

Introduction

This report documents the results of low rate total dose testing of the [ISL73051ASEH](#) low dropout regulator. The results also include post-irradiation high temperature biased annealing. The tests were conducted to provide an assessment of the total dose hardness of the part and to determine any bias or anneal sensitivity. Parts were irradiated under bias and with all pins grounded to 100krad(Si) followed by high temperature biased anneal. The ISL73051ASEH is rated at 50krad(Si) at low dose rate (0.01rad(Si)/s) and is acceptance tested on a wafer-by-wafer basis to these limits.

Part Description

The ISL73051ASEH is a radiation hardened low voltage, high current single output Low Dropout (LDO) linear voltage regulator specified for a 3.0A continuous output current. The device operates across an input voltage range of 2.2V to 6.0V and is capable of providing output voltages of 0.8V to 5.0V, with the output voltage adjusted by an external resistor divider network. Dropout voltages as low as 65mV can be achieved.

The OCP pin allows the short-circuit output current limit threshold to be programmed by a resistor from the OCP pin to GND. The OCP setting range is 0.5A minimum to 8.5A maximum. The resistor sets the constant current threshold for the output under fault conditions. The thermal shutdown disables the output if the device temperature exceeds the specified value. It subsequently enters an ON/OFF cycle until the fault is removed. The ENABLE feature allows the part to be placed into a low current shutdown mode that typically draws about 10µA.

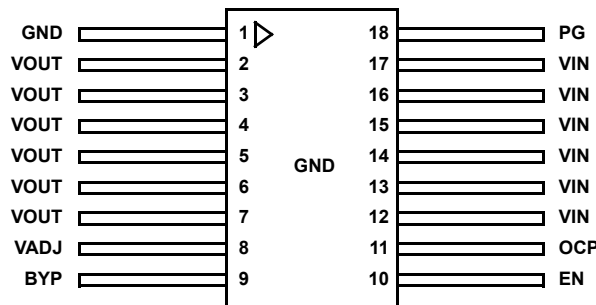
The ISL73051ASEH is implemented in the submicron P6 power management process, with 0.6µm minimum ground rules and three layers of interconnect. Active devices include low voltage CMOS and high voltage DMOS devices in addition to complementary bipolar junction transistors. This process is in volume production under MIL-PRF-38535 certification and is used for a wide range of commercial power management devices.

The ISL73051ASEH pinout configuration is shown in [Figure 1](#), with the pin descriptions shown in [Table 1 on page 2](#). The part is available in an 18 Ld CDFP Package.

Related Literature

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

- [ISL73051ASEH](#) product page
- MIL-STD-883 Test Method 1019



Note: The ESD triangular mark indicates Pin #1. It is a part of the device marking and is placed on the lid in the quadrant in which Pin #1 is located.

Figure 1. ISL73051ASEH Pinout Configuration

Table 1. ISL73051ASEH Pinout and Pin Descriptions

Pin Number	Pin Name	Description
1	GND	GND pin
2, 3, 4, 5, 6, 7	VOU	Output voltage pins
8	VADJ	Allows V_{OUT} to be programmed with an external resistor divider.
9	BYP	To filter the internal reference, connect a 0.1 μ F capacitor from the BYP pin to GND.
10	EN	V_{IN} independent chip enable. TTL and CMOS compatible.
11	OCP	Allows the current limit to be programmed with an external resistor.
12, 13, 14, 15, 16, 17	VIN	Input supply pins
18	PG	V_{OUT} in regulation signal. Logic low defines when V_{OUT} is not in regulation. Must be grounded if not used.
Top Lid	GND	The top lid is connected to the GND pin of the package.
Bottom Metal	-	The bottom E-pad is available on the K18.E package only and is not electrically connected.

1. Test Description

1.1 Irradiation Facilities

Low Dose Rate (LDR) testing was performed at 0.01rad(Si)/s using the Renesas Palm Bay Hopewell Designs N40 panoramic irradiator. A PbAl spectrum hardening filter was used to shield the test board and devices under test against low energy secondary gamma radiation. Half of the samples were irradiated under bias and the other half were grounded during irradiation. Both sets of samples underwent post-irradiation anneal at +100°C for 168 hours in a small temperature chamber.

1.2 Test Fixturing

Figure 2 shows the configuration used for biased irradiation. Note that the part is biased at 6.0V.

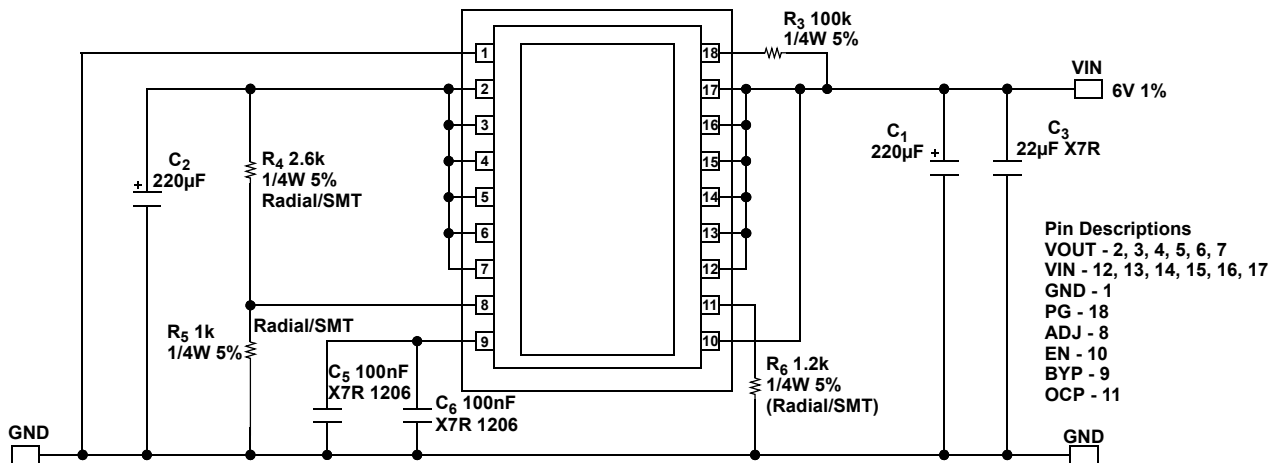


Figure 2. ISL73051ASEH TID Bias Schematic

1.3 Characterization Equipment and Procedures

All electrical testing was performed at room temperature outside the irradiator, using production Automated Test Equipment (ATE) with data-logging at each downpoint.

1.4 Experimental Matrix

Irradiation was performed in accordance with the guidelines of MIL-STD-883 Test Method 1019. The experimental matrix consisted of 24 samples irradiated under bias and 24 samples irradiated with all pins grounded. All anneal samples were biased. Due to oven size limitations, only 24 samples could be annealed at a time, so 12 biased samples and 12 unbiased samples were randomly chosen for the biased anneal. Three control units were used.

The ISL73051ASEH samples were from wafer lot 1JLUB. All samples were packaged in the 18 Ld ceramic flatpack package (package code K18.D). Samples were processed through the standard burn-in cycle before irradiation.

1.5 Downpoints

Downpoints for the LDR tests were 0, 10, 30, 50, 75, and 100krad(Si), followed by a 168 hour high temperature anneal at +100°C under bias.

2. Test Results

2.1 Attributes Data

Total dose testing of the ISL73051ASEH is complete. All tested parameters passed the SMD limits. [Table 2](#) summarizes the results.

Table 2. ISL73051ASEH Total Dose Test Attributes Data

Dose Rate (rad(Si)/s)	Bias	Sample Size	Downpoint	Pass (Note 1)	Fail
0.01	Biased (Figure 2)	24	Pre-irradiation	24	
			10krad(Si)	24	0
			30krad(Si)	24	0
			50krad(Si)	24	0
			75krad(Si)	24	0
			100krad(Si)	24	0
			Anneal	12	0
0.01	Gnd	24	Pre-irradiation	24	
			10krad(Si)	24	0
			30krad(Si)	24	0
			50krad(Si)	24	0
			75krad(Si)	24	0
			100krad(Si)	24	0
			Anneal	12	0

Note:

- 'Pass' indicates a sample that passes all SMD limits.

2.2 Key Parameter Listing

Table 3 lists 35 key selected parameters that are considered indicative of part performance. These parameters are plotted in Figures 3 through 37. All limits are taken from the ISL73051ASEH SMD; refer to SMD 5962-11212 for further details.

