

DISTRIBUTION BOARDS

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Types of Distribution Boards

1. Main Distribution Board (MDB)
2. Sub Main Distribution Board (SMDB)
3. Distribution Boards (DB) / Consumer Units (CU)
4. Automatic Power Factor Corrections Units (APFCU)
5. Motor Control Centers (MCC) / Motor Control Panels (MCP)

Types of Distribution Boards



MDB



SMDB



APFCU



DB / CU



MCP

Main Distribution Boards (MDB)

- There will generally be one MDB for an Electrical Installation such as Apartment, Hospital, Factory, etc.
- However, there will be more than one MDBs in large Electrical Installations such as Shopping Complexes, Hotels, etc.
- The Low Voltage (LV) output of the Transformer will be directly connected to the MBD. Sometimes, MDB will consist of Automatic Transfer Switch (ATS) also in order to receive power supply from CEB / LECO and Generator. The fault current at MDB level is very high as it is very closer to the Transformer (10 – 15 m distance).
- So, it mainly consists of ACBs and MCCBs as the fault current rating of those are very high.
- MDBs are generally made out of sheet steel of 1.5 – 2.0 mm thickness.
- MDBs are generally Floor Mounted Type.

Sub Main Distribution Boards (SMDB)

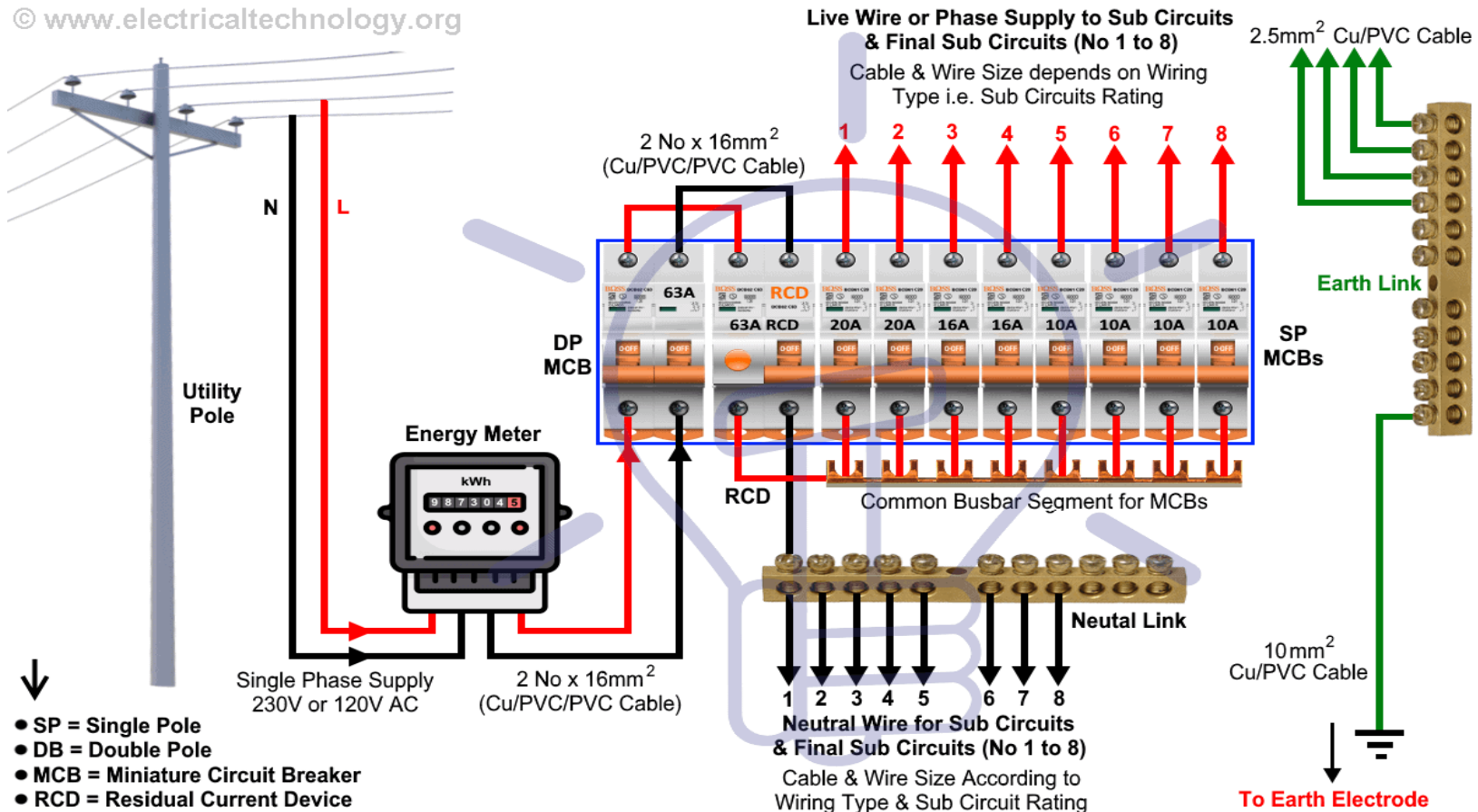
- There will generally be one SMDB per floor / section of an Electrical Installation.
- The SMDBs are directly fed from MDBs.
- The fault current at SMDB level is lesser than that of MDB. Nevertheless, it is more than the fault current ratings of the standard MCBs.
- Therefore, SMDBs mainly consist of MCCBs and MCBs.
- SMDBs are generally made out of sheet steel of 1.2 – 1.5 mm thickness.
- These generally come as Wall Mounting Type. Nevertheless, there are Floor Mounted Type SMDBs also.

