Protection schemes

The various protection schemes are

(i)OverCurrent Protection

(ii)Distance Protection

(iii)Carrier current Protection

(iv)Differential protection

(i) OverCurrent Protection

An overcurrent exists when current exceeds the rating of conductors or equipment. It can result from overload, short circuit, or ground fault.

- An *overload* is a condition in which equipment or conductors carry current exceeding their rated ampacity. An example is plugging two 12.5A (1,500W) hair dryers into a 20A branch circuit.
- A *short circuit* is the unintentional electrical connection between any two normally current-carrying conductors of a circuit (line-to-line or line-to-neutral).

.A *ground fault* is an unintentional, electrically conducting connection between an ungrounded conductor of a circuit and the equipment grounding conductor, metallic enclosures, metallic raceways, metallic equipment, or earth. During a ground fault, dangerous voltages and abnormally large currents exist.

(ii) Distance protection

Distance protection relay is the name given to the protection, whose action depends on the distance of the feeding point to the fault. The time of operation of such protection is a function of the ratio of voltage and current, i.e., impedance. This impedance between the relay and the fault depends on the electrical distance between them. The principal type of distance relays is impedance relays, reactance relays, and the reactance relays.

Distance protection relay principle differs from other forms of protection because their performance does not depend on the magnitude of the current or voltage in the protective circuit but it depends on the ratio of these two quantities. It is a double actuating quantity relay with one of their coil is energized by voltage and the other coil is energized by the current. The current element produces a positive or pick-up torque while the voltages element has caused a negative and reset torque.

The relay operates only when the ratio of voltage and current falls below a set value. During the fault the magnitude of current increases and the voltage at the fault point decreases. The ratio of the current and voltage is measured at the point of the current and potential transformer. The voltage at potential transformer region depends on the distance between the PT and the fault.

If the fault is nearer, measured voltage is lesser, and if the fault is farther, measured voltage is more. Hence, assuming constant fault impedance each value of the ratio of voltage and current measured from relay location comparable to the distance between the relaying point and fault point along the line. Hence such protection is called the distance protection or impedance protection.

Distance zone is non-unit protection, i.e., the protection zone is not exact. The distance protection is high-speed protection and is simply to apply. It can be employed as a primary as well as backup protection. It is very commonly used in the protection of transmission lines.

Distance relays are used for both phase fault and ground fault protection, and they provide higher speed for clearing the fault. It is also independent of changes in the magnitude of the short circuits, current and hence they are not much affected by the change in the generation capacity and the system configuration. Thus, they eliminate long clearing times for the fault near the power sources required by overcurrent relay if used for the purpose.

(iii) Carrier current protection

Carrier current protection scheme is mainly used for the protection of the long transmission line. In the carrier, current protection schemes, the phase angle of the current at the two phases of the line are compared instead of the actual current. And then the phase angle of the line decides whether the fault is internal and external. The main elements of the carrier channel are a transmitter, receiver, coupling equipment, and line trap.

The carrier current receiver receives the carrier current from the transmitter at the distant end of the line. The receiver converts the received carrier current into a DC voltage that can be used in a relay or other circuit that performs any desired function. The voltage is zero when the carrier current, is not being received.

Line trap is inserted between the bus-bar and connection of coupling capacitor to the line. It is a parallel LC network tuned to resonance at the high frequency. The traps restrict the carrier current to the unprotected section so as to avoid interference from the with or the other adjacent carrier current channels. It also avoids the loss of the carrier current signal to the adjoining power circuit.

The coupling capacitor connects the high-frequency equipment to one of the line conductors and simultaneously separate the power equipment from the high power line voltage. The normal current will be able to flow only through the line conductor, while the high current carrier current will circulate over the line conductor fitted with the high- frequency traps, through the trap capacitor and the ground.The different methods of current carrier protection and the basic form of the carrier current protection are

1. Directional Comparison protection
2. Phase Comparison Protection

These types are explained below in details

1. Directional Comparison Protection

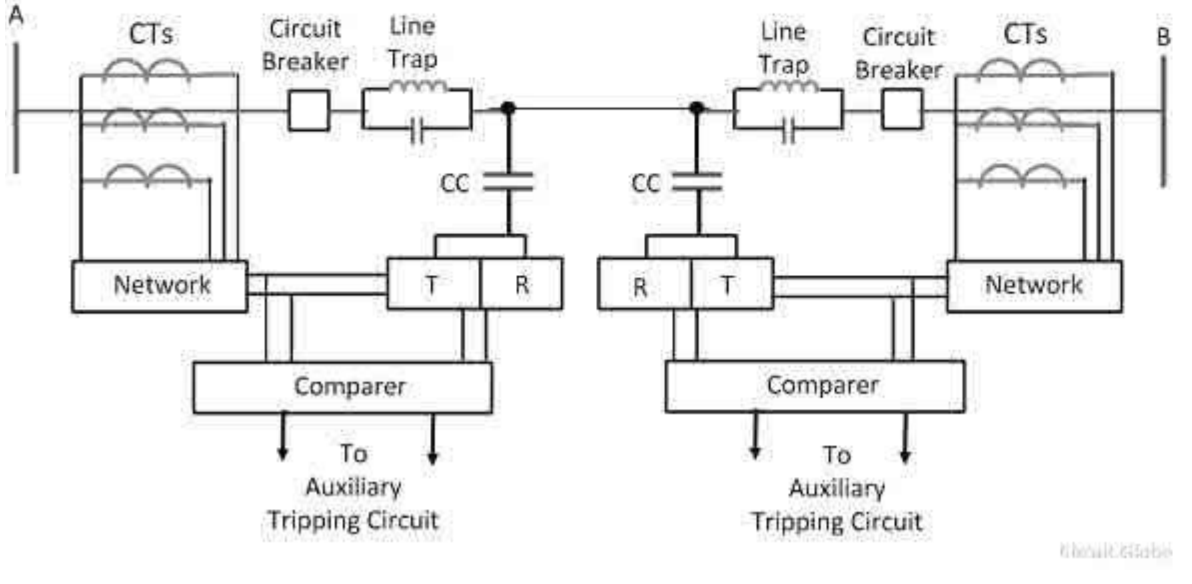
In this protection schemes, the protection can be done by the comparison of a fault of the power flow direction at the two ends of the line. The operation takes place only when the power at both the end of the line is on the bus to a line direction. After the direction comparison, the carrier pilot relay informs the equipment how a directional relay behaves at the other end to a short circuit.

