Dataforth LiPo BMCS

Hamad Aldossary, Hunter Browning, Sean Conlin, Darby DeGan
School of Informatics Computing and Cyber Systems

Abstract

Dataforth Corporation tasked us with creating a battery charging and cell balancing system which integrates with their data acquisition line of products for demonstration at trade shows. The Dataforth MAQ20 data acquisition products are integral to our system; they are modular, programmable, multichannel, and fully isolated data I/O devices. We programmed a TI MSP430 to act as our primary control module for efficiently cycling a high performance LiPo battery pack. Our design is built for reliability, signal integrity, and ease of maintenance.

Requirements

- Charge rates ranging from 1C to 3C
- 75°C maximum system temperature
- 60°C maximum battery temperature
- Monitor and regulate voltage drop across each cell
- Acquire control data from Dataforth MAQ20

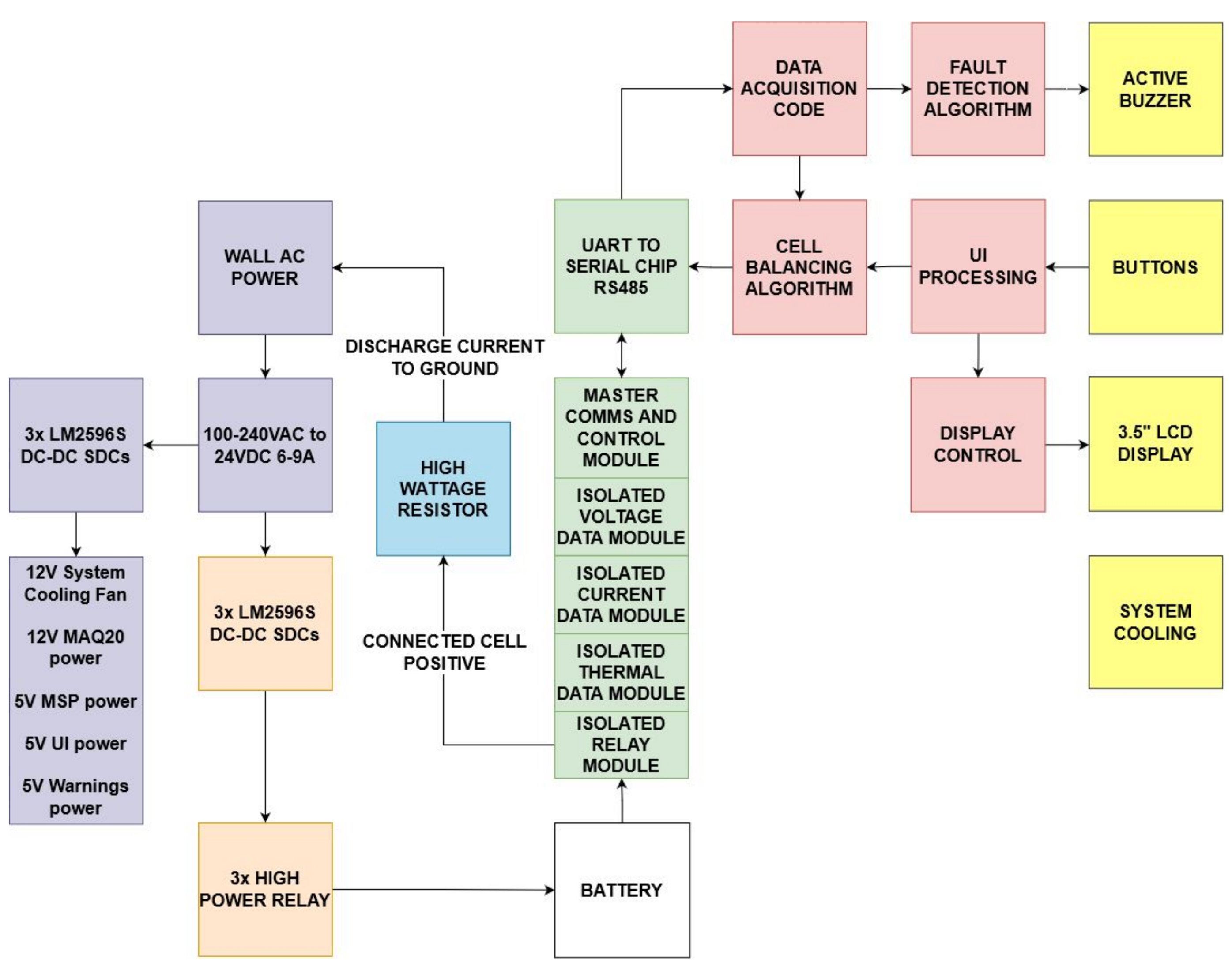

Figure 1: System Architecture

Design

The battery charger's two central components, the MAQ20 data acquisition system and the MSP430 microcontroller, gather data on each of the battery cells and control the charging and discharging of the unit respectively.

