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Educational Pico and Nano Satellites (4)

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EXAMINING OF MECHANICAL SHOCK WAVES ON NANOSATELLITES

Abstract

Spacecrafts experience intense dynamic and static loading during the launch. Specifically, the transient pyroshock events could lead to a catastrophic mission failure. Nanosatellites are integrated to the launch vehicle as secondary payloads through a complex clamping and joints mechanism that mitigate the risk of transient and shock vibrations. However, due to the emerging technologies of micro-launchers and small rockets, the Nanosatellites will be very likely launched as the primary payloads and experience severe shock levels. Therefore, examining the effects of pyroshock events on Nanosatellites is becoming essential for future Nanosatellites developers. This paper proposes a novel CubeSat deployment system design that mitigates shock vibrations intensity. Space-qualified passive isolator Sorbothane thin films were integrated within the dynamic envelope of a testpod to examine the attenuation and isolation effects of the mechanical shock waves. A metal-to-metal Mid-Field Shock Testing (MFST) facility was manufactured to perform in-plane (IP) and out of plane (OOP) impacts. MFST is capable to generate shock waves up to 10,000 g for OOP direction and 5000 g for IP excitations. The experiments illustrated the capability of Sorbothane isolators in attenuating the mechanical shock waves by 7 dB in total. Sorbothane isolators attenuated shock levels by 3 dB and the flat adapter (mechanical joint) attenuated the shock levels by 4 dB. The measurements were successfully validated using positive and negative Shock Response Spectrum (SRS) approach. In addition to that, the commercially available finite element analysis software ABAQUS was utilized to verify the experimental measurements and simulate the mechanical shock waves using explicit analysis. The entire measurements and numerical analyses were qualified using NASA shock testing tolerances. This paper would provide the future Nanosatellites developers with a complete set of Nanosatellites vibration testing protocol that includes sine, random and shock vibrations testing procedures.