SPACE POWER SYMPOSIUM (C3)
Small and Very Small Advanced Space Power Systems (4)

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ARCHITECTURAL DESIGN OF RADIATION-HARDENED SOC SOLUTION FOR NANOSATELLITE POWER MANAGEMENT

Abstract

With the rapid development of nanosatellite industry, adaptive and ultra-small-scale power management system (PMS) is demanded for maintenance and sustainable use of Li-ion batteries. Radiation-tolerant System-on-Chip (SoC) technology has been recognized as a promising solution but challenges still exist.

Firstly, we present a comprehensive architectural design of SoC power solution for nanosatellite applications including space-level 16-bit processor, 8-channel ADC, dual DAC, precision amplifiers, memory and interface units. To derive the anti-radiation requirements, the application scenarios are classified into three types: reconfigurable architecture, fault tolerance strategy and in-orbit calibration strategy. The space-level processor named FC-4065 uses these anti-irradiation portfolios simultaneously. The processor FC-4065 fabricated in 65nm technology remains fully function after Total Ionizing Dose (TID) and Single Event Upset (SEU) tests. The frequency is up to 350 MHz, and its power consumption is less than 90 uW/MHz.

Secondly, aiming for the nanosatellite application, optimized power conditioning procedures are proposed in this paper. Based on our existing radiation-tolerant SoC platform, we customize a modularized solution for nanosatellite power management. It comprises Main Error Amplifier (MEA) IP, Pulse Width Modulation IP, Li-ion battery balancing IP, solar cell control IP and other soft IP cores in power conditioning unit. Through 1553B interface module, it has a smooth way integrating PMS with nanosatellite communication. This microsystem can monitor and control the entire nanosatellite power modules without manual operations.

Finally, moderate and large TID experiment is carried out in Shanghai Institute of Applied Physics in China. Practical stability and accuracy of the proposed SoC architectures are proven, and suggestions for future nanosatellite power development are discussed based on the space missions.