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2559-2971

Elementary Pre-Amplifier Design Report

Introduction

This module uses two different amplifiers, the LT1632 operational amplifier (op-amp), and the LM386 low voltage audio power amplifier. The former has a gain-bandwidth product of 45 MHz, making it perfect for Part 1 of the assignment, as opposed to the LT1490, which has a gain bandwidth product of 200kHz. The goal of Part 1 of the assignment was to design a small-signal amplifier using the LT1632, with a single power supply, to provide a gain of 26 dB to an open circuit output, for frequencies between 100 Hz and 15 kHz. The goal of Part 2 of the assignment was to design an amplifier with the same specifications, but using the LM386 instead, while also supplying gain to an output speaker instead of an open circuit.

Design

The diagram of the circuit for Part 1 is provided in Figure 1. This design uses a 10uF DC blocking capacitor to the inverting input of the LT1632. The non-inverting input is biased with 2.5V, done by using the 5V supply and two 1M resistors in series as a voltage divider circuit. From the capacitor, there is a 1.1K resistor connected to the inverting input, with a 22K resistor as feedback, resulting in a gain of 20, or 26dB. The LTSpice circuit and simulation is shown in Figure 2, with the physical circuit shown in Figure 3, and the Waveforms simulation in Figure 4.

The diagram of the circuit for Part 2 is provided in Figure 5. This design uses a 10-uF DC blocking capacitor to the inverting input of the LM386. A 10K potentiometer is connected to the inverting terminal to vary the amplitude of the input between 0V and its maximum value. The output of the amplifier is connected to a 0.047-uF capacitor (a 0.05-uF was not available) in series with a 10-ohm resistor, as well as a 250-uF capacitor in series with the speaker. A diagram from Texas Instruments of this circuit is shown in Figure 6, with the physical circuit in Figure 7.

The bill of materials is shown in Table 1, with the total cost coming to $18.94.

Conclusion

In Part 1, the circuit reaches a gain of 26dB within the required range, as well as at 20kHz. When an 8-ohm speaker is connected to the output instead of an open circuit, the voltage measured is approximately zero volts. This is because the 8-ohm speaker and the 22K resistor act as a voltage divider, with almost all the voltage across the 22K resistor, and none across the speaker. Rather than try to modify the circuit to acquire the same gain with the speaker, the LM386 is used, as it has a default gain of 20. With the speaker connected, the gain is unchanged. The LT1632 is ideal for small signal sensor pre-amplification, as it can readily apply a large gain to a small-signal input with low output current, if the load that it drives is sufficiently large. However, the amplifier fails to function properly when driving a low impedance load. The LM386 is better for driving low impedance loads, and already has the necessary gain circuitry internally.

