

Bipolar Junction Transistor and Their Applications

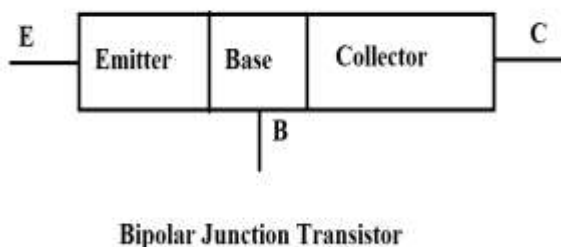
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Abstract— BJT is an electronic device with three terminals. It is a versatile device invented by William Shockley and John Bardeen. BJT stands for bipolar junction transistor as the current conduction is due to the two types of charge carriers electron and holes. The invention of transistor has revolutionized the field of electronics. It has replaced the bulky vacuum tubes used earlier in the electronic circuits. BJT is a current controlled device since the output can be controlled by the input current. Transistor is capable of increasing strength of a weak input signal called amplification. This amplification characteristic of transistor has made it one of the most widely used semiconductor device. The types, configurations and applications are discussed in this article.

Keywords—BJT, Amplification, Semiconductor.

Introduction: The term transistor has evolved from two word transfer and resistor. As it transfer an input signal from a low resistance to a high resistance. BJT has two junctions formed by sandwiching one type of semiconductor between two opposite types. There are three regions in BJT which are as follows



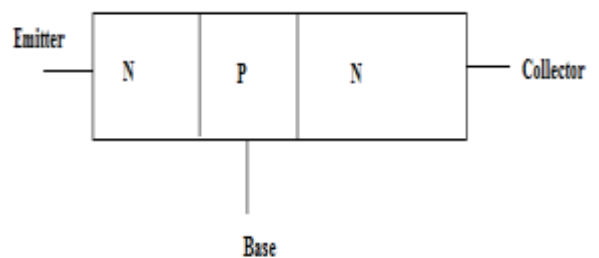
- **Emitter:** It is the region which injects the charge carriers. Emitter is highly doped and thin in size.
- **Base:** Base is the middle region which connects the emitter with collector. It is thin in size and its doping level is less in respect to other two.
- **Collector:** Collector is the region which collects the charge carriers injected by emitter. The size of collector is largest

among all the three regions while its doping level is moderate.

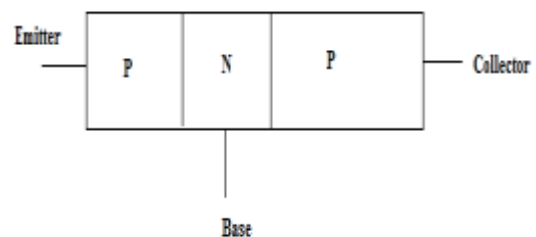
1. Classification of BJT

BJT are classified in two types depending on the semiconductor type used as emitter, base and collector.

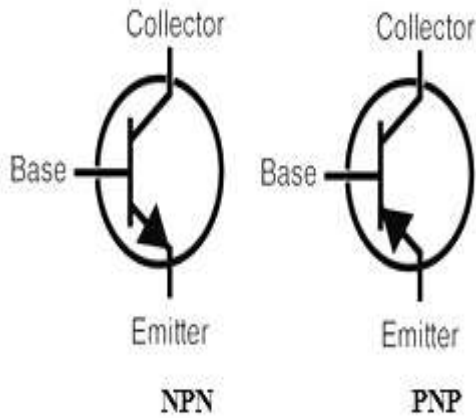
- **NPN Transistor:** NPN transistor is the one in which emitter and collector regions are made of N type semiconductor and base is of P type semiconductor. The block diagram of NPN is shown in figure below.



- **PNP Transistor:** PNP transistor is the transistor in which emitter and collector are made of P type semiconductor and base is made of N type semiconductor. The block representation of PNP is shown in figure below.

