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ELECTRICAL AND THERMAL BATTERY MANAGEMENT TO SUPPORT DEEP-SPACE
EXPLORATION: LICIAcube EXAMPLE

Abstract

The growth of deep space missions based on microsatellite-class platforms boosted the development of new technologies, leading the world of small satellites to a straight expansion. One of the principal problems in a micro-satellite mission aiming at a remote location is the electrical and thermal management of the battery over long transfers, which could limit the maximum feasible cruise period or even compromise the mission. Considerations related to specific behaviors of certain battery chemistries can pose additional constraints e.g., spending a long time at a very high State-of-Charge (SoC) can increase the capacity fading of a Li-ion battery.

Argotec, an Italian aerospace company based in Turin and Maryland, designed and developed a rad-hard, high-reliability External Battery Charger (EBC) to support the transfer phase of LICIAcube spacecraft from Earth to the Didymos asteroids system. Developed under the management and the funding of Italian Space Agency, the EBC unit, together with the LICIAcube Satellite, has been chosen to take part of the first planetary defence mission, as part of NASA DART probe. The EBC has been connected between DART and LICIAcube battery, in order to charge the battery before the deployment of the micro-satellite.

The EBC has two main features: it is capable of charging the battery of the microsatellite and it manages a couple of heaters with two different thermal profiles, one for long cruise phases and one used during actual charging operations. Both the output current for the battery charging and the temperature ranges of the heaters actuation can be reprogrammed according to mission-specific needs.

The high-reliability of the EBC is not only assured by the usage of high-rel components (with TID up to 300krad) but also by leveraging an architecture design to be fault-tolerant. In order to not occupy precious space in the micro-satellite nor in the mother spacecraft, the EBC has been designed to be externally mounted to a typical 6U CubeSat dispenser, with a volume of 173 x 157 x 42 mm and its total weight is less than 1.3 kg.

The DART Probe has been launched in November 2021, and it is currently directed to Dimorphos, the moon of Didymos, where it will impact to deflect its orbit. This paper aims not only at describing the EBC, its role and its impact on mission design, but also at providing a first set of flight data collected during LICIACube first months of cruise.