Distribution Boards (DB) / Consumer Units (CU)

- There will generally be one DB / CU in a designated consumer area such as Apartments, Guest Rooms, Patient Rooms, etc.
- These are directly fed from SMDBs.
- The fault current at DB / CU level is generally below 10 kA.
- Therefore, DBs / CUs mainly consist of MCBs, whose fault current rating comes as 4.5kA, 6kA and 10kA.
- DBs / CUs are generally made out of sheet steel of 1.0 – 1.2 mm thickness / Polycarbonate.
- These are feeding to all the final circuits such as light points, socket outlets, etc.
- These generally come as “surface mounted” type and / or “recessed mounted” type.

Internal Components of a Household Distribution Boards

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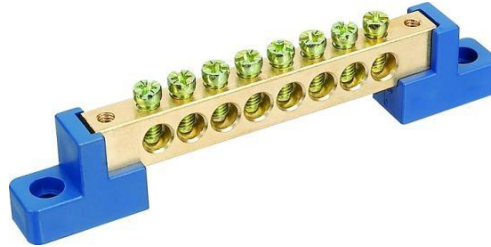
Wiring of the Distribution Board with RCD (Single Phase Supply)
(From Utility Pole & Energy Meter to the Consumer Unit)

The Main Components of the DB

1. Circuit Breakers



2. Neutral Link



3. Earth Link



4. Comb Busbar

Types of Low Voltage Switchgears

- Miniature Circuit Breakers (MCB)
- Moulded Case Circuit Breakers (MCCB)
- Air Circuit Breakers (ACB)
- Residual Current Circuit Breakers (RCCB)
- Residual Current Breaker with Over Current (RCBO)

MINIATURE CIRCUIT BREAKERS

Types of MCBs used in DBs

1. Single Pole Miniature Circuit Breakers (MCB, SP)



2. Double Pole Miniature Circuit Breakers (MCB, DP)



3. Triple Pole Miniature Circuit Breakers (MCB, TP)



4. Four Pole Miniature Circuit Breakers (MCB, FP)



What is a Miniature Circuit Breakers (MCB)?

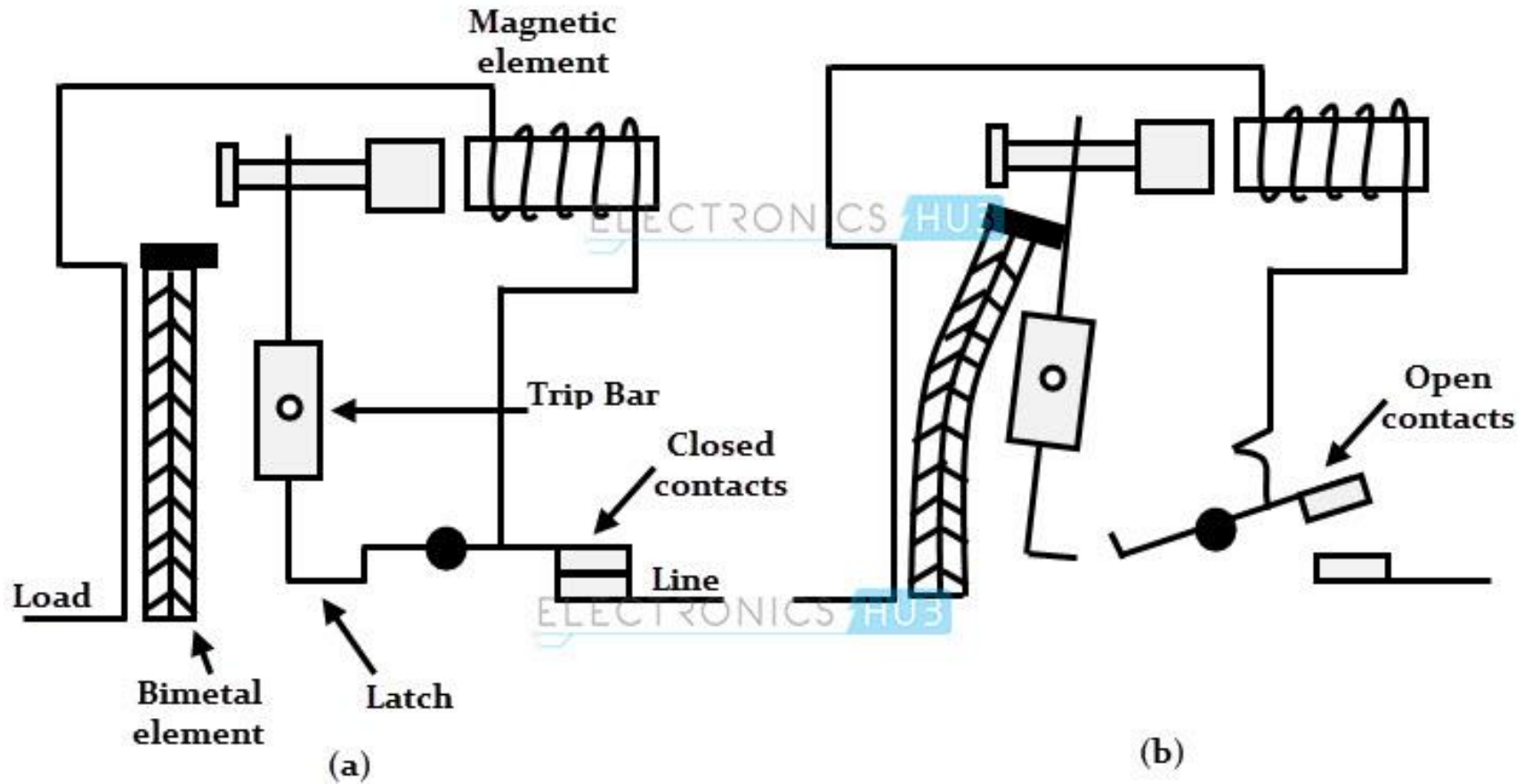
- The MCB is an automatically operated Electrical Switch in case of excess current to prevent damages to the Electrical Circuit and / or Appliances.
- In other words, the MCB is used for the protection against “Overload” and “Short Circuit” conditions.

