SIEMENS

Residual Current Protective Devices / Arc Fault Detection Devices

SENTRON

Configu-ration Manual

Edition 10/2015

siemens.com/lowvoltage

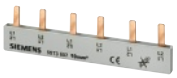
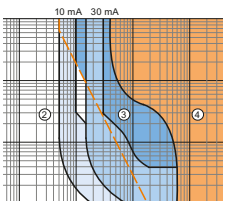
Residual Current Protective Devices / Arc Fault Detection Devices (AFDDs)

For further technical product information:

Siemens Industry Online Support:
www.siemens.com/lowvoltage/product-support

→ Entry type:
Application example
Certificate
Characteristic
Download
FAQ
Manual
Product note
Software archive
Technical data

Overview

Devices		Page	Application	Standards	Used in		
					Non-residential buildings	Residential buildings	Industry
	**5SV RCCBs**	4	Personnel, material and fire protection, as well as protection against direct contact. SIGRES with active condensation protection for use in harsh environments. Super resistant and selective versions	IEC/EN 61008 ÖVE EN 61008 ÖVE/ÖNORM E 8601 IEC/EN 62423	✓	✓	✓
	**5SM3 RCCBs**	4	Personnel, material and fire protection, as well as protection against direct contact	IEC/EN 61008 ÖVE EN 61008 ÖVE/ÖNORM E 8601 IEC/EN 62423	✓	✓	✓
	**SIQUENCE 5SM3/5SU1 Universal current sensitive RCCBs, type B and type B+**	13	SIQUENCE, the technology of universal current-sensitive residual current protective devices	VDE 0664-100 VDE 0664-200 VDE V 0664-110	✓	--	✓
	**Additional components**	19	Remote controlled mechanisms, auxiliary switches for all residual current operated circuit breakers. Leakage current measurement device for fault locating and the optimum selection of RCCBs	IEC/EN 62019	✓	--	✓
	**RC units, 5SM2**	23	The freely selectable combination of RC units with miniature circuit breakers permits the flexible configuration of RCBO combinations	IEC/EN 61009	✓	--	✓
	**5SU1 RCBOs**	26	The ideal protection combination for all electrical circuits due to the compact device versions of RCCBs and miniature circuit breakers in a single device	IEC/EN 61009	✓	✓	✓
	**5SM6 AFD units**	34	Enhanced fire protection through the detection and isolation of arcing faults	IEC/EN 62606	✓	✓	--
	**5ST busbars for modular installation devices**	39	Busbars in 10 mm^2 and 16 mm^2save space in the distribution board and time during mounting.	--	✓	✓	✓
	**5SM1 and 5SZ9 RCCB Socket outlets**	42	For retrofitting in existing installations	VDE 0664	✓	✓	✓
	**Configuration**	43	This section tells you all you need to know about RCCBs in combination with miniature circuit breakers, with information about tripping characteristics, selectivity and breaking capacity	--	✓	✓	✓

SIGRES

SIGRES RCCBs were developed for use in harsh ambient conditions, such as swimming baths as protection against chlorine and ozone, in the agricultural sector (ammonia), on building sites and in the chemical industry (nitrogen oxide, sulfur dioxide, solvents), in the food processing industry (hydrogen sulfide) and in unheated rooms (dampness). The patented active condensation protection requires a continuous power supply and bottom infeed if the RCCB is switched off.

When used in ambient conditions as defined in product standard EN 61008-1, the operation interval for pressing the test button can be extended to once a year.

Super resistant K

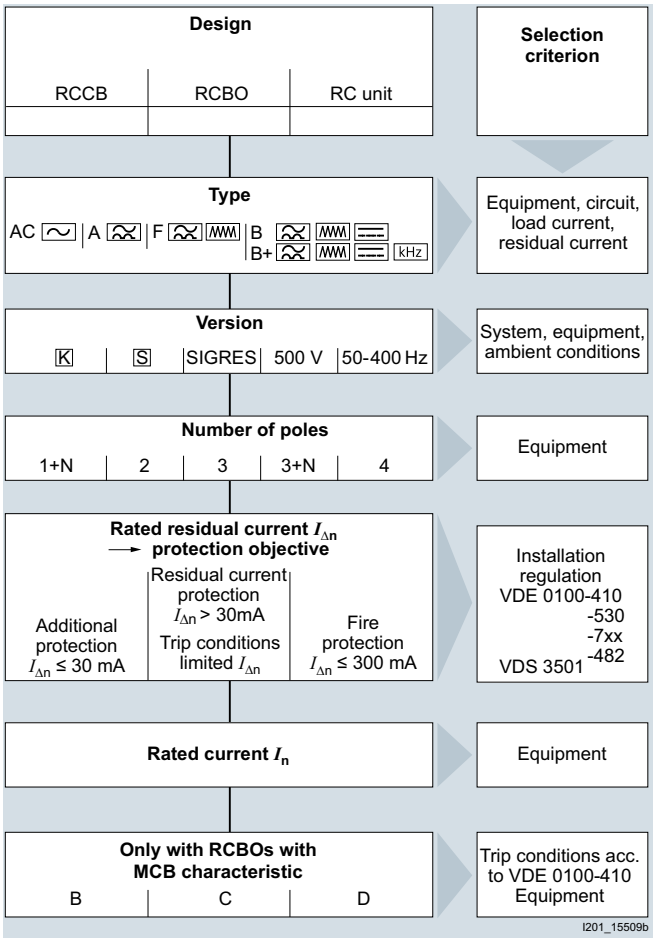
Super resistant (short-time delayed) RCCBs meet the maximum permissible break times for instantaneous devices. However, by implementing a short-time delay they prevent unnecessary tripping operations, and thus plant faults, when pulse-shaped leakage currents occur – as is the case when capacitors are switched on.

Selective S

Can be used as upstream group switch for selective tripping contrary to downstream, instantaneous or short-time delayed RCCBs.

Note:

For more information on the subject of residual current protective devices, see the technology primer "Residual Current Protective Devices", Article No.: E10003-E38-2B-G0090-7600.



Selection aid for finding the appropriate residual current protective device

Overview

RCCBs are used in all systems up to 240/415 V AC. Devices of type AC trip in the event of sinusoidal AC residual currents, type A also trips in the event of pulsating DC residual currents.

In addition, RCCBs type F also detect residual currents with mixed frequencies up to 1 kHz.

RCCBs with a rated residual current of maximum 30 mA are used for personnel, material and fire protection, as well as for protection against direct contact. RCCBs with a rated residual current of 10 mA are primarily used in areas that represent an increased risk for personnel.

Since the introduction of DIN VDE 0100-410, all socket outlet current circuits up to 20 A must also be fitted with residual current protective devices with a rated residual current of max. 30 mA. This also applies to outdoor electrical circuits up to 32 A for the connection of portable equipment.

Devices with a rated residual current of maximum 300 mA are used as preventive fire protection in case of insulation faults. RCCBs with a rated residual current of 100 mA are primarily used outside Europe.

Benefits

- Instantaneous RCCBs with the N connection on the left-hand side enable simple bus mounting with standard pin busbars with miniature circuit breakers installed on the right-hand side
- Instantaneous RCCBs with the N connection on the right-hand side can be bus-mounted with miniature circuit breakers using a special pin busbar
- Instantaneous type A devices have a surge current withstand capability with current waveform 8/20 µs of more than 1 kA, super resistant of more than 3 kA and selective of more than 5 kA. This ensures safe operation
- SIGRES has an extremely long service life due to a patented active condensation protection and identical dimensions enable the quick and easy replacement of existing instantaneous RCCBs
- Super resistant devices increase system availability, as unnecessary tripping is prevented in power supply systems with short-time glitches
- Selective RCCBs increase system availability as a staggered tripping time enables the selective tripping of RCCBs connected in series in the event of a fault
- Auxiliary switches or remote controlled mechanisms are also available as additional components
- The operating handle and the test button can be locked by means of a handle locking device
- All additional components that match the 5SY and 5SL miniature circuit breakers can also be fitted on the 5SV

Technical specifications

5SV3

			Instantaneous	SIGRES	Super resistant	Selective
Standards			IEC/EN 61008-1 (VDE 0664-10); IEC/EN 61008-2-1 (VDE 0664-11); IEC/EN 61543 (VDE 0664-30); IEC/EN 62423 (VDE 0664-40)			
Surge current withstand capability						
• Type A with current waveform 8/20 µs	Acc. to EN 60060-2 (VDE 0432-2)	kA	> 1		> 3	> 5
• Type F with current waveform 8/20 µs	Acc. to EN 60060-2 (VDE 0432-2)	kA	--	--	> 3	--
Minimum operational voltage for test function operation						
• 30 mA devices		V AC	195			
• Non-30 mA devices		V AC	100			
• 24 V devices		V AC	20			
Test cycles			1/2 year	1 year	1/2 year	
Insulation coordination						
• Overvoltage category			III			
Pollution degree			2			
Terminal conductor cross-sections						
• 1-wire						
- Solid (≤ 10 mm^2) / stranded (≥ 16 mm^2)		mm^2	0.75 ... 35			
- Finely stranded with non-insulated end sleeve		mm^2	0.75 ... 25			
- Finely stranded with insulated end sleeve		mm^2	0.75 ... 25			
- Finely stranded without end sleeve		mm^2	1 ... 35			
• 2-wire, same cross-section, same conductor type						
- Solid (≤ 10 mm^2) / stranded (≥ 16 mm^2)		mm^2	0.75 ... 10			
- Finely stranded with non-insulated end sleeve		mm^2	0.75 ... 4			
- Finely stranded with insulated end sleeve		mm^2	0.75 ... 4			
- Finely stranded without end sleeve		mm^2	1 ... 4			
• 1-wire + busbar (pin thickness 1.5 mm)						
- Solid (≤ 10 mm^2) / stranded (≥ 16 mm^2)		mm^2	10 ... 25			
- Finely stranded with non-insulated end sleeve		mm^2	6 ... 25			
- Finely stranded with insulated end sleeve		mm^2	6 ... 16			
Terminal tightening torque						
• Up to I_n = 80 A		Nm	2.5			
• At I_n = 100 A, 125 A		Nm	3.0 ... 3.5			
Mains connection			Top or bottom	Bottom	Top or bottom	
Rated frequency		Hz	50/60[1)]			
Mounting position (on a standard mounting rail)			Any			
Degree of protection	Acc. to EN 60529 (VDE 0470-1)		IP20, if the distribution board is installed, with connected conductors			
Touch protection	Acc. to EN 50274 (VDE 0660-514)		Finger and back-of-hand safe			
Service life	Average number of switching cycles Test cycle acc. to IEC/EN 61008		> 10000			
Storage temperature		°C	-40 ... +75			
Ambient temperature		°C	-25 ... +45, marked with -25			
Resistance to climate	Acc. to IEC 60068-2-30		28 cycles (55 °C; 95 % rel. air humidity)			
CFC and silicone-free			Yes			

1) 5SV residual current operated circuit breakers have been developed for 50 Hz systems and can detect and shut down ground fault currents of this frequency, but in the case of residual currents that deviate markedly from this frequency, or that have a higher proportion of harmonics, the trip values increase slightly.

Power losses per conducting path under rated current load

[1] Note:
For SIGRES versions, the power ratings below must be added for each device for heating of the holding magnet release:
- 2 MW: 0.33 W
- 4 MW: 0.4 W

MLFB	Power losses per conducting path P_v [W]	MLFB	Power losses per conducting path P_v [W]
5SV3111-6	0.7	5SV3612-6	0.6
5SV3111-6KL	0.7	5SV3612-6KK01	0.5
5SV3311-6	0.4	5SV3612-6KL	0.6
5SV3311-6KK12	0.5 [1]	5SV3612-8	0.5
5SV3311-6KK13	0.4	5SV3614-3	1.0
5SV3311-6KL	0.4	5SV3614-6	1.6
5SV3312-3	0.8	5SV3614-6KK01	1.0
5SV3312-6	1.0	5SV3614-6KL	1.6
5SV3312-6KK01	0.8	5SV3614-7	1.0
5SV3312-6KK12	0.8 [1]	5SV3614-8	1.0
5SV3312-6KK13	1.0	5SV3614-8KL	1.0
5SV3312-6KL	1.0	5SV3616-3	2.7
5SV3314-3	1.5	5SV3616-6	2.7
5SV3314-6	2.6	5SV3616-6KK01	2.7
5SV3314-6KK01	1.5	5SV3616-6KL	2.7
5SV3314-6KK12	1.5 [1]	5SV3616-8	2.7
5SV3314-6KK13	2.6	5SV3616-8KL	2.7
5SV3314-6KL	2.6	5SV3617-3	3.9
5SV3314-6LA	1.5	5SV3617-6	3.9
5SV3314-6LA01	1.5	5SV3617-6KK01	3.9
5SV3316-3	5.3	5SV3617-6KL	3.9
5SV3316-6	5.3	5SV3617-7	3.9
5SV3316-6KK01	5.3	5SV3617-8	3.9
5SV3316-6KK12	5.3 [1]	5SV3642-3	0.8
5SV3316-6KK13	5.3	5SV3642-6	0.7
5SV3316-6KL	5.3	5SV3642-6KK01	0.8
5SV3317-3	5.6	5SV3642-6KK12	0.8 [1]
5SV3317-6	5.6	5SV3642-6KL	0.7
5SV3317-6KK01	5.6	5SV3642-8	0.8
5SV3317-6KL	5.6	5SV3644-3	1.8
5SV3342-3	0.8	5SV3644-6	2.0
5SV3342-6	1.3	5SV3644-6KK01	1.8
5SV3342-6KK01	0.8	5SV3644-6KK12	1.8 [1]
5SV3342-6KK03	1.3	5SV3644-6KL	2.0
5SV3342-6KK12	0.8 [1]	5SV3644-7	1.8
5SV3342-6KL	1.3	5SV3644-8	1.8
5SV3344-3	1.8	5SV3644-8LA	1.8
5SV3344-6	3.9	5SV3646-3	3.9
5SV3344-6KK01	1.8	5SV3646-6	3.9
5SV3344-6KK03	3.9	5SV3646-6KK01	3.9
5SV3344-6KK12	1.8 [1]	5SV3646-6KK12	3.9 [1]
5SV3344-6KL	3.9	5SV3646-6KL	3.9
5SV3344-6LA	1.8	5SV3646-8	3.9
5SV3344-6LA01	1.8	5SV3646-8KK12	3.9 [1]
5SV3346-3	3.9	5SV3646-8KL	3.9
5SV3346-6	3.9	5SV3646-8LA	3.9
5SV3346-6KK01	3.9	5SV3647-3	4.1
5SV3346-6KK12	3.9 [1]	5SV3647-6	4.1
5SV3346-6KL	3.9	5SV3647-6KK01	4.1
5SV3346-6LA	3.9	5SV3647-6KK12	4.1 [1]
5SV3346-6LA01	3.9	5SV3647-6KL	4.1
5SV3347-3	4.1	5SV3647-7	4.1
5SV3347-6	4.1	5SV3647-8	4.1
5SV3347-6KK01	4.1	5SV3652-6	0.8
5SV3347-6KK12	4.1 [1]	5SV3654-6	1.8
5SV3347-6KL	4.1	5SV3656-6	3.9
5SV3352-6	0.8	5SV3657-6	4.1
5SV3354-6	1.8	5SV3742-6	0.8
5SV3356-6	3.9	5SV3744-6	1.8
5SV3357-6	4.1	5SV3746-6	3.9
5SV3412-6	0.6	5SV3746-6KL	3.9
5SV3412-6KL	0.6	5SV3747-6	4.1
5SV3414-6	1.6	5SV3846-8	3.9
5SV3414-6KL	1.6	5SV3312-6BA	1.0

Power losses per conducting path under rated current load

[1] Note:
For SIGRES versions, the power ratings below must be added for each device for heating of the holding magnet release:
- 2 MW: 0.33 W
- 4 MW: 0.4 W

MLFB	Power losses per conducting path P_v [W]	MLFB	Power losses per conducting path P_v [W]
5SV3416-6	2.7	5SV3314-6BA	2.6
5SV3416-6KL	2.7	5SV3316-6BA	5.3
5SV3416-8	5.3	5SV3342-6BA	1.3
5SV3417-6	3.9	5SV3344-6BA	3.9
5SV3417-6KL	3.9	5SV3346-6BA	3.9
5SV3442-6	0.7	5SV3612-6BA	0.6
5SV3444-6	2.0	5SV3614-6BA	1.6
5SV3444-6LA	1.8	5SV3616-6BA	2.7
5SV3444-6LA01	1.8	5SV3642-6BA	0.7
5SV3444-8	1.8	5SV3644-6BA	2.0
5SV3444-8LA	1.8	5SV3646-6BA	3.9
5SV3446-6	3.9	5SV5311-6KL	0.4
5SV3446-6LA	3.9	5SV5312-6KL	1.0
5SV3446-6LA01	3.9	5SV5314-6KL	2.6
5SV3446-8	3.9	5SV5342-6KL	1.3
5SV3446-8LA	3.9	5SV5344-6KL	3.9
5SV3447-6	4.1	5SV5346-6KL	3.9
5SV3612-3	0.5	5SV5646-6KL	3.9

5SM3

			Instantaneous	Selective
Standards			IEC/EN 61008-1 (VDE 0664-10); IEC/EN 61008-2-1 (VDE 0664-11); IEC/EN 61543 (VDE 0664-30); IEC/EN 62423 (VDE 0664-40)	
Surge current withstand capability				
• Type A with current waveform 8/20 µs	Acc. to EN 60060-2 (VDE 0432-2)	kA	> 1	> 5
Minimum operational voltage for test function operation		V AC	195	
Test cycles			1/2 year	
Insulation coordination				
• Overvoltage category			III	
Pollution degree			2	
Terminal conductor cross-sections				
• 2 MW	I_n = 100 A, 125 A	mm^2	1.5 ... 50	
• 4 MW	I_n = 100 A, 125 A	mm^2	2.5 ... 50	
Terminal tightening torque				
• I_n = 100 A, 125 A		Nm	3.0 ... 3.5	
Mains connection			Top or bottom	
Mounting position (on a standard mounting rail)			Any	
Degree of protection	Acc. to EN 60529 (VDE 0470-1)		IP20, if the distribution board is installed, with connected conductors	
Touch protection	Acc. to EN 50274 (VDE 0660-514)		Finger and back-of-hand safe	
Service life	Average number of switching cycles		> 10000	
Storage temperature		°C	-40 ... +75	
Ambient temperature		°C	-25 ... +45, marked with -25	
Resistance to climate	Acc. to IEC 60068-2-30		28 cycles (55 °C; 95 % rel. air humidity)	
CFC and silicone-free			Yes	

Power losses per conducting path under rated current load

Note:
0.4 W per unit must be added for SIGRES versions.

