Principles of RCD Operation
Why we have them.
What they do

What is an RCD

An RCD is a device that is designed to protect against electrocution or electrical fires by cutting off the flow of electricity automatically when it senses a leakage of electric current from a circuit.

To appreciate the importance of an RCD. It is important to understand how much energy it takes to kill a human being.

At currents equal to and over 40 mA a person would experience severe shock with possibilities of non-reversable disturbances to the normal cardiac cycle, "ventricular fibrillation". This risk is greater as time and current increase.

RCD's BS EN 61008-1 - Defined within the standard as:-

Residual current operated circuit-brakers **without** integral overcurrent protection for household and similar uses (RCCBs)

RCD: Generic term for devices that can detect residual currents and are suitable for fault disconnection, for an RCD used in a consumer unit we should use the terms RCCB or RCBO - to **BS EN 61009-1** standard, **BS EN 62423** type F & Type B **–** Defined as 61008-1 above

Table 53.1 from BS7671 provides maximum value of earth loop impedance R_A for maximum $I_{\Delta n}$ for RCD

RCD's for personal protection ≤ 30mA / Additional protection cannot be used in isolation. Must be used with overcurrent protection device as regulation 411.1.2 which directs us to see 411 to 414 Protective measure: Automatic disconnection of supply.

1. **RCCB** with circuit breaker or fuse
2. **RCBO**

Fundamental Principle of how an RCD works

Kirchhoff's current law: is a practical way to view how an RCD functions

This law is also called Kirchhoff's first law, Kirchhoff's junction (Node) rule.

This law states that a junction in an electrical circuit, the sum of currents flowing into that node is equal to the sum of currents flowing out of that node; or equivalently:

The algebraic sum of currents in a network of conductors meeting at a point is zero

RCDs do not measure what is flowing into the circuit protection cables to earth (example CPC). The RCD will measure the current that flows to the Load, and the Current that flows from the load. When there is no leakage or earth fault. The Neutral return current will be equal to the Line supply current.

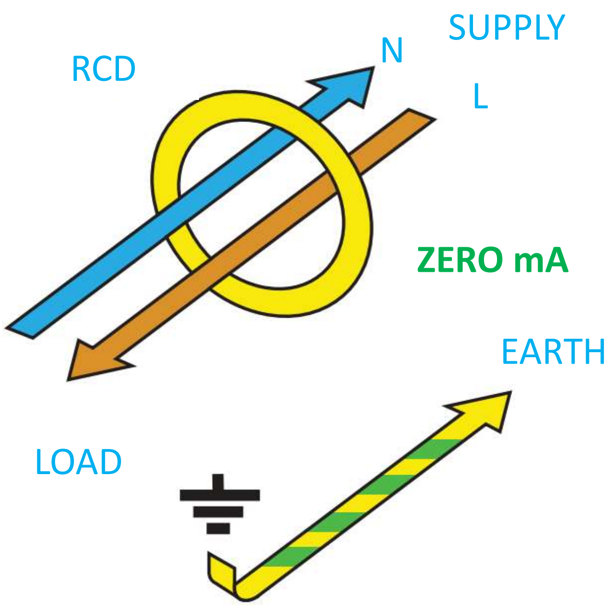
What goes in: → **10A**

0.0A

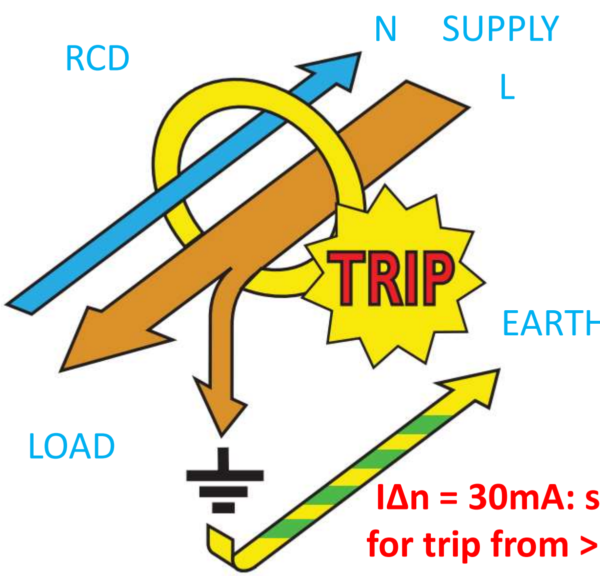
Must come out: ← **10A**

RCD operation

In an RCD, the line and neutral conductors of a circuit pass through a sensitive current transformer. If the line a neutral currents are equal and opposite, the core remains balanced = **Zero mA loses**



If there is an earth fault the neutral current will be lower than the line current. This imbalance produces an output from the current transformer which is used to trip the RCD and so break the circuit

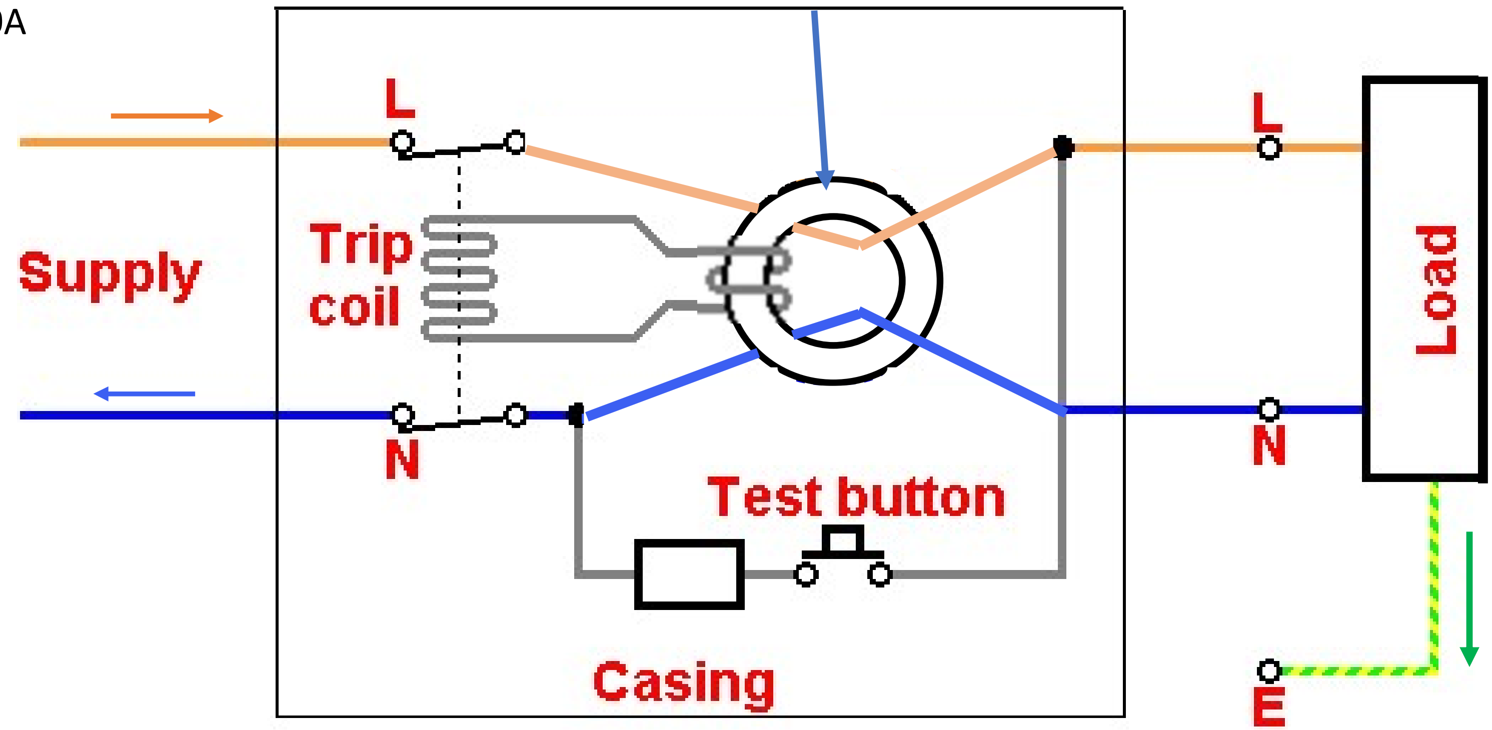


IΔn = 30mA: standard allows for trip from >15mA to 30mA

Type AC Residual current device (RCD) BS EN 61008 / 61009

Demonstrates current carrying conductors will pass through transformer. Consider size of conductor for current carrying capacity of 100A

