April 17, 2020

Amplification

$p^+ n p$ BJT

3 currents i_E i_B i_C

i_E is comprised primarily of holes

$i_E \rightarrow i_{Ep}$ but $i_E = i_{Ep} + i_{En}$

$i_c = B\, i_{Ep}$ $B \equiv$ base transport factor

$\gamma \equiv$ emitter efficiency $\equiv \dfrac{i_{Ep}}{i_E} = \dfrac{i_{Ep}}{i_{Ep} + i_{En}}$

$\alpha \equiv$ current transfer ratio $\equiv \dfrac{i_c}{i_E}$

$$\alpha = \frac{i_C}{i_E} = \frac{B\, i_{Ep}}{i_{En} + i_{Ep}} = B\gamma$$

$B < 1 \quad \gamma < 1 \rightarrow \alpha < 1$

No amplification wrt i_E & i_C

$$i_B = i_E - i_C = (i_{En} + i_{Ep}) - i_C$$

$$= i_{En} + i_{Ep} - B\, i_{Ep}$$

$$= i_{En} + (1 - B)\, i_{Ep}$$

$$\frac{i_C}{i_B} = \frac{B\, i_{Ep}}{i_{En} + (1-B)\, i_{Ep}} = \frac{B\left[i_{Ep} / (i_{En} + i_{Ep}) \right]}{1 - B\left[\frac{i_{Ep}}{i_{En} + i_{Ep}} \right]}$$

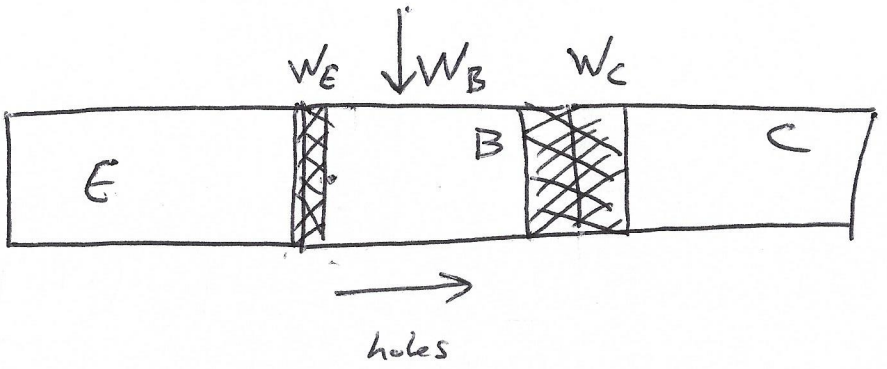
$$= \frac{B\gamma}{1 - B\gamma} = \frac{\alpha}{1-\alpha} \equiv \beta$$

$\alpha < 1$ [redacted] $\alpha \approx 0.9999$

$\beta \rightarrow$ very large

$$\beta \equiv \frac{i_C}{i_B}$$

holes

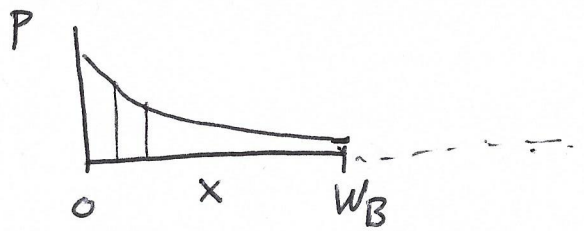


$\tau_p \rightarrow N_d$ in the base

$\tau_t \equiv$ average transit time

from emitter to collector

$\tau_t < \tau_p$



$\rightarrow$ W_B very small

electrons ?

$\tau_{electrons} = \tau_p$

For every electron that enters the base to maintain S.C.N

$\frac{\tau_p}{\tau_t}$ holes make it to collector

$$\beta \equiv \frac{i_C}{i_B} = \frac{\tau_p}{\tau_t}$$