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GOVERNMENT OF INDIA
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Pamphlet

MOTOR PROTECTION CIRCUIT BREAKER (MPCB)

CAMTECH/E/2023-24/EP-04/MPCB/1.0



DECEMBER
2023

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GENERAL SERVICE MAINTENANCE
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MOTOR PROTECTION CIRCUIT BREAKER (MPCB)

MPCB is the electromechanical protection device, which is specially designed for the protection and operating purposes of Electrical motors.

MPCB is called as a specially designed protective device because it has relay mechanism and an optional provision for contactor.



FUCTIONS & FEATURES

The main function of MPCB is, it will trip when the motor draws current exceeding the set limit.
The Motor may draw the excessive current due to

- Line to Line faults
- Overload faults/ Conditions
- Phase failure/ missing (Phase Unbalance)

MPCB deals with the above faults and provide the protections by combination of two protection system i.e. thermal relay for overload & phase unbalance and magnetic release (coil) for short circuit faults.

MPCB has two different current ratings one for thermal overload and another for short circuit overcurrent.

The response time of thermal overload protection is slower in comparison to magnetic protection so that thermal protection mechanism can allow a short duration overcurrent, which is a normal part of the operation in electric motors driven equipment. Electric motors often draw between five to eight times their rated current during initial start-up, but only for a few seconds.

Note

MPCBs typically have an adjustable dial on the front side that allows the user to define and set the trip current in direct amps or as a percentage of the full-load rating but there is no adjustable dial that allows the user to adjust or set the short circuit current rating.