Number of poles	Rated current	Rated residual current $I_{\Delta n}$ [mA]	Power losses per conducting path P_v [W]
2	16	10	2.5
		30	0.82
	25	30	2
		100/300	1
	40	30	4.3
		100/300	2.5
	63	30	4.2
		100/300	3.25
	80	30	4.4
		100/300	3.65
4	25	30	1.2
		300/500	0.47
	40	30	3
		100/300/500	1.2
	63	30	4.9
		100/300/500/1000	3
	80	30	5.8
		300	4.8
	125	30	8.9
		100/300/500	8.9

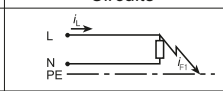
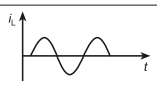
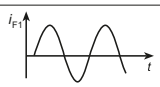
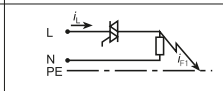
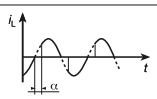
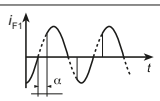
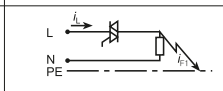
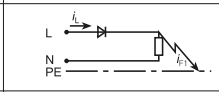
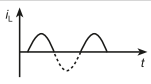
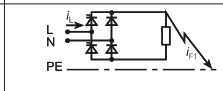
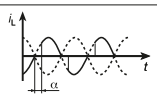
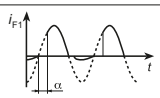
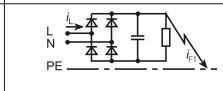
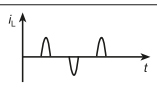
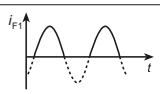
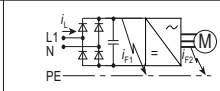
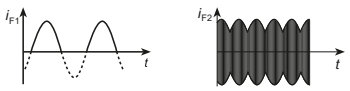
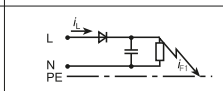
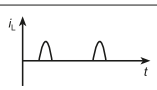
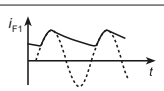
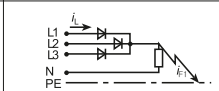
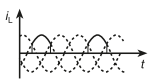
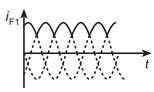
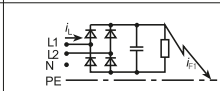
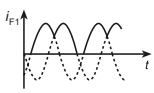
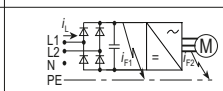
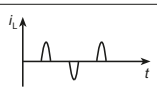
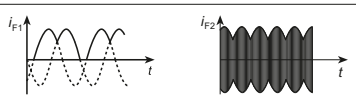
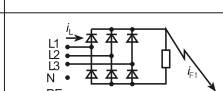
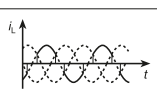
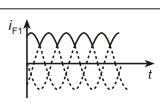
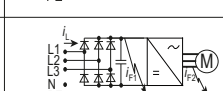
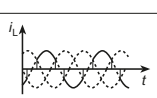
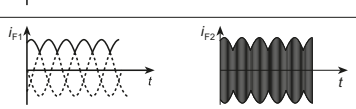
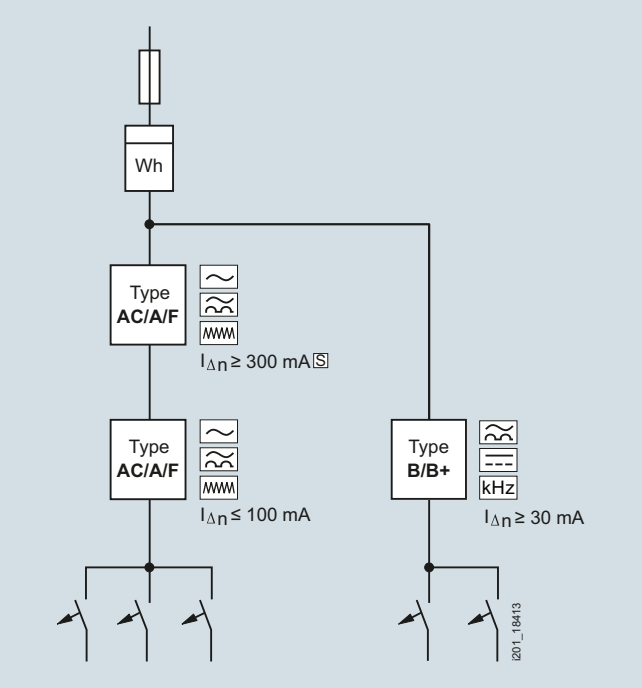
Suitable RCCB type					Circuits	Load current	Residual current	
B	F	A	AC					
B+				1				
				2				
				3				
				4				
				5				
				6				
				7				
				8				
				9				
				10				
				11				
				12				
				13				i201_16045

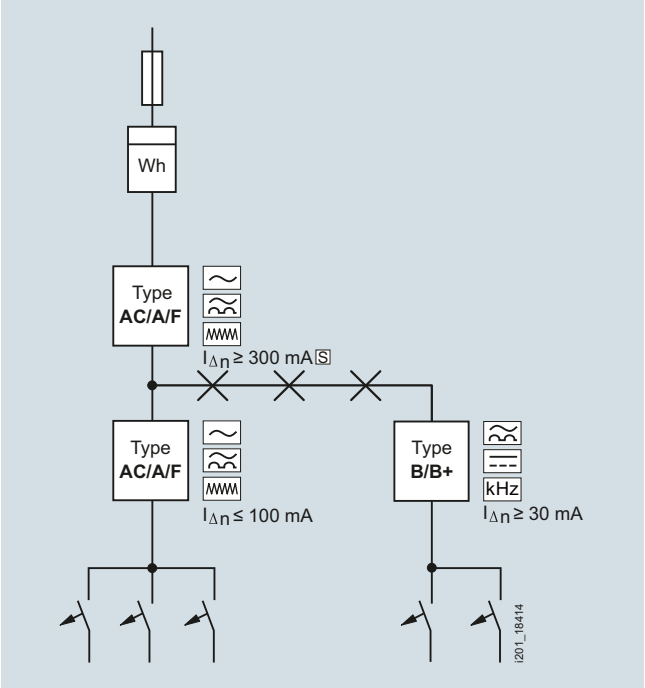
Table: Possible residual current forms and suitable residual current devices

Configuration

When using residual current protective devices type F, please note the following:

- They are not suitable for equipment that can generate smooth DC residual currents (see Table, page 9, circuits 8 to 13).
- They are not suitable for installation in networks with frequencies that deviate from the rated frequency (50 Hz) (not at the outgoing terminal of a frequency converter).
- When configuring and setting up electrical systems with type F, the same applies as for residual current protective devices type A, i.e. electrical loads that can generate smooth DC residual currents in the event of a fault are assigned their own circuit with a universal current-sensitive residual current protective device (type B or type B+).

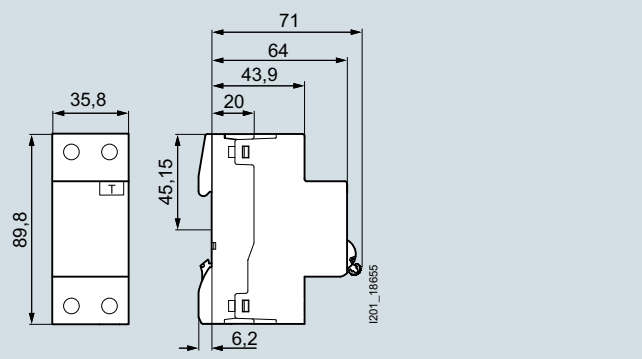




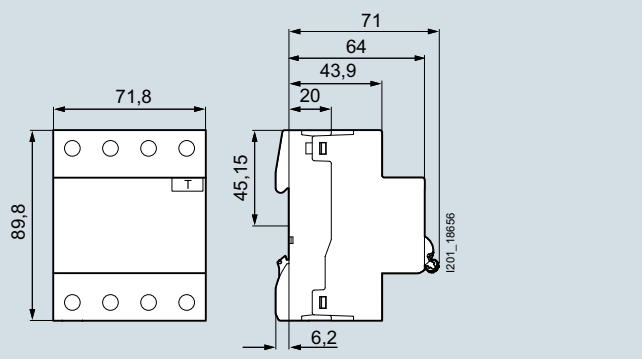
It is not permitted to branch off electrical circuits with these types of electrical loads downstream of pulse-current-sensitive residual current protective devices (type A or type F).

Dimensional drawings

5SV3 dimensional drawings



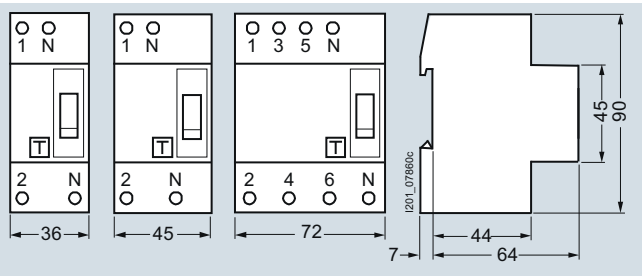
RCCBs, type A and type AC
1P+N, 2 MW



RCCBs, type A and type AC
3P+N, 4 MW

5SM3 dimensional drawings

RCCBs up to 80 A

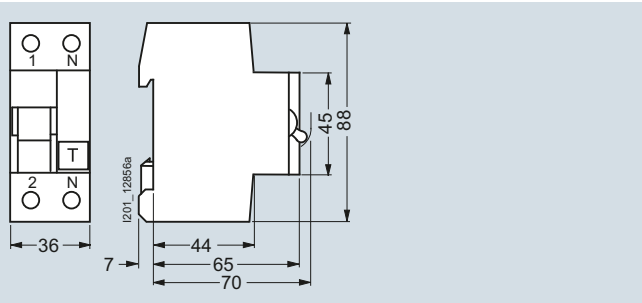


1P+N
2 MW

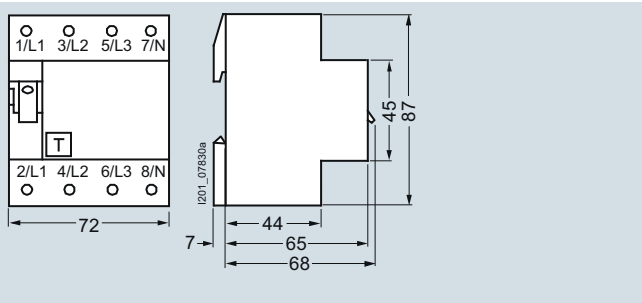
1P+N
2.5 MW

3P+N
4 MW

RCCBs 100 and 125 A



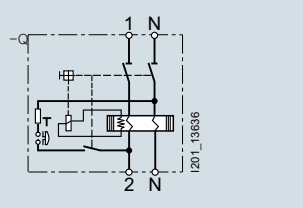
1P+N, 2 MW



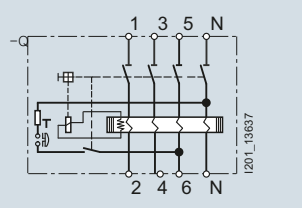
3P+N, 4 MW

Circuit diagrams

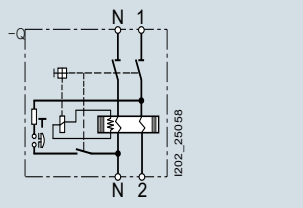
Graphic symbols



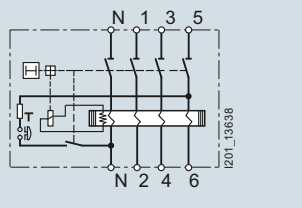
1P+N



3P+N
N connection, right



N connection, left



N connection, left

Note:
The infeed for SIGRES devices must be from below at terminals 2, 4, 6 and N.

Overview

Frequency converters, medical devices and UPS systems are seeing increasing use in industry. Smooth DC residual currents or currents with low residual ripple may occur in the event of faults on these devices.

Type A residual current protective devices are unable to detect these smooth DC residual currents. Furthermore, such smooth DC residual currents make type A devices increasingly insensitive to AC residual currents and pulsating DC residual currents. If a fault occurs, there is therefore no tripping and the desired protective function is no longer assured.

UC-sensitive residual current protective devices of types B and B+ have an additional transformer which is supplied with a control signal. This enables an evaluation of the change of the transformer's operating range caused by smooth DC residual currents, thus ensuring the desired protective function.

The residual current protective devices of type B are suitable for use in three-phase current systems before input circuits with rectifiers. They are not intended for use in DC systems and in networks with operating frequencies other than 50 Hz or 60 Hz.

The devices in this series are designed as residual current operated circuit breakers (RCCBs) up to 80 A and as residual current circuit breakers with integral overcurrent protection (RCBOs) for 100 A or 125 A in Characteristics C or D.

All universal current-sensitive RCCBs, type B or B+ are now also available in a SIGRES version, meaning they are also ideal for use in harsh ambient conditions.

When used in ambient conditions as defined in product standard EN 61008-1, the operation interval for pressing the test button can be extended to once a year.

Benefits

- Universal current-sensitive residual current protective devices detect not only AC residual currents and pulsating DC residual currents, but also smooth DC residual currents, thus ensuring the desired protective function with all types of residual current
- With type B, the tripping characteristic is adapted to suit the increase of leakage currents at higher frequencies in systems with capacitive impedances, thus ensuring greater operating safety
- Type B+ versions offer enhanced preventative fire protection and correspond to the prestandards DIN V VDE V 0664-110 and/or DIN V VDE V 0664-210 and VdS Directive 3501
- The RCBO is a compact device for up to 125 A. It provides not only personnel, material and fire protection but also overload and short-circuit protection for cables. This reduces wiring and mounting outlay
- The RCBOs offer external remote tripping over terminals Y1/Y2 This supports implementation of central OFF circuits.

Technical specifications

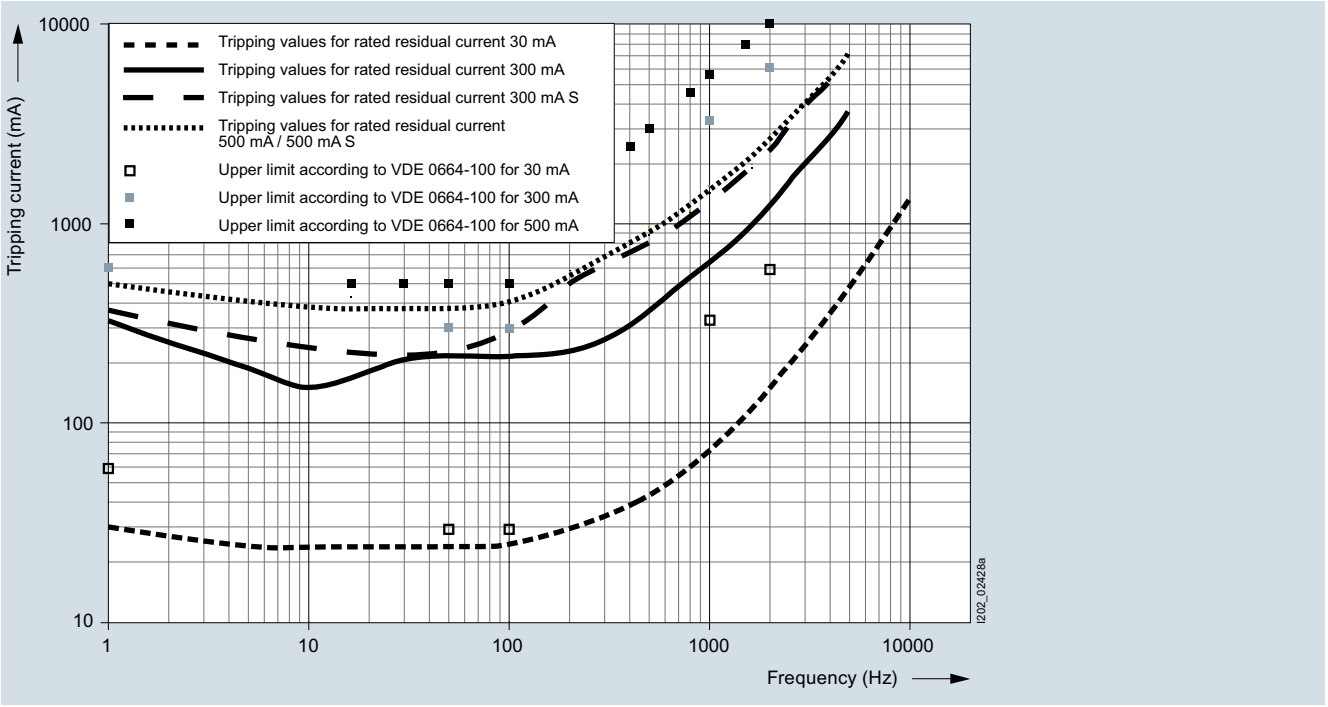
		SIQUENCE, 5SM3 RCCBs, type B and type B+		SIQUENCE, 5SU1 RCBOs type B and type B+
Standards		IEC/EN 62423 (VDE 0664-40); IEC/EN 61543 (VDE 0664-30); additionally applicable for type B+; DIN VDE 0664-400		IEC/EN 62423 (VDE 0664-40); IEC/EN 61543 (VDE 0664-30); additionally applicable for type B+; DIN VDE 0664-401
Versions		1P+N	3P+N	4P
Tripping characteristic		--	--	C, D
Surge current withstand capability With current waveform 8/20 µs Acc. to EN 60060-2 (VDE 0432-2)				
• Super resistant	kA	> 3	> 3	> 3
• Selective	kA	--	> 5	> 5
Minimum operational voltage for test function operation	V AC	195	195	195
Rated voltages U_n	V AC	230	400	400, 480
Rated frequency f_n	Hz	50 ... 60		
Rated currents I_n	A	16, 25, 40, 63	25, 40, 63, 80	100, 125
Rated residual currents $I_{\Delta n}$	mA	30, 300	30, 300, 500	30, 300
Rated breaking capacity				
• I_m	A	800		--
• I_{cn}	kA	--		10
Insulation coordination				
• Overvoltage category		III		
Conductor cross-sections				
• Solid and stranded	mm^2	1.5 ... 25		6 ... 50
• Finely stranded, with end sleeve	mm^2	1.5 ... 16		6 ... 35
Terminal tightening torque For all devices	Nm	2.5 ... 3.0		3.0 ... 3.5
Mains connection		Either top or bottom (bottom for the effectiveness of the SIGRES function even when switched off)		
Mounting position (on a standard mounting rail)		Any		
Degree of protection according to EN 60529 (VDE 0470-1)		IP20, if the distribution board is installed, with connected conductors		
Touch protection Acc. to EN 50274 (VDE 0660-514)		Finger and back-of-hand safe		
Service life Average number of switching cycles		> 10000 switching cycles		
Storage temperature	°C	-40 ... +75		
Ambient temperature	°C	-25 ... +45, marked with -25		
Resistance to climate acc. to IEC 60068-2-30		28 cycles (55 °C; 95 % rel. air humidity)		
CFC and silicone-free		Yes		

Power losses per conducting path under rated current load

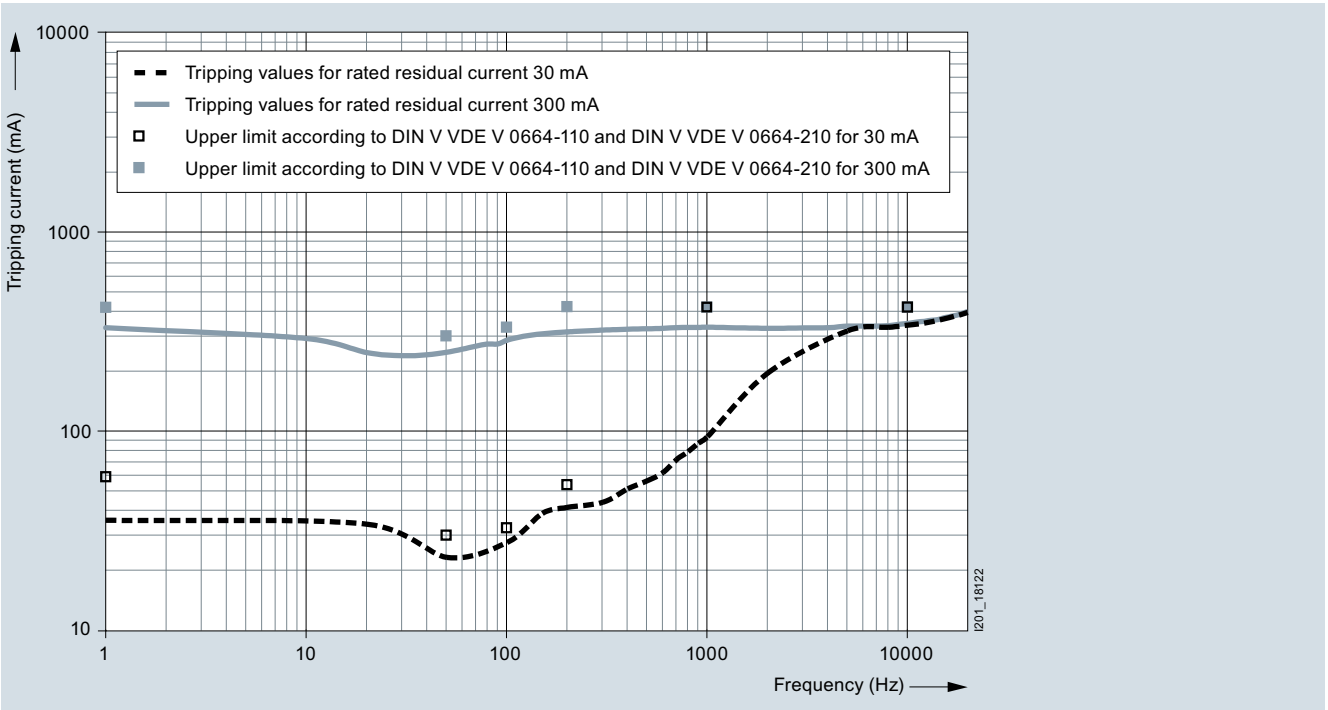
Note:
0.4 W per unit must be added for SIGRES versions.