Appendix

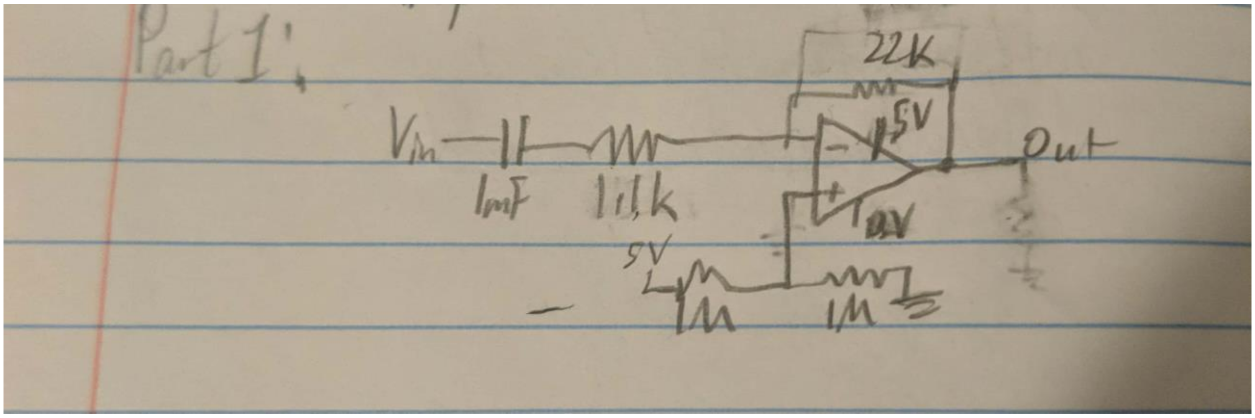

Figure 1: Design for Part 1

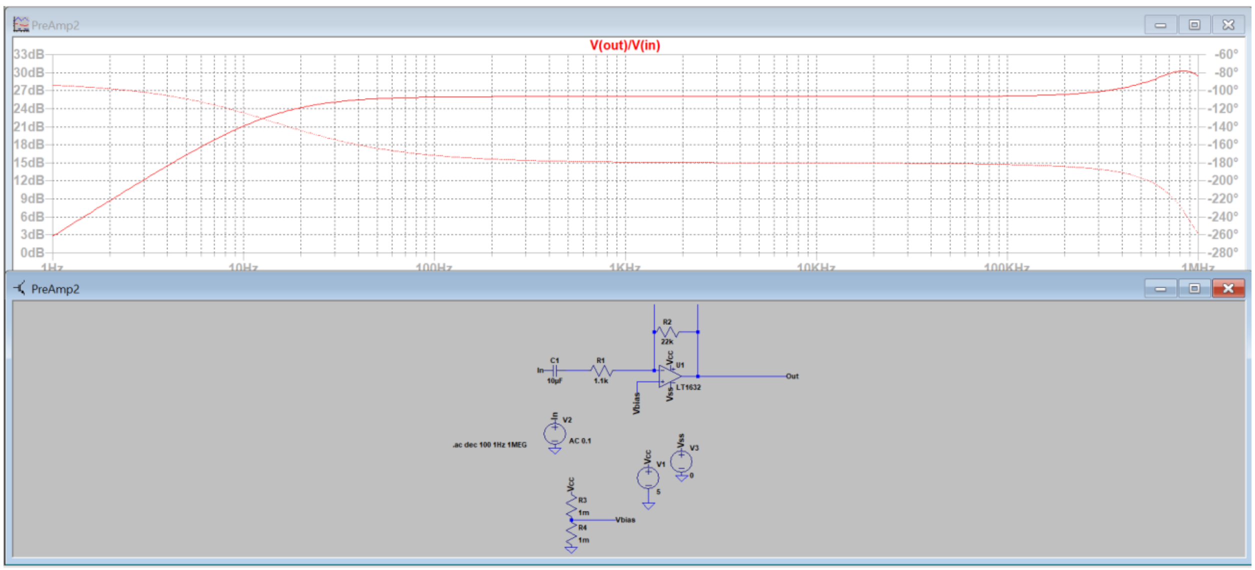

Figure 2: LTSpice Schematic and Simulation for Part 1

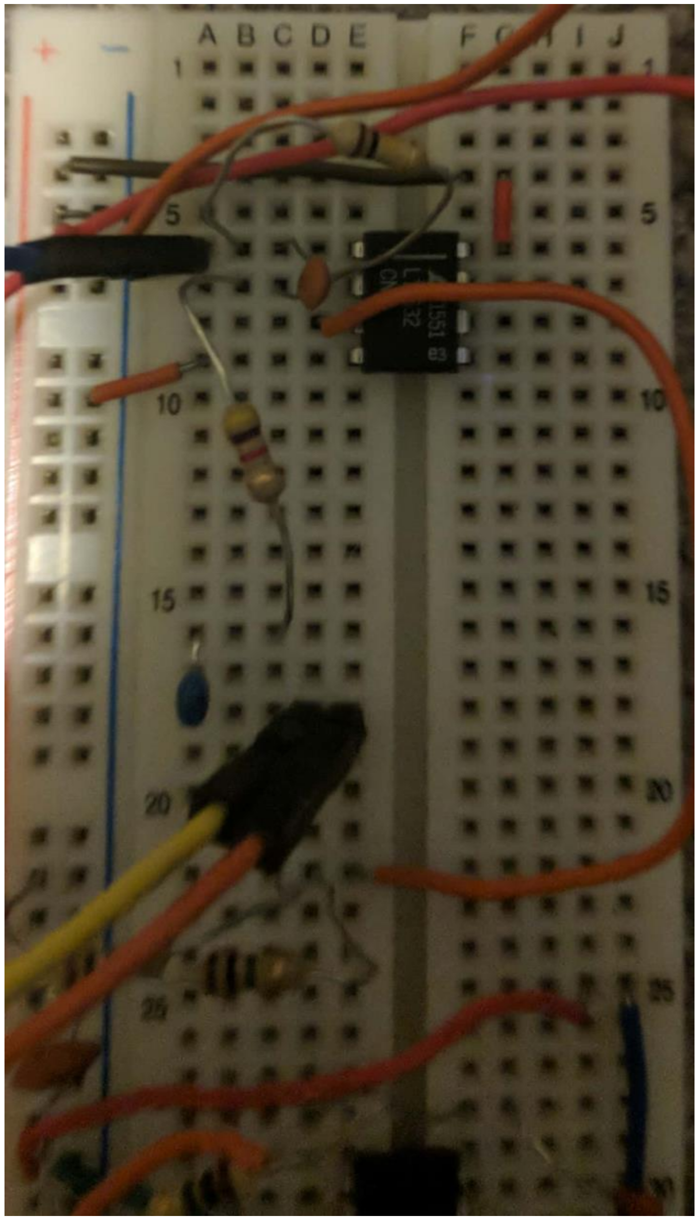

Figure 3: Constructed Circuit for Part 1

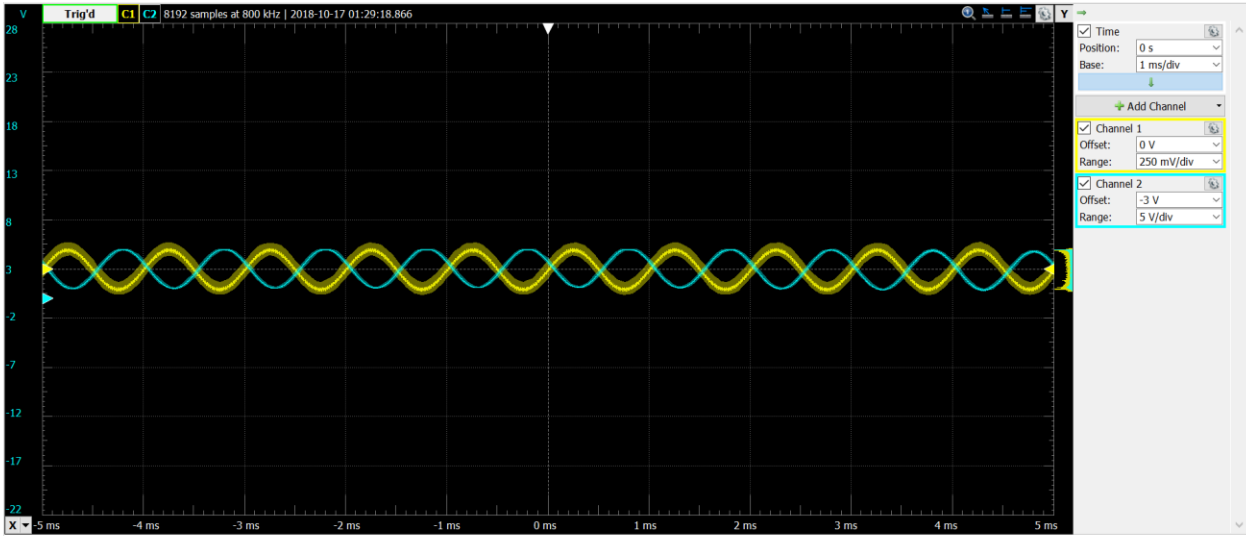

