Total dose testing of the HS-26CT31RH Radiation Hardened Quad Differential Line Driver

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1. Introduction

This report reports the results of a low and high dose rate total dose test of the HS-26CT31RH quad differential line driver. The test was conducted in order to determine the sensitivity of the part to the total dose environment and to determine if dose rate and bias sensitivity exist.

2. Reference Documents

MIL-STD-883G test method 1019.7
HS-26CT31RH data sheet
DSCC Standard Microcircuit Drawing (SMD) 5962-95632

3: Part Description

The Intersil HS-26CT31RH is a quad differential line driver designed for digital data transmission over balanced lines and meets the requirements of EIA standard RS-422. Radiation hardened CMOS processing assures low power consumption, high speed, and reliable operation in the most severe radiation environments.

The HS-26CT31RH accepts TTL signal levels and converts them to RS-422 compatible outputs. This circuit uses special outputs that enable the drivers to power down without loading down the bus. Enable and disable pins allow several devices to be connected to the same data source and addressed independently.

Specifications for Rad Hard QML devices are controlled by the Defense Supply Center in Columbus (DSCC). The SMD numbers listed here must be used when ordering. Detailed Electrical Specifications for these devices are contained in SMD 5962-95632. A "hot-link" is provided on our homepage for downloading.

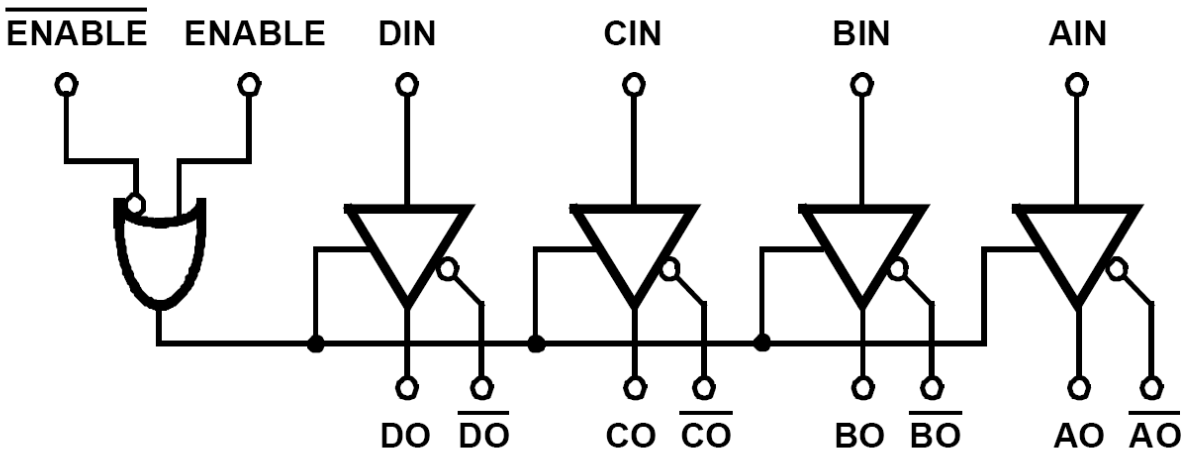


Figure 1: HS-26CT31RH block diagram.

4: Test Description

4.1 Irradiation Facilities

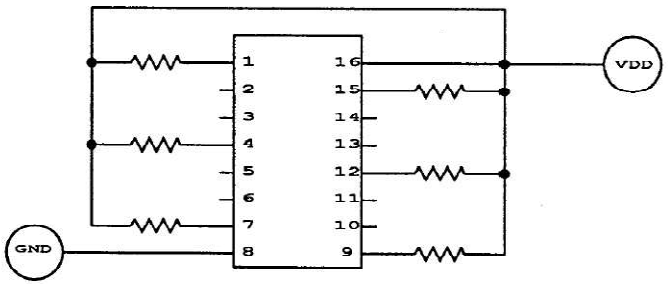
High dose rate testing was performed using a Gammacell 220 ^{60}Co irradiator located in the Palm Bay, Florida Intersil facility. Low dose rate testing was performed on a subcontract basis at White Sands Missile Range (WSMR) Survivability, Vulnerability and Assessment Directorate (SVAD), White Sands, NM. The high dose rate irradiations were done at 55rad(Si)/s and the low dose rate work was performed at 0.010rad(Si)/s, both per MIL-STD-883 Method 1019.7. Dosimetry for both tests was performed using Far West Technology radiochromic dosimeters and readout equipment.

4.2 Test Fixturing

Figure 2 shows the configuration used for biased irradiation in conformance with Standard Microcircuit Drawing (SMD) 5962-95632.

FIGURE 134

HS26C31MSR



NOTES:

A) VDD = +5V, +/-5%

B) GND = GROUND

C) ALL RESISTOR ARE 47K OHM, +/-5%

D) USE GENERIC 16 PIN UNIVERSAL BOARD

E) USE PATCH LABLED HS26C31

Figure 2: Irradiation bias configuration for the HS-26CT31RH per Standard Microcircuit Drawing (SMD) 5962-95632.

4.3 Characterization equipment and procedures

All electrical testing was performed outside the irradiator using the production automated test equipment (ATE) with datalogging at each downpoint. Downpoint electrical testing was performed at room temperature. The low dose rate testing at a remote site introduced some challenges, and shipping had to be done in a foam container with a frozen Gelpack™ along with a strip chart temperature recorder in order to remain well within the temperature limits imposed by MIL-STD-883 Test Method 1019.7.

4.4 Experimental matrix

Testing proceeded in accordance with the guidelines of MIL-STD-883 Test Method 1019.7. The experimental matrix consisted of five samples irradiated at high dose rate with all pins grounded, five samples irradiated at high dose rate under bias, five samples irradiated at low dose rate with all pins grounded and five samples irradiated at low dose rate under bias. One control unit was used.

Samples of the HS-26CT31RH die were drawn from wafer 3 of production lot DCXLCBAA and were packaged in the standard hermetic 16-pin solder-sealed flatpack (CDFP4-F16) production package. Samples were processed through the standard burnin cycle before irradiation, as required by MIL-STD-883, and were screened to the SMD 5962-95632 limits at room, low and high temperatures prior to the test.

4.5 Downpoints

Downpoints for the tests were zero, 50krad(Si), 100krad(Si) and 150krad(Si) for the high dose rate test and zero, 10krad(Si), 25krad(Si), 50krad(Si), 100krad(Si), 125krad(Si) and 150krad(Si) for the low dose rate test.

5: Results

5.1 Test results

Testing at both dose rates to 150krad(Si) of the HS-26CT31RH is complete and showed no reject devices after irradiation to 150krad(Si), screening to the SMD pre- and post-irradiation limits. As a determinant of low dose rate sensitivity, MIL-STD-883 Test Method 1019.7 specifies that a delta_parameter calculation be performed for any ‘sensitive parameters’ that exceed the pre-irradiation Group A limits, but not necessarily the post-irradiation limits. These calculations were not required as there were no rejects against the pre-irradiation Group A limits, meaning there are no formal ‘sensitive parameters’. Accordingly, the part is considered ELDRS-free up to 150krad(Si). No bias sensitivity was noted.

5.2 Variables data

The plots in Figures 3 through 44 show data at all downpoints. The plots show the median of key parameters as a function of total dose for each of the four irradiation conditions.

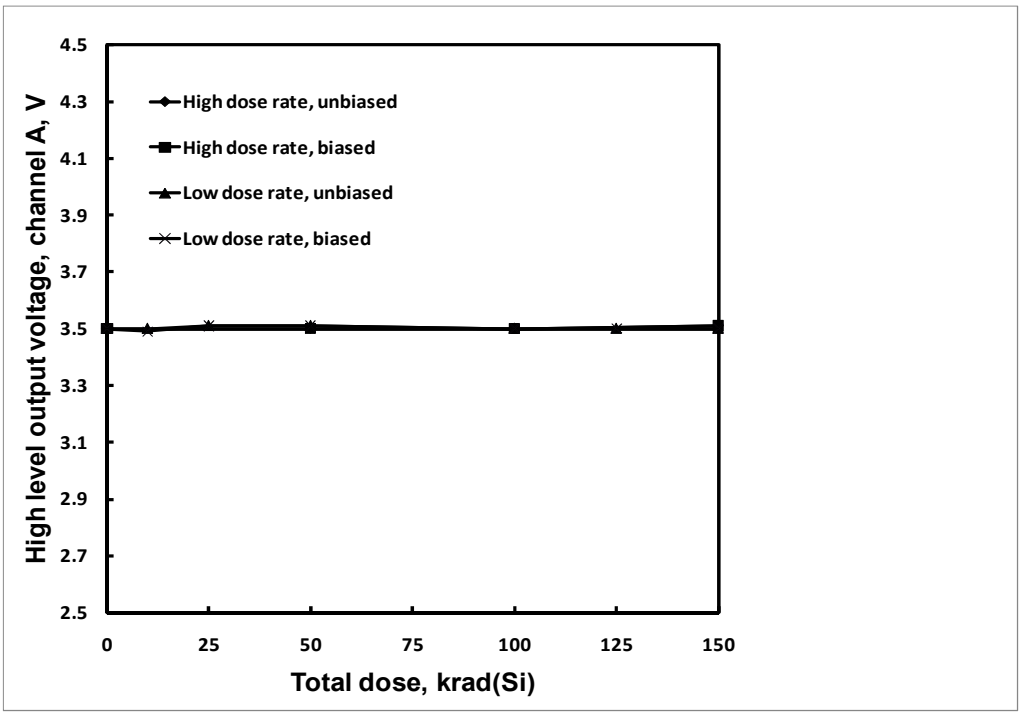


Figure 3: HS-26CT31RH HIGH level output voltage, channel A, as a function of total dose irradiation at low and high dose rate for the unbiased (all pins grounded) and the biased (per Figure 2) cases. The low dose rate was 0.01rad(Si)/s and the high dose rate 55rad(Si)/s. Sample size for each cell was 5. The post-irradiation SMD limit is 500mV maximum.

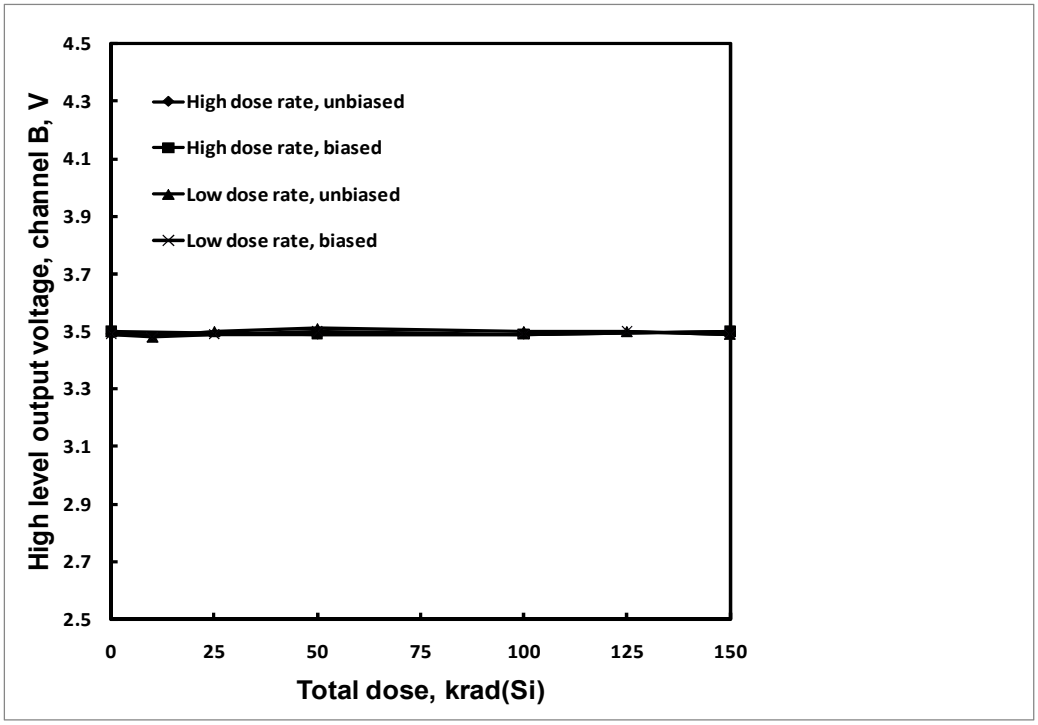


Figure 4: HS-26CT31RH HIGH level output voltage, channel B, as a function of total dose irradiation at low and high dose rate for the unbiased (all pins grounded) and the biased (per Figure 2) cases. The low dose rate was 0.01rad(Si)/s and the high dose rate 55rad(Si)/s. Sample size for each cell was 5. The post-irradiation SMD limit is 500mV maximum.

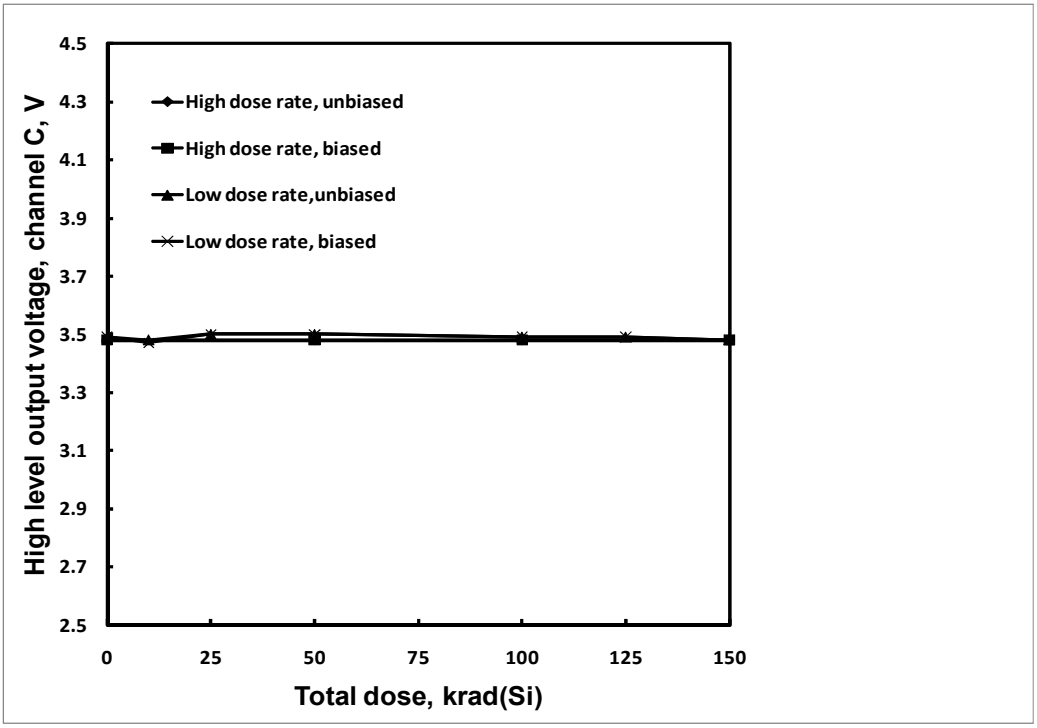


Figure 5: HS-26CT31RH HIGH level output voltage, channel C, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limit is 500mV maximum.

