Residual current devices
Technical Data

Protection against electric shocks

Effects of current passing through the human body

Present thinking on the effects of electrical current passing through the human body is based on information from many sources.

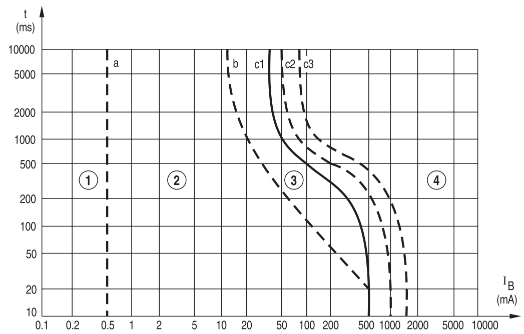
- Experiments on animals
- Clinical observation
- Experiments on dead human beings
- Experiments on live human beings

We must remember that we are considering here the effects of shock current. Other factors must be considered when setting safety requirements:
- Probability of fault
- Probability of contact with live or faulty parts
- Experience
- Technical possibilities
- Economics

The degree of danger to people depends mainly on the magnitude and duration of current flow through the human body. The major parameter, which influences the current magnitude, is the impedance of the human body.

The effects of electrical current on people are specified in figure 1 (table time/current IEC 60479-1).

Time / current zones of effects of AC current (15Hz to 100 Hz) on persons (fig. 1)



Zones	Physiological effects:
Zone 1	Usually no reaction effects.
Zone 2	Usually no harmful physiological effects.
Zone 3	Usually no organic damage to be expected. Likelihood of muscular contractions and difficulty in breathing, reversible disturbances of formation and conduction of impulses in the heart, including atrial fibrillation and transient cardiac arrest without ventricular fibrillation increasing with current magnitude and time.
Zone 4	In addition to the effects of Zone 3, probability of ventricular fibrillation increasing up to about 5% (curve c_2), up to about 50% (curve c_3) and above 50% beyond curve c_3. Increasing with magnitude and time, pathophysiological effects such as cardiac arrest, breathing arrest and heavy burns may occur.

Risk of electric shock

Electric shock is produced when the human body is in contact with conductive surfaces at different potentials. There are two kind of contact which causes electric shock:
- Direct contact
- Indirect contact

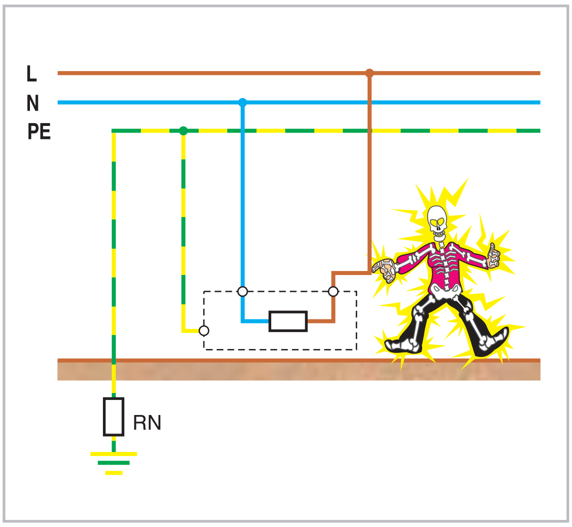
The main causes of electric shock are:
- Defect of insulation in the high/low voltage transformer
- Overvoltages due to atmospheric sources
- Ageing of the load or wiring insulation
- Live parts not sufficiently protected

In IEC 61200-413, derived from IEC 60479, it is explained how the maximum safety voltage is a function of the environmental conditions and the prospective touch voltage is a function of the maximum tripping time.
Maximum safety voltage:
- U_L= 24V (wet conditions)
- U_L= 50V (dry conditions)

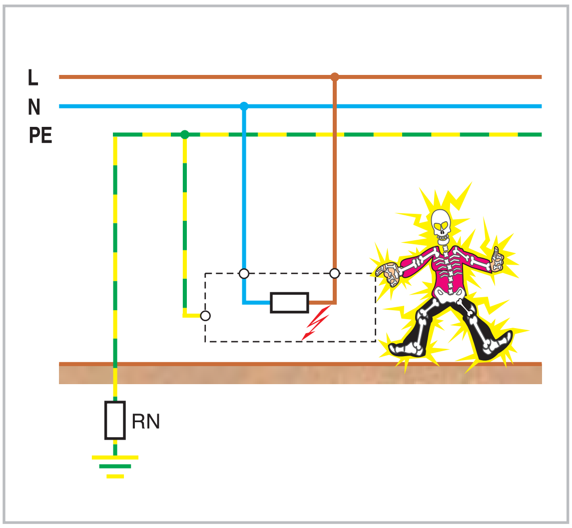
Tripping time in function of touch voltage

Prospective touch voltage (V)	U_L = 50V maximum tripping time (s)	
	ac	dc
< 50	5	5
50	5	5
75	0.6	5
90	0.45	5
120	0.34	5
150	0.27	1
220	0.17	0.4
280	0.12	0.3
350	0.08	0.2
500	0.04	0.1

Direct contact
When a person accidentally touches a live part of the installation not connected to an earth electrode. In this situation the person becomes part of the electric circuit by means of body resistance and earth resistance.



Indirect contact
When a person touches a metal part of the load, which is earthed, and accidentally makes contact with an electrical conductor due to a loss of insulation.



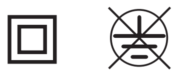
How to prevent direct and indirect contact

Protection against electric shock shall be provided by applying the following concepts according to IEC 60364-4-41:

Protection against direct and indirect contact
Protection by means of the use of very low voltage:
- SELV (safety extra low voltage)
- PELV (protective extra low voltage)
- FELV (functional extra low voltage)

Protection against direct contact
Prevention of direct contact can be summarised as follows:
- Insulate conductor with appropriate materials
- Using barriers or enclosures with appropriate IP degree
- Designing the installation with appropriate safety distances
- Complementary protection by using RCD $\leq$ 30 mA

Protection against indirect contact
To prevent indirect contact there are different ways of protection:
Using materials that ensure a class II protection



Protection in non conductive environments
All the exposed conductive parts must be under normal circumstances in such a way that people can not touch any live part.
This installation will not necessitate any protective conductors.
Walls and floors shall be isolated with a resistance no less than:
- 50 kΩ for installations with nominal voltage <500V
- 100 kΩ for installations with nominal voltage >500V

Protection by means of local equipotential links in installations not connected to earth
The equipotential link must not be connected to earth either through the exposed conductive parts or the protective conductors.

Protection by means of electric (galvanic) isolation
By using isolation transformers.

Protection by automatic disconnection of the installation
Necessary in the case of risk of physiological effects on persons, due to the amplitude and duration of the touch voltage.
This kind of protection requires a good co-ordination among the connections to Earth, the characteristics of the protective conductor and the protective device.

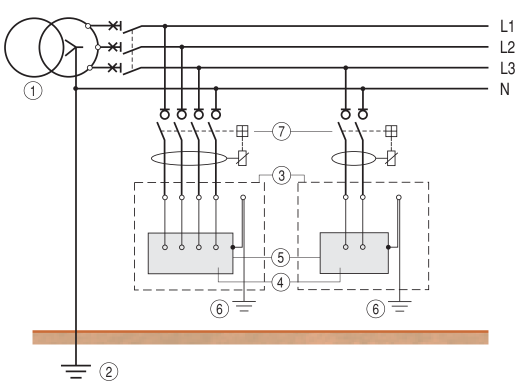
- Connection to Earth and protective conductor.
All the exposed conductive parts must be earthed by means of protective conductors according to any of the different installation distribution systems.

- Protective device.
The protective device must isolate the installation from the source of energy in case any exposed conductive part becomes live. Such a device ensures that the safety voltage (U_L) does not exceed 50V or 120V ⎓ ripple free.

Installation distribution systems

TT system
A system having one point of the source of energy directly earthed, the exposed conductive parts of the installation being connected to earth electrodes electrically independent of the earth electrodes of the source.

TT wiring diagram



① Source of energy
② Source earth
③ Consumers' installation
④ Equipment in installation
⑤ Exposed conductive part
⑥ Installation earth electrode
⑦ Residual current device

In the case of isolation fault, the potential of the exposed conductive parts will suddenly increase causing a dangerous situation of electric shock. This can be avoided with the use of RCD's with the proper sensitivity in function of touch voltage.

To ensure safety conditions in the installation, the earth values shall comply with:

$$R_A \times I_{\Delta n} \leq 50V$$

R_A = Earth resistance value of the installation.
$I_{\Delta n}$ = Residual operating current value of the RCD.

Sensitivity in function of earth resistance values

Safety voltage	Sensitivity						S
	0.01A	0.03A	0.1A	0.3A	0.5A	1A	0.3A
50V	5000 Ω	1666Ω	500Ω	166Ω	100Ω	50Ω	83Ω
25V	2500 Ω	833Ω	250Ω	83Ω	50Ω	25Ω	41Ω

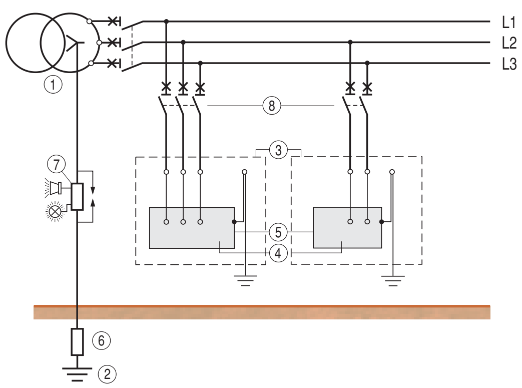
IT system
A system having no direct connection between live parts and earth, the exposed conductive parts of the electrical installation connected to an earth electrode.
The source is either connected to earth through a deliberately introduced earthing impedance or is isolated from earth.
In case of an insulation fault the value of the current is not high enough to generate dangerous voltages. Nevertheless protection against indirect contact must be provided by means of an insulation monitoring device which shall provide visual and sonorous alarm when the first fault occurs. The service interruption by means of breakers must be done in case of a second fault according to the following tripping conditions:

To ensure safety conditions in the installation, it shall comply with:

$$R_A \times Id \leq 50V$$

R_A = Earth resistance value of the installation.
Id = Fault current value of the first fault.

IT wiring diagram



① Source of energy
② Source earth
③ Consumers' installation
④ Equipment in installation
⑤ Exposed conductive part
⑥ Earthing impedance
⑦ Isolation controller
⑧ Protective device for the second fault

Maximum tripping time

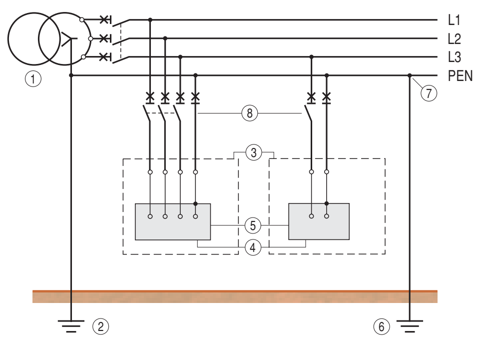
Uo/U (V)	Tripping time(s) UL=50V	
Uo= Voltage phase/neutral U= Voltage between 2 phases	No distributed Neutral	Distributed Neutral
127/220	0.8	0.8
230/400	0.4	0.4
400/690	0.2	0.2
580/1000	0.1	0.1

TN system
A system having one or more points of the source of energy directly earthed, the exposed conductive part of the installation being connected to that point by protective conductors. In case of an insulation fault a short-circuit (phase – neutral) is caused in the installation.

There are two types of TN systems: TN-C and TN-S

TN-C, a system in which neutral and protective functions are combined in a single conductor throughout the system.

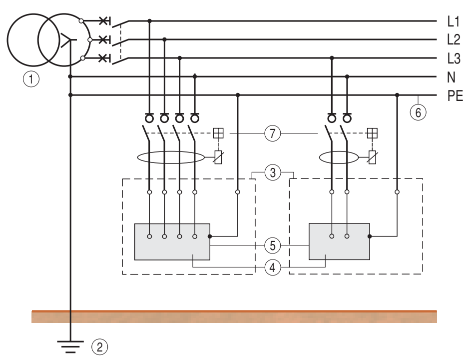
TN-C wiring diagram



① Source of energy
② Source earth
③ Consumers' installation
④ Equipment in installation
⑤ Exposed conductive part
⑥ Additional source Earth
⑦ Combined protective and neutral conductor PEN
⑧ Short-circuit protective device

TN-S, a system having separate neutral and protective conductors throughout the system.

