

ISL72813SEH

Total Dose Testing

TR040

Rev 1.00

February 27, 2017

Introduction

This report provides results of low dose rate and high dose rate, Total Ionizing Dose (TID) testing of the [ISL72813SEH](#), a high-voltage, high-current driver. The tests were conducted to determine the sensitivity of the part to the total dose environment. Low dose rate irradiations were performed to 75krad(Si) at 0.01rad(Si)/s under biased and grounded conditions. High dose rate irradiations were performed to 150krad(Si) at 187.2rad(Si)/s, also under biased and grounded conditions. Both irradiations were followed by a biased anneal at +100° C for 168 hours.

Related Literature

- For a full list of related documents, visit our website
 - [ISL72813SEH](#) product page
 - MIL-STD-883 test method 1019

Product Description

The ISL72813SEH is a radiation hardened, high-voltage, high-current driver fabricated using Intersil's proprietary PR40 silicon-on-insulator process technology to mitigate single event effects. This device utilizes 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 a 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) as well as level shifting circuitry to reference the output of the decoder to a negative voltage. This conveniently allows the user 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. See [Figure 1](#) for a depiction of the pinout. [Table 1](#) shows the pin descriptions. Refer to the relevant Intersil datasheet and other on-line information for further details.

Test Description

Irradiation Facilities

Low dose rate irradiations were performed using a Hopewell Designs N40 panoramic vault-type low dose rate ⁶⁰Co irradiator located in the Intersil Palm Bay, Florida facility. The dose rate was 0.0089rad(Si)/s (8.9mrad(Si)/s).

High dose rate testing was performed using a Gammacell 220 ⁶⁰Co irradiator located in the Palm Bay, Florida Intersil facility at a dose rate of 187.2rad(Si)/sec.

Both irradiators use PbAl spectrum hardening filters to shield the test board and devices under test against low energy secondary gamma radiation.

Test Fixturing

[Figure 1 on page 2](#) shows the configuration used for biased irradiation.

TABLE 1. ISL72813SEH PINOUT

PIN NUMBER	PIN NAME	DESCRIPTION
1, 8, 24, 38	VEE	Common emitter of all 32 current drivers
2-7, 9-18, 28-37, 39-44	Cx	Channels 0 through 31 current driver collector output
19 - 23	Ax	Address lines for the decoder
25	EN	Active high-enable input to the decoder
26	GND	Supply ground. Connect this pin to the PCB ground plane
27	VCC	Bias supply for the decoder and the level shift circuit, connect to 5V
Package Lid	N/AN/A	Tied internally to terminal 26 (ground)

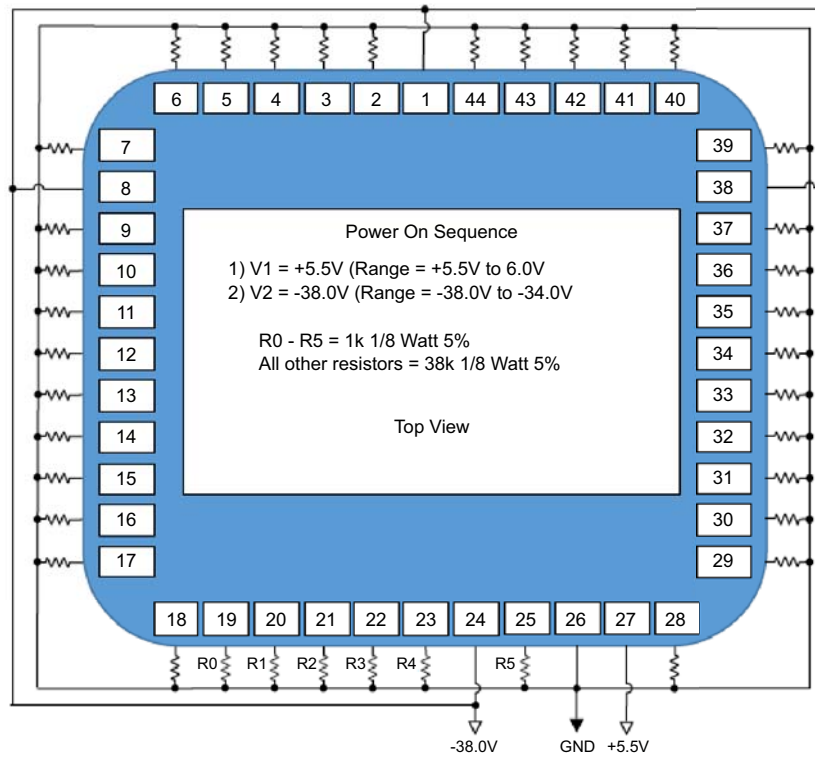


FIGURE 1. IRRADIATION BIAS CONFIGURATION FOR THE ISL72813SEH

Characterization Equipment and Procedures

All electrical testing was performed outside the irradiator using production Automated Test Equipment (ATE) with data logging of all parameters at each downpoint. All downpoint electrical testing was performed at room temperature.

Experimental Matrix

Testing proceeded in accordance with the guidelines of MIL-STD-883 Test Method 1019. The experimental matrix for the low dose rate testing consisted of five samples irradiated under bias and five samples irradiated with all pins grounded (unbiased). Six control units were used. For the high dose rate testing, two samples were irradiated under bias and two samples were irradiated with all pins grounded (unbiased). Three control units were used.

Samples of the ISL72813SEH were drawn from fabrication lot X7COJ and were packaged in the production hermetic 44 Ld CLCC, Package Outline Drawing (POD) J44.A. The samples were processed through the standard burn-in cycle and were screened to the SMD 5962-17208 limits at room, low, and high temperatures before irradiation.

Downpoints

Downpoints were 0krad(Si), 10krad(Si), 30krad(Si), 50krad(Si), and 75krad(Si). Downpoints for high dose rate testing were 0krad(Si), 30krad(Si), 50krad(Si), 100krad(Si), and 150krad(Si).

The samples were subjected to a high temperature biased anneal for 168 hours at +100 °C following irradiation.

Results

Attributes Data

Testing of the ISL72813SEH at both low and high dose rates is complete. [Table 2](#) summarizes the low dose rate results, while the high dose rate results are shown in [Table 3](#).

TABLE 2. ISL72813SEH LOW DOSE RATE TOTAL DOSE TEST ATTRIBUTES DATA

RATE	BIAS	SAMPLE SIZE	DOWNPOINT	BIN 1 (Note 1)	REJECTS
0.0089rad(Si)/s	Figure 1	5	Pre-irradiation	5	
			10krad(Si)	5	0
			30krad(Si)	5	0
			50krad(Si)	5	0
			75krad(Si)	5	0
			Anneal, 168h at +100 °C	5	0
0.0089rad(Si)/s	Grounded	5	Pre-irradiation	5	
			10krad(Si)	5	0
			30krad(Si)	5	0
			50krad(Si)	5	0
			75krad(Si)	5	0
			Anneal, 168h at +100 °C	5	0

NOTE:

- Bin 1 indicates a device that passes all pre-irradiation specification limits.

TABLE 3. ISL72813SEH HIGH DOSE RATE TOTAL DOSE TEST ATTRIBUTES DATA

RATE	BIAS	SAMPLE SIZE	DOWNPOINT	BIN 1 (Note 2)	REJECTS
187.2rad(Si)/s	Figure 1	2	Pre-irradiation	2	
			30krad(Si)	2	0
			50krad(Si)	2	0
			100krad(Si)	2	0
			150krad(Si)	2	0
			Anneal, 168h at +100 °C	2	0
187.2rad(Si)/s	Grounded	2	Pre-irradiation	2	
			30krad(Si)	2	0
			50krad(Si)	2	0
			100krad(Si)	2	0
			150krad(Si)	2	0
			Anneal, 168h at +100 °C	2	0

NOTE:

- Bin 1 indicates a device that passes all pre-irradiation specification limits.

Variables Data

The plots in [Figures 2](#) through [33](#) show data at all downpoints for both low and high dose rates. The plots show the average tested values of key parameters as a function of total dose for each of the two irradiation conditions, Biased (B) and Unbiased (U). PA_L on the graphs indicates Post-Anneal for the low dose rate samples and PA_H indicates the Post-Anneal downpoint for the high dose rate samples. The plots also include error bars at each test point, representing the minimum and maximum measured values of the samples, although on some of the graphs the minimum and maximum values were too close to the average to be seen on the scale used for the graph. The figure sequence and the symbols of the reported parameters are consistent with those used in the SMD.

For attributes that are tested on multiple inputs or outputs, such as voltage input levels and collector emitter saturation voltages, only a typical case is shown. The data for the graphs of the enable turn on and disable turn off times were taken in the lab because they are not part of the production ATE tests.

All parameters showed excellent stability over irradiation, with no observed dose rate or bias sensitivity.

Variables Data Plots

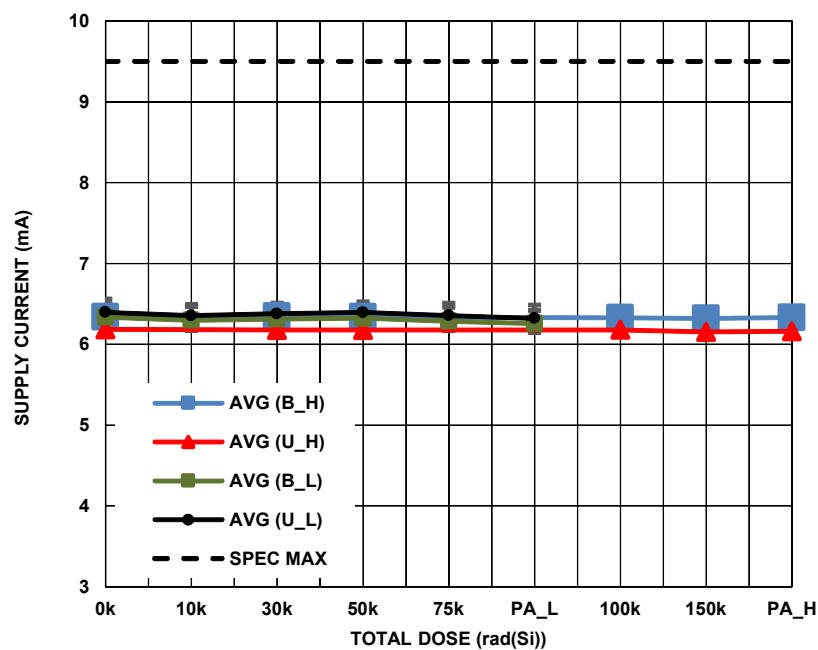


FIGURE 2. ISL72813SEH 32-Channel Driver Supply Current at $V_{CC} = 3.6V$ and $V_{EE} = 0V$ as a function of irradiation dose for the Biased (B_H, B_L) ([Figure 1](#)) and Unbiased (U_H, U_L) (all pins grounded) cases. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 9.5mA.

