Description
- Automatically trips in event of earth leakage fault
- Provides protection against direct & indirect contact with live parts

Technical data
- IS 12640-1, IEC 61008
- **ISI marking**
- CE marking
- Ratings - 16A, 25A, 40A, 63A, 100A
- No. of poles - 2P & 4P
- Sensitivity - 10mA, 30mA, 100mA & 300mA
- Trip class - class AC

Features & benefits
- Positive contact indicator on front face
- Earth fault indicator on front face
- Bi-connect terminals with pull-up design
- Finger proof (IP2X) terminal with safety shutters
- Protection against nuisance tripping due to switching transients
- **CE & RoHS compliant, " Green" product**
- Wide range of accessories are available

Connection
25-63A: 25sq.mm rigid
16sq.mm flexible
100A: 50sq.mm rigid
35sq.mm flexible

CD240Y

Sensitivity IDn	Rating In	Modules	Catalogue No.
Double Pole (1P + N)			
10mA	16A	2	**CC216Y**
	25A	2	**CC225Y**
30mA	25A	2	**CD225Y**
	40A	2	**CD240Y**
	63A	2	**CD263Y**
	100A	2	**CD284Y**
100mA	25A	2	**CE225Y**
	40A	2	**CE240Y**
	63A	2	**CE263Y**
	100A	2	**CE284Y**
300mA	25A	2	**CF225Y**
	40A	2	**CF240Y**
	63A	2	**CF263Y**
Four Pole			
30mA	25A	4	**CD425Y**
	40A	4	**CD440Y**
	63A	4	**CD463Y**
	100A	4	**CD484Y**
100mA	25A	4	**CE425Y**
	40A	4	**CE440Y**
	63A	4	**CE463Y**
	100A	4	**CE484Y**
300mA	25A	4	**CF425Y**
	40A	4	**CF440Y**
	63A	4	**CF463Y**
	100A	4	**CF484Y**

CD440Y

Residual current circuit breakers (RCCBs) - type Hi (high immunity)

Description
- Automatically trips in event of earth leakage fault
- Provides protection against direct & indirect contact with live parts
- Suitable for electrically disturbed networks with pulsated DC, transients & harmonics
- Avoids " nuisance tripping" & " blinding"

Technical data
- Conforms to IEC 61008
- Ratings - 25A, 40A, 63A
- No. of poles - 2P & 4P
- Sensitivities - 30mA & 300mA
- Trip Class - class Hi

Features & benefits
- Positive contact indicator on front face
- Earth fault indicator on front face
- Bi-connect terminals with pull-up design
- Finger proof (IP2X) terminal with safety shutters
- Protection against nuisance tripping due to switching transients & harmonics
- Avoids " blinding" due to pulsated DC currents
- **RoHS compliant, " Green" product**
- Wide range of accessories are available

Connection
25sq.mm rigid
16sq.mm flexible

CH225J

CQ440J

Sensitivity IDn	Rating In	Modules	Catalogue No.
Double Pole (1P + N)			
30mA	25A	2	**CH225J**
	40A	2	**CH240J**
	63A	2	**CH263J**
300mA	25A	2	**CQ225J**
	40A	2	**CQ240J**
	63A	2	**CQ263J**
Four pole			
30mA	25A	2	**CH425J**
	40A	2	**CH440J**
	63A	2	**CH463J**
300mA	25A	2	**CQ425J**
	40A	2	**CQ440J**
	63A	2	**CQ463J**

Residual current devices

A residual current device is the generic term for a device which simultaneously performs the functions of detection of the residual current, comparison of this value with the rated residual operating value and opening the protected circuit when the residual current exceeds this value.

For fixed domestic installations and similar applications we have two types :-

- Residual current operated circuit-breaker without integral over-current protection (RCCB) which should comply with the requirements of IEC 61008
- Residual current operated circuit-breaker with integral over-current protection (RCBO) which should comply with the requirements of IEC 61009

Both RCCBs and RCBOs are further divided into types depending on their operating function:

Type AC for which tripping is ensured for residual sinusoidal alternating currents, whether suddenly applied or slowly rising.

Type A for which tripping is ensured for residual sinusoidal alternating currents and residual pulsating direct currents, whether suddenly applied or slowly rising.

S Type S for selectivity, with time-delay.

