

Abstract:

In this experiment we used two operational amplifiers, capacitors, resistors, a potentiometer, a condenser microphone, and an earpiece, to create a hearing aid. The hearing aid required two op amps, which inverted and amplified the sound. We were able to use the hearing aid to hear how the op amps do amplify the sound. By amplifying the sound in two op amps, the user is able to hear the sound/signal much better than a human ear would be able to hear on its own.

Introduction:

Operational amplifiers, commonly known as op amps, are components of circuits that allow for the signal to be boosted, inverted, or both boosted and inverted. An op amp consists of a negative pin, which is the inverting input, and a positive pin, which is the non-inverting input, which can be seen below in figure 1. Op amps also have two power supplies, +Vs and -Vs. It is important to always assume the circuit has an ideal op amp; when we have an ideal op amp the input impedance is infinite, meaning the input resistance is infinity and current is zero, so the voltage drop between the inverting and non-inverting pins are zero, meaning V^+ and V^- are assumed to be equal (1).

Capacitors are circuit components that store electrical energy but when the voltage changes, current is produced within the circuit. Overall, capacitors try to resist changes in voltage drop in the circuit (1). A capacitor can be seen below in Figure 1.

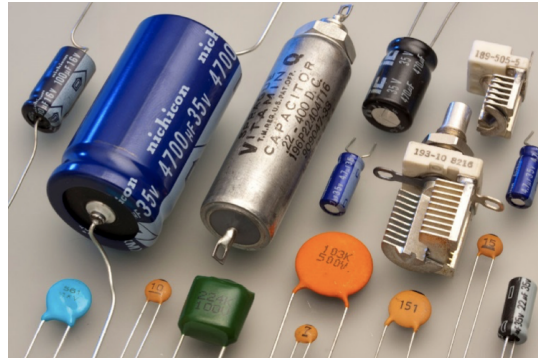


Figure 1

A potentiometer is a resistor that can be adjusted by use of its second terminal, which is a wiper. The wiper acts as a resistance divider and when it's adjusted we can see different values of resistance (1), which can be seen below in Figure 2.

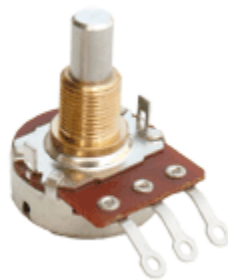


Figure 2

A condenser microphone is a microphone that uses sound waves, which causes a vibration. That vibration changes the capacitance, which affects the circuit (2). A condenser microphone can be seen below in Figure 3.

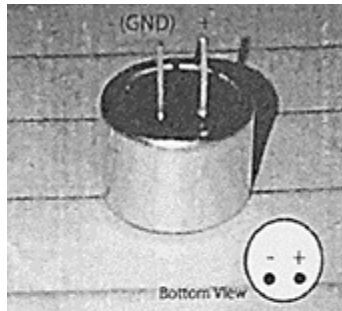


Figure 3

In this experiment we created a hearing aid which consists of an inverting amplifier, operational amplifiers, capacitors, a potentiometer, and a condenser microphone. The inverting amplifier feed's the output into the circuit, which allows for the signal to be inverted and amplified (1). A hearing aid is used to amplify sounds so a person with hearing loss can hear and communicate better.

Methods:

In this experiment we built a comparator using $R1=1.5K$ Ohms, $C1=1$ μF , $R2=2K$ Ohms, $R3=47K$ Ohms, potentiometer= $10K$, $R4=2K$ Ohms, $R5=100K$ Ohms, $C2=220$ μF , and two operational amplifiers. For one op amp we connected V_{out} to op amp port 1, V_- to the second port, V_+ to the third port, V_{CC-} to the fourth port, $2V_+$ to the fifth port, $2V_-$ to the sixth port, $2V_0$ to the seventh port, and V_{CC+} to the eighth port. For the second op amp we connected V_{out} to op amp port 1, V_- to the second port, V_+ to the third port, V_{CC+} to the fourth port, $2V_0$ to the fifth port, $2V_-$ to the sixth port, $2V_+$ to the seventh port, $3V_+$ to the eighth port, $3V_-$ to the ninth port, $3V_0$ to the tenth port, V_{CC-} to the eleventh port, $4V_+$ to the twelfth port, $4V_-$ to the thirteenth port, and $4V_0$ to the fourteenth port. For the potentiometer, we used the first connection and the wiper, and for the earpiece we connected the circuit to $C2$. We used $5V$ for V_{in} , $5V$ for V_{CC+} , $-5V$ for V_{CC-} , and we then measured the V_{out} of the circuit by connecting our red and black alligator wires to the ground and op amp, which can be seen below in Figure 4

