

# Emax air circuit-breakers. The Open M



Emax air circuit-breakers have always been appreciated for their high electrical performances, maximum modularity and standardisation which the all the ranges feature. Their very high safety, quality and rationality features, are the result of absolutely innovative design criteria.



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# Minded.



## Innovative by tradition.

The Emax low voltage air circuit-breakers, designed and manufactured by ABB SACE, are the absolute top available on the market today for all applications for functional and qualitative excellency. Nothing comes about by chance: the long tradition of quality, reliability, and care that ABB SACE has always put into the design and production of its cir-

cuit-breakers are the best guarantee for anyone looking for advanced solutions in absolute peace of mind. Simply pass back over the history of ABB SACE air circuit-breakers to see a long series of success stories - fifty years passed in a constant search for innovative and safe solutions and, above all, always those providing top performances.





# Emax air circuit-breakers. Firm ground for you



Modularity and compactness of Emax air circuit-breakers considerably simplify construction of the switchboards. The accessories are always fitted from the front simply and rapidly, without the need for cabling and in complete safety. The simplicity of these operations means that any personalisation required can be carried out directly by the end customer.



# our solutions.



## **With this choice, there is no choice.**

Whatever the application you have in mind, there is certainly just the apparatus you need for your applications in the ranges of Emax air circuit-breakers.

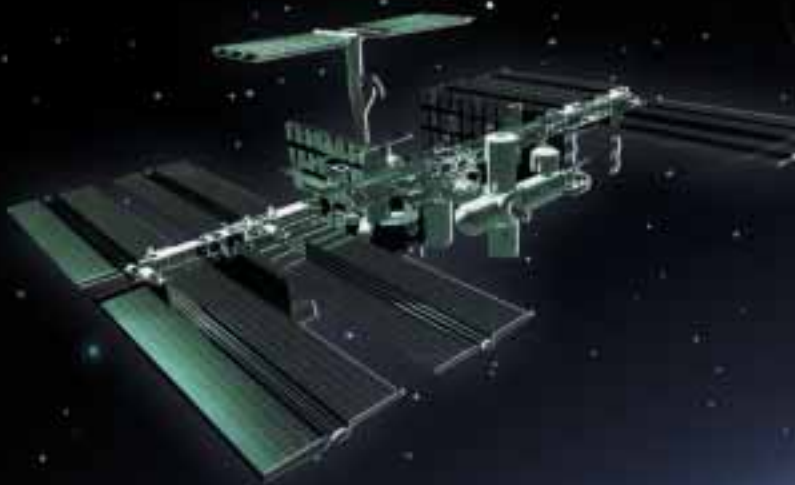
The great appreciation shown by the market for this new series of air circuit-breakers has encouraged introduction of new ranges which go to increase the extensive offer available to date.

The very new 1000V AC/DC switch-disconnectors

up to 4000A go to extend the circuit-breakers for special applications up to 1000V in alternating current. In order to satisfy more specific and up-to-date needs, ABB SACE proposes two new Full Size circuit-breakers with neutral conductor with full cross-section, specifically for applications in installations with high harmonic content due to advanced electronic devices.

# Emax

## Emax air circuit-breakers. The benchmark for you



The high electrical performances of all the Emax ranges go hand in hand with their mechanical and construction characteristics, thought up to provide top quality in all cases. The compactness of Emax air circuit-breakers is the fruit of perfect integration of both their components and performances.



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# ur solutions.



## The strong point - strength.

You can tell Emax air circuit-breakers are solid at a glance. Built with an extremely sturdy metal structure, they deal brilliantly with any dynamic or thermal stresses, making each installation reliable and safe.

Thanks to the materials used, an Emax air circuit-breaker has a much longer mechanical life compared with the other circuit-breakers in its category, and, during



its very long life span, only requires minimum maintenance. As always, ABB SACE stands out for the quality of its products, for the care and attention it pays to all details - both constructional or technological - to offer the market apparatus which always achieves top performance.

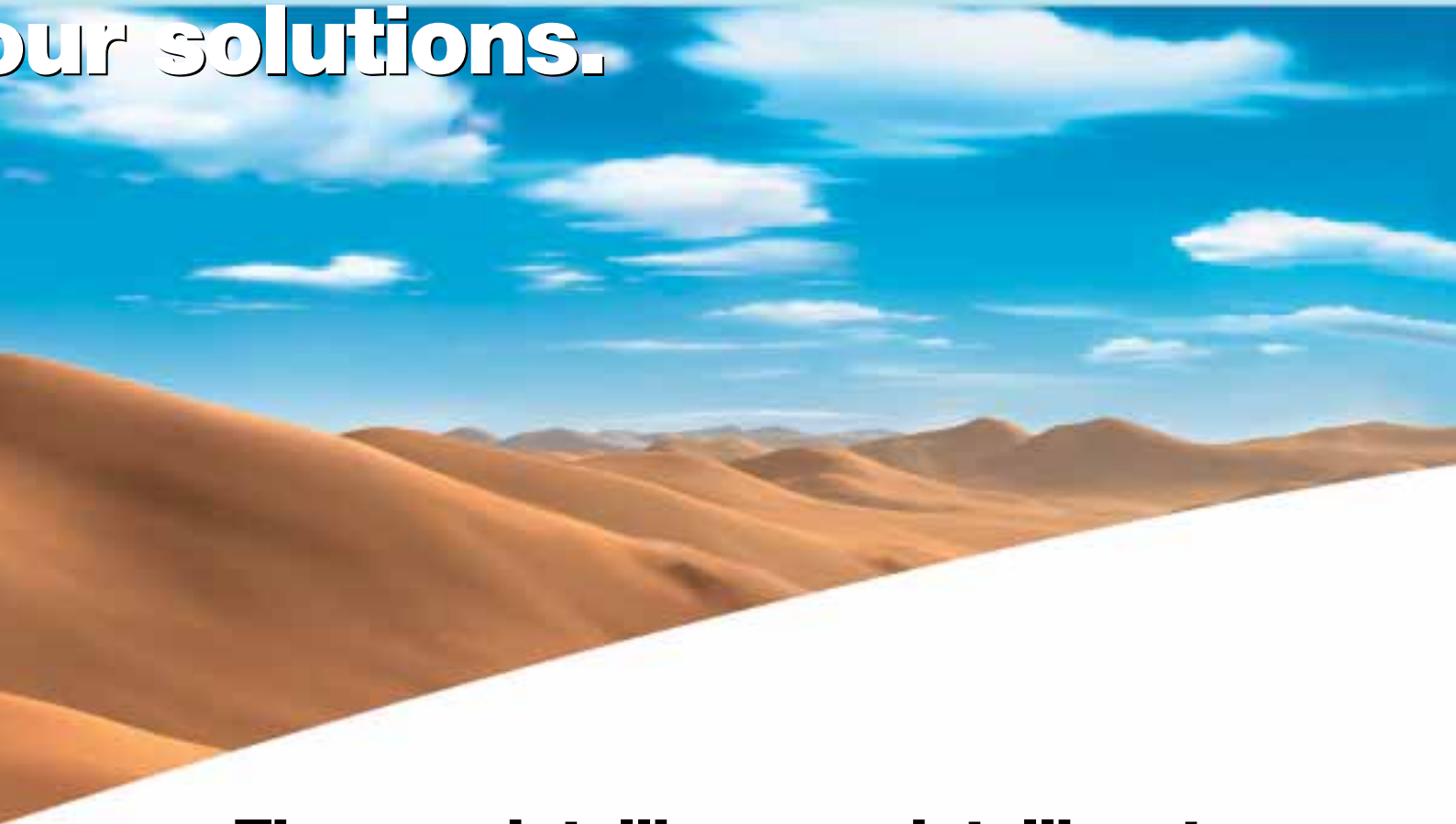
# Emax air circuit-breakers. The finishing line for you

The modern releases Emax can be fitted with make all installations more complete and efficient: the intelligence they are equipped with can carry out many different functions, giving the circuit-breaker high trip precision.





# our solutions.



## The new intelligence - intelligent.

With Emax air circuit-breakers you can always choose the amount of intelligence you need. Like the latest generation PR113 releases, which carry out a complete set of protection, signalling, data storage and control functions. Fitted with a splendid graphic display, these are available both in the protection only and in the protection plus dialogue versions. The PR112 releases have also been improved and new

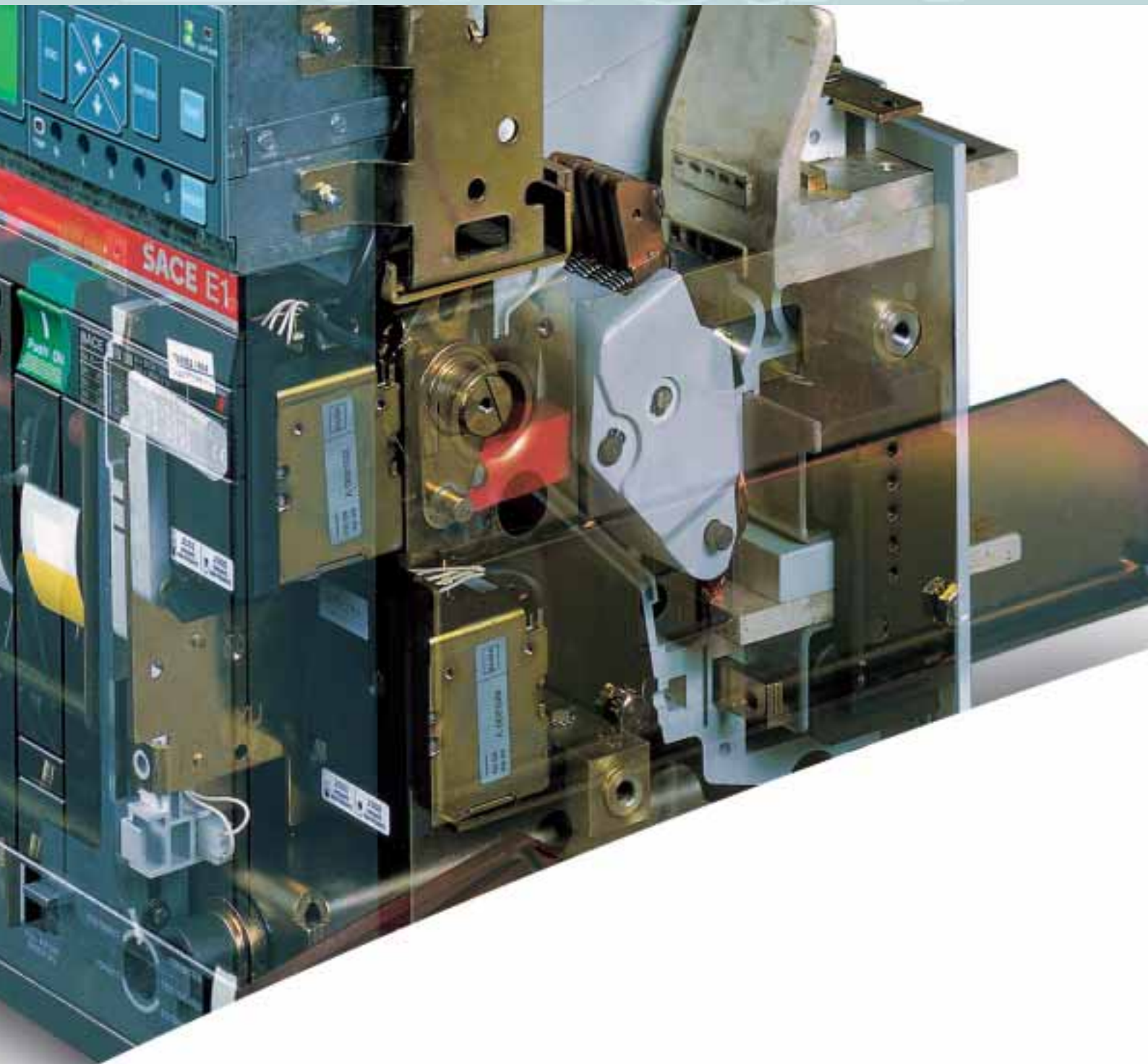
functions have been added, with five languages available to help configure the unit. Moreover, setting protection is carried out using a password.

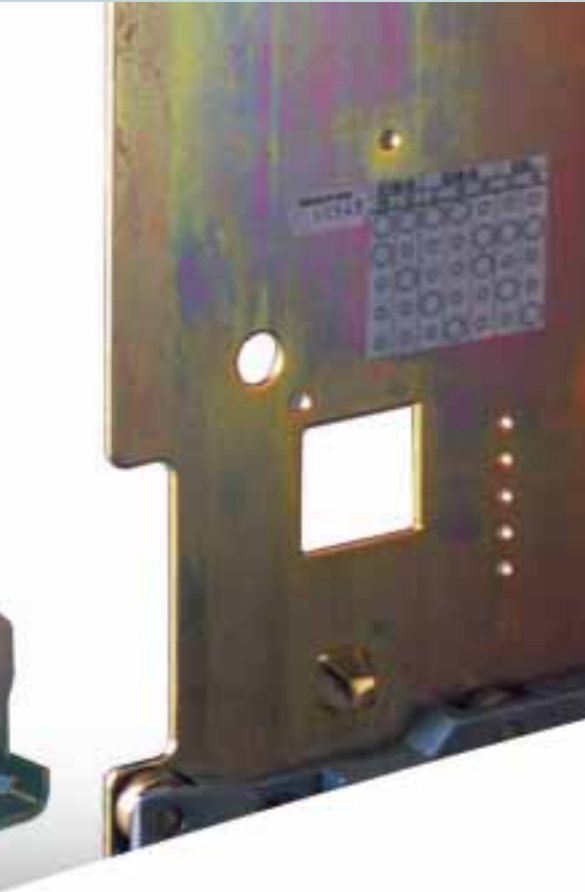
And there are not only protection functions, but also dialogue functions, meaning that these releases are able to communicate with the most advanced automation and control systems, such as the LON<sup>®</sup> and Modbus<sup>®</sup> protocols.





# Emax





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# Overview of the SACE Emax family

## Fields of application

1

		E1		E2		
<b>Automatic circuit-breakers</b>						
		<b>E1B</b>	<b>E1N</b>	<b>E2B</b>	<b>E2N</b>	<b>E2L</b>
Poles	[No.]	3 - 4		3 - 4		
Neutral capacity of 4p circuit-breakers	[% I <sub>n</sub> ]	100		100		
<b>I<sub>u</sub></b> (40 °C)	[A]	800-1250	800-1250	1600-2000	1250-1600-2000	1250-1600
<b>U<sub>e</sub></b>	[V~]	690	690	690	690	690
<b>I<sub>cu</sub></b> (220...415V)	[kA]	42	50	42	65	130
<b>I<sub>cs</sub></b> (220...415V)	[kA]	42	50	42	65	130
<b>I<sub>cw</sub></b> (1s)	[kA]	36	50	42	55	10
(3s)	[kA]	36	36	42	42	-
<b>Automatic circuit-breakers with full-size neutral conductor</b>						
Poles	[No.]	Standard version		Standard version		
Neutral capacity of 4p circuit breakers	[% I <sub>n</sub> ]					
<b>I<sub>u</sub></b> (40 °C)	[A]					
<b>U<sub>e</sub></b>	[V~]					
<b>I<sub>cu</sub></b> (220...415V)	[kA]					
<b>I<sub>cs</sub></b> (220...415V)	[kA]					
<b>I<sub>cw</sub></b> (1s)	[kA]					
(3s)	[kA]					
<b>Switch-disconnectors</b>						
		<b>E1B/MS</b>	<b>E1N/MS</b>	<b>E2B/MS</b>	<b>E2N/MS</b>	
Poles	[No.]	3 - 4	3 - 4	3 - 4	3 - 4	
<b>I<sub>u</sub></b> (40 °C)	[A]	800-1250	800-1250	1600-2000	1250-1600-2000	
<b>U<sub>e</sub></b>	[V~]	690	690	690	690	
<b>I<sub>cw</sub></b> (1s)	[kA]	36	50	42	55	
(3s)	[kA]	36	36	42	42	
<b>I<sub>cm</sub></b> (220...440V)	[kA]	75,6	105	88,2	121	
<b>Automatic circuit-breakers for applications up to 1000 V AC</b>						
				<b>E2B/E</b>	<b>E2N/E</b>	
Poles	[No.]			3 - 4	3 - 4	
<b>I<sub>u</sub></b> (40 °C)	[A]			1600-2000	1250-1600-2000	
<b>U<sub>e</sub></b>	[V~]			1000	1000	
<b>I<sub>cu</sub></b> (1000V)	[kA]			20	30	
<b>I<sub>cs</sub></b> (1000V)	[kA]			20	30	
<b>I<sub>cw</sub></b> (1s)	[kA]			20	30	
<b>Switch-disconnectors for applications up to 1000 V AC</b>						
				<b>E2B/E MS</b>	<b>E2N/E MS</b>	
Poles	[No.]			3 - 4	3 - 4	
<b>I<sub>u</sub></b> (40 °C)	[A]			1600-2000	1250-1600-2000	
<b>U<sub>e</sub></b>	[V~]			1000	1000	
<b>I<sub>cw</sub></b> (1s)	[kA]			20	30	
<b>I<sub>cm</sub></b> (1000V)	[kA]			40	63	
<b>Switch-disconnectors for applications up to 1000 V DC</b>						
		<b>E1B/E MS</b>		<b>E2N/E MS</b>		
Poles	[No.]	3 - 4		3 - 4		
<b>I<sub>u</sub></b> (40 °C)	[A]	800-1250		1250-1600-2000		
<b>U<sub>e</sub></b>	[V~]	750 (3p)-1000(4p)		750 (3p)-1000(4p)		
<b>I<sub>cw</sub></b> (1s)	[kA]	20		25		
<b>I<sub>cm</sub></b> (750V)	[kA]	20		25		
(1000V)	[kA]	20		25		
<b>Sectionalizing truck</b>						
		<b>E1 CS</b>		<b>E2 CS</b>		
<b>I<sub>u</sub></b> (40 °C)	[A]	1250		2000		
<b>Earthing switch with making capacity</b>						
		<b>E1 MTP</b>		<b>E2 MTP</b>		
<b>I<sub>u</sub></b> (40 °C)	[A]	1250		2000		
<b>Earthing truck</b>						
		<b>E1 MT</b>		<b>E2 MT</b>		
<b>I<sub>u</sub></b> (40 °C)	[A]	1250		2000		

E3				E4		E6			
E3N	E3S	E3H	E3L	E4S	E4H	E6H	E6V		
	3 - 4			3 - 4		3 - 4			
	100			50		50			
2500-3200	1250-1600-2000-2500-3200	1250-1600-2000-2500-3200	2000-2500	4000	3200-4000	5000-6300	3200-4000-5000-6300		
690	690	690	690	690	690	690	690		
65	75	100	130	75	100	100	150		
65	75	85	130	75	100	100	125		
65	75	75	15	75	100	100	100		
65	65	65	-	75	75	85	85		
				<b>E4S/f</b>			<b>E6H/f</b>		
Standard version				4			4		
				100			100		
				4000			5000-6300		
				690			690		
				80			100		
				80			100		
				80			100		
				75			85		
<b>E3N/MS</b>	<b>E3S/MS</b>				<b>E4S/MS</b>	<b>E4S/f MS</b>	<b>E4H/MS</b>	<b>E6H/MS</b>	<b>E6H/f MS</b>
3 - 4	3 - 4				3 - 4	4	3 - 4	3 - 4	4
2500-3200	1250-1600-2000-2500-3200				4000	4000	3200-4000	5000-6300	5000-6300
690	690				690	690	690	690	690
65	75				75	80	100	100	100
65	65				75	75	75	85	85
143	165				165	176	220	220	220
<b>E3H/E</b>				<b>E4H/E</b>					
3 - 4				3 - 4					
1250-1600-2000-2500-3200				3200-4000					
1000				1000					
50				65					
50				65					
50				65					
<b>E3H/E MS</b>				<b>E4H/E MS</b>					
3 - 4				3 - 4					
1250-1600-2000-2500-3200				3200-4000					
1000				1000					
50				65					
105				143					
<b>E3H/E MS</b>				<b>E4H/E MS</b>					
3 - 4				3					
1250-1600-2000-2500-3200				3200-4000					
750 (3p)-1000(4p)				750					
40				65					
40				65					
40				-					
<b>E3 CS</b>			<b>E4 CS</b>			<b>E6 CS</b>			
3200			4000			6300			
<b>E3 MTP</b>			<b>E4 MTP</b>			<b>E6 MTP</b>			
3200			4000			6300			
<b>E3 MT</b>			<b>E4 MT</b>			<b>E6 MT</b>			
3200			4000			6300			

## Construction characteristics

### Structure of the circuit-breakers

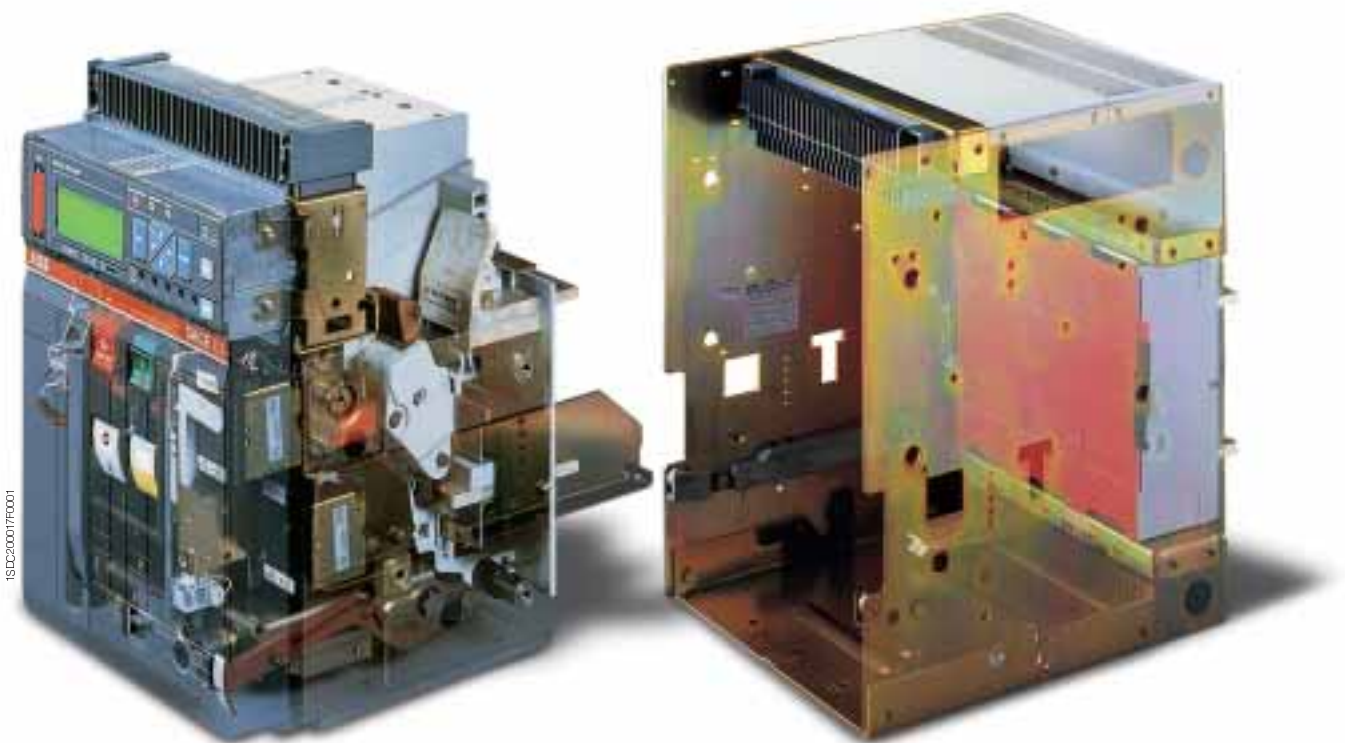
The sheet steel structure of the circuit-breaker is extremely compact, considerably reducing overall dimensions.

Safety is improved by adopting double insulation for the live parts and total segregation between phases.

The sizes have the same height and depth for all of the circuit-breakers in each version.

The depth of the withdrawable version is suitable for installation of switchboards 500 mm deep.

The width of 324 mm (up to 2000 A) in the withdrawable version allows the equipment to be used in switchboard compartments 400 mm wide. The compact dimensions also allow them to replace air circuit breakers of any size from earlier series.





## Construction characteristics

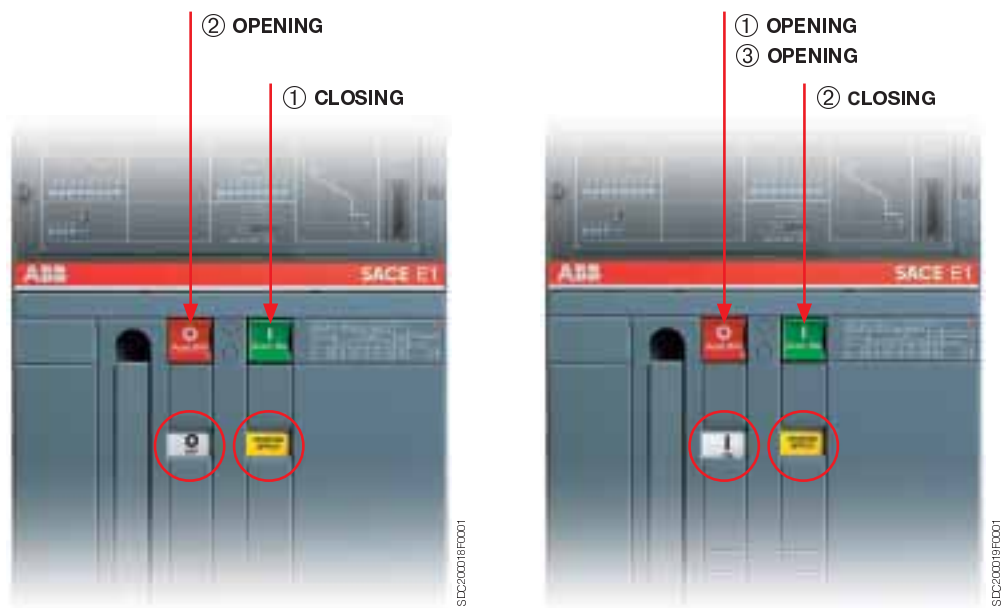
### Operating mechanism

The operating mechanism is of the stored energy type, operated using pre-charged springs.

The springs are charged manually by operating the front lever or using a gearmotor, supplied on request.

The opening springs are charged automatically during the closing operation.

With the operating mechanism fitted with shunt closing and opening releases and the gearmotor for charging the springs, the circuit-breaker can be operated by remote control and, if required, co-ordinated by a supervision and control system.



The following operating cycles are possible without recharging the springs:

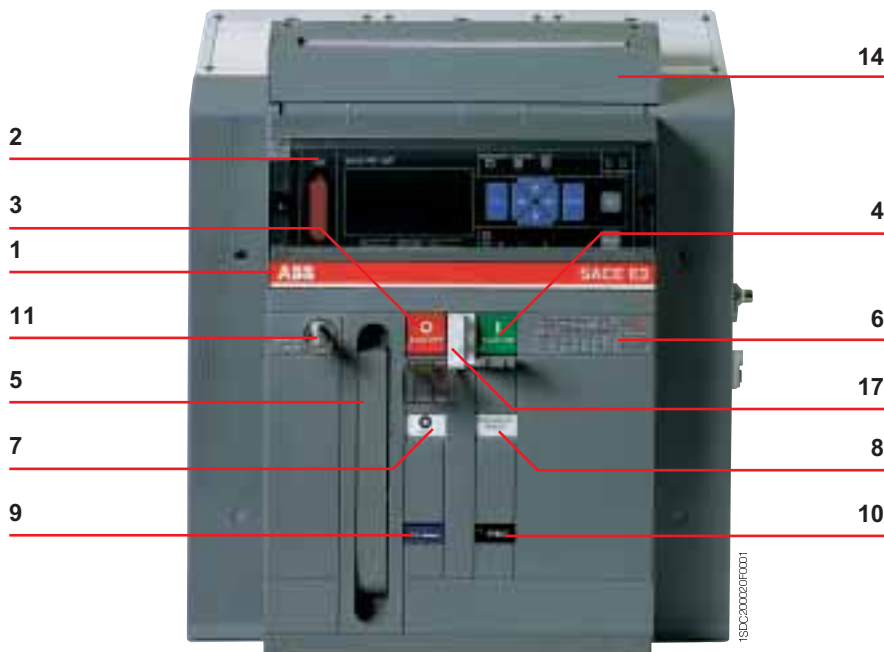
- starting with the circuit-breaker open (0) and the springs charged ■: closing-opening
- starting with the circuit-breaker closed (I) and the springs charged ■: opening-closing-opening.

