

**ECE 331: Electronics Principles
I Fall 2013**

Lab #3: MOSFETs Characterization

Pre-lab due on Thurs. Oct. 24, before noon

Report due on Tues, Oct. 12 to Fri, Oct. 15, at the beginning of your registered lab session

Week 2

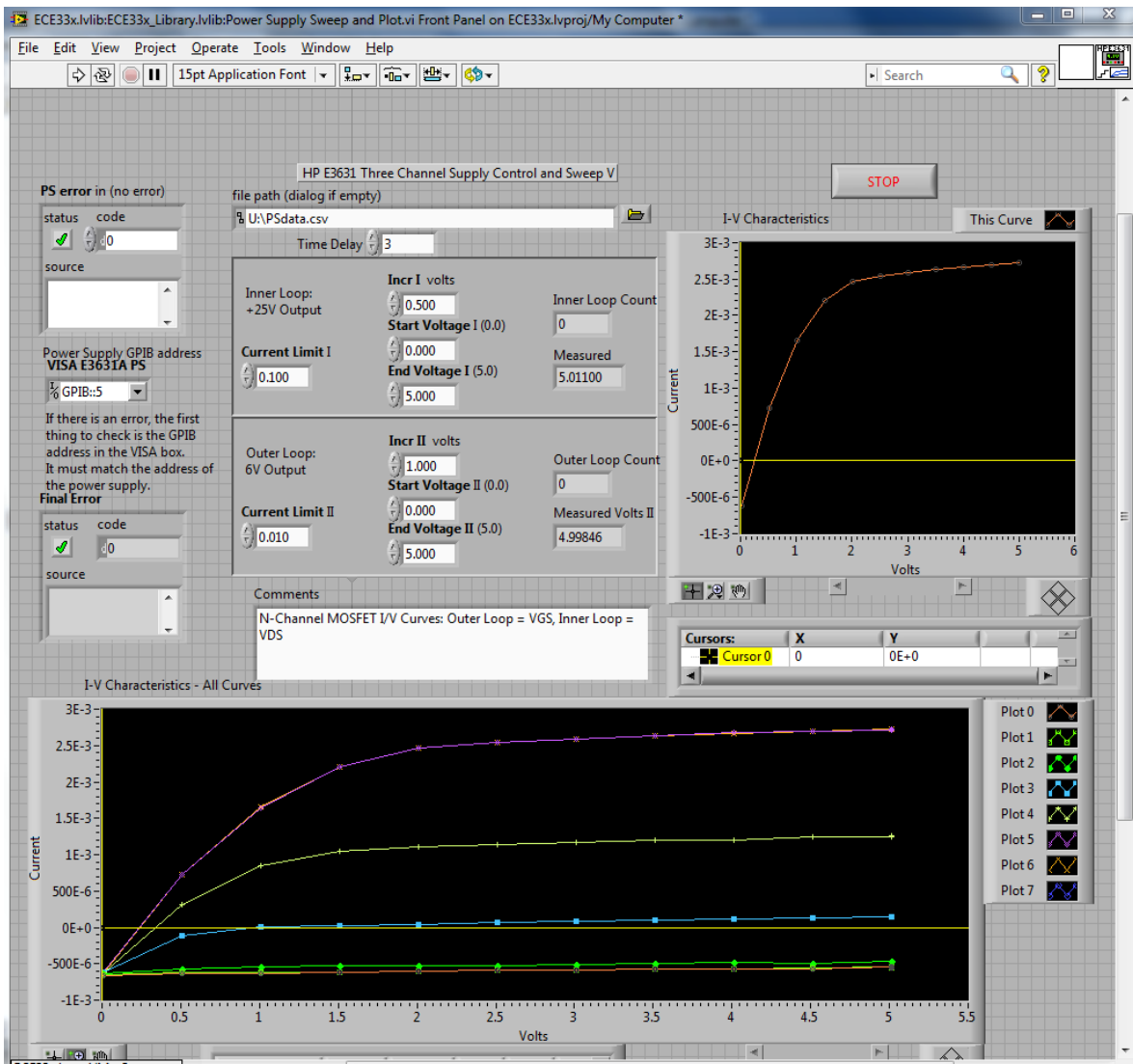
Note: *This lab requires a breadboard.*

This lab will use the ALD1106 NMOS transistors found in the tube container in C107. The computer files necessary to run Labview will be provided to you by the TA.

1. The Labview program provides an efficient way to control inputs to, as well as process and display data from breadboard testings. Run LabView program with:

Start >> National Instruments >> National Instruments LabView 2011

Open the vi project “Power Supply Sweep and plot.vi”. You will find it from vi tree in the LabView folder from ECE33X. The window would be like below after you open it.



