

Basics of Over Current Protection

Over current and its causes

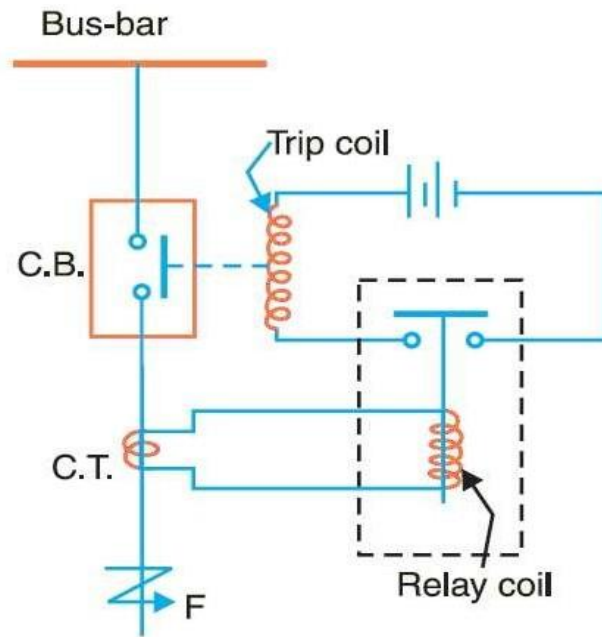
In an electric power system, **over current** or **excess current** is a situation where a larger than intended electric current exists through a conductor, leading to excessive generation of heat, and the risk of fire or damage to equipment.

Possible causes for over current include short circuits, excessive load, incorrect design, or a ground fault.

Working Principle of Over Current Relay

In an over current relay, there would be essentially a current coil. When normal current flows through this coil, the magnetic effect generated by the coil is not sufficient to move the moving element of the relay, as in this condition the restraining force is greater than deflecting force. But when the current through the coil increased, the magnetic effect increases, and after certain level of current, the deflecting force generated by the magnetic effect of the coil, crosses the restraining force, as a result, the moving element starts moving to change the contact position in the relay.

Over current Protection



Over current relays are fed from Current Transformers.

Whenever the current through the relay exceeds the preset value. The Relay operates

and actuates the trip coil of the circuit breaker, isolating the

Types of over current relays

Depending upon time of operation, Over current relays are classified into 3 groups.

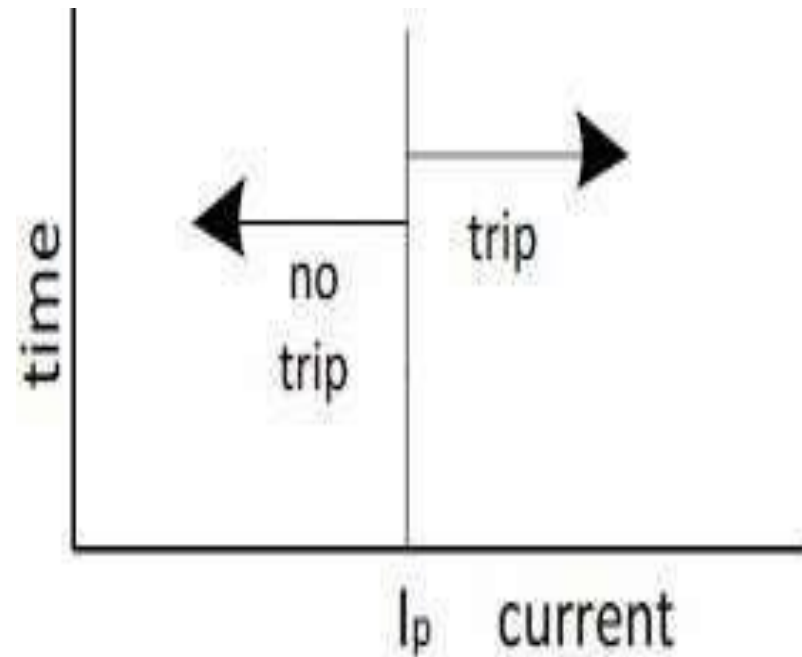
- Instantaneous over current relay.
- Definite time over current relay.
- Inverse time over current relay.

Instantaneous over current relay

This relay is referred as instantaneous over current relay, the relay operates as soon as the current in the coil gets higher than pre set value (I_p).

There is no intentional time delay set. There is always an inherent time delay of the order of a few milliseconds.

Attracted armature type relays shows this characteristics.

