Product overview

	Number of poles	Rated fault current $I_{\Delta n}$ mA	Rated current I_n A	MW	Auxiliary switches can be mounted	(Type A)	(Type B)
5SM1and 5SM3 RCCBs							
5SM1 N-type standard product range	2	10, 30	16	2	•	•	–
5SM3 Industry guard product range		30, 100, 300	25		•	•	–
(70 mm mounting depth)			40		•	•	–
	2	30, 100, 300	63	2.5	•	•	–
			80		•	•	–
	4	30, 300, 500	25	4	•	•	–
		30, 100, 300, 500	40		•	•	–
			63		•	•	–
		30, 300	80		•	•	–
Short-time delayed	4	30	25	4	•	•	–
			40		•	•	–
		100	63		•	•	–
Selective	2	300	63	2.5	•	•	–
	4	100, 300	40	4	•	•	–
		300, 1,000	63		•	•	–
Special applications							
- for 50 Hz to 400 Hz	4	30	25	4	•	•	–
			40		•	•	–
- for 500 V AC	4	30, 300	25	4	•	•	–
			40		•	•	–
			63		•	•	–
5SM3 RCCBs, 125 A							
Industry guard product range (70 mm mounting depth)	4	30, 100, 300, 500	125	4	–	•	–
Selective	4	300, 500	125	4	–		–
5SZ3 and 5SZ6 N-type RCCBs							
AC/DC sensitive	4	30, 300	25	8	–	–	•
			40		–	–	•
			63		–/fixed-mounted	–	•
Selective		300	63		–/fixed-mounted	–	•
For medical facilities	4	30, 300	63	8	–/fixed-mounted	–	•
RCCB module, additional component for 5SY4, 5SY7 miniature circuit-breakers (see part 2)							
	2	30, 300	6/40	2	on the MCB part	•	–
		30, 300	6/63	2	on the MCB part	•	–
	4	30, 300	6/40	3	on the MCB part	•	–
		30, 300	6/63	3	on the MCB part	•	–
Selective	2	300	6/40	2	on the MCB part	•	–
		300	6/63	2	on the MCB part	•	–
	4	300	6/40	3	on the MCB part	•	–
		300	6/63	3	on the MCB part	•	–
RCCB module, additional component for 5SP4 miniature circuit-breakers (see part 2)							
	2	30, 300	80/100	3.5	on the MCB part	•	–
	4	30, 300	80/100	5	on the MCB part	•	–
Selective	2	300	80/100	3.5	on the MCB part	•	–
	4	300, 1,000	80/100	5	on the MCB part	•	–
RCCB protected socket outlets							
Molded-plastic enclosure fitted with RCCB and SCHUKO socket outlets	2	10	16	–	–	•	–
Body Guard protected socket outlet Degree of protection IP 44	2	30	16	–	–	•	–
RCCB protected socket outlet DELTA profil							
SCHUKO socket outlet DELTA profil titanium white	2	10, 30	16	–	–	•	–

For RCCB module, additional component for 5SY and 5SP4 miniature circuit-breakers, see chapter 2.

= for AC and pulsating DC fault currents

= for AC fault currents, pulsating and smooth DC fault currents

Combined devices RCBO

	Number of poles	Rated fault current $I_{\Delta n}$ mA	Rated current I_n A	MW	(Type A)
With MCB characteristic B					
• For 50 Hz to 60 Hz	2	30, 300 10, 30, 300 30, 300	6 10 16 20 25 32	4	• • • • • •
	4	30, 300	6 10 16 20 25 32	6	• • • • • •
• For 50 Hz to 400 Hz	4	30	6 16	6	•
With MCB characteristic C					
• For 50 Hz to 60 Hz	2	10, 30, 300 30, 300	10 16 20 25 32	4	• • • • •
	4	30, 300	10 16 20 25 32	6	• • • • •
• For 50 Hz to 400 Hz	4	30	16	6	•
With MCB characteristic C in two MW (modular widths)					
• For 50 Hz to 60 Hz	2	30, 300	6 10 16 20 25 32 40	2	• • • • • •

