ISL73141SEH

Combined Neutron and TID Testing of the ISL73141SEHMFN 3.3V, 14-Bit, 750ksps SAR ADC

Introduction

This report summarizes the results of combined 1MeV equivalent neutron testing and Low Dose Rate (LDR) Total Ionizing Dose (TID) testing of the ISL73141SEHMFN, the 3.3V version of the ISL73141SEH 14-BIT, 750ksps Successive Approximation Register (SAR) Analog-to-Digital Converter (ADC). The results also apply to the 5V version (ISL73141SEHMF7) because the differences between the versions are only the result of different trimmings. The test was conducted to determine the sensitivity of the parts to displacement damage (DD) and total dose effects caused by neutron or proton environments. Neutron fluences ranged from 5×10^{11}n/cm^2 to 1×10^{13}n/cm^2. LDR testing was completed through 100krad(Si).

Product Description

The ISL73141SEH is a radiation hardened high precision 14-bit, SAR ADC with a Signal-to-Noise Ratio (SNR) of 80.3dBFS with a 3.3V supply while operating at 750ksps with a power consumption of 28mW.

The ISL73141SEH features 750ksps throughput at 3.3V with no data latency, excellent linearity, and dynamic accuracy. It also provides a high-speed SPI-compatible serial interface that supports logic ranging from 2.2V to 3.6V using a separate digital I/O supply pin.

The ISL73141SEH provides a separate power-down pin that reduces power dissipation to <50µW. An external reference determines the analog input signal range.

The ISL73141SEH operates across the military temperature range from -55°C to +125°C and is available in a 14-lead hermetically sealed Ceramic Dual Flat-Pack (CDFP) package.

A typical application schematic for the ISL73141SEH is shown in Figure 1.

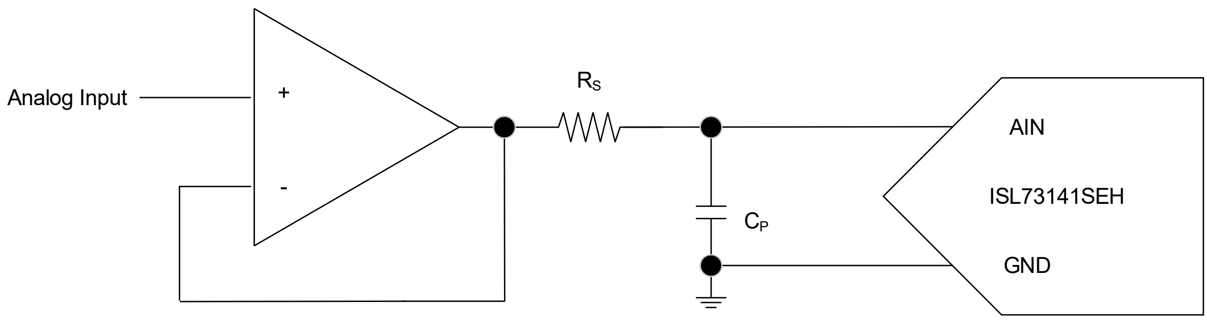

Figure 1. ISL73141SEH Typical Application Schematic

Contents

1. Test Description

1.1 Irradiation Facility

Neutron fluence irradiations were performed on the test samples on August 1, 2022, at the University of Massachusetts, Lowell (UMASS Lowell) fast neutron irradiator per Mil-STD-883G, Method 1017.2, with each part unpowered 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 cooldown time before being shipped back to Renesas (Palm Bay, FL) for electrical testing.

LDR testing was performed using a Hopewell Designs N40 vault-type LDR irradiator at the Renesas Palm Bay, Florida facility. The LDR irradiations were performed at 0.01rad(Si)/s per MIL-STD-883 Method 1019.7. A PbAl box was used to shield the test fixture and devices under test against low energy, secondary gamma radiation.

1.2 Test Fixturing

No formal irradiation test fixturing is involved for the neutron testing, as these DD tests are bag tests in the sense that the parts are irradiated with all leads unbiased.

Figure 2 shows the configuration used for the TID testing.

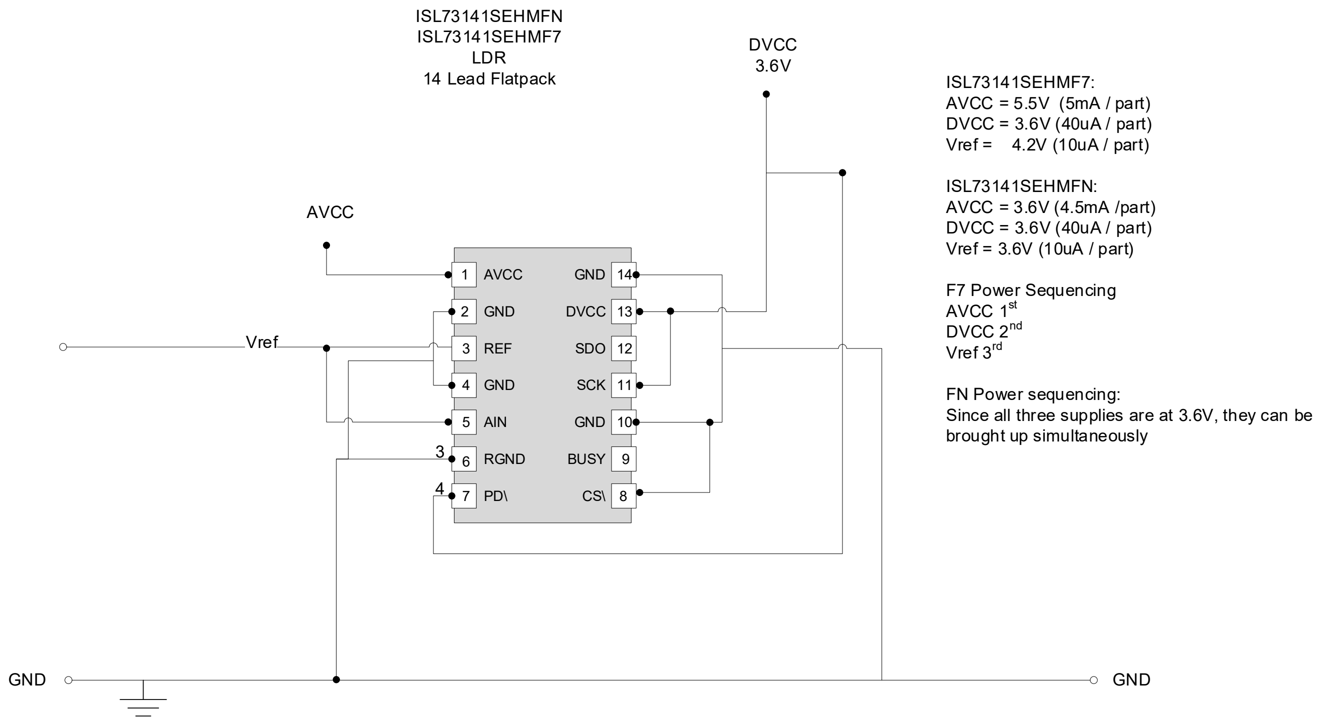

Figure 2. Irradiation Bias configuration for the ISL73141SEH

1.3 Radiation Dosimetry

Table 1 shows dosimetry from UMASS Lowell indicating the total accumulated gamma dose and actual neutron fluence exposure levels for each set of samples.

Table 1. ISL73141SEH 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 1000kW, the gamma dose is 41krad(Si)/hr ±5.3% as mapped by TLD-based dosimetry.
4. Validated by S-32 flux monitors.

1.4 Characterization Equipment and Procedures

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

All electrical testing for the LDR test was performed outside the irradiator using the ATE with datalogging at each downpoint. Downpoint electrical testing was performed at room temperature.

1.5 Experimental Matrix

Neutron 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 at 2×10^{12}n/cm^2, and five at 1×10^{13}n/cm^2. Table 2 shows the actual levels achieved, which were 5.38×10^{11}n/cm^2, 2.05×10^{12}n/cm^2, and 1.14×10^{13}n/cm^2. Following neutron testing, each set of samples underwent LDR TID testing. Each set of samples was irradiated under bias to 100krad(Si) with downpoints at 10krad(Si), 30krad(Si), 50krad(Si), 75krad(Si), and 100krad(Si). Three control units were used.

The 15 ISL73141SEH samples were from Lot V6C4983B. The samples were in the 14-lead hermetically sealed Ceramic Dual Flat-Pack (CDFP) production package. The samples were processed through burn-in before irradiation and screened to the datasheet limits at room, low, and high temperatures before the neutron testing started.

2. Results

Combined neutron and LDR total ionizing dose testing of the ISL73141SEH 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; the damage from neutron testing was not cumulative. Following neutron testing, each set of samples underwent LDR TID testing in which the damage was accumulative.

2.1 Attributes Data

Table 2. ISL73141 Attributes Data

1MeV Fluence, (n/cm^2)		TID (krad(Si))	Sample Size	Pass[1]	Fail	Notes
Planned	Actual					
5×10^{11}	5.38×10^{11}	10	5	5	0	All passed
		30				
		50				
		75				
		100				
2×10^{12}	2.05×10^{12}	10	5	5	0	All passed
		30				
		50				
		75				
		100				
1×10^{13}	1.14×10^{13}	10	5	5	0	All passed
		30				
		50				
		75				
		100				

1. A pass indicates a sample that passes all datasheet limits.

2.2 Variables Data

The plots in Figure 3 through Figure 31 show data for key parameters before and after irradiation to each level. The plots show the mean of each parameter as a function of neutron and total dose irradiation. Each set of samples was irradiated to a different neutron fluence and plotted as a distinct line. Each line only has markers at the radiation levels to which the corresponding set of samples was exposed. For example, the line representing a parameter of the set of samples irradiated to 5×10^{11}n/cm^2 has a marker at 5×10^{11}n/cm^2 but not at 2×10^{12}n/cm^2 or 1×10^{13}n/cm^2. All lines have makers at the pre-irradiation level and the total dose levels of 10krad(Si), 30krad(Si), 50krad(Si), 75krad(Si), and 100krad(Si).

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. While the applicable electrical limits taken from the datasheet are also shown, it should be noted that these limits are provided for guidance only as the ISL73141SEH is not specified for the neutron environment.

All samples passed the post-irradiation datasheet limits after all three neutron exposures up to and including 1.14×10^{13}n/cm^2 and after LDR irradiation through 100krad(Si).

