CDCLVP111-SP Total Ionizing Dose (TID) Radiation Report

High Reliability, High Performance Analog

ABSTRACT

This report discusses the results of the Total Ionizing Dose (TID) testing the Radiation Hardness Assured (RHA), QML Class V Texas Instrument's CDCLVP111-SP (5962R1620701VXC). The RHA version of the CDCLVP111-SP passes up to 75-krad(Si) Low Dose Rate (LDR) and 100-krad(Si) High Dose Rate (HDR) TID.

NOTE: For questions or comments, contact hirelmarketing@list.ti.com.

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1 Device Information

1.1 Product Description

The CDCLVP111-SP clock driver distributes one differential clock pair of LVPECL input, (CLK0, CLK1) to ten pairs of differential LVPECL clock (Q0, Q9) outputs with minimum skew for clock distribution. The CDCLVP111-SP can accept two clock sources into an input multiplexer. The CDCLVP111-SP is specifically designed for driving 50-Ω transmission lines. When an output pin is not used, leaving it open is recommended to reduce power consumption. If only one of the output pins from a differential pair is used, the other output pin must be identically terminated to 50 Ω. The VBB reference voltage output is used if single-ended input operation is required. In this case, the VBB pin should be connected to CLK0 and bypassed to GND via a 10-nF capacitor. For high-speed performance, the differential mode is strongly recommended. The CDCLVP111-SP is characterized for operation from –55°C to 125°C. It has been RHA qualified to 75 krad(Si) under both LDR and HDR (after 540 hours of anneal).

1.2 Device Details

Table 1 lists the device information used in the initial RHA TID characterization and qualification of HDR tests. Current production lot RLAT data can always be found in the Group E report shipped. The process for pulling the group E report from TI is described in the Section 3.2 section.

Table 1. Device and Exposure Details

TID HDR/LDR Details: 50 krad(Si)	
TI Device Number	CDCLVP111-RHA (5962R1620701VXC)
Package	36-Pin Ceramic Flatpack (HKG)
Technology	RF-SIGE
Die Lot Number	5243712
A/T Lot Number / Date Code	5950799
Quantity Tested	51 units including 2 control units
Lot Accept/Reject	Devices passed 3 krad(Si), 10 krad(Si), 30 krad(Si) and 50 krad(Si)
HDR Radiation Facility	Texas Instruments SVA Group in Santa Clara, California
LDR Radiation Facility	RAD/Aeroflex in Colorado Springs, Colorado
HDR Dose Level	3 krad(Si), 10 krad(Si), 30 krad(Si) and 50 krad(Si)
HDR Dose Rate	65 rad(Si)/s
LDR Dose Level	20 krad(Si), 30 krad(Si), 50 krad(Si) and 75 krad(Si)
LDR Dose Rate	0.01 rad(Si)/s
HDR Radiation Source	Gammacell 220 Excel (GC-220E) Co-60
LDR Radiation Source	Gammacell JLSA 81-24 Co-60
Irradiation Temperature	Ambient, room temperature

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Figure 1. CDCLVP111-SP Device Used in Exposure

2 Total Dose Test Setup

2.1 Test Overview

The CDCLVP111-SP was tested according to MIL-STD-883, Test Method 1019.9. For this testing, Condition A and Condition D was used. For Condition A and Condition D the product was irradiated up to 75 krad(Si) the rated radiation level and then put through parametric testing on the ATE. The device was functional and passed all electrical parametric tests with the readings within (guard bands) of the Standard Microcircuit Drawing (SMD) electrical specification limits and is ELDRS free.

The CDCLVP11-SP RF-SIGE process technology contains Bipolar and CMOS components. Both HDR and LDR tests were performed.

