s), which can be used for fault analysis as well.

Distance protection zone, quadrilateral characteristic, separate settings ZMRPDIS, ZMRAPDIS

The line distance protection is up to five zone full scheme protection with three fault loops for phase-to-phase faults and three fault loops for phase-to-earth fault for each of the independent zones. Individual settings for each zone in resistive and reactive reach gives flexibility for use as back-up protection for transformer connected to overhead lines and cables of different types and lengths.

Mho alternative quadrilateral characteristic is available.

ZMRPDIS together with Phase selection, quadrilateral characteristic with settable angle FRPSPDIS has functionality for load encroachment, which increases the possibility to detect high resistive faults on heavily loaded lines, as shown in figure 8.

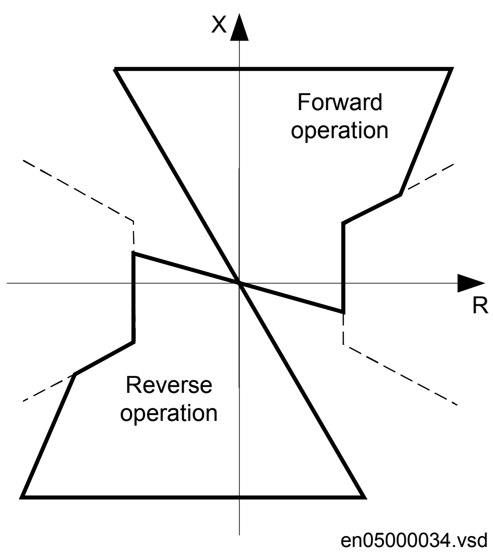


Figure 12. **Typical quadrilateral distance protection zone with Phase selection, quadrilateral characteristic with settable angle function FRPSPDIS activated**

The independent measurement of impedance for each fault loop together with a sensitive and reliable built-in phase selection makes the function suitable in applications with single pole tripping and autoreclosing.

Built-in adaptive load compensation algorithm prevents overreaching of zone 1 at load exporting end at phase-to-earth faults on heavily loaded power lines.

The distance protection zones can operate, independent of each other, in directional (forward or reverse) or non-directional mode. This makes them suitable, together with different communication schemes, for the protection of power lines and cables in complex network configurations, such as parallel lines, multi-terminal lines and so on.

Phase selection, quadrilateral characteristic with settable angle FRPSPDIS

The operation of transmission networks today is in many cases close to the stability limit. Due to environmental considerations, the rate of expansion and reinforcement of the power system is reduced for example, difficulties to get permission to build new power lines. The ability to accurately and reliably classify the different types of fault, so that single pole tripping and autoreclosing can be used plays an important role in this matter. The phase selection function is designed to accurately select the proper fault loop in the distance function dependent on the fault type.

The heavy load transfer that is common in many transmission networks may make fault resistance coverage difficult to achieve. Therefore, the function has a built in algorithm for load encroachment, which gives the possibility to enlarge the resistive setting of both the phase selection and the measuring zones without interfering with the load.

The extensive output signals from the phase selection gives also important information about faulty phase(s) which can be used for fault analysis.

A current-based phase selection is also included. The measuring elements continuously measure three phase currents and the residual current and, compare them with the set values.

Distance zones quad with high speed distance protection ZMFPDIS

The High speed distance protection (ZMFPDIS) is providing sub-cycle, down towards half-cycle, operate time for basic faults within 60% of the line length and up to around SIR 5. At the same time, it is specifically designed for extra care during difficult conditions in high voltage transmission networks, like faults on long heavily loaded lines and faults generating heavily distorted signals. These faults are handled with outmost security and dependability, although sometimes with reduced operating speed.

The ZMFPDIS function is a six zone full scheme protection with three fault loops for phase-to-phase faults and three fault loops for phase-to-earth faults for each of the independent zones, which makes the function suitable in applications with single-phase autoreclosing.

The zones can operate independently of each other in directional (forward or reverse) or non-directional mode. However, zone1 and zone2 is designed to measure in forward direction only, while one zone (ZRV) is designed to measure in the reverse direction. This makes them suitable, together with a communication scheme, for protection of power lines and cables in complex network configurations, such as parallel lines, multi-terminal lines, and so on.

A new built-in adaptive load compensation algorithm prevents overreaching of the distance zones in the load exporting end during phase-to-earth faults on heavily loaded power lines. It also reduces underreach in the importing end.

The ZMFPDIS function-block itself incorporates a phase-selection element and a directional element, contrary to previous designs in the 670-series, where these elements were represented with separate function-blocks.

The operation of the phase-selection element is primarily based on current change criteria (i.e. delta quantities), with significantly increased dependability. There is also a phase selection criterion operating in parallel which bases its operation only on voltage and current phasors.

The directional element utilizes a set of well-established quantities to provide fast and correct directional decision during various power system operating conditions, including close-in three-phase faults, simultaneous faults and faults with only zero-sequence in-feed.

Distance zones quad with high speed distance for series compensated networks ZMFCPDIS

High speed distance protection (ZMFCPDIS) provides sub-cycle, down towards half-cycle, operate time for basic faults within 60% of the line length and up to around SIR 5. At the same time, it is specifically designed for extra care during difficult conditions in high voltage transmission networks, like faults on long heavily loaded lines and faults generating heavily distorted signals. These faults are handled with outmost security and dependability, although sometimes with reduced operating speed.

High speed distance protection ZMFCPDIS is fundamentally the same function as ZMFPDIS but provides more flexibility in zone settings to suit more complex applications, such as series compensated lines. In operation for series compensated networks, the parameters of the directional function are altered to handle voltage reversal.

The ZMFCPDIS function is a six-zone full scheme protection with three fault loops for phase-to-phase faults and three fault loops for phase-to-earth faults for each of the independent zones, which makes the function suitable in applications with single-phase autoreclosing.

The zones can operate independently of each other in directional (forward or reverse) or non-directional mode. This makes them suitable, together with a communication scheme, for protection of power lines and cables in complex network configurations, such as parallel lines, multi-terminal lines, and so on.

A new built-in adaptive load compensation algorithm prevents overreaching of the distance zones in the load exporting end during phase-to-earth faults on heavily loaded power lines. It also reduces underreach in the importing end.

The ZMFCPDIS function block incorporates a phase-selection element and a directional element, contrary to previous designs in the 670–series, where these elements were represented with separate function blocks.

The operation of the phase-selection element is primarily based on current change criteria, with significant increased dependability. Naturally, there is also a part operating with continuous criteria that operates in parallel

The directional element utilizes a set of well-established quantities to provide fast and correct directional evaluation during various conditions, including close-in three-phase faults, simultaneous faults and faults with only zero-sequence in-feed.

Power swing detection ZMRPSB

Power swings may occur after disconnection of heavy loads or trip of big generation plants.

Power swing detection function ZMRPSB is used to detect power swings and initiate block of all distance protection zones. Occurrence of earth-fault currents during a power swing inhibits the ZMRPSB function, to allow fault clearance.

Power swing logic PSLPSCH

Power Swing Logic (PSLPSCH) is a complementary function to Power Swing Detection (ZMRPSB) function. It provides possibility for selective tripping of faults on power lines during system oscillations (power swings or pole slips), when the distance protection function should normally be blocked. The complete logic consists of two different parts:

- Communication and tripping part: provides selective tripping on the basis of special distance protection zones and a scheme communication logic, which are not blocked during the system oscillations.
- Blocking part: blocks unwanted operation of instantaneous distance protection zone 1 for oscillations, which are initiated by faults and their clearing on the adjacent power lines and other primary elements.

Pole slip protection PSPPPAM

Sudden events in an electric power system such as large changes in load, fault occurrence or fault clearance, can cause power oscillations referred to as power swings. In a non-recoverable situation, the power swings become so severe that the synchronism is lost, a condition referred to as pole slipping. The main purpose of the pole slip protection (PSPPPAM) is to detect, evaluate, and take the required action for pole slipping occurrences in the power system.

Out-of-step protection OOSPPAM

The out-of-step protection OOSPPAM function in the IED can be used for both generator protection and as well for line protection applications.

The main purpose of the OOSPPAM function is to detect, evaluate, and take the required action during pole slipping occurrences in the power system.

The OOSPPAM function detects pole slip conditions and trips the generator as fast as possible, after the first pole-slip if the center of oscillation is found to be in zone 1, which normally includes the generator and its step-up power transformer. If the center of oscillation is found to be further out in the power system, in zone 2, more than one pole-slip is usually allowed before the generator-transformer unit is disconnected. A parameter setting is available to take into account the circuit breaker opening time. If there are several out-of-step relays in the power system, then the one which finds the center of oscillation in its zone 1 should operate first.

Two current channels I3P1 and I3P2 are available in OOSPPAM function to allow the direct connection of two groups of three-phase currents; that may be needed for very powerful generators, with stator windings split into two groups per phase, when each group is equipped with current transformers. The protection function performs a simple summation of the currents of the two channels I3P1 and I3P2.

Automatic switch onto fault logic, voltage and current based ZCVPSOF

Automatic switch onto fault logic (ZCVPSOF) is a function that gives an instantaneous trip at closing of breaker onto a fault. A dead line detection check is provided to activate the function when the line is dead.

Phase preference logic PPLPHIZ

The optional phase preference logic main purpose is to provide a selective tripping for cross-country faults in isolated or high impedance-earthed networks.

5. Current protection

Instantaneous phase overcurrent protection PHPIOC

The instantaneous three phase overcurrent function has a low transient overreach and short tripping time to allow use as a high set short-circuit protection function.

Four step phase overcurrent protection OC4PTOC

The four step three-phase overcurrent protection function OC4PTOC has an inverse or definite time delay independent for step 1 to 4 separately.

All IEC and ANSI inverse time characteristics are available together with an optional user defined time characteristic.

The directional function needs voltage as it is voltage polarized with memory. The function can be set to be directional or non-directional independently for each of the steps.

Second harmonic blocking level can be set for the function and can be used to block each step individually

Instantaneous residual overcurrent protection EFPIOC

The Instantaneous residual overcurrent protection EFPIOC has a low transient overreach and short tripping times to allow the use for instantaneous earth-fault protection, with the reach limited to less than the typical eighty percent of the line at minimum source impedance. EFPIOC is configured to measure the residual current from the three-phase current inputs and can be configured to measure the current from a separate current input.

Four step residual overcurrent protection, zero sequence and negative sequence direction EF4PTOC

The four step residual overcurrent protection EF4PTOC has an inverse or definite time delay independent for each step.

All IEC and ANSI time-delayed characteristics are available together with an optional user defined characteristic.

EF4PTOC can be set directional or non-directional independently for each of the steps.

IDir, UPol and IPol can be independently selected to be either zero sequence or negative sequence.

Second harmonic blocking can be set individually for each step.

EF4PTOC can be used as main protection for phase-to-earth faults.

EF4PTOC can also be used to provide a system back-up for example, in the case of the primary protection being out of service due to communication or voltage transformer circuit failure.

Directional operation can be combined together with corresponding communication logic in permissive or blocking teleprotection scheme. Current reversal and weak-end infeed functionality are available as well.

Residual current can be calculated by summing the three phase currents or taking the input from neutral CT

Four step negative sequence overcurrent protection NS4PTOC

Four step negative sequence overcurrent protection (NS4PTOC) has an inverse or definite time delay independent for each step separately.

All IEC and ANSI time delayed characteristics are available together with an optional user defined characteristic.

The directional function is voltage polarized.

NS4PTOC can be set directional or non-directional independently for each of the steps.

NS4PTOC can be used as main protection for unsymmetrical fault; phase-phase short circuits, phase-phase-earth short circuits and single phase earth faults.

NS4PTOC can also be used to provide a system backup for example, in the case of the primary protection being out of service due to communication or voltage transformer circuit failure.

Directional operation can be combined together with corresponding communication logic in permissive or blocking teleprotection scheme. The same logic as for directional zero sequence current can be used. Current reversal and weak-end infeed functionality are available.

Sensitive directional residual overcurrent and power protection SDEPSDE

In isolated networks or in networks with high impedance earthing, the earth fault current is significantly smaller than the short circuit currents. In addition to this, the magnitude of the fault current is almost independent on the fault location in the network. The protection can be selected to use either the residual current or residual power component $3U0 \cdot 3I0 \cdot \cos\varphi$, for operating quantity with maintained short circuit capacity. There is also available one nondirectional 3I0 step and one 3U0 overvoltage tripping step.

No specific sensitive current input is needed. SDEPSDE can be set as low 0.25% of IBase.

Thermal overload protection, one time constant LCPTTR/ LFPTTR

The increasing utilization of the power system closer to the thermal limits has generated a need of a thermal overload protection for power lines.

A thermal overload will often not be detected by other protection functions and the introduction of the thermal overload protection can allow the protected circuit to operate closer to the thermal limits.

The three-phase current measuring protection has an I^2t characteristic with settable time constant and a thermal memory. The temperature is displayed in either Celsius or Fahrenheit, depending on whether the function used is LCPTTR (Celsius) or LFPTTR (Fahrenheit).

An alarm level gives early warning to allow operators to take action well before the line is tripped.

Estimated time to trip before operation, and estimated time to reclose after operation are presented.

Breaker failure protection CCRBRF

Breaker failure protection (CCRBRF) ensures a fast backup tripping of surrounding breakers in case the own breaker fails to open. CCRBRF can be current-based, contact-based or an adaptive combination of these two conditions.

Current check with extremely short reset time is used as check criterion to achieve high security against inadvertent operation.

Contact check criteria can be used where the fault current through the breaker is small.

CCRBRF can be single- or three-phase initiated to allow use with single phase tripping applications. For the three-phase version of CCRBRF the current criteria can be set to operate only if two out of four for example, two phases or one phase plus the residual current start. This gives a higher security to the back-up trip command.

CCRBRF function can be programmed to give a single- or three-phase re-trip of the own breaker to avoid unnecessary tripping of surrounding breakers at an incorrect initiation due to mistakes during testing.

Stub protection STBPTOC

When a power line is taken out of service for maintenance and the line disconnector is opened in multi-breaker arrangements the voltage transformers will mostly be outside on the disconnected part. The primary line distance protection will thus not be able to operate and must be blocked.

The stub protection STBPTOC covers the zone between the current transformers and the open disconnector. The three-phase instantaneous overcurrent function is released from a normally open, NO (b) auxiliary contact on the line disconnector.

Pole discordance protection CCPDSC

An open phase can cause negative and zero sequence currents which cause thermal stress on rotating machines and can cause unwanted operation of zero sequence or negative sequence current functions.

Normally the own breaker is tripped to correct such a situation. If the situation persists the surrounding breakers should be tripped to clear the unsymmetrical load situation.

The Pole discordance protection function CCPDSC operates based on information from auxiliary contacts of the circuit breaker for the three phases with additional criteria from unsymmetrical phase currents when required.

Directional over/underpower protection GOPPDOP/ GUPPDUP

The directional over-/under-power protection GOPPDOP/ GUPPDUP can be used wherever a high/low active, reactive or apparent power protection or alarming is required. The functions can alternatively be used to check the direction of active or reactive power flow in the power system. There are a number of applications where such functionality is needed. Some of them are:

- detection of reversed active power flow
- detection of high reactive power flow

Each function has two steps with definite time delay.

Broken conductor check BRCPTOC

The main purpose of the function Broken conductor check (BRCPTOC) is the detection of broken conductors on protected power lines and cables (series faults). Detection can be used to give alarm only or trip the line breaker.

Voltage-restrained time overcurrent protection VRPVOC

Voltage-restrained time overcurrent protection (VRPVOC) function can be used as generator backup protection against short-circuits.

The overcurrent protection feature has a settable current level that can be used either with definite time or inverse time characteristic. Additionally, it can be voltage controlled/ restrained.

One undervoltage step with definite time characteristic is also available within the function in order to provide functionality for overcurrent protection with undervoltage seal-in.

6. Voltage protection

Two step undervoltage protection UV2PTUV

Undervoltages can occur in the power system during faults or abnormal conditions. Two step undervoltage protection (UV2PTUV) function can be used to open circuit breakers to prepare for system restoration at power outages or as long-time delayed back-up to primary protection.

UV2PTUV has two voltage steps, each with inverse or definite time delay.

UV2PTUV has a high reset ratio to allow settings close to system service voltage.

Two step overvoltage protection OV2PTOV

Overvoltages may occur in the power system during abnormal conditions such as sudden power loss, tap changer regulating failures, and open line ends on long lines.

OV2PTOV has two voltage steps, each of them with inverse or definite time delayed.

OV2PTOV has a high reset ratio to allow settings close to system service voltage.

Two step residual overvoltage protection ROV2PTOV

Residual voltages may occur in the power system during earth faults.

Two step residual overvoltage protection ROV2PTOV function calculates the residual voltage from the three-phase voltage input transformers or measures it from a single voltage input transformer fed from an open delta or neutral point voltage transformer.

ROV2PTOV has two voltage steps, each with inverse or definite time delay.

Reset delay ensures operation for intermittent earth faults.

Overexcitation protection OEXPVPH

When the laminated core of a power transformer or generator is subjected to a magnetic flux density beyond its design limits, stray flux will flow into non-laminated components that are not designed to carry flux. This will cause eddy currents to flow. These eddy currents can cause excessive heating and severe damage to insulation and adjacent parts in a relatively short time. The function has settable inverse operating curves and independent alarm stages.

Voltage differential protection VDCPTOV

A voltage differential monitoring function is available. It compares the voltages from two three phase sets of voltage transformers and has one sensitive alarm step and one trip step.

Loss of voltage check LOVPTUV

Loss of voltage check LOVPTUV is suitable for use in networks with an automatic system restoration function. LOVPTUV issues a three-pole trip command to the circuit breaker, if all three phase voltages fall below the set value for a time longer than the set time and the circuit breaker remains closed.

The operation of LOVPTUV is supervised by the fuse failure supervision FUFSPVC.

Radial feeder protection PAPGAPC

The PAPGAPC function is used to provide protection of radial feeders having passive loads or weak end in-feed sources. It is possible to achieve fast tripping using communication system with remote end or delayed tripping not requiring communication or upon communication system failure. For fast tripping, scheme communication is required. Delayed tripping does not require scheme communication.

The PAPGAPC function performs phase selection using measured voltages. Each phase voltage is compared to the opposite phase-phase voltage. A phase is deemed to have a fault if its phase voltage drops below a settable percentage of the opposite phase-phase voltage. The phase - phase voltages include memory. This memory function has a settable time constant.

The voltage-based phase selection is used for both fast and delayed tripping. To achieve fast tripping, scheme communication is required. Delayed tripping does not require scheme communication. It is possible to permit delayed tripping only upon failure of the communications channel by blocking the delayed tripping logic with a communications channel healthy input signal.

On receipt of the communications signal, phase selective outputs for fast tripping are set based on the phase(s) in which the phase selection function has operated.

For delayed tripping, single pole and three pole delays are separately and independently settable. Furthermore, it is possible to enable or disable single pole and three pole delayed tripping. For single phase faults, it is possible to include a residual current check in the tripping logic. Three pole tripping is always selected for phase selection on more than one phase. Three pole tripping will also occur if the residual current exceeds the set level during fuse failure for a time longer than the three pole trip delay time.

7. Frequency protection

Underfrequency protection SAPTUF

Underfrequency occurs as a result of a lack of generation in the network.

Underfrequency protection SAPTUF measures frequency with high accuracy, and is used for load shedding systems, remedial action schemes, gas turbine startup and so on. Separate definite time delays are provided for operate and restore.

SAPTUF is provided with undervoltage blocking.

The operation is based on positive sequence voltage measurement and requires two phase-phase or three phase-neutral voltages to be connected. For information about how to connect analog inputs, refer to Application manual/IED application/Analog inputs/Setting guidelines

Overfrequency protection SAPTOF

Overfrequency protection function SAPTOF is applicable in all situations, where reliable detection of high fundamental power system frequency is needed.

Overfrequency occurs because of sudden load drops or shunt faults in the power network. Close to the generating plant, generator governor problems can also cause over frequency.

SAPTOF measures frequency with high accuracy, and is used mainly for generation shedding and remedial action schemes. It is also used as a frequency stage initiating load restoring. A definite time delay is provided for operate.

SAPTOF is provided with an undervoltage blocking.

The operation is based on positive sequence voltage measurement and requires two phase-phase or three phase-neutral voltages to be connected. For information about how to connect analog inputs, refer to Application manual/IED application/Analog inputs/Setting guidelines

Rate-of-change frequency protection SAPFRC

The rate-of-change frequency protection function SAPFRC gives an early indication of a main disturbance in the system.

SAPFRC measures frequency with high accuracy, and can be used for generation shedding, load shedding and remedial action schemes. SAPFRC can discriminate between a positive or negative change of frequency. A definite time delay is provided for operate.

SAPFRC is provided with an undervoltage blocking. The operation is based on positive sequence voltage measurement and requires two phase-phase or three phase-neutral voltages to be connected. For information about how to connect analog inputs, refer to Application manual/IED application/Analog inputs/Setting guidelines.

8. Multipurpose protection

General current and voltage protection CVGAPC

The General current and voltage protection (CVGAPC) can be utilized as a negative sequence current protection detecting unsymmetrical conditions such as open phase or unsymmetrical faults.

CVGAPC can also be used to improve phase selection for high resistive earth faults, outside the distance protection reach, for the transmission line. Three functions are used, which measures the neutral current and each of the three phase voltages. This will give an independence from load currents and this phase selection will be used in conjunction with the detection of the earth fault from the directional earth fault protection function.

9. Secondary system supervision

Current circuit supervision CCSSPVC

Open or short circuited current transformer cores can cause unwanted operation of many protection functions such as differential, earth-fault current and negative-sequence current functions.

It must be remembered that a blocking of protection functions at an occurrence of open CT circuit will mean that the situation will remain and extremely high voltages will stress the secondary circuit.

Current circuit supervision (CCSSPVC) compares the residual current from a three phase set of current transformer cores with the neutral point current on a separate input taken from another set of cores on the current transformer.

A detection of a difference indicates a fault in the circuit and is used as alarm or to block protection functions expected to give inadvertent tripping.

Fuse failure supervision FUFSPVC

The aim of the fuse failure supervision function FUFSPVC is to block voltage measuring functions at failures in the secondary circuits between the voltage transformer and the IED in order to avoid inadvertent operations that otherwise might occur.

The fuse failure supervision function basically has three different detection methods, negative sequence and zero sequence based detection and an additional delta voltage and delta current detection.

The negative sequence detection algorithm is recommended for IEDs used in isolated or high-impedance earthed networks. It is based on the negative-sequence quantities.

The zero sequence detection is recommended for IEDs used in directly or low impedance earthed networks. It is based on the zero sequence measuring quantities.

The selection of different operation modes is possible by a setting parameter in order to take into account the particular earthing of the network.

A criterion based on delta current and delta voltage measurements can be added to the fuse failure supervision function in order to detect a three phase fuse failure, which in practice is more associated with voltage transformer switching during station operations.

Fuse failure supervision VDSPVC

Different protection functions within the protection IED operates on the basis of measured voltage at the relay point. Some example of protection functions are:

- Distance protection function.
- Undervoltage function.
- Energisation function and voltage check for the weak infeed logic.

These functions can operate unintentionally, if a fault occurs in the secondary circuits between voltage instrument transformers and the IED. These unintentional operations can be prevented by VDSPVC.

VDSPVC is designed to detect fuse failures or faults in voltage measurement circuit, based on phase wise comparison of voltages of main and pilot fused circuits. VDSPVC blocking output can be configured to block functions that need to be blocked in case of faults in the voltage circuit.

Multipurpose filter SMAIHPAC

The multi-purpose filter function block, SMAIHPAC, is arranged as a three-phase filter. It has very much the same user interface (e.g. inputs and outputs) as the standard pre-processing function block SMAI. However the main difference is that it can be used to extract any frequency component from the input signal. Thus it can, for example, be used to build sub-synchronous resonance protection for synchronous generator.

10. Control

Synchrocheck, energizing check, and synchronizing SESRSYN

The Synchronizing function allows closing of asynchronous networks at the correct moment including the breaker closing time, which improves the network stability.

Synchrocheck, energizing check, and synchronizing SESRSYN function checks that the voltages on both sides of the circuit breaker are in synchronism, or with at least one side dead to ensure that closing can be done safely.

SESRSYN function includes a built-in voltage selection scheme for double bus and 1½ breaker or ring busbar arrangements.

Manual closing as well as automatic reclosing can be checked by the function and can have different settings.

For systems, which are running asynchronous, a synchronizing function is provided. The main purpose of the synchronizing function is to provide controlled closing of circuit breakers when two asynchronous systems are going to be connected. The synchronizing function evaluates voltage difference, phase angle difference, slip frequency and frequency rate of change before issuing a controlled closing of the circuit breaker. Breaker closing time is a parameter setting.

Autorecloser SMBRREC

The autorecloser SMBRREC function provides high-speed and/or delayed auto-reclosing for single or multi-breaker applications.

Up to five three-phase reclosing attempts can be included by parameter setting. The first attempt can be single-, two and/or three phase for single phase or multi-phase faults respectively.

Multiple autoreclosing functions are provided for multi-breaker arrangements. A priority circuit allows one circuit breaker to close first and the second will only close if the fault proved to be transient.

Each autoreclosing function is configured to co-operate with the synchrocheck function.

The autoreclosing function provides high-speed and/or delayed three pole autoreclosing.

Apparatus control APC

The apparatus control functions are used for control and supervision of circuit breakers, disconnectors and earthing switches within a bay. Permission to operate is given after evaluation of conditions from other functions such as interlocking, synchrocheck, operator place selection and external or internal blockings.

Apparatus control features:
- Select-Execute principle to give high reliability
- Selection function to prevent simultaneous operation
- Selection and supervision of operator place
- Command supervision
- Block/deblock of operation
- Block/deblock of updating of position indications
- Substitution of position and quality indications
- Overriding of interlocking functions
- Overriding of synchrocheck
- Operation counter
- Suppression of mid position

Two types of command models can be used:
- Direct with normal security
- SBO (Select-Before-Operate) with enhanced security

Normal security means that only the command is evaluated and the resulting position is not supervised. Enhanced security means that the command is evaluated with an additional supervision of the status value of the control object. The command sequence with enhanced security is always terminated by a CommandTermination service primitive and an AddCause telling if the command was successful or if something went wrong.

Control operation can be performed from the local HMI with authority control if so defined.

Interlocking

The interlocking function blocks the possibility to operate primary switching devices, for instance when a disconnector is under load, in order to prevent material damage and/or accidental human injury.

