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5193-6096

Report – Elementary Preamp

Introduction

The purpose of this module is to further explore a few amplification circuits using different opamps. For this module, the primary purpose of the circuit is audio amplification. There are two main circuits to be designed for this module. The first of which is an inverting amplifier with gain 20dB from 100Hz to 15kHz. This circuit will have an open output for the first section and will then be modified to drive an 8 ohm speaker. The second circuit will use an LM386 audio amplifier to accomplish the same task.

Design

For part 1 of this module, the following circuit was utilized.

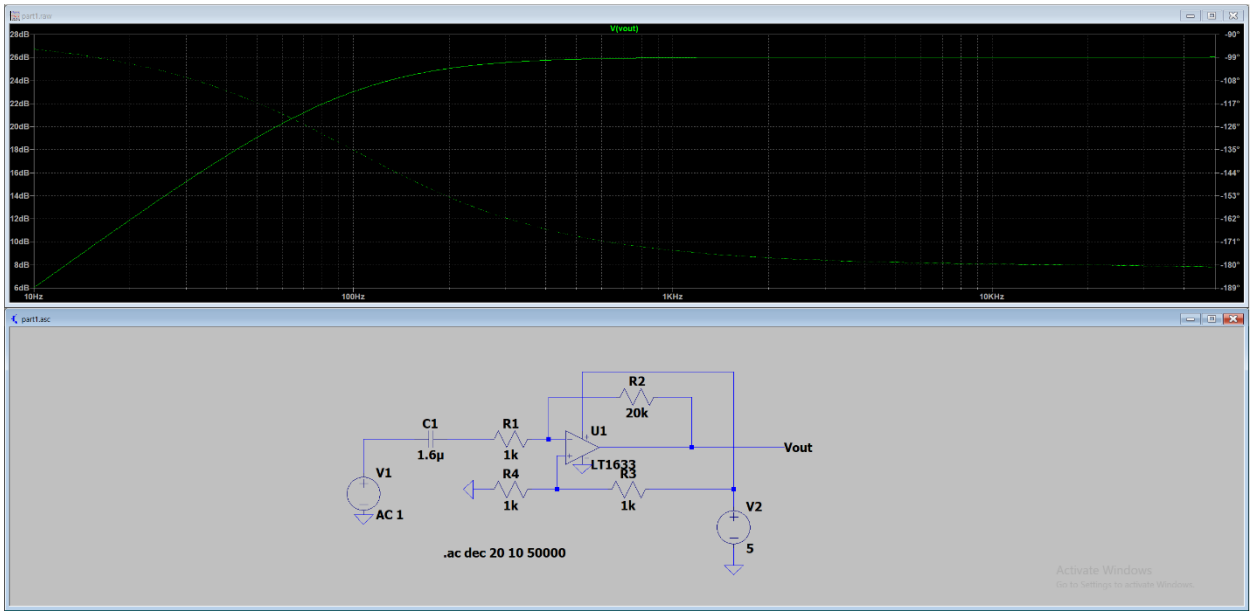

Figure 1. LTSpice schematic with frequency response

As shown, the LT1632 was used instead of the LT1490. This is because the LT1490 has a gain bandwidth product of only 180kHz, not high enough to carry the proper amount of required gain through 15kHz. The LT1632, however, will be capable of this.

Other design elements include a 1.6uF capacitor on the input in order to set the lower cutoff frequency, and a voltage divider connected to the positive input of the amplifier, since we are only given one power supply.

The physical implementation of the circuit provided the following results.

