ECE 523/421 – Analog Electronics

Lecture 9: Analog IC Building Blocks: Improved Current Mirror

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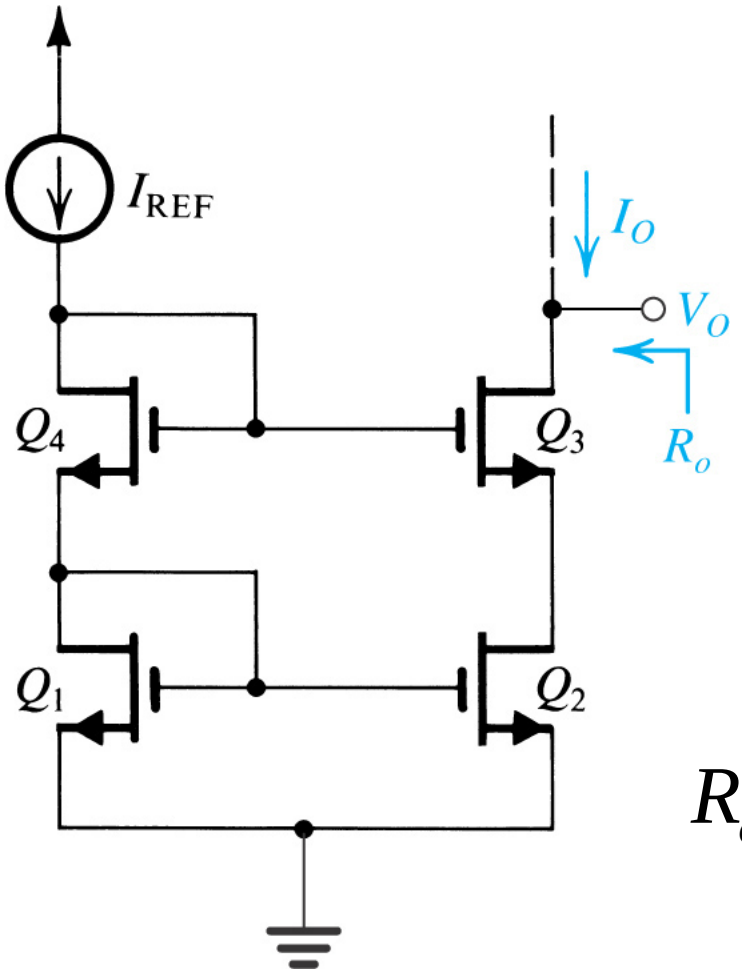
Review of Last Lecture

- **Current Mirror Circuits**
- **Current Sources**
- **Current Steering Circuits**

Today's Lecture

- **Cascode Current Mirror Circuits**
- **BJT Mirrors with Base Compensation Circuit**
- **Wilson Current Mirror**
- **Widlar Current Source**