- The MSP430 receives voltage, current, and temperature data upon request from the MAQ20 and sends control signals to the relevant subsystems. These signals allow the charger to respond appropriately to nominal cycling conditions or suboptimal states such as cell overvoltage, overheating, or excessive charge rate.
- The MSP430 also sends data to the user interface to display voltage, charging rate, and warnings due to faults in the battery. This is shown in Figures 1 and 3.

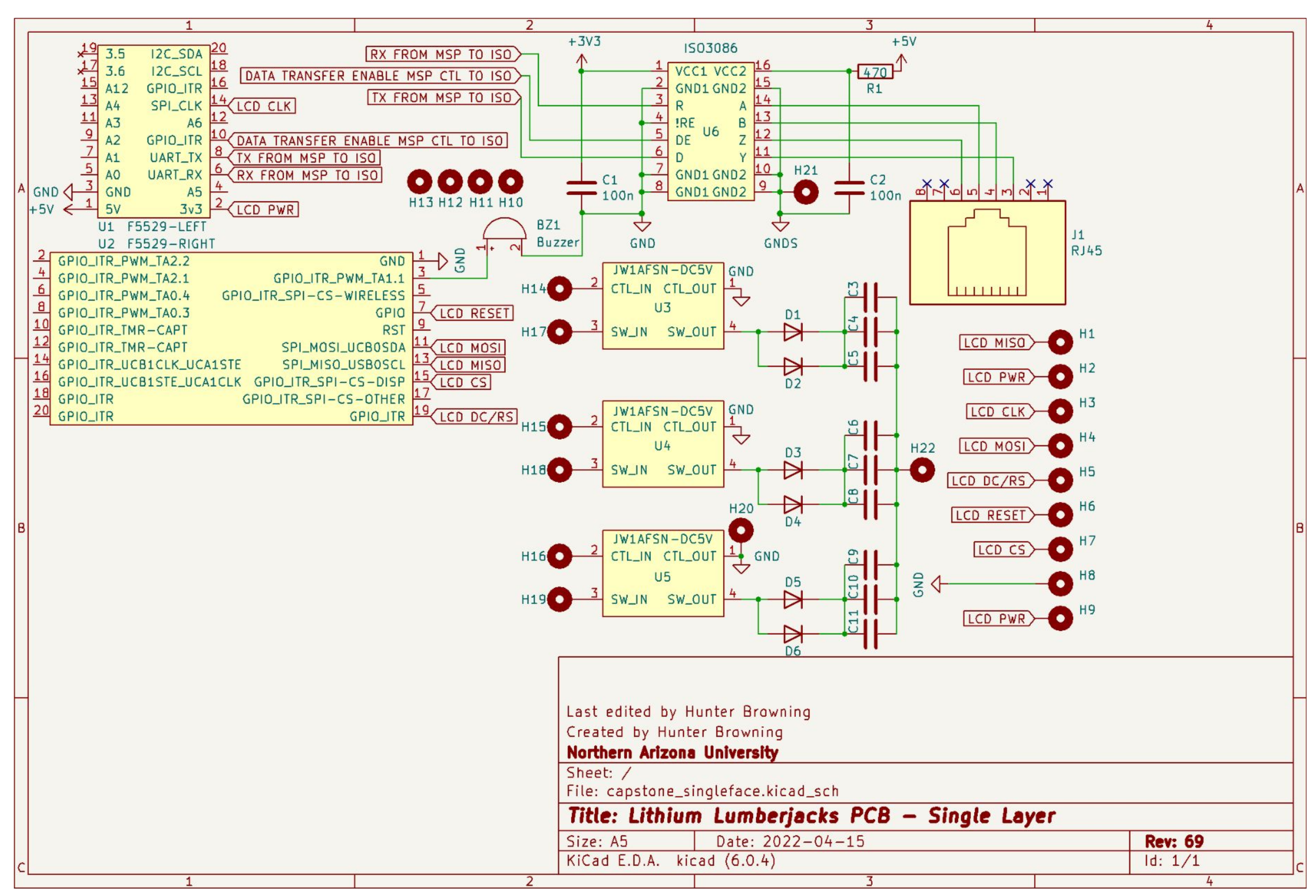

Figure 2: PCB Schematic Layout

Testing

Our team had three major subsystems that passed extensive testing:

- **System Power and Charging:** The first major test was a charging step down converters matrix test. Each converter was given 24V DC from the primary power supply module to create the required power rails for charging the battery, running system peripherals, and powering the microcontroller individually.
- **User Interface:** The second major subsystem test was the user interface. While the LCD screen never reached a functioning state the test did allow the team to see that user input was being seen by CCS. That helped the team to progress and improve the algorithm.
- **MAQ20 Communication:** The first step of this test was to establish that there was communication with the COM4 module by powering the MAQ20 system, featuring the COM4 and ISOV2, and connecting it to the MSP430 via the ISO3086 Serial to UART converter.

