

# Digital Protection Relays



# SYMAP<sup>®</sup>

SYMAP<sup>®</sup> - BC

**CURRENT**

298

A, kA, %

**VOLTAGE**

10.0

V, kV, %

**POWER**

3.84

kW, MW, %

**FREQ. / PF**

0.82

cos φ, Hz

METERS OVERVIEW

I1:	256	I2:	256	[A]
I3:	256	Io:	0	
U12:	10000	U23:	10000	[V]
U31:	10000	Vo:	0	

P : 3636 kW  
Q : 2538 kvar  
F : 60 Hz  
PF: 0.82 cos Phi

4120 kWh  
1988 kvarh

10.0kV

Loc31 Remote

ACK

EMSTOP

F1 METERS

F2 ALARMS

F3 PROCESS

F4

TRIP

ALARM

READY

COM.

SYS. CHECK

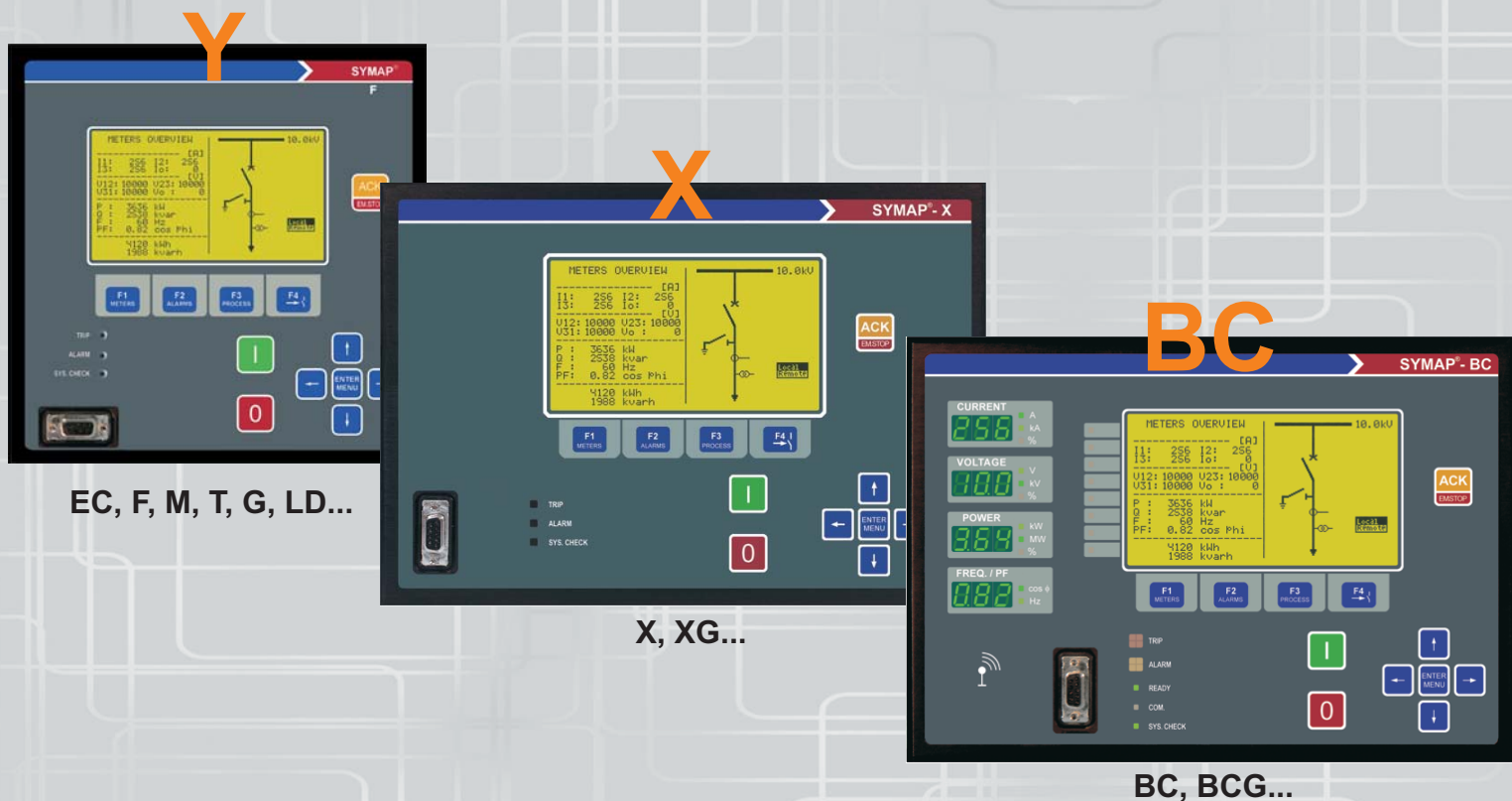
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ENTER MENU