Number of poles	Rated current	Rated residual current $I_{\Delta n}$ [mA]	Power losses per conducting path P_v [W]
2/4	16	30/300	0.17
	25	30/300	0.42
	40	30/300	1.09
	63	30/300/500	2.7
	80	30/300/500	4.35

Characteristic curves

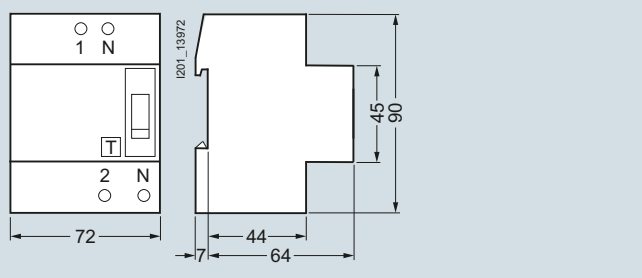


Tripping current as a function of frequency for type B

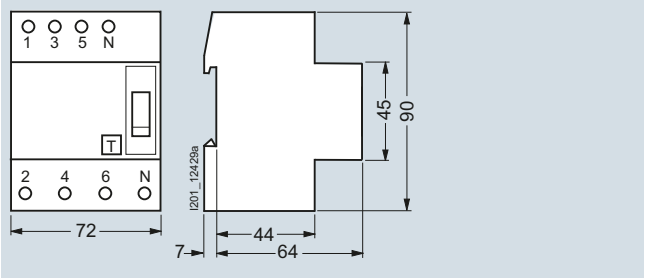


Tripping current as a function of frequency for type B+

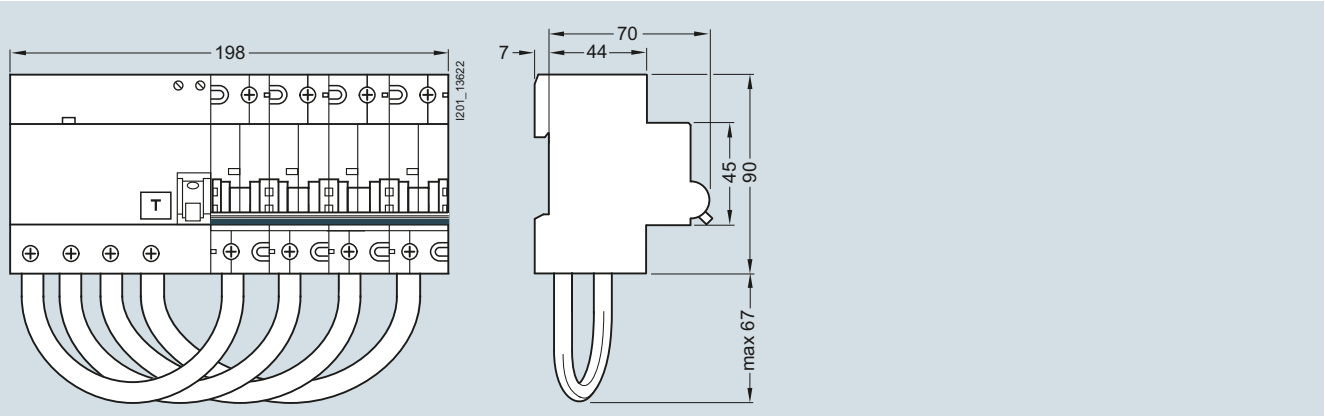
Dimensional drawings



SIQUENCE RCCBs, type B and type B+
1P+N, 4 MW



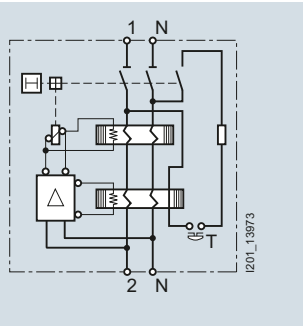
SIQUENCE RCCBs, type B and type B+
3P+N, 4 MW



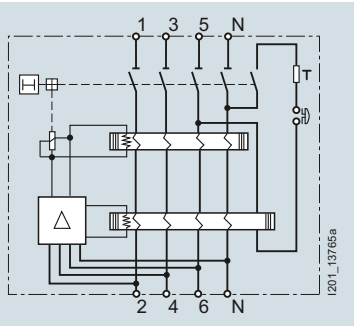
SIQUENCE RCBOs, type B and type B+
4P, 11 MW

Circuit diagrams

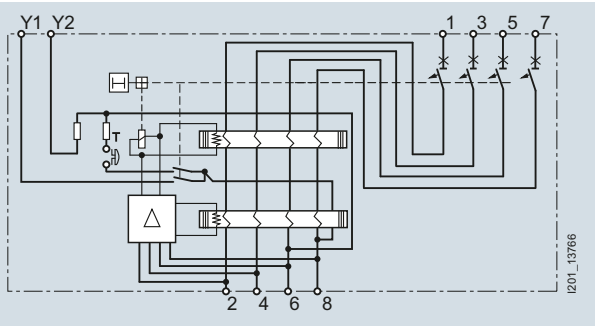
Graphic symbols



SIQUENCE RCCBs, type B
and type B+
1P+N, 4 MW



SIQUENCE RCCBs, type B
and type B+
3P+N, 4 MW



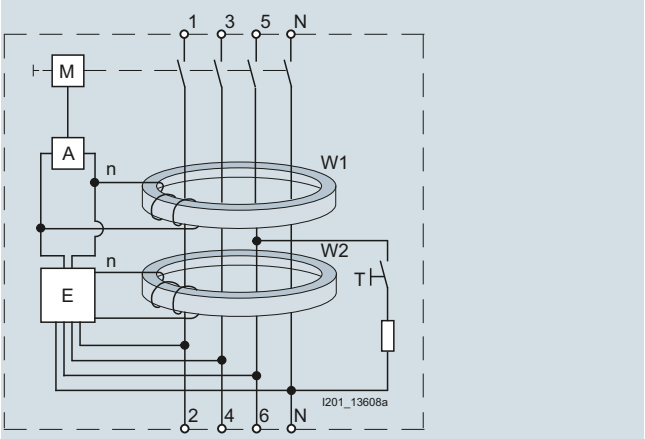
SIQUENCE RCBOs, type B
and type B+
4P, 11 MW

More information

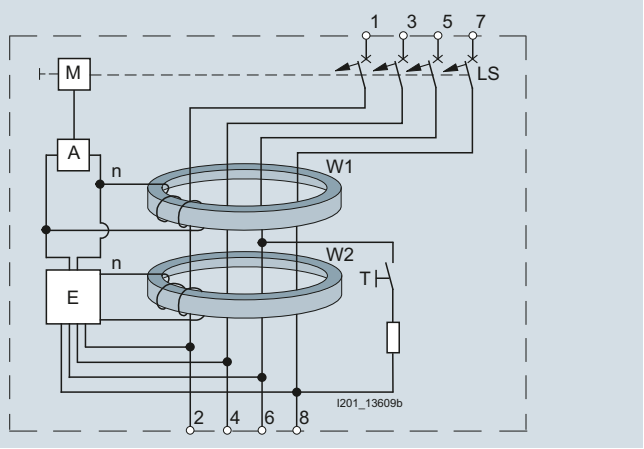
Device configuration

Universal current-sensitive protective devices are based on a pulse-current-sensitive circuit-protection device with tripping independent of line voltage, supplemented with an auxiliary unit for the detection of smooth DC residual currents. The following diagrams show the basic design.

The summation current transformer W1 monitors the electrical system for AC and pulse current-type residual currents. The summation current transformer W2 detects the smooth DC residual currents and, in the event of a fault, relays the tripping command through electronic unit E to release A, which uses the mechanics to disconnect the circuit.



Design of RCCBs type B and type B+



Design of RCBOs type B and type B+

M	Mechanics of the RCCB
LS	Miniature circuit breaker component
A	Release
E	Electronics for tripping in the event of smooth DC residual currents
n	Secondary winding
W1	Summation current transformer for detection of sinusoidal residual currents
W2	Summation current transformer for detection of smooth DC residual currents
T	Test equipment

Method of operation

The universal current-sensitive residual current protective devices work independently of the supply voltage compliant with applicable requirements in Germany for Type A according to DIN VDE 0664-100.

A voltage supply is required solely for the detection of smooth DC residual currents by a second transformer. This is done from all system cables and is dimensioned so that the electronics still reliably trip even with a voltage reduction to 50 V.

This ensures tripping for smooth DC residual currents, as long as such residual current waveforms can occur, even in the event of faults in the electrical power supply, e.g. an N-conductor break. This means that the pulse-current-sensitive breaker component, which trips regardless of line voltage, will still reliably trigger the tripping operation – even in the highly unlikely event that two phase conductors and the neutral conductor fail – if the remaining intact phase conductor presents a fire hazard due to a ground fault.

The residual current protective devices of type B are suitable for use in three-phase current systems before input circuits with rectifiers. They are not intended for use in DC systems and in networks with operating frequencies other than 50 Hz or 60 Hz.

RCBOs are a combination of an RCCB and a miniature circuit breaker for up to 125 A in a single compact device.

This means they provide not only personnel, property and fire protection, but also overload and short-circuit protection for cables. The mechanics of the residual current protective device act on the tripping unit of the miniature circuit breaker, which disconnects the circuit.

SIQUENCE 5SM3/5SU1 universal current-sensitive RCCBs, type B and type B+

Protective effect at high frequencies

In addition to the described residual current waveforms (AC residual currents, pulsating and smooth DC residual currents), AC residual currents with a wide range of frequencies may also occur on electronic equipment such as rectifiers in frequency converters or computer tomographs as well as at the outgoing terminal of a frequency converter.

Requirements for frequencies up to 2 kHz are defined in the device regulations DIN VDE 0664-100.

To date, only limited statements can be made with regard to the risk of ventricular fibrillations (up to 1 kHz) for frequencies higher than 100 Hz. No reliable statements can be made on any further effects of thermal or electrolytic influence on the human organism.

For this reason, protection against direct contact is only possible for frequencies up to 100 Hz.

For higher frequencies, protection against indirect contact must be implemented under consideration of the frequency response of the residual current protective device, the maximum permissible touch voltage up to 50 V and permissible grounding resistance derived from this information.

Rated residual current	Max. permissible grounding resistance for touch voltage	
	50 V	25 V
30 mA	160 Ω	80 Ω
300 mA	16 Ω[1)]	8 Ω[1)]
500 mA	10 Ω	5 Ω

[1)] For type B+ the value is allowed to be up to 120 Ω at 50 V and 60 Ω at 25 V.

Recommended maximum grounding resistance for SIQUENCE universal current-sensitive residual current protective devices type B and type B+.

Versions

Super resistant [K]:
Short-time delayed tripping in the case of transient leakage currents. High surge current withstand capability > 3 kA.

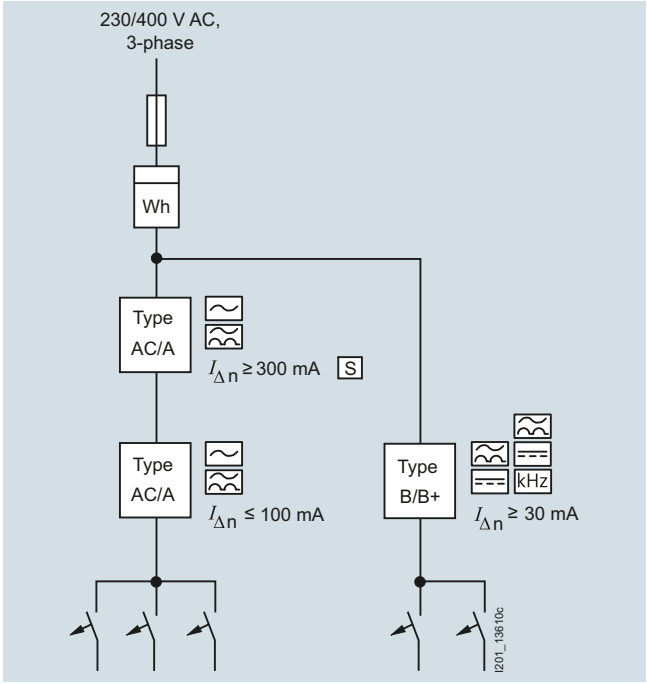
Selective [S]:
Can be used as upstream group switch for selective tripping contrary to a downstream, instantaneous or super resistant RCCB.

Configuration

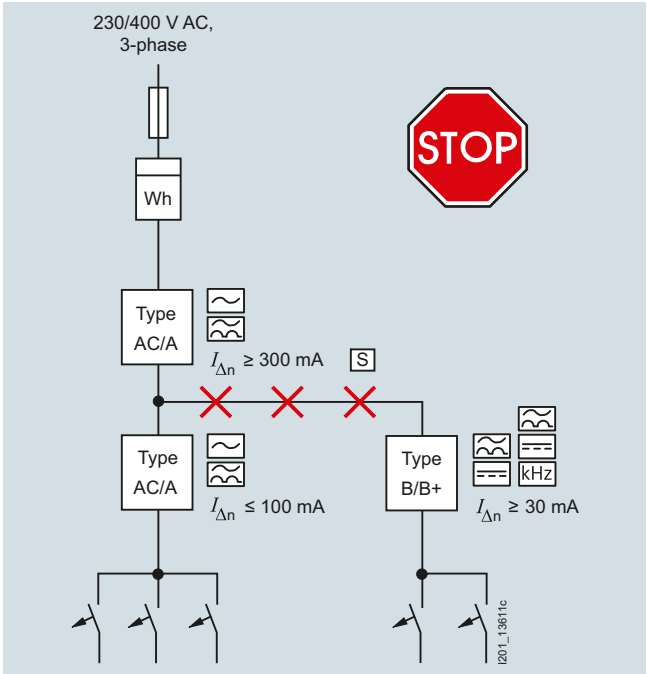
DIN VDE 0100-530 "Selection of protective devices" also describes the configuration of systems with residual current protective devices.

EN 50178 (DIN VDE 0160) "Electronic equipment for use in power installations" describes, among other things, how to select the type of residual current protective device suitable.

When configuring and installing electrical installations, electrical loads that can generate smooth DC residual currents in the event of a fault must be assigned a separate electrical circuit with a universal current-sensitive residual current protective device (type B):



It is not permitted to branch electrical circuits with these types of electrical loads after pulse-current-sensitive residual current protective devices (type A):



Overview

Auxiliary switches (AS)

The auxiliary switch (AS) always signals the contact position, regardless of whether the RCCB was tripped manually or as the result of a fault. An additional version is also available for the switching of small currents and voltages for the control of programmable control systems (PLCs) acc. to EN 61131-2. The auxiliary switch with test button enables the testing of control circuits without the need to switch the RCCB.

Fault signal contacts (FC)

The fault signal contact (FC) signals automatic breaking in the event of a fault. If the fault signal contact is activated, the contact position does not change if the RCCB is tripped manually. Fault signal contacts with TEST and RESET buttons enable testing of control circuits without the need to trip the RCCB. The red RESET button integrated in the handle also indicates automatic tripping of the RCCB. The signal can be acknowledged manually using the RESET button.

Shunt trips (ST)

Shunt trips are used for the remote tripping of RCCBs.

Undervoltage releases (UR)

Undervoltage releases are integrated (e.g. in EMERGENCY STOP loops), thus ensuring tripping in the event of an emergency, which, in turn, ensures disconnection of the control circuit according to EN 60204. In the event that the voltage is interrupted or too low, it also trips, i.e. prevents activation of the RCCB.

Remote controlled mechanisms are used for the remote ON/OFF switching of RCCBs. They also enable local manual switching. A blocking function permits maintenance work. A tripped RCCB must be acknowledged prior to switching back on.

The leakage current measurement device detects the leakage currents – like the circuit breaker – thus providing a direct statement as to the current loading of the RCCB. It is used to measure leakage currents up to 300 mA. This requires a voltmeter with an internal resistance over 1 MΩ/V and a measuring range for AC voltages of U_{rms} = 1 mV to 2 V. For the fault-free operation of an RCCB, the measured leakage current should be no greater than 1/3 of the rated residual current.

Benefits

Can be universally retrofitted with all additional components

- Captive metal brackets on the additional components ensure the quick and easy mounting of devices without the need for tools.
- Fault signal contacts with TEST and RESET button enable simple testing of auxiliary circuits and, in the event of a fault, acknowledgement of the fault over the RESET button, without the need to switch the RCCBs.
- The auxiliary switches with TEST button enable simple manual testing of control circuits during operation of the entire installation without the need to switch the RCCBs.
- Bus systems, such as *instabus* KNX, AS-Interface bus or PROFIBUS, can be integrated in the communication over binary inputs
- The leakage current measurement device enables the systematic selection of the rated residual current, thus preventing inadvertent tripping of an RCCB.

Technical specifications

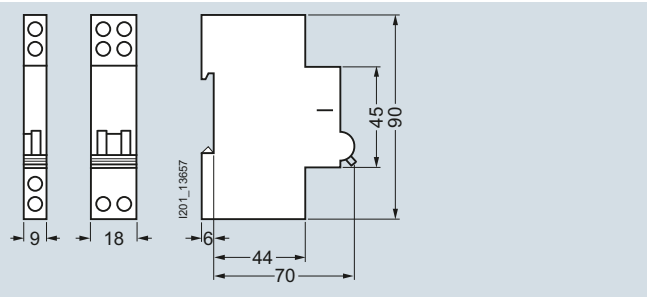
		Auxiliary switches (AS) 5SW330.	Auxiliary switches (AS) 5SW3330
Standards		EN 62019	
Terminals			
• Conductor cross-section	mm^2	0.75 ... 2.5	
• Tightening torque	Nm	0.5	
Short-circuit protection		B6 or C6 or gL/gG 6 A fuse	
Min. contact load		50 mA/24 V	
Max. contact load			
• 230 V AC, AC-12	A	6	5
• 230 V AC, AC-14	A	3.6	--
• 220 V DC, DC-12	A	1	0.5

Additional components

			Auxiliary switches (AS)		Fault signal contacts (FC)
			5ST3010, 5ST3010-2 5ST3011, 5ST3011-2 5ST3012, 5ST3012-2	5ST3013, 5ST3013-2 5ST3014, 5ST3014-2 5ST3015, 5ST3015-2	5ST3020, 5ST3020-2 5ST3021, 5ST3021-2 5ST3022, 5ST3022-2
Standards			EN 62019; IEC/EN 60947-5-1; UL 1077; CSA C22.2 No. 235		
Approvals			www.siemens.com/lowvoltage/certificates		
Short-circuit protection			Miniature circuit breaker or gG 6 A fuse		
Contact load					
• Min. • Max.			50 mA, 24 V --	1 mA/5 V DC 50 mA/30 V DC	50 mA, 24 V --
• 400 V AC, AC-14, NO • 230 V AC, AC-14, NO • 400 V AC, AC-13, NC • 230 V AC, AC-13, NC		A A A A	2 6 2 6	-- -- -- --	2 6 2 6
• 220 V DC, DC-13, NO+NC • 110 V DC, DC-13, NO+NC • 60 V DC, DC-13, NO+NC • 24 V DC, DC-13, NO+NC		A A A A	1 1 3 6	-- -- -- --	1 1 3 6
Service life, on average, with rated load			20 000 actuations	20000 actuations	20000 actuations
Conductor cross-sections		mm^2 AWG	0.5 ... 2.5 22 ... 14	0.5 ... 2.5 22 ... 14	0.5 ... 2.5 22 ... 14
Terminals					
• Terminal tightening torque		Nm lbs/in.	0.5 4.5	0.5 4.5	0.5 4.5
Mounting position			Any	Any	Any
Ambient temperature		°C	-25 ... +55	-25 ... +55	-25 ... +55
Storage temperature		°C	-40 ... +75	-40 ... +75	-40 ... +75
Resistance to climate	Acc. to IEC 60068-2-30	Cycles	28		
Shock	Acc. to IEC 60068-2-27	m/s	50 at 11ms half-sine		
Resistance to vibrations	Acc. to IEC 60068-2-6	m/s^2	50 at 10 ... 150 Hz		

