

2.4 Miniature Circuit Breaker

A Miniature Circuit Breaker (MCB) is an automatically operated electrical switch used to protect low voltage electrical circuits from damage caused by excess current from an overload or short circuit. MCBs are typically rated up to a current up to 125 A, do not have adjustable trip characteristics, and can be thermal or thermal-magnetic in operation.

Fuse vs MCB

Nowadays miniature circuit breakers (MCBs) are much more commonly used in low voltage electrical networks instead of fuses. The **MCB** has many advantages compared to a fuse:

1. It automatically switches off the electrical circuit during the abnormal conditions of the network (both overload and fault conditions). The MCB is much more reliable in the detection of such conditions, as it is more sensitive to change in current.
2. As the switch operating knob comes at its off position during tripping, the faulty zone of the electrical circuit can easily be identified. But in case of a fuse, the fuse wire should be checked by opening fuse grip or cut out from fuse base, for confirming the blow of fuse wire. Thus, is it much detect if an MCB has been operated compared to a fuse.
3. Quick restoration of supply cannot be possible in case of fuse, as fuses have to be rewirable or replaced for restoring the supply. But in the case of an MCB, quick restoration is possible by (literally) flipping a switch.
4. The handling of an MCB is more electrically safe than a fuse.
5. MCBs can be controlled remotely, whereas fuses cannot.

Because of these many advantages of MCB over fuse units, in modern low voltage electrical network, the miniature circuit breaker is almost always used instead of a fuse,

The only one disadvantage of MCB over fuse is that this system is costlier than a fuse unit system.

Working Principle Miniature Circuit Breaker

There is two arrangement of operation of a miniature circuit breaker. One due to the thermal effect of over current and other due to electromagnetic effect of over current. The thermal operation of the miniature circuit breaker is achieved with a bimetallic strip whenever continuous overcurrent flows through MCB, the bimetallic strip is heated and deflects by bending.

This deflection of the bimetallic strip releases a mechanical latch. As this mechanical latch is attached to the operating mechanism, it causes to open the miniature circuit breaker contacts.

But during short circuit conditions, the sudden rising of current causes electromechanical displacement of plunger associated with tripping coil or solenoid of MCB. The plunger strikes the trip lever causing the immediate release of the latch mechanism consequently open the circuit breaker contacts. This was a simple explanation of the miniature circuit breaker working principle.

Miniature Circuit Breaker Construction

Miniature circuit breaker construction is very simple, robust and maintenance-free. Generally, an MCB is not repaired or maintained, it just replaced by a new one when required. A miniature circuit breaker has normally three main constructional parts.

The operating mechanism of a miniature circuit breaker provides the means of manual opening and closing operation of a miniature circuit breaker. It has three-positions “ON,” “OFF,” and “TRIPPED”. The external switching latch can be in the “TRIPPED” position if the MCB is tripped due to over-current.

When manually switch off the MCB, the switching latch will be in the “OFF” position. In the closed condition of an MCB, the switch is positioned at “ON”. By observing the positions of the switching latch one can determine the condition of MCB whether it is closed, tripped or manually switched off.

Trip Unit of Miniature Circuit Breaker

The trip unit is the main part, responsible for the proper working of the miniature circuit breaker. Two main types of trip mechanisms are provided in MCB. A bimetal provides protection against overload current and an electromagnet provides protection against short-circuit current.

Operation of Miniature Circuit Breaker

There are three mechanisms provided in a single miniature circuit breaker to make it switched off. If we carefully observe the picture besides, we will find there is mainly one bimetallic strip, one trip coil and one-hand operated on-off lever. The electric current-carrying path of a miniature circuit breaker shown in the picture is as follows. First left-hand side power terminal – then bimetallic strip – then-current coil or trip coil – then moving contact – then fixed contact and – lastly right hand side power terminal. All are arranged in series.

If the circuit is overloaded for a long time, the bimetallic strip becomes overheated and deformed. This deformation of bimetallic strip causes, displacement of latch point. The moving contact of the MCB is so arranged by means of spring pressure, with this latch point, that a little displacement of latch causes, release of spring and makes the moving contact to move for opening the MCB.

The current coil or trip coil is placed in such a manner, that during short circuit fault the MMF of that coil causes its plunger to hit the same latch point and make the latch to be displaced. Hence the MCB will open in the same manner.

Again, when the operating lever of the miniature circuit breaker is operated by hand, that means when we make the MCB at off position manually, the same latch point is displaced as a result moving contact separated from fixed contact in the same manner.

Regardless of the operating mechanism – e.g. due to the deformation of the bimetallic strip, or due to the increased MMF of the trip coil, or due to manual operation – the same latch point is displaced and same deformed spring is released. This is ultimately responsible for the movement of the moving contact. When the moving contact separated from fixed contact, there may be a high chance of arc.

This arc then goes up through the arc runner and enters into arc splitters and is finally quenched. When we switch on an MCB, we actually reset the displaced operating latch to its previous on position and make the MCB ready for another switch off or trip operation.

