Paper ID: 54356
student

IAF SPACE POWER SYMPOSIUM (C3)
Interactive Presentations - IAF SPACE POWER SYMPOSIUM (IP)

Author: Mr. Nihal Singh
Birla Institute of Technology and Science(BITS), India, nihal.s.singh@gmail.com

Mr. Nishant Raman
Birla Institute of Technology and Science(BITS), India, f20170226@pilani.bits-pilani.ac.in
Mr. Varun Goradia
Birla Institute of Technology and Science(BITS), India, f2016433@pilani.bits-pilani.ac.in
Mr. Joy Parikh
Birla Institute of Technology and Science(BITS), India, f2016136@pilani.bits-pilani.ac.in

HARDWARE ARCHITECTURE OF ELECTRICAL POWER SYSTEM FOR 3U HYPERSPECTRAL IMAGING CUBESAT

Abstract

This paper discusses the hardware architecture of the Electrical Power System (EPS) of a 3U CubeSat along with a fully functioning Simulink model of the same. This nanosatellite features a hyperspectral camera as its primary payload and a Field Programmable gate Array (FPGA) as its secondary payload. Both payloads pose harsh power constraints on a satellite with limited power generation capabilities and battery capacity. Thus the EPS requires an efficient and well tested hardware architecture. The Photovoltaic Arrays are placed on five out of six faces of the nanosatellite, and are connected through bypass diodes to the DC/DC boost converter implementing Maximum Power Point Tracking (MPPT) algorithms and control. The values for the inductor and capacitor are chosen such that the converter operates efficiently in continuous conduction mode by limiting the output ripples. The Perturb and Observe (PO) Algorithm for MPPT tracking has been successfully tested using MATLAB for duty cycles based on the range of input voltage from solar panels, and the paper provides the relevant results obtained. Sufficient power generation from the PV arrays has been verified on software for varying temperature and irradiance based on values expected in the orbit, thereby ensuring robustness of the system. The Lithium Ion batteries are charged by constant-current constant-voltage (CCCV) charging method. These are connected in a 2S-2P configuration across the output of the boost converter with the battery protection circuitry implementing overcharge and overcurrent protection. Sensors interfaced in EPS measure the SOC of the batteries, the voltage across the batteries and the current from/into the battery combination. The sensor values obtained are used for battery charging control, satellite housekeeping data, and as parameters for switching between the modes of operation. A bus connected across the batteries leads to two Buck converters which step down the battery voltage to 3.3V and 5V. These two buses provide power to the various subsystems of the satellite, and have been successfully tested and implemented on both hardware and software. EPS also implements noise filtering and overcurrent protection circuitry for each load. The architecture presented in this paper demonstrates that power intensive payloads can be featured on nanosatellites by integrating an efficient hardware architecture with systematic modes of operation for balanced power distribution across various subsystems.