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ADVANCED POWER SYSTEM ARCHITECTURE FOR FUTURE SPACECRAFT: CONCEPT AND HIGH-LEVEL DESIGN

Abstract

Future space applications, from Low Earth Orbit Satellites to planetary exploration spacecraft, will require reliable and innovative power systems. The key elements for the next generation power systems are high reliability, high specific power, lifetime and cost. The high reliability is the cornerstone of every single spacecraft. A high specific power system allows the reduction of the overall system mass for a given power budget. But it allows also to build more powerful spacecraft within a given mass figures. Lifetime is another crucial parameter of every space system. The target lifetime is usually achieved by an intentional overdesign of the system. The option of the on-orbit servicing is becoming a viable solution in the next future but currently there is no system designed for such occurrence. The financial effort associated to the entire lifecycle is also one of the key figures of a space program. This includes development, industrialization, system integration, testing and other operative aspects. The proposed electrical architecture aims to match all the aforementioned key elements by adopting innovative solutions. In particular, this paper contains a highly diversified system based on Solar Arrays, Fuel Cells, Kinetic Energy System and ultracapacitors. This architecture is easily scalable due to the modular nature of its components and could be integrated in an on-orbit serviceable spacecraft. For commercial application, this may lead to an increased profitability. In the domain of space exploration, it could be integrated into manned and unmanned spacecraft, ensuring a reliable, serviceable and easy to maintain power system. The paper is composed by three main sections. The first describes the main electrical architecture of the system, depicting the benefits and the main mission constraints under the technical and operational point of view. The second part reports a first order sizing of the Electrical Power System, highlighting the design trade-offs and the main technical budgets, with an emphasis on the power source, storage and utilization strategies. The last part reports the main challenges and open points towards the adoption of this electrical architecture into a spacecraft.