Each apparatus control function has interlocking modules included for different switchyard arrangements, where each function handles interlocking of one bay. The interlocking function is distributed to each IED and is not dependent on any central function. For the station-wide interlocking, the IEDs communicate via the system-wide interbay bus (IEC 61850-8-1) or by using hard wired binary inputs/outputs. The interlocking conditions depend on the circuit configuration and apparatus position status at any given time.

For easy and safe implementation of the interlocking function, the IED is delivered with standardized and tested software interlocking modules containing logic for the interlocking conditions. The interlocking conditions can be altered, to meet the customer’s specific requirements, by adding configurable logic by means of the graphical configuration tool.

Switch controller SCSWI

The Switch controller (SCSWI) initializes and supervises all functions to properly select and operate switching primary apparatuses. The Switch controller may handle and operate on one three-phase device or up to three one-phase devices.

Circuit breaker SXCBR

The purpose of Circuit breaker (SXCBR) is to provide the actual status of positions and to perform the control operations, that is, pass all the commands to primary apparatuses in the form of circuit breakers via binary output boards and to supervise the switching operation and position.

Circuit switch SXSWI

The purpose of Circuit switch (SXSWI) function is to provide the actual status of positions and to perform the control operations, that is, pass all the commands to primary apparatuses in the form of disconnectors or earthing switches via binary output boards and to supervise the switching operation and position.

Reservation function QCRSV

The purpose of the reservation function is primarily to transfer interlocking information between IEDs in a safe way and to prevent double operation in a bay, switchyard part, or complete substation.

Reservation input RESIN

The Reservation input (RESIN) function receives the reservation information from other bays. The number of instances is the same as the number of involved bays (up to 60 instances are available).

Bay control QCBAY

The Bay control QCBAY function is used together with Local remote and local remote control functions to handle the selection of the operator place per bay. QCBAY also provides blocking functions that can be distributed to different apparatuses within the bay.

Local remote LOCREM/Local remote control LOCREMCTRL

The signals from the local HMI or from an external local/remote switch are connected via the function blocks LOCREM and LOCREMCTRL to the Bay control QCBAY function block. The parameter *ControlMode* in function block LOCREM is set to choose if the switch signals are coming from the local HMI or from an external hardware switch connected via binary inputs.

Logic rotating switch for function selection and LHMI presentation SLGAPC

The logic rotating switch for function selection and LHMI presentation SLGAPC (or the selector switch function block) is used to get an enhanced selector switch functionality compared to the one provided by a hardware selector switch. Hardware selector switches are used extensively by utilities, in order to have different functions operating on pre-set values. Hardware switches are however sources for maintenance issues, lower system reliability and an extended purchase portfolio. The selector switch function eliminates all these problems.

Selector mini switch VSGAPC

The Selector mini switch VSGAPC function block is a multipurpose function used for a variety of applications, as a general purpose switch.

VSGAPC can be controlled from the menu or from a symbol on the single line diagram (SLD) on the local HMI.

Generic communication function for Double Point indication DPGAPC

Generic communication function for Double Point indication DPGAPC function block is used to send double indications to other systems, equipment or functions in the substation through IEC 61850-8-1 or other communication protocols. It is especially used in the interlocking station-wide logics.

Single point generic control 8 signals SPC8GAPC

The Single point generic control 8 signals SPC8GAPC function block is a collection of 8 single point commands that can be used for direct commands for example reset of LED's or putting IED in "ChangeLock" state from remote. In this way, simple commands can be sent directly to the IED outputs, without confirmation. Confirmation (status) of the result of the commands is supposed to be achieved by other means, such as binary inputs and SPGAPC function blocks. The commands can be pulsed or steady with a settable pulse time.

AutomationBits, command function for DNP3.0 AUTOBITS

AutomationBits function for DNP3 (AUTOBITS) is used within PCM600 to get into the configuration of the commands coming through the DNP3 protocol. The AUTOBITS function plays the same role as functions GOOSEBINRCV (for IEC 61850) and MULTICMDRCV (for LON).

Single command, 16 signals

The IEDs can receive commands either from a substation automation system or from the local HMI. The command function block has outputs that can be used, for example, to control high voltage apparatuses or for other user defined functionality.

11. Scheme communication

Scheme communication logic for distance or overcurrent protection ZCPSCH

To achieve instantaneous fault clearance for all line faults, scheme communication logic is provided. All types of communication schemes for permissive underreaching, permissive overreaching, blocking, delta based blocking, unblocking and intertrip are available.

The built-in communication module (LDCM) can be used for scheme communication signaling when included.

Phase segregated scheme communication logic for distance protection ZC1PPSCH

Communication between line ends is used to achieve fault clearance for all faults on a power line. All possible types of communication schemes for example, permissive underreach, permissive overreach and blocking schemes are available. To manage problems with simultaneous faults on parallel power lines phase segregated communication is needed. This will then replace the standard Scheme communication logic for distance or Overcurrent protection (ZCPSCH) on important lines where three communication channels (in each subsystem) are available for the distance protection communication.

The main purpose of the Phase segregated scheme communication logic for distance protection (ZC1PPSCH) function is to supplement the distance protection function such that:

- fast clearance of faults is also achieved at the line end for which the faults are on the part of the line not covered by its underreaching zone.
- correct phase selection can be maintained to support single-pole tripping for faults occurring anywhere on the entire length of a double circuit line.

To accomplish this, three separate communication channels, that is, one per phase, each capable of transmitting a signal in each direction is required.

ZC1PPSCH can be completed with the current reversal and WEI logic for phase segregated communication, when found necessary in Blocking and Permissive overreaching schemes.

Current reversal and weak-end infeed logic for distance protection ZCRWPSCH

The ZCRWPSCH function provides the current reversal and weak end infeed logic functions that supplement the standard scheme communication logic. It is not suitable for standalone use as it requires inputs from the distance protection functions and the scheme communications function included within the terminal.

On detection of a current reversal, the current reversal logic provides an output to block the sending of the teleprotection signal to the remote end, and to block the permissive tripping at the local end. This blocking condition is maintained long enough to ensure that no unwanted operation will occur as a result of the current reversal.

On verification of a weak end infeed condition, the weak end infeed logic provides an output for sending the received teleprotection signal back to the remote sending end and other output(s) for local tripping. For terminals equipped for single- and two-pole tripping, outputs for the faulted phase(s) are provided. Undervoltage detectors are used to detect the faulted phase(s).

Current reversal and weak-end infeed logic for phase segregated communication ZC1WPSCH

Current reversal and weak-end infeed logic for phase segregated communication (ZC1WPSCH) function is used to prevent unwanted operations due to current reversal when using permissive overreach protection schemes in application with parallel lines where the overreach from the two ends overlaps on the parallel line.

The weak-end infeed logic is used in cases where the apparent power behind the protection can be too low to activate the distance protection function. When activated, received carrier signal together with local undervoltage criteria and no reverse zone operation gives an instantaneous trip. The received signal is also echoed back to accelerate the sending end.

Local acceleration logic ZCLCPSCH

To achieve fast clearing of faults on the whole line, when no communication channel is available, local acceleration logic ZCLCPSCH can be used. This logic enables fast fault clearing and re-closing during certain conditions, but naturally, it can not fully replace a communication channel.

The logic can be controlled either by the autorecloser (zone extension) or by the loss-of-load current (loss-of-load acceleration).

Scheme communication logic for residual overcurrent protection ECPSCH

To achieve fast fault clearance of earth faults on the part of the line not covered by the instantaneous step of the residual overcurrent protection, the directional residual overcurrent protection can be supported with a logic that uses communication channels.

In the directional scheme, information of the fault current direction must be transmitted to the other line end. With directional comparison, a short operate time of the protection including a channel transmission time, can be achieved. This short operate time enables rapid autoreclosing function after the fault clearance.

The communication logic module for directional residual current protection enables blocking as well as permissive under/overreaching, and unblocking schemes. The logic can also be supported by additional logic for weak-end infeed and current reversal, included in Current reversal and weak-end infeed logic for residual overcurrent protection ECRWPSCH function.

Current reversal and weak-end infeed logic for residual overcurrent protection ECRWPSCH

The Current reversal and weak-end infeed logic for residual overcurrent protection ECRWPSCH is a supplement to Scheme communication logic for residual overcurrent protection ECPSCH.

To achieve fast fault clearing for all earth faults on the line, the directional earth fault protection function can be supported with logic that uses tele-protection channels.

This is why the IEDs have available additions to the scheme communication logic.

If parallel lines are connected to common busbars at both terminals, overreaching permissive communication schemes can trip unselectively due to fault current reversal. This unwanted tripping affects the healthy line when a fault is cleared on the other line. This lack of security can result in a total loss of interconnection between the two buses. To avoid this type of disturbance, a fault current reversal logic (transient blocking logic) can be used.

Permissive communication schemes for residual overcurrent protection can basically operate only when the protection in the remote IED can detect the fault. The detection requires a sufficient minimum residual fault current, out from this IED. The fault current can be too low due to an opened breaker or high-positive and/or zero-sequence source impedance behind this IED. To overcome these conditions, weak-end infeed (WEI) echo logic is used. The weak-end infeed echo is limited to 200 ms to avoid channel lockup.

Direct transfer trip DTT

Low active power and power factor protection LAPPGAPC

Low active power and power factor protection (LAPPGAPC) function measures power flow. It can be used for protection and monitoring of:

- phase wise low active power
- phase wise low power factor
- phase wise reactive power and apparent power as service values

Following features are available:

- Definite time stage for low active power protection
- Definite time stage for low power factor protection
- Individual enabling of Low active power and Low power factor functions
- Low active power trip with 2 selection modes '1 out of 3' and '2 out of 3'
- Phase wise calculated values of apparent power, reactive power, active power and power factor are available as service values
- Insensitive to small variations in voltage and current

Compensated over and undervoltage protection COUVGAPC

Compensated over and undervoltage protection (COUVGAPC) function calculates the remote end voltage of the transmission line utilizing local measured voltage, current and with the help of transmission line parameters, that is, line resistance, reactance, capacitance and local shunt reactor. For protection of long transmission line for in zone faults, COUVGAPCcan be incorporated with local criteria within direct transfer trip logic to ensure tripping of the line only under abnormal conditions.

Sudden change in current variation SCCVPTOC

Sudden change in current variation (SCCVPTOC) function is a fast way of finding any abnormality in line currents. When there is a fault in the system, the current changes faster than the voltage. SCCVPTOC finds abnormal condition based on phase-to-phase current variation. The main application is as a local criterion to increase security when transfer trips are used.

Carrier receive logic LCCRPTRC

In Direct transfer trip (DTT) scheme, the received CR signal gives the trip to the circuit breaker after checking certain local criteria functions in order to increase the security of the overall tripping functionality. Carrier receive logic (LCCRPTRC) function gives final trip output of the DTT scheme.

Features:

- Carrier redundancy to ensure security in DTT scheme
- Blocking function output on CR Channel Error
- Phase wise trip outputs

Negative sequence overvoltage protection LCNSPTOV

Negative sequence components are present in all types of fault condition. Negative sequence voltage and current get high values during unsymmetrical faults.

Zero sequence overvoltage protection LCZSPTOV

Zero sequence components are present in all abnormal conditions involving earth. They can reach considerably high values during earth faults.

Negative sequence overcurrent protection LCNSPTOC

Negative sequence components are present in all types of fault condition. They can reach considerably high values during abnormal operation.

Zero sequence overcurrent protection LCZSPTOC

Zero sequence components are present in all abnormal conditions involving earth. They have a considerably high value during earth faults.

Three phase overcurrent LCP3PTOC

Three phase overcurrent (LCP3PTOC) is designed for overcurrent conditions.

Features:

- Phase wise start and trip signals
- Overcurrent protection
- Phase wise RMS current is available as service values
- Single definite time stage trip function.

Three phase undercurrent LCPCPTUC

Three phase undercurrent function (LCP3PTUC) is designed for detecting loss of load conditions.

Features:

- Phase wise start and trip signals
- Phase wise RMS current is available as service values
- Single definite time stage trip function

12. Logic

Tripping logic SMPPTRC

A function block for protection tripping is provided for each circuit breaker involved in the tripping of the fault. It provides a settable pulse prolongation to ensure a trip pulse of sufficient length, as well as all functionality necessary for correct co-operation with autoreclosing functions.

The trip function block also includes a settable latch functionality for evolving faults and breaker lock-out.

Trip matrix logic TMAGAPC

Trip matrix logic TMAGAPC function is used to route trip signals and other logical output signals to different output contacts on the IED.

The trip matrix logic function has 3 output signals and these outputs can be connected to physical tripping outputs according to the specific application needs for settable pulse or steady output.

Group alarm logic function ALMCALH

The group alarm logic function ALMCALH is used to route several alarm signals to a common indication, LED and/or contact, in the IED.

Group warning logic function WRNCALH

The group warning logic function WRNCALH is used to route several warning signals to a common indication, LED and/or contact, in the IED.

Group indication logic function INDCALH

The group indication logic function INDCALH is used to route several indication signals to a common indication, LED and/or contact, in the IED.

Extension logic package

The logic extension block package includes additional trip matrix logic and configurable logic blocks.

Logic rotating switch for function selection and LHMI presentation SLGAPC

The logic rotating switch for function selection and LHMI presentation SLGAPC (or the selector switch function block) is used to get an enhanced selector switch functionality compared to the one provided by a hardware selector switch. Hardware selector switches are used extensively by utilities, in order to have different functions operating on pre-set values. Hardware switches are however sources for maintenance issues, lower system reliability and an extended purchase portfolio. The selector switch function eliminates all these problems.

Selector mini switch VSGAPC

The Selector mini switch VSGAPC function block is a multipurpose function used for a variety of applications, as a general purpose switch.

VSGAPC can be controlled from the menu or from a symbol on the single line diagram (SLD) on the local HMI.

Fixed signal function block

The Fixed signals function FXDSIGN generates nine pre-set (fixed) signals that can be used in the configuration of an IED, either for forcing the unused inputs in other function blocks to a certain level/value, or for creating certain logic. Boolean, integer, floating point, string types of signals are available.

Elapsed time integrator with limit transgression and overflow supervision (TEIGAPC)

The Elapsed time integrator function TEIGAPC is a function that accumulates the elapsed time when a given binary signal has been high.

The main features of TEIGAPC

- Applicable to long time integration (≤999 999.9 seconds).
- Supervision of limit transgression conditions and overflow.
- Possibility to define a warning or alarm with the resolution of 10 milliseconds.
- Retaining of the integration value.
- Possibilities for blocking and reset.
- Reporting of the integrated time.

Boolean 16 to Integer conversion with logic node representation BTIGAPC

Boolean 16 to integer conversion with logic node representation function BTIGAPC is used to transform a set of 16 binary (logical) signals into an integer. The block input will freeze the output at the last value.

BTIGAPC can receive remote values via IEC 61850 depending on the operator position input (PSTO).

Integer to Boolean 16 conversion IB16

Integer to boolean 16 conversion function IB16 is used to transform an integer into a set of 16 binary (logical) signals.

Integer to Boolean 16 conversion with logic node representation ITBGAPC

Integer to boolean conversion with logic node representation function ITBGAPC is used to transform an integer which is transmitted over IEC 61850 and received by the function to 16 binary coded (logic) output signals.

ITBGAPC function can only receive remote values over IEC 61850 when the R/L (Remote/Local) push button on the front HMI, indicates that the control mode for the operator is in position R (Remote i.e. the LED adjacent to R is lit), and the corresponding signal is connected to the input PSTO ITBGAPC function block. The input BLOCK will freeze the output at the last received value and blocks new integer values to be received and converted to binary coded outputs.

13. Monitoring

Measurements CVMMXN, CMMXU, VNMMXU, VMMXU, CMSQI, VMSQI

The measurement functions are used to get on-line information from the IED. These service values make it possible to display on-line information on the local HMI and on the Substation automation system about:

- measured voltages, currents, frequency, active, reactive and apparent power and power factor
- measured analog values from merging units
- primary phasors
- positive, negative and zero sequence currents and voltages
- mA, input currents
- pulse counters

Supervision of mA input signals

The main purpose of the function is to measure and process signals from different measuring transducers. Many devices used in process control represent various parameters such as frequency, temperature and DC battery voltage as low current values, usually in the range 4-20 mA or 0-20 mA.

Alarm limits can be set and used as triggers, e.g. to generate trip or alarm signals.

The function requires that the IED is equipped with the mA input module.

Disturbance report DRPRDRE

Complete and reliable information about disturbances in the primary and/or in the secondary system together with continuous event-logging is accomplished by the disturbance report functionality.

Disturbance report DRPRDRE, always included in the IED, acquires sampled data of all selected analog input and binary signals connected to the function block with a, maximum of 40 analog and 96 binary signals.

The Disturbance report functionality is a common name for several functions:

- Event list
- Indications
- Event recorder
- Trip value recorder
- Disturbance recorder
- Fault locator

The Disturbance report function is characterized by great flexibility regarding configuration, starting conditions, recording times, and large storage capacity.

A disturbance is defined as an activation of an input to the AnRADR or BnRBDR function blocks, which are set to trigger the disturbance recorder. All connected signals from start of pre-fault time to the end of post-fault time will be included in the recording.

Every disturbance report recording is saved in the IED in the standard Comtrade format as a reader file HDR, a configuration file CFG, and a data file DAT. The same applies to all events, which are continuously saved in a ring-buffer. The local HMI is used to get information about the recordings. The disturbance report files may be uploaded to PCM600 for further analysis using the disturbance handling tool.

Event list DRPRDRE

Continuous event-logging is useful for monitoring the system from an overview perspective and is a complement to specific disturbance recorder functions.

The event list logs all binary input signals connected to the Disturbance recorder function. The list may contain up to 1000 time-tagged events stored in a ring-buffer.

Indications DRPRDRE

To get fast, condensed and reliable information about disturbances in the primary and/or in the secondary system it is important to know, for example binary signals that have changed status during a disturbance. This information is used in the short perspective to get information via the local HMI in a straightforward way.

There are three LEDs on the local HMI (green, yellow and red), which will display status information about the IED and the Disturbance recorder function (triggered).

The Indication list function shows all selected binary input signals connected to the Disturbance recorder function that have changed status during a disturbance.

Event recorder DRPRDRE

Quick, complete and reliable information about disturbances in the primary and/or in the secondary system is vital, for example, time-tagged events logged during disturbances. This information is used for different purposes in the short term (for example corrective actions) and in the long term (for example functional analysis).

The event recorder logs all selected binary input signals connected to the Disturbance recorder function. Each recording can contain up to 150 time-tagged events.

The event recorder information is available for the disturbances locally in the IED.

The event recording information is an integrated part of the disturbance record (Comtrade file).

Trip value recorder DRPRDRE

Information about the pre-fault and fault values for currents and voltages are vital for the disturbance evaluation.

The Trip value recorder calculates the values of all selected analog input signals connected to the Disturbance recorder function. The result is magnitude and phase angle before and during the fault for each analog input signal.

The trip value recorder information is available for the disturbances locally in the IED.

The trip value recorder information is an integrated part of the disturbance record (Comtrade file).

Disturbance recorder DRPRDRE

The Disturbance recorder function supplies fast, complete and reliable information about disturbances in the power system. It facilitates understanding system behavior and related primary and secondary equipment during and after a disturbance. Recorded information is used for different purposes in the short perspective (for example corrective actions) and long perspective (for example functional analysis).

The Disturbance recorder acquires sampled data from selected analog- and binary signals connected to the Disturbance recorder function (maximum 40 analog and 96 binary signals). The binary signals available are the same as for the event recorder function.

The function is characterized by great flexibility and is not dependent on the operation of protection functions. It can record disturbances not detected by protection functions. Up to ten seconds of data before the trigger instant can be saved in the disturbance file.

The disturbance recorder information for up to 100 disturbances are saved in the IED and the local HMI is used to view the list of recordings.

Event function

When using a Substation Automation system with LON or SPA communication, time-tagged events can be sent at change or cyclically from the IED to the station level. These events are created from any available signal in the IED that is connected to the Event function (EVENT). The event function block is used for LON and SPA communication.

Analog and double indication values are also transferred through EVENT function.

Generic communication function for Single Point indication SPGAPC

Generic communication function for Single Point indication SPGAPC is used to send one single logical signal to other systems or equipment in the substation.

Generic communication function for Measured Value MVGAPC

Generic communication function for Measured Value MVGAPC function is used to send the instantaneous value of an analog signal to other systems or equipment in the substation. It can also be used inside the same IED, to attach a RANGE aspect to an analog value and to permit measurement supervision on that value.

Measured value expander block RANGE_XP

The current and voltage measurements functions (CVMMXN, CMMXU, VMMXU and VNMMXU), current and voltage sequence measurement functions (CMSQI and VMSQI) and IEC 61850 generic communication I/O functions (MVGAPC) are provided with measurement supervision functionality. All measured values can be supervised with four settable limits: low-low limit, low limit, high limit and high-high limit. The measure value expander block (RANGE_XP) has been introduced to enable translating the integer output signal from the measuring functions to 5 binary signals: below low-low limit, below low limit, normal, above high limit or above high-high limit. The output signals can be used as conditions in the configurable logic or for alarming purpose.

Fault locator LMBRFLO

The accurate fault locator is an essential component to minimize the outages after a persistent fault and/or to pin-point a weak spot on the line.

The fault locator is an impedance measuring function giving the distance to the fault in km, miles or % of line length. The main advantage is the high accuracy achieved by compensating for load current and for the mutual zero-sequence effect on double circuit lines.

The compensation includes setting of the remote and local sources and calculation of the distribution of fault currents from each side. This distribution of fault current, together with recorded load (pre-fault) currents, is used to exactly calculate the fault position. The fault can be recalculated with new source data at the actual fault to further increase the accuracy.

Especially on heavily loaded long lines, where the source voltage angles can be up to 35-40 degrees apart, the accuracy can be still maintained with the advanced compensation included in fault locator.

Event counter with limit supervison L4UFCNT

The 30 limit counter L4UFCNT provides a settable counter with four independent limits where the number of positive and/or negative flanks on the input signal are counted against the setting values for limits. The output for each limit is activated when the counted value reaches that limit.

Overflow indication is included for each up-counter.

14. Metering

Pulse-counter logic PCFCNT

Pulse-counter logic (PCFCNT) function counts externally generated binary pulses, for instance pulses coming from an external energy meter, for calculation of energy consumption values. The pulses are captured by the binary input module and then read by the PCFCNT function. A scaled service value is available over the station bus. The special Binary input module with enhanced pulse counting capabilities must be ordered to achieve this functionality.

Function for energy calculation and demand handling (ETPMMTR)

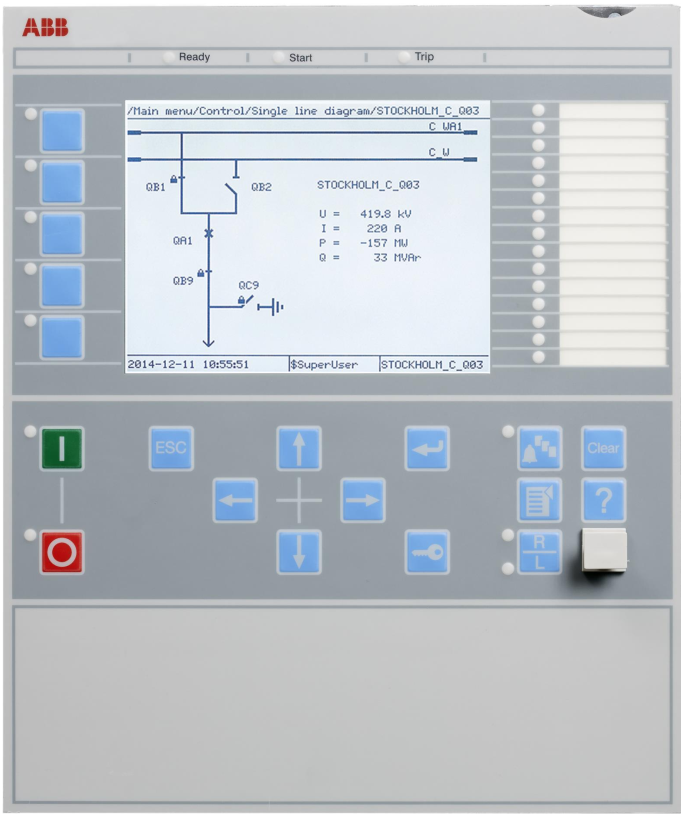
Measurements function block (CVMMXN) can be used to measure active as well as reactive power values. Function for energy calculation and demand handling (ETPMMTR) uses measured active and reactive power as input and calculates the accumulated active and reactive energy pulses, in forward and reverse direction. Energy values can be read or generated as pulses. Maximum demand power values are also calculated by the function. This function includes zero point clamping to remove noise from the input signal. As output of this function: periodic energy calculations, integration of energy values, calculation of energy pulses, alarm signals for limit violation of energy values and maximum power demand, can be found.

The values of active and reactive energies are calculated from the input power values by integrating them over a selected time *tEnergy*. The integration of active and reactive energy values will happen in both forward and reverse directions. These energy values are available as output signals and also as pulse outputs. Integration of energy values can be controlled by inputs (STARTACC and STOPACC) and *EnaAcc* setting and it can be reset to initial values with RSTACC input.

The maximum demand for active and reactive powers are calculated for the set time interval *tEnergy* and these values are updated every minute through output channels. The active and reactive maximum power demand values are calculated for both forward and reverse direction and these values can be reset with RSTDMD input.

15. Human machine interface

Local HMI



IEC13000239-2-en.vsd

Figure 13. Local human-machine interface

The LHMI of the IED contains the following elements:
- Graphical display capable of showing a user defined single line diagram and provide an interface for controlling switchgear.
- Navigation buttons and five user defined command buttons to shortcuts in the HMI tree or simple commands.
- 15 user defined three-color LEDs.
- Communication port for PCM600.

The LHMI is used for setting, monitoring and controlling.

16. Basic IED functions

Time synchronization

The time synchronization function is used to select a common source of absolute time for the synchronization of the IED when it is a part of a protection system. This makes it possible to compare events and disturbance data between all IEDs within a station automation system and in between sub-stations. A common source shall be used for IED and merging unit when IEC 61850-9-2LE process bus communication is used.

17. Station communication

670 series protocols

Each IED is provided with a communication interface, enabling it to connect to one or many substation level systems or equipment, either on the Substation Automation (SA) bus or Substation Monitoring (SM) bus.

Following communication protocols are available:

- IEC 61850-8-1 communication protocol
- IEC 61850-9-2LE communication protocol
- LON communication protocol
- SPA or IEC 60870-5-103 communication protocol
- DNP3.0 communication protocol

Several protocols can be combined in the same IED.

