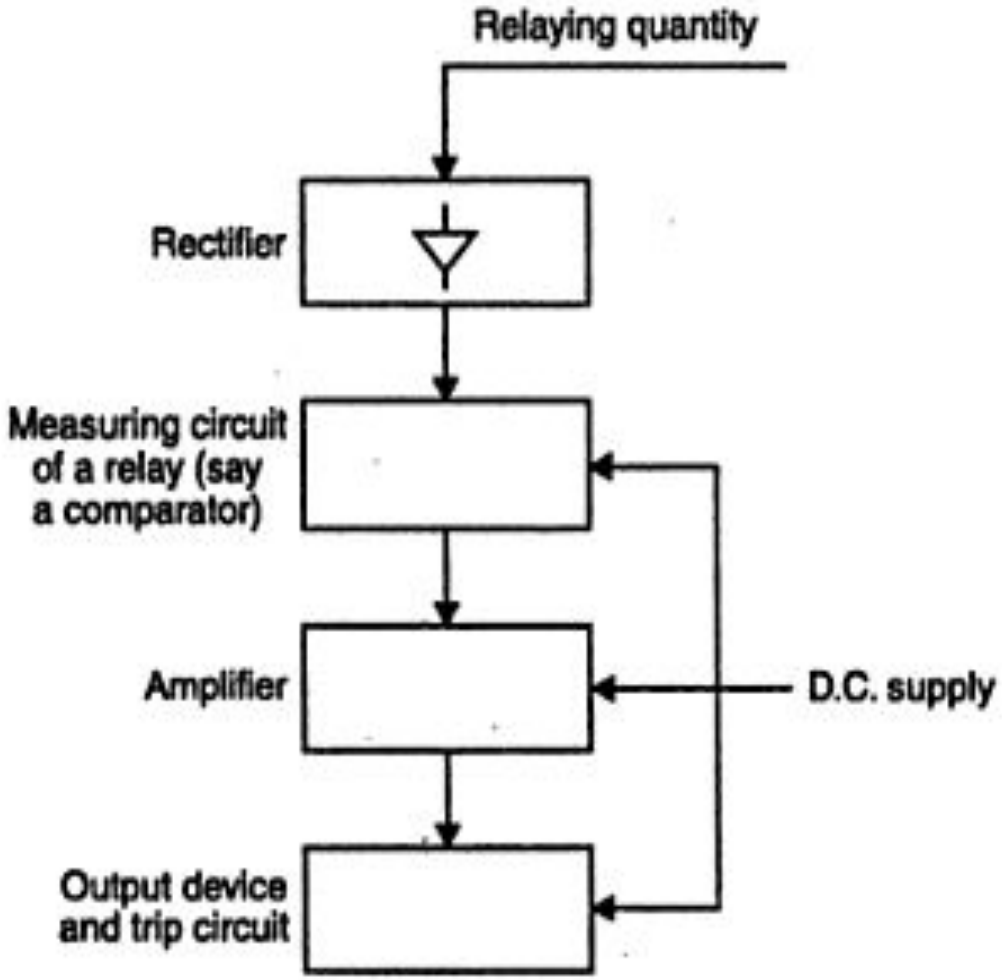
Unit IV

Static Relays

What is a Static Relay?

- The term '***static***' implies that the relay ***has no moving mechanical parts*** in it.
- It is a relay that uses solid state components like transistors and diodes for the measurement or comparison of electrical quantities.
- The static relays are designed to replace all the functions achieved earlier by electromechanical relays.