How does a MCB work?

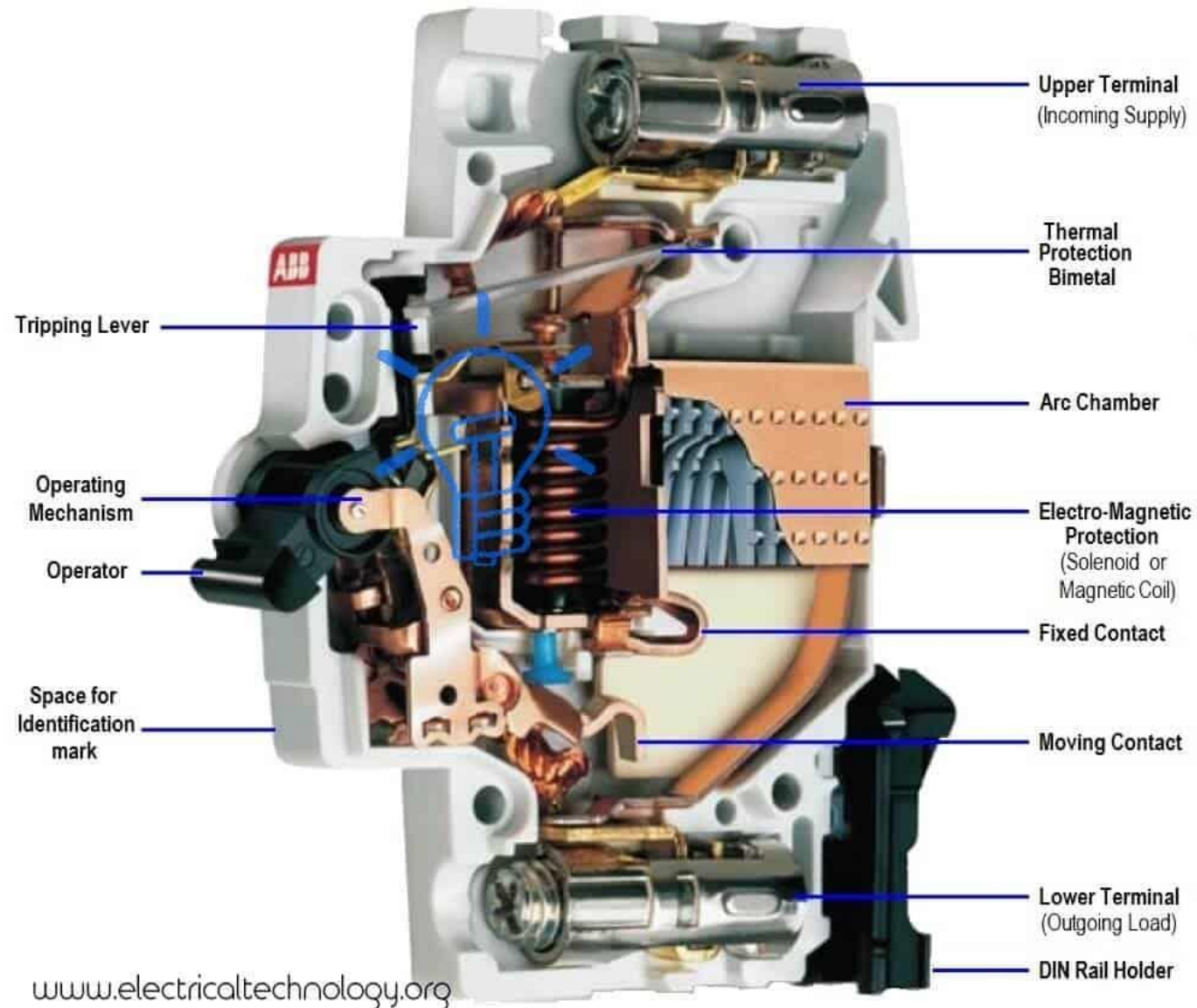
Overload protection – It is provided by bimetallic strip using thermal operation. The excess current causes the bimetallic strip within the MCB to heat, bend and trip.