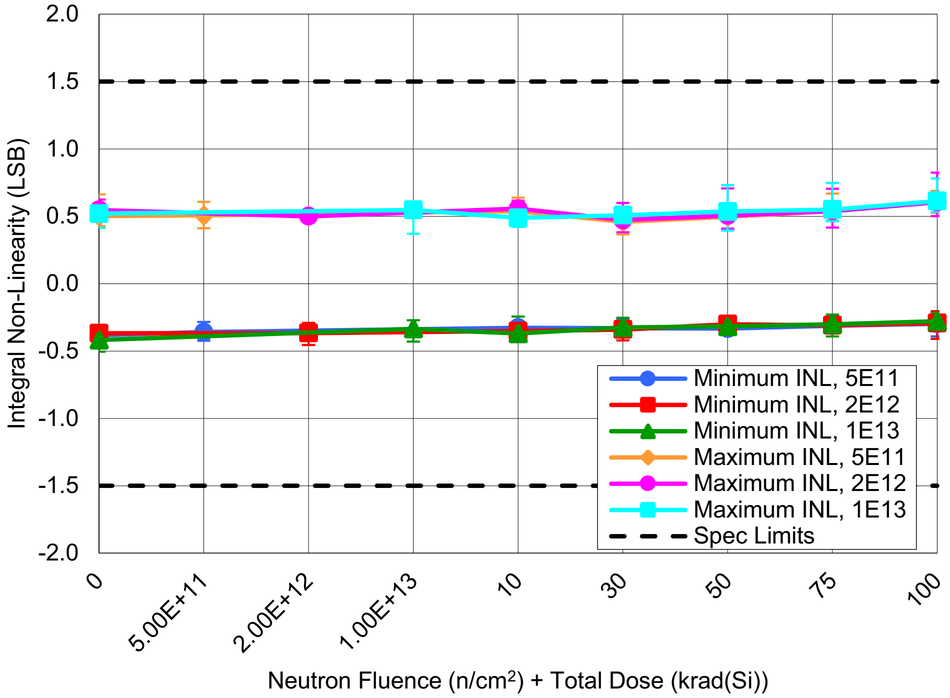

Figure 3. ISL73141SEH average minimum and maximum integral non-linearity (INL) with AV_{CC} = 3.3V, DV_{CC} = 2.5V, REF = 3.0V, f_{SAMP} = 750ksps, and A_{IN} = full-scale sine wave following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post – TID irradiation datasheet limits are a minimum of -1.5LSB with a maximum of 1.5LSB.

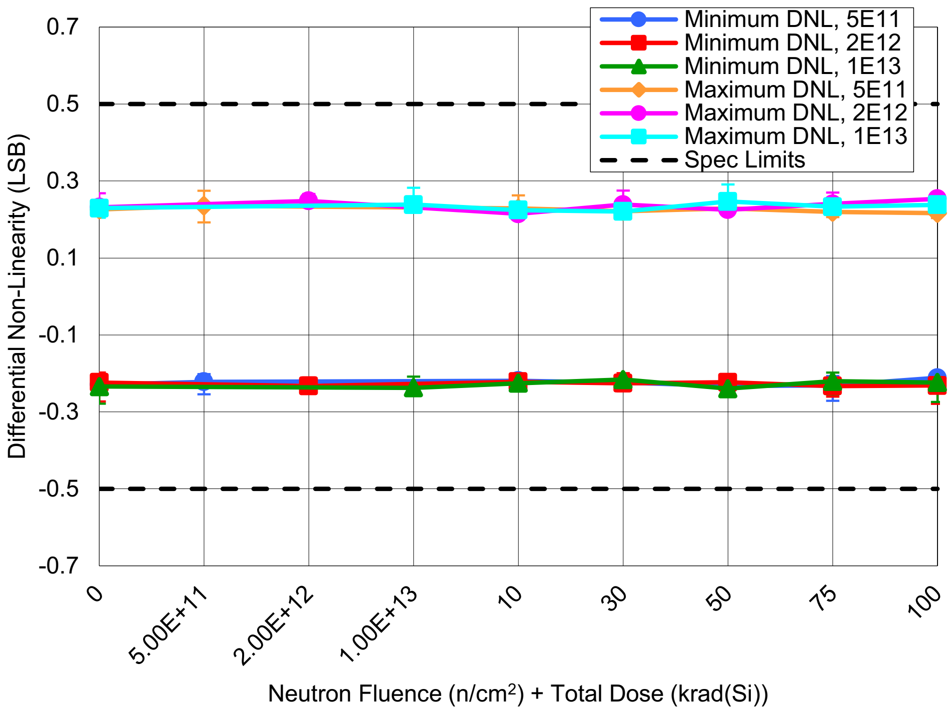

Figure 4. ISL73141SEH average minimum and maximum differential non-linearity (DNL) with AV_{CC} = 3.3V, DV_{CC} = 2.5V, REF = 3.0V, f_{SAMP} = 750ksps, and A_{IN} = full-scale sine wave following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post – TID irradiation datasheet limits are a minimum of -0.5LSB with a maximum of 0.5LSB.

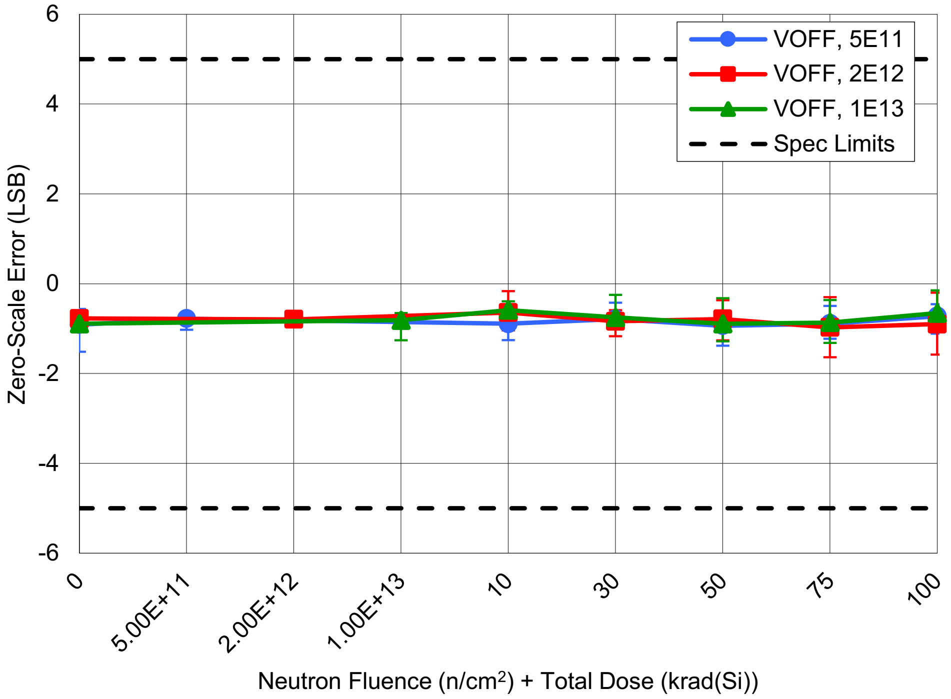

Figure 5. ISL73141SEH average zero scale error (VOFF) with AV_{CC} = 3.3V, DV_{CC} = 2.5V, REF = 3.0V, f_{SAMP} = 750ksps, and A_{IN} = GND following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post – TID irradiation datasheet limits are a minimum of -5LSB with a maximum of 5LSB.

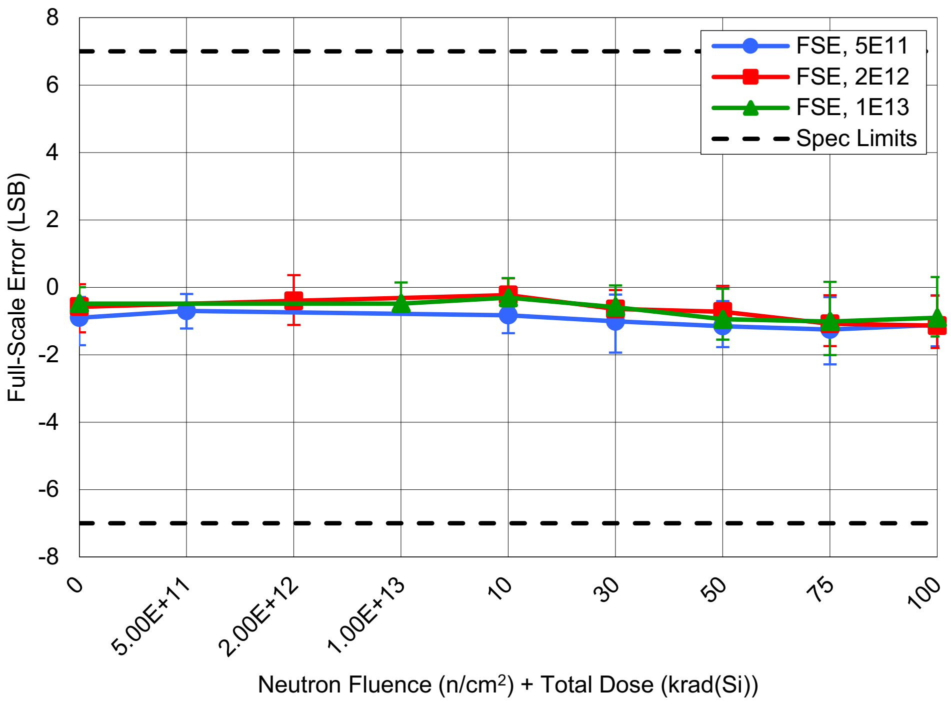

Figure 6. ISL73141SEH average full-scale error (FSE) with AV_{CC} = 3.3V, DV_{CC} = 2.5V, REF = 3.0V, f_{SAMP} = 750ksps, and A_{IN} = VREF following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post – TID irradiation datasheet limits are a minimum of -7LSB with a maximum of 7LSB.

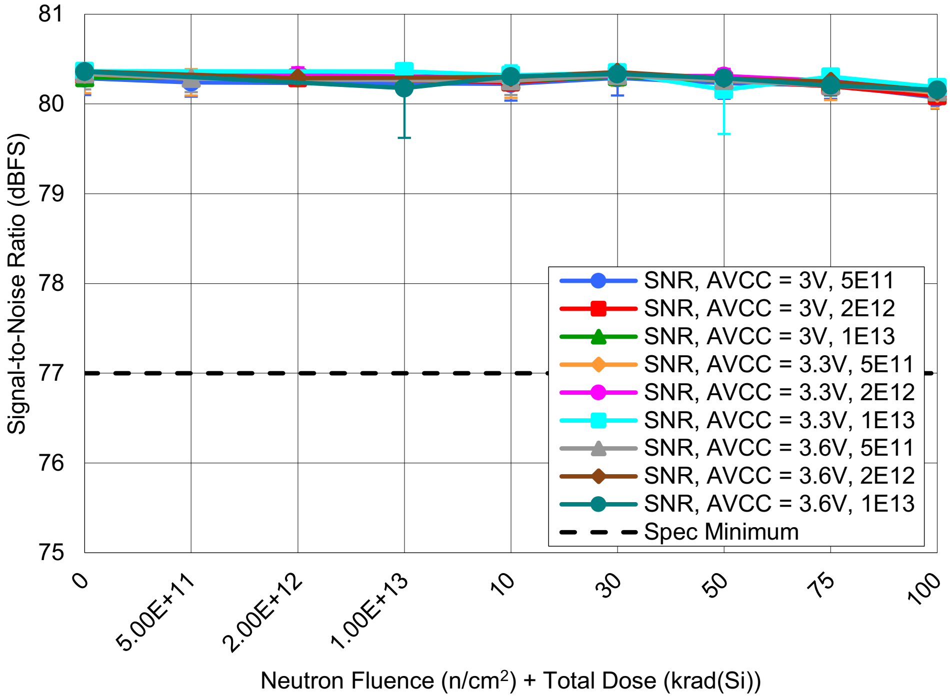

Figure 7. ISL73141SEH average signal-to-noise ratio (SNR) with AV_{CC} = 3.6V, 3.3V and 3.0V, DV_{CC} = 2.5V, REF = 3.0V, F_{IN} = 105kHz, and A_{IN} = -1dBFS following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post – TID irradiation datasheet limit is a minimum of 77dB.

