
RCCBs


RCD-blocks


RCBOs

Functions and classification criteria for RCDs

A residual current operated circuit-breaker is an amperometric protection device which is tripped when the system leaks a significant current to earth.

This device continuously calculates the vector sum of the single-phase or three-phase system line currents and while the sum is equal to zero allows electricity to be supplied. This supply is rapidly interrupted if the sum exceeds a value preset according to the sensitivity of the device.

Residual current operated circuit-breakers can be classed according to four parameters:
- type of construction
- detectable wave form
- tripping sensitivity
- tripping time.

Depending on the type of construction, RCDs may be classed as:
- RCBOs (magnetothermic with overcurrent protection)
- RCCBs (without overcurrent protection releaser incorporated)
- RCD blocks.

RCBOs combine, in a single device, the residual current function and the overcurrent protection function typical of MCBs. RCBOs are tripped by both current leakage to earth and overloads and short-circuits and they are self-protecting up to a maximum short-circuit current value indicated on the label.

RCCBs are only sensitive to current leakage to earth. They must be used in series with an MCB or fuse which protects them from the potentially damaging thermal and dynamic stresses of any overcurrents.

These devices are used in systems already equipped with MCBs which preferably limit the specific energy passing through, also acting as the main disconnecting switches upstream of any derived MCBs (e.g.: domestic consumer unit).

RCD blocks are residual current devices suitable for assembly with a standard MCB. IEC/EN 61009 app. G only allows assembly of RCBOs once on site, that is to say outside the factory, using adaptable RCD blocks and the appropriate MCBs. Any subsequent attempts to separate them must leave permanent visible damage. The residual current operated circuit-breaker obtained in this way maintains both the electrical characteristics of the MCB and those of the RCD block.

According to the wave form of the earth leakage currents they are sensitive to, the RCDs may be classed as:
- AC type (for alternating current only)
- A type (for alternating and/or pulsating current with DC components)
- B type (for alternating and/or pulsating current with DC components and continuous fault current).

AC type RCDs are suitable for all systems where users have sinusoidal earth current.

They are not sensitive to impulsive leakage currents up to a peak of 250 A (8/20 wave form) such as those which may occur due to overlapping voltage impulses on the mains (e.g.: insertion of fluorescent bulbs, X-ray equipment, data processing systems and SCR controls).

A type RCDs are not sensitive to impulsive currents up to a peak of 250 A (8/20 wave form).

They are particularly suitable for protecting systems in which the user equipment has electronic devices for rectifying the current or phase cutting adjustment of a physical quantity (speed temperature, light intensity, etc.) supplied directly by the mains without the insertion of transformers and insulated in class I (class II is, by definition, free of faults to earth). These devices may generate a pulsating fault current with DC components which the A type RCD can recognise.

Technical details
Functions and classification criteria for RCDs

B type RCDs are recommended for use with drives and inverters for supplying motors for pumps, lifts, textile machines, machine tools, etc., since they recognise a continuous fault current with a low level ripple.

Type AC and type A RCDs comply with IEC/EN 61008/61009, whilst type B RCDs are not yet covered by any reference Standard for the household and similar use. Type B is covered only by IEC/EN 60947-2 for low voltage switchgear and control gear and by IEC/EN 60755 for residual current operated protective devices.

According to tripping sensitivity ($I_{\Delta n}$ value), RCDs may be divided into the following categories:

- low-sensitivity ($I_{\Delta n}$ >0.03 A), not suitable for protection against direct contacts; co-ordinated with the earth system according to the formula $I_{\Delta n}$ <50/R, to provide protection against indirect contacts;
- high-sensitivity ($I_{\Delta n}$: 0.01…0.03 A), or "physiologically sensitivity"for protection against indirect contacts, with simultaneous additional protection against direct contacts.
- against fire (up to 500 mA) according to IEC/EN 60364

Residual current sensitivity and environment

Household and special environments

$I_{\Delta n}$ ≤30 mA

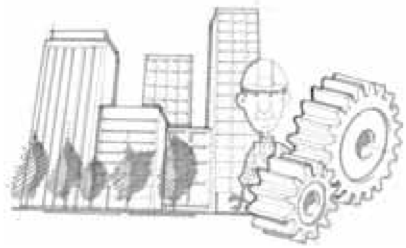
High-sensitivity or physiologically sensitive RCDs

IEC/EN 60364 make the use of these devices mandatory in all bathrooms, showers and private and public swimming pools and environments in which plugs and sockets may be installed without insulating or low safety voltage transformers.

Laboratories, service industry and small industry

$I_{\Delta n}$ from 30 mA to 500 mA

Large service industry and industrial complex



$I_{\Delta n}$ from 500 mA to 1000 mA

Low-sensitivity RCDs

According to their tripping time, RCDs can be classed as:
- instantaneous or rapid or general
- type S selective, or - incorrectly - delayed.

Selective RCDs (RCBOs - RCCBs or RCD-blocks) have a delayed tripping action and are installed upstream of other rapid residual current operated circuit-breakers to guarantee selectivity and limit the power out only to the portion of the system affected by a fault.

Technical details
Functions and classification criteria for RCDs

The tripping time is not adjustable. It is set according to a predetermined time – current characteristic with an intrinsic delay for small currents, tending to disappear as the current grows.

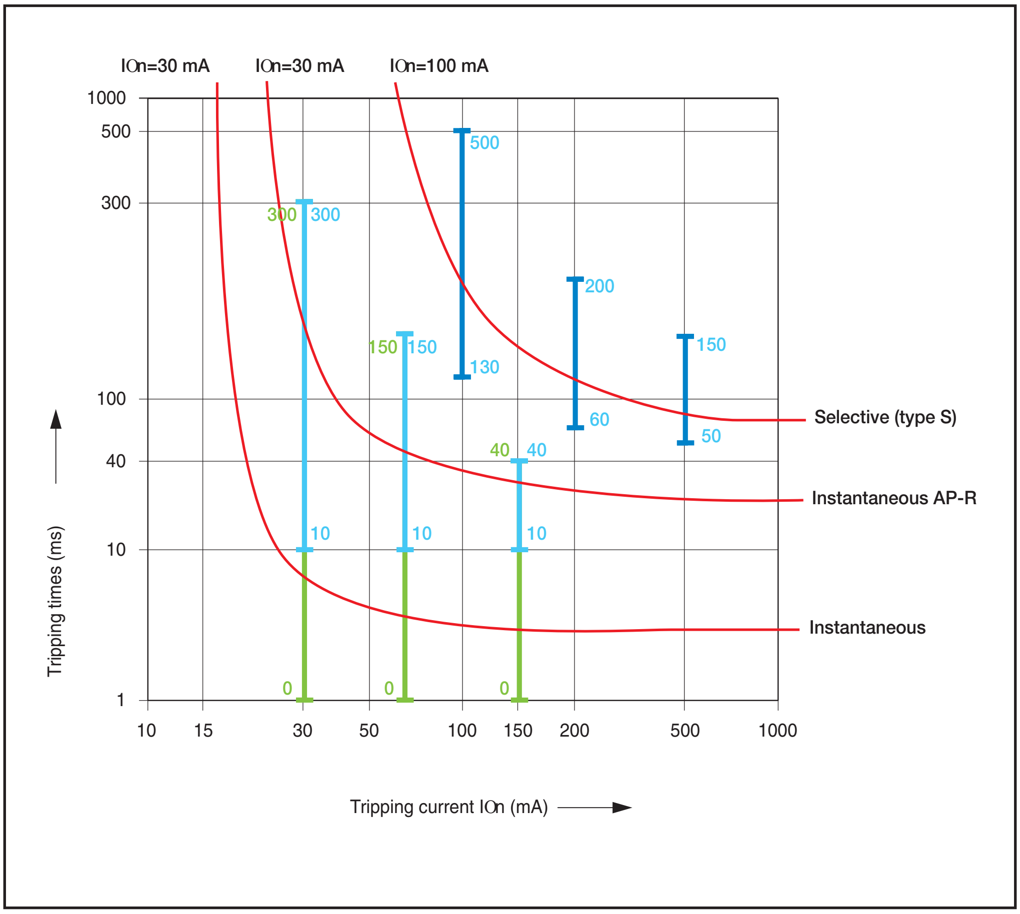
IEC/EN 61008 and 61009 establish the tripping times relative to the type of RCD and the IOn.

