Lab 11
MOSFET characteristics and current mirror

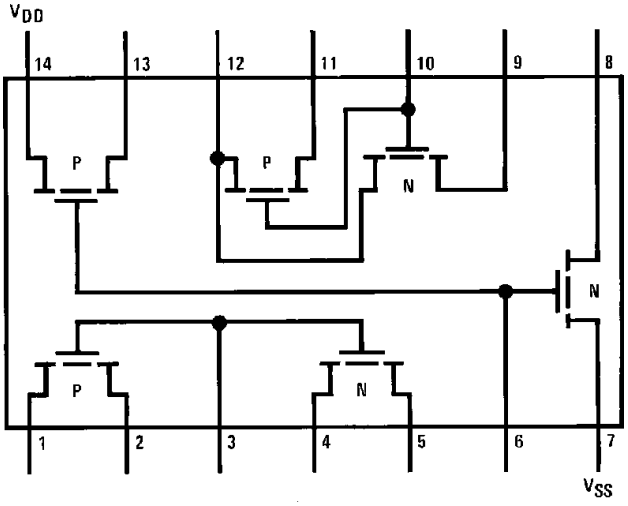
Pre-Lab

1. Read Sedra and Smith section 6.3.1.
2. Find the data sheet for the CD 4007 MOSFET chip
3. Find the maximum allowed voltage range.
4. Decide which transistor(s) to use for each of the three sections of the lab, and how to connect them.
5. Provide initial estimates of the size of current sense resistors based on the information in the data sheet.

In this lab you will characterize MOSFETs and then build a current mirror.

Static precautions and other preparations

In this lab we will use the CD4007 dual complimentary pair plus inverter MOSFET device. MOSFETs are extremely sensitive to static discharge. Use wrist straps, or otherwise ground your body and the prototype board before handling the chips. Make sure all connections are correct before turning on power to the circuit. Do not move wires while the circuit is connected to power. Ground your body whenever you are handling the chips or when you are inserting wires into the proto board. Any unused pins should be connected to ground. Pin 7 should be connected to the most negative voltage in the circuit. Pin 14 should be connected to the most positive voltage in the circuit. Think and measure before connecting power.



IV characteristic of a NMOS

In this section you will plot the IV characteristic. You will plot i_D (on the Y-axis) as a function of v_{DS} (on the X-axis) for several different values of v_{GS}.

1. Connect V_{DD} to 10 V and V_{SS} to 0 V.
2. Connect the source to ground and the gate to a voltage divider providing (in succession) 0.5, 1, 2, and 4 V (feel free to modify these, but the suggestion is one voltage below V_t and several different above V_t).
3. Create a triangular wave between 0 and 9 V. Be sure the output does not go below 0 V or above 10 V. If the function generator cannot generate the necessary offset, use a op-amp summer. Connect this signal to the drain.
4. Attach a very small resistor between the source and ground. This is called a current sense resistor. Make sure it is small enough that the voltage across it is much smaller than the gate voltage. You may need to experiment with the size of the current sense resistor.
5. Plot v_{DS} versus i_D in XY mode for the different values of v_{GS}.
6. Plan and carry out a measurement program to determine V_t and $k'\frac{W}{L}$ from measurements of v_{GS}, v_{DS}, and i_D.

IV characteristic of a PMOS

1. Plan and carry out a measurement program for the PMOS to obtain $k'\frac{W}{L}$ and V_t. For example:
2. Connect $V_{DD} = 0$ and $V_{SS} = -10$ V, and also choose a negative voltage to V_G.
3. Make the necessary measurements to obtain V_t and $k'\frac{W}{L}$.

NMOS current mirror

In this section you will build a MOSFET current mirror and measure its output resistance.

1. Design and build a NMOS current mirror. It is laid out similar to the NPN BJT current mirror we built during the previous lab.
2. Measure pairs of values of output current and drain voltage. Plot these values and also use them to determine the output resistance of the current mirror.