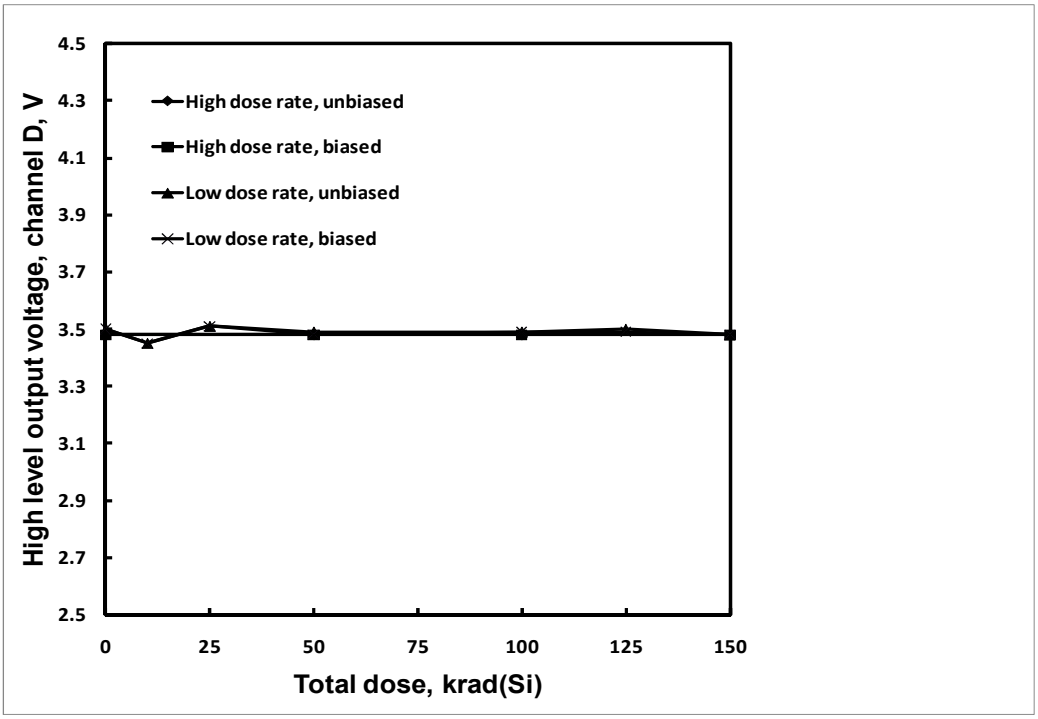


Figure 6: HS-26CT31RH HIGH level output voltage, channel D, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limit is 500mV maximum.

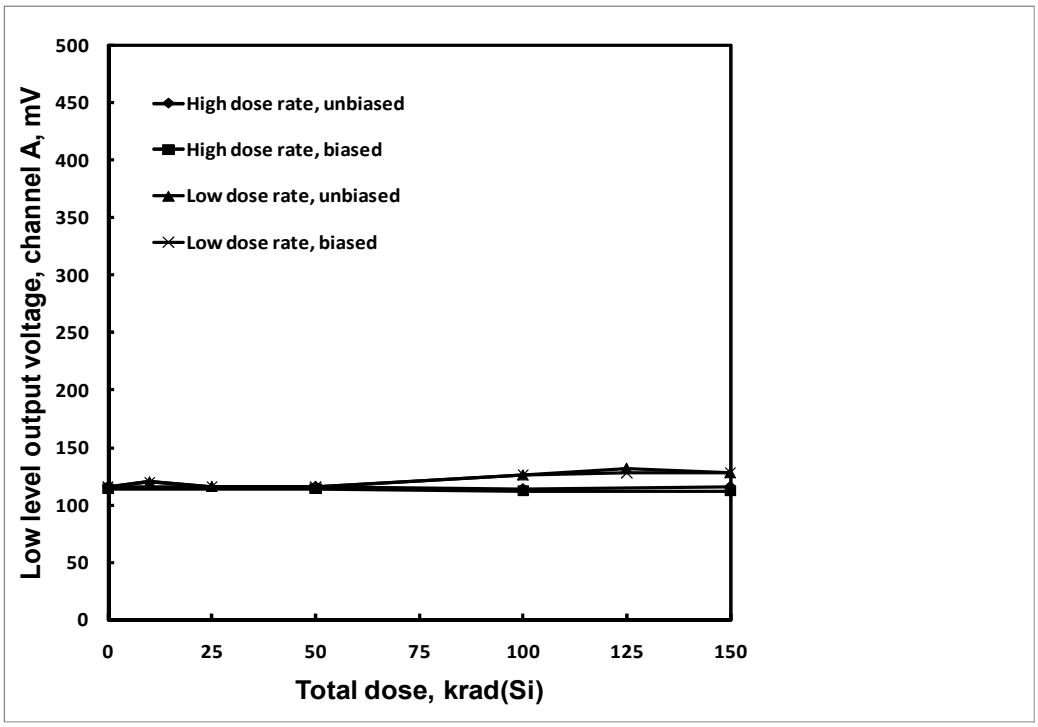


Figure 7: HS-26CT31RH LOW level output voltage, channel A, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limit is 2.5V minimum.

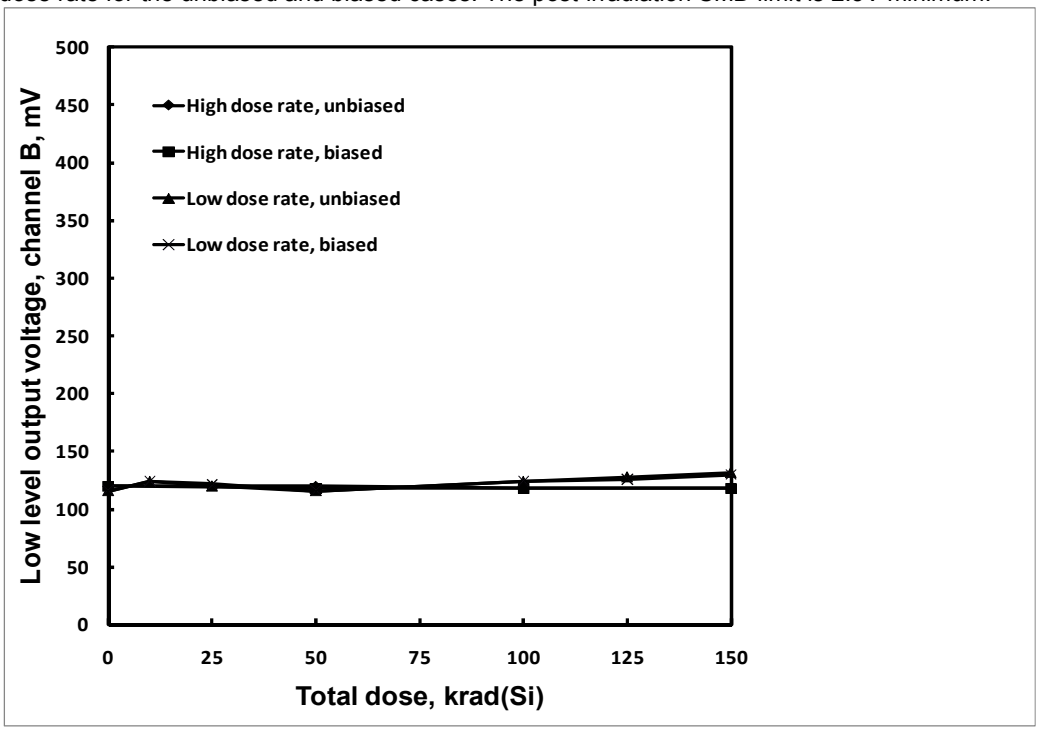


Figure 8: HS-26CT31RH LOW level output voltage, channel B, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limit is 2.5V minimum.

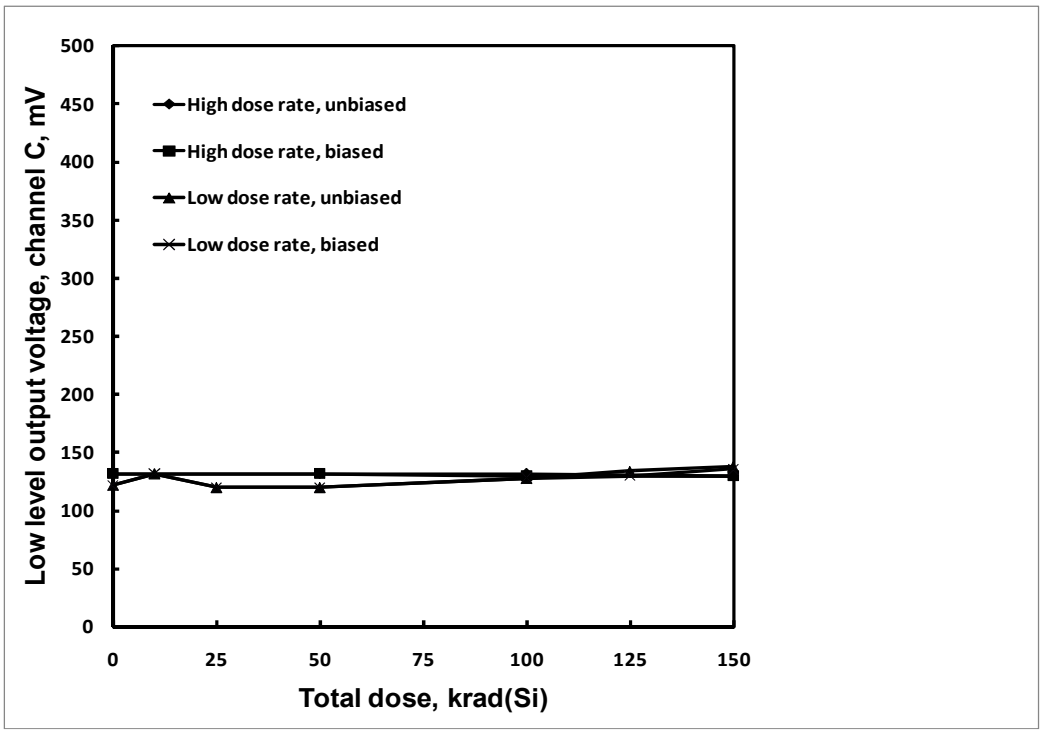


Figure 9: HS-26CT31RH LOW level output voltage, channel C, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limit is 2.5V minimum.

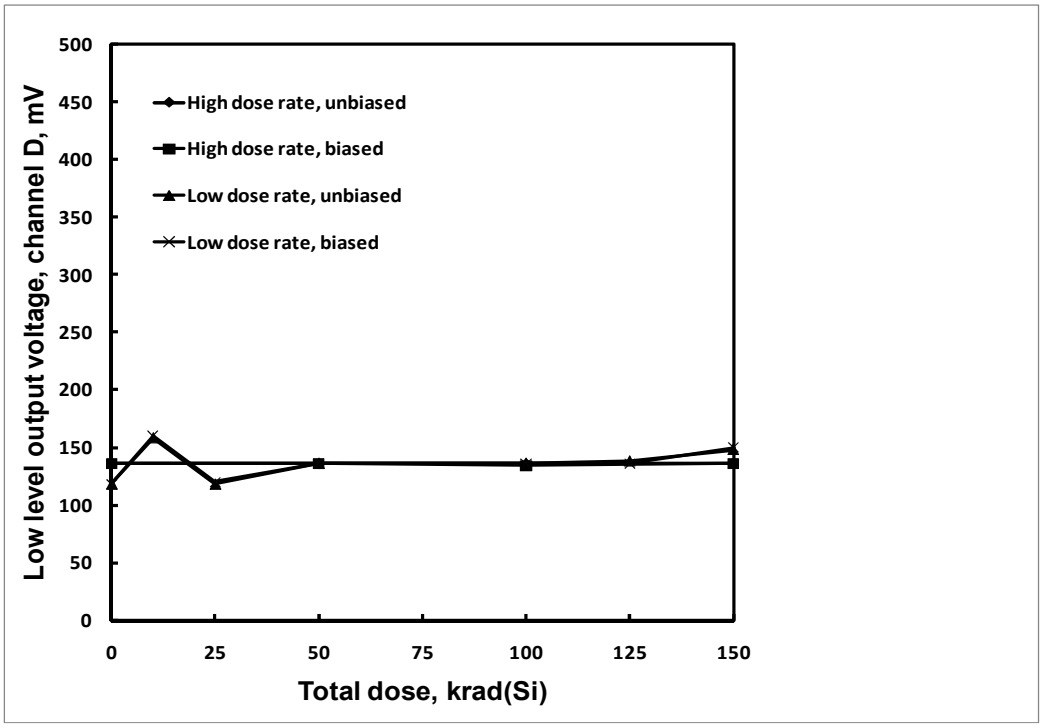


Figure 10: HS-26CT31RH LOW level output voltage, channel D, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limit is 2.5V minimum.

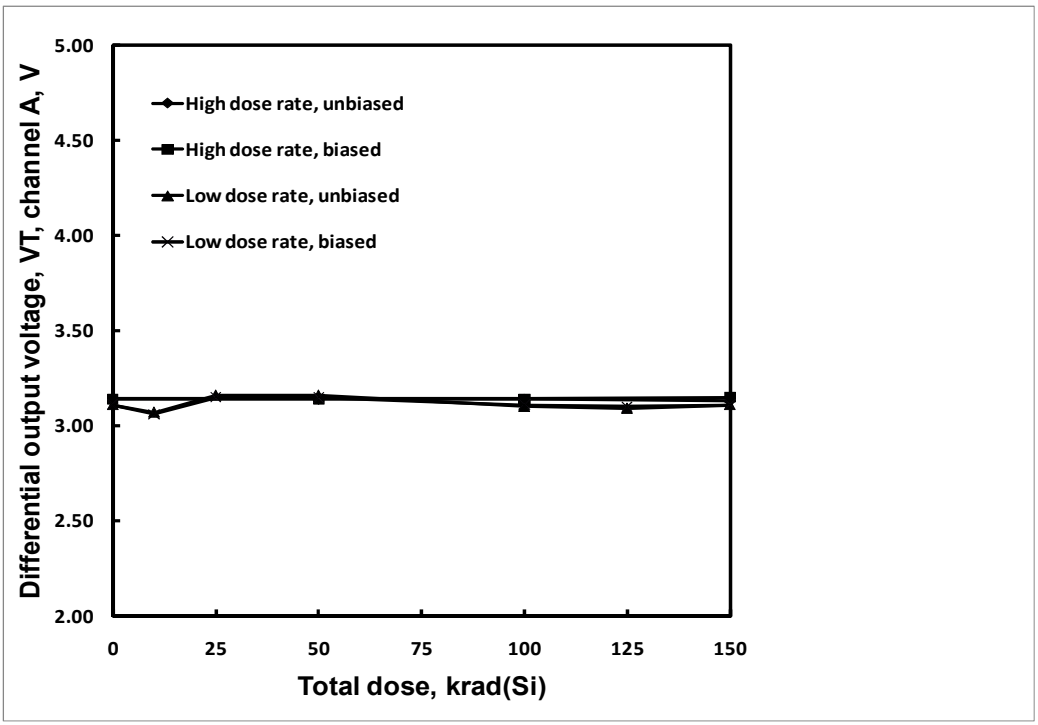


Figure 11: HS-26CT31RH differential output voltage, VT, channel A, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limit is 2V minimum.

