SEE Test Report V4.0
Heavy ion SEE test of MAX997ESA from MAXIM

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I. Introduction

This study was undertaken to determine the Single Event Latchup (SEL) and Single Event Transient (SET) susceptibility of the MAX997ESA high-speed +3V/+5V beyond the rails voltage comparator for transient interruptions in the output signal and for destructive events induced by exposing it to a heavy ion beam at TEXAS A&M Cyclotron Institute Radiation Effects Testing Facility. This test was performed in the frame of Lunar Reconnaissance Orbiter/Lunar Orbiter Laser Altimeter (LRO/LOLA) project.

II. Devices Tested

The sample size of the testing was four devices. Three devices were exposed and one served as a control sample. The test samples lot date code was 0531. This bipolar device was packaged in an 8-pin plastic SOP package and was prepped for testing by delidding.

III. Test Facility

Facility: TAMU Cyclotron Single Event Effects Test Facility, 15 MeV/amu beams
Flux: 2.48×10^3 to 9.93×10^4 particles/cm^2/s.
Fluence: For destructive events, all tests were ran to $< 2 \times 10^7$ p/cm^2 or until destructive events occurred
For non destructive events, all tests were ran to 2×10^7 p/cm^2 or until a sufficient (>100) number of transient events occurred.

Table 1: Ion an LET and range values at target for 0 degree incidence

Ion	LET (MeV•cm^2/mg)	Range (µm)
Ar	8.2	197
Xe	50.9	125

IV. Test Conditions and Error Modes

Test Temperature: Room Temperature
Bias conditions Device was biased as shown in Table 1.

Table 1: DUT bias condition

Pin function	Positive Power Supply	Ground	Shutdown input	Non inverting input	Inverting input	TTL output
Pin #	**7**	**4**	**8**	**3**	**2**	**6**
Pin name	**Vcc**	**GND**	**SHDN**	**V+**	**V-**	**Q**
Bias conditions	4.3 V	GND	GND	0	0.4	50 ohm
	4.3 V	GND	GND	0.1	0	50 ohm

Parts were mounted on a PCB. Because of MAX997 high-bandwidth a high-speed layout was required. This included ground plane and decoupling capacitor (0.1uF ceramic).

PARAMETERS OF INTEREST: Power supply currents, output voltage

SEE Conditions: SEL, SET

V. Test Methods

Test circuit, as shown in Figure 1, for the voltage comparator contained a power supply for the power supply input and the input voltages and a digital scope for capturing any output anomalies. Once the device output was present and the load conditions were set, the digital scope was set to trigger on and voltages that were above or below a predetermined threshold (set to 100 mV).