**FOR LOW, MEDIUM AND HIGH VOLTAGES POWER SYSTEMS**

# SYMAP®



EC, F, M, T, G, LD...

X, XG...

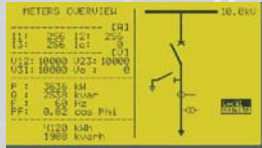
BC, BCG...

## Product Overview

SYMAP® is a digital protection relay for use in low, medium, and high-voltage power systems. Because of its integrated protection functions and human-machine interface capabilities, it is an efficient and cost-effective solution for all types of switchbays. With three powerful microprocessors, SYMAP® offers complete protection functions for generators, motors (synchronous and asynchronous), transformers, power lines, and distributions. All protection functions can be activated simultaneously, and there are no limits to using all of them at the same time.

With SYMAP®, five main breaker controls can be activated with all the necessary functions, such as display, control, and blocking, for optimal breaker management. A small integrated PLC allows individual interlocks from controlling functions. For flexibility in commissioning and during use, both digital and analog outputs can be used to connect the SYMAP® control unit to main switchboard controls. Additionally, a variety of serial interfaces with different kinds of protocols can be used for communication between SYMAP® units and the central control system.

For diagnostics and monitoring, SYMAP® has three microprocessors that supervise each other, providing a watchdog system. Important functions are laid out in a double redundancy combination, operating independently with the second processor. Connected separately, an optional unit for short circuit protection operates parallel to the SYMAP® device and will do so even if the entire voltage fails.



# Human Machine Interface(HMI)

SYMAP® is easy to program and operate. A large graphic LCD with optional LED indicators conveys important data, such as position of all connected breakers, parameter settings, and event histories, at a glance. Graphics and measurements are displayed side-by-side on the LCD, so that the user does not have to switch between pages.

The entire programming of SYMAP® can be done with the keys on its front panel, eliminating the use of external programming devices. The programming is built in and is menu-tree driven, making setting parameters an intuitive process - similar to inputting data in a modern handheld telephone. Optionally, parameters can also be programmed using a laptop computer. Using a laptop offers certain advantages, such as parameter data stored in the laptop can be easily input into other SYMAP® units. Either way, ease of programming is guaranteed and on-site visits by the manufacturer's engineers during commissioning are not required.

SYMAP® provides four hotkeys under the LCD offering access to four groups of values:

- "Meters,"
- "Alarm,"
- "Process," and
- "Breaker Control."

The user can press the hotkeys to scroll through pages of information pertaining to these values.

Under the hotkey "Meters," detailed information of electric measurement values, counters for active and reactive power, and of working hours is provided. Under the hotkey "Alarms," all active alarms, event stores, and blockings are displayed. Under "Process," all process data, such as synchronization display, motor thermal indication, and breaker counters, are shown.

Under "Breaker Control," up to five breakers can be accessed and controlled. When programming breaker controls, the user has access to various layout configurations available through a library of graphics maintained within SYMAP®. Programmed blockings remain active when manual control of the breaker is used. Each of the highlighted breakers in the LCD can be further controlled by the keys "O" and "I."

