Motorized Robotic Hand Controlled by Surface Electromyography (sEMG)
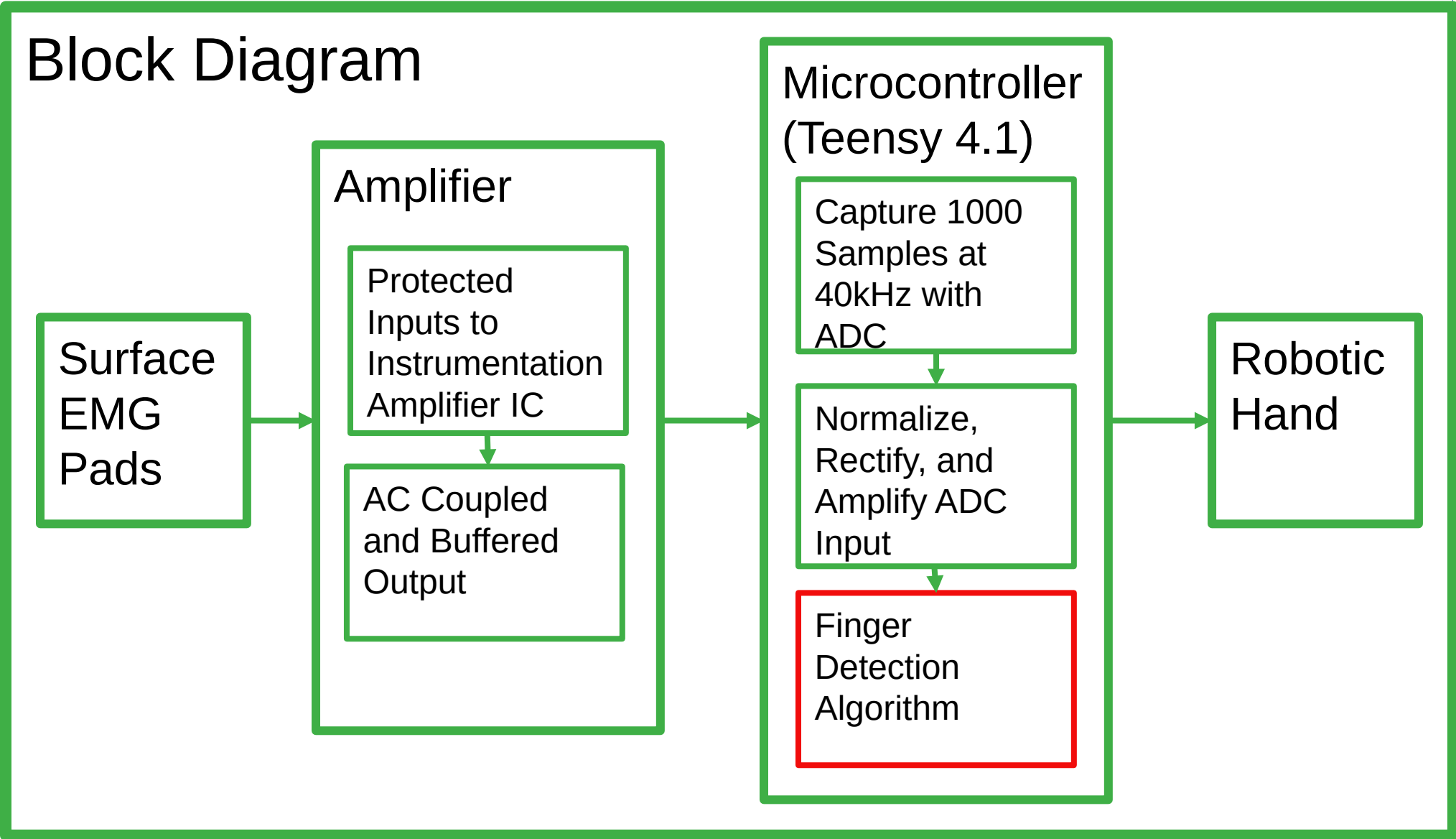