SPACE SYSTEMS SYMPOSIUM (D1)
Enabling Technologies for Space Systems (2)

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PERMEABLE RODS GROUND TESTING SYSTEM FOR CUBESAT ANGULAR VELOCITY AND RESIDUAL OSCILLATIONS DAMPING

Abstract

Permeable rods have been used in passive magnetic attitude stabilization systems since the beginning of space era, as an efficient means to damp out the satellite angular velocity and residual spacecraft oscillatory motion. A new interest in these kinds of systems has arisen with the nanosatellites coming on the space market and the advent of small university satellites, such as Cubesats. Permeable rods can be interesting for these kinds satellite for two main reasons: when the satellite is passively stabilized, either magnetically, gravitationally or aerodynamically, and when there is a possibility that the angular velocity exceeds its maximum allowed threshold for the on-board attitude control system to work correctly. This last situation is related to the fact that the separation system for these kinds of satellites is typically based on spring release mechanisms, which can give a high angular impulse to the spacecraft. The resulting angular velocity can be very high and, in case the on board sensors sampling rate is too low with respect to the angular rate, the on-board attitude determination algorithms functionality is impaired. A safe measure to recover from these kinds of failures consists in installing a passive energy damping system on-board, to damp out the kinetic energy and slow down the spacecraft rotational motion. Despite its conceptual simplicity, the physical phenomena governing the permeable rods magnetization in orbit are very complex and permeable rods design is not trivial. The design process involves the selection of the right combination of permeable rods material, technological manufacturing process, shape, number and location on board the spacecraft. Approximate analytical models describing the permeable rods magnetic behaviour, based on simplifying assumptions, are available for single, magnetically isolated, permeable rods. This is rarely the case in small spacecraft, in which a number of permeable rods are installed to reach the necessary damping effectiveness. Moreover, a lesson learned from the UNISAT-3 microsatellite in orbit performance is that the permeable rod magnetic parameters strongly depend on the manufacturing process. Therefore permeable rods performance can be assessed only by measurements. In this paper a ground testing system is described, for the measurement of a permeable rod system performance in a 1U-Cubesat volume, including a uniform magnetic field generator, pick-up coils and processing algorithms. This system allows to measure the effect of interactions among the rods and to compare different material and geometric configurations performance, improving the confidence in the predictions of in orbit performance.