Type AC	In [A]	IO [A]	Tripping times (s)xcurrents			
			1xIO	2xIO	5xIO	500A
Generic	Any	Any	0.3	0.15	0.04	0.04
S (selective)	B25	>0.030	0.13-0.5	0.06-0.2	0.05-0.15	0.04-0.15

The indicated maximum tripping times are also valid for A type RCDs, but increasing the current values of factor 1.4 for RCDs with IOn > 0.01 A and of factor 2 for RCDs with IOn A 0.01 A.

The range of ABB RCDs also includes AP-R (anti-disturbance) devices which trip according to the limit times allowed by the Standards for instantaneous RCDs. This function is due to the slight tripping delay (approx. 10 ms) relative to the standard instantaneous ones.

The graph shows the comparison of the qualitative tripping curves for:
- a 30 mA instantaneous RCD
- a 30 mA AP-R instantaneous RCD
- a 100 mA selective RCD (type S)



Note: this is a qualitative chart; it is referred only to industrial frequencies of 50-60 Hz.

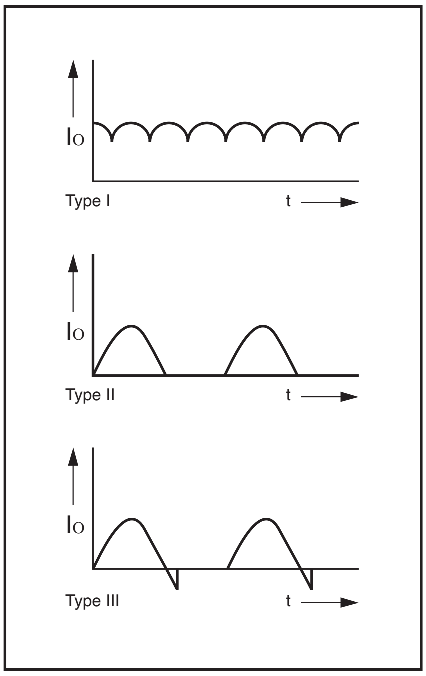
Technical details
Influence on RCDs of currents with DC components

For many years the manufacturers of electrical appliances and other electrical equipment have been using electronic components to improve the performance of their products, increase comfort and save energy.

Loads such as washing machines with variations in spin speed, variable-speed tools, thermostats and dimmers operate at currents with varying wave shapes (pulsating currents with DC components, inverted currents, levelled currents).

There are three different types of current (fig. A).

Figure A



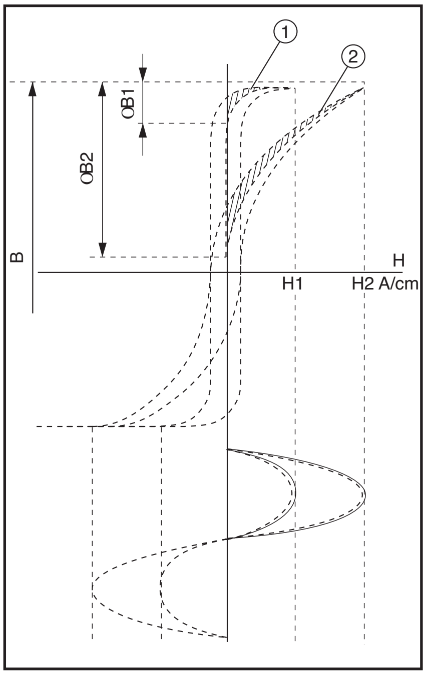
Type I Inverted current with DC components, with value continuously greater than zero, caused by:
- three-phase current
- median point and three-phase current
- jumper connection
- unidirectional rectification with inductive and capacitive levelling
- Villard type voltage doubling.

Type II Pulsating current with DC components sometimes with zero value, caused by ohmic load with:
- unidirectional rectification without levelling
- single-phase jumper connection with or without levelling
- regulation of the symmetrical and asymmetrical phase operating angle (dimmers, RPM meters).

Type III Pulsating current with DC components passing through zero caused by inductive loads with:
- unidirectional rectification without levelling
- single-phase jumper connection with or without levelling
- symmetrical and asymmetrical regulation of the phase operating angle (dimmers, RPM meters).

If there is a fault current to earth after an insulation fault on live parts supplied with rectified current, the contact voltages are the same size as in alternating current.

Figure B



Standard RCDs, which are designed to operate with alternating current at 50-60 Hz, are insensitive to fault currents with DC components.

Non-tripping of a RCD when there are fault currents with DC components may have two consequences:

- it is dangerous for people and equipment (electrocution or fire)
- it causes desensitivation of RCD due to excessive polarization of the transformer core that is no longer able to send the necessary power supply to the releaser (figure B - hysteresis cycle 1).

To avoid this problem, type A RCDs must be used. Thanks to the specific technology of the residual current transformer toroidal cores, the supply level is increased to a value sufficient to trigger the releaser or tripping mechanism (figure B - hysteresis cycle 2).