TN-S wiring diagram



① Source of energy
② Source earth
③ Consumers' installation
④ Equipment in installation
⑤ Exposed conductive part
⑥ Protective conductor
⑦ Short-circuit protective device (MCB or RCD)

The short-circuit caused by the insulation fault shall be switched by a protective device which should be fast enough according to the following conditions:

1. To ensure safety conditions in the installation, the protective device shall comply with:

$$Z_S \times Ia \leq U_0$$

Z_S = Total impedance of the fault ringlet (including the impedance's of the source of energy, the active conductor and the protective conductor).
Ia = Fault current which ensures the operating of the protective device.
(In case of RCD: Ia=Idn)
U_0 = Rated voltage phase-earth

Maximum tripping time

Voltage Phase/neutral Uo (V)	Maximum tripping time (s) ac
127	0.8
230	0.4
400	0.2
>400	0.1

2. The breaking speed is provided by the magnetic tripping system of the breaker or by the protective fuse.

3. In case of long cables the short-circuit current may not reach the tripping values of the protective device, therefore we need to use RCD's (TN-S).

4. To verify that the fault current generated is high enough to trip the protective device, we should take into account the following parameters:

4.1. Tripping characteristic of the protective device:
MCB's: B characteristic (3-5 x In)
C characteristic (5-10 x In)
D characteristic (10-20 x In)

MCCB's: According to the magnetic calibration

Fuses: According to the time/current characteristic: - gI
- gG
- aM

4.2. Rated current of the protective device (In).

4.3. Installation impedance
Length and cross section of cables.
See tables on B.6

Maximum protected cable length for people protection (indirect contact)

TN 3 x 400V, UL = 50V, m = 1 by means of fuses gI-gG

gG fuses Copper conductor In (A)	16	20	25	32	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1000
S mm²																			
1.5	99	86	40	21	13	7													
2.5		134	110	67	41	25	13	8											
4			183	139	108	67	46	24	14	7.3									
6				214	165	139	94	55	33	20	10								
10					275	226	172	130	90	57	30	17.5							
16							283	217	168	128	86	53	30						
25								336	257	197	155	118	73	42					
35									367	283	220	172	134	59	48				
50										379	299	229	179	136	93	58			
70											441	336	268	202	134	124	55		
95												472	367	278	215	172	109	63	
120													462	346	268	215	145	109	52
150													483	373	283	231	151	124	79
185														441	336	273	185	147	107
240															504	315	215	172	126

Maximum protected cable length for people protection (indirect contact)

TN 3 x 400V, UL = 50V, m = 1 by means of MCB's & MCCB's

Curve C (Im: 10 x In) Copper conductor In (A)	0,5	1	2	4	6	10	16	20	25	32	40	50	63	80	100	125	160	250	400	630	800	1000	1250	1600
S mm²																								
1.5	1232	616	308	154	103	62	38	31	25	19	15													
2.5		1026	513	257	171	103	64	51	41	32	26	21	16											
4		1642	821	411	274	164	103	82	66	51	41	33	26	21										
6			1232	616	411	246	154	123	99	77	62	49	39	31	25									
10				1026	684	411	257	205	164	128	103	82	65	51	41	33								
16				1642	1095	657	411	328	263	205	164	131	104	82	66	53	41							
25					1711	1026	642	513	411	321	257	205	163	128	103	82	64							
35						1437	898	718	575	449	359	287	228	180	144	115	90	57						
50							1283	1026	821	642	513	411	326	**257**	205	164	128	82						
70							1796	1437	1150	898	718	575	456	359	287	230	180	115	72					
95								1950	1560	1219	975	780	619	488	390	312	244	156	98					
120									1971	1540	1232	985	782	616	493	394	308	197	123	78				
150										1673	1339	1071	850	669	536	428	335	214	134	85				
185										1978	1582	1266	1005	791	633	506	396	253	158	100	79			
240											1971	1577	1251	985	788	631	493	315	197	125	99	79		
300												1895	1504	1184	947	758	592	379	237	150	118	95		
400													1629	1283	1026	821	642	411	257	163	128	103	82	
500													1810	1426	1140	912	713	456	285	181	143	114	91	
625													1851	1458	1166	933	729	467	292	185	146	117	93	73
2x95											1950	1560	1238	975	780	624	488	312	195	124	98	78		
2x120												1971	1564	1232	985	788	616	394	246	156	123	99	79	
2x150													1700	1339	1071	857	669	428	268	170	134	107	86	
2x185														1582	1266	1013	791	506	316	201	158	127	101	79
2x240														1971	1577	1261	985	631	394	250	197	158	126	99
3x95													1857	1463	1170	936	731	468	293	186	146	117	94	73
3x120														1848	1478	1182	924	591	370	235	185	148	118	92
3x150															1607	1285	1004	643	402	255	201	161	129	100
3x185															1899	1519	1187	760	475	301	237	190	152	119
3x240																1892	1478	946	591	375	296	236	189	148

Correction coefficients

Tripping characteristic	K1	Voltage	K2	Conductor	K3	Cross section of PE(N) conductor	K4
Curve B	x 2	3 x 230V	x 0.58	Aluminium	0.62	m = Sphase / Spe(n)	
Curve D	x 0.5					m = 0.5	x 2
Curve K	x 1.6					m = 1	x 1
Curve Gi	x 0.8					m = 2	x 0.67
Curve Im	x 10/Im					m = 3	x 0.5
						m = 4	x 0.4

Example

3-phase TN system Un = 230 V protected with MCCB 80A (Im = 8 x In). Phase conductor 50 mm² copper and PE conductor 25 mm² copper.

L_{max} = **257** x $\frac{10}{8}$ x 0.58 x 0.67 = 125m

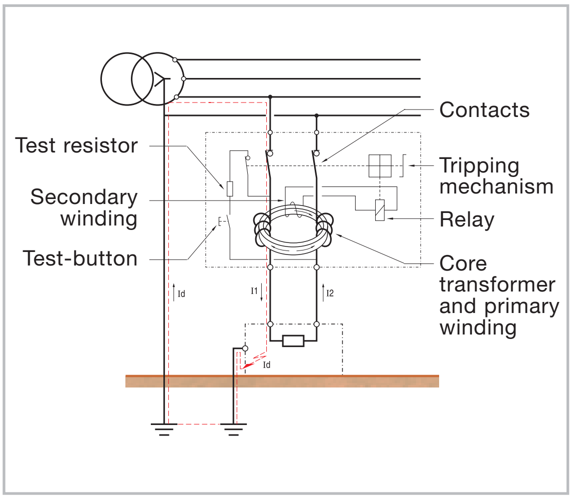
What is an RCD?

The RCD (Residual Current Device) is a device which intends to protect people against indirect contact, the exposed conductive parts of the installation being connected to an appropriate earth electrode. It may be used to provide protection against fire hazards due to a persistent earth fault current, without the operation of the overcurrent protective device.

RCD's having a rated residual operating current not exceeding 30 mA are also used as a means for additional protection in case of failure of the protective means against electric shock (direct contact).

WORKING PRINCIPLE
The main components of a RCD are the following:
- The core transformer: which detects the earth current fault.
- The relay: when an earth fault current is detected the relay reacts by tripping and opening the contacts.
- The mechanism: Element to open and close the contacts either manual or automatically.
- The contacts: To open or close the main circuit.

The RCD constantly monitors the vectorial sum of the current passing through all the conductors. In normal conditions the vectorial sum is zero (I1+I2=0) but in case of an earth fault, the vectorial sum differs from zero (I1+I2=Id), this causes the actuation of the relay and therefore the release of the main contacts.



Definitions related to RCD's

RCCB = Residual Current Circuit Breaker without overcurrent protection

RCBO = Residual Current Circuit Breaker with overcurrent protection

Breaking capacity
A value of AC component of a prospective current that a RCCB is capable of breaking at a stated voltage under prescribed conditions of use and behavior.

Residual making and breaking capacity (I∆m)
A value of the AC component of a residual prospective current which a RCCB can make, carry for its opening time and break under specified conditions of use and behavior.

Conditional residual short-circuit current (I∆c)
A value of the AC component of a prospective current which a RCCB protected by a suitable SCPD (short-circuit protective device) in series, can withstand under specific conditions of use and behavior.

Conditional short-circuit current (Inc)
A value of the AC component of a residual prospective current which a RCCB protected by a suitable SCPD in series, can withstand under specific conditions of use and behavior.

Residual short-circuit withstand current
Maximum value of the residual current for which the operation of the RCCB is ensured under specified conditions and above which the device can undergo irreversible alterations.

Prospective current
The current that would flow in the circuit, if each main current path of the RCCB and the overcurrent protective device (if any) were replaced by a conductor of negligible impedance.

Making capacity
A value of AC component of a prospective current that a RCCB is capable to make at a stated voltage under prescribed conditions of use and behavior.

Open position
The position in which the predetermined clearance between open contacts in the main circuit of the RCCB is secured.

Close position
The position in which the predetermined continuity of the main circuit of the RCCB is secured.

Tripping time
The time which elapses between the instant when the residual operating current is suddenly attained and the instant of arc extinction in all poles.

Residual current (I∆n)
Vector sum of the instantaneous values of the current flowing in the main circuit of the RCCB.

Residual operating current
Value of residual current which causes the RCCB to operate under specified conditions.

Rated short-circuit capacity (Icn)
Is the value of the ultimate short-circuit breaking capacity assigned to the circuit breaker.
(Only applicable to RCBO)

Conventional non-tripping current (Int)
A specified value of current which the circuit breaker is capable of carrying for a specified time without tripping. (Only applicable to RCBO)

Conventional tripping current (It)
A specified value of current which causes the circuit breaker to trip within a specified time.
(Only applicable to RCBO)

RCD's classification acc. EN/IEC 61008/61009

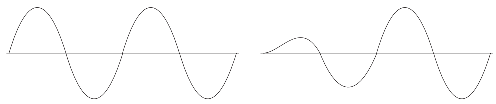
RCD's may be classified according to:

- The behavior in presence of dc current (types for general use).
  - Type AC
  - Type A

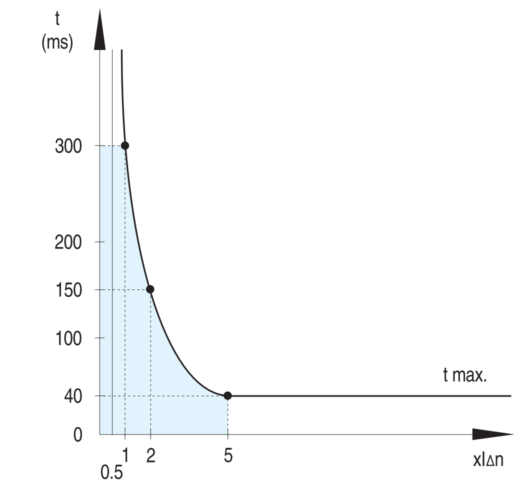
- The time-delay (in presence of residual current)
  - RCD's without time delay: type for general use
  - RCD's with time delay: type S for selectivity

Type AC

The type AC RCDs are designed to release with sinusoidal residual currents which occur suddenly or slowly rise in magnitude.



Residual current	Tripping time
0.5 x IΔn	t = ∞
1 x IΔn	t = < 300 ms
2 x IΔn	t = < 150 ms
5 x IΔn	t = ≤ 40 ms

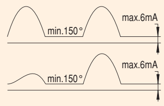
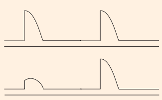
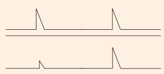


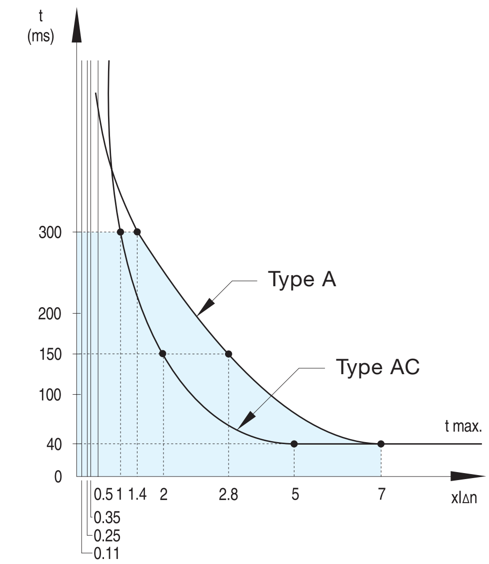
Tripping curve type AC

Type A

Certain devices during faults can be the source of non-sinusoidal earth leakage currents (DC components) due to the electronic components e.g.: diodes, thyristors.....
The type A RCD's are designed to ensure that under this conditions the residual current devices operate on sinusoidal residual current and also with pulsating direct current(*) which occur suddenly or slowly rise in magnitude.

(*) Pulsating direct current: current of pulsating wave form which assumes, in each period of the rated power frequency, the value 0 or a value not exceeding 0,006 A dc during one single interval of time, expressed in angular measure of at least 150º.

