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PREDICTING TRANSMISSIBILITY OF RAIL-TYPE CUBESAT DEPLOYERS WITH ISOLATION

Abstract

Secondary payload accommodations often place CubeSats in unusual locations on the launch vehicle resulting in severe dynamic environments. CubeSats and their payloads have recently become more sophisticated and thus, more sensitive to these harsh environments. This is even more relevant for larger CubeSats (6U and 12U) with very sophisticated but fragile instruments. Developers of this class of CubeSats desire low environmental loads that can be accurately predicted, in order to ensure mission success through analysis. Predicting environmental loads in rail-type CubeSat deployers is difficult due to the lack of linear CubeSat constraints. One option to address these problems is to incorporate isolation at the rail-to-CubeSat interface. Thus reduce environmental loads and providing a more linear CubeSat constraint that can be modeled using traditional methods.

Preliminary system test results show load reductions that range from 23% to 63% when compared to an un-isolated baseline 3U case. In order to accommodate larger payloads, the isolation design has been implemented on rail–type 6U and 12U deployers, and tested with a variety of payload mass configurations to determine the load reductions accomplished by the system.

Predicting spacecraft dynamic levels in rail-type CubeSat deployers can be very difficult due to the poorly defined interfaces between the deployer and the spacecraft. Implementing a rail isolation system effectively removes some of the degrees of freedom in the CubeSat constraints and simplifies the analysis. Test data has been compared to preliminary deployer finite element models to investigate the accuracy of the analytical dynamic levels in the isolated configuration. The finite element model uses spring-damper elements to model the isolated rail constrains. The results of the analysis are very promising and demonstrate a significant improvement in prediction accuracy. In the paper, analysis fidelity improvements are identified and explored. Models for 3U, 6U, and 12U deployer are developed and compared to experimental results to determine how accurately dynamic loads can be predicted in a number of rail-type deployers with isolation. The results indicate that this system can be accurately modeled to provide predictable environments to CubeSat payloads.

Overall, the internal rail isolation system developed successfully addresses the severe dynamic loads during launch and provides an analyzable interface for CubeSat developers to determine the response experienced by the CubeSat. The resulting CubeSat deployer systems will provide significant benefits to CubeSat developers working to incorporate ever more sophisticated payloads even if they are more fragile than existing systems.