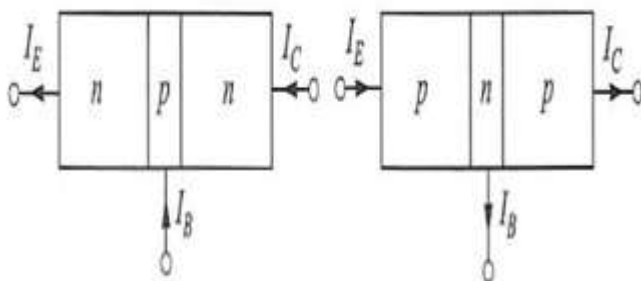


Symbols



2. Bipolar Junction Transistor currents

There are three types of current in a BJT emitter current, base current and collector current. As the charge carriers are injected by the emitter into base the injection of charge carrier causes a current called emitter current I_E . Few injected charge carriers recombine in base region and constitute a base current I_B . The remaining charge carriers collected by collector causes a current at collector called collector current I_C .



The relation between different currents in BJT is given by equation

$$I_E = I_B + I_C$$

3. Modes of Operation of BJT

To operate BJT dc voltages are applied across the different terminals of a transistor. This process is called biasing of BJT. Since there are two junctions in a transistor namely emitter-base junction and collector base junction, each of them can be forward and reverse biased. On the basis of biasing of these two junctions there are three modes of operation of BJT.

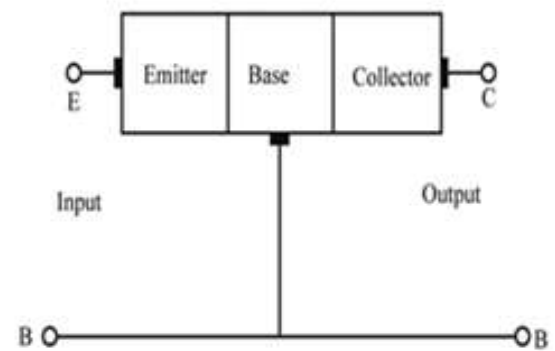
- **Active Mode:** When the emitter-base junction is forward bias and collector base junction is reverse biased, BJT is called in active mode. In this mode BJT is used as amplifier.
- **Saturation Mode:** When both junctions are forward biased BJT is called under saturation mode. In saturation mode BJT operates as an ON switch.

- **Cut-off Mode:** In cut-off mode both the junctions are made reverse biased. BJT behave like an open switch in cut-off mode.

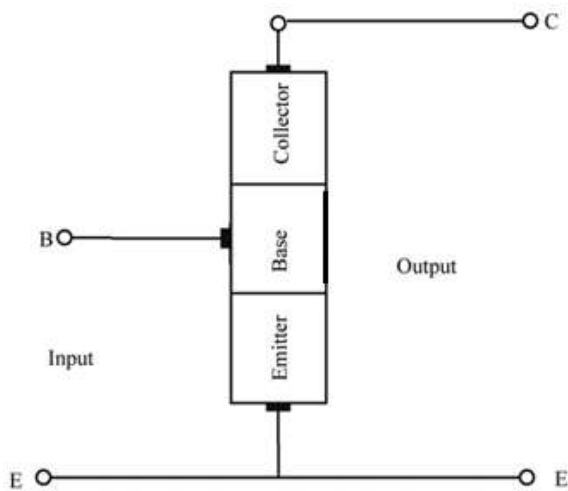
4. Configurations of BJT

BJT has three terminals however when a transistor is connected in circuit it requires four terminals two for input and two for output. This problem is overcome by using one terminal from the three terminals as common terminal between input and output. Depending upon which terminal is made common; BJT has three configurations in which it can be connected in a circuit. These configuration are discusses in the following section.

- **Common Base Configuration:** Common base configuration is configuration in which base terminal is common in between the input and output. Hence the input signal is provided in between emitter and base while output is taken from collector and base. The arrangement of common base configuration is shown in figure below.

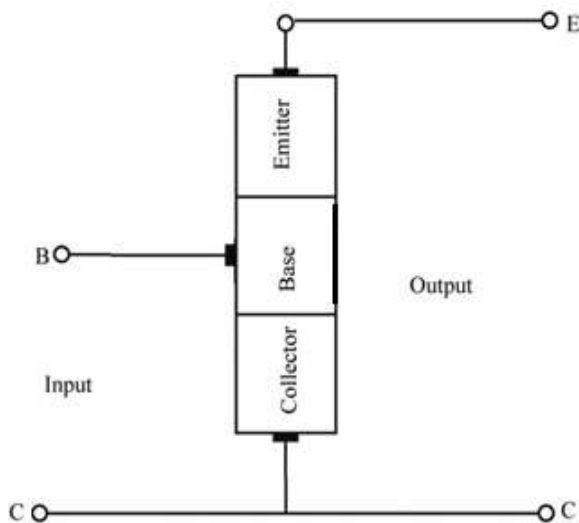


- **Common Emitter Configuration:** Common emitter configuration is the configuration in which emitter terminal is made common in between the input and output. Hence the input signal is provided in between base and emitter while output is taken from collector and emitter. The arrangement of common base configuration is shown in figure below



