Heavy ion Single Event Effects test of Power Supply for GaAs power amplifier TPS9103 from Texas Instruments

Test Report

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1 Introduction

This report presents the heavy ion SEE test data on the Power Supply for GaAs power amplifier TPS9103 from Texas Instruments. This work has been performed in the frame of the ST5 project.

2 Tested Devices

The tested devices are described in Table 1. The parts have been delidded for testing, a picture of the die is shown in Figure 2.

Type	**TPS9103**
Manufacturer	Texas Instruments
Function	Power Supply for GaAs power amplifier
Package	TSSOP 20
Package marking	See Figure 1
Previous SEE testing	No data available

Table 1: description of the tested devices.

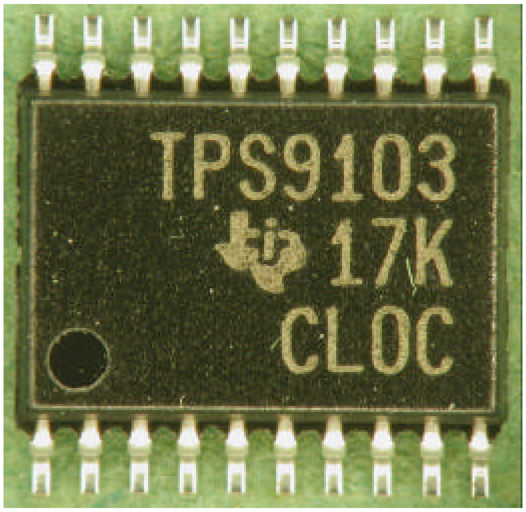

Figure 1: package marking

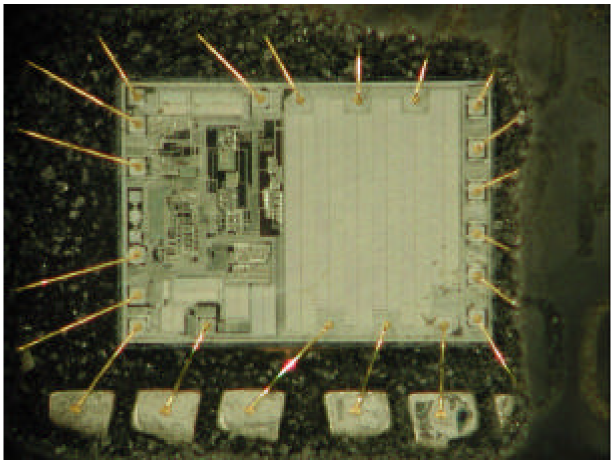

Figure 2: die picture

3 Test description

3.1 Irradiation facility

The tests have been performed at the Brookhaven National Laboratories in June 2002. The ion beams used are described in Table 2.

Ion	Energy (MeV)	Average flux (#/cm^2-s)	Range (mm)	LET (MeVcm^2/mg)
Cl-35	210	~1E+04	63	11.4
Br-81	278	~1E+04	36	37.5
Fe-56	256	~1E+04	44	24.0
F-19	140	~2E+04	120	3.4
I-127	320	~5E+03	31	59.7

Table 2: Ions used at BNL.

3.2 Test set-up

Figure 3 shows the test bias conditions. They are similar to the application conditions. An oscilloscope monitors the batt_out and gate bias outputs. As soon as one of the device output deviates of 500 mV from the nominal output voltage, a Single Event Transient (SET) is counted.
The power supply current was monitored during irradiation. As soon as the current is larger than 5 mA, a Single Event Latchup (SEL) is counted. The device nominal power supply current is about 300 µA.

