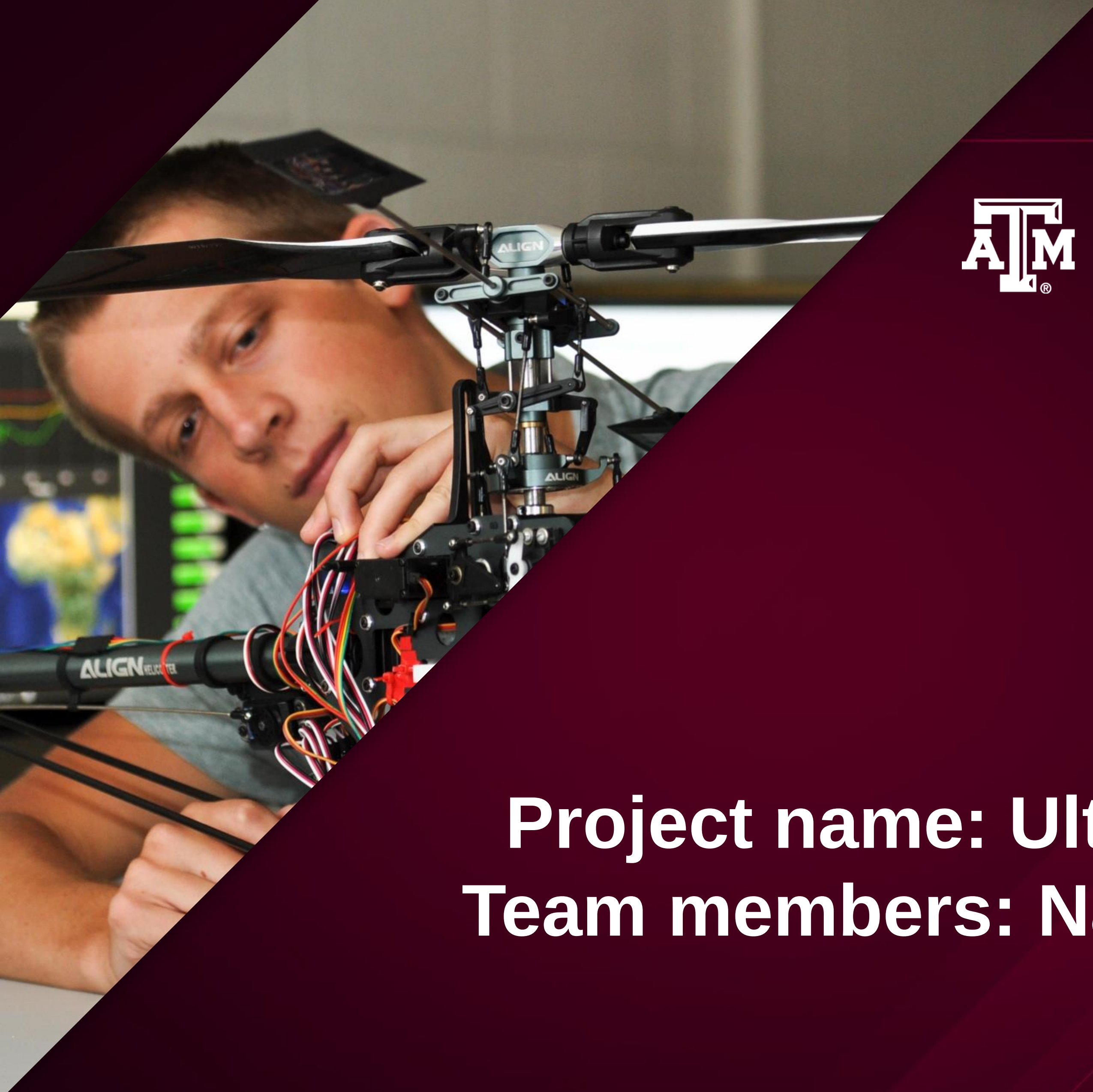

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ENGINEERING
TEXAS A&M UNIVERSITY

Project name: Ultrasonic Radio

Team members: Nathan Cinocca
Jacob Ralls

Project description

Problem statement:

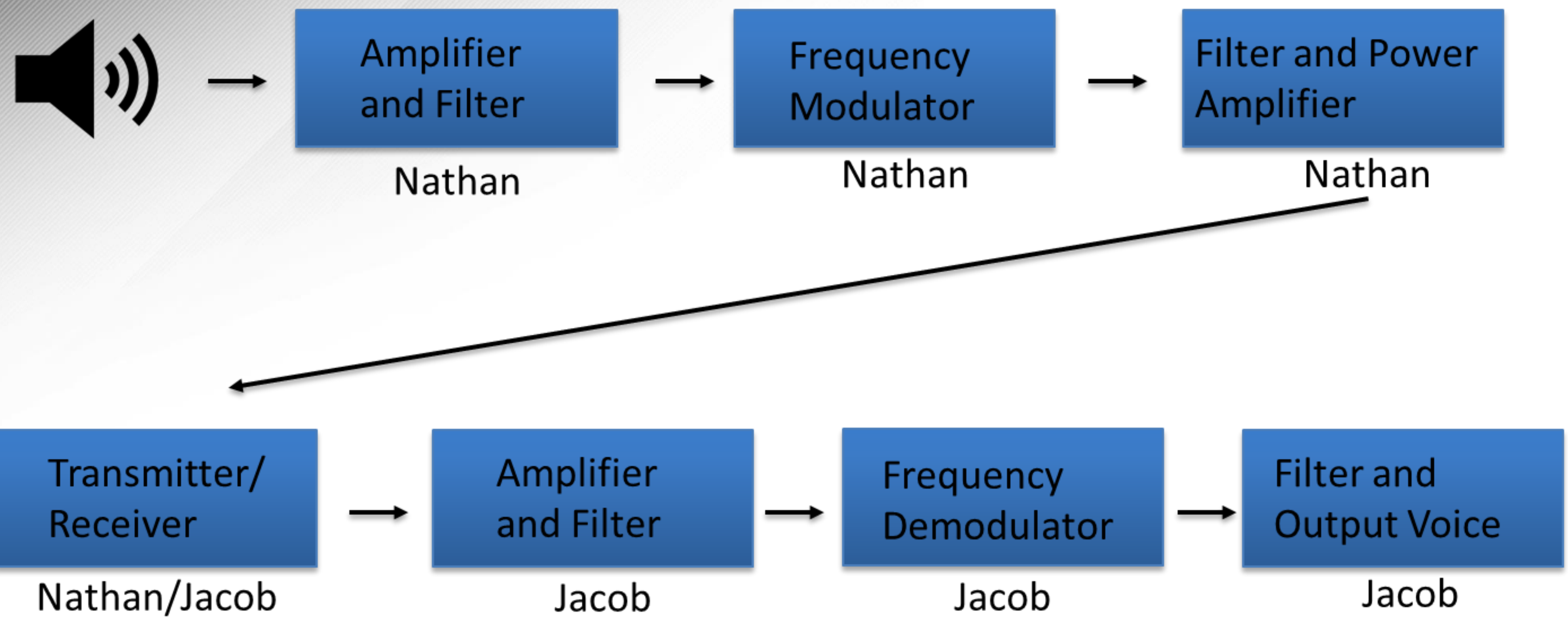
- Communicating information is very important in almost every military operation. However, sometimes sending information through traditional methods is not feasible.
- For example, electromagnetic waves can interfere with airplane or submarine equipment which can cause accidents.

