ISL74422ARH

Low Dose Rate Results of the ISL74422ARH, Radiation Hardened 9A Non-Inverting MOSFET Driver

Introduction

This report documents the results of Low Dose Rate (LDR) total dose testing of the ISL74422ARH, radiation hardened 9A, non-inverting, high-speed MOSFET driver. The test provides an assessment of the total dose hardness of the part when exposed at a LDR and an estimate of bias sensitivity. The ISL74422ARH does not have a corresponding EH version (indicating RLAT at both High Dose Rate (HDR) and LDR) and is lot acceptance tested (RLAT) at HDR only. Parts were irradiated biased and unbiased at LDR (0.01rad(Si)/s) to 100krad(Si). The ISL74422ARH is rated to 50krad(Si) at LDR.

Related Literature

- MIL-STD-883 Test Method 1019
- ISL74422ARH datasheet

Product Description

The Radiation Hardened ISL74422ARH is a non-inverting, monolithic high-speed MOSFET driver that converts a CMOS level input signal into a high current output at voltages up to 18V. Its fast rise times and high current output allow quick control of even the largest power MOSFETs in high frequency applications.

The input of the ISL74422ARH can be directly driven by our HS-1825ARH and IS-1845ASRH PWM devices. The 9A high current output minimizes power losses in MOSFETs by rapidly charging and discharging high gate capacitances.

Constructed with the Renesas dielectrically isolated Rad Hard Silicon Gate (RSG) BiCMOS process, these devices are immune to single event latch-up and have been specifically designed to provide highly reliable performance in harsh radiation environments. The pin assignments for the ISL74422ARH is shown in Figure 1 with the pin descriptions shown in Table 1.

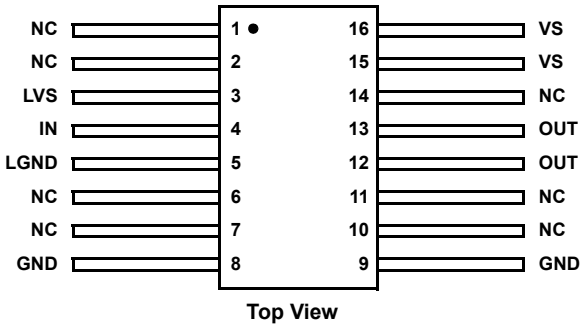

Figure 1. ISL74422ARH Package and Pin Configuration

Table 1. ISL74422ARH Pin Descriptions

Pin Number	Pin Name	Description
1, 2, 6, 7, 10, 11, 14	NC	No Connection
3	LVS	Provides the supply voltage for the control logic. It is not internally connected to Pins 15 and 16 for noise immunity purposes, but may be connected externally.
4	IN	Input voltage to the driver.
5	LGND	Control logic return. It is not internally connected to Pins 8 and 9 for noise immunity purposes, but may be connected externally.
8, 9	GND	Pins must be connected to GND.
12, 13	OUT	Pins must be connected to output.
15, 16	VS	Pins must be connected to VS.

Contents

1. Test Description

1.1 Irradiation Facilities

The irradiation was performed at 0.01rad(Si)/s using the Renesas Palm Bay Hopewell Designs N40 panoramic commercial irradiator. This irradiator uses PbAl spectrum hardening filters to shield the test board and devices under test against low energy secondary gamma radiation.

1.2 Test Fixturing

Figure 2 shows the configuration used for biased irradiation.

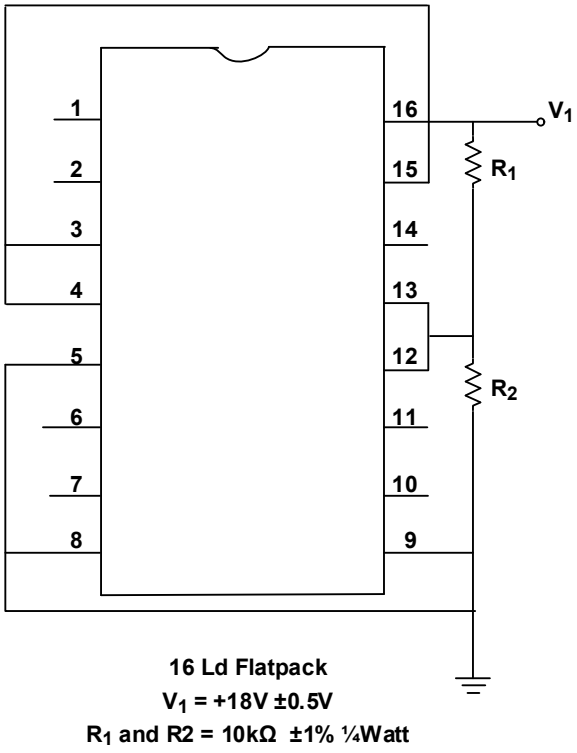

Figure 2. ISL74422ARH TID Bias Schematic

1.3 Characterization Equipment and Procedures

All electrical testing was performed at room temperature outside the irradiator, using production automated test equipment (ATE) with data logging at each downpoint.

1.4 Experimental Matrix

Irradiation was performed in accordance with the guidelines of MIL-STD-883 Test Method 1019. The experimental matrix consisted of 10 samples irradiated under bias and 10 samples irradiated with all pins grounded.

The ISL74422ARH samples were drawn from wafer lot E36542A0/1. All samples were packaged in the standard 16 pin CDFP package (PKG Code CDFP4-16). Samples were processed through the standard burn-in cycle before irradiation.

1.5 Downpoints

Downpoints for the tests were 0, 50, 75 and 100krad(Si).

2. Test Results

2.1 Attributes Data

Total dose testing of the ISL74422ARH was completed. All tested parameters passed the SMD limits. Table 2 summarizes the results.