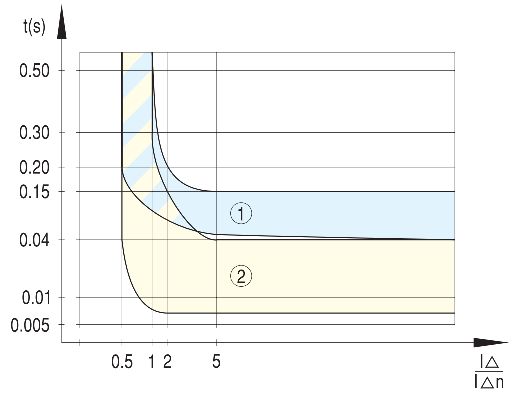
	Residual current	Tripping time
1. For sinusoidal residual current		
	0.5xIΔn	t = ∞
	1 xIΔn	t = < 300ms
	2 xIΔn	t = < 150ms
	5 xIΔn	t = < 40ms
2. For residual pulsating direct current		
	At point of wave 0°	
	0.35xIΔn	t = ∞
	1.4 xIΔn	t = < 300ms
	2.8 xIΔn	t = < 150ms
	7 xIΔn	t = < 40ms
	At point of wave 90°	
	0.25xIΔn	t = ∞
	1.4 xIΔn	t = < 300ms
	2.8 xIΔn	t = < 150ms
	7 xIΔn	t = < 40ms
	At point of wave 135°	
	0.11xIΔn	t = ∞
	1.4 xIΔn	t = < 300ms
	2.8 xIΔn	t = < 150ms
	7 xIΔn	t = < 40ms



Tripping curve type A

Type S [S]

RCD's type A or AC have instantaneous tripping. In order to provide full people protection in vertical installation (no class II) with more than one circuit, as well as to ensure the service in the installation in case of earth leakage in one of the circuits or to avoid unwanted tripping because of harmonics, high connection currents due to the use of motors, reactive loads, or variable speed drivers, we need to use selective RCD's at the top of the installation. Any RCD type S is selective to any other instantaneous RCD installed downstream with lower sensitivity.



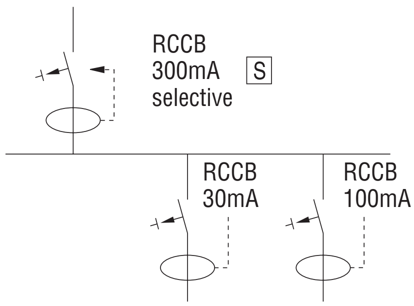
Selectivity

Vertical selectivity

In an installation with RCD's installed in series we need to pay special attention to the vertical selectivity, in order to ensure that in case of earth leakage only the RCD which is immediately upstream of the fault point will operate.
Selectivity is ensured when the characteristic time/current of the upstream RCD (A) is above the characteristic time /current of the downstream RCD (B). To obtain vertical selectivity we should take into consideration the following parameters:
The RCD placed at the top of the installation shall be Type S. The residual operating current of the RCCB installed downstream shall have a lower residual operating current than the RCD installed upstream according to:

IΔn downstream < IΔn upstream/3

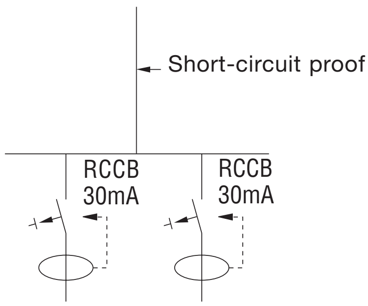
Vertical selectivity



Horizontal selectivity

To have horizontal selectivity in an installation with RCD's we need to avoid the use of RCD in cascading. Every single circuit of the installation shall be provided with a RCD of the appropriate residual operating current. The connection between the back-up protective device and the RCD must be short-circuit proof (Class II).

Horizontal selectivity



Nuisance tripping

Type AI (High immunity to nuisance tripping)
Electric equipment incorporates more and more electronic components which causes nuisance tripping to the conventional 30mA RCD's type A or AC (always in the most critical moment like weekends, areas with no people presence...) due to overvoltages or high frequency currents produced by atmospheric disturbances, lighting equipment (electronic balasters), computers, appliances, connections to long cables which induce a high capacity to ground, etc.

Some times the filter incorporated on the standard RCD's type A or AC which are protected to prevent nuisance tripping against current peak up to 250 A 8/20 μs, does not avoid 100% unwanted tripping. Therefore GE Power Controls has developed a new RCD generation which protects against nuisance tripping of peak currents up to 5000 A 8/20 μs.

Installations with either lighting equipment incorporating electronic balasters or computers.

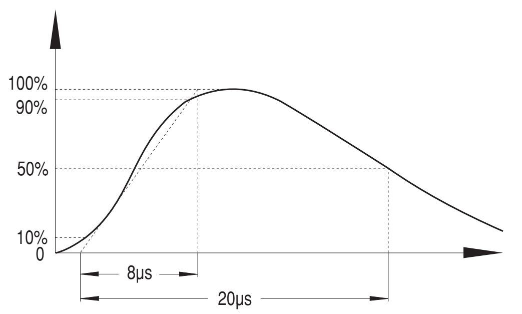
The most typical problem in these installations is the tripping of the RCD when switching the equipment ON-OFF. It is recommended that, in case several devices are installed in the same line, the sum of all leakages shall not exceed 1/3 IΔn since any disturbance in the line can trip the RCD. For this kind of installation it is recommended to split up circuits or to **use type AI RCD's.**

RCD's type AI or ACI have a tripping characteristic according to EN/IEC 61008/61009.

All RCD's have a high level of immunity to transient currents, against current impulses of 8/20 μs according to EN/IEC 61008/61009 and VDE 0664.T1

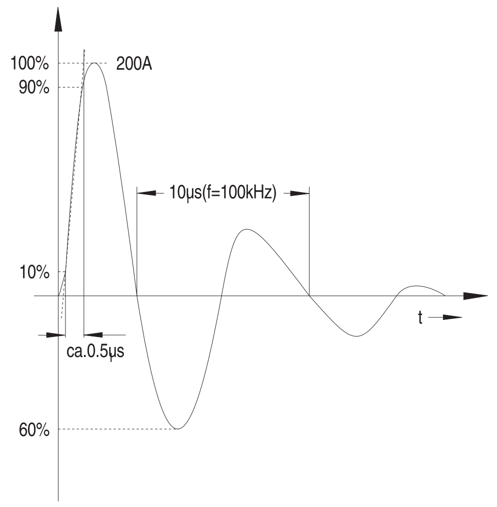
Type A, AC ....250 A 8/20 μs
Type S ....3000 A 8/20 μs
Type Ai ....3000 A 8/20 μs
Type Si ....5000 A 8/20 μs

Curve 8/20 μs



RCD's have a high level of immunity against ring wave currents of high frequency according to EN/IEC 61008/61009

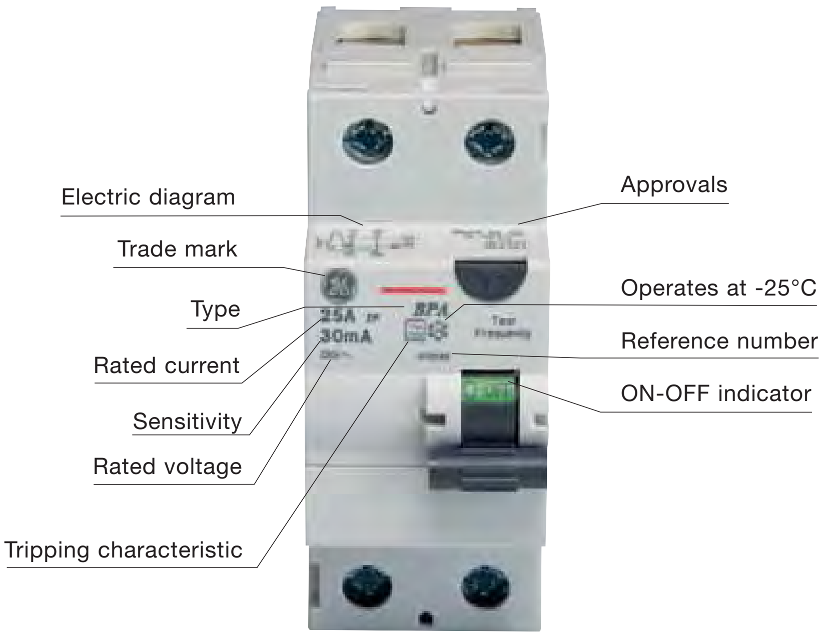
Curve 0.5 μs - 100 kHz - 200 A - EN/IEC 61008/61009



Product identification of an RCCB Series BPC/BDC and its use

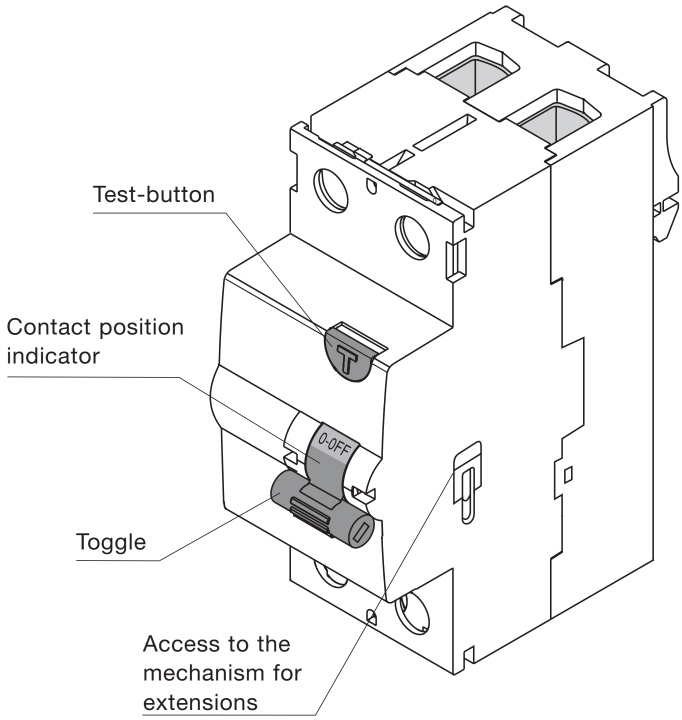
Information on product

Example: RCCB 2P 25A 30mA Type A

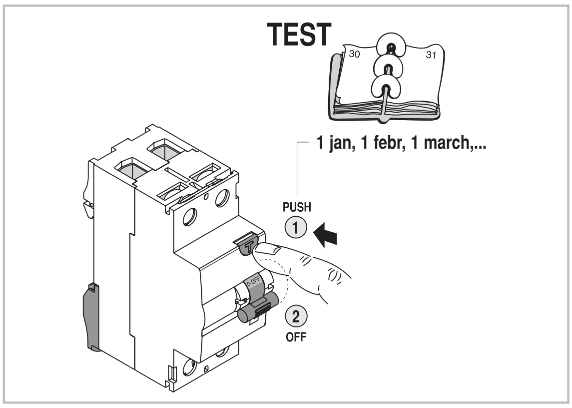


Use of an RCCB

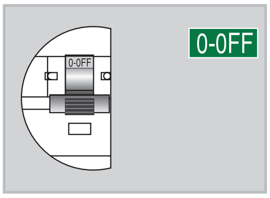
RCCB BPC/BDC



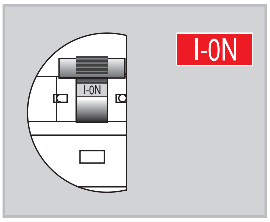
TEST-BUTTON
To ensure the correct functioning of the RCCB, the test button T shall be pressed frequently. The device must trip when pressed.



CONTACT POSITION INDICATOR
Printing on the toggle to provide information of the real contact position.



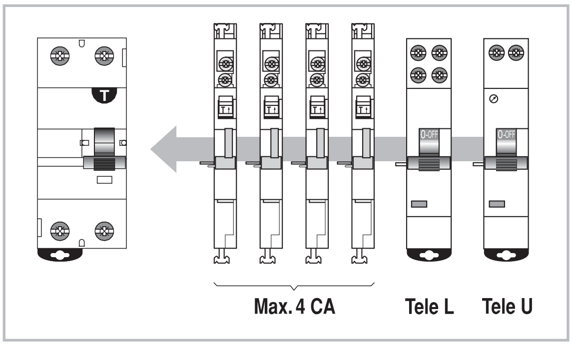
O-OFF
Contacts in open position. Ensure a distance between contacts > 4mm.