Table 3. ISL73051A SMD Total Dose Key SMD Parameters ($T_A = +25^\circ\text{C}$)

Figure	Parameter	Symbol	Limit, Low	Limit, High	Unit
3	DC output voltage accuracy, 0.52V output, 2.2V input, no load	V_{OUT}	0.512	0.528	V
4	DC output voltage accuracy, 0.52V output, 2.2V input, 3A load	V_{OUT}	0.512	0.528	V
5	DC output voltage accuracy, 0.52V output, 3.6V input, no load	V_{OUT}	0.512	0.528	V
6	DC output voltage accuracy, 0.52V output, 3.6V input, 3A load	V_{OUT}	0.512	0.528	V
7	DC output voltage accuracy, 0.52V output, 5.5V input, no load	V_{OUT}	0.512	0.528	V
8	DC output voltage accuracy, 1.5V output, 2.2V input, no load	V_{OUT}	1.478	1.522	V
9	DC output voltage accuracy, 1.5V output, 2.2V input, 3A load	V_{OUT}	1.478	1.522	V
10	DC output voltage accuracy, 1.5V output, 3.6V input, no load	V_{OUT}	1.478	1.522	V
11	DC output voltage accuracy, 1.5V output, 3.6V input, 3A load	V_{OUT}	1.478	1.522	V
12	DC output voltage accuracy, 1.5V output, 5.5V input, no load	V_{OUT}	1.478	1.522	V
13	DC output voltage accuracy, 1.8V output, 2.2V input, no load	V_{OUT}	1.773	1.827	V
14	DC output voltage accuracy, 1.8V output, 2.2V input, 3A load	V_{OUT}	1.773	1.827	V
15	DC output voltage accuracy, 1.8V output, 3.6V input, no load	V_{OUT}	1.773	1.827	V
16	DC output voltage accuracy, 1.8V output, 3.6V input, 3A load	V_{OUT}	1.773	1.827	V
17	DC output voltage accuracy, 1.8V output, 5.5V input, no load	V_{OUT}	1.773	1.827	V
18	DC output voltage accuracy, 5.0V output, 5.4V input, no load	V_{OUT}	4.925	5.075	V
19	DC output voltage accuracy, 5.0V output, 5.4V input, 3A load	V_{OUT}	4.925	5.075	V
20	DC output voltage accuracy, 5.0V output, 6.0V input, no load	V_{OUT}	4.925	5.075	V
21	DC output voltage accuracy, 5.0V output, 6.0V input, 3A load	V_{OUT}	4.925	5.075	V
22	Feedback pin, 1.5V output, 2.2V input, no load	V_{ADJ}	514.8	525.2	mV
23	Feedback pin, 1.5V output, 6.0V input, no load	V_{ADJ}	514.8	525.2	mV
24	DC input line regulation, 1.5V output			3.50	mV
25	DC input line regulation, 1.8V output			3.50	mV
26	DC input line regulation, 5.0V output			20.0	mV
27	DC output load regulation, 1.5V output		-4.00	-0.10	mV
28	DC output load regulation, 1.8V output		-4.80	-0.05	mV
29	DC output load regulation, 5.0V output		-15.0	-0.05	mV
30	Feedback input current, $V_{ADJ} = 0.5\text{V}$			1.00	μV
31	Ground pin current, 1.5V output, 2.2V input, no load	I_Q		13.0	mA
32	Ground pin current, 5.0V output, 6.0V input, no load	I_Q		19.0	mA
33	Ground pin current, 1.5V output, 2.2V input, 3A load	I_Q		14.0	mA
34	Ground pin current, 5.0V output, 6.0V input, 3A load	I_Q		20.0	mA
35	Dropout voltage, 2.5V output, 1A load	V_{DO}		100	mV
36	Dropout voltage, 2.5V output, 2A load	V_{DO}		200	mV
37	Dropout voltage, 2.5V output, 3A load	V_{DO}		300	mV

2.3 Key Parameter Variables Data

The plots in [Figures 3](#) through [37](#) illustrate the Total Ionizing Dose (TID) response of key selected SMD parameters outlined in [“Key Parameter Listing”](#) on [page 4](#). The plots show the average tested values of the parameters as a function of total dose and high temperature biased anneal for each of the irradiation conditions, biased and grounded. For example, the legend LDR_Bias indicates the average LDR response for biased parts. On the x-axis, along with the total dose, PA_L represents the Post-Anneal LDR points. The plots also include error bars at each datapoint, representing the minimum and maximum measured values of the samples, although in some plots the error bars might not be visible due to their values compared to the scale of the graph.

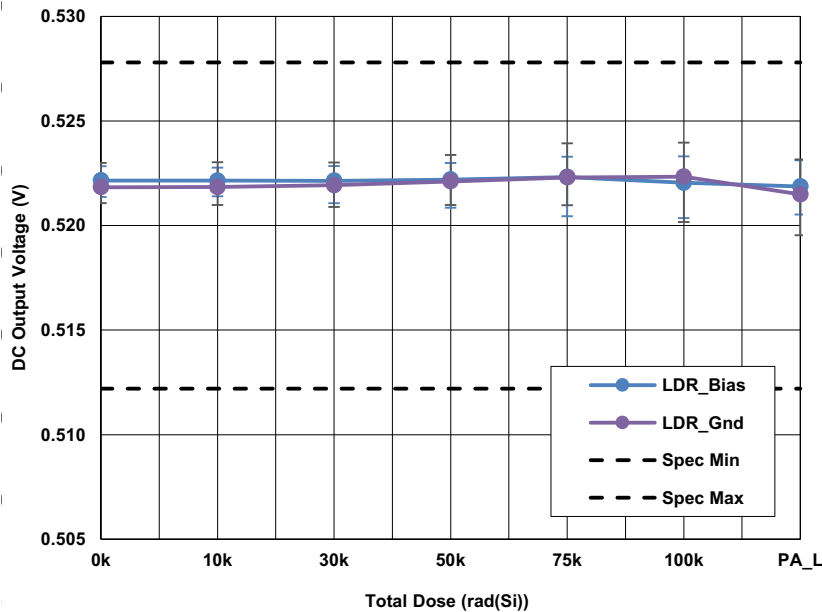


Figure 3. ISL73051ASEH DC output voltage accuracy (VOUT), 0.52V output, 2.2V input, no load, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limits are 0.512V minimum and 0.528V maximum.

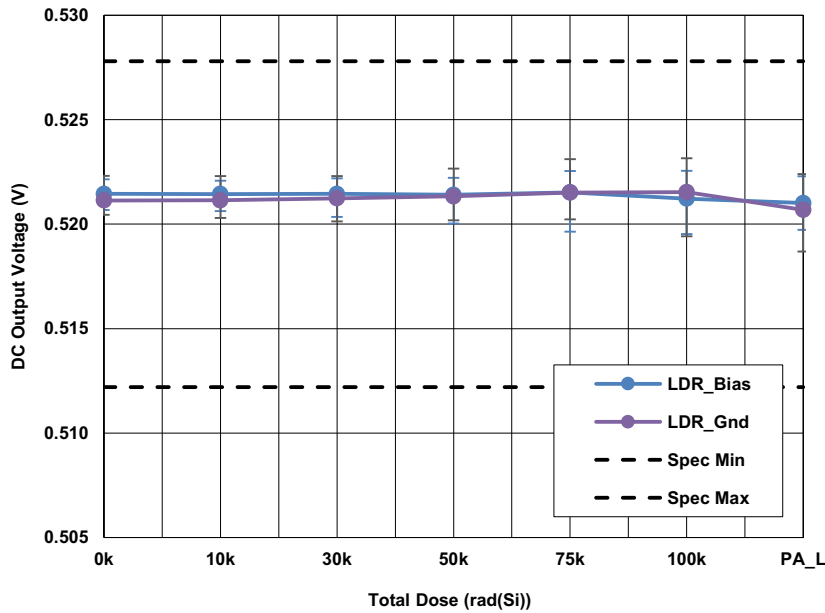


Figure 4. ISL73051ASEH DC output voltage accuracy (V_{OUT}), 0.52V output, 2.2V input, 3A load, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limits are 0.512V minimum and 0.528V maximum.

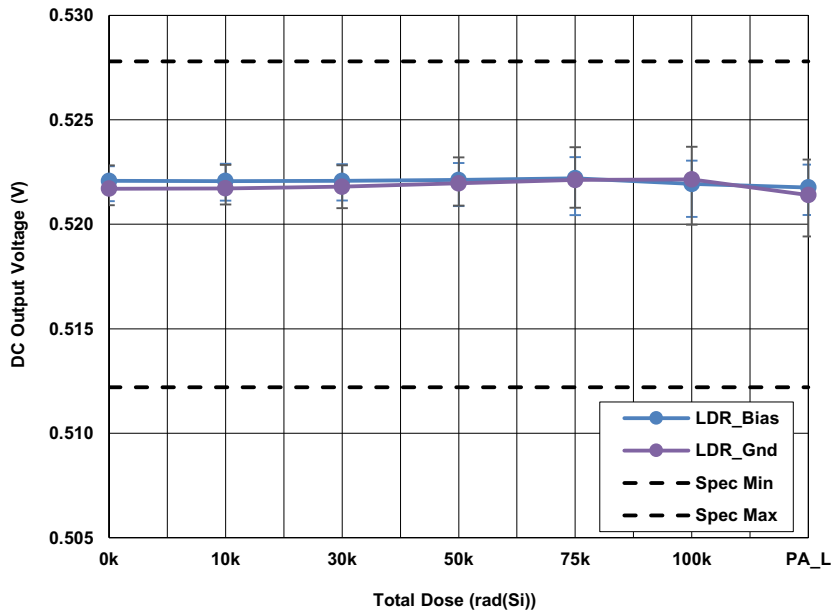


Figure 5. ISL73051ASEH DC output voltage accuracy (V_{OUT}), 0.52V output, 3.6V input, no load, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limits are 0.512V minimum and 0.528V maximum.