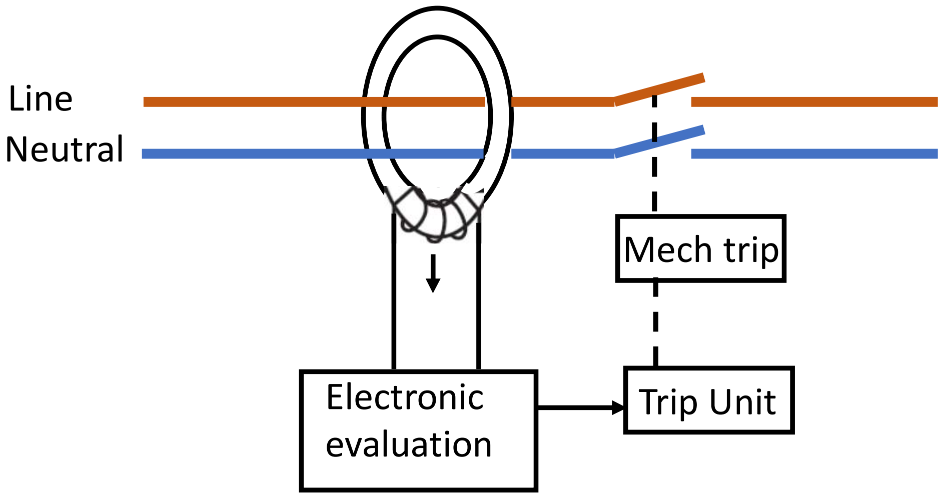
What goes in must come out



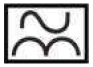
Leakage current mA somewhere in electronic circuits. Insulation failures leading to earth fault.

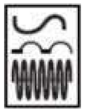
Basic typical internal design for AC,A,F RCCD

Typical circuit design below is true for AC,A & F types RCD apart from variations in the tripping circuit. Basic components would be Summation transformer Electronics for measuring, evaluating variables, converting into mechanical latch release to trip the RCD



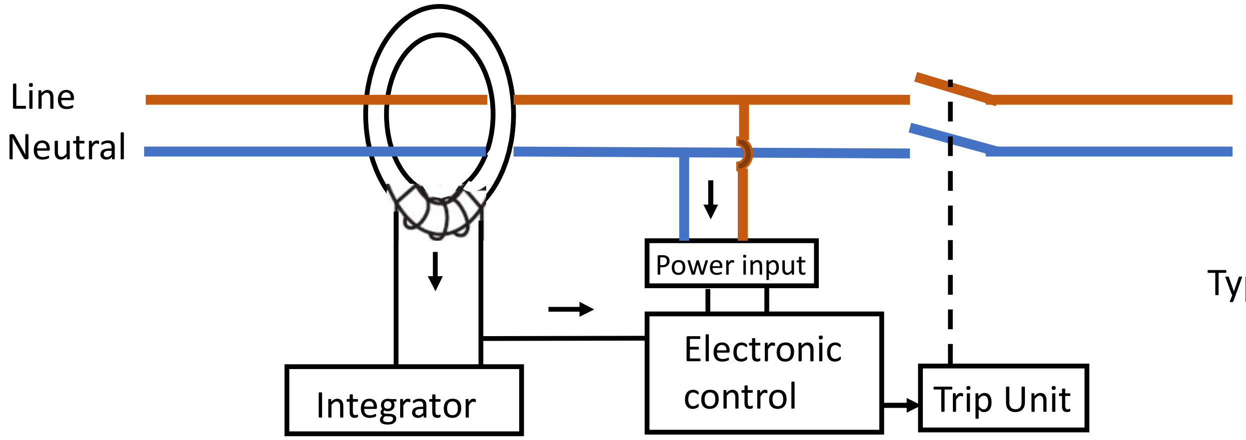
Type AC  AC Sinusoidal Wave form

Type A  AC Sinusoidal Wave form + smooth residual DC current up to 6 mA.

Type F  As type A , and including detection of composite residual currents, frequencies 10Hz to 1000Hz. And smooth DC residual current of up to 10 mA

Basic typical internal design for B RCCB

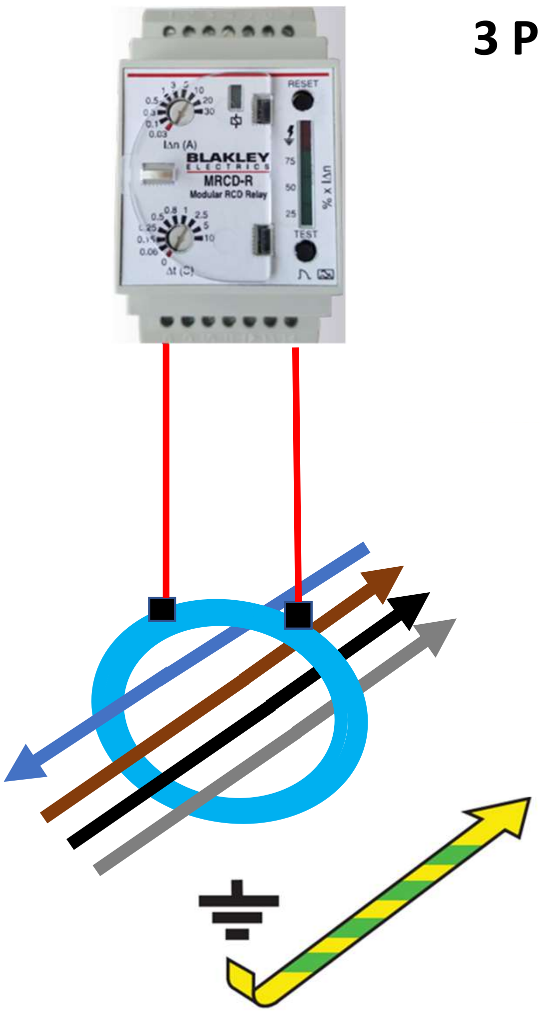
Fluxgate technology can be used to detect AC & DC currents. Using amplifier circuitry and shunt resistors to accurately produce a voltage directly proportional to the current in the conductor being measured, this will accurately provide us with the true current levels of AC and DC within the circuit. Converting the variables into mechanical latch release current to trip the RCD when trip level reached.



Type B

The standard Type B RCD will detect residual current faults comprising of pure AC up to 1000 hertz, rectified AC, Smooth DC and pulsating DC Up to 10mA

3 Phase principle is the same as single phase



Sum of the 3 phase in a balanced load is 0
No Neutral required for Motor Loads, the 3 line cables pass through the CT

For unbalanced loads. The neutral will be passed through the summation transformer in the same way as single phase. When Neutral return is not the same as the sum of the 3 phases. There will be a current produced in the coil around the CT.

If the RCD is an integral part of the switching device tripping will occur exactly the same as with single phase RCDs

If the summation transformer is remote from the RCD Relay, the connected device will pick this up and trip at the level pre-set on device
Example settings could be anywhere between 0.01 to 30A depending on the application it is being used for.

Test Circuit – Test Button

The test circuit is always incorporated within the RCD.

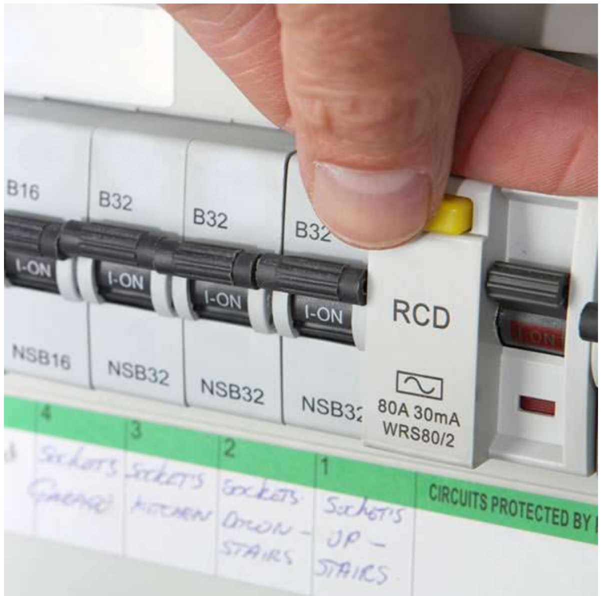
Typically, Test Button, connected to a resistive load between the line conductor on the load-side of the RCD and the supply side Neutral.

