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Author: Mr. Dhananjay Ashok Gujarathi
College of Engineering Pune, India

Mr. Dnyanesh Rokade
College of Engineering, Pune, India
Mr. Amey Landge
College Of Engineering , Pune, India

DESIGN OF A SOLAR ARRAY DEPLOYMENT MECHANISM FOR A NANOSATELLITE

Abstract

Roll-Out Solar Arrays (ROSA) are an alternative to existing solar array technologies. These arrays have a compact design, are more affordable, and offer autonomous capabilities. The student satellite team at COEP Technological University, Pune, is working on the development of a 3U nanosatellite, PS-4 that aims at the experimental validation of a solar array deployment mechanism using booms and a stepper motor. A deployment unit is used to deploy the solar array. The unit consists of two end spindles for the attachment of booms and a central spindle over which the solar array is stowed in a rolled state. A spreader bar is used, that establishes a connection between the two booms and the solar array. It ensures uniform, simultaneous deployment of booms and the solar array. The dimensions of the array are 0.16 m * 0.6 m, giving it an approximate area of 0.1 m2. Two metallic booms, 0.6m each, have been used for deployment. The flattened height of the booms is constrained between 18mm-20mm, considering the geometrical parameters of the deployment unit. Two cross sections of the boom, i.e., C-shaped and Mini-Collapsible Tubular Masts (mini-CTM), are primarily considered and experimented upon, based on the stresses in the coiled state and the forces acting on the boom during and after the deployment while maintaining a significant factor of safety. A test setup has been designed to measure the forces acting on the booms during the deployment process. FEA simulations have been performed to deduce optimal parameters for the boom cross-sections. Four extension springs, in a rectangular arrangement and four compression rollers have been used to provide radially inward forces at the periphery of the stowed booms, keeping the radius of coiling minimum at all stages of deployment. Spring parameters have been found out by considering the inter-layer friction between the shells of the coiled booms and the changes in coiling radius during the deployment. The paper includes the design of the deployment unit considering the blossoming of the support booms for the solar array and the dynamics of the deployment process.