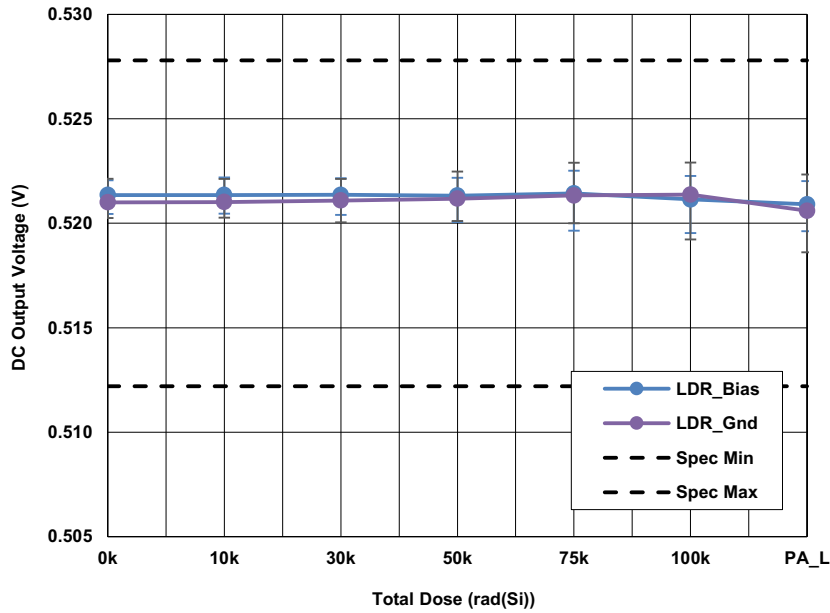


Figure 6. ISL73051ASEH DC output voltage accuracy (V_{OUT}), 0.52V output, 3.6V input, 3A load, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limits are 0.512V minimum and 0.528V maximum.

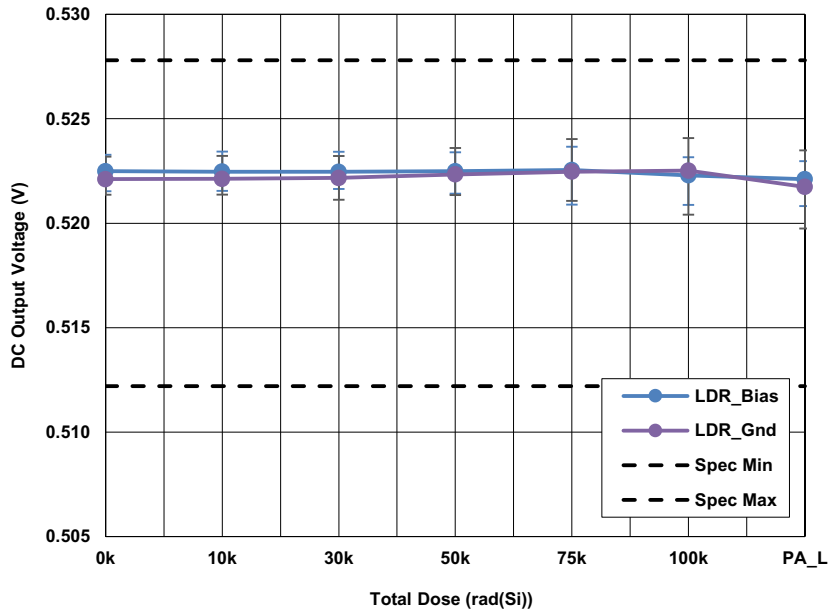


Figure 7. ISL73051ASEH DC output voltage accuracy (V_{OUT}), 0.52V output, 5.5V input, no load, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limits are 0.512V minimum and 0.528V maximum.

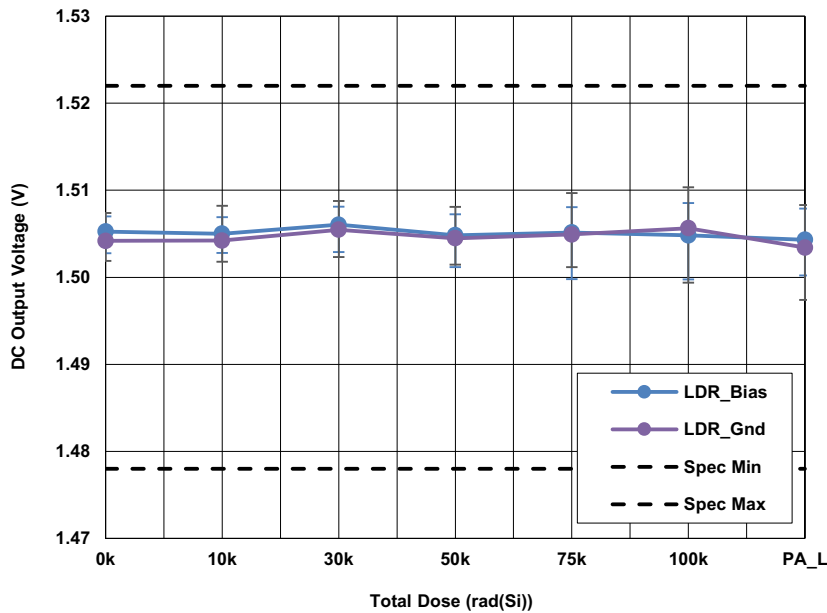


Figure 8. ISL73051ASEH DC output voltage accuracy (V_{OUT}), 1.5V output, 2.2V input, no load, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limits are 1.478V minimum and 1.522V maximum.

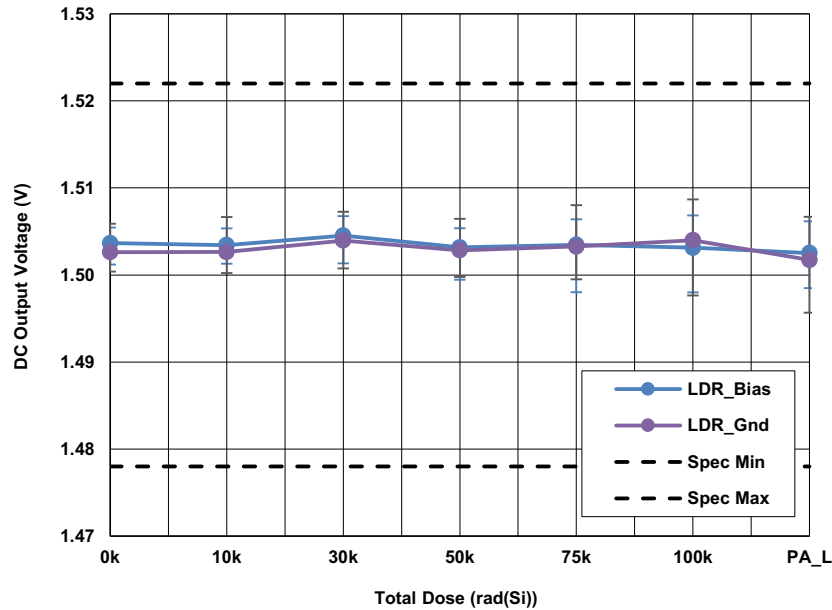


Figure 9. ISL73051ASEH DC output voltage accuracy (V_{OUT}), 1.5V output, 2.2V input, 3A load, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limits are 1.478V minimum and 1.522V maximum.

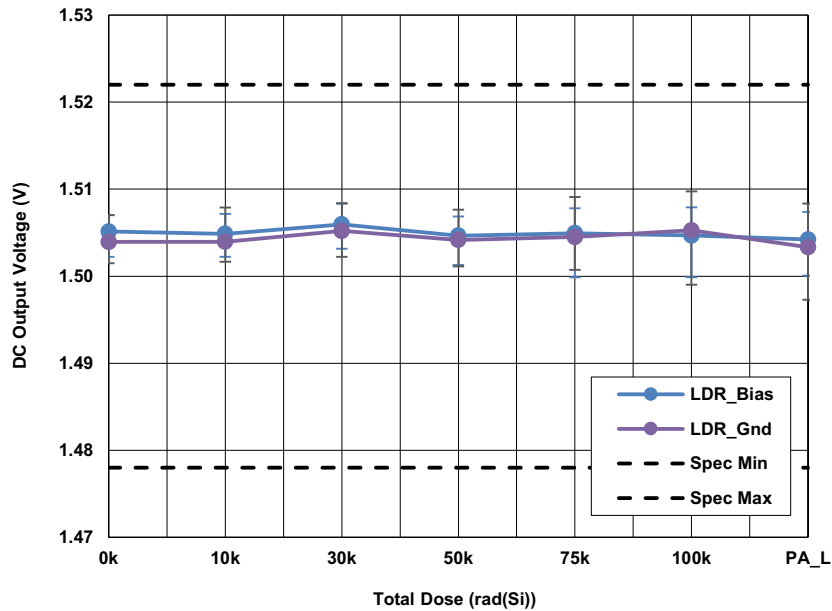


Figure 10. ISL73051ASEH DC output voltage accuracy (V_{OUT}), 1.5V output, 3.6V input, no load, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limits are 1.478V minimum and 1.522V maximum.

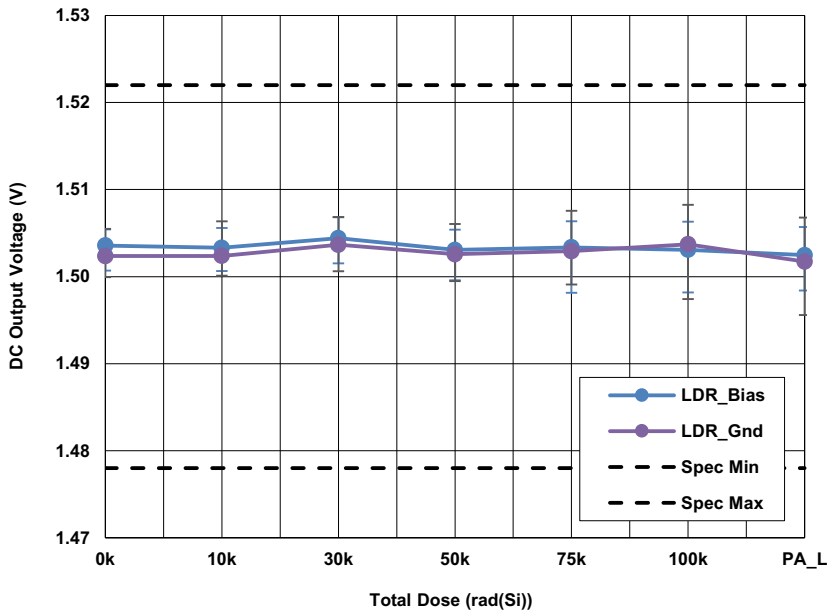


Figure 11. ISL73051ASEH DC output voltage accuracy (V_{OUT}), 1.5V output, 3.6V input, 3A load, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limits are 1.478V minimum and 1.522V maximum.