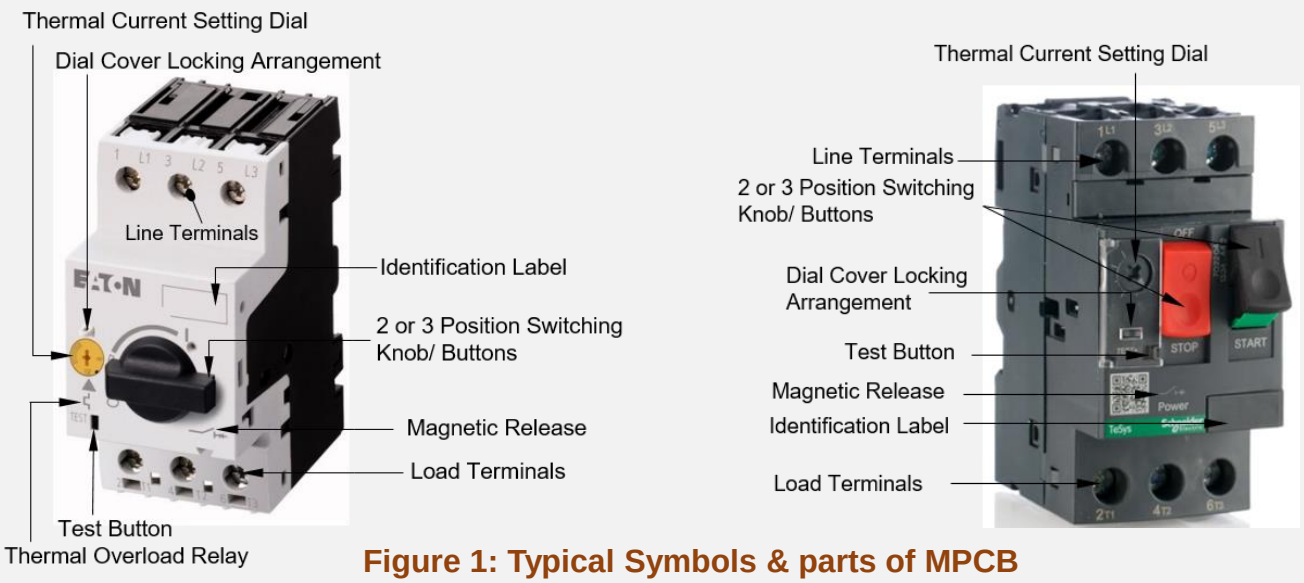


Figure 1: Typical Symbols & parts of MPCB

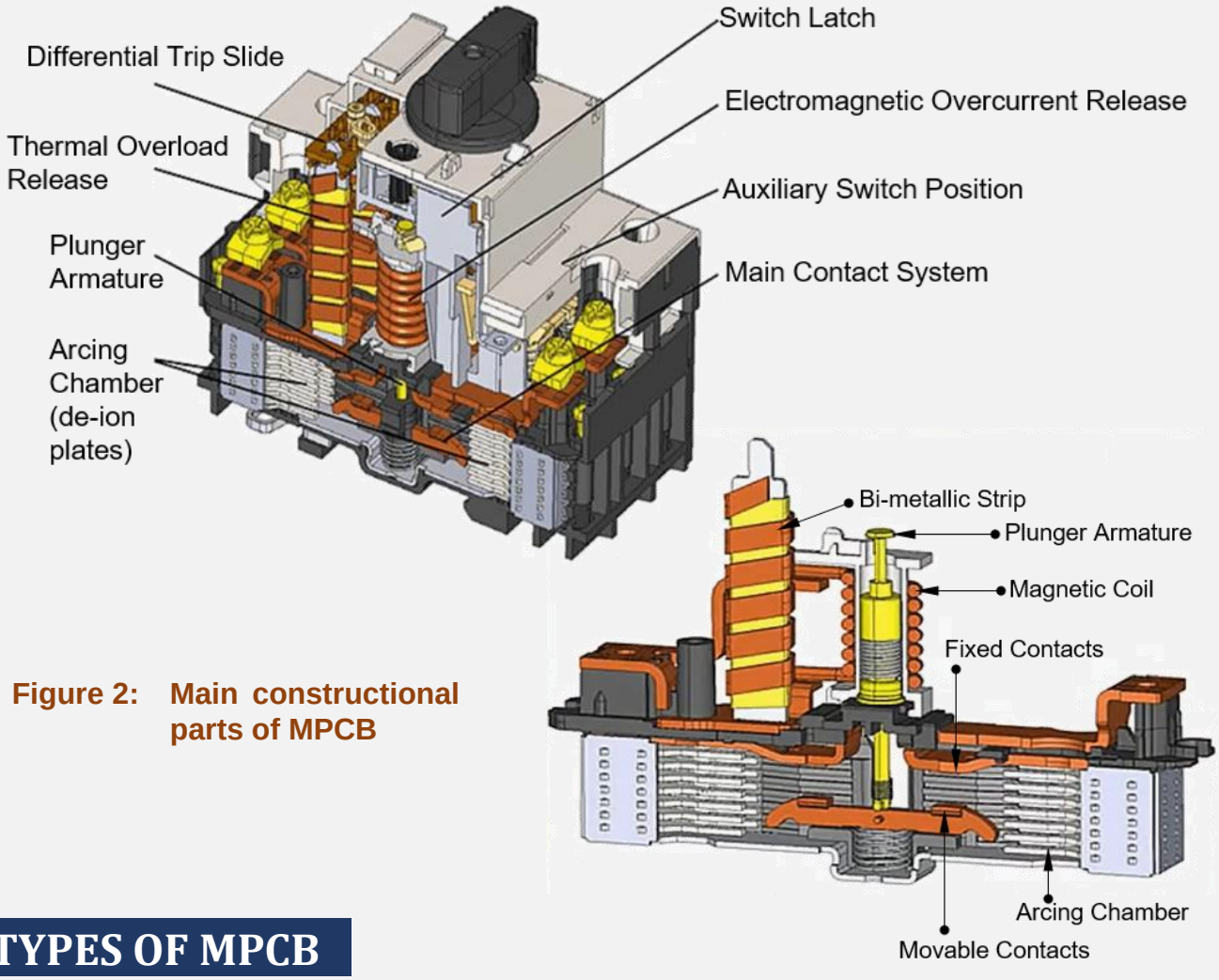


Figure 2: Main constructional parts of MPCB

TYPES OF MPCB

According to Knob

- Rotary type
- Rocker type

According to protection devices

- Thermal and Magnetic protection
- Magnetic protection without Thermal protection

