

Analog CMOS Integrated Circuits

Exercise 3: Common-Source Stage

1. The gain of a common-source stage with a diode type load was found to be

$$A = -\frac{g_{m_n}}{g_{m_p}} = \frac{\mu_n \cdot C_I \cdot \frac{W_n}{l_n} \cdot (V_{GS_n} - V_{TH_n})}{\mu_p \cdot C_I \cdot \frac{W_p}{l_p} \cdot (V_{GS_p} - V_{TH_p})} \text{ neglecting body effect. This formula seems to imply}$$

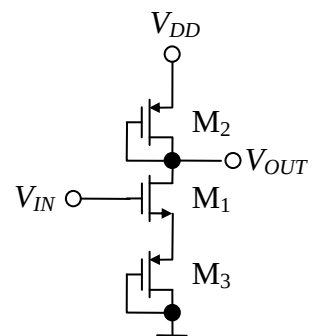
$$A \sim \frac{V_{GS_n} - V_{TH_n}}{V_{GS_p} - V_{TH_p}}. \text{ In fact, however, it is } A \sim \frac{V_{GS_p} - V_{TH_p}}{V_{GS_n} - V_{TH_n}}. \text{ Try to find out the reason for this}$$

apparent contradiction !

2. Determine intuitively the small signal gain of the depicted amplifier with diode type load and source degeneration !
Neglect body effect and channel length modulation !

What is the gain limit for sufficiently high g_{m1} ?

What is the theoretical minimum for the DC voltage level of V_{IN} and V_{DD} ?



3. Determine the small signal gain of the depicted amplifier with current source type load using its Norton equivalent !

Confirm the result by calculating v_{out} as a function of v_{in} !