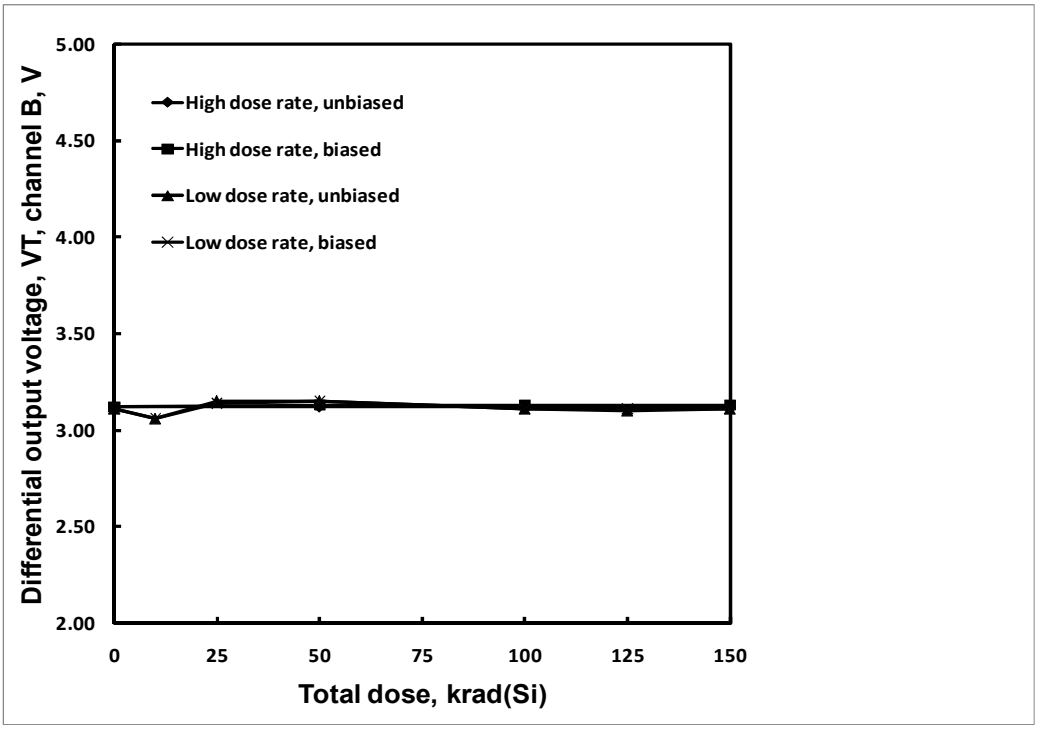


Figure 12: HS-26CT31RH differential output voltage, VT, channel B, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limit is 2V minimum.

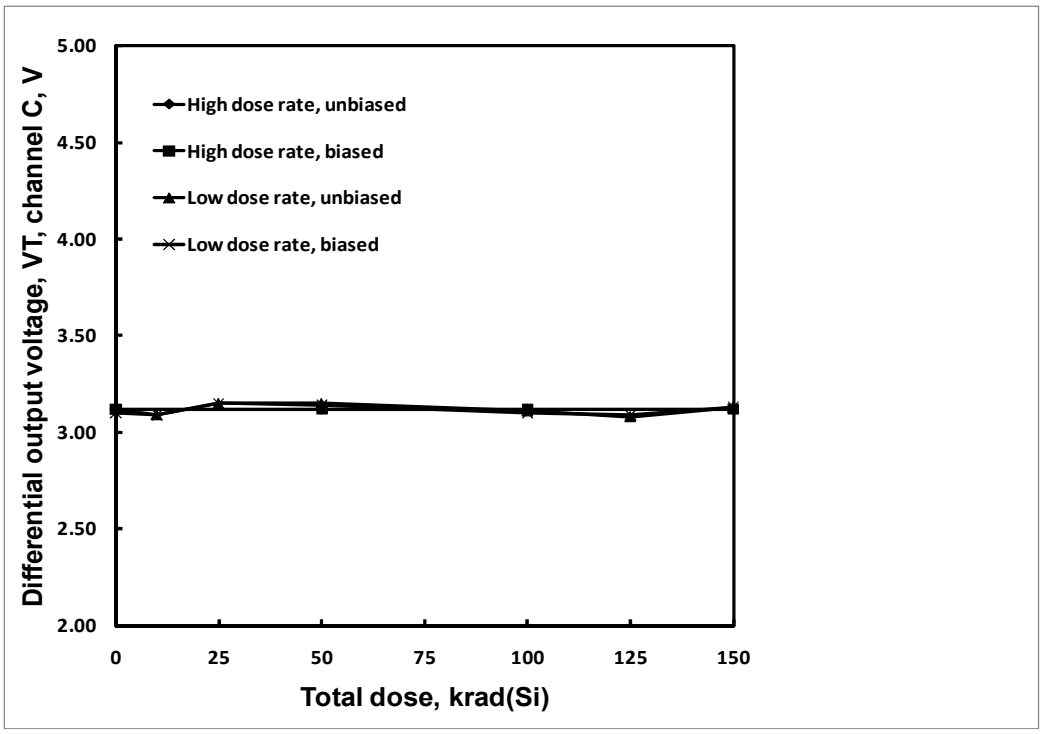


Figure 13: HS-26CT31RH differential output voltage, VT, channel C, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limit is 2V minimum.

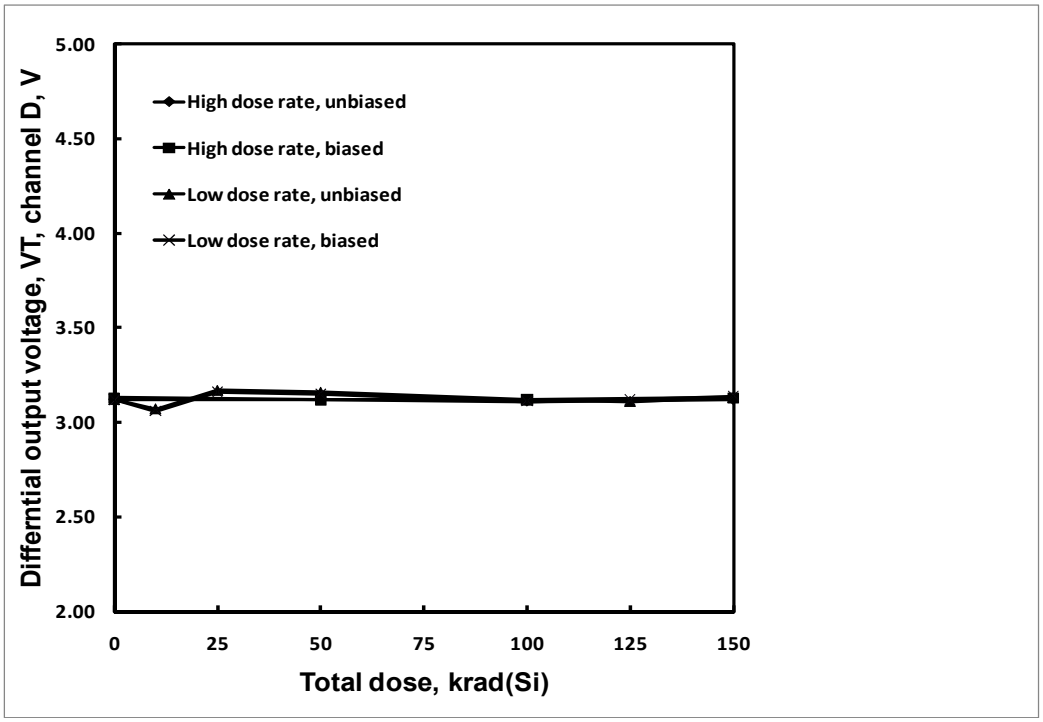


Figure 14: HS-26CT31RH differential output voltage, VT, channel D, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limit is 2V minimum.

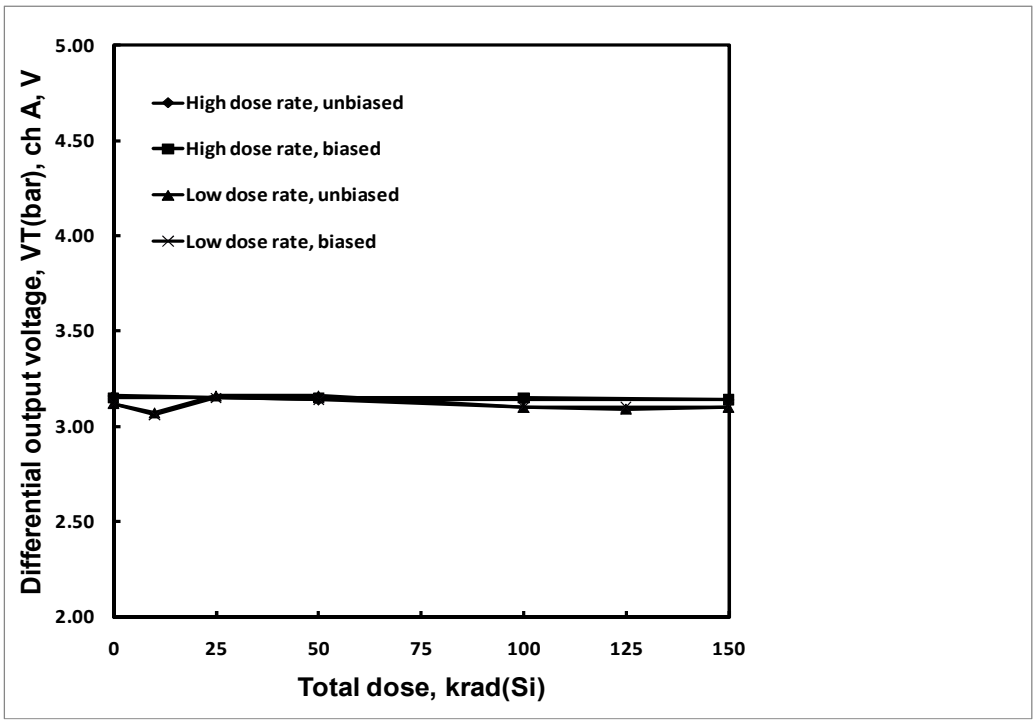


Figure 15: HS-26CT31RH differential output voltage, VT(bar), channel A, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limit is 2V minimum.

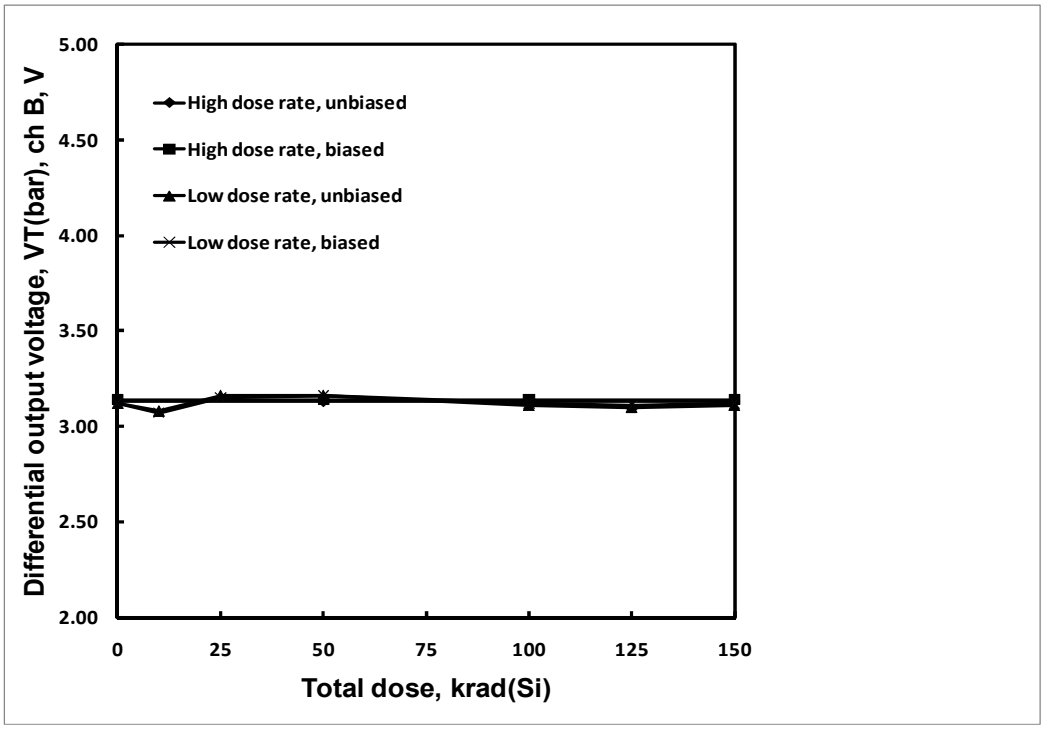


Figure 16: HS-26CT31RH differential output voltage, VT(bar), channel B, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limit is 2V minimum.

