Parallel Battery Management Evaluation Board

“Power to the People”

Team 1
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Parallel Battery Management

- Parallel battery management systems are necessary for all devices with two or more batteries powering one device or multiple components of a device

Google Pixel Buds Pro

Ring Camera

Nintendo Switch

Problem Statement

Design a PCB with Type-C PPS input and software to showcase the parallel battery management functionality of the MAX17330 (charger, fuel gauge, and protector for lithium ion batteries) for customer technology demonstrations and trade shows.

Introduction

- Who is this for?
  - Analog Devices' Battery Management Team in the Consumer and Cloud Infrastructure Group
- What do they want?
  - A smart system that can dynamically charge two batteries at the same time using their battery management IC (MAX17330) and showcase its parallel battery management capabilities
    - Take our product to trade shows and customer demonstrations
- Our product
  - PCB with Type-C PPS input and software that showcases the parallel battery management functionality of the MAX17330 (charger, fuel gauge, and protector for lithium ion batteries)

Significance of Our Solution

- Through our smart charging system, we are looking to increase the longevity of two batteries in a mobile device
  - Manage simultaneous charging of two batteries utilizing ADI's powerful chips
  - Higher efficiency
    - More power cycles lead to shorter battery life
- Gives our client, ADI, an effective way to showcase their battery management ICs on one platform

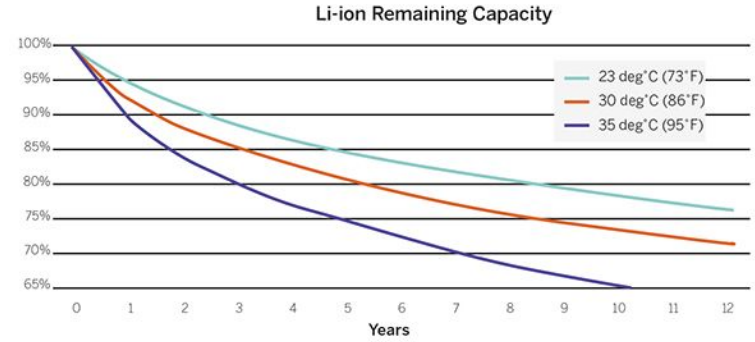


Figure 1. *Lithium-ion battery calendar life chart*

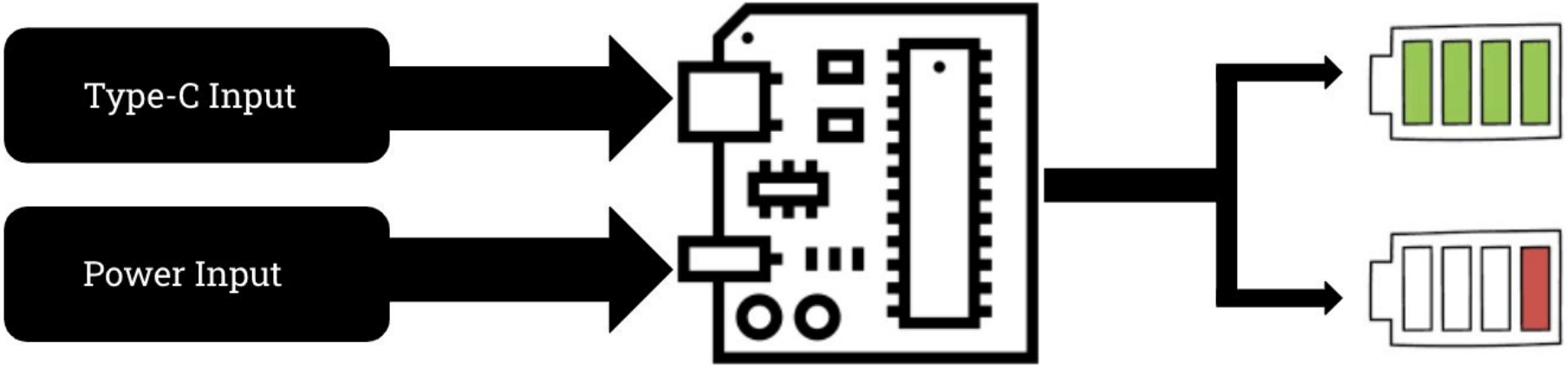
Key Final Requirements

- Showcase the ability to simultaneously charge two batteries within one device using ADI’s powerful chip
  - Potential customers/audience should be able to see that two batteries can be charged and discharged efficiently (i.e., should be faster than charging the batteries in series) from the same source simultaneously
- Attract more customers at trade shows and positively influence the minds of potential buyers
  - To simulate this, we will demonstrate our final product to our client, professors, and our peers