This passes current in excess of the tripping current of the RCD to simulate an out of balance condition.

This will not test the condition of the circuits installed protective conductor

And cannot be used in place of electrical test procedures for RCD

Note: All RCD's should be checked by pressing this button to confirm that the RCD trips. And at a minimum every 6 months. BS7671 regulation 514.12.2



Now this is not the end. It is not even the beginning of the end. But it is, perhaps, the end of the beginning.

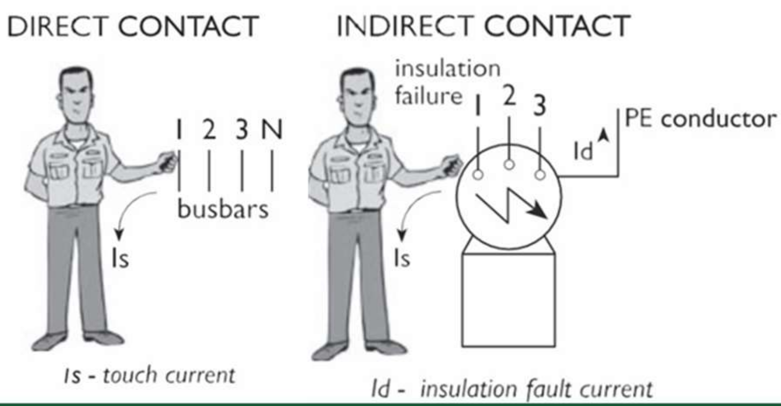
(Winston Churchill)

Effects of Electricity

Risk of electrocution.

It only takes a small continuous electrical current of 40 mA or more flowing through the body to cause irreversible damage to the cardiac cycle, possible death. A bodies impedance is around a constant 1000 ohms, this is influenced by the external conditions, very humid, wet, to very dry conditions.

A person in direct contact with Mains voltage and earth, the current flowing through the body, hand to Hand or Hand to foot… will be approximately 80mA to a maximum of 230 mA about ¼ of an Amp



Effects of Electricity

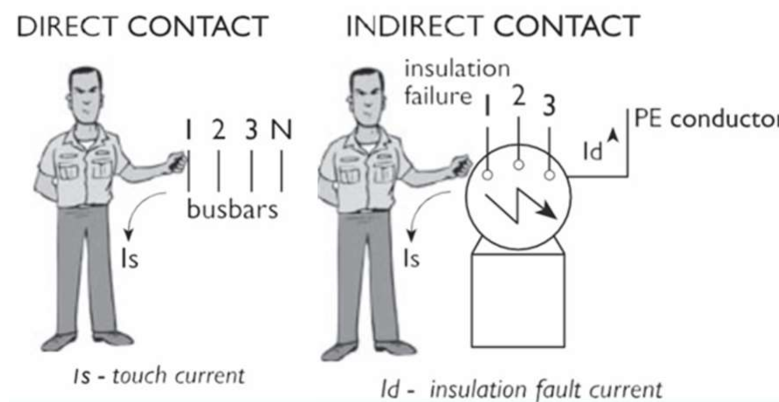
Risk of electrocution.

To prevent serious injury or death disconnection time in a fraction of a second is required (<40 ms)

High sensitivity RCD's rated ≤ 30 mA are designed to disconnect the supply within ≤ 40ms at 5 IΔn or 0.25A (manufacturer decision) – BS EN 61008-1.

≤ 300ms at rated tripping current of RCD, 1 IΔn
≤ 200ms for TT installations

(For older BS 4293 1 IΔn ≤ 200ms & ≤ 40ms at 5 x IΔn)



Effects of Electricity

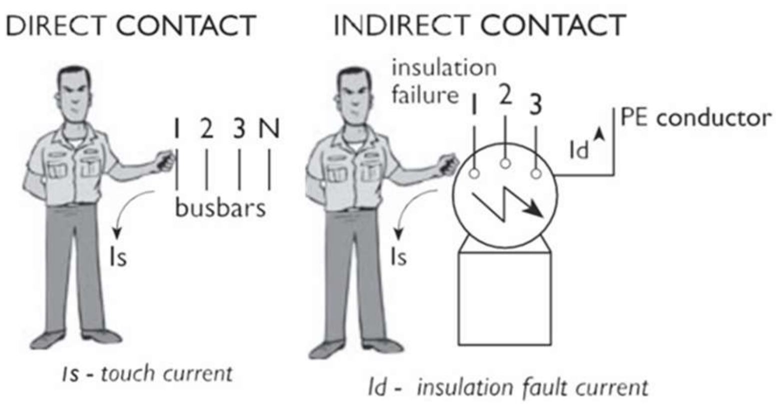
Types of Electrocution Risk.

1. **Direct Contact:** cable leads insulation becomes damaged exposing the conductors. If a person comes into contact with the live and earth conductors there is a more serious risk. The current flowing in the human body.

   The body is a poor conductor as a result the current flow will be low, approximately 80 mA to 230 mA,

With an RCD installed the leakage to earth (imbalance between live and Neutral measured within the RCD)
will trip within 40 ms when trip point is reached.
(This can be anywhere between 15mA to 30mA to BS EN 61008-1)

This would not stop the sensation of shock, but would minimise the risk of serious injury



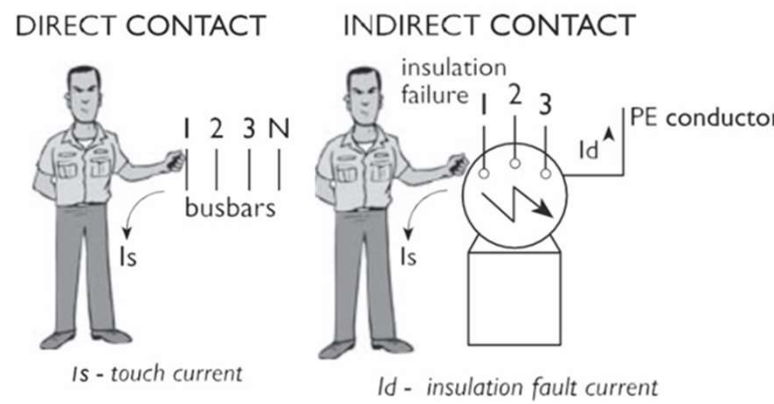
LUCECO | BG British General | ROSS | masterplug | Kingfisher Lighting

Effects of Electricity

Types of Electrocution Risk.

2. Indirect Contact is when the metal enclosure of equipment or any metal fixture such as exposed metalwork of an appliance, sink or plumbing metalwork comes into contact with a live conductor causing the metalwork to become live.

