UNIT 5 - INTRODUCTION OF SOLID STATE RELAYS

A relay comprises of an electromagnet and a contact unit. The definition is: Activating the contact unit using electromagnetic attraction, which is produced when electric current exceeding the specified value flows to the electromagnet; the voltage and current (input signal) applied to the coil opens or shuts the contact.

Relays used for i. as interfaces between control circuits and load circuits, ii. for signal multiplication, iii. for separation of direct current and alternating current circuits, iv.linking information.

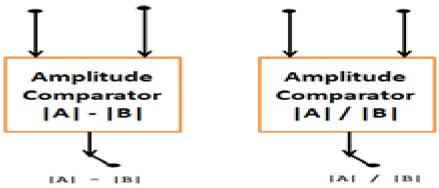
Functions Number of pins Description 1 2 Normally closed contact 3 4 Normally open contact 5 6 Normally closed contact, time delay 7 8 Normally open contact, time delay 1 2 4 Changeover contact 5 6 8 Changeover contact, time delay A1 A2 The coil terminals (common) relay contacts are either normally open (NO) or normally closed (NC), The term “normally” refers to the state in which the coil is not energized. Relays can have many independent contacts, some NO and others NC, and each contact can be used in a different circuit for a different task. When the coil is energized, all NO contacts belonging to that relay close, whereas all NC contacts open.

PHASE AND AMPLITUDE COMPARATORS:

Amplitude Comparators:

An amplitude comparator compares the magnitude of two input quantities irrespective of the angle between them. One of the inputs is the operating quantity and the other a restraining quantity.

When the amplitude of the operating quantity exceeds that of restraining quantity, the relay sends a tripping signal to the circuit breaker.



- The Amplitude comparator compares two vector, |A| and |B|
- Gives an output: the algebraic difference between the magnitudes |A| and |B|
- Output is +ve, if |A| > |B|
- Output is –ve, if |A| < |B|
- Output is zero, if |A| = |B|

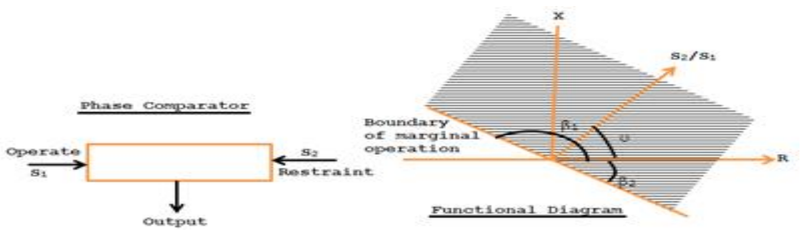
Comparison by ratio:
- Output is >1, if |A| > |B|
- Output <1, if |A| < |B|
- Output is Zero, if |A| is zero.

Phase Comparators:

Phase comparison technique is the most widely used one for all practical directional, distance, differential and carrier relays.

If the two input signals are S_1 and S_2 the output occurs when the inputs have phase relationship lying within the specified limits.

Both the input must exist for an output to occur. The operation is independent of their magnitudes and is dependent only on their **phase relationship**. The figures below show that the phase comparator is simple form. The function is defined by the boundary of marginal operation and represented by the straight lines from the origin of the S-plane.



The condition of operation is $\beta_1 \leq \theta \leq \beta_2$.

θ is the angle by which S_2 lands S_1. If $\beta_1 = \beta_2 = 90^o$, the comparator is called **cosine comparator** and if $\beta_1=0$ and $\beta_2=180^o$, it is a **sine comparator**.

In short, **a phase comparator compares two input quantities in phase angle** (vertically) irrespective of the magnitude and operates if the phase angle between them is $\leq 90^o$.

There are two **types of phase comparators**:

1. Vector product comparator
2. Coincidence type phase comparator.

Vector Product comparator:

This comparator recognizes the vector product or division between the two or more quantities. Thus, the output is A, B or A/B

Coincidence Comparator:

Consider two signals S_1 and S_2. The period of Coincidence of S_1 and S_2 will depend on the phase difference between S_1 and S_2. The fig below shows the coincidence of S_1 and $S_2$when S_2 lags S_1 by less than $\pi/2$ ie., θ.The period of coincidence of S_1 and S_2 with a phase difference of θ is $\Psi = 180^o - \theta$. Different techniques are used to measure the period of coincidence. Two of the important types are

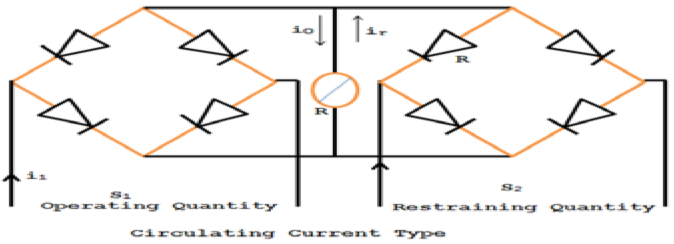
1. Bloke Spike Method (Direct Phase Comparison) and
2. Coincidence type – Integrating phase comparator.