Project description

Solution proposal:

- A solution to this issue is to develop an acoustic ultrasonic radio.
  - Acoustic waves and lower frequencies will limit electromagnetic radiation
- This radio will allow for two-way communications over relatively short distances.
- Communication will be slower than devices using electromagnetic waves

System Breakdown



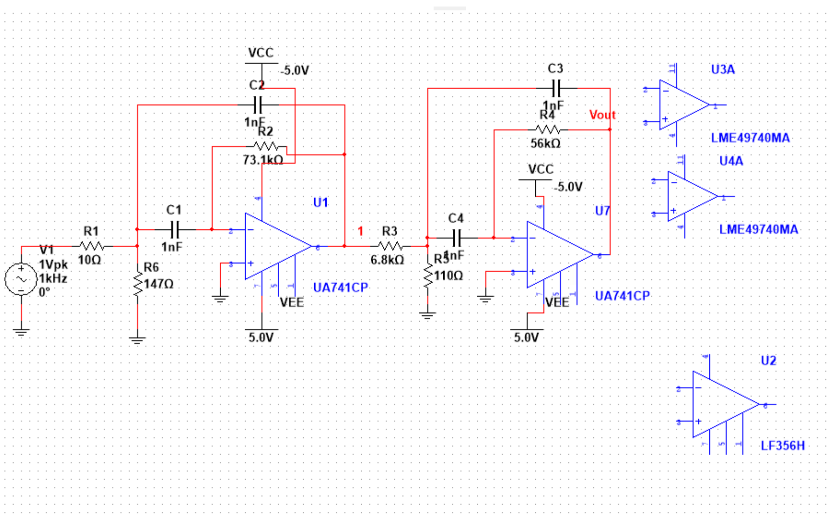
The ultrasonic radio's input microphone covers human voice frequencies (100 Hz to 3 kHz), translating voice into an electrical signal. This signal is amplified and filtered to enhance its quality and eliminate unwanted noise. Next, it's modulated to ultrasonic frequencies for transmission, with optional additional filtering. The modulated signal goes through a power amplifier to achieve the required gain, then travels to the receiving microphone, where it's filtered and amplified for demodulation. After demodulation, it's filtered and output through a speaker within the human hearing range.

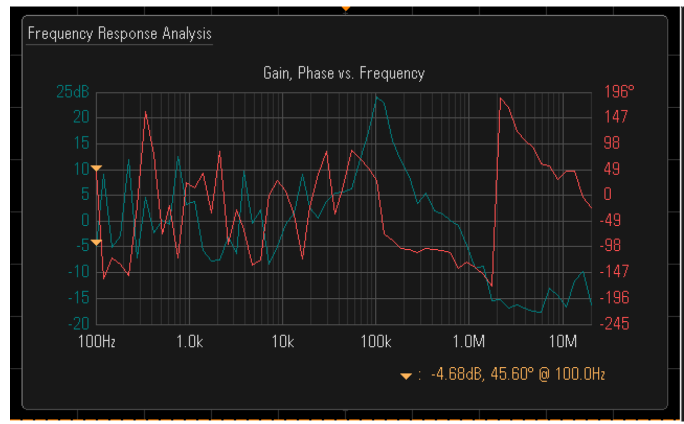
Signal Amplifier and High Frequency Filter

Jacob Ralls

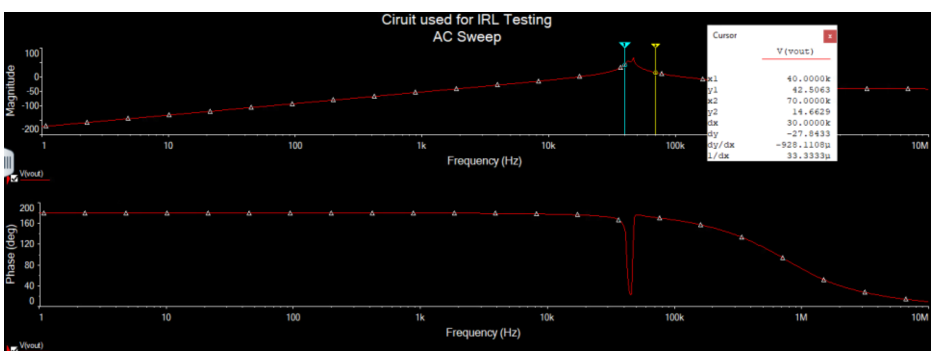
Overall Accomplishments

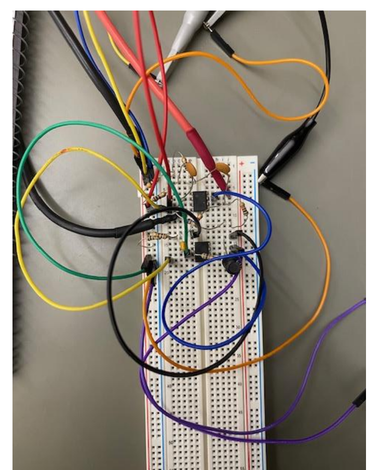
- Designed and Simulated 4th Order Chebyshev Bandpass Filter through Multisim
- Tested the constructed Bandpass Filter on a Breadboard
- Moved design to Altium Design
- From here created and ordered the Bandpass Filter PCB
- All parts have been ordered and shipped





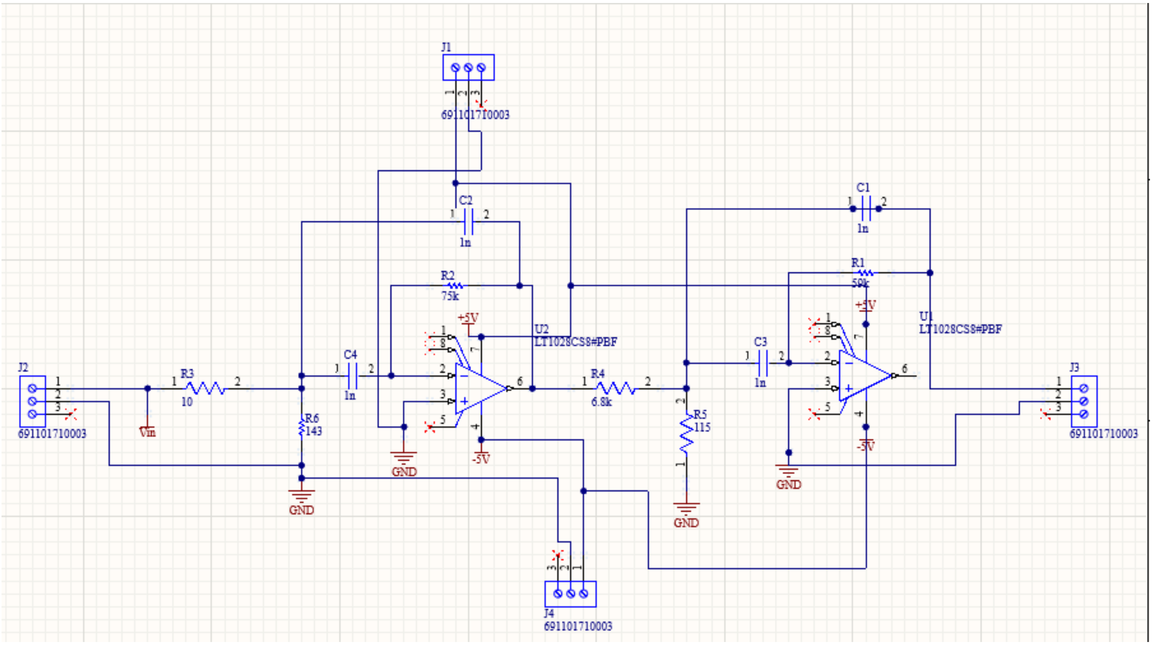
Freq	Gain
36.49k	5.65
44.72k	5.75
54.81k	6.41
67.18k	12.1
82.33k	17.39
100.9k	24.32
123.7k	23.04
151.6k	15.72
185.8k	11.86
227.7k	8.91
279.0k	3.62

