ISL72813SEH

Neutron Testing of the ISL72813SEH 32-Channel Driver Circuit with an Integrated Decoder

Introduction

This report summarizes results of 1MeV equivalent neutron testing of the ISL72813SEH 32-channel driver circuit with an integrated decoder. 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 5x10^{11}n/cm^{2} to 1x10^{14}n/cm^{2}. This project was carried out in collaboration with Honeywell Aerospace and their support is gratefully acknowledged.

Product Description

The ISL72813SEH is a radiation tolerant, high-voltage, high-current driver fabricated using the proprietary PR40 silicon-on-insulator process technology to mitigate single-event effects. This device uses a complementary Darlington output configuration to integrate 32 current drivers that feature high-voltage, common emitter, and open-collector outputs with a 42V breakdown voltage and peak current rating of 600mA.

To further reduce solution size and increase system power density, the ISL72813SEH integrates a 5-bit to 32-channel decoder (plus enable pin) and level shifting circuitry to reference the output of the decoder to a negative voltage. This allows you to select 1 of 32 available current driver channels. The inputs to the decoder are TTL/CMOS compatible allowing easy integration to CPUs, FPGAs, or microprocessors.

The ISL72813SEH operates across the military temperature range from -55°C to +125°C and is available in a 44 Ld hermetically sealed Ceramic Lead-Less Chip Carrier (CLCC) package.

Related Literature

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

- ISL72813SEH device page
- MIL-STD-883 test method 1017

Contents

1. Test Description

1.1 Irradiation Facility

Neutron fluence irradiations were performed on the test samples on June 25, 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 $5x10^{11}n/cm^2$, $2x10^{12}n/cm^2$, $1x10^{13}n/cm^2$, and $1x10^{14}n/cm^2$. 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 considered bag tests, which means 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. ISL72813SEH Neutron Fluence Dosimetry Data

TLD		Sulfur Pellet						
TLD #	**cGy(Si)[1]**	**Pellet #**	**Distance (inches)**	**Exposure ID**	**Flu >3MeV (n/cm^2)**	**% Unc[2]**	**Total Fluence (n/cm^2)**	**1Mev Si (n/cm^2)**
291	1.215E+02	6477	26.6	Free Field	7.693E+10	7.1%	6.221E+11	5.35E+11
278	3.918E+02	6414	13.45	Free Field	2.739 E+11	7.1%	2.161E+12	1.92E+12
262	1.796E+03	6487	24	Free Field	1.395E+12	7.1%	1.119E+13	9.68E+12
258	1.770E+04	6483	8	Free Field	1.230E+13	7.1%	9.657E+13	8.63E+13

1. 1cGy(Si) = 1rad(Si)
2. The Uncertainty (% Unc) column is applicable only to the Fluence > 3MeV.

1.4 Characterization Equipment and Procedures

Electrical testing was performed before and after irradiation using the 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 irradiated at $5x10^{11}n/cm^2$, five samples irradiated at $1x10^{12}n/cm^2$, five irradiated at $1x10^{13}n/cm^2$, and five irradiated at $1x10^{14}n/cm^2$. Three control units were used.

ISL72813SEH samples were drawn from Lot X7C0JBEHA. Samples were packaged in the standard hermetic 44 Ld hermetically sealed Ceramic Lead-Less Chip Carrier (CLCC) 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 ISL72813SEH 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 summarizes the neutron exposure test results.

Table 2. Attributes Data

Fluence, (n/cm^2)		Sample Size	Pass[1]	Fail
Planned	Actual			
5x10^{11}	5.35x10^{11}	5	5	0
2x10^{12}	1.92x10^{12}	5	5	0
1x10^{13}	9.68x10^{12}	5	5	0
1x10^{14}	8.63x10^{13}	5	0	5

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

2.2 Variables Data

The plots in Figure 1 through Figure 13 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.

All samples passed the post-irradiation SMD limits after all exposures up to and including 1x10^{13}n/cm^2, and although the parts were still functional, many parameters failed the SMD post-irradiation limits after 1x10^{14}n/cm^2.

