

Abstract

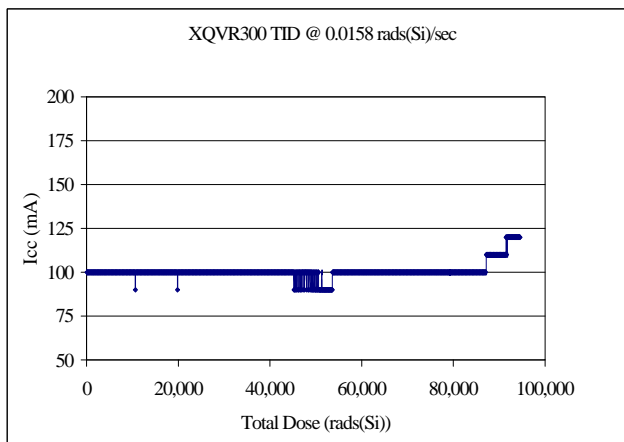
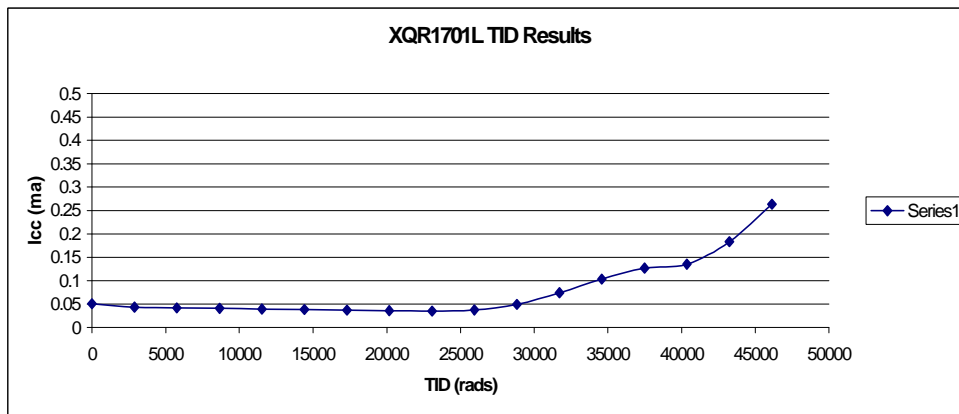
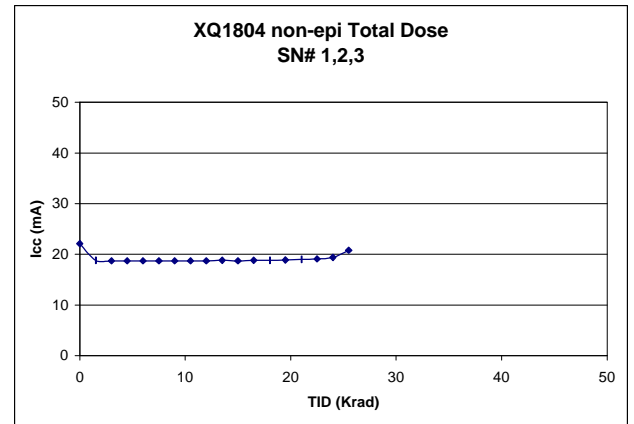
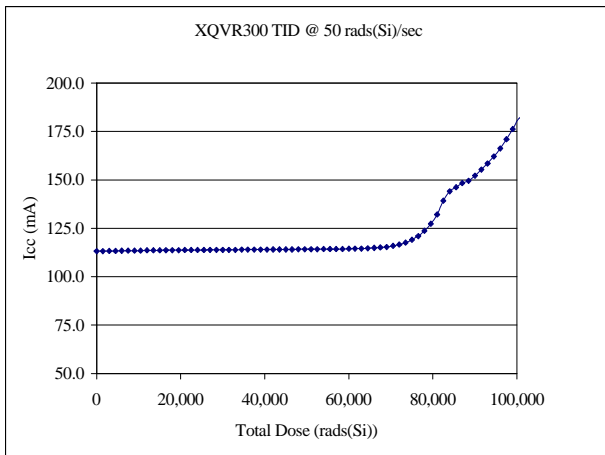
“Total Ionizing Dose Performance of SRAM-based FPGAs and supporting PROMs”
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Field reprogrammable (SRAM-based) FPGAs are increasingly being utilized for satellite and deep space applications. The advantages of these types of devices in satellite and space applications are numerous, including the ability to create standard multi-platform application modules, the ability to re-configure the architecture on orbit or in space in response to changing mission requirements, the ability to make last minute design changes and, of course, the reduced time from design to flight (and the consequent savings in low volume ASIC tooling costs). This paper describes the testing methodology used to evaluate these devices for their response to total ionizing dose stress and summarizes the TID performance of the XQR4000XL, the XQVR Virtex and VirtexE families, as well as the families of supporting configuration SPROMs (both OTP and ISP versions). In addition, a unique application will be described for greatly enhancing the resistance of the configuration PROMs to TID stresses, even while using the PROMs for configuration scrubbing¹.

Total Ionizing Performance was examined over various dose ranges, spanning orbital simulation at dose rates as low as 0.0158 rads(Si)/sec to Method 1019² compliant dose rates of 50-300 rads(Si)/sec. Testing included in-situ monitoring of key parameters (such as Icc), as well as full functional, parametric and timing evaluation of devices both pre- and post-dose. In addition, at various cumulative dose steps, devices were temporarily removed for full functional and parametric testing using the vendor's comprehensive final test program(s). Variation in performance of some of the referenced devices with dose rate, as well as a comparison of performance with static (Method 1019 compliant worse-case) and dynamic (simulation mission usage rational) bias will be presented.

Testing was performed utilizing the GammaCell Cobalt 60 source at Lockheed-Martin in Sunnyvale California (primarily for the moderate dose rate testing) and the Cobalt 60 source at McClellan Air Force Base (for testing at both the low and high dose rates). Annealing at both room temperature and at 100°C was used as a test for the rebound phenomenon. These anneals resulted in degraded devices returning to pre-rad performance, indicating that trapped surface state effects were not observed. The results typically show marginally higher dose degradation threshold at lower dose rates, as might be expected given the annealing responses observed.

The graphs below show some of the preliminary TID results taken under fixed state bias from a Virtex SRAM-based FPGA (at two drastically different dose rates), from a one-time programmable EPROM and from an ISP reprogrammable PROM. Additional data on other SRAM-based FPGA devices and supporting PROM circuits and the results of different TID test modes will be presented in the paper.



1. E. Fuller et al, "Radiation Characterization and SEU Mitigation of the Virtex FPPGA for Space-Based Reconfigurable Computing, NSREC2000, July 2000.
2. MIL-STD-883, Method 1019.5, issued 1 December 1997