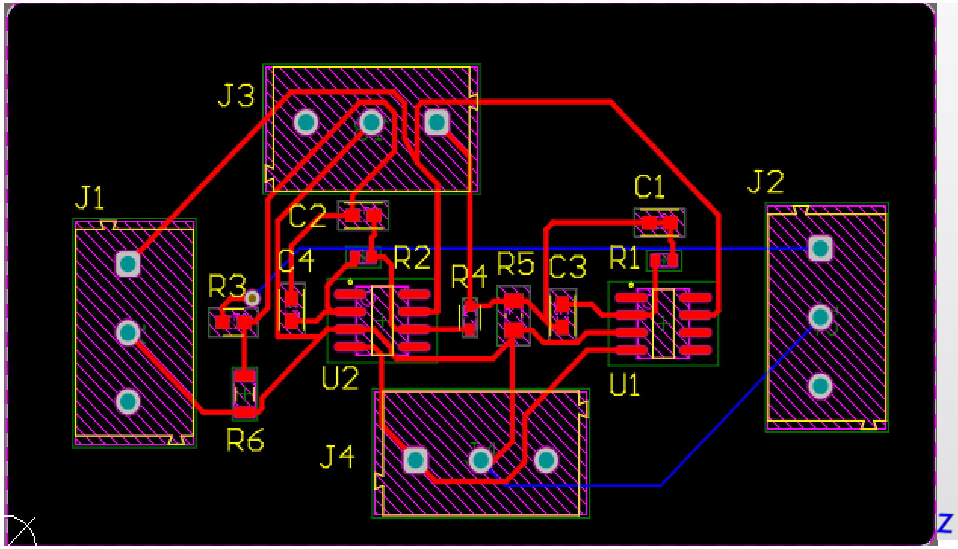


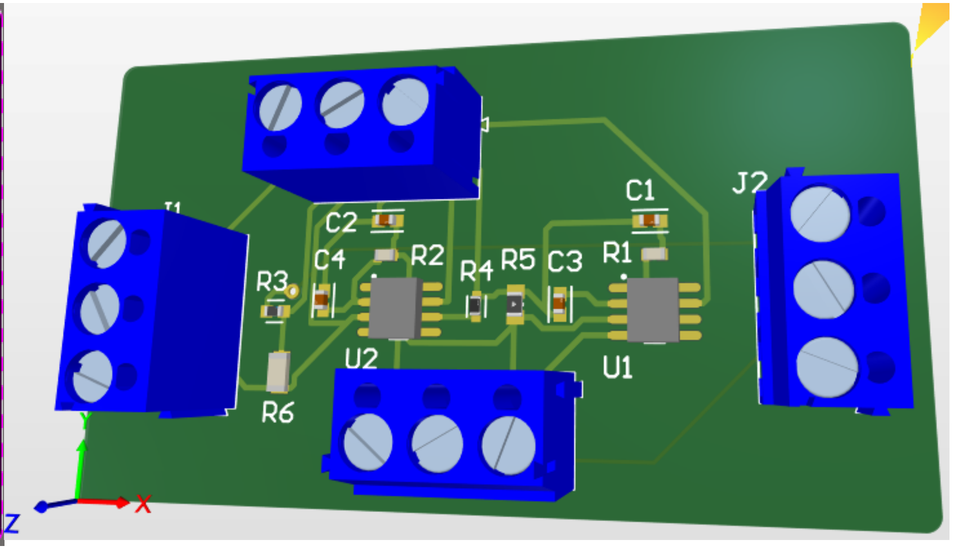


Signal Amplifier and High Frequency Filter

Jacob Ralls

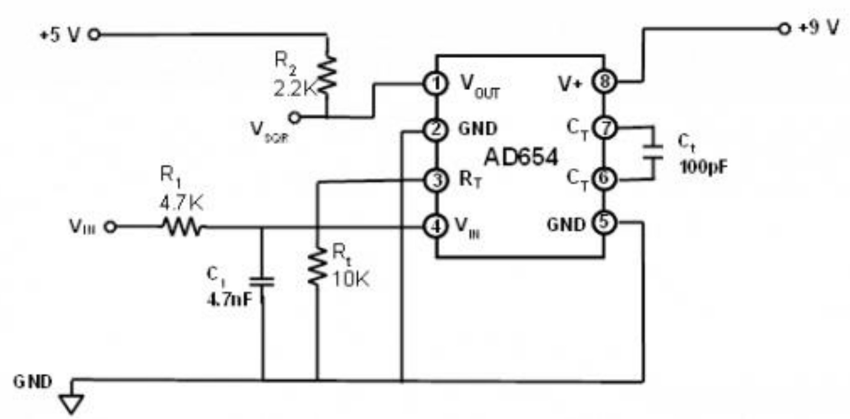


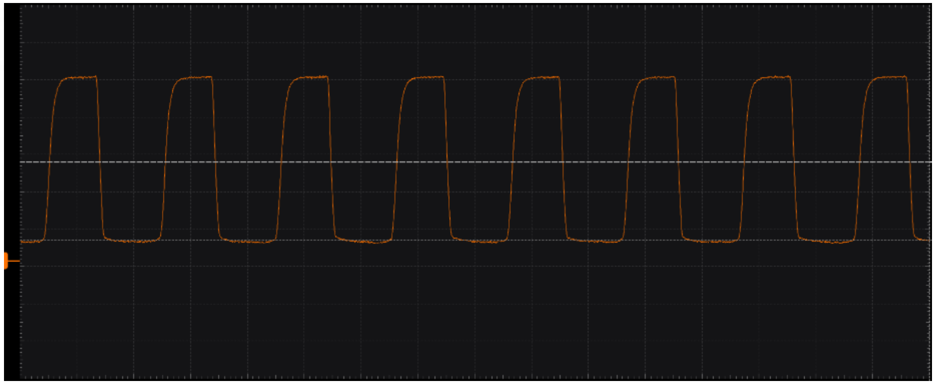


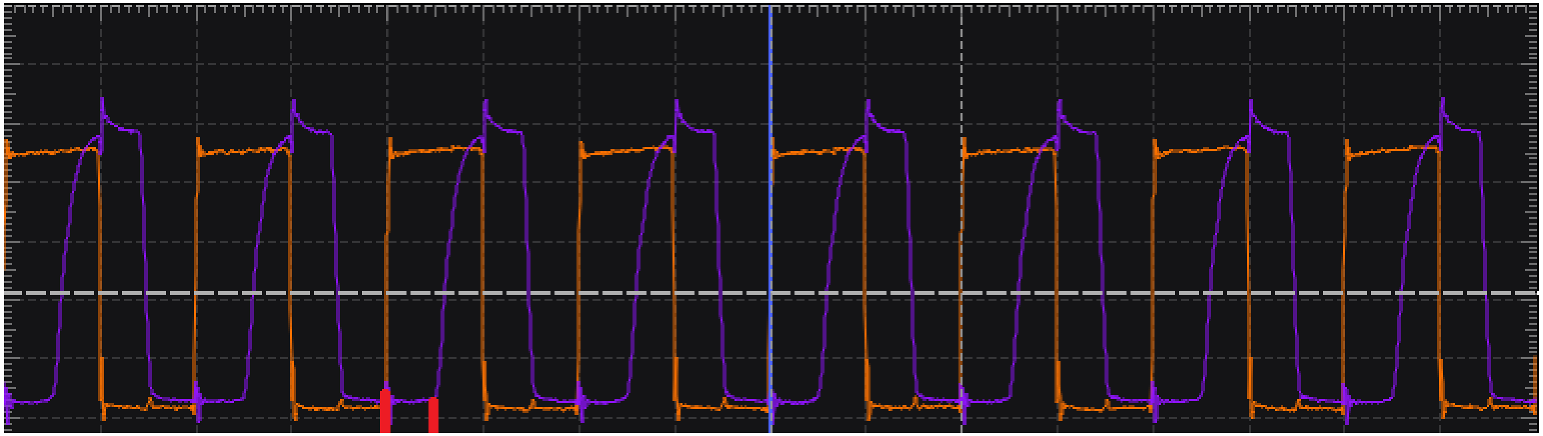


Demodulator
Jacob Ralls

Overall Accomplishments	
• Designed and Simulated Demodulator using a Phase Locked Loop (First Isolated the Voltage to Frequency Converter then looked at complete PLL Design)	• Moved design to Altium Design • From here created and ordered the Bandpass Filter PCB • All parts have been ordered and shipped

