Illini Theremixer

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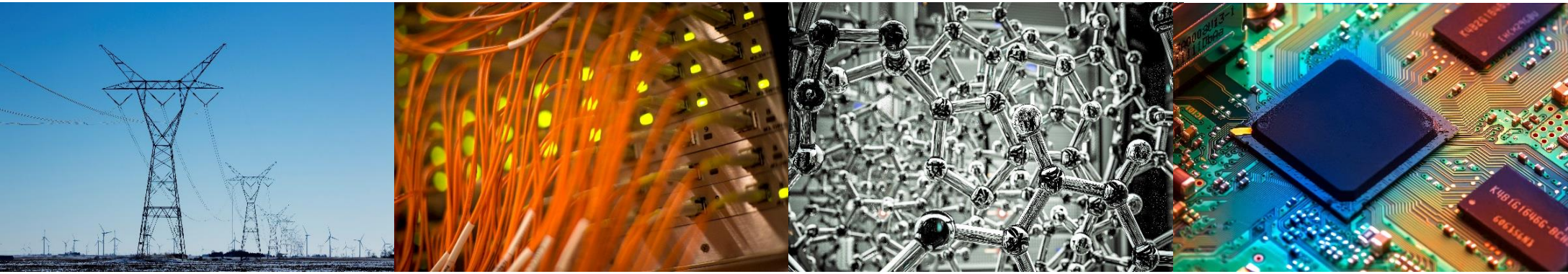
Team 15



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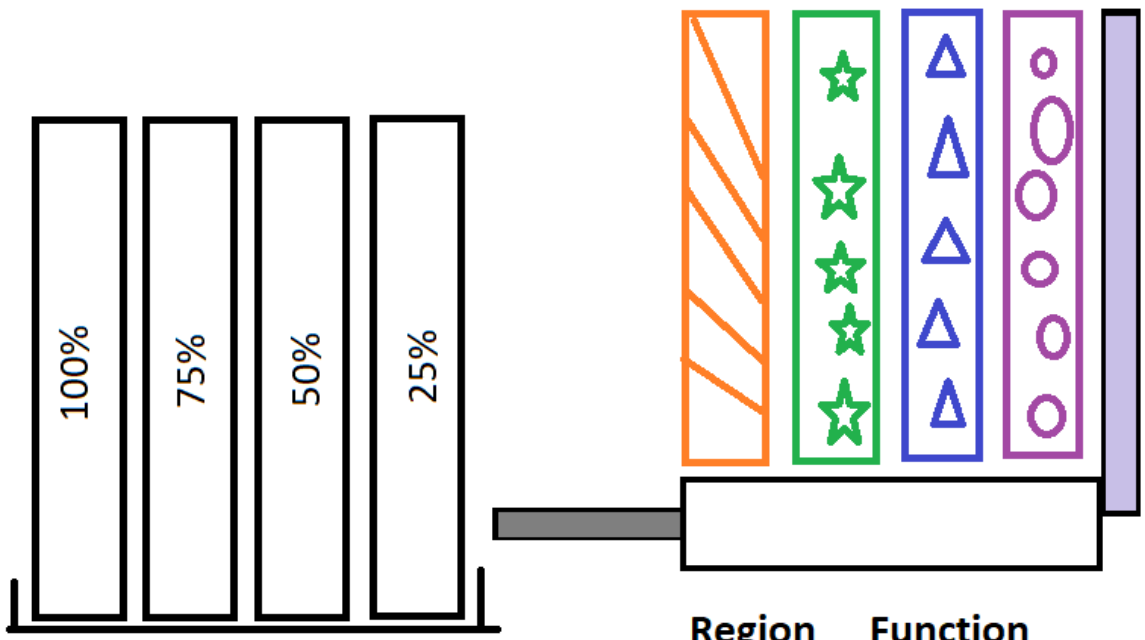
Introduction – What is a Theremin?

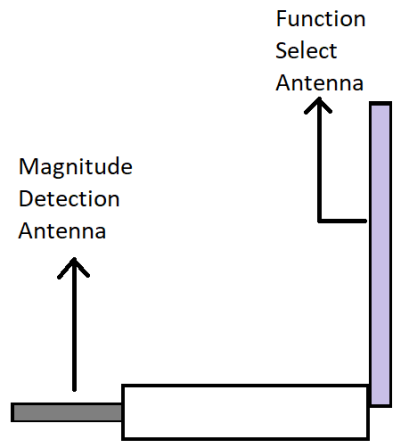
- Created by Léon Theremin in the 1920s
- Project idea: repurposed analog theremin
  - Two outputs as control signals

Objective

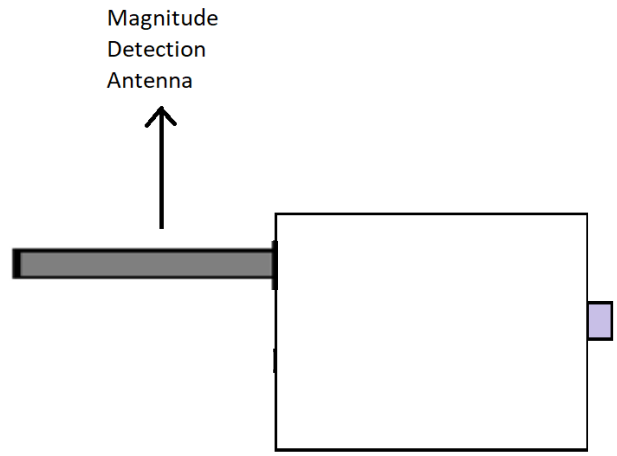
- Control Signals:
  - Frequencies from Oscillators *(Representing Relative Hand Placement)*
- Functions:
  - Increase/Decrease Bass, Mid, Treble, Volume
- Components:
  - Hardware: Etherwave Antennas & Oscillators, ADC (AD7352)
  - Software: Microcontroller (Teensy 3.2)