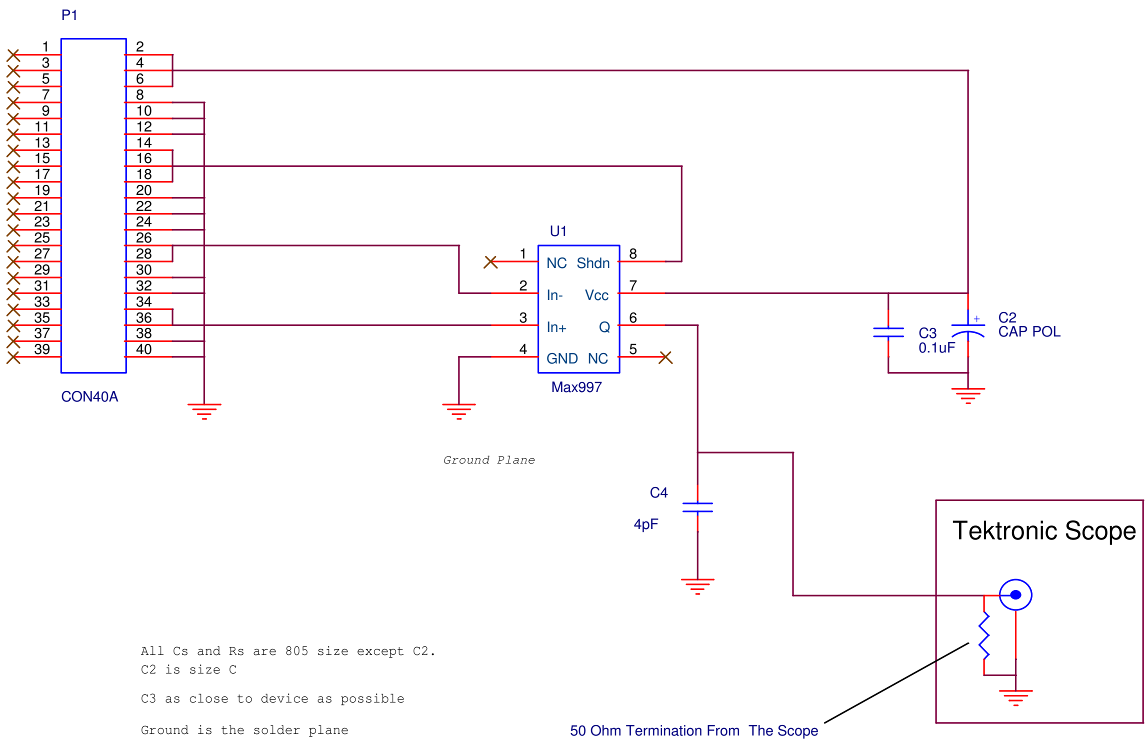

Figure 1. Schematic Diagram for the testing of the MAX997.

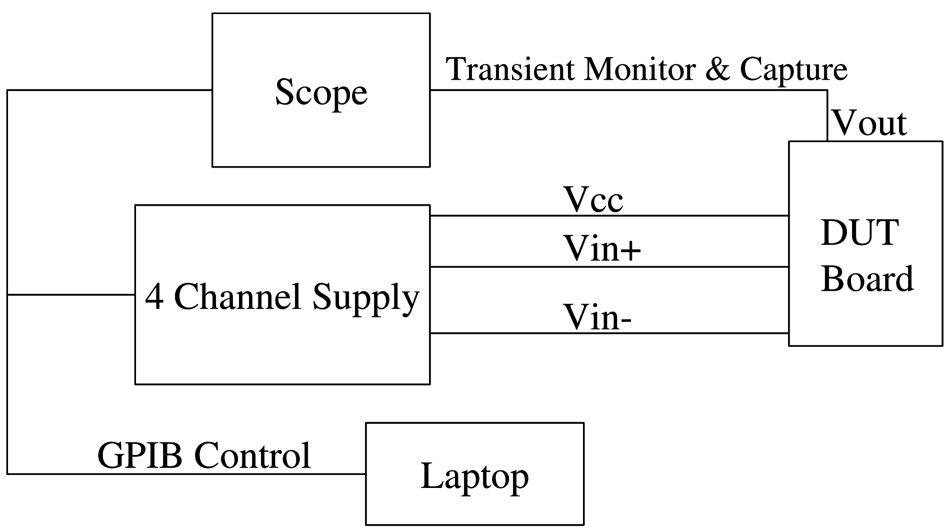

Figure 2. Overall Block Diagram for the testing of the MAX997.

