<EE 210 Final Project>

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Introduction

This project involved designing, simulating, and building a complete tone-control and karaoke audio circuit. The circuit takes a stereo audio input and processes it through five stages: mixer/karaoke selector, tone control, volume control, LED volume display, and output buffer. Each stage builds on concepts covered earlier in the EE 210 course, like op-amps, voltage dividers, and comparators. The final result is a working audio circuit that can adjust bass and treble, mute vocals, show volume levels using LEDs, and safely use headphones.

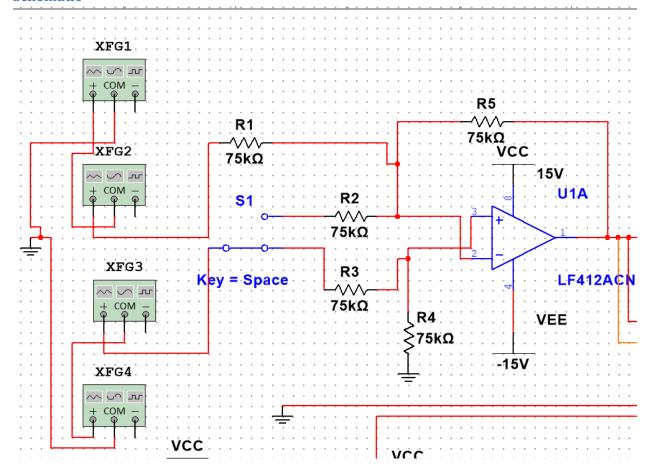
Design and Simulation

Block 1

Design Objective

Combine (mix) or subtract (karaoke) left and right audio channels using op-amp configurations.

Schematic



Block 1 schematic

Theory of Operation

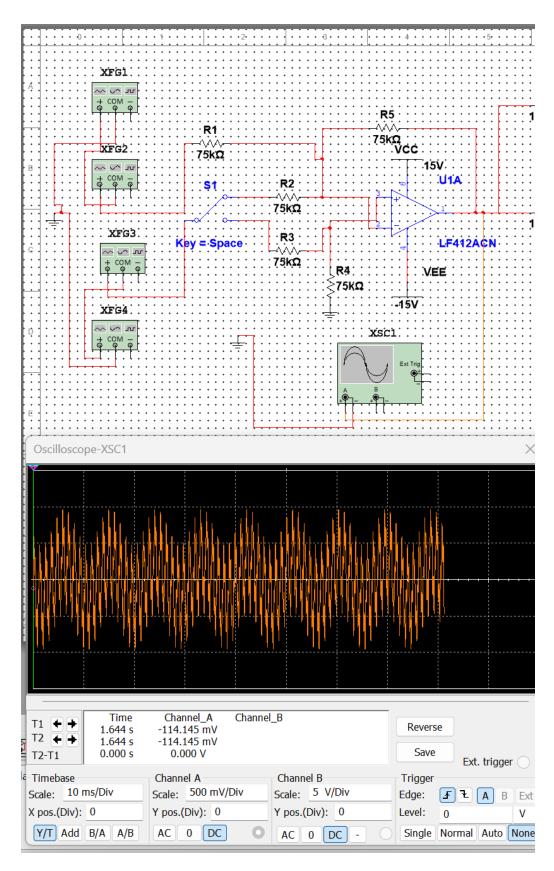
This block uses a SPDT switch to select between two op-amp modes. In mixer mode, it acts as an inverting summing amplifier, outputting –(L+R). In karaoke mode, it subtracts one channel from the other, outputting (L–R), which suppresses vocals that are common to both channels. The circuit relies on matched resistors for balanced output.