In the UK all exposed metalwork is connected to earth. In a correctly designed and installed installation the current flow will be sufficient to blow the fuse or trip the circuit-breaker



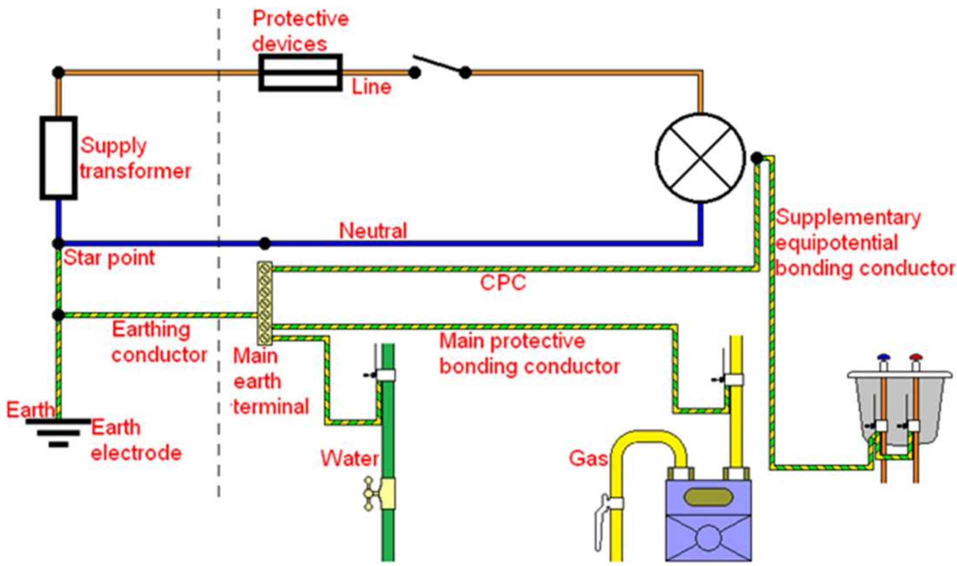
Effects of Electricity

CPC & Equipotential Bonding

Earth Leakage Current (Protective Conductor Current): Electrical appliances, connections and cables allow some current to leak to earth, due to internal or natural capacitance and inductance associated with the installation.

Capacitors connected to earth in switch mode power supplies as an example, will produce leakage. This current should travel to earth via the (PE) protective earth conductor.

If the PE conductor is disconnected or faulty (high resistance), a person touching uninsulated parts of the equipment or pipe work would be subject to the leakage current, that normally flows through the PE conductor.



Effects of Electricity

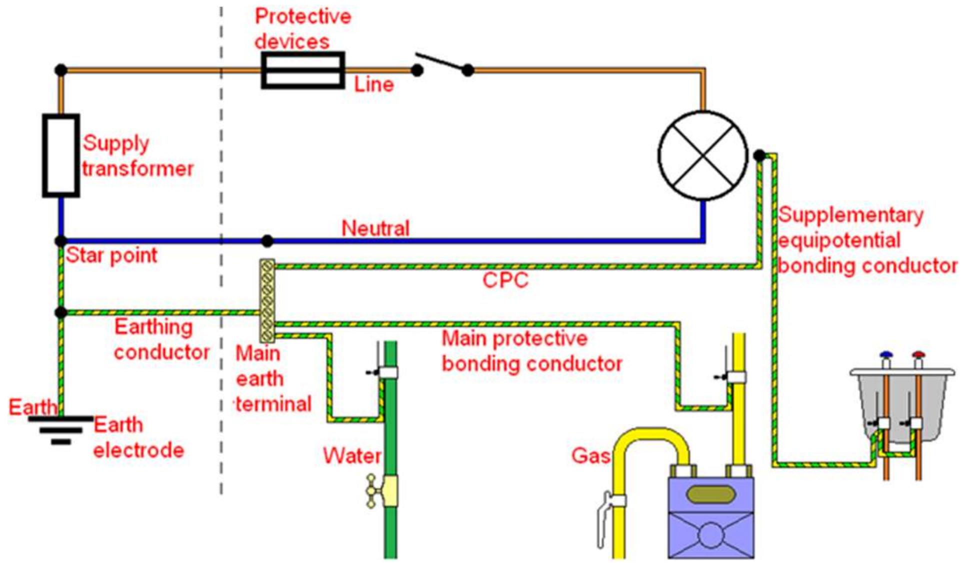
CPC & Equipotential Bonding

In a house the earthing system, CPC's and equipotential bonding form an area containment system to maintain good earth connection to equipment. In a fault, persons could touch an exposed metal part.

Protective Bonding conductors – see 544

TN-C-S system. Table 54.8 minimum of 10mm2

544.1.1 TN-S & TT system. The CSA of bonding conductors shall have a cross sectional area of not less than is half the size of the earthing conductor, 16mm earthing conductor – 8mm not available, so 10mm2… ☺ "subject to a minimum of 6mm and need not exceed 25mm"



What is earth Leakage

leakage current is, “electric current in an unwanted conductive path under normal operating conditions. It is present within healthy a circuit where no fault is present and finds its way to earth via an unintended path.

This can have an effect of causing trips to the RCD. Due to imbalance in the coil of the RCD

There is nothing faulty with the circuit. The way the circuits have been subdivided and or the types of appliances on the circuit. Modern washing machines, dishwashers, induction hobs can contribute large earth leakage values. Induction hob 6mA when off.

Driving more installers to use RCBO circuits to meet regulation **531.3.2.**

Regulation 531.3.2. Unwanted tripping

(Consideration: Division of circuits 314.1 & 314.2)

Options to meet this regulation for consumer units are:

1. Calculate each final circuit, add the values of the combined circuits to ensure RCD total leakage does not exceed trip 30% of trip value, (standards allow an RCD to trip between 50% to 100% of $I_{\delta n}$ Rating) so no more than 9mA, 30% of 30 mA (Ramp test)
2. Use RCBO's no need to calculate.

3. Commercial installs, still need to be mindful, example LED installs, leakage present

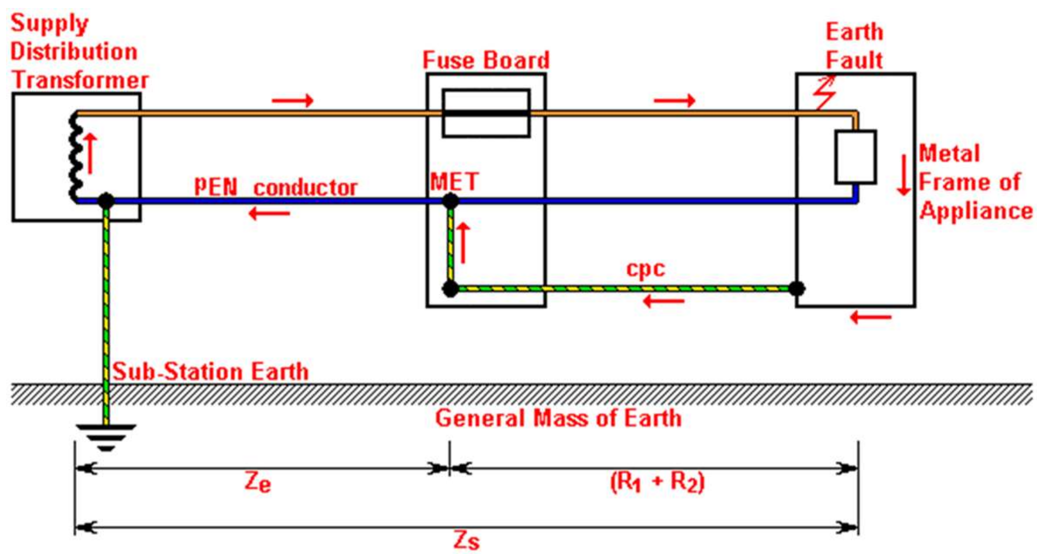
BS7671 recognises that earth leakage exists without any fault to a circuit

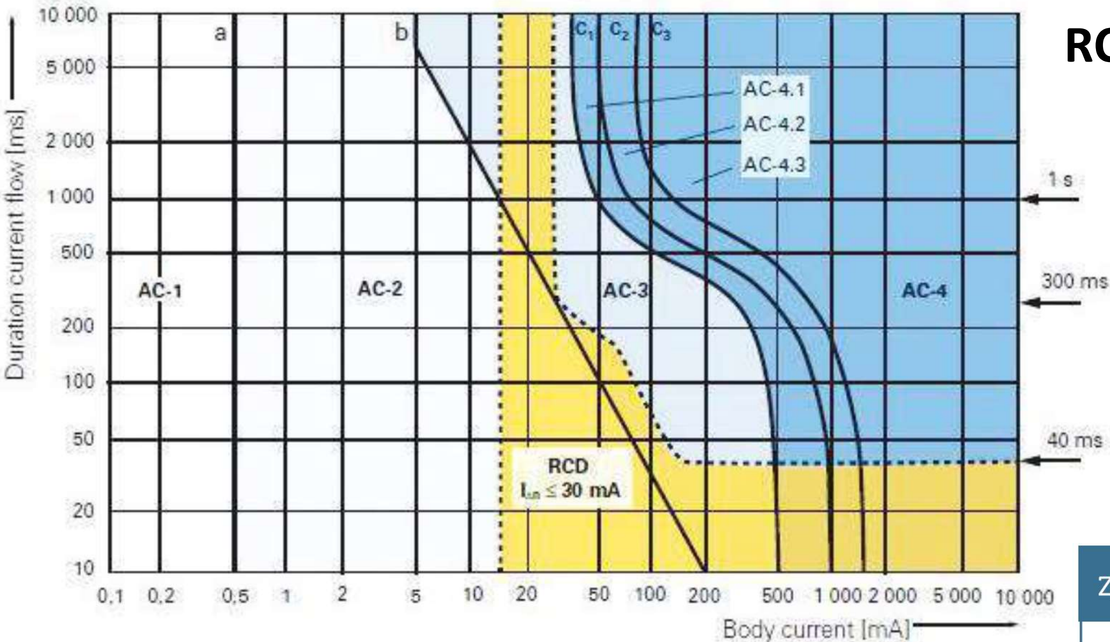
Driving more and more installers to look at RCBO solutions

What is earth fault

What is earth fault: An earth fault is a failure of the circuit that allows the live conductor to connect to earth : damaged insulation, nail through a wall into a cable for example.

