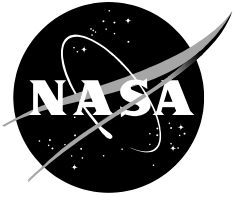


NASA/TM-20210014980



SEE Test Report for Arizona Microtek AZ88923 High Speed Limiting Post Amplifier

Raymond Ladbury

May 2021

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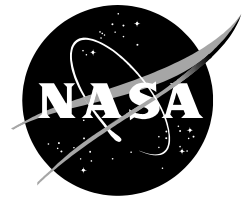
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Test Date: 24-27 October 2014
Report Date: 5 November 2014*

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1. Reference Documents

- AZ88923 Datasheet, <http://azmicrotek.com/wp-content/uploads/2012/04/az88923.pdf>, 9/15/2014
- Johnston, A.H.; , "The influence of VLSI technology evolution on radiation-induced latchup in space systems," *IEEE Trans. Nucl. Sci.*, vol.43, no.2, pp. 505-521, Apr 1996.
- "IEEE Recommended Practice for Latchup Test Methods for CMOS and BiCMOS Integrated-Circuit Process Characterization," *IEEE Std 1181-1991*. (Deprecated)
- JEDEC JESD57

2. Purpose

The primary purpose of this testing is to characterize the Arizona Microtek AZ88923 post amplifier for susceptibility to single-event latchup (SEL) and other destructive Single-Event Effects (SEE). These data will be used to assess the destructive SEE risk for the OSIRIS-REx Laser Altimeter (OLA). A secondary goal is to assess the susceptibility of the post amplifier to single-event transients (SET) and other nondestructive SEE. In particular, the loss-of-signal feature could give rise to some significant anomalies. However, it is not used on OLA.

3. Test Samples

Six (6) parts were provided to Code 561 for de-encapsulation and SEL testing. A minimum of two devices will be exposed to heavy ion irradiation. More information about the devices can be found in Table I.

The parts were prepared for testing by removing the plastic encapsulation from the target die. The parts were fabricated in Positive Emitter Coupled Logic (PECL) SiGe technology. While the bipolar nature of the technology makes SEL unlikely, destructive failures have been seen in some bipolar SiGe technologies in the past. Since we do not know the number of overlayers used in these processes, linear energy transfer calculations were recorded based on the top-surface incident ion species and kinetic energy, and except for the highest angles of incidence (60° to the die normal) we ensured that the particles had a range in Si of more than 100 microns from the top of the die. The scaling of cross section with Linear Energy Transfer (LET) suggests that the range was adequate for all ions.

