Audio Equalizer

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Abstract

For the final lab, we created an audio equalizer. To do this we separated the low, mid, and high frequencies by using frequency filters. We then construct subcircuits made up of potentiometers and inverting amplifiers that we would use to adjust the volume of each frequency. Finally, the low, mid and high frequencies would then come together again. We implemented a subcircuit that would adjust the overall volume of the signal; this was then put through a power amplifier which would deliver our signal to the speakers to play audio.

1. Objectives

Construct a circuit that acts as an audio equalizer.

1.1. Construct and Test Low, Band, and High Pass Filters

The goal here was to create three frequency filters that met the specifications given to us. We were tasked with building one low pass filter with a cutoff frequency of 320Hz, a high pass filter with a cutoff frequency of 3200Hz, and finally a band pass filter that had both -3dB points at 320Hz and 3200Hz.

1.2. Volume Control with Potentiometers

We had to create four volume controls for this circuit. We stuck one at the end of each filter to control the volume of the low, mid, and high frequencies. The fourth potentiometer we attached to the output of the summing amplifier to act as a overall volume controller. Note that for these potentiometers to work as volume controllers, we only used two adjacent pins so the potentiometer would act as a variable resistor.

1.3. Summing and Power Amplifier

The summing amplifier is basically the combined output of all three of the frequency filters. The goal of the power amplifier was to increase the signal enough to produce an audible sound on the speakers.

2. Theory

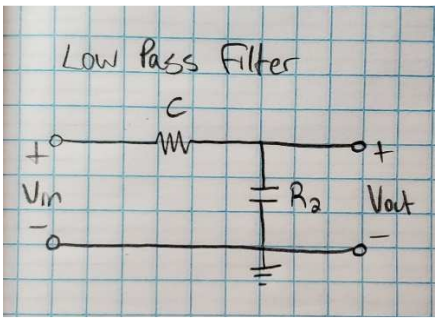


Figure 1

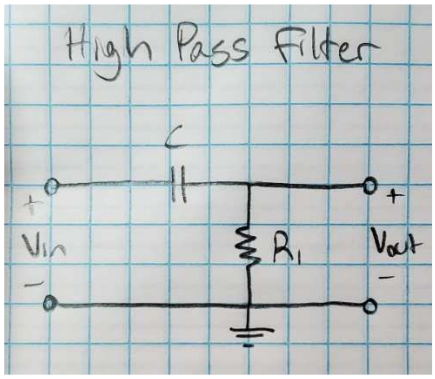


Figure 2

To solve for the necessary resistance and capacitance in the circuit we used the equation:

$$f_c = \frac{1}{2\pi RC}$$

We were given the cutoff frequency for each filter, so we just plugged that in and solved for RC. Then we picked values for resistor and capacitor that would multiply to equal that value.

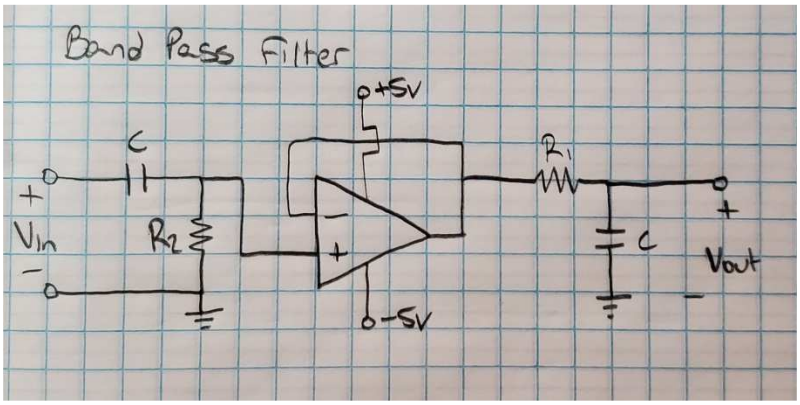


Figure 3

For the band pass filter, we recreated our high pass and low pass, swapped their resistor values, then connected them with a buffer to prevent the low pass from loading the high pass. The reason we swap the resistances for the high pass and low pass in the mid pass filter is because now, the high pass will let all the signals above 320Hz through, and the low pass only let in signals below 3200Hz.