Derivations/Calculations

6=	Block 1 Page
	8 248 81 29
	Voot = V V2 P+ 100K
	Vout = - (V2+V2) 72
	D = 1 100k = 10
	2+100kJ2 10
	102 = 22 100K 100K p
	912=1001
	R= 100K 96 30 0 R= 11,111 2
	9 62 8-51-21 3

Simulation Results XFG1: R1 75kΩ 15V U1A ::::R2: **R**3 XFG3::: ····-LF412ACN + COM -∵75kΩ §75kΩ ∷ -15V XFG4xsc1.... Oscilloscope-XSC1 Channel_A Channel_B Time T1 + + Reverse 685.301 ms 376.462 mV T2 + + 685.301 ms 376.462 mV 0.000 s 0.000 V Save T2-T1 Ext. trigger Timebase Channel A Channel B Trigger Scale: 10 ms/Div Scale: 500 mV/Div Scale: 5 V/Div Edge: F & A B X pos.(Div): 0 Y pos.(Div): 0 Y pos.(Div): 0 Level: AC 0 DC AC 0 DC -Y/T Add B/A A/B Single Normal Auto No

Block 1- Mixer Mode

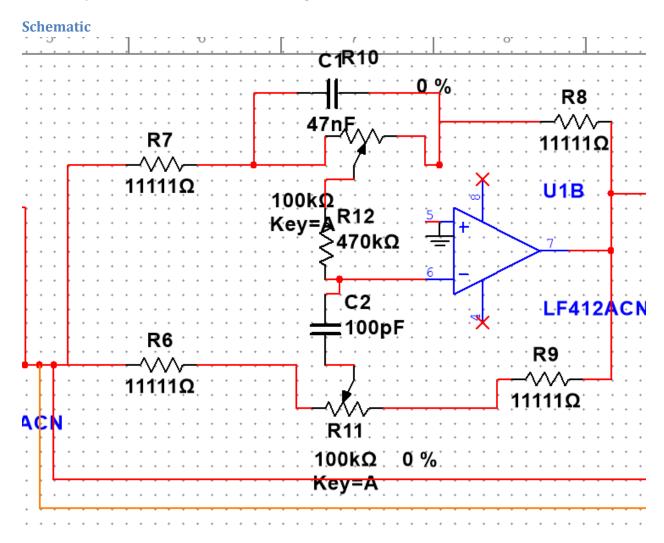


Block 1- Karaoke Mode

Block 2

Design Objective

Allow independent bass and treble control using a Baxandall tone control circuit.

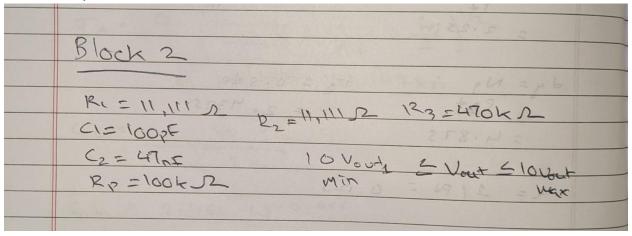


Block 2 schematic

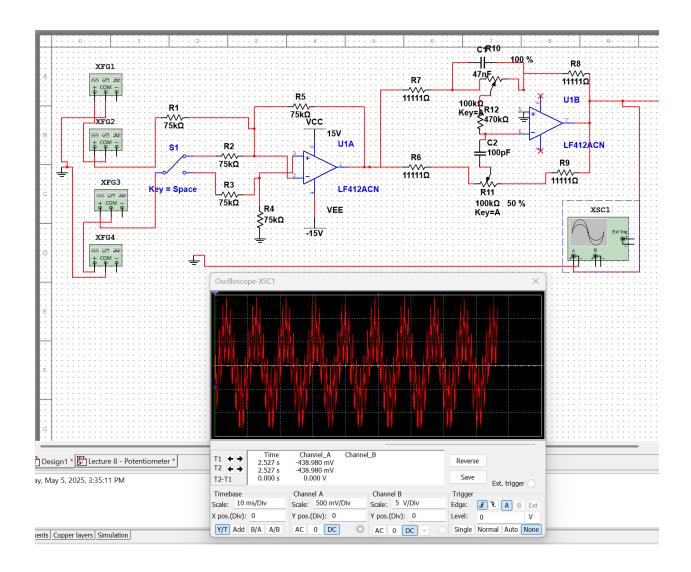
Theory of Operation

This stage adjusts frequency content using two op-amp-based feedback loops. The user can boost or cut bass and treble with potentiometers. The circuit shapes the frequency response depending on the position of these pots and the values of surrounding resistors and capacitors, achieving a gain range from roughly 0.1 to 10.

