TMAX. COMPLETE FREEDOM.

Tmax is freedom. Freedom now reaching up to 1600 A with the new Tmax T7 circuit-breaker. There's a boundless and highly diversified world of differing types of installations, requirements, needs and problems from 0 to 1600 A. With T Generation everything becomes simple and rational – seven sizes to find the solutions you're looking for.

BE FREE TO SIZE ANY TYPE OF INSTALLATION IN AN IDEAL WAY AT ALL TIMES.

Thanks to the seven sizes and a complete series of magnetic only, thermomagnetic and electronic trip units.

And also a wide range of accessories and the possibility of selecting dedicated ranges for all market applications, even the most specific and advanced ones.

BE FREE TO INSTALL ALL THE SIZES WITHOUT ANY DIFFICULTY.

T Generation is undeniably the family of moulded-case circuit-breakers with the top performance/size ratio available on the market, so can you imagine how much more space there is for cabling and how simply you'll be able to carry it out? And further, what about the reduced dimensions of the switchboard?

ATION

BE FREE TO RIDE THE MOST ADVANCED TECHNOLOGY.

It is thanks to this technology that T Generation offers you performances which were out of the question until now in circuit-breakers with these dimensions. And there are some exclusive technical solutions which only ABB SACE can offer you, such as the brand new electronic trip units designed for the new Tmax T7 or the new rapid accessory fitting system.

FREEDOM OF TOTALLY SAFE SELECTION.

The safety of knowing that behind Tmax there's ABB SACE's strong and constant commitment to continually search for excellence of quality at the base of each product and service. ABB quality.

TMAX T1, T2 AND T3. ALL SOLUTIONS PERFECTLY COORDINATED, UP TO 250 A.

Tmax T1, T2 and T3 – the three “little ones” of the Tmax family - were thought up from the beginning to work together. You can select functions and performances which until now couldn't be found in circuit-breakers with these dimensions. Perfect up to 250 A.

There are so many characteristics common to the three sizes. The single depth (70 mm) of the three pieces of apparatus making installation truly simpler, the new arcing chambers produced with a gasifying material, and an innovative construction system allowing the arc extinction time to be reduced.

All three sizes are fitted with adjustment of the thermal threshold as standard and have new - three-pole and four-pole - residual current releases, designed and constructed to optimise space in the switchboard and simplify coupling with the circuit-breaker. Tmax T1, T2 and T3 have a completely standardised range of accessories.

TMAX T1. THE LITTLE ONE THAT'S REALLY BIG.

Thanks to its extremely compact dimensions, Tmax T1 is a unique circuit-breaker in its category. Compared with any other circuit-breaker with the same performance (160 A – up to 36 kA at 415 V AC), the overall dimensions of the apparatus are notably smaller.

TMAX T2. INTELLIGENCE AND HIGH PERFORMANCE IN THE PALM OF YOUR HAND.

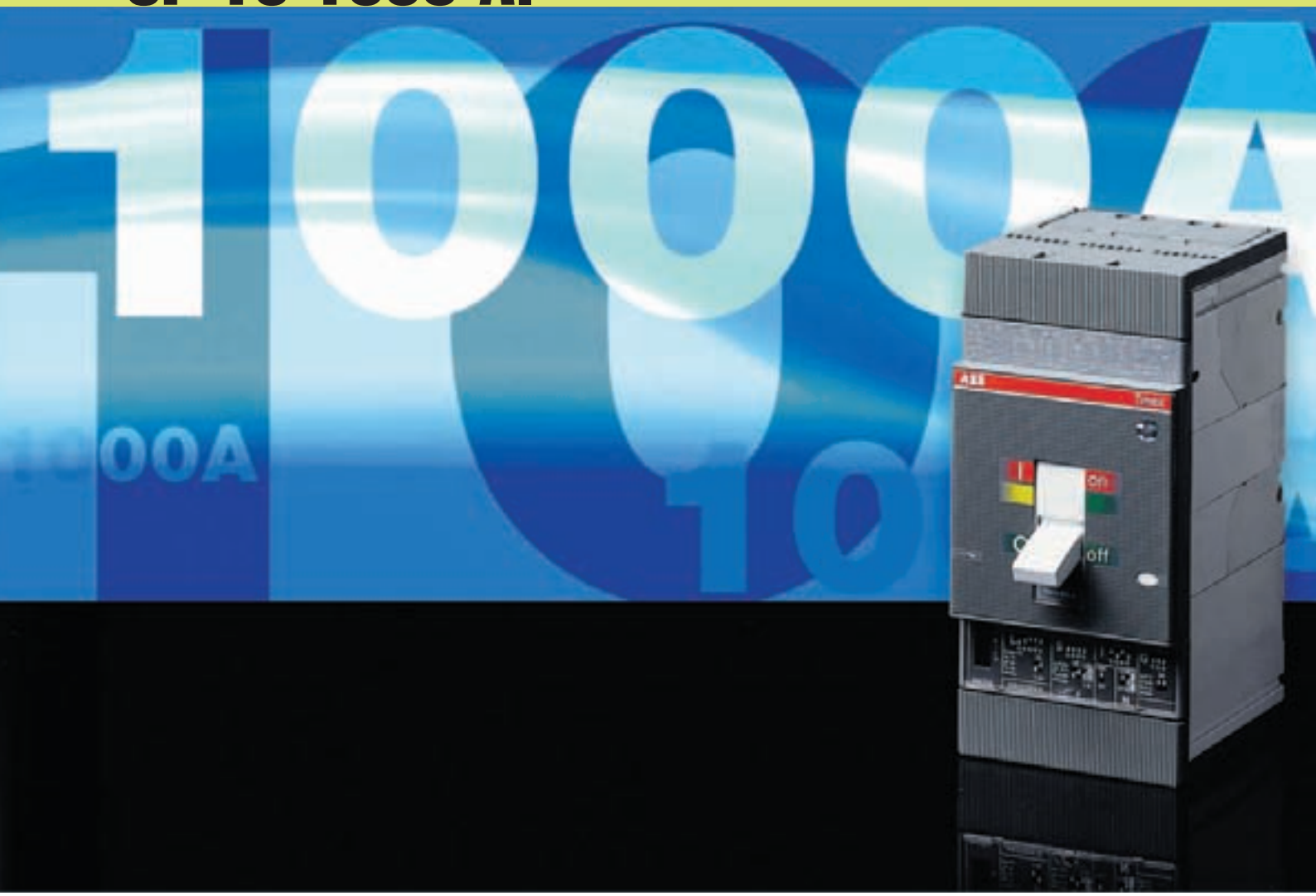
Tmax T2 is the only 160 A circuit-breaker available with such high performances in such very limited overall dimensions. A breaking capacity of 85 kA at 415 V AC can be achieved. Tmax T2 can be fitted with a latest generation electronic trip unit.

TMAX T3. 250 A IN A DEPTH OF 70 MM FOR THE FIRST TIME.

Tmax T3 is the first circuit-breaker which carries 250 A in considerably limited overall dimensions compared with any other similar apparatus – a really large step forward for this type of equipment.

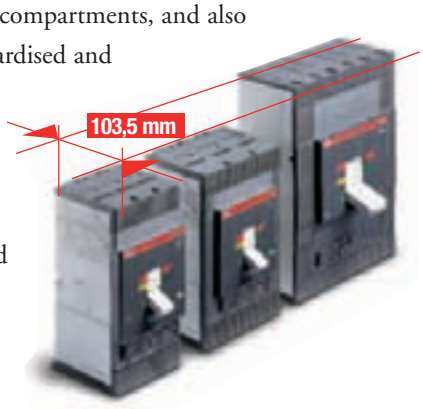
Tmax T3 allows coordinations for motor protection to be made up to a power of 90 kW at 415 V AC.

TMAX T4, T5 AND T6. BE FREE TO CHOOSE UP TO 1000 A.



Tmax T4, T5 and T6 are the moulded-case circuit-breakers with the best performance/size ratio on the market.
Their application possibilities are practically unlimited, thanks to their dedicated and specific ranges, advanced electronics, as well as a complete and standardised range of accessories.
The top quality materials and innovative construction techniques used by ABB SACE mean Tmax circuit-breakers can guarantee truly exceptional performances, with a really high rated current/volume ratio. For example, T4 and T5 guarantee a breaking capacity up to 200 kA at 415 V AC and an extraordinary 80 kA at 690 V AC. Moreover, they complete the range of applications up to 1150 V in alternating current and 1000 V in direct current.

The series of electronic trip units, equipped with latest generation technology, offers solutions exclusive to ABB.
T4, T5 and T6 have the same depth, simplifying their positioning in the switchboard compartments, and also have a complete, standardised and unified range of accessories available, simplifying selection, making them flexible to use and reducing stocks.



NEW PR223EF TRIP UNIT. THIS IS WHERE THE EXCLUSIVE INNOVATION IS TO BE FOUND.

The new PR223EF trip unit with the EFDP system offers two characteristics which until now were antithetic: selectivity and rapid tripping. With the new PR223EF, a new range up to 1000 A has been conceived for specific needs requiring high selectivity values: rapid detection of the fault and no limit to the number of hierarchical levels of the distribution plant. With the EFDP system, the size of the apparatus inside the installation can be reduced and cable and busbar sizing can be optimised. And the outcome? Considerable reductions in plant costs.

NEW PR223DS TRIP UNIT. FREEDOM OF CONTROL.

The new PR223DS trip unit has been conceived and built for power distribution circuit-breakers.

Now all the different electrical values of the installation can be measured. And that's not all – there are LEDs available on the front of the trip unit which signal some configurations and the presence of any alarms (overload, incorrect connections, etc.).

TMAX T7. FREEDOM TO THE NTH POWER.

The new Tmax T7, available in two versions up to 1600 A either with manual operating mechanism or motor operator, was conceived with a really revolutionary design for circuit-breakers of this type: advanced electronics, exceptional performances and new installation and accessory fitting solutions.

Flexibility is absolutely exceptional with Tmax T7: they can be installed both vertically and horizontally (in the withdrawable version, too), there are all types of terminals (among which, flat orientated rear terminals) and a new, faster and safer racking-out system for the moving part. Moreover, cabling is considerably facilitated by the reduced height.

A great news is the new rapid accessory wiring system. No wires inside the circuit-breaker, rapid, simple and safe connection to the external circuit, and no screws for fixing the external power supply cables.

The exclusive news of the new cable interlock provides notable benefits in terms of optimal sizing. By using this accessory it is possible to interlock two circuit-breakers in any position and, above all, to interlock a T7 with an air circuit-breaker as well. Impossible until today, this answer is ideal for automatic transfer switch solutions.

Special attention has been paid to the electronics and the results are there to be seen … PR231, PR232, PR331 and PR332 are the new interchangeable electronic trip units, with modularity and rating-plugs which can be replaced by the customer.

The PR231 and PR232 trip units, with dip-switches for setting the protection thresholds, offer LEDs to signal protection tripped for each protection function: this means the reason for circuit-breaker tripping can always be found.
The PR332 is decidedly ahead of its time in the present reference panorama: fitted with a large graphic display, it allows all the information needed to be displayed simply and clearly. It also offers advanced protection functions (as well as the "classic" protection functions). For example, the exclusive data logger function allowing all the events and values before the fault to be recorded for later analysis.


Tmax
on
off

Main characteristics

1

Index

Overview of the Tmax family

Circuit-breakers for AC-DC distribution

			T1 1p	T1
Size	[A]		160	160
In	[A]		16…160	16…160
Poles	[Nr]		1	3/4
Ue	[V]	(AC) 50 - 60 Hz	240	690
	[V]	(DC)	125	500
Icu (380-415 V AC)	[kA]	B	25* (220/230 V AC)	16
	[kA]	C		25
	[kA]	N		36
	[kA]	S		
	[kA]	H		
	[kA]	L		
	[kA]	V		

Circuit-breakers for zone selectivity

Size	[A]				
Poles	[Nr]				
Ue	[V]	(AC) 50 - 60 Hz			
EFDP zone selectivity					
ZS zone selectivity					

Circuit-breakers for motor protection

Size	[A]				
Poles	[Nr]				
Ue	[V]	(AC) 50 - 60 Hz			
Magnetic only trip unit, IEC 60947-2					
PR221DS-I trip unit, IEC 60947-2					
PR222MP trip unit, IEC 60947-4-1					
PR231/P-I trip unit, IEC 60947-2					

Circuit-breakers for use up to 1150 V AC and 1000 V DC

Size	[A]				
Poles	[Nr]				
Icu max	[KA]	1000 V AC			
	[KA]	1150 V AC			
	[KA]	1000 V DC 4 poles in series			

Switch-disconnectors

			T1D
Ith	[A]		160
Ie	[A]		125
Poles	[Nr]		3/4
Ue	[V]	(AC) 50 - 60 Hz	690
	[V]	(DC)	500
Icm	[kA]		2.8
Icw	[kA]		2

* For In 16 A and In 20 A: Icu @ 220/230 V AC = 16 kA

Note: ABB SACE's moulded-case circuit-breakers are also available in the versions according to UL Standards (see catalogue "ABB SACE molded case circuit-breakers - UL 489 and CSA C22.2 Standard").






	T2	T3	T4	T5	T6	T7
	160	250	250/320	400/630	630/800/1000	800/1000/1250/1600
	1.6…160	63…250	20…320	320…630	630...1000	200...1600
	3/4	3/4	3/4	3/4	3/4	3/4
	690	690	690	690	690	690
	500	500	750	750	750	
	36	36	36	36	36	
	50	50	50	50	50	50
	70		70	70	70	70
	85		120	120	100	120
			200	200		150

			T4	T5	T6	T7
			250/320	400/630	630/800/1000	800/1000/1250/1600
			3/4	3/4	3/4	3/4
			690/1000	690/1000	690	690
			■	■	■	
						■

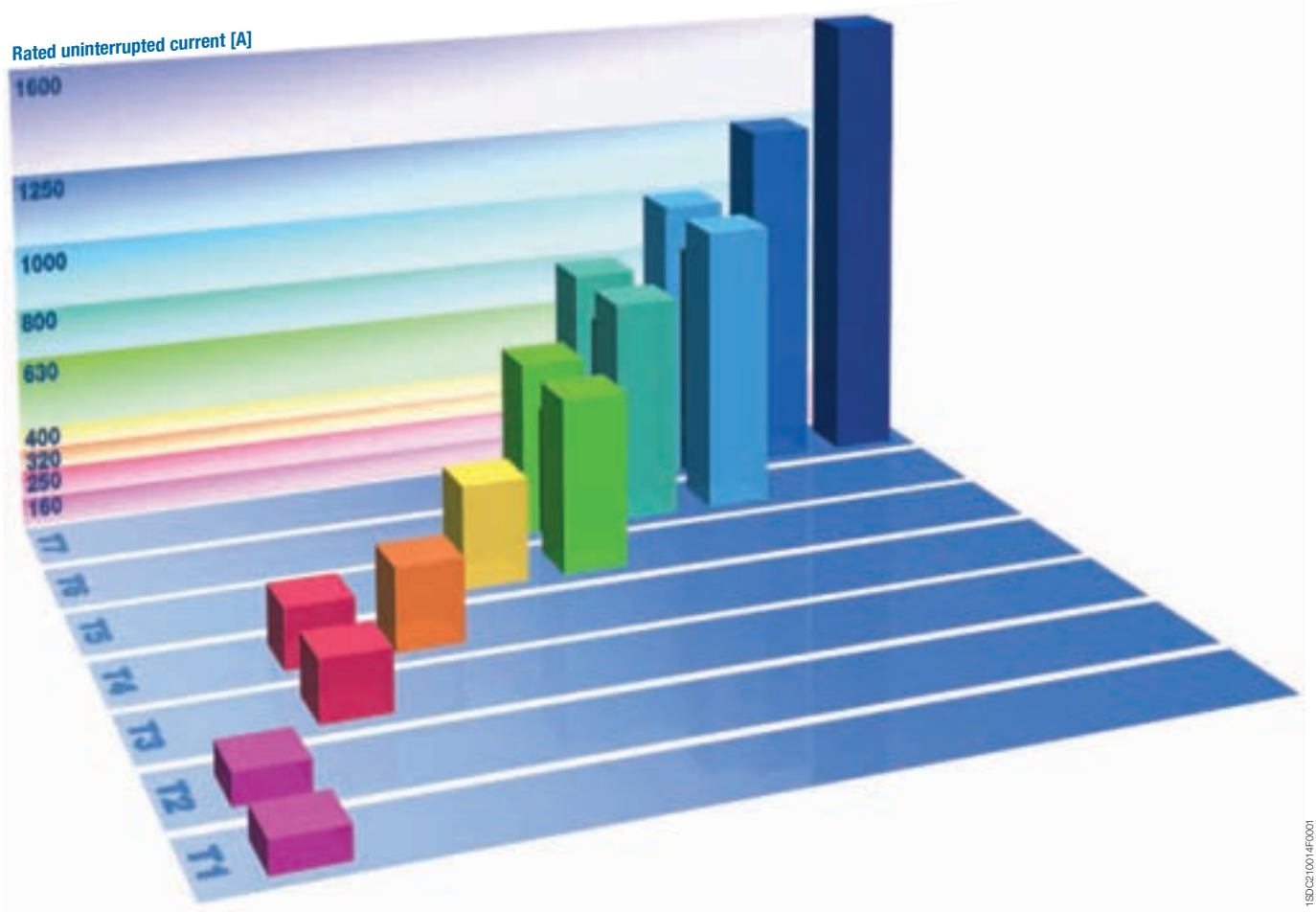
	T2	T3	T4	T5	T6	T7
	160	250	250/320	400/630	800	800/1000/1250
	3	3	3	3	3	3
	690	690	690	690	690	690
	■	■	■			
	■		■	■	■	
			■	■	■	
						■

			T4	T5	T6	
			250	400/630	630/800	
			3/4	3/4	3/4	
			20	20	12	
			12	12		
			40	40	40	

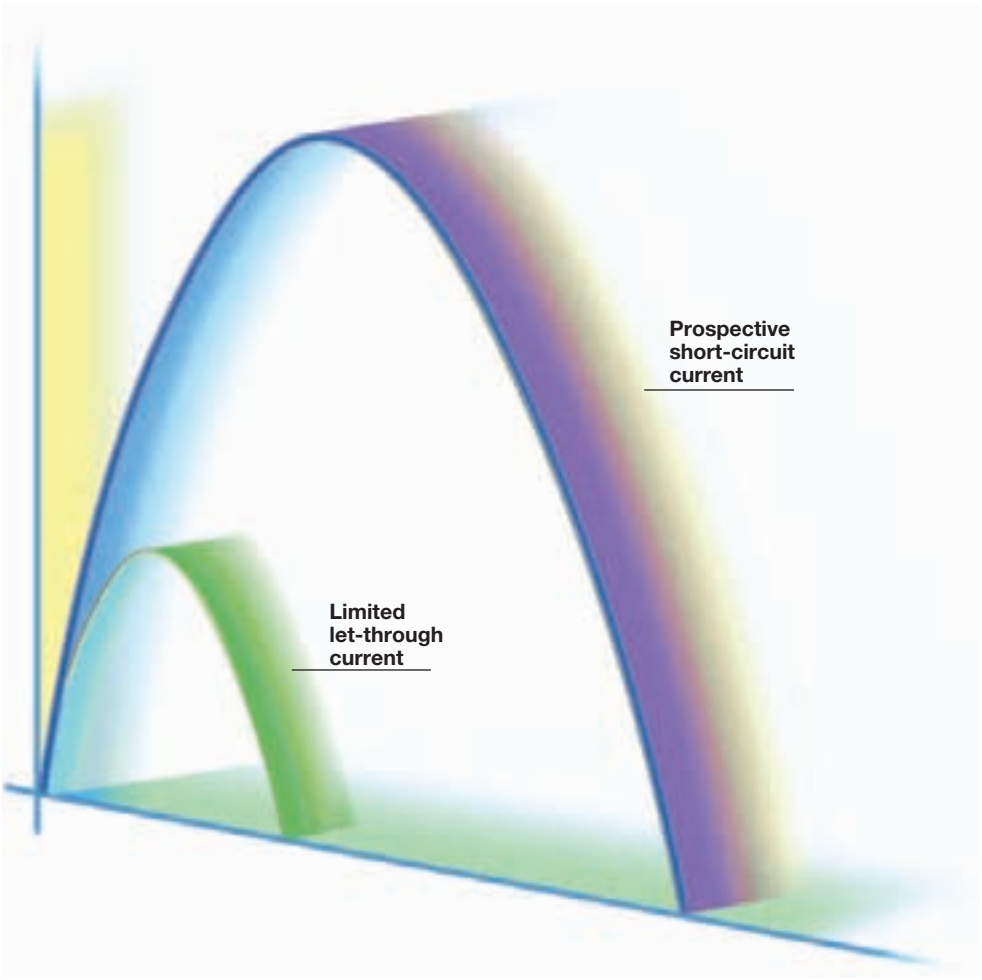
		T3D	T4D	T5D	T6D	T7D
		250	250/320	400/630	630/800/1000	1000/1250/1600
		200	250/320	400/630	630/800/1000	1000/1250/1600
		3/4	3/4	3/4	3/4	3/4
		690	690	690	690	690
		500	750	750	750	750
		5.3	5.3	11	30	52.2
		3.6	3.6	6	15	20

General

Tmax family is now available as a complete range of moulded case circuit-breakers up to 1600 A. All the circuit-breakers, both three-pole and four-pole, are available in the fixed version; the sizes T2, T3, T4 and T5 in the plug-in version and T4, T5, T6 and T7 in the withdrawable one as well.
With the same frame size, the circuit-breakers in the Tmax family, are available with different breaking capacities and different rated uninterrupted currents.

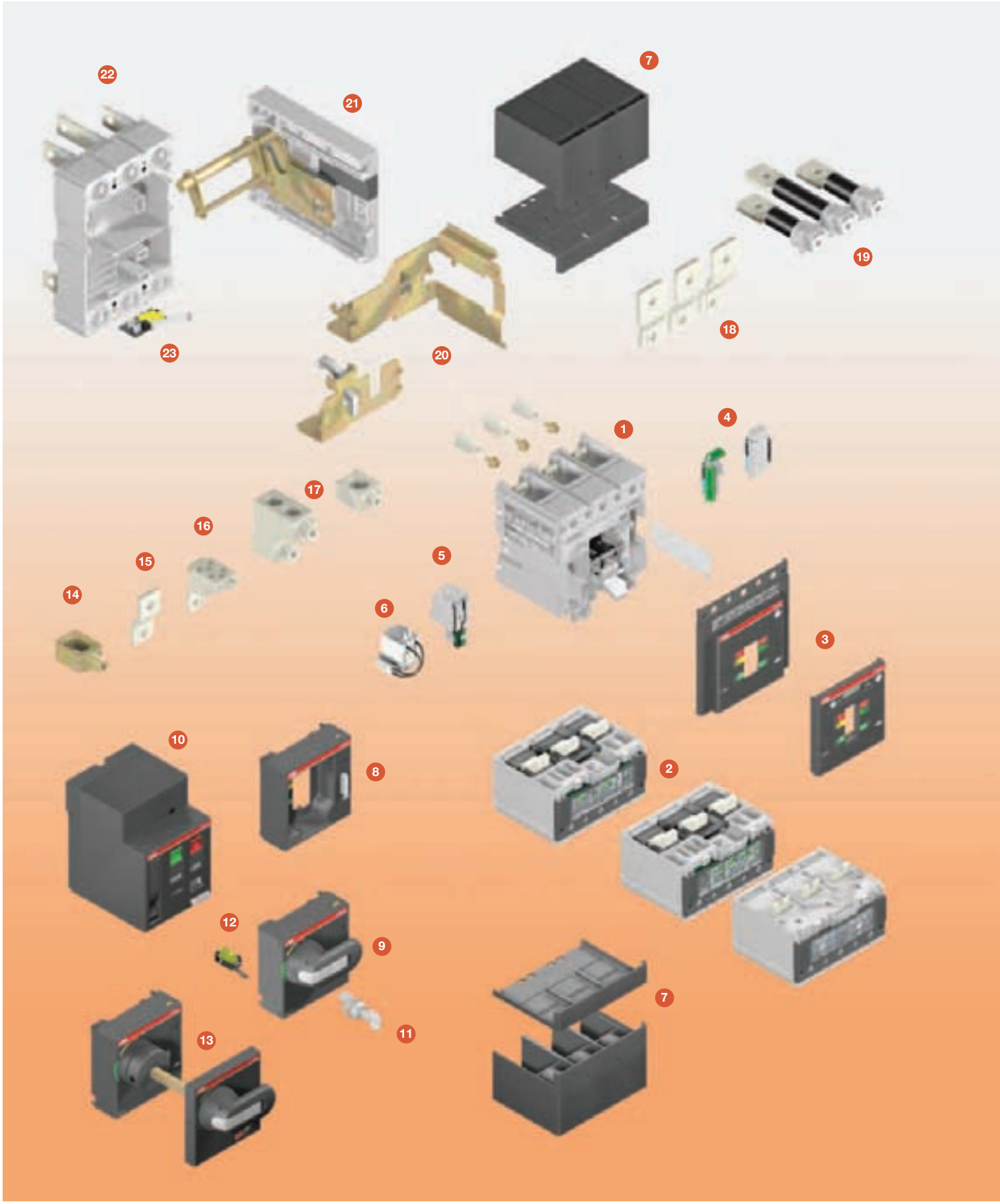


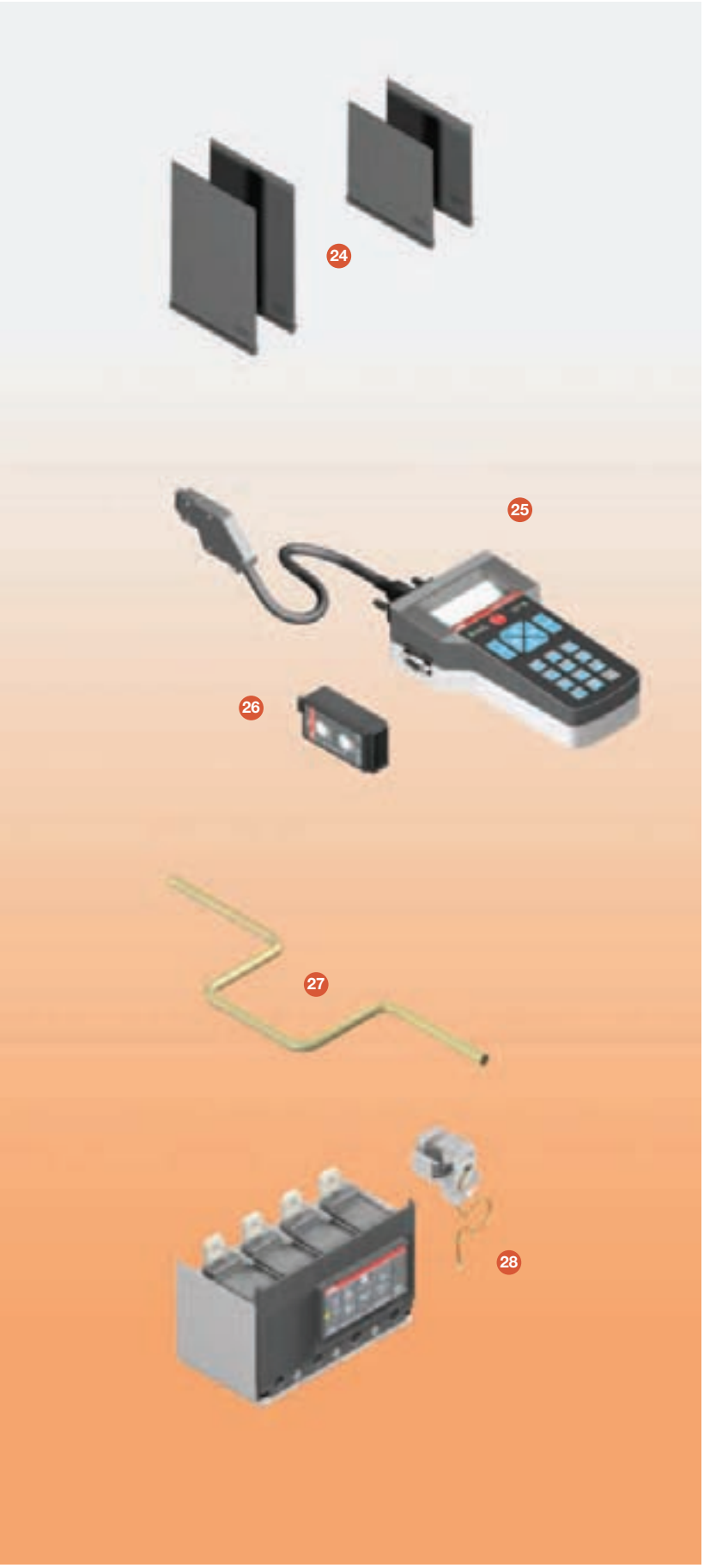
The electric arc interruption system used on the Tmax circuit-breakers allows the short-circuit currents of very high value to be interrupted extremely rapidly. The considerable opening speed of the contacts, the dynamic blasting action carried out by the magnetic field and the structure of the arcing chamber contribute to extinguishing the arc in the shortest possible time, notably limiting the value of the specific let-through energy I^2t and the current peak.



