

Radiation-Hardened (Rad-Hard) Microelectronics Capabilities

Hardening Microelectronics to Radiation

Since its formation in 2000, Ridgetop has designed effective radiation-hardening tools, test structure libraries and mixed-signal IP cores for demanding applications. Ridgetop has also provided independent engineering assessments of radiation vulnerability of critical systems in space satellites, and foundry capabilities. Ridgetop maintains a DSS-approved facility and is certified as a Trusted Design House by the Defense Microelectronics Activity (DMEA). Ridgetop has been chosen to help design critical systems for NASA, NAVAIR, the Air Force, Department of Energy, and U.S. government prime contractors.

General Rad-Hard Design Methods

Electronics, when exposed to radiation, will degrade and eventually fail, but methods can be adopted to extend the life of electronics. Microelectronic circuits can also be subjected to sudden changes due to single-event particle strikes in radiation environments. These hazards can be temporary (single-event transient, SET), or permanent, requiring corrective actions (single-event upset, SEU, single-event functional interrupt, SEFI) or destructive (single-event latchup, SEL, and single-event gate rupture, SEGR).

There are typically three methods of reducing the vulnerability of electronics to radiation damage:

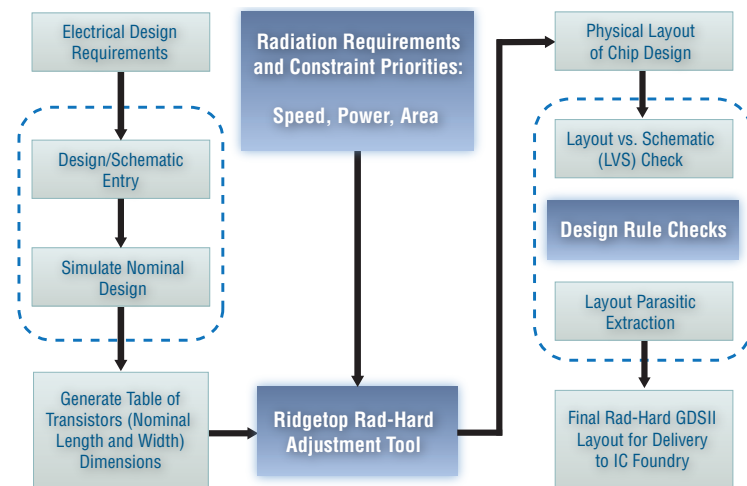
- Rad-Hard by Design (RHBD)
- Rad-Hard by Process (RHBP)
- Rad-Hard by Shielding (RHBS)

Rad-Hard by Design Methods

Many effective RHBD techniques exist for microelectronic circuits. These can be grouped as total ionizing dose (TID) RHBD techniques such as enclosed gate layout techniques,

guard ring techniques, and adaptive biasing techniques; and single-event effect mitigation techniques such as triple module redundancy, guard gates, dual-interlocked storage cells, etc.

This figure shows the standard design flow used by Ridgetop.



Ridgetop Rad-Hard Design Process

Ridgetop has also designed and built the following rad-hard design libraries of analog and mixed-signal building blocks that can be incorporated into critical designs:

InstaCell™ Analog Mixed-Signal Library

- Rad-hard analog-to-digital converters (ADCs)
- Radiation prognostic cells
- Rad-hard bandgap references
- Rad-hard op amps and comparator cells

InstaBIST™ Built-in Test Library

- ADC BIST
- RadCell Fox
- RadCell V_T





Rincon™ Harmonic Balance Circuit Simulator

Introduced in 2004, Rincon was the first VHDL-AMS-based harmonic balance simulator for use in radiation-hardened design applications. The VHDL-AMS language supports the creation of new and extended degradation models that can fully incorporate the expected radiation environment.

Rad-Hard by Process

Ridgetop utilizes advanced semiconductor processes that can help reduce vulnerability of critical systems. These process methods include the use of Silicon On Insulator (SOI) and Silicon On Sapphire (SOS) processes for single-event effect mitigation, and small-geometry CMOS processes that provide inherent hardness to TID effects. Ridgetop maintains a full tool suite that supports the use of RHBP methods. Often RHBP is combined with RHBD methods to achieve a specific tolerance target. Examples of suitable processes include the IBM 45 nm SOI process, the Honeywell 150 nm process, and BAE Systems' epitaxial CMOS process. Ridgetop is familiar with various semiconductor processes and is well-suited to meet demanding design requirements.

Rad-Hard by Shielding

Ridgetop expects to introduce a new radiation shielding tool early in 2011. This tool will enable easy translation of data between CAD (computer-aided drawing) models into inputs for radiation transport analysis.

This tool will allow examination of "what-if" design scenarios that support optimization of shielding against incident radiation. Features will include:

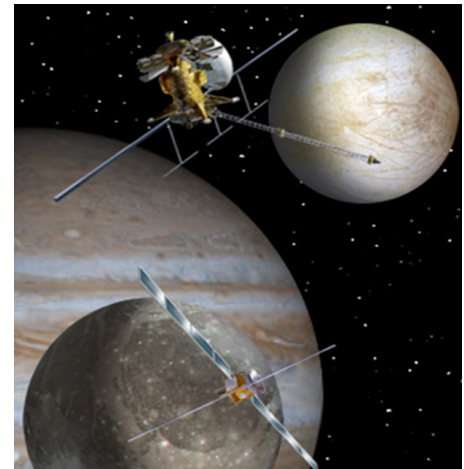
- Advanced modular system providing flexible, adaptive modeling framework (AML)
- Easy and quick conversion of CAD models into TART and MCNP Monte Carlo input files
- Searchable broad set of rad-hard product design

configurations that can avert need for additional shielding

- Bridging between CAD and radiation transport geometries
- Documented, highly accurate and efficient CG representations of real-world parts designed in the Pro/ENGINEER CAD system

Contact Ridgetop Group for more information.

Jupiter-Europa Radiation Environment



Ridgetop is currently developing an extremely rad-hard (4 Mrads) 12-bit ADC for ice-penetrating radar for NASA's Jupiter-Europa mission.

Summary

There are established methods to meet a desired level of radiation tolerance, including design, process and shielding methods. To reach a specific level of hardness, the tradeoffs on performance, weight, processing speed, and other factors need to be considered. The variables are complex, but Ridgetop maintains a staff of experienced personnel to handle the most demanding applications.



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