TYPICAL INTERNAL OPERATING MECHANISM

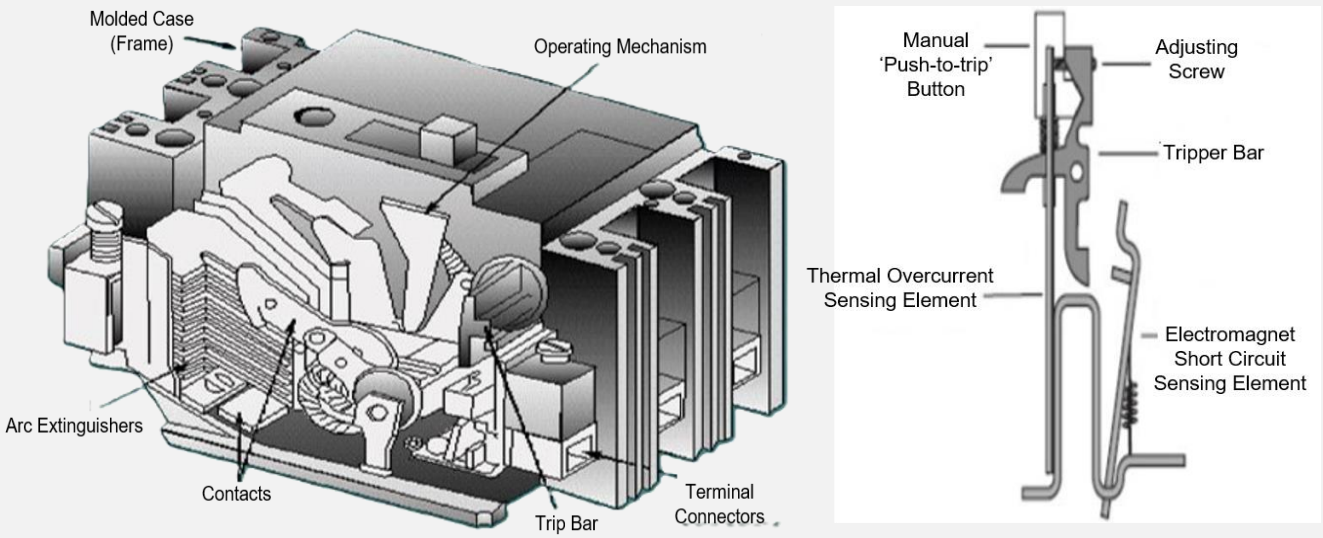


Figure 3: Typical circuit breaker operating mechanism

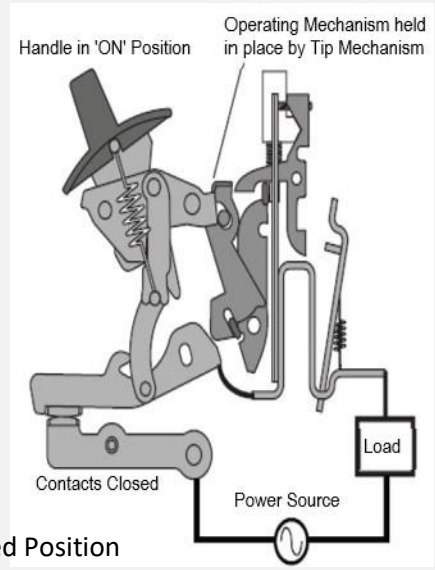


Figure 4: Typical circuit breaker mechanism in (a) Closed Position, (b) Open position

WORKING PRINCIPLE OF MPCB

Under normal condition, MPCB does not trip the circuit. It is a combination of circuit breaker and overload relay. Therefore, MPCB functions in two following ways:

Thermal overload tripping

Each conductor has some resistance and as the current passes through that conductor causes some power loss in terms of heat. The heat produced in the conductor is directly proportional to the value of the current.

$$h = i^2Rt$$

Hence, the bimetallic strip made of two dissimilar metal is designed to bend at the particular value of the current.

Under normal conduction, the strip releases a small amount of heat and it bends slightly.

In case of motor drawing the higher current than the rating and there is no line to line or line to earth fault, the strip bends higher and touches the tripping mechanism and cut off the supply to motor.

