ISL70218SEH

Total Dose Testing

Introduction

This document reports the results of low and high dose rate total dose testing of the ISL70218SEH dual operational amplifier (op amp). The test was conducted to provide an assessment of the total dose hardness of the ISL70218SEH. Samples were irradiated under bias and with all pins grounded.

The ISL70218SEH is available in two versions differing in total ionizing dose acceptance testing. The ISL70218SEH is acceptance tested on a wafer-by-wafer basis to 50krad(Si) at Low Dose Rate (LDR) (0.01rad(Si)/s) and to 100krad(Si) at High Dose Rate (HDR) (50 – 300rad(Si)/s). The ISL70218SRH is acceptance tested on a wafer by wafer basis to 100krad(Si) at HDR (50 – 300rad(Si)/s) only. The “EH” and “RH” devices use the same design and silicon and differ in screening flows only.

Related Literature

For a full list of related documents, visit our website:

- ISL70218SEH device page
- MIL-STD-883 Test Method 1019

Part Description

The ISL70218SEH is a low-power precision dual op amp optimized for single-supply applications. The part features a common mode input voltage range extending to 0.5V below the negative supply rail, rail-to-rail differential input voltage range, and rail-to-rail output voltage swing, which makes it ideal for single-supply applications where input operation at ground is important. The ISL70218SEH features low power, low offset voltage, and low temperature drift, making it ideal for applications requiring both high DC accuracy and AC performance.

The ISL70218SEH is designed to operate over a single supply range of 3V to 36V or a split supply voltage range of +1.8V/-1.2V to ±18V. Applications include precision instrumentation, data acquisition, and precision power supply controls. The ISL70218SEH is available in a 10 Ld hermetic ceramic flatpack and operates across the extended temperature range of -55°C to +125°C.

1. Test Description

1.1 Irradiation Facilities

LDR gamma ray testing was performed at 0.01rad(Si)/s using the Renesas Electronics America Palm Bay panoramic irradiator. HDR gamma ray testing was performed at 65rad(Si)/s using a Gammacell 220 irradiator located in the Renesas Palm Bay, Florida facility.

1.2 Test Fixturing

Figure 1 shows the configuration used for biased irradiation.

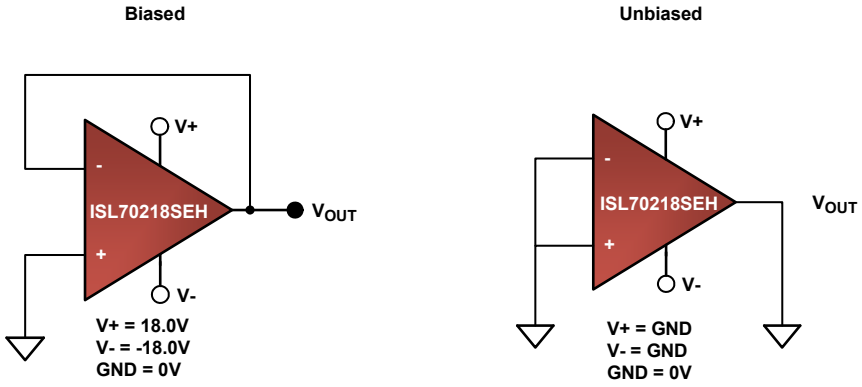

Figure 1. Irradiation Bias Configuration for the ISL70218SEH per SMD 5962-12222.

1.3 Characterization Equipment and Procedures

All electrical testing was performed outside the irradiator using production Automated Test Equipment (ATE) with datalogging at each downpoint. Downpoint electrical testing was performed at room temperature.

1.4 Experimental Matrix

Total dose irradiation proceeded in accordance with the guidelines of MIL-STD-883 Test Method 1019. The experimental matrix consisted of four samples irradiated at LDR under bias, four samples irradiated at LDR with all pins grounded, and four samples irradiated at HDR under bias.

Samples of the ISL70218SEH were drawn from preproduction lots WLH4WAAAA and WLH4WAAB and were packaged in the production 10 Ld solder-sealed flatpack (CDFP3-F10). Samples were processed through the standard burnin cycle before irradiation, as required by MIL-STD-883, and were screened to the ATE limits at room temperature prior to the test.

1.5 Downpoints

Downpoints for the LDR tests were 0, 50, 100, and 150krad(Si). Downpoints for the HDR test were 0 and 100krad(Si).

2. Attributes Data

Table 1. ISL70218SEH Total Dose Test Attributes Data

Part	Dose Rate (Note 1)	Bias	Sample Size	Downpoint	Pass (Note 2)	Rejects
ISL70218SEH	LDR	Biased	4	Pre-irradiation	4	0
				50krad(Si)	4	0
				100krad(Si)	4	0
				150krad(Si)	4	0

Table 1. ISL70218SEH Total Dose Test Attributes Data (Continued)

Part	Dose Rate (Note 1)	Bias	Sample Size	Downpoint	Pass (Note 2)	Rejects
ISL70218SEH	LDR	Grounded	4	Pre-irradiation	4	0
				50krad(Si)	4	0
				100krad(Si)	4	0
				150krad(Si)	4	0
ISL70218SEH	HDR	Biased	4	Pre-irradiation	4	0
				100krad(Si)	4	0

Notes:
1. 'HDR' indicates high dose rate and 'LDR' indicates low dose rate.
2. 'Pass' indicates a sample that passes all post-irradiation SMD limits.

2.1 Variables Data

The plots in Figures 2 through 20 show variables data. The plots show the median and minimum/maximum error bars of key parameters at each downpoint. We chose to plot the median for these parameters due to the small sample sizes of four per experimental cell. A discussion of each parameter's total dose response is presented in "Discussion and Conclusion" on page 13.

