

National Aeronautics and Space Administration



Single-Event Testing of the Texas Instruments SNV54LVC00AW Quadruple 2-Input Positive-NAND Gates

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1. Purpose

The purpose of this testing was to characterize the Texas Instruments SNV54LVC00AW for single-event latchup (SEL) in support of a NASA GSFC flight program. The SNV54LVC00A quadruple 2-input positive-NAND gate. These devices were tested at the Berkeley Accelerator Space Effects (BASE) Facility at Lawrence Berkeley National Laboratory (LBNL) where they were irradiated with the 10 MeV/amu heavy ion cocktail.

2. Device Information

The SNV54LVC00A quadruple 2-input positive-NAND gate is designed for 2.7-V to 3.6-V V_{cc} operation. The devices tested are in 14-pin ceramic flat packages (CFP) and are mechanically de-lidded to expose the die prior to testing. Table 1 lists relevant device characteristics and Figure 1 shows a functional diagram. Two (2) parts from the lot of these parts were provided for SEE testing.

Table 1: Part Identification Information

Flight Part Number	5962-9753301QDA
Generic Part Number	SNV54LVC00AW
Function	Logic
Manufacturer	Texas Instruments
Lot Date Code	1432A
Wafer/Diffusion Lot Number	N/A
Quantity	2 tested
Package Type	CFP
REAG ID #	19-044
Process	CMOS

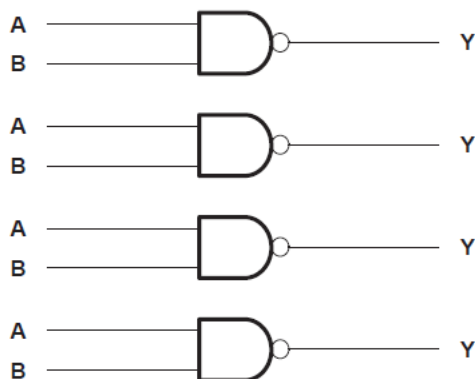


Figure 1: Simplified schematic¹

3. Test Facilities

Facility: Lawrence Berkeley National Laboratory. Tune: 10 MeV/amu
Flux: 4×10^2 ions $\text{cm}^{-2} \text{s}^{-1}$ to 6×10^4 ions $\text{cm}^{-2} \text{s}^{-1}$
Fluence: Up to 1×10^7 ions cm^{-2}

Table 2 shows the ions used during irradiation. Note that energy and LET values are calculated based on 1 mil aramica window and 50 mm of air prior to the silicon target. Additional LET values were obtained by changing the angle of incidence.

Table 2: Ions Used During Test 2

Facility	Ion	Angle (deg.)	Beam Energy (MeV/amu)	LET in Si (MeV-cm ² /mg)
LBNL	¹²⁴ Xe	0	10	58.78
LBNL	¹²⁴ Xe	45	10	87.85

* LET: Linear Energy Transfer (MeV/mg/cm²)

** All values were taken from LBNL BASE's list of Cocktails and Ions (<http://cyclotron.lbl.gov/base-rad-effects/heavy-ions/cocktails-and-ions>)

4. Test Conditions

Single Event Latch-up (SEL) was tested for a maximum positive operating voltage value. The device was tested at high temperature to ensure SEL.

Table 3: Test Conditions during Irradiation

Test Temperature	Maximum: +99°C
Power Supply Voltage	V _{CC} = 3.3V to 3.6V
Voltage monitoring	Supply voltages will be recorded in strip charts for documentation and analysis. Any events will be captured/saved by oscilloscope and the LEDs.
Error modes	Test for latch-up

5. Test Setup

The device under test (DUT) was mounted in a socket on a motherboard which provided a microcontroller to operate the device, power supply connections, heating and temperature-sensing circuitry. The devices were operated in the following circuit configuration in Fig. 2.