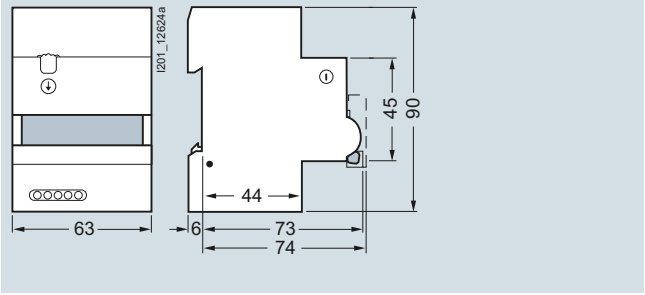
			Undervoltage releases (UR)	Shunt trips (ST)	
			5ST304.	5ST3030	5ST3031
Standards			EN 60947-1		
Rated voltages U_n		V AC	230	110 ... 415	24 ... 48
		V DC	24, 110	110	24 ... 48
• Operating range U_n			0.85 ... 1.1 x U_n	0.7 ... 1.1 x U_n	
• Rated frequency f_n		Hz	--	50 ... 60	
Response limits					
• Tripping			< 0.35 ... 0.7 × U_n	--	
Short-circuit protection			Miniature circuit breakers B/C 6 A or fuse gG 6 A		
Minimum contact load			50 mA, 24 V	50 mA, 24 V	
Tripping operations			max. 2000	max. 2000	
Service life, on average, with rated load			20000 actuations	20000 actuations	
Conductor cross-sections		mm^2 AWG	0.5 ... 2.5 22 ... 14	0.5 ... 2.5 22 ... 14	
Terminals					
• Terminal tightening torque		Nm lbs/in.	0.8 6.8	0.8 6.8	
Mounting position			Any	Any	
Ambient temperature		°C	-25 ... +55	-25 ... +55	
Storage temperature		°C	-40 ... +75	-40 ... +75	
Resistance to climate	Acc. to IEC 60068-2-30	Cycles	28		
Shock	Acc. to IEC 60068-2-27	m/s	50 at 11ms half-sine		
Resistance to vibrations	Acc. to IEC 60068-2-6	m/s^2	50 at 10 ... 150 Hz		
Switching frequency			--		
Switching duration		s	--		
Minimum command duration		s	--		
Rated power dissipation		VA	--		
Behavior in the event of control voltage failure			--		

Dimensional drawings

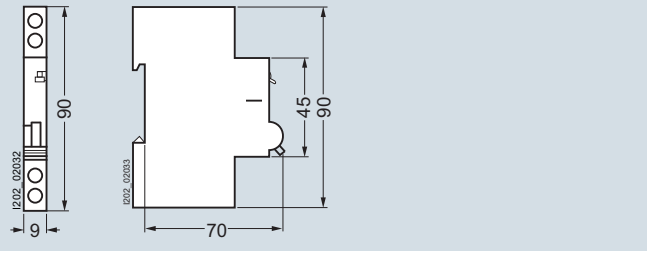


5ST3010
5ST3011
5ST3012
5ST3013
5ST3014
5ST3015
5ST3020
5ST3021
5ST3022

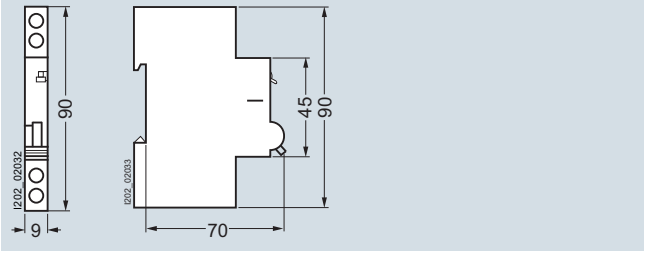
5ST3030
5ST3031
5ST3040
5ST3041
5ST3042
5ST3043
5ST3044
5ST3045



5ST3050

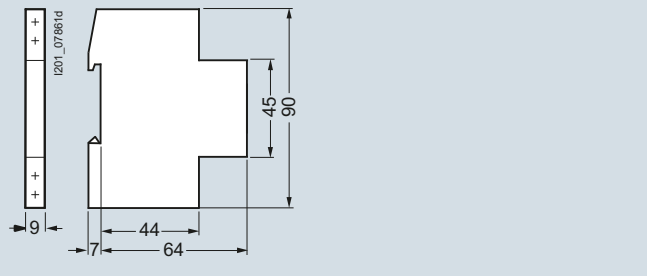


5ST3010-2
5ST3011-2
5ST3012-2
5ST3013-2
5ST3014-2
5ST3015-2

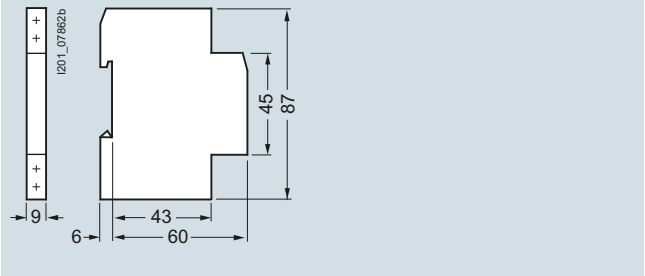


5ST3020-2
5ST3021-2
5ST3022-2

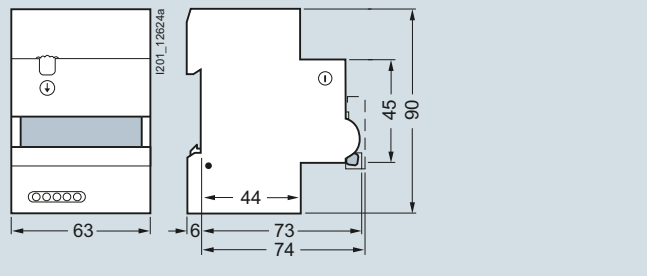
Auxiliary switches (AS) for RCCBs for 5SM3 up to 80 A



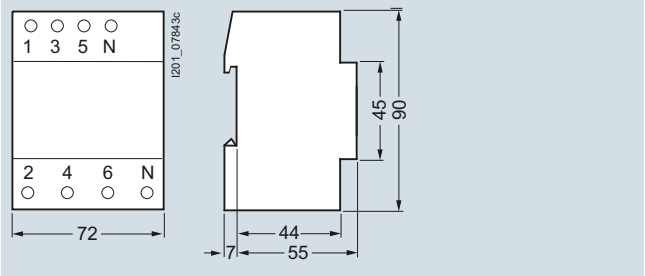
Auxiliary switches (AS) for RCCBs for 5SM3, 100 A, 125 A, 3P+N



Remote-controlled mechanism



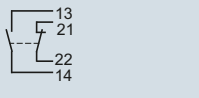
Leakage current measurement device



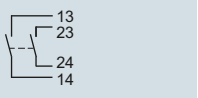
Circuit diagrams

Graphic symbols

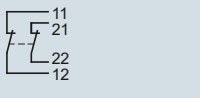
Auxiliary switches (AS)



5ST3010
5ST3013
5ST3010-2

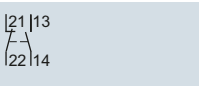


5ST3011
5ST3014
5ST3011-2

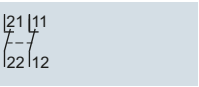


5ST3012
5ST3015
5ST3012-2

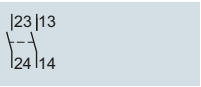
Auxiliary switches (AS) for RCCBs for 5SM3 up to 80 A



1 NO + 1 NC

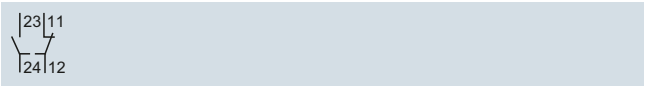


2 NC



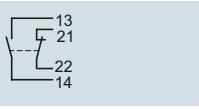
2 NO

Auxiliary switches (AS) for RCCBs for 5SM3, 100 A, 125 A, 3P+N

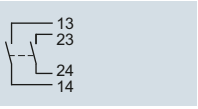


1 NO + 1 NC

Fault signal contacts (FC)



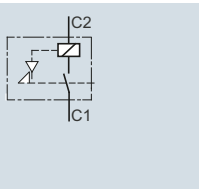
5ST3020
5ST3020-2



5ST3021
5ST3021-2

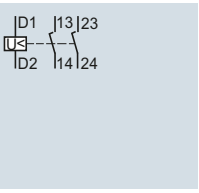
5ST3022
5ST3022-2

Shunt trips (ST)

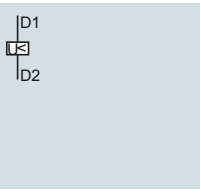


5ST3030
5ST3031

Undervoltage releases (UR)

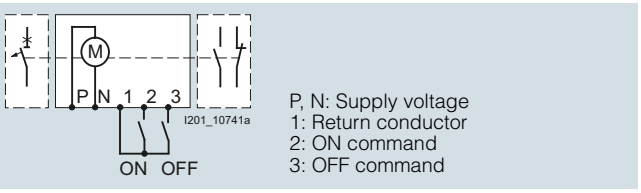


5ST3040
5ST3041
5ST3042

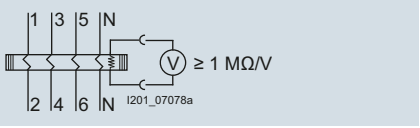


5ST3043
5ST3044
5ST3045

Remote controlled mechanisms (RC)



Leakage current measurement device



More information

Gossen-Metrawatt offers suitable test devices for RCCB function tests and for testing protective measures.

Information is available at:

Gossen-Metrawatt GmbH
Thomas-Mann-Str. 16-20
D-90471 Nuremberg

Tel. 0049 (0)/86 02-111
Fax 0049 (0) 9 11/86 02-777

www.gmc-instruments.com
email: info@gmc-instruments.com

Overview

RC units are used in all supply systems up to 240/415 V AC. Devices of type AC trip in the event of sinusoidal AC residual currents, type A also trips in the event of pulsating DC residual currents.

In addition, RC units, type F also detect residual currents with mixed frequencies up to 1 kHz.

RCCBs with a rated residual current of maximum 30 mA are used for personnel, material and fire protection, as well as for protection against direct contact.

Devices with a rated residual current of maximum 300 mA are used as preventative fire protection in case of insulation faults.

RC units are combined with miniature circuit breakers with A, B, C and D characteristics, provided that these are available in the MCB range. The two components are simply plugged together without the need for any tools.

They then form a combination of RCCB and miniature circuit breakers for personnel, fire and line protection.

The dimensioning of the rated residual current depends on the size of the plant.

Benefits

- Our wide variety of RC unit types and comprehensive range of miniature circuit breakers offer a huge spectrum of combinations for all applications
- Instantaneous type A devices have a surge current withstand capability with current waveform 8/20 µs of more than 1 kA, super resistant of more than 3 kA and selective of more than 5 kA. This ensures safe operation
- All additional components for miniature circuit breakers can be retrofitted on the right-hand side
- All 100 A and 125 A RC units offer external remote tripping over terminals Y1/Y2. This supports implementation of central OFF circuits
- Both components can be simply plugged into each other and secured with captive metal brackets – no tools required. This saves considerable time when mounting

Technical specifications

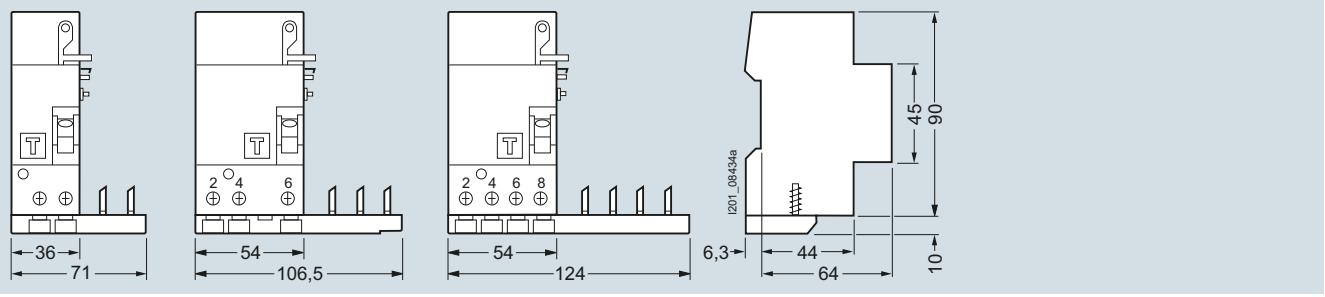
			5SM2
Standards			IEC/EN 61009-1 (VDE 0664-20), IEC/EN 61009-2-1 (VDE 0664-21), IEC/EN 61543 (VDE 0664-30), IEC/EN 62423 (VDE 0664-40)
Surge current withstand capability			
• Type A with current waveform 8/20 µs	• Acc. to EN 60060-2 (VDE 0432-2)		
- Instantaneous		kA	> 1
- Super resistant		kA	> 3
- Selective		kA	> 5
• Type F with current waveform 8/20 µs	Acc. to EN 60060-2 (VDE 0432-2)	kA	> 3
Minimum operational voltage for test function operation		V AC	195
Rated voltage U_n		V AC	230 ... 400
Rated frequency f_n		Hz	50 ... 60
Rated currents I_n		A	0.3 ... 16; 0.3 ... 40; 0.3 ... 63; 80 ... 100
Rated residual currents $I_{\Delta n}$		mA	10, 30, 100, 300, 500, 1000
Insulation coordination			
• Overvoltage category			III
Pollution degree			2
Terminal conductor cross-sections			
• Up to I_n = 63 A		mm^2	1.5 ... 25
• At I_n = 80 ... 100 A		mm^2	6.0 ... 50
Terminal tightening torque		Nm	2.5 ... 3.0
Mains connection			Either top or bottom
Mounting position (on a standard mounting rail)			Any
Degree of protection	Acc. to EN 60529 (VDE 0470-1)		IP20, if the distribution board is installed, with connected conductors
Touch protection	Acc. to EN 50274 (VDE 0660-514)		Finger and back-of-hand safe
Service life	Average number of switching cycles		> 10000 switching cycles
Storage temperature		°C	-40 ... +75
Ambient temperature		°C	-25 ... +45, marked with -25
Resistance to climate	Acc. to IEC 60068-2-30		28 cycles (55 °C; 95 % rel. air humidity)
CFC and silicone-free			Yes

Power losses per conducting path under rated current load

Number of poles	Rated current	Rated residual current $I_{\Delta n}$ [A]	Power losses per conducting path P_v [W]
2	16	0.01	2.5
2/3/4	40	0.03	3.6
	63	0.03	4.6
	40	0.3/0.5/1	1.9
	63	0.1/0.3/0.5/1	3.0
2/4	80	0.3	4.8
	80	0.3/1	4.0
	100	0.3	6.0
	100	0.3/1	5.0

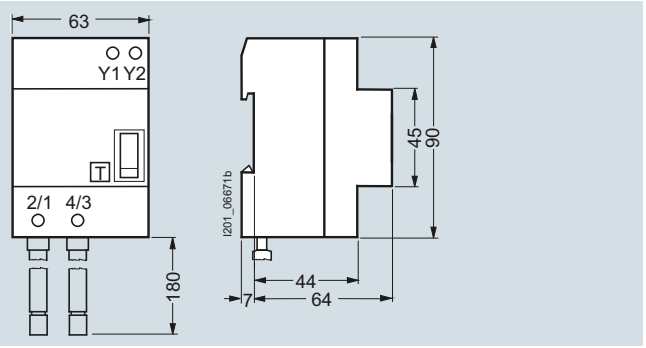
Dimensional drawings

RC units for 5SY

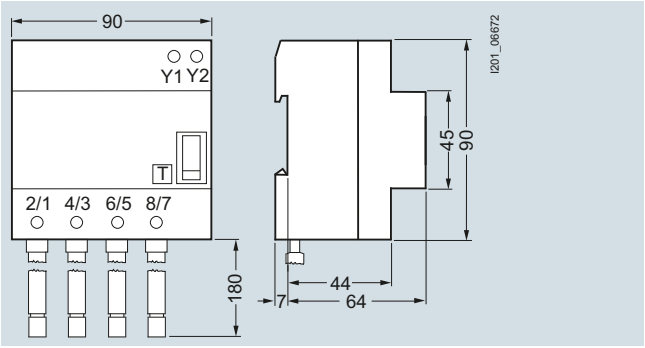


2P 3P 4P

RC units for 5SP4



2P

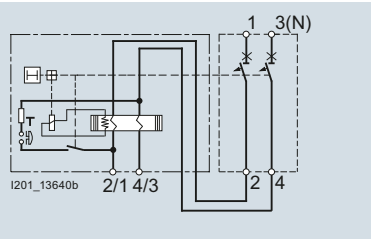


4P

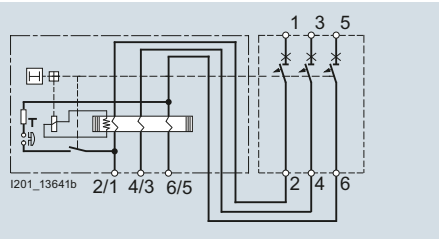
Circuit diagrams

Graphic symbols

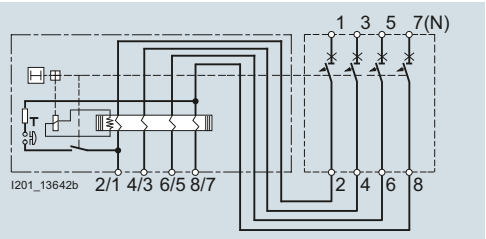
RC units for 5SY



2P

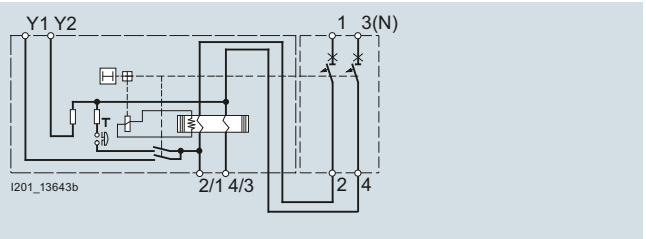


3P

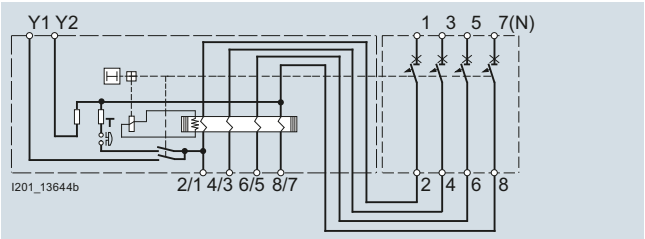


4P

RC units for 5SP4



2P



4P

Overview

RCBOs are a combination of an RCCB and a miniature circuit breaker in a compact design for personnel, fire and line protection. For personnel protection and fire protection, the residual current part of the type AC trips in the event of sinusoidal AC residual currents, type A also trips in the event of pulsating DC residual currents.

In addition, RCBOs type F also detect residual currents with mixed frequencies up to 1 kHz.

RCBOs with a rated residual current of maximum 30 mA are used for personnel, material and fire protection, as well as for protection against direct contact. RCBOs with a rated residual current of 10 mA are primarily used in areas that represent an increased risk for personnel and in the outdoor installations of residential buildings.

Devices with a rated residual current of maximum 300 mA are used as preventative fire protection in case of insulation faults.

The MCB part of the RCBO protects lines against overload and short circuits and is available in characteristics B and C.

Since DIN VDE 0100-410 came into effect in June 2007, all socket outlet current circuits up to 20 A must now also be fitted with residual current protective devices with a rated residual current of max. 30 mA. This also applies to outdoor electrical circuits up to 32 A for the connection of portable equipment.

In order to implement this protection, we recommend the national use of RCBOs with 30 mA.

Assignment to each individual branch circuit helps prevent the undesired tripping of fault-free circuits induced by the accumulation of operation-related leakage currents or by transient current pulses during switching operations.

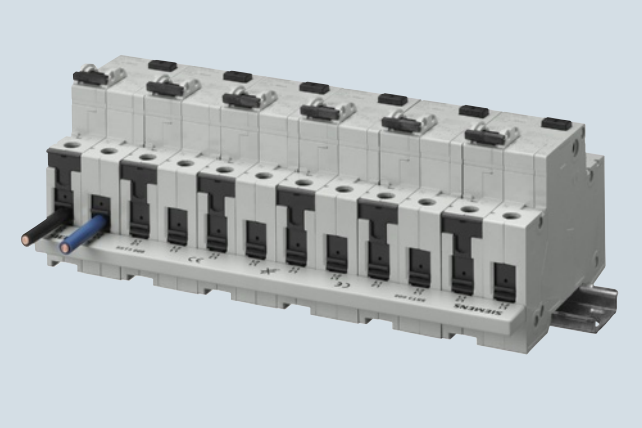
Additional components of the 5SY miniature circuit breakers can be mounted at the side and carry out additional functions.