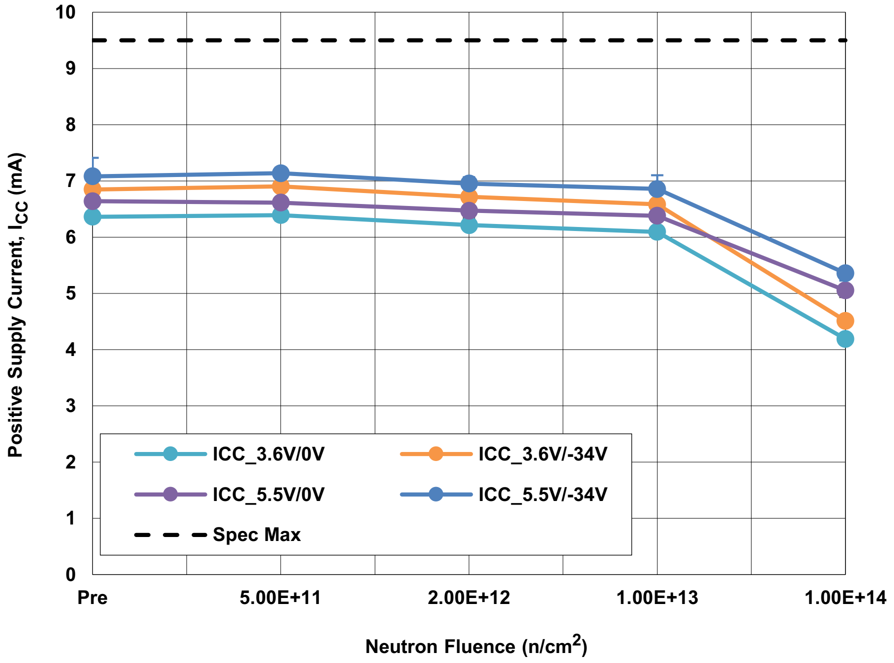

Figure 1. ISL72813SEH supply current (I_{CC}) at V_{CC} = 3.6V and 5.5V and V_{EE} = 0V and -34V as a function of neutron dose to each level. The error bars, if visible, represent the minimum and maximum measured values. The SMD limit is 9.5mA maximum.

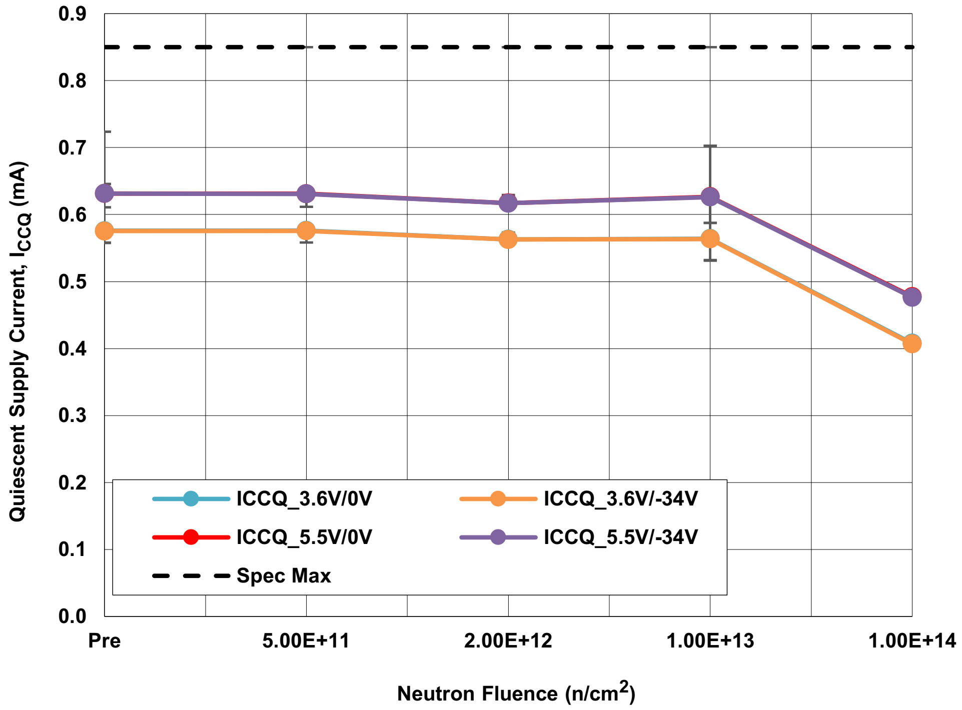

Figure 2. ISL72813SEH quiescent supply current (I_{CCQ}) at V_{CC} = 3.6V and 5.5V and V_{EE} = 0V and -34V as a function of neutron dose to each level. The error bars, if visible, represent the minimum and maximum measured values. The SMD limit is 0.85mA maximum. Note: The V_{EE} = 0V and -34V lines are coincident.