Variables Data Plots (Continued)

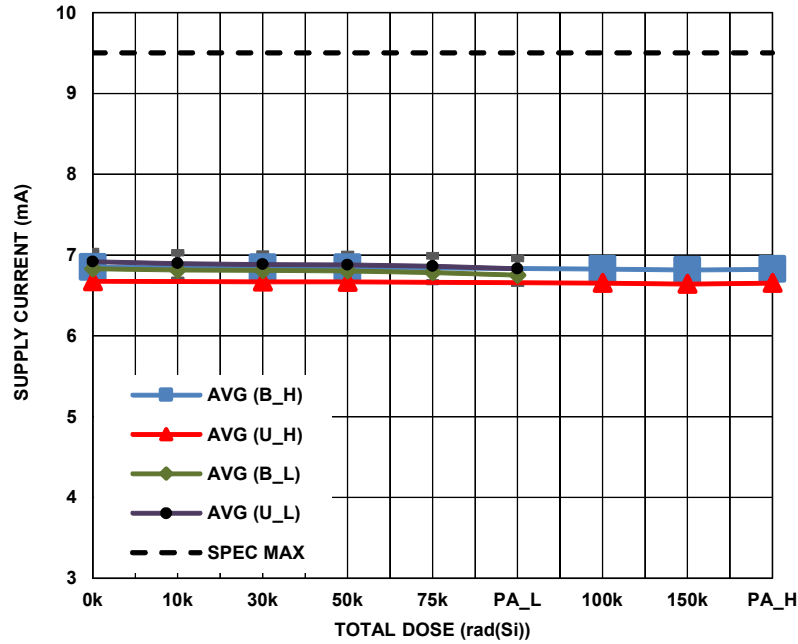


FIGURE 3. ISL72813SEH 32-Channel Driver Supply Current at $V_{CC} = 3.6V$ and $V_{EE} = -34V$ as a function of irradiation dose for the Biased (B_H, B_L) (Figure 1) and Unbiased (U_H, U_L) cases. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 9.5mA.

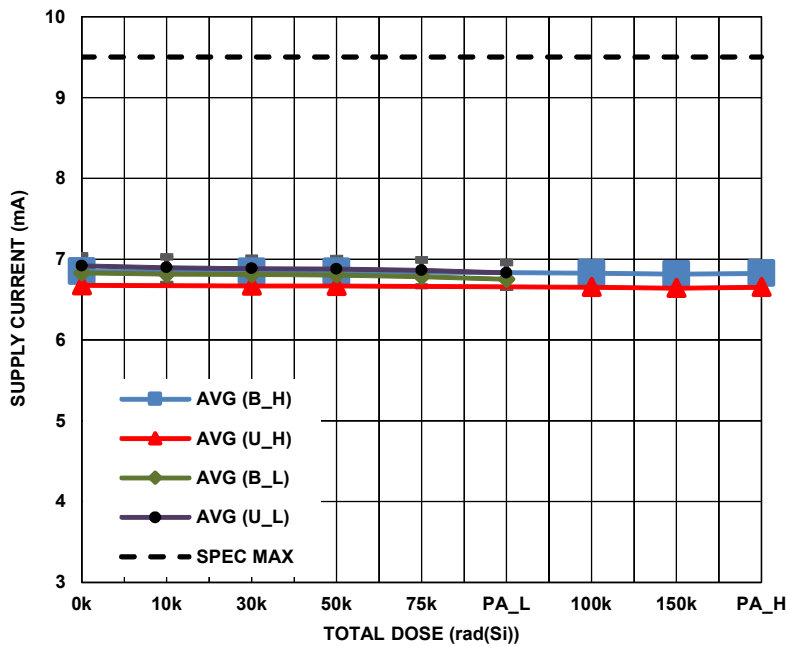


FIGURE 4. ISL72813SEH 32-Channel Driver Supply Current at $V_{CC} = 5.5V$ and $V_{EE} = 0V$ as a function of irradiation dose for the Biased (B_H, B_L) (Figure 1) and Unbiased (U_H, U_L) (all pins grounded) cases. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 9.5mA.

Variables Data Plots (Continued)

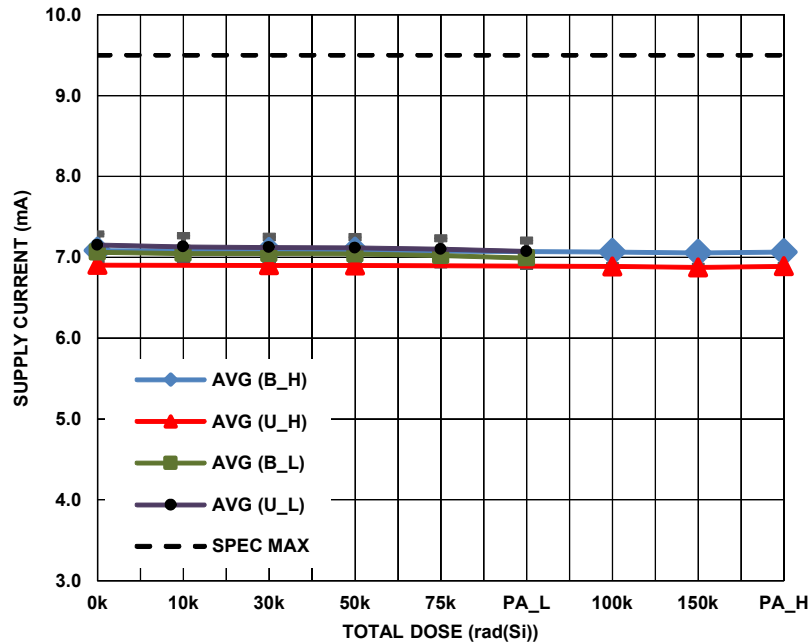


FIGURE 5. ISL72813SEH 32-Channel Driver Supply Current at $V_{CC} = 5.5V$ and $V_{EE} = -34V$ as a function of irradiation dose for the Biased (B_H, B_L) (Figure 1) and Unbiased (U_H, U_L) (all pins grounded) cases. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 9.5mA.

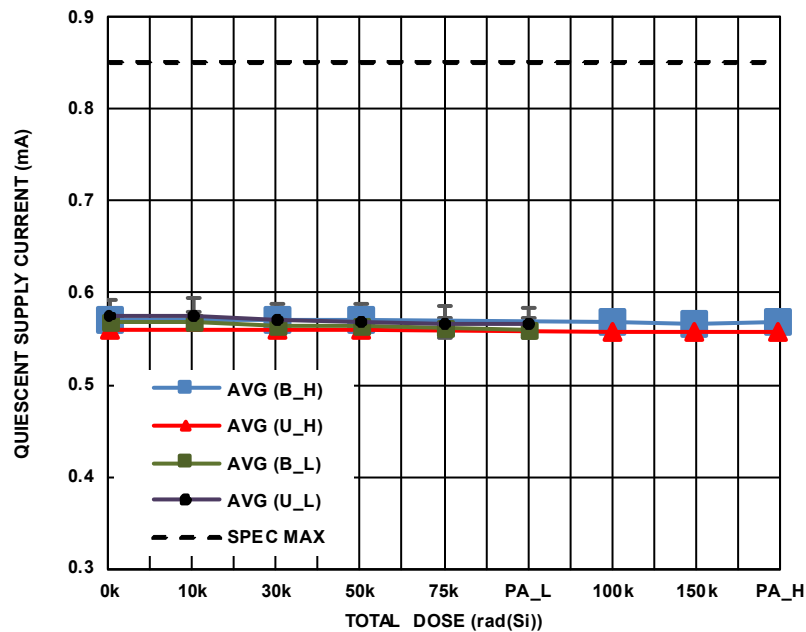


FIGURE 6. ISL72813SEH 32-Channel Driver Quiescent Supply Current at $V_{CC} = 3.6V$ and $V_{EE} = 0V$ as a function of irradiation dose for the Biased (B_H, B_L) (Figure 1) and Unbiased (U_H, U_L) (all pins grounded) cases. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 0.85mA.

Variables Data Plots (Continued)

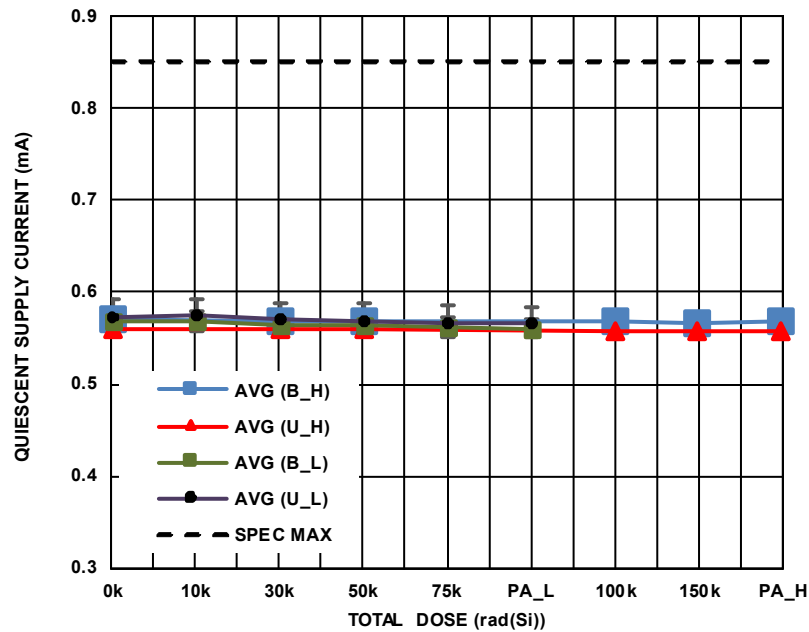


FIGURE 7. ISL72813SEH 32-Channel Driver Quiescent Supply Current at $V_{CC} = 3.6V$ and $V_{EE} = -34V$ as a function of irradiation dose for the Biased (B_H, B_L) (Figure 1) and Unbiased (U_H, U_L) (all pins grounded) cases. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 0.85mA.

