ISL70592SEH

Neutron Test Report

Introduction

This report summarizes results of 1MeV equivalent neutron testing of the ISL70592SEH 1mA precision current source. 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 in Clearwater, FL, and their support is gratefully acknowledged.

Product Description

The ISL70592SEH is a radiation tolerant 1mA precision current source, designed for thermistor and other resistive sensor excitation applications and provides a precision output current (±1%) across voltages of 3V to 40V and across temperatures of -55°C to +125°C. This device is fabricated in the proprietary PR40 Silicon on Insulator (SOI) process and is immune to single event latch-up.

The ISL70592SEH is a bipolar, monolithic floating current source. The part contains a bandgap core that generates a temperature-independent voltage, and through feedback, forces the total current running through the part to also be independent of temperature. The high output impedance leaves ample room for variations in the power supply voltage and allows it to be insensitive to voltage drops across long lines, resulting in a typical initial accuracy of ±0.3% with a supply voltage of 20V and an accuracy over radiation of less than ±1% of the initial value of the part. The part can withstand a forward operating voltage of 40V and a reverse voltage of -0.5V.

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.

Reference Literature

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

- ISL70592SEH device page
- MIL-STD-883 test method 1017

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) 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 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. ISL70592SEH Neutron Fluence Dosimetry Data

TLD		Sulfur Pellet						
TLD #	cGy(Si)	Pellet #	Distance (inches)	Exposure ID	Flu >3 MeV (n/cm^2)	% Unc	Total Fluence (n/cm^2)	1Mev Si (n/cm^2)
293	1.169E+02	6479	26.6	Free Field	7.926E+10	7.1%	6.409E+11	5.513E+11
281	4.220E+02	6417	13.45	Free Field	3.043E+11	7.1%	2.401E+12	2.129E+12
263	2.147E+03	6488	24	Free Field	1.385E+12	7.1%	1.111E+13	9.613E+12
254	1.218E+04	6469	8	Free Field	8.774E+12	7.1%	6.888E+13	6.153E+13

Notes:
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 planned experimental matrix consisted of five samples irradiated at $5x10^{11}n/cm^2$, five samples irradiated at $2x10^{12}n/cm^2$, five irradiated at $1x10^{13}n/cm^2$, and five irradiated at $1x10^{14}n/cm^2$. Three control units were used.

ISL70592SEH samples were drawn from Lot X84DAAEH. All samples were packaged in the 4 LD ceramic flatpack package (PKG code K4.A) and processed through burn-in before irradiation and screened to the SMD limits at room, low, and high temperatures before the start of neutron testing.

2. Results

Neutron testing of the ISL70592SEH 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 5.1 Attributes Data

Table 2 summarizes the neutron exposure test results. The maximum planned fluence of $1x10^{14}n/cm^2$ was not quite achieved, with the actual maximum fluence only reaching $6.15x10^{13}n/cm^2$.

Table 2. Attributes Data

Fluence, (n/cm^2)		Sample Size	Pass (Note 3)	Fail
Planned	Actual			
$5x10^{11}$	$5.51x10^{11}$	5	5	0
$2x10^{12}$	$2.13x10^{12}$	5	5	0
$1x10^{13}$	$9.61x10^{12}$	5	0	5
$1x10^{14}$	$6.15x10^{13}$	5	0	5

Note:
3. Pass indicates a sample that passes all SMD limits.

2.2 Variables Data

The plots in Figures 1 through 8 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 downpoint, 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 SMD are also shown, it should be noted that these limits are provided for guidance only as the ISL70592SEH is not specified for the neutron environment.

All samples passed the post-irradiation SMD limits after all exposures up to and including $2x10^{12}n/cm^2$, but most of the parameters, failed the SMD post-irradiation limits after $1x10^{13}n/cm^2$ and $1x10^{14}n/cm^2$ and some parameters could not be plotted without greatly increasing the minimum or maximum y-axis values of the graphs and comprising the usefulness of the passing data.