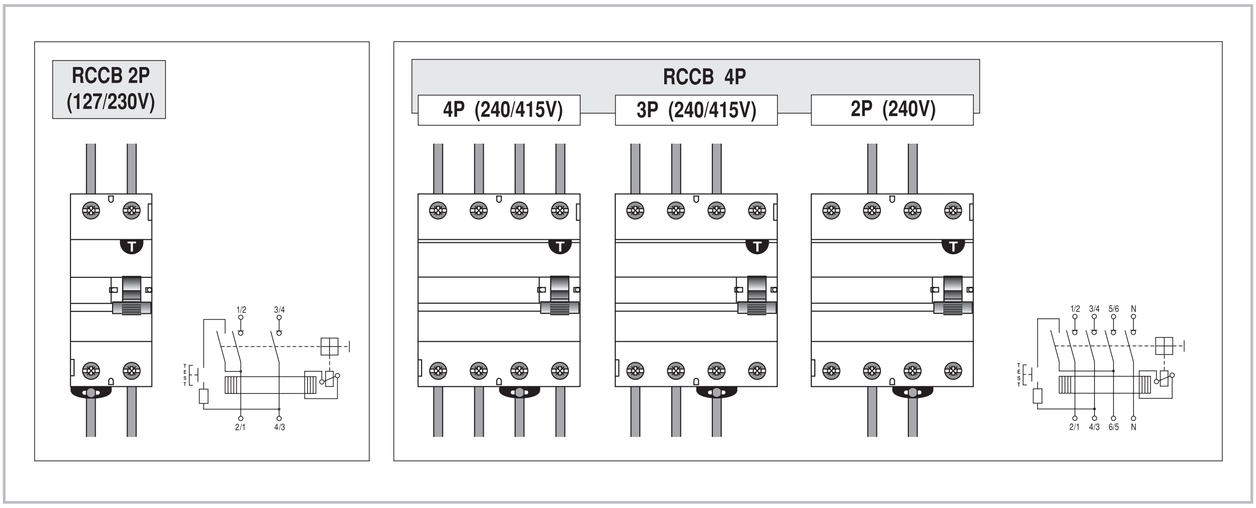


I-ON
Contacts in closed position. Ensure continuity in the main circuit.

ALL CABLES MUST BE CONNECTED TO THE RCCB
All conductors, phases and neutral, that constitute the power supply of the installation to be protected, must be connected to the RCCB to either upper or lower terminals according to one of the following diagrams.

ACCESS TO THE MECHANISM FOR EXTENSIONS
To couple extensions we need to remove the cap on the right hand side, in order to get access to the mechanism.
It is possible to add any auxiliary contact, shunt trip, undervoltage release or motor operator, following the stack-on configuration of the extensions in chap. T3.

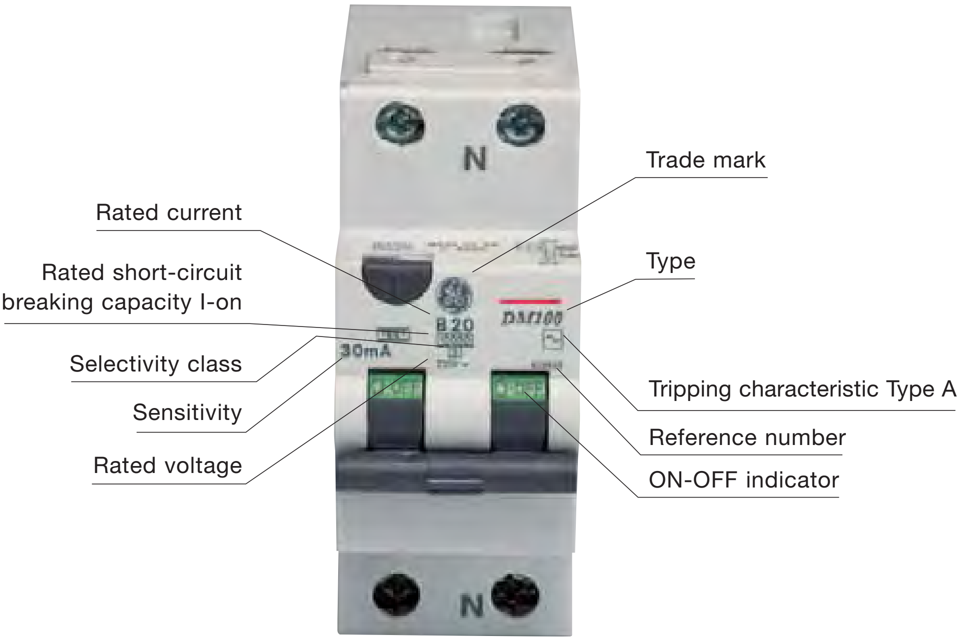




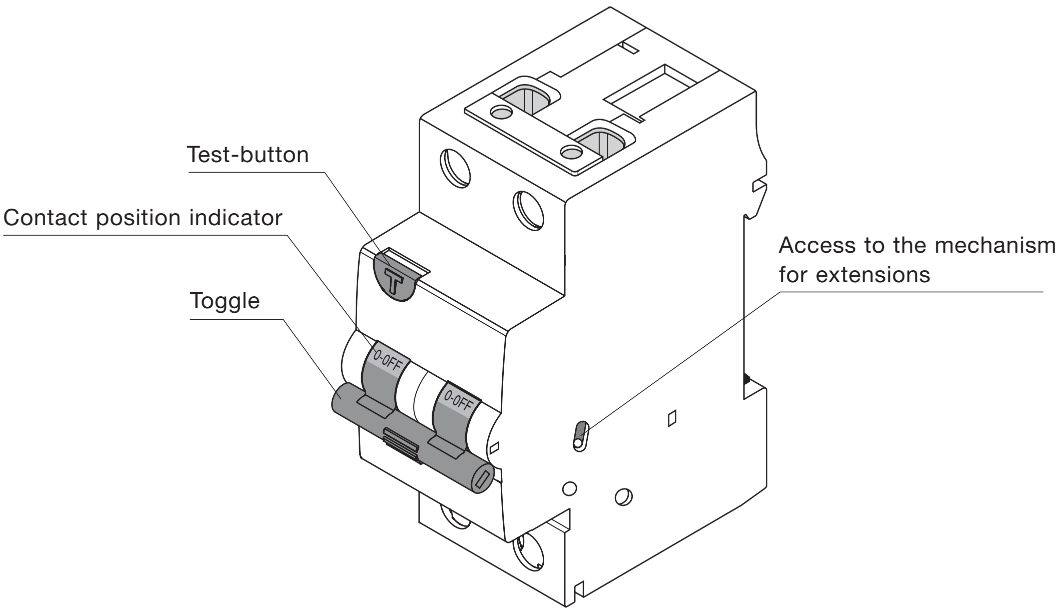
Product identification of an RCBO series DM and its use

Information on product

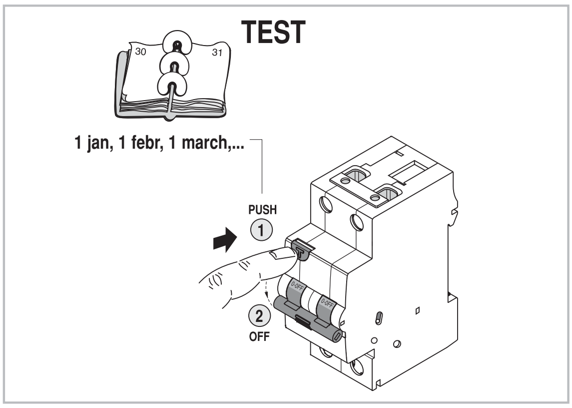
Example: RCBO 1P+N C16 30mA Type A



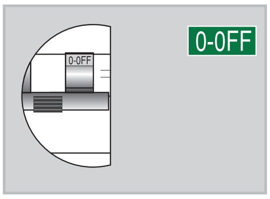
Use of an RCBO



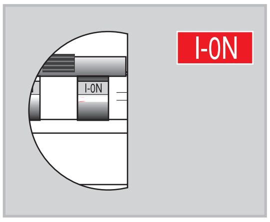
TEST-BUTTON
To ensure the correct functioning of the RCBO, the test button T shall be pressed frequently. The device must trip when the test button is pressed.



CONTACT POSITION INDICATOR
Printing on the toggle to provide information of the real contact position.



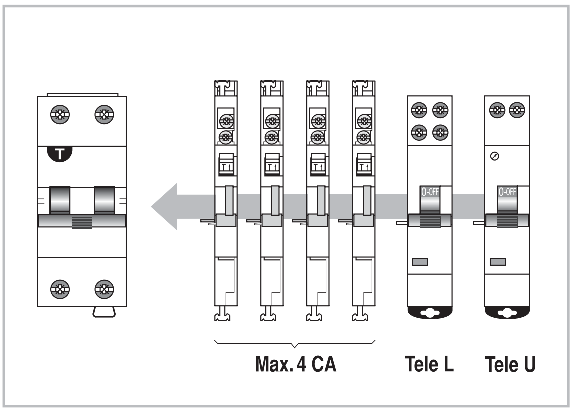
O-OFF
Contacts in open position. Ensure a distance between contacts > 4mm.



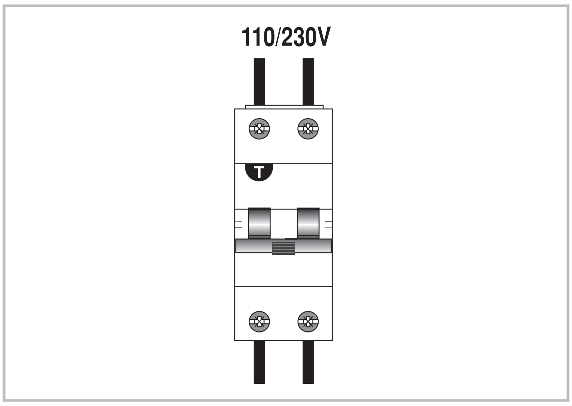
I-ON
Contacts in close position. Ensure continuity in the main circuit.

TOGGLE
To switch the RCBO ON or OFF

ACCESS TO THE MECHANISM FOR EXTENSIONS
It is possible to add any auxiliary contact, shunt trip, undervoltage release or motor operator, following the stack-on configuration of the extensions in page C.3.



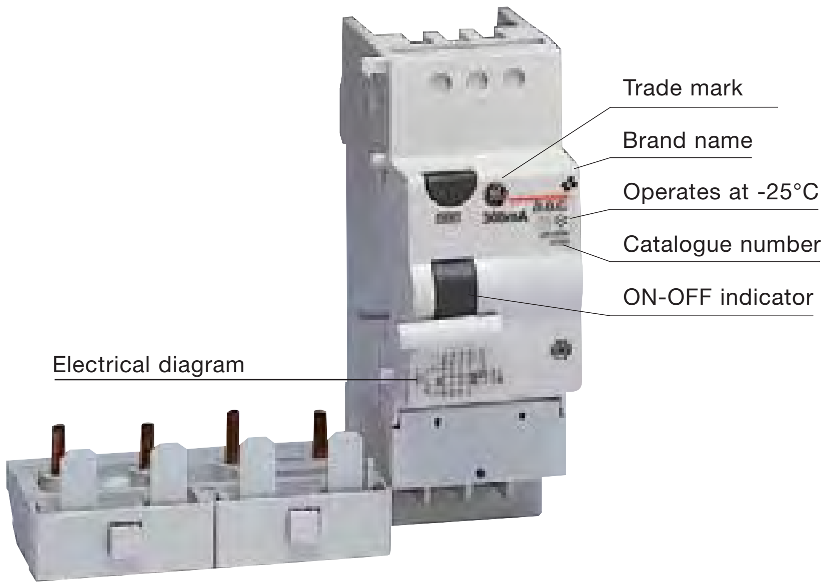
ALL CABLES MUST BE CONNECTED TO THE RCCB
All conductors, phase and neutral, that constitute the power supply of the installation to be protected, must be connected to the RCBO to either upper or lower terminals according to the following diagram.