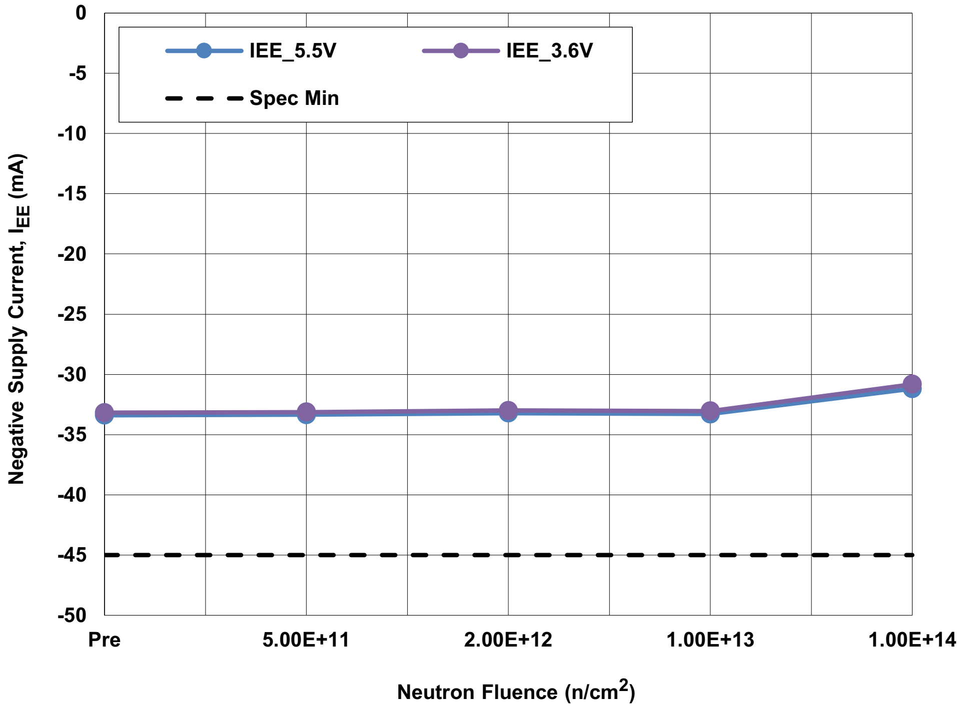

Figure 3. ISL72813SEH negative supply current (I_{EE}) at V_{CC} = 3.6V and 5.5V and V_{EE} = -34V as a function of neutron dose to each level. The error bars, if visible, represent the minimum and maximum measured values. The SMD limit is -45mA.

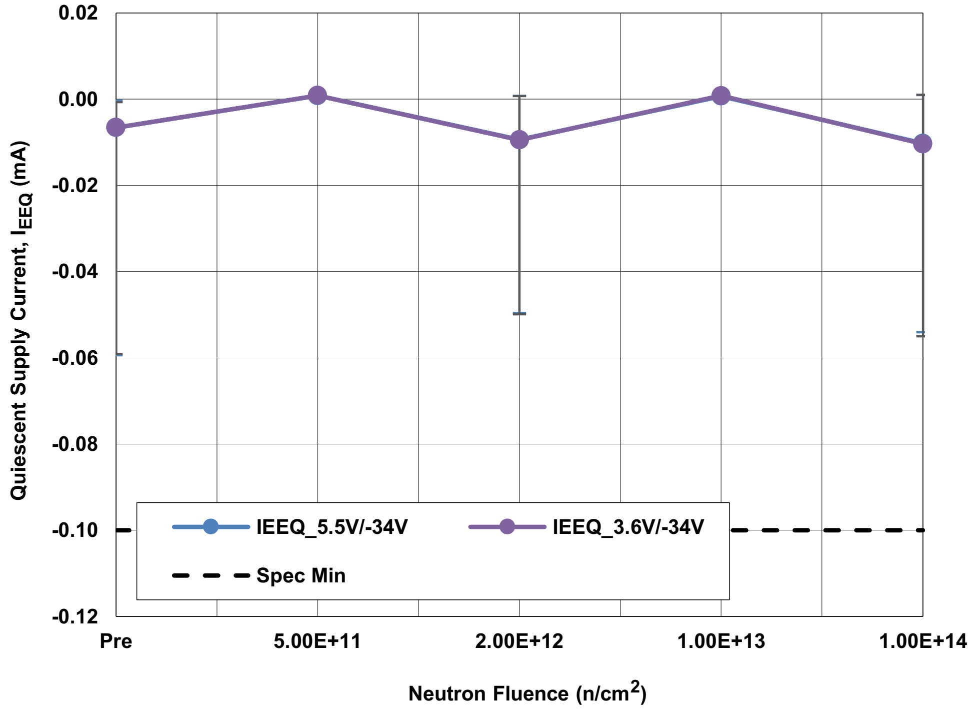

Figure 4. ISL72813SEH quiescent supply current (I_{EEQ}) at V_{CC} = 3.6V and 5.5V and V_{EE} = -34V, as a function of neutron dose to each level. The error bars, if visible, represent the minimum and maximum measured values. The SMD limit is -0.10mA.

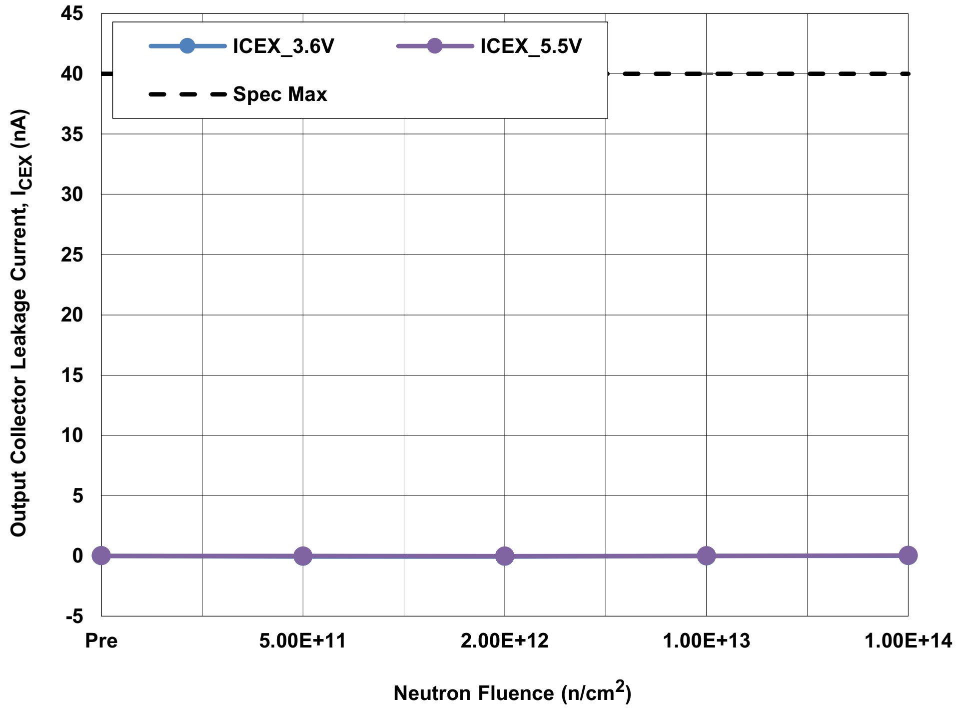

Figure 5. ISL72813SEH output collector leakage current (I_{CEX}) at V_{CC} = 3V and 5.5V and V_{EE} = -34V, as a function of neutron dose to each level. The error bars, if visible, represent the minimum and maximum measured values. The SMD limit is 40nA maximum. Note: This limit is set by temperature, typical 25°C values are 0.01nA.