The same operating mechanism is used for the entire series and is fitted with a mechanical and electrical anti-pumping device.

# Construction characteristics

## Operating and signalling parts

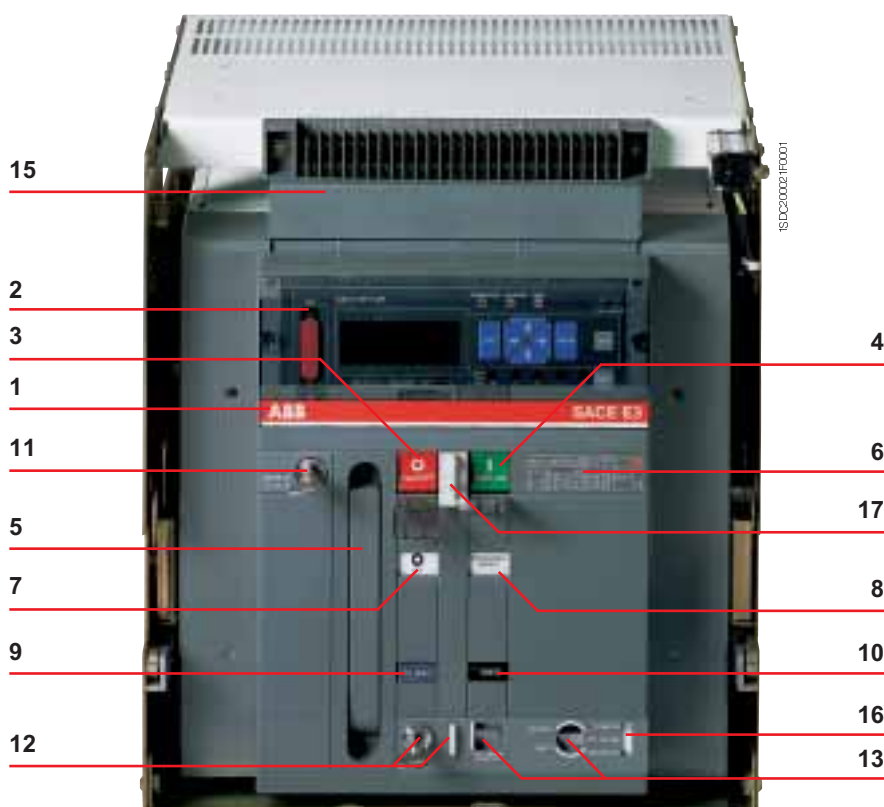
### Fixed version



#### Legend

- |    |   |
|----|---|
| 1  | Trademark and size of circuit-breaker   |
| 2  | SACE PR111, PR112 or PR113 Release  |
| 3  | Pushbutton for manual opening   |
| 4  | Pushbutton for manual closing   |
| 5  | Lever to manually charge closing springs  |
| 6  | Electrical rating plate   |
| 7  | Mechanical device to signal circuit-breaker open "O" and closed "I"   |
| 8  | Signal for springs charged or discharged  |
| 9  | Mechanical signal for protection release tripped  |
| 10 | Operation counter   |
| 11 | Key lock in open position   |
| 12 | Key lock and padlock in racked-in/racked-out position (for withdrawable version only)   |
| 13 | Racking-in/racking out device (for withdrawable version only)   |
| 14 | Terminal box (for fixed version only)   |
| 15 | Sliding contacts (for withdrawable version only)  |
| 16 | Circuit breaker position indicator: racked-in/ test isolated /racked-out / connected/test isolated/disconnected (for withdrawable version only) |
| 17 | Padlock device in open position   |

### Withdrawable version



#### Note:

"Racked-in" refers to the position in which both the power contacts and auxiliary contacts are connected; "racked-out" is the position in which both the power contacts and auxiliary contacts are disconnected; "test isolated" is the position in which the power contacts are disconnected, while the auxiliary contacts are connected.



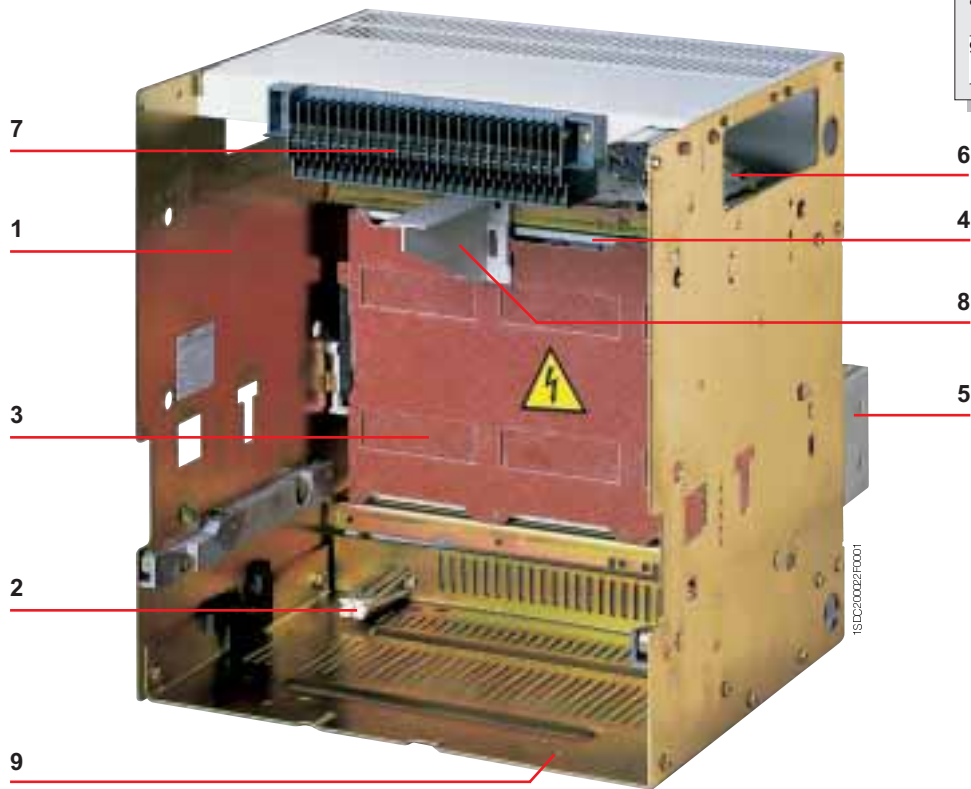
## Construction characteristics

### Fixed parts of withdrawable circuit-breakers

The fixed parts of withdrawable circuit-breakers have shutters for segregating the fixed contacts when the circuit-breaker is withdrawn from the compartment. These can be locked in their closed position using padlock devices.

#### Legend

- 1 Sheet steel supporting structure
- 2 Single earthing clamp mounted on the left for E1, E2 and E3, double earthing clamps for E4 and E6
- 3 Safety shutters (protection rating IP20)
- 4 Terminal support base
- 5 Terminals (rear, front or flat)
- 6 Contacts signalling that the circuit-breaker is racked-in, test isolated, racked-out
- 7 Sliding contacts
- 8 Padlock device for safety shutters (on request)
- 9 Fastening points (4 for E1, E2, E3 and 6 for E4, E6)



# Construction characteristics

## Utilization category

1

### Selective and current-limiting circuit-breakers

**Selective** (non current-limiting) **circuit-breakers** are classified in class B (according to IEC 60947-2 Standard). It is important to know their  $I_{cw}$  values in relation to any possible delayed operations in the event of short-circuits.

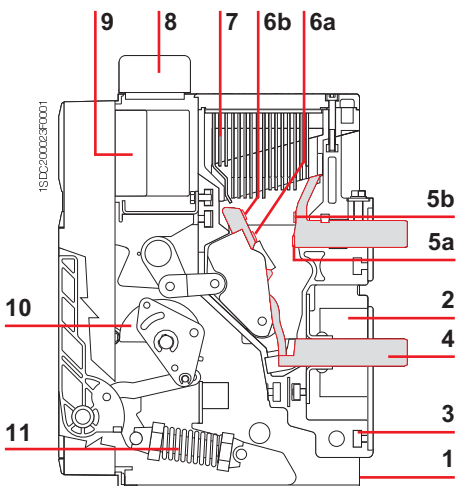
The **current-limiting circuit-breakers** E2L and E3L belong to class A. The short-term current  $I_{cw}$  is not very important for these circuit-breakers, and is necessarily low due to the operating principle on which they are based. The fact that they belong to class A does not preclude the possibility of obtaining the necessary selectivity (e.g. current-type or time-type selectivity) within the  $I_{cw}$  rated short-time withstand current thresholds.

The special advantages of current-limiting circuit-breakers are also worthy of emphasis. Indeed, they make it possible to:

- significantly reduce the peak current in relation to the prospective value;
- drastically limit specific let-through energy.

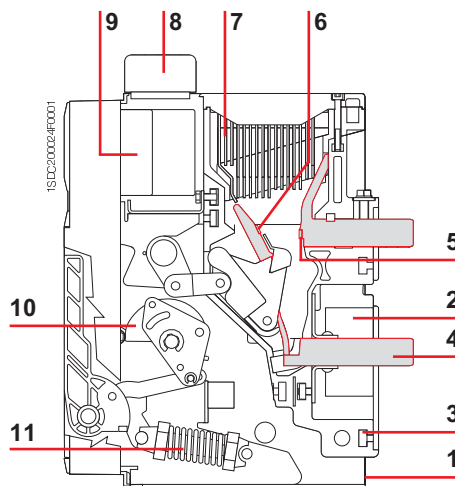
The resultant benefits include:

- reduced electrodynamic stresses;
- reduced thermal stresses;
- savings on the sizing of cables and busbars;
- the possibility of coordinating with other circuit-breakers in the series for back-up or discrimination.



**Selective circuit-breaker**

E1 B-N, E2 B-N, E3 N-S-H, E4 S-H, E6 H-V



**Current-limiting circuit-breaker**

E2 L, E3 L

#### Legend

1	Sheet steel supporting structure
2	Current transformer for protection release
3	Pole group insulating box
4	Horizontal rear terminals
5-5a	Plates for fixed main contacts
5b	Plates for fixed arc-breaking contacts
6-6a	Plates for main moving contacts
6b	Plates for moving arc-breaking contacts
7	Arcing chamber
8	Terminal box for fixed version - Sliding contacts for withdrawable version
9	Protection release
10	Circuit-breaker closing and opening control
11	Closing springs



# Versions and connections

All circuit-breakers are available in fixed and withdrawable, three-pole or four-pole versions.

Each series of circuit-breakers offers terminals made of silver-plated copper bars in the same sizes, regardless of the rated currents of the circuit-breakers.

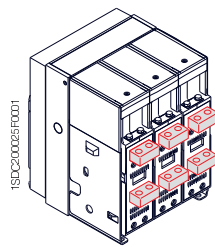
The fixed parts for withdrawable circuit-breakers are common to each model, regardless of the rated current and breaking capacity.

A version with gold-plated terminals is available for circuit breakers that must be used in corrosive environments.

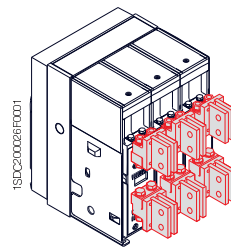
The availability of various types of terminals makes it possible to build wall-mounted switchboards, or switchboards to be accessed from behind with rear connections.

For special installation needs, the circuit-breakers may be fitted with various combinations of upper and lower terminals.

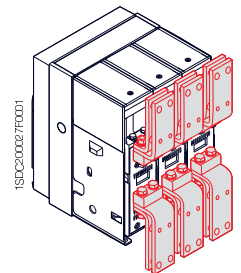
## Fixed circuit-breaker



Horizontal rear terminals

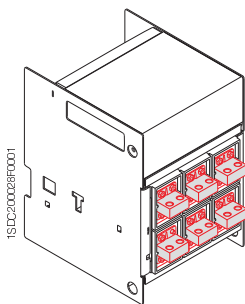


Vertical rear terminals

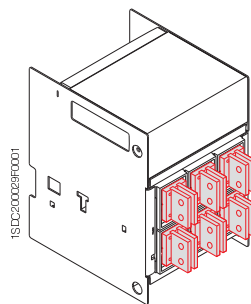


Front terminals

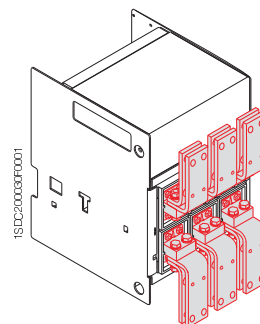
## Withdrawable circuit-breaker



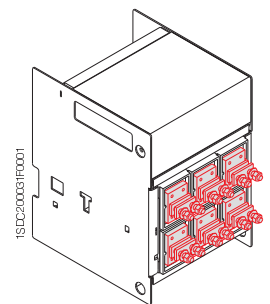
Horizontal rear terminals



Vertical rear terminals



Front terminals



Flat terminals

# Microprocessor-based overcurrent releases

## General specifications

The overcurrent protection for AC installations uses three types of microprocessor-based releases in the SACE PR111, PR112 and PR113 series, which can be installed as alternatives to one another on SACE Emax circuit-breakers:

- SACE PR111 with protection functions only
- SACE PR112 with protection, current measurement and dialogue functions
- SACE PR113 with a complete set of functions for protection, measurement, signalling, control and dialogue.

The protection systems can be three-phase or three-phase with neutral depending on the type of circuit-breaker used (three-pole, three-pole with external neutral or four-pole).

The protection system is made up of:

- 3 or 4 current transformers (CT) depending on the number of circuit-breaker poles; the fourth CT may be external
- a protection unit selected from among SACE PR111/P, SACE PR112/P and SACE PR113/P, or a protection and communication unit selected from among SACE PR112/PD with LON<sup>®</sup> or Modbus<sup>®</sup> protocol and SACE PR113/PD with Modbus<sup>®</sup> protocol
- an opening solenoid which acts directly on the circuit-breaker's operating mechanism (supplied with the protection unit).





# Microprocessor-based overcurrent releases

## Versions available




General specifications of the microprocessor-based releases include:

- operation without the need for an external power supply
- microprocessor technology (8-bit for SACE PR111 and 16-bit for SACE PR112 and PR113)
- high precision
- sensitivity to the true r.m.s. value of the current
- interchangeability among all types of releases
- setting for neutral normally 50% of setting for phases, with possibility of setting it to 100% (on request only for circuit -breakers E1, E2, E3 standard and E4/f, E6/f full-size versions).

For the release PR113, it is also possible to select neutral protection at 150% and 200% of the rated current of the phases, if compatible with the setting of the current transformers.

The main performance features of the releases are listed in the tables below.

1

SACE PR111																					
	<table border="0"> <tr> <td></td> <td style="text-align: center;"><b>PR111/P</b></td> <td style="text-align: center;"><b>PR111/P</b></td> <td style="text-align: center;"><b>PR111/P</b></td> </tr> <tr> <td>Protection</td> <td style="text-align: center;">L S I G</td> <td style="text-align: center;">L S I</td> <td style="text-align: center;">L I</td> </tr> </table>		<b>PR111/P</b>	<b>PR111/P</b>	<b>PR111/P</b>	Protection	L S I G	L S I	L I												
	<b>PR111/P</b>	<b>PR111/P</b>	<b>PR111/P</b>																		
Protection	L S I G	L S I	L I																		
SACE PR112																					
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	<b>PR112/P</b>	<b>PR112/P</b>																			
Protection	L S I G	L S I																			
	<b>PR112/PD Modbus</b>	<b>PR112/PD Modbus</b>	<b>PR112/PD LON</b>	<b>PR112/PD LON</b>																	
Protection and communication	L S I G	L S I	L S I G	L S I																	
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	<b>PR113/PD Modbus</b>																				
Protection and communication	L S I G D U OT UV OV RV RP M																				

# Microprocessor-based overcurrent releases

## Versions available

### Features

Protection functions	PR111	PR112	PR113
<b>L</b> Inverse long time-delay trip overload protection Adjustable-slope curve (IEC 60255-3)	■	■	■
<b>S</b> Selective short-circuit protection with inverse or definite short time-delay trip	■	■	■
<b>I</b> Instantaneous short-circuit protection with adjustable trip current threshold	■	■	■
<b>G</b> Earth fault protection	residual (internal sensor)	■	■
	source ground return (external sensor)	■	■
<b>D</b> Directional short-circuit protection with adjustable delay			■
<b>U</b> Protection against phase unbalance			■
<b>OT</b> Protection against overtemperature		■	■
<b>UV</b> <b>OV</b> Undervoltage and overvoltage protection			■
<b>RV</b> Residual voltage protection / neutral displacement protection			■
<b>RP</b> Reverse power protection			■
<b>M</b> Thermal memory for L and S functions		■	■
<b>Measurements</b>			
Currents (phases, neutral, earth fault)		■	■
Voltage (phase-phase, phase-neutral, residual)			■
Power (active, reactive, apparent)			■
Power factor			■
Frequency and peak factor			■
Energy (active, reactive, apparent, counter)			■
Harmonics calculation (displays waveform and module of the harmonics)			■
<b>Maintenance events and data</b>			
Events stored in chronological order		■	■
Counting number of operations and contact wear		■	■
<b>Communication with centralized supervision and control system</b>			
Remote setting of parameters for protection functions, unit configuration and communication		■	■
Transmission of measurements, states and alarms from circuit-breaker to system		■	■
Transmission of maintenance events and data from circuit-breaker to system		■	■
<b>Self-test</b>			
Alarm and tripping for release overtemperature		■	■
Alarm for microprocessor fault		■	■
<b>User interface</b>			
Parameters set using DIP switches	■		
Parameters set using keys and liquid crystal display		■	■
Alarm signals for L, S, I and G functions		■	■
Alarm signalling one of the following protections: undervoltage, overvoltage, residual voltage, reverse power			■
Imbalance phase and overtemperature signal		■	■
Complete management of pre-alarms and alarms for all protection and self-monitoring functions		■	■
Password for use with "READ" or "EDIT" mode		■	■
<b>Load control</b>			
Connection-disconnection of loads in relation to the current flowing through the circuit-breaker		■	■
<b>Zone selectivity</b>			
May be activated for protection functions S or G		■	
May be activated for protection functions S, G or D			■
<b>Number of programmable contacts</b>		1	2
<b>Start-up function S, D, I and G</b>			■



# Microprocessor-based overcurrent releases

## Setting the current transformers

1

Rated CT current $I_n$ [A]		R250	R400	R800	R1000	R1250	R1600	R2000	R2500	R3200	R4000	R5000	R6300
E1B	800	■	■	■									
	E1N	1250	■	■	■	■	■						
E2B	1600	■	■	■	■	■	■						
	2000	■	■	■	■	■	■	■					
E2N	1250	■	■	■	■	■							
	1600	■	■	■	■	■	■						
	2000	■	■	■	■	■	■	■					
E2L	1250	■	■	■	■	■							
	1600	■	■	■	■	■	■						
E3N	2500	■	■	■	■	■	■	■	■				
	3200	■	■	■	■	■	■	■	■	■			
E3S	1250	■	■	■	■	■							
	1600	■	■	■	■	■	■						
	2000	■	■	■	■	■	■	■					
	E3H	2500	■	■	■	■	■	■	■	■			
E3L	3200	■	■	■	■	■	■	■	■	■			
	2000	■	■	■	■	■	■	■					
E4S	2500	■	■	■	■	■	■	■	■				
	E4H	4000								■	■		
E4H	3200									■	■		
	4000									■	■		
E4S/f	4000								■	■			
E6H	5000									■	■	■	
	6300									■	■	■	■
E6H/f	5000									■	■	■	
	6300									■	■	■	■
E6V	3200									■			
	4000									■	■		
	5000									■	■	■	
	6300									■	■	■	■

# Compliance with Standards

## Standards, approvals and certifications

SACE Emax circuit-breakers and their accessories meet the international standards IEC 60947, EN 60947 (harmonized in 17 CENELEC countries), CEI EN 60947 and IEC 61000, and comply with EC directive:

- “Low Voltage Directive” (LVD) nr. 73/23 EEC
- “Electromagnetic Compatibility Directive” (EMC) nr. 89/336 EEC.

The main versions of the equipment are approved by the following Shipping Registries:

- RINA (Registro Italiano Navale)
- Det Norske Veritas
- Bureau Veritas
- Germanischer Lloyd
- Loyd's Register of Shipping
- Polsk Reiestr Statkow
- Gost
- ABS (American Bureau of Shipping)
- NK

Certification of conformity with the aforementioned product Standards is carried out in compliance with European Standard EN 45011 by the Italian certification body ACAE (Associazione per la Certificazione delle Apparecchiature Elettriche - Association for the Certification of Electrical Equipment), recognized by the European organization LOVAG (Low Voltage Agreement Group).

**Note:** Contact ABB SACE for a list of approved types of circuit breakers, approved performance data and the corresponding validity





## Compliance with Standards

A design dedicated to Quality and respect for the environment

Quality has always been the leading commitment of ABB SACE. This commitment involves every function of the company, and has allowed us to achieve prestigious recognition internationally.

The company's Quality System is certified by RINA, one of the most prestigious international certification boards, and complies with ISO 9001 Standards; the ABB SACE test facility is accredited by SINAL; the plants in Frosinone, Patrica, Vittuone and Garbagnate Monastero are also certified in compliance with OHSAS 18001 Standards for workplace health and safety. ABB SACE, Italy's first industrial company in the electro-mechanical sector to achieve this, has been able to reduce its raw material consumption and machining scrap by 20% thanks to an ecology-centred revision of its manufacturing process. All of the company's Divisions are involved in streamlining raw material and energy consumption, preventing pollution, limiting noise pollution and reducing scrap resulting from manufacturing processes, as well as to carrying out periodic environmental audits of leading suppliers.

ABB SACE is committed to environmental protection, as also evidenced by the Life Cycle Assessments (LCA) of products carried out at the Research Center: thus assessments and improvements of the environmental performance of products throughout their life cycle are included right from the initial engineering stage. The materials, processes and packaging used are chosen with a view to optimizing the actual environmental impact of each product, including its energy efficiency and recyclability.

ENVIRONMENTAL MANAGEMENT SYSTEM CERTIFIED



ISO 14001:2004



ISO 9001:2008





# Emax





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# SACE Emax automatic circuit-breakers

## Shared specifications

Voltages	
Rated service voltage <b>Ue</b>	[V] 690 ~
Rated insulation voltage <b>Ui</b>	[V] 1000
Rated impulse withstand voltage <b>Uimp</b>	[kV] 12
Test voltage at industrial frequency for 1 minute	[V] 3500 ~
<b>Service temperature</b>	[°C] -25...+70
<b>Storage temperature</b>	[°C] -40...+70
<b>Frequency f</b>	[Hz] 50 - 60
<b>Number of poles</b>	3 - 4
<b>Versions</b>	Fixed - Withdrawable



		E1		E2		
		B	N	B	N	L
<b>Performance levels</b>						
<b>Currents</b>						
<b>Rated uninterrupted current (at 40 °C) Iu</b>	[A]	800	800	1600	1250	1250
	[A]	1250	1250	2000	1600	1600
	[A]				2000	
	[A]					
	[A]					
Capacity of neutral pole on four-pole circuit-breakers	[%Iu]	100	100	100	100	100
<b>Rated ultimate short-circuit breaking capacity Icu</b>						
220/230/380/400/415 V ~	[kA]	42	50	42	65	130
440 V ~	[kA]	42	50	42	65	110
500/660/690 V ~	[kA]	36	36	42	55	85
<b>Rated service short-circuit breaking capacity Ics</b>						
220/230/380/400/415 V ~	[kA]	42	50	42	65	130
440 V ~	[kA]	42	50	42	65	110
500/660/690 V ~	[kA]	36	36	42	55	65
Rated short-time withstand current Icw	(1s) [kA]	36	50	42	55	10
	(3s)	36	36	42	42	-
<b>Rated short-circuit making capacity (peak value) Icm</b>						
220/230/380/400/415 V ~	[kA]	88,2	105	88,2	143	286
440 V ~	[kA]	88,2	105	88,2	143	242
500/660/690 V ~	[kA]	75,6	75,6	88,2	121	187
<b>Utilisation category</b> (in accordance with IEC 60947-2)		B	B	B	B	A
<b>Isolation behavior</b> (in accordance with IEC 60947-2)		■	■	■	■	■
<b>Overcurrent protection</b>						
Microprocessor-based releases for AC applications		■	■	■	■	■
<b>Operating times</b>						
Closing time (max)	[ms]	80	80	80	80	80
Break time for I<Icw (max) <sup>(1)</sup>	[ms]	70	70	70	70	70
Break time for I>Icw (max)	[ms]	30	30	30	30	12
<b>Overall dimensions</b>						
Fixed: H = 418 mm - D = 302 mm L (3/4 poles)	[mm]	296/386			296/386	
Withdrawable: H = 461 mm - D = 396.5 mm L (3/4 poles)	[mm]	324/414			324/414	
<b>Weights</b> (circuit-breaker complete with releases and CT, not including accessories)						
Fixed 3/4 poles	[kg]	45/54	45/54	50/61	50/61	52/63
Withdrawable 3/4 poles (including fixed part)	[kg]	70/82	70/82	78/93	78/93	80/95

(1) Without intentional delays (2) Performance at 600 V is 100 kA (3) Performance at 500 V is 100 kA

		E1 B-N		E2 B-N			E2 L	
<b>Rated uninterrupted current (a 40 °C) Iu</b>	[A]	800	1250	1250	1600	2000	1250	1600
<b>Mechanical life</b> with regular routine maintenance	[No. operations x 1000]	25	25	25	25	25	20	20
Frequency	[Operations per hour]	60	60	60	60	60	60	60
Electrical life	(440 V ~) [No. operations x 1000]	10	10	15	12	10	4	3
	(690 V ~) [No. operations x 1000]	10	8	15	10	8	3	2
Frequency	[Operations per hour]	30	30	30	30	30	20	20



E3				E4		E6	
N	S	H	L	S	H	H	V
2500	1250	1250	2000	4000	3200	5000	3200
3200	1600	1600	2500		4000	6300	4000
	2000	2000					5000
	2500	2500					6300
	3200	3200					
100	100	100	100	50	50	50	50
65	75	100	130	75	100	100	150
65	75	100	110	75	100	100	150
65	75	85 <sup>(2)</sup>	85	75	85 <sup>(2)(3)</sup>	100	100
65	75	85	130	75	100	100	125
65	75	85	110	75	100	100	125
65	75	85	65	75	85 <sup>(3)</sup>	100	100
65	75	75	15	75	100	100	100
65	65	65	-	75	75	85	85
143	165	220	286	165	220	220	330
143	165	220	242	165	220	220	330
143	165	187	187	165	187	220	220
B	B	B	A	B	B	B	B
■	■	■	■	■	■	■	■
■	■	■	■	■	■	■	■
80	80	80	80	80	80	80	80
70	70	70	70	70	70	70	70
30	30	30	12	30	30	30	30
	404/530			566/656		782/908	
	432/558			594/684		810/936	
66/80	66/80	66/80	72/83	97/117	97/117	140/160	140/160
104/125	104/125	104/125	110/127	147/165	147/165	210/240	210/240

E3 N-S-H					E3 L		E4 S-H		E6 H-V			
1250	1600	2000	2500	3200	2000	2500	3200	4000	3200	4000	5000	6300
20	20	20	20	20	15	15	15	15	12	12	12	12
60	60	60	60	60	60	60	60	60	60	60	60	60
12	10	9	8	6	2	1,8	7	5	5	4	3	2
12	10	9	7	5	1,5	1,3	7	4	5	4	2	1,5
20	20	20	20	20	20	20	10	10	10	10	10	10

# Automatic circuit-breakers with full-size neutral conductor

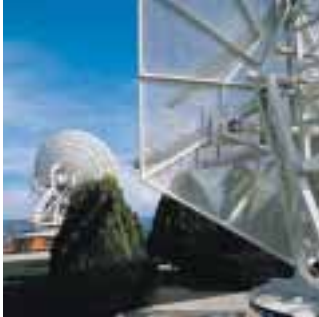
The Emax range of automatic circuit-breakers with full-size neutral conductor is used in special applications where the presence of triple-N harmonics on individual phases may lead to a very high current on the neutral conductor.

