

## ISL70244SEH, ISL73244SEH

Neutron Testing of the ISL7x244SEH Radiation Hardened 40V Dual Rail-to-Rail Input-Output, Low-Power

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### Introduction

This report summarizes results of 1MeV equivalent neutron testing of the ISL70244SEH 40V dual rail-to-rail input-output, low-power operational amplifier. These results also apply to the ISL73244SEH. The test was conducted to determine the sensitivity of the part to Displacement Damage (DD) caused by neutron or proton environments. Planned neutron fluences ranged from  $5 \times 10^{11} \text{ n/cm}^2$  to  $1 \times 10^{14} \text{ n/cm}^2$  with actual fluences coming in within  $\pm 15\%$  of that. This project was carried out in collaboration with Honeywell Aerospace in Clearwater, FL, and their support is gratefully acknowledged.

### Related Literature

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

- [ISL70244SEH](#) and [ISL73244SEH](#) device pages
- MIL-STD-883 test method 1017

### Product Description

The radiation hardened ISL7x244SEH is a 40V dual rail-to-rail input-output, low-power operational amplifier featuring two low-power amplifiers optimized to provide maximum dynamic range. These operational amplifiers (op amps) feature a unique combination of rail-to-rail operation on the input and output and a slew-rate enhanced front end that provides ultra fast slew rates positively proportional to a given step size. These features increase accuracy under both periodic and transient conditions. The ISL7x244SEH also offers low power, low offset voltage, and low temperature drift, which makes it ideal for applications requiring both high DC accuracy and AC performance.

The amplifiers are designed to operate over a single supply range of 2.7V to 40V or a split supply voltage range of  $\pm 1.35\text{V}$  to  $\pm 20\text{V}$ .

Specifications for Rad Hard QML devices are controlled by the Defense Logistics Agency (DLA) in Columbus, OH. The SMD is the controlling document and must be cited when ordering.

# 1. Test Description

## 1.1 Irradiation Facility

Neutron fluence irradiations were performed on the test samples on June 26, 2018, at the WSMR Fast Burst Reactor (FBR) per Mil-STD-883G, Method 1017.2, with each part unpowered during irradiation and all leads shorted. The target irradiation levels were  $5 \times 10^{11} \text{ n/cm}^2$ ,  $2 \times 10^{12} \text{ n/cm}^2$ ,  $1 \times 10^{13} \text{ n/cm}^2$ , and  $1 \times 10^{14} \text{ n/cm}^2$ . 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 cooldown 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 in the sense that the parts are irradiated with all leads shorted together.

## 1.3 Radiation Dosimetry

Table 1 shows the TLD and Sulfur pellet dosimetry from WSMR indicating the total accumulated gamma dose and actual neutron fluence exposure levels for each sets of samples. This dosimetry process is traceable to NIST (IAW ASTM E722).

Table 1. ISL7x244SEH Neutron Fluence Dosimetry Data

TLD		Sulfur Pellet						
TLD #	cGy(Si) <sup>[1]</sup>	Pellet #	Distance (inches)	Exposure ID	Flu >3MeV (n/cm <sup>2</sup> )	% Uncertainty <sup>[2]</sup>	Total Fluence (n/cm <sup>2</sup> )	1Mev Si (n/cm <sup>2</sup> )
290	1.190E+02	6478	26.6	Free Field	7.493E+10	7.1%	6.059E+11	5.212E+11
280	3.802E+02	6416	13.45	Free Field	2.702E+11	7.1%	2.132E+12	1.890E+12
260	2.255E+03	6485	24	Free Field	1.427E+12	7.1%	1.145E+13	9.907E+12
257	1.562E+04	6482	8	Free Field	1.221E+13	7.1%	9.588E+13	8.565E+13

1. 1 cGy(Si) = 1rad(Si)

2. The % Uncertainty column is applicable only to the Fluence >3MeV.

## 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  $5 \times 10^{11} \text{ n/cm}^2$ , five to be irradiated at  $2 \times 10^{12} \text{ n/cm}^2$ , five to be irradiated at  $1 \times 10^{13} \text{ n/cm}^2$  and five to be irradiated at  $1 \times 10^{14} \text{ n/cm}^2$ . The actual levels achieved, which are shown in Table 2, were  $5.2 \times 10^{11} \text{ n/cm}^2$ ,  $1.9 \times 10^{12} \text{ n/cm}^2$ ,  $9.9 \times 10^{12} \text{ n/cm}^2$  and  $8.6 \times 10^{13} \text{ n/cm}^2$ . Two control units were used.

The 20 ISL7x244SEH samples were drawn from Lots X2LOTT (18) and X2LOTS (2). Samples were packaged in the standard hermetic 10 lead Ceramic Flatpack (CFP) production package, code K10.A. 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 ISL7x244SEH 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

Table 2. ISL7x244SEH Attributes Data

1MeV Fluence, (n/cm <sup>2</sup> )		Sample Size	Pass <sup>[1]</sup>	Fail	Notes
Planned	Actual				
5x10 <sup>11</sup>	5.2x10 <sup>11</sup>	5	5	0	All passed
2x10 <sup>12</sup>	1.9x10 <sup>12</sup>	5	5	0	All passed
1x10 <sup>13</sup>	9.9x10 <sup>12</sup>	5	0	5	Failed I <sub>B</sub> at ±2.5V
1x10 <sup>14</sup>	8.6x10 <sup>13</sup>	5	0	5	Failed V <sub>OS</sub> , I <sub>B</sub> , A <sub>VOL</sub> , PSRR

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

### 2.2 Variables Data

The plots in Figure 1 through Figure 36 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 due to their values compared to the scale of the graph. The applicable post-TID electrical limits taken from the SMD are also shown.

All samples passed the post-irradiation SMD limits after all exposures up to and including 1.9x10<sup>12</sup>n/cm<sup>2</sup>, but all five tested units failed the SMD post-irradiation limits for input bias (I<sub>B</sub>) at 2.5V (Figure 15) after 9.9x10<sup>12</sup>n/cm<sup>2</sup> and some or all units failed measurements for input offset voltage (V<sub>OS</sub>), input bias (I<sub>B</sub>), open loop gain (A<sub>VOL</sub>), Power Supply Rejection Ratio (PSRR), output voltage high (V<sub>OH</sub>) and output voltage low (V<sub>OL</sub>) after 8.6x10<sup>13</sup>n/cm<sup>2</sup>. Several of the V<sub>OS</sub> measurements clamped the ATE at 509μV.

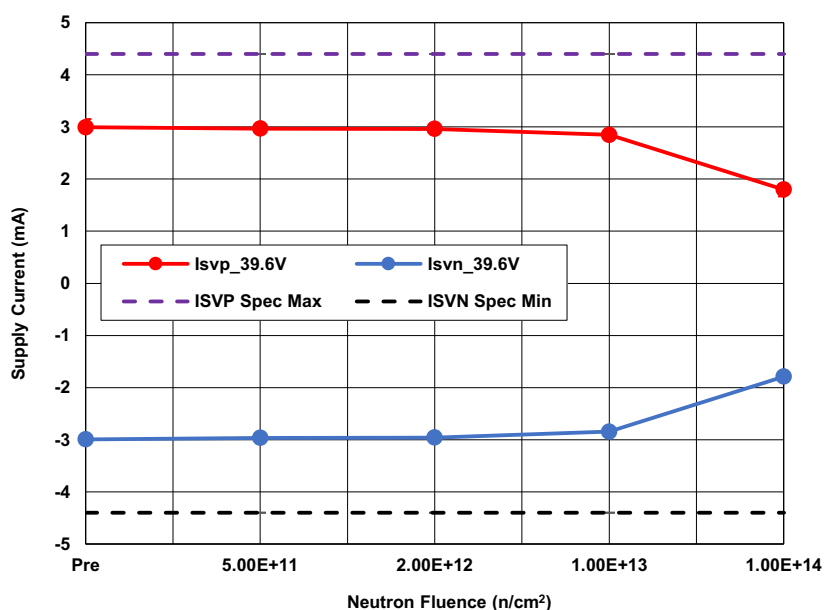


Figure 1. ISL7x244SEH positive (I<sub>SVP</sub>) and negative (I<sub>SVN</sub>) supply current (sum of both channels) at V<sub>S</sub> = ±19.8V following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are -4.4mA minimum and 4.4mA maximum.

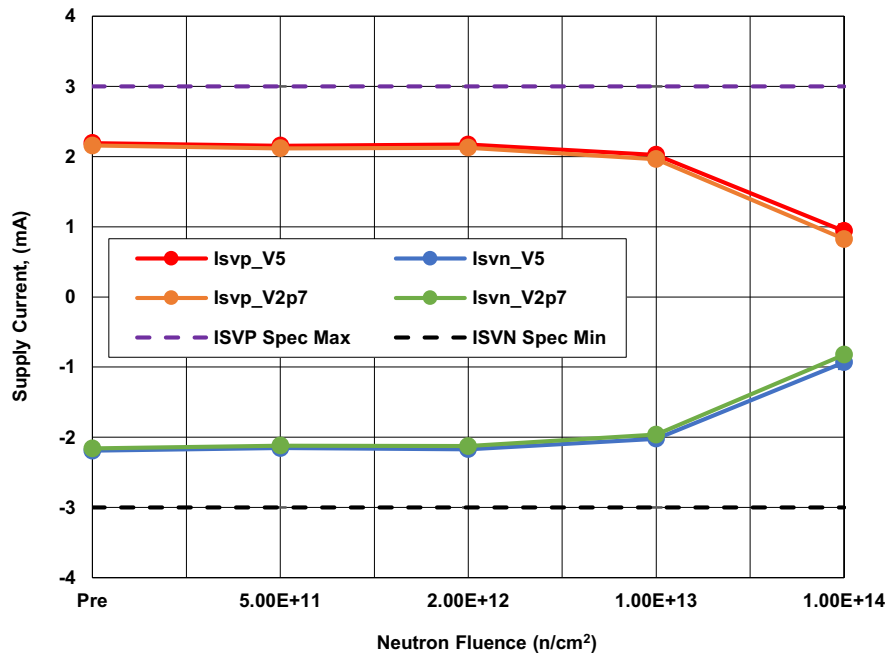


Figure 2. ISL7x244SEH positive ( $I_{SVP}$ ) and negative ( $I_{SVN}$ ) supply current (sum of both channels) at  $V_S = \pm 2.5V$  and  $\pm 1.35V$  following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are -3mA minimum and 3mA maximum.

