UNIT V

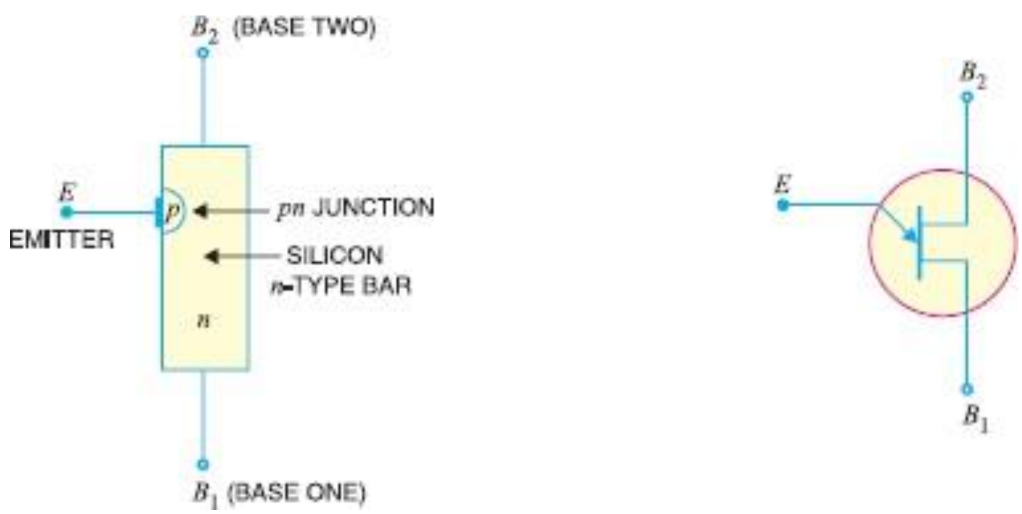
POWER DEVICES AND DISPLAY DEVICES

Uni Junction Transistor (UJT)

A unijunction transistor (UJT) is an electronic semiconductor device that has only one junction.

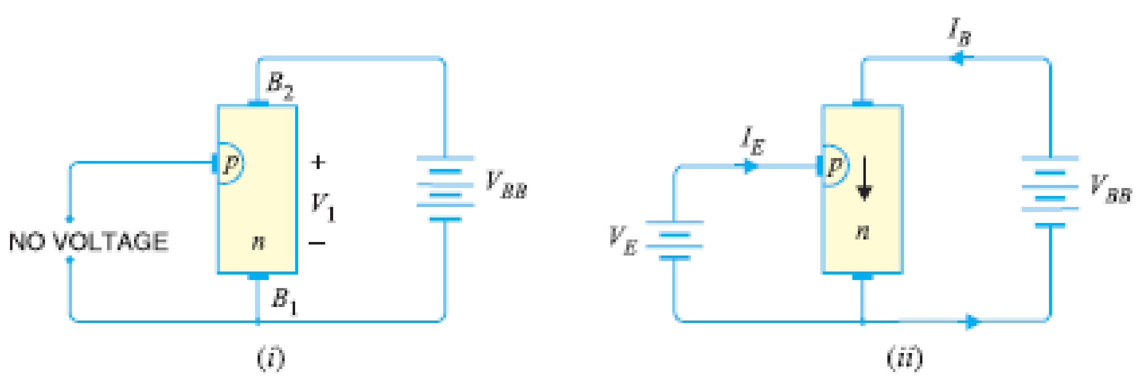
The UJT has three terminals: an emitter (E) and two bases (B1 and B2).

The base is formed by lightly doped n-type bar of silicon. Two ohmic contacts B1 and B2 are attached at its ends. The emitter is of p-type and it is heavily doped. The resistance between B1 and B2, when the emitter is open-circuit is called interbase resistance.



Since the device has one pn junction and three leads it is commonly called UJT.

