CURRENT MIRROR DESIGN EXAMPLE

- ACM PARAMETERS: $I_{SQ} = 100\,nA$

$V_{th} = 400\,mV$

$n = 1.25$

$\left|\frac{\partial X_d}{\partial V_{DS}}\right| = 0.05\ \mu m/V$

- DESIGN GOALS:
  - INPUT CURRENT = 100μA
  - GAIN OF 2
  - $V_{OUT_{MIN}} = 250\,mV$ @ 27°C
  - $\frac{\Delta I_{out}}{I_{out}} \leq 5\%$ WITH $\Delta V_{out} = 1V$
  - DESIGN FOR MINIMUM AREA.

- SOLUTION:

$$V_{DS_{SAT}} = V_T\left(3 + \sqrt{14 + i_f}\right) \leq 250\,mV$$

$$\boxed{i_f \leq 42.7}$$

MAX INVERSION LEVEL

$$I_D = I_{SQ}\frac{W}{L}\,i_f = 100\mu A$$

$$\frac{W}{L} = \frac{100\mu A}{I_{SQ}\,i_f}$$

- DUE TO MATCHING CONSIDERATIONS, MAKE $W, L \geq 1\,\mu m$
- ∴ MINIMUM AREA OBTAINED WHEN $\frac{W}{L}$ CLOSER TO 1

$\frac{W}{L} = 1 \Rightarrow i_f = \frac{100\mu A}{I_{SQ}} = 1000$ TOO HIGH!

(2) ∴ SET i_F AS HIGH AS POSSIBLE (FOR THIS EXAMPLE ONLY).

- LEAVING 5% MARGIN: $i_F \cong 40$

$$\left.\frac{W}{L}\right|_{i_F=40} = 25$$

$$\frac{\Delta I_{OUT}}{I_{OUT}} \leq 5\,\%$$

$$\frac{\Delta V_{OUT}}{\Delta I_{OUT}} = r_o = \frac{L}{\left|\frac{\partial X_D}{\partial V_{DS}}\right| I_{OUT}} \Rightarrow \frac{\Delta I_{OUT}}{I_{OUT}} = \frac{\Delta V_{OUT}\left|\frac{\partial X_D}{\partial V_{DS}}\right|}{L}$$

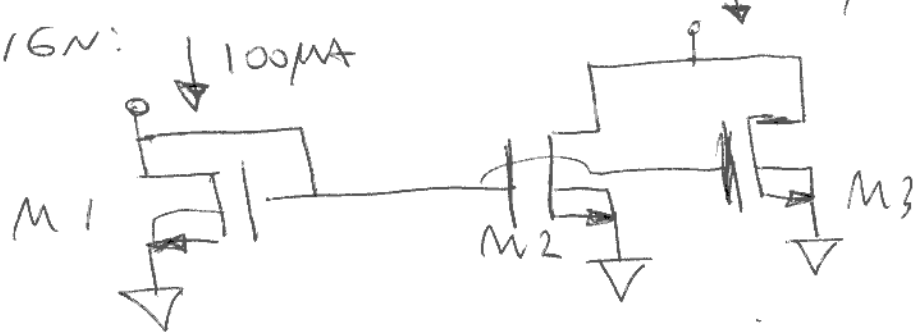
$$L_{min} = \frac{1V \times 0{,}05\ \frac{\mu m}{V}}{0{,}05}$$

$$L_{min} = 1.0\,\mu m$$

- USE 10% MARGIN IN L TO ALSO ACCOUNT FOR LATERAL DIFFUSION.

$$L = 1.1\,\mu m \rightarrow W = 27.5\,\mu m$$

- FINAL DESIGN:



$M1 = M2 = M3$

$$\frac{W}{L} = \frac{27.5\,\mu m}{1.1\,\mu m}$$

NOTE: TRANSISTORS MAY BE SUB-DIVIDED IN SMALLER UNIT TRANSISTORS FOR BETTER MATCHING PROPERTIES