1.3 Study of TRIAC

Triacs are electronic components that are widely used in AC power control applications. They are able to switch high voltages and high levels of current, and over both parts of an AC waveform. This makes triac circuits ideal for use in a variety of applications wherepower switching is needed.

An SCR is a unidirectional device as it can conduct from anode to cathode only and not from cathode to anode. A triac can, however, conduct in both the directions. A triac is thus a bidirectional thyristor with three terminals. It is used extensively for the controlof power in ac circuits . Triac is the word derived by combining the capital letters from the words TRIode and AC. When in operation, a triac is equivalent to two SCRs connected in anti parallel.

The triac is a development of the thyristor. While the thyristor can only control current over one half of the cycle, the triac controls it over two halves of an AC waveform.

The triac can be considered as a pair of parallel but opposite thyristors with the two gates connected together and the anode of one device connected to the cathode of the other.

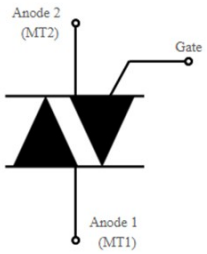

Fig 1.3.1 Symbol of TRIAC

[Source: "Power Electronics" by P.S.Bimbra, Khanna Publishers Page: 123]

As the triac can conduct in both the directions, the terms anode and cathode are not applicable to triac. Its three terminals are usually designated as MTl (main terminal 1), MT2 and the gate by G. The gate G is near terminal MTl. The cross-hatched strip shows that G is connected to N3 as well as P2.Similarly terminal MTI is connected to P2 and N2, terminal MT2 to P1 and N4 . With no signal to gate, the triac will block both half cycles of the applied voltage in case peak value of this voltage is less than the breakover voltage vBDl or VBD2 of the triac, Fig.

The triac can, be turned on in each half cycle of the applied voltage by applying a positive or negative voltage to the gate with respect to terminal MTl. For convenience, terminal MTI is taken as the point for measuring the voltage and current at the gate and MT2 terminals.

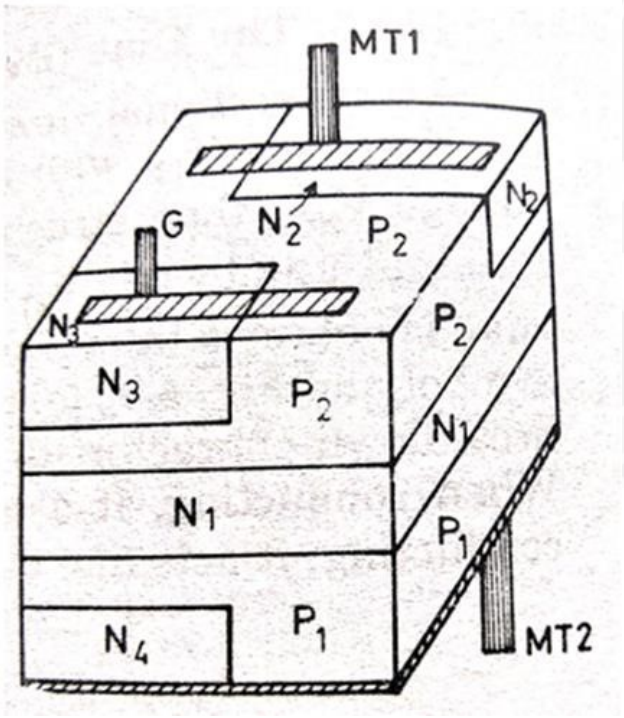

Fig.1.3.2 cross sectional view of TRIAC

[Source: "Power Electronics" by P.S.Bimbra, Khanna Publishers Page: 123]

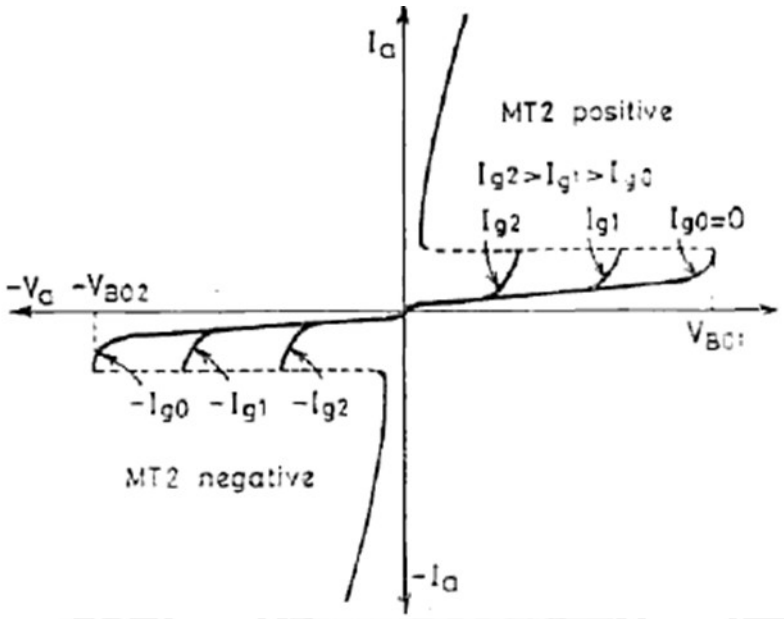

Fig.1.3.3 Static VI characteristics of TRIAC

[Source: "Power Electronics" by P.S.Bimbra, Khanna Publishers Page: 124]

TRIGERRING MODES OF OPERATION OF TRIAC

1.Terminal MT2 and gate are positive with respect to terminal MT1

2.Terminal MT2 is positive but gate is negative with respect to terminal MT1

3.Terminal MT2 and gate are negative with respect to terminal MT1

4.Terminal MT2 is negative but gate is positive with respect to terminal MT1

MT2 is positive and gate current is also positive.