Design Model



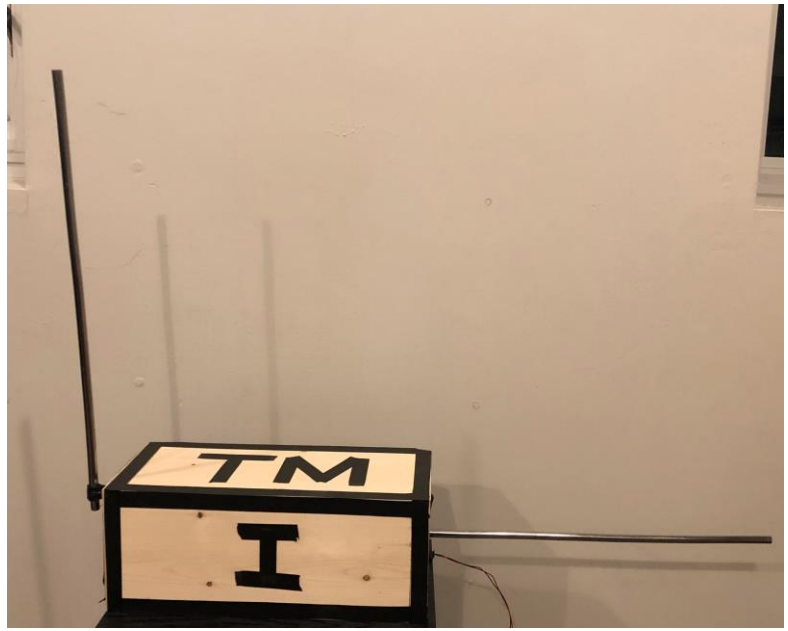


Theremin Side View



Theremin Top View

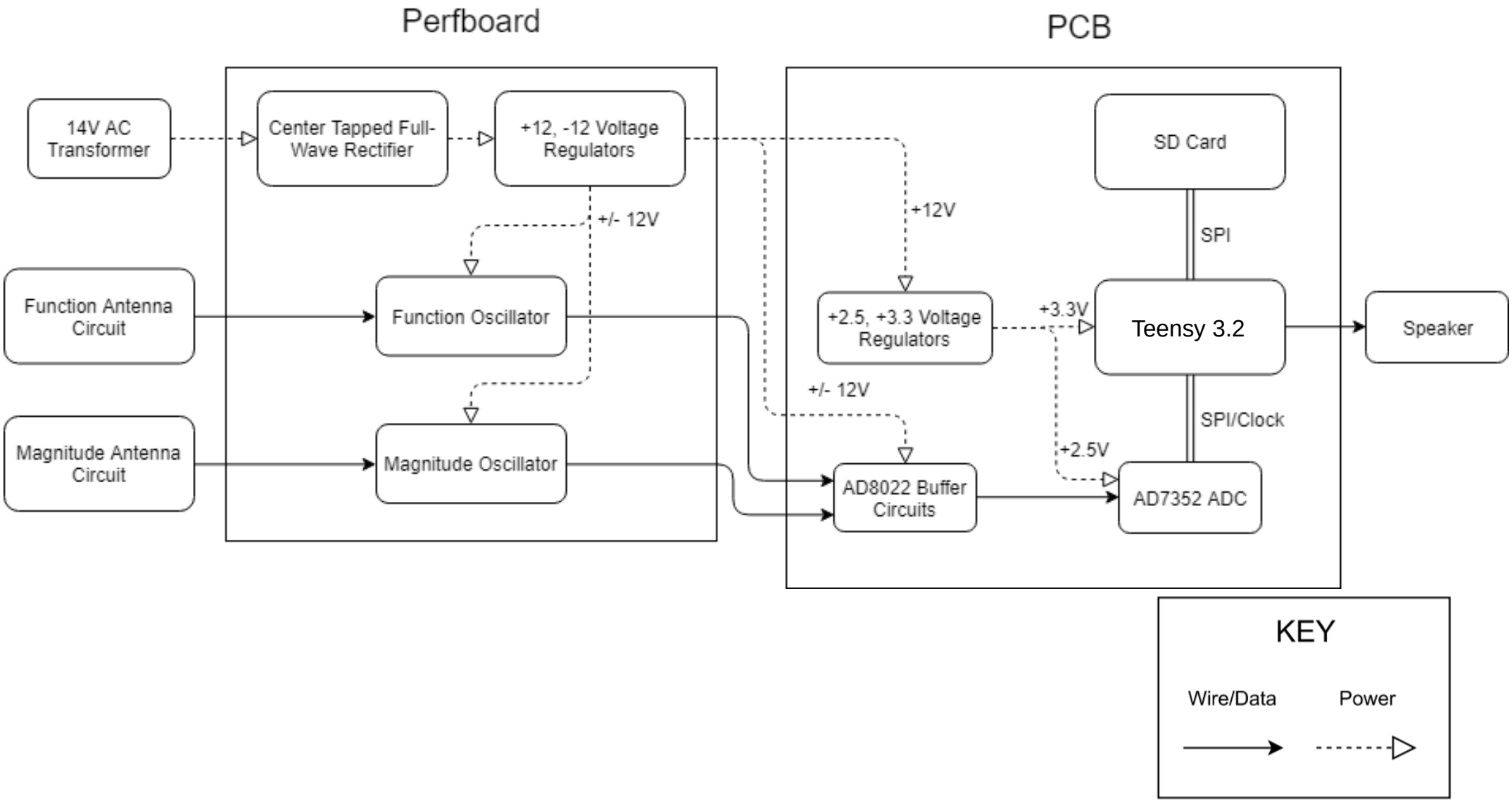
Physical Model



Front View

Side View

Block Diagram



Overview of Requirements and Verifications

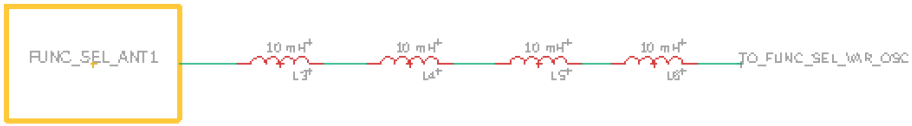
Power Module	14 Volt AC Transformer	± 12 Voltage Regulator	+ 3.3 Voltage Regulator	+ 2.5 Voltage Regulator
Hardware Module	Magnitude Detection Antenna	Magnitude Detection Oscillator	Function Select Antenna	Function Select Oscillator
H/S Integration Module	Analog to Digital Converter			
Software Module	Micro-controller			