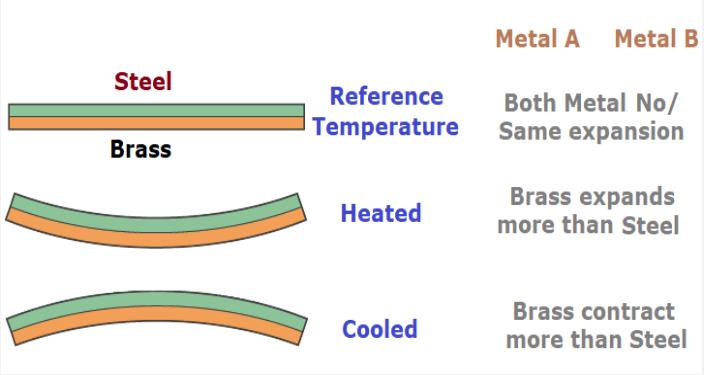


Figure 5: Bimetallic Strip bending action with change in temperature

Short circuit/ Magnetic release tripping

The short circuit fault will be cleared by the magnetic trip.

Magnetic release interrupts on the occurrence of short circuit fault, which flow current having much higher magnitudes than an overload.

Tripping due to Magnetic release is based on induction onto a coil inside the MPCB that produces a strong magnetic field when there is a short circuit fault current. This results in an immediate tripping of the internal contacts.

Unbalance & Phase loss protection

Note that, the MPCB's unbalance protection does not work immediately, it is depending upon the current level. It is a very simple concept that while decreasing the voltage the current will increase.

