Circuit Breaker

Prepared By :

Eng : Ayman Soliman Selmy

Circuit Breaker

Specification of circuit Breaker:-

[1] Operating voltage of C.B

[2] Rated current of C.B (Ir or In) Amp.

[3] Instantaneous short circuit current (Ics) KA

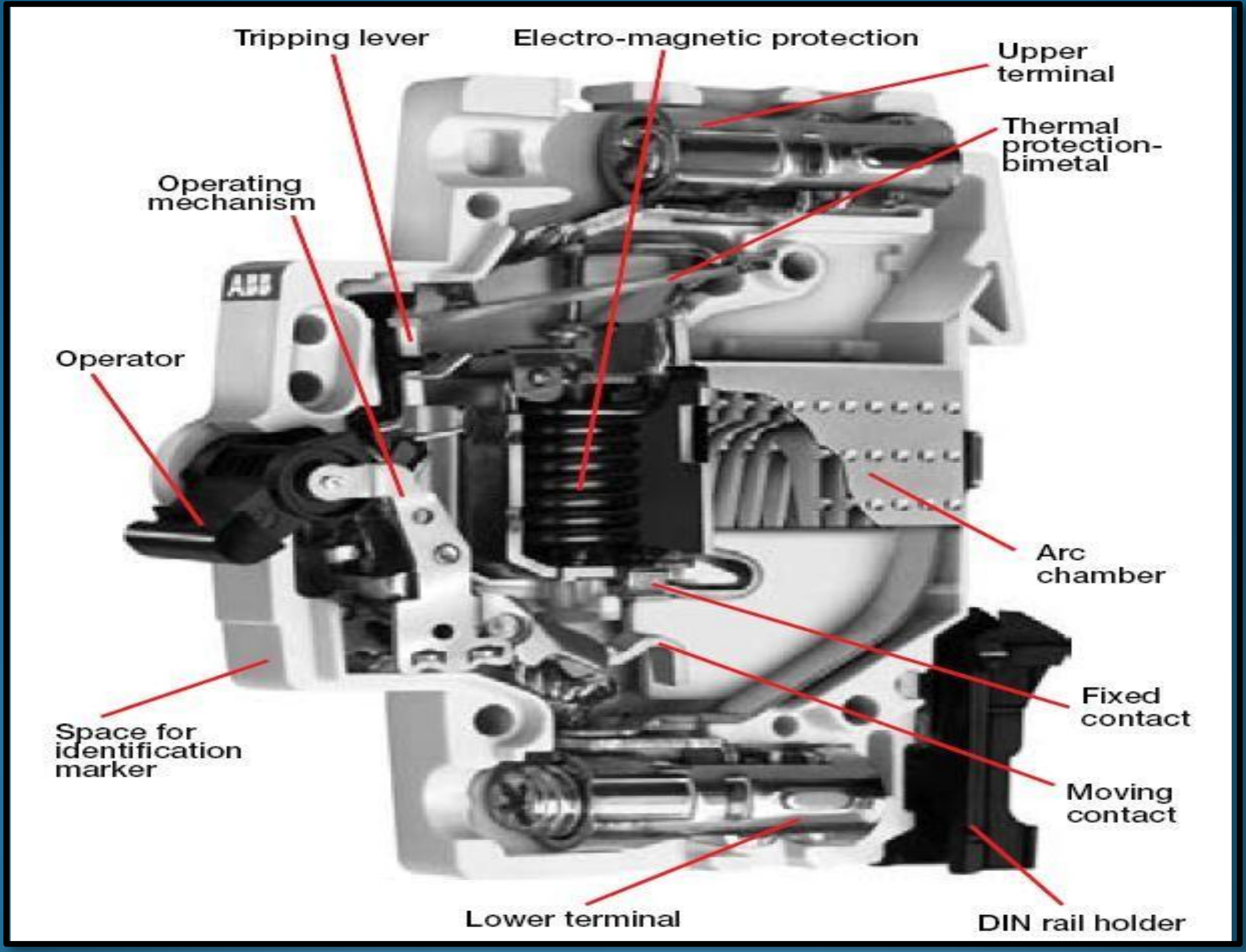
[4] Rated breaking capacity (Icu) KA

[5] Types of C.B

[6] Types of poles.