3. Procedure

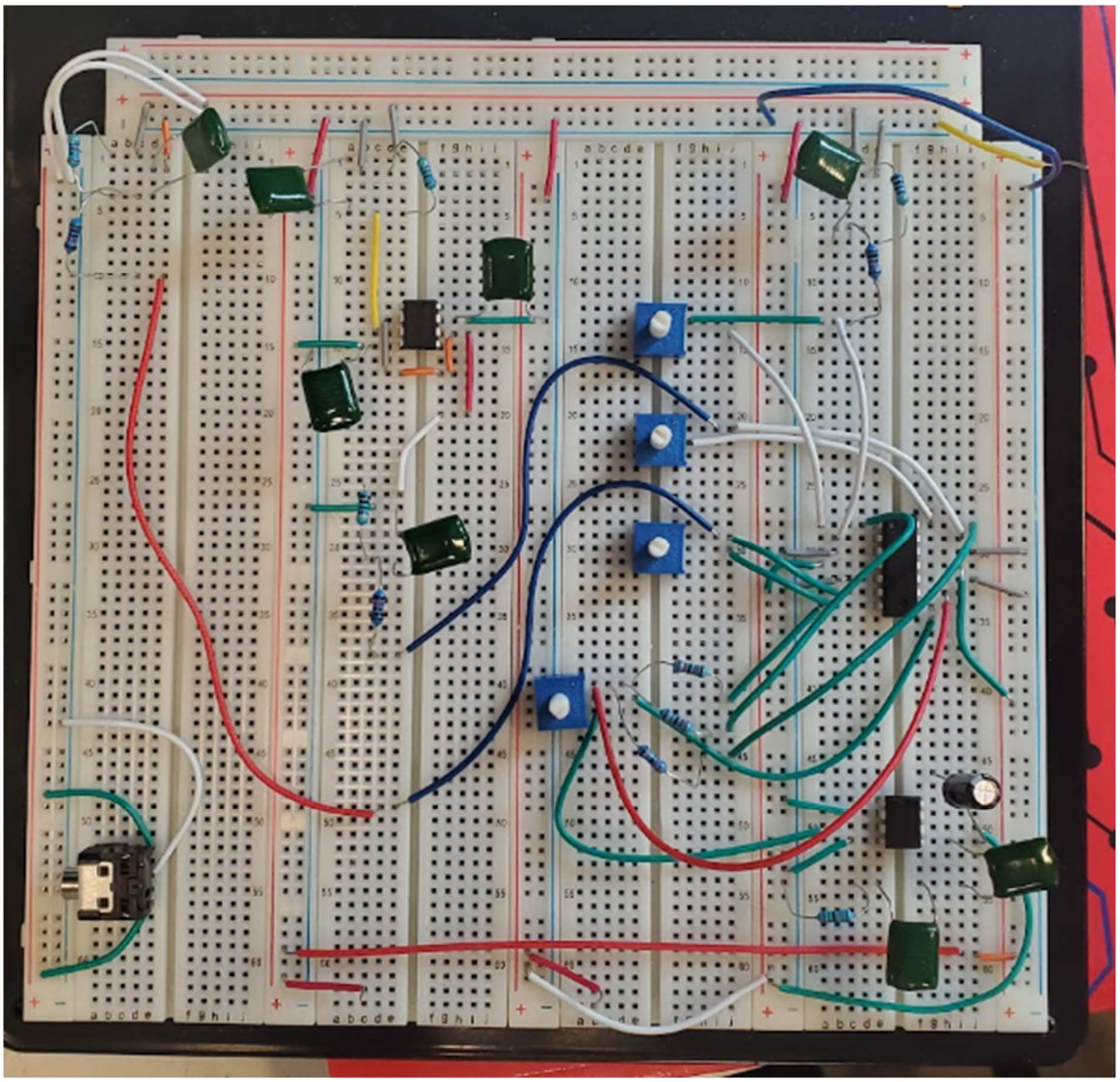


Figure 4

Table 1: Components Used

Low Pass Resistor	4700 ohms
High Pass Resistor	470 ohms
Capacitors	0.1 microfarads
Op-amp Buffer	LF356
Inverting Op-amp	LM324N
Power Amplifier	LM386N
Resistors after frequency filters	10k ohms
Potentiometers	0-10k ohms
Capacitor at output	100 microfarads
Three resistors before main volume control	3300 ohms