General Data

Summary of technical data

Standards		EN 61 008, DIN VDE 0664, IEC 61 008, EN 61 543, EN 61 009, DIN VDE 0664 Part 2, IEC 61 009	
Versions		2-pole and 4-pole	
Rated voltages U_n	V AC	125 - 230 230 - 400 500	50 - 60 Hz 50 - 60 Hz, 50 - 400 Hz 50 - 60 Hz
Rated currents I_n	A	16, 25, 40, 63, 80, 125	
Rated fault currents $I_{\Delta n}$	mA	10, 30, 100, 300, 500	
Enclosure		gray molded-plastic (RAL 7035)	
Terminals		Tunnel terminals at both ends with wire protection, lower combined terminal for simultaneous connection of busbars (fork-type) and conductors	
		for 2 MW	for I_n = 16 A, 25 A, 40 A for 1.0 - 16 mm^2 conductors
		for 2.5 MW	for I_n = 63 A, 80 A for 1.5 - 25 mm^2 conductors
		for 4 MW	for I_n = 25 A, 40 A, 63 A for 1.5 - 25 mm^2 conductors
			for I_n = 125 A for max. 50 mm^2 conductors
		for auxiliary switches	up to 0.75 - 2.5 mm^2 conductors
		for RCCB module	up to I_n = 63 A for max. 25 mm^2 conductors
			up to I_n = 80/100 A for max. 35 mm^2 conductors
Supply connection		either top or bottom	
Mounting position		any	
Degree of protection		IP 20 according to DIN VDE 0470 Part 1 IP 40 when mounted in distribution boards IP 54 when mounted in molded-plastic enclosures	
Minimum operating voltage for test function operation	V AC	for RCCB 16 A - 80 A: 100 for RCBO in two modular widths: 230 +/-10 %	
Device service life		> 10,000 operations (electrical and mechanical)	
Storage temperature	°C	-40 to +60	
Ambient temperature	°C	-5 to +45, for designs with the symbol -25 : -25 ... +45	
Climate resistance acc. to DIN IEC 68 Part 2-30		humid heat, cyclic (55 °C/28 cycles) used according to DIN 50 019 Part 1 “Technoklimate“ temperate and dry heat	
Flammability		Class IIb according to DIN VDE 0304	
Chlorofluorocarbon-free		yes	

Definitions

1 MW = Modular width of 18 mm

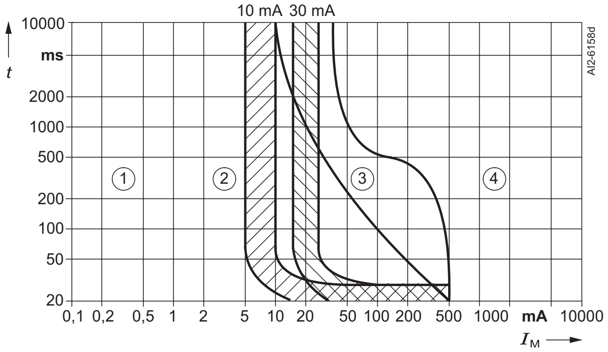
N-type = 55 mm device mounting depth

70 mm mounting depth = 70 mm device mounting depth

Protection against hazardous shock currents according to DIN VDE 0100 Part 410

Application

- Protection against indirect contact (indirect personnel protection). Protection is provided by disconnecting hazardous high touch voltages caused by a short circuit to exposed conductive parts of equipment.
- When using RCCBs with $I\Delta_n \leq 30$ mA, protection from direct contact (direct personnel protection) is also provided. Supplementary protection measure by disconnection when live parts are touched.



Current ranges acc. to IEC 479

Range ① Usually, the effect is not perceived.

Range ② Usually, there are no noxious effects.

Range ③ Usually, no danger of heart fibrillation.

Range ④ Heart fibrillation danger.