[7] Earth leakage C.B

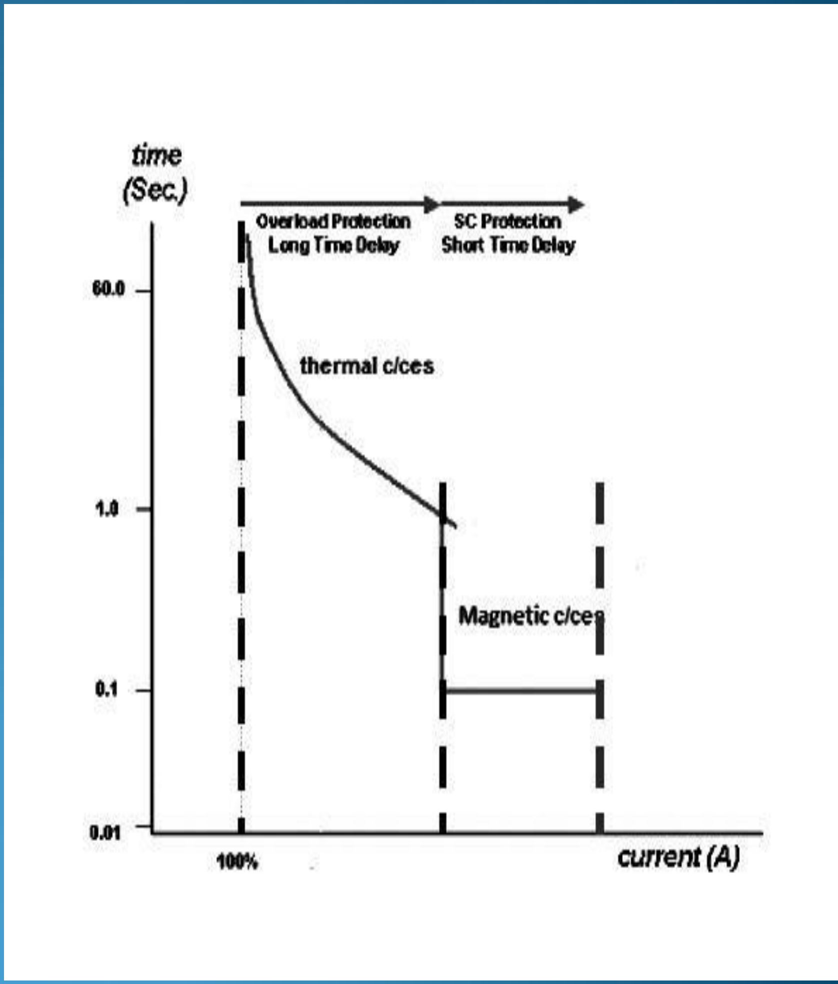
Construction of low voltage C.B



Operating Principle of low voltage C.B

Ir: rated current of C.B
Ic.s: short circuit current of C.B
Ic.u: max short circuit current or (Rated Breaking capacity)

Note:
Ir: depend on KVA of load
Icu & Ics: depend on the impedance of (Cables, Bus Bars and Transformers)



Operating voltage of C.B

Low voltage (1V – 1KV)	***Medium voltage (1KV – 66KV)***	***High voltage (66KV – 500KV)***
1 f– 220 3 f– 380 V	11 KV, 22KV 6.6KV,3.3 KV	132KV, 220KV 500KV
MCB – MCCB - ACB	SF6 - Vacuum	Oil - SF6