Fully Meets Requirement

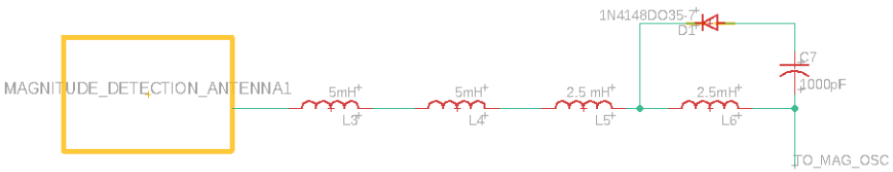
Partially Meets Requirement

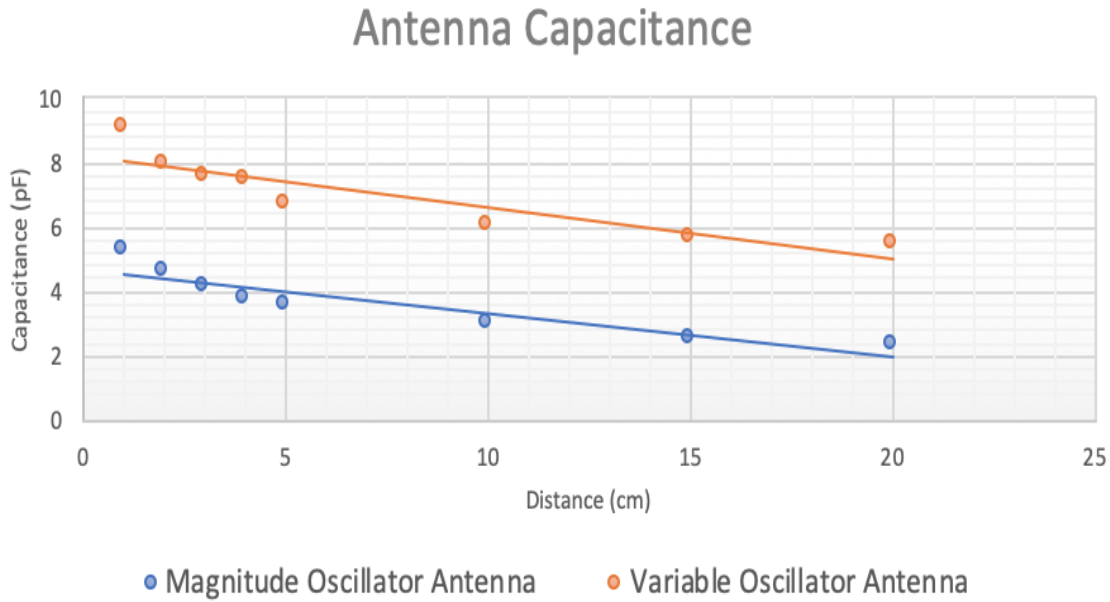
Hardware: Antennas

Function Oscillator Antenna Circuit:



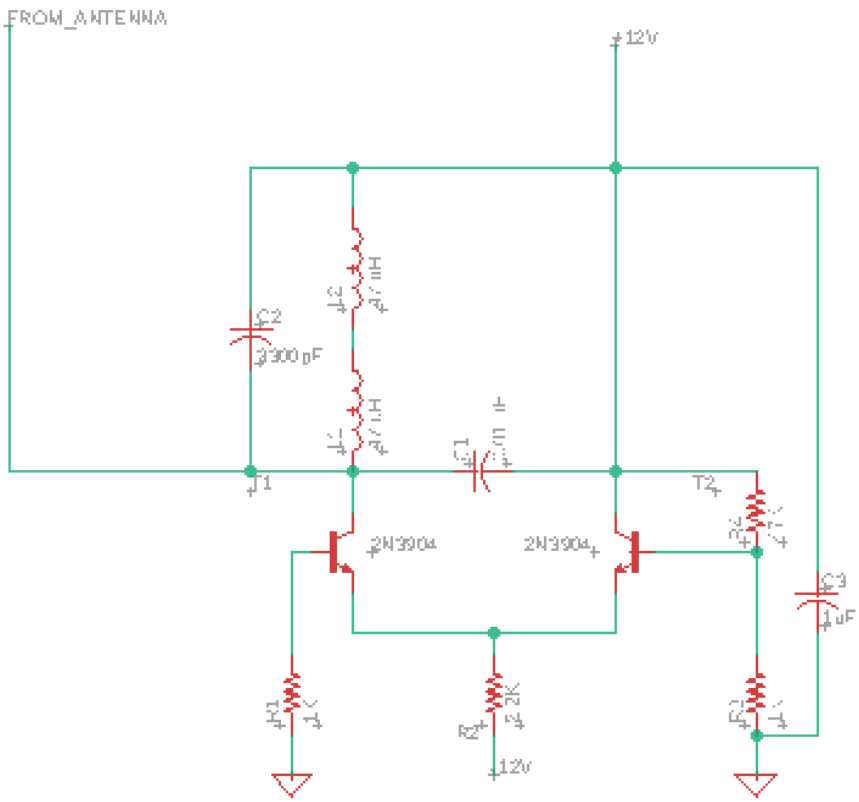
Magnitude Oscillator Antenna Circuit:

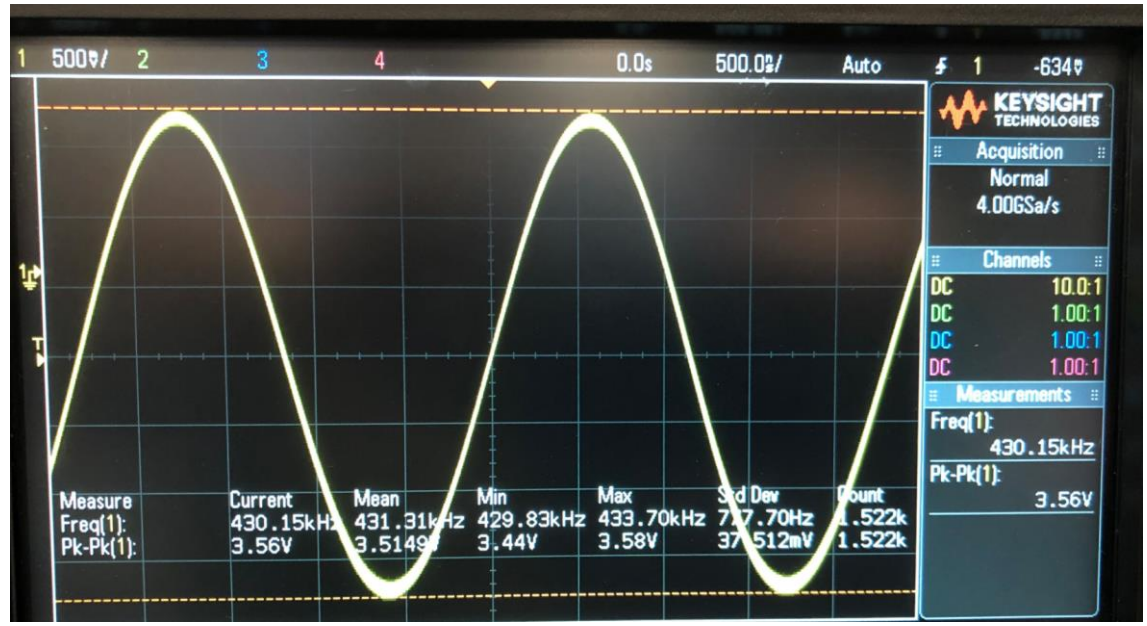




Distance (cm)	0	1	2	3	4	5	10	15	20
Magnitude Oscillator Antenna Capacitance (pF)	87.17	5.33	4.59	4.14	3.82	3.6	3.01	2.59	2.31
Variable Oscillator Antenna Capacitance (pF)	120.01	9.06	7.93	7.62	7.48	6.75	6.07	5.67	5.52