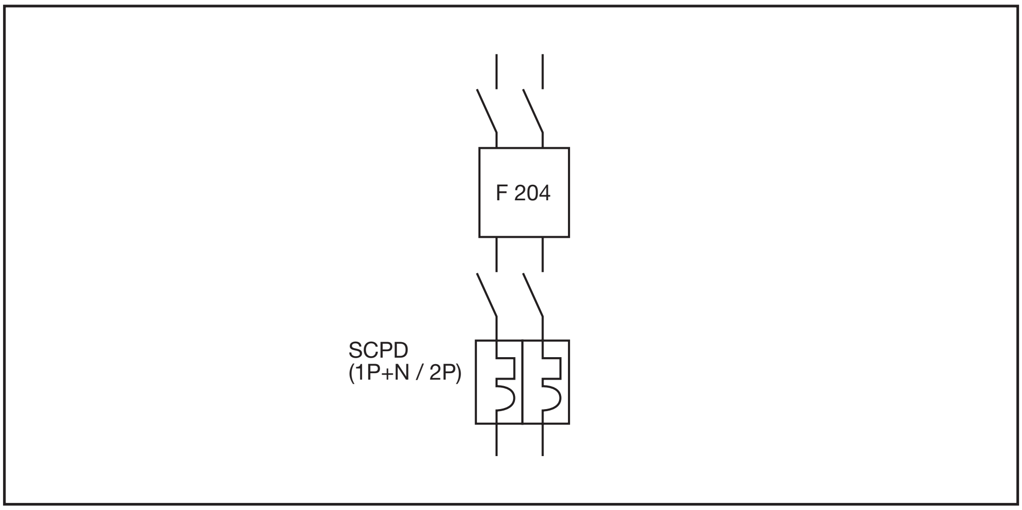
The sensitivity of the tripping mechanism is further increased by its connection to an electrical circuit sensitive to the wave shape of the current.

In this way the tripping of the RCD is assured for any unidirectional pulsating wave shape even in case of overlapping of a DC component up to 6 mA.

Coordination tables between Short Circuit Protection Devices (SCPD) and 2P RCCBs (maximum withstanding short-circuit current expressed in eff. KA).

F 202 (25-40-63 A)

Voltage	230 - 240 V		400 - 415 V
Poles SCPD	**1P/1P+N**	**2P**	**2P**
gG fuse 25A	50	100	50
gG fuse 40A	30	60	30
gG fuse 63A	20	40	20
gG fuse 100A	10	20	10
S941N (2-40A)	4.5		
S951N (2-40A)	6		
S971N (2-40A)	10		
S200 L (6-40A)	4.5	10	4.5
S200 (0.5-63A)	6	20	6
S200 M (0.5-63A)	10	25	10
S200 P (0.2-25A)	25	40	25
S200 P (32-63A)	15	25	15
S290 (80-125A)	10	25	10

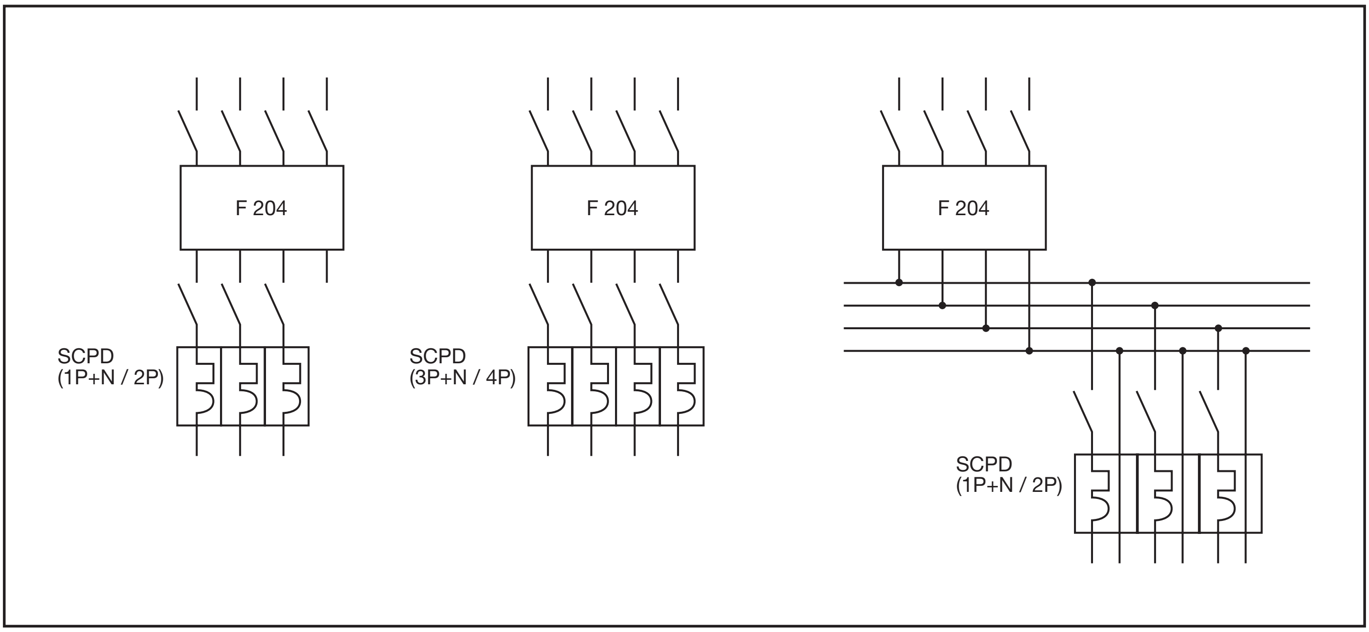


Technical details
Coordination tables: F 200 RCCBs

Coordination tables between Short Circuit Protection Devices (SCPD) and 4P RCCBs (maximum withstanding short-circuit current expressed in eff. KA).

F 204 (25-40-63A)

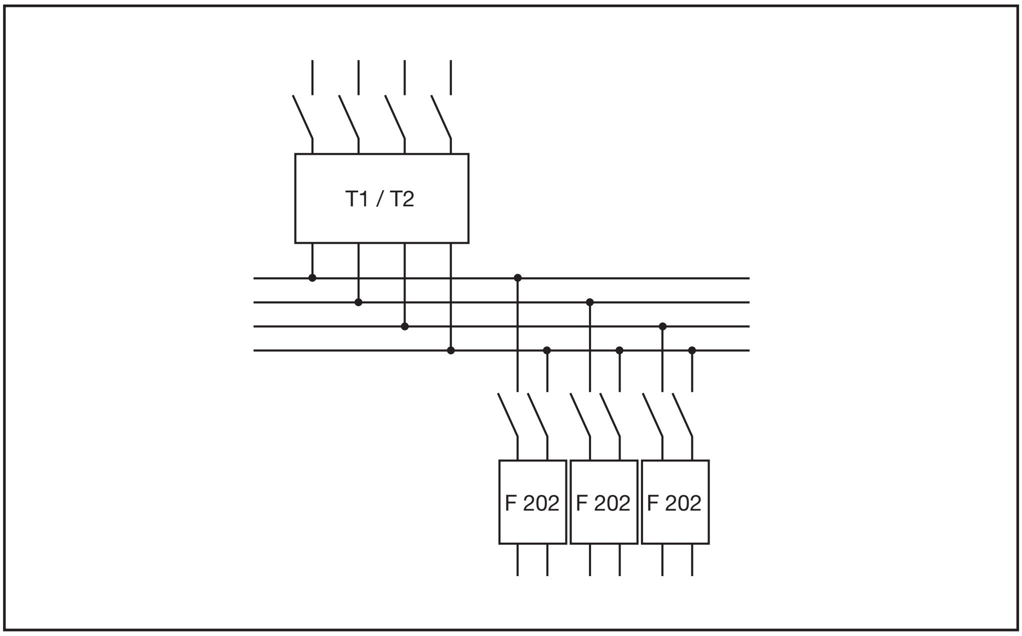
Voltage (–/~)	133 - 138 V/230 - 240 V	230 - 240 V/400 - 415 V
Poles SCPD	**3P/3P+N/4P/3*1P+N/3*2P**	**3P/3P+N/4P/3*1P+N/3*2P**
gG fuse 25A	100	50
gG fuse 40A	60	30
gG fuse 63A	40	20
gG fuse 100A	20	10
S941N (2-40A)	10	4.5
S951N (2-40A)	15	6
S971N (2-40A)	20	10
S200 L (6-40A)	10	4.5
S200 (0.5-63A)	20	6
S200 M (0.5-63A)	25	10
S200 P (0.2-25A)	40	25
S200 P (32-63A)	25	15
S290 (80-125A)	25	10



Coordination tables between MCCBs and 2P RCCBs (maximum withstanding short-circuit current expressed in eff. KA).