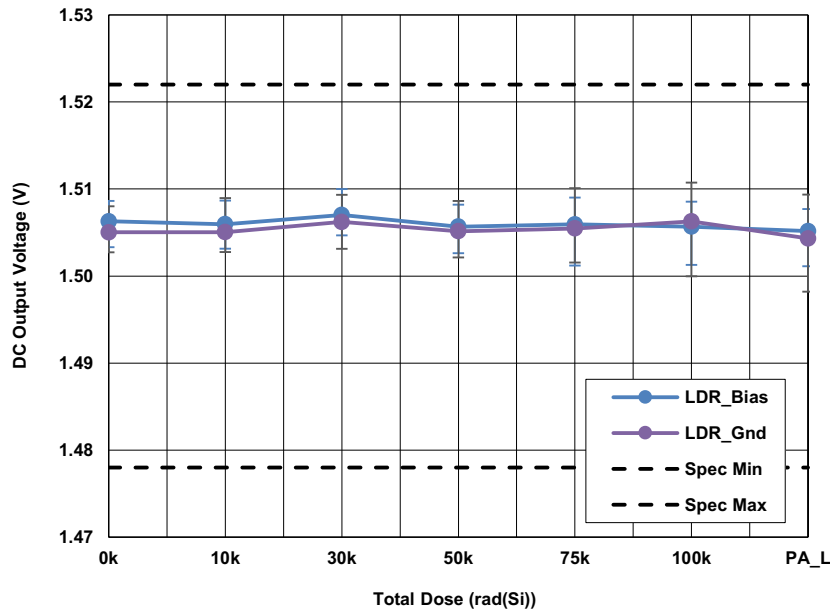


Figure 12. ISL73051ASEH DC output voltage accuracy (V_{OUT}), 1.5V output, 5.5V input, no load, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limits are 1.478V minimum and 1.522V maximum.

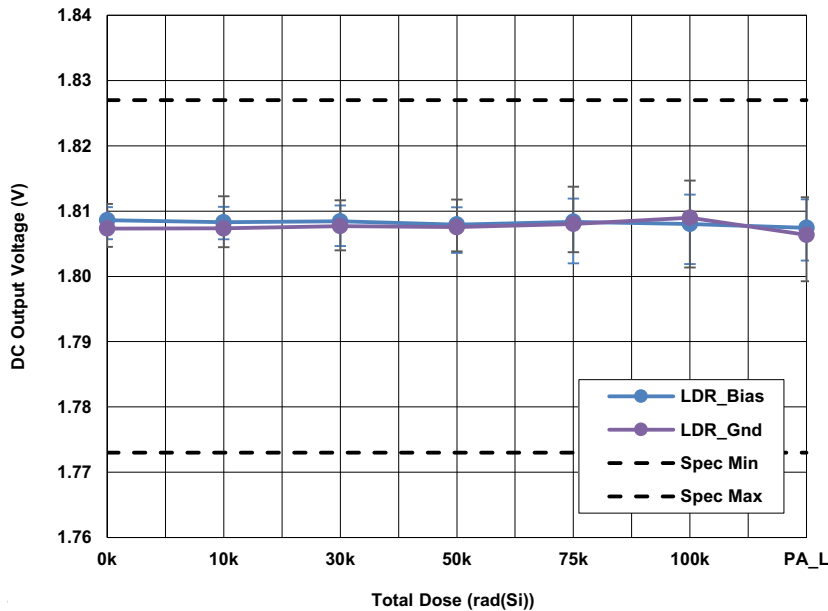


Figure 13. ISL73051ASEH DC output voltage accuracy (V_{OUT}), 1.8V output, 2.2V input, no load, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limits are 1.773V minimum and 1.827V maximum.

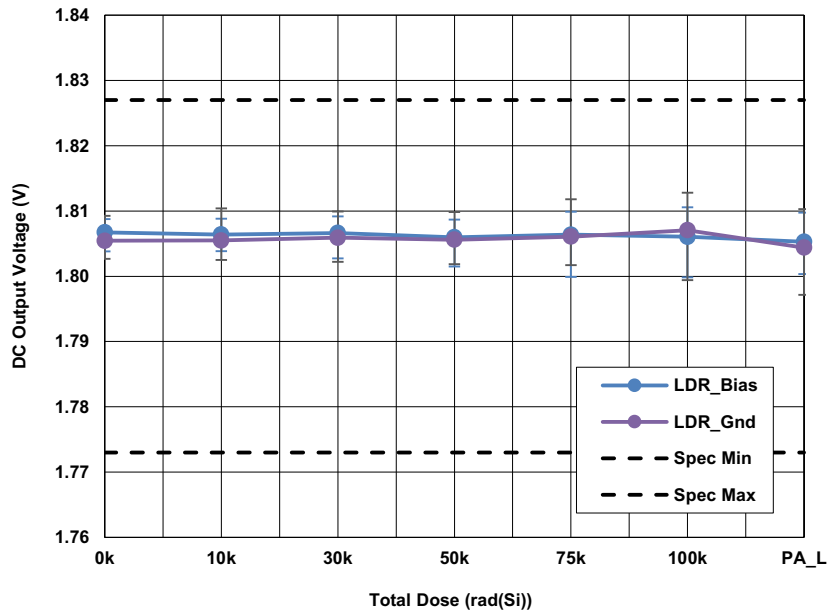


Figure 14. ISL73051ASEH DC output voltage accuracy (V_{OUT}), 1.8V output, 2.2V input, 3A load, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limits are 1.773V minimum and 1.827V maximum.

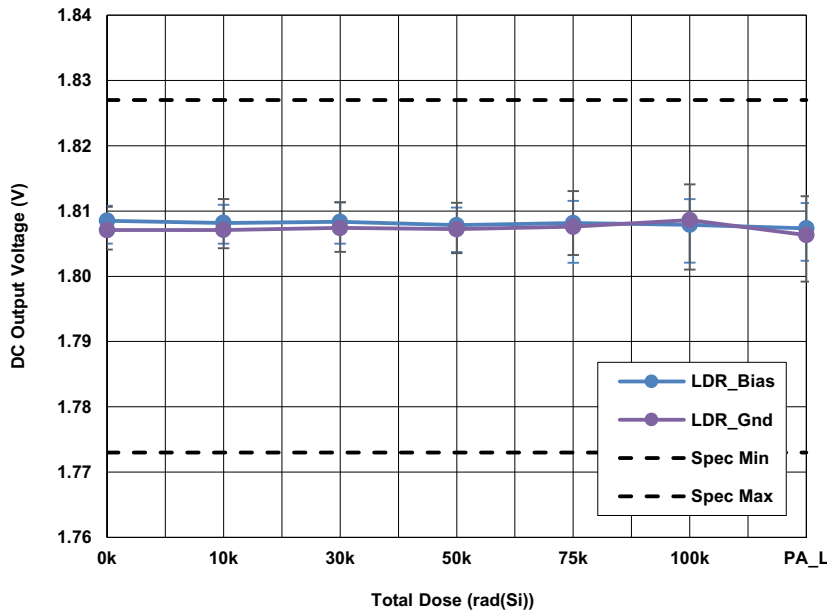


Figure 15. ISL73051ASEH DC output voltage accuracy (V_{OUT}), 1.8V output, 3.6V input, no load, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limits are 1.773V minimum and 1.827V maximum.

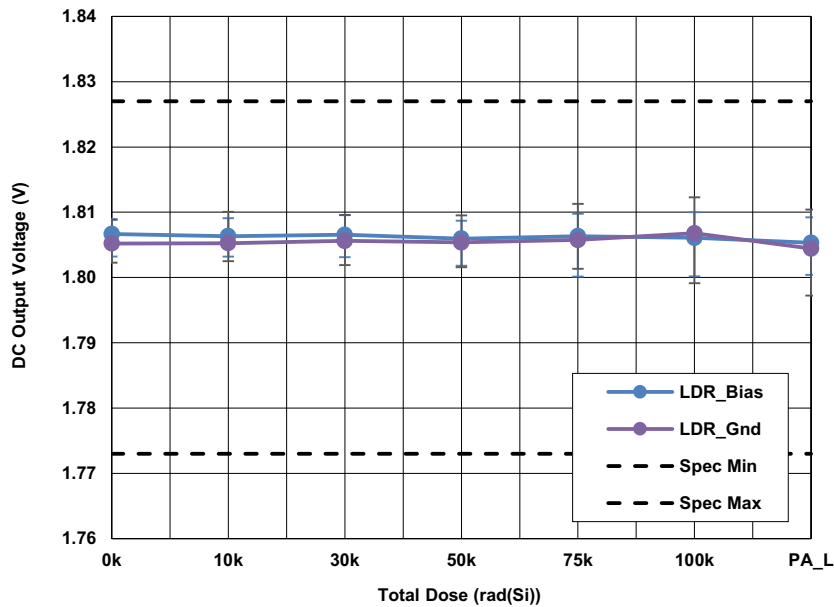


Figure 16. ISL73051ASEH DC output voltage accuracy (V_{OUT}), 1.8V output, 3.6V input, 3A load, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limits are 1.773V minimum and 1.827V maximum.

