ISL70100SEH, ISL73100SEH

Neutron Testing of the ISL70100SEH and ISL73100SEH 40V Current Sense Amplifiers

Introduction

This report summarizes the results of 1MeV equivalent neutron testing of the ISL70100SEH and ISL73100SEH (ISL7x100SEH) current sense amplifiers. The test was conducted to determine the sensitivity of the part to displacement damage (DD) caused by neutron or proton environments. Neutron fluences ranged from 5×10^{11}n/cm^2 to 1×10^{13}n/cm^2.

Reference Documents

- MIL-STD-883 Test Method 1017
- ISL70100SEH, ISL73100SEH Data Sheet
- Standard Military Drawing (SMD) – 5962-20212

Product Description

The ISL70100SEH and ISL73100SEH are radiation hardened 40V current sense amplifiers built on Renesas' proprietary PR40 SOI process and have a wide power supply range that starts at 2.7V and goes up to 40V. The common-mode input range is independent of the supply voltage and extends from -0.3V to 40.0V, making them ideal for use in either high-side or low-side applications. The ISL70100SEH and ISL73100SEH differ only in the level of total ionizing dose acceptance testing.

The ISL7x100SEH are transconductance amplifiers that monitor current through an external sense resistor and output a current proportional to the sensed voltage. The overall gain is adjustable with a single resistor from output to ground.

These amplifiers have extremely low offset voltage and input bias currents, making them ideal for precision applications. They have a bandwidth of 500kHz with a slew rate of 500µA/µs, making them useful for current feedback in telemetry applications. When the parts are powered down (V+ = V- = 0V), the sense pins (RS+, RS-) are high impedance to avoid loading the monitored circuit.

Both parts are available in a hermetically sealed 10-lead ceramic flat-pack package or die form and operate over the full-range military temperature of -55°C to +125°C.

The pinout for the ISL7x100SEH is shown in Figure 1, and the pin descriptions are shown in Table 1.

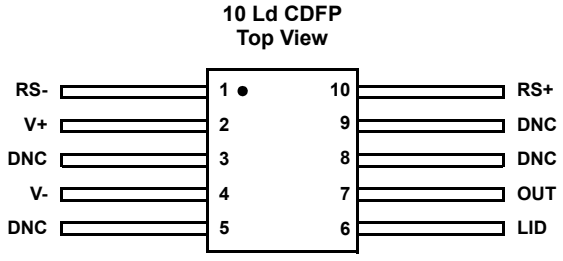

Figure 1. ISL7x100SEH Package and Pin Assignment

Table 1. ISL7x100SEH Pin Descriptions

Pin Number	Pin Name	Description
1	RS-	Negative sense input of current sense amplifier
2	V+	Positive power supply
3	DNC	Do not connect, leave floating.
4	V-	Negative power supply
5	DNC	Do not connect, leave floating.
6	LID	Electrically connected to the lid, connect this pin to V- to avoid floating metal
7	OUT	Scaled output of the input differential (current out for ADJ version and voltage out for fixed)
8	DNC	Do not connect, leave floating.
9	DNC	Do not connect, leave floating.
10	RS+	Positive sense input of current sense amplifier

Contents

1. Test Description

1.1 Irradiation Facility

Neutron fluence irradiations were performed on the test samples on August 31, 2021, at the University of Massachusetts, Lowell (UMASS Lowell) fast neutron irradiator per Mil-STD-883G, Method 1017.2, with each underpowered part during irradiation. The target irradiation levels were 5×10^{11}n/cm^2, 2×10^{12}n/cm^2, and 1×10^{13}n/cm^2. As neutron irradiation activates many of the heavier elements found in a packaged integrated circuit, the parts exposed at the higher neutron levels required (as expected) some cool-down time before being shipped back to Renesas (Palm Bay, FL) for electrical testing.

1.2 Test Fixturing

No formal irradiation test fixturing is involved, as these DD tests are bag tests such that the parts are irradiated with all leads unbiased.

1.3 Radiation Dosimetry

Table 2 shows dosimetry from UMASS Lowell indicating the total accumulated gamma dose and actual neutron fluence exposure levels for each set of samples.

Table 2. ISL7x100SEH Neutron Fluence Dosimetry Data

Irradiation	Requested Fluence (n/cm^2)	Reactor Power (kW)	Time (s)	Fluence Rate (n/cm^2-s)[1][2]	Gamma Dose (rad(Si))[3]	Measured Fluence (n/cm^2)[4]
CRF#62106-A	5.00E+11	10	617	8.10E+08	70	5.38E+11
CRF#62106-B	2.00E+12	100	247	8.10E+09	281	2.05E+12
CRF#62106-C	1.00E+13	1000	123	8.10E+10	1401	1.14E+13

1. Dosimetry method: ASTM E-265.
2. The neutron fluence rate is determined from Initial Testing of the New Ex-Core Fast Neutron Irradiator at UMass Lowell (6/18/02). Validated on 6/07/2011 under the Trident II D5LE neutron facility study by Navy Crane.
3. Based on reactor power at 1,000kW, the gamma dose is 41 ±5.3% krad(Si)/hr as mapped by TLD-based dosimetry.
4. Validated by S-32 flux monitors.

1.4 Characterization Equipment and Procedures

Electrical testing was performed before and after irradiation using the Renesas production automated test equipment (ATE). All electrical testing was performed at room temperature.

1.5 Experimental Matrix

Testing proceeded in general accordance with the guidelines of MIL-STD-883 TM 1017. The experimental matrix consisted of five samples to be irradiated at 5×10^{11}n/cm^2, five to be irradiated at 2×10^{12}n/cm^2, and five to be irradiated at 1×10^{13}n/cm^2. The actual levels achieved, which are shown in Table 2, were 5.2×10^{11}n/cm^2, 1.9×10^{12}n/cm^2, 9.9×10^{12}n/cm^2, and 8.6×10^{13}n/cm^2. Three control units were used.

The 15 ISL70100SEH samples were drawn from Lot XEL3DEHA. Samples were packaged in the standard hermetic 10-lead ceramic (CDFP) production package. Samples were processed through burn-in before irradiation and were screened to the SMD limits at room, low, and high temperatures before the start of neutron testing.

2. Results

Neutron testing of the ISL70100SEH is complete, and the results are reported in the balance of this report. It should be understood when interpreting the data that each neutron irradiation was performed on a different set of samples; this is not total dose testing, where the damage is cumulative.

2.1 Attributes Data

Total dose testing of the ISL7x100SEH is complete. All tested parameters on all samples passed the post-irradiation SMD limits up to 2.05×10^{12}n/cm^2, but all five samples failed some parameters after 1.14×10^{13}n/cm^2. Table 3 summarizes the results.

Table 3. ISL7x100SEH Attributes Data

1MeV Fluence, (n/cm^2)		Sample Size	Pass[1]	Fail	Notes
Planned	Actual				
5×10^{11}	5.38×10^{11}	5	5	0	All passed
2×10^{12}	2.05×10^{12}	5	5	0	All passed
1×10^{13}	1.14×10^{13}	5	0	5	Some Parameters Failed

1. A Pass indicates a sample that passes all SMD limits.

2.2 Key Parameter Variables Data

The plots in Figure 2 through Figure 41 show data plots for key parameters before and after irradiation to each level. The plots show the mean of each parameter as a function of neutron irradiation. The plots also include error bars at each down-point, representing the minimum and maximum measured values of the samples, although in some plots the error bars might not be visible because of their values compared to the scale of the graph. While the applicable electrical limits taken from the SMD are also shown, it should be noted that these limits are provided for guidance only as the ISL7x100SEH is not specified for the neutron environment. It should also be noted that each marker represents a separate set of five samples. The line connecting them is for trend visualization only.

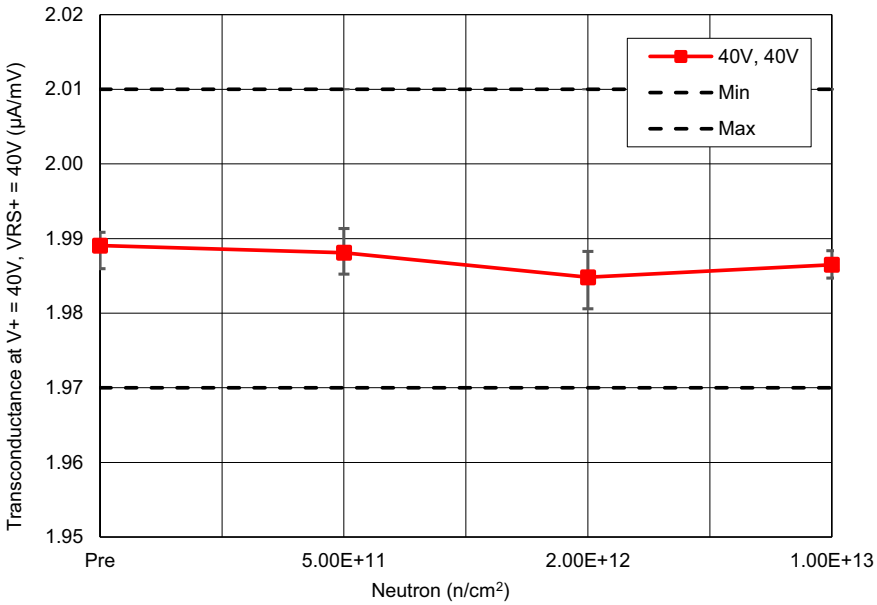

Figure 2. ISL7x100SEH transconductance (gm) with V+ = 40V, V_{RS+} = 40V, and V_{SEN} = 25mV to 150mV, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limits are 1.970µA/mV minimum and 2.010µA/mV maximum.

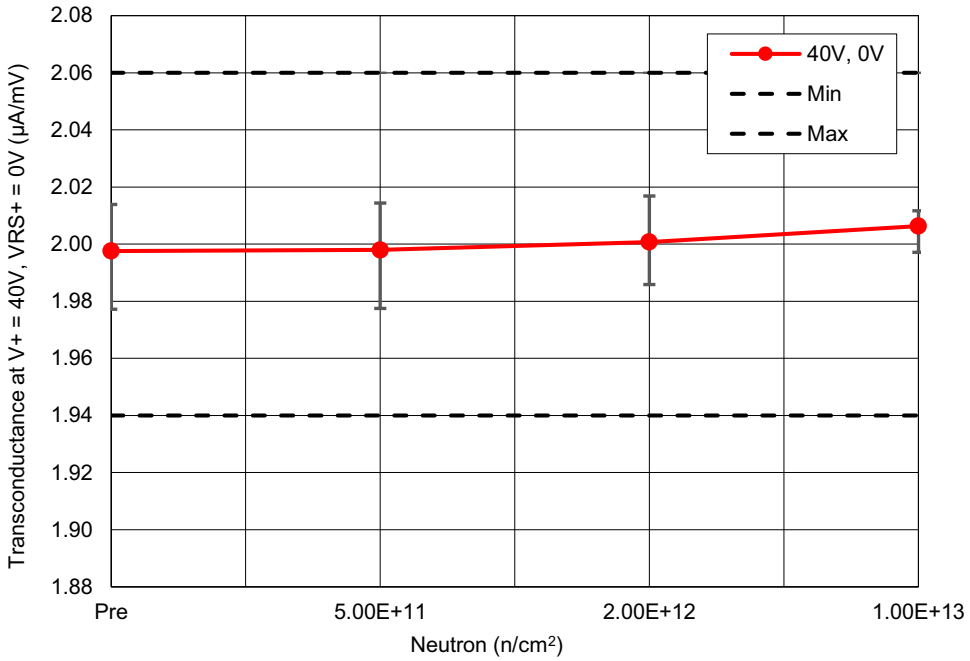

Figure 3. ISL7x100SEH transconductance (g_m) with V+ = 40V, V_{RS+} = 0V, and V_{SEN} = 25mV to 150mV, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limits are 1.940µA/mV minimum and 2.060µA/mV maximum.

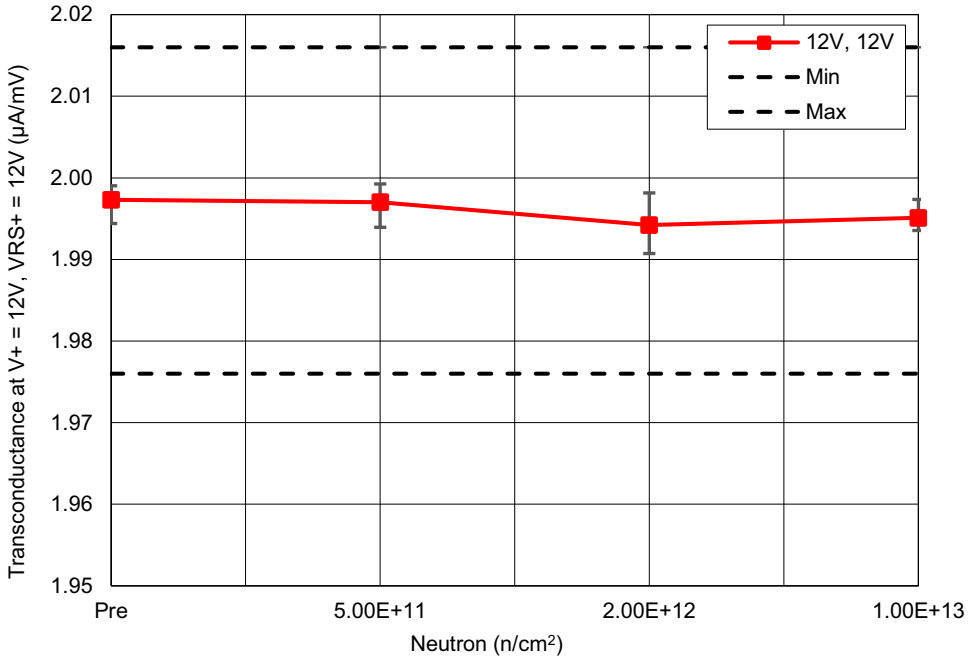

Figure 4. ISL7x100SEH transconductance (g_m) with V+ = 12V, V_{RS+} = 12V, and V_{SEN} = 25mV to 150mV, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limits are 1.976µA/mV minimum and 2.016µA/mV maximum.

