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SPACE SYSTEMS SYMPOSIUM (D1)
Enabling Technologies for Space Systems (2)

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RADIATION-HARDENED ELECTRONICS AND FERROELECTRIC MEMORY FOR SPACE FLIGHT SYSTEMS

Abstract

Over the past few years, there has been an increasing interest in the exploration of space beyond Low Earth orbit. Radiation is a major concern for Low Earth orbit space flight systems since the radiation environment in Low Earth orbit is much harsher than at Earth's surface. Thus, the need for radiation-hardened electronics is undeniable. These electronics need to be radiation tolerant, low power, and reliable. Therefore, the National Aeronautics and Space Administration (NASA) is carrying out the Advanced Avionics and Processor Systems (AAPS) project in order to develop high-tolerant, radiation-hardened electronics and processors. Specifically, the AAPS project aims to improve the Total Ionization Dose (TID) tolerance of the electronics, reduce Single Event Upset (SEU) rates, increase threshold for Single Event Latch-up (SEL), increase the processor efficiency and sustained processor performance, increase the speed of dynamic reconfigurability, reduce the operating temperature range's lower bound, increase the available levels of redundancy and reconfigurability, and increase the reliability and accuracy of radiation effects modeling. The AAPS project is subdivided into several tasks, including Modeling of Radiation Effects on Electronics (MREE), Single Event Effects (SEE)-Immune Reconfigurable Field Programmable Gate Array (FPGA) (SIRF), Radiation-Hardened High Performance Processors (HPP), Reconfigurable Computing (RC), Silicon-Germanium (SiGe) Integrated Electronics for Extreme Environments, and Radiation-Hardened Volatile and Nonvolatile Memory. It has been observed that ferroelectric-based electronics possess several critical characteristics, including their inherent radiation-hardened property, that distinguish them as highly viable candidates for radiation-hardened electronics. The use of ferroelectric materials in memory devices, as well as digital and analog circuits, promises to provide the needed radiation-tolerant electronics. Memory devices in particular can benefit from the use of ferroelectric materials, as memory elements are highly susceptible to the effects of radiation. Replacing static random access memory (SRAM) cells with ferroelectric RAM (FRAM) cells provides non-volatile, radiation-hardened, reliable memory devices. We have been studying the field of ferroelectric memory and devices and have extensively published papers on this topic. To test the effectiveness of FRAMs in Low Earth orbit, a 512K Ramtron FRAM will be flown on a Low Earth orbit satellite that will be launched by NASA. This paper discusses the AAPS project and outlines the Low Orbit ferroelectric memory test experiment.