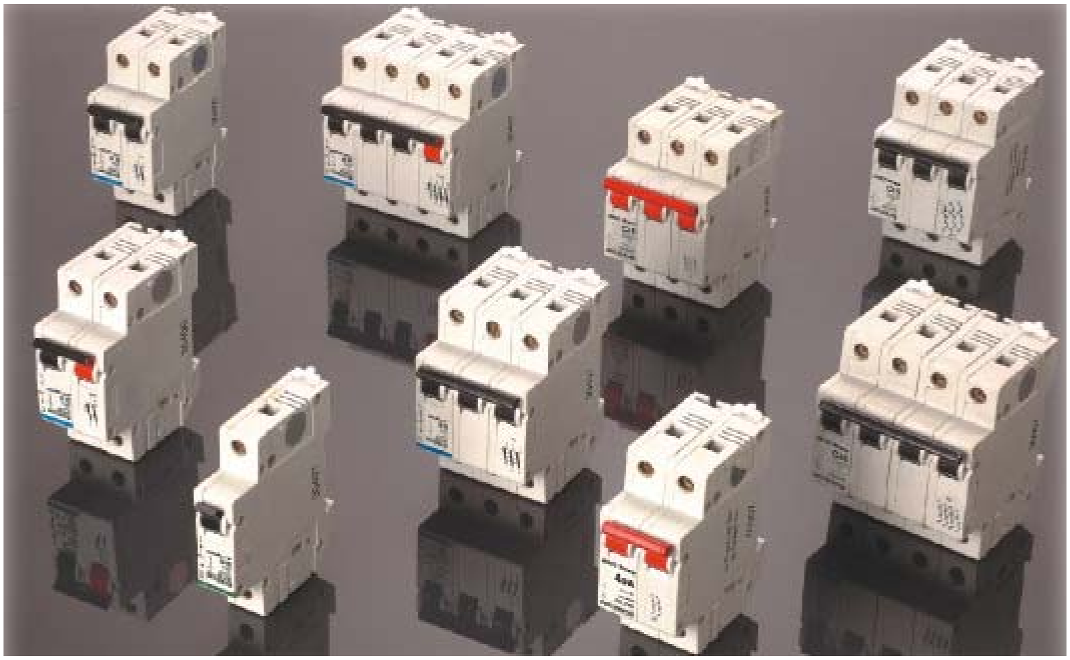
MCB: Miniature circuit breaker



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١-Introduction - (MCB)

A MCB is a mechanical switching device which is capable of making, carrying and breaking currents under normal circuit conditions and also making, carrying for a specified time and automatically breaking currents under specified abnormal circuit conditions such as those of short circuit. In short, MCB is a device for overload and short circuitprotection. They are used in residential & commercial areas. Just like we spend time to make a thorough check before buying appliances like washing machines or refrigerators, we must also research about MCBs

٢- MCB Components

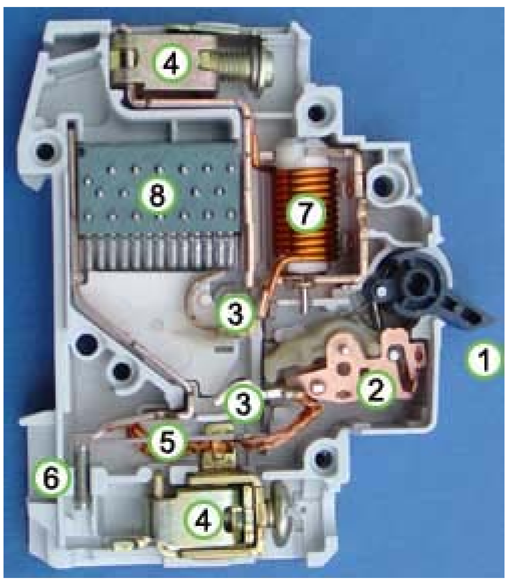


Photo of inside of a circuit breaker

Actuator lever - used to manually trip and reset the circuit breaker. Also indicates the status of the circuit breaker (On or Off/tripped). Most breakers are designed so they can still trip even if the lever is held or locked in the "on" position. This is sometimes referred to as "free trip" or "positive trip" operation.