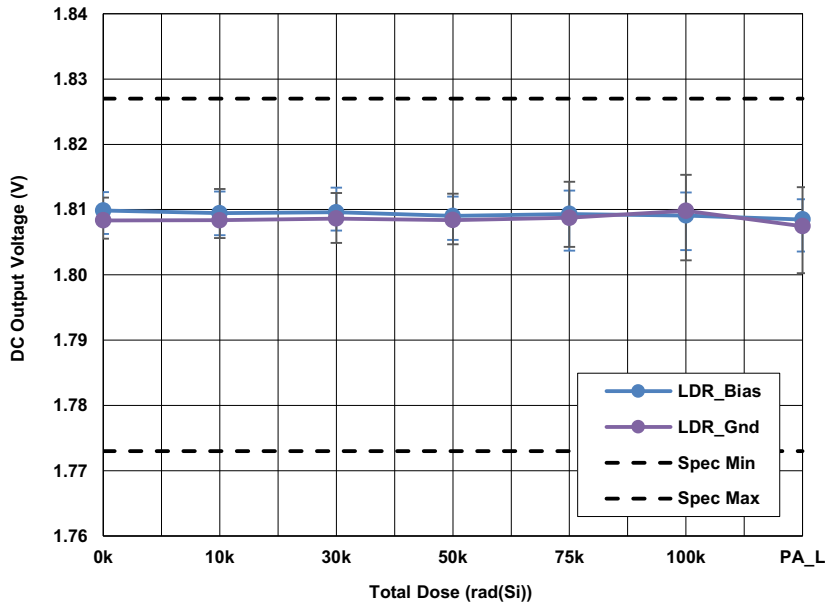


Figure 17. ISL73051ASEH DC output voltage accuracy (V_{OUT}), 1.8V output, 5.5V input, no load, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limits are 1.773V minimum and 1.827V maximum.

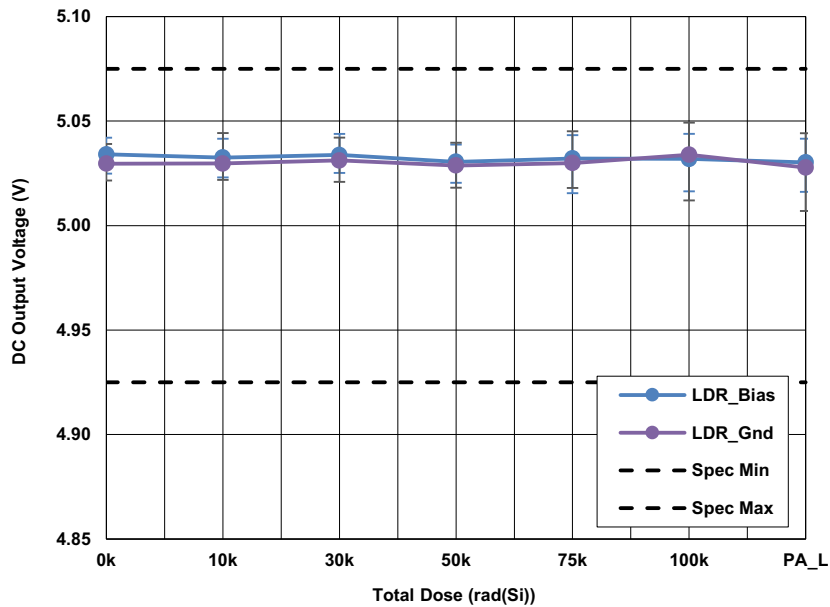


Figure 18. ISL73051ASEH DC output voltage accuracy (V_{OUT}), 5.0V output, 5.4V input, no load, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limits are 4.925V minimum and 5.075V maximum.

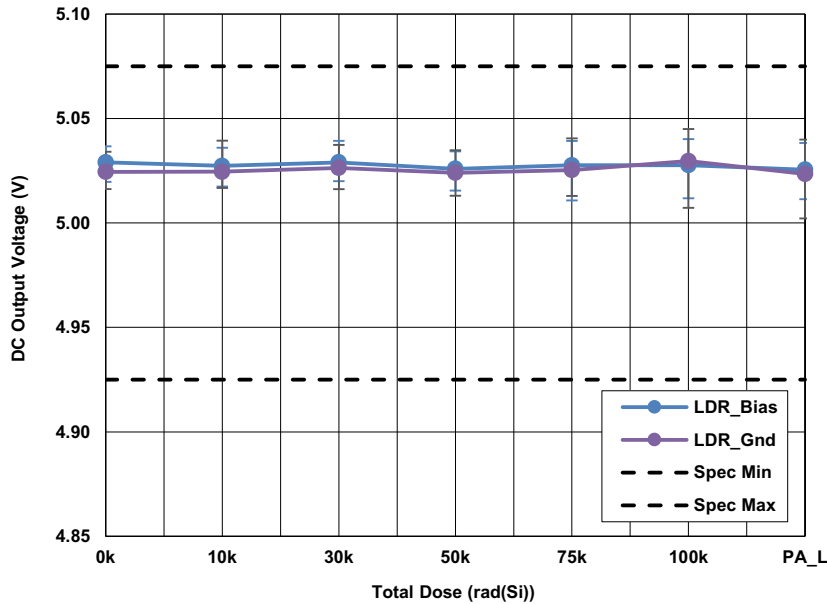


Figure 19. ISL73051ASEH DC output voltage accuracy (V_{OUT}), 5.0V output, 5.4V input, 3A load, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limits are 4.925V minimum and 5.075V maximum.

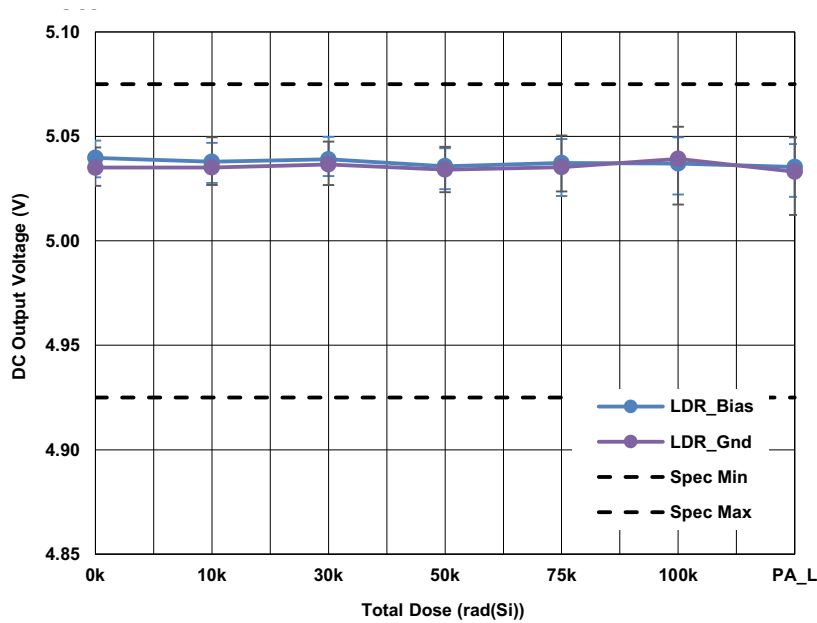


Figure 20. ISL73051ASEH DC output voltage accuracy (V_{OUT}), 5.0V output, 6.0V input, no load, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limits are 4.925V minimum and 5.075V maximum.

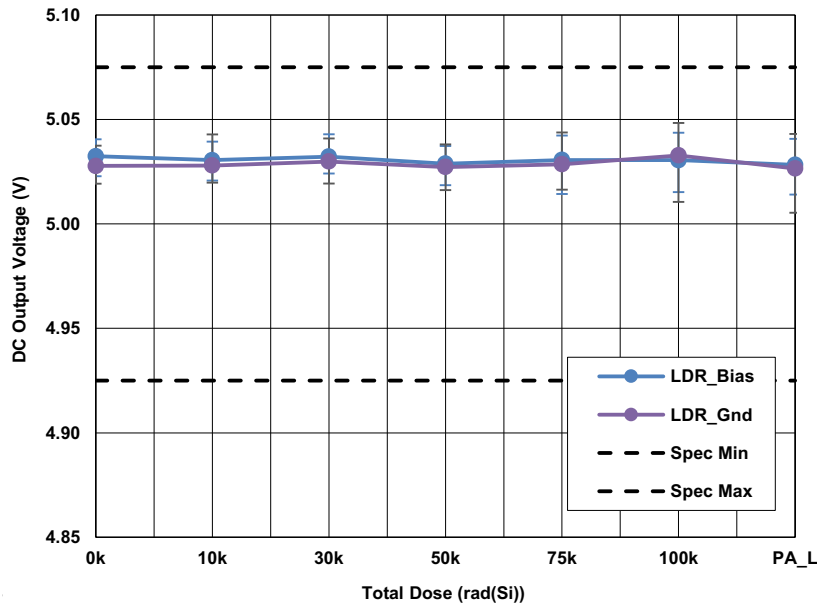


Figure 21. ISL73051ASEH DC output voltage accuracy (V_{OUT}), 5.0V output, 6.0V input, 3A load, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limits are 4.925V minimum and 5.075V maximum.