IEC 61850-8-1 communication protocol

IEC 61850 Ed.1 or Ed.2 can be chosen by a setting in PCM600. The IED is equipped with single or double optical Ethernet rear ports (order dependent) for IEC 61850-8-1 station bus communication. The IEC 61850-8-1 communication is also possible from the electrical Ethernet front port. IEC 61850-8-1 protocol allows intelligent electrical devices (IEDs) from different vendors to exchange information and simplifies system engineering. IED-to-IED communication using GOOSE and client-server communication over MMS are supported. Disturbance recording file (COMTRADE) uploading can be done over MMS or FTP.

IEC 61850-9-2LE communication protocol

Single optical Ethernet port communication standard IEC 61850-9-2LE for process bus is provided. IEC 61850-9-2LE allows Non Conventional Instrument Transformers (NCIT) with Merging Units (MU) or stand alone Meging Units to exchange information with the IED and simplifies SA engineering.

LON communication protocol

Existing stations with ABB station bus LON can be extended with use of the optical LON interface. This allows full SA functionality including peer-to-peer messaging and cooperation between the IEDs.

SPA communication protocol

A single glass or plastic port is provided for the ABB SPA protocol. This allows extensions of simple substation automation systems but the main use is for Substation Monitoring Systems SMS.

IEC 60870-5-103 communication protocol

A single glass or plastic port is provided for the IEC 60870-5-103 standard. This allows design of simple substation automation systems including equipment from different vendors. Disturbance files uploading is provided.

DNP3.0 communication protocol

An electrical RS485 and an optical Ethernet port is available for the DNP3.0 communication. DNP3.0 Level 2 communication with unsolicited events, time synchronizing and disturbance reporting is provided for communication to RTUs, Gateways or HMI systems.

Multiple command and transmit

When IEDs are used in Substation Automation systems with LON, SPA or IEC 60870-5-103 communication protocols, the Event and Multiple Command function blocks are used as the communication interface for vertical communication to station HMI and gateway, and as interface for horizontal peer-to-peer communication (over LON only).

IEC 62439-3 Parallel Redundancy Protocol

Redundant station bus communication according to IEC 62439-3 Edition 1 and IEC 62439-3 Edition 2 parallel redundancy protocol (PRP) are available as options when ordering IEDs. Redundant station bus communication according to IEC 62439-3 uses both port AB and port CD on the OEM module.

18. Remote communication

Analog and binary signal transfer to remote end

Three analog and eight binary signals can be exchanged between two IEDs. This functionality is mainly used for the line differential protection. However it can be used in other products as well. An IED can communicate with up to 4 remote IEDs.

Binary signal transfer to remote end, 192 signals

If the communication channel is used for transfer of binary signals only, up to 192 binary signals can be exchanged between two IEDs. For example, this functionality can be used to send information such as status of primary switchgear apparatus or intertripping signals to the remote IED. An IED can communicate with up to 4 remote IEDs.

Line data communication module, short, medium and long range LDCM

The line data communication module (LDCM) is used for communication between the IEDs situated at distances <110 km/68 miles or from the IED to optical to electrical converter with G.703 or G.703E1 interface located on a distances < 3 km/1.9 miles away. The LDCM module sends and receives data, to and from another LDCM module. The IEEE/ANSI C37.94 standard format is used.

Galvanic X.21 line data communication module X.21-LDCM

A module with built-in galvanic X.21 converter which e.g. can be connected to modems for pilot wires is also available.

Galvanic interface G.703 resp G.703E1

The external galvanic data communication converter G.703/G.703E1 makes an optical-to-galvanic conversion for connection to a multiplexer. These units are designed for 64 kbit/s resp 2Mbit/s operation. The converter is delivered with 19” rack mounting accessories.

19. Hardware description

Hardware modules

Power supply module PSM

The power supply module is used to provide the correct internal voltages and full isolation between the IED and the battery system. An internal fail alarm output is available.

Binary input module BIM

The binary input module has 16 optically isolated inputs and is available in two versions, one standard and one with enhanced pulse counting capabilities on the inputs to be used with the pulse counter function. The binary inputs are freely programmable and can be used for the input of logical signals to any of the functions. They can also be included in the disturbance recording and event-recording functions. This enables extensive monitoring and evaluation of operation of the IED and for all associated electrical circuits.

Binary output module BOM

The binary output module has 24 independent output relays and is used for trip output or any signaling purpose.

Static binary output module SOM

The static binary output module has six fast static outputs and six change over output relays for use in applications with high speed requirements.

Binary input/output module IOM

The binary input/output module is used when only a few input and output channels are needed. The ten standard output channels are used for trip output or any signaling purpose. The two high speed signal output channels are used for applications where short operating time is essential. Eight optically isolated binary inputs cater for required binary input information.

mA input module MIM

The milli-ampere input module is used to interface transducer signals in the –20 to +20 mA range from for example OLTC position, temperature or pressure transducers. The module has six independent, galvanically separated channels.

Optical ethernet module OEM

The optical fast-ethernet module is used for fast and interference-free communication of synchrophasor data over IEEE C37.118 and/or IEEE 1344 protocols. It is also used to connect an IED to the communication buses (like the station bus) that use the IEC 61850-8-1 protocol (OEM rear port A, B). The process bus use the IEC 61850-9-2LE protocol (OEM rear port C, D). The module has one or two optical ports with ST connectors.

Serial and LON communication module SLM, supports SPA/IEC 60870-5-103, LON and DNP 3.0

The serial and LON communication module (SLM) is used for SPA, IEC 60870-5-103, DNP3 and LON communication. The module has two optical communication ports for plastic/plastic, plastic/glass or glass/glass. One port is used for serial communication (SPA, IEC 60870-5-103 and DNP3 port) and one port is dedicated for LON communication.

Line data communication module LDCM

Each module has one optical port, one for each remote end to which the IED communicates.

Alternative cards for Long range (1550 nm single mode), Medium range (1310 nm single mode) and Short range (850 nm multi mode) are available.

Galvanic X.21 line data communication module X.21-LDCM

The galvanic X.21 line data communication module is used for connection to telecommunication equipment, for example leased telephone lines. The module supports 64 kbit/s data communication between IEDs.

Examples of applications:

- Line differential protection
- Binary signal transfer

Galvanic RS485 serial communication module

The Galvanic RS485 communication module (RS485) is used for DNP3.0 and IEC 60870-5-103 communication. The module has one RS485 communication port. The RS485 is a balanced serial communication that can be used either in 2-wire or 4-wire connections. A 2-wire connection uses the same signal for RX and TX and is a multidrop communication with no dedicated Master or slave. This variant requires however a control of the output. The 4-wire connection has separated signals for RX and TX multidrop communication with a dedicated Master and the rest are slaves. No special control signal is needed in this case.

GPS time synchronization module GTM

This module includes a GPS receiver used for time synchronization. The GPS has one SMA contact for connection to an antenna. It also includes an optical PPS ST-connector output.

IRIG-B Time synchronizing module

The IRIG-B time synchronizing module is used for accurate time synchronizing of the IED from a station clock.

The Pulse Per Second (PPS) input shall be used for synchronizing when IEC 61850-9-2LE is used.

Electrical (BNC) and optical connection (ST) for 0XX and 12X IRIG-B support.

Transformer input module TRM

The transformer input module is used to galvanically separate and adapt the secondary currents and voltages generated by the measuring transformers. The module has twelve inputs in different combinations of currents and voltage inputs.

Alternative connectors of Ring lug or Compression type can be ordered.

High impedance resistor unit

The high impedance resistor unit, with resistors for pick-up value setting and a voltage dependent resistor, is available in a single phase unit and a three phase unit. Both are mounted on a 1/1 19 inch apparatus plate with compression type terminals.

Layout and dimensions

Dimensions

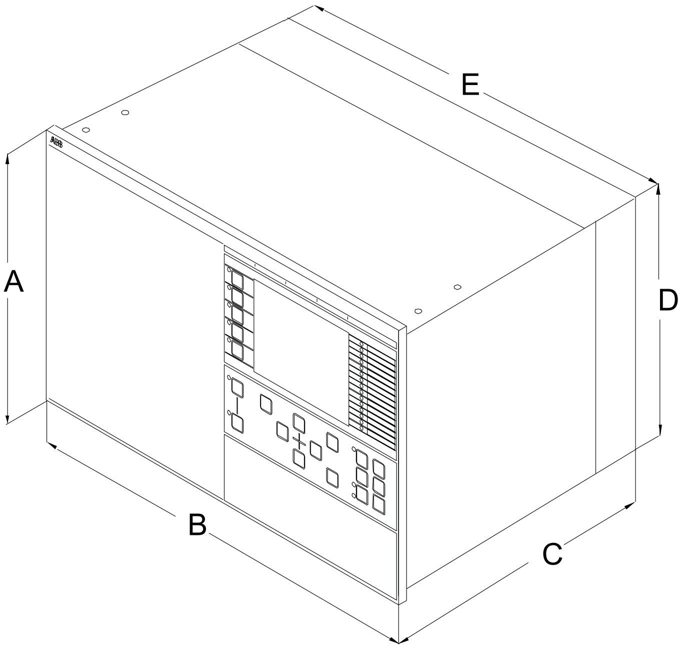


Figure 14. Case with rear cover

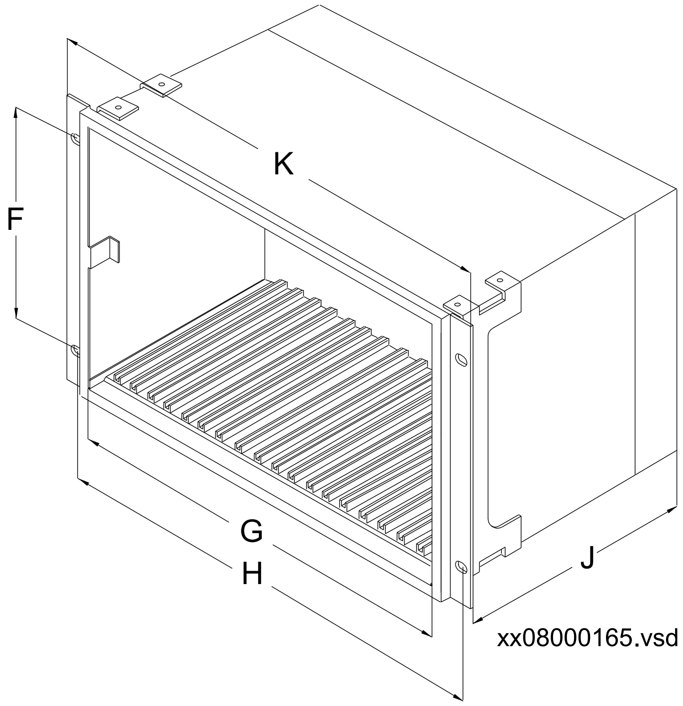


Figure 15. Case with rear cover and 19” rack mounting kit

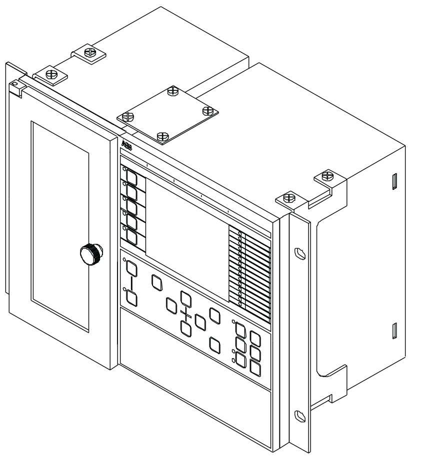


Figure 16. A 1/2 x 19” size IED side-by-side with RHGS6.

Case size (mm)/(inches)	A	B	C	D	E	F	G	H	J	K
6U, 1/2 x 19”	265.9/ 10.47	223.7/ 8.81	242.1/ 9.53	255.8/ 10.07	205.7/ 8.10	190.5/ 7.50	203.7/ 8.02	-	228.6/ 9.00	-
6U, 3/4 x 19”	265.9/ 10.47	336.0/ 13.23	242.1/ 9.53	255.8/ 10.07	318.0/ 12.52	190.5/ 7.50	316.0/ 12.4	-	228.6/ 9.00	-
6U, 1/1 x 19”	265.9/ 10.47	448.3/ 17.65	242.1/ 9.53	255.8/ 10.07	430.3/ 16.86	190.5/ 7.50	428.3/ 16.86	465.1/ 18.31	228.6/ 9.00	482.6/19.00

The H and K dimensions are defined by the 19” rack mounting kit.

Mounting alternatives

See ordering for details about available mounting alternatives.

- 19” rack mounting kit
- Flush mounting kit with cut-out dimensions:
  - 1/2 case size (h) 254.3 mm/10.01” (w) 210.1 mm/8.27”
  - 3/4 case size (h) 254.3 mm/10.01” (w) 322.4 mm/12.69”
  - 1/1 case size (h) 254.3 mm/10.01” (w) 434.7 mm/17.11”
- Wall mounting kit

20. Connection diagrams

Connection diagrams

The connection diagrams are delivered on the IED Connectivity package DVD as part of the product delivery.

The latest versions of the connection diagrams can be downloaded from http://www.abb.com/substationautomation.

Connection diagrams for Customized products

Connection diagram, 670 series 2.0 1MRK002801-AE

Connection diagrams for Configured products

Connection diagram, REL670 2.0, A21 1MRK002803-LE

Connection diagram, REL670 2.0, A31 1MRK002803-LA

Connection diagram, REL670 2.0, B31 1MRK002803-LB

Connection diagram, REL670 2.0, A32 1MRK002803-LC

Connection diagram, REL670 2.0, B32 1MRK002803-LD

21. Technical data

General

Definitions	
Reference value	The specified value of an influencing factor to which are referred the characteristics of the equipment
Nominal range	The range of values of an influencing quantity (factor) within which, under specified conditions, the equipment meets the specified requirements
Operative range	The range of values of a given energizing quantity for which the equipment, under specified conditions, is able to perform its intended functions according to the specified requirements

Energizing quantities, rated values and limits
Analog inputs

Table 2. TRM - Energizing quantities, rated values and limits for protection transformer modules

Quantity	Rated value	Nominal range
Current	I_r = 1 or 5 A	(0.2-40) × I_r
Operative range	(0-100) x I_r	
Permissive overload	4 × I_r cont. 100 × I_r for 1 s *)	
Burden	< 150 mVA at I_r = 5 A < 20 mVA at I_r = 1 A	
Ac voltage	U_r = 110 V	0.5–288 V
Operative range	(0–340) V	
Permissive overload	420 V cont. 450 V 10 s	
Burden	< 20 mVA at 110 V	
Frequency	f_r = 50/60 Hz	±5%

*) max. 350 A for 1 s when COMBITEST test switch is included.

Table 3. TRM - Energizing quantities, rated values and limits for measuring transformer modules

Quantity	Rated value	Nominal range
Current	I_r = 1 or 5 A	(0-1.8) × $I_r$at I_r = 1 A (0-1.6) × $I_r$at I_r = 5 A
Permissive overload	1.1 × I_r cont. 1.8 × I_r for 30 min at I_r = 1 A 1.6 × I_r for 30 min at I_r = 5 A	
Burden	< 350 mVA at I_r = 5 A < 200 mVA at I_r = 1 A	
Ac voltage	U_r = 110 V	0.5–288 V
Operative range	(0–340) V	
Permissive overload	420 V cont. 450 V 10 s	
Burden	< 20 mVA at 110 V	
Frequency	f_r = 50/60 Hz	±5%

Table 4. MIM - mA input module

Quantity:	Rated value:	Nominal range:
Input resistance	R_{in} = 194 Ohm	-
Input range	± 5, ± 10, ± 20mA 0-5, 0-10, 0-20, 4-20mA	-
Power consumption each mA-board each mA input	 ≤ 2 W ≤ 0.1 W	-

Table 5. OEM - Optical ethernet module

Quantity	Rated value
Number of channels	1 or 2 (port A, B for IEC 61850-8-1 / IEEE C37.118 and port C, D for IEC 61850-9-2LE / IEEE C37.118)
Standard	IEEE 802.3u 100BASE-FX
Type of fiber	62.5/125 μm multimode fibre
Wave length	1300 nm
Optical connector	Type ST
Communication speed	Fast Ethernet 100 Mbit/s

Auxiliary DC voltage

Table 6. PSM - Power supply module

Quantity	Rated value	Nominal range
Auxiliary DC voltage, EL (input)	EL = (24-60) V EL = (90-250) V	EL ±20% EL ±20%
Power consumption	50 W typically	-
Auxiliary DC power in-rush	< 10 A during 0.1 s	-

Binary inputs and outputs

Table 7. BIM - Binary input module

Quantity	Rated value	Nominal range
Binary inputs	16	-
DC voltage, RL	24/30 V 48/60 V 110/125 V 220/250 V	RL ±20% RL ±20% RL ±20% RL ±20%
Power consumption 24/30 V, 50 mA 48/60 V, 50 mA 110/125 V, 50 mA 220/250 V, 50 mA 220/250 V, 110 mA	 max. 0.05 W/input max. 0.1 W/input max. 0.2 W/input max. 0.4 W/input max. 0.5 W/input	-
Counter input frequency	10 pulses/s max	-
Oscillating signal discriminator	Blocking settable 1–40 Hz Release settable 1–30 Hz	
Debounce filter	Settable 1–20 ms	

Maximum 176 binary input channels may be activated simultaneously with influencing factors within nominal range.

Table 8. BIM - Binary input module with enhanced pulse counting capabilities

Quantity	Rated value	Nominal range
Binary inputs	16	-
DC voltage, RL	24/30 V 48/60 V 110/125 V 220/250 V	RL ±20% RL ±20% RL ±20% RL ±20%
Power consumption 24/30 V 48/60 V 110/125 V 220/250 V	 max. 0.05 W/input max. 0.1 W/input max. 0.2 W/input max. 0.4 W/input	-
Counter input frequency	10 pulses/s max	-
Balanced counter input frequency	40 pulses/s max	-
Oscillating signal discriminator	Blocking settable 1–40 Hz Release settable 1–30 Hz	
Debounce filter	Settable 1-20 ms	

Maximum 176 binary input channels may be activated simultaneously with influencing factors within nominal range.

Table 9. IOM - Binary input/output module

Quantity	Rated value	Nominal range
Binary inputs	8	-
DC voltage, RL	24/30 V 48/60 V 110/125 V 220/250 V	RL ±20% RL ±20% RL ±20% RL ±20%
Power consumption 24/30 V, 50 mA 48/60 V, 50 mA 110/125 V, 50 mA 220/250 V, 50 mA 220/250 V, 110 mA	 max. 0.05 W/input max. 0.1 W/input max. 0.2 W/input max. 0.4 W/input max. 0.5 W/input	-
Counter input frequency	10 pulses/s max	
Oscillating signal discriminator	Blocking settable 1-40 Hz Release settable 1-30 Hz	
Debounce filter	Settable 1-20 ms	

Maximum 176 binary input channels may be activated simultaneously with influencing factors within nominal range.

Table 10. IOM - Binary input/output module contact data (reference standard: IEC 61810-2)

Function or quantity	Trip and signal relays	Fast signal relays (parallel reed relay)
Binary outputs	10	2
Max system voltage	250 V AC, DC	250 V DC
Test voltage across open contact, 1 min	1000 V rms	800 V DC
Current carrying capacity Per relay, continuous Per relay, 1 s Per process connector pin, continuous	 8 A 10 A 12 A	 8 A 10 A 12 A
Making capacity at inductive load with L/R>10 ms 0.2 s 1.0 s	30 A 10 A	0.4 A 0.4 A
Making capacity at resistive load 0.2 s 1.0 s	30 A 10 A	220–250 V/0.4 A 110–125 V/0.4 A 48–60 V/0.2 A 24–30 V/0.1 A
Breaking capacity for AC, cos φ > 0.4	250 V/8.0 A	250 V/8.0 A
Breaking capacity for DC with L/R < 40 ms	48 V/1 A 110 V/0.4 A 125 V/0.35 A 220 V/0.2 A 250 V/0.15 A	48 V/1 A 110 V/0.4 A 125 V/0.35 A 220 V/0.2 A 250 V/0.15 A
Maximum capacitive load	-	10 nF

Table 11. IOM with MOV and IOM 220/250 V, 110mA - contact data (reference standard: IEC 61810-2)

Function or quantity	Trip and Signal relays	Fast signal relays (parallel reed relay)
Binary outputs	IOM: 10	IOM: 2
Max system voltage	250 V AC, DC	250 V DC
Test voltage across open contact, 1 min	250 V rms	250 V rms
Current carrying capacity Per relay, continuous Per relay, 1 s Per process connector pin, continuous	 8 A 10 A 12 A	 8 A 10 A 12 A
Making capacity at inductive loadwith L/R>10 ms 0.2 s 1.0 s	 30 A 10 A	 0.4 A 0.4 A
Making capacity at resistive load 0.2 s 1.0 s	 30 A 10 A	 220–250 V/0.4 A 110–125 V/0.4 A 48–60 V/0.2 A 24–30 V/0.1 A
Breaking capacity for AC, cos φ>0.4	250 V/8.0 A	250 V/8.0 A
Breaking capacity for DC with L/R < 40 ms	48 V/1 A 110 V/0.4 A 220 V/0.2 A 250 V/0.15 A	48 V/1 A 110 V/0.4 A 220 V/0.2 A 250 V/0.15 A
Maximum capacitive load	-	10 nF

Table 12. SOM - Static Output Module (reference standard: IEC 61810-2): Static binary outputs

Function of quantity	Static binary output trip	
Rated voltage	48-60 VDC	110-250 VDC
Number of outputs	6	6
Impedance open state	~300 kΩ	~810 kΩ
Test voltage across open contact, 1 min	No galvanic separation	No galvanic separation
Current carrying capacity: Continuous 1.0 s	 5 A 10 A	 5 A 10 A
Making capacity at capacitive load with the maximum capacitance of 0.2 μF : 0.2 s 1.0 s	 30 A 10 A	 30 A 10 A
Breaking capacity for DC with L/R ≤ 40 ms	48 V/1 A 60 V/0.75 A	110 V/0.4 A 125 V/0.35 A 220 V/0.2 A 250 V/0.15 A
Operating time	< 1 ms	< 1 ms

Table 13. SOM - Static Output module data (reference standard: IEC 61810-2): Electromechanical relay outputs

Function of quantity	Trip and signal relays
Max system voltage	250 V AC/DC
Number of outputs	6
Test voltage across open contact, 1 min	1000 V rms
Current carrying capacity: Continuous 1.0 s	 8 A 10 A
Making capacity at capacitive load with the maximum capacitance of 0.2 μF: 0.2 s 1.0 s	 30 A 10 A
Breaking capacity for DC with L/R ≤ 40 ms	48 V/1 A 110 V/0.4 A 125 V/0.35 A 220 V/0.2 A 250 V/0.15 A

Table 14. BOM - Binary output module contact data (reference standard: IEC 61810-2)

Function or quantity	Trip and Signal relays
Binary outputs	24
Max system voltage	250 V AC, DC
Test voltage across open contact, 1 min	1000 V rms
Current carrying capacity Per relay, continuous Per relay, 1 s Per process connector pin, continuous	 8 A 10 A 12 A
Making capacity at inductive load with L/R>10 ms 0.2 s 1.0 s	 30 A 10 A
Breaking capacity for AC, cos φ>0.4	250 V/8.0 A
Breaking capacity for DC with L/R < 40 ms	48 V/1 A 110 V/0.4 A 125 V/0.35 A 220 V/0.2 A 250 V/0.15 A

Influencing factors

Table 15. Temperature and humidity influence

Parameter	Reference value	Nominal range	Influence
Ambient temperature, operate value	+20°C	-10 °C to +55°C	0.02% / °C
Relative humidity Operative range	10%-90% 0%-95%	10%-90%	-
Storage temperature	-	-40 °C to +70 °C	-

Table 16. Auxiliary DC supply voltage influence on functionality during operation

Dependence on	Reference value	Within nominal range	Influence
Ripple, in DC auxiliary voltage Operative range	max. 2% Full wave rectified	15% of EL	0.01% / %
Auxiliary voltage dependence, operate value		±20% of EL	0.01% / %
Interrupted auxiliary DC voltage Interruption interval 0–50 ms 0–∞ s Restart time		24-60 V DC ± 20% 90-250 V DC ±20%	No restart Correct behaviour at power down <300 s

Table 17. Frequency influence (reference standard: IEC 60255–1)

Dependence on	Within nominal range	Influence
Frequency dependence, operate value	f_r ±2.5 Hz for 50 Hz f_r ±3.0 Hz for 60 Hz	±1.0% / Hz
Frequency dependence for distance protection operate value	f_r ±2.5 Hz for 50 Hz f_r ±3.0 Hz for 60 Hz	±2.0% / Hz
Harmonic frequency dependence (20% content)	2^{nd}, 3^{rd} and 5^{th} harmonic of f_r	±2.0%
Harmonic frequency dependence for distance protection (10% content)	2^{nd}, 3^{rd} and 5^{th} harmonic of f_r	±10.0%
Harmonic frequency dependence for high impedance differential protection (10% content)	2^{nd}, 3rd and 5^{th} harmonic of f_r	±10.0%
Harmonic frequency dependence for overcurrent protection	2^{nd}, 3^{rd} and 5^{th} harmonic of f_r	±3.0% / Hz

Type tests according to standards

Table 18. Electromagnetic compatibility

Test	Type test values	Reference standards
1 MHz burst disturbance	2.5 kV	IEC 60255-26
100 kHz slow damped oscillatory wave immunity test	2.5 kV	IEC 61000-4-18, Class III
Ring wave immunity test, 100 kHz	2-4 kV	IEC 61000-4-12, Class IV
Surge withstand capability test	2.5 kV, oscillatory 4.0 kV, fast transient	IEEE/ANSI C37.90.1
Electrostatic discharge Direct application Indirect application	15 kV air discharge 8 kV contact discharge 8 kV contact discharge	IEC 60255-26 IEC 61000-4-2, Class IV
Electrostatic discharge Direct application Indirect application	15 kV air discharge 8 kV contact discharge 8 kV contact discharge	IEEE/ANSI C37.90.1
Fast transient disturbance	4 kV	IEC 60255-26, Zone A
Surge immunity test	2-4 kV, 1.2/50 μs high energy	IEC 60255-26, Zone A
Power frequency immunity test	150-300 V, 50 Hz	IEC 60255-26, Zone A
Conducted common mode immunity test	15 Hz-150 kHz	IEC 61000-4-16, Class IV
Power frequency magnetic field test	1000 A/m, 3 s 100 A/m, cont.	IEC 61000-4-8, Class V
Pulse magnetic field immunity test	1000 A/m	IEC 61000–4–9, Class V
Damped oscillatory magnetic field test	100 A/m	IEC 61000-4-10, Class V
Radiated electromagnetic field disturbance	20 V/m, 80-1000 MHz 1.4-2.7 GHz	IEC 60255-26
Radiated electromagnetic field disturbance	20 V/m 80-1000 MHz	IEEE/ANSI C37.90.2
Conducted electromagnetic field disturbance	10 V, 0.15-80 MHz	IEC 60255-26
Radiated emission	30-5000 MHz	IEC 60255-26
Radiated emission	30-5000 MHz	IEEE/ANSI C63.4, FCC
Conducted emission	0.15-30 MHz	IEC 60255-26