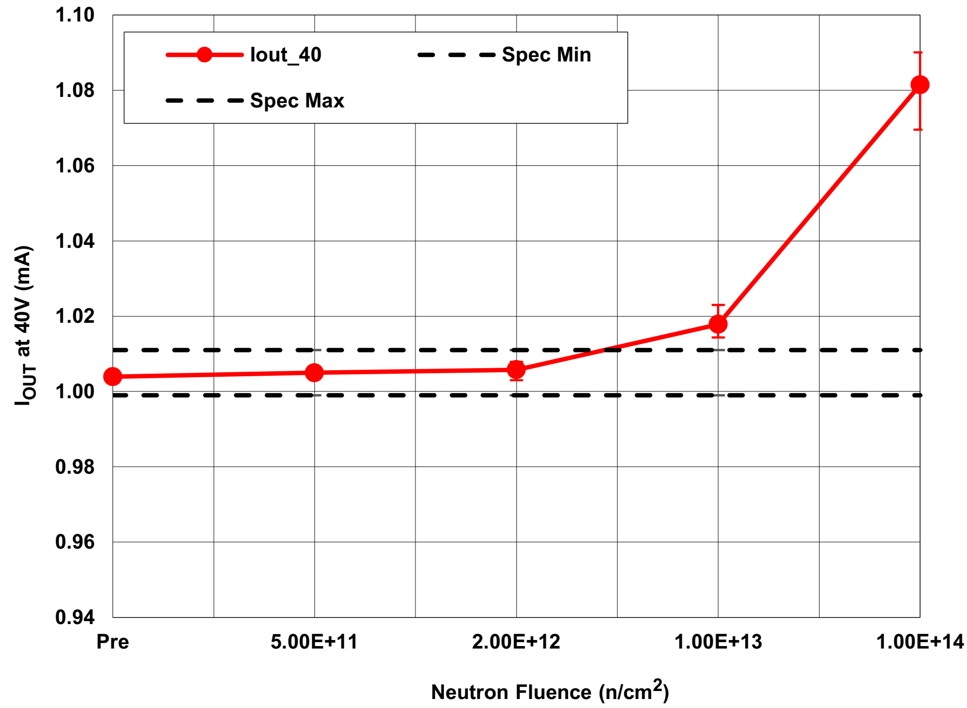

Figure 1. ISL70592SEH output current at 40V (I_{O40V}), following irradiation to each neutron fluence level. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limits are 0.9990mA minimum and 1.0110mA maximum.

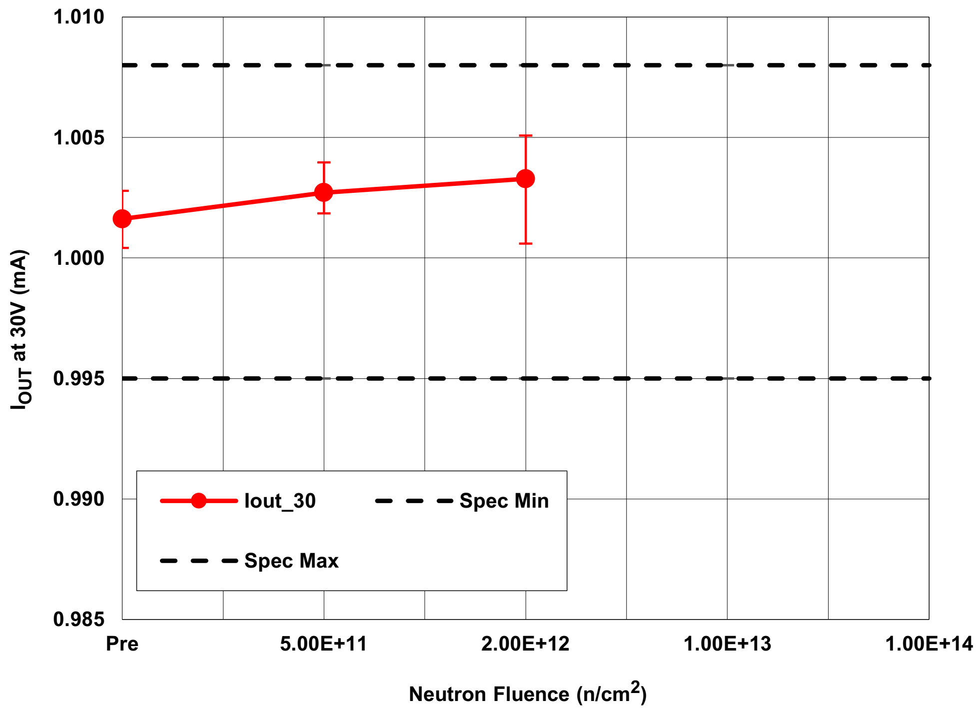

Figure 2. ISL70592SEH output current at 30V (I_{O30V}), following irradiation to each neutron fluence level. The error bars represent the minimum and maximum measured values. The $1x10^{13}$n/cm^2 and $1x10^{14}$n/cm^2 data are not shown because they could not be accurately measured. The post-irradiation SMD limits are 0.9950mA minimum and 1.0080mA maximum.