١. **Actuator mechanism** - forces the contacts together or apart.
٢. **Contacts** - Allow current when touching and break the current when moved apart.
٣. **Terminals**
٤. **Bimetallic strip.**
٥. **Calibration screw** - allows the manufacturer to precisely adjust the trip current of the device after assembly.
٦. **Solenoid**
٧. **Arc divider/extinguishe**

٣- Trip types:

٣.١- *Overload*

A slow and small overcurrent situation that causes the ampacity and temperature of the circuit to gradually increase over time. This type of event is characterized by a slight increase in the load (ampacity) on the circuit and is interrupted by the thermal trip unit of the breaker.

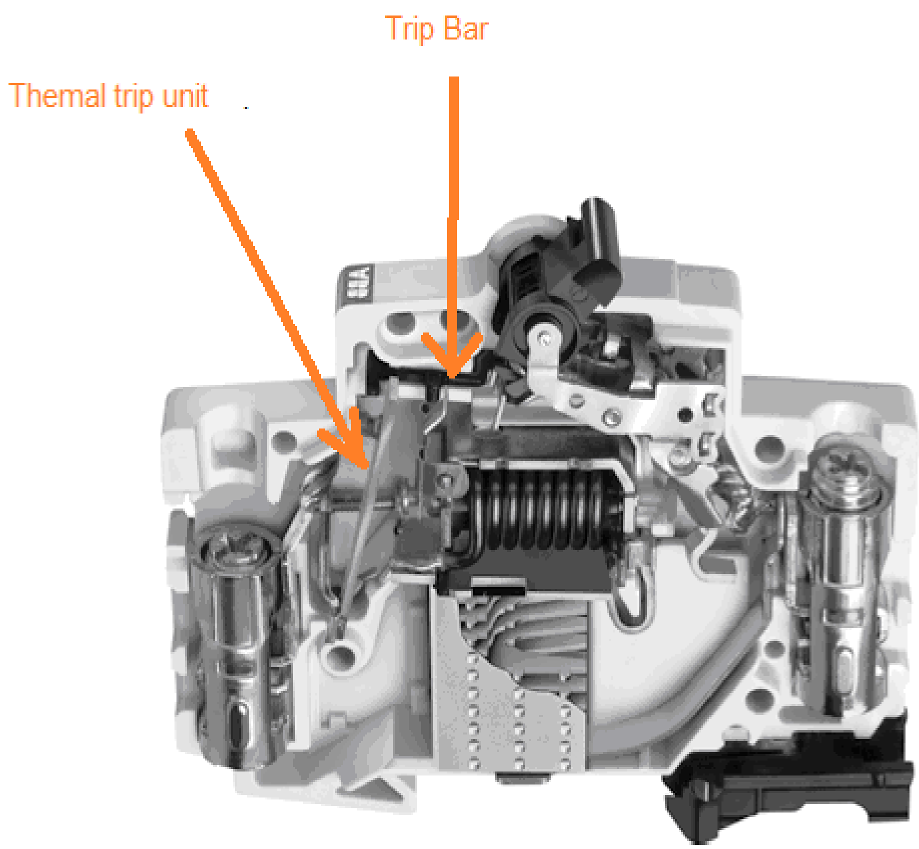
Thermal trip units definition:

an electromechanical (Thermal Magnetic) trip unit to open the breaker contacts during a overcurrent event. The thermal trip unit is temperature sensitive and the magnetic trip unit is current sensitive. Both units act independently and mechanically with the breaker's trip mechanism to open the breaker's contacts.

<u>Overload protection</u>

The thermal trip unit protects against a continuous overload. The thermal unit is comprised of a bimetal element located behind the
circuit breaker trip bar and is part of the breaker's current carrying path When there is an overload, the increased current flow heats the bimetal causing it to bend. As the bimetal bends it pulls the trip bar which opens the breaker's contacts

The time required for the bimetal to bend and trip the breaker varies inversely with the current. Because of this, the tripping time becomes quicker as current increases in magnitude.
Overload protection is applicable to any installation, conductor, or component which can be subjected to low-magnitude but long time over-currents. Low-magnitude, long-time over-currents can be dangerous because they reduce the life of the electrical installation conductor, and components and if left unchecked could result in fire .



