Victor Espidol
8/6/2019
3892-7678

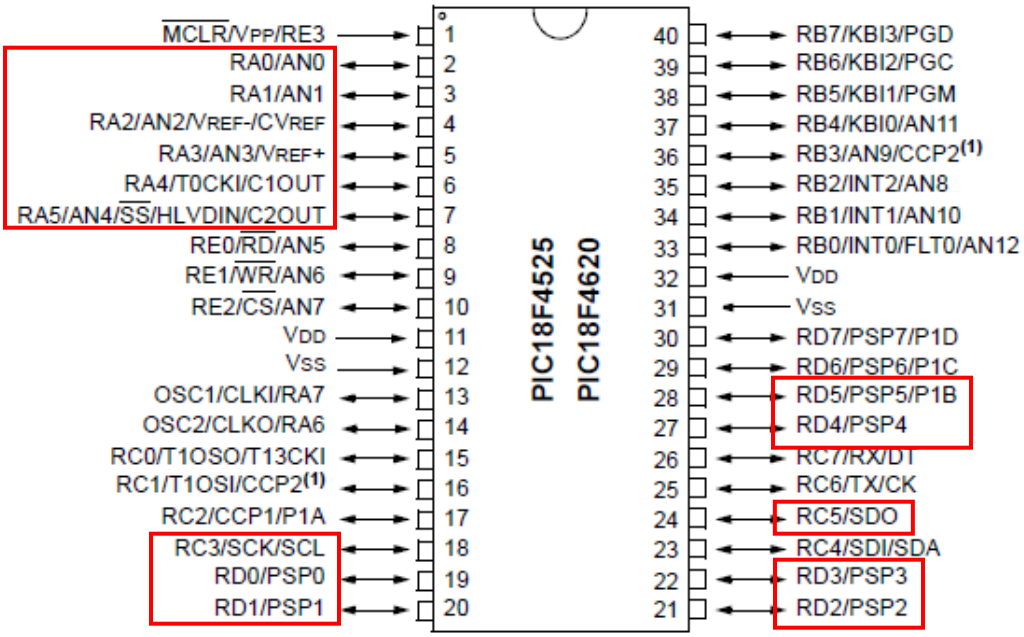
FINAL PROJECT – Report

Introduction

The goal of the final project is to utilize all understandings from each module this semester to create a fully functioning design. The final design must be constructed onto a printed circuit board and will be fully functioning when powered. This design utilizes both analog and digital inputs with some form of code manipulation to produce a digital and analog output based on the inputs.

Design

LCD pins: RD0, RD1, RD2, RD3, RD4, RD5
DAC pins: RA5/SS, RC3/SCK, RC5/SDO
ADC pin: RA0/AN0
Switch Pins: RA1, RA2
LED pins: RA3, RA4



Explanation of the design:

The design for this project is controlled by the inputs from two pushbutton switches and a potentiometer. The outputs of the microcontroller is interfaced with a DAC chip, preamplifier circuit, a speaker, and an LCD screen.

Pushbutton switch Value:

0x00:

The switches aren't pressed therefore both LED's will be off, and the analog output of the DAC will be a DC Voltage with the LCD screen reading "Out DC Voltage"

0x01:

The first pushbutton switch is pressed therefore the first LED will be turned on, but the second will be off. The analog output of the DAC will be a sinewave and the frequency of the output will be controlled by the potentiometer to the ADC, which will go from 500 to 1000 Hz. The LCD will display "Sine Wave."

0x02:

The second pushbutton switch is pressed therefore the second LED will be turned on, but the first LED will be off. The analog output of the DAC will be a triangle wave and the frequency of the output will also be controlled by the potentiometer to the ADC, which will go from 500 to 1000 Hz. The LCD will display "Triangle Wave."

