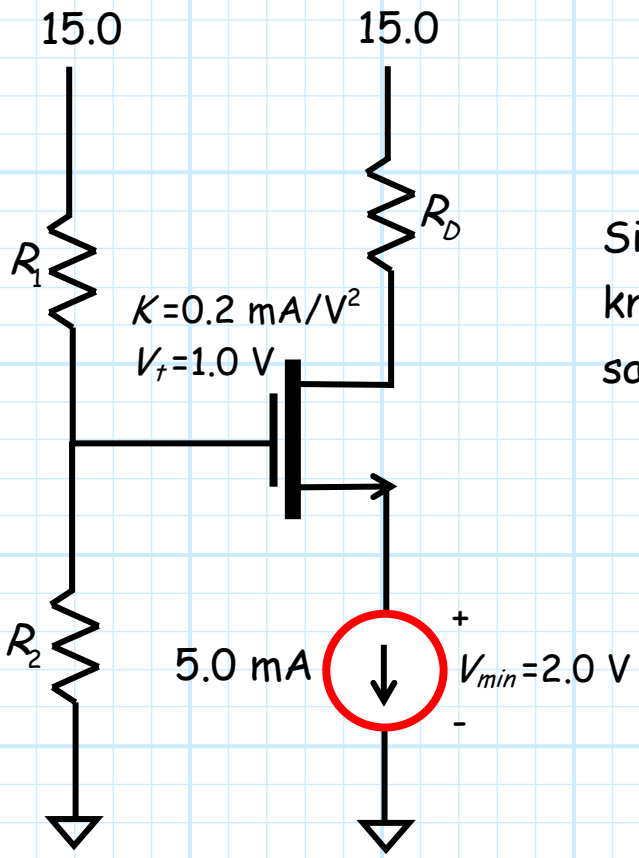
Example: MOSFET Biasing using a Current Mirror

Let's determine the proper resistor values to DC bias this MOSFET. The current source is 5.0 mA and has a minimum voltage of 2.0 Volts in order to operate properly



Since $I = I_D = 5.0\,\text{mA}$, we know that V_{GS} will be (if in saturation):

$$V_{GS} = \sqrt{\frac{I}{K}} + V_t$$
$$= \sqrt{\frac{5.0}{0.2}} + 1.0$$
$$= 6.0\,\text{V}$$

Assuming that we want the DC source voltage to be the minimum value of $V_S = 2.0$, we nee for the DC gate voltage to be:

$$V_G = V_{GS} + V_S$$
$$= 6.0 + 2.0$$
$$= 8.0\,\text{V}$$

Thus, we need to select resistors R_1 and R_2 so that:

$$V_G = 8.0 = V_{DD}\left(\frac{R_2}{R_1 + R_2}\right)$$

or in other words, we want:

$$\left(\frac{R_2}{R_1 + R_2}\right) = \frac{8.0}{15.0}$$

Since we can make R_1 and R_2 large, let's assume that we want:

$$R_1 + R_2 = 300\,\text{K}$$

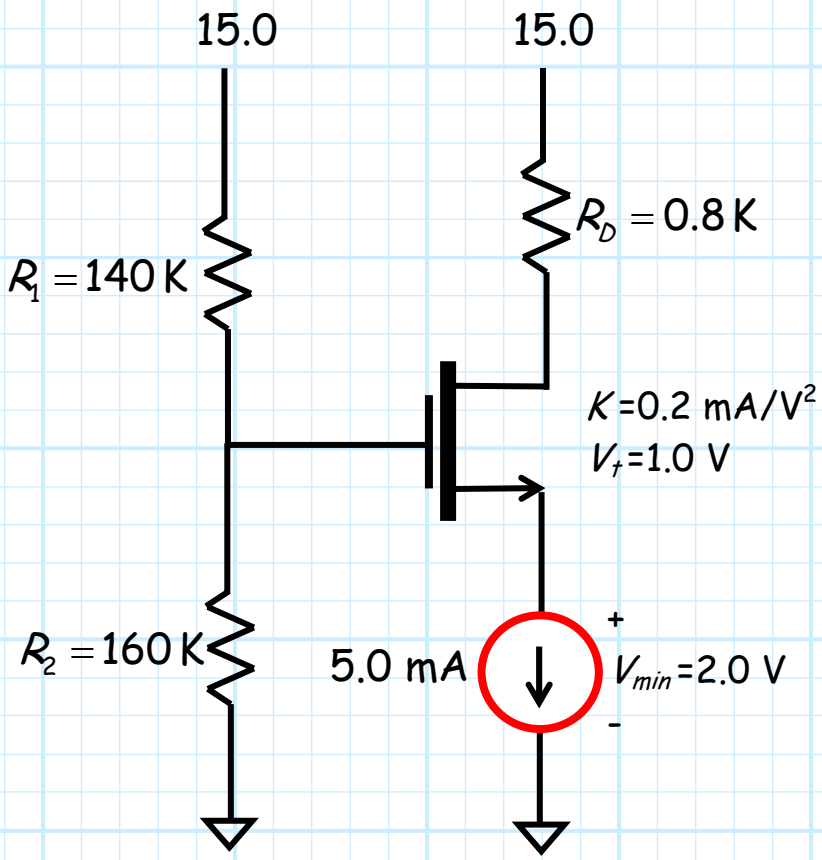
So that $R_1 = 140\ \text{K}\Omega$ and $R_2 = 160\ \text{K}\Omega$.

Finally, we want the DC drain voltage to be:

$$\begin{aligned} V_D &= \frac{V_{DD} + (V_G - V_t)}{2} \\ &= \frac{15.0 + (8.0 - 1.0)}{2} \\ &= 11.0\,\text{V} \end{aligned}$$

So that the resistor R_D is:

$$\begin{aligned} R_D &= \frac{V_{DD} - V_D}{I_D} \\ &= \frac{15.0 - 11.0}{5.0} \\ &= 0.8\,\text{K}\Omega \end{aligned}$$


15.0
15.0
$R_D = 0.8\,K$
$R_1 = 140\,K$
$K = 0.2\ mA/V^2$
$V_t = 1.0\ V$
$R_2 = 160\,K$
5.0 mA
+
$V_{min} = 2.0\ V$
-