Components of Overload protection

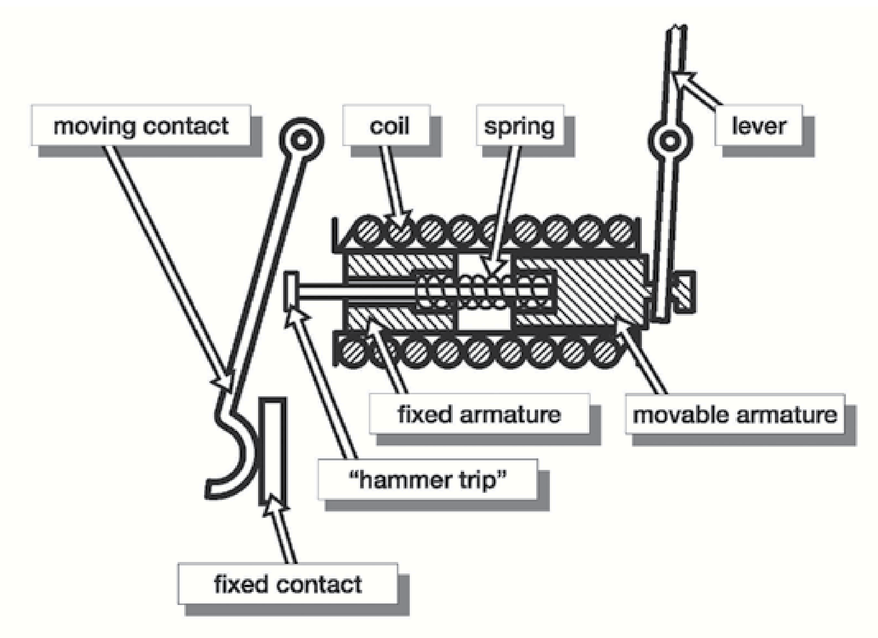
٣. ٢- *Short circuit*

A rapid and intense overcurrent situation that causes the ampacity of the circuit to increase. This type of event is characterized by a dramatic increase in the load (ampacity) on the circuit and is interrupted by the magnetic trip unit of the breaker.

short circuit protection (Magnetic trip units):

The Magnetic trip unit protects against a short circuit. The magnetic trip unit is comprised of an electromagnet and an armature.

When there is a short circuit, a high magnitude of current passes through the coils creating a magnetic field that attracts the movable armature towards the fixed armature. The hammer trip is pushed against the movable contact and the contacts are opened. The opening of the breakers contacts during a short circuit is complete in .٥ milli-seconds



Components of a magnetic trip unit

٤-APPLICATIONS:

B Type MCB

- For protection of Resistive loads such as bulbs, heaters etc ,generally suitable for domestic applications. They may also be used in light commercial applications.

C type MCB

- For protection of Inductive loads such as motors, air conditioners etc devices are the normal choice for commercial and industrial applications.

D type MCB

- For protection of Cables and highly inductive loads which have high starting current such as examples include large battery charging systems, winding motors, transformers, X-ray machines and some types of discharge lighting.

٥-Selecting the right MCB :

The decision to use Type B, C or D miniature circuit-breakers for final circuit protection in residential, commercial, industrial or public buildings can be based on a few simple rules. However, an understanding of the differences between these Types of device can help the installer overcome problems of unwanted tripping or make a suitable selection where lines of demarcation are less clearly defined.

It should be stressed that the primary purpose of circuit protection devices such as miniature circuit breakers and fuses is to protect the cable downstream of the device

Basic applications:

The essential distinction between Type B, C or D devices is based on their ability to handle surge currents without tripping. These are, typically, inrush currents associated with fluorescent and other forms of discharge lighting, induction motors, battery charging equipment etc.

- The classification of Types B, C or D is based on the fault current rating at which magnetic operation occurs to provide short time protection (typically less than ١٠٠ms) against short-circuits. It is important that equipment having high inrush currents should not cause the circuit-breaker to trip unnecessarily, and yet the device should trip in the event of a short-circuit current that could damage the circuit cables.

- ***Type B*** devices are designed to trip at fault currents of ٣-٥ times rated current (In). For example a ١٠A device will trip at ٣٠-٥٠A.
- ***Type C*** devices are designed to trip at ٥-١٠ times In (٥٠-١٠٠A for a ١٠A device).
- ***Type D*** devices are designed to trip at ١٠-٢٠ times In (١٠٠-٢٠٠A for a ١٠A device).