MPCB CIRCUIT & ITS CONNECTION DIAGRAM WITH MOTOR

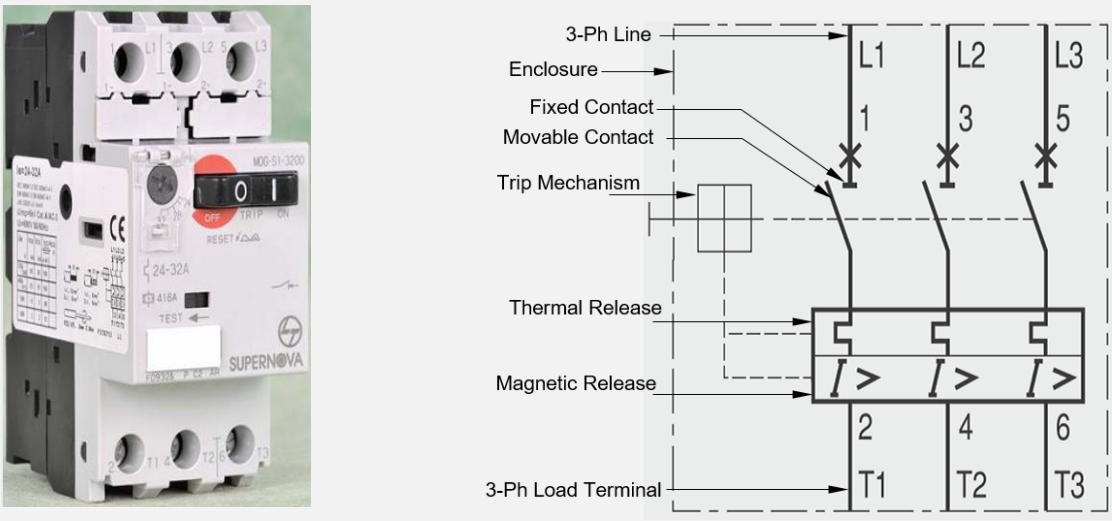


Figure 6: Representation of circuit of MPCB

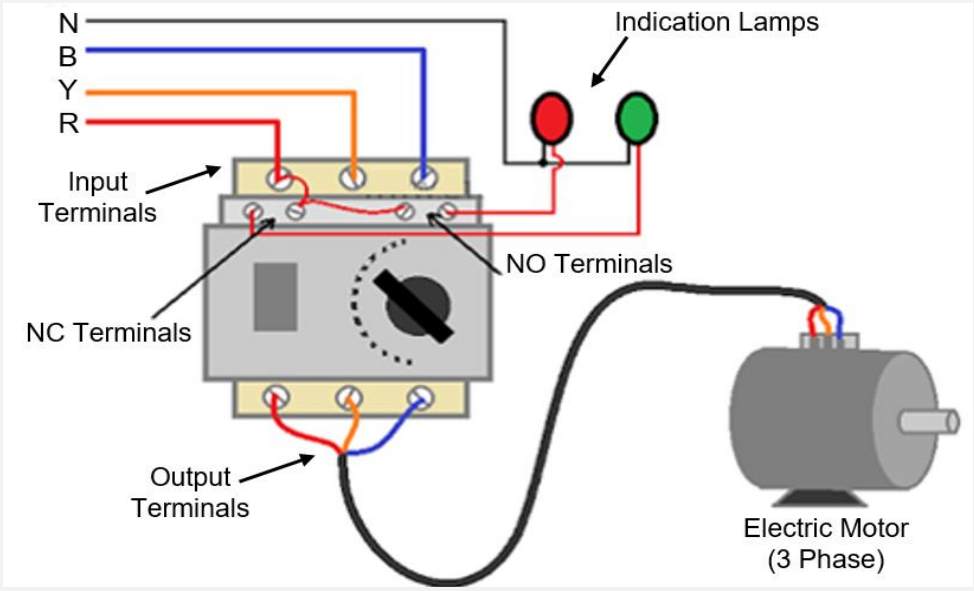


Figure 7: Connection diagram of MPCB with 3-ph motor & Supply Without Contactor

Note: In the figure shown above, the NO & NC terminals/ Contacts are given as an optional item only for indication lamp, which gives the status of MPCB only.
For controlling the MPCB from other location a contactor to be provided along with MPCB.