For security, access to SYMAP®'s parameter and breaker control data is protected by a code system. The code system offers dual access: by a transponder card or by password input.



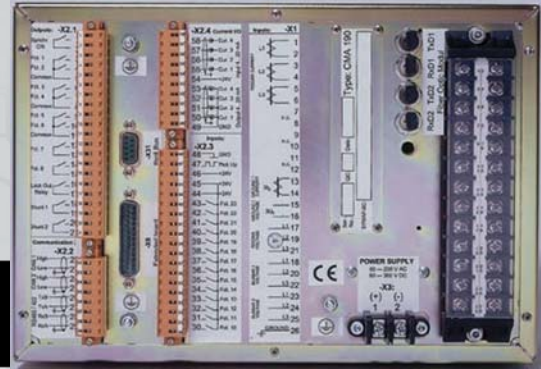
## Terminal Connection

All connections to SYMAP® are made with terminal plugs on the back of the device, allowing the device to be exchanged easily. The terminal blocks are divided into the following groups:

- Analog input for measurement
- Additional analog channels
- Digital inputs and outputs



- Communication interfaces
- Extended board (optional)



## Analog Input for Measurement

SYMAP<sup>®</sup> provides inputs for analog sensors at the rear of the device. If terminal plugs for the Cts are disconnected, the circuits will be linked automatically so there is no disconnection in the CT circuit loops. A total of 17 analog inputs for current and voltage transformers are used for protection functions. The following list shows possible connections for current transformers (CT) and potential transformers (PT):

- 3 x CT for feeder current
- 3 x CT for differential current
- 2 x CT for ground current
- 3 x PT for feeder voltage
- 3 x PT for bus bar 1 voltage
- 3 x PT for bus bar 2 voltage
- 2 x PT for ground voltage

By use of combined sensors, SYMAP<sup>®</sup> can provide:

- 3 x for feeder current
- 3 x for feeder voltage

## Communication

SYMAP<sup>®</sup> can serve as the main bay controller for the power management system or substation system. The following list shows the station system items available through SYMAP<sup>®</sup>:

- Remote supervision
- Remote control
- Remote parameter setting
- Central registration of measured and calculated values
- Central event logging
- Central fault recording, analysis and logging
- Plant power management

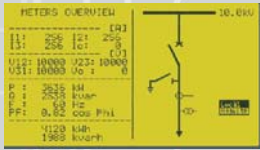
## Communication Interfaces

- RS 232 on the front panel for programming and data output
- 2 CANBUS
- RS 422/485 port
- MODEM
- IEC 60870-5-103
- MODBUS
- PROFIBUS DP

## Extended Board (Optional)

An extended board can be connected to SYMAP<sup>®</sup>, providing additional in and output channels. The extended board is customized to individual client requirements and can be equipped to a maximum of the following in and output channels:

- 36 digital inputs
- 24 relay outputs
- 8 analog outputs 4...20 mA
- 21 analog inputs PT 100 / PT 1000 or analog inputs 4 - 20mA



## Recording Unit

SYMAP<sup>®</sup>'s recording unit contains up to three separate parts:

- 1) event history
- 2) detailed protection function history
- 3) measure data recorder (optional).

All data recorded by the unit can be transferred and analyzed via a PC tool. And, regardless of power supply, the data store is permanent. SYMAP<sup>®</sup>'s data recording unit stores the following:

- Protection function events, such as activation and eventual intervention
- The change of binary inputs and outputs
- The control of Local/Remote/Scada
- The change of each switching device
- On-Off commands through central power management system
- Every attempt or trail to give a command prohibited by interlocking
- Every alarm signal (also from diagnostics)
- Data logs for measurement inputs

## Event History

SYMAP<sup>®</sup> automatically collects and stores all activated events with their number, title, appearing and disappearing status, and a time stamp. A maximum of 5,000 events can be stored. In case of overflow, the oldest data will be recorded over.

