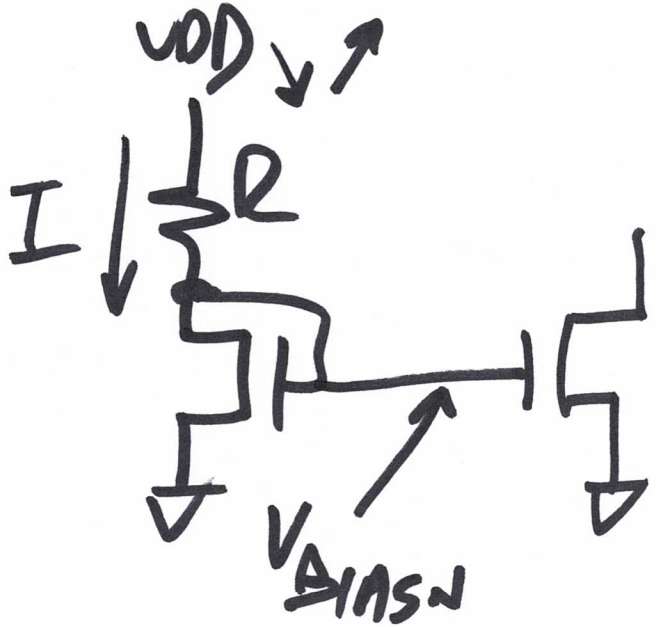
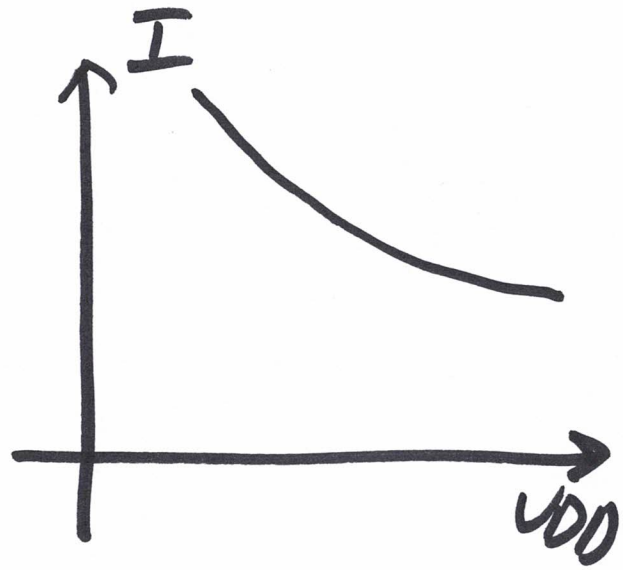
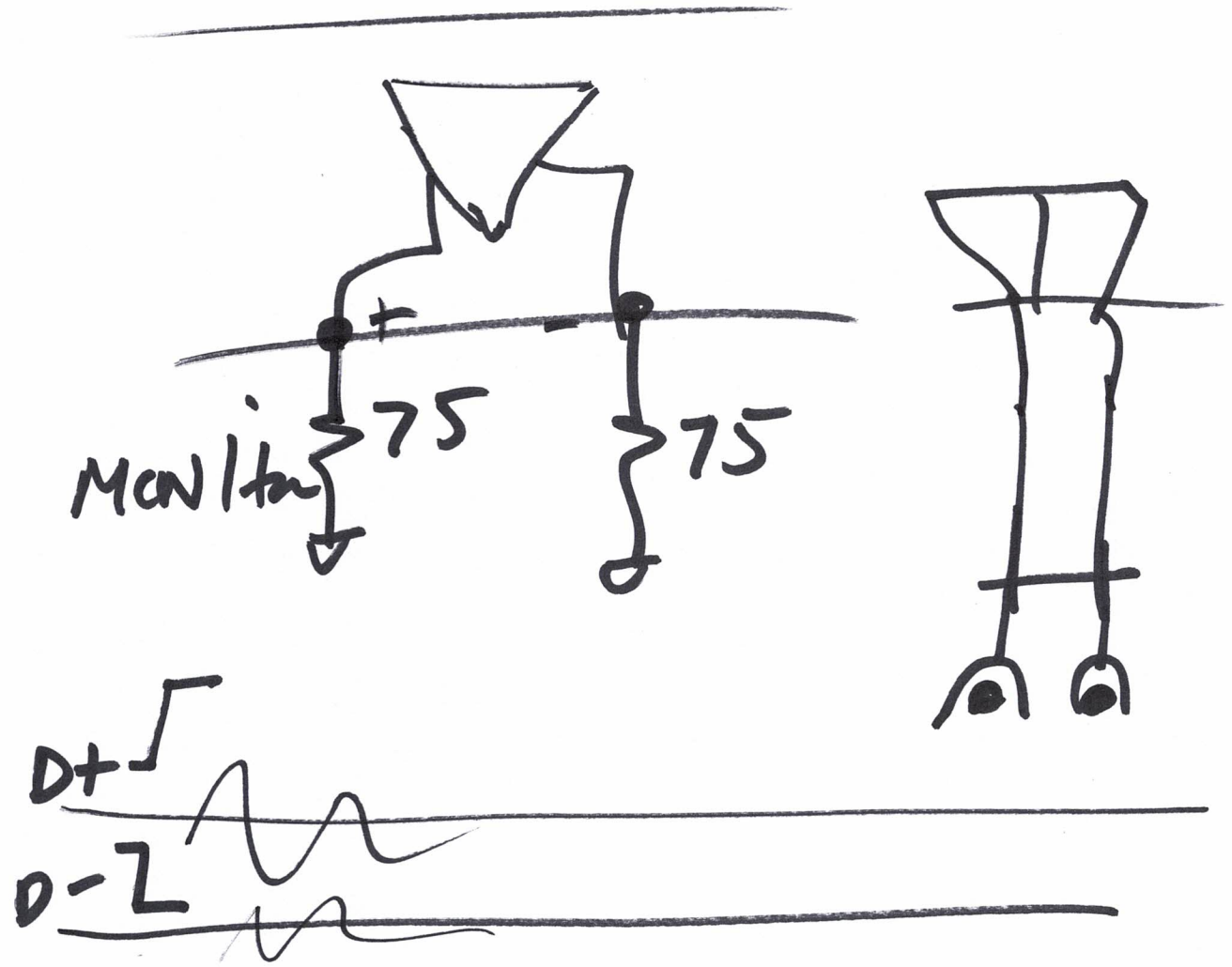