0x03:

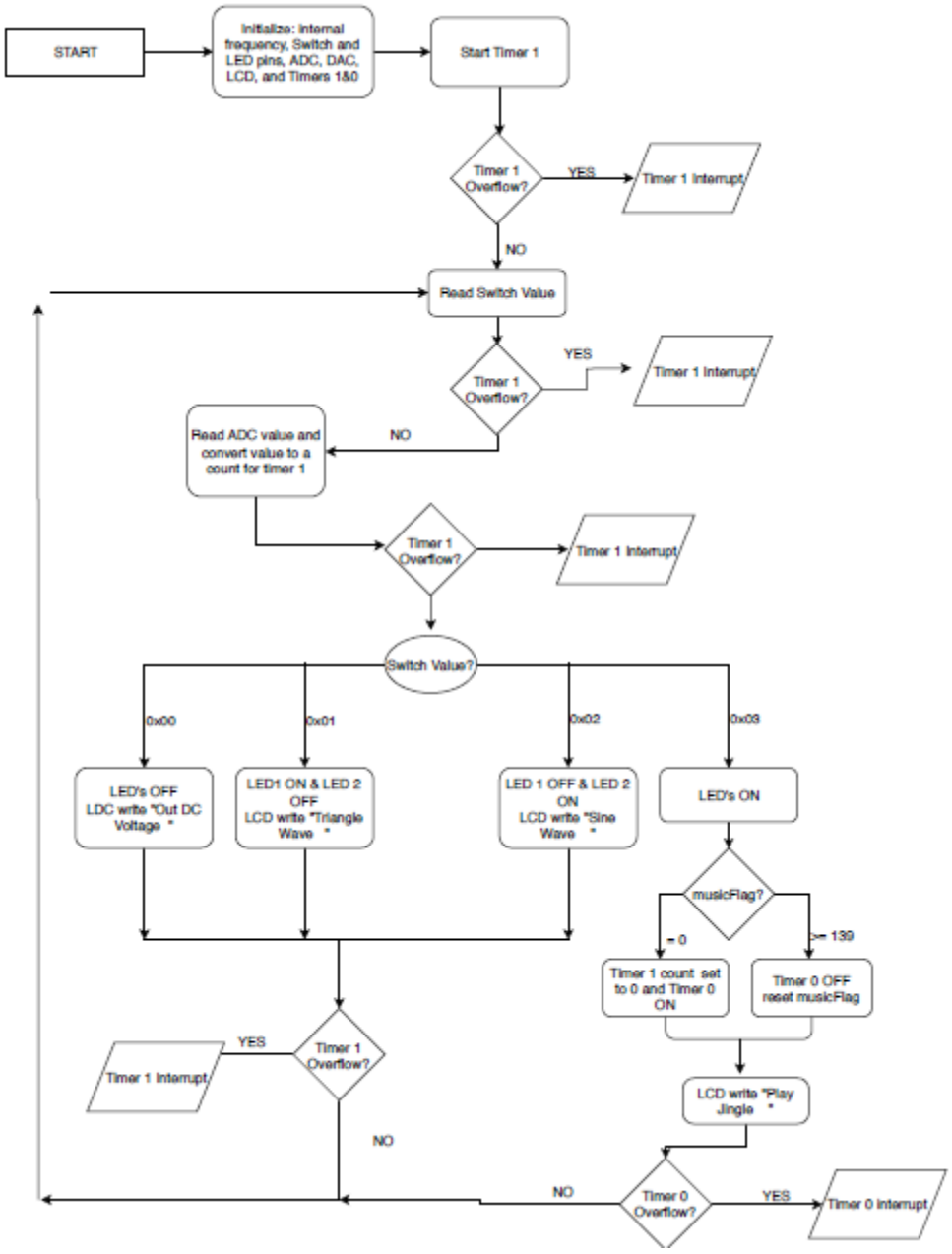
The two pushbutton switches will be pressed therefore both LED's will be turned on. The analog output will be 7 notes (A4, B4, C5, D5, E5, F5, and G5) played in a row with each note having 20 periods each. The LCD will display "Play Jingle."