Low Voltage C.B

1 ϕ C.B	3 ϕ C.B
220 Volt	380 Volt
$S < 5$ KVA	$S > 5$ KVA

<table>
<tr><th colspan="27">Circuir Breaker Ratings</th></tr>
<tr><td>10</td><td>16</td><td>20</td><td>25</td><td>32</td><td>40</td><td>50</td><td>63</td><td>80</td><td>100</td><td>125</td><td>160</td><td>200</td><td>250</td><td>400</td><td>630</td><td>800</td><td>1000</td><td>1250</td><td>1600</td><td>2000</td><td>2500</td><td>3200</td><td>4000</td><td>5000</td><td>6300</td><td>CB (A)</td></tr>
<tr><td colspan="11">MCB</td><td colspan="4"></td><td colspan="11">ACB</td><td></td></tr>
<tr><td></td><td colspan="19">MCCB</td><td colspan="7"></td></tr>
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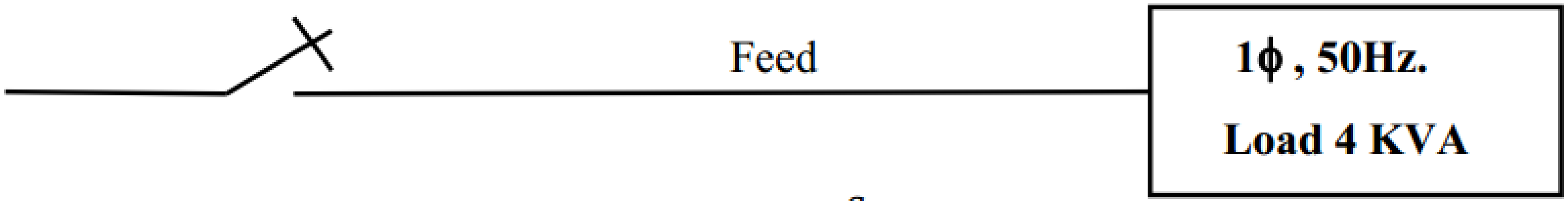
How to select C.B according to Ir ?

Ir of C.B= ?



As, $S_{1\phi} = VI$ So, $I_{load} = \frac{S}{V}$ (Single Phase)

$$I_{load} = \frac{S * 1000}{220} = 4.5 * S$$

$I_L = 4.5 * KVA$ for 1-ϕ Load

∴ $I_{load} = 4.5 * 4 = 18$ A

$$I_{C.B} = Safety\ factor * I_{load}$$

Safety factor

E.C	IEC	NEC
25% over load	20%over load	10% over load

$I_{C.B} = 1.25 * 18 = 22.5$ Amp.

(But there is no C.B with Ir = 22.5A)

So, from C.B standard:-

20A 25A 32A

22.5A

So, Select **C.B = 25 Amp.**

Ir of C.B = ?

As, $S_{3\phi} = \sqrt{3}\, V\, I$ So, $I_{load} = \frac{S}{\sqrt{3}\, V}$ (Three Phase)