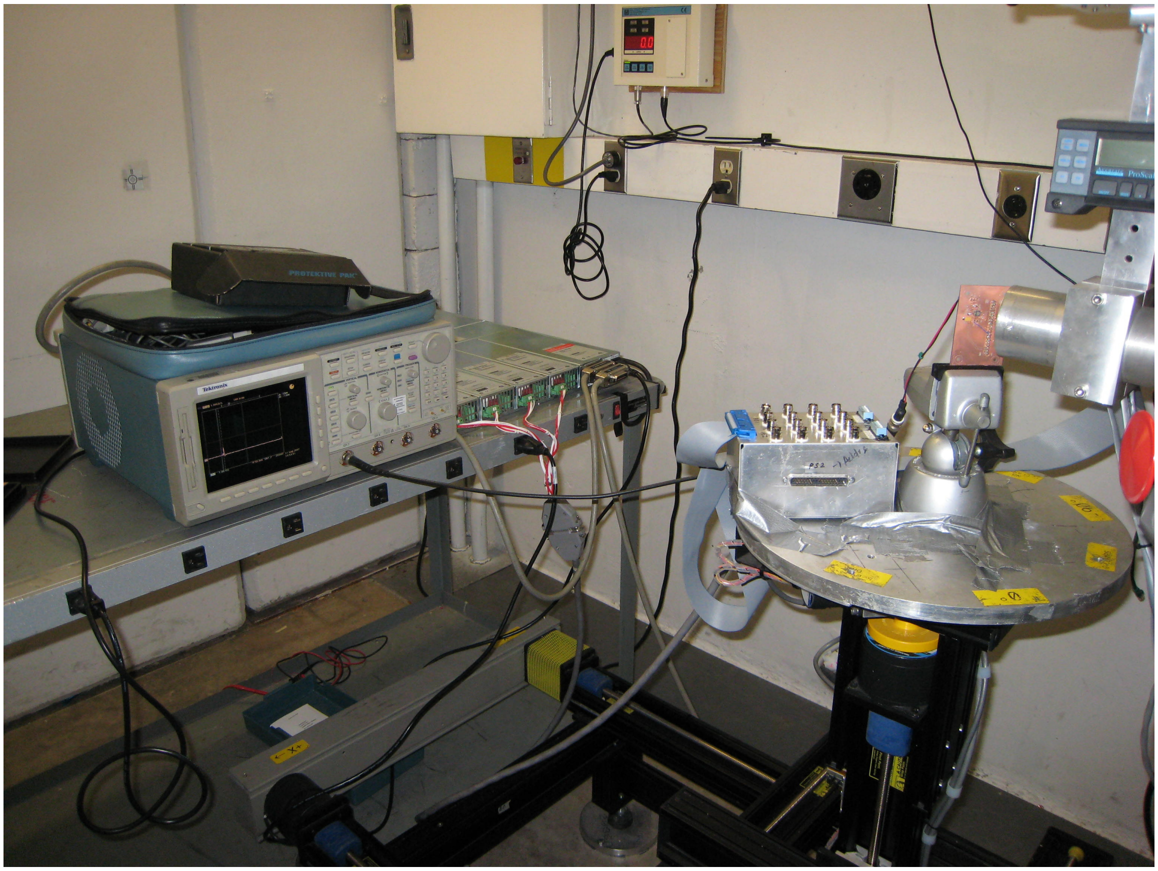

Figure 3. Test Setup for the testing of the MAX997 at Texas A&M University Cyclotron.

