

Abstract

- FSAE is a competition in which student teams build formula-style racecars.
- All-electric formula racecars require a battery-management system (BMS).
- Many formula racing teams use off-the-shelf BMS solutions, which have various limitations, such as packaging efficiency and hardware integration issues.
- We build a custom BMS to rectify these issues, which is also a lot cheaper than the prevailing off-the-shelf solution, the Orion BMS.

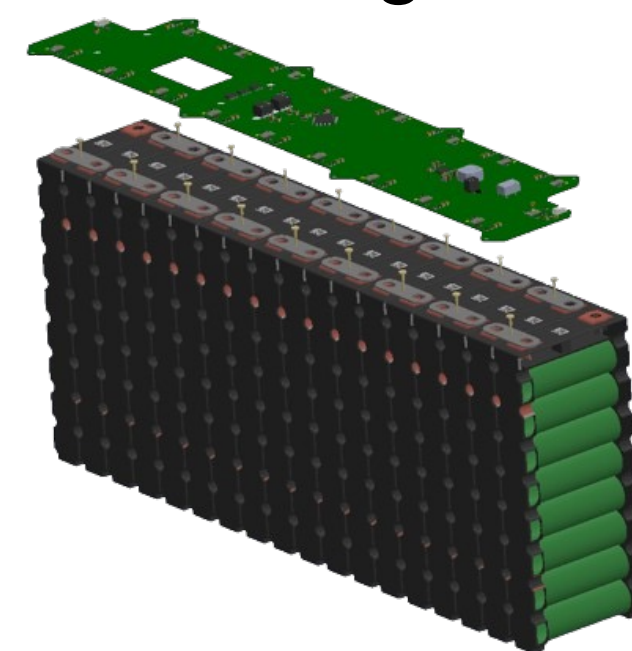
Figure 1 → The Orion BMS, the system currently in use for the RFR racecar.



Motivations and Objectives

- Create a management system to solve the limitations of the off-the-shelf BMS.
- Design and manufacture a printed circuit board (PCB) to collect and manage data from the cells.
- Test and debug the PCB, and integrate code, to ensure proper functions.
- Use a battery stack monitor IC controlled by a microcontroller to easily measure and balance the batteries.
- Physically integrate the PCB with the battery cells and create a casing to house our final product.

Figure 2 → BMS with battery pack



System Design

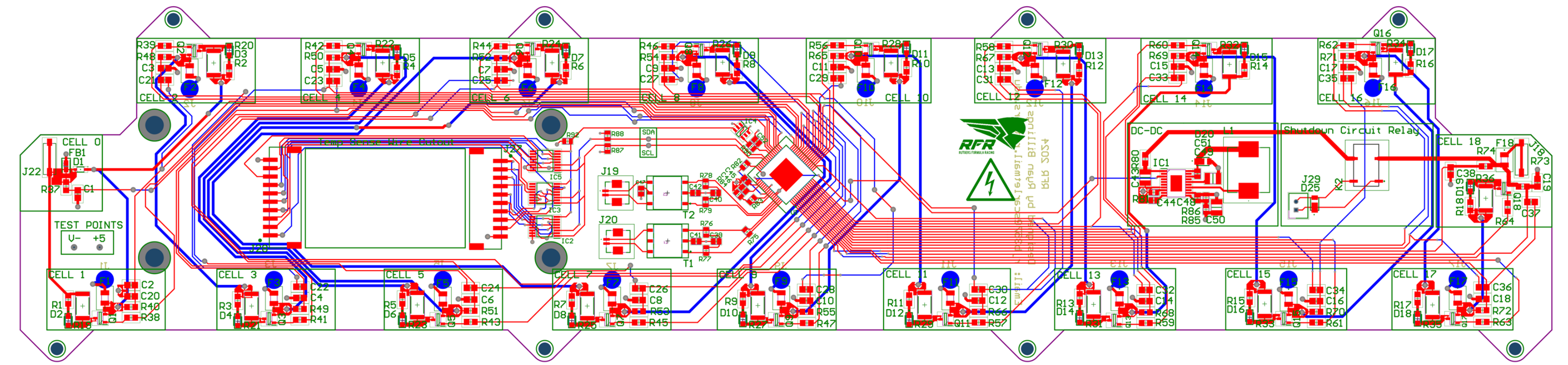


Figure 3 ↑ The PCB layout of the balancing board.