F 202 (25-40-63 A)

Voltage (~)	133-138 V/230 - 240 V	230 - 240 V/400 - 415 V
T1 B	6	4
T1 C	6	4
T2 S	10	6
T2 N	10	6

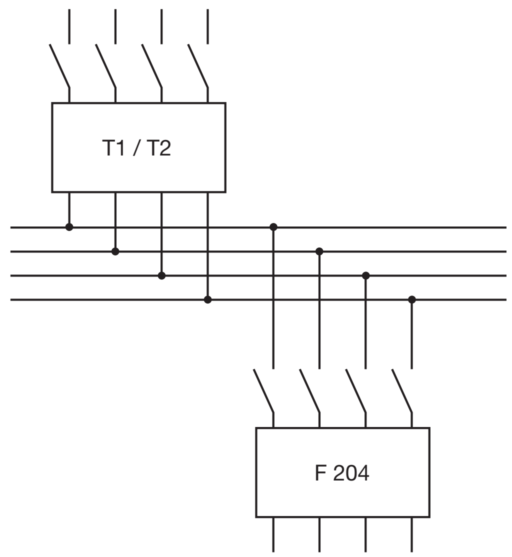


Technical details
Coordination tables: F 200 RCCBs

Coordination tables between MCCBs and 4P RCCBs (maximum withstanding short-circuit current expressed in eff. KA).

F 204 (25-40-63 A)

Voltage (⊀O)	133 - 138 V/230 - 240 V	230 - 240 V/400 - 415 V
T1 B	6	4
T1 C	6	4
T2 S	6	4
T2 N	10	6



Selectivity

RCDs raise similar issue to those surrounding the installation of MCBs, and in particular the need to reduce to a minimum the parts of the system out of order in the event of a fault.

For RCBOs the problem of selectivity in the case of short-circuit currents may be handled with the same specific criteria as for MCBs.

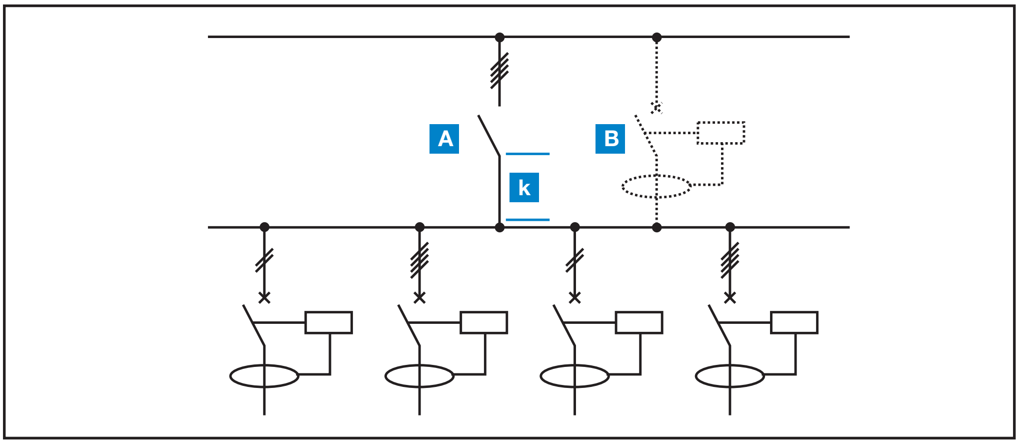
However, for correct residual current protection, the more important aspects are linked to tripping times. Protection against contact voltages is only effective if the maximum times indicated on the safety curve are not exceeded.

If an electrical system has user devices with earth leakage currents which exceed the normal values (e.g.: presence of capacitor input filters inserted between the device phase and earth cables) or if the system consists of many user devices, it is good practice to install various RCDs, on the main branches, with an upstream main residual current or non-residual current device instead of a single main RCD.

Horizontal selectivity

The non-residual current main circuit-breaker provides “horizontal selectivity,” preventing an earth fault at any point on the circuit or small leakage from causing unwanted main circuit-breaker tripping, which would put the entire system out of order.

However, in this way, section k of the circuit between the main circuit-breaker and the RCDs remains without “active” protection. Using a main RCD to protect it would lead to problems with “vertical selectivity,” which require tripping of the various devices to be co-ordinated, so that service continuity and system safety are not compromised. In this case, selectivity may be amperometric (partial) or chronometric (total).



Vertical selectivity

Vertical selectivity may also be established for residual current tripping, bearing in mind that in working back from system peripheral branches to the main electrical panels the risk of unskilled persons coming into contact with dangerous parts is significantly reduced.

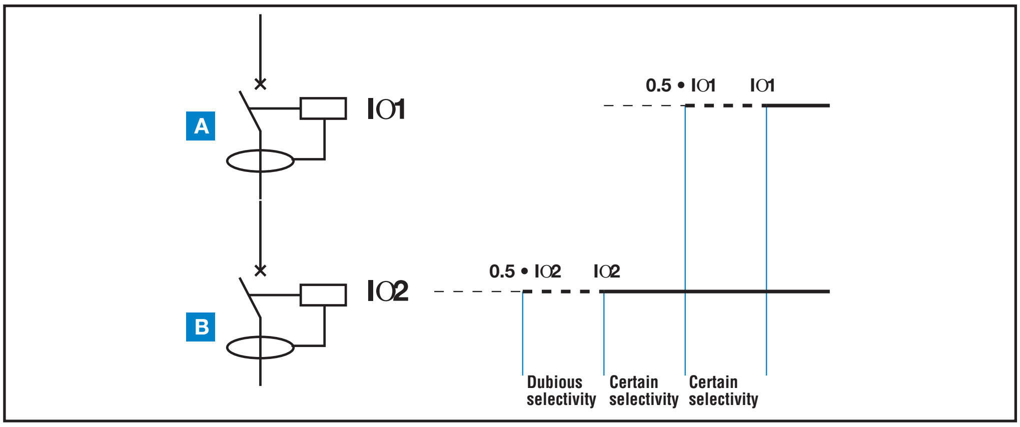
Amperometric (partial) selectivity

Selectivity may be created by placing low-sensitivity RCDs upstream and higher-sensitivity RCDs downstream.