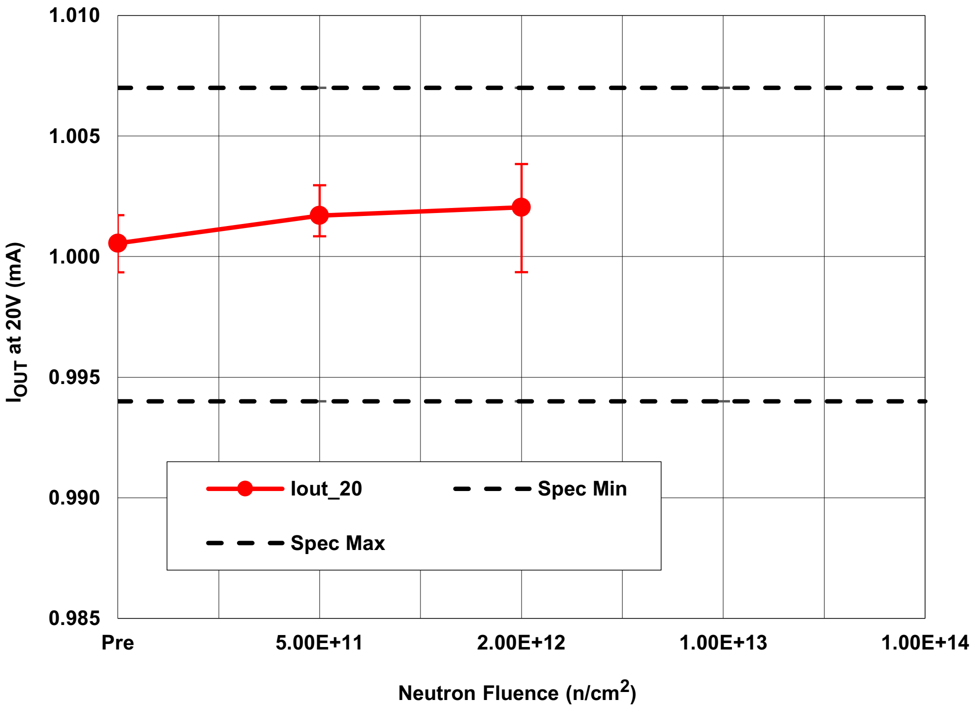

Figure 3. ISL70592SEH output current at 20V (I_{O20V}), following irradiation to each neutron fluence level. The error bars represent the minimum and maximum measured values. The $1x10^{13}n/cm^2$ and $1x10^{14}n/cm^2$ data are not shown because they could not be accurately measured. The post-irradiation SMD limits are 0.9940mA minimum and 1.0070mA maximum.

