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MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures I - Development and Verification (Space Vehicles and Components) (1)

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DESIGN STRATEGY, NUMERICAL ANALYSIS AND TESTING OF A MODULAR SATELLITE STRUCTURE

Abstract

The full modular architecture presented in this paper subdivides the common monolithic satellite bus on subsystem level. A catalogue of independent system building blocks or modules called iBLOCKs (intelligent Building Blocks) is defined where each distinct module carries components of a certain subsystem. By subsequently connecting these iBLOCKs via a multifunctional, androgynous interface, which transfers mechanical loads, electrical and thermal energy and data, the satellite bus is reassembled in a modular way. Assembly, disassembly, upgrade, reconfiguration and repowering of such a satellite systems by means of robotic manipulation in space is possible by adding or removing modules. This research project is funded by the German Aerospace Center DLR Space Administration.

The paper focuses on the primary structure design of these building blocks which is responsible for the satellite's overall integrity and provides interfaces and hard points for subsystem components and payload. It has to withstand all static and dynamic launch loads and a wide spectrum of environmental loads during its lifetime in space. Within this project a cubic shaped building block which is assembled of a CFRP frame structure and sandwich side panels was developed.

Design driving parameters of the iBLOCK are a standard load bearing design featuring a high thermal stability, flexible mounting positions for components and payloads and high volume manufacturing. On the basis of an a-priori load envelop for LEO missions mechanical launch behavior and thermo-mechanical analysis are presented using sophisticated numerical models.

In order to verify the theoretical approach validation and margin tests are carried out in a thermal vacuum chamber. Additionally, mechanical tests of the adhesively bonded frame structure, mechanical analysis and testing of the CFRP sandwich panels with and without openings, inserts and stiffening elements as well as the thermo-mechanical performance of the primary structure are performed.

The overall aim of this effort is to fit into the standardization philosophy of the researched modular satellite architecture.