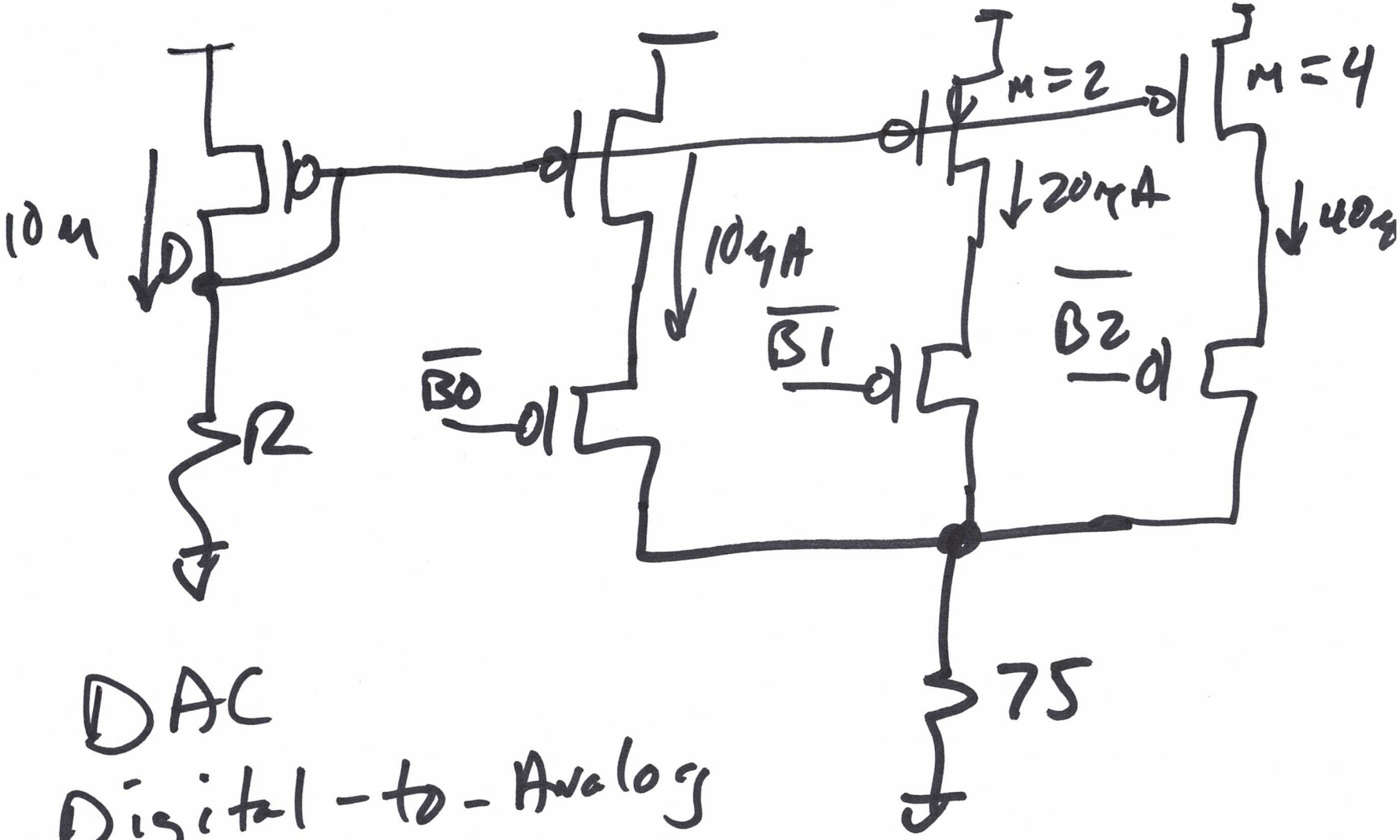
EE 420 / EEG 620
Analog IC Design
Lecture 8,
Feb. 19, 2020



