IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Interactive Presentations - IAF MATERIALS AND STRUCTURES SYMPOSIUM (IP)

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MECHANICAL ANALYSIS OF A NOVEL CYLINDRICAL LANGMUIR PROBE MODULE OF CUBESAT UNDER LAUNCH VIBRATION ENVIRONMENT

Abstract

A Langmuir probe has been used as an onboard scientific instrument on satellites and sounding rockets for in-situ study of ionospheric plasma characterization. However, one of the most important criteria in the mission's success is assuring the structural safety of a deployable Langmuir probe module in a severe launch vibration load environment and a reliable release action in an orbit. This work presents a novel Cylindrical Langmuir probe module combined with a burn wire triggering-based holding and release mechanism (HRM) for a 3U CubeSat application. In a launch scenario, the proposed deployable Langmuir probe module ensures the structural safety of the module as well as guarantees reliable release in an orbit. The holding and release action of the module is achieved by a burn wire triggering-based mechanism. The design feasibility and structural safety are validated by performing the mechanical analysis. The modal analysis is performed to determine eigenfrequency, mode shapes, mode participation factor, and effective mass of the Langmuir probe module as it is the most fundamental of all dynamic analyses. Additionally, the module's dynamic clearance in a poly picosatellite orbital deployer (P-POD) was investigated. Random vibration and static analysis were conducted to validate the module's design effectiveness and structural safety under qualification-level launch vibration stresses.

Keywords: Langmuir Probe, CubeSat, Structural Analysis, Launch Vibration Environment