Table 2. ISL74422ARH Total Dose Test Attributes Data

Dose Rate (rad(Si)/s)	Condition	Sample Size	Downpoint	Pass[1]	Fail
0.01	Biased (Figure 2)	10	Pre-irradiation	10	
			50krad(Si)	10	0
			75krad(Si)	10	0
			100krad(Si)	10	0
0.01	GND	10	Pre-irradiation	10	
			50krad(Si)	10	0
			75krad(Si)	10	0
			100krad(Si)	10	0

1. A pass indicates a sample that passes all post-irradiation SMD limits.

2.2 Key Parameter Variables Data

The plots in Figure 3 through Figure 18 illustrate the TID response of selected parameters as shown in Table 3. The plots show the average tested values of the key parameters as a function of total dose for both conditions, biased and grounded. 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 are not visible because of their values compared to the scale of the graph.

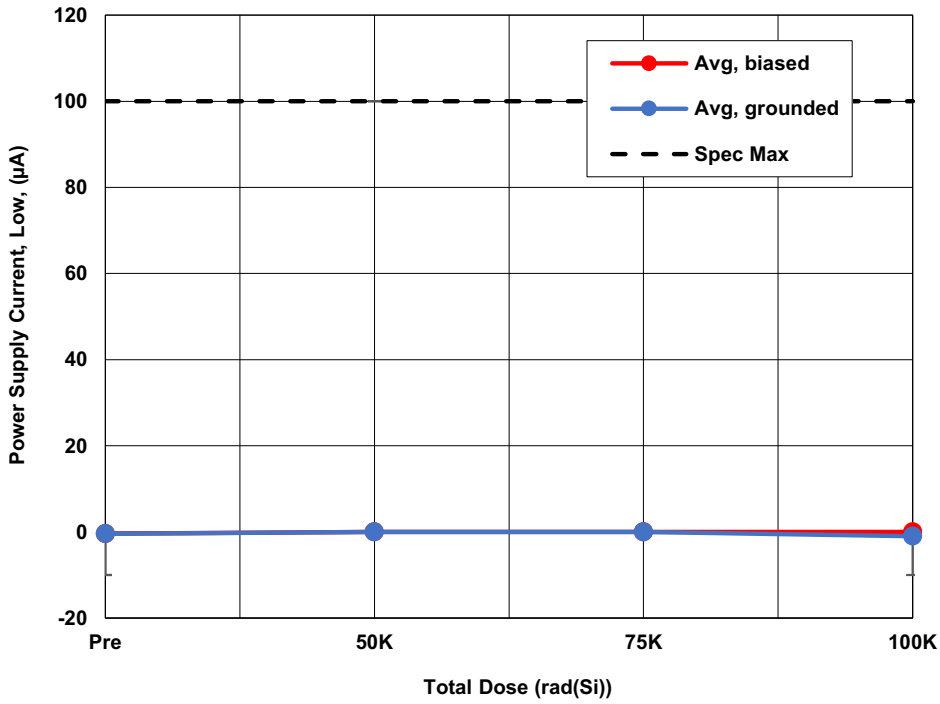

Figure 3. ISL74422ARH average power supply current, low (I_{SSB} low) with V_S = 18V and V_{IN} = 0.8V as a function of LDR irradiation. The error bars (if visible) represent the minimum and maximum measured values. The SMD limit is 100µA maximum.

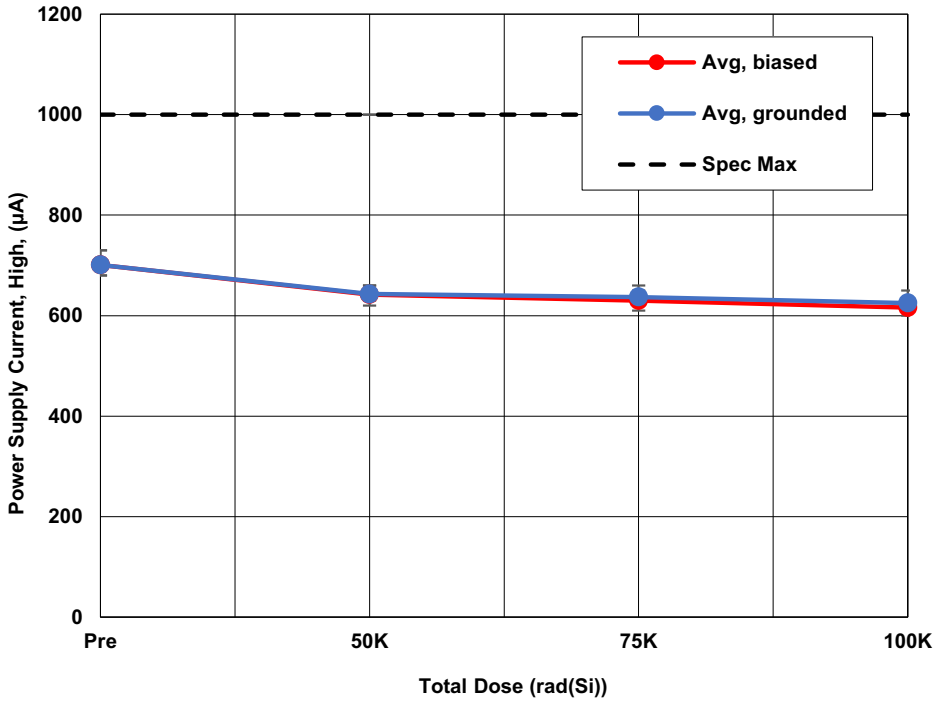

Figure 4. ISL74422ARH average power supply current, high (I_{SSB} high) with V_S = 18V and V_{IN} = 10V as a function of LDR irradiation. The error bars represent the minimum and maximum measured values. The SMD limit is 1mA maximum.

