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DESIGN AND IMPLEMENTATION OF AN INNOVATIVE CHARGED PARTICLE MONITORING SYSTEM ON-BOARD A CUBESAT

Abstract

Cube Satellite missions provide a unique opportunity and platform for college students to work on challenging space systems and to create and develop new ideas. College of Engineering Pune (COEP) Satellite Initiative's next mission involves demonstration of orbit maneuvering from low earth orbit to a higher orbit using solar sails. This provides a unique opportunity to characterize various space parameters with altitude. The ionosphere surrounding the Earth comprises of weak X and Gamma rays, neutral elemental atoms and charged particles viz. charged ions, protons and electrons. These constituents are dynamic due to the events such as Coronal Mass Ejection and solar flares. Among these, the density of charged particles is found to be maximum. Interaction of Sun's plasma wind with the Earth's Magnetosphere traps charged particles into Ionosphere. By observing these charged particles, we can study space weather in Ionosphere and Solar emission events. Very few cube satellite missions have performed the study of space environment with variation in altitudes. The proposed system will detect energy of incident charged particles using a scintillator detector. Silicon Photomultiplier Detectors, which are lighter and more efficient than bulky Photomultiplier Tubes and Microchannel Plate Detectors, are suitable for charged particle detection. Such sensors require efficient readout circuits, which shall be implemented using traditional low noise analog pulse processing circuits. The analog pulse processing circuit comprises of charge-sensitive preamplifiers and pulse-shaping circuits. The output of the analog pulse processing circuit will be further processed by a Field Programmable Gate Array (FPGA) to interpret the energy of the incident charged particles. The FPGA is interfaced with the rest of the system for transferring the data. Usage of the FPGA allows for fast parallel processing with data being transferred at the same time as it is detected. Keeping in mind the power and space constraints in a cubesat mission, the students have developed an innovative system which achieves the high speeds required by the application without compromising the power budget of the satellite. This paper pertains to the design and implementation of the charged particle monitoring system developed by the students of COEP.