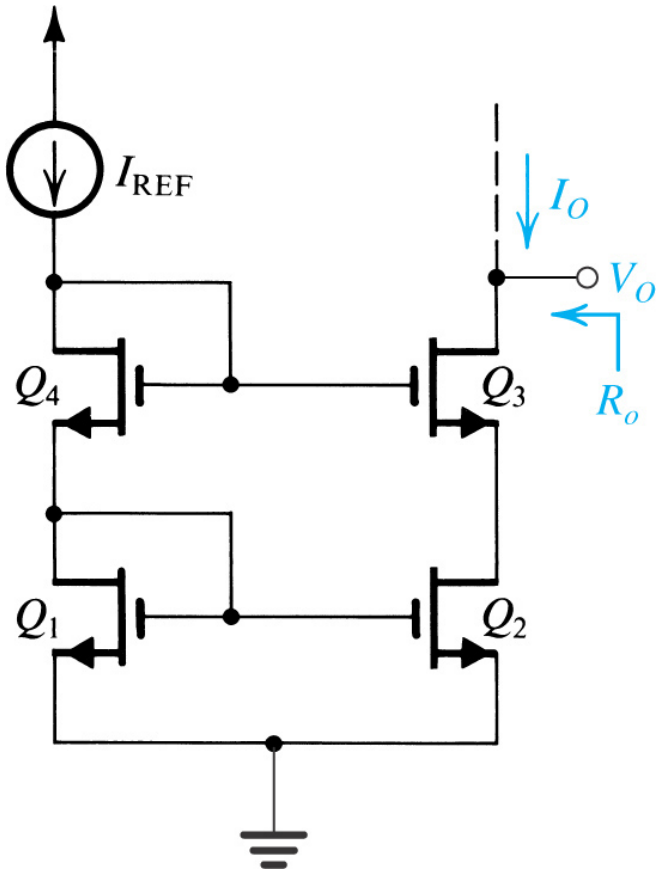
Cascode Current Mirror



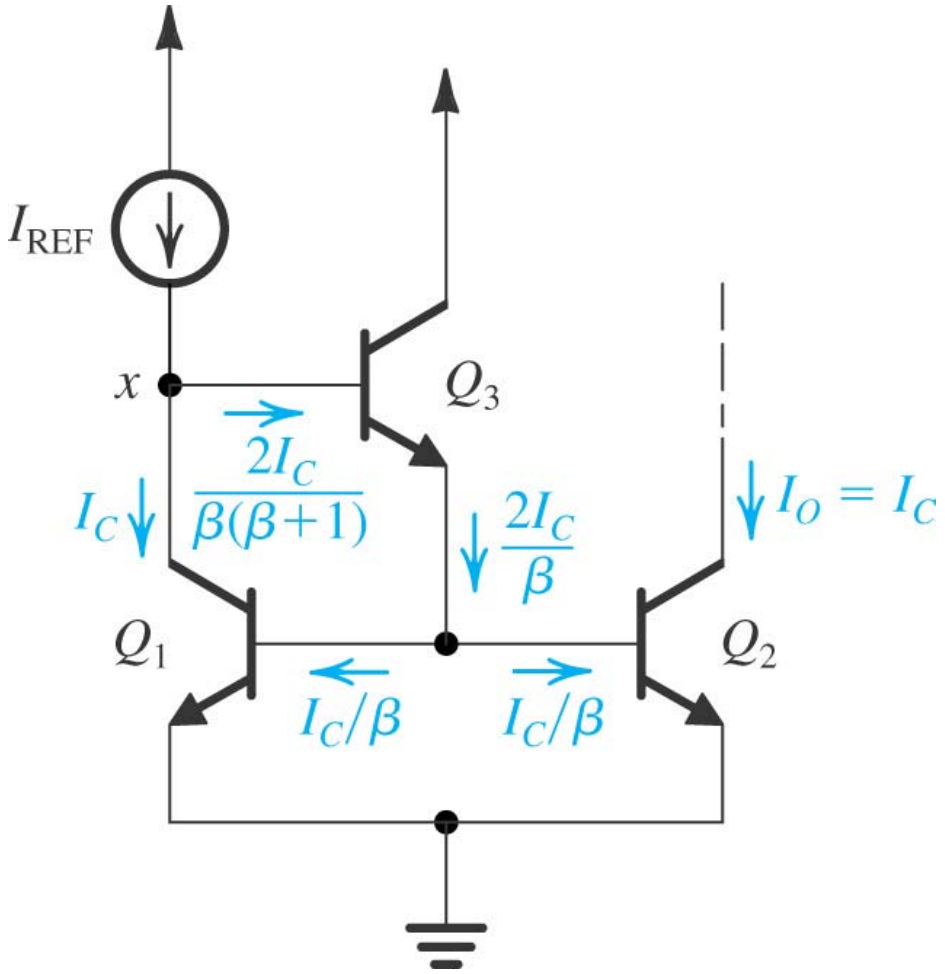
$$R_o \approx g_{m3} r_{o3} r_{o2}$$

Example: Cascode Current Source Design

1) Assume that V_t=0.5V, K'_n=387uA/V^2, V'_A=5V/um, (W/L)=3.6um/0.36um, and I_{REF}=100uA. Find R_{out} and V_{omin}.



