BRADLEY
University

Senior Capstone Project

Battery Electrochemical Impedance Spectroscopy Board

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I. Introduction

The battery market is one of the fastest growing markets in recent years as we are becoming more and more dependent on technologies that rely on battery storage. Consequently, there is a need for the performance of these rechargeable batteries to be as efficient and reliable as fundamentally possible. The two most common metrics for measuring the capabilities of a battery are state of charge (SOC) and state of health (SOH). The SOC metric reports the amount of energy remaining in the battery as compared to when the battery was at it maximum energy potential. The SOH metric, ideally, is a subjective method able to inform the battery user with the overall condition and performance capabilities to be expected of the battery.

However, there is a great deal of uncertainty associated with being able to accurately report the SOH of a battery over its lifetime as there is no universal definition of SOH. Many of the current SOH solutions require bulky and expensive equipment that is not viable for use on most battery management systems. As a result, a lightweight, compact, low power, and inexpensive solution must be found for a real-time SOH monitor to be attached to a deployable battery.

Through an extensive review of relevant literature, it has been determined that Electrochemical Impedance Spectroscopy (EIS) is the most effective solution for characterizing the performance of batteries. The basic principle of EIS is to input an excitation signal into the battery and observe the characteristic response. The proper implementation of EIS on board in real-time would greatly improve the overall effectiveness of a battery management system by: enhancing accuracy of SOC and SOH measurements, fine tuning individual cell balancing, extending discharge cycles, shortening charge cycles, and second life benefits. Consequently, Sandia National Laboratories has created an EIS board that utilizes the AD5933 impedance analyzer to excite a battery and characterize the impedance response on board and in real time.

My objective moving forward in this project will be to write all of the firmware for this EIS board, debug and ensure performance of all of the hardware, and have the system functioning at a level capable of retrieving the impedance data from a power supply or battery simulator.