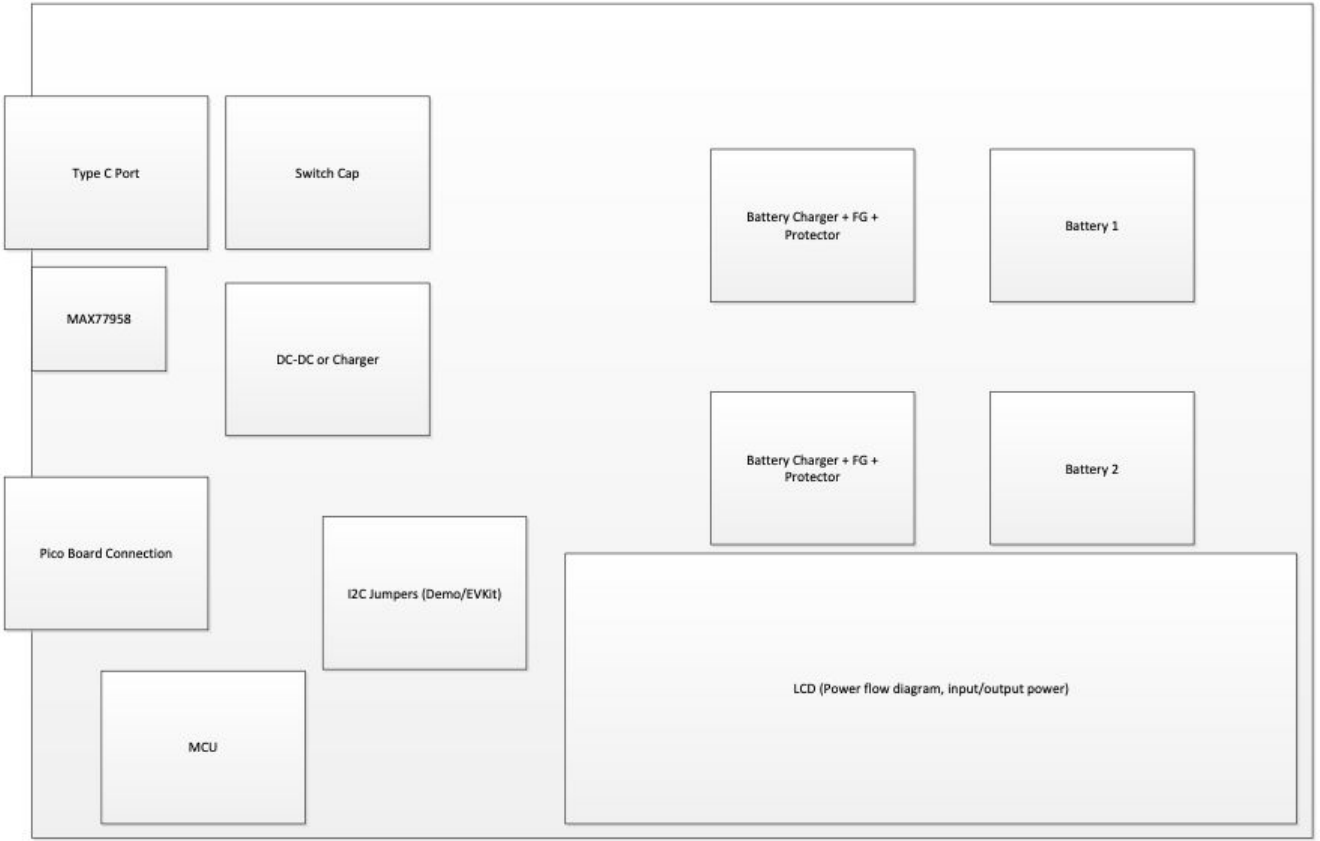
Deliverables

- Physical PCB is fully fabricated, assembled, shipped to us and our client on time, and functions without issue. Includes the following components:
  - MAX17330 (Two of these) — Battery Management IC
  - MAX77958 — Type-C Power Delivery Controller IC
  - MAX77932— Switch-Capacitor IC
  - MAX77986A— Boost Converter IC
  - LCD (40X4 FSTN GRAY CHARACTER LCD by Focus LCDs, soldered separately)
  - Microcontroller (Raspberry Pi Pico, soldered separately)
- Microcontroller reads and writes to MAX17330s upon reaching battery capacity thresholds (e.g., if one battery is reaching full, supply higher current to other battery)
- Microcontroller updates power and battery data on LCD every second
  - Charging current through each MAX17330
  - Battery capacities (%)
  - CHG and DIS FET statuses of each MAX17330
  - Input voltage from Type-C PD controller and switch capacitor

