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Author: Mr. Andreas Dueck
RWTH Aachen University, Germany

Mr. Christopher Zeis
RWTH Aachen University, Germany
Dr. Athanasios Dafnis
RWTH Aachen University, Germany
Prof. Kai-Uwe Schröder
RWTH Aachen University, Germany

TUNING GUIDELINE FOR A SHOCK TEST FACILITY FOR SPACECRAFT EQUIPMENT QUALIFICATION

Abstract

A tuning guideline for a newly built shock test facility for spacecraft equipment qualification is presented. The method is based on parameter identification methods considering geometrical, physical and mechanical parameters of the test environment. The tuning guideline is investigated in the framework of the qualification process of spacecraft equipment within the research project iBOSS (intelligent Building Blocks for On-Orbit Satellite Servicing and Assembly) funded by DLR Space Administration.

Within the iBOSS project a modular satellite system is under development. The satellite is subdivided in cubical building blocks which carry the payload. The building blocks are connected by multifunctional interfaces. These interfaces provide mechanical coupling and energy, data and heat transfer. Especially the integrated mechanisms and electronical and optical components are prone to shock events. The shock events occur during stage separation, clampband release and appendage release and are characterized by high acceleration amplitudes over a wide frequency range. To minimize the risk of failure, the respective equipment is exposed to the specified shock environment before flight in a test.

For a planned in-orbit demonstration of the iBOSS concept an extensive test campaign will be performed. For the shock tests a shock test facility is developed in line with the guidelines of ECSS. Two different test concepts are investigated. The first concept consists of an aluminum shock plate which is supported by foam. For the second concept the aluminum plate is suspended on four ropes, one at each corner of the aluminum plate. The excitation of the plate in out-of-plane and in in-plane direction is carried out using two pendulum hammers. The shock impact is applied not on the shock plate directly but on variable anvil plates which are attached to the shock plate.

The two shock test concepts are tuned by a series of tests. Therefore, a number of parameters are identified and their influence is systematically examined. These parameters include the hammer mass, the drop height, the hammer head diameter and material, the specimen location, the specimen mass and geometry, the impact location and the anvil plate material. The test results and explicit numerical finite element analyses are subjected to appropriate parameter identification methods in order to derive a general applicable tuning rule. The resulting guideline is applied to the iBOSS multifunctional interfaces.