Normal cable ratings relate to continuous service under specified installation conditions. Cables will, of course, carry higher currents for a short time without suffering permanent damage. Type B and C circuit breakers can generally be selected to achieve tripping times that will protect the circuit conductors against normal surge currents in accordance with BS ٧٦٧١. This is more difficult to achieve with Type D devices, which may require a lower earth loop impedance (Zs) to achieve the operating times required by Regulation ٤١٣-٠٢-٠٨.

Sources of surge currents:

Surge currents in domestic installations are generally low, so that a Type B device is adequate. For example inrush currents associated with one or two fluorescent fittings, or the compressor motor in a refrigerator/freezer are unlikely to cause unwanted tripping.

٦-Overcoming unwanted tripping:

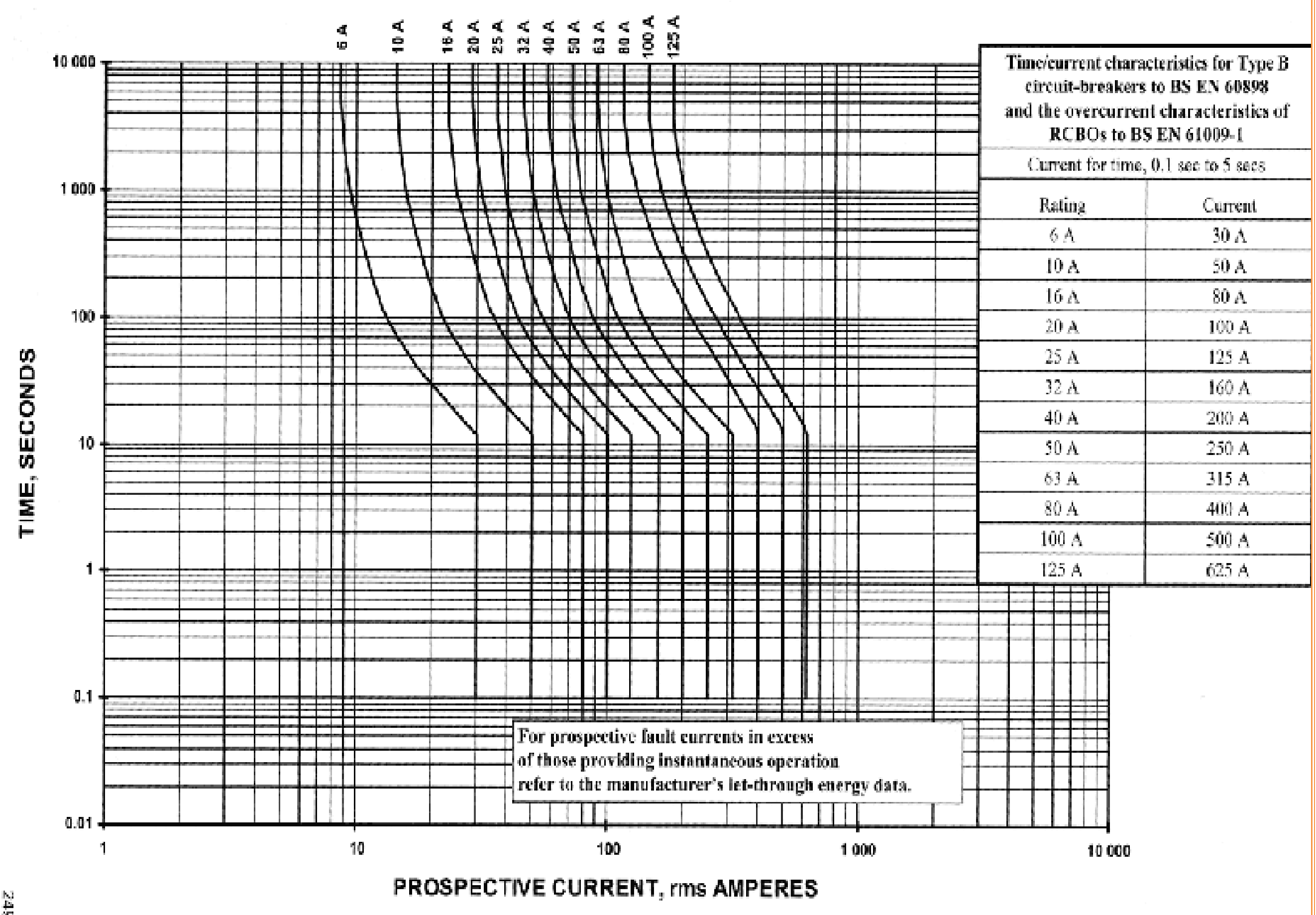
Sometimes failure of tungsten filament lamps can trip Type B circuit-breakers in domestic and retail environments. This is caused by high arcing currents occurring at the time of failure and is generally associated with inferior quality lamps. If possible the user should be encouraged to use better quality lamps. If the problem persists then one of the measures listed below should be considered.