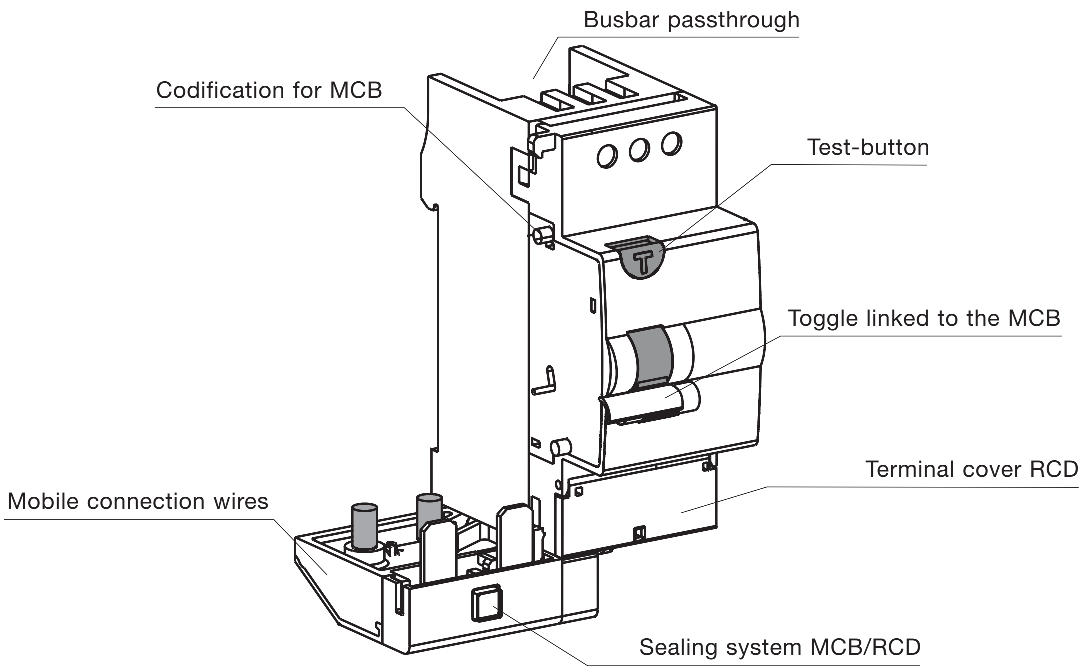
Product identification of an add-on RCD and its use

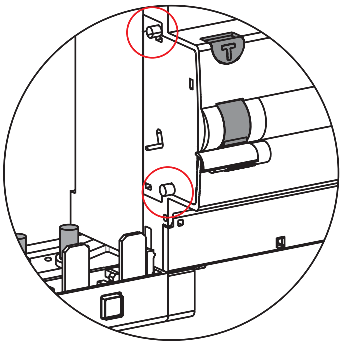
Information on product

Example: Add-on RCD



Use of an add-on RCD





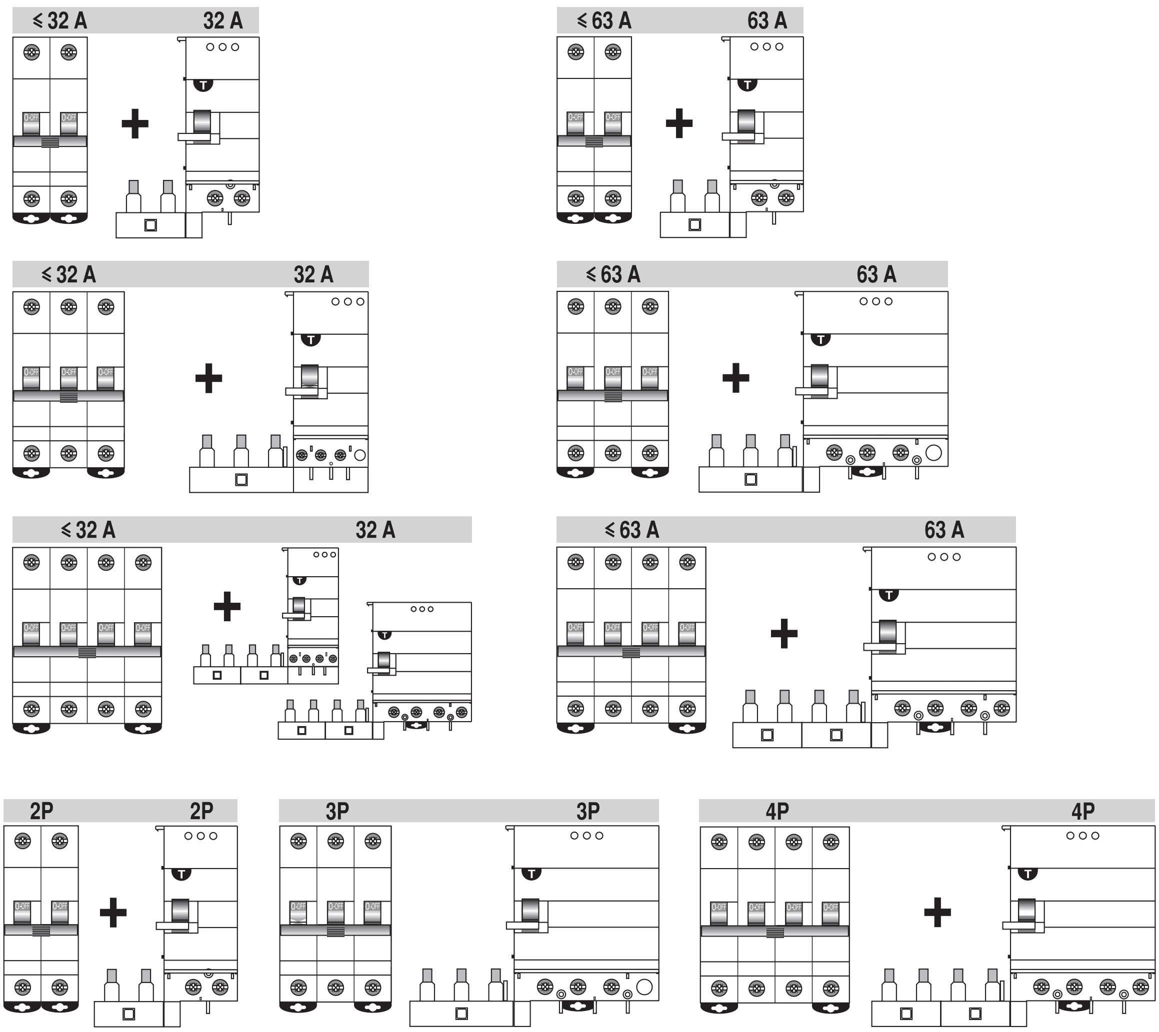
CONDITIONS FOR ASSEMBLY

The annex G of the EN/IEC 61009-1 standard says:

- It shall not be possible to assemble a MCB of a given rated current with an add-on RCD unit of a lower maximum current.
- It shall not be possible to assemble an add-on RCD with a MCB having no provision for switching the associated neutral.

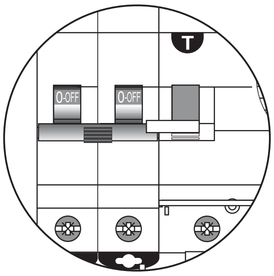
To comply with the mentioned conditions it is implemented on the add-on RCD a codification system which avoids any wrong assembly.

The correct assembly shall be done as follows:



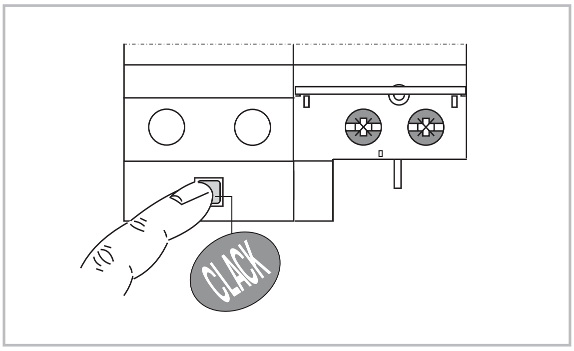
TOGGLE

To switch the add-on RCD ON or OFF. The toggle is overlapped with the one of the coupled MCB and both can be swithced on at the same time.



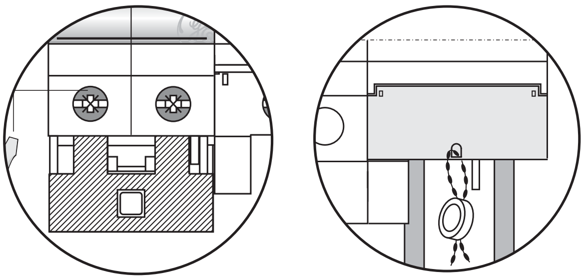
UNMANIPULATION SEALING SYSTEM

To seal the combination MCB/RCD once the assembly is finished. Any manipulation after sealing the combined unit, visible damage will remain.



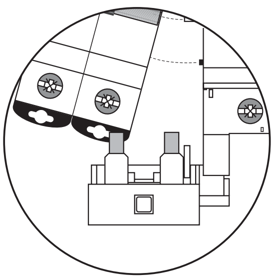
TERMINAL COVERS

Unlosable terminal covers for the MCB bottom terminals as well as for the RCD terminals are provided.



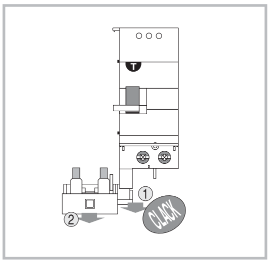
MOBILE CONNECTION

For an easy and quick assembly the connection wires are bi-stable

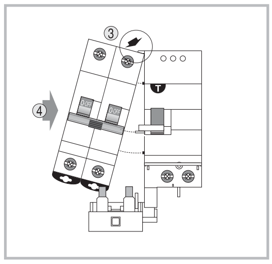


HOW TO ASSEMBLE ADD-ON RCD+MCB

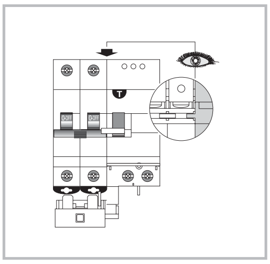
Pull down the connector block.



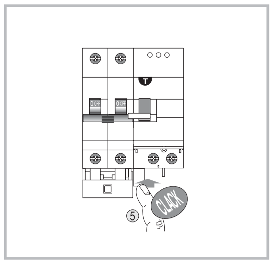
Place the RCD and the MCB along side one another, both in OFF position.



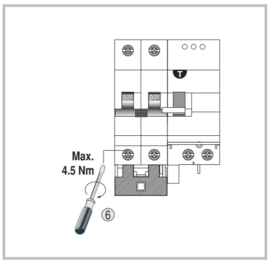
Make sure the coupling is well done.



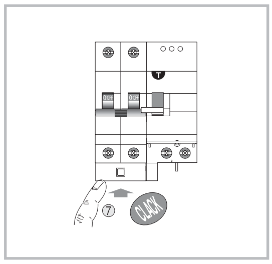
Push up the connector block.



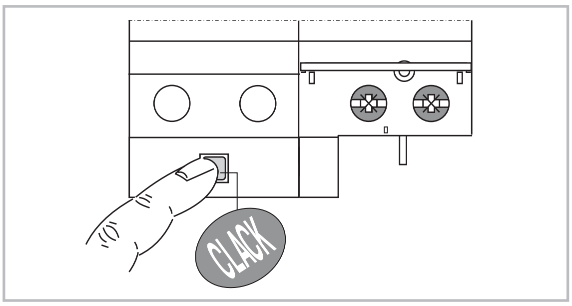
Maximum screwing torque 4,5 Nm



Push up the MCB cover terminals

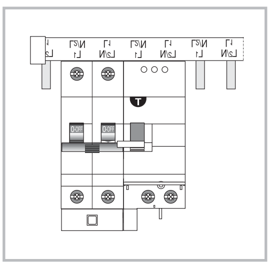


Once tested the correct electrical functioning of the combined unit, seal the combined unit by means of the sealing button.



BUSBAR PASSTHROUGH

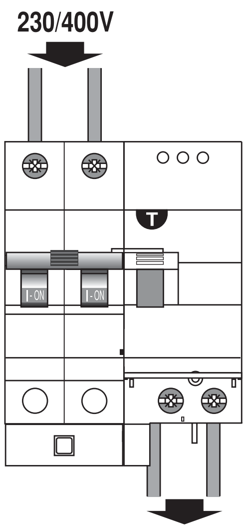
The add-on RCD permitts the passthrough of both pin and fork busbars at the top terminals.

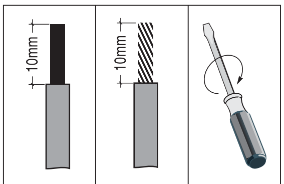


ALL CABLES MUST BE CONNECTED TO THE RCBO

In order to protect the RCD in the proper way, it is recommended to feed the combined unit (MCB/RCD) by the MCB (top terminals), in such a way the MCB provides back up protection to the RCD.

All conductors, phases and neutral, that constitute the power of the installation to be protected must be connected to the MCB/RCD combination.