• Common Collector Configuration:

Common emitter configuration is the configuration in which emitter terminal is made common in between the input and output. Hence the input signal is provided in between base and emitter while output is taken from collector and emitter. The arrangement of common base configuration is shown in figure below.



5. Advantages of BJT

- It has high efficiency
- It has small Size
- BJT is light weight
- Operate at Low voltage.
- Do not require any filament power
- Has Long Life
- Capable of amplifying input
- Has Linear transfer characteristics
- Provide high Voltage Gain
- Provide Large Gain Bandwidth
- BJT offer High Current Density

- Forward voltage Drop is low

6. Drawbacks of BJT

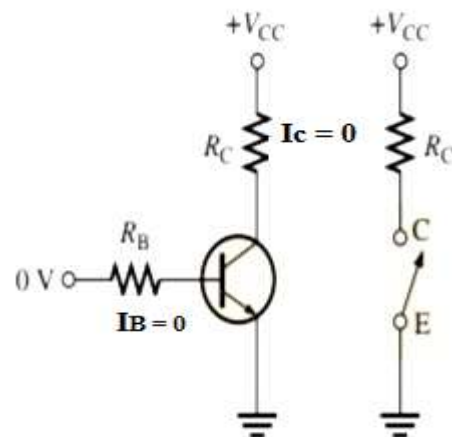
- Low thermal stability
- Low switching frequency
- More effect by radiation
- Less Noise Immune

7. Applications of BJT

BJT is a versatile device and is used mostly in all electronic circuits. BJT has a wide range of application however it is mostly used for switching and amplification purpose.

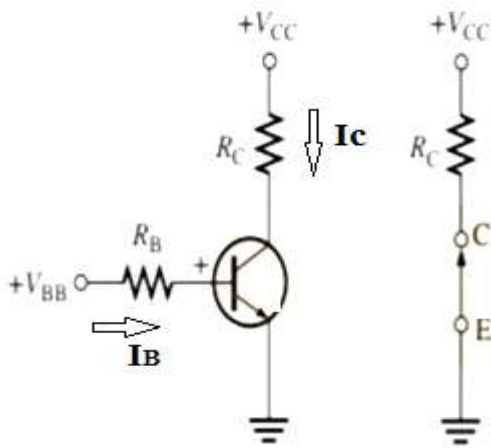
- **BJT as a Switch:** For switching applications transistor is operated in either saturation or in cutoff region. Transistor in cutoff region act as an open switch and in saturation it works as a closed switch.

Open Switch- when both junctions are reversed biased transistor works as open switch. The input voltage is zero so both base and collector currents are zero, hence the BJT offer very high resistance and it does not allow the flow of current.



In the figure the base voltage is low which makes emitter base junction reverse biased and hence there will no current at base and collector and it will behave like an off switch.

Closed Switch when both junctions are forward biased BJT works as a closed switch. In this case a high input voltage is applied at the base. The forward bias at base causes a base current to flow at base terminal. This base current provides a large current at collector terminal. Thus in this case BJT allow the flow of current through it and behave like a closed switch. The circuit of BJT as closed switch is shown below.



In the figure the base voltage is high which makes emitter base junction forward biased and hence there will a current at base and collector and it will behave like an ON switch.

- BJT as an Amplifier:** The most widely used application of BJT is its uses as an amplifier. BJT has the capability to amplify the low input signal. BJT works as an amplifier in active region when emitter – base junction is forward bias and collector base junction is reverse biased. Since due to forward bias a base current flow at base and the collector current is beta times higher than the base current. A small base current causes a large collector current. Since the output of BJT is taken from the collector this causes a large output at the output for a small input signal. The circuit of amplifier in common emitter configuration is shown in figure below.