Short circuit protection – It is provided by electro-magnetic operation.

How does a MCB work? (continue).....



Important Components of MCB



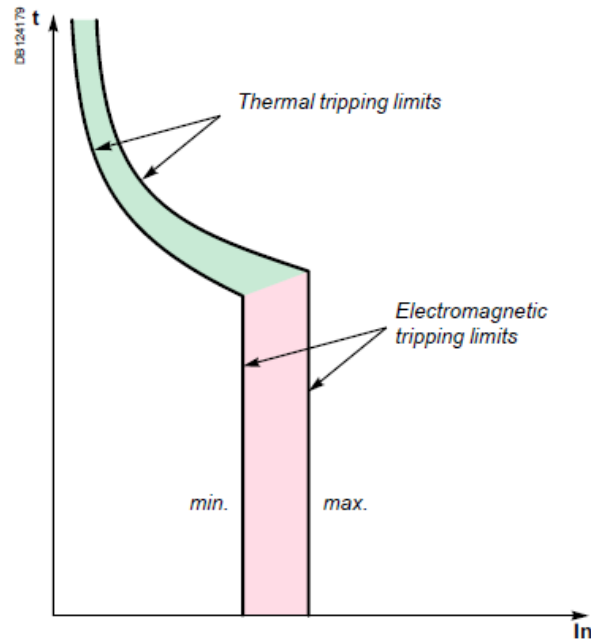
Types of MCBs

There are different types of MCBs. The major types based on the instantaneous tripping current are

(a) Type B

(b) Type C

(c) Type D



Types of MCBs *(continue).....*

Type B MCB

- This is the most sensitive type of MCB.
- Mainly used for domestic application and light commercial applications, where the switching surges / inrush currents are low in the range of 3 – 5 times of the rated / nominal current of the MCB.
- This is intended for circuit with resistive loads.
- Examples – Lighting, General purpose socket outlets, Computers, etc.

