

LAB 5

Field Effect Transistors

Reading: Malvino, Ch. 13 and 14
 Hayes and Horowitz, Class 7, worked example and Lab 7

This lab introduces Field Effect Transistors and their applications.

1. Junction FET Characteristic Curves

Use a transistor curve tracer to determine the drain characteristics and transfer characteristics. The 2N5486 is an n-channel JFET having the following maximum ratings:

V_{DS}	25 V
V_{DG}	25 V
V_{GS}	25 V
I_D	30 mA

The terminal pins are illustrated in Fig 5.1.

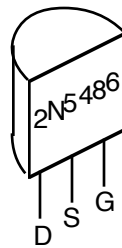


Fig. 5.1

a) Measure the drain characteristics (I_D vs. V_{DS})

Function	Acquisition
N-FET	
V_{ds} max	20 V
I_d max	20 mA
V_g /step	0.5 V
Offset <i>varies with</i> $V_{gs(off)}$, try	-5V
Steps	10
R load	0.25 Ohm
P max	2 Watt

b) Measure the transfer characteristics (I_D vs. V_{GS}).

Use the cursor to read I_D for each of the drain curves of part (a) at $V_{DS} = 5, 15$ and 20 V. Plot the values on graph paper.

Determine I_{DSS} , V_P and g_{m0} . Compare with specifications.

2. FET Current Source

The circuit of Fig. 5.2 allows you to explore the behaviour of a JFET current source.

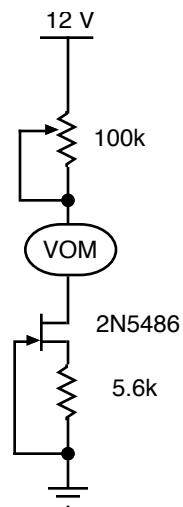


Fig 5.2

Vary the load resistance and watch V_{DS} , and I_D . Note the value of V_{DS} which marks the departure from current-source behaviour. (Select your own criterion.) Repeat for different V_{GS} , i.e., different source resistors, and explain your results in terms of the characteristics measured in Part 1.

3. Source Follower

Drive the source follower of Fig. 7.3 with a small 1 kHz sine wave. Measure how much the gain differs from unity. Observe the phase shift and examine the onset of distortion.

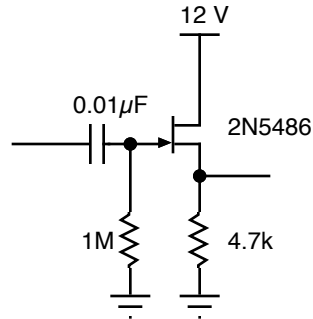


Fig. 5.3

4. Using the JFET as a Variable Resistor

In part 2 you found that the current source failed when V_{DS} fell too low. Here you will deliberately bias the FET into the linear Ohmic region.

a) Build the circuit of Fig. 5.4 without the greyed-out components. Drive it with a small sine wave of about 0.2V amplitude at 1 kHz. Notice what happens to the gain and the distortion when you adjust the potentiometer. The distortion is clearer if you drive the circuit with a triangle wave. Explain the distortion.

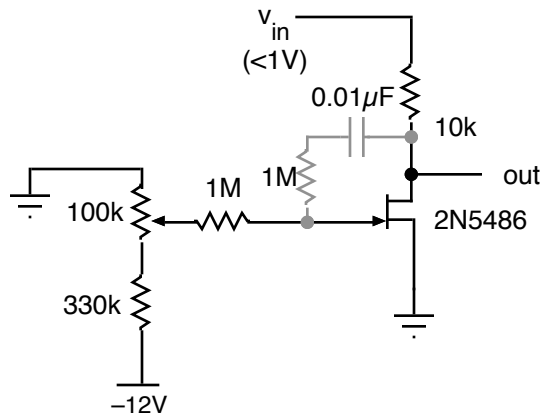


Fig. 5.4

b) Now try the compensation indicated by the greyed-out components. Check the improvement by driving this circuit with a triangle wave. Explain why there is some improvement.

c) **The World's Simplest AM Radio Transmitter:** Amplitude modulation can be produced with a slight modification shown in Fig 5.5. Use two function generators. One supplies the *carrier* frequency of around 1 MHz. The other can be set to sweep through an audible frequency range, e.g., 400-2000 Hz. This provides the variable *modulation* voltage. You may have

to increase the modulating voltage for increased range. Attach a long wire antenna (a metre or two long) to the output and you're on the air. Try to pick up the signal on a radio some distance away. For fun you might connect the earphone output from a tape player or a microphone to v_{mod} instead of the second signal generator.

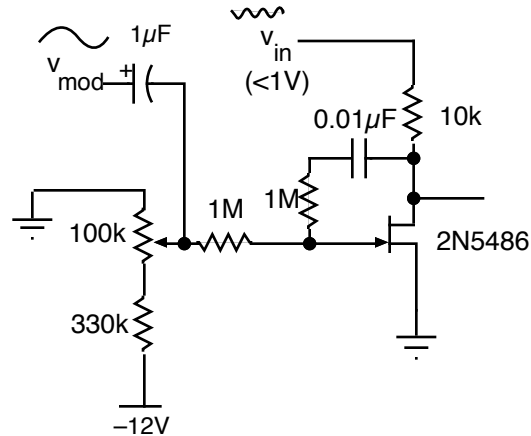


Fig. 5.5

5. The Common Source JFET Amplifier

(OPTIONAL, if there is time.)

a) Build the common source JFET amplifier of Fig. 5.6.

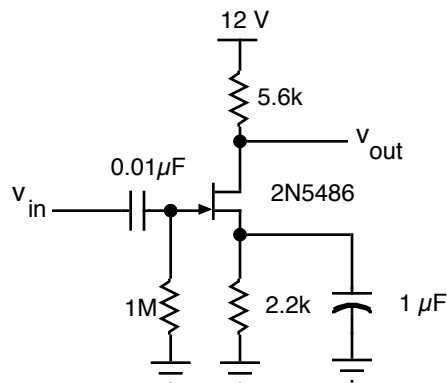


Fig. 5.6

b) Calculate the drain current and V_{GS} . Measure I_D , V_{GS} and V_{DS} and compare with the calculation.

c) Calculate and measure the small signal voltage gain of the amplifier.

d) Check the gain as a function of frequency and observe the phase shift.

e) Drive the amplifier into distortion and explain its origin.

f) Measure the input and output impedances.

Homework

For all problems assume you have a JFET with $I_{DSS} = 9 \text{ mA}$ and $V_{GS(off)} = -5 \text{ V}$.

1. Calculate the current through the load for the circuit of Fig.5.2 assuming the JFET is in the current-source region. What are the limits (maximum or minimum) for the load resistance that allow the JFET to operate as a current source?
2. Calculate the gain of the source follower in part 3.
3. Do the calculations indicated for the optional part 5.