University of Utah
Electrical & Computer Engineering Department
ECE 1250 Lab 8

Audio Circuits

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rev,

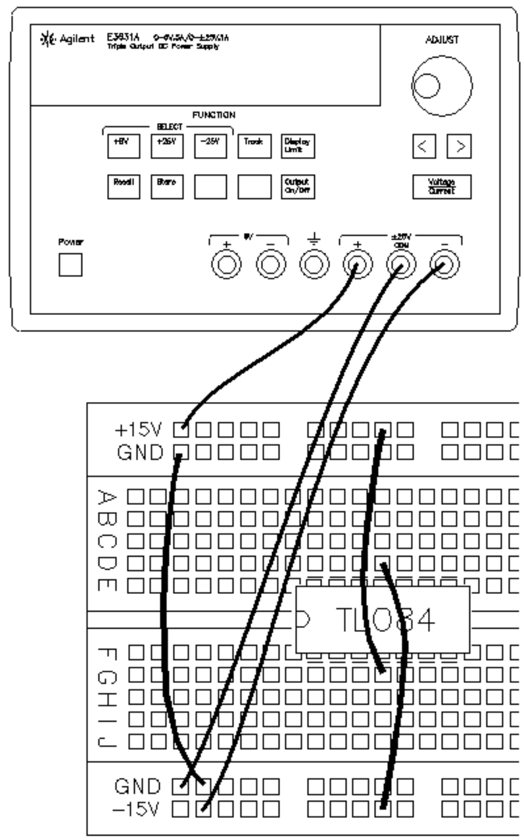
Note: Bring an audio source like and MP3 player, inexpensive headphones or earbuds, your textbook and analog parts used in earlier labs.

Objective

Build and test some basic audio circuits and filters.

Parts to be supplied by the student:

- TL084 or LM324 quad operational amplifier IC
- 4 10 kΩ, and 2 100 kΩ resistors
- 1 kΩ, and 47 kΩ resistors
- 10 kΩ (103) trim potentiometer (pot)
- Small plastic screwdriver to adjust the trim pot
- 3 0.01 µF (103) capacitors
- 0.1 µF (104) capacitor
- Condenser microphone
- Breadboard and wires



Check out from window:

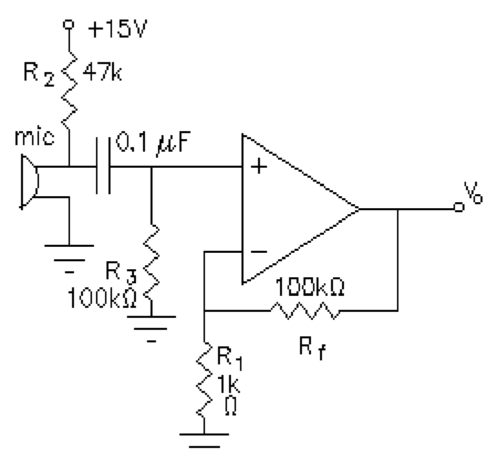
- 3.5mm stereo plug with leads (optional, if available. Not needed if you don't want to hook up your expensive player to your circuit)
- Headphones may also be available if you don't have some with you.

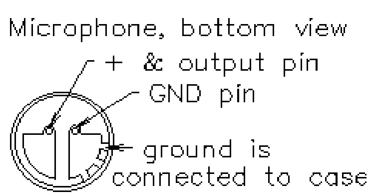
Experiment

Plug the TL084 (or LM324) into the breadboard and connect the power supply connections like you've done before. Set up the power supply to get ±15 just like you did to get ±6 V in lab 4. Hit the "Output On/Off" switch to turn off the power supply output for now without losing the setting.

Microphone amplifier

Construct the circuit shown at right. The microphone connections are shown below.





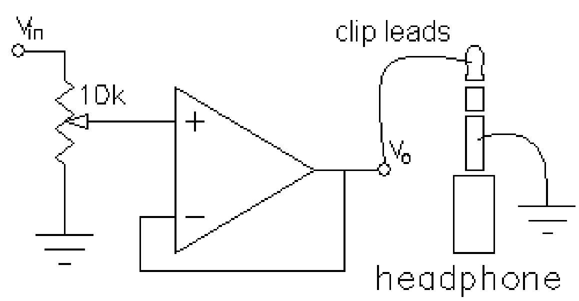
Test the circuit by hooking the output to the oscilloscope and looking at audio signals from the microphone. Play with the scope adjustments and try some different sounds and noises. Comment in your lab notebook about how much a true audio signal looks like the sine waves that we normally use as "signals" in the lab. Comment about the randomness and unpredictability of this signal. see if you can make a sound that produces something like a sine wave, comment in lab notebook.

Frequencies of different sounds
Make vowel sounds; ahhh, aye, eeee, oooo, eww, etc.. notice the different frequencies of the different sounds. Try some consonant sounds, like ssssss, shhhh, fffff, or zzzzz. What kinds of sounds are generally higher in frequency?

