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ADVANCED HYBRID ENERGY STORAGE SYSTEM FOR SMALL SPACECRAFTS IN DEEP SPACE

Abstract

Nowadays, small spacecrafts evolution introduced the use of CubeSats for deep space exploration missions. One of the crucial challenge was to design an Energy Storage system able to operate in extreme environmental conditions. In this paper an innovative Hybrid Energy Storage device, based on the coupling between a Li-Ion Battery pack and a Battery Auxiliary System (BAS), will be presented. In parallel, technological evolutions allowed to develop Mini-Satellites (100-500kg) having payloads more and more performing. Given their reduced mass and high performances, MiniSats physical characteristics are suitable to deploy Satellites constellations within a single launch campaign, so that it is possible to maximize the number of data gettable from a single mission. Therefore, a great challenge could be to develop MiniSats for future constellations and to apply them to the study of outer planets. The development of a suitable Energy Storage system is one of the first steps, thus a mission of a CubeSat will be necessary, with the aim to In-Orbit Demonstrate (IOD) the new Energy Storage concept functionality and performance increasing due to BAS implementation. In the frame of an Italian space program, S.A.B. Aerospace is qualifying a modular Battery pack for MiniSats in LEO missions, equipped with SAFT MP 176065 XLR Li-Ion cells. Capacity fading of MP XLR cells, evaluated for a 12 years mission at 20% DOD LEO cycling, has been estimated by SAFT around to 25% of initial cell capacity. Thus, S.A.B. Aerospace intends to improve the design of its recurring Battery pack, with the aim to make it suitable for deep space exploration missions. To this scope, as first step S.A.B. Aerospace is approaching to the development of an Hybrid Energy Storage System for CubeSats equipped with BAS to IOD functionalities of the concept. A Battery Management System (BMS) will be implemented, in order to control Battery functions and communication by using electronics with embedded algorithms. The benefits introduced by the BAS will be assessed, with the purpose to: enhance power peaks management; save mass and volume to design a suitable thermal control sub-system and the BMS. Through thermal, electrical and radiation analyses S.A.B. Hybrid Energy Storage System performance will be estimated with respect to a possible application. A trade-off analysis in relation to others Hybrids Energy Storage devices will be carried out, in order to demonstrate the performance increasing due to the use of BAS.