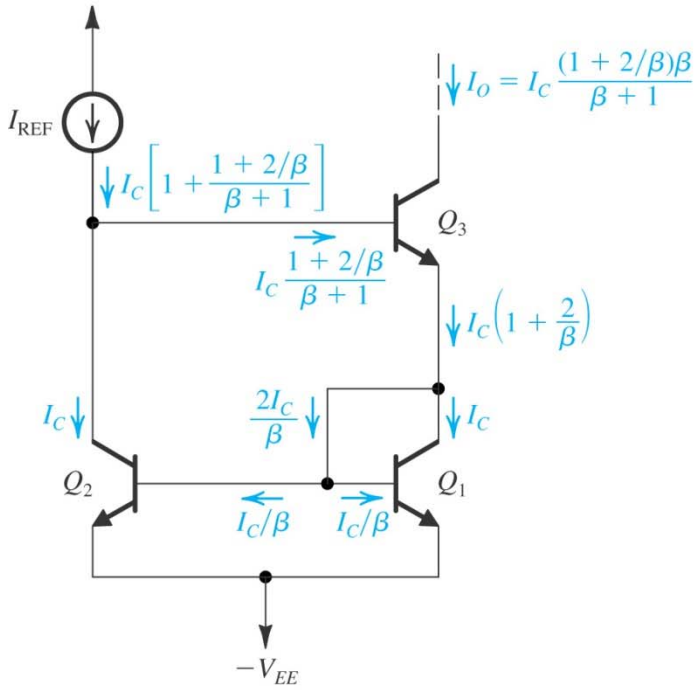
Base-Current Compensation



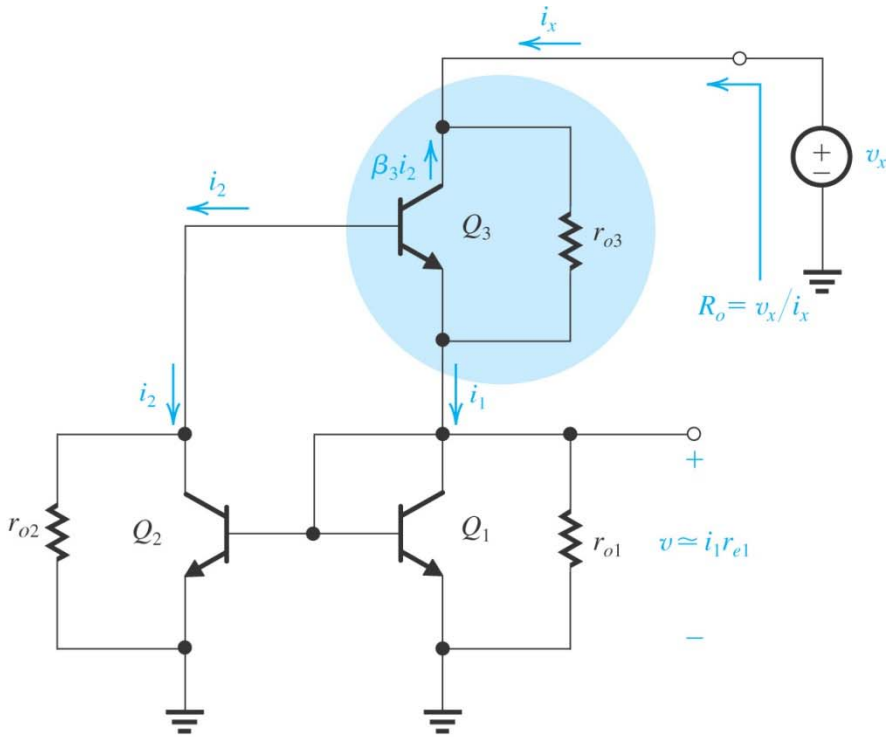
$$I_O = I_{REF}\left(\frac{1}{1+\frac{2}{\beta^2}}\right)$$

$$R_O = r_{o2}$$

Wilson BJT Current Mirror



(a)

