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Educational Pico and Nano Satellites (4)

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POWER SUBSYSTEM OF KUAUHTLISAT, A TUBESAT-TYPE NANOSATELLITE, USING TRISOLX SOLAR CELLS ARRAYS

Abstract

Recent standardization of nanosatellites construction, specifically on size and shape like CubeSat standard, has enabled more institutions to gain access to this kind of technology. However, restrictions in dimensions represent a challenge for the energy harvesting, given that the sun is the only source of energy available and the area for the solar cells is very limited. This work presents the design of the power system for KuauhtliSat, a nanosatellite that follows a new standard introduced by Interorbital Systems called "TubeSat". The objectives are to determine the scopes of the TubeSat configuration for capturing more efficiently the sunlight and to design a circuit that maximizes the power extraction from the solar panels to the battery included in the satellite. The TubeSat is a hexadecagon-shaped satellite that proposes to use out of the total 6 faces of the nanosatellite as solar panels and the design is restricted by the use of space-quality TrisolX solar cells of 28% efficiency. The nanosatellite was modeled in order to run simulations and estimate the effective area of the solar panels for this particular satellite shape and solar cells. The simulations showed a total effective area of 40.2 cm^2, which is correspondent to approximately 2.72 solar panels and a power of 0.74 W in a Low Earth Orbit (LEO). Then, a circuit for the electric power system (EPS) was designed using a Maximum Power Point Tracking (MPPT) topology and the selection of a 2500 mAh Li-ion battery. The circuit included a buck converter to regulate the voltage from the solar panels to the voltage necessary to charge the battery. For the control part of the MPPT algorithm a Perturb&Observe method was implemented using a microcontroller. The solar panels were manufactured as well as the MPPT circuit. Results show the manufacture process of the solar panels to yield a 95% efficiency. The circuit developed can reach a 90% efficiency of energy conversion. The power system is capable of charging 2.9% of the battery capacity during one orbit when the satellite is in operation mode, which is when it consumes the most energy. If the satellite remains in standby mode during one orbit, then the battery can be charged 7.2% of its capacity.