

■ Technical data

Nature and consequences of electrical risks

Direct and indirect contact

All electrical risks for people are the result of direct or indirect contact. What are these contacts? And how can we protect ourselves against them?

All the answers appear in the following section.

Electrical risks do not just concern people : these risks - especially fire affect installations as well. A 500 mA current, for example, flowing through combustible material is sufficient to ignite such material after a certain time. Every electrical installation is subject to current leakages which can vary considerably depending on such factors as the installation's condition, age, environment, etc.

These current leaks may flow through the fabric of the building (trunking, metal girders or other metal components), generating heat which in turn may lead to fire.

Direct contacts

Direct contact is caused by humans and may be due to either carelessness or clumsiness.

What is a direct contact? How can we protect ourselves? Here are the answers...

This is when someone makes contact with a live electrical component of a device or installation.

For example :

- a person inadvertently touching a live cable.
- a child sticking a metal object into a power socket.
- using male/male extensions or unprotected test cables.

In this case only basic protection is effective



Other examples

Someone touching a live busbar in a distribution panel or cabinet, or someone touching flush-mounted electrical trunking with the end of a tool, etc. In this case basic protection plus additional protection is effective.

How can we protect ourselves?

There are two ways (independent of the neutral earthing system) of ensuring that personnel are protected against direct contact.

• Preventing access to live parts where possible.

Basic protection via physical or electrical isolation of live parts.

This protection must ensure that live parts cannot be touched, even inadvertently.

How?

By using barriers, enclosures, closed cabinets which physically or electrically isolate live parts presenting a danger to the user, shuttered sockets, or insulation.

• Additional protection

Must be provided by a 30 -mA residual current device such as Lexic range of residual current devices. This protection is required in case the basic protection detailed above fails.

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Indirect contacts

Indirect contacts are independent of humans : it results from an internal hardware fault.

What is an indirect contact?

How can we protect ourselves? Here are the answers...

What is an indirect contact?

This is when a person makes contact with a metal earthed part which has accidentally been powered up following an insulation fault. This type of contact is very dangerous as, unlike direct contact, it is completely unexpected. For example, a person touching the metal frame of an electrical appliance which has defective insulation may be electrocuted through no fault of their own if the appliance is not protected.

How can we protect ourselves?

There are three possibilities :

- Preventing to potentially dangerous metal components via class II protection.
- Grounding of all exposed conductive parts to an effective earth.
- Protective RCD according to the neutral earthing system.



A person is in danger of electrocution if the fault current raises the voltage of the accessible metal part above 50 V to earth.

Important note:

Under the Indian Electricity Rules [rules 61 (A), 71 (1) and 73 (1)], installation of an RCCB is mandatory in all installations of 5 KW and above, in all luminous tube signs and X-ray installations. The bureau of Indian standards recommends that RCCBs installed at construction sites, temporary installations, agriculture and horticulture premises, limit the residual current to 30 mA.

Residual current devices, selection and operation

The main function of a residual current device is to ensure that people are protected from any risk of electrocution. It can also ensure protection against risk of fire.

What is the nature of these risks? What are the consequences?

Here are the answers...

Risks of electrocution-

The dangerous effects of electricity depend on two factors :-

- the flowing time through the human body
- the current value

These two factors are independent and the importance of the risk varies in accordance with the level of each factor.

The dangerous current value through a human body depends on the touch voltage and touch resistance of the human body.

In practice, the current value is defined using a standard "safety" voltage of 50 V. This voltage takes into account the maximum current which can be withstood by a human being with a minimum internal electrical resistance in given conditions. It also takes into account the maximum permissible time for the current to pass through the body without dangerous physio-pathological effects.

50 V is considered as the safe limit of voltage for human body in dry condition.

How does an electrical current affect the human body?