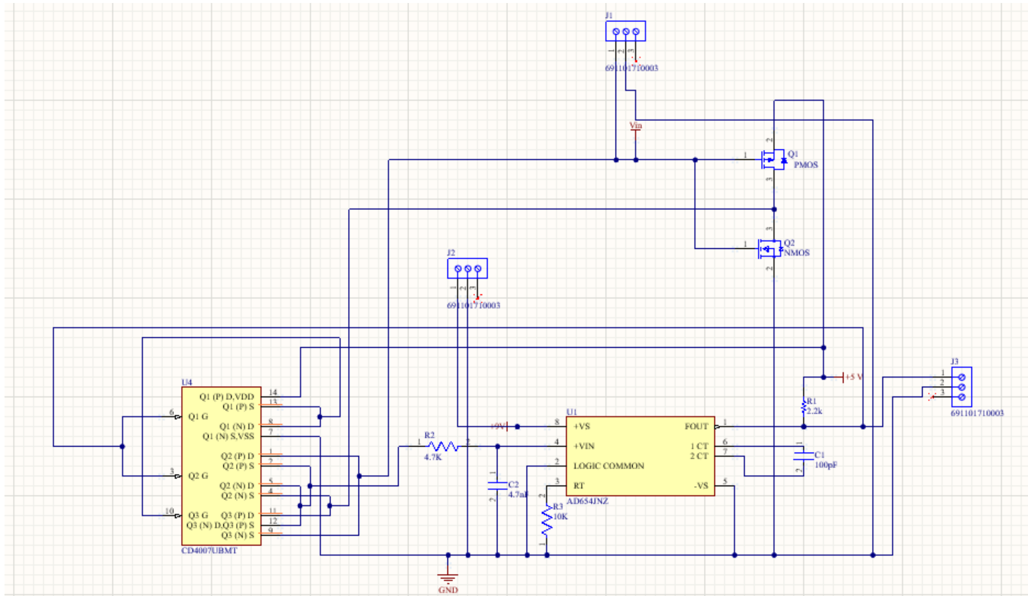


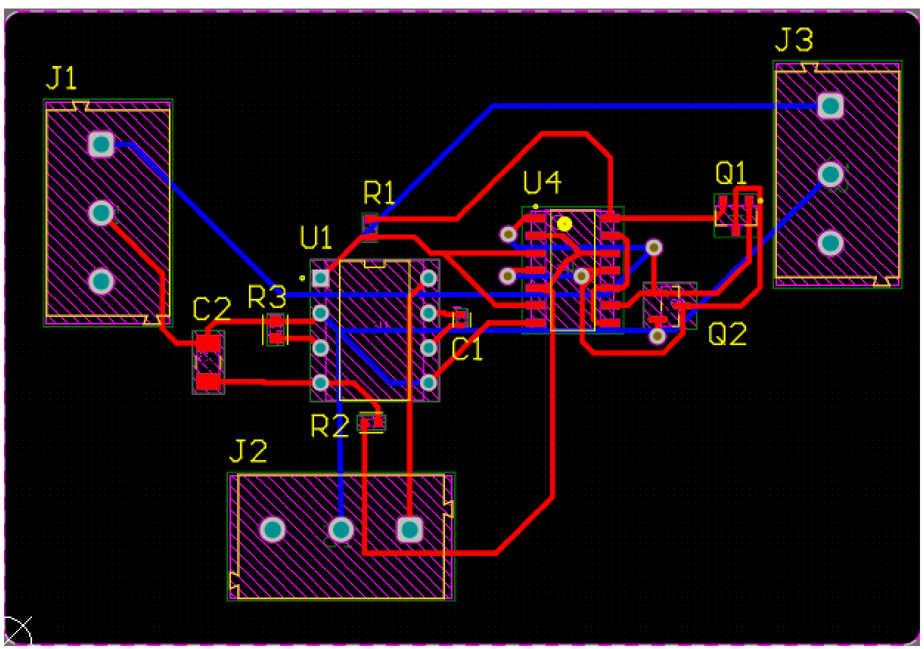


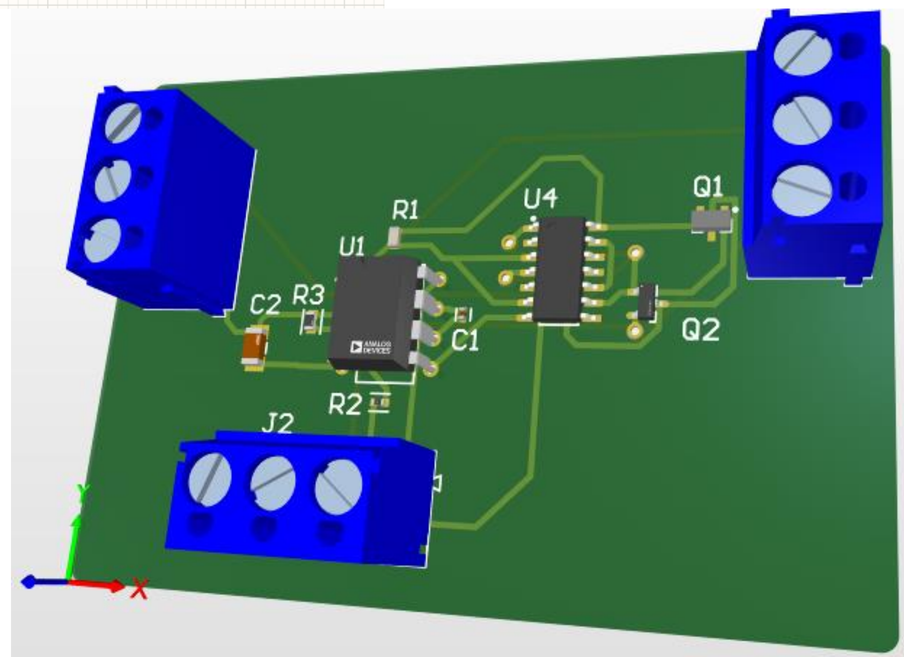


Demodulator

Jacob Ralls



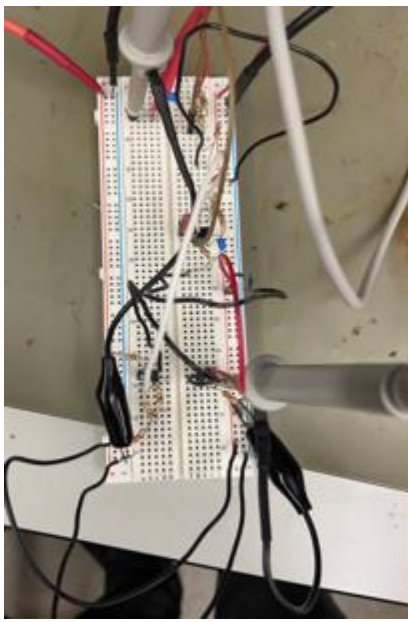


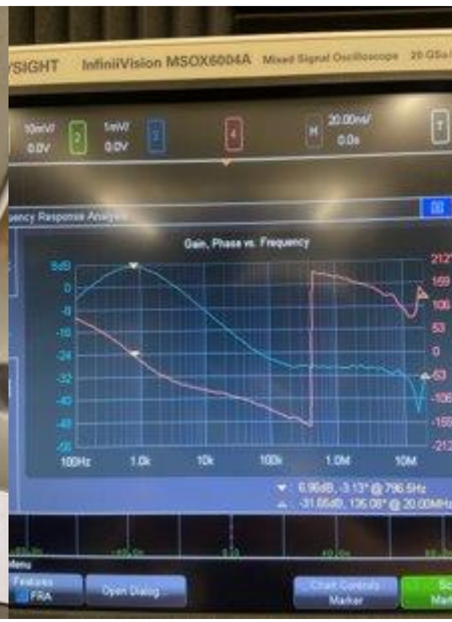


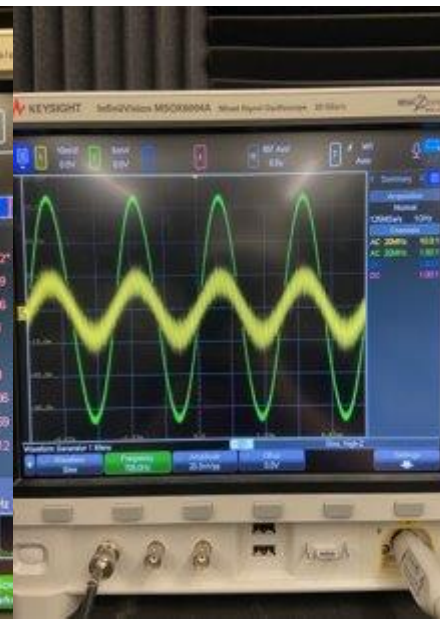
Signal Amplifier and Filter

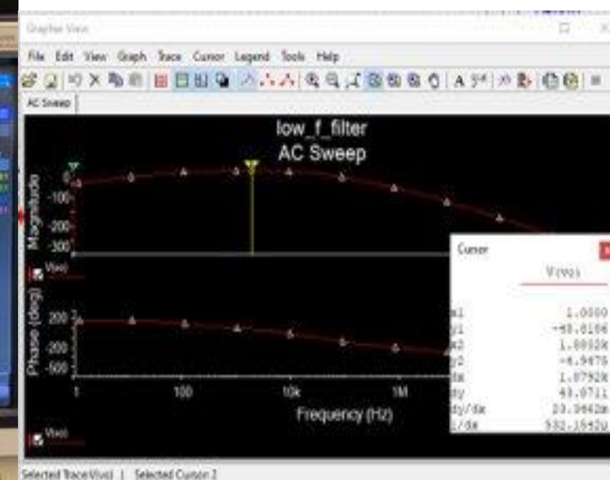
Nathan Cinocca

Overall Accomplishments	
• Designed and Simulated Low Frequency Filter through Multisim • Designed and Simulated Signal Amplifier through Multisim • Tested Signal Amplifier	• Moved design to Altium Design • Created PCB for both the signal amplifier and the filter