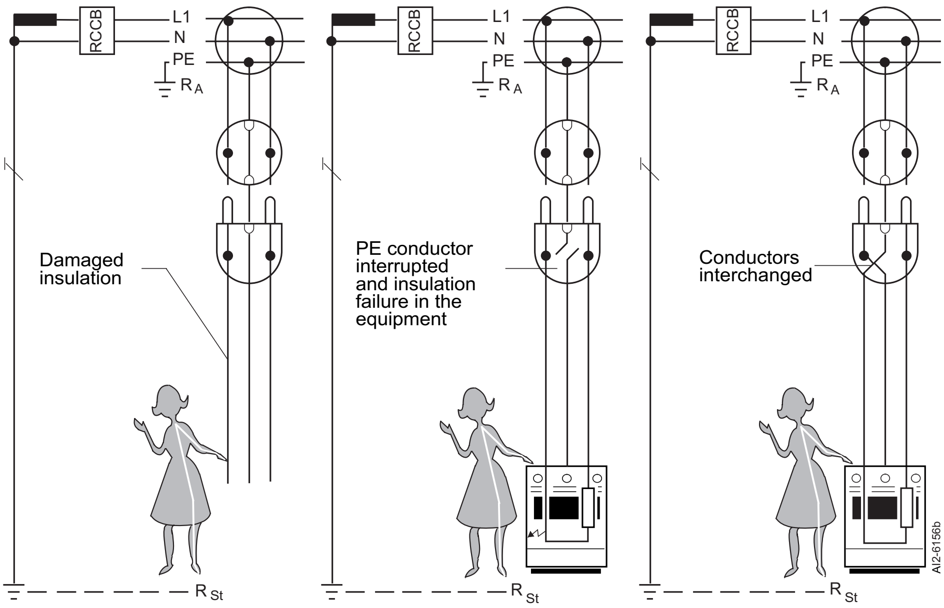
I_M : Shock current

t : Duration

Protective action

While RCCBs for rated fault current $I\Delta_n > 30$ mA provide protection against indirect contact, the installation of RCCBs with $I\Delta_n \leq 30$ mA provides a high level of additional protection against unintentional direct contact with live parts.
The above diagram shows the physiological responses in the human body when current flows through it, classified into current ranges. Current/time values in range 4 are dangerous, as they can initiate heart fibrillation which can result in death.
The tripping range for RCCBs with rated fault currents of 10 mA and 30 mA is also indicated. On the average, the release time lies between 10 ms and 30 ms. The permissible release time, according to DIN VDE 0664 and EN 61 008 or IEC 1008, of max. 0.2 s (200 ms) or 0.3 s (300 ms) is not reached.
Thus, RCCBs with rated fault currents of 10 mA or 30 mA provide reliable protection even if a current flows through a person as a result of unintentional direct contact with live parts. This level of protection cannot be achieved by any other comparable means of protection against indirect contact.

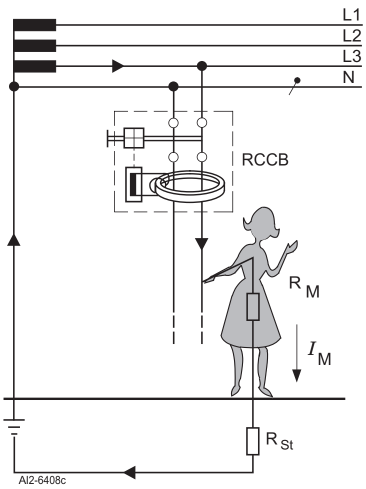
Wherever RCCBs are used, an appropriate protective ground conductor must also be provided and connected to all of the equipment and parts of the system. Thus, a current can only flow through a human body if two faults are present or if the person accidentally touches live parts.



Examples for unintentional direct contact

If a person directly touches live parts, two resistances determine the level of the current flowing through the human body, i.e. the internal resistance of the person R_M and the local ground leakage resistance R_{St}.
For the purpose of accident prevention, the worst case must be assumed which means that the local ground leakage resistance is almost zero.

The resistance of the human body is dependent on the current path. For example, measurements have shown for a hand-to-hand or hand-to-foot path, a resistance of approximately 1,000 Ω.
For 230 V AC fault voltage, this results in a current of 230 mA for the hand-to-hand path.



I_M: Shock current

R_M: Internal resistance of human beings

R_{St}: Standard ground leakage resistance

R_A: Grounding resistance of all conductive parts exposed to the grounding electrodes

Schematic drawing: Additional protection when directly touching live parts

Description

Fire protection according to DIN VDE 0100 Part 720

Application

- When using RCCBs with $I_{\Delta n}$ ≤ 300 mA, protection against electrically ignited fires due to insulation failures is provided.