Figure 8: 3 Phase MPCB Connection with Single Phase Motor

PROTECTION SCHEME OF MOTOR

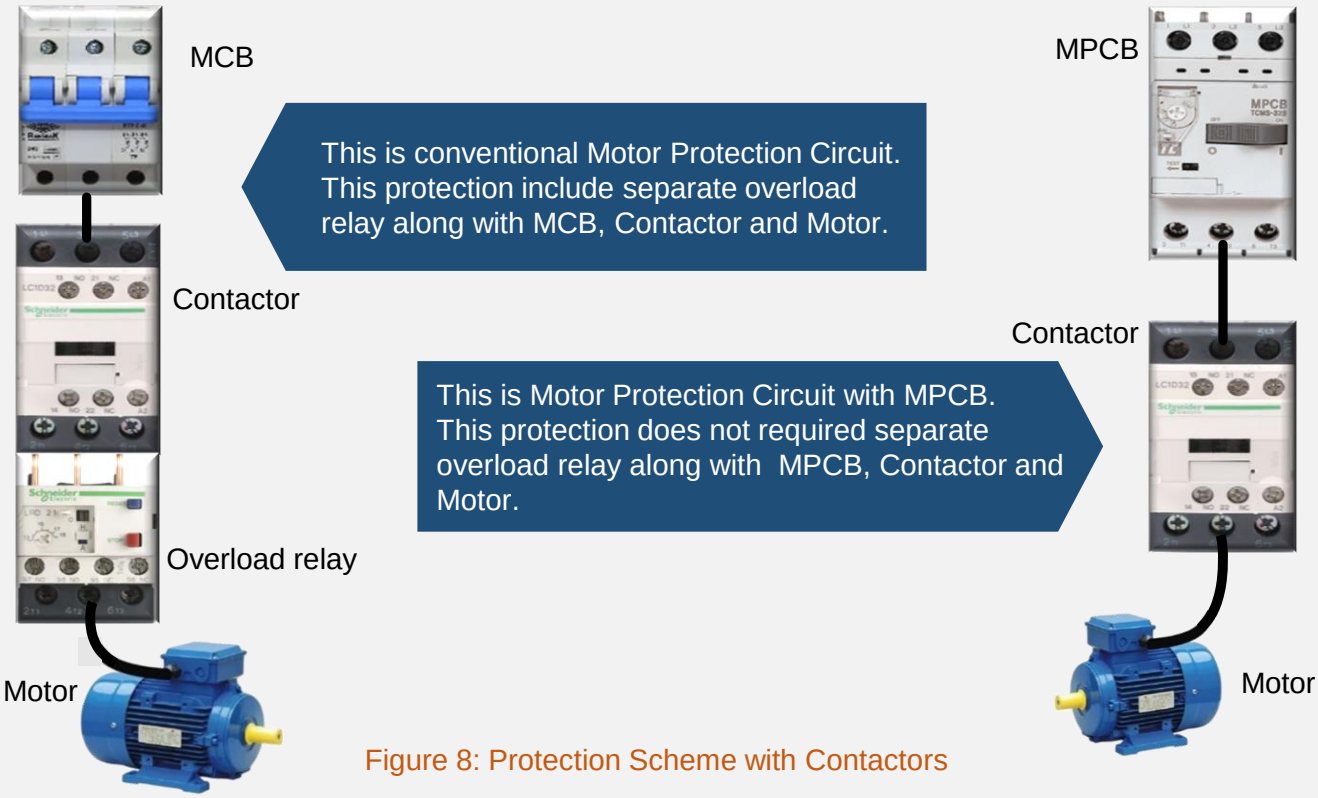


Figure 8: Protection Scheme with Contactors

TIME - CURRENT CHARACTERISTICS

Thermal Overload Relays have a hot and a cold state.

Cold State: Motor has been off for a period equal to or greater than its cooling time constant, which is different for every motor.

Hot State : Motor has been running for a period.

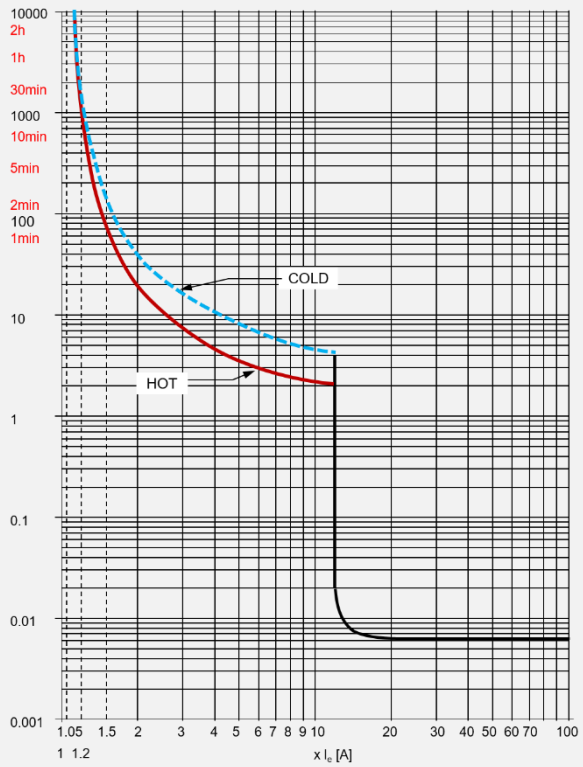


Figure 9: Typical I-T characteristic of MPCB (Three Phase Balanced Operation)

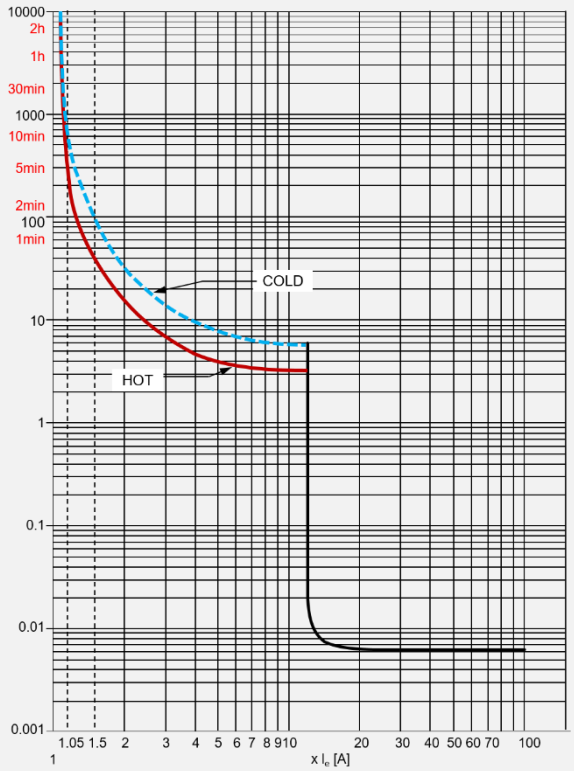


Figure 10: Typical I-T characteristic of MPCB [Two-phase operation (phase failure/single phasing)]