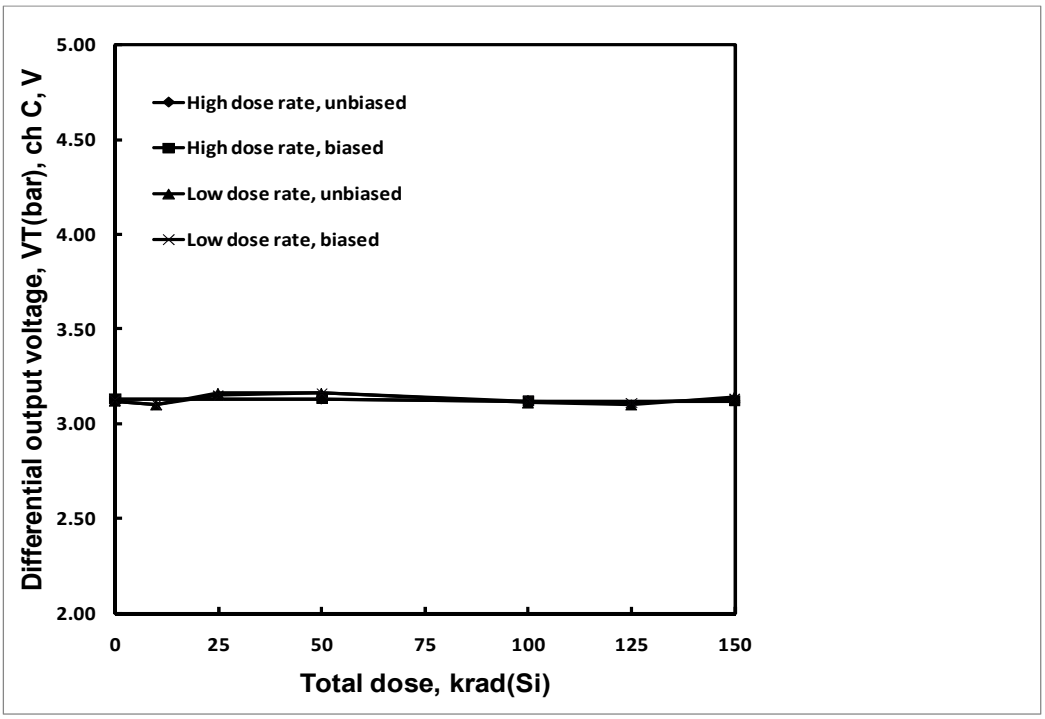


Figure 17: HS-26CT31RH differential output voltage, VT(bar), channel C, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limit is 2V minimum.

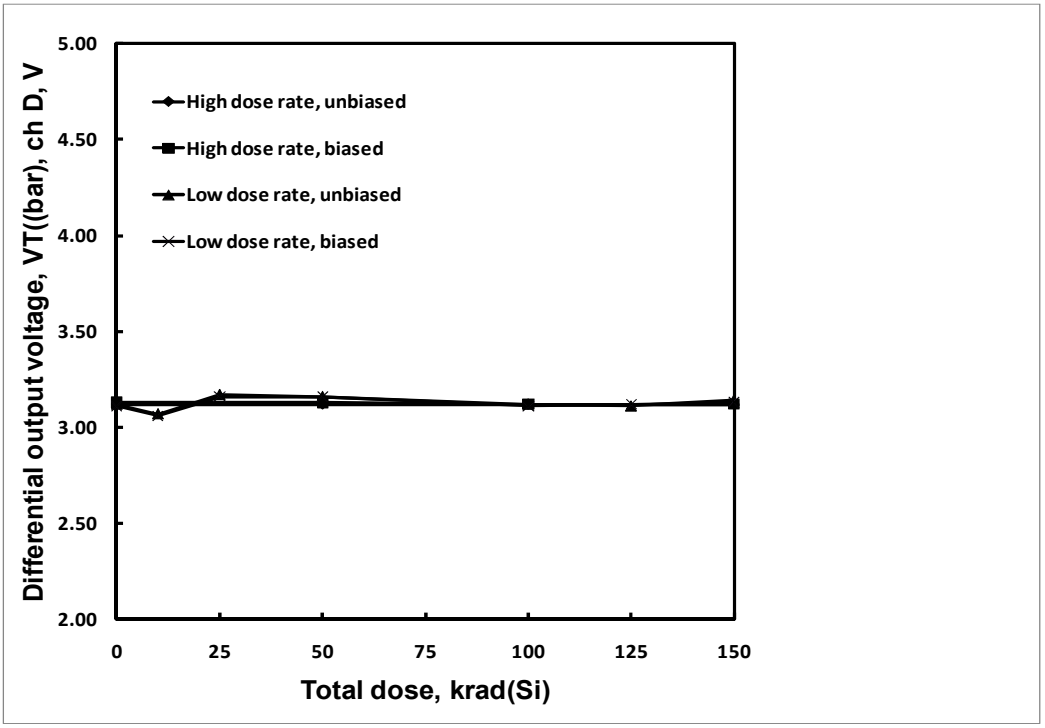


Figure 18: HS-26CT31RH differential output voltage, VT(bar), channel D, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limit is 2V minimum.

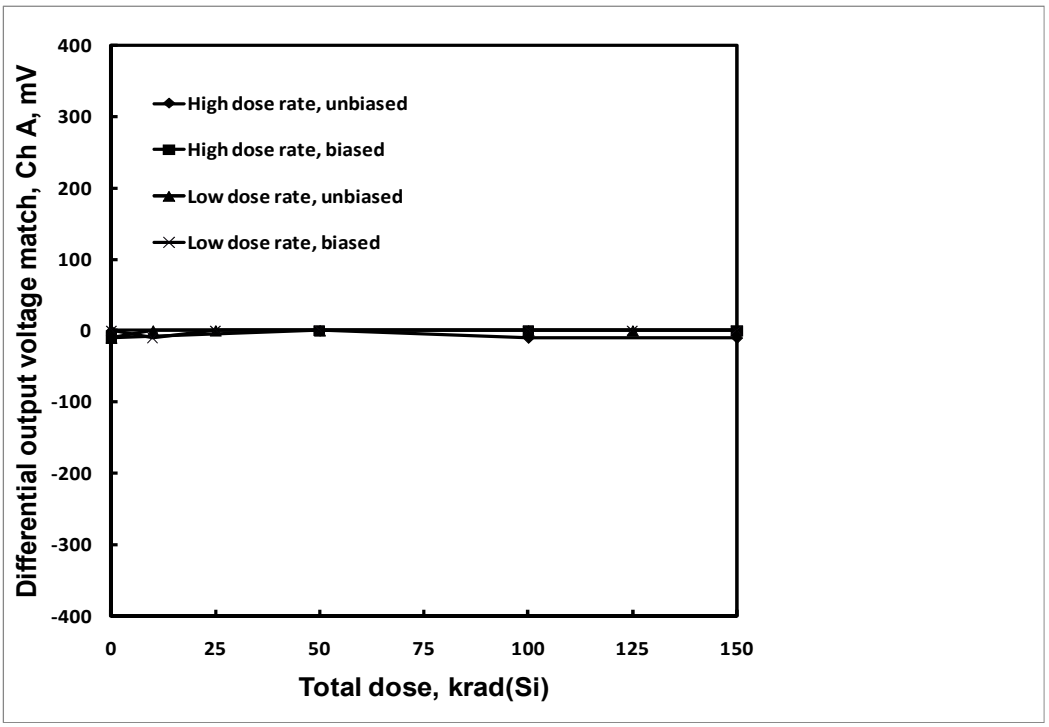


Figure 19: HS-26CT31RH differential output voltage match, channel A, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limits are -400mV to +400mV.

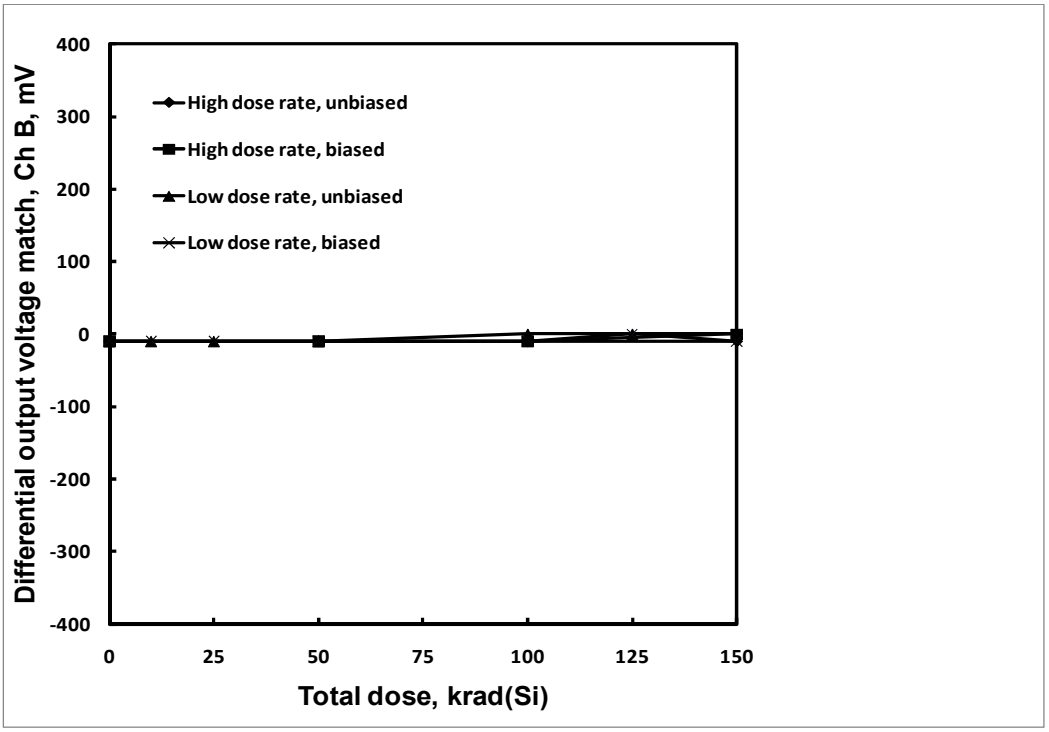


Figure 20: HS-26CT31RH differential output voltage match, channel B, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limits are -400mV to +400mV.

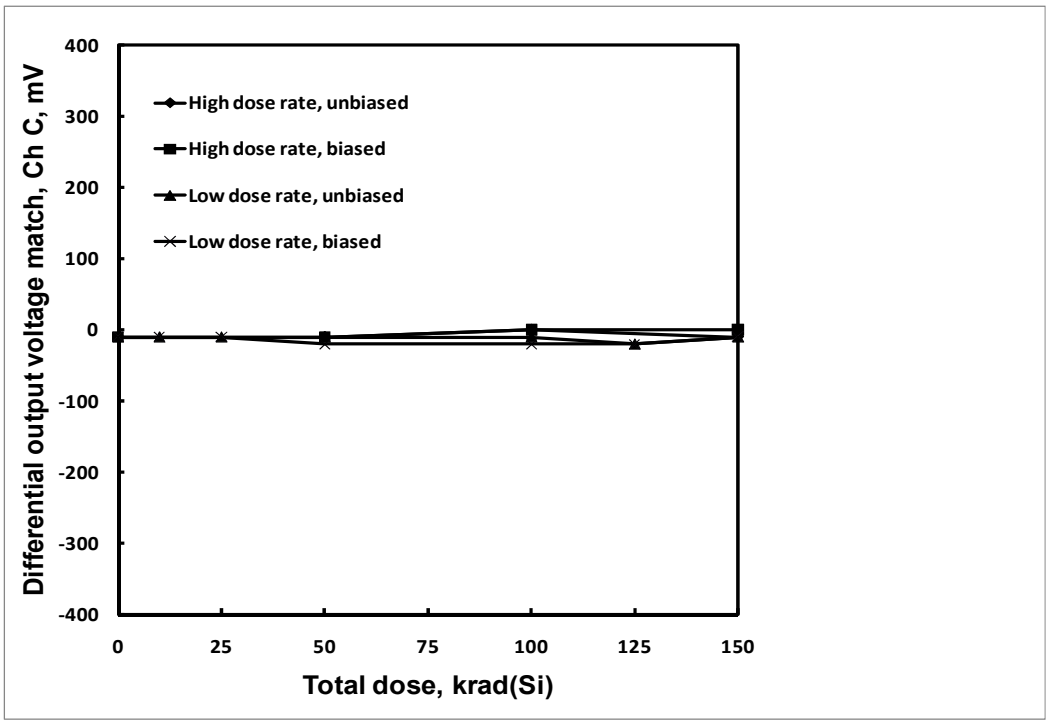


Figure 21: HS-26CT31RH differential output voltage match, channel C, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limits are -400mV to +400mV.

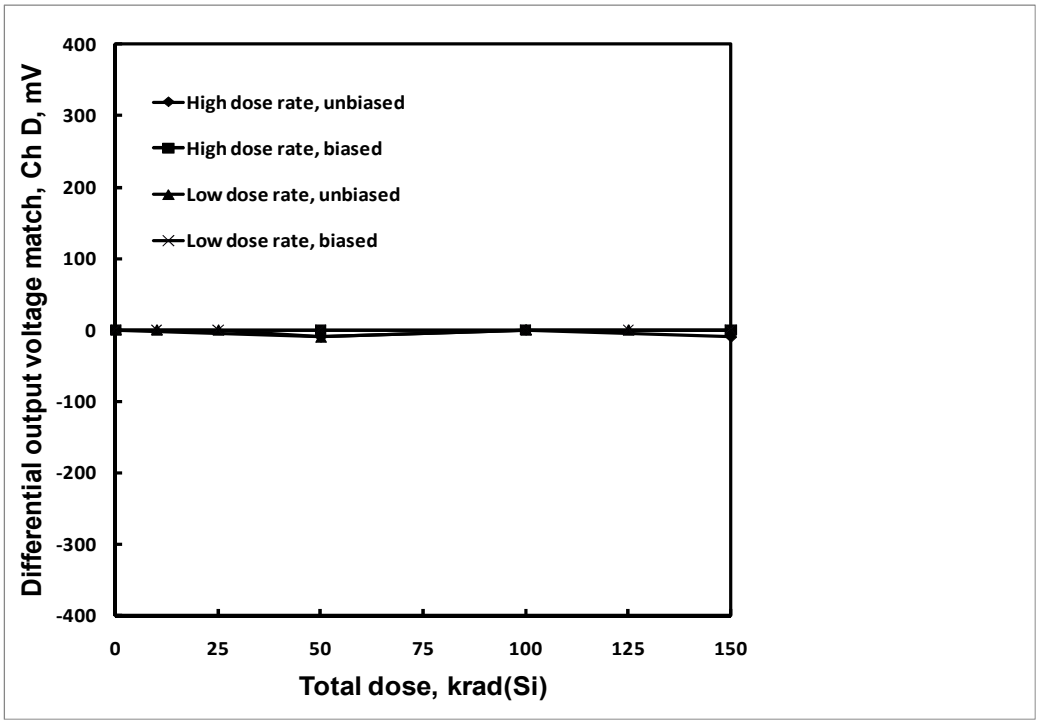


Figure 22: HS-26CT31RH differential output voltage match, channel D, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limits are -400mV to +400mV.

