JFET Circuits II

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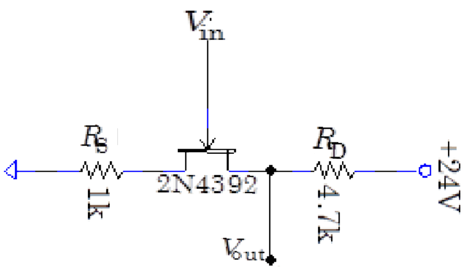

Figure 1: Schematic of an amplifier.

Introduction

5.1

We construct the amplifier as shown in Fig. 1.

Without the signal applied, we measured the voltages across the respective terminals of the JFET and current through the drain and source to get a V_{GS} value of 1.60V±0.592 mV, V_{DS} of 11.42V ± 5.3704mV, I_{DS} of 0.0149± 2.188×10^{-6}mA. The theoretical gain is computed as below, by assuming that the assumption that the transductance is high:

$$G = -\frac{R_D}{R_s + r_s} \approx -\frac{R_D}{R_s} \tag{1}$$

and obtain a predicted gain of -4.7.

We drove the amplifier with a 10kHz , $1V_{pp}$ signal sine wave and record the V_out. The V_{out} is measured at 40.8V when we input a signal of 9.90V. So we compute the gain by taking the ratio of the voltage output and input:

$$\text{Gain} = -\frac{V_{out}}{V_{in}} = \frac{V_{40.8}}{9.90V} = -4.12 \tag{2}$$

The experimental value is within ≈ 5% of the theoretical predicted value.

As we tune the waveform generator, the maximum undistorted output amplitude is found to be 4.30V, and above that we can clearly see that the bottom part of the output signal is flat. (SCOPETRACE?) The fact that the gain is also a function of the V_{in} is what limits the amplitude. Therefore, for a small signal amplitude, the effect is negligible, but for larger amplitude this functional dependency of the gain results in the distortion.

There is no change in the output amplitude when the JFET is cooled, the gain remains at around 4, as we have previously found in 2. By substituiiting our JFET with four other JFETS, we found that the gain for each JFET is still around 4 as shown in the $-\frac{V_{out}}{V_{in}}$ calculations below:

$$Gain_{JFET1} = -\frac{40.8V}{9.80V} = -4.16$$
$$Gain_{JFET2} = -\frac{40.0V}{9.80V} = -4.082$$
$$Gain_{JFET3} = -\frac{40.8V}{9.90V} = -4.1212$$
$$Gain_{JFET4} = -\frac{40.8V}{9.80V} = -4.16$$

5.2

To improve the gain in the Fig.1 setup,

5.3

5.5

We built the differential amplifier as shown in 2 by connecting the two 100kΩ and 10kΩ resistors to ground. Driving the V_+, with 1kHz, $0.1V_{pp}$ sine wave, we get a signal amplitude of $3.00 \pm 3.64 \times 10^{-4}$ V. Connecting the scope to the V_{invout} terminal, we get approximately the same amplitude. The phase measurement is 140.7° and -54° respectively.

Then we drive the V_- using the same signal and we again obtain a signal amplitude of $3.00 \pm 3.64 \times 10^{-4}$ V. Connecting the scope to the V_{invout} terminal, we get approximately the same amplitude. The phase measurement is -82.50° and 70.00° respectively. Such behavior is expected because the two sides of the differential amplifier is supposed to exhibit symmetrical behavior, so it does not matter whether we drive on V_+ or V_-.

Next, we drive both V_+ or V_- with the same 0.1V signal and obtain V_{out} of 1.00V, so the common mode gain is around 10. By putting on a random JFET, the V_{out} is ———(???)———. Along with the voltage drop masurement across the R_{drain}, we conclude that the differential amplifier circuit does not work anymore if we connect a pair of unmatched JFET.

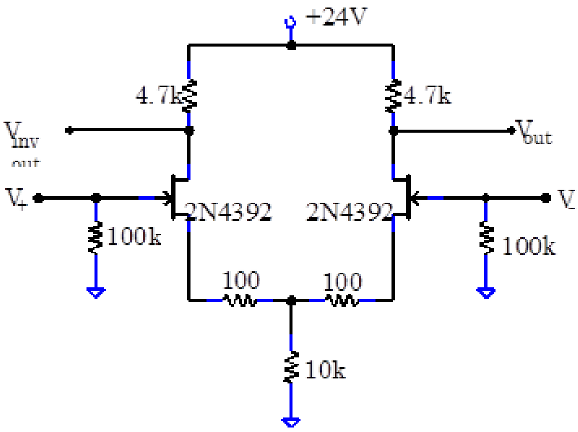

Figure 2: Differential amplifier schematic.