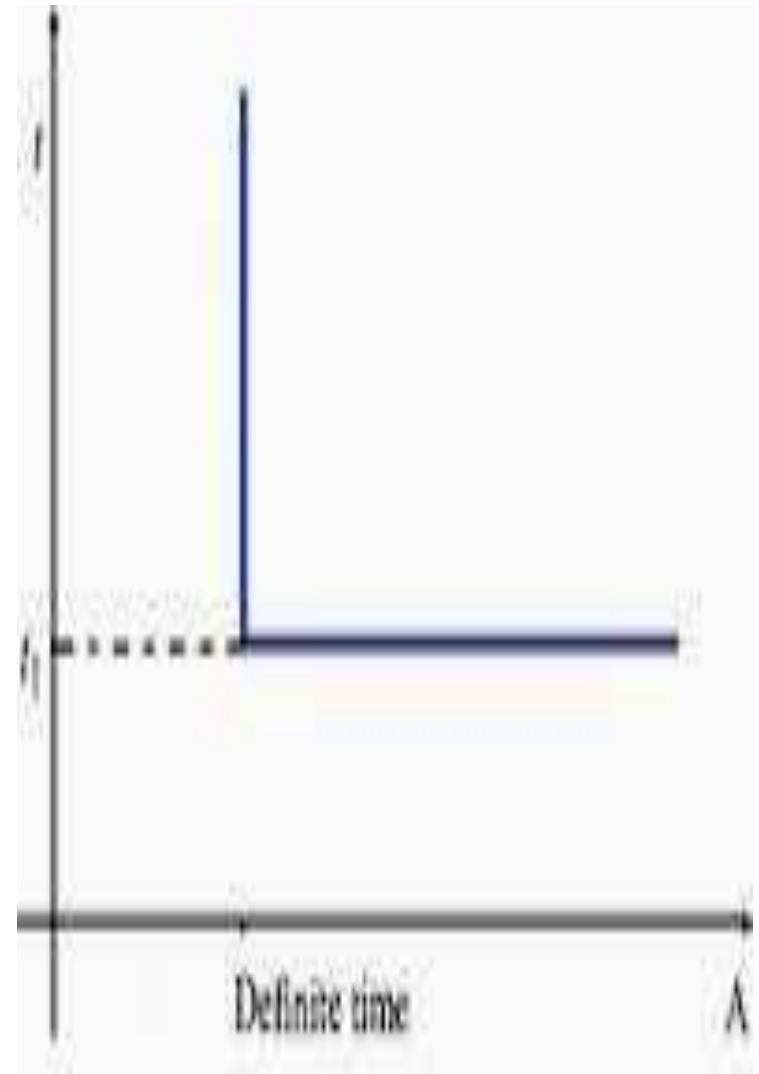


Characteristic of instantaneous overcurrent relays

Definite time over current relay

This relay is created by applying intentional time delay after crossing pick up value of the current. A definite time over current relay can be adjusted to issue a trip output at definite amount of time after it picks up. Thus, it has a time setting adjustment and pick up adjustment.

Attracted armature type relays with time element shows this characteristics.

