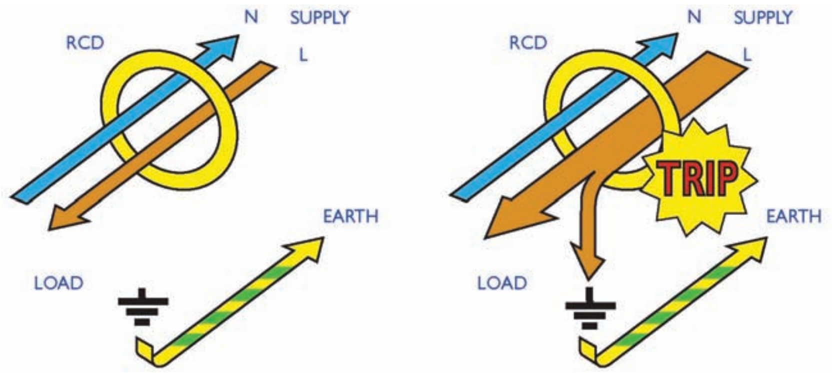
How does an RCD work?

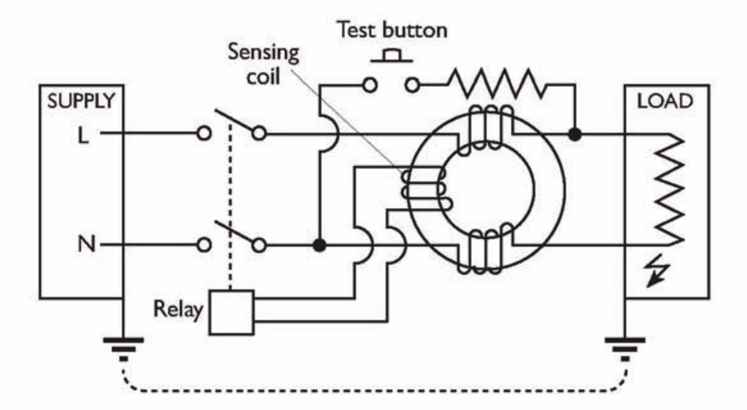
RCDs (Residual Current Devices)

RCD is a generic term which embraces the various forms such as RCCB, RCBO, etc. Residual Current Devices are now firmly established around the world as a primary means of providing protection against electrocution and fires caused by electrical faults. Less than one quarter of an amp (250mA) leaking from a faulty installation can generate sufficient heat to start a fire (the heating effect is proportional to the current squared), or if leaking through a human body for only 200mS can cause heart fibrillation and subsequent death.

Principle of RCD Operation

An RCD protects by constantly monitoring the current flowing in the live and neutral wires supplying a circuit or an individual item of equipment. Under normal circumstances, the current flowing in the two wires is equal. When an earth leakage occurs due to a fault in the circuit or an accident with the equipment, an imbalance occurs and this is detected by the RCD, which automatically cuts off the power before injury or damage can result.





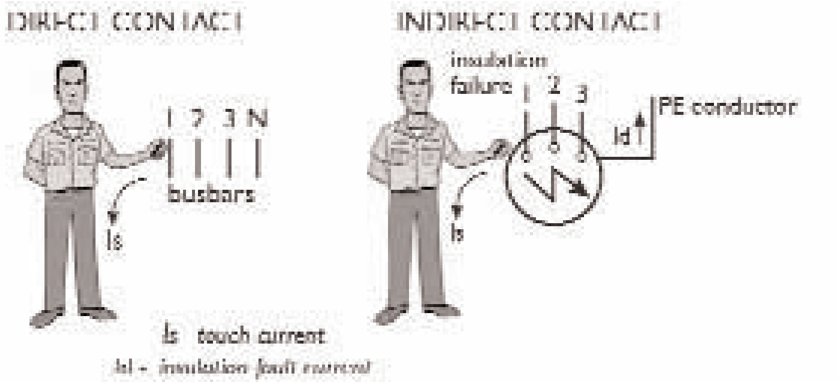
To be effective, the RCD must operate very quickly at a low earth leakage current. Those designed to protect human life are engineered to trip out with an earth leakage current of 30mA within 200mS and at a higher earth current of 150mA, they will trip in less than 40mS. These limits are well inside the safety zone, within which electrocution or fire would not be expected to occur.

Shock Protection

Principles of Shock Protection

Protection of persons and livestock against electric shock is a fundamental principle in the design of electrical installations in accordance with BS 7671: Requirements for Electrical installations, commonly known as The IEE Wiring Regulations 16th Edition. Use of the correct earthing system is an essential part of this process.

Figure 7. Direct and indirect contact electric shock



Fuses and circuit-breakers provide the first line of defence against indirect contact electric shock. If the installation is correctly earthed (i.e. all the exposed metalwork is connected together and to the main earth terminal of the installation) then an indirect contact fault will cause a very high current to flow to earth through the exposed metalwork. This will be sufficient 'to blow' the fuse or trip the circuit-breaker, disconnecting the part of the installation within the time specified in BS 7671 and so protecting the user.

Fuses and circuit-breakers cannot provide protection against the very small electric currents flowing to earth through the body as a result of direct contact. Residual current devices, provided they have been selected correctly, can afford this protection as described in the previous chapter. They also provide protection against indirect contact under certain installation conditions where fuses and circuit-breakers cannot achieve the desired effect, for example where the earthing systems described above are ineffective.

The Effects of an electric shock

The effects of electricity on the human body have been widely studied and researched by the IEC and its findings have been published in several reports (IEC publication 479-1, 1984 and 479-2, 1987). The reports contain a number of useful graphs, showing the effects of both AC and DC currents and also the influence of frequency, and are recommended for further reading. From the reports and other sources, it may be observed that an electrical shock, whilst not always sufficiently serious to cause death, can still have a long term adverse effect on a person's health. Much of the data generated refers to adult people in good health at the time of the shock, but if the victim is a child or a person in poor health, the effects can be more serious and the need for RCD protection is even greater.

The degree of risk depends not only on current, but also on time – the higher the current or the longer the time of shock, the greater the danger. In considering a 230V 50Hz AC supply, the following effects of current are typically observed.

Current	Effect
0 - 0.5mA	Generally this current is below the level of perception, resulting in no reaction.
0.5 - 5mA	Although no dangerous physiological effects, this current may produce a startle effect that results in injury due to falling etc.
5mA - 10mA	Same effect as above but in addition muscular reaction may cause inability to let go of equipment. Once current flow ceases letting go is then possible.
10mA - 40mA	Severe pain and shock as current value increases. At currents over 20mA the victim may experience breathing difficulties with asphyxia if current flow is uninterrupted. Reversible disturbance to heart rhythm and even cardiac arrest is possible at higher values of current and time.
40mA - 250mA	Severe shock and possibility of non-reversible disturbances to the normal cardiac cycle, referred to as ventricular fibrillation. The possibility of fibrillation increases as current and time increase. It is also possible to experience heavy burns at higher currents in addition to full cardiac arrest.