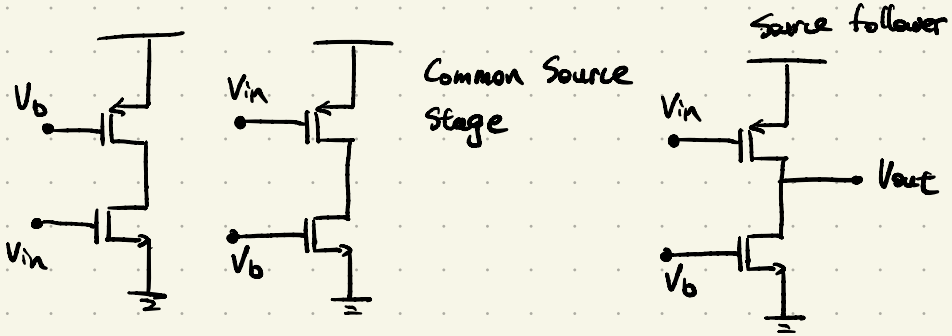
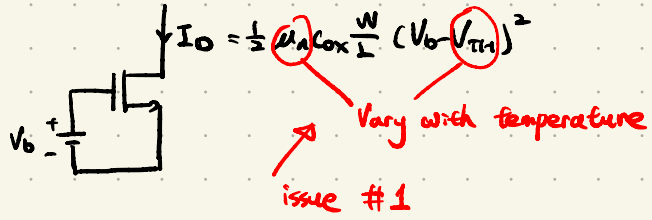
Lec 5: Problem of Biasing; Intro to Current Mirrors

- The Need for Current Sources
- Problem of Biasing Current Sources
- Current Mirrors

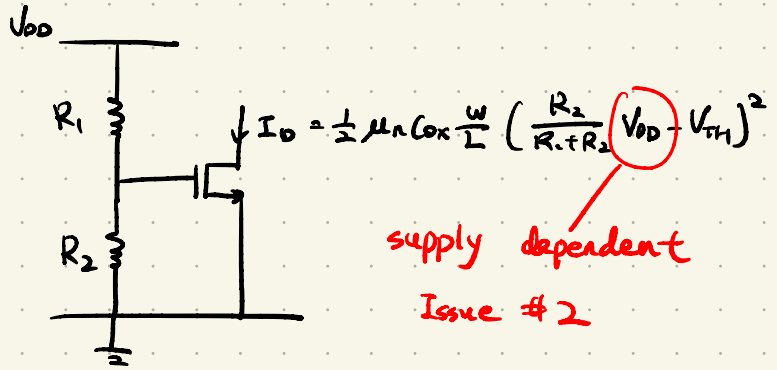
- Current Sources are everywhere:



- Problem of Biasing Current Sources



How to generate V_b:

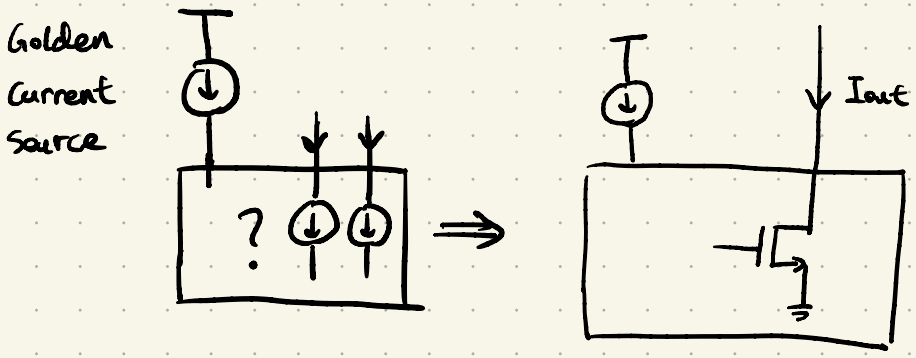


- Current Mirror

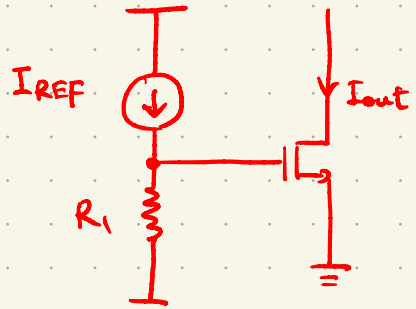
Basic Concept

First, build one "golden" current source using a bandgap circuit.