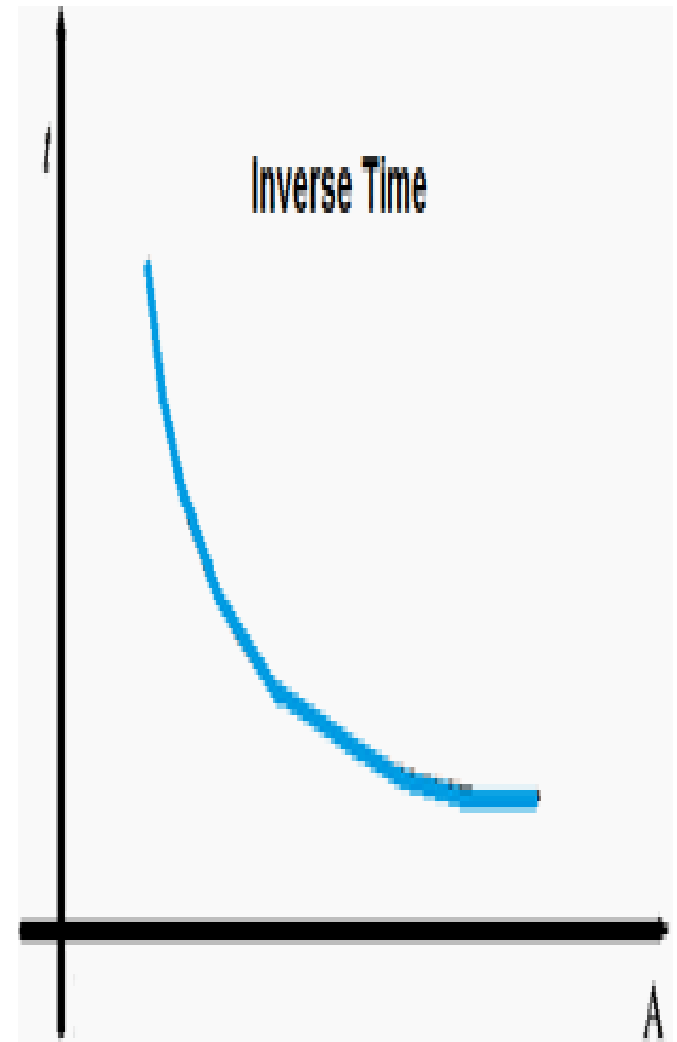


Inverse time over current relay

Inverse time is a natural character of any induction type rotating device. This means that, the time of operation inversely varies with input current.

This characteristic of electromechanical induction disc relay is very suitable for over current protection.

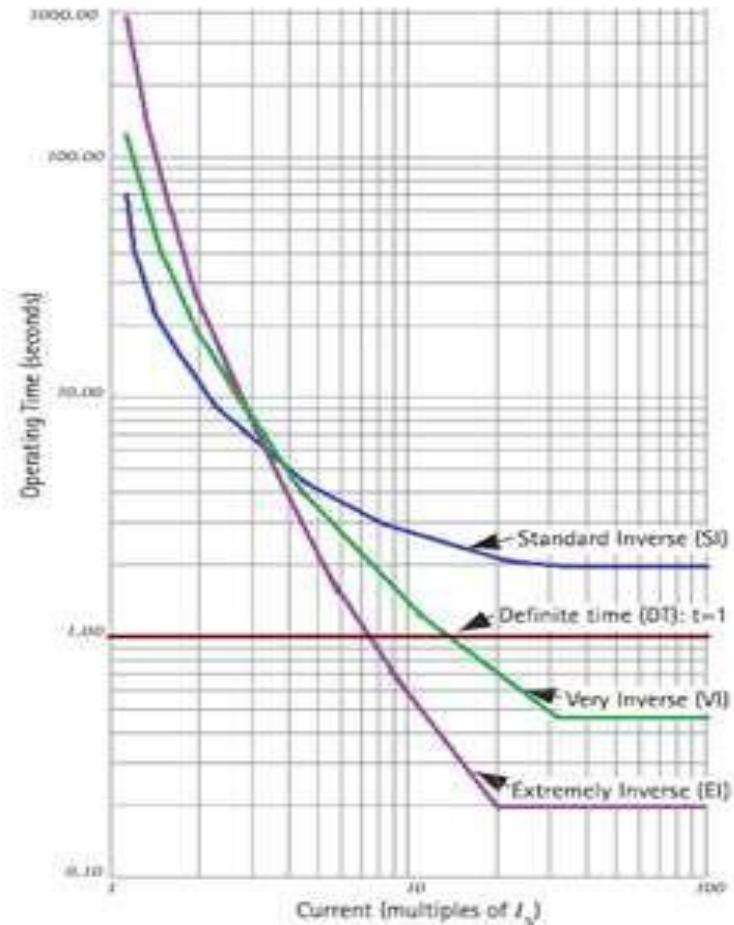
In this relay, if fault is more severe, it would be cleared more faster.



Classification of Inverse time relays

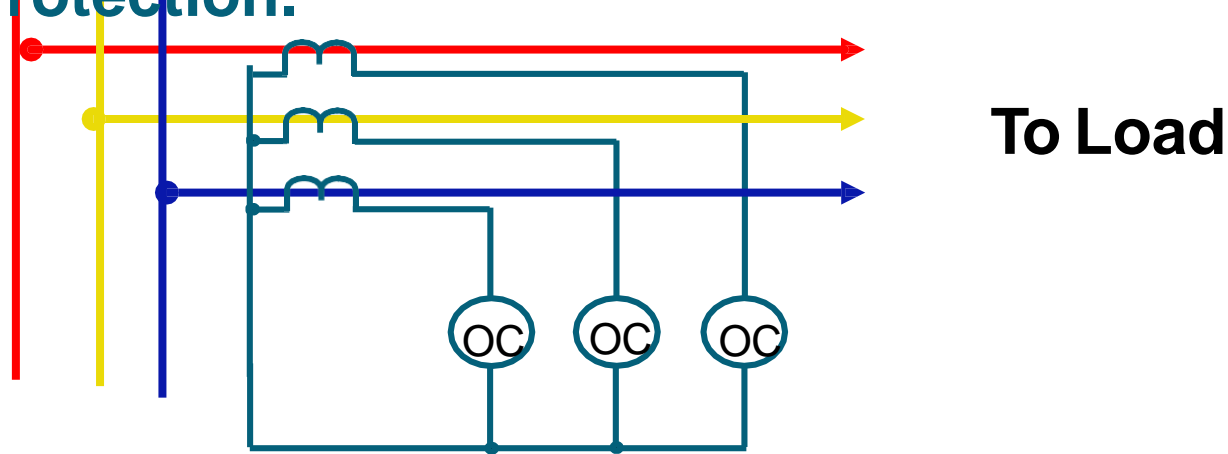
Inverse time over current relay (IDMT) is again subdivided as

