Small Satellite Verification and Assessment Test Facility with Space Environments Effects Ground-testing Capabilities

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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 Sr90 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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