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RCDs: everything an electrician should know

Electricians do the best they can every day they go to work – and we want to leave a job safer than when we found it. But what if despite our best efforts, we actually made things worse without realising it? This article seeks to answer this question!

Quick history

Historically, two basic types of earth-leakage circuit-breaker (ELCB) were recognised by BS 7671: what we know to be a current-operated type or residual current device (RCD) and the even older voltage-operated type. Today, only the current-operated type is recognised and used.

So, if we look back in time before the 17th Edition came out in 2008 (BS 7671:2008), the 16th Edition and previous editions, the more experienced (older) sparks will remember when ELCB devices were referred to by one of the following terms:

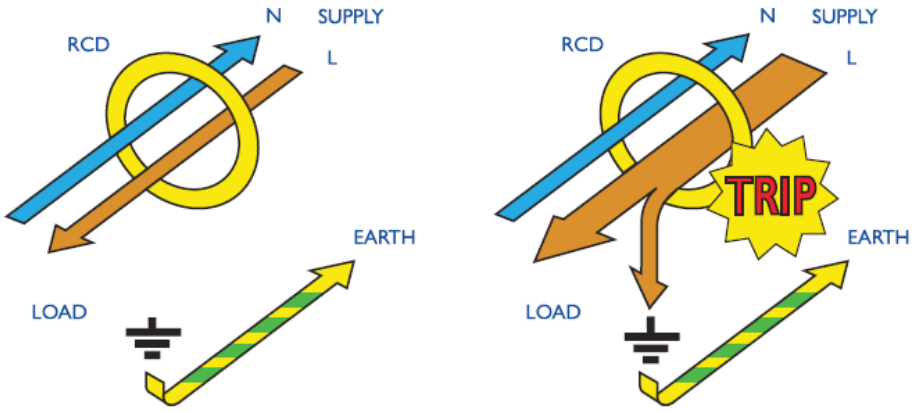
- protection against indirect contact – now called fault protection;
- supplementary protection against direct contact – now called basic protection;
- protection against fire and thermal effects; and
- additional protection.

In fact, when we adopted current operated devices (RCDs) to BS 4293, the trip times were much quicker than modern devices, although they may not comply with BS EN standards. BS 4293 was withdrawn in 2000 and manufacturing of these devices should have ceased in 2005. The device was replaced by BS EN 61008.

One of the negatives in using the older mechanical devices were that they could seize up. Modern devices are either electronic or electromagnetic.

What is an RCD?

They are devices installed within an electrical system unit to provide protection to the wiring, fixed appliances and persons using the installation. Protection is achieved by constantly monitoring the electric current flowing through one or more circuits that an RCD is used to protect. If it detects electricity flowing down an unintentional path, such as via a person or faulty appliance down to earth, then the RCD will switch off the circuit very quickly, reducing the risk or death, injury or fire.



The device monitors the ingoing and outgoing current flow and trips when an imbalance occurs as illustrated above.

RCDs are defined by three main characteristics:

- the rating in amps;
- the rated residual operating current of the protective device in amps, known as the IΔn (pronounced 'I delta N'); and
- the instantaneous trip that occurs or an intentional time delay to permit discrimination*. Such devices are called 'S' or Special/Selective.

***Note:** the term 'discrimination' is proposed to be replaced by 'selectivity' in the upcoming 18th Edition of BS 7671 (BS 7671:2018).

We find ourselves now using the term 'RCD' to cover a range of devices found within an electrical installation. They include:

- residual current device – RCD found in older devices to BS 4293;
- residual circuit current breakers – RCCB to BS EN 61008;
- residual current breaker with overload – RCBO to BS EN 61009 found in consumer units;
- circuit breaker with RCD fitted – CBR larger industrial application;
- SRCD – socket outlet incorporating an RCD to BS 7288;
- FCURCD – fused spur with RCD integrated; and
- PRCD – a device that contains a portable RCD within the plug.

As can be seen above, RCDs have merged into other many different products and protective devices although the principles of protection remain the same.

Most domestic electricians use, and are familiar with, RCD main switches for circuits or RCBOs in today's world.

So what's the concern?

Once we've got through the vast array of different manufacturer-branded devices we are left believing we are fully compliant with the regulations! Well, maybe not …

As we all know the MCBs we use come in differing 'types'– by this I mean Type B (domestic use), C (commercial installations) or D (industrial large loads).The information on these 'types' is found in Appendix 3 of BS 7671 and is formally known as 'time/current characteristics of overcurrent protective devices'.