Normal (standard) inverse,
Very inverse time and
Extremely inverse time
relay



Over current Protection Schemes

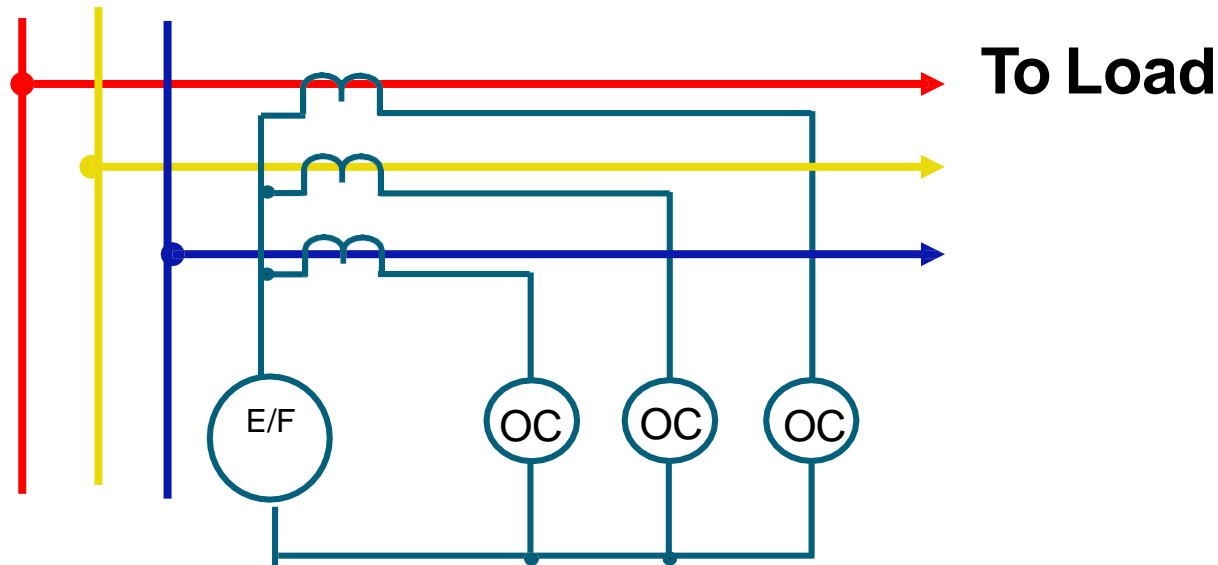
(1). 3 Nos. of Over Current relays for Over current and Earth fault Protection.



- For phase to phase faults the relays in only the affected phases operate. For single line to ground faults only the relay in the faulty phase gets the fault current and operates.
- the desired sensitivity with earth fault relays cannot be obtained in as much as the high current setting will have to be necessarily adopted for the over current relay avoid operation under maximum load condition.

Over current Protection Schemes

(2). 3 Nos. of Over Current relays + 1 No. E/F relay for Over current and Earth fault Protection.