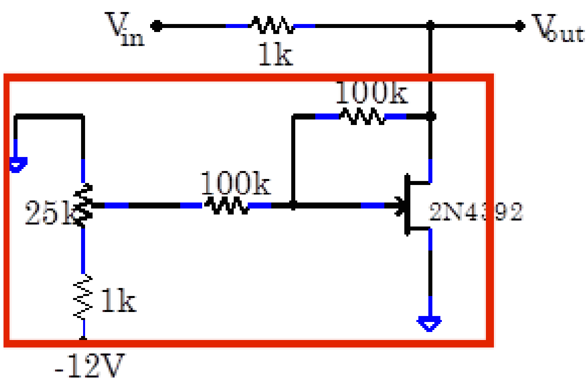

Figure 3: JFET Attenuator schematic.

5.8

We set the potentiometer so that we achieve the greatest attenuation on the input signal. Treating the whole red boxed region as R_2 in Fig.3, we use the voltage divider equation to

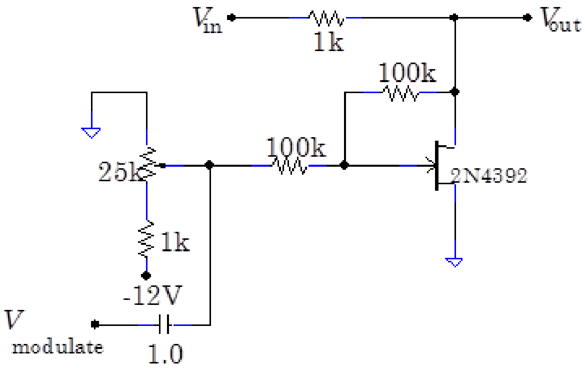

Figure 4: JFET Modulator schematic.

Figure 5: Scope traces for the AM signal. Channel 1: modulated V_{out}; Channel 2: 1MHz signal; Channel 3: 1kHz signal.

find the drain source resistance:

$$V_{out} = \frac{R_2}{R_1 + R_2} V_{in}$$

$$230mV = \frac{R_2}{1000\Omega + R_2}(318mV)$$

Solving for R_2 yields 2613Ω, this is the lowest possible JFET drain-source resistance corresponding to this setting.

5.9

We added a 1.0μF capacitor to the JFET attenuator circuit as shown in Fig.4 to build an amplitude modulator. Using another function generator to drive the a 1kHz, 1V_{pp} sine wave on the potentiometer gate signal, we find that the input carrier wave (1MHz) is modulated by the 1kHz wave. The modulated output signal is shown in Fig.5. (NEED TRACE!!!)

5.10

We tune the AM radio to a quiet channel in the AM band at around 540kHz. The wire is connected to the V_{out} and acts as an

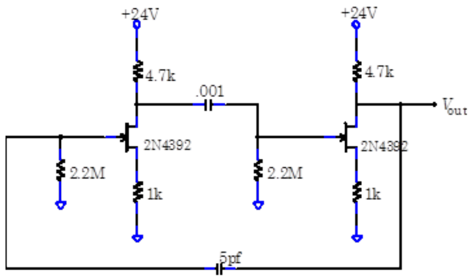

Figure 6: Surprise circuit setup

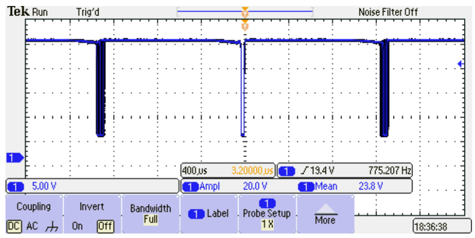

Figure 7: Channel 2 shows the original DC signal, which is just noise.

AM transmitter for the output signal. We tune the frequency of the modulating signal from the wave generator and then heard the audio signal when the modulating frequency is adjusted to 552kHz. This modulating frequency is very close to the bands that our AM radio is tuned to detect. [1]

5.12

We fed in +24V input on both sides of the surprise circuit as shown in Fig.**??**. The circuit acts like a periodic timer, outputting a square wave with period of 1200μs. (MUST EXPLAIN WHY??)

Conclusion

In this lab, we investigated the characteristics of

[1]We also found that the signal sounds a lot cleaner if we coiled the transmitting wire around the antenna of the AM radio receiver.

Acknowledgments

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References

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