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THE ON-BOARD COMPUTER OF THE ACUBESAT MISSION

Abstract

The architecture of the On-Board Computer (OBC) subsystem for CubeSats is naturally evolving, characterized by the integration of low-power, lightweight components, cutting-edge microprocessors harnessing multiprocessor or heterogeneous computing, and sophisticated algorithms enabling autonomous operation in increasingly compact platforms.

Despite the ongoing standardization efforts within the space community, the unique payload requirements of the AcubeSAT mission, an open-source nanosatellite that aims to probe the effects of radiation and microgravity on eukaryotic cells in LEO within the FYS3 program of the ESA Education Office, necessitated the development of a custom, cost-effective module. This module shall not only meet the spatial and functional demands of the mission but also serve as an educational tool, providing valuable hands-on experience to project members involved in designing space-grade equipment and developing critical system software that conform to the ECSS Standard.

The single printed circuit board (PCB) hosts two distinct subsystems: one resembling a conventional OBC responsible for telecommand execution, telemetry fetching, onboard time synchronization, in-orbit patching, and FDIR. The second entails the implementation of an Attitude and Orbit Control System (AOCS) for both nominal and downlinking scenarios, facilitating a directional patch antenna for payload data transmission. The hardware for each subsystem resides on separate sides of the PCB and includes non-volatile memories for critical data and telemetry storage, custom radiation-tested LCL protection circuits, sensors, interfaces with the Payload Subsystem, the actuators and the rest of the in-house and COTS components, all while maintaining compatibility with the LibreCube standard. At the core of each subsystem lies a Radiation Tolerant Arm Cortex-M7 MCU. This architecture not only decentralizes processing power, mitigating single points of failure but also leverages redundancy capabilities.

This paper aims to elucidate the decision-making process, design iterations, and development stages of the custom board and accompanying in-house software. Insights garnered from the initial partially successful environmental test campaign at the ESA CSF will be shared, along with the ensuing preparations, results, and lessons learned from subsequent testing endeavors in April 2024. Furthermore, the current developmental status will be discussed alongside future EMC testing, integration plan on a FlatSat, and prospects for the open-source design as a cost-effective, and modular solution that can be tailored with little effort for upcoming missions.

Repository link: https://gitlab.com/acubesat/obc/obc-pcb