SEE Test Report V2.0

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 three devices. Two 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: 1.74×10^3 to 9.52×10^4 particles/cm²/s.
Fluence: For destructive events, all tests were ran to 1×10^7 p/cm² or until destructive events occurred
For non destructive events, all tests were ran to 1×10^6 p/cm² 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•cm²/mg)	Range (µm)
Ne	2.8	262
Ar	8.7	174
Xe	53.9	102

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	5 Kohm
	4.3 V	GND	GND	0	0.4	5 Kohm
	4.3 V	GND	GND	0.1	0	5 Kohm
	4.3 V	GND	GND	0.1	0.4	5 Kohm
	4.3 V	GND	GND	0.5	0	5 Kohm
	4.3 V	GND	GND	0.5	0.4	5 Kohm
	4.3 V	GND	GND	1	0	5 Kohm
	4.3 V	GND	GND	1	0.4	5 Kohm
	4.3 V	GND	GND	2	0	5 Kohm
	4.3 V	GND	GND	2	0.4	5 Kohm
	5	GND	GND	2	2.0045	20Kohm pullup
	5	GND	GND	2.0045	2	20Kohm pullup

Parts were mounted on a PCB. Because of MAX997 high-bandwidth a high-speed layout was required. This included ground plane, decoupling capacitor (0.1uF ceramic), and a 1000pF capacitor between the inputs as recommended in data sheet.

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).

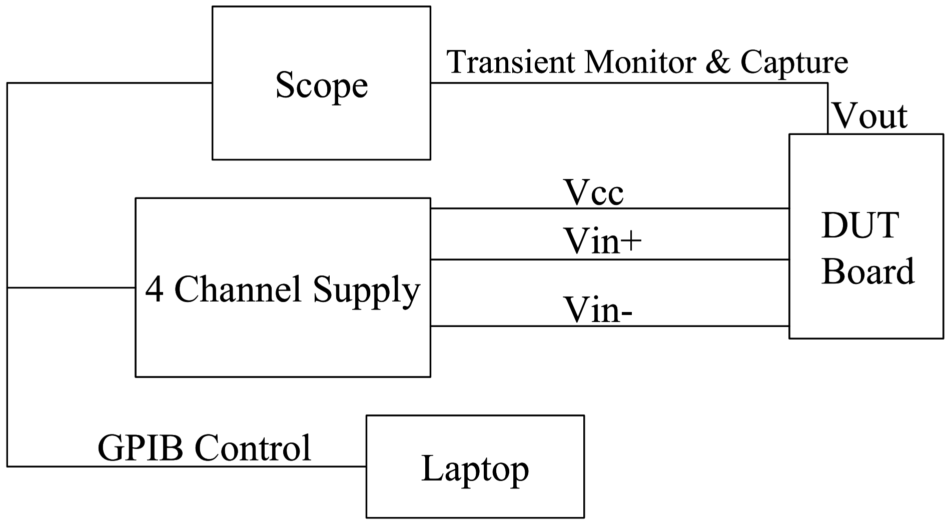

Figure 2. Overall Block Diagram for the testing of the MAX997

VI. Test Performance

Detailed test results are shown in Table 2 below. The devices were exposed from a fluence of 1.81 x 10^5 to 2.00 x 10^7 particles/cm^2 of the Neon, Argon, and Xenon ion beams. Observations for destructive events were for energies up to the maximum LET of 76 $MeVcm^2/mg$. The MAX997 was sensitive to SETs at a variety of inputs shown in Table 1. The DUT current did increase but it did not cause a destructive latchup. Chart 1 below shows a Weibull Fit Curve of the data collected.

