Consider

\[ I_0 \quad \uparrow \quad \downarrow I_0 + \Delta I_0 \]

\[ Q_1 \quad Q_2 \]

Where it is desired to have \( \Delta I_0 = 0 \)

Q1 and Q2 are ideal except for

\( \beta \) and \( V_t \) mismatch and

\[
\left( \frac{V_t}{I} \right)_1 \neq \left( \frac{V_t}{I} \right)_2 \quad \text{and some}
\]

This is useful when transmitting bias currents around chip

Assume mismatch errors are

\[ A_{\beta} = 1 \quad \left[ \frac{20 \mu m}{0.18 \mu m} \right] \quad \text{Technology} \]

\[ A_{V_t} = 5 \quad \left[ mV \mu m \right] \]

And they are inversely proportional to the area of a device
$$\Delta V_t = \frac{AV_t}{WL} \quad \frac{\Delta \beta}{\beta} = \frac{AV_t}{WL}$$

$$\left( \frac{I_0 (\Delta I_0)}{I_0} \right)^2 = (\beta)^2 + \left( \frac{q m}{I_0} \right)^2 \left( \frac{AV_t}{WL} \right)^2$$

First check whether $\beta^2$ or $\left( \frac{q m}{I_0} \right)^2 \left( \frac{AV_t}{WL} \right)^2$

Dominates when devices are in active region

$$\beta = \frac{q m}{I_0} \quad AV_t = \frac{2 I_0}{V_{eff}} \quad AV_t = \frac{2 AV_t}{V_{eff}}$$

$$= 0.01 \text{ [m]} = \frac{0.01}{V_{eff}} \text{ [m]}$$

So $\frac{q m}{I_0} \Delta V_t > \beta$ if $V_{eff} < 1$ (almost always true)

$$\left( \frac{I_0 (\Delta I_0)}{I_0} \right)^2 \leq \left( \frac{2}{V_{eff}} \right)^2 \left( \frac{AV_t}{WL} \right)^2$$

For a single device, in case of 2 devices (as shown above with $q_1, q_2$)

$$\left( \frac{I_0 (\Delta I_0)}{I_0} \right)^2 = 2 \left( \frac{2}{V_{eff}} \right)^2 \left( \frac{AV_t}{WL} \right)^2$$
\( N_{07E} - \left( \frac{\Delta I_0}{I_0} \right)^2 \) is independent of \( I_0 \).

\[
WL = \left( \frac{\Delta I_0}{I_0} \right)^2 \left( \frac{\Delta t}{V_{eff}} \right)^2 (AVt)^2
\]

For \( \frac{\Delta I_0}{I_0} = 0.005 \) and \( V_{eff} = 200 \text{ mV} \)

\( AVt = 5 \text{ mV} \)

\[
WL = 200 \text{ (mV nsec)}^2
\]