Types of MCBs *(continue).....*

Type C MCB

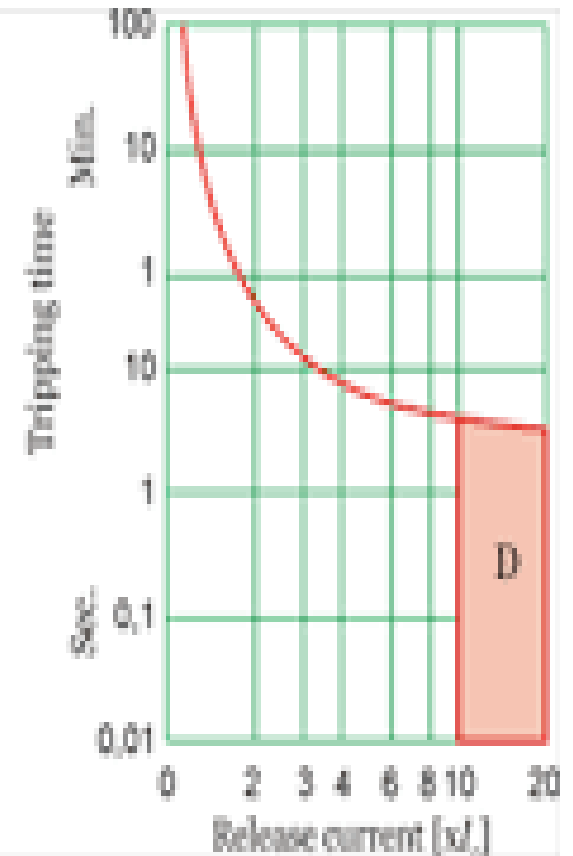
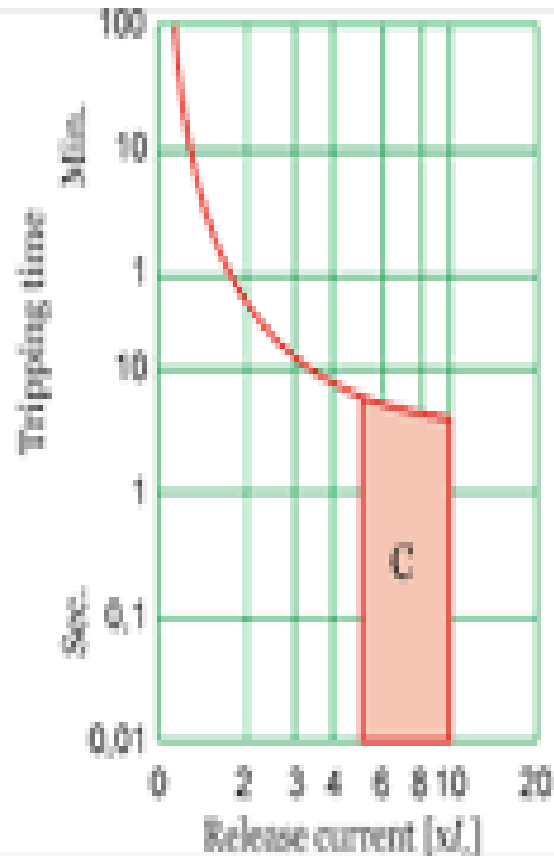
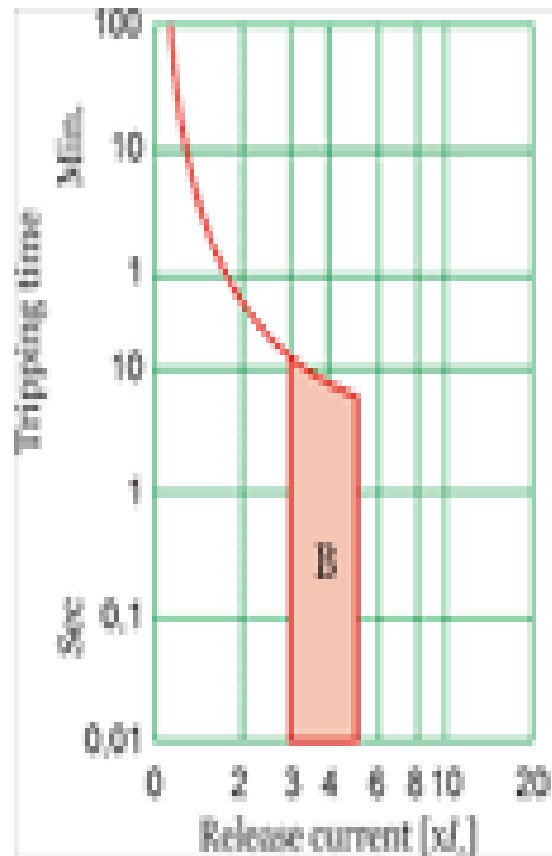
- Mainly used for commercial and industrial applications, where the switching surges / inrush currents in the range of 5 – 10 times the rated / nominal current of the MCB.
- This is intended for circuits with medium inductive loads.
- Examples – Induction motors, discharge lights, etc.