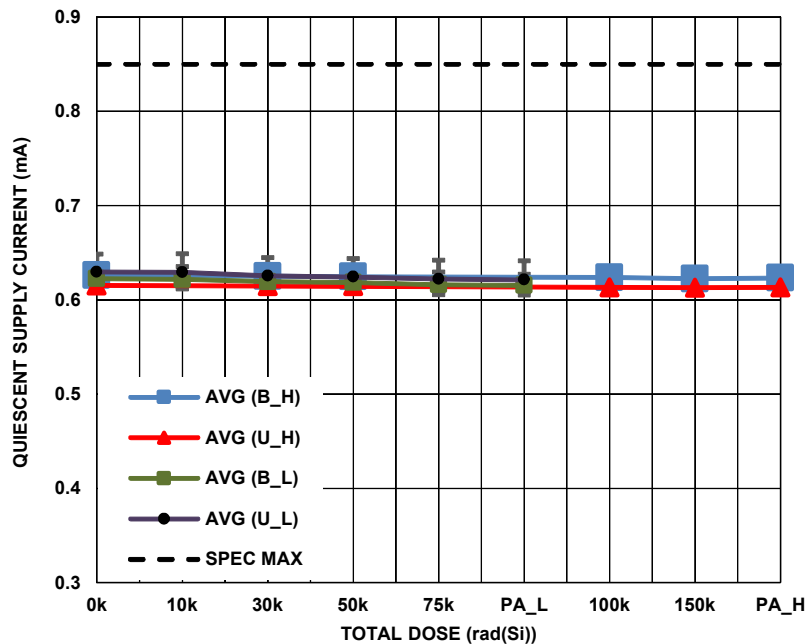


FIGURE 8. ISL72813SEH 32-Channel Driver Quiescent Supply Current at $V_{CC} = 5.5V$ and $V_{EE} = 0V$ as a function of irradiation dose for the Biased (B_H, B_L) (Figure 1) and Unbiased (U_H, U_L) (all pins grounded) cases. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 0.85mA.

Variables Data Plots (Continued)

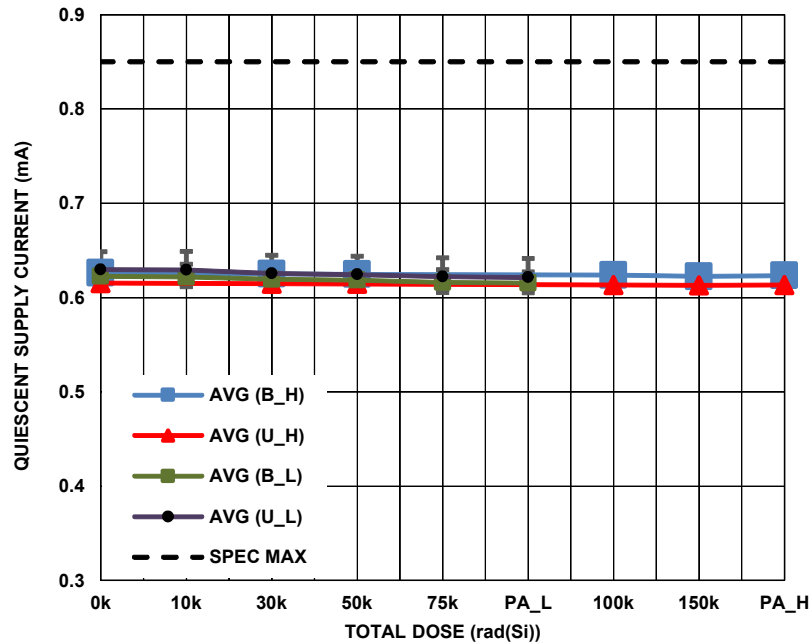


FIGURE 9. ISL72813SEH 32-Channel Driver Quiescent Supply Current at $V_{CC} = 5.5V$ and $V_{EE} = -34V$ as a function of irradiation dose for the Biased (B_H, B_L) (Figure 1) and Unbiased (U_H, U_L) (all pins grounded) cases. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 0.85mA.

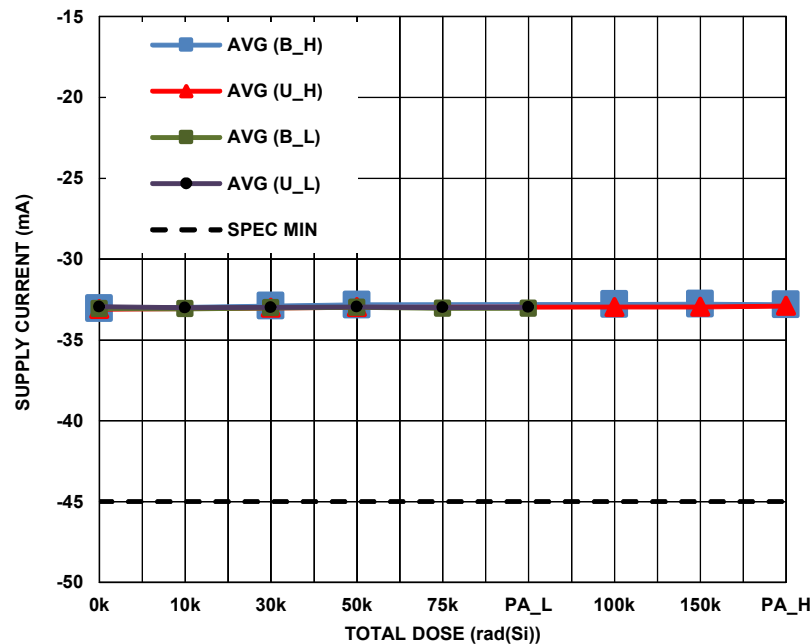


FIGURE 10. ISL72813SEH 32-Channel Driver Supply Current at $V_{CC} = 3.6V$ and $V_{EE} = -34V$ as a function of irradiation dose for the Biased (B_H, B_L) (Figure 1) and Unbiased (U_H, U_L) (all pins grounded) cases. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is -45mA.

Variables Data Plots (Continued)

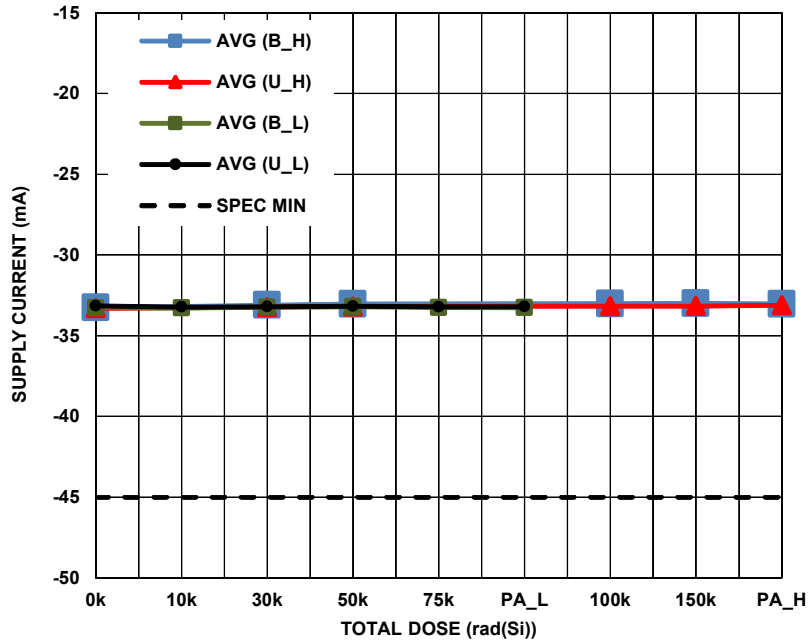


FIGURE 11. ISL72813SEH 32-Channel Driver Supply Current at $V_{CC} = 5.5V$ and $V_{EE} = -34V$ as a function of irradiation dose for the Biased (B_H, B_L) (Figure 1) and Unbiased (U_H, U_L) (all pins grounded) cases. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is -45mA.

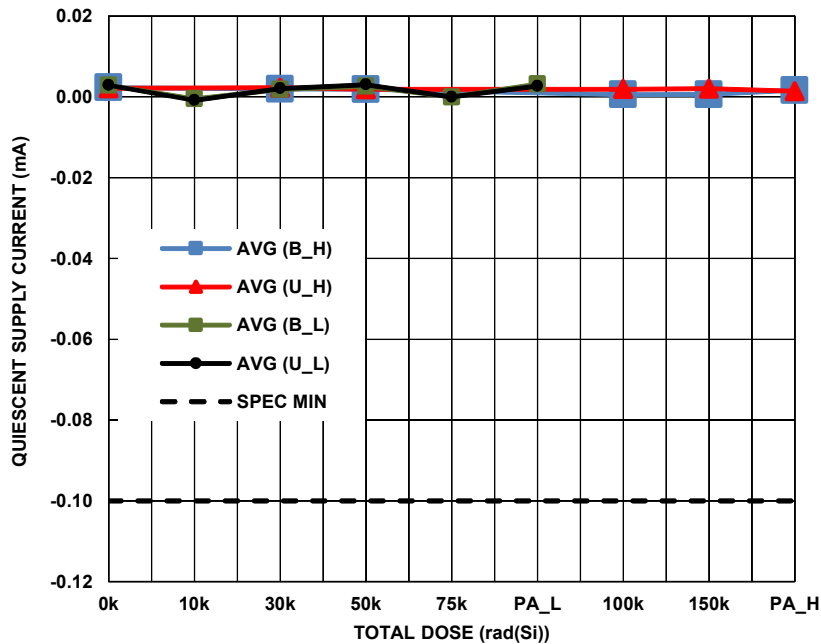


FIGURE 12. ISL72813SEH 32-Channel Driver Quiescent Supply Current at $V_{CC} = 3.6V$ and $V_{EE} = -34V$ as a function of irradiation dose for the Biased (B_H, B_L) (Figure 1) and Unbiased (U_H, U_L) (all pins grounded) cases. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is -0.10 mA.

