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DELINEATION OF AN EFFICACIOUS POWER SYSTEM OF A NANO SATELLITE

Abstract

This paper delineates the salient features of electrical power subsystem of College of Engineering, Pune's satellite mission. Premier objective of the mission is to demonstrate the technique of propulsion using solar sail and the characterization of charge particle environment with respect to altitude. A Solar sail is a large reflective surface and works on the principle of photon momentum transfer. The thrust imparted can be used for orbit maneuvering and changing the altitude of the satellite. Solar side DC-DC converter incorporates Direct Energy Transfer mechanism (DET) for optimized solar energy transfer to the battery. The mission uses deployable solar panels placed laterally to maximize incident area. The system includes battery pack to supplement the stipulated power demand emanating due to deployments and actuators in the inceptive phase of the satellite, after ejection from the launch vehicle. It is pivotal during the eclipse phase for providing power to Charge Particle Monitor(CPM), Communication and the Attitude Determination and Control System(ADCS). Loads affixed to the electrical power system of the satellite entail different voltages whereas the battery voltage needs to be maintained at 4.2 V. To satisfy the voltage requirements of the loads, various DC-DC converters are implemented. The proposed mission requires a 10 V bus for BLDC motor, 35 V for charged particle detector, 5 V and -5 V for CPM,3.3 V for microcontrollers and sensors which are realized using inverting charge pump, buck and boost converters. Three-axis magnetorquers are incorporated to detumble the satellite after the ejection from the launch vehicle. A low power switch-mode converter is designed for controlling current through the magnetorquers. To attain precise control over solar sail deployment, the mechanism is driven by a stepper motor. Similarly,

the reaction wheel is used for pitch axis attitude control of the satellite during orbit maneuvering. A BLDC motor is used to drive the reaction wheel. Two different current control topologies are used to control the torques of both the motors. The load protection module allows recovery and protection from electrical faults like over-current, under-voltage and over-voltage. Load protection circuitry has numerous functions like permanent load shutdown, auto-retry, soft-start and Power-On Reset (POR). A POR is provided to the onboard controllers to remove the latch-ups caused by high energy particles in space. Power system design and optimization apt for the overall system is described in this paper. Block diagram, design techniques, actuator control circuits and testing results are also presented.