Construction characteristics

Modularity of the series





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Starting from the fixed version circuit-breaker, all the other versions used for various requirements are obtained by means of mounting conversion kits.
The following are available:
– kit for converting a fixed circuit-breaker into the moving part of a plug-in and withdrawable one
– circuit-breaker fixed parts for plug-in and withdrawable circuit-breakers
– conversion kit for the connection terminals.

Various accessories are also available:
1. Breaking unit
2. Trip units
3. Front
4. Auxiliary contacts - AUX and AUX-E
5. Undervoltage release - UVR
6. Shunt opening release - SOR and P-SOR
7. Terminal covers
8. Front for lever operating mechanism - FLD
9. Direct rotary handle - RHD
10. Stored energy motor operator - MOE
11. Key lock - KLF
12. Early auxiliary contact - AUE
13. Transmitted rotary handle - RHE
14. Front terminal for copper cable - FC Cu
15. Front extended terminal - EF
16. Multi-cable terminal (only for T4) - MC
17. Front terminal for copper-aluminium - FC CuAl
18. Front extended spread terminal - ES
19. Rear orientated terminal - R
20. Conversion kit for plug-in/withdrawable versions
21. Guide of fixed part in the withdrawable version
22. Fixed part - FP
23. Auxiliary position contact - AUP
24. Phase separators
25. PR010T
26. TT1
27. Racking out crank handle
28. Residual current release.

Construction characteristics

Distinguishing features of the series


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Double insulation

Tmax has double insulation between the live power parts (excluding the terminals) and the front parts of the apparatus where the operator works during normal operation of the installation. The seat of each electrical accessory is completely segregated from the power circuit, thereby preventing any risk of contact with live parts, and, in particular, the operating mechanism is completely insulated in relation to the powered circuits.
Furthermore, the circuit-breaker has oversized insulation, both between the live internal parts and in the area of the connection terminals. In fact, the distances exceed those required by the IEC Standards and comply with what is foreseen by the UL 489 Standard.

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Positive operation

The operating lever always indicates the precise position of the moving contacts of the circuit-breaker, thereby guaranteeing safe and reliable signals, in compliance with the prescriptions of the IEC 60073 and IEC 60417-2 Standard (I = Closed; O = Open; yellow-green line = Open due to protection trip). The circuit-breaker operating mechanism has free release regardless of the pressure on the lever and the speed of the operation. Protection tripping automatically opens the moving contacts: to close them again, the operating mechanism must be reset by pushing the operating lever from the intermediate position into the lowest open position.

Isolation behaviour

In the open position, the circuit-breaker guarantees circuit in compliance with the IEC 60947-2 Standard. The oversized insulation distances guarantee there are no leakage currents and dielectric resistance to any overvoltages between input and output.

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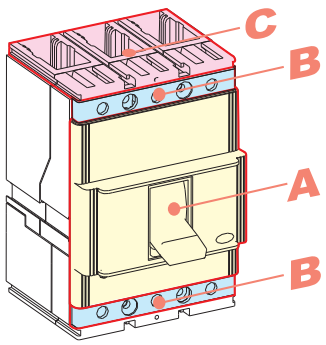

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Degrees of protection

The table indicates the degrees of protection guaranteed by the Tmax circuit-breakers according to the prescriptions of the IEC 60529 Standard:

	With front	Without front [2]	Without terminal covers	With high terminal covers	With low terminal covers	With IP40 protection kit on the front
A	IP 40[3]	IP 20	-	-	-	-
B[4]	IP 20	IP 20	IP 20	IP 40	IP 40	IP 40
C	-	-	-	IP 40[1]	IP 30[1]	-

[1] After correct installation
[2] During installation of the electrical accessories
[3] Also for front for lever operating mechanism and direct rotary handle
[4] Only for T1...T6

The fixed parts are always preset with IP20 degree of protection. IP54 degree of protection can be obtained with the circuit-breaker installed in a switchboard fitted with a rotary handle operating mechanism transmitted on the compartment door and special kit (RHE – IP54).

Operating temperature

The Tmax circuit-breakers can be used in ambient conditions where the surrounding air temperature varies between -25 °C and +70 °C, and stored in ambients with temperatures between -40 °C and +70 °C.
The circuit-breakers fitted with thermomagnetic trip units have their thermal element set for a reference temperature of +40 °C. For temperatures other than +40 °C, with the same setting, there is a thermal trip threshold variation as shown in the table on page 4/50 and following.
The electronic trip units do not undergo any variations in performance as the temperature varies but, in the case of temperatures exceeding +40 °C, the maximum setting for protection against overloads L must be reduced, as indicated in the derating graph on page 4/37 and following, to take into account the heating phenomena which occur in the copper parts of the circuit-breaker passed through by the phase current.
For temperatures above +70 °C the circuit-breaker performances are not guaranteed. To ensure service continuity of the installations, the way to keep the temperature within acceptable levels for operation of the various devices and not only of the circuit-breakers must be carefully assessed, such as using forced ventilation in the switchboards and in their installation room.

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Altitude

Up to an altitude of 2000 m the Tmax circuit-breakers do not undergo any alterations in their rated performances. As the altitude increases, the atmospheric properties are altered in terms of composition, dielectric resistance, cooling capacity and pressure. Therefore the circuit-breaker performances undergo derating, which can basically be measured by means of the variation in significant parameters such as the maximum rated operating voltage and the rated uninterrupted current.

Altitude	**[m]**	**2000**	**2600**	**3000**	**3900**	**4000**	**5000**
Derating on service voltage, Ue	[%]	100	93	88	79	78	68
Derating on uninterrupted current	[%]	100	99	98	94	93	90

Construction characteristics

Distinguishing features of the series

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Electromagnetic compatibility

Operation of the protections is guaranteed in the presence of interferences caused by electronic apparatus, atmospheric disturbances or electrical discharges by using the electronic trip units and the electronic residual current releases. No interference with other electronic apparatus near the place of installation is generated either. This is in compliance with the IEC 60947-2 Appendix B + Appendix F Standards and European Directive No. 89/336 regarding EMC - electromagnetic compatibility.

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Tropicalisation

Circuit-breakers and accessories in the Tmax series are tested in compliance with the IEC 60068-2-30 Standard, carrying out 2 cycles at 55 °C with the “variant 1” method (clause 7.3.3). The suitability of the Tmax series for use under the most severe environmental conditions is therefore ensured with the hot-humid climate defined in the climatograph 8 of the IEC 60721-2-1 Standards thanks to:

– moulded insulating cases made of synthetic resins reinforced with glass fibres;
– anti-corrosion treatment of the main metallic parts;
– Fe/Zn 12 zinc-plating (ISO 2081) protected by a conversion layer, free from hexavalent-cromium (ROHS-compliant), with the same corrosion resistance guaranteed by ISO 4520 class 2c;
– application of anti-condensation protection for electronic overcurrent releases and relative accessories.

Resistance to shocks and vibrations

The circuit-breakers are unaffected by vibrations generated mechanically and due to electromagnetic effects, in compliance with the IEC 60068-2-6 Standards and the regulations of the major classification organisations[1]:

– RINA
– Det Norske Veritas
– Bureau Veritas
– Lloyd’s register of shipping
– Germanischer Lloyd
– ABS
– Russian Maritime Register of Shipping.

The T1-T5 Tmax circuit-breakers are also tested, according to the IEC 60068-2-27 Standard, to resist shocks up to 12g for 11 ms. Please ask ABB SACE for higher performances in terms of resistance to shocks.

[1] Ask to ABB for Tmax certificates of approval.


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Versions and types

All the Tmax circuit breakers are available in fixed versions, T2, T3, T4 and T5 in the plug-in version and T4, T5, T6(*) and T7 also in the withdrawable one.
All the circuit breakers can be manually operated, by the operating lever or the rotary handle (direct or transmitted), and electrically operated. For this issue different solutions are available:
– The solenoid operator for T1, T2 and T3
– The stored energy motor operator for T4, T5 and T6
– T7 with the stored energy operating mechanism, gear motor for the automatic charging of the closing springs and shunt opening and closing releases.

Installation

Tmax circuit-breakers can be installed in the switchboards, mounted in any horizontal, vertical or lying down position on the back plate or on rails, without undergoing any derating of their rated characteristics. Tmax circuit-breakers can be installed easily in all types of switchboards, above all thanks to the possibility of being supplied either by top or bottom terminals, without jeopardizing the apparatus functionality(**).
Apart from fixing on the base plate, T1, T2 and T3 can also be installed on DIN 50022 rails, thanks to the special fixing brackets.
Furthermore, the depth of 70 mm takes Tmax T3 to the same standard as the two smaller sizes, making assembly of circuit-breakers up to 250 A in standard switchboards even simpler. In fact, it is possible to prepare standardised support structures, facilitating the design stage and construction of the switchboard metalwork.

(*) Not available on the 1000 A version.
(**) For uses at a voltage of 1000 V, T4V250 and T5V400 in the fixed version, and T4L250 and T5L400 in the plug-in version must be supplied from above.

Construction characteristics

Distinguishing features of the series

Racking-out with the door closed

With Tmax T4, T5, T6 and T7 circuit-breakers, in the withdrawable version, the circuit-breaker can be racked-in and out with the compartment door closed, thereby increasing operator safety and allowing rationalisation of low voltage arc proof switchboards.
Racking out can only be carried out with the circuit-breaker open (for obvious safety reasons), using a special racking-out crank handle supplied with the conversion kit from fixed circuit-breaker to moving part of withdrawable circuit-breaker.

Range of accessories

The completeness and installation rationality of the Tmax series is also achieved thanks to innovative solutions in development of the accessories:

– single range of accessories for T1, T2 and T3; one for T4, T5 and T6, and one for T7, characterised by completeness and simplicity for installation. Harmonisation of the accessories allows reduction in stocks and greater service flexibility, offering increasing advantages for users of the Tmax series;
– new system of rapid assembly for internal electrical accessories of Tmax T7 without cables for the connections to the terminal box;
– same possibility of equipping with accessories, in terms of connection devices (terminals, terminal covers and phase separators), between fixed circuit-breakers and fixed parts of plug-in circuit-breakers for Tmax T2 and T3.
– moreover, Tmax offers a wide choice of residual current releases:
  - three-pole and four-pole RC221 and RC222 up to 250 A with T1, T2 and T3;
  - RC222 placed below, four-pole up to 500 A for T4 and T5;
  - RC223 (type B) also sensitive to currents with continuous slowly variable components (IEC 60947-2 Annex M), four-pole for T3 and T4, up to 250 A;
  - integrated residual current protection for PR332/P-LSIRc trip unit available for Tmax T7.

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Compliance with Standards and company quality system

Tmax circuit-breakers and their accessories comply with the international IEC 60947-2 Standards and the EC directive:

– "Low Voltage Directives" (LVD) no. 2006/95/CE (replaces 72/23/EEC and subsequent amendments)
– Electromagnetic Compatibility Directive (EMC) no. 89/336 EEC.

Certification of compliance with the product Standards mentioned above is carried out, in accordance with the European EN 45011 Standard, by the Italian certification organisation ACAE (Association for Certification of Electrical Apparatus), member of the European organization LOVAG (Low Voltage Agreement Group) and by the Swedish certification organization SEMKO.

The Test Room at ABB SACE is accredited by SINAL (certificate No. 062). The Tmax series also has a range which has undergone certification according to the severe American UL 489 and CSA C22.2 Standards. Furthermore, the Tmax series is certified by the Russian GOST (Russia Certificate of Conformity) certification organisation. The pieces of apparatus comply with the prescriptions for on-board shipping installations and are approved by the major Naval Registers - Lloyd's Register of Shipping, Germanischer Lloyd, Bureau Veritas, Rina, Det Norske Veritas, Russian Maritime Register of Shipping, and ABS (please ask ABB SACE for confirmation about the versions available).

ABB SACE's Quality System complies with the international ISO 9001-2000 Standard (model for quality assurance in design, development, construction, installation and service assistance) and with the equivalent European EN ISO 9001 and Italian UNI EN ISO 9001 Standards.

The third certifying Organisation is RINA-QUACER. ABB SACE received the first certification in 1990 with three-year validity and this has now reached its fifth confirmation. The ABB SACE quality system complies also with IRIS International Railway Industry Standard.

The new Tmax series has a hologram on the front, obtained using special anti-imitation techniques - a guarantee of the quality and genuineness of the circuit-breaker as an ABB SACE product. Attention to protection of the environment is another priority commitment for ABB SACE, and, as confirmation of this, the environmental management system has been certified by RINA. ABB SACE - the first industry in the electromechanical sector in Italy to obtain this recognition - thanks to a revision of the production process with an eye to ecology - has been able to reduce the consumption of raw materials and waste from processing by 20%. ABB SACE's commitment to safeguarding the environment is also shown in a concrete way by Life Cycle Assessments (LCA) of the products, carried out directly by ABB SACE's Research and Development in collaboration with the ABB Research Centre. Selection of materials, processes and packing materials is made optimising the true environmental impact of the product, also foreseeing the possibility of its being recycled.

Furthermore, in 1997 ABB SACE developed its Environmental Management system and got it certified in conformity with the international ISO14001 Standard, integrating it in 1999 with the Management System for Health and Safety in the workplace according to OHSAS 18001 (Swedish National Testing and Research Institute).

ISO 14001, 18001 and SA8000 recognitions together with ISO 9001 made it possible to obtain RINA, BEST FOUR CERTIFICATION.

Index

Power distribution

Circuit-breakers for power distribution

Index

2

Circuit-breakers for power distribution

Electrical characteristics

				Tmax T1 1P	Tmax T1			Tmax T2			
Rated uninterrupted current			[A]	160	160			160			
Poles			[No.]	1	3/4			3/4			
Rated service voltage, **Ue**	(AC) 50-60 Hz		[V]	240	690			690			
	(DC)		[V]	125	500			500			
Rated impulse withstand voltage, **Uimp**			[kV]	8	8			8			
Rated insulation voltage, **Ui**			[V]	500	800			800			
Test voltage at industrial frequency for 1 min.			[V]	3000	3000			3000			
Rated ultimate short-circuit breaking capacity, **Icu**				**B**	**B**	**C**	**N**	**N**	**S**	**H**	**L**
	(AC) 50-60 Hz 220/230 V		[kA]	25*	25	40	50	65	85	100	120
	(AC) 50-60 Hz 380/400/415 V		[kA]	–	16	25	36	36	50	70	85
	(AC) 50-60 Hz 440 V		[kA]	–	10	15	22	30	45	55	75
	(AC) 50-60 Hz 500 V		[kA]	–	8	10	15	25	30	36	50
	(AC) 50-60 Hz 690 V		[kA]	–	3	4	6	6	7	8	10
	(DC) 250 V - 2 poles in series		[kA]	25 (at 125 V)	16	25	36	36	50	70	85
	(DC) 250 V - 3 poles in series		[kA]	–	20	30	40	40	55	85	100
	(DC) 500 V - 2 poles in series		[kA]	–	–	–	–	–	–	–	–
	(DC) 500 V - 3 poles in series		[kA]	–	16	25	36	36	50	70	85
	(DC) 750 V - 3 poles in series		[kA]	–	–	–	–	–	–	–	–
Rated service short-circuit breaking capacity, **Ics**											
	(AC) 50-60 Hz 220/230 V		[%Icu]	75%	100%	75%	75%	100%	100%	100%	100%
	(AC) 50-60 Hz 380/400/415 V		[%Icu]	–	100%	100%	75%	100%	100%	100%	75% (70 kA)
	(AC) 50-60 Hz 440 V		[%Icu]	–	100%	75%	50%	100%	100%	100%	75%
	(AC) 50-60 Hz 500 V		[%Icu]	–	100%	75%	50%	100%	100%	100%	75%
	(AC) 50-60 Hz 690 V		[%Icu]	–	100%	75%	50%	100%	100%	100%	75%
Rated short-circuit making capacity, **Icm**											
	(AC) 50-60 Hz 220/230 V		[kA]	52.5	52.5	84	105	143	187	220	264
	(AC) 50-60 Hz 380/400/415 V		[kA]	–	32	52.5	75.6	75.6	105	154	187
	(AC) 50-60 Hz 440 V		[kA]	–	17	30	46.2	63	94.5	121	165
	(AC) 50-60 Hz 500 V		[kA]	–	13.6	17	30	52.5	63	75.6	105
	(AC) 50-60 Hz 690 V		[kA]	–	4.3	5.9	9.2	9.2	11.9	13.6	17
Opening time (415 V)			[ms]	7	7	6	5	3	3	3	3
Utilisation category (IEC 60947-2)				A	A			A			
Reference Standard				IEC 60947-2	IEC 60947-2			IEC 60947-2			
Isolation behaviour				■	■			■			
Trip units:	thermomagnetic										
	T fixed, M fixed	TMF		■	–			–			
	T adjustable, M fixed	TMD		–	■			■			
	T adjustable, M adjustable (5…10 x In)	TMA		–	–			–			
	T adjustable, M fixed (3 x In)	TMG		–	–			■ (3)			
	T adjustable, M adjustable (2.5…5 x In)	TMG		–	–			–			
	magnetic only	MA		–	–			■ (MF up to In 12.5 A)			
	electronic	PR221DS		–	–			■			
		PR221GP/PR221MP		–	–			■			
		PR222DS		–	–			–			
		PR223DS		–	–			–			
		PR231/P		–	–			–			
		PR232/P		–	–			–			
		PR331/P		–	–			–			
		PR332/P		–	–			–			
Interchangeability				–	–			–			
Versions				F	F			F-P			
Terminals	fixed			FC Cu	FC Cu-EF-FC CuAl-HR			F-FC Cu-FC CuAl-EF-ES-R			
	plug-in			–	–			F-FC Cu-FC CuAl-EF-ES-R			
	withdrawable			–	–			–			
Fixing on DIN rail				–	DIN EN 50022			DIN EN 50022			
Mechanical life			[No. operations]	25000	25000			25000			
			[No. Hourly operations]	240	240			240			
Electrical life @ 415 V AC			[No. operations]	8000	8000			8000			
			[No. Hourly operations]	120	120			120			
Basic dimensions - fixed version		3 poles	W [mm]	25.4 (1 pole)	76			90			
		4 poles	W [mm]	–	102			120			
			D [mm]	70	70			70			
			H [mm]	130	130			130			
Weight	fixed	3/4 poles	[kg]	0.4 (1 pole)	0.9/1.2			1.1/1.5			
	plug-in	3/4 poles	[kg]	–	–			1.5/1.9			
	withdrawable	3/4 poles	[kg]	–	–			–			

TERMINAL CAPTION
F = Front
EF = Front extended
ES = Front extended spread

FC Cu = Front for copper cables
FC CuAl = Front for copper-aluminium cables
R = Rear orientated
HR = Rear flat horizontal

VR = Rear flat vertical
HR/VR = Rear flat orientated
MC = Multicable
F = fixed circuit-breakers

P = plug-in circuit-breakers
W = withdrawable circuit-breakers
(*) The breaking capacity for settings In = 16 A and In = 20 A is 16 kA

	Tmax T3		Tmax T4					Tmax T5					Tmax T6				Tmax T7			
	250		250/320					400/630					630/800/1000				800/1000/1250/1600			
	3/4		3/4					3/4					3/4				3/4			
	690		690					690					690				690			
	500		750					750					750				–			
	8		8					8					8				8			
	800		1000					1000					1000				1000			
	3000		3500					3500					3500				3500			
	N	**S**	**N**	**S**	**H**	**L**	**V**	**N**	**S**	**H**	**L**	**V**	**N**	**S**	**H**	**L**	**S**	**H**	**L**	**V**[6]
	50	85	70	85	100	200	200	70	85	100	200	200	70	85	100	200	85	100	200	200
	36	50	36	50	70	120	200	36	50	70	120	200	36	50	70	100	50	70	120	150
	25	40	30	40	65	100	180	30	40	65	100	180	30	45	50	80	50	65	100	130
	20	30	25	30	50	85	150	25	30	50	85	150	25	35	50	65	40	50	85	100
	5	8	20	25	40	70	80	20	25	40	70	80	20	22	25	30	30	42	50	60
	36	50	36	50	70	100	150	36	50	70	100	150	36	50	70	100	–	–	–	–
	40	55	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	25	36	50	70	100	25	36	50	70	100	20	35	50	65	–	–	–	–
	36	50	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	16	25	36	50	70	16	25	36	50	70	16	20	36	50	–	–	–	–
	75%	50%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	75%	100%	100%	100%	100%
	75%	50% (27 kA)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	75%	100%	100%	100%	100%
	75%	50%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	75%	100%	100%	100%	100%
	75%	50%	100%	100%	100%	100%	100%	100%	100%	100%	100%[1]	100%[2]	100%	100%	100%	75%	100%	100%	75%	100%
	75%	50%	100%	100%	100%	100%	100%	100%	100%	100%[1]	100%[2]	100%[2]	75%	75%	75%	75%	100%	75%	75%	75%
	105	187	154	187	220	440	660	154	187	220	440	660	154	187	220	440	187	220	440	440
	75.6	105	75.6	105	154	264	440	75.6	105	154	264	440	75.6	105	154	220	105	154	264	330
	52.5	84	63	84	143	220	396	63	84	143	220	396	63	94.5	105	176	105	143	220	286
	40	63	52.5	63	105	187	330	52.5	63	105	187	330	52.5	73.5	105	143	84	105	187	220
	7.7	13.6	40	52.5	84	154	176	40	52.5	84	154	176	40	46	52.5	63	63	88.2	105	132
	7	6	5	5	5	5	5	6	6	6	6	6	10	9	8	7	15	10	8	8
	A		A					B (400 A)[3] - A (630 A)					B (630A - 800A)[5] - A (1000A)				B[7]			
	IEC 60947-2		IEC 60947-2					IEC 60947-2					IEC 60947-2				IEC 60947-2			
	■		■					■					■				■			
	–		–					–					–				–			
	■		■ (up to 50 A)					–					–				–			
	–		■ (up to 250 A)					■ (up to 500 A)					■ (up to 800 A)[4]				–			
	■		–					–					–				–			
	–		–					■ (up to 500 A)					–				–			
	■		■					–					–				–			
	–		■					■					■				–			
	–		–					–					–				–			
	–		■					■					■				–			
	–		■					■					■				–			
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	–		–					–					–				■			
	–		–					–					–				■			
	–		–					–					–				■			
	–		■					■					■				■			
	F-P		F-P-W					F-P-W					F-W[4]				F-W			
	F-FC Cu-FC Cu Al-EF-ES-R		F-FC Cu-FC CuAl-EF-ES-R-MC					F-FC CuAl-EF-ES-R-RC					F-FC CuAl-EF-ES-R-RC				F-EF-ES-FC CuAl-HR/VR			
	F-FC Cu-FC Cu Al-EF-ES-R		EF-ES-HR-VR-FC Cu-FC CuAl					EF-ES-HR-VR-FC Cu-FC CuAl					–				–			
	–		EF-ES-HR-VR-FC Cu-FC CuAl					EF-ES-HR-VR-FC Cu-FC CuAl					EF-HR-VR				EF-HR/VR-RS-ES			
	DIN EN 50022		–					–					–				–			
	25000		20000					20000					20000				10000			
	240		240					120					120				60			
	8000		8000 (250 A) - 6000 (320 A)					7000 (400 A) - 5000 (630 A)					7000 (630A) - 5000 (800A) - 4000 (1000A)				2000 (S, H, L versions) / 3000 (V version)			
	120		120					60					60				60			
	105		105					140					210				210			
	140		140					186					280				280			
	70		103.5					103.5					103.5				154 (manual) /178 (motorizable)			
	150		205					205					268				268			
	1.5/2		2.35/3.05					3.25/4.15					9.5/12				9.7/12.5 (manual) - 11/14 (motorizable)			
	2.7/3.7		3.6/4.65					5.15/6.65					–				–			
	–		3.85/4.9					5.4/6.9					12.1/15.1				29.7/39.6 (manual) - 32/42.6(motorizable)			

[1] 75% for T5 630
[2] 50% for T5 630
[3] Icw = 5 kA
[4] W version is not available on T6 1000 A
[5] Icw = 7.6 kA (630 A) - 10 kA (800 A)
[6] Only for T7 800/1000/1250 A
[7] Icw = 20 kA (S,H,L versions) - 15 kA (V version)
[8] For availability, please ask ABB SACE

Notes: In the plug-in version of T2, T3 and T5 630 and in the withdrawable version of T5 630 the maximum rated current available is derated by 10% at 40 °C

Circuit-breakers for power distribution

General characteristics

The series of Tmax moulded-case circuit-breakers - complying with the IEC 60947-2 Standard - is divided into seven basic sizes, with an application range from 1 A to 1600 A and breaking capacities from 16 kA to 200 kA (at 380/415 V AC).
For protection of alternating current networks, the following are available:

- T1B 1p circuit-breaker, equipped with TMF thermomagnetic trip units with fixed thermal and magnetic threshold (I_3 = 10 x In);
- T1, T2, T3 and T4 (up to 50 A) circuit-breakers equipped with TMD thermomagnetic trip units with adjustable thermal threshold (I_1 = 0.7…1 x In) and fixed magnetic threshold (I_3 = 10 x In);
- T2, T3 and T5 circuit-breakers, fitted with TMG trip units for long cables and generator protection with adjustable thermal threshold (I_1 = 0.7…1 x In) and fixed magnetic threshold (I_3 = 3 x In) for T2 and T3 and adjustable magnetic threshold (I_3 = 2.5…5 x In) for T5;
- T4, T5 and T6 circuit-breakers with TMA thermomagnetic trip units with adjustable thermal threshold (I_1 = 0.7…1 x In) and adjustable magnetic threshold (I_3 = 5…10 x In);
- T2 with PR221DS electronic trip unit;
- T4, T5 and T6 with PR221DS, PR222DS/P, PR222DS/PD and PR223DS electronic trip units;
- the T7 circuit-breaker, which completes the Tmax family up to 1600 A, fitted with PR231/P, PR232/P, PR331/P and PR332/P electronic trip units. The T7 circuit-breaker is available in the two versions: with manual operating mechanism or motorizable with stored energy operating mechanism(*).