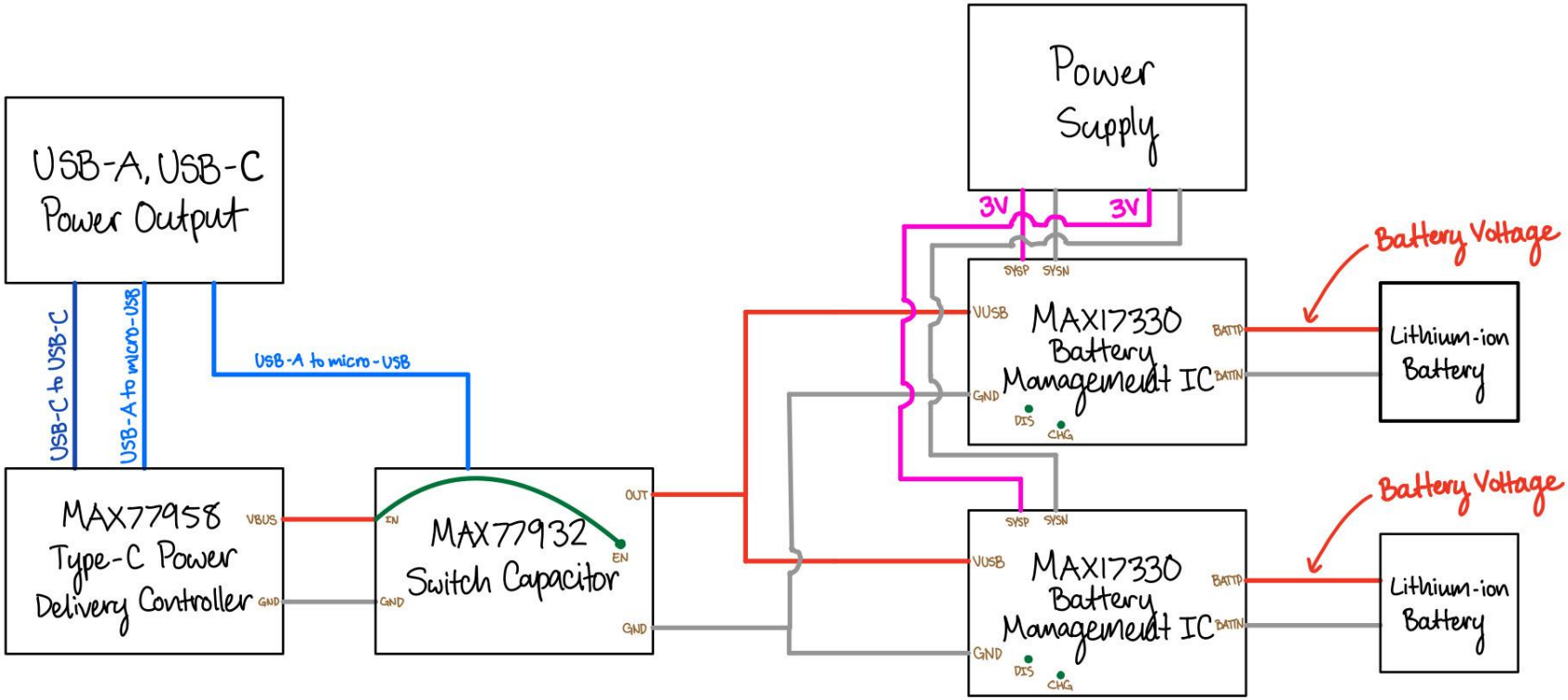
Simplified System Overview



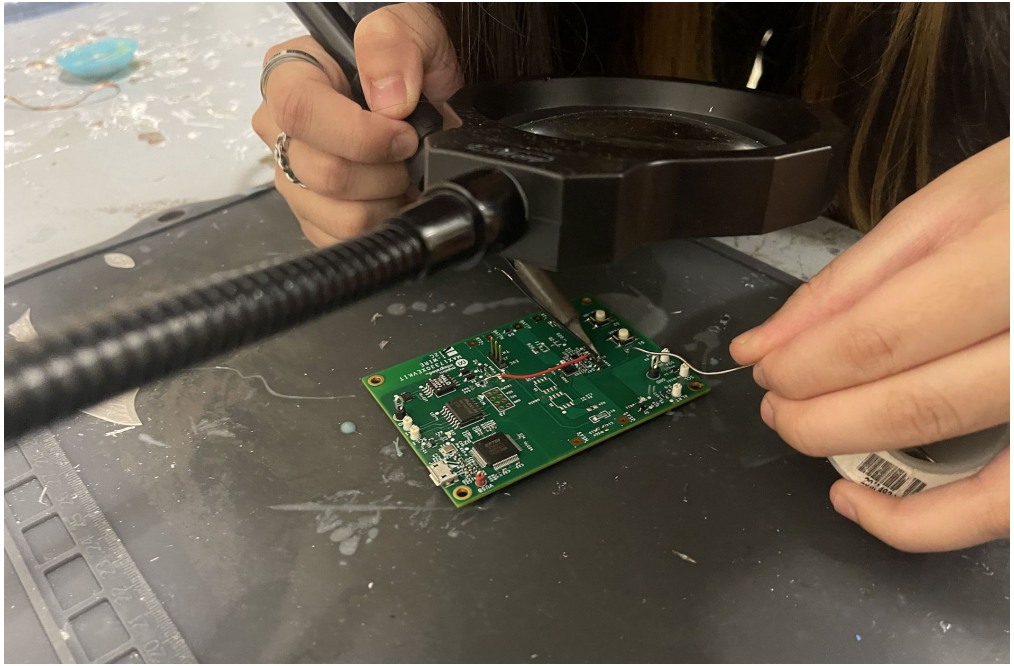
Visualization



Power Flow Block Diagram

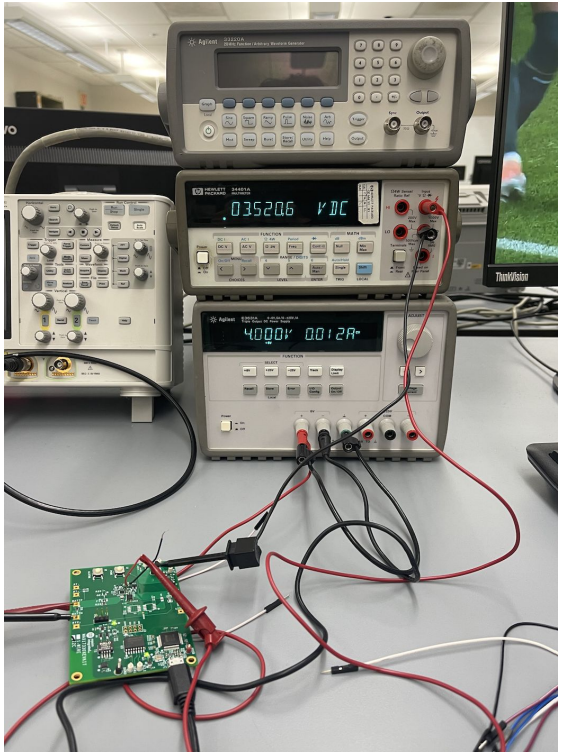


