

☑ Reference:C:\Users\Bernhard Boser\Documents\Files\Lib\MathCAD\Default\defaults.mcd

L17: CS Design Example

CS with R_s

$$a_{vO} := 10 \quad R_L := 10k\Omega \quad R_s := 5M\Omega \quad BW := 10MHz$$

$$g_m := \frac{a_{vO}}{R_L} \quad g_m = 1mS$$

$$BW = \frac{1}{2 \cdot \pi \cdot R_s \cdot C_{GS}} \quad C_{GS} := \frac{1}{2 \cdot \pi \cdot BW \cdot R_s} \quad C_{GS} = 3.183fF \quad \text{max!}$$

$$f_T := \frac{1}{2 \cdot \pi} \cdot \frac{g_m}{C_{GS}} \quad f_T = 50GHz \quad \text{min!} \quad \text{choose minimum L to maximize } f_T: \quad L := 180nm$$

get f_T from measurements (or SPICE). Approximation:

$$f_T = \frac{1}{2 \cdot \pi} \cdot \frac{\mu \cdot (V_{GS} - V_{TH})}{L^2}$$

$$\mu_n := 400 \cdot \frac{cm^2}{V \cdot s} \quad C_{ox} := 10 \frac{fF}{\mu m} \quad k_{pn} := \mu_n \cdot C_{ox} \quad k_{pn} = 400 \frac{\mu A}{V^2}$$

$$V_{dsat} := \frac{2 \cdot \pi \cdot f_T \cdot L^2}{\mu_n} \quad V_{dsat} = 254.469mV \quad \text{min}$$

current

$$\frac{g_m}{I_D} = \frac{2}{V_{GS} - V_{TH}} \quad I_D := \frac{g_m \cdot V_{dsat}}{2} \quad I_D = 127.235\mu A \quad \text{min}$$

finally, get W:

$$I_D = \frac{1}{2} \cdot \mu_n \cdot C_{ox} \cdot \frac{W}{L} \cdot (V_{GS} - V_{TH})^2$$

$$W := \frac{2 \cdot I_D \cdot L}{V_{dsat}^2 \cdot \mu_n \cdot C_{ox}} \quad W = 1.768\mu m \quad \frac{W}{L} = 9.824$$

SPICE model parameter calculation:

$$\epsilon_0 = 8.854 \frac{pF}{m} \quad \epsilon_r := 3.9 \quad C_{ox} = \frac{\epsilon_0 \cdot \epsilon_r}{t_{ox}} \quad t_{ox} := \frac{\epsilon_r \cdot \epsilon_0}{C_{ox}} \quad t_{ox} = 3.453nm$$