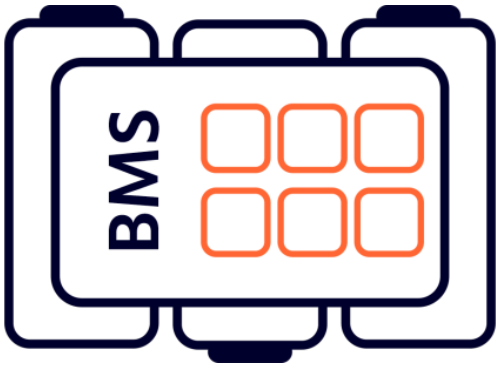
Master's Thesis Proposal

BATTERY MANAGEMENT SYSTEM (BMS) DESIGN FOR HEAVY-DUTY VEHICLES



Scope:

The electrification of vehicles is a transformative shift in the automotive industry, driven by the need for sustainable, energy-efficient alternatives to fossil fuel-powered transportation. By replacing internal combustion engines with electric motors, electrified vehicles (EVs) significantly reduce greenhouse gas emissions, improve energy efficiency, and contribute to cleaner air quality. This transition is fueled by advancements in battery technology, particularly lithium-ion batteries, which offer higher energy density, longer range, and faster charging capabilities. Electrification is not limited to passenger cars but extends to heavy-duty vehicles, and industrial machinery, which can benefit from reduced operational costs and lower environmental impact. The scope of Maxwell & Spark is industrial mobility systems electrification by using Li-ion technology. In this regard, Maxwell & Spark has a plan to develop a new BMS. A Battery Management System (BMS) is crucial for the electrification of vehicles, ensuring the safe and efficient operation of electric vehicle (EV) batteries. For electrifying vehicles, especially heavy-duty applications, a robust BMS is essential to manage large-scale battery packs, ensure energy efficiency, and maintain the overall safety and reliability of the electric powertrain, contributing to the broader adoption of electric mobility. This project aims to implement a universal BMS for different heavy-duty industrial vehicles. After that, a smart energy management system will be designed based on this BMS.

Methodology:

A detailed study on conventional BMS features and specifications will be done. Based on company needs, the new feature will be added to the BMS. To implement the Battery Management System software, designing, modeling, simulating, and improving systems will be done with advanced tools like MATLAB/Simulink. To do that Model-based design and Digital Twin are preferred methods, in which different sections of the system will be modeled and simulated as follows:

1. System Design and Architecture
2. Battery Monitoring and Control
3. Thermal Management
4. Power Electronics and Energy Management
5. Safety and Fault Diagnosis
7. Vehicle Integration and Real-world Application

In the first step, the high-tech evaluation board will be used for hardware tests. When software and hardware will be verified, a new BMS board will be implemented.

Research Objectives:

- Contribute to the system architecture design, focusing on BMS integration into industrial and electrified vehicle platforms.
- Explore and refine the use of Model-based design using tools like MATLAB/Simulink for designing BMS.
- Delivering the software and hardware of the battery management system

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