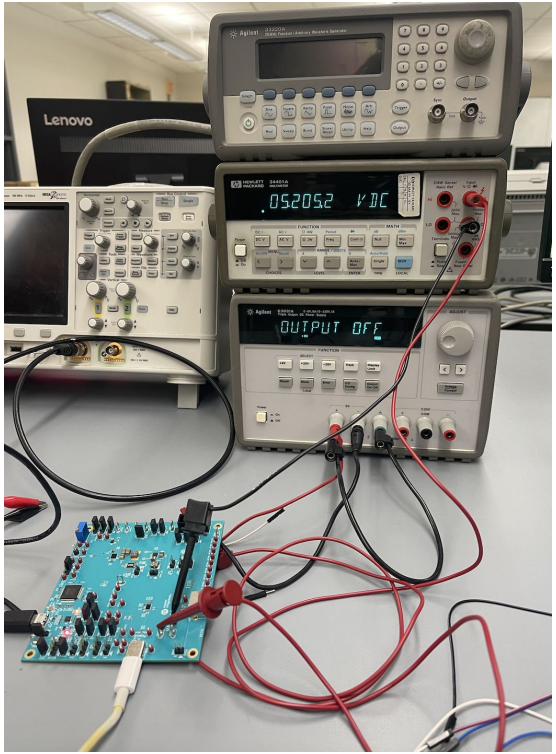
Design Preparation



The MAX17330 Boards required pins to be soldered in certain vias in order to be properly tested and integrated into test bench.