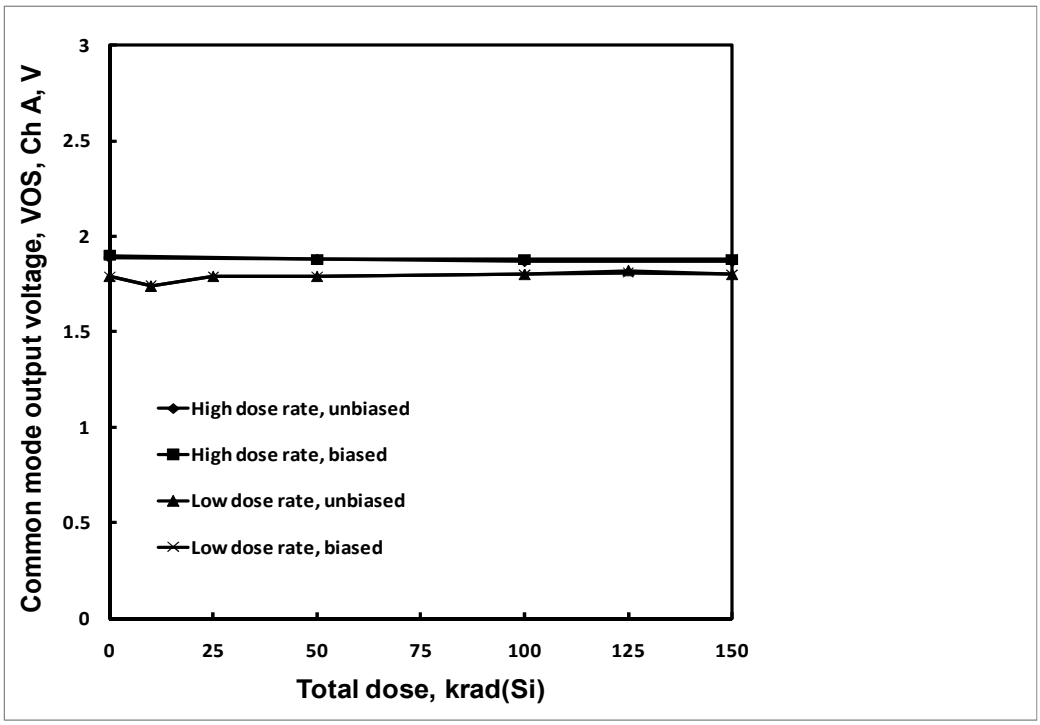


Figure 23: HS-26CT31RH common mode output voltage, VOS, channel A, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limit is 3V maximum.

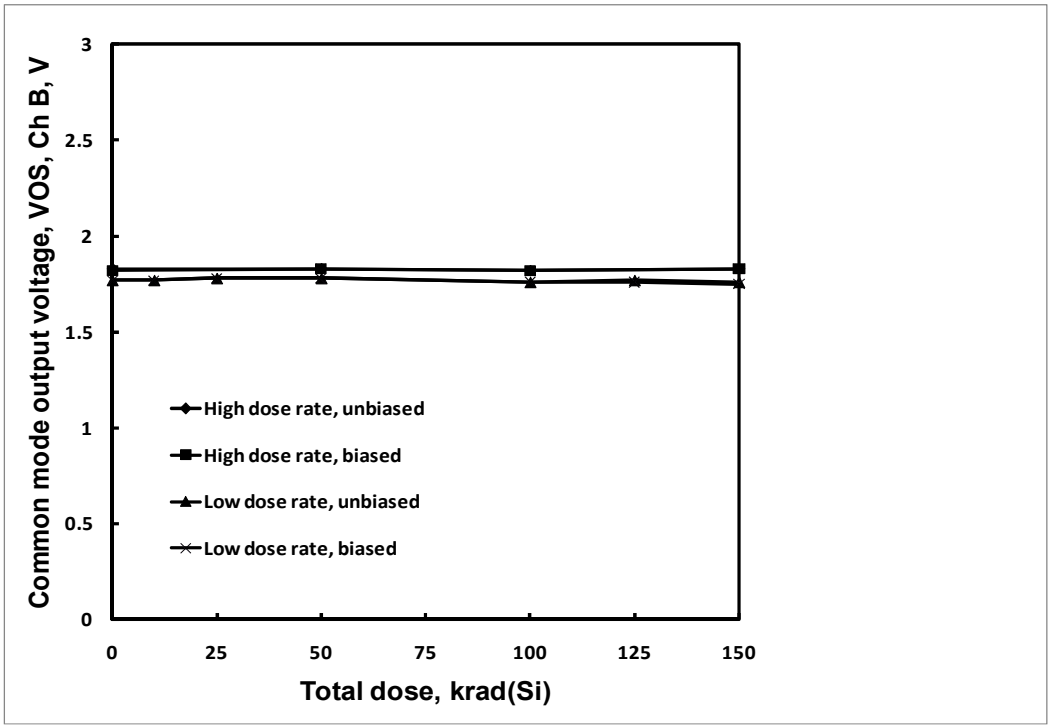


Figure 24: HS-26CT31RH common mode output voltage, VOS, channel B, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limit is 3V maximum.

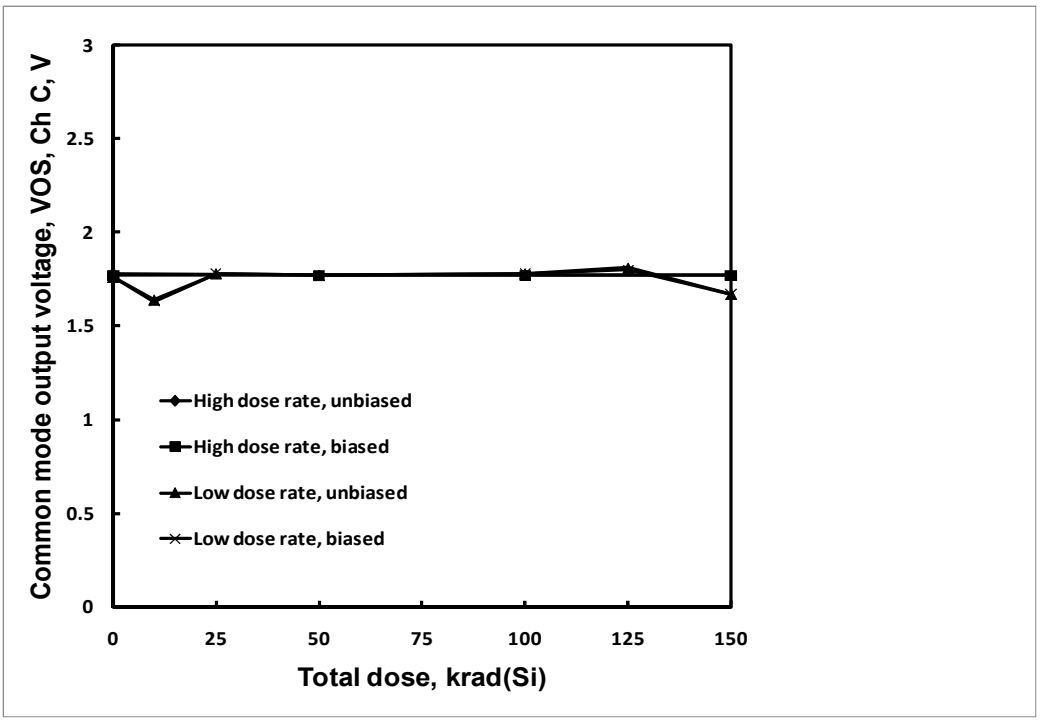


Figure 25: HS-26CT31RH common mode output voltage, VOS, channel C, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limit is 3V maximum.

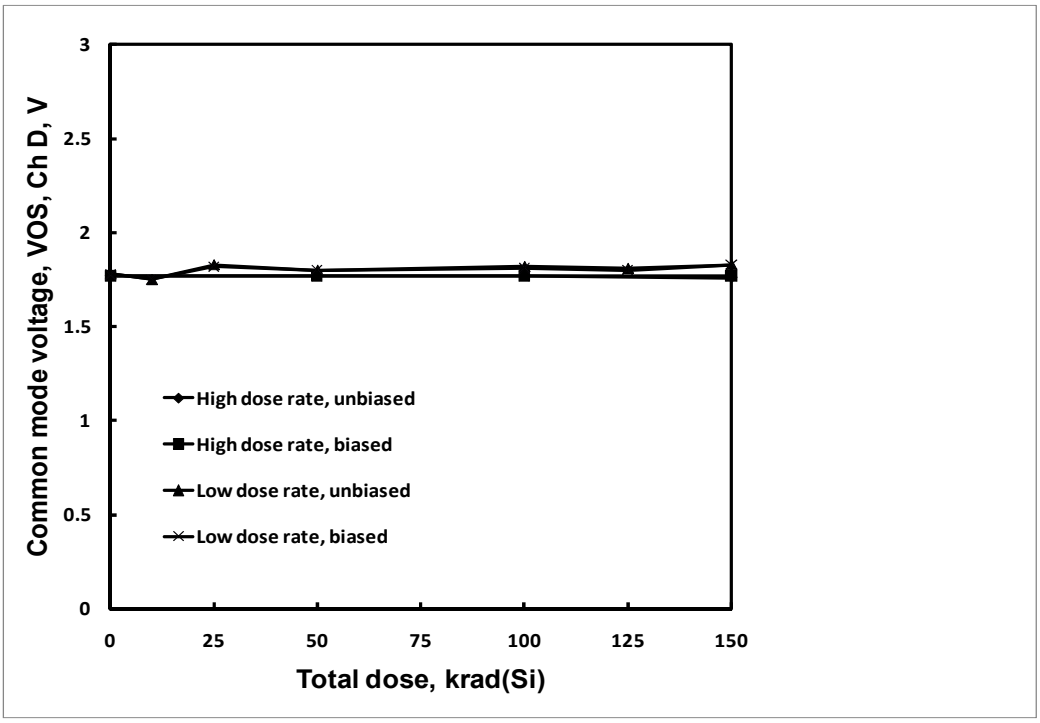


Figure 26: HS-26CT31RH common mode output voltage, VOS, channel D, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limit is 3V maximum.

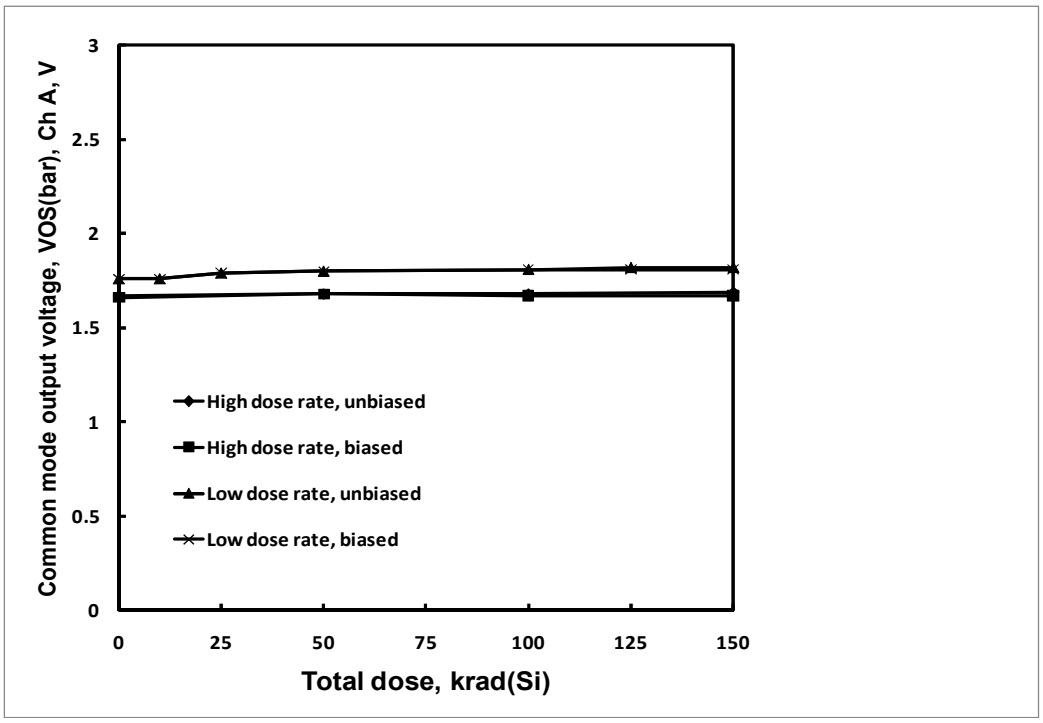


Figure 27: HS-26CT31RH common mode output voltage, VOS(bar), channel A, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limit is 3V maximum.

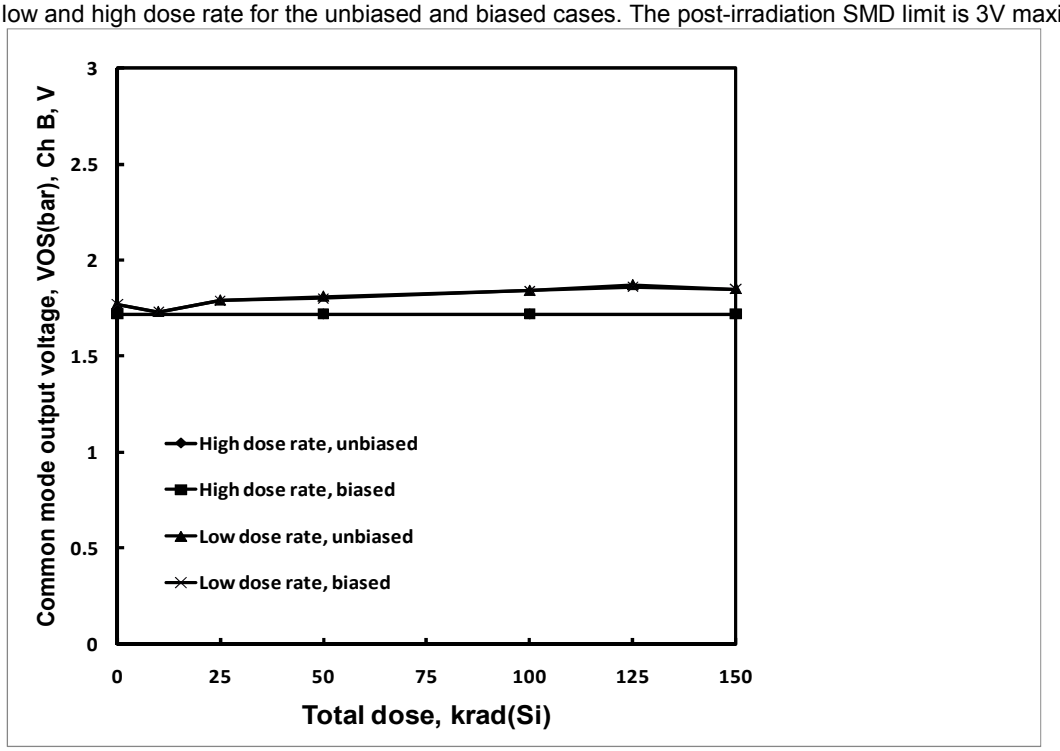


Figure 28: HS-26CT31RH common mode output voltage, VOS(bar), channel B, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limit is 3V maximum.