Block Diagram of a Static Relay



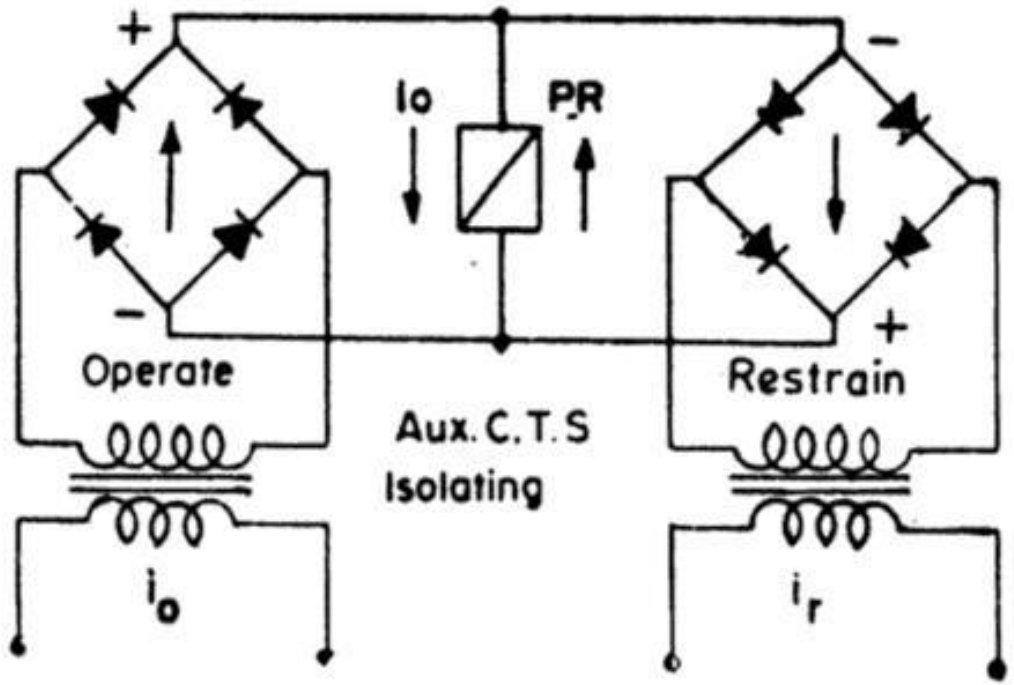
1. Comparator

- The magnitude of voltage & current and phase angle between them may change when a fault occurs.
- Static relay senses the change in these parameters to differentiate between healthy and faulty conditions.
- This is achieved by comparing either the magnitudes of voltage & current or the phase angle between them.
- The circuitry which performs this function is called comparator.
- Two types – amplitude comparator and phase comparator

1.1 Amplitude Comparator

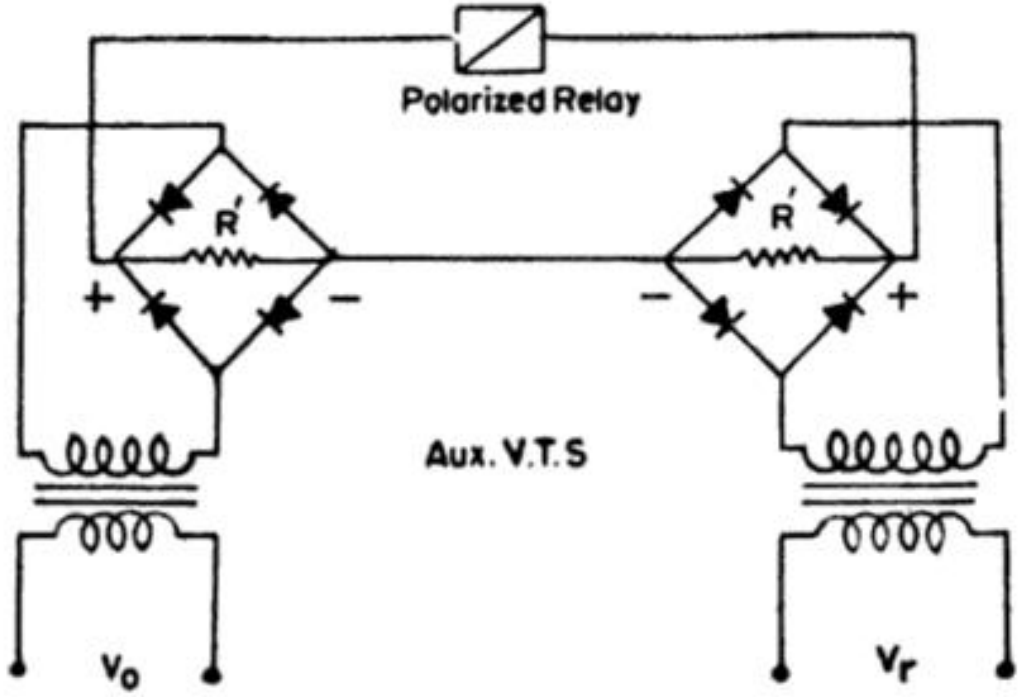
- It compares the magnitude of two input quantities irrespective of the angle between them.
- The two quantities are operating quantity and restraining quantity.
- When the magnitude of the operating quantity is greater than the restraining quantity, the relay sends trip signal to C.B.
- Types
    - Circulating current comparator
    - Opposed voltage comparator

