# Final Project

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May 2 2022
EE210 sec.002
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## Introduction

This is a Tone control/Karaoke circuit. It can control volume, base and treble. It also has a volume display which indicates how high/low the volume is by lighting the LEDs. this circuit has two modes: a mixer mode and a karaoke mode.

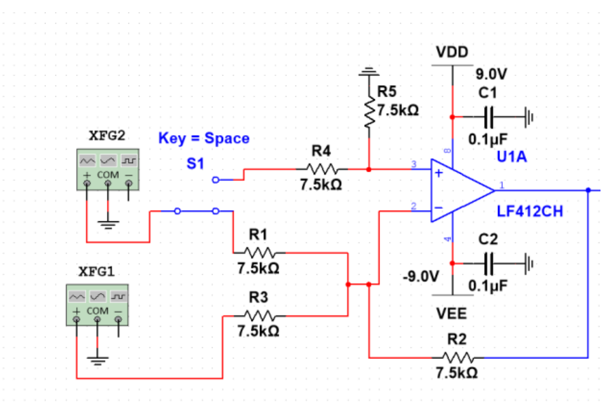
## Design and Simulation

### Block 1 mixer/Karaoke

#### Design Objective

This block is meant to take 2 inputs from the left and right channel and acts as either a summing (mixer mode) or a subtracting (karaoke mode) depending on the position of the switch. In the mixer mode, this block takes two input sound and outputs a weighted sum of both volumes. In the karaoke mode, this block outputs the difference of the two sound inputs

#### Schematic




#### Theory of Operation

The voltage output for a summing amplifier is $V_{out} = -\frac{R_2}{R_3}V_L - \frac{R_2}{R_1}V_R$ and for a subtracting amplifier its $V_{out} = -\frac{R_2}{R_3}V_L + \frac{R_2}{R_3}V_R$. In order to get a gain of $V_{out} = -V_L - V_R$ for a summing amplifier or $V_{out} = -V_L + V_R$ for a subtracting amplifier, we needed to use resistors with equal resistance values.

## Derivations/Calculations

Summing amplifier

$$R_1 = R_2 = R_3$$

$$V_{out} = -\frac{R_2}{R_3}V_L - \frac{R_2}{R_1}V_R$$

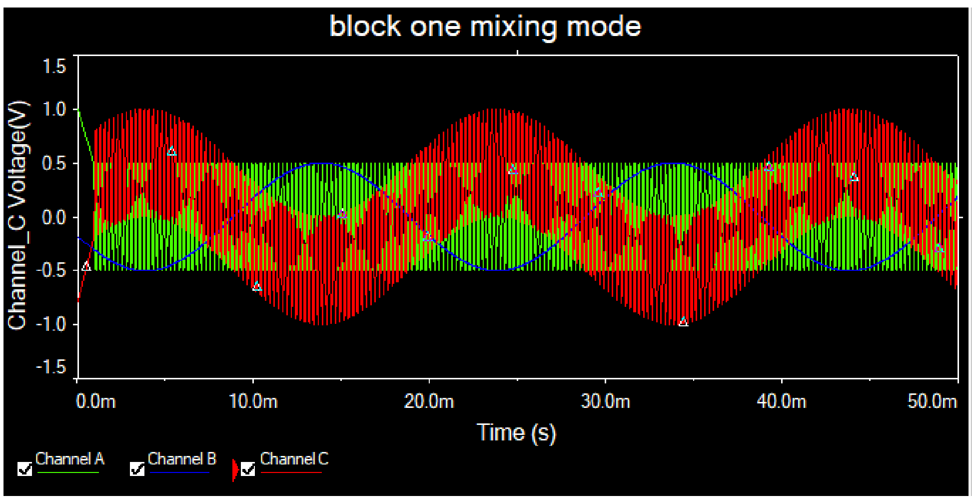
$$V_{out} = -\frac{R_2}{R_3}V_L - \frac{R_2}{R_1}V_R$$