$$I_{load} = \frac{S * 1000}{\sqrt{3}\, 380} = 1.5 * S$$

$I_L = 1.5 * KVA$ for 3-ϕLoad

$I_L = 1.5 * 50 = 75$ A

$I_{C.B} = 75 * 1.25 = 94$ A

From C.B standard

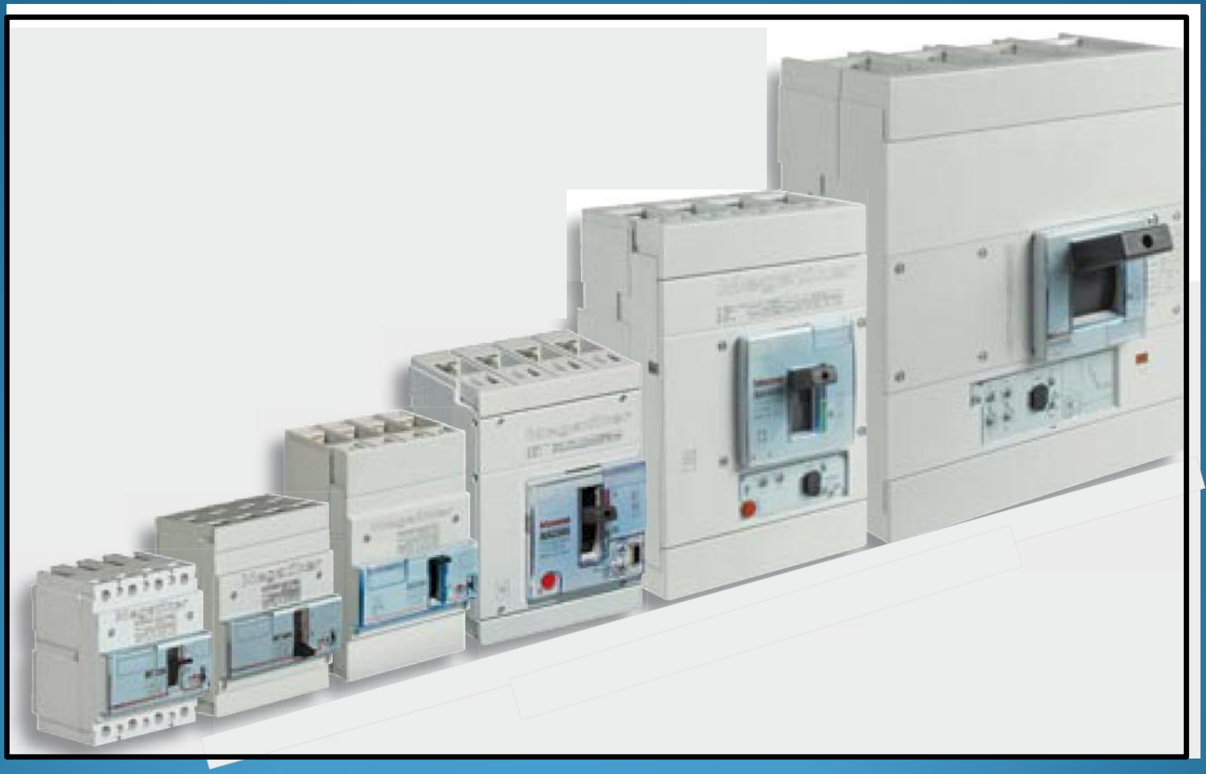
80A ← 94A → 100A 125A

Select **C.B = 100 AMP**

Types of low voltage Circuit Breakers

(1) Miniature C.B (10 ~ 125A)

(2) Moulded Case C.B (16~ 1600A)



(3) Air C.B (630 ~ 6300A)