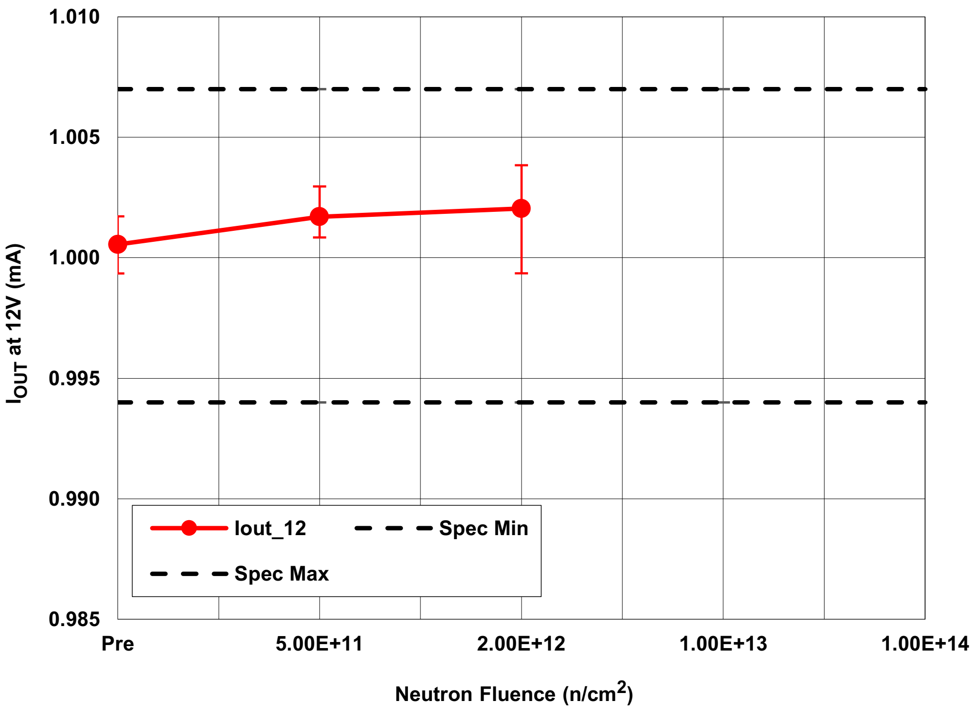

Figure 4. ISL70592SEH output current at 12V (I_{O12V}), following irradiation to each neutron fluence level. The error bars represent the minimum and maximum measured values. The $1x10^{13}n/cm^2$ and $1x10^{14}n/cm^2$ data are not shown because they could not be accurately measured. The post-irradiation SMD limits are 0.9930mA minimum and 1.0070mA maximum.

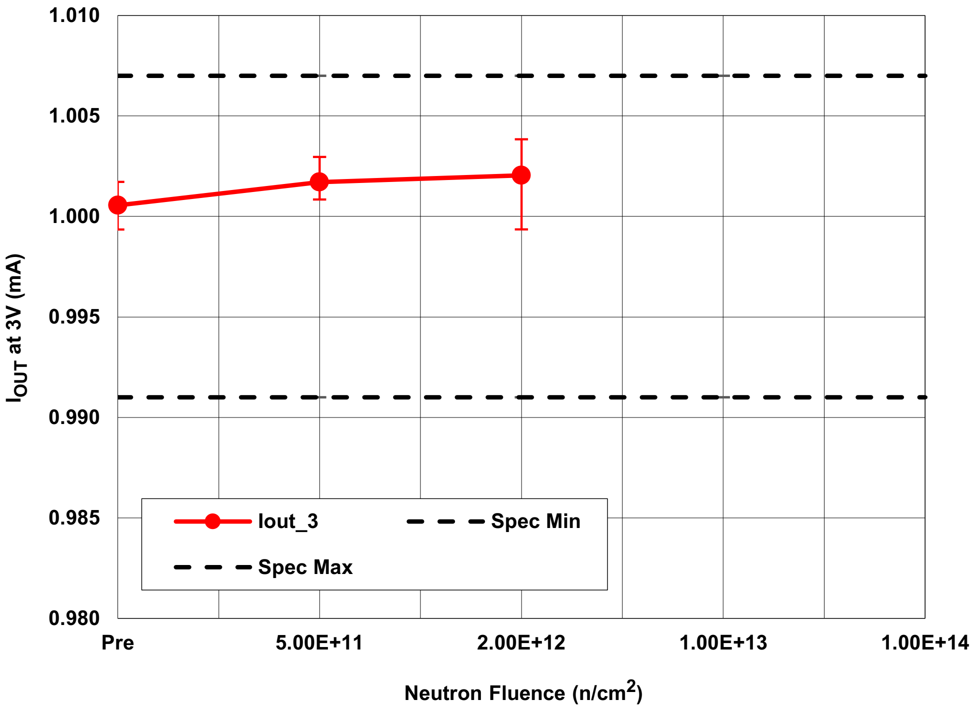

Figure 5. ISL70592SEH output current at 3V (I_{O3V}), following irradiation to each neutron fluence level. The error bars represent the minimum and maximum measured values. The $1x10^{13}n/cm^2$ and $1x10^{14}n/cm^2$ data are not shown because they could not be accurately measured. The post-irradiation SMD limits are 0.9910mA minimum and 1.0070mA maximum.

