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DESIGN AND TESTING OF A SOLAR SAIL DEPLOYMENT UNIT FOR A SOLAR SAILING NANOSATELLITE

Abstract

The paper presents the design and testing of a solar sail deployment unit used in COEPSAT-2, a nanosatellite being developed by students of College of Engineering, Pune (COEP) which aims to demonstrate orbit manoeuvring using a solar sail while characterizing the charged particle density in space. The solar sail used is an aluminium deposited thin polymer film of area 40 metre-square. The large size of the solar sail creates the requirement for a system to store and deploy it without damage. The sail deployment unit of COEPSAT-2 has a deployer section that contains four booms coiled around a spindle driven by a stepper motor, and a storage unit consisting of four quadrants of the sail wound around a spindle. A novel feature is incorporated that provides the ability to couple the two spindles when required. Guide rollers are used in the deployer to direct the booms along a confined path while compressing rollers through springs provide the force to prevent blossoming. Curved slots have been provided in the deployer to maintain tangential contact between the compressing rollers and booms as the booms are deployed. Criteria such as the number of creases, storage design, and packing efficiency were evaluated for various folding patterns which led to the selection of the single-z folding pattern. The storage unit was designed and optimized for minimum size of the spindle which led to an assembled spindle design instead of a singular part. This prevents the use of fasteners for the attachment of sail to storage spindle which simplifies the assembly process. Full scale testing of the solar sail unit is enabled by an indigenously developed test set-up. Review of other such test setups and study of feasibility of the methods suggested therein are also presented here. Results of the tests include forces on the booms during sail deployment for different grid sizes of the folding pattern, measured using a miniature load cell. The test setup enabled

to create a low friction deployment platform and minimize the effect of gravity on sail and boom during deployment. This was achieved by using Teflon sheets and fixtures for supporting booms. The test bed was designed considering modularity for easy assembly and access to different parts of the test bed for adjustments. This paper serves to enhance the present knowledge in solar sail deployment systems and to introduce a newly developed system for use in the aforesaid satellite mission.