5.4 THREE TERMINAL AC SWITCH (TRIAC)

Triac is a three terminal AC switch which is different from the other silicon controlled rectifiers in the sense that it can conduct in both the directions that is whether the applied gate signal is positive or negative, it will conduct. Thus, this device can be used for AC systems as a switch.This is a three terminal, four layer, bi-directional semiconductor device that controls AC power. The triac of maximum rating of 16 kw is available in the market.

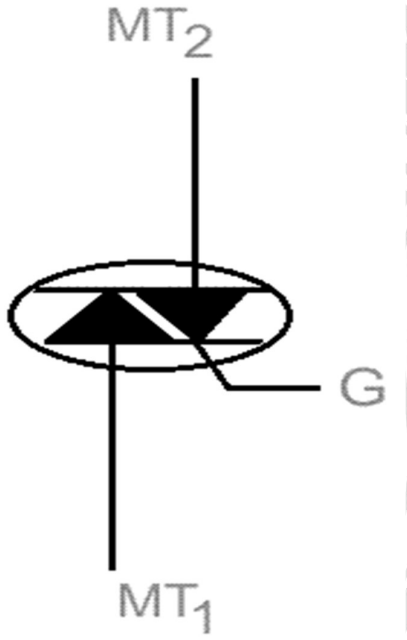

Fig:5.4.1 Symbol of TRIAC

Figure shows the symbol of triac, which has two main terminals MT1 and MT2 connected in inverse parallel and a gate terminal.

Construction of Triac

Two SCRs are connected in inverse parallel with gate terminal as common. Gate terminals is connected to both the N and P regions due to which gate signal may be applied which is irrespective of the polarity of the signal. Here, we do not have anode and cathode since it works for both the polarities which means that device is bilateral. It consists of three terminals namely, main terminal 1(MT1), main terminal 2(MT2), and gate terminal G.

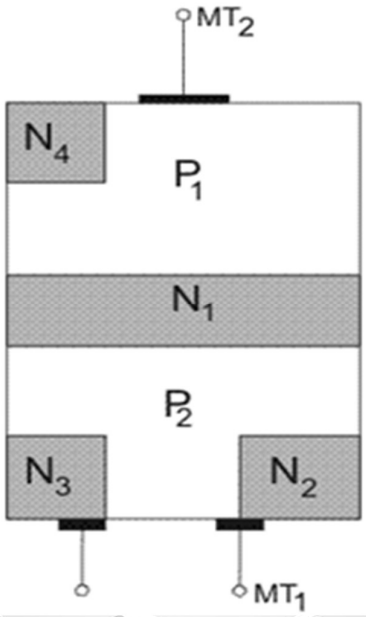

Fig:5.4.2 Construction of TRIAC

Figure shows the construction of a triac. There are two main terminals namely MT1 and MT2 and the remaining terminal is gate terminal.

Operation of Triac

The triac can be turned on by applying the gate voltage higher than break over voltage. However, without making the voltage high, it can be turned on by applying the gate pulse of 35 micro seconds to turn it on. When the voltage applied is less than the break over voltage, we use gate triggering method to turn it on. There are four different modes of operations, they are-