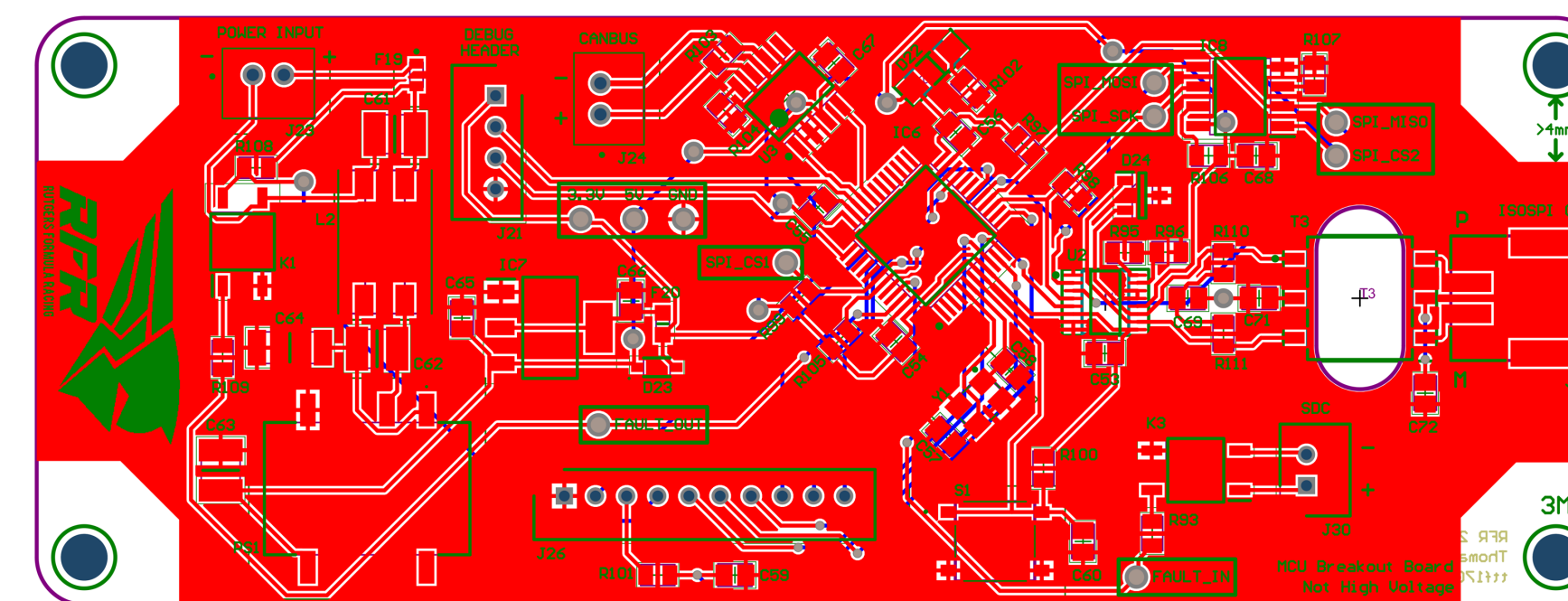


Figure 4 ↑ The PCB layout of the control board.