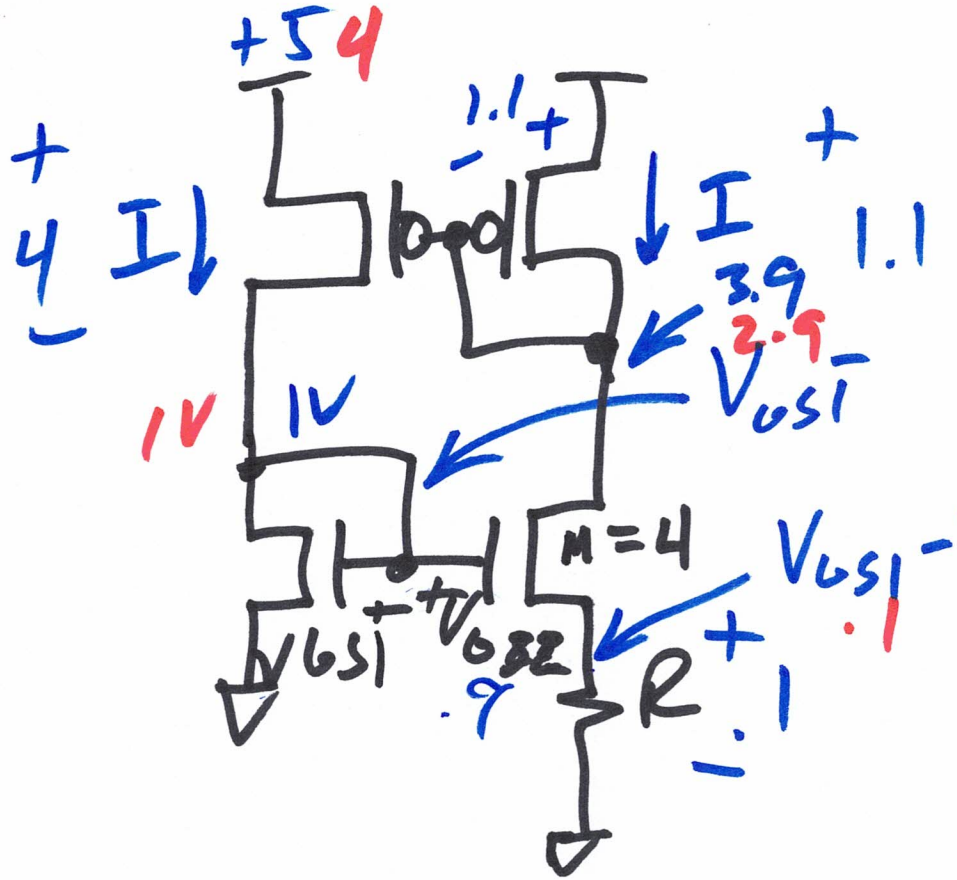


Digital to analog converter





DAC
Digital-to-Analog
Converter



$$I = \frac{KP}{2}\frac{W}{L}(V_{GS} - V_{THN})^2$$

$$I = \frac{V_{GS1} - V_{GS2}}{R}$$

$$= \frac{\sqrt{\frac{2I}{KP\cdot\frac{W}{L}}} + V_{THN} - \left(\sqrt{\frac{2I}{KP\cdot M\cdot\frac{W}{L}}} + V_{THN}\right)}{R}$$