The field of application in alternating current of the Tmax series varies from 1 A to 1600 A with voltages up to 690 V. The Tmax T1, T2, T3, T4, T5 and T6 circuit-breakers equipped with TMF, TMD and TMA thermomagnetic trip units can also be used in direct current plants, with a range of application from 1 A to 800 A and a minimum operating voltage of 24 V DC, according to the appropriate connection diagrams.
The three-pole T2, T3 and T4 circuit-breakers can also be fitted with MF and MA adjustable magnetic only trip units, both for applications in alternating current and in direct current, in particular for motor protection (see page 2/45 and following).
For all the circuit-breakers in the series, fitted with thermomagnetic and electronic trip units, the single-phase trip current is defined (see page 4/57).

(*) For motorisation, the T7 circuit-breaker with stored energy operating mechanism must be ordered, complete with geared motor for automatic spring charging, opening coil and closing coil.

Interchangeability

The Tmax T4, T5 and T6 circuit-breakers can be equipped either with TMF, TMD, TMG or TMA thermomagnetic trip units, MA magnetic only trip units or PR221DS, PR222DS/P, PR222DS/PD, PR222MP and PR223DS electronic trip units.
Similarly, Tmax T7 can also mount the latest generation PR231/P, PR232/P, PR331/P(1) and PR332/P(1) electronic trip units.

Trip units

Circuit-breakers	TMD			TMA										TMG		
In [A]	20	32	50	80	100	125	160	200	250	320	400	500	630	800	320	400	500
T4 250	■	■	■	■	■	■	■	■	■								
T4 320	▲	▲	▲	▲	▲	▲	▲	▲	▲								
T5 400										■	■				▲	▲	
T5 630										▲	▲	■			▲	▲	▲
T6 630													■				
T6 800														■			
T6 1000																	
T7 800																	
T7 1000																	
T7 1250																	
T7 1600																	

■ = Complete circuit-breaker already coded
▲ = Circuit-breaker to be assembled

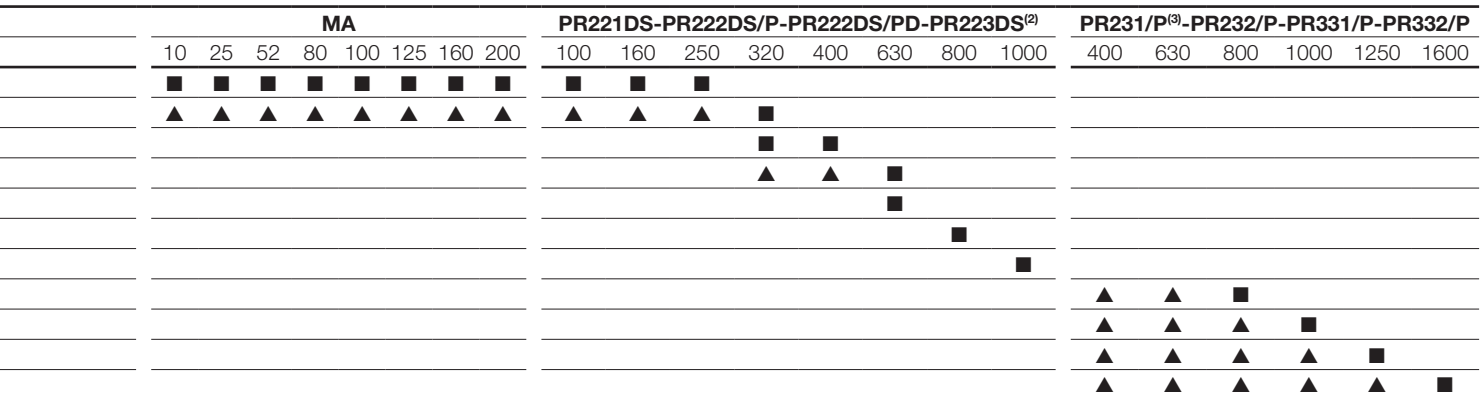
(1) If ordered loose PR331/P and PR332/P must be completed with the "trip unit adapters" (see page 3/42)

Range of application of the circuit-breakers in alternating current and in direct current

AC	Trip unit	Range [A]
T1 1p 160	TMF	16…160
T1 160	TMD	16…160
T2 160	TMD	1.6…160
	TMG	16…160
	MF/MA	1…100
	PR221DS	10…160
	PR221GP	63…160
	PR221MP	40…100
T3 250	TMG	63…250
	TMD	63…250
	MA	100…200
T4 250/320	TMD	20…50
	TMA	80…250
	MA	10…200
	PR221DS	100…320
	PR222DS/P-PR222DS/PD	100…320
	PR223DS	160…320
T5 400/630	TMG	320…500
	TMA	320…500
	PR221DS	320…630
	PR222DS/P-PR222DS/PD	320…630
	PR223DS	320…630
T6 630/800/1000	TMA	630…800
	PR221DS	630…1000
	PR222DS/P-PR222DS/PD	630…1000
	PR223DS	630…1000
T7 800/1000/1250/1600	PR231/P-PR232/P	400…1600
	PR331/P-PR332/P	400…1600
DC		
T1 1p 160	TMF	16…160
T1 160	TMD	16…160
T2 160	TMD	1.6…160
	MF/MA	1…100
T3 250	TMD/TMG	63…250
	MA	100…200
T4 250/320	TMD	20…50
	TMA	80…250
	MA	10…200
T5 400/630	TMA/TMG	320…500
T6 630/800/1000	TMA	630…800

MF = magnetic only trip unit with fixed magnetic thresholds
MA = magnetic only trip unit with adjustable magnetic thresholds
TMF = thermomagnetic trip unit with fixe thermal and magnetic thresholds
TMD = thermomagnetic trip unit with adjustable thermal and fixedmagnetic thresholds
TMA = thermomagnetic trip unit with adjustable thermal and magnetic thresholds
TMG = thermomagnetic trip unit for generator protection
PR22_, PR23_, PR33_ = electronic trip units

Thanks to their simplicity of assembly, the end customer can change the type of trip unit extremely rapidly, according to their own requirements and needs: in this case, correct assembly is the customer's responsibility. Above all, this means into increased flexibility of use of the circuit-breakers with considerable savings in terms of costs thanks to better rationalisation of stock management.



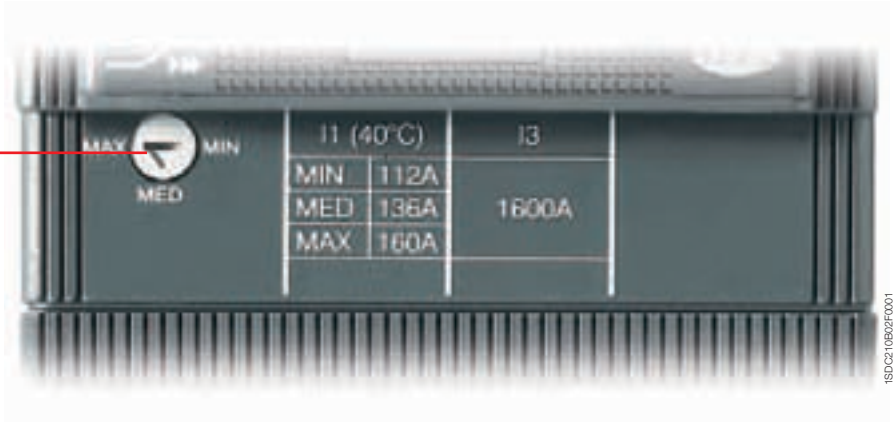
(2) PR223DS, minimum In = 160 A.

(3) Interchangeability of PR231/P can be requested by means of the dedicated ordering code 1SDA063140R1.

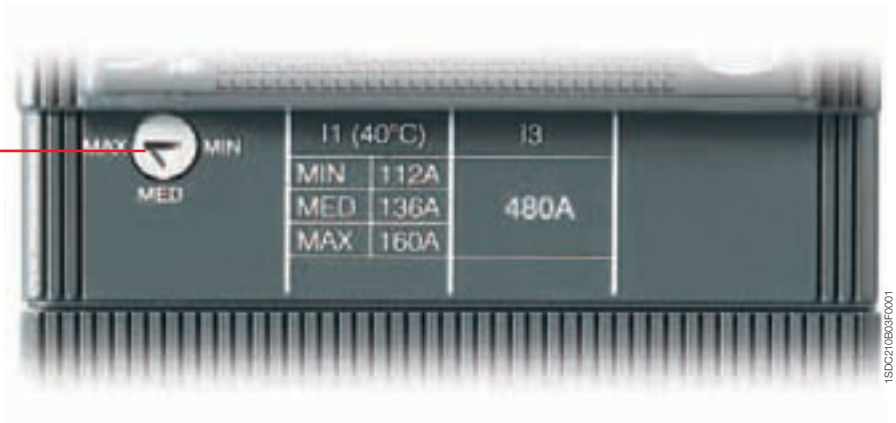
The Tmax T1 1p, T1, T2, T3, T4, T5 and T6 circuit-breakers can be fitted with thermomagnetic trip units and are used in protection of alternating and direct current networks with a range of use from 1.6 A to 800 A. They allow the protection against overload with a thermal device (with fixed threshold for T1 1p and adjustable threshold for T1, T2, T3, T4, T5 and T6) realised using the bimetal technique, and protection against short-circuit with a magnetic device (with fixed threshold for T1, T2 and T3 and T4 up to 50 A and adjustable threshold for T4, T5 and T6).
The four-pole circuit-breakers are always supplied with the neutral protected by the trip unit and with protection of the neutral at 100% of the phase setting for settings up to 100 A. For higher settings, the protection of the neutral is at 50% of the phase setting unless the protection of the neutral at 100% of the phase setting is required.

Thermomagnetic trip units TMD e TMG (for T1, T2 and T3)

Thermal threshold
Adjustable from 0.7 to 1 x In



Thermal threshold
Adjustable from 0.7 to 1 x In



TMD = thermomagnetic trip unit with adjustable thermal threshold (I_1 = 0.7…1 x In) and fixed magnetic threshold (I_3 = 10 x In).
TMG = thermomagnetic trip unit with adjustable thermal threshold (I_1 = 0.7…1 x In) and fixed magnetic threshold (I_3 = 3 x In).

Furthermore, for Tmax T2, T3 and T5, the TMG thermomagnetic trip units with low magnetic trip threshold are available. For T2 and T3 the trip unit has adjustable thermal threshold (I_1 = 0.7…1 x In) and fixed magnetic threshold (I_3 = 3 x In), whereas for T5 the trip unit has adjustable thermal threshold (I_1 = 0.7…1 x In) and adjustable magnetic threshold (I_3 = 2.5… 5 x In). The thermomagnetic trip units can be used to protect long cables and for generator protection, both in direct current and in alternating current.

TMD - T1 and T3

	In [A]	16(1)	20(1)	25(2)	32	40	50	63	80	100	125	125	160	200	250
	Neutral [A] - 100%	16	20	25	32	40	50	63	80	100	125	–	160	200	250
I_1=0.7…1 x In	Neutral [A] - 50%	–	–	–	–	–	–	–	–	–	–	80	100	125	160
T1 160		■	■	■	■	■	■	■	■	■	■	–	■	–	–
T3 250								■	■	■	■	■	■	■	■
	I_3 [A]	630(3)	630(3)	630(3)	630(3)	630(3)	630(3)	630	800	1000	1250	1250	1600	2000	2500
	Neutral [A] - 100%	630	630	630	630	630	630	630	800	1000	1250	1250	1600	2000	2500
I_3 = 10 x In	Neutral [A] - 50%	–	–	–	–	–	–	–	–	–	–	800	1000	1250	1600

TMD - T2

	In [A]	1.6	2	2.5	3.2	4	5	6.3	8	10	12.5	16	20	25	32	40	50	63	80	100	125	160
	Neutral [A] - 100%	1.6	2	2.5	3.2	4	5	6.3	8	10	12.5	16	20	25	32	40	50	63	80	100	125	160
I_1=0.7…1 x In	Neutral [A] - 50%	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	100
	I_3 [A]	16	20	25	32	40	50	63	80	100	125	500	500	500	500	500	500	630	800	1000	1250	1600
	Neutral [A] - 100%	16	20	25	32	40	50	63	80	100	125	500	500	500	500	500	500	630	800	1000	1250	1600
I_3 = 10 x In	Neutral [A] - 50%	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	800	1000

TMG - T2

	In [A]	25	40	63	80	100	125	160
	Neutral [A] - 100%	25	40	63	80	100	125	160
I_1=0.7…1 x In								
	I_3 [A]	160	200	200	240	300	375	480
	Neutral [A] - 100%	160	200	200	240	300	375	480
I_3 = 3 x In								

TMG - T3

	In [A]	63	80	100	125	160	200	250
	Neutral [A] - 100%	63	80	100	125	160	200	250
I_1=0.7…1 x In								
	I_3 [A]	400	400	400	400	480	600	750
	Neutral [A] - 100%	400	400	400	400	480	600	750
I_3 = 3 x In								

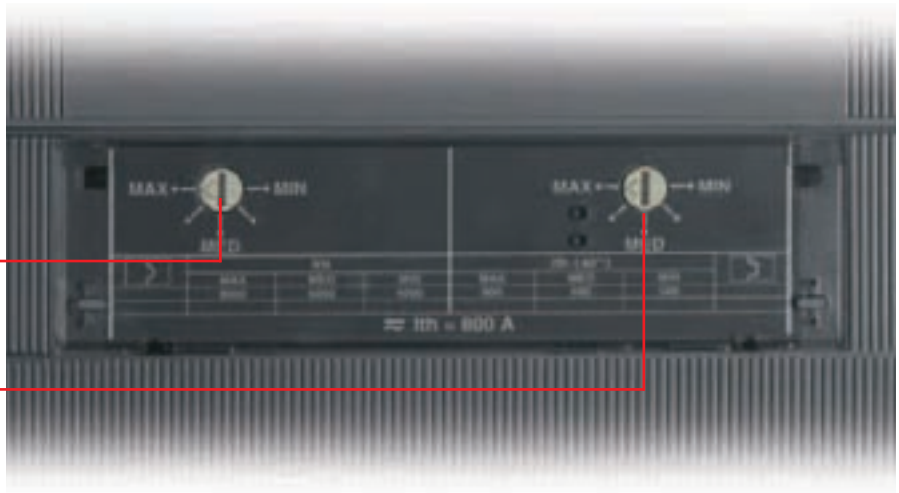
Notes: (1) only T1B (2) only T1B and T1C (3) T1N ⇒ I_3 [A] = 500; T1B-C available also the version with ⇒ I_3 [A] = 500

– In identifies the setting current for protection of the phases (L1, L2 and L3) and of the neutral.

– The TMD and TMA thermomagnetic trip units have the thermal element with adjustable threshold I_1 = 0.7…1 x In. The value of the thermal element adjustment which is obtained by acting on the special selector, is intended at 40 °C. The magnetic element has fixed trip threshold with ± 20% tolerance according to what is indicated by the IEC 60947-2 (pos. 8.3.3.1.2) Standard. The trip thresholds of the magnetic protection I_3 are a function of the setting used both by the phase and neutral protection.

2

Thermomagnetic trip units TMD/TMA and TMG (for T4, T5 and T6)



TMA = thermomagnetic trip unit with adjustable thermal threshold (I_1 = 0.7…1 x In) and adjustable magnetic threshold (I_3 = 5… 10 x In)
TMG (for T5) = thermomagnetic trip unit with adjustable thermal threshold (I_1 = 0.7…1 x In) and adjustable magnetic threshold (I_3 = 2.5 …5 x In)

TMD/TMA - T4

	In [A]	20	32	50	80	100	125	160	200	250
	Neutral [A] - 100%	20	32	50	80	100	125	160	200	250
I_1=0.7…1 x In	Neutral [A] - 50%	–	–	–	–	–	80	100	125	160
	I_3 = 10 x In [A]	320	320	500						
	I_3 = 5...10 x In [A]				400…800	500…1000	625…1250	800…1600	1000…2000	1250…2500
I_3 = 10 x In	Neutral [A] - 100%	320	320	500	400…800	500…1000	625…1250	800…1600	1000…2000	1250…2500
I_3 = 5...10 x In	Neutral [A] - 50%	–	–	–	–	–	400…800	500…1000	625…1250	800…1600

TMA - T5

	In [A]	320	400	500
	Neutral [A] - 100%	320	400	500
I_1=0.7…1 x In	Neutral [A] - 50%	200	250	320
	I_3 [A]	1600…3200	2000…4000	2500…5000
	Neutral [A] - 100%	1600…3200	2000…4000	2500…5000
I_3 = 5...10 x In	Neutral [A] - 50%	1000…2000	1250…2500	1600…3200

TMG - T5

	In [A]	320	400	500
	Neutral [A] - 100%	320	400	500
I_1=0.7…1 x In				
	I_3 [A]	800…1600	1000…2000	1250…2500
	Neutral [A] - 100%	800…1600	1000…2000	1250…2500
I_3 = 2.5...5 x In				

TMA - T6

	In [A]	630	800
	Neutral [A] - 100%	630	800
I_1=0.7…1 x In	Neutral [A] - 50%	400	500
	I_3 [A]	3150...6300	4000...8000
	Neutral [A] - 100%	3150...6300	4000...8000
I_3 = 5…10 x In	Neutral [A] - 50%	2000...4000	2500...5000

Notes
- In identifies the setting current for protection of the phases (L1, L2 and L3) and of the neutral.
- The TMA and TMG thermomagnetic trip units which equip the Tmax T4, T5 and T6 circuit-breakers have the thermal element with adjustable threshold I_1 = 0.7…1 x In. The set current value which is obtained using the special selector is intended at 40 °C. The magnetic element has adjustable trip threshold (I_3 = 5…10 x In for TMA and I_3 = 2.5…5 x In for TMG) with a tolerance of ± 20% according to what is indicated in the IEC 60947-2 (par. 8.3.3.1.2) Standard. The trip thresholds of the magnetic protection I_3 are a function of the setting used both by the phase and neutral protection.

The Tmax T2, T4, T5, T6 and T7 circuit-breakers, for use in alternating current, can be equipped with overcurrent releases constructed using electronic technology. This allows protection functions to be obtained which guarantee high reliability, tripping precision and insensitivity to temperature and to the electromagnetic components in conformity with the standards on the matter.
The power supply needed for correct operation is supplied directly by the current sensors of the release, and tripping is always guaranteed, even under single-phase load conditions and in correspondence with the minimum setting.

Characteristics of the Tmax electronic trip units

Operating temperature	-25 °C … +70 °C
Relative humidity	98%
Self-supply	0.2 x In (single phase)
Auxiliary power supply (where applicable)	24 V DC
Operating frequency	45…66 Hz
Electromagnetic compatibility (LF and HF)	IEC 60947-2 Annex F

For Tmax T2, T4, T5 and T6 the protection trip unit consists of:
– 3 or 4 current sensors (current transformers)
– external current sensors (e.g. for the external neutral), when available
– a trip unit
– a trip coil (for T2 housed in the right slot, for T4, T5 and T6 integrated in the electronic trip unit).
For Tmax T7 the protection trip unit consists of:
– 3 or 4 current sensors (Rogowski coils and current transformers)
– external current sensors (e.g. for the external neutral)
– interchangeable rating plug
– a trip unit
– a trip coil housed in the body of the circuit-breaker.

Rating plugs

Circuit-breaker	CS Rated current	In [A]					
		400	630	800	1000	1250	1600
T7	800	■	■	■			
	1000	■	■	■	■		
	1250	■	■	■	■	■	
	1600	■	■	■	■	■	■

The current sensors supply the electronic trip unit with the energy needed for correct operation of the trip unit and the signal needed to detect the current.
The current sensors are available with rated primary current as shown in the table.

Current sensors

	In [A]	10	25	63	100	160	250	320	400	630	800	1000	1250	1600
PR221DS	T2	■	■	■	■	■								
	T4				■	■	■	■						
	T5							■	■	■				
	T6									■	■	■		
PR222DS/P, PR222DS/PD, PR223DS[1]	T4				■	■	■	■						
	T5							■	■	■				
	T6									■	■	■		
PR231/P, PR232/P, PR331/P, PR332/P	T7								■	■	■	■	■	■

[1] For PR223DS, the minimum rated current is In=160 A.

When a protection function trips, the circuit-breaker opens by means of the trip coil, which changes over a contact (AUX-SA, supplied on request, see chapter “Accessories” at page 3/20 and following) to signal trip unit tripped. Signalling reset is of mechanical type and takes place with resetting of the circuit-breaker.

Basic protection functions

(L) Protection against overload
This protection function trips when there is an overload with inverse long-time delay trip according to the IEC 60947-2 Standard ($I^2t=k$). The protection cannot be excluded.

(S) Protection against short-circuit with time delay
This protection function trips when there is a short-circuit, with long inverse time-delay trip ($I^2t=k$ ON) or a constant trip time ($I^2t=k$ OFF). The protection can be excluded.

(I) Instantaneous protection against short-circuit
This protection function trips instantaneously in case of a short-circuit. The protection can be excluded.

(G) Protection against earth fault
The protection against earth fault trips when the vectorial sum of the currents passing through the current sensors exceeds the set threshold value, with long inverse time-delay trip ($I^2t=k$ ON) or a constant trip time ($I^2t=k$ OFF). The protection can be excluded.

Advanced protection functions

The PR332/P trip unit makes it possible to carry out highly developed protection against the most varied types of fault. In fact, it adds the following advanced protection functions to the basic protection functions.

IEC 60255-3

(L) Protection against overload (IEC 60255-3)
This protection trips in case of an overload with inverse long-time delay according to IEC 60255-3 Standard, for the coordination with fuses and MV protections. The protection can be excluded.

(U) Protection against unbalanced phase
The protection function against unbalanced phase U can be used in those cases where a particularly precise control is needed regarding missing and/or unbalance of the phase currents. The trip time is instantaneous. The protection can be excluded.

(OT) Protection against overtemperature
The protection against overtemperature trips instantaneously when the temperature inside the trip unit exceeds 85 °C, in order to prevent any temporary or continual malfunction of the microprocessor. The protection cannot be excluded.

(Rc) Protection against residual current [1]
This integrated protection is based on current measurements made by an external toroid and is alternative to protection against earth fault G. The protection can be excluded.

(ZS) Zone selectivity [2]
ZS zone selectivity is an advanced method for carrying out coordination of the protections in order to reduce the trip times of the protection closest to the fault in relation to the time foreseen by time selectivity. Zone selectivity can be applied to the protection functions S and G, with constant time-delay trip. The protection can be excluded.

(UV, OV, RV) Protections against voltage
The three protections trip with a constant time-delay in the case of undervoltage, overvoltage and residual voltage respectively. The latter allows to detect interruptions of the neutral (or of the earthing conductor in systems with earthed neutral) and faults which cause movement of the star centre in systems with isolated neutral (e.g. large earth faults) to be identified. Movement of the star centre is calculated by vectorially summing the phase voltages. The protections can be excluded.

(RP) Protection against reversal of power
The protection against reversal power causes tripping of the breaker, with constant time-delay trip, when the flow of power reverses sign and exceeds, as an absolute value, the set threshold. It is particularly suitable for protection of large machines such as generators. The protection can be excluded.

(UF, OF) Protections of frequency
The two protections detect the variation in network frequency above or below the adjustable thresholds, opening the circuit-breaker, with constant time-delay trip. The protection can be excluded.

[1] It is not suitable for human protection.
[2] For further information about zone selectivity, please see the section: “Circuit-breakers for zone selectivity”.

Electronic trip units for power distribution

SACE PR221DS

	PR221DS	PR221DS	PR221GP
Protection functions	L S / I	I	L S I

SACE PR222DS/P

	PR222DS/P	PR222DS/P
Protection functions	L S I	L S I G

SACE PR222DS/PD

	PR222DS/PD	PR222DS/PD
Protection functions	L S I	L S I G

SACE PR223DS

	PR223DS
Protection functions	L S I G

SACE PR231/P

	PR231/P	PR231/P
Protection functions	L S / I	I

SACE PR232/P

	PR232/P
Protection functions	L S I

SACE PR331/P

	PR331/P
Protection functions	L S I G

SACE PR332/P

	PR332/P	PR332/P	PR332/P	PR332/P
Protection functions	L I	L S I	L S I G(1)	L S I Rc
Advanced protection function(*)	L(***) U OT	L(***) U OT	L(***) U OT	L(***) U OT
Opt.(**)	UV OV RV RP UF OF	UV OV RV RP UF OF	UV OV RV RP UF OF	UV OV RV RP UF OF

(1) In alternative to Rc (with external toroid).
(*) For all versions.
(**) Available with PR330/V. Measurement module.
(***) According to IEC 60255-3.