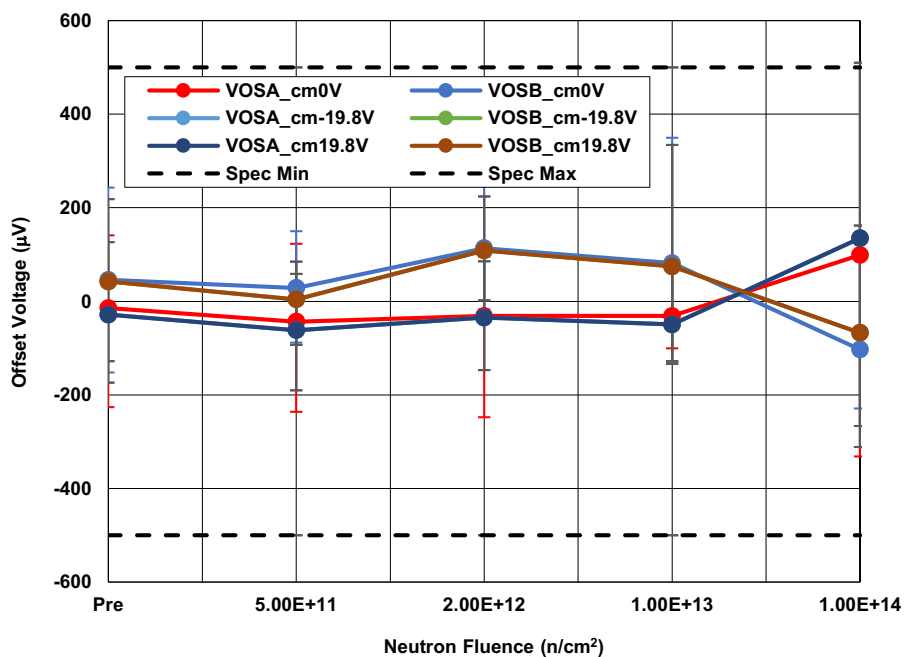


Figure 3. ISL7x244SEH input offset voltage ( $V_{OS}$ ) at  $V_S = \pm 19.8V$  and  $V_{CM} = 0V, +19.8V$  and  $-19.8V$  following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are -500µV minimum and 500µV maximum.

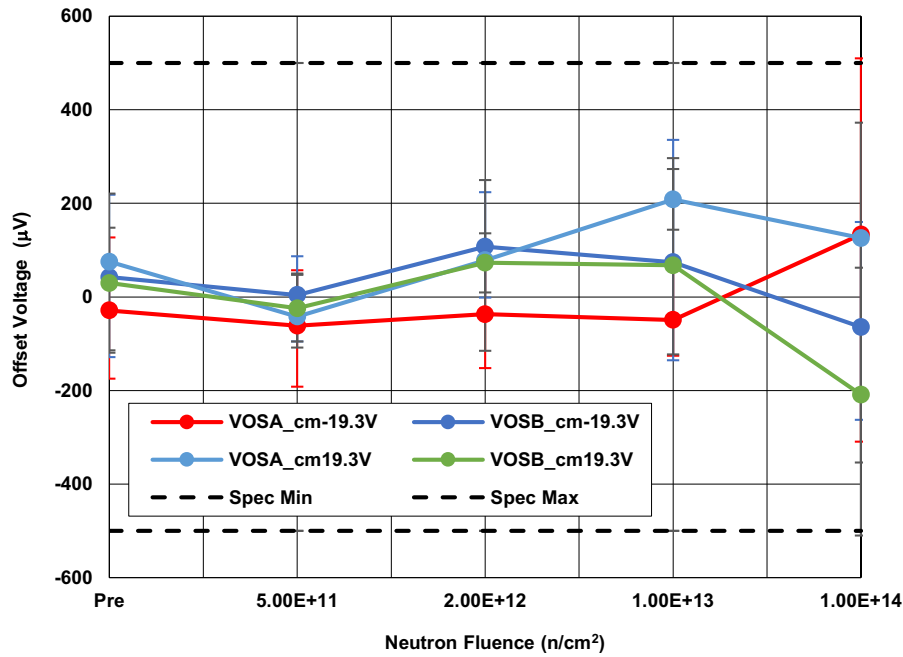


Figure 4. ISL7x244SEH input offset voltage ( $V_{OS}$ ) at  $V_S = \pm 19.8V$  and  $V_{CM} = +19.3V$  and  $-19.3V$  following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are  $-500\mu V$  minimum and  $500\mu V$  maximum.

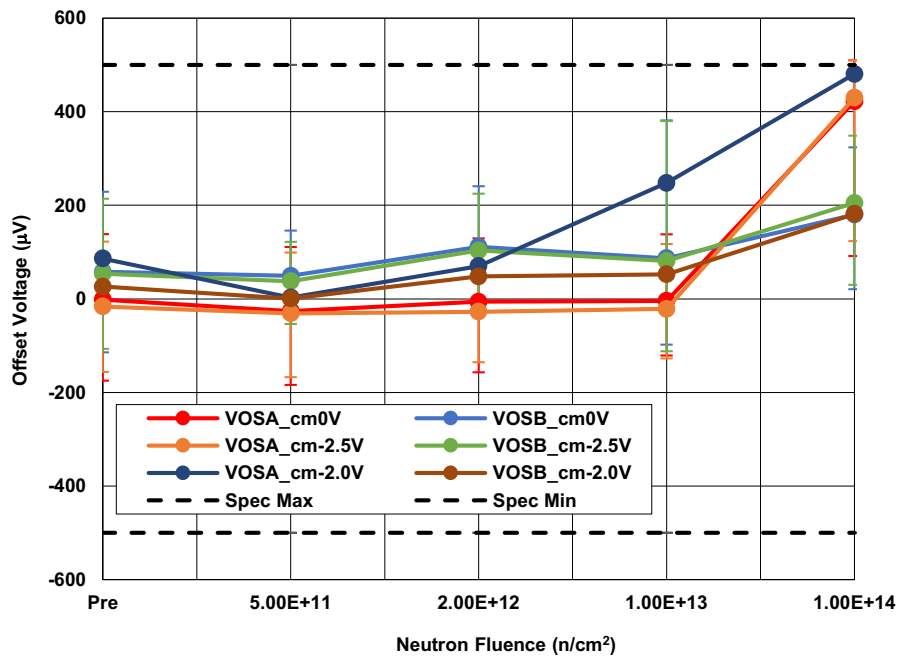


Figure 5. ISL7x244SEH input offset voltage ( $V_{OS}$ ) at  $V_S = \pm 2.5V$  and  $V_{CM} = 0V, +2.5V$  and  $-2.5V$  following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are  $-500\mu V$  minimum and  $500\mu V$  maximum.

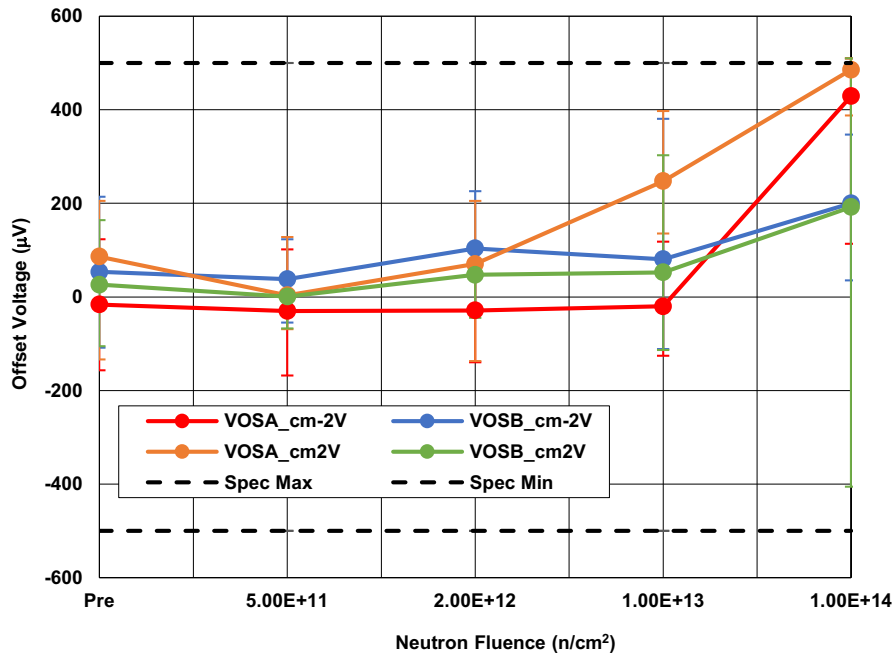


Figure 6. ISL7x244SEH input offset voltage ( $V_{OS}$ ) at  $V_S = \pm 2.5V$  and  $V_{CM} = +2.0V$  and  $-2.0V$  following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are  $-500\mu V$  minimum and  $500\mu V$  maximum.

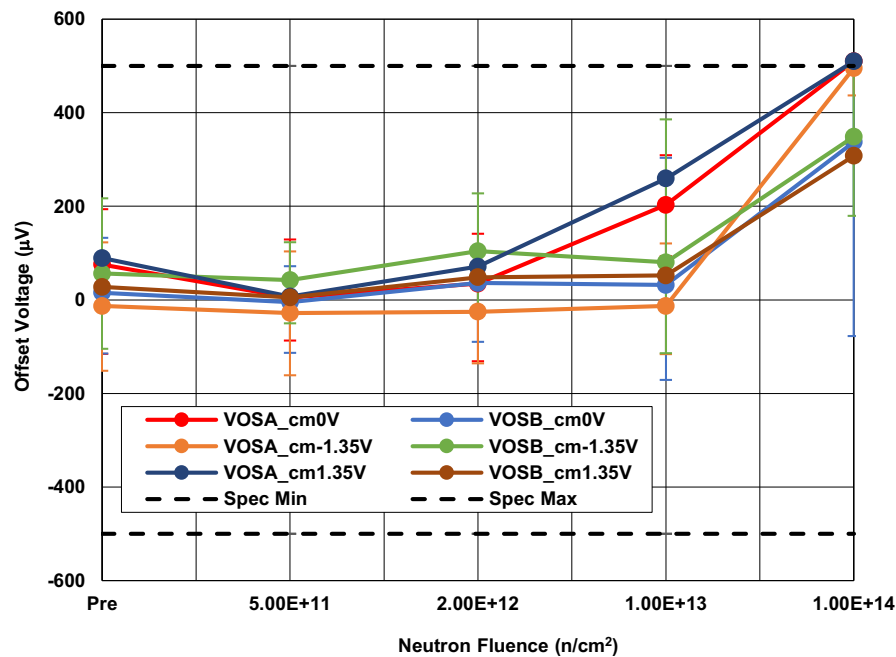


Figure 7. ISL7x244SEH input offset voltage ( $V_{OS}$ ) at  $V_S = \pm 1.35V$  and  $V_{CM} = 0V$ ,  $+1.35V$  and  $-1.35V$  following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are  $-500\mu V$  minimum and  $500\mu V$  maximum.

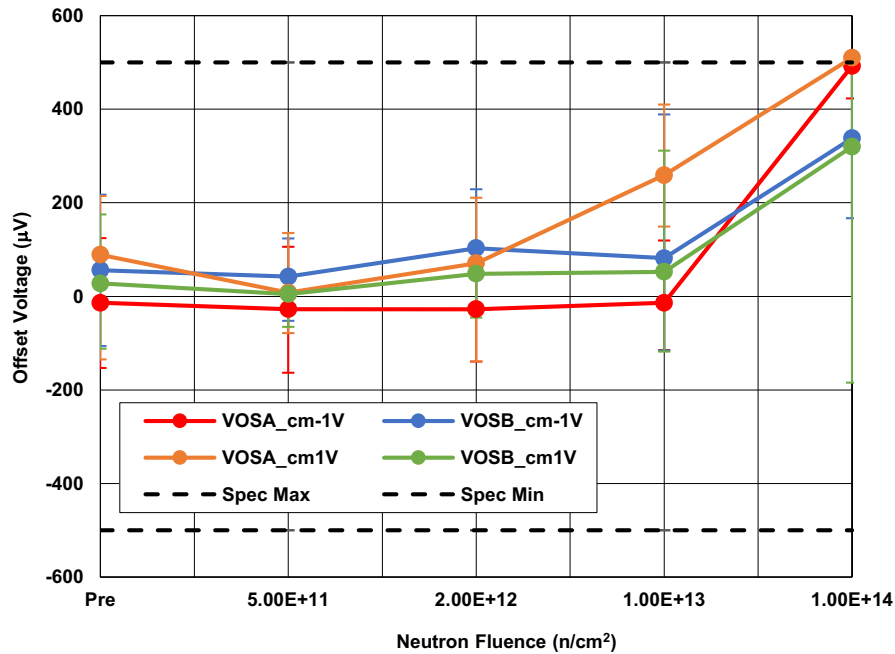


Figure 8. ISL7x244SEH input offset voltage ( $V_{OS}$ ) at  $V_S = \pm 1.35V$  and  $V_{CM} = +1.0V$  and  $-1.0V$  following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are  $-500\mu V$  minimum and  $500\mu V$  maximum.