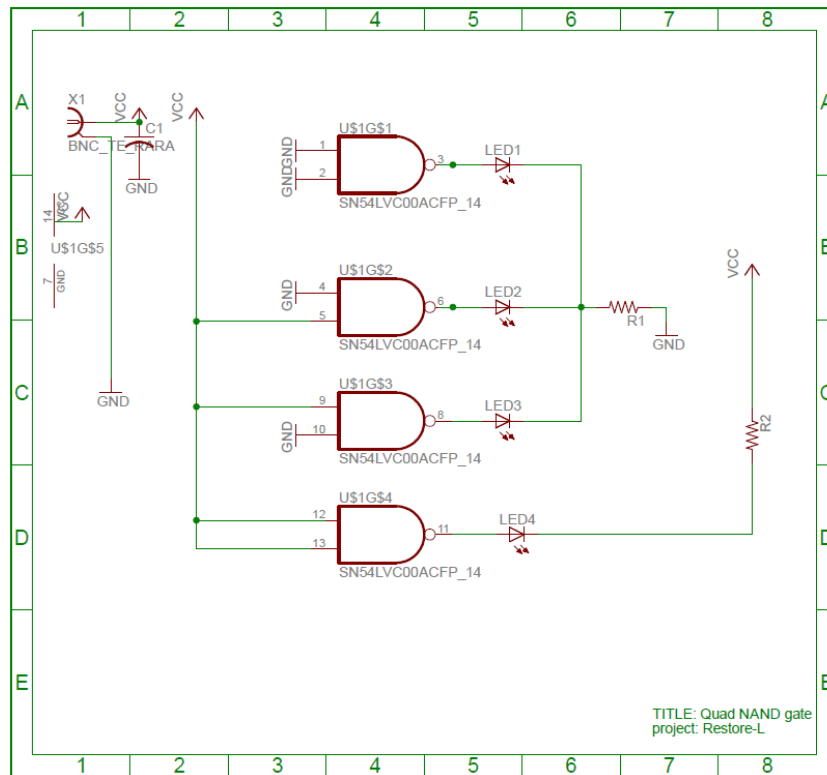


Fig. 2. Circuit configuration for testing

Fig. 3 provides a photograph of the device and tester board.