A Type C device may be substituted for a Type B device where unwanted tripping persists, especially in commercial applications. Alternatively it may be possible to use a higher rated Type B MCB, say ١٠A rather than ٦A. Whichever solution is adopted, the installation must be in accordance with BS ٧٦٧١.

A change from Type C to Type D devices should only be taken after careful consideration of the installation conditions, in particular the operating times required by Regulation ٤١٣-٠٢-٠٨.

٧- *Type B chart curve*

Fig 3.4 Type B circuit-breakers to BS EN 60898 and RCBOs to BS EN 61009-1



Time/current characteristics for Type B circuit-breakers to BS EN 60898 and the overcurrent characteristics of RCBOs to BS EN 61009-1

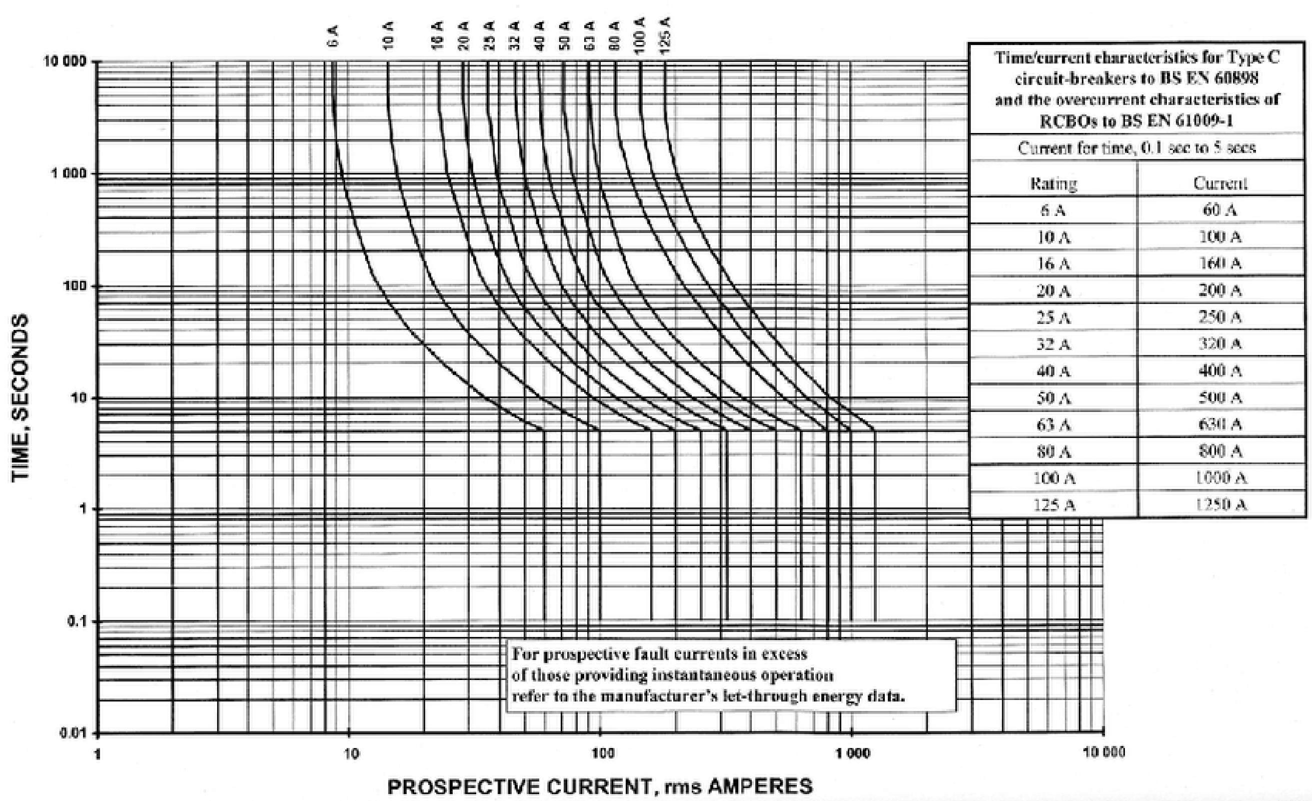
Current for time, 0.1 sec to 5 secs

Rating	Current
6 A	30 A
10 A	50 A
16 A	80 A
20 A	100 A
25 A	125 A
32 A	160 A
40 A	200 A
50 A	250 A
63 A	315 A
80 A	400 A
100 A	500 A
125 A	625 A