subtracting amplifier

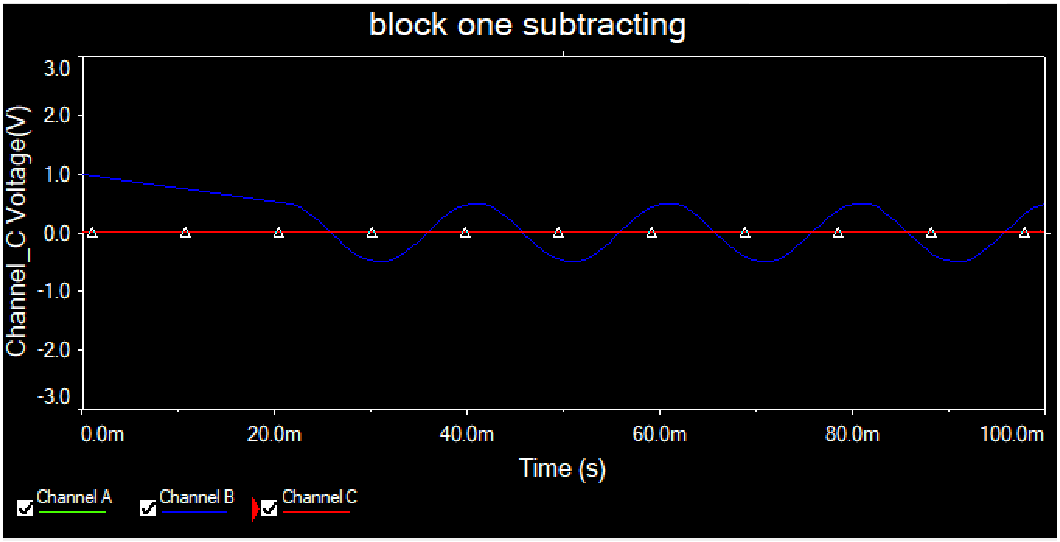
$$V_{out} = -\frac{R_2}{R_3}V_L - \frac{R_2}{R_3}V_R$$

$$V_{out} = -V_L + V_R$$

## Simulation Results




the blue wave represents the input of the left channel, the green represents the input of the right channel and the red represent the output voltage. This matches with the derivations above since the amplitude of the output wave is the sum of the input waves



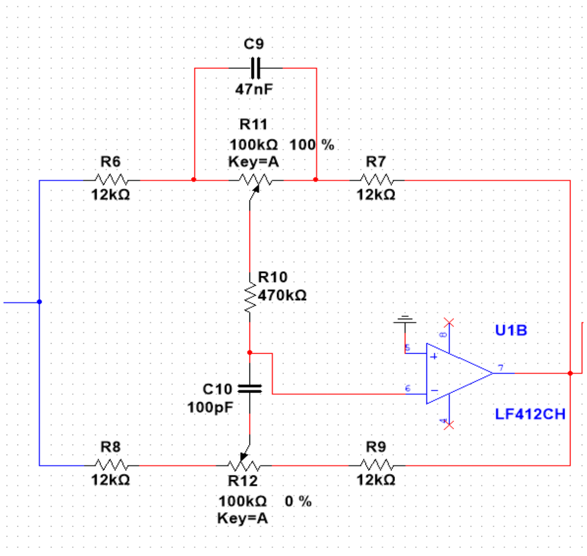

Since we had equal frequencies and equal voltage amplitude for both the input of the left channel and the right channel, the waves overlap, the output wave(red) is the difference between the left and tight inputs. This matches with the derivations above since the amplitude of the output wave is the difference between the input waves

# Block 2 tone control

## Design Objective

This block is a Baxandall tone control circuit. It is meant to control the base and treble of the sound inputs by independently controlling the low and high frequencies using low high frequency properties of a capacitor.