For further details on additional components, see Catalog LV 10, chapter "Miniature Circuit Breakers".

RCBOs comprise one part for fault-current detection and one part for overcurrent detection. They are equipped with a delayed overload/time-dependent thermal release (thermal bimetal) for low overcurrents and with an instantaneous electromagnetic release for higher overload and short-circuit currents.

The special contact materials used guarantee a long service life and offer a high degree of protection against contact welding.

Benefits



For all versions

- Clear and visible conductor connection in front of the rear busbar facilitates controls
- Large and easily accessible wiring space enables easy insertion of conductor in the terminals
- The surge current withstand capability of over 1 kA ensures safe and reliable operation
- All additional components for miniature circuit breakers can be retrofitted on the right-hand side.

For all 10 kA versions up to 40 A

- Integrated movable terminal covers located at the cable entries ensure the terminals are fully insulated when the screws are tightened. The effective touch protection when grasping the device considerably exceeds the requirements of BGV A3
- The RCBOs can be quickly and easily removed from the assembly by hand if connections need to be changed. Time-saving replacement of parts as busbars no longer need to be freed from adjacent miniature circuit breakers.

For all 125 A versions

- The RCBOs offer external remote tripping over terminals Y1/Y2. This supports implementation of central OFF circuits.

Technical specifications

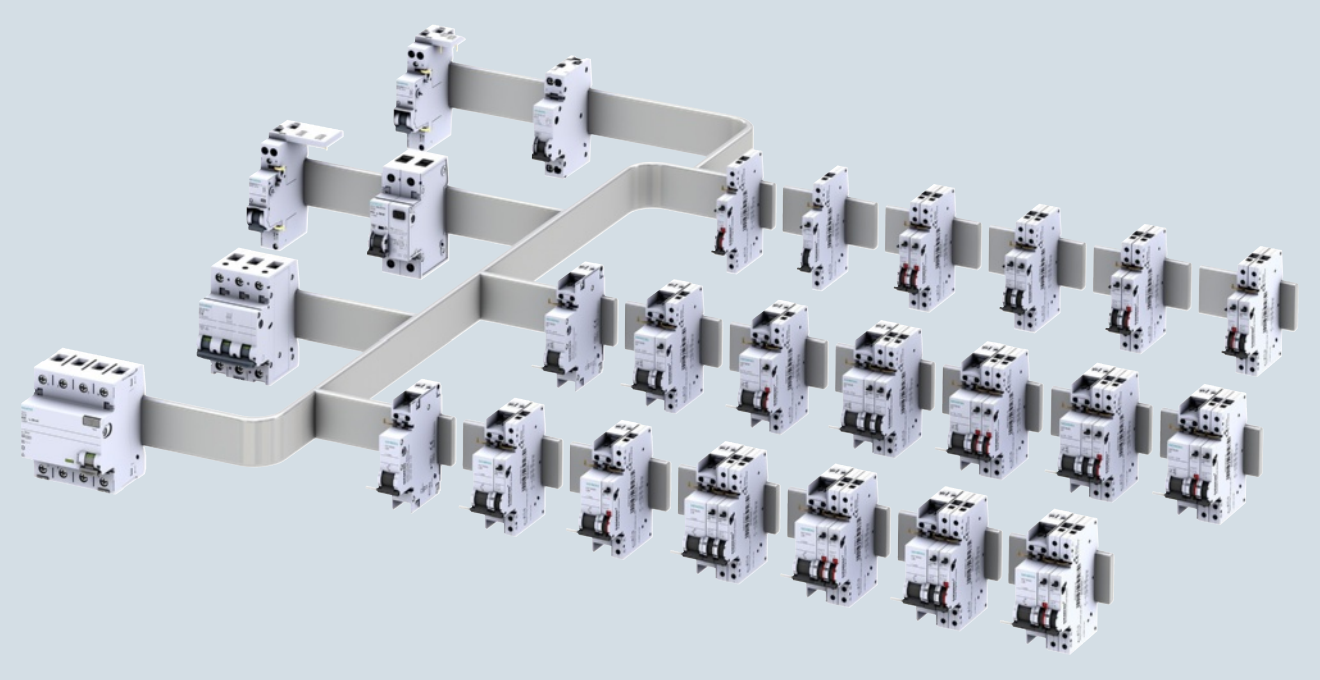
			Up to 40 A	125 A
Standards			IEC/EN 61009-1 (VDE 0664-20); IEC/EN 61009-2-1 (VDE 0664-21) IEC/EN 61543 (VDE 0664-30); IEC/EN 62423 (VDE 0664-40)	
Rated voltages U_n		V AC	230	400
Rated frequency f_n		Hz	50 ... 60	
Rated currents I_n		A	6, 8, 10, 13, 16, 20, 25, 32, 40	125
Rated residual currents $I_{\Delta n}$		mA	10, 30, 100, 300	30, 300, 1000
Rated breaking capacity		kA	6 / 10	10
Energy limitation class			3	--
Surge current withstand capability, type A				
• With current waveform 8/20 µs	Acc. to EN 60060-2 (VDE 0432-2)			
- Instantaneous		kA	> 1	
- Super resistant		kA	> 3	--
- Selective		kA	> 5	
• Type F with current waveform 8/20 µs		kA	> 3	--
Minimum voltage for operation of the test equipment		V AC	195	
Insulation coordination				
• Overvoltage category			III	
Pollution degree			2	
Terminal conductor cross-sections				
• Solid and stranded		mm^2	0.75 ... 35	6 ... 50
• Finely stranded with end sleeve		mm^2	0.75 ... 25	6 ... 35
Terminal tightening torque		Nm	2.5 ... 3.0	3.0 ... 3.5
Mains connection			Top or bottom	
Mounting position (on a standard mounting rail)			Any	
Degree of protection	Acc. to EN 60529 (VDE 0470-1)		IP20, if the distribution board is installed, with connected conductors	
Touch protection	Acc. to EN 50274 (VDE 0660-514)		Finger and back-of-hand safe	
Service life	Average number of switching cycles		> 10000	
Storage temperature		°C	-40 ... +75	
Ambient temperature		°C	-25 ... +45, marked with -25	
Resistance to climate	Acc. to IEC 60068-2-30		28 cycles (55 °C; 95 % rel. air humidity)	
CFC and silicone-free			Yes	

Power losses

Note:
All data under loading with rated current I_n.

Rated current I_n [A]	Rated residual current $I_{\Delta n}$ [mA]	Power losses per conducting path P_v [W]	
		Characteristic B	Characteristic C
6	10	2.8	2.2
	30 ... 300	2.7	1.9
8	30 ... 300	--	1.2
10	10	2.4	2.2
	30 ... 300	1.8	1.6
13	10	3.5	3.3
	30 ... 300	2.4	2.2
16	10	4.7	4.5
	30 ... 300	3.0	2.8
20	30 ... 300	3.7	3.3
25	30 ... 300	5.1	5.1
32	30 ... 300	5.7	5.7
40	30 ... 300	7.8	7.8

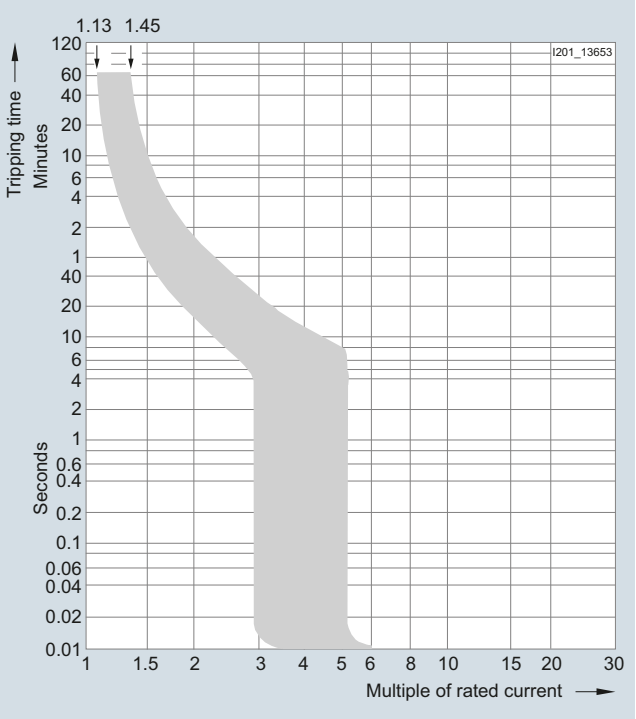
5SU1 RCBOs



Characteristic curves

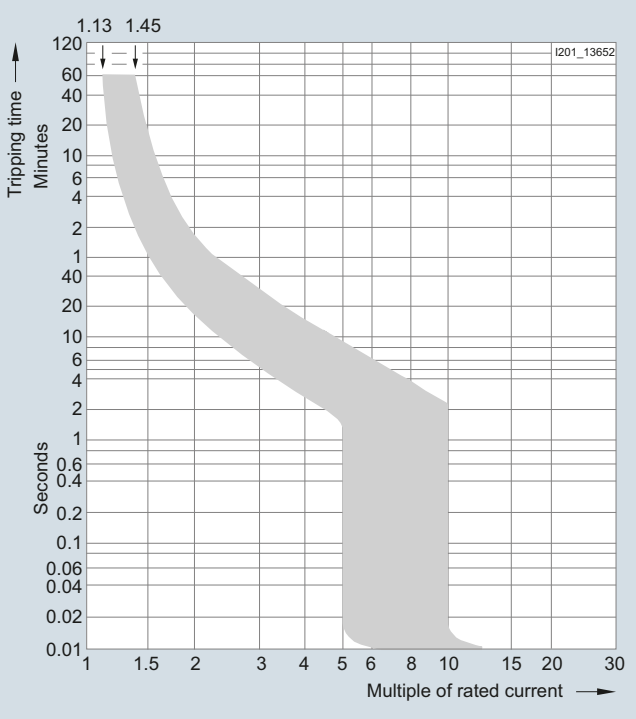
Tripping characteristics according to EN 61009-1 (VDE 0664 Part 20)

Tripping characteristic B



Line protection mainly in outlet circuits; no proof required regarding personal safety

Tripping characteristic C



General line protection, especially advantageous with higher starting currents (lamps, motors, etc.)

Tripping characteristics at ambient temperature 30 °C

Tripping characteristic	Standards	Thermal release				Electromagnetic release		
		Test currents: Small test current I_1	Large test current I_2	Tripping time $I_n \leq 63$ A t	$I_n > 63$ A	Test currents: Hold I_4	Latest tripping I_5	Tripping time t
B	IEC/EN 61009-1	1.13 × I_n		> 1 h	> 2 h	3 × I_n		≥ 0.1 s
	VDE 0664 Part 20		1.45 × I_n	< 1 h	< 2 h		5 × I_n	< 0.1 s
C		1.13 × I_n		> 1 h	> 2 h	5 × I_n		≥ 0.1 s
			1.45 × I_n	< 1 h	< 2 h		10 × I_n	< 0.1 s

In the case of an ambient temperature other than 30 °C, the current values of the delayed tripping operation change by approx. 5 % per 10 K temperature difference. They rise in case of temperatures lower than 30 °C and fall in case of temperatures higher than 30 °C.

If more than one electrical circuit is loaded in a series of MCBs or RCBOs, the resulting increase in ambient temperature affects the characteristic curve.

In this case, it is necessary to take into account an additional correction factor, specific to the rated current of the RCBO.

Number	1	2 ... 3	4 ... 6	> 7
Correction factor K	1.00	0.90	0.88	0.85

Breaking capacity

Particular demands are made on the MCB part of the RCBO with regard to breaking capacity.

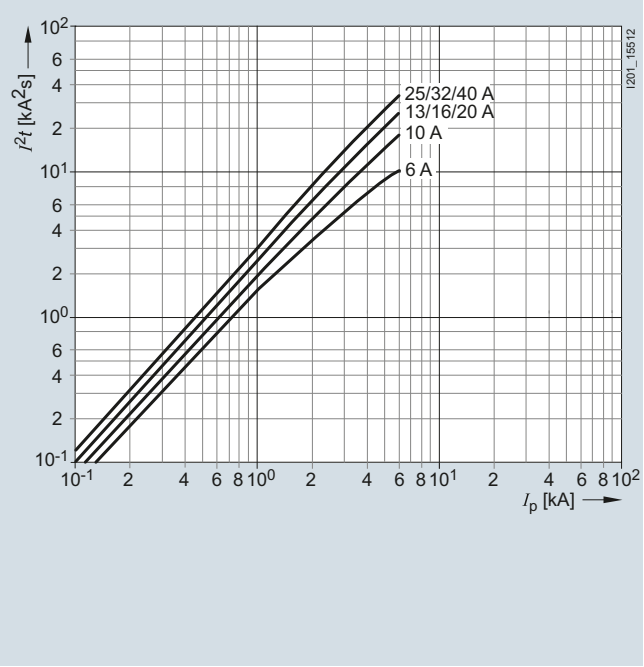
The values are standardized and are determined according to the test conditions of EN 61009-1 (VDE 0664 Part 20).

The most common values are 6 000 and 10 000.