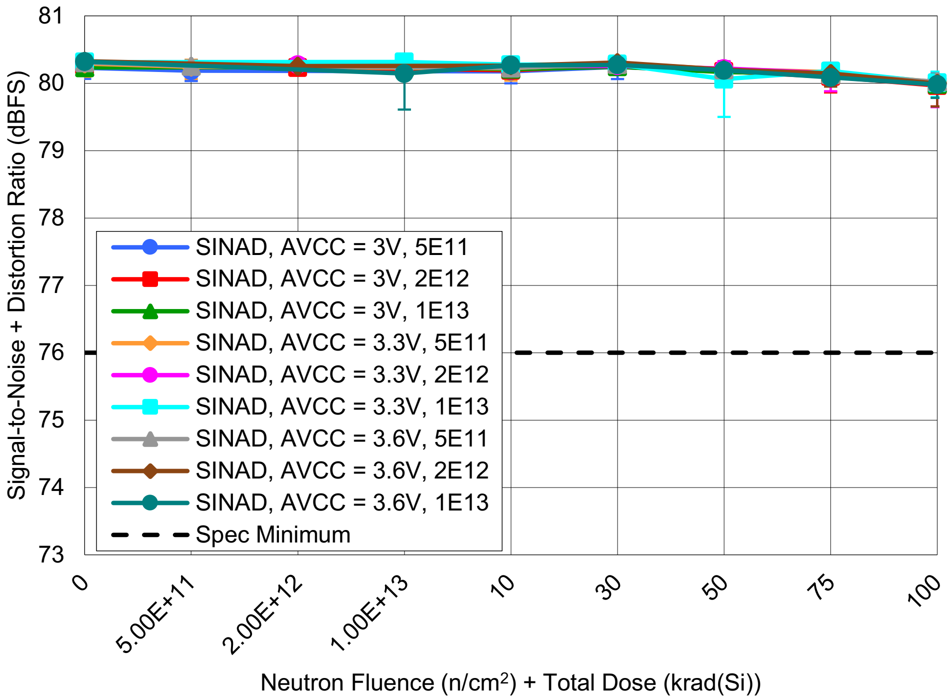

Figure 8. ISL73141SEH average signal-to-noise + distortion ratio (SINAD) with AV_{CC} = 3.6V, 3.3V and 3.0V, DV_{CC} = 2.5V, REF = 3.0V, F_{IN} = 105kHz, and A_{IN} = -1dBFS following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post – TID irradiation datasheet limit is a minimum of 76dB.

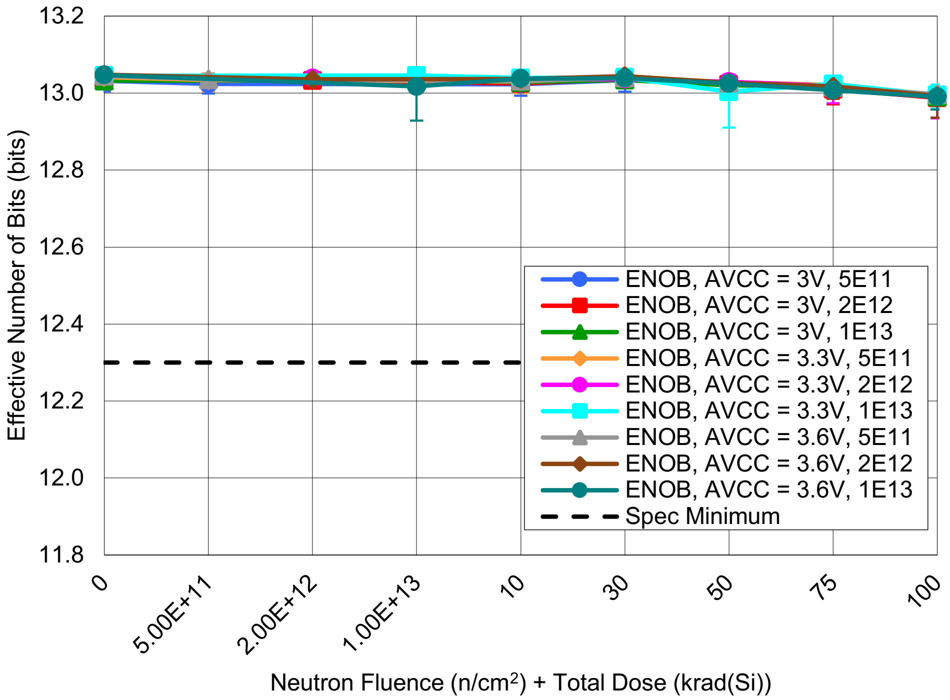

Figure 9. ISL73141SEH average effective number of bits (ENOB) with AV_{CC} = 3.6V, 3.3V and 3.0V, DV_{CC} = 2.5V, REF = 3.0V, F_{IN} = 105kHz, and A_{IN} = -1dBFS following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post – TID irradiation datasheet limit is a minimum of 12.3bits.

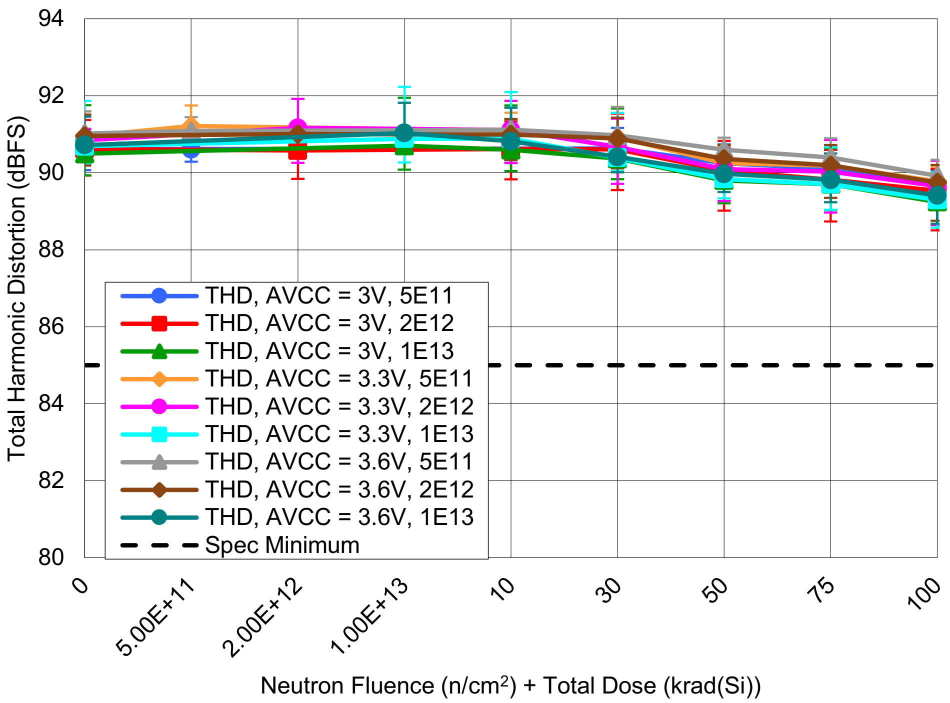

Figure 10. ISL73141SEH average total harmonic distortion (THD) with AV_{CC} = 3.6V, 3.3V and 3.0V, DV_{CC} = 2.5V, REF = 3.0V, F_{IN} = 105kHz (first five harmonics), and A_{IN} = -1dBFS following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post – TID irradiation datasheet limit is a minimum of 85dB.

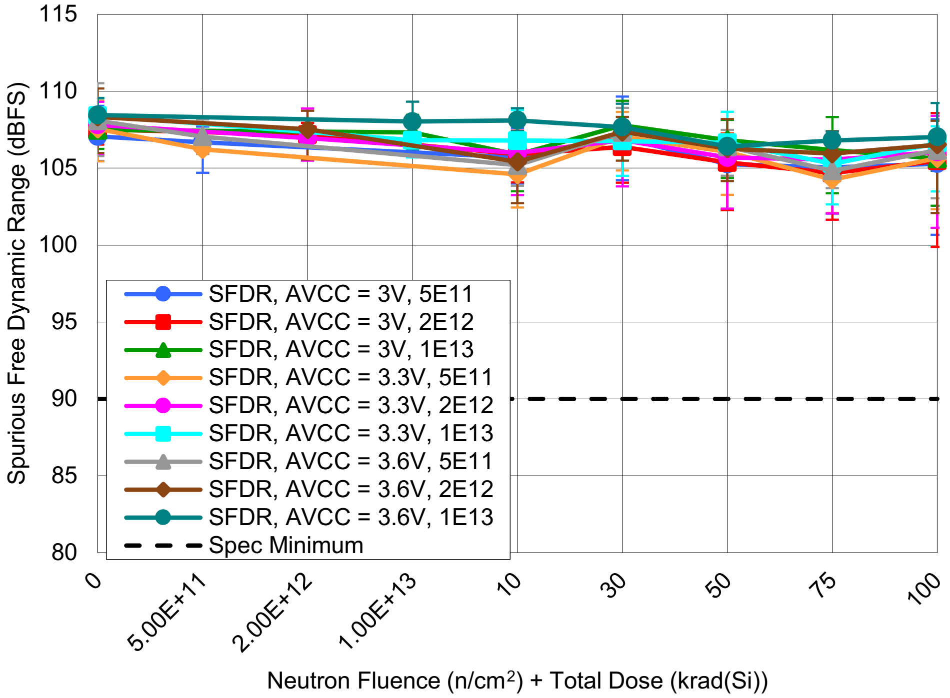

Figure 11. ISL73141SEH average spurious free dynamic range (SFDR) with AV_{CC} = 3.6V, 3.3V and 3.0V, DV_{CC} = 2.5V, REF = 3.0V, F_{IN} = 105kHz (first five harmonics excluded), and A_{IN} = -1dBFS following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post – TID irradiation datasheet limit is a minimum of 90dB.