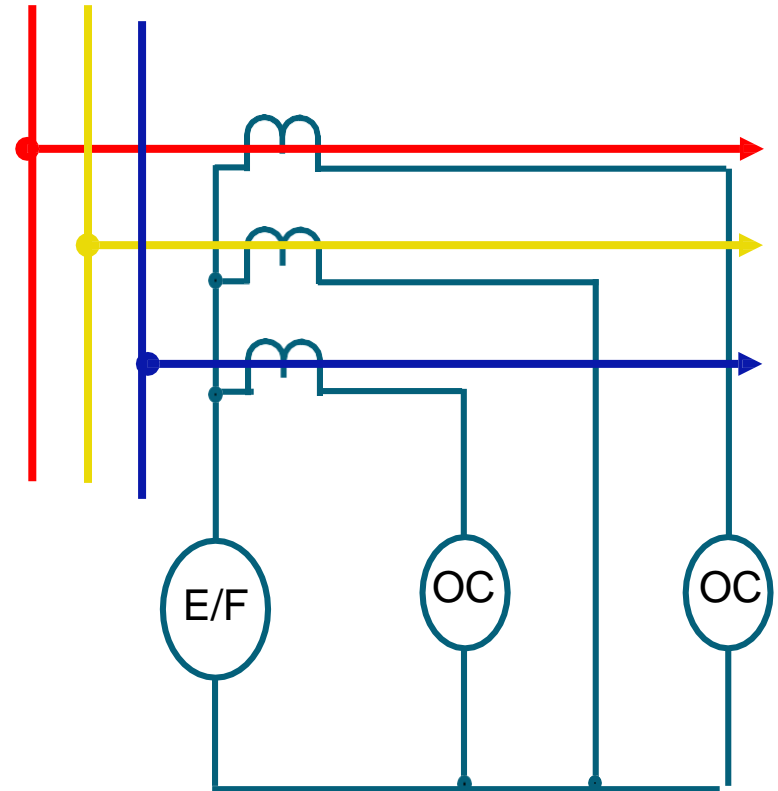


- For phase to phase faults the relays in only the affected phases operate.
- Under normal operating conditions and three phase fault conditions the current in the 3-phase are equal and symmetrically displaced by 120 degree, Hence the sum of these three currents is zero. No current flow through the earth

(3). 2 No O/C Relay + 1 No E/F Relay for Over Current and Earth Fault Protection

The two over current relays in R&B phases will respond to phase faults. At least one relay will operate for fault involving two phase.

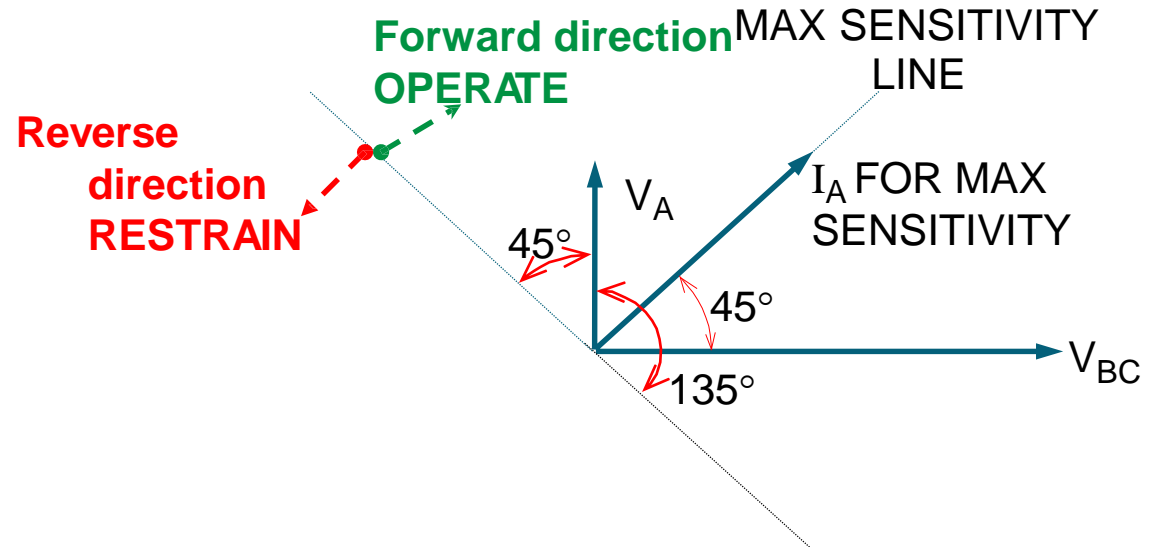
For fault involving ground reliance is placed on earth fault relay.