1.1.1 Circulating current Comparator



- i_O and i_r are operating and restraining currents.
- Under no fault condition, $i_r > i_O$. The differential current flows through the relay in -ve direction.
- During a fault, $i_o > i_r$. Hence the differential current flows through the relay in +ve direction to trip C.B

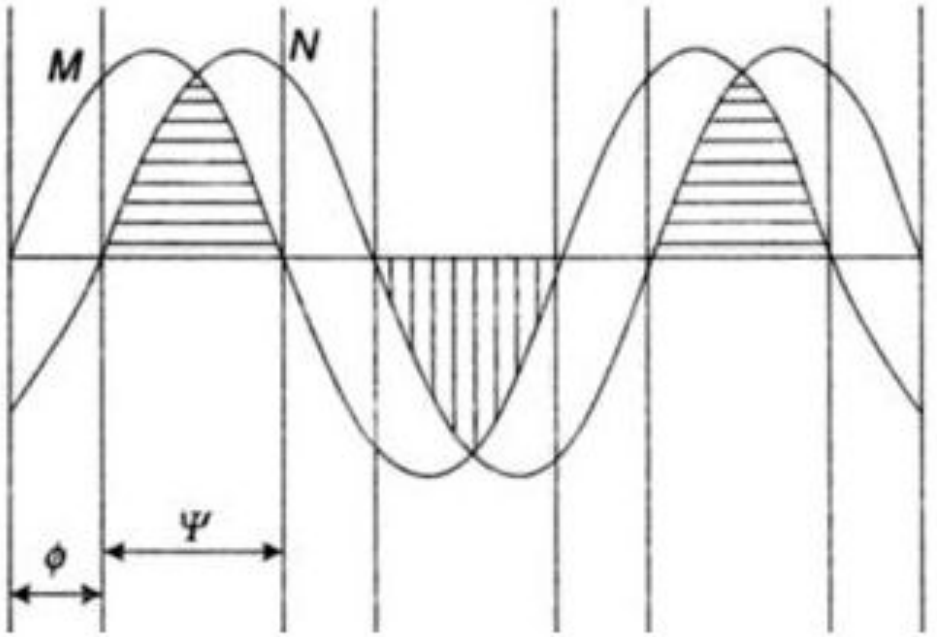
1.1.2 Opposed Voltage Comparator



- V_O and V_r are operating and restraining voltages.
- Under no fault condition, $V_r > V_O$. The differential current flows through the relay in -ve direction.
- During a fault, $V_o > V_r$. Hence the differential current flows through the relay in +ve direction to trip C.B.

1.2 Phase Comparator

- Period of coincidence of +ve polarity of 2 signals are compared with a reference angle. (usually 90 degree)
- If the 2 signals have a phase difference of ϕ, then the angle of coincidence $\psi = 180 - \phi$.
- If $\phi < 90^0$, then $\psi > 90^0$. The phase comparat the C.B, when $\psi > 90^0$.
- The period of coincidence is measured by diffe