Note: Tripping times can have a deviation with respect to the average tripping curve value above & depends upon product to product.

SELECTION CRITERIA

Step 01 Check the motor's full load current from the nameplate rating of the motor.

Step 02 Calculate the short-circuit current of the circuit and verify that it should be within the short circuit current range of MPCB.

Step 03 Select the operating characteristics of MPCB (Thermal Overload + Magnetic Release/ Magnetic Release only)

Step 04 Selection of MPCB rating should be such that motor full load current should fall within the range of thermal current rating of MPCB.

Step 05 Check the Load & Make the connections accordingly. (For applications in a single-phase circuit, connect the 3-pole in series)

USAGE

MPCB is specially designed for motor protection because in around us the motor are used a lot off just like as domestic and industrial such as:

AHU (Air Handling Unit), Air Compressors, Lift Motors, Elevators, cranes, escalators, Exhaust Motors etc.

PROS & CONS

Table 1: Pros and Cons of MPCB

PROS	CONS
Adjustable thermal current limit	Costly
Does not trip on the starting inrush currents of motor	Unrepairable
No need of separate Overload protection relay with motor	Un-adjustable Short circuit current limit
Compact in size/ Less space required	Separate earth fault/ leakage protection device required
Reduced wiring work	--
Combination of two protection (thermal relay & magnetic release) in one unit	--
Inbuilt contactor (Optional)	--
Automatic reconnect feature (Optional)	--

DIFFERENCE BETWEEN MPCB AND MCCB/ MCB

Basis of Difference	MPCB	MCCB/ MCB
Used for	MPCB is used to manually turn ON/ OFF an electric motor and to provide protection to the motor in case of fault.	MCCB/ MCB is used for switching and protection of distribution circuits and electric motors.
Design purpose	MPCB is mainly designed to protect an electric motor from faults.	MCCB/ MCB is a designed to provide protection to the general purpose circuits such as wiring systems, distribution systems, etc.
Protection provided	MPCB provides protection to the electric motors against short circuit current, overload current, phase unbalance and phase loss.	MCCB/ MCB protects the circuit or motor against overload and short circuit currents only.
Selection criteria	MPCB is selected based on the full-load current of the motor and the maximum possible value of short circuit current.	MCCB/ MCB is selected on basis of maximum load current and maximum short circuit current that it must interrupt safely.
Function in motor circuit	MPCB protects a motor against both overload and short circuit.	MCCB/ MCB protects a motor against short circuit only.
Need of overload protection relay	There is no need of an overload protection relay in the motor circuit with the MPCB, as it has inbuilt overload protection feature.	It is required to connect an overload protection relay in the circuit with MCCB/ MCB.
Auto – resetting feature	Modern MPCBs are designed to have auto-resetting feature so that the motor can resume its operation after a short period from occurrence of an overload trip.	The auto-resetting is not available in MCCB/MCBs.
Response to starting currents	MPCB can withstand the starting inrush currents of the motor without disconnecting the circuit.	MCCB/ MCB must be selected based on the starting current of the motor, otherwise it may cause false tripping.
Need of contactor	In case of MPCB, the contactor is optional, i.e. the MPCB can be used itself for turning ON and OFF the motor manually.	For switching purpose, a contactor is necessarily required in case of MCCB/ MCB.

Disclaimer:

It is clarified that this pamphlet does not supersede any existing provisions laid down by Indian Standards, Railway Board, RDSO or Zonal Railways. The pamphlet is for guidance only and it is not a statutory document.

If you have any suggestion or comment, please write to:

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