Directional Over current and E/F Relays

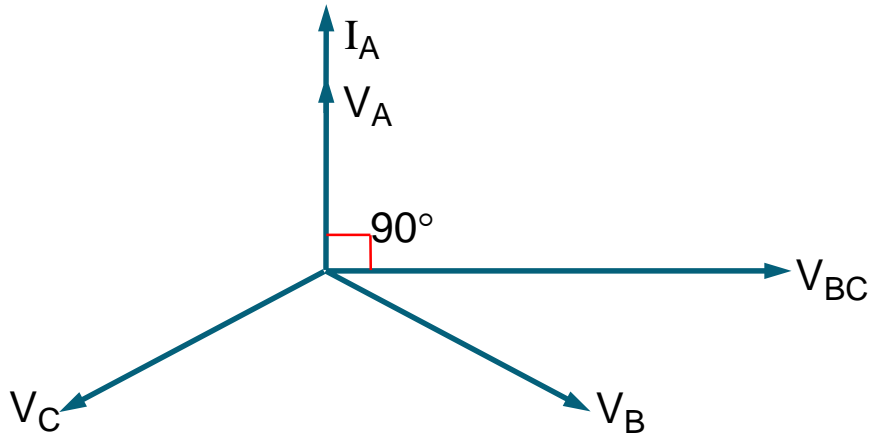
- When fault currents can flow in more than one direction it is desirable to determine which direction the fault current is flowing and trip the appropriate devices accordingly to contain a given fault.
- Directional Relay has a characteristics that it responds to over current condition in the forward direction only. Relay will not respond to reverse faults
- Compares the current in the line versus a known reference (that will always be the same). This reference voltage or current is known as **polarizing voltage** or **polarizing current**.

Characteristics of Directional Overcurrent Relay



Characteristics of Directional Relay (A-phase)

Polarizing Voltages commonly used



Polarizing Voltage for A-phase

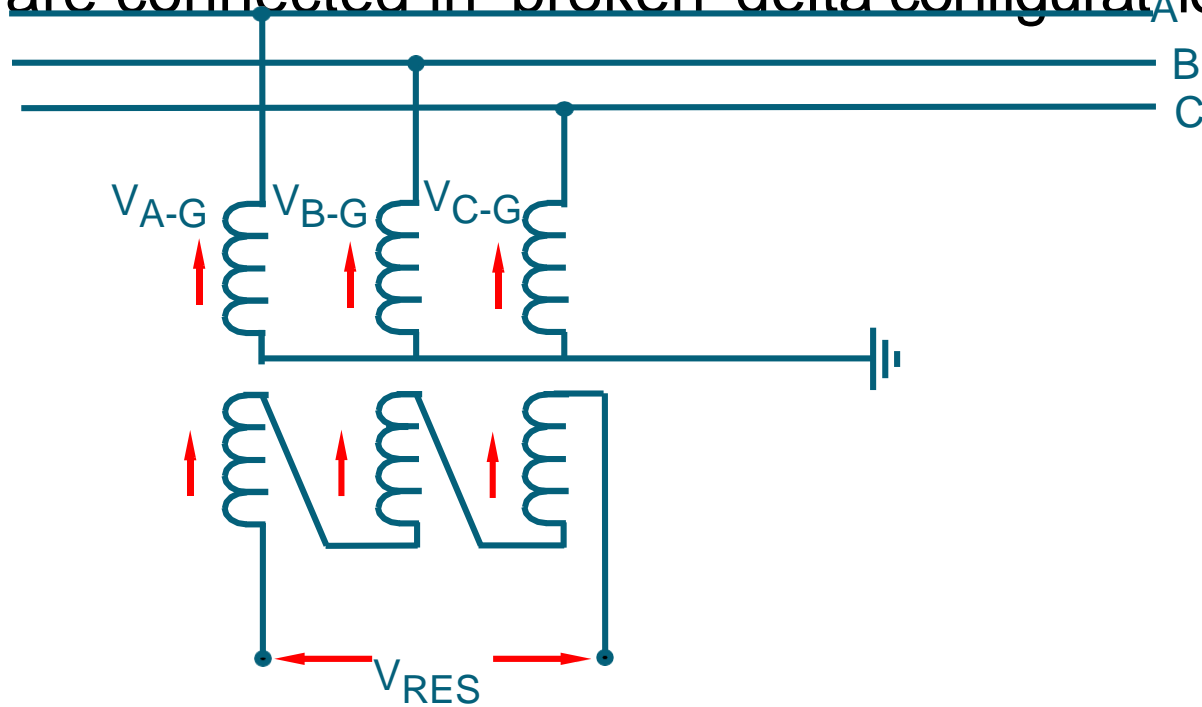
Phase	Current	Polarizing Voltage
A - phase	I_A	V_{BC}
B - phase	I_B	V_{CA}
C - phase	I_C	V_{AB}

Directional E/F Protection Scheme

- The directional earth-fault relay has two coils. One of the coils is connected in residual current circuits (like ordinary earth fault relay). This coil gets current during earth-faults only. The other coil gets residual voltage V_{RES} from broken delta connection. (figure is shown in next page)

