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NEXT-generation physics and data-based Battery Management Systems for optimised battery utilisation

NEXTBMS - Deliverable report

D3.2 - BMS HW design

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Project summary

NEXTBMS will develop an advanced battery management systems (BMS) built on fundamental knowledge and experience with the physicochemical processes of lithium-ion batteries, which will enable the significant enhance of current modelling approaches, including the readiness for upcoming lithium (Li) battery material developments. These modelling approaches will be further improved by optimising sensors and measurement techniques to meet modelling needs (and optimising models based on physical sensor data) and the physical cell configurations to form a framework that supports improving the battery state prediction and -control. By solving these challenges, NEXTBMS will ensure that the next generation of BMSs will enable higher performance, safety, and longer lifetime of the battery cells for an overall optimal utilisation of the battery system.

Publishable summary

This report provides a detailed overview of the hardware design of a Battery Management System (BMS) of the NEXTBMS project, emphasizing the integration and functionality of its key components. The design encompasses:

1. Daughter Board: This board integrates synchronized voltage and current measurement capabilities, enabling cell-level electrochemical impedance spectroscopy (EIS) measurements. It also incorporates battery balancing circuitry, which has been thoroughly analysed to determine the optimal configuration that aligns with NEXTBMS requirements, ensuring consistent cell performance and precise monitoring accuracy.
2. Main Board: This board comprises two distinct units, designated as the Slave Control Unit and the Master Control Unit, each with the following functionalities
    - Slave controller unit : Responsible for managing and processing the operations of the daughter board (CMB), ensuring seamless coordination and control.
    - Master Control Unit (MCU): Executes advanced physics-based battery models, state-of-charge (SoC) and state-of-health (SoH) estimations, and supports communication interfaces for robust data transfer between cloud and edge systems.
    - Battery protection unit: Incorporates solid-state switches to provide comprehensive protection mechanisms, including controlled charging and disconnection, as well as safeguards against short circuits and inrush current events.
3. Integration of the innovative temperature sensing technology: These components enable precise thermal monitoring and management, ensuring the battery operates within safe and efficient temperature ranges.

NEXTBMS hardware architecture is designed to deliver high performance, safety, and reliability, aligning with the evolving demands of project requirements.