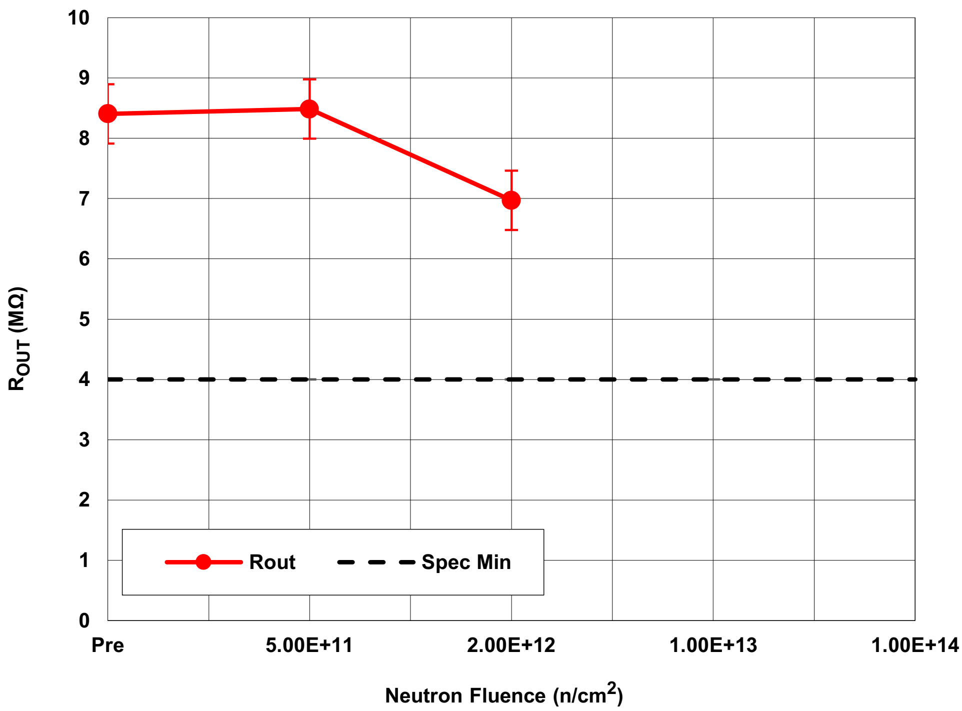

Figure 6. ISL70592SEH output impedance (R_{OUT}), following irradiation to each neutron fluence level. The error bars represent the minimum and maximum measured values. The $1x10^{13}n/cm^2$ and $1x10^{14}n/cm^2$ data are not shown because they could not be accurately measured. The post-irradiation SMD limit is 4MΩ minimum.

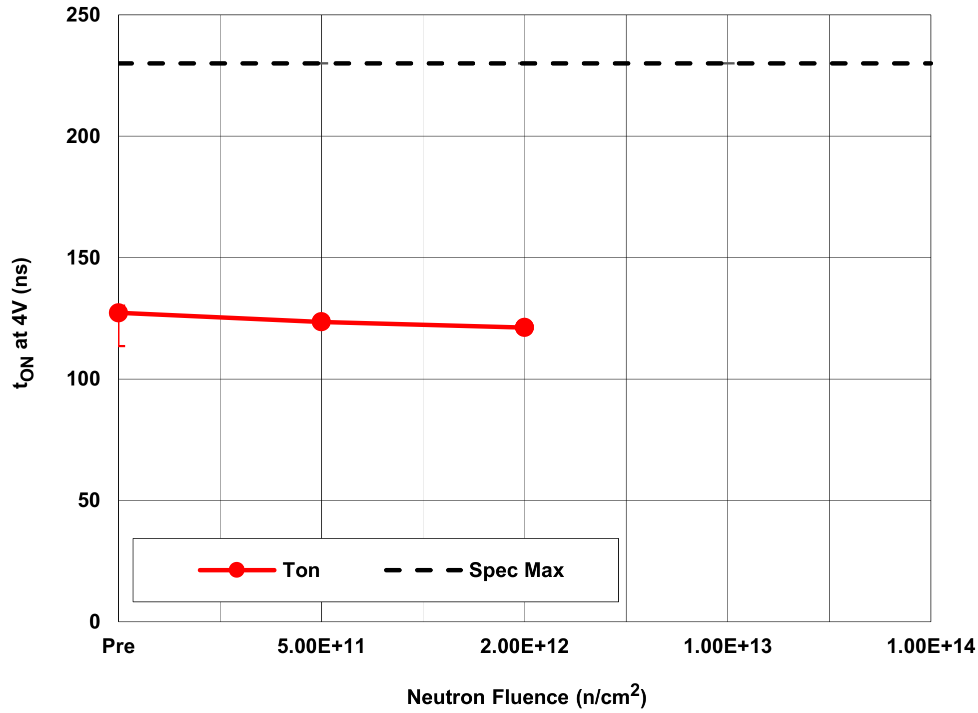

Figure 7. ISL70592SEH turn-on time at 4V (t_{ON}), following irradiation to each neutron fluence level. The error bars represent the minimum and maximum measured values. The $1x10^{13}n/cm^2$ and $1x10^{14}n/cm^2$ data are not shown because they could not be accurately measured. The post-irradiation SMD limit is 230µs maximum.