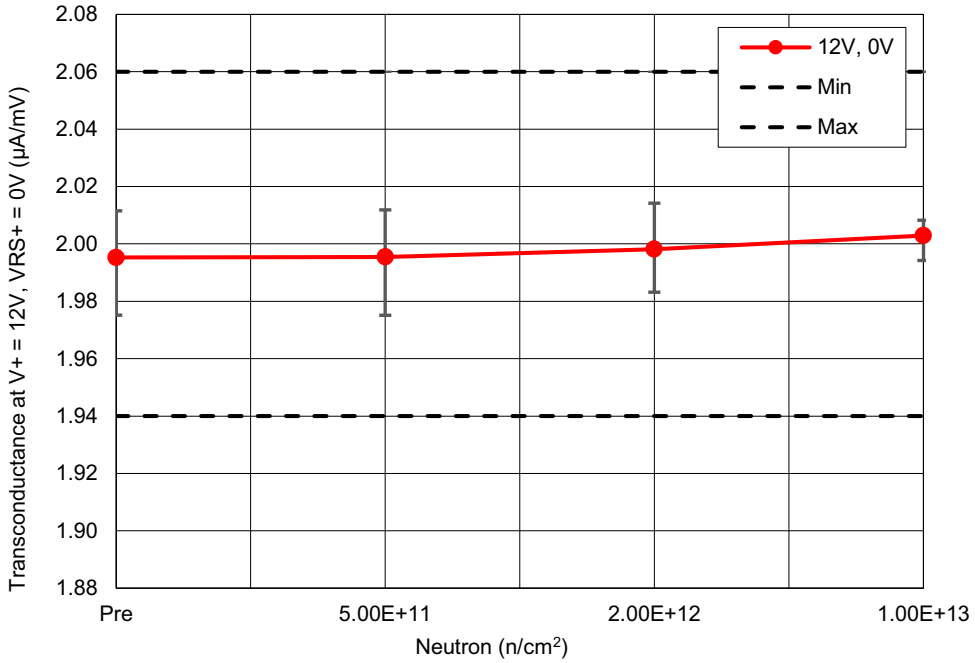

Figure 5. ISL7x100SEH transconductance (g_m) with V+ = 12V, V_{RS+} = 0V, and V_{SEN} = 25mV to 150mV, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limits are 1.940µA/mV minimum and 2.060µA/mV maximum.

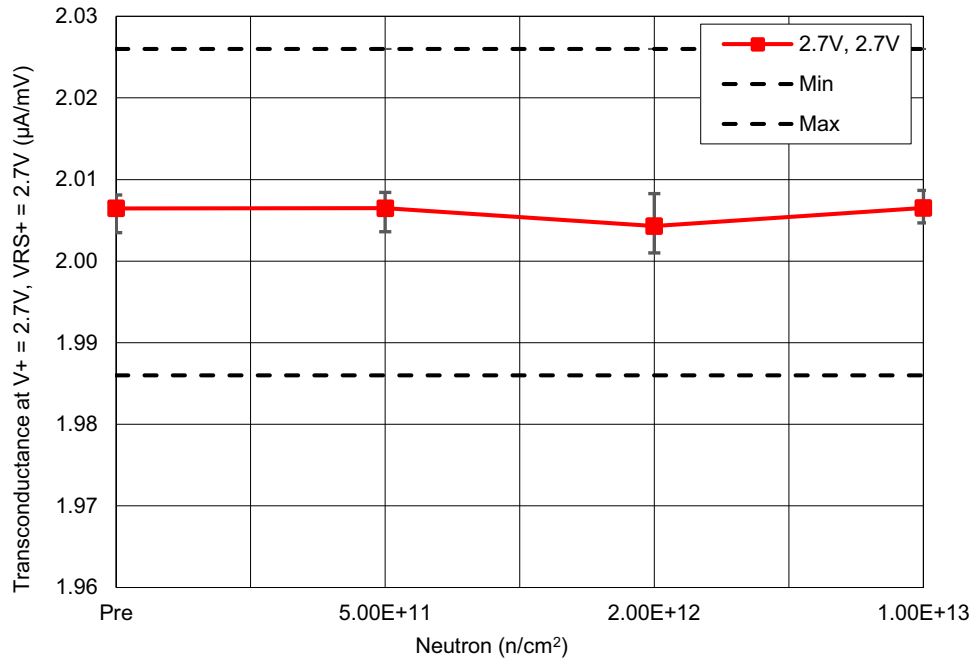

Figure 6. ISL7x100SEH transconductance (g_m) with V+ = 2.7V, V_{RS+} = 2.7V, and V_{SEN} = 25mV to 150mV, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limits are 1.986µA/mV minimum and 2.026µA/mV maximum.

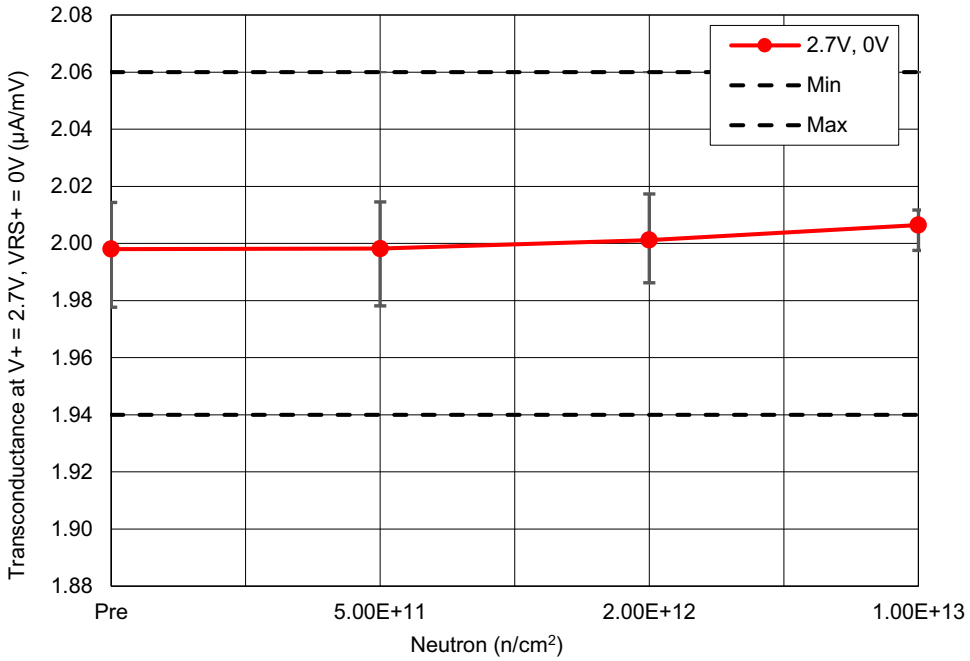

Figure 7. ISL7x100SEH transconductance (g_m) with V+ = 2.7V, V_{RS+} = 0V, and V_{SEN} = 25mV to 150mV, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limits are 1.940µA/mV minimum and 2.060µA/mV maximum.

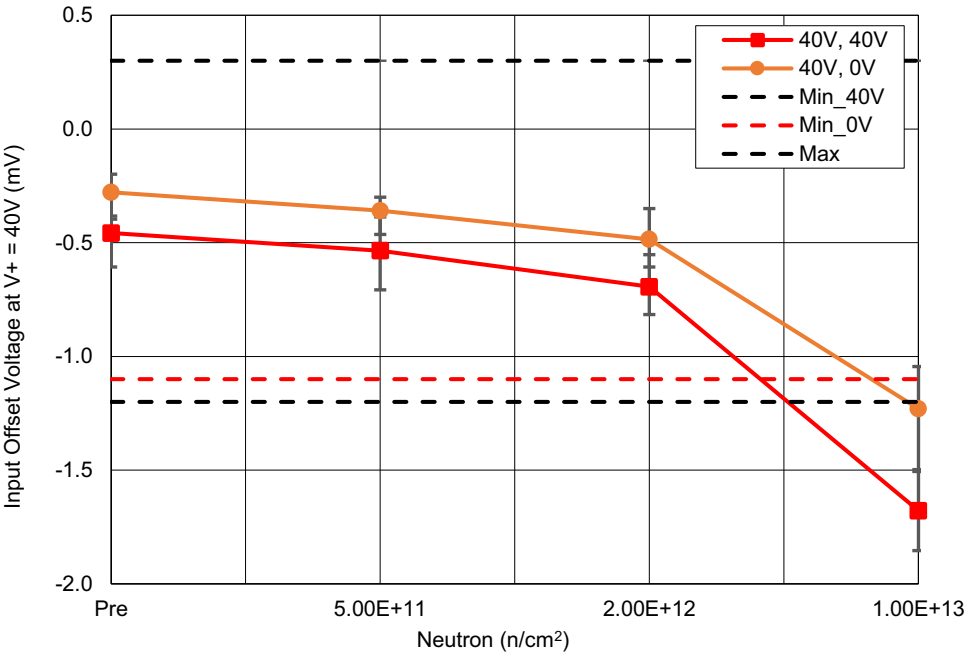

Figure 8. ISL7x100SEH input offset voltage (V_{OS}) with V+ = 40V, V_{RS+} = 40V and 0V, and V_{SEN} = 5mV, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limits are -1200µV (-1.2mV) minimum for V_{RS+} = 40V, -1100µV (-1.1mV) minimum for V_{RS+} = 0V, and 300µV (0.3mV) maximum for both conditions.

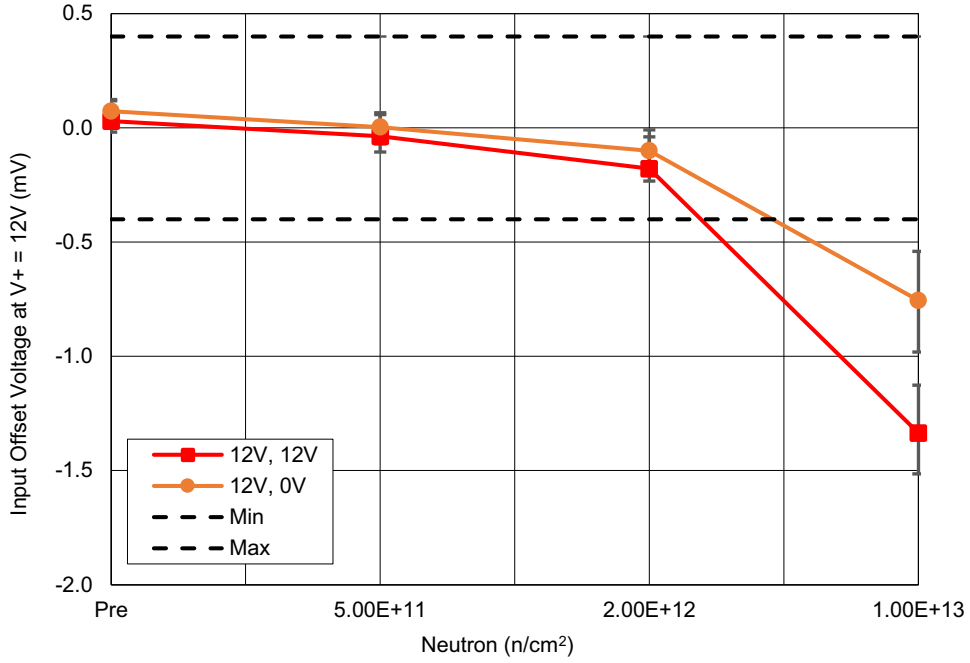

Figure 9. ISL7x100SEH input offset voltage (V_{OS}) with V+ = 12V, V_{RS+} = 12V and 0V, and V_{SEN} = 5mV, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limits are -400µV (-0.4mV) minimum and 400µV (0.4mV) maximum.