Operation



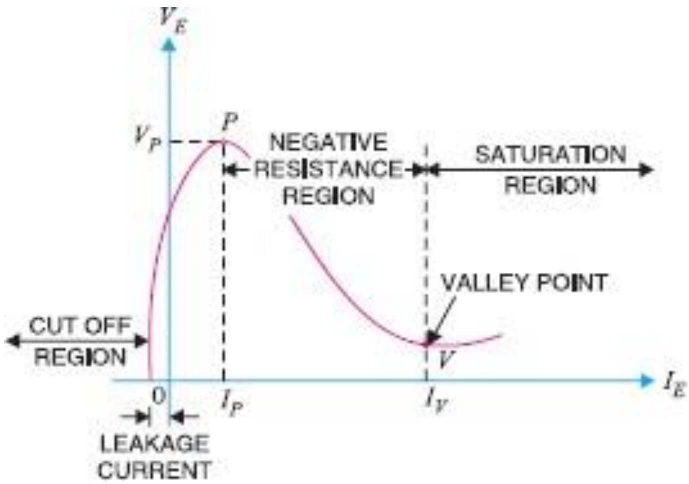
The device has normally B2 is positive w.r.t B1.

(i) If voltage V_{BB} is applied between B2 and B1 with emitter open (fig. i) a voltage gradient is established along the n type bar. The voltage V1 between emitter and B1 establishes a reverse bias of pn junction and the emitter current is cut off. Small leakage current flows from B2 to emitter.

(ii) If a positive voltage is applied at E (fig. ii) the pn junction remains reverse biased as long as the input is less than V1. The voltage exceeds V1 the pn junction become forward biased. Here holes are injected from p type towards B1. The device is ON state.

(iii) If a negative pulse is applied to E, the pn junction is reverse biased and the emitter current is cut off. The device is OFF state.

Characteristics



Initially in the cut off region, as V_E increases from zero, slight leakage current flows from terminalB2 to the emitter.

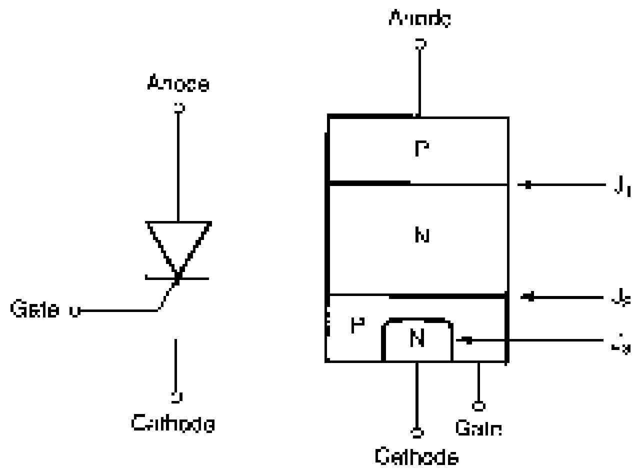
Above a certain value of V_E forward I_E begins to flow, increasing until the peak voltage Vp and current Ip are reached at point P.

After the peak point P an attempt to increase V_E is followed by a sudden increase in emitter current I_E with a corresponding decrease in V_E. This is a negative resistance portion of the curve because in I_E, V_E decreases.

Applications

In switching circuits, Pulse generator and Saw-tooth generator.

Silicon Controlled Rectifier (SCR)



Three terminals

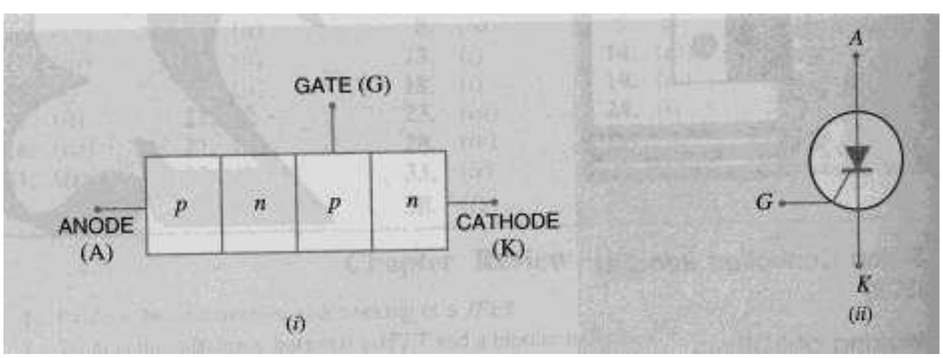
- anode - P-layer
- cathode - N-layer (opposite end)
- gate - P-layer near the cathode