## Detailed Protection Function History

SYMAP® automatically collects and stores all activated events related to protection functions with a time stamp.

- Event number
- Event title
- Time stamp
- Pickup or trip value (with fault phase indication)
- Setting value
- Trip time
- 3-line voltage and current pickup, synchronized with the trip event

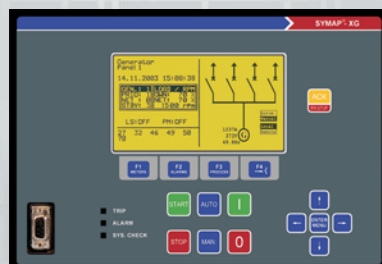
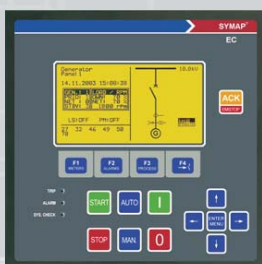
A maximum of 1,000 protection function events can be stored. In case of overflow, the oldest data will be recorded over.

## Data Recorder (Optional)

The data recorder can log 16 analog inputs, 14 digital inputs and 12 digital outputs. The recorder has the following settings:

- Recorder on/off
- Number of samples per cycle (6, ..., 72)
- Recording period (5s – 60 s)
- Pre-trigger (0 % – 100 %)

The recording period depends on the number of samples. The recorder can be set with the pre-trigger in such a way as to record event data even before the event happens. Stopping the recorder can be triggered either by an event or by a preset time. For easier management and troubleshooting, event data can be transferred and analyzed via a PC tool. The transfer of data is made by a link through a plug on the front panel of the SYMAP® device..





# Protection Functions

SYMAP® provides the protection functions shown in accordance to ANSI. The protection functions are based on IEC rules.

- 15 ..... Matching device
- 24 ..... Overexcitation, volts / hertz
- 25/A ..... Automatic synchronizing
- 27 ..... Undervoltage, instantaneous, definite time
- 27B ..... Bus 1 undervoltage, definite time
- 32 ..... Overload relay
- 37 ..... Undercurrent
- 40/Q ..... Loss of field
- 46 ..... Reverse phase or phase balance current
- 47 ..... Phase sequence voltage
- 49 ..... Thermal overload protection
- 50BF ..... Circuit-breaker failure
- 50 ..... Overcurrent, instantaneous
- 50G/N ..... Current earth fault, instantaneous
- 51 ..... AC time overcurrent, definite time, IDMT
- 51G ..... AC ground overcurrent, definite time, IDMT
- 51LR ..... Locked rotor
- 51VR ..... Voltage restrained overcurrent
- 59 ..... Overvoltage relay, instantaneous, definite-time, normal inverse
- 59B ..... Bus overvoltage, definite time, IDMT
- 59N ..... Residual overvoltage
- 64 ..... Ground overvoltage
- 66 ..... Start inhibit
- 67 ..... AC directional overcurrent, definite time, IDMT
- 67GS/D ..... AC directional earth fault, definite time
- 78 ..... Vector surge supervision
- 78S ..... Out-of-step tripping
- 79 ..... Auto reclosing
- 81 ..... Frequency supervision
- 81B ..... Bus frequency supervision
- 86 ..... Electrical lock out
- 87M ..... Motor differential
- 87G ..... Generator differential
- 87T ..... Transformer differential
- 87LD ..... Line differential
- 87N ..... Restrict earth-fault relay
- 90 ..... Voltage regulating
- 94 ..... Trip circuit supervision
- 95i ..... Inrush blocking
- FF ..... Fuse failure (voltages)





