Radiation Report

SN55LVRA4-SEP Total Ionizing Dose (TID) Report

ABSTRACT

This report covers the radiation characterization results of the SN55LVRA4-SEP, radiation tolerant high-speed differential line reciever. The study was done to determine Total Ionizing Dose (TID) effects under high dose rate (HDR) up to 30krad(Si) as a one time characterization. The results show that all samples passed within the specified limits up to 30krad(Si). The data shows that HDR produces the worst-case parametric shifts and therefore will be used for Radiation Lot Acceptance Testing (RLAT). RLAT will be performed using 5 units at a dose level of 30krad(Si) for future wafer lots per MIL-STD-883 TM 1019. All future wafer lots will be tested under the same conditions. TID HDR characterization was performed per TM 1019.

The SN55LVRA4-SEP LIN3B process technology contains Bipolar and CMOS components. In addition to an HDR TID, an ELDRS characterization was performed on technology process node (LIN3B) that is used by this product. Results showed that worst case values post-irradiation were still within pre-radiation specification limits for both HDR and LDR, hence no ELDRS effects were exhibited. Thus, HDR will be performed on each wafer lot for future RLAT testing.

The SN55LVRA4-SEP is packaged in a space enhanced plastic package for low outgassing characteristics and is Single Event Latch-Up (SEL) immune up to 50MeV-cm^2/mg, which makes the device an option for low Earth orbit space applications. Single Event Transient (SET) data is also provided in the Single Event Effects Radiation Report.

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Trademarks

1 Device Information

The SN55LVRA4-SEP is a radiation tolerant quad channel differential receiver that implements the electrical characteristics of low-voltage differential signaling (LVDS) with a 3.3V supply. The intended application and signaling technique of these devices is point-to-point baseband data transmission over controlled impedance media of approximately 100Ω.

1.1 Device Details

Table 1-1 lists the device information used for TID HDR characterization and qualification.

Table 1-1. Device and Exposure Details

TID HDR Details: Up To 30krad(Si)	
TI Device Number	SN55LVRA4-SEP
VID Number	V62/25606
Package	16-pin D(SOIC)
Technology	LIN3B
Die Lot Number	4045684FFB
A/T Lot Number and Date Code	4892755ML4 / 4CC3EDK
Quantity Tested	15 irradiated devices + 2 control
Lot Accept or Reject	Devices passed 30krad(Si)
HDR Radiation Facility	Texas Instruments CLAB in Dallas, Texas
HDR Dose Level	10krad(Si), 20krad(Si), 30krad(Si)
HDR Dose Rate	169.21rad(Si)/s ionizing radiation
HDR Radiation Source	Gammacell 220 Excel (GC-220E) Co-60
Irradiation Temperature	Ambient, room temperature

2 Total Dose Test Setup

2.1 Test Overview

The SN55LVRA4-SEP samples were irradiated at a high dose rate of 169.21rad(Si)/s up to 30krad(Si) and then put through full electrical parametric testing on the production Automated Test Equipment (ATE). The samples were functional and passed all electrical parametric tests with readings within data sheet electrical specification limits.

The SN55LVRA4-SEP LIN3B process technology contains Bipolar and CMOS components. In addition to an HDR TID, an ELDRS characterization was performed on technology process node (LIN3B) that is used by this product. Results showed that worst case values post-irradiation were still within pre-radiation specification limits for both HDR and LDR, hence no ELDRS effects were exhibited. Thus, HDR will be performed on each wafer lot for future RLAT testing.

2.2 Test Description and Facilities

The SN55LVRA4-SEP HDR exposure was performed on biased devices in a Co-60 gamma cell at TI facility in Dallas, Texas. The un-attenuated dose rate of this cell is 169.21rads(Si)/s. After exposure, the devices were packed in dry ice (per MIL-STD-883 Method 1019.9 section 3.10) and full post radiation electrical evaluation using Texas Instruments ATE was conducted. ATE test limits are set per data sheet electrical limits based on qualification and characterization data. Post radiation measurements were taken within 30 minutes of removing the devices from the dry ice container. The devices were allowed to reach room temperature prior to electrical post radiation measurements.

2.3 Test Setup Details

The devices were tested in biased conditions as described in the following sections.

2.3.1 Bias Diagram

Figure 2-1 shows the bias conditions for each pin during irradiation.

