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COMBINED ENVIRONMENTAL TESTING DEVICE FOR PICOSATELLITES

Abstract

As access to space conditions becomes more available, both technically and economically, scientists' interest in launching finer and more sophisticated experiments grows. To be qualified for launch, such experiments need to be carefully tested prior to the event. The tests should represent actual launch conditions as closely and in a detailed manner. Typical tests for payload include: vibration tests, thermal and vacuum tests, and sometimes shock tests. Acceleration tests with a centrifuge are rarely performed. In traditional static tests the load application tools are usually jacks or weights, in conjunction with a proper levers system to introduce forces on attachment points or pressure on surface pads. Alternative systems as air-bags are sometimes used. Such approaches are also notorious for their tendency to both over- and under-test at the same time. These are scolded as inadequate and in some cases causing damage to otherwise suitable for spacecraft structures. Furthermore, all these tests are performed separately, which disables study on any crosscorrelation effects, for example changing of stiffness of some elements in changing temperature. A prototype of a solution is suggested in combined environment testing device for picosatellites. A prototype has been successfully tested in the Large Diameter Facility in ESTEC. The aim of the device is to recreate as accurately as possible: dynamic, thermal and vacuum environment of a space rocket. The prototype hosted a 1U CubeSat dummy with sensors to measure various environments. Dynamic environment includes both high frequency but low amplitude vibrations as well as low frequency, quasi-stationary accelerations. This has been achieved by placing a custom designed shaker table inside the centrifuge. By controlling centrifuge, high amplitude, quasi-stationary rocket acceleration due to thrust can be recreated. By controlling the shaker, high frequency vibrations can be recreated. On the shaker table, a small vacuum chamber is be mounted. Additionally thermal testing is also possible. Many vehicles experience simultaneous acceleration and vibration loads during their missions and are therefore susceptible to nonlinear structural responses that can only be evaluated by combined environments testing. This novel approach to testing may allow payloads and vehicle subsystems to be tested in a more realistic setting prior to operations in the real world, and may lead to higher performance systems, as well as result in reduced cost. Such a device altogether will be able to perform not only tests, but also to recreate conditions of a given rocket launch to enable investigation of failures.