RCCBs must be protected against over-current (overload & short-circuit) by means of circuit-breakers or fuses

RCBOs have their own in built short-circuit protection, up to its rated breaking capacity

RCCBs - domestic installation

RCCBs can be installed in two ways:

1. whole house protection
2. per phase isolation (PPI)

Whole house protection is provided typically by a consumer unit where the RCCBs serves as the main switch. Although very popular this suffers from a disadvantage: all circuits are disconnected in the event of fault. Selective protection can be provided by associating the RCCBs with identified high risk circuits by adopting one or more of the following:

- Split busbar consumer unit:

  All circuits are fed via an overall isolator and selected circuits fed additionally via the RCCBs. Typical circuits fed direct are lighting, freezer, storage heating: and circuits fed via the RCCBs are socket outlets, garage circuits. This concept minimises inconvenience in the event of fault.

- Per phase isolation (PPI):

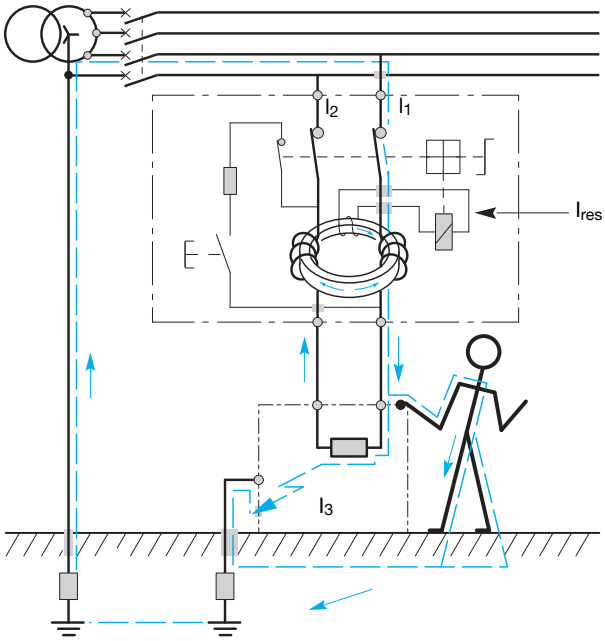
  A 30mA RCD is used as sub-incomer for each individual phase. In event of a fault, only faulty phase is disconnected and supply to remaining healthy phases is not affected.

Nuisance tripping

All Hager RCCBs incorporate a filtering device preventing the risk of nuisance tripping due to transient voltage (lightning, line disturbances on other equipment) and transient currents (from high capacitive circuit).

Two opposing diodes placed in parallel to secondary coil prevent voltage surges from reaching the secondary and hence the delay.

Working principle of RCCBs



Current flowing through torroid in healthy circuit

$$\overset{\bullet}{I}_{res} \propto \overset{\bullet}{I}_1 + \overset{\bullet}{I}_2 = 0$$

Current flowing through torroid in circuit with earth fault I_3

$$\overset{\bullet}{I}_{res} \propto \overset{\bullet}{I}_3 = \overset{\bullet}{I}_1 + \overset{\bullet}{I}_2$$

The drawing above shows how a torroid is located around the line and neutral conductors to measure the magnetic fields created by the current flowing in these conductors. The sum of the magnetic fields set up by these currents (which takes into consideration both the magnitude and phase relationship of the currents) is detected by the torroid.

In a normal healthy circuit the vector sum of the current values added together will be zero. Current flowing to earth, due to a line earth fault, will return via the earth conductor, and regardless of load conditions will register as a fault. This current flow will give rise to a residual current (Ires) which will be detected by the device.

It is most important that the line and neutral conductors are passed through the torroid. A common cause of nuisance operation is the failure to connect the neutral through the device.

RCCBs work just as well on three phase or three phase and neutral circuits, but when the neutral is distributed it must pass through the torroid.

Use of RCCBs

RCCBs offer excellent protection against earth leakage currents, the main areas of application being as follows:

- **Zs value too high to allow disconnection in the required time**

Where the overcurrent protection or a circuit breaker cannot provide disconnection within the specified time because the earth fault loop impedance is too high, the addition of RCCB protection may well solve the problem without any other change in the system. Because of its high sensitivity to earth fault current and its rapid operating time, in most cases the RCCB will ensure disconnection within the specified time. This is achieved without any detriment to overcurrent discrimination because, unlike the situation in a fuse based system, the increased sensitivity is obtained without increasing sensitivity to overcurrent faults. Use of RCCBs in this way can be particularly useful for construction sites and bathrooms where disconnection times are more stringent than for standard installations. (Construction sites - 0.2s at 220-277V, bathrooms - 0.4s).