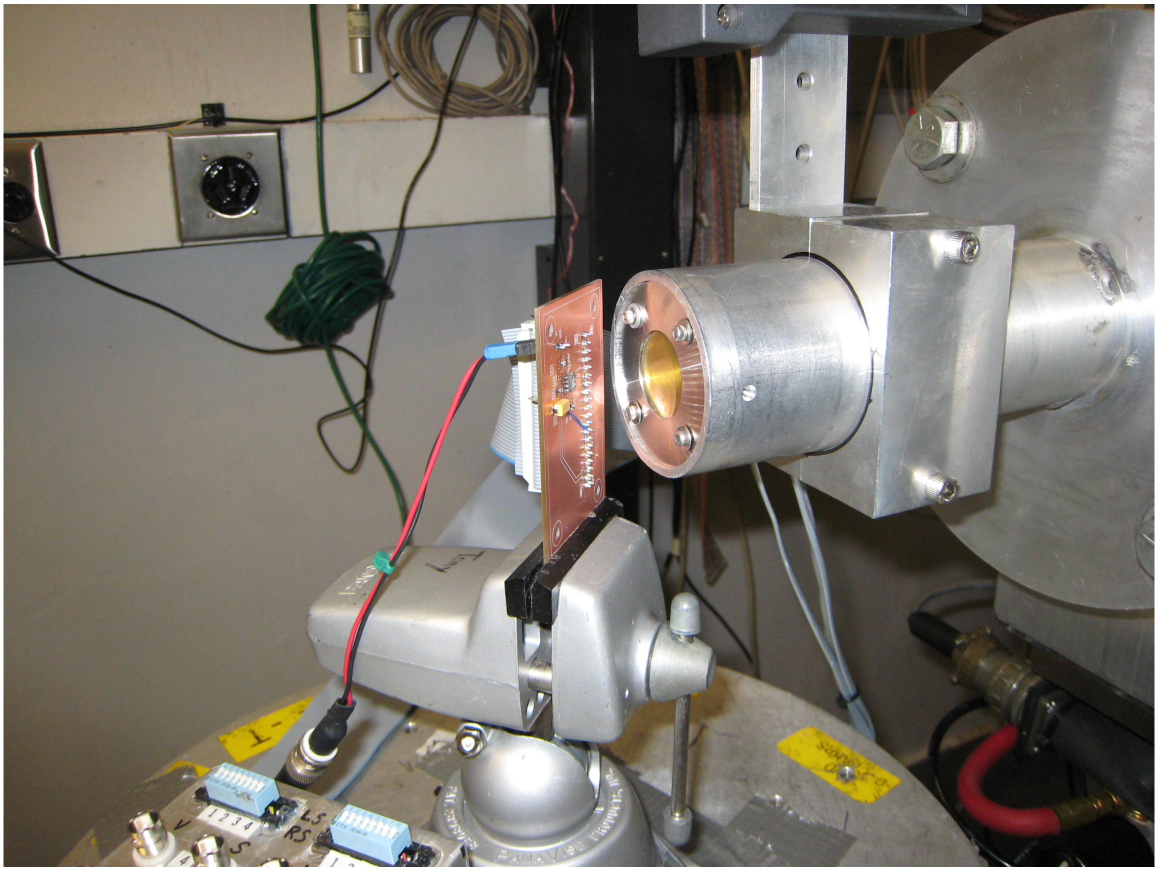

Figure 4. MAX997 Test Card at 45 degrees ready for beam at Texas A&M University Cyclotron.

VI. Test Performance

Detailed test results are shown in Table 2 below. The devices were exposed from a fluence of 1.67 x 10^5 to 2.00 x 10^7 particles/cm^2 of the Argon and Xenon ion beams. Observations for destructive events were for energies up to the maximum LET of 72 MeV-cm^2/mg. The MAX997 was sensitive to SETs for the inputs shown in Table 1. The current of DUT1 was twice the nominal current but the device functioned properly. Occasionally a power reset was needed to bring the device back to full functionality. The current of DUT2 and DUT3 was stable and the outputs were as expected. Chart 1 below shows a Weibull Fit Curve of the data collected where runs 6 and 7 were masked out.

Table 2: Test Data

RUN #	DUT #	Vcc	V+	V-	Icc (mA)	Errors	Energy (MeV)	Effective LET (MeV-cm2/mg)	X/SEC Cross Section (cm2/device)
1	1	4.3	0.0	0.4	4.50	118	1583	50.9	5.90E-05
2	1	4.3	0.0	0.4	4.50	70	1583	50.9	1.73E-05
3	1	4.3	0.0	0.4	42.00	85	1583	50.9	2.82E-05
4	1	4.3	0.0	0.4	42.00	81	1583	50.9	2.63E-05