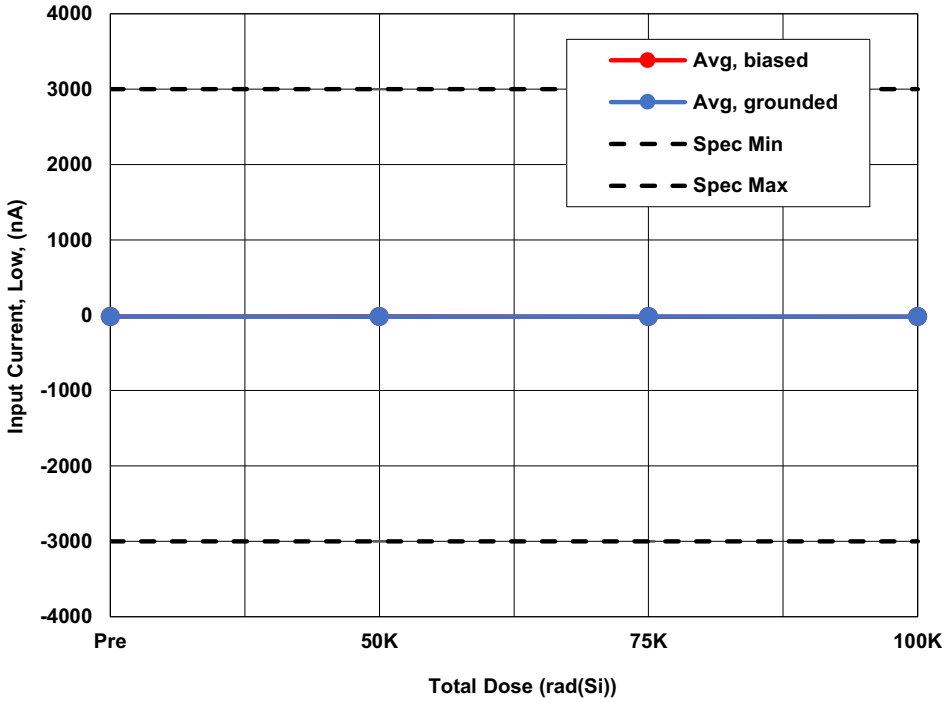

Figure 5. ISL74422ARH average input current, low (I_{IL}) with V_S = 18V and V_{IN} = -5V as a function of LDR irradiation. The error bars represent the minimum and maximum measured values. The SMD limits are -3µA minimum and 3µA maximum.

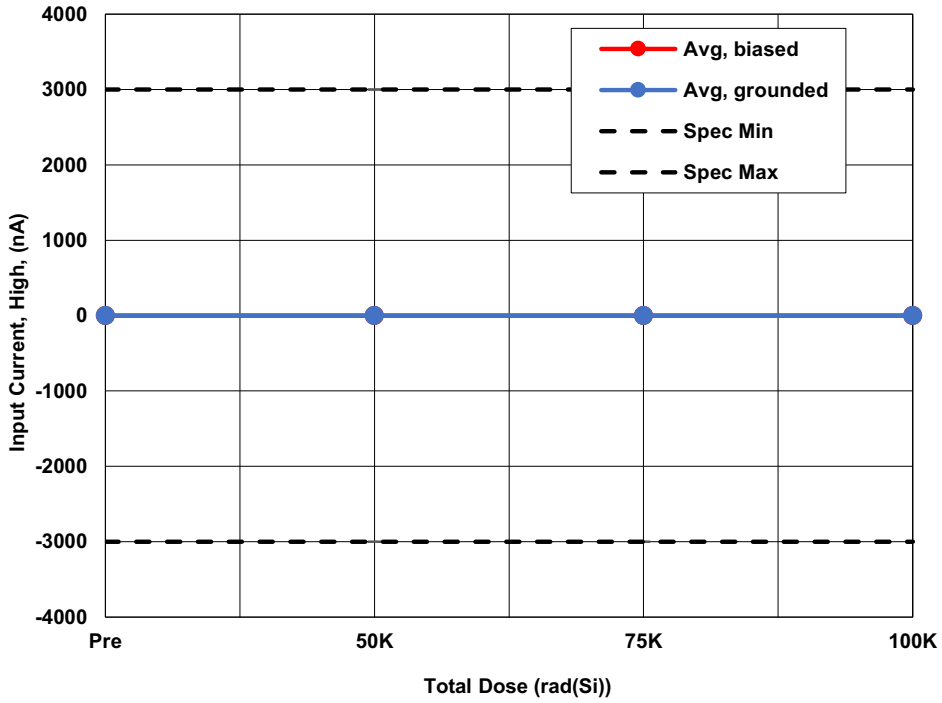

Figure 6. ISL74422ARH average input current, high (I_{IH}) with V_S = 18V and V_{IN} = 18V as a function of LDR irradiation. The error bars represent the minimum and maximum measured values. The SMD limits are -3µA minimum and 3µA maximum.

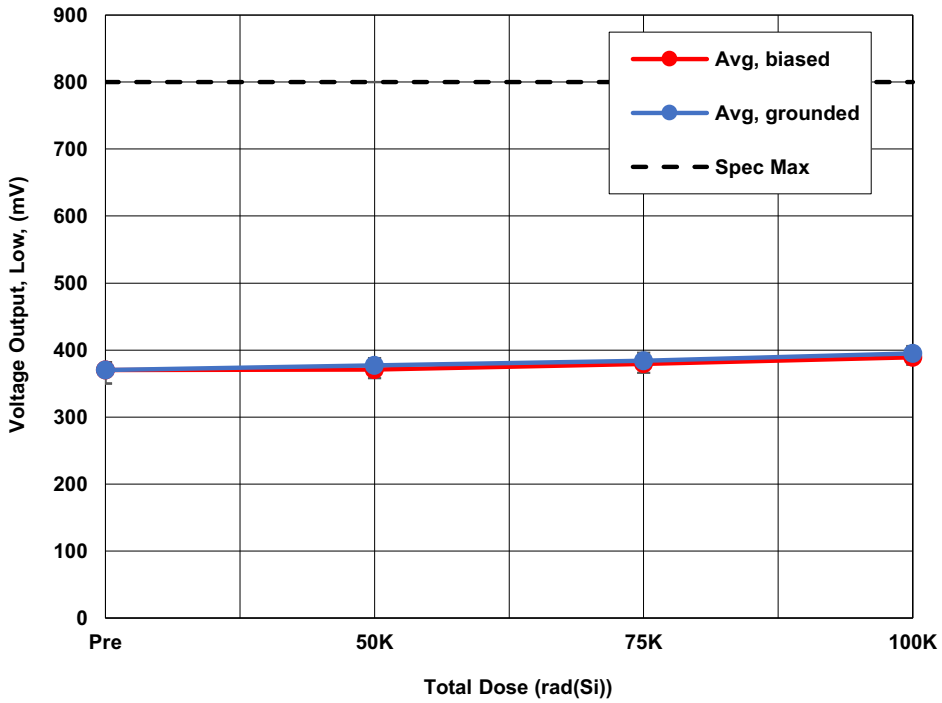

Figure 7. ISL74422ARH average voltage output, low (V_{OL}) with V_S = 18V and I_{OUT} = 10mA as a function of LDR irradiation. The error bars represent the minimum and maximum measured values. The SMD limit is 0.8V maximum.