2.2 Test Description and Facilities

The CDCLVP111-SP LDR exposure was performed on biased and unbiased devices in a Co60 gamma cell under a 10 mrad(Si)/s exposure rate. The dose rate of the irradiator used in the exposure ranges from < 10 mrad(Si)/s to a maximum of approximately 65 rad(Si)/s, determined by the distance from the source. For the LDR (10 mrad(Si)/s) exposure, the test box was positioned approximately 2 m from the source. The exposure boards are housed in a lead-aluminum box (as specified in MIL-STD-883 TM 1019.9) to harden the gamma spectrum and minimize dose enhancement effects. The irradiator calibration is maintained by Logmire Laboratories using Thermoluminescence Dosimeters (TLDs) traceable to the National Institute of Standards and Technology (NIST) and the dosimetry was verified using TLDs prior to the radiation exposures. After exposure, the devices were packed in dry ice (per MIL-STD-883 Method 1019.9 section 3.10) and returned to TI Dallas for a full post radiation electrical evaluation using Texas Instruments production Automated Test Equipment (ATE). ATE guard band test limits are set within SMD electrical limits to ensure a minimum Cpk and test error margin based on initial qualification and characterization data. Post radiation measurements were taken within 30 minutes of removal of the devices form the dry ice container. The devices were allowed to reach room temperature prior to electrical post radiation measurements.

The CDCLVP111-SP HDR exposure was performed on biased and unbiased devices in a Co60 gamma cell at TI SVA facility in Santa Clara, California. The un-attenuated dose rate of this cell is 65 rad(Si)/s. After exposure, the devices were packed in dry ice (per MIL-STD-883 Method 1019.9 section 3.10) and returned to TI Dallas for a full post radiation electrical evaluation using Texas Instruments Automated Test Equipment (ATE). ATE guard band test limits are set within SMD electrical limits to ensure a minimum Cpk and test error margin based on initial qualification and characterization data. Post radiation measurements were taken within 30 minutes of removal of the devices form the dry ice container. The devices were allowed to reach room temperature prior to electrical post radiation measurements.

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2.3 Test Setup Details

The devices under HDR and LDR exposure were tested in both biased and unbiased conditions as described below.

(A) **Unbiased** - - *For the unbiased LDR conditions, the exposure was performed with all pins grounded.*

(B) **Biased** - - *Figure 2 is used for HDR and LDR exposure with biased condition.*

Figure 2. Bias Diagram Used in TID Exposure

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2.4 Test Configuration and Condition

A step-stress (3k, 10k, 30k, 50k, 75k) 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 SMD electrical test limits. MIL-STD-883, Test Method 1019.9, Condition A, Condition D. If this passes, then the wafer lot can be certified as an RHA wafer lot.

The tables below list the samples that used during the RHA characterization.

Table 2. HDR Biased Device and Exposure Information

HDR = 65 rad(Si)/s			
Total Samples: 5 Biased/TID level			
Exposure Level:			
3k	10k	30k	75k
36, 37, 38	39, 40, 41	42, 43, 44	45, 46, 47

Control Unit: 33

Table 3. LDR Biased Device and Exposure Information

LDR = 10 mrad(Si)/s			
Total Samples: 5 Biased/TID level			
Exposure Level:			
20k	30k	50k	75k
1, 2, 3	7, 8, 9	13, 14, 15	19, 20, 21

Table 4. LDR Unbiased Device and Exposure Information

LDR = 10 mrad(Si)/s			
Total Samples: 5 Unbiased/TID level			
Exposure Level:			
20k	30k	50k	75k
4, 5, 6	10, 11, 12	16, 17, 18	22, 23, 24

Control Unit: 42, 44

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3 Total Ionizing Dose (RHA) Characterization Test Results

3.1 Total Ionizing Dose RHA Characterization Summary Results

The parametric data for the CDCLVP111-SP passes up to 75-krad(Si) LDR and HDR.

The drift of SMD electrical parameters including critical parameters through LDR is within experimental error to the drift at HDR. The device is tested to maximum total dose of 75 krad(Si) per MIL-STD-883, TM1090 Condition A, Condition D.

The CDLVP111-SP passed post electrical test over all the conditions below ensuring that the wafer lot is certifiable as 75-krad(Si) RHA. Samples were assembled from one wafer level variability regarding TID drift through post electrical test on ATE after LDR and HDR exposure.