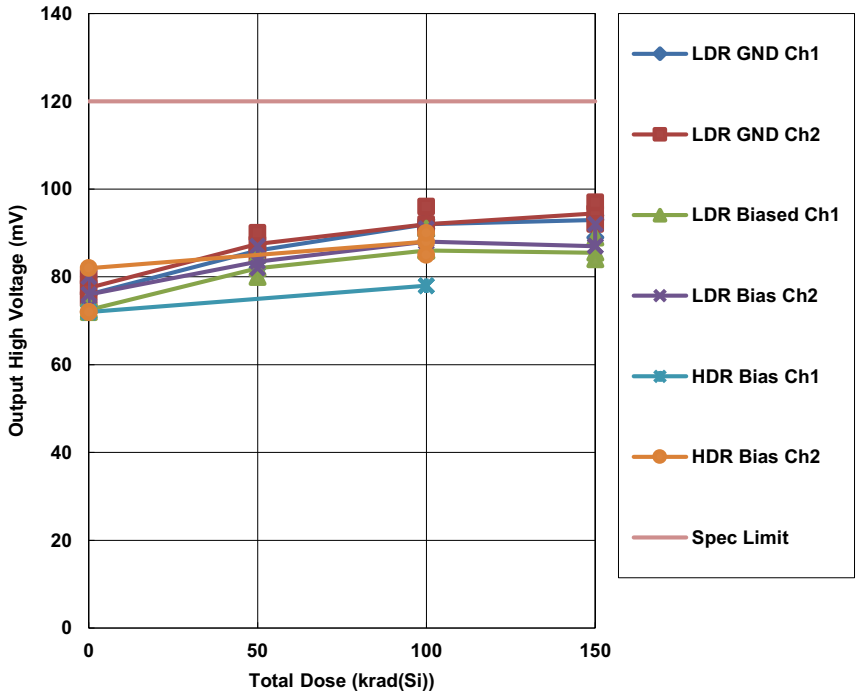

Figure 2. ISL70218SEH output high voltage (see "Discussion and Conclusion" on page 13 for a definition), Channels 1 and 2, as a function of total dose irradiation at LDR (biased and unbiased) and at HDR (biased only). The dose rate was 0.01rad(Si)/s for LDR irradiation and 65rad(Si)/s for HDR irradiation. Sample sizes for all three cells were four. The post-irradiation SMD limit is 120mV maximum.

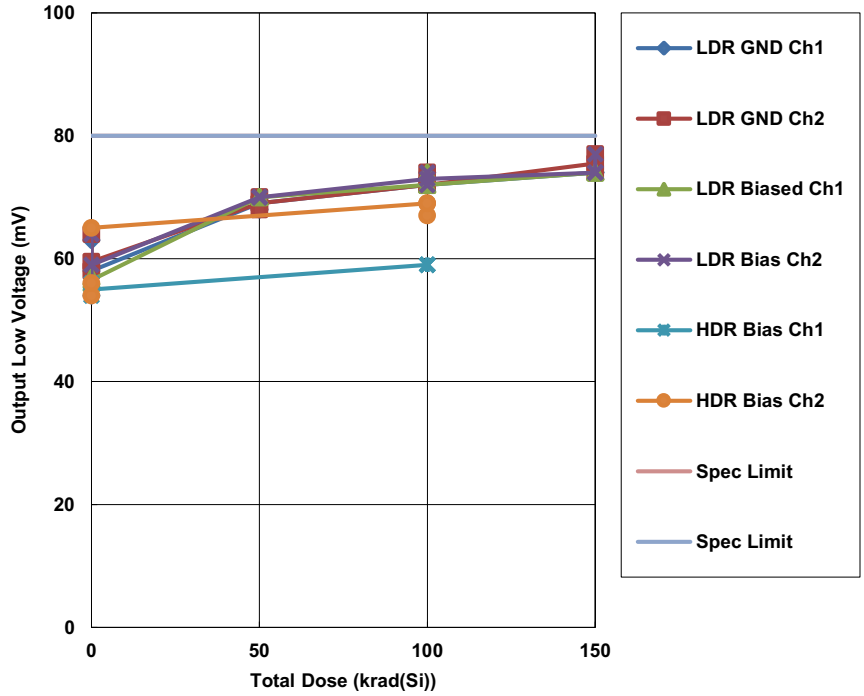

Figure 3. ISL70218SEH output low voltage (see "Discussion and Conclusion" on page 13), Channels 1 and 2, as a function of total dose irradiation at LDR (biased and unbiased) and at HDR (biased only). The dose rate was 0.01rad(Si)/s for LDR irradiation and 65rad(Si)/s for HDR irradiation. Sample sizes for all three cells were four. The post-irradiation SMD limit is 80mV maximum.

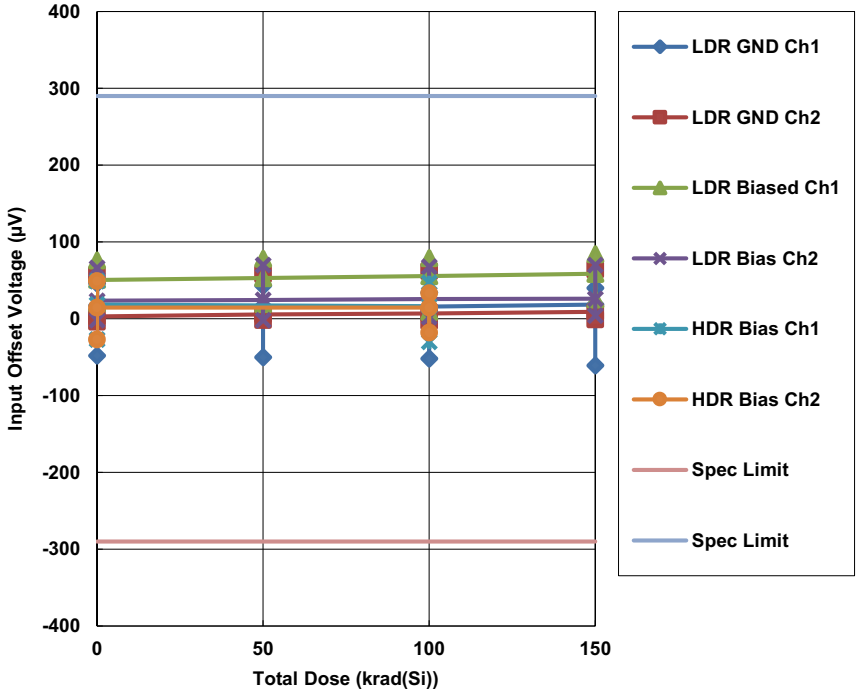

Figure 4. ISL70218SEH input offset voltage, Channels 1 and 2, as a function of total dose irradiation at LDR (biased and unbiased) and at HDR (biased only). The dose rate was 0.01rad(Si)/s for LDR irradiation and 65rad(Si)/s for HDR irradiation. Sample sizes for all three cells were four. The post-irradiation SMD limits are -290µV to 290µV.