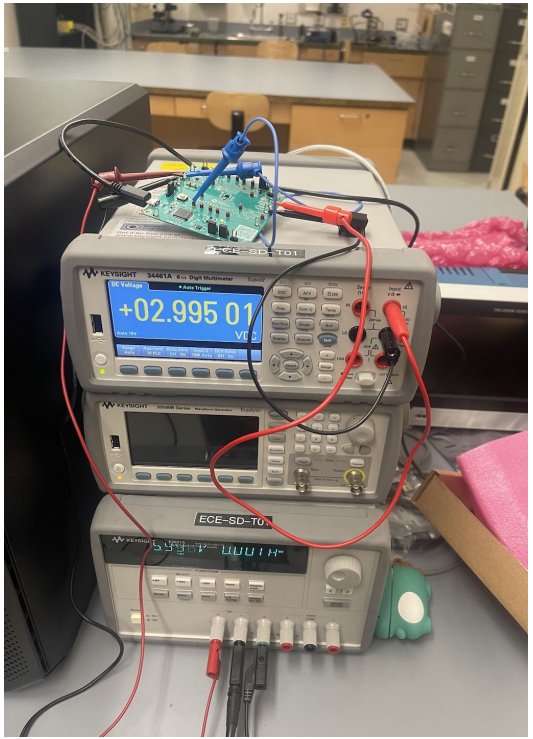
EV Board Testing

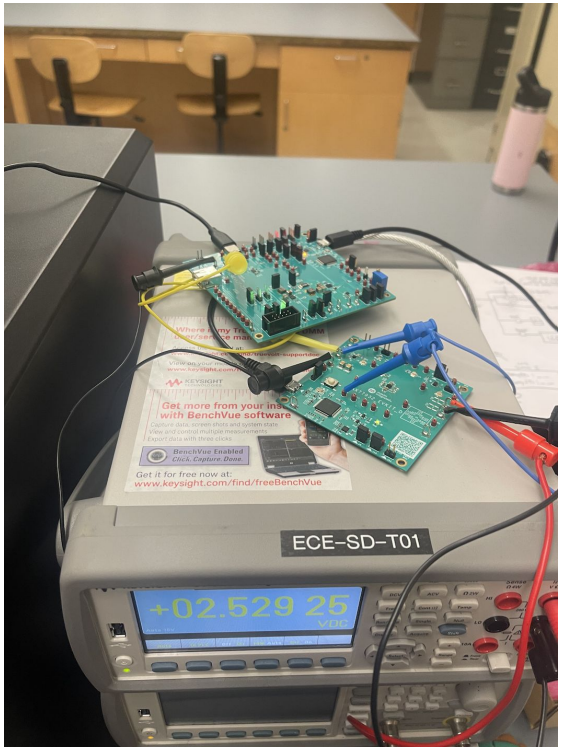




- Tested boards using Power Supplies to determine whether tested outputs match desired outputs from datasheets.
- Help understand how ICs function

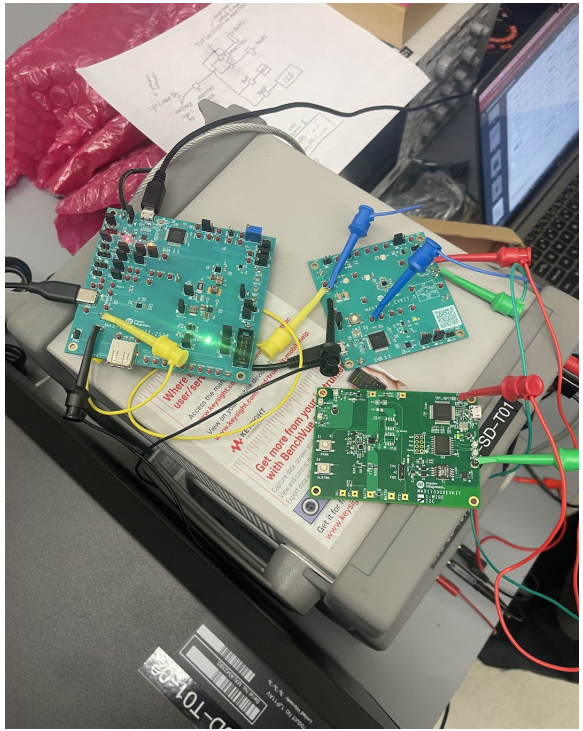
Initial Prototype Hardware Testing

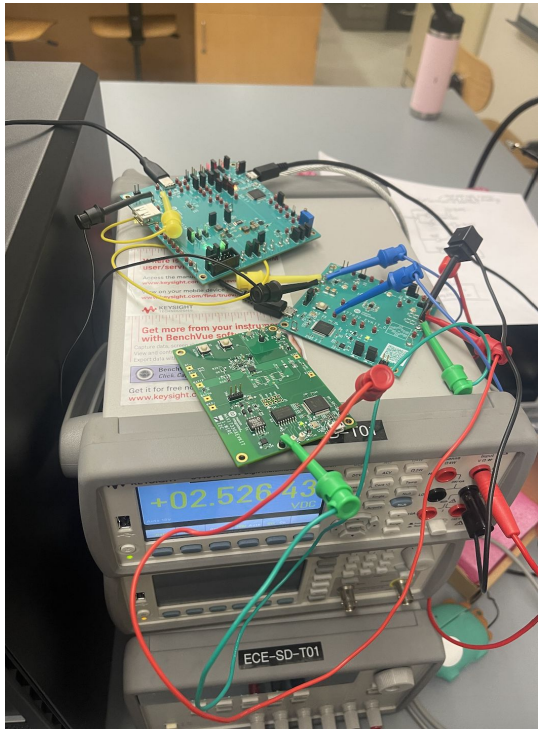




- Connected the Type C power controller to a switch capacitor.
- Type C input is transformed into 5V, and the switch cap halves the voltage. Hence why the multimeter displays 2.529 V.