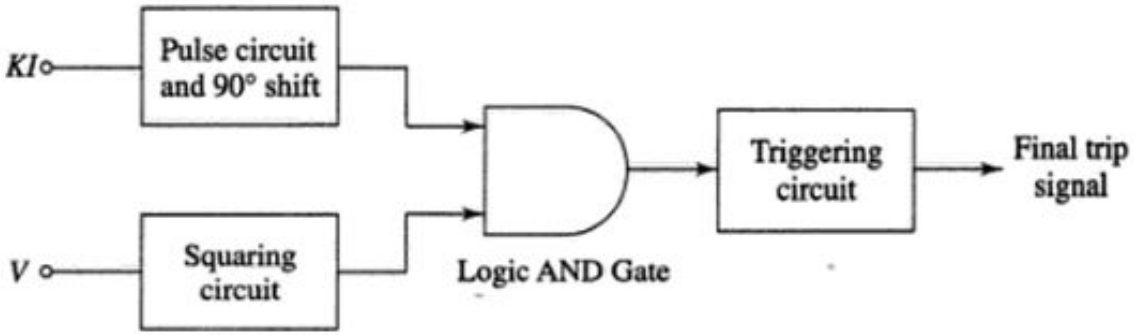


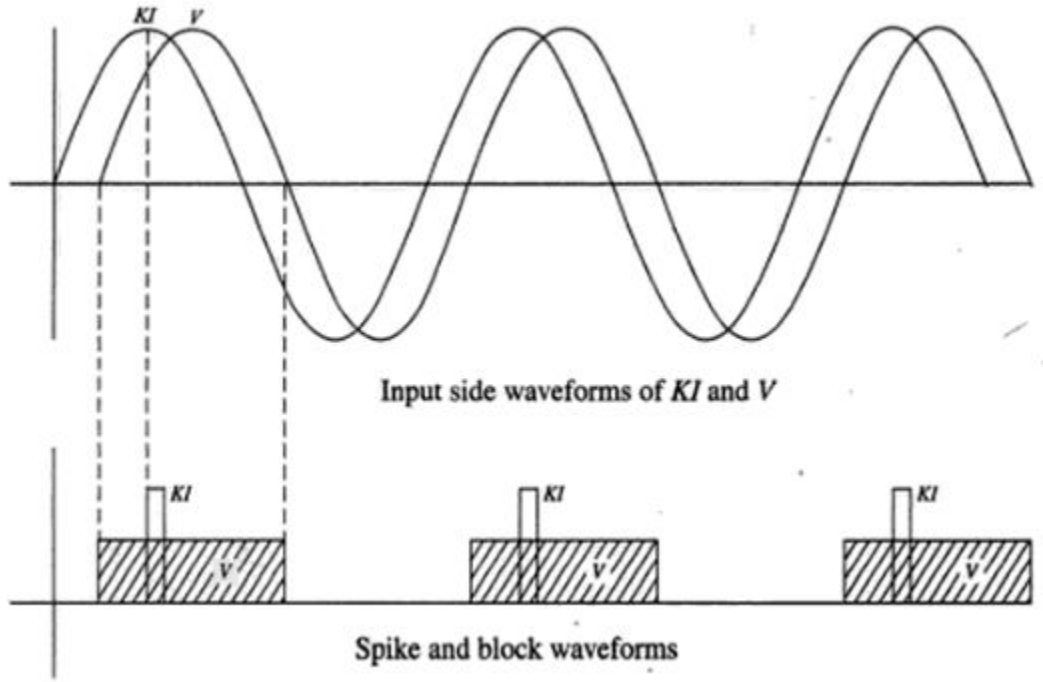
Types of Phase Comparator

- **1.2.1 Vector product P.C**
  a) Hall effect P.C
  b) Magneto-resistivity P.C
- **1.2.2 Coincidence type P.C**
  a) Block spike P.C
  b) Phase-splitting type P.C
  c) Integrating type P.C
  d) Rectifier bridge type P.C

a) Block and Spike Phase Comparator

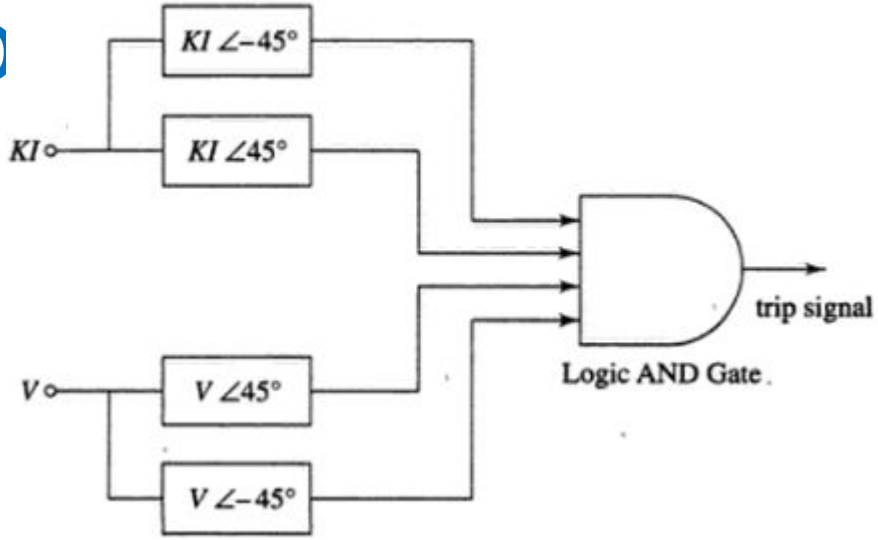
- In this method, one of the two input signals is converted into a square wave and the other is converted into a spike during its peak.
- Square wave and spike are given to an AND gate whose output is 1 when both square wave and spike are coinciding.
- Coincidence will happen only when the angle between the input signals are less than 90^0 which indicates a fault.
- Output of AND gate is used to trip the C.B