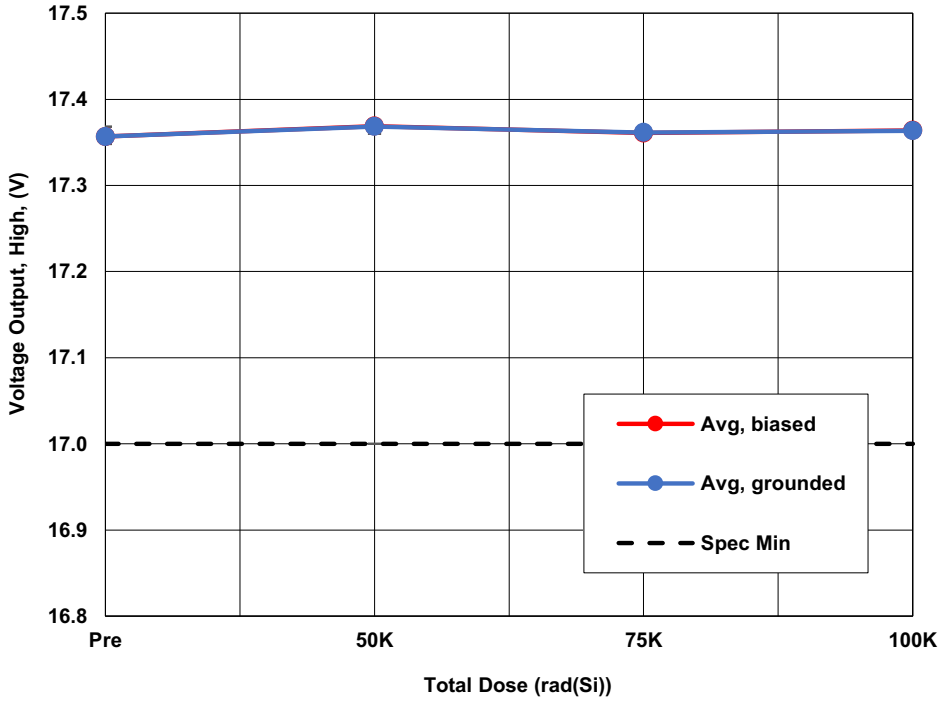

Figure 8. ISL74422ARH average voltage output, high (V_{OH}) with V_S = 18V and I_{OUT} = -10mA as a function of LDR irradiation. as a function of LDR irradiation. The error bars represent the minimum and maximum measured values. The SMD limit is 17V minimum.

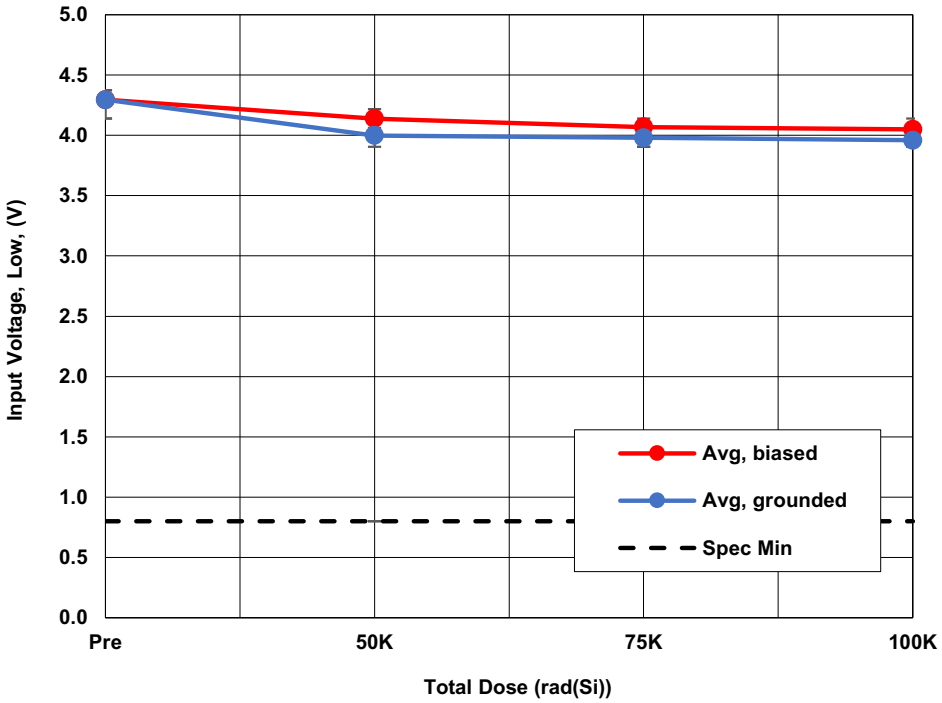

Figure 9. ISL74422ARH average input voltage, low (V_{IL1}) with V_S = 18V as a function of LDR irradiation. as a function of LDR irradiation. The error bars represent the minimum and maximum measured values. The SMD limit is 0.8V maximum.