Table 2: Specifications

Speaker Resistance	8 ohms
Bass Filter -3dB cutoff	320 Hz ±10%
Mid Filter -3dB Bandwidth	320Hz to 3200 Hz ±10%
Treble Filter -dB cutoff	3200 Hz ±10%

3.1. Constructing Frequency Filters

3.1a Low Pass

To construct our low pass filter, we used 0.1 microfarad for our capacitance, and 4700 ohms for our resistor. Then we simply set it up like we have shown in Figure 1 above.

3.1b High Pass

To construct the high pass filter, we used 0.1 microfarads again, but made our resistor to be 470 ohms this time. We followed the same schematic shown in Figure 2 to build this.

3.1c Band Pass

To construct the mid pass filter, we first built our high pass filter, then connected it's output the input of a voltage buffer. Then we took the output of the buffer and connected it to the input of the low pass filter. One important note is that we couldn't use the exact same resistors for the high and low pass in the bandpass filter that we used for our two previous filters; we had to swap the resistor values for it to work. This can be seen in Figure 3 above.

3.2. Volume control with potentiometers

To construct something that would control the volume or strength of the signal, we used an inverting amplifier (LM324N) in conjunction with a potentiometer. The potentiometer was used as a feedback resistor for the LM324N. and just before the LM324N, we used a 10k ohm resistor to act as our gain resistor. We basically repeated this three time for each filter.

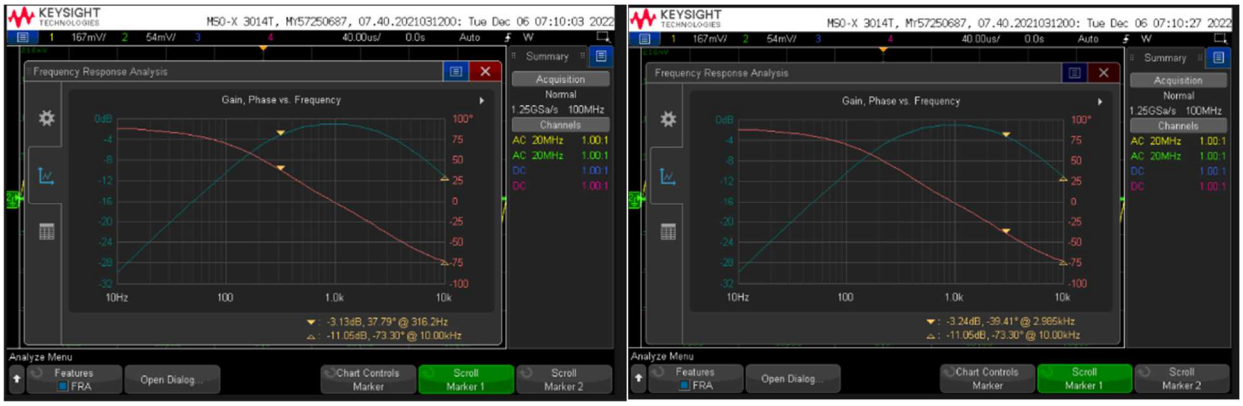
3.3. Summing and Power amplifier

The summing amplifier is basically the same as our inverting amp volume controller setup. The only real difference being the input and the gain resistors. The input is all three signals combined; and for the resistors, we used 3.3k ohms for each one.