5	1	4.3	0.0	0.4	60.00	9	1583	72.0	9.00E-06
6	1	4.3	0.0	0.4	67.09	46	1583	72.0	2.30E-06
7	1	4.3	0.0	0.4	68.80	3	1583	72.0	1.97E-07
8	1	4.3	0.0	0.4	76.19	101	1583	72.0	6.83E-05
9	1	4.3	0.0	0.4	73.60	38	1583	72.0	4.79E-05
10	1	4.3	0.0	0.4	70.21	102	1583	72.0	5.89E-05
11	1	4.3	0.0	0.4	75.45	101	1583	72.0	6.52E-05
12	1	4.3	0.0	0.4	72.39	81	1583	72.0	4.06E-05
13	1	4.3	0.1	0.0	141.50	93	1583	72.0	4.72E-05
14	1	4.3	0.1	0.0	135.90	86	1583	72.0	6.41E-05
15	1	4.3	0.1	0.0	132.45	76	1583	72.0	6.52E-05
16	1	4.3	0.1	0.0	127.13	73	1583	72.0	7.20E-05
17	1	4.3	0.1	0.0	155.00	24	1583	50.9	1.17E-05
18	1	4.3	0.1	0.0	136.60	103	1583	50.9	3.26E-05
19	1	4.3	0.1	0.0	130.60	118	1583	50.9	5.53E-05
20	1	4.3	0.1	0.0	127.78	107	1583	50.9	4.20E-05
21	1	4.3	0.0	0.4	70.66	177	1583	50.9	5.60E-05
22	1	4.3	0.0	0.4	70.85	203	1583	50.9	7.42E-05
23	1	4.3	0.0	0.4	46.31	97	1583	50.9	1.16E-04
24	1	4.3	0.0	0.4	48.11	106	1583	50.9	1.42E-04
25	2	4.3	0.0	0.4	4.52	98	1583	50.9	1.49E-04
26	2	4.3	0.0	0.4	4.51	86	1583	50.9	1.43E-04
27	2	4.3	0.0	0.4	4.54	71	1583	50.9	1.42E-04
28	2	4.3	0.0	0.4	4.55	93	1583	50.9	1.67E-04
29	2	4.3	0.0	0.4	4.52	111	1583	72.0	2.00E-04
30	2	4.3	0.0	0.4	4.52	60	1583	72.0	1.67E-04
31	2	4.3	0.1	0.0	69.84	117	1583	72.0	5.50E-04
32	2	4.3	0.1	0.0	69.80	97	1583	72.0	5.82E-04
33	2	4.3	0.1	0.0	69.80	89	1583	50.9	4.24E-04
34	2	4.3	0.1	0.0	69.80	99	1583	50.9	4.64E-04
35	2	4.3	0.0	0.4	4.52	82	1583	50.9	1.63E-04
36	2	4.3	0.0	0.4	4.52	85	1583	50.9	1.44E-04
37	3	4.3	0.0	0.4	4.45	29	1583	50.9	1.19E-04
38	3	4.3	0.0	0.4	4.41	96	1583	50.9	1.69E-04
39	3	4.3	0.1	0.0	69.77	246	1583	50.9	3.98E-04
40	3	4.3	0.1	0.0	69.75	107	1583	50.9	3.82E-04
41	3	4.3	0.1	0.0	69.75	107	1583	72.0	5.30E-04
42	3	4.3	0.1	0.0	69.74	131	1583	72.0	5.38E-04
43	3	4.3	0.0	0.4	4.45	101	1583	72.0	1.92E-04
44	3	4.3	0.0	0.4	4.42	118	1583	72.0	2.29E-04
45	3	4.3	0.0	0.4	4.45	103	540	8.2	3.70E-05
46	3	4.3	0.0	0.4	4.45	98	540	8.2	2.81E-05
47	3	4.3	0.1	0.0	69.70	97	540	8.2	1.25E-04
48	3	4.3	0.1	0.0	69.70	102	540	8.2	1.09E-04
49	3	4.3	0.1	0.0	69.75	103	540	11.6	1.66E-04
50	3	4.3	0.1	0.0	69.75	93	540	11.6	1.82E-04
51	3	4.3	0.0	0.4	4.45	94	540	11.6	6.44E-05
52	3	4.3	0.0	0.4	4.45	107	540	11.6	6.34E-05
53	2	4.3	0.0	0.4	4.45	68	540	8.2	3.29E-05