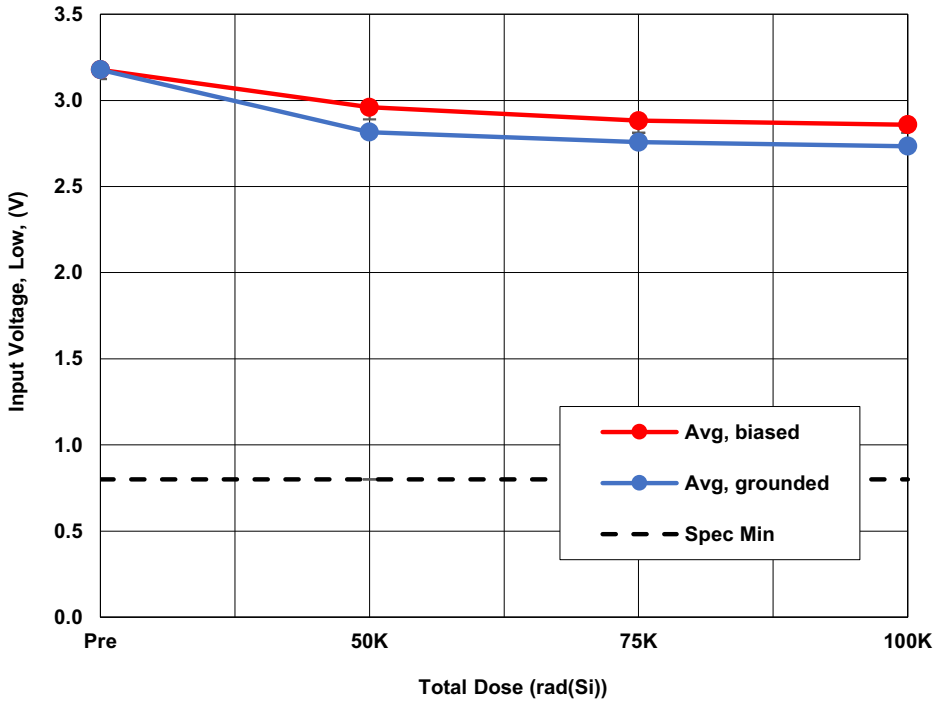

Figure 10. ISL74422ARH average input voltage, low (V_{IL2}) with V_S = 7V as a function of LDR irradiation. The error bars represent the minimum and maximum measured values. The SMD limit is 0.8V maximum.

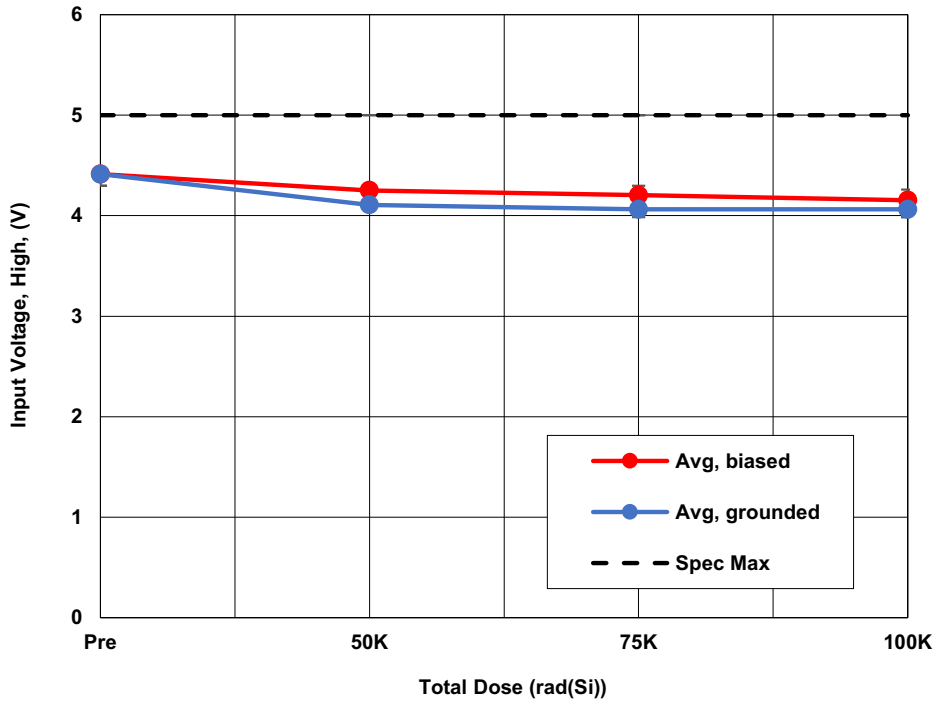

Figure 11. ISL74422ARH average input voltage, high (V_{IH1}) with V_S = 18V as a function of LDR irradiation. The error bars represent the minimum and maximum measured values. The SMD limit is 5V minimum.

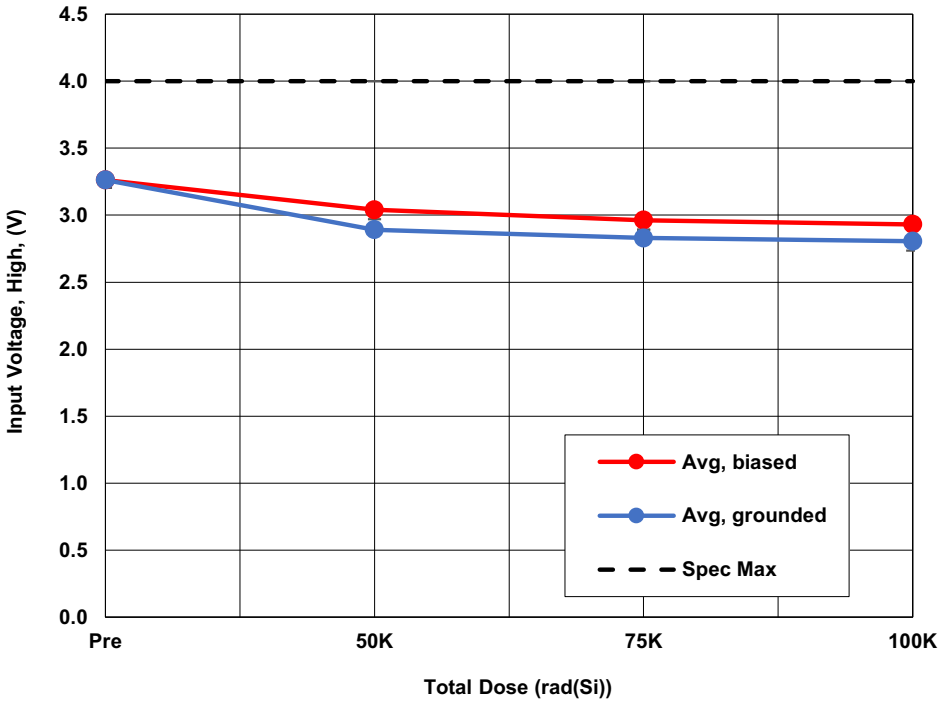

Figure 12. ISL74422ARH average input voltage, high (V_{IH2}) with V_S = 7V as a function of LDR irradiation. The error bars represent the minimum and maximum measured values. The SMD limit is 4V minimum.