## Schematic



## Theory of Operation

The minimum gain (potentiometer at 0%) is 1/10 and the maximum gain(potentiometer at 100%) is 10 for both low and high frequencies. The value of the potentiometers is 100kohm

## Derivations/Calculations

Min gain low freq.

$$.1 = \frac{R_2}{R_2 + 100k}$$

$$.1R_2 + 100k = R_2$$

$$100k = .9R_2$$

$$R_2 \approx 11kohm$$

Max gain

$$10 = \frac{11k + 100k}{11k}$$

Min gain high freq.

$$.1 = \frac{R_1}{R_1 + 100k}$$

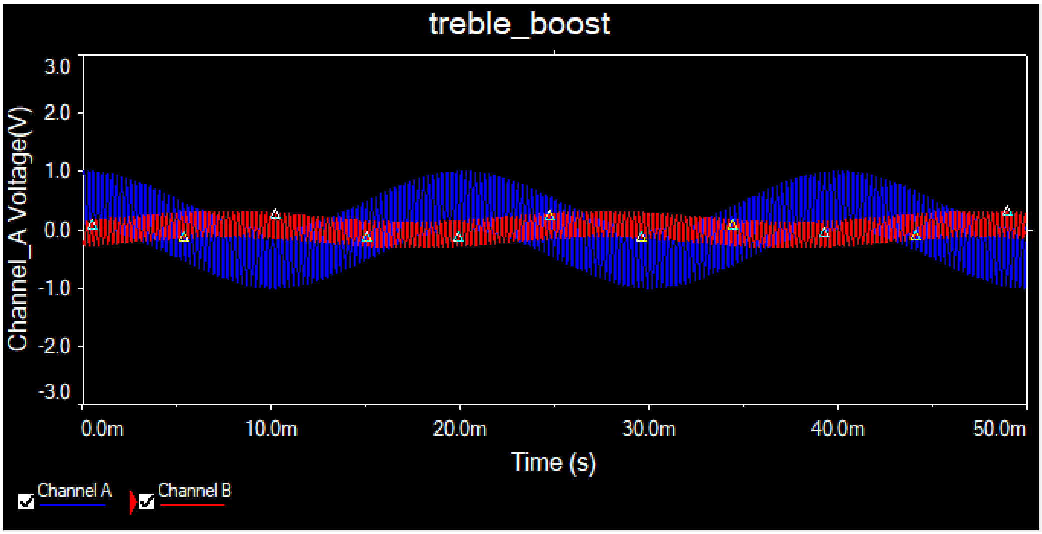
$$.1R_1 + 100k = R_1$$

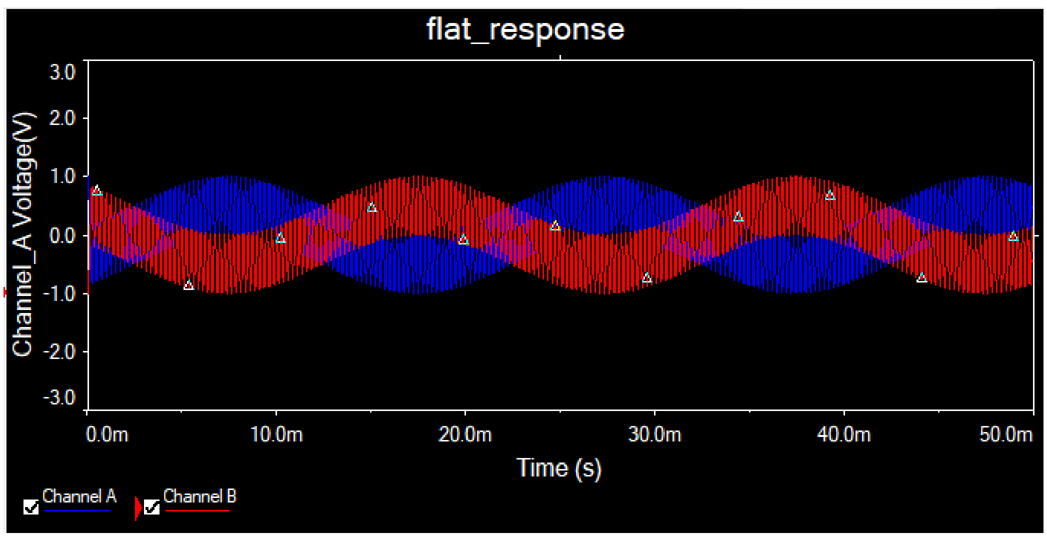
$$R_1 \approx 11kohm$$

Max gain

$$10 = \frac{11k + 100k}{11k}$$

## Simulation Results



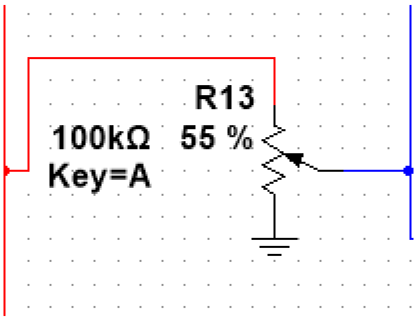



# Block 3 volume control

## Design Objective

This block is composed of a potentiometer that allows us to increase/decrease volume.

