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Design and Thermal Analysis of Power Harvesting System of a Hexagonal Shaped Small Spacecraft

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Abstract : Many universities around the world are working on modular and low budget architecture of small spacecraft to reduce the development cost of the overall system. This paper focuses on the design of a modular solar power harvesting system for a hexagonal-shaped small satellite. The designed solar power harvesting systems are composed of solar panels and power converter subsystems. The solar panel is composed of solar cells mounted on the external face of the printed circuit board (PCB), while the electronic components of power conversion are mounted on the interior side of the same PCB. The solar panel with dimensions 16.5cm × 99cm is composed of 36 solar cells (each solar cell is 4cm × 7cm) divided into four parallel banks where each bank consists of 9 solar cells. The output voltage of a single solar cell is 2.14V, and the combined output voltage of 9 series connected solar cells is around 19.3V. The output voltage of the solar panel is boosted to the satellite power distribution bus voltage level (28V) by a boost converter working on a constant voltage maximum power point tracking (MPPT) technique. The solar panel module is an eight-layer PCB having embedded coil in 4 internal layers. This coil is used to control the attitude of the spacecraft, which consumes power to generate a magnetic field and rotate the spacecraft. As power converter and distribution subsystem components are mounted on the PCB internal layer, therefore it is mandatory to do thermal analysis in order to ensure that the overall module temperature is within thermal safety limits. The main focus of the overall design is on compactness, miniaturization, and efficiency enhancement.

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