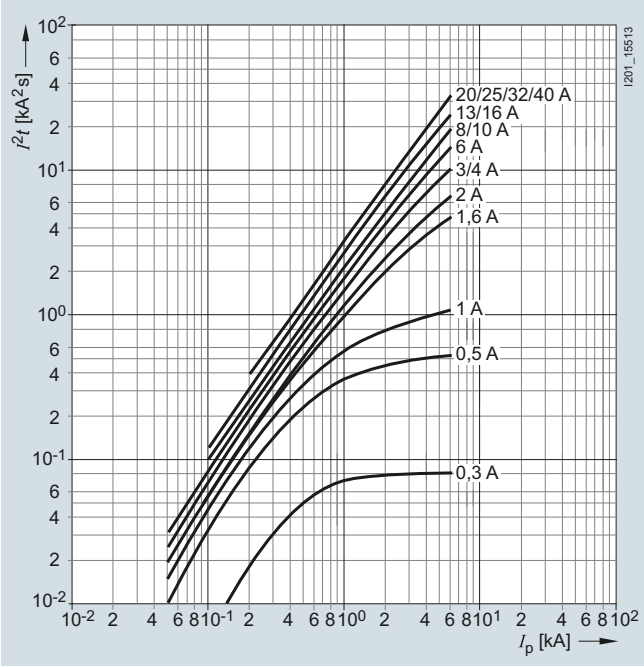
Let-through I^2t values

Rated switching capacity 5SU1, 6000 A

Characteristic B

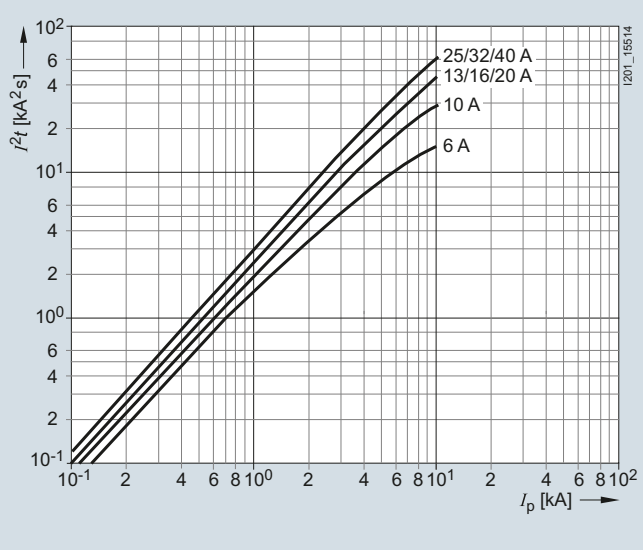


Characteristic C

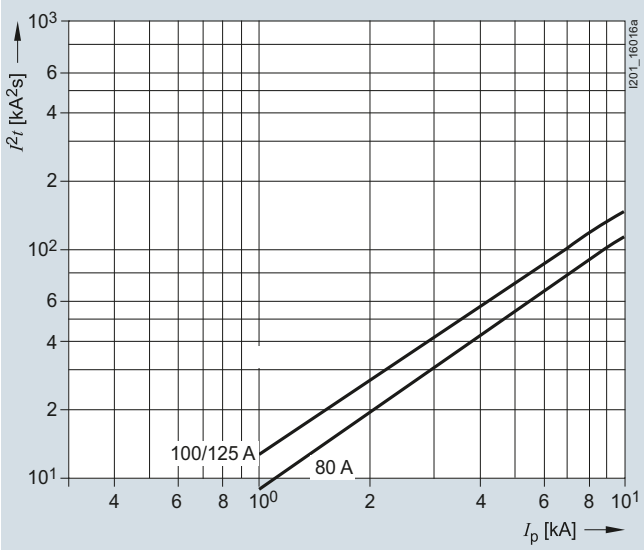


Rated breaking capacity 5SU1, 10000 A

Characteristic B

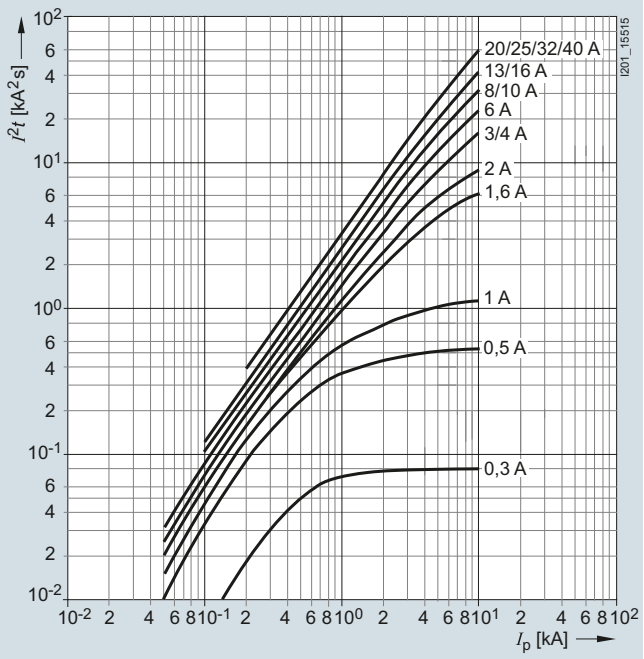


Characteristic B

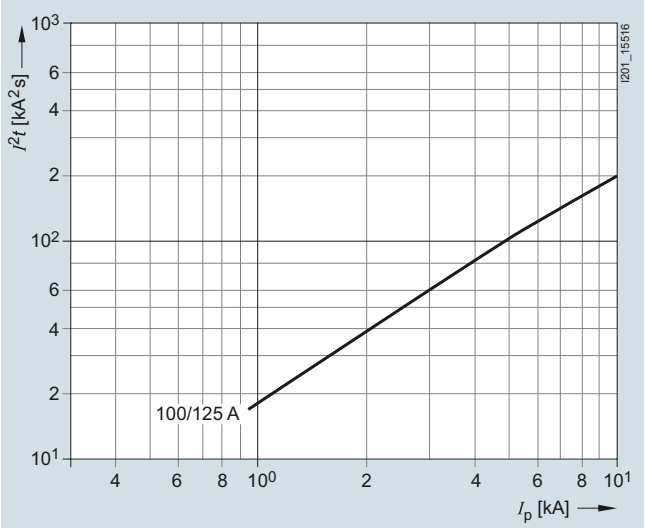


Rated breaking capacity 5SU1, 10000 A

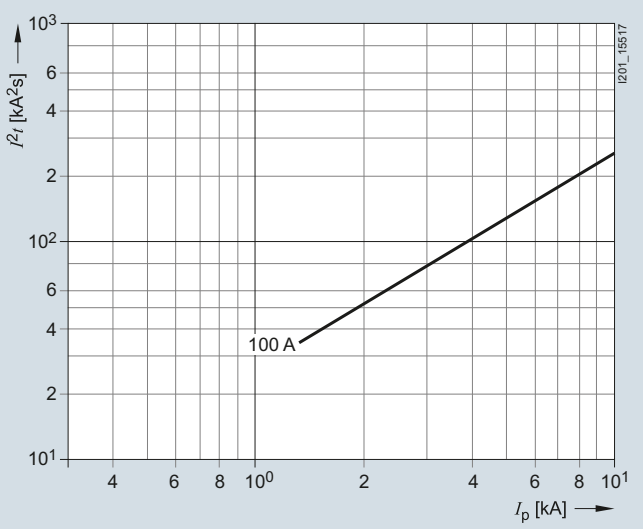
Characteristic C



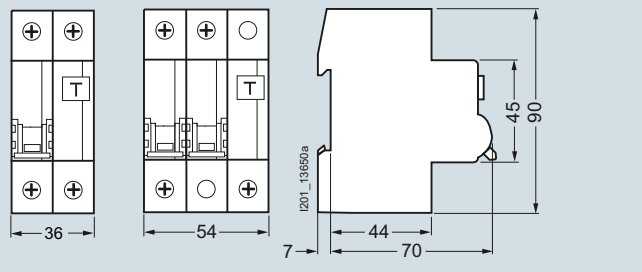
Characteristic C



Characteristic D

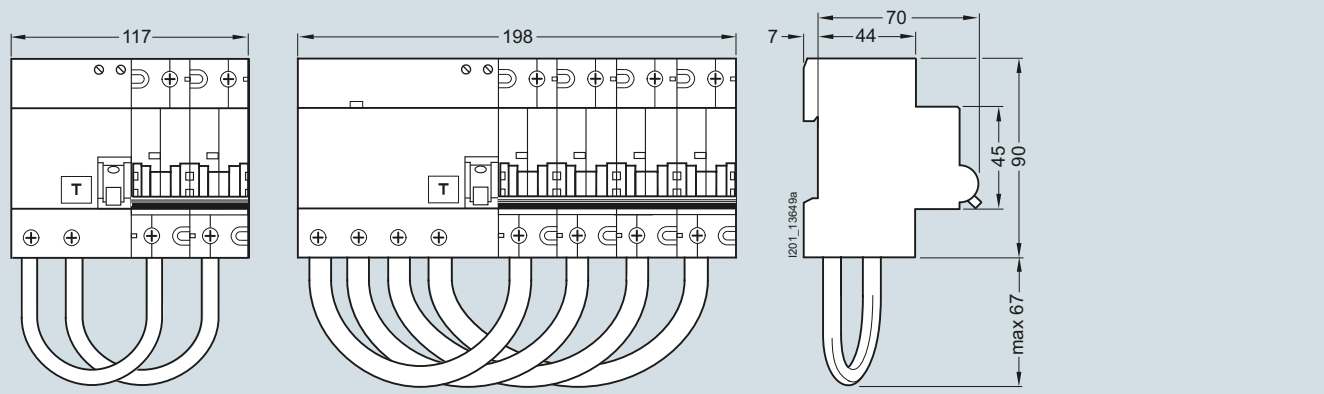


Dimensional drawings



1P+N,
up to 40 A

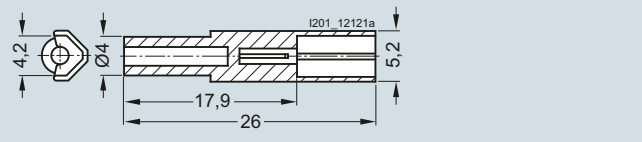
2P,
up to 40 A



2P,
125 A

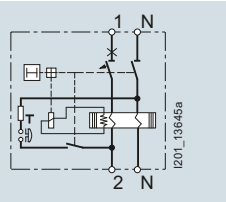
4P,
125 A

Handle coupler

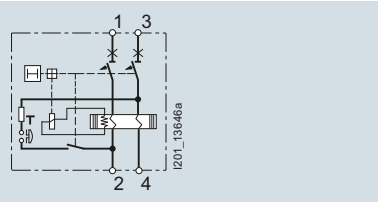


Circuit diagrams

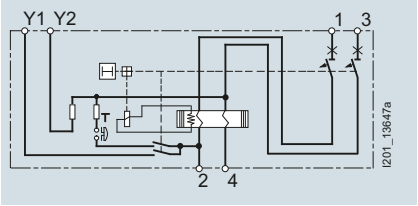
Graphic symbols



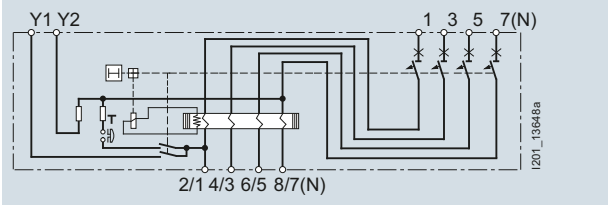
1P+N,
up to 40 A



2P,
up to 40 A



2P,
125 A



4P,
125 A

More information

Selectivity of RCBOs/fuses

Distribution systems are usually set up as radial networks. An overcurrent protection device is required for each reduction of the conductor cross-section. This produces a series connection staggered according to rated currents, which should, if possible, be "selective".

Selectivity means that, in the event of a fault, only the protective device that is directly next to the fault source in the current path is tripped. This means that current paths in parallel can maintain a power flow.

In the case of RCBOs with upstream fuses, the selectivity limit depends largely on the current limitation and tripping characteristics of the RCBO and the melting I^2t value of the fuse.

This produces different selectivity limits for RCBOs with different characteristics and rated switching capacity.

The following tables provide information on the short-circuit currents up to which selectivity exists between RCBOs and upstream fuses according to DIN VDE 0636 Part 21. The values specified in kA are limit values that were determined under unfavorable test conditions. Under normal practical conditions, you can often expect considerably better values, depending on the upstream fuses.

Limit values of selectivity of RCBOs/fuses in kA

Downstream RCBOs		Upstream fuses								
	I_n [A]	16 A	20 A	25 A	35 A	50 A	63 A	80 A	100 A	125 A
B characteristic 5SU1.56	6	0.4	0.7	1.1	2.0	4.1	•	•	•	--
	10	--	0.5	0.75	1.4	2.4	3.4	4.2	•	--
	13	--	0.45	0.7	1.3	2.0	2.7	3.6	•	--
	16	--	0.45	0.7	1.3	2.0	2.7	3.6	•	--
	20	--	--	0.7	1.3	2.0	2.7	3.6	•	--
	25	--	--	--	1.3	2.0	2.7	3.6	•	--
	32	--	--	--	--	2.0	2.7	3.6	•	--
	40	--	--	--	--	1.8	2.7	3.6	•	--
C characteristic 5SU1.56	6	0.35	0.55	0.8	1.5	2.8	4.7	•	•	--
	8	--	0.45	0.7	1.4	2.3	3.3	4.2	•	--
	10	--	0.45	0.7	1.4	2.3	3.3	4.2	•	--
	13	--	0.4	0.6	1.2	2.0	3.0	3.5	•	--
	16	--	0.4	0.6	1.2	2.0	3.0	3.5	•	--
	20	--	--	0.6	1.2	2.0	3.0	3.5	•	--
	25	--	--	--	1.2	2.0	3.0	3.5	•	--
	32	--	--	--	--	2.0	2.8	3.5	•	--
	40	--	--	--	--	1.8	2.8	3.5	•	--

• ≙ ≥ Rated breaking capacity according to EN 61009-1 6 000 .

B characteristic 5SU1.54	6	0.45	0.7	1.1	2.2	5.0			•	•
	10	--	0.55	0.8	1.5	2.8	4.6	7.0	•	•
	13	--	0.5	0.75	1.4	2.3	3.9	6.0	•	•
	16	--	0.5	0.75	1.4	2.3	3.9	6.0	•	•
	20	--	--	0.75	1.4	2.3	3.9	6.0	•	•
	25	--	--	--	1.2	2.0	3.1	4.5	8.0	•
	32	--	--	--	--	2.0	3.1	4.5	8.0	•
	40	--	--	--	--	1.8	2.8	4.0	7.0	•
C characteristic 5SU1.54	6	0.4	0.6	0.9	1.7	3.3	6.5	•	•	•
	8	--	0.5	0.8	1.5	2.7	5.0	7.0	•	•
	10	--	0.5	0.8	1.5	2.7	5.0	7.0	•	•
	13	--	0.5	0.7	1.3	2.3	4.0	5.0	•	•
	16	--	0.5	0.7	1.3	2.3	4.0	5.0	•	•
	20	--	--	0.6	1.2	2.0	3.2	4.4	8.0	•
	25	--	--	--	1.2	2.0	3.2	4.4	8.0	•
	32	--	--	--	--	1.8	2.8	3.6	7.0	•
	40	--	--	--	--	1.8	2.8	3.6	7.0	•

• ≙ ≥ Rated breaking capacity according to EN 61009-1 10 000 .

Overview

Characteristics

The Siemens portfolio of protective devices has been proving itself in the field for many years. This range of fuses, miniature circuit breakers and residual current protective devices has now been expanded to include AFDDs (arc fault detection devices). These AFDDs detect arcing faults caused by serial faults or loose contacts or as a result of insulation faults that enable contact between phase conductors or between phase and protective conductors. They therefore offer extremely effective protection against fires started by electrical faults.

Generally speaking, arcing faults in the circuit can result from damage to cables and other insulations and from contamination. Insulation faults result, for example, from vibrations, thermal expansion and contraction, mechanical loads and aging.

A distinction is made between 3 types of arcing faults:

Serial arcing faults

This is caused by breaks in the conductor or when a loose contact is in the circuit in series with the load. As the current flow in such cases is always lower than the operational load current, miniature circuit breakers and residual current protective devices are unable to detect such faults and initiate tripping.

The AFDD is specially designed to detect the specific characteristics of these arcing faults, and it reliably disconnects the affected circuit as soon as the limit values are exceeded.

Parallel arcing faults between phase conductor/neutral conductor or phase conductor/phase conductor

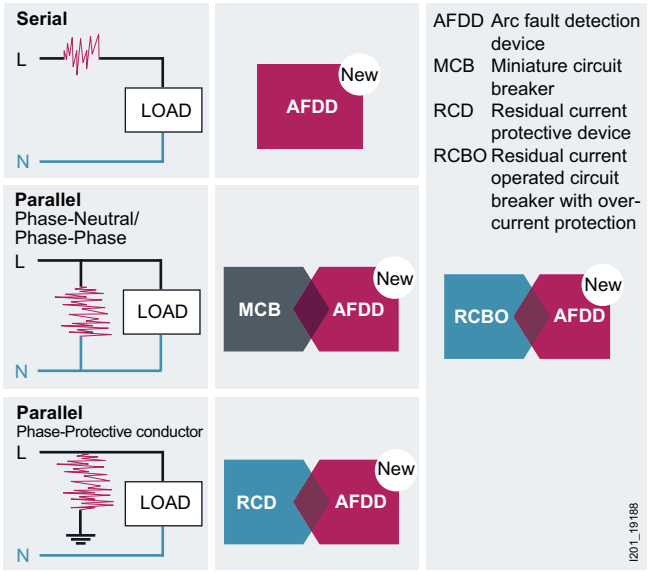
These are caused by electric arcs resulting from damage to the insulation that permits contact between the two conductors. In this case, the level of current is determined by the impedances in the circuit. Depending on the rated current of the overcurrent protection device (for instance a miniature circuit breaker), this can be disconnected. However, if the impedance in the circuit is too high to reach the trip current of the overcurrent protection device, no tripping takes place. AFDDs disconnect the currents of arcing faults upwards of 2.5 A, thus providing reliable protection in the case of such faults.

Parallel arcing faults between phase conductor/protective conductor

Arcing faults against the protective conductor are reliably detected and shut down by residual current protective devices. Residual current protective device with rated residual currents up to max. 300 mA have already been providing effective fire protection in such cases for many years.

AFDDs also detect these arcing faults and provide adequate fire protection where no residual current protective device is implemented.

Closing of the safety gap on the IEC market



Preventing undesired tripping operations

Electric arcs and high-frequency signals occur during normal operation in networks with multiple electrical loads (e.g. electric motors, light switches, dimmers). The AFDD must not break the circuit in such cases.

Thanks to the sophisticated detection logic of our AFDDs, they are able to clearly distinguish between normal operational interference signals and hazardous arcing faults.

Product versions and application

Siemens offers two product versions, which can be used in various combinations with a range of 1MW/2MW miniature circuit breakers and/or RCBOs up to max. 16 A rated current.

This simplifies product selection and reduces inventory, while enabling coverage of every conceivable application. It also means that our tried and tested protective devices (MCBs, RCBOs) can be combined with the new functionality provided by arc fault protection. In particular, the version with RCBOs offers a protective device that provides comprehensive personnel, short-circuit, overload and fire protection in a single device.

The version combined with a compact miniature circuit breaker in 1 MW is a space-saving alternative that is ideal for retrofitting.

Whether auxiliary switch or fault signal contact – the 5SM6 AFDD units can be combined at random with the versatile range of additional components from the familiar portfolio of 5SY miniature circuit breakers and 5SU1 RCBOs.

This also enables connection to a higher-level I&C system.

The 5SM6 AFDD units can be connected easily and quickly. The miniature circuit breakers or RCBOs can be mounted quickly and simply by just snapping them onto the mounting rail without the need for tools. For a fast and reliable power supply, the infeed can be implemented via a busbar assembly.

The AFDDs are primarily intended for protection of final circuits in cases where

- There is an increased risk of fire due to flammable materials being stored or processed (e.g. wood processing)
- Flammable building materials are in use (e.g. wood paneling)
- Valuable goods need to be protected (e.g. museums)
- There are rooms in which a fire might not be noticed immediately (e.g. bedrooms, children's bedrooms)

Status displays and self tests

In order to facilitate fault locating in the event of tripping, AFDDs have a display with 5 LEDs that provide information on the cause of tripping (serial/parallel arcing faults, overvoltage). The sophisticated detection electronics system also automatically checks the functionality of the AFDD. If the self-monitoring process detects a fault, the AFDD switches off and displays the corresponding indication.

	Arc fault detection device (5SM6) fault indication
	Device functional
	Restricted device function (background noise marginal)
	Serial or parallel arcing faults detected
	Overvoltage (> 275 V)
	Self-test failed
	No power supply

Integrated overvoltage protection

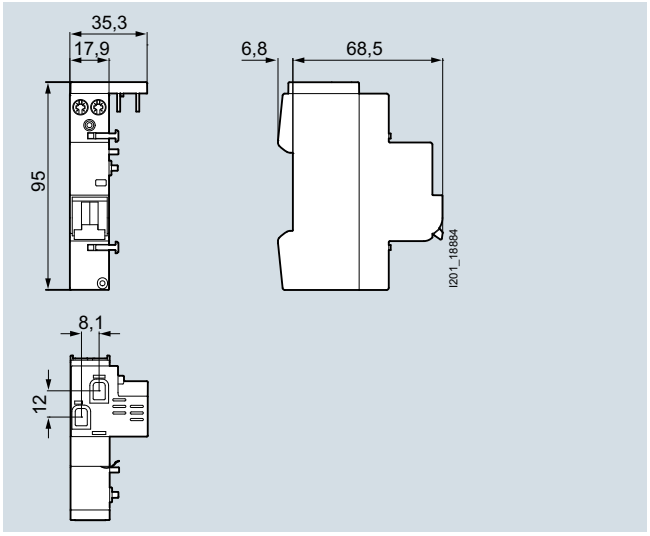
Depending on the load distribution in the three-phase current system, an interruption on the infeed side of the neutral conductor may cause a shift of the neutral point and thus an increase in voltage between the phase conductor and the neutral conductor. This increase in voltage can damage the loads or present a fire risk due to overloaded components.

In order to ensure all-round protection, the AFDDs are fitted with an overvoltage release that disconnects when the voltage between phase conductor and neutral conductor exceeds 275 V, thus isolating downstream loads from the hazardous line voltage.

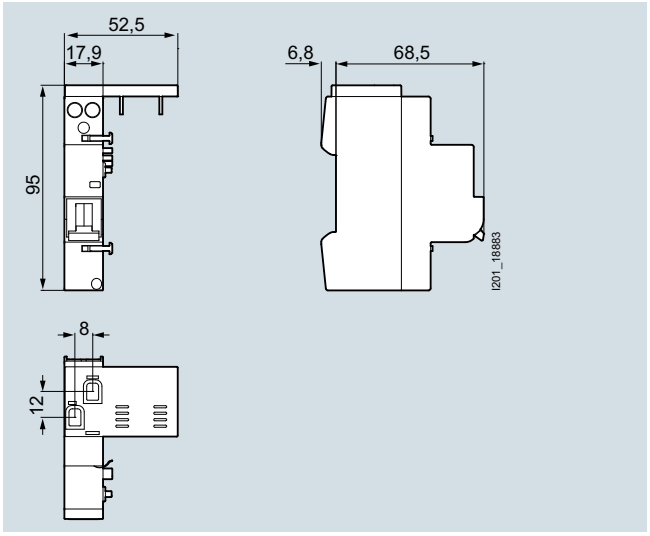
Technical specifications

Standards			Future standard – IEC/EN 62606
Versions			2-pole
Rated voltage U_n		V	230
Rated current I_n		A	Up to 16
Rated frequency		Hz	50
Mains connection			Bottom
Tripping in the event of overvoltage		V	> 275
Degree of protection	Acc. to EN 60529 (VDE 0470-1)		IP20, with connected conductors
Surge current withstand capability			
With current waveform 8/20 µs		kA	3
Touch protection	Acc. to EN 50274 (VDE 0660-514)		Finger and back-of-hand safe
Terminal tightening torque		Nm	2.0 ... 2.5
Terminal/conductor cross-sections			
• Solid and stranded		mm^2	0.75 ... 16
• Finely stranded with end sleeve		mm^2	0.75 ... 10
Overvoltage category			III
Mounting position			Any
Service life average number of switching cycles			> 10000
Ambient temperature		°C	-25 ... +40, marked with 
Storage temperature		°C	-40 ... +75
Resistance to climate	Acc. to IEC 60068-2-30		28 cycles (55 °C; 95 % rel. air humidity)
Pollution degree			2
CFC and silicone-free			Yes
Power losses		W	0.6

Dimensional drawings

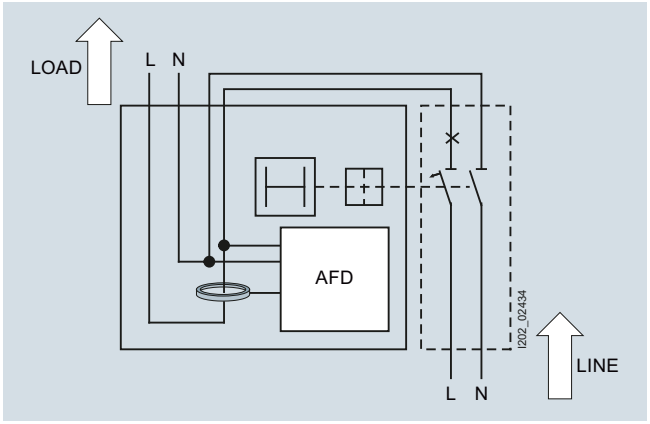


5SM6011-1



5SM6021-1

Circuit diagrams



NEW 5SM6 AFD units for PV applications

Overview

The Siemens portfolio of protective devices has been proving itself in the field for many years. This range of fuses, miniature circuit breakers and residual current protective devices has now been expanded to include the 5SM6 AFD units. These AFD units detect arcing faults that may be caused, for example, by serial faults or loose contacts.