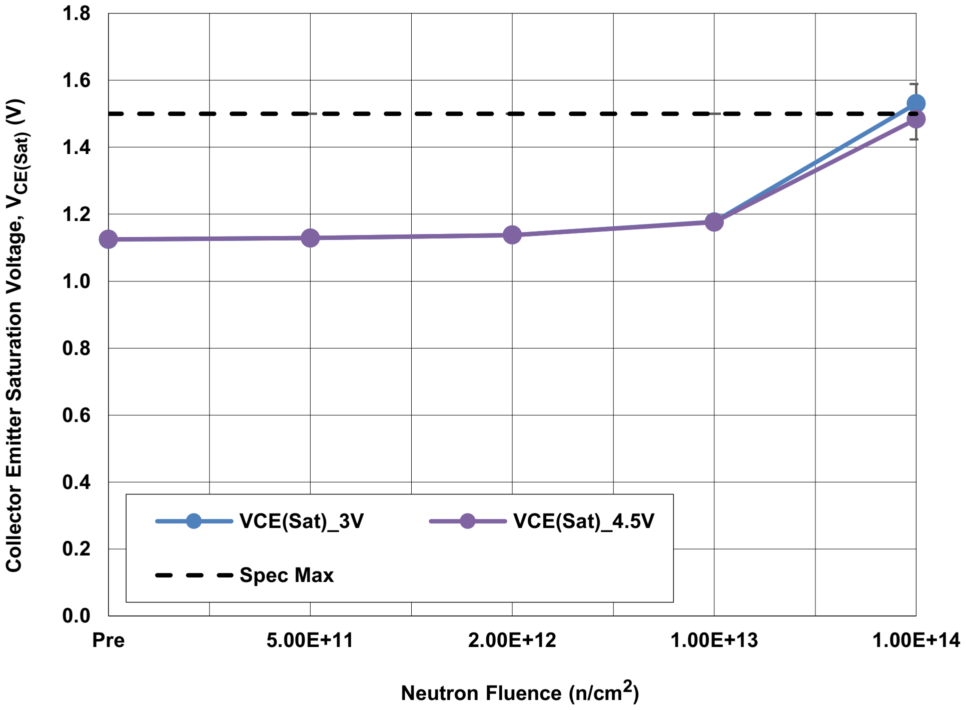

Figure 6. ISL72813SEH collector emitter saturation voltage ($V_{CE(Sat)}$) with V_{CC} = 3V and 4.5V with I_C = 530mA, as a function of neutron dose to each level. The error bars, if visible, represent the minimum and maximum measured values. The SMD limit is 1.5V maximum.

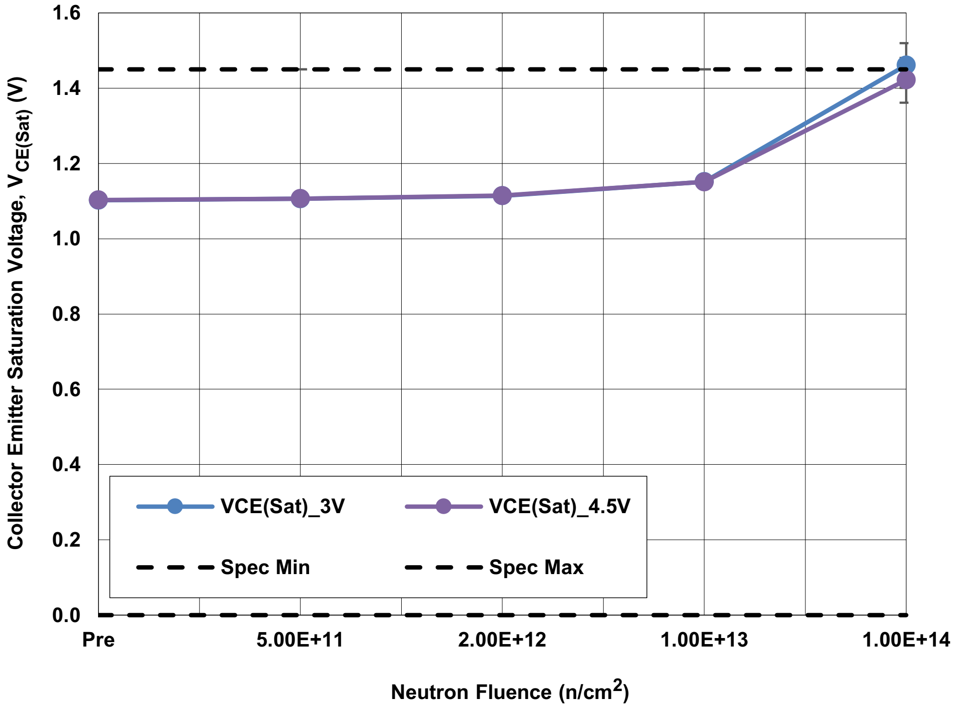

Figure 7. ISL72813SEH collector emitter saturation voltage ($V_{CE(Sat)}$) with V_{CC} = 3V and 4.5V with I_C = 500mA, as a function of neutron dose to each level. The error bars, if visible, represent the minimum and maximum measured values. The SMD limit is 1.45V maximum.