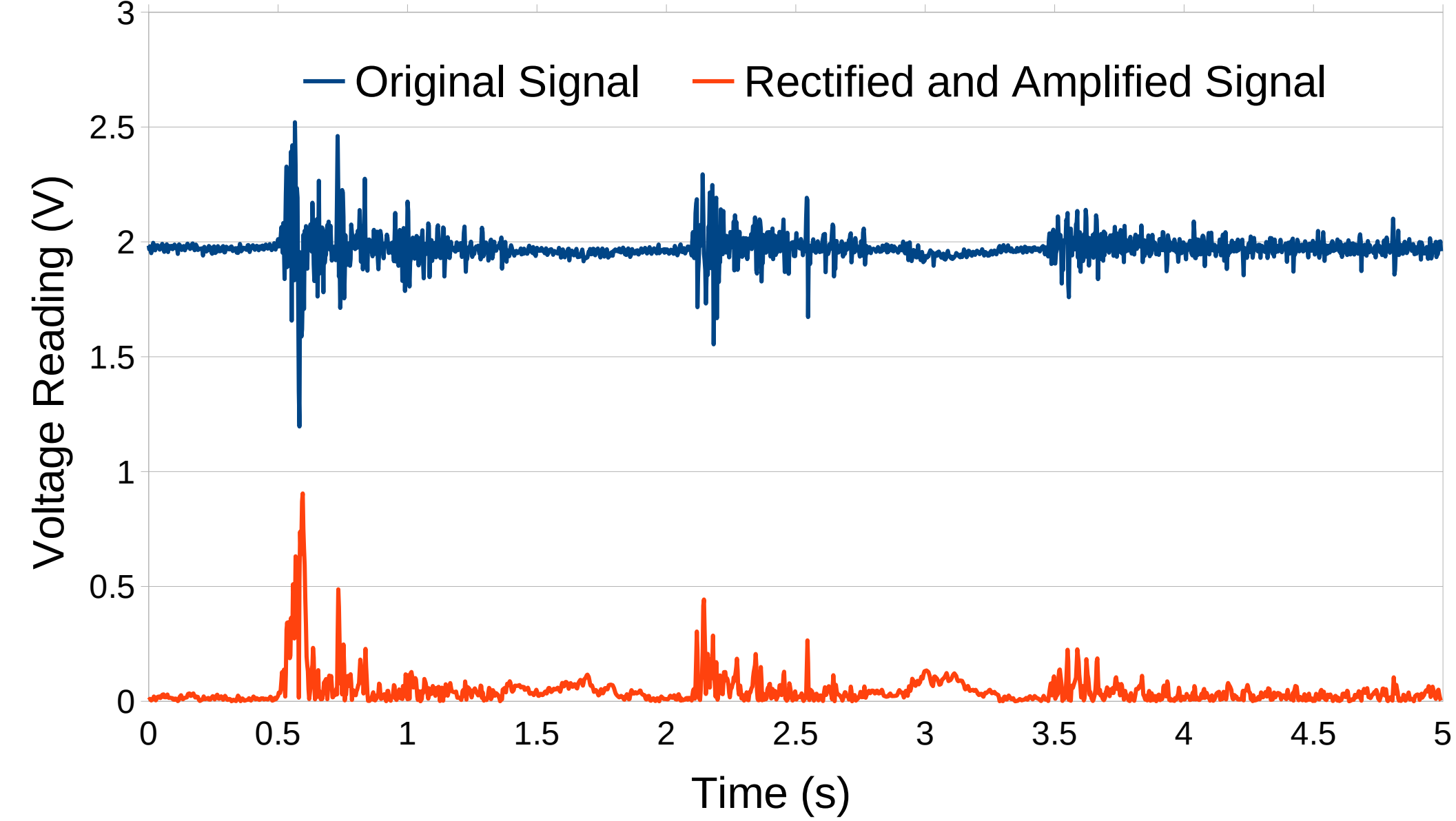
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Abstract