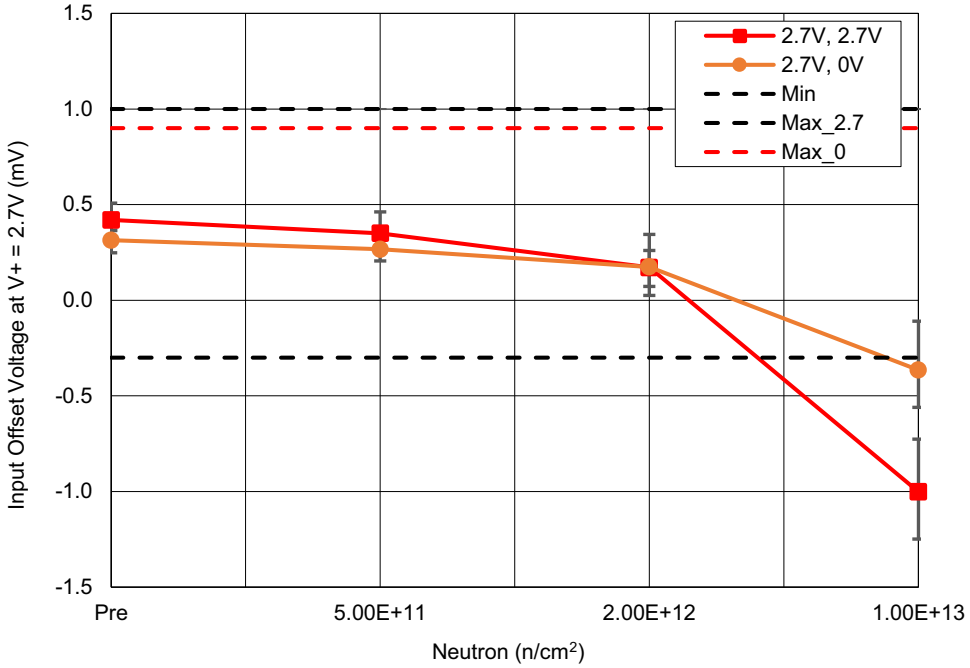

Figure 10. ISL7x100SEH input offset voltage (V_{OS}) with V+ = 2.7V, V_{RS+} = 2.7V and 0V, and V_{SEN} = 5mV, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limits are -300µV (-0.3mV) minimum for both conditions and 1000µV (1.0mV) maximum for V_{RS+} = 2.7V and 900µV (0.9mV) maximum for V_{RS+} = 0V.

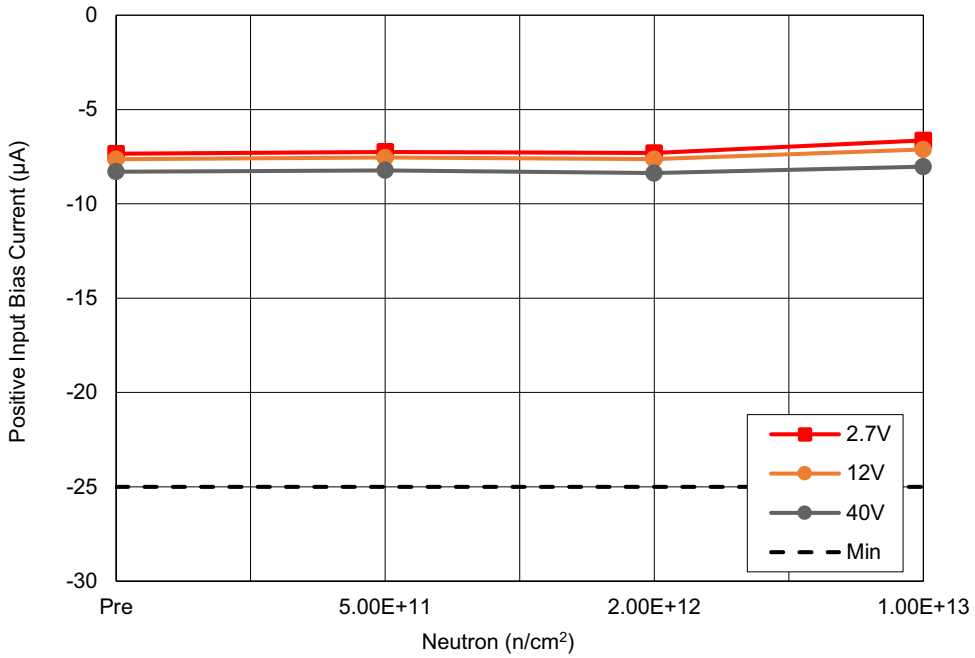

Figure 11. ISL7x100SEH positive input bias current (I_{BIAS+}) with V+ = 2.7V, 12V and 40V, V_{RS+} = 0V, and V_{SEN} = 0mV, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limit is -25µA minimum.

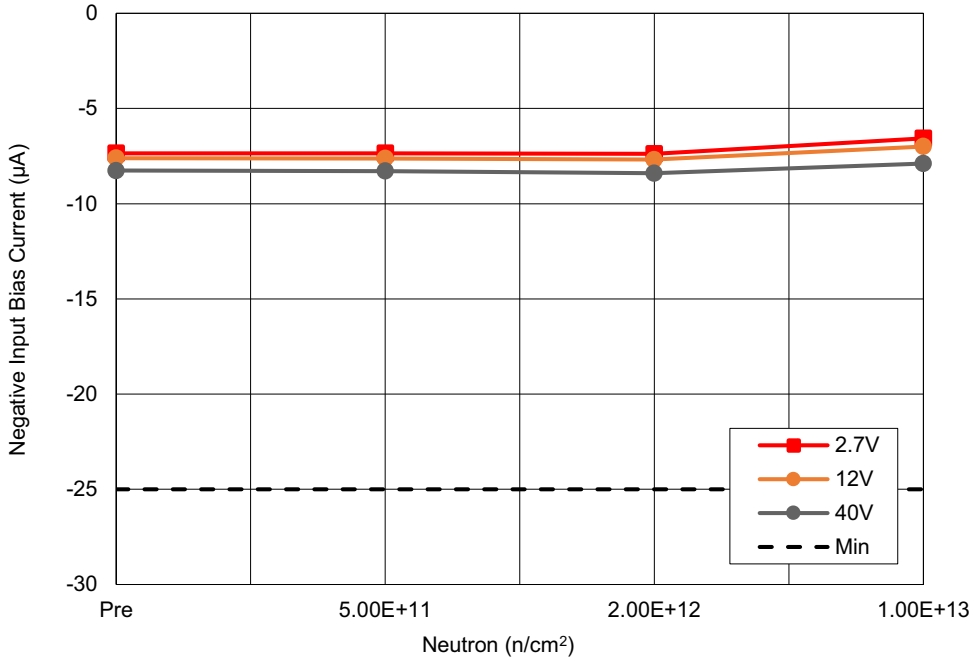

Figure 12. ISL7x100SEH negative input bias current (I_{BIAS-}) with V+ = 2.7V, 12V and 40V, V_{RS+} = 0V, and V_{SEN} = 0mV, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limit is -25µA minimum.

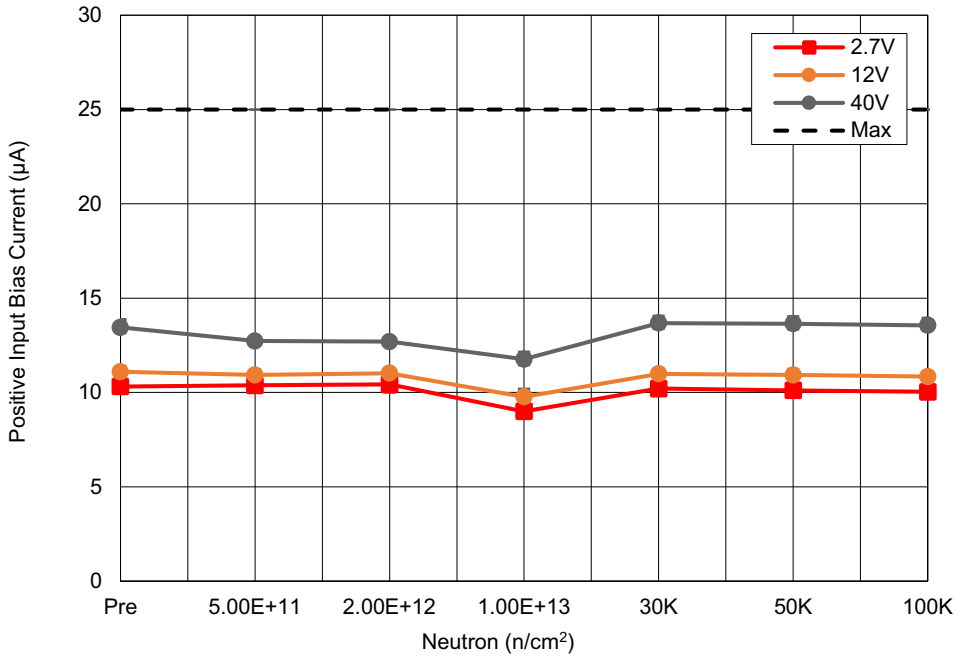

Figure 13. ISL7x100SEH positive input bias current (I_{BIAS+}) with V+ = V_{RS+} = 2.7V, 12V and 40V, V_{SEN} = 0mV, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limit is 25µA maximum.

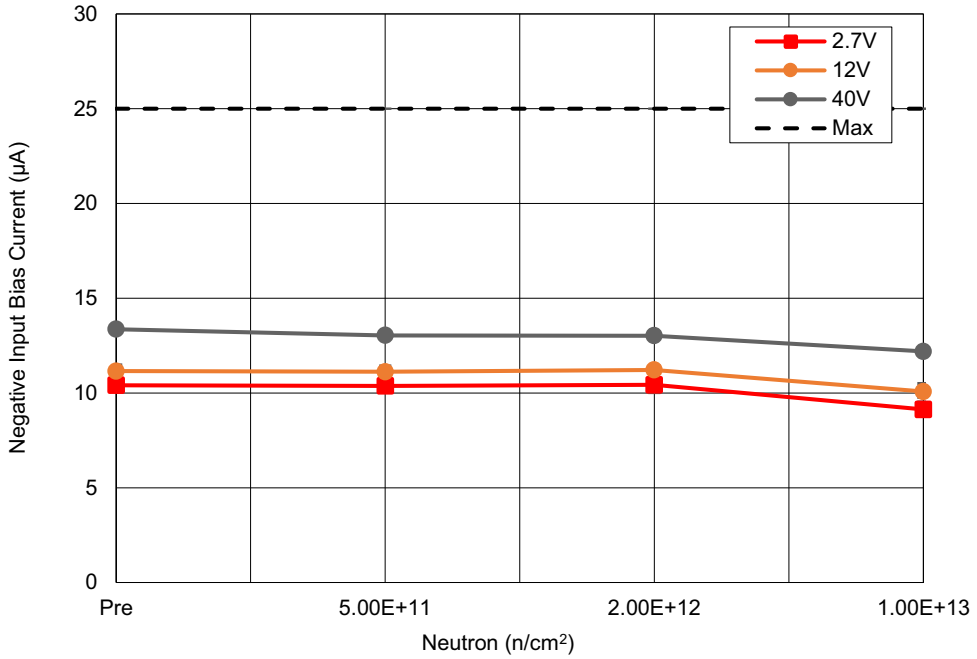

Figure 14. ISL7x100SEH negative input bias current (I_{BIAS-}) with V+ = V_{RS+} = 2.7V, 12V and 40V, V_{SEN} = 0mV, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limit is 25µA maximum.

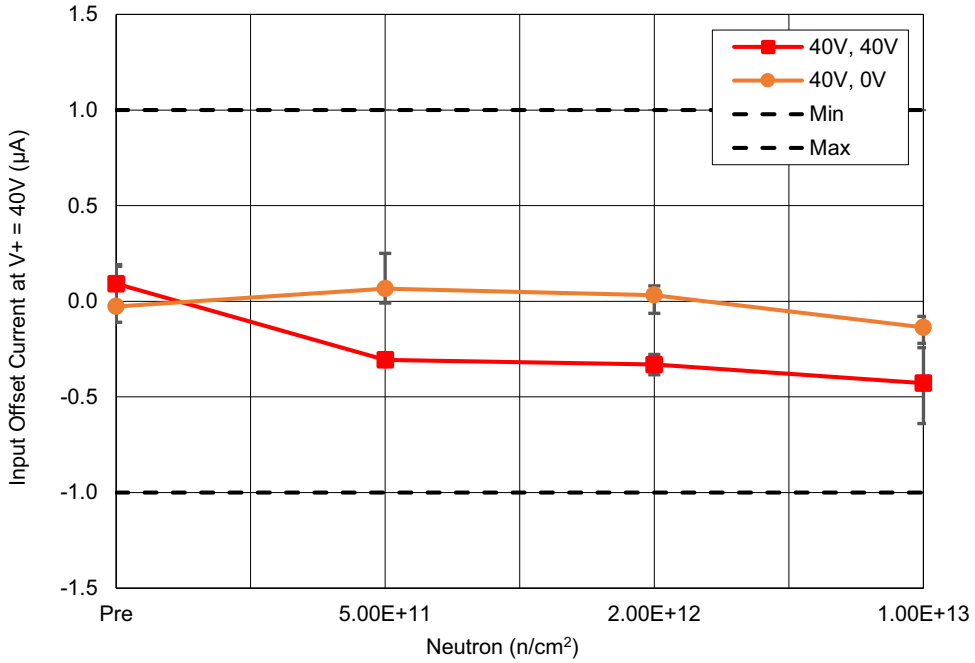

Figure 15. ISL7x100SEH input offset current (I_{OS}) with V+ = 40V, V_{SEN} = 0mV and V_{RS+} = 40V and V_{RS+} = 0V, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limits are -1µA minimum and 1µA maximum.