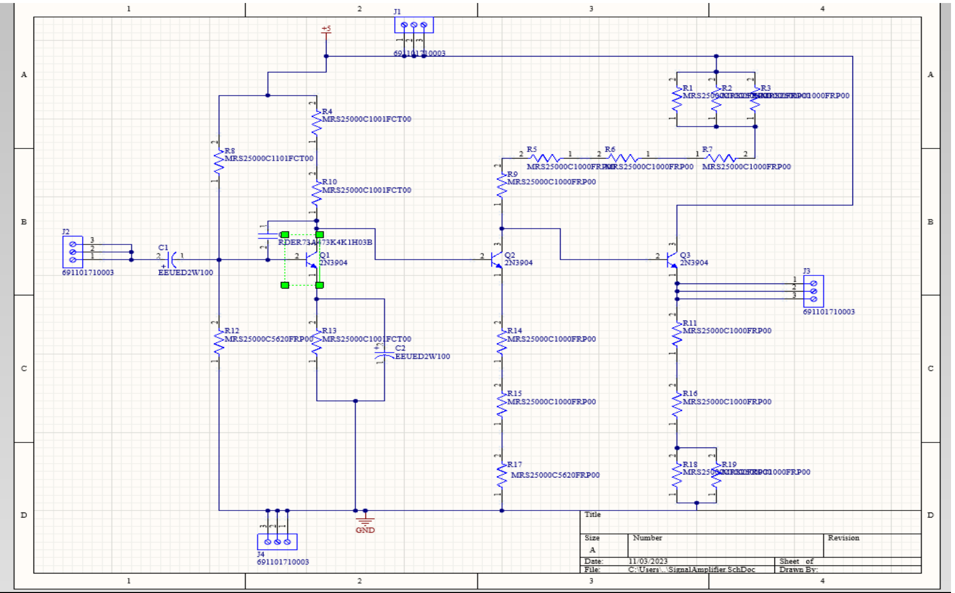


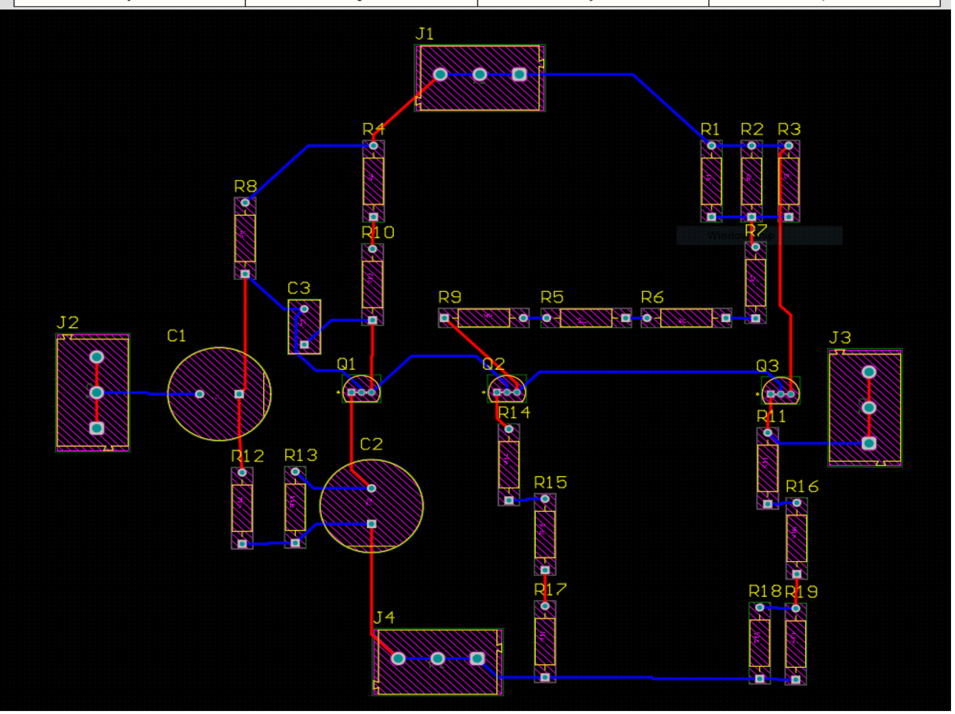




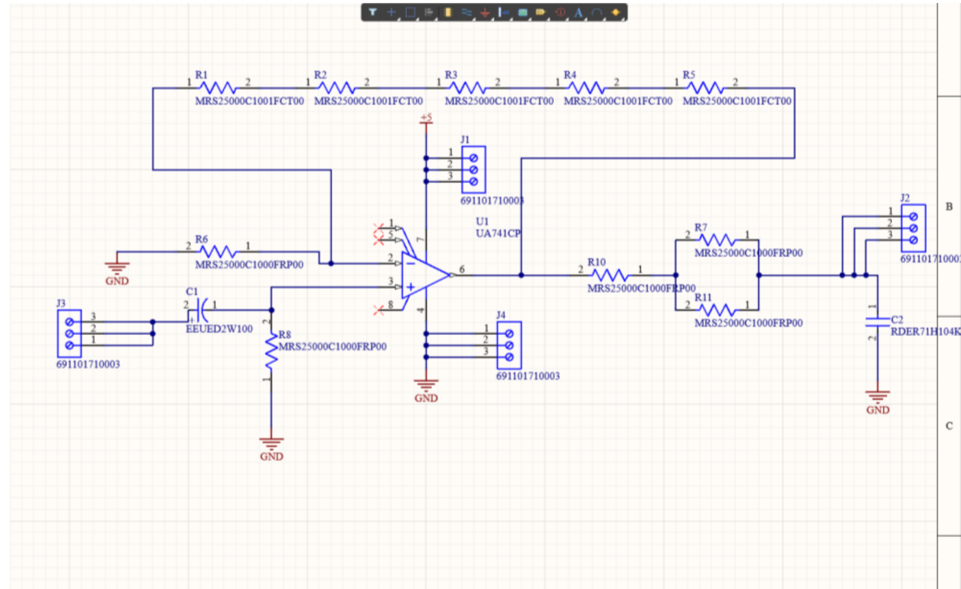


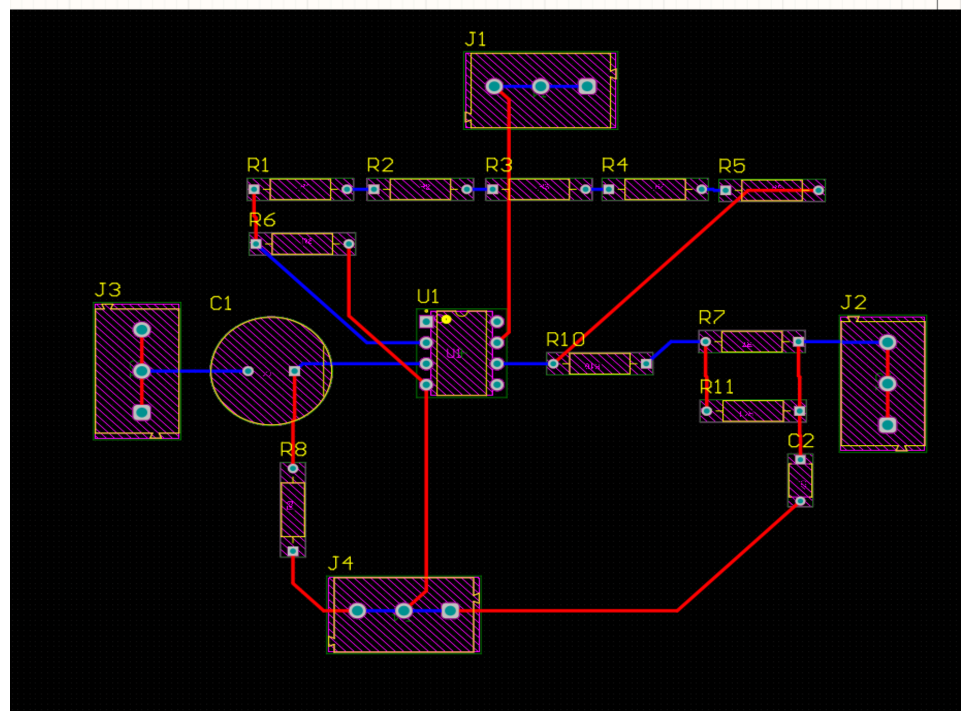
Signal Amplifier





Filter

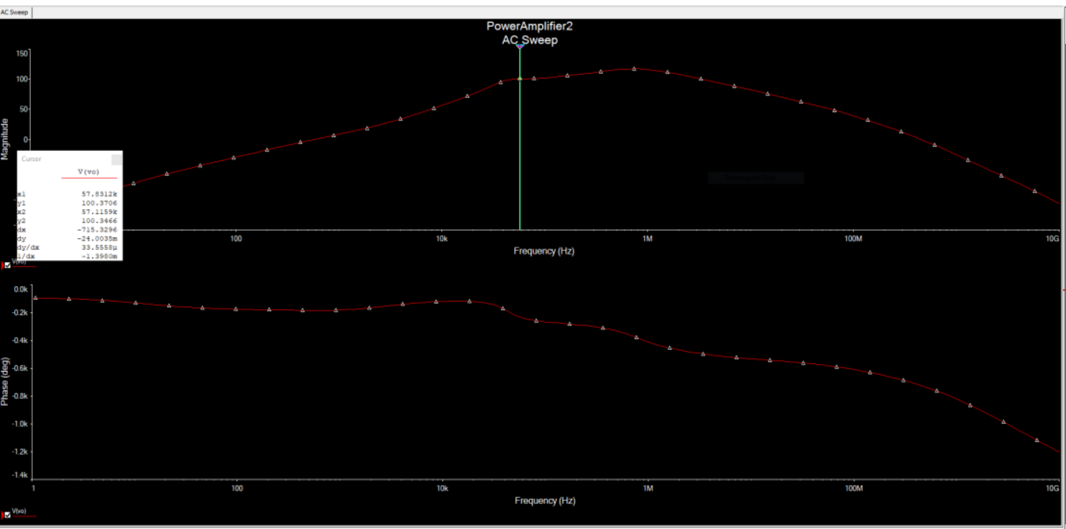


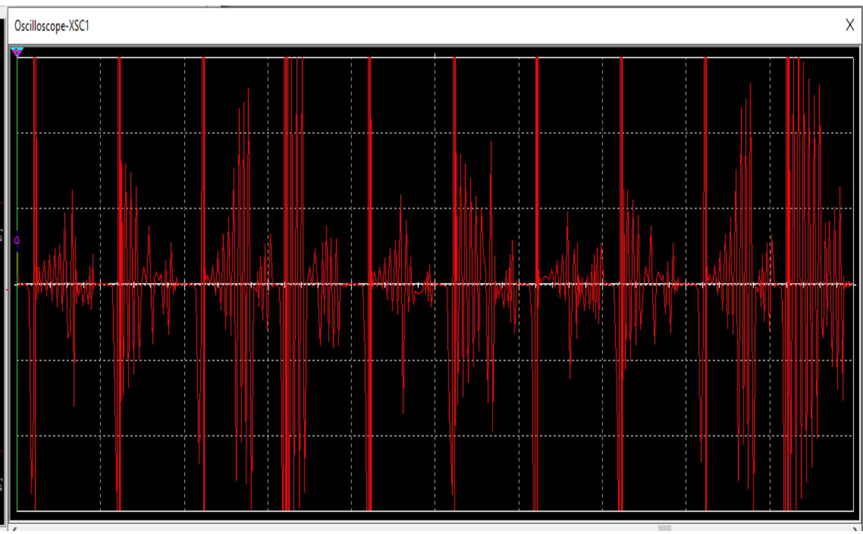


Power Amplifier and Modulator