Protective action

DIN VDE 0100 Part 720 specifies for “locations exposed to the hazards of fire“ measures to prevent fires resulting from insulation failures. A distinction is made between:

- Short-circuit fire protection
- Ground-fault fire protection
- Safe clearance (only for cable and conductor routing).

Short-circuit fire protection is ensured by overcurrent protective devices and ground-fault fire protection by RCCBs. However, it is stipulated that only RCCBs with a maximum rated fault current up to 0.5 A are used. This upper limit should not be utilized. The best level of protection is achieved with devices of max. 0.3 A.

The additional protection against fire provided by RCCBs should not only be used at locations with increased fire hazard but should be generally used.

Design and mode of operation of RCCBs

An RCCB essentially comprises 3 major function groups:

1. Summation current transformer for fault current detection
2. Release to convert the electrical measured value into a mechanical release
3. Contact latching mechanism with the contacts

The summation current transformer involves all of the conductors, i.e. also the neutral conductor.
In a fault-free system, for the summation current transformer, the magnetizing effects of current carrying conductors cancel each other out in accordance with Kirchhoff’s law. There is no residual magnetic field which could induce a voltage in the secondary winding.

However, if an insulation fault causes a fault current to flow, this balance is disturbed and a residual magnetic field remains in the transformer core. This produces a voltage in the secondary winding, which, via the release and the contact latching mechanism, disconnects the circuit with the insulation fault.
This tripping principle works independently of the supply voltage or an auxiliary supply. This is also a prerequisite for the high level of protection which RCCBs provide according to DIN VDE 0664.
This is the only way to ensure that the full protective function of the RCCB is maintained, even in the event of a supply fault, e.g. if a phase conductor fails or the neutral conductor is interrupted.

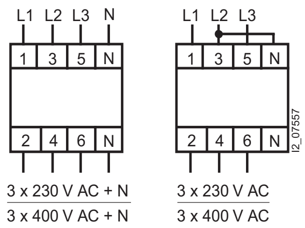
Test button

Each RCCB has a test button which can be used to check its operability. When the test button is pressed, an artificial fault current is produced and the RCCB must trip.
We recommend that the functionality of the RCCB is tested after installation and at regular intervals (about twice a year).
Furthermore, other standards or regulations (e.g. accident prevention regulations) which specify test intervals must also be met.
The minimum operating voltage for the test function is 100 V AC (5SM series).

3-pole connection

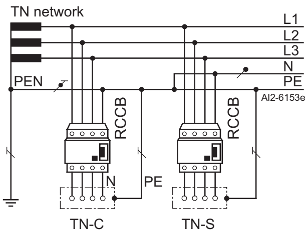
4-pole RCCBs can also be used in 3-pole supply networks. In this case, the device must be connected at the terminals 1, 3, 5 and 2, 4, 6.

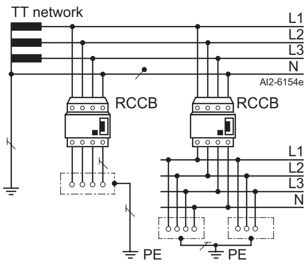
The functionality of the test facility is only ensured if a jumper is inserted between the terminals 3 and N.

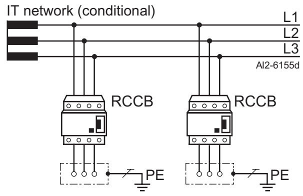


Usage

RCCBs may be used in all three distribution network types (DIN VDE 0100 Part 410) and in an IT network system provided that the capacity of the network to ground is sufficient to allow a fault current to flow which has the same level as the rated fault current.
The IT network can still be monitored using an insulation monitor. Both protective systems do not mutually interfere with one another.



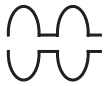
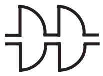




Current types

When using electronic components in household appliances and in industrial plants for equipment with a protective ground conductor (protection class I), non-sinusoidal fault currrents may flow through a RCCB in case of an insulation fault.

The standards for residual current operated circuit-breakers contain additional requirements and test specifications for fault currents, which become or almost become zero within one period. RCCBs which trip on both sinusoidal AC fault currents as well as on pulsating DC fault currents have the symbol  .