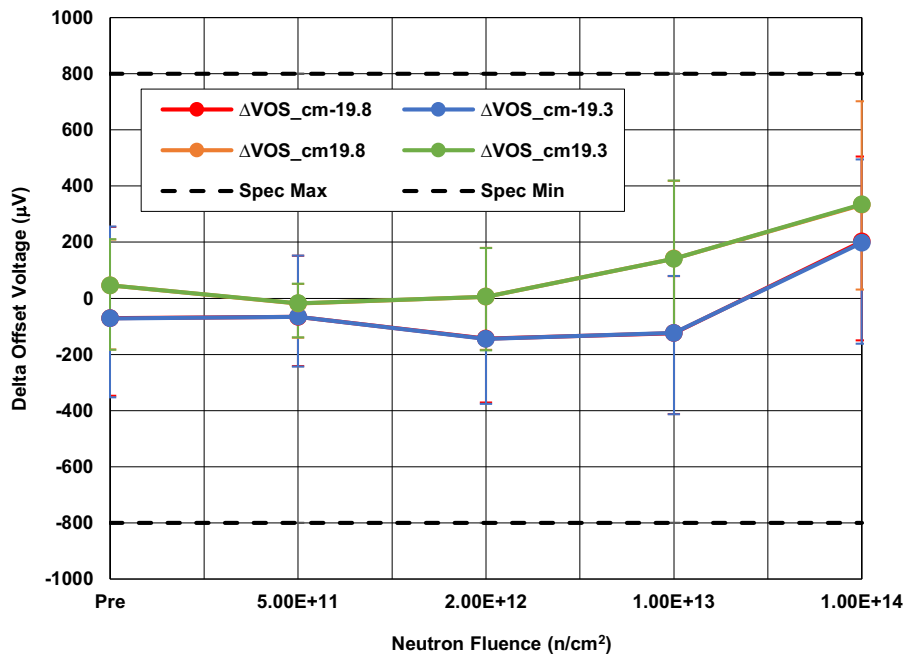


Figure 9. ISL7x244SEH input offset channel to channel match ( $\Delta V_{OS}$ ) at  $V_S = \pm 19.8V$  and  $V_{CM} = \pm 19.8V$  and  $\pm 19.3V$  following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are  $-800\mu V$  minimum and  $800\mu V$  maximum.

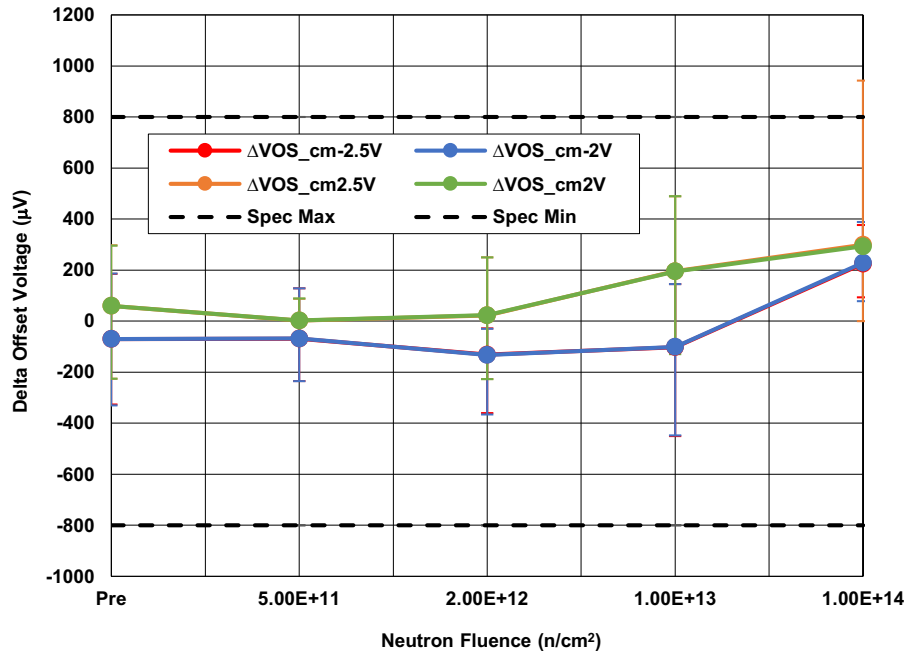


Figure 10. ISL7x244SEH input offset channel to channel match ( $\Delta V_{OS}$ ) at  $V_S = \pm 2.5V$  and  $V_{CM} = \pm 2.5V$  and  $\pm 2.0V$  following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are  $-800\mu V$  minimum and  $800\mu V$  maximum.

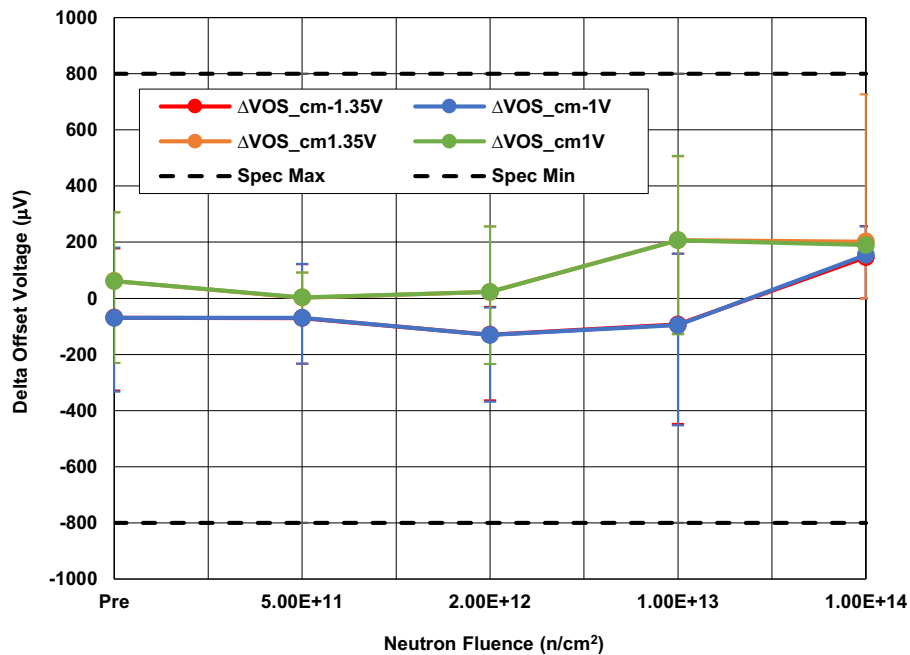


Figure 11. ISL7x244SEH input offset channel to channel match ( $\Delta V_{OS}$ ) at  $V_S = \pm 1.35V$  and  $V_{CM} = \pm 1.35V$  and  $\pm 1.0V$  following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are  $-800\mu V$  minimum and  $800\mu V$  maximum.



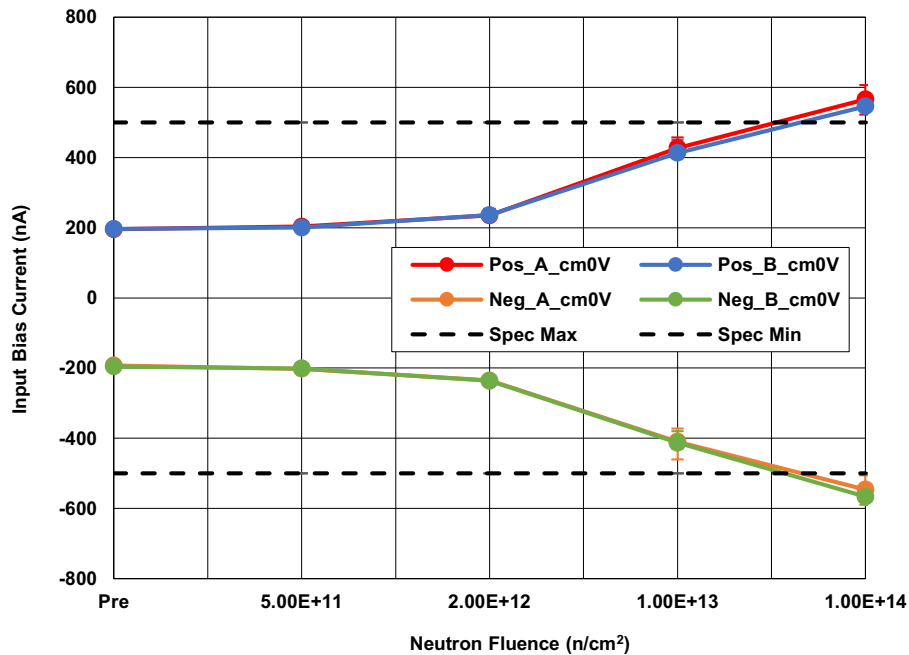


Figure 12. ISL7x244SEH input bias current ( $I_B$ ) at  $V_S = \pm 19.8V$  and  $V_{CM} = 0V$  following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are -500nA minimum and 500nA maximum.

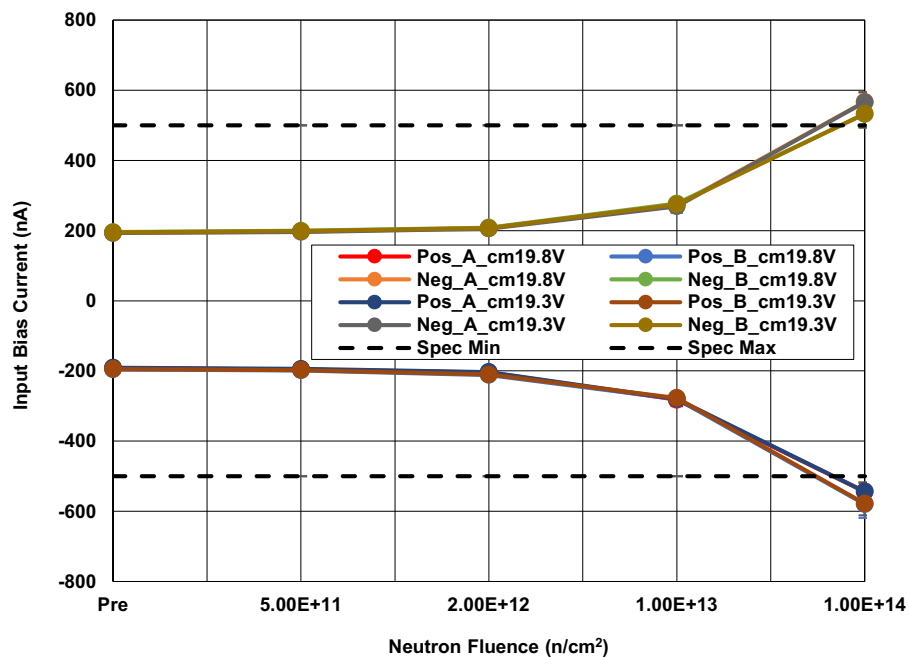


Figure 13. ISL7x244SEH input bias current ( $I_B$ ) at  $V_S = \pm 19.8V$  and  $V_{CM} = +19.8V$  and  $+19.3V$  following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are -500nA minimum and 500nA maximum.