An essential condition which must be satisfied in order to achieve selective co-ordination is that the $I_{\Delta 1}$ value of the breaker upstream (main breaker) is more than double the $I_{\Delta 2}$ value of the breaker downstream. The operative rule to obtain an amperometric (partial) selectivity is $I_{\Delta n}$ of the upstream breaker = 3 x $I_{\Delta n}$ of the downstream breaker (e. g.: F 204, A type, 300 mA upstream; F 202, A type, 100 mA downstream).

In this case, selectivity is partial and only the downstream breaker trips for earth fault currents $I_{\Delta 2} < I_{\Delta m} < 0.5 * I_{\Delta 1}$.

Technical details
Coordination tables: residual current protection selectivity



Chronometric (total) selectivity

To achieve total selectivity, delayed or selective RCDs must be installed.

The tripping times of the two devices connected in series must be co-ordinated so that the total interruption time t2 of the downstream breaker is less than the upstream breaker's no-response limit time t1, for any current value. In this way, the downstream breaker completes its opening before the upstream one.

To completely guarantee total selectivity, the IΔ value of the upstream device must also be more than double that of the downstream device in accordance with IEC 64-8/563.3, comments. The operative rule to obtain an amperometric (partial) selectivity is IΔn of the upstream breaker = 3 x IΔn of the downstream breaker (e. g.: F 204, S type, 300 mA upstream; F 202, A type, 100 mA downstream).

For safety reasons, the delayed tripping times of the upstream breaker must always be below the safety curve.

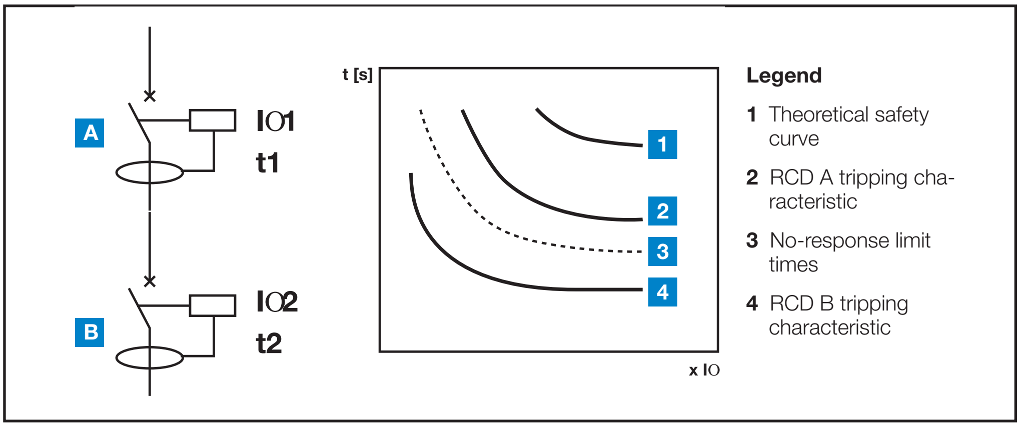


Table of RCD selectivity

	Upstream IΔn [mA]	10	30	100	300	300	500	500	1000	1000
Downstream IΔn [mA]		inst	inst	inst	inst	S	inst	S	inst	S
10	inst		■ (yellow)	■ (yellow)	■ (yellow)	■ (green)	■ (yellow)	■ (green)	■ (yellow)	■ (green)
30	inst			■ (yellow)	■ (yellow)	■ (green)	■ (yellow)	■ (green)	■ (yellow)	■ (green)
100	inst				■ (yellow)	■ (green)	■ (yellow)	■ (green)	■ (yellow)	■ (green)
300	inst							■ (yellow)		■ (green)
300	S							■ (yellow)		■ (yellow)
500	inst									
500	S									
1000	inst									
1000	S									

inst=instantaneous S=selective ■ (yellow)=amperometric (partial) selectivity ■ (green)=chronometric (total) selectivity

Technical details
Power loss, derating and performance in altitude

Power loss of RCDs

RCCBs F200 series

Rated Current In [A]	Power loss W [W]	
	2P	4P
16	1.5	-
25	2.0	4.8
40	4.8	8.4
63	7.2	13.2

RCD-Blocks DDA200 series

Rated current Ib [A]	Power loss W_{Ib}* [W]	
	2P	3P,4P
25	2.1	2.8
40	5.4	7.2
63	7.8	13.8

*The power loss W_{Ib} shown in the table refers to Ib. For use with circuit-breakers with lower rated current In the power loss W must be determined using the formula: $W = (I / Ib) \bullet W_{Ib}$

DDA for S290 series

Rated current Ib [A]	Rated residual current IΔn [A]	Power loss W [W]	
		2P	4P
100	0.03	6	6
100	0.03 - 1	5	5

RCBO FS201-DS200 series

Rated current In [A]	Power loss W [W]		
	1P+N	2P	3P,4P
1	1.8	-	-
2	1.8	-	-
4	1.8	-	-
6	2	4.1	6.2
10	2.1	2.9	4.4
13	3.7	5.2	7.7
16	4.5	4.5	6.6
20	4.8	6.4	9.3
25	6.3	8.5	12.4
32	8.8	10.9	15.7
40	9.9	15.0	21.6
50	-	11.4	18.4
63	-	17.4	28.2

Derating of load capability of RCBOs FS 201 and DS 200

For FS 201 and DS 200 see tables for S 200 MCBs in technical details MCBs, within the range of temperatures from -25 °C to +55 °C.

Performance in altitude of RCDs

Up to the height of 2000 m, ABB RCDs do not undergo any alterations in their rated performances. Over this height the properties of the atmosphere change in terms of composition, dielectric capacity, cooling capacity and pressure, therefore the performances of the RCDs undergo derating, which can basically be measured in terms of variations in significant parameters, such as the maximum operating voltage and the rated current.

F 200/DDA 200/FS 201/DS 200

Altitude [m]	2000	3000	4000
Rated service voltage Ue [V]	400	380	380
Rated current In	In	0.96xIn	0.93xIn

Emergency stop using DDA 200 AE series RCD blocks

The AE series RCD block combines the protection supplied by the RCBOs with a positive safety emergency stop function for remote tripping.

In the AE version, the DDA 200 AE series RCD blocks are available.

Operating principle (patented)

Two additional primary circuits powered with the same voltage and equipped with the same resistance have been added to the transformer; under normal conditions the same current would flow through, but since they are wound by the same number of coils in opposite directions they cancel each other out and do not produce any flow.

One of these two windings acts as the remote control circuit: the emergency stop is obtained by interrupting the current flow in this circuit.

The positive safety is therefore obvious: an accidental breakage in the circuit is equivalent to operating an emergency control button.