Variables Data Plots (Continued)

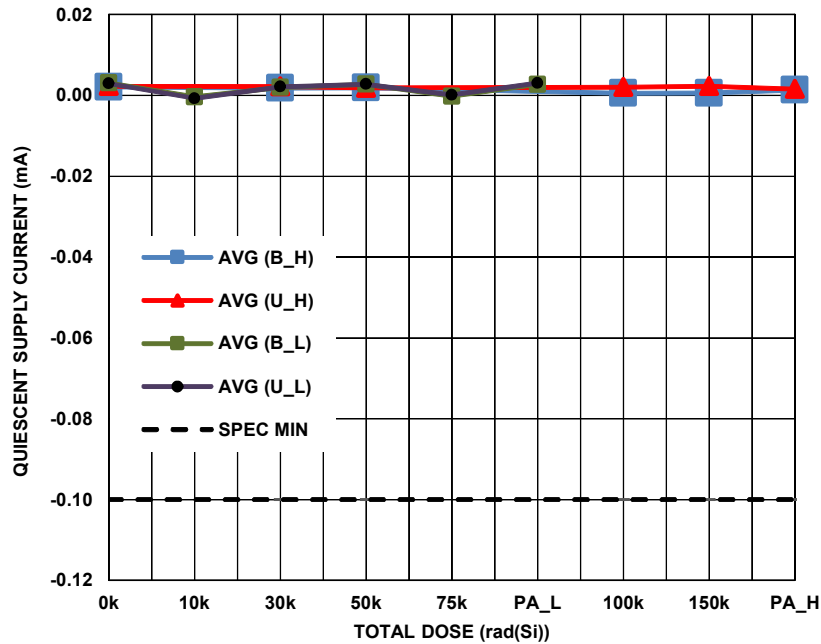


FIGURE 13. ISL72813SEH 32-Channel Driver Quiescent Supply Current at $V_{CC} = 5.5V$ and $V_{EE} = -34V$ as a function of irradiation dose for the Biased (B_H, B_L) (Figure 1) and Unbiased (U_H, U_L) (all pins grounded) cases. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is -0.10mA.

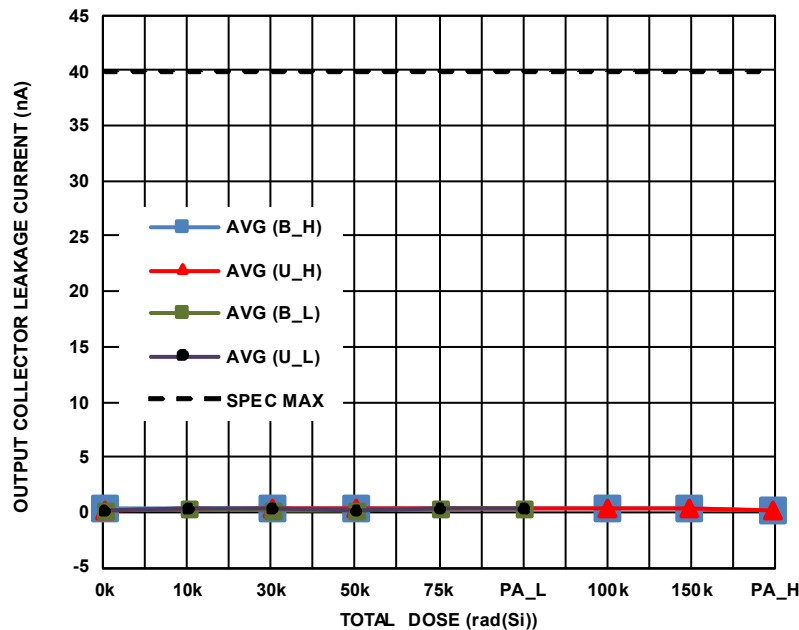


FIGURE 14. ISL72813SEH 32-Channel Driver Output Collector Leakage Current at $V_{CC} = 3.6V$ and $V_{EE} = -34V$ as a function of irradiation dose for the Biased (B_H, B_L) (Figure 1) and Unbiased (U_H, U_L) (all pins grounded) cases. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 40nA maximum.

Variables Data Plots (Continued)

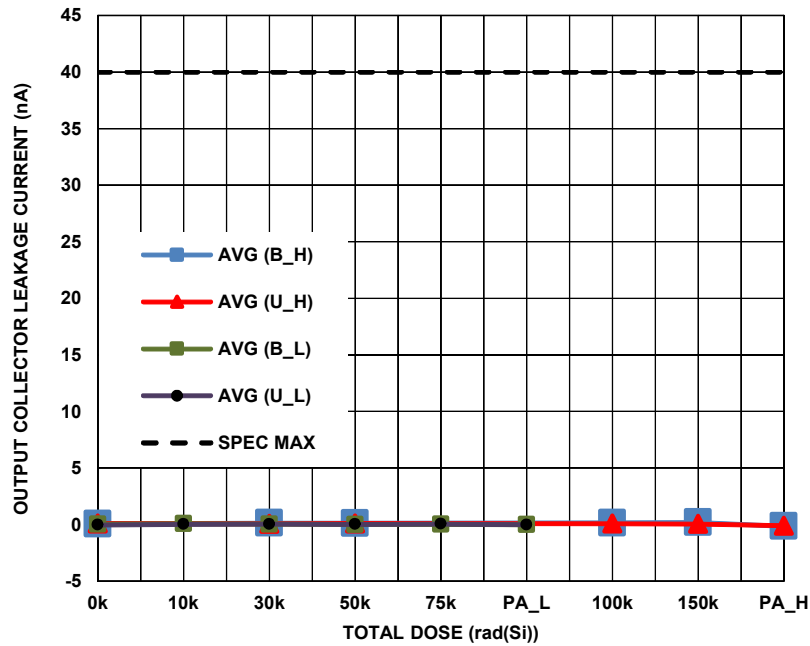


FIGURE 15. ISL72813SEH 32-Channel Driver Output Collector Leakage Current at $V_{CC} = 5.5V$ and $V_{EE} = -34V$ as a function of irradiation dose for the Biased (B_H, B_L) (Figure 1) and Unbiased (U_H, U_L) (all pins grounded) cases. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 40nA maximum.

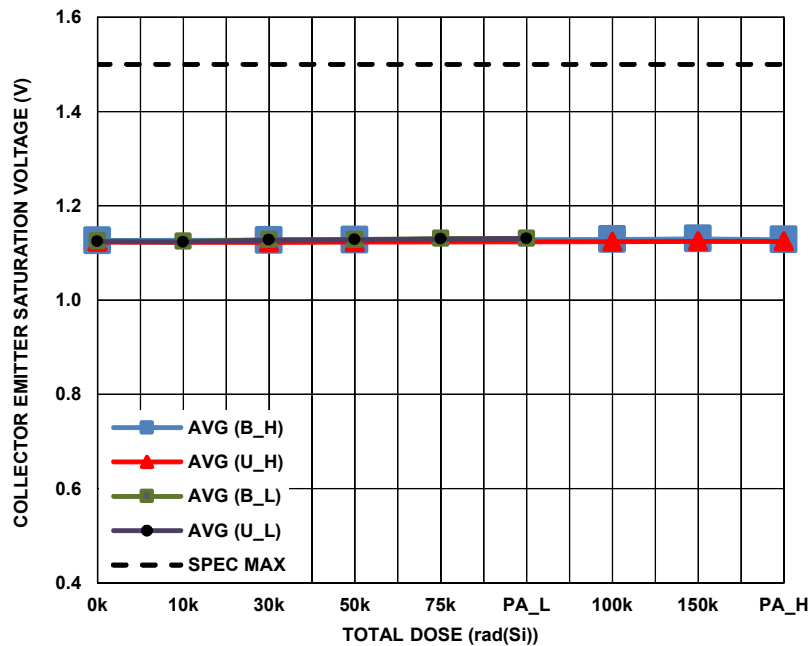


FIGURE 16. ISL72813SEH 32-Channel Driver Collector Emitter Saturation Voltage at $V_{CC} = 3.0V$ and $I_C = 530mA$ as a function of irradiation dose for the Biased (B_H, B_L) (Figure 1) and Unbiased (U_H, U_L) (all pins grounded) cases. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 1.5V maximum.

Variables Data Plots (Continued)

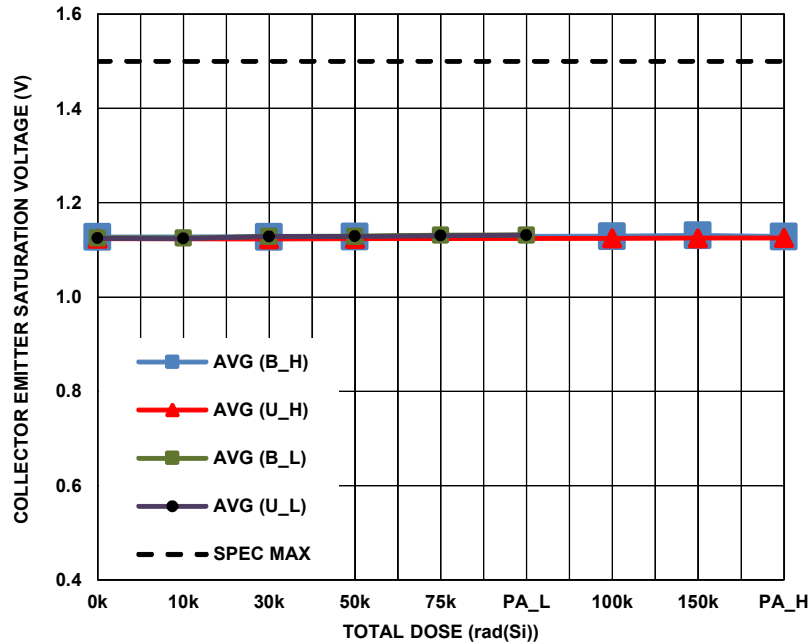


FIGURE 17. ISL72813SEH 32-Channel Driver Collector Emitter Saturation Voltage at $V_{CC} = 4.5V$ and $I_C = 530mA$ as a function of irradiation dose for the Biased (B_H, B_L) (Figure 1) and Unbiased (U_H, U_L) (all pins grounded) cases. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 1.5V maximum.

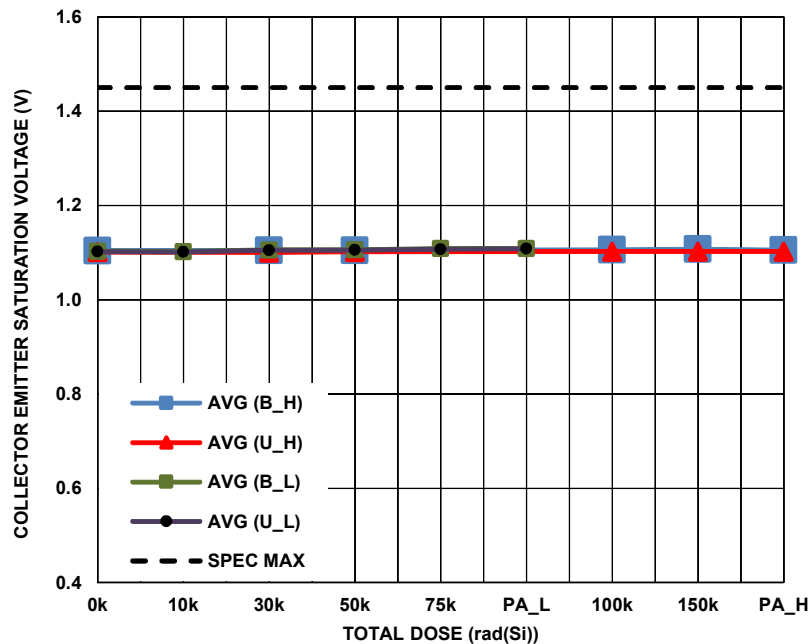


FIGURE 18. ISL72813SEH 32-Channel Driver Collector Emitter Saturation Voltage at $V_{CC} = 3.0V$ and $I_C = 500mA$ as a function of irradiation dose for the Biased (B_H, B_L) (Figure 1) and Unbiased (U_H, U_L) (all pins grounded) cases. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 1.45V maximum.

