

Summary of Proton Test on
the Actel A1280A at Indiana
University

June, 1998

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Test Facility

The Actel A1280A FPGA was tested at the Indiana University Cyclotron Facility (IUCF). The proton energy was 193 MeV and the flux was set at approximately 2×10^8 p/cm²/sec. The total fluence for each device was determined by the total dose response of the device and its affect on the current draw; details for each device including bias are given in the tables below. The device was irradiated normal to the beam.

Device Under Test

The A1280A devices were in a CPGA176 package and were active during irradiation. All die were from the Matsushita (MEC) foundry with a 1.0 μ m feature size. Upsets and currents were monitored in real-time with the device being clocked at 1 MHz. The stimulation pattern was a 500 kHz square wave. The test pattern used, the TMRA2.C, contains 522 S-Module flip-flops and 40 C-Module flip-flops.

Sample devices were taken from several lots used previously in radiation tests along with a few 'spare devices' to increase sample size. A total of 19 devices were used in this study. The intent of the study was to investigate the proton response of the hard-wired S-Module flip-flops with a large sample size. Previous testing did not detect proton upset within the operating voltage range but used a low fluence.

Test Results

Table 1. Summary for $V_{CC} = 4.5VDC$.

S/N	Lot	Total Dose kRads (Si)	Upsets	Fluence (p/cm ²)	Estimated Cross-Section (cm ² /flip-flop) by Lot
BC284	9424	5	6	80 x 10 ⁹	96 x 10 ⁻¹⁵
BC283	9424	5	2	80 x 10 ⁹	
BC209	9424	5	4	80 x 10 ⁹	
JJ9	9614 Lot Split 2	5	5	80 x 10 ⁹	120 x 10 ⁻¹⁵
JJ1	9614 Lot Split 3	7	13	112 x 10 ⁹	139 x 10 ⁻¹⁵
JJ2	9614 Lot Split 3	7	7	112 x 10 ⁹	
JJ10	9614 Lot Split 3	5	2	80 x 10 ⁹	
JJ5	9614 Lot Split 4	7	9	112 x 10 ⁹	165 x 10 ⁻¹⁵
JJ6	9614 Lot Split 4	7	14	112 x 10 ⁹	
JJ11	9614 Lot Split 4	5	6	80 x 10 ⁹	
JJ12	9614 Lot Split 4	5	4	80 x 10 ⁹	

Table 2. Summary for $V_{CC} = 5.0VDC$.