A.C.B	MCCB A.C.B	M.C.C.B	M.C.B M.C.C.B	M.C. B

6300A 1600A 630A 125A 16A 10A

(1) If C.B $I_r = 10$ A or 16 A M.C.B

(2) If C.B 125 A $< I_r <$ 360 A M.C.B

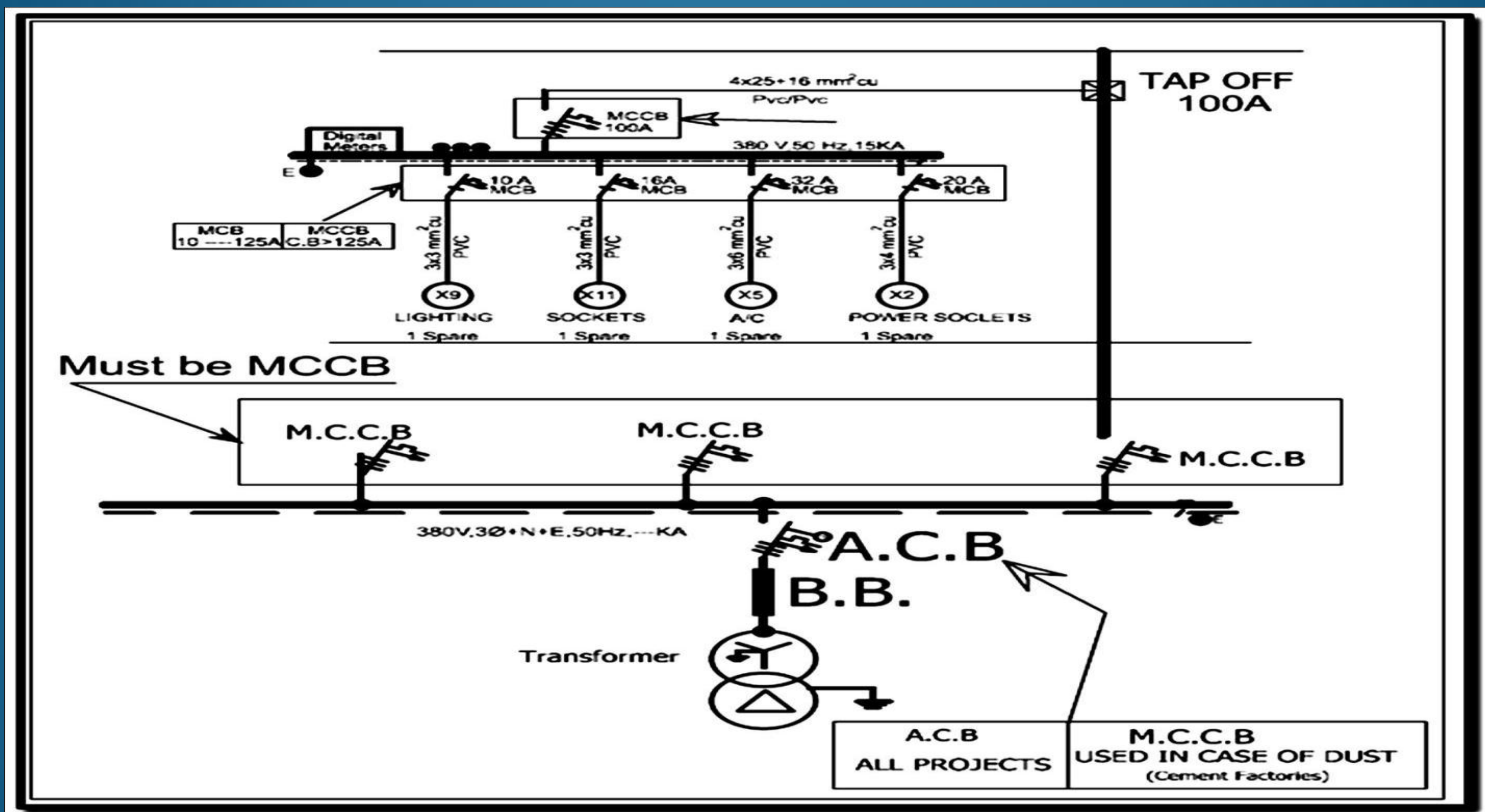
(3) If C.B 2500 A $< I_r <$6300 A A.C.B

(4) If C.B 16A $\leq I_r \leq$ 125A may be M.C.B *or* M.C.C.B

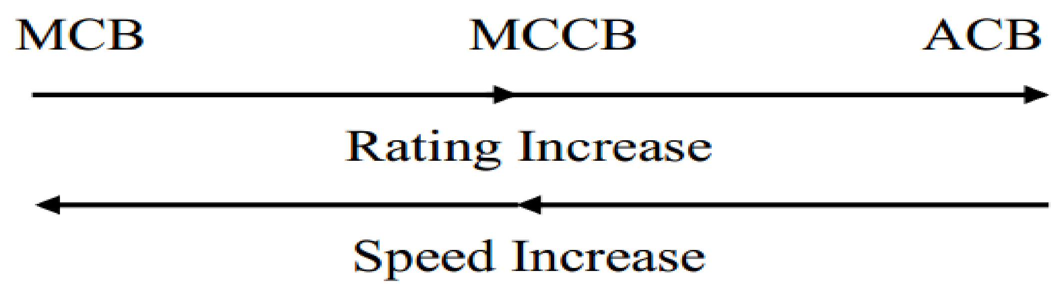
(5) If C.B 360A $\leq I_r \leq$ 2500A may be M.C.C.B *or* A.C. B

So, How to select the suitable type?!

