Laboratory 6: Design of a BJT Amplifier

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***Abstract*—This lab aims to design a transconductance amplifier based on the provided specifications. A gain of 50 V/V is to be achieved in the circuit with a tolerance of 10 percent. It was also meant to have a minimum input resistance of 1k Ohm supporting a 10kHz wave and have the ability to support a load of 10k and a wave with 1V RMS. The techniques learnt in class were leveraged to achieve those outcomes.**

***Index Terms*—MOSFET, BJT, temperature, electrical characteristics, curve tracer, transconductance, small-signal model, Elvis-II+, MATLAB**

I. INTRODUCTION

This lab aims to utilize 2N2222A BJT in order to develop an amplifier respecting some imposed criteria. The design specification included that the amplifier should achieve a gain of 50 V/V with a 10 percent tolerance, have a minimum input resistance of 1k Ohm, withstand a wave with 1V RMS and a load of 10k Ohm, and support a 10kHz wave. In order to meet those specifications, I used a variable power supply of 9V along with the 2N2222A BJT, some transistors, and capacitors of 100µF. Moreover, the thermal effects were characterized using a handheld thermal thermometer and a heat gun.

II. METHODOLOGY AND ANALYSIS

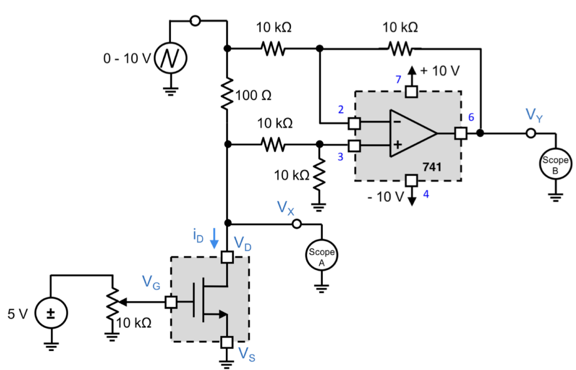

Fig. 1. Modeled Circuit [1]

Figure 1 depicts the circuit of a common emitter amplifier. I based myself on this circuit and modified some of its components. The VCC is set to 9V; the RL is 10k Ohm, at Rsig, a 1k Ohm resistor is set to make sure the 1k Ohm input resistance mark is achieved, and capacitors of 100µF are used. The equation provided in the circuit analysis part helped determine the resistor pattern needed in the rest of the circuit. After those preliminary steps, the circuit is tested and tweaked to ensure it functions properly and without errors.

The results obtained in the final circuit are RB1 = 31k Ohm, RC = 1k Ohm, RE = 100 Ohm, and RL = 10k Ohm. It was recommended that the final output should be 8V. Thus, I set an input voltage of 0.16V, and based on the specification imposed for the circuit, the input frequency is set to 10 kHz.

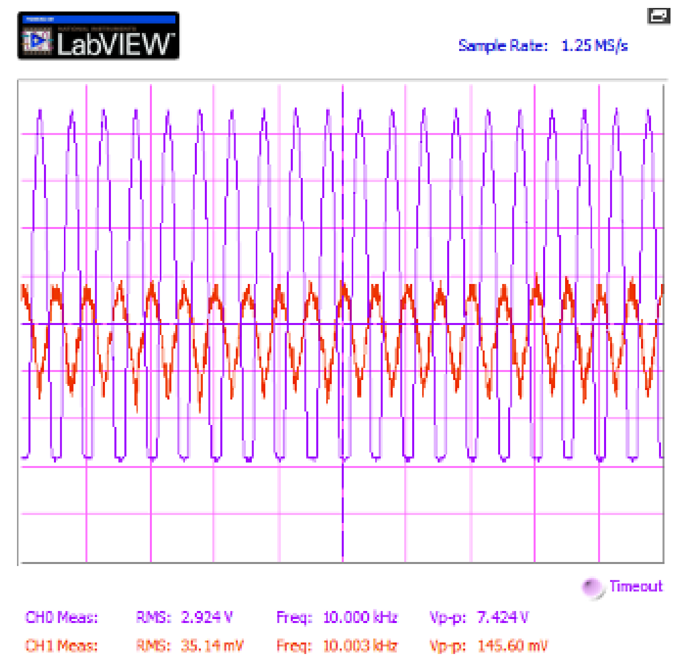

Fig. 2. Oscilloscope Output

In the above figure 2, we can see that the wave has a gain of 51.2 V/V. This value lies with the specified gain of 50 ± 5 V/V. It supports a 10kHz wave and has RL = 10k Ohm and Rsig ¡ 1k Ohm. In order to determine if the result holds, the RMS is increased in the following part.