That's first principles I hear you say: I use a Type B or C MCB all the time, I'll stick with them!

So far so good, we all know this well by now.

However, if you look at Chapter 13 of BS 7671 you will find that it contains copious warnings about external influences on an installation to help you ensure that what you do does not make an installation unsafe or compromised. Regulations 132.5, 132.7, 132.11, 133.3, 133.4 and Appendix 5 are a must-read for any electrician; more importantly, there is no reason not to comply fully with Chapter 13 Fundamental Principles.

Appendix 5 External Influences contains lots of items that can affect an electrical installation.

So, do you think with all the onslaught of modern technology and the drive for smart homes, we are adequately considering and taking all precautions required in terms of our methods of protection?

The issue at hand – what do I need to know?

With all the modern technology that is now installed into domestic installations, would you ever have thought that DC current could be a real issue for you?

Within an installation today it is not rare to find the following:

- switch mode power supplies – found in all electronic devices to convert AC to DC;
- solar PV panels;
- electric vehicle charging;
- USB socket outlets; and
- smart home and data networks.

All of these have one thing in common: DC current and voltage.

DC has a tendency to leak to earth. When it does, it immediately becomes an AM7 external influence under the categories in Appendix 5. If this does happen, your RCD, in whatever form you use, will NOT perform to the requirements of the standard it is made to. In a nutshell, it becomes less safe –the greater the DC current the bigger the effect.

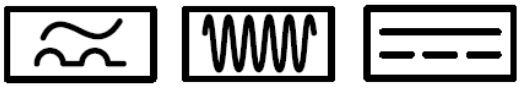
So what if I told you your RCD was a Type AC or a Type A or F? Confused? Don't be: there is another use for the term 'type'– it applies to the RCD device itself and its performance. They are known as Type AC, A, B, F, and more recently a B+ has turned up on the market.

AC: this device ensures tripping for residual AC currents whether sudden or rising; this is standard in most domestic installations. The marking for this is shown below.

A: this device ensures tripping for all types of AC currents and pulsating DC currents that may appear within an installation. The marking for this is shown below.

F: this device ensures tripping for all types of AC currents and pulsating DC currents that may appear within an installation. It also ensures no unwanted tripping and detection of high frequency faults up to 1KHz. The markings for this are shown below.

B: this device ensures tripping for residual AC currents, pulsating DC currents and smooth DC currents, whether applied suddenly or rising. The markings for this are shown below.



B+: this device ensures tripping for residual AC currents, pulsating DC currents and smooth DC currents, whether applied suddenly or rising. It also ensures no unwanted tripping and detection of high frequency faults up to 20 kHz. The markings for this are shown below.

The challenges ahead

So why do I need a 'type' B or B+ RCD? They are needed to protect:

- micro generators or small scale electricity generators (SSEG) including:
  - solar photovoltaic (PV);
  - electric vehicle (EV) charger points; and
  - wind turbines/generation.
- three phase rectified supplies.

Did you know?

IEC 62109-1 specifies requirements for inverters (changing DC to AC) used in photovoltaic systems that states clearly that only Type B RCDs should be used in such systems because Type A or Type AC RCDs cannot provide appropriate protection. This is due to the leakage we talked about above and the fact that some inverters have only simple separation. The DC current leaks and renders the RCDs in standard boards as inoperable. They don't teach you that in college, do they!

Electricians should now be looking in more depth and preparing for the future where possible; if the client thinks they will have an electric vehicle and solar PV panels in future then make sure you accommodate this.

Domestic installations are now swamped with DC-producing equipment and I have seen homes with 8-10 socket-outlets per room with USB chargers within all those outlets.

Lastly, ask yourself the following:

- what type RCD would I want in my home of the modern era?
- do I recognise or look for these symbols when inspecting existing installations/systems?
- how do I know that what we have chosen to install is safe?
- if a USB charger goes faulty what happens to my protection?
- what type device would you choose?
- what is the legal duty of care placed upon me?
- is the split-load consumer unit I bought fit for the work I need to carry out?
- is there any special testing I need to do or test kit?
- how do the new devices proposed in BS 7671:2018 called 'arc fault detection devices' fit in to all this?

Hopefully, this article goes a way to addressing questions that you may have had on RCDs or at least set you on a path to gaining a better understanding.