Safehouse

The power to protect

Guide to

Miniature Circuit Breakers

Introduction

In South Africa, miniature circuit breakers (MCBs) have become commoditised over the past 20 years or so to the extent that their all-important function has been blurred and, in most cases, largely misunderstood.

From around the 1960s, the MCB has replaced the fuse in incoming distribution boards, thereby increasing the safety standard of the incoming protection by making it impossible to replace a blown fuse with a nail or a piece of wire – a frequent and dangerous practice. The following are some of the more visible consequences, as seen from the point of view of clients of these institutions:

What does a MCB do?

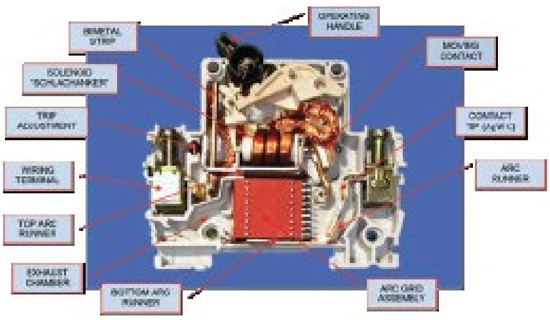
A MCB is a 'mechanical switching device, capable of making, carrying and breaking currents under normal circuit conditions and also making, carrying for a specified time and breaking currents under specified abnormal circuit conditions, such as those of overload and short circuit'.

In all cases the MCB should operate:

- With safety for the user and the environment; and
- Without damage to the electrical and physical installation.

Typical internal construction of a thermal magnetic type MCB

The switching mechanism forms the main current path from the line terminal connection to the load terminal connection. It includes special contact tip materials to handle the arc energy on make-and-break operations. The arc runners lead the arc away from the contacts and into an arc grid arrangement designed to split the arc between the iron plates, thereby increasing the arc voltage – generally 10 V per arc foot – to a point where the system voltage is too low to sustain it and would cause the arc's collapse.



This chamber also plays an important role in exhausting the hot gases away from the incoming line and the delicate trip mechanism.

The mechanical trip mechanism is a delicate set of spring-loaded levers connecting the moving contact through a latch to the operating handle, allowing the MCB to be switched on and off manually. However, when acted upon, the latch automatically disconnects the moving contact from the incoming supply.

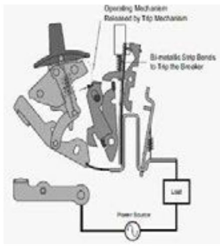
The overload control mechanism determines at what current and for what period of time the MCB will disconnect from the incoming supply in the case where the rated current of the MCB is exceeded. In this aspect, there are two different technologies available.

What are the two technologies?

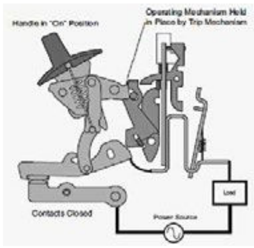
The two technologies are: thermal magnetic and hydraulic magnetic. Here is a brief overview of what makes them work and why:

Thermal magnetic principle of operation

The main element in a thermal magnetic MCB is a bi-metallic strip, which is heated by the passage of current through it, causing it to bend and bias onto the main latch. At a pre-defined temperature, the latch is released – causing the main contacts to separate.



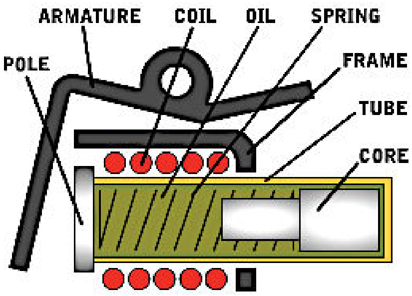
As the strip bends due to the increased temperature and the different expansion of the two metals – it causes the trip mechanism to unlatch and opens the main contacts.



MCB in the ON condition, with the main contacts closed – current flows through the bi-metallic strip.

Hydraulic magnetic principle of operation

In this design, the bi-metallic strip is replaced by a 'dashpot', which is an oil-filled tube containing a spring-loaded iron core. The current is passed through a coil placed around the tube. A spring-loaded armature, an iron frame and an iron pole piece complete the magnetic circuit. As the current increases past the rated value of the MCB, the core is attracted towards the pole. Once the core reaches the pole, the armature is attracted towards it and this causes the latch to trip and the contacts to separate.