## Schematic




## Theory of Operation

This block is a potentiometer. it is a 3 terminal device composed of a resistor with 2 fixed terminals (A,C) and a movable wiper that is attached to a 3rd terminal (B) the wiper allows the pot to be used as a variable voltage divider. This allows us to increase/decrease the volume of the inputs.

## Derivations/Calculations

N/A

## Simulation Results

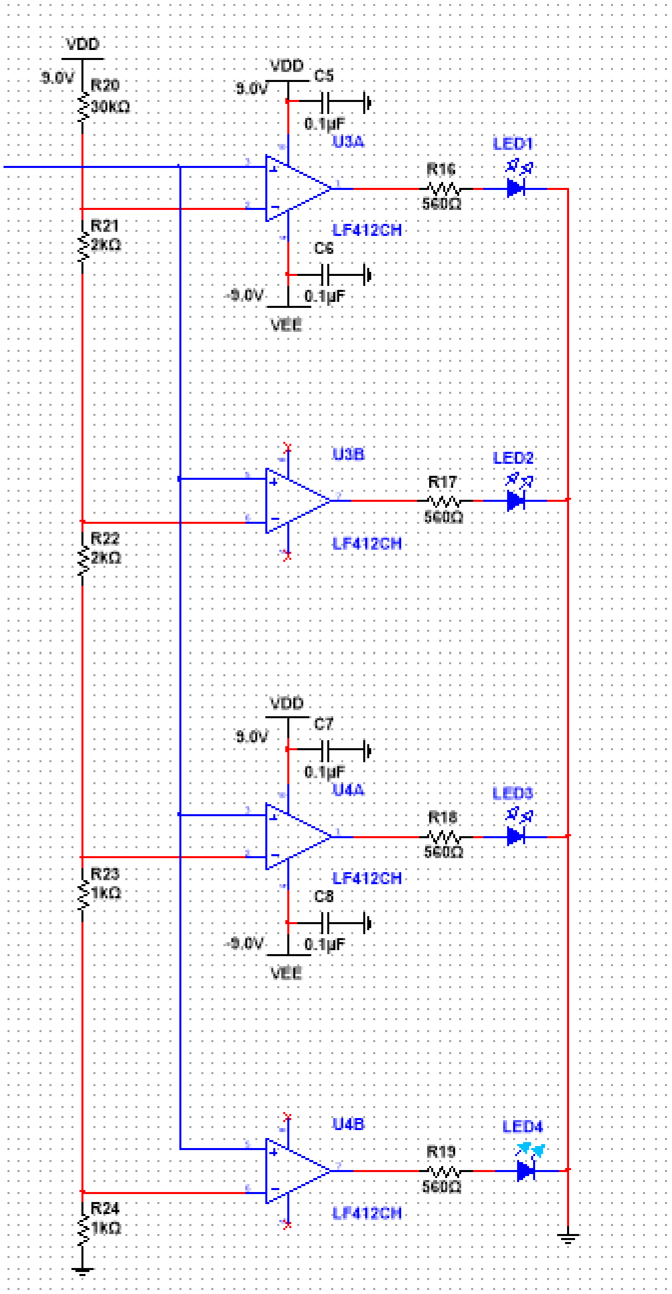
N/A

## Block 4 LED volume display

### Design Objective

This block is an LED volume display. It includes a voltage meter that allows certain voltages to go through the op amp depending on resistor values. LED's are attached in the output of the op amps and they light up when there's a voltage going through the negative terminal of the op amp.