54	2	4.3	0.0	0.4	4.45	50	540	8.2	2.88E-05
55	2	4.3	0.1	0.0	69.89	139	540	8.2	1.26E-04
56	2	4.3	0.1	0.0	69.89	114	540	8.2	1.82E-04
57	2	4.3	0.1	0.0	69.82	111	540	11.6	1.62E-04
58	2	4.3	0.1	0.0	69.82	108	540	11.6	1.83E-04
59	2	4.3	0.0	0.4	4.45	93	540	11.6	6.42E-05
60	2	4.3	0.0	0.4	4.45	100	540	11.6	5.24E-05

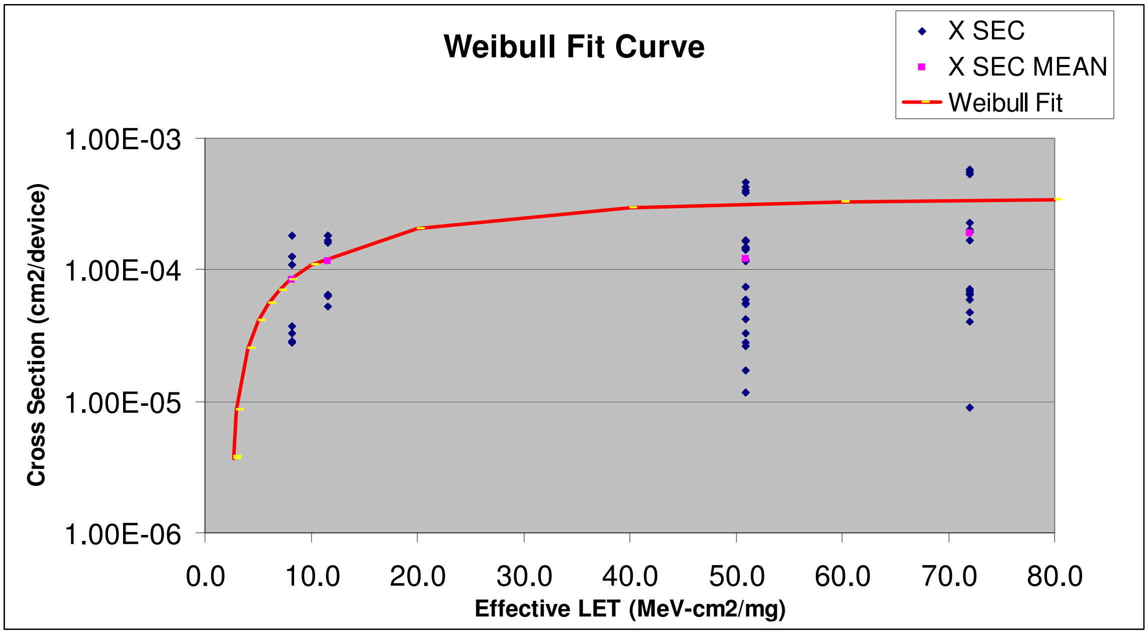

Chart 1. Weibull fit curve for SET testing of the MAX997.