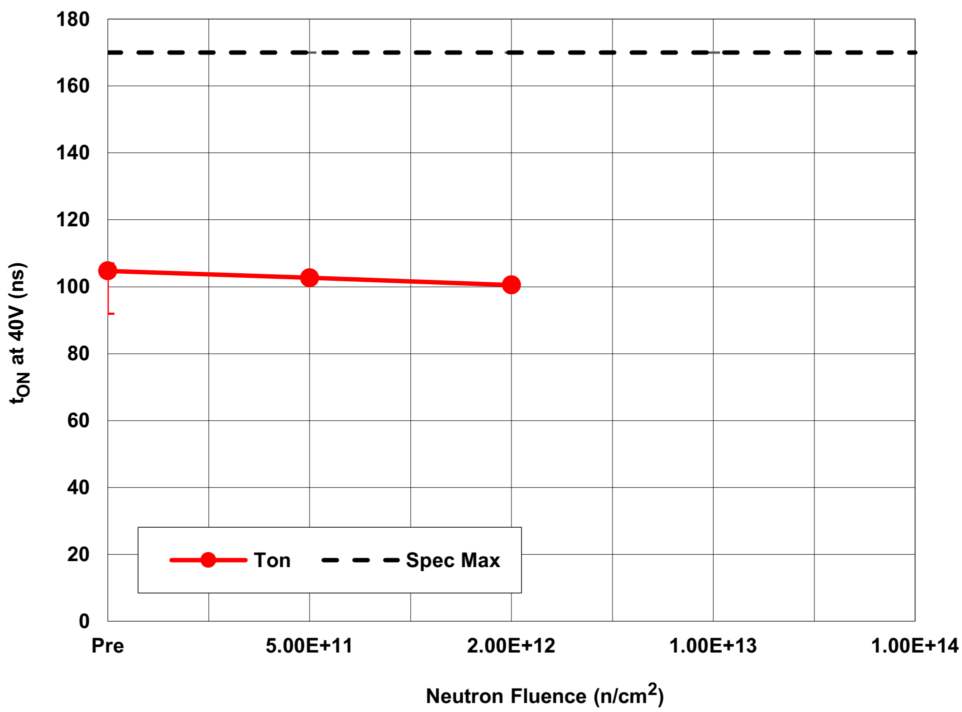

Figure 8. ISL70592SEH turn-on time at 40V (t_{ON}), following irradiation to each neutron fluence level. The error bars represent the minimum and maximum measured values. The $1x10^{13}n/cm^2$ and $1x10^{14}n/cm^2$ data are not shown because they could not be accurately measured. The post-irradiation SMD limit is 170µs maximum.

3. Discussion and Conclusion

This document reports the results of 1MeV equivalent neutron testing of the ISL70592SEH 1mA precision current source. 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 Figures 1 through 8. 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 $1x10^{12}n/cm^2$, but failed after $1x10^{13}n/cm^2$ and could not be effectively plotted. Although the figures show the applicable electrical limits taken from the SMD, it should be remembered that these limits are provided for guidance only as the ISL70592SEH is not specified for the neutron environment.

4. Appendices

4.1 Reported Parameters

Fig.	Parameter	Symbol	Low Limit	High Limit	Units
1	Output Current at 40V	I_{O40V}	0.9990	1.0110	mA
2	Output Current at 30V	I_{O30V}	0.9950	1.0080	mA
3	Output Current at 20V	I_{O20V}	0.9940	1.0070	mA
4	Output Current at 12V	I_{O12V}	0.9930	1.0070	mA
5	Output Current at 3V	I_{O3V}	0.9910	1.0070	mA
6	Output Impedance	R_{OUT}	4	-	MΩ
7	Turn-On Time at 4V	t_{ON}	-	230	µs
8	Turn-On Time at 40V	t_{ON}	-	170	µs

5. Revision History

Rev.	Date	Description
1.00	Aug.9.19	Initial release

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