Next, we clone this current source to build many others



Q:

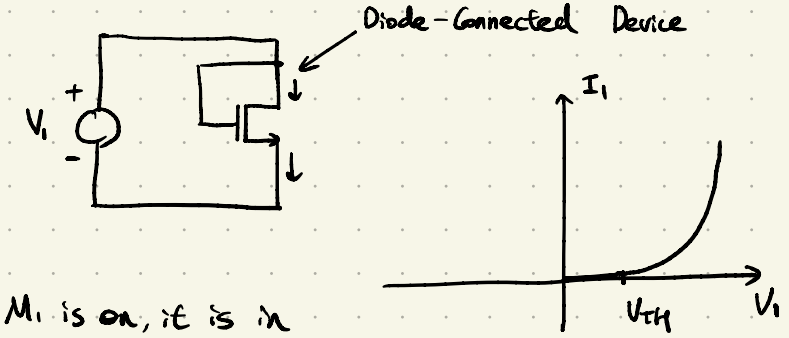


$$I_{out} = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}(R_1 I_{REF} - V_{TH})^2$$

Vary with temperature

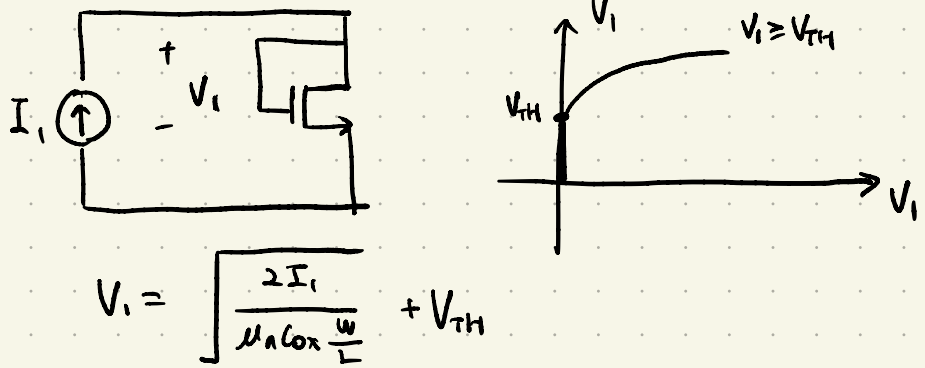
Observations

①



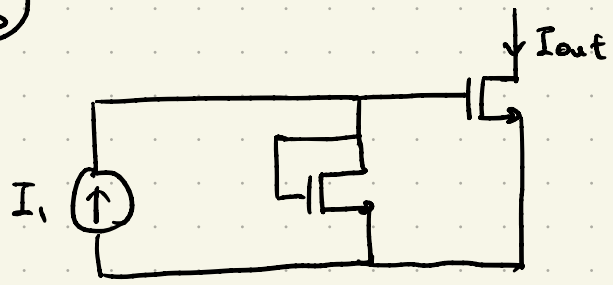
If M_1 is on, it is in sat. $I_1 = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}(V_1 - V_{TH})^2 \quad V_1 \geq V_{TH}$

②



$$V_1 = \sqrt{\frac{2I_1}{\mu_n C_{ox}\frac{W}{L}}} + V_{TH}$$

③

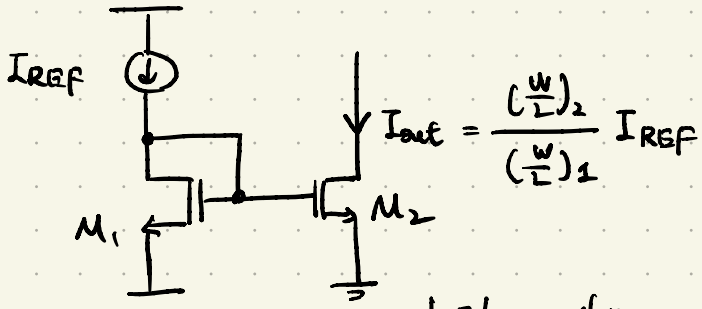


$$I_{out} = \frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right)_2 (V_1 - V_{TH})^2$$

$$= \frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right)_2 \left[\sqrt{\frac{2I_1}{\mu_n C_{ox}\left(\frac{W}{L}\right)_1}} + V_{TH} - V_{TH}\right]^2$$

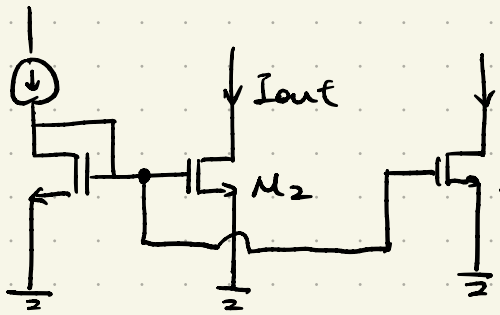
$$= \frac{\left(\frac{W}{L}\right)_2}{\left(\frac{W}{L}\right)_1} \cdot I_1$$

Current Mirror



$L_1 = L_2$ always

Select $\frac{W_2}{W_1}$ accordingly



$$I_{out_3} = \frac{\left(\frac{W}{L}\right)_3}{\left(\frac{W}{L}\right)_1} I_{REF}$$