### Schematic



## Theory of Operation

This block is a 4-level volume display with levels at 1.5V, 1V, .5V and .25V, as we increase the volume in block three, more LEDs will light up, the way this works is that the voltage meter allows certain voltages to go through the op amp depending on resistor value, with the voltage values above, we needed four resistors in the voltage meter. The first resistor would be 30x the last two resistors and the middle two resistors would be double the first two resistors.

## Derivations/Calculations

$$R_1 = \frac{9 - 1.5}{0.1} = 75ohm$$

$$R_2 = \frac{1.5 - 1}{0.1} = 5ohm$$

$$R_3 = \frac{1 - 0.5}{0.1} = 5ohm$$

$$R_4 = \frac{0.5 - 0.25}{0.1} = 2.5ohm$$

$$R_5 = \frac{0.25}{0.1} = 2.5ohm$$

$$R_1 = 30R, R_2 = 2R, R_3 = 2R, R_4 = R, R_5 = R$$

## Simulation Results

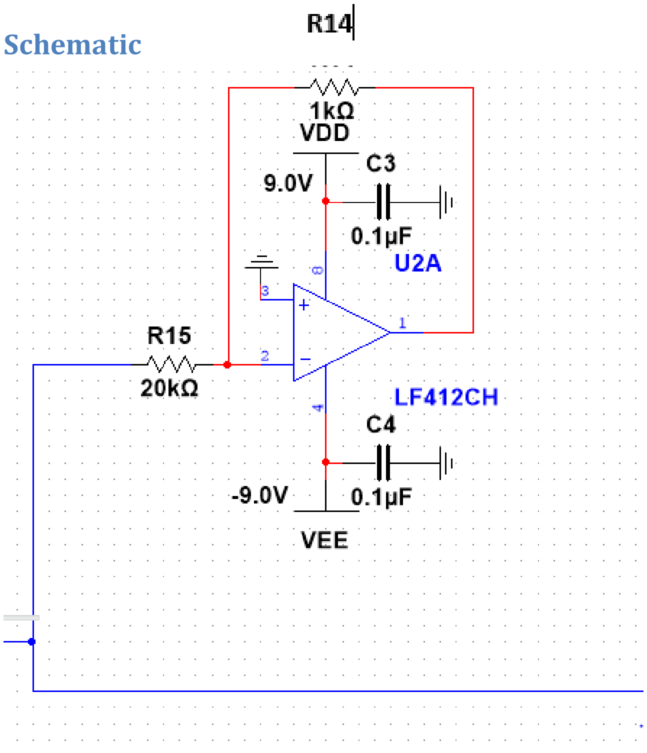
N/A

## Block 5 attenuation

### Design Objective

This block is an inverting op amp that is designed to attenuate the volume or reduce unwanted noise.

