

SPACE POWER SYMPOSIUM (C3)
Small and Very Small Advanced Space Power Systems (4)

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INNOVATIVE POWER MANAGEMENT TILE FOR NANO SATELLITES

Abstract

Power Management Tile (PMT) is the most essential element of any aerospace mission. It has power supply and attitude sensors sections. Aerospace systems need very efficient Power supply and precise attitude sensor subsystems. So keeping in mind the importance of these subsystems, the idea is to develop them in a single module for the CubeSats and other Nano satellites. An innovative modular power management tile is developed for small satellites, called CubePMT. Modular PMTs are already available in the market but their efficiency, size, weight, compactness and power consumption are main issues. The goal of this work is to implement these subsystems in a single module focusing on the main issues and adding some additional features. Commercial off the shelf (COTS) components are used for CubePMT implementation which is feasible in micro and NanoSatellites, reducing power consumption and cost.

The onboard components of CubePMT include two solar cells, boost converter, magnetorquer, magnetometer, gyroscope, sun sensor, current sensor, temperature sensor and testing connectors all on a single PCB with dimensions 82.5mm x 98.0mm x 2.2mm. The external face of PCB has two solar cells, sun sensor and temperature sensor while the internal face contains all the electronic components for the power supply and attitude sensors. The solar cells are triple junction space qualified providing an efficiency of 27%. They are connected in series to achieve an output voltage of approximately 4.4V (each cell generating 2.2V). The external face has a photo diode that is used as a sun directional sensor. A temperature sensor is mounted close to the photo diode to compensate for its temperature drift. The inner face has a boost converter with an efficiency of 93% that step up the voltage from 4.4V to 14V (power distribution bus voltage). A magnetometer and yaw rate gyroscope with dynamic range of 80degree/sec which is connected to the onboard controller through SPI bus. A magnetorquer with 200 turns, is integrated into the PCB four internal layers, thus occupy no extra space in the spacecraft. MSP430 microcontroller is mounted on the inner face for monitoring the operations of the PMT.

OrCAD PSpice, MentorGraphics and UML are used for simulations, PCB design and documentation. Once simulation results were in agreement with our requirements we moved forward with prototyping. At the end full set of tests and analysis were performed on the module. In conclusion, the actual results were in close agreement with the simulations.