Benefits

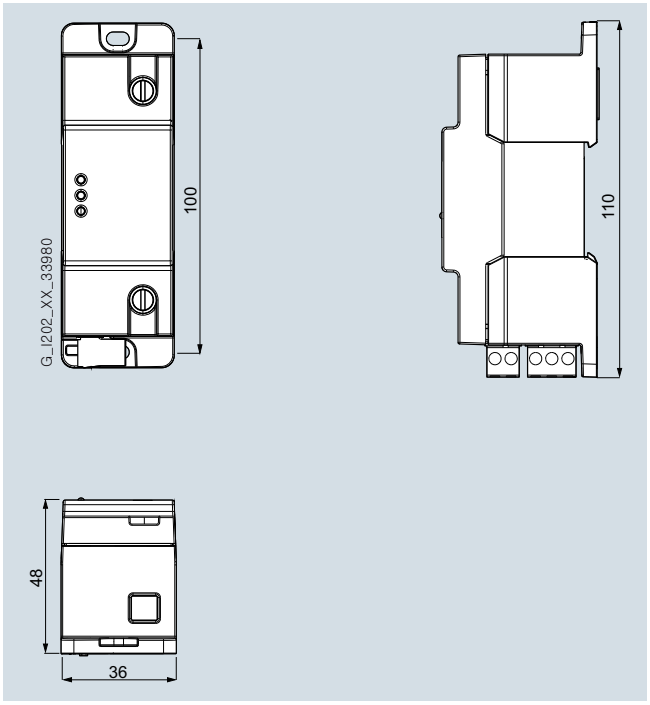
- Easy to install and retrofit
- Visual and acoustic indication of arcing faults when a fault is detected
- Resetting of the arcing fault indication
- Developed according to UL 1699B
- Cost savings thanks to easy installation
- Integration into an external safety system for safe system disconnection

Technical specifications

			5SM6094-1
Standards			IEC 60364-7-712, UL1699B
Category			PV AFD Type 1 (UL 1699B)
Rated current I_n		A	40
Rated voltage DC		V	1000
Tripping current for serial arcs		A	1 … 40
Tripping voltage DC		V	Min. 100
Supply voltage DC		V	24
Terminal conductor cross-sections			
• String connection		mm^2	2.5 to 10
• Supply voltage connection		mm^2	2.5
• Signal connection		mm^2	2.5
Terminal tightening torque			
• String connection		Nm	Max. 3.5 mm^2
• Supply voltage connection		Nm	Max. 1.5 mm^2
• Signal connection		Nm	Max. 1.5 mm^2
Current consumption			
• Active		mA	120
• Passive		mA	60
Operational current (load) alarm relay (125 V AC)		A	0.3
Operational current (load) alarm relay (30 V DC)		A	1
Overvoltage category			III
Supply voltage connection			Bottom
Mounting position			Any
Number of poles			1
Degree of protection			
• Acc. to EN 60529 (VDE 0470-1)			IP20, with connected conductors
• Acc. to EN 50274 (VDE 0660-514)			Finger and back-of-hand safe
CFC and silicone-free			Yes
Pollution degree			2
Storage temperature		°C	-40 ... +75
Ambient temperature		°C	-20 … +50
Resistance to climate	Acc. to IEC 60068-2-30		28 cycles (55 °C; 95 % rel. air humidity)

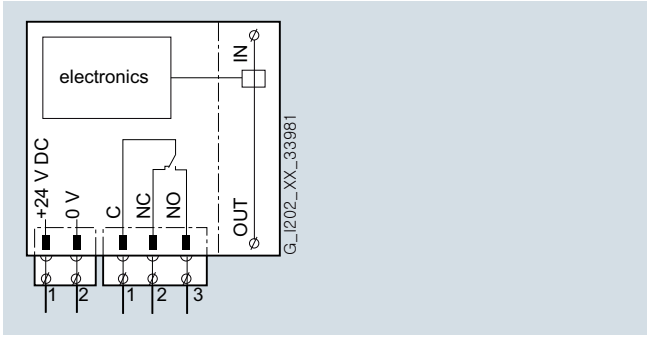
5SM6 AFD units for PV applications NEW

Dimensional drawings



5SM6094-1

Circuit diagrams



Overview

4-pole 5SM3 RCCBs are bus-mounted either together or in combination with miniature circuit breakers. RCCBs with an N conductor connection on the left-hand side facilitate installation because standard busbars are used, as those used for bus mounting miniature circuit breakers.

Busbars in 10 mm^2 and 16 mm^2 versions are available.

The extremely flexible 5ST36 busbar system with fixed lengths also enables installation in any lengths as the busbars can be overlapped.

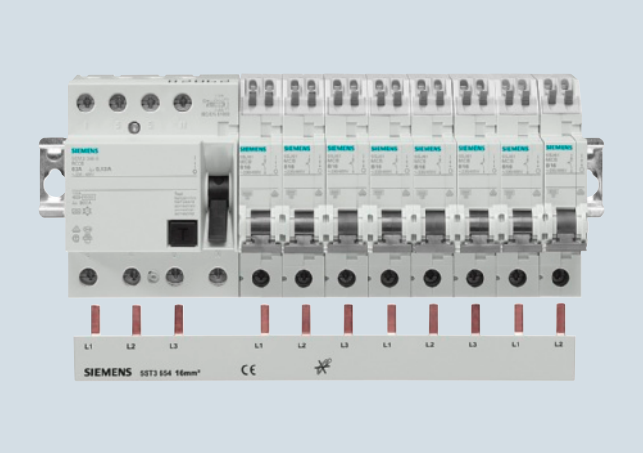
No further need for time-consuming tasks, such as cutting, cutting to length, deburring, cleaning of cut surfaces and mounting of end caps.

Any free pins on the busbars can be made safe by covering with touch protection.

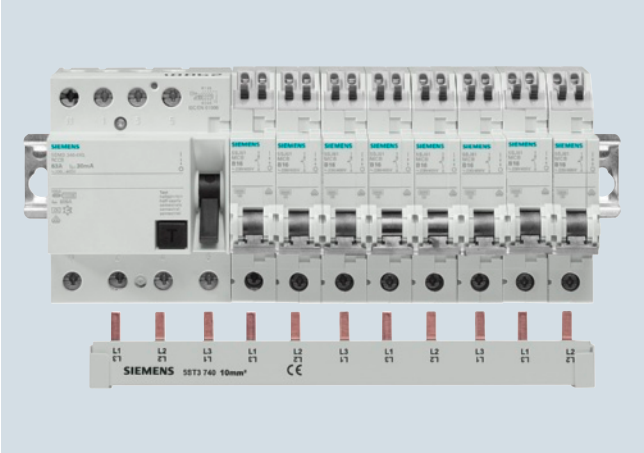
If several RCBOs are bus-mounted together, this is implemented with 2-phase busbars, which are thus used as 1+N busbars.

Benefits

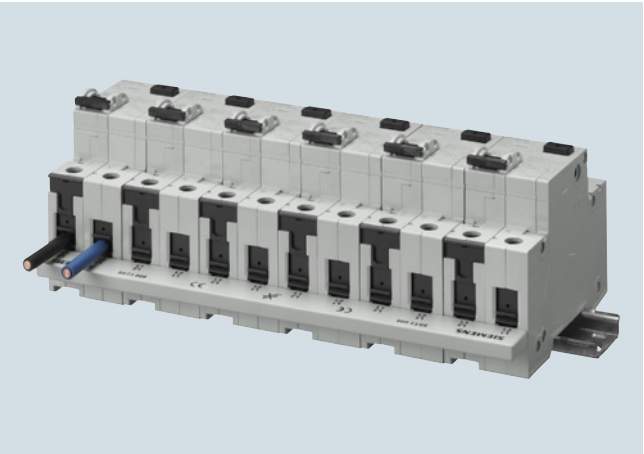
- Connection of miniature circuit breakers to 4-pole RCCBs with N connection right and 3-phase busbar, using busbar specially designed for this application. No cutting or end caps required.



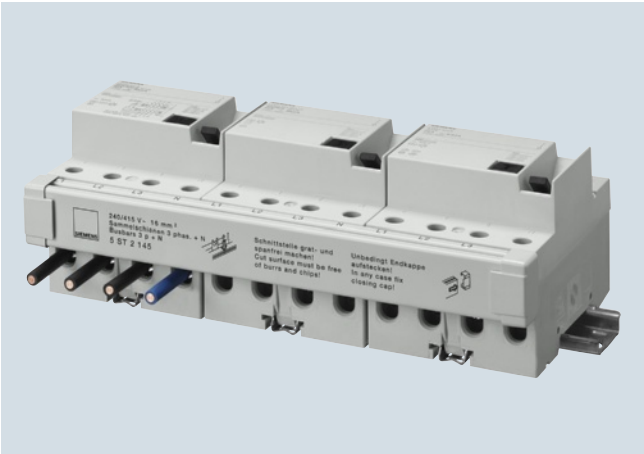
- Connection of miniature circuit breakers to 4-pole RCCBs with N connection left, with 3-phase busbar that can be cut. No additional items to be stored and busbars that are always available.



- Connection of 1P+N RCBOs with two-phase busbar. No cutting or end caps required.



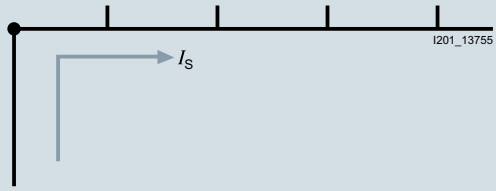
- Bus-mounting of residual current protective devices on busbar (3-phase +N) that can be cut. A proven and frequently used application.



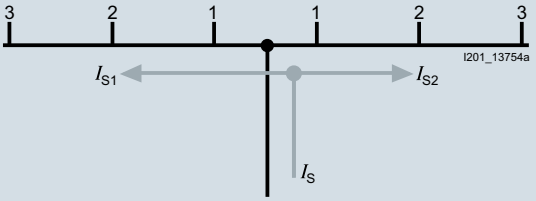
Technical specifications

			5ST3, 5ST2
Standards			EN 60439-1 (VDE 0660-500): 2005-01
Busbar material			SF-Cu F 24
Partition material			Plastic Cycoloy 3600 Temperature-resistant above 90 °C Flame-retardant Self-extinguishing Dioxin-free and halogen-free
Rated operational voltage U_e		V AC	400
Rated current I_n			
• Cross section 10 mm^2		A	63
• Cross section 16 mm^2		A	80
Rated impulse withstand voltage U_{imp}		kV	4
Test pulse voltage (1.2/50)		kV	6.2
Rated conditional short-circuit current I_{cc}		kA	25
Resistance to climate			
• Constant atmosphere	Acc. to DIN 50015		23/83; 40/92; 55/20
• Humid heat	Corresponds to IEC 68-2-30		28 cycles
Insulation coordination	Acc. to IEC 60664-1 (VDE 0110-1)		
• Overvoltage category			III
• Pollution degree			2
Maximum busbar current I_S per phase			
• Infeed at the start of the busbar			
- Cross section 10 mm^2		A	63
- Cross section 16 mm^2		A	80
• Infeed at the center of the busbar			
- Cross section 10 mm^2		A	100
- Cross section 16 mm^2		A	130

Infeed at the start or end of the busbar

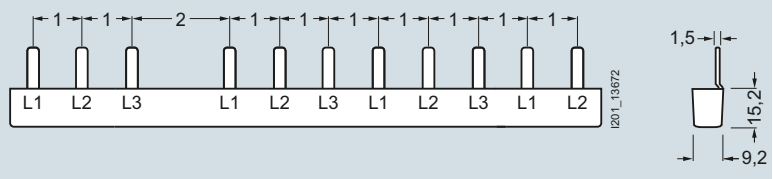


Infeed along the busbar or midpoint infeed

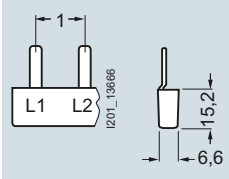


The sum of the outgoing current per branch (1, 2, 3...n) must not be greater than the max. busbar current I_S/phase.

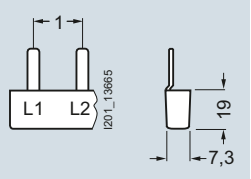
Dimensional drawings



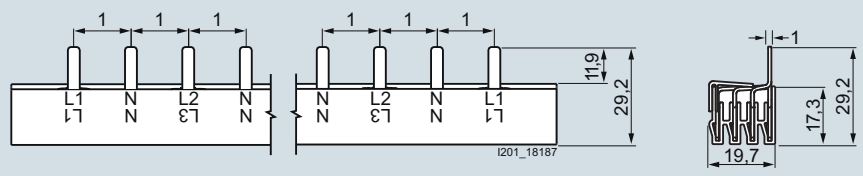
5ST3624



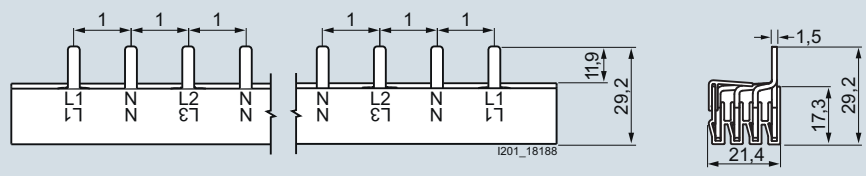
5ST3608



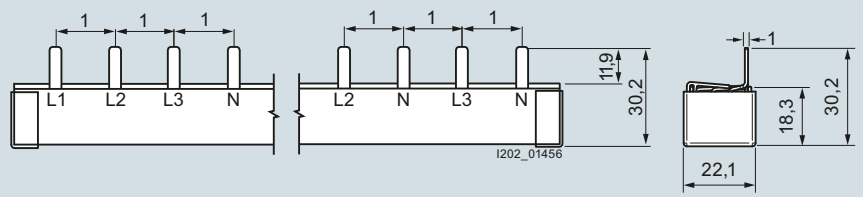
5ST3638



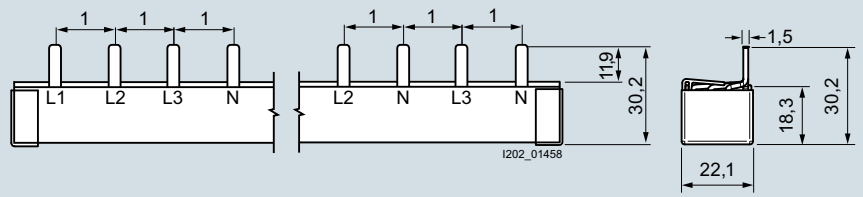
5ST3770-2



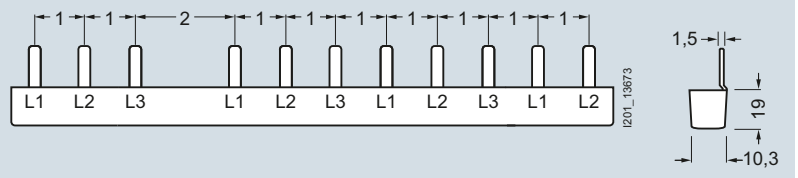
5ST3770-3



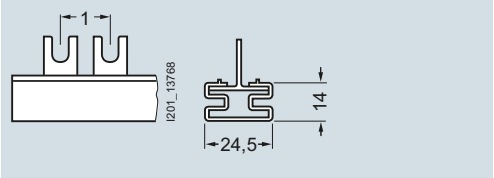
5ST3770-4



5ST3770-5



5ST3654



5ST2145

Note:

Pin spacing in MW
Dimensions of side view in mm (approx.).

Further busbars can also be found in the configuration manual for miniature circuit breakers.

Overview

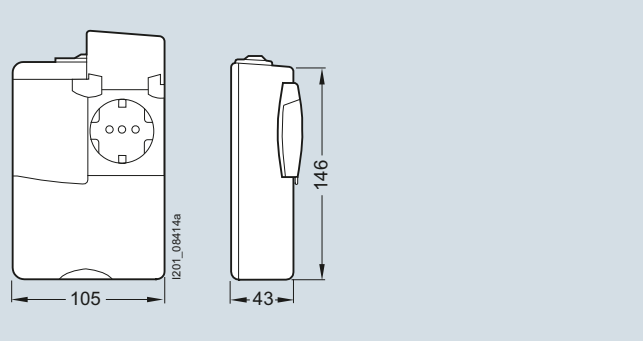
	Number of poles	Rated current I_n A	Rated residual currents $I_{\Delta n}$ mA	⏦ (Type A)
RCCB protective socket outlets				
• For mounting onto device box, equipped with RCCB and 2 SCHUKO® socket outlets	2	16	10, 30	✓
• Molded-plastic enclosures, equipped with RCCB and SCHUKO® socket outlet	2	16	10	✓

⏦ = Type A for AC and pulsating DC residual currents

Dimensional drawings

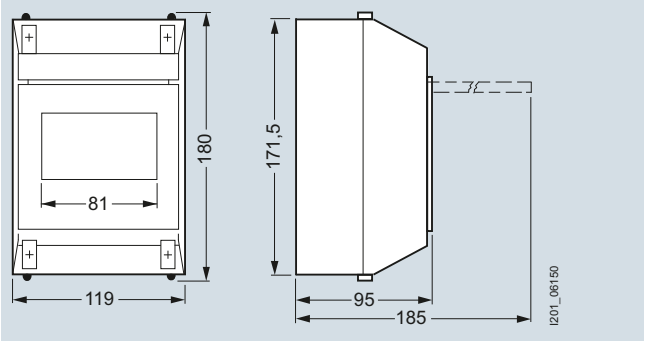
5SM1920 RCCB protective socket outlet

According to VDE 0664 for mounting on device boxes, equipped with residual current operated circuit breaker and 2 SCHUKO childproof socket outlets.



5SZ92.6 RCCB protective socket outlets, 5SW1200 molded-plastic enclosures

Molded-plastic enclosures, equipped with RCCB and flush-mounting SCHUKO socket outlets.



Overview

Protection by means of residual current protective devices

In the case of "automatic disconnection of the power supply" by means of a residual current protective device, it is essential that the system components and equipment to be protected are fitted with an appropriately grounded PE conductor. This means that it is only possible for a person to be subjected to a flow of current if two faults occur (in addition to an insulation fault, the interruption of the PE conductor) or in the event of accidental contact with live parts.

Additional protection (Protection against direct contact) with $I_{\Delta n} \leq 30$ mA

Direct contact refers to a situation where a person comes into direct contact with a part that is live under operating conditions. If a person directly touches live parts, two series-connected resistors determine the level of the current flowing – the internal resistance of the person R_m and the contact resistance of the location R_{st}.

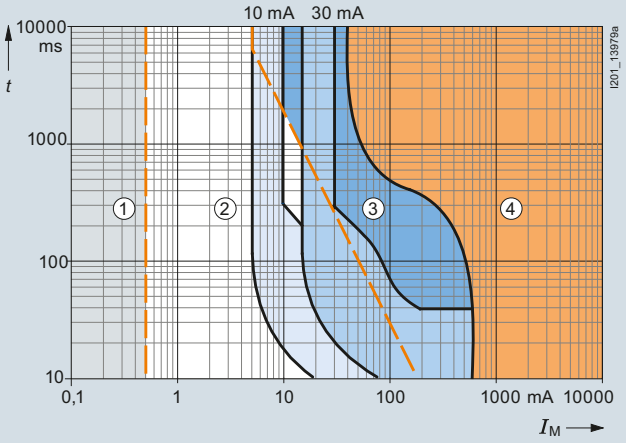
For a proper assessment of the accident risk, it must be assumed that the contact resistance of the location is virtually zero.

The resistance of the human body depends on the current path and the contact resistance of the skin. Measurements have shown, for example, that a current path of hand/hand or hand/foot has a resistance of approx. 1000 Ω.

Based on this assumption, a touch voltage of 230 V would produce a dangerous leakage current of 230 mA. The figure "Areas of impact of alternating current 50/60 Hz on the human body" shows the current intensity/contact time curves with reference to the physiological reactions of the human body. The dangerous values are the current intensity/contact time values in range 4, as they can trigger ventricular fibrillations, which can cause death.

It also shows the tripping ranges of the residual current protective devices with rated residual current of 10 mA and 30 mA. The max. permissible tripping times according to VDE 0664-10 are entered here. As can be seen from the tripping curve, residual current protective devices do not restrict the level of the residual current, rather they have a protective effect due to the fast disconnection of the current, and thus short contact time.

Areas of impact of alternating current 50/60 Hz on the human body



Range ①: Usually not perceptible

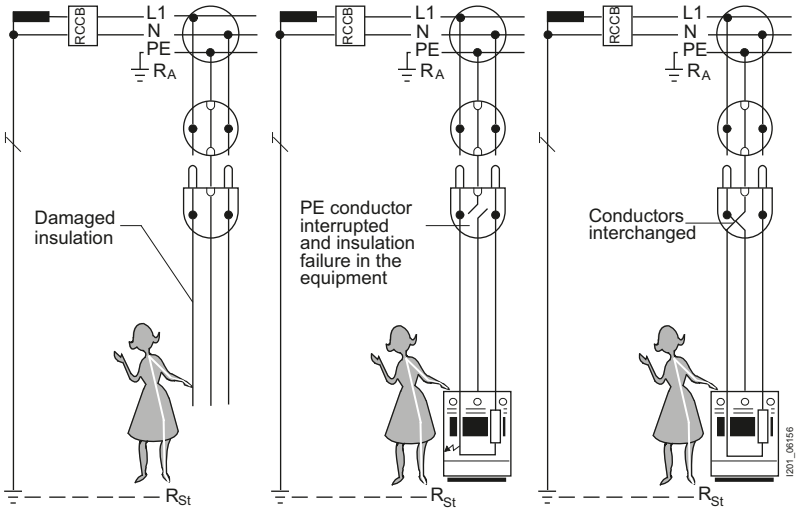
Range ②: No muscle spasms

Range ③: Muscle spasms possible

Range ④: Ventricular fibrillations may occur

I_M: Leakage current

t: Contact time



Examples of accidental direct contact

Residual current protective devices with a rated residual current $I_{\Delta n} \leq 10$ mA have a tripping characteristic in range 2 below the let-go current. There are generally no injurious effects or muscle spasms (see illustration). They are therefore suitable for sensitive areas, such as bathrooms.