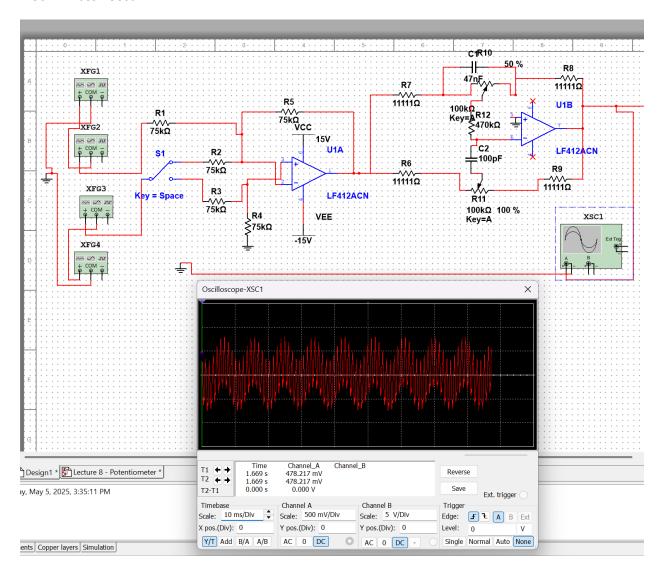
Derivations/Calculations



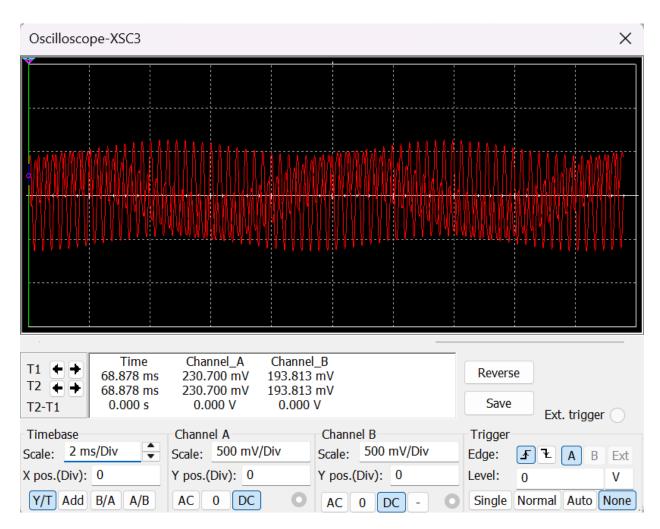
Simulation Results



Block 2- Bass Boost



Block 2- Treble boost

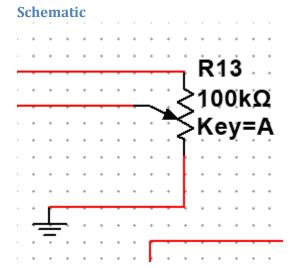


Block 2- Bass and Treble attenuation

Block 3

Design Objective

Provide overall volume adjustment of the audio signal.

