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MECHANICAL DEVELOPMENT, PRODUCTION AND TESTING OF A MINIATURIZED HIGH FIDELITY ACCELEROMETER FOR A CUBESAT

Abstract

There are numerous scientific missions that rely on a high fidelity accelerometer. The application of these devices ranges from fundamental physics and on-orbit thruster characterization, to modeling gravitational and aerodynamic perturbations in orbit. These high fidelity accelerometers have been used across different missions like the Gravity Probe, the LISA Pathfinder and Champ. Moreover, this technology has not yet been successfully miniaturized for its usage within the Cubesat form factor . While the specific scientific application of the accelerometer defines its feasibility for usage in a Cubesat, studies suggest there are possible missions such as atmospheric density characterization in this type of spacecraft. This paper presents the development and validation of the mechanism for a miniaturized high fidelity accelerometer.

The high fidelity accelerometer here presented measures the relative displacement of a free flying test mass isolated from external perturbations to which the satellite is subjected to. The most important mechanical advancement from this proposal is a mechanism that constrains the test mass during the launch phase and releases it at the center of the test chamber once it is in orbit. Additionally, a convenient feature is to have the ability to enact this mechanism whenever the test mass needs to be recentered. Moreover, the selection of materials has to comply with the scientific requirements on how good the test mass shall be isolated from external forces while meeting the mass and wear requirements of the mechanism. All of these with a target volume of 1U of the Cubesat.

The work presents the design and testing phases of the mechanical device associated with this high fidelity accelerometer. The design phase considers a variety of finite element analysis on different configurations of the mechanism. It also presents a study on the convenience of the materials selected using Ashby materials charts. The production phase identifies the appropriate manufacturing processes for a Cubesat's scale. The testing campaign consists of functionality testing, a durability analysis of the mechanism and finally a comparative test once the mechanism has been subjected to vibration testing.

Additionally, the tests must also determine the need and quality of lubrication on the mechanism as well as define operational requirements to be considered in the operations design of the mission.