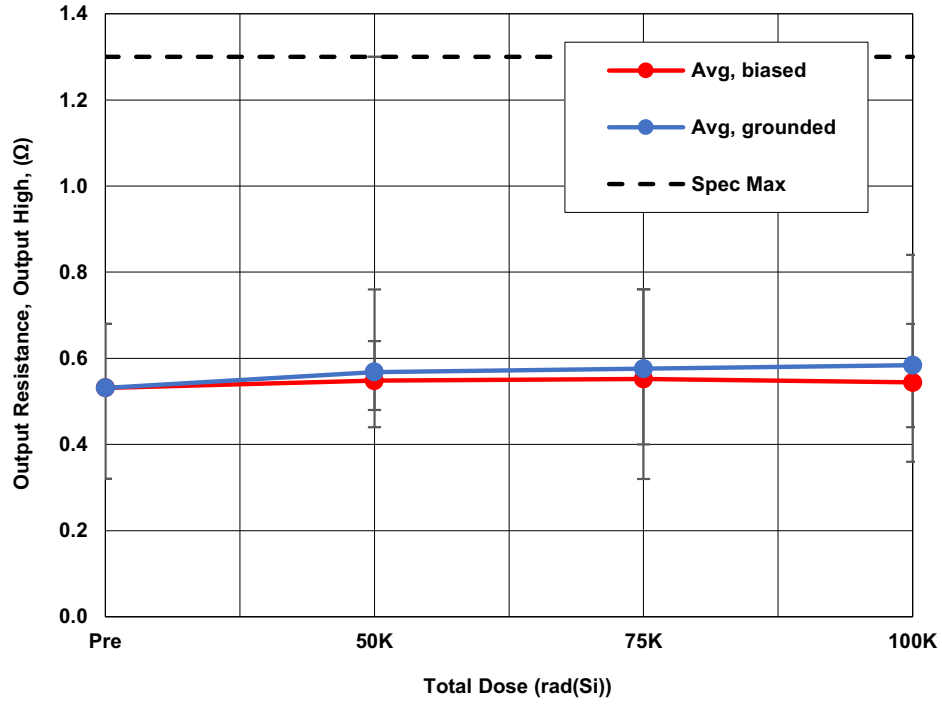

Figure 13. ISL74422ARH average output resistance, output high (R_{ONH}) with V_S = 18V, V_{IN} = 5V and I_{OUT} = 175mA to 225mA, as a function of LDR irradiation. The error bars represent the minimum and maximum measured values. The SMD limit is 1.3Ω maximum.

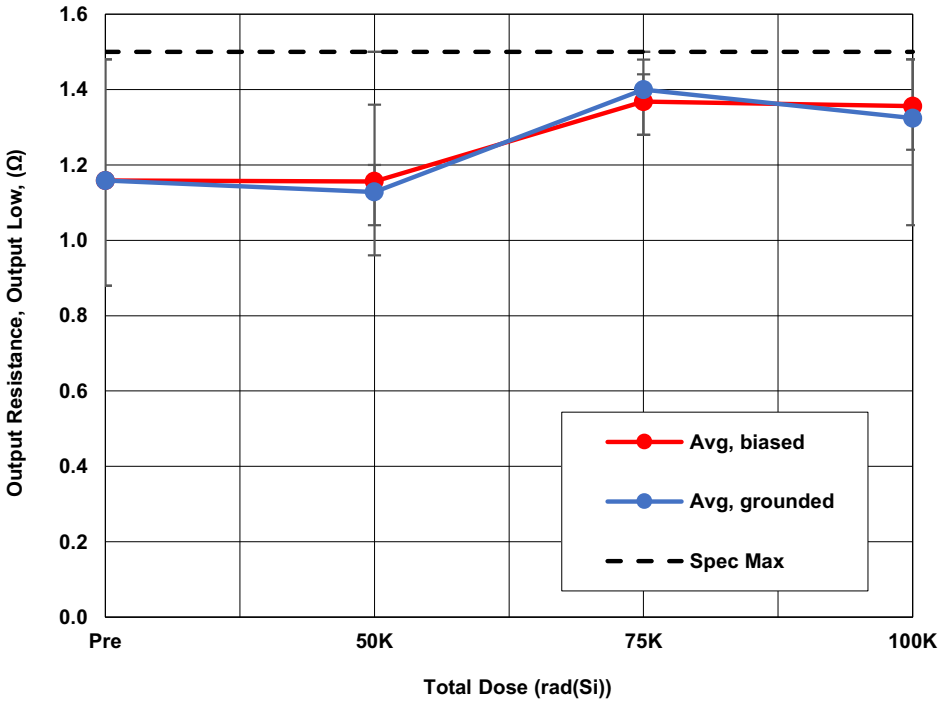

Figure 14. ISL74422ARH average output resistance, output low (R_{ONL}) with V_S = 18V, V_{IN} = 0.8V and I_{OUT} = 175mA to 225mA as a function of LDR irradiation. The error bars represent the minimum and maximum measured values. The SMD limit is 1.5Ω maximum.

