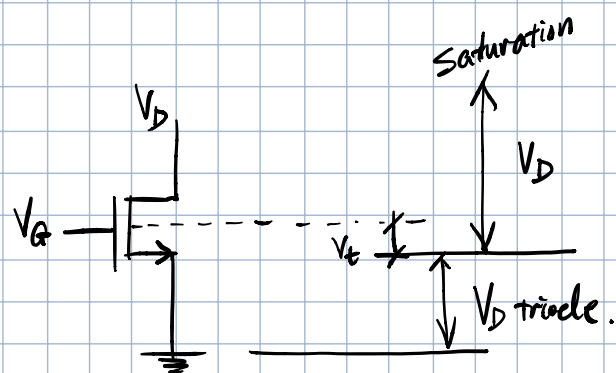
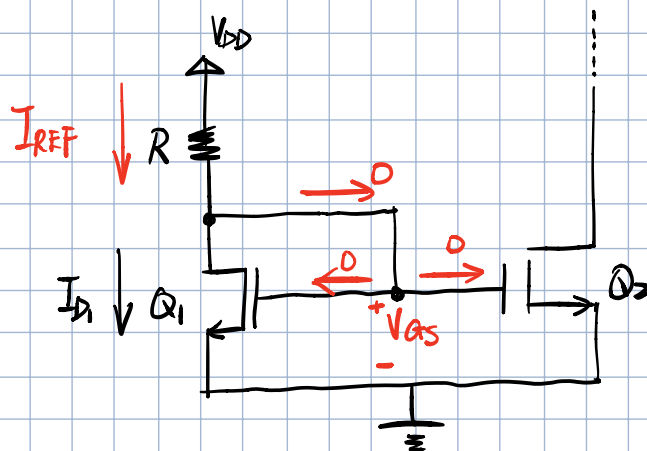


Current mirror



Q_1 is in saturation mode.

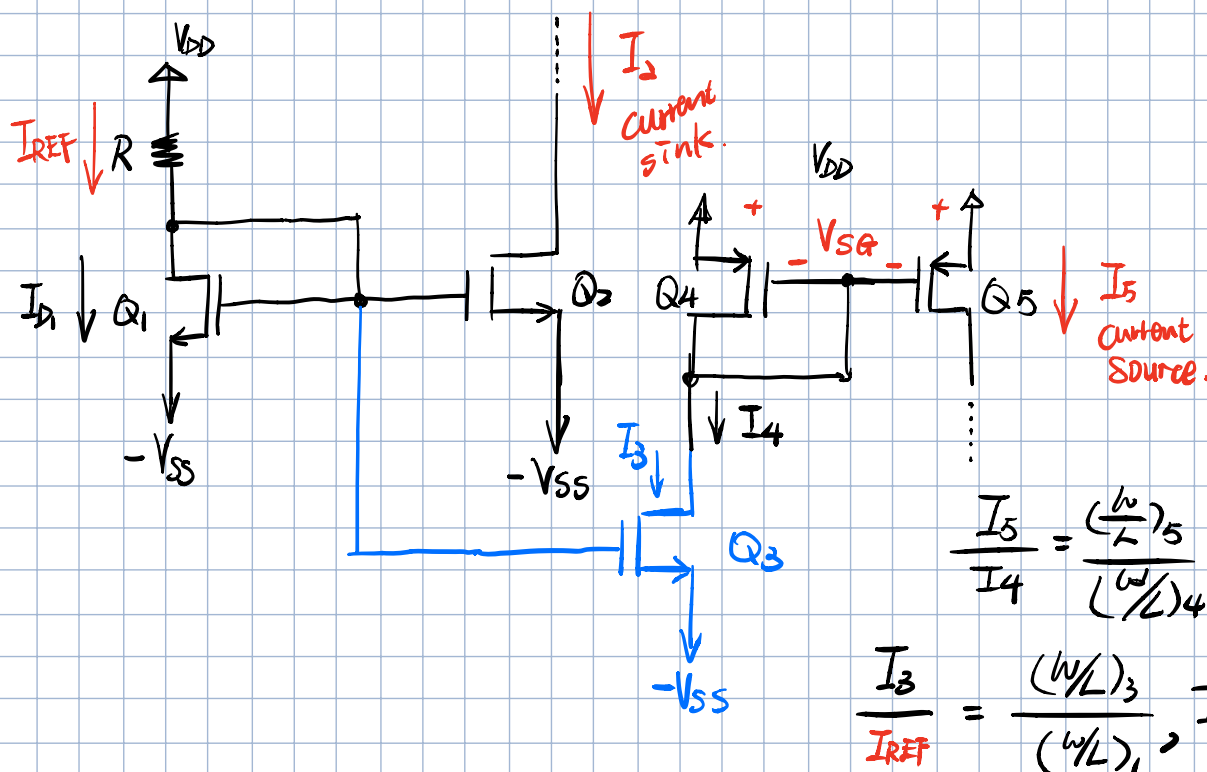
$$I_{D1} = \frac{1}{2} k'_n \left(\frac{W}{L} \right)_1 (V_{GS} - V_t)^2$$

$$I_{REF} = \frac{V_{DD} - V_{GS}}{R}$$

If Q_2 can be kept in saturation mode.

$$I_{D2} = \frac{1}{2} k'_n \left(\frac{W}{L} \right)_2 (V_{GS} - V_t)^2$$

$$\frac{I_{D2}}{I_{REF}} = \frac{\left(\frac{W}{L} \right)_2}{\left(\frac{W}{L} \right)_1}$$



$$\frac{I_5}{I_4} = \frac{\left(\frac{W}{L} \right)_5}{\left(\frac{W}{L} \right)_4}$$

$$\frac{I_3}{I_{REF}} = \frac{\left(\frac{W}{L} \right)_3}{\left(\frac{W}{L} \right)_1}, I_3 = I_4.$$

I_3 is the reference current for the Q_4 - Q_5 current mirror

BJT current mirror

$$I_0 \simeq I_{REF} \text{ (for matching } \frac{w}{L} \text{)}$$

Hand-drawn schematic of a Wilson current source circuit. The circuit consists of three transistors: Q_1 , Q_2 , and Q_3 .

- Q_1 is an NPN transistor with its emitter connected to a resistor R , which is connected to $-V_{EE}$. The base of Q_1 is connected to the collector of Q_2 .
- Q_2 is an NPN transistor with its emitter connected to the base of Q_3 . The collector of Q_2 is connected to V_{CC} .
- Q_3 is an NPN transistor with its emitter connected to $-V_{EE}$. The collector of Q_3 is connected to the base of Q_1 .

The output current I_{Wilson} is taken from the collector of Q_2 . The reference current I_{REF} is the current through resistor R .

Handwritten notes in red and blue ink provide additional information:

- I_{REF} (red)
- $I_1 \approx I_{REF}$ (source) (red)
- $I_4 \approx I_{REF}$ (sink) (red)
- $I \approx 2 I_{REF}$ (blue)
- $I_{REF} = \frac{V_{CC} + V_{EE}}{R}$ (red)

$$I_{REF} = \frac{V_{CC} + V_{EE} - 2 \times 0.7}{R}$$