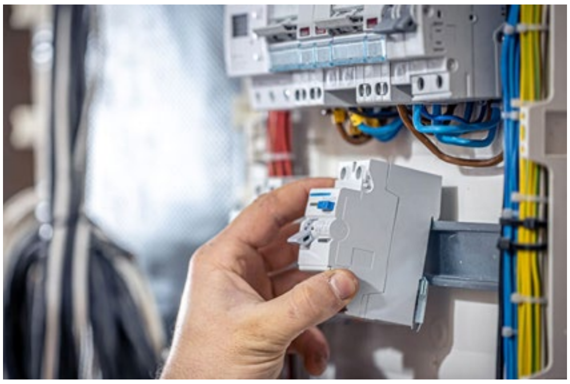


	Pros	Cons
Thermal Magnetic	Conpact, simple design	Sensitive to ambient temperature.
	Can perform current limiting.	Minimum width of single module = 18 mm width.
Hydraulic Magentic	Insensitive to ambient temperature.	Difficulty in performing current limiting. Zero point extinguisher.
	Minimum width of single module = 13 mm width.	Complicated dashpot design.

What are the MCBs electrical characteristics?

In the standard wiring of domestic, commercial and light industrial installations, electrical characteristics of both technologies comprise:

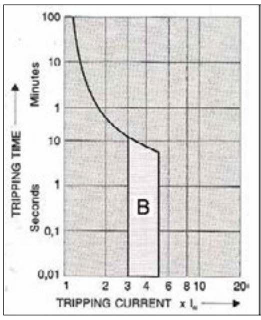
- Voltage rating: 230/400 V (+/- 10%) – 50 Hz.
- Current ratings: From 1 A to 100 A (1, 6, 10, 16, 20, 25, 32, 40, 50 and 63 A being the most used).
- Overload characteristics: Curves B, C and D.
- Breaking capacity: 3, 6 and 10 kA alternating current (one- and three-phase).



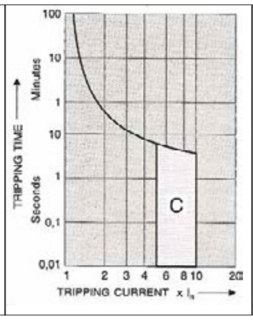
Time delay curves

The function of an 'inverse time delay curve' is essential for the principle that the time to 'trip' or disconnect the breaker needs to be progressively less as the overload increases. This ties in with the principle that the installation wiring and/or appliances at increasing fault levels can tolerate a limited amount of overload energy. In addition, many appliances demonstrate a current 'inrush' when switched on – electric motors, in particular, have an inrush of around 10 to 15 times the rated current for a short duration of time; the MCB must be able to allow this without tripping.

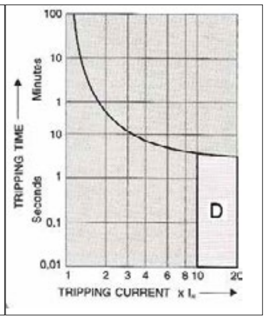
Typical thermal magnetic time delay curves:



Fast acting response for normal household applications.



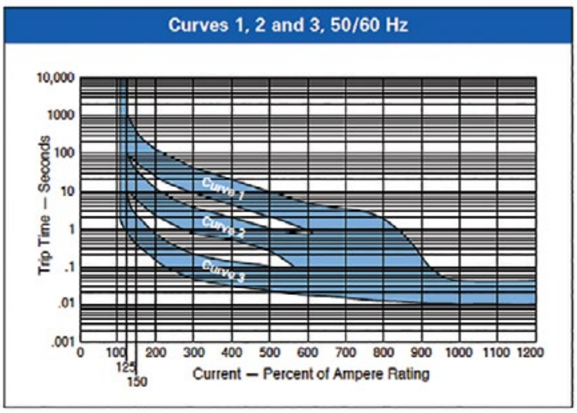
Slow acting for normal applications that include motors.



Very slow acting for industrial applications that include motors and pumps.

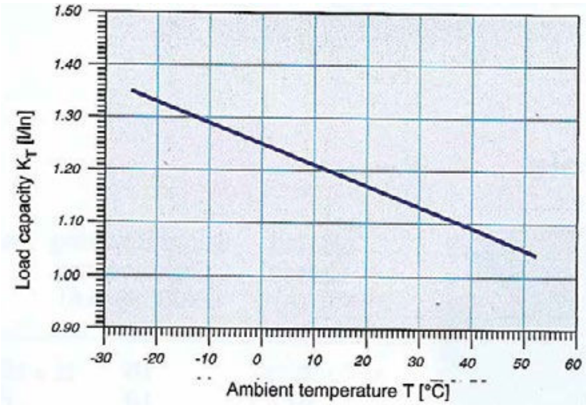
The essence of these curves is to demonstrate the 'instantaneous tripping' point – the current beyond which the MCB offers no practical time delay and is said to trip instantaneously. The lower this value, the more likely the MCB will trip on start-up of any electric motor.

As mentioned previously, the thermal MCB is affected by ambient temperature and the proponents of this technology argue that this is beneficial since, at higher temperatures, damage is more likely to occur to the installed cables and therefore, a reduced trip characteristic is desirable.



Breaking capacity

- Another subtle technical differentiator is the MCB's inherent design, which enables it to limit the let-through current during short circuit conditions. The design of the tripping mechanism is enhanced to accelerate
- the moving contact opening speed and the effective dissipation of the arc into the arc chamber – and this is referred to as either a current-limiting or zero-point extinguishing breaker.