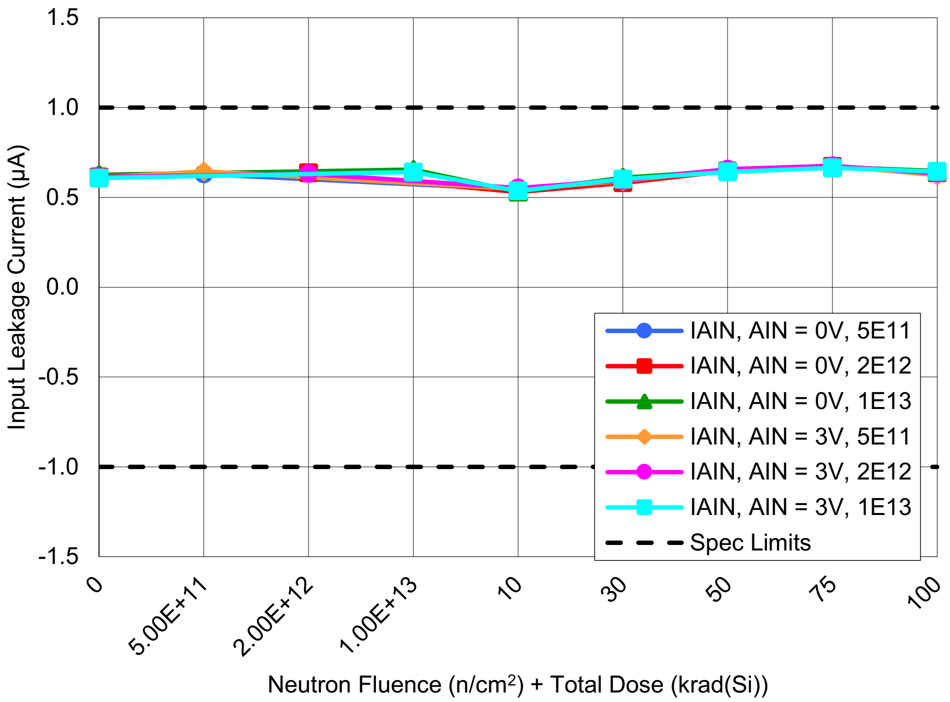

Figure 12. ISL73141SEH average input leakage current (IA_{IN}) with AV_{CC} = 3.3V, DV_{CC} = 2.5V, REF = 3.0V, f_{SAMP} = 750ksps, and A_{IN} = 3.0V and 0V following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post – TID irradiation datasheet limits are a minimum of -1µA with a maximum of 1µA.

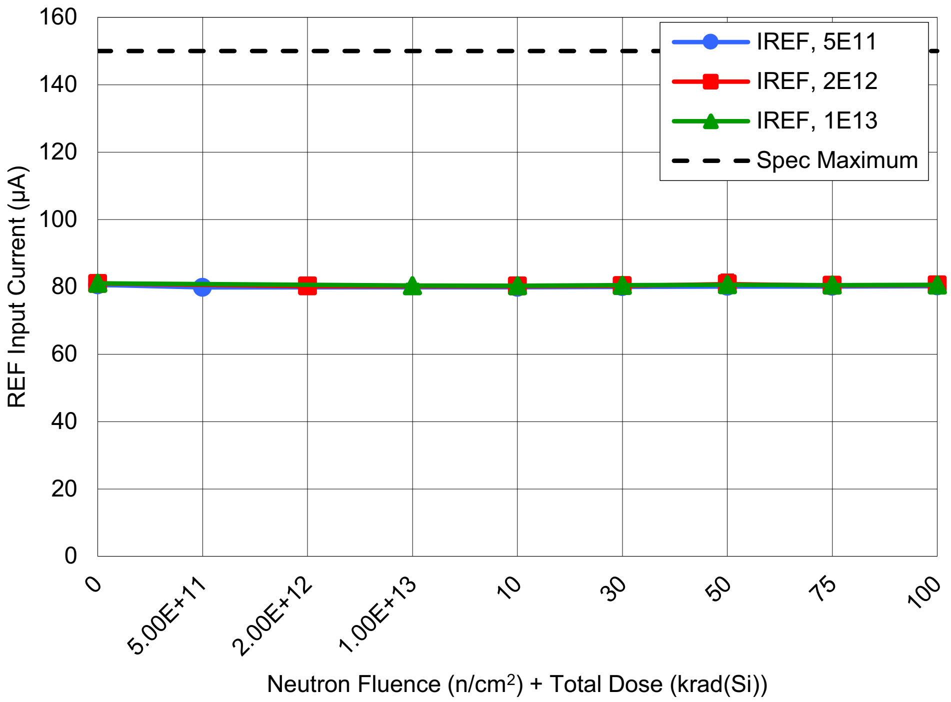

Figure 13. ISL73141SEH average REF input current (I_{REF}) with AV_{CC} = 3.3V, DV_{CC} = 2.5V, REF = 3.0V, f_{SAMP} = 750ksps, and A_{IN} = -1dBFS following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post – TID irradiation datasheet limit is a maximum of 150µA.

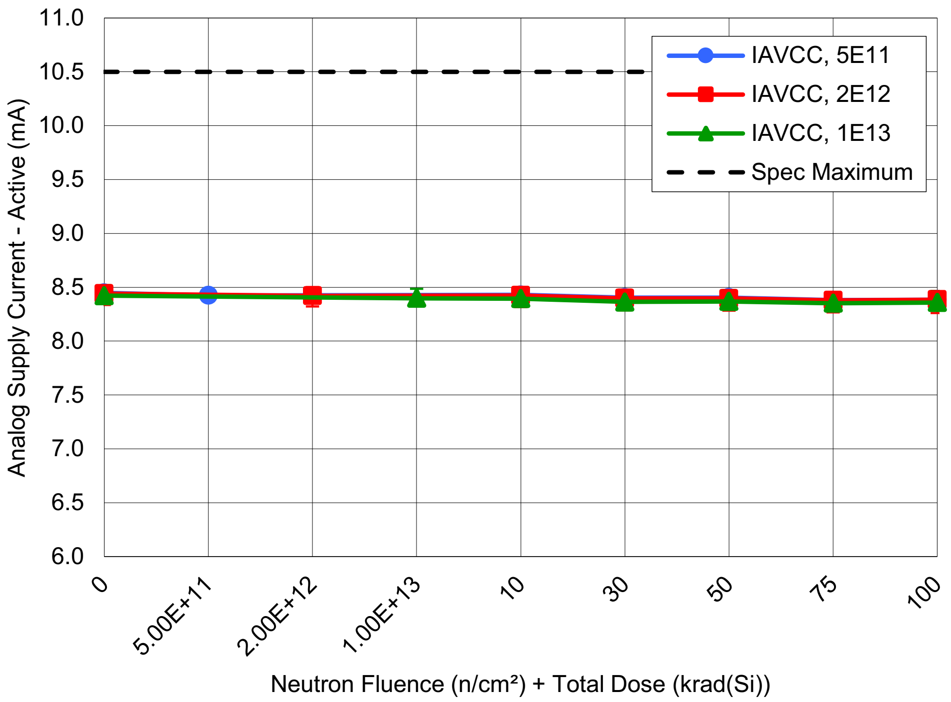

Figure 14. ISL73141SEH average analog supply current – active (IAV_{CC}) with AV_{CC} = 3.3V, DV_{CC} = 2.5V, REF = 3.0V, f_{SAMP} = 750ksps, and A_{IN} = -1dBFS following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post – TID irradiation datasheet limit is a maximum of 10.5mA.

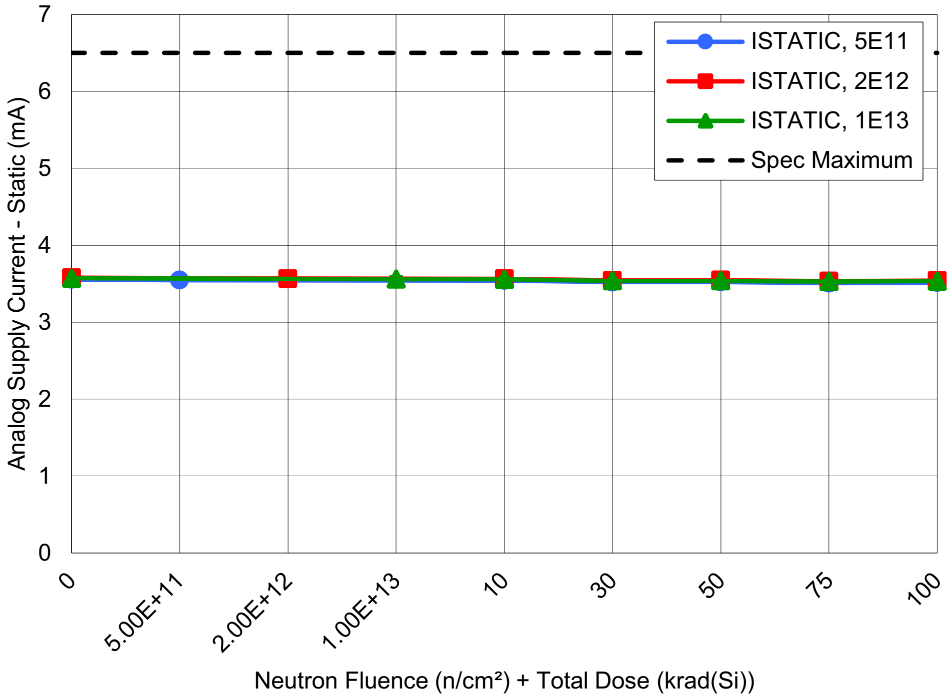

Figure 15. ISL73141SEH average analog supply current – static (I_{STATIC}) with AV_{CC} = 3.3V, DV_{CC} = 2.5V, REF = 3.0V, and $\overline{CS}$ = DV_{CC} following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post – TID irradiation datasheet limit is a maximum of 6.5mA.

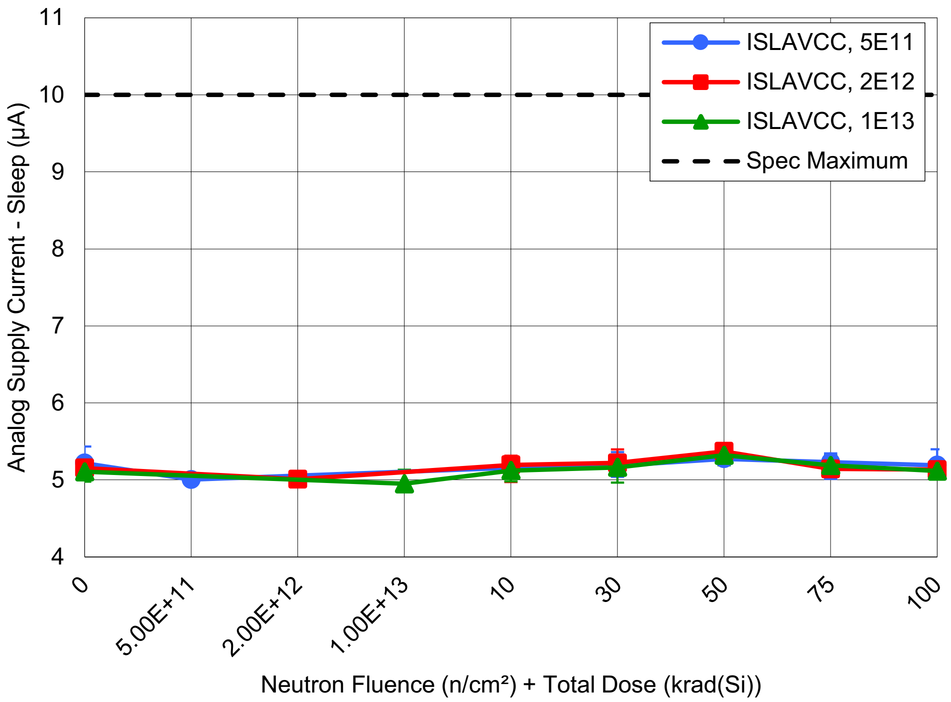

Figure 16. ISL73141SEH average analog supply current – sleep (I_{SLAVCC}) with AV_{CC} = 3.3V, DV_{CC} = 2.5V, REF = 3.0V, and $\overline{PD}$ = GND following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post – TID irradiation datasheet limit is a maximum of 10µA.