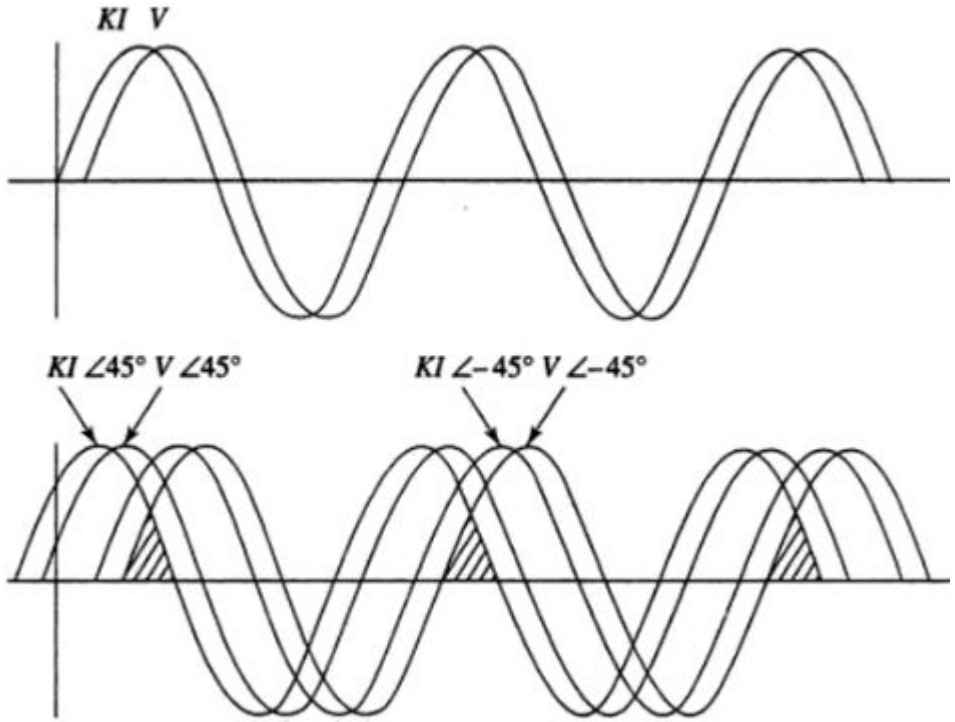




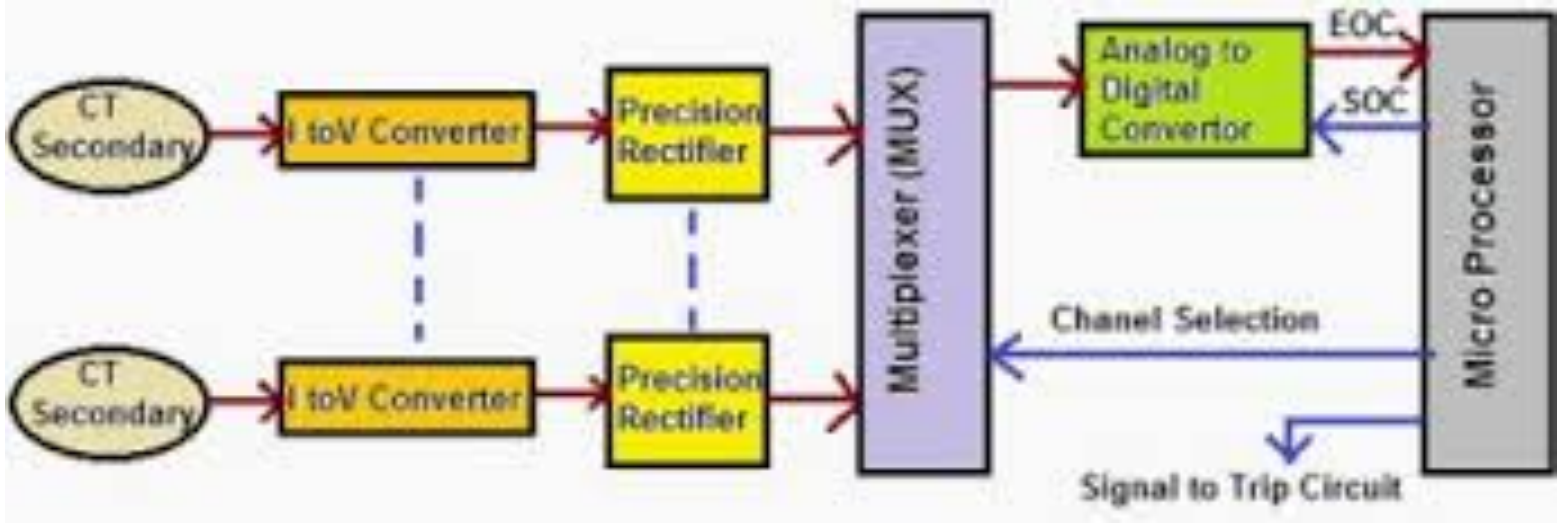
b) Phase Splitting Comparato

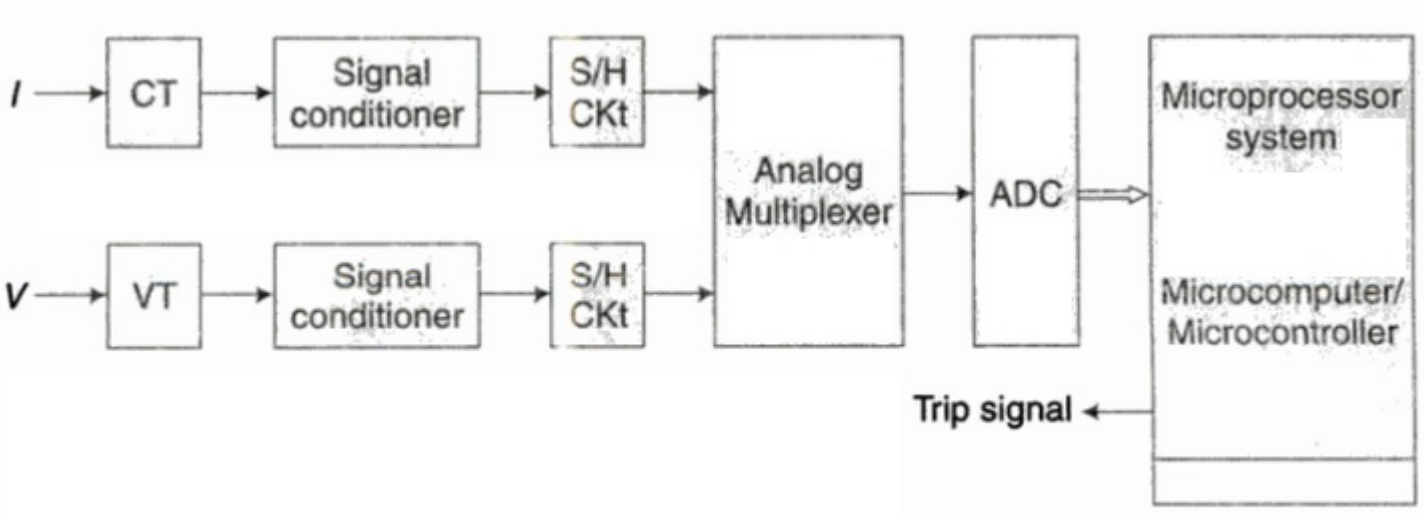
- In this method, two phase shifted (+/-45^0) components are obtained for each of the input signals.
- These 4 components are fed into an AND gate.
- Output will be 1 if all 4 signals are positive at a time. This happens only during a faulty condition.
- Output of AND gate is used to trip the C.B





