ELEC-313
Lab 7: MOSFET Amplifier Circuits

November 12, 2013

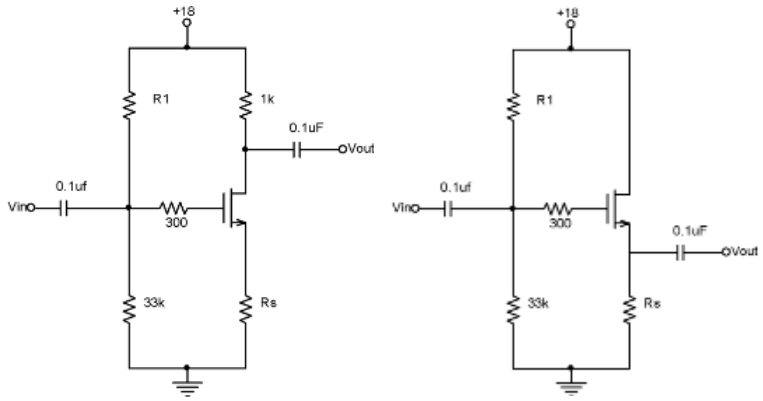
Date Performed: November 06, 2013
Partners: Charles Pittman
Stephen Wilson

1 Objective

2 Equipment

Transistor: 2N7000	Power supply: HP E3631A
Function generator: HP 33120	Multimeter: HP 34401A
Oscilloscope: Agilent 54622D	Capacitors: 0.1 µF
Resistors: 100 Ω, 300 Ω, 470 Ω, 1 kΩ (x2) 33 kΩ, 100 kΩ (x2)	

3 Schematics



(a) Common-source amplifier (b) Source-follower amplifier

Figure 1: Circuits used in this lab. $R_1 = 100\,\text{k}\Omega$, $R_s = 470\,\Omega$

4 Procedure

The following procedures were identified to observe the basic operation of MOSFET amplifier circuits.

4.1 Common-Source Amplifier

1. Build the circuit shown in Figure 1a. Use the closest resistor values available for R1 and Rs.

2. Measure and record the drain current and DC voltages at all terminals of the MOSFET.

3. Set the function generator for a $200\,\text{V}_{\text{pp}}$, 20 kHz sine wave with 0 V DC offset. Connect it to V_{in}.

4. Connect a 100 kΩ load resistor from V_{out} to ground. This will be considered a no-load scenario.

5. Connect channel 1 of the oscilloscope to V_{in} and channel 2 to V_{out}. Set the scope to trigger off of channel 1. This setting is accessed using the EDGE button on the oscilloscope.

6. Adjust the function generator to an amplitude of 200 V_{pp} as measured on channel 1 of the oscilloscope.

7. Measure the peak-to-peak output voltage on channel 2 of the oscilloscope.

8. Repeat step 6 for input voltages of 300, 400, 500, 600, 700, 800, 900, and 1000 mV_{pp}.

9. Replace the 100 kΩ from V_{out} to ground with a 1 kΩ load resistor.

10. Reset the function generator to an amplitude of 200 V_{pp} as measured on channel 1 of the oscilloscope.

11. Measure the peak-to-peak output voltage on channel 2 of the oscilloscope.

4.2 Source-Follower Amplifier

1. Construct the circuit shown in Figure 1b by removing the 1 kΩ drain resistor and moving the output capacitor to the source of the MOSFET.

2. Measure and record the drain current and DC voltages at all terminals of the MOSFET.

3. Connect a 100 kΩ load resistor from V_{out} to ground. This will be considered a no-load scenario.

4. Adjust the function generator to an amplitude of 200 V_{pp} as measured on channel 1 of the oscilloscope.

5. Measure the peak-to-peak output voltage on channel 2 of the oscilloscope.

6. Repeat step 4 for input voltages of 300, 400, 500, 600, 700, 800, 900, and 1000 mV_{pp}.

7. Reset the function generator to an amplitude of 200 V_{pp} as measured on channel 1 of the oscilloscope.

8. Replace the 100 kΩ resistor from V_{out} to ground with a 1 kΩ resistor and measure the peak-to-peak output voltage on channel 2 of the oscilloscope.

9. Now replace the 1 kΩ load resistor with a 100 ohm load resistor and measure the peak-to-peak output voltage on channel 2 of the oscilloscope.

5 Results

5.1 Common-Source Amplifier

	V_G (V)	V_D (V)	V_S (V)	I_D (mA)
Measured	4.391	13.498	2.11	4.52
Theoretical	4.466	14.000	2.4214	4.00
% Difference	1.712%	3.719%	14.800%	11.500%

Table 1: Transistor characteristics

V_{in} (mV)	V_{out} (V)
200	0.382
300	0.566
400	0.760
500	0.939
600	1.140
700	1.340
800	1.530
900	1.721
1000	1.90

Table 2: Common-source amplifier

5.2 Source-Follower Amplifier

V_G	V_D	V_S	I_D
4.391 V	18.003 V	2.12 V	4.579 mA

Table 3: Transistor characteristics

6 Conclusion

7 Equations

$$V_{o,L} = V_{o,NL}\frac{R_L}{R_o + R_L} \tag{1}$$

$$V_G = \frac{V_{DD} \cdot 33\,\text{k}\Omega}{100\,\text{k}\Omega + 33\,\text{k}\Omega} \tag{2}$$

$$V_S = V_G \cdot \sqrt{\frac{I_D}{K_N}} - V_{TN} \tag{3}$$

V_{in} (mV)	V_{out} (mV)
200	182
300	268
400	360
500	451
600	541
700	634
800	725
900	813
1000	906

Table 4: Source-follower amplifier

$$V_D = V_{DD} - I_D \cdot 1\,\mathrm{k}\Omega \tag{4}$$

$$\%_{diff} = \frac{|measured - theoretical|}{theoretical} \times 100\% \tag{5}$$