BIPOLAR JUNCTION TRANSISTOR II

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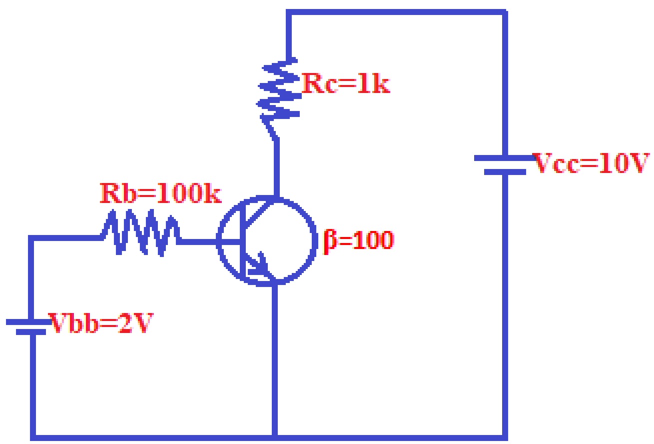
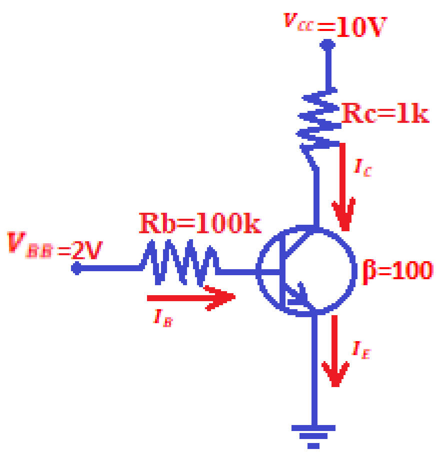




V_{BE}= 0.7 V, as emitter is grounded V_B= 0.7V

$$V_{BB} = I_B R_B + V_{BE}$$

$$2\text{ V} = I_B\ 100\text{k} + 0.7\text{V}$$

$$I_B = \frac{2-0.7}{100} \times 10^{-3}\text{ amp}$$

$$I_B = 13\mu A$$

$I_C = \beta I_B = 100\times 13\ \mu A = 1.3mA$

$V_{CC} = I_C R_C + V_{CE} \Rightarrow V_{CE} = V_{CC} - I_C R_C = 10 - 1.3 = 8.7V$

$V_{BC} = V_B - V_C = 0.7 - 8.7 = -8V$

Thus the collector- base junction is reverse biased.

Three primary currents which flow across the forward biased emitter junction and reverse biased collector junction are I_E, I_B, and I_C

$$I_E = I_B + I_C$$

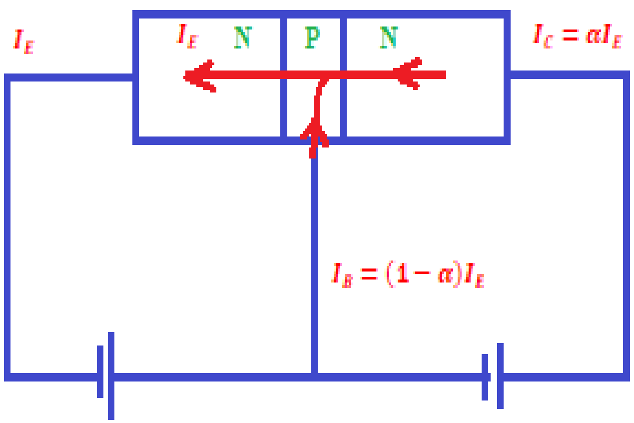
Also $I_C = \alpha I_E$

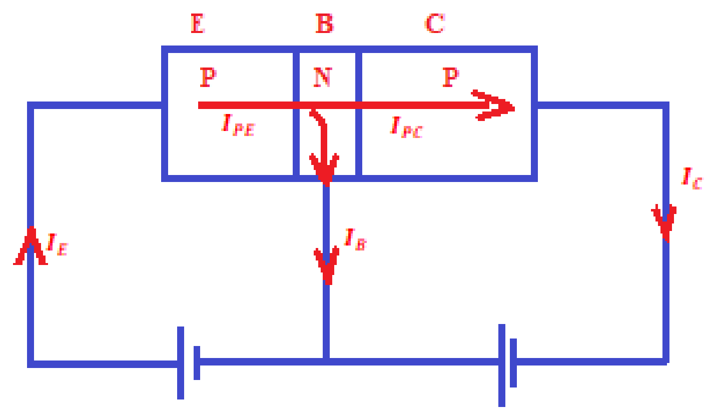
$$I_B = I_E - I_C$$
$$= (1-\alpha)I_E$$
$$= (1-.98)I_E$$
$$= 0.02I_E$$

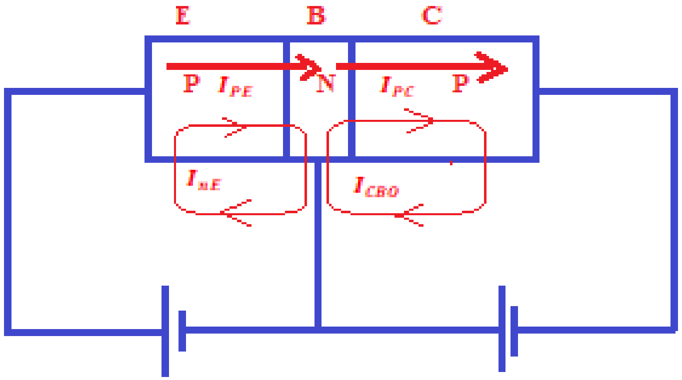
So considering the current due to the majority carriers, the emitter current split into two parts

(i)$(1-\alpha)I_E$ which becomes base current I_B in the external circuit, and

(ii)αI_E which becomes collector current I_C in the external circuit.