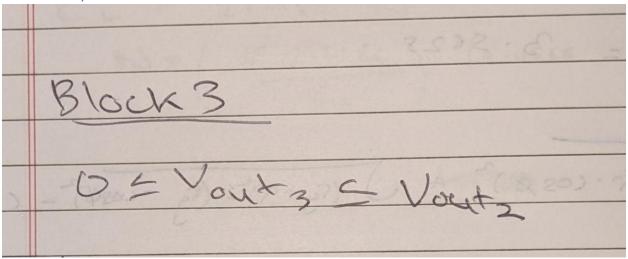


Block 3 schematic

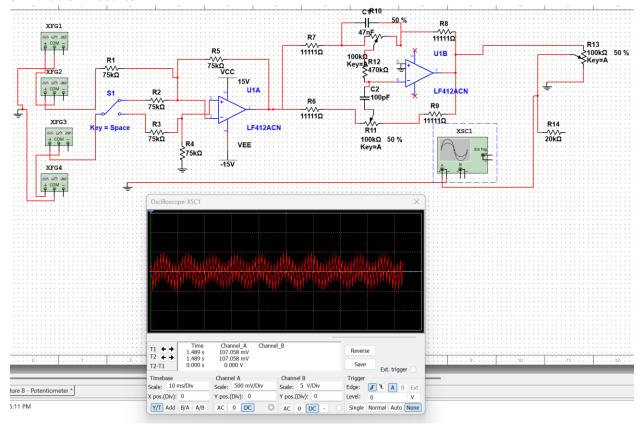
Theory of Operation

This block is a simple voltage divider, typically implemented with a single potentiometer. By changing the wiper position, the user can scale the amplitude of the audio signal anywhere from 0 to full output, making it the simplest yet crucial part of user control.





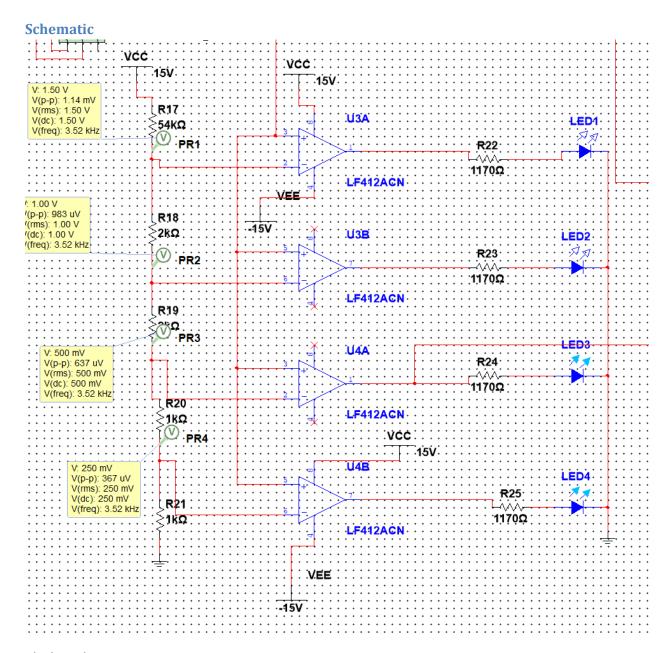
Simulation Results



Block 4

Design Objective

Visually indicate the output volume level using a 4-LED bar.



Block 4 schematic

Theory of Operation

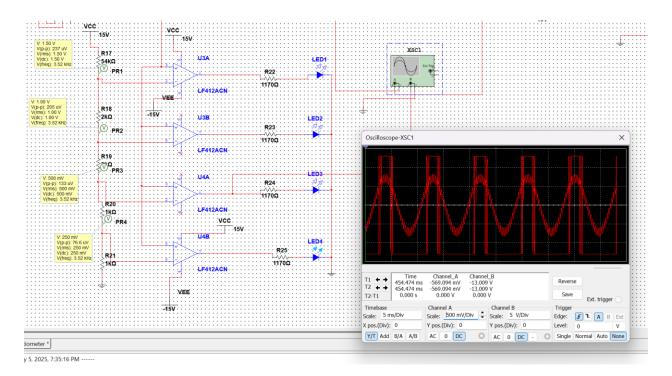
This block uses comparator op-amps to compare the audio signal with fixed voltage references (0.25 V, 0.5 V, 1.0 V, 1.5 V). As the input signal exceeds each threshold, the corresponding LED lights up. This gives a rough but effective indication of audio intensity.