You can find the GPIB addresses for the Power Supply, Multi-meter or Function generator when they first power up. While the machine is beeping and starting up, the words “addr ##” should flash, giving you the address number of the unit. You will then need to update the accurate address numbers for the instruments you will utilize the PS (Power Supply)) into the appropriate fields in the vi screen.

The interface controls two nested loops to sweep the outputs of the power supply. The 25V power supply is the default V_D for the inner loop and the +6V power supply is the default V_G for the inner loop.

For NMOS transistors in ALD1106, perform voltage sweeps as below using Labview:

Plot i_D vs. v_{DS} while sweeping v_{GS} from 0 to 5 V

Then you need to perform the measurement with ALD1106 to find:

- **V_{TH} : Threshold voltage,**
the minimum voltage needed to make the MOSFET conduct current. This parameter can be found by applying a DC sweep to the gate-source voltage while measuring the drain current. The V_{TH} value can be read easily from the I_D vs. V_{GS} curve, it is the voltage where significant current flow begins. Use $V_{DS} = 3V$ for your measurement.

- **g_m : Transconductance,** defined as

$$g_m = \frac{\partial i_d}{\partial V_{gs}}$$

This parameter is found by measuring the ratio of the incremental changes in drain current and gate-source voltage by slightly varying the gate voltage from the operating point. You will need to vary V_{DD} to make sure that V_{DS} is constant in your measurement. Use $V_{DS} = 3V$ for your measurement.

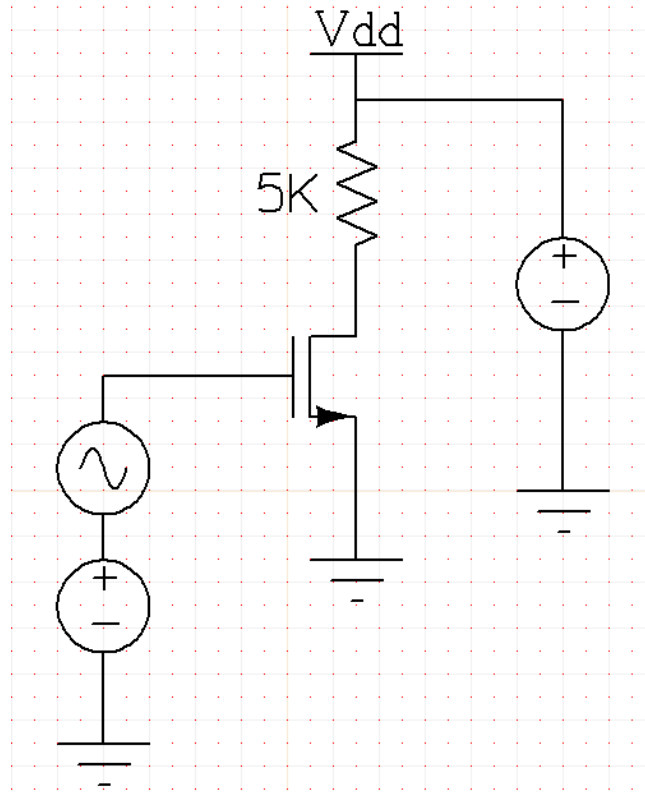
2: Common Source amplifier and small signal parameters.

Build and measure a MOS Common Source Amplifier and consolidate the concept and procedure of performing basic measurement on electronic circuit and device Measure the small-signal parameters of the common source amplifier built with ALD1106. Record and calculate the parameters as described below:

The components and instruments used in this lab include:

- ALD1106. (NMOS transistors)
- Resistors, Capacitor (1 μ F).
- Oscilloscope.
- Function generator.
- 3440 Digital multi-meter.
- E3631A Power supply

The circuit to be experimented in this lab is shown below. To ensure that the circuit functions as an amplifier, we need to first make sure the MOSFET is biased properly in the saturation region. The circuit bias is set in such a way that **output DC voltage is 5V**. The required **input DC bias is 3.5 V**. You need to build the circuit on a breadboard and perform the required measurement as described.



Build the circuit and make sure you evaluate the DC values for V_G , V_S and V_D to ensure that the DC operating point is what we expect before you connect the AC source.

- **r_o : Output resistance**, or drain to source resistance, defined as

$$r_o = 1 / \frac{\partial i_d}{\partial V_{ds}}$$

This parameter is found by measuring the ratio of the incremental changes in drain-source voltage and drain current by slightly varying V_{DD} . Measure **r_o** under $V_{DS} = 5V$ and $V_{GS} = 3.5V$.

- Input signal is set to be 100mV amplitude, $f = 200$ Hz sinusoidal waveform. Measure and capture the input signal and the output signal with oscilloscope. Determine the small-signal (AC) gain of the amplifier and compare the phase.
- Input signal is set to be 2V amplitude, $f = 200$ Hz sinusoidal waveform. Measure and

capture the input signal and the output signal with oscilloscope. What happens to V_{out} ? Why?