The objective of this project was to discover the fundamentals of signal acquisition and processing, in a situation requiring extremely precise hardware requirements in order to achieve both common mode signal rejection and extremely high gain. Because this is a medical device, considerations of safety had to be made as well. The final product is a printed circuit board designed around the Texas Instruments INA82x that handles differential gain, with input resistance to limit the shock hazard were a fault to occur. The amplified input signal is processed so that a microcontroller is able to determine what command the signal is closest to.
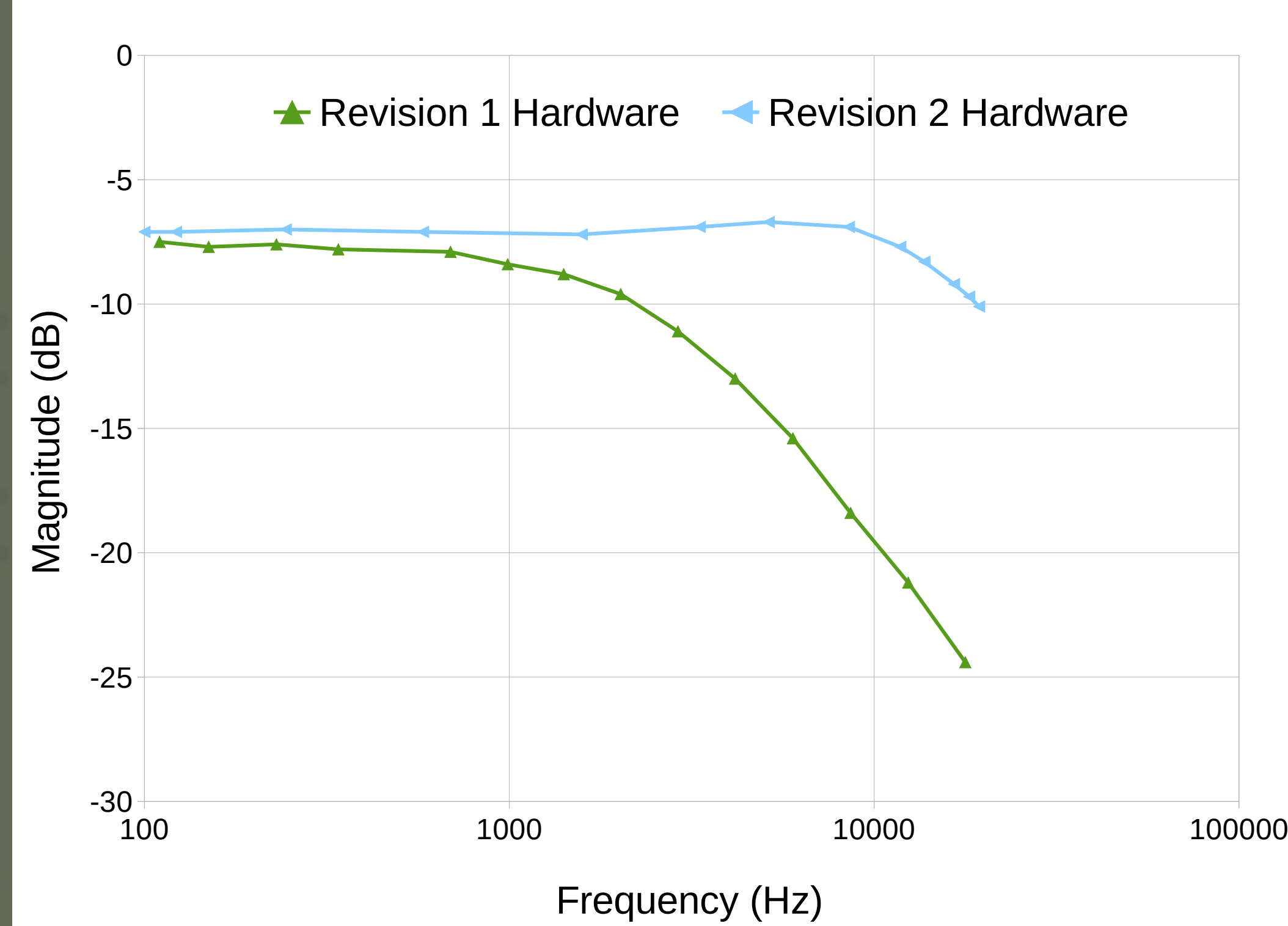
Block Diagram