Table I: Part Identification Information

Qty	Part Number	LDC	Source	Package
3	AZ88923	N/A	Arizona Microtek	MSOP-10

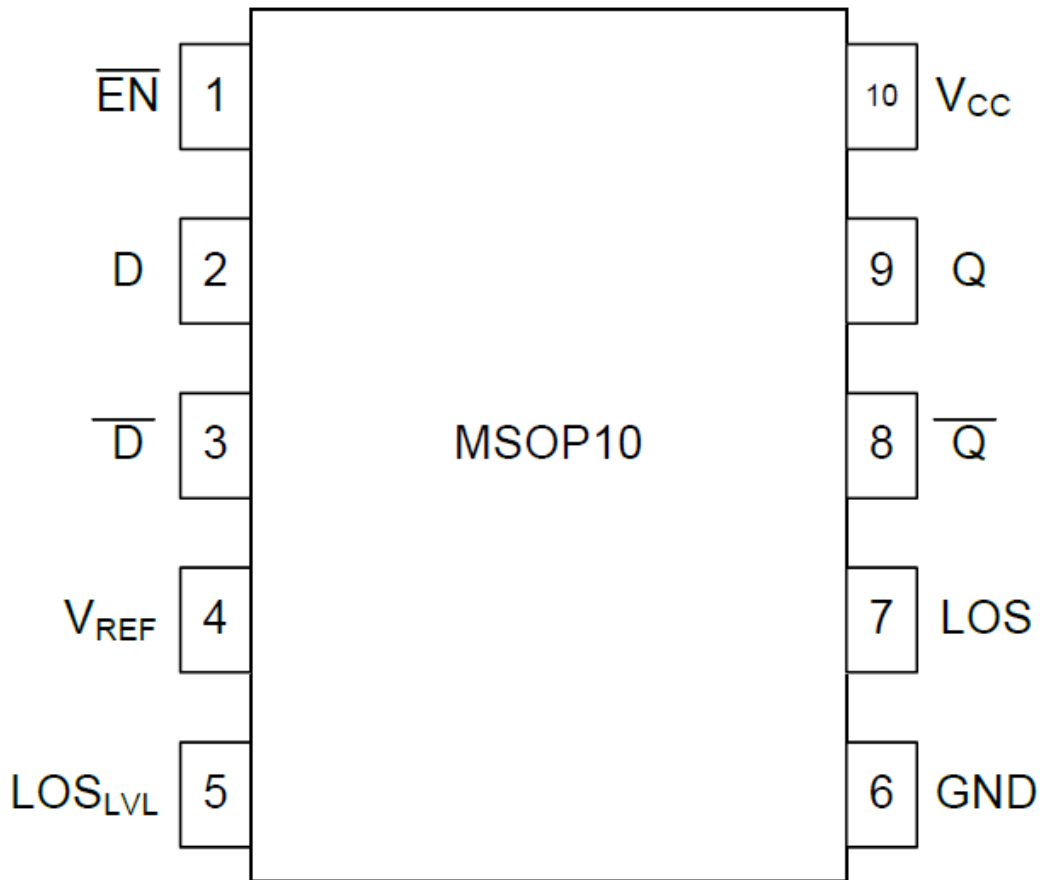


Figure 1: Pin diagram for AZ88923 post amplifier

4. Test Facility

Facility: Texas A&M University Radiation Effects Facility. Tune: 15 MeV/amu

Flux: 5×10^3 to 5×10^5 ions $\text{cm}^{-2} \text{s}^{-1}$

Fluence: All tests will be run to a fluence of $1 \times 10^7 \text{ cm}^{-2}$ or until a latchup event is observed

Table II: Possible Ions Used for Device Irradiation

Ion	Energy (MeV)	Range in Silicon	Silicon LET ($\text{MeV cm}^2/\text{mg}$)
^{197}Au	2954	155	80.2
^{129}Xe	1934	156	47.3
^{109}Ag	1634	156	38.5
^{84}Kr	1259	170	25.4
^{40}Ar	599	229	7.7
^{20}Ne	300	316	2.5

Note that energy, range, and LET are those characteristic of ions before traversing the aramica window and 50 mm of air prior to the silicon target.

5. Test Conditions and Error Modes

Table III: AZ88923 Test Conditions

Test Temperature	Ambient and 80° C
Operating Conditions	Steady State, Inputs=VCC and GND
Power Supply Voltage	3.3 Vdc
Parameters of Interest	LET _{th} , temperature, supply voltage
SEE Conditions	Prolonged and self-sustained high-current state, SETs

Current limit was set to 110% of absolute maximum rating. In the event of observing SEL, a destructive test limiting current to 1 A could be run.

6. Test Methods

The test circuits for these devices were built to approximate the intended application. The schematics in figure 2 capture the essentials of the application.

The test setup required only power supplies and data logging equipment. The power supplies were located in the irradiation cave, while the data logging equipment will be in the control room. Each test board had a single device under test, with new samples switched by hand.