Numerical Relay





Numerical Relay

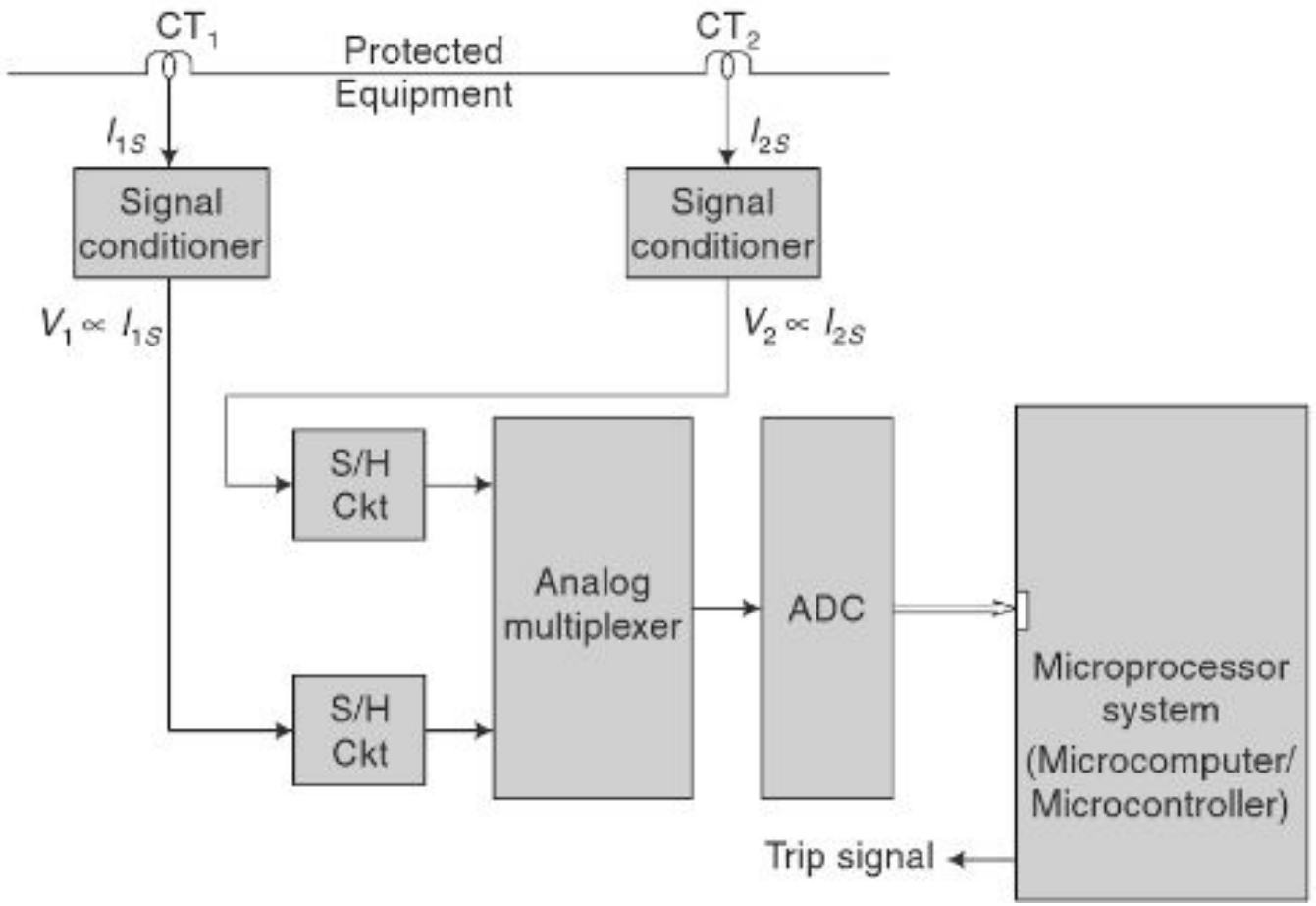
- Numerical is the relay in which the measured AC quantities are sequentially sampled and converted into numerical data that is mathematically and/or logically processed to make trip decisions.

- Numerical relay is the latest development in the area of power system protection.

- The design and method of operation these relays are different from the conventional electromechanical relays.

- Numerical relays are based on numerical devices such as microprocessors, microcontrollers and digital signal processors etc.

Numerical Relay for Differential Protection



Numerical Relay for Distance Protection