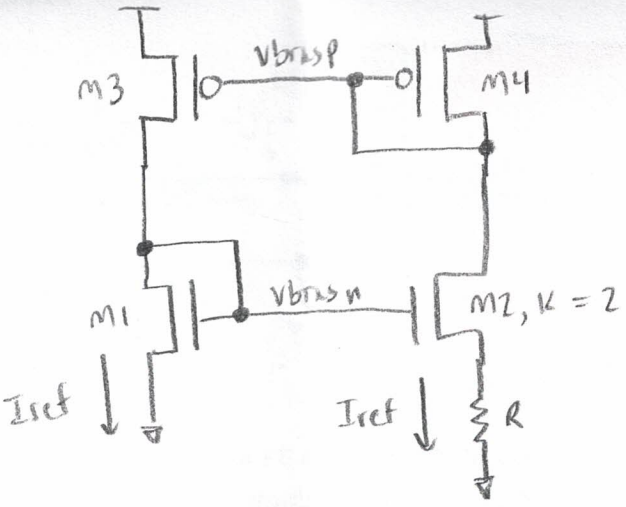
Hand Calculations

Given parameters:

CD4007 models

NMOS: $V_{THN} = 1.6V$
$K_{PN} = 6\mu A/V^2$
$\lambda = 0.01$
$W = 500\mu m$
$L = 5\mu m$
$\frac{W}{L} = 100$

PMOS: $V_{THP} = 1.5V$
$K_{PP} = 5\mu A/V^2$
$\lambda = 0.03$
$W = 500\mu m$
$L = 5\mu m$
$\frac{W}{L} = 100$



From eq. (20.23) in CMOS book, we can write the equation for Iref by:

$$① \quad I_{ref} = \frac{2}{R^2 \cdot K_{PN} \cdot \frac{W}{L}} \left(1 - \frac{1}{\sqrt{K}}\right)^2$$

and the equation for gm by:

$$② \quad g_m = \sqrt{2 \cdot K_{PN} \cdot \frac{W}{L} \cdot I_{ref}}$$

from ②, $\frac{(g_m)^2}{2 \cdot K_{PN} \cdot \frac{W}{L}} = I_{ref}$

$$I_{ref} = \frac{(20\mu A/V)^2}{2 \cdot (6\mu A/V^2) \cdot 100}$$

$$\boxed{I_{ref} = 0.333\mu A = 333\,nA}$$

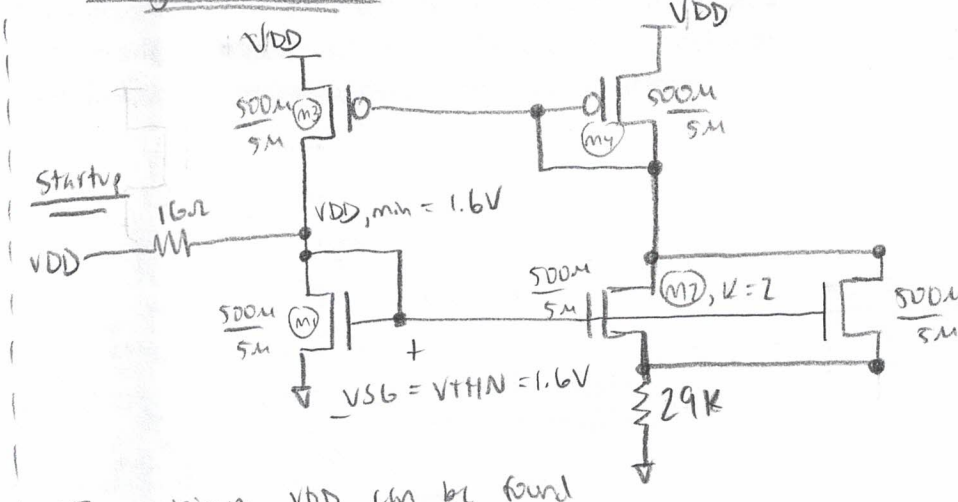
Rearranging ①,

$$R = \sqrt{\frac{2}{I_{ref} \cdot K_{PN} \cdot \frac{W}{L}}} \left(1 - \frac{1}{\sqrt{K}}\right)$$

$$R = \sqrt{\frac{2}{333nA \cdot 6\mu A/V^2 \cdot 100}} \left(1 - \frac{1}{\sqrt{2}}\right)$$

$$\boxed{R = 29k\Omega}$$

Designed Circuit:



- The minimum VDD can be found assuming that the VGS/VSG = VTHN/VTHP; Because device M1 is diode connected, and because there is a very small voltage drop across the 16Ω resistor, $\boxed{VDDmin = VTHN}$. Once $\boxed{VDD = 1.6V = VTHN}$, M1 begins sinking the desired amount of current and the BMR begins operating.