Figure 4: Waveforms Simulation Showing Gain of 20, or 26dB

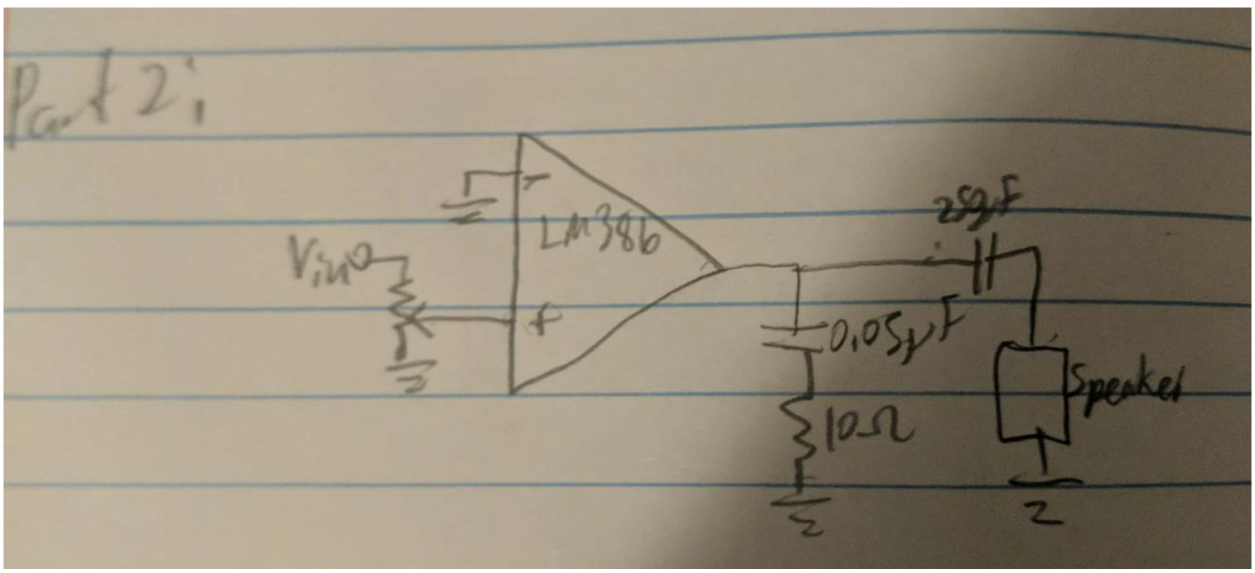

Figure 5: Design for Part 2

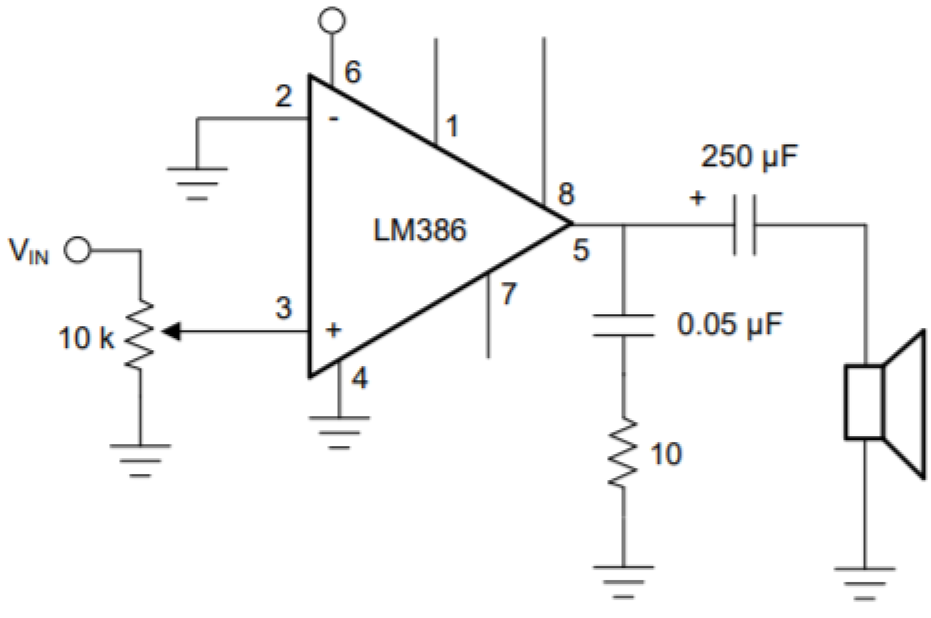

Figure 6: Diagram of Part 2

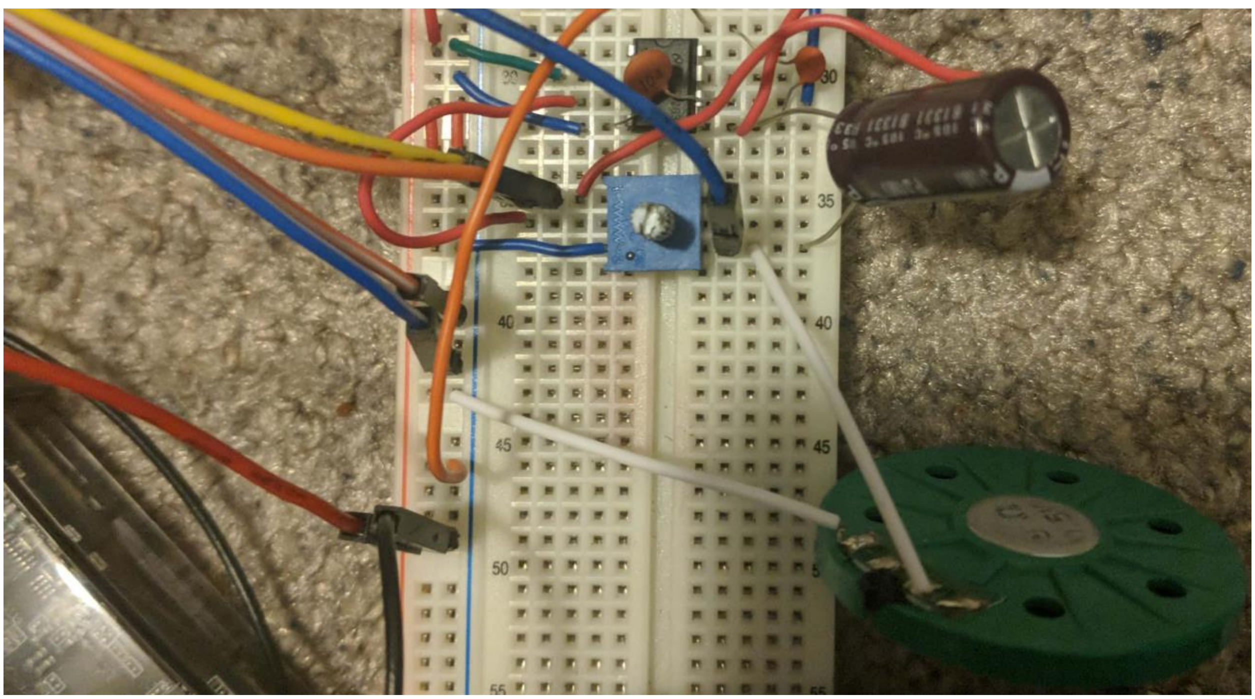

Figure 7: Constructed Circuit for Part 2

Part Number	Part Name	Cost per Part	Volume Discount (Price per unit for 100 units)	Source
1	LT1632	$6.80	$3.33	Mouser Electronics
2	LM386	$0.89	$0.59	Jameco Electronics
3	8-ohm speaker with wires	$1.95	N/A	Mouser Electronics
4	Breadboard with Wires	$3.59	N/A	Amazon
5	10K Potentiometer	$0.57	$0.45	Mouser Electronics
6	22K Resistor	$0.19	$0.15	Jameco Electronics
7	1.1K Resistor	$0.10	$0.04	Jameco Electronics
8	1M Resistor (x2)	$0.19	$0.15	Jameco Electronics
9	10 -Ohm Resistor	$0.19	$0.15	Jameco Electronics
10	10-uF Capacitor	$0.12	$0.07	Jameco Electronics
11	47-nF Capacitor	$0.19	$0.15	Jameco Electronics
12	250-uF Capacitor	$3.97	$2.88	Mouser Eletronics
Total		$18.94		

Table 1: Bill of Materials