Amplifier
Protected Inputs to Instrumentation Amplifier IC
AC Coupled and Buffered Output

Microcontroller (Teensy 4.1)
Capture 1000 Samples at 40kHz with ADC
Normalize, Rectify, and Amplify ADC Input
Finger Detection Algorithm

Surface EMG Pads

Robotic Hand

Picture of Complete Project Here

Picture of Probes on Arm, or many smaller pictures of physical setup

Recorded Vs Processed Signal From Probe

— Original Signal   — Rectified and Amplified Signal

Software/Hardware Overview
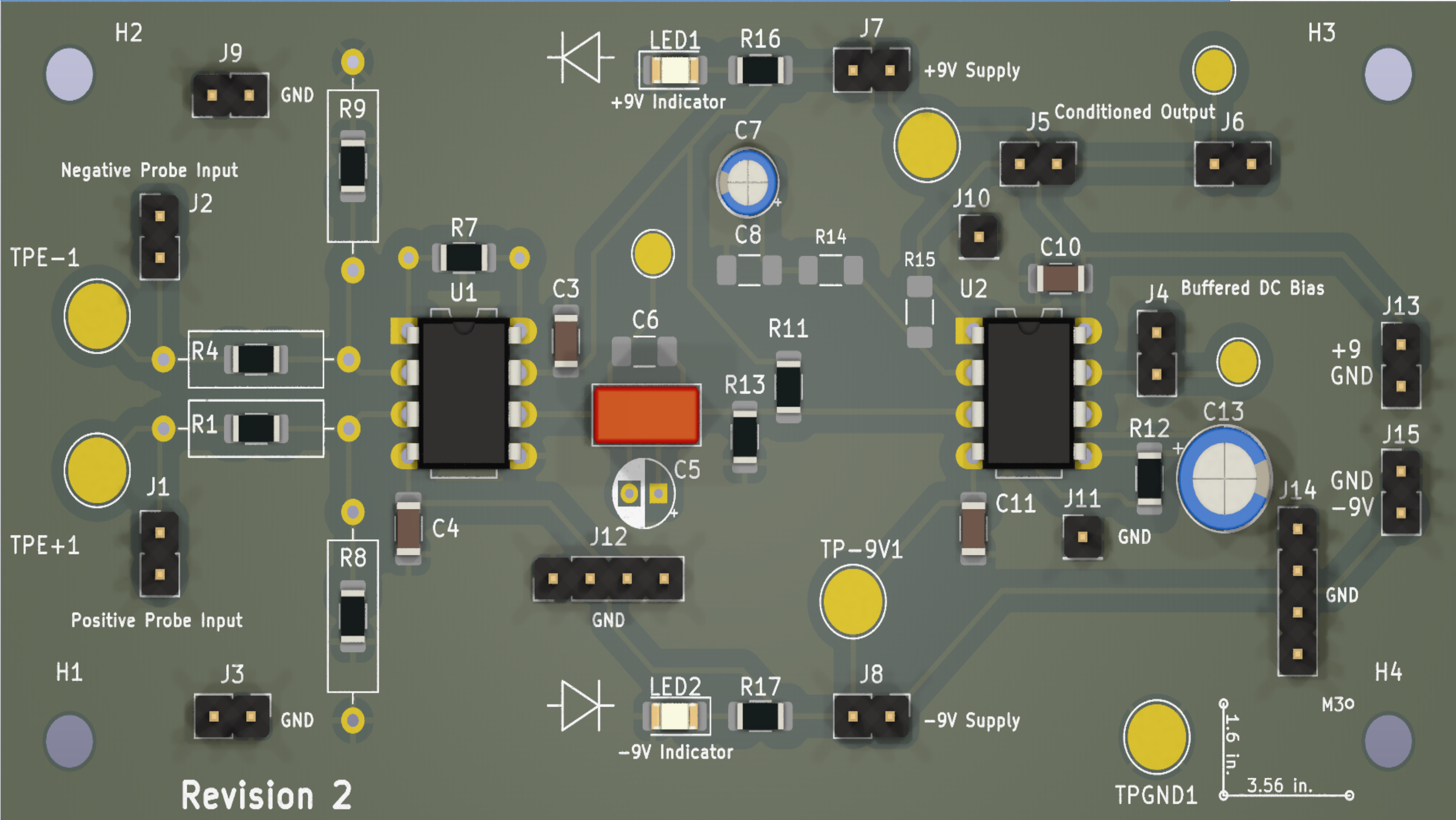
Gain Comparison of Probe Board Revisions

Revision 1 Hardware   Revision 2 Hardware

Conclusion

Compare amplifier characteristics between discrete inamp, breadboarded ina129, and assembled hardware. Design tradeoffs made, such as removing 60hz HP filter. Nature of MUAPs, long spacing and frequency components. Power supply noise rejection and grounding issues with amplifier. Conclude with what went right what went wrong, what to improve next time

References and Inspiration

https://people.ece.cornell.edu/land/courses/ece4760/FinalProjects/f2016/mh2298_jyh37_sv376/mh2298_jyh37_sv376/mh2298_jyh37_sv376/index.html