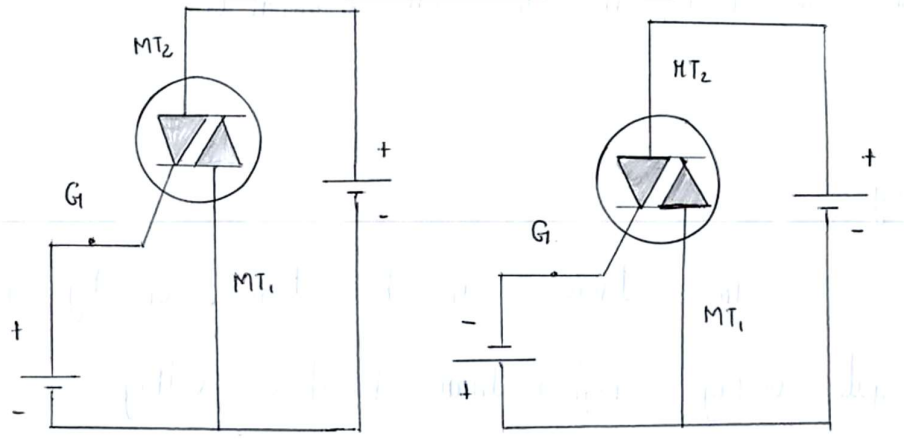

Fig:5.4.3 MT2 Positive and Gate Being Positive or Negative

1. **When MT2 and Gate being Positive with Respect to MT1** When this happens, current flows through the path P1-N1-P2-N2. Here, P1-N1 and P2-N2 are forward

biased but N1-P2 is reverse biased. The triac is said to be operated in positively biased region. Positive gate with respect to MT1 forward biases P2-N2 and breakdown occurs.

2. **When MT2 is Positive but Gate is Negative with Respect to MT1** The current flows through the path P1-N1-P2-N2. But P2-N3 is forward biased and current carriers injected into P2 on the triac.

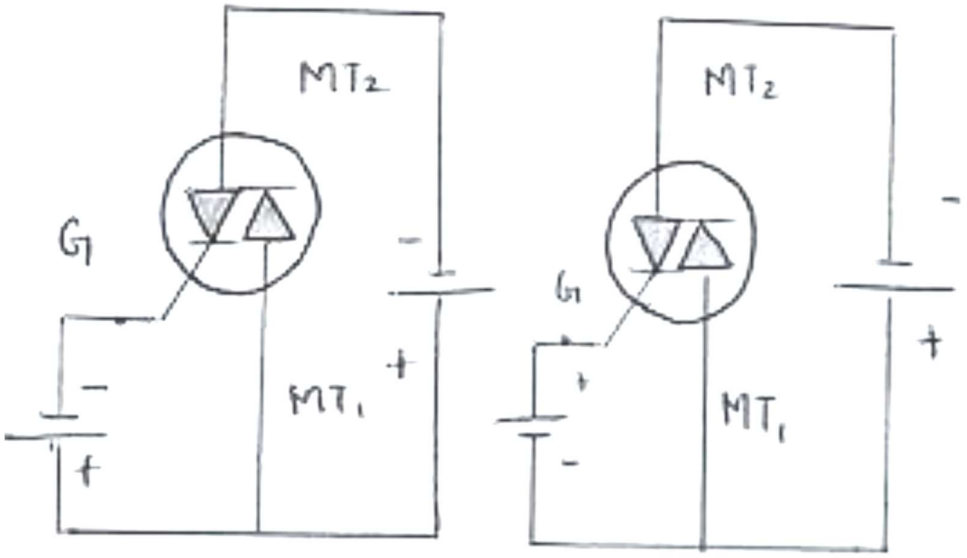

Fig:5.4.4 MT2 Negative and Gate Being Positive or Negative

3. **When MT2 and Gate are Negative with Respect to MT1** Current flows through the path P2-N1-P1-N4. Two junctions P2-N1 and P1-N4 are forward biased but the junction N1-P1 is reverse biased. The triac is said to be in the negatively biased region.

4. **When MT2 is Negative but Gate is Positive with Respect to MT1** P2-N2 is forward biased at that condition. Current carriers are injected so the triac turns on. This mode of operation has a disadvantage that it should not be used for high (di/dt) circuits. Sensitivity of triggering in mode 2 and 3 is high and if marginal triggering capability is required, negative gate pulses should be used. Triggering in mode 1 is more sensitive than mode 2 and mode 3.

Characteristics of a Triac

The triac characteristics is similar to SCR but it is applicable to both positive and negative triac voltages. The operation can be summarized as follows-

First Quadrant Operation of Triac

Voltage at terminal MT2 is positive with respect to terminal MT1 and gate voltage is also positive with respect to first terminal.

