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A MODULAR, EFFICIENT, LOW COST POWER SYSTEM FOR PICO-SATELLITE APPLICATIONS

Abstract

Opportunities for innovations in designing power systems for pico-satellite missions are extremely restricted owing to space constraints. The system described and being developed, aims to develop a low cost and optimized power system stressing on maximum energy utilization, while respecting the environmental parameters prevalent at Low-Earth Orbits (LEO). The system is currently being implemented as the power sub-system of the COEP communication satellite, a student designed HAM communication pico-satellite. Though inherently designed to power a pico-satellite, certain parameters of the modules can be rearranged, modified and upgraded for different mission profiles including those in the scope of nano-satellites. The system is further insured by providing double or triple redundancy for all critical applications namely power conditioners, load protection circuits without over populating the available PCB real estate. The power system is designed in a way to maximize the available solar energy such that it ensures minimum dependence on the On-Board batteries. The Li-ion batteries powering the system are charged and utilized in the most efficient way prescribed for the chemistry by using the Li-ion charging algorithm and upholding concepts like state-of-charge (SOC) and depth-of-discharge (DOD). Exhaustive research and testing of the DC-DC converter, which is the critical module of the system, for optimum operation and maximum efficiency under dynamic load conditions has been carried out. Without using low ESR capacitors and the best variety inductors, we have managed to obtain efficiencies of 85-95% in our converters. The On-Board Computer (OBC)'s participation in power system functioning is restricted to house- keeping data collection and relaying system state to earth stations. Missions in LEOs are susceptible to single event upsets (SEU) owing to their proximity to the Van Allen radiation belts and radiation hardened electronics are prohibitively expensive for student satellites, especially from developing nations. Digital components are the most vulnerable electronic elements to SEUs. Hence the modules of the proposed system, performing critical functions, are almost completely analog and independent of any programmable intelligence. The switching logic of energy source from PV cells to batteries is developed and successfully implemented solely using analog techniques. Thus the Power system is made highly in-

telligent by means of analog control without compromising on energy optimization under the given space and power constraints.