Now try to capture some more transient sounds, like t, k, ch, or g. These will be difficult to see, especially with all the noise in the lab. Try this: Hit the "Edge" button in the "TRIGGER" section of the scope and hit the button under the screen that corresponds to the channel you are using for the audio (A1 or A2). Now hit the "Mode/Coupling" button and the Normal button under the screen. Adjust the "Analog Level" knob in the "TRIGGER" section. You'll see a horizontal line appear on the scope which will show you the trigger level. Turn it up until the trace stands still on the scope most of the time (you may have to turn down the vertical "Volts/Div" somewhat). Now, making a noise should trigger the scope and make a single trace that you can look at. If that doesn't work for youe or doesn't apply to the scope at your bench, try RUN/STOP and SINGLE. Try to look at the t, k, ch, or g sounds again.

You should find that the vowel sounds are generally louder and lower in frequency than the consonant sounds. Comment in your notebook. Unfortunately, the consonant sounds are the most important when it comes to understanding speech, so a common complaint of someone who's lost some of their hearing at higher frequency is, "I can hear, but I can't understand."

Audio Output
Construct the headphone amp with volume control shown at right and hook the output of your microphone amplifier to the input of this circuit. The potentiometer is used as a volume control in this case. Describe in your notebook how the volume control works.



Feedback
Turn up the volume and bring the headphone and mic close enough to one another that the circuit begins to squeal on its own. What is causing this sound? Perform some experimentation and list a couple of things you can do stop feedback.

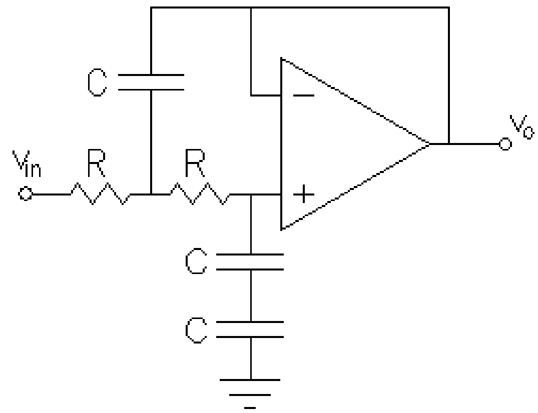
Volume control
The pot that you're using for a volume control is linear, but your hearing is not. With a relatively constant level of input, turn the volume control up and down. (You may wish to replace the mic circuit with the signal generator for this test.) Does the response seem linear to you? That is, when the volume control is half-way up, does the output sound half as loud? At what setting of the control does the output sound half as loud?

Filters

Consult chapter 8 of your textbook (p.565) and read the introductory section. Skip forward to section 8.8 (p.578) and look through this section on active filters. Unfortunately, the design methodology is too condensed and very confusing, so I'll give you the two filters you will make.

Low-pass filter

Construct the two-pole Butterworth active filter shown at right. All the resistors are 10 kΩ and all the capacitors are 0.01 µF (103). The input should be the output of your microphone amplifier and the output could be either your volume control and buffer. Make the connection to the volume control such that it can easily be move from the output of this filter to the input and back again. That way you can quickly compare the audio with and without the filter.

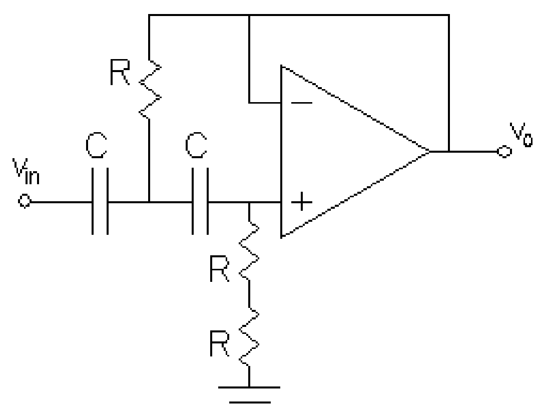


When you have the circuit constructed and hooked up correctly listen to the output with and without the filter. This filter is designed to pass frequencies up to about 2 kHz and then roll off at about 40 dB per decade at higher frequencies. That means the output of this filter is attenuated by a factor of 100 at 20 kHz. This reduction of the high frequencies should be very evident to those of you with normal hearing. (For an explanation of dB, see p204 and for more on filters see p211 in text.) Comment in you lab notebook.

You may now wish to replace your microphone and microphone amplifier with the output of you MP3 player or other audio source. The green lead is ground. Use either the red or white lead as one channel of the stereo output. Be careful with your connections so that you don't short the output of your player or accidentally hook it to a power source. If you're not sure you can do this safely, don't risk an expensive player, just stick with the microphone and amp. You will probably be able to hear the difference in sound quality more easily with a music source than just the microphone.

High-pass filter

Take apart the low-pass filter and use the same parts to construct the high-pass active filter shown at right. All the resistors are 10 kΩ and all the capacitors are 0.01 µF (103).   Repeat the procedures for the low-pass filter. This filter is designed to pass frequencies above 1 kHz and attenuate lower frequencies. You should easily hear this in the output.



Conclude

Check off and write a normal conclusion in your notebook. Before leaving, make sure everything is turned off and return the stuff you checked out and took from the posts.