# SYMAP<sup>®</sup> Digital Protection Devices

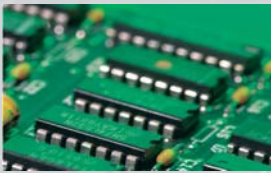
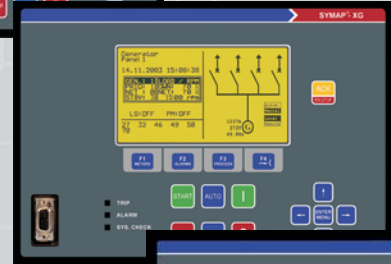
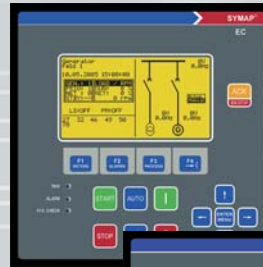
There are three series of SYMAP<sup>®</sup> units as follows:

## SYMAP<sup>®</sup> - Y Essential cost series

- EC - ENGINE CONTROL
- F - FEEDER
- M - MOTOR
- T - TRANSFORMER
- G - GENERATOR
- LD - LINE DIFFERENTIAL

## SYMAP<sup>®</sup> - X Basic series

## SYMAP<sup>®</sup> - BC Basic series expanded to include LED indicators, event data recorder, extended board, Power management, and diesel control



## Technical Data

Description (Y, X, BC)	Condition / Characteristics	
Dimension (w x h x d) (mm)	192x192x110; 279x192x110; 279 × 192 × 150	
Weight	2,3kg ; 3,2kg; 5 kg	
Power supply	12-36 V DC, 36-72 V DC, 80-300 V DC or 60-230 V AC	
Power consumption	< 30 W	
Ambient condition	Service temperature	-20 °C to +70°C
	Storage temperature	-40 °C to +70°C
	Transport temperature	-40 °C to +70°C
	Humidity	< 80 %
Degree of protection	Front panel	IP54 (IEC529)
	Terminals	IP10 (IEC529)
Vibration	Standards:	IEC 60068-2-6
	Frequency range:	5 Hz to 100 Hz
	Cross-over frequency:	15,8 Hz; +/- 1,0 mm amplitude to 1 g acceleration
Seismic vibration*	in 3 orthogonal axes (X,Y,Z)	
	Standards:	KWU DWR 1300
	Frequency range:	5 Hz to 100 Hz
	Cross-over frequency:	11,2 Hz; +/- 10,0 mm amplitude to 5 g acceleration
	Sweep rate 5 Hz to 35 Hz:	1 Oct/min
	Sweep rate 35 Hz to 100 Hz:	10 Oct/min
Tests	in 3 orthogonal axes (X,Y,Z)	
	Electromagnetic compatibility Protection functions	EN 55011, EN 61000-4, KERI IEC255, KERI

