

Summary of SEU Heavy Ion

Test on the RT54SX16

Prototype at BNL

May, 1998

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Background and Test Setup

Previous SEU testing of this device utilized a simple burn-in circuit, originally designed for reliability analysis by factory engineers. As such, there was a small number of flip-flops configured in several ripple counters. Estimates on SEU performance were made and errors, thought to be attributed to the IEEE 1149.1 JTAG TAP controller, were observed. For the prototype devices, the JTAG TRST signal is not brought out to an external pin. Additionally, for previous tests, the “P-Fuse” was not programmed. This fuse permits access to the TAP controller, whose protocol guarantees that the TEST-LOGIC-RESET state will be entered in 5 TCKs or less.

This work uses prototype RT54SX16 devices, configured as twin shift registers, each 200 elements long, originally designed for the STRV-1d flight radiation experiment. The P-Fuse was programmed with most runs utilizing a 6 kHz TCK. This was the configuration for both the antifuse hardness testing (results published in a separate report) and the SEU and SEL data published here.

Our test set permitted TCK to be either turned off or a different frequency programmed. These modes were used to verify that these units had failure modes similar to that seen in previous tests and to measure the effects of TCK frequency on the error signature. Details of this will be published in a separate JTAG application note.

Production of the RT54SX16 will have an option of an external JTAG TRST pin; these devices are not yet available for testing.

All devices in this report are 0.6 μm technology, fabricated at MEC.

Test Conditions and Results

Latchup

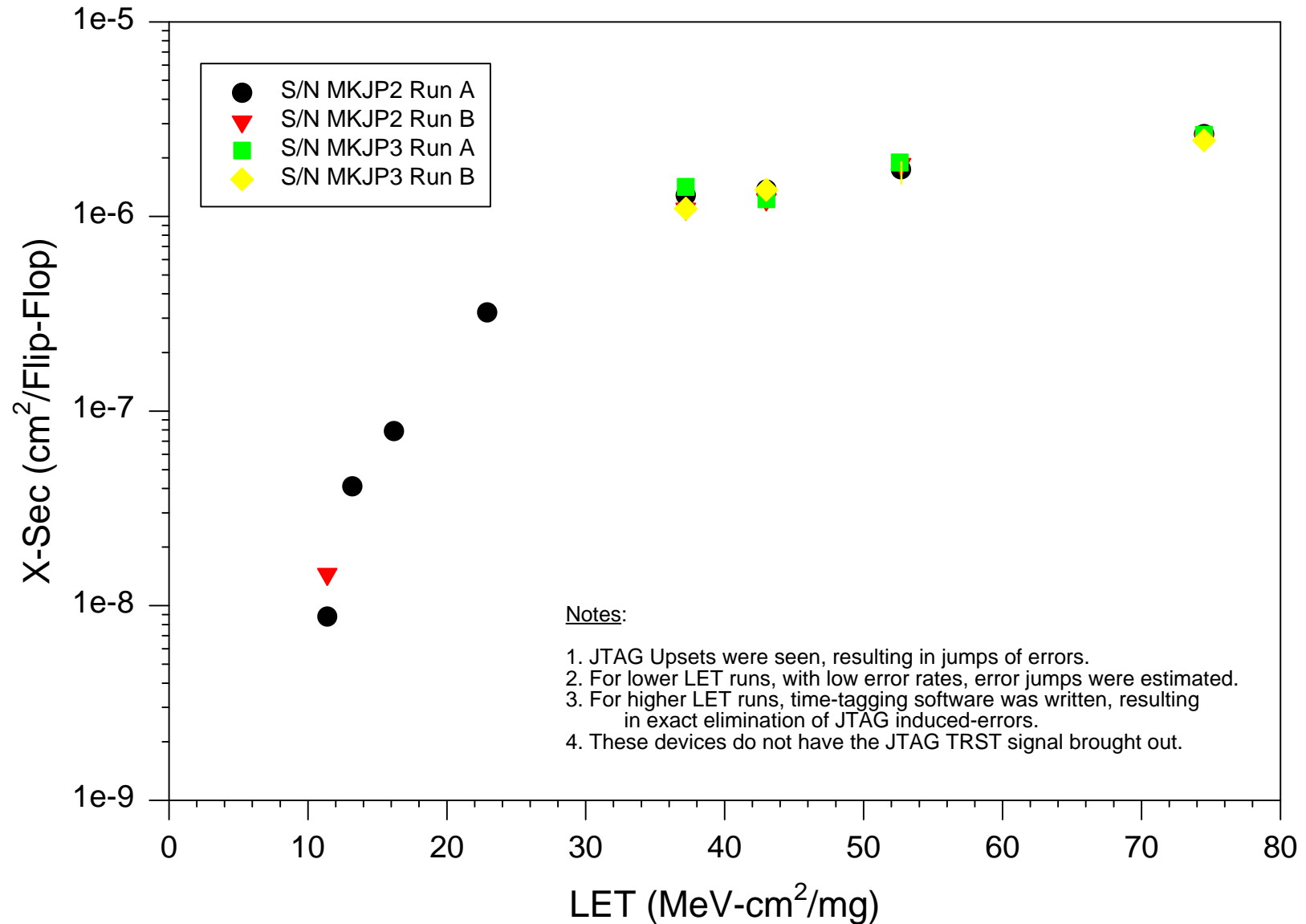
Latchup was a concern since previous tests showed high current jumps in addition to other failure modes. However, prototypes produced on a radiation-hardened line showed a similar signature so no conclusion had previously been reached. While the source of the problem was suspected to be the JTAG TAP controller, it had not yet been proven.

This test operated 4 devices at $V_{IO} = 5.5$ VDC and V_{CORE} at 4.0 VDC (3.6VDC is the rated maximum) for the latchup test. Gold ions were used with an LET = 82.6 MeV-cm²/mg and a fluence of 10⁷ ions/cm²/run. No latchup was observed for any of the devices.

SEU

The results of the heavy ion upset tests are shown in the figure below. Each run nominally had a fluence of 10⁷ ions/cm² with a flux = 10⁵ ions/cm²/sec. Part to part and run to run results were consistent. Upsets as a result of JTAG TAP controller upsets were removed as they averaged approximately 700 upsets per event. For the lower LET runs, with slow error counts, the jump sizes were determined by visually inspecting the error counters in real time. For the higher LET runs with higher upset rates, SEU time-tagging software was written, permitting exact removal of the burst errors as a result of the JTAG TAP controller upset. An example of three upset bursts are shown in Figure 2, below.

RT54SX16 Prototype SEU Test
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Fluence = 10^7 ions/cm²/run
P-Fuse Programmed; TCK = 6 kHz
 $V_{CC} = 3.3$ VDC



RT54SX16 Prototype Test
BNL - May, 1998
Flux = 1.2E5; Fluence = 1E7
P-Fuse Programmed; TCK = 6 kHz
Vcc = 3.3 VDC

Sample of 3 JTAG 'Upsets'