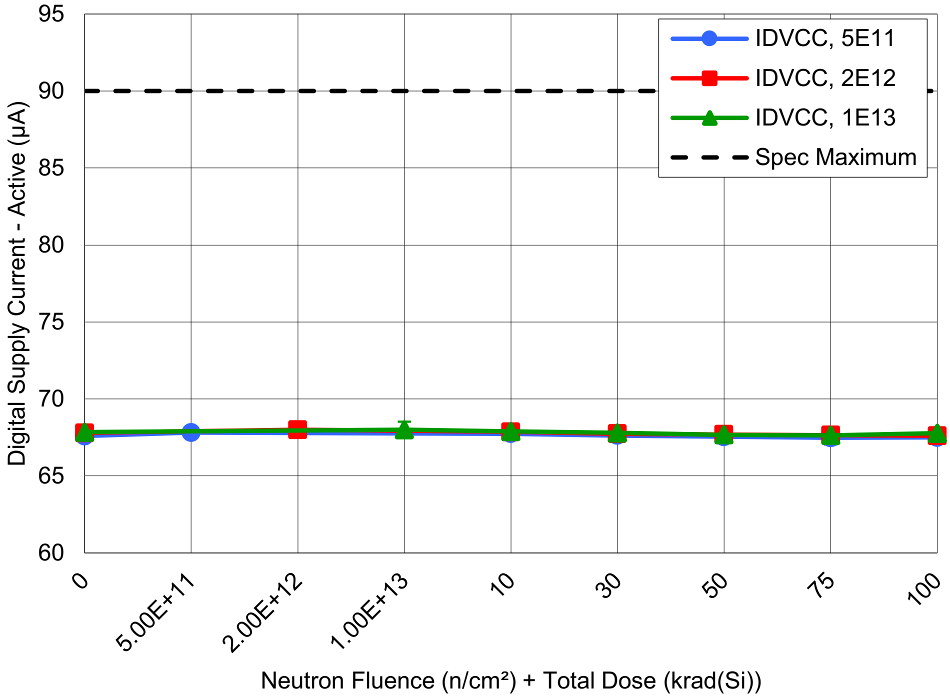

Figure 17. ISL73141SEH average digital supply current – active (I_{DVCC}) with AV_{CC} = 3.3V, DV_{CC} = 2.5V, REF = 3.0V, f_{SCK} = 33MHz, and C_L = 10pF following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post – TID irradiation datasheet limit is a maximum of 90µA.

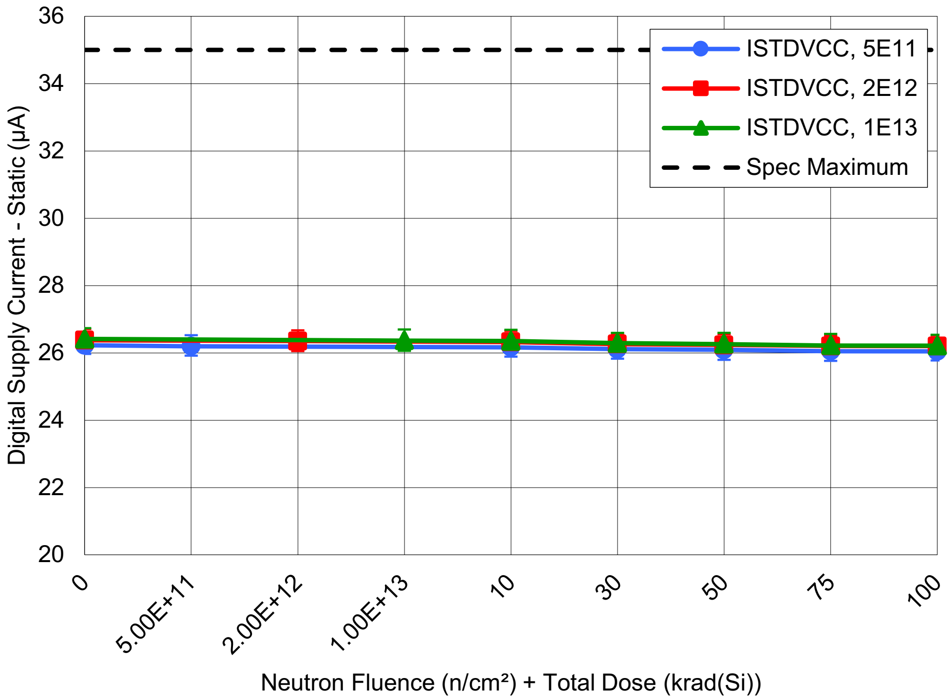

Figure 18. ISL73141SEH average digital supply current – static (I_{STDVCC}) with AV_{CC} = 3.3V, DV_{CC} = 2.5V, REF = 3.0V, and $\overline{CS}$ = DV_{CC} following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post – TID irradiation datasheet limit is a maximum of 35µA.

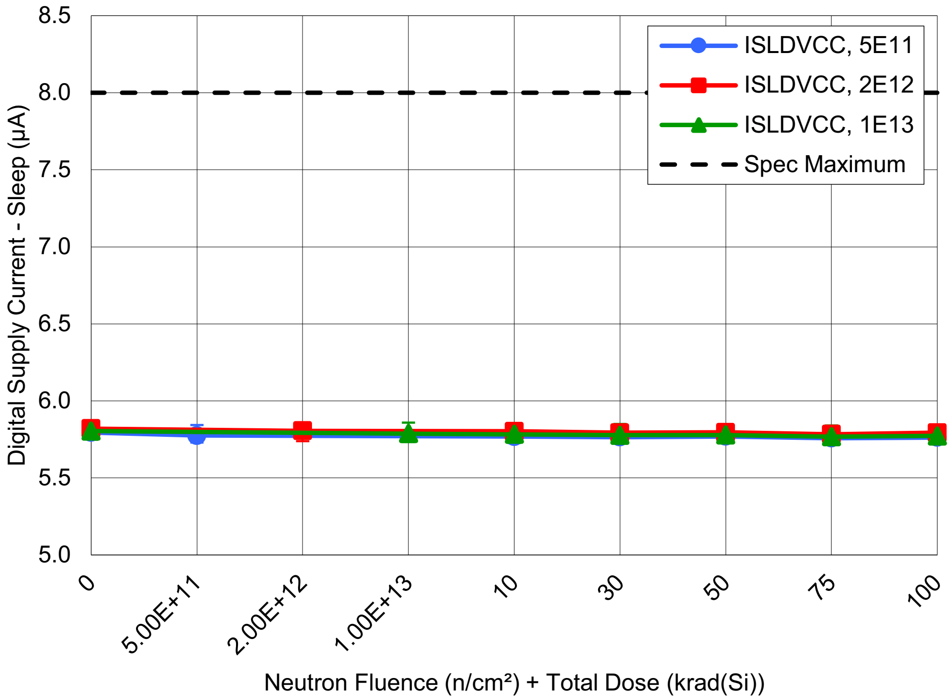

Figure 19. ISL73141SEH average digital supply current – sleep (I_{SLDVCC}) with AV_{CC} = 3.3V, DV_{CC} = 2.5V, REF = 3.0V, and $\overline{PD}$ = GND following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post – TID irradiation datasheet limit is a maximum of 8µA.

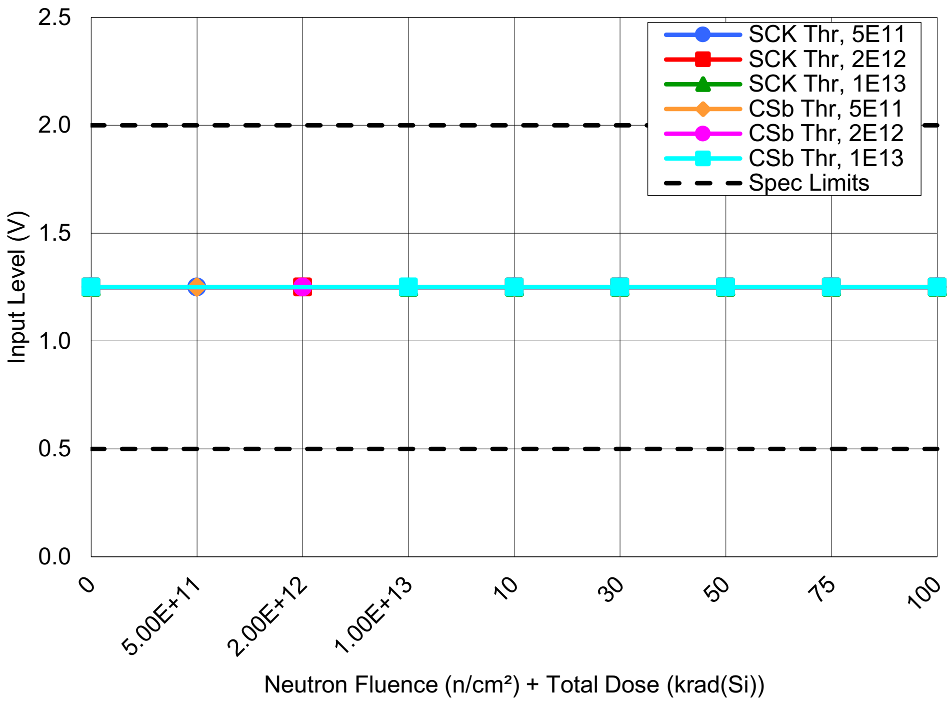

Figure 20. ISL73141SEH average high-level input (V_{IH}) and low-level input (V_{IL}) with AV_{CC} = 3.3V, DV_{CC} = 2.5V, and REF = 3.0V following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post – TID irradiation datasheet limits are a 2.0V minimum for V_{IH} and a 0.5V maximum for V_{IL}.

