

Introduction

This document reports the results of low and high dose rate total dose testing of the ISL70417SEH quad operational amplifier. The tests were conducted to provide an assessment of the total dose hardness of the part. Parts were irradiated under bias and with all pins grounded at low and high dose rate. The ISL70417SEH is acceptance tested on a wafer by wafer basis to 300krad(Si) at high dose rate (50 - 300rad(Si)/s) and to 50krad(Si) at low dose rate (0.01rad(Si)/s).

Reference Documents

- MIL-STD-883 test method 1019
- ISL70417SEH data sheet ([FN7962](#))

Part Description

The ISL70417SEH is a precision quad operational amplifier featuring low noise vs power consumption characteristics, low offset voltage, low input bias current and low temperature drift, making this device the ideal choice for hardened applications requiring high DC accuracy and moderate AC performance. The ISL70417SEH is offered in a 14 lead hermetic package. Constructed with Intersil's dielectrically isolated PR40 process, this device is immune to single event latchup. The ISL70417SEH offers guaranteed performance over the full -55°C to +125°C military temperature range. Key pre- and post-radiation specifications follow.

Key Specifications

- Input offset voltage ±75µV pre, ±110µV post
- Input offset voltage TC 1.0µV/°C post maximum
- Input bias current ±1.0nA pre, ±5.0nA post
- Input bias current TC ±5pA/°C post, maximum
- Supply current, each amplifier 530µA pre, 680µA post, maximum
- Voltage noise 8nV/√Hz post, maximum
- Supply voltage range 4.5V-40V in beam (LET = 73MeV.cm²/mg)
- Operating temperature range -55°C to +125°C

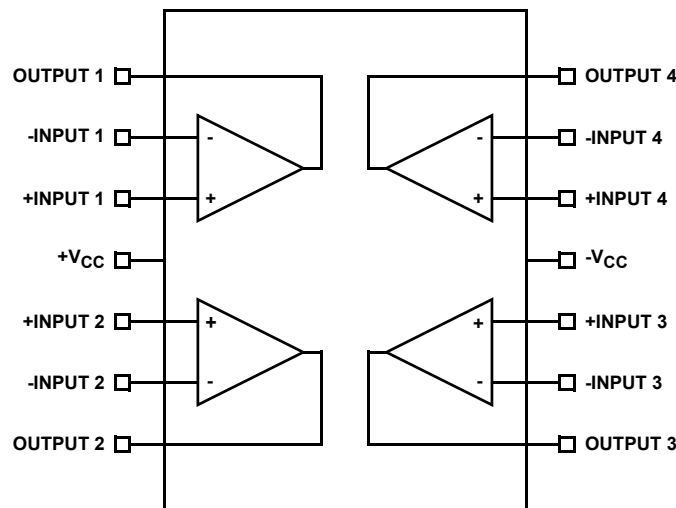


FIGURE 1. ISL70417SEH BLOCK DIAGRAM

Test Description

Irradiation Facilities

High dose rate testing was performed at 50rad(Si)/s using a Gammacell 220 ⁶⁰Co irradiator located in the Palm Bay, Florida Intersil facility. Low dose rate testing was performed at 0.01rad(Si)/s using the Intersil Palm Bay panoramic ⁶⁰Co irradiator.

Test Fixturing

Figure 2 shows the configuration used for biased irradiation.

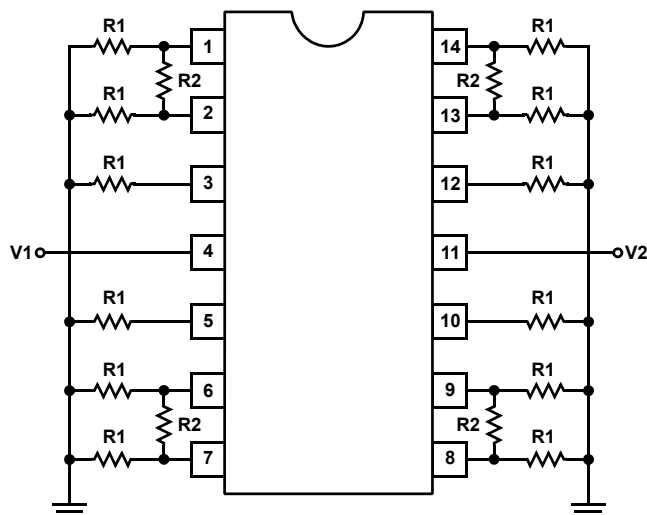


FIGURE 2. IRRADIATION BIAS CONFIGURATION FOR THE ISL70417SEH

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.

Experimental Matrix

Total dose irradiation proceeded in accordance with the guidelines of MIL-STD-883 Test Method 1019.7. The experimental matrix consisted of six samples irradiated at low dose rate under bias, six samples irradiated at low dose rate with all pins grounded, five samples irradiated at high dose rate under bias and five samples irradiated at high dose rate with all pins grounded.

Samples of the ISL70417SEH were drawn from preproduction inventory and were packaged in the hermetic 14 Ld solder-sealed flatpack (CDFP4-F14) package. 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.

Downpoints

Downpoints for the low dose rate tests were zero, 50 and 100krad(Si). Downpoints for the high dose rate tests were 0, 50, 100, 150, 200 and 300krad(Si).

Results

Test Results

Testing at low and high dose rate of the ISL70417SEH is complete.

The input offset voltage was extremely stable over both tests. The positive and negative input bias currents were stable over high dose rate irradiation, but showed an increase over low dose rate. The parameters remained within the post-irradiation specification limits but the part is considered low dose rate sensitive based on the 'delta parameter' diagnostic algorithm outlined in MIL-STD-888 test method 1019. The input offset current showed some variation at low dose rate but remained well within the Group A limits. The positive and negative open-loop gain remained stable but showed considerable variation, which is considered indicative of testing issues for this parameter and not of any effects of ⁶⁰Co irradiation. The positive and negative power supply rejection ratio and common mode rejection ratio were stable over both tests, as were the positive and negative supply currents. The positive and negative slew rates were stable.

No differences in total dose response were noted between biased and grounded 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.

Variables Data

The plots in Figures 3 through 16 show data at all downpoints. The plots show the median of key parameters as a function of low and high dose rate total dose for each of the two irradiation conditions. We chose to plot the median for these parameters due to the relatively small sample size of five or six per experimental cell.