Advantages

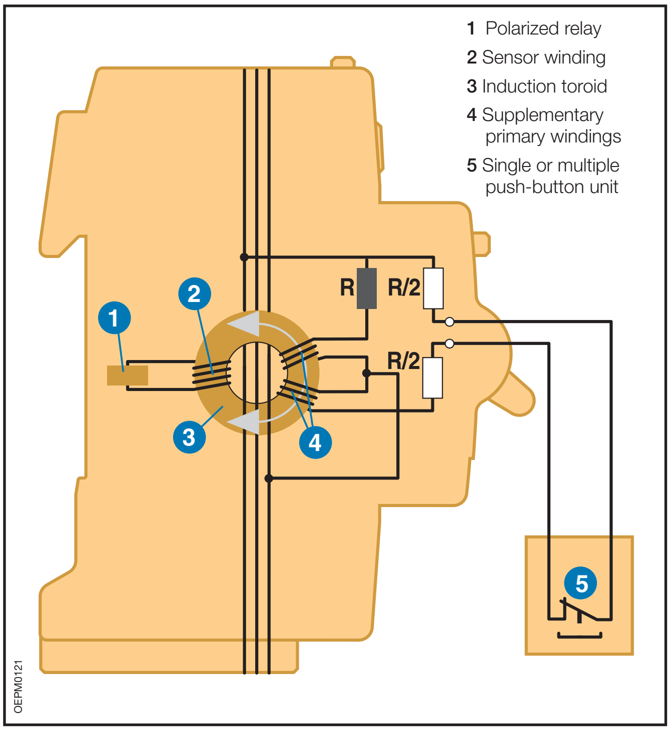
Compared with the devices which are normally used in emergency circuits, DDA 200 AE blocks have the following advantages:

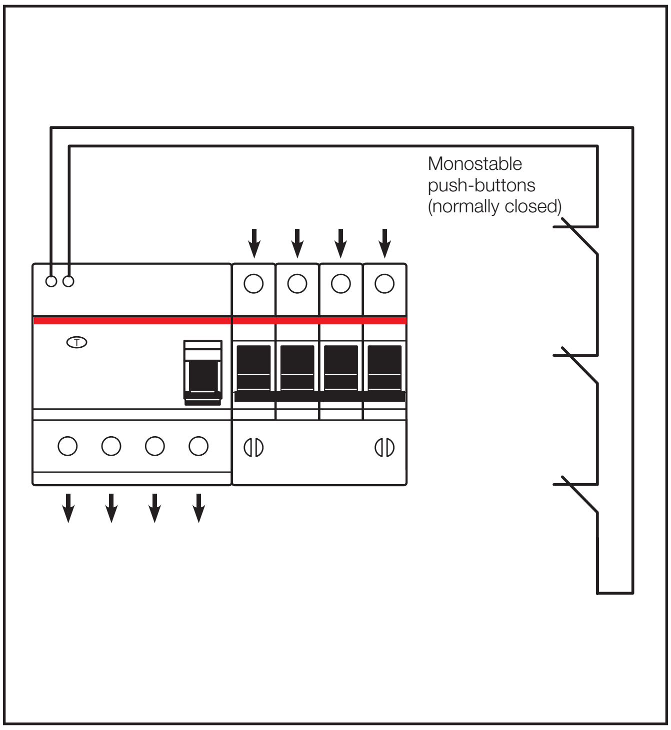
- positive safety
- no undesirable tripping if there is a temporary reduction or interruption of the mains voltage
- efficient immediate operating even after long off-service periods of the installation.

Use

Application of the DDA 200 AE blocks complies with the requirements of IEC/EN 60364-8. They are therefore suitable, for example, for escalators, lifts, hoists, electrically operated gates, machine tools, car washes and conveyor belts.

No more than one DDA 200 AE can be controlled using the same control circuit. Each DDA 200 AE requires a dedicated control circuit.





Technical details
Unwanted tripping - AP-R solution (high immunity)

Unwanted tripping

In the event of disturbance in the mains, the RCDs normally present in the system are tripped, breaking the circuit even in the absence of a true earth fault.

Disturbances of this kind are most often caused by:

- operation overvoltages caused by inserting or removing loads (opening or closing protection of control devices, starting and stopping motors, switching fluorescent lighting systems on and off, etc.)
- overvoltages of atmospheric origin, caused by direct or indirect discharges on the electrical line.

Under these circumstances, breaker tripping is unwanted, since it does not satisfy the need to avoid the risks due to direct and indirect contacts. On the contrary, the sudden and unjustified interruption of the power supply may result in very serious problems.

AP-R RCDs

The ABB range of AP-R anti-disturbance residual current circuit-breakers and blocks was designed to overcome the problem of unwanted tripping due to overvoltages of atmospheric or operation origin.

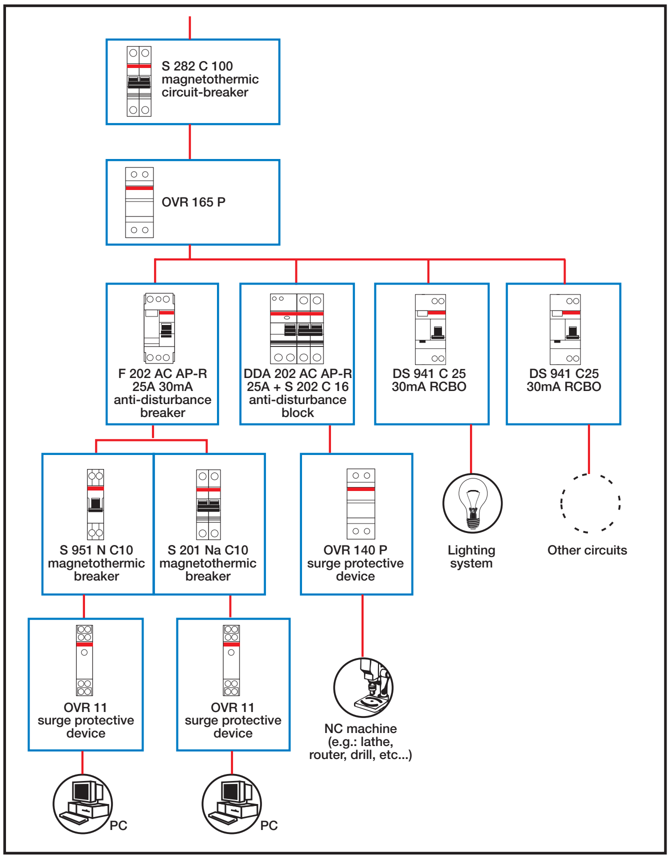
The electronic circuit in these devices can distinguish between temporary leakage caused by disturbances on the mains and permanent leakage due to actual faults, only breaking the circuit in the latter case.

AP-R residual current circuit-breakers and blocks have a slight delay into the tripping time, but this does not compromise the safety limits set by the Standards in force (release time at 2 $I_{\Delta n}$=150 ms).

Guaranteeing conventional residual current protection, their installation in the electrical circuit therefore allows any unwanted tripping to be avoided in domestic and industrial systems in which service continuity is essential.

For continuous service of priority circuits and simultaneous protection of user devices and systems from transient overvoltage peaks, combine RCCBs and AP-R blocks with overvoltage surge protective devices OVR.