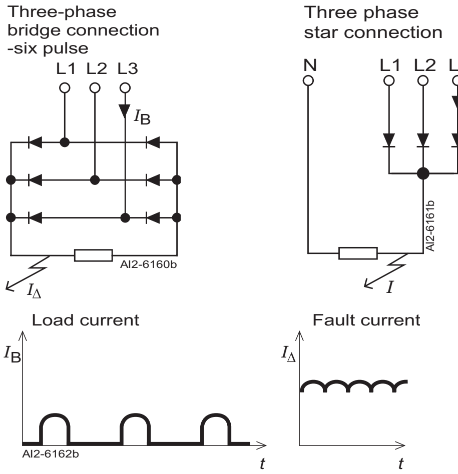
	Current type			Tripping current
1	AC fault currents			0.5 ... 1 $I_{\Delta n}$
2	Pulsating DC fault currents Half-wave current (pos. and neg. half-waves)			0.35 ... 1.4 $I_{\Delta n}$
	Phased half-wave currents: Phase control angle	90°el 135°el		0.25 ... 1.4 $I_{\Delta n}$ 0.11 ... 1.4 $I_{\Delta n}$
3	Half-wave current with superimposed smooth 6 mA DC current			max. 1.4 $I_{\Delta n}$+ 6 mA

Tripping currents for RCCBs defined according to DIN VDE 0664 Part 1

DC fault currents

In industrial electrical equipment, circuits are being increasingly used where smooth DC fault currents or fault currents with a low residual ripple may flow in the event of a fault condition. This is shown on the following diagram with the example of a piece of electrical equipment with a three-phase rectifier circuit. Electrical equipment such as this includes for example AC drive converters, medical equipment (e.g. X-ray equipment and CT systems) as well as UPS systems.

Pulsating current-sensitive RCCBs cannot detect such DC fault currents and cannot trip. Furthermore, this has a negative impact on their tripping function. Thus, electrical equipment which generates fault currents such as these when faults occur, may not be operated together with pulsating current sensitive RCCBs on electrical supply networks. An alternative protective measure can, for instance, include protective separation, which, however, can only be implemented using heavy and expensive transformers. A technically optimum and cost-effective solution is obtained by using the new AC/DC sensitive RCCBs. This type of RCCB has been included in prEN 50 178 (replacing DIN VDE 0160) "Equipment for power plants with electronic equipment".



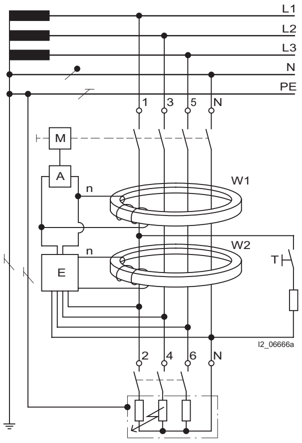
Block diagram with fault location

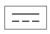
AC/DC sensitive protective device

Design

The basis for the AC/DC sensitive protective device comprises a pulsating current-sensitive protective switching unit with a release which operates independently of the line supply, supplemented by an additional unit which senses smooth DC fault currents. The following diagram shows the fundamental design.

The summation current transformer W1 monitors, as before, the electrical system or plant for AC and pulsating fault currents. The summation current transformer W2 senses the smooth DC fault currents, and, when a fault occurs, outputs a disconnection command to release A via electronic unit E.



A Release
M Mechanical system of the protective device
E Electronics to trip in the event of smooth DC fault currents
T Test device
n Secondary winding
W1 Summation CT to sense sinusoidal fault currents 
W2 Summation CT to sense smooth DC fault currents 