Three junctions - four layers

Connect power such that the anode is positive with respect to the cathode - no current will flow

A silicon controlled rectifier is a semiconductor device that acts as a true electronic switch. It can change alternating current and at the same time can control the amount of power fed to the load. SCR combines the features of a rectifier and a transistor.

CONSTRUCTION

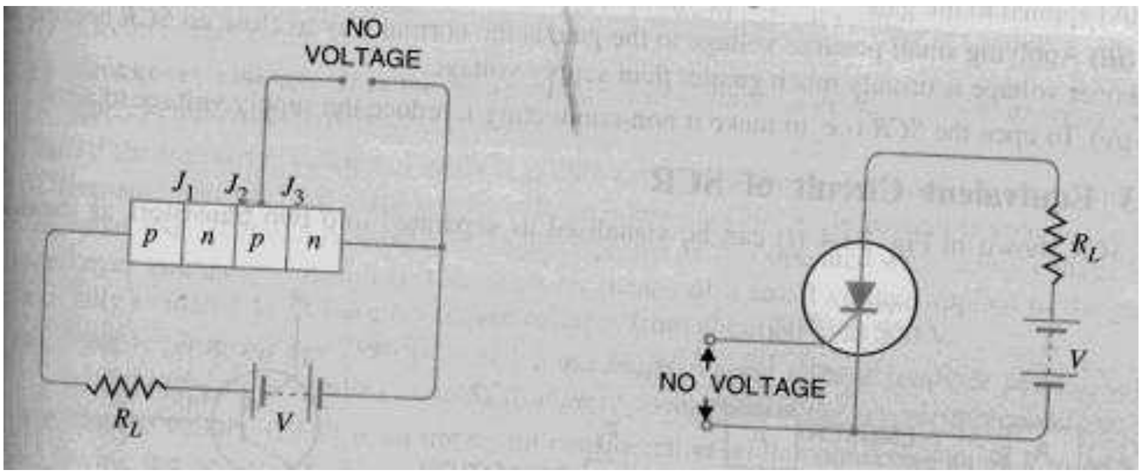


When a pn junction is added to a junction transistor the resulting three pn junction device is called a SCR. ordinary rectifier (pn) and a junction transistor (npn) combined in one unit to form pnpn device. three terminals are taken : one from the outer p- type material called anode a second from the outer n- type material called cathode K and the third from the base of transistor called Gate. GSCR is a solid state equivalent of thyratron. the gate anode and cathode of SCR correspond to the grid plate and cathode of thyratron SCR is called thyristor.