To make protection more effective and widespread, it may be useful to create a cascade system extending over several levels, like the one illustrated below.



Provisions of the Standards

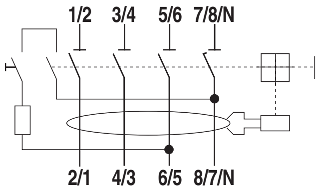
IEC/EN 61008 and IEC/EN 61009 check RCD resistance to operation overvoltages, envisaging the use of the 0.5 µs/100 kHz ring wave. All RCDs must pass the test with a current peak value of 200 A.

For overvoltages of atmospheric origin, IEC 61008 and IEC 61009 establish the resistance to a 8/20 µs surge with 3000A peak current, but limit the provision to RCDs classed as selective. No test is required for other types of RCDs.

ABB AP-R anti-disturbance RCDs pass the general resistance test at 0.5 µs/100 kHz, also resisting the 8/20 µs surge with the same peak current of 3000 A prescribed for the selective RCDs.

Use of a 4P RCCB in a 3-phase circuit without neutral

The test button circuit of these RCCBs 4P F 200 is wired inside the device between terminal 5/6 and 7/8/N as indicated below, and has been sized for an operating voltage between 110 and 254 V (110 and 277 V according tu UL 1053).

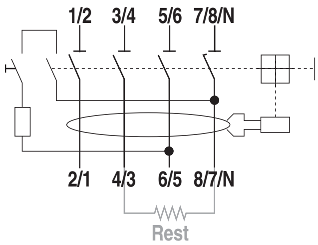


In case of installation in a 3 phase circuit without neutral, if the concatenate voltage is between 110 and 254 V (277 V according to UL 1053) for the correct working of the test button there are two possible solutions:

1) To connect the 3 phases to the terminals 3/4 5/6 7/8/N and the terminals 4/3 6/5 8/7/N (supply and load side respectively)

2) To connect the 3 phases normally (supply to terminals 1/2 3/4 5/6 and load to terminals 2/1 4/3 6/5) and to bridge terminal 1/2 and 7/8/N in order to bring to the terminal 7/8/N the potential of the first phase. In this way the test button is supplied with the phases' concatenate voltage.

If the circuit is supplied with a concatenate voltage higher than 254 V, as in the typical case of 3 phase net with concatenate voltage of 400 V - or 480 V according to UL 1053 - (and voltage between phase and neutral of 230 V or 277 V according to UL 1053), it is not possible to use these connections because the circuit of the test button will be supplied at 400 V and could be damaged by this voltage.

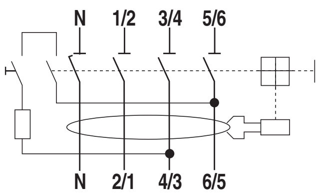


IΔn [A]	Rest [K]
0.03	3300
0.1	1000
0.3	330
0.5	200

In order to allow the correct operation of the test button also in 3 phase nets at 400 V - 480 V according to UL 1053 - (concatenate voltage) it is necessary to connect normally the phases (supply to terminals 1/2 3/4 5/6 and load to terminals 2/1 4/3 6/5) and to jump terminal 4/3 and 8/7/N by mean of an electric resistance as indicated above.
In this way the test button circuit is fed at 400 V - 480 V according to UL 1053 - but for example in an RCCB with IΔn=0.03 A there will be the R_{est}=3.3 kOhm resistance in series to the test circuit resistance. R_{est} will cause a voltage drop that leaves in the test circuit a voltage less than 254 V - 277 V according to UL 1053. R_{est} resistance must have a power loss higher than 4 W.

In the normal operation of the RCCB (test circuit opened) the R_{est} resistance is not fed so it does not cause any power loss.

The solution RCCBs with neutral pole on left side
The test button circuit of these RCCBs is wired inside the device between terminal 3/4 and 5/6 as indicated below, and it has been sized for an operating voltage between 195 V and 440 V - 480 V according to UL 1053. In case of a three phase system without neutral with concatenate voltage between phases of 230 V or 400 V - 277 V or 480 V according to UL 1053 - it is enough to connect the 3 phases normally (supply to terminals 1/2 3/4 5/6 and load to terminals 2/1 4/3 6/5) without any bridge.



Type B RCDs

In industrial electrical applications it is more and more common to use devices where in the event of an earth fault current unidirectional direct currents or currents with a minimum residual ripple which flow through the PE conductor can emerge. These devices can be for example inverters, medical equipment (e.g. x-ray equipment and CAT), or UPS.

Type A RCDs sensitive to pulsating currents (in addition to sinusoidal currents detected by RDCs of type AC as well) cannot detect and break these earth fault direct currents or currents with a minimum level residual ripple. In case there are electrical appliances which generate this type of currents in the event of an earth fault the use of RCDs of type AC or type A would not be appropriate.

In order to meet these new demands, type B RCDs have been designed (which are able to detect the same earth fault currents detected by type AC and type A RCDs).
This type of RCD (type B) is not mentioned in the reference standards for RCDs (IEC 61008-1 and IEC 61009-1). Until an international standard is issued regulating this kind of device, the only reference document is the IEC 60755 report.

As already said, type B RCDs are not only sensitive to alternating and pulsating earth fault currents with DC components at a frequency of 50/60 Hz (type A), but they are also sensitive to:

- alternating currents up to a frequency of 1000 Hz;
- alternating and/or pulsating currents with DC components overlapping with a direct current;
- earth fault currents generated by a rectifier with two or more phases;
- direct earth fault currents without residual ripple

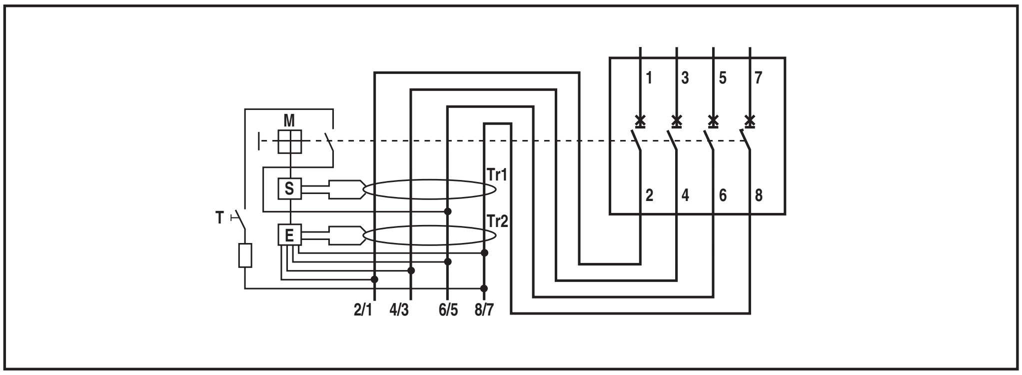
...independently of the polarity or whether the earth fault current appears suddenly or increases gradually.

Type B RCDs must be marked with the following symbols highlighting the switches' capacity to detect every type of current:  .