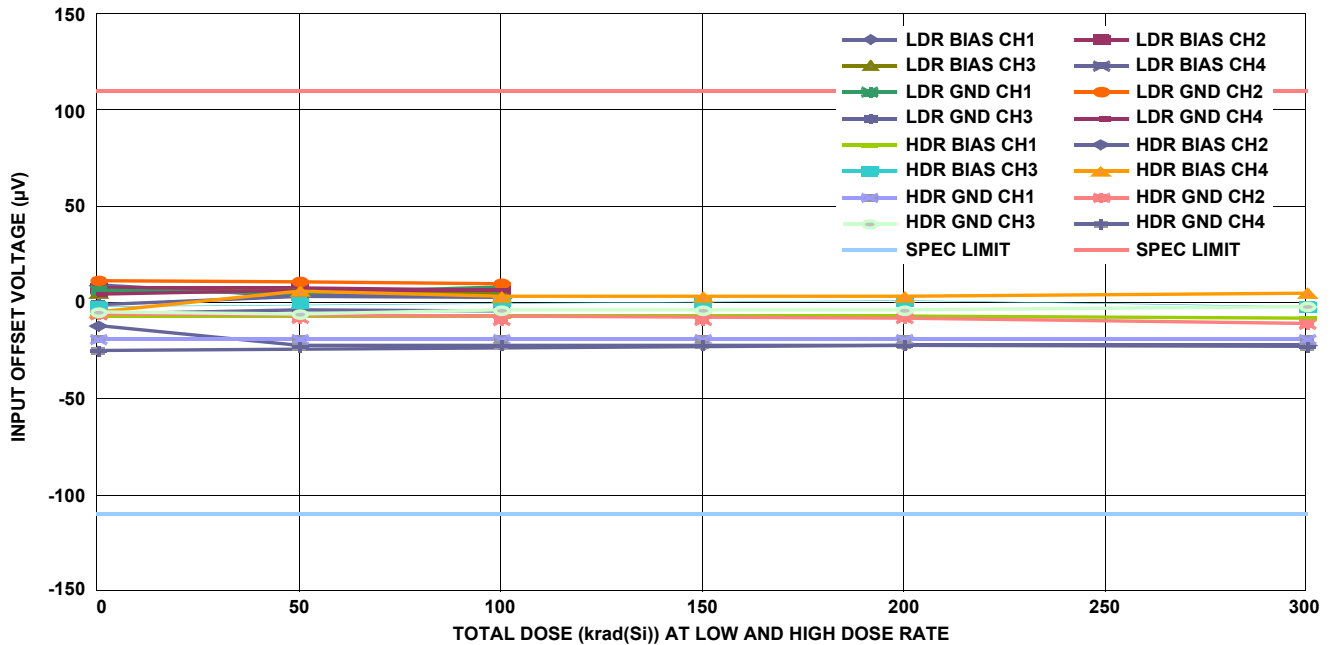


FIGURE 3. ISL70417SEH input offset voltage, channels 1 through 4, as a function of total dose irradiation at low and high dose rate for the biased (per Figure 2) and unbiased (all pins grounded) cases. The dose rate was 0.01rad(Si)/s for low dose rate irradiation and 50rad(Si)/s for high dose rate irradiation. Sample size for the low dose rate cells was 6, while the sample size for the high dose rate cells was 5. The pre-irradiation limits are -75µV to +75µV, while the post-irradiation limits are -110µV to +110µV.

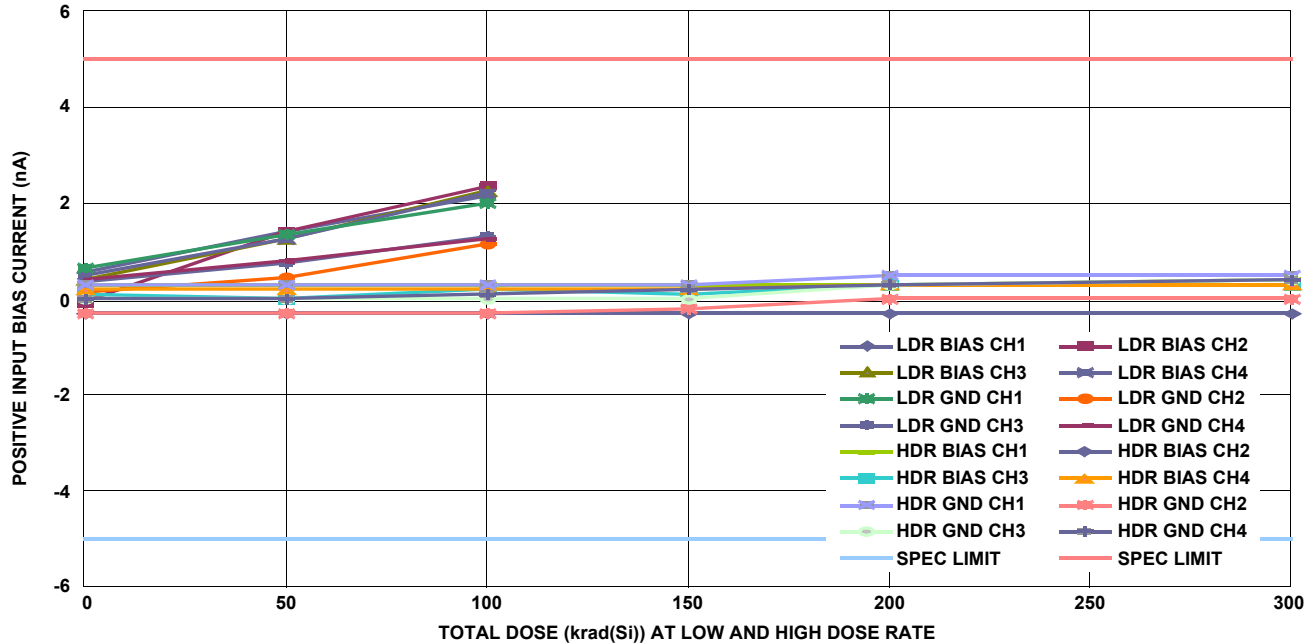


FIGURE 4. ISL70417SEH positive input bias current, channels 1 through 4, as a function of total dose irradiation at low and high dose rate for the biased (per Figure 2) and unbiased (all pins grounded) cases. The dose rate was 0.01rad(Si)/s for low dose rate irradiation and 50rad(Si)/s for high dose rate irradiation. Sample size for the low dose rate cells was 6, while the sample size for the high dose rate cells was 5. The pre-irradiation limits are -1.0nA to +1.0nA, while the post-irradiation limits are -5.0nA to +5.0nA.