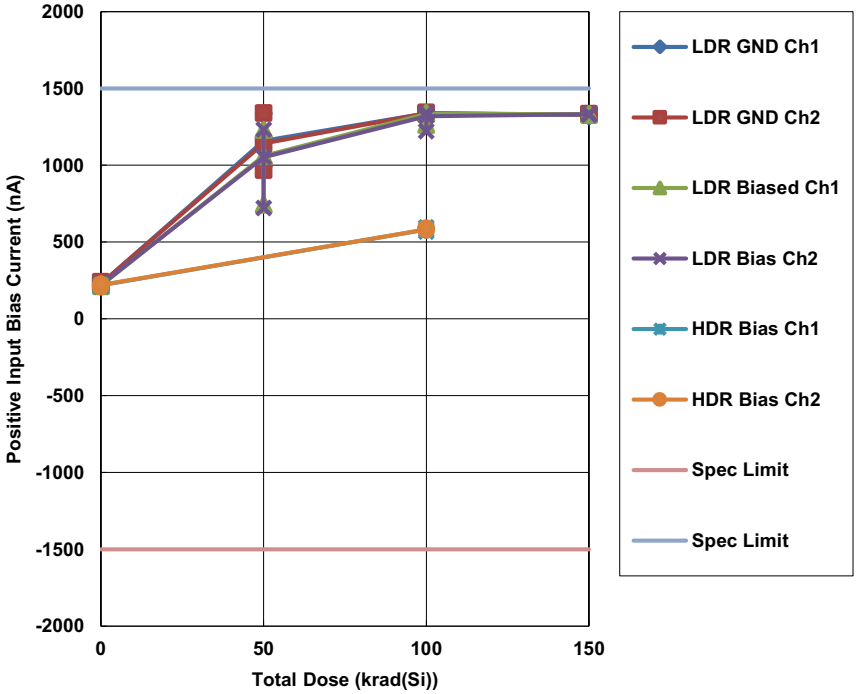

Figure 5. ISL70218SEH positive input bias current, Channels 1 and 2, as a function of total dose irradiation at LDR (biased and unbiased) and at HDR (biased only). The dose rate was 0.01rad(Si)/s for LDR irradiation and 65rad(Si)/s for HDR irradiation. Sample sizes for all three cells were four. The post-irradiation SMD limits are -1500nA to 1500nA.

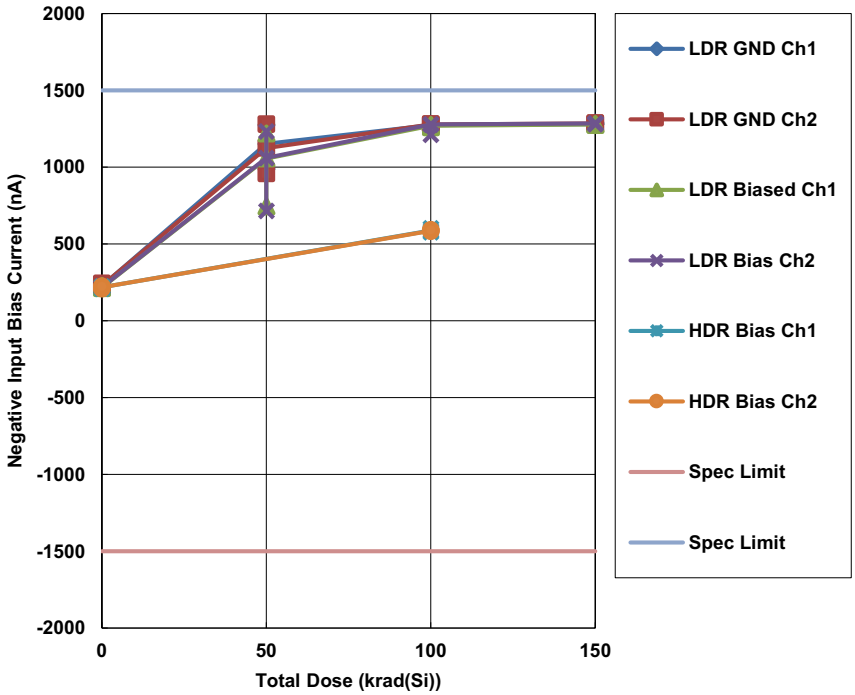

Figure 6. ISL70218SEH negative input bias current, Channels 1 and 2, as a function of total dose irradiation at LDR (biased and unbiased) and at HDR (biased only). The dose rate was 0.01rad(Si)/s for LDR irradiation and 65rad(Si)/s for HDR irradiation. Sample sizes for all three cells were four. The post-irradiation SMD limits are -1500nA to 1500nA.

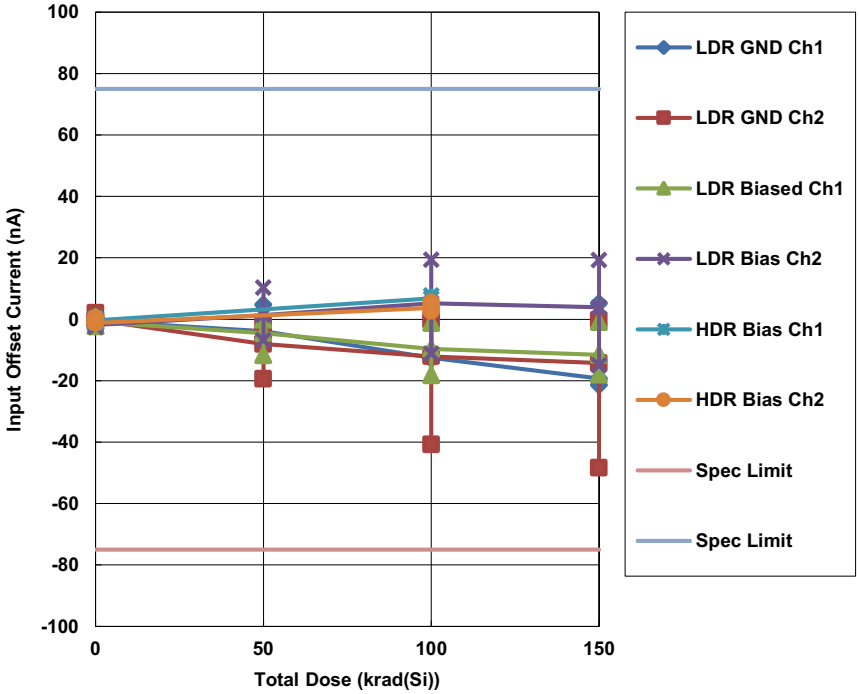

Figure 7. ISL70218SEH input offset current, Channels 1 and 2, as a function of total dose irradiation at LDR (biased and unbiased) and at HDR (biased only). The dose rate was 0.01rad(Si)/s for LDR irradiation and 65rad(Si)/s for HDR irradiation. Sample sizes for all three cells were four. The post-irradiation SMD limits are -75nA to 75nA.