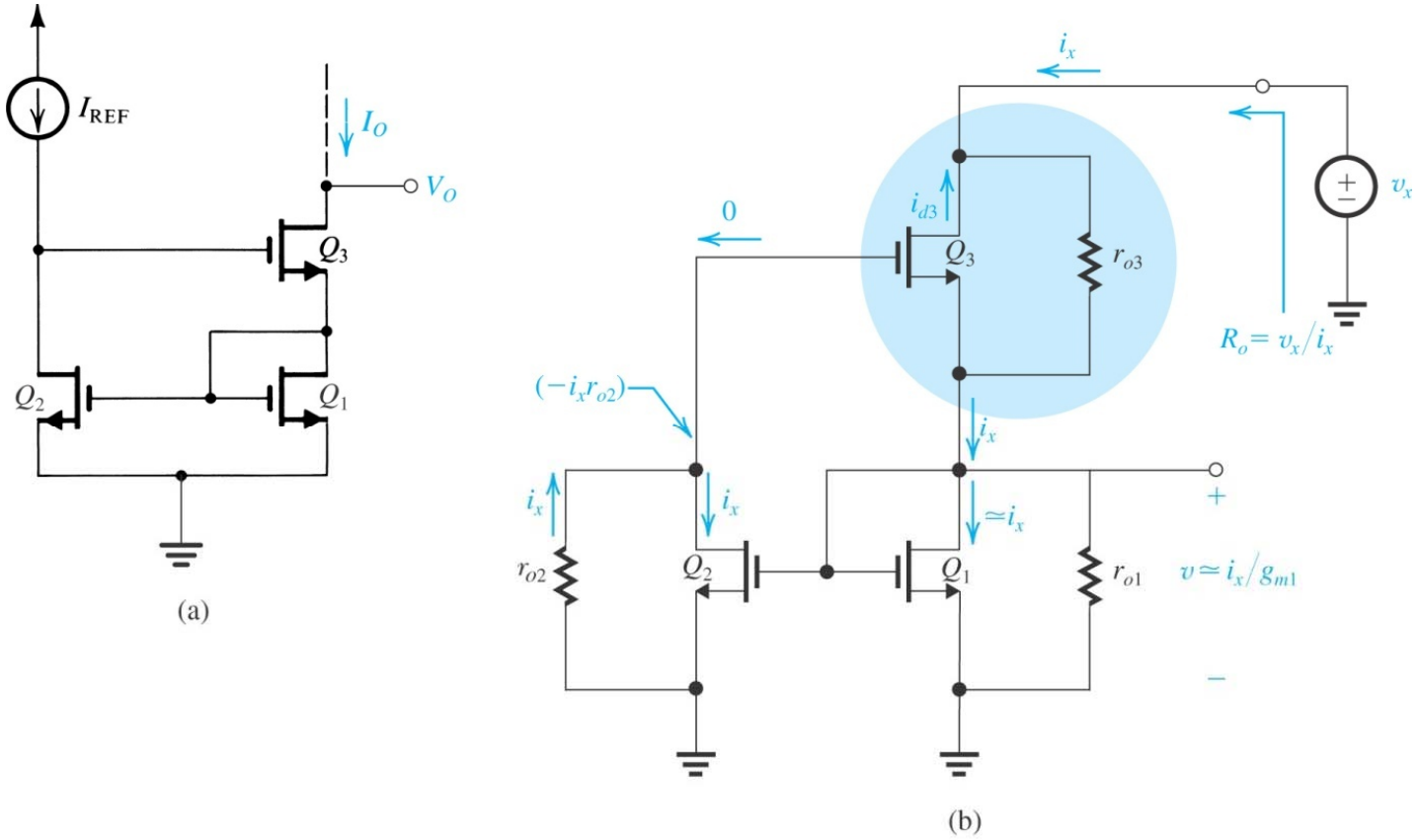


(b)