Table 19. Insulation

Test	Type test values	Reference standard
Dielectric test	2.0 kV AC, 1 min.	IEC 60255-27 ANSI C37.90
Impulse voltage test	5 kV, 1.2/50 μs, 0.5 J	
Insulation resistance	>100 MΩ at 500 VDC	

Table 20. Environmental tests

Test	Type test value	Reference standard
Cold operation test	Test Ad for 16 h at -25°C	IEC 60068-2-1
Cold storage test	Test Ab for 16 h at -40°C	IEC 60068-2-1
Dry heat operation test	Test Bd for 16 h at +70°C	IEC 60068-2-2
Dry heat storage test	Test Bb for 16 h at +85°C	IEC 60068-2-2
Change of temperature test	Test Nb for 5 cycles at -25°C to +70°C	IEC 60068-2-14
Damp heat test, steady state	Test Ca for 10 days at +40°C and humidity 93%	IEC 60068-2-78
Damp heat test, cyclic	Test Db for 6 cycles at +25 to +55°C and humidity 93 to 95% (1 cycle = 24 hours)	IEC 60068-2-30

Table 21. CE compliance

Test	According to
Immunity	EN 60255–26
Emissivity	EN 60255–26
Low voltage directive	EN 60255–27

Table 22. Mechanical tests

Test	Type test values	Reference standards
Vibration response test	Class II	IEC 60255-21-1
Vibration endurance test	Class I	IEC 60255-21-1
Shock response test	Class I	IEC 60255-21-2
Shock withstand test	Class I	IEC 60255-21-2
Bump test	Class I	IEC 60255-21-2
Seismic test	Class II	IEC 60255-21-3

Differential protection

Table 23. 1Ph High impedance differential protection HZPDIF

Function	Range or value	Accuracy
Operate voltage	(10-900) V I=U/R	± 1.0% of I_r at I ≤ I_r ± 1.0% of I at I > I_r
Reset ratio	>95% at (30-900) V	-
Maximum continuous power	U>Trip^2/SeriesResistor ≤200 W	-
Operate time at 0 to 10 x U_d	Min = 5 ms Max = 15 ms	
Reset time at 10 to 0 x U_d	Min = 75 ms Max = 95 ms	
Critical impulse time	2 ms typically at 0 to 10 x U_d	-
Operate time at 0 to 2 x U_d	Min = 25 ms Max = 35 ms	
Reset time at 2 to 0 x U_d	Min = 50 ms Max = 70 ms	
Critical impulse time	15 ms typically at 0 to 2 x U_d	-

Table 24. Additional security logic for differential protection LDRGFC

Function	Range or value	Accuracy
Operate current, zero sequence current	(1-100)% of IBase	±1.0% of I_r
Operate current, low current operation	(1-100)% of IBase	±1.0% of I_r
Operate voltage, phase to neutral	(1-100)% of UBase	±0.5% of U_r
Operate voltage, phase to phase	(1-100)% of UBase	±0.5% of U_r
Independent time delay, zero sequence current at 0 to 2 x I_{set}	(0.000-60.000) s	±0.2% or ±40 ms whichever is greater
Independent time delay, low current operation at 2 x I_{set} to 0	(0.000-60.000) s	±0.2% or ± 40 ms whichever is greater
Independent time delay, low voltage operation at 2 x U_{set} to 0	(0.000-60.000) s	±0.2% or ±40 ms whichever is greater
Reset time delay for startup signal at 0 to 2 x U_{set}	(0.000-60.000) s	±0.2% or ±40 ms whichever is greater

Impedance protection

Table 25. Distance measuring zone, Quad ZMQPDIS

Function	Range or value	Accuracy
Number of zones	Max 5 with selectable direction	-
Minimum operate residual current, zone 1	(5-1000)% of IBase	-
Minimum operate current, phase-to-phase and phase-to-earth	(10-1000)% of IBase	-
Positive sequence reactance	(0.10-3000.00) Ω/phase	±2.0% static accuracy ±2.0 degrees static angular accuracy Conditions: Voltage range: (0.1-1.1) x U_r Current range: (0.5-30) x I_r Angle: at 0 degrees and 85 degrees
Positive sequence resistance	(0.01-1000.00) Ω/phase	
Zero sequence reactance	(0.10-9000.00) Ω/phase	
Zero sequence resistance	(0.01-3000.00) Ω/phase	
Fault resistance, phase-to-earth	(0.10-9000.00) Ω/loop	
Fault resistance, phase-to-phase	(0.10-3000.00) Ω/loop	
Dynamic overreach	<5% at 85 degrees measured with CVT's and 0.5<SIR<30	-
Definite time delay Ph-Ph and Ph-E operation	(0.000-60.000) s	±0.2% or ±40 ms whichever is greater
Operate time	25 ms typically	IEC 60255-121
Reset ratio	105% typically	-
Reset time at 0.1 x Zreach to 2 x Zreach	Min. = 20 ms Max. = 50 ms	-

Table 26. Distance measuring zone, quadrilateral characteristic for series compensated lines ZMCPDIS, ZMCAPDIS

Function	Range or value	Accuracy
Number of zones	Max 5 with selectable direction	-
Minimum operate residual current, zone 1	(5-1000)% of *IBase*	-
Minimum operate current, Ph-Ph and Ph-E	(10-1000)% of *IBase*	-
Positive sequence reactance	(0.10-3000.00) Ω/phase	±2.0% static accuracy ±2.0 degrees static angular accuracy Conditions: Voltage range: (0.1-1.1) x U_r Current range: (0.5-30) x I_r Angle: at 0 degrees and 85 degrees
Positive sequence resistance	(0.10-1000.00) Ω/phase	
Zero sequence reactance	(0.01-9000.00) Ω/phase	
Zero sequence resistance	(0.01-3000.00) Ω/phase	
Fault resistance, Ph-E	(0.10-9000.00) Ω/loop	
Fault resistance, Ph-Ph	(0.10-3000.00) Ω/loop	
Dynamic overreach	<5% at 85 degrees measured with CCVT's and 0.5<SIR<30	-
Definite time delay Ph-Ph and Ph-E operation	(0.000-60.000) s	±0.2% or ± 35 ms whichever is greater
Operate time	25 ms typically	IEC 60255-121
Reset ratio	105% typically	-
Reset time at 0.1 x Zreach to 2 x Zreach	Min. = 20 ms Max. = 50 ms	-

Table 27. Phase selection, quadrilateral characteristic with fixed angle FDPSPDIS

Function	Range or value	Accuracy
Minimum operate current	(5-500)% of *IBase*	± 1.0% of I_r at $I \leq I_r$ ± 1.0% of I at $I > I_r$
Reactive reach, positive sequence	(0.50–3000.00) Ω/phase	± 2.5% static accuracy ± 2.0 degrees static angular accuracy Conditions: Voltage range: (0.1-1.1) x U_r Current range: (0.5-30) x I_r Angle: at 0 degrees and 85 degrees
Resistive reach, positive sequence	(0.10–1000.00) Ω/phase	
Reactive reach, zero sequence	(0.50–9000.00) Ω/phase	
Resistive reach, zero sequence	(0.50–3000.00) Ω/phase	
Fault resistance, phase-to-earth faults, forward and reverse	(1.00–9000.00) Ω/loop	
Fault resistance, phase-to-phase faults, forward and reverse	(0.50–3000.00) Ω/loop	
Load encroachment criteria: Load resistance, forward and reverse Safety load impedance angle	(1.00–3000.00) Ω/phase (5-70) degrees	
Reset ratio	105% typically	-

Table 28. Full-scheme distance protection, Mho characteristic ZMHPDIS

Function	Range or value	Accuracy
Number of zones, Ph-E	Max 5 with selectable direction	-
Minimum operate current	(10–30)% of IBase	-
Positive sequence impedance, Ph-E loop	(0.005–3000.000) Ω/phase	± 2.0% static accuracy Conditions: Voltage range: (0.1-1.1) x U_r Current range: (0.5-30) x I_r Angle: 85 degrees
Positive sequence impedance angle, Ph-E loop	(10–90) degrees	
Reverse reach, Ph-E loop (Magnitude)	(0.005–3000.000) Ω/phase	
Magnitude of earth return compensation factor KN	(0.00–3.00)	
Angle for earth compensation factor KN	(-180–180) degrees	
Dynamic overreach	<5% at 85 degrees measured with CVT's and 0.5<SIR<30	-
Definite time delay Ph-Ph and Ph-E operation	(0.000-60.000) s	± 0.2% or ± 60 ms whichever is greater
Operate time	22 ms typically	IEC 60255-121
Reset ratio	105% typically	-
Reset time at 0.5 to 1.5 x Zreach	Min = 30 ms Max = 45 ms	-

Table 29. Full-scheme distance protection, quadrilateral for earth faults ZMMPDIS

Function	Range or value	Accuracy
Number of zones	Max 5 with selectable direction	-
Minimum operate current	(10-30)% of *IBase*	-
Positive sequence reactance	(0.50-3000.00) Ω/phase	±2.0% static accuracy ±2.0 degrees static angular accuracy Conditions: Voltage range: (0.1-1.1) x U_r Current range: (0.5-30) x I_r Angle: at 0 degrees and 85 degrees
Positive sequence resistance	(0.10-1000.00) Ω/phase	
Zero sequence reactance	(0.50-9000.00) Ω/phase	
Zero sequence resistance	(0.50-3000.00) Ω/phase	
Fault resistance, Ph-E	(1.00-9000.00) Ω/loop	
Dynamic overreach	<5% at 85 degrees measured with CCVT's and 0.5<SIR<30	-
Definite time delay Ph-Ph and Ph-E operation	(0.000-60.000) s	±0.2% or ±40 ms whichever is greater
Operate time	25 ms typically	IEC 60255-121
Reset ratio	105% typically	-
Reset time at 0.1 to 2 x Zreach	Min. = 20 ms Max. = 35 ms	-

Table 30. Faulty phase identification with load encroachment FMPSPDIS

Function	Range or value	Accuracy
Load encroachment criteria: Load resistance, forward and reverse	(1.00–3000.00) Ω/phase (5–70) degrees	±2.0% static accuracy Conditions: Voltage range: (0.1–1.1) x U_r Current range: (0.5–30) x I_r Angle: at 0 degrees and 85 degrees

Table 31. Distance measuring zone, quadrilateral characteristic, separate settings ZMRPDIS, ZMRAPDIS

Function	Range or value	Accuracy
Number of zones	Max 5 with selectable direction	-
Minimum operate residual current, zone 1	(5-1000)% of IBase	-
Minimum operate current, phase-to-phase and phase-to-earth	(10-1000)% of IBase	-
Positive sequence reactance	(0.10-3000.00) Ω/phase	±2.0% static accuracy ±2.0 degrees static angular accuracy Conditions: Voltage range: (0.1-1.1) x U_r Current range: (0.5-30) x I_r Angle: at 0 degrees and 85 degrees
Positive sequence resistance	(0.01-1000.00) Ω/phase	
Zero sequence reactance	(0.10-9000.00) Ω/phase	
Zero sequence resistance	(0.01-3000.00) Ω/phase	
Fault resistance, phase-to-earth	(0.10-9000.00) Ω/loop	
Fault resistance, phase-to-phase	(0.10-3000.00) Ω/loop	
Dynamic overreach	<5% at 85 degrees measured with CVT's and 0.5<SIR<30	-
Definite time delay phase-phase and phase-earth operation	(0.000-60.000) s	±0.2% or ±40 ms whichever is greater
Operate time	25 ms typically	IEC 60255-121
Reset ratio	105% typically	-
Reset time at 0.1 x Zreach to 2 x Zreach	Min. = 20 ms Max. =50 ms	-

Table 32. Phase selection with load encroachment, quadrilateral characteristic FRPSPDIS

Function	Range or value	Accuracy
Minimum operate current	(5-500)% of IBase	±1.0% of I_r at $I \leq I_r$ ±1.0% of I at $I > I_r$
Reactive reach, positive sequence	(0.50–3000.00) Ω/phase	±2.0% static accuracy ±2.0 degrees static angular accuracy Conditions: Voltage range: (0.1-1.1) x U_r Current range: (0.5-30) x I_r Angle: at 0 degrees and 85 degrees
Resistive reach, positive sequence	(0.10–1000.00) Ω/phase	
Reactive reach, zero sequence	(0.50–9000.00) Ω/phase	
Resistive reach, zero sequence	(0.50–3000.00) Ω/phase	
Fault resistance, Ph-E faults, forward and reverse	(1.00–9000.00) Ω/loop	
Fault resistance, Ph-Ph faults, forward and reverse	(0.50–3000.00) Ω/loop	
Load encroachment criteria: Load resistance, forward and reverse Safety load impedance angle	(1.00–3000.00) Ω/phase (5-70) degrees	
Reset ratio	105% typically	-

Table 33. Fast distance protection ZMFPDIS, ZMFCPDIS

Function	Range or value	Accuracy
Number of zones	3 selectable directions, 3 fixed directions	-
Minimum operate current, Ph-Ph and Ph-E	(5-6000)% of IBase	±1.0% of I_r
Positive sequence reactance reach, Ph-E and Ph-Ph loop	(0.01 - 3000.00) ohm/phase	±2.0% of static accuracy ±2.0 deg static angular accuracy Conditions: Voltage range: (0.1-1.1) x U_r Current range: (0.5-30) x I_r Angle: At 0 deg and 85 deg
Positive sequence resistance reach, Ph-E and Ph-Ph loop	(0.00 - 1000.00) ohm/phase	
Zero sequence reactance reach	(0.01 - 9000.00) ohm/p	
Zero sequence resistive reach	(0.00 - 3000.00) ohm/p	
Fault resistance reach, Ph-E and Ph-Ph	(0.01 -9000.00) ohm/l	
Dynamic overreach	< 5% at 85 deg measured with CVTs and 0.5 < SIR < 30	
Definite time delay to trip, Ph-E and Ph-Ph operation	(0.000-60.000) s	±2.0% or ±35 ms whichever is greater
Operate time	16 ms typically	IEC 60255-121
Reset time at 0.1 to 2 x Zreach	Min = 20 ms Max = 35 ms	-
Reset ratio	105% typically	-

Table 34. Power swing detection ZMRPSB

Function	Range or value	Accuracy
Reactive reach	(0.10-3000.00) Ω/phase	± 2.0% static accuracy Conditions: Voltage range: (0.1-1.1) x U_r Current range: (0.5-30) x I_r Angle: at 0 degrees and 85 degrees
Resistive reach	(0.10–1000.00) Ω/loop	
Power swing detection operate time	(0.000-60.000) s	± 0.2% or ± 10 ms whichever is greater
Second swing reclaim operate time	(0.000-60.000) s	± 0.2% or ± 20 ms whichever is greater
Minimum operate current	(5-30)% of IBase	± 1.0% of I_r

Table 35. Power swing logic PSLPSCH

Function	Range or value	Accuracy
Permitted maximum operating time difference between higher and lower zone	(0.000 — 60.0000) s	±0,2% or ±15 ms whichever is greater
Delay for operation of underreach zone with detected difference in operating time	(0.000 — 60.0000) s	±0,2% or ±15 ms whichever is greater
Conditional timer for sending the CS at power swings	(0.000 — 60.0000) s	±0,2% or ±15 ms whichever is greater
Conditional timer for tripping at power swings	(0.000 — 60.0000) s	±0,2% or ±15 ms whichever is greater
Timer for blocking the overreaching zones trip	(0.000 — 60.0000) s	±0,2% or ±15 ms whichever is greater

Table 36. Pole slip protection PSPPPAM

Function	Range or value	Accuracy
Impedance reach	(0.00 - 1000.00)% of Zbase	±2.0% of U_r/I_r
Zone 1 and Zone 2 trip counters	(1 - 20)	-

Table 37. Out-of-step protection OOSPPAM

Function	Range or value	Accuracy
Impedance reach	(0.00 - 1000.00)% of Zbase	±2.0% of $U_r/(\sqrt{3} \cdot I_r)$
Rotor start angle	(90.0 - 130.0) degrees	±5.0 degrees
Rotor trip angle	(15.0 - 90.0) degrees	±5.0 degrees
Zone 1 and Zone 2 trip counters	(1 - 20)	-

Table 38. Phase preference logic PPLPHIZ

Function	Range or value	Accuracy
Operate value, phase-to-phase and phase-to-neutral undervoltage	(1 - 100)% of UBase	±0.5% of U_r
Reset ratio, undervoltage	< 105%	-
Operate value, residual voltage	(5 - 300)% of UBase	±0.5% of U_r at $U \le U_r$ ±0.5% of U at $U > U_r$
Reset ratio, residual voltage	> 95%	-
Operate value, residual current	(10 - 200)% of IBase	±1.0% of I_r at $I \le I_r$ ±1.0% of I at $I > I_r$
Reset ratio, residual current	> 95%	-
Independent time delay for residual current at 0 to 2 x I_{set}	(0.000 - 60.000) s	±0.2% or ±25 ms whichever is greater
Independent time delay for residual voltage at 0.8 to 1.2 x U_{set}	(0.000 - 60.000) s	±0.2% or ±25 ms whichever is greater
Independent dropoff-delay for residual voltage at 1.2 to 0.8 x U_{set}	(0.000 - 60.000) s	±0.2% or ±25 ms whichever is greater
Operating mode	No Filter, NoPref Cyclic: 1231c, 1321c Acyclic: 123a, 132a, 213a, 231a, 312a, 321a	

Table 39. Automatic switch onto fault logic, voltage and current based ZCVPSOF

Parameter	Range or value	Accuracy
Operate voltage, detection of dead line	(1–100)% of *UBase*	± 0.5% of U_r
Operate current, detection of dead line	(1–100)% of *IBase*	± 1.0% of I_r
Time delay to operate for the switch onto fault function	(0.03-120.00) s	± 2.0% or ± 20 ms whichever is greater
Time delay for UI detection (s)	(0.000-60.000) s	± 2.0% or ± 20 ms whichever is greater
Delay time for activation of dead line detection	(0.000-60.000) s	± 2.0% or ± 20 ms whichever is greater
Drop-off delay time of switch onto fault function	(0.000-60.000) s	± 2.0% or ± 30 ms whichever is greater

Current protection

Table 40. Instantaneous phase overcurrent protection PHPIOC

Function	Range or value	Accuracy
Operate current	(5-2500)% of IBase	± 1.0% of I_r at $I \leq I_r$ ± 1.0% of I at $I > I_r$
Reset ratio	> 95% at (50–2500)% of IBase	-
Operate time at 0 to 2 x I_{set}	Min. = 15 ms Max. = 25 ms	-
Reset time at 2 to 0 x I_{set}	Min. = 15ms Max. = 25ms	-
Critical impulse time	10 ms typically at 0 to 2 x I_{set}	-
Operate time at 0 to 10 x I_{set}	Min. = 5ms Max. = 15 ms	-
Reset time at 10 to 0 x I_{set}	Min. = 25ms Max. = 40 ms	-
Critical impulse time	2 ms typically at 0 to 10 x I_{set}	-
Dynamic overreach	< 5% at τ = 100 ms	-

Table 41. Four step phase overcurrent protection OC4PTOC

Function	Setting range	Accuracy
Operate current	(5-2500)% of *IBase*	± 1.0% of I_r at $I \leq I_r$ ± 1.0% of I at $I > I_r$
Reset ratio	> 95% at (50–2500)% of *IBase*	-
Min. operating current	(1-10000)% of *IBase*	± 1.0% of I_r at $I \leq I_r$ ±1.0% of I at $I > I_r$
Relay characteristic angle (RCA)	(40.0–65.0) degrees	± 2.0 degrees
Relay operating angle (ROA)	(40.0–89.0) degrees	± 2.0 degrees
2nd harmonic blocking	(5–100)% of fundamental	± 2.0% of I_r
Independent time delay at 0 to 2 x I_{set}	(0.000-60.000) s	± 0.2 % or ± 35 ms whichever is greater
Minimum operate time	(0.000-60.000) s	± 2.0 % or ± 40 ms whichever is greater
Inverse characteristics, see table 129, table 130 and table 131	16 curve types	See table 129, table 130 and table 131
Operate time, start non-directional at 0 to 2 x I_{set}	Min. = 15 ms Max. = 30 ms	
Reset time, start non-directional at 2 to 0 x I_{set}	Min. = 15 ms Max. = 30 ms	
Critical impulse time	10 ms typically at 0 to 2 x I_{set}	-
Impulse margin time	15 ms typically	-

Table 42. Instantaneous residual overcurrent protection EFPIOC

Function	Range or value	Accuracy
Operate current	(5-2500)% of IBase	±1.0% of I_r at $I \le I_r$ ±1.0% of I at $I > I_r$
Reset ratio	> 95% at (50–2500)% of IBase	-
Operate time at 0 to 2 x I_{set}	Min. = 15 ms Max. = 25 ms	-
Reset time at 2 to 0 x I_{set}	Min. = 15 ms Max. = 25 ms	-
Critical impulse time	10 ms typically at 0 to 2 x I_{set}	-
Operate time at 0 to 10 x I_{set}	Min. = 5 ms Max. = 15 ms	-
Reset time at 10 to 0 x I_{set}	Min. = 25 ms Max. = 35 ms	-
Critical impulse time	2 ms typically at 0 to 10 x I_{set}	-
Dynamic overreach	< 5% at τ = 100 ms	-

Table 43. Four step residual overcurrent protection EF4PTOC technical data

Function	Range or value	Accuracy
Operate current	(1-2500)% of *IBase*	± 1.0% of I_r at $I < I_r$ ± 1.0% of I at $I > I_r$
Reset ratio	> 95% at (1-2500)% of *IBase*	-
Operate current for directional comparison	(1–100)% of *IBase*	For RCA ± 60 degrees: ± 2.5% of I_r at $I \le I_r$ ± 2.5% of $I < I_r$
Independent time delay for step 1, 2, 3, and 4	(0.000-60.000) s	± 0.2% or ± 35 ms whichever is greater at 0 to 2 x I_{set}
Inverse characteristics, see table 129, table 130 and table 131	18 curve types	See table 129, table 130 and table 131
Second harmonic restrain operation	(5–100)% of fundamental	± 2.0% of I_r
Relay characteristic angle	(-180 to 180) degrees	± 2.0 degrees
Minimum polarizing voltage	(1–100)% of *UBase*	± 0.5% of U_r
Minimum polarizing current	(2-100)% of *IBase*	± 1.0% of I_r
Real part of source Z used for current polarization	(0.50-1000.00) Ω/phase	-
Imaginary part of source Z used for current polarization	(0.50–3000.00) Ω/phase	-
Operate time, start function at 0 to 2 x I_{set}	Min 18 ms Max 28 ms	-
Reset time, start function at 2 to 0 x I_{set}	Min 18 ms Max 28 ms	-
Critical impulse time	10 ms typically at 0 to 2 x I_{set}	-
Impulse margin time	15 ms typically	-

Table 44. Four step negative sequence overcurrent protection NS4PTOC

Function	Range or value	Accuracy
Operate value, negative sequence current, step 1-4	(1-2500)% of *IBase*	± 1.0% of I_r at $I \le I_r$ ± 1.0% of I at $I > I_r$
Reset ratio	> 95% at (10-2500)% of *IBase*	-
Independent time delay for step 1, 2, 3, and 4 at 0 to 2 x I_{set}	(0.000-60.000) s	± 0.2% or ± 35 ms whichever is greater
Inverse characteristics, see table 129, table 130 and table 131	16 curve types	See table 129, table 130 and table 131
Minimum operate current for steps 1 - 4	(1.00 - 10000.00)% of *IBase*	± 1.0% of I_r at $I \le I_r$ ± 1.0% of I at $I > I_r$
Relay characteristic angle	(-180 to 180) degrees	± 2.0 degrees
Operate value, negative current for directional release	(1–100)% of *IBase*	For RCA ± 60 degrees: ± 2.5% of I_r at $I \le I_r$ ± 2.5% of I at $I > I_r$
Minimum polarizing voltage	(1–100)% of *UBase*	± 0.5% of U_r
Minimum polarizing current	(2-100)% of *IBase*	±1.0% of I_r
Real part of negative sequence source impedance used for current polarization	(0.50-1000.00) Ω/phase	-
Imaginary part of negative sequence source impedance used for current polarization	(0.50–3000.00) Ω/phase	-
Operate time, start function at 0 to 2 x I_{set}	Min = 15 ms Max = 30 ms	-
Reset time, start function at 2 to 0 x I_{set}	Min = 15 ms Max = 30 ms	-
Critical impulse time, start function	10 ms typically at 0 to 2 x I_{set}	-
Impulse margin time, start function	15 ms typically	-
Transient overreach	<10% at τ = 100 ms	-

Table 45. Sensitive directional residual overcurrent and power protection SDEPSDE

Function	Range or value	Accuracy
Operate level for $3I_0 \cdot \cos\varphi$ directional residual overcurrent	(0.25-200.00)% of *IBase*	± 1.0% of I_r at $I \le I_r$ ± 1.0% of I at $I > I_r$
Operate level for $\cdot 3I_0 \cdot 3U_0 \cos\varphi$ directional residual power	(0.25-200.00)% of *SBase*	± 1.0% of S_r at $S \le S_r$ ± 1.0% of S at $S > S_r$
Operate level for $3I_0$ and φ residual overcurrent	(0.25-200.00)% of *IBase*	± 1.0% of I_r at $\le I_r$ ± 1.0% of I at $I > I_r$
Operate level for non-directional overcurrent	(1.00-400.00)% of *IBase*	±1.0% of I_r at $I \le I_r$ ± 1.0% of I at $I > I_r$
Operate level for non-directional residual overvoltage	(1.00-200.00)% of *UBase*	± 0.5% of U_r at $U \le U_r$ ± 0.5% of U at $U > U_r$
Residual release current for all directional modes	(0.25-200.00)% of *IBase*	± 1.0% of I_r at $I \le I_r$ ± 1.0% of I at $I > I_r$
Residual release voltage for all directional modes	(1.00-300.00)% of *UBase*	± 0.5% of U_r at $U \le U_r$ ± 0.5% of U at $U > U_r$
Operate time for non-directional residual overcurrent at 0 to 2 x Iset	Min = 40 ms Max = 65 ms	
Reset time for non-directional residual overcurrent at 2 to 0 x Iset	Min = 40 ms Max = 65 ms	
Operate time for directional residual overcurrent at 0 to 2 x Iset	Min = 115 ms Max = 165 ms	
Reset time for directional residual overcurrent at 2 to 0 x Iset	Min = 25 ms Max = 65 ms	
Independent time delay for non-directional residual overvoltage at 0.8 to 1.2 x Uset	(0.000 – 60.000) sec	±0.2% or ± 80 ms whichever is greater
Independent time delay for non-directional residual overcurrent at 0 to 2 x Iset	(0.000 – 60.000) sec	±0.2% or ± 80 ms whichever is greater
Independent time delay for directional residual overcurrent at 0 to 2 x Iset	(0.000 – 60.000) sec	±0.2% or ± 180 ms whichever is greater
Inverse characteristics	16 curve types	See table 129, table 130 and table 131
Relay characteristic angle RCA	(-179 to 180) degrees	± 2.0 degrees
Relay Open angle ROA	(0 to 90) degrees	± 2.0 degrees