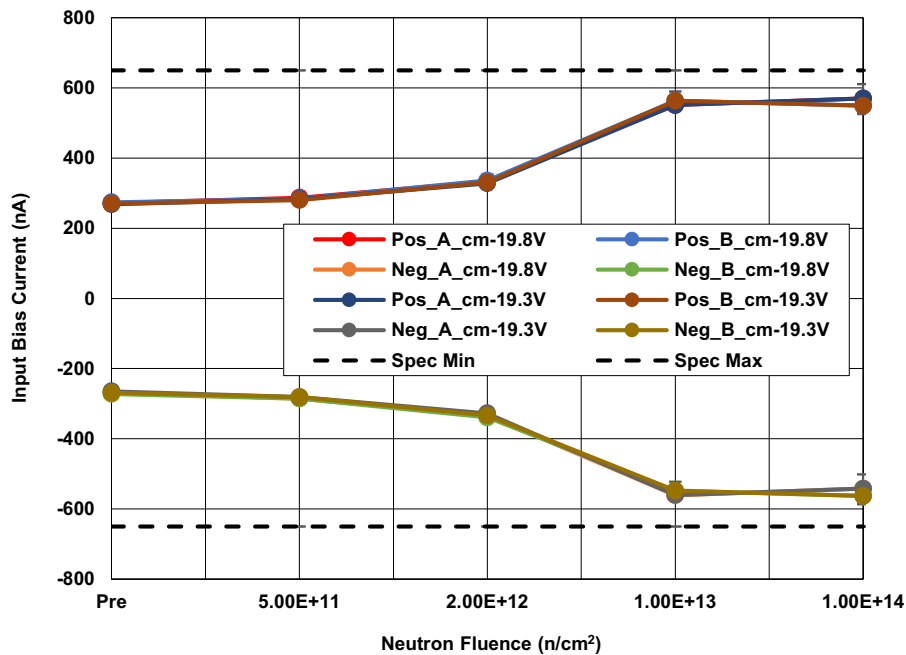


Figure 14. ISL7x244SEH input bias current ( $I_B$ ) at  $V_S = \pm 19.8V$  and  $V_{CM} = -19.8V$  and  $-19.3V$  following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are  $-650nA$  minimum and  $650nA$  maximum.

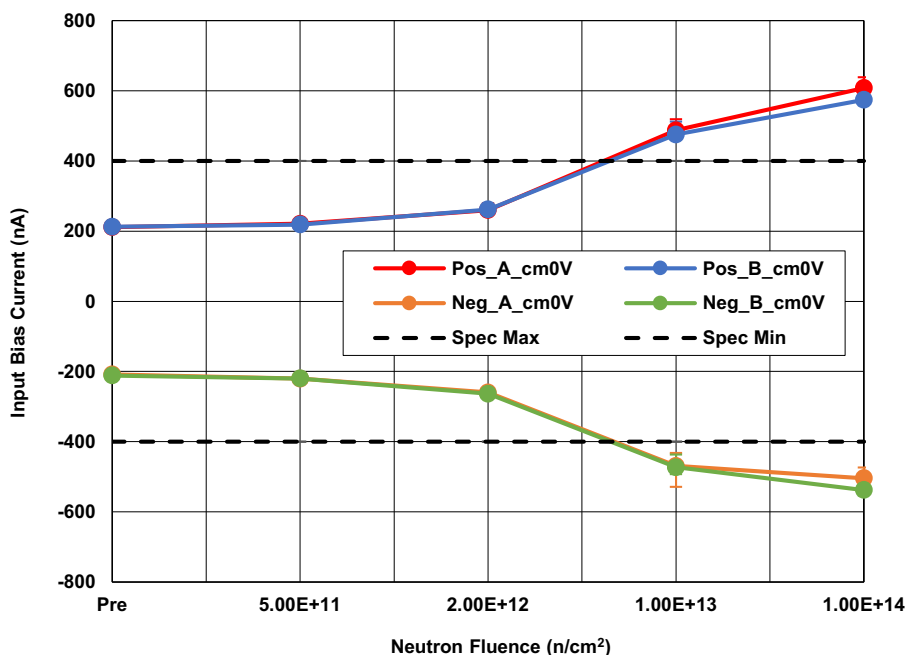


Figure 15. ISL7x244SEH input bias current ( $I_B$ ) at  $V_S = \pm 2.5V$  and  $V_{CM} = 0V$  following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are  $-400nA$  minimum and  $400nA$  maximum.

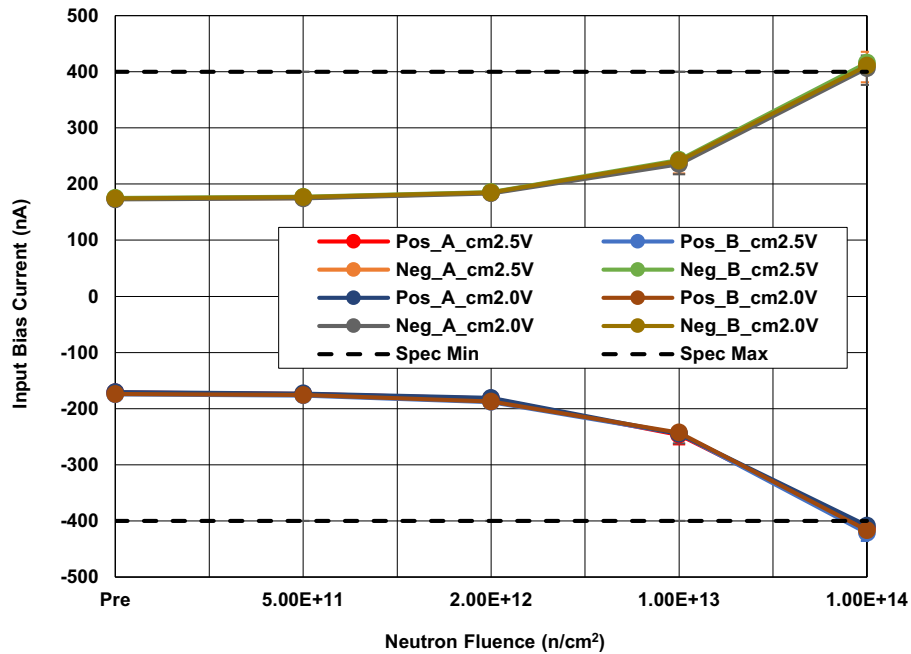


Figure 16. ISL7x244SEH input bias current ( $I_B$ ) at  $V_S = \pm 2.5\text{V}$  and  $V_{CM} = +2.0\text{V}$  and  $+2.5\text{V}$  following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are  $-400\text{nA}$  minimum and  $400\text{nA}$  maximum.

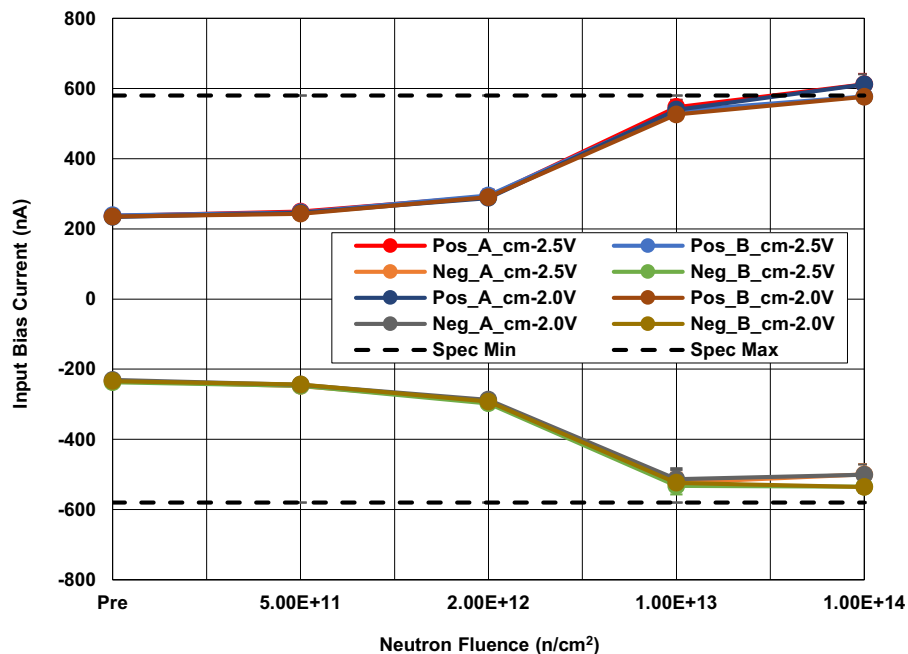


Figure 17. ISL7x244SEH input bias current ( $I_B$ ) at  $V_S = \pm 2.5\text{V}$  and  $V_{CM} = -2.0\text{V}$  and  $-2.5\text{V}$  following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are  $-580\text{nA}$  minimum and  $580\text{nA}$  maximum.

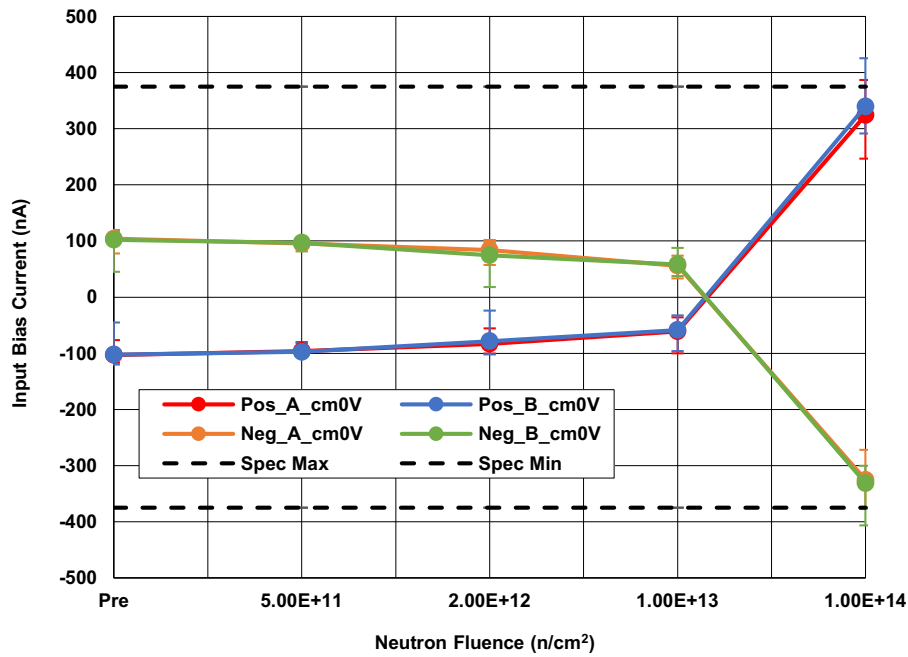


Figure 18. ISL7x244SEH input bias current ( $I_B$ ) at  $V_S = \pm 1.35V$  and  $V_{CM} = 0V$  following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are -375nA minimum and 375nA maximum