Residual Voltage for E/F Relay

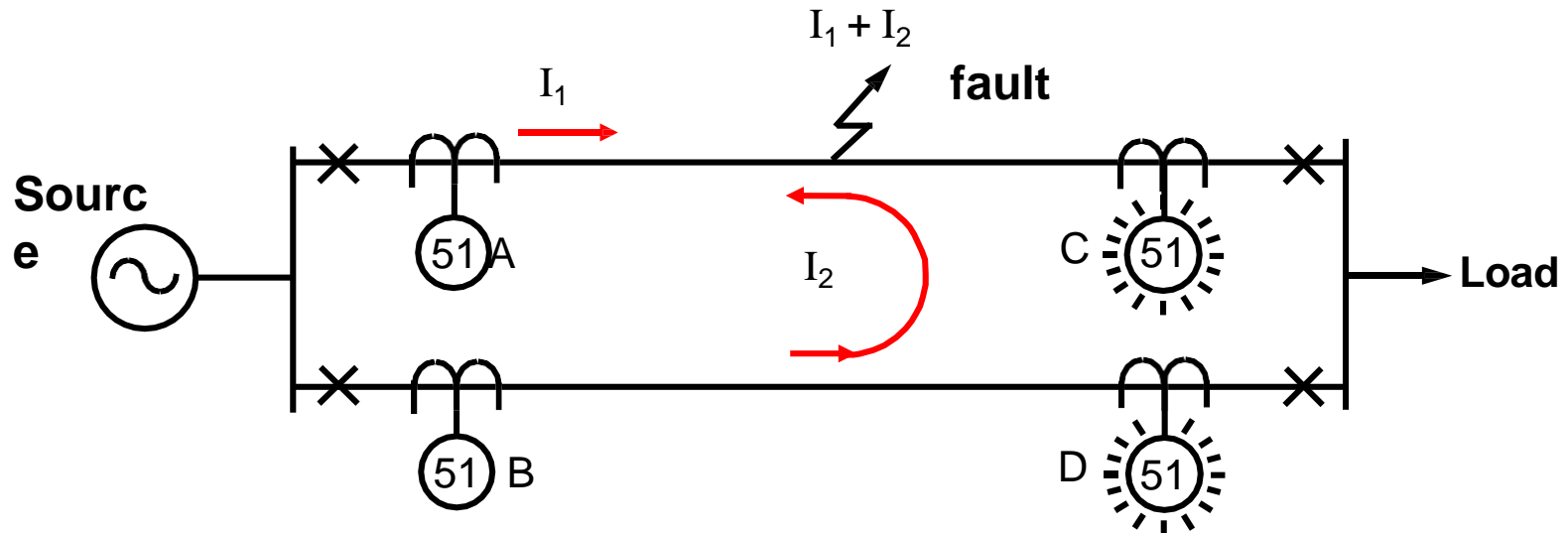
Polarizing voltage is obtained from V.T.
Secondaries which
are connected in 'broken' delta configuration.



