Paper ID: 62418
student

Key Technologies (7)
Key Technologies (2) (2)

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FLIPSAT-1: OPTIMIZING RADIATION HARDENING FOR A SPACE ENVIRONMENT

Abstract

The FlipSat-1 is an optimization mission that seeks to optimize methods of radiation hardening. Galactic cosmic rays, solar flare particles, and radiation belt particles vary in origin and type, however, they all are relatively high energy and are incredibly detrimental to the wellbeing of satellite operations. FlipSat-1 will test three different methods of radiation protection (broad methods, more individual methods will additionally be tested.) Results from FlipSat-1 can then be taken into further application for large satellites and high radiation sites on Earth. The three methods of radiation hardening that the FlipSat-1 will be utilizing are error-correcting code, watchdog timers, and physical radiation protection. All tests will be running on small heat hardened printed circuit boards (PCB.) Error-correcting code will be tested on 5 different printed circuit boards. Watchdog timers will have 3 PCBs for physical watchdog timers, with a period kick, and 3 PCBs for electronic watchdog timers with a function-based kick. Physical protection will use a thickness of physical protection ranging from 1 to 5 millimeters of material, each material having 3 PCBs. Error-correcting code (ECC) is a database focused system. ECC is a common method of error prevention, commonly used in data transmission in circumstances where data packets may be prone to lose. The system works by automatically comparing certain strings of binary data to binary data chunks that are saved, and then 'autocorrecting' data packets to those most likely if received data packets don't correspond with preexisting data strings stored in a 'library.'

Watchdog timers are another type of (partially) software run radiation protection method. Via either electronic or physical detection, if a certain function is not detected as completed via the watchdog timer in a certain period. If a function is not detected, the watchdog timer manually resets the system (a kick,) which should there be a code failure, would result in that being wiped. Additionally, simply time-driven automatic resets can be used which will reset the system over intervals automatically, regardless of function error.

Physically, radiation protection is a rather crude method, but remains a potentially effective way to prevent any binary code changes. By physically absorbing radiation that would otherwise reach vulnerable or vital components, the vital components are adequately protected. The material for physical radiation protection will be polyethylene. Polyethylene is cheaper than alternatives and has a large hydrogen count. This hydrogen count disperses and absorbs the radiation.