Nathan Cinocca

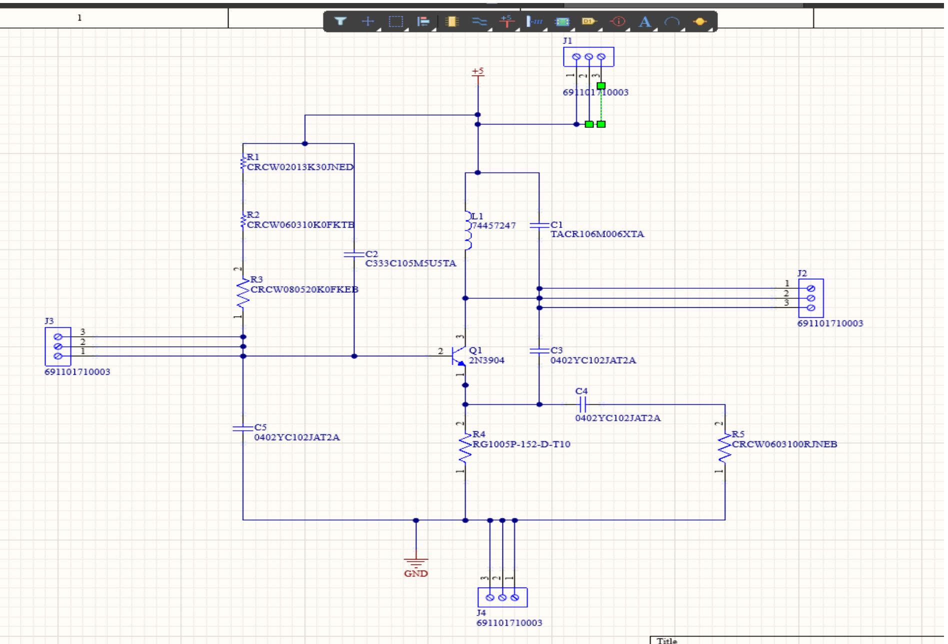
Overall Accomplishments	
• Designed and Simulated Power Amplifier through Multisim • Designed and Frequency Modulator through Multisim	• Moved design to Altium Design • Created PCB for both the power amplifier and the frequency modulator