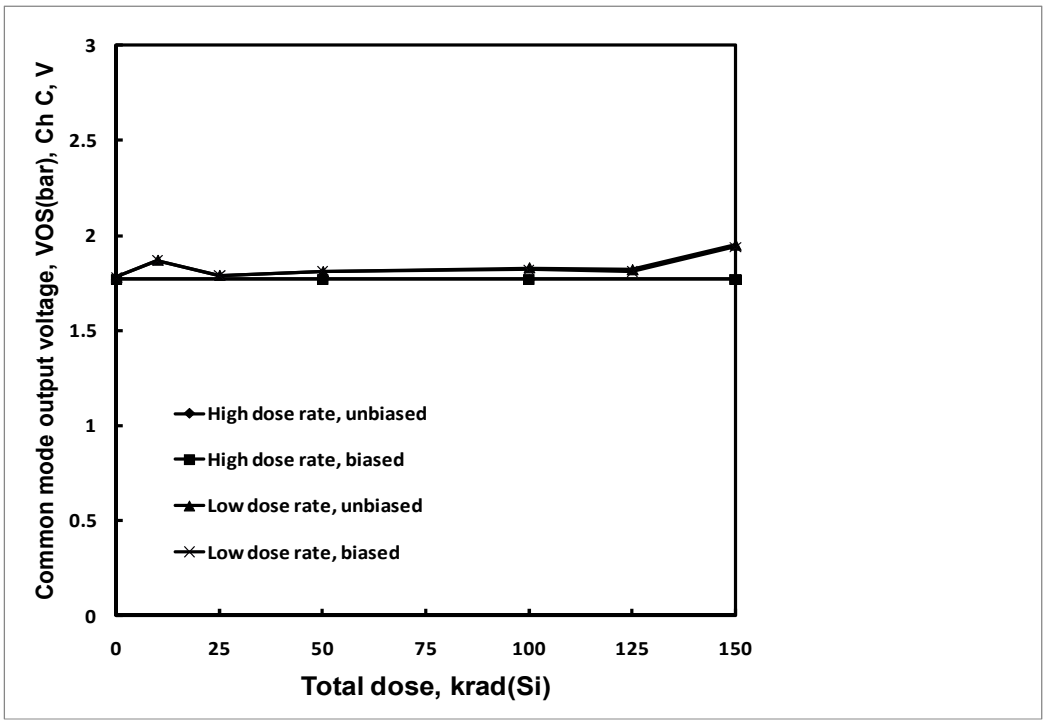


Figure 29: HS-26CT31RH common mode output voltage, VOS(bar), channel C, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limit is 3V maximum.

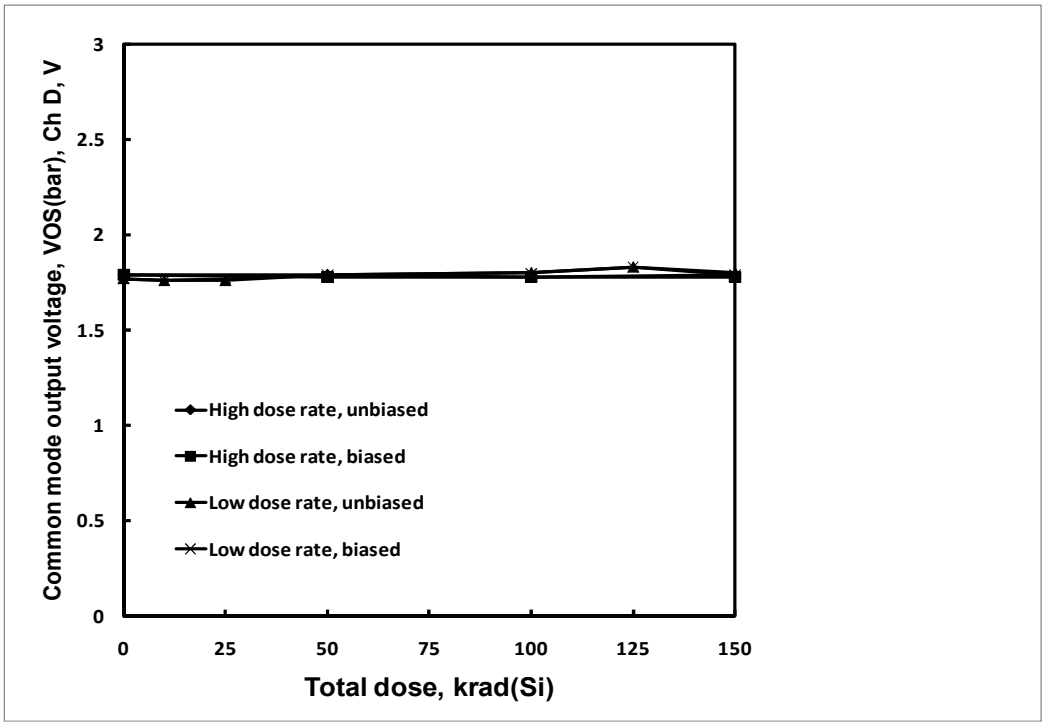


Figure 30: HS-26CT31RH common mode output voltage, VOS(bar), channel D, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limit is 3V maximum.

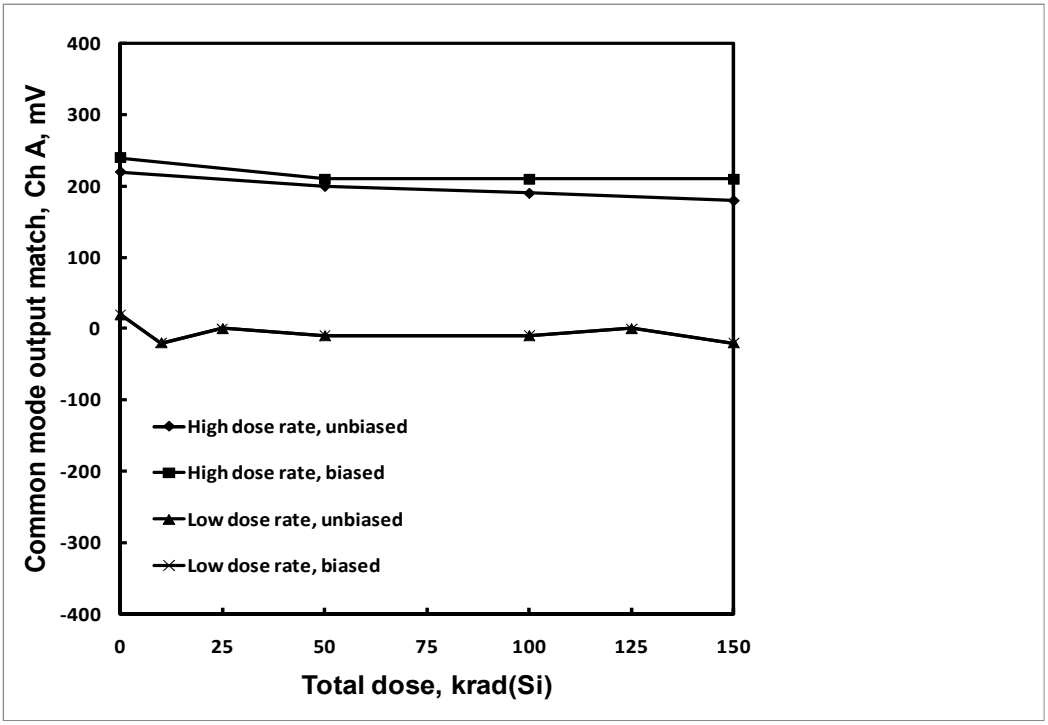


Figure 31: HS-26CT31RH common mode output voltage match, channel A, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limits are -400mV to +400mV.

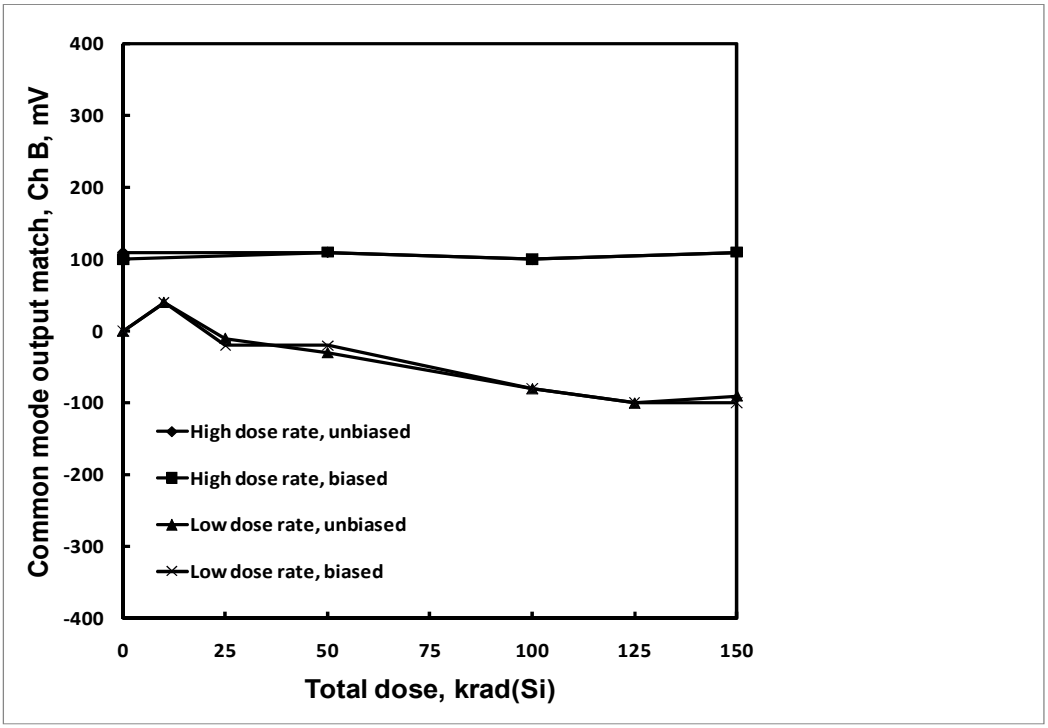


Figure 32: HS-26CT31RH common mode output voltage match, channel B, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limits are -400mV to +400mV.

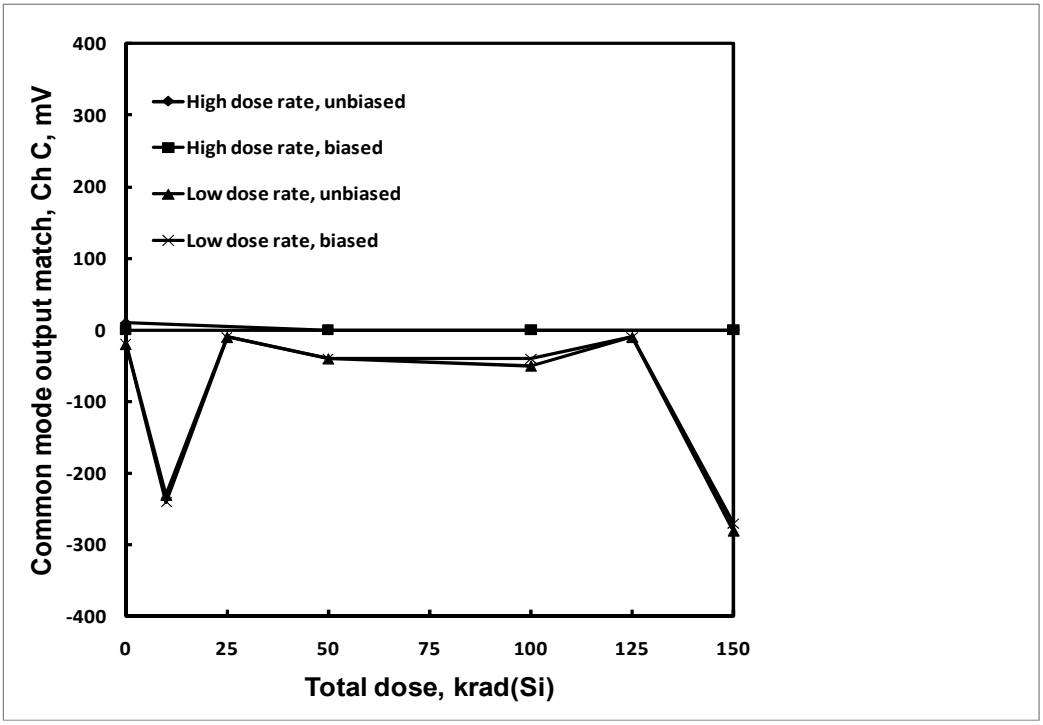


Figure 33: HS-26CT31RH common mode output voltage match, channel C, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limits are -400mV to +400mV.

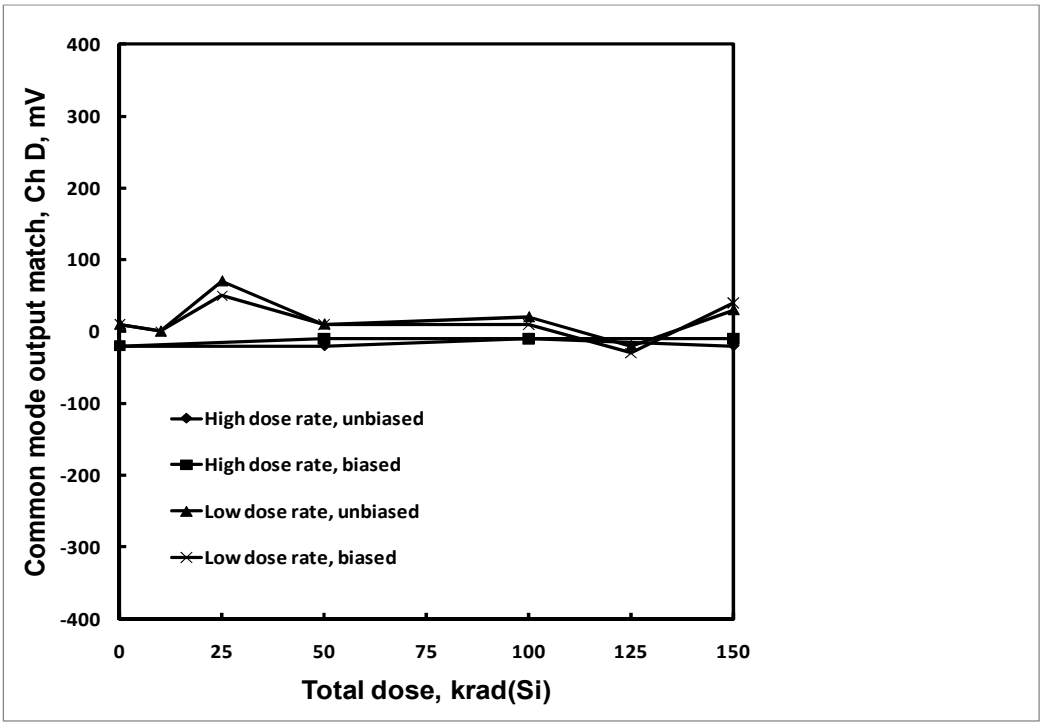


Figure 34: HS-26CT31RH common mode output voltage match, channel D, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limits are -400mV to +400mV.

