IAF SPACE POWER SYMPOSIUM (C3)
Space Power System for Ambitious Missions (4)

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DESIGN AND IMPLEMENTATION OF THE SOFTWARE ARCHITECTURE AND CONTROL FOR THE ELECTRICAL POWER SUBSYSTEM OF A 3U HYPERSPECTRAL IMAGING CUBESAT

Abstract

The paper discusses the conceptualization, design and implementation specifics of the software architecture and control for the Electrical Power Subsystem (EPS) of a 3U CubeSat equipped with a hyperspectral imaging camera as its primary payload and an FPGA as the secondary payload.The On Board Computer(OBC) of the satellite already runs multiple attitude control and maneuvering operations in addition to the command and overall data handling.Given that the satellite needs to execute some more tasks simultaneously the EPS has its own software control for administering tasks related to power management, storage and other interfaces. For this purpose, MSP430F5529LP microcontroller by Texas Instruments is chosen. Being the first subsystem to turn on, EPS is responsible for booting the OBC and deploying the onboard antennas.The microcontroller executes the OBC bootup sequence by powering it up and loading the OS either from the onboard PROM or EEPROM. The process runs continuously till the microcontroller receives a timer reset signal from the OBC. After the OBC has booted the EPS continues to function as an external watchdog. The code for implementing the external watchdog has been successfully tested on the microcontroller.Furthermore, the burn-wire mechanism for antenna deployment has also been evaluated with the antenna deployment module. Considering the power constraints, the EPS implements the Perturb and Observe(PO) Algorithm for Maximum Power Point Tracking (MPPT) of the solar panels. The algorithm has been successfully implemented on the microcontroller. To implement the PO algorithm the microcontroller has to acquire current and voltage data from the solar panels. Furthermore the microcontroller also collects housekeeping data from the rest of the satellite. This data includes current, voltage, temperature parameters and status flags of the battery, solar panel and different satellite subsystems. This data is then transmitted as a simple beacon and provided to the OBC on demand. I2C protocol has been implemented for data acquisition from various sensors to the microcontroller.The EPS also monitors the overcurrent protection circuitry of the satellite and reports to the OBC when any overcurrent fault occurs The paper thus provides a complete and detailed view into the functioning and implementation of an autonomous Electrical Power System in terms of both hardware and software. It also attempts to explain the interaction of EPS with other components, including sensors, power management ICs as well as other on-board controllers.