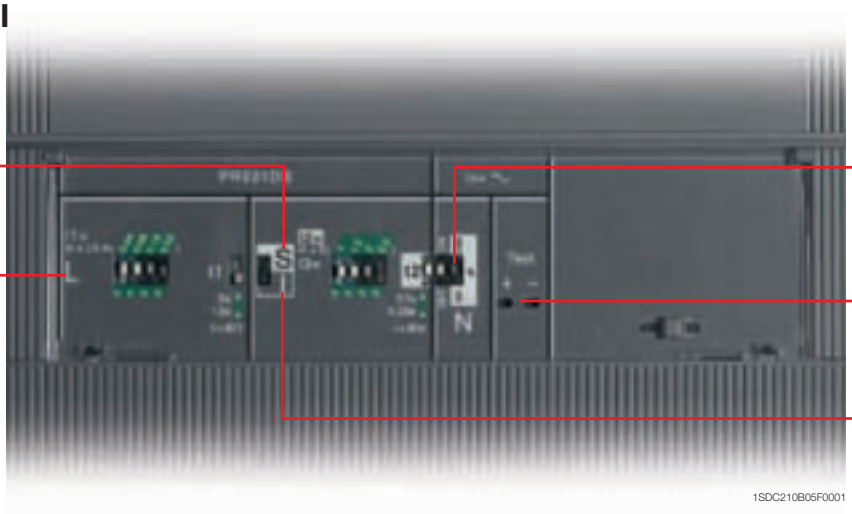
PR221DS

The PR221DS trip unit, available for T2,T4, T5 and T6, provides protection functions against overload L and short-circuit S/I (version PR221DS-LS/I): with this version, by moving the dedicated dip-switch, you can choose whether to have inverse time-delay S or instantaneous I protection against short-circuit. Alternatively, the version with only the protection function against instantaneous short-circuit I is available (version PR221DS-I, also see page 2/45 and following).
There is a single adjustment for the phases and the neutral. However, for the neutral it can be decided whether to request the protection threshold of the functions at 50 - 100% of that of the phases for Tmax T2 In = 160 A (T2 In<160 A, N = 100%), whereas for T4, T5 and T6 it is possible to select the protection threshold OFF, 50% or 100% directly from the front of the trip unit by means of the specific dip switch.
The trip coil is always supplied with the PR221DS trip unit for Tmax T2 and is housed in the right-hand slot of the circuit-breaker. Dedicated auxiliary contacts are available for T2 with electronic trip unit (see page 3/22).
For Tmax T4, T5 and T6, the opening solenoid is housed internally and therefore, by not using the right-hand slot of the circuit-breaker, all the auxiliary contacts available can be used.

PR221DS-LS/I

Protection S
Against short-circuit with delayed trip

Protection L
Against overload



Dip-switch for neutral setting (only for T4, T5 and T6)

Socket for TT1 test unit

Protection I
Against short-circuit with instantaneous trip

PR221DS - Protection functions and parameterisations

Protection functions[1]		Trip threshold	Trip curves	Excludability	Relation t = f(I)
L	Against overload with long inverse time delay trip and trip characteristic according to an inverse time curve ($I^2t=k$) according to IEC 60947-2 Standard	I_1 = 0.40 - 1 x In step = 0.04 x In Trip between 1.1...1.30 x I_1 (T4,T5,T6) Trip between 1.05...1.30 x I_1 (T2)	at 6 x I_1 t_1 = 3-6 **(only for T2)** - 12s **(only for T4,T5,T6)** Tolerance: ± 10% up to 6 x In (T4,T5,T6) ± 10% up to 2 x In (T2) ± 20% above 6 x In (T4,T5,T6) ± 20% above 2 x In (T2)	–	$t = k/I^2$
S	Against short-circuit with inverse short time delay trip and trip characteristic with inverse time ($I^2t=k$) (selectable as an alternative to protection function I)	I_2 = 1-1.5-2-2.5-3-3.5-4.5-5.5-6.5-7-7.5-8-8.5-9-10 x In[2] Tolerance: ± 10% (T4,T5,T6) ± 10% up to 2 x In (T2) ± 20% above 2 x In (T2)	at 8 x In t_2 = 0.1 - 0.25s Tolerance: ± 10% up to 6 x In (T4,T5,T6) ± 20% above 6 x In (T4,T5,T6) ± 20% (T2)	■	$t = k/I^2$
I	Against short-circuit with instantaneous trip (selectable as an alternative to protection function S)	I_3 = 1-1.5-2-2.5-3-3.5-4.5-5.5-6.5-7-7.5-8-8.5-9-10 x In[2] Tolerance: ± 10% (T4,T5,T6) ± 20% (T2)	instantaneous	■	t = k

[1] These tolerances hold in the following conditions:
– self-powered trip unit at full power (without start-up)
– two or three-phase power supply
In conditions other than those considered, the following tollerances hold:

	Trip threshold	Trip time
S	± 20%	± 20%
I	± 20%	≤ 40ms

[2] For T4 In = 320 A. T5 In = 630 A and T6 In = 1000 A ⇒ I_2max = 9.5 x In, I_3max = 9.5 x In.
The setting at 10 x In corresponds to 9.5 x In.

PR221GP

The PR221GP electronic release, only available on Tmax T2, is specific for protection of generators with the following rated currents: In = 63 A, In = 100 A, In = 160 A.
It allows wide adjustment of the protection against overload L, I_1 = 0.4…1 x In and above all provides the possibility of selecting four trip curves.
Generator protection typically requires low trip thresholds with regard to protection against short-circuit. Thanks to the PR221GP protection with time delay adjustable up to 2.5 times the rated current, I_2 = 1…2.5 x In is guaranteed, with the possibility of selecting between two trip curves.
It is also possible to set an instantaneous protection again short-circuit (I) fixed at 4 times the trip threshold of the protection against delayed short-circuit (S).
The S and I protection functions are not alternative to each other.
As for Tmax T2 PR221DS, it is necessary to house the opening solenoid (SA) in the right-hand slot of the circuit-breaker. Tmax T2 PR221GP can be fitted with the same electrical accessories available with PR221DS.
The functions present on this release allow the requirements imposed by the major naval registers, such as LLRRS, ABS and RINA to be satisfied.

PR221GP

Protection S
Against short-circuit with delayed trip

Protection L
Against overload

Socket for TT1 test unit

Protection I
Against short-circuit with instantaneous trip

PR221GP – Protection and parameterisation functions

Protection function[1]		Trip threshold	Trip curves	Excludability	Relation t = f(I)
L	Against overload with long inverse time delay trip and trip characteristic according to an inverse time curve (I^2t=constant) according to IEC 60947-2 Standard	I_1 = 0.40 - 1 x In step = 0.04 x In	at 6 x I_1 t_1 = 0.7 - 1.4 - 2.8 - 5.5 s Tolerance: ± 10% up to 2 x In ± 20% over 2 x In	–	–
S	Against short-circuit with inverse short time delay trip and trip characteristic with inverse time (I^2t=constant)	I_2 = 1...2.5 x In step = 0.5 x In Tolerance: ± 10%	at 5 x In t_2 = 0.07 - 0.175 s Tolerance: ± 10% up to 2 x In	–	t = k/I
I	Against short-circuit with instantaneous trip with adjustable threshold	I_3 = 4 x I_2 fixed Tolerance: ± 20%	instantaneous	■	t = k

[1] The tolerances are valid with these hypotheses:
– self-supplied release at full power and/or auxiliary power supply (without start up)
– two-phase or three-phase power supply
For all the cases not foreseen in the above hypotheses, the following tolerance values are valid:

	Trip threshold	Trip time
S	± 20%	± 20%
I	± 20%	≤ 40ms

PR222DS/P

The PR222DS/P trip unit, available for T4, T5 and T6, has protection functions against overload L, delayed S and instantaneous I short-circuit (version PR222DS/P-LSI). Alternatively, as well as the functions L, S, I, it also has protection against earth fault G (version PR222DS/P-LSIG).
Setting of the PR222DS trip unit can be carried out by means of dip switches on the front of the circuit-breaker or electronically, using the PR010/T programming and control unit (see page 3/46) or the BT030 wireless communication unit (see page 3/42).
There is a single setting for the phases and neutral, for which one can decide whether to set the threshold of the protection functions to OFF, to 50% or to 100% that of the phases by means of two dedicated dip switches.
Furthermore, on the front of the PR222DS/P (or PR222DS/PD) trip units, signalling of pre-alarm and alarm of protection L is available. The pre-alarm threshold value, signalled by the red LED fixed, is equal to 0.9 x I1. It is also possible to transmit remotely the alarm of protection L, simply connecting connector X3 to the dedicated contact.

PR222DS/PD

Apart from the protection functions available for the PR222DS/P trip unit (for the settings see page 2/20), the PR222DS/PD trip unit, available for T4, T5 and T6 also has the dialogue unit integrated with Modbus® RTU protocol.
The Modbus® RTU protocol has been known and used worldwide for many years and is now a market standard thanks to its simplicity of installation, configuration and to its integration in the various different supervision, control and automation systems, as well as good level performances.
The PR222DS/PD trip units allow the Tmax T4, T5 and T6 circuit-breakers to be integrated in a communication network based on the Modbus® RTU protocol. Modbus® RTU provides a Master-Slave system architecture where a Master (PLC, PC…) cyclically interrogates several Slaves (field devices). The devices use the EIA RS485 standard as the physical means for data transmission at a maximum transmission speed of 19.2 kbps.
Again for this trip unit, the power supply needed for correct operation of the protection functions is supplied directly by the current transformers of the trip unit, and tripping is always guaranteed, even under conditions of single-phase load down. Nevertheless, communication is only possible with an auxiliary power supply of 24 V DC.

PR222DS/PD - Electrical characteristics

Auxiliary power supply (galvanically insulated)	24 V DC ± 20%
Maximum ripple	± 5%
Inrush current @ 24 V	1 A for 30 ms
Rated current @ 24 V	100 mA
Rated power @ 24 V	2.5 W

The PR222DS/PD release, with integrated communication and control functions, allows a wide range of information to be acquired and transmitted remotely, opening and closing commands to be carried out by means of the electronic version motor operator, the configuration and programming parameters of the unit to be stored, such as the current thresholds of the protection functions and the protection curves.
All the information can be consulted both locally, directly on the front of the circuit-breaker with the front display unit FDU or on the HMI030 switchgear multi-meter, and remotely by means of supervision and control systems.
Moreover, by means of the BT030 external module, to be connected to the test connector of the PR222DS/PD trip unit, wireless communication to a PDA or Notebook is possible through a Bluetooth port.
The PR222DS/PD trip units can be associated with the AUX-E auxiliary contacts in electronic version, to know the state of the circuit-breaker (open/closed), and with MOE-E motor operator (the AUX-E are compulsory when MOE-E is to be used) to remotely control circuit- breaker opening and closing as well.
If the circuit-breaker fitted with the PR222DS/PD trip unit is inserted in a supervision system, during the test phases with the PR010/T unit, communication is automatically abandoned and starts again on completion of this operation.

Communication functions	PR222DS/P	PR222DS/PD	PR223DS
Protocol		Modbus RTU standard	Modbus RTU standard
Physical medium		EIA RS485	EIA RS485
Speed (maximum)		19.2 kbps	19.2 kbps
Measurement functions			
Phase currents	■(1)	■	■
Neutral current	■(1)	■	■
Ground current	■(1)	■	■
Voltages (phase to phase, phase to earth)			■(6)
Powers (active, reactive, apparent)			■(6)
Power factors			■(6)
Energies			■(6)
Peak factor			■
Frequency			■(6)
Signalling functions			
L pre-alarm and alarm LED	■(5)	■(5)	■
L alarm output contact (2)	■	■	■
Available data			
Circuit-breaker status (open, closed) (3)		■	■
Mode (local, remote)		■	■
Protection parameters set	■(1)	■	■
Alarms			
Protections: L, S, I, G	■(1)	■	■
Failed tripping under fault conditions	■(1)	■	■
Maintenance			
Total number of operations (3)		■	■
Total number of trips		■	■
Number of trip tests		■	■
Number of manual operations		■	■
Number of trips for each individual protection function		■	■
Record of last trip data		■	■
Commands			
Circuit-breaker opening/closing (with motor operator)		■	■
Alarm reset	■(1)	■	■
Circuit-breaker reset (with motor operator)		■	■
Setting the curves and protection thresholds	■(1)	■	■
Safety function			
Automatic opening in the case of failed Trip command fail (with motor operator) (4)		■	■
Events			
Changes in circuit-breaker state, in the protections and all the alarms		■	■

(1) With PR010/T unit or BT030 unit
(2) Typical contact: MOS photo Vmax: 48 V DC/30 V AC
Rmax = 35 ohm
(3) Available with AUX-E electronic auxiliary contacts
(4) The motor operator must be in electronic version (MOE-E) and electronic auxiliary contacts (AUX-E) have to be used
(5) Signals: – Pre-alarm L - permanently lit
– Alarm L - flashing (0.5 s ON / 0.5 s OFF)
– Incongruent manual setting (L > S / S > I) - flashing (1 s ON / 2 s OFF)
– WINK (remote control to identify the relay) - flashing (0.125 s ON / 0.125 s OFF)
(6) With VM210

PR222DS/P

Protection S
Against short-circuit with delayed trip

Protection L
Against overload

Socket for TT1 test unit

Socket for connection of PR010/T test unit and BT030 wireless communication unit

Protection I
Against short-circuit with instantaneous trip

Dip-switch for neutral setting

Selection for electronic or manual setting

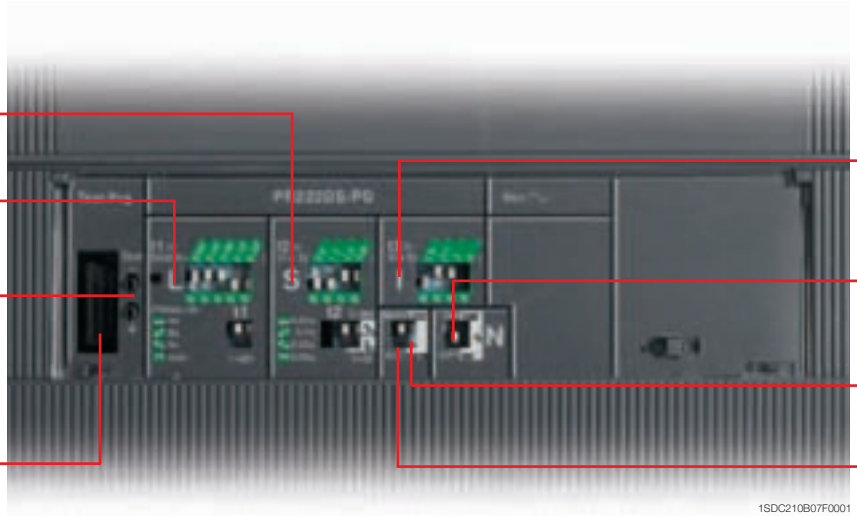
PR222DS/PD

Protection S
Against short-circuit with delayed trip

Protection L
Against overload

Socket for TT1 test unit

Socket for connection of PR010/T test unit and BT030 wireless communication unit



Protection I
Against short-circuit with instantaneous trip

Dip-switch for neutral setting

Enablement of remote operations

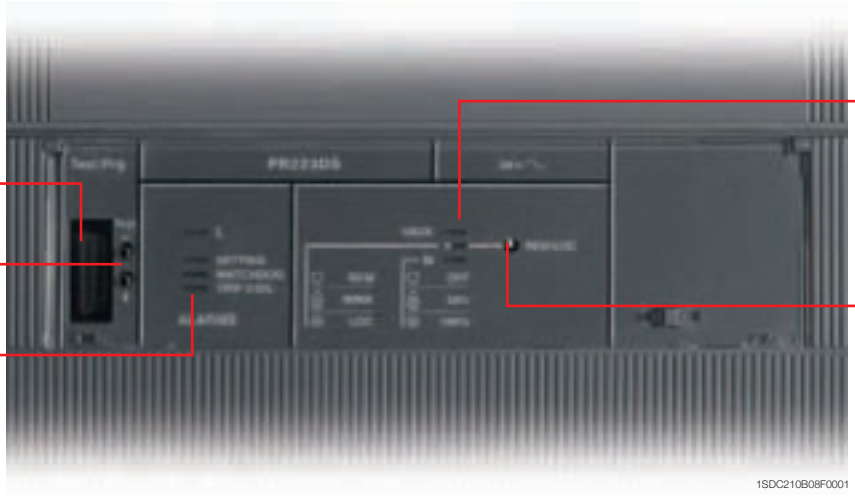
Selection for electronic or manual setting

PR223DS

Socket for connection of PR010/T test unit and BT030 wireless communication unit

Socket for TT1 test unit

LED signalling alarm of the circuit-breaker



LED signalling the status of the circuit-breaker

Push botton for operation mode selection (local/remote) and on-board diagnosis system

PR222DS/P, PR222DS/PD and PR223DS[5] - Protection functions and parameterisations

Protection functions		Trip threshold	Trip curves[1]	Excludability	Relation t = f(I)
L	Against overload with long inverse time delay trip and trip characteristic according to an inverse time curve (I^2t= k) according to IEC 60947-2 Standard	**Manual setting** I_1 = 0.40….1 x In step = 0.02 x In	**Manual setting** at 6 x I_1 t_1 = 3 - 6 - 9/12 - MAX[2]	–	$t = k/I^2$
		Electronic setting I_1= 0.40…1 x In step 0.01 x In Trip between 1.1...1.3 x I_1	**Electronic setting** at 6 x I_1 t_1 = 3…18s step 0.5s[2] Tolerance: ± 10%		
S	Against short-circuit with inverse short time delay trip and trip characteristic with inverse time (I^2t= k) or definite time	**Manual setting** I_2 = 0.6-1.2-1.8-2.4-3-3.6-4.2-5.8-6. 4-7-7.6-8.2-8.8-9.4-10 x In[3]	**Manual setting** at 8 x In t_2 = 0.05 - 0.1- 0.25 - 0.5s	■	$t = k/I^2$
		Electronic setting I_2 = 0.60…10 x In step 0.1 x In Tolerance: ± 10%	**Electronic setting** at 8 x In t_2 = 0.05…0.5s step 0.01s Tolerance: ± 10%[4]		
		Manual setting I_2 = 0.6-1.2-1.8-2.4-3-3.6-4.2-5.8-6. 4-7-7.6-8.2-8.8-9.4-10 x In[3]	**Manual setting** t_2 = 0.05 - 0.1 - 0.25 - 0.5s	■	t = k
		Electronic setting I_2 = 0.60…10 x In step 0.1 x In Tolerance: ± 10%	**Electronic setting** t_2 =0.05…0.5s step 0.01s Tolerance: ± 10%[4]		
I	Against short-circuit with instantaneous trip	**Manual setting** I_3 = 1.5-2.5-3-4-4.5-5-5.5-6.5-7-7.5 -8-9-9.5-10.5-12 x In[3]	instantaneous	■	t = k
		Electronic setting I_3 = 1.5…12 x In[3] step 0.1 x In Tolerance: ± 10%			
G	Against earth fault with inverse short time delay trip and trip characteristic according to an inverse time curve (I^2t= k)	**Manual setting** I_4 = 0.2-0.25-0.45-0.55-0.75-0.8- 1 x In	**Manual setting** up to 3.15 x I_4 t_4 = 0.1s; up to 2.25 x I_4 t_4 = 0.2s; up to 1.6 x I_4 t_4 = 0.4s; up to 1.10 x I_4 t_4 = 0.80s	■	$t = k/I^2$ [6]
		Electronic setting I_4 = 0.2…1 x In step 0.1 x In Tolerance: ± 10%	**Electronic setting** t_4 = 0.1...0.8s step 0.01s Tolerance: ± 15%		

[1] These tolerances hold in the following conditions:
– self-powered trip unit at full power and/or auxiliary supply
– two or three-phase power supply
In conditions other than those considered, the following tollerances hold:

	Trip threshold	Trip time
S	± 20%	± 20%
I	± 20%	≤ 50ms
G	± 20%	± 20%

[2] t_1 values for MAX setting:

CB	Electronic setting	Manual setting
T4 320	3...10.5 s Step 0.5 s	3-6-9-10.5
T5 630		
T6 1000		
T4 250	3...18 s Step 0.5 s	3-6-9-18
T5 400		
T6 800	3...18 s Step 0.5 s	3-6-9-18
T6 630	3...18 s Step 0.5 s	3-6-12-18

[3] For T4 In = 320 A and T5 In = 630 A. T6 In = 1000 A ⇒ I_2max = 9.5 x In and I_3max = 9.5 x In
For T6 In = 800 A ⇒ I_3max = 10.5 x In
[4] Tolerance: ± 10 ms
[5] The setting of the PR223DS trip unit is electronic only (local/remote)
The L protection can be set at I_1 = 0.18...1 x In. For I_1 < 0.4 x In the neutral setting must be at 100% of that of the phases
[6] $t = k/I^2$ up to the current value indicated, t = k (equating to the chosen setting) beyond the current value indicated

PR223DS

Apart from the traditional L, S, I, and G protection functions, the PR223DS release, available on T4, T5 and T6, also offers the possibility of measuring the main electrical values. In fact, using the accessory VM210, and without using any voltage transformers, the user has access not only to the current values but also to the voltage, power and energy values, both locally, directly on the front of the circuit-breaker with the front display unit FDU, or on the interface for the front of the switchboard HMI030, and remotely via a supervisor and control system.
Setting the PR223DS release can only be carried out electronically, using the PR010/T test unit (setting in local mode) or the dialogue (setting in remote mode). For the protection function adjustments, see page 2/20.
For the neutral, it is possible to set the protection threshold of the functions to OFF, to 50% and to 100% of that of the phases (for protection L settings below 0.4 x In, it is obligatory to set the neutral to 100%). The pre-alarm and alarm signalling of protection L are also available by means of a dedicated LED on the front of the release. The pre-alarm threshold value is equal to 0.9 x I_1.
Still on the front of the release, the LEDs signalling the following information are available: state of the connection to the opening solenoid, use of the default parameters, mode (local or remote), presence of auxiliary power supply and setting the neutral.

PR223DS - Measurements

Measurements	With distributed N	Without distributed N
Effective current values	I_1, I_2, I_3, I_{ne}	I_1, I_2, I_3
Effective voltage values	V_1, V_2, V_3, V_{12}, V_{23}, V_{31}	V_{12}, V_{23}, V_{31}
Apparent powers	S_{tot}, S_1, S_2, S_3	S_{tot}
Active powers	P_{tot}, P_1, P_2, P_3	P_{tot}
Reactive powers	Q_{tot}, Q_1, Q_2, Q_3	Q_{tot}
Power factors	cos φ	cos φ
Energies	E_{TOT}	E_{TOT}
Phase peak factor	■	■
Frequency	*f*	*f*

The PR223DS trip unit, with integrated ModBus RTU protocol based dialogue unit, allows a wide range of information to be acquired and transmitted remotely and to carry out opening and closing commands.
The PR223DS trip unit can be associated with the AUX-E auxiliary contacts, to know the state of the circuit-breaker (open, closed), and with MOE-E motor operator (the AUX-E are compulsory when MOE-E is to be used) to remotely control circuit-breaker opening and closing as well.
If the PR223DS trip unit is inserted in a supervision system, during the test and configuration with the PR010/T unit, communication is automatically abandoned and starts again on completion of these operations.
The unit is self-supplied by means of current sensors housed in the electronic release. Operation of the electronic release is also guaranteed when there is a single-phase load and in correspondence with the minimum setting. An external power supply must be connected to activate the dialogue function and the measurement functions.

Auxiliary power supply - Electrical characteristics

	PR223DS
Auxiliary power supply (galvanically insulated)	24 V DC ± 20%
Maximum ripple	± 5%
Inrush current @ 24 V	~ 4 A for 0.5 ms
Rated current @ 24 V	~ 80 mA
Rated power @ 24 V	~ 2 W

PR231/P

The PR231/P trip unit is the basic trip unit for Tmax T7. It provides protection functions against overload L and short-circuit S/I (version PR231/P-LS/I): with this version, by moving the dedicated dip-switch, you can choose whether to have protection S or protection I. Alternatively the version with only the protection function against instantaneous short-circuit I is available (version PR231/P-I see also page 2/45 and following).
Setting the trip parameters of the PR231/P trip unit is made directly on the front of the circuit-breaker by means of dip switches, and there is only one for the phases and the neutral, so it is possible to set the protection threshold, at 50% or at 100% of the phase protection.
To guarantee protection of the installation by means of the PR231/P protection trip unit, it is necessary to select the rated network frequency (50/60 Hz), by means of the special dip-switch.
Interchangeability of PR231/P can be requested by means of the dedicated ordering code 1SDA063140R1.

PR231/P

PR231/P - Protection functions and parameterisations

Protection functions		Trip threshold	Trip curves[1]	Excludability	Relation t = f(I)
L	Against overload with long inverse time delay trip and trip characteristic according to an inverse time curve (I^2t= k) according to IEC 60947-2 Standard	I_1 = 0.40...1 x In step = 0.04 x In Trip between 1.1...1.3 x I_1	at 6 x I_1 at 6 x I_1 t_1 = 3 - 12s Tolerance: ±10%	–	$t = k/I^2$
S	Against short-circuit with long inverse time delay trip and trip characteristic with inverse time (I^2t= k) (selectable as an alternative to protection function I)	I_2 = 1-1.5-2-2.5-3-3.5-4.5-5.5-6.5-7-7.5-8-8.5-9-10 x In Tolerance: ±10%	at 10 x In at 10 x In t_2 = 0.1 - 0.25s Tolerance: ±10%	■	$t = k/I^2$
I	Against short-circuit with istantaneous trip (selectable as an alternative to protection function S)	I_3 = 1-1.5-2-2.5-3-3.5-4.5-5.5-6.5-7-7.5-8-8.5-9-10 x In Tolerance: ±10%	instantaneous	–	t = k

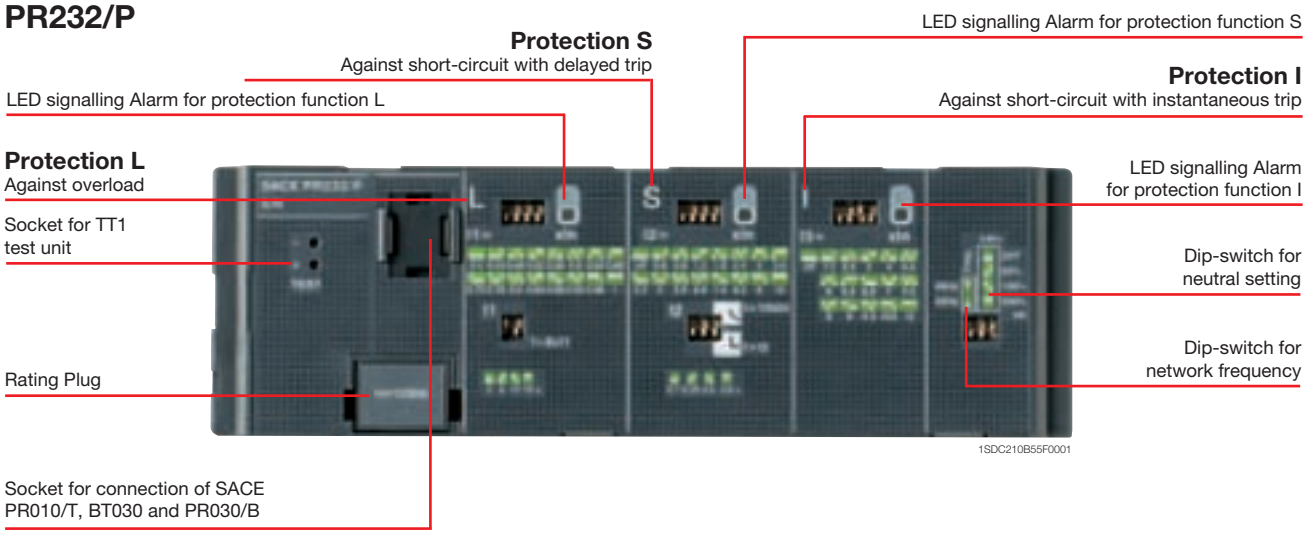
(1) These tolerances hold in the following conditions:
– self-powered trip unit at full power
– two or three-phase power supply
In conditions other than those considered, the following tollerances hold:

	Trip threshold	Trip time
S	± 10%	± 20%
I	± 15%	≤ 60ms

PR232/P

The PR232/P release, available for T7, provides protection functions against overload L, delayed short-circuit S and instantaneous short-circuit I (version PR232/P-LSI).
Setting the trip parameters (see table) of the PR232/P release can be carried out by means of the dip-switches, and is unique for the phases and the neutral, for which it is possible to set the protection threshold to OFF, to 50%, 100% or 200% of the threshold of the phases directly from the front of the release by means of a special dip-switch. In particular, adjustment of the neutral to 200% of the phase current requires setting protection L to respect the current-carrying capacity of the circuit-breaker.
To guarantee protection of the installation by means of the PR232/P protection release, it is necessary to select the rated network frequency (50/60 Hz), by means of the special dip-switch.