The relay at both the end removes the fault from the bus. If the fault is in protection section the power flows in the protective direction and for the external fault power will flow in the opposite direction. During the fault, a simple signal through carrier pilot is transmitted from one end to the other. The pilot protection relaying schemes used for the protection of transmission are mainly classified into two types. They are

- *Carrier Blocking Protection Scheme* – The carrier blocking protection scheme restricts the operation of the relay. It blocks the fault before entering into the protected section of the system. It is one of the most reliable protecting schemes because it protects the system equipment from damage.
- *Carrier Permitting Blocking Scheme* – The carrier, protective schemes allows the fault current to enter into the protected section of the system.

2. Phase Comparison Carrier Protection

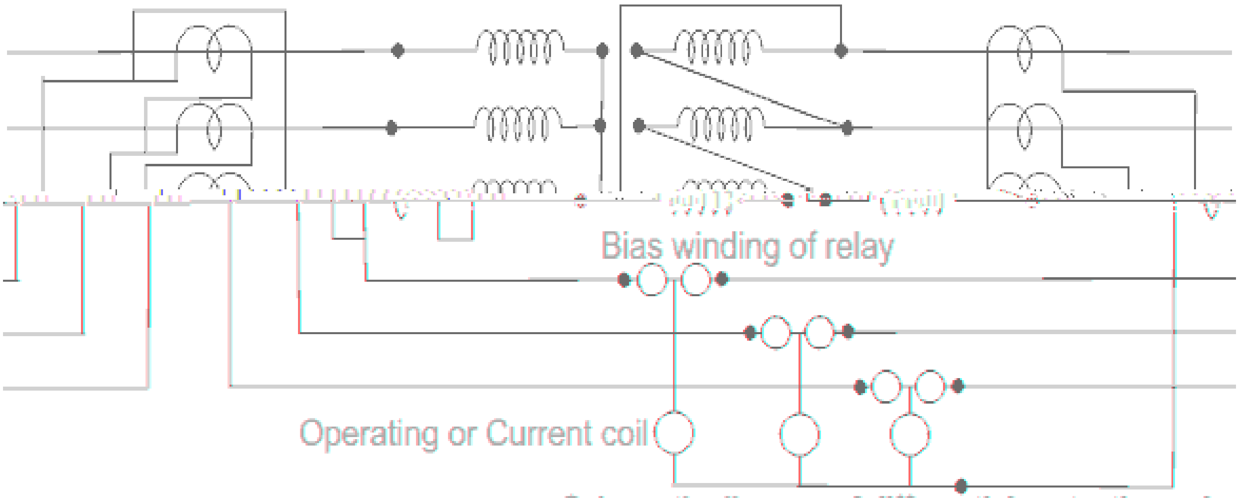
This system compares the phase relation between the current enter into the pilot zone and the current leaving the protected zone. The current magnitudes are not compared. It provided only main or primary protection and backup protection must be provided also.



The transmission line CTs feeds a network that transforms the CTs output current into a single phase sinusoidal output voltage. This voltage is applied to the carrier current transmitter and the comparer. The output of the carrier current receiver is also applied to the comparer. The comparer regulates the working of an auxiliary relay for tripping the transmission line circuit breaker.

(iv) Differential protection

Principle of Differential Protection scheme is one simple conceptual technique. The differential actually compares between primary current and secondary current of power transformer, if any unbalance found in between primary and secondary currents the relay will actuate and inter trip both the primary and secondary circuit breaker of the transformer. Suppose you have one transformer which has primary rated current I_p and secondary current I_s. If you install CT of ratio I_p/1A at the primary side and similarly, CT of ratio I_s/1Aat the secondary side of the transformer. The secondaries of these both CTs are connected together in such a manner that secondary currents of both CTs will oppose each other. In other words, the secondaries of both CTs should be connected to the same current coil of a differential relay in such an opposite manner that there will be no resultant current in that coilin a normal working condition of the transformer. But if any major fault occurs inside the transformer due to which the normal ratio of the transformer disturbed then the secondary current of both transformers will not remain the same and one resultant current will flow through the current coil of the differential relay, which will actuate the relay and inter trip both the primary and secondary circuit breakers. To correct phase shift of current because of star-delta connection of transformer winding in the case of three-phase transformer, the current transformer secondary‘s should be connected in delta and star as shown here.



Schematic diagram of differential protection scheme

At maximum through fault current, the spill output produced by the smallpercentage unbalance may be substantial. Therefore, differential protection of transformer should be provided with a proportional bias of an amount which exceeds in effect the maximum ratio deviation.