In PNP transistor collector-base junction is reverse biased for majority charged carriers but it is forward biased for thermally generated minority carriers.

The current flow in the same direction of I_C due to the minority carriers, called leakage current and denoted by I_{CBO}.
This current flows even when emitter is disconnected from the dc supply source
This current is extremely temperature dependent
Similarly I_{nE} flows in the emitter base junction
The emitter current I_E consists of the hole current I_{pE} and electron current I_{nE}

$$i.e. I_E = I_{pE} + I_{nE}$$

The collector current I_C consists of I_{pC} and the temperature dependent current I_{CBO} due to the minority carriers

$$i.e. I_C = I_{pC} + I_{CBO}$$
$$= \alpha I_E + I_{CBO}$$

Thus $\alpha = \frac{I_C - I_{CBO}}{I_E}$

I_B depends on $I_{pE}, I_{pC}, I_{nE}, I_{CBO}$

Emitter efficiency, $\gamma = \frac{current\ of\ injected\ carriers\ from\ the\ emitter}{total\ current}$

$$= \frac{I_{pE}}{I_{pE} + I_{nE}}$$

$$= \frac{I_{pE}}{I_E}$$

We may say $I_{pE} \gg I_{nE}$

$$\gamma = \frac{1}{(1 + \frac{I_{nE}}{I_{pE}})} = 1 - \frac{I_{nE}}{I_{pE}}$$

Transport factor β^*, also known as base transport factor

$$\beta^* = \frac{injected\ carrier\ current\ reaching\ collector\ junction}{injected\ carrier\ current\ at\ emitter\ junction}$$

$$= \frac{I_{pC}}{I_{pE}}$$

The collector efficiency, δ is the ratio of the current crossing the collector junction to the current arriving at the base side of the junction

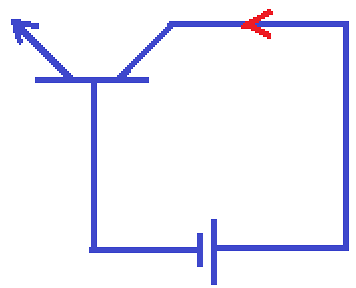
We know $\alpha = \frac{I_C - I_{CBO}}{I_E}$

$$= \frac{I_{pC}}{I_E}$$

$$= \frac{I_{pC}}{I_{pE}} \times \frac{I_{pE}}{I_E} = \beta^* . \gamma$$

LEAKAGE CURRENTS

1.COLLECTOR TO BASE LEAKAGE CURRENT(I_{CBO})



The collector current I_C consists of

(i)The part of emitter current I_E which reaches the collector, and

(ii)The collector–base leakage current I_{CBO} or I_{CO}

Thus the part of I_E which reaches collector is equal to $I_C - I_{CBO}$

$$\alpha = \frac{I_C - I_{CBO}}{I_E}$$

$$I_C = \alpha I_E + I_{CBO}$$

We know $I_E = I_C + I_B$

Therefore $I_C = \alpha(I_C + I_B) + I_{CBO}$

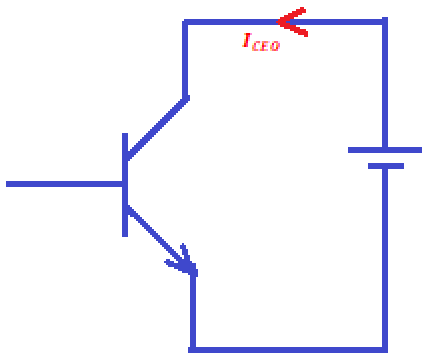
$$I_C(1-\alpha) = \alpha I_B + I_{CBO}$$

$$I_C = \frac{\alpha}{1-\alpha} I_B + \frac{1}{1-\alpha} I_{CBO}$$

$$I_C = \beta I_B + (\beta + 1) I_{CBO}$$

2.COLLECTOR TO EMITTER LEAKAGE CURRENT(I_{CEO})