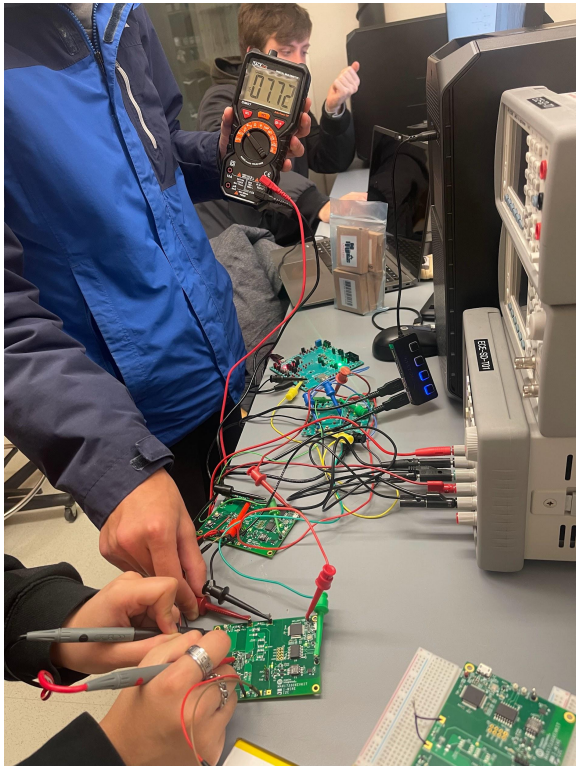
First Prototype with Single Battery

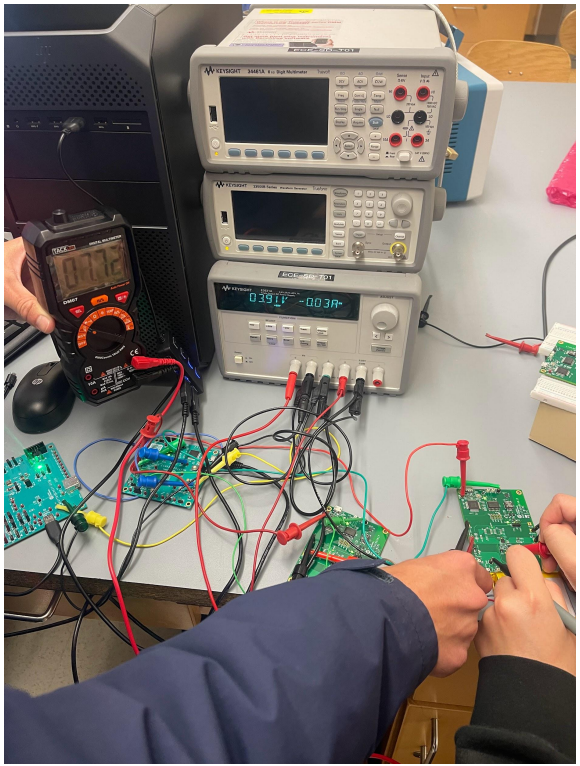




Successfully Connected a Type C power delivery controller, switch capacitor, and the MAX17330 board together to be able to charge a single battery

Prototype with Two Batteries

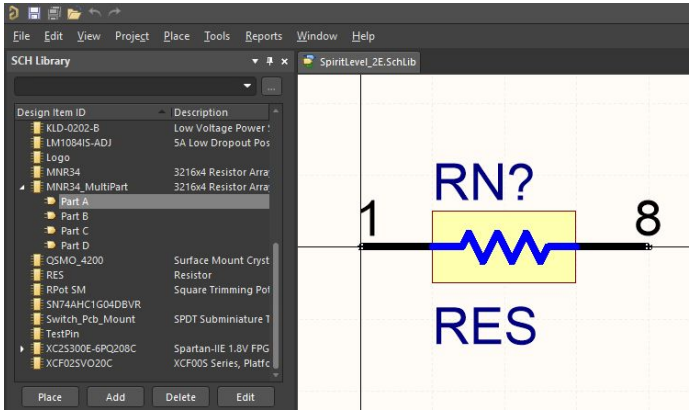


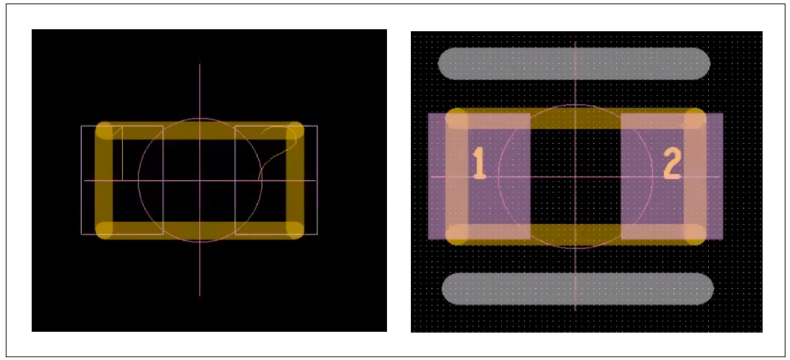


Implemented another MAX17330 board to the existing prototype to be able to charge 2 separate batteries.

