ISL74324M

Neutron Test Results of the ISL74324M Radiation Tolerant High-Gain Broadband RF Amplifier

Introduction

This report documents the results of 1MeV equivalent neutron testing of the ISL74324M, a High-Gain Broadband RF Amplifier. The testing was conducted on samples of the ISL7432MRZ to provide an assessment of the displacement damage (DD) hardness of the parts caused by neutron or proton environments but is applicable to all versions of this part. Neutron fluences ranged from $5{\times}10^{11}$n/cm^2 to $1{\times}10^{13}$n/cm^2.

Product Description

The ISL74324M is a 500MHz to 6500MHz SiGe BiCMOS High-Gain Broadband RF Amplifier. The combination of low noise figure (NF) and high linearity performance allows the device to be used in L-Band, S-Band, and C-Band receiver and transmitter applications.

The ISL74324M operates with a single 5V or 3.3V power supply using a nominal 60mA of current. With a supply voltage of 5V, the ISL74324M provides 16.6dB gain with +38.4dBm Output Third Order Intercept Point (OIP3) and 2.2dB noise figure at 4200MHz. The part is bias adjustable and can be operated as low as at 40mA for improved efficiency.

This ISL74324M incorporates convenient shutdown capability through the STBY pin. It is packaged in a 3×3mm, 16-pin thin QFN with 50Ω single-ended RF input and output impedances for ease of integration into the signal path. The package and pin assignments for the ISL74324M are shown in Figure 1 and the pin descriptions are shown in Table 1.

The ISL74324M30 is rated at 30krad(Si) and the ISL74324M50 is rated at 50krad(Si) at low dose rate (0.01 rad(Si)/s). The ISL7432MRZ is rated at 75krad(Si) LDR.

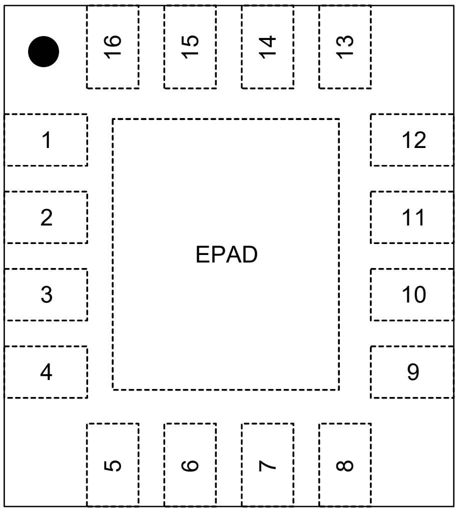

Figure 1. ISL74324M Pin Assignments

Table 1. ISL74324M Pin Descriptions

Pin Number	Pin Name	Description
1	VCC	Power supply. The bypass capacitor must be as close to the pin as possible.
2	RFIN	RF input internally matched to 50Ω. An external DC block is required.
3	NC	No Internal Bond Wire. Connect to GND.
4	RSET	Main amplifier current bias setting resistor. Connect to GND.

Table 1. ISL74324M Pin Descriptions (Cont.)

Pin Number	Pin Name	Description
5	NC	No Internal Bond Wire. Connect to GND.
6	NC	
7	NC	
8	NC	
9	RDSET	Distortion amplifier current bias setting resistor. Connect to GND.
10	STBY	Standby. If this pin is not connected or is logic LOW, the device operates under its normal operating condition. If this pin is logic HIGH, the ISL74324M is in STBY Mode.
11	RFOUT	RF output internally matched to 50Ω. An external DC block is required.
12	NC	Internally bonded. Connect to GND.
13	NC	No Internal Bond Wire. Connect to GND.
14	NC	
15	NC	
16	NC	
-	EPAD	Exposed pad. This pad is internally connected to GND. Solder this exposed pad to a printed circuit board (PCB) pad that uses multiple ground vias to provide heat transfer out of the device into the PCB ground planes. These multiple ground vias are also required to achieve the specified RF performance.

Related Literature

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

- ISL74324M device page
- MIL-STD-883 Test Method 1017

Contents

1. Test Description

1.1 Irradiation Facilities

Neutron fluence irradiations were performed on the test samples on May 27, 2025, 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. The parts were shipped back to Renesas (Palm Bay, FL) for post-irradiation electrical testing.

1.2 Test Fixturing

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

1.3 Dosimetry

Table 2 shows dosimetry from UMASS Lowell indicating the total accumulated gamma dose and actual neutron fluence exposure levels for each set of samples.

Table 2. Neutron Fluence Dosimetry Data

Irradiation	Requested Fluence (n/cm^2)	Reactor Power (kW)	Time (s)	Flux (n/cm^2-s)[1][2]	Gamma Dose (rad(Si))[3]	Measured Fluence (n/cm^2)[4]
CRF#98191-C	5.00E+11	40	262	3.06E+09	119	6.12E+11
CRF#98191-D	2.00E+12	80	531	6.12E+09	484	2.38E+12
CRF#98191-E	1.00E+13	800	266	6.12E+10	2424	1.19E+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. Reaffirmed 8/1/17 using SACRR transistor transfer calibration based on ASTM E1855 – 15.
3. Based on reactor power at 1000kW, the gamma dose is 41 ±5.3% krad(Si)/hr as mapped by TLD-based dosimetry.
4. Validated by S-32 flux monitors.

1.4 Characterization Equipment and Procedures

Electrical testing was performed before and after irradiation using the Renesas 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 5×10^{11}n/cm^2, five irradiated at 2×10^{12}n/cm^2, and five irradiated at 1×10^{13}n/cm^2. The actual levels achieved (shown in Table 3) were 6.12×10^{11}n/cm^2, 2.38×10^{12}n/cm^2, and 1.19×10^{13}n/cm^2. Three control units were used. The ISL74324M samples were pulled from wafer lot 3A9AB00B33A.

2. Test Results

Neutron testing of the ISL74324M 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 separate set of samples; this is not total dose testing, where the damage is cumulative. Each marker represents a separate set of five samples. The line connecting them is for trend visualization only.

2.1 Attributes Data

Table 3 shows the ISL74324M attributes data.

Table 3. Attributes Data

1MeV Fluence, (n/cm^2)		Sample Size	Pass[1]	Fail	Notes
Planned	Actual				
5×10^{11}	6.12E+11	5	5	0	All passed
2×10^{12}	2.38E+12	5	5	0	All passed
1×10^{13}	1.19E+13	5	5	0	All passed

1. A Pass indicates a sample that passes all post-irradiation datasheet limits.

2.2 Key Parameter Variables Data

The plots in Figure 2 through Figure 18 illustrate the neutron irradiation response of the selected parameters shown in Table 4 in the Appendix. The plots show the average tested values of the parameters as a function of neutron fluence. 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.