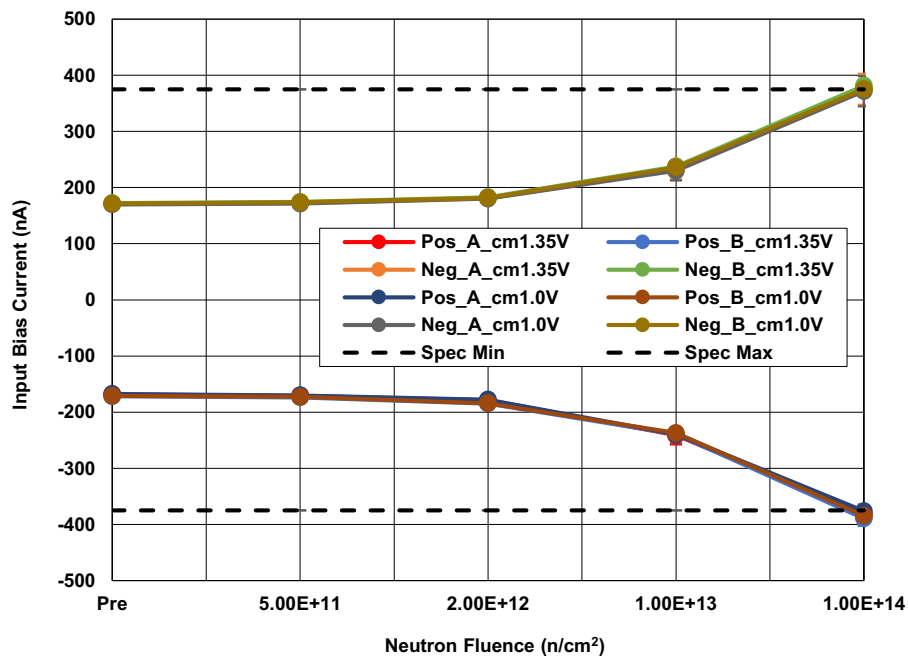


Figure 19. ISL7x244SEH input bias current ( $I_B$ ) at  $V_S = \pm 1.35V$  and  $V_{CM} = +1.0V$  and  $+1.35V$  following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are -375nA minimum and 375nA maximum.

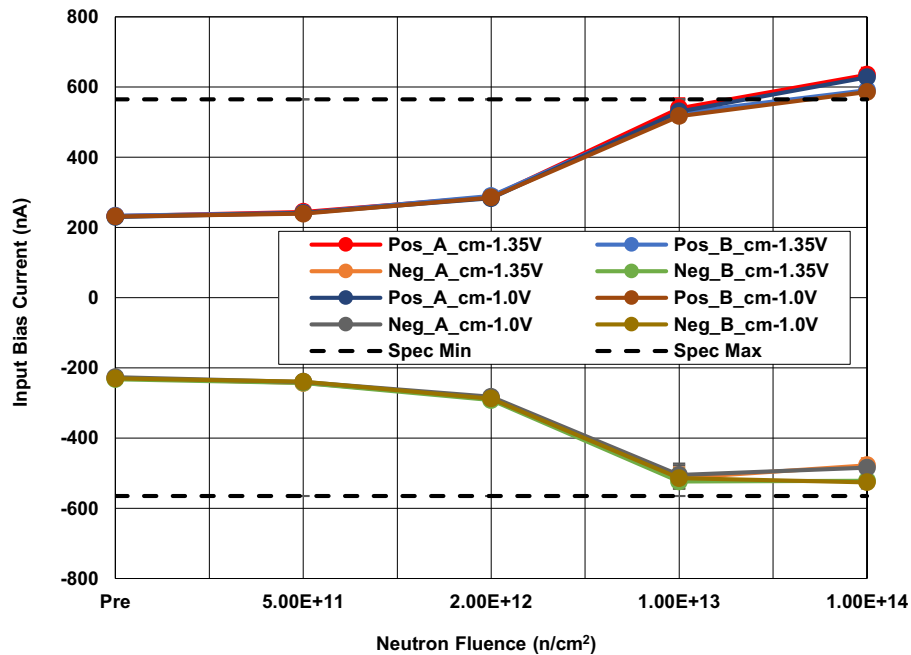


Figure 20. ISL7x244SEH input bias current ( $I_B$ ) at  $V_S = \pm 1.35V$  and  $V_{CM} = -1.0V$  and  $-1.35V$  following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are  $-565$  nA minimum and  $565$  nA maximum.

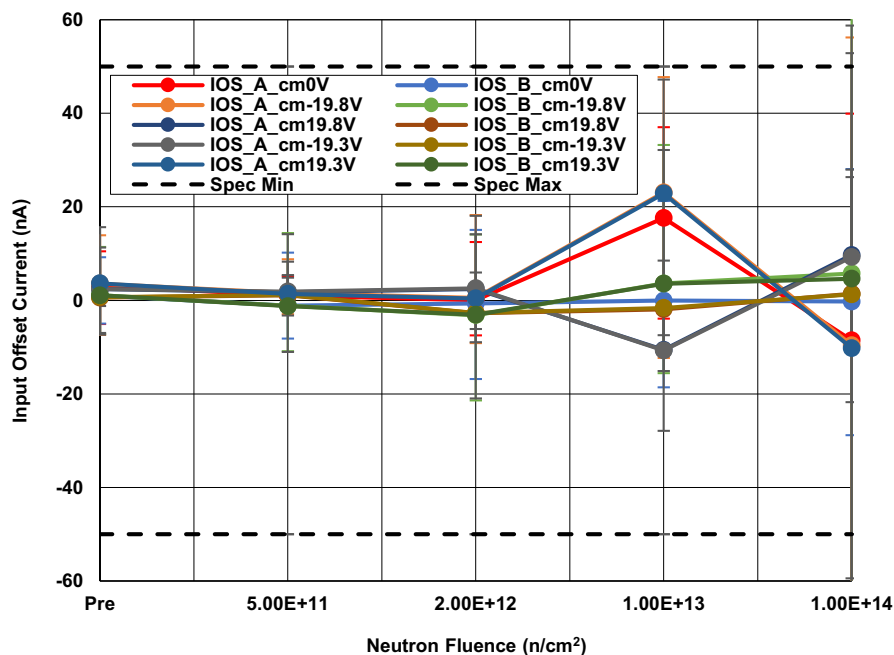


Figure 21. ISL7x244SEH input offset current ( $I_{OS}$ ) at  $V_S = \pm 19.8V$  and  $V_{CM} = 0V, \pm 19.3V$  and  $\pm 19.8V$  following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are  $-50$  nA minimum and  $50$  nA maximum.

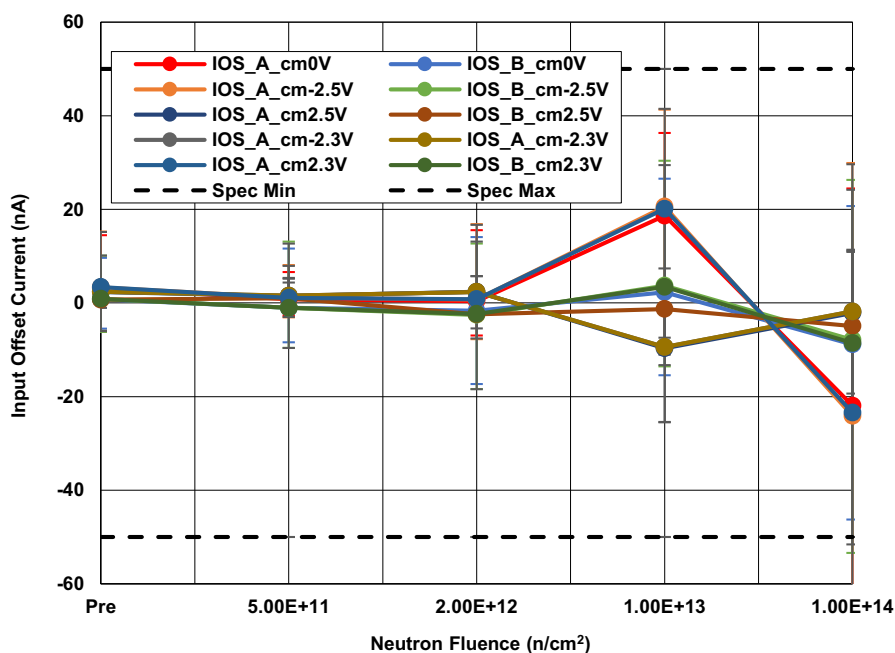


Figure 22. ISL7x244SEH input offset current ( $I_{OS}$ ) at  $V_S = \pm 2.5V$  and  $V_{CM} = 0V, \pm 2.3V$  and  $\pm 2.5V$  following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are  $-50nA$  minimum and  $50nA$  maximum.

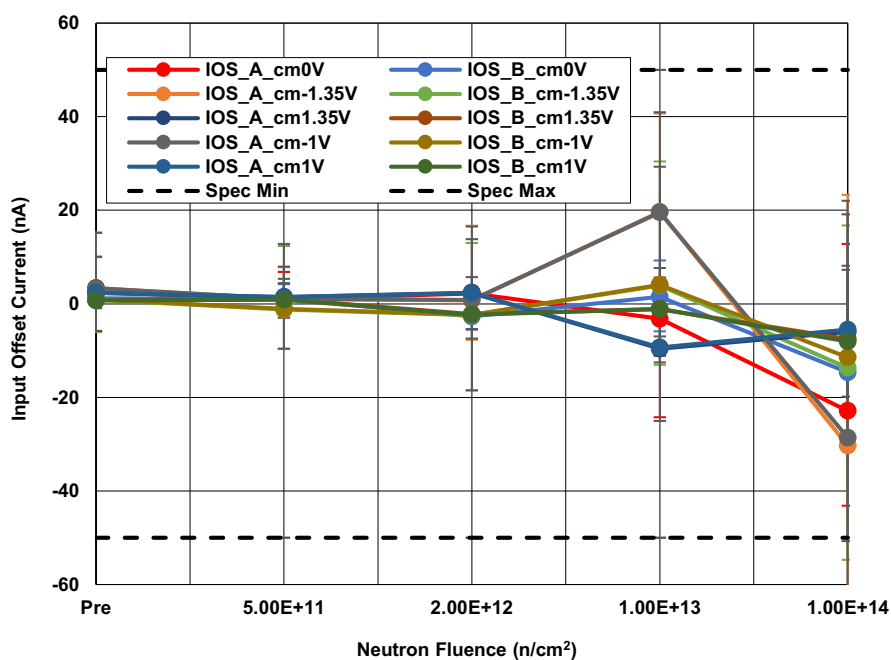


Figure 23. ISL7x244SEH input offset current ( $I_{OS}$ ) at  $V_S = \pm 1.35V$  and  $V_{CM} = 0V, \pm 1.0V$  and  $\pm 1.35V$  following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are  $-50nA$  minimum and  $50nA$  maximum.