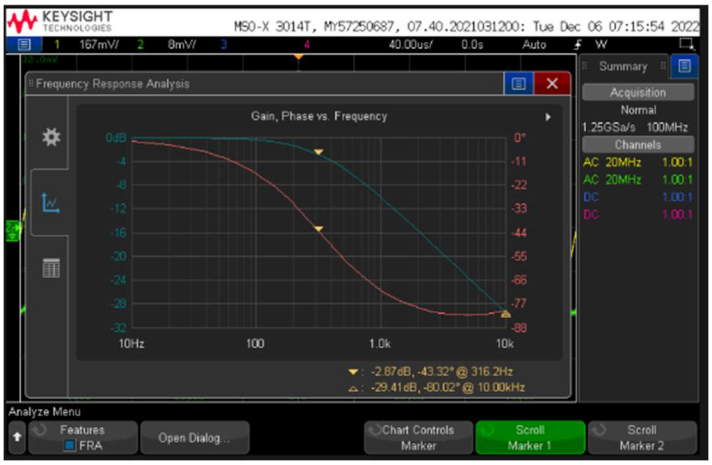
The power amplifier takes the output of our summing amplifier as its input, and the output of the power amplifier is what we connect to our speaker.

4. Results

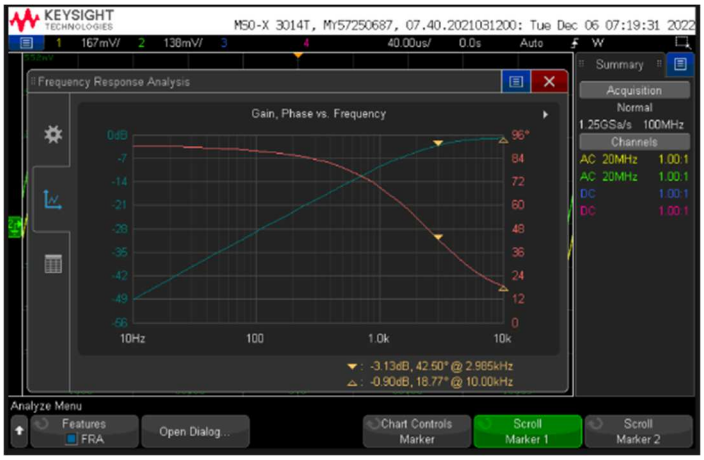
Band Pass Filter Results



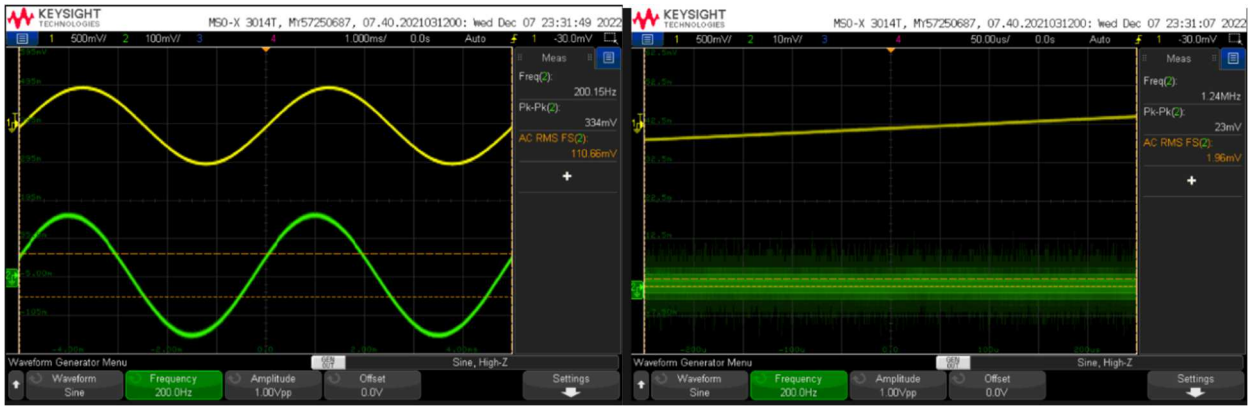
Low Pass Filter Results



High Pass Filter Results



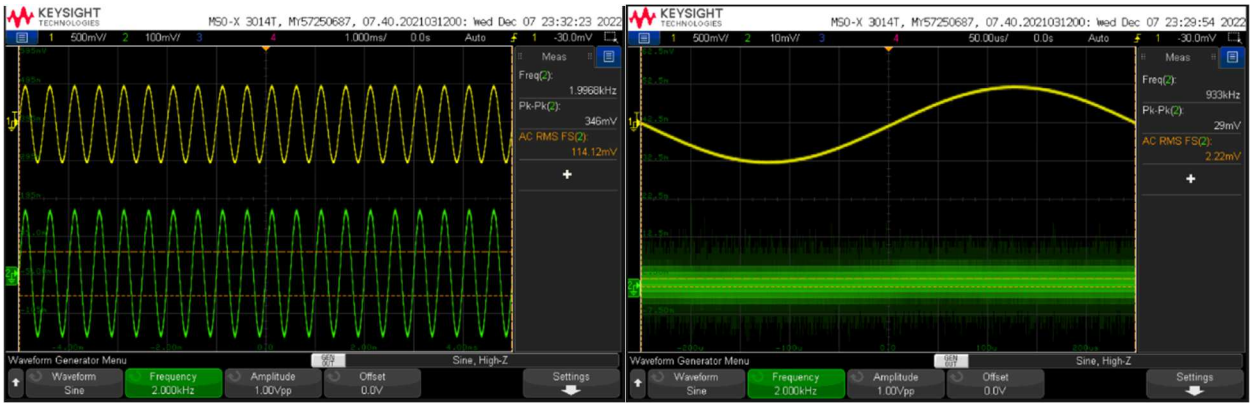
AC RMS At Different Frequencies



1Vpp Sine Wave at 200Hz

(left) potentiometer at ~0 ohms

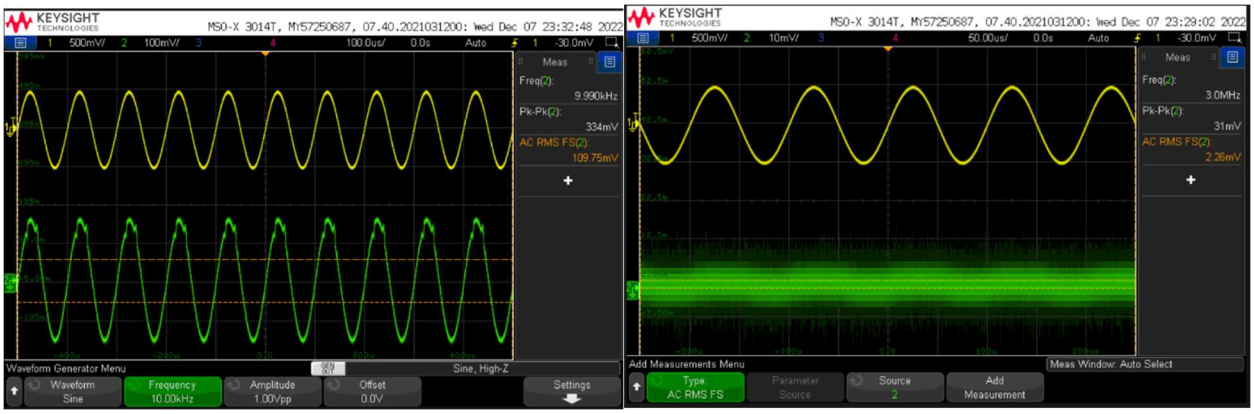
(right) potentiometer at ~10k ohms



1Vpp Sine Wave at 2,000Hz

(left) potentiometer at ~0 ohms

(right) potentiometer at ~10k ohms



1Vpp Sine Wave at 10,000Hz
(left) potentiometer at ~0 ohms
(right) potentiometer at ~10k ohms

Note: These signals were all measured from the output of the potentiometer at our summing amplifier

5. Conclusion

The goal of this lab was to create an audio equalizer. This was done by combining many subcircuits that would work together to create one cohesive circuit to act as our equalizer. We created a high pass filter, a low pass filter, and a band pass filter to separate the lows, the mids, and the highs. From there, we put these signals through an inverting amplifier with a potentiometer to act as a volume controller for each respective frequency. The lows, mids, and highs then combined back into one signal where we then made another volume controller for overall loudness. This combined signal was then run through a power amplifier so that the speaker would play the audio at reasonable volumes. We were able to play run audio through our input and adjust the low, mid, and high frequencies as well as the overall volume, so I think this project was a success.