UNI-JUNCTION TRANSISTOR

The UJT as the name implies, is characterized by a single pn junction. It exhibits negative resistance characteristic that makes it useful in oscillator circuits.

The symbol for UJT is shown in fig. 1. The UJT is having three terminals base1 (B1), base2 (B2) and emitter (E). The UJT is made up of an N-type silicon bar which acts as the base as shown in fig. 2. It is very lightly doped. A P-type impurity is introduced into the base, producing a single PN junction called emitter. The PN junction exhibits the properties of a conventional diode.

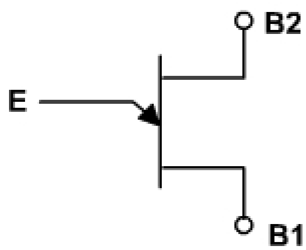

Fig. 1

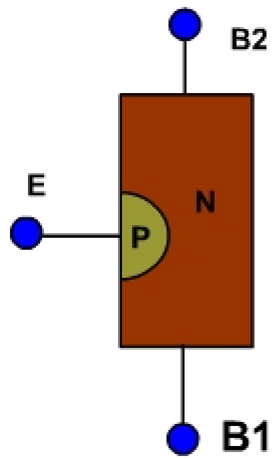

Fig .2

A complementary UJT is formed by a P-type base and N-type emitter. Except for the polarity of voltage and current the characteristic is similar to those of a conventional UJT.

A simplified equivalent circuit for the UJT is shown in fig. 3. VBB is a source of biasing voltage connected between B2 and B1. When the emitter is open, the total resistance from B2 to B1 is simply the resistance of the silicon bar, this is known as the inter base resistance RBB. Since the N-channel is lightly doped, therefore RBB is relatively high, typically 5 to 10K ohm. RB2 is the resistance between B2 and point ‘a', while RB1 is the resistance from point ‘a' to B1, therefore the interbase resistance RBB is

RBB = RB1 + RB2

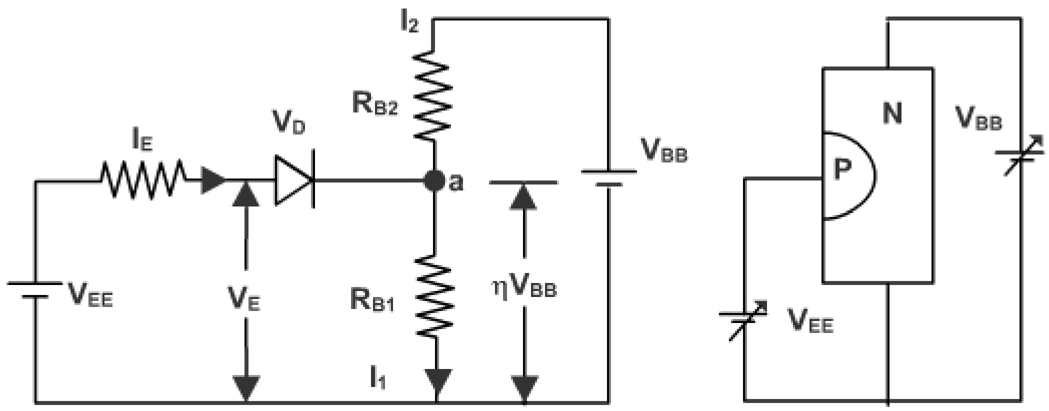

Fig. 3

The diode accounts for the rectifying properties of the PN junction. VD is the diode's threshold voltage. With the emitter open, IE = 0, and I1 = I 2 . The interbase current is given by

I1 = I2 = VBB / R BB .

Part of VBB is dropped across RB2 while the rest of voltage is dropped across RB1. The voltage across RB1 is

Va = VBB * (RB1) / (RB1 + RB2)

The ratio RB1 / (RB1 + RB2) is called intrinsic standoff ratio

h = RB1 / (RB1 + RB2) i.e. Va = h VBB .

The ratio h is a property of UJT and it is always less than one and usually between 0.4 and 0.85. As long as IB = 0, the circuit of behaves as a voltage divider.

Assume now that vE is gradually increased from zero using an emitter supply VEE . The diode remains reverse biased till vE voltage is less than h VBB and no emitter current flows except leakage current. The emitter diode will be reversed biased.

When vE = VD + h VBB, then appreciable emitter current begins to flow where VD is the diode's threshold voltage. The value of vE that causes, the diode to start conducting is called the peak point voltage and the current is called peak point current IP

The graph of fig. 4 shows the relationship between the emitter voltage and current. v_E is plotted on the vertical axis and I_E is plotted on the horizontal axis. The region from $v_E = 0$ to $v_E = V_P$ is called cut off region because no emitter current flows (except for leakage). Once v_E exceeds the peak point voltage, I_E increases, but v_E decreases. up to certain point called valley point (V_V and I_V). This is called negative resistance region. Beyond this, I_E increases with v_E this is the saturation region, which exhibits a positive resistance characteristic.

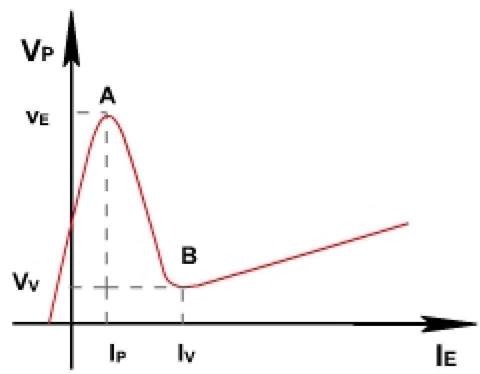

Fig. 4

The physical process responsible for the negative resistance characteristic is called conductivity modulation. When the v_E exceeds V_P voltage, holes from P emitter are injected into N base. Since the P region is heavily doped compared with the N-region, holes are injected to the lower half of the UJT.

The lightly doped N region gives these holes a long lifetime. These holes move towards B1 to complete their path by re-entering at the negative terminal of VEE. The large holes create a conducting path between the emitter and the lower base. These increased charge carriers represent a decrease in resistance RB1, therefore can be considered as variable resistance. It decreases up to 50 ohm.

Since h is a function of RB1 it follows that the reduction of RB1 causes a corresponding reduction in intrinsic standoff ratio. Thus as IE increases, RB1 decreases, h decreases, and Va decreases. The decrease in V a causes more emitter current to flow which causes further reduction in RB1, h, and Va. This process is regenerative and therefore Va as well as vE quickly drops while IE increases. Although RB decreases in value, but it is always positive resistance. It is only the dynamic resistance between VV and VP. At point B, the entire base1 region will saturate with carriers and resistance RB1 will not decrease any more. A further increase in Ie will be followed by a voltage rise. The diode threshold voltage decreases with temperature and RBB resistance increases with temperature because Si has positive temperature coefficient.