Table 46. Thermal overload protection, one time constant LCPTTR/LFPTTR

Function	Range or value	Accuracy
Reference current	(2-400)% of IBase	±1.0% of I_r
Reference temperature	(0-300)°C, (0 - 600)°F	±1.0°C, ±2.0°F
Operate time: $$t = \tau \ln \left[\frac{I^2 - I_p^2}{I^2 - I_p^2 - \frac{T_{Trip} - T_{Amb}}{T_{ref}} \cdot I_{ref}^2} \right]$$ (Equation 1) T_{Trip}= set operate temperature T_{Amb} = ambient temperature T_{ref} = temperature rise above ambient at I_{ref} I_{ref} = reference load current I = actual measured current I_p = load current before overload occurs	Time constant τ = (1–1000) minutes	IEC 60255-8, ±5.0% or ±200 ms whichever is greater
Alarm temperature	(0-200)°C, (0-400)°F	±2.0°C, ±4.0°F
Operate temperature	(0-300)°C, (0-600)°F	±2.0°C, ±4.0°F
Reset level temperature	(0-300)°C, (0-600)°F	±2.0°C, ±4.0°F

Table 47. Breaker failure protection CCRBRF

Function	Range or value	Accuracy
Operate phase current	(5-200)% of *IBase*	±1.0% of I_r at $I \le I_r$ ±1.0% of I at $I > I_r$
Reset ratio, phase current	> 95%	-
Operate residual current	(2-200)% of *IBase*	±1.0% of I_r at $I \le I_r$ ±1.0% of I at $I > I_r$
Reset ratio, residual current	> 95%	-
Phase current level for blocking of contact function	(5-200)% of *IBase*	±1.0% of I_r at $I \le I_r$ ±1.0% of I at $I > I_r$
Reset ratio	> 95%	-
Operate time for current detection	10 ms typically	-
Reset time for current detection	15 ms maximum	-
Time delay for re-trip at 0 to 2 x I_{set}	(0.000-60.000) s	±0.2% or ±15 ms whichever is greater
Time delay for back-up trip at 0 to 2 x I_{set}	(0.000-60.000) s	±0.2% or ±15 ms whichever is greater
Time delay for back-up trip at multi-phase start at 0 to 2 x I_{set}	(0.000-60.000) s	±0.2% or ±20 ms whichever is greater
Additional time delay for a second back-up trip at 0 to 2 x I_{set}	(0.000-60.000) s	±0.2% or ±20 ms whichever is greater
Time delay for alarm for faulty circuit breaker	(0.000-60.000) s	±0.2% or ±15 ms whichever is greater

Table 48. Stub protection STBPTOC

Function	Range or value	Accuracy
Operating current	(5-2500)% of *IBase*	± 1.0% of I_r at I ≤ I_r ± 1.0% of I at I > I_r
Reset ratio	> 95% at (50-2500)% of *IBase*	-
Independent time delay at 0 to 2 x I_{set}	(0.000-60.000) s	±0.2% or ±30 ms whichever is greater
Operate time, start at 0 to 2 x I_{set}	Min. = 10 ms Max. = 20 ms	-
Reset time, start at 2 to 0 x I_{set}	Min. = 10 ms Max. = 20 ms	-
Critical impulse time	10 ms typically at 0 to 2 x I_{set}	-
Impulse margin time	15 ms typically	-

Table 49. Pole discordance protection CCPDSC

Function	Range or value	Accuracy
Operate current	(0–100)% of *IBase*	±1.0% of I_r
Independent time delay between trip condition and trip signal	(0.000-60.000) s	±0.2% or ± 25 ms whichever is greater

Table 50. Directional underpower protection GUPPDUP

Function	Range or value	Accuracy
Power level for Step 1 and Step 2	(0.0–500.0)% of *SBase*	± 1.0% of S_r at S ≤ S_r ± 1.0% of S at S > S_r where $S_r = 1.732 \cdot U_r \cdot I_r$
Characteristic angle for Step 1 and Step 2	(-180.0–180.0) degrees	± 2.0 degrees
Independent time delay to operate for Step 1 and Step 2 at 2 to 0.5 x S_r and *k=0.000*	(0.01-6000.00) s	± 0.2% or ± 40 ms whichever is greater

Table 51. Directional overpower protection GOPPDOP

Function	Range or value	Accuracy
Power level for Step 1 and Step 2	(0.0–500.0)% of SBase	±1.0% of S_r at S ≤ S_r ±1.0% of S at S > S_r
Characteristic angle for Step 1 and Step 2	(-180.0–180.0) degrees	±2.0 degrees
Operate time, start at 0.5 to 2 x S_r and *k=0.000*	Min. =10 ms Max. = 25 ms	
Reset time, start at 2 to 0.5 x S_r and *k=0.000*	Min. = 35 ms Max. = 55 ms	
Independent time delay to operate for Step 1 and Step 2 at 0.5 to 2 x S_r and *k=0.000*	(0.01-6000.00) s	±0.2% or ±40 ms whichever is greater

Table 52. Broken conductor check BRCPTOC

Function	Range or value	Accuracy
Minimum phase current for operation	(5–100)% of *IBase*	±1.0% of I_r
Unbalance current operation	(50–90)% of maximum current	±1.0% of I_r
Independent operate time delay	(0.000-60.000) s	±0.2% or ±45 ms whichever is greater
Independent reset time delay	(0.010-60.000) s	±0.2% or ±30 ms whichever is greater
Start time at current change from I_r to 0	Min. = 25 ms Max. = 35 ms	-
Reset time at current change from 0 to I_r	Min. = 5 ms Max. = 20 ms	-

Voltage protection

Table 53. Two step undervoltage protection UV2PTUV

Function	Range or value	Accuracy
Operate voltage, low and high step	(1.0–100.0)% of *UBase*	±0.5% of U_r
Absolute hysteresis	(0.0–50.0)% of *UBase*	±0.5% of U_r
Internal blocking level, step 1 and step 2	(1–50)% of *UBase*	±0.5% of U_r
Inverse time characteristics for step 1 and step 2, see table 133	-	See table 133
Definite time delay, step 1 at 1.2 to 0 x U_{set}	(0.00-6000.00) s	±0.2% or ±40ms whichever is greater
Definite time delay, step 2 at 1.2 to 0 x U_{set}	(0.000-60.000) s	±0.2% or ±40ms whichever is greater
Minimum operate time, inverse characteristics	(0.000–60.000) s	±0.2% or ±40ms whichever is greater
Operate time, start at 2 to 0 x U_{set}	Min= 15 ms Max= 30 ms	-
Reset time, start at 0 to 2 x U_{set}	Min= 15 ms Max= 30 ms	-
Operate time, start at 1.2 to 0 x U_{set}	Min= 5 ms Max= 25 ms	-
Reset time, start at 0 to 1.2 x U_{set}	Min= 15 ms Max= 35 ms	-
Critical impulse time	5 ms typically at 1.2 to 0 x U_{set}	-
Impulse margin time	15 ms typically	-

Table 54. Two step overvoltage protection OV2PTOV

Function	Range or value	Accuracy
Operate voltage, step 1 and 2	(1.0-200.0)% of *UBase*	±0.5% of U_r at $U \le U_r$ ±0.5% of U at $U > U_r$
Absolute hysteresis	(0.0–50.0)% of *UBase*	±0.5% of U_r at $U \le U_r$ ±0.5% of U at $U > U_r$
Inverse time characteristics for steps 1 and 2, see table 132	-	See table 132
Definite time delay, low step (step 1) at 0 to 1.2 x U_{set}	(0.00 - 6000.00) s	±0.2% or ±45 ms whichever is greater
Definite time delay, high step (step 2) at 0 to 1.2 x U_{set}	(0.000-60.000) s	±0.2% or ±45 ms whichever is greater
Minimum operate time, Inverse characteristics	(0.000-60.000) s	±0.2% or ±45 ms whichever is greater
Operate time, start at 0 to 2 x U_{set}	Min. = 15 ms Max. = 30 ms	-
Reset time, start at 2 to 0 x U_{set}	Min. = 15 ms Max. = 30 ms	-
Operate time, start at 0 to 1.2 x U_{set}	Min. = 20 ms Max. = 35 ms	-
Reset time, start at 1.2 to 0 x U_{set}	Min. = 5 ms Max. = 25 ms	-
Critical impulse time	10 ms typically at 0 to 2 x U_{set}	-
Impulse margin time	15 ms typically	-

Table 55. Two step residual overvoltage protection ROV2PTOV

Function	Range or value	Accuracy
Operate voltage, step 1 and step 2	(1.0-200.0)% of *UBase*	± 0.5% of U_r at $U \le U_r$ ± 0.5% of U at $U > U_r$
Absolute hysteresis	(0.0–50.0)% of *UBase*	± 0.5% of U_r at $U \le U_r$ ± 0.5% of U at $U > U_r$
Inverse time characteristics for low and high step, see table 134	-	See table 134
Definite time delay low step (step 1) at 0 to 1.2 x U_{set}	(0.00–6000.00) s	± 0.2% or ± 45 ms whichever is greater
Definite time delay high step (step 2) at 0 to 1.2 x U_{set}	(0.000–60.000) s	± 0.2% or ± 45 ms whichever is greater
Minimum operate time	(0.000-60.000) s	± 0.2% or ± 45 ms whichever is greater
Operate time, start at 0 to 2 x U_{set}	Min. = 15 ms Max. = 30 ms	-
Reset time, start at 2 to 0 x U_{set}	Min. = 15 ms Max. = 30 ms	-
Operate time, start at 0 to 1.2 x U_{set}	Min. = 20 ms Max. = 35 ms	-
Reset time, start at 1.2 to 0 x U_{set}	Min. = 5 ms Max. = 25 ms	-
Critical impulse time	10 ms typically at 0 to 2 x U_{set}	-
Impulse margin time	15 ms typically	-

Table 56. Overexcitation protection OEXPVPH

Function	Range or value	Accuracy
Operate value, start	(100–180)% of (*UBase*/f_{rated})	± 0.5% of U
Operate value, alarm	(50–120)% of start level	± 0.5% of U_r at U ≤ U_r ± 0.5% of U at U > U_r
Operate value, high level	(100–200)% of (*UBase*/f_{rated})	± 0.5% of U
Curve type	IEEE or customer defined $$IEEE: t = \frac{(0.18 \cdot k)}{(M-1)^2}$$ (Equation 2) where M = (E/f)/(Ur/fr)	± 5.0 % or ± 45 ms, whichever is greater
Minimum time delay for inverse function	(0.000–60.000) s	± 1.0% or ± 45 ms, whichever is greater
Maximum time delay for inverse function	(0.00–9000.00) s	± 1.0% or ± 45 ms, whichever is greater
Alarm time delay	(0.00–9000.00)	± 1.0% or ± 45 ms, whichever is greater

Table 57. Voltage differential protection VDCPTOV

Function	Range or value	Accuracy
Voltage difference for alarm and trip	(2.0–100.0) % of *UBase*	±0.5% of U_r
Under voltage level	(1.0–100.0) % of *UBase*	±0.5% of U_r
Independent time delay for voltage differential alarm at 0.8 to 1.2 x UDAlarm	(0.000–60.000)s	±0.2% or ±40 ms whichever is greater
Independent time delay for voltage differential trip at 0.8 to 1.2 x UDTrip	(0.000–60.000)s	±0.2% or ±40 ms whichever is greater
Independent time delay for voltage differential reset at 1.2 to 0.8 x UDTrip	(0.000–60.000)s	±0.2% or ±40 ms whichever is greater

Table 58. Loss of voltage check LOVPTUV

Function	Range or value	Accuracy
Operate voltage	(1–100)% of UBase	±0.5% of U_r
Pulse timer when disconnecting all three phases	(0.050–60.000) s	±0.2% or ±15 ms whichever is greater
Time delay for enabling the functions after restoration	(0.000–60.000) s	±0.2% or ±35 ms whichever is greater
Operate time delay when disconnecting all three phases	(0.000–60.000) s	±0.2% or ±35 ms whichever is greater
Time delay to block when all three phase voltages are not low	(0.000–60.000) s	±0.2% or ±35 ms whichever is greater

Table 59. Radial feeder protection PAPGAPC

Function	Range or value	Accuracy
Residual current detection	(10 - 150)% of IBase	±1.0% of Ir at I ≤ Ir ±1.0% of I at I > Ir
Reset ratio	>95% at (50 - 150)% of IBase	-
Operate time, residual current detection at 0 to 2 x I_{set}	Min. = 15 ms Max. = 30 ms	-
Independent time delay to operate, residual current detection at 0 to 2 x I_{set}	(0.000 - 60.000) s	±0.2% or ±40 ms whichever is greater
Voltage based phase selection	(30 - 100)% of UBase	±1.0% of U_r
Reset ratio	<115%	-
Operate time, voltage based phase selection at 1.2 to 0.8 x U_{set}	Min. = 15 ms Max. = 30 ms	-
Independent time delay to operate, voltage based phase selection at 1.2 to 0.8 x U_{set}	(0.000 – 60.000) s	±0.2% or ±40 ms whichever is greater

Frequency protection

Table 60. Underfrequency protection SAPTUF

Function	Range or value		Accuracy
Operate value, start function, at symmetrical three phase voltage	(35.00-75.00) Hz		± 2.0 mHz
Operate time, start at f_{set} + 0.02 Hz to f_{set} - 0.02 Hz	fn = 50 Hz	Min. = 80 ms Max. = 95 ms	-
	fn = 60 Hz	Min. = 65 ms Max. = 80 ms	
Reset time, start at f_{set} - 0.02 Hz to f_{set} + 0.02 Hz	Min. = 15 ms Max. = 30 ms		-
Operate time, definite time function at f_{set} + 0.02 Hz to f_{set} - 0.02 Hz	(0.000-60.000)s		± 0.2% or ± 100 ms whichever is greater
Reset time, definite time function at f_{set} - 0.02 Hz to f_{set} + 0.02 Hz	(0.000-60.000)s		± 0.2% or ± 120 ms whichever is greater
Voltage dependent time delay	Settings: UNom=(50-150)% of U_{base} UMin=(50-150)% of U_{base} Exponent=0.0-5.0 tMax=(0.010–60.000)s tMin=(0.010–60.000)s		± 1.0% or ± 120 ms whichever is greater

$$t = \left[\frac{U - UMin}{UNom - UMin} \right]^{Exponent} \cdot (tMax - tMin) + tMin$$

(Equation 3)

$U=U_{measured}$

Table 61. Overfrequency protection SAPTOF

Function	Range or value		Accuracy
Operate value, start function at symmetrical three-phase voltage	(35.00-90.00) Hz		± 2.0 mHz
Operate time, start at f_{set} - 0.02 Hz to f_{set} + 0.02 Hz	fn = 50Hz	Min. = 80 ms Max. = 95 ms	-
	fn = 60 Hz	Min. = 65 ms Max. = 80 ms	
Reset time, start at f_{set} + 0.02 Hz to f_{set} - 0.02 Hz	Min. = 15 ms Max. = 30 ms		-
Operate time, definite time function at f_{set} -0.02 Hz to f_{set} + 0.02 Hz	(0.000-60.000)s		± 0.2% ± 100 ms whichever is greater
Reset time, definite time function at f_{set} + 0.02 Hz to f_{set} - 0.02 Hz	(0.000-60.000)s		± 0.2% ± 120 ms, whichever is greater

Table 62. Rate-of-change frequency protection SAPFRC

Function	Range or value	Accuracy
Operate value, start function	(-10.00-10.00) Hz/s	±10.0 mHz/s
Operate value, restore enable frequency	(45.00-65.00) Hz	±2.0 mHz
Definite restore time delay	(0.000-60.000) s	±0.2% or ±100 ms whichever is greater
Definite time delay for frequency gradient trip	(0.200-60.000) s	±0.2% or ±120 ms whichever is greater
Definite reset time delay	(0.000-60.000) s	±0.2% or ±250 ms whichever is greater

Multipurpose protection

Table 63. General current and voltage protection CVGAPC

Function	Range or value	Accuracy
Measuring current input	phase1, phase2, phase3, PosSeq, -NegSeq, -3*ZeroSeq, MaxPh, MinPh, UnbalancePh, phase1-phase2, phase2-phase3, phase3-phase1, MaxPh-Ph, MinPh-Ph, UnbalancePh-Ph	-
Measuring voltage input	phase1, phase2, phase3, PosSeq, -NegSeq, -3*ZeroSeq, MaxPh, MinPh, UnbalancePh, phase1-phase2, phase2-phase3, phase3-phase1, MaxPh-Ph, MinPh-Ph, UnbalancePh-Ph	-
Start overcurrent, step 1 - 2	(2 - 5000)% of IBase	±1.0% of I_r at $I \leq I_r$ ±1.0% of I at $I > I_r$
Start undercurrent, step 1 - 2	(2 - 150)% of IBase	±1.0% of I_r at $I \leq I_r$ ±1.0% of I at $I > I_r$
Independent time delay, overcurrent at 0 to 2 x I_{set}, step 1 - 2	(0.00 - 6000.00) s	±0.2% or ±35 ms whichever is greater
Independent time delay, undercurrent at 2 to 0 x I_{set}, step 1 - 2	(0.00 - 6000.00) s	±0.2% or ±35 ms whichever is greater
Overcurrent (non-directional):		
Start time at 0 to 2 x I_{set}	Min. = 15 ms Max. = 30 ms	-
Reset time at 2 to 0 x I_{set}	Min. = 15 ms Max. = 30 ms	-
Start time at 0 to 10 x I_{set}	Min. = 5 ms Max. = 20 ms	-
Reset time at 10 to 0 x I_{set}	Min. = 20 ms Max. = 35 ms	-
Undercurrent:		
Start time at 2 to 0 x I_{set}	Min. = 15 ms Max. = 30 ms	-
Reset time at 0 to 2 x I_{set}	Min. = 15 ms Max. = 30 ms	-
Overcurrent:		
Inverse time characteristics, see table 129, 130 and table ""	16 curve types	See table 129, 130 and table ""
Overcurrent:		
Minimum operate time for inverse curves, step 1 - 2	(0.00 - 6000.00) s	±0.2% or ±35 ms whichever is greater
Voltage level where voltage memory takes over	(0.0 - 5.0)% of UBase	±0.5% of U_r
Start overvoltage, step 1 - 2	(2.0 - 200.0)% of UBase	±0.5% of U_r at $U \leq U_r$ ±0.5% of U at $U > U_r$
Start undervoltage, step 1 - 2	(2.0 - 150.0)% of UBase	±0.5% of U_r at $U \leq U_r$ ±0.5% of U at $U > U_r$
Independent time delay, overvoltage at 0.8 to 1.2 x U_{set}, step 1 - 2	(0.00 - 6000.00) s	±0.2% or ±35 ms whichever is greater

Table 63. General current and voltage protection CVGAPC , continued

Function	Range or value	Accuracy
Independent time delay, undervoltage at 1.2 to 0.8 x U_{set}, step 1 - 2	(0.00 - 6000.00) s	±0.2% or ±35 ms whichever is greater
Overvoltage: Start time at 0.8 to 1.2 x U_{set} Reset time at 1.2 to 0.8 x U_{set}	 Min. = 15 ms Max. = 30 ms Min. = 15 ms Max. = 30 ms	 - -
Undervoltage: Start time at 1.2 to 0.8 x U_{set} Reset time at 1.2 to 0.8 x U_{set}	 Min. = 15 ms Max. = 30 ms Min. = 15 ms Max. = 30 ms	 - -
Overvoltage: Inverse time characteristics, see table 132	 4 curve types	 See table 132
Undervoltage: Inverse time characteristics, see table 133	 3 curve types	 See table 133
High and low voltage limit, voltage dependent operation, step 1 - 2	(1.0 - 200.0)% of UBase	±1.0% of U_r at $U \leq U_r$ ±1.0% of U at $U > U_r$
Directional function	Settable: NonDir, forward and reverse	-
Relay characteristic angle	(-180 to +180) degrees	±2.0 degrees
Relay operate angle	(1 to 90) degrees	±2.0 degrees
Reset ratio, overcurrent	> 95%	-
Reset ratio, undercurrent	< 105%	-
Reset ratio, overvoltage	> 95%	-
Reset ratio, undervoltage	< 105%	-
Overcurrent: Critical impulse time Impulse margin time	 10 ms typically at 0 to 2 x I_{set} 15 ms typically	 - -
Undercurrent: Critical impulse time Impulse margin time	 10 ms typically at 2 to 0 x I_{set} 15 ms typically	 - -
Overvoltage: Critical impulse time Impulse margin time	 10 ms typically at 0.8 to 1.2 x U_{set} 15 ms typically	 - -
Undervoltage: Critical impulse time Impulse margin time	 10 ms typically at 1.2 to 0.8 x U_{set} 15 ms typically	 - -

Table 64. Voltage-restrained time overcurrent protection VRPVOC

Function	Range or value	Accuracy
Start overcurrent	(2.0 - 5000.0)% of IBase	±1.0% of I_r at $I \leq I_r$ ±1.0% of I at $I > I_r$
Reset ratio, overcurrent	> 95%	-
Operate time, start overcurrent at 0 to 2 x I_{set}	Min. = 15 ms Max. = 30 ms	-
Reset time, start overcurrent at 2 to 0 x I_{set}	Min. = 15 ms Max. = 30 ms	-
Operate time, start overcurrent at 0 to 10 x I_{set}	Min. = 5 ms Max. = 20 ms	-
Reset time, start overcurrent at 10 to 0 x I_{set}	Min. = 20 ms Max. = 35 ms	-
Independent time delay to operate at 0 to 2 x I_{set}	(0.00 - 6000.00) s	±0.2% or ±35 ms whichever is greater
Inverse time characteristics, see tables 129 and 130	13 curve types	See tables 129 and 130
Minimum operate time for inverse time characteristics	(0.00 - 60.00) s	±0.2% or ±35 ms whichever is greater
High voltage limit, voltage dependent operation	(30.0 - 100.0)% of UBase	±1.0% of U_r
Start undervoltage	(2.0 - 100.0)% of UBase	±0.5% of U_r
Reset ratio, undervoltage	< 105%	-
Operate time start undervoltage at 2 to 0 x U_{set}	Min. = 15 ms Max. = 30 ms	-
Reset time start undervoltage at 0 to 2 x U_{set}	Min. = 15 ms Max. = 30 ms	-
Independent time delay to operate, undervoltage at 2 to 0 x U_{set}	(0.00 - 6000.00) s	±0.2% or ±35 ms whichever is greater
Internal low voltage blocking	(0.0 - 5.0)% of UBase	±0.25% of U_r
Overcurrent: Critical impulse time Impulse margin time	 10 ms typically at 0 to 2 x I_{set} 15 ms typically	-
Undervoltage: Critical impulse time Impulse margin time	 10ms typically at 2 to 0 x U_{set} 15 ms typically	-

Secondary system supervision

Table 65. Current circuit supervision CCSSPVC

Function	Range or value	Accuracy
Operate current	(10-200)% of IBase	±10.0% of I_r at I ≤ I_r ±10.0% of I at I > I_r
Reset ratio, Operate current	>90%	
Block current	(20-500)% of IBase	±5.0% of I_r at I ≤ I_r ±5.0% of I at I > I_r
Reset ratio, Block current	>90% at (50-500)% of IBase	

Table 66. Fuse failure supervision FUFSPVC

Function	Range or value	Accuracy
Operate voltage, zero sequence	(1-100)% of UBase	± 0.5% of U_r
Operate current, zero sequence	(1–100)% of IBase	± 0.5% of I_r
Operate voltage, negative sequence	(1-100)% of UBase	0.5% of U_r
Operate current, negative sequence	(1–100)% of IBase	± 0.5% of I_r
Operate voltage change level	(1-100)% of UBase	± 10.0% of U_r
Operate current change level	(1–100)% of IBase	± 10.0% of I_r
Operate phase voltage	(1-100)% of UBase	± 0.5% of U_r
Operate phase current	(1–100)% of IBase	± 0.5% of I_r
Operate phase dead line voltage	(1-100)% of UBase	± 0.5% of U_r
Operate phase dead line current	(1–100)% of IBase	± 0.5% of I_r
Operate time, start, 1 ph, at 1 to 0 x U_r	Min. = 10 ms Max. = 25 ms	-
Reset time, start, 1 ph, at 0 to 1 x U_r	Min. = 15 ms Max. = 30 ms	-

Table 67. Fuse failure supervision VDSPVC

Function	Range or value	Accuracy
Operate value, block of main fuse failure	(10.0-80.0)% of UBase	±0.5% of Ur
Reset ratio	<110%	
Operate time, block of main fuse failure at 1 to 0 x U_r	Min. = 5 ms Max. = 15 ms	–
Reset time, block of main fuse failure at 0 to 1 x U_r	Min. = 15 ms Max. = 30 ms	–
Operate value, alarm for pilot fuse failure	(10.0-80.0)% of UBase	±0.5% of Ur
Reset ratio	<110%	–
Operate time, alarm for pilot fuse failure at 1 to 0 x U_r	Min. = 5 ms Max. = 15 ms	–
Reset time, alarm for pilot fuse failure at 0 to 1 x U_r	Min. = 15 ms Max. = 30 ms	–