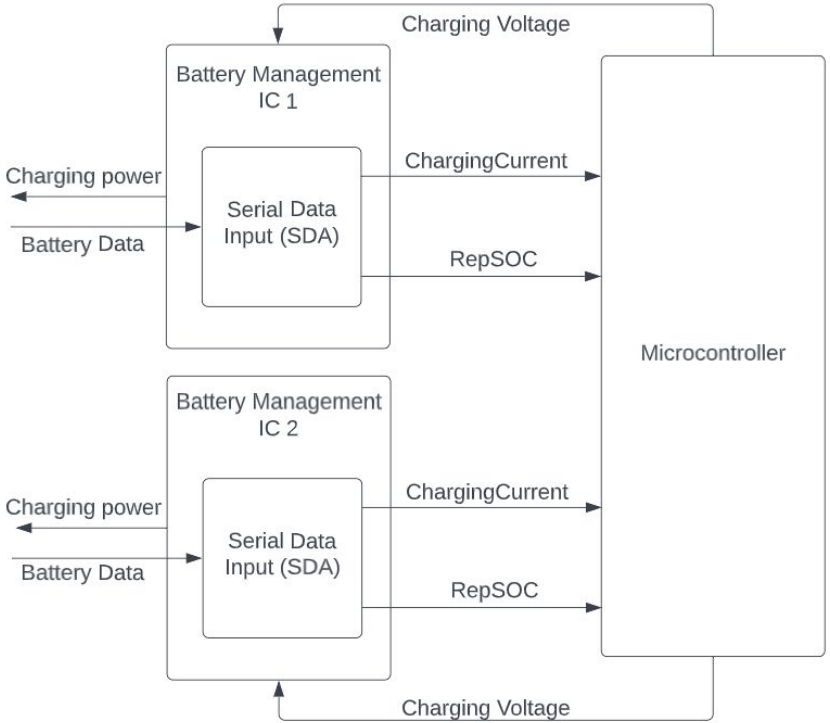
Technology/Design (Hardware)

- In order to design a PCB deliverable, we required a printed circuit board design software.
  - Chose Altium Designer
- Requires creation of a custom Schematic Component Library and a Schematic Footprint Library





Technology/Design (Software)



- The battery will provide information through its DATA connection.
- Through the microcontroller, we can access that information by calling different registers, e.g. ChargingCurrent (current being O/P) or RepSOC (percentage battery charge)

Technology/Design (Software)

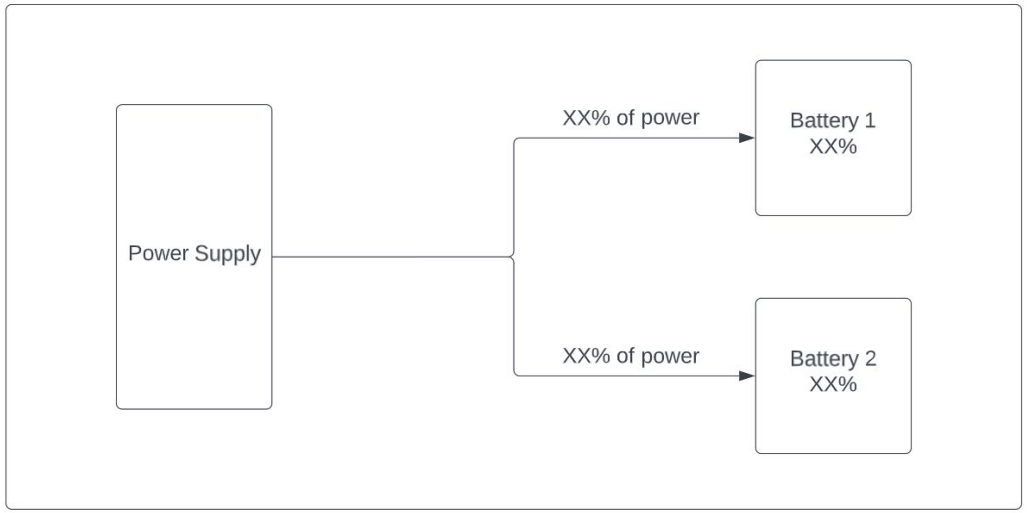
We have not fully fleshed out what algorithm we will use to determine how much to charge one battery vs. the next, but this is a preliminary formula:

$$PS_a = \frac{100 - RepSOC_a}{200 - RepSOC_a - RepSOC_b}$$

Where PS_X is the percentage of total power supplied that goes to battery X, and $RepSOC_X$ is the battery percentage of battery X.