Table 2: Test Data

RUN #	DUT #	Vcc	V+	V-	Icc (mA)	Errors	Energy (MeV)	Effective LET (MeV-cm2/mg)	SEL	X/SEC Cross Section (cm2/device
8	1	4.3	0.5	0.4	5.45	434	1291	53.9	0	1.68E-04
9	1	4.3	0.0	0.0	4.45	191	1291	53.9	0	5.28E-04
10	1	4.3	0.0	0.0	4.45	119	1291	53.9	0	4.52E-04
11	1	4.3	0.0	0.0	4.45	119	1291	53.9	0	4.27E-04
12	1	4.3	0.0	0.4	4.45	10	1291	53.9	0	1.85E-04
13	1	4.3	0.0	0.4	4.45	68	1291	53.9	0	1.94E-04
14	1	4.3	0.0	0.4	4.45	104	1291	53.9	0	1.79E-04
15	1	4.3	0.1	0.0	5.45	113	1291	53.9	0	2.86E-04
16	1	4.3	0.1	0.4	4.45	107	1291	53.9	0	1.69E-04
17	1	4.3	0.5	0.0	4.45	83	1291	53.9	0	1.25E-04
18	1	4.3	0.5	0.0	4.45	126	1291	53.9	0	3.06E-04
19	1	4.3	0.5	0.4	4.45	117	1291	53.9	0	2.82E-04
20	1	4.3	1.0	0.0	4.45	181	1291	53.9	0	2.79E-04
21	1	4.3	1.0	0.4	4.45	125	1291	53.9	0	2.49E-04
22	1	4.3	2.0	0.0	4.45	114	1291	53.9	0	2.43E-04
23	1	4.3	2.0	0.4	4.45	112	1291	53.9	0	2.86E-04
24	1	5	2.0	2.0	4.45	181	1291	53.9	0	3.97E-04
25	1	5	2.0	2.0	4.45	121	1291	53.9	0	4.43E-04

27	1	5	2.0	2.0	6.20	144	1291	76.2	0	5.85E-04
28	1	5	2.0	2.0	6.20	192	1291	76.2	0	5.73E-04
29	1	4.3	2.0	0.4	6.20	110	1291	76.2	0	2.83E-04
30	1	4.3	2.0	0.0	6.20	113	1291	76.2	0	3.46E-04
31	1	4.3	1.0	0.4	6.20	115	1291	76.2	0	2.67E-04
32	1	4.3	1.0	0.0	6.20	112	1291	76.2	0	3.44E-04
33	1	4.3	0.5	0.4	6.20	113	1291	76.2	0	3.41E-04
34	1	4.3	0.5	0.0	6.20	119	1291	76.2	0	3.20E-04
35	1	4.3	0.1	0.4	5.10	108	1291	76.2	0	1.98E-04
36	1	4.3	0.1	0.0	6.20	108	1291	76.2	0	3.35E-04
37	1	4.3	0.0	0.4	5.10	106	1291	76.2	0	2.70E-04
38	1	4.3	0.0	0.0	5.10	116	1291	76.2	0	5.35E-04
39	2	4.3	0.0	0.0	4.80	120	1291	53.9	0	4.14E-04
40	2	4.3	0.0	0.4	4.80	106	1291	53.9	0	2.09E-04
41	2	4.3	0.1	0.0	5.60	107	1291	53.9	0	2.42E-04
42	2	4.3	0.1	0.4	4.80	109	1291	53.9	0	2.05E-04
43	2	4.3	0.5	0.0	5.60	110	1291	53.9	0	2.09E-04
44	2	4.3	0.5	0.4	5.60	113	1291	53.9	0	2.46E-04
45	2	4.3	1.0	0.0	5.60	111	1291	53.9	0	2.61E-04
46	2	4.3	1.0	0.4	4.80	109	1291	53.9	0	2.34E-04
47	2	4.3	2.0	0.0	5.60	9	1291	53.9	0	1.04E-05
48	2	4.3	2.0	0.0	5.60	110	1291	53.9	0	2.56E-04
49	2	4.3	2.0	0.4	5.60	111	1291	53.9	0	2.25E-04
50	2	5	2.0	2.0	4.80	114	1291	53.9	0	4.18E-04
51	2	5	2.0	2.0	5.60	114	1291	53.9	0	4.44E-04
52	2	5	2.0	2.0	5.60	111	1291	76.2	0	6.13E-04
53	2	5	2.0	2.0	4.80	115	1291	76.2	0	6.02E-04
54	2	4.3	2.0	0.4	5.60	107	1291	76.2	0	2.83E-04
55	2	4.3	2.0	0.0	5.60	110	1291	76.2	0	3.34E-04
56	2	4.3	1.0	0.4	5.60	112	1291	76.2	0	3.59E-04
57	2	4.3	1.0	0.0	5.60	107	1291	76.2	0	3.32E-04
58	2	4.3	0.5	0.4	5.60	105	1291	76.2	0	3.96E-04
59	2	4.3	0.5	0.0	5.60	112	1291	76.2	0	4.15E-04
60	2	4.3	0.1	0.4	4.80	107	1291	76.2	0	2.23E-04
61	2	4.3	0.1	0.0	5.60	110	1291	76.2	0	4.10E-04
62	2	4.3	0.0	0.4	4.80	110	1291	76.2	0	2.60E-04
63	2	4.3	0.0	0.0	4.80	106	1291	76.2	0	4.51E-04
64	2	4.3	0.0	0.0	4.70	130	496	8.7	0	1.77E-04
65	2	4.3	0.0	0.4	4.70	38	496	8.7	0	1.48E-05
66	2	4.3	0.1	0.0	5.40	113	496	8.7	0	9.58E-05
67	2	4.3	0.1	0.4	4.70	88	496	8.7	0	5.18E-05
68	2	4.3	0.5	0.0	5.40	81	496	8.7	0	7.64E-05
69	2	4.3	0.5	0.4	5.40	115	496	8.7	0	1.10E-04
70	2	4.3	1.0	0.0	5.40	86	496	8.7	0	8.11E-05
71	2	4.3	1.0	0.4	5.40	111	496	8.7	0	9.17E-05
72	2	4.3	2.0	0.0	5.40	112	496	8.7	0	9.18E-05
73	2	4.3	2.0	0.4	5.40	101	496	8.7	0	8.42E-05
74	2	5	2.0	2.0	4.70	122	496	8.7	0	1.57E-04
75	2	5	2.0	2.0	5.60	123	496	8.7	0	1.52E-04
76	2	5	2.0	2.0	5.60	125	496	12.3	0	2.40E-04