$V_{GS1} > V_{GS2}$

$$I = \sqrt{\frac{2I}{KP\cdot\frac{W}{L}\cdot R^2}}\left(1 - \frac{1}{\sqrt{M}}\right)$$

$$I = \frac{2}{KP \cdot \frac{W}{L} R^2} \left(1 - \frac{1}{m}\right)^2$$

for example $m = 4$

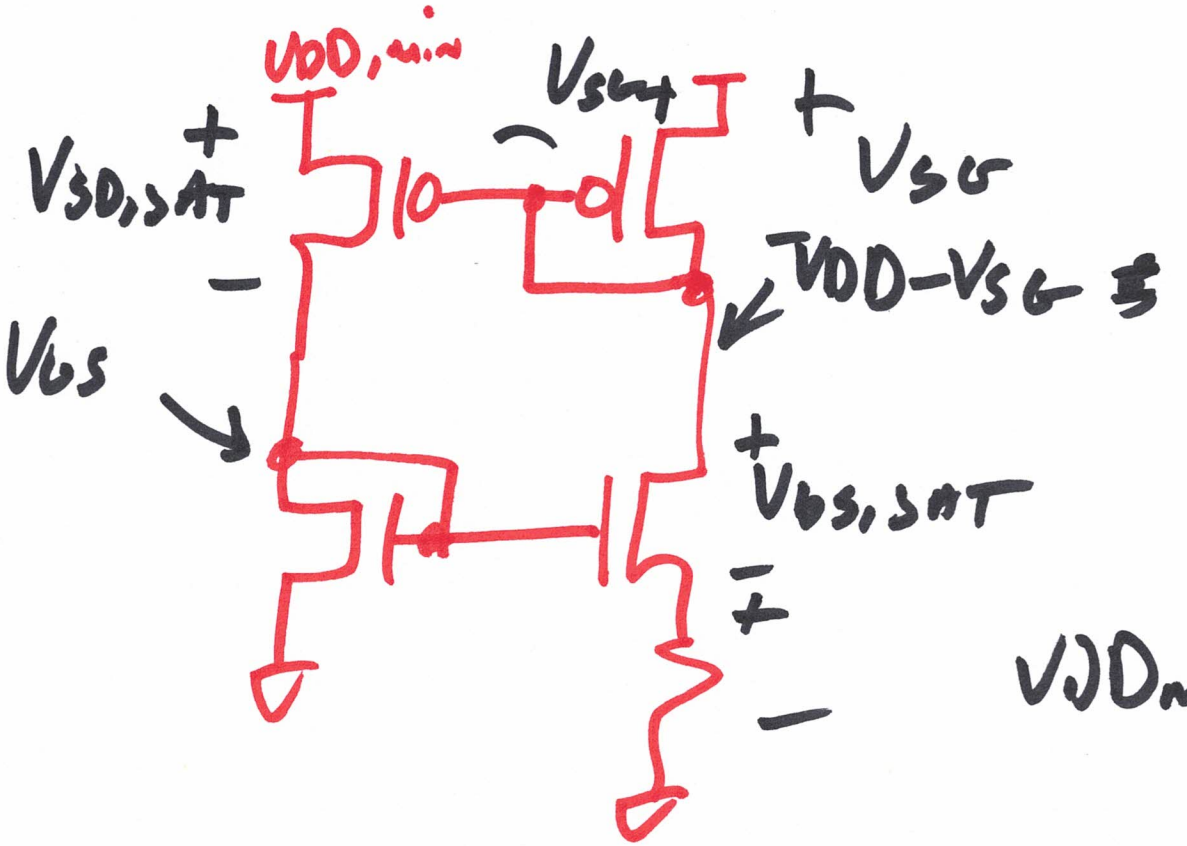
$\frac{1}{2}$ $\quad$ $\left(\frac{1}{2}\right)^2$ $\quad$ $\frac{1}{4}$