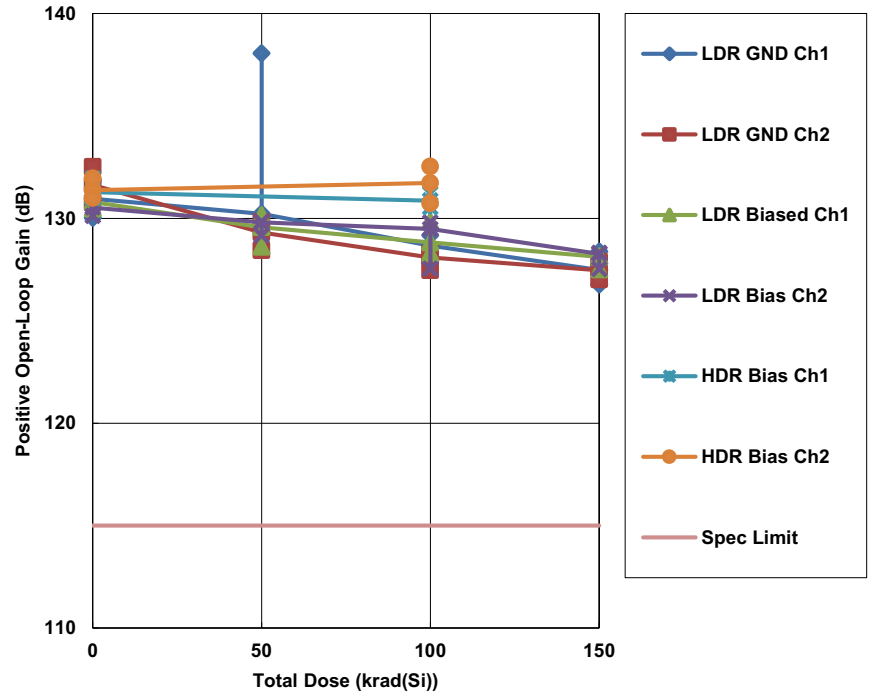

Figure 8. ISL70218SEH positive open-loop gain, Channels 1 and 2, as a function of total dose irradiation at LDR (biased and unbiased) and at HDR (biased only). The dose rate was 0.01rad(Si)/s for LDR irradiation and 65rad(Si)/s for HDR irradiation. Sample sizes for all three cells were four. The post-irradiation SMD limit is 115dB minimum.

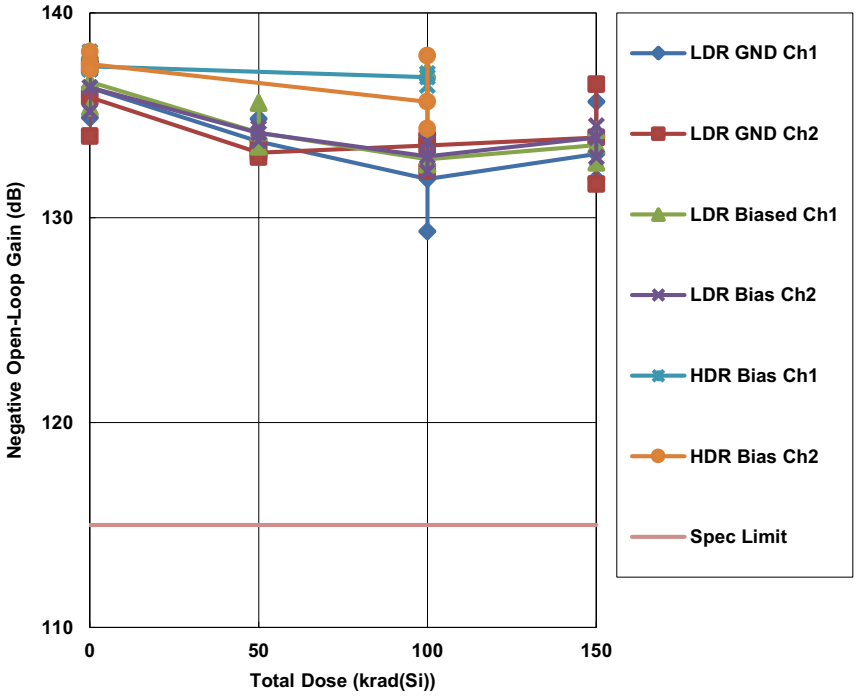

Figure 9. ISL70218SEH negative open-loop gain, Channels 1 and 2, as a function of total dose irradiation at LDR (biased and unbiased) and at HDR (biased only). The dose rate was 0.01rad(Si)/s for LDR irradiation and 65rad(Si)/s for HDR irradiation. Sample sizes for all three cells were four. The post-irradiation SMD limit is 115dB minimum.

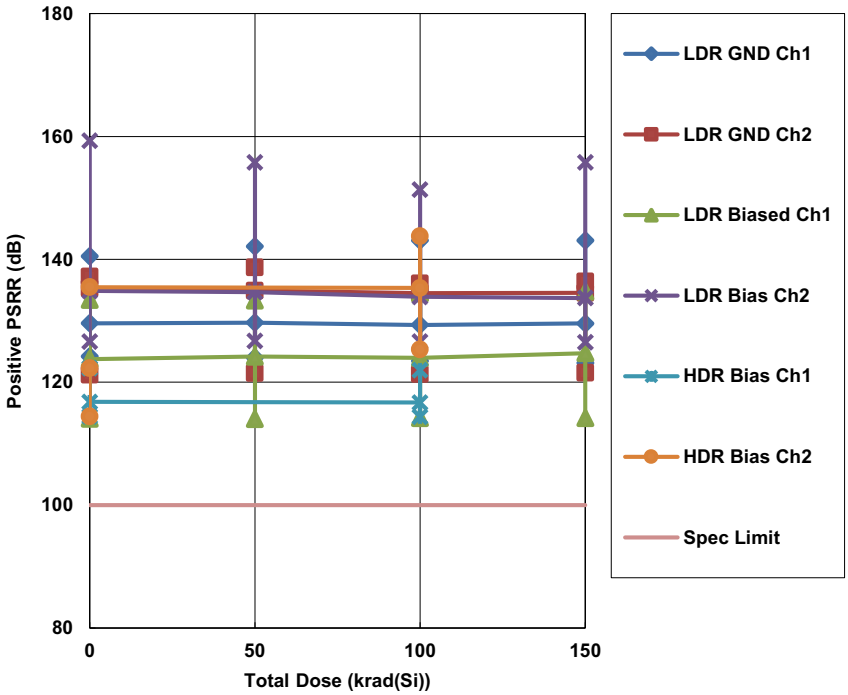

Figure 10. ISL70218SEH positive power supply rejection ratio, Channels 1 and 2, as a function of total dose irradiation at LDR (biased and unbiased) and at HDR (biased only). The dose rate was 0.01rad(Si)/s for LDR irradiation and 65rad(Si)/s for HDR irradiation. Sample sizes for all three cells were four. The post-irradiation SMD limit is 100dB minimum.