77	2	5	2.0	2.0	4.70	127	496	12.3	0	2.17E-04
78	2	4.3	2.0	0.4	5.60	91	496	12.3	0	9.10E-05
79	2	4.3	2.0	0.0	5.60	96	496	12.3	0	9.23E-05
80	2	4.3	1.0	0.4	5.60	106	496	12.3	0	9.30E-05
81	2	4.3	1.0	0.0	5.60	86	496	12.3	0	8.60E-05
82	2	4.3	0.5	0.4	5.60	110	496	12.3	0	1.12E-04
83	2	4.3	0.5	0.0	5.60	98	496	12.3	0	9.70E-05
84	2	4.3	0.1	0.4	4.80	112	496	12.3	0	9.82E-05
85	2	4.3	0.1	0.0	5.60	110	496	12.3	0	1.29E-04
86	2	4.3	0.0	0.4	4.80	92	496	12.3	0	9.11E-05
87	2	4.3	0.0	0.0	4.80	110	496	12.3	0	2.05E-04
88	2	4.3	0.0	0.0	5.60	150	266	2.8	0	9.09E-05
89	2	4.3	0.0	0.4	6.20	35	266	2.8	0	2.82E-06
90	2	4.3	0.1	0.0	7.50	82	266	2.8	0	1.08E-05
91	2	4.3	0.1	0.4	6.30	19	266	2.8	0	2.68E-06
92	2	4.3	0.5	0.0	7.20	61	266	2.8	0	1.19E-05
93	2	4.3	0.5	0.4	7.30	25	266	2.8	0	1.21E-05
94	2	4.3	1.0	0.0	7.20	15	266	2.8	0	1.07E-05
95	2	4.3	1.0	0.4	7.20	19	266	2.8	0	1.17E-05
96	2	4.3	2.0	0.0	7.10	20	266	2.8	0	1.42E-05
97	2	4.3	2.0	0.4	7.10	22	266	2.8	0	9.44E-06
98	2	5	2.0	2.0	6.60	122	266	2.8	0	6.89E-05
99	2	5	2.0	2.0	7.40	111	266	2.8	0	7.60E-05
100	2	5	2.0	2.0	7.20	161	266	4.0	0	1.07E-05
101	2	5	2.0	2.0	7.20	274	266	4.0	0	9.82E-05
102	1	4.3	0.0	0.0	5.40	202	266	2.8	0	8.87E-05
103	1	4.3	0.0	0.4	4.70	13	266	2.8	0	1.24E-05
104	1	4.3	0.1	0.0	5.40	15	266	2.8	0	1.50E-05
105	1	4.3	0.1	0.4	4.70	17	266	2.8	0	1.68E-05
106	1	4.3	0.5	0.0	6.10	12	266	2.8	0	1.19E-05
107	1	4.3	0.5	0.4	8.40	15	266	2.8	0	1.50E-05
108	1	4.3	1.0	0.0	8.60	7	266	2.8	0	7.00E-06
109	1	4.3	1.0	0.4	8.30	10	266	2.8	0	9.80E-06
110	1	4.3	2.0	0.0	9.90	7	266	2.8	0	7.00E-06
111	1	4.3	2.0	0.4	9.70	12	266	2.8	0	1.19E-05
112	1	5	2.0	2.0	10.40	75	266	2.8	0	7.50E-05
113	1	5	2.0	2.0	11.40	73	266	2.8	0	7.30E-05
114	1	4.3	0.0	0.0	10.20	94	266	2.8	0	8.70E-05

