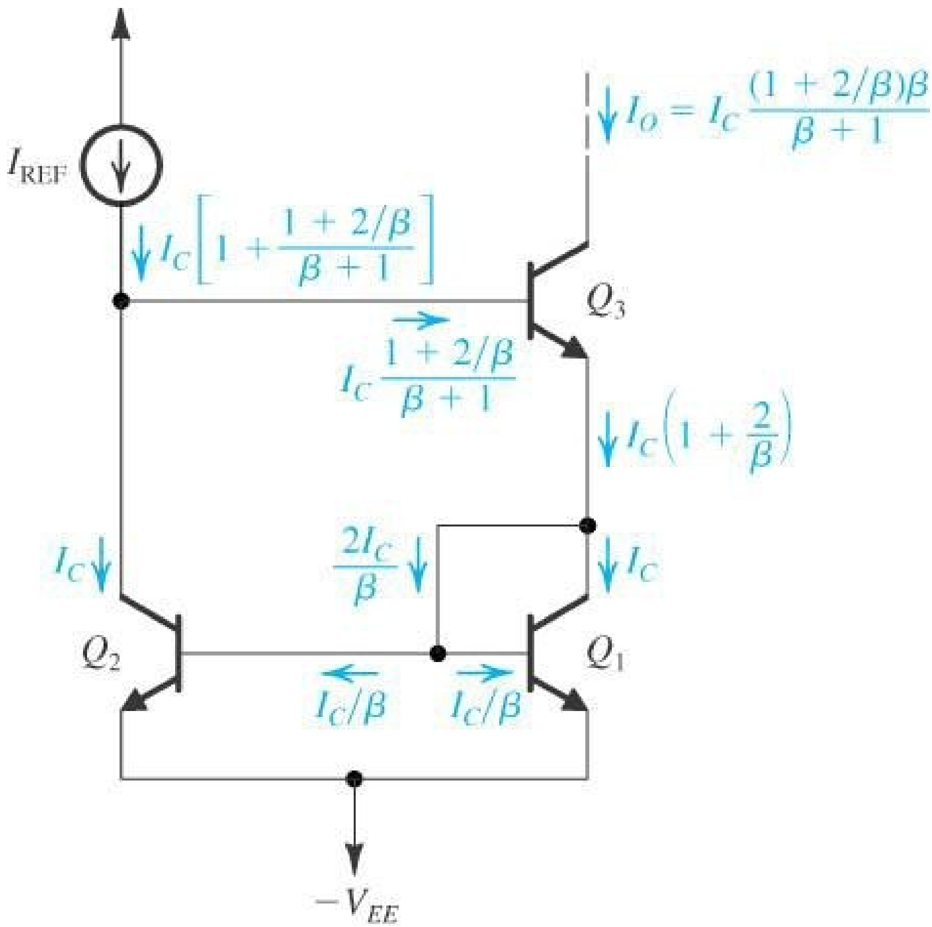
UNIT-1
Lecture-3

Wilson and Improved Wilson Current Mirrors,
Widlar Current source

Wilson Bipolar Current Mirror



(a)

$$\frac{I_o}{I_{REF}} \cong \frac{1}{1+\frac{2}{\beta^2}}$$

$$R_o \approx \frac{\beta r_o}{2}$$

The Wilson current source

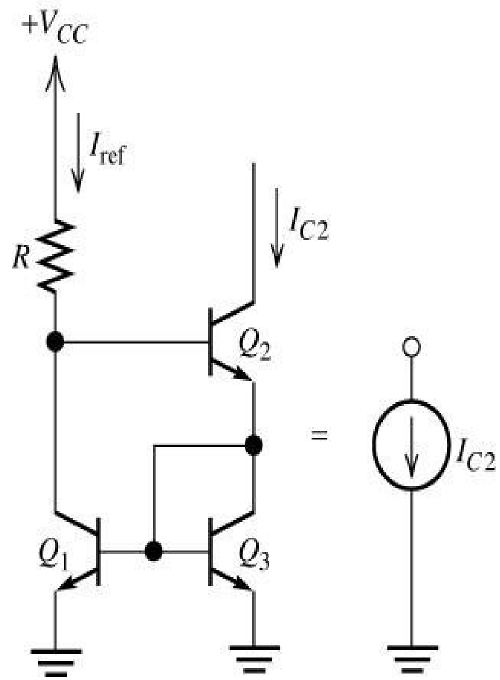
An improved circuit, called Wilson current source, with higher output impedance that the previous current mirror is shown in the Figure.

