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DEVELOPMENT AND QUALIFICATION OF A SCALABLE COTS-BASED LI-ION BATTERY RESOURCE MANAGER FOR SATELLITES IN LOW EARTH ORBIT

Abstract

This paper introduces a COTS-based (Commercial of-the-shelf) lithium ion battery system for satellites in LEO (Low Earth Orbit). The COTS battery system is developed to reduce the price of future satellites. Development and testing of the battery system is supported by the fundamental knowledge of batteries at the DLR's Institute of Engineering Thermodynamics. The approach of using only or mostly COTS components including the battery cells has an influence on system architecture, electronic design, software and the qualification process. In this paper the challenges during the development of such a battery system are described. The battery system has the ability to measure temperature, voltage and current of each battery cell. This allows for further functions like cell balancing, state of charge and state of health estimation. Moreover, the aspect of scalability is outlined. The scalability will allow usage of one battery system and its functionality in several satellites with different power needs. The fundamental building block of the battery system is a cell module that consists of eight battery cells. By stacking several modules inside of a structure to form one battery unit the capacity can be extended. Further, it is possible to use several battery units in a larger satellite to increase capacity and maximum current. This modular approach also makes the battery system redundant. During the development various commercial battery cells were investigated and tested for reliability and life expectancy. A crucial part of the success of the battery system is the durability of the battery cells. Studies of the influences of temperature, current, SOC (state of charge) and DOD (depth of discharge) on cell durability were conducted. Further work will be dedicated towards the state estimation of SOH (State of Health) and RUL (Remaining useful life). Furthermore, a qualification plan for the finalized battery system was defined to verify that all components are able to withstand the space conditions and to stay operable during a LEO mission.