PR232/P



PR232/P - Protection functions and parameterisations

Protection functions		Trip threshold	Trip curves[1]	Thermal memory[2]	Excludability	Relation t = f(I)
L	Against overload with long inverse time delay trip and trip characteristic according to an inverse time curve (I^2t= k) according to IEC 60947-2 Standard	I_1 = 0.40...1 x In step = 0.04 x In Trip between 1.1...1.3 x I_1	at 6 x I_1 t_1 = 3s t_1 = 6s t_1 = 12s t_1 = 18s Tolerance: ±10%	■	–	$t = k/I^2$
S	Against short-circuit with inverse short time delay trip and trip characteristic with inverse time (I^2t = k) or definite time	I_2 = 0.6 - 0.8 - 1.2 - 1.8 - 2.4 - 3 - 3.6 - 4.2 - 5 - 5.8 - 6.6 - 7.4 - 8.2 - 9 - 10 x In Tolerance: ±10%	at 10 x In t_2=0.1s t_2=0.25s t_2=0.5s t_2=0.8s Tolerance: ±10%	■	■	$t = k/I^2$
		I_2 = 0.6 - 0.8 - 1.2 - 1.8 - 2.4 - 3 - 3.6 - 4.2 - 5 - 5.8 - 6.6 - 7.4 - 8.2 - 9 - 10 x In Tolerance: ±10%	I > I_2 t_2=0.1s t_2=0.25s t_2=0.5s t_2=0.8s Tolerance: ±10%	–	■	t = k
I	Against short-circuit with istantaneous trip	I_3 = 1.5 - 2.5 - 3 - 4 - 4.5 - 5 - 5.5 - 6.5 - 7 - 7.5 - 8 - 9 - 9.5 - 10.5 - 12 x In Tolerance: ±10%	instantaneous	–	■	t = k

[1] These tolerances hold in the following conditions:
– self-powered trip unit at full power (without start-up)
– two or three-phase power supply
In conditions other than those considered, the following tollerances hold:

	Trip threshold	Trip time
S	± 10%	± 20%
I	± 15%	≤ 60ms

[2] Active up to 7 min. after tripping of the breaker (ON/OFF setting by means of PR010/T test unit).

There are three red LEDs available on the front of the PR232/P trip unit dedicated to signalling alarm of protections L, S, and I. Furthermore, a yellow flashing LED allows the state of pre-alarm of function L to be signalled, which is activated when 90% of the set trip threshold is reached.
The yellow flashing LED every 3s indicates the normal operation.

PR232/P - Alarm and Pre-alarm LED

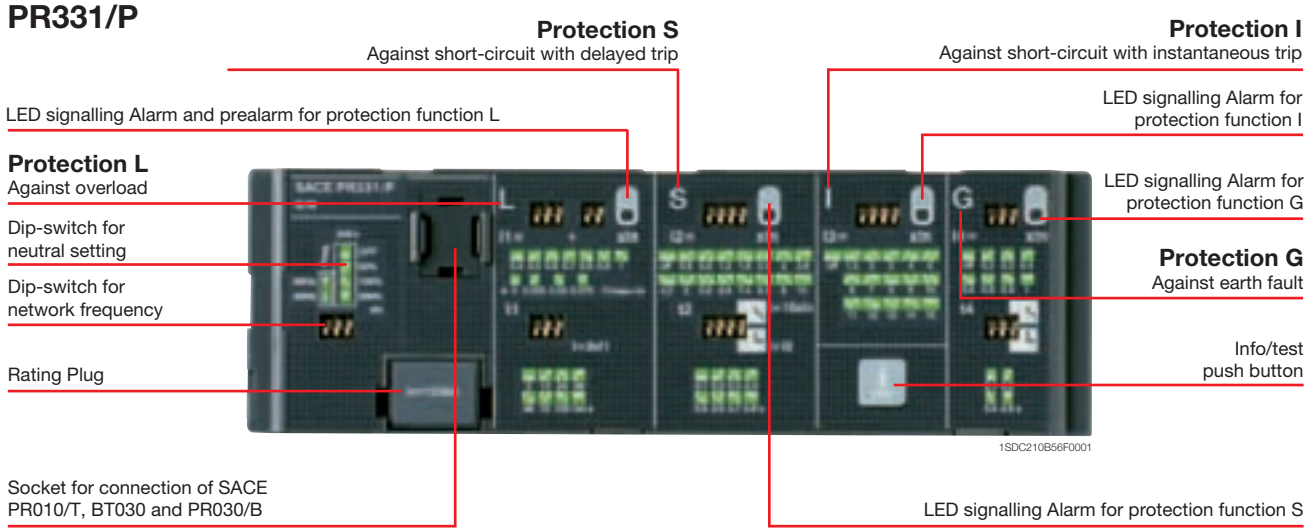
Protection	Colour	Pre-alarm	Alarm	Last trip
L	Yellow	■	–	–
	Red	–	■	■
S	Red	–	■	■
I	Red	–	■	■

Following circuit-breaker opening, it is possible to know which protection function made the release trip by connecting the PR030/B battery unit onto the front of the release. This is also possible thanks to the PR010/T test and configuration unit.
By means of the BT030 wireless communication unit the PR232/P can be connected to a PDA or to a personal computer, extending the range of information available for the user. Infact, by means of the ABB SACE's SD-Pocket communication software, it is possible to read the values of the currents flowing through the circuit-breaker, the value of the last 20 interrupted currents, and the protection settings.

PR331/P

The PR331/P, available for Tmax T7 in the PR331/P-LSIG version, with its complete range of protection functions together with the wide combination of thresholds and trip times offered is it suitable for protecting a wide range of alternating current installations. In addition to protection functions the unit is provided with multifunction LED indicators. Furthermore, PR331/P allows connection to external devices enhancing its advanced characteristics like remote signalling and monitoring, or interface from front of HMI030 panel.

PR331/P



PR331/P - Protection functions and parameterisations

Protection functions		Trip threshold	Trip curves[1]	Excludability	Relation t = f(I)
L	Against overload with long inverse time-delay trip and trip characteristic according to an inverse time curva ($I^2t=k$) according to the IEC 60947-2 Standard	I_1 = 0.40….1 x In step = 0.025 x In Trip between 1.05 ... 1.2 x I_1	at 3 x I_1 t_1 = 3 - 12 - 24 - 36 - 48 - 72 - 108 - 144s Tolerance: ±10% up to 6 x In ±20% above 6 x In	–	$t = k/I^2$
S	Against short-circuit with short inverse time-delay trip and trip characteristic with inverse time ($I^2t=k$) or with definite time	I_2 = 0.6 - 0.8 - 1.2 - 1.8 - 2.4 - 3 - 3.6 - 4.2 - 5 - 5.8 - 6.6 - 7.4 - 8.2 - 9 - 10 x In Tolerance: ±7% up to 6 x In ±10% above 6 x In	at 10 x In t_2 = 0.1….0.8s step = 0.1s Tolerance: min (±10%. ±40ms)	■	$t = k/I^2$
		I_2 = 0.6 - 0.8 - 1.2 - 1.8 - 2.4 - 3 - 3.6 - 4.2 - 5 - 5.8 - 6.6 - 7.4 - 8.2 - 9 - 10 x In Tolerance: ±7% up to 6 x In ±10% above 6 x In	I > I_2 t_2 = 0.1….0.8s step = 0.1s Tolerance: ±15% up to 6 x In ±20% above 6 x In	■	t = k
I	Against short-circuit with adjustable instantaneous trip	I_3 = 1.5-2-3-4-5-6-7-8-9-10-11-12-13-14-15 x In[2] Tolerance: ±10%	≤ 30 ms	■	t = k
G	Against earth fault with short inverse time-delay trip and trip characteristic according to an inverse time curve ($I^2t=k$) or with definite time	I_4 = 0.2-0.3-0.4-0.6-0.8-0.9-1 x In Tolerance: ±7%	4.47 x I_4 3.16 x I_4 2.24 x I_4 1.58 x I_4 t_4 = 0.1s t_4 = 0.2s t_4 = 0.4s t_4 = 0.80s Tolerance: ±15%	■	$t = k/I^2$ [3]
		I_4 = 0.2-0.3-0.4-0.6-0.8-0.9-1 x In Tolerance: ±7%	t_4 = 0.1s t_4 = 0.2s t_4 = 0.4s t_4 = 0.80s Tolerance: min (±10%. ±40ms)	■	t = k

(1) These tolerances hold in the following conditions:
– self-powered trip unit at full power and/or auxiliary supply
– two or three-phase power supply
In conditions other than those considered, the following tollerances hold:

	Trip threshold	Trip time
L	Release between 1.05 and 1.25 x I_1	± 20%
S	± 10%	± 20%
I	± 15%	≤ 60ms
G	± 15%	± 20%

(2) For T7 In = 1250 A/1600 A ⇒ I_3max = 12 x In

(3) $t = k/I^2$ up to the current value indicated, t = k equating to the chosen setting) beyond the current value indicated

User interface

The user communicates directly with the trip unit by means of the dip switches. Up to four LEDs (according to the version) are also available for signalling. These LEDs (one for each protection) are active when:

- a protection is timing. For protection L the pre-alarm status is also shown;
- a protection has tripped (the corresponding LED is activated by pressing the “Info/Test” pushbutton);
- a failure in connection of a current sensor or in the trip coil is detected. The indication is active when the unit is powered (through current sensors or an auxiliary power supply);
- wrong rating plug for the circuit-breaker.

The protection tripped indication works even with the circuit-breaker open, without the need for any internal or external auxiliary power supply. This information is available for 48 hours of inactivity after the trip and is still available after reclosing. If the query is made more than 48 hours later it is sufficient to connect a PR030/B battery unit, PR010/T, or a BT030 wireless communication unit.

Setting the neutral

Protection of the neutral can be set at 50%, 100% or 200% of the phase currents. In particular, adjustment of the neutral at 200% of the phase current is possible if the following inequality is respected: I_1 x In x %Ne ≤ Iu. The user can also switch the neutral protection OFF.

Test function

The Test function is carried out by means of the Info/Test pushbutton and the PR030/B battery unit (or BT030) fitted with a polarized connector housed on the bottom of the box, which allows the device to be connected to the test connector on the front of PR331/P trip units. The PR331/P electronic trip unit can be tested by using the SACE PR010/T test and configuration unit by connecting it to the TEST connector.

Power supply

The unit does not require an external power supply either for protection functions or for alarm signalling functions. It is self-supplied by means of the current sensors installed on the circuit-breaker.
For operation, it is required for the three phases to be passed through by a current of 70 A. An external power supply can be connected in order to activate additional features, and in particular for connection to external devices: HMI030 and PR021/K.

PR331/P - Electrical characteristics

Auxiliary power supply (galvanically insulated)	24 V DC ± 20%
Maximum ripple	5%
Inrush current @ 24 V	3 A for 5 ms
Rated power @ 24 V	1 W

Communication

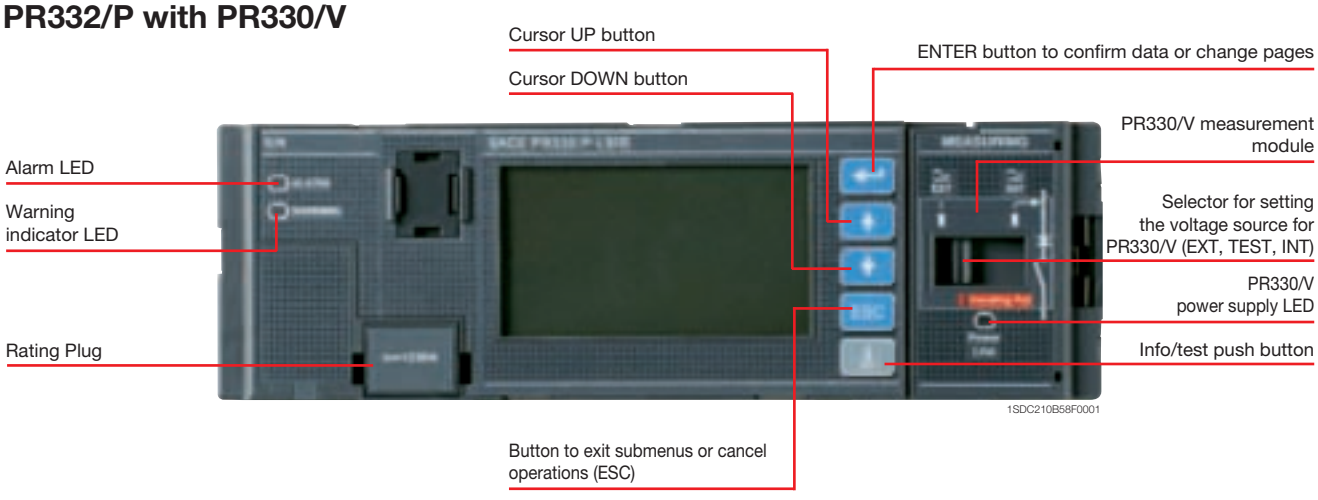
By means of the BT030 wireless communication unit, PR331/P can be connected to a PDA or to a personal computer, extending the range of information available for the user. In fact, by means of ABB SACE’s SD-Pocket communication software, it is possible to read the values of the currents flowing through the circuit-breaker, the value of the last 20 interrupted currents, and the protection settings.
PR331/P can also be connected to the optional external PR021/K signalling unit, for the remote signalling of protections alarms and trips, and to HMI030, for the remote user interfacing.

PR332/P

The SACE PR332/P trip unit for Tmax T7 (available in four versions: PR332/P-LI, PR332/P-LSI, PR332/P-LSIG and PR332/P-LSIRc) is a sophisticated and flexible protection system based on a state-of-the art microprocessor and DSP technology. Fitted with the optional internal PR330/D-M dialogue unit, PR332/P turns into an intelligent protection, measurement and communication device, based on the Modbus® RTU protocol. By means of the PR330/D-M, PR332/P can also be connected to the ABB EP010 Fieldbus plug adapter, which makes it possible to choose among several different networks, such as Profibus and DeviceNet.
The new PR332/P is the result of ABB SACE's experience in designing protection trip units. The exhaustive range of settings makes this protection unit ideal for general use in power distribution.
Access to information and programming using a keyboard and graphic liquid crystal display is extremely simple and intuitive. An integrated ammeter and many other additional features are provided over and above the protection functions. These additional functions can be further increased with addition on board of the dialogue, signalling, measurement, and wireless communication units. All the thresholds and trip curve delays of the protection functions are stored in special memories which retain the information even when no power is supplied.

PR332/P

PR332/P with PR330/V



PR332/P - Protection functions and parameterisations

Protection functions		Trip threshold	Trip curves[1]	Excludability	Relation t = f(I)	Thermal memory[2]	Zone selectivity[2]
L	Against overload with inverse long-time delay trip according to IEC 60947-2 Standard ($I^2t=k$) or in accordance with the IEC 60255-3 Standard ($t=f(\alpha)$[3])	I_1 = 0.4...1 x In step = 0.01 x In Trip between 1.05...1.2 x I_1	at 3 x I_1 t_2 = 3...144s step = 3s Tolerance: ±10% up to 6 x In ±20% above 6 x In	–	$t = k/I^2$	■	–
		I_1 = 0.4...1 x In step = 0.01 x In Trip between 1.05...1.2 x I_1	at 3 x I_1 t_2 = 3...144s step = 3s Tolerance: ±10% up to 6 x In ±20% above 6 x In	■	$t = f(\alpha)$[3] α = 0.02-1-2	■	–
S	Against short-circuit with short inverse time-delay trip and trip characteristic with inverse time ($I^2t=k$) or with definite time	I_2 = 0.6...10 x In step = 0.1 x In Tolerance: ±7% up to 6 x In ±10% above 6 x In	at 10 x In t_2 = 0.05...0.8s step = 0.01s Tolerance: ±15% up to 6 x In ±20% over 6 x In	■	$t = k/I^2$	■	–
		I_2 = 0.6...10 x In step = 0.1 x In Tolerance: ±7% up to 6 x In ±10% above 6 x In	t_2 = 0.05...0.8s step = 0.01s t_2 sel = 0.04...0.2s step = 0.01s Tolerance: min (±10%; ±40ms)	■	t = k	–	■
I	Against short-circuit with adjustable instantaneous trip	I_3 = 1.5...15 x In step = 0.1 x In Tolerance: ±10%	≤ 30 ms	■	t = k	–	–
G	Against earth fault with short inverse time-delay trip and trip characteristic according to an inverse time curve ($I^2t=k$) or with definite time	I_4 = 0.2...1 x In step = 0.02 x In Tolerance: ±7%	t_4 = 0.1...1s step = 0.05s Tolerance: ±15%	■	$t = k/I^2$[5]	–	–
		I_4 = 0.2...1 x In step = 0.02 x In Tolerance: ±7%	t_4 = 0.1...1s step = 0.05s t_4 sel = 0.04...0.2s step = 0.05s Tolerance: min (±10%; ±40ms)	■	t = k	–	■
Rc	Against residual current fault with definite time-delay trip	IΔ = 3-5-7-10-20-30 A Tolerance: 0-20%	tΔ = 0.06-0.1-0.2-0.3-0.4-0.5-0.8s Tolerance: ±20%	■	t = k	–	–
OT	Against overtemperature of the trip unit with instantaneous trip	Trip unit temperature over 85 °C	instantaneous	–	temp = k	–	–
U	Against unbalanced phase with definite time-delay trip	I_6 = 2%...90% x I_1 step = 1% x I_1 Tolerance: ±10%	t_6 = 0.5...60 s step = 0.5s Tolerance: min (±20%; ±100ms)	■	t = k	–	–

PR332/P with PR330/V - Advanced protection functions and parameterisations

Advanced protection functions		Trip threshold	Trip curves[1]	Excludability	Relation t = f(I)	Thermal memory[2]	Zone selectivity
UV	Against undervoltage with adjustable constant time	U_8= 0.5...0.95 x Un step = 0.01 x Un Tolerance: ±5%	t_8 = 0.1...5s step = 0.1s Tolerance: min (±20% ±100ms)	■	t = k	–	–
OV	Against overvoltage with adjustable constant time	U_9= 1.05...1.2 x Un step = 0.01 x Un Tolerance: ±5%	t_9 = 0.1...5s step = 0.1s Tolerance: min (±20% ±100ms)	■	t = k	–	–
RV	Against residual voltage with adjustable constant time	U_{10}= 0.1...0.4 x Un step = 0.01 x Un Tolerance: ±5%	t_{10} = 0.5...30s step = 0.5s Tolerance: min (±10% ±100ms)	■	t = k	–	–
RP	Against reversal of power with adjustable constant time	P_{11}= -0.3...-0.1 x Pn step = 0.02xPn Tolerance: ±10%	t_{11} = 0.5...25s step = 0.1s Tolerance: min (±10% ±100ms)	■	t = k	–	–
UF	Against underfrequency with adjustable constant time	f_{12}= 0.90...0.99 x fn step = 0.01 x fn Tolerance:±5%	t_{12} = 0.5...3s step = 0.1s Tolerance: min (±10% ±100ms)	■	t = k	–	–
OF	Against overfrequency with adjustable constant time	f_{13}= 1.01...1.10 x fn step = 0.01 x fn Tolerance:±5%	t_{13} = 0.5...3s step = 0.1s Tolerance: min (±10% ±100ms)	■	t = k	–	–

[1] These tolerances are valid under the following conditions:
– trip unit self-supplied at full power and/or auxiliary supply
– two or three-phase power supply

In conditions other than those considered, the following tollerances hold:

	Trip threshold	Trip time
L	Release between 1.05 and 1.25 x I_1	± 20%
S	± 10%	± 20%
I	± 15%	≤ 60ms
G	± 15%	± 20%
Other	± 10%	± 20%

[2] Active with 24V auxiliary power supply

[3] $t = \frac{(3^{\alpha} - 1)}{\left(\frac{I}{I_1}\right)^{\alpha} - 1} \; t_1 \; (3 \times I_1)$

[4] For T7 In = 1250 A/1600 A ⇒ I_3max = 12 x In

[5] k = (2s) · $(I_4)^2$

Setting the neutral

In PR332/P, the neutral protection is 50% of the value set for phase protection in the standard version. The neutral protection can be excluded or set to 100%.
In installations where very high harmonics occur, the resulting current at the neutral can be higher than that of the phases. Therefore it is possible to set the neutral protection at 150% or 200% of the value set for the phases. In this case it is necessary to reduce the setting of protection L accordingly. The table below lists the neutral settings for the various possible combinations between type of circuit-breaker and the threshold I_1 setting.

Adjustable neutral protection settings

Threshold I_1 settings (overload protection)

Circuit-breaker model	$0.4 < I_1 < 0.5$	$0.5 < I_1 < 0.66$	$0.66 < I_1 < 1$ (*)
T7	0-50-100-150-200%	0-50-100-150%	0-50-100%

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

Start-up function

The start-up function allows protections S, 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 30 s, in steps of 0.01 s. It is automatically recognized by the PR332/P trip unit when the peak value of the maximum current exceeds the threshold that can be set by the user. A new start-up becomes possible after the current has fallen down to 0.1 x In, if the trip unit is supplied from an external source.

Protection against overtemperature

The user has the following signals or commands available for the protection against overtemperature:
– lighting up of the "Warning" LED when the temperature is higher than 70 °C or lower than -20 °C (temperature at which the microprocessor is still able to operate correctly);
– lighting up of the "Alarm" LED when the temperature is higher than 85 °C or lower than -25 °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 indication of the trip directly on the display, as for the other protections.

Self-diagnosis

The PR332/P range of trip units contains an electronic circuit which periodically checks the continuity of internal connections (trip coil and each current sensor, including the Source Ground Return when present).
In the case of a malfunction an alarm message appears directly on the display. The Alarm is highlighted by the Alarm LED as well.

Residual Current

Different solutions are available for integrated residual current protection. The basic choice is PR332/P-LSIRc, which has all the characteristics of PR332/P-LSI and residual current protection as well. When additional features are required, the solution is PR332/P-LSIG with an additional PR330/V module (see next paragraph). Using this configuration, residual current protection is added to a powerful unit, having the features of PR332/P-LSI and all the add-ons described for the PR330/V module, such as voltage protection and advanced measurement functions.
Residual current protection acts by measuring the current by means the external dedicated toroid.

Test Functions

Once enabled from the menu, the “Info/Test” pushbutton on the front of the trip unit allows correct operation of the chain consisting of the microprocessor, trip coil and circuit-breaker tripping mechanism to be checked.
The control menu also includes the option of testing correct operation of the display, signalling LEDs.
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 PR222DS/P, PR222DS/PD, PR223DS, PR223EF, PR232/P, PR331/P and PR332/P ranges of trip units to be tested and checked.

User interface

The human-machine interface (HMI) of the device is made up of a wide graphic display, LEDs, and browsing pushbuttons. The interface is designed to provide maximum simplicity.
The language can be selected from among five available options: Italian, English, German, French and Spanish.
As in the previous generation of trip units, a password system is used to manage the “Read” or “Edit” modes. The default password, 0001, can be modified by the user.
The protection parameters (curves and trip thresholds) can be set directly via the HMI of the device. The parameters can only be changed when the trip unit is operating in “Edit” mode, but the information available and the parameter settings can be checked at any time in “Read” mode.
When a communication device (internal PR330/D-M module or external BT030 device) is connected, it is possible to set parameters simply by downloading them into the unit (over the network for PR330/D-M, by using the SD-Pocket software and a PDA or a notebook for BT030). Parameterisation can then be carried out quickly and automatically in an error-free way by transferring data directly from DocWin.

Indicator LEDs

LEDs on the front panel of the trip unit are used to indicate all the pre-alarms (“WARNING”) and alarms (“ALARM”). A message on the display always explicitly indicates the type of event concerned.
Example of events indicated by the “WARNING” LED:
– unbalance between phases;
– pre-alarm for overload (L1>90% x I_1);
– first temperature threshold exceeded (70 °C);
– contact wear beyond 80%;
– phase rotation reversed (with optional PR330/V).

Example of events indicated by the “ALARM” LED:
– timing of function L;
– timing of function S;
– timing of function G;
– second temperature threshold exceeded (85 °C);
– contact wear 100%;
– timing of Reverse Power flow protection (with optional PR330/V).

Data logger

By default PR332/P, is provided with the Data Logger function that automatically records in a wide memory buffer the instantaneous values of all the currents and voltages. Data can be easily downloaded from the unit by means of SD-Pocket or SD-TestBus2 applications and can be transferred to any personal computer for elaboration. The function freezes the recording whenever a trip occurs or in case of other events, so that a detailed analysis of faults can be easily performed. SD-Pocket and SD-TestBus2 allow also reading and downloading of all the others trip information.
- Number of analog channels: 8
- Maximum sampling rate: 4800 Hz
- Maximum sampling time: 27 s (@ sampling rate 600 Hz)
- 64 events tracking.

Trip information and opening data

In case a trip occurs PR332/P store all the needed information:
- Protection tripped
- Opening data (current)
- Time stamp (guaranteed with auxiliary supply or self-supply with power failure no longer than 48h).

By pushing the “Info/Test” pushbutton the trip unit shows all these data directly on display.
No auxiliary power supply is needed. The information is available to user for 48 hours with the circuit breaker open or without current flowing.
The information of the latest 20 trips are stored in memory.
If the information can be furthermore retrieved more than 48 hours later, it is sufficient to connect a PR030/B battery unit or a BT030 wireless communication unit.