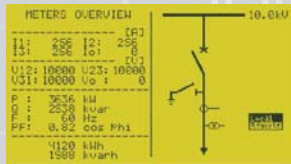




# Hardware capabilities

SYMAP®	Series - Type -	Y						X		BC	
		EC	F	G	M	T	LD	X	XG	BC	BCG
<b>Front panel</b>											
- Graphic-LCD		X	X	X	X	X	X	X	X	X	X
- Keyboard		X	X	X	X	X	X	X	X	X	X
- 7 segment displays		-	-	-	-	-	-	-	-	X	X
- 8 Alarm LEDs		-	-	-	-	-	-	-	-	X	X
- Transponder access		-	-	-	-	-	-	-	-	X	X
<b>COMMUNICATION</b>											
- RS232		X	X	X	X	X	X	X	X	X	X
- PROFIBUS		-	(X)	(X)	(X)	(X)	(X)	X	X	X	X
- CANBUS 1		-	-	-	-	-	-	X	X	X	X
- CANBUS 2		X	-	-	-	-	-	X	X	X	X
- RS485 / RS422		-	(X)	(X)	(X)	(X)	(X)	X	X	X	X
- IEC 60870-5-103, RS485		X	X	X	X	X	X	X	X	X	X
- MODEM (analog)		X	-	-	-	-	-	-	-	-	-
- MODEM (ISDN)		X	-	-	-	-	-	-	-	-	-
<b>INPUTS/ OUTPUTS</b>											
- Digital inputs		20	20	20	20	20	20	14	14	14	14
- Digital inputs ext. board		-	-	-	-	-	-	36	36	36	36
- Relay outputs basic unit		16	16	16	16	16	16	12	12	12	12
- Relay outputs ext. board		-	-	-	-	-	-	24	24	24	24
<b>ANALOG I/O 4-20 mA</b>											
- Analog in 4...20 mA		1	1	1	1	1	1	4	4	4	4
- Analog out 4...20 mA		-	1	1	1	1	1	4	4	4	4
- PT100 / PT1000 + ext. converter		-	-	-	8	-	-	4	4	4	4
- PT100 / PT1000 ext. board		-	-	-	-	-	-	21	21	21	21
<b>ANALOG INPUT FOR MEASURING AND PROTECTION</b>											
- Total analog inputs		9	13	13	13	13	13	13	13	17	17
- 3 CT's for FEEDER CURRENT		-	X		X	X	X	X	X	X	X
- 3 Ph.current via combined sens		-	-	-	-	-	-	-	-	X	X
- 3 CT's for DIFF. CURRENT		-	-	-	-	-	-	-	-	X	X
- CT for GROUND CURRENT 1		-	X*	X*	X*	X*	X*	X*	X*	X	X
- CT for GROUND CURRENT 2		-	-	-	-	-	-	-	-	X	X
- 3 PT's for FEEDER VOLTAGE		X	X	X	X	X	X	X	X	X	X
- 3 Ph.voltage via combined sens		-	-	-	-	-	-	-	-	X	X
- 3 PT's for BUS VOLTAGE 1		X	X	X	X	X	X	X	X	X	X
- 3 PT's for BUS VOLTAGE 2		X	X	X	X	X	X	X	X	X	X
- PT for GROUND VOLTAGE 1		-	X*	X*	X*	X*	X*	X*	X*	X	X
- PT for GROUND VOLTAGE 2		-	-	-	-	-	-	-	-	X	X
<b>RECORDING UNIT</b>											
- Data logger		-	-	-	-	-	-	-	-	X	X
- Detailed protection history		X	X	X	X	X	X	X	X	X	X
* : one ground input available: $U_{GND}$ $I_{GND}$											