Types of MCBs *(continue).....*

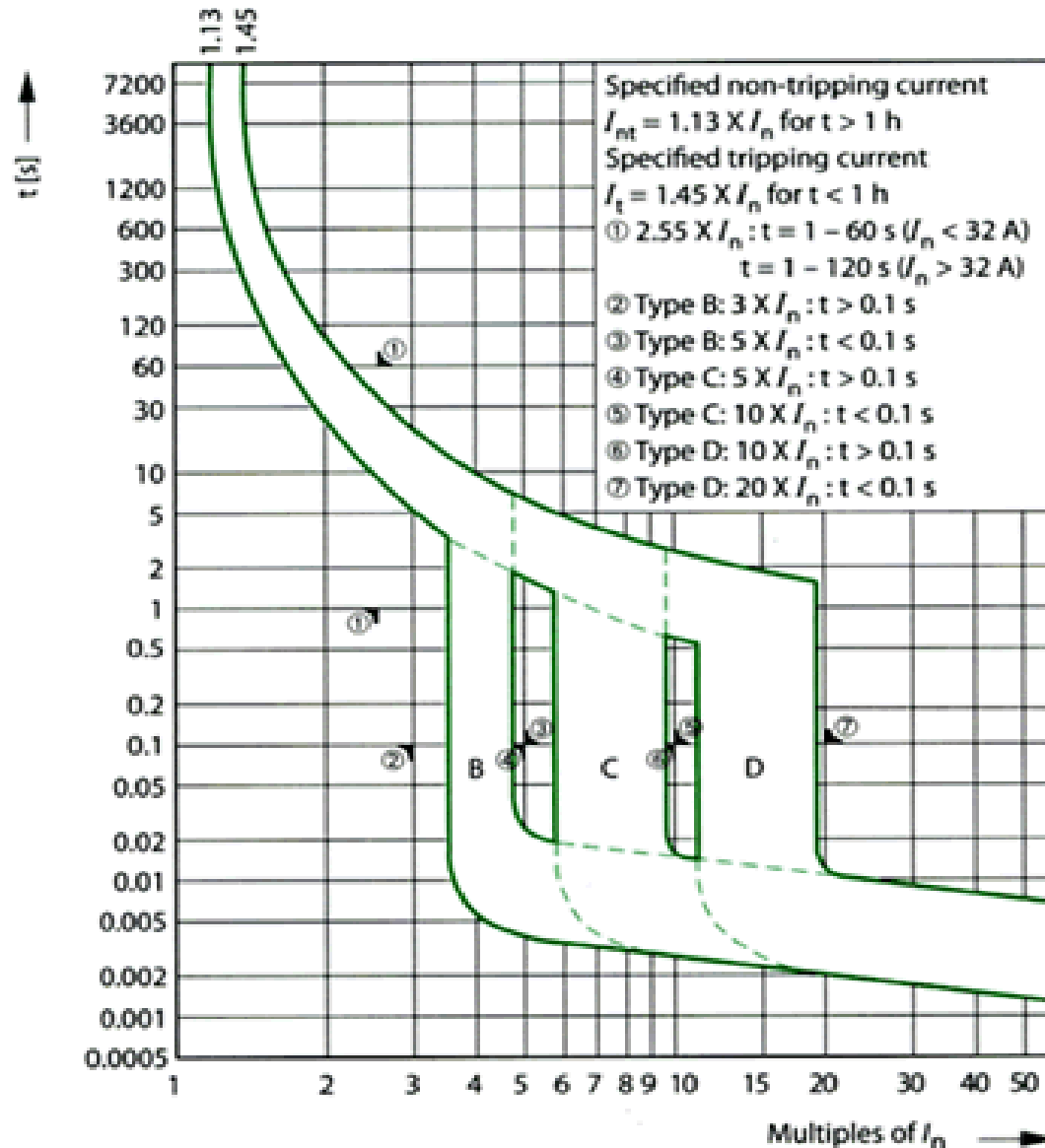
Type D MCB

- Mainly used for heavy duty commercial and industrial applications, where the switching surges / inrush currents in the range of 10 – 20 times the rated / nominal current of the MCB.
- This is intended for circuits with highly inductive and capacitive loads.
- Examples – Large induction motors, Transformers, Welding plants, X-ray machines, Capacitor Banks, etc.

Tripping Curve Characteristic of the MCBs



Tripping Curves of B, C and D Type of the MCBs



Comparison of Tripping Current of Different Types of MCBs

MCB Types	Instantaneous Tripping Current	Operating Time
Type B	3 – 5 times the I_n	0.04 – 13 sec.
Type C	5 – 10 times the I_n	0.04 – 5 sec.
Type D	10 – 20 times the I_n	0.04 – 3 sec.

Standards Applicable to MCBs

- There are MCBs certified under IEC 60898-1 and IEC 60947-2.
- IEC 60898-1 is applicable to MCBs of Residential usage.
- IEC 60947-2 is applicable to MCBs of Industrial usage.

Summary of MCBs

- The MCBs are used to provide protection against “**overload**” and “**short circuit**” conditions in electric circuits.
- The MCBs are produced in compliance with IEC 60898-1 and 60947-2.
- The available nominal current ratings (I_n) of the MCBs are 0.5 – 63 A.
- The MCBs are available in 1, 2, 3 and 4 poles.
- The MCBs are available 240 V or 415 V.
- The available fault current ratings (I_{cu}) of the MCBs are 4.5, 6, 10 kA.
- The impulse withstand voltage of the MCBs is 6 kV.
- The overload tripping characteristics of a MCB shall be as follows:
 - Conventional no tripping current = $1.13 \cdot I_n$
 - Conventional tripping current = $1.45 \cdot I_n$

RESIDUAL CURRENT DEVICES

Residual Current Devices (RCD)

- RCDs are used for protection against the risk of electrocution and fire caused by earth faults.
- RCDs will trip the circuit within 10 – 40 milliseconds in case of an earth fault.