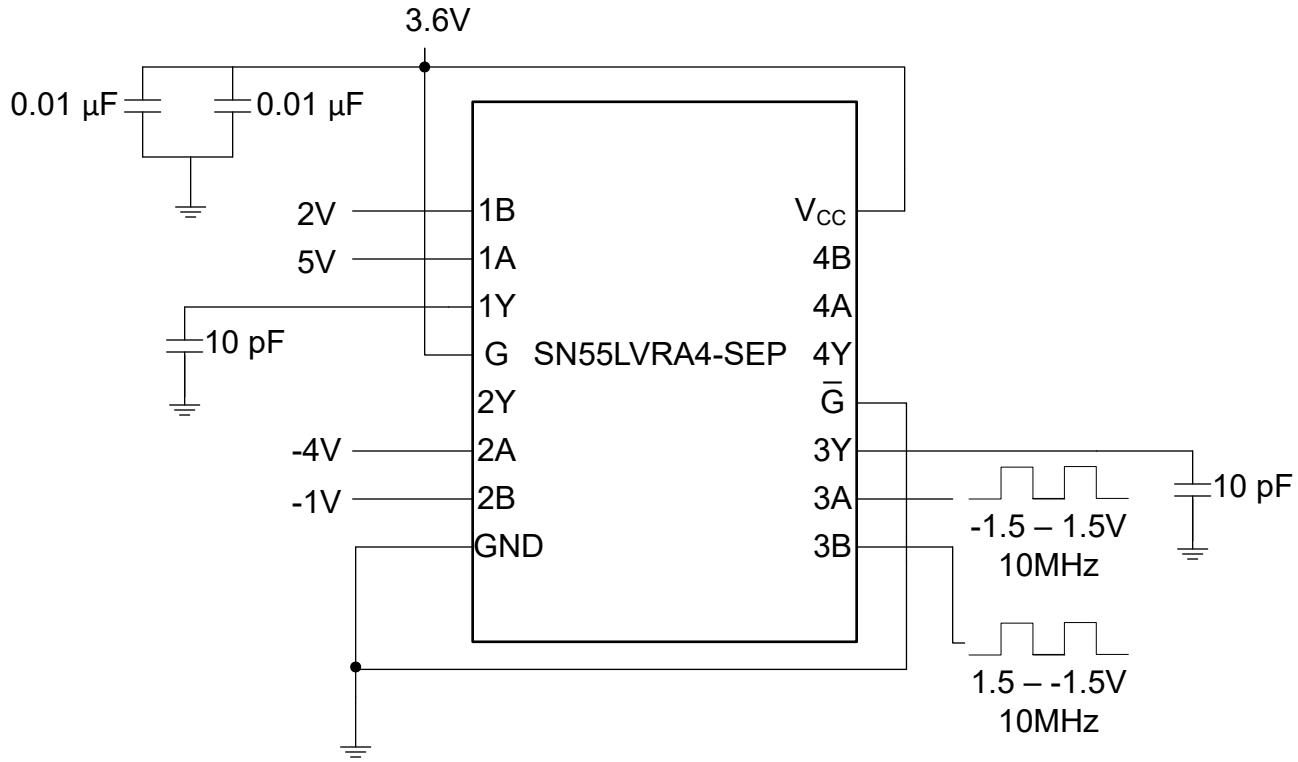

Figure 2-1. SN55LVRA4-SEP Bias Diagram

2.4 Test Configuration and Condition

A step stress (10k, 20k, and 30k) test method was used to determine the TID hardness level. That is, after a predetermined TID level was reached, an electrical test was performed on a given sample of parts to verify that the units are within specified data sheet electrical test limits. The HDR RLAT units were irradiated to 30krad(Si), and parametrically tested on ATE. The units that were irradiated to 30krad(Si) and the data is shown in Appendix A.

Table 2-1 and Table 2-1 list the serialized samples used for TID characterization.

Table 2-1. HDR Device Information

Control Group	HDR Dose Rate = 169.21rad(Si)/s		
Total Samples: 2	Total Samples: 15 Biased		
	Exposure Levels		
0krad (Si)	10krad (Si)	20krad(Si)	30krad(Si)
Biased	Biased	Biased	Biased
1 - 2	3 - 7	8 - 12	13- 17

3 TID Characterization Test Results

3.1 TID Characterization Summary Results

The parametric data for the SN55LVRA4-SEP passes up to 30krad(Si) HDR TID irradiation. The drifts of the electrical parameters through HDR were within the data sheet limits.

