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UWE-3, IN-ORBIT PERFORMANCE AND LESSONS LEARNED OF A MODULAR AND FLEXIBLE SATELLITE BUS FOR FUTURE PICOSATELLITE FORMATIONS

Abstract

Formations of small satellites are promising as they could provide advantages in temporal or spatial coverage and resolution at reasonable costs. As a midterm objective of the University of Wuerzburg Experimental Satellite (UWE) program a small formation of cooperating distributed small spacecraft is planned to be realized within this decade. The third generation of UWE satellites carries experiments to evaluate real-time attitude determination and control as an important technical milestone for formation applications.

UWE-3 introduces a modular and flexible picosatellite bus as a robust and extensible base for future missions. The key design driver was to achieve a very low power consumption of the COTS-based system while maintaining a robust and fully functional miniature satellite. Further, the generic design is optimized to support robust and rapid development, integration and testing of the satellite as well as easy maintenance, extension and replacement of subsystems in any configuration during development or integration. In order to achieve a consistent realization of the mentioned aspects all subsystems of the satellite have been designed and developed in Wuerzburg. UWE-3 features a dual-redundant ultra-low power onboard computer, a redundant and scalable distributed electrical power system, a fully redundant UHF communication system and an attitude determination and control system being capable of operating continuously on the small-scale picosatellite.

After successful integration, testing and launch in late 2013, UWE-3 is currently operated in low Earth orbit and its performance in Space environment is analyzed. This contribution will briefly outline interesting technical aspects of the UWE bus before discussing in more detail the satellite's performance during its first months of operation.

In particular the individual subsystems' performance characteristics will be discussed, including thermal aspects on the passive temperature controlled satellite as well as in-situ measurements of power generation and power consumption during operation. The COTS-based technologies response to its LEO radiation environment is described in terms of observed anomalies during operation and corresponding recovery mechanisms. Furthermore, the satellite's ADCS operations ranging from initial motion determination at rotation rates up to 25deg/s, a rapid detumbling phase in which the satellite's rotation was slowed down to about 1deg/s within 7 minutes up to subsequent attitude control using magnetictorquers and a single-axis reaction wheel will be presented. Attitude determination with a high accuracy in the order of a few degrees could be shown and will be discussed in detail. The contribution finishes with some lessons learned during integration, test and operation phase.