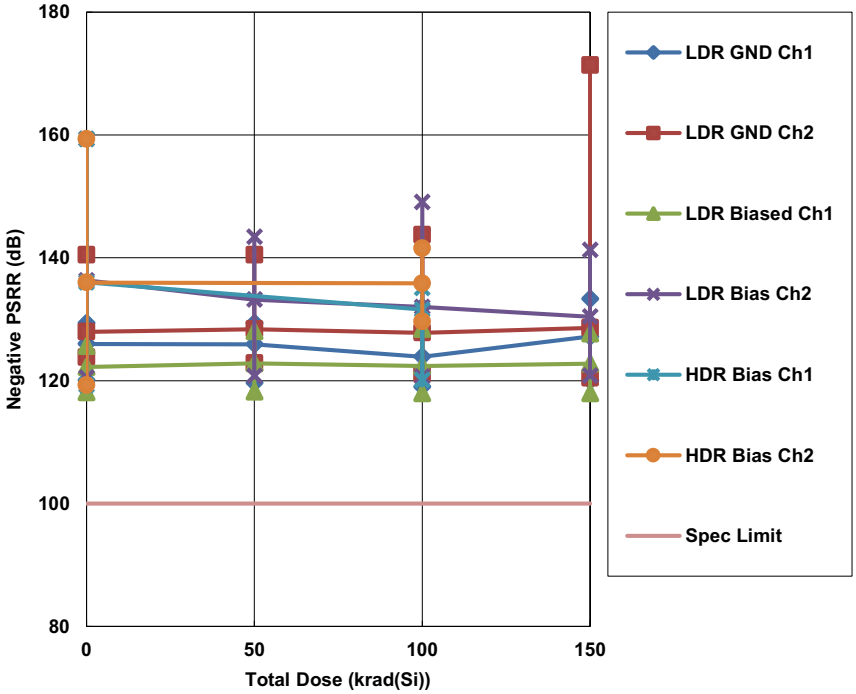

Figure 11. ISL70218SEH negative power supply rejection ratio, Channels 1 and 2, as a function of total dose irradiation at LDR (biased and unbiased) and at HDR (biased only). The dose rate was 0.01rad(Si)/s for LDR irradiation and 65rad(Si)/s for HDR irradiation. Sample sizes for all three cells were four. The post-irradiation SMD limit is 100dB minimum.

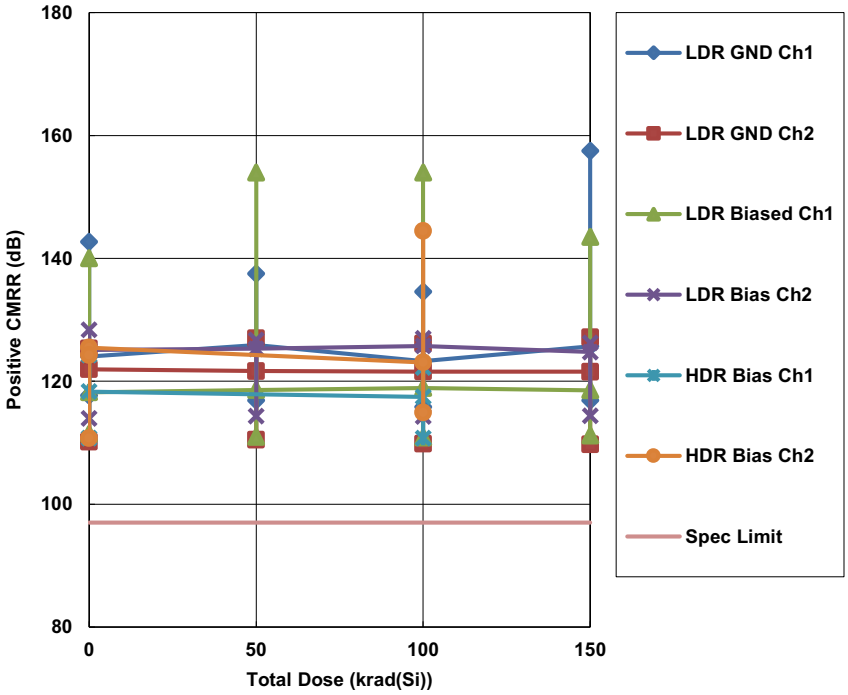

Figure 12. ISL70218SEH positive common-mode rejection ratio, Channels 1 and 2, as a function of total dose irradiation at LDR (biased and unbiased) and at HDR (biased only). The dose rate was 0.01rad(Si)/s for LDR irradiation and 65rad(Si)/s for HDR irradiation. Sample sizes for all three cells were four. The post-irradiation SMD limit is 97dB minimum.

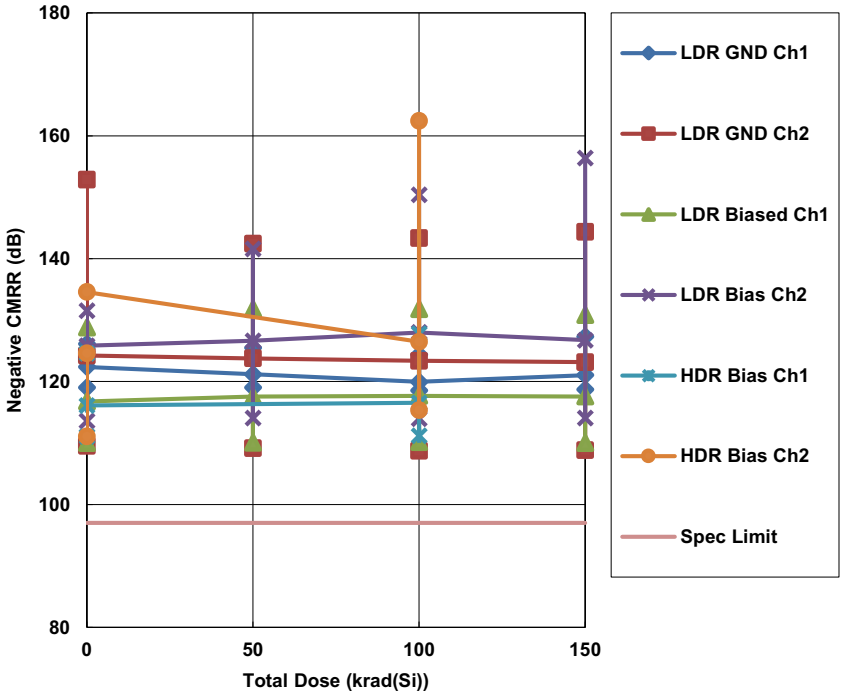

Figure 13. ISL70218SEH negative common-mode rejection ratio, Channels 1 and 2, as a function of total dose irradiation at LDR (biased and unbiased) and at HDR (biased only). The dose rate was 0.01rad(Si)/s for LDR irradiation and 65rad(Si)/s for HDR irradiation. Sample sizes for all three cells were four. The post-irradiation SMD limit is 97dB minimum.