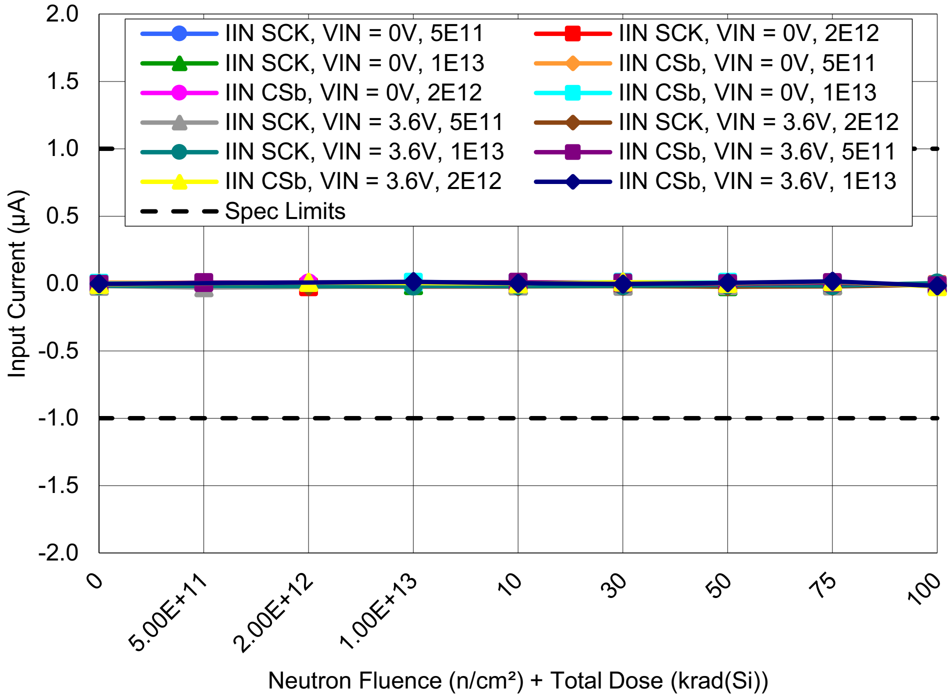

Figure 21. ISL73141SEH average input leakage current (I_{IN}) on SCK and $\overline{CS}$ with AV_{CC} = 3.3V, DV_{CC} = 2.5V, REF = 3.0V, and V_{IN} = 3.6V and 0V following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post – TID irradiation datasheet limits are a minimum of -1µA with a maximum of 1µA.

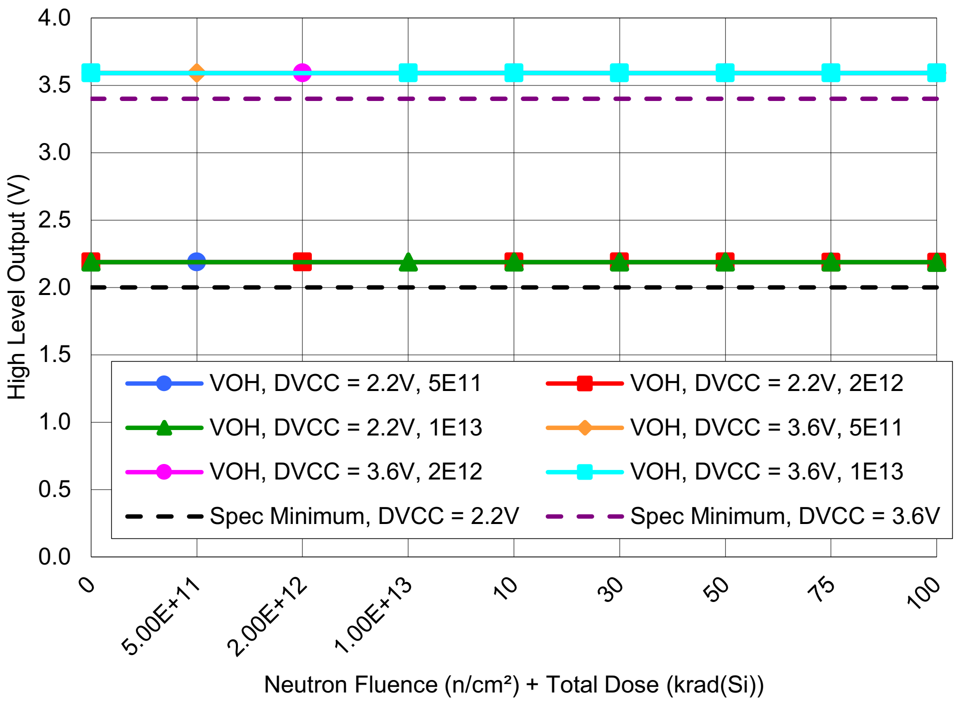

Figure 22. ISL73141SEH average high-level output (V_{OH}) with AV_{CC} = 3.3V, DV_{CC} = 3.6V and 2.2V, REF = 3.0V, and I_O = -500µA following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post – TID irradiation datasheet limits are minimums of 3.4V and 2.0V for DV_{CC} = 3.6V and 2.2V respectively.

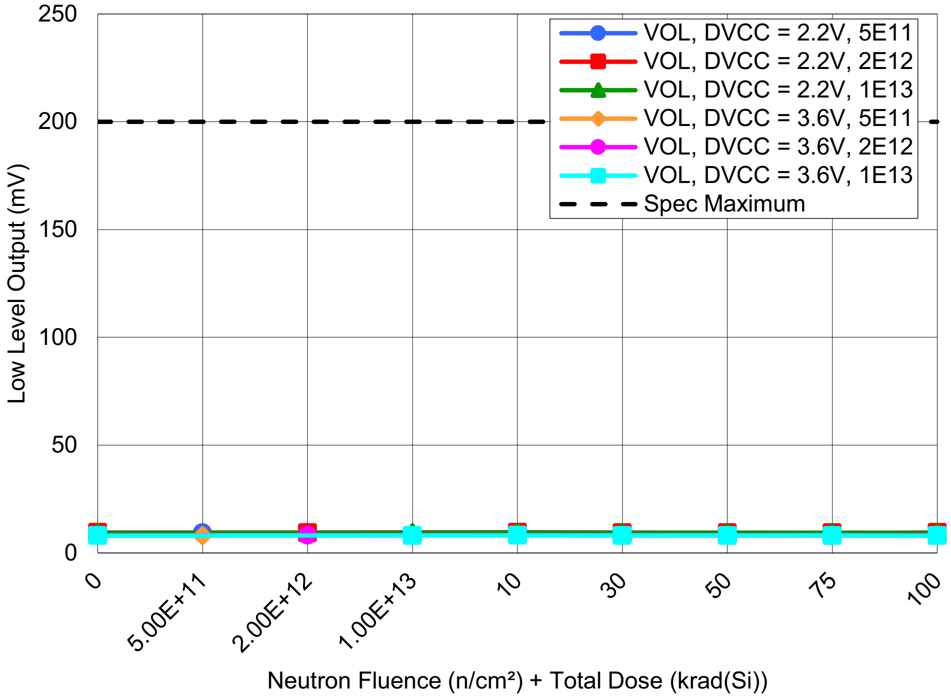

Figure 23. ISL73141SEH average low-level output (V_{OL}) with AV_{CC} = 3.3V, DV_{CC} = 3.6V and 2.2V, REF = 3.0V, and I_O = 500µA following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post – TID irradiation datasheet limit is a maximum of 200mV.

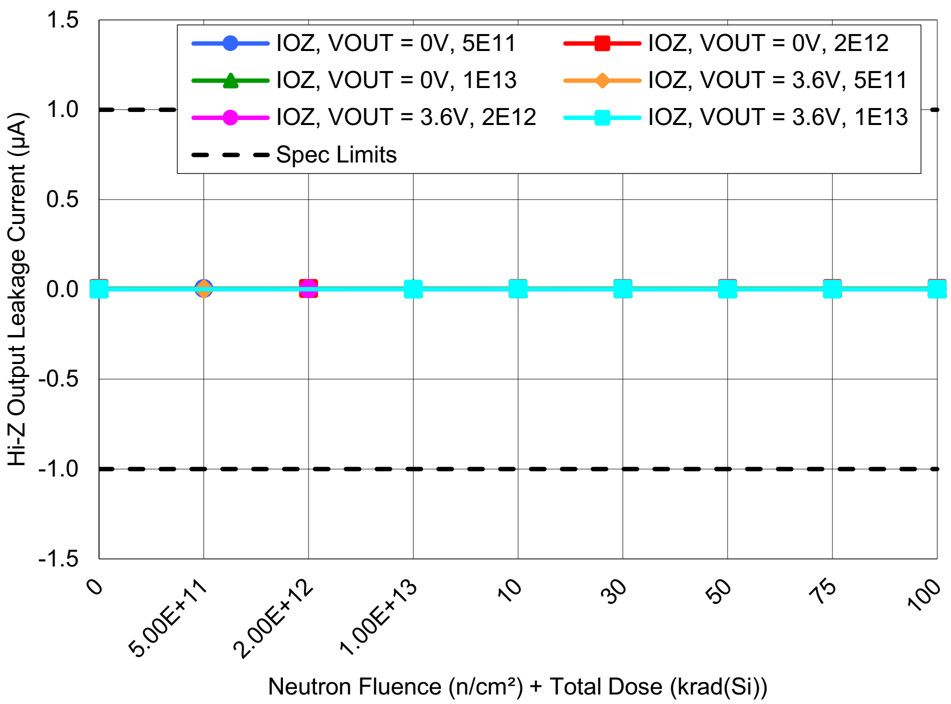

Figure 24. ISL73141SEH average Hi-Z output leakage current (I_{OZ}) with AV_{CC} = 3.3V, DV_{CC} = 3.6V, V_{OUT} = 3.6V and 0V, and REF = 3.0V following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post – TID irradiation datasheet limits are a minimum of -1µA with a maximum of 1µA.