RCD will see an imbalance. In the same way earth leakage is detected and trips within 40ms





RCD Time current graph

Longer the time greater the risk even at low current values

0 – 0.5A (1/2 a milliamp) Usually no reaction
0.5 mA – 5 mA may startle person or cause a fall
5 mA – 10mA same as above. But may not be able to let go
10 mA – 40mA Severe pain. Breathing difficulties, if continued contact over time, may cause cardiac arrest
40 mA – 250 mA Sever shock and possibility of non – reversible affects to heart. Leading to possible Cardiac arrest. At higher currents severe burns and cardiac arrest

Zone	Boundaries	Physiological effects
AC-1	Up to curve a	Usually no reaction
AC-2	Curve a up to curve b	Usually no physiological effects
AC-3	Curve b up to curve c_1	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 magnitude and time.
AC-4	Above curve c_1	Increasing with magnitude and time, dangerous pathophysiological effects such as cardiac arrest, breathing arrest and severe burns may occur in addition to the effects of Zone AC-3:
	$c_1 - c_2$	Probability of ventricular fibrillation increasing up to about 5 %.
	$c_2 - c_3$	Probability of ventricular fibrillation increasing up to about 50 %
	Beyond curve c_3	Probability of ventricular fibrillation above 50 %.


THE END IS NEAR!
WACKO...
THE END IS FAR!

Electric shock Protection

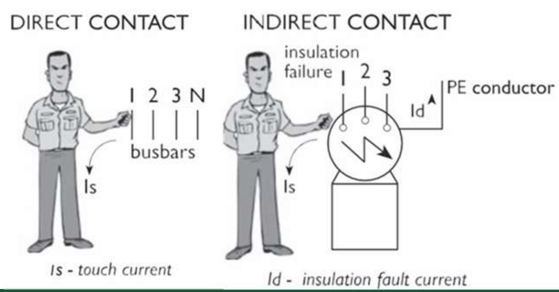
Fuses and circuit-breakers provide the first line of defence against indirect contact electric shock.

If the installation is earthed correctly with Zs values within required level then the indirect contact fault will trip the circuit-breaker or blow the fuse, within the disconnection times stated in BS7671.

However, fuses and circuit-breakers cannot provide protection against very small currents that flow through the body (230 mA) as a result of Direct contact.

RCD’s provided they have been selected correctly, can afford this protection (≤ 30 mA trip <40 ms)

They also provide protection against indirect contact under certain installation conditions where fuses and circuit-breakers cannot achieve disconnection.

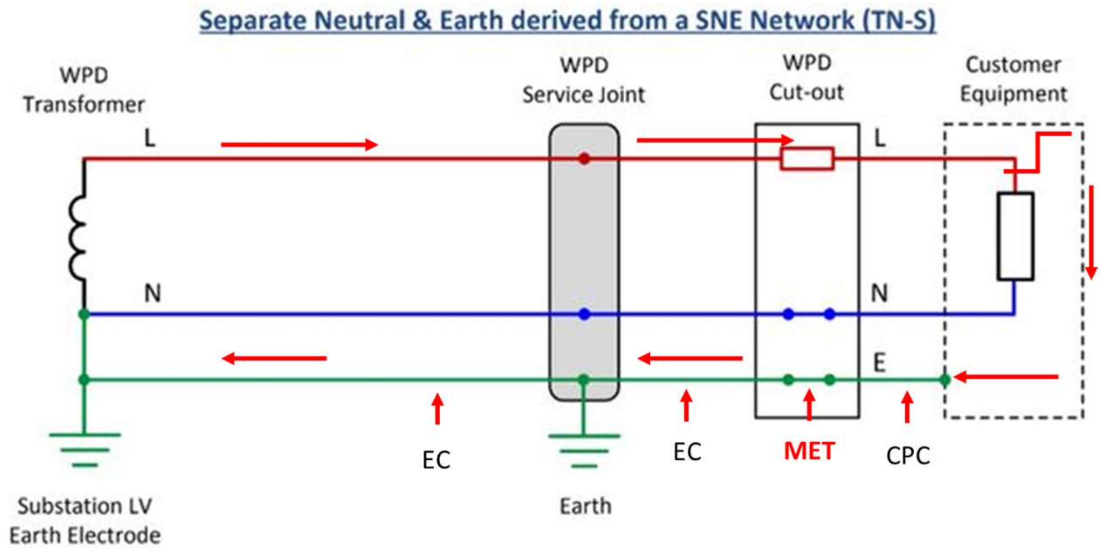


Electric shock Protection

RCD’s and Indirect contact shock protection

Indirect contact protection by fuses or circuit-breakers is dependant on the circuit earth loop impedances being within parameters laid down by BS7671. where these parameters cannot be achieved or where there is some doubt about their stability, then an alternative method is required.

It is in these situations that the RCD offers the most practical solution because of its ability to operate on circuits having a much higher values of earth loop impedance



Electric Shock Protective measures

411 Protective measures: Automatic Disconnection of supply

411.1 provides us with details for basic protection, look at section 416, and fault protection, and sections 411.3 to 411.6 and also informs us that.

Where specified, additional protection is provided by and RCD with a rated operating current not exceeding 30mA, in accordance with:- & see 415.1

Regulation **415.1** The use of RCDs with a rated residual operating current not exceeding ≤ 30mA is recognized in AC systems as additional protection in the event of failure of the provision for basic protection and / or the provision for fault protection or carelessness by users.

From the above we see that an RCD can be used for additional protection against electric shock and for the provision for fault protection.

When do we need to consider RCD for fault protection

Zs Values allowed for specific rating of MCB Table 41.3 BS7671

(a) Type B circuit-breakers to BS EN 60898 and the overcurrent characteristics of RCBOs to BS EN 61009-1

Rating (amperes)	3	6	10	16	20	25	32	40	50	63	80	100	125	I_n
Z_s (ohms)	14.57	7.28	4.37	2.73	2.19	1.75	1.37	1.09	0.87	0.69	0.55	0.44	0.35	230 x 0.95/(5In)

(b) Type C circuit-breakers to BS EN 60898 and the overcurrent characteristics of RCBOs to BS EN 61009-1

Rating (amperes)	6	10	16	20	25	32	40	50	63	80	100	125	I_n
Z_s (ohms)	3.64	2.19	1.37	1.09	0.87	0.68	0.55	0.44	0.35	0.27	0.22	0.17	230 x 0.95/(10In)

(c) Type D circuit-breakers to BS EN 60898 and the overcurrent characteristics of RCBOs to BS EN 61009-1

Rating (amperes)	6	10	16	20	25	32	40	50	63	80	100	125	I_n
Z_s (ohms) 0.4 sec	1.82	1.09	0.68	0.55	0.44	0.34	0.27	0.22	0.17	0.14	0.11	0.09	230 x 0.95/(20In)
Z_s (ohms) 5 secs	3.64	2.19	1.37	1.09	0.87	0.68	0.55	0.44	0.35	0.27	0.22	0.17	230 x 0.95/(10In)

NOTE 1: The circuit loop impedances have been determined using a value for factor C_{min} of 0.95.

