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DESIGN AND TESTING OF A SOLAR PANEL DEPLOYMENT MECHANISM FOR A SOLAR SAILING NANOSATELLITE

Abstract

Solar cells are used in satellites to satisfy the power demand. In case of solar sailing missions, the sunlight falls only on a limited portion of the satellite due to the presence of the large solar sail and hence the solar cells attached to the satellite walls may not satisfy the power requirements. To increase the number of solar cells facing the sun, deployable solar panels with solar cells fixed on them are needed. These panels are kept in a stowed state using a nylon wire before launch owing to the constrained volume availability in the launch vehicle. This paper is about the design and testing of a reliable, minimum power consuming solar panel deployment mechanism for COEPSAT-2 which is a nanosatellite being developed by the students of College of Engineering, Pune (COEP). The satellite aims to demonstrate orbit manoeuvring using a solar sail of area 40 metre-square while characterizing the charged particle density in space. The satellite has four solar panels with nine solar cells on each panel. The mechanism uses an outside stop type hinge, loaded with a 180 degree torsion spring of stiffness 90 N-mm/degree. One leaf of the hinge is fixed on the satellite while the other movable leaf holds the solar panel. The working of the mechanism consists of three stages viz. release, deployment and locking. When the nylon nichrome mechanism is actuated the panel gets deployed by the torsion spring. The locking is done after deployment using a cam follower mechanism in which the follower fixed on the free end of a flat spring moves into a slot made on the cam integral with the movable leaf. Due to the geometry of the mechanism there is a definite relationship between upward movement of the follower block and rotation of the panel. Constraints on the length, allowable deflection of the free end of the flat spring and the need of sufficient locking force demanded a material for flat spring with high Young's modulus and high tensile strength

which led to the selection of carbon fibre. Design of the hinge, torsion spring and hinge pin was done using analytical calculations and structural simulations. The mechanism was successfully tested experimentally by deploying the panels horizontally to minimize the effect of gravity. Thus this paper provides the design and validation of an effective method of deployment and locking of the solar panels for a solar sailing nanosatellite.