

Ghosts in the Machine:

How subatomic-scale events impact us and what we can do about it

A tutorial presented by:

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Abstract:

It may be hard to believe that singular subatomic nuclear events can gravely effect our lives, but soft errors, or more specifically, single event effects (SEEs) caused by the terrestrial radiation environment actually can limit the reliability performance of advanced semiconductor devices. Unmitigated, SEEs are responsible for qualified product failure rates that far exceed those caused by the sum total of all other “hard” reliability mechanisms (gate oxide integrity, negative-bias instability, electromigration, etc.).

As the motivation for this tutorial, we shall start by examining the human impact of the ephemeral SEE phenomena in two, now infamous, real-world examples; one which ultimately led to the demise of an entire corporation. We will review the qualities of the three primary radiation mechanisms responsible for SEEs in the terrestrial environment and the ways in which the transient charge disturbances caused by these events disrupt circuit operation. The sensitivity to SEEs as a function of technology scaling will be discussed for several types of digital components (SRAM, DRAM, sequential logic, combinatorial logic). We shall also review accelerated testing and extrapolation techniques and the circuit and architectural derating effects that actually make complex SOCs more robust than they might first appear from the raw component data alone.

Finally, we close with a discussion of many of the mitigation solutions that have been proposed and will focus on the costs/benefits of the practical solutions in use in the commercial semiconductor industry.

Author Biography:

A Texas Instruments and IEEE Fellow and EDS Distinguished Lecturer with 22 years of experience in semiconductor reliability, Dr. Baumann is TI's radiation effects expert for advanced digital technologies. He co-lead the SIA panel directly responsible for changes in the ITAR that significantly reduced the risk of commercial electronics being export controlled. He led and was one of the main authors of the JEDEC JESD89 and 89A test standards for radiation testing of commercial microelectronics and was awarded the JEDEC Chairman's Award as a result. He has coauthored over 60 papers, two book chapters, and holds seven U.S. patents.