Typical applications include installations with loads having high harmonics distortion (computers and electronic devices in general), lighting systems with a large number of fluorescent lamps, systems with inverters and rectifiers, UPS, systems for adjusting the speed of electric motors.

This range includes standard circuit-breakers with full-size neutral conductor in sizes E1, E2, E3. Models E4 and E6 are available in the "Full size" version up to rated currents of 6300A.

Models E4/f and E6/f are available in fixed and withdrawable four-pole versions. These models may be fitted with all accessories available for the Emax range; the exception, on the E6/f model, are the mechanical interlocks made using flexible wires and 15 external auxiliary contacts, which are therefore incompatible.

All the models may be fitted with all available versions of electronic protection relays, in the standard version.



SACE E4S 40/f		I <sub>n</sub> = 400A U <sub>e</sub> = 690V I <sub>cu</sub> = 80kA x 1s					ABB	
cat. B → ←	50-60 Hz					IEC EN 60947-2		
U <sub>b</sub> [V]	230	415	440	500	690	250	IEC 947-2	
I <sub>cu</sub> [kA]	80	80	80	75	75	75	CE	
I <sub>cs</sub> [kA]	80	80	80	75	75	75		

		E4S/f	E6H/f	
<b>Rated uninterrupted current (at 40 °C) I<sub>u</sub></b>	[A]	<b>4000</b>	<b>5000</b>	
	[A]		<b>6300</b>	
Number of poles		4	4	
Rated service voltage U <sub>e</sub>	[V ~]	690	690	
<b>Rated ultimate short-circuit breaking capacity I<sub>cu</sub></b>				
	220/230/380/400/415 V ~	[kA]	80	100
	440 V ~	[kA]	80	100
	500/660/690 V ~	[kA]	75	100
<b>Rated service short-circuit breaking capacity I<sub>cs</sub></b>				
	220/230/380/400/415 V ~	[kA]	80	100
	440 V ~	[kA]	80	100
	500/660/690 V ~	[kA]	75	100
<b>Rated short-time withstand current I<sub>cw</sub></b>				
	(1s)	[kA]	80	100
	(3s)	[kA]	75	85
Rated short-circuit making capacity (peak value) I <sub>cm</sub>		[kA]	176	220
Application category (in accordance with IEC 60947-2)			B	B
Isolation behavior (in accordance with IEC 60947-2)			■	■
<b>Overall dimensions</b>				
	Fixed: H = 418 mm - D = 302 mm L	[mm]	746	1034
	Withdrawable: H = 461 - D = 396.5 mm L	[mm]	774	1062
<b>Weights (circuit-breaker complete with releases and CT, not including accessories)</b>				
	Fixed	[kg]	120	165
	Withdrawable (including fixed part)	[kg]	170	250

## Switch-disconnectors

The switch-disconnectors are derived from the corresponding automatic circuit-breakers, of which they maintain the overall dimensions and the possibility of mounting accessories. This version differs from the automatic circuit-breakers only in the absence of overcurrent releases.

The circuit-breaker is available in both fixed and withdrawable versions, three-pole and four-pole. The switch-disconnectors, identified by the label “/MS”, may be used according to the category of use AC-23A (switching motor loads or other highly inductive loads) in accordance with the standard IEC 60947-3. The electrical specifications of the switch-disconnectors are listed in the table below.



ISDC2006/0001

2

		E1B/MS	E1N/MS	E2B/MS	E2N/MS	E3N/MS	E3S/MS	E4S/MS	E4S/fMS	E4H/MS	E6H/MS	E6H/f MS
Rated uninterrupted current (a 40 °C) <b>I<sub>u</sub></b>	[A]	800	800	1600	1250	2500	1250	4000	4000	3200	5000	5000
	[A]	1250	1250	2000	1600	3200	1600			4000	6300	6300
	[A]				2000		2000					
	[A]						2500					
	[A]						3200					
Rated service voltage <b>U<sub>e</sub></b>	[V ~]	690	690	690	690	690	690	690	690	690	690	690
	[V -]	250	250	250	250	250	250	250	250	250	250	250
Rated insulation voltage <b>U<sub>i</sub></b>	[V ~]	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Rated impulse withstand voltage <b>U<sub>imp</sub></b>	[kV]	12	12	12	12	12	12	12	12	12	12	12
Rated short-time withstand current <b>I<sub>cw</sub></b>	(1s) [kA]	36	50	42	55	65	75	75	80	100	100	100
	(3s) [kA]	36	36	42	42	65	65	75	75	75	85	85
Rated short-circuit making capacity (peak value) <b>I<sub>cm</sub></b>	220/230/380/400/415/440 V ~ [kA]	75,6	105	88,2	121	143	165	165	176	220	220	220
	500/660/690 V ~ [kA]	75,6	75,6	88,2	121	143	165	165	165	187	220	220

# Automatic circuit-breakers for applications up to 1000V AC

SACE Emax circuit-breakers may be supplied in a special version for rated service voltages up to 1000 V in AC.

Circuit-breakers in this version are identified by the label of the standard range (rated service voltage up to 690 V AC) plus "/E", and are derived from the corresponding standard SACE Emax circuit-breakers. They offer the same versions and accessories as the latter. The SACE Emax range of circuit-breakers for applications up to 1000V in AC may be either fixed and withdrawable, in both three-pole and four-pole versions. SACE Emax/E circuit-breakers are especially suitable for installation in mines, oil and chemical plants, and for traction.

The table below shows the electrical specifications of the range.



SACE E3H/E 16				ABB	
Cat. B	50-60HZ	$I_n = 1600A$	CEI EN 60947-2		
$U_e$ (V)	1000	$U_e = 1000V$	IEC 947-2		
$I_{cu}$ (kA)	50	$I_{cw} = 50kA \cdot 1s$	CE		
$I_{cs}$ (kA)	50				

		E2B/E		E2N/E			E3H/E				E4H/E		
		1600	2000	1250	1600	2000	1250	1600	2000	2500	3200	3200	4000
<b>Rated uninterrupted current (at 40 °C) <math>I_u</math></b>	[A]	1600	2000	1250	1600	2000	1250	1600	2000	2500	3200	3200	4000
<b>Rated service voltage <math>U_e</math></b>	[V~]	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
<b>Rated ultimate short-circuit breaking capacity <math>I_{cu}</math></b>	[kA]	20	20	30	30	30	50	50	50	50	50	65	65
<b>Rated service short-circuit breaking capacity <math>I_{cs}</math></b>	[kA]	20	20	30	30	30	50	50	50	50	50	65	65
<b>Rated short-time withstand current <math>I_{cw}</math> (1s)</b>	[kA]	20	20	30	30	30	50	50	50	50	50	65	65

## Switch-disconnectors for applications up to 1000V AC

The switch-disconnectors complete the range of equipment for applications at 1000V in alternating current (AC). These circuit-breakers meet international IEC standard 60947-3.

Circuit-breakers in this version are identified by the label of the standard range, where the rated service voltage is up to 690 V AC, plus "/E", thus becoming SACE Emax/E MS. They are derived from the corresponding standard SACE Emax switch-disconnectors.

They are available in three-pole and four-pole, both in the fixed and withdrawable versions in the same sizes, accessory options and installations as the corresponding standard circuit-breakers. All accessories available for the SACE Emax range may be used. Standard fixed parts may also be used for circuit-breakers in the withdrawable version.

ISDC2006-110001



		E2B/E MS	E2N/E MS	E3H/E MS	E4H/E MS
Rated uninterrupted current (at 40 °C) <b>I<sub>u</sub></b>	[A]	1600	1250	1250	3200
	[A]	2000	1600	1600	4000
	[A]		2000	2000	
	[A]			2500	
	[A]			3200	
Number of poles		3/4	3/4	3/4	3/4
Rated AC service voltage <b>U<sub>e</sub></b>	[V]	1000	1000	1000	1000
Rated AC insulation voltage <b>U<sub>i</sub></b>	[V]	1000	1000	1000	1000
Rated impulse withstand voltage <b>U<sub>imp</sub></b>	[kV]	12	12	12	12
Rated short-time withstand current <b>I<sub>cw</sub></b> (1s)	[kA]	20	30	50	65
Rated making capacity <b>I<sub>cm</sub></b> 1000 VAC (peak value)	[kA]	40	63	105	143

## Switch-disconnectors for applications up to 1000V DC

ABB SACE has developed the SACE Emax/E MS range of switch-disconnectors for applications in direct current up to 1000V in compliance with international standard IEC60947-3. These non-automatic circuit-breakers are especially suitable for use as busbar links or main isolators in direct current systems, such as for applications involving electric traction.

The range covers all installation needs up to 1000V DC / 3200A or up to 750V DC / 4000A.

They are available in fixed and withdrawable versions, three-pole and four-pole.

By connecting three breaking poles in series, it is possible to achieve a rated insulation voltage of 750V DC, while with four poles in series the limit rises to 1000V DC.

The switch-disconnectors of the SACE Emax/E MS range maintain the overall dimensions and fastening points of the standard range circuit-breakers. They may be fitted with the various terminal kits and all accessories common to the SACE Emax range. They may obviously not be associated with the electronic releases, CT and with the current detection and protection accessories for AC applications.

The withdrawable circuit-breakers should be used together with the special version fixed parts for applications at 750/1000V DC.



ISDC2006-110001

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		E1B/E MS		E2N/E MS		E3H/E MS		E4H/E MS	
Rated uninterrupted current (at 40 °C) <b>I<sub>u</sub></b>	[A]	800		1250		1250		3200	
	[A]	1250		1600		1600		4000	
	[A]			2000		2000			
	[A]					2500			
	[A]					3200			
Number of poles		3	4	3	4	3	4	3	
Rated AC service voltage <b>U<sub>e</sub></b>	[V]	750	1000	750	1000	750	1000	750	
Rated AC insulation voltage <b>U<sub>i</sub></b>	[V]	1000	1000	1000	1000	1000	1000	1000	
Rated impulse withstand voltage <b>U<sub>imp</sub></b>	[kV]	12	12	12	12	12	12	12	
Rated short-time withstand current <b>I<sub>cw</sub></b> (1s)	[kA]	20	20	25	25	40	40	65	
Rated making capacity <b>I<sub>cm</sub></b>	750 V DC	[kA]	20	20	25	25	40	40	65
	1000 V DC		–	20	–	25	–	40	–



## Sectionalizing truck

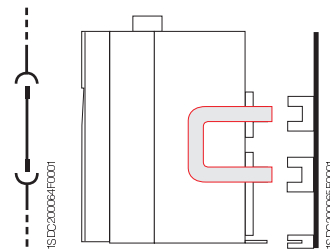
### Sectionalizing truck - CS

This version is derived from the corresponding withdrawable circuit-breaker, replacing all of the circuit breaking parts and operating mechanism with simple connections between the upper and lower contacts.

It is used as a no load isolator where required by the system.



2



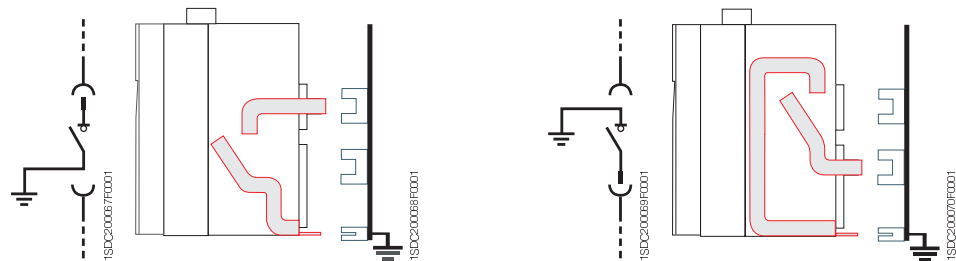
# Earthing switch with making capacity

## Earthing switch with making capacity - MTP

This version is based on the mobile part of the corresponding withdrawable circuit-breaker (without overcurrent releases) and the top or bottom isolating contacts, which are replaced with connections that short circuit the phases to earth through the circuit-breaker. The earthing switch is available with top or bottom isolating contacts.

The earthing circuit is dimensioned for a short-time current equal to 60% of the maximum  $I_{cw}$  of the circuit-breaker from which it is derived (IEC 60439-1).

The earthing switch is inserted in the fixed part of a withdrawable circuit-breaker to earth the top or bottom terminals before carrying out inspection or maintenance operations on the external circuit in safety conditions. It should be used in cases where the installations to be earthed may produce residual or recovery voltages.



## Earthing truck

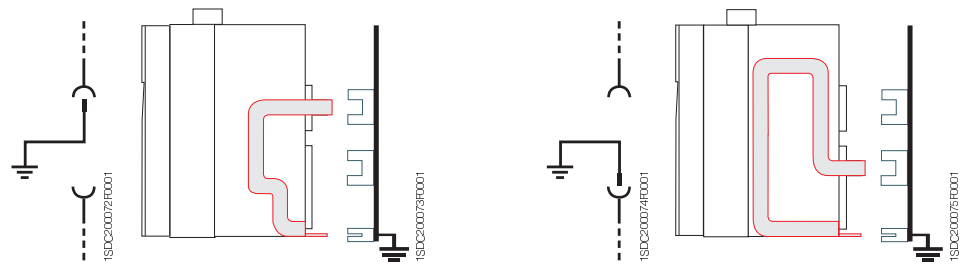
## Other versions

### Earthing truck- MT

This version is similar to the sectionalizing truck, but with the bottom or top isolating contacts replaced by short-circuited, earthed connections. The earthing truck is available with bottom or top isolating contacts, suitable for the fixed part of the size.

The earthing circuit is dimensioned for a short-time current equal to 60% of the maximum  $I_{cw}$  of the circuit-breaker from which it is derived (IEC 60439-1).

The truck is temporarily racked into the fixed part of a withdrawable circuit-breaker to earth the top or bottom terminals before carrying out maintenance operations on the external circuit when no residual voltages are expected.



### Other versions

Upon request, SACE Emax circuit breakers may be built in special versions designed for particularly aggressive environments (SO<sub>2</sub> / H<sub>2</sub>S) and for seismic installations.



# Emax



## Contents

### Installation in switchboards

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## Installation in switchboards

### Modular design

The circuit-breakers in the SACE Emax series have been built to modular design criteria for easier installation and integration in Low Voltage electrical switchboards, giving them the same depth and height for every model while simultaneously achieving a significant reduction in their overall installation dimensions.

The front shield of the circuit-breaker is also identical for the entire series. This simplifies the construction of the switchboard doors since only one type of drilling is required and makes the front of the switchboard the same for all sizes.

SACE Emax circuit-breakers are suitable for Power Center switchboards and make it easy to comply with the segregation requirements of the IEC 60439-1 standards.

3



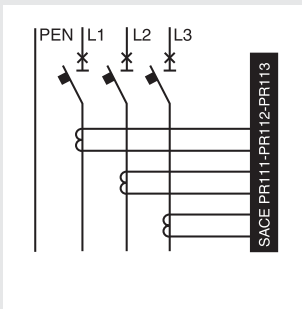
# Installation in switchboards

## Choosing the type of circuit breaker

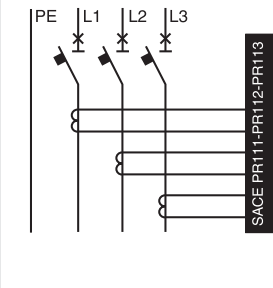
### Number of poles

The choice of the number of poles for circuit-breakers that simultaneously provide switching, protection and isolation functions in three-phase installations depends on the type of electrical system (TT, TN-S, TN-C, IT) and the type of user or, more generally, whether it features a distributed or non-distributed neutral.

#### Three-pole circuit breakers

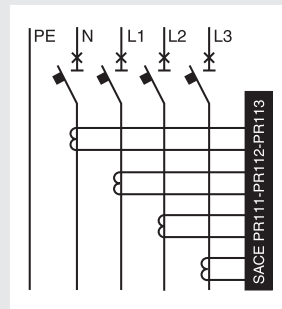


For TN-C systems (the neutral cannot be interrupted because it also acts as the protection conductor).



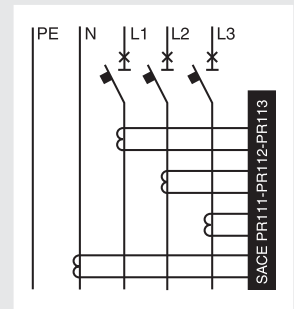
For users that do not use the neutral (e.g.: asynchronous motors) and, for systems with non-distributed neutral in general.

#### Four-pole circuit breakers



In all other instances, with exceptions for the IT system (see CEI Standards 64-8/473.3.2.2).

#### Three-pole circuit breakers with external neutral



Current transformers can be installed on the external neutral of five-wire systems (TN-S) with 3-pole circuit-breakers.

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### Fixed or withdrawable version

The fixed version of the circuit-breaker is more compact in size than the withdrawable version. It is recommended for installations that can tolerate service interruptions in the event of faults or routine maintenance.

The withdrawable version of the circuit-breaker is recommended for:

- applications that can only tolerate brief interruptions due to faults or routine maintenance;
- dual lines, one of which is a standby for the other, with a single circuit-breaker for each pair.



# Installation in switchboards

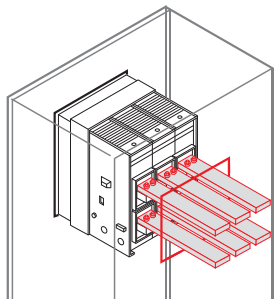
## Choosing the type of circuit breaker

### Connecting the main circuit-breaker circuits

When designing switchboards, one must always bear in mind the problem of making the most rational connections between the circuit-breaker and main busbar system and the busbars to the users. The SACE Emax series offers switchboard analysts a range of options to satisfy different circuit-breaker connection requirements.

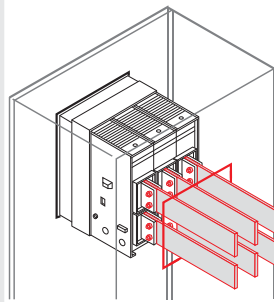
The figures alongside here show a number of indications for terminal selection.

Horizontal rear terminals



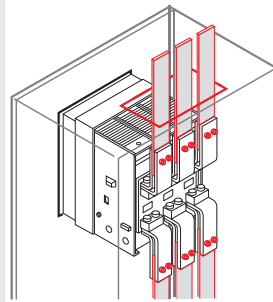
For switchboards with access from the rear

Vertical rear terminals



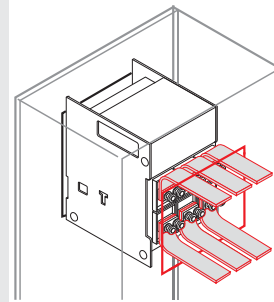
For switchboards with access from the rear

Front terminals



For wall-mounted switchboards, with access from the front only

Flat rear terminals



(withdrawable version only) For switchboards with access from the rear

### Protection degrees

A number of solutions have been adopted on SACE Emax circuit-breakers to achieve IP22 protection degree for fixed or withdrawable circuit-breakers, not including their terminals, and IP30 for their front parts using a flange. Automatic shutters have been designed for the fixed parts of withdrawable circuit-breakers which can be locked using padlock devices to allow maintenance of the load side or power-supply side of the fixed part. A transparent protective cover is also available upon request, to completely segregate the front of the circuit breaker with a protection degree of IP54. The front panel and protection release, as well as their indicators, still remain completely visible.

**IP22** Fixed or withdrawable circuit-breaker, not including terminals.

**IP30** Front parts of circuit-breakers (using flange).

**IP54** Fixed or withdrawable circuit-breaker, fitted with transparent protective cover to be fastened to the front of the switchboard (on request).



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### Power losses

The IEC 439-1 and CEI EN 60439-1 standards prescribe calculations for determining the heat dissipation of ANS (non-standard) switchboards which require the engineer to consider the following:

- the overall dimensions
- the rated current of the bus-bars and connections and their power loss values
- the power loss of the switch-gear fitted in the switch-board.

For the latter, the following table provides information on the circuit-breakers. Where other equipment is concerned, please consult the catalogues of the relative manufacturers.

Power loss			
Circuit breaker	Iu [A]	Fixed 3/4 Poles [W]	Withdrawable 3/4 Poles [W]
<b>E1 B-N</b>	800	65	95
	1250	150	230
<b>E2 B-N</b>	1250	70	130
	1600	115	215
	2000	180	330
	2500	265	445
<b>E2 L</b>	1250	105	165
	1600	170	265
<b>E3 N-S-H</b>	1250	60	90
	1600	85	150
	2000	130	225
	2500	205	350
<b>E3 L</b>	3200	330	570
	2000	215	330
	2500	335	515
<b>E4 S-H</b>	3200	235	425
	4000	360	660
<b>E6 H-V</b>	3200	170	290
	4000	265	445
	5000	415	700
	6300	650	1100

**Note**

The table values refer to balanced loads, a current flow of Iu, and automatic circuit-breakers.



**Note**

The same standards prescribe type tests for AS switchboards (standard factory-manufactured switchgear), including those for maximum temperature rise.

# Installation in switchboards

## Current carrying capacity in switchboards

The following table lists examples of the continuous current carrying capacity for circuit breakers installed in a switchboard with the dimensions indicated below.

These values refer to withdrawable switchgear installed in non-segregated switchboards with a protection rating of up to IP31, and the following dimensions:

2300x800x900 (HxLxD) for E1 - E2 - E3;

2300x1400x1500 (HxLxD) for E4 - E6.

The values refer to a maximum temperature at the terminals of 120°C.

For withdrawable circuit-breakers with a rated current of 6300A, the use of vertical rear terminals is recommended.

**Note:**

The tables should be used solely as a general guideline for selecting products. Due to the extensive variety of switchboard formats and conditions that may affect the behavior of the equipment switchboard, solutions must always be tested in the actual installation.

Type	In [A]	Vertical terminals				Horizontal and front terminals			
		Continuous capacity [A]			Busbars section [mm <sup>2</sup> ]	Continuous capacity [A]			Busbars section [mm <sup>2</sup> ]
		35°C	45°C	55°C		35°C	45°C	55°C	
E1B/N 08	800	800	800	800	1x(60x10)	800	800	800	1x(60x10)
E1B/N 12	1250	1250	1250	1250	1x(80x10)	1250	1250	1200	2x(60x8)
E2N 12	1250	1250	1250	1250	1x(60x10)	1250	1250	1250	1x(60x10)
E2B/N 16	1600	1600	1600	1600	2x(60x10)	1600	1600	1530	2x(60x10)
E2B/N 20	2000	2000	2000	1800	3x(60x10)	2000	2000	1750	3x(60x10)
E2L 12	1250	1250	1250	1250	1x(60x10)	1250	1250	1250	1x(60x10)
E2L 16	1600	1600	1600	1500	2x(60x10)	1600	1490	1400	2x(60x10)
E3S/H 12	1250	1250	1250	1250	1x(60x10)	1250	1250	1250	1x(60x10)
E3S/H 16	1600	1600	1600	1600	1x(100x10)	1600	1600	1600	1x(100x10)
E3S/H 20	2000	2000	2000	2000	2x(100x10)	2000	2000	2000	2x(100x10)
E3N/S/H 25	2500	2500	2500	2500	2x(100x10)	2500	2490	2410	2x(100x10)
E3N/S/H 32	3200	3200	3100	2800	3x(100x10)	3000	2880	2650	3x(100x10)
E3L 20	2000	2000	2000	2000	2x(100x10)	2000	2000	1970	2x(100x10)
E3L 25	2500	2500	2390	2250	2x(100x10)	2375	2270	2100	2x(100x10)
E4H 32	3200	3200	3200	3200	3x(100x10)	3200	3200	3020	3x(100x10)
E4S/H 40	4000	4000	3980	3500	4x(100x10)	3600	3510	3150	6x(60x10)
E6V 32	3200	3200	3200	3200	3x(100x10)	3200	3200	3200	3x(100x10)
E6V 40	4000	4000	4000	4000	4x(100x10)	4000	4000	4000	4x(100x10)
E6H/V 50	5000	5000	4850	4600	6x(100x10)	4850	4510	4250	6x(100x10)
E6H/V 63	6300	6000	5700	5250	7x(100x10)	-	-	-	-

# Changing the rated uninterrupted current in relation to temperature

## Temperature derating

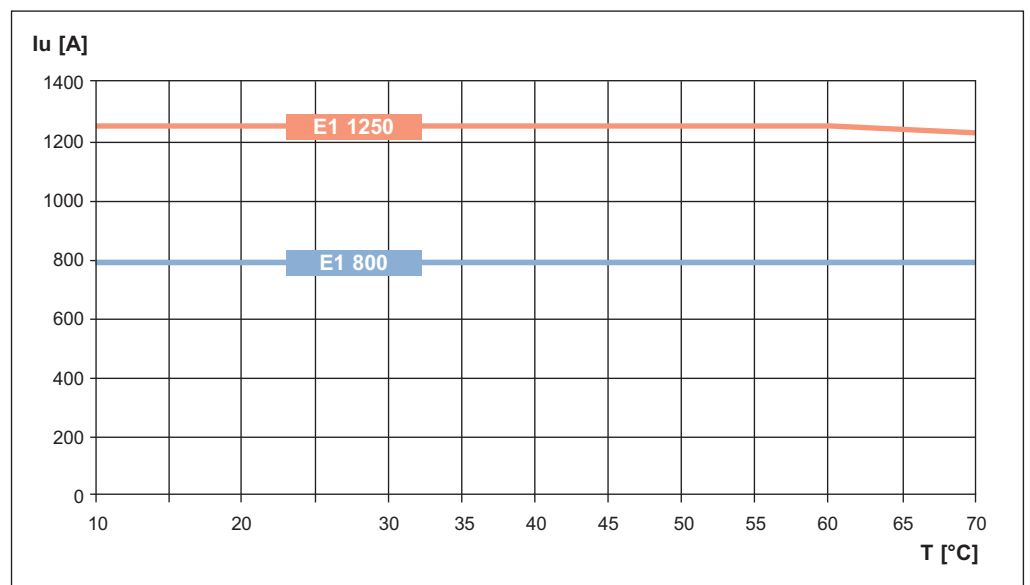
The circuit-breakers may operate at higher temperatures than their reference temperature (40 °C) in certain installation conditions. In these cases the current-carrying capacity of the switchgear should be reduced.

The SACE Emax series of air circuit-breakers uses microprocessor-based electronic releases that offer the benefit of great operating stability when subjected to temperature changes.

The tables below show the current-carrying capacities of the circuit breakers (as absolute values and percentage values) in relation to their rated values at T = 40 °C.