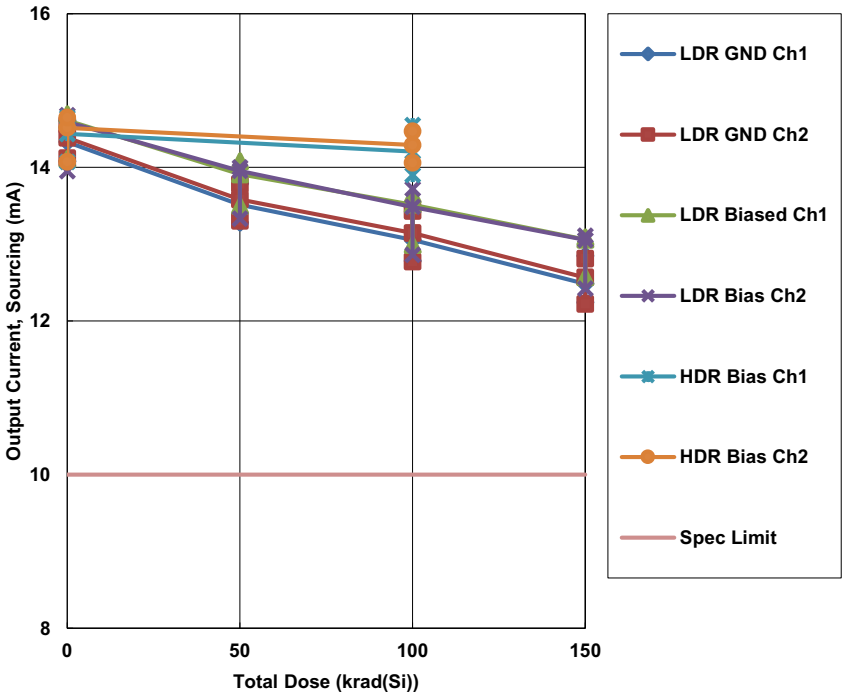

Figure 14. ISL70218SEH output current, sourcing, Channels 1 and 2, as a function of total dose irradiation at LDR (biased and unbiased) and at HDR (biased only). The dose rate was 0.01rad(Si)/s for LDR irradiation and 65rad(Si)/s for HDR irradiation. Sample sizes for all three cells were four. The post-irradiation SMD limit is 10mA minimum.

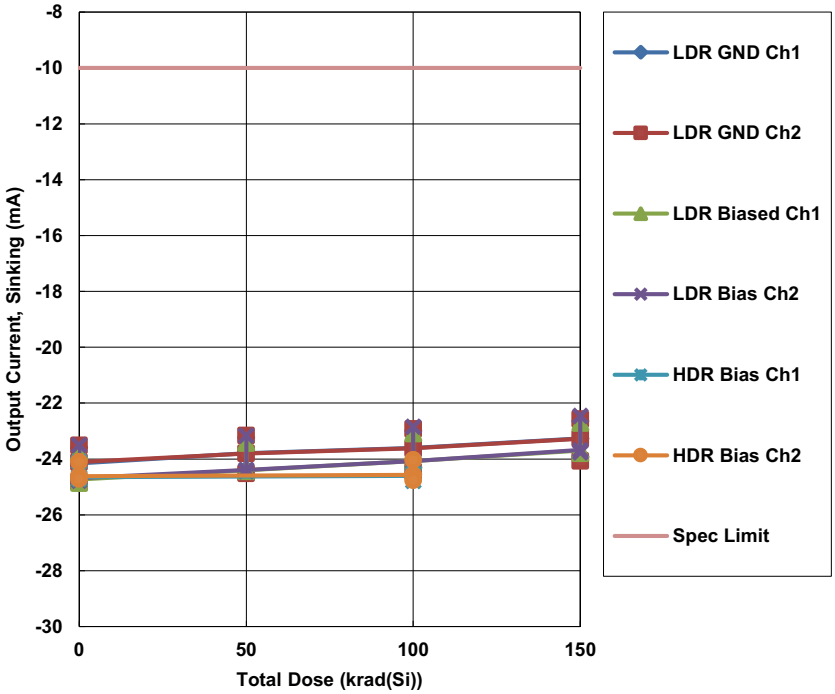

Figure 15. ISL70218SEH output current, sinking, Channels 1 and 2, as a function of total dose irradiation at LDR (biased and unbiased) and at HDR (biased only). The dose rate was 0.01rad(Si)/s for LDR irradiation and 65rad(Si)/s for HDR irradiation. Sample sizes for all three cells were four. The post-irradiation SMD limit is -10mA maximum.

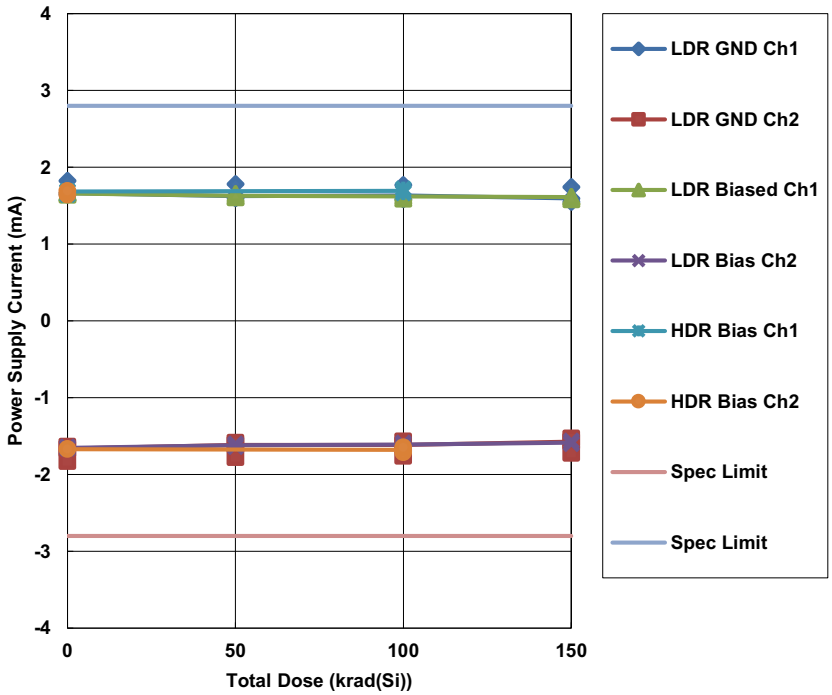

Figure 16. ISL70218SEH positive and negative supply current, Channels 1 and 2, as a function of total dose irradiation at LDR (biased and unbiased) and at HDR (biased only). The dose rate was 0.01rad(Si)/s for LDR irradiation and 65rad(Si)/s for HDR irradiation. Sample sizes for all three cells were four. The post-irradiation SMD limits are 2.8mA maximum (positive supply current) and -2.8mA maximum (negative supply current).