$$I_O \approx I_{REF}\left(\frac{1}{1+\frac{2}{\beta^2}}\right)$$

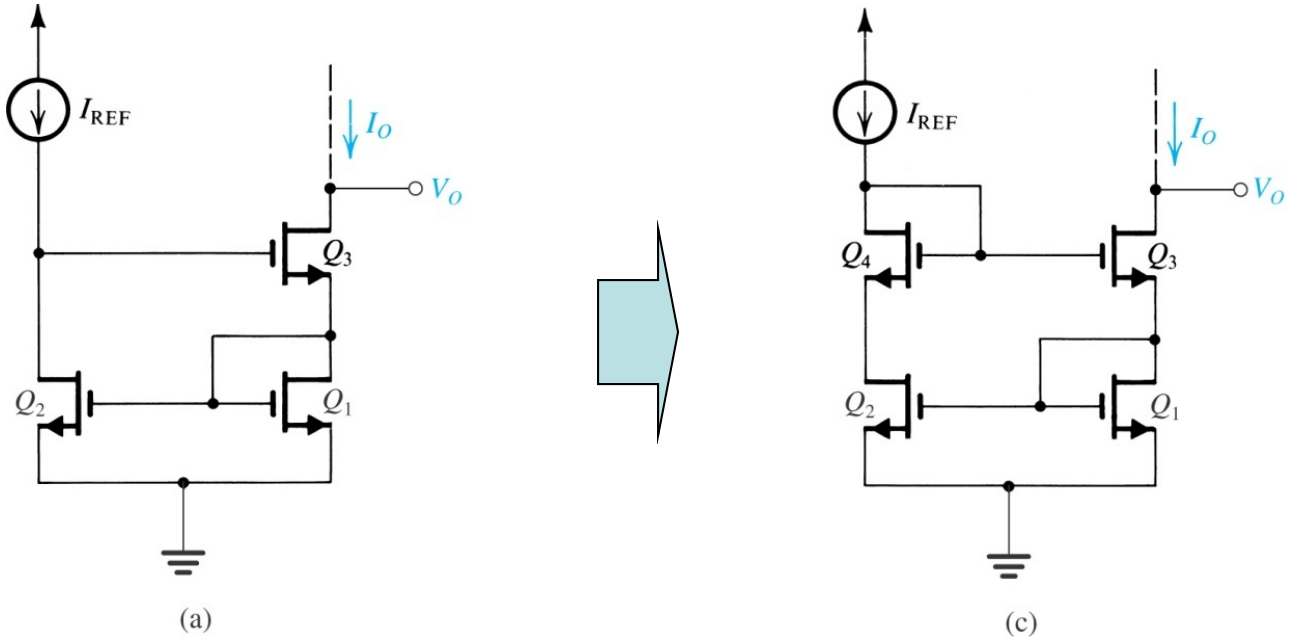
$$R_O = \beta_3 r_{o3} / 2$$

Wilson MOS Current Mirror

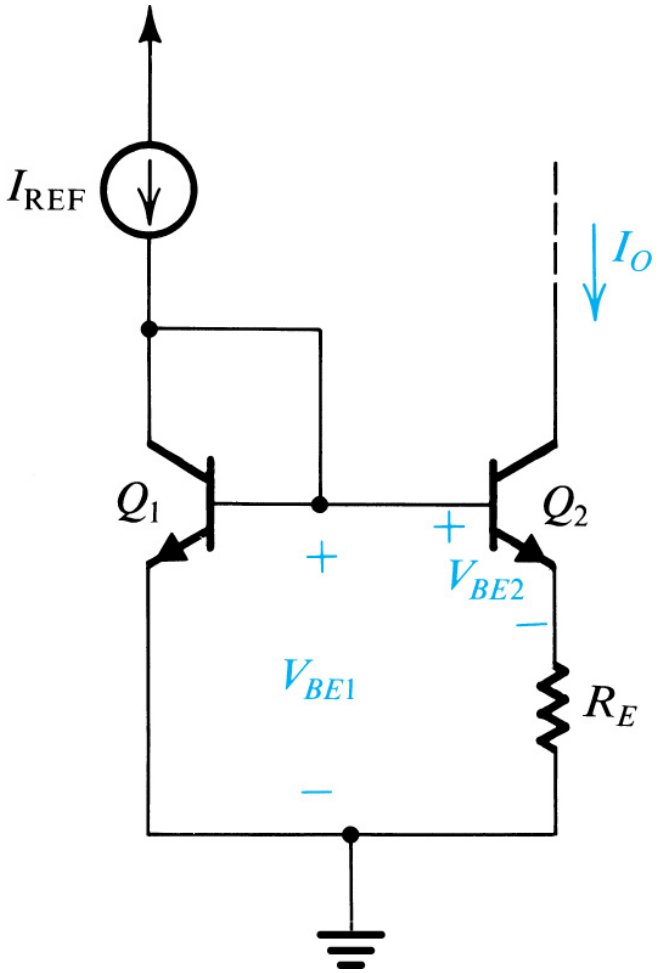


$$I_O = I_{REF} \qquad R_O = (g_{m3} r_{o3}) r_{o2}$$

Modified Wilson MOS Current Mirror



Widlar Current Compensation



$$I_O R_E = V_T Ln\left(\frac{I_{REF}}{I_O}\right)$$

$$R_O \approx \left[1 + g_m\left(R_E \| r_\pi\right)\right] r_o$$

Example: Widlar Current Source Design

1) Design the following circuits to get I_O=10uA with 10V supply. Assume that V_{BE}=0.7 at 1mA and β is large.
2) If V_A=100V and β=100, determine the R_{out} of the two circuits.