### SACE Emax E1

Temperature [°C]	E1 800		E1 1250	
	%	[A]	%	[A]
10	100	800	100	1250
20	100	800	100	1250
30	100	800	100	1250
40	100	800	100	1250
45	100	800	100	1250
50	100	800	100	1250
55	100	800	100	1250
60	100	800	100	1250
65	100	800	99	1240
70	100	800	98	1230



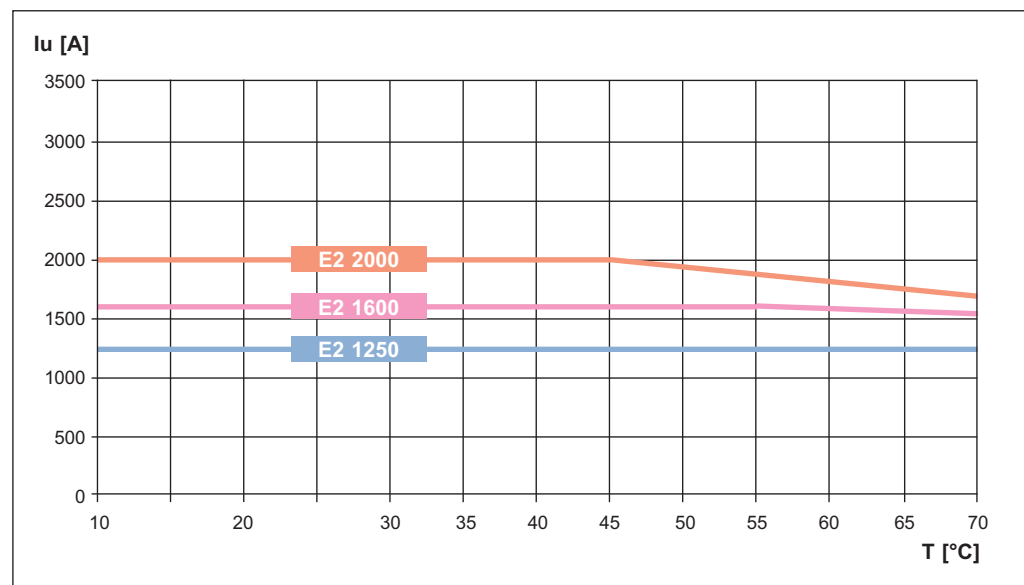


# Changing the rated uninterrupted current in relation to temperature

## Temperature derating

### SACE Emax E2

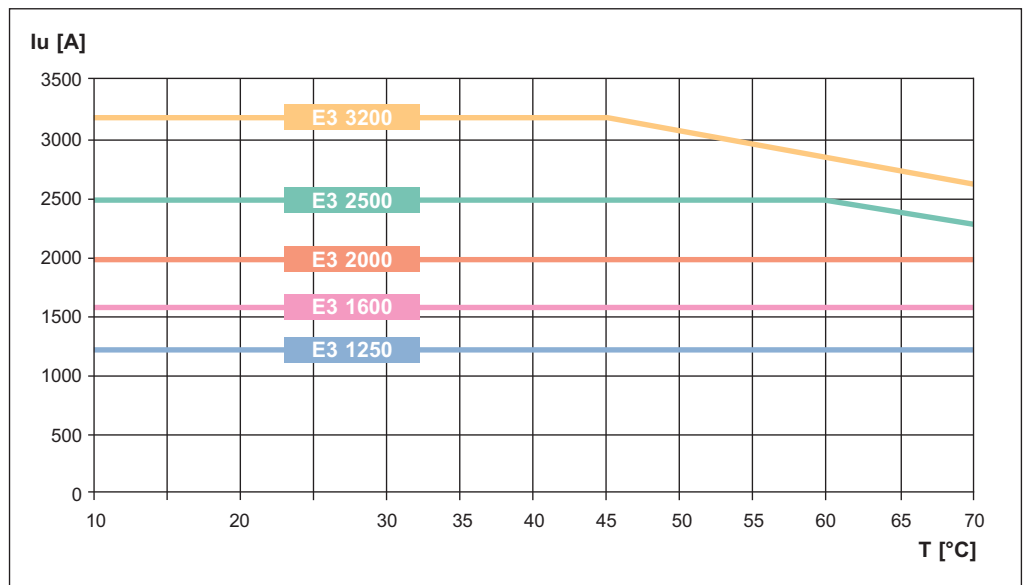
Temperature [°C]	E2 1250		E2 1600		E2 2000	
	%	[A]	%	[A]	%	[A]
10	100	1250	100	1600	100	2000
20	100	1250	100	1600	100	2000
30	100	1250	100	1600	100	2000
40	100	1250	100	1600	100	2000
45	100	1250	100	1600	100	2000
50	100	1250	100	1600	97	1945
55	100	1250	100	1600	94	1885
60	100	1250	98	1570	91	1825
65	100	1250	96	1538	88	1765
70	100	1250	94	1510	85	1705



3

### SACE Emax E3

Temperature [C°]	E3 1250		E3 1600		E3 2000		E3 2500		E3 3200	
	%	[A]	%	[A]	%	[A]	%	[A]	%	[A]
10	100	1250	100	1600	100	2000	100	2500	100	3200
20	100	1250	100	1600	100	2000	100	2500	100	3200
30	100	1250	100	1600	100	2000	100	2500	100	3200
40	100	1250	100	1600	100	2000	100	2500	100	3200
45	100	1250	100	1600	100	2000	100	2500	100	3200
50	100	1250	100	1600	100	2000	100	2500	97	3090
55	100	1250	100	1600	100	2000	100	2500	93	2975
60	100	1250	100	1600	100	2000	100	2500	89	2860
65	100	1250	100	1600	100	2000	97	2425	86	2745
70	100	1250	100	1600	100	2000	94	2350	82	2630



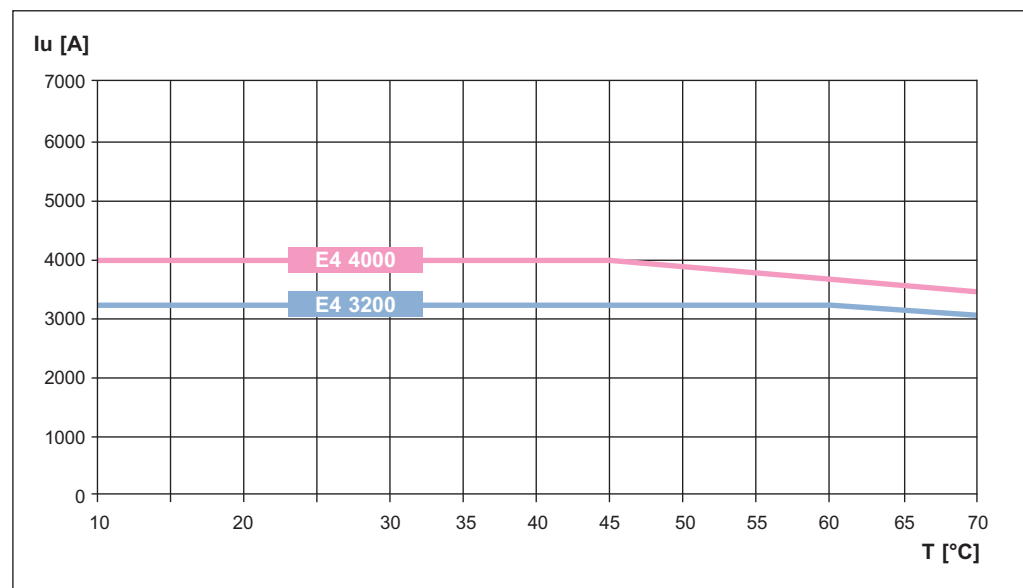


# Changing the rated uninterrupted current in relation to temperature

## Temperature derating

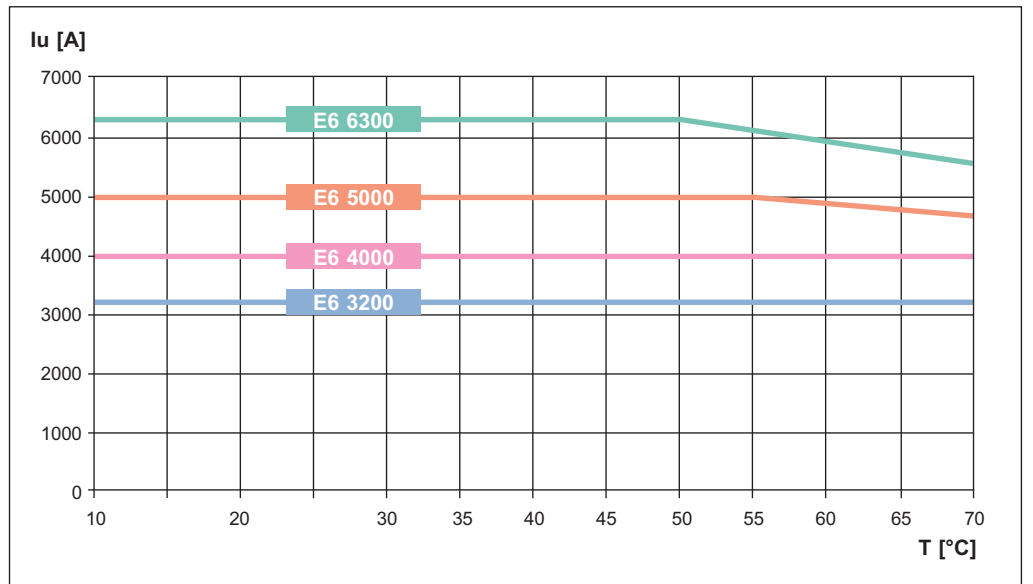
### SACE Emax E4

Temperature [°C]	E4 3200		E4 4000	
	%	[A]	%	[A]
10	100	3200	100	4000
20	100	3200	100	4000
30	100	3200	100	4000
40	100	3200	100	4000
45	100	3200	100	4000
50	100	3200	98	3900
55	100	3200	95	3790
60	100	3200	92	3680
65	98	3120	89	3570
70	95	3040	87	3460



### SACE Emax E6

Temperature [°C]	E6 3200		E6 4000		E6 5000		E6 6300	
	%	[A]	%	[A]	%	[A]	%	[A]
10	100	3200	100	4000	100	5000	100	6300
20	100	3200	100	4000	100	5000	100	6300
30	100	3200	100	4000	100	5000	100	6300
40	100	3200	100	4000	100	5000	100	6300
45	100	3200	100	4000	100	5000	100	6300
50	100	3200	100	4000	100	5000	100	6300
55	100	3200	100	4000	100	5000	98	6190
60	100	3200	100	4000	98	4910	96	6070
65	100	3200	100	4000	96	4815	94	5850
70	100	3200	100	4000	94	4720	92	5600





## Derating in altitude

SACE Emax air circuit-breakers do not undergo any changes in their rated performance up to an altitude of 2000 meters.

As the altitude increases the atmospheric properties alter in terms of composition, dielectric capacity, cooling power and pressure.

The performance of the circuit-breakers therefore undergoes derating which can be measured through the variation in significant parameters such as the maximum rated voltage of operation and the rated uninterrupted current.

The table below shows the aforementioned values in relation to altitude.

Altitude	H [m]	<2000	3000	4000	5000
Rated service voltage	<b>U<sub>e</sub></b> [V]	690	600	500	440
Rated current	<b>I<sub>n</sub></b> [A]	I <sub>n</sub>	0,98xI <sub>n</sub>	0,93xI <sub>n</sub>	0,90xI <sub>n</sub>

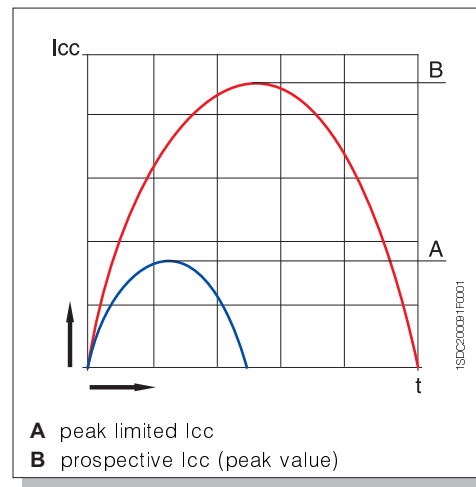
## Current-limiting and specific let-through energy curves for circuit-breakers E2L and E3L

The current-limiting capacity of an automatic current-limiting circuit-breaker indicates its ability to let through or determine a current lower than the prospective fault current in short-circuit conditions. This characteristic is represented by two different curves which indicate the following, respectively:

- the value of the specific energy " $I^2t$ " (in  $A^2s$ ) let through by the circuit-breaker in relation to the uninterrupted symmetrical short-circuit current.
- the peak value (in kA) of the limited current in relation to the uninterrupted symmetrical short-circuit current.

The graph shown here schematically indicates the pattern of uninterrupted current, with its established peak (curve B), and the pattern of limited current with a lower peak value (curve A).

Comparing the areas beneath the two curves shows how the specific let-through energy is reduced as a result of the limiting effects of the circuit breaker.

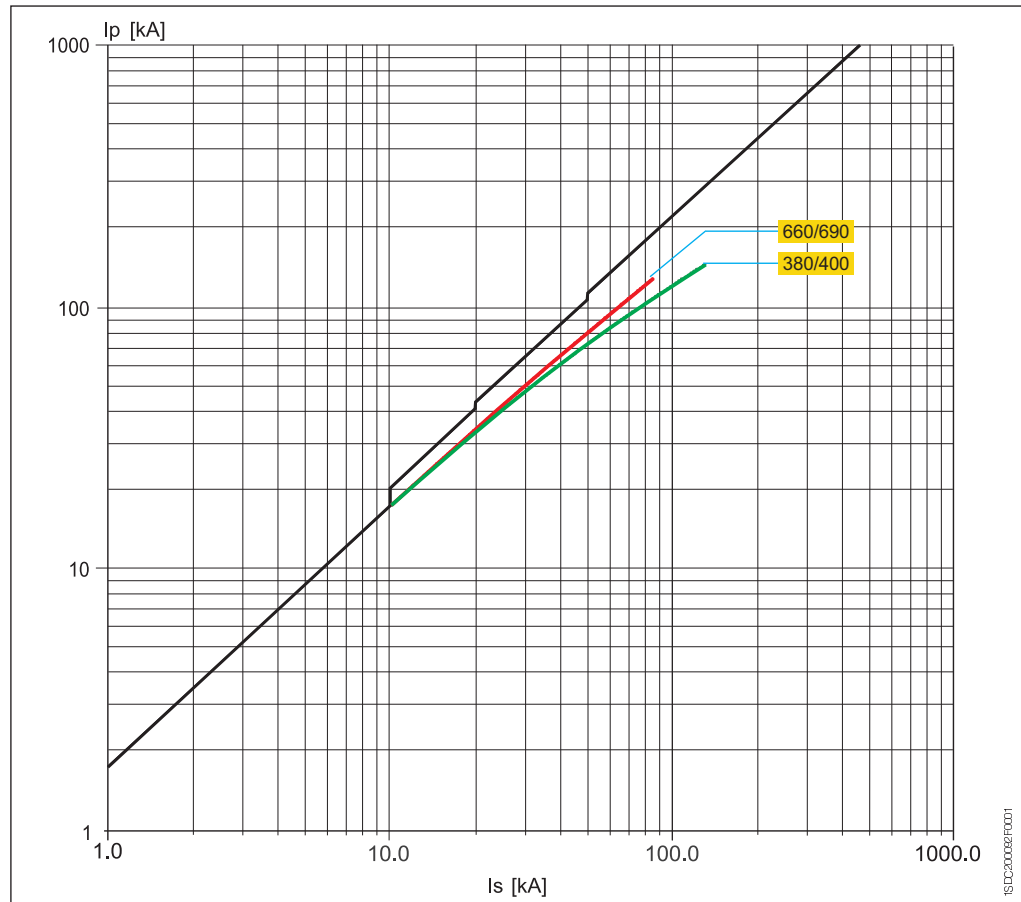




# Current-limiting and specific let-through energy curves for circuit-breakers E2L and E3L

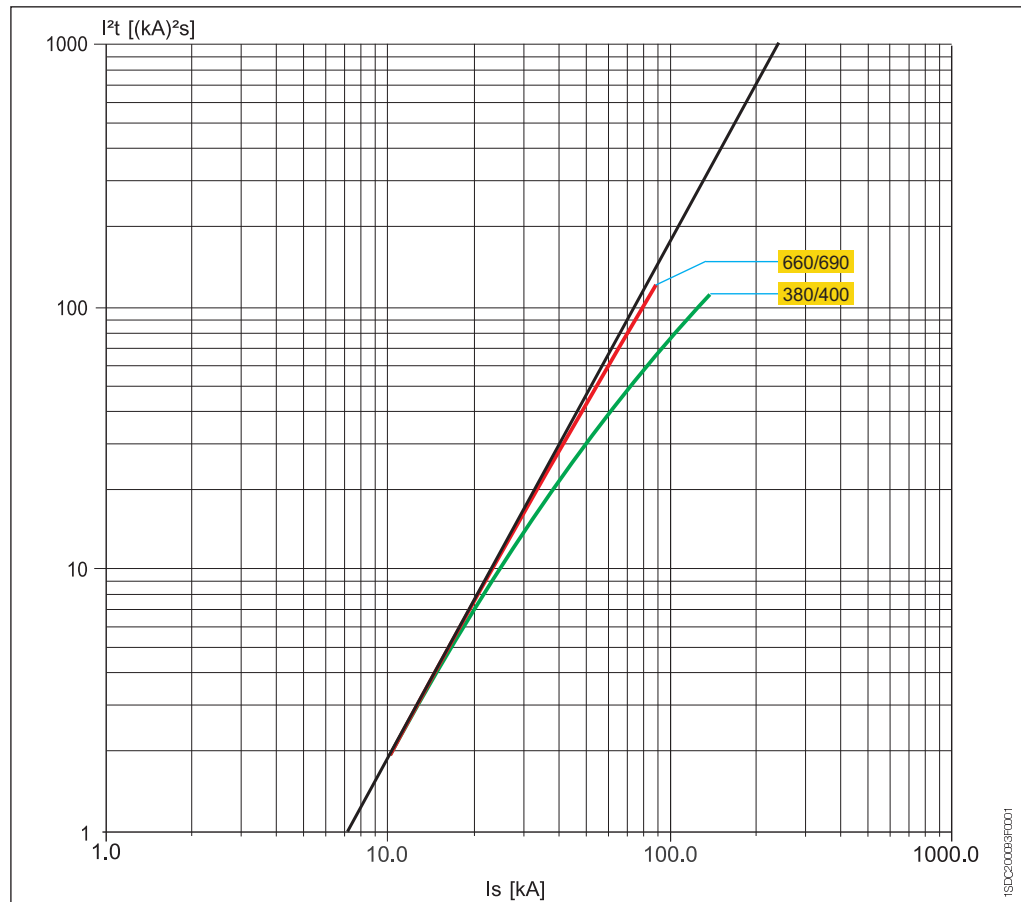
## E2L

Current-limiting curves



## E2L

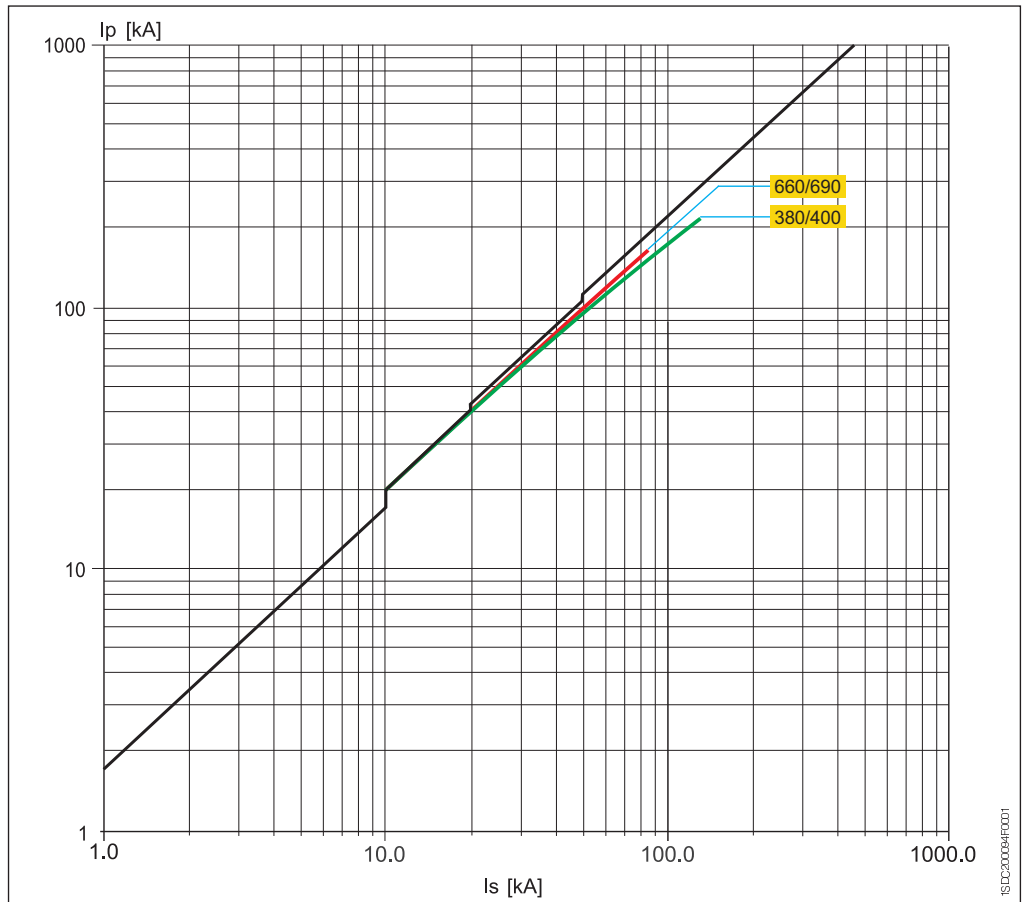
Specific let-through energy curves



- Is** prospective symmetrical short-circuit current
- Ip** peak current
- I²t** specific let-through energy at the voltages indicated

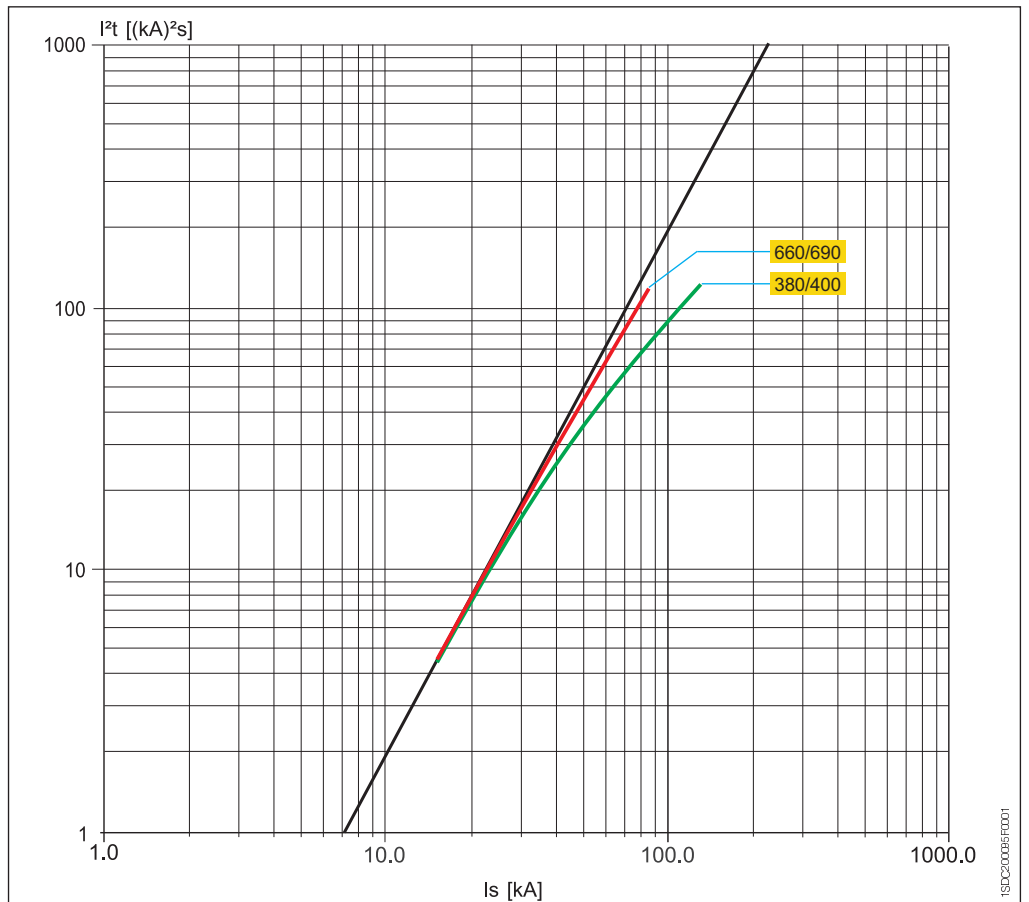
### E3L

#### Current-limiting curves



### E3L

#### Specific let-through energy curves



- Is** prospective symmetrical short-circuit current
- Ip** peak current
- I²t** specific let-through energy at the voltages indicated



# Emax





# Overcurrent releases and related accessories



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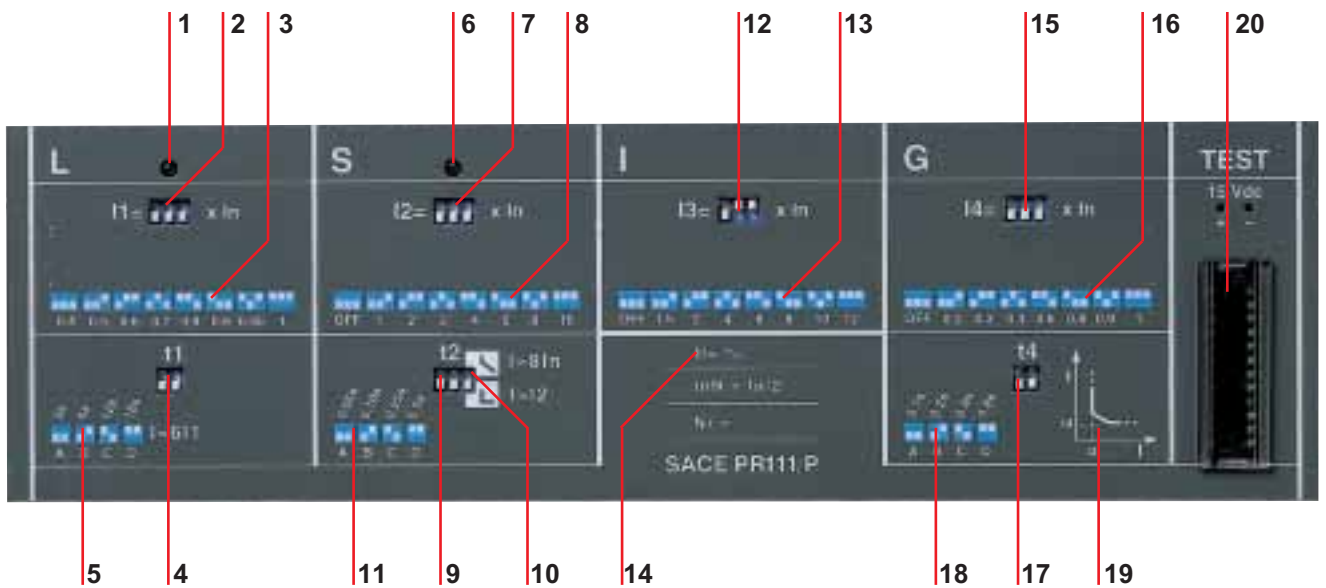


# Microprocessor-based protection releases and trip curves

PR111/P

## Characteristics

This is the basic release for the Emax series. The complete range of protection functions and the variety of thresholds and trip times offered make it suitable for protecting any type of alternating current installation. The release does not have any additional functions over and above its protection functions, except a few signals.



1SDC200069R0001

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### Legend

- |   |   |   |
|---|---|---|
| <ul style="list-style-type: none"> <li>1 Alarm indicator LED for protection function L</li> <li>2 DIP switches for setting current threshold I1</li> <li>3 Indication of the DIP switch positions for the various values of current thresholds I1</li> <li>4 DIP switches for setting trip time t1 (type of curve)</li> <li>5 Indication of the DIP switch positions for the various time settings</li> <li>6 Alarm indicator LED for protection function S</li> <li>7 DIP switches for setting current threshold I2</li> <li>8 Indication of the DIP switch positions for the various current threshold values I2</li> </ul> | <ul style="list-style-type: none"> <li>9 DIP switches for setting trip time t2 (type of curve)</li> <li>10 Dip switches for setting inverse time or definite time characteristic</li> <li>11 Indication of DIP switch positions for the various time settings</li> <li>12 DIP switches for setting current threshold I3</li> <li>13 Indication of the DIP switch positions for the various current threshold values I3</li> <li>14 Rating plate showing the rated current of the neutral CT and the release serial number</li> <li>15 DIP switches for setting current threshold I4</li> <li>16 Indication of the DIP switch positions for the various current threshold values I4</li> </ul> | <ul style="list-style-type: none"> <li>17 DIP switches for setting trip time t4 (type of curve)</li> <li>18 Indication of DIP switch positions for the various time settings</li> <li>19 Symbol diagram showing operation of function G</li> <li>20 Connection module with external units for testing the release and socket for connection to the trip test (SACE TT1 unit and SACE PR010/T unit)</li> </ul> |
|---|---|---|

## Operation and protection functions

### Power supply

The unit requires no external power supply. It is self-powered by means of the current transformers installed on the circuit-breaker. For it to operate, it is sufficient for at least one phase to be loaded at 18% of the rated current of the current transformers ( $I_n$ ).

