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WIPTHERM: HYBRID POWER HARVESTING SYSTEM FOR A 3U CUBESAT

Abstract

CubeSats are becoming an alternative challenge for space exploration. Research in the technology and applicability of these small platforms has received an increasing interest in the last years. They represent an emergent technological market (CAGR growth of 37.91 % in the 2017-2021 period), while a variety of fields like meteorology, climatic research, transportation safety, or navigation is resorting to this technology.

As more complex CubeSats missions are defined, a natural increase in the mission power demand occurs. In a scarce-resource environment like the space, this demands the development of new ways of harvesting spacecraft electrical energy.

An alternative to traditional energy harvesting systems composed of solar panels and batteries is Wireless Energy Transfer (WET). It originates in the electromagnetic transfer, proven to have two important limitations: high power efficiency decrease at distances bigger than coil size and the need of mobile parts. A new approach is proposed as a solution to these limitations: the possibility of mounting on a 3U Cubesat photo-thermoelectric generator array devices that can convert photonic energy to electrical energy via thermal gradient generation. For creating the thermal gradient, a long-range laser source targets cells from each array forming the photo-thermoelectric plasmonic system of HPTP.

Two possible scenarios are presented in terms of mission requirements and analysis: a controlled pulsed large-range laser source located on Earth, in the case of Earth-orbiting missions, or on a "master spacecraft" meant to charge a "slave spacecraft" , in a deep-space mission. For Earth, Mars and Jupiter, a simulation of the total energy produced by solar panels and the HPTP system is presented to illustrate the potential use of the WiPTherm technology. In each of the scenarios, key measures of effectiveness will be analyzed to overcome potential CubeSat and constituent subsystems overheat, by comparison with nominal component and shield temperature profiles in both eclipse and illuminated cases when the HPTP system is not used. Pointing budget accuracy and jitter for targeting the HPTP generator cells and required laser link budget for a planned energy transfer efficiency of up to 10 % of the source power are other challenges covered in the presentation, apart from research topics from a multidisciplinary group covering nanomaterials science, optics, photonics, and CubeSats power systems engineering.

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