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Author: Mr. Martin Losekamm
Technische Universität München, Germany, m.losekamm@tum.de

Mr. Martin Dziura
Technische Universität München, Germany, martin.dziura@tum.de
Mr. Johannes Gutsmiedl
Technische Universität München, Germany, johannes.gutsmiedl@tum.de
Mr. Martin Langer
Technische Universität München, Germany, martin.langer@tum.de

INVESTIGATING METAL CORE RIGID-FLEX CIRCUIT BOARD ASSEMBLIES FOR CUBESAT STRUCTURAL DESIGN

Abstract

Since its introduction in 1999, the CubeSat standard provided the basis for the development of a satellite platform for small technology demonstrator and science missions. Due to comparatively low costs required for development and launch, and the opportunity to use commercial off-the-shelf standardized subsystems, CubeSats are now widely used within universities and companies worldwide. However, the satellites' small form factor requires extreme miniaturization and tight packing of subsystems, creating new engineering integration challenges which have previously not been encountered in space applications. In scientific CubeSat missions the payload further reduces the volume and mass available for the satellite bus. Deployable solar arrays are oftentimes necessary to meet the payload's power demand. In combination, these factors result in complex satellite systems that are difficult to integrate and test on such a small form factor.

In traditional satellites, the main structure is usually assembled before integrating subsystems, an approach hampered by the tight packing in CubeSats. Consequently, subsystems and structural elements are mostly integrated simultaneously, resulting in complicated integration procedures and restricted access for testing. Based on experiences from the First-MOVE and AFIS-P missions at Technische Universität München (TUM), a new design approach for TUM's follow-on MOVE-II satellite was investigated: All subsystems are first joined together into a stack – the satellite 'core' – having sufficient stability for handling during assembly and test. Structural elements are then added from the inside out. This complete reversal of the traditional order was inspired by the design of the UWE-3 satellite, developed by the University of Würzburg.

In order to minimize mass, most structural elements are made of rigid-flex printed circuit boards with an aluminum metal core. Solar cells, attitude determination sensors and magnetic torquers are directly integrated into these side panels, drastically reducing the need for cable connections. Rigid-flex bridges are used to establish power connections between deployable solar arrays and the spacecraft bus. A new hold-down release mechanism utilizing shape-memory alloy springs is integrated into the structure. Attitude sensors and magnetic control coils are interfaced through distributed microcontroller systems, operating on a system-wide data bus. By integrating these active components into the side panels, testing and replacement of components is facilitated. This paper presents a series of prototypes, as well as first results from mechanical, thermal and electrical tests.