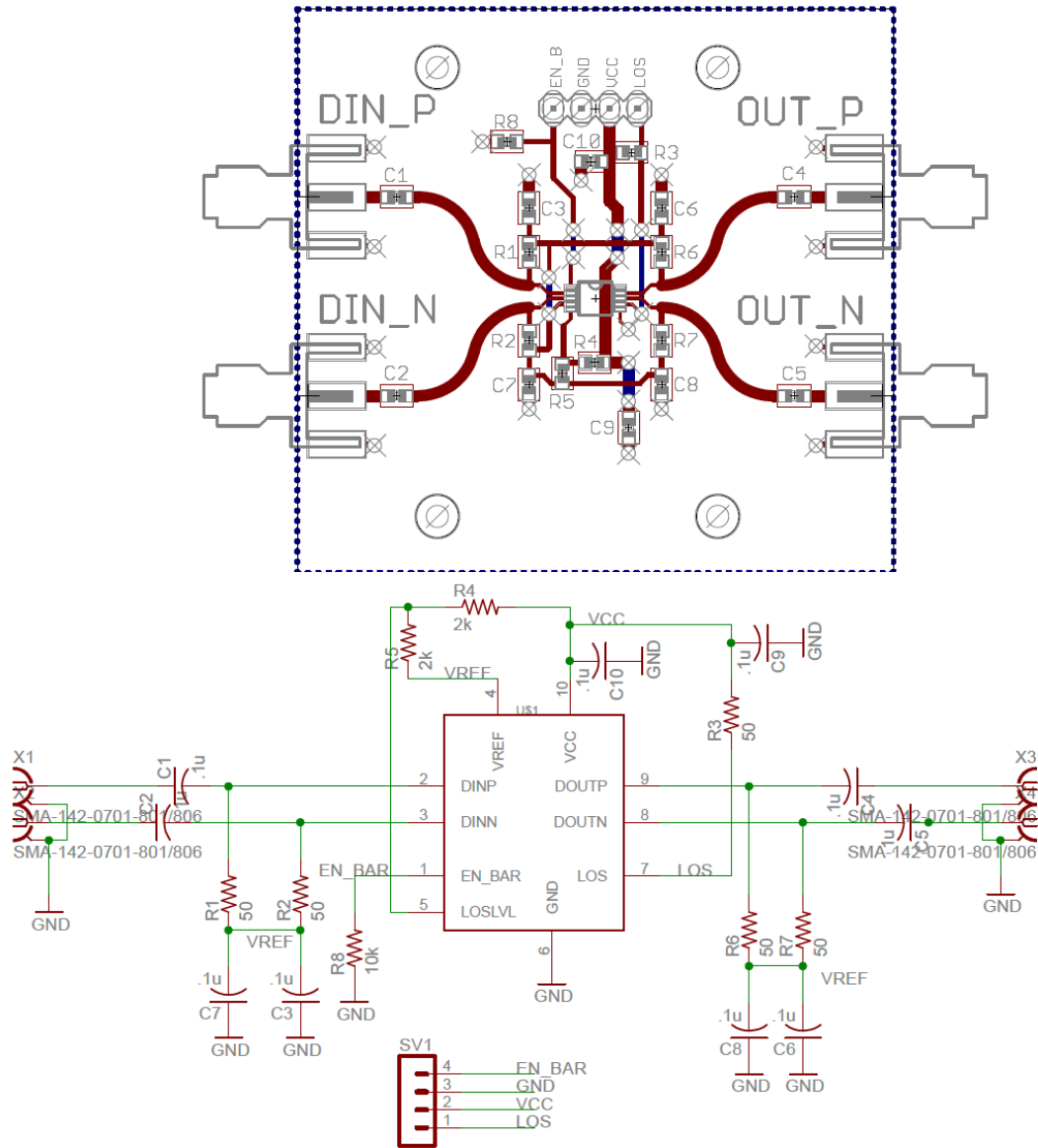


Figure 2: AZ88923 daughter card (top) and mother board (bottom)

7. Test Performance

Test personnel included the principal investigator and the test engineer. Eight hours are allotted for the test. A test was stopped if an SEL was seen, if the number of transients exceeded a desired level (e.g. 100-200 transients) or if the effective fluence reached 1×10^7 ions/cm². The following table is a rough outline of the tests planned during the test slot.

Table IV: Test Condition Plan

Condition	Temp (°C)	Tilt (°)	Roll (°)	Ion	Notes
1	80	0	0	Ne, Ar, Kr, Xe	Worst-case, normal incidence
2	80	45,60	0	Ne, Ar, Kr, Xe	Repeat first condition at steeper angle
4	25	0, 60	0	Ne, Ar, Kr, Xe	Map out SET σ vs. LET

8. Results and Test Report

No SEL or other destructive SEE was seen for any LET or angle of incidence up to the highest effective LET of 106 MeVcm²/mg (Xe incident at 60 degrees to the normal). No Single-Event Gate Rupture (SEGR) or burnout was seen even for the worst-case ion for these failure modes (Xe at normal incidence). SETs were seen for the lowest test LET (2.8 MeVcm²/mg, Ne at normal incidence). At low LET, most transients were fairly short (<1 μ s), while those seen with Xe were rail-to-rail and lasted up to several microseconds (<10). Figure 3 shows the SET cross section vs. effective LET.