The limitation to this technique is the requirement that the rated residual operating current multiplied by Zs should not exceed 50V. This is to avoid the danger of exposed conductive parts reaching an unacceptably high voltage level.

Residual current protection can even be added to a completed distribution system where the value of Zs is excessive, either because of a design oversight or subsequent wiring modification.

- **Protection against shock by direct contact**

So far we have considered shock by indirect contact only. Direct contact is defined thus:

Direct contact - contact of persons or livestock with live parts which may result in electric shock. The consideration here is not the hazard of parts becoming live as a result of a fault but the possibility of touching circuit conductors which are intentionally live.

RCCBs, although provides good protection against the potentially lethal effects of electric shock, must not be used as the sole means of protection against shock by direct contact. The other measures that should be taken are :

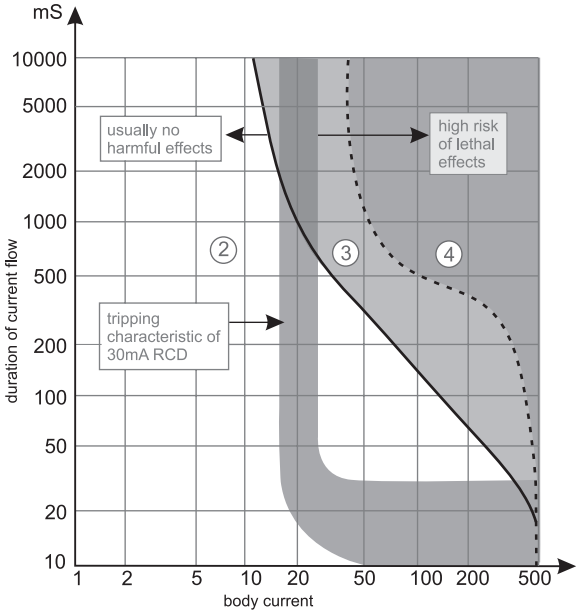
- insulation of live parts
- barriers or enclosures
- obstacles
- placing live parts out of reach

Additionally an RCCB used for this purpose should have:

- a sensitivity of 30mA
- an operating time not exceeding 40mS at a residual current of 150mA

The specified sensitivity is based on research that has been carried out to estimate the effect of various levels and duration of current can have on the human body. This experience is summarised in a graph shown in 'IEC 60479-1: Effects of current passing through the human body'. A simplified version of this graph is shown. It shows that very small currents can be tolerated for reasonably long periods and moderate currents for very short periods. It can be seen, for instance, that 100mA for 100mS or 20mA for 500mS will not normally cause any harmful effect. 200mA for 200mS or 50mA for 500mS which are in Zone 3, would be more dangerous; and shock levels in Zone 4 carry a risk of lethal consequences.

The tripping characteristic for a 30mA RCD is also shown in the graph. It shows the level of current required to cause the RCD to trip, for example; 50mA will cause a trip but not 10mA. Comparing its characteristic with the various zones on the graph it can be seen that the 30mA RCD gives a very good measure of protection against the hazards associated with electric shock. Where a higher level of protection is required, for example in laboratories, 10mA devices are available.



Note:
Although RCDs are extremely effective devices they must never be used as the only method of protection against electric shock. With or without RCD protection all electrical equipment should be kept in good condition and should never be worked on live.

Various national & international regulations make it mandatory to use RCCBs in electrical installation. For ex - IEC-60364 standard also deals with protection against electric shocks resulting from direct & indirect contacts with electrically parts in electrical installations. IS-12640 part I & part II and IEC-61008 & IEC-61009 gives guidelines for residual current devices for protection against electric shocks.

RCCBs are an efficient protection device for ensuring people' s protection against electrical shocks resulting from direct and indirect contact with electrically live parts in any installation.

RCCBs are used for various applications depending upon different current sensitivities.

- 30mA RCCB - for protection against direct contacts
- 100mA RCCB - for protection against indirect contact / in large or old installations where natural leakage is high
- 300mA RCCB - for protection against fire, insulation faults in commercial & industrial installations

High Immunity (Hi) RCCBs

Increased use of semi-conductors in electronic instruments in commercial application such as computers, printer, photocopiers and other non-linear loads and in industrial applications such as VFD, thristors, inverters, speed controllers have increased problems of pulsated DC currents, harmonics and transients in electrical networks. These electrical disturbances (pulsated DC currents, harmonics and transients) distorts the pure sine waveform of alternating current and lowers the overall power quality.