- When MT2 is positive with respect to MTI, junction PI NI, P2 N2 are forward biased but junction NI P2 is reverse biased.
- When gate terminal is positive with respect to MTl, gate current flows mainly through P2 N2 junction like an ordinary SCR.

- When gate current has injected sufficient charge into P2 layer, reverse biased junction NI P2 breaks down just as in a normal SCR.
- Triac starts conducting through PI N I P2 N2 layers.
- Thus when MT2 and gate terminals are positive with respect to MTl, triac turns on like a conventional thyristor. Under this condition, triac operates in the first quadrant of Fig.
- The device is more sensitive in this mode. It is recommended method of triggering if the conduction is desired in the first quadrant.

MT2 is positive but gate current is negative.

- When gate terminal is negative with respect to MTl, gate current flows through P2 N3 junction, Fig, 1.11 (b) and reverse biased junction N1 P2 is forward biased as in a normal thyristor.
- Triac starts conducting through P1 NI P2 N3 layers initially.
- With the conduction of Pl N1P2 N 3, the voltage drop across this path falls but potential of layer between P2 N2 rises towards the anode potential of MT2.
- The right hand portion of P2 is clamped at the cathode potential of MTl, a potential gradient exists across layer P2, its left hand region being at higher potential than itsright hand region.
- A current shown dotted is thus established in layer P2 from left to right.

This current is similar to conventional gate current of an SCR. As a consequence, right-hand part of triac consisting of main structure PI NI P2 N2 begins to conduct.

- The device structure PI N1 P2 N3 is pilot SCR and the structure PINI P2N2 as the main SCR.

- The anode current of pilot SCR serves as the gate current for the main SCR.
- With the device MT2 positive but gate current negative is less sensitive and therefore, more gate current is required.

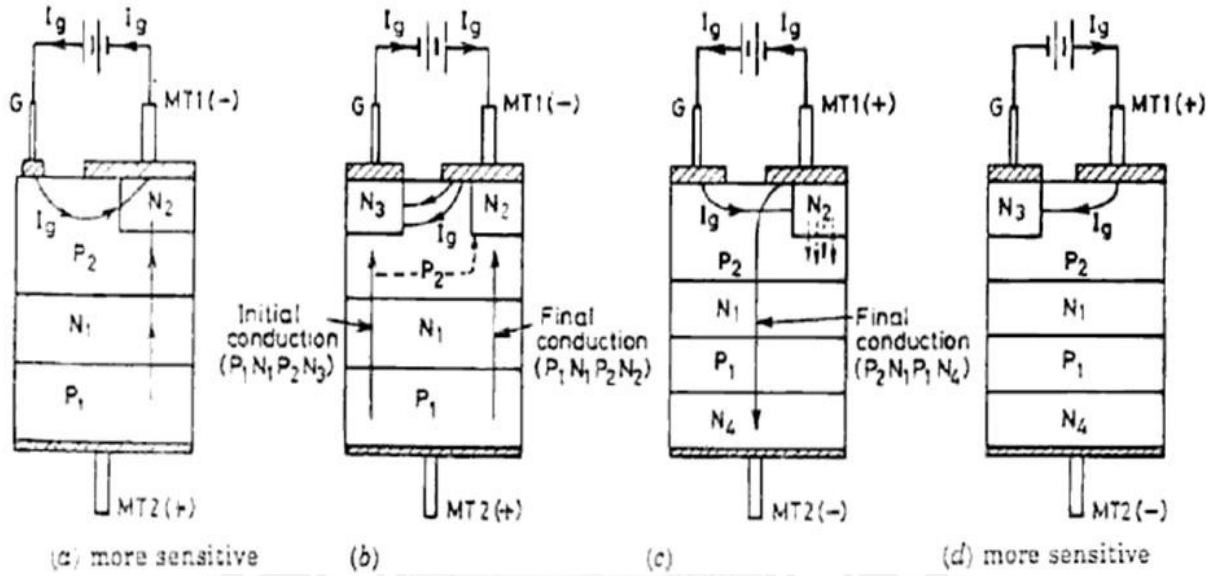

Fig 1.11. Modes of operation of TRIAC

[Source: "Power Electronics" by P.S.Bimbra, Khanna Publishers Page: 124]

MT2 is negative but gate current is positive.

- The gate current Ig forward biases P2 N2 junction
- Layer N2 injects electrons into P2 1ayer as shown by dotted arrows.
- The reverse biased junction N1P 1 breaks down as in a conventional thyristor.
- The structure P2 N1 PI N4 is completely turned on.
- As the triac is' turned on by remote gate N2, the device is less sensitive in the thirdquadrant with positive gate current.

Both MT2 and gate current are negative.

- In this mode, N3 acts as a remote gate,
- The gate current 1g flows from P2 to N3 as in a normal thyristor.
- Reverse-biased junction N1 P1 is broken and finally, the structure P2 N1 Pl N4 is turned oncompletely.
- The triac is turned on by remote gate N3 in third quadrant, yet the device is moresensitive.

ADVANTAGES OF TRIAC

1. It can be triggered with positive or negative polarity gate pulses.
2. It requires only a single heat sink of slightly larger size, whereas for SCR, two heat sinksshould 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 givenwith parallel diode.

APPLICATION OF TRIAC

- They are used in control circuits.
- It is used in AC power control