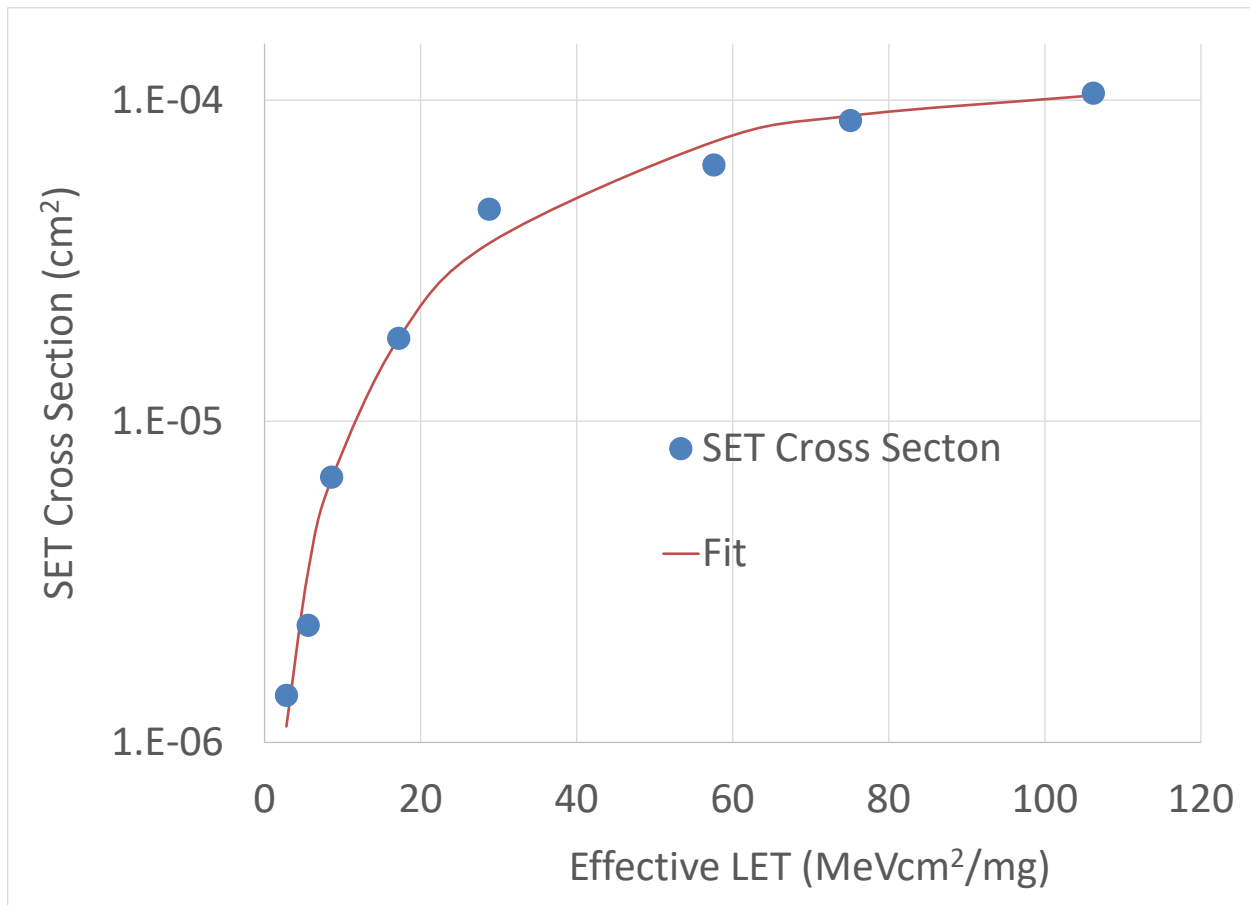


Figure 3: SET cross section vs effective LET, along with a best-fit Weibull form of the cross section

Figure 3 shows the SET cross section vs effective LET, along with a best-fit Weibull form or the cross section. At the lowest LET, 95% CL error bars were less than 50% and at the highest <5%, which is negligible for the purposes of a Weibull fit.

The fit to the SET cross section data shows a very low onset LET (0.3 MeVcm²/mg). Based on this fit, the SET rate for this part is likely less than 1 in 1000 days during periods of quiescent solar activity. However during solar particle events, the rate could be 1000x higher for a few days.

9. Implications of Results

The only error mode to which this part proved susceptible was SET. The rate for such events was low, except for during solar particle events. If SETs with rail-to-rail amplitude and lasting up to 10 microseconds are a concern for this application, we will need to examine the data more carefully to estimate rates specifically for the transients (e.g. of sufficient magnitude and duration) that cause concern.