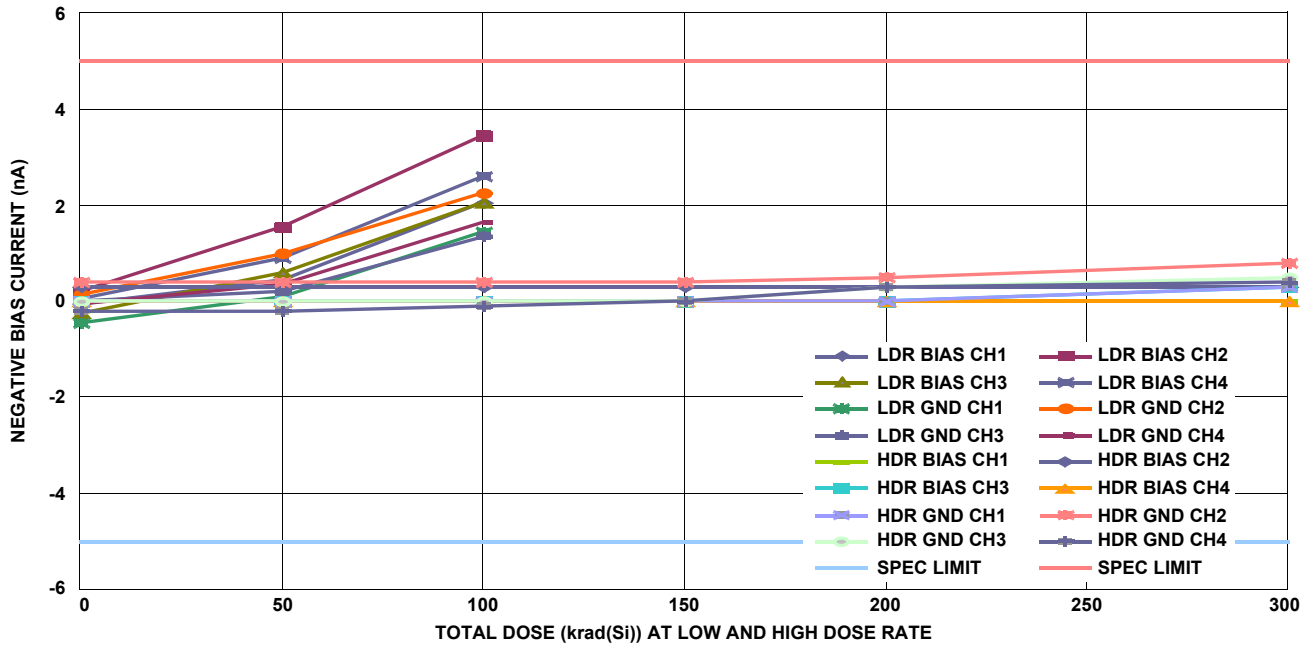


FIGURE 5. ISL70417SEH negative input bias current, channels 1 through 4, as a function of total dose irradiation at low and high dose rate for the biased (per Figure 2) and unbiased (all pins grounded) cases. The dose rate was 0.01rad(Si)/s for low dose rate irradiation and 50rad(Si)/s for high dose rate irradiation. Sample size for the low dose rate cells was 6, while the sample size for the high dose rate cells was 5. The pre-irradiation limits are -1.0nA to +1.0nA, while the post-irradiation limits are -5.0nA to +5.0nA.

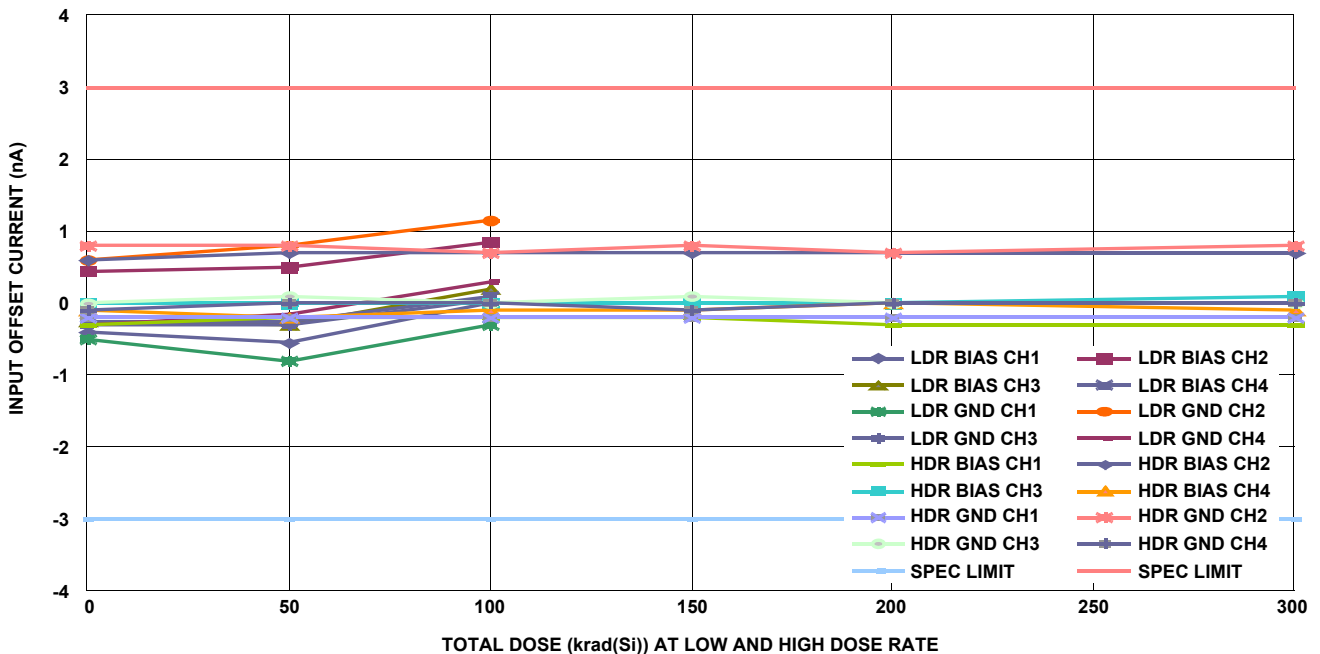


FIGURE 6. ISL70417SEH input offset current, channels 1 through 4, as a function of total dose irradiation at low and high dose rate for the biased (per Figure 2) and unbiased (all pins grounded) cases. The dose rate was 0.01rad(Si)/s for low dose rate irradiation and 50rad(Si)/s for high dose rate irradiation. Sample size for the low dose rate cells was 6, while the sample size for the high dose rate cells was 5. The pre-irradiation limits are -1.5nA to +1.5nA, while the post-irradiation limits are -3.0nA to +3.0nA.