### Protection functions

The PR111 release offers the following protection functions:

- overload (L)
- selective short-circuit (S)
- instantaneous short-circuit (I)
- earth fault (G).

### Overload (L)

The inverse long time-delay trip overload protection L is type  $I^2t=k$ ; eight current thresholds and 4 curves are available, labeled A, B, C, D. Each curve is identified by the trip time in relation to the current  $I = 6 \times I_1$  ( $I_1$ =set threshold).

### Selective short-circuit (S)

The selective short-circuit protection S can be set with two different types of curves with a trip time that is independent of the current ( $t=k$ ) or with a constant specific let-through energy ( $t = k/I^2$ ).

Seven current thresholds and 4 curves are available, labeled A, B, C, D. Each curve is identified as follows:

- for curves ( $t = k$ ) by the trip time for  $I > I_2$
- for curves  $t = k/I^2$  by the trip time for  $I = 8 \times I_n$  ( $I_n$ =rated current of the current transformer).

The function can be excluded by setting the DIP switches to the combination labeled "OFF".

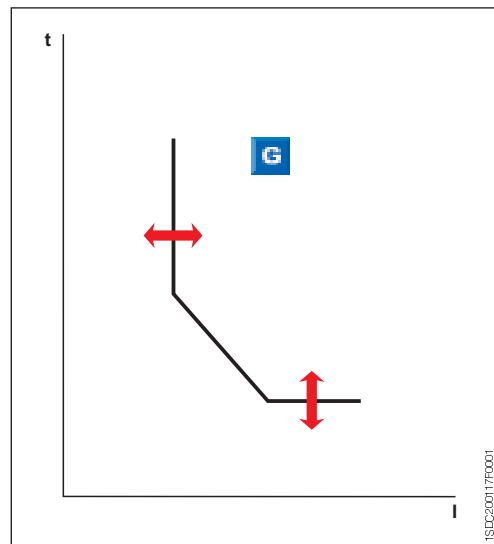
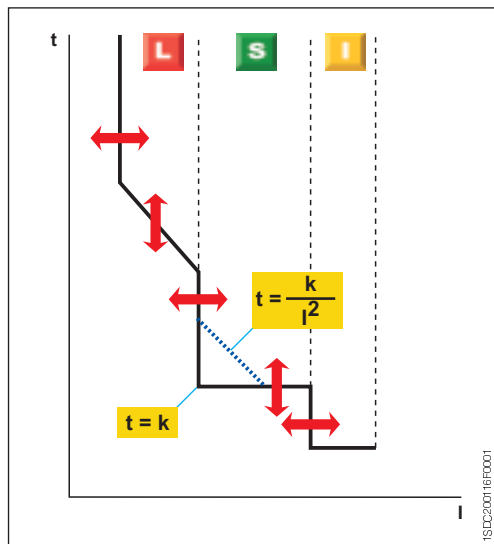
### Adjustable instantaneous short-circuit (I)

The protection I offers 7 trip thresholds and may be excluded (dip switches in "OFF" position).

### Earth fault (G)

The inverse short time-delay trip earth fault protection G (which can be excluded) offers 7 current thresholds and 4 curves labeled A, B, C, D. Each curve is identified by the time  $t_4$  in relation to current  $I_4$  as shown in the diagram on the front of the release.

Note: the function G is repressed for fault current values  $I > 4 \times I_n$  ( $I_n$ =rated current of the CT).





# Microprocessor-based protection releases and trip curves

## PR111/P

### User interface

The user communicates with the release in the trip parameter preparation stage by means of the dip switches.

Two LEDs are also available for alarm signalling (timing start) for the L and S functions respectively.

### Setting the neutral

Protection of the neutral is available at 50% in the standard version or at 100% (version which can be supplied on request for E1-E2-E3-E4/f and E6/f), of the phase currents.

### Test Function

The Test function is carried out by means of the pocket-sized SACE TT1 Trip Test unit, fitted with a two-pole polarized connector housed on the bottom of the box, which allows the device to be connected to the test input sockets on the front of PR111/P releases.

A complete test of the PR111/P microprocessor-based electronic release can be carried out using the special SACE PR010/T apparatus by applying it to the TEST connector.

All the release functions can be checked by means of this unit.

### Versions available

The following versions are available:



PR111/P LI







PR111/P LSI



PR111/P LSIG

## Protection functions and setting values - PR111

Function	Trip threshold	Trip time	Can be excluded	Relation $t=f(I)$
 Overload protection	$I1 = 0.4 - 0.5 - 0.6 - 0.7 - 0.8 - 0.9 - 0.95 - 1 \times I_n$	With current $I = 6 \times I1$ $t1 = 3 \text{ s (curve A), } 6 \text{ s (curve B), } 12 \text{ s (curve C), } 18 \text{ s (curve D)}$	–	$t=k/I^2$
	Tolerance <sup>(1)</sup> Release between 1.1 and 1.2 x I1	$\pm 10\% \quad I_g \leq 3 \times I_n$ $\pm 20\% \quad I_g > 3 \times I_n$		
 Selective short-circuit protection	$I2 = 1 - 2 - 3 - 4 - 6 - 8 - 10 \times I_n$	With current $I = 8 \times I_n$ $t2 = 0.05 \text{ s (curve A), } 0.10 \text{ s (curve B), } 0.25 \text{ s (curve C), } 0.5 \text{ s (curve D)}$	■	$t=k/I^2$
	Tolerance <sup>(1)</sup> $\pm 10\%$	$\pm 20\%$		
	$I2 = 1 - 2 - 3 - 4 - 6 - 8 - 10 \times I_n$	With current $I > I2$ $t2 = 0.05 \text{ s (curve A), } 0.10 \text{ s (curve B), } 0.25 \text{ s (curve C), } 0.5 \text{ s (curve D)}$	■	$t=k$
Tolerance <sup>(1)</sup> $\pm 10\%$	The better of the two figures: $\pm 20\% \text{ or } \pm 50 \text{ ms}$			
 Instantaneous short-circuit protection	$I3 = 1.5 - 2 - 4 - 6 - 8 - 10 - 12 \times I_n$	Instantaneous	■	$t=k$
	Tolerance <sup>(1)</sup> $\pm 20\%$	$\leq 35 \text{ ms } I_g \leq 3 \times I_n$ $\leq 30 \text{ ms } I_g > 3 \times I_n$		
 Earth fault protection	$I4 = 0.2 - 0.3 - 0.4 - 0.6 - 0.8 - 0.9 - 1 \times I_n$	With current $I = 4 \times I4$ $t4 = 0.1 \text{ s (curve A), } 0.2 \text{ s (curve B), } 0.4 \text{ s (curve C), } 0.8 \text{ s (curve D)}$	■	$t=k/I^2$
	Tolerance <sup>(1)</sup> $\pm 10\%$	$\pm 20\%$		

(1) These tolerances hold in the following conditions:  
 - self-powered relay at full power (without start-up)  
 - two- or three-phase power supply

The following tolerance values apply in all cases not covered by the above:

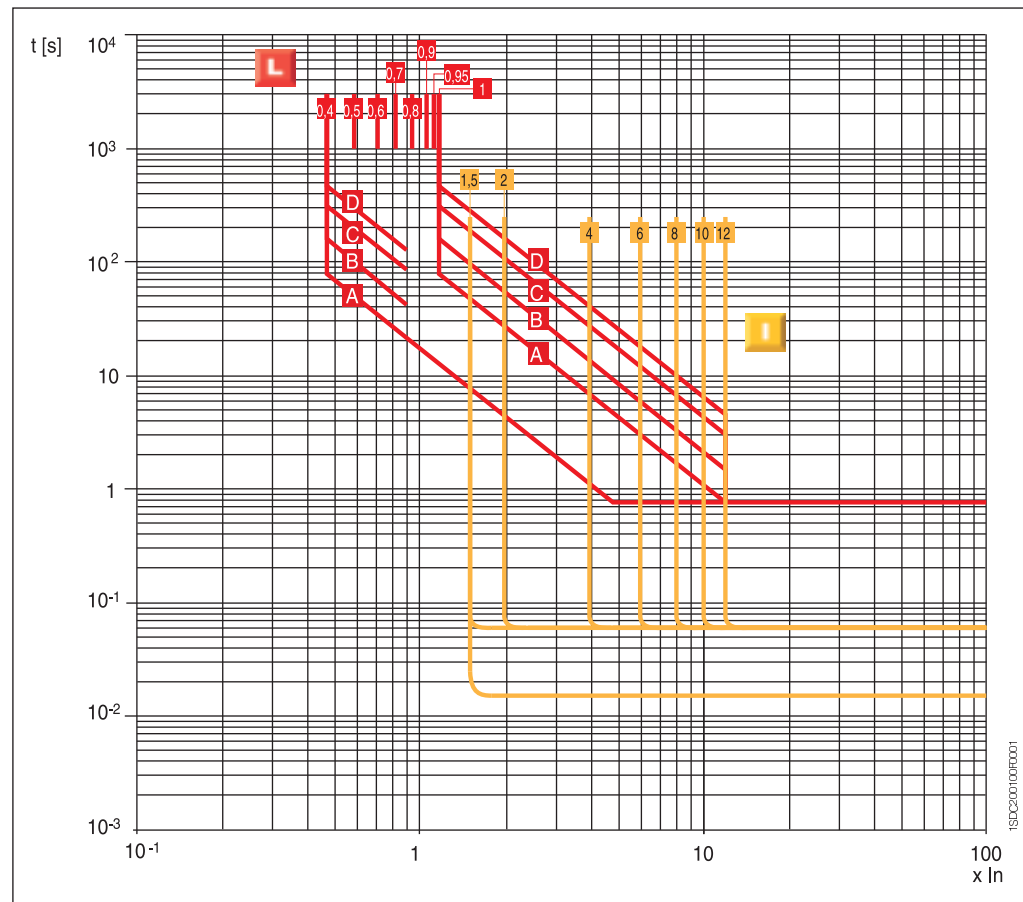
Function	Trip threshold	Trip time
L	Release between 1.1 and 1.25 x I1	$\pm 20\%$
S	$\pm 10\%$	$\pm 20\%$
I	$\pm 20\%$	$\leq 60\text{ms}$
G	$\pm 15\%$	$\pm 20\%$



# Microprocessor-based protection releases and trip curves

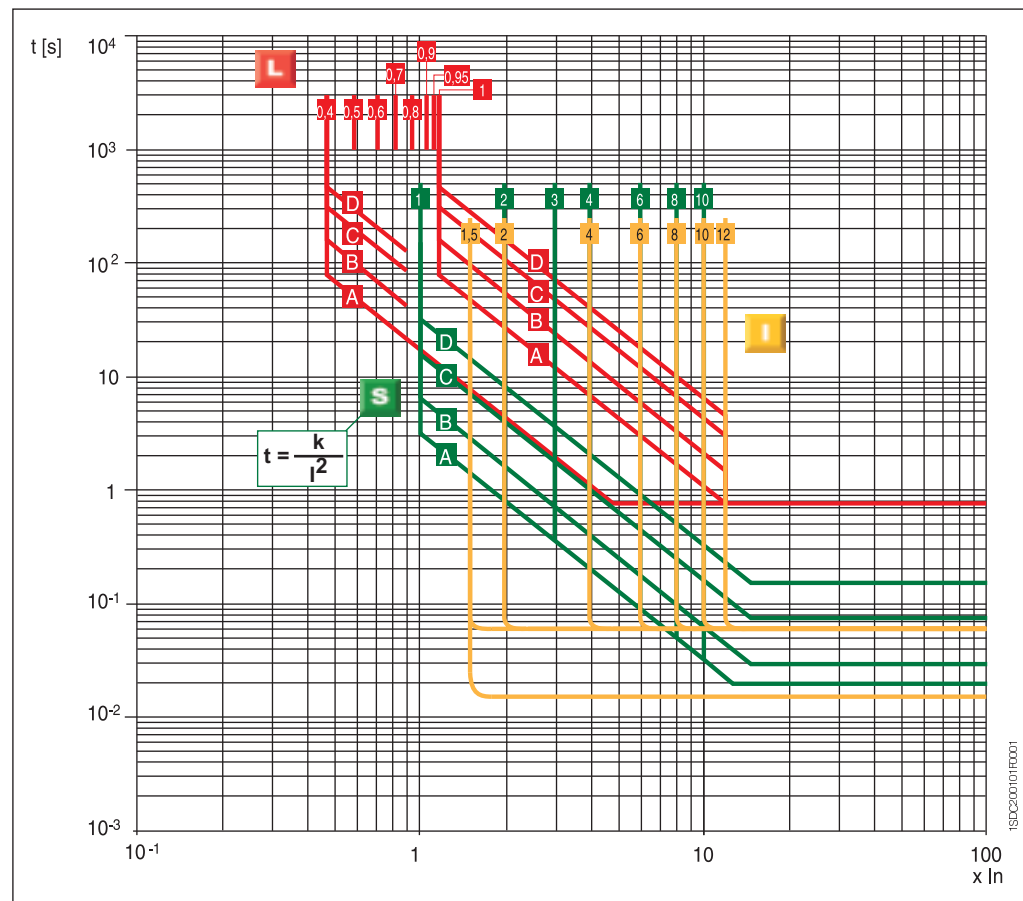
PR111/P

## Functions L-I



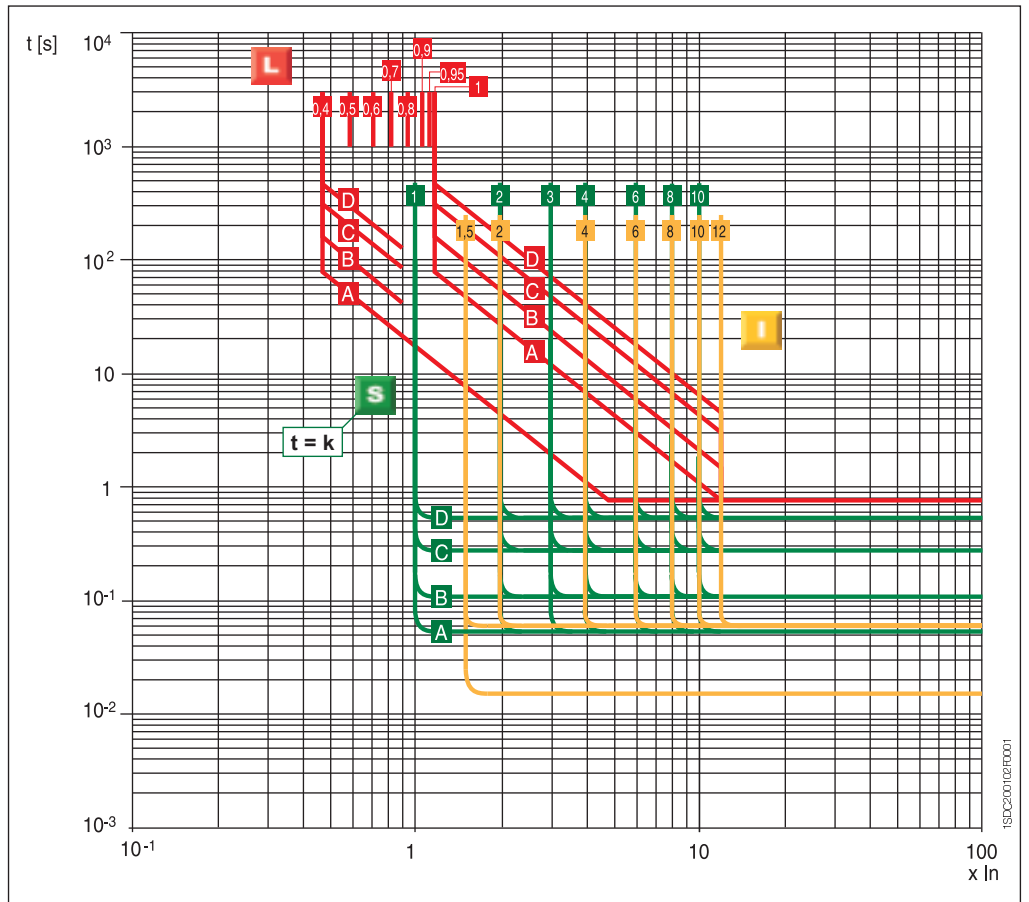
4

## Functions L-S-I

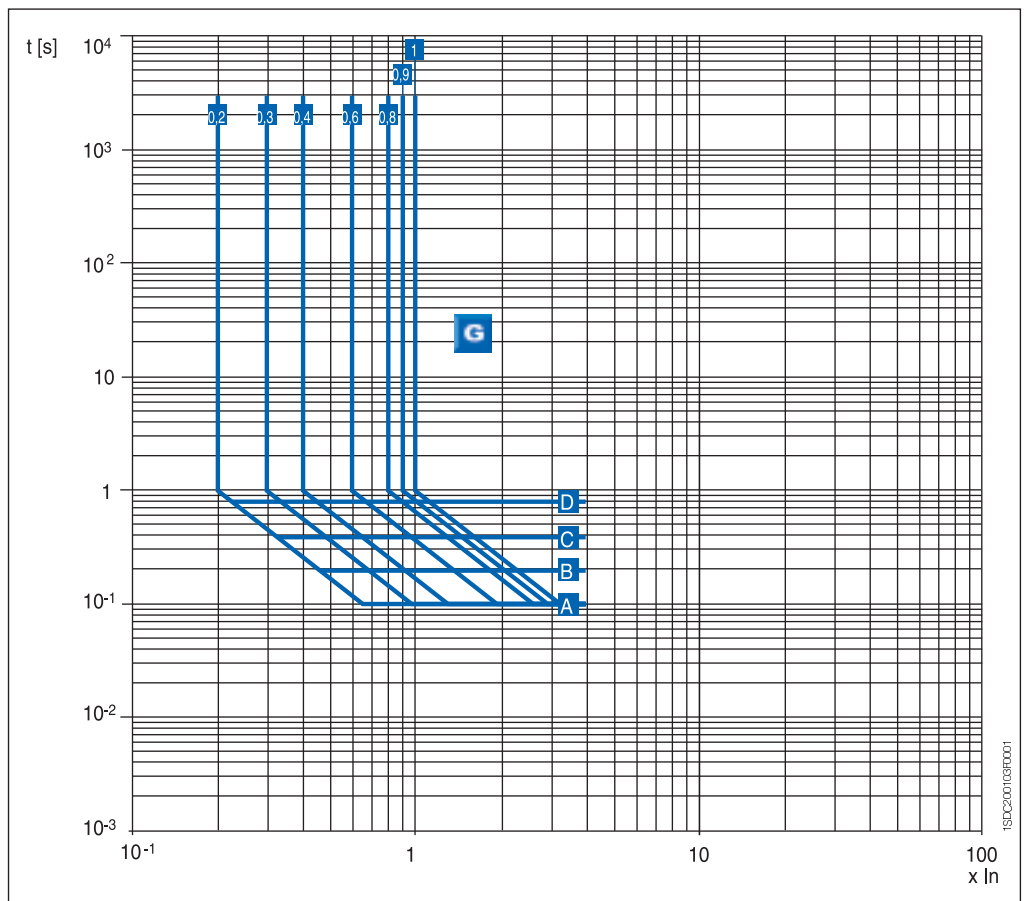


Tolerances on thresholds and trip times ..... page 4/5

## Functions L-S-I



## Functions G



Tolerances on thresholds and trip times ..... page 4/5



# Microprocessor-based protection releases and trip curves

## PR112/P

### Characteristics

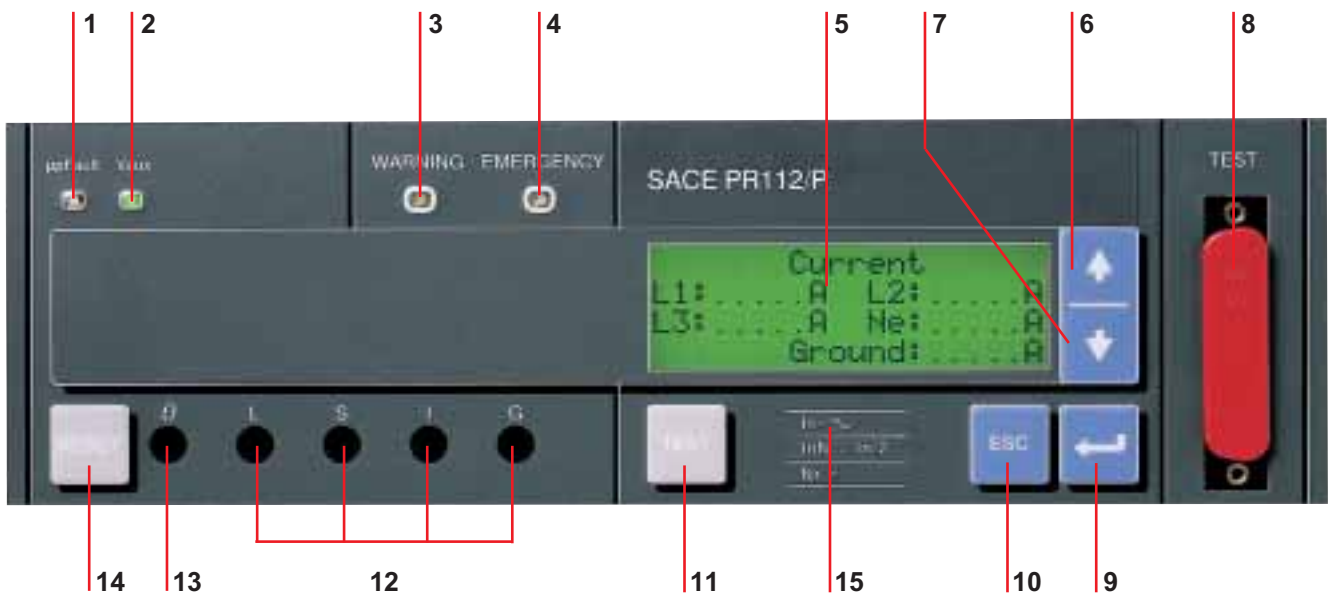
The SACE PR112 release is a sophisticated protection system using microprocessor technology. It comprises the PR112/P protection unit and, on request, the PR112/PD protection and dialogue unit. In this case both versions are available: the PR112/PD LON for the LON® communication protocol, and PR112/PD Modbus for the Modbus® protocol.

The wide range of settings makes this protection unit ideal for general use in any type of installation.

Consulting information and programming is extremely easy using a keyboard and alphanumeric liquid crystal display.

An ammeter function and many additional functions are provided over and above the protection functions. These additional functions can be further increased with the addition of the dialogue and signalling unit.

4



#### Legend

- 1 Microprocessor fault indicator LED
- 2 Auxiliary power supply indicator LED
- 3 Pre-alarm indicator LED
- 4 Alarm indicator LED
- 5 Backlit alphanumeric display
- 6 Cursor UP button
- 7 Cursor DOWN button
- 8 TEST connector to link to SACE PR010/T and SACE PR120/B external accessory units
- 9 ENTER button to confirm data or change pages
- 10 Button to exit submenus or cancel operations (ESC)
- 11 TEST button
- 12 Magnetic devices to signal protection functions L, S, I, G tripped
- 13 Magnetic device to signal excessive release case temperature rise
- 14 Key for resetting the magnetic signalling devices and protection device tripped signalling contact (RESET)
- 15 Rating plate indicating the rated current of the CTs and neutral plus the release serial number

## Operation, protection functions and self-test

### Power supply

The PR112 release does not normally require any external power supplies, being self-powered from the current transformers (CT): to activate the protection and ammeter functions, it is sufficient for at least one phase to have a current load equivalent to 35% of the rated current of the CTs (20% in cases where two phases are powered, 15% for three phases). In order for the display to come on, at least one phase must have a current load equivalent to 50% of the rated current of the CTs, 30% if two phases are powered and 20% for three phases.

The unit ensures fully self-powered operation; when an auxiliary power supply is present, it is also possible to use the unit with the circuit-breaker open or closed.

It is also possible to use an auxiliary power supply provided by the PR120/B portable battery unit (always supplied) which allows the protection functions to be set when the release is not self-powered.

A wide range of setting options is available for the thresholds and trip times of all the functions.

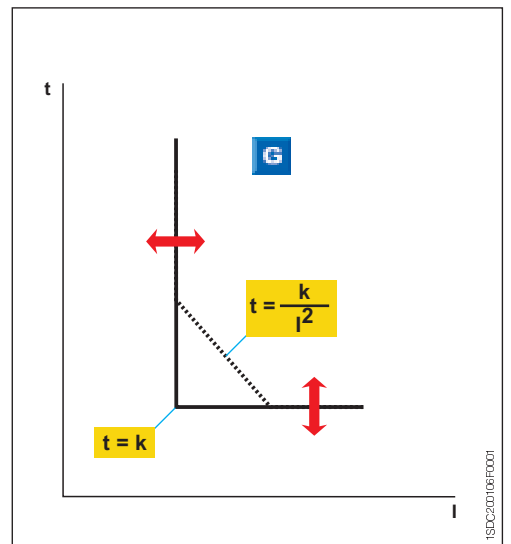
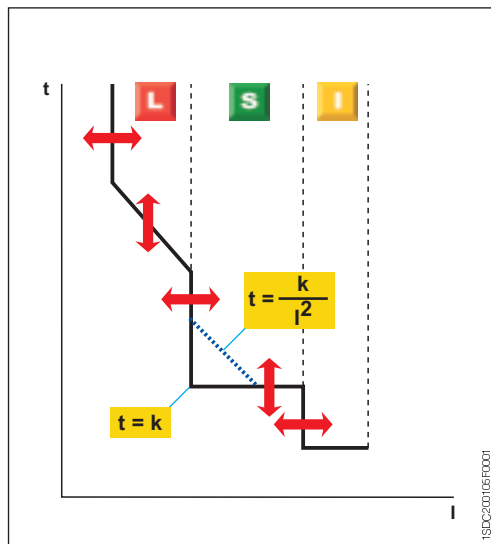
Functions S and G can operate with a time delay that is in-

dependent of the current ( $t = k$ ) or with an inverse time delay (constant specific let-through energy:  $I^2t = k$ ), as required.

Protection against earth faults can also be obtained by connecting the PR112 release to an external toroid located on the conductor that connects the transformer star center to earth (homopolar toroid).

All the thresholds and trip curve delays of the protection functions are stored in special memories which retain the information even if no power is supplied.

	PR112/P	PR112/PD
Auxiliary power supply (galvanically insulated)	24 V DC ± 20%	24 V DC ± 20%
Maximum ripple	5%	5%
Inrush current @ 24V	~3 A for 30 ms	~5 A for 30 ms
Starting current @ 24V	~1.0 A for 150 ms	~1.0 A for 150 ms
Rated current @ 24V	~125 mA	~250 mA
Rated power @ 24V	~3 W	~6 W





# Microprocessor-based protection releases and trip curves

## PR112/P

### Protection functions

The PR112 release offers the following protection functions:

- overload (L)
- selective short-circuit (S)
- instantaneous short-circuit (I)
- earth fault (G) (Residual or Source ground return: the latter via a toroid installed on the earth connection of the main power supply)
- self-protection against overtemperature (OT)
- thermal memory for L and S functions
- zone selectivity for functions S or G

### Setting the neutral

The neutral protection is 50% of the value set for phase protection in the standard version. The neutral protection may be set to 100% for E1, E2, E3, E4/f, E6/f.

### Protection against overtemperature

The range of SACE PR112 releases allows the presence of abnormal temperatures, which could cause temporary or continuous malfunctions of the microprocessor, to be signalled to the user. The user has the following signals or commands available:

- lighting up of the “Warning” LED when the temperature is higher than 70 °C (temperature at which the microprocessor is still able to operate correctly)
- lighting up of the “Emergency” LED when the temperature is higher than 85 °C (temperature above which the microprocessor can no longer guarantee correct operation) and, when decided during the unit configuration stage, simultaneous opening of the circuit-breaker with change-over of the corresponding magnetic signal.

### Zone selectivity for S or G

The zone selectivity function S or G may be activated or deactivated using the keyboard. Protection is provided by connecting together all of the zone selectivity outputs of the releases belonging to the same zone, and bringing this signal to the zone selectivity input of the release just upstream.

### Phase unbalance U

Function U against phase unbalance simply emits a warning signal if an unbalance is detected between two or more phases. This function may be disabled.