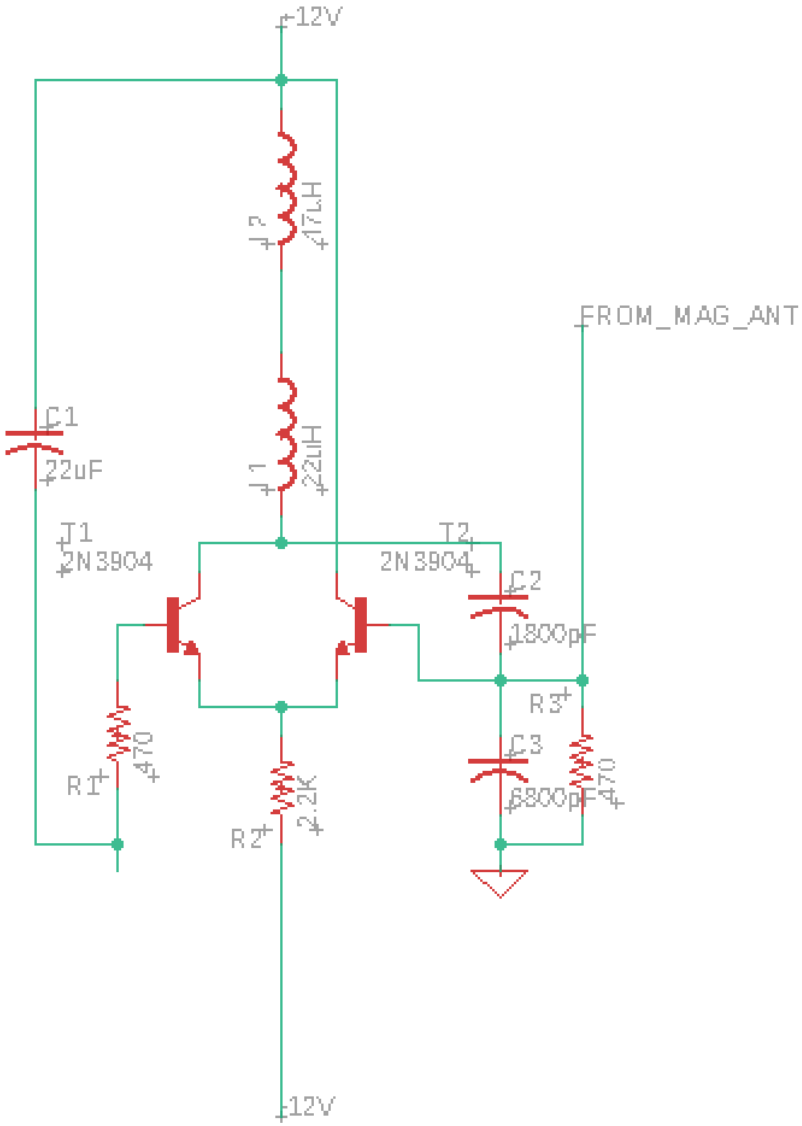
Hardware: Function Oscillator

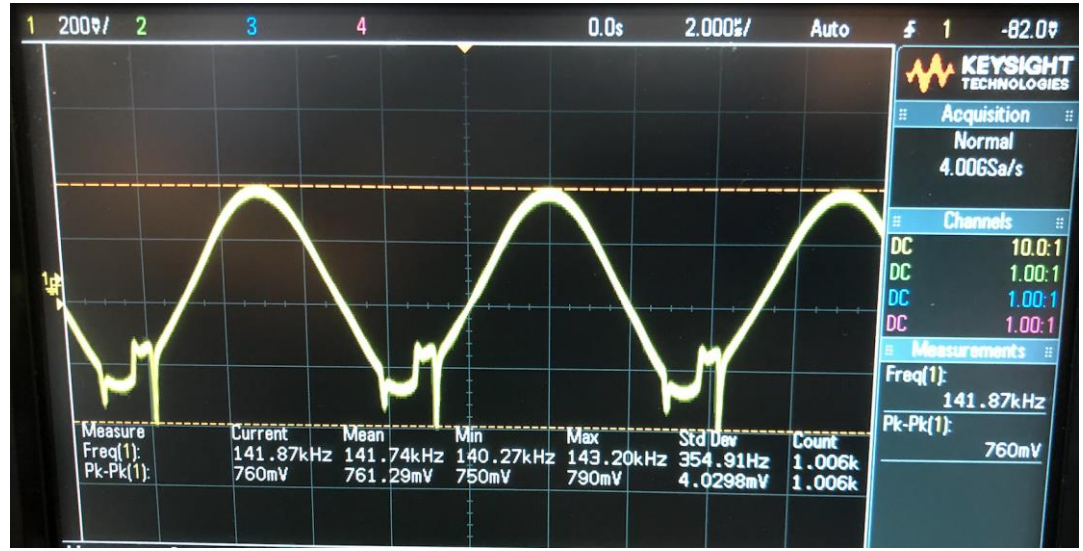




- Average Frequency: 431.31 kHz
- Average Peak to Peak: 3.51 V

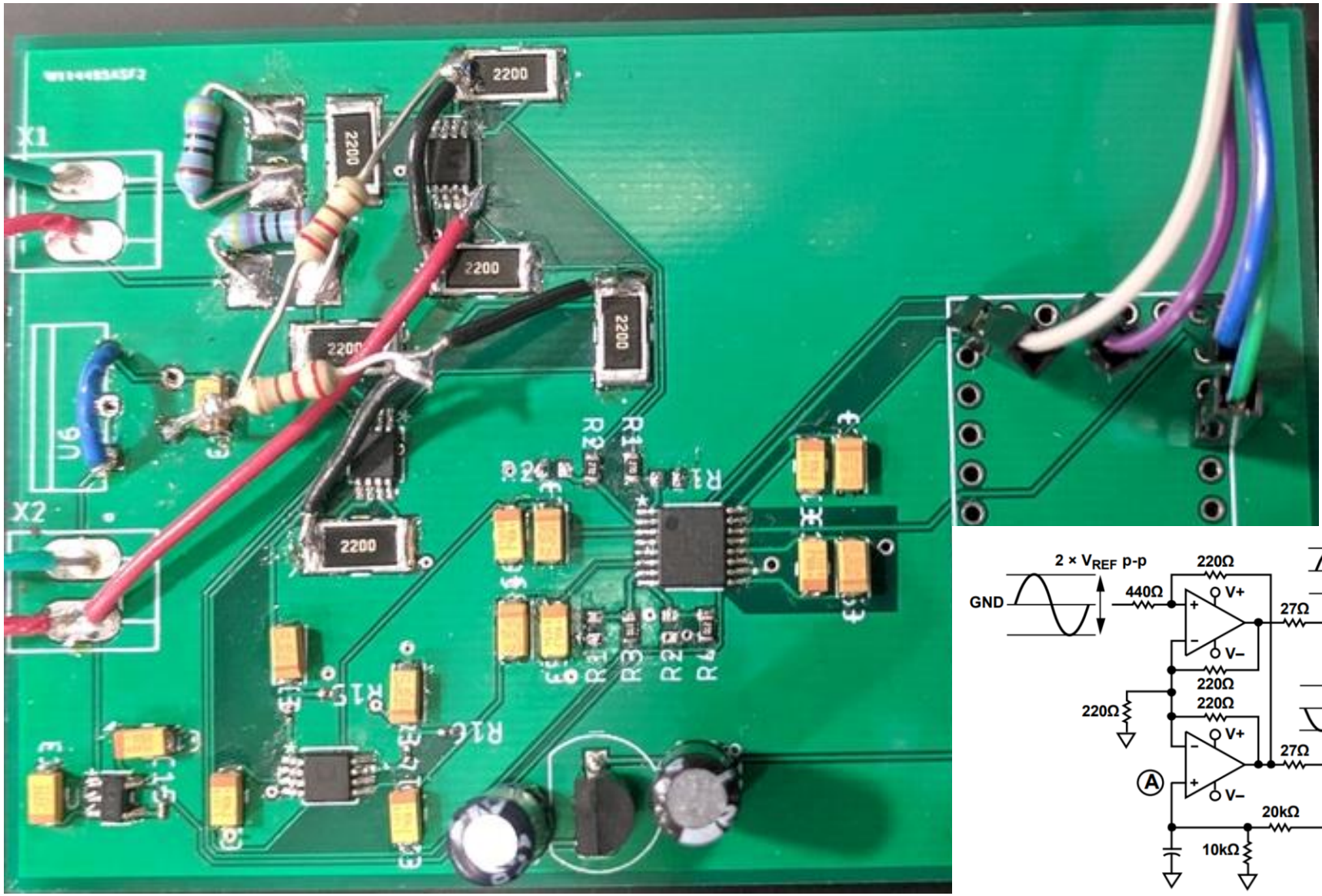
Hardware: Magnitude Oscillator