Overall, the SN55LVRA4-SEP showed a strong degree of hardness to HDR TID irradiation up to 30krad(Si). The measurements taken post-irradiation for each sample set showed a marginal shift for most parameters at each dose level. The parameters that did show a greater degree of change between pre- and post-irradiation were still within the electrical performance characteristics specified in the data sheet electrical parameters. For the data sheet electrical parameters and associated tests, see *SN55LVRA4-SEP Radiation Tolerant Quad Channel High-Speed Differential Line Reciever*.

The SN55LVRA4-SEP LIN3B process technology contains Bipolar and CMOS components. In addition to an HDR TID, an ELDRS characterization was performed on technology process node (LIN3B) that is used by this product. Results showed that worst case values post-irradiation were still within pre-radiation specification limits for both HDR and LDR, hence no ELDRS effects were exhibited. Thus, HDR will be performed on each wafer lot for future RLAT testing.

See Appendix A for HDR report up to 30krad(Si).

3.2 Specification Compliance Matrix

Table 3-1. Electrical Parameters Table

Parameter	Test Conditions	V_{CC}	T_A = -55°C to +125°C			Unit	Test Name
			MIN	TYP	MAX		
V_{IT1}	Positive-going differential input voltage threshold, VIB = 0V, 1.2 or 5V, Tested at VIT1 = 80mV	3.0V - 3.6V			85	mV	VIT1
V_{IT2}	Negative-going differential input voltage threshold, VIB = 0V, 1.2 or 5V, Tested at VIT2 = -80mV	3.0V - 3.6V	-85			mV	VIT2
V_{OH}	High-level output voltage	3.0V - 3.6V	2.4			V	VOH
V_{OL}	Low-level output voltage	3.0V - 3.6V			0.8	V	VOL
$I_{I(OFF)}$	Output current with power off, VO = 0 or 2.4V	0V	-25		25	µA	IOFF_2
$I_{I(OFF)}$	Output current with power off, VO = 5V or -4V	0V	-70		70		IOFF_1
I_I	Input current (A or B inputs) VI = 0V, other input open	3.0V - 3.6V	-25		25	µA	II_0V
I_I	Input Current (A or B inputs) VI = 2.4V, other input open	3.0V - 3.6V	-25		25	µA	II_2p4V
I_I	Input Currents (A or B inputs) VI = -4V, other input open	3.0V - 3.6V	-80		80	µA	II_N4p0V
I_I	Input Currents (A or B inputs) VI = 5V, other input open	3.0V - 3.6V	-45		45	µA	II_5p0V
I_{ID}	Differential input current (IIA – IIB)	3.0V - 3.6V	-5		5	µA	IIO
I_{OZ}	High impedance state output current, VO = 0 or 2.4V, G = 0.8V and $\overline{G}$ = 2V	3.0V - 3.6V	-12		12	µA	IOZ
V_{IH}	High level input voltage (G, $\overline{G}$, A)	3.0V - 3.6V	2			V	VIH
V_{IL}	Low level input voltage (G, $\overline{G}$, A)	3.0V - 3.6V			0.8	V	VIL
I_{IH}	High level input (G, $\overline{G}$, A), VIH = 3.6V	3.0V - 3.6V			15	µA	IIH
I_{IL}	Low level input (G, $\overline{G}$, A), VIL = 0V	3.0V - 3.6V			15	µA	IIL
I_{CC}	Supply current, No load, enabled	3.0V - 3.6V		16	25	mA	ICC_Enabled
I_{CC}	Supply current, disabled and in deep sleep, G at GND for >100µS	3.0V - 3.6V		1.1	6	mA	ICC_Disabled

4 Reference Documents

Texas Instruments total ionizing dose radiation (total dose) test procedure follows the standards put forth in MIL-STD-883 TM 1019. The document can be found at the DLA website.

Appendix A: HDR TID Report Data

This appendix provides the SN55LVRA4-SEP TID HDR report. The report shows the variation for each parameter up to 30krad(Si).

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