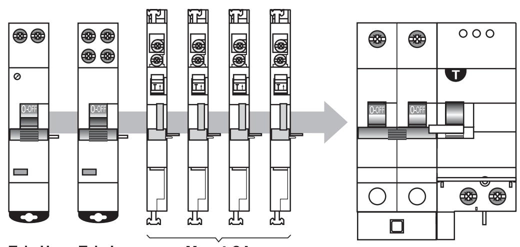




		max.	max.	max.
2 P	2 mod	35 mm	25 mm	4.5 Nm
3 P 4 P	4 mod	35 mm	25 mm	4.5 Nm
4 P	2 mod	16 mm	10 mm	2.5 Nm

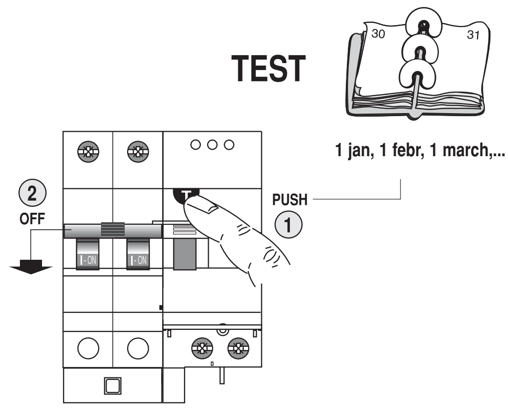
ACCESS TO THE MECHANISM FOR EXTENSIONS

It is possible to add any auxiliary contact, shunt trip, undervoltage release or motor operator on the left hand side, following the stack on configuration of the extensions in chap. T3.



TEST-BUTTON

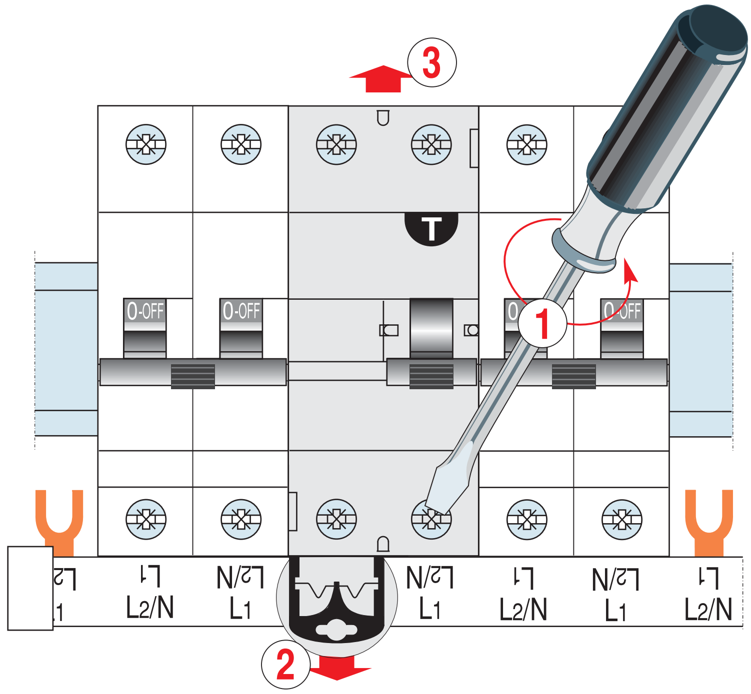
To ensure the correct functioning of the RCBO, the test-button T shall be pressed frequently. The device must trip when the test button is pressed.



Easy DIN-rail extraction

RCCB's can easilly be removed from the DIN rail when installed with busbars just taking into consideration the following instructions.

Pin and fork busbar - bottom terminals



① Open the terminals totally
② Unclick the DIN rail clip
③ Lift the RCCB up and remove
it from the DIN rail

Product related information

Influence of air ambient temperature in the rated current

Influence of temperature in RCCB

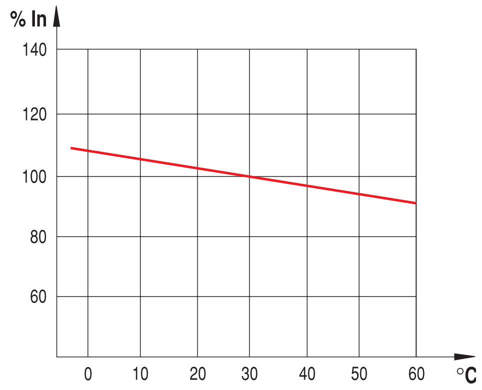
The maximum value of the current which can flow through a RCCB depends of the nominal current as well as the ambient air temperature. The protective device placed up-stream of the RCCB must ensure the disconnection at the values in the following table:

In	25°C	30°C	40°C	50°C	60°C
16 A	19	18	16	14	13
25 A	31	28	25	23	25
40 A	48	44	40	36	32
63 A	76	69	63	57	51
80 A	97	88	80	72	65
100 A	121	110	100	90	81
125 A	151	137	125	112	101

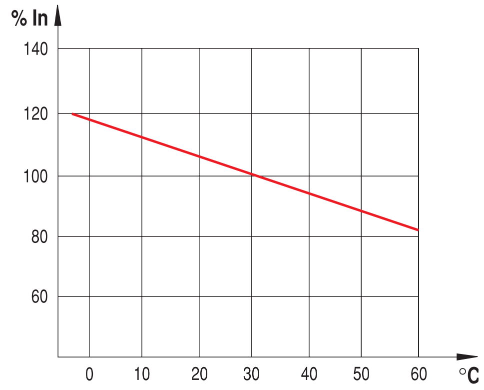
Influence of temperature in RCBO's

The thermal calibration of the RCBO was carried out at an ambient temperature of 30°C. Ambient temperatures different from 30°C influence the bimetal and this results in earlier or later thermal tripping.

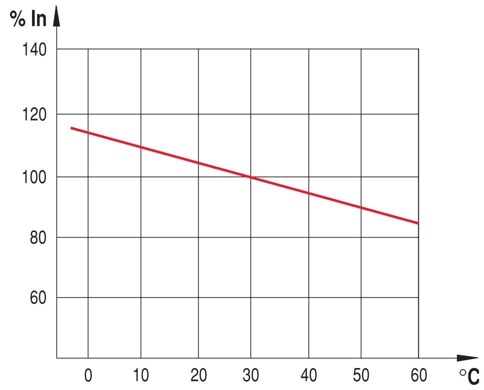
0.5 - 6A



10A



16 - 40A



Tripping current as a function of the frequency

All the RCD's are designed to work at frequencies of 50-60 Hz, therefore to work at different values, we must consider the variation of the tripping sensitivity according tables below. It should be taken into consideration that there is a no tripping risk when pushing the test-button, due to the fact that such action is made by means of a internal resistor with a fixed value.

RCCB Series BDC/BPC/BPA/BPS and Add-on RCD DOC

Type AC	10 Hz	30 Hz	50 Hz	100 Hz	200 Hz	300 Hz	400 Hz
30mA	3.63	1.50	0.80	1.63	2.40	3.03	4.63
100mA	0.75	0.74	0.80	1.18	1.69	2	2.46
300mA	0.62	0.71	0.80	1.15	1.45	1.84	2.16
500mA	0.80	0.72	0.80	1.15	1.52	1.79	2.12
Type A							
30mA	7.57	2.40	0.75	1.63	2.53	3.70	9.23
100mA	4.50	1.85	0.75	1.22	2.17	4.35	10.85
300mA	3.56	1.55	0.75	1.18	2.10	4.40	17.10
500mA	3.24	1.39	0.75	0.95	12.17	25.40	33.06

RCBO Series DM/DMA

Type AC	10 Hz	30 Hz	50 Hz	100 Hz	200 Hz	300 Hz	400 Hz
30mA	0.62	0.65	0.80	0.91	1.24	1.55	1.88
100mA	0.74	0.71	0.80	0.95	1.16	1.38	1.59
300mA	0.80	0.74	0.80	0.97	1.19	1.44	1.64
500mA	1.10	0.81	0.80	0.89	1.18	1.38	1.68
Type A							
30mA	8.17	3.13	0.75	1.70	3.10	3.52	3.67
100mA	6.81	2.71	0.75	1.43	2.35	2.58	2.71
300mA	6.20	2.16	0.75	0.49	0.87	0.74	0.95
500mA	4.34	1.53	0.75	0.39	0.59	0.62	0.64

Protection of RCCB

RCCB's are not overcurrent protected. Therefore we don't need to consider both protection against short-circuits and overloads.

Protection against short-circuits
COORDINATION OF RCCB's WITH MCB's OR FUSES, BACK-UP PROTECTION

RCCB's protected with a SCPD have to be able to withstand, without damage, short-circuit currents up to its rated conditional short-circuit capacity. The SCPD has to be carefully selected, since the association of this device with the RCCB is interrupting the short-circuit of the installation.

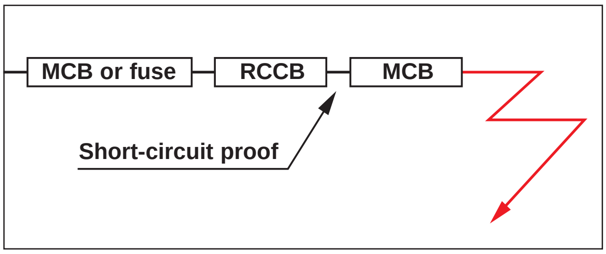
The value of the presumed short-circuit current at the point where the RCCB is installed shall be lower than the values of the following table:

The RCCB and the protective device must be installed in the same switchboard, paying special attention to the connection between these two devices since if the SCPD is installed downstream of the RCCB such a connection must be short-circuit proof.
SCPD = Short-Circuit Protective Device.

RCCB co-ordination with MCB or fuses

	UPSTREAM PROTECTION										
	MCB'S							FUSES			
RCCB EFI/EHFI	G60 up to 40A	G100 ≤ 40A	GT25 > 40A	GT25 ≤ 40A	GT25 > 40A	Hti 80...125A	S90	Fuse 160A	Fuse 250A	Fuse 400A	Fuse 630A
DOWNSTREAM G60 ≤ 25A	6 kA	10 kA	10 kA	10 kA	10 kA	–	25 kA	–	–	–	–
DOWNSTREAM G100 ≤ 25A	–	25 kA	25 kA	25 kA	25 kA	10 kA	25 kA	16 kA	10 kA	10 kA	10 kA
DOWNSTREAM G100 > 25A	–	25 kA	25 kA	25 kA	25 kA	10 kA	25 kA	10 kA	10 kA	10 kA	10 kA
DOWNSTREAM Fuse 25A	100 kA	100 kA	100 kA	100 kA	100 kA	100 kA	100 kA	100 kA	100 kA	100 kA	100 kA

The values indicated in the table are the maximum short-circuit current in kA rms.
For RCCB's 2P 230V c.a. and 4P 400 V c.a.



Power losses

The power losses are calculated by means of measuring of the voltage drop between the incoming and the outgoing terminal of the device at rated current.

Power loss per pole:

Power losses per pole RCCB BDC/BPC/BPA

In (A)	16	25	40	63	80	100
Z (mOhm)	9.94	3.75	2.15	1.30	1.30	0.87
Pw (W)	2.55	2.33	3.43	5.15	8.30	8.70

Power losses per pole RCBO DM/DMA

In (A)	4	6	10	16	20	25	32	40
Z (mOhm)	125.00	53.00	16.30	9.80	7.10	5.60	4.70	3.60
Pw (W)	2.00	1.91	1.63	2.51	2.84	3.50	4.81	5.76

Power losses per pole MCB G Add-on RCD DOC

In (A)	6	10	13	16	20	25	32	40	50	63
Z (mOhm)	45.4	17.4	13.7	11.9	8.7	6.9	4.8	3.6	2.9	2.4
Pw (W)	1.6	1.7	2.3	3	3.5	4.3	4.9	5.8	7.3	9.6

Power losses per pole RCBO DME/DMAE

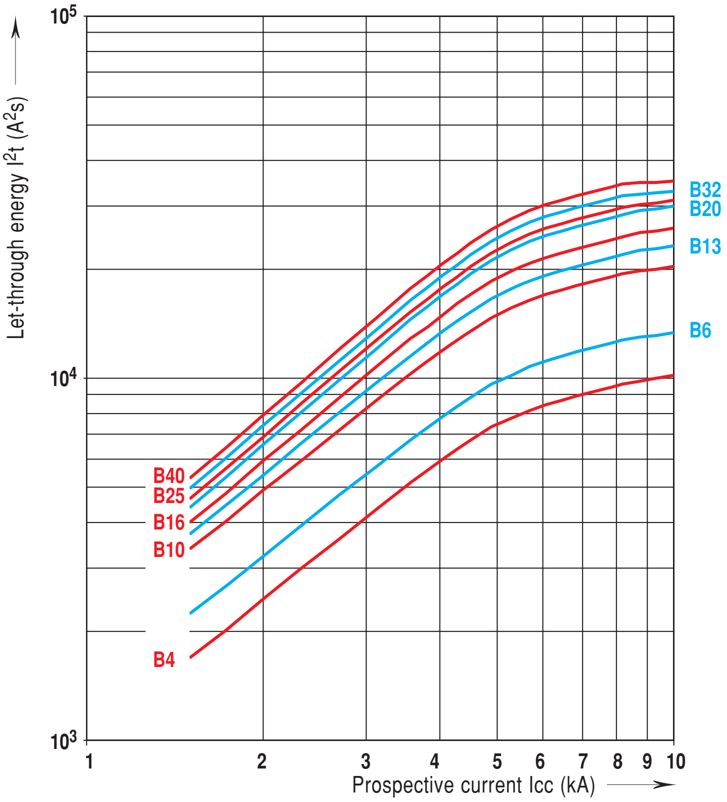
In (A)	6	8	10	13	16	20	25	32	40	50	63
Voltage drop	0.26	0.16	0.16	0.155	0.162	0.138	0.128	0.096	0.1	0.09	0 .082
Z (mOhm)	43.6	19.4	15.6	11.9	10.1	6.9	5.1	3	2.5	1.8	1.3
Pw (W)	1.57	1.242	1.56	2.011	2.566	2.76	3.188	3.188	4	4.5	5.16

RCBO let-through energy I^2t

The limitation of an RCBO in short-circuit conditions, is its capacity to reduce the value of the let-through energy that the short-circuit would be generating.