Technology/Design (Software)

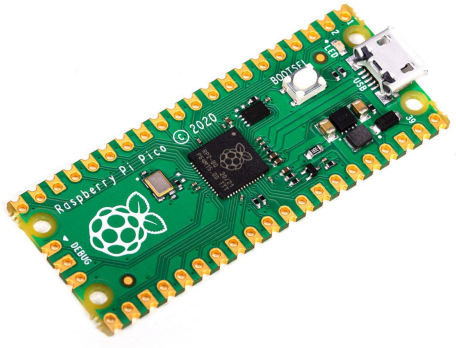
We also have to output information onto an LCD. This display should be as informative and intuitive as possible. We hope the user is able to reach any screen from - at most - 3 clicks of a button.



Other pages on the display will include more technical information, this will be the main visual.

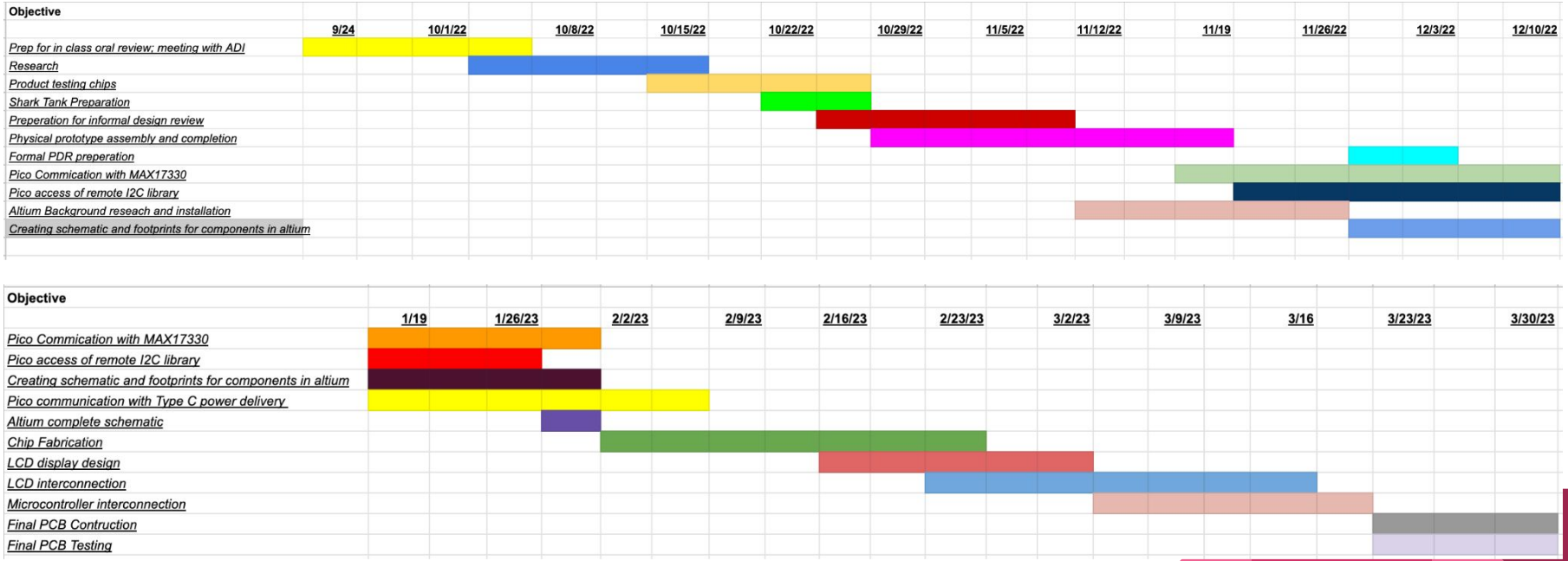
Technology/Design (Software)

For communication between our microcontroller (Raspberry pi pico) and the ICs, we will use the Inter-Integrated Circuit (I2C) protocol. This is a well established protocol that is commonly used to communicate with different devices.



We will likely use MicroPython to implement the I2C protocol, though using C is also a valid option.

Gantt Chart


Objective
9/24
10/1/22
10/8/22
10/15/22
10/22/22
10/29/22
11/5/22
11/12/22
11/19
11/26/22
12/3/22
12/10/22
Prep for in class oral review; meeting with ADI
Research
Product testing chips
Shark Tank Preparation
Preperation for informal design review
Physical prototype assembly and completion
Formal PDR preperation
Pico Commication with MAX17330
Pico access of remote I2C library
Altium Background reseach and installation
Creating schematic and footprints for components in altium
Objective
1/19
1/26/23
2/2/23
2/9/23
2/16/23
2/23/23
3/2/23
3/9/23
3/16
3/23/23
3/30/23
Pico Commication with MAX17330
Pico access of remote I2C library
Creating schematic and footprints for components in altium
Pico communication with Type C power delivery
Altium complete schematic
Chip Fabrication
LCD display design
LCD interconnection
Microcontroller interconnection
Final PCB Contruction
Final PCB Testing

Thank you!