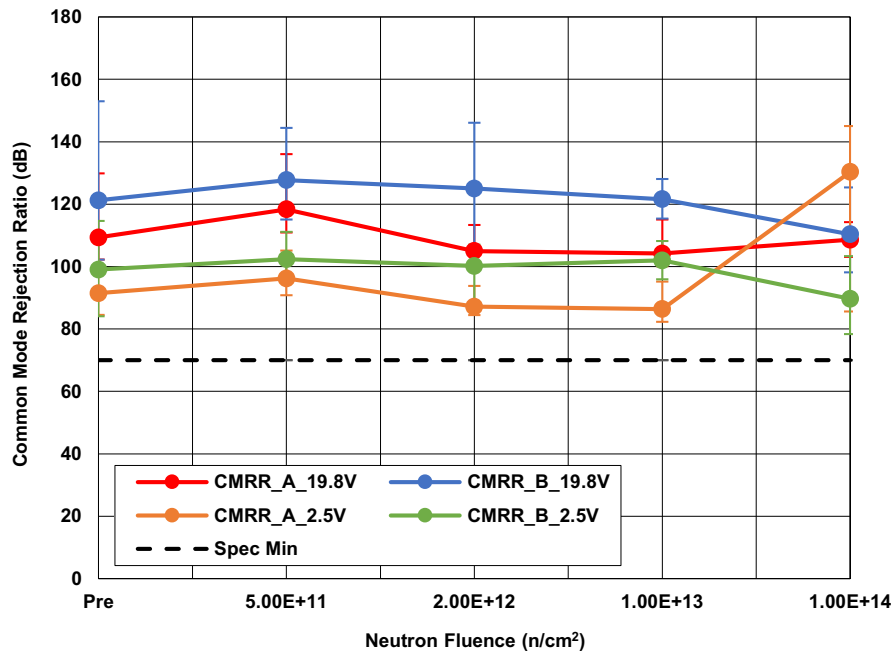


Figure 24. ISL7x244SEH Common Mode Rejection Ratio (CMRR) at  $V_S = \pm 2.5V$  and  $\pm 19.8V$  and  $V_{CM} = -V_S$  to  $+V_S$  following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limit is 70dB minimum.

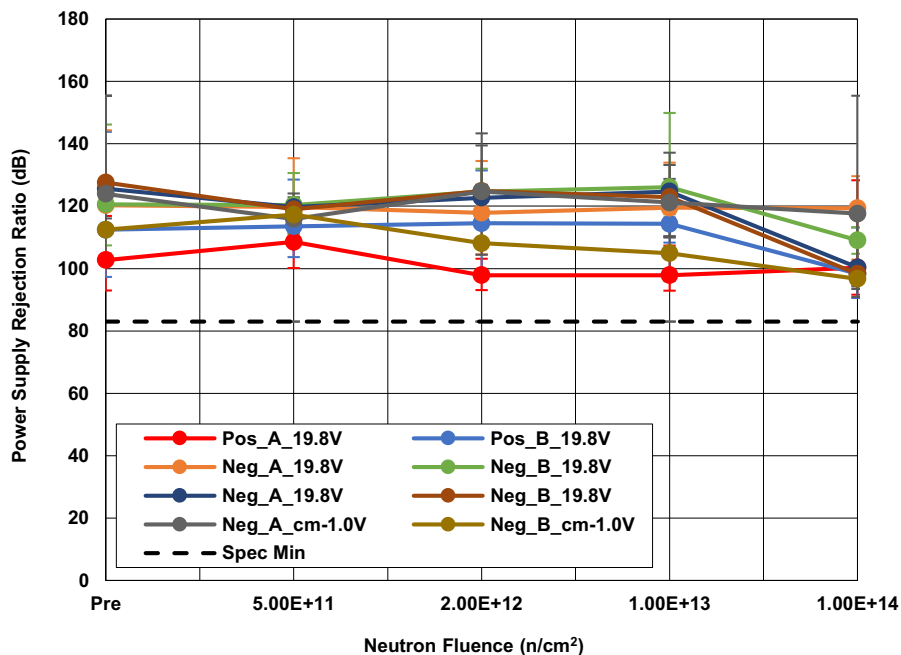


Figure 25. ISL7x244SEH Power Supply Rejection Ratio (PSRR) at  $V_S = \pm 18V$  following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limit is 83dB minimum.

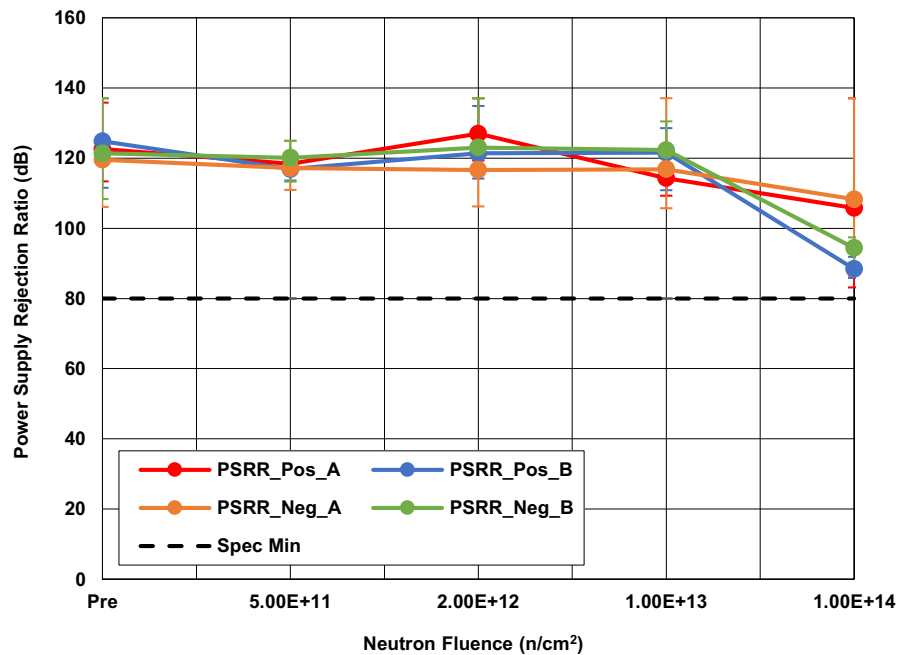


Figure 26. ISL7x244SEH power supply rejection ratio (PSRR) at  $V_S = \pm 2.5V$  following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limit is 80dB minimum.

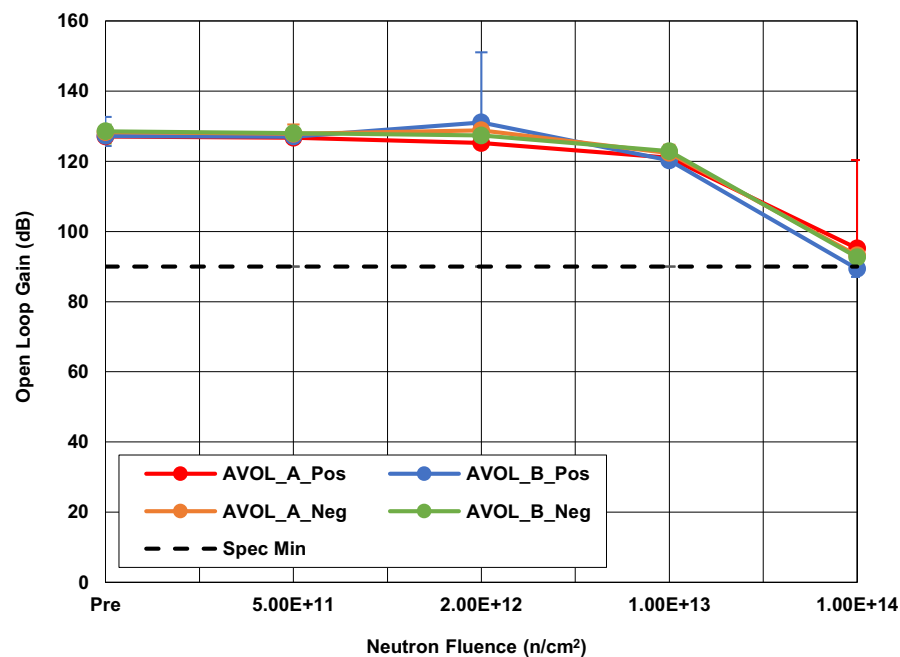


Figure 27. ISL7x244SEH open loop gain ( $A_{VOL}$ ) at  $V_S = \pm 19.8V$  and  $R_L = 10k\Omega$  to ground following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limit is 90dB minimum.



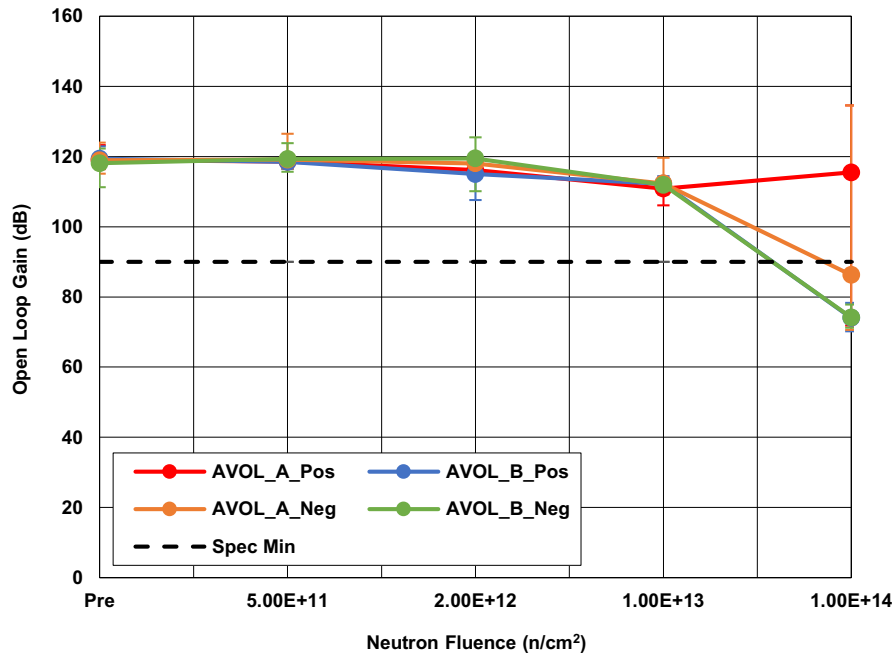


Figure 28. ISL7x244SEH open loop gain ( $A_{VOL}$ ) at  $V_S = \pm 2.5V$  and  $R_L = 10k\Omega$  to ground following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limit is 90dB minimum.