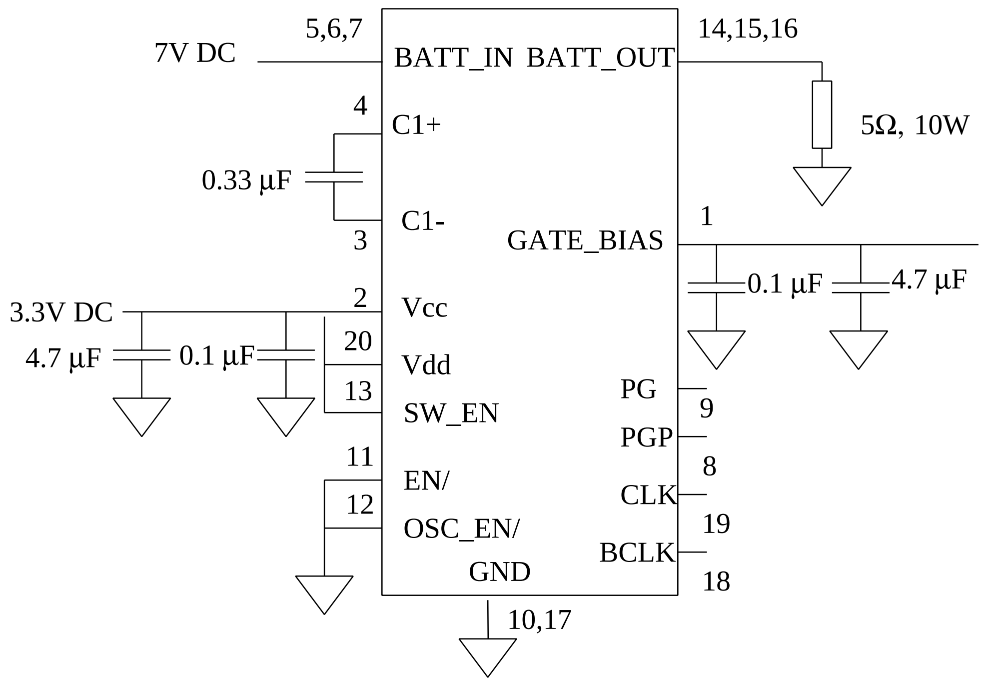

Figure 3: Bias conditions used for the test.

4 Test results

The test results are presented in Table 3. The part is sensitive to both SET and SEL.

run#	SN#	tilt	eff. LET	eff. Fluence	SEL	SETbatout	SET gatebias	Xsec SEL (cm^2/dev)	Xsec SET Bat_out (cm^2/dev)
14	1	0	37.46	3.17E+05	1	yes	0	3.15E-06	
15	1	0	37.46	6.20E+04	1	yes	0	1.61E-05	
16	1	0	37.46	1.37E+05	1	yes	0	7.30E-06	
17	2	0	37.46	7.00E+05	1	yes	0	1.43E-06	
18	2	0	37.46	6.80E+05	1	yes	0	1.47E-06	
19	2	45	52.98	5.50E+05	1	yes	0	1.82E-06	
20	2	0	11.44	2.00E+06	0	200	0	0.00E+00	1.00E-04
21	2	50	17.80	4.40E+06	1	yes	0	2.27E-07	
22	2	50	17.80	1.30E+06	1		0	7.69E-07	
23	2	0	11.44	1.00E+07	0	291	0	0.00E+00	2.91E-05
24	2	40	14.93	4.50E+05	1	yes	0	2.22E-06	
25	2	40	14.93	8.93E+06	1	yes	0	1.12E-07	
26	1	0	11.44	9.35E+06	1	yes	0	1.07E-07	
27	1	50	17.80	2.54E+05	1	yes	0	3.94E-06	
28	1	50	17.80	8.38E+05	1	yes	0	1.19E-06	
29	1	50	17.80	1.64E+06	1	yes	0	6.10E-07	
30	1	40	14.93	1.02E+06	1	yes	0	9.85E-07	
31	1	40	14.93	1.70E+06	1	yes	0	5.88E-07	
32	1	0	24.00	1.00E+06	1	yes	0	1.00E-06	
33	1	0	24.00	7.43E+05	1	yes	0	1.35E-06	
34	1	37	30.05	2.41E+05	1	yes	0	4.15E-06	
35	1	37	30.05	1.73E+05	1	yes	0	5.78E-06	
36	1	37	30.05	1.34E+05	1	yes	*0*	7.46E-06	
37	1	37	30.05	1.42E+05	1	yes	0	7.04E-06	
38	1	37	30.05	5.34E+05	1	yes	0	1.87E-06	
39	2	0	24.00	6.50E+05	1	yes	0	1.54E-06	
40	2	0	24.00	1.75E+05	1	yes	0	5.71E-06	
41	2	0	24.00	1.47E+05	1	yes	0	6.80E-06	
42	2	37	30.05	8.50E+05	1	yes	0	1.18E-06	
43	2	37	30.05	1.78E+05	1	yes	0	5.62E-06	
44	2	37	30.05	1.95E+05	1	yes	0	5.13E-06	
45	2	37	30.05	1.78E+05	1	yes	0	5.62E-06	
46	2	0	3.38	1.00E+07	0	0	0	0.00E+00	0.00E+00
47	2	60	6.76	5.51E+06	0	203	0	0.00E+00	3.68E-05
48	2	45	4.78	1.00E+07	0	0	0	0.00E+00	0.00E+00
49	1	60	6.76	4.92E+06	0	201	0	0.00E+00	4.09E-05
50	1	50	5.26	1.00E+07	0	137	0	0.00E+00	1.37E-05
51	1	0	3.38	1.00E+07	0	0	0	0.00E+00	0.00E+00
52	1	0	59.72	2.00E+05	1	yes	0	5.01E-06	
53	1	0	59.72	3.60E+04	1	yes	0	2.78E-05	
54	1	0	59.72	4.13E+04	1	yes	0	2.42E-05	
55	1	0	59.72	1.19E+05	1	yes	0	8.40E-06	
56	1	0	59.72	2.62E+04	1	yes	0	3.82E-05	
57	1	0	59.72	1.97E+05	1	yes	0	5.08E-06	
58	1	45	84.46	9.60E+04	1	yes	0	1.04E-05	
59	1	45	84.46	4.49E+05	1	yes	0	2.23E-06	
60	1	45	84.46	1.92E+05	1	yes	0	5.21E-06	
61	2	0	59.72	5.76E+04	1	yes	0	1.74E-05	
62	2	0	59.72	1.77E+05	1	yes	0	5.65E-06	
63	2	0	59.72	3.59E+05	1	yes	0	2.79E-06	
64	2	0	59.72	1.58E+05	1	yes	0	6.33E-06	
65	2	45	84.46	1.39E+05	1	yes	0	7.19E-06	
66	2	45	84.46	4.12E+05	1	yes	0	2.43E-06	
67	2	45	84.46	5.52E+05	1	yes	0	1.81E-06	