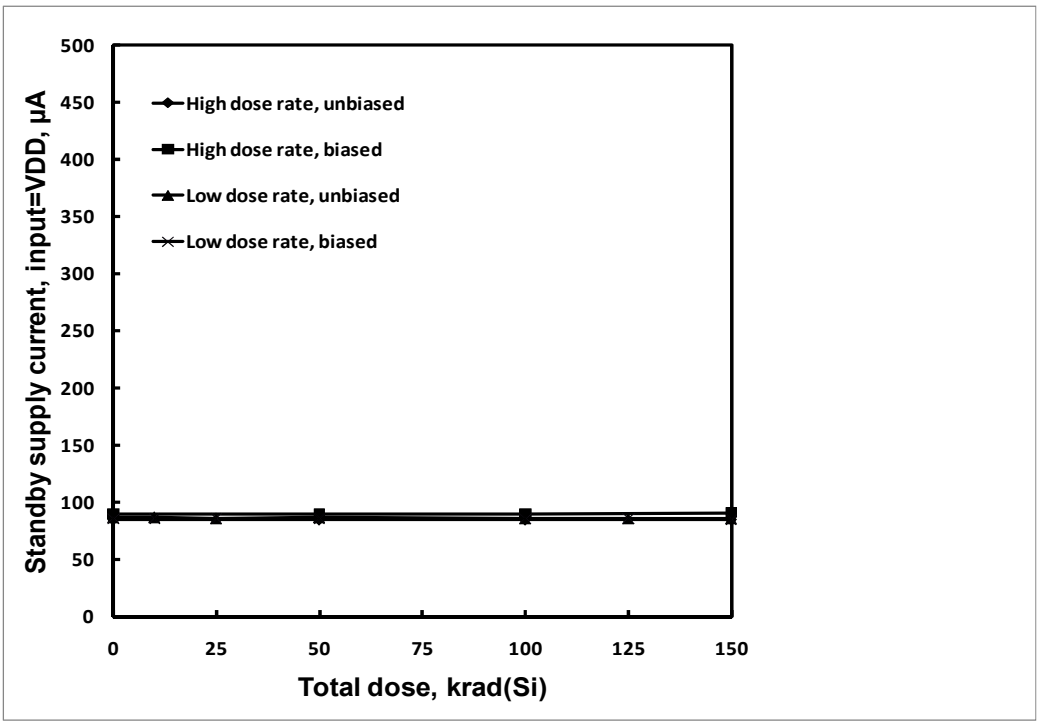


Figure 35: HS-26CT31RH standby supply current, input at VDD, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limit is 500µA maximum.

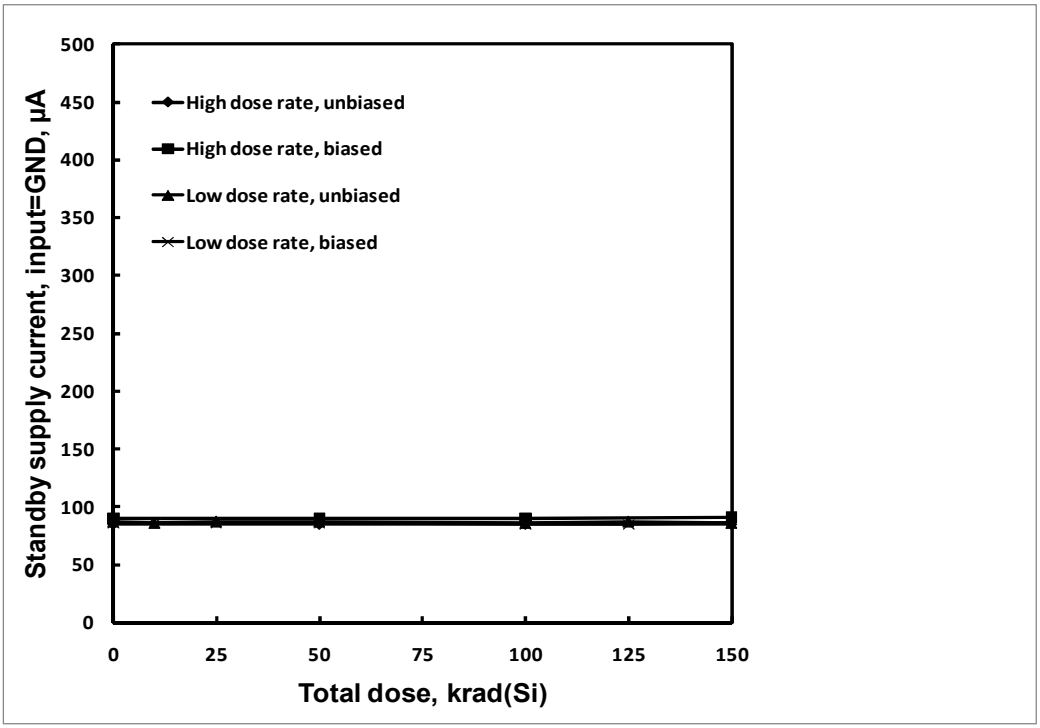


Figure 36: HS-26CT31RH standby supply current, input at ground, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limit is 500µA maximum.

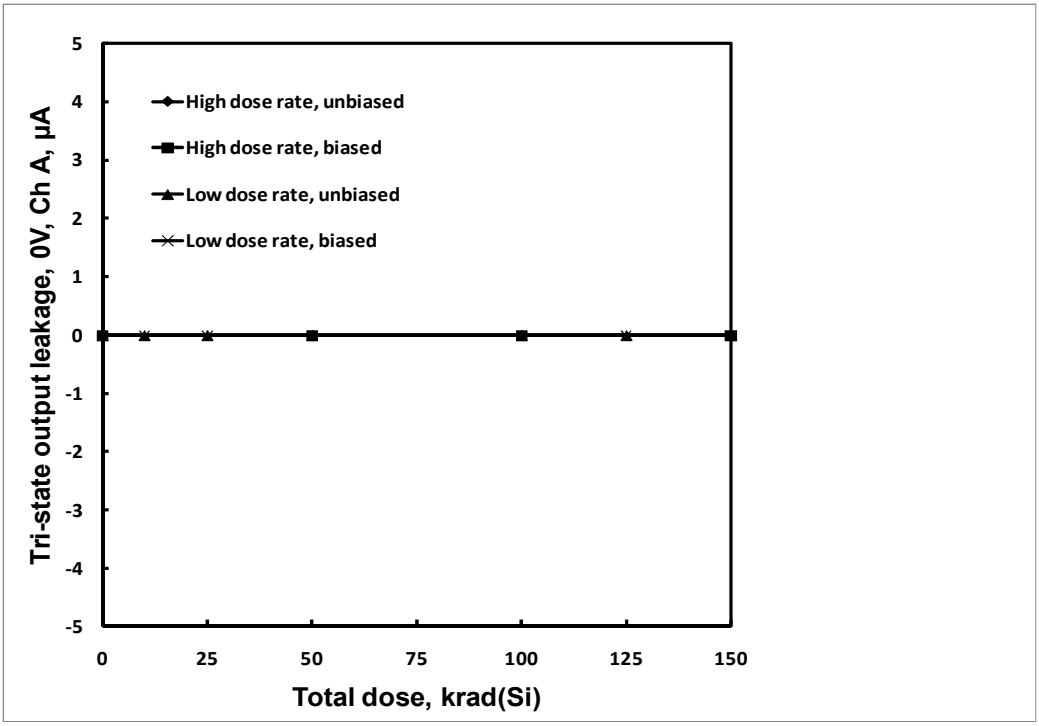


Figure 37: HS-26CT31RH tri-state output leakage current at 0V, channel A, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limits are -5µA to 5µA. Channels B, C and D and complementary output channels A, B, C and D showed identical results.

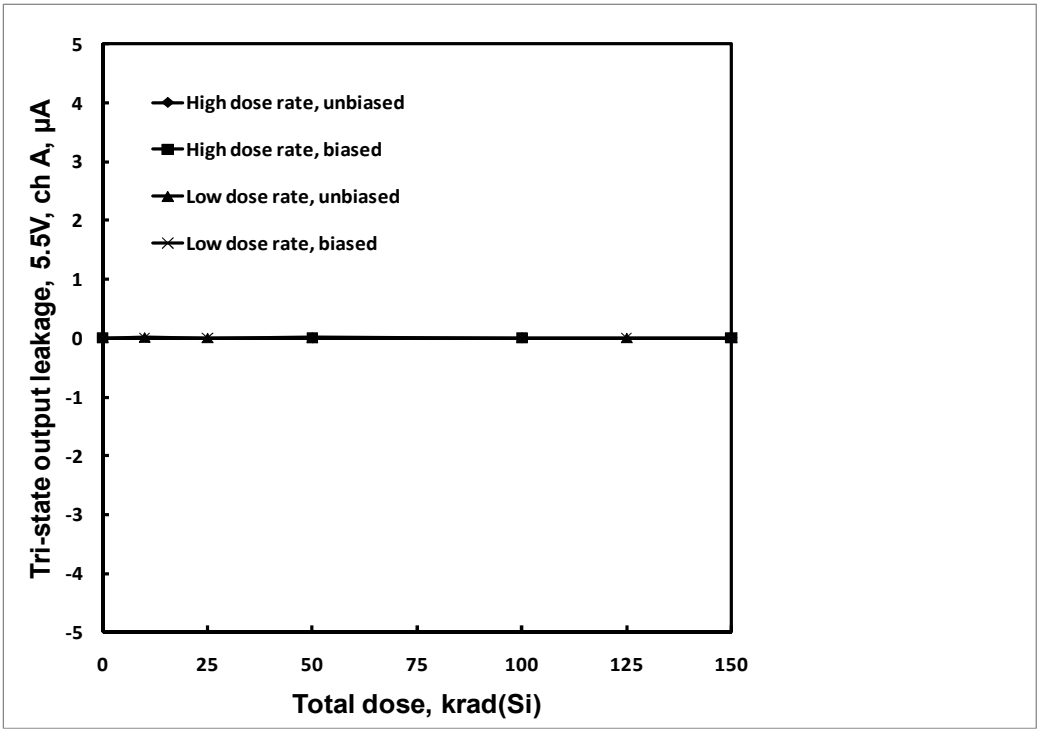


Figure 38: HS-26CT31RH tri-state output leakage current at 5.5V, channel A, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limits are -5µA to 5µA. Channels B, C and D and complementary output channels A, B, C and D showed identical results.

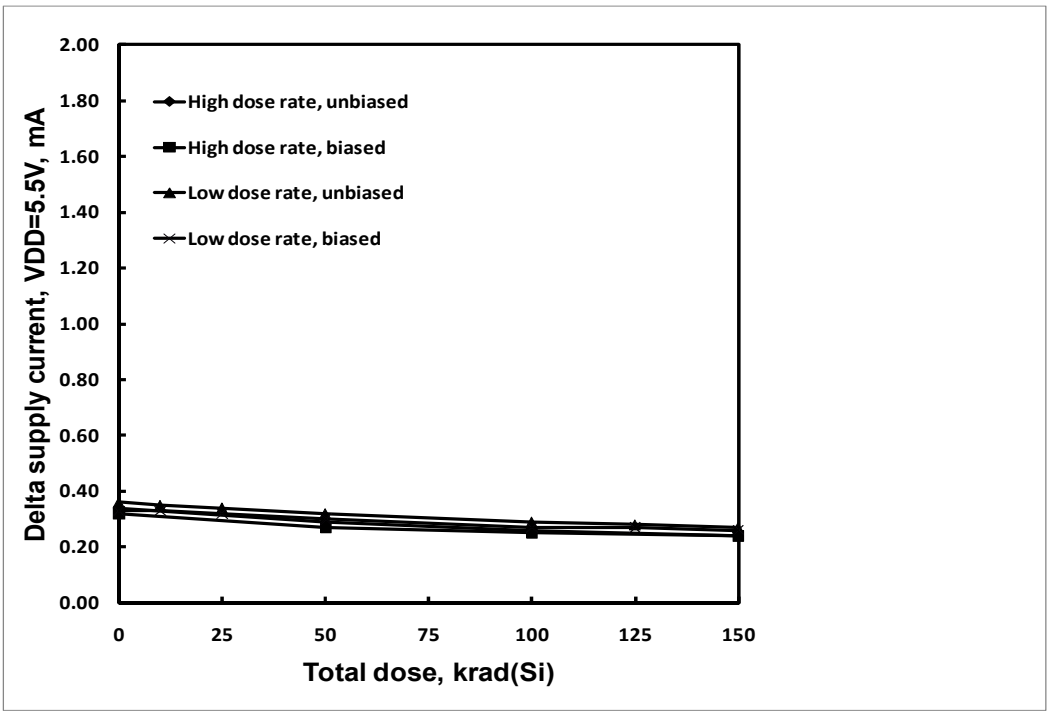


Figure 39: HS-26CT31RH delta supply current, Vin from 2.4V to 0.5V, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limit is 2mA maximum.

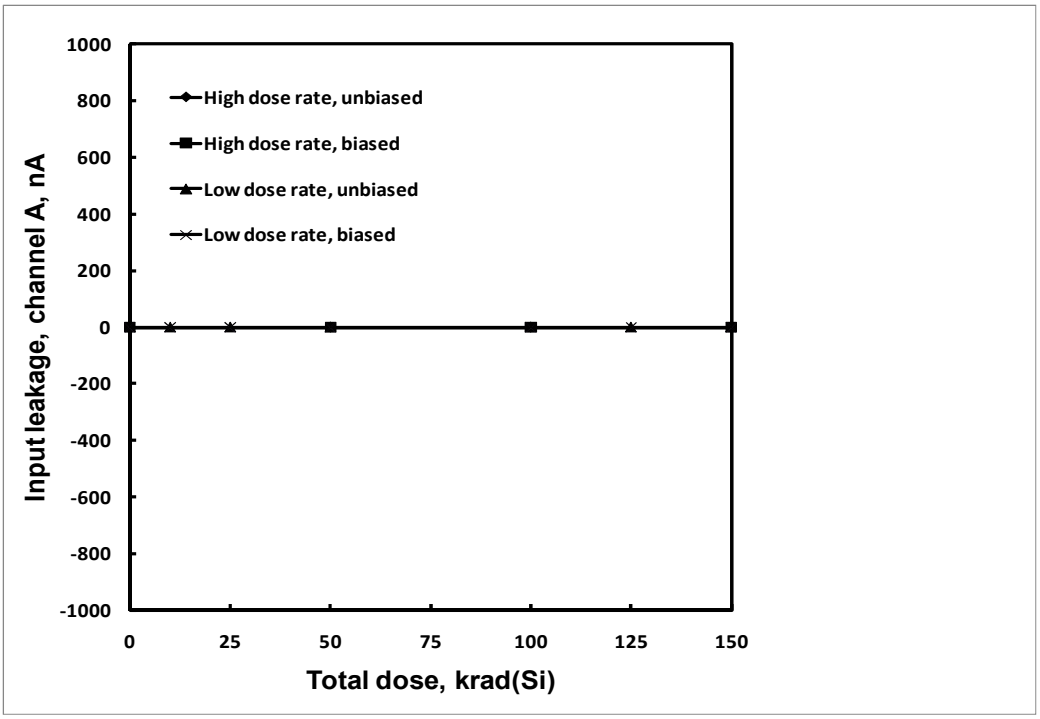


Figure 40: HS-26CT31RH input leakage, channel A, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limits are -1000nA to +1000nA.