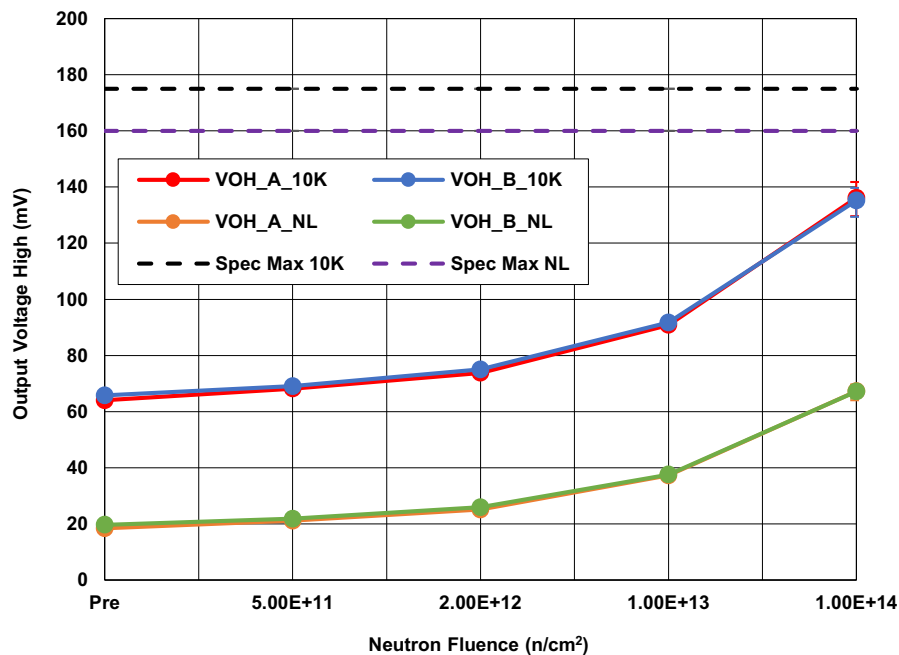


Figure 29. ISL7x244SEH output voltage high ( $V_{OH}$ ) at  $V_S = \pm 19.8V$  and  $R_L = 10k\Omega$  to ground and No Load (NL) following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are 175mV maximum for  $R_L = 10k\Omega$  and 160mV maximum for NL.

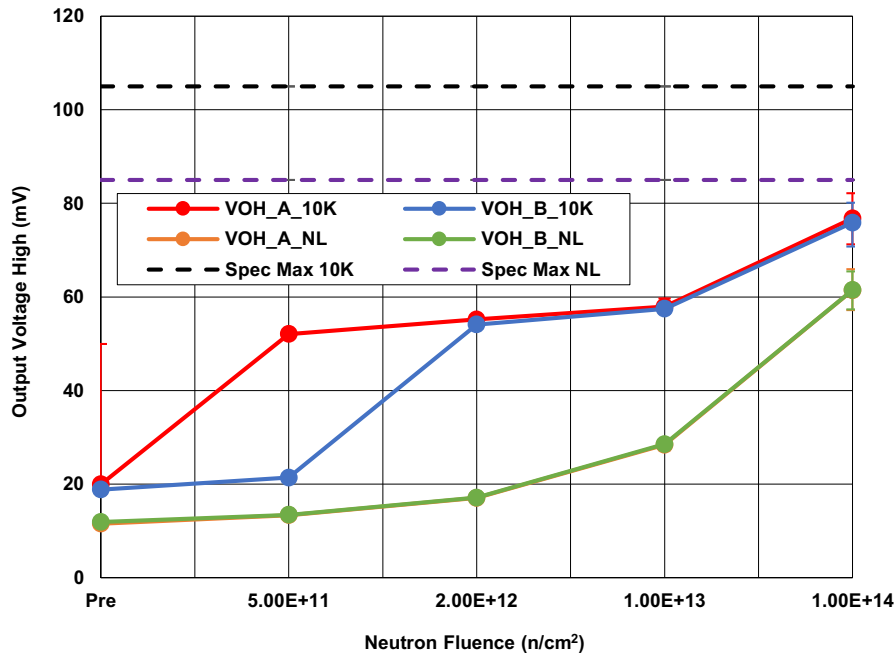


Figure 30. ISL7x244SEH output voltage high ( $V_{OH}$ ) at  $V_S = \pm 2.5V$  and  $R_L = 10k\Omega$  to ground and No Load (NL) following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are 105mV maximum for  $R_L = 10k\Omega$  and 85mV maximum for NL.

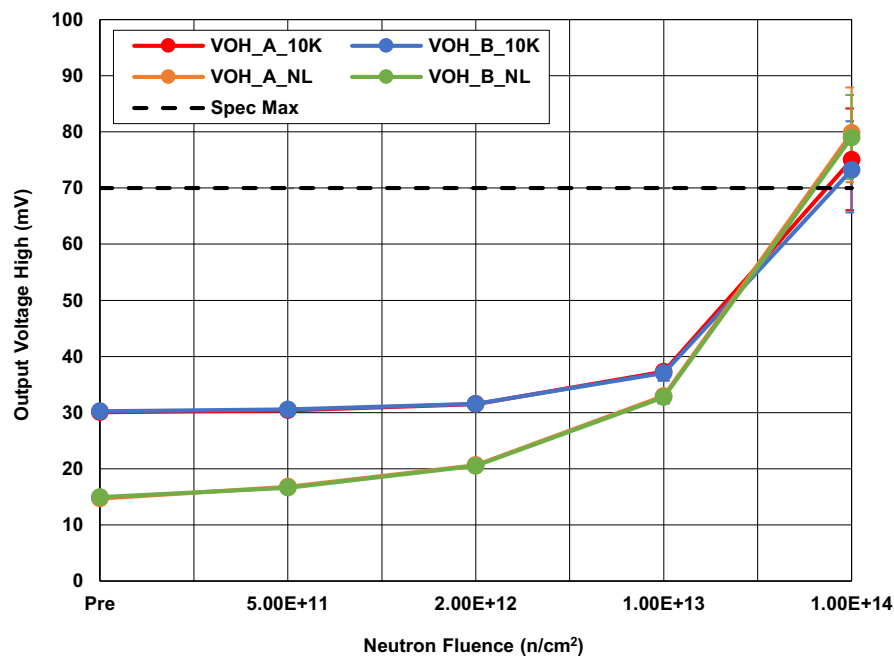


Figure 31. ISL7x244SEH output voltage high ( $V_{OH}$ ) at  $V_S = \pm 1.35V$  and  $R_L = 10k\Omega$  to ground and No Load (NL) following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limit is 70mV maximum for  $R_L = 10k\Omega$  and NL.

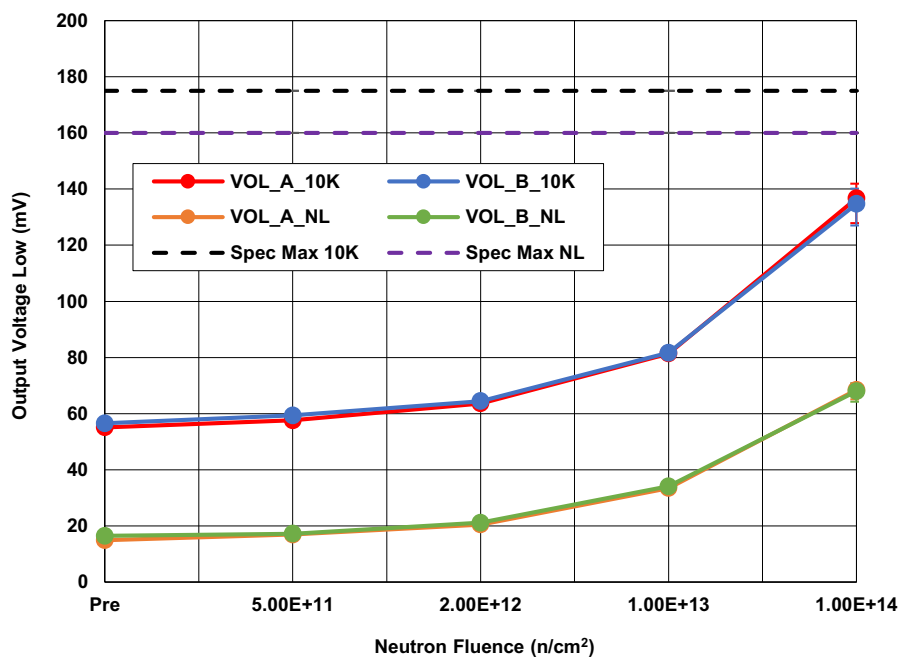


Figure 32. ISL7x244SEH output voltage low ( $V_{OL}$ ) at  $V_S = \pm 19.8V$  and  $R_L = 10k\Omega$  to ground and No Load (NL) following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are 175mV maximum for  $R_L = 10k\Omega$  and 160mV maximum for NL.

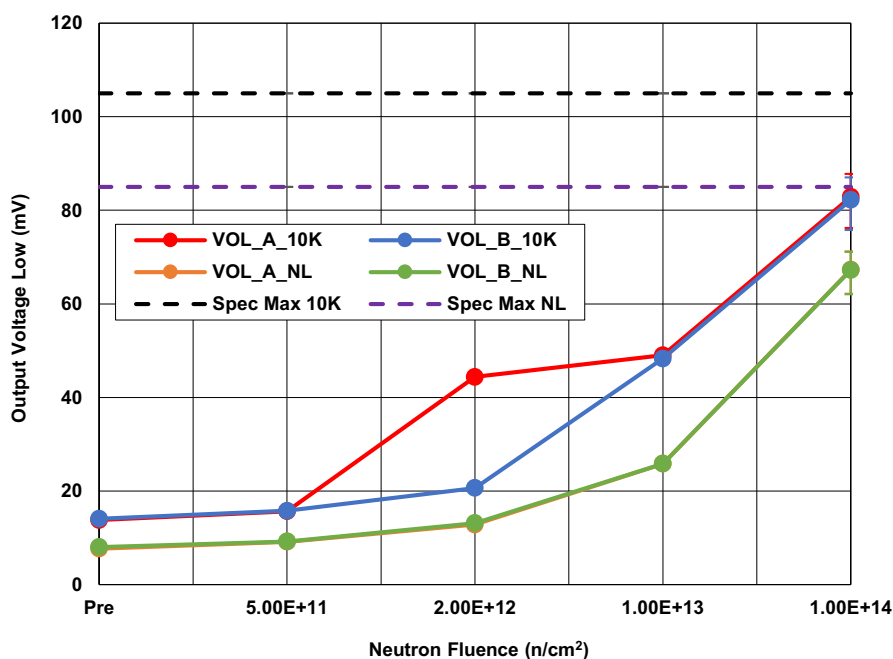


Figure 33. ISL7x244SEH output voltage low ( $V_{OL}$ ) at  $V_S = \pm 2.5V$  and  $R_L = 10k\Omega$  to ground and No Load (NL) following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are 105mV maximum for  $R_L = 10k\Omega$  and 85mV maximum for NL.

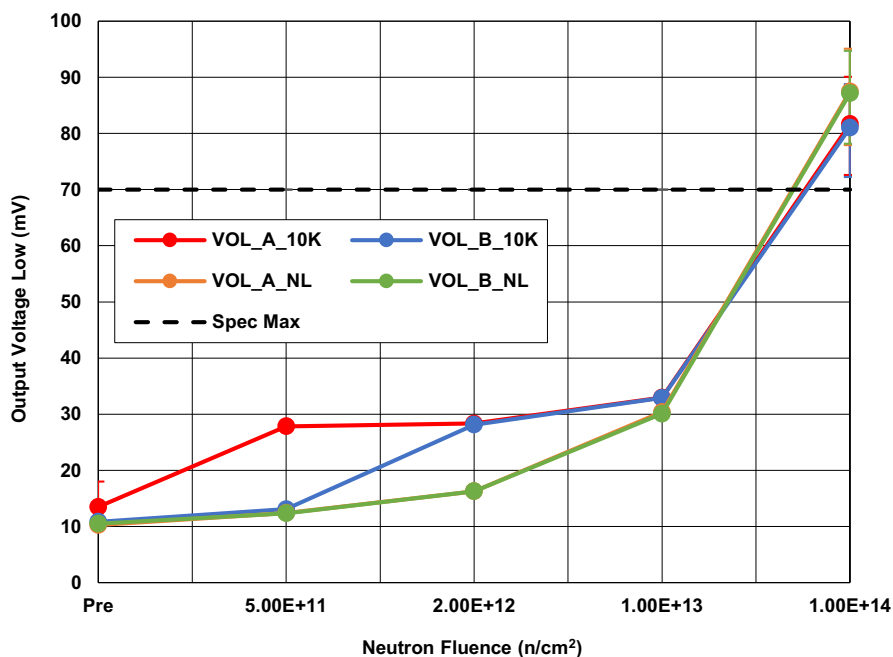


Figure 34. ISL7x244SEH output voltage low ( $V_{OL}$ ) at  $V_S = \pm 1.35V$  and  $R_L = 10k\Omega$  to ground and No Load (NL) following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limit is 70mV maximum for  $R_L = 10k\Omega$  and NL.