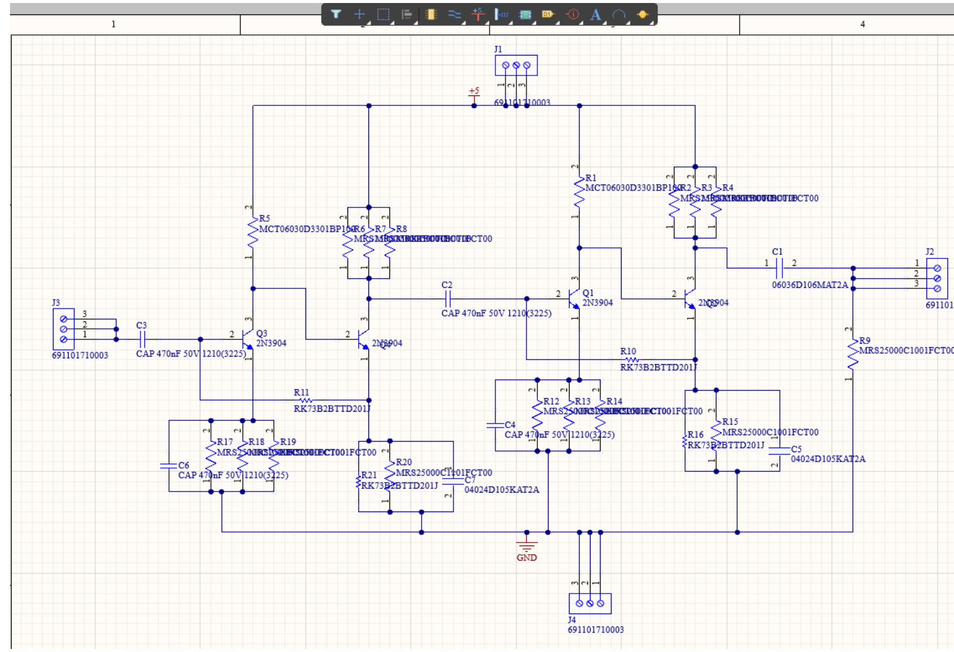


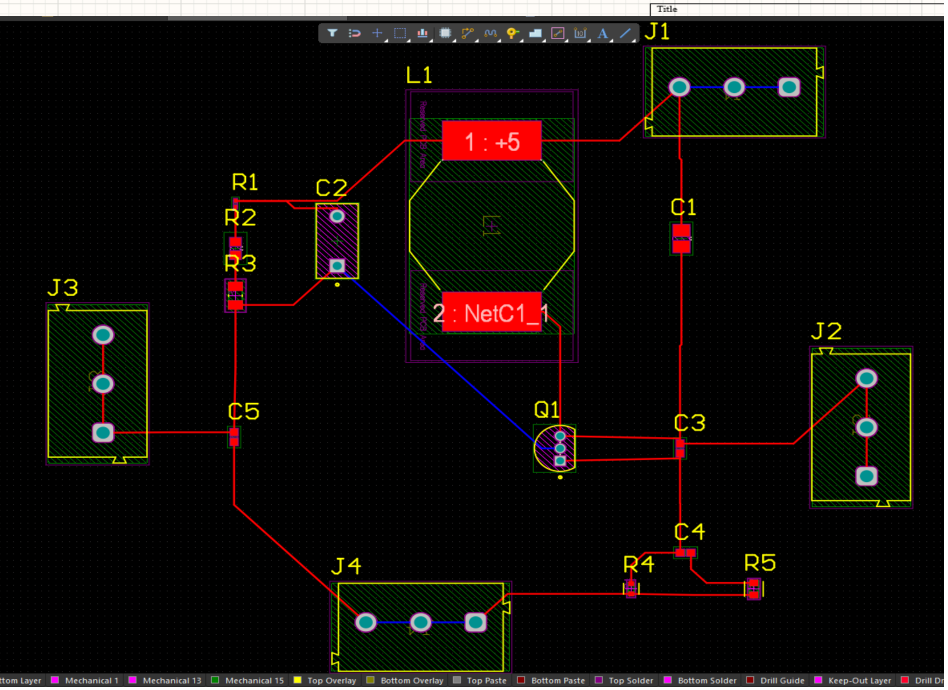


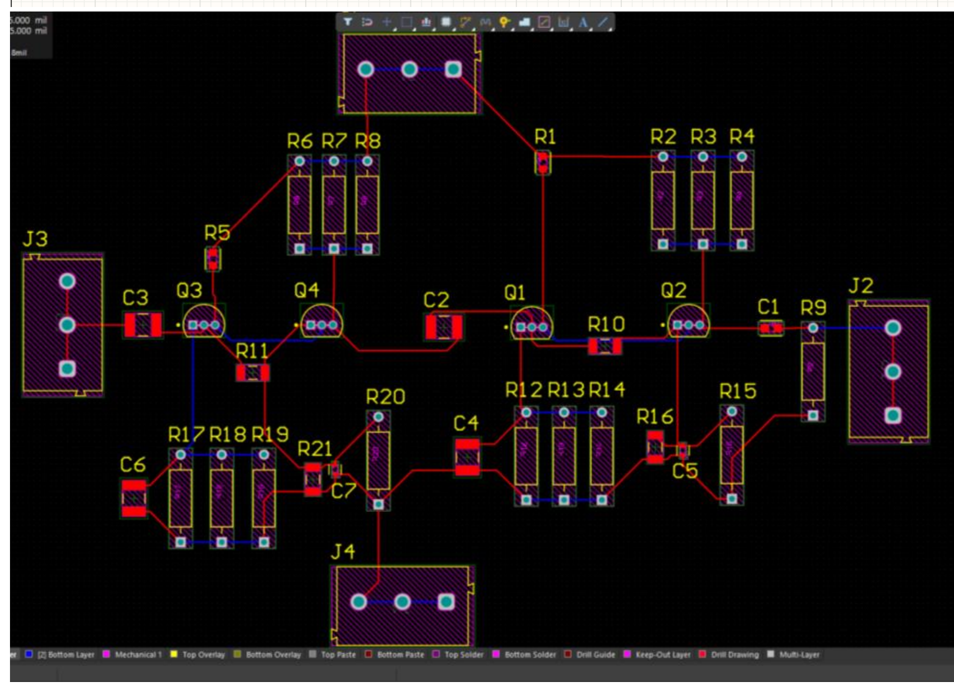
Frequency Modulator

Power Amplifier









Remaining Tasks – Jacob Ralls

- PCBs need to be delivered
- Solder all components onto the PCBs
- Test circuits using Multimeter, Oscilloscope (via transient response or AC response depending on function to be tested)
- Video Demo successful outcome

Remaining Tasks – Nathan Cinocca

- PCBs need to be ordered and delivered
- Solder all components onto the PCBs
- Test circuits using Multimeter, Oscilloscope (via transient response or AC response depending on function to be tested)
- Video Demo successful outcome

Execution Plan

	October 2nd	October 9th	October 16th	October 23th	October 30th	November 6th	November 13th	November 20th
Design and simulate signal amplifier								
Power Amplifier Research								
Modulation/demodulation Research								
Order Parts								
Filter Design								
Signal Amplifier Test								
Design and simulate modulation/demodulation								
Power Amplifier Design								
Filter Test (For Modulation)								
Filter Test (For Demodulation)								
Test modulation/demodulation								
Power Amplifier simulation and test								
Completed Altium PCB								
All PCBs soldered								
Final Testing (Filters)								
Final Testing (Modulator)								
Final Testing (Demodulator)								
Final Testing (Power Amp)								

Completed Pending Not Started Behind Schedule

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Validation Plan

Paragraph #	Test Name	Success Criteria	Methodology	Status	Responsible Engineer(s)
3.2.1.1	Signal to Noise Ratio	The transmission signal from the transmitter to the receiver should have >= 60 dB signal to noise ratio	Test gain with an oscilloscope at the output node of the receiver	UNTESTED	Full Team
3.2.1.2	Transmission Distance	The signal should be able to transmit and be received at 15 meters or more	Send the signal and measure the maximum distance with a tape measure	UNTESTED	Full Team
