National Aeronautics and Space Administration

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

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Test Report to be published on https://radhome.gsfc.nasa.gov/.

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

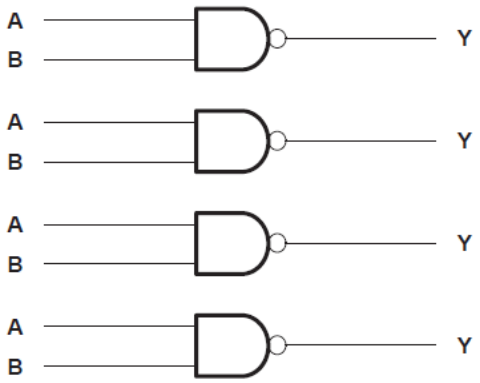

Figure 1: Simplified schematic[1]

3. Test Facilities

Facility: Lawrence Berkeley National Laboratory. Tune: 10 MeV/amu
Flux: 4×10^{2} ions cm^{-2} s^{-1} to 6×10^{4} ions cm^{-2} s^{-1}
Fluence: Up to $1x10^{7}$ 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/cm^2)
** 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.

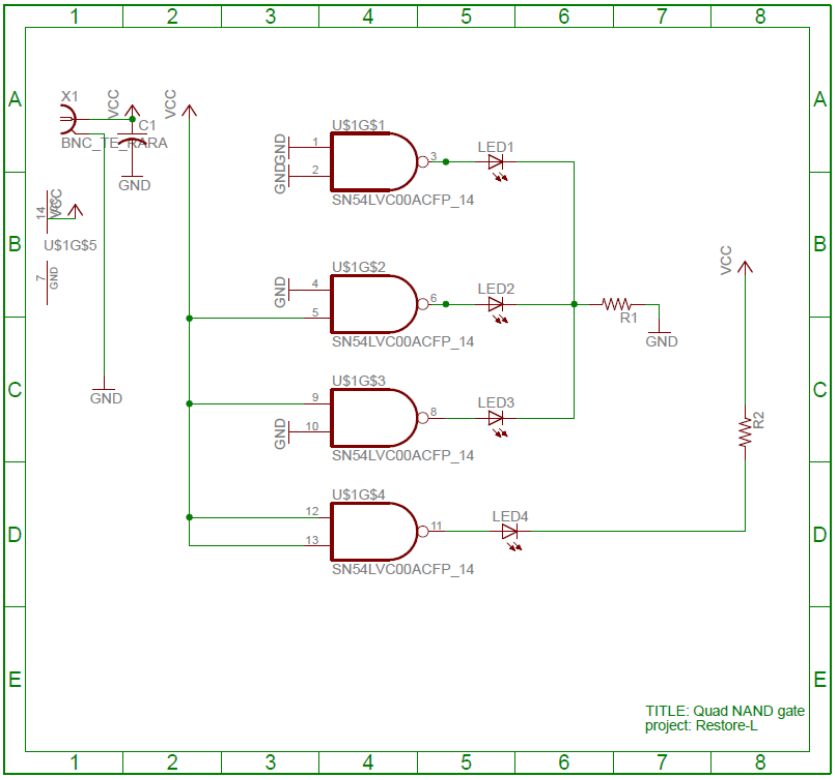

Fig. 2. Circuit configuration for testing

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

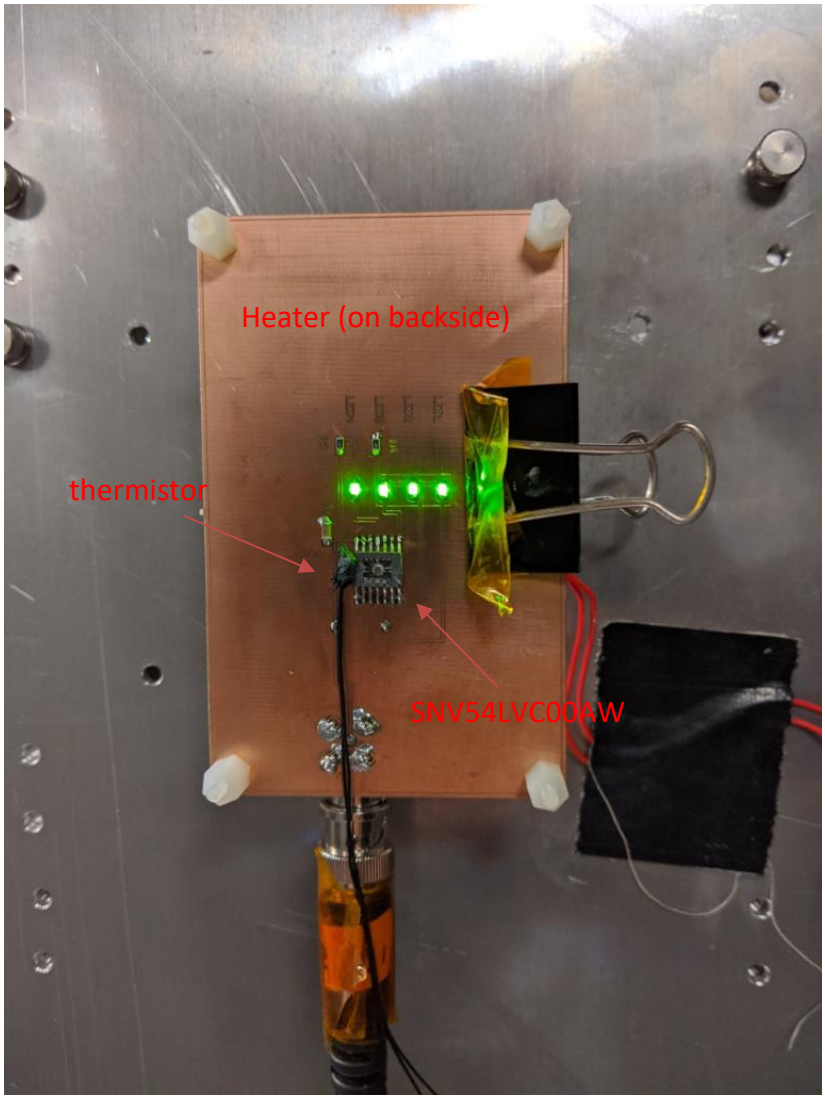

Fig. 3. Test setup

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 $1x10^{7}cm^{-2}$ of xenon ions (nominal LET of 58.78 MeV·cm^2/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 MeV·cm^2/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 MeV-cm^2/mg) and an effective fluence of $1x10^{7}$ cm^{-2}. The power supply was set to a V_{cc} of 3.6V 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·cm^2/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