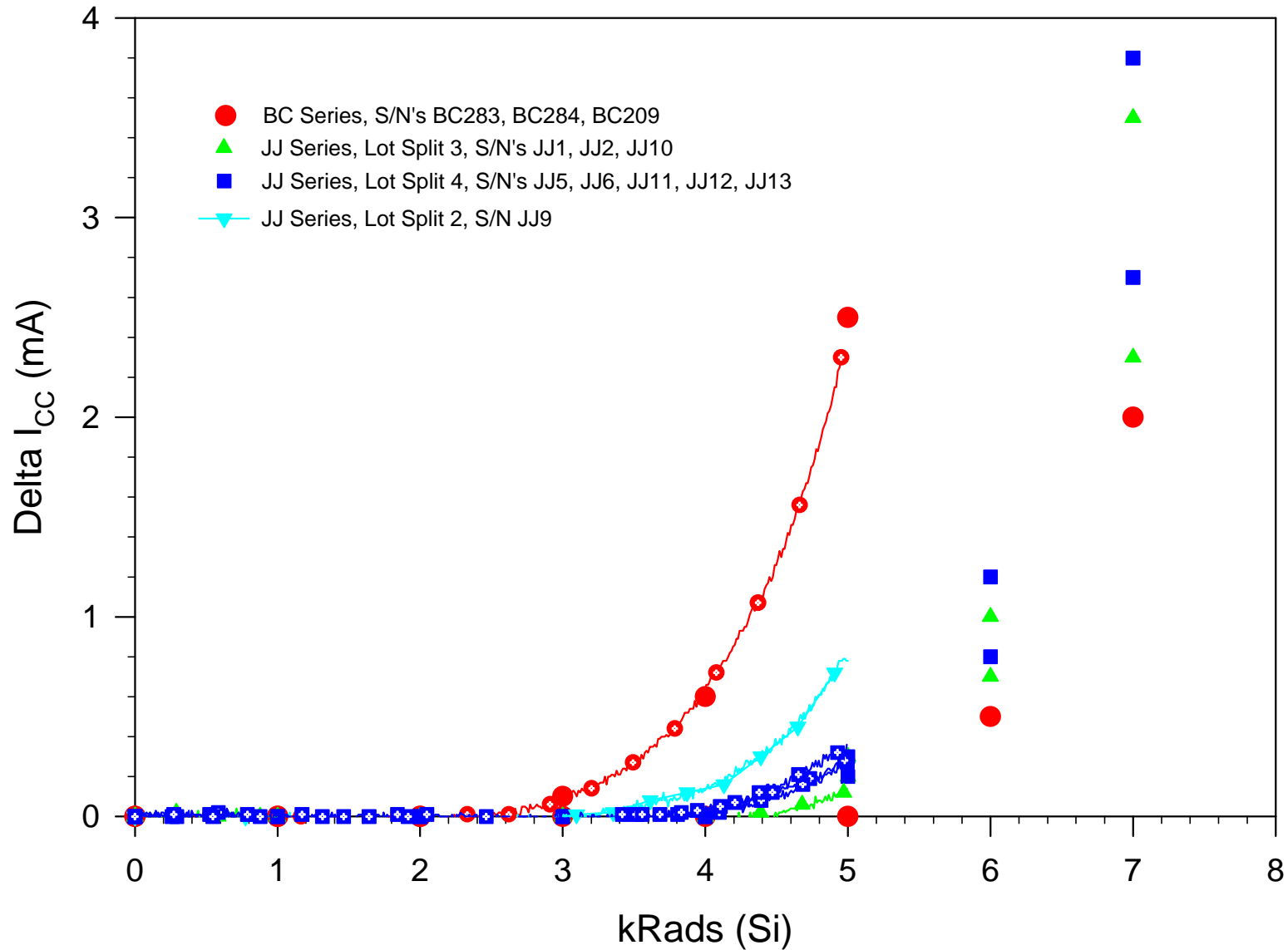
S/N	Lot	Total Dose kRads (Si)	Upsets	Fluence (p/cm ²)	Estimated Cross-Section (cm ² /flip-flop) by Lot
JJ3	9614 Lot Split 3	7	7	112×10^9	137×10^{-15}
JJ4	9614 Lot Split 3	7	9	112×10^9	
BC203	9424	5	5	80×10^9	83.8×10^{-15}
BC104	9424	5	2	80×10^9	
JJ7	9614 Lot Split 4	7	8	112×10^9	154×10^{-15}
JJ8	9614 Lot Split 4	7	10	112×10^9	
RK1	9415	5	4	80×10^9	95.8×10^{-15}

Nineteen devices were irradiated, with 12 devices at a worst-case bias of 4.5V and the remaining 7 devices at a nominal bias of 5.0V. An estimate of the cross-sections, by lot and bias, are given in Table 1 and Table 2, above. Previous tests of the A1280 (1.2 μm) and the A1280A (1.0 μm) did not detect proton upset. The large sample size for this study, with upsets detected in each device, shows that this device is sensitive to protons for S-Modules. No upsets were detected in the C-module flip-flops. However, there was a small number of flip-flops in this pattern so a different pattern should be used for measuring the C-module flip-flops' sensitivity to protons. Note that the C-module flip-flops in the RH1020, tested in June 1998, have a small, but non-zero cross-section for 193 MeV protons.

There was no clock upset detected in any of the devices.

The device's total dose performance falls into the radiation-soft range, typical for devices of this class. The data within a lot was relatively consistent.

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193 MeV, $2E8 \text{ p/cm}^2/\text{Sec}$
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