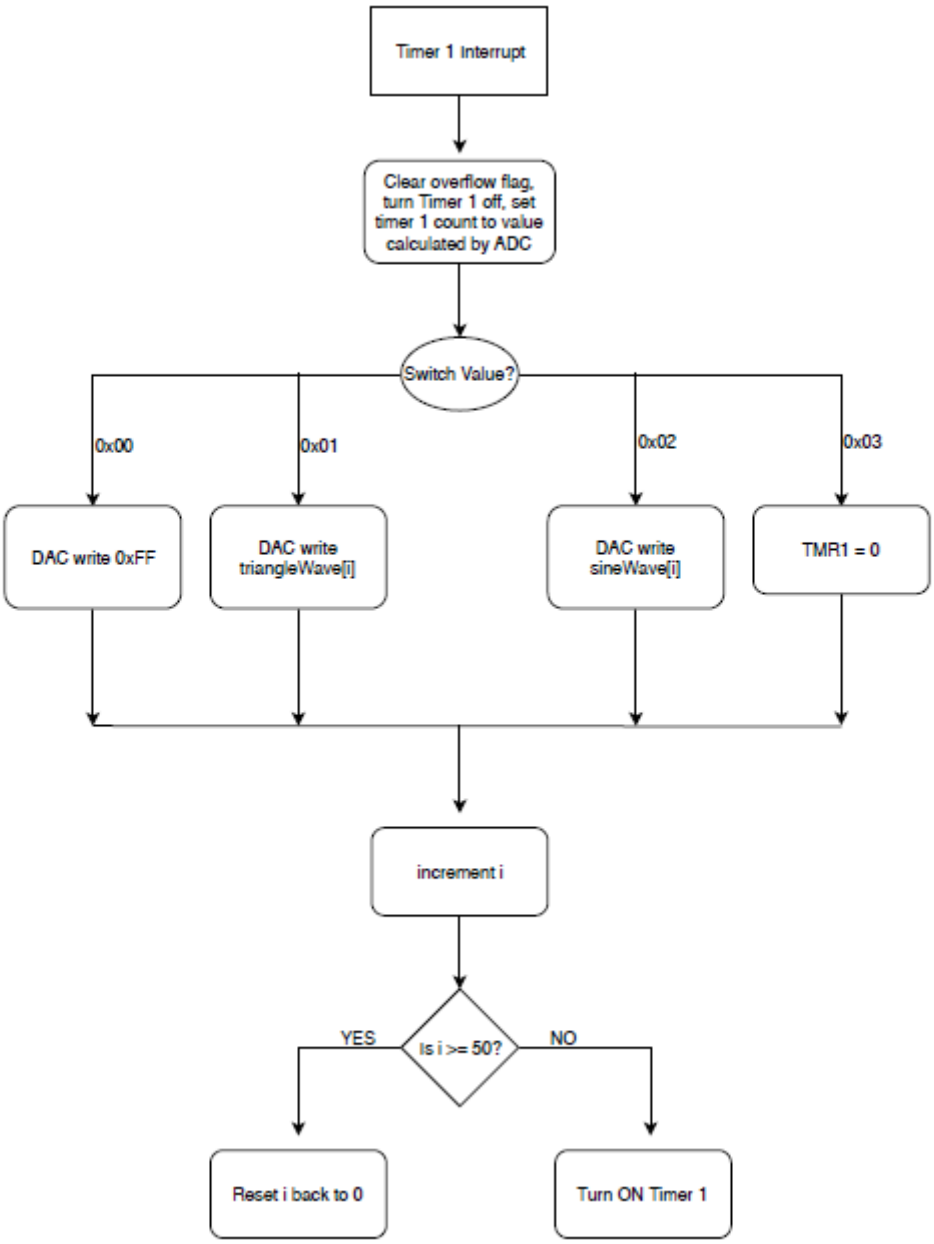
The potentiometer is connected to the ADC pin on the microcontroller to input a voltage range from 0 to 5 V. These voltage values correspond to the 500 to 1000 Hz output of the triangle and sine waves. The output of the microcontroller is sent to the DAC chip via SPI interface where the analog output from the DAC is then interfaced with an amplifier circuit with a gain of 20 db. This output is then fed through the speaker which will make the noise for the observer to hear. The volume of the speaker is controlled by another potentiometer connected to the output of the DAC chip.