Derivations/Calculations

	0
Block 4	7 3
	79
15-1-5=13-5 R=13-5KJZ	
1.5-1 = 6.5 R2=5002	
1-0-5 = 0.5 R3=5002	
U-5-0.25 = 0.25 124= 250-2	
U-25-0=0.25 RS 30 2502	
Rim = 1170, 2= 15 - 0-3.3	
O TO	

Simulation Results vcc::::: 15V V(p-p): 238 uV V(rms): 1.50 V V(dc): 1.50 V R17: U3A 54kΩ: V(freq): 3.52 kHz Ø PR1 R22 1170Ω LF412ACN V(p-p): 206 uV V(rms): 1.00 V V(dc): 1.00 V R18:: 2kΩ∷ U₃B LED2 V(freq): 3.52 kHz R23 1170Ω LF412ACN R19 :: ÕΩ PR3 LED3 V: 500 mV V(p-p): 133 uV V(rms): 500 mV V(dc): 500 mV R24 1170Ω V(freq): 3.52 kHz [R20]] LF412ACN **≥1kΩ**::: .vcc... V: 250 mV V(p-p): 76.6 uV V(rms): 250 mV V(dc): 250 mV V(freq): 3.52 kHz LED4 R25 R21 : 1kΩ LF412ACN VEE

-15V

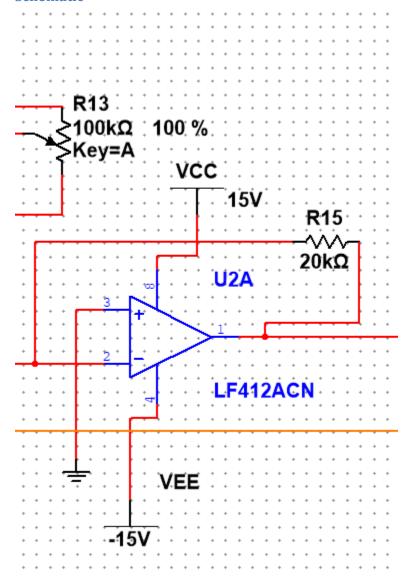


Block 5

Design Objective

Reduce and buffer the signal to headphone-safe levels (0.5–1 V).

Schematic

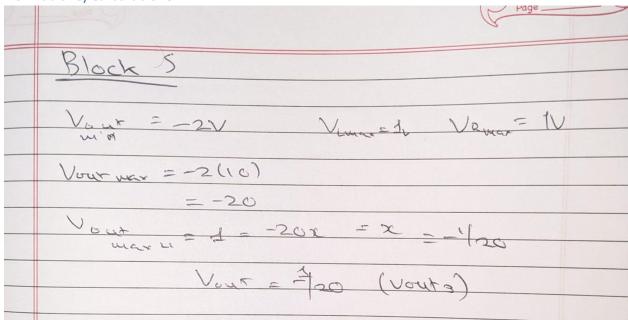


Block 5 schematic

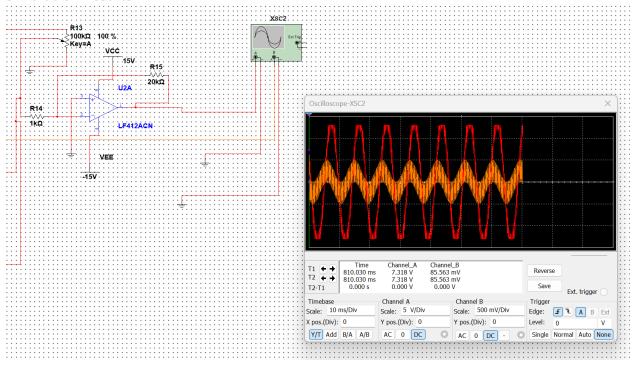
Theory of Operation

This final stage uses an inverting amplifier with gain <1. It attenuates the potentially high output of the earlier stages to prevent distortion or damage to headphones. High-value resistors help avoid loading the previous stage. The op-amp also acts as a buffer to preserve signal integrity at the output jack.

