Residual Current Circuit Breaker

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Introduction – Residual Current Circuit Breaker / ELCB

The Fault current overloads and short circuits can be detected by circuit breakers like MCB's MCCB's & HRC Fuses etc. But, Circuit breakers don't detect leakage currents, which are dangerous for humans and livestock and if not detected can lead to fire hazards. We need a solution that detects such leakages currents and disconnects the circuits from the power supply. Here comes the solution in the form of RCCB (Residual Current Circuit Breaker) also known as ELCB (Earth Leakage Circuit Breaker) which provides protection against direct and indirect contact of personnel or livestock and against probable fires.

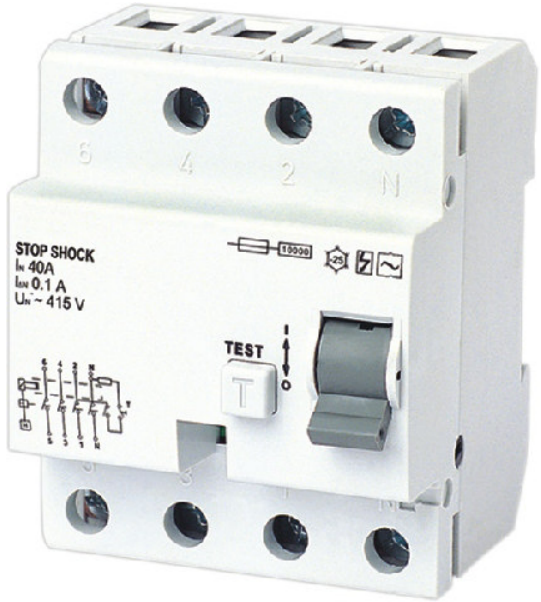
Product
Stop Shock RCCB's.

Classification
Domestic and Industrial use Residual Current Circuit Breaker.

Range
Available in 2 Pole and 4 Pole.

Application
Prevents shocks caused by earth leakage which could be fatal.

As per the Rule 61A of the Indian Electricity Rules 1956, the supply of energy of following installations shall be controlled by the earth leakage protective devices so as to disconnect the supply instantly on the occurrence of earth fault or leakage current.



- Installations having load above 5KW.
- Luminous Tube Installations.
- X – Ray Machines.

2 Pole
Used for three phase electrical connections, for industrial and commercial purposes.

As per Government of India Gadget notice, the RCCB's must have ISI mark in India.
Selling of non ISI RCCB's in India is prohibited.

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Salient Features

- Use of special magnetic materials for the toroidal core balance transformer and a specially developed highly sensitive miniature relay ensure positive detection of earth leakage currents as low as 30mA in less than 40 milli seconds thereby acting as a life saver. All the RCCB's are protected from nuisance tripping against transit voltages (lighting, line disturbances...) and transient currents (from high capacitive circuits).
- STOP SHOCK RCCB's are housed in high quality thermoplastic insulating material. The materials used are fire retardant, anti tracking, non-hygroscopic, impact resistant and can withstand high temperatures.
- The moving contacts of the phases are put on a moving arm, actuated by a rugged toggle mechanism. Hence the closing and opening of all the phases occur simultaneously. This also ensures simultaneous opening of all the contact under automatic tripping conditions.

- STOP SHOCK RCCB's incorporate advanced neutral i.e. neutral makes ahead of phases and breaks after phases, which ensures complete discharge of line inductance and capacitance. (It also has safe interrupting clearances as per IS: 13947-1. These two provisions make STOP SHOCK RCCB an ideal selection as main switch.)
- ON & OFF Positions is clearly visible with the help of window provided at the top of housing. The green colour indicates the OFF position and red colour indicates the ON Position.
- Mechanism components are made of plastic which are of high-quality, high-strength, low inertia and self lubricating properties. This results in a very fast opening action of the device under fault conditions. Though the moving components of the mechanism are made of plastic for friction free and smooth operation, load bearing parts of mechanism are made of high-strength steel thus the combination resulting in making the mechanism more sturdy.
- RCCB’s relay draws the energy from the residual current which it needs to trip the RCCB that’s why it can still operate normally if the mains voltage drops or if the neutral wire is interrupted, even a relatively long period of over voltage resulting from a fault current in the mains can’t destroy RCCB or interfere with its normal operations.
- The ever increasing use of rectifies, particularly in the mining industry, requires safety measures against fault current which will also safety detect and respond to AC residual currents with a frequency of 50Hz to smooth DC residual currents. This so-called universal sensitivity which can only be achieved with auxiliary voltage-dependents circuit breakers, i.e ‘DI’ devices.
  Equipments likely to emit smooth DC residual currents may only be used outside house instillations and it may not be operated downstream of ‘normal’ RCCB’s to which other circuits are connected. In the events of a residual DC current arising, the RCCB’s operation could be impaired and it might not even trip if a residual current occurs simultaneously at another electrical equipments. In order to be able to ensure selective protection against direct and indirect contact, professional bodies are increasingly demanding that AC-DC sensitive devices be employed. Our devices are designed and constructed to IEC 1008 / IS: 12640 – 2000. They will respond to residual currents from smooth DC currents to 400Hz AC and pulsating currents and provide extremely high operational reliability. These RCCB’s are available in selected rating only.

