BATTERY MANAGEMENT SYSTEM

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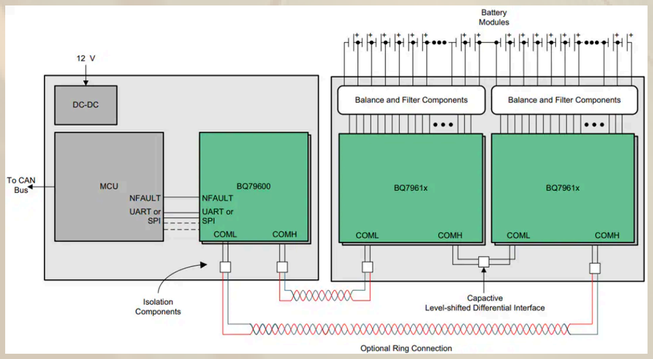
ABSTRACT

Battery Management Systems (BMS) are crucial for safely operating devices with multiple battery packs—from electric vehicles to renewable energy storage. They monitor voltage, current, and temperature, balance cell charges, and maintain stable voltage levels. BMSs optimize performance, prevent hazards, and trigger protections if safety limits are exceeded.

MATERIALS

We built our system using an STM32 microcontroller and two Battery Management System (BMS) chips from Texas Instruments, generously provided through a sponsorship by Tesla.



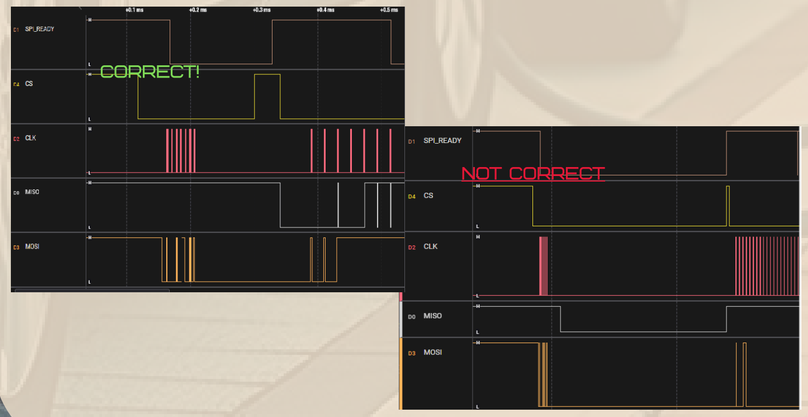
- The BQ79616 is a battery monitor IC capable of monitoring up to 16 cells in series. It also includes 8 general-purpose I/O pins for temperature sensing or control tasks.
- The BQ79600 is a communication interface IC that acts as the bridge device between the STM32 and one or more BQ79616 devices, managing all serial communication using SPI.

This daisy-chained communication setup—using differential twisted pairs—ensures reliable data transmission even in noisy environments and makes the system easily expandable. Additional BQ79616 monitors can be added to the chain, allowing the system to scale with higher-voltage battery packs simply by extending the chain of secondary devices.

CHALLENGES & CONCLUSIONS

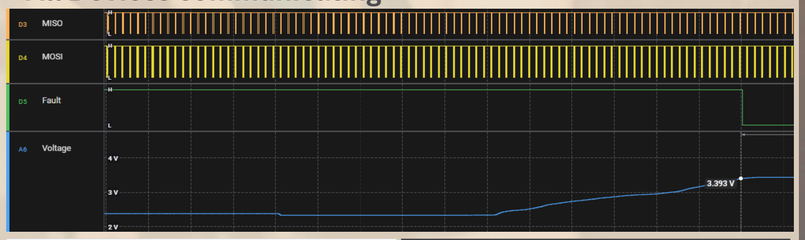
One of the biggest challenges was establishing reliable communication between the STM32 and the two Texas Instruments BMS chips.

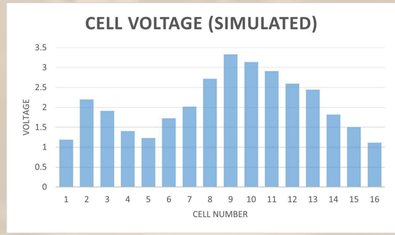
- Serial Communication Stack:
  - Initial difficulties came from correctly configuring the stack for serial communication between the BQ79600 (bridge) and BQ79616 (monitoring) devices.
- SPI with the BQ79600:
  - The BQ79600 does not support simultaneous transmit/receive like typical SPI devices. It requires the STM32 to send a command, then wait for a signal indicating the bridge is ready to respond—handled via a fifth SPI line.
- Solutions & Help
  - Through troubleshooting and consultation with TI and other developers experienced with this chipset, we discovered a key requirement: the MOSI line must remain high even during read operations over SPI.

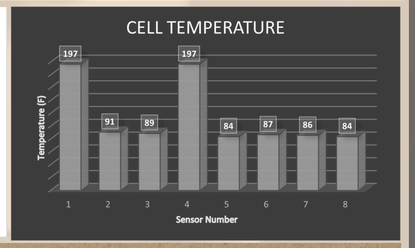


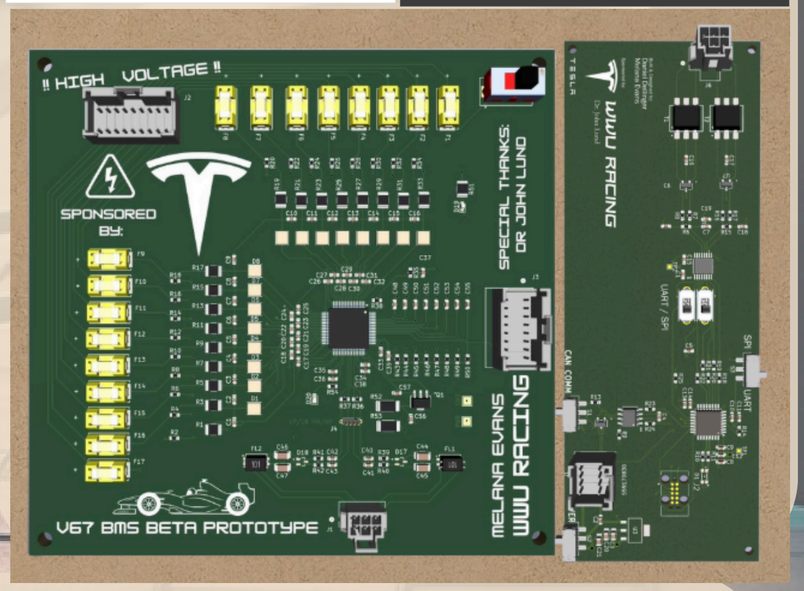
RESULTS

Communication with Fault Line At 3.3V: All Devices communicating









FUTURE DIRECTION:

This project is designed as a Beta Prototype. Future versions will expand the number of secondary PCBs to manage more battery cells. A key goal of our prototype was to ensure that future upgrades would be easy to implement—adding secondaries should require minimal changes to the code and PCB design we deliver to the WWU Racing Team.

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