Control

Table 68. Synchronizing, synchrocheck and energizing check SESRSYN

Function	Range or value	Accuracy
Phase shift, $\varphi_{line} - \varphi_{bus}$	(-180 to 180) degrees	-
Voltage high limit for synchronizing and synchrocheck	(50.0-120.0)% of UBase	± 0.5% of U_r at $U \leq U_r$ ± 0.5% of U at $U > U_r$
Reset ratio, synchrocheck	> 95%	-
Frequency difference limit between bus and line for synchrocheck	(0.003-1.000) Hz	± 2.5 mHz
Phase angle difference limit between bus and line for synchrocheck	(5.0-90.0) degrees	± 2.0 degrees
Voltage difference limit between bus and line for synchronizing and synchrocheck	(0.02-0.5) p.u	± 0.5% of U_r
Time delay output for synchrocheck when angle difference between bus and line jumps from “PhaseDiff” + 2 degrees to “PhaseDiff” - 2 degrees	(0.000-60.000) s	± 0.2% or ± 35 ms whichever is greater
Frequency difference minimum limit for synchronizing	(0.003-0.250) Hz	± 2.5 mHz
Frequency difference maximum limit for synchronizing	(0.050-0.500) Hz	± 2.5 mHz
Maximum allowed frequency rate of change	(0.000-0.500) Hz/s	± 10.0 mHz/s
Breaker closing pulse duration	(0.050-60.000) s	± 0.2% or ± 15 ms whichever is greater
tMaxSynch, which resets synchronizing function if no close has been made before set time	(0.000-6000.00) s	± 0.2% or ± 35 ms whichever is greater
Minimum time to accept synchronizing conditions	(0.000-60.000) s	± 0.2% or ± 35 ms whichever is greater
Voltage high limit for energizing check	(50.0-120.0)% of UBase	± 0.5% of U_r at $U \leq U_r$ ± 0.5% of U at $U > U_r$
Reset ratio, voltage high limit	> 95%	-
Voltage low limit for energizing check	(10.0-80.0)% of UBase	± 0.5% of U_r
Reset ratio, voltage low limit	< 105%	-
Maximum voltage for energizing	(50.0-180.0)% of UBase	± 0.5% of U_r at $U \leq U_r$ ± 0.5% of U at $U > U_r$
Time delay for energizing check when voltage jumps from 0 to 90% of Urated	(0.000-60.000) s	± 0.2% or ± 100 ms whichever is greater
Operate time for synchrocheck function when angle difference between bus and line jumps from “PhaseDiff” + 2 degrees to “PhaseDiff” - 2 degrees	Min = 15 ms Max = 30 ms	–
Operate time for energizing function when voltage jumps from 0 to 90% of Urated	Min = 70 ms Max = 90 ms	–

Table 69. Autorecloser SMBRREC

Function	Range or value	Accuracy
Number of autoreclosing shots	1 - 5	-
Autoreclosing open time: shot 1 - t1 1Ph shot 1 - t1 2Ph shot 1 - t1 3PhHS shot 1 - t1 3Ph	(0.000-120.000) s	± 0.2% or ± 35 ms whichever is greater
shot 2 - t2 3Ph shot 3 - t3 3Ph shot 4 - t4 3Ph shot 5 - t5 3Ph	(0.00-6000.00) s	± 0.2% or ± 35 ms whichever is greater
Extended autorecloser open time	(0.000-60.000) s	± 0.2% or ± 35 ms whichever is greater
Minimum time CB must be closed before AR becomes ready for autoreclosing cycle	(0.00-6000.00) s	± 0.2% or ± 35 ms whichever is greater
Maximum operate pulse duration	(0.000-60.000) s	± 0.2% or ± 15 ms whichever is greater
Reclaim time	(0.00-6000.00) s	± 0.2% or ± 15 ms whichever is greater
Circuit breaker closing pulse length	(0.000-60.000) s	± 0.2% or ± 15 ms whichever is greater
Wait for master release	(0.00-6000.00) s	± 0.2% or ± 15 ms whichever is greater
Inhibit reset time	(0.000-60.000) s	± 0.2% or ± 45 ms whichever is greater
Autorecloser maximum wait time for sync	(0.00-6000.00) s	± 0.2% or ± 45 ms whichever is greater
CB check time before unsuccessful	(0.00-6000.00) s	± 0.2% or ± 45 ms whichever is greater
Wait time after close command before proceeding to next shot	(0.000-60.000) s	± 0.2% or ± 45 ms whichever is greater

Scheme communication

Table 70. Scheme communication logic for distance or overcurrent protection ZCPSCH

Function	Range or value	Accuracy
Scheme type	Intertrip Permissive Underreach Permissive Overreach Blocking	-
Co-ordination time for blocking communication scheme	(0.000-60.000) s	± 0.2% or ± 15 ms whichever is greater
Minimum duration of a send signal	(0.000-60.000) s	± 0.2% or ± 15 ms whichever is greater
Security timer for loss of guard signal detection	(0.000-60.000) s	± 0.2% or ± 15 ms whichever is greater
Operation mode of unblocking logic	Off NoRestart Restart	-

Table 71. Phase segregated scheme communication logic for distance protection ZC1PPSCH

Function	Range or value	Accuracy
Scheme type	Intertrip Permissive UR Permissive OR Blocking	-
Co-ordination time for blocking communication scheme	(0.000-60.000) s	±0.2% or ±15 ms whichever is greater
Minimum duration of a carrier send signal	(0.000-60.000) s	±0.2% or ±15 ms whichever is greater

Table 72. Current reversal and weak-end infeed logic for distance protection ZCRWPSCH

Function	Range or value	Accuracy
Detection level phase-to-neutral voltage	(10-90)% of UBase	±0.5% of U_r
Detection level phase-to-phase voltage	(10-90)% of UBase	±0.5% of U_r
Operate time for current reversal logic	(0.000-60.000) s	±0.2% or ±15 ms whichever is greater
Delay time for current reversal	(0.000-60.000) s	±0.2% or ±15 ms whichever is greater
Coordination time for weak-end infeed logic	(0.000-60.000) s	±0.2% or ±15 ms whichever is greater

Table 73. Current reversal and weak-end infeed logic for phase segregated communication ZC1WPSCH

Function	Range or value	Accuracy
Detection level phase to neutral voltage	(10-90)% of UBase	±0.5% of U_r
Detection level phase to phase voltage	(10-90)% of UBase	±0.5% of U_r
Reset ratio	<105% at (20-90)% of UBase	-
Operate time for current reversal	(0.000-60.000) s	±0.2% or ±15 ms whichever is greater
Delay time for current reversal	(0.000-60.000) s	±0.2% or ±15 ms whichever is greater
Coordination time for weak-end infeed logic	(0.000-60.000) s	±0.2% or ±15 ms whichever is greater

Table 74. Scheme communication logic for residual overcurrent protection ECPSCH

Function	Range or value	Accuracy
Scheme type	Permissive Underreaching Permissive Overreaching Blocking	-
Communication scheme coordination time	(0.000-60.000) s	±0.2% or ±20 ms whichever is greater

Table 75. Current reversal and weak-end infeed logic for residual overcurrent protection ECRWPSCH

Function	Range or value	Accuracy
Operate mode of WEI logic	Off Echo Echo & Trip	-
Operate voltage 3U0 for WEI trip	(5-70)% of UBase	± 0.5% of U_r
Operate time for current reversal logic	(0.000-60.000) s	± 0.2% or ±30 ms whichever is greater
Delay time for current reversal	(0.000-60.000) s	± 0.2% or ±30 ms whichever is greater
Coordination time for weak-end infeed logic	(0.000–60.000) s	± 0.2% or ±30 ms whichever is greater

Direct transfer trip

Table 76. Low active power and power factor protection LAPPGAPC

Function	Range or value	Accuracy
Operate value, low active power	(2.0-100.0)% of SBase	±1.0% of S_r
Reset ratio, low active power	<105%	-
Operate value, low power factor	0.00-1.00	±0.02
Independent time delay to operate for low active power at 1.2 to 0.8 x P_{set}	(0.000-60.000) s	±0.2% or ±40 ms whichever is greater
Independent time delay to operate for low power factor at 1.2 to 0.8 x PF_{set}	(0.000-60.000) s	±0.2% or ±40 ms whichever is greater
Critical impulse time, low active power	10 ms typically at 1.2 to 0.8 x P_{set}	-
Impulse margin time, low active power	10 ms typically	-

Table 77. Compensated over- and undervoltage protection COUVGAPC

Function	Range or value	Accuracy
Operate value, undervoltage	(1-100)% of UBase	±0,5% of U_r
Absolute hysteresis	(0.00–50.0)% of UBase	±0.5% of U_r at U ≤ U_r ±0.5% of U at U > U_r
Critical impulse time, undervoltage	10 ms typically at 1.2 to 0.8x U_{set}	-
Impulse margin time, undervoltage	15 ms typically	-
Operate value, overvoltage	(1-200)% of UBase	±0.5% of U_r at U≤U_r ± 0.5% of U at U>U_r
Critical impulse time, overvoltage	10 ms typically at 0.8 to 1.2 x U_{set}	-
Impulse margin time, overvoltage	15 ms typically	-
Independent time delay for undervoltage functionality at 1.2 to 0.8 x U_{set}	(0.000-60.000) s	±0.2% or ±40 ms whichever is greater
Independent time delay for overvoltage functionality at 0.8 to 1.2 x U_{set}	(0.000-60.000) s	±0.2% or ±40 ms whichever is greater

Table 78. Sudden change in current variation SCCVPTOC

Function	Range or value	Accuracy
Operate value, overcurrent	(5-100)% of IBase	±2.0% of I_r
Hold time for operate signal at 0 to 2 x Iset	(0.000-60.000) s	±0.2% or ±15 ms whichever is greater

Table 79. Carrier receive logic LCCRPTRC

Function	Range or value	Accuracy
Operation mode	1 Out Of 2 2 Out Of 2	-
Independent time delay	(0.000-60.000) s	±0.2% or ±35 ms whichever is greater

Table 80. Negative sequence overvoltage protection LCNSPTOV

Function	Range or value	Accuracy
Operate value, negative sequence overvoltage	(1-200)% of UBase	±0.5% of U_r at U≤U_r ±0.5% of U at U>U_r
Reset ratio, negative sequence overvoltage	>95% at (10–200)% of UBase	-
Operate time, start at 0 to 2 x U_{set}	Min. = 15 ms Max. = 30 ms	-
Reset time, start at 2 to 0 x U_{set}	Min. = 15 ms Max. = 30 ms	-
Critical impulse time, negative sequence overvoltage	10 ms typically at 0 to 2 x U_{set}	-
Impulse margin time, negative sequence overvoltage	15 ms typically	-
Independent time delay to operate at 0 to 1.2 x U_{set}	(0.000-120.000) s	±0.2% or ±40 ms whichever is greater

Table 81. Zero sequence overvoltage protection LCZSPTOV

Function	Range or value	Accuracy
Operate value, zero sequence overvoltage	(1-200)% of UBase	±0.5% of U_r at U ≤ U_r ±0.5% of U at U > U_r
Reset ratio, zero sequence overvoltage	>95% at (10–200)% of UBase	-
Operate time, start at 0 to 2 x U_{set}	Min. = 15 ms Max. = 30 ms	-
Reset time, start at 2 to 0 x U_{set}	Min. = 15 ms Max. = 30 ms	-
Critical impulse time, zero sequence overvoltage	10 ms typically at 0 to 2 x U_{set}	-
Impulse margin time, zero sequence overvoltage	15 ms typically	-
Independent time delay to operate at 0 to 1.2 x U_{set}	(0.000-120.000) s	±0.2% or ±40 ms whichever is greater

Table 82. Negative sequence overcurrent protection LCNSPTOC

Function	Range or value	Accuracy
Operate value, negative sequence overcurrent	(3 - 2500)% of IBase	±1.0% of Ir at $I \leq I_r$ ±1.0% of I at $I > I_r$
Reset ratio, negative sequence overcurrent	>95% at (50–2500)% of IBase	-
Operate time, start at 0 to 2 x I_{set}	Min. = 15 ms Max. = 25 ms	-
Reset time, start at 2 to 0 x I_{set}	Min. = 15 ms Max. = 25 ms	-
Operate time, start at 0 to 10 x I_{set}	Min. = 10 ms Max. = 20 ms	-
Reset time, start at 10 to 0 x I_{set}	Min. = 20 ms Max. = 35 ms	-
Critical impulse time, negative sequence overcurrent	10 ms typically at 0 to 2 x I_{set} 2 ms typically at 0 to 10 x I_{set}	-
Impulse margin time, negative sequence overcurrent	15 ms typically	-
Independent time delay at 0 to 2 x I_{set}	(0.000-60.000) s	±0.2% or ±35 ms, whichever is greater
Transient overreach, start function	<5% at τ = 100 ms	-

Table 83. Zero sequence overcurrent protection LCZSPTOC

Function	Range or value	Accuracy
Operate value, zero sequence overcurrent	(3-2500)% of IBase	±1.0% of I_r at $I \leq I_r$ ±1.0% of I at $I > I_r$
Reset ratio, zero sequence overcurrent	>95% at (50–2500)% of IBase	-
Operate time, start at 0 to 2 x I_{set}	Min. = 15 ms Max. = 30 ms	-
Reset time, start at 2 to 0 x I_{set}	Min. = 15 ms Max. = 30 ms	-
Operate time, start at 0 to 10 x I_{set}	Min. = 10 ms Max. = 20 ms	-
Reset time, start at 10 to 0 x I_{set}	Min. = 20 ms Max. = 35 ms	-
Critical impulse time, zero sequence overcurrent	10 ms typically at 0 to 2 x I_{set} 2 ms typically at 0 to 10 x I_{set}	-
Impulse margin time, zero sequence overcurrent	15 ms typically	-
Independent time delay at 0 to 2 x I_{set}	(0.000-60.000) s	±0.2% or ±35 ms whichever is greater

Table 84. Three phase overcurrent LCP3PTOC

Function	Range or value	Accuracy
Operate value, overcurrent	(5-2500)% of IBase	±1.0% of I_r at $I \le I_r$ ±1.0% of I at $I > I_r$
Reset ratio, overcurrent	> 95% at (50-2500)% of IBase	-
Start time at 0 to 2 x I_{set}	Min. = 10 ms Max. = 25 ms	-
Reset time at 2 to 0 x I_{set}	Min. = 20 ms Max. = 35 ms	-
Critical impulse time, overcurrent	5 ms typically at 0 to 2 x I_{set} 2 ms typically at 0 to 10 x I_{set}	-
Impulse margin time, overcurrent	10 ms typically	-
Independent time delay to operate at 0 to 2 x I_{set}	(0.000-60.000) s	±0.2% or ±30 ms whichever is greater

Table 85. Three phase undercurrent LCP3PTUC

Function	Range or value	Accuracy
Operate value, undercurrent	(1.00-100.00)% of IBase	±1.0% of I_r
Reset ratio, undercurrent	< 105% at (50.00-100.00)% of IBase	-
Start time at 2 to 0 x I_{set}	Min. = 15 ms Max. = 30 ms	-
Reset time at 0 to 2 x I_{set}	Min. = 10 ms Max. = 25 ms	-
Critical impulse time, undercurrent	10 ms typically at 2 to 0 x I_{set}	-
Impulse margin time, undercurrent	10 ms typically	-
Independent time delay to operate at 2 to 0 x I_{set}	(0.000-60.000) s	±0.2% or ±45 ms whichever is greater

Logic

Table 86. Tripping logic common 3-phase output SMPPTRC

Function	Range or value	Accuracy
Trip action	3-ph, 1/3-ph, 1/2/3-ph	-
Minimum trip pulse length	(0.000-60.000) s	± 0.2% or ± 30 ms whichever is greater
3-pole trip delay	(0.020-0.500) s	± 0.2% or ±10 ms whichever is greater
Single phase delay, two phase delay and evolving fault delay	(0.000-60.000) s	± 0.2% or ±10 ms whichever is greater

Table 87. Configurable logic blocks

Logic block	Quantity with cycle time			Range or value	Accuracy
	fast	medium	normal		
LogicAND	60	60	160	-	-
LogicOR	60	60	160	-	-
LogicXOR	10	10	20	-	-
LogicInverter	30	30	80	-	-
LogicSRMemory	10	10	20	-	-
LogicRSMemory	10	10	20	-	-
LogicGate	10	10	20	-	-
LogicTimer	10	10	20	(0.000–90000.000) s	± 0.5% ± 10 ms
LogicPulseTimer	10	10	20	(0.000–90000.000) s	± 0.5% ± 10 ms
LogicTimerSet	10	10	20	(0.000–90000.000) s	± 0.5% ± 10 ms
LogicLoopDelay	10	10	20	(0.000–90000.000) s	± 0.5% ± 10 ms
Trip Matrix Logic	6	6	-	-	-
Boolean 16 to Integer	4	4	8	-	-
Boolean 16 to integer with Logic Node	4	4	8	-	-
Integer to Boolean 16	4	4	8	-	-
Integer to Boolean 16 with Logic Node	4	4	8	-	-

Table 88. Configurable logic blocks Q/T

Logic block	Quantity with cycle time		Range or value	Accuracy
	medium	normal		
ANDQT	20	100	-	-
ORQT	20	100	-	-
INVERTERQT	20	100	-	-
XORQT	10	30	-	-
SRMEMORYQT	10	30	-	-
RSMEMORYQT	10	30	-	-
TIMERSETQT	10	30	(0.000-90000.000) s	± 0.5% ± 10 ms
PULSETIMERQT	10	30	(0.000-90000.000) s	± 0.5% ± 10 ms
INVALIDQT	6	6	-	-
INDCOMBSPQT	10	10	-	-
INDEXTSPQT	10	10	-	-

Table 89. Elapsed time integrator with limit transgression and overflow supervision TEIGAPC

Function	Cycle time (ms)	Range or value	Accuracy
Elapsed time integration	3	0 ~ 999999.9 s	±0.2% or ±20 ms whichever is greater
	8	0 ~ 999999.9 s	±0.2% or ±100 ms whichever is greater
	100	0 ~ 999999.9 s	±0.2% or ±250 ms whichever is greater

Table 90. Number of TEIGAPC instances

Function	Quantity with cycle time		
	3 ms	8 ms	100 ms
TEIGAPC	4	4	4

Monitoring

Table 91. Measurements CVMMXN

Function	Range or value	Accuracy
Frequency	(0.95-1.05) × f_r	± 2.0 mHz
Voltage	(0.1-1.5) ×U_r	± 0.5% of U_r at U≤U_r ± 0.5% of U at U > U_r
Connected current	(0.2-4.0) × I_r	± 0.5% of I_r at I ≤ I_r ± 0.5% of I at I > I_r
Active power, P	0.1 x U_r< U < 1.5 x U_r 0.2 x I_r < I < 4.0 x I_r	± 1.0% of S_r at S ≤ S_r ± 1.0% of S at S > S_r Conditions: 0.8 x U_r < U < 1.2 U_r 0.2 x I_r < I < 1.2 I_r
Reactive power, Q	0.1 x U_r< U < 1.5 x U_r 0.2 x I_r < I < 4.0 x I_r	
Apparent power, S	0.1 x U_r < U < 1.5 x U_r 0.2 x I_r< I < 4.0 x I_r	
Power factor, cos (φ)	0.1 x U_r < U < 1.5 x U_r 0.2 x I_r< I < 4.0 x I_r	± 0.02

Table 92. Phase current measurement CMMXU

Function	Range or value	Accuracy
Current at symmetrical load	(0.1-4.0) × I_r	± 0.3% of I_r at I ≤ 0.5 × I_r ± 0.3% of I at I > 0.5 × I_r
Phase angle at symmetrical load	(0.1-4.0) × I_r	± 1.0° at 0.1 × I_r < I ≤ 0.5 × I_r ± 0.5° at 0.5 × I_r < I ≤ 4.0 × I_r

Table 93. Phase-phase voltage measurement VMMXU

Function	Range or value	Accuracy
Voltage	(10 to 300) V	± 0.5% of U at U ≤ 50 V ± 0.2% of U at U > 50 V
Phase angle	(10 to 300) V	± 0.5° at U ≤ 50 V ± 0.2° at U > 50 V

Table 94. Phase-neutral voltage measurement VNMMXU

Function	Range or value	Accuracy
Voltage	(5 to 175) V	± 0.5% of U at U ≤ 50 V ± 0.2% of U at U > 50 V
Phase angle	(5 to 175) V	± 0.5° at U ≤ 50 V ± 0.2° at U > 50 V

Table 95. Current sequence component measurement CMSQI

Function	Range or value	Accuracy
Current positive sequence, I1 Three phase settings	(0.1–4.0) × I_r	± 0.3% of I_r at I ≤ 0.5 × I_r ± 0.3% of I at I > 0.5 × I_r
Current zero sequence, 3I0 Three phase settings	(0.1–1.0) × I_r	± 0.3% of I_r at I ≤ 0.5 × I_r ± 0.3% of I at I > 0.5 × I_r
Current negative sequence, I2 Three phase settings	(0.1–1.0) × I_r	± 0.3% of I_r at I ≤ 0.5 × I_r ± 0.3% of I at I > 0.5 × I_r
Phase angle	(0.1–4.0) × I_r	± 1.0° at 0.1 × I_r < I ≤ 0.5 × I_r ± 0.5° at 0.5 × I_r < I ≤ 4.0 × I_r

Table 96. Voltage sequence measurement VMSQI

Function	Range or value	Accuracy
Voltage positive sequence, U1	(10 to 300) V	± 0.5% of U at U ≤ 50 V ± 0.2% of U at U > 50 V
Voltage zero sequence, 3U0	(10 to 300) V	± 0.5% of U at U ≤ 50 V ± 0.2% of U at U > 50 V
Voltage negative sequence, U2	(10 to 300) V	± 0.5% of U at U ≤ 50 V ± 0.2% of U at U > 50 V
Phase angle	(10 to 300) V	± 0.5° at U ≤ 50 V ± 0.2° at U > 50 V

Table 97. Supervision of mA input signals

Function	Range or value	Accuracy
mA measuring function	±5, ±10, ±20 mA 0-5, 0-10, 0-20, 4-20 mA	±0.1 % of set value ±0.005 mA
Max current of transducer to input	(-20.00 to +20.00) mA	
Min current of transducer to input	(-20.00 to +20.00) mA	
Alarm level for input	(-20.00 to +20.00) mA	
Warning level for input	(-20.00 to +20.00) mA	
Alarm hysteresis for input	(0.0-20.0) mA	

Table 98. Limit counter L4UFCNT

Function	Range or value	Accuracy
Counter value	0-65535	-
Max. count up speed	30 pulses/s (50% duty cycle)	-

Table 99. Disturbance report DRPRDRE

Function	Range or value	Accuracy
Pre-fault time	(0.05–9.90) s	-
Post-fault time	(0.1–10.0) s	-
Limit time	(0.5–10.0) s	-
Maximum number of recordings	100, first in - first out	-
Time tagging resolution	1 ms	See table 125
Maximum number of analog inputs	30 + 10 (external + internally derived)	-
Maximum number of binary inputs	96	-
Maximum number of phasors in the Trip Value recorder per recording	30	-
Maximum number of indications in a disturbance report	96	-
Maximum number of events in the Event recording per recording	150	-
Maximum number of events in the Event list	1000, first in - first out	-
Maximum total recording time (3.4 s recording time and maximum number of channels, typical value)	340 seconds (100 recordings) at 50 Hz, 280 seconds (80 recordings) at 60 Hz	-
Sampling rate	1 kHz at 50 Hz 1.2 kHz at 60 Hz	-
Recording bandwidth	(5-300) Hz	-

Table 100. Fault locator LMBRFLO

Function	Value or range	Accuracy
Reactive and resistive reach	(0.001-1500.000) Ω/phase	±2.0% static accuracy Conditions: Voltage range: (0.1-1.1) x U_r Current range: (0.5-30) x I_r
Phase selection	According to input signals	-
Maximum number of fault locations	100	-

Table 101. Event list

Function		Value
Buffer capacity	Maximum number of events in the list	1000
Resolution		1 ms
Accuracy		Depending on time synchronizing

Table 102. Indications

Function		Value
Buffer capacity	Maximum number of indications presented for single disturbance	96
	Maximum number of recorded disturbances	100

Table 103. Event recorder

Function		Value
Buffer capacity	Maximum number of events in disturbance report	150
	Maximum number of disturbance reports	100
Resolution		1 ms
Accuracy		Depending on time synchronizing

Table 104. Trip value recorder

Function		Value
Buffer capacity	Maximum number of analog inputs	30
	Maximum number of disturbance reports	100

Table 105. Disturbance recorder

Function		Value
Buffer capacity	Maximum number of analog inputs	40
	Maximum number of binary inputs	96
	Maximum number of disturbance reports	100
Maximum total recording time (3.4 s recording time and maximum number of channels, typical value)		340 seconds (100 recordings) at 50 Hz 280 seconds (80 recordings) at 60 Hz

Metering

Table 106. Pulse-counter logic PCFCNT

Function	Setting range	Accuracy
Input frequency	See Binary Input Module (BIM)	-
Cycle time for report of counter value	(1–3600) s	-

Table 107. Energy metering ETPMMTR

Function	Range or value	Accuracy
Energy metering	kWh Export/Import, kvarh Export/Import	Input from MMXU. No extra error at steady load

Station communication

Table 108. Communication protocols

Function	Value
Protocol	IEC 61850-8-1
Communication speed for the IEDs	100BASE-FX
Protocol	IEC 60870–5–103
Communication speed for the IEDs	9600 or 19200 Bd
Protocol	DNP3.0
Communication speed for the IEDs	300–19200 Bd
Protocol	TCP/IP, Ethernet
Communication speed for the IEDs	100 Mbit/s

Table 109. IEC 61850-9-2 communication protocol

Function	Value
Protocol	IEC 61850-9-2
Communication speed for the IEDs	100BASE-FX

Table 110. LON communication protocol

Function	Value
Protocol	LON
Communication speed	1.25 Mbit/s

Table 111. SPA communication protocol

Function	Value
Protocol	SPA
Communication speed	300, 1200, 2400, 4800, 9600, 19200 or 38400 Bd
Slave number	1 to 899

Table 112. IEC 60870-5-103 communication protocol

Function	Value
Protocol	IEC 60870-5-103
Communication speed	9600, 19200 Bd

Table 113. SLM – LON port

Quantity	Range or value
Optical connector	Glass fiber: type ST Plastic fiber: type HFBR snap-in
Fiber, optical budget	Glass fiber: 11 dB (1000m/3000 ft typically *) Plastic fiber: 7 dB (10m/35ft typically *)
Fiber diameter	Glass fiber: 62.5/125 μm Plastic fiber: 1 mm
*) depending on optical budget calculation	

Table 114. SLM – SPA/IEC 60870-5-103/DNP3 port

Quantity	Range or value
Optical connector	Glass fiber: type ST Plastic fiber: type HFBR snap-in
Fiber, optical budget	Glass fiber: 11 dB (1000m/3000ft m typically *) Plastic fiber: 7 dB (25m/80ft m typically *)
Fiber diameter	Glass fiber: 62.5/125 µm Plastic fiber: 1 mm
*) depending on optical budget calculation	

Table 115. Galvanic X.21 line data communication module (X.21-LDCM)

Quantity	Range or value
Connector, X.21	Micro D-sub, 15-pole male, 1.27 mm (0.050") pitch
Connector, ground selection	2 pole screw terminal
Standard	CCITT X21
Communication speed	64 kbit/s
Insulation	1 kV
Maximum cable length	100 m

Table 116. Galvanic RS485 communication module

Quantity	Range or value
Communication speed	2400–19200 bauds
External connectors	RS-485 6-pole connector Soft ground 2-pole connector

Table 117. IEC 62439-3 Edition 1 and Edition 2 parallel redundancy protocol

Function	Value
Communication speed	100 Base-FX

Remote communication

Table 118. Line data communication module

Characteristic	Range or value		
Type of LDCM	Short range (SR)	Medium range (MR)	Long range (LR)
Type of fiber	Graded-index multimode 62.5/125 µm	Singlemode 9/125 µm	Singlemode 9/125 µm
Peak Emission Wave length Nominal Maximum Minimum	 820 nm 865 nm 792 nm	 1310 nm 1330 nm 1290 nm	 1550 nm 1580 nm 1520 nm
Optical budget Graded-index multimode 62.5/125 µm, Graded-index multimode 50/125 µm	13 dB (typical distance about 3 km/2 mile *) 9 dB (typical distance about 2 km/1 mile *)	22 dB (typical distance 80 km/50 mile *)	26 dB (typical distance 110 km/68 mile *)
Optical connector	Type ST	Type FC/PC	Type FC/PC
Protocol	C37.94	C37.94 implementation **)	C37.94 implementation **)
Data transmission	Synchronous	Synchronous	Synchronous
Transmission rate / Data rate	2 Mb/s / 64 kbit/s	2 Mb/s / 64 kbit/s	2 Mb/s / 64 kbit/s
Clock source	Internal or derived from received signal	Internal or derived from received signal	Internal or derived from received signal

*) depending on optical budget calculation
**) C37.94 originally defined just for multimode; using same header, configuration and data format as C37.94

Hardware

IED

Table 119. Case

Material	Steel sheet
Front plate	Steel sheet profile with cut-out for HMI
Surface treatment	Aluzink preplated steel
Finish	Light grey (RAL 7035)

Table 120. Water and dust protection level according to IEC 60529

Front	IP40 (IP54 with sealing strip)
Sides, top and bottom	IP20
Rear side	IP20 with screw compression type IP10 with ring lug terminals

Table 121. Weight

Case size	Weight
6U, 1/2 x 19”	≤ 10 kg/22 lb
6U, 3/4 x 19”	≤ 15 kg/33 lb
6U, 1/1 x 19”	≤ 18 kg/40 lb

Connection system

Table 122. CT and VT circuit connectors

Connector type	Rated voltage and current	Maximum conductor area
Screw compression type	250 V AC, 20 A	4 mm^2 (AWG12) 2 x 2.5 mm^2 (2 x AWG14)
Terminal blocks suitable for ring lug terminals	250 V AC, 20 A	4 mm^2 (AWG12)

Table 123. Auxiliary power supply and binary I/O connectors

Connector type	Rated voltage	Maximum conductor area
Screw compression type	250 V AC	2.5 mm^2 (AWG14) 2 × 1 mm^2 (2 x AWG18)
Terminal blocks suitable for ring lug terminals	300 V AC	3 mm^2 (AWG14)

Because of limitations of space, when ring lug terminal is ordered for Binary I/O connections, one blank slot is necessary between two adjacent IO cards. Please refer to the ordering particulars for details.