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- RCCB's are provided with an ARC chamber consisting of arc-chute. They arc-chute quenches the arc faster, which further increases electrical contacts life.
- STOP SHOCK RCCB's are life saving devices and hence, incorporate a lest button 'T' for periodic checking of the mechanism and function of the RCCB.
- Apart from suitability to copper cables the terminals are suitable for aluminum cables from 1 to 25 Sq.mm.
- STOP SHOCK RCCB can be easily mounted on a standard DIN rail of 35mm. Furthermore, operation of the RCCB is independents of mounting position. Supply connections can be terminated can be terminated either from top or bottom.
- STOP SHOCK RCCB's have been completely type tested at CPRI / ERDA in accordance with IS: 12640-1-2000 and is ISI Marked.

RCCB works on the principle that in an electrical circuit the incoming current is the same as out going current as shown in the Diagram. RCCB incorporates a core balance transformer having primary and secondary windings and a sensitive relay for instantaneous detection of fault signal. The primary winding lies in series with the supply mains and load. Secondary winding is Connected to a very sensitive relay. In a faultless situation, the magnetizing effects of the current carrying conductors cancel each other out. There is no residual magnetic field that could Induce a voltage in the secondary. During flow of leakage current in the circuit an imbalance is created in the circuit which gives Rise to leakage flux in the core. This leakage flux generates an electrical signal that is sensed by the relay and it trips the Mechanism thereby disconnecting the supply. When pressing the TEST button 'T', a fault is simulated via the Test resistance & RCCB trips.

To ensure that the RCCB switches off the protected circuit Immediately. If there is an insulation fault causing a short-circuit to an exposed part (frame etc.) of machinery and equipment (protection against indirect contact), the maximum permissible touch voltage U must occur at a residual current greater than or equal to the rated residual operating current I that triggers the ?n RCCB. This condition is met by earthing the exposed part with a Sufficiently low resistance to earth RE.

$$\text{Earth Resistance RE} \quad \frac{< \text{Touch Voltage U E T}}{\text{Rated Residual operating current} - I}$$

The maximum values of R for touch voltages of 25V, 50V & 65V E
are given in the specification tables.

To provide extra protection in the event of direct contact with an (unearthed) live part, extremely sensitive RCCB's with a rated residual operating current of 30 mA or less (I = 30 mA) are used instead of more conventional RCCB's with higher residual operating fault currents.

This extra protection is necessary if:
1) The insulation of totally insulated devices or their loads are damaged.
2) The earth wire is interrupted
3) The earth wire and live wire are transposed (accidentally thus rendering line the body of a protection class I device).
4) A component which is live in normal operation is touched during repair work.

In view of this increased range of protection, an RCCB or RCCB/MCB with

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I = 30 mA is must - by law in some European countries - to be used when? Installing machinery of equipment in areas with particularly high accident risk.

l Socket-outlet power circuits in rooms with bath or shower.
l Caravans, boats and yachts and their power supply on camping or berthing Sites
l Electrical appliances in rooms used for medical purposes.

The drawn-in switch-off characteristics of residual current devices with a rated fault current of 10 and 30 mA make it clear that these residual current devices are able to prevent the occurrence of the dangerous heart chamber fibrillation. For this reason, residual current circuit breakers with rated fault currents of 10 mA are used for the protection of particularly exposed individual equipment. Residual current circuit breakers with 30 mA rated fault current are already specified today for many areas (bath, medically utilized rooms, outside areas, agriculture, etc.) in order to ensure the protection of persons.

- Usually no reaction effects.
- Usually no harmful physiological effects.
- Usually no organic damage to be expected. Likelihood of muscular contraction and difficulty of breathing reversible disturbance of formation and conduction of impulses in the heart and transient cardiac arrest without ventricular fibrillation increase with current magnitude and time.
- In addition to the effects of zone 3, increasing with magnitude and time pathy physiological effects such as cardiac arrest, breathing arrest and heavy burns may occur.