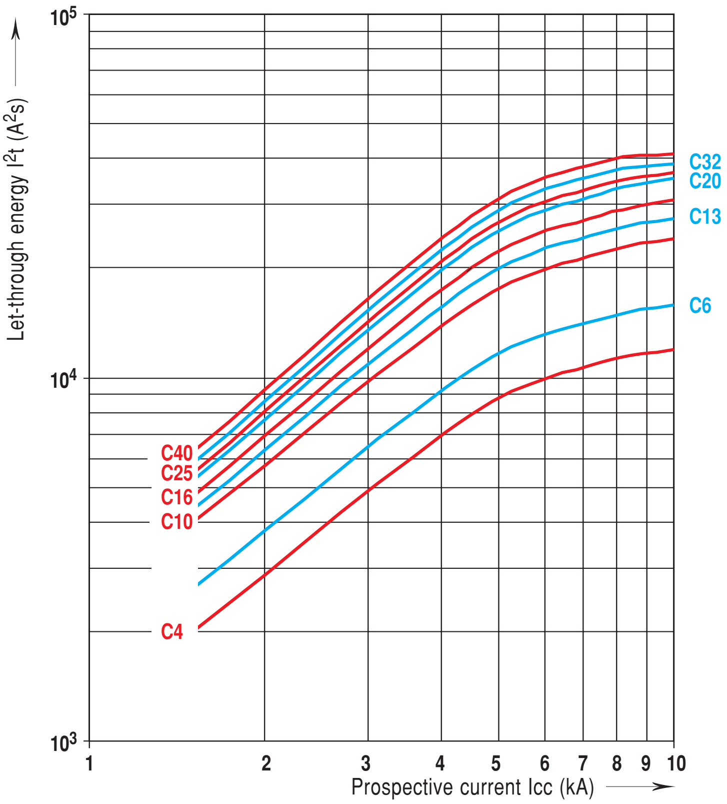
Series DM - Curve B

Let-through energy at 230 V



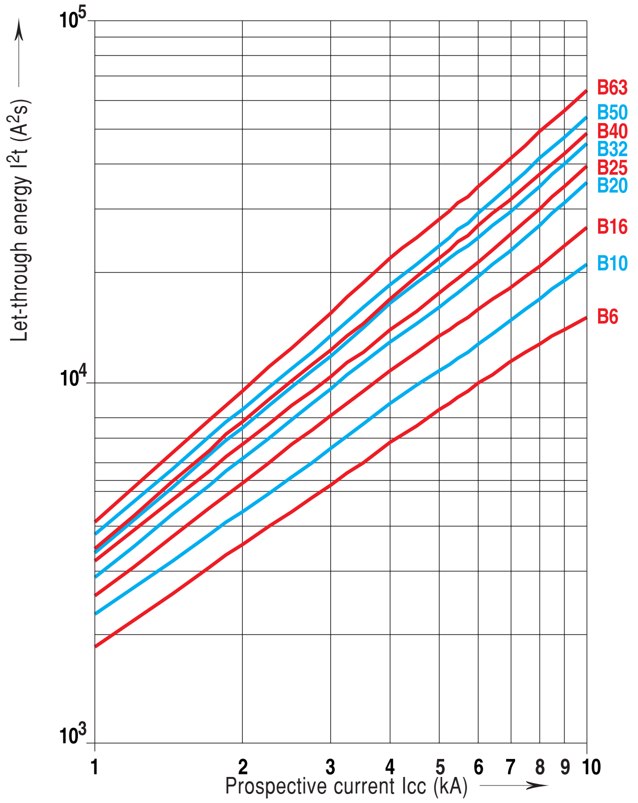
Series DM - Curve C

Let-through energy at 230 V



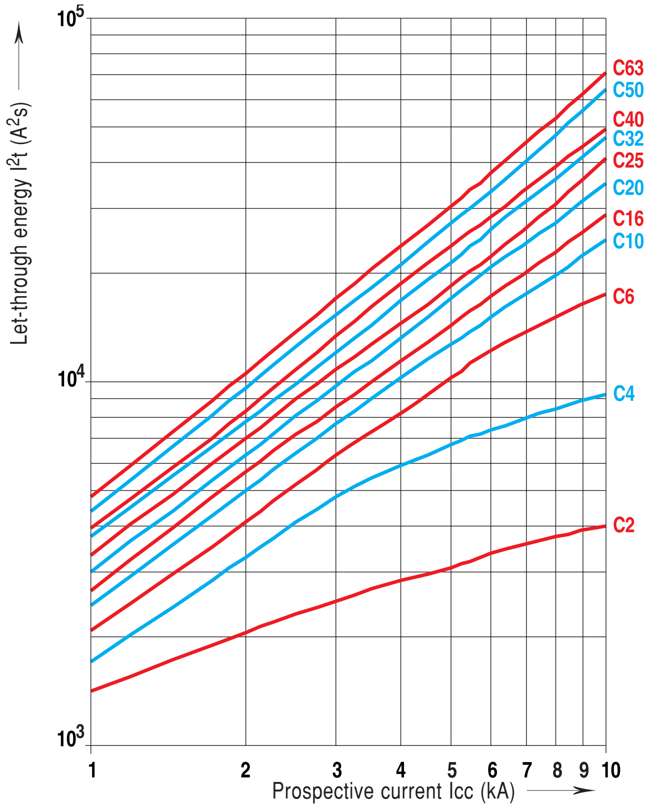
Series DME - Curve B

Let-through energy at 230 V



Series DME - Curve C

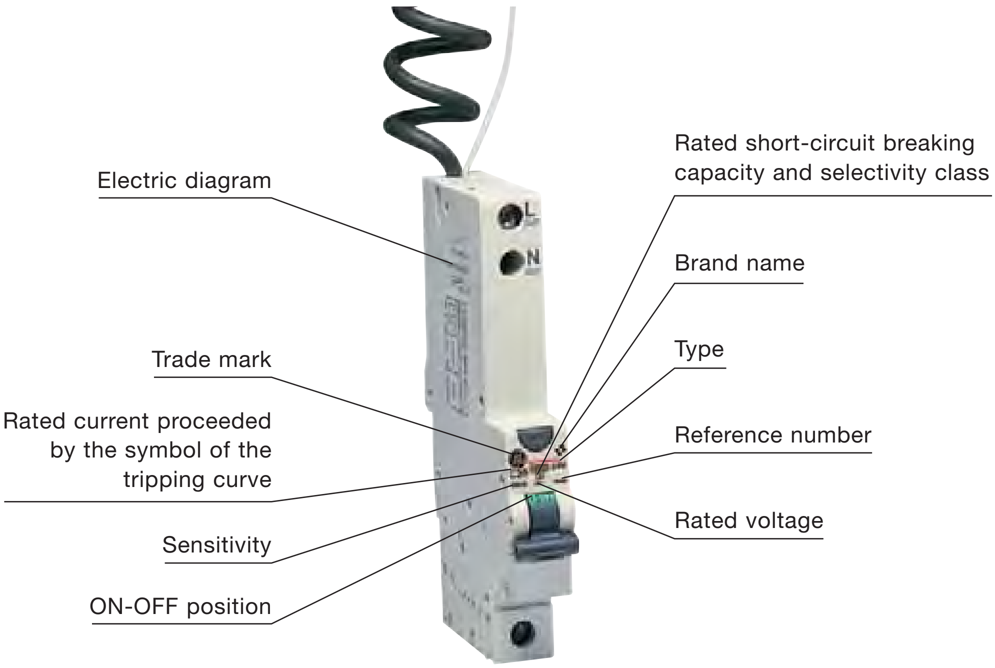
Let-through energy at 230 V



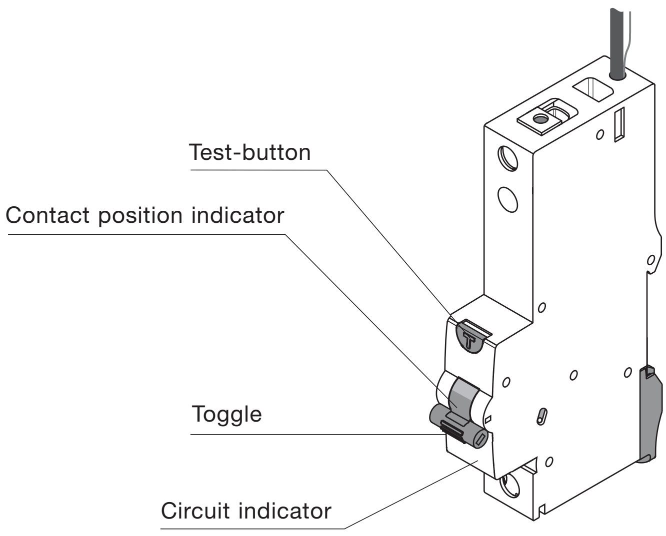
Product identification of an RCBO Series DME and its use

Information on product

Example: RCBO 1P+N B16 30mA Type AC

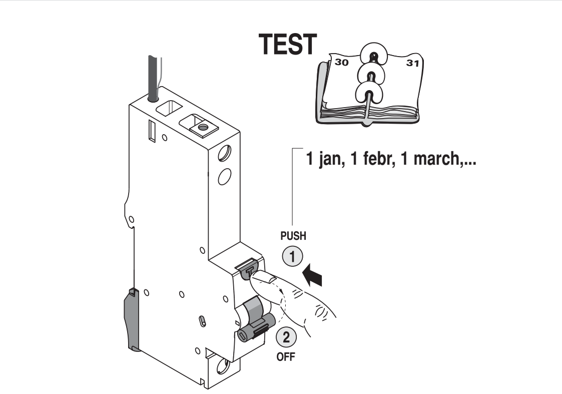


Use of an RCBO



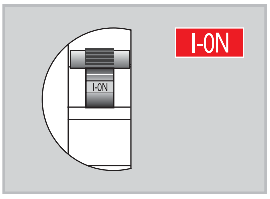
TEST-BUTTON

To ensure the correct functioning of the RCBO, the test-button T shall be pressed frequently. The device must trip when the test-button is pressed.



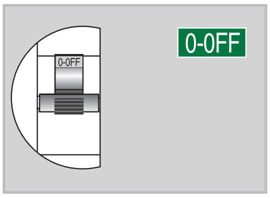
CONTACT POSITION INDICATOR

Printing on the toggle to provide information of the real contact position.



I-ON

Contacts in closed position. Ensure continuity in the main circuit.



O-OFF

Contacts in open position. Ensure a distance between contacts > 4mm.

TOGGLE

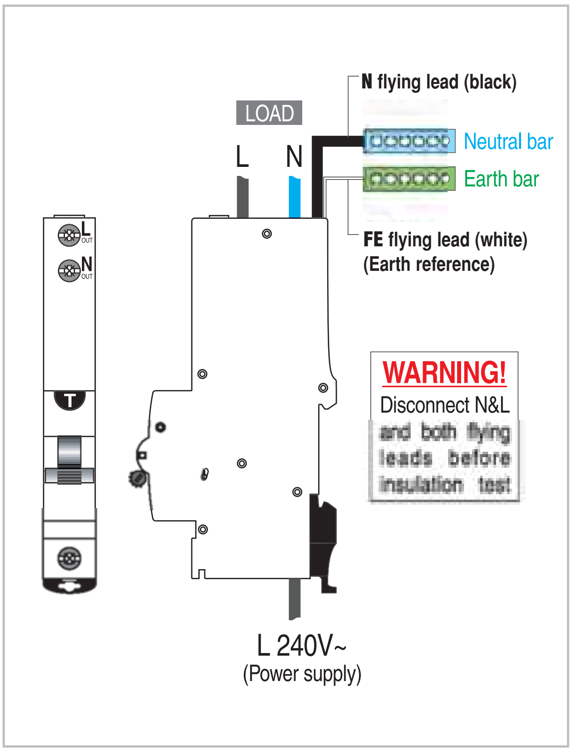
To switch the RCBO ON or OFF

CABLE CONNECTION

The power supply (L) must be done at the bottom terminal, and the supply Neutral flying cable (black) shall be connected to the Neutral bar.