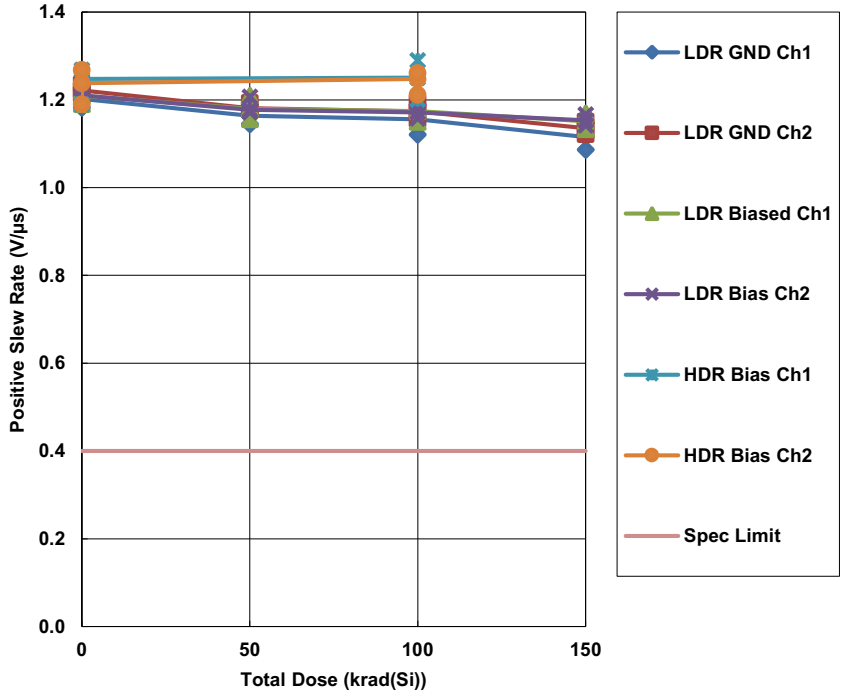

Figure 17. ISL70218SEH positive slew rate, Channels 1 and 2, as a function of total dose irradiation at LDR (biased and unbiased) and at HDR (biased only). The dose rate was 0.01rad(Si)/s for LDR irradiation and 65rad(Si)/s for HDR irradiation. Sample sizes for all three cells were four. The post-irradiation SMD limit is 0.4V/µs minimum.

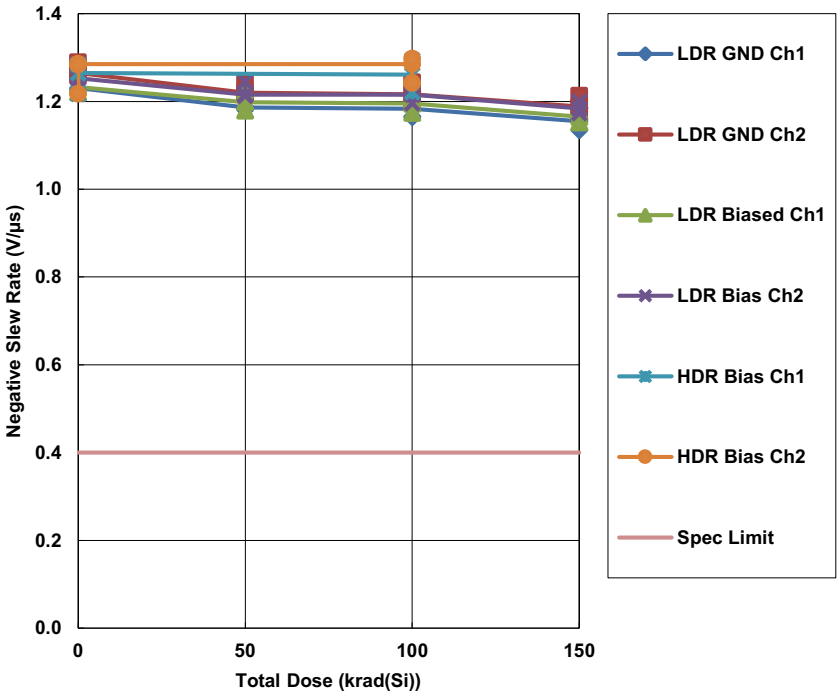

Figure 18. ISL70218SEH negative slew rate, Channels 1 and 2, as a function of total dose irradiation at LDR (biased and unbiased) and at HDR (biased only). The dose rate was 0.01rad(Si)/s for LDR irradiation and 65rad(Si)/s for HDR irradiation. Sample sizes for all three cells were four. The post-irradiation SMD limit is 0.4V/µs minimum.

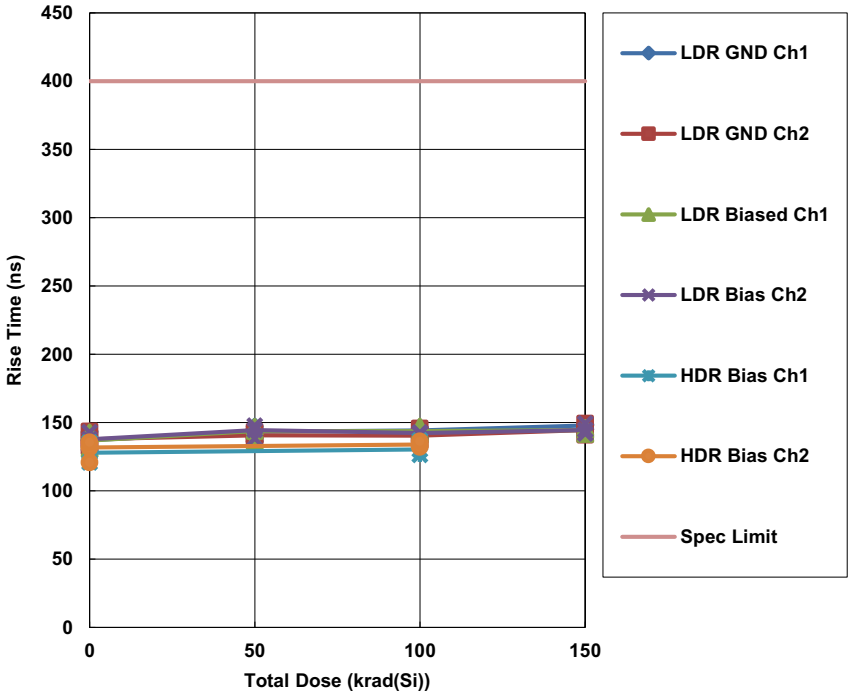

Figure 19. ISL70218SEH rise time, Channels 1 and 2, as a function of total dose irradiation at LDR (biased and unbiased) and at HDR (biased only). The dose rate was 0.01rad(Si)/s for LDR irradiation and 65rad(Si)/s for HDR irradiation. Sample sizes for all three cells were four. The post-irradiation SMD limit is 400ns maximum.

