Smart Cell Development Platform for Embedded Battery Management

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Abstract—Embedded Battery Management (EBM) \cite{1}, in contrast to the existing state-of-the-art centralized Battery Management Systems (BMSs) found in Electric Vehicles (EVs) or stationary Electrical Energy Storage (EES) applications, focuses on monitoring and controlling each individual cell of the battery pack with a dedicated Cell Management Unit (CMU). This novel approach of battery management might offer significant advantages over the centralized BMSs, such as higher modularity, plug-and-play integration and shorter time to market. The combination of a battery cell and a CMU forms the smart cell and the system-level functionalities of the EBM are performed in a decentralized manner by the network of smart cells, with the help of the computational and communication resources of CMUs. We present a development platform for such a smart cell enabled EBM. The development platform consists of two components, the hardware platform and the software platform. The hardware platform of the demonstrator comprises of battery cells and their dedicated CMUs which consist of a smart cell controller board and an active cell balancing board. The software platform provides the smart cell firmware as well as a software tool for verification of active cell balancing architectures and a smart cell simulator for simulating system-level EBM functionalities.

I. DEVELOPMENT PLATFORM

The individual parts of the development platform are discussed in the following.

A. Hardware Platform

The hardware platform of the demonstration consists of battery cells, active cell balancing boards and smart cell controller boards as shown in Fig. 1. The active cell balancing board and the smart cell controller board forms the Cell Management Unit (CMU) of the smart cell. The CMU boards are custom designed Printed Circuit Boards (PCBs) and are powered from the monitoring cell itself. A Controller Area Network (CAN) bus communication is implemented between the CMUs and the system-level functionalities of the EBM are performed in a distributed fashion by co-ordination via messages, forming a network of smart cells.

![Fig. 1: Hardware platform of the smart cell demonstrator consisting of battery cells, active cell balancing boards and smart cell controllers.](image1)

B. Software Platform

The software platform consists of the smart cell firmware that executes on the CMU microcontroller, enabling monitoring, controlling and communication functionalities. Moreover, we present a smart cell simulator which enables system-level simulation of a network of over 100 smart cells as shown in Fig. 2(a), that are difficult to realize in a hardware platform. The smart cell simulator is supported in the back-end by the detailed analytical models of the underlying hardware \cite{2} and it allows to implement and verify several battery management algorithms and functions. Finally, the design and verification tool \cite{3} for active cell balancing architectures as shown in Fig. 2(b) enables to design efficient active cell balancing architectures and verify their functionality, in order to avoid any possible short circuit between cells.

REFERENCES