### Schematic




### Theory of Operation

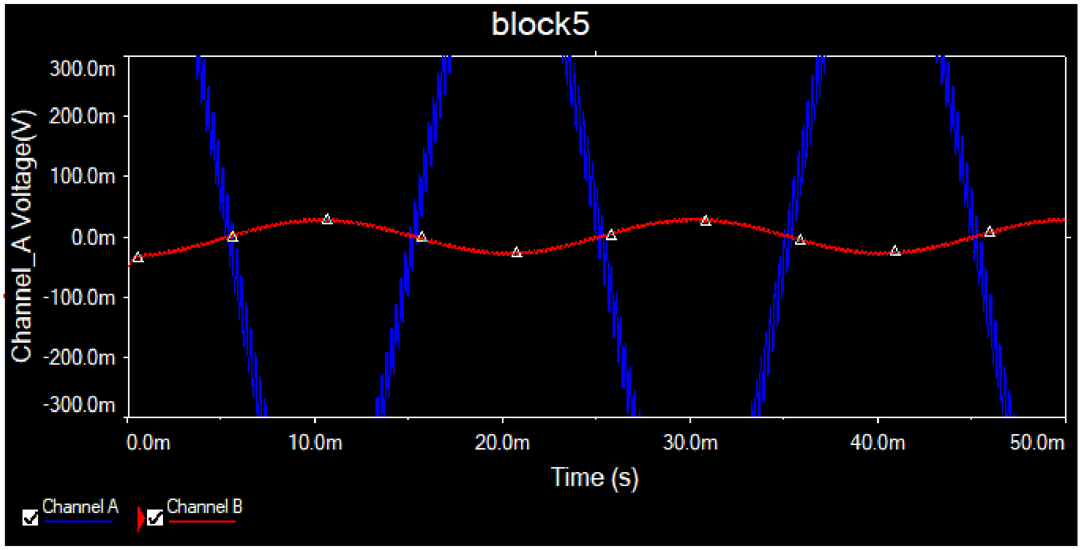
This block reduces the amplitude of the sound input by having a gain of 1/20. To achieve this gain, we need a 20kohm resistor connected to the negative terminal and a 1kohm resistor in the feedback loop. This is because the gain of an inverting op amp is $G = \frac{V_{out}}{V_{in}} = -\frac{R_{14}}{R_{15}}$

### Derivations/Calculations

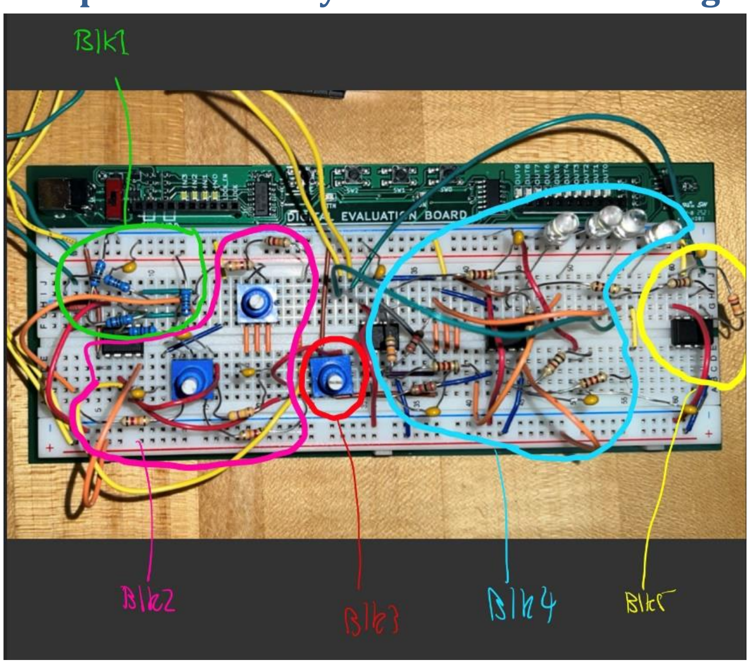
$$\frac{1}{20} = -\frac{R_{14}}{R_{15}}$$

$$R_{14} = 1kohm, R_{15} = 20kohm$$

### Simulation Results




## Complete Assembly and Breadboard Images



## Conclusion

The project was an overall success, using what we learned in the lectures and the labs and applying it to the project solidified my understanding of the course material. The problems that I've faced most were technical problems such as needing to desolder because I've put a resistor in the wrong place. Another issue I've faced was not knowing how to test each block when building the circuit on the breadboard. I ended up building all five blocks without testing each block. This made it an issue because I had problems with multiple block and it took a very long time to debug.