Basic IED functions

Table 124. Self supervision with internal event list

Data	Value
Recording manner	Continuous, event controlled
List size	40 events, first in-first out

Table 125. Time synchronization, time tagging

Function	Value
Time tagging resolution, events and sampled measurement values	1 ms
Time tagging error with synchronization once/min (minute pulse synchronization), events and sampled measurement values	± 1.0 ms typically
Time tagging error with SNTP synchronization, sampled measurement values	± 1.0 ms typically

Table 126. GPS time synchronization module (GTM)

Function	Range or value	Accuracy
Receiver	–	±1μs relative UTC
Time to reliable time reference with antenna in new position or after power loss longer than 1 month	<30 minutes	–
Time to reliable time reference after a power loss longer than 48 hours	<15 minutes	–
Time to reliable time reference after a power loss shorter than 48 hours	<5 minutes	–

Table 127. GPS – Antenna and cable

Function	Value
Max antenna cable attenuation	26 db @ 1.6 GHz
Antenna cable impedance	50 ohm
Lightning protection	Must be provided externally
Antenna cable connector	SMA in receiver end TNC in antenna end
Accuracy	+/-1μs

Table 128. IRIG-B

Quantity	Rated value
Number of channels IRIG-B	1
Number of optical channels	1
Electrical connector:	
Electrical connector IRIG-B	BNC
Pulse-width modulated	5 Vpp
Amplitude modulated – low level – high level	 1-3 Vpp 3 x low level, max 9 Vpp
Supported formats	IRIG-B 00x, IRIG-B 12x
Accuracy	+/-10μs for IRIG-B 00x and +/-100μs for IRIG-B 12x
Input impedance	100 k ohm
Optical connector:	
Optical connector IRIG-B	Type ST
Type of fibre	62.5/125 μm multimode fibre
Supported formats	IRIG-B 00x
Accuracy	+/- 1μs

Inverse characteristic

Table 129. ANSI Inverse time characteristics

Function	Range or value	Accuracy
Operating characteristic: $$t = \left(\frac{A}{\left(I^P - 1\right)} + B \right) \cdot k + tDef$$ Reset characteristic: $$t = \frac{t_r}{\left(I^2 - 1\right)} \cdot k$$ $I = I_{measured}/I_{set}$	k = (0.05-2.00) in steps of 0.01	ANSI/IEEE C37.112 , ± 2.0% or ± 40 ms whichever is greater
ANSI Extremely Inverse	A=28.2, B=0.1217, P=2.0 , tr=29.1	
ANSI Very inverse	A=19.61, B=0.491, P=2.0 , tr=21.6	
ANSI Normal Inverse	A=0.0086, B=0.0185, P=0.02, tr=0.46	
ANSI Moderately Inverse	A=0.0515, B=0.1140, P=0.02, tr=4.85	
ANSI Long Time Extremely Inverse	A=64.07, B=0.250, P=2.0, tr=30	
ANSI Long Time Very Inverse	A=28.55, B=0.712, P=2.0, tr=13.46	
ANSI Long Time Inverse	A=0.086, B=0.185, P=0.02, tr=4.6	

Table 130. IEC Inverse time characteristics

Function	Range or value	Accuracy
Operating characteristic: $$t = \left(\frac{A}{\left(I^P - 1\right)} \right) \cdot k$$ I = $I_{measured}/I_{set}$	k = (0.05-2.00) in steps of 0.01	IEC 60255-151, ± 2.0% or ± 40 ms whichever is greater
IEC Normal Inverse	A=0.14, P=0.02	
IEC Very inverse	A=13.5, P=1.0	
IEC Inverse	A=0.14, P=0.02	
IEC Extremely inverse	A=80.0, P=2.0	
IEC Short time inverse	A=0.05, P=0.04	
IEC Long time inverse	A=120, P=1.0	
Programmable characteristic Operate characteristic: $$t = \left(\frac{A}{\left(I^P - C\right)} + B \right) \cdot k$$ Reset characteristic: $$t = \frac{TR}{\left(I^{PR} - CR\right)} \cdot k$$ I = $I_{measured}/I_{set}$	k = (0.05-999) in steps of 0.01 A=(0.005-200.000) in steps of 0.001 B=(0.00-20.00) in steps of 0.01 C=(0.1-10.0) in steps of 0.1 P=(0.005-3.000) in steps of 0.001 TR=(0.005-100.000) in steps of 0.001 CR=(0.1-10.0) in steps of 0.1 PR=(0.005-3.000) in steps of 0.001	

Table 131. RI and RD type inverse time characteristics

Function	Range or value	Accuracy
RI type inverse characteristic $$t = \frac{1}{0.339 - \frac{0.236}{I}} \cdot k$$ I = $I_{measured}/I_{set}$	k = (0.05-2.00) in steps of 0.01	IEC 60255-151, ± 2.0% or ± 40 ms whichever is greater
RD type logarithmic inverse characteristic $$t = 5.8 - \left(1.35 \cdot \ln \frac{I}{k}\right)$$ I = $I_{measured}/I_{set}$	k = (0.05-999) in steps of 0.01	

Table 132. Inverse time characteristics for overvoltage protection

Function	Range or value	Accuracy
Type A curve: $$t = \frac{k}{\left(\frac{U - U>}{U>}\right)}$$ U> = U_{set} U = $U_{measured}$	k = (0.05-1.10) in steps of 0.01	±5.0% or ±45 ms whichever is greater
Type B curve: $$t = \frac{k \cdot 480}{\left(32 \cdot \frac{U - U>}{U>} - 0.5\right)^{2.0}} + 0.035$$	k = (0.05-1.10) in steps of 0.01	
Type C curve: $$t = \frac{k \cdot 480}{\left(32 \cdot \frac{U - U>}{U>} - 0.5\right)^{3.0}} + 0.035$$	k = (0.05-1.10) in steps of 0.01	
Programmable curve: $$t = \frac{k \cdot A}{\left(B \cdot \frac{U - U>}{U>} - C\right)^{P}} + D$$	k = (0.05-1.10) in steps of 0.01 A = (0.005-200.000) in steps of 0.001 B = (0.50-100.00) in steps of 0.01 C = (0.0-1.0) in steps of 0.1 D = (0.000-60.000) in steps of 0.001 P = (0.000-3.000) in steps of 0.001	

Table 133. Inverse time characteristics for undervoltage protection

Function	Range or value	Accuracy
Type A curve: $$t = \frac{k}{\left(\frac{U< - U}{U<}\right)}$$ $U< = U_{set}$ $U = U_{measured}$	k = (0.05-1.10) in steps of 0.01	±5.0% or ±45 ms whichever is greater
Type B curve: $$t = \frac{k \cdot 480}{\left(32 \cdot \frac{U< - U}{U<} - 0.5\right)^{2.0}} + 0.055$$ $U< = U_{set}$ $U = U_{measured}$	k = (0.05-1.10) in steps of 0.01	
Programmable curve: $$t = \left[\frac{k \cdot A}{\left(B \cdot \frac{U< - U}{U<} - C\right)^{P}}\right] + D$$ $U< = U_{set}$ $U = U_{measured}$	k = (0.05-1.10) in steps of 0.01 A = (0.005-200.000) in steps of 0.001 B = (0.50-100.00) in steps of 0.01 C = (0.0-1.0) in steps of 0.1 D = (0.000-60.000) in steps of 0.001 P = (0.000-3.000) in steps of 0.001	

Table 134. Inverse time characteristics for residual overvoltage protection

Function	Range or value	Accuracy
Type A curve: $$t = \frac{k}{\left(\frac{U - U>}{U>}\right)}$$ U> = U_{set} U = $U_{measured}$	k = (0.05-1.10) in steps of 0.01	±5.0% or ±45 ms whichever is greater
Type B curve: $$t = \frac{k \cdot 480}{\left(32 \cdot \frac{U - U>}{U>} - 0.5\right)^{2.0}} + 0.035$$	k = (0.05-1.10) in steps of 0.01	
Type C curve: $$t = \frac{k \cdot 480}{\left(32 \cdot \frac{U - U>}{U>} - 0.5\right)^{3.0}} + 0.035$$	k = (0.05-1.10) in steps of 0.01	
Programmable curve: $$t = \frac{k \cdot A}{\left(B \cdot \frac{U - U>}{U>} - C\right)^{P}} + D$$	k = (0.05-1.10) in steps of 0.01 A = (0.005-200.000) in steps of 0.001 B = (0.50-100.00) in steps of 0.01 C = (0.0-1.0) in steps of 0.1 D = (0.000-60.000) in steps of 0.001 P = (0.000-3.000) in steps of 0.001	

22. Ordering for customized IED

Table 135. General guidelines

Guidelines
Carefully read and follow the set of rules to ensure problem-free order management. Please refer to the available functions table for included application functions. PCM600 can be used to make changes and/or additions to the delivered factory configuration of the pre-configured.

Table 136. Example ordering code

To obtain the complete ordering code, please combine code from the selection tables, as given in the example below.
The selected qty of each table must be filled in, if no selection is possible the code is 0

Example of a complete code: REL670*2.0-F00X00 - A00000030000001 - B552000011010200112110100 0 - C000033202202001222100030 0 - D22212011 - E2220 - F0 - S6 - G032 - H20401100000 - K11111111 - L0611 - M21 - P01 - B1X0 - AC - KB - B - A3X0 - D1D1ARGN1N1XXXXXXX - AAFXXX - AX

Product definition					-	Differential protection															-
REL670*	2.0	-		X00	-	A	0	0	0	0	0	0		0	0	0	0	0	0		-

Impedance protection																									-
B																					0		0	0	0	-

Current protection																							-
C			00							0		00					1	0	0	0		0	0	-

Voltage protection									-	Frequency protection					-	Multipurpose protection		-	General calculation		-
D						0	1		-	E				00	-	F		-	S		-

Secondary system supervision				-	Control												-
G				-	H		0		0			0	0	0	0	0	-

Scheme communication									-	Logic			-	Monitoring			-	Station communication			-
K					1				-	L			-	M		1	-	P	0	1	-

Language		-	Casing and Mounting		-	Connection and power		-	HMI	-	Analog input				-	Binary input/output														-
B1		-			-			-		-					-															-

Remote end serial communication						-	Serial communication unit for station communication	
						-		

Table 137. Product definition

REL670*	2.0		X00

Table 138. Product definition ordering codes

Product	REL670*
Software version	2.0
Configuration alternatives	
Line distance protection REL 670	F00
Line distance protection REL670 61850-9-2LE	N00
Selection:	
ACT configuration	
ABB Standard configuration	X00

Table 139. Differential protection

Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14
A	0	0	0	0	0	0		0	0	0	0	0	0	

Table 140. Differential functions

Function	Function identification	Ordering no	Position	Available qty	Selected qty	Notes and rules
1Ph High impedance differential protection	HZPDIF	1MRK005904-HA	7	0-3		
Additional security logic for differential protection	LDRGFC	1MRK005904-TA	14	0-1		

Table 141. Impedance protection

Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
B																	1				0		0	0	0

Table 142. Impedance functions, alternatives

Function	Function identification	Ordering no	Position	Available qty	Selected qty	Notes and rules
Note: One, and only one alternative must be selected. Selected qty is 0 for other functions in an unselected alternative.						
Alternative 1 Distance protection, quadrilateral						
Distance protection zone, quadrilateral characteristic	ZMQPDIS, ZMQAPDIS	1MRK005907-AA	1	1-5		
Directional impedance quadrilateral	ZDRDIR	1MRK005907-BA	2	1-2		
Phase selection, quadrilateral characteristic with fixed angle	FDPSPDIS	1MRK005907-CA	3	2		
Alternative 2 Distance protection for series compensated lines, quadrilateral						
Phase selection, quadrilateral characteristic with fixed angle	FDPSPDIS	1MRK005907-CA	3	2		
Distance measuring zone, quadrilateral characteristic for series compensated lines	ZMCPDIS, ZMCAPDIS	1MRK005907-DA	4	1-5		
Directional impedance quadrilateral, including series compensation	ZDSRDIR	1MRK005907-EA	5	1-2		
Alternative 3 Distance protection, mho (mho for phase - phase fault and mho in parallel with quad for earth fault)						
Fullscheme distance protection, mho characteristic	ZMHPDIS	1MRK005907-FA	6	1-5		
Fullscheme distance protection, quadrilateral for earth faults	ZMMPDIS, ZMMAPDIS	1MRK005907-GA	7	1-5		
Directional impedance element for mho characteristic	ZDMRDIR	1MRK005907-HA	8	1-2		
Additional distance protection directional function for earth faults	ZDARDIR	1MRK005907-KA	9	1-2		
Mho Impedance supervision logic	ZSMGAPC	1MRK005907-LA	10	1		
Faulty phase identification with load encroachment	FMPSPDIS	1MRK005907-MA	11	2		
Alternative 4 Distance protection, quadrilateral with separate settings for PP and PE						
Directional impedance quadrilateral	ZDRDIR	1MRK005907-BA	2	1-2		
Distance protection zone, quadrilateral characteristic, separate settings	ZMRPDIS, ZMRAPDIS	1MRK005907-NA	12	1-5		
Phase selection, quadrilateral characteristic with settable angle	FRPSPDIS	1MRK005907-PA	13	2		
Alternative 5 High speed distance protection, quadrilateral						
Directional distance protection with phase selection	ZMFPDIS	1MRK005907-SA	14	1		
Alternative 6 High speed distance protection for series compensated lines, quadrilateral						
Directional distance protection with phase selection, series compensation	ZMFCPDIS	1MRK005907-RA	15	1		
Optional with alternative 1						
Directional impedance element for mho characteristic	ZDMRDIR	1MRK005907-HA	8	1-2		
Optional with alternative 3						
Phase selection, quadrilateral characteristic with fixed angle	FDPSPDIS	1MRK005907-CA	3	2		
Optional with alternatives 1, 2 and 4						
Additional distance protection directional function for earth faults	ZDARDIR	1MRK005907-KA	9	1-2		
Faulty phase identification with load encroachment	FMPSPDIS	1MRK005907-MA	11	2		
Optional with any alternative						
Power swing detection	ZMRPSB	1MRK005907-UA	16	0-1		
Automatic switch onto fault logic, voltage and current based	ZCVPSOF	1MRK005908-AA	17	1		
Power swing logic	PSLPSCH	1MRK005907-VA	18	0-1		
PoleSlip/Out-of-step protection	PSPPPAM	1MRK005908-CA	19	0-2		
Out-of-step protection	OOSPPAM	1MRK005908-GA	20	0-1		
Phase preference logic	PPLPHIZ	1MRK005908-DA	22	0-1		

Table 143. Current protection

Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
C			00							0		00					1	0	0	0		0	0

Table 144. Current functions

Function	Function identification	Ordering no	Position	Available qty	Selected qty	Notes and rules
Instantaneous phase overcurrent protection	PHPIOC	1MRK005910-AA	1	0-3		
Four step phase overcurrent protection	OC4PTOC	1MRK005910-BA	2	0-3		
Instantaneous residual overcurrent protection	EFPIOC	1MRK005910-DA	4	0-3		
Four step residual overcurrent protection	EF4PTOC	1MRK005910-EA	5	0-3		
Four step directional negative phase sequence overcurrent protection	NS4PTOC	1MRK005910-FA	6	0-2		
Sensitive Directional residual over current and power protetcion	SDEPSDE	1MRK005910-GA	7	0-1		
Thermal overload protection, one time constant, Celcius	LCPTTR	1MRK005911-BA	8	0-2		
Thermal overload protection, one time constant, Fahrenheit	LFPTTR	1MRK005911-AA	9	0-2		
Breaker failure protection	CCRBRF	1MRK005910-LA	11	0-2		
Stub protection	STBPTOC	1MRK005910-NA	13	0-1		
Pole discordance protection	CCPDSC	1MRK005910-PA	14	0-2		
Directional Underpower protection	GUPPDUP	1MRK005910-RA	15	0-2		
Directional Overpower protection	GOPPDOP	1MRK005910-TA	16	0-2		
Broken conductor check	BRCPTOC	1MRK005910-SA	17	1		
Voltage restrained overcurrent protection	VRPVOC	1MRK005910-XA	21	0-3		

Table 145. Voltage protection

Position	1	2	3	4	5	6	7	8
D						0	1	

Table 146. Voltage functions

Function	Function identification	Ordering no	Position	Available qty	Selected qty	Notes and rules
Two step undervoltage protection	UV2PTUV	1MRK005912-AA	1	0-2		
Two step overvoltage protection	OV2PTOV	1MRK005912-BA	2	0-2		
Two step residual overvoltage protection	ROV2PTOV	1MRK005912-CA	3	0-2		
Overexcitation protection	OEXPVPH	1MRK005912-DA	4	0-1		
Voltage differential protection	VDCPTOV	1MRK005912-EA	5	0-2		
Loss of voltage check	LOVPTUV	1MRK005912-GA	7	1		
Radial feeder protection	PAPGAPC	1MRK005912-HA	8	0-1		

Table 147. Frequency protection

Position	1	2	3	4
E				00

Table 148. Frequency functions

Function	Function identification	Ordering no	position	Available qty	Selected qty	Notes and rules
Underfrequency protection	SAPTUF	1MRK005914-AA	1	0-2		
Overfrequency protection	SAPTOF	1MRK005914-BA	2	0-2		
Rate-of-change frequency protection	SAPFRC	1MRK005914-CA	3	0-2		

Table 149. Multipurpose protection

Position	1
F	

Table 150. Multipurpose functions

Function	Function identification	Ordering no	Position	Available qty	Selected Qty	Notes and rules
General current and voltage protection	CVGAPC	1MRK005915-AA	1	0-4		

Table 151. General calculation

Position	1
S	

Table 152. General calculation functions

Function	Function identification	Ordering no	Position	Available qty	Selected qty	Notes and rules
Frequency tracking filter	SMAIHPAC	1MRK005915-KA	1	0-6		

Table 153. Secondary system supervision

Position	1	2	3
G			

Table 154. Secondary system supervision functions

Function	Function identification	Ordering no	Position	Available qty	Selected qty	Notes and rules
Current circuit supervison	CCSSPVC	1MRK005916-AA	1	0-2		
Fuse failure supervision	FUFSPVC	1MRK005916-BA	2	0-3		
Fuse failure supervision based on voltage difference	VDSPVC	1MRK005916-CA	3	0-2		

Table 155. Control

Position	1	2	3	4	5	6	7	8	9	10	11
H		0		0			0	0	0	0	0

Table 156. Control functions

Function	Function identification	Ordering no	Position	Available qty	Selected Qty	Notes and rules
Synchrocheck, energizing check and synchronizing	SESRSYN	1MRK005917-AA	1	0-2		
Autorecloser	SMBRREC	1MRK005917-BA	3	0-4		
Apparatus control for single bay, max 8 app. (1CB) incl. Interlocking	APC8	1MRK005917-AX	5	0-1		**Note**: Only one Apparatus control can be ordered.
Apparatus control for single bay, max 15 app. (2CBs) incl. Interlocking	APC15	1MRK005917-BX	6	0-1		

Table 157. Scheme communication

Position	1	2	3	4	5	6	7	8
K					1			

Table 158. Scheme communication functions

Function	Function identification	Ordering no	Position	Available qty	Selected qty	Notes and rules
Scheme communication logic for distance or Overcurrent protection	ZCPSCH	1MRK005920-AA	1	0-1		Note: Only one of (ZCPSCH/ ZC1PPSCH) can be ordered
Phase segregated Scheme communication logic for distance protection	ZC1PPSCH	1MRK005920-BA	2	0-1		
Current reversal and weak-end infeed logic for distance protection	ZCRWPSCH	1MRK005920-CA	3	0-1		Note: Only one of (ZCRWSCH/ ZC1WPSCH) can be ordered
Current reversal and weak-end infeed logic for phase segregated communication	ZC1WPSCH	1MRK005920-DA	4	0-1		
Local acceleration logic	ZCLCPSCH	1MRK005920-EA	5	1		
Scheme communication logic for residual overcurrent protection	ECPSCH	1MRK005920-FA	6	0-1		
Current reversal and weakend infeed logic for residual overcurrent protection	ECRWPSCH	1MRK005920-GA	7	0-1		
Direct transfer trip	DTT	1MRK005921-AX	8	0-1		

Table 159. Logic

Position	1	2
L		

Table 160. Logic functions

Function	Function identification	Ordering no	Position	Available qty	Selected qty	Notes and rules
Configurable logic blocks Q/T		1MRK005922-ML	1	0-1		
Extension logic package		1MRK005922-AX	2	0-1		

Table 161. Monitoring

Position	1	2
M		1

Table 162. Monitoring functions

Function	Function identification	Ordering no	Position	Available qty	Selected qty	Notes and rules
Circuit breaker condition monitoring	SSCBR	1MRK005924-HA	1	0-6		
Fault locator	LMBRFLO	1MRK005925-XA	2	1		

Table 163. Station communication

Position	1	2
P		

Table 164. Station communication functions

Function	Function identification	Ordering no	Position	Available qty	Selected qty	Notes and rules
Process Bus communication IEC 61850-9-2		1MRK005930-TA	1	0-6		**Note**: REL670 customized qty = 0, REL670 61850-9-2 qty = 6
IEC 62439-3 parallel redundancy protocol	PRP	1MRK002924-YB	2	0-1		**Note**: Not valid in REL670 61850-9-2 LE product **Note**: Requires 2–channel OEM

Table 165. Language selection

First local HMI user dialogue language	Selection		Notes and Rules
HMI language, English IEC	B1		
Additional HMI language			
No additional HMI language		X0	
HMI language, English US		A12	
Selected	B1		

Table 166. Casing selection

Casing	Selection	Notes and Rules
1/2 x 19" case	A	
3/4 x 19" rack case 1 TRM slot	B	
3/4 x 19" case 2 TRM slots	C	
1/1 x 19" rack case 1 TRM slot	D	
1/1 x 19" case 2 TRM slots	E	
Selected		

Table 167. Mounting selection

Mounting details with IP40 of protection from the front	Selection	Notes and Rules
No mounting kit included	X	
19" rack mounting kit for 1/2 x 19" case of 2xRHGS6 or RHGS12	A	
19" rack mounting kit for 3/4 x 19" case or 3xRGHS6	B	
19" rack mounting kit for 1/1 x 19" case	C	
Wall mounting kit	D	Note: Wall mounting not recommended with communication modules with fibre connection (SLM, OEM, LDCM)
Flush mounting kit	E	
Flush mounting kit + IP54 mounting seal	F	
Selected		

Table 168. Connection type and power supply

Connection type for Power supply modules, and Input/Output modules	Selection		Notes and Rules
Compression terminals	K		
Ringlug terminals	L		
Auxiliary power supply			
Power supply module 24-60 VDC		A	
Power supply module 90-250 VDC		B	
Selected			

Table 169. Human machine interface selection

Human machine hardware interface	Selection	Notes and Rules
Medium size - graphic display, IEC keypad symbols	B	
Medium size - graphic display, ANSI keypad symbols	C	
Selected		

