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List of Acronyms

**ETW** – Electronic Technology Workshop
**FY** – Fiscal Year
**GSFC** – Goddard Space Flight Center
**JEDEC** – (not an acronym)
**JESD** – JEDEC Standard
**JPL** – Jet Propulsion Laboratory
**LET** – Linear Energy Transfer
**MBU** – Multiple Bit Upset
**MCU** – Multiple Cell Upset
**MOSFET** – Metal Oxide Semiconductor Field Effect Transistor

**NEPP** – NASA Electronic Parts and Packaging program
**SBU** – Single Bit Upset
**SEB** – Single-Event Burnout
**SEE** – Single-Event Effect
**SEFI** – Single-Event Functional Interrupt
**SEGR** – Single-Event Gate Rupture
**SEU** – Single-Event Upset
**SET** – Single-Event Transient
Standard Rationale

- Standards & Guidelines are developed/revised to:
  - Ensure tests follow best practices
  - Ensure results from different vendors/testers are comparable
  - Minimize and bound systematic and random errors

Data must be meaningful and must facilitate part selection and risk analysis

Best practices must be disseminated to new members of the test community
# Key Space Radiation Test Standards

<table>
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<tr>
<th>Standard</th>
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<td>MIL-STD-883</td>
<td>Microcircuits&lt;br&gt;TM 1017: Neutron irradiation&lt;br&gt;TM 1019: Ionizing radiation (total dose) test procedure</td>
<td>2014</td>
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<td>ESA-ESCC-25100</td>
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(Prompt dose and terrestrial radiation standards not included)

*TM = Test Method*
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JESD57 Update: The “Who”

• JESD57 ownership: JEDEC JC-13.4 Government Liaison Subcommittee on Radiation Hardness Assurance
• Committee meetings 3 times/year:
  – Both JC13.4 and G12 Radiation Hardness Assurance subcommittees provide a platform to work with relevant industry and user communities to:
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- Draft rewrites between web conferences:
  - Provide initial changes as a starting point
  - Incorporate suggestions and reorganize content for better flow
Web Conference Participants

- Aerospace Corp.
- BAE Systems
- Boeing
- Defense Logistics Agency
- Intersil
- Linear Technology
- Microsemi
- NASA GSFC
- NASA JPL
- NAVSEA Crane
- Semicoa
- Texas Instruments

Many more participants are involved via a mailing list
Key Updates in FY15

- Streamlining into test standard format: guideline material to be captured in an “informative” annex
- Single-event transient (SET) test procedure added
  - Contribution from Nick VanVonno, Intersil
- Much effort spent on Terms & Definitions...

https://en.wikipedia.org/wiki/Webster%27s_Dictionary
Terms & Definitions Highlights: Single-Event Upset (SEU)

- **1996:**

  **single-event upset (SEU):** A single latched logic state from one to zero, or vice versa.

  NOTE The SEU is “soft” because the latch can be rewritten and behave normally thereafter.

- **Proposed:**

  **single-event upset (SEU):** The change of a bi-stable node state from one to zero, or vice versa, due to the passage of a single energetic particle.

  NOTE 1 SEU, including SBU, MBU, and MCU, is typically "soft" because the affected nodes can be rewritten and behave normally thereafter.

  NOTE 2 An SEU that results in a change in device functionality requiring intervention is defined instead as a SEFI.
Terms & Definitions Highlights: Single-Event Upset (SEFI)

• 1996:

**single-event functional interrupt (SEFI):** The loss of functionality of the device that does not require cycling of the device’s power to restore operability unlike SEL and does not result in permanent damage as in SEB.

**NOTE** SEFI is typically caused by a device being cycled to a nongenerational test mode due to a heavy ion strike.

• Proposed:

**single-event functional interrupt (SEFI):** A non-destructive interruption resulting from a single ion strike that causes the component to reset, hang, or enter a different operating condition or test mode.

**NOTE 1** A SEFI is often associated with an SBU/MBU in a control bit or register.

**NOTE 2** Changes in functionality may require a soft or hard reset of the device, reprogramming of the control registers, or power cycling.

**NOTE 3** A SEFI can introduce a latent reliability issue due to a period of high current. SEFIs that result in permanent damage are designated as single-event hard errors.
JESD57 Challenge: Advanced Electronics

• How do we incorporate advanced electronics SEE testing into SEE test standards?
  – Revision of JESD57 is an opportunity for inclusion of more established methods for testing advanced electronics
  – Highly complex technologies will benefit from specific guidelines
    • ex/ NASA FPGA test guideline
  – Complex devices incorporate many modes and functions
    • Test results depend on how we test the device
    • The bleeding edge of testing is generalizing application specific test results to bound flight performance at all stages of the mission

High-Speed Test Fixture

Photo credit: J. A. Pellish, 2013
The Time Lag

- Test standards & guidelines can (and often do) take years to develop or revise
  - Widespread compliance can take additional years
- Technology & research continuously evolve

The time lag is both useful and problematic
Summary

- **JESD57 is the only U.S. test standard covering many of the heavy-ion induced single-event effects**
  - ASTM F1192 guideline for measuring single-event phenomena induced by heavy ions
  - ESA-ESCC-25100 Single-event effect test method and guidelines

- **JESD57 is undergoing a long-overdue revision**
  - Broad participation by government, industry, and end users

- **Test standards such as JESD57 are a compromise between technical rigor and economic realities**
  - The goal is to be good enough to ensure success and cheap enough that the standards & guidelines will actually be used