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Abstract

The Utah State University Space Dynamics Laboratory (SDL) and Materials Physics Group (MPG) have developed an extensive versatile and cost-effective pre-launch test capability for verification and assessment of small satellites, system components, and spacecraft materials. The facilities can perform environmental testing, component characterization, system level hardware in-the-loop testing, and qualification testing to ensure that each element is functional, reliable, and working per its design. Unique capabilities of SDL's Nano-Satellite Operation Verification and Assessment (NOVA) test facility include: (i) mass and moment of inertia testing using a high resolution mass measurement table to determine the center of gravity and an inverted pendulum table; (ii) dynamic magnetic field environment capable of simulating varying magnetic fields and interorbital variations in field strength accomplished using a large Helmholtz cage; (iii) *ex situ* solar simulation and solar array testing using a solar simulator light source; (iv) speed, jitter, and torque measurements of attitude control systems and small satellites weighing <10 kg; (v) attitude control sensor calibration and characterization using a combination of a zero-gauss chamber for magnetometer calibration, an Earth horizon simulator for horizon crossing sensors, and illumination sources for sun/moon recognition sensors; and (vi) communications protocol testing. Additional SDL environmental test facilities for small satellites include: (i) vacuum chambers for simulating the near-vacuum environments of space; (ii) thermal chambers for temperature bakeout and thermal swing characterization; (iii) outgassing measurement capabilities for screening new materials and (iv) a vibration table capable of a suite of sinusoidal and random vibration profiles to simulate environments seen on launch vehicles. Complimentary testing for potential environmental-induced modifications of small satellites, components, and materials are conducted at the MPG's Space Environment Effects Materials (SEEM) test facility in their new Space Survivability Test (SST) high vacuum chamber; this provides long-duration exposure of these elements to simulated space environment conditions. The facility simulates critical environmental components including the neutral gas atmosphere/vacuum, the far UV through near IR solar spectrum, electron plasma fluxes, and temperature with exposure to within <5% uniformity over the area of a cubesat face at intensities for 5X or greater accelerated testing. A Sr^{90} β-radiation source produces a high-energy (~100 keV to >2 MeV) spectrum similar to the GEO spectrum for testing of radiation damage, single event interrupts, and COTS parts. An automated data acquisition system periodically monitors and records the real-time environmental conditions—along with *in situ* monitoring of key satellite/component/sample performance metrics and characterization of material properties and calibration standards—during the sample exposure cycle. A wide array of results for a prototypical 1U cubesat—including performance of solar arrays, electronics, sensor and memory components, radiation damage, *basic* communication responses, structural integrity, etc.—acquired at the NOVA and the SST facilities are presented to demonstrate their combined test capabilities.

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