### Microprocessor self-diagnosis

The PR112 range of releases contains an electronic circuit which checks operation of the microprocessor of the protection unit in real time (an additional electronic circuit is provided for the PR112/PD unit for checking the microprocessor of the dialogue unit).

In case of a temporary or continuous malfunction, the following two signals are activated:

- lighting up of the LED “ $\mu$ P Fault” (if the 112/PD unit is present, the LED “ $\mu$ P Communication Fault” also lights)
- when there is auxiliary power supply, closure of the “ $\mu$ P Fault” contact.

### Test Functions

Once enabled from the “control” menu, the “TEST” pushbutton on the front of the release allows correct operation of the chain consisting of the microprocessor, opening solenoid and circuit-breaker to be checked.

The control menu also includes the option of testing correct operation of the display, indicator LEDs, magnetic signals and electrical contacts supplied in all versions of the PR112 release.

By means of the front multi-pin connector it is possible to apply a SACE PR010/T Test unit, which allows the functions of the PR111, PR112 and PR113 ranges of releases to be tested and checked.

### User interface

The human-machine interface (HMI) of the device is made up of an alphanumeric display, LEDs, pushbuttons and magnetic flags to signal the release trip causes.

A password system has been installed in this new version to manage “Read” or “Edit” modes. The protection parameters (curves and trip thresholds) may be set directly via the device’s HMI. The parameters may be changed only when the release is operating in “Edit” mode, but the information available and the parameter settings may be checked at any time in “Read” mode. The language may be selected from among five available options: Italian, English, German, French and Spanish.

### Indicator LEDs

LEDs on the front panel of the release are used to indicate pre-alarms (“WARNING”) and alarms (“ALARM”). A message on the display always explicitly indicates the type of event concerned.

Events indicated by the “WARNING” LED:

- unbalance between phases;
- pre-alarm for overload ( $L1 > 90\%$ );
- first temperature threshold exceeded ( $70\text{ °C}$ );
- contact wear beyond 80%.

Events indicated by the “EMERGENCY” LED:

- overload (may begin from  $1.05 \times I1 < I < 1.3 \times I1$  in accordance with the standard IEC 60947-2);
- timing of function L;
- timing of function S;
- timing of function G;
- second temperature threshold exceeded ( $85\text{ °C}$ );
- contact wear 100%.

Other LEDs indicate, respectively:

- “ $\mu$ P Fault”: indicates that the protection unit microprocessor has a temporary (briefly lit) or permanent (steadily lit) fault
- “Vaux”: indicates there is an auxiliary power supply

### Electrical signalling contacts PR112

Three clean contacts provided on all versions of the PR112 release enable electrical signalling of the following :

- contact K51/p1, which may be set to any of the following based on user preference: timing for protections L, S, G; protections L, S, I, G, OT tripped and other events;
- contact K51/Y01, for when any of the protections L, S, I, G is tripped;
- contact K51/ $\mu$ P, for microprocessor with temporary or permanent fault.

#### Note:

The overload and microcontroller fault alarm contacts are available with an external auxiliary power supply.

# Microprocessor-based protection releases and trip curves

## PR112/P

### Resetting trip signals

The “RESET” pushbutton allows local resetting of the protection trip signals (relay tripped contact and magnetic flags).

In the case of remote control, the resetting signal for the protection trip signals can be transmitted by means of a dialogue unit (PR112/PD version) only for relay trip caused by excessive temperature and by overload (L). Trip signals for the other functions (S, I and G) may only be reset locally. When the signal is not reset, the dialogue unit is prevented from actuating the circuit-breaker closing command.

### Load control

The load control function takes place in combination with the PR020/K accessory unit. The function is active only when auxiliary power supply is present.

Alternatively, using two separate curves (with lower threshold currents and trip times than those available for selection with protection L), the load-control function implements the following logics:

- disconnection of two separate loads,
- connection and disconnection of a load.

These functions make it possible to engage/disengage individual downstream loads before the overload protection L is tripped, thereby tripping the upstream circuit-breaker.

### Measuring function

The current measuring function (ammeter) is present on all versions of the SACE PR112 unit. The display shows the currents of the three phases, neutral and earth fault.

The latter current value takes on two different meanings depending on whether the external toroidal transformer for the “Source Ground Return” function or the internal transformer (residual type) is connected.

The ammeter can operate either with self-supply or with auxiliary power supply voltage.

Accuracy of the ammeter measurement chain (current transformer plus ammeter) is no more than 5% in the current interval 30% - 120% of  $I_n$ .

### Versions available

The following versions are available:



PR112/P LSI



PR112/P LSIG



PR112/PD LSI



PR112/PD LSiG

1SDC201081R0001

1SDC201081R0001

## Protection functions and setting values - PR112

Function	Trip threshold	Threshold steps	Trip Time	Time Step	Can be excluded	Relation t=f(I)	Thermal memory	Zone selectivity
<b>L</b> Overload Tolerance (3)	$I1 = 0,4 \dots 1 \times I_n$ Release between 1,1 and 1,2 x I1	0,01 x I <sub>n</sub>	$t1 = 3 \text{ s} \dots 144 \text{ s}$ $\pm 10\% \text{ } I_g \leq 4 \times I_n$ $\pm 20\% \text{ } I_g > 4 \times I_n$	3 s <sup>(1)</sup>	–	$t = k/I^2$	■	–
<b>S</b> Selective short-circuit protection Tolerance (3)	$I2 = 0,6 \dots 10 \times I_n$ $\pm 7\% \text{ } I_g \leq 4 \times I_n$ $\pm 10\% \text{ } I_g > 4 \times I_n$	0,1 x I <sub>n</sub>	$t2 = 0,05 \text{ s} \dots 0,75 \text{ s}^{(2)}$ The better of the two figures: $\pm 10\% \text{ or } \pm 50 \text{ ms } I_g \leq 4 \times I_n$ $\pm 15\% \text{ or } 50 \text{ ms } I_g > 4 \times I_n$	0,01s	■	$t = k$	–	■
<b>I</b> Instantaneous short-circuit protection Tolerance (3)	$I3 = 1,5 \dots 15 \times I_n$ $\pm 10\% \text{ } I_g \leq 4 \times I_n$ $\pm 15\% \text{ } I_g > 4 \times I_n$	0,1 x I <sub>n</sub>	Instantaneous $\leq 25 \text{ ms}$	–	■	$t = k$	–	–
<b>G</b> Earth fault protection Tolerance (3)	$I4 = 0,2 \dots 1 \times I_n$ $\pm 10\%$	0,02 x I <sub>n</sub>	$t4 = 0,1 \text{ s} \dots 1 \text{ s}$ The better of the two figures: $\pm 10\% \text{ or } \pm 50 \text{ ms } I_g \leq 4 \times I_n$	0,05 s	■	$t = k$	–	■
<b>G</b> Earth fault protection Tolerance (3)	$I4 = 0,2 \dots 1 \times I_n$ $\pm 10\%$	0,02 x I <sub>n</sub>	$t4 = 0,1 \text{ s} \dots 1 \text{ s}$ $\pm 20\%$	0,05 s	■	$t = k/I^2$	–	–
<b>OT</b> Protection against overtemperature	may not be set	–	Instantaneous	–	–	temp=k	–	–

(1) The minimum trip value is 750 ms, regardless of the type of curve set (self-protection)

(2) In addition, if the fixed time trip curve is selected (t=k), it will also be possible to set the trip time t2=minimum time

(3) These tolerances hold in the following conditions:

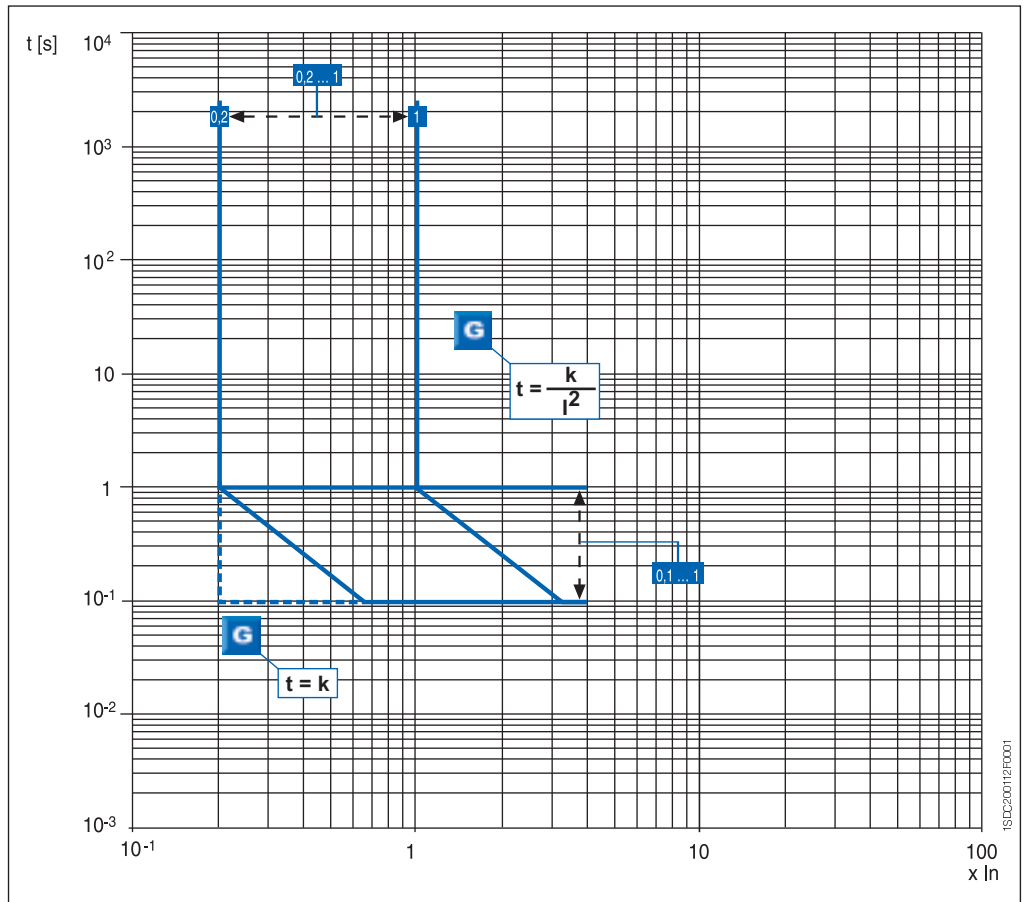
- self-powered relay at full power and/or auxiliary power supply (without start-up)
- two- or three-phase power supply

The following tolerance values apply in all cases not covered by the above:

Function	Trip threshold	Trip time
L	Release between 1.1 and 1.25 x I1	± 20%
S	± 10%	± 20%
I	± 15%	≤ 60ms
G	± 15%	± 20%



# Function G



Tolerances on thresholds and trip times ..... page 4/13

# Microprocessor-based protection releases and trip curves

## PR113/P

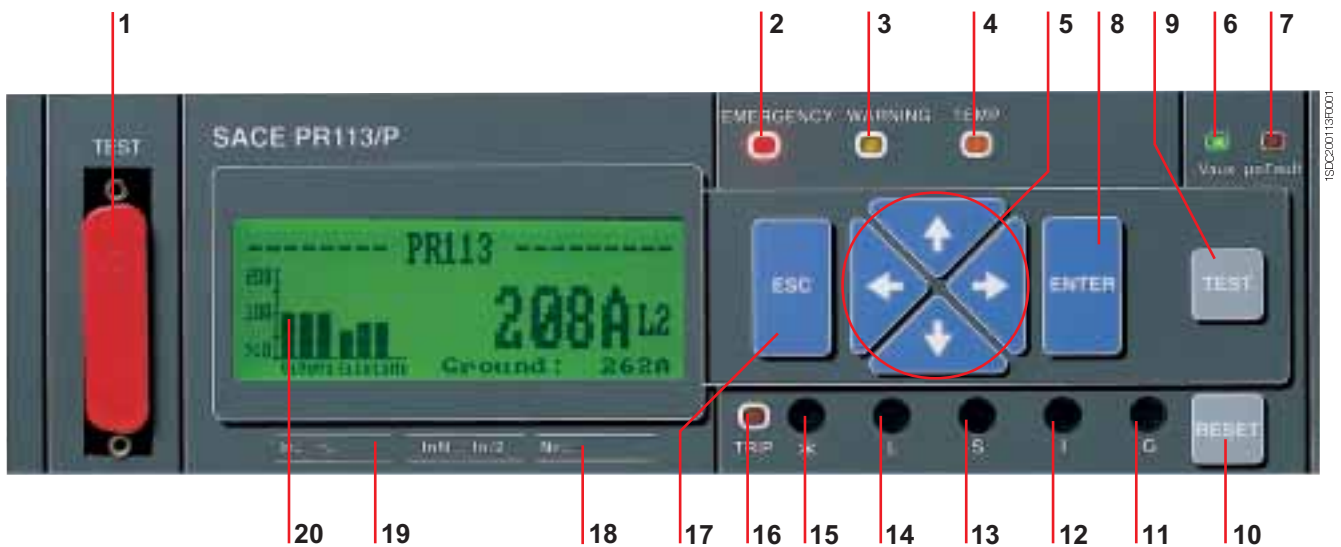
### Characteristics

The PR113 protection release completes the range of available releases for the Emax family of circuit-breakers. It is available in versions PR113/P, for the protection unit, and PR113/PD, fitted with a dialogue unit.

It is a high-performance and extraordinarily versatile release that can offer a complete set of functions for protection, measurement, self-monitoring, signalling, data storage and control of the circuit-breaker.

The front interface of the unit is extremely simple thanks to the aid of the graphical liquid crystal display (LCD), which shows diagrams, bar graphs, measurements and sine curves for the various electrical values.

The PR113 release also offers other functions in addition to standard protections, such as protection against under- and overvoltage, residual voltage protection, phase unbalance protection and protection from directional short-circuit (i.e., those used for ring distribution networks).



#### Legend

- |   |  |   |
|---|--|---|
| <p><b>1</b> TEST connector to apply SACE PR120/B or SACE PR010/T accessories</p> <p><b>2</b> Alarm indicator LED</p> <p><b>3</b> Pre-alarm indicator LED</p> <p><b>4</b> Overtemperature alarm indicator LED</p> <p><b>5</b> Buttons to move the cursor and set parameters: UP, DOWN, LEFT, RIGHT</p> <p><b>6</b> Auxiliary power supply indicator LED</p> <p><b>7</b> Microprocessor fault indicator LED</p> <p><b>8</b> ENTER button to enter or confirm data</p> <p><b>9</b> Test button (TEST) and setting values</p> | <p><b>10</b> Pushbutton to reset magnetic and electrical alarm signals (RESET), end the self-Test or return to the currents page from the Trip page</p> <p><b>11</b> Magnetic signal indicating earth fault protection "G" tripped</p> <p><b>12</b> Magnetic signal indicating instantaneous short-circuit protection "I" tripped.</p> <p><b>13</b> Magnetic signal indicating protection functions "S" or "D" tripped</p> <p><b>14</b> Magnetic signal indicating overload protection "L" tripped</p> | <p><b>15</b> Magnetic signal indicating that one of the following protections is tripped: undervoltage, overvoltage, residual voltage, reverse power, phase unbalance, overtemperature</p> <p><b>16</b> "TRIP" indicator LED</p> <p><b>17</b> Button to exit submenus or cancel operations (ESC)</p> <p><b>18</b> Serial number of the unit</p> <p><b>19</b> Rating plate indicating the rated current of the CTs and neutral</p> <p><b>20</b> Backlit graphics display</p> |
|---|--|---|

## Operation, protection functions and self-test

### Power supply

The PR113 release does not require auxiliary power supply for its protection functions: it draws the energy it needs for operation from the current transformers (CT) installed on the circuit-breaker. Indeed, for the protections to operate, it is sufficient for at least one phase to be powered at 35% of the rated current of the CTs (20% of the current if two phases are powered, and 15% for three phases). Instead, in order for the display to come on, at least one phase must have a current load equivalent to 50% of the rated current of the CTs (30% if two phases are powered and 20% for three phases).

Complete operation of the protection unit may be guaranteed by providing an auxiliary power supply capable of monitoring the functions and protections, including: zone selectivity, load control, measuring and calculating harmonics, energy and maintenance.

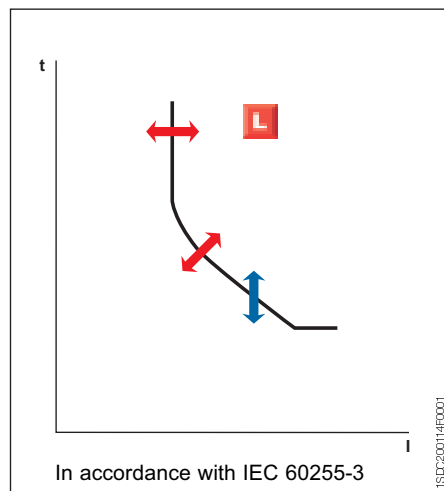
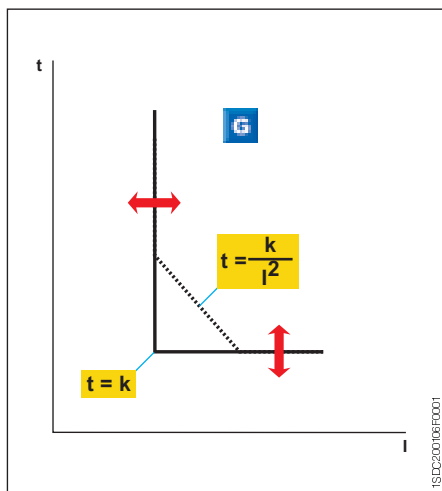
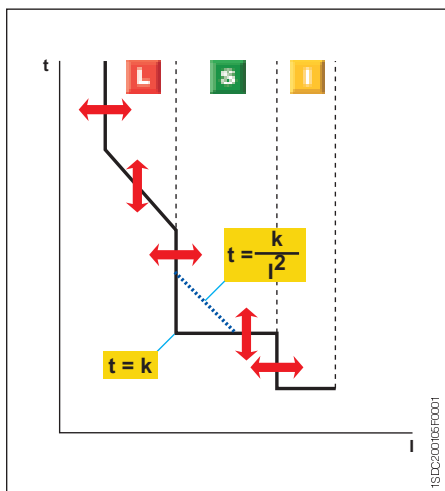
Auxiliary power is available through the SACE PR120/B accessory, always supplied, which makes it possible to read data and program the releases in the event of:

- circuit-breaker not powered
- circuit-breaker unavailable for power
- withdrawable circuit-breaker in racked-out position.

The earth fault protection may also be obtained by connecting the PR113 release to an external toroid located on the conductor that connects the transformer star center to earth (homopolar toroid).

All the thresholds and trip curve delays of the protection functions are stored in special memories which retain the information even if no power is supplied.

	PR113/P	PR113/PD
Auxiliary power supply (galvanically insulated)	24 V DC ± 20%	24 V DC ± 20%
Maximum ripple	5%	5%
Inrush current @ 24V	~3 A for 30 ms	~5 A for 30 ms
Starting current @ 24V	~1.0 A for 150 ms	~1.0 A for 150 ms
Rated current @ 24V	~200 mA	~310 mA
Rated power @ 24V	~5 W	~8 W





# Microprocessor-based protection releases and trip curves

## PR113/P

### Protection functions

The PR113 release offers the following protection functions:

- overload (L),
- selective short-circuit (S),
- instantaneous short-circuit (I),
- earth fault with adjustable delay (G),
- directional short-circuit with adjustable delay (D)<sup>(1)</sup>,
- phase unbalance (U),
- protection against overtemperature (OT),
- load control (K),
- undervoltage (UV)<sup>(1)</sup>,
- overvoltage (OV)<sup>(1)</sup>,
- residual voltage (RV)<sup>(1)</sup>,
- reverse power (RP)<sup>(1)</sup>

**Note (1):** For these protections it is necessary to use a set of three external voltage transformers.

Shielded Voltage Transformers			
Rated Primary Voltage ANSI/IEC	(Un)	[V]	[100, 115, 120, 190, 208, 220, 230, 240, 277, 347, 380, 400, 415, 440, 480, 500, 550, 600, 660, 690, 910, 950, 1000] / $\sqrt{3}$
Rated Secondary Voltage (recommended)	(Us)	[V]	100/ $\sqrt{3}$
Precision class			0,5
Primary winding resistance		[Ohm]	> 600
Load resistance		[kOhm]	$\geq 10$
Overload			20% permanent
Insulation		[kV]	4 between IN and OUT 4 between shield and IN (the shield must be earthed) 4 between shield and OUT (the shield must be earthed)
Frequency		[Hz]	$45 \leq f \leq 66$

Note: sample choice of the voltage transformer.

For maximum measuring performance in installations with rated phase-phase voltage 690V AC it is necessary to use a voltage transformer with

$$U_n = 690/\sqrt{3}$$

$$\text{Class} = 0,5$$

**Notes:**

The directional short-circuit protection can be disabled for an adjustable set time ( $t = k$ ), and may either be self-powered or use the auxiliary power supply. Directional protection is not available on the 250A and 400A CTs.

**Overload protection L**

With the PR113 unit, the overload protection L includes the option to adjust the slope of the protection curve. This adjustment allows perfect coordination with fuses or with medium-voltage protection systems.

**Directional short-circuit protection with adjustable delay D**

The protection works in a similar way to the fixed-time protection “S”, with the added ability to recognize the direction of the phases current during the fault period.

The current direction makes it possible to determine whether the fault is upstream or downstream of the circuit-breaker; particularly in ring distribution systems, this makes it possible to identify and disconnect the distribution segment where the fault has occurred, while keeping the rest of the installation running. If multiple PR112 or PR113 releases are used, this protection may be associated with zone selectivity.

**Phase unbalance protection U**

Protection function U, against phase unbalance, is used in those situations requiring especially accurate control over missing and/or unbalanced phase currents. This function can be excluded.

**Load control function K**

There are two separate curves with threshold currents and trip times lower than those available for selection with the protection L, which may be used for the two applications:

- disconnection of two separate loads;
- connection and disconnection of a load.

These functions make it possible to engage/disengage individual loads before the overload protection L is tripped and definitively opens the circuit-breaker.

The load control may be activated directly through the programmable contacts, or using the load control and signalling device PR020/K.

**Voltage protections UV, OV, RV**

The PR113 unit offers three types of voltage protection, which may be excluded:

- undervoltage (UV),
- overvoltage (OV),
- residual voltage (RV).

The residual voltage protection RV identifies interruptions of the neutral (or of the earthing conductor in systems with earthed neutral) and faults that shift the star center in systems with insulated neutral (e.g., large earth faults). The star center shift is calculated as a vector sum of the phase voltages.

With the circuit-breaker closed, these protections also operate when the release is self-powered. With the circuit-breaker open they operate only when the auxiliary power supply is present: in this case the release will indicate the “ALARM” status.



# Microprocessor-based protection releases and trip curves

## PR113/P

### Reverse power protection RP

Reverse power protection is especially suited for protecting large machines such as engines and generators. The PR113 unit can analyze the direction of the active power and open the circuit-breaker if the direction is opposite to normal operation. The reverse power threshold and the trip time are adjustable.

### Setting the neutral

The neutral protection is normally set to a current value equivalent to 50% of the phase setting. In installations where very high harmonics occur, the resulting current at the neutral may be higher than that of the phases.

This protection may be set for the following values on the PR113 release:

$$I_{1N} = 50\% - 100\% - 150\% - 200\% \times I_1$$

The table below lists the neutral settings for the various possible combinations between type of circuit-breaker and the setting of threshold  $I_1$ .

Adjustable neutral protection settings			
Circuit-breaker size	Threshold $I_1$ settings (overload protection)		
	$0,4 \leq I_1 \leq 0,5$	$0,5 < I_1 \leq 0,66$	$0,66 < I_1 \leq 1^{(*)}$
E1B	50-100-150-200%	50-100-150%	50-100%
E1N	50-100-150-200%	50-100-150%	50-100%
E2B	50-100-150-200%	50-100-150%	50-100%
E2N	50-100-150-200%	50-100-150%	50-100%
E2L	50-100-150-200%	50-100-150%	50-100%
E3N	50-100-150-200%	50-100-150%	50-100%
E3S	50-100-150-200%	50-100-150%	50-100%
E3H	50-100-150-200%	50-100-150%	50-100%
E3L	50-100-150-200%	50-100-150%	50-100%
E4S	50-100%	50%	50%
E4H	50-100%	50%	50%
E4S/f	50-100-150-200%	50-100-150%	50-100%
E6H	50-100%	50%	50%
E6V	50-100%	50%	50%
E6H/f	50-100-150-200%	50-100-150%	50-100%

(\*) The setting  $I_1=1$  indicates the maximum overload protection setting. The actual maximum allowable setting must take into account any derating based on temperature, the terminals used and the altitude (see chapter "Installations")

### Start-up function

The start-up function allows the protections S, D, I and G to operate with higher trip thresholds during the start-up phase. This avoids untimely tripping caused by the high inrush currents of certain loads (motors, transformers, lamps).

The start-up phase lasts from 100 ms to 1.5 s, in steps of 0.05 s. It is automatically recognized by the PR113 release as follows:

- when the circuit-breaker closes with self-powered release;
- when the peak value of the maximum current exceeds  $0.1 \times I_n$ ; a new start-up becomes possible after the current has fallen below the threshold of  $0.1 \times I_n$ , if the release is powered by an external source.

### Zone selectivity function

The zone selectivity function permits the fault area to be insulated by very rapidly segregating the system only at the level closest to the fault, while leaving the rest of the installation running. This is done by connecting the releases: the release nearest the fault is instantly tripped, sending a block signal to the other releases affected by the same fault.

The zone selectivity function may be enabled if the fixed-time curve has been selected and the auxiliary power supply is present.

Zone selectivity may be applied with protections S and G or, alternatively, with protection D.

### Contact programming functions

The PR113 release is equipped with two relays, with contacts known as K51/p1 and K51/p2 (the latter is not available on PR113/PD).

They may signal a variety of situations selected by the user, including: protection timing, alarms, cause of opening, temperature thresholds exceeded, zone selectivity, load control, disconnected opening solenoid or CT, harmonic distortion, etc.

### Measuring functions

The PR113 release provides a complete set of measurements:

- Currents: three phases (L1, L2, L3), neutral (Ne), earth fault
- Voltage: phase-phase, phase-neutral, residual voltage<sup>(1)</sup>
- Power: active, reactive, apparent<sup>(1)</sup>
- Power factor<sup>(1)</sup>
- Frequency and peak factor
- Energy: active, reactive, apparent, counter<sup>(1)</sup>
- Harmonics calculation: up to the twentieth harmonic (waveform and module of the harmonics displayed); up to the nineteenth for frequency  $f=60\text{Hz}$
- Maintenance: number of operations, percentage of contact wear, opening data storage.

The PR113 unit is able to provide the pattern of measurements for some values over an adjustable period of time P, such as: mean active power, maximum active power, maximum current, maximum voltage and minimum voltage. The last 24 periods P (adjustable from 5 to 120 min.) are stored in non-volatile memory and displayed in a bar graph.

**Note** (1): These measurements require voltage transformers



# Microprocessor-based protection releases and trip curves

## PR113/P

### Signalling functions

The PR113 unit provides optic signals (via indicator LEDs, magnetic flags and display messages) and electrical signals.

**Optic signals** on the front of the release:

- Vaux LED (green): indicates there is an auxiliary power supply
- $\mu$ P Fault LED (red): indicates a temporary or permanent fault in the microprocessor
- Temp LED (orange): the signal is flashing for internal relay temperatures  $<-20^{\circ}\text{C}$  or  $>+70^{\circ}\text{C}$ , steadily lit for temperatures  $<-25^{\circ}\text{C}$  or  $>+85^{\circ}\text{C}$
- Trip LED (red): with auxiliary voltage only, this lights after the circuit-breaker opens due to tripped protections
- Warning LED (yellow): is a generic pre-alarm signal following the occurrence of any of the conditions listed below:
  - one or more phases with current values in the range of  $0.9 \times I_{11} < I < 1.05 \times I_{11}$  (IEC)
  - two or three phases with unbalance greater than the programmed level for the protection U (phase unbalance), with protection trip disabled
  - distorted waveform with form factor  $>2.1$  (harmonic distortion)
  - contact wear beyond 80%.
  - frequency out of range
  - Warning Threshold exceeded (current pre-alarm threshold settable via the configuration menu)
  - circuit-breaker status error
- Emergency LED (red): it's a generic alarm signal when one of the conditions listed below occurs:
  - one or more phases overloaded with current values  $I > 1.3 \times I_{11}$
  - timing in progress for protection functions: S, I, G, D, UV, OV, RV, RP
  - timing in the event of a phase unbalance greater than the value set, with protection trip set to on
  - contact wear at 100%
  - CTs disconnected
  - opening solenoid disconnected
- Yellow magnetic flag  $\star$  indicates one of the following protections is tripped: undervoltage (UV), overvoltage (OV), residual voltage (RV), reverse power (RP), phase unbalance (U), overtemperature (OT). The release display indicates which protection has been tripped
- Yellow magnetic flag L: indicates protection L tripped
- Yellow magnetic flag S: signals protection S or D tripped
- Yellow magnetic flag I: instantaneous short-circuit protection I is tripped
- Yellow magnetic flag G: earth fault protection G is tripped.