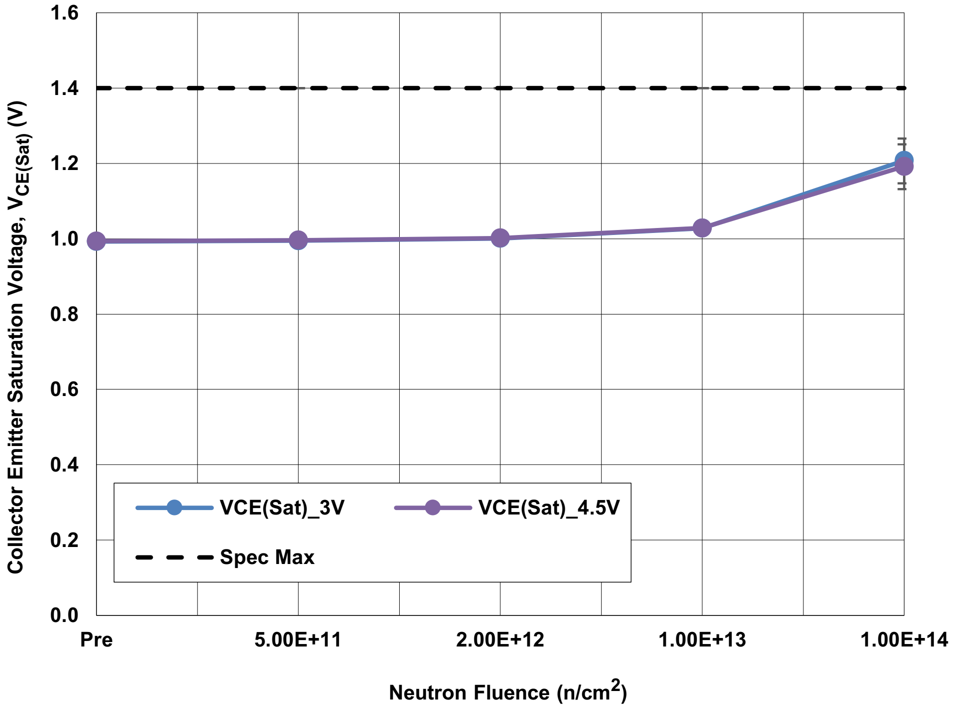

Figure 8. ISL72813SEH collector emitter saturation voltage ($V_{CE(Sat)}$) with V_{CC} = 3V and 4.5V with I_C = 350mA, as a function of neutron dose to each level. The error bars, if visible, represent the minimum and maximum measured values. The SMD limit is 1.4V maximum.

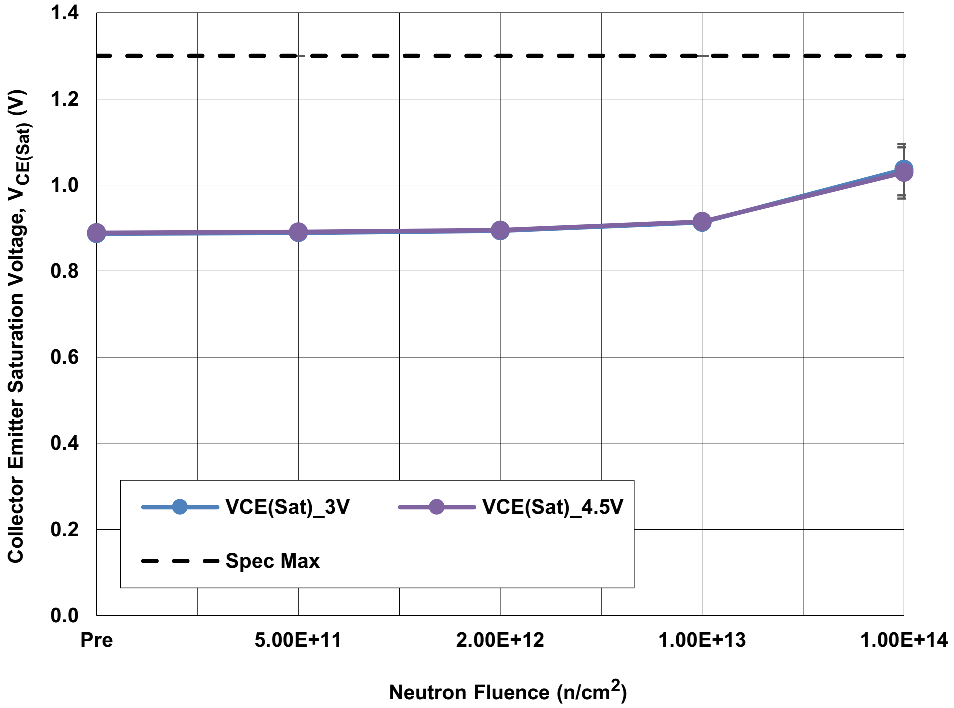

Figure 9. ISL72813SEH collector emitter saturation voltage ($V_{CE(Sat)}$) with V_{CC} = 3V and 4.5V with I_C = 200mA, as a function of neutron dose to each level. The error bars, if visible, represent the minimum and maximum measured values. The SMD limit is 1.3V maximum.