Marking and information required on the MCB

Every MCB is required to have the following marking:

In the product's technical literature – visible on purchasing the MCB

- Rated short circuit making capacity (Icm) if higher than Icu.
- Rated insulation voltage (Ui) if higher than Ue, i.e. 500 V.
- Pollution degree, if higher than three.
- Conventional enclosed thermal current (Ithe) if different from the rated current.
- IP code where applicable.
- Further items for large frame MCBs.
- Further Items for opening and closing devices for large frame MCBs.

On the body – not visible to the user when installed

- Type designation or serial number.
- IEC 60947-2 (or SANS 60947-2) or VC8036.
- Selectivity category, i.e. 'Category A'.
- Rated operational voltage (Ue) in Volts, i.e. 250 V.
- Rated impulse withstand voltage (Uimp) in kV, i.e. 4 kV.
- Rated frequency, i.e. 50 Hz (note that there are special requirements for dc types).
- Rated service short circuit breaking capacity (Ics) at the voltage Ue, in kA, i.e. 6 kA.
- Rated ultimate short circuit breaking capacity Icu) at the voltage Ue, in kA, i.e. 10 kA. Note this may be given in the form Ics=Icu = 6 kA or Ics = 0.5 Icu = 3 kA.
- Line and load terminals, unless their connection is immaterial.
- Reference temperature for non-compensated releases, if different from 30 °C.

On the front – visible to the user – MCB is installed in the distribution board:

- Rated current (In) in Amperes, i.e. 20 A. In some instances this is coupled to the DIN time delay curve designation, i.e. for curve Type C: C 20 A.
- Suitability for isolation, by way of the symbol:
- Indication of the open and closed positions with the symbols ‘I’ and ‘O’.
- Manufacturer’s name or trade mark – this is usually on the front and is visible to the user.

Typical MCB front marking. The look-alike aspect of MCBs emphasises the need for scrutiny of the detail.

Proof of compliance with regulations

In order to legally distribute the product, the manufacturer or importer of a MCB up to 10kA / 125A will require a Letter of Authority (LoA) issued by the National Regulator for Compulsory Specifications (NRCS) on the strength of a Type Test report, issued by an accredited laboratory, proving that the product complies with the requirements of VC8036.

What are the applicable standards?

SANS 10142-1	The SA National Standard for The Wiring of Premises.	Specifies the types of circuit breakers, the safety standards and their application in LV installations.
VC8036	The SA Compulsory Specification for Circuit Breakers.	Legislation issued under Government Gazette No. 29265 of 6 October 2006, makes the compliance with SANS 556-1 a mandatory requirement for the selling and distribution of these products.
SANS 556-1	The SA National Standard for Circuit Breakers.	SA ‘front-end’ specification, referring to SANS 60947-2; with the three national deviations; covering all aspects of the performance requirements of circuit breakers.
SANS 60947-2	The SA National Standard for Low Voltage Switchgear and Controlgear. Part 2: Circuit Breakers.	This standard – together with Part 1: General Rules – covers all the test requirements for circuit breaker products and is an adoption of the IEC standard.

What should a purchaser look for to help ensure the product is compliant and safe?

The MCB is a vital safety device and the choice of MCB is a complex issue that is often best left to qualified persons who will know what characteristics are required for a particular installation and network. However, the purchaser will best be served by following these guidelines:

- Insist on being informed by the supplier about the origin of the product and, where applicable, by the consulting engineer or electrical contractor about available choices.
- Be critical about their choice if you have any doubts.
- Ask for proof of compliance with regulations.
- Deal with a supplier and brand that you know and can trust.
- Look for the markings and information details above – if absent or deficient, be suspicious.
- Look for certification marks such as SABS or VDE marks.
- Look for the test specification marking: 'Tested to SANS or IEC 60947-1' or 'VC8036'.
- Try to validate 'sales talk' about quality and performance.
- Make contact with the original supplier in South Africa.
- Beware of copies of prominent brands.
- Beware of products at substantially lower prices than other products on offer.
- Look for the SAFEhouse logo on any packaging.
- Check with the SAFEhouse Association for information it may have on products.

About Safehouse

Safehouse is a non-profit organisation that protects South African businesses and people from preventable harm caused by unsafe electrical products and services.

We're a voluntary group of electrical industry stalwarts, technical experts and leaders of our respective businesses and fields.We believe it's our civic and commercial duty to protect our industry and fellow South Africans from suppliers of unsafe electrical products and services.

We work to eradicate dangerous products from the market, to make electrical safety information understandable and accessible and to hold one another, and our industry, to the highest standards of excellence.

Safehouse members have signed a code of conduct that commits them to dealing only in safe electrical products and to responsible behaviour.

If you have doubts about a particular product or service, contact Safehouse for guidance.

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