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ADVANCED POWER BUDGET ESTIMATION THROUGH MULTI-DOMAIN SIMULATION FOR A 1U CUBESAT

Abstract

Miscalculated power budget should never be a reason for a CubeSat mission to fail. This paper presents the design and implementation of a multi-domain simulator designed to accurately predict in-orbit power consumption on a 1U CubeSat. The study will consider 6S, the CubeSat developed by PoliSpace, a student association of Politecnico di Milano, and part of ESA's "Fly Your Satellite! Design Booster" program. 6S includes a large COTS battery module and five body mounted solar panels. The study establishes a deep mathematical framework crucial for comprehending the interaction of electrical and thermal power dynamics, essential for mission success. A comprehensive and nonlinear energy balance model has been designed, considering the influence of thermal aspects, time of the year, selected orbit and many other factors. The thermal and power sides of the simulation work in a closed loop: on a satellite as small as 6S every change in temperature has a profound influence on the power systems. In this study this connection will be analyzed and valuable simulation results will be presented. The need for the development of this simulator comes from the necessity of providing a more accurate estimation of the energy availability than what is typically done with spreadsheets, as lack of precise estimation didn't allow for proper mission planning. The simulation has been developed in MATLAB Simulink, using SimScape for thermal and attitude simulations. It allows the user to set simulation parameters such as satellite modes, relating directly to operations planning, radiation degradation of the solar cells, failure modes such as single cell or whole panel failures. The simulation also accounts for different AOCS modes, such

as sun pointing, tumbling, or spinning. It also accounts for the closed loop control of battery heaters, which are a major power draw on spacecrafts with very tight power budgets. The study aims to give a proven and easy-to-implement approach to develop a tailored simulation for any CubeSat mission, and reduce power budget related risks and uncertainties to allow for better and more accurate flight operations planning.