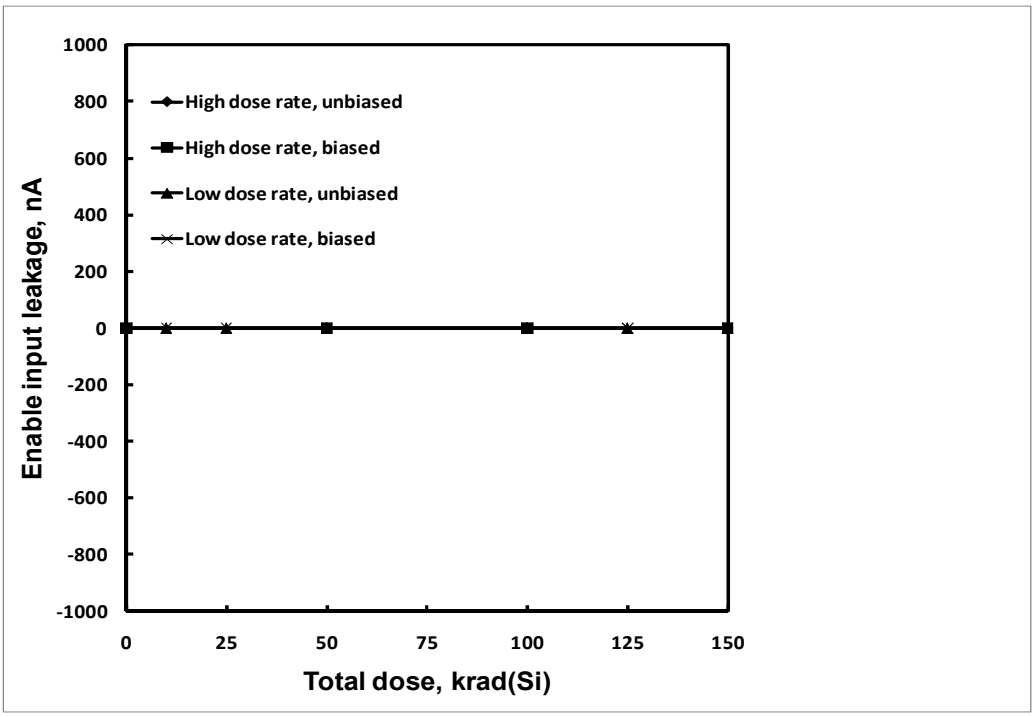


Figure 41: HS-26CT31RH input leakage, enable pin, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limits are -1000nA to +1000nA.

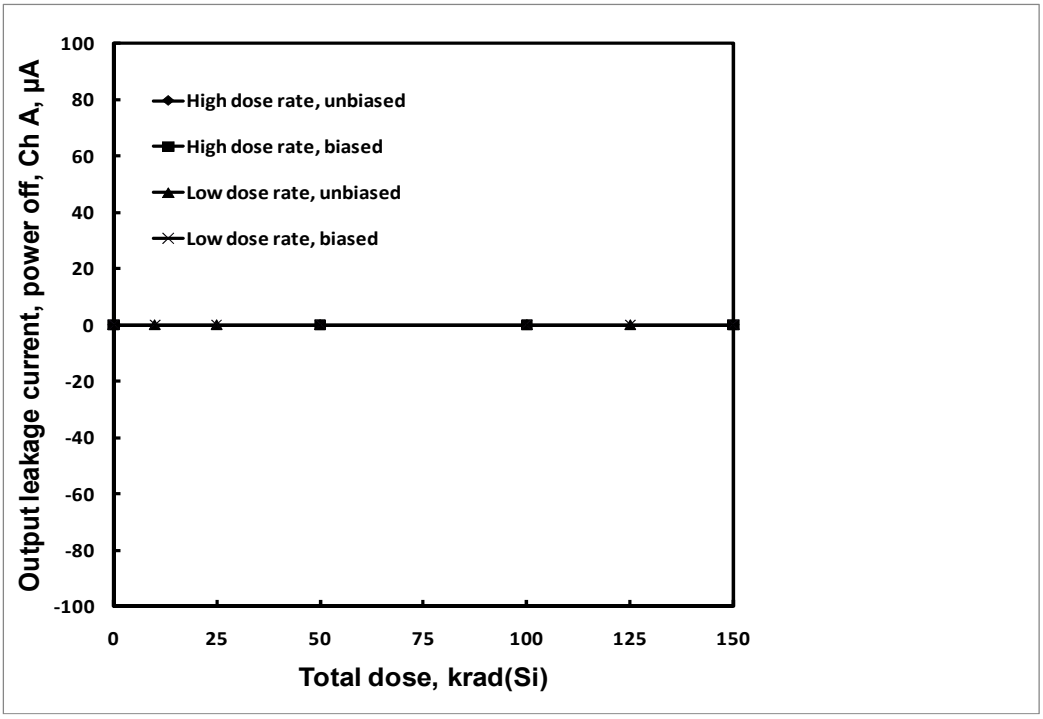


Figure 42: HS-26CT31RH output leakage current, power OFF, channel A, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limits are -100µA to +100µA. Channels B, C and D and complementary output channels A, B, C and D showed identical results.

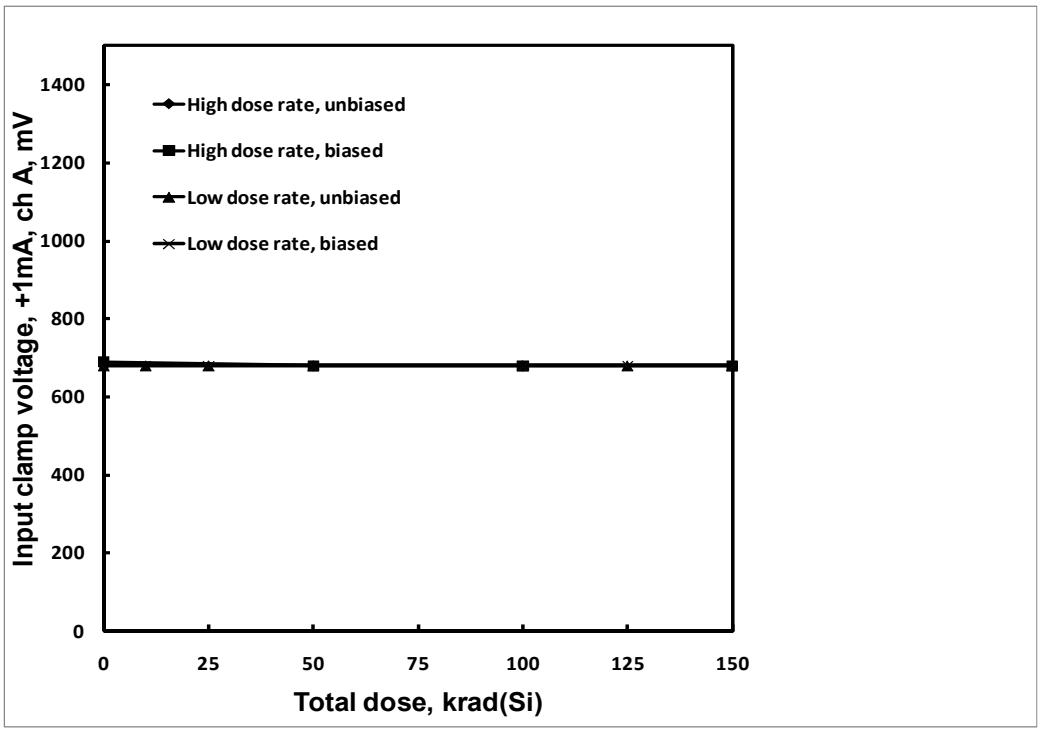


Figure 43: HS-26CT31RH input clamp voltage, +1mA, channel A, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limit is +1500mV maximum. Channels B, C and D and complementary output channels A, B, C and D showed identical results.

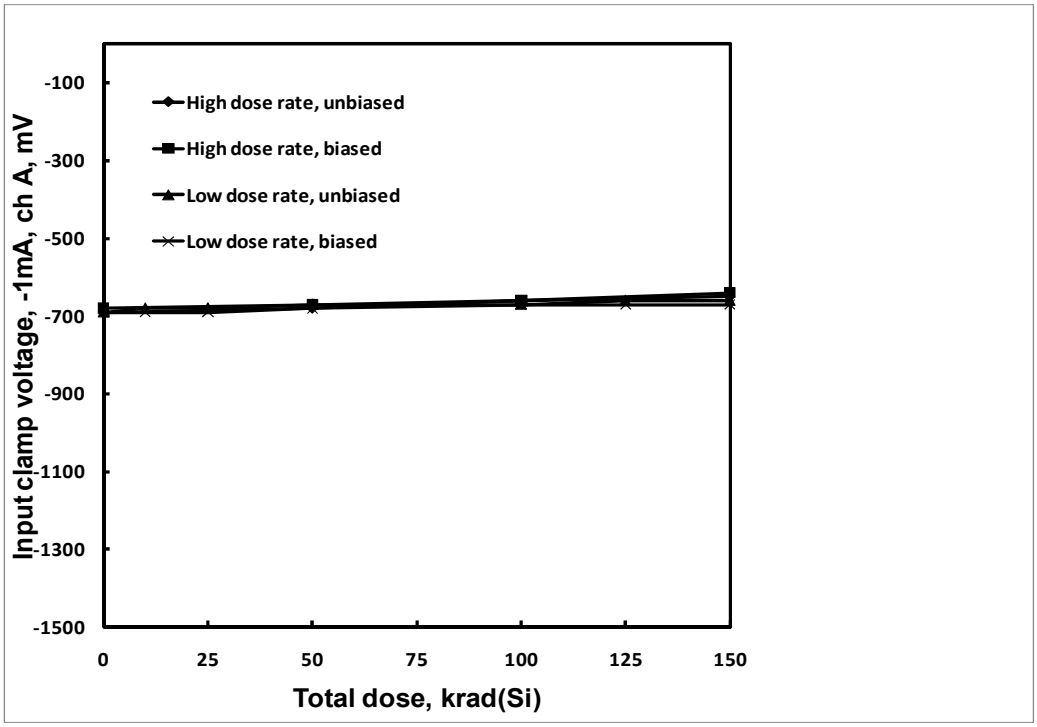


Figure 44: HS-26CT31RH input clamp voltage, -1mA, channel A, as a function of total dose irradiation at low and high dose rate for the unbiased and biased cases. The post-irradiation SMD limit is -1500mV maximum. Channels B, C and D and complementary output channels A, B, C and D showed identical results.

6: Conclusion

This document reports results of a total dose test of the HS-26CT31RH quad differential line driver. Parts were tested at low and high dose rate under biased and unbiased conditions as outlined in MIL-STD-883 Test Method 1019.7, to a maximum total dose of 150krad(Si).

Testing at both dose rates to 150krad(Si) of the HS-26CT31RH is complete and showed no reject devices after irradiation to 150krad(Si), screening to the SMD pre- and post-irradiation limits. The part is considered ELDRS-free up to 150krad(Si). No bias sensitivity was noted.

7: Appendices

7.1: Reported parameters.

Figure	Parameter	Limit, low	Limit, high	Units	Notes
3	High level output voltage	2.5		V	Channel A
4	High level output voltage	2.5		V	Channel B
5	High level output voltage	2.5		V	Channel C
6	High level output voltage	2.5		V	Channel D
7	Low level output voltage		0.5	V	Channel A
8	Low level output voltage		0.5	V	Channel B
9	Low level output voltage		0.5	V	Channel C
10	Low level output voltage		0.5	V	Channel D
11	Differential output voltage, VT	2.0			Channel A
12	Differential output voltage, VT	2.0			Channel B
13	Differential output voltage, VT	2.0			Channel C
14	Differential output voltage, VT	2.0			Channel D
15	Differential output voltage, VT(bar)	2.0			Channel A
16	Differential output voltage, VT(bar)	2.0			Channel B
17	Differential output voltage, VT(bar)	2.0			Channel C
18	Differential output voltage, VT(bar)	2.0			Channel D
19	Differential output voltage match	-400	+400	mV	Channel A
20	Differential output voltage match	-400	+400	mV	Channel B
21	Differential output voltage match	-400	+400	mV	Channel C
22	Differential output voltage match	-400	+400	mV	Channel D
23	Common mode output voltage, VT		3.0	V	Channel A
24	Common mode output voltage, VT		3.0	V	Channel B
25	Common mode output voltage, VT		3.0	V	Channel C
26	Common mode output voltage, VT		3.0	V	Channel D
27	CM output voltage, VT(bar)		3.0	V	Channel A
28	CM output voltage, VT(bar)		3.0	V	Channel B
29	CM output voltage, VT(bar)		3.0	V	Channel C
30	CM output voltage, VT(bar)		3.0	V	Channel D

31	CM output voltage match		400	mV	Channel A
32	CM output voltage match		400	mV	Channel B
33	CM output voltage match		400	mV	Channel C
34	CM output voltage match		400	mV	Channel D
35	Standby supply current		500	µA	Vin = VDD
36	Standby supply current		500	µA	Vin = GND
37	Tri-state output leakage		5.0	µA	0V
38	Tri-state output leakage		5.0	µA	5.5V
39	Delta supply current		2.0	mA	0.5V to 2.4V
40	Input leakage, Channel A		1.0	µA	
41	Input leakage, ENABLE		1.0	µA	
42	Output leakage, power off	-100	+100	µA	
43	Input clamp voltage		+1.5	V	+1.0mA
44	Input clamp voltage		-1.5	V	-1.0mA

Note 1: Limits are taken from Standard Microcircuit Drawing (SMD) 5962-95632.

8: Document revision history

Revision	Date	Pages	Comments
0	4 August 2010	All	Original issue