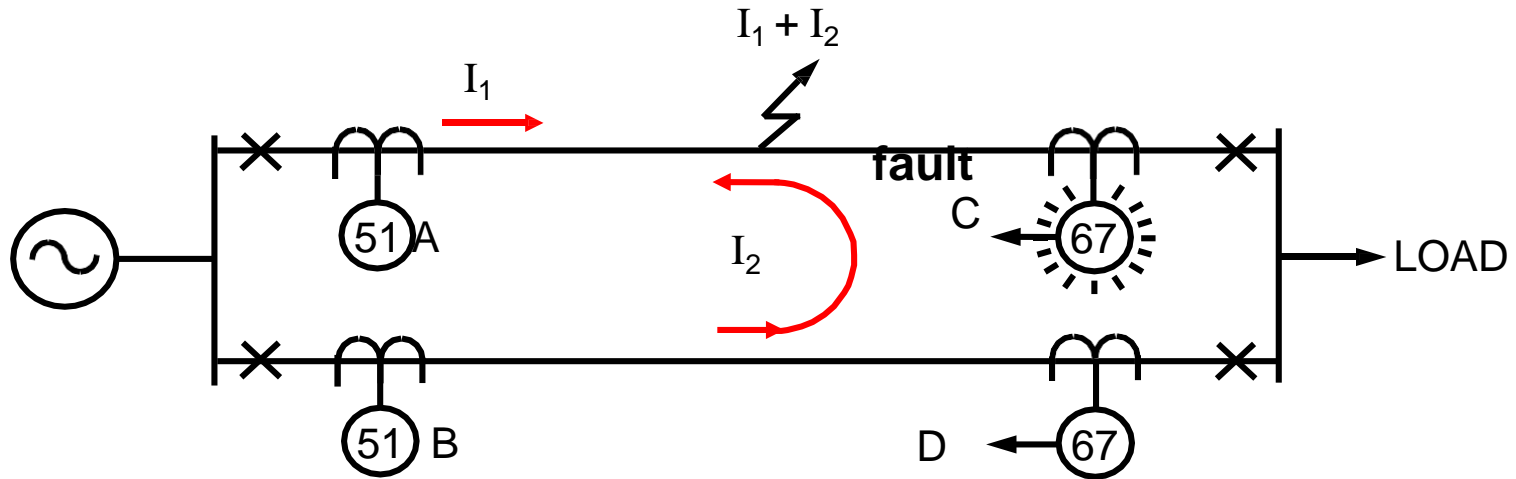
$$V_{RES} = V_a + V_b + V_c$$

Application of Directional Relays for protection of Parallel Feeders

Consider a fault on one feeder 'AC'

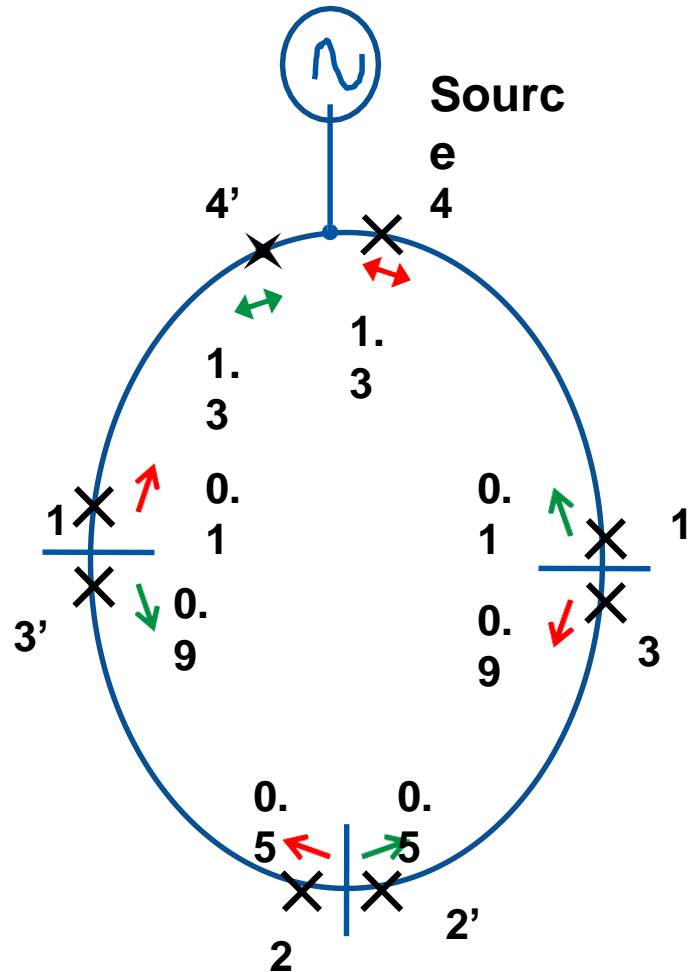


Non directional Relays at 'C' and 'D' see the same fault current (I_2). As 'C' and 'D' have similar settings, both feeders will be tripped. This isolates the load completely.



The directional over current relay (67) at 'D' is looking towards the direction of B. Since the flow of fault current is in the reverse direction of relay at 'D' it does not operate due to fault in line 'AC'. The fault will be isolated by relays 'A' and 'C'. The supply to the load will be fed through line 'BD'

Directional relay for ring main protection



- The arrows associated with relays indicate the direction of flow that will cause the relay to operate. Non directional relays are provided at supply point (where power can flow only in one direction) and directional relays are provided at intermediate substations around the ring where power flow can be in either direction. One set of relays will be operative according to the direction of fault current.
- The ring is graded first in a clock wise direction and then in anti-clock wise direction. The relays looking in clock wise direction are arranged to operate in 1-2-3-4 sequence and relays looking in the anti-clockwise are arranged to operate in sequence 1'-2'-3'-4'.

Application of Over current Protection

Overcurrent & Earth fault Protection is used in almost all electrical equipments such as.

- HT lines
- Transformers
- Generators
- Reactors
- Capacitor Banks
- Motors
- Neutral displacement relays in capacitor banks
- EHT lines (Directional overcurrent &E/F)
- Breaker failure Protection

Bibliography

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- <http://electrical-engineering-portal.com/>
- <https://electricalnotes.wordpress.com/>
- Network Protection And Automation Guide, Alstom.