WORKING PRINCIPLE

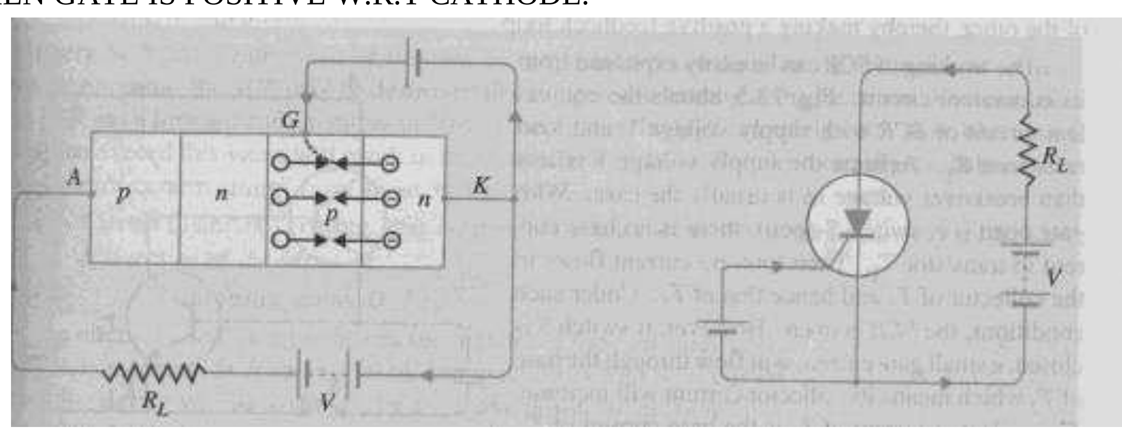
Load is connected in series with anode the anode is always kept at positive potential w.r.t cathode.

WHEN GATE IS OPEN



No voltage applied to the gate, j2 is reverse biased while j1 and j3 are FB . J1 and J3 is just in npn transistor with base open .no current flows through the load RL and SCR is cut off. If the applied voltage is gradually increased a stage is reached when RB junction J2 breakdown .the SCR now conducts heavily and is said to be ON state. the applied voltage at which SCR conducts heavily without gate voltage is called Break over Voltage.

WHEN GATE IS POSITIVE W.R.T CATHODE.



The SCR can be made to conduct heavily at smaller applied voltage by applying small positive potential to the gate.J3 is FB and J2 is RB the electron from n type material start moving across J3 towards left holes from p type toward right. electrons from j3 are attracted across junction J2 and gate current starts flowing. as soon as gate current flows anode current increases. the increased anode current in turn makes more electrons available at J2 breakdown and SCR starts conducting heavily. the gate loses all control if the gate voltage is removed anode current does not decrease at all. The only way to stop conduction is to reduce the applied voltage to zero.

BREAKOVER VOLTAGE

It is the minimum forward voltage gate being open at which SCR starts conducting heavily i.e turned on.

PEAK REVERSE VOLTAGE(PRV)

It is the maximum reverse voltage applied to an SCR without conducting in the reverse direction.

HOLDING CURRENT

It is the maximum anode current gate being open at which SCR is turned off from on conditions.

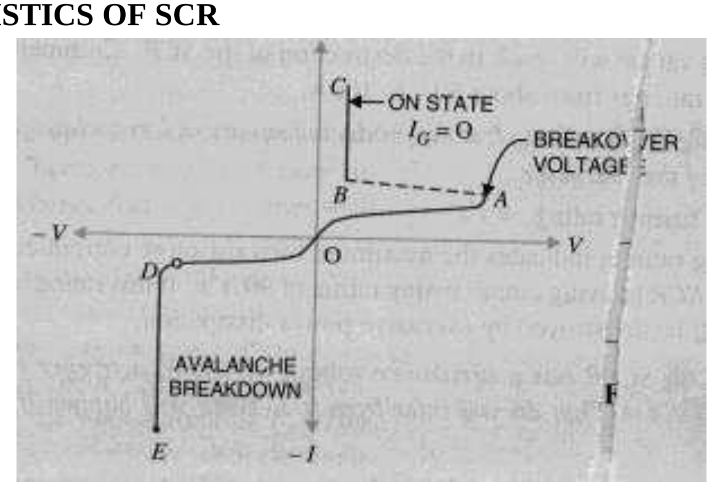
FORWARD CURRENT RATING

It is the maximum anode current that an SCR is capable of passing without destruction

CIRCUIT FUSING RATING

It is the product of of square of forward surge current and the time of duration of the surge.