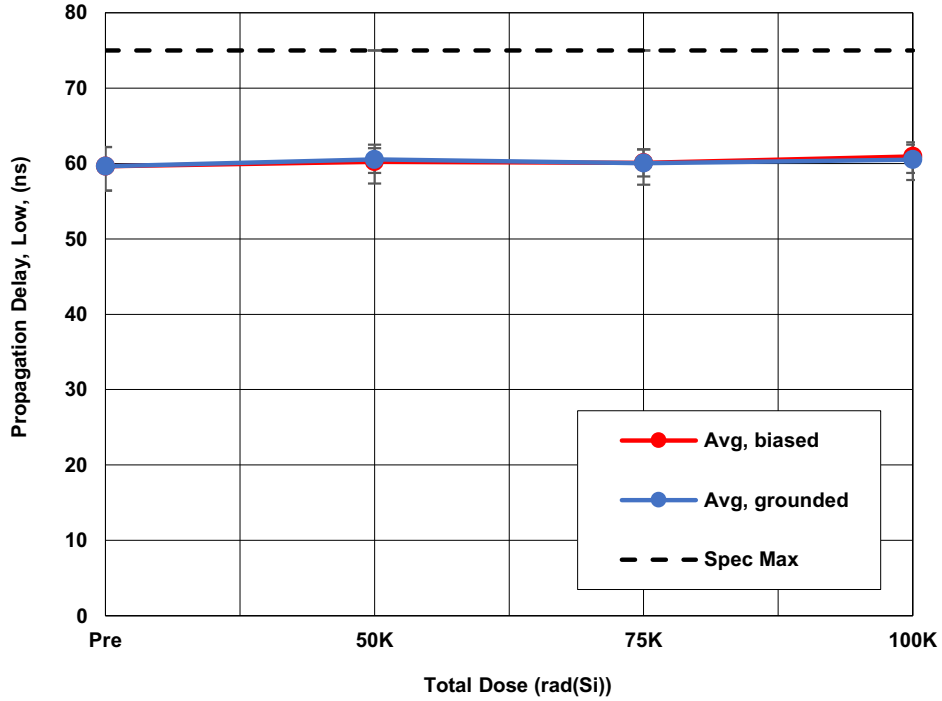

Figure 15. ISL74422ARH average propagation delay, low (t_{PHL}) with V_S = 18V, C_L = 10nF as a function of LDR irradiation. The error bars represent the minimum and maximum measured values. The SMD limit is 75ns maximum.

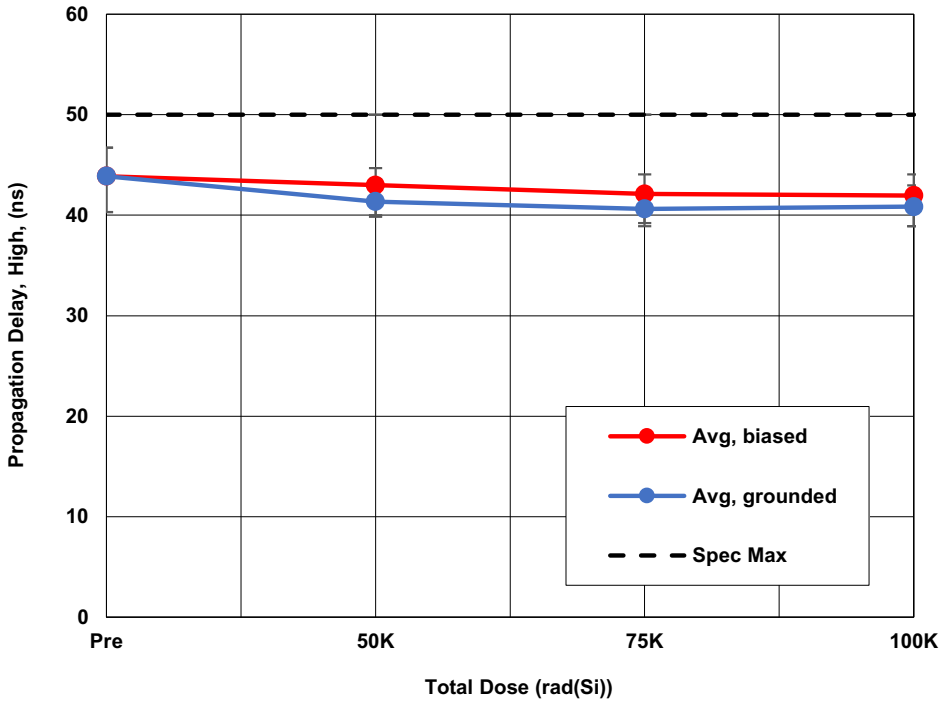

Figure 16. ISL74422ARH average propagation delay, high (t_{PLH}) with V_S = 18V, C_L = 10nF, as a function of LDR irradiation. The error bars represent the minimum and maximum measured values. The SMD limit is 50ns maximum.

