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Enhancing UPS battery life through C-rate control with a supercapacitor-assisted battery management system

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Battery management systems (BMS) are essential for optimizing the efficiency and dependability of batteries. BMS employs various methodologies and techniques for state of health (SOH) determination, state of charge (SOC) estimation, cell balancing, voltage regulation, current regulation, and overload prevention. This study aims to create a Supercapacitor Assisted Battery Management System (SCABMS) to enhance battery performance and lifespan using a C-rate controlled system by analyzing battery dynamics and load demands. The suggested Battery Management System (BMS) incorporates supercapacitors (SCs) to effectively handle sudden increases in power demand, thereby lessening stress on the main battery and improving its overall lifespan. Previous research indicates that reducing the C-rate extends battery lifespan. The C-rate control method is used to manage battery discharge, with the system functioning in two modes depending on the load current. The first is when the load is drawing less than the set current where the load current is completely drawn from the battery without the SC assistant. When the load current exceeds the set current value, the current control circuit begins to limit the battery current for the selected value. In this scenario, the load voltage drops, and the parallel connected buck-boost converter is used to fix the load voltage into the rated value by supplying the rest of the load current. The buck-boost converter output voltage is fixed for the load voltage. The implemented prototype incorporates supplementary functionalities encompassing cell balancing, voltage regulation, current regulation, and overload protection within its BMS. The real-time current and voltage monitoring system was integrated into BMS to ensure a constant C-rate in charging/discharging cycles. Also, the battery's operating periods with and without the Battery Management System (BMS) under the same load circumstances should be compared. This technology successfully reduces power fluctuations and guarantees safe equipment shutdown in case of a power outage. The results indicate a well-maintained c-rate and show the potential of integrating SCABMS in high-power-demanding situations, subject to improvements in efficiency and practicality.

Keywords: Battery discharge, Battery Management System, Battery lifetime, C-rate of Battery, Supercapacitor

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