Mode of operation

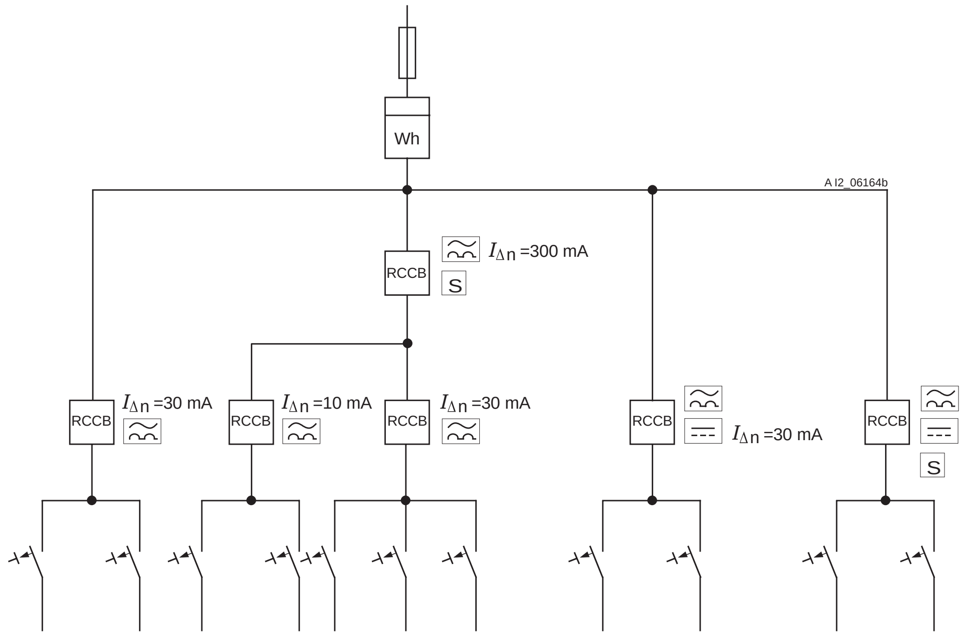
In order to ensure a highly secure supply, the power supply for the electronics unit is derived from all three phase conductors and the neutral conductor. Furthermore, it is dimensioned to ensure that the electronics still operate when the voltage is reduced down to 70 % (e.g. between the phase conductor and neutral conductor). Consequently, a tripping is still ensured in the event of a smooth DC fault current which may occur also in case of faults in the supply network, e.g. when the neutral conductor is interrupted. Even in the extremely improbable case of a failure of the two phase conductors and the neutral conductor and if the remaining intact phase conductor represents a fire hazard due to a ground fault, protection is still provided by the pulsating current-sensitive breaker part, which due to its supply-independent release, reliably trips.

Description

Configuration

When designing and installing electrical systems, it must be ensured that electrical devices, which can generate smooth DC fault currents when a fault develops, have their own circuit with an AC/DC sensitive RCCB. It is not permissible to branch circuits with these types of electrical devices after pulsating currrent-sensitive RCCBs. Devices, which can generate DC fault currents under fault conditions, would then diminish the tripping capability of the pulsating current-sensitive RCCBs.

The tripping conditions according to DIN VDE 0664 also apply to the AC/DC sensitive RCCB. To trip in the event of smooth DC fault currents, they have been extended, corresponding to the current compatibility characteristics according to IEC 479, so that tripping must be realized at a tripping current of 0.50 to 2 × $I_{\Delta n}$.
AC/DC sensitive RCCBs have the symbol . This new protective device has a monitoring symbol from VDE.



Note:
If you use the available auxiliary switches, (see page 3/12) you can integrate the RCCBs into the building management systems with *instabus EIB* and AS-i-Bus or PROFIBUS.

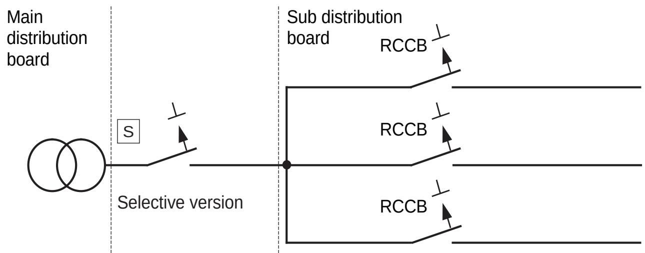
Selective tripping

Residual current operated circuit-breakers normally have an instantaneous release. This means that a series connection of such residual current operated circuit-breakers with the aim to provide selective tripping will not operate correctly when a fault occurs. To achieve selectivity when RCCBs are connected in series, the devices connected in series must be graded both with regard to the release time as well as with regard to the rated fault current. Selective RCCBs have a tripping delay.

Furthermore, selective RCCBs according to DIN VDE 0664 must have an increased surge strength of at least 3 kA. Siemens devices have a surge strength of ≥ 5 kA.