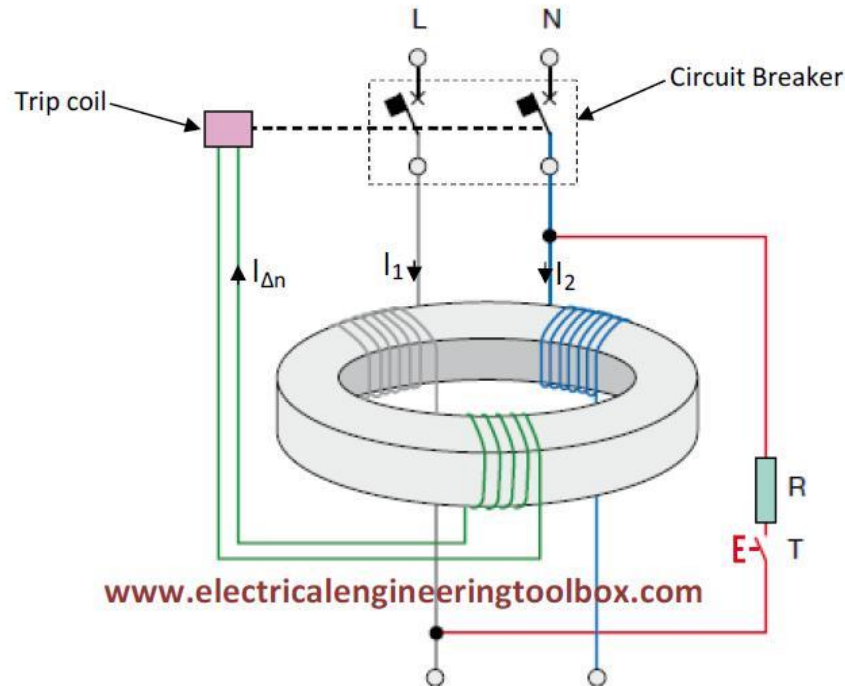
DP RCD



FP RCD

Operating Principle of the RCD

- The vector sum of the current ($I_1 + I_2$) is equal to zero in absence of an earth fault.
- The vector sum of the current ($I_1 + I_2$) will not be equal to zero in case of an earth fault as there will be a leakage current to the earth.
- If the vector sum of ($I_1 + I_2$) exceeds the rating of the RCD under an earth fault, the RCD operates to discount the circuit.



Available Ratings of the RCDs

- 10 mA RCDs – used for human safety in wet areas.
 - 30 mA RCDs – used for human protection.
 - 100 mA RCDs – used for protection against fire hazards.
 - 300 mA RCDs – used for protection against fire hazards.
 - 500 mA RCDs – used for protection against fire hazards.
 - 1 A RCDs – used for protection against fire hazards.
-
- If higher rated RCDs are required, then Earth Leakage Relays (ELR) are the options.
 - ELRs will be used with SHT or UVR in order to achieve the circuit breaking in case of earth leakage beyond the acceptable levels.

MOULDED CASE CIRCUIT BREAKERS

Moulded Case Circuit Breakers

- MCCBs have higher fault current withstand capacities compared to MCBs.
- MCBs – 4.5kA, 6kA, 10kA and 16kA (rarely).
- MCCBs – 25kA, 36kA, 50kA, 65kA and 100kA.
- So, MCCBs are required to be used in places where the fault current rating is high.
- MCCBs are available from 20A to 2500A and in different poles such as SP, DP, TP and 4P.
- MCCBs are used for the followings purposes:

Overload protection.

Short circuit protection.

Isolation / Disconnection.

- Overload protection is achieved by a bimetallic contact as in the case of MCBs.
- Short circuit protection is achieved based on the principle of electromagnetism.

Characteristics of MCCBs

(a) Rated Frame Current (I_{nm})

This refers to the maximum current that the MCCB is rated to handle. This defines the upper limit of the adjustable trip unit.

(b) Rated Current (I_n)

This refers to the current that determines when the MCCB trips due to overload protection. This can be adjusted to a maximum of the I_{nm} .

(c) Rated Insulation Voltage (U_i)

This refers to the maximum voltage which MCCB can resist in lab conditions.

(d) Rated Working Voltage (U_e)

This value is the rated voltage for the continuous operation of the MCCB. This is normally the same as or close to the system voltage.

Characteristics of MCCBs

(e) Rated Impulse Withstand Voltage (U_{imp})

This determines the ability of the MCCB to withstand transient over voltages. The size of the impulse used for this testing is 1.2/50 μ s.

(f) Service / Operating Short Circuit Breaking Capacity (I_{cs})

This is the maximum fault current that a MCCB can handle without being permanently damaged. MCCBs are generally reusable after fault interruption operation provided that they do not exceed I_{cs} . The higher the I_{cs} , the more reliable the MCCB is. This is the maximum fault current value that a MCCB can handle.