Load control

Load control makes it possible to engage/disengage individual loads on the load side before the overload protection L is tripped, thereby avoiding unnecessary trips of the circuit-breaker on the supply side. This is done by means of contactors or switch-disconnectors (externally wired to the trip unit), controlled by the PR332/P through PR021/K unit.
Two different Load Control schemes can be implemented:
– disconnection of two separate loads, with different current thresholds
– connection and disconnection of a load, with hysteresis.

Current thresholds and trip times are smaller than those available for selection with protection L, so that load control can be used to prevent overload tripping. External PR021/K accessory unit is required for Load Control. The function is only active when an auxiliary power supply is available.

PR330/V Measurement Module

This optional internal module, installed in PR332/P, allows the trip unit to measure the phase and neutral voltages and to process them in order to achieve a series of features, in terms of protection and measurement.
PR330/V module, when is ordered mounted on the circuit-breaker, does not require any external connection or voltage transformers since it is connected internally to the upper terminals of Tmax T7 (selector in “INT” position) through the internal voltage sockets. When necessary, the connection of voltage pick-ups can be moved to any other point (i.e. lower terminals), by using the alternative connection located in the terminal box and switching the selector to the “EXT” position. For the dielectric test of the circuit-breaker the selector must be switched to the “Insulating TEST” position.
PR330/V is able to energize the PR332/P while line voltage input is above 85 V. The use of Voltage Transformers is mandatory for rated voltages higher than 690 V.
Voltage transformers shall have burdens between 5 VA and 10 VA and accuracy class 0.5 or better.
Additional Protections with PR330/V:
– Undervoltage (UV) protection
– Overvoltage (OV) protection
– Residual voltage (RV) protection
– Reversal of power (RP) protection
– Underfrequency (UF) protection
– Overfrequency (OF) protection.

All the above indicated protections can be excluded, although it is possible to leave only the alarm active when required: in this case the trip unit will indicate the “ALARM” status. With the circuit-breaker closed, these protections also operate when the trip unit is self-supplied. With the circuit-breaker open, they operate when the auxiliary power supply (24 V DC or PR330/V) is present.

Measurement function

The current measurement function (ammeter) is present on all versions of the PR332/P trip unit. The display shows histograms showing the currents of the three phases and neutral on the main page. Furthermore, the most loaded phase current is indicated in numerical format. Earth fault current, where applicable, is shown on a dedicated page.
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 an auxiliary power supply voltage. The display is rear-lit and the ammeter is active even at current levels lower than 160 A.
Accuracy of the ammeter measurement chain (current sensor plus ammeter) is no more than 1.5% in the 0.3-6 x In current interval of In.
– Currents: three phases (L1, L2, L3), neutral (Ne) and earth fault;
– Instantaneous values of currents during a period of time (data logger);
– Maintenance: number of operations, percentage of contact wear, opening data storage (last 20 trips and 20 events).

When the optional PR330/V is connected the following additional measurement function are present:
– Voltage: phase-phase, phase-neutral and residual voltage
– Instantaneous values of voltages during a period of time (data logger)
– Power: active, reactive and apparent
– Power factor
– Frequency and peak factor
– Energy: active, reactive, apparent, counter.

Communication

PR332/P electronic trip unit can be fitted with communication modules, which make possible to exchange data and information with other industrial electronic devices by means of a network.
The basic communication protocol implemented is Modbus RTU, a well-known standard of widespread use in industrial automation and power distribution equipment. A Modbus RTU communication interface can be connected immediately and exchange data with the wide range of industrial devices featuring the same protocol. ABB SACE has developed a complete series of accessories for electronic trip unit PR332/P:

– PR330/D-M is the communication module for PR332/P protection trip units. It is designed to allow easy integration of the Tmax circuit-breakers in a Modbus network. The Modbus RTU protocol is of widespread use in the power as well as the automation industry. It is based on a master/slave architecture, with a bandrate of up to 19.2 kbps. A standard Modbus network is easily wired up and configured by means of an RS485 physical layer. ABB SACE trip units work as slaves in the field bus network. All information required for simple integration of PR330/D-M in an industrial communication system are available on the ABB Web page.
– BT030 is a device to be connected to the Test connector of PR222DS/P, PR222DS/PD, PR223DS, PR223EF, PR232/P, PR331/P and PR332/P trip units. It allows Bluetooth communication between the trip unit and a PDA or a Notebook with a Bluetooth port. This device is dedicated to use with the SD-Pocket or SD-TestBus2 application. It can provide the auxiliary supply needed to energize the protection trip unit by means of rechargeable batteries.
– EP010-FBP-PDP22 is the Fieldbus Plug interface allows connection of ABB SACE trip units with Modbus communication to a Profibus, DeviceNet, or AS-I field bus network.

Furthermore, a new generation of software dedicated to installation, configuration, supervision and control of protection trip units and circuit- breakers is now available:
– SD-View 2000
– SD-Pocket
– SD-TestBus2.

All information required for simple integration of PR330/D-M in an industrial communication system are available on the ABB Web page (http://www.abb.com).

Measurement, signalling and available data functions

Details about functions available on PR332/P, trip units with PR330/D-M and EP010 – FBP – PDP22 are listed in the table below:

Communication functions	**PR332/P +PR330/D-M**	**PR332/P+PR330/D-M and EP010**
Protocol	Modbus RTU standard	FBP-PDP22
Physical means	RS485	Profibus-DP or DeviceNet cable
Speed (maximum)	19.2 kbps	115 kbps
Measurement functions		
Phase currents	■	■
Neutral current	■	■
Ground current	■	■
Voltage (phase-phase, phase-neutral, residual)	opt.(1)	opt.(1) (2)
Power (active, reactive, apparent)	opt.(1)	opt.(1) (3)
Power factor	opt.(1)	(4)
Frequency and peak factor	opt.(1)	(4)
Energy (active, reactive, apparent)	opt.(1)	(4)
Harmonic analysis	–	–
Signalling functions		
LED: auxiliary power supply, pre-alarm, alarm, transmission, reception	■	■
Temperature	■	■
Indication for L, S, I, G and other protection	■	■
Available data		
Circuit-breaker status (open, closed)	■	■
Circuit-breaker position (racked-in, racked-out)	■	■
Mode (local, remote)	■	■
Protection parameters set	■	■
Load control parameters	■	■
Alarms		
Protections: L, S, I, G	■	■
Undervoltage, overvoltage and residual voltage protection (timing and trip)	opt.(1)	opt.(1)
Reverse power protection (timing and trip)	opt.(1)	opt.(1)
Directional protection (timing and trip)	–	–
Underfrequency/overfrequency protection (timing and trip)	opt.(1)	opt.(1)
Phases rotation	–	–
Failed tripping under fault conditions	■	■
Maintenance		
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	■	■
Commands		
Circuit-breaker open/close	■	■
Alarms reset	■	■
Setting of curves and protection thresholds	■	■
Synchronize system time	■	■
Events		
Status changes in circuit-breaker, protections and all alarms	■	■

(1) with PR330/V
(2) no residual voltage
(3) no apparent power available
(4) please ask ABB for further details

Power supply

The PR332/P trip unit does not normally require any external power supplies, being self-supplied from the current sensors (CS): to activate the protection and ammeter functions, it is sufficient for at least one phase to have a current load higher than 80 A.
The unit ensures fully self-supplied operation. When an auxiliary power supply is present, it is also possible to use the unit with the circuit-breaker either open or closed with very low current flowing through (<80 A).
It is also possible to use an auxiliary power supply provided by the PR030/B portable battery unit (always supplied), which allows the protection functions to be set when the trip unit is not self supplied.
PR332/P stores and shows all the information needed after a trip (protection tripped, trip current, time, date). No auxiliary supply is required for this functionality.

	PR332/P	PR330/D-M
Auxiliary power supply (galvanically insulated)	24 V DC ± 20%	from PR332/P
Maximum ripple	5%	± 5%
Inrush current @ 24 V	3 A for 5 ms	~0.5 A for 5 ms
Rated power @ 24 V	2 W	+1 W
Inrush current @ 24 V when modules connected	5 A for 5 ms	
Rated power @ 24 V when modules connected	3 W	

(1) PR330/V can give power supply to the trip unit when at least one line voltage is equal or higher to 85V RMS.

Zone selectivity

Circuit-breaker for zone selectivity

Index

Circuit-breaker for zone selectivity

Electrical characteristics

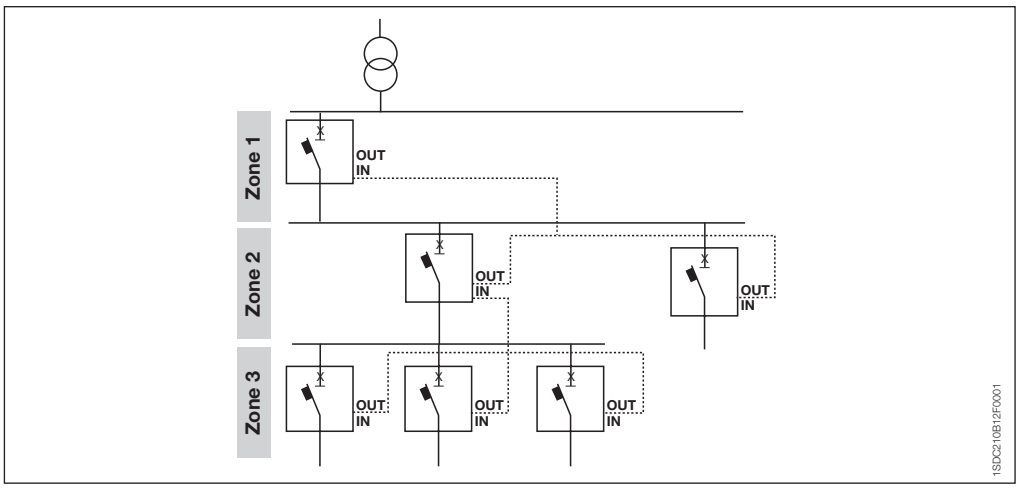
Zone selectivity

				T4	T5	T6	T7			
Rated uninterrupted current			[A]	250/320	400/630	630/800/1000	800/1000/1250/1600			
Poles			[No.]	3/4	3/4	3/4	3/4			
Rated service voltage, **Ue**		(AC) 50-60 Hz	[V]	690	690	690	690			
		(DC)	[V]	750	750	750	750			
Rated impulse withstand voltage, **Uimp**			[kV]	8	8	8	8			
Rated insulation voltage, **Ui**			[V]	1000	1000	1000	1000			
Test voltage at industrial frequency for 1 min.			[V]	3500	3500	3500	3500			
Rated ultimate short-circuit breaking capacity, **Icu**				**L**	**L**	**L**	**S**	**H**	**L**	**V**[1]
(AC) 50-60 Hz 220/230 V			[kA]	200	200	200	85	100	200	200
(AC) 50-60 Hz 380/415 V			[kA]	120	120	100	50	70	120	150
(AC) 50-60 Hz 440 V			[kA]	100	100	80	50	65	100	130
(AC) 50-60 Hz 500 V			[kA]	85	85	65	40	50	85	100
(AC) 50-60 Hz 690 V			[kA]	70	70	30	30	42	50	60
(AC) 50-60 Hz 1000 V			[kA]	16	16	–	–	–	–	–
Rated service short-circuit breaking capacity, **Ics**										
(AC) 50-60 Hz 220/230 V			[%Icu]	100%	100%	75%	100%	100%	100%	100%
(AC) 50-60 Hz 380/415 V			[%Icu]	100%	100%	75%	100%	100%	100%	100%
(AC) 50-60 Hz 440 V			[%Icu]	100%	100%	75%	100%	100%	100%	100%
(AC) 50-60 Hz 500 V			[%Icu]	100%	100%[2]	75%	100%	100%	75%	100%
(AC) 50-60 Hz 690 V			[%Icu]	100%	100%[3]	75%	100%	75%	75%	75%
(AC) 50-60 Hz 1000 V			[%Icu]	50%	25%	–	–	–	–	–
Rated short-circuit making capacity, **Icm**										
(AC) 50-60 Hz 220/230 V			[kA]	440	440	440	187	220	440	440
(AC) 50-60 Hz 380/415 V			[kA]	264	264	220	105	154	264	330
(AC) 50-60 Hz 440 V			[kA]	220	220	176	105	143	220	286
(AC) 50-60 Hz 500 V			[kA]	187	187	143	84	105	187	220
(AC) 50-60 Hz 690 V			[kA]	154	154	63	63	88.2	105	132
(AC) 50-60 Hz 1000 V			[kA]	32	32	–	–	–	–	–
Utilisation category (IEC 60947-2)				A	B (400A)[4] - A (630A)	B (630A - 800A)[5]- A (1000A)	B[6]			
Isolation behaviour				■	■	■	■			
Reference Standard				IEC 60947-2	IEC 60947-2	IEC 60947-2	IEC 60947-2			
Trip unit:	electronic	PR223EF		■	■	■	–			
		PR332/P		–	–	–	■			
Versions				F-P-W[7]	F-P-W[7]	F-W	F-W			
Terminals	fixed			F-FC Cu-FC CuAl-EF-ES-R-MC[8]	F-FC Cu-FC CuAl-EF-ES-R[8]	F-FC CuAl-EF-ES-R-RC	F-EF-ES-FC CuAl-HR/VR			
	plug-in			EF-ES-HR-VR-FC Cu-FC CuAl	EF-ES-HR-VR-FC Cu-FC CuAl	–	–			
	withdrawable			EF-ES-HR-VR-FC Cu-FC CuAl	EF-ES-HR-VR-FC Cu-FC CuAl	EF-HR-VR	EF-HR/VR-ES-RS			
Mechanical life			[No. operations]	20000	20000	20000	10000			
			[No. Hourly operations]	240	120	120	60			
Electrical life @ 415 V AC			[No. operations]	8000 (250A) - 6000 (320A)	7000 (630A) - 5000 (800A)	7000 (630A) - 5000 (800A) - 4000 (1000A)	2000 (S, H, L versions) - 3000 (V version)			
			[No. Hourly operations]	120	60	60	60			
Basic dimensions - fixed version		3 poles	W [mm]	105	140	210	210			
		4 poles	W [mm]	140	184	280	280			
			D [mm]	103.5	103.5	103.5	154 (manual)/178 (motorizable)			
			H [mm]	205	205	268	268			
Weight	fixed	3/4 poles	[kg]	2.35/3.05	3.24/4.15	9.5/12	9.7/12.5 (manual)/ 11/14 (motorizable)			
	plug-in	3/4 poles	[kg]	3.6/4.65	5.15/6.65	–	–			
	withdrawable	3/4 poles	[kg]	3.85/4.9	5.4/6.9	12.1/15.1	29.7/39.6 (manual)/ 32/42.6 (motorizable)			

TERMINAL CAPTION
EF = Front extended
F = Front
ES = Front extended spread
R = Rear orientated
MC = Multi-cable
HR = Rear flat horizontal
VR = Rear flat vertical
HR/VR = Rear flat horientated
F = Fixed circuit-breaker
P = Plug-in circuit-breaker
W = Withdrawable circuit-breaker

(1) Only for T7 800/1000/1250 A
(2) 75% for T5 630
(3) 50% for T5 630
(4) Only up to 630 V, Icw = 5 kA
(5) Icw = 7.6 kA (630 A) - 10 kA (800 A)
(6) Icw = 20 kA (S, H, L versions) - 15 kA (V version)
(7) For applications at 1000 V, only available in the fixed version
(8) For applications at 1000 V, only available with Fc Cu terminals

Note: in the plug-in/withdrawable version of T5 630 the maximum rated current is derated by 10% at 40 °C.



This type of coordination, a development of time coordination, is made by means of logic connections between current measuring devices which, once the set threshold having been exceeded is detected, allow just the fault area to be identified and to have its power supply cut off.
By means of zone selectivity it is possible obtain selectivity considerably reducing the trip times and therefore the thermal stresses all the plant components are subjected to during the fault.
Making the protection is done by connecting all the zone selectivity outputs of the trip units belonging to the same zone to each other and taking this signal to the zone selectivity input of the trip unit immediately to the supply side. By means of a simple shielded twisted-pairwire (maximum length of 200 m), each circuit-breaker which detects a fault communicates this to the one on the supply side sending a timed locking signal. The circuit-breaker which does not receive any communication from those on the load side, sends the opening command within the set selectivity time.
Zone selectivity can be activated for Tmax circuit-breakers in the case where:
– there is a source of 24 V auxiliary power supply;
– the Tmax T4, T5 or T6 circuit-breaker is equipped with the PR223EF trip unit (EFDP zone selectivity) or Tmax T7 equipped with the PR332/P trip unit (ZS zone selectivity).

Current sensors

	In [A]	160	250	320	400	630	800	1000	1250	1600
PR223EF	**T4 250**	■	■							
	T4 320			■						
	T5 400			■	■					
	T5 630					■				
	T6 630					■				
	T6 800						■			
	T6 1000							■		
PR332/P	**T7 800**				▲	▲	■			
	T7 1000				▲	▲	▲	■		
	T7 1250				▲	▲	▲	▲	■	
	T7 1600				▲	▲	▲	▲	▲	■

■ = Complete circuit-breaker already coded
▲ = Circuit-breaker to be assembled

When only PR223 are used, it is possible to invert the selectivity chain hierarchy by means of the SW210 interlock module.
For further information on zone selectivity, please consult the section: “Characteristic curves and technical information” on page 4/73.

Circuit-breaker for zone selectivity

EFDP Zone selectivity: PR223EF

The PR223EF electronic trip unit available on T4, T5 and T6 in the L version (120 kA @ 380/415 V) for use in alternating current, is able to isolate a fault present in extremely rapid times.
This performance is made possible thanks to the EFDP (Early Fault Detection and Prevention) algorithm, which is able to detect the short-circuit at its onset, exploiting analysis of the trend of the shunted current in relation to the current. The PR223EF trip unit therefore offers two performances simultaneously which, until today, were antithetic: selectivity and trip rapidity.
Thanks to extremely rapid detection and quenching of the short-circuit, the MCCB equipped with this trip unit are totally selective up to over 100 kA, and are not subject to any limits regarding the number of hierarchical levels of the installation. Trip rapidity, together with just as rapid transmission of the order to wait, allow a high number of circuit-breakers to be interlocked, making a global selectivity chain in the installation: by using the PR223EF no limitation in topological terms is introduced, with distances between interlocked circuit-breakers reaching up to 1 Km, thereby making the protection system highly flexible.
EFDP zone selectivity is carried out by means of a logic interlocking protocol (Interlocking, IL). The connection is made by means of a simple screened-twisted-pair cable cable which connects the circuit-breakers fitted with the PR223EF. In the case of a fault, the circuit-breaker immediately to the supply side sends a locking signal to the hierarchically higher circuit-breaker by means of the bus and, before intervening, checks that a similar locking signal has not been reached by the circuit-breakers on the load side.
The soundness of the system is controlled by a monitoring function of the interlock channel, guaranteeing the system a very high level of safety.
All the protection functions can be programmed remotely using the dialogue function present on the trip unit or locally by means of the PR010/T which can be connected to a serial port on the front of the PR223EF.
The trip unit can be supplied from a 24 V DC auxiliary source or directly through the current transformers (self-supply). The electronic trip unit operation is guaranteed even in the case of single-phase load up to 0.18 x In.
In the presence of an auxiliary power supply:

- the device implements the L, S, EF and G protection functions; if the EF is disabled by the user, function I is enabled
- EFDP zone selectivity is implemented on the S, EF and G functions.

If it is under self-supply conditions:

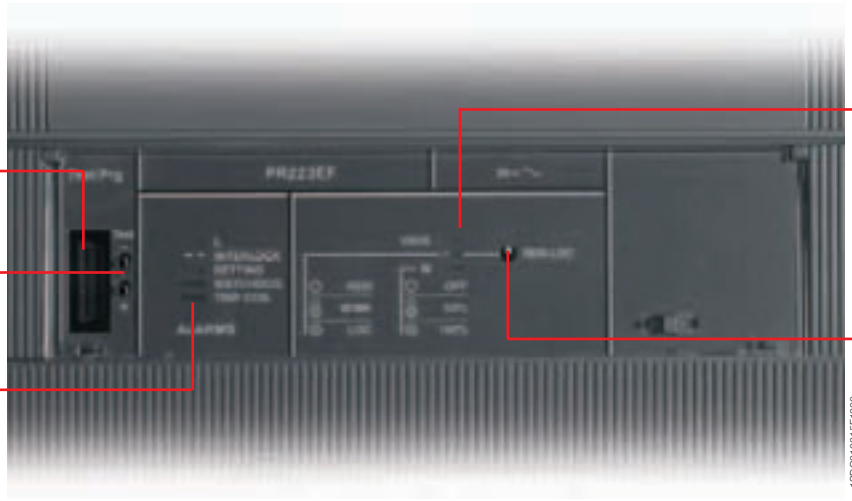
- the trip unit disables the EF, implementing the classic protection functions which also characterize the PR223/DS trip unit: L, S, I and G
- EFDP zone selectivity is not enabled.

Auxiliary power supply - Electrical characteristics

	PR223EF
Auxiliary power supply (galvanically insulated)	24 V DC ± 20%
Maximum ripple	± 5%
Inrush current @ 24 V	~4 A for 0.5 ms
Rated current @ 24 V	~80 mA
Rated power @ 24 V	~2 W

Connection of the logic interlock and auxiliary power supply is made by means of the X3 and X4 connectors located on the back of the trip unit.
For the neutral, it is possible set the protection threshold of the functions to OFF, at 50% and at 100% that of the phase, by means of the dialogue function or PR010/T. Furthermore, pre-alarm and alarm signalling of protection L is available on the front of the trip units. The pre-alarm threshold value is 0.9 x I_1.
The PR223EF trip unit, just like the PR223DS one, allows storage and display of information regarding a trip unit trip. The information is saved permanently and up to 20 trip events are recorded, which can be acquired by a supervision system using the Modbus protocol or can be displayed locally by means of the FDU or PR010/T unit.

PR223EF



PR223EF - Protection functions and parameterisations

Protection functions		Trip threshold	Trip curves[1]	Excludability	Relation t = f(I)	EFDP zone selectivity
L	Against overload with long inverse time-delay trip and trip characteristic according to an inverse time curva ($I^2t=k$) according to the IEC 60947-2 Standard	**Electronic setting** I_1=0.18…1 x In[5] step 0.01 x In Trip between 1.1...1.3 x I_1 (IEC 60947-2)	**Electronic setting** at 6 x I_1 t_1 = 3…18s[2] step 0.5s Tolerance: ± 10%	–	$t = k/I^2$	–
S	Against short-circuit with short inverse time-delay trip and trip characteristic with inverse time ($I^2t=k$) or with definite time	**Electronic setting** I_2 = 0.60…10 x In[3] step 0.1 x In Tolerance: ± 10%	**Electronic setting**[3] at 8 x In t_2 = 0.05…0.5s step 0.01s Tolerance: ± 10%	■	$t = k/I^2$	■
		Electronic setting I_2 = 0.60…10 x In[3] step 0.1 x In Tolerance: ± 10%	**Electronic setting** t_2 =0.05…0.5s step 0.01s Tolerance: ± 10%	■	t = k	■
EF	Against short-circuit with ultra rapid trip[4]			■	t = k	■
I	Against short-circuit with instantaneous trip with adjustable threshold	**Electronic setting** I_3 = 1.5…12 x In[3] step 0.1 x In Tolerance: ± 10%	instantaneous	■	t = k	–
G	Against earth fault with inverse short time delay trip and trip characteristic with inverse time ($I^2t=k$)	**Electronic setting** I_4 = 0.2…1 x In (step 0.1 x In) Tolerance: ± 10%	**Electronic setting** t_4 = 0.1...0.8s (step 0.01s) Tolerance: ± 15%	■	$t = k/I^2$	■

[1] These tolerances are valid under the following conditions:
– trip unit self-supplied at full power and/or auxiliary supply;
– two or three-phase power supply;

In conditions other than those considered, the following tollerances hold:

	Trip threshold	Trip curves
S	± 20%	± 20%
I	± 20%	≤ 50ms
G	± 20%	± 20%

[2] For T4. In = 320 A and T5. In = 630 A ⇒ t_1 = 10.5s
[3] For T4 In = 320 A, T5 In = 630 A and T6 In = 1000 A ⇒ I_2max = 9.5 x In, I_3max = 9.5 x In
For T6 In = 800 A ⇒ I_3max = 10.5 x In
[4] Active in auxiliary power supply (24 V DC)
[5] For I_1 < 0.4 x In the neutral setting must be at 100% of that of the phases

The information recorded when the protection release trips is:
- Currents (L1, L2, L3, N) which caused opening
- Events
- States
- Alarms
- Trips
- Tripped protection
- Parameters of the tripped protection.

When there is an auxiliary power supply, providing it is complete with the VM210 module, the PR223EF enables you to see not only the currents but also the voltages in the system, both locally via the FDU or HMI030, and remotely via a supervisor system using the Modbus protocol. In addition, up to 20 trip events can be recorded, even in self-supply mode.

PR223EF - Measurements

Measurements	With distributed N	Without distributed N
Effective current values	I_1, I_2, I_3, I_{ne}	I_1, I_2, I_3
Effective voltage values	V_1, V_2, V_3, V_{12}, V_{23}, V_{31}	V_{12}, V_{23}, V_{31}
Phase peak factor	■	■
Frequency	*f*	*f*

The PR223EF trip unit is an integral part of the circuit-breaker and is therefore not interchangeable with the other protection trip units available on T4, T5 and on T6.