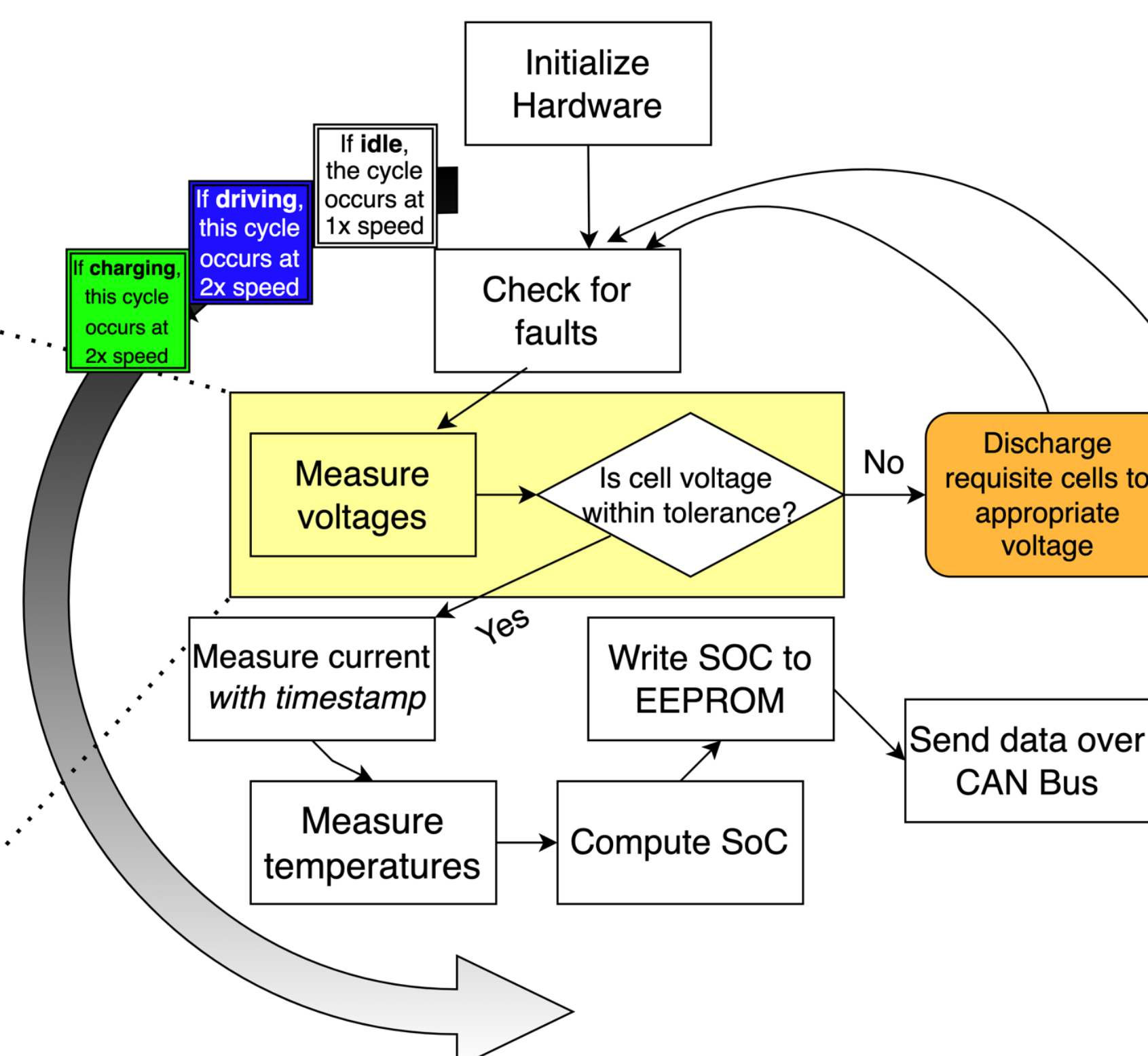