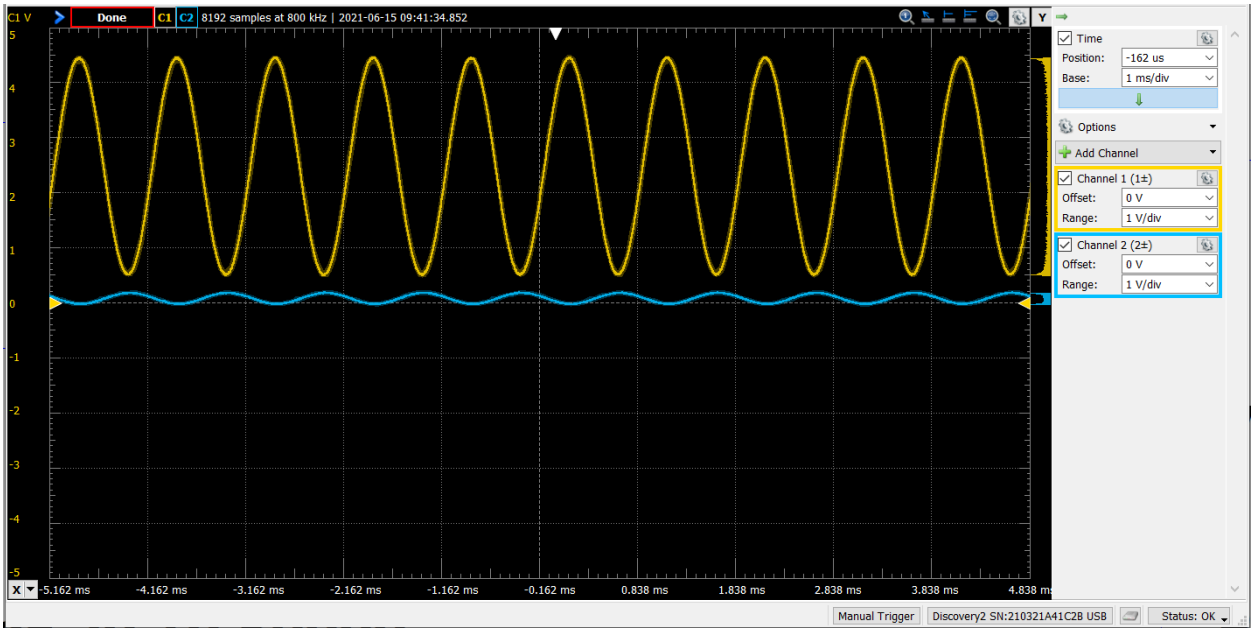

Figure 2. Physical circuit implementation – oscilloscope output

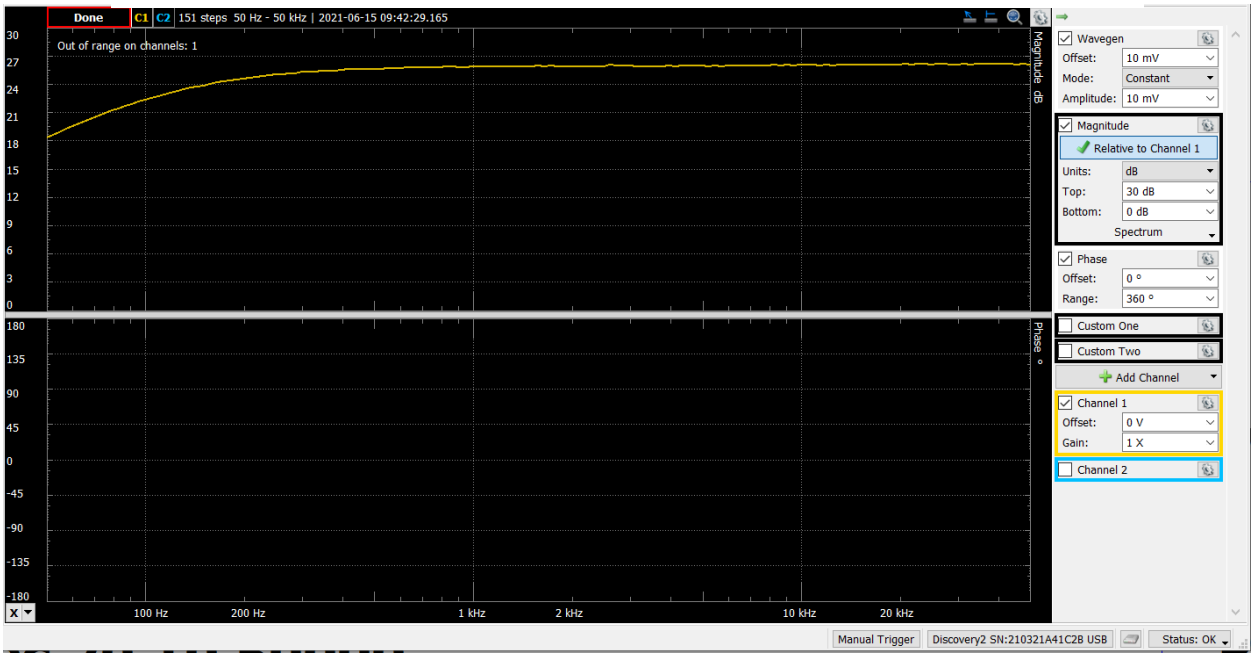

Figure 3. Physical circuit implementation – frequency response output

For part 2, an 8-ohm speaker with an AC coupling capacitor was added to the output of the circuit. The following results were obtained.