When subject to a voltage, the human body reacts like any other receiver with a given internal resistance. An electrical current passes through the body with three serious risks :

- **Locking** the muscles, or tetanisation : the muscles through which the current passes contract and remain contracted : if this includes the rib cage, breathing may be impeded.
- **Action** on heart : the cardiac rhythm is completely disrupted (ventricular fibrillation).
- **Thermal** may cause varying levels of damage to body tissue, including severe burns in the case of very high currents.

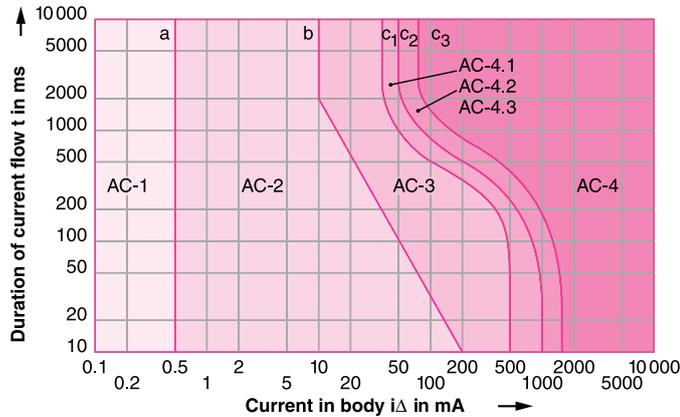


Examples of electrocution by direct or indirect contact.

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Effect of current on human body

The standards define the following curves, which take into account the two parameters required to assess the risk:



$i\Delta$: current flowing through body
 t : time taken for current to pass through body.

These curves show the various zones of effect of an alternating current on people : they derive from IEC 60 479 and determine

4 main risk zones

Zone designation	Physiological effects
zone AC-1	Usually no reaction
zone AC-2	Usually no harmful physiological effects
zone AC-3	Usually no organic damage to be expected. Likelihood of cramp like muscular contractions and difficulty in breathing for durations of current-flow longer than 2 s. 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 AC-4	Increasing with magnitude and time, dangerous pathophysiological effects such as cardiac arrest, breathing arrest and serious burns may occur in addition to the effects of zone-3
zone AC-4.1	Probability of ventricular fibrillation increasing up to about 5% C1 - C2
zone AC-4.2	Probability of ventricular fibrillation up to about 50% C2 - C3
zone AC-4.3	Probability of ventricular fibrillation above 50%

* For durations of current flow below 10 ms, the limit for the body current at line b remains constant at a value of 200 mA.

A residual current device continuously measures the difference between the value of the input and the output currents. If the value is not equal to zero, this indicates a leak.

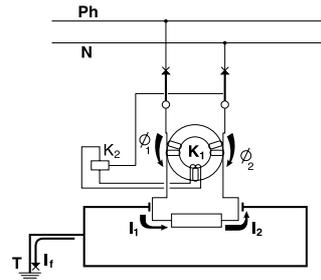
When this leak reaches the level at which the differential is set (its sensitivity), the device trips and breaks the circuit.

What are the operating principles of a residual current device?

What are the selection criteria for a residual current device? Here are the answers...

Operating principle of a residual current device

No fault present



Therefore no current is induced in coil K_1 , and coil K_2 is not excited. The contacts do not open. The equipment operates normally

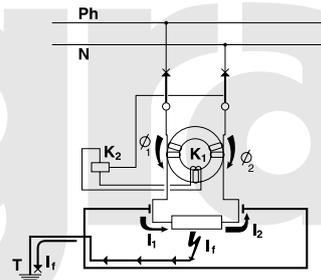
$I_f = 0$, thus

$I_1 = I_2$

$\Phi_1 = \Phi_2$

$\Phi_1 - \Phi_2 = 0$

Insulation fault



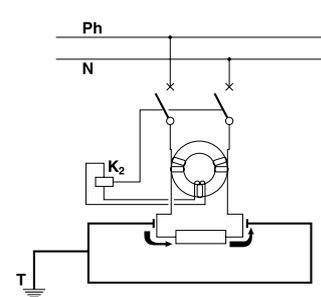
A current is thus induced in coil K_1 ...