The **electrical signals** refer instead to the contacts:

- K51/p1 and K51/p2, which may be set by the user (with auxiliary power supply only)
- K51/YO1, which signals that one of the following protections is tripped: L, S, D, I, G, U, OT, UV, OV, RV, RP
- K51/ $\mu$ P, to signal temporary or permanent fault of the microprocessor.

In addition to the optic and electrical signals, the PR113 release display also shows messages about incorrect configurations, general alarms, tripped protection functions, load control (with the aid of SACE PR020/K) and password management.

### Versions available

The following versions are available:



PR113/P LSIG



PR113/PD LSIG

1SBC200115F0001

1SBC200115F0001

# Microprocessor-based protection releases and trip curves

PR113/P

## Protection functions and setting values - PR113

Function	Trip threshold	Threshold steps	Trip Time	Time Step	Can be excluded	Relation t=f(I)	Thermal memory	Zone selectivity
<b>L</b> Overload protection Tolerance (3)	$I1 = 0.4 \dots 1 \times I_n$ Release between 1.1 e 1.2 x I1	0.01 x In	$t1 = 3 \text{ s} \dots 144 \text{ s}$ $\pm 10\% \text{ } I_g \leq 4 \times I_n$ $\pm 20\% \text{ } I_g > 4 \times I_n$	3 s <sup>(1)</sup>	–	$t = k/I^2$	■	–
Tolerance	$I1 = 0.4 \dots 1 \times I_n$ 1.1 ... 1.25 x I1 <small>(in accordance with IEC 60255-3)</small>	0.01 x In	$b = 0.2 \dots 10$ $\pm 20\% \text{ } I_g > 5 \times I1$ $\pm 30\% \text{ } 2 \times I1 < I_g < 5 \times I1 \text{ } I_n$	0,1s	–			
<b>S</b> Selective short-circuit protection Tolerance (3)	$I2 = 0.6 \dots 10 \times I_n$ $\pm 7\% \text{ } I_g \leq 4 \times I_n$ $\pm 10\% \text{ } I_g > 4 \times I_n$	0.1 x In	$t2 = 0.05 \text{ s} \dots 0.75 \text{ s}^{(2)}$ The better of the two figures: $\pm 10\% \text{ } 0 \leq 50 \text{ ms } I_g \leq 4 \times I_n$ $\pm 15\% \text{ } 0 \leq 50 \text{ ms } I_g > 4 \times I_n$	0.01s	■	$t = k$	–	■
Tolerance (3)	$I2 = 0.6 \dots 10 \times I_n$ $\pm 7\% \text{ } I_g \leq 4 \times I_n$ $\pm 10\% \text{ } I_g > 4 \times I_n$	0.1 x In	$t2 = 0.05 \text{ s} \dots 0.75 \text{ s}$ $\pm 15\% \text{ } I_g \leq 4 \times I_n$ $\pm 20\% \text{ } I_g > 4 \times I_n$	0.01s	■	$t = k/I^2$	■	–
<b>I</b> Instantaneous short-circuit protection Tolerance (3)	$I3 = 1.5 \dots 15 \times I_n$ $\pm 10\% \text{ } I_g \leq 4 \times I_n$ $\pm 15\% \text{ } I_g > 4 \times I_n$	0,1 x In	Instantaneous $\leq 25 \text{ ms}$	–	■	$t = k$	–	–
<b>G</b> Earth fault protection Tolerance (3)	$I4 = 0.2 \dots 1 \times I_n$ $\pm 7\% \text{ } I_g \leq 4 \times I_n$	0.02 x In	$t4 = 0.1 \text{ s} \dots 1 \text{ s}$ The better of the two figures: $\pm 10\% \text{ } 0 \leq 50 \text{ ms } I_g \leq 4 \times I_n$	0.05 s	■	$t = k$	–	■
Tolerance (3)	$I4 = 0.2 \dots 1 \times I_n$ $\pm 7\% \text{ } I_g \leq 4 \times I_n$	0.02 x In	$t4 = 0.1 \text{ s} \dots 1 \text{ s}$ $\pm 15\%$	0.05 s	■	$t = k/I^2$	–	–
<b>D</b> Directional short-circuit protection Tolerance	$I7 = 0.6 \dots 10 \times I_n$ $\pm 10\%$	0.1 x In	$t7 = 0.20 \text{ s} \dots 0.75 \text{ s}$ $\pm 20\%$	0.01 s	■	$t = k$	–	■
<b>U</b> Phase unbalance protection Tolerance	$I6 = 10\% \dots 90\%$ $\pm 10\%$	10%	$t6 = 0.5 \text{ s} \dots 60 \text{ s}$ $\pm 20\%$	0.5 s	■	$t = k$	–	–
<b>OT</b> Protection against overtemperature	may not be set	–	Instantaneous	–	–	$\text{temp} = k$	–	–
<b>UV</b> Undervoltage protection Tolerance	$I8 = 0.6 \dots 0.95 \times U_n$ $\pm 5\%$	0.01 x In	$t8 = 0.1 \text{ s} \dots 5 \text{ s}$ $\pm 20\%$	0.1 s	■	$t = k$	–	–
<b>OV</b> Overvoltage protection Tolerance	$I9 = 1.05 \dots 1.2 \times U_n$ $\pm 5\%$	0.01 x In	$t9 = 0.1 \text{ s} \dots 5 \text{ s}$ $\pm 20\%$	0.1 s	■	$t = k$	–	–
<b>RV</b> Residual voltage protection Tolerance	$I10 = 0.1 \dots 0.4 \times U_n$ $\pm 5\%$	0.05 Un	$t10 = 0.5 \text{ s} \dots 30 \text{ s}$ $\pm 20\%$	0.5 s	■	$t = k$	–	–
<b>RP</b> Reverse power protection Tolerance	$P11 = -0.3 \dots -0.1 \times P_n$ $\pm 10\%$	0.02 Pn	$t11 = 0.5 \text{ s} \dots 25 \text{ s}$ $\pm 20\%$	0.1 s	■	$t = k$	–	–

(1) The minimum trip value is 750 ms, regardless of the type of curve set (self-protection)

(2) In addition, if the fixed time trip curve is selected ( $t=k$ ), it will also be possible to set the trip time  $t2$ =minimum time

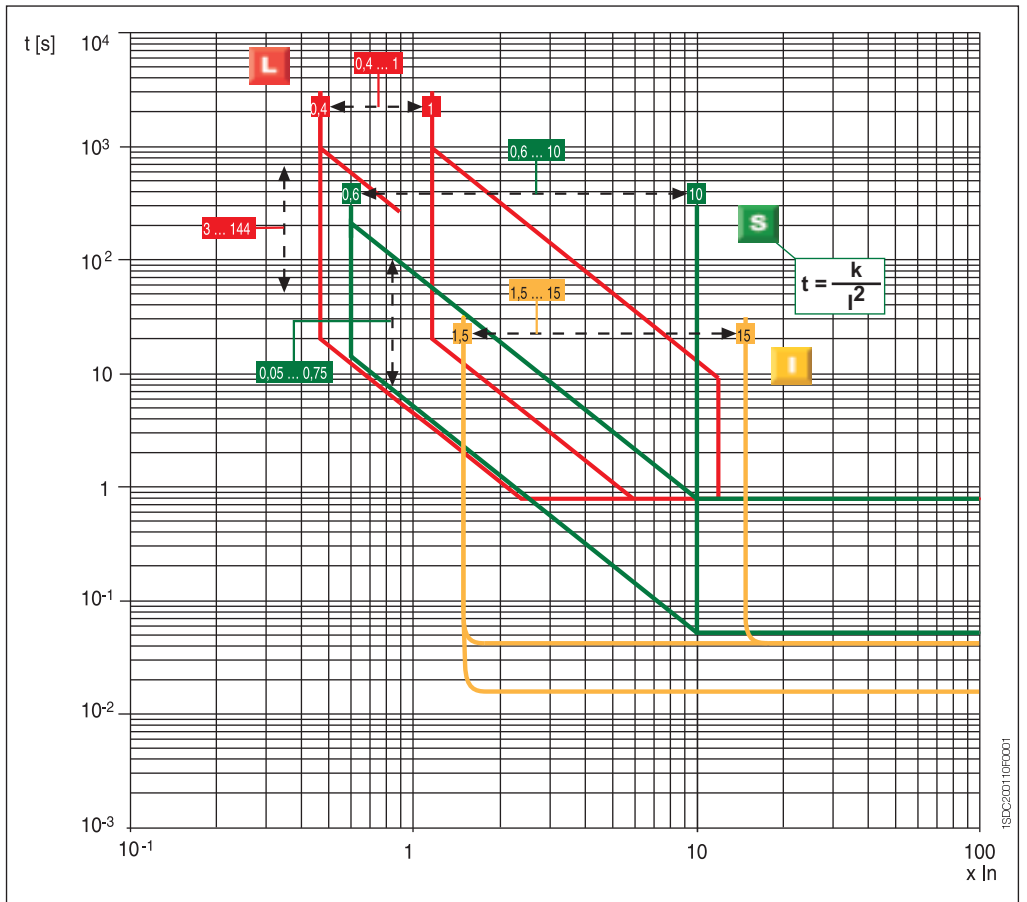
(3) These tolerances hold in the following conditions:

- self-powered relay at full power and/or auxiliary power supply (without start-up)
- two- or three-phase power supply

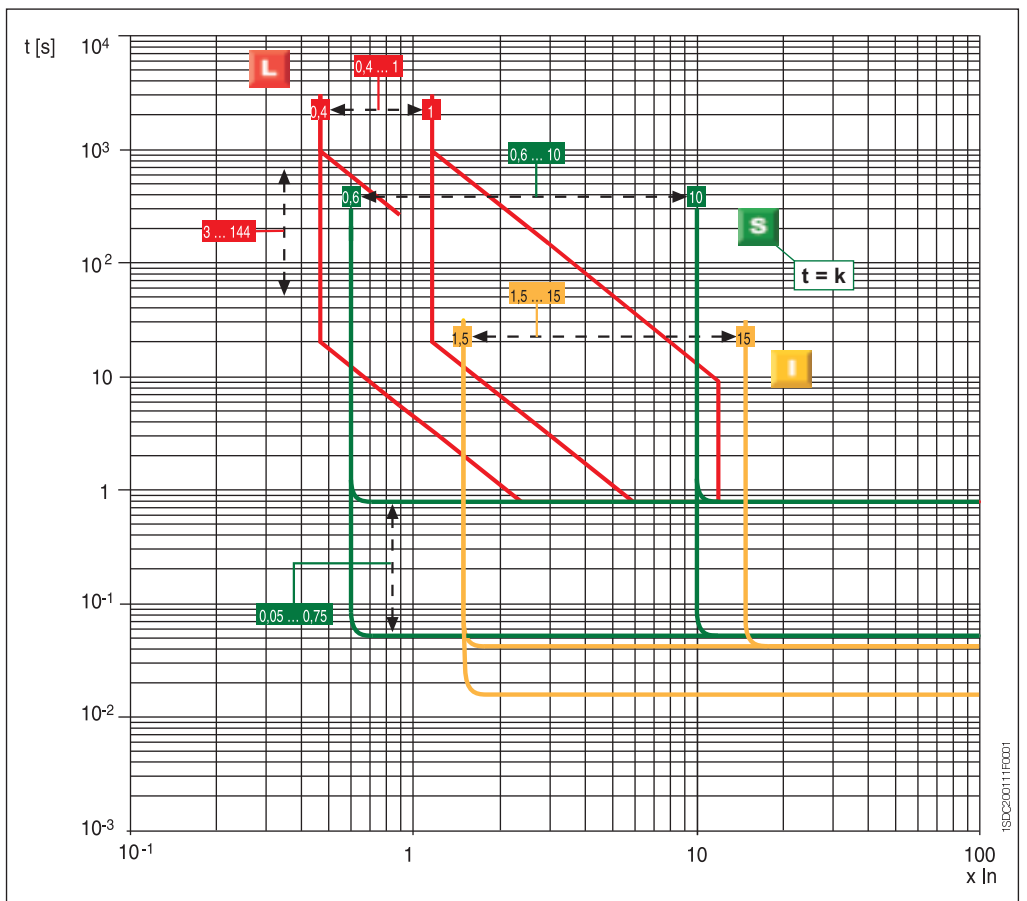
The following tolerance values apply in all cases not covered by the above:

Trip threshold	Trip time
L Release between 1.1 and 1.25 x I1	$\pm 20\%$
S $\pm 10\%$	$\pm 20\%$
I $\pm 15\%$	$\leq 60\text{ms}$
G $\pm 10\%$	$\pm 20\%$

## Functions L-S-I



## Functions L-S-I



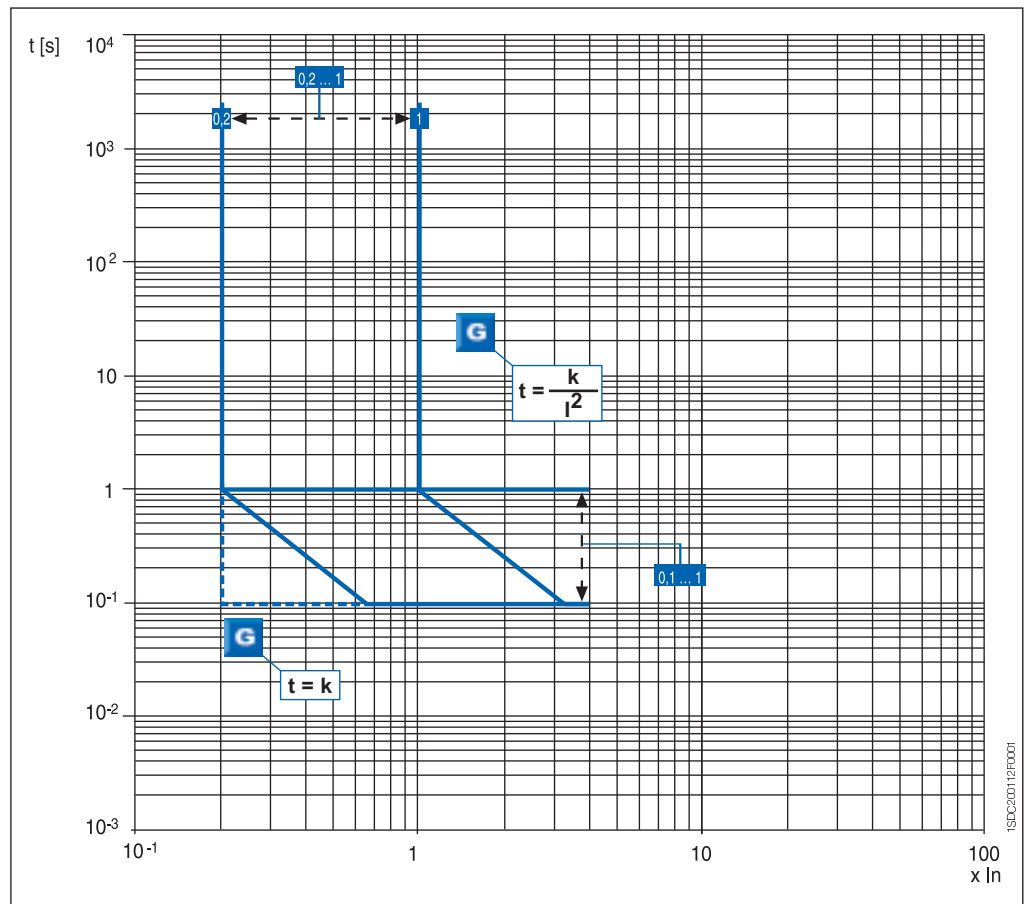
Tolerances on thresholds and trip times ..... page 4/24



# Microprocessor-based protection releases and trip curves

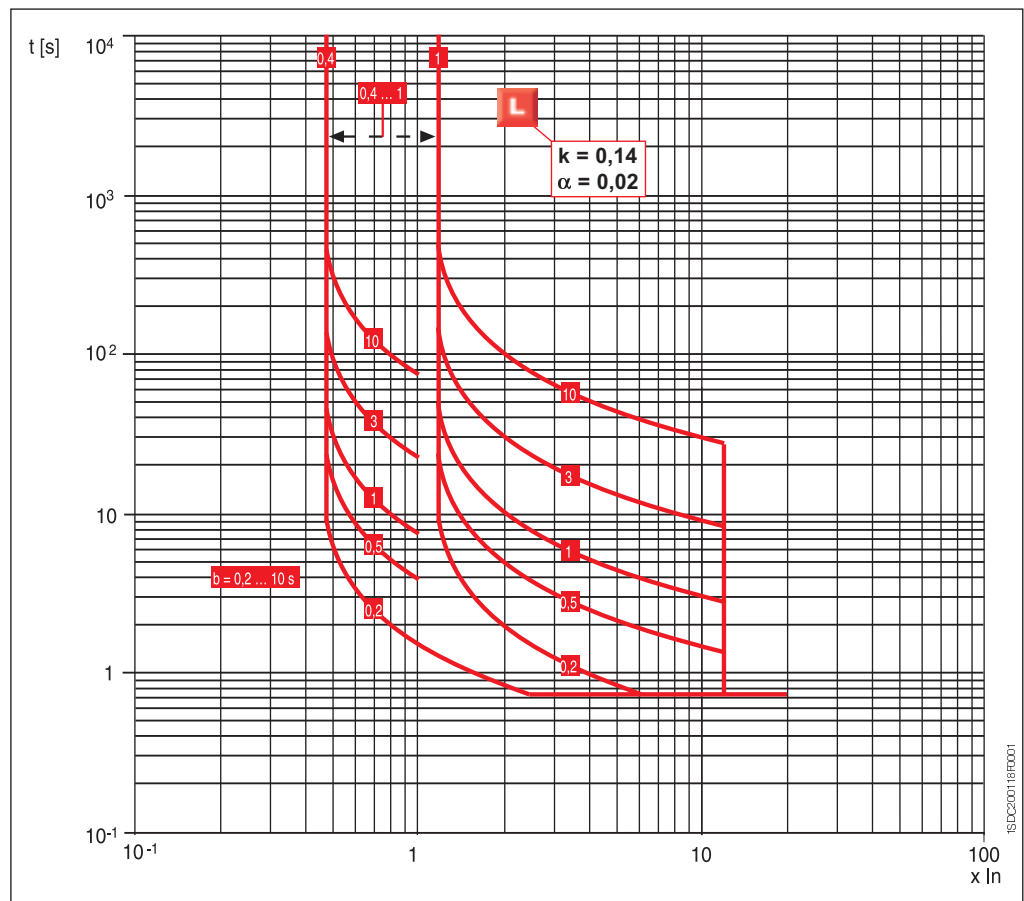
PR113/P

## Function G



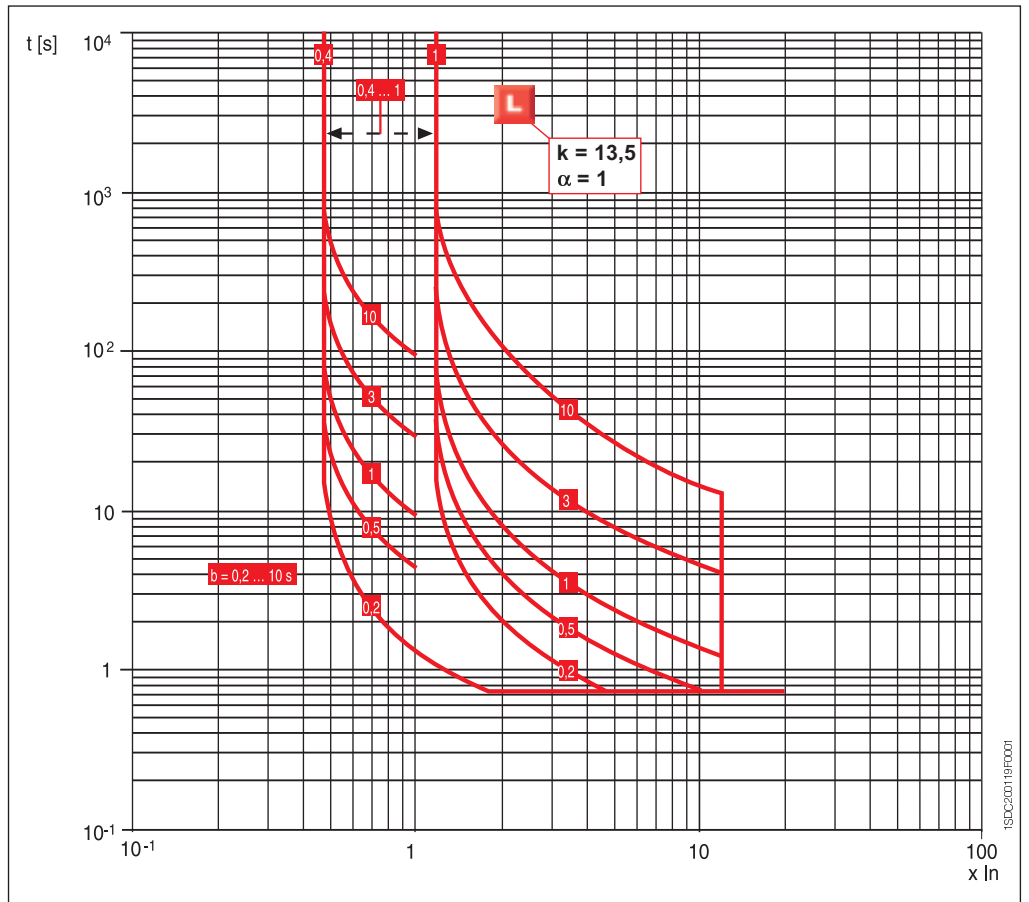
4

## Function L

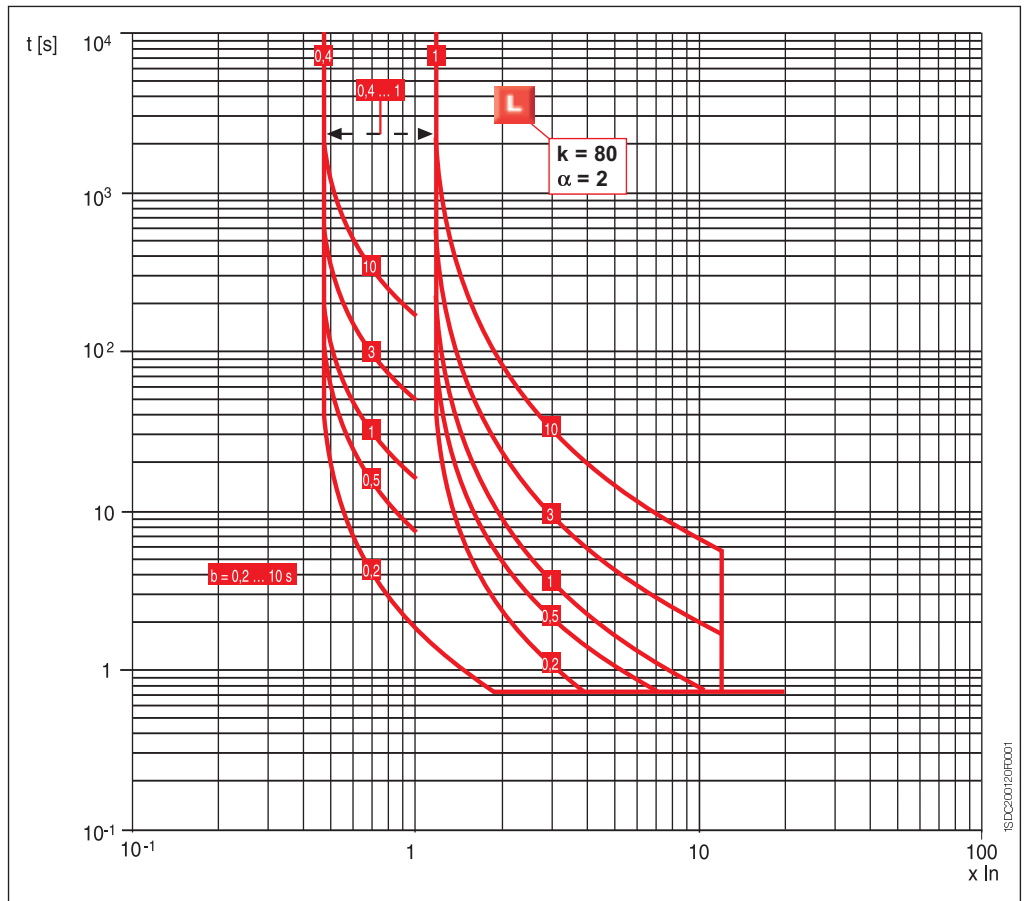


Tolerances on thresholds and trip times ..... page 4/24

## Function L



## Function L



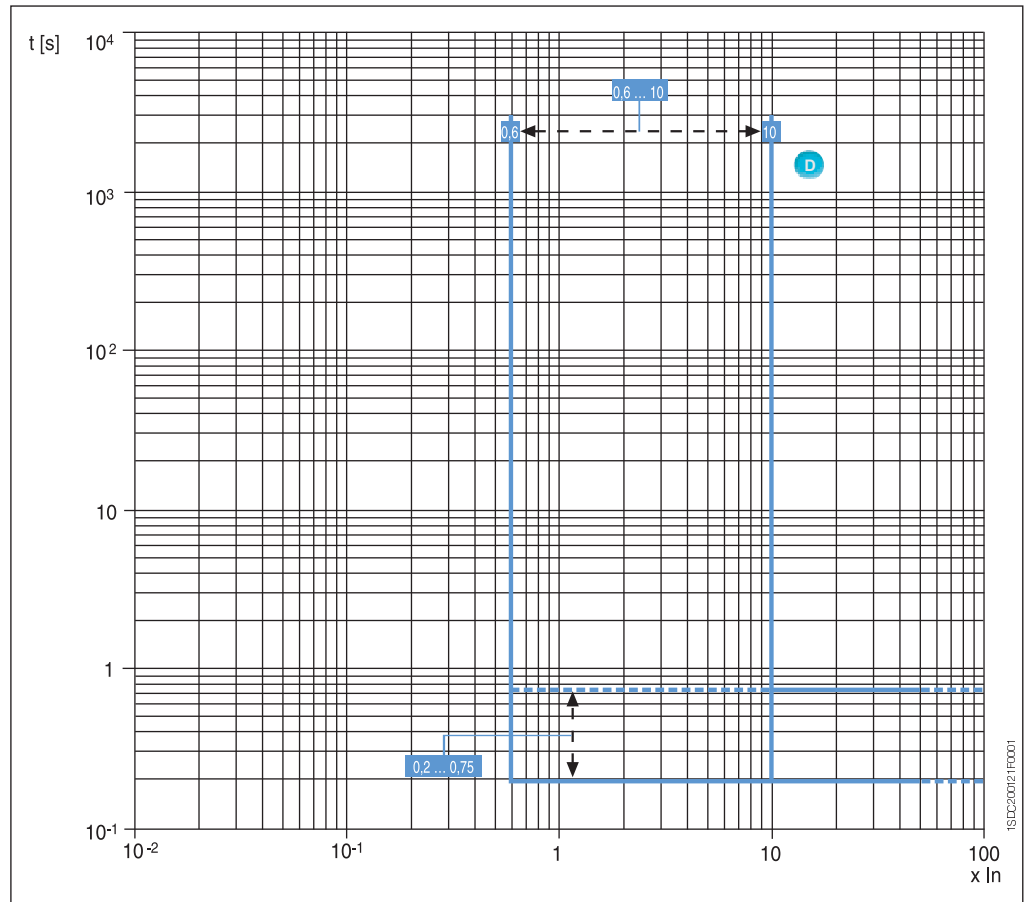
Tolerances on thresholds and trip times ..... page 4/24