Second Quadrant Operation of Triac

Voltage at terminal 2 is positive with respect to terminal 1 and gate voltage is negative with respect to terminal 1.

Third Quadrant Operation of Triac

Voltage of terminal 1 is positive with respect to terminal 2 and the gate voltage is negative.

Fourth Quadrant Operation of Triac

Voltage of terminal 2 is negative with respect to terminal 1 and gate voltage is positive.

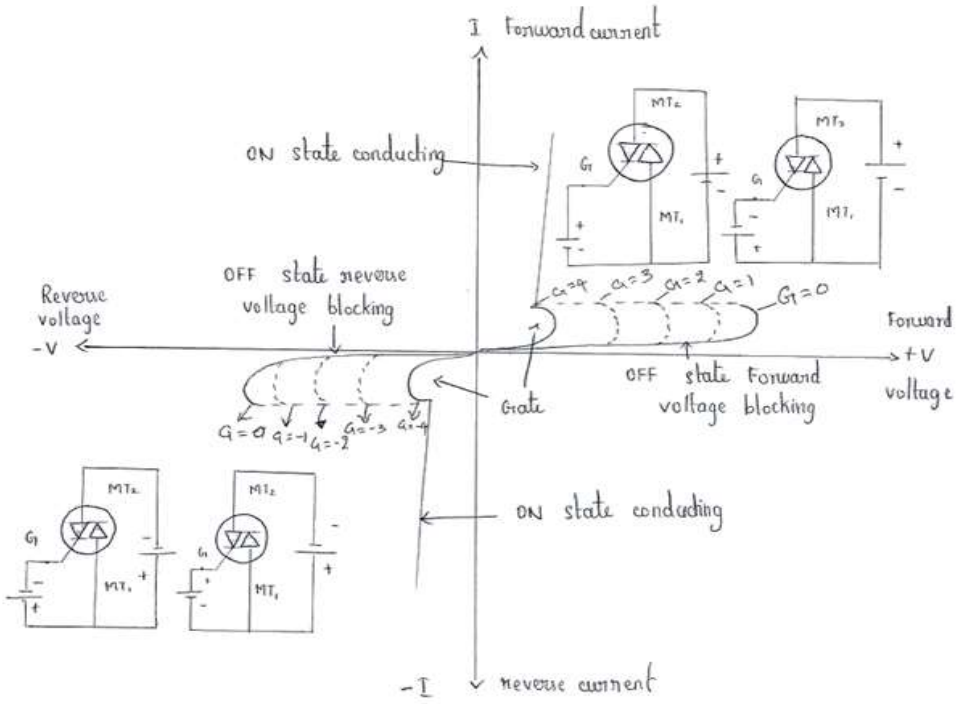

Fig:5.4.5 V-I Characteristics of TRIAC

When the device gets turned on, a heavy current flows through it which may damage the device, hence in order to limit the current a current limiting resistor should be connected externally to it. By applying proper gate signal, firing angle of the device may be controlled. The gate triggering circuits should be used for proper gate triggering. We can use diac for triggering the gate pulse. For firing of the device with proper firing angle, a gate pulse may be applied up to a duration of 35 micro seconds.

Advantages of Triac

1. It can be triggered with positive or negative polarity of gate pulses.
2. It requires only a single heat sink of slightly larger size, whereas for SCR, two heat sinks should be required of smaller size.
3. It requires single fuse for protection.
4. A safe breakdown in either direction is possible but for SCR protection should be given with parallel diode.

Disadvantages of Triac

1. They are not much reliable compared to SCR.
2. It has (dv/dt) rating lower than SCR.
3. Lower ratings are available compared to SCR.

Uses of Triac

1. They are used in control circuits.
2. It is used in High power lamp switching.
3. It is used in AC power control.