Technical details
Type B RCDs

Construction features

Type B RCDs consist of one section for the detection of alternating earth fault currents and unidirectional pulsating earth fault currents, which functions independently of the line voltage. For the detection of direct earth fault currents or currents with a minimum residual ripple, type B RCDs have a second electronic section, the functioning of which depends on the line voltage.
The structure of the product is illustrated in the following diagram.

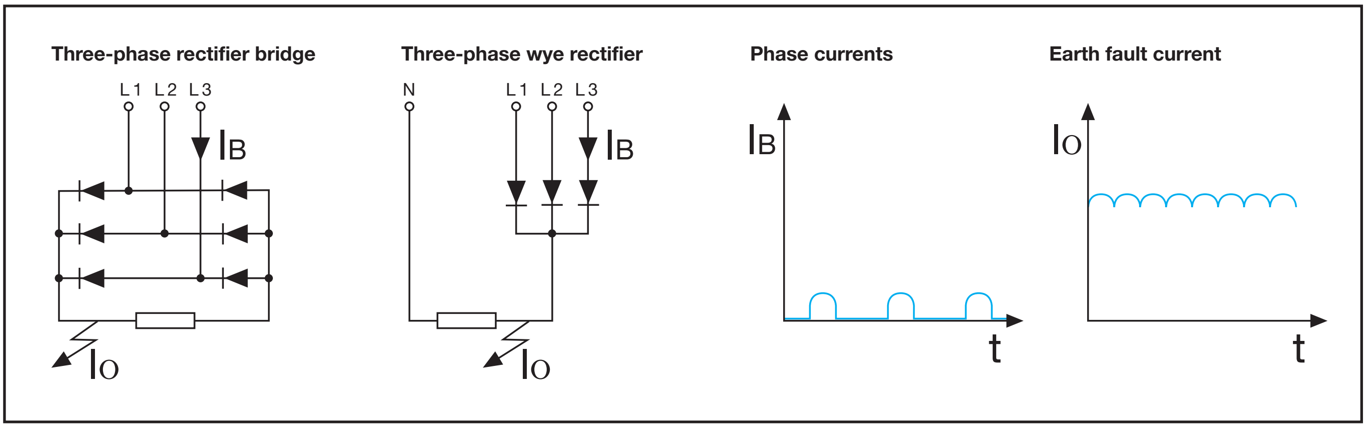


S Release
M Protection device mechanism
E Electronics for the intervention with direct unidirectional earth fault currents
T Test device
Tr1 Residual current transformer for the detection of sinusoidal earth fault currents
Tr2 Residual current transformer for the detection of direct unidirectional currents.

The residual current transformer Tr1 monitors the presence of pulsating and alternating earth fault currents in the electronic installation while residual current transformer Tr2 measures the direct unidirectional currents. In the event of a fault the second transformer transmits the opening command to the release S via the (printed) circuit board E. In type B RCCBs, the section whose functioning depends on the line voltage is supplied by all three-phase conductors and the neutral, so that the functioning as type B is guaranteed even if there is a voltage only in two of the 4 power conductors. In addition, the supply of the electronic section is sized in such a way that the device can safely intervene even if there is a voltage drop of 70%.
In this way an intervention takes place when direct unidirectional earth fault currents emerge, even in the event of faults in the electric power supply grid, for example if there is no neutral conductor.

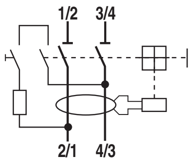
Direct or similar earth fault currents

An increasing amount of industrial equipment is supplied by circuits which in the event of a fault generate direct earth fault currents with a very low residual ripple, which can be even less than 10%. For example with direct current supplied motor drives for pumps, elevators, textile machines etc. it is becoming more common to use inverters with a three-phase rectifier bridge.
In the event of an earth fault current the wave of the earth fault is as indicated in the figure below.

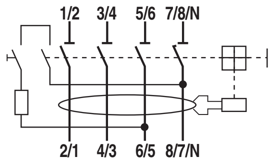


RCDs

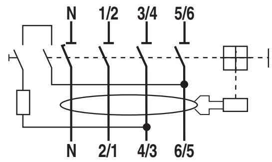
F 202



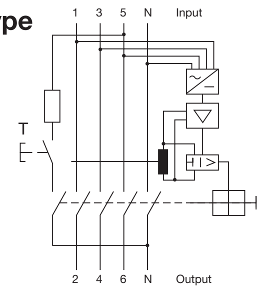
F 204



F 204 Left neutral

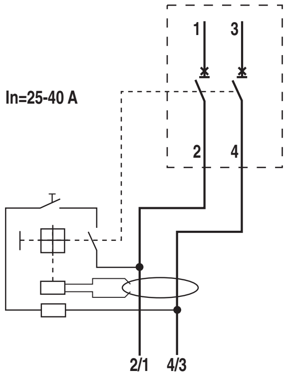


F 204 B type

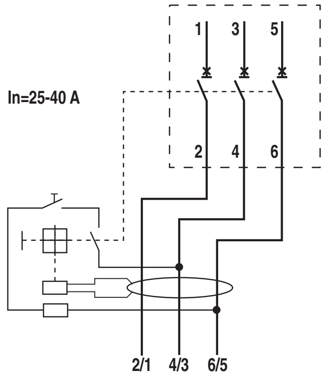


RCD-blocks

DDA 202



DDA 203



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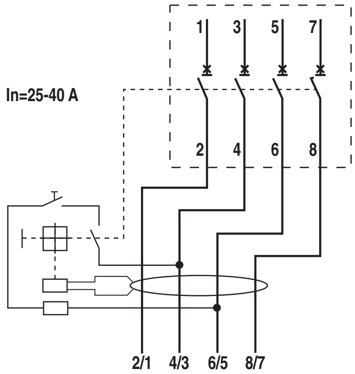

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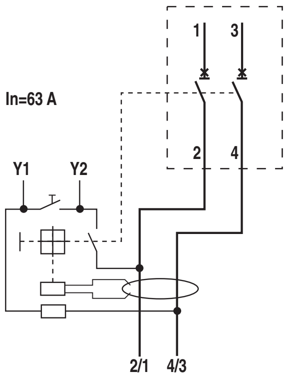
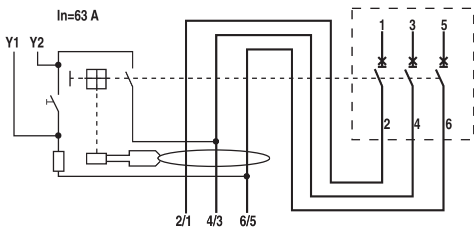
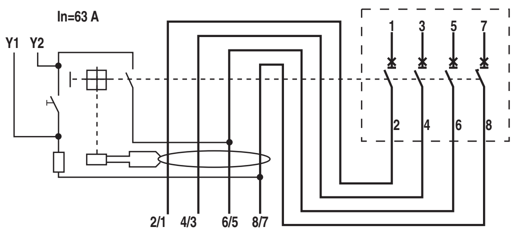


DDA 203



DDA 204



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