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Generic Technologies for Nano/Pico Platforms (6B)

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INFLATABLE ANTENNAS FOR SMALL SATELLITES

Abstract

Small satellites such as nano-satellites or CubeSats have greatly reduced the cost of access to space. Commercially available components built to well defined standards have allowed for modular development of these satellites which also reduces risk and development time periods. Communication systems on board these satellites face significant challenges due to low available mass and volume. This restricts available transmit powers. For such systems, maintaining high transmit data rates, typically required for science quality data requires high gain antennas (HGAs). Conventional HGA technology for nanosatellites are restricted to reflect-arrays and complex linkage systems. The ability to package these systems compactly comes at the cost of greatly enhancing mechanical complexity of their deployment. Hence, these are not readily scalable to larger sizes. FreeFall Aerospace along with University of Arizona is focusing on the development of inflatable spherical antenna systems for small satellites. These systems are comprised of Mylar spheres with a partially reflective surface inflated pneumatically from sizes ranging from half to 2 meters. The metallized portion of the sphere serves as a spherical reflector which, together with a custom line feed, forms a high gain, electronically steerable antenna system. This technical approach can provide the missing link in creating high bandwidth telecom systems for smallsats. Deployment and packaging systems have been designed and prototyped for these inflatable systems that fit into 1-2 U CubeSat form factors making them well suited for small satellites ranging in size from 6U and above. The design of these systems focus separately on deployment and packaging aspects. The deployment mechanism is based on a simple spring loaded burn-wire release mechanism with very low risk of failure and extensive flight heritage. Deployment forces have been modulated to lower the risk of introducing un-damped vibratory modes on inflation. The inflation system itself has been designed to prevent over-pressurization of the membrane. Packaging of the membrane has been tested with multiple folding patterns aimed at maximizing packing efficiency and minimizing creases on the membrane's reflective surface. We present thermo-structural analysis of the inflated membrane's mode shapes in different thermal environments for axi-symmetric and non-axisymmetric deployment cases. Experimental tests in a thermal vacuum chamber are presented and compared to simulations. Our work presents a mechanically simple deployable antenna system that can be scaled over increasing sizes for higher gain while conforming to constraints imposed by CubeSat design standards.