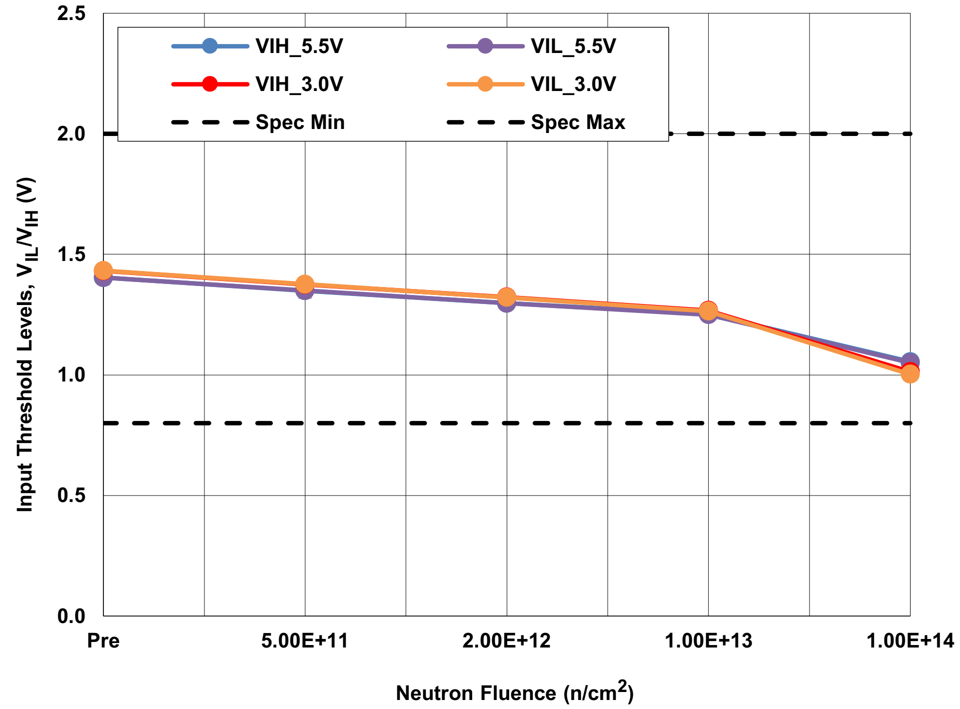

Figure 10. ISL72813SEH high-level threshold (V_{IH}) and low-level threshold (V_{IL}) voltages at V_{CC} = 3V and 5.5V as a function of neutron dose to each level. The error bars, if visible, represent the minimum and maximum measured values. The SMD limits are 2V minimum for V_{IH} and 0.8V maximum for V_{IL}.

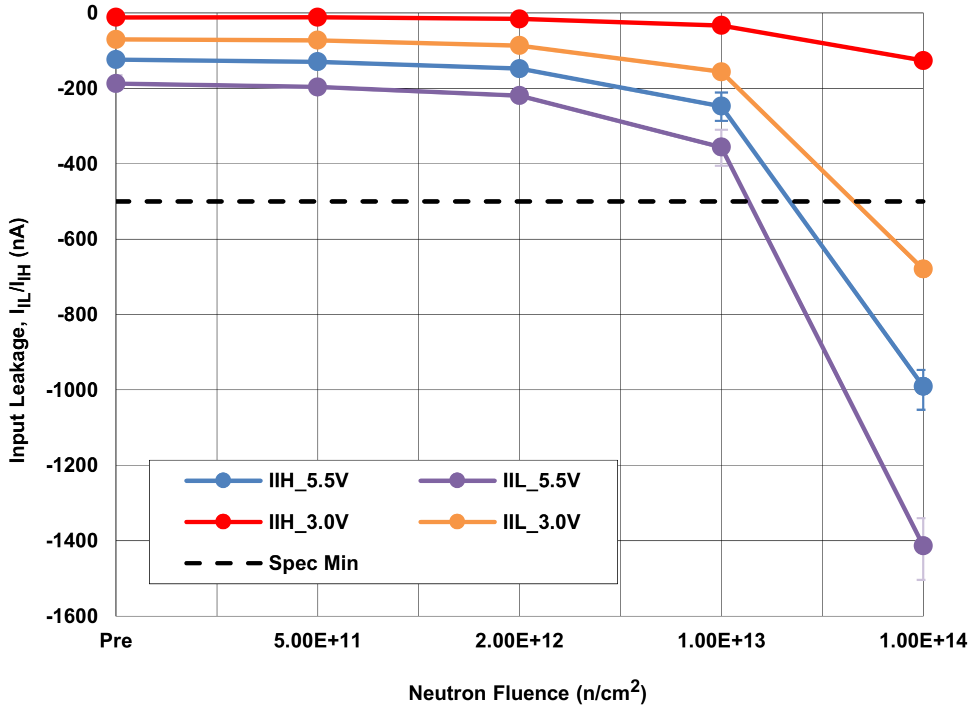

Figure 11. ISL72813SEH input high current (I_{IH}) and input low current (I_{IL}) at V_{CC} = 3V and 5.5V, with tested logic input = 2V, as a function of neutron dose to each level. The error bars, if visible, represent the minimum and maximum measured values. The SMD limit is -500nA.