VI CHARACTERISTICS OF SCR



FORWARD CHARCTERISTICS

When anode is +ve w.r.t cathode the curve between V & I is called Forward characteristics. OABC is the forward characteristics of the SCR at Ig =0. if the supplied voltage is increased from zero point A is reached .SCR starts conducting voltage across SCR suddenly drops (dotted curve AB) most of supply voltage appears across RL

REVERSE CHARCTERISTICS

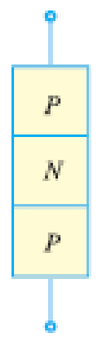
When anode is –ve w.r.t.cathode the curve b/w V&I is known as reverse characteristics reverse voltage come across SCR when it is operated with ac supply reverse voltage is increased anode current remains small avalanche breakdown occurs and SCR starts conducting heavily is known as reverse breakdown voltage

Application

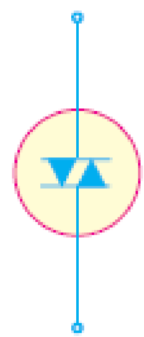
SCR as a switch
SCR Half and Full wave rectifier
SCR as a static contactor
SCR for power control
SCR for speed control of d.c.shunt motor
Over light detector

DIAC (Diode A.C. switch)

A Diac is two terminal , three layer bi directional device which can be switched from its off state for either polarity of applied voltage.



DIAC BASIC CONSTRUCTION



DIAC SYMBOL

Construction

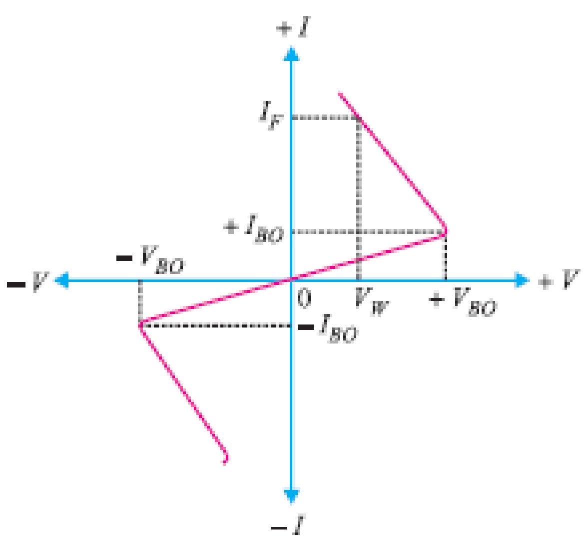
The diac can be constructed in either npn or pnp form.The two leads are connected to p regions of silicon separated by an n region. the structure of diac is similar to that of a transistor differences are

- There is no terminal attached to the base layer
- The three regions are nearly identical in size. the doping concentrations are identical to give the device symmetrical properties.

Operation

When a positive or negative voltage is applied across the terminals of Diac only a small leakage current Ibo will flow through the device as the applied voltage is increased , the leakage current will continue to flow until the voltage reaches breakover voltage Vbo at this point avalanche breakdown of the reverse biased junction occurs and the device exhibits negative resistance i.e current through the device increases with the decreasing values of applied voltage the voltage across the device then drops to breakback voltage Vw.

V- I CHARECTERISTICS OF A DIAC



For applied positive voltage less than + Vbo and Negative voltage less than -Vbo , a small leakage current flows thrugh the device. Under such conditions the diac blocks flow of current and behaves as an open circuit. the voltage +Vbo and -Vbo are the breakdown voltages and usually have range of 30 to 50 volts.

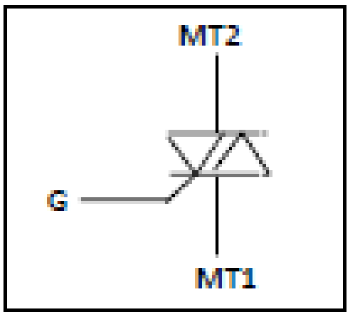
When the positive or negative applied voltage is equal to or greater than tha breakdown voltage Diac begins to conduct and voltage drop across it becomes a few volts conduction then continues until the device current drops below its holding current breakover voltage and holding current values are identical for the forward and reverse regions of operation.