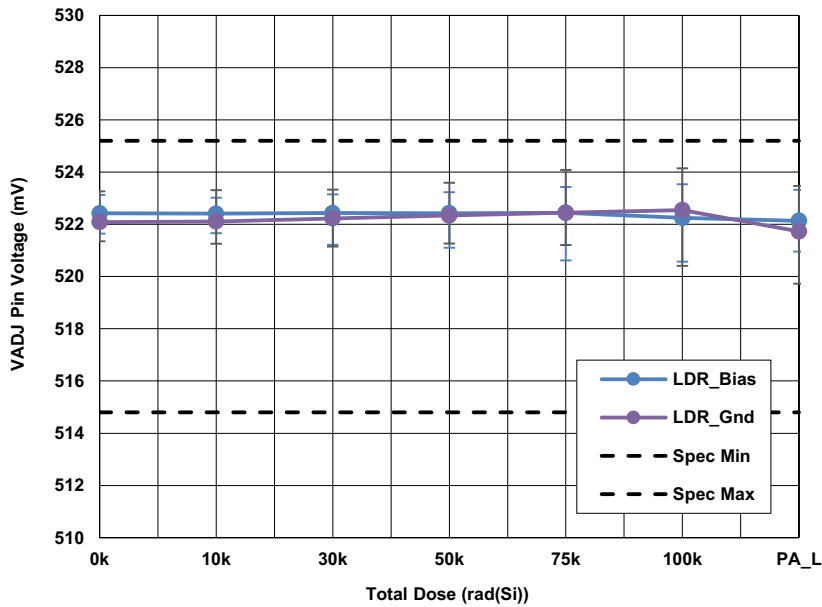


Figure 22. ISL73051ASEH feedback pin (V_{ADJ}), 1.5V output, 2.2V input, no load, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limits are 514.8mV minimum and 525.2mV maximum.

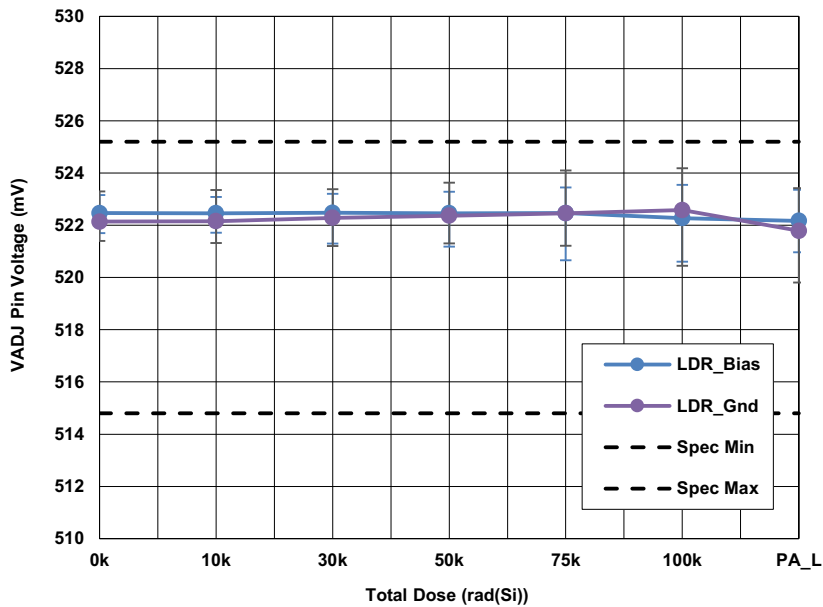


Figure 23. ISL73051ASEH feedback pin (V_{ADJ}), 1.5V output, 6.0V input, no load, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limits are 514.8mV minimum and 525.2mV maximum.

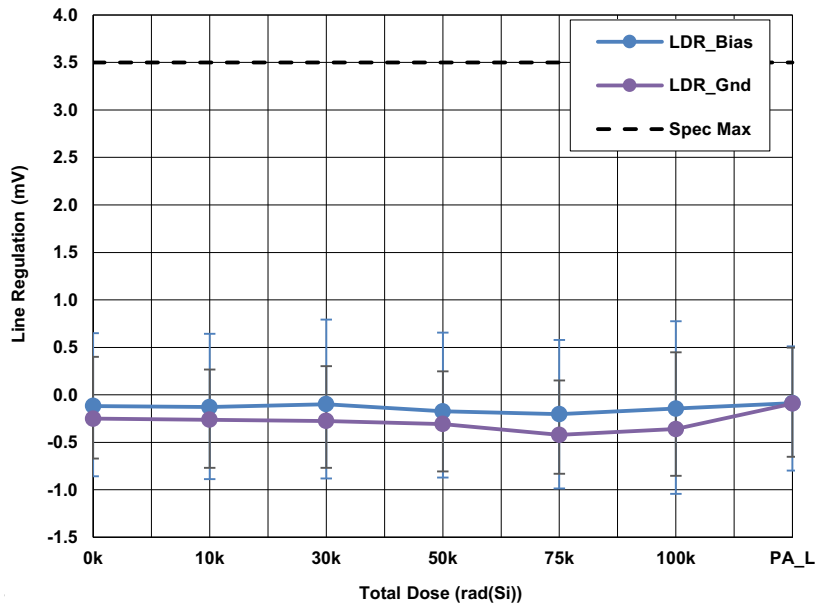


Figure 24. ISL73051ASEH DC input line regulation, 1.5V output, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 3.5mV maximum.

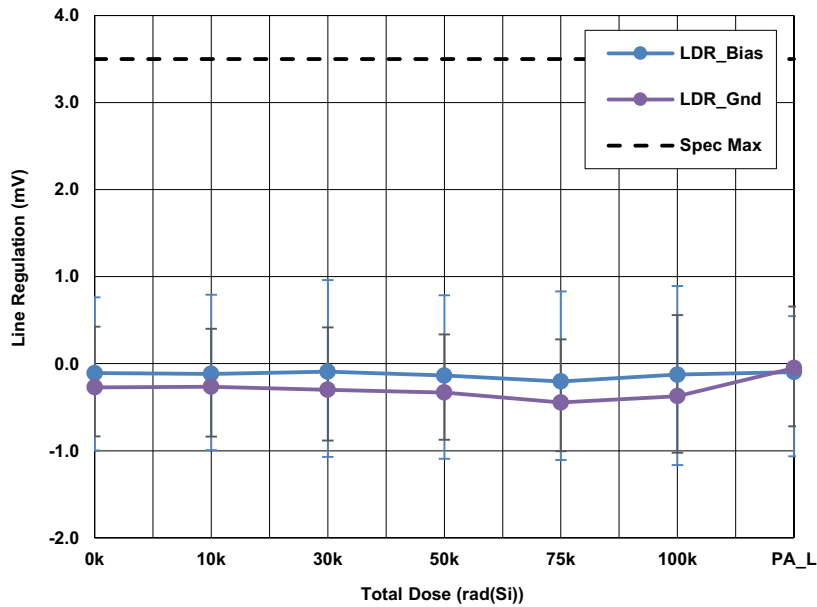


Figure 25. ISL73051ASEH DC input line regulation, 1.8V output, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 3.5mV maximum.

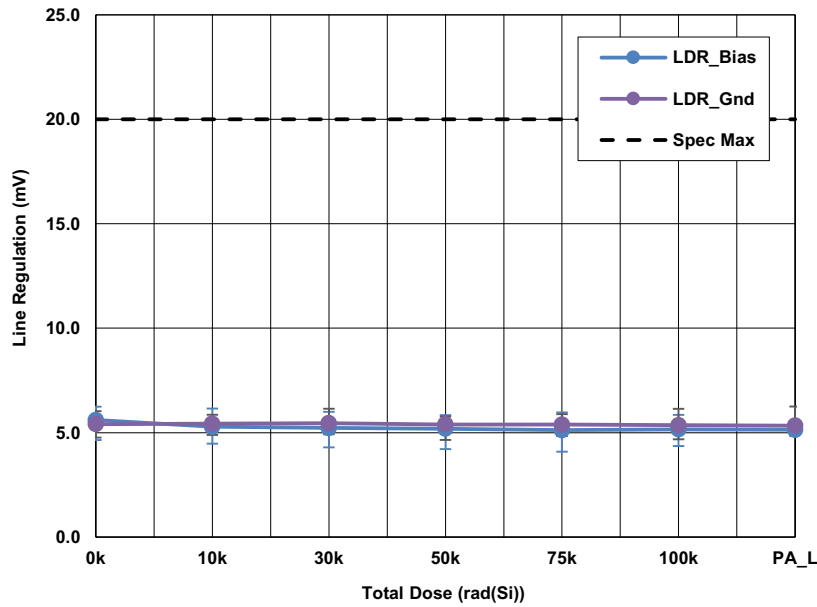


Figure 26. ISL73051ASEH DC input line regulation, 5.0V output, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 20.0mV maximum.

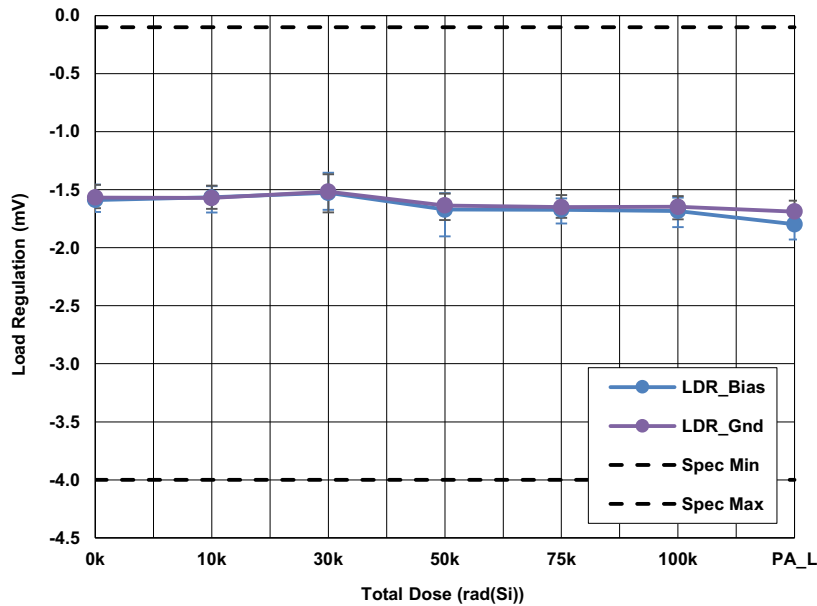


Figure 27. ISL73051ASEH DC output load regulation, 1.5V output, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limits are -4.00mV minimum and -0.10mV maximum.