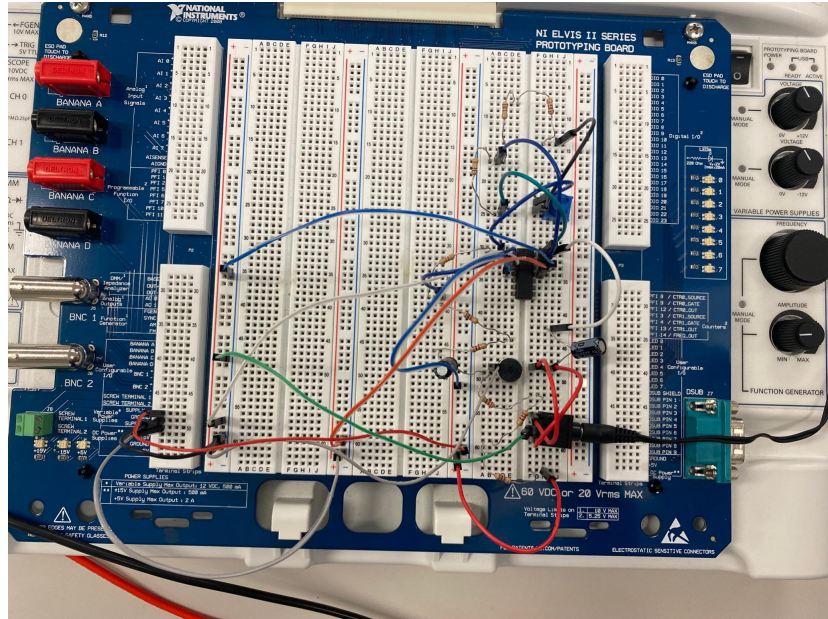


Figure 4

Results:

After building the circuit, we were able to hear noise through the earpiece. We then created the circuit in TinkerCAD, but we replaced the microphone with a power source and the earpiece with an oscilloscope, which can be seen below in Figure 5.

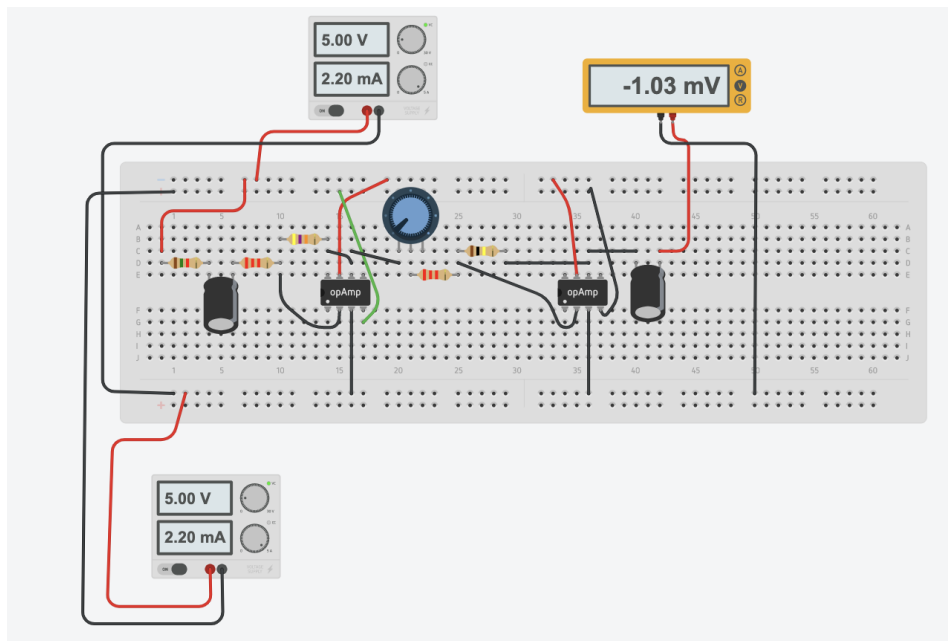


Figure 5

Both op amps are inverting op amps in this circuit. The first op amp integrates and amplifies the signal, which then travels down through the potentiometer, where it can be adjusted with the wiper, and then the second op amp integrates and amplifies the signal, which is eventually passed through the ear piece. The hearing aid amplified the noises in the room, but the volume was still relatively quiet, although there was some background noise due to the circuit. After adjusting the 10K potentiometer, the earpiece/noise got louder, but the noise in the circuit still remained.

Conclusion:

In this experiment we created a hearing aid by building a circuit, which consisted of operational amplifiers, potentiometers, capacitors, an earpiece, and a condenser microphone. This experiment allowed us to see how simple it is to create a hearing aid with a circuit, but it also allowed us to see that a hearing aid like this will have a lot of noise. The op amps invert and amplify the signal, which causes the user to hear the signal/sound at a much louder volume than the human ear can hear on its own.

Works Cited:

1. Filip Stefanovic's BE403 notes
2. <https://www.merriam-webster.com/dictionary/condenser%20microphone#:~:text=Definition%20of%20condenser%20microphone,one%20plate%20of%20a%20condenser>