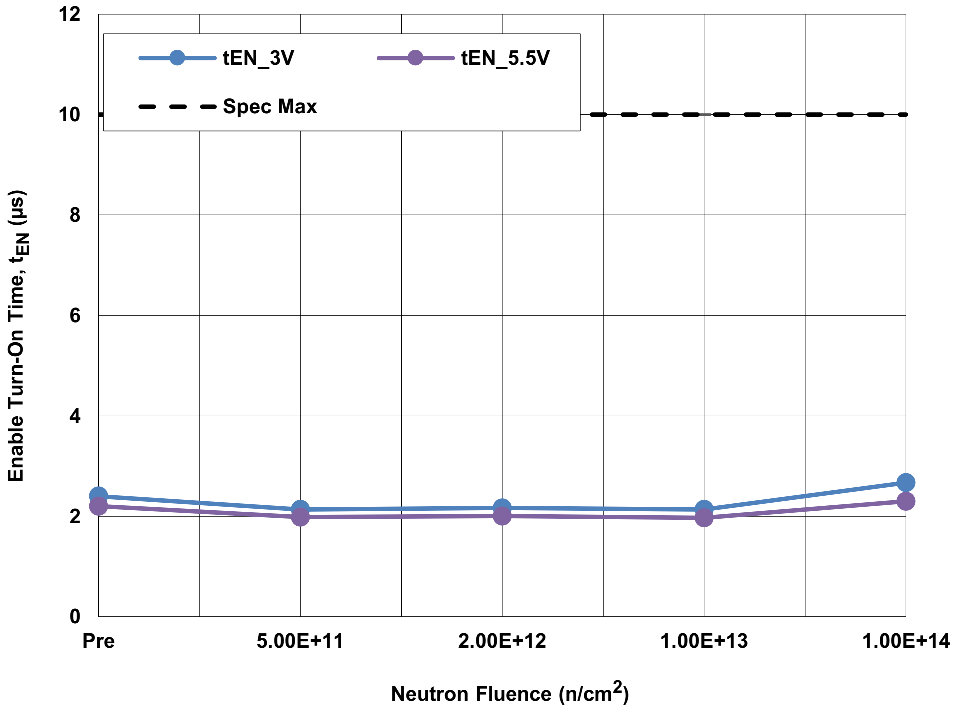

Figure 12. ISL72813SEH enable turn-on time (t_{EN}) at V_{CC} = 3.0V and 5.5V, with V_{EE} = -34V and R_{LOAD} = 64Ω as a function of neutron dose to each level. The error bars, if visible, represent the minimum and maximum measured values. The SMD limit is 10µs maximum.

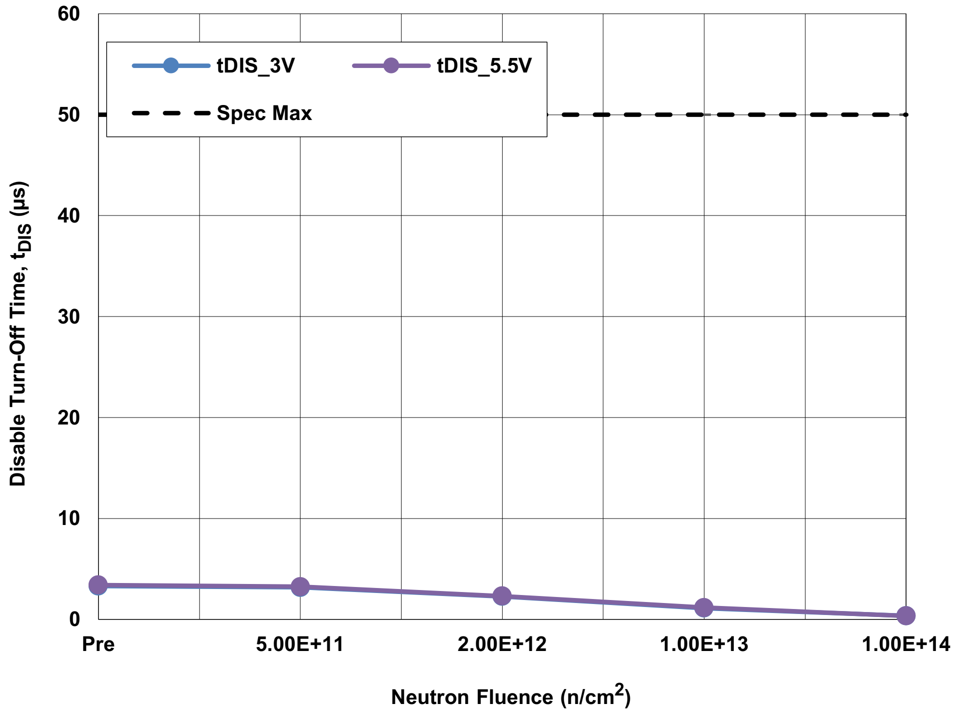

Figure 13. ISL72813SEH disable turn-off time (t_{DIS}) at V_{CC} = 3.0V and 5.5V, with V_{EE} = -34V and R_{LOAD} = 64Ω as a function of neutron dose to each level. V_{CC} = 5.5V as a function of neutron dose to each level. The error bars, if visible, represent the minimum and maximum measured values. The SMD limit is 50µs maximum.