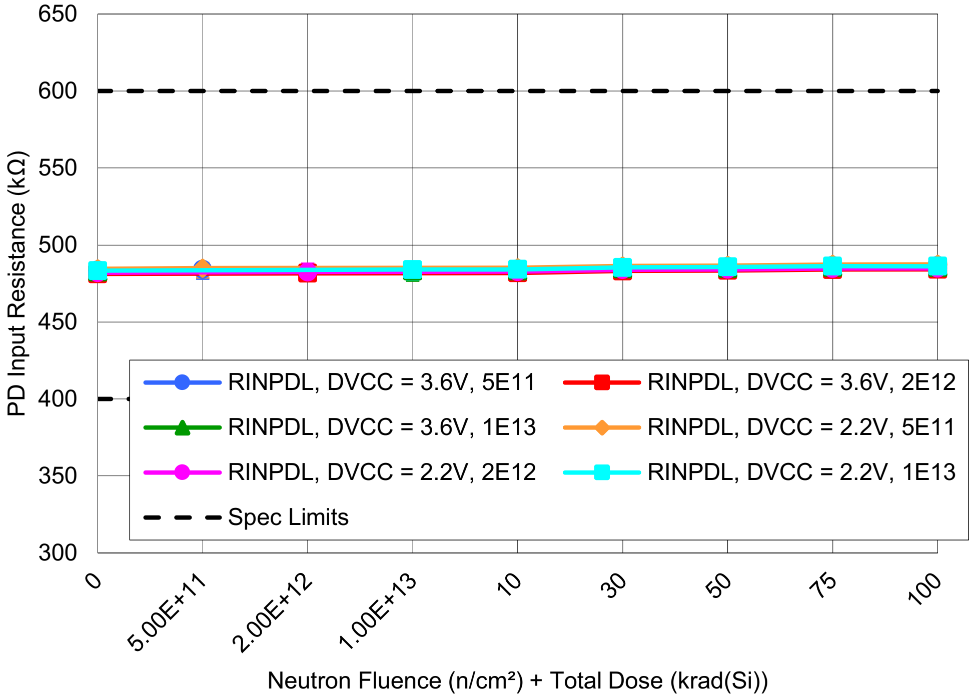

Figure 25. ISL73141SEH average $\overline{PD}$ input resistance (R_{INPDL}) with AV_{CC} = 3.3V, DV_{CC} = 3.6V and 2.2V, and REF = 3.0V following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post – TID irradiation datasheet limits are a minimum of 400kΩ with a maximum of 600kΩ.

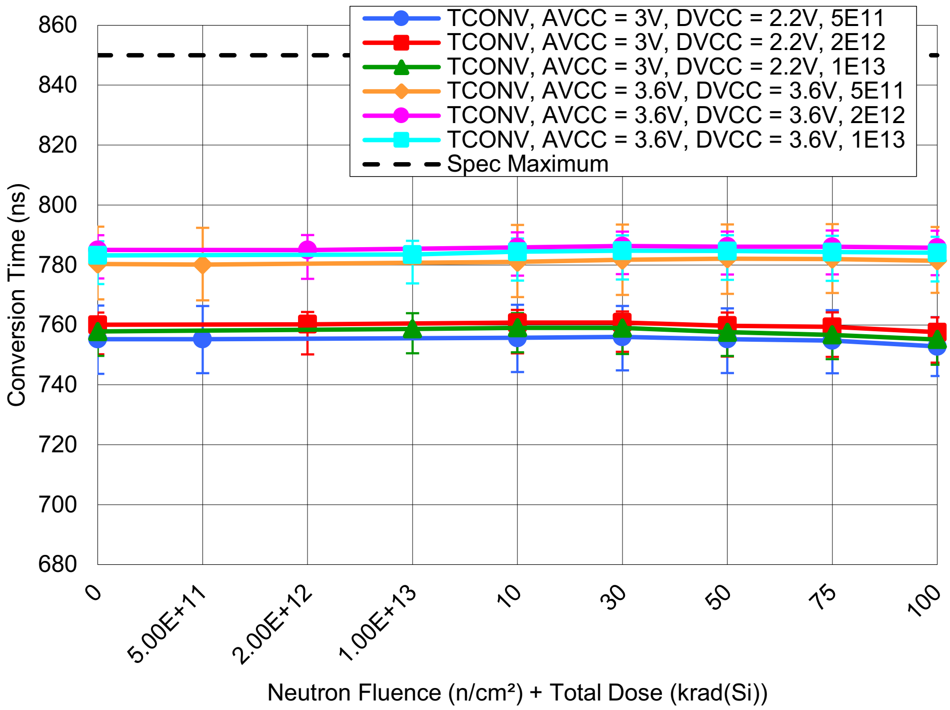

Figure 26. ISL73141SEH average conversion time (t_{CONV}) with AV_{CC} = 3.6V, DV_{CC} = 3.6V and AV_{CC} = 3.0V, DV_{CC} = 2.2V, REF = 3.0V, f_{SAMP} = 750ksps, and A_{IN} = -1dBFS following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post – TID irradiation datasheet limit is a maximum of 850ns.

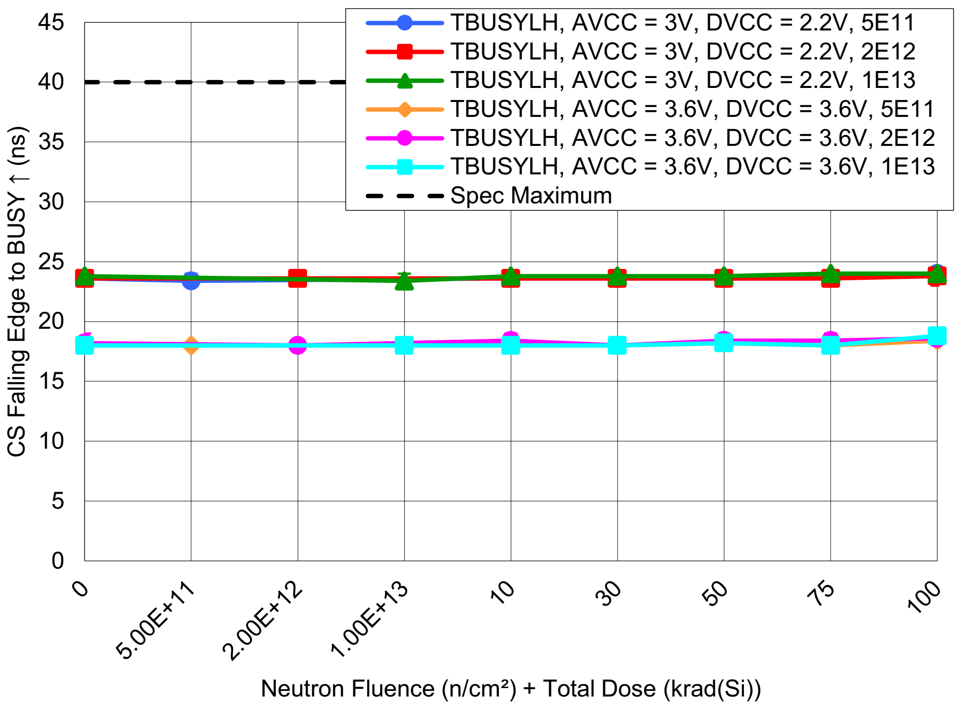

Figure 27. ISL73141SEH average $\overline{CS}$ falling edge to BUSY rising edge (t_{BUSYLH}) with AV_{CC} = 3.6V, DV_{CC} = 3.6V and AV_{CC} = 3.0V, DV_{CC} = 2.2V, REF = 3.0V, f_{SAMP} = 750ksps, A_{IN} = -1dBFS, and C_L = 10pF following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post – TID irradiation datasheet limit is a maximum of 40ns.

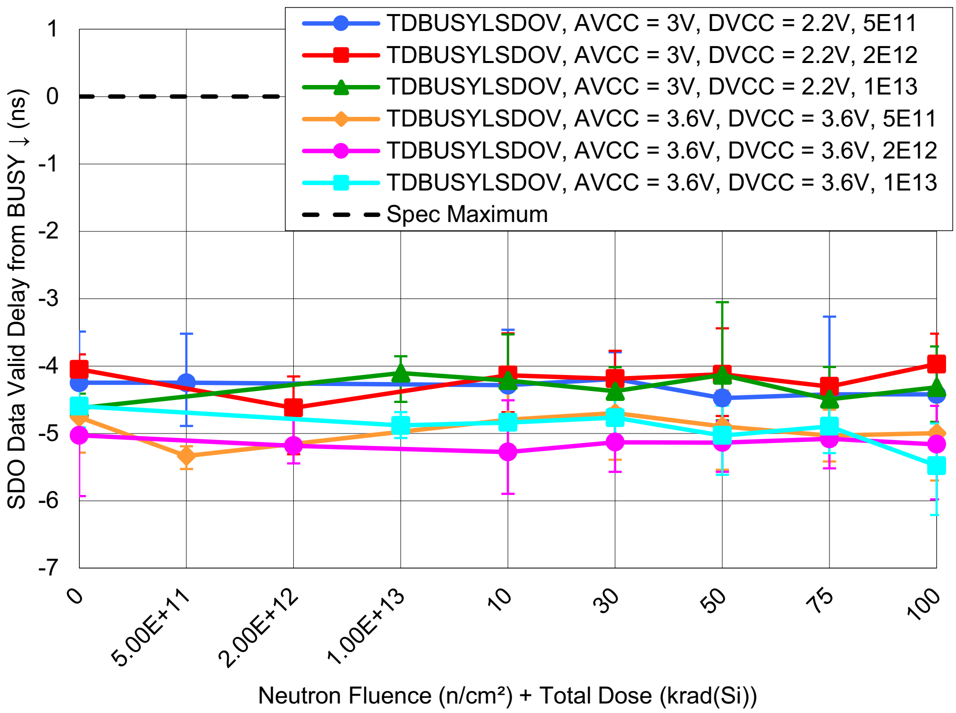

Figure 28. ISL73141SEH average SDO data valid delay from BUSY falling edge ($t_{DBUSYLSDOV}$) with AV_{CC} = 3.6V, DV_{CC} = 3.6V and AV_{CC} = 3.0V, DV_{CC} = 2.2V, REF = 3.0V, f_{SAMP} = 750ksps, A_{IN} = -1dBFS, and C_L = 10pF following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post – TID irradiation datasheet limit is a maximum of 0ns.

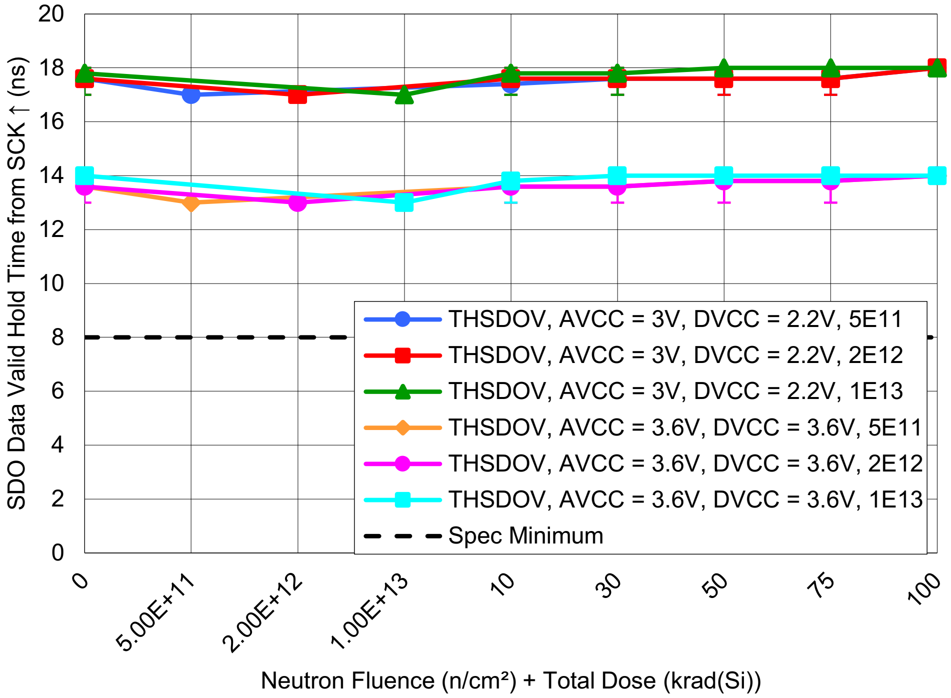

Figure 29. ISL73141SEH average SDO data valid hold time from SCK rising edge (t_{HSDOV}) with AV_{CC} = 3.6V, DV_{CC} = 3.6V and AV_{CC} = 3.0V, DV_{CC} = 2.2V, REF = 3.0V, f_{SAMP} = 750ksps, A_{IN} = -1dBFS, and C_L = 10pF following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post – TID irradiation datasheet limit is a minimum of 8ns.