Derived from using the formula
Zs x Ia ≤ Uo x Cmin

32 B Type 5 times In Automatic disconnection
32 x 5 = 160 = Ia

$\frac{230}{160}$ = 1.4375 x 0.95 = 1.365625 or 1.37

Onsite Guide tabe B6

0.1 to 5 second disconnection times

Circuit-breaker type	Circuit-breaker rating (amperes)														
	3	5	6	10	15	16	20	25	30	32	40	45	50	63	100
1	14.56	8.74	7.28	4.4	2.93	2.76	2.2	1.76	1.47	1.38	1.1	0.98	0.88	0.7	0.44
2	8.4	5.0	4.2	2.5	1.67	1.58	1.25	1.0	0.83	0.79	0.63	0.56	0.5	0.4	0.25
B	11.65	7.0	5.87	3.5	2.3	2.2	1.75	1.4	1.17	1.1	0.88	0.78	0.7	0.56	0.35
3&C	5.82	3.49	2.91	1.75	1.16	1.09	0.87	0.7	0.58	0.55	0.44	0.38	0.35	0.27	0.17

Circuit-breakers. Maximum measured earth fault loop impedance (in ohms) at ambient temperature where the overcurrent device is a circuit-breaker to BS EN 60898 type D or RCBO to BS EN 61009 type D

Circuit-breaker type	Circuit-breaker rating (amperes)									
	6	10	16	20	25	32	40	50	63	100
D 0.4 sec	1.46	0.87	0.55	0.44	0.35	0.28	-	-	-	-
D 5 sec	2.91	1.75	1.09	0.87	0.7	0.55	0.44	0.35	0.28	0.17

Regulation 434.5.2 of BS 7671:2018 requires that the protective conductor csa meets the requirements of BS EN 60898-1, -2 or BS EN 61009-1, or the minimum quoted by the manufacturer. The sizes given in Table B7 are for energy limiting class 3, Types B and C devices only.

For a more exact Ia Automatic disconnection current level consult the manufacturer of the device. This s generally lower than the using 5 X or 10 X.

32 B Type 5 times In Automatic disconnection

$\frac{230}{160}$ = 1.4375 x 0.95 = 1.365625 or 1.37 x temperature adjustment of 0.8 = 1.096 or 1.1

RCDs used as fault protection

Regulation 411.5.3 Where an RCD is used for fault protection the following conditions shall be fulfilled

(i) The disconnection time shall be that required by regulation 411.3.2.2 or 411.3.2.4 and

(ii) RA x IΔn ≤ 50 V (where RA is not known, it may be replaced by Zs)

	Non-delayed RCD Rated		Max Value Earth fault	
	RCD Operaing current	Safe	Loop impedance, Zs	Division of
IΔn (mA)	IΔn (mA)	Voltage	Ohms	V / IΔn (mA)
0.03	30	50	1677	1666.67
0.1	100	50	500	500.00
0.3	300	50	167	166.67
0.5	500	50	100	100.00

If the Zs Values for MCB is too high to provide trip times to meet table 41

TN 0.4 s = 400ms

TT 0.2 s = 200ms

Fault protection test @ X1 and must trip within 200ms for TT systems

Fault Protection Using an RCD - combined with an overcurrent protection device

Where the earth fault loop impedance of a circuit (Z_s) is too high for an overcurrent device to provide **Fault Protection**, such as a fuse or a circuit breaker, an RCD may be installed to provide the **Fault Protection.** This is a common situation in installations with a TT earthing system where the earth fault path resistance is too high for a fuse or circuit breaker to operate in the required disconnection time for an earth fault.   The RCD must be installed with overcurrent protection device as part of the circuit

For an RCD to provide **Fault Protection** the disconnection time (tripping time for the RCD) required for the circuit, as set out in Regulations 411.3.2.2 and 411.3.2.4, must be achieved AND $R_A \times I_{\Delta n} \leq 50V$, where R_A = sum of resistance of the earth electrode and the resistance of the protective conductor connecting the exposed conductive parts (RA may be replaced by Zs.) The maximum values of Zs are set out in Table 41.5 of BS7671,

Can be a solution on commercial installs, where C type RCBOs are installed with long cable runs

TABLE 41.1
Maximum disconnection times

System	$50 V < U_0 \leq 120 V$ seconds		$120 V < U_0 \leq 230 V$ seconds		$230 V < U_0 \leq 400 V$ seconds		$U_0 > 400 V$ seconds	
	a.c.	d.c.	a.c.	d.c.	a.c.	d.c.	a.c.	d.c.
TN	0.8	NOTE 1	0.4	5	0.2	0.4	0.1	0.1
TT	0.3	NOTE 1	0.2	0.4	0.07	0.2	0.04	0.1

Table 41.1 applied to final circuits

411.3.2.2 applicable to a final circuit with rated current not exceeding
(i) 63A with one or more socket outlets
(ii) 32A supplying only fixed connected current- using equipment

411.3.2.3 TN disconnect not exceeding 5s for distribution circuit
411.3.2.4 In a TT system a disconnection not exceeding 1s time

411.3.3 Additional requirement for socket outlets and for supply of mobile equipment for use outdoors
AC circuits RCD not exceeding 30mA shall be provided for
(i) Socket outlets not exceeding 32A for residential and Commercial
Risk assessment for non RCD in Commercial can be used: But does not apply to residential
(i) Mobile equipment with rated current not exceeding 32A: Includes 3 Phase equipment, no exceptions

411.3.4 Additional requirements for circuits with luminaires
Domestic : RCD not exceeding 30mA Shall be used


NowTheEndBegins.com
The End Is Near

Fire Protection

Where there is an increased risk of fire BS7671 requires installations to have RCD protection by the use of an RCD with a tripping current ($I_{\Delta n}$) not exceeding 300mA.

The use of RCD protection is required for **Fire Protection** in buildings that are mostly constructed of combustible materials such as wood, or where combustible materials are stored, or where they may be additional fire hazards from dust or fibres. See Regulations 422.4, 422.3.9.

In agricultural and horticultural premises there is a requirement for all circuits to have RCD protection with a tripping current not exceeding 300mA for **Fire Protection.** This is required as it is likely that there will be stored combustible materials in the form of hay and straw and also the presence of rodents who are prone to chewing cable insulation. See Regulation 705.422.7

What RCD can be used for fire protection

Any RCD up to 300mA is suitable for fire protection, this is based on a power level of up to 60 watts which is considered enough to cause a fire.

A 300 mA time delayed RCD can also be used to provide fire protection.

From the 1st slide: An RCD not exceeding 300mA can be used for fire protection.

So a 10 mA RCD could be used ?

10 mA as part of the main circuit supply would probably trip frequently.

And probably a 30mA as the Main incoming Device may also experience trips

It is common to see 100mA RCD’s as well as 300 mA RCD with and with out time Delay to offer Fire protection.

Installation Risks where an RCD provides protection

Typical Risks

Mechanical damage of cables:

Penetration of cable insulation in floors and walls

Cutting supply lead of extension lead with Lawn mower

Trapped or poorly maintained extension leads

Verim : chewing through cables

Even if bodily contact does not occur, damaged to the cable insulation can result in a fire risk if RCD protection is not used.