Cross section curves are shown in Figure 4.

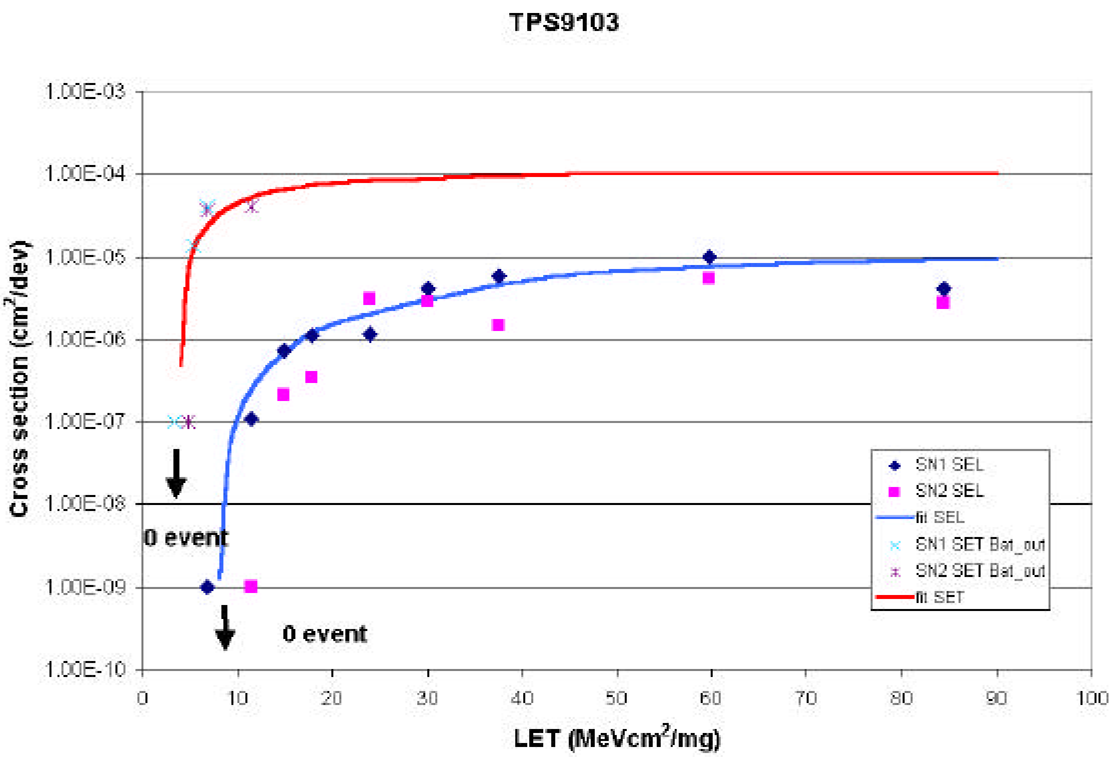

Figure 4: SEL and SET Bat_out cross section curves.