Configuration

Residual current protective devices with a rated residual current $I_{\Delta n} \leq 30$ mA meet the conditions for additional protection against electric shock (see figure):

- From unintentional, direct contact with live parts as for standard operations (e.g.: failure of the basic insulation, improper use, ineffectiveness of the basic protection)
- In the case of negligence on the part of the user (e.g. use of defective devices, inexpert repairs to systems and/or equipment)
- In the case of contact with faulty live parts (e.g. failure of leakage protection in the event of interruption of the protective conductor)

The use of residual current protective devices with rated residual current of up to 30 mA has proven an effective enhanced protection in the event of failure of basic protection measures (protection against direct contact) and/or fault protection measures (protection against indirect contact), as well as in the case of negligence on the part of the user when handling electrical equipment. However, this must not be the sole means of protection against electric shock. This does not replace the need for further protective measures as required by DIN VDE 0100-410.

The requirement for "enhanced protection" with residual current protective devices according to sections 411.3.3 and 415.1 of DIN VDE 0100-410 does not mean that the application of this protection is optional. Rather, it means that this enhanced protection may be required in relation to external influences and in specific areas in coordination with further protective measures.

In several parts of the standards for Groups 4 and 7 of DIN VDE 0100, this additional protection is required or explicitly recommended. The following explains some of the key requirements.

The general building standard for protection against electric shock, DIN VDE 0100-410:2007-06 requires the use of residual current protective devices with rated residual current ≤ 30 mA for

- All socket outlets with a rated current ≤ 20 A if they are intended for use by non-experts and for general use
- Branch circuits for portable tools and equipment used outdoors with a rated current ≤ 32 A

Note:
While DIN VDE 0100-410:06-2007 specifies two exceptions to these requirements, these are not generally applicable to the majority of applications.

The standard does not specify enhanced protection for socket outlets that are used solely by electrical engineers and persons with electrical training (e.g. in electrical workshops) or if it is ensured that the socket outlet is permanently used solely for "specific equipment".

The standard DIN VDE 0100-723:2005-06 "Requirements for special installations or locations – class-rooms with experimental equipment" stipulates that, for the supply of experimental equipment and their circuits, the TN or TT systems must be fitted with residual current protective devices, type B, with rated residual current ≤ 30 mA.

Leakage protection (protection against indirect contact)

Indirect contact refers to the electric contact of persons with an electrically conductive part which is not normally live under operating conditions but has become live under fault conditions. In such cases, it is essential that the power supply is automatically disconnected if a fault means that the level and duration of the touch voltage could pose a risk.

For this purpose, residual current protective devices with a rated residual current of over 30 mA are also suitable. The interrupt conditions must be observed if the protective effect is to be obtained. Taking into account the grounding resistance and the rated residual current, the dangerous touch voltage must not persist for a time sufficient to cause a risk of harmful physiological effect in a person.

Fire barrier

DIN VDE 0100-482 requires measures to be taken to prevent fires in "Locations exposed to fire hazards" that may result from insulation faults. This stipulates that cables and conductors in TN and TT systems must be protected by means of residual current protective devices with a rated residual current of $I_{\Delta n}$ = 300 mA. This does not include mineral-insulated cables and busbar systems.

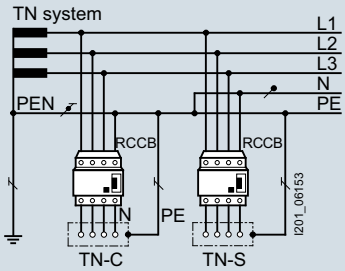
In the case of applications where resistance-related faults may cause a fire (e.g. ceiling heating with panel heating elements), the rated residual current must be $I_{\Delta n}$ = 30 mA.

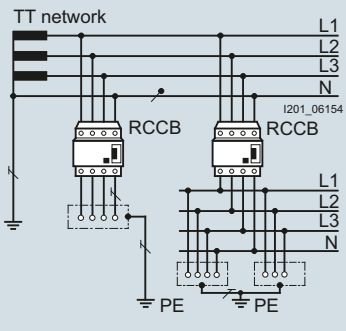
Protection against fires provided by separate residual current protective devices should not be solely restricted to locations exposed to fire hazards, but universally implemented.

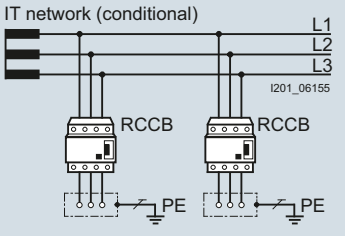
Use

Residual current protective devices can be used in all three system types (DIN VDE 0100-410).

In the IT system, tripping is not required for the first fault as this situation cannot produce any dangerous touch voltages. It is essential that an insulation monitoring device is fitted so that the first fault is indicated by an acoustic or visual signal and the fault can be eliminated as quickly as possible. Tripping is not requested until the 2nd fault. Depending on the grounding situation, the trip conditions of the TN or TT system must be complied with. A residual current protective device is also a suitable circuit-protection device, whereby a separate residual current protective device is required for each piece of current-using equipment.







Grounding resistances

When using residual current protective devices in a TT system, the maximum grounding resistances (as shown in the following table) must be complied with, depending on the rated residual current and the max. permissible touch voltage.

Rated residual current	Max. permissible grounding resistance at a max. permissible touch voltage of	
$I_{\Delta n}$	50 V	25 V
10 mA	5000 Ω	2500 Ω
30 mA	1660 Ω	830 Ω
100 mA	500 Ω	250 Ω
300 mA	166 Ω	83 Ω
500 mA	100 Ω	50 Ω
1 A	50 Ω	25 Ω

Design and method of operation of residual current protective devices

The design of residual current protective devices is largely determined by 3 function groups:
1) Summation current transformer for recording fault current
2) Releases to convert the electrical measured quantities into a mechanical tripping operation
3) Breaker mechanism with contacts

The summation current transformer covers all conductors required to conduct the current, i.e. also the neutral conductor where applicable.
In a fault-free system, the magnetizing effects of the conductors through which current is flowing cancel each other out for the summation current transformer as, in accordance with Kirchhoff's current law, the sum of all currents is zero. There is no residual magnetic field left that could induce a voltage in the secondary winding.

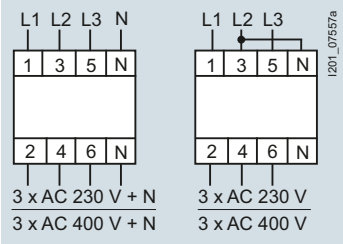
However, by contrast, if a residual current is flowing due to an insulation fault, this destroys the equilibrium and a residual magnetic field is left in the transformer core. This generates a voltage in the secondary winding, which then uses the release and the breaker mechanism to switch off the electrical circuit afflicted by the insulation fault.
This tripping principle operates independently of the supply voltage or an auxiliary power supply. This is also a condition for the high protection level provided by residual current protective devices according to IEC/EN 61008 (VDE 0664).
Only this way can it be ensured that the full protective action of the residual current protective device is maintained even in the event of a system fault, e.g. failure of a phase conductor or an interruption in the neutral conductor.

Test button

All residual current protective devices are equipped with a test button. Simply press this button to test whether the residual current protective device is ready to run. Pressing the test button generates an artificial residual current – the residual current protective device must trip.
We recommend testing the functionality when commissioning the system and then at regular intervals – approx. every six months.
Furthermore, it is also essential to ensure compliance with the test intervals specified in the pertinent rules and regulations (e.g. accident prevention regulations).

3-pole connection

4-pole residual current protective devices can also be operated in 3-pole systems. In this case, connection must be at terminals 1, 3 and 5 and 2, 4 and 6.
The function of the test equipment is only ensured if a jumper is fitted between terminals 3 and N.



Configuration

SIGRES RCCBs for severe ambient conditions

Our SIGRES RCCBs have been developed for use in environments with increased pollution gas loads, such as

- Indoor swimming pools: chlorine gas atmosphere
- Agriculture: ammoniac
- Construction site distribution boards, chemical industry: Nitrogen oxide [NO_x] and sulfur dioxide [SO_2].

A significant increase in service life is achieved using our patented active condensation protection.

When using SIGRES RCCBs, the following points must be observed:

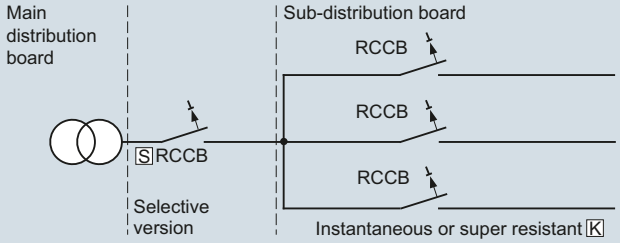
- The infeed must always be from below, at terminals 2/N or 2/4/6/N
- Before carrying out insulation tests on installation systems with voltages greater than 500 V, the SIGRES RCCB must be switched off or the cables on the input side (below) must be disconnected

Short-time delayed tripping, super resistant K

Electrical loads that temporarily produce high leakage currents when they are switched on (e.g. temporary residual currents flowing through interference-suppression capacitors between phase conductor and PE) may trip instantaneous residual current protective devices if the leakage current exceeds the rated residual current $I_{\Delta n}$ of the residual current protective device. Short-time delayed, super resistant residual current protective devices can be installed for this type of application, where it is not possible, or only partially possible, to eliminate such interference sources. These devices have a minimum tripping delay of 10 ms, i.e. they should not trip for a residual current pulse of 10 ms. This complies with the maximum permissible break times according to IEC/EN 61008-1 (VDE 0664-10). The devices have a high surge current withstand capability of 3 kA.
Short-time delayed, super resistant residual current protective devices have the identification code K.

Selective tripping S

Residual current protective devices normally have an instantaneous tripping operation. This means that a series connection of this type of residual current protective devices does not provide selective tripping in the event of a fault. In order to achieve selectivity for a series connection of residual current protective devices, both the tripping time and the rated residual current of series-connected devices must be time graded. Selective residual current protective devices have a tripping delay.
Furthermore, selective residual current protective devices must have an increased surge current withstand capability of at least 3 kA according to IEC/EN 61008-1 (VDE 0664-10). Siemens devices have a surge current withstand capability of ≥ 5 kA.
Selective residual current circuit breakers have the identification code S.
The table below shows the time grading options available for residual current protective devices for selective tripping in series connection with devices without time delay and super resistant with short-time delay K.



Upstream RCCB for selective disconnection S		Downstream RCCB or		
			Instantaneous version	Super resistant version K
$I_{\Delta n}$	Break time at 5 x $I_{\Delta n}$	$I_{\Delta n}$	Break time at 5 x $I_{\Delta n}$	Break time at 5 x $I_{\Delta n}$
100 mA 300 mA 500 mA 1000 mA	50 ...150 ms	10 mA or 30 mA 10 mA, 30 mA or 100 mA 10 mA, 30 mA ,100 mA 300 mA	≤ 40 ms	20 … 40 ms

I201_15510a

Versions for 50 ... 400 Hz

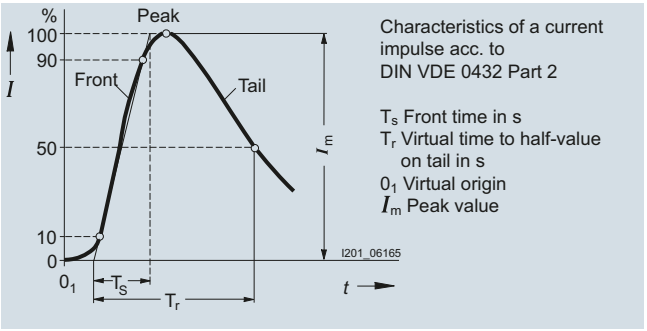
Due to their principle of operation, the standard versions of residual current protective devices are designed for maximum efficiency in 50/60 Hz systems. Product standards and tripping conditions also refer to this frequency. The sensitivity decreases with increasing frequency. In order to implement effective residual current protection for applications in systems up to 400 Hz (e.g. industry), you need to use suitable devices. Such residual current protective devices fulfill the tripping conditions up to the specified frequency and provide the appropriate level of protection.

RCCBs with left-side N connection

The fact that the RCCBs are usually located to the left of the miniature circuit breakers, but have their N conductor connection on the right-hand side, interferes with the integrated busbar connection. For this reason, RCCBs require a special busbar when used with miniature circuit breakers. In order to enable the use of standard busbars, four-pole RCCBs are also provided with their N connection on the left-hand side. This means that RCCBs can continue to be installed to the left of miniature circuit breakers using standard busbar connections.

Surge current withstand capability

During thunderstorms, atmospheric overvoltages in the form of traveling waves can penetrate the installations of a system over an overhead system and trip the residual current protective devices.
To prevent such inadvertent tripping operations, residual current protective devices sensitive to power pulse currents must pass specific tests to verify the surge current withstand capability. These tests are carried out using a surge current of the standardized surge current wave 8/20 µs.



Surge current wave 8/20 µs (front time 8 µs: Time to half-value 20 µs)

Siemens residual current protective devices of types A and B all have a high surge current withstand capability. The following table shows the surge current withstand capability of the various versions:

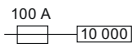
Version	Surge current withstand capability
Instantaneous	> 1 kA
Short-time delayed, super resistant K	> 3 kA
Selective S	> 5 kA

Breaking capacity, short-circuit strength

In accordance with the installation specifications DIN VDE 0100-410 (protection against electric shock) residual current protective devices can be installed in all three system types (TN, TT and IT systems).
However, if using the neutral conductor as a protective conductor in TN systems, a fault may cause residual currents similar to a short-circuit. For this reason, residual current protective devices must be installed together with a back-up fuse and have the appropriate short-circuit strength. Tests have been defined for this purpose.
The short-circuit strength of the combination must be specified on the devices.
Siemens residual current protective devices, together with a suitable back-up fuse, have a short-circuit strength of 10000 A. This is the highest possible level of short-circuit strength as specified in the VDE regulations.
Data for the rated breaking capacity according to IEC/EN 61008, i.e. the maximum permissible short-circuit back-up fuses for 5SM3 residual current protective devices are contained in the following table:

Rated current of the residual current protective device		**Rated switching capacity I_m acc. to IEC/EN 61008 (VDE 0664) for a grid distance of 35 mm**	**Maximum permissible short-circuit back-up fuse LV HRC, DIAZED, NEOZED**	
Type AC			**Operational class gG for residual current protection device**	
Type A			125 AC ... 400 V	500 V AC
Type F				
Type B				
Type B+				
A		A	A	A
16 ... 40	2 MW	500	63	--
63, 80	2.5 MW	800	100	--
100, 125	2 MW	1250	125	--
25, 40 (400 Hz)	4 MW	800	80	--
25 ... 63	4 MW	800	100	63
80	4 MW	800	100	--
100	4 MW	1000	100	--
125	4 MW	1250	125	--

Example:



Short-circuit strength 10 kA with max. permissible short-circuit series fuse 100 A.

Configuration

Types of current

Due to the use of electronic components in household appliances and industrial plants, insulation faults can also cause residual currents that are not AC residual currents to flow through residual current protective devices, even in the case of devices with ground terminals (safety class I).

The regulations for residual current protective devices contain additional requirements and test regulations for residual currents whose power supply frequency is zero or virtually zero within a certain period.

Residual current protective devices that trip for both sinusoidal AC residual currents and pulsating DC residual currents (type A) are identified by the mark .

Residual current protective devices that also trip for smooth DC residual currents (type B) are identified by the mark .

Type of current	Current waveform	Correct function of residual current protective devices of type					Tripping current[1]
		Type AC	Type A	Type F	Type B	Type B+	
AC fault current		✓	✓	✓	✓	✓	0.5 ... 1.0 $I_{\Delta n}$
Pulsating DC residual currents (pos. or neg. half-waves)		--	✓	✓	✓	✓	0.35 ... 1.4 $I_{\Delta n}$
Truncated half-wave currents		-- --	✓ ✓	✓ ✓	✓ ✓	✓ ✓	Start angle 90° 0.25 ... 1.4 $I_{\Delta n}$ Start angle 135° 0.11 ... 1.4 $I_{\Delta n}$
Half-wave current during superimposition with smooth direct current		-- --	✓ + 6 mA	✓ + 10 mA	✓ +0.4 mA	✓ +0.4 $I_{\Delta n}$	Max. 1.4 I $I_{\Delta n}$ + DC
Residual current from mixed frequency		--	--	✓	✓	✓	0.5 ... 1.4 $I_{\Delta n}$
Smooth direct current		--	--	--	✓	✓	0.5 ... 2.0 $I_{\Delta n}$

[1] Tripping operations according to IEC/EN 61008-1 (VDE 0664-10); for smooth DC residual currents defined to IEC 60755 UB1 INT.

Note:

For more information on the subject of
You will find residual current protective devices in the technology primer "Residual Current Protective Devices", Article No.: E10003-E38-2B-G0090.

Application

Standards	Application	Required $I_{\Delta n}$ [mA]	Recommended Siemens residual current protective devices			
			Type A	Type F	SIQUENCE type B/ type B+	SIGRES
DIN VDE 0100-410	Protection against electric shock	30 ... 500	✓	✓	✓	✓
	Socket outlets up to 20 A, plants outdoors	10 ... 30	✓	✓	--	--
DIN VDE 0100-482	Fire protection for particular risks or safety hazards	30, 300	✓	✓	✓	--
DIN VDE 0100-701	Rooms with baths or showers, socket outlets in zone 3	10 ... 30	✓	✓	--	--
DIN VDE 0100-702	Basins for swimming pools and other basins	10 ... 30	✓	--	--	✓
DIN VDE 0100-703	Rooms and cabins with sauna heating	10 ... 30	✓	--	--	✓
DIN VDE 0100-704 BGI 608	Building sites, socket outlet current circuits up to 32 A and for handheld equipment, plug-and-socket devices I_n > 32 A	≤ 30	✓	✓	✓	✓
		≤ 500	✓	✓	✓	✓
DIN VDE 0100-705	Agricultural and general horticultural premises, socket outlet circuits	≤ 500	✓	✓	--	✓
		≤ 30	✓	✓	--	✓
DIN VDE 0100-706	Conductive areas with limited freedom of movement, permanently attached resources	10 ... 30	✓	--	--	--
DIN VDE 0100-708	Electrical installations on camping sites, fixed feeding points for every socket outlet and every final circuit	10 ... 30	✓	--	--	✓
DIN VDE 0100-710	Medical premises in TN-S system, depending on application group 1 or 2 and equipment	10 ... 30	✓	--	✓	--
		≤ 300	✓	--	✓	--
DIN VDE 0100-712	Solar PV power supply systems (without simple separation)	≤ 300	--	--	✓	--
DIN VDE 0100-723	Classrooms with experimental equipment	10 ... 30	--	--	✓	--
DIN VDE 0100-739	Additional protection against direct contact in homes	10 ... 30	✓	--	--	--
EN 50178 (VDE 0160)	Fitting of power installations with electronic equipment	General requirements for correct selection when using res. current protection	✓	✓	✓	--
EN 50293 (VDE 0832-100)	Traffic signal systems • Class T1 • Class U1	 ≤ 300 ≤ 30	 ✓ ✓	 -- --	 -- --	 ✓ ✓
	Food processing and chemical industry	≤ 30 (recommended)	✓	--	--	✓

Note:

For reasons of basic fire protection, we recommend the use of residual current protective devices with maximum 300 mA rated residual current.

Notes

Siemens AG
Energy Management
Low Voltage & Products
Postfach 10 09 53
93009 REGENSBURG
GERMANY

Subject to change without prior notice
PDF (3ZW1012-5SM33-0AC1)
PH 0216 3. En
Produced in Germany

www.siemens.com/lowvoltage