Load connection shall be done in both terminals at the top side (L out / N out).

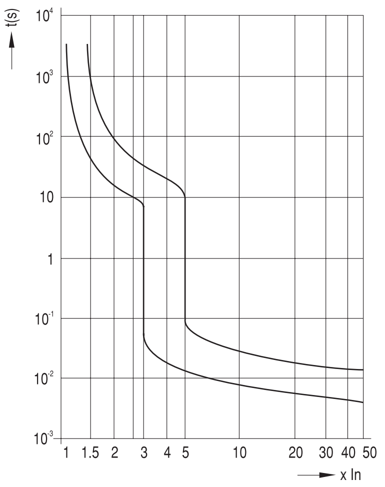
The earth reference cable (FE white) ensures protection against earth leakage in case of loss of supply Neutral.



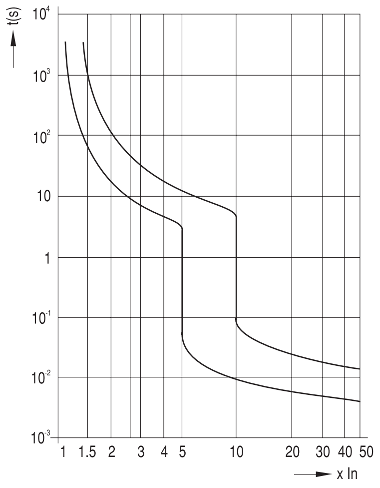
RCBO tripping curves acc. EN/IEC 61009

In the following tables it is possible to see the average tripping curves of the RCBO's in function of the thermal calibration as well as of the magnetic characteristic.

Curve B



Curve C



Text for specifiers

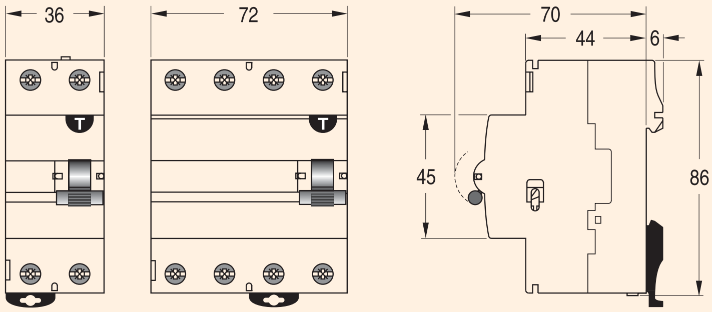
RCCB
- According to EN/IEC 61008 standard.
- Intended to detect residual sinusoidal currents (type AC) or residual pulsating direct currents (type A).
- Resistance against nuisance tripping according to VDE 0664 T1 and EN/IEC 61008.
- Working ambient temperature from –25°C up to +40°C for type A and from –5° C up to +40°C for type AC.
- Approved by CEBEC, KEMA...
- The RCCB are 2P and 3P+N with 2 and 4 modules wide.
- The Neutral pole in the 3P+N RCCB is on the right hand side. The N pole closes first of all poles and opens last of all poles.
- Nominal rated currents are: 16, 25, 40, 63, 80*A.
- Nominal residual currents are: 10, 30, 100, 300, 500 mA.
- The test circuit is protected against overloads.
- All RCCB's have a minimum short-circuit resistance of 10kA when they are back-up protected by means of MCB's or fuses.
- The making and breaking capacity is 500 A.
- The residual making and breaking capacity is 1.500 A.
- Terminal capacity from 1 up to 50 mm^2 rigid wire or 1,5 up to 50 mm^2 flexible wire.
- The devices 10,30,100 mA type A or AC have always vertical selectivity with devices 300 mA type S.
- The selective types have a delayed tripping time in comparison with the instantaneous ones (type A, AC) with sensitivity lower than 300mA.
- Both incoming and outgoing terminals have a protection degree of IP20 and are sealable.
- Isolator function due to the printing Red/Green on the toggle.
- Auxiliary contacts can be added on the right hand side.
- RCCB's can be released by means of shunt trip or undervoltage release.
- RCCB's can be remotely controled by means of a motor operator.

Add-on RCD
- According to EN/IEC 61009 standard.
- Intended to detect residual sinusoidal currents (type AC) or residual pulsating direct currents (type A).
- Resistance against nuisance tripping according to VDE 0664 T1 and EN/IEC 61009.
- Working ambient temperature from –25°C up to +40°C for type A and from –5°C up to +40°C for type AC.
- Approved by CEBEC, KEMA…
- Add-on RCD widths are:
  - 2P - 2 modules 32 A & 63 A
  - 3P - 2 modules 32 A & 4 modules 63 A
  - 4P – 2 or 4 modules 32 A & 4 modules 63 A
- Nominal rated currents are: 0,5 – 63 A & 80 – 125 A
- Nominal residual currents are: 30, 100, 300, 500, 1000 mA.
- The test circuit is protected against overloads.
- The short-circuit capacity depends on the associated MCB:
  - G30............3000 A G60 ....6000 A
  - G45............4500 A G100 ....10000 A
- The residual making and breaking capacity depends of the associated MCB:
  - G30............3000 A G60 ....6000 A
  - G45............4500 A G100 ....7500 A
- Terminal capacity:
  - 2P-2 modules 32 A & 63 A ....35 mm^2
  - 3P-2 modules 32 A................................16 mm^2
  - 3P-4 modules 63 A................................35 mm^2
  - 4P-2 modules 32 A................................16 mm^2
  - 4P-4 modules 32 A & 4 modules 63 A....35 mm^2
- The devices 10, 30, 100 mA type A or AC have always vertical selectivity with devices 300 mA type S.
- The selective types have a delayed tripping time in comparison with the instantaneous ones (type A, AC) with sensitivity lower than 300 mA.
- Both incoming and outgoing terminals (MCB+Add-on RCD) have a protection degree of IP20 and they are sealable.
- A codification system between MCB and RCD avoid a incorrect assembly (i.e. MCB 50 A coupled with RCD 32 A).
- Auxiliary contacts can be added on the left hand side of the MCB part.
- It can be released by means of shunt trip or under-voltage release.
- It can be remotely controled by means of a motor operator. The toggle of MCB and RCD are independent, so it is possible to identify the reason of the release.

RCBO
- According to EN/IEC 61009 standard.
- Intended to detect residual sinusoidal currents (type AC) or residual pulsating direct currents (type A).
- Resistance against nuisance tripping according to VDE 0664 T1 and EN/IEC 61009.
- Working ambient temperature from –25°C up to +40°C for type A and from –5°C up to +40°C for type AC. Approved by CEBEC, KEMA…
- The RCBO 1P+N is 2 modules wide or 1 module wide.
- The Neutral pole is on the left hand side. The N pole closes first of all poles and opens last of all poles.
- Nominal rated currents are: 4 up to 40 A.
- Characteristic B & C.
- Nominal residual currents are: 10, 30, 100, 300, 500, 1000 mA.
- The test circuit is protected against overloads .
- The short-circuit capacity is 10 kA, with selectivity class 3.
- The making and breaking capacity is 500 A
- The residual making and breaking capacity is 7500 A.
- Terminal capacity from 1 up to 25 mm^2 rigid in the top terminals and from 1 up to 35 mm^2 in the bottom terminals.
- The devices 10, 30, 100 mA type A or AC have always vertical selectivity with devices 300 mA type S.
- Both incoming and outgoing terminals have a protection degree of IP20.
- Isolator function due to the printing Red/Green on the toggle.
- Auxiliary contacts can be added on the right hand side.
- RCBO's can be released by means of shunt trip or undervoltage release.
- RCBO's can be remotely controled by means of a motor operator.

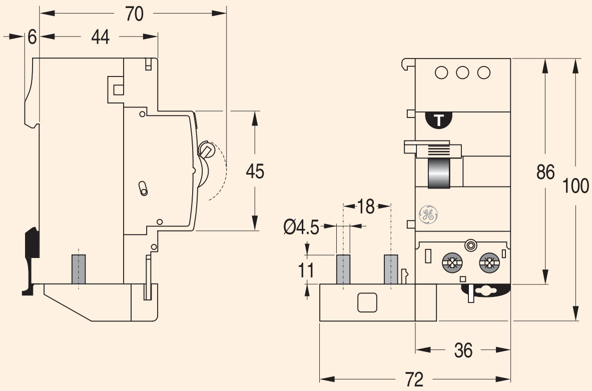
Dimensional drawings

RCCB's - Series BP

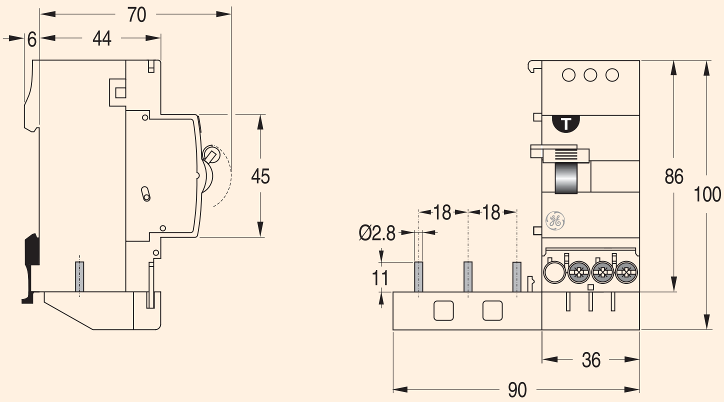


Add-on RCCB - Series Diff-o-Click

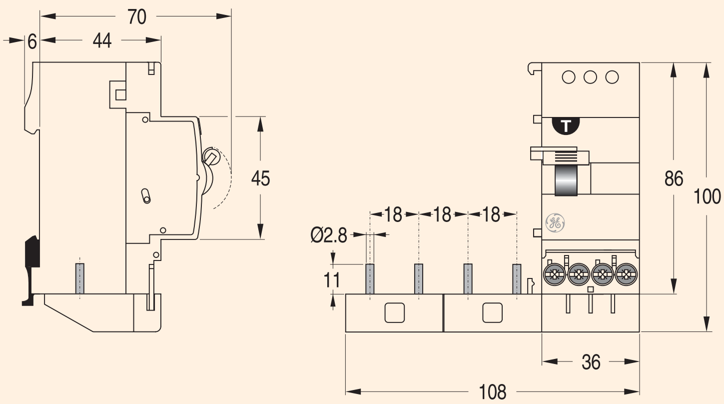
2P 32A
2P 63A



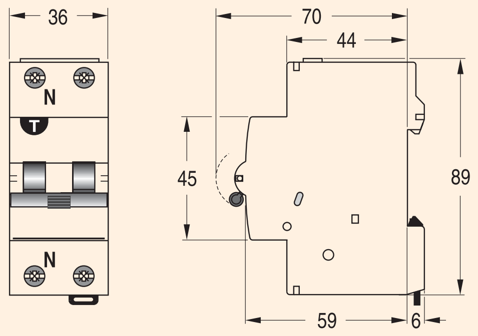
3P 32A



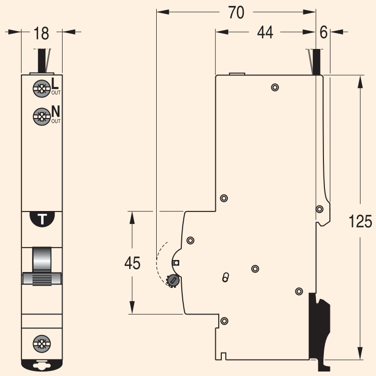
4P 32A



RCBO's - Series DM

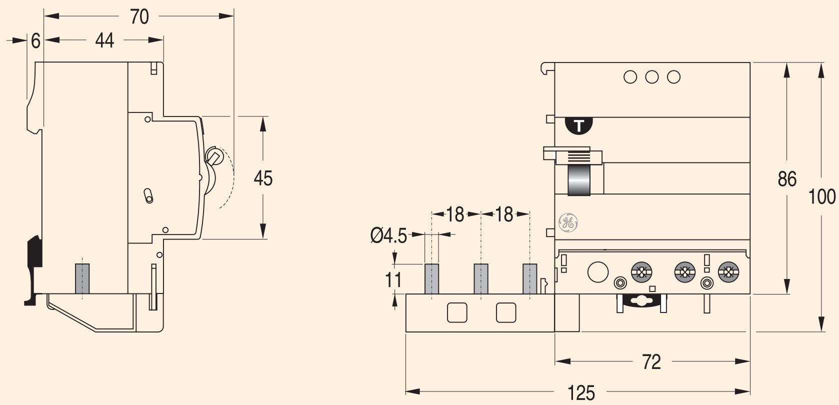


RCBO's - Series DME



Add-on RCCB - Series Diff-o-Click

3P 63A



4P 63A