The SEL LET threshold is about 8 MeVcm^2/mg. The SEL cross section at saturation is about 1E-05 cm^2/device. The maximum latchup current is 50 mA.

The SET LET threshold for the BAT_OUT output is about 4 MeVcm^2/mg. Because of the SEL sensitivity, it has not been possible to measure the SET cross section at a LET higher than 11.4 MeVcm^2/mg. The maximum measured cross section is 4E-5 cm^2/device. A typical transient waveform on the Bat_out output is shown in Figure 5.

No SET was seen on the GATE_BIAS output.

A worst-case estimation of the SEL and SET rates in the ST5 environment have been performed for the worst-case environment conditions (Galactic Cosmic Rays at solar minimum) and with conservative estimates of the part geometry (thickness of the sensitive volume = 2µm). The results are a latchup rate of 4E-6 SEL/device-day and a transient rate on the Bat_out output of 5E-4 SET/device-day.

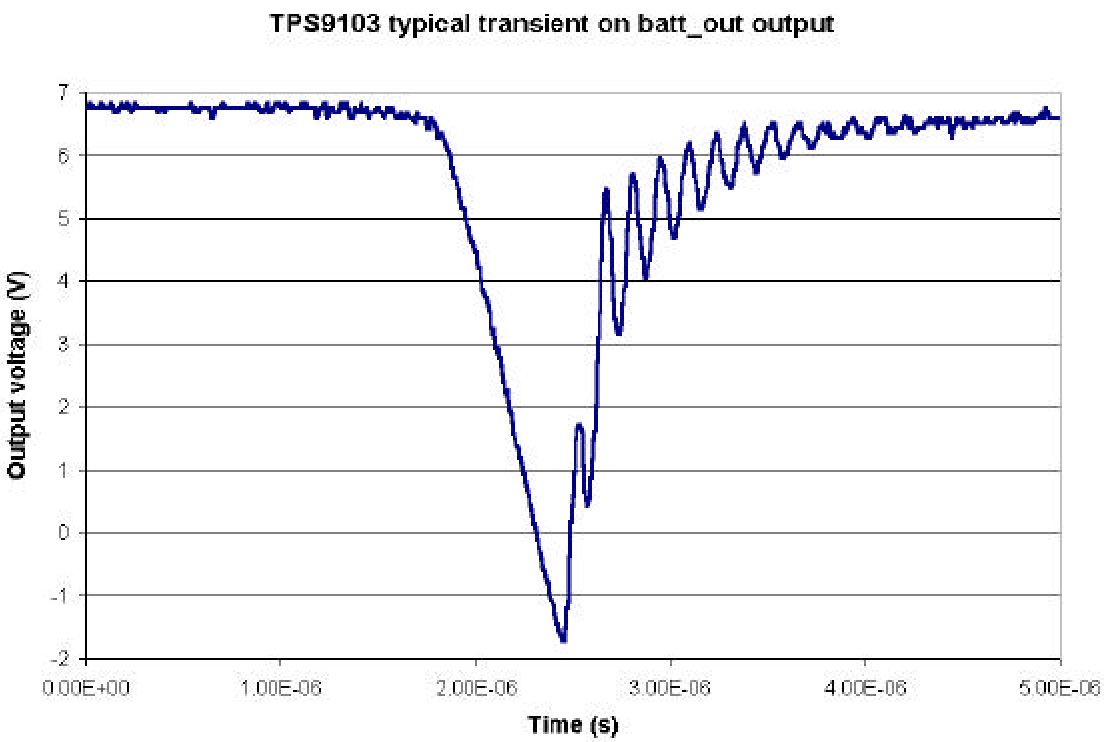

Figure 5: Typical transient on Bat_out output

5 Conclusions

The test results show that the TPS9103 power supply device is sensitive to both SEL and SET. SEL and SET rates are low but are not negligible for the 3 months ST5 mission. The application needs a SEL circumvention circuitry and need to be tolerant to SET on the Bat_out output.