$$I_D = \frac{1}{2 KP \frac{W}{L} \cdot R^2}$$

$$g_m = \sqrt{2 I_D \cdot KP \cdot \frac{W}{L}}$$

$$R^2 = \frac{1}{2 I_D \cdot KP \cdot \frac{W}{L}} \Bigg|_{K=4}$$

$$R = \frac{1}{\sqrt{2 I_D KP \cdot \frac{W}{L}}} = \frac{1}{g_m} \Bigg|_{K=4}$$



$V_{DD,min} \geq 1.5V$

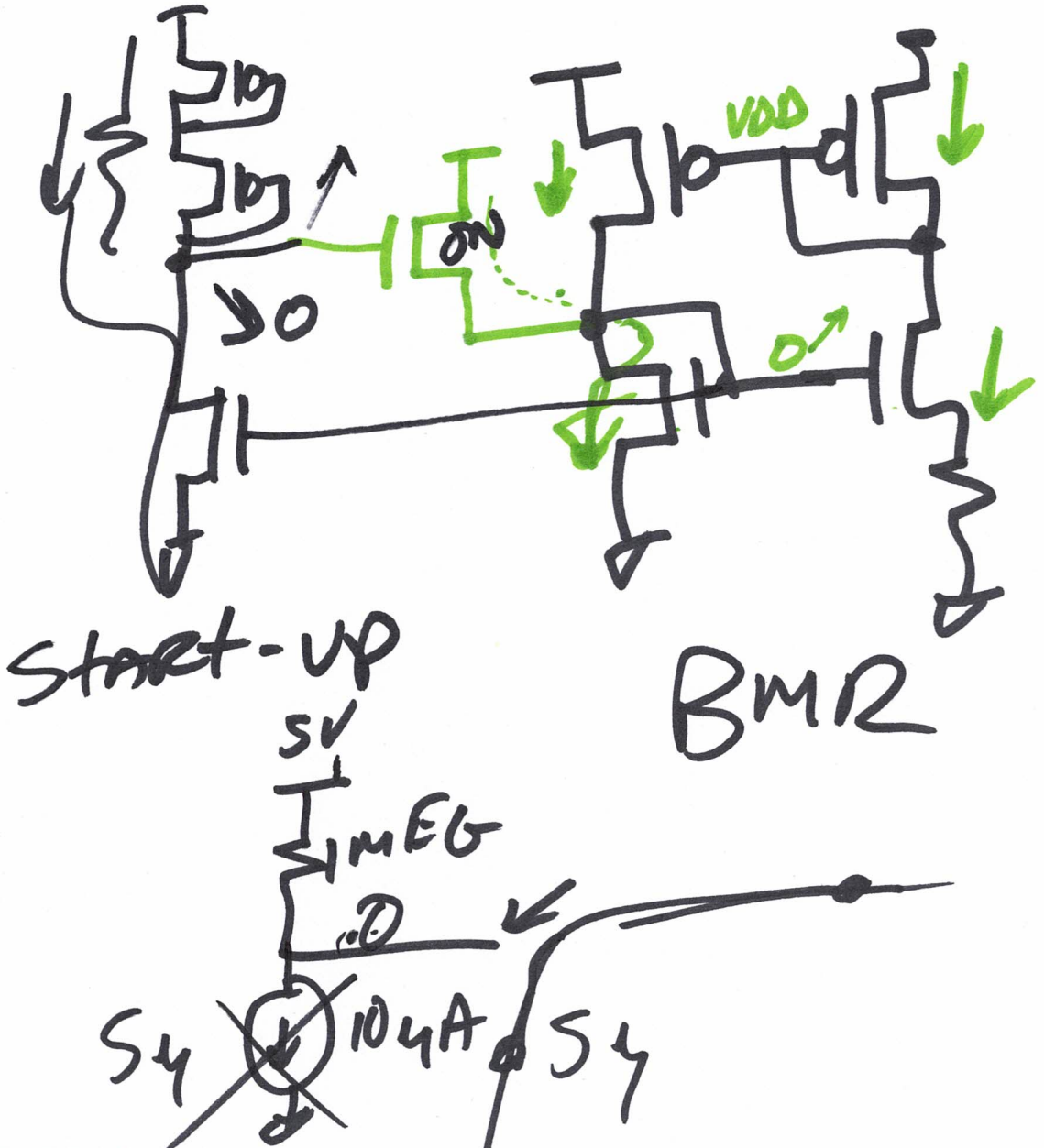
$V_{DD,min} \geq V_{SD,SAT} + V_{DS}$

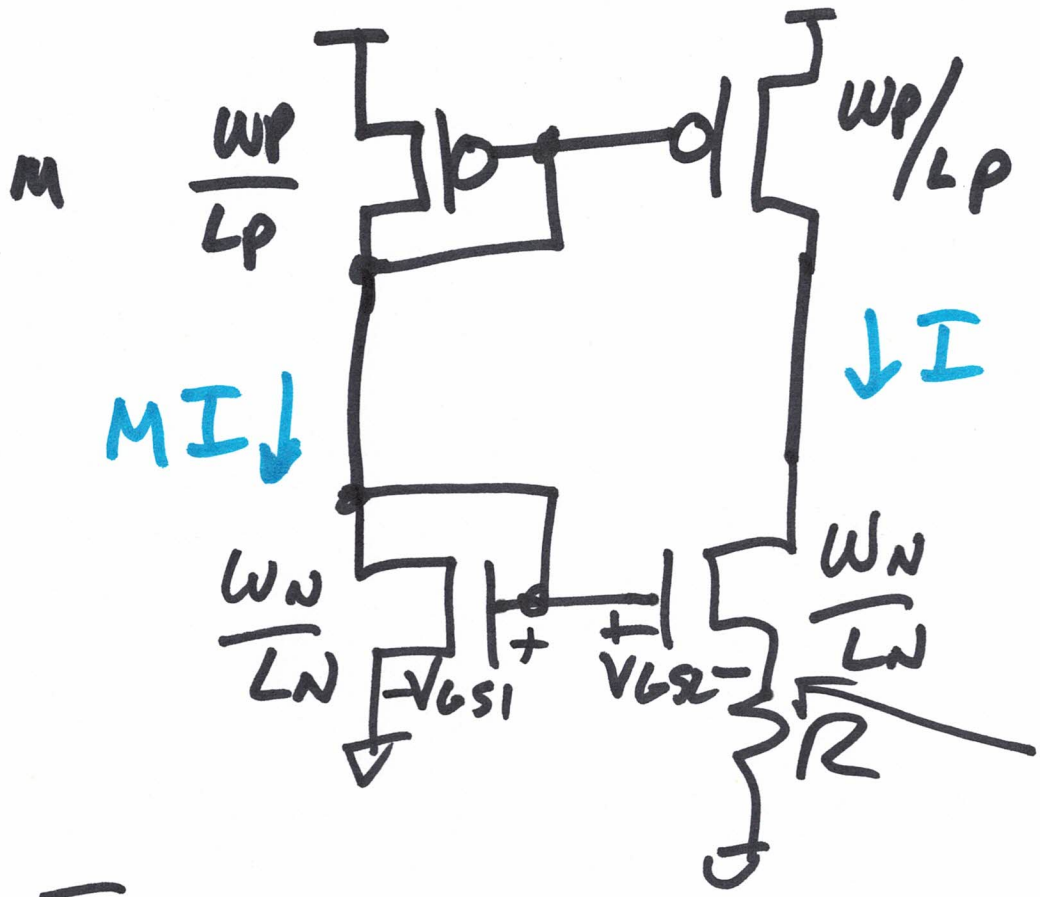
$1.05 + .25 = 1.3V$

$V_{DD,min} \geq V_{SG} + V_{DS,SAT}$

$1.15 + .25 = 1.4V$

Why need a start-up





$$\frac{V_{GS1} - V_{GS2}}{R} = I$$

$$I = \left[\sqrt{\frac{2MI}{KP \cdot \frac{W}{L}}} + V_{THN} - \left(\sqrt{\frac{2I}{KP \cdot \frac{W}{L}}} + V_{THN} \right) \right] \frac{1}{R}$$

$$\sqrt{\frac{2I}{KP \frac{W}{L} R^2}} \left(\sqrt{M} - 1 \right) = \sqrt{I}$$

$$I = \frac{2}{KP \cdot \frac{W}{L} R^2} \left(\sqrt{M} - 1\right)^2$$

e.g. $m = 2$ $\quad (.41)^2$

$.17$

$$\left(1 - \frac{1}{\sqrt{4}}\right)^2$$

$$\left(\frac{1}{2}\right)^2 = .25$$