II. Functional Diagrams

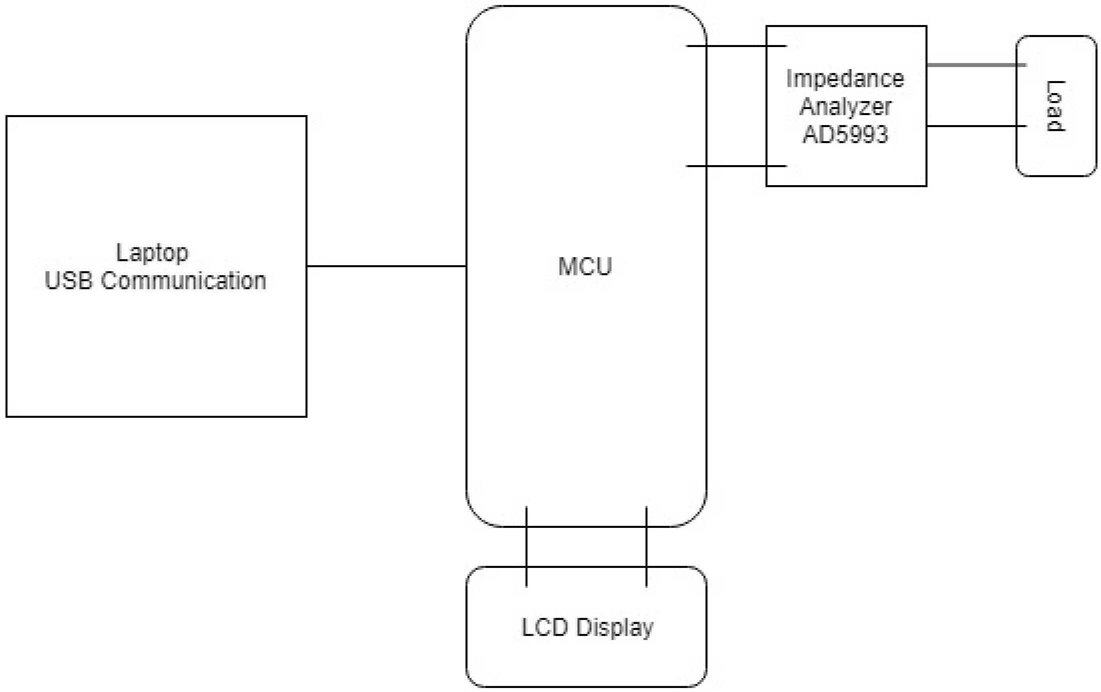

Figure 1: High Level EIS Block Diagram

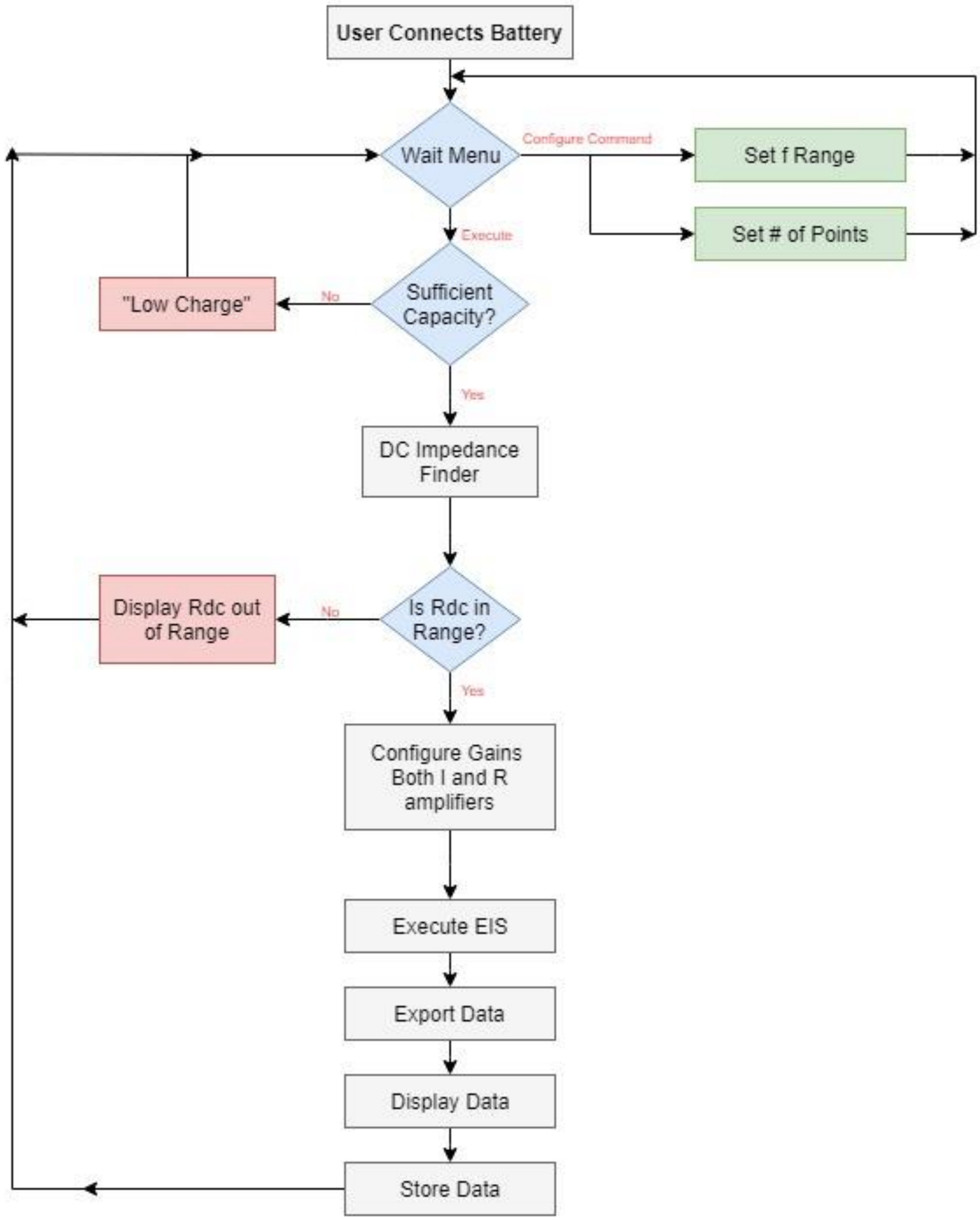

Figure 2: EIS Software Block Diagram

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