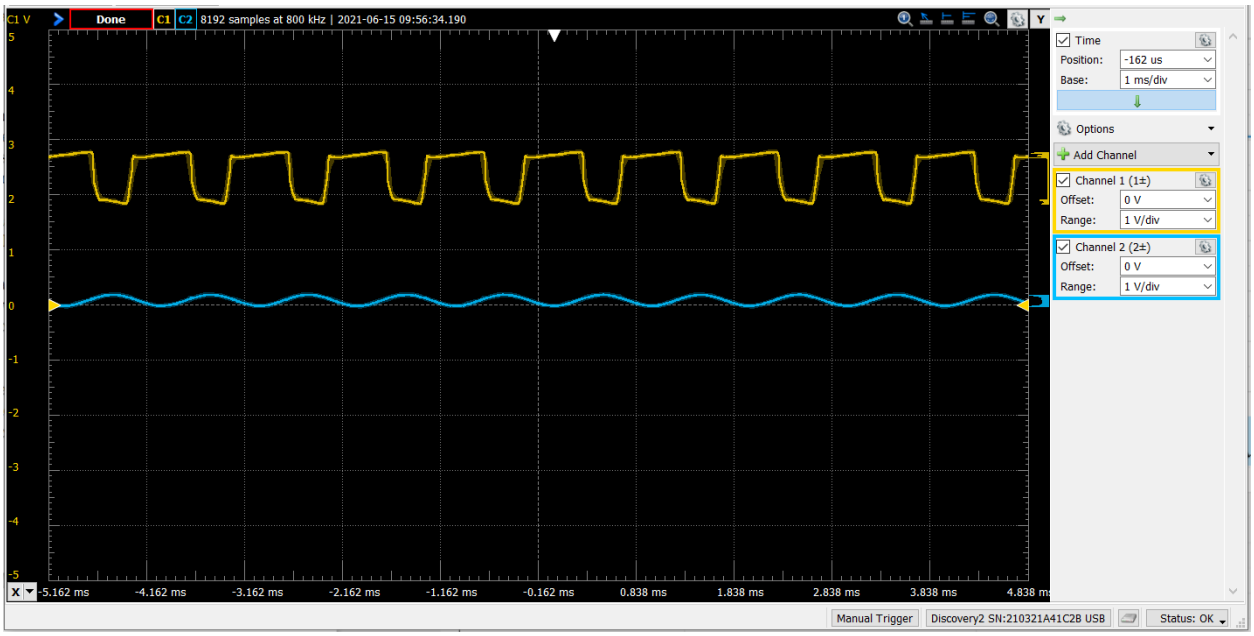

Figure 4. Physical circuit implementation – oscilloscope output w/ 8-ohm speaker

With an open circuit as shown in figure 2, there was no clipping. As clearly shown – the output clips heavily when there is an 8-ohm speaker attached to the output. After connecting the 8-ohm speaker to the original circuit, the mid band voltage gain is approximately 5, or only 14dB. The power input with an 8-ohm speaker connected is .005W, the power output is .125W, this gives a power gain of also 14dB. This is because the LT1632 does not have the available current to drive this speaker at full power. This is the difference between the open circuit and the 8-ohm speaker load. To remedy this, in the next part we use an LM386 opamp that is purpose built for audio amplification.