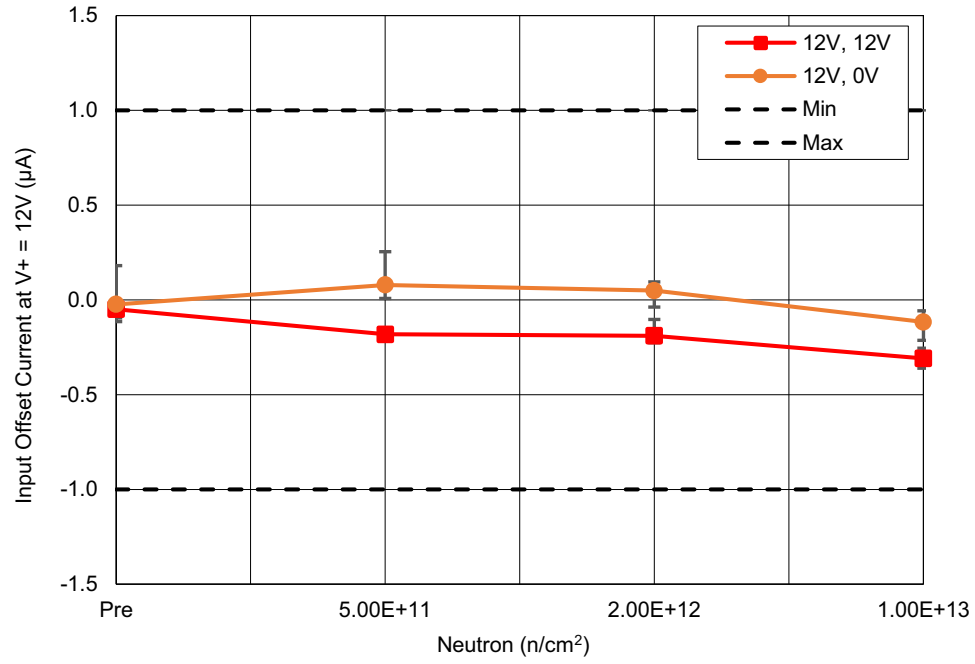

Figure 16. ISL7x100SEH input offset current (I_{OS}) with V+ =12V, V_{SEN} = 0mV and V_{RS+} = 12V and V_{RS+} = 0V, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limits are -1µA minimum and 1µA maximum.

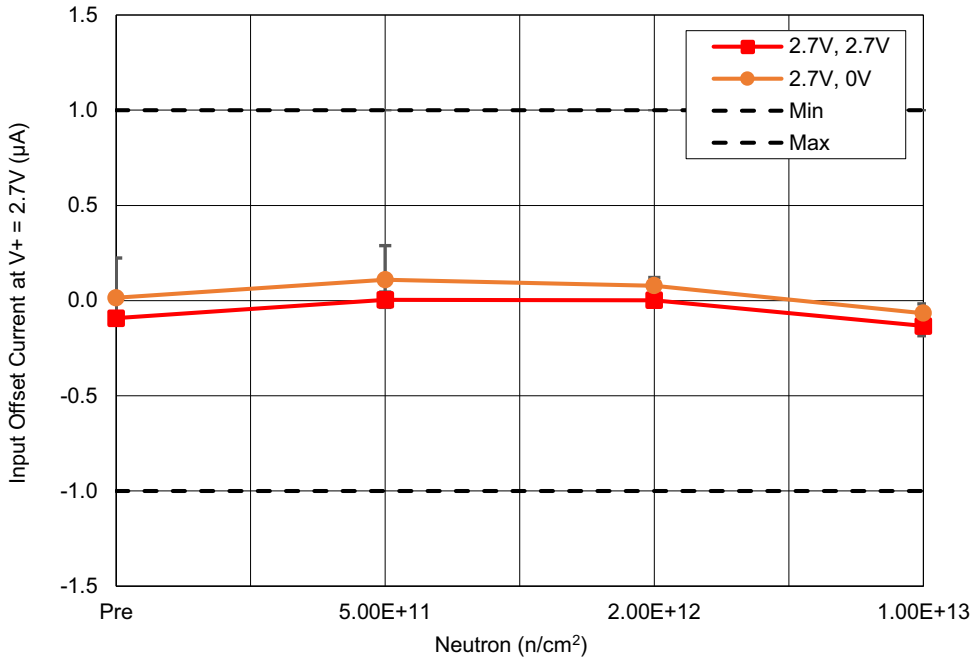

Figure 17. ISL7x100SEH input offset current (I_{OS}) with V+ = 2.7V, V_{SEN} = 0mV and V_{RS+} = 2.7V and V_{RS+} = 0V, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limits are -1µA minimum and 1µA maximum.

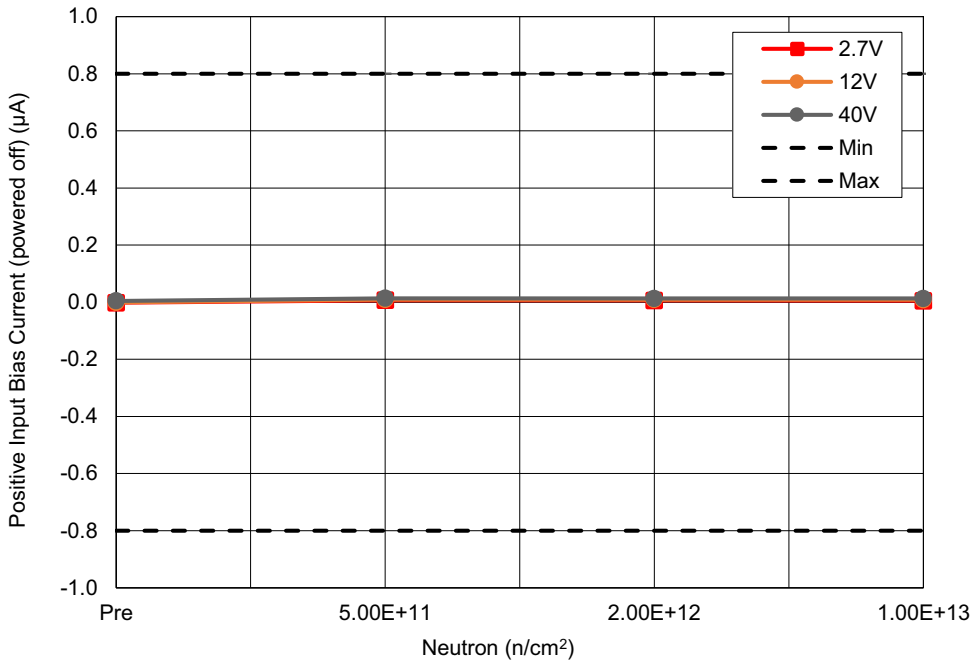

Figure 18. ISL7x100SEH positive input bias current (powered off) (I_{OFF+}) with V+ = V_{SEN} = 0V, and V_{RS+} = 2.7V, 40V and 12.7V, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limits are -0.8µA minimum and 0.8µA maximum.

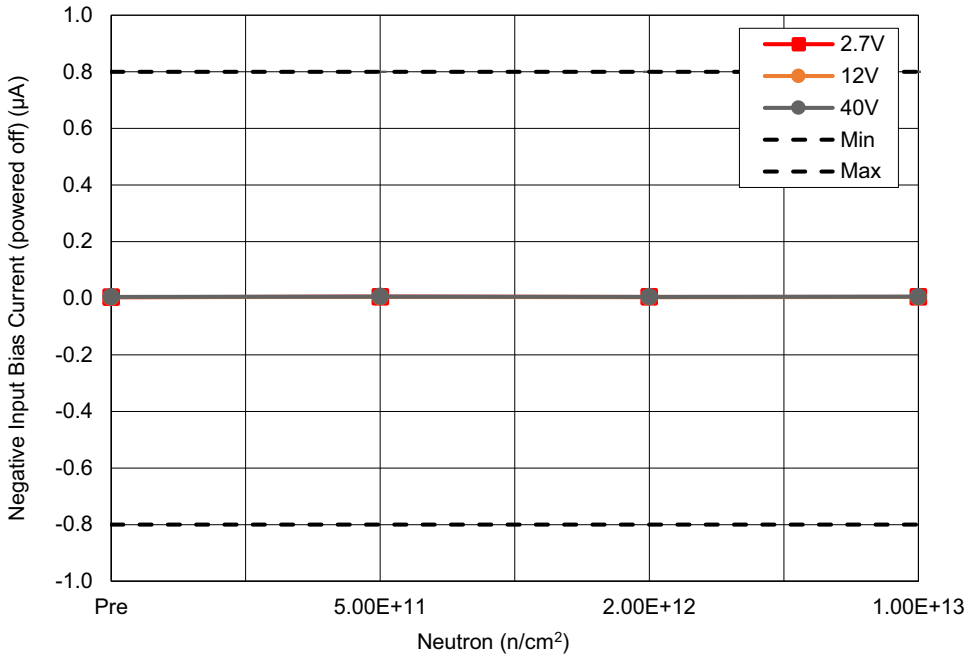

Figure 19. ISL7x100SEH negative input bias current (powered off) (I_{OFF-}) with V+ = V_{SEN} = 0V, and V_{RS+} = 2.7V, 40V, and 12.7V, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limits are -0.8µA minimum and 0.8µA maximum.

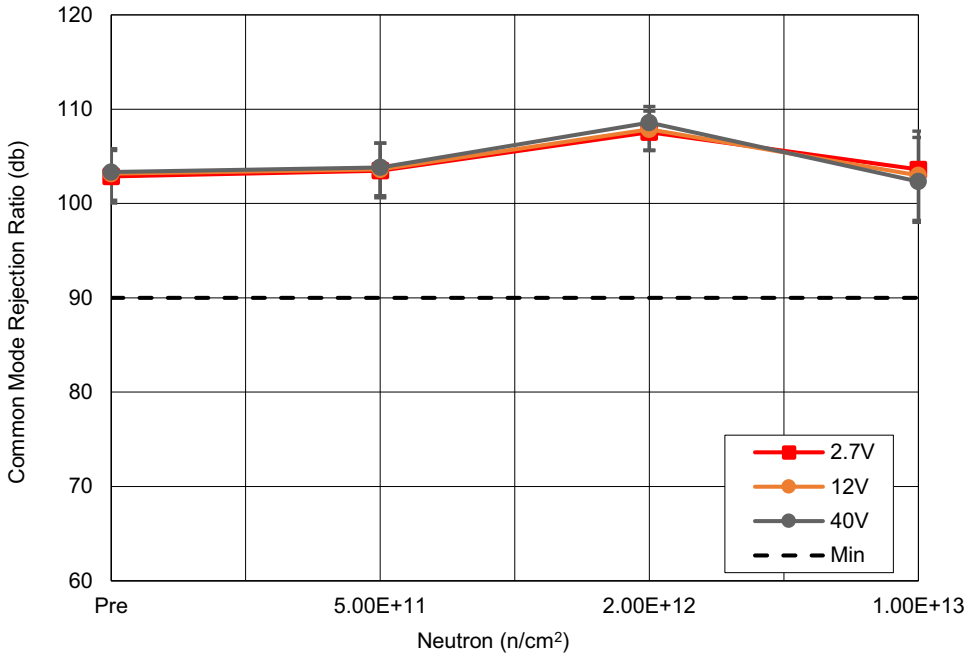

Figure 20. ISL7x100SEH common-mode rejection ratio (CMRR) with V+ = 40V, V_{SEN} = 5mV, V_{RS+} = 2.7V to 40V and -0.3V to 40V, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limit is 90dB minimum.

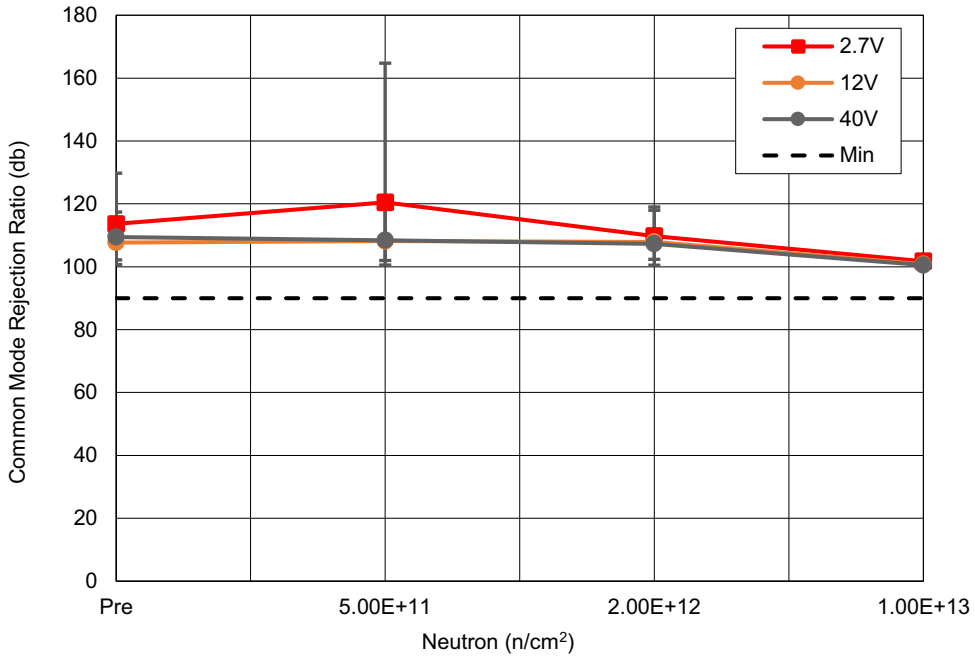

Figure 21. ISL7x100SEH common-mode rejection ratio (CMRR) with V+ = 12V, V_{SEN} = 5mV, V_{RS+} = 2.7V to 40V and -0.3V to 40V, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limit is 90dB minimum.