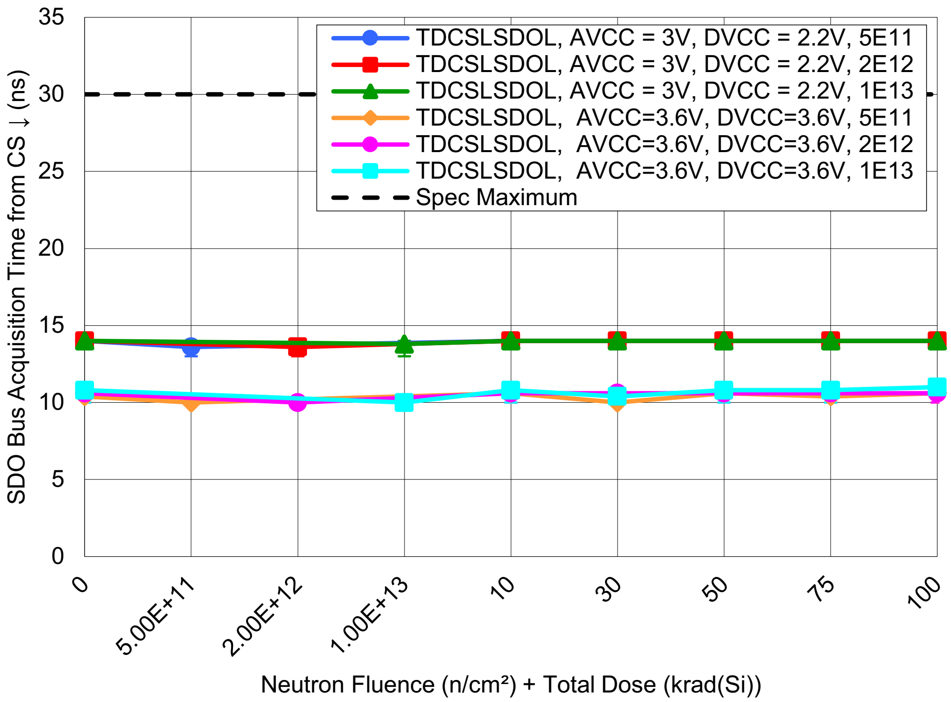

Figure 30. ISL73141SEH average SDO bus acquisition time from $\overline{CS}$ falling edge ($t_{DCSLSDOL}$) with AV_{CC} = 3.6V, DV_{CC} = 3.6V and AV_{CC} = 3.0V, DV_{CC} = 2.2V, REF = 3.0V, f_{SAMP} = 750ksps, A_{IN} = -1dBFS, and C_L = 10pF following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post – TID irradiation datasheet limit is a maximum of 30ns.

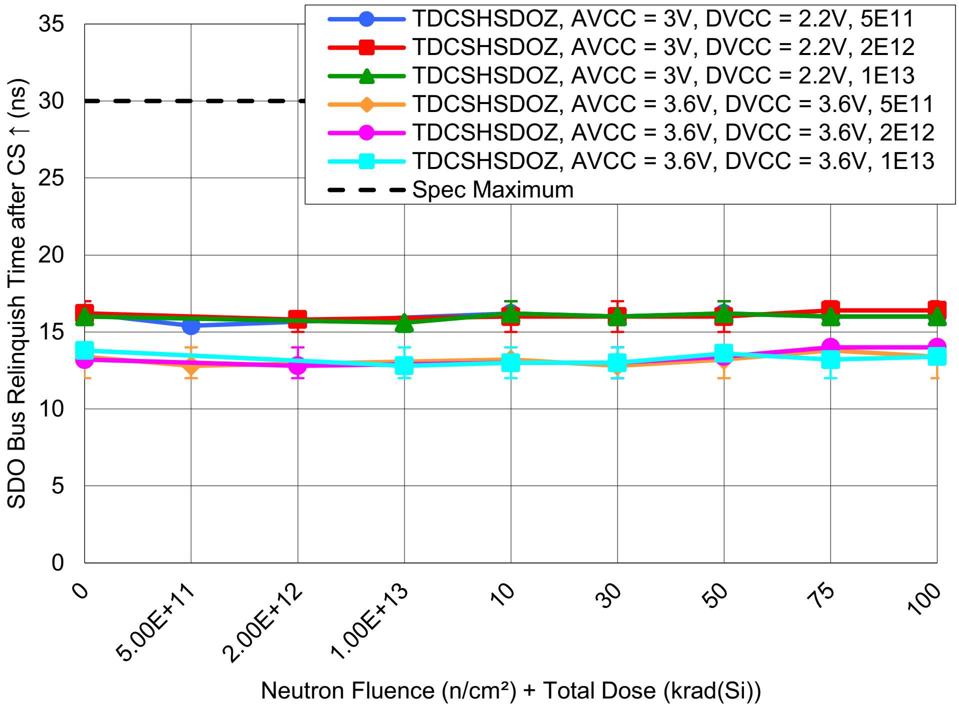

Figure 31. ISL73141SEH average SDO bus relinquish time after $\overline{CS}$ raising edge ($t_{DCSHSDOZ}$) with AV_{CC} = 3.6V, DV_{CC} = 3.6V and AV_{CC} = 3.0V, DV_{CC} = 2.2V, REF = 3.0V, f_{SAMP} = 750ksps, A_{IN} = -1dBFS, and C_L = 10pF following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The post – TID irradiation datasheet limit is a maximum of 30ns.

3. Discussion and Conclusion

This report summarizes the results of combined 1MeV equivalent neutron testing and LDR TID testing of the ISL73141SEH 3.3V, 14-Bit, 750ksps SAR ADC. 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. Following neutron irradiation and testing, each set of samples underwent LDR TID testing. Each set of samples was irradiated under bias to 100krad(Si) with downpoints at 10krad(Si), 30krad(Si), 50krad(Si), 75krad(Si), and 100krad(Si). The results of key parameters before and after irradiation to each level are plotted in Figure 3 through Figure 31. The plots show the mean of each parameter as a function of neutron and total dose irradiation, with error bars representing the minimum and maximum measured values. The figures also show the applicable electrical limits taken from the datasheet. However, note that these limits are provided for guidance only as the ISL73141SEH is not specified for the neutron environment.

All samples passed the post-irradiation datasheet limits after all three neutron exposures up to and including 1.14×10^{13}n/cm^2 and after LDR irradiation through 100krad(Si).

4. Revision History

Revision	Date	Description
1.00	Mar 6, 2023	Initial release.

Appendix

Table 3. Reported Parameters

Fig.	Parameter	Symbol	Test Conditions	Low Limit	High Limit	Unit
3	Integral Non-Linearity	INL	Measured with full-scale input signal	-1.5	1.5	LSB
4	Differential Non-Linearity	DNL	Measured with full-scale input signal	-0.5	0.5	LSB
5	Zero Scale Error	VOFF	Measured with input grounded	-5	5	LSB
6	Full-Scale Error	FSE	Measured with input connected to VREF	-7	7	LSB
7	Signal to Noise Ratio	SNR	F_{IN} = 105kHz	77	-	LSB
8	Signal to Noise + Distortion Ratio	SINAD	F_{IN} = 105kHz	76	-	LSB
9	Effective Number of Bits	ENOB	F_{IN} = 105kHz	12.3	-	bits
10	Total Harmonic Distortion	THD	F_{IN} = 105kHz, first five harmonics	85	-	dB
11	Spurious Free Dynamic Range	SFDR	F_{IN} = 105kHz, first five harmonics excluded	90	-	dB
12	Input Leakage Current	I_{AIN}	A_{IN} = 0V, 3V	-1	1	µA
13	REF Input Current	I_{REF}		-	150	µA
14	Analog Supply Current - Active	I_{AVCC}	Active, f_{SAMP} = 750ksps	-	10.5	mA
15	Analog Supply Current - Static	I_{STATIC}	$\overline{CS}$ held high	-	6.5	mA
16	Analog Supply Current - Sleep	I_{SLAVCC}	$\overline{PD}$ held low	-	10	µA
17	Digital Supply Current - Active	I_{DVCC}	f_{SCK} = 33MHz; 10pF load	-	90	µA
18	Digital Supply Current - Static	I_{STDVCC}	$\overline{CS}$ held high	-	35	µA
19	Digital Supply Current - Sleep	I_{SLDVCC}	$\overline{PD}$ held low	-	8	µA
20	High Input Level	V_{IH}		0.8 × DV_{CC}	-	V
	Low Input Level	V_{IL}		-	0.2×DV_{CC}	V
21	Input Current ($\overline{CS}$, SCK)	I_{IN}	V_{IN} = 0V to DV_{CC}	-1	1	µA
22	High Level Output	V_{OH}	DV_{CC} - Output; I_O = -500µA	DV_{CC} - 0.2V	-	V
23	Low Level Output	V_{OL}	I_O = 500µA	-	200	mV
24	Hi-Z Output Leakage Current	I_{OZ}	V_{OUT} = 0V to DV_{CC}	-1	1	µA
25	$\overline{PD}$ Input Resistance	R_{INPDL}	Internal pull-up resistance to DV_{CC}	400	600	kΩ
26	Conversion Time	t_{CONV}	BUSY Output High Time	-	850	ns
27	$\overline{CS}$ Falling Edge to BUSY ↑	t_{BUSYLH}	C_L = 10pF	-	40	ns
28	SDO Data Valid Delay from BUSY ↓	$t_{DBUSYLSDOV}$	C_L = 10pF	-	0	ns
29	SDO Data Valid Hold Time from SCK ↑	t_{HSDOV}	C_L = 10pF	8	-	ns
30	SDO Bus Acquisition Time from $\overline{CS}$ ↓	$t_{DCSLSDOL}$	C_L = 10pF	-	30	ns
31	SDO Bus Relinquish Time after $\overline{CS}$ ↑	$t_{DCSHSDOZ}$	C_L = 10pF	-	30	ns

Related Information

- ISL73141SEH documents
- MIL-STD-883 test method 1017
- MIL-STD-883 test method 1019

IMPORTANT NOTICE AND DISCLAIMER

Corporate Headquarters

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

Contact Information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit:
www.renesas.com/contact/

Trademarks