$I_f \neq 0$

$I_1 > I_2$, thus

$\Phi_1 > \Phi_2$, thus

$\Phi_1 - \Phi_2 \neq 0$



...coil K_2 is excited, the contacts open and the equipment is automatically switched OFF

Selecting a residual current device

First determine your requirement. This exists on two levels :

- 1 The need to protect against direct or indirect contacts.
- 2 The need to ensure protection against overloads and short-circuits.

If protection against indirect contact is required, use residual current devices with a sensitivity of :

- 30 mA,
- 100 mA,
- 300 mA,

The rating (40, 63 A, etc.) is selected according to the load.

If protection against direct contact is required, use residual current device with a sensitivity of 30 mA.

The sensitivity of a residual current device $I \Delta n$ is the current level at which tripping is sure to occur. To do this, the standards concerning residual current devices stipulate that tripping must occur between $I \Delta n / 2$ and $I \Delta n$.

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Types of residual current device

There are 2 types of RCD: the AC type and the A type
Both types are produced in the "S" (discriminating) or normal versions. They conform to Indian and International standards IS 12640, IEC 61008 and IEC 61009 as well as European standards EN 61008 and EN 61009.

• **Type A** 

Sensitive to residual alternating currents and residual currents with a DC component.

Use: special applications

- if it is possible that the fault currents are not purely sinusoidal (rectifier bridge, etc.)

• **Type AC** 

Sensitive to residual alternating currents

Use: standard applications

• **Type S** 

Delayed trip for discrimination with other residual current devices.

Use: for discrimination with a downstream device.

• **Type Hpi** 

Enhanced immunity to unwanted tripping in environments with disturbances. eg. diesels, computers, printers, etc.

• Detects faults with DC components eg. thyristors, triac etc.

Residual current circuit-breaker with or without overload protection? Which do I choose?

Choose a residual current circuit-breaker (RCCB) if you do not need to protect against overload and short circuits (caution! an RCCB must be connected to some form of line protection device: either a circuit-breaker or a fuse).

Choose a residual current circuit-breaker with overload and short circuit protection (RCBO) if this type of protection is not available.

Residual current circuit-breakers without overload and short circuit protection (RCCB)



These provide two functions: fault current detection, measurement and cut-off: and isolation of an installation.

RCCBs are governed by standards IS 12640 (part 1), IEC 61008-1.

Residual current circuit-breakers with overload and short circuit protection (RCBO)



These provide three functions: fault current detection, measurement and cut-off: protection against overloads and short-circuits : and isolation of an installation.

Residual current circuit-breakers are governed by standards IS 12640 (part 2), IEC 61009-1.

The "test" function

A residual current device is a safety device, and it is therefore vital that it is regularly tested. This function is therefore required by the standard governing residual current protective devices, and ensures correct operation. All Lexic RCDs are equipped with this function.

Note : We offer Type AC, Type A-S and Type Hpi RCDs

■ **Compatibility MCBs/add-on modules**

Breaking capacity	Number of poles	Add-on module for 1.5 module/pole MCBs
16 kA	2P, 4P	In ≥ 80 A
25 kA	4P	In ≥ 32 A
	2P	In ≥ 40 A
	4P	In ≥ 12,5 A
	2P	In ≥ 32 A
50 kA	2P, 4P	All range

DX³ RCDs (continued)

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• Type A

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Use: special applications

- if it is possible that the fault currents are not purely sinusoidal (rectifier bridge, etc.)

• Type AC

Sensitive to residual alternating currents

Use: standard applications

• Type S

Delayed trip for discrimination with other residual current devices.

Use: for discrimination with a downstream device.

• Type Hpi

• Enhanced immunity to unwanted tripping in environments with disturbances. eg. diesels, computers, printers, etc.

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