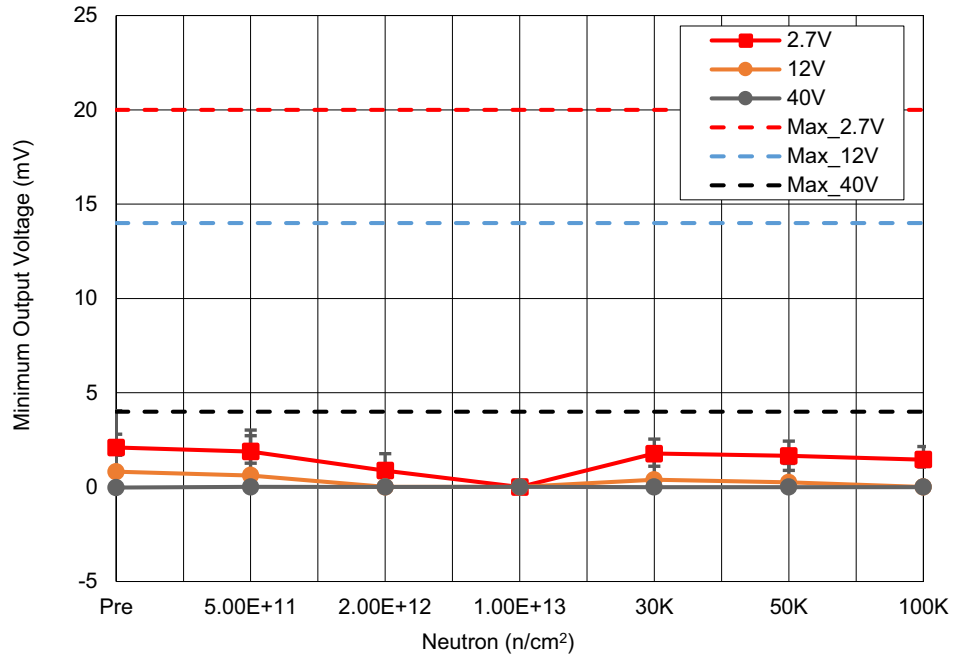

Figure 22. ISL7x100SEH minimum output voltage (V_{OL}) with V+ = 2.7V, 12V, and 40V, and V_{SEN} = 0V, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limits are 14mV maximum for V+ = 2.7V, 20mV maximum for V+ = 12V, and 4mV maximum for V+ = 40V.

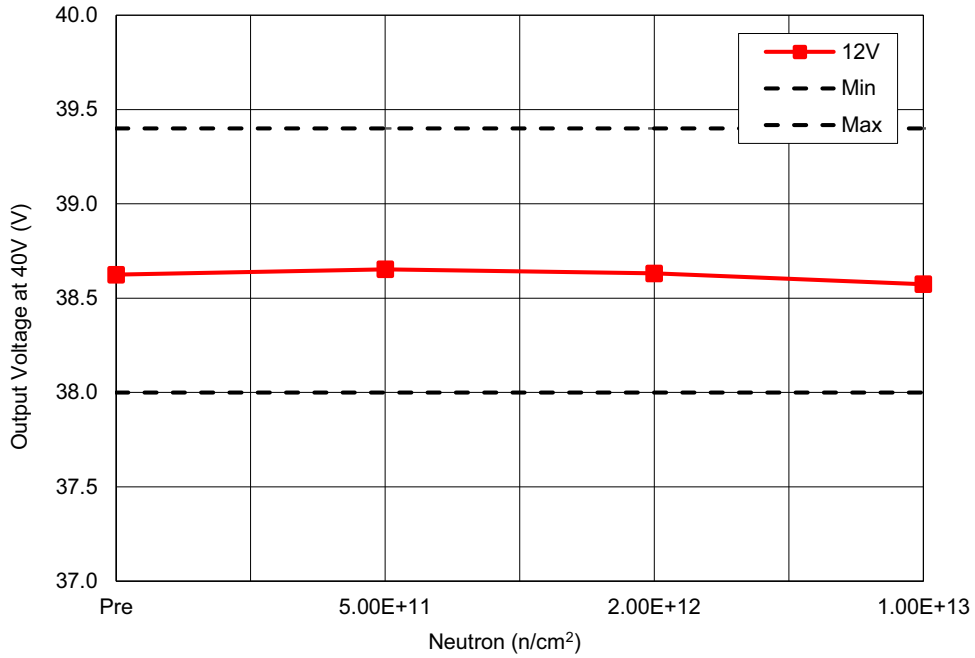

Figure 23. ISL7x100SEH maximum output voltage (V_{OH}) with V+ = 40V, V_{SEN} = 100mV, and A_V = 400, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limits are 38V minimum and 39.4V maximum.

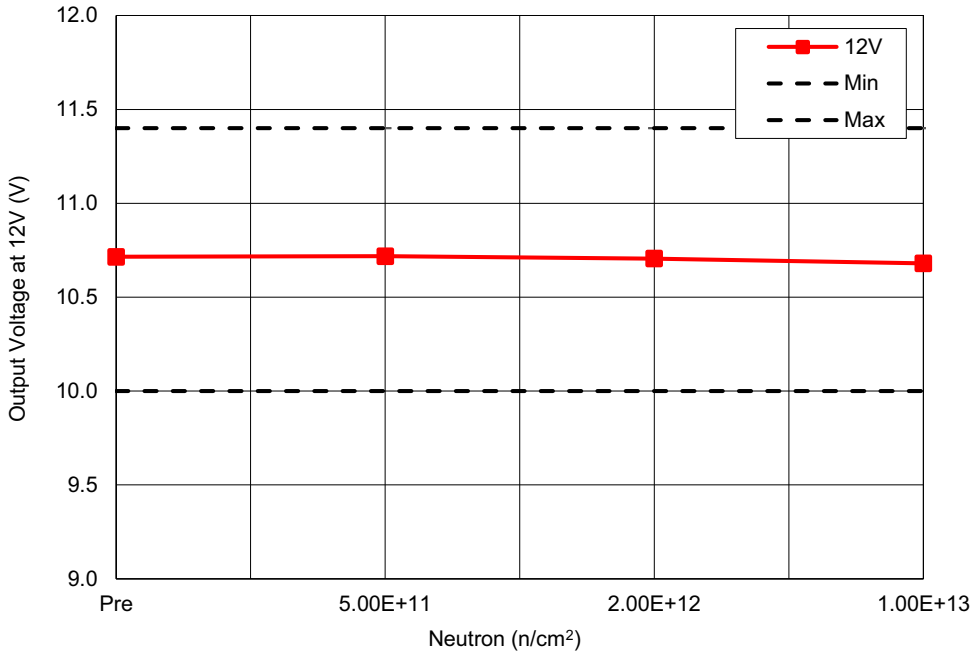

Figure 24. ISL7x100SEH maximum output voltage (V_{OH}) with V+ = 12V, V_{SEN} = 100mV, and A_V = 100, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limits are 10V minimum and 11.4V maximum.

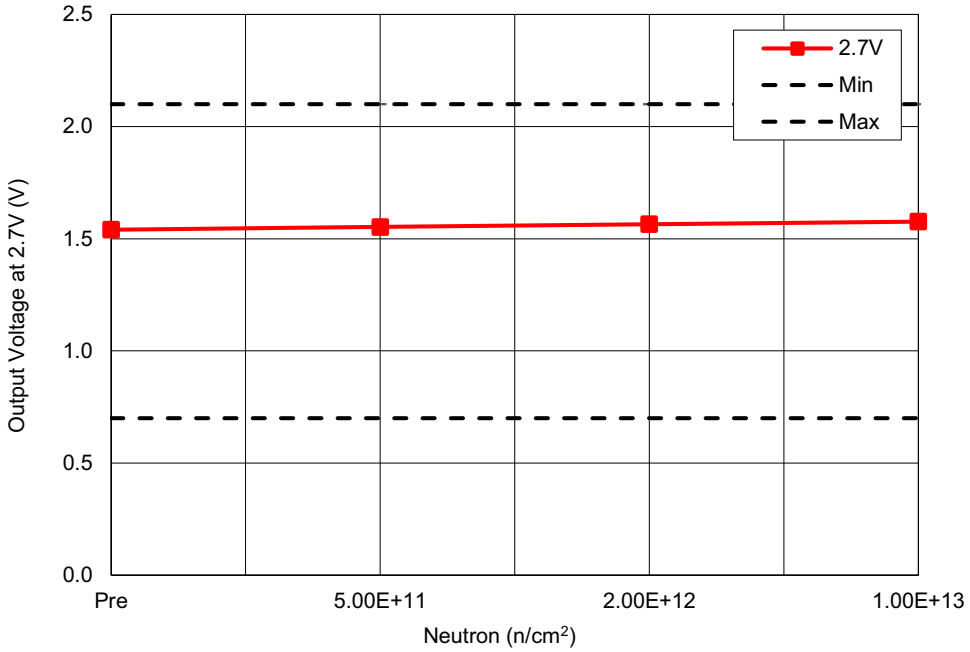

Figure 25. ISL7x100SEH maximum output voltage (V_{OH}) with V+ = 2.7V, V_{SEN} = 120mV, and A_V = 100, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limits are 0.7V minimum and 2.1V maximum.

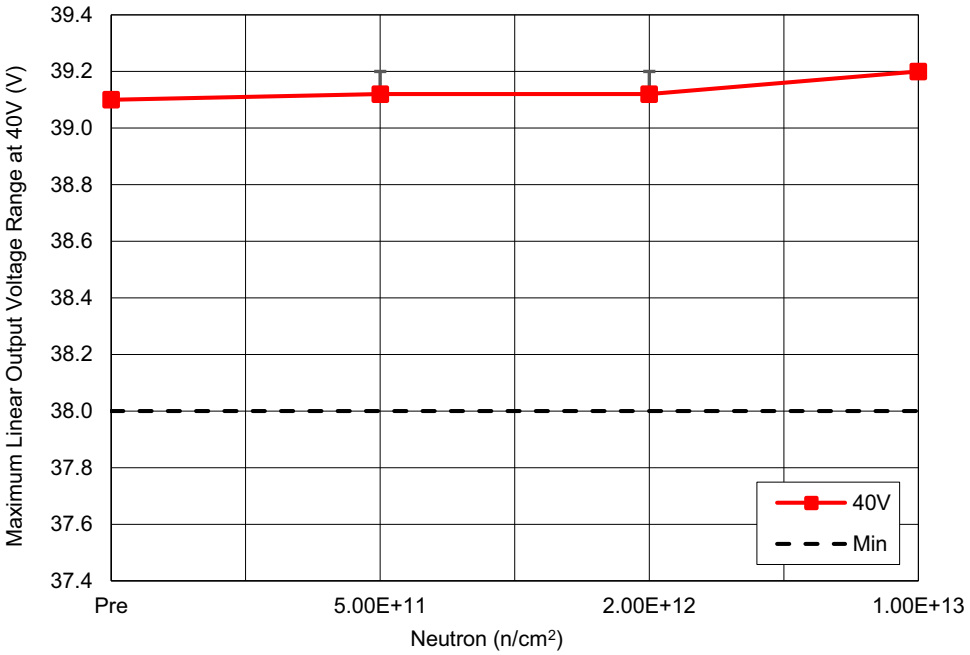

Figure 26. ISL7x100SEH maximum linear output voltage range (OVR) with V+ = 40V, V_{SEN} = 150mV, and R_L = OPEN, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limit is 38V minimum.

