IMPEDANCE–BASED BATTERY MANAGEMENT SYSTEM FOR SAFETY MONITORING OF LITHIUM-ION BATTERIES

Abstract:

Multi-frequency impedance measurements have been recognized as a technique for the monitoring of individual calls in Lithium-ion (Li-ion) batteries. However, its practical introduction for battery management has been slow, mainly due to added size and larger operating power requirements. Here, we describe a small, low-power, multi-frequency (1-1000 Hz) impedance-based battery management system (BMS) for multi-cell batteries of varying capacities. This BMS ensures battery safety and efficiency by tracking and acting on emerging mismatches and other electrical and thermal abnormalities in each individual cell without adding cost, volume, weight and power, compared to conventional BMSs. Multi-cell batteries face a unique problem that single cell Li-ion batteries do not: mismatching of one or more cells is detrimental to the safety and efficiency of the entire battery. Thus, cell matching is an important first step required for safe operation of multi-cell Li-ion batteries. Cell mismatch can occur due to battery over-discharge, overcharge, internal and external shorts, etc., or even when leaving a battery unused for an extended period (calendar aging). Predicting a mismatch is essential for a battery's thermal safety and electrical efficiency. Conventional BMSs typically monitor cell voltages and surface temperature. However, these measurements and related protocols have not succeeded in ensuring battery safety or improving efficiency. Data for batteries with intentionally calendar-aged and over-discharged cells convincingly demonstrate that such BMSs cannot identify cell mismatches and emerging failures. In contrast, the impedance-based BMS, described here, tracks, identifies, and acts on changes in the internal state of each cell continuously in real time, including battery charging, discharging, and at rest.

Reference:

[1] Bliss G. Carkhuff, Plamen A. Demirev and Rengaswamy Srinivasan, "Impedance-Based Battery Management System for Safety Monitoring of Lithium-Ion Btteries.", *IEEE Trans. Ind. Electron.* , vol. 65, no. 8, August 2018.

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