Variables Data Plots (Continued)

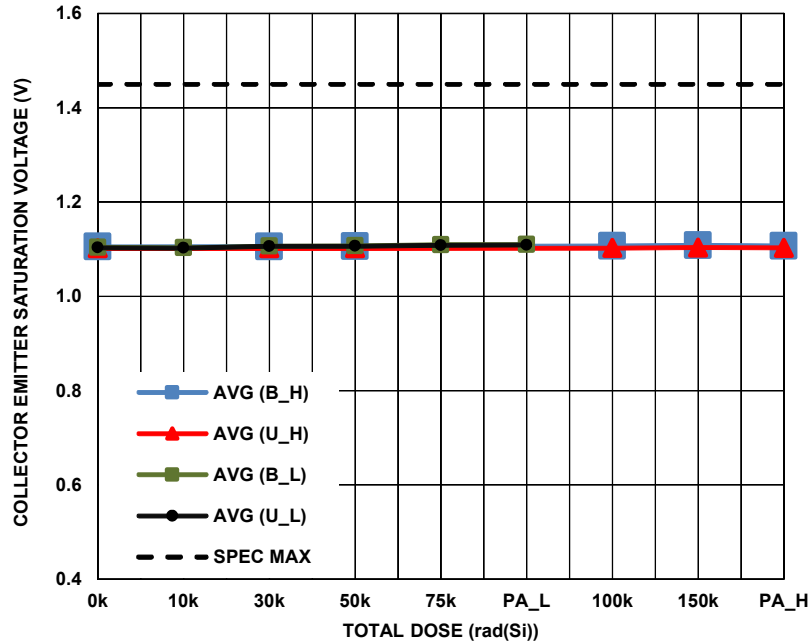


FIGURE 19. ISL72813SEH 32-Channel Driver Collector Emitter Saturation Voltage at $V_{CC} = 4.5V$ and $I_C = 500mA$ as a function of irradiation dose for the Biased (B_H, B_L) (Figure 1) and Unbiased (U_H, U_L) (all pins grounded) cases. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 1.45V maximum.

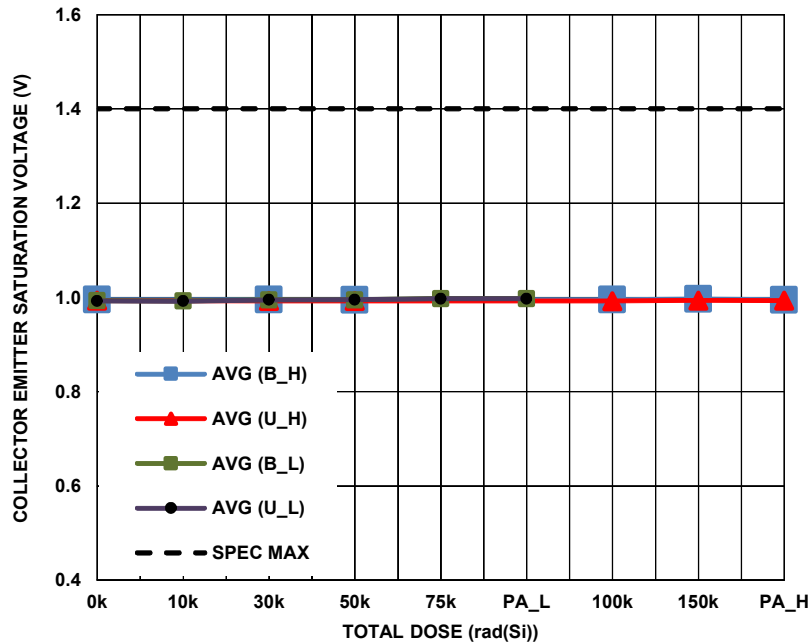


FIGURE 20. ISL72813SEH 32-Channel Driver Collector Emitter Saturation Voltage at $V_{CC} = 3.0V$ and $I_C = 350mA$ as a function of irradiation dose for the Biased (B_H, B_L) (Figure 1) and Unbiased (U_H, U_L) (all pins grounded) cases. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 1.4V maximum.

Variables Data Plots (Continued)

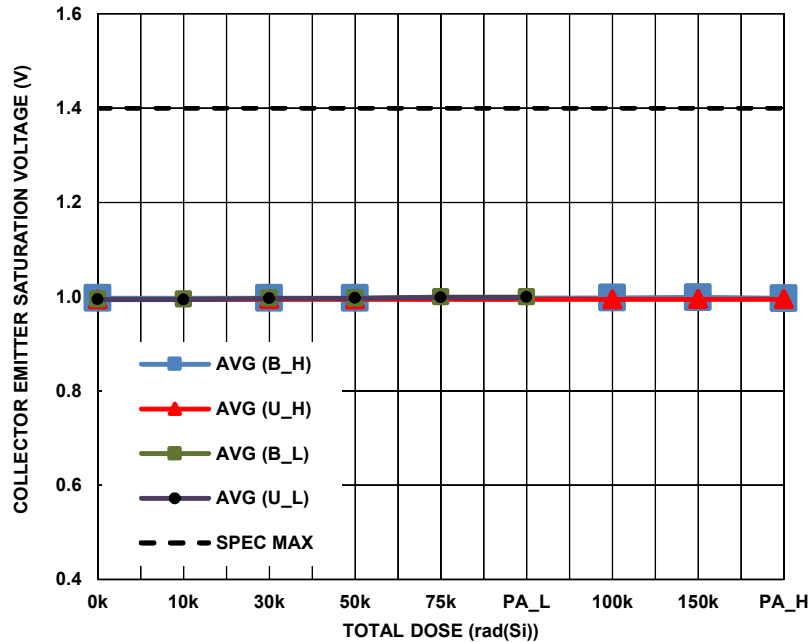


FIGURE 21. ISL72813SEH 32-Channel Driver Collector Emitter Saturation Voltage at $V_{CC} = 4.5V$ and $I_C = 350mA$ as a function of irradiation dose for the Biased (B_H, B_L) (Figure 1) and Unbiased (U_H, U_L) (all pins grounded) cases. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 1.4V maximum.

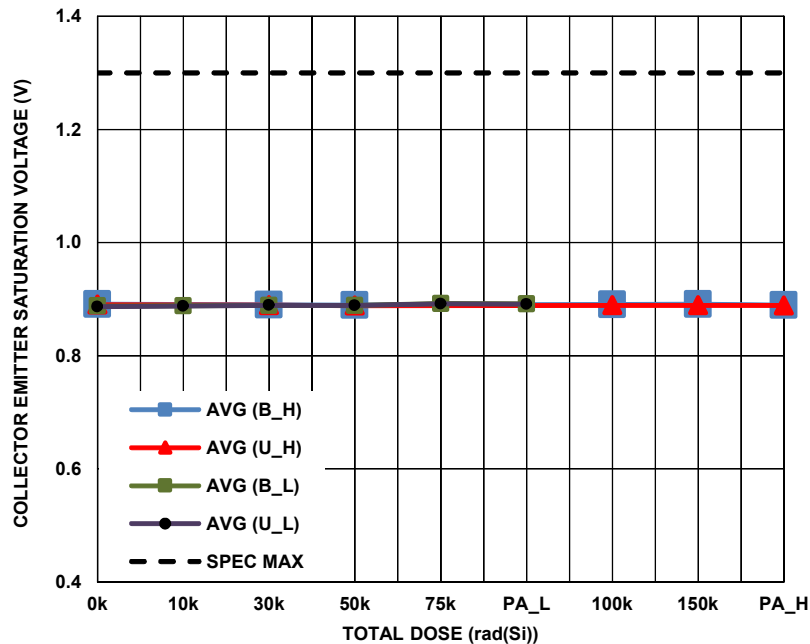


FIGURE 22. ISL72813SEH 32-Channel Driver Collector Emitter Saturation Voltage at $V_{CC} = 3.0V$ and $I_C = 200mA$ as a function of irradiation dose for the Biased (B_H, B_L) (Figure 1) and Unbiased (U_H, U_L) (all pins grounded) cases. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 1.3V maximum.

Variables Data Plots (Continued)

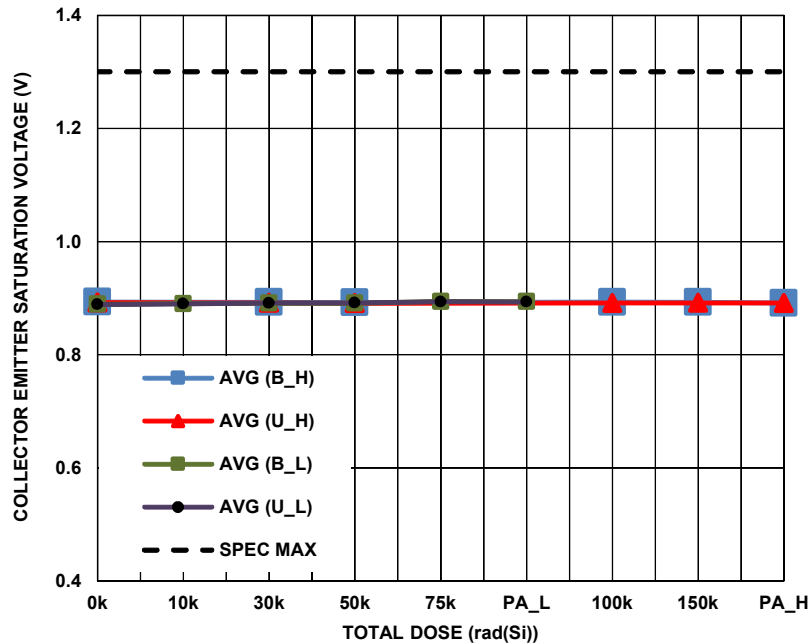


FIGURE 23. ISL72813SEH 32-Channel Driver Collector Emitter Saturation Voltage at $V_{CC} = 4.5V$ and $I_C = 200mA$ as a function of irradiation dose for the Biased (B_H, B_L) (Figure 1) and Unbiased (U_H, U_L) (all pins grounded) cases. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 1.3V maximum.