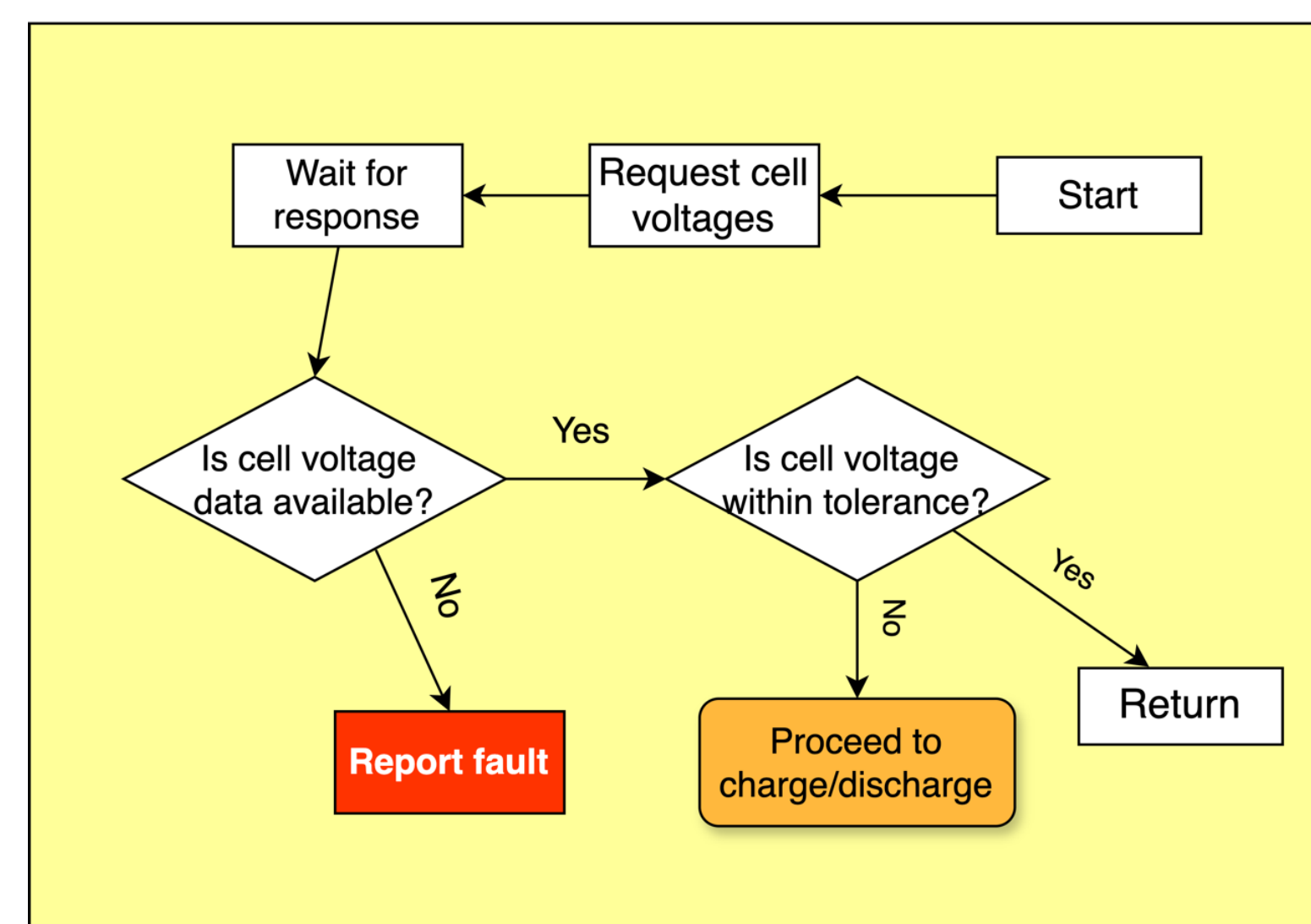