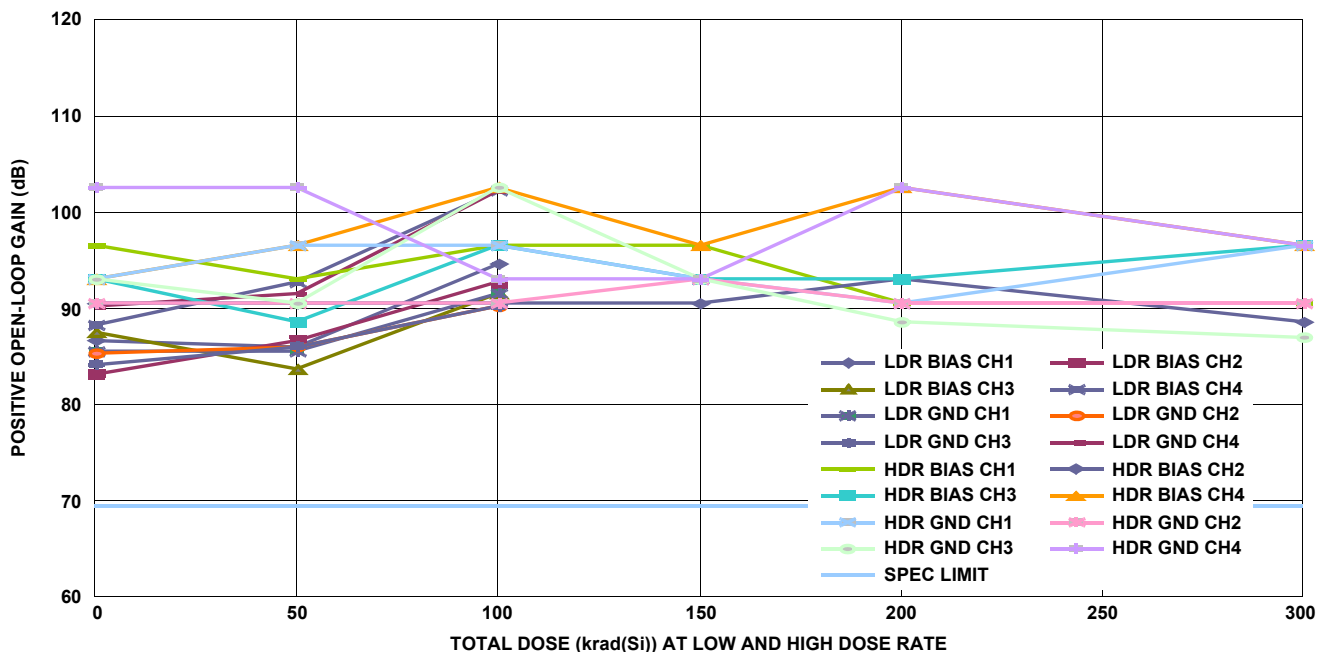


FIGURE 7. ISL70417SEH positive open-loop voltage gain, channels 1 through 4, as a function of total dose irradiation at low and high dose rate for the biased (per Figure 2) and unbiased (all pins grounded) cases. The dose rate was 0.01rad(Si)/s for low dose rate irradiation and 50rad(Si)/s for high dose rate irradiation. Sample size for the low dose rate cells was 6, while the sample size for the high dose rate cells was 5. The pre- and post-irradiation limits are 69.5dB minimum.

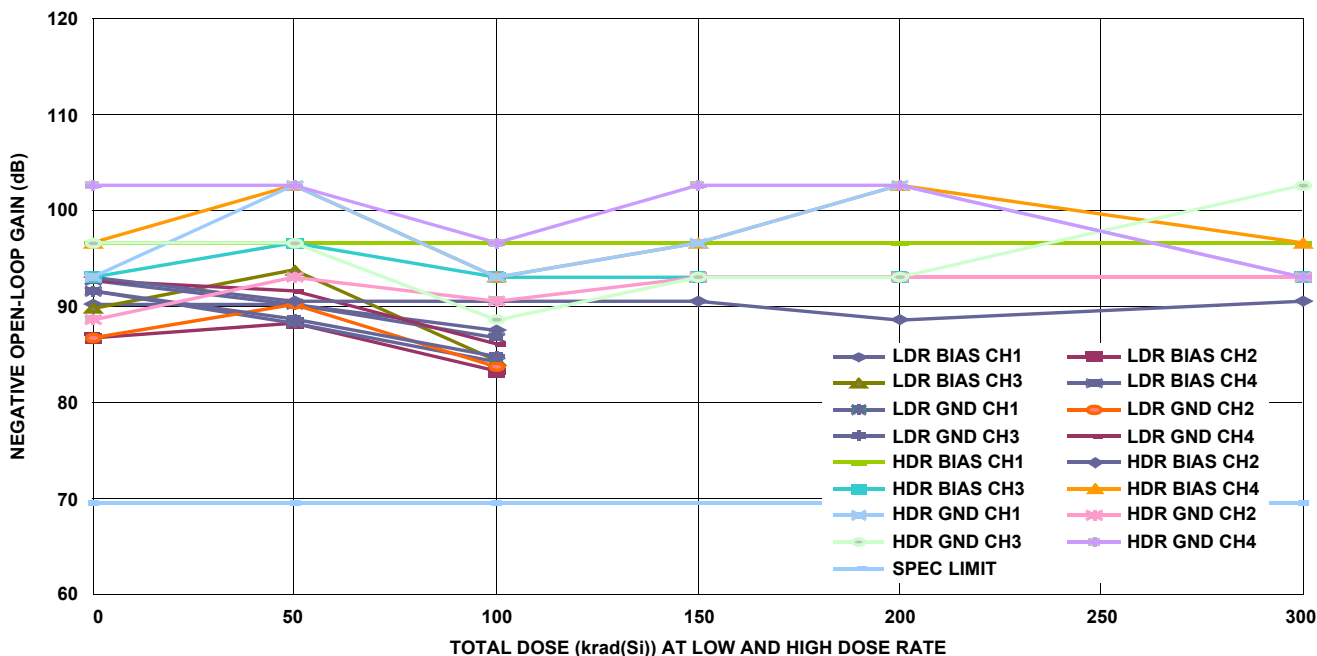


FIGURE 8. ISL70417SEH negative open-loop voltage gain, channels 1 through 4, as a function of total dose irradiation at low and high dose rate for the biased (per Figure 2) and unbiased (all pins grounded) cases. The dose rate was 0.01rad(Si)/s for low dose rate irradiation and 50rad(Si)/s for high dose rate irradiation. Sample size for the low dose rate cells was 6, while the sample size for the high dose rate cells was 5. The pre- and post-irradiation limits are 69.5dB minimum.

