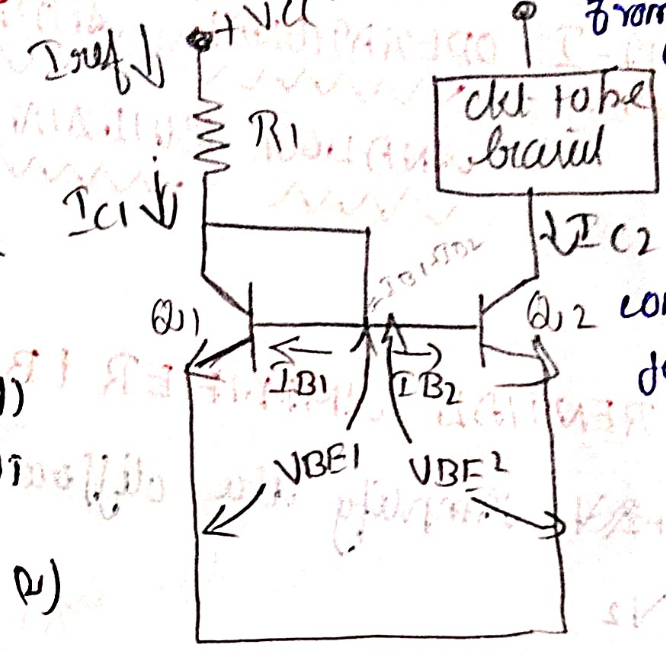
CURRENT MIRROR CIRCUIT :

A ckt using two matched BJTs to replicate (mirror) a ref current from one part of a circuit to another, providing a stable, constant current for loads.



ckt Analysis

$$I_{C1} = \alpha_F I_{ES} e^{V_{BE1}/V_T} \longrightarrow (1)$$

$$I_{C2} = \alpha_F I_{ES} e^{V_{BE2}/V_T} \longrightarrow (2)$$

From eqn (1) & (2)

$$\frac{I_{C2}}{I_{C1}} = \frac{\alpha_F \cancel{I_{ES}} e^{V_{BE2}/V_T}}{\alpha_F \cancel{I_{ES}} e^{V_{BE1}/V_T}}$$

e^x (1÷2) ÷ (−)

$$\frac{I_{C2}}{I_{C1}} = e^{(V_{BE2} - V_{BE1})/V_T}$$

Since $V_{BE1} = V_{BE2}$ = identical so

$$I_{C1} = I_{C2} = I_C = I_0$$

Also both the transistors are identical.

$$\beta_1 = \beta_2 = \beta$$

KCL at the collector of the Q_1 gives

$$I_B = \frac{I_C}{\beta}$$

$$I_{ref} = I_{C1} + I_{B1} + I_{B2}$$

$$= I_{C1} + \frac{I_{C1}}{\beta_1} + \frac{I_{C2}}{\beta_2} \quad (\because I_{C1} = I_{C2})$$

$$I_{ref} = I_{C1}\left(1 + \frac{1}{\beta_1} + \frac{1}{\beta_2}\right)$$

$$\beta = \beta_1 = \beta_2$$

$$I_{ref} = I_{C1} = \left(1 + \frac{1}{\beta} + \frac{1}{\beta}\right)$$

$$I_{ref} = I_{C1}\left(1 + \frac{2}{\beta}\right) \longrightarrow (4)$$

$$I_{ref} = I_{C1}\left(\frac{\beta+2}{\beta}\right)$$

$$I_{C1} = I_C = I_0$$

$$I_{ref} = I_C\left(\frac{\beta+2}{\beta}\right)$$

$$I_C = I_{ref}\left(\frac{\beta}{\beta+2}\right) \longrightarrow (5)$$

where,

$$I_{ref} = \frac{V_{CC} - V_{BE}}{R_1} = \frac{V_{CC}}{R_1} \longrightarrow (6)$$

($V_{BE} = 0.7 \rightarrow$ small)

From eqn (5)

$$I_C = I_{ref}\left(\frac{\beta}{\beta+2}\right) \quad \nearrow \beta \qquad \beta > 1$$

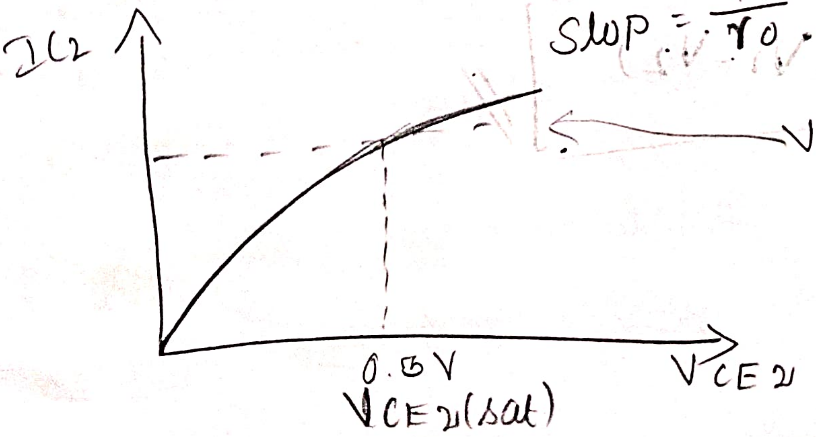
$\beta/\beta+2$ almost unity $\qquad \frac{\beta}{\beta+2} \simeq 1$

$I_C = I_{ref}$ — O/P current reflects input current

$$\boxed{I_{ref} = I_0}$$

$r \rightarrow \infty$

$I_{C2} \rightarrow$



Slop $= \frac{1}{r_0}$

$V_{CE2} > 0.3V$

$Q_2 \rightarrow$ AC. RC

$V_{CE2} < 0.3V$

$Q_2 \rightarrow$ sat

Draw back

I ~~∝~~ R. ~~overcome~~, $\beta < 1$. overcome widler current

The nodal equation at node 'b' is

$$\frac{V_1 - V_b}{R_1} + \frac{0 - V_b}{R_2} = 0$$

$$\frac{V_1}{R_1} - \frac{V_b}{R_1} - \frac{V_b}{R_2} = 0.$$

$$\frac{V_1}{R_1} = V_b\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$$

$$= V_b\left(\frac{R_1 + R_2}{R_1 \cdot R_2}\right)$$

$$V_b = \frac{V_1}{R_1}\left(\frac{R_1 \cdot R_2}{R_1 + R_2}\right) \longrightarrow (2)$$

$$\boxed{V_b = V_a}$$

$$\therefore V_d = V_a - V_b$$

$$= V_a - V_a$$

$$\boxed{V_d = 0}$$

same ($V_d = 0$) so $V_b = V_a$

From equation (1)

$$\frac{V_0}{R_2} = \frac{V_1}{R_1}\left(\frac{R_1 \cdot R_2}{R_1 + R_2}\right)\left(\frac{1}{R_1} + \frac{1}{R_2}\right) - \frac{V_2}{R_1}$$

$$= \frac{V_1}{R_1}\left(\frac{\cancel{R_1 \cdot R_2}}{\cancel{R_1 + R_2}}\right)\left(\frac{\cancel{R_1 + R_2}}{\cancel{R_1 \cdot R_2}}\right) - \frac{V_2}{R_1}$$

$$\frac{V_0}{R_2} = \frac{V_1}{R_1} - \frac{V_2}{R_1}$$

$$\therefore \boxed{V_0 = \frac{R_2}{R_1}(V_1 - V_2)}$$

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