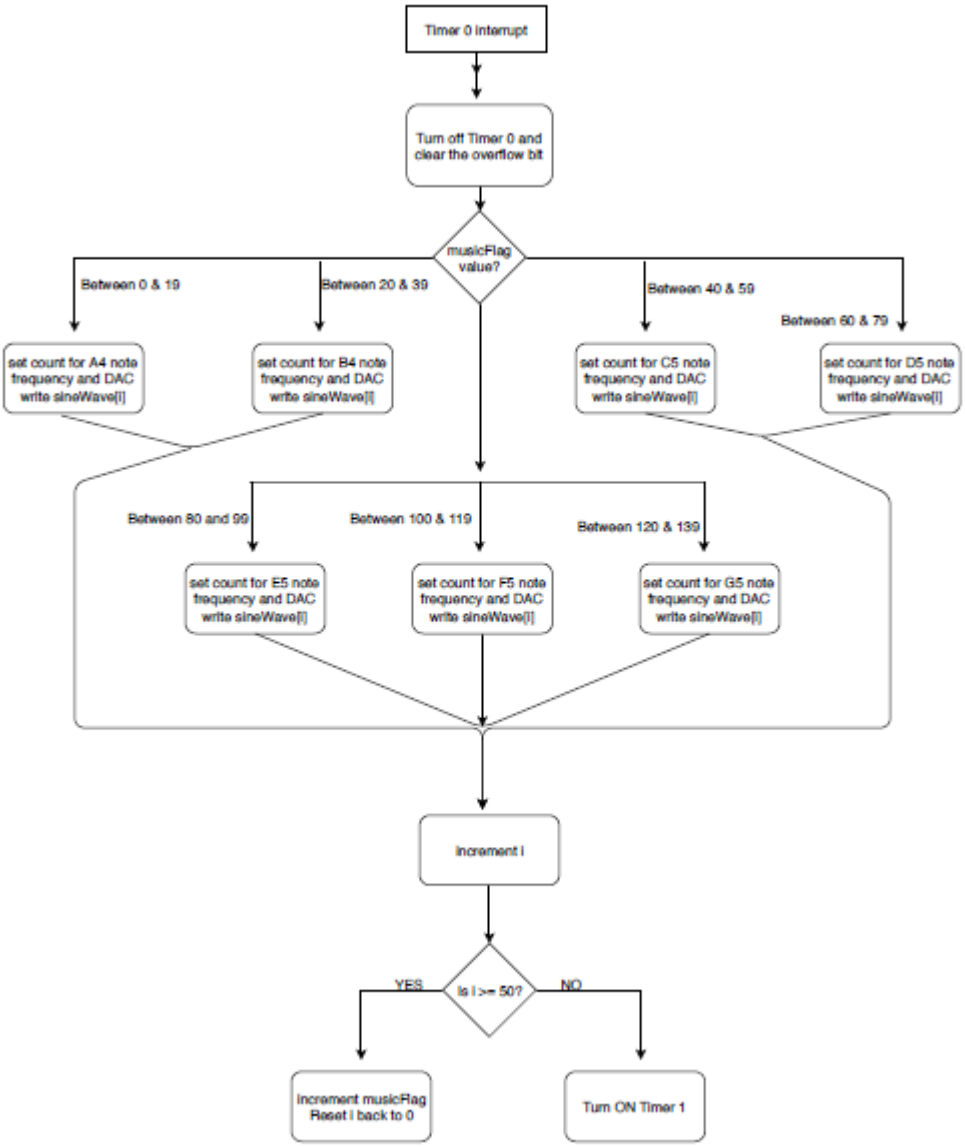
LCD interface:

The LCD driver function is written so that the system knows which of the four analog outputs is happening in the system.