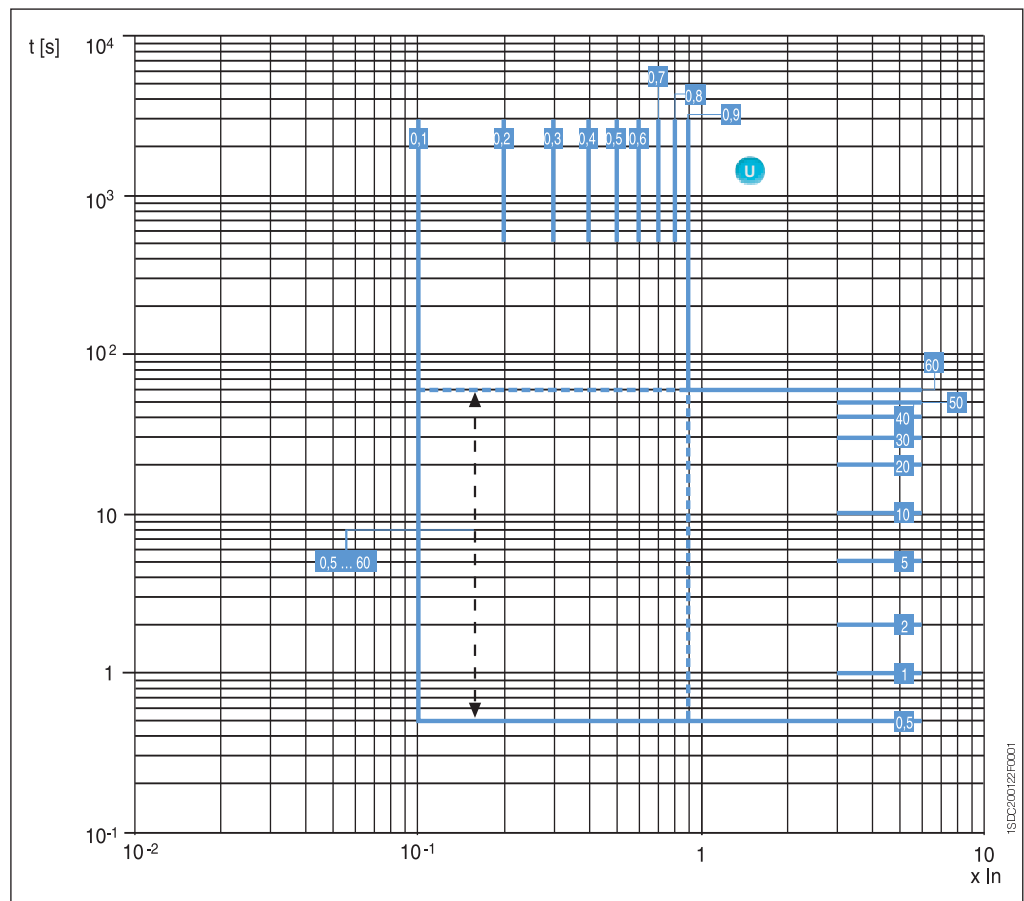
# Microprocessor-based protection releases and trip curves

PR113/P

## Function D

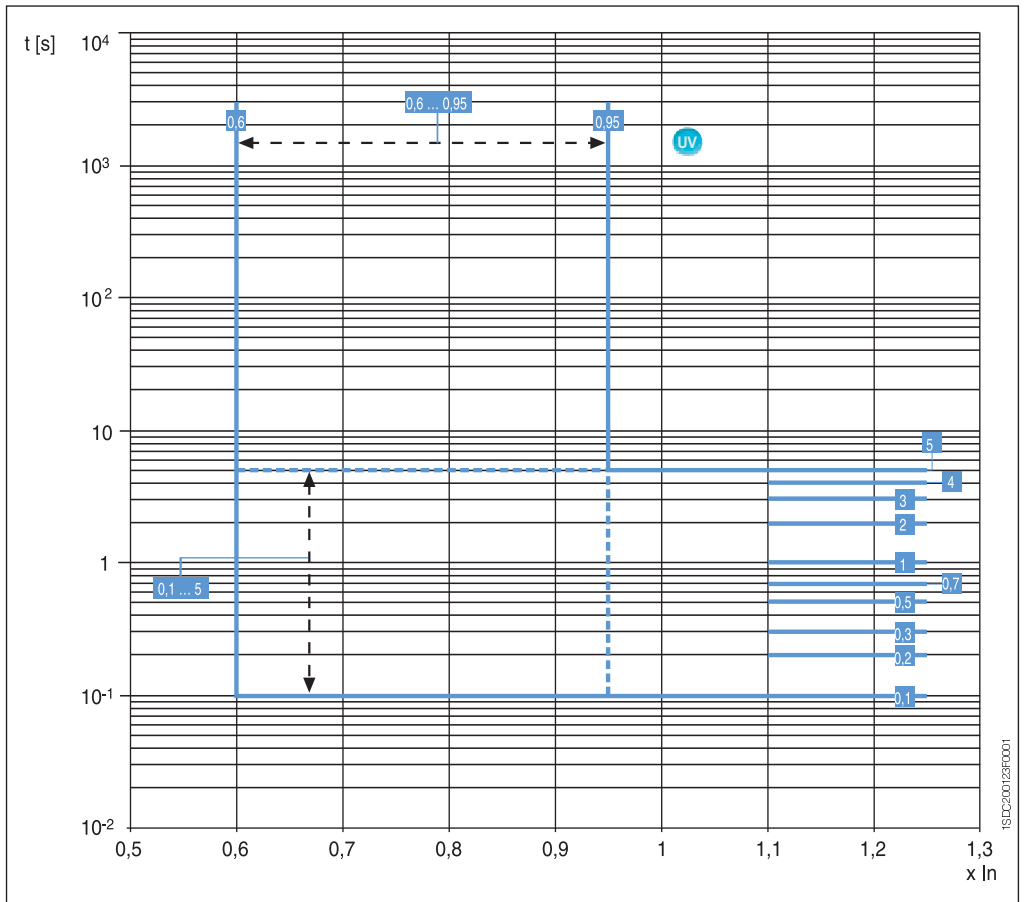


## Function U

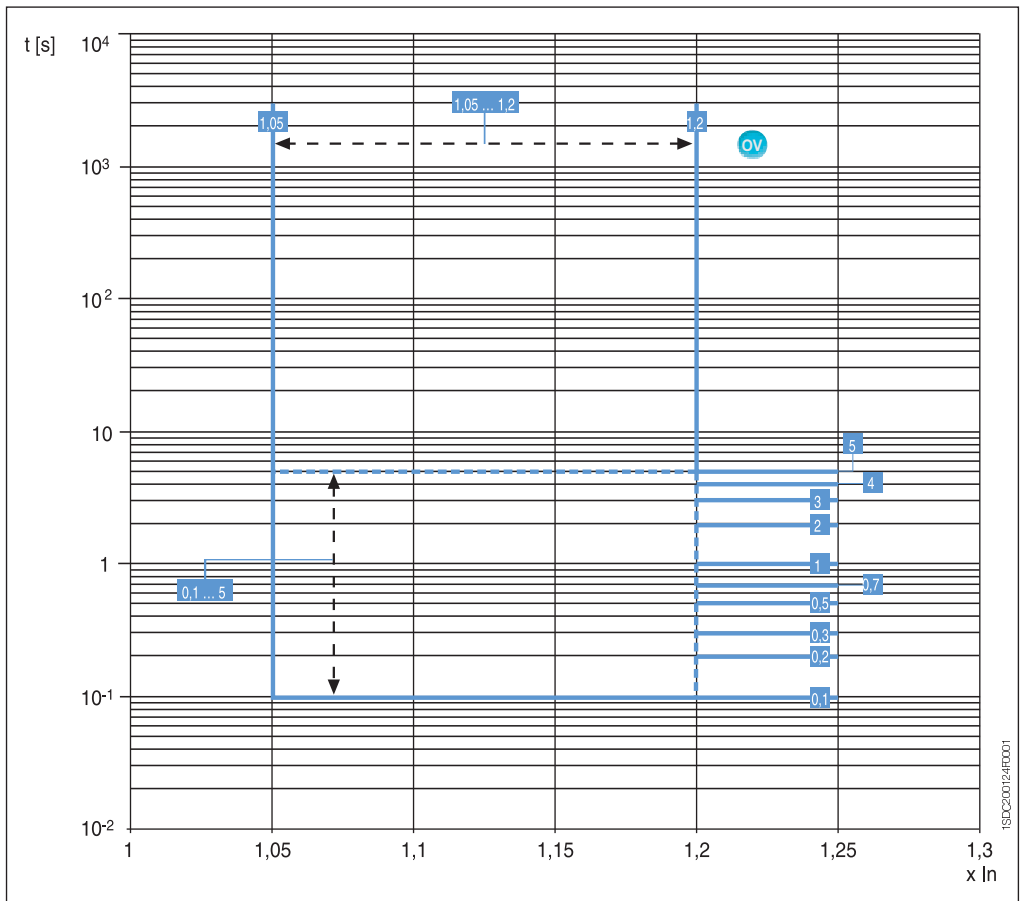


Tolerances on thresholds and trip times ..... page 4/24

## Function UV



## Functions OV



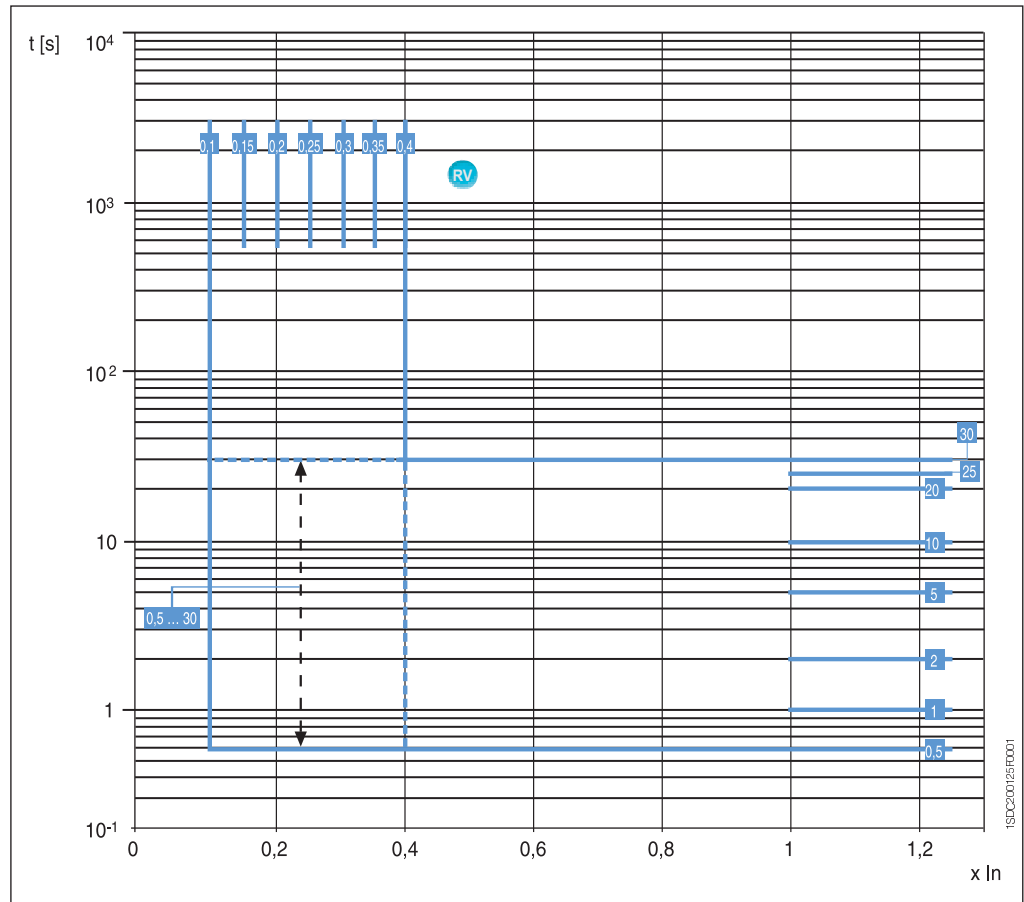
Tolerances on thresholds and trip times ..... page 4/24



# Microprocessor-based protection releases and trip curves

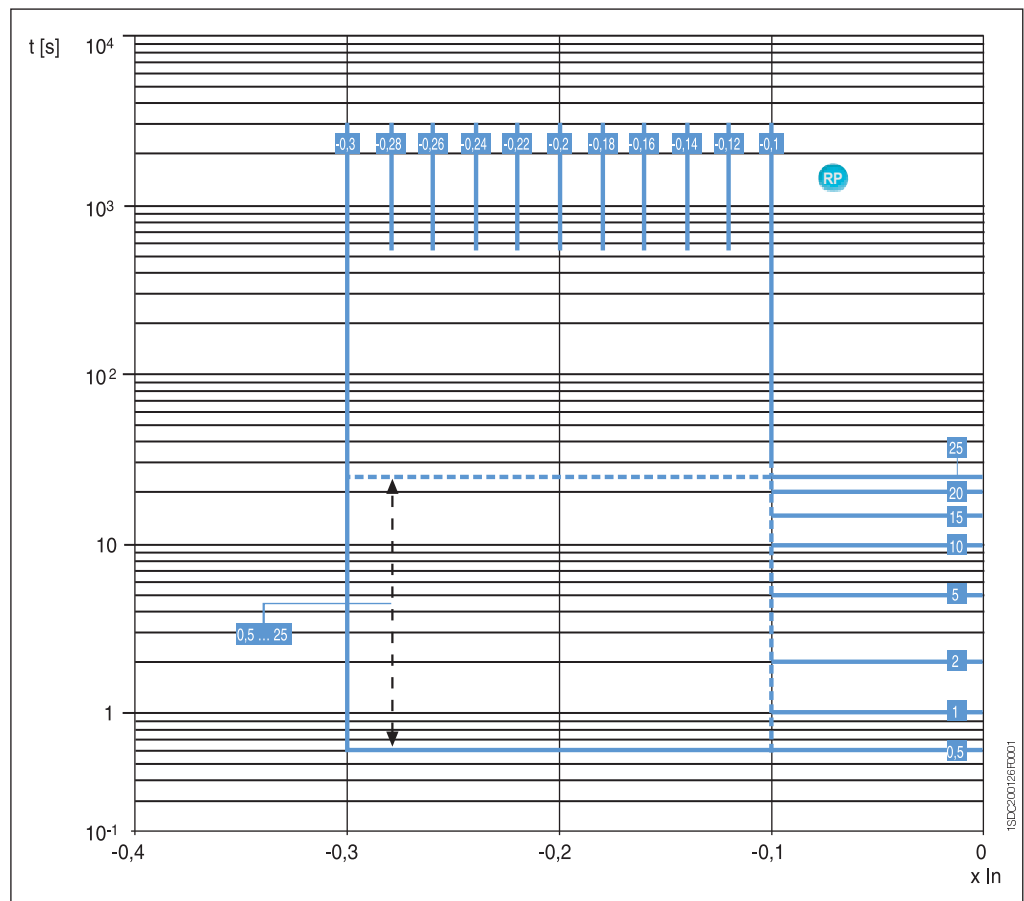
## PR113/P

### Function RV



4

### Functions RP



Tolerances on thresholds and trip times ..... page 4/24



# Protection and dialogue releases for LONWORKS® and Modbus® networks

## PR112/PD and PR113/PD

Functional integration among various kinds of technological installations in industry and services is gradually increasing the need for communication, control and automation in low-voltage electrical installations. Modern microprocessor-based systems that operate using a logic of distributed intelligence (through components able to process data, exchange information, signals and commands) offer the most effective and flexible solution and cover a variety of different applications and specific needs. For a prompt and effective response to the demand for interconnection, intelligence, function, flexibility, interoperability and ease of installation, ABB SACE has developed new communication and control devices for low-voltage circuit-breakers based on the LonTalk® and Modbus® RTU protocols.

The new devices developed for the Emax range of air circuit-breakers, in particular, include:

- PR112/PD LON® releases, based on LONWORKS® technology with LonTalk® protocol;
- PR112/PD Modbus® releases, based on the Modbus® RTU protocol;
- PR113/PD Modbus® releases, based on the Modbus® RTU protocol.

### LONWORKS®

LON® (Local Operate Network) is a data transmission technology with applications in a variety of settings, from the service industry to process control. The PR112/PD LON releases (available in LSI and LSI-G versions) and the device PR212/D-L (the latter available on the Isomax range of moulded-case circuit-breakers), make it possible to integrate ABB SACE Emax air circuit-breakers and SACE Isomax S moulded-case circuit-breakers in a communication network based on LONWORKS® technology, according to the LonTalk® protocol (Ansi/EIA 709.1-A-199). The devices are developed in accordance with LONMARK® directives to ensure HW and SW development in line with the interoperability standard defined by the LONMARK® Association. These devices also make it possible to integrate the circuit-breakers with ABB INSUM, the integrated supervision and measurement control system instrument gauge for motor control centers (MCC). LONWORKS® technology allows high performance while ensuring event-driven peer-to-peer communication. The devices use the TP/XF 78 transceiver (physical data transmission means: braided pair; transmission rate: 78000 bit/sec).

### Modbus® RTU

The Modbus® RTU protocol has been well known and used worldwide for several years. It is essentially the market standard thanks to its ease of installation, configuration and integration into different supervision, control and automation systems, in addition to good performance. PR112/PD Modbus (available in LSI and LSI-G versions) and PR112/PD Modbus releases and the PR212/D-M device (the latter available on the Isomax range of moulded-case circuit-breakers), allow ABB SACE Emax air circuit-breakers and Isomax S moulded-case circuit-breakers to be integrated into a communication network based on the Modbus® RTU protocol. Modbus® RTU provides a Master-Slave system architecture in which a Master (PLC, PC, etc.) cyclically queries multiple Slaves (field devices). The devices use the standard EIA RS485 as the physical data transmission means, and a maximum transmission rate of 19200 bit/sec.

#### Note:

LONWORKS®, LONMARK®, LonTalk®, LON® are registered trademarks of Echelon® Corporation.  
Modbus® and Modbus® RTU are registered trademarks of Modicon, Inc.



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# Protection and dialogue releases for LonWorks® and Modbus® networks

## PR112/PD and PR113/PD

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### PR112/PD and PR113/PD dialogue units

The human-machine interface (HMI) of the PR112/PD LON, PR112/PD Modbus and PR112/PD Modbus devices is made up of a graphic display (LCD), LEDs, magnetic flags and touchpad pushbuttons.

The user may choose from among five available languages: Italian, English, German, French and Spanish. The HMI is active when the auxiliary power supply is used, if the PR120/B battery unit is connected, or, finally, if the single-phase current is more than 35% of the rated current of the current transformers.

PR112/PD LON, PR112/PD Modbus and PR112/PD Modbus releases are always supplied with the PR120/B battery unit. This accessory is connected to the front connector of the release, and allows the protection parameters to be set regardless of the circuit-breaker status.

The dialogue functions and parameter settings are available only when the auxiliary power supply is present.

### Sending and receiving data

Releases with built-in dialogue and control functions—PR112/PD LON, PR112/PD Modbus and PR113/PD Modbus—allow the remote acquisition and transmission of a wide range of information; opening and closing, thanks to opening and closing releases installed on the circuit-breaker; storing configuration and programming parameters for the unit; the current thresholds of the protection functions and protection curves.

All information may be consulted either locally, directly on the front of the circuit-breaker, or remotely via supervision and control systems.

### Protection functions

All releases with dialogue functions perform the same protection functions as the corresponding protection releases. See the corresponding sections for the protection releases.

### Measuring, signalling, available data functions

The table below provides details of the functions available on each of the releases PR112/PD LON, PR112/PD Modbus and PR113/PD Modbus.

	PR112/PD LON	PR112/PD Modbus	PR113/PD Modbus
<b>Communication functions</b>			
Protocol	LonTalk	Modbus RTU	Modbus RTU standard standard
Physical means	Twisted pair	EIA RS485	EIA RS485
Speed (maximum)	78000bps	19200bps	19200bps
<b>Measuring functions</b>			
Phase currents	■	■	■
Neutral	■	■	■
Earth	■	■	■
Voltage (phase-phase, phase-neutral, residual)			■
Power (active, reactive, apparent)			■
Power factor			■
Frequency and peak factor			■
Energy (active, reactive, apparent)			■
Harmonics calculation up to the 20th harmonic			■
<b>Signalling functions</b>			
LED: auxiliary power supply, microprocessor fault, warning, emergency	■	■	■
Temperature			■
Magnetic flags: indicate trip for L, S, I, G and T	■	■	
Magnetic flags: indicate trip for L, S, I, G and other protection			■
Output contacts: microprocessor fault, trip and one available for configuration	■	■	
Output contacts: microprocessor fault, trip and two available for configuration			■
<b>Data available</b>			
Circuit-breaker status (open, closed)	■	■	■
Circuit-breaker position (racked-in, racked-out)	■	■	■
Mode (local, remote)	■	■	■
Protection parameters set	■	■	■
Load control parameters	■	■	■
<b>Alarms</b>			
Protection L	■	■	■
Protection S	■	■	■
Protection I	■	■	■
Protection G	■	■	■
Protection T	■	■	■
Fault release mechanism failure	■	■	■
Undervoltage, overvoltage and residual voltage (timing and trip) protection			■
Reverse power protection (timing and trip)			■
Directional protection (timing and trip)			■
<b>Maintenance</b>			
Total number of operations	■	■	■
Total number of trips	■	■	■
Number of trip tests	■	■	■
Number of manual operations	■	■	■
Number of separate trips for each protection function	■	■	■
Contact wear (%)	■	■	■
Record data of last trip	■	■	■
<b>Operating mechanisms</b>			
Circuit-breaker opening/closing	■	■	■
Reset alarms	■	■	■
Setting of curves and protection thresholds	■	■	■
Synchronize system time	■		
<b>Safety function</b>			
Automatic opening in case of failure to release for fault (through opening coil)	■	■	■
<b>Events</b>			
Status changes in circuit-breaker, protections and all alarms	■		



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## Protection and dialogue releases for LonWorks® and Modbus® networks

PR112/PD and PR113/PD

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### Event time-stamping and saving function (only with LON® protocol)

The PR112/PD LON release keeps its base synchronized with the absolute system time. The availability of absolute time makes it possible to time-stamp the events that occur in the circuit-breaker and in the PR112 release itself.

By gathering these events from the various devices installed, the supervision and control system can compile a list of significant events for managing and analyzing the installation. Such an analysis may be especially useful, for example, in tracing the causes that led to a fault.

Detected and time-stamped events:

- all protection events,
- all “Warning” and “Emergency” signals,
- all “Read/Edit” change-overs
- all opening and closing operations.

The above information is stored locally and made available to the supervision and control system.



1SDC200127R0001

### SACE PR120/B power supply unit

This accessory, always supplied with the PR112 and PR113 range of releases, makes it possible to read and configure the parameters of the unit whatever the status of the circuit-breaker (open-closed, in test isolated or racked-in position, with/without auxiliary power supply).

An internal electronic circuit powers the unit for approximately 3 consecutive hours for the sole purpose of reading and configuring data.

In relation to the amount of use, battery life decreases if the SACE PR120/B accessory is also used to perform the “COMMAND” menu functions (Trip test, Auto test).



1SDC200128R0001

### SACE TT1 test unit

The SACE TT1 unit checks the tripping of the PR111/P releases and tests the tripping of the opening solenoid.

The device is powered by a 12V replaceable battery.



1SDC200129R0001

### SACE PR010/T configuration test unit

The SACE PR010/T unit is an instrument capable of performing the functions of testing, programming and reading parameters for the protection units equipping SACE Emax low-voltage air circuit-breakers.

The test function in particular involves the units:

- PR111 (all versions)
- PR112 (all versions)
- PR113 (all versions)

while the parameter programming and reading functions concern the range of PR112 and PR113 releases.

All of the functions mentioned may be carried out “on board” by connecting the SACE PR010/T unit to the front multi-pin connector on the various protection units. Special interface cables supplied with the unit should be used for this connection.

The human-machine interface takes the form of a touchpad and multi-line alphanumeric display. The unit also has two LEDs to indicate, respectively:

- POWER-ON and STAND BY
- battery charge status.



## Accessories for protection releases

The unit also has two LEDs to indicate, respectively:

- POWER-ON and STAND BY
- battery charge status.

Two different types of test are available: automatic (for PR111, PR112 and PR113) and manual. By connecting to a PC (using the disc supplied by ABB SACE) it is also possible to upgrade the software of the SACE PR010/T unit and thus adapt the test unit to the development of new products.

It is also possible to store the most interesting test results in the unit itself, and send a report to the personal computer with the following information:

- type of protection tested
- threshold selected
- curve selected
- phase tested
- test current
- estimated trip time
- measured trip time
- test results.

At least 5 complete tests may be stored in memory. The report downloaded onto PC allow the creation of an archive of tests carried out on the installation.

In automatic mode, the SACE PR010/T unit is capable of testing the following with the PR112 range:

- protection functions L, S, I,
- G protection function with internal transformer,
- G protection function with toroid on the transformer star center,
- monitoring of smooth microprocessor operation.

The PR113 release also tests:

- overvoltage protection function OV,
- undervoltage protection function UV,
- residual voltage protection function RV,
- phase unbalance protection function U.

The same tests may be repeated manually for PR111 and PR112.

The SACE PR010/T unit is portable and runs on rechargeable batteries and/or with an external power supply (always supplied) with a rated voltage of 100-240V AC/12V DC.

The standard version of the SACE PR010/T unit includes:

- SACE PR010/T test unit complete with rechargeable batteries
- SACE TT1 test unit
- 100 - 240V AC/12V DC external power supply with cord
- cables to connect the unit and the connector
- cable to connect the unit and the computer (RS232 serial )
- user manual and disc containing application software
- plastic suitcase.

## SACE PR020/K signalling unit

The SACE PR020/K signalling unit can convert the digital signals supplied by the PR112 and PR113 protection unit (in version P or PD) into electrical signals, via normally open electrical contacts.

The unit is connected to the protection release by means of a dedicated serial line through which flows all of the information about the activation status of the protection functions. The corresponding power contacts are closed based on this information.

The following signals/contacts are available for the PR112 release:

- overload pre-alarm L
- timing and tripping of the protections L, S and G
- protection I tripped
- timing and exceeded overtemperature threshold ( $T > 85\text{ °C}$ )
- two load control contacts (connection and disconnection of a load, or disconnection of two loads)
- release tripped
- dialogue fault on a serial line (connecting the protection and signalling units).

With the release PR113 in standard configuration, tripping of the phase unbalance protection is also indicated in addition to the signals listed above.

Setting a dip-switch allows up to seven signal contacts to be freely configured, including: directional protection D tripped, under- and overvoltage UV and OV tripped, reverse power RP tripped, and others.

Two contacts available on the SACE PR020/K unit (load control) can pilot a circuit-breaker opening or closing release. These contacts allow various applications, including load control, alarms, signals, electrical locks.

The alarm signal remains active throughout the overload, until the release is tripped.

The trip signals of the protections remain active during the timing phase, and even after the release is tripped.

Pressing the Reset pushbutton resets the status of all signals.

The unit also contains ten LEDs to visually signal the following information:

- “Power ON”: auxiliary power supply present
- “TX (Int Bus)”: flashing synchronized with dialogue with the Internal Bus
- eight LEDs associated with the internal contacts

the table below lists the characteristics of the signalling relays available in the SACE PR020/K unit.

Auxiliary power supply	24 V DC $\pm$ 20%
Maximum ripple	5%
Rated power @ 24 V	4.4 W

Specifications of the signalling relays	
Type	Monostable STDP
Maximum switching power (resistive load)	100 W/1250 VA
Maximum switching voltage	130 V DC/250 V AC
Maximum switching current	5 A
Breaking capacity (resistive load)	
@ 30V DC	3.3 A
@ 250V AC	5 A
Contact/coil insulation	2000 V eff (1 min@ 50 Hz)