Type B Curve

٨- *Type C chart curve*

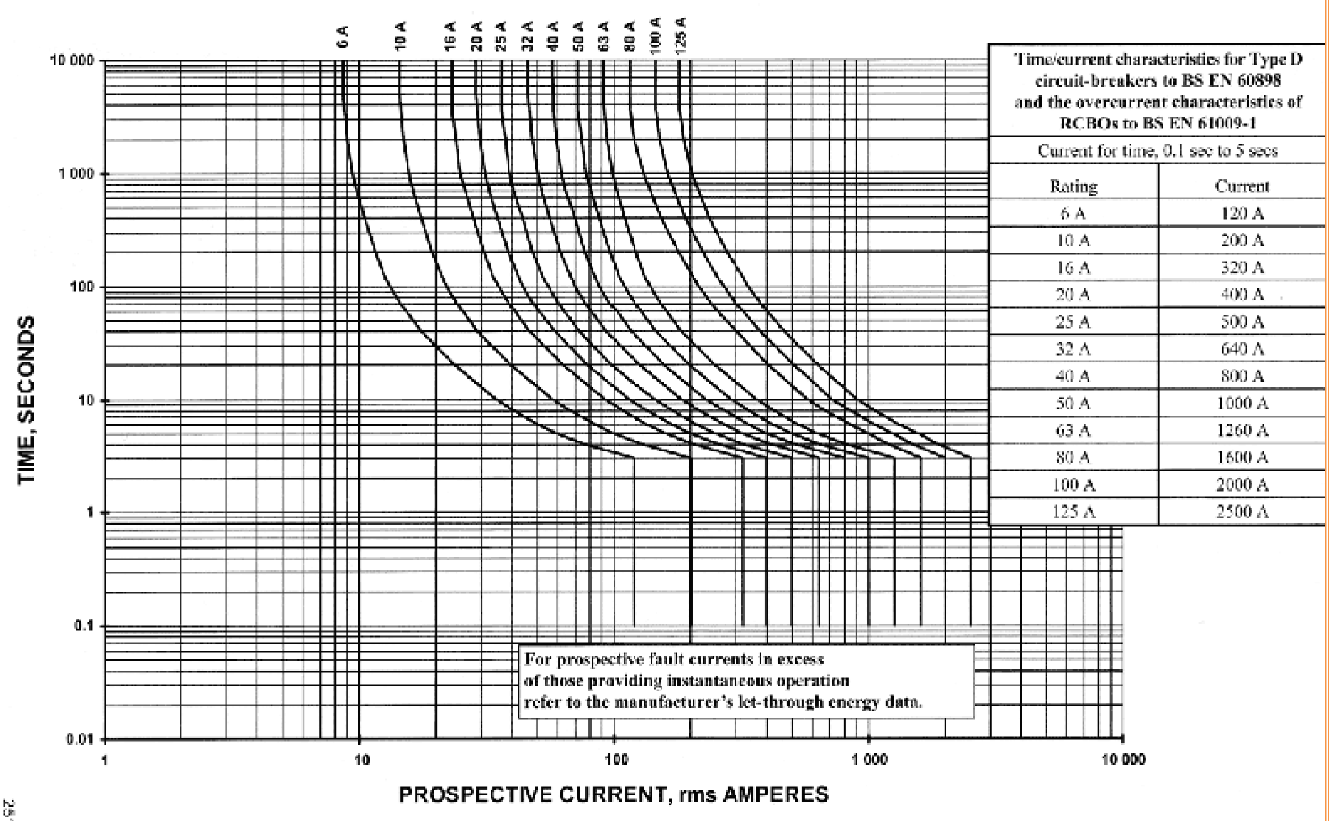
Fig 3.5 Type C circuit-breakers to BS EN 60898 and RCBOs to BS EN 61009-1