Applications

Diacs are used for triggering of triacs in adjustable phase control of a c mains power. Applications are light dimming heat control universal motor speed control.

<u>TRIAC</u>

Triacs are three terminal devices that are used to switch large a.c. currents with a small trigger signal. Triacs are commonly used in dimmer switches, motor speed control circuits and equipment that automatically controls mains powered equipment including remote control. The triac has many advantages over a relay, which could also be used to control mains equipment; the triac is cheap, it has no moving parts making it reliable and it operates very quickly.

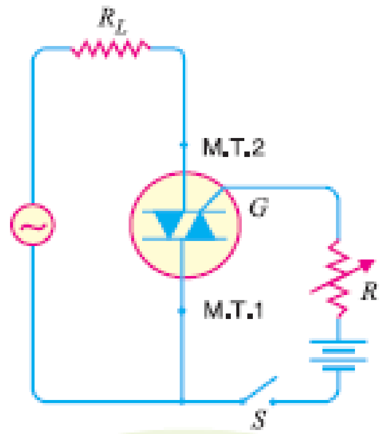


The three terminals on a triac are called Main Terminal 1 (MT1), Main Terminal 2(MT2) and Gate (G). To turn on the triac there needs to be a small current IGT flowing through the gate, this current will only flow when the voltage between G and MT1 is at least VGT. The signal that turns on the triac is called the trigger signal. Once the triac is turned on it will stay on even if there is no gate current until the current flowing between MT2 and MT1 fall below the hold current IH.

Operation

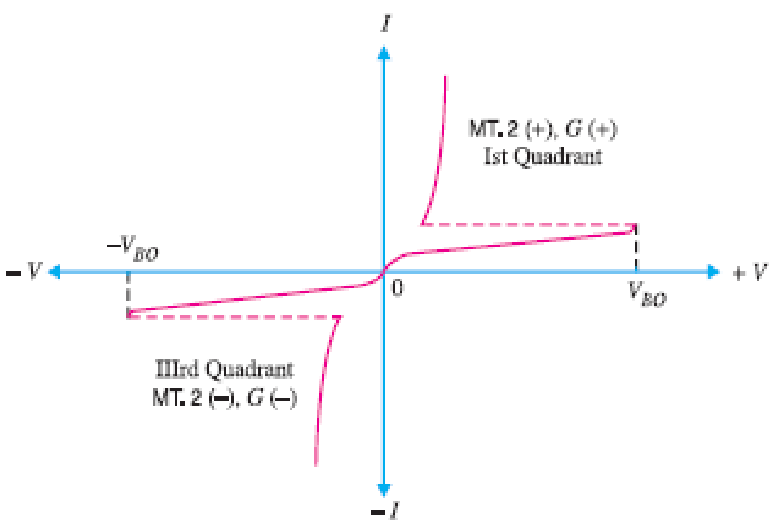
With switch S open, there will be no gate current and the triac is cut off. Even with no current the triac can be turned on provided the supply voltage becomes equal to the breakover voltage.

When switch S is closed, the gate current starts flowing in the gate circuit. Breakover voltage of triac can be varied by making proper currnt flow. Triac starts to conduct wheather MT2 is positive or negative w.r.t MT1.



If terminal MT2 is positive w.r.t MT1 the triac is on and the conventional current will flow from MT2 to MT1.
If terminal MT2 is negative w.r.t MT1 the triac is again turned on and the conventional current will flow from MT1 to MT2.

Characteristics



The V-I curve for triac in the Ist and IIIrd quadrants are essentially identical to SCR in the Ist quadrant.

The triac can be operated with either positive or negative gate control voltage but in normal operation usually the gate voltage is positive in quadrant I and negative in quadrant III.

The supply voltage at which the triac is ON depends upon gate current. The greater gate current and smaller supply voltage at which triac is turned on. This permits to use triac to control a,c. power in a load from zero to full power in a smooth and continuous manner with no loss in the controlling device.