Table 170. Analog system selection

Analog system	Selection				Notes and Rules
No first TRM included	X0				**Note**: Only valid for REL670–N00
Compression terminals	A				**Note**: only the sametype of TRM (Compression or Ringlug) can be selected in the same terminal.
Ringlug terminals	B				
First TRM 9I+3U 1A, 100/220V, 50/60Hz		3			
First TRM 9I+3U 5A, 100/220V, 50/60Hz		4			
First TRM 5I, 1A+4I, 5A+3U, 100/220V, 50/60Hz		5			
First TRM 6I+6U 1A, 100/220V, 50/60Hz		6			
First TRM 6I+6U 5A, 100/220V, 50/60Hz		7			
First TRM 7I+5U 1A, 100/220V, 50/60Hz		12			
First TRM 7I+5U 5A, 100/220V, 50/60Hz		13			
First TRM 6I, 5A + 1I, 1A + 5U, 110/220V, 50/60Hz		14			
First TRM 3I, 5A + 4I, 1A + 5U, 110/220V, 50/60Hz		15			
First TRM 3I, 5A + 3I, 1A + 6U, 110/220V, 50/60Hz		16			
First TRM 3IM, 1A + 4IP, 1A + 5U, 110/220V, 50/60Hz		17			
First TRM 3IM, 5A + 4IP, 5A + 5U, 110/220V, 50/60Hz		18			
No second TRM included			X0		
Compression terminals			A		
Ringlug terminals			B		
Second TRM 9I+3U 1A, 100/220V, 50/60Hz				3	
Second TRM 9I+3U 5A, 100/220V, 50/60Hz				4	
Second TRM 5I, 1A+4I, 5A+3U, 100/220V, 50/60Hz				5	
Second TRM 6I+6U 1A, 100/220V, 50/60Hz				6	
Second TRM 6I+6U 5A, 100/220V, 50/60Hz				7	
Second TRM 6I 1A, 50/60Hz				8	
Second TRM 6I 5A, 50/60Hz				9	
Second TRM 7I+5U 1A, 100/220V, 50/60Hz				12	
Second TRM 7I+5U 5A, 100/220V, 50/60Hz				13	
Second TRM 6I, 5A + 1I, 1A + 5U, 110/220V, 50/60Hz				14	
Second TRM 3I, 5A + 4I, 1A + 5U, 110/220V, 50/60Hz				15	
Second TRM 3I, 5A + 3I, 1A + 6U, 110/220V, 50/60Hz				16	
Second TRM 3IM, 1A + 4IP, 1A + 5U, 110/220V, 50/60Hz				17	
Second TRM 3IM, 5A + 4IP, 5A + 5U, 110/220V, 50/60Hz				18	
Selected					

Table 171. Maximum quantity of I/O modules

When ordering I/O modules, observe the maximum quantities according to tables below.
Note: Standard order of location for I/O modules is BIM-BOM-SOM-IOM-MIM from left to right as seen from the rear side of the IED, but can also be freely placed.
Note: Maximum quantity of I/O modules depends on the type of connection terminals.
Note: When ordering I/O modules, observe the maximum quantities according to the table below

Case sizes	BIM	IOM	BOM/ SOM	MIM	Maximum in case
1/1 x 19”, one (1) TRM	14	6	4	4	14 (max 4 BOM+SOM+MIM)
1/1 x 19”, two (2) TRM	11	6	4	4	11 (max 4 BOM+SOM+MIM)
3/4 x 19”, one (1) TRM	8	6	4	4	8 (max 4 BOM+SOM+1 MIM)
3/4 x 19”, two (2) TRM	5	5	4	4	5 (max 4 BOM+SOM+1 MIM)
1/2 x 19”, one (1) TRM	3	3	3	1	3

Table 172. Maximum quantity of I/O modules, with ring lug terminals, module limits se above

Case sizes	Maximum in case	Possible locations for I/O modules with ringlug
1/1 x 19”, one (1) TRM	14	P3, P5, P7, P9, P11, P13, P15
1/1 x 19”, two (2) TRM	11	P3, P5, P7, P9, P11
3/4 x 19”, one (1) TRM	8	P3, P5, P7, P9
3/4 x 19”, two (2) TRM	5	P3, P5
1/2 x 19”, one (1) TRM	3	P3

Table 173. Binary input/output module selection

Binary input/output modules	Selection														Notes and Rules
Slot position (rear view)	X31	X41	X51	X61	X71	X81	X91	X101	X111	X121	X131	X141	X151	X161	Note! Max 3 positions in 1/2 rack, 8 in 3/4 rack with 1 TRM, 5 in 3/4 rack with 2 TRM, 11 in 1/1 rack with 2 TRM and 14 in 1/1 rack with 1 TRM
1/2 Case with 1 TRM	■	■	■												
3/4 Case with 1 TRM	■	■	■	■	■	■	■	■							
3/4 Case with 2 TRM	■	■	■	■	■										
1/1 Case with 1 TRM	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
1/1 Case with 2 TRM	■	■	■	■	■	■	■	■	■	■	■				
No board in slot	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Binary output module 24 output relays (BOM)	A	A	A	A	A	A	A	A	A	A	A	A	A	A	
BIM 16 inputs, RL24-30 VDC, 50 mA	B1	B1	B1	B1	B1	B1	B1	B1	B1	B1	B1	B1	B1	B1	
BIM 16 inputs, RL48-60 VDC, 50 mA	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	
BIM 16 inputs, RL110-125 VDC, 50 mA	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	
BIM 16 inputs, RL220-250 VDC, 50 mA	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	
BIM 16 inputs, 220-250 VDC, 120mA	E2	E2	E2	E2	E2	E2	E2	E2	E2	E2	E2	E2	E2	E2	
BIMp 16 inputs, RL24-30 VDC, 30 mA, for pulse counting	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
BIMp 16 inputs, RL48-60 VDC, 30 mA, for pulse counting	G	G	G	G	G	G	G	G	G	G	G	G	G	G	
BIMp 16 inputs, RL110-125 VDC, 30 mA, for pulse counting	H	H	H	H	H	H	H	H	H	H	H	H	H	H	
BIM 16 inputs, RL220-250 VDC, 30 mA, for pulse counting	K	K	K	K	K	K	K	K	K	K	K	K	K	K	
IOM 8 inputs, 10+2 output, RL24-30 VDC, 50 mA	L1	L1	L1	L1	L1	L1	L1	L1	L1	L1	L1	L1	L1	L1	
IOM 8 inputs, 10+2 output, RL48-60 VDC, 50 mA	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	
IOM 8 inputs, 10+2 output, RL110-125 VDC, 50 mA	N1	N1	N1	N1	N1	N1	N1	N1	N1	N1	N1	N1	N1	N1	
IOM 8 inputs, 10+2 output, RL220-250 VDC, 50 mA	P1	P1	P1	P1	P1	P1	P1	P1	P1	P1	P1	P1	P1	P1	
IOM 8 inputs 10+2 output relays, 220-250 VDC, 110mA	P2	P2	P2	P2	P2	P2	P2	P2	P2	P2	P2	P2	P2	P2	
IOM with MOV 8 inputs, 10-2 output, 24-30 VDC, 30 mA	U	U	U	U	U	U	U	U	U	U	U	U	U	U	
IOM with MOV 8 inputs, 10-2 output, 48-60 VDC, 30 mA	V	V	V	V	V	V	V	V	V	V	V	V	V	V	
IOM with MOV 8 inputs, 10-2 output, 110-125 VDC, 30 mA	W	W	W	W	W	W	W	W	W	W	W	W	W	W	
IOM with MOV 8 inputs, 10-2 output, 220-250 VDC, 30 mA	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
mA input module MIM 6 channels	R	R	R	R	R	R	R	R	R	R	R	R	R	R	

Table 173. Binary input/output module selection, continued

Binary input/output modules	Selection														Notes and Rules
SOM Static output module, 12 outputs, 48-60 VDC	T1	T1	T1	T1	T1	T1	T1	T1	T1	T1	T1	T1	T1	T1	Note: SOM must not to be placed in position nearest to NUM; 1/2 case slot P5, 3/4 case 1 TRM slot P10, 3/4 case 2 TRM slot P7, 1/1 case 1 TRM slot P16, 1/1 case 2 TRM slot P13
SOM static outputs module, 12 outputs, 110-250 VDC	T2	T2	T2	T2	T2	T2	T2	T2	T2	T2	T2	T2	T2	T2	
Selected.															

Table 174. Remote end serial communication selection

Remote end communication, station communication and time synchronization modules	Selection						Notes and Rules
Slot position (rear view)	X312	X313	X302	X303	X322	X323	
Available slots in 1/2, 3/4 and 1/1 case with 1TRM	▮	▮	▮	▮			Note: Max 1 LDCM in 1/2 case
Available slots in 3/4 and 1/1 case with 2 TRM	▮	▮	▮	▮	▮	▮	Note: Max 2 LDCM in 3/4 and 1/1 case
No remote communication board included	X	X	X	X	X	X	
Optical short range LDCM	A	A	A	A	A	A	Note: Max 2 LDCM (same or different type) can be selected **Rule**: if 2 LDCM are selected, always place LDCM modules on the same board to support redundant communication; in P30:2 and P30:3, P31:2 and P31:3 or P32:2 and P32:3
Optical medium range, LDCM 1310 nm	B	B	B	B	B	B	
Optical long range, LDCM 1550 nm	C	C	C	C	C	C	
Galvanic X21 line data communication module	E	E	E	E	E	E	
IRIG-B Time synchronization module	F	F	F	F	F	F	
Galvanic RS485 communication module	G	G	G	G	G	G	
GPS time synchronization module	S	S			S	S	
Selected							

Table 175. Serial communication unit for station communication selection

Serial communication unit for station communication	Selection		Notes and Rules
Slot position (rear view)	X301	X311	
No communication board included	X	X	
Serial SPA/LON/DNP/IEC 60870-5-103 plastic interface	A		
Serial SPA/LON/DNP/IEC 60870-5-103 plastic/glass interface	B		
Serial SPA/LON/DNP/IEC 60870-5-103 glass interface	C		
Optical ethernet module, 1 channel glass		D	
Optical ethernet module, 2 channel glass		E	
Selected.			

23. Ordering for pre-configured IED

Guidelines
Carefully read and follow the set of rules to ensure problem-free order management.
Please refer to the available functions table for included application functions.
PCM600 can be used to make changes and/or additions to the delivered factory configuration of the pre-configured.

To obtain the complete ordering code, please combine code from the tables, as given in the example below.

Example code: REL670 *2.0-A30X00- A02H02-B1A3-AC-KB-B-A3X0-DAB1RGN1N1XXXXXXX-AXFXXX-AX. Using the code of each position #1-12 specified as REL670*1-2 2-3 3 3 3 3 3 3 3 3 3 3 3 3-4 4-5-6-7 7-8-9 9 9 9-10 10 10 10 10 10 10 10 10 10 10-11 11 11 11 11 11-12 12

#	1	-	2		-	3													-	4		-	5	6	-	7		-	8	-
REL670*		-			-														-			-			-			.		-

9				-	10											-	11						-	12	
				-												.							-		

	Position	
SOFTWARE	#1	Notes and Rules
Version number		
Version no	2.0	
Selection for position #1.		

Configuration alternatives		#2	Notes and Rules
Isolated or high impedance earthed systems	A21		
Single breaker, 3-phase tripping	A31		
Multi breaker, 3-phase tripping	B31		
Single breaker, 1-phase tripping	A32		
Multi breaker, 1-phase tripping	B32		
CAP configuration			
ABB standard configuration		X00	
Selection for position #2.			

Software options	#3															Notes and Rules
No option	X00															All fields in the ordering form do not need to be filled in
1Ph high impedance differential protection - 3 blocks	A02															Note: Only for A31/B31/A32/B32
Power swing logic		B03														
Phase segregated scheme communication			B05													Note: Only for A32/B32
Out-of-step protection				B22												Note: Only for A31/B31/A32/B32
Sensitive directional residual overcurrent and power protection					C16											
Directional power protection						C17										
Four step directional negative phase sequence overcurrent protection							C41									
Overexcitation protection, 2 windings								D03								
Frequency protection — line									E02							
General current and voltage protection										F01						
Fuse failure supervision based on voltage difference											G03					
Autorecloser, 1 circuit breaker												H04				Note: H04 only for A31/A32 1 block already included
Autorecloser, 2 circuit breakers												H05				Note: H05 only for B31/B32 2 blocks already included
Apparatus control 8 objects													H07			Note: H07 only for A21/A31/A32. H08 only for B31/B32
Apparatus control 15 objects													H08			
Circuit breaker condition monitoring — 6CB														M15		Note: M15 only for B31 and B32, M17 only for A21, A31 and A32
Circuit breaker condition monitoring — 9CB														M17		
IEC 62439-3 parallel redundancy protocol															P03	
Selection for position #3																

First local HMI user dialogue language	#4		Notes and Rules
HMI language, English IEC	B1		
Additional HMI language			
No additional HMI language		X0	
HMI language, English US		A12	
Selection for position #4.			

Casing	#5	Notes and Rules
1/2 x 19" case	A	
3/4 x 19" case 2 TRM slots	C	
1/1 x 19" case 2 TRM slots	E	
Selection for position #5.		

Mounting details with IP40 of protection from the front	#6	Notes and Rules
No mounting kit included	X	
19" rack mounting kit for 1/2 x 19" case of 2xRHGS6 or RHGS12	A	
19" rack mounting kit for 3/4 x 19" case or 3xRGHS6	B	
19" rack mounting kit for 1/1 x 19" case	C	
Wall mounting kit	D	Note: Wall mounting not recommended with communication modules with fibre connection (SLM, OEM, LDCM)
Flush mounting kit	E	
Flush mounting kit + IP54 mounting seal	F	
Selection for position #6.		

Connection type for Power supply, Input/output and Communication modules	#7		Notes and Rules
Compression terminals	K		
Auxiliary power supply			
24-60 VDC		A	
90-250 VDC		B	
Selection for position #7.			

Human machine hardware interface	#8	Notes and Rules
Medium size - graphic display, IEC keypad symbols	B	
Medium size - graphic display, ANSI keypad symbols	C	
Selection for position #8.		

Analog input system	#9				Notes and Rules
Compression terminals	A				
Ringlug terminals	B				
First TRM, 6I+6U 1A, 100/220V		6			
First TRM, 6I+6U 5A, 100/220V		7			
First TRM, 3I, 5A + 3I, 1A + 6U, 100/220 V		16			Note: Only for A21/A31/A32
No second TRM included			X0		Note: Second TRM only for A31/A32/B31/B32
Compression terminals			A		
Ringlug terminals			B		
Second TRM, 9I+3U 1A, 100/220V				3	
Second TRM, 9I+3U 5A, 100/220V				4	
Second TRM, 5I, 1A+4I, 5A+3U, 100/220V				5	
Second TRM, 6I+6U 1A, 100/220V				6	
Second TRM, 6I+6U 5A, 100/220V				7	
Second TRM, 6I, 1A, 100/220V				8	
Second TRM, 6I, 5A, 100/220V				9	
Second TRM, 7I+5U 1A, 100/220V				12	
Second TRM, 7I+5U 5A, 100/220V				13	
Second TRM, 3I, 5A+3I, 1A+6U, 100/220V				16	Note: Only for A31/A32
Selection for position #9.					

Binary input/output module, mA and time synchronization boards.	#10											Notes and Rules
For pulse counting, for example kWh metering, the BIM with enhanced pulse counting capabilities must be used. Note: 1BIM and 1 BOM included In A31/A32/B31/B32, 1 IOM basic in A21.												
Slot position (rear view)	X31	X41	X51	X61	X71	X81	X91	X101	X111	X121	X131	Note: Max 3 positions in 1/2 rack with 1 TRM, Max 5 positions in 3/4 rack with 2 TRM, Max 11 positions in 1/1 rack with 2 TRM
1/2 Case with 1 TRM	■	■	■									Note: Only 1/2 case for A21.
3/4 Case with 2 TRM	■	■	■	■	■							
1/1 Case with 2 TRM	■	■	■	■	■	■	■	■	■	■	■	
No board in slot	X	X	X	X	X	X	X	X	X	X	X	
Binary output module 24 output relays (BOM)		A	A	A	A	A	A	A	A	A	A	Note: Maximum 4 (BOM+SOM +MIM) boards.
BIM 16 inputs, RL24-30 VDC	B1	B1	B1	B1	B1	B1	B1	B1	B1	B1	B1	Note: X31 only for A31/A32/B31/ B32, X41 only for A21 X51 not in B32
BIM 16 inputs, RL48-60 VDC	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	C1	
BIM 16 inputs, RL110-125 VDC	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	
BIM 16 inputs, RL220-250 VDC	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	
BIM 16 inputs, 220-250 VDC, 120mA	E2	E2	E2	E2	E2	E2	E2	E2	E2	E2	E2	
BIMp 16 inputs, RL24-30 VDC, for pulse counting		F	F	F	F	F	F	F	F	F	F	Note: X41 only for A21 X51 not in B32
BIMp 16 inputs, RL48-60 VDC, for pulse counting		G	G	G	G	G	G	G	G	G	G	
BIMp 16 inputs, RL110-125 VDC, for pulse counting		H	H	H	H	H	H	H	H	H	H	
BIMp 16 inputs, RL220-250 VDC, for pulse counting		K	K	K	K	K	K	K	K	K	K	
IOM 8 inputs, 10+2 output, RL24-30 VDC	L1	L1	L1	L1	L1	L1	L1	L1	L1	L1	L1	Note: X31 and X41 only for A21, X51 not in B32
IOM 8 inputs, 10+2 output, RL48-60 VDC	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	
IOM 8 inputs, 10+2 output, RL110-125 VDC	N1	N1	N1	N1	N1	N1	N1	N1	N1	N1	N1	
IOM 8 inputs, 10+2 output, RL220-250 VDC	P1	P1	P1	P1	P1	P1	P1	P1	P1	P1	P1	
IOM 8 inputs 10+2 output relays, 220-250 VDC, 110mA	P2	P2	P2	P2	P2	P2	P2	P2	P2	P2	P2	
IOM with MOV 8 inputs, 10-2 output, 24-30 VDC	U	U	U	U	U	U	U	U	U	U	U	
IOM with MOV 8 inputs, 10-2 output, 48-60 VDC	V	V	V	V	V	V	V	V	V	V	V	
IOM with MOV 8 inputs, 10-2 output, 110-125 VDC	W	W	W	W	W	W	W	W	W	W	W	
IOM with MOV 8 inputs, 10-2 output, 220-250 VDC	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
mA input module MIM 6 channels		R	R	R	R	R	R	R	R	R	R	Note: Maximum 1 MIM board in 1/2 case. X51 not for B32 X41 only for A21.
SOM Static output module, 12 outputs, 48-60 VDC		T1	T1	T1	T1	T1	T1	T1	T1	T1	T1	No SOM board in slot X51 for 1/2 case, X71 for 3/4 case and X131 for 1/1 case. X41 only for A21. X51 not in B32 Note: SOM must not to be placed in position nearest to NUM; 1/2 case slot P5, 3/4 case 1 TRM slot P10, 3/4 case 2 TRM slot P7, 1/1 case 1 TRM slot P16, 1/1 case 2 TRM slot P13
SOM static outputs module, 12 outputs, 110-250 VDC		T2	T2	T2	T2	T2	T2	T2	T2	T2	T2	
Selection for position #10.												

Remote end communication, DNP serial comm. and time synchronization modules	#11						Notes and Rules
Slot position (rear view)	X312	X313	X302	X303	X322	X323	
Available slots in 1/2 case with 1TRM	■	■	■	■			Note: Max 1 LDCM in 1/2 case
Available slots in 3/4 and 1/1 case with 2 TRM	■	■	■	■	■	■	Note: Max 2 LDCM in 3/4 and 1/1 case
No remote communication board included	X	X	X	X	X	X	
Optical short range LDCM	A	A	A	A	A	A	Note: if 2 LDCM are selected, always place LDCM modules on the same board to support redundant communication; in P30:2 and P30:3, P31:2 and P31:3 or P32:2 and P32:3
Optical medium range, LDCM 1310 nm	B	B	B	B	B	B	
Optical long range, LDCM 1550 nm	C	C	C	C	C	C	
Galvanic X21 line data communication module	E	E	E	E	E	E	
IRIG-B Time synchronization module	F	F	F	F	F	F	
Galvanic RS485 communication module	G	G	G	G	G	G	
GPS time synchronization module	S	S			S	S	
Selection for position #11.							

Serial communication unit for station communication	#12		Notes and Rules
Slot position (rear view)	X301	X311	
No communication board included	X	X	
Serial SPA/LON/DNP/IEC 60870-5-103 plastic interface	A		
Serial SPA/LON/DNP/IEC 60870-5-103 plastic/glass interface	B		
Serial SPA/LON/DNP/IEC 60870-5-103 glass interface	C		
Optical ethernet module, 1 channel glass		D	
Optical ethernet module, 2 channel glass		E	
Selection for position #12.			

24. Ordering for Accessories

Accessories

GPS antenna and mounting details

GPS antenna, including mounting kits	Quantity:	☐	1MRK 001 640-AA
Cable for antenna, 20 m	Quantity:	☐	1MRK 001 665-AA
Cable for antenna, 40 m	Quantity:	☐	1MRK 001 665-BA

Interface converter (for remote end data communication)

External interface converter from C37.94 to G703	Quantity:	1 ☐ 2 ☐	1MRK 002 245-AA
External interface converter from C37.94 to G703.E1	Quantity:	1 ☐ 2 ☐	1MRK 002 245-BA

Test switch

The test system COMBITEST intended for use with the IED 670 products is described in 1MRK 512 001-BEN and 1MRK 001024-CA. Please refer to the website: www.abb.com/substationautomation for detailed information.

Due to the high flexibility of our product and the wide variety of applications possible the test switches needs to be selected for each specific application.

Select your suitable test switch base on the available contacts arrangements shown in the reference documentation.

However our proposals for suitable variants are;

Single breaker/Single or Three Phase trip with internal neutral on current circuits (ordering number RK926 315-AK).

Single breaker/Single or Three Phase trip with external neutral on current circuits (ordering number RK926 315-AC).

Multi-breaker/Single or Three Phase trip with internal neutral on current circuits (ordering number RK926 315-BE).

Multi-breaker/Single or Three Phase trip with external neutral on current circuit (ordering number RK926 315-BV).

The normally open "In test mode" contact 29-30 on the RTXP test switches should be connected to the input of the test function block to allow activation of functions individually during testing.

Test switches type RTXP 24 is ordered separately. Please refer to Section Related documents for references to corresponding documents.

RHGS 6 Case or RHGS 12 Case with mounted RTXP 24 and the on/off switch for dc-supply are ordered separately. Please refer to Section Related documents for references to corresponding documents.

Protection cover

Protective cover for rear side of RHGS6, 6U, 1/4 x 19”	Quantity:	☐	1MRK 002 420-AE
Protective cover for rear side of terminal, 6U, 1/2 x 19”	Quantity:	☐	1MRK 002 420-AC
Protective cover for rear side of terminal, 6U, 3/4 x 19”	Quantity:	☐	1MRK 002 420-AB
Protective cover for rear side of terminal, 6U, 1/1 x 19”	Quantity:	☐	1MRK 002 420-AA

External resistor unit

High impedance resistor unit 1-ph with resistor and voltage dependent resistor for 20-100V operating voltage	Quantity:	1 ☐ 2 ☐ 3 ☐	RK 795 101-MA
High impedance resistor unit 3-ph with resistor and voltage dependent resistor for 20-100V operating voltage	Quantity:	☐	RK 795 101-MB
High impedance resistor unit 1-ph with resistor and voltage dependent resistor for 100-400V operating voltage	Quantity:	1 ☐ 2 ☐ 3 ☐	RK 795 101-CB
High impedance resistor unit 3-ph with resistor and voltage dependent resistor for 100-400V operating voltage	Quantity:	☐	RK 795 101-DC

Combiflex

Key switch for settings

Key switch for lock-out of settings via LCD-HMI	Quantity:	☐	1MRK 000 611-A

Note: To connect the key switch, leads with 10 A Combiflex socket on one end must be used.

Mounting kit			Ordering number
Side-by-side mounting kit	Quantity:	☐	1MRK 002 420-Z

Configuration and monitoring tools

Front connection cable between LCD-HMI and PC	Quantity:	☐	1MRK 001 665-CA
LED Label special paper A4, 1 pc	Quantity:	☐	1MRK 002 038-CA
LED Label special paper Letter, 1 pc	Quantity:	☐	1MRK 002 038-DA

Manuals

Note: One (1) IED Connect CD containing user documentation (Operation manual, Technical manual, Installation manual, Commissioning manual, Application manual and Getting started guide), Connectivity packages and LED label template is always included for each IED.

Rule: Specify additional quantity of IED Connect CD requested.	Quantity:	☐	1MRK 002 290-AD

User documentation

Rule: Specify the number of printed manuals requested

Application manual	IEC	Quantity:		1MRK 506 338-UEN
	ANSI	Quantity:		1MRK 506 338-UUS
Technical manual	IEC	Quantity:		1MRK 506 339-UEN
	ANSI	Quantity:		1MRK 506 339-UUS
Commissioning manual	IEC	Quantity:		1MRK 506 340-UEN
	ANSI	Quantity:		1MRK 506 340-UUS
Communication protocol manual, IEC 61850 Edition 1, 670 series	IEC	Quantity:		1MRK 511 302-UEN
Communication protocol manual, IEC 61850 Edition 2, 670 series	IEC	Quantity:		1MRK 511 303-UEN
Communication protocol manual, IEC 60870-5-103, 670 series	IEC	Quantity:		1MRK 511 304-UEN
Communication protocol manual, LON, 670 series	IEC	Quantity:		1MRK 511 305-UEN
Communication protocol manual, SPA, 670 series	IEC	Quantity:		1MRK 511 306-UEN
Communication protocol manual, DNP, 670 series	ANSI	Quantity:		1MRK 511 301-UUS
Point list manual, DNP 670 series	ANSI	Quantity		1MRK 511 307-UUS
Operation manual, 670 series	IEC	Quantity:		1MRK 500 118-UEN
	ANSI	Quantity:		1MRK 500 118-UUS
Installation manual, 670 series	IEC	Quantity:		1MRK 514 019-UEN
	ANSI	Quantity:		1MRK 514 019-UUS

Engineering manual, 670 series	IEC	Quantity:	☐	1MRK 511 308-UEN
	ANSI	Quantity:	☐	1MRK 511 308-UUS
Cyber security guideline	IEC	Quantity:	☐	1MRK 511 309-UEN

Reference information

For our reference and statistics we would be pleased to be provided with the following application data:

Country: End user:

Station name: Voltage level: kV

Related documents

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

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

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