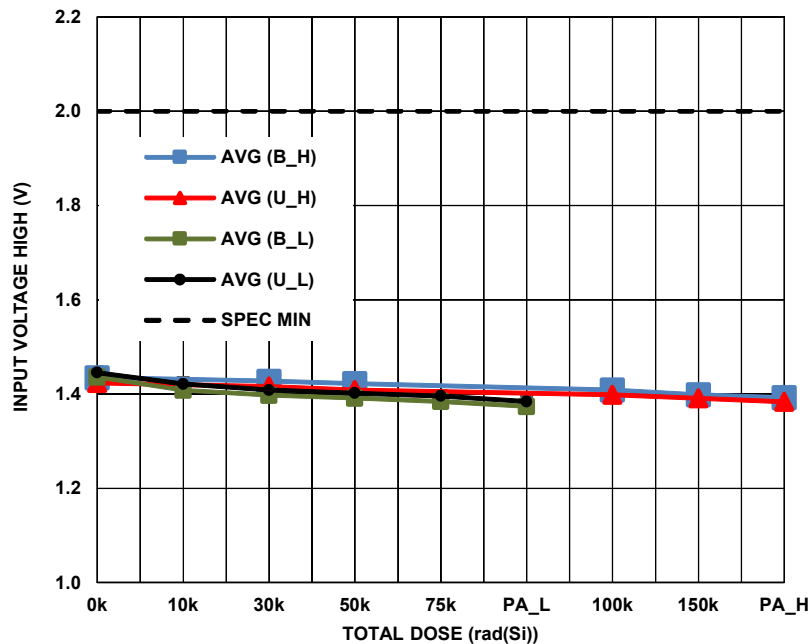


FIGURE 24. ISL72813SEH 32-Channel Driver Input Voltage HIGH at $V_{CC} = 3.0V$ as a function of irradiation dose for the Biased (B_H, B_L) (Figure 1) and Unbiased (U_H, U_L) (all pins grounded) cases. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 2.0V.

Variables Data Plots (Continued)

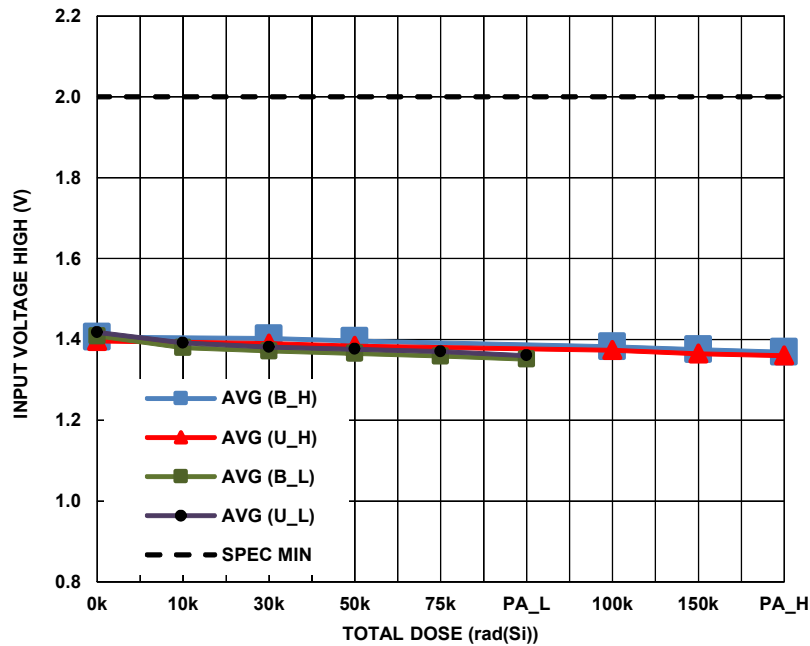


FIGURE 25. ISL72813SEH 32-Channel Driver Input Voltage HIGH at $V_{CC} = 5.5V$ as a function of irradiation dose for the Biased (B_H, B_L) (Figure 1) and Unbiased (U_H, U_L) (all pins grounded) cases. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 2.0V.

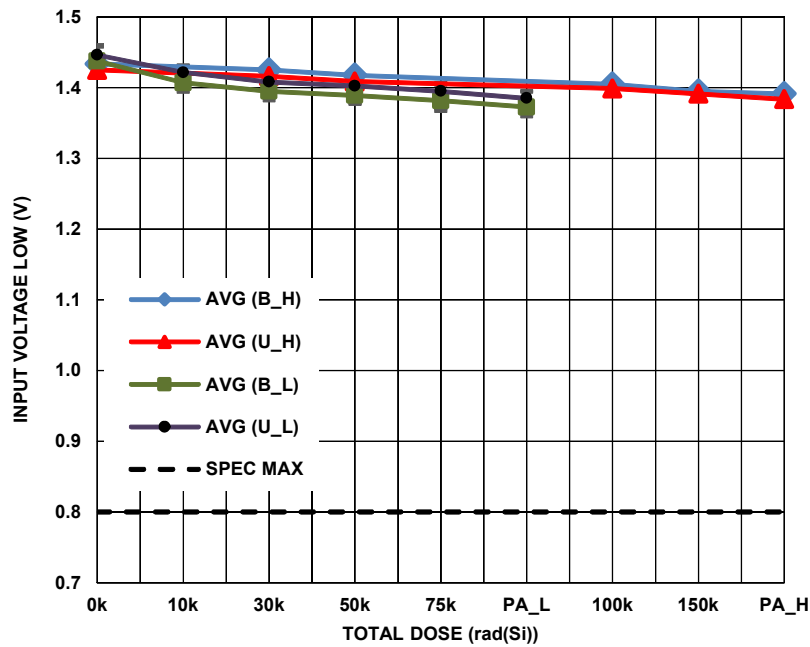


FIGURE 26. ISL72813SEH 32-Channel Driver Input Voltage LOW at $V_{CC} = 3.0V$ as a function of irradiation dose for the Biased (B_H, B_L) (Figure 1) and Unbiased (U_H, U_L) (all pins grounded) cases. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 0.8V.

Variables Data Plots (Continued)

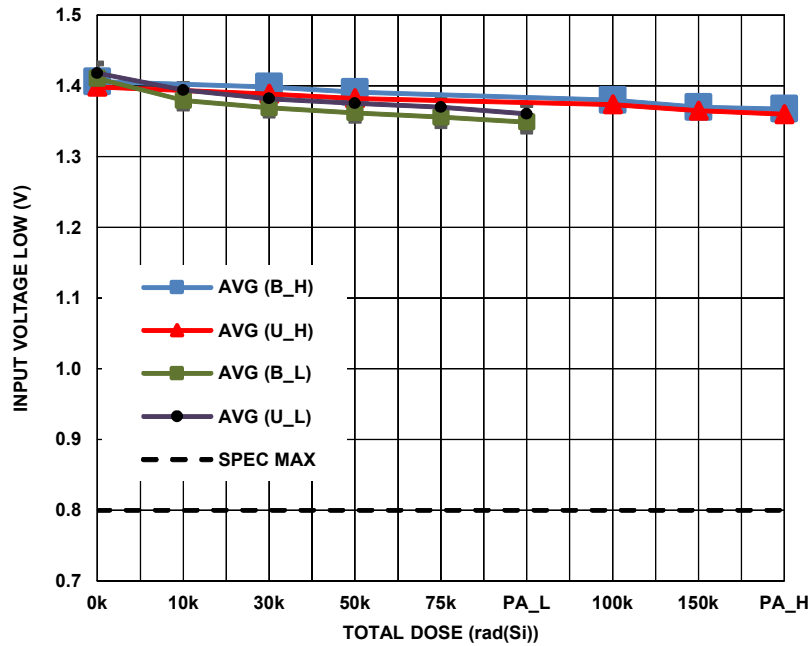


FIGURE 27. ISL72813SEH 32-Channel Driver Input Voltage LOW at $V_{CC} = 5.5V$ as a function of irradiation dose for the Biased (B_H, B_L) (Figure 1) and Unbiased (U_H, U_L) (all pins grounded) cases. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 0.8V.

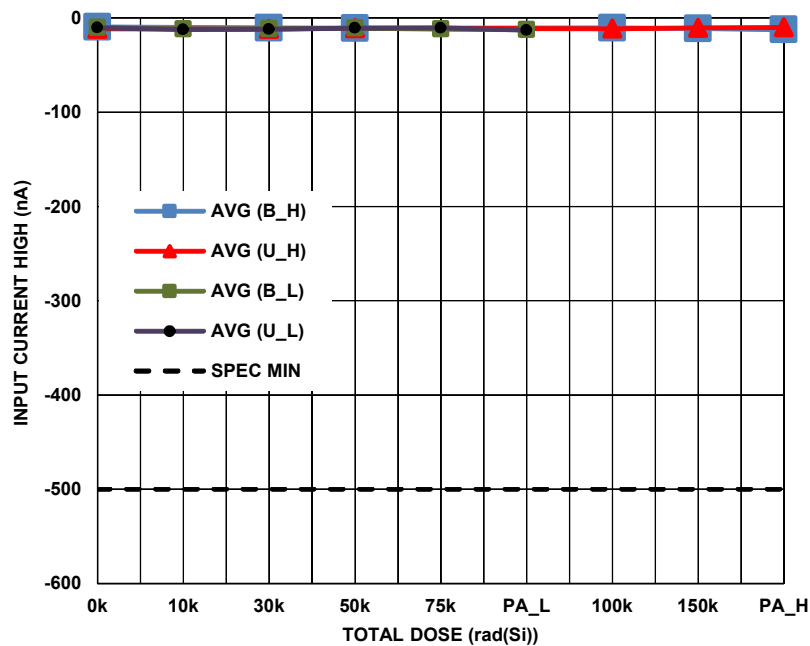


FIGURE 28. ISL72813SEH 32-Channel Driver Input Current HIGH at $V_{CC} = 3.0V$ as a function of irradiation dose for the Biased (B_H, B_L) (Figure 1) and Unbiased (U_H, U_L) (all pins grounded) cases. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is -500nA.