High Output – Worse Case Transient

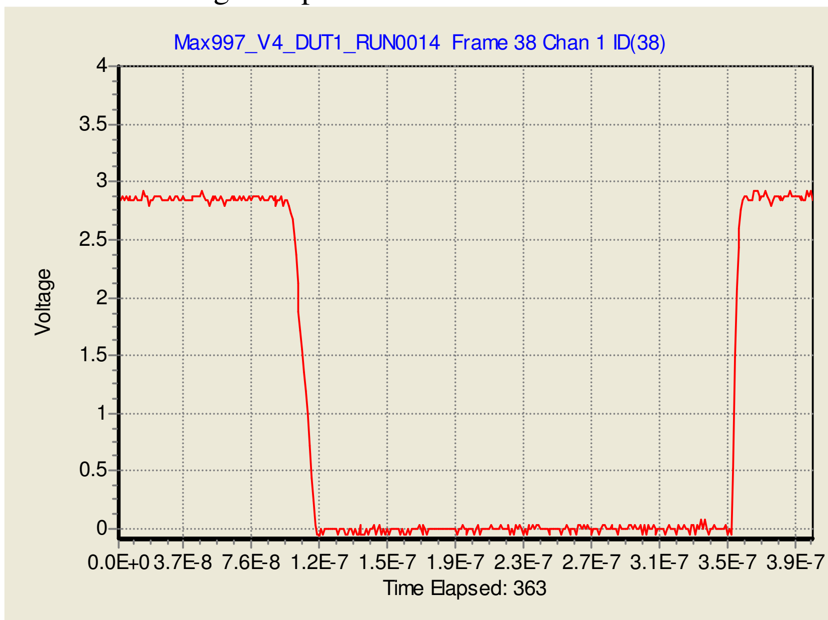

Chart 2. High Output FWHM error of 260ns for MAX997.

Low Output – Worse Case Transient

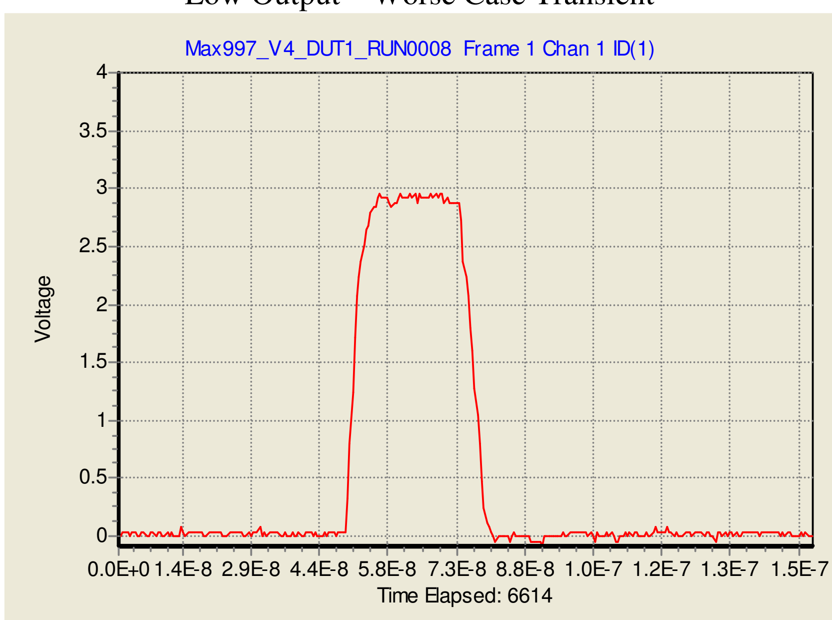

Chart 3. Low Output FWHM error of 26ns for MAX997.

VII. COMMENTS AND RECOMMENDATIONS

This MAX997 did not experience a destructive latchup to the maximum available LET of 72 MeV-cm^2/mg for three devices tested however the DUT current increased in DUT1 up to two times normal levels. DUT1 required a power reset occasionally to return to normal state. DUT2 and DUT3 performed normally after irradiation. The data shows that this device experienced errors down to an LET of 8.2 MeV-cm^2/mg. Chart 2 above shows a high output with a worse case error Full Width Half Max (FWHM) of approximately 260ns at about 1.5V. Chart 3 shows a low output with a worse case error FHWM of approximately 26ns at about 1.5V and the output did not exceed 3V.

Appendix 1:
http://www.maxim-ic.com/
http://www.maxim-ic.com/quick_view2.cfm/qv_pk/1481