# Selection of Integrated Circuits for Space Systems

## *Announcement for the 2009 NSREC Short Course*

**MONDAY, JULY 20, 2009**
**QUÉBEC CITY,**
**QUÉBEC, CANADA**

*On behalf of the 2009 Nuclear and Space Radiation Effects Conference (NSREC) Committee, I cordially invite you to attend the 30th annual NSREC Short Course. This six-part course will focus on the real-world aspects of selecting integrated circuits for space systems.*

**Ken LaBel**
Short Course Chairman

### COURSE DESCRIPTION

A one-day Short Course "Selection of Integrated Circuits for Space Systems" will be presented at the 2009 Nuclear and Space Radiation Effects Conference (NSREC). With the advent and explosion of commercial electronic devices dominating the semiconductor market, the decision process for selecting ICs for space systems has become more complex. In this short course, we provide a discussion of the processes and risk trades that are involved. The main concepts revolve around the selection of device types (i.e., what circuits are appropriate to provide a function), as well as the ever more considered question of commercial-off-the-shelf (COTS) versus radiation hardened (RH) components.

The Short Course is organized into six sessions starting with a systems engineering and management perspective for selection. The second through fourth sessions delve into the technical considerations: radiation, reliability, and design performance. Finally, two examples will be provided focusing on advanced digital and mixed signal applications, respectively.

The speakers for the 2009 Short Course are all experts in their respective areas. They will present the knowledge base in their topical areas extending the information beyond the traditional radiation effects short course and providing a larger perspective to the issues. An example of this includes the cost trades involved with buying RH devices versus testing of devices not guaranteed for radiation performance. The speakers will focus on determining the relevant considerations that should be weighed for selection.

The course is applicable to designers, radiation effects engineers, component specialists, and other technical and management personnel who are involved in developing reliable systems designed to operate in space environments. This course provides a unique opportunity for NSREC attendees to benefit from the expertise of the instructors, as well as the in-depth coverage and application-oriented perspective provided by the short course format. Each instructor will develop the core content of their respective topics from background material largely found in the literature and from their unique interactions with actual space systems. As such, the course will benefit both new and experienced engineers, scientists, and managers. In-depth notes will be provided at registration.

For those interested in Continuing Education Units (CEUs), there will be an open-book test at the end of the course. The course is valued at 0.6 CEUs and is endorsed by the IEEE and the International Association for Continuing Education and Training (IACET).

### PART I — PROGRAMMATIC ASPECTS OVERVIEW

John M. Stone, Southwest Research Institute, will discuss the programmatic (cost and schedule) aspects of hardware development for the radiation environment. Too often, systems, hardware development, and radiation engineers don't understand the impact that their work has on the programmatic success of a given project. This section of the short course will emphasize the close link between everyday engineering and programmatic success. After an overview of the scope and importance of programmatic issues, Mr. Stone will discuss the connection between those issues and the requirements definition process. This will be followed by a discussion of the programmatic impact created by product implementation and assurance activities. A variety of practical examples drawn from various projects will be used to illustrate the points made.

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**www.nsrec.com**


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**PART 2 — RADIATION EFFECTS POINT OF VIEW**

Keith Avery, Air Force Research Laboratory, will discuss what is meant by the term "radiation hardened" (RH) as it applies to modern micro-circuits. This includes total ionizing dose (TID) and single event effects (SEE) along with mitigation techniques that are available. The designer is left performing a tradespace between using commercial-off-the-shelf (COTS) devices vs. radiation hardened devices as it applies to a board level design and an example will be shown. This tradespace will include items such as cost of upscreening a COTS part, cost of an ASIC development, and the impacts on size, weight, and power (SWAP) when making those choices. Woven into these trades is the overriding factors of mission risk and mission cost which will impact each decision.

**PART 3 — RELIABILITY CONSIDERATIONS**

Doug Sheldon, Jet Propulsion Laboratories, will focus on the understanding of reliability as it pertains to individual devices, as well as to systems. The continued evolution in parts technology requires a similar evolution of reliability considerations for successful risk management of mission requirements. This talk will provide a framework of modern reliability tools and concepts as they relate to risk management. A mathematical framework will be established based on process technology and physics of failure models. These concepts are then integrated with quality metrics. This fundamental inter-relationship between quality and reliability is then used to define appropriate risk management tools that can be used by engineers and managers to correctly evaluate parts. With these interrelationships appropriately defined, such concepts as lifetimes, screening levels, etc. can now be accurately implemented.

**PART 4 — ELECTRONIC DESIGNER'S PERSPECTIVE**

Dr. Kirk Kohnen and Kay Jobe, Boeing Space and Intelligence Systems (S&IS), will discuss the challenges faced by electronic systems designers in the selection of ICs for space missions. Commercial electronic devices provide substantial improvements in SWAP when compared with their RH counterparts. System requirements often will drive these non-RH ICs to be inserted into systems. However, since these parts are not designed to tolerate the space environment, tradespaces exist for design and system complexity as it relates to the successful device insertion. Dr. Kohnen and Ms. Jobe will focus on the electrical performance requirements that drive the selection of state-of-the art technologies and the enabling features that systems desire. A discussion comparing modern commercial device performance versus the RH options will be presented. This will be followed by an overview of applying the general challenges described in Parts 1-3 for state-of-the-art device offerings using practical samples for actual missions.

**PART 5 — EXAMPLE 1:TRADING ASIC AND FPGA CONSIDERATIONS FOR SYSTEM INSERTION**

Melanie Berg, MEI Technologies Inc., will utilize the concepts discussed in Parts 1-4 for the selection of high performing digital devices. The presentation will begin with general definitions and comparisons of the varying device architectures. Within this section, similarities and differences of ASICS and FPGAs will be presented focusing on the radiation, reliability, and design performance aspects. A brief discussion of radiation effects and mitigation strategies specific to ASIC and FPGA design implementation will follow. A sample trade will be performed illustrating how the information provided in previous sections is used for selecting an FPGA or ASIC for space missions.

**PART 6 — EXAMPLE 2:TRADING MIXED SIGNAL DEVICES FOR INSTRUMENT OR HIGH-PRECISION APPLICATIONS**

Dr. Steven C. Moss, The Aerospace Corporation, will discuss trades associated with using analog-to-digital converters for sensor applications for space systems. Types of ADCs and metrics commonly used to evaluate ADCs will be presented, followed by a discussion of how ADCs are used in conjunction with sensors such as focal plane arrays. The sensitivity of ADCs of various types to space radiation effects including total integrated dose, displacement damage, and single event effects will be discussed. Generic reliability issues, as well as those specific to ADCs will be discussed. Tradeoffs between performance, resource requirements, reliability, and radiation sensitivity will be discussed. Finally, advanced ADCs and the direction of research into ADCs will be discussed.