3. Discussion and Conclusion

This document reports the results of 1MeV equivalent neutron testing of the ISL72813SEH 32-Channel Driver Circuit with an Integrated Decoder. Parts were tested at $5x10^{11}n/cm^2$, $2x10^{12}n/cm^2$, $1x10^{13}n/cm^2$, and $1x10^{14}n/cm^2$. The results of key parameters before and after irradiation to each level are plotted in Figure 1 through Figure 13. 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. All samples passed the SMD limits after all exposures up to and including $1x10^{13}n/cm^2$, but failed many parameters after $1x10^{14}n/cm^2$ although the parts were still functional. The figures show the applicable electrical limits taken from the SMD.

4. Revision History

Rev	Date	Description
1.01	Apr 30, 2026	Applied latest template. Updated Variables Data and Discussion and Conclusion sections.
1.00	Aug 22, 2019	Initial release

A. Appendix

A.1 Reported Parameters

Limits are taken from Standard Microcircuit Drawing (SMD) 5962-17208.

Table 3. Reported Parameters

Figure	Parameter	Symbol	Low Limit	High Limit	Units	Conditions
1	Supply Current	I_{CC}	-	9.5	mA	V_{CC} = 3.6V, V_{EE} = 0V, Cx = OPEN, EN = V_{CC}
						V_{CC} = 3.6V, V_{EE} = -34V, Cx = OPEN, EN = V_{CC}
						V_{CC} = 5.5V, V_{EE} = 0V, Cx = OPEN, EN = V_{CC}
						V_{CC} = 5.5V, V_{EE} = -34V, Cx = OPEN, EN = V_{CC}
2	Quiescent Supply Current	I_{CCQ}	-	850	µA	V_{CC} = 3.6V, V_{EE} = 0V, Cx = OPEN, EN = 0
						V_{CC} = 3.6V, V_{EE} = -34V, Cx = OPEN, EN = 0
						V_{CC} = 5.5V, V_{EE} = 0V, Cx = OPEN, EN = 0
						V_{CC} = 5.5V, V_{EE} = -34V, Cx = OPEN, EN = 0
3	Supply Current	I_{EE}	-45	-	mA	V_{CC} = 3.6V, V_{EE} = -34V, Cx = OPEN, EN = V_{CC}
						V_{CC} = 5.5V, V_{EE} = -34V, Cx = OPEN, EN = V_{CC}
4	Quiescent Supply Current	I_{EEQ}	-100	-	µA	V_{CC} = 3.6V, V_{EE} = -34V, Cx = OPEN, EN = 0
						V_{CC} = 5.5V, V_{EE} = -34V, Cx = OPEN, EN = 0
5	Output Collector Leakage Current	I_{CEX}	-	40	nA	V_{CC} = 3.6V, V_{CX} = 0V, V_{EE} = -34V, EN = 0V
						V_{CC} = 5.5V, V_{CX} = 0V, V_{EE} = -34V, EN = 0V
6	Collector Emitter Saturation Voltage $V_{CE(SAT)} = V_{CX} - V_{EE}$	$V_{CE\ (SAT)}$	-	1.5	V	I_C = 530mA, V_{CC} = 3.0V, V_{EE} = -34V, EN = V_{CC}
						I_C = 530mA, V_{CC} = 4.5V, V_{EE} = -34V, EN = V_{CC}
7			-	1.45	V	I_C = 500mA, V_{CC} = 3.0V, V_{EE} = -34V, EN = V_{CC}
						I_C = 500mA, V_{CC} = 4.5V, V_{EE} = -34V, EN = V_{CC}
8			-	1.4	V	I_C = 350mA, V_{CC} = 3.0V, V_{EE} = -34V, EN = V_{CC}
						I_C = 350mA, V_{CC} = 4.5V, V_{EE} = -34V, EN = V_{CC}
9			-	1.3	V	I_C = 200mA, V_{CC} = 3.0V, V_{EE} = -34V, EN = V_{CC}
						I_C = 200mA, V_{CC} = 4.5V, V_{EE} = -34V, EN = V_{CC}
10	High-Level Threshold	V_{IH}	2	-	V	V_{CC} = 3.0V
						V_{CC} = 5.5V
	Low-Level Threshold	V_{IL}	-	0.8	V	V_{CC} = 3.0V
						V_{CC} = 5.5V
11	Input High Current	I_{IH}	-500	-	nA	V_{CC} = 3.0V, Tested Logic Input = 2.0V
						V_{CC} = 5.5V, Tested Logic Input = 2.0V
	Input Low Current	I_{IL}	-500	-	nA	V_{CC} = 3.0V, Tested Logic Input = 0.8V
						V_{CC} = 5.5V, Tested Logic Input = 0.8V
12	Enable Turn-On Time	t_{EN}	-	10	µs	V_{CC} = 3.0V, 5.5V, R_{LOAD} = 64.4Ω
13	Disable Turn-Off Time	t_{DIS}	-	50	µs	V_{CC} = 3.0V, 5.5V, R_{LOAD} = 64.4Ω

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