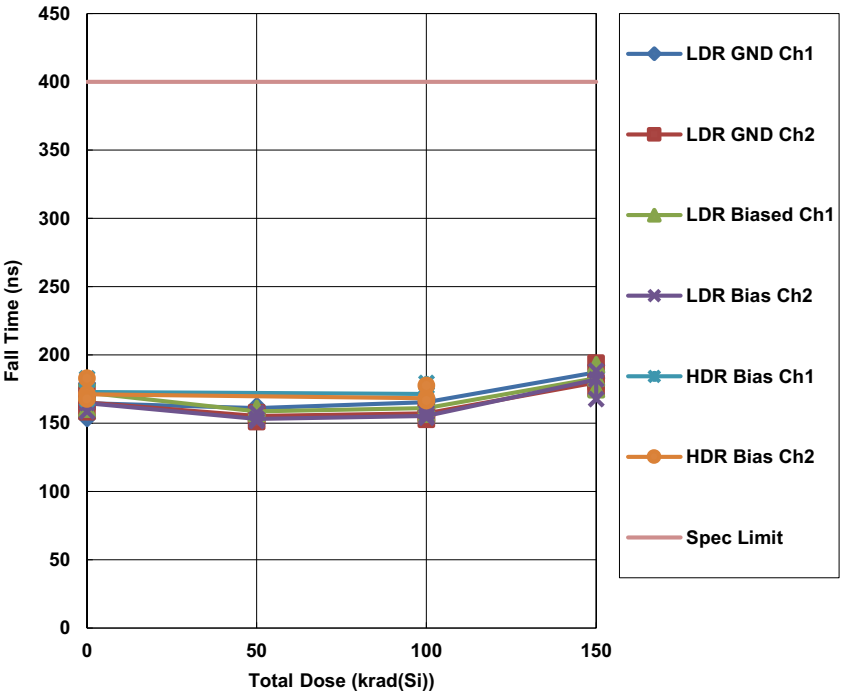

Figure 20. ISL70218SEH fall time, Channels 1 and 2, as a function of total dose irradiation at LDR (biased and unbiased) and at HDR (biased only). The dose rate was 0.01rad(Si)/s for LDR irradiation and 65rad(Si)/s for HDR irradiation. Sample sizes for all three cells were four. The post-irradiation SMD limit is 400ns maximum.

3. Discussion and Conclusion

This document reports results for the Low Dose Rate (LDR) and High Dose Rate (HDR) total dose testing of the ISL70218SEH dual operational amplifier. Parts were tested at LDR under biased and unbiased conditions and at HDR under biased conditions only at 0.01rad(Si)/s and 65rad(Si)/s, respectively. The LDR tests were run to 150krad(Si) and the HDR test was run to 100krad(Si). All parameters showed good stability out to the maximum total dose for each test.

The output HIGH and LOW voltages (Figures 2 and 3) were stable over irradiation and remained within the SMD post-irradiation limits at both dose rates. Note that this parameter provides a measure of the amplifier's ability to swing close to the rail and is not the 'LOW' and 'HIGH' voltage parameter as seen in digital parts.

The input offset voltage, positive and negative input bias current, and input offset current were stable over irradiation and remained within the SMD post-irradiation limits at both dose rates. The input offset voltage (Figure 4) and input offset current (Figure 7) were stable over LDR and HDR irradiation. The positive and negative bias current (Figures 5 and 6) showed an increase at both dose rates but remained well within the ±75nA SMD post-irradiation limit. The part is not considered LDR sensitive.

The positive and negative open-loop gain (Figures 8 and 9) showed some variation but remained well within the SMD limits.

The positive and negative power supply rejection ratio (Figures 10 and 11) and the common-mode rejection ratio (Figures 12 and 13) showed some variation but remained well within the SMD limits.

The sourcing and sinking output short circuit current (Figures 14 and 15) and the positive and negative supply currents (Figure 16) were stable over irradiation and remained within the SMD post-irradiation limits at both dose rates.

The positive and negative slew rates (Figures 17 and 18) were stable over irradiation and remained within the SMD post-irradiation limits at both dose rates, as were the rise time and fall time (Figures 19 and 20).

In conclusion, the ISL70218SEH showed good performance to the SMD low and high dose rate limits of 150krad(Si) at LDR and 100krad(Si) at HDR. The part showed no LDR sensitivity. No differences in total dose response were noted between biased and grounded LDR irradiation for any parameters. Additionally, no channel-to-channel differences were noted, either in the pre-irradiation data or in the total dose response of the parts.

4. Appendices

4.1 Reported parameters.

Table 2. ISL70218SEH Reported Parameters

Figure	Parameter	Low Limit	High Limit	Units	Notes
2	Output High Voltage	-	120	mV	Channels 1 and 2
3	Output Low Voltage	-	80	mV	Channels 1 and 2
4	Input Offset Voltage	-290	290	µV	Channels 1 and 2
5	Positive Input Bias Current	-1500	1500	nA	Channels 1 and 2
6	Negative Input Bias Current	-1500	1500	nA	Channels 1 and 2
7	Input Offset Current	-75	75	nA	Channels 1 and 2
8	Positive Open Loop Gain	115	-	dB	Channels 1 and 2
9	Negative Open Loop Gain	115	-	dB	Channels 1 and 2
10	Positive Power Supply Rejection Ratio	100	-	dB	Channels 1 and 2
11	Negative Power Supply Rejection Ratio	100	-	dB	Channels 1 and 2
12	Positive Common-Mode Rejection Ratio	97	-	dB	Channels 1 and 2
13	Positive Common-Mode Rejection Ratio	97	-	dB	Channels 1 and 2
14	Output Current, Sourcing	10	-	mA	Channels 1 and 2
15	Output Current, Sinking	-10	-	mA	Channels 1 and 2
16	Positive Supply Current	-	2.8	mA	Sum of both channels
	Negative Supply Current	-	-2.8	mA	Sum of both channels
17	Positive Slew Rate	0.4	-	V/µs	Channels 1 and 2
18	Negative Slew Rate	0.4	-	V/µs	Channels 1 and 2
19	Positive Rise Time	-	400	ns	Channels 1 and 2
20	Negative Rise Time	-	400	ns	Channels 1 and 2

5. Revision History

Rev.	Date	Description
1.00	May.14.19	Applied new formatting. Added 100krad(Si) HDR and 150krad(Si) LDR information throughout document. Updated disclaimer
0.00	Jan.10.17	Initial release

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