Joule Tome

Joule Tome Battery Blaster (JTBB)

ELECOMP Capstone Design Project 2023-2024

Sponsoring Company:

EaglePicher Technologies
2000 S. County Trail
East Greenwich, RI 02818
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https://www.eaglepicher.com/

Company Overview:

EaglePicher Technologies is a leading producer of batteries and energetic devices. For more than 75 years, we have been serving the mission-critical aerospace, defense and aviation battery markets. EaglePicher's batteries are a key component of the U.S. space program; our batteries provided the emergency power that successfully brought the Apollo 13 crew home. Today, EaglePicher batteries power the International Space Station, Mars Rovers, commercial jets and helicopters and more than 85 percent of U.S. missile platforms.

Technical Directors:

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Project Motivation:

Under water, over land, in the air and out in space; EaglePicher batteries are providing power to the most extreme applications ever conceived. Our batteries are commonly required to deliver and absorb high power and energy while exposed to dynamic conditions and over a long service life. EaglePicher batteries are unique; testing these batteries is challenging. Will a new battery design deliver the required power without a problem? At the technological limits of battery design, this question is difficult to answer. What are the impacts to reliability and performance when batteries are stressed with very dynamic loads? Available battery test systems are not capable of providing the dynamic load conditions that our batteries are expected to support. This program seeks to develop a battery test system, which is able to replicate the high rate of change power delivery demands our customers require.

Anticipated Best Outcome:

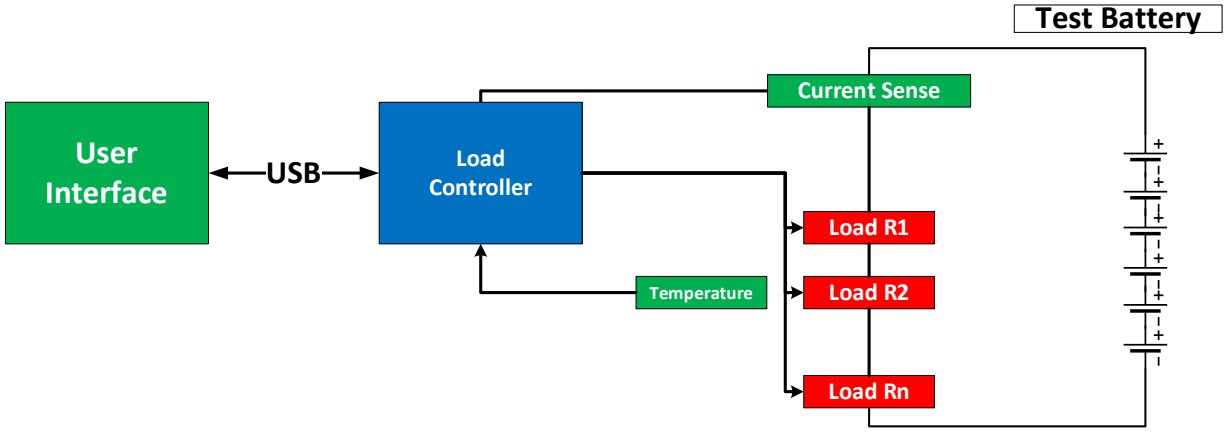
- Develop the Joule Tome dynamic battery load system.
- Merge the Joule Tome with the Eagle-Li platform.
- Demonstrate the performance of the system.
- **Stretch Goal:** Use Dynamic load architecture concurrently with a power supply

Project Details:

The objective of this project is to design and build a system capable of providing load step profiles with microsecond resolution at significant power levels to exercise EaglePicher batteries. The system is intended to enhance the Eagle-Li Battery Management Research System and the Battery Oracle Machine Learning System developed by previous Capstone teams.

> The Eagle-Li system is an investigational platform that integrates a typical battery management system with a high-fidelity data acquisition system.
>
> The Battery Oracle project is an ongoing effort to employ machine learning methods and algorithms to improve the performance of Li-Ion battery management systems.

The system will consist of an embedded controller which manages an array of switched resistive load channels connected to a battery under test. The load channels may alternately be configurable as constant power or constant current. The embedded controller will communicate with a host user interface over a USB channel. The system will manage and execute dynamic load profiles. The user interface will operate on a laptop computer. The system will allow for creation, storage and retrieval of a dynamic load profiles.



Hardware/Electrical Tasks:

1. Along with the CS team, draft a requirements specification for the Joule Tome system
2. Benchmark the Eagle-Li system to baseline the response time for complex profiles.
3. Evaluate and Propose design concepts in accordance with the specification document.
4. Create a preliminary design based on the selected concept. Present a block diagram design and description for review and approval
5. Perform a detailed design of the Joule Tome with a hardware design description and supporting analysis.
6. Present the system design for critical review with EaglePicher support
7. Build and test the Joule Tome system
8. Determine the achievable slew rate in kA/ms or kW/ms
9. Integrate the Joule Tome with the Eagle-Li platform.
10. Present findings

Firmware/Software/Computer Tasks:

1. Collaborate with the electrical team in proposing and evaluating design proposals for the Joule Tome system
2. Draft a software requirements specification for the joule Tome system.
3. Develop a Software Design Description detailing the software architecture
4. Present the SDD for critical review with EaglePicher support
5. Develop functional software in accordance with the SDD
6. Test and validate the operational software on the Joule Tome system
7. Demonstrate the Joule Tome, integrated with the Eagle-Li platform.
8. Present findings

Composition of the Team:

1-2 Electrical Engineers & 1-2 Computer Engineers.

US Citizenship Required; Background Checks will also be conducted before the first kick-off meeting with the Technical Director.

Skills Required:

Electrical Engineering Skills Required:

- Organization and Documentation
- Circuit simulation
- Electrical Safety knowledge and awareness
- Analog circuit design
- Digital circuit design
- Power circuit design
- Knowledge and use of common lab equipment
- PCB layout
- Soldering, Troubleshooting, Repair

Computer Engineering Skills Required:

- Organization and Documentation
- Embedded software development
- User interface design
- IDEs / Debuggers
- Algorithm development
- Analog Signal processing
- Digital Signal processing and Filters
- Test, Debug and Validate code

Anticipated Best Outcome's Impact on Company's Business, and Economic Impact

If successful, this project will accelerate the evaluation and validation of next generation EaglePicher Technology batteries and systems for critical applications.

Broader Implications of the Best Outcome on the Company's Industry:

This project creates an improved method for validating the performance of EaglePicher Technology high performance batteries. Accurately reproducing the operating conditions for demanding applications will reduce the development time for new products. Better laboratory data will also improve our battery modeling, further enhancing our competitive advantage in a fast moving, rapidly evolving market.