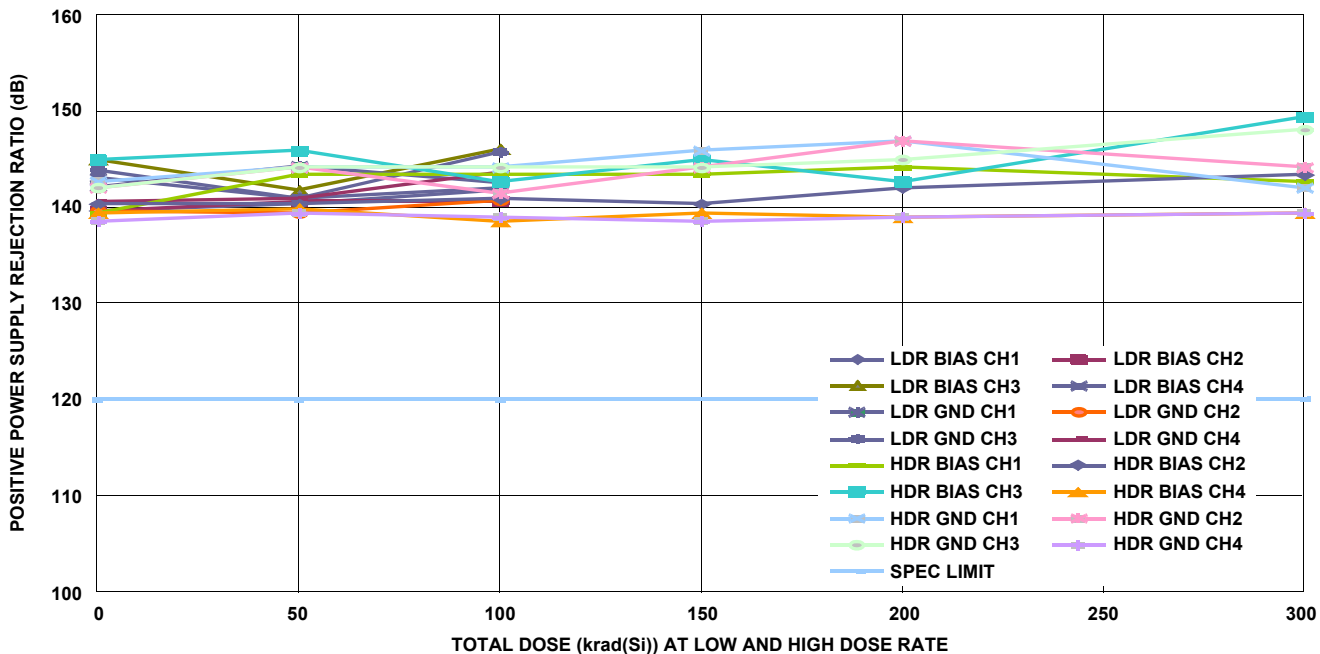


FIGURE 9. ISL70417SEH positive power supply rejection ratio, channels 1 through 4, as a function of total dose irradiation at low and high dose rate for the biased (per Figure 2) and unbiased (all pins grounded) cases. The dose rate was 0.01rad(Si)/s for low dose rate irradiation and 50rad(Si)/s for high dose rate irradiation. Sample size for the low dose rate cells was 6, while the sample size for the high dose rate cells was 5. The pre- and post-irradiation limits are 120.0dB minimum.

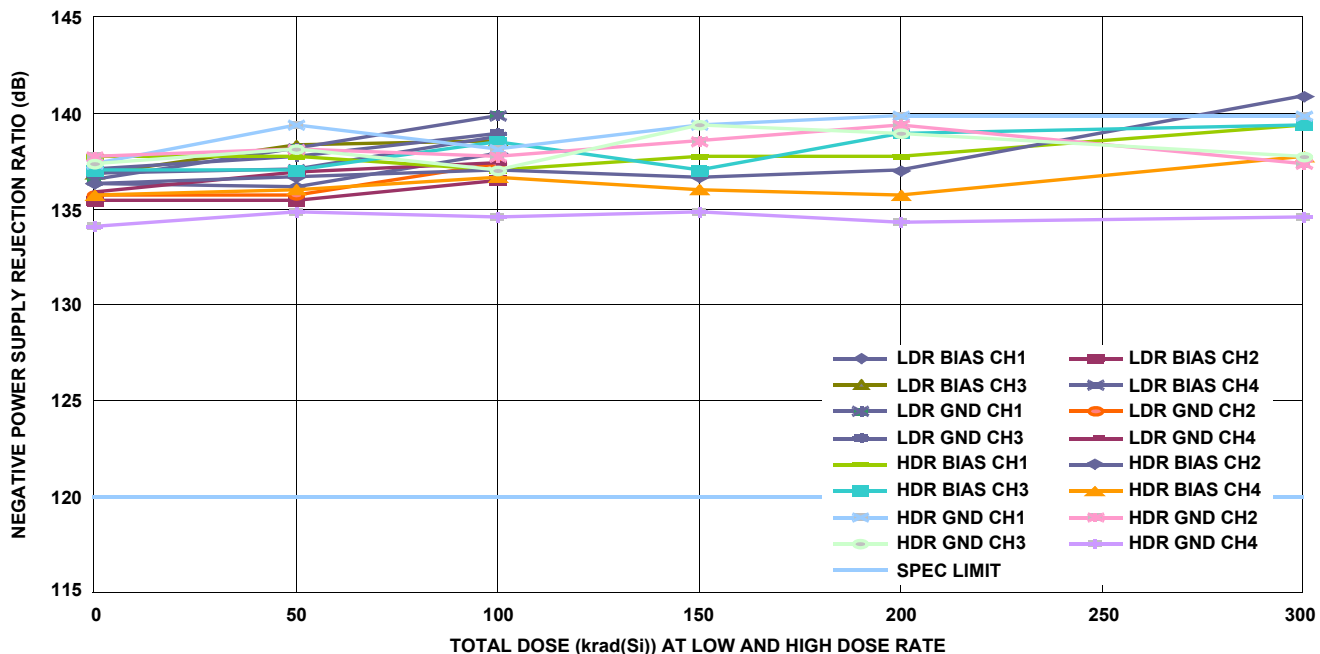


FIGURE 10. ISL70417SEH negative power supply rejection ratio, channels 1 through 4, as a function of total dose irradiation at low and high dose rate for the biased (per Figure 2) and unbiased (all pins grounded) cases. The dose rate was 0.01rad(Si)/s for low dose rate irradiation and 50rad(Si)/s for high dose rate irradiation. Sample size for the low dose rate cells was 6, while the sample size for the high dose rate cells was 5. The pre- and post-irradiation limits are 120.0dB minimum.