# Software capabilities



SYMAP®		Series -		Y				X		BC			
-		Type		EC	F	G	M	T	LD	X	XG	BC	BCG
<b>POWER MANAGEMENT MODULES</b>													
- Synchronizing unit		X	X	X	X	X	X	X	X	X	X	X	X
- Load sharing / asymmetrical load ctrl.		-	-	-	-	-	-	-	-	-	X	-	X
- Frequency controller		X	-	-	-	-	-	-	-	-	X	-	X
- Voltage regulator		X	-	-	-	-	-	-	-	-	X	-	X
- Power factor control		-	-	-	-	-	-	-	-	-	X	-	X
- Load controller(big consumer)		-	-	-	-	-	-	-	-	-	X	-	X
- Load depending start/stop (PMS)		-	-	-	-	-	-	-	-	-	X	-	X
- Preferential trip management		-	-	-	-	-	-	-	-	-	X	-	X
- Blackout management		X	-	-	-	-	-	-	-	-	X	-	X
- Diesel control		X	-	-	-	-	-	-	-	-	X	-	X
<b>LOGIC BUILDER UNIT (PLC)</b>													
- Breaker controls / interlocks		X	X	X	X	X	X	X	X	X	X	X	X
- Logic diagrams		X	X	X	X	X	X	X	X	X	X	X	X
<b>PROTECTION RELAYS (ACCORDING TO ANSI DEVICE NUMBERS)</b>													
15	Matching device (motorpoti)	X	-	-	-	-	-	-	-	X	X	X	X
24	Overexcitation protection	-	-	X	X	-	-	-	-	X	X	X	X
25/A	Automatic synchronizing	X	X	X	X	-	-	-	-	X	X	X	X
27	Undervoltage, inst., def. time	X	X	X	X	X	X	X	X	X	X	X	X
27B	Bus undervoltage, def.time	X	X	-	-	X	X	X	X	X	X	X	X
32	Overload relay	-	X	X	X	X	-	-	-	X	X	X	X
37	Undercurrent	-	-	X	X	X	-	-	-	X	X	X	X
40/Q	Loss of field, reac.power, impedance	-	-	-	-	-	-	-	-	X	X	X	X
46	Reverse phase current	-	-	X	X	-	-	-	-	X	X	X	X
47	Phase sequence voltage	X	X	X	X	X	X	X	X	X	X	X	X
49	Thermal overload protection	-	X	X	X	X	-	-	-	X	X	X	X
50BF	Circuit-Breaker failure	-	X	X	X	X	X	X	X	X	X	X	X
50	Overcurrent, instantaneous	-	X	X	X	X	X	X	X	X	X	X	X
50G/N	Current earth fault, instantaneous	-	X	X	X	X	X	X	X	X	X	X	X
51	AC time overcurrent, def.time, IDMT	-	X	X	X	X	X	X	X	X	X	X	X
51G	AC Ground overcurr., def.time, IDMT	-	X	X	X	X	X	X	X	X	X	X	X
51LR	Locked rotor	-	-	-	X	-	-	-	-	X	X	X	X
51VR	Voltage restrained overcurrent	-	-	-	X	-	-	-	-	X	X	X	X
59	Overvoltage, inst.,def.time, norm.inv	X	X	X	X	X	X	X	X	X	X	X	X
59B	Bus overvoltage, def.time	X	X	X	X	X	X	X	X	X	X	X	X
59N	Residual overvoltage	X	X	X	X	X	X	X	X	X	X	X	X
64	Ground overvoltage	X	X	X	X	X	X	X	X	X	X	X	X
66	Start inhibit	-	-	-	X	X	X	X	X	X	X	X	X
67	AC dir. overcurr., def. time, IDMT	-	X	X	X	X	X	X	X	X	X	X	X
67GS/D	AC dir.earth fault, definite time	-	X	X	X	X	X	X	X	X	X	X	X
78	Vector surge supervision	X	-	X	-	-	-	-	-	X	X	X	X
78S	Out of step tripping	-	-	X	-	-	-	-	-	X	X	X	X
79	Auto reclosing	-	X	-	-	-	-	-	-	X	X	X	X
81	Frequency supervision	X	X	X	X	X	X	X	X	X	X	X	X
81B	Bus frequency supervision	X	X	X	X	X	X	X	X	X	X	X	X
86	Electrical lock out	X	X	X	X	X	X	X	X	X	X	X	X
87G/M	Generator/Motor differential	-	-	-	-	-	-	-	-	-	-	X	X
87T	Transformer differential	-	-	-	-	-	-	-	-	-	-	X	X
87LD	Line differential	-	-	-	-	-	-	-	X	-	-	-	-
87N	Restrict earth fault relay	-	-	-	-	-	-	-	-	-	-	X	X
94	Trip circuit supervision	X	X	X	X	X	X	X	X	X	X	X	X
95i	Inrush blocking	-	-	-	-	X	-	-	-	X	X	X	X
-- FF	Fuse failure (voltages)	-	X	X	X	X	X	X	X	X	X	X	X



# Classification Approvals

The SYMAP<sup>®</sup> families have approval from the following classification societies:

- Germanischer Lloyd (GL)
- American Bureau of Shipping (ABS)
- Bureau Veritas (BV)
- Det Norske Veritas (DNV)
- Lloyds Register of Shipping (LR)
- Polish Register of Shipping (PRS)
- Russian Maritime Register of Shipping (RMRS)
- China Classification Society (CCS)
- Nippon Kaiji Kyokai (ClassNK)

## Additional Tests:

- CE
- Deutsche Kraftwerksunion (KWU)
- Korea Electrotechnology Research Institute (KERI)

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