Circuit-breaker for zone selectivity

ZS Zone selectivity: PR332/P

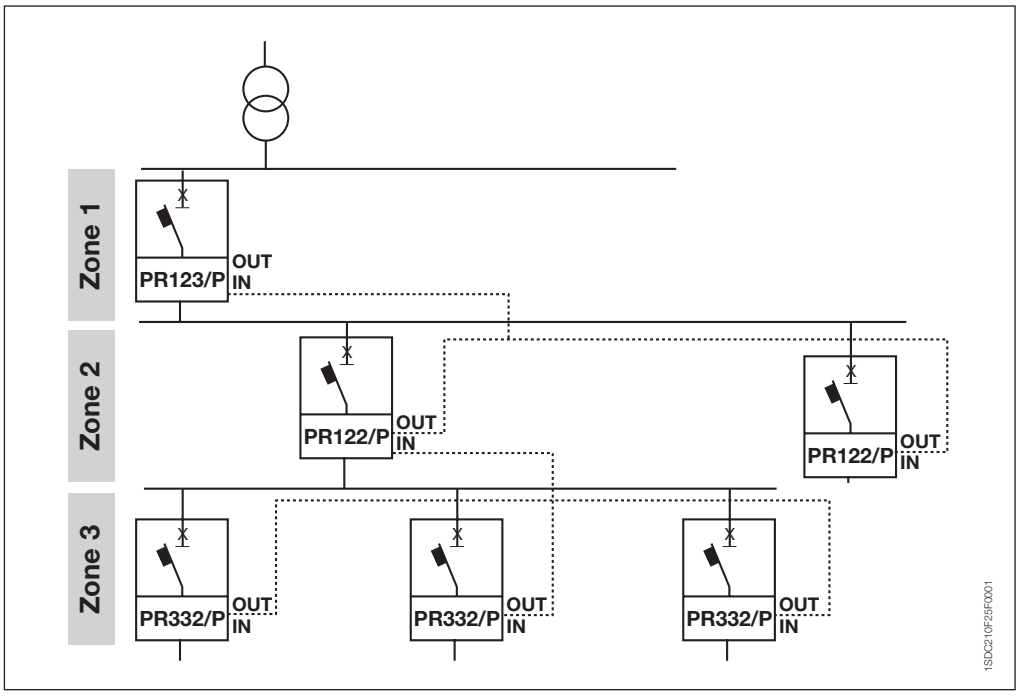
With the PR332/P trip unit (see chapter: “Tmax circuit-breakers for power distribution”, page 2/27 and foll.) it is now possible to extend the ZS zone selectivity function, already available on ABB SACE Emax air circuit-breakers to the Tmax moulded-case circuit-breakers.
The ZS zone selectivity, which is applicable to protection functions S and G, can be enabled in the case where the curve with fixed time is selected and the auxiliary power supply is present.
To realize correctly the ZS zone selectivity the following settings are suggested for the upstream circuit-breaker:

S	$t_2 \geq t_2$ set time + 70 ms*
I	I_3 = OFF
G	$t_4 \geq t_4$ set time + 70 ms*
Selectivity time	same setting for each circuit-breaker

* At minimum between the trip times of two CBs in series, with auxiliary power supply.
** See page 2/28 for $t_2$set and $t_4$set settings.

To carry out the cabling, a shielded twisted pair cable (not supplied with the trip unit; ask ABB for information) can be used. The shield should only be earthed on the trip unit of the circuit-breaker on the supply side.
The maximum length of the cabling for zone selectivity, between two units, is 200 meters.
The maximum number of the circuit-breakers which can be connected to the outputs (Z out) of a trip unit is 16.
The ZS of selectivity is identical to that which can be obtained through the trip units type PR333/P (for Emax X1) and PR122/P- PR123/P (for Emax). Tmax T7 circuit-breaker equipped with PR332/P can be connected directly without external accessories on the load side of a zone selectivity chain created through the other devices (PR333/P, PR122/P and PR123/P).

For example:



Motor Protection

Circuit-breakers for motor protection

Index

Circuit-breakers for motor protection

Electrical characteristics

Motor Protection			Tmax T2				Tmax T3	
Rated uninterrupted current		[A]	160				250	
Rated service current, **In**		[A]	1…100				100…200	
Poles		[No.]	3				3	
Rated service current, **Ue**	(AC) 50-60 Hz	[V]	690				690	
	(DC)	[V]	500				500	
Rated impulse withstand voltage, **Uimp**		[kV]	8				8	
Rated insulation voltage, **Ui**		[V]	800				800	
Test voltage at industrial frequency for 1 min.		[V]	3000				3000	
Rated ultimate short-circuit breaking capacity, **Icu**			**N**	**S**	**H**	**L**	**N**	**S**
(AC) 50-60 Hz 220/230 V		[kA]	65	85	100	120	50	85
(AC) 50-60 Hz 380/415 V		[kA]	36	50	70	85	36	50
(AC) 50-60 Hz 440 V		[kA]	30	45	55	75	25	40
(AC) 50-60 Hz 500 V		[kA]	25	30	36	50	20	30
(AC) 50-60 Hz 690 V		[kA]	6	7	8	10	5	8
Rated service short-circuit breaking capacity, **Ics**								
(AC) 50-60 Hz 220/230 V		[%Icu]	100%	100%	100%	100%	75%	50%
(AC) 50-60 Hz 380/415 V		[%Icu]	100%	100%	100%	75% (70 kA)	75%	50% (27 kA)
(AC) 50-60 Hz 440 V		[%Icu]	100%	100%	100%	75%	75%	50%
(AC) 50-60 Hz 500 V		[%Icu]	100%	100%	100%	75%	75%	50%
(AC) 50-60 Hz 690 V		[%Icu]	100%	100%	100%	75%	75%	50%
Rated short-circuit making capacity, **Icm**								
(AC) 50-60 Hz 220/230 V		[kA]	143	187	220	264	105	187
(AC) 50-60 Hz 380/415 V		[kA]	75.6	105	154	187	75.6	105
(AC) 50-60 Hz 440 V		[kA]	63	94.5	121	165	52.5	84
(AC) 50-60 Hz 500 V		[kA]	52.5	63	75.6	105	40	63
(AC) 50-60 Hz 690 V		[kA]	9.2	11.9	13.6	17	7.7	13.6
Opening time (415 V)		[ms]	3	3	3	3	7	6
Utilisation category (IEC 60947-2)			A				A	
Isolation behaviour			■				■	
Reference Standard			IEC 60947-2				IEC 60947-2	
Protection against short-circuit								
Magnetic only trip unit	MA		■ (MF up to In 12.5 A)				■	
Electronic trip unit	PR221DS-I		■				–	
	PR231/P-I		–				–	
Integrated protection (IEC 60947-4-1)								
Electronic trip unit	PR221MP		■				–	
	PR222MP		–				–	
Interchangeability			–				–	
Versions			F - P				F - P	
Terminals	fixed		F - FC Cu - FC CuAl - EF - ES - R				F - FC Cu - FC CuAl - EF - ES - R	
	plug-in		F - FC Cu - FC CuAl - EF - ES - R				F - FC Cu - FC CuAl - EF - ES - R	
	withdrawable		–				–	
Fixing on DIN rail			DIN EN 50022				DIN EN 50022	
Mechanical life		[No. operations]	25000				25000	
		[No. Hourly operations]	240				240	
Electrical life @ 415 V AC		[No. operations]	8000				8000	
		[No. Hourly operations]	120				120	
Basic fixed version dimensions		W [mm]	90				105	
		D [mm]	70				70	
		H [mm]	130				150	
Weight	fixed	[kg]	1.1				1.5	
	plug-in	[kg]	–				–	
	withdrawable	[kg]	1.5				2.7	

TERMINAL CAPTION
F = Front
EF = Front extended
ES = Front extended spread
FC Cu = Front for copper cables
R = Rear orientated
FC CuAl = Front for CuAl cables
MC = Multicable
HR = Rear flat horizontal
VR = Rear flat vertical
HR/VR = Rear flat orientated

(1) 75% for T5 630
(2) 50% for T5 630
(3) Icw = 5 kA
(4) Icw = 10 kA
(5) Icw = 20 kA (S, H, L versions) - 15 kA (V version)

Note: in the plug-in version of T2, T3 and T5 630, and in the withdrawable version of T5 630 the maximum rated current is derated by 10% at 40 °C.

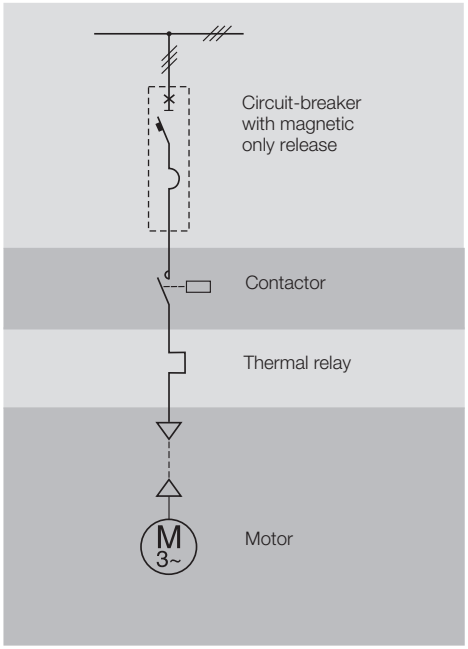
	Tmax T4					Tmax T5					Tmax T6				Tmax T7			
	250/320					400/630					630/800				800/1000/1250			
	10…320					320, 400, 630					630, 800				–			
	3					3					3				3			
	690					690					690				690			
	750					–					–				–			
	8					8					8				8			
	1000					1000					1000				1000			
	3500					3500					3500				3500			
	N	**S**	**H**	**L**	**V**	**N**	**S**	**H**	**L**	**V**	**N**	**S**	**H**	**L**	**S**	**H**	**L**	**V**
	70	85	100	200	200	70	85	100	200	200	70	85	100	200	85	100	200	200
	36	50	70	120	200	36	50	70	120	200	36	50	70	100	50	70	120	150
	30	40	65	100	180	30	40	65	100	180	30	45	50	80	50	65	100	130
	25	30	50	85	150	25	30	50	85	150	25	35	50	65	40	50	85	100
	20	25	40	70	80	20	25	40	70	80	20	22	25	30	30	42	50	60
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	75%	100%	100%	100%	100%
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	75%	100%	100%	100%	100%
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	75%	100%	100%	100%	100%
	100%	100%	100%	100%	100%	100%	100%	100%	100%(1)	100%(2)	100%	100%	100%	75%	100%	100%	75%	100%
	100%	100%	100%	100%	100%	100%	100%	100%(1)	100%(2)	100%(2)	75%	75%	75%	75%	100%	75%	75%	75%
	154	187	220	440	660	154	187	220	440	660	154	187	220	440	187	220	440	440
	75.6	105	154	264	440	75.6	105	154	264	440	75.6	105	154	220	105	154	264	330
	63	84	143	220	396	63	84	143	220	396	63	94.5	105	176	105	143	220	286
	52.5	63	105	187	330	52.5	63	105	187	330	52.5	73.5	105	143	84	105	187	220
	40	52.5	84	154	176	40	52.5	84	154	176	40	46	52.5	63	63	88.2	105	132
	5	5	5	5	5	6	6	6	6	6	10	9	8	7	15	10	8	8
	A					B (400 A)(3) - A (630 A)					B(4)				B(5)			
	■					■					■				■			
	IEC 60947-2/IEC 60947-4					IEC 60947-2/IEC 60947-4					IEC 60947-2/IEC 60947-4				IEC 60947-2			
	■					–					–				–			
	■					■					■				–			
	–					–					–				■			
	–					–					–				–			
	■					■					■				–			
	■					■					■				■			
	F - P - W					F - P - W					F - W				F - W			
	F - FC Cu - FC CuAl - EF - ES - R - MC - HR - VR					F - FC Cu - FC CuAl - EF - ES - R - HR - VR					F - FC CuAl - EF - ES - R - RC				F - EF - ES - FC CuAl - HR/VR			
	EF - ES - R - FC Cu - FC CuAl - HR - VR					EF - ES - R - FC Cu - FC CuAl - HR - VR					–				–			
	EF - ES - FC Cu - FC CuAl					EF - ES - FC Cu - FC CuAl					EF - HR - VR				EF - HR/VR - ES - RS			
	–					–					–				–			
	20000					20000					20000				10000			
	240					120					120				60			
	8000					7000					5000				2000 (S, H, L versions) / 3000 (V version)			
	120					60					60				60			
	105					140					210				210			
	103.5					103.5					103.5				154 (manual) /178 (motorizable)			
	205					205					268				268			
	2.35					3.25					9.5/12				9.7/12.5 (manual) - 11/14 (motorizable)			
	3.6					5.15					–				–			
	3.85					5.4					12.1/15.1				29.7/39.6 (manual) - 32/42.6(motorizable)			

Starting, switching and protection of three-phase asynchronous motors are basic operations for their correct use. ABB SACE proposes two different solutions for this type of application:

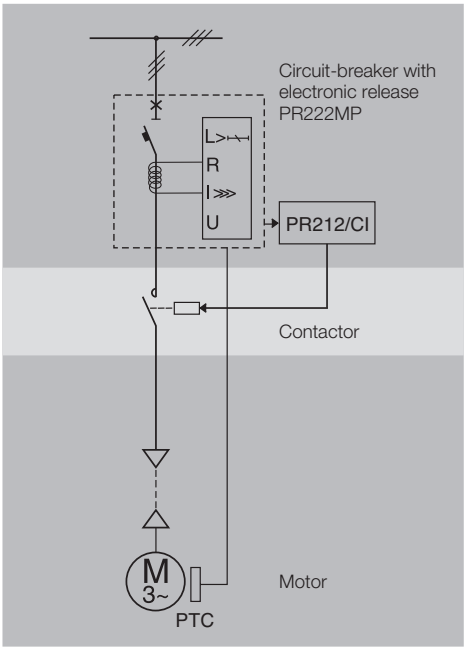
– **a traditional system**, which foresees a circuit-breaker for protection against short-circuit, a thermal relay for protection against overload and missing or unbalanced phase and a contactor for motor switching;
– **a system of integrated protection** thanks to the PR222MP trip unit, which ensures both protection against short-circuit, and against overload, as well as that against missing or unbalanced phase and that against the rotor block.

All this must necessarily take into account the problems which arise at the moment of starting.
In particular, when selecting these devices, different factors must be taken into consideration, such as:

– the motor power
– the diagram and type of starting
– the type of motor: with cage rotor or with wound rotor
– the fault current at the point of the network where the motor is installed.



Protection against short-circuit



Integrated protection

Circuit-breakers for motor protection

Protection against short-circuit

With the new series of Tmax moulded-case circuit-breakers, ABB SACE proposes a range up to 400 A, which implementing exclusively the protection against short-circuit, is suitable for use inside protected starters of traditional type.
The Tmax T2 ,T3 and T4 circuit-breakers in the three-pole version with fixed magnetic only trip unit (only for T2, I_3= 13 x In up to In = 12.5 A) or adjustable between 6 and 12 times the rated service current for T2 and T3, and between 6 and 14 times for T4, stand out for their compactness and exceptional performances in terms of breaking capacity and limitation of the specific let-through energy. Furthermore, thanks to the great flexibility given by the wide range of magnetic threshold settings, they allow optimal motor protection.
They can be used in a wide range of start-ups, from 0.37 kW to 45 kW for T2 and up to 250 kW for T5 (at 400 V).
Finally, thanks to their wide setting range of protection against short-circuit, T2, T4, T5 and T6, in the three-pole version equipped with PR221DS-I electronic trip units and T7, in three-pole version equipped with PR231/P-I electronic trip units, allow the most suitable trip value to be selected for any type of motor for rated currents up to 1250 A and 560 kW (at 400 V).

MF – Fixed magnetic only trip units

Tmax T2

	In [A]	1	1.6	2	2.5	3.2	4	5	6.5	8.5	11	12.5
	I_3 = 13 x In	13	21	26	33	42	52	65	84	110	145	163

Note: The magnetic only trip units which equip the Tmax T2 in three-pole version circuit-breaker have a trip threshold I_3 fixed at 13 x In, according to what is indicated in the table.

MA – Adjustable magnetic only trip units

Tmax T2-T3-T4

	In [A]	10	20	25	32	52	80	100	125	160	200
	Tmax T2		■		■	■	■	■			
	Tmax T3							■	■	■	■
	Tmax T4	■		■		■	■	■	■	■	■
	Tmax T2, T3 I_3= 6…12 x In	–	120…240	–	192…384	312…624	480…960	600…1200	750…1500	960…1920	1200…2400
	Tmax T4 I_3= 6…14 x In	60…140	–	150…350	–	312…728	480…1120	600…1400	750…1750	960…2240	1200…2800

Note: The magnetic only trip units which equip the Tmax T2 and T3 three-pole version circuit-breakers have a trip thresould I_3 which can be adjusted from 6 to 12 x In for T2 and T3 and from 6 to 14 x In for T4, according to what is indicated in the table.

Circuit-breakers for motor protection

Protection against short-circuit

Current sensors

	In [A]	10	25	63	100	160	250	320	400	630	800	1000	1250	1600
PR221DS-I	T2 160	■	■	■	■	■								
	T4 250				■	■	■							
	T4 320				▲	▲	▲	■						
	T5 400							■	■					
	T5 630							▲	▲	■				
	T6 630									■				
	T6 800										■			
PR231/P-I	T7 800									▲	■			
	T7 1000									▲	▲	■		
	T7 1250									▲	▲	▲	■	
	T7 1600									▲	▲	▲	▲	■
	I_3 [A]	10...100	25...250	63...630	100...1000	160...1600	250...2500	320...3200	400...4000	630...6300	800...8000	1000...10000	1250...12500	1600...16000

■ = Complete circuit-breaker already coded
▲ = Circuit-breaker to be assembled

PR221DS-I

Protection function		Trip threshold	Excludability	Relation t=f(I)
	Against short-circuit with adjustable instantaneous trip	I_3 = 1 - 1.5 - 2 - 2.5 - 3 - 3.5 - 4.5 - 5.5 - 6.5 - 7 - 7.5 - 8 - 8.5 - 9 - 10 x In Tolerance: ± 20% (T2) ± 10% (T4-T5, T6)	■	t = k

Note: The tolerances are valid under the following hypotheses:
– relay self-supplied on running and/or auxiliary power supply (without start up)
– two-phase or three-phase power supply
In all the cases not foreseen by the above-mentioned hypotheses, the following tolerance values are valid:

	Trip threshold	Trip time
I	± 20%	≤ 40ms

PR231P-I

Protection function		Trip threshold	Excludability	Relation t=f(I)
	Against short-circuit with adjustable instantaneous trip	I_3 = 1 - 1.5 - 2 - 2.5 - 3 - 3.5 - 4.5 - 5.5 - 6.5 - 7 - 7.5 - 8 - 8.5 - 9 - 10 x In Tolerance: ± 10%	–	t = k

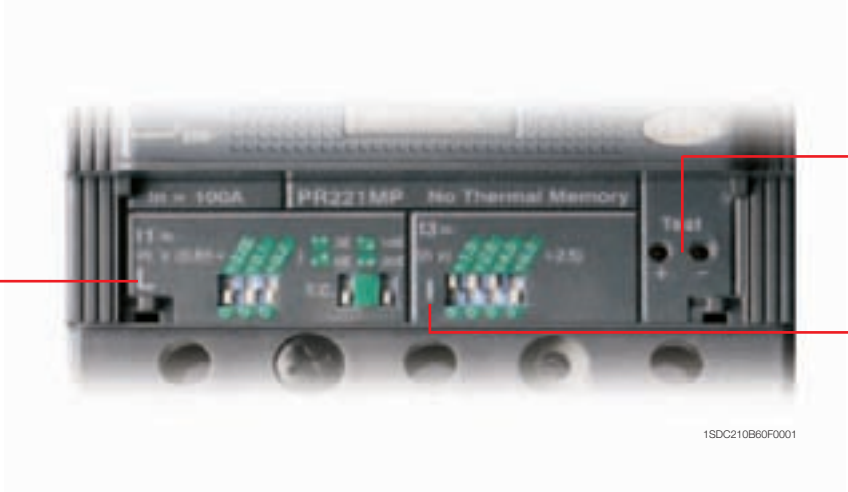
Note: The tolerances are valid under the following hypotheses:
– relay self-supplied on running and/or auxiliary power supply (without start up)
– two-phase or three-phase power supply
In all the cases not foreseen by the above-mentioned hypotheses, the following tolerance values are valid:

	Trip threshold	Trip time
I	± 15%	≤ 60ms

The PR221MP electronic release is dedicated to protection of motors with powers up to 55 kW.
The L protection function protects the motor from overloads according to the indications and classes defined by the IEC 60947-4-1 Standard. The function can be adjusted manually, I_1 = 0.65…1 x In, by means of the dip switches on the front of the release. Then the start-up class of the motor must be selected which determines the trip time for overload, in accordance with the IEC 60947-4-1 Amend. 2, Table 2 Standards: “Class 3E” corresponds to a trip time of t_1 = 2.77s, “Class 5E” t_1 = 4.16s, “Class 10E” t_1 = 8.33s, and “Class 20E” t_1 = 11.1s at 7.2 x I_1.
The protection against short-circuit allows adjustment of the trip threshold up to 17.5 times the rated current, I_3 = 2.5…17.5 x In.
As for Tmax T2 PR221DS, it is necessary to house the opening solenoid (SA) in the right-hand slot of the circuit-breaker. Tmax T2 PR221MP can be fitted with the same electrical accessories available with PR221DS.

PR221MP

Protection L
Against overload



Socket for TT1 test unit

Protection I
Against short-circuit with instantaneous trip

PR221MP – Protection and parameterisation functions

Protection function[1]		Trip threshold	Trip curves	Excludability	Relation t = f(I)
L	Against overload with long inverse time delay trip and trip characteristic according to an inverse time curve (I^2t=constant) according to IEC 60947-2 Standard	I_1 = 0.65 - 1 x In step = 0.05 x In	Trip classes: 3E - 5E - 10E - 20E Protection for unbalanced phase not available	–	–
I	Against short-circuit with instantaneous trip with adjustable threshold	I_3 = 2.5...17.5 x In step = 1 x In Tolerance: ± 20% (T2)	instantaneous	–	t = k

[1] The tolerances are valid with these hypotheses:
– self-supplied release at full power and/or auxiliary power supply (without start up)
– two-phase or three-phase power supply
For all the cases not foreseen in the above hypotheses, the following tolerance values are valid:

	Trip threshold	Trip time
I	± 20%	≤ 40ms

Circuit-breakers for motor protection

Integrated protection: PR222MP


1SDC210B14F0001

In the three-pole version, the Tmax T4, T5 and T6 circuit-breakers are fitted with PR222MP electronic trip units. This makes it possible to obtain functions which guarantee high trip precision, extreme reliability and immunity to variations in the external temperature. The PR222MP trip units fully integrated on board the circuit-breaker guarantee complete protection of the motor. In fact, it is not necessary to provide the help of an external thermal relay for protection against overloads as, on the other hand, occurs with the standard solution.
The PR222MP can be connected to a contactor for the basic protection function (NORMAL mode) of the motor: the circuit-breaker can control contactor opening in the case of a fault (excluding short-circuit), by means of the SACE PR212/CI accessory control unit. In fact, a contactor has breaking capacities at high currents which are less efficient than the circuit-breaker, but a high number of possible operations consistently higher than those of the circuit-breaker (about 1.000.000). The combination of the two devices therefore optimises motor protection and control. In Heavy operation mode and for currents below the set magnetic trip threshold, the PR222MP trip unit allows control of the circuit-breaker opening and not of the contactor. In this operating mode, the circuit-breaker is therefore called on to protect the plant under any overcurrent conditions, assigning just motor control operations (turning on and turning off) to the contactor.

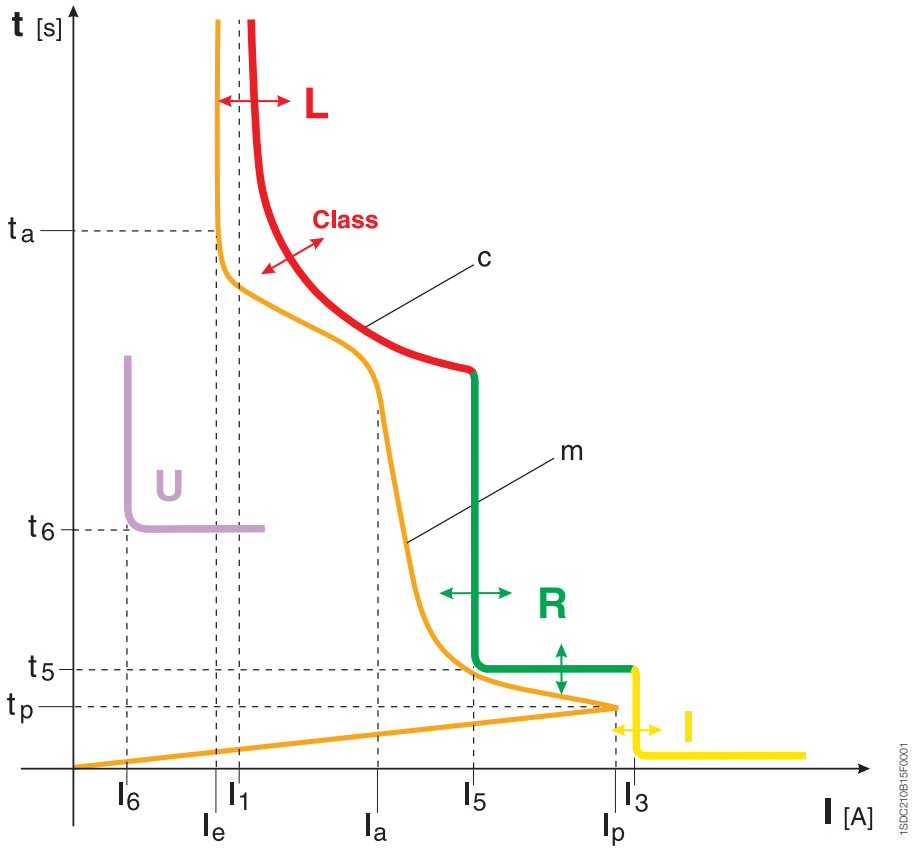
PR222MP electronic trip unit - Current sensors

Tmax T4-T5-T6						
In [A]	**100**	**160**	**200**	**320**	**400**	**630**
T4 250	■	■	■			
T5 400				■	■	
T6 800						■

■ = Complete circuit-breaker already coded

In any case, the PR010/T unit for testing the trip unit and checking the protection functions, and the PR021/K signalling unit are available for the PR222MP trip unit. The electronic trip units are self-supplied and are made up of three current transformers, the PR222MP protection unit and a trip coil which acts directly on the circuit-breaker operating mechanism. The current transformers, housed inside the trip unit, supply the energy and the signal required for correct protection operation. Operation is guaranteed with a single-phase current equal to 20% of the rated current. The trip unit is temperature-compensated and is sensitive to missing phase according to Table IV of the IEC60947-4-1 7.2.1.5.2 Standards.
The T4, T5 and T6 circuit-breakers for motor protection are perfectly integrated with the new line of ABB contactors. The latter - defined as A-line - together with the line of thermal relays and ABB SACE moulded-case circuit-breakers, is the basis for the new generation of apparatus specially designed to guarantee a system of products which can be integrated according to the required applications. All this has the aim not only of continually improving the products, but above all of providing designers, installers and end users with the best solutions in terms of performances and reliability, combined with the simplicity of the system.
The Tmax T4 and T5 circuit-breakers with PR222MP trip unit and the “A” series of contactors are, in particular, an extraordinary solution in terms of compactness, sharing the same width and thereby saving space, assembly material, installation time and relative cabling operations. The combination of circuit-breaker-contactor allows an extremely compact protected starter to be made.

Typical operating characteristic of an asynchronous motor



I_1 = function L trip current
I_3 = function I trip current
I_5 = function R trip current
t_5 = function R trip time
I_6 = function U trip current
t_6 = function U trip time
I_e = rated service current of the motor
I_a = motor starting current
I_p = peak value of the sub-transient starting current
t_a = motor starting time
t_p = duration of the sub-transient starting phase
m = typical motor starting curve
c = example of trip curve of a motor protection circuit-breaker with electronic release
The different curves of the functions, with numerous threshold and time settings, allow an overall trip curve to be drawn which is really close to the motor starting curve, thereby optimising its protection.