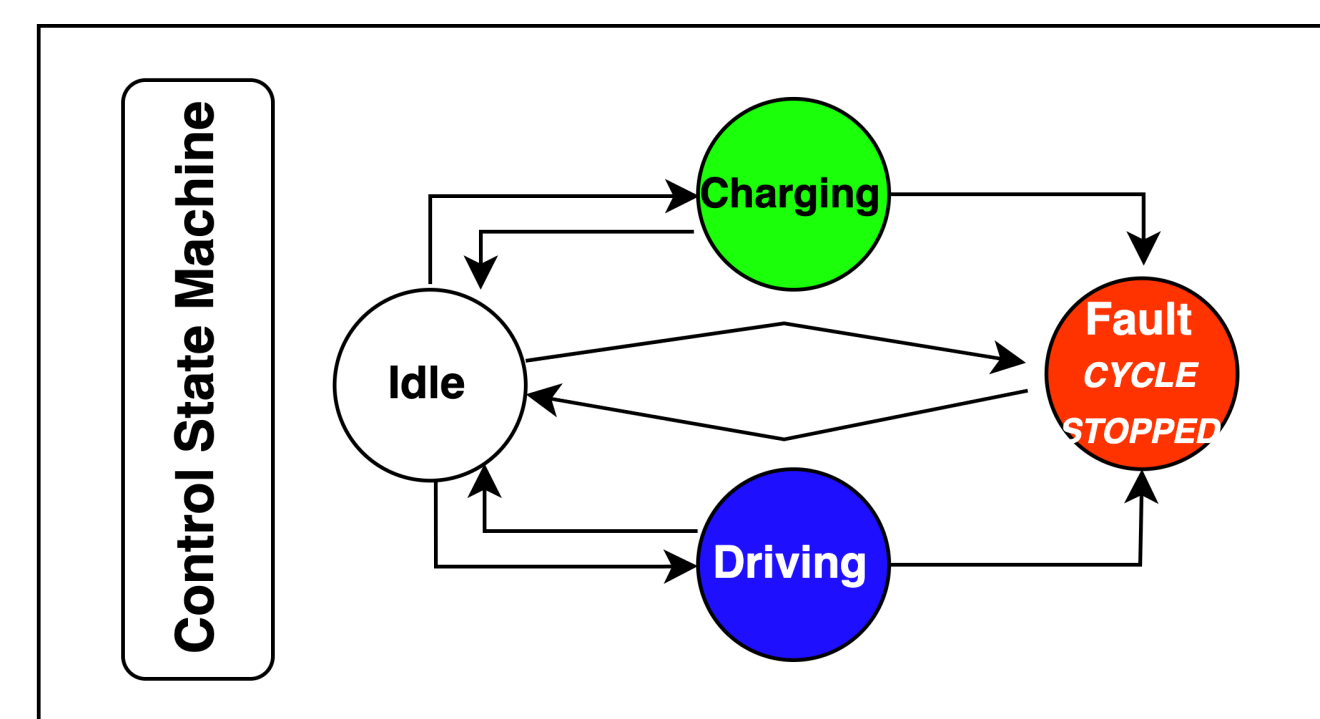
Project Impact

