Protective Relaying

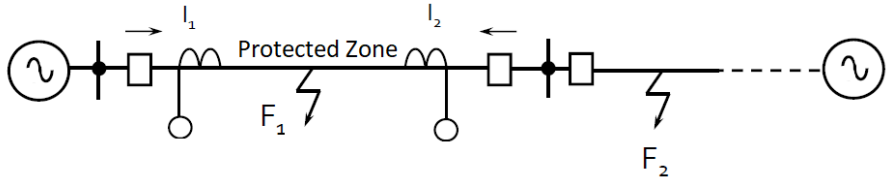
Differential Protection
Protective relays generally operate based on predetermined threshold values for one or more quantities.
Differential relays are unique because they compare two or more currents with each other.
ANSI Device # 87 – Differential Protective Relay
Differential protection is considered the best protection method.

Some of the key features of differential protection include the following:
It can be applied to all power system components – transformers, motors, generators, buses, transmission lines...
Generally a preferred option for primary protection.
Doesn't offer back-up protection or co-ordination to other zones.
Due to lack of co-ordination requirement it allows high-speed tripping.
Doesn't require system fault current and voltage calculations.

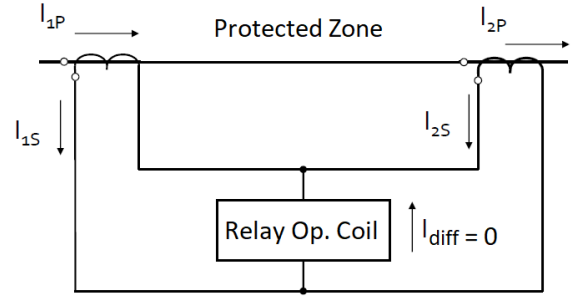
Principle of Protection
Currents at interconnection of protected equipment/zones are compared - this is called differential current.
Internal faults (such as F1) will result in differential current equal to fault current
→ $I_{diff} = I_1 - I_2 = I_{F1}$

External faults and all other conditions will result in differential current equal to 0 → $I_{diff} = I_1 - I_2 = 0$

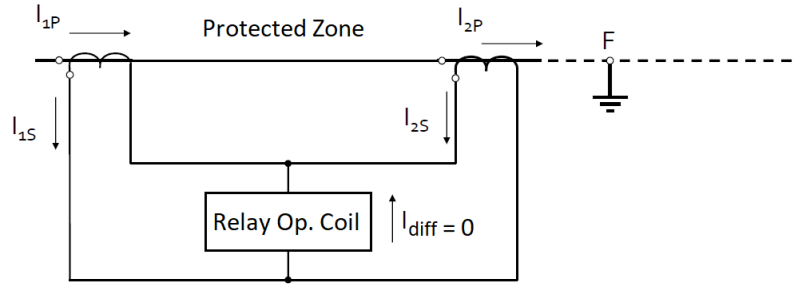
Differential principle is based on KCL.



Normal Operation
Primary and secondary current through both CTs are equal.
$I_{diff} = I_1 - I_2 = 0$



External Fault
Primary and secondary current through both CTs are much higher than normal condition but still equal.
$I_{diff} = I_1 - I_2 = 0$



Internal Fault
Current direct and magnitude are no longer equal. $I_{diff} = I_1 - I_2 \neq 0$
This will result in a differential current flow which will cause the relay to operate if following condition is met: $I_{pick\text{-}up} \geq kI_{diff}$