Protection functions

(L) Protection against overload

Function L protects the motor against overloads according to the indications and classes defined by the IEC 60947-4-1 Standard.
The protection is based on a pre-defined model (ABB SACE international patent) which, by simulating the copper and iron over-temperatures inside the motor, allows precise safeguarding of the motor. The protection intervenes when the established over-temperature is reached. The trip time is fixed by selecting the trip class defined in the above-mentioned Standard.
The function is temperature-compensated and sensitive to a missing/unbalanced phase according to the IEC 60947-4-1 Standard.
In the case of an auxiliary power supply, the thermal memory function is guaranteed, which allows the trip unit to continue to calculate the motor temperature even following an opening.
Function L, which cannot be excluded, can be set manually to I_1 = 0.4…1 x In with 60 thresholds which can be set by means of the dip-switches on the front of the trip unit, or electronically by means of the SACE PR010T test and configuration unit.
The starting class of the motor must then be selected, which determines the trip time for overload according to the IEC 60947-4-1 5.7.3 Table II Standards: class 10 A corresponds to a trip time t_1= 4s, class 10 to t_1= 8s, class 20 to t_1= 16s and class 30 to t_1= 24s at 7.2 x In . Setting this trip time can also be carried out electronically with the PR010T: the electronic steps are equal to 1s.
Tripping of this protection leads to contactor opening (with the PR212/CI unit). Any anomaly of the contactor would make the circuit-breaker open, thanks to the BACK UP function.
For protection L, there is then a pre-alarm and an alarm LED: the pre-alarm threshold value is fixed and equal to 0.9 x I_1 and the LED is permanently lit, whereas it flashes in case of alarm (I > 1.05 x I_1). It is also possible to transmit remotely the alarm of protection L, simply connecting connector X_3 to the dedicated contact.

(R) Protection against rotor block

Function R protects the motor against possible rotor block during operation. Protection R has the characteristic of protecting the motor in two different ways, according to whether the fault is present at start-up or whether it is present during normal service of an already active plant.
In the former case, protection R is linked to protection L for time selection as well: in the presence of a fault during start-up, protection R is inhibited for a time equal to the time set with the trip class. Once this time is exceeded, protection R becomes active leading to a trip after a fixed set t_5 time.
In the latter case, protection R is already active and the protection tripping time will be equal to t_5.
The protection intervenes when at least one of the phase currents exceeds the established value and remains over that threshold for time t_5.
Function R can be set manually I_5= 3…10 x I_1 with 8 thresholds which can be set by means of the dip-switches on the front of the trip unit, or with 70 thresholds by means of the SACE PR010T test and configuration unit (steps of 0.1 x I_1). The trip time t_5 can be set to 1, 4, 7 or 10 seconds by means of a dip-switch, or with steps of 0.5s by means of PR010T.
Tripping of this protection leads to contactor opening (with the PR212/CI unit); any anomaly of the contactor would make the circuit-breaker open, thanks to the BACK UP function.

(I) Protection against short-circuit

This protection function intervenes in the case of a short-circuit between phases. It is sufficient for just a single phase to exceed the set threshold to cause immediate opening of the circuit-breaker (protection cannot be excluded).
The PR222MP trip unit is able to recognise whether the motor to be protected is in the start-up hase or if there is a short-circuit: this has the aim of allowing completely safe start-up conditions. It cannot be excluded.

(U) Protection against missing phase and/or unbalanced

Function U can be used in those cases where a particularly precise control is needed regarding phase missing/unbalanced. This protection can be excluded and intervenes if the effective value of one or two currents drops below the level equal to 0.4 of the current I_1 set for protection L and remains there for longer than 4 seconds.
This protection can be set electronically with the PR010T from 0.4 to 0.9 x I_1 with time adjustable between 1 and 10s (steps of 0.5s).
Tripping of this protection leads to contactor opening (with the PR212/CI unit); any anomaly of the contactor would make the circuit-breaker open, thanks to the BACK UP function.

Parameterisation of the PR222MP trip unit

Man/Elt: by means of a dip switch located on the front, the trip unit can be provided for manual parameterisation (Man) of the thresholds and times acting directly on the dip switches located on the front of the trip unit or with electronic parameterisation (Elt) by means of the PR010T.

Reset Mode

Auto/Man: this function (AUTO) allows the state of activation of the PR212/CI to be automatically reset following contactor trip for L function, after a fixed time of 15s. The AUTO reset is only possible when there is an auxiliary voltage.

Setting the working modes

Normal: the Normal mode foresees the use of a circuit-breaker and a contactor: this configuration makes intervention towards the contactor possible, through the PR212/CI unit, when the PR222MP considers this appropriate.
Heavy: the heavy mode foresees circuit-breaker opening for all overcurrent conditions, and the contactor is assigned just the motor operation function.

BACK UP Function

This protection is conceived to manage the possibility that an opening command sent to the contactor might not have a positive outcome, i.e. that the contactor does not intervene. In this case, after having waiting for the time defined using the dip switch “k time” (min = 80ms or max = 160ms), the PR222MP sends a trip signal to the circuit-breaker.
By introducing a time delay between the command sent to the contactor and to the back-up one, it is necessary to compensate the contactor actuation time.

Setting the PTC protection

PTC: by means of a PTC sensor inserted in the motor, this protection controls the internal temperature of the protected motor. In the case of excessive temperature, the PR222MP release will command opening of the contactor (if it is in “Normal” mode) or of the circuit-breaker (if it is in “Heavy” mode).
0/1: in this mode, as an alternative to the PTC protection, it is possible to signal the state of a generic contact without potential by means of the ABB SACE PR021/K signalling unit (see page 3/43) (for the electrical circuit diagram, see page 5/20).

PR222MP

Protection R
Against rotor block

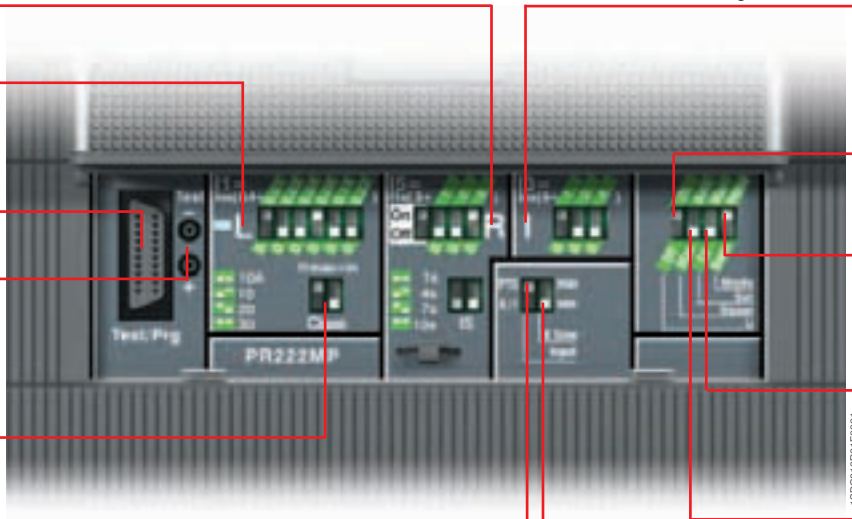
Protection L
Against motor overload

Socket for connection of SACE PR010/T test unit and BT030 wireless communication unit

Socket for SACE TT1 test unit

Class
Class of motor starting according to the IEC 60947-4-1 Standards

Selection between:
- PTC[1] temperature sensor input
- 0/1 generic input



Protection I
Against short-circuit with instantaneous trip

Protection U
Against phase current unbalance or loss of phase

Setting the work methods

Man/Elt
Release parametrisation methods

Setting the reset following trip
- manual
- automatic

Setting the back-up time

[1] A special input is available to connect a PTC temperature probe, inserted in the motor to be protected

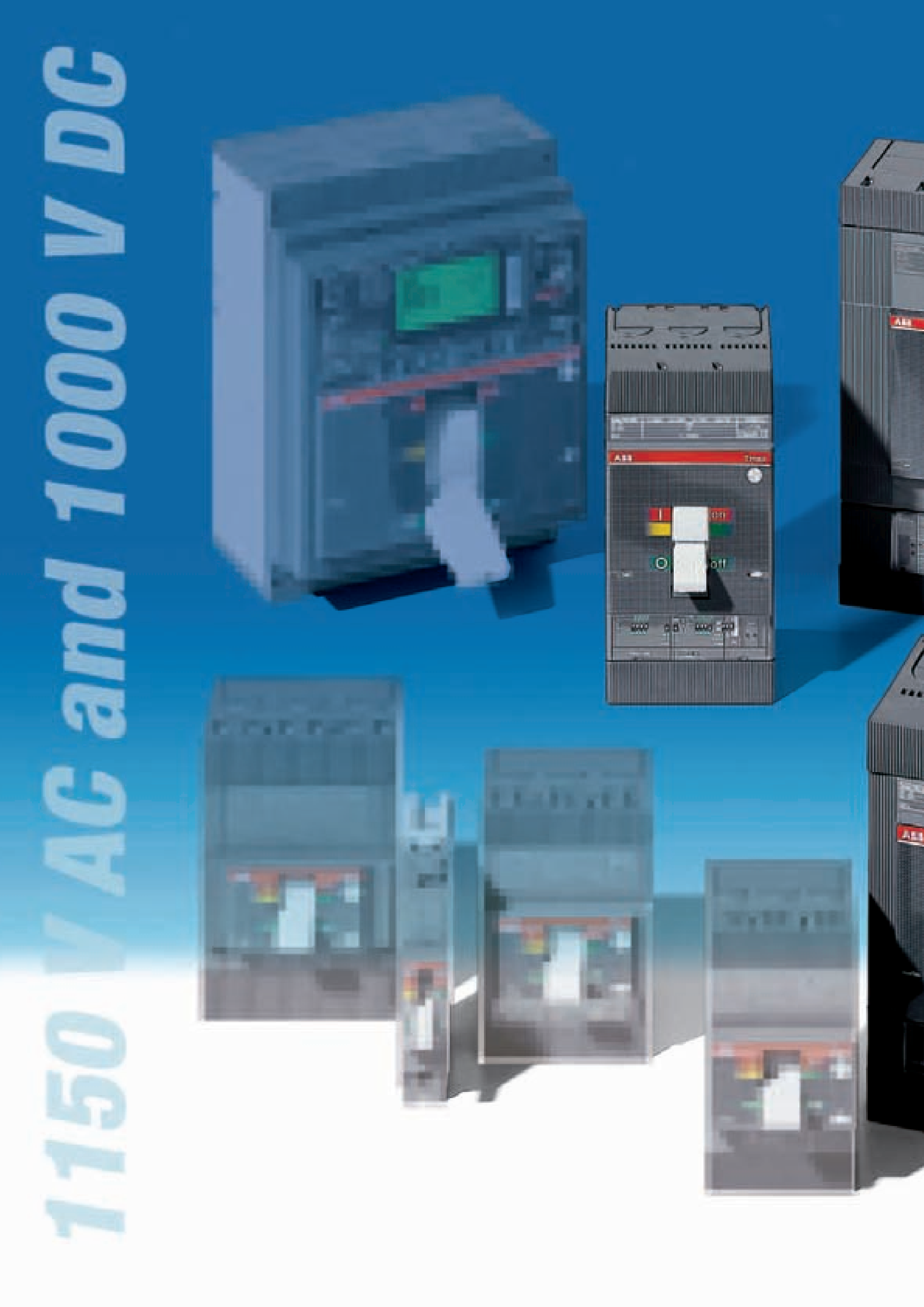
PR222MP - Protection functions and parameterisation

Protection functions		Trip threshold	Trip curves[1]	Excludability	t = f(I)	Thermal memory [2]
L	Against overload with long inverse time delay trip and trip characteristic according to an inverse time curve according to IEC 60947-4-1 Standard	**Manual setting** I_1 = 0.4…1 x In step = 0.01 x In Tolerance: ± 15%	**Manual setting** Trip classes: 10 A - 10 - 20 - 30 (IEC 60497-4-1) t_1 = 4-8-16-24s where t1 is the trip time at 7.2 x I_1 cold. depending on the class selected	–	–	■
		Electronic setting I_1 = 0.4…1 x In step = 0.01 x In Tolerance: ± 15%	**Electronic setting** t_1 = 4…24s step = 1s Tolerance: ± 15%			
R	Against rotor block with delayed trip and trip characteristic with definite time	**Manual setting** I_5 = OFF - 3...10 x I_1 step = 1 x In Tolerance: ± 15%	**Manual setting** t_5 = 1 - 4 - 7 - 10 s Tolerance: ± 10%	■	t = k/I²	–
		Electronic setting I_5 = OFF - 3…10 x I_1 step = 0.1 x I_1 Tolerance: ± 15%	**Electronic setting** t_5 = 1…10s step = 0.5s Tolerance: ± 10%			
I	Against short-circuit with instantaneous trip	**Manual setting** I_3 = 6…13 x In step = 1 x In Tolerance: ± 15%	instantaneous	–	t = k[3]	–
		Electronic setting I_3 = 6…13 x In step = 0.1 x In Tolerance: ± 15%				
U	Against phase current unbalance or loss of phase with delayed trip and trip characteristic with definite time	**Manual setting** I_6 = ON (0.4 x I_1) - OFF Tolerance: ± 15%	**Manual setting** t_6 = 4s Tolerance: ± 10%	■	t = k	–
		Electronic setting I_6 = 0.4…0.9 x I_1 - OFF Tolerance: ± 15%	**Electronic setting** t_6 = 1…10s step 0.5s Tolerance: ± 10%			

[1] These tolerances hold in the following conditions:
– self-powered trip unit at full power and/or auxiliary supply (without start-up);
– two or three-phase power supply.
In conditions other than those considered, the following tollerances hold:

	Trip threshold	Trip time
R	± 20%	± 20%
I	± 20%	≤ 50ms
U	± 20%	± 20%

[2] Available in auxiliary supply at 24 V DC
[3] Full power: t = t_5
Start up: t = t_1 + t_5


1150 V AC and 1000 V DC

Circuit-breakers for use up to 1150 V AC and 1000 V DC

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Circuit-breakers for use up to 1150 V AC and 1000 V DC

Electrical characteristics

The range of T4, T5 and T6 circuit-breakers for applications in direct current at 1000 V or in alternating current up to 1150 V (T6 up to 1000 V) also comes into the panorama of the Tmax proposals.
The typical sectors of use are installations in mines, road and railway tunnels, electrical transport and industrial applications in general.
The circuit-breakers are available in the three-pole and four-pole version with TMD or TMA adjustable thermomagnetic releases or with PR221DS, PR222DS/P, PR222DS/PD, PR222MP and PR223EF electronic trip units (see the dedicated section on page 2/37).
The dimensions of these circuit-breakers are the same as the standard one. The Tmax circuit-breakers for these applications are available in the fixed, plug-in and withdrawable version (for which the use of the 1000 V fixed parts supplied only by upper terminals is mandatory) and they are compatible with all the accessories except for the residual current release.

T4-T5 circuit-breakers for use up to 1150 V AC and T6 circuit-breakers for use up to 1000 V AC

				Tmax T4		Tmax T5		Tmax T6
Rated uninterrupted current			[A]	250		400/630		630/800
Poles				3, 4		3, 4		3, 4
Rated service voltage, **Ue**	(AC) 50-60 Hz		[V]	1000	1150	1000	1150	1000
Rated impulse withstand voltage, **Uimp**			[kV]	8		8		8
Rated insulation voltage, **Ui**			[V]	1000	1150	1000	1150	1000
Test voltage at power frequency for 1 min.			[V]	3500		3500		3500
Rated ultimate short-circuit breaking capacity, **Icu**				**L**	**V**(1)	**L**	**V**(1)	**L**(1)
	(AC) 50-60 Hz 1000 V		[kA]	12	20	12	20	12
	(AC) 50-60 Hz 1150 V		[kA]		12		12	
Rated service short-circuit breaking capacity, **Ics**								
	(AC) 50-60 Hz 1000 V		[kA]	12	12	10	10	6
	(AC) 50-60 Hz 1150 V		[kA]		6		6	
Rated short-circuit making capacity, **Icm**								
	(AC) 50-60 Hz 1000 V		[kA]	24	40	24	40	24
	(AC) 50-60 Hz 1150 V		[kA]		24		24	
Category of use (IEC 60947-2)				A		B (400 A)(2) - A (630 A)		B (3)
Behaviour on isolation				■		■		■
Reference Standards				IEC 60947-2		IEC 60947-2		IEC 60947-2
Thermomagnetic releases	TMD				■			
	TMA				■		■	■
Electronic trip units	PR221DS/LS/I			■	■	■	■	■
	PR221DS/I			■	■	■	■	■
	PR222DS/P_LSI			■	■	■	■	■
	PR222DS/P_LSIG			■	■	■	■	■
	PR222DS/PD_LSI			■	■	■	■	■
	PR222DS/PD_LSIG			■	■	■	■	■
	PR222MP			■		■		
Terminals				FC Cu		FC Cu		F - FC CuAl - R
Version				F, P, W	F	F, P, W(4)	F	F (5)
Mechanical life			[No. operations]	20000		20000		20000
			[No. hourly operations]	240		120		120
Basic fixed dimensions(6)		3 poles	W [mm]	105		140		210
		4 poles	W [mm]	140		184		280
			D [mm]	103.5		103.5		103.5
			H [mm]	205		205		268
Weight	fixed	3/4 poles	[kg]	2.35 / 3.05	2.35 / 3.05	3.25 / 4.15	3.25 / 4.15	9.5 / 12
	plug-in	3/4 poles	[kg]	3.6 / 4.65		5.15 / 6.65		
	withdrawable	3/4 poles	[kg]	3.85 / 4.9		5.4 / 6.9		

TERMINAL CAPTION
F = Front
FC Cu = Front for copper cables
FC CuAl = Front for copper cables CuAl
R = Rear
F = Fixed circuit-breakers
P = Plug-in circuit-breakers
W = Withdrawable circuit-breakers

(1) Power supply only from the top
(2) Icw = 5 kA
(3) Icw = 7.6 kA (630 A) - 10 kA (800 A)
(4) Tmax T5630 is only available in the fixed version
(5) For T6 in the withdrawable version, please ask ABB SACE
(6) Circuit-breaker without high terminal covers

PR221DS and PR222DS for use up to 1150 V AC - Current sensor

Tmax T4-T5-T6						
In [A]	100	250	320	400	630	800
T4 250	■	■				
T5 400			■	■		
T5 630					■	
T6 630(1)					■	
T6 800(1)						■

Note: For the PR222MP setting, please see page 2/56
(1) up to 1000 V

Circuit-breakers for use at 1000 V DC

			Tmax T4	**Tmax T5**	**Tmax T6**
Rated uninterrupted current		[A]	250	400/630	630/800
Poles			4	4	4
Rated service voltage, **Ue**		[V]	1000	1000	1000
Rated impulse withstand voltage, **Uimp**		[kV]	8	8	8
Rated insulation voltage, **Ui**		[V]	1150	1150	1000
Test voltage at power frequency for 1 min.		[V]	3500	3500	3500
Rated ultimate short-circuit breaking capacity, **Icu**			**V**(2)	**V**(2)	**L**(2)
	(DC) 4 poles in serie(1)	[kA]	40	40	40
Rated service short-circuit breaking capacity, **Ics**					
	(DC) 4 poles in serie	[kA]	20	10	
Category of use (IEC 60947-2)			A	B (400 A)(3) - A (630 A)	B(4)
Behaviour on isolation			■	■	■
Reference Standards			IEC 60947-2	IEC 60947-2	IEC 60947-2
Thermomagnetic releases	TMD		■	–	–
	TMA		■	■	■
Terminals			FC Cu	FC Cu	F - FC CuAl - R
Interchangeability			■	■	■
Versions			F	F	F(5)
Mechanical life		[No. operations]	20000	20000	20000
		[No. hourly operations]	240	120	120
Basic fixed dimensions	4 poles	W [mm]	140	184	280
		D [mm]	103.5	103.5	103.5
		H [mm]	205	205	268
Weight fixed	4 poles	[kg]	3.05	4.15	12

TERMINAL CAPTION
F = Front
FC Cu = Front for copper cables
FC CuAl = Front for copper cables CuAl
R = Rear
F = Fixed circuit-breakers

(1) See the wiring diagrams on page 4/65 diagram D
(2) Power supply only from above
(3) Icw = 5 kA
(4) Icw = 7.6 kA (630 A) - 10 kA (800 A)
(5) For T6 in the withdrawable version, please ask ABB SACE

Thermomagnetic trip unit for use up to 1150 V AC and 1000 V DC - TMD and TMA

	In [A]	32	50	80	100	125	160	200	250	320	400	500	630	800
	Neutral [A] - 100%	32	50	80	100	125	160	200	250	320	400	500	630	800
L	T4 250	■	■	■	■	■	■	■	■					
	T5 400									■	■			
I_1=0.7…1xIn	T5 630											■		
	T6 630												■	
	T6 800													■
I	I_3 = 10 x In [A]	320	500											
I_3 = 10xIn	I_3 = 5...10 x In [A]	–	–	400...800	500...1000	625...1250	800...1600	1000...2000	1250...2500	1600...3200	2000...4000	2500...5000	3150...6300	4000...8000
I_3 = 5...10xIn														

Switch-disconnectors

Switch-disconnectors

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Switch-disconnectors

Electrical characteristics

The Tmax switch-disconnectors derive from the corresponding circuit-breakers, of which they keep the overall dimensions, versions, fixing systems and the possibility of mounting accessories unchanged. This version only differs from the circuit-breakers in the absence of the protection trip units. They are characterised by a rated voltage of 690 V in alternating current and 750 V in direct current.

Switch-disconnectors

				Tmax T1D
Conventional thermal current, **Ith**			[A]	160
Rated service current in category AC22, **Ie**			[A]	160
Rated service current in category AC23, **Ie**			[A]	125
Poles			[No.]	3/4
Rated service voltage, **Ue**	(AC) 50-60 Hz		[V]	690
	(DC)		[V]	500
Rated impulse withstand voltage, **Uimp**			[kV]	8
Rated insulation voltage, **Ui**			[V]	800
Test voltage at industrial frequency for 1 minute			[V]	3000
Rated short-circuit making capacity, Icm	(min) switch-disconnector only		[kA]	2.8
	(max) with circuit-breaker on supply side		[kA]	187
Rated short-time withstand current for 1s, **Icw**			[kA]	2
Reference Standard				IEC 60947-3
Versions				F
Terminals				FC Cu - EF - FC CuAl
Mechanical life			[No. operations]	25000
			[No. Hourly operations]	120
Basic dimensions, fixed		3 poles	W [mm]	76
		4 poles	W [mm]	102
			D [mm]	70
			H [mm]	130
Weight	fixed	3/4 poles	[kg]	0.9/1.2
	plug-in	3/4 poles	[kg]	–
	withdrawable	3/4 poles	[kg]	–

Switch-disconnector coordination [380/415 V AC]

	T1			T2				T3		T4					T5 400				
	B	C	N	N	S	H	L	N	S	N	S	H	L	V	N	S	H	L	V
Icu [kA]	16	25	36	36	50	70	85	36	50	36	50	70	120	200	36	50	70	120	200
T1D 160	16	25	36	36	50	70	85												
T3D 250								36	50	36	50	70	120	200					
T4D 320										36	50	70	120	200					
T5D 400															36	50	70	120	200
T5D 630																			
T6D 630																			
T6D 800																			
T6D 1000																			
T7D 1000																			
T7D 1250																			
T7D 1600																			

Applications

They can be used as general circuit-breakers in sub-switchboards as switching and isolation parts for lines, busbars or groups of apparatus, or as bus-ties. They can be part of general isolation devices of groups of machines or of complexes for motor switching and protection.

Isolation

The main function carried out by this apparatus consists of isolation of the circuit they are inserted in. Once the contacts are open they are at a distance which prevents an arc from striking, in accordance with the prescriptions in the standards regarding isolation behaviour. The position of the operating lever corresponds definitely with that of the contacts (positive operation).

	Tmax T3D	Tmax T4D	Tmax T5D	Tmax T6D	Tmax T7D
	250	250/320	400/630	630/800/1000[1]	1000/1250/1600
	250	250/320	400/500	630/800/1000	1000/1250/1600
	200	250	400/400	630/800/800	1000/1250/1250
	3/4	3/4	3/4	3/4	3/4
	690	690	690	690	690
	500	750	750	750	750
	8	8	8	8	8
	800	800	800	1000	1000
	3000	3000	3000	3500	3000
	5.3	5.3	11	30	40
	105	440	440	440	440
	3.6	3.6	6	15	20
	IEC 60947-3	IEC 60947-3	IEC 60947-3	IEC 60947-3	IEC 60947-3
	F - P	F - P - W	F - P - W	F - W	F - W
	F-FC CuAl-FC Cu-EF-ES-R	F-FC CuAl-FC Cu-EF-ES-R-MC-HR-VR	F-FC CuAl-FC Cu-EF-ES-R-HR-VR	F-FC CuAl-EF-ES-R-RC	F-EF-ES-FC CuAl HR/VR
	25000	20000	20000	20000	10000
	120	120	120	120	60
	105	105	140	210	210
	140	140	184	280	280
	70	103.5	103.5	268	154(manual)/178(motorizable)
	150	205	205	103.5	268
	1.5/2	2.35/3.05	3.25/4.15	9.5/12	9.7/12.5(manual)/11/14(motorizable)
	2.1/3.7	3.6/4.65	5.15/6.65	–	–
	–	3.85/4.9	5.4/6.9	12.1/15.1	29.7/39.6(manual)/32/42.6(motorizable)

[1] Withdrawable version not available for T6 1000 A.

	T5 630					T6 630				T6 800				T6 1000				T7 1000				T7 1250				T7 1600		
	N	S	H	L	V	N	S	H	L	N	S	H	L	N	S	H	L	S	H	L	V	S	H	L	V	S	H	L
	36	50	70	120	200	36	50	70	100	36	50	70	100	36	50	70	100	50	70	120	150	50	70	120	150	50	70	120
	36	50	70	120	200																							
						36	50	70	100	36	50	70	100	36	50	70	100											
										36	50	70	100	36	50	70	100											
														36	50	70	100											
																		50	70	120	150	50	70	120	150	50	70	120
																						50	70	120	150	50	70	120
																										50	70	120

Protection

Each switch-disconnector must be protected on the supply side by a coordinated device which safeguards it against short-circuits. The coordination table below indicates the Tmax circuit-breaker which can carry out the protection function for each switch-disconnector. These are always pieces of apparatus of a size corresponding to or smaller than that of the switch disconnector.

Making capacity

The making capacity Icm is a performance of notable importance since a switch-disconnector must be able to withstand the dynamic, thermal and current stresses which can occur during closure without being destroyed, up to the short-circuit closing conditions.