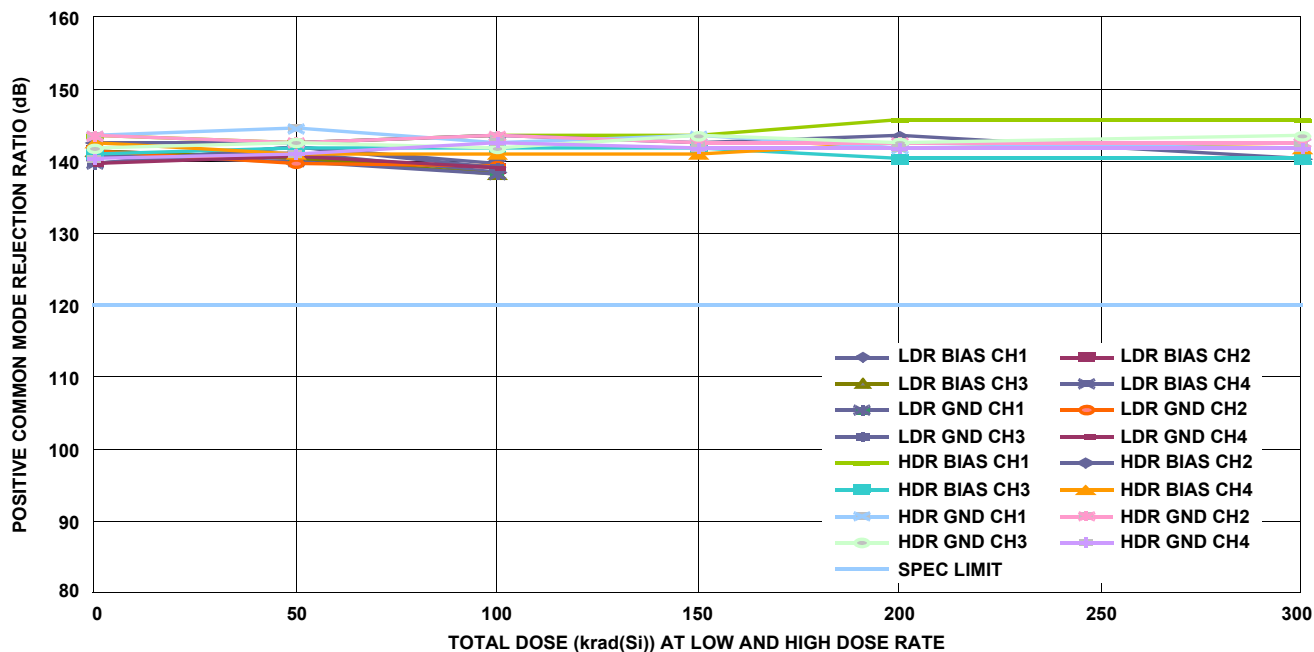


FIGURE 11. ISL70417SEH positive common mode rejection ratio, channels 1 through 4, as a function of total dose irradiation at low and high dose rate for the biased (per Figure 2) and unbiased (all pins grounded) cases. The dose rate was 0.01rad(Si)/s for low dose rate irradiation and 50rad(Si)/s for high dose rate irradiation. Sample size for the low dose rate cells was 6, while the sample size for the high dose rate cells was 5. The pre- and post-irradiation limits are 120.0dB minimum.

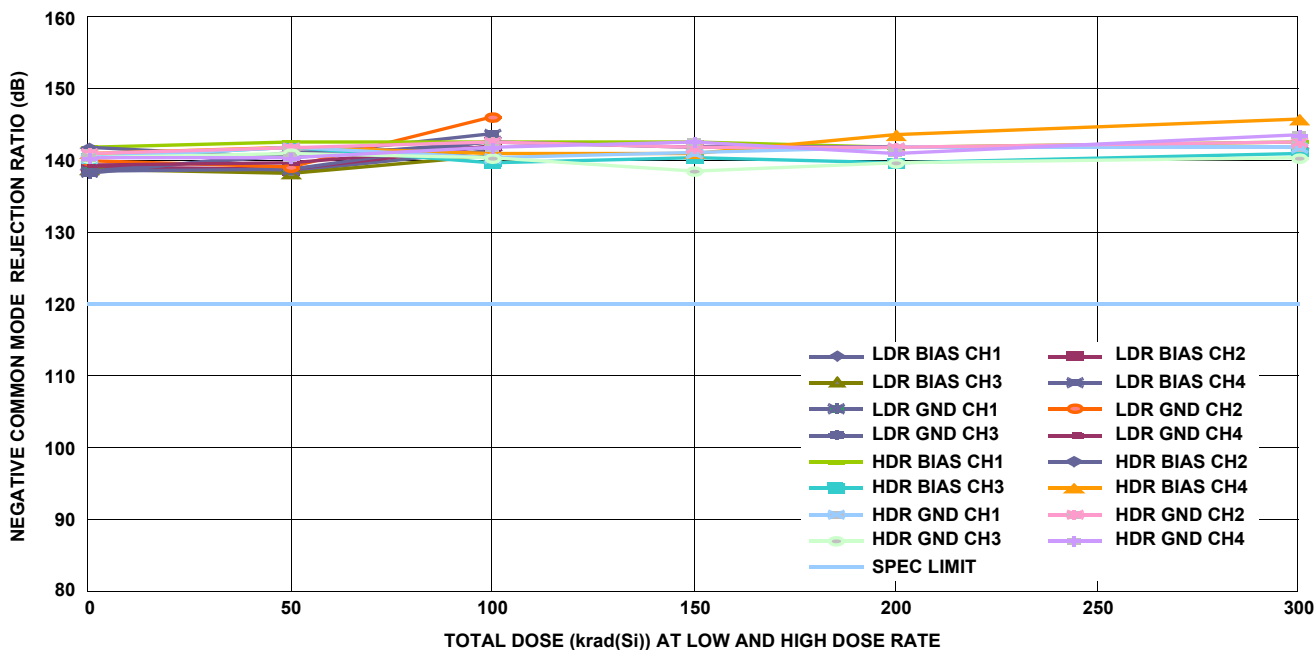


FIGURE 12. ISL70417SEH negative common mode rejection ratio, channels 1 through 4, as a function of total dose irradiation at low and high dose rate for the biased (per Figure 2) and unbiased (all pins grounded) cases. The dose rate was 0.01rad(Si)/s for low dose rate irradiation and 50rad(Si)/s for high dose rate irradiation. Sample size for the low dose rate cells was 6, while the sample size for the high dose rate cells was 5. The pre- and post-irradiation limits are 120.0dB minimum.