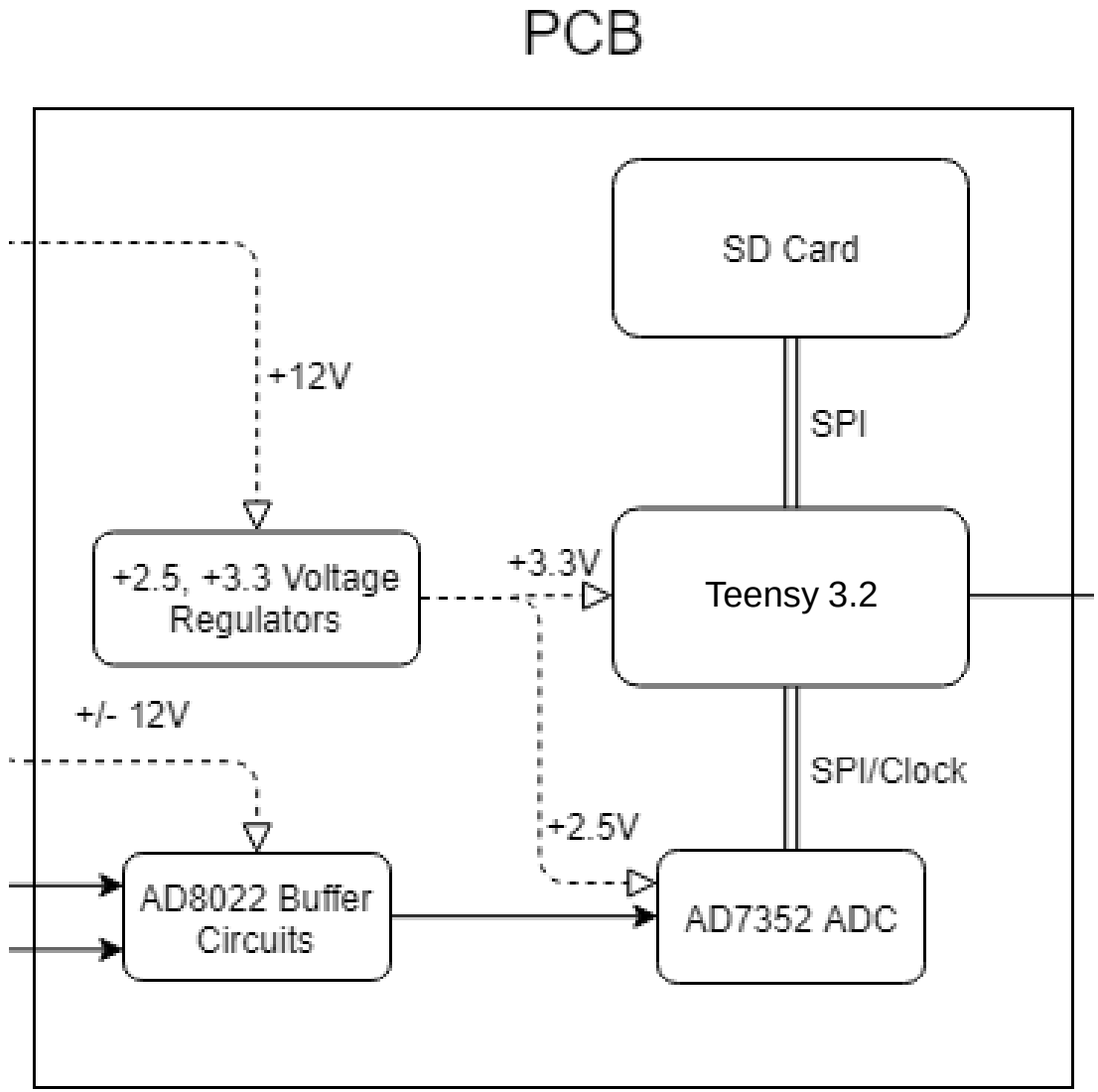
- Average Frequency: 141.76 kHz
- Average Peak to Peak: 761.29 mV

Hardware: ADC

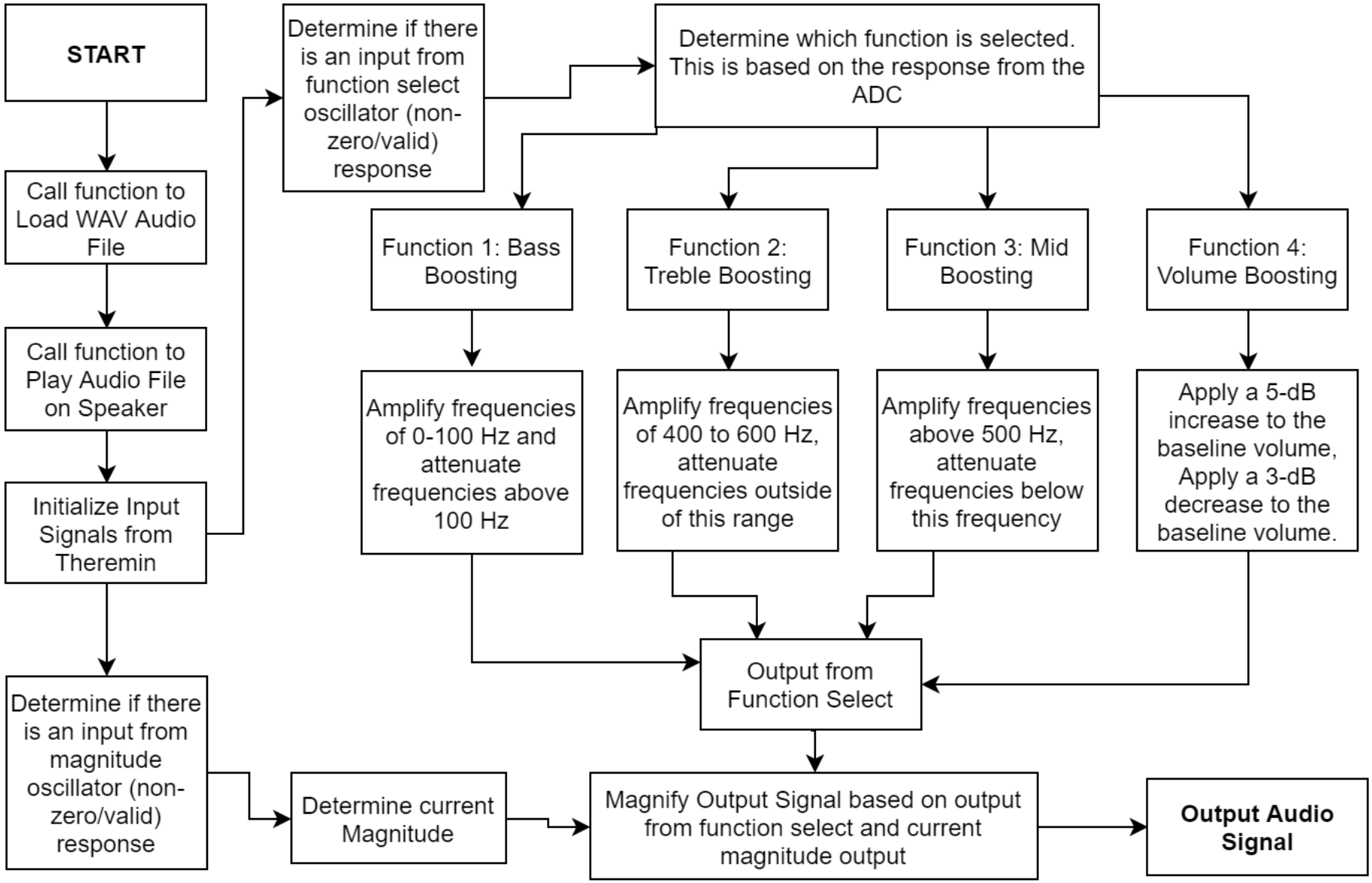


Hardware/Software: Integration

- AD8022 opamps
- AD7352 12-bit ADC
  - Outputs data via SPI protocol
- Teensy Microprocessor