For the Wilson current source, the following holds:

$$I_{ref} = \frac{V_{CC} - V_{BE2} - V_{BE3}}{R}$$

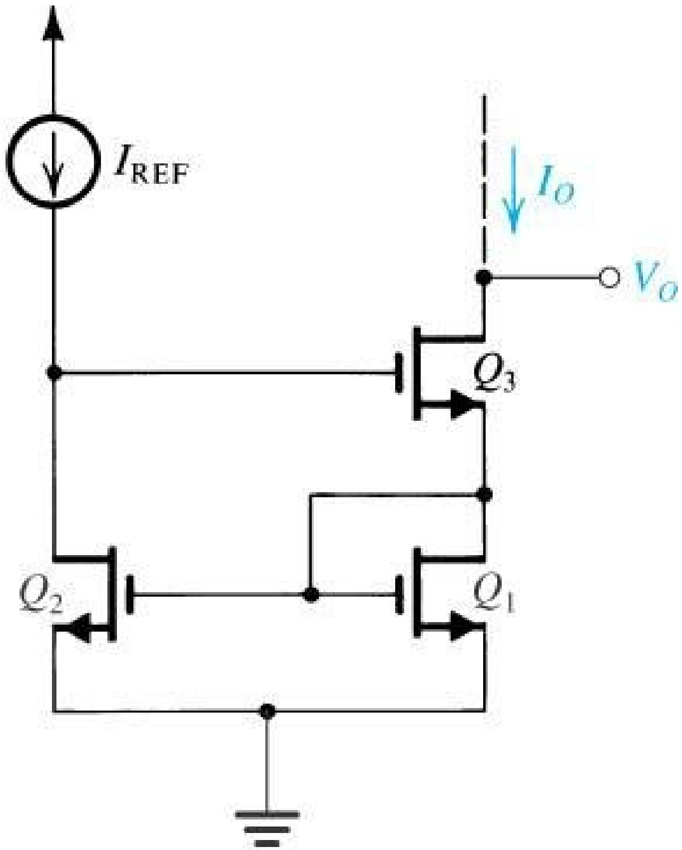
$$I_{C2} \approx \frac{A_3}{A_1} I_{ref}$$

A1, A3 are the relative junction areas of the Q1 and Q3 respectively.



The Wilson current source, which has a high output resistance.

Wilson MOS Current Mirror



(a)

$$R_o \cong g_{m3} r_{o3} r_{o2}$$

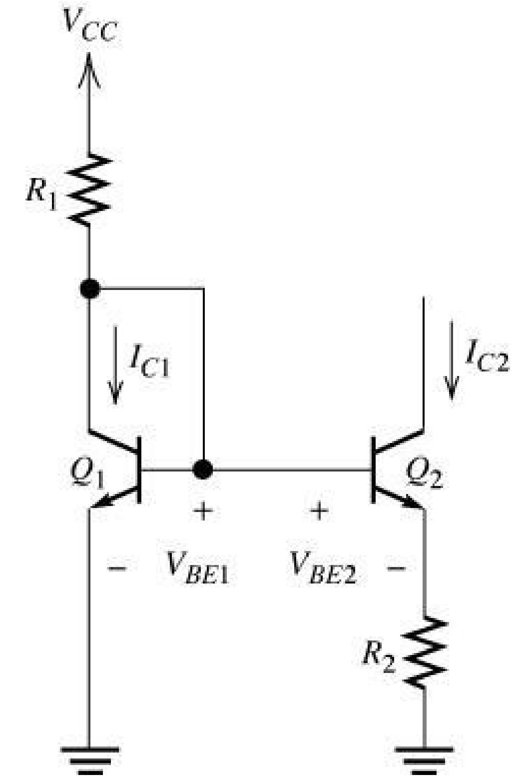
The Widlar current source

When the desired current is small, the Widlar current source may be a better alternative, as shown in the Figure.