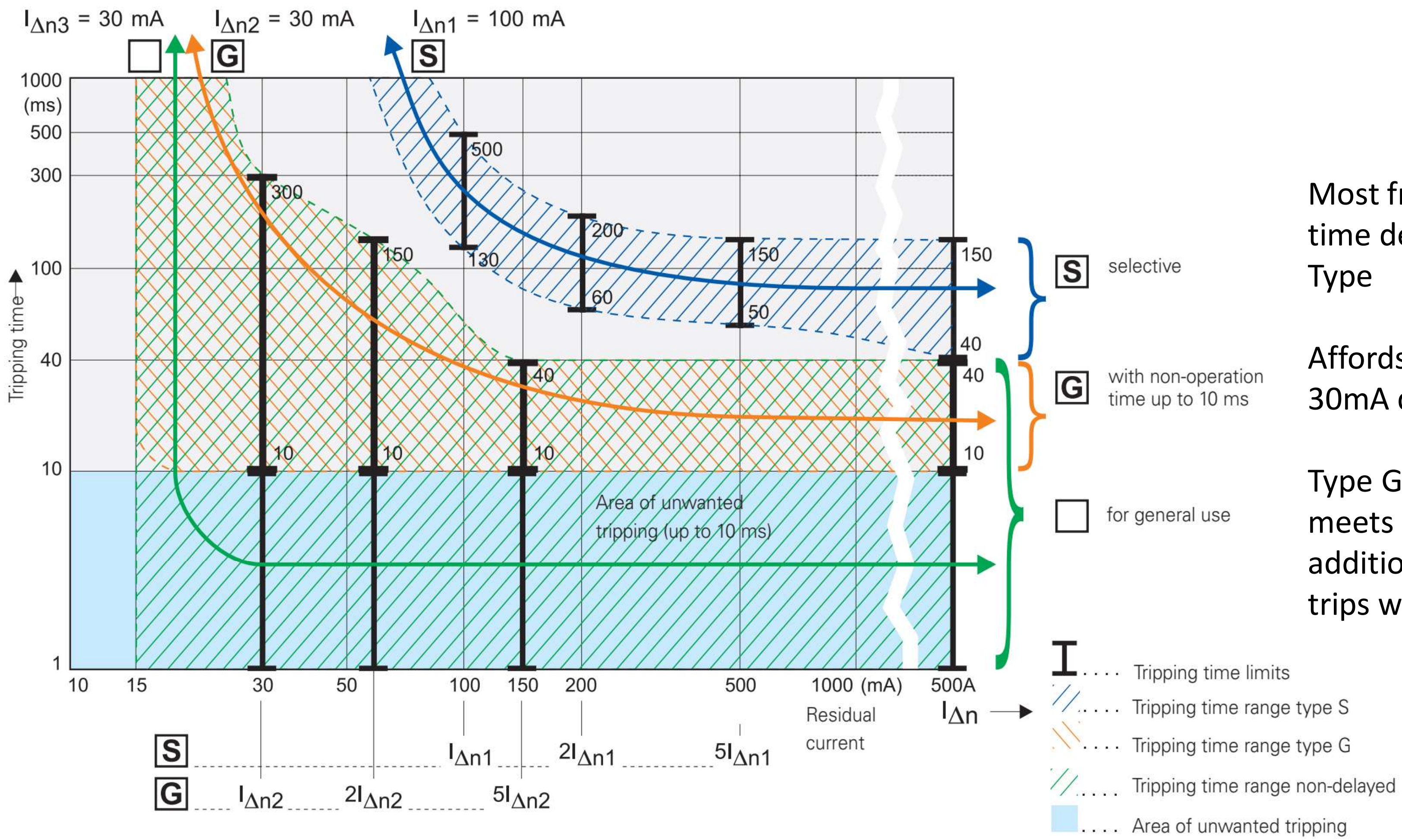
Selection of RCDs

RCD's can also be subdivided into :-

Non-delayed
Delayed

RCD type		Tripping times [ms]			
		$I_{\Delta} = I_{\Delta n}$	$I_{\Delta} = 2\ I_{\Delta n}$	$I_{\Delta} = 5\ I_{\Delta n}$	$I_{\Delta} = 500$ A
$\square$	no delay – for general use	≤ 300	≤ 150	≤ 40	≤ 40
G	delayed with non-operation time min. 10 ms	10 - 300	10 - 150	10 - 40	10 - 40
S	selective – with non-operation time min. 40 ms	130 - 500	60 - 200	50 - 150	40 - 150

Tripping characteristics of non-delayed & Delayed RCD



Most frequently used time delay RCD is the S Type

Affords selectivity to 30mA down stream RCD's

Type G offers 10mA delay, meets requirement of additional protection, trips within 40ms.

Selection and installation of RCD’s

Selection criteria

Sensitivity: RCD’s offer a choice of residual sensitivity (tripping current)

This defines the level of protection afforded to the installation and or the individual circuit

Protection is divided into 2 broad categories

Person Protection (additional protection of persons or livestock against direct contact)

This is ensured when the minimum operating current of the RCD does not exceed 30 mA and the RCD operates to disconnect the circuit within the specified time (40ms) in the event of an earth leakage

Installation Protection This is associated with devices that are used to protect against the risk of fire caused by an electrical fault.

RCD’s which operate at residual current levels up to and including 300 mA provide this type protection

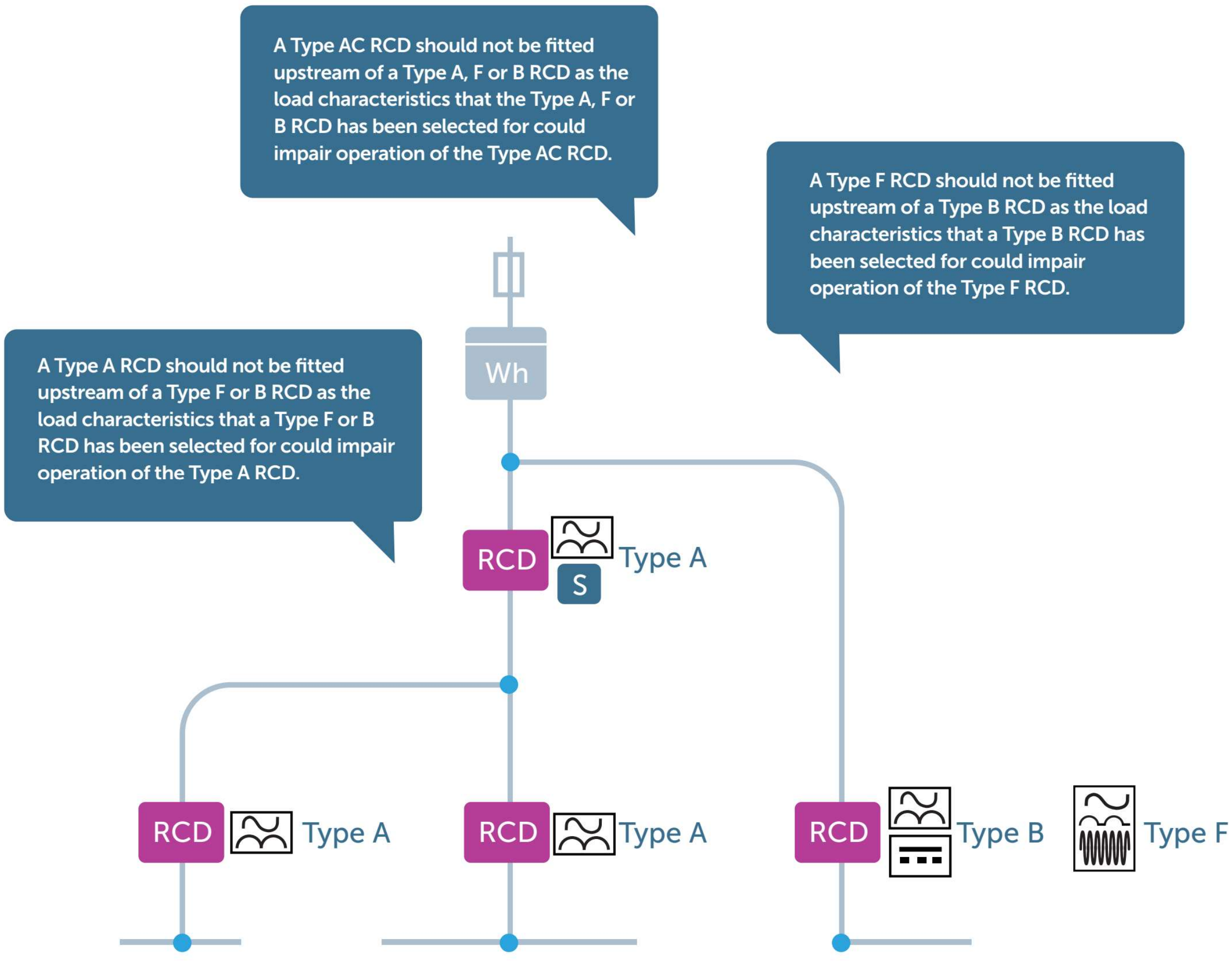
BS 7671 cover this in 536.4.1.4 Selectivity between RCDs

(ii) Is given under the following conditions

Upstream RCD is S type, or appropriate with time delay setting And
the ratio of the rated residual operating current of the upstream RCD to downstream RCD is at least 3:1.