The answer is where the location of C.B in the network is.



- M.C.B operates in 3 msec.
- M.C.C.B operates in 9 msec.
- A.C.B operates in 30 msec.



If C.B Incoming ⇨ Select MCCB

If C.B Outgoing ⇨ Select MCB

If C.B After Transformer must be A.C.B except only one case, If the transformer locates in any area contain dust such as outdoor & factories must be selected MCCB.

Because the MCCB can be maintained, but the ACB is very hard to be maintained.

Types of Poles of CB

(1) Single Phase - Single pole C.B

Line is protected

Neutral is non-protected

(2) Single Phase - Two Pole C.B

Neutral and line are protected

High cost than single pole

(3) 3 Phase - 3 Pole C.B

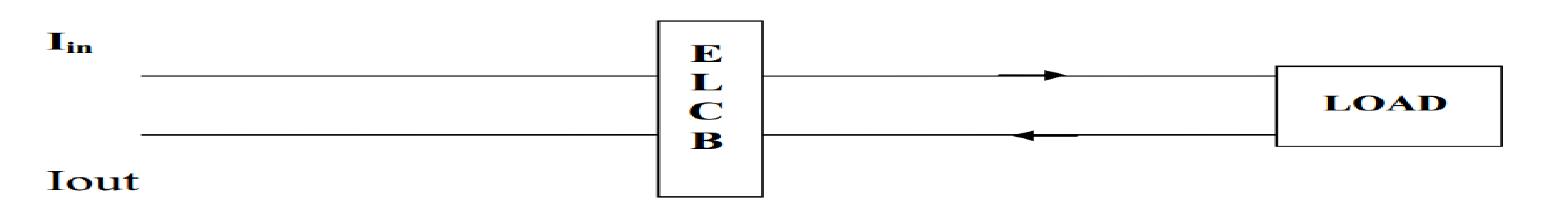
(4) 3 Phase - 4 Pole C.B

Earth leakage C.B (ELCB or RCCB)

There are two types: 1ϕ ELCB **and** 3ϕ ELCB

Operating Principle:-

For single phase system the ELCB compare the difference between the life and neutral phases with the adjusted setting value.



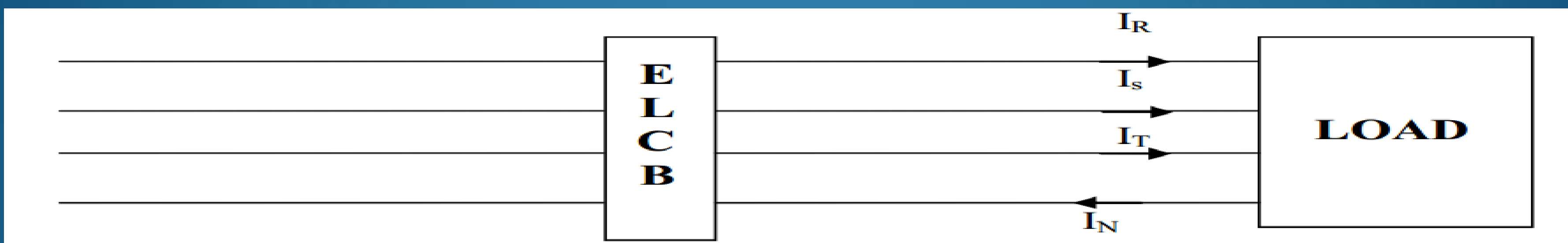
Iin = Iout	Normal Operation
Iin ≠ Iout	Earth Leakage

So,

Iin = Io + ILeakage

ILeakage = Iin - Iout

In case of **three phase** system the ELCB compare the difference between the three line phase and the neutral with the adjusted setting value.