For Widlar current source, the following holds

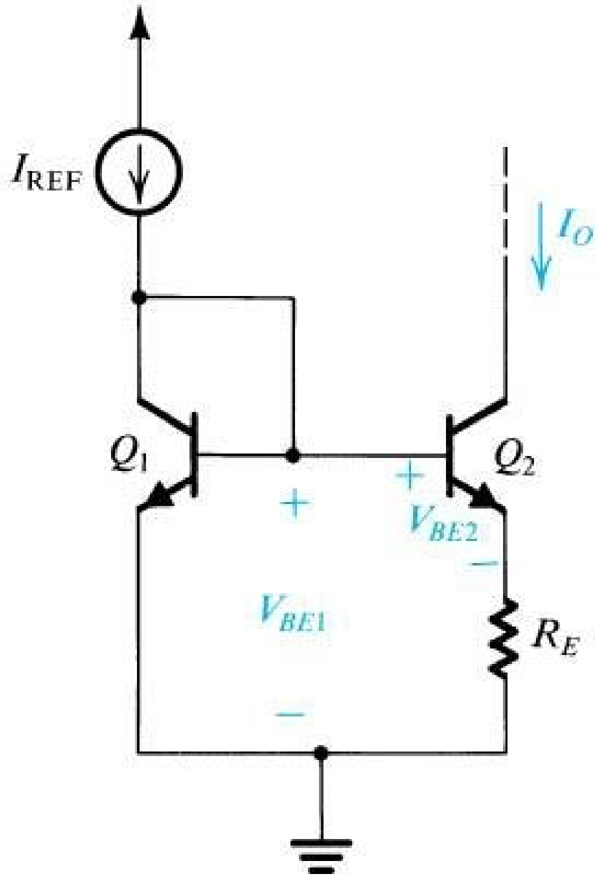
$$R_2 \approx \frac{V_T}{I_{C2}} \ln(\frac{I_{C1}}{I_{C2}})$$

$$I_{C1} \approx I_{ref} = \frac{V_{CC} - V_{BE1}}{R_1}$$



The Widlar current source,
which is useful for small currents.

Widler Current Mirror



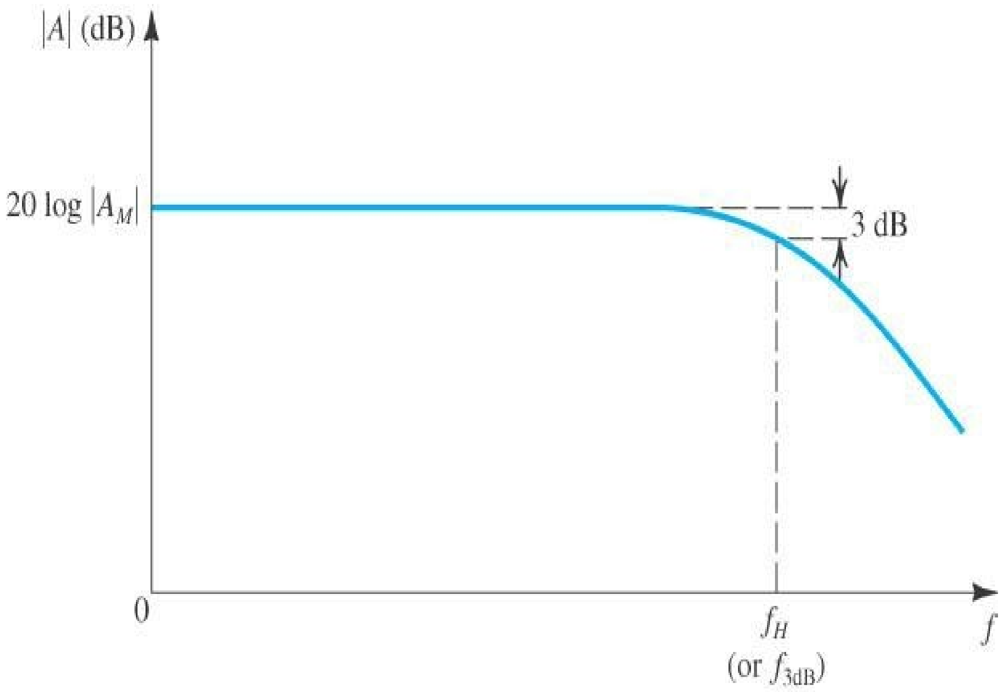
$$I_o = \frac{V_T}{R_E} \ln\left(\frac{I_{REF}}{I_o}\right)$$

$$R_o \cong \left[1 + g_m (R_E // r_\pi)\right] r_o$$

High Frequency Response

- The high-frequency gain function
- Determining the 3-dB frequency
  - By definition
  - Dominant-pole
  - Open-circuit time constants

High Frequency Gain Response



- Directly coupled
- Low pass filter
- gain does *not* fall off at low frequencies
- Midband gain A_M extends down to zero frequency

High Frequency Gain Function

- Gain function

$$A(s) = A_M F_H(s)$$

$$F_H(s) = \frac{(1 + s/\omega_{Z1})(1 + s/\omega_{Z2}).....(1 + s/\omega_{Zn})}{(1 + s/\omega_{P1})(1 + s/\omega_{P2}).....(1 + s/\omega_{Pn})}$$

- ω_{P1} , ω_{P2} , ….ω_{Pn} are positive numbers representing the frequencies of the *n* real poles.
- ω_{Z1} , ω_{Z2} , ….ω_{Zn} are positive, negative, or infinite numbers representing the frequencies of the *n* real transmission zeros.