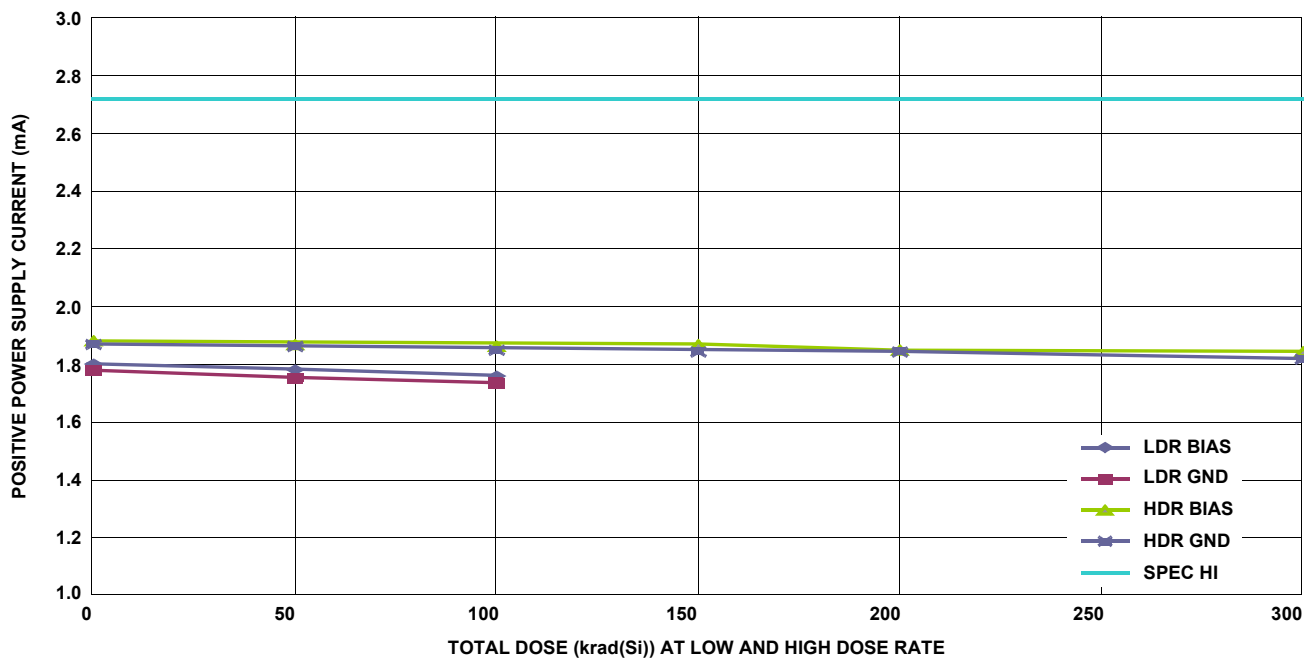


FIGURE 13. ISL70417SEH positive power supply current, sum of all four channels (1 through 4), as a function of total dose irradiation at low and high dose rate for the biased (per Figure 2) and unbiased (all pins grounded) cases. The dose rate was 0.01rad(Si)/s for low dose rate irradiation and 50rad(Si)/s for high dose rate irradiation. Sample size for the low dose rate cells was 6, while the sample size for the high dose rate cells was 5. The pre-irradiation limit is -2.12mA maximum and the post-irradiation limit is -2.72mA maximum.

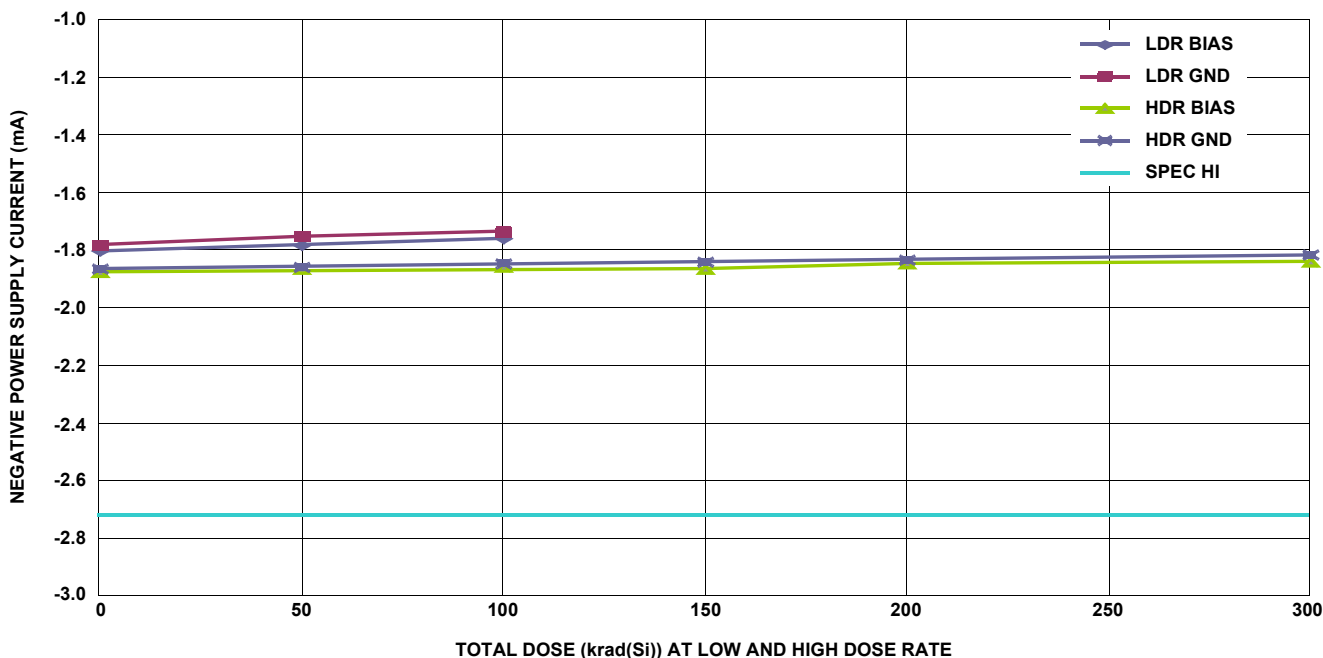


FIGURE 14. ISL70417SEH negative power supply current, sum of all four channels (1 through 4), as a function of total dose irradiation at low and high dose rate for the biased (per Figure 2) and unbiased (all pins grounded) cases. The dose rate was 0.01rad(Si)/s for low dose rate irradiation and 50rad(Si)/s for high dose rate irradiation. Sample size for the low dose rate cells was 6, while the sample size for the high dose rate cells was 5. The pre-irradiation limit is -2.12mA maximum and the post-irradiation limit is -2.72mA maximum.