This then provides the RCD standards applicable BS EN 61008 series or BS EN 61009 as well as BS EN 60947-2 and marked with a symbol Δt followed by S.
(Note with 60947, there are a range of RCDs with adjustable time delays and current settings)

The important factor for final circuit additional protection is the RCD must be a non adjustable setting and ≤ 30 mA



When considering **selectivity** we must also consider the Type of RCD to be installed in terms of their protection characteristics Types AC, A, B, F types

We could for example add a Type AC to a branch circuit where the load was only resistive.

Nothing wrong with the RCD

Potential causes of unwanted tripping

Supply side (upstream of the RCD)

- Mains borne disturbance
- Site machinery/plant
- Lightning strike
- Equipment or faults external to the installation e.g. cable joints breaking down causing sporadic unwanted tripping to one or more premises, a fault in an adjacent installation

Load side (protected 'downstream' side of the RCD)

- Wrongly specified RCD
- Wet plaster / condensation
- No 'selectivity between RCDs
- Crossed neutral on split load board
- N – E fault
- High standing earth leakage currents caused by:
- Surge Protection Devices (SPDs)
- Too many items of current using equipment containing filter circuits
- Excessive length of mineral insulated cables
- Heating elements (e.g. cookers)
- Householder / DIy faults (e.g. nails/picture hooks)
- Moisture ingress (appliances, sockets etc.)

RCD – Residual-Current Device

Enclosure mounted

RCCB (**R**esidual **C**urrent Operated **C**ircuit-**B**reaker without Integral Overcurrent Protection) - BS EN 61008-1

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RCBO Residual **C**urrent circuit **B**reaker with **O**vercurrent protection. (Residual Current Operated Circuit-Breaker with Integral Overcurrent Protection) BS EN 61009-1

CBR (**C**ircuit-**B**reaker incorporating Residual Current Protection) (BS EN 60947-2)

MRCD (**M**odular **R**esidual **C**urrent **D**evice) (BS EN 60947-2)
An independently mounted device incorporating residual current protection, without overcurrent protection, and capable of giving a signal to trip an associated switching device

RCM (**R**esidual **C**urrent **M**onitor) (IEC 62020)
A device designed to monitor electrical installations or circuits for the presence of unbalanced earth fault: *Cannot be used to provide protection. Monitoring and alarm only*

Externally located/wall mounted/ Portable (BG Mfr)

SRCD (**S**ocket-Outlet incorporating a **R**esidual **C**urrent **D**evice) BS EN 62640

FCURCD (**F**used **C**onnection **U**nit incorporating a **R**esidual **C**urrent **D**evice)

PRCD (**P**ortable **R**esidual **C**urrent **D**evice)
A device comprising a plug, a residual current device and one or more socket-outlets BS EN 61540

IC-CPD (**I**n **C**able **C**ontrol and **P**rotection **D**evice)
30mA RCD and control unit in Mode 2 Charging Cable

Enclosure mounted

Note: depending on the manufacturing construction.
AFDD: Arc Fault Detection Devices could also afford RCCB "Additional protection" or RCBO Fault Protection + "Additional protection"

CBR (Circuit-Breaker incorporating Residual Current Protection) (IEC 60947-2)

RCCB Residual Current Circuit breaker

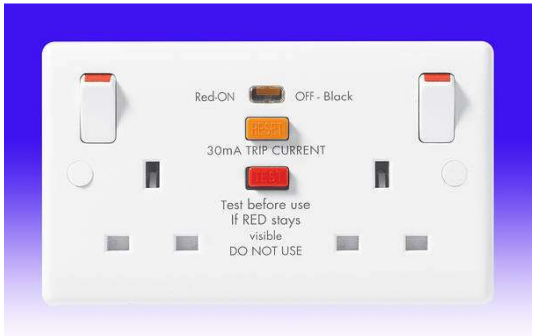
RCBO Residual Current Operated Circuit-Breaker

RCM
Residual current monitors

MRCD (Modular Residual Current Device)

Toroidal Ring CT (Current Transformer)

SRCD (Socket-Outlet incorporating a Residual Current Device)



FCURCD (Fused Connection Unit incorporating a Residual Current Device)

PRCD (Portable Residual Current Device)
A device comprising a plug, a residual current device and one or more socket-outlets

IC-CPD (In Cable Control and Protection Device)
30mA RCD and control unit in Mode 2 Charging Cable

Regulation	Area	notes
522.6.202 522.6.204.	Cables without mechanical protection at a depth of less than 50mm in a wall	Cables should be in Safe Zones and 30mA RCD protected.
522.6.203 522.6.204.	Cables in walls with internal metal construction unless protected	Unprotected cables such as twin and earth in metal studwork walls.
701.411 .3.3 701.415.2	Alllow voltagecircuits in a bathroom	None
701.411 .3.3	Circuitspassing through bathrooms Zones 1 and/or 2	Only applies to Zones 1 and 2, not to cables outside the Zones.
702.410.3.4.2, 702.419.3.4.3 702.53 702.55.1	Swimming pools	Supplies to equipment in the Zones.
703.411.3.3	Saunas	All circuits in the sauna.
704.410.3.10	Construction sites	230/400V Sockets up to 32A.
705.411.1	Agricultural and Horticultural Premises	(i) Sockets up to 32A not exceeding 30mA, (ii) Socket Greater than 32A not exceeding 100mA (iii) All other circuits not exceeding 300mA
712.411.3.2.1.2	Solar PV power supply systems	May need to fit Type B
722.531.2.101	EV vehicle Charging Installations	Type A double pole, dependent on the vehicle on board circuits limiting DC leakage to 6mA and below

DEVICE TYPE	RCCB						RCBO						SRCD		FCURCD		PRCD		CBR	MRCD
Earth Leakage Sensitivity mA (2)	10	30	100	300	100 Time Delay	300 Time Delay	10	30	100	300	100 Time Delay	300 Time Delay	10	30	10	30	10	30	10 up to many amps	30 up to many amps
Suitable for Domestic Applications	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
Suitable for Industrial & Commercial Applications	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Suitable as a Main Incoming Device (CU)	N	Y	Y	Y	Y	Y	N	Y (6)	Y (6)	Y (6)	Y (6)	Y (6)	N	N	N	N	N	N	N	N
Suitable as an Outgoing Device on a CU, DB, PB or SB (5,7)	Y (1)	Y (1)	Y (1)	Y (1)	Y (1)	Y (1)	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	Y	Y(1)
Part of the Incomer on a CU, DB, PB or SB (5,7)	N	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	N	N	N	N	N	N	Y	Y
Provides Personal Protection	Y	Y	N	N	N	N	Y	Y	N	N	N	N	Y	Y	Y	Y	Y	Y	Y(3)	Y(3)
Provides Protection Against Electrical Fire(8)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Socket outlets not exceeding 32A	Y	Y	N	N	N	N	Y	Y	N	N	N	N	Y	Y	Y	Y	N	N	N	N
Fixed Wiring Protection	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	Y	N
Portable appliances not exceeding 32A	Y	Y	N	N	N	N	Y	Y	N	N	N	N	Y	Y	Y	Y	Y	Y	N	N
Can be used to Discriminate with Instantaneous Downstream Device	N	N	N	N	Y	Y	N	N	N	N	Y	Y	N	N	N	N	N	N	Y(4)	Y(4)

Notes:

(1) Only if used in conjunction with suitable overcurrent protection (e.g. Fuse/circuit-breaker)

(2) 10 mA RCD's are associated with highly sensitive equipment and high risk areas such as school laboratories and in hospital areas

(3) Yes provided 30 mA or less, but not normally used.

(4) With time delay

(5) CU – Consumer unit to Bs EN 61439-3

(6) Must provide double pole isolation

(7) DB – Distribution Board; PB – Panel Board; SB – Switch Board

(8) For agricultural and horticultural premises, the RCD is required to disconnect all live conductors`

Principles of RCD Operation
Why we have them.
What they do