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DESIGN AND FABRICATION OF DEBRISAT – A REPRESENTATIVE LEO SATELLITE FOR IMPROVEMENTS TO STANDARD SATELLITE BREAKUP MODELS

Abstract

This paper discusses the design and fabrication of DebriSat, a 50 kg satellite developed to be representative of a modern low Earth orbit satellite in terms of its components, materials used, and fabrication procedures. DebriSat will be the target of a future hypervelocity impact experiment to determine the physical characteristics of debris generated after an on-orbit collision of a modern LEO satellite. The major ground-based satellite impact experiment used by DoD and NASA in their development of satellite breakup models was SOCIT, conducted in 1992. The target used for that experiment was a Navy transit satellite (40 cm, 35 kg) fabricated in the 1960's. Modern satellites are very different in materials and construction techniques than those built 40 years ago. Therefore, there is a need to conduct a similar experiment using a modern target satellite to improve the fidelity of the satellite breakup models.

To ensure that DebriSat is truly representative of typical LEO missions, a comprehensive study of historical LEO satellite designs and missions within the past 15 years for satellites ranging from 1 kg to 5000 kg was conducted. This study identified modern trends in hardware, material, and construction practices utilized in recent LEO missions. Although DebriSat is an engineering model, specific attention is placed on the quality, type, and quantity of the materials used in its fabrication to ensure the integrity of the outcome. With the exception of software, all other aspects of the satellite's design, fabrication, and assembly integration and testing will be as rigorous as that of an actual flight vehicle. For example, to simulate survivability of launch loads, DebriSat will be subjected to a vibration test. As well, the satellite will undergo thermal vacuum tests to verify that the components and overall systems meet typical environmental standards. Proper assembly and integration techniques will involve comprehensive joint analysis, including the precise torqueing of fasteners and thread locking. Finally, the implementation of process documentation and verification procedures is discussed to provide a comprehensive overview of the design and fabrication of this representative LEO satellite.

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