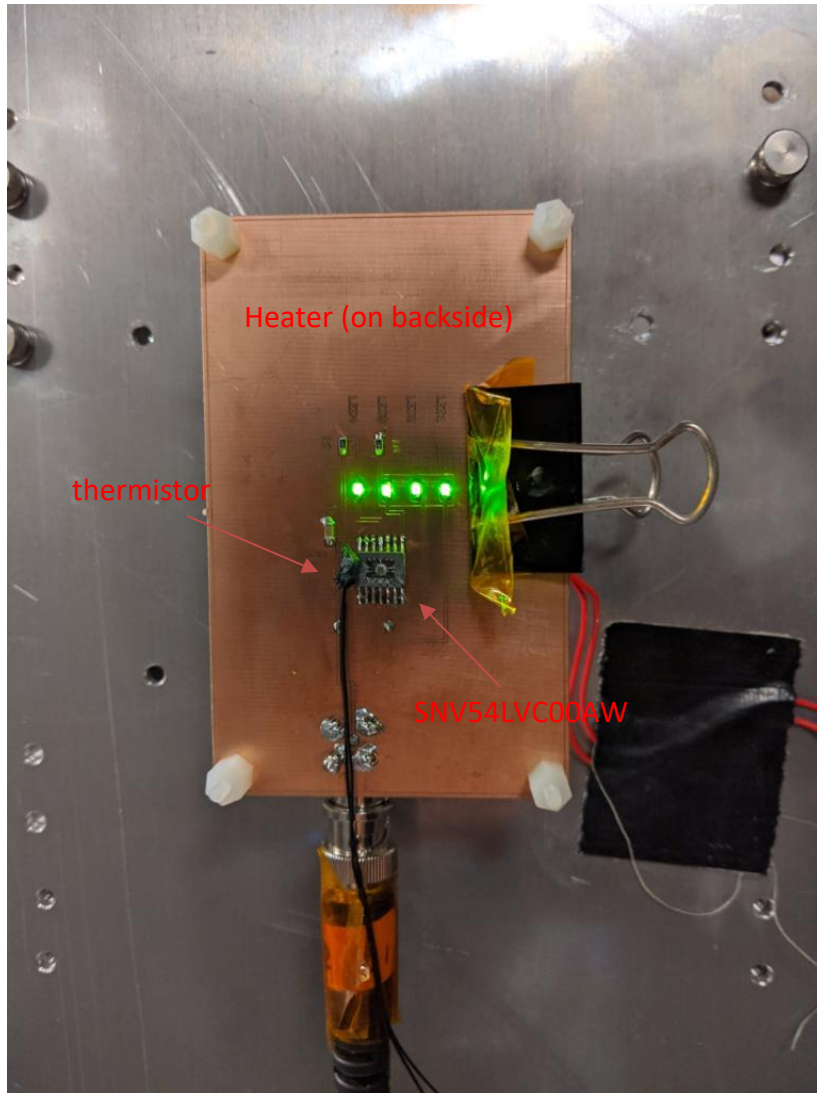


Fig. 3. Test setup

The test setup used a modular power supply system to separately provide V_{cc} to the DUT. A host PC sent high-level operational commands to the microcontroller and logged the power supply voltages and resistance.

6. Test Results

A series of latchup tests were conducted to $1 \times 10^7 \text{ cm}^{-2}$ of xenon ions (nominal LET of $58.78 \text{ MeV} \cdot \text{cm}^2/\text{mg}$) while operating at 97.5°C . The power supply was set to a V_{cc} of 3.6 V . The device was rotated to 45 degrees to increase effective LET to $87.85 \text{ MeV} \cdot \text{cm}^2/\text{mg}$ and operated at 99°C . No single event latchup was observed.

A second device was tested. That device was tested at a 45 degree angle using xenon ions (effective LET of $87.85 \text{ MeV} \cdot \text{cm}^2/\text{mg}$) and an effective fluence of $1 \times 10^7 \text{ cm}^{-2}$. The power supply was set to a V_{cc} of 3.6 V and an operating temperature of 95°C . Once again no single event latchup was observed.

7. Summary

The SNV54LVC00AW is not susceptible to destructive single-event effects below an effective LET of at least 87.85 MeV·cm²/mg at 99°C. These results do not extend to other types of radiation testing, such as total ionizing dose, and were conducted with a specific application circuit design.

8. Run-log

Run #	DUT	resistance (kOhms)	Temperature	Ion	Angle	eff. LET	eff. Fluence (max)	voltage	time	notes
1	1	2.2		63 Xe	0	58.78	5.04E+06	3.30E+00	4:40	
2	1	1.79		70 Xe	0	58.78	5.02E+06	3.30E+00		
3	1	1.29		79 Xe	0	58.78	5.02E+06	3.30E+00		
4	1	1.09		85 Xe	0	58.78	5.03E+06	3.30E+00		
5	1	0.9		90 Xe	0	58.78	5.02E+06	3.30E+00		not seeing nothin'
6	1			Xe		58.78		3.30E+00	5:03	lost beam
7	1	0.78		95 Xe	0	58.78	5.02E+06	3.30E+00		
8	1	0.75		95 Xe	0	58.78	5.02E+06	3.60E+00		
9	1	0.73		97.5 Xe	0	58.78	1.00E+07	3.60E+00		
10	1	0.7		99 Xe	45	87.85	1.00E+07	3.60E+00		
11	1	0.7		99 Xe	45	87.85	1.00E+07	3.60E+00		
12	2	0.75		95 Xe	45	87.85	1.00E+07	3.60E+00		

9. URLs for Device Datasheets

1. <http://www.ti.com/lit/ds/symlink/sn54lvc00a.pdf>