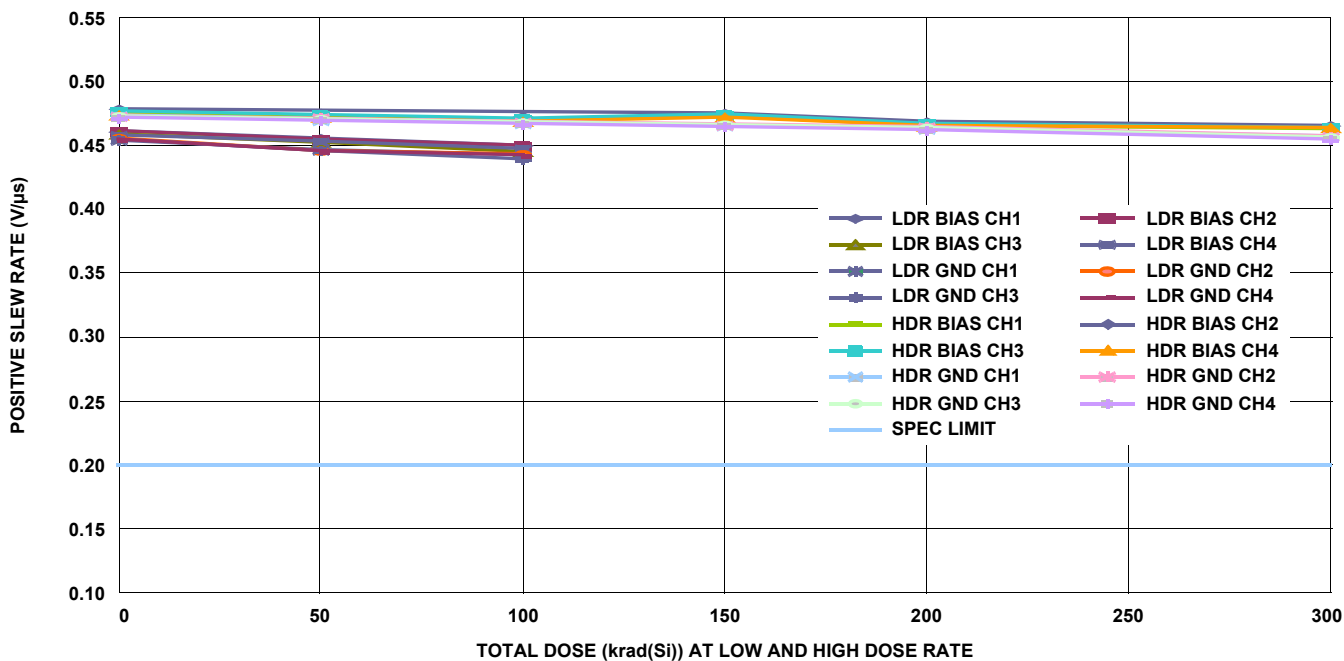


FIGURE 15. ISL70417SEH positive slew rate, channels 1 through 4, as a function of total dose irradiation at low and high dose rate for the biased (per Figure 2) and unbiased (all pins grounded) cases. The dose rate was 0.01rad(Si)/s for low dose rate irradiation and 50rad(Si)/s for high dose rate irradiation. Sample size for the low dose rate cells was 6, while the sample size for the high dose rate cells was 5. The pre-irradiation limit is 0.30V/μs minimum and the post-irradiation limit is 0.20V/μs minimum.

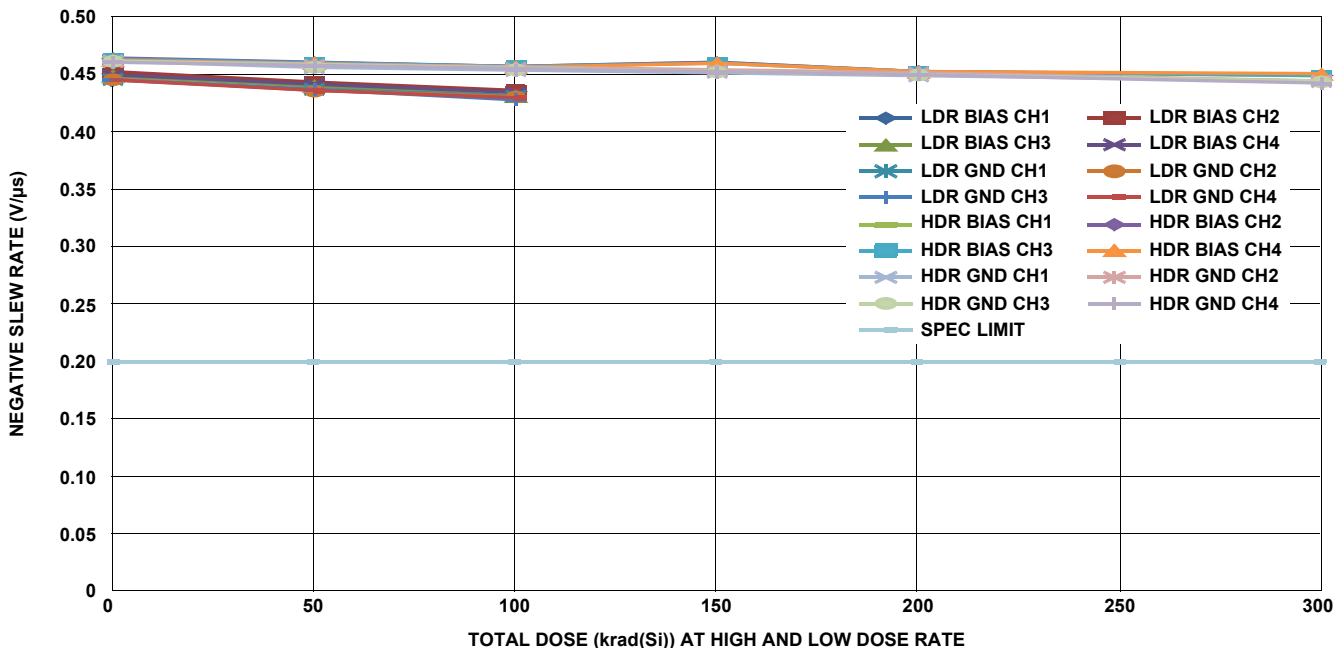


FIGURE 16. ISL70417SEH negative slew rate, channels 1 through 4, as a function of total dose irradiation at low and high dose rate for the biased (per Figure 2) and unbiased (all pins grounded) cases. The dose rate was 0.01rad(Si)/s for low dose rate irradiation and 50rad(Si)/s for high dose rate irradiation. Sample size for the low dose rate cells was 6, while the sample size for the high dose rate cells was 5. The pre-irradiation limit is 0.30V/μs minimum and the post-irradiation limit is 0.20V/μs minimum.

Conclusion

This document reports results of low and high dose rate testing of the ISL70417SEH quad operational amplifier. Parts were tested at low and high dose rate under biased and unbiased conditions per MIL-STD-883 Test Method 1019.7, at 0.01rad(Si)/s and 50rad(Si)/s respectively. The low dose rate test was run to 150krad(Si) and the high dose rate was run to 300krad(Si). All parameters remained within the post-irradiation limits to the maximum total dose for each test.

The positive and negative input bias currents were stable over high dose rate irradiation but showed an increase over low dose

rate. The parameter remained within the post-irradiation specification limits, but the part must be considered low dose rate sensitive based on the 'delta parameter' diagnostic algorithm outlined in MIL-STD-888 test method 1019. The part is acceptance tested on a wafer by wafer basis to 300krad(Si) at high dose rate (50 – 300rad(Si)/s) and to 50krad(Si) at low dose rate (0.01rad(Si)/s), insuring hardness to the specified level for both dose rates. No significant differences in total dose response were noted between biased and grounded 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.

Appendices

Reported parameters and their post-irradiation limits.

TABLE 1. REPORTED PARAMETERS

FIGURE	PARAMETER	LIMIT, LOW	LIMIT, HIGH	UNITS	NOTES
3	Input offset voltage	-110	+110	μV	Channels 1 through 4
4	Positive input bias current	-5.0	+5.0	nA	Channels 1 through 4
5	Negative input bias current	-5.0	+5.0	nA	Channels 1 through 4
6	Input offset current	-3.0	+3.0	nA	Channels 1 through 4
7	Positive open loop gain, biased	69.5		dB	Channels 1 through 4
8	Negative open loop gain, biased	69.5		dB	Channels 1 through 4
9	Positive power supply rejection ratio	120		dB	Channels 1 through 4
10	Negative power supply rejection ratio	120		dB	Channels 1 through 4
11	Positive common mode rejection ratio	120		dB	Channels 1 through 4
12	Positive common mode rejection ratio	120		dB	Channels 1 through 4
13	Positive supply current		2.72	mA	Sum of all 4 channels
14	Negative supply current		2.72	mA	Sum of all 4 channels
15	Positive slew rate	0.2		V/μs	Channels 1 through 4
16	Negative slew rate	0.2		V/μs	Channels 1 through 4

Revision History

The revision history provided is for informational purposes only and is believed to be accurate, but not warranted. Please go to web to make sure you have the latest revision.

DATE	REVISION	CHANGE
January 14, 2013	AN1792.0	Initial Release.

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Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

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