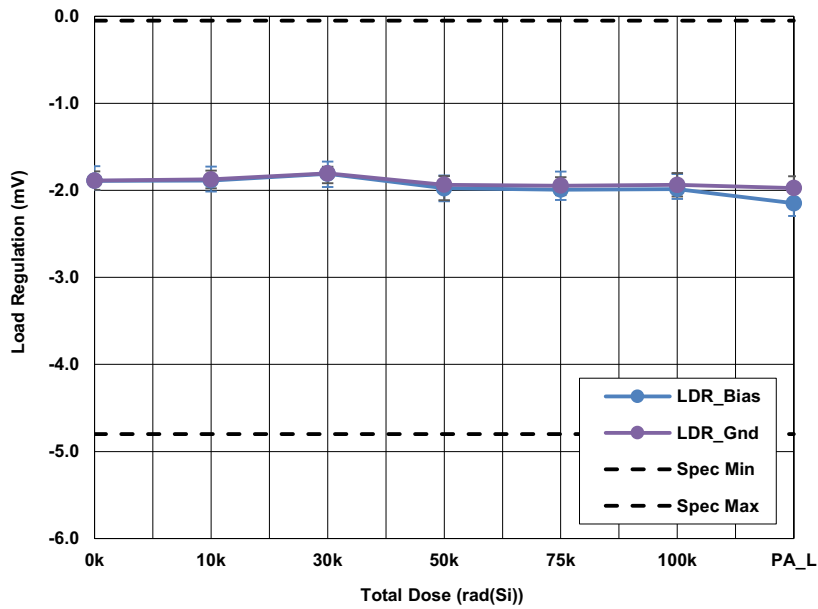


Figure 28. ISL73051ASEH DC output load regulation, 1.8V output, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limits are -4.80mV minimum and -0.05mV maximum.

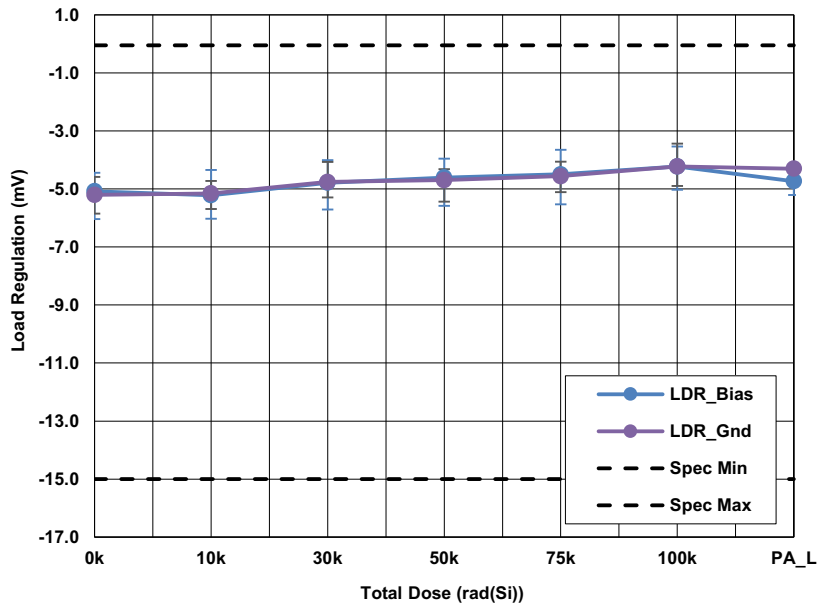


Figure 29. ISL73051ASEH DC output load regulation, 5.0V output, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limits are -15.0mV minimum and -0.05mV maximum.

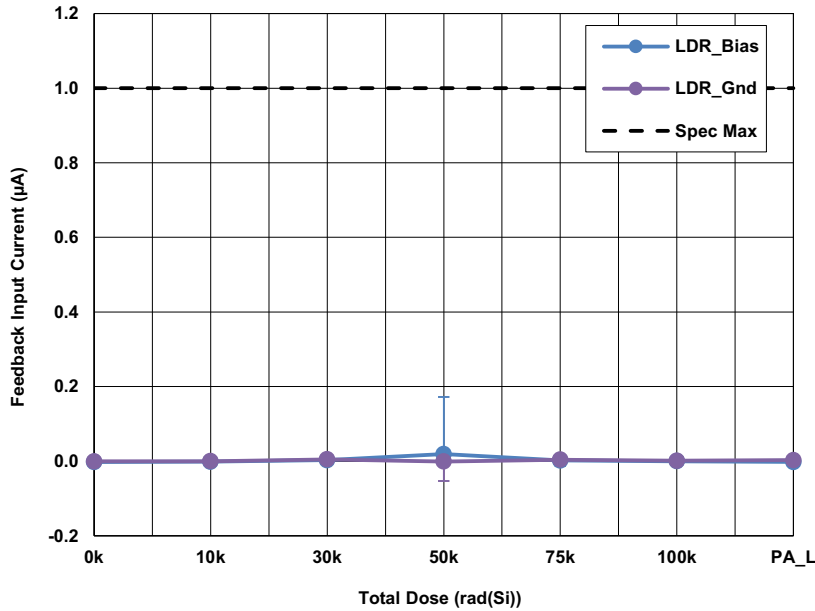


Figure 30. ISL73051ASEH feedback input current, VADJ = 0.5V, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 1.0µA maximum.

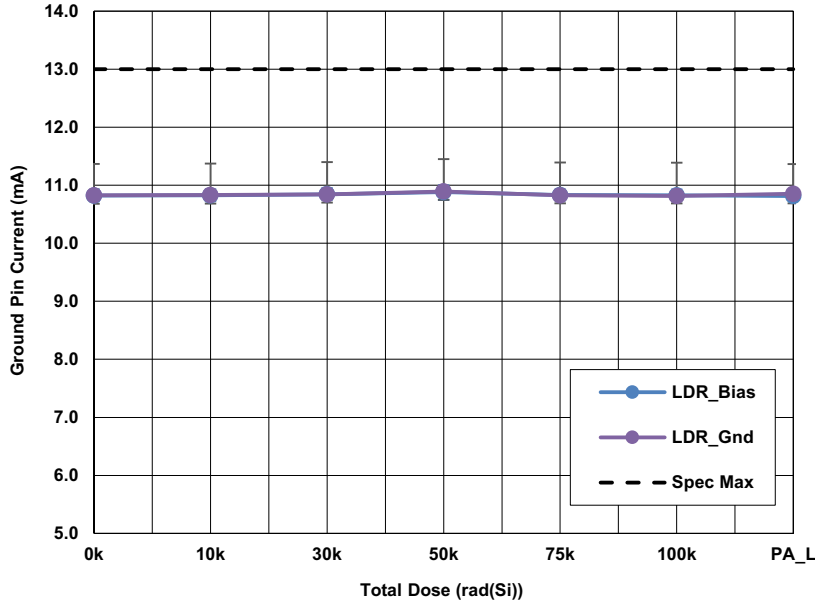


Figure 31. ISL73051ASEH ground pin current (I_Q), 1.5V output, 2.2V input, no load, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 13.0mA maximum.

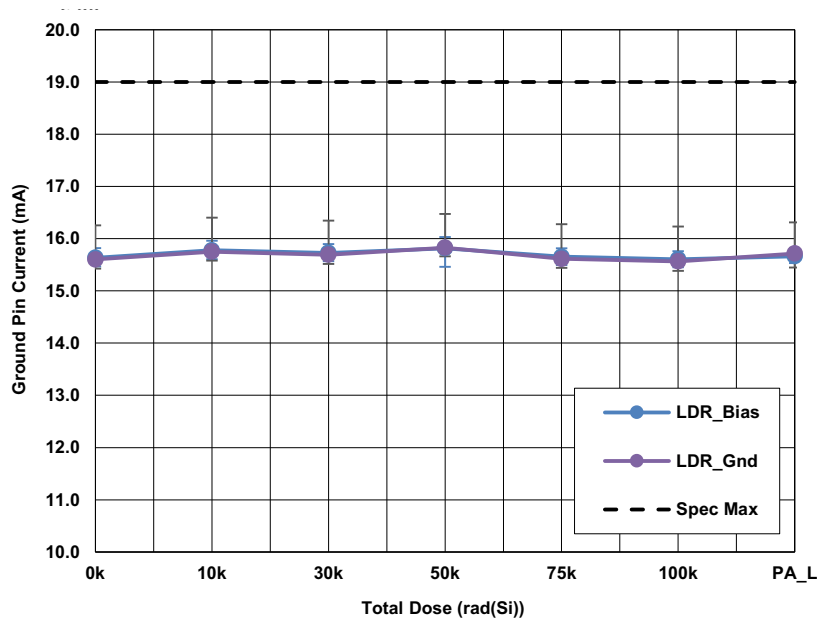


Figure 32. ISL73051ASEH ground pin current (I_Q), 5.0V output, 6.0V input, no load, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 19.0mA maximum.

