SPACE PROPULSION SYMPOSIUM (C4)
Electric Propulsion (4)

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OFF-THE-SHELF ELECTRIC PROPULSION SYSTEM FOR NANOSATELLITES

Abstract

Cubesat is one of the most fast-growing sectors in the space industry allowing cheap access to space. One of the main limiting factors of their lifetime is the natural, drag-induced, de-orbiting. Indeed, the lifetime of the cubesats, normally launched into sun-synchronous or LEO orbits at a height of 600 Km, is about three years.

To improve cubesat lifetime Clyde Space Ltd, Mars Space Ltd and the University of Southampton have started a study, founded by the ESA ITI program, to adapt a Teflon fed PPT to a 3U cubesat: its mission will consist in doubling the lifetime of the cubesat, compensating the atmospheric drag for a period of 3 years. Ablative Pulsed Plasma thrusters have been chosen as propulsion subsystem thanks to their high scalability in terms of geometry, power input and performance, and thanks to their high reliability and easiness of control. In this paper the design process of a PPT for a 3U cubesat will be presented together with the experimental results regarding its actual performances.

This PPT will be required to work with 1W power input and the 2.3 J energy for each shot will be stored in a 3.2 mF capacitor bank, charged to 1200 V. Given the cubesat strict dimensions requirements, the electrode length has been fixed to 1.5 cm, while a side-fed design has been selected in order to save space. In the design process the thruster performance has been analyzed assuming two different values of the Ibit/E ratio, 23 mNs/J representing the "best case" performance level and 12 mNs/J to represent a "worst case" scenario. Assuming different values of the ratio of the propellant mass per shot over the discharge energy (Dm/E) the total energy needed and total impulse delivered by the thruster can be calculated. If the thruster will work in its "optimal" conditions, delivering 23 mNs/J, the mission can be accomplished, given that the mass ablated per unit of energy is below 5.63 mg/J. This value and the corresponding minimum required efficiency of 4.7

Total mass and volume of the propulsive system will be reported together with the expected performance in terms of impulse bit, specific impulse and cubesat life extension. The measured current waveforms, mass ablated per pulse and impulse bit will also be reported and compared with the predicted values. Moreover, the efficiency of the thruster will be calculated.