- HDR (100 rad(Si)/s) biased: Post 3 krad(Si), 10 krad(Si), 30 krad(Si), 50 krad(Si), 75 krad(Si)
- LDR (0.01 rad(Si)/s) unbiased: Post 20 krad(Si), 30 krad(Si), 50 krad(Si), 75 krad(Si), 100 krad(Si)
- LDR (0.01 rad(Si)/s) biased: Post 20 krad(Si), 30 krad(Si), 50 krad(Si), 75 krad(Si)

Overall radiation performance was very solid. There were no functional or parametric failures at any read point. All datasheet parameters passed at all exposure levels with margin and ELDRS free. There were 2 parameters that showed a consistent trend during exposure and these were the worst case shift seen of all parameters tested. These are listed below.

1. **Clk0Tpd_1000MHz:clk0Tpdlh_1000MHz@Q4**

   Propagation delay of the signal – exhibits a decrease from 0 krad(Si) to 20 krad(Si), but then an increase in time from 20 krad(Si) to 100 krad(Si). This amounts to a shift of ~20 ps which is < 20% of the guardbanded limit range. No failures.

2. **Clk1Tskp_1000MHz:clk1Tskp@Q0**

   Channel to channel skew – exhibits an increase of channel skew through increased exposure.

These timing measurements can be partially attributed to slight voltage shifts seen on the output pins. The test method uses a strobe set a particular voltage to determine the output timing. If the voltage levels shift, this strobe is kept constant, this will result in a shift of the timing reading.

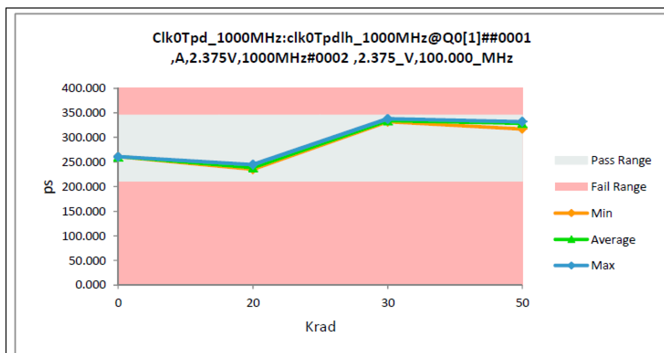

Figure 3. Radiation Exposure Effect on Propagation Delay

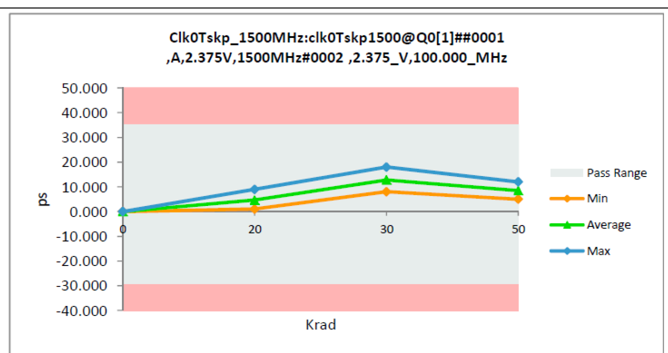

Figure 4. Radiation Exposure Effect on Output to Output Skew

3.2 Group E Full RHA Radiation Lot Acceptance (RLAT) Report

The Group E RHA RLAT summary is shipped with each TI RHA QMLV product. To see the list of all documents shipped with TI QMLV products review *Texas Instruments QML Lot Documents* (SBOA140). This document also has instructions on how to pull the full RHA (Group E) report.

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4 Applicable and Reference Documents

4.1 Applicable Documents

CDCLVP111-SP 1:10 High Speed Clock Buffer with Selectable Input Clock Driver (SCAS946)

CDCLVP111-SP Evaluation Module

CDCLVP111-SP Evaluation Module User Guide (SCAU055)

4.2 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.

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