When base is open circuited and collector is reverse biased with respect to emitter,



a small current I_{CEO} flows from collector to emitter.
The collector current consists of
(i)The part of the emitter current I_E which reaches the collector, and
(ii)The collector emitter leakage current I_{CEO}
The part of I_E, which reaches collector is $I_C - I_{CEO}$
Thus when leakage current is taken into consideration the equation for β can be written as

$$\beta = \frac{I_C - I_{CEO}}{I_B}$$

$$I_C = \beta I_B + I_{CEO}$$

Also we have

$$I_C = \beta I_B + (\beta + 1)I_{CBO}$$

Equating

$$I_{CEO} = (\beta + 1)I_{CBO}$$

We know the relation between α and β as

$$\beta = \frac{\alpha}{1-\alpha}$$

Let us take some values of α and calculate corresponding value of β

α	β
0.9	9
0.95	19
0.99	99
0.995	199
0.999	999

Thus a change in α by 1% introduces a large change in β

The leakage current I_{CBO} of the reverse biased collector base junction changes greatly with temperature

An increase in temperature increases the value of I_{CBO} since $I_C = \beta I_B + (\beta + 1)I_{CBO}$

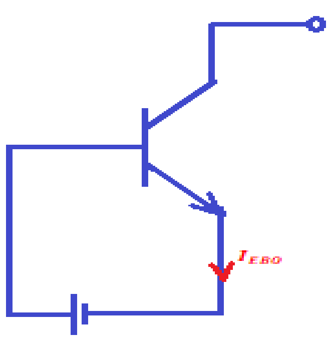
An increase in I_{CBO} increases I_C

The increase of I_C increases the power dissipation at the collector junction and thereby increases the junction temperature.

The increase of temperature further increases I_{CBO}

3.EMITTER TO BASE LEAKAGE CURRENT(I_{EBO})

When the collector is open circuited and the emitter base junction is reverse biased, a small emitter current flows through the emitter base junction.



CHARACTERISTICS OF TRANSISTOR

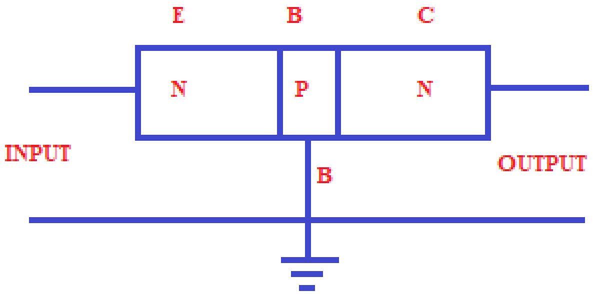
The method of connection of a transistor into a circuit largely affects input and output impedances, and characteristics of the transistor will vary according to the method of connection

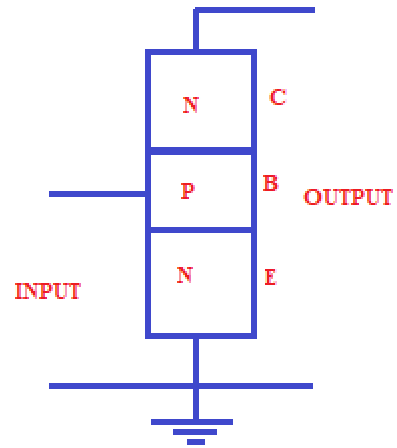
The three methods of connections are

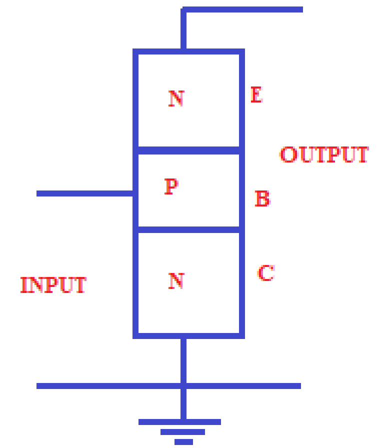
(i)Common base

(ii)Common emitter, and

(iii)Common collector


E
B
C
N
P
N
INPUT
B
OUTPUT


N
C
P
B
OUTPUT
INPUT
N
E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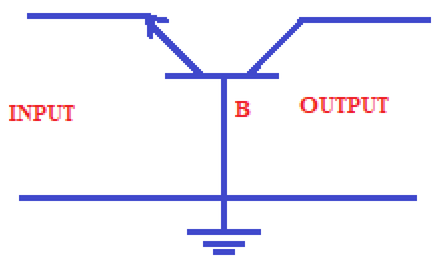
E
OUTPUT
P
B
INPUT
N
C


INPUT
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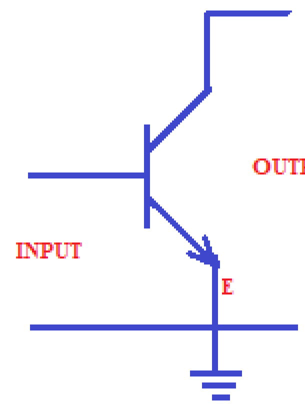
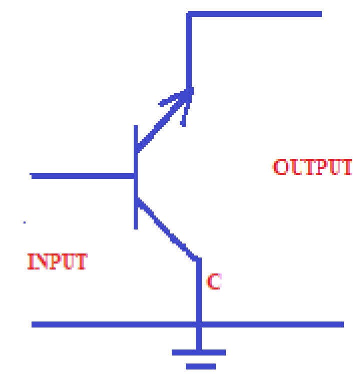
OUTPUT


OUTPUT
INPUT
E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