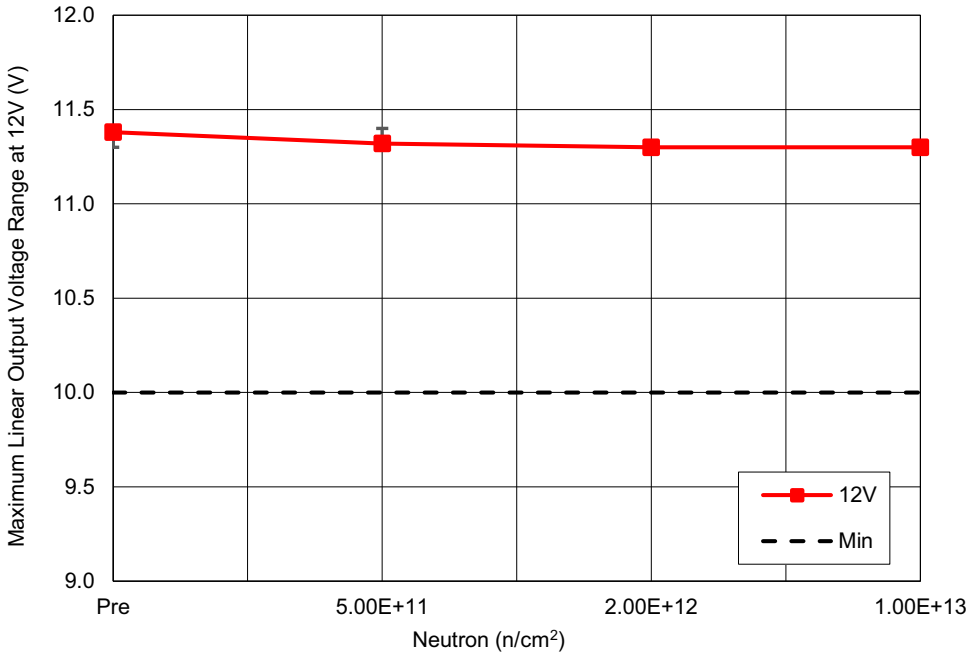

Figure 27. ISL7x100SEH maximum linear output voltage range (OVR) with V+ = 12V, V_{SEN} = 150mV, and R_L = OPEN, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limit is 10V minimum.

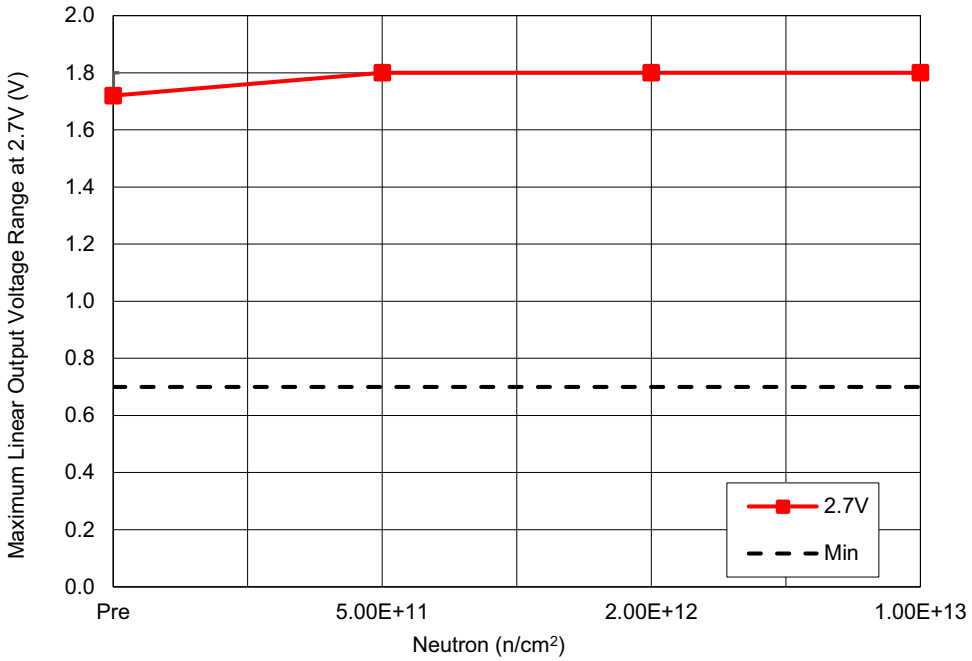

Figure 28. ISL7x100SEH maximum linear output voltage range (OVR) with V+ = 2.7V, V_{SEN} = 150mV, and R_L = OPEN, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limit is 0.7V minimum.

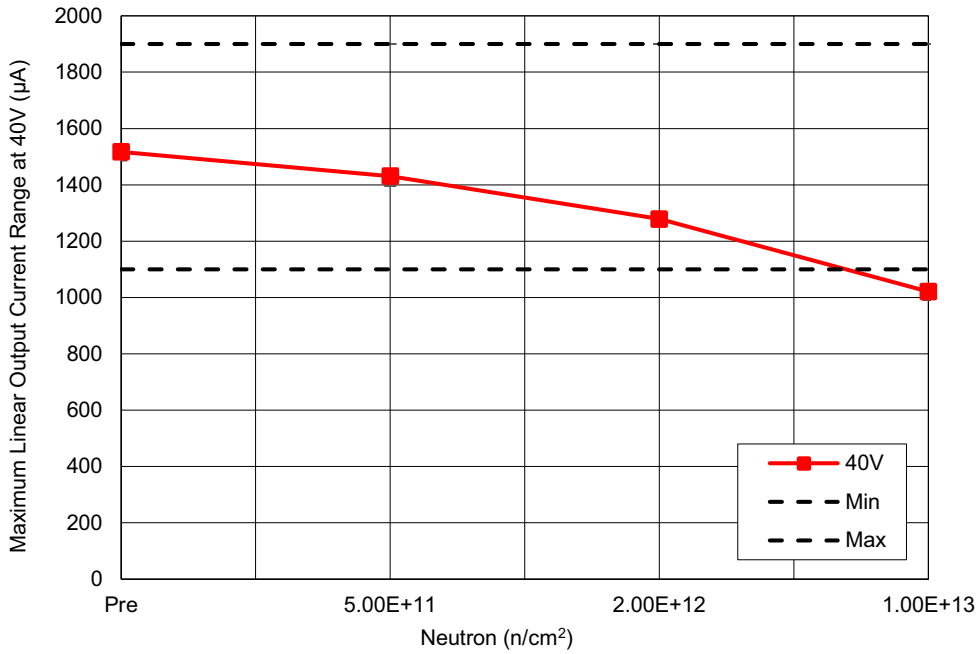

Figure 29. ISL7x100SEH maximum linear output current range (I_{OUT}) with V+ = 40V and R_{OUT} = 0Ω, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limits are 1100µA minimum and 1800µA maximum.

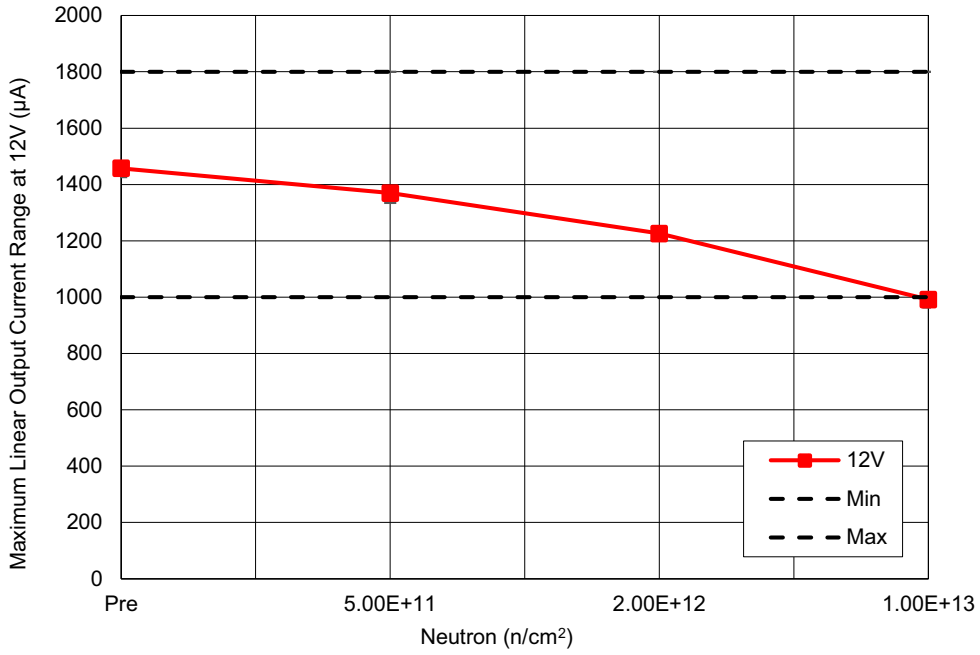

Figure 30. ISL7x100SEH maximum linear output current range (I_{OUT}) with V+ = 12V and R_{OUT} = 0Ω, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limits are 1000µA minimum and 1800µA maximum.

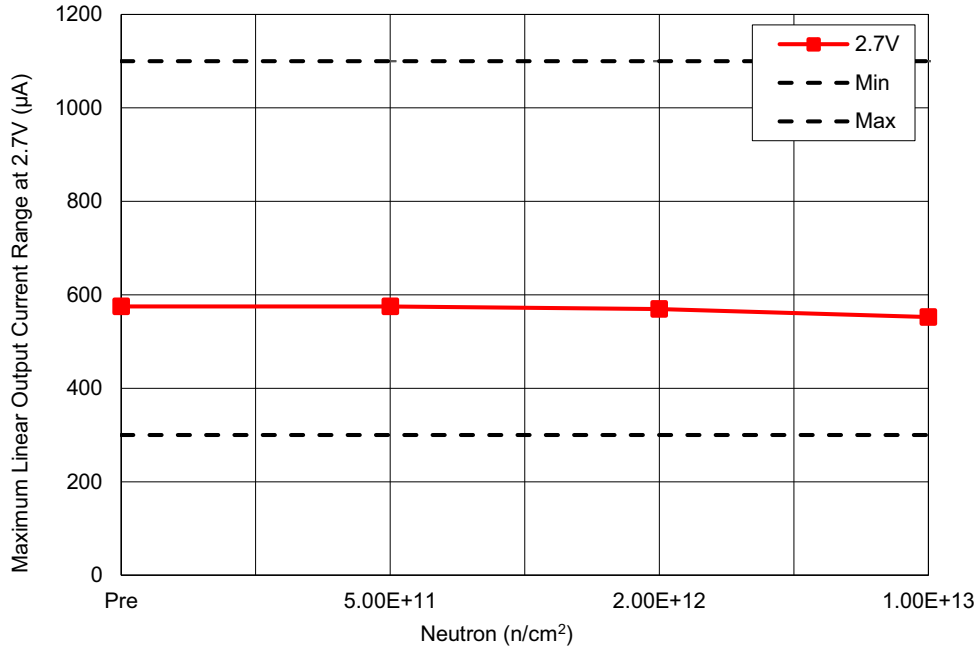

Figure 31. ISL7x100SEH maximum linear output current range (I_{OUT}) with V+ = 2.7V and R_{OUT} = 0Ω, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limits are 300µA minimum and 1100µA maximum.

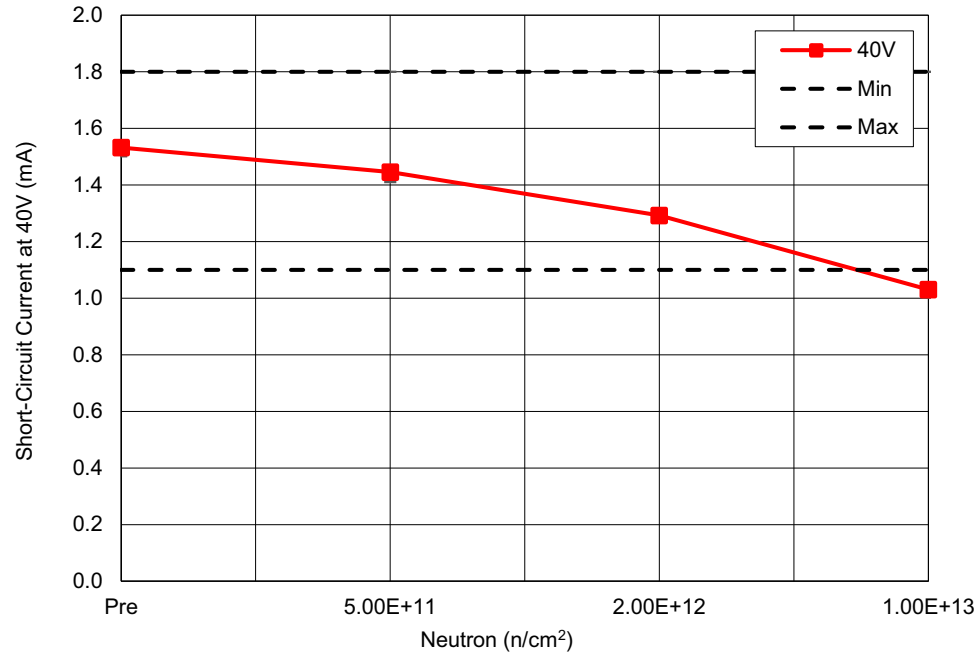

Figure 32. ISL7x100SEH short-circuit current (I_{SC}) with V+ = 40V, V_{RS+} = 40V, V_{RS-} = 0V and R_{OUT} = 0Ω, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limits are 1.1mA minimum and 1.8mA maximum.