- Our custom BMS is significantly cheaper compared to the Orion BMS.
- Our custom BMS is much smaller and lighter than the Orion BMS, which is beneficial for the RFR racecar, where the overall vehicle weight must be as low as possible.
- Our custom BMS is designed specifically for the geometry of the vehicle, improving the physical integration and packing efficiency of the battery pack.

Project Challenges

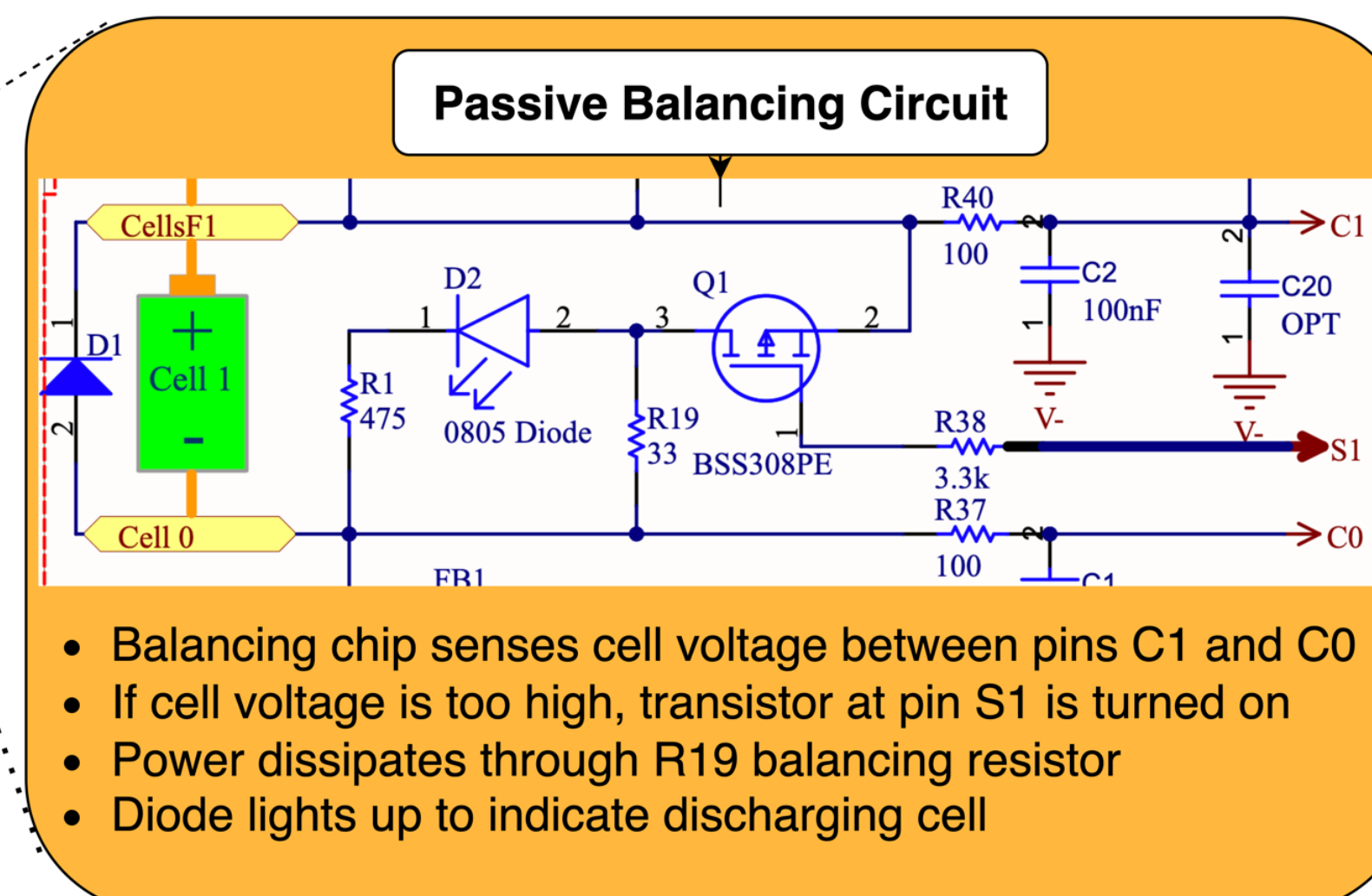
- Debugging the balancing board and the control board
- Programming the STM32 microcontroller
- Carefully soldering all components and minimizing damage to our components when constructing the BMS
- Integration of our hardware components and its software

Control Algorithm



Cost Analysis

Cost of Balancing Board:	\$70.13
Cost of Control Board:	\$32.99
Total Cost of Boards:	\$142.17
Cost of Orion BMS used by RFR in 2023:	\$2735.58
Cost of custom BMS for one RFR car:	\$558.60
Total Saved by RFR:	\$2176.98



Selected References

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