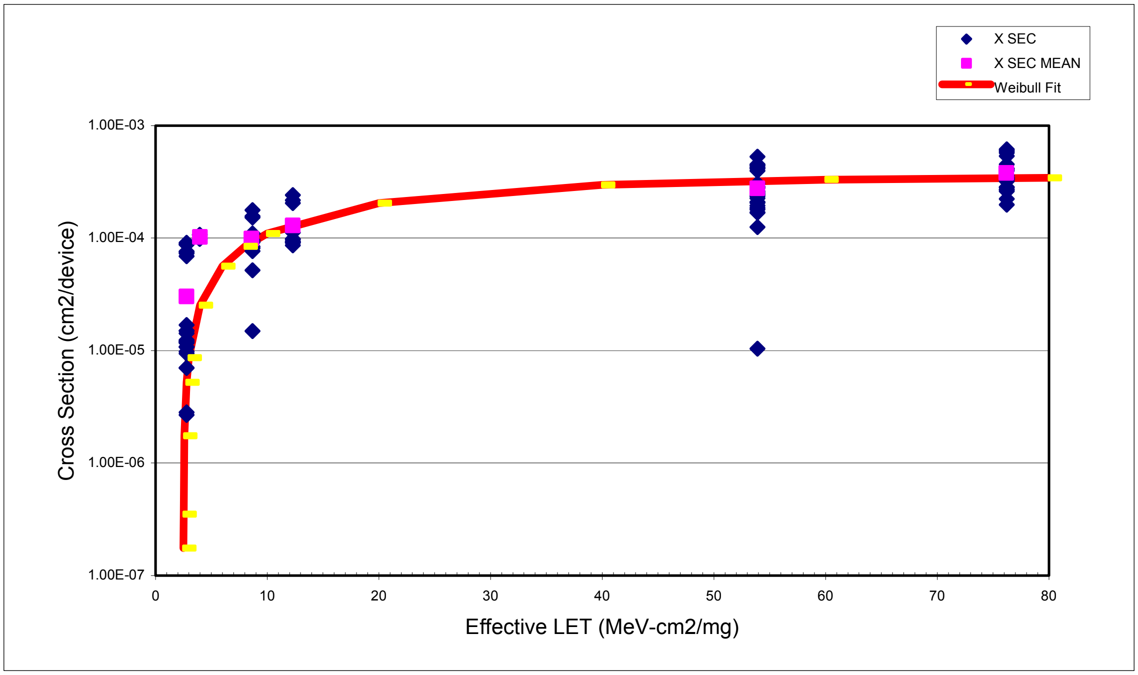

Chart 1. Weibull fit curve for SET testing of the MAX997.