RCCB being a very sensitive device may trip due to these electrical disturbances in the system, which deforms/distort the sine wave.

These disturbances can be due to:

- External disturbance - High voltage network disturbance, natural lightening
- Internal disturbances - Harmonics - non linear loads like VFD, electronic loads
  Pulsated DC currents – Thyristors, SMPS, electronic loads
  Switching surges – switching of induction motors, transformers

IEC 61008 defines RCCB as per following class:

- Class AC - for normal AC supply networks with no harmonics
- Class A - for disturbed AC supply networks having pulsated DC currents
- Class B - for pure DC networks

Effect of network disturbances of working of RCCBs
Pulsated DC currents

Electrical networks feeding power to devices like SMPS, thyristors, dimmers, VFDs, power electronics etc. would generate pulsated DC components in the leakage currents.

As per Faraday' s law, the rate change of flux generated at the core due to the leakage current with pulsated DC components is not proportional to the magnitude of the leakage current. The tripping relay then would not have sufficient power to trip the RCCB, thereby compromising on safety. This phenomena is know as " Blinding" of RCCBs.

Harmonics

In a normal alternating current power system, the voltage varies sinusoidally at a specific frequency, 50 hertz for India. When a linear electrical load is connected to the system, it draws a sinusoidal current at the same frequency as the voltage (though usually not in phase with the voltage).

When a non-linear load, such as a rectifier, is connected to the system, it draws a current that is not necessarily sinusoidal. The current waveform can become quite complex, depending on the type of load and its interaction with other components of the system. It is possible to decompose it into a series of simple sinusoidal waveforms, with each waveform having a frequency which is an integer multiple of fundamental frequency. These current waveforms which have frequency which is integer multiple of main power frequency current is known as harmonic current. Some common examples of non-linear loads include common office equipment such as computers and printers, and also variable speed drives.

These high frequency harmonic current negatively affects the performance of RCCBs. Harmonic current increases the impedance of the secondary circuit (given by $XL = 2 \pi fL$) of the RCCB CBCT. This increase in impedance of secondary circuit hampers the power transfer to the tripping relay. It leads to non-tripping of RCCBs which is also known as " blinding" of RCCBs.

Transients

Transient over voltages when present in a network generally exceeds the insulation voltage of an installation. This leads to momentary puncture of the insulation, thereby generating leakage current, causing nuisance tripping of AC class RCDs. AC class RCDs cannot differentiate between a transient and permanent leakage current.

Effects of electronic loads on RCCBs

Electronic devices like computers, printers, copiers, medical equipments like x-ray machines, to comply with EMC directives, are equipped with interference filters. These interference filters generate permanent leakage current to the tune of 1.5 mA. When a few such loads are connected in a network, the summation of the leakage currents may cross the tripping threshold, and trip the AC class RCD. The risk is high when the installed RCD is AC class with sensitivity of 30 mA.

Effect of harmonic filters on RCCBs

Harmonics generated and circulating in the networks is harmful and needs to be eliminated by employing filtering condensers between phase / neutral & earth, i.e Harmonic filters. This is essential to facilitate proper functioning of other equipments connected in the network.

AC class RCDs installed in such networks cannot differentiate between a high frequency harmonic leakage current bypassed to the earth and a normal 50 HZ leakage current and trips.

In summary, electrical disturbance in power supply interferes with the operation of RCCBs connected to network. These disturbances have following effects on the working of residual current devices:

- **Nuisance Tripping**
  - RCCB may trip without a genuine earth leakage.
  - Continuity of supply is affected, though no compromise in people' s safety.

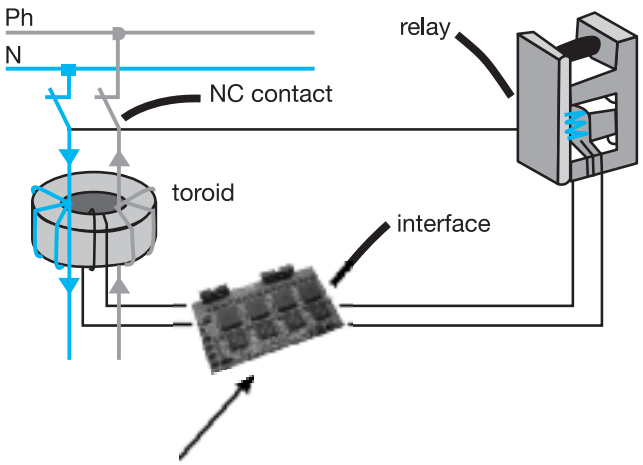
- **Blinding**
  - RCCB may not trip on a genuine earth leakage
  - People' s safety is no longer guaranteed

In both above cases, either continuity of supply or people' s safety is compromised which is not desirable.