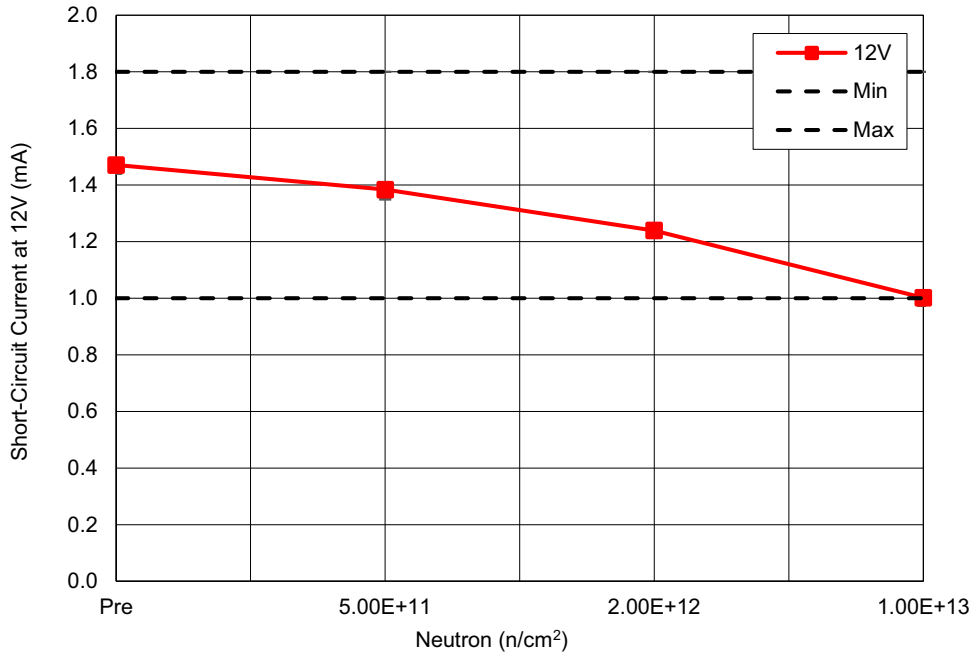

Figure 33. ISL7x100SEH short-circuit current (I_{SC}) with V+ = 12V, V_{RS+} = 12V, V_{RS-} = 0V and R_{OUT} = 0Ω, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limits are 1mA minimum and 1.8mA maximum.

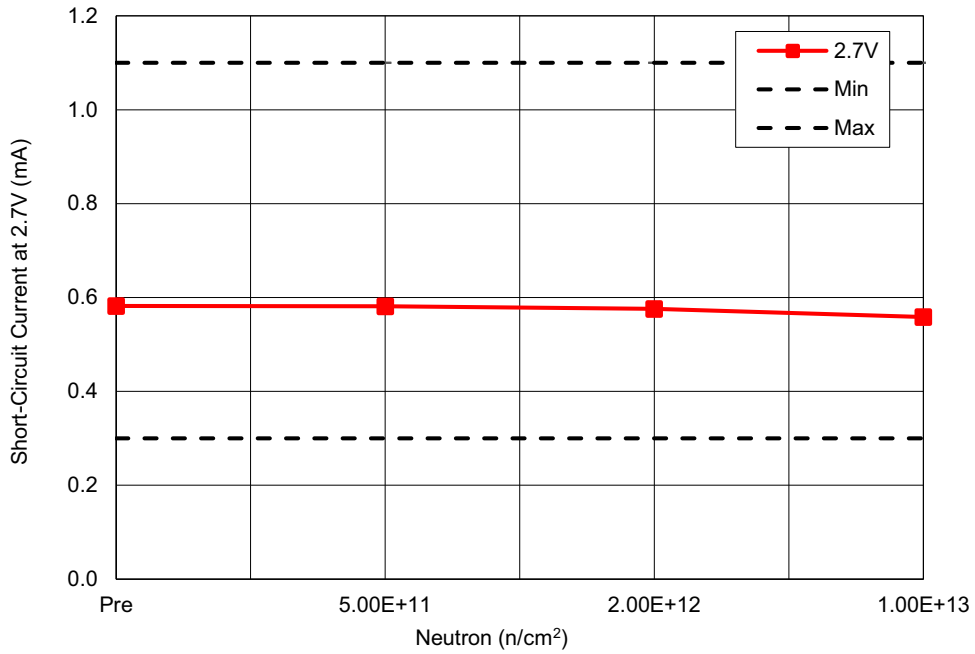

Figure 34. ISL7x100SEH short-circuit current (I_{SC}) with V+ = 2.7V, V_{RS+} = 2.7V, V_{RS-} = 0V and R_{OUT} = 0Ω, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limits are 0.3A minimum and 1.1mA maximum.

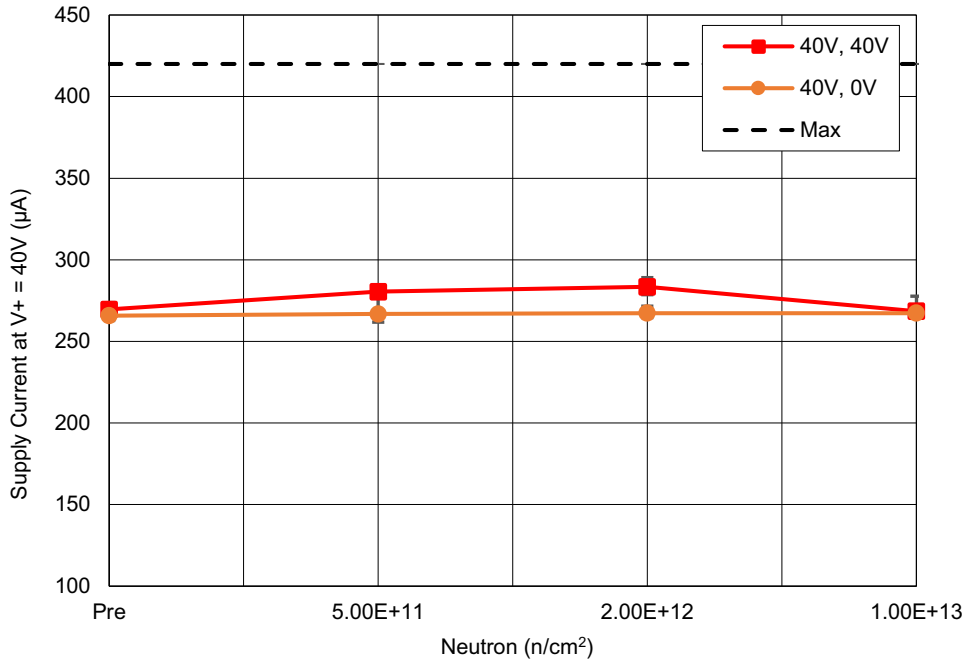

Figure 35. ISL7x100SEH supply current (I_+) with V+ = 40V, V_{SEN} = 0V, V_{RS+} = 40V and 0V, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limit is 420µA maximum.

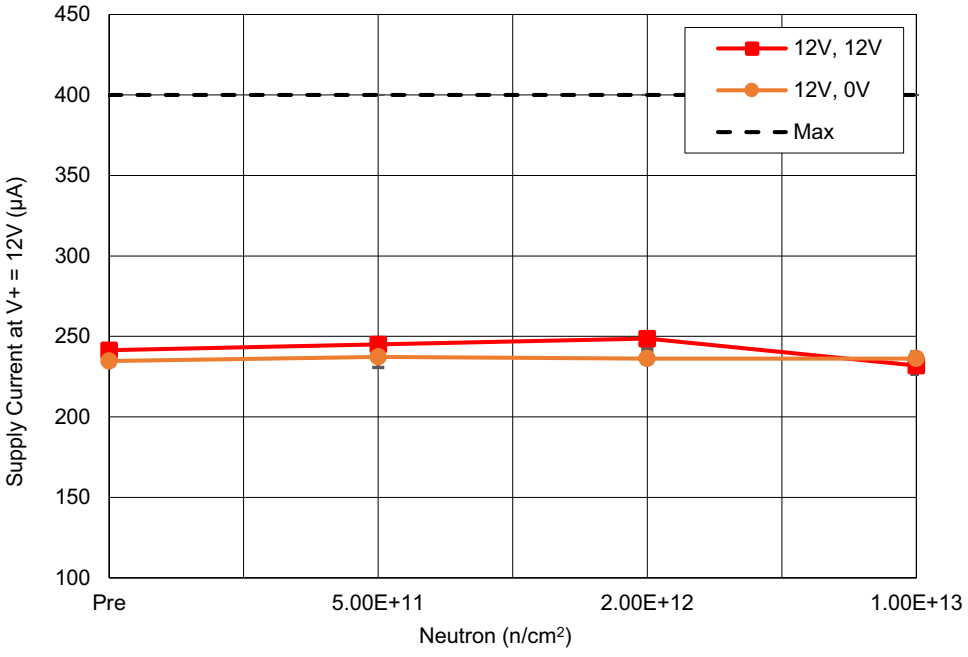

Figure 36. ISL7x100SEH supply current (I_+) with V+ = 12V, V_{SEN} = 0V, V_{RS+} = 12V and 0V, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limit is 400µA maximum.

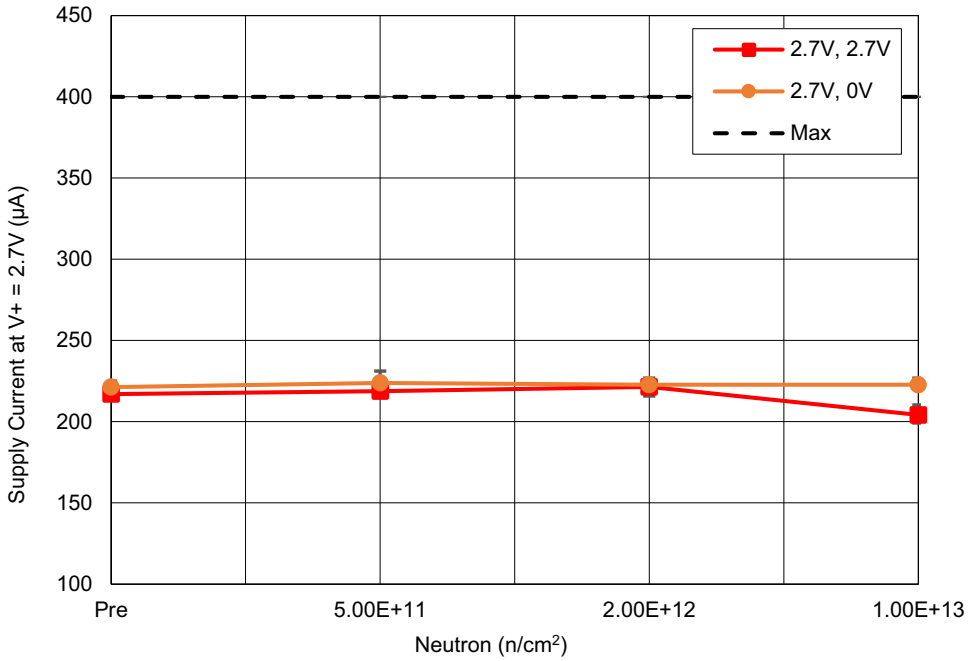

Figure 37. ISL7x100SEH supply current (I_+) with V+ = 2.7V, V_{SEN} = 0V, V_{RS+} = 2.7V and 0V, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limit is 400µA maximum.

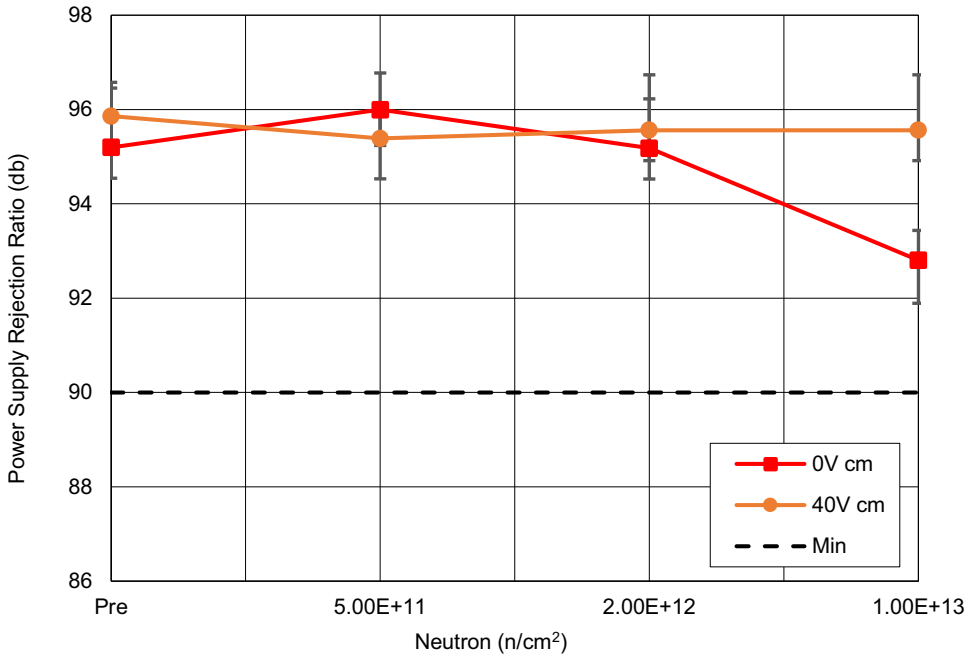

Figure 38. ISL7x100SEH power supply rejection ration (PSRR) with V+ = 40V, V_{RS+} = 0V, 40V and V_{SEN} = 5mV to 150mV, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limit is 90dB minimum.