Variables Data Plots (Continued)

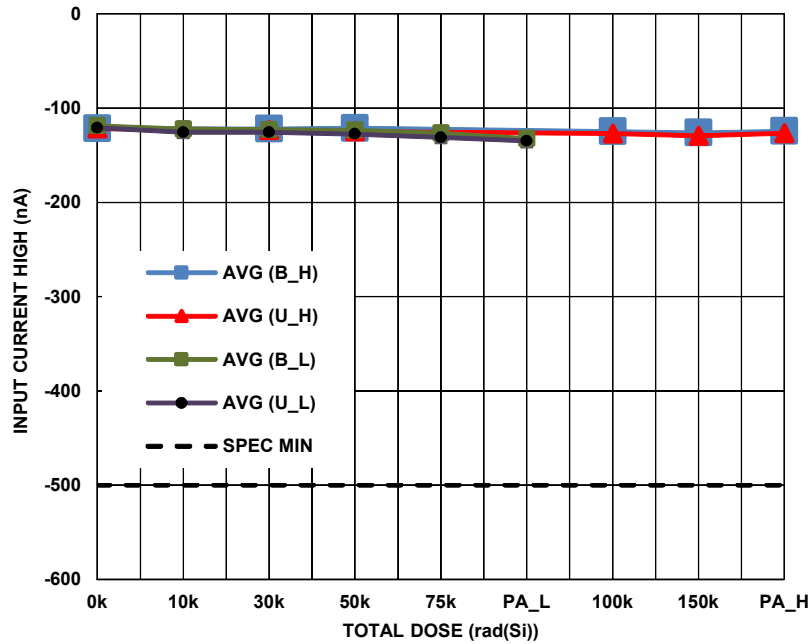


FIGURE 29. ISL72813SEH 32-Channel Driver Input Current HIGH at $V_{CC} = 5.5V$ as a function of irradiation dose for the Biased (B_H, B_L) (Figure 1) and Unbiased (U_H, U_L) (all pins grounded) cases. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is -500nA.

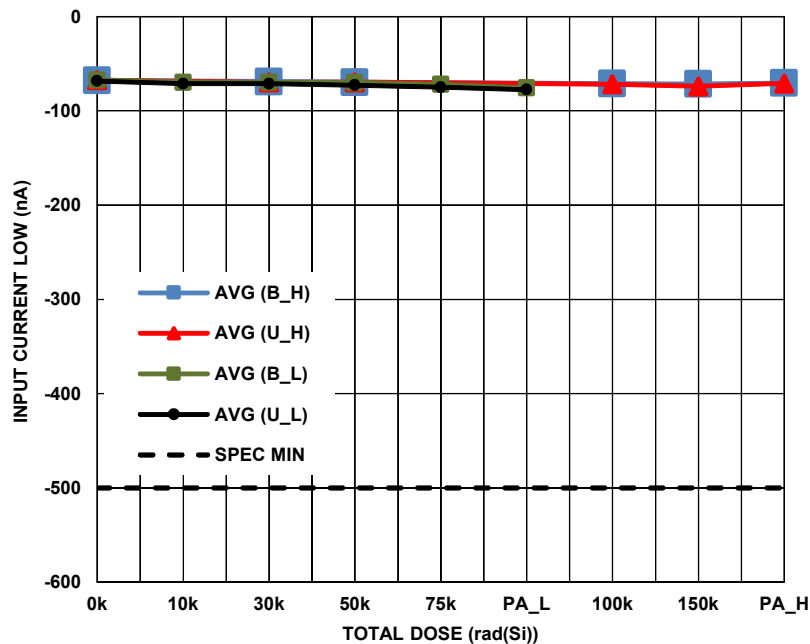


FIGURE 30. ISL72813SEH 32-Channel Driver Input Current LOW at $V_{CC} = 3.0V$ as a function of irradiation dose for the Biased (B_H, B_L) (Figure 1) and Unbiased (U_H, U_L) (all pins grounded) cases. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is -500nA.

Variables Data Plots (Continued)

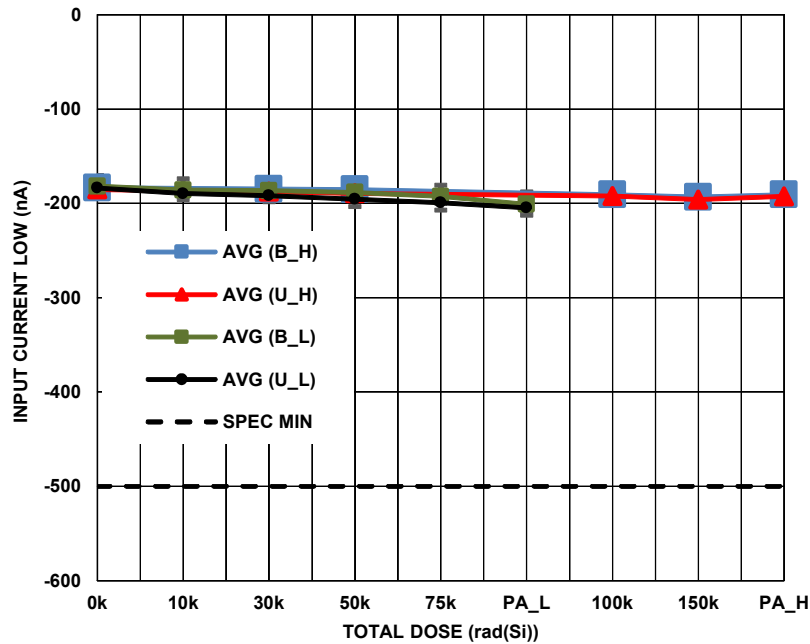


FIGURE 31. ISL72813SEH 32-Channel Driver Input Current LOW at $V_{CC} = 5.5V$ as a function of irradiation dose for the Biased (B_H, B_L) (Figure 1) and Unbiased (U_H, U_L) (all pins grounded) cases. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is -500nA.

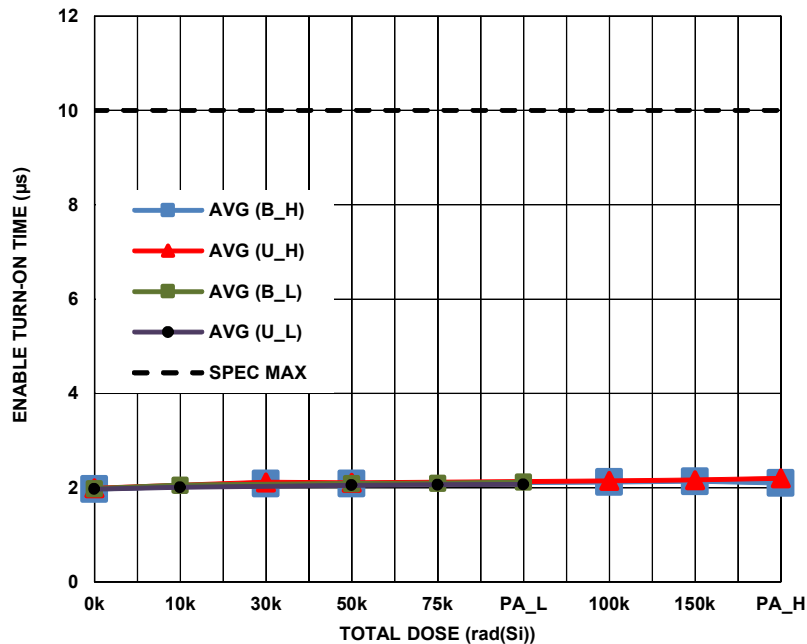


FIGURE 32. ISL72813SEH 32-Channel Driver Enable Turn-On Time at $V_{CC} = 5.5V$ as a function of irradiation dose for the Biased (B_H, B_L) (Figure 1) and Unbiased (U_H, U_L) (all pins grounded) cases. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is 10µs maximum.

Variables Data Plots (Continued)

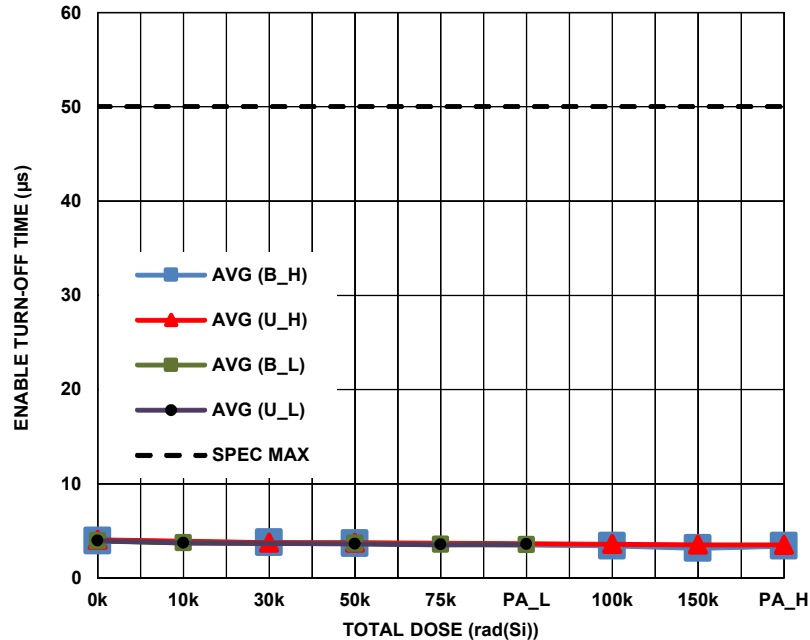


FIGURE 33. ISL72813SEH 32-Channel Driver Disable Turn-Off Time at $V_{CC} = 5.5V$ as a function of irradiation dose for the Biased (B_H, B_L) (Figure 1) and Unbiased (U_H, U_L) (all pins grounded) cases. The error bars represent the minimum and maximum measured values. The post-irradiation SMD limit is $50\mu s$ maximum.

Conclusion

This report describes the results of the total ionizing dose (TID) tests of the ISL72813SEH high-current driver. The tests were conducted to determine the sensitivity of the part to total dose environment. Samples were tested to 75krad(Si) at a low dose rate under Biased and Unbiased conditions and were then subjected to a high temperature Biased anneal at $+100^{\circ}C$ for 168 hours. An additional set of samples were tested to 150krad(Si) at a high dose rate under Biased and Unbiased conditions and then also subjected to a high temperature Biased anneal at $+100^{\circ}C$ for 168 hours.