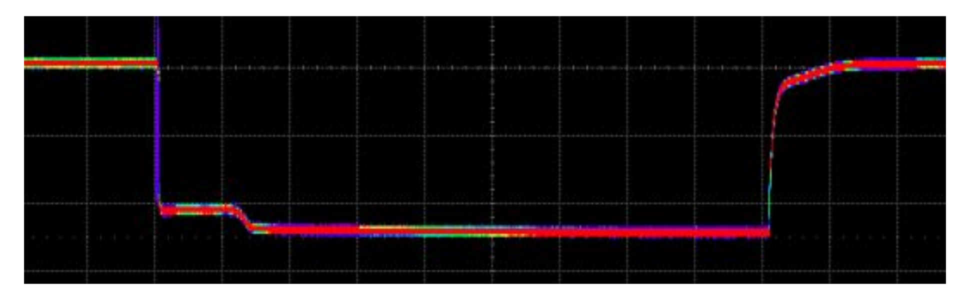

Figure 4: Bounce and rise of the reset switch. Voltage spike on left at first contact of the switch required the use of decoupling capacitors.

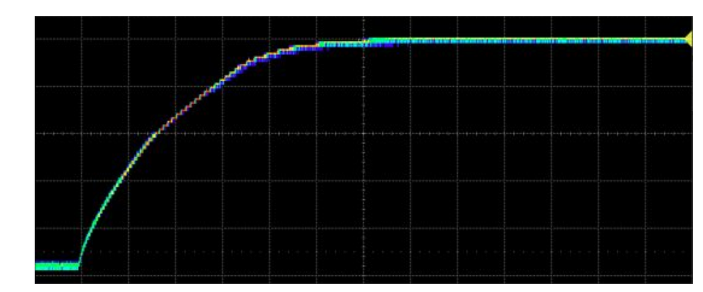

Figure 5: Rise signal for the primary power module upon startup.

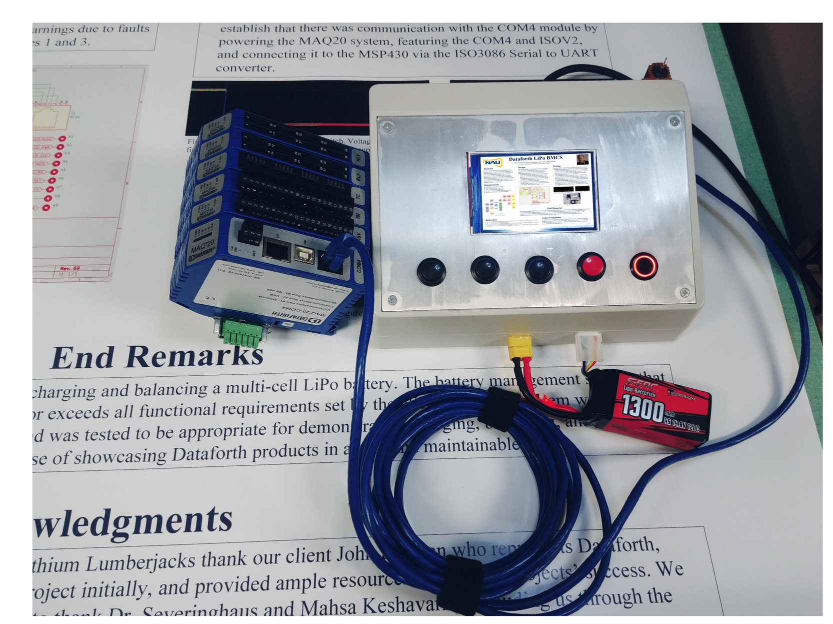

Figure 3: Battery Charger Final Product

End Remarks

Dataforth Corporation initially tasked our team with charging and balancing a multi-cell LiPo battery. The battery management system that was developed follows industry standards and meets or exceeds all functional requirements set by the client. The final system was integrated with the MAQ20 data acquisition system and was tested to be appropriate for demonstrating charging, balancing, and discharging the battery over time for the express purpose of showcasing Dataforth products in a safe and maintainable way.

References

[1] "IEEE Guide for the Characterization and Evaluation of Lithium-Based Batteries in Stationary Applications," in IEEE Std 16791-2017 , vol., no., pp.1-47, 31 Jan. 2018, doi: 10.1109/IEEESTD.2018.8262521.
[2] S. Tseng, T. Shih, S. Fan and G. Chang, "Design and implementation of lithium-ion/lithium-polymer battery charger with impedance compensation," 2009 International Conference on Power Electronics and Drive Systems (PEDS), 2009, pp. 866-870.
[3] "IEEE Draft Standard for the Design of Chargers Used in Stationary Battery Applications," in IEEE P2405/D9.5 June 2021 , pp.1-49, 22 July 2021.

Acknowledgments

We as team Lithium Lumberjacks thank our client John Lehman who represents Dataforth, proposed the project initially, and provided ample resources toward the projects' success. We would also like to thank Dr. Severinghaus and Mahsa Keshavarz for guiding us through the project and mentoring us along the way.

2021-2022