The oscilloscope in figure 3 shows that the input's RMS does not significantly impact the output, so our circuit still respects the criteria. As a last part, we investigate the thermal effect on the circuit. Thus we reproduce the oscilloscope measurement with a temperature of 50°C.

When a temperature of 50C is imposed, the gain significantly decreases to a value of 40.5 V/V. We extrapolate that the thermal variation affects the gain of the amplifier. In our case a temperature increase decreases the gain.

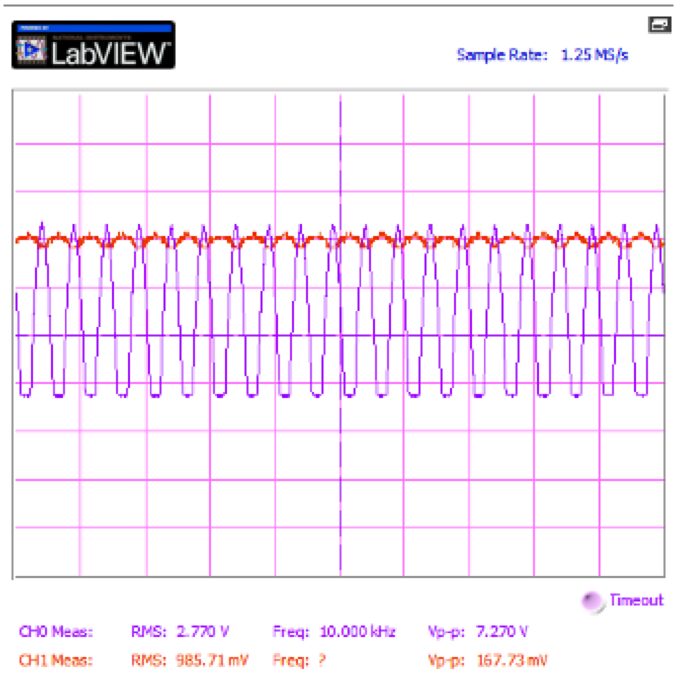

Fig. 3. Oscilloscope Output

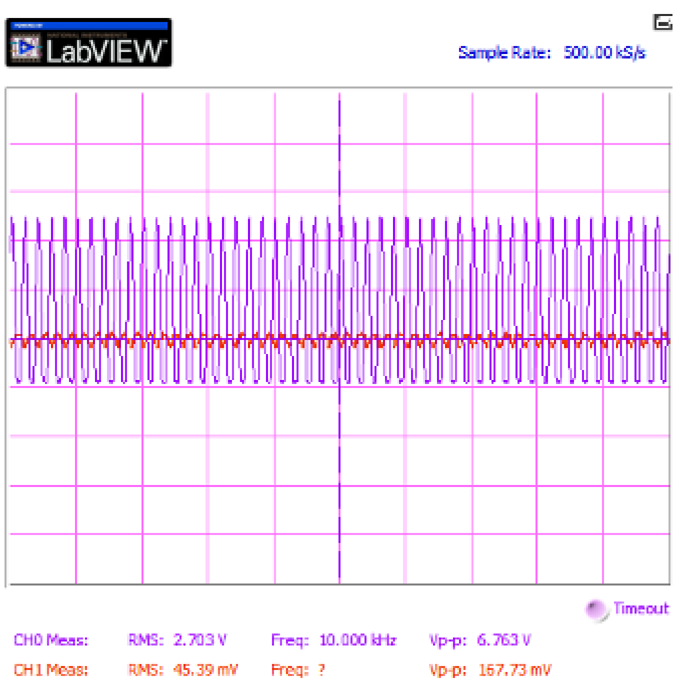

Fig. 4. Oscilloscope Output

III. Conclusion

In conclusion, this lab effectively designed and implemented an amplifier using a 2N2222A BJT transistor, meeting the specified criteria for gain, input resistance, load, and frequency. The amplifier was able to support a 10kHz wave and withstand a 1V RMS input without significant output impact. However, the investigation shows the amplifier's sensitivity to temperature changes.

IV. References

[1] A. S. Sedra and K. C. Smith, Microelectronic Circuits, 8th ed. Oxford University Press, 2019.