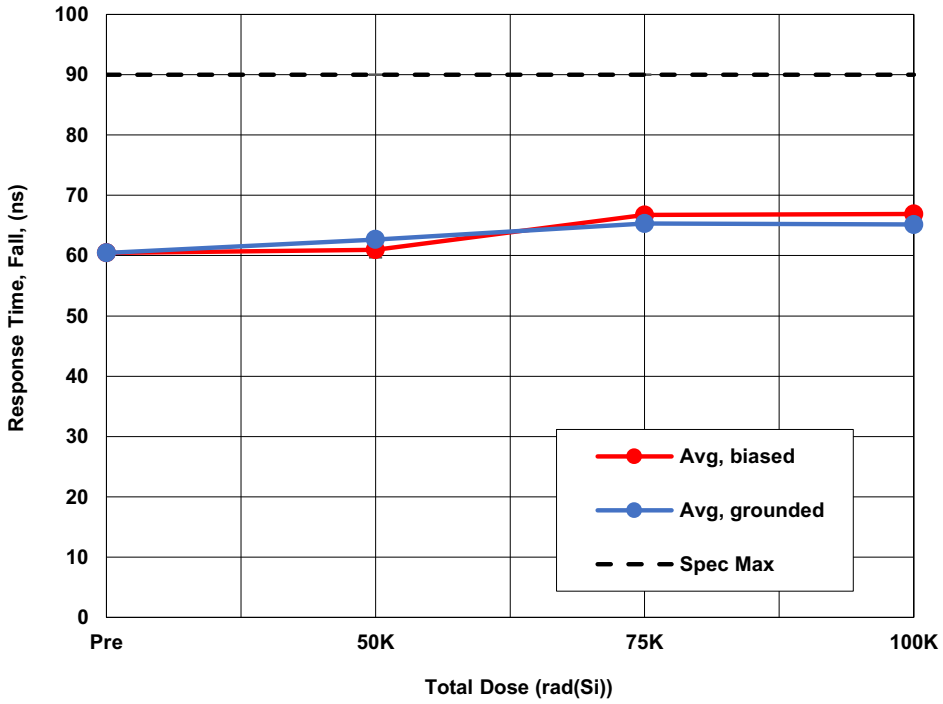

Figure 17. ISL74422ARH average response time, fall (T_F) with V_S = 18V, C_L = 10nF as a function of LDR irradiation. The error bars represent the minimum and maximum measured values. The SMD limit is 90ns maximum.

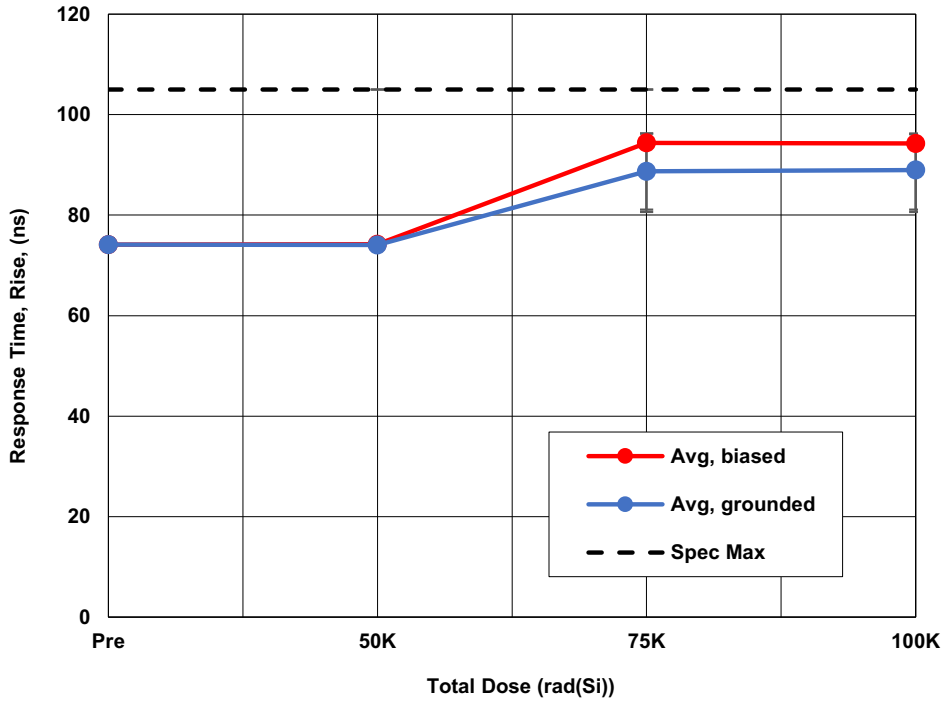

Figure 18. ISL74422ARH average response time, rise (T_R) with V_S = 18V, C_L = 10nF as a function of LDR irradiation. The error bars represent the minimum and maximum measured values. The SMD limit is 105ns maximum.

3. Discussion and Conclusion

We reported the results of a LDR total dose test of the ISL74422ARH radiation hardened 9A, non-inverting, high-speed MOSFET driver. The irradiation consisted of 10 biased and 10 grounded samples to 100krad(Si). All SMD parameters passed at all downpoints. No evidence of bias dependence was observed. It should be noted that this was only for characterization as the part is only specified for LDR performance to 50krad(Si) and an -EH version is not available or planned. The results of this test are therefore intended as customer guidance only.

4. Revision History

Revision	Date	Description
1.0	Apr 19, 2021	Initial release

Appendix A. Reported Parameters

Table 3 lists the key parameters that are considered indicative of part performance. These parameters are plotted in Figure 3 through Figure 18. All limits are taken from the ISL74422ARH SMD (5962-00521).

Table 3. ISL74422ARH Key Total Dose Parameters (T_A = 25°C)

Figure	Parameter	Symbol	Conditions	Low Limit	High Limit	Units
3	Power Supply Current, Low	IS_{SB} low	V_S = 18V, V_{IN} = 0.8V		100	µA
4	Power Supply Current, High	IS_{SB} high	V_S = 18V, V_{IN} = 10V		1	mA
5	Input Current, Low	I_{IL}	V_S = 18V, V_{IN} = -5V	-3	3	µA
6	Input Current, High	I_{IH}	V_S = 18V, V_{IN} = 18V	-3	3	µA
7	Voltage Output, Low	V_{OL}	V_S = 18V, I_{OUT} = 10mA		0.8	V
8	Voltage Output, High	V_{OH}	V_S = 18V, I_{OUT} = -10mA	17.0		V
9	Input Voltage, Low	V_{IL1}	V_S = 18V		0.8	V
10		V_{IL2}	V_S = 7V		0.8	V
11	Input Voltage, High	V_{IH1}	V_S = 18V	5.0		V
12		V_{IH2}	V_S = 7V	4.0		V
13	Output Resistance, Output High	R_{ONH}	V_S = 18V, V_{IN} = 5V, I_{OUT} = 175mA to 225mA		1.3	Ω
14	Output Resistance, Output Low	R_{ONL}	V_S = 18V, V_{IN} = 0.8V, I_{OUT} = 175mA to 225mA		1.5	Ω
15	Propagation Delay, Low	t_{PHL}	V_S = 18V, C_L = 10nF		75	ns
16	Propagation Delay, High	t_{PLH}	V_S = 18V, C_L = 10nF		50	ns
17	Response Time, Fall	T_F	V_S = 18V, C_L = 10nF		90	ns
18	Response Time, Rise	T_R	V_S = 18V, C_L = 10nF		105	ns

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