Selective RCCBs have the symbol **S**.

The table opposite shows a possible grading of RCCBs for selective tripping when the RCCBs are connected in series without time delay.



For undelayed disconnection	undelayed	
$I_{\Delta n}$ = 300 mA	10 mA or 30 mA	
$I_{\Delta n}$ = 500 mA	10 mA or 30 mA	
$I_{\Delta n}$ = 1000 mA	10 mA or 30 mA	0,3; 0,5

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Short-time delayed tripping

For electrical devices, which cause high discharge currents at switch-on (e. g. as a result of transient fault currents which flow between the phase and PE via noise suppression capacitors), can cause instantaneous RCCBs to undesirably trip if the discharge current exceeds the rated fault current $I_{\Delta n}$ of the RCCB.

For applications such as these, where it is either not possible or only partially possible to eliminate such fault sources short-time delayed RCCBs can be used. These devices have a minimum release time of 10 ms, i. e. they may not trip for fault current pulses of 10 ms. In this case, the tripping conditions according to DIN VDE 0664 Part 1 are maintained. The devices have a surge strength of 3kA, thus exceeding the requirements of DIN VDE 0664.

Short-time delayed RCCBs are marked with a **K**.

3

Breaking capacity, short-circuit capacity

According to DIN VDE 0100 Part 410 (protection against hazardous shock currents), RCCBs may be used in all three network types (TN, TT and IT systems).

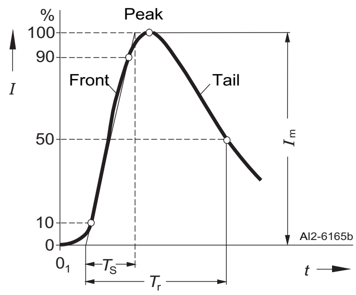
If the neutral conductor is used as protective conductor in TN systems, short-circuit-type fault currents may flow in the event of a fault. Thus, RCCBs together with a back-up fuse must have an appropriate short-circuit capacity. Tests have been defined for this purpose.

The short-circuit capacity of the combination must be specified on the devices.
Siemens RCCBs have, together with an appropriate back-up fuse, a short-circuit capacity of 10,000 A. This is the highest possible short-circuit capacity level according to VDE regulations.
Data regarding the rated breaking capacity according to EN 61 008 and the maximum permissible short-circuit back-up fuse for RCCBs are shown in the following table:

Rated current of the RCCB		Rated breaking capacity I_m acc. to EN 61 008 for a 35 mm grid clearance	Maximum short-circuit back-up fuse LV HRC DIAZED, NEOZED utilization category gL/gG for the RCCB	
			125 V AC to 400 V	500 V AC
A		A	A	A
16 - 40	2 MW	800	63	-
63	2.5 MW	800	100	-
80	2.5 MW	800	100	-
25	4 MW	800	100	35
40	4 MW	800	100	50
63	4 MW	800	100	-
25 - 63	8 MW	630	63	-

Surge strength

During thunderstorms, atmospheric-related overvoltage conditions may enter a system or plant via the overhead power lines in the form of travelling waves and thus the RCCBs are tripped. In order to prevent these undesirable trips pulsating current-sensitive RCCBs must meet the requirements of the tests defined to prove the surge strength. A surge current of $\hat{I}$ = 250 A is used for testing with a standardized surge wave of 8/20 µs. Siemens pulsating current-sensitive RCCBs have a surge strength of ≥ 1,000 A.



Characteristics of a current impulse acc. to DIN VDE 0432 Part 2

T_S front time in s
T_r virtual time to half-value on tail in s
0_1 virtual origin
I_m peak value

Surge current 8/20 µs (8 µs front time: 20 µs time to half-value on tail)

Application of RCCBs in medical facilities

Siemens residual current operated circuit-breakers, with the exception of the selective design, can be used in medical facilities without limitations since the devices disconnect in a fault condition within 200 ms according to the requirements.

Further information regarding RCCBs is included in the brochure „Mehr Sicherheit durch Fehlerstrom-Schutzeinrichtungen“, Order No. E20001-P311-A17-V1. Available in German only. Out of stock at the moment.