Type C Curve

٩- *Type D chart curve*

Fig 3.6 Type D circuit-breakers to BS EN 60898 and RCBOs to BS EN 61009-1



Type D Curve

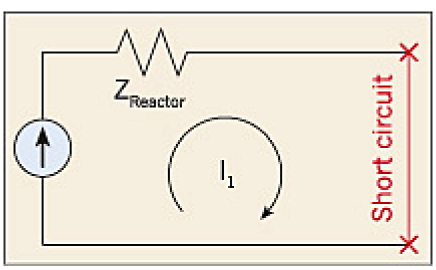
١٠- MCB Selection table

Appliances	Capacity / Approx Wattage at ٢٤٠V AC single phase	Current Rating of MCB (Amps)	Type of MCB
Air-conditioners	i) ٠.٥ Ton ٧٧٥W	٥	C
	ii) ٠.٧٥ Ton upto ١٢٠٠W	٧.٥	C
	iii) ١ Ton upto ١.٥kW	١٠	C
	iv) ١.٥ Ton upto ٢.٥kW	١٦	C
	v) ٢ Ton split unit upto ٣.٥kW	٢٠	C
Refrigerator	i)١٦٥ Ltrs.	١.٥	C
	ii) ٢٨٥ Ltrs.	٢	C
	iii) ٤٠٠ Ltrs.	٣	C
	iv) ٥٨١ Ltrs.	٥	C
Washing Machine	i) ٣٠٠ Watts	٢	C
	ii) ١٣٠٠ Watts (with heater)	٧.٥	C
	iii) ١٨٠٠ Watts (with heater)	١٠	C
	iv) ٢٢٠٠ Watts (with heater)	١٦	C
Domestic Pump Set	i) ٠.٥ H.P.	٦	C
	ii) ١ H.P.	١٠	C
	iii) ٢ H.P.	١٦	C
Water Heater	i) ١ kW	٦	B
(Storage or instantaneous Geysers)	ii) ٢ kW	١٠	B
	iii) ٣ kW	١٦	B
	iv) ٦ kW	٣٢	B
Cooking Range	٤٥٠٠ Watts	٢٥	B
Oven cum Griller	١٧٥٠ Watts	١٠	B
Oven only	٧٥٠ Watts	٦	B
Hot Plate only	٢٠٠٠ Watts	١٠	B
Microwave Oven	١٠٠٠ Watts	٦	C
Electric Kettle	١٥٠٠ Watts	١٠	B
Room Heater	i) ١٠٠٠ Watts	٦	B
	ii) ٢٠٠٠ Watts	١٠	B
Iron	i) ٧٥٠ Watts	٥	B
	ii) ١٢٥٠ Watts	٧.٥	B
Auto Toaster (٢ slices)	١٢٠٠ Watts	٨	B

١١- *Short-Circuit Calculations: The Easy Way*

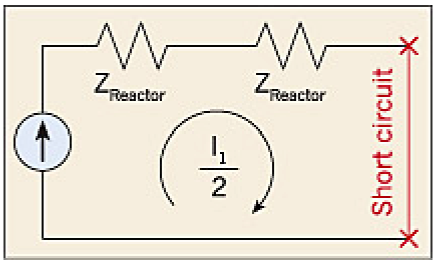
Short-circuit currents represent a tremendous amount of destructive energy, which can be released through electrical systems under fault conditions. Baseline short-circuit studies should be performed when the facility electrical system is first designed, and then updated when a major modification or renovation takes place — but no less frequently than every five years. Major changes would be considered a change in feed by the electric utility, a change in the primary or secondary system configuration within the facility, a change in transformer size or impedance, a change in conductor lengths or sizes, or a change in the motors that are energized by the system.

Every electrical system confines electrical current flow to selected paths by surrounding the conductors with insulators of various types. Short-circuit current is the flow of electrical energy that results when the insulation barrier fails and allows current to flow in a shorter path than the intended circuit.



In normal operations, as shown in Fig. ١, the impedance of the electrical load limits the current flow to relatively small values. However, a short-circuit path bypasses the normal current-limiting load impedance, resulting in excessively high current values that are restricted only by limitations of the power system itself, and by the impedances of the conductive elements that still remain in the path between the power source and the short-circuit point (Fig. ٢).

Using basic Ohm's Law ($E = I \times Z$ or $I = E \div Z$) as a guide, it's obvious that if the voltage remains constant and the impedance suddenly decreases, approaching zero, then the current must simultaneously increase, approaching infinity, to satisfy Ohm's Law.