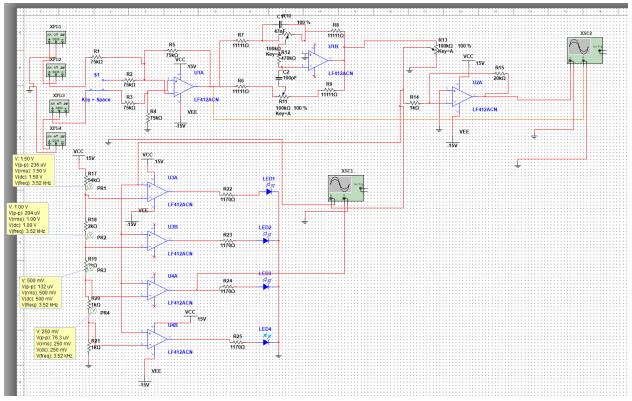




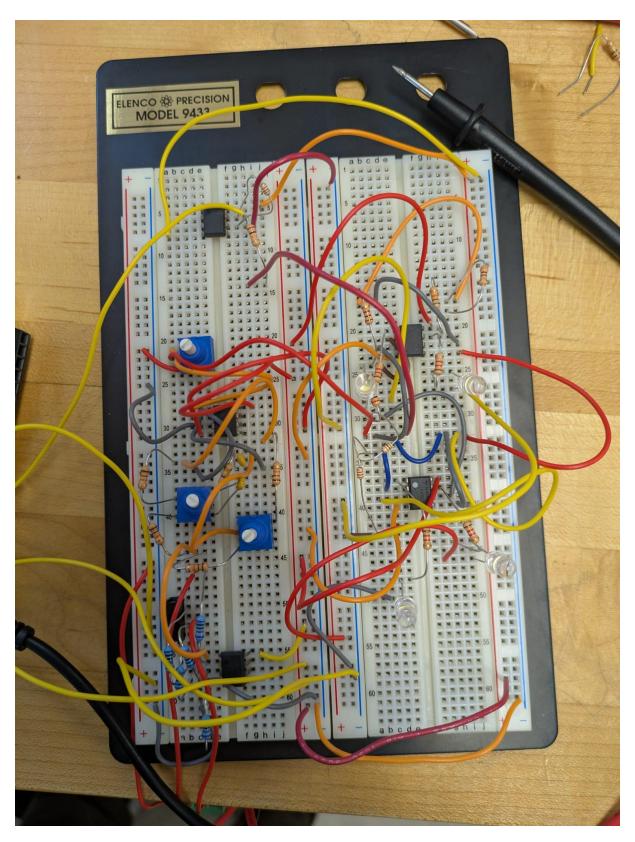
Simulation Results



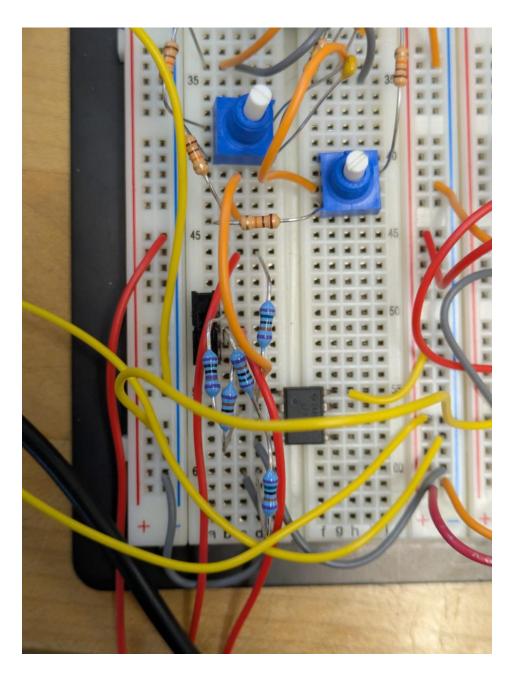
Complete Assembly and Breadboard Images



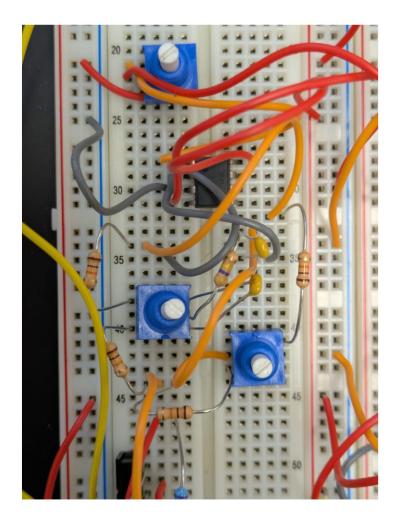
Overall Circuit



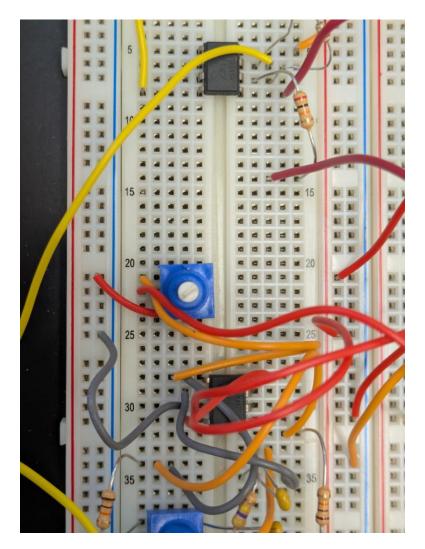
Overall Circuit on breadboard



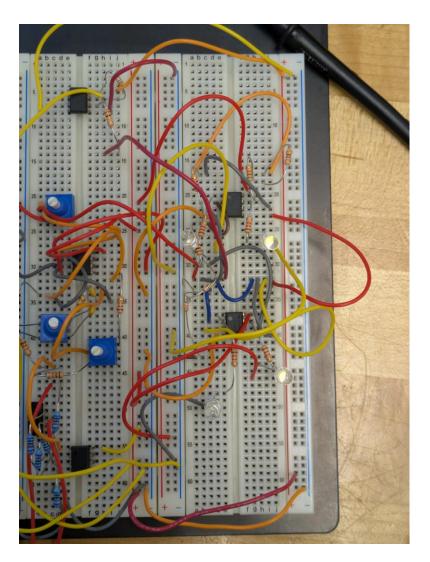
Block 1 on breadboard



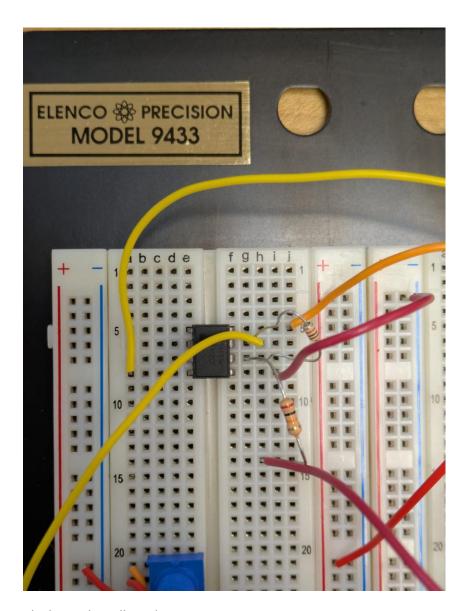
Block 2 on breadboard



Block 3 on breadboard



Block 4 on breadboard (right hand side)



Block 5 on breadboard

Conclusion

The project successfully integrated multiple analog circuit concepts into a functional and interactive audio device. Each block performed its role as expected, and the full system worked well when powered and tested with audio signals. The most challenging parts were tuning resistor values for gain and avoiding loading issues between blocks. Overall, this project was a practical way to apply EE 210 topics and gain confidence working with real audio signals.