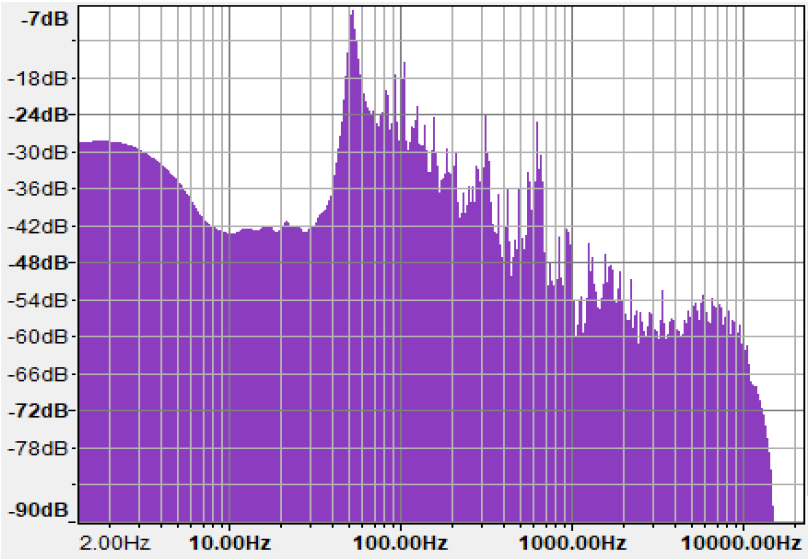
Software: Flow Chart



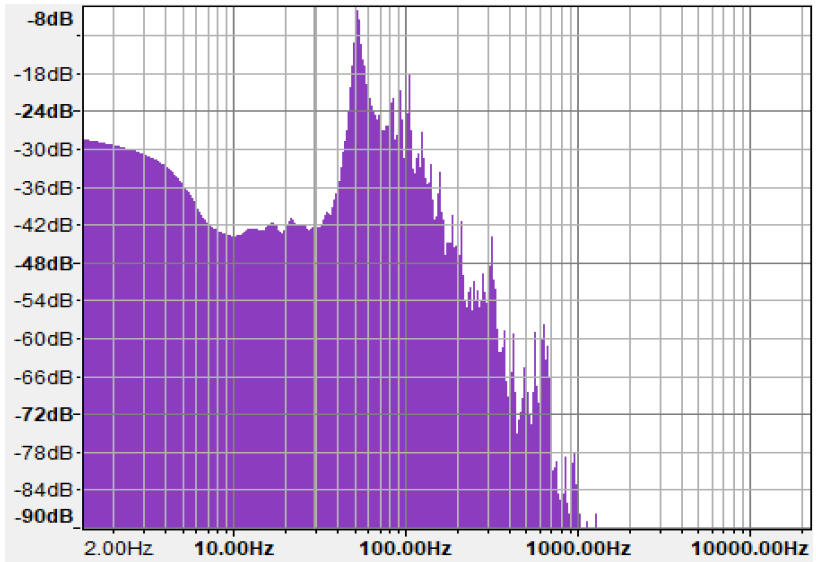
Software: Filters

- Function Select Input Signal
  - Bass Boosting ➔ Low Pass Filter (100 Hz)
  - Mid Boosting ➔ Band Pass Filter (400 to 600 Hz)
  - Treble Boosting ➔ High Pass Filter (800 Hz)
  - Volume Boosting ➔ Modify Baseline Volume
- Magnitude Input Signal
  - Amplify output audio signal at higher frequencies
  - Attenuate output audio signal at lower frequencies