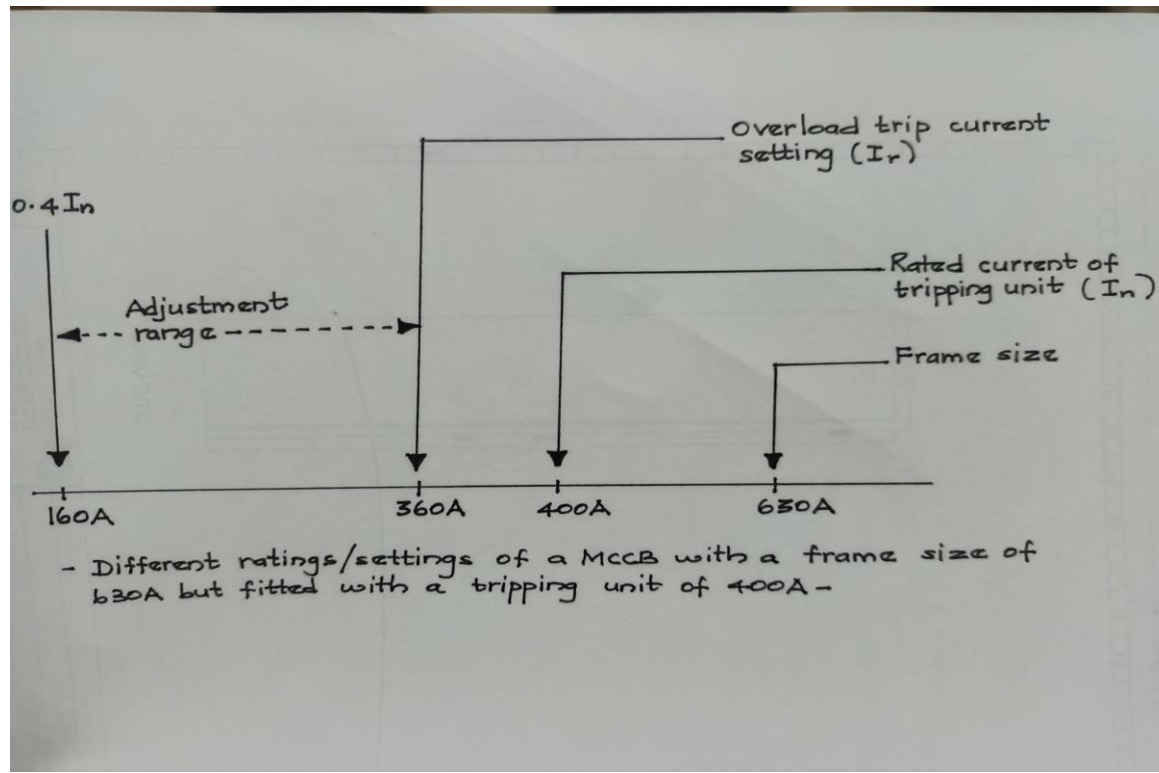
(g) Ultimate Short Circuit Breaking Capacity (I_{cu})

If the fault current exceeds this value, the MCCB will be unable to trip. In other words, if the fault current exceeds I_{cs} but does not exceed I_{cu} , the MCCB can still remove the fault, but may be damaged and require replacement.

Characteristics of MCCBs

(h) Overload Relay Trip Current (I_r)

- There are two types of trip units for the MCCBs; Electronic Trip Unit (E) and Thermal-Magnetic Trip Unit (TM).
- The trip unit in the E type MCCBs can be adjustable in the range of 0.4 – 1.0 times I_n (0.4, 0.5, 0.6, 0.7, 0.8, 0.9 and 1.0).
- The trip unit in the TM type MCCBs can be adjustable in the range of 0.8 – 1.0 times I_n (0.8, 0.9 and 1.0).
- $I_n = 400\text{A}$
- $I_r = 400 \times 0.9 = 360\text{A}$
- For the fixed MCCBs, The $I_n = I_r$.



Categories of the Circuit Breakers

As per IEC 60947-2, there are two main selectivity categories. Those are Category A and B.

Category A: Mainly MCBs and some MCCBs comes under this category. In the event of a short circuit, they trip immediately.

Category B: Mainly MCCBs comes under this category. In the event of a short circuit, they will not trip immediately and hence allow the downstream circuit breaker to trip.

- The Category A circuit breakers will be used for the protection of final circuits.
- The Category B circuit breakers will be used in MDBs, SMDBs and MCCs / MCPs.

Characteristics of MCCBs

- Rated Insulation Voltage, $U_i = 800 \text{ V}$
- Rated Working Voltage, $U_e = 380/415 \text{ V}$ (Sri Lanka)
- Rated Impulse Withstand Voltage, $U_{imp} = 8 \text{ kV}$
- Service Short-Circuit Breaking Capacity, $I_{cs} = 70 \text{ kA}$
- Ultimate Short-Circuit Breaking Capacity, $I_{cu} = 70 \text{ kA}$
- Rated Frame Size, $I_{nm} = 250 \text{ A}$
- Utilization Category = Cat A (immediate tripping)

Schneider
Electric

Compact

NSX250 H

U_i 800 V	U_{imp} 8 kV
U_e (V)	I_{cu} (kA) I_{cs}
220/240 ~	100 100
380/415 ~	70 70
440 ~	65 65
500 ~	50 50
525 ~	35 35
660/690 ~	10 10

50/60Hz **cat A**

IEC / EN 60947-2

NEMA AB1	HIC (kA)
240V	100
480V	65
600V	35