ATE characterization testing showed no rejects to the SMD Group A parametric limits (indicated by a 'Bin 1' category) after Biased and grounded irradiation at both dose rates and after the 168 hour $+100^{\circ}C$ Biased anneals. Attributes data are presented in Tables 2 and 3, while variables data are plotted in Figures 2 through 33.

For attributes that are tested on multiple inputs or outputs, such as voltage input levels and collector emitter saturation voltages, only a typical case is shown. The data for the graphs of the enable turn on and disable turn off times were taken in the lab because they are not part of the production ATE tests.

No meaningful differences between low dose rate and high dose rate exposures or between Biased and Unbiased irradiation were noted, and the samples showed no significant response to the high temperature anneal.

TABLE 4. REPORTED PARAMETERS

FIGURE	PARAMETER	SYMBOL	LIMIT, LOW	LIMIT, HIGH	UNITS	CONDITIONS
2	Supply Current	I_{CC}		9.5	mA	$V_{CC} = 3.6V, V_{EE} = 0V, Cx = OPEN, EN = V_{CC}$
3						$V_{CC} = 3.6V, V_{EE} = -34V, Cx = OPEN, EN = V_{CC}$
4						$V_{CC} = 5.5V, V_{EE} = 0V, Cx = OPEN, EN = V_{CC}$
5						$V_{CC} = 5.5V, V_{EE} = -34V, Cx = OPEN, EN = V_{CC}$
6	Quiescent Supply Current	I_{CCQ}	-	850	μA	$V_{CC} = 3.6V, V_{EE} = 0V, Cx = OPEN, EN = 0$
7						$V_{CC} = 3.6V, V_{EE} = -34V, Cx = OPEN, EN = 0$
8						$V_{CC} = 5.5V, V_{EE} = 0V, Cx = OPEN, EN = 0$
9						$V_{CC} = 5.5V, V_{EE} = -34V, Cx = OPEN, EN = 0$
10	Supply Current	I_{EE}	-45	-	mA	$V_{CC} = 3.6V, V_{EE} = -34V, Cx = OPEN, EN = V_{CC}$
11						$V_{CC} = 5.5V, V_{EE} = -34V, Cx = OPEN, EN = V_{CC}$
12	Quiescent Supply Current	I_{EEQ}	-100	-	μA	$V_{CC} = 3.6V, V_{EE} = -34V, Cx = OPEN, EN = 0$
13						$V_{CC} = 5.5V, V_{EE} = -34V, Cx = OPEN, EN = 0$
14	Output Collector Leakage Current	I_{CEX}	-	40	nA	$V_{CC} = 3.6V, V_{CX} = 0V, V_{EE} = -34V, EN = 0V$
15						$V_{CC} = 5.5V, V_{CX} = 0V, V_{EE} = -34V, EN = 0V$
16	Collector - Emitter Saturation Voltage $V_{CE(SAT)} = V_{CX} - V_{EE}$	$V_{CE(SAT)}$	-	1.5	V	$I_C = 530mA, V_{CC} = 3.0V, V_{EE} = -34V, EN = V_{CC}$
17						$I_C = 530mA, V_{CC} = 4.5V, V_{EE} = -34V, EN = V_{CC}$
18				1.45		$I_C = 500mA, V_{CC} = 3.0V, V_{EE} = -34V, EN = V_{CC}$
19						$I_C = 500mA, V_{CC} = 4.5V, V_{EE} = -34V, EN = V_{CC}$
20				1.4		$I_C = 350mA, V_{CC} = 3.0V, V_{EE} = -34V, EN = V_{CC}$
21						$I_C = 350mA, V_{CC} = 4.5V, V_{EE} = -34V, EN = V_{CC}$
22				1.3		$I_C = 200mA, V_{CC} = 3.0V, V_{EE} = -34V, EN = V_{CC}$
23						$I_C = 200mA, V_{CC} = 4.5V, V_{EE} = -34V, EN = V_{CC}$
24	High Level Threshold	V_{IH}	2	-	V	$V_{CC} = 3.0V$
25						$V_{CC} = 5.5V$
26	Low Level Threshold	V_{IL}	-	0.8	V	$V_{CC} = 3.0V$
27						$V_{CC} = 5.5V$
28	Input High Current	I_{IH}	-500	-	nA	$V_{CC} = 3.0V, \text{Tested Logic Input} = 2.0V$
29						$V_{CC} = 5.5V, \text{Tested Logic Input} = 2.0V$
30	Input Low Current	I_{IL}	-500	-	nA	$V_{CC} = 3.0V, \text{Tested Logic Input} = 0.8V$
31						$V_{CC} = 5.5V, \text{Tested Logic Input} = 0.8V$
32	Enable Turn-On Time	t_{EN}	-	10	μs	$V_{CC} = 3.0V, 5.5V, R_{LOAD} = 64.4\Omega$ (Note 4)
33	Disable Turn-Off Time	t_{DIS}	-	50	μs	$V_{CC} = 3.0V, 5.5V, R_{LOAD} = 64.4\Omega$ (Note 4)

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

4. Lab characterization at 5.5V ONLY (determined to be worst case).

Notice

1. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation or any other use of the circuits, software, and information in the design of your product or system. Renesas Electronics disclaims any and all liability for any losses and damages incurred by you or third parties arising from the use of these circuits, software, or information.
2. Renesas Electronics hereby expressly disclaims any warranties against and liability for infringement or any other claims involving patents, copyrights, or other intellectual property rights of third parties, by or arising from the use of Renesas Electronics products or technical information described in this document, including but not limited to, the product data, drawings, charts, programs, algorithms, and application examples.
3. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
4. You shall not alter, modify, copy, or reverse engineer any Renesas Electronics product, whether in whole or in part. Renesas Electronics disclaims any and all liability for any losses or damages incurred by you or third parties arising from such alteration, modification, copying or reverse engineering.
5. Renesas Electronics products are classified according to the following two quality grades: "Standard" and "High Quality". The intended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below.
"Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; industrial robots; etc.
"High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control (traffic lights); large-scale communication equipment; key financial terminal systems; safety control equipment; etc.
Unless expressly designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not intended or authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems; surgical implantations; etc.), or may cause serious property damage (space system; undersea repeaters; nuclear power control systems; aircraft control systems; key plant systems; military equipment; etc.). Renesas Electronics disclaims any and all liability for any damages or losses incurred by you or any third parties arising from the use of any Renesas Electronics product that is inconsistent with any Renesas Electronics data sheet, user's manual or other Renesas Electronics document.
6. When using Renesas Electronics products, refer to the latest product information (data sheets, user's manuals, application notes, "General Notes for Handling and Using Semiconductor Devices" in the reliability handbook, etc.), and ensure that usage conditions are within the ranges specified by Renesas Electronics with respect to maximum ratings, operating power supply voltage range, heat dissipation characteristics, installation, etc. Renesas Electronics disclaims any and all liability for any malfunctions, failure or accident arising out of the use of Renesas Electronics products outside of such specified ranges.
7. Although Renesas Electronics endeavors to improve the quality and reliability of Renesas Electronics products, semiconductor products have specific characteristics, such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Unless designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not subject to radiation resistance design. You are responsible for implementing safety measures to guard against the possibility of bodily injury, injury or damage caused by fire, and/or danger to the public in the event of a failure or malfunction of Renesas Electronics products, such as safety design for hardware and software, including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult and impractical, you are responsible for evaluating the safety of the final products or systems manufactured by you.
8. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. You are responsible for carefully and sufficiently investigating applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive, and using Renesas Electronics products in compliance with all these applicable laws and regulations. Renesas Electronics disclaims any and all liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
9. Renesas Electronics products and technologies shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You shall comply with any applicable export control laws and regulations promulgated and administered by the governments of any countries asserting jurisdiction over the parties or transactions.
10. It is the responsibility of the buyer or distributor of Renesas Electronics products, or any other party who distributes, disposes of, or otherwise sells or transfers the product to a third party, to notify such third party in advance of the contents and conditions set forth in this document.
11. This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.
12. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products.
(Note 1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its directly or indirectly controlled subsidiaries.
(Note 2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

(Rev.4.0-1 November 2017)



SALES OFFICES

Renesas Electronics Corporation

<http://www.renesas.com>

Refer to "<http://www.renesas.com/>" for the latest and detailed information.

Renesas Electronics America Inc.
1001 Murphy Ranch Road, Milpitas, CA 95035, U.S.A.
Tel: +1-408-432-8888, Fax: +1-408-434-5351

Renesas Electronics Canada Limited
9251 Yonge Street, Suite 8309 Richmond Hill, Ontario Canada L4C 9T3
Tel: +1-905-237-2004

Renesas Electronics Europe Limited
Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K
Tel: +44-1628-651-700, Fax: +44-1628-651-804

Renesas Electronics Europe GmbH
Arcadiastrasse 10, 40472 Düsseldorf, Germany
Tel: +49-211-6503-0, Fax: +49-211-6503-1327

Renesas Electronics (China) Co., Ltd.
Room 1709 Quantum Plaza, No.27 ZhichunLu, Haidian District, Beijing, 100191 P. R. China
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

Renesas Electronics (Shanghai) Co., Ltd.
Unit 301, Tower A, Central Towers, 555 Langao Road, Putuo District, Shanghai, 200333 P. R. China
Tel: +86-21-2226-0888, Fax: +86-21-2226-0999

Renesas Electronics Hong Kong Limited
Unit 1601-1611, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong
Tel: +852-2265-6688, Fax: +852-2886-9022

Renesas Electronics Taiwan Co., Ltd.
13F, No. 363, Fu Shing North Road, Taipei 10543, Taiwan
Tel: +886-2-8175-9600, Fax: +886-2-8175-9670

Renesas Electronics Singapore Pte. Ltd.
80 Bendemeer Road, Unit #06-02 Hyflux Innovation Centre, Singapore 339949
Tel: +65-6213-0200, Fax: +65-6213-0300

Renesas Electronics Malaysia Sdn.Bhd.
Unit 1207, Block B, Menara Amcorp, Amcorp Trade Centre, No. 18, Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia
Tel: +60-3-7955-9390, Fax: +60-3-7955-9510

Renesas Electronics India Pvt. Ltd.
No.777C, 100 Feet Road, HAL 2nd Stage, Indiranagar, Bangalore 560 038, India
Tel: +91-80-67208700, Fax: +91-80-67208777

Renesas Electronics Korea Co., Ltd.
17F, KAMCO Yangjae Tower, 262, Gangnam-daero, Gangnam-gu, Seoul, 06265 Korea
Tel: +82-2-558-3737, Fax: +82-2-558-5338