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For a successful space program: Quality and Safety! (1)

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STRUCTURAL AND THERMAL MODEL TESTING CAMPAIGN OF A 1U CUBESAT

Abstract

Cubesat platforms are subject to high in-orbit failure rates. This is often associated to a lack of a proper testing campaign. To mitigate the risk, the 6S CubeSat team is putting a lot of effort into testing and validation activities of the satellite's thermal and mechanical models. The 6S CubeSat is the first student-made 1U CubeSat of Politecnico di Milano, developed within PoliSpace students' association and ESA's "Fly Your Satellite! Design Booster" programme. The model philosophy adopted for the CubeSat's verification activities involves the use of a Structural Thermal Model (STM). The purpose of the STM is to validate both the thermal and mechanical models, developed respectively in ESATAN and Abaqus, through a single hardware assembly and testing campaign.

The paper will present the STM model design definition and manufacturing, as well as the thermal and the mechanical tests performed on it. The components of the STM are modelled to reproduce the actual thermal, mechanical, and geometrical properties, as well as the heat generation, of the final components mounted on the Flight Model (FM). Structural compliance with the FM is achieved by positioning mockup masses in the place of the CubeSat's internal components. Thermal compliance, on the other hand, is achieved using materials with similar thermo-optical properties to the actual components and by reproducing the internal dissipations with electrical heaters. Temperature, acceleration and stress data are collected using sensors that will be positioned based on knowledge of the satellite's geometry, critical zones, interfaces and in compliance with the location of the heaters.

The paper will analyze the STM Thermal Balance (TBal), shock, sine and random vibration tests procedures. The main focus of the TBal test presentation will be the plateaus duration, the temperature definition and the analysis of the retrieved data. Beyond that, the objective of the mechanical tests is to assess internal stresses and displacements on the CubeSat's primary and secondary structural components, ensuring that they will be able to sustain the flight thermo-mechanical loads. This approach completes the design phase for both the thermal and structural subsystems, addressing the inherent complexity of the configuration that could not be fully accounted for in a purely simulated environment.