There are three basic sources of short-circuit current: the electric utility, motors, and on-site generators. Obviously, the largest source is the electric utility, although the high- and medium-voltage lines leading to the facility do have finite impedances, as does the utility service transformer. The second largest source is from motors within a facility.

With today's high fault currents, it's more important than ever to protect electrical equipment from extremely high current levels. Otherwise, the equipment will explode as it attempts to interrupt the fault. But for many, fault current calculations have always been difficult to get a handle on, until now.

Here's a new method to calculate short-circuit currents, one we like to call the “Easy Way kVA Method.” You can use in it in place of the abstract “per-unit” method of short-circuit calculations from the past. With the kVA method, you can easily visualize what currents will flow and where they will flow, and you can calculate them using an inexpensive handheld calculator in moments, regardless of the complexity of the electrical power system.

This method is simple because there are no awkward “base” changes to make, because kVAs are the same on both the primary and secondary sides of every transformer. Best of all, you only need one calculation to determine the short-circuit values at every point within the entire electrical power system. With the old per-unit method, you needed a separate calculation for each point in the system.

You can obtain short-circuit kVA values from your electrical utility company, but short-circuit power is also protected by generators and motors. The kVA produced by a motor is equal to its starting inrush current. Likewise, the kVA produced by a generator is equal to its kVA nameplate rating divided by its nameplate subtransient reactance rating (Xd).

For example, suppose we have a ١,٠٠٠kVA generator with a subtransient rating of ٠.١٥. It would instantaneously produce ٦,٦٦٧kVA (١,٠٠٠ ÷ ٠.١٥). Or, suppose we have a ١٠٠-hp motor with subtransient rating of ٠.١٧. It would instantaneously produce ٥٨٨kVA (١٠٠ ÷ ٠.١٧).

Now suppose this motor and generator connects to the same bus. Then, the short-circuit power available at that bus is the sum ٦,٦٦٧kVA plus ٥٨٨kVA, or ٧,٢٥٥kVA. If the electrical utility is rated to deliver ١٠٠,٠٠٠kVA to this same bus, then the total short-circuit power available at that bus is ١٠٧,٢٥٥kVA.

Using the kVA method also greatly simplifies the calculation of short-circuit power attenuation (or holdback) provided by reactors, transformers, and conductors. For example, a ٢,٠٠٠kVA, ٧% impedance transformer will pass through its windings a maximum of ٢٨,٥٧١kVA of power (٢,٠٠٠ ÷ ٠.٠٧), if infinite power flows to one side of its windings. If instead of an infinite current source, the above bus connects to this transformer, then the amount of power that will be "let through" the transformer is the reciprocal of the sum of the reciprocals of the two, or ١ ÷ ([١ ÷١٠٧,٢٥٤] + [١ ÷ ٢٨,٥٧١]), or ٢٢,٥٦١kVA. You can determine transformer impedance, reactor impedance, or cable size with the kVA method quickly enough to make "what-if" calculations.

Comparisons over several years have found results of the kVA method to be accurate within ٣% of computer calculations using expensive software, so you can even use the kVA method as a "check" on the input and output of a computer calculation. This is an excellent benefit because standard engineering procedure requires you to check calculations using a different method from the one originally use

١٢- Abstract

The aims of this document are:

١- Showing some topics on MCB operations mechanism, applications & how many types exists according to handling surge current without tripping.
٢- Help the user to select right MCB according to nature of the installed devises load.

٣- Short circuit calculation in easy way to predicting short circuit current.

Abbreviation:

Ampacity : *ampere capacity* defined by National Electrical Safety Codes, in some North American countries. **Ampacity** is defined as the maximum amount of electrical current a conductor or device can carry before sustaining immediate or progressive deterioration. Also described as **current rating** or **current-carrying capacity**, ampacity is the RMS electric current which a device or conductor can continuously carry while remaining within its temperature rating.

The ampacity of a conductor depends on:

- its insulation temperature rating;
- the electrical resistance of the conductor material;
- frequency of the current, in the case of alternating current;
- ability to dissipate heat, which depends on conductor geometry and its surroundings;
- ambient temperature.

BS ٧٦٧١ : British Standard BS ٧٦٧١ "Requirements for electrical installations" is the national standard in the United Kingdom.

References: through internet