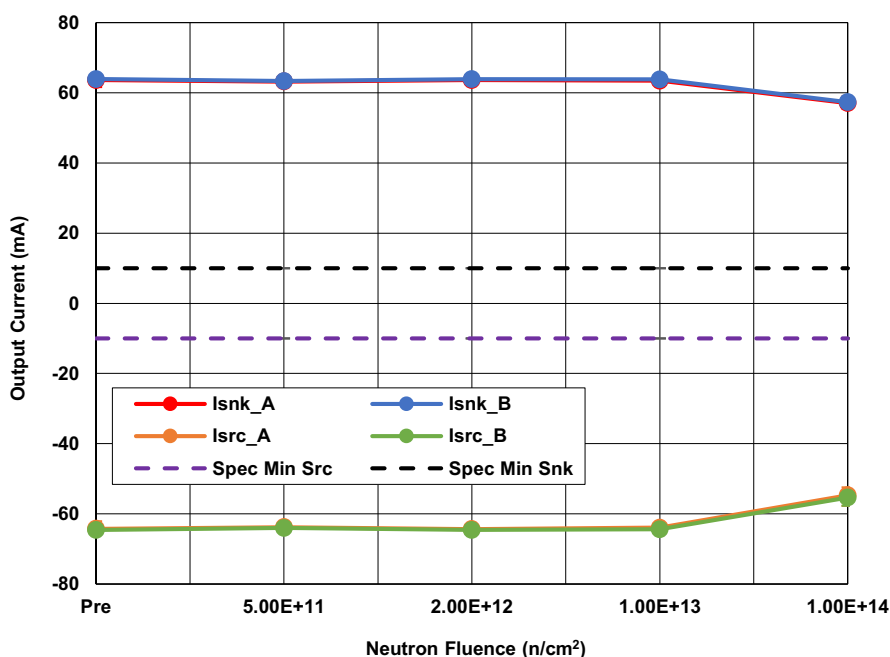


Figure 35. ISL7x244SEH output short circuit current ( $I_{SC}$ ), sourcing and sinking at  $V_S = \pm 19.8V$  and  $V_{OUT} = -18V$  sourcing and +18V sinking, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are -10mA minimum (sourcing) and 10mA minimum (sinking).

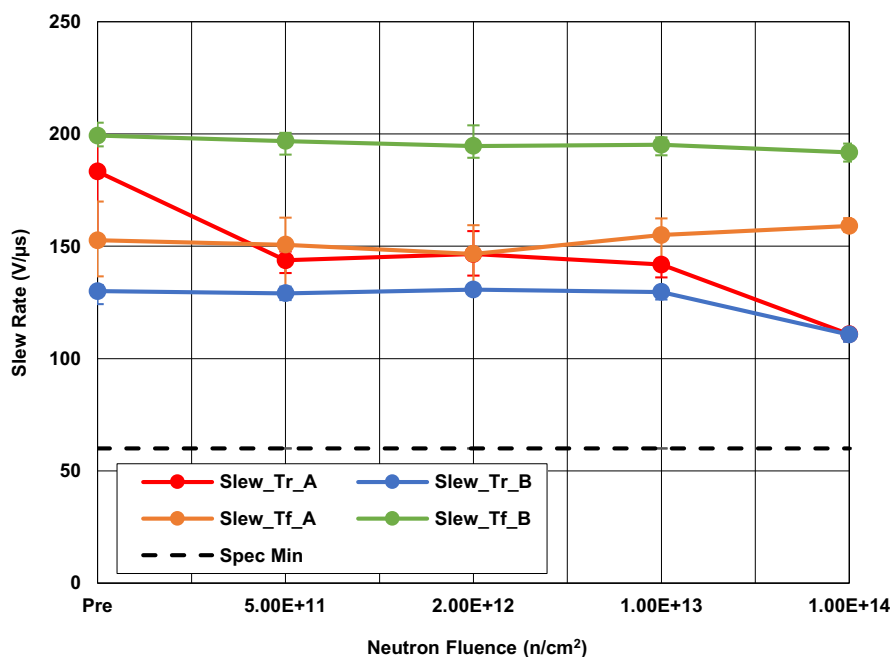


Figure 36. ISL7x244SEH slew rate (SR) at  $V_S = \pm 19.8V$  and  $A_V = 1$ ,  $R_L = 10k\Omega$  to ground and  $V_O = 10V_{PP}$  following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limit is 60V/ $\mu s$  minimum.

### 3. Discussion and Conclusion

This document reports the results of 1MeV equivalent neutron testing of the ISL7x244SEH radiation hardened 40V dual rail-to-rail input-output, low-power operational amplifier. Parts were tested at  $5.2 \times 10^{11} n/cm^2$ ,  $1.9 \times 10^{12} n/cm^2$ ,  $9.9 \times 10^{12} n/cm^2$  and  $8.6 \times 10^{13} n/cm^2$ . The results of key parameters before and after irradiation to each level are plotted in Figure 1 through Figure 36. 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.

All samples passed the post-irradiation SMD limits after all exposures up to and including  $1.9 \times 10^{12} n/cm^2$ , but all five tested units failed the SMD post-irradiation limits for input bias ( $I_B$ ) at 2.5V (Figure 15) after  $9.9 \times 10^{12} n/cm^2$  and some or all units failed measurements for input offset voltage ( $V_{OS}$ ), input bias ( $I_B$ ), open loop gain ( $A_{VOL}$ ), power supply rejection ratio (PSRR), output voltage high ( $V_{OH}$ ) and output voltage low ( $V_{OL}$ ) after  $8.6 \times 10^{13} n/cm^2$ . Several of the  $V_{OS}$  measurements clamped the ATE at 509 $\mu V$ .

## 4. Appendices

### 4.1 Reported Parameters

Fig.	Parameter	Symbol	Limit, Low	Limit, High	Units	Notes
1	Supply current, $V_S = \pm 19.8V$	$I_{SVN}$	-4.4		mA	Sum of both channels
		$I_{SVP}$		4.4		
2	Supply current, $V_S = \pm 1.35V, \pm 2.5V$	$I_{SVN}$	-3		mA	Sum of both channels
		$I_{SVP}$		3		
3	Input offset voltage, $V_{CM} = 0V, \pm 19.8V$	$V_{OS}$	-500	500	$\mu V$	$V_S = \pm 19.8V$
4	Input offset voltage, $V_{CM} = \pm 19.3V$					

Fig.	Parameter	Symbol	Limit, Low	Limit, High	Units	Notes
5	Input offset voltage, $V_{CM} = 0V, \pm 2.5V$	$V_{OS}$	-500	500	$\mu V$	$V_S = \pm 2.5V$
6	Input offset voltage, $V_{CM} = \pm 2.0V$					
7	Input offset voltage, $V_{CM} = 0V, \pm 1.35V$	$V_{OS}$	-500	500	$\mu V$	$V_S = \pm 1.35V$
8	Input offset voltage, $V_{CM} = \pm 1.0V$					
9	Offset voltage match, $V_{CM} = \pm 19.3V, \pm 19.8V$	$\Delta V_{OS}$	-800	800	$\mu V$	$V_S = \pm 19.8V$
10	Offset voltage match, $V_{CM} = \pm 2.0V, \pm 2.5V$					$V_S = \pm 2.5V$
11	Offset voltage match, $V_{CM} = \pm 1.0V, \pm 1.35V$					$V_S = \pm 1.35V$
12	Input bias current, $V_{CM} = 0V$	$I_B$	-500	500	nA	$V_S = \pm 19.8V$
13	Input bias current, $V_{CM} = +19.3V, +19.8V$					
14	Input bias current, $V_{CM} = -19.3V, -19.8V$		-650	650		
15	Input bias current, $V_{CM} = 0V$	$I_B$	-400	400	nA	$V_S = \pm 2.5V$
16	Input bias current, $V_{CM} = +2.0V, +2.5V$					
17	Input bias current, $V_{CM} = -2.0V, -2.5V$		-580	580		
18	Input bias current, $V_{CM} = 0V$	$I_B$	-375	375	nA	$V_S = \pm 1.35V$
19	Input bias current, $V_{CM} = +1.0V, +1.35V$					
20	Input bias current, $V_{CM} = -1.0V, -1.35V$		-565	565		
21	Input offset current, $V_{CM} = 0V, \pm 19.3V, \pm 19.8V$	$I_{OS}$	-50	50	nA	$V_S = \pm 19.8V$
22	Input offset current, $V_{CM} = 0V, \pm 2.3V, \pm 2.5V$	$I_{OS}$	-50	50	nA	$V_S = \pm 2.5V$
23	Input offset current, $V_{CM} = 0V, \pm 1.0V, \pm 1.35V$	$I_{OS}$	-50	50	nA	$V_S = \pm 1.35V$
24	Common-mode rejection ratio, $V_{CM} = -V_S$ to $+V_S$	CMRR	70	-	dB	$V_S = \pm 2.5V, \pm 19.8V$
25	Power supply rejection ratio	PSRR	83	-	dB	$V_S = \pm 18V$
26			80			$V_S = \pm 2.5V$
27	Open loop gain, $R_L = 10k\Omega$ to ground	$A_{VOL}$	90	-	dB	$V_S = \pm 19.8V$
28						$V_S = \pm 2.5V$
29	Output voltage high, $V_S = \pm 19.8V$	$V_{OH}$	-	175	mV	$R_L = 10k\Omega$
				160		$R_L = NL$
30	Output voltage high, $V_S = \pm 2.5V$	$V_{OH}$	-	105	mV	$R_L = 10k\Omega$
				85		$R_L = NL$
31	Output voltage high, $V_S = \pm 1.35V$	$V_{OH}$	-	70	mV	$R_L = NL$ or $10k\Omega$
32	Output voltage low, $V_S = \pm 19.8V$	$V_{OL}$	-	175	mV	$R_L = 10k\Omega$
				160		$R_L = NL$
33	Output voltage low, $V_S = \pm 2.5V$	$V_{OL}$	-	105	mV	$R_L = 10k\Omega$
				85		$R_L = NL$
34	Output voltage low, $V_S = \pm 1.35V$	$V_{OL}$	-	70	mV	$R_L = NL$ or $10k\Omega$
35	Output short-circuit current, sourcing	$I_{SC}$	-10	-	mA	$V_{OUT} = -18V$
	Output short-circuit current, sinking		10	-		$V_{OUT} = +18V$
36	Slew rate, $A_V = 1, R_L = 10k\Omega, V_O = 10V_{PP}$	SR	60	-	V/ $\mu s$	$V_S = \pm 19.8V$

## 5. Revision History

Rev.	Date	Description
1.01	Apr 25, 2025	Applied latest template. Updated the Variables Data section. Updated the Discussion and Conclusion section.
1.00	Apr 30, 2020	Initial release

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