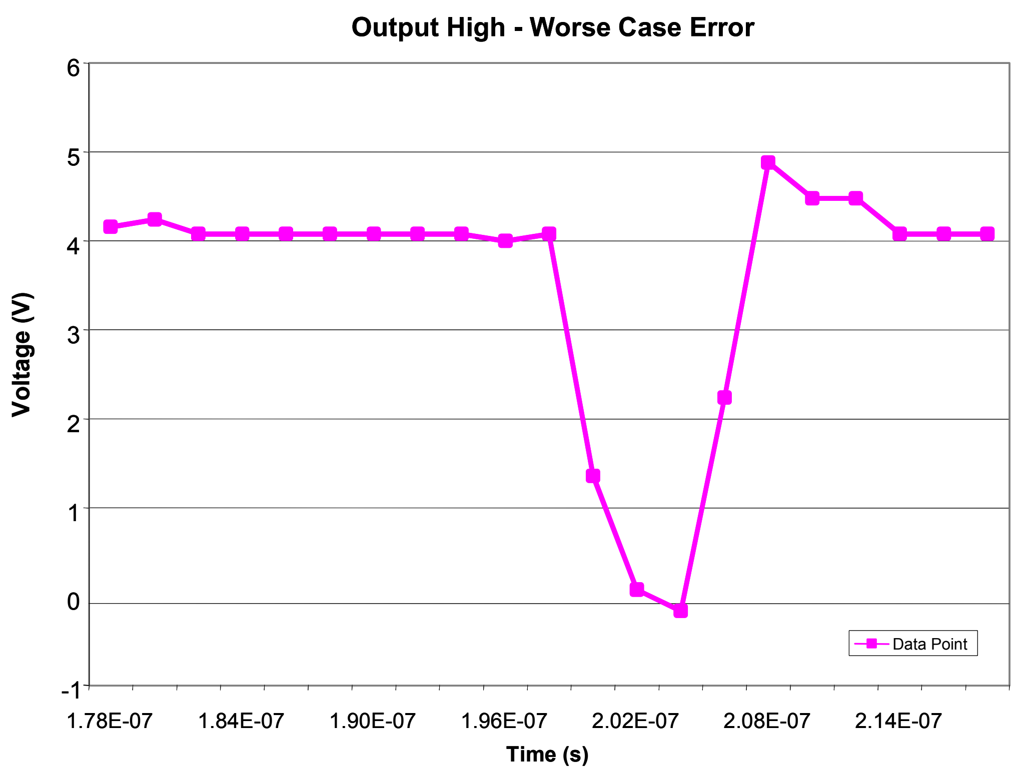

Chart 2. High Output FWHM error of 200 ns for MAX997.

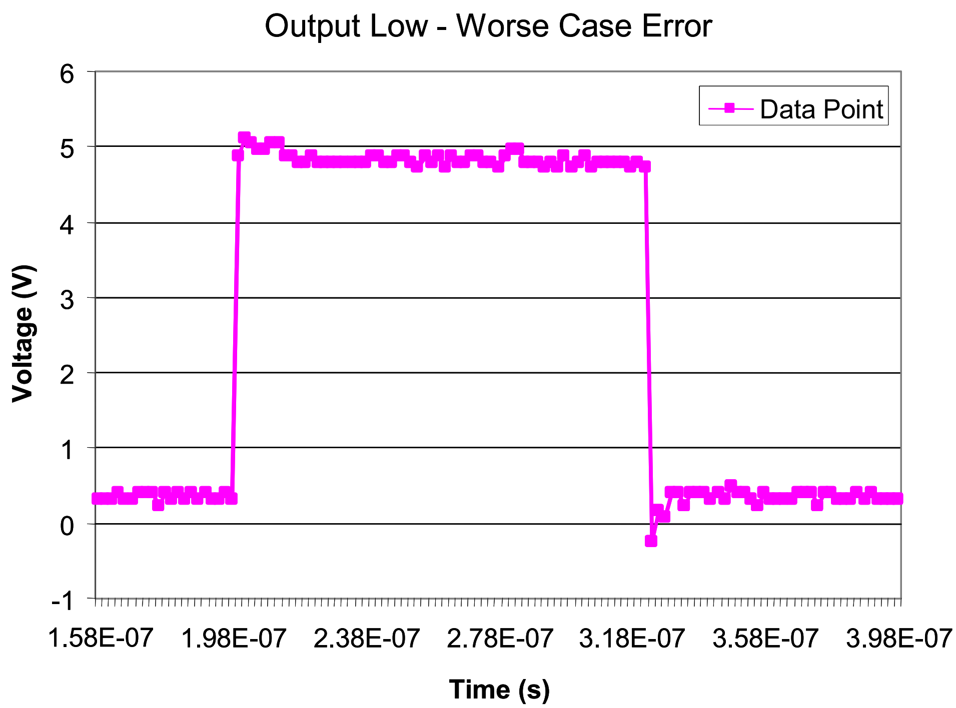

Chart 3. Low Output FWHM error of 120ns for MAX997.

VII. COMMENTS

This MAX997 did not experience a destructive latchup to the maximum available LET of 76 MeV-cm^2/mg for two devices tested but the DUT current increased as the total dose increased on the devices. The data shows that this device experienced errors down to an LET of 2.8 MeV-cm^2/mg. Chart 2 above shows a high output with a worse case error Full Width Half Max (FWHM) of approximately 200ns at about 2.2V. Chart 3 shows a low output with a worse case error FHWM of approximately 120ns at 2.2V. Total Ionizing Dose (TID) testing of this device will take place at NASA GSFC.

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