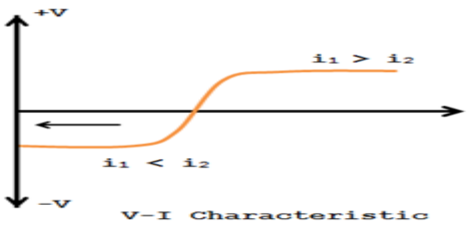
INTEGRATING COMPARATOR:

-Circulating Current Type

- Opposed Voltage Type

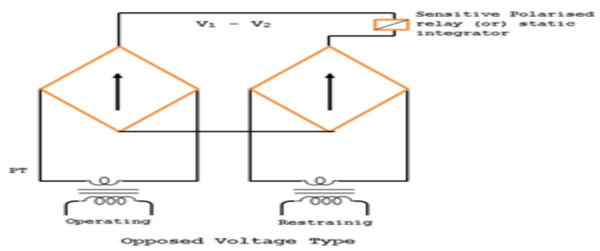
Circulating Current Type





It can also be used as impedance relay. Two rectifier bridges can be arranged in such a manner as shown in the figure below, to function as amplitude comparator circulating type. The polarized relay operates when $S_1>S_2$ where $S_1=K_1i_1$ and $S_2 = K_2i_2$. This arrangement gives a sensitive relay whose voltage may be represented in the VI characteristic of the figure.

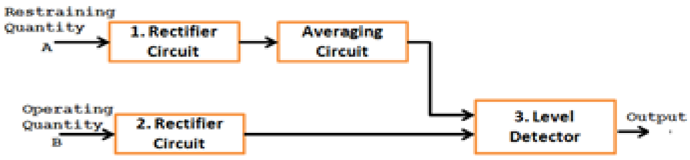
Opposed Voltage type



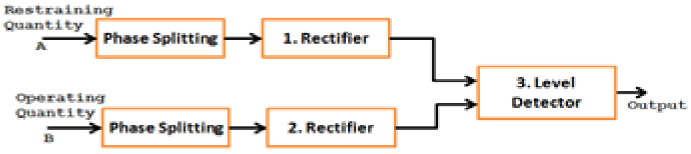
This type works with voltage input signals derived from PTs. The operation depends on the difference of the average **rectified voltage** (V1-V2).Here the rectifiers are not protected against higher currents. The relay operates when V1 >V2.

Instantaneous Comparator (Directing Amplitude Comparator) –

DIRECT COMPARATOR:



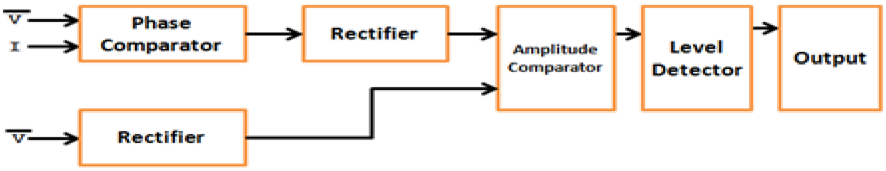
Here the restraining signal is rectified and smoothed completely in order to provide a level restraint.This is then compared with the peak value of operating signal, which may or may not be rectified but is smoothened. The tripping signal is provided if the operating signal exceeds the level of the restraint. The block diagram is shown in the fig above. Since this method involves smoothening, the operation is slow. A faster method is phase splitting the wave shapes of instantaneous amplitude comparator are shown in fig below before rectification and the averaging circuit can be eliminated.



Block Diagram of Phase Spliting for amplitude comparator

HYBRID COMPARATOR:

This kind of comparator compares both magnitude and phase of the input quantities. Hence this type is of mixed version. In the hybrid comparator, both amplitude and phase comparators are used. Inputs are given to a phase comparator. The output of the phase comparator is given to amplitude comparator.



Static impedance relays comparing V and I are generally of Hybrid Comparator.