$I_R + I_s + I_T = I_N =$ Zero — Normal Operation

$I_R + I_s + I_T = I_N =$ Value But $I_R + I_s + I_T + I_N =$ Zero — Unbalance

$I_R + I_s + I_T = I_N + I_{Leakage}$ Or $I_R + I_s + I_T + I_N = I_{Leakage}$ — Earth Leakage

Main function of ELCB

(1) To protect Human, we select I **setting** = Iin - Iout = 30 mA

(2) To protect machines, we select I **setting** = 300 mA

Medium Voltage C.B

Rated Voltages are

- 22 KV
- 11KV
- 6.6 KV
- 3.3 KV

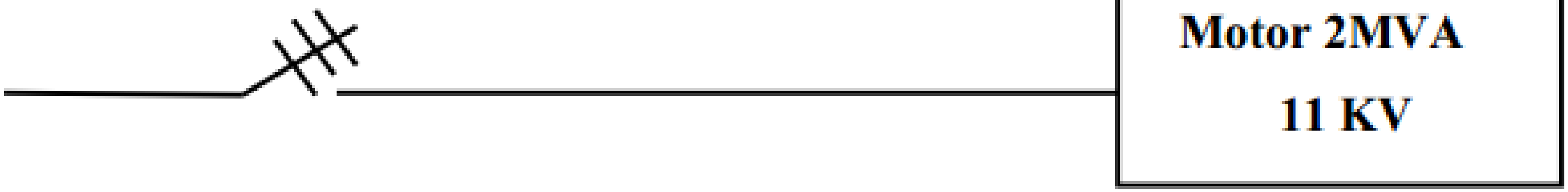
Rated currents are I rated = 630 ~ 4000A

Rated Breaking Capacity

(A) 11KV MVAs.c = 500 MVA
(B) 22KV MVAs.c = 750 MVA
(C) 6.6KV MVAs.c = 250 MVA

Types of MV C.B are: oil , Vacuum and SF6

Ir of C.B = ?



$$I_{load} = \frac{2 \, x \, 10\text{^}6}{\sqrt{3} \, x \, 11 \, x \, 10\text{^}3} = 104 \text{ A}$$

Select: I_{CB} = 630A Type: SF6 C.B

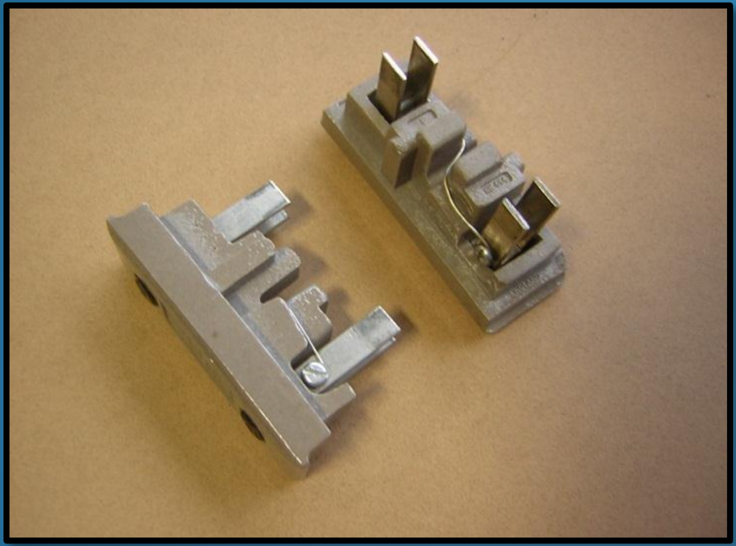
$I_{s.c}$ ⇨ at 11KV ⇨ 500 MVA

$$I_{SC} = \frac{500 \, x \, 10\text{^}6}{\sqrt{3} \, x \, 11 \, x \, 10\text{^}3} = 26 \text{ KV}$$