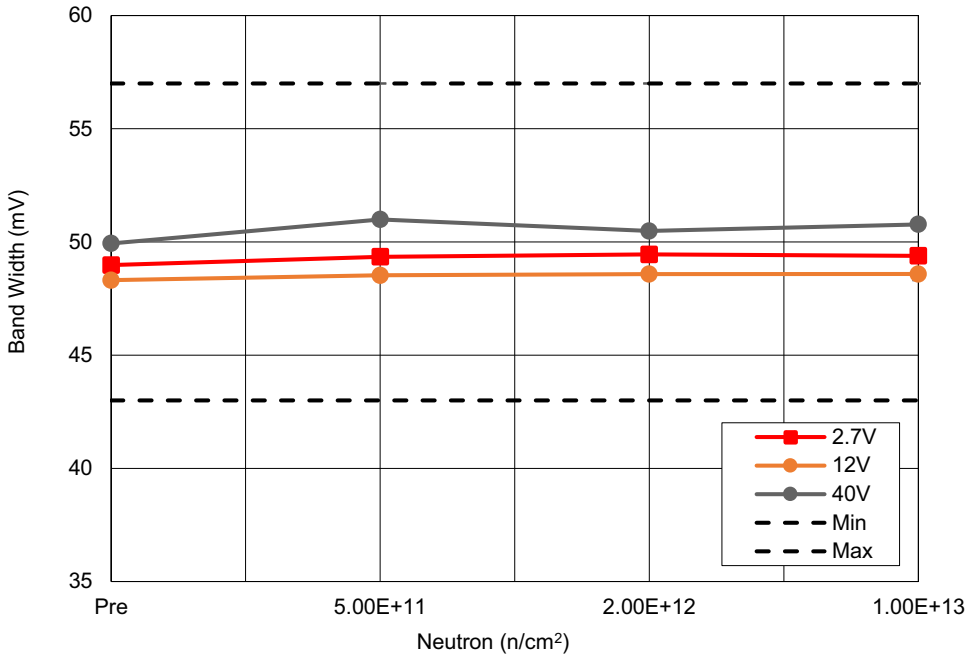

Figure 39. ISL7x100SEH 500KHz Attenuation (Att_{500kHz}) with V+ = 40V, 12V, and 2.7V, V_{SEN} = 5mV to 150mV, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limit is -3dB minimum.

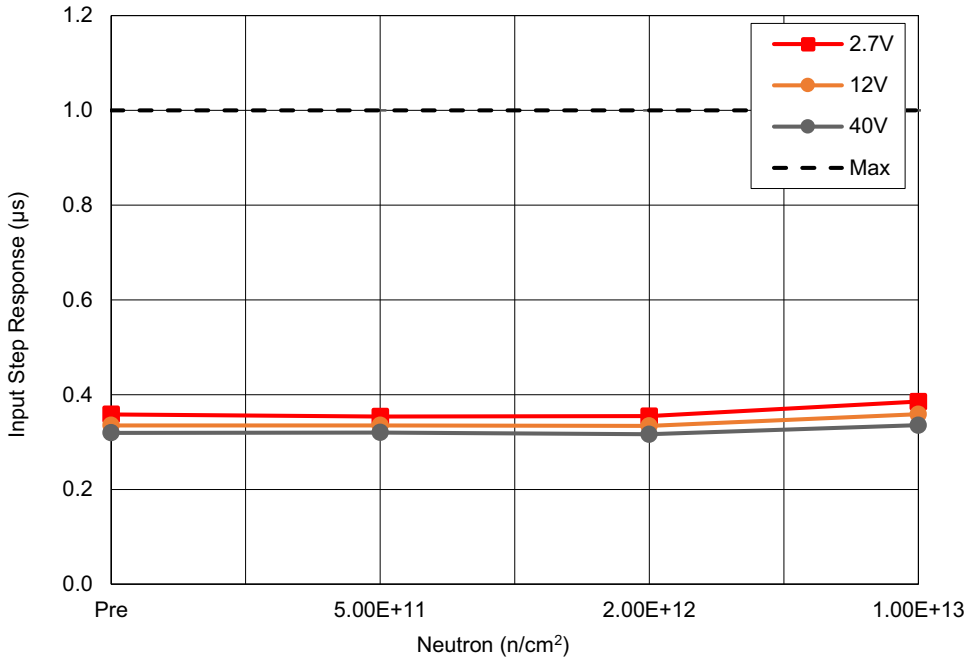

Figure 40. ISL7x100SEH input step response time (t_{RES}) with V+ = 40V, 12V, and 2.7V, V_{SEN} = 5mV to 150mV, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limit is 1µs maximum.

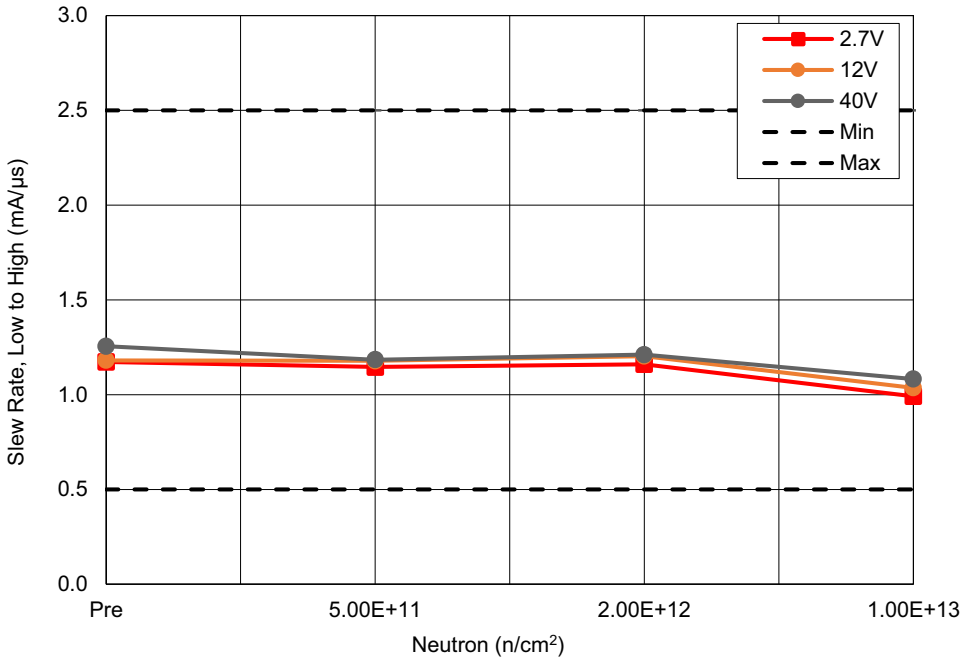

Figure 41. ISL7x100SEH slew rate (SR) with V+ = 40V, 12V, and 2.7V, V_{SEN} = 5mV to 150mV, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post-irradiation SMD limits are 0.5mA/µs minimum and 2.5mA/µs maximum.

3. Discussion and Conclusion

The results of 1MeV equivalent neutron testing of the ISL70100SEH and ISL73100SEH radiation hardened 40V current sense amplifiers were reported. Parts were tested at actual fluences of 5.4×10^{11}n/cm^2, 2.1×10^{12}n/cm^2, and 1.1×10^{13}n/cm^2. All samples passed the post-irradiation SMD limits after all exposures up to and including 2.1×10^{12}n/cm^2; however, all five units failed several SMD post-irradiation limits after 1.1×10^{13}n/cm^2, even though they remained functional. The results of key parameters before and after irradiation to each level are plotted in Figure 2 through Figure 41. The plots show the mean of each parameter as a function of neutron irradiation, with error bars that represent the minimum and maximum measured values. The figures also show the applicable electrical limits taken from the SMD; however, it should be noted that these limits are TID and are provided for guidance only as the ISL7x100SEH is not specified for the neutron environmen

Three parameters failed the post-TID SMD limits and were shown in Figure 8 through Figure 10 (input offset voltage), Figure 29 through Figure 30 (maximum linear output current range), and Figure 32 through Figure 33 (short-circuit current).

The input offset voltage is defined as the voltage that must be applied between the two input terminals of the op amp to obtain zero volts at the output. Ideally the output of the op amp should be at 0V when the inputs are grounded. Figure 8 through Figure 10 show an ever-increasing negative differential voltage must be applied to the inputs to achieve 0V on the output because of displacement created mismatches in the input transistors.

4. Revision History

Revision	Date	Description
1.01	Oct 26, 2022	Corrected mistakes in the Attributes Data section. Updated Figures 2 through 41. Added failure explanations in the Discussion and Conclusions section.
1.00	Jun 21, 2022	Initial release.

Appendix

Table 4 lists the key parameters that are considered indicative of part performance. These parameters are plotted in Figure 2 through Figure 41. All limits are taken from the ISL7x100SEH SMD.

Table 4. ISL7x100SEH Key Total Dose SMD Parameters (T_A = 25°C)

Fig.	Parameter	Symbol	Conditions	Low Limit	High Limit	Unit
2	Transconductance (V_{SEN} = 25mV to 150mV)	g_m	V+ = 40V, V_{RS+} = 40V	1.970	2.010	µA/mV
3			V+ = 40V, V_{RS+} = 0V	1.940	2.060	
4			V+ = 12V, V_{RS+} = 12V	1.976	2.016	
5			V+ = 12V, V_{RS+} = 0V	1.940	2.060	
6			V+ = 2.7V, V_{RS+} = 2.7V	1.986	2.026	
7			V+ = 2.7V, V_{RS+} = 0V	1.940	2.060	
8	Input Offset Voltage (V_{SEN} = 5mV)	V_{OS}	V+ = 40V, V_{RS+} = 40V	-1200	300	µV
			V+ = 40V, V_{RS+} = 0V	-1100	300	
9			V+ = 12V, V_{RS+} = 12V	-400	400	
			V+ = 12V, V_{RS+} = 0V	-400	400	
10			V+ = 2.7V, V_{RS+} = 2.7V	-300	1000	
			V+ = 2.7V, V_{RS+} = 0V	-300	900	
11	Input Bias Current (V_{SEN} = 0mV)	I_{BIAS+}	V+ = 2.7V, 12V, 40V, V_{RS+} = 0V	-25	-	µA
12		I_{BIAS-}				
13		I_{BIAS+}	V+ = V_{RS+} = 2.7V, 12V, 40V	-	25	
14		I_{BIAS-}				
15	Input Offset Current (V_{SEN} = 0mV)	I_{OS}	V+ = 40V, V_{RS+} = 40V, 0V	-1	1	µA
16			V+ = 12V, V_{RS+} = 12V, 0V	-1	1	
17			V+ = 2.7V, V_{RS+} = 2.7V, 0V	-1	1	
18	Input Bias Current (powered off) (V+ = V_{SEN} = 0mV)	I_{OFF+}	V_{RS+} = 40V, 12V, 2.7V	-0.8	0.8	µA
19		I_{OFF-}				
20	Common-Mode Rejection Ratio (V_{SEN} = 5mV)	CMRR	V_{RS+} = 2.7V to V+	90	-	dB
21			V_{RS+} = -0.3V to V+			
22	Minimum Output Voltage (V_{SEN} = 0mV)	V_{OL}	V+ = 40V	-	4	mV
			V+ = 12V	-	20	
			V+ = 2.7V	-	14	
23	Maximum Output Voltage (referenced to V+)	V_{OH}	V+ = 40V; (V_{SEN} = 100mV, A_V = 400)	38	39.4	V
24			V+ = 12V; (V_{SEN} = 120mV, A_V = 100)	10	11.4	
25			V+ = 2.7V; (V_{SEN} = 120mV, A_V = 100)	0.7	2.1	
26	Maximum Linear Output Voltage Range (V_{SEN} = 150mV, R_L = OPEN)	OVR	V+ = 40V	38	-	V
27			V+ = 12V	10	-	
28			V+ = 2.7V	0.7	-	

Table 4. ISL7x100SEH Key Total Dose SMD Parameters (T_A = 25°C) (Cont.)

Fig.	Parameter	Symbol	Conditions	Low Limit	High Limit	Unit
29	Maximum Linear Output Current Range (R_{OUT} = 0Ω)	I_{OUT}	V+ = 40V	1100	1800	µA
30			V+ = 12V	1000	1800	
31			V+ = 2.7V	300	1100	
32	Short-Circuit Current (R_{OUT} = 0Ω)	I_{SC}	V+ = 40V, V_{RS+} = 40V, 0V	1.1	1.8	mA
33			V+ = 12V, V_{RS+} = 12V, 0V	1.0	1.8	
34			V+ = 2.7V, V_{RS+} = 2.7V, 0V	0.3	1.1	
35	Supply Current (V_{SEN} = 0mV)	I+	V+ = 40V, V_{RS+} = 40V, 0V	-	420	µA
36			V+ = 12V, V_{RS+} = 12V, 0V	-	400	
37			V+ = 2.7V, V_{RS+} = 2.7V, 0V	-	400	
38	Power Supply Rejection Ratio (V_{SEN} = 5mV to 150mV)	PSRR	V+ = 40V, V_{RS+} = 0V, 40V	90	-	dB
39	500kHz Attenuation	Att_{500kHz}	V+ = 40V, 12V, 2.7V	-3	-	dB
40	Input Step Response Time (V_{SEN} = 5mV to 150mV)	t_{RES}	V+ = 40V, 12V, 2.7V	-	1	µs
41	Slew rate (V_{SEN} = 5mV to 150mV)	SR	V+ = 40V, 12V, 2.7V	0.5	2.5	mA/µs

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