

# Definitions (1)

**Single Event Upset (SEU)** is a change of state or transient induced by an ionizing particle such as a cosmic ray or proton in a device. This may occur in digital, analog, and optical components or may have effects in surrounding circuitry. These are "soft" bit errors in that a reset or rewriting of the device causes normal behavior thereafter. A full SEU analysis considers the system effects of an upset. For example, a single bit flip, while not damaging to the circuitry involved, may damage the subsystem or system (i.e., initiating a pyrotechnic event).

**Single Hard Error (SHE)** is an SEU which causes a permanent change to the operation of a device. An example is a permanent stuck bit in a memory device.

# Definitions (2)

**Single Event Functional Interrupt (SEFI)** is a condition where the device stops operating in its normal mode, and usually requires a power reset or other special sequence to resume normal operations. It is a special case of SEU changing an internal control signal. One example would be a DRAM entering the test mode defined by JEDEC. Another example is a microcircuit with IEEE 1149.1 JTAG circuitry leaving the TEST\_LOGIC\_RESET state and loading an unintended instruction into the instruction register (IR). Like other SEUs, the system effects must be properly analyzed. For example, a JTAG upset can cause the device to draw high currents or turn inputs into an output. The latter could, for example, drive a clock line to ground; thus, an independent clock signal should be used for the TCLK pin on devices without the optional TRST\* pin.

# Definitions (3)

**Single Event Latchup (SEL)** is a potentially destructive condition involving parasitic circuit elements forming a silicon controlled rectifier (SCR). In traditional SEL, the device current may destroy the device if not current limited and removed "in time." A "microlatch" is a subset of SEL where the device current remains below the maximum specified for the device. A removal of power to the device is required in all non-catastrophic SEL conditions in order to recover device operations.

**Single Event Burnout (SEB)** is a highly localized burnout of the drain-source in power MOSFETs. SEB is a destructive condition.

# Definitions (4)

**Single Event Gate Rupture (SEGR)** is the burnout of a gate insulator in a power MOSFET. SEGR is a destructive condition.

**Linear Energy Transfer (LET)** is a measure of the energy transferred to the device per unit length as an ionizing particle travels through a material. The common unit is MeV-cm<sup>2</sup>/mg of material (Si for MOS devices).

**LET threshold (LET<sub>TH</sub>)** is the minimum LET to cause an effect. The JEDEC recommended definition is the first effect when the particle fluence = 10<sup>7</sup> ions/cm<sup>2</sup>.

# Definitions (5)

**Cross section (sigma)** is the device SEE response to ionizing radiation. For an experimental test for a specific LET,  $\sigma = \text{\#errors}/(\text{ion fluence})$ . The units for cross section are  $\text{cm}^2$  per device or per bit.

**Asymptotic or saturation cross section (sigmasat)** is the value that the cross section approaches as LET gets very large.

**Sensitive volume** refers to the device volume affected by SEE-inducing radiation. The geometry of the sensitive volume is not easily known, but some information is gained from test cross section data.