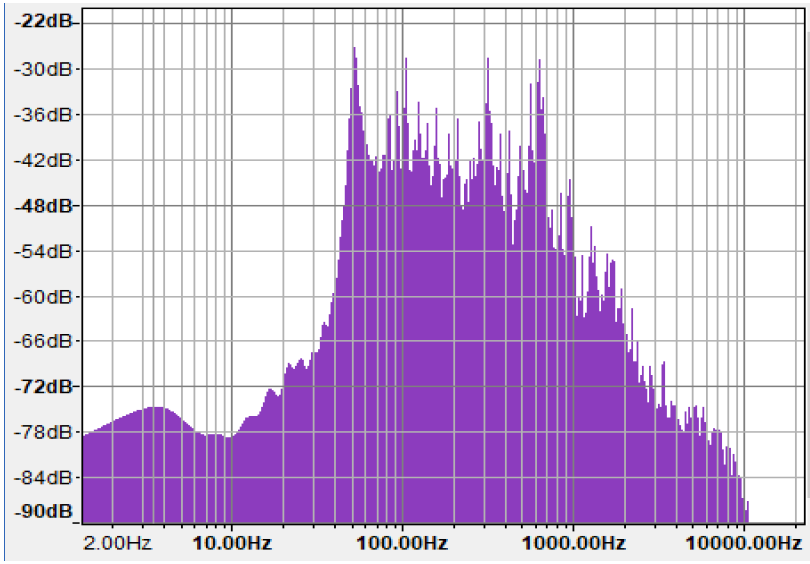
Software: Outputs of Filters



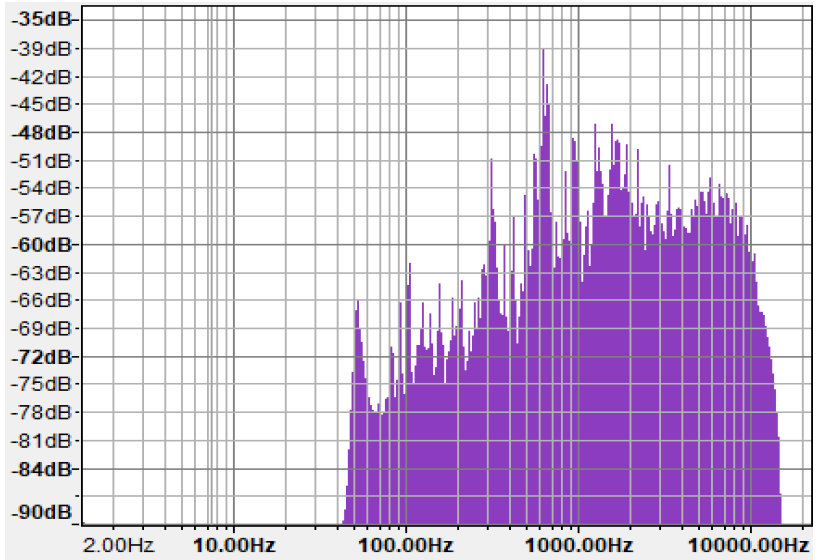
Original Audio



Low Pass Filter



Band Pass Filter



High Pass Filter

Project Successes & Challenges

Successes:

- Audio Filters
- ADC Sampling
- Oscillator Frequencies
- Antenna Sensitivity

Challenges:

- Antenna & Oscillator Integration
- FFT at high frequencies
- Buffer implementation

Hardware: Next Steps

- Enhance effect of antenna capacitance on oscillator frequency
- Design new PCB to reflect design changes and problems
  - Buffer circuits
  - Ground loops in mixed signal design

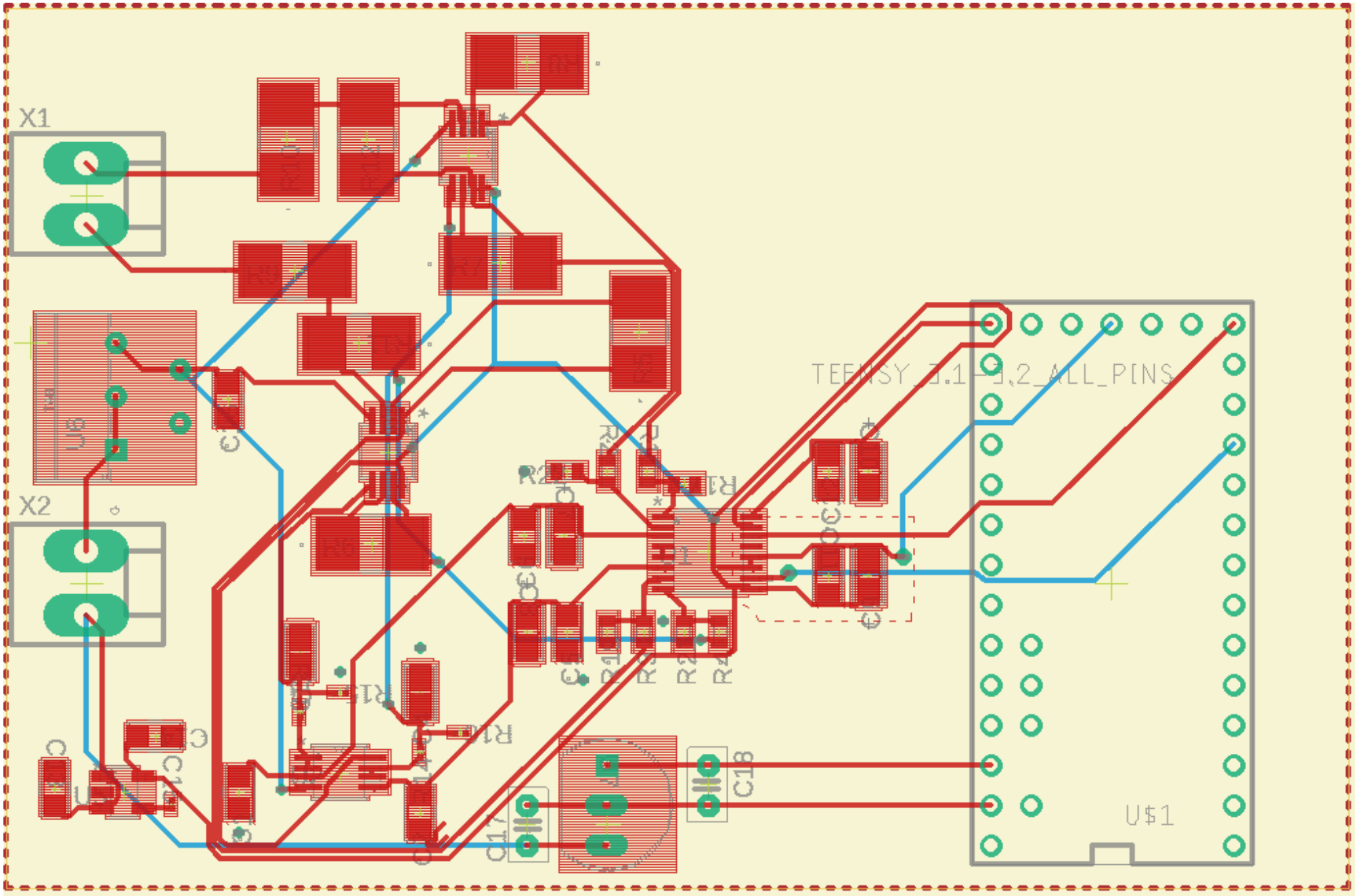
Software: Next Steps

- Implement FFT to measure control signal frequency
- Provide Additional Features:
  - Cut-Off Frequency Selection using a Potentiometer
  - Reset/Pause/Play/Skip Options using Buttons
  - Visual Display of Current Filters
  - New Mixing Effects

Conclusion: Lessons Learned

- Understanding individual modules and their role in the overall project
- Being adaptable to different circumstances and outcomes
- Teamwork and collaboration helps solve challenging problems

Q & A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X2
U8
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C18