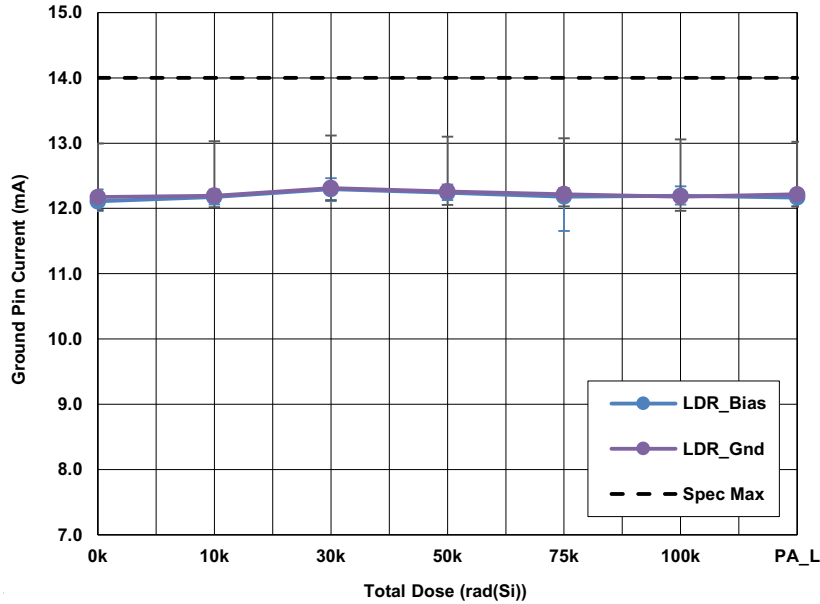


Figure 33. ISL73051ASEH ground pin current (I_Q), 1.5V output, 2.2V input, 3A load, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 14.0mA maximum.

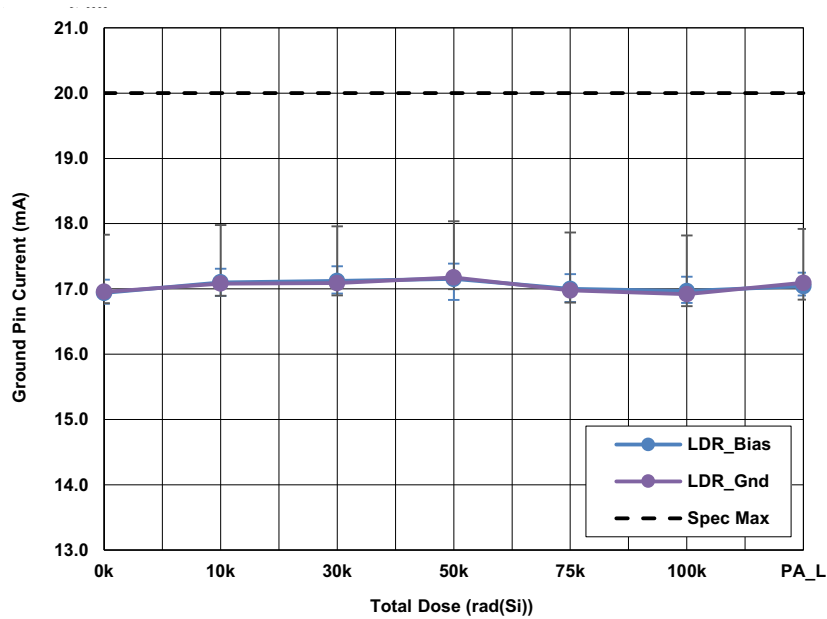


Figure 34. ISL73051ASEH ground pin current (I_Q), 5.0V output, 6.0V input, 3A load, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 20.0mA maximum.

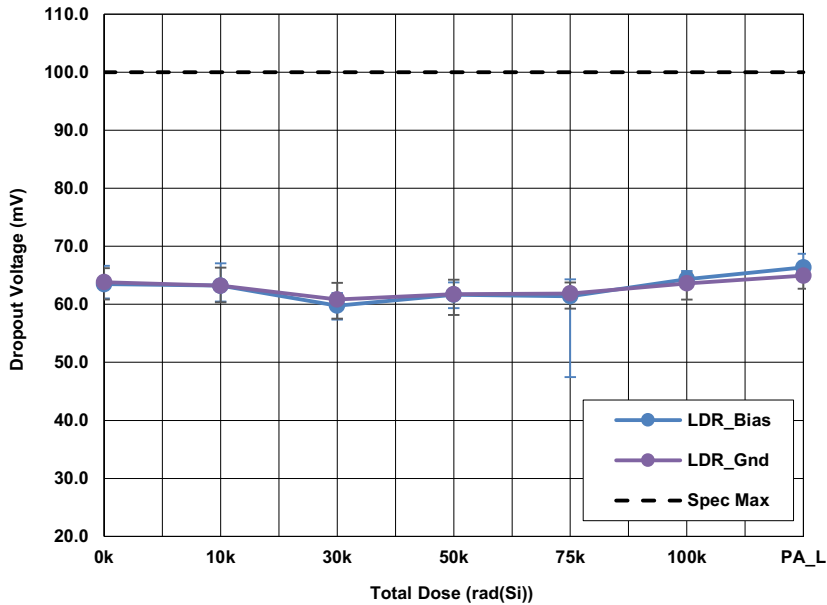


Figure 35. ISL73051ASEH dropout voltage (V_{DO}), 2.5V output, 1A load, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 100.0mV maximum.

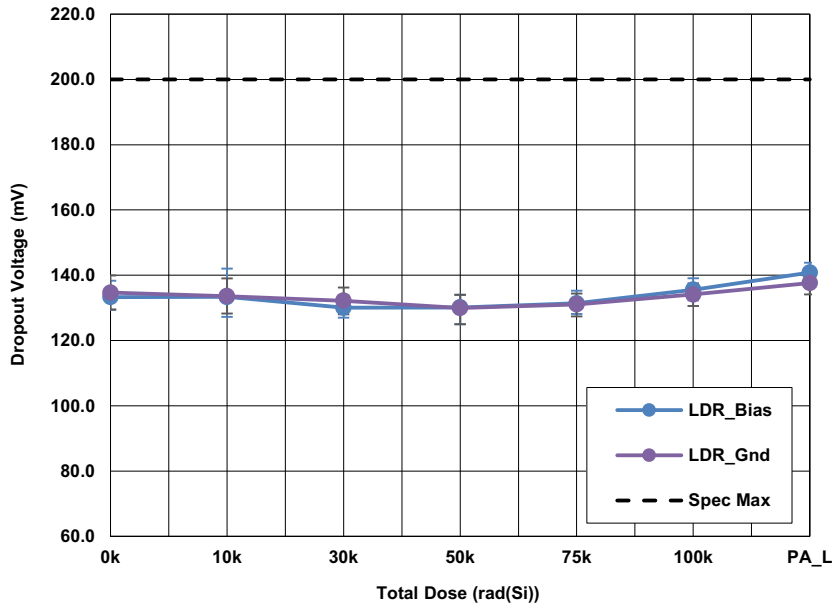


Figure 36. ISL73051ASEH dropout voltage (V_{DO}), 2.5V output, 2A load, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 200.0mV maximum.

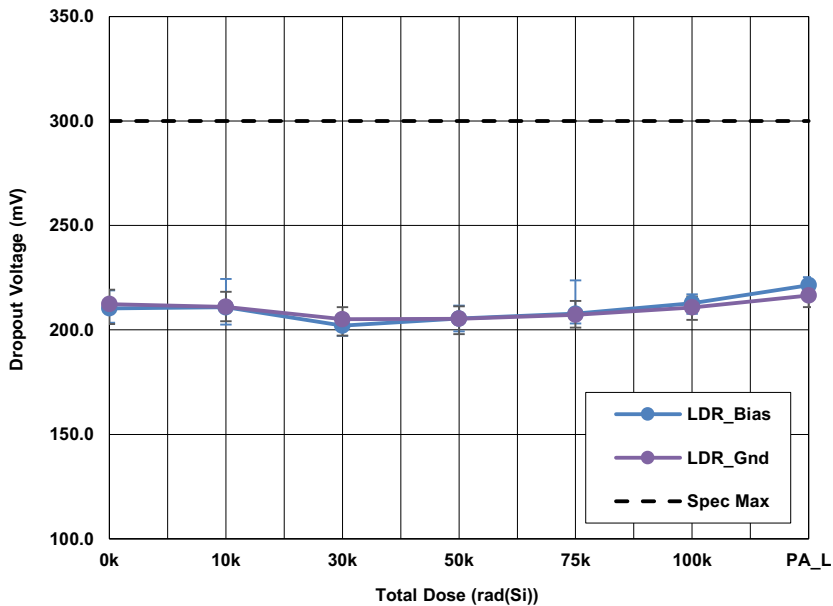


Figure 37. ISL73051ASEH dropout voltage (V_{DO}), 2.5V output, 3A load, as a function of total dose irradiation at LDR for biased and grounded configurations and subsequent high temperature anneal. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 300.0mV maximum.

3. Discussion and Conclusion

All tested SMD parameters passed at all downpoints. No bias or anneal sensitivity was observed. [“Attributes Data” on page 3](#) summarizes the attributes data for the test. [“Key Parameter Listing” on page 4](#) summarizes selected key parameters for the part. Finally [“Key Parameter Variables Data” on page 5](#) provides plots of the total dose and anneal response for the selected critical parameters.

4. Revision History

Rev.	Date	Description
0.00	Nov 1, 2018	Initial release

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