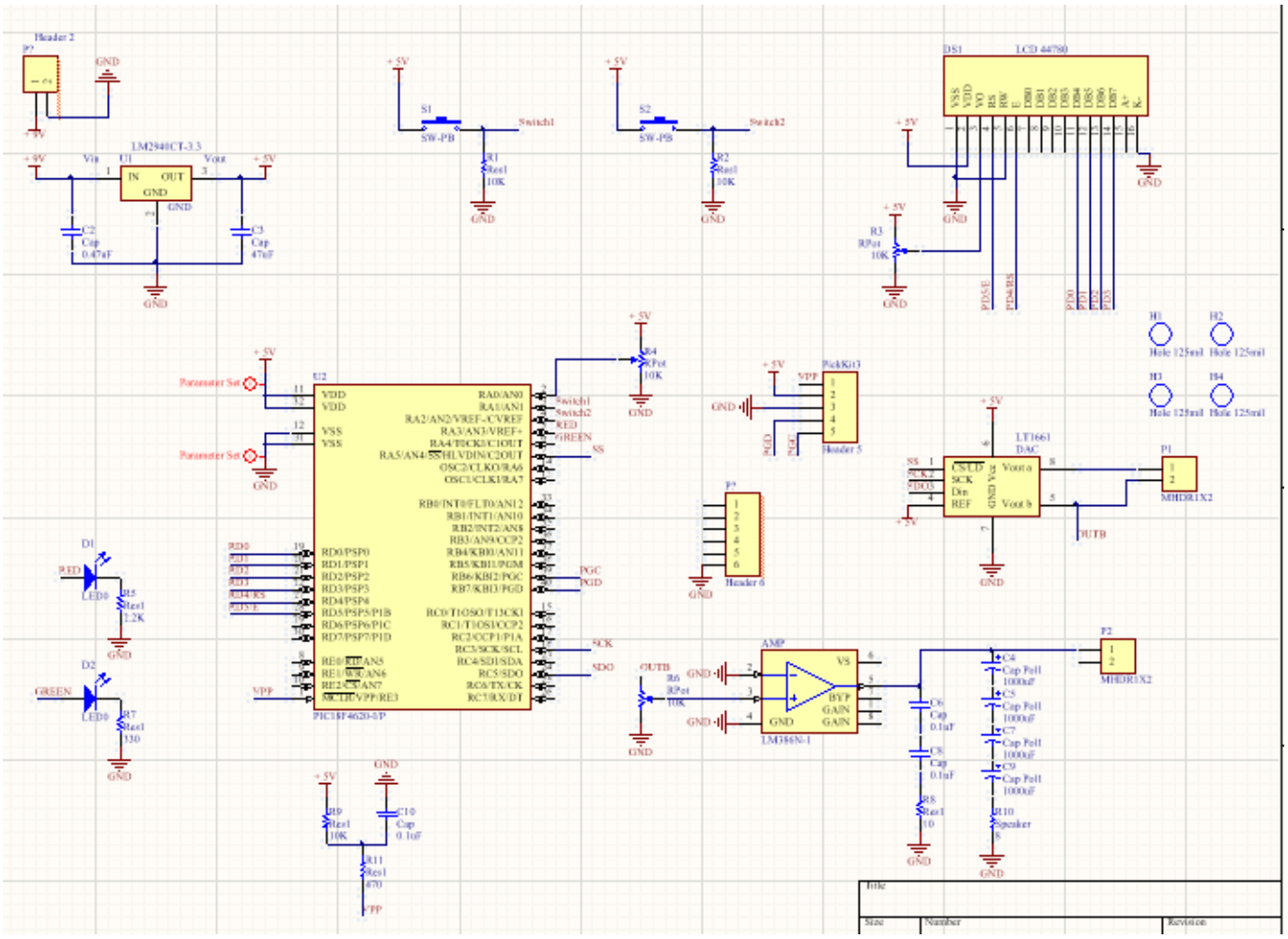
Software Code Flow Charts:



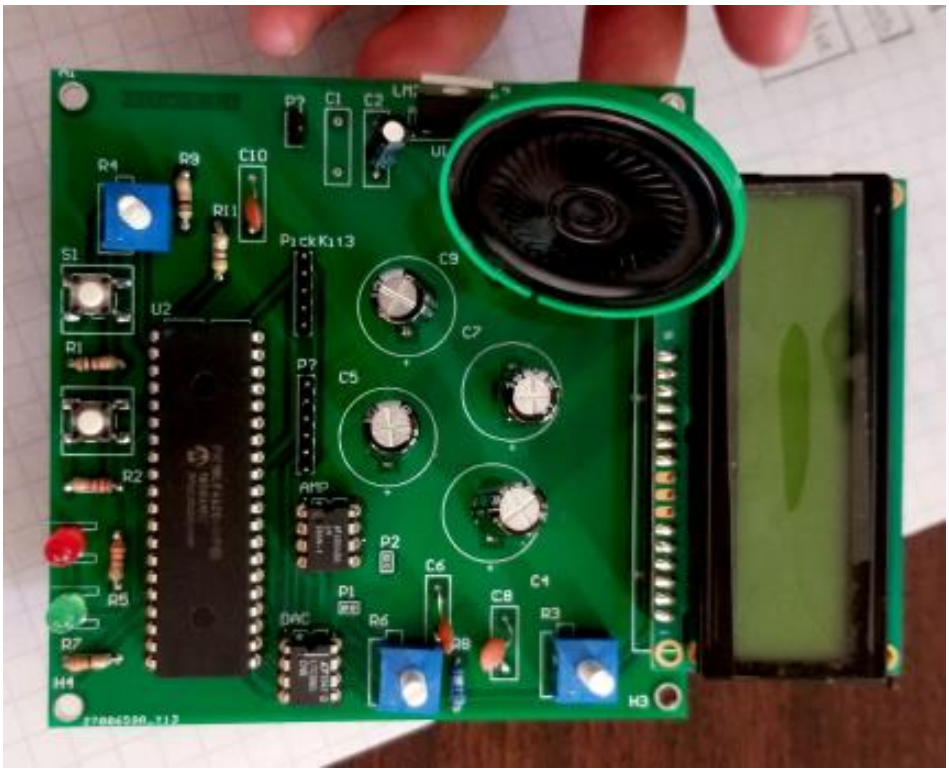

Timer 1 Interrupt
Clear overflow flag, turn Timer 1 off, set timer 1 count to value calculated by ADC
Switch Value?
0x00
0x01
0x02
0x03
DAC write 0xFF
DAC write triangleWave[i]
DAC write sineWave[i]
TMR1 = 0
increment i
YES
Is i >= 50?
NO
Reset i back to 0
Turn ON Timer 1


Timer 0 Interrupt
Turn off Timer 0 and clear the overflow bit
musicFlag value?
Between 0 & 19
Between 20 & 39
Between 40 & 59
Between 60 & 79
set count for A4 note frequency and DAC write sineWave[i]
set count for B4 note frequency and DAC write sineWave[i]
set count for C5 note frequency and DAC write sineWave[i]
set count for D5 note frequency and DAC write sineWave[i]
Between 80 and 99
Between 100 & 119
Between 120 & 139
set count for E5 note frequency and DAC write sineWave[i]
set count for F5 note frequency and DAC write sineWave[i]
set count for G5 note frequency and DAC write sineWave[i]
increment i
YES
Is i >= 50?
NO
Increment musicFlag
Reset i back to 0
Turn ON Timer 1

Altium Design:



Final product of the design:



Bill of Materials:

Design 1 - Final Project - Bill of Materials				
Description	Quantity	Price/Part	Part Number	Source
16x2 Parallel Character LCD	1	$ 12.16	CFAH1602Z-YYH-ET	digikey
IC MCU 8BIT 64KB FLASH 40DIP	1	$ 5.62000	PIC18LF4620-I/P-ND	
IC DAC 10BIT V-OUT 8DIP	1	$ 4.00000	LTC1661CN8#PBF-ND	
Capacitor- 47uF -Electrolytic Capacitor	1	$ 0.99000	2721027	
Capacitor- 1000uF-Electrolytic Capacitor	4	$ 1.11	667-EEU-FP1E102	
LM2940 Regulator	1	$ 2.00	LM2940IMP-5.0/NOPBCT-ND	
RES 10 OHM 2W 5% AXIAL	1	$ 0.12880	FW20A10R0JATB-ND	0
CAP CER 0.1UF 50V X7R RADIAL	3	$ 0.03240	SR215C104KAT-ND	

