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

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DESIGN OF A ROBUST ELECTRICAL POWER SYSTEM OF A 3U CUBESAT

Abstract

This paper describes the design and salient features of electrical power subsystem of College Of Engineering, Pune's second satellite mission. Primary scientific objective of the mission is to raise the orbit using solar sail with scientific data collection, particularly about radiation and charge particle density over its lifetime. Area available for solar energy harvesting in a 3U satellite is limited, which is further minimized by virtue of sails preventing sunlight illumination over satellite's lateral surfaces. Solar side DC-DC converter in SEPIC topology incorporates Maximum Power Point Tracking (MPPT) for maximizing solar energy extraction. MPPT algorithm and SEPIC converter control are implemented with a microcontroller. Software configurable SEPIC with supporting analog circuitry provides flexible power handling capacity and can track maximum power point with varying irradiance over the orbit, providing a source of intelligence as compared to fully analog power system of previous satellite, Swayam. Deployable solar panels enhance power generation and co-planar arrangement of solar arrays eliminates the complexity of discrete MPPT design. The mission will use battery pack capable of supporting high current surges owing to subsequent deployments in the initial phase of the satellite after ejection from launch vehicle and to withstand eclipse phase with high load demands, particularly from amplifiers of communication subsystem, attitude control system actuators and radiation monitoring module. For precise timing and rotation control during solar sail deployment, the deployer is driven by a stepper motor. The reaction wheel used for attitude control of satellite will be driven by BLDC motor because of it's high energy efficiency, torque and speed. Auto retry feature of load protection module allows recovery and protection

from electrical faults like over-current, under voltage and over-voltage and possible latch-ups in space. Load protection circuitry serves multiple functionalities like permanent load shutdown, power mode definitions and implementation of half duplex communication system through the control logic spread over On-board Computer and Terminal Node Controller. Diverse components associated with all the electrical systems of the satellite necessitate implementation of multiple voltage buses employing separate DC-DC converters. The proposed mission require high voltage bus(es) for motors and magnetorquers, a standard 3.3V bus for micro-controllers and sensors, low voltage and negative voltage buses for radiation monitoring block. Power system designed and optimized to suit the mission requirements is described in this paper. Block diagram research, design techniques and testing results are also presented.