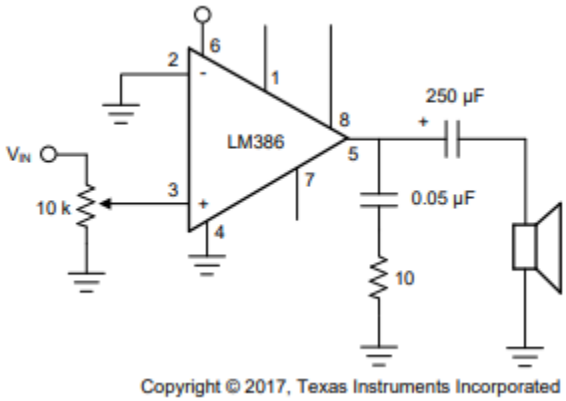

Figure 5. LM386 amplifier circuit

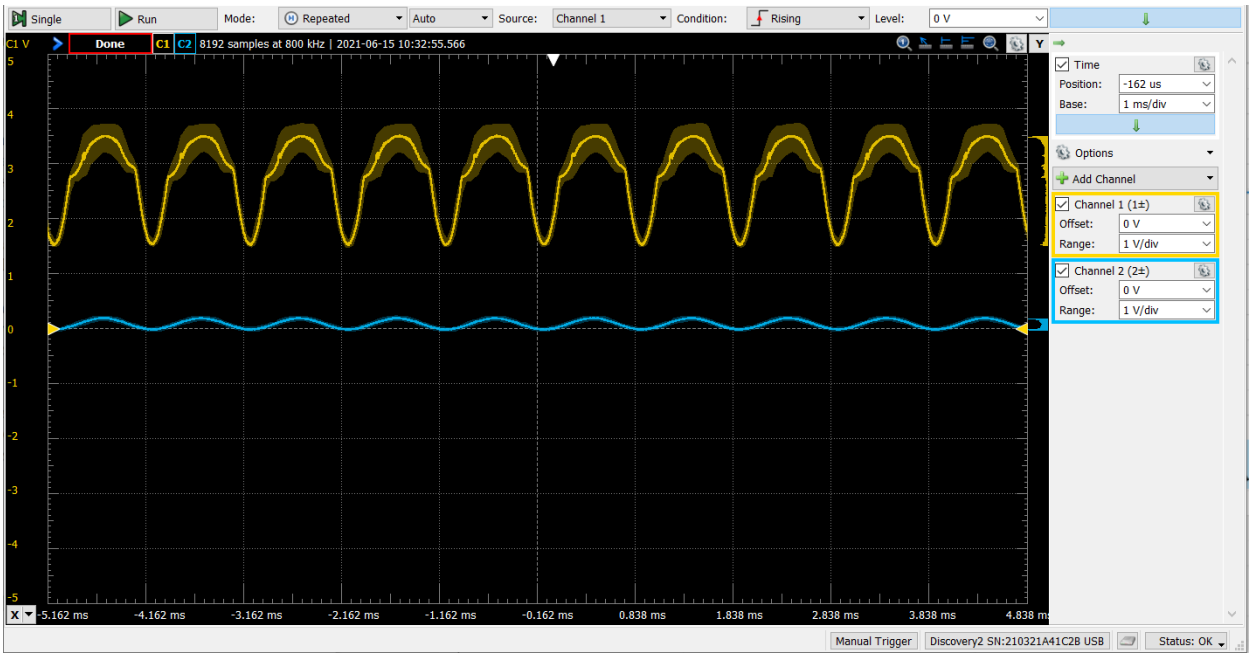

Figure 6. Output for LM386 circuit

With the LM386 circuit – the output is slightly deformed due to noise, however the clipping that was present with the first circuit design is eliminated. The LT1632 is a high-performance low-noise amplifier, but does not have the available current to drive an 8-ohm speaker without clipping. It would be a good choice for an application where there is little current draw. The LM386, however, has the available current to drive a speaker at full power without clipping.

Design 1 - Final Project - Bill of Materials				
Description	Quantity	Price/Part	Part Number	Source
Potentiometer - 10kOhms - Through-Hole	1	$ 2.90	3310C-125-103L	https://www.digikey.com/en/products/detail/bourns-inc/3310C-125-103L/2534044
Resistor - 1kOhms - Through-Hole	3	$ 0.10	2197-293-1K-RC-ND	https://www.digikey.com/en/products/detail/xicon/293-1K-RC/10487931
Capacitor - 1.5uF - Through-hole	1	$ 0.57	FK16X7R1E155K	https://www.digikey.com/en/products/detail/tdk-corporation/FK16X7R1E155K/2256812
Opamp	1	$ 8.40	LT1632	https://www.digikey.com/en/products/detail/analog-devices-inc/LT1632CN8-PBF/891007
Audio Amplifier	1	$ 1.33	LM386N-4	https://www.digikey.com/en/products/detail/texas-instruments/LM386N-4-NOPB/148192
Capacitor - 250uF - Through-hole	1	$ 1.88	220BXC250M18X31.5	https://www.digikey.com/en/products/detail/rubycon/220BXC250M18X31-5/6182438
	Total:	$ 15.38		

Conclusion

The design and implementation of this module was overall a success. A source of error was the fact that the input capacitor was chosen after the resistor values, leaving the physical implementation to be slightly off from the desired value of 1.6uF. This resulted in a gain that was not perfectly 26dB, but still within acceptable tolerance. The LM386 circuit also had some distortion at higher gain values. This could have been improved with better filtering throughout the circuit, but again was within acceptable rates. Ultimately, the circuit designs demonstrated met all requirements for this module.