FUSES

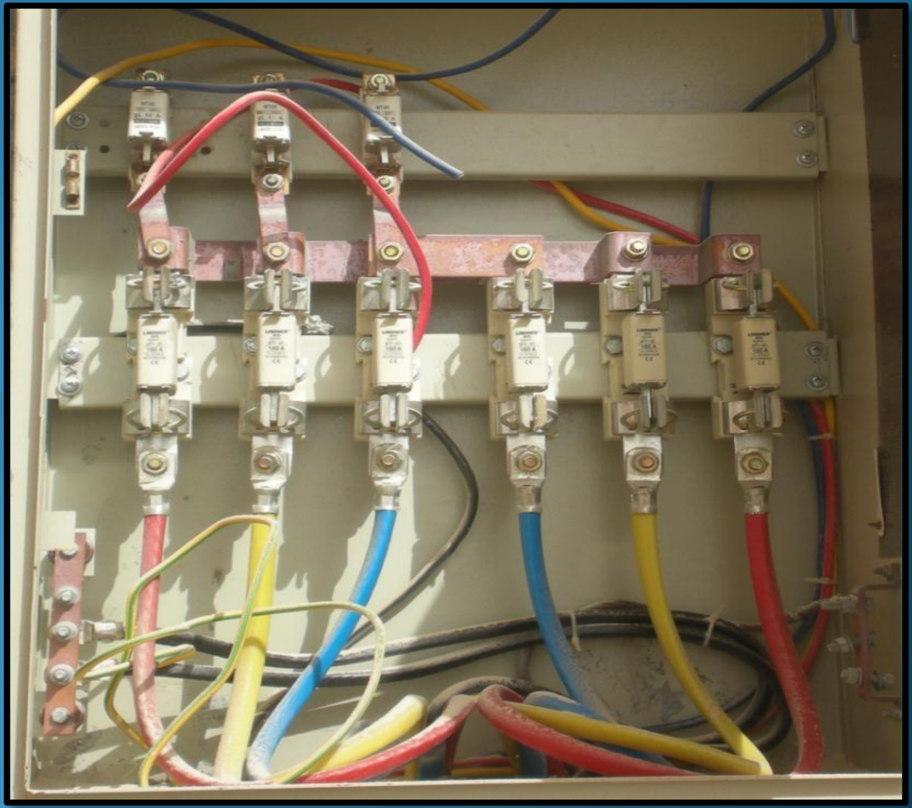
Types of Fuses

(1) Semi-enclosed Fuse



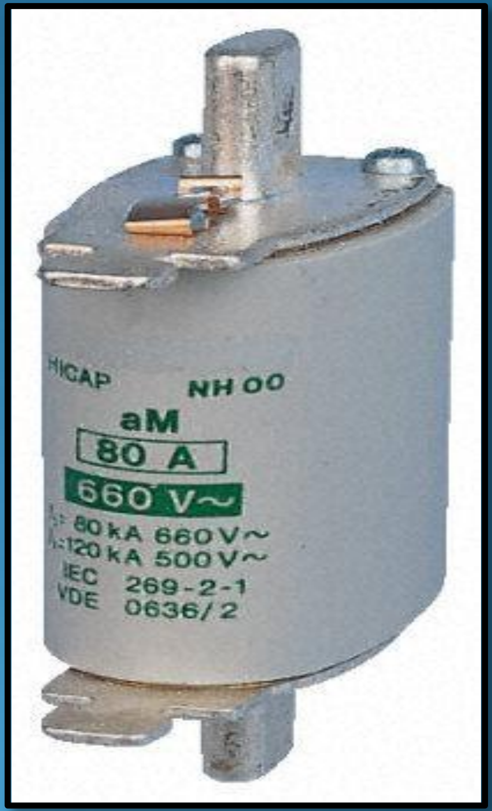
(2) Cartridge Fuse

Mainly used in Siemens boxes



(3) High Rupture Capacity Fuse (HRCF)

(4) aM-Type Fuse



Where:

- Semi enclosed and cartridge used in low voltage.
- High Rupture Capacity used in medium voltage
- H.R.C.F used to protect transformer from short circuit.
- aM fuse used to protect short circuit protection in motors, transformer and other load with high inrush currents due to the good current limiting capability and low I^2t values.

- Rating of fuses start from 10A, 16A, 20A, 25, 32, 40, 50, 63, 80, 100, 125,160, 200, 250, 320, 400, 630, 800, 1000, 1250A.

Thanks