CAP ALUM 0.47UF 20% 50V RADIAL	1	$ 0.04874	493-5923-3-ND
POT 10K OHM 1/4W PLASTIC LINEAR	3	$ 2.90000	3310Y-001-103L-ND
LED GREEN DIFFUSED T-1 3/4 T/H	1	$ 0.36000	160-1130-ND
LED RED DIFFUSED T-1 3/4 T/H	1	$ 0.36000	160-1132-ND
SWITCH PUSHBUTTON	2	$ 0.28661	PS12F91AF3.3NS-ND
SPEAKER 8OHM 250MW TOP PORT 86DB	1	$ 1.26000	458-1130-ND
IC AMP AUDIO PWR .325W MONO 8DIP	1	$ 1.17000	296-44414-5-ND
RES 10K OHM 1/4W 5% AXIAL	1	$ 0.00475	CF14JT10K0TR-ND
RES 470 OHM 1/4W 5% AXIAL	1	$ 0.004750	CF14JT470RTR-ND
RES 1K OHM 1/4W 5% AXIAL	4	$ 0.00475	CF14JT1K00TR-ND

	$
Total:	32.44

Conclusion

The design worked exactly as it should have been with only a few errors that occurred in the Altium design that were easily fixed.

Issue 1:

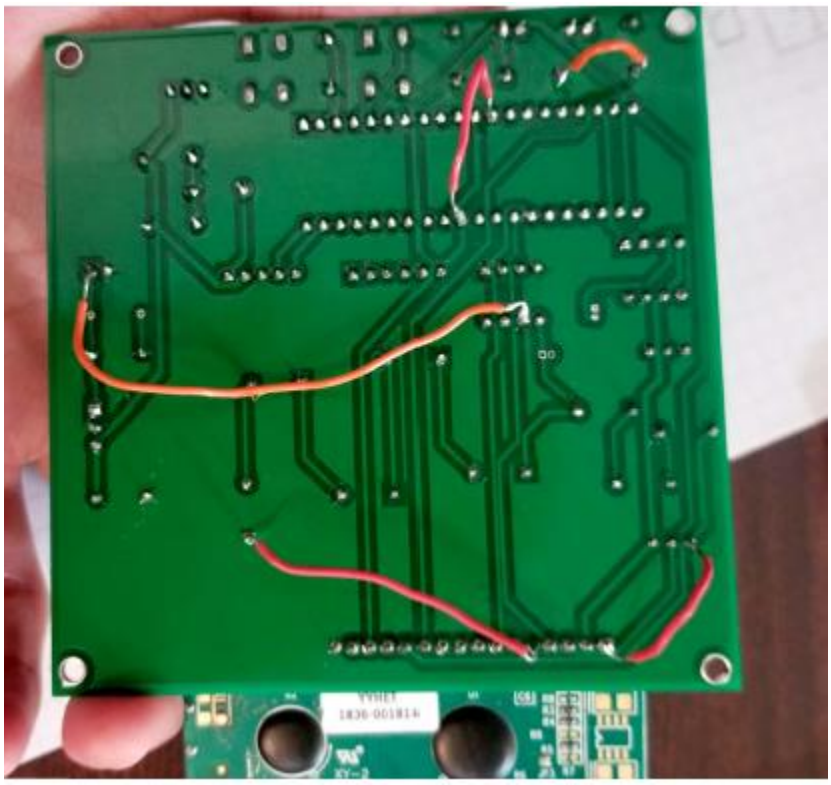
I forgot to use a netlabel for pin 6 of the LM386, thus the chip didn't have a power source. I fixed it but connect a wire on the back of the PCB to the 9V input.

Issue 2:

I was initially going to use the backlight of the LCD but forgot to connect a resistor from pin 16 to ground on the LCD. I fixed this issue by using an X-ACTO knife to cut the 5 V connection to pin 15. This will prevent an overcurrent from happening if left untouched.

Issue 3:

When designing the PCB on Altium I did the mistake of using auto route for the pins, which caused several of my ground pins to not be connected throughout the board. I fixed this issue by soldering wires to ground on the back of the PCB.



This figure shows the wires used to connect all the pins to ground.