Even relatively insensitive RCCB's (I = 300 mA) can be used to provide effective protection against fire caused by earth-leakage faults. With a residual current = 300 mA, the electrical energy released at the location of the earth fault is not sufficient to ignite normal building materials. With larger residual currents, the RCCB switches off the circuit in less than 200 milliseconds, thus limiting the amount of energy released to a harmless level.

Additional Protection Against Pulsating Fault Currents.

While the tripping of residual current circuit breakers with pure alternating fault currents was usual and adequate in the past, these can only be used conditionally in modern electrical installations. With light controls, speed controls etc. pulsating forms of current increasingly occur also as fault currents as a result of the use of electronic components. In order to tackle such pulsating direct fault currents which tend to zero or almost zero within every period of the mains frequency at least for half a period, 'A' type of RCCB's are suitable. Type A is more sensitive than AC type. It covers all requirements of AC type plus it is pulse current sensitive.

Precaution for Installations

- Wiring should be done by a trained & qualified electrician as per the wiring diagram.
- All wiring necessary for operation shall be passed through the RCCB.
- The neutral conductor must be insulated against earth to the same extent as the live conductors.
- All equipments used must be properly earthed.
- To ensure correct functioning care must be taken that the neutral conductor on the load side of the RCCB must not be Connected to earth, otherwise nuisance tripping may occur or tripping may be impaired.
- Suitable device either MCB or HRC fuses shall be used for short circuit and overload protection of the circuit under installation.

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- Don't expose the circuit breaker to direct sunlight, rough weather and keep it away from the influence of magnetic field.

Fault finding when RCCB Trips
Switch OFF all the switches/MCB connected in the circuit downstream the RCCB. Switch ON RCCB and switch ON the Switches one by one. You will find that during switching ON of a particular appliance/switch RCCB trips again and again
Which shows that this is the faulty circuit/appliance. Isolate the faulty circuit, rectify the fault and switch ON the RCCB.

Permissible Earth Resistance (R) With Max. Permissible Touch Voltage (U)

Therefore the following earth resistance must be guaranteed with 300mA rated fault current of the selective switches :

U = 25V R = 83 Ohm U = 50V R = 166 Ohm U = 65V R = 216 Ohm

Touch Voltage (U) (V)	Earth Resistance R (?) Sensitivity I (mA)		
	30	100	300
25	833	250	83
50	1666	500	166
65	2160	650	216

Sensitivity	**Application**
30mA	Tripping current designed for additional protection against direct contact, or where specially required b y the Indian wiring regulations, the 30 mA RCCB protects against leakage currents and indirect contact with earth loop impedance up to 1667 Ohms; for use as additional protection against direct contact, residual tripping current must not exceed 30 mA.
100mA	Tripping current is suitable for protection against indirect contact and leakage currents for larger installations; the 100 mA RCCB's operate within 30 ms, but do not provide the same level of personal protection as the 30 mA units; the 100 mA RCCB protects against leakage currents and indirect contact with earth loop impedance up to 500 ohms.
300mA	A less sensitive protection suitable for large installations having high levels of leakage current; 300 mA RCCB's protect against leakage current and indirect contact up to 167 ohms earth loop impedance.

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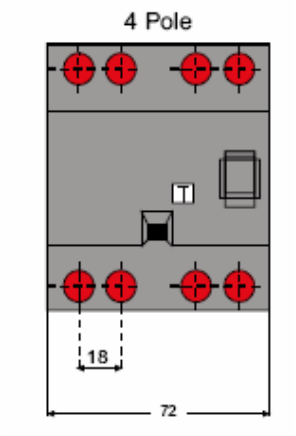
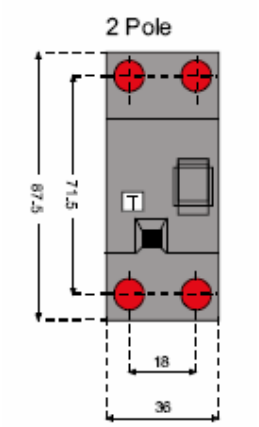
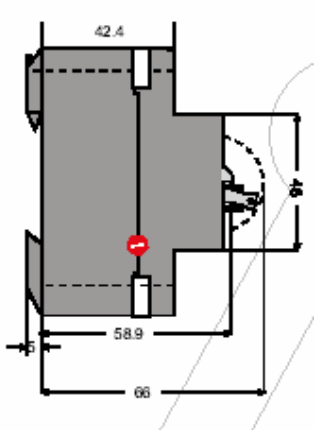
Dimensional Drawing







Wiring Diagram