To take care of " blinding" & " nuisance tripping" problems, Hager offers special " Hi RCCB" which can withstand the disturbances which causes nuisance tripping or blinding in normal (class AC & class A) RCCBs.

Hager Hi RCCBs have following design features which make it superior than Class A or AC RCCBs for electrically disturbed networks:

- specially designed torrid which solves the problem of non-activation of relay in case of leakage of pulsated DC current.
- electronic filter circuits for treatment of tripping signals to improve the performance compared to standard RCCBs.
- Improved tripping band of 80 - 100% of rated sensitivity which is much narrower than a normal class AC RCCBs (50-100%).



Special filter circuit to take care of pulsated DC currents, harmonics & transients is shown above.

Hager Hi (High Immunity) RCCBs provides reliable earth leakage protection in electrically disturbed networks (electrical networks having pulsated DC components, harmonics & switching transients).

Comparison of Hager Hi RCCBs with Class A & Class AC RCCBs generally available

Following table shows the comparison between Class AC, Class A & Hager Hi RCCBs.

RCCB type	Suitable for electrical networks with		
	Pulsated DC current	Harmonics	Switching surges
Class AC RCCB	No	No	No
Class A RCCB	Yes	No	No
Hager Hi RCCB	Yes	Yes	Yes

Class A RCCB may not work satisfactorily in electrical networks disturbed by harmonics & switching transients and may give nuisance tripping.

Hager Hi (High Immunity) RCCBs are suitable for earth leakage protection in electrically disturbed networks (electrical networks having pulsated DC components, harmonics & switching transients).

Hager Hi RCCBs employs special filter circuits to avoid " nuisance tripping" (tripping without any genuine fault) and ensure tripping on genuine earth faults (avoids blinding).

Various disturbances causing nuisance tripping or blinding

Following table shows the common loads in commercial & industrial application which generate pulsated DC components or harmonics.

Disturbance	Nuisance Tripping	Blinding	Loads / Factors
50 Hz constant leakage currents	!		Charged Cables
HF Transient leakage currents / Equipped with filters	!	!	Electronic Ballasts, Dimmers, SMPS, Power Electronic Equipments
Leakage currents with pulsed DC components		!	DC Motors, SMPS, Variable Speed Drives
Devices with interference filters for EMC complaince	!		Computers, Printers, Copiers, X rays, Medical equipments
Lightning surges	!		Natural lightning
Switching surges	!		Motors, Transformers, Neon Lights

Technical Specifications

Standards	IEC 61008-1, IS 12640 (Part 1)
Rated Current In	25, 40, 63 & 100A
No. of poles	2P & 4P
Sensitivity	10, 30, 100 & 300mA
Class	Class AC & Class Hi (high immunity)
Rated Voltage	230V (2P) 415V (4P)
Rated Frequency	50Hz
Rated Residual Making & Breaking Capacity I**D**m	1500A
Rated Making & Breaking Capacity I**D**m	1500A
Short Circuit Withstand: with fuse back up	10kA for 25, 40A; 6kA for 63A
with MCB 10kA back up	10kA for 25, 40A; 9kA for 63A
Rated Impulse Withstand Current 1.2/50µs	6000A
Electrical Endurance at pf = 0.9	10000 operations
Rated Insulation Voltage Ui	500V (2P), 900V (4P)
Dielectric Voltage	2500V
Degree of Protection	IP2X
Contact Flag Indication	Red for ON, Green for OFF
Fault Indication	Yellow flag indication
Ambient Temperature	-25 to +40℃
Storage Temperature	-55 to +70℃
Mounting Position	Horizontally, vertically or flat
Bus Bars	KDNxxx

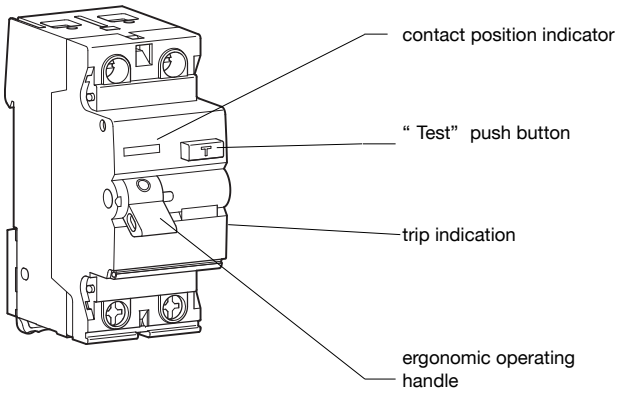
Residual current circuit breaker with over current protection (RCBO)

RCBO gives combined protection against earth leakages as well as against overloads and short circuits.

Technical Specifications

Standards	IEC 61009-1, EN 61009-1
Rated Current In	6,10,16,20,25,32 & 40 A
No. of Poles	2P
Sensitivity	30, 100 & 300mA
Class	Class AC & Class Hi (high immunity)
Tripping curve	C curve (5 - 10 in)
Energy Limiting Class	3
Rated Voltage	240V AC
Rated Frequency	50Hz
Rated Residual Making and Breaking Capacity IΔm	6000A
Electrical Endurance at pf = 0.9	10000
Rated Insulation Voltage Ui	500V
Dielectric Voltage	2500V
Degree of protection	IP2X
Fault Indication	Yellow flag indication
Ambient Temperature	-25℃ to + 30℃
Storage Temperature	-55℃ to + 70℃
Mounting Position	Horizontally, Vertically or Flat
Busbars	KDNxxx

Product presentation



Contact position indicator

The mechanical indicator on the front of RCCB shows the physical position of the contacts.

- Red indication for closed contacts
- Green indication for open contacts

The green indication is the guarantee that the contacts are open and that the terminals are not live.

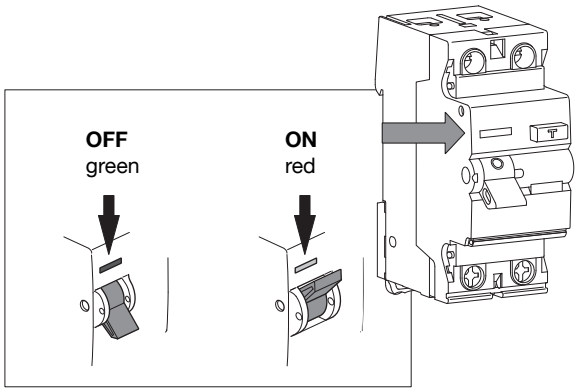
Trip indicator

The status of the RCCB can be visualised by the colour of the trip indicator in addition to the position of the operating lever.

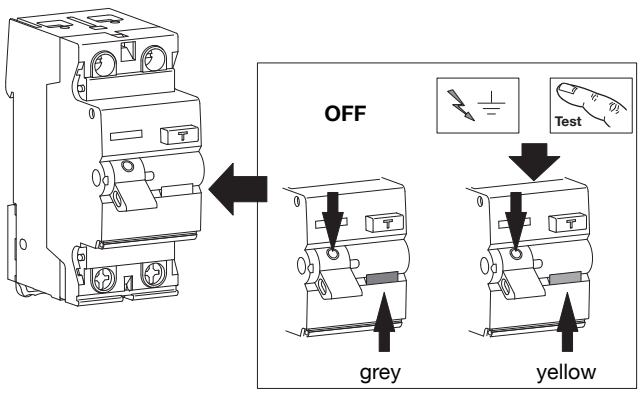
- Grey indication for normal conditions (even when operating lever is in ON/OFF position)
- Yellow indication for tripped condition, operating lever in OFF position

Similar condition exists when TEST button is pushed or RCCB is remotely tripped via protection auxiliaries.

Positive contact indication



Earth leakage fault indication

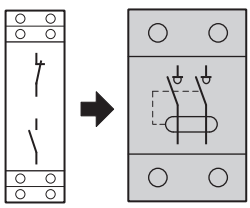


Mounting of auxiliaries

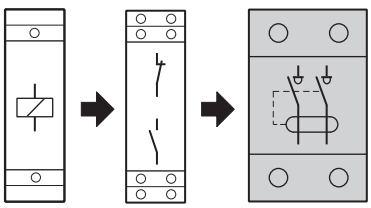
It is possible to mount two auxiliaries on RCCB.

- Auxiliary CZ 001 for ON/OFF status and TRIP indication is mounted first on the left hand side of the RCCB.
- Additional protection auxiliary MZ 203 to MZ 209 can be mounted besides CZ 001.

Auxiliaries association possibilities



CZ 001
(CA+SD)



MZ 203... + CZ 001
MZ 206 (CA+SD)
MZ 209