3.2.1.3	Total Harmonic Distortion	The output signal should have a total harmonic distortion less than or equal to 5%	Test the output total harmonic distortion at the output node of the radio with an oscilloscope	UNTESTED	Jacob Ralls
3.2.2.1	Mass	Have the entire ultrasonic radio be less than or equal to 10 kilograms	Weigh all PCBs that make up the radio on a scale	UNTESTED	Full Team
3.2.3.1.1	Power Consumption	The maximum peak power of the system shall not exceed 4.5 watts	Use multimeter to check power consumption of ultrasonic radio	UNTESTED	Full Team
3.2.3.1.2	Input Voltage Level	The input voltage level for the ultrasonic radio shall be +5 VDC	Use multimeter to check voltage levels of ultrasonic radio	UNTESTED	Full Team
3.2.3.1.3	Input Current Level	The input current for the ultrasonic radio shall not exceed 900 mA	Use multimeter to check current levels of ultrasonic radio	UNTESTED	Full Team
3.2.3.1.4	Voice Input	The ultrasonic radio shall take user voice input that operates from 100 Hz to 3 kHz	Test input microphone with different voice frequency recording within the 100 – 3kHz range	UNTESTED	Nathan Cinocca
3.2.3.2.1	Voice Output	The ultrasonic radio shall output the voice input up to 15 meters away at frequencies 100 Hz to 3 kHz	Test output speaker with different voice frequency recording within the 100 – 3kHz range	UNTESTED	Jacob Ralls
3.2.4.1	Pressure (Altitude)	The ultrasonic radio may be able to operate up to 2.5 atm of pressure	Use ultrasonic radio in a container with higher pressure	UNTESTED	Full Team
3.2.4.2	Thermal	The ultrasonic radio may be able to operate at thermal temperatures ranging from 55 degrees Fahrenheit to 95 degrees Fahrenheit	Use ultrasonic radio outside or in a temperature-controlled area such as oven	UNTESTED	Full Team
3.2.4.3	Humidity	The ultrasonic radio should be able to function in 0-95% relative humidity	Use a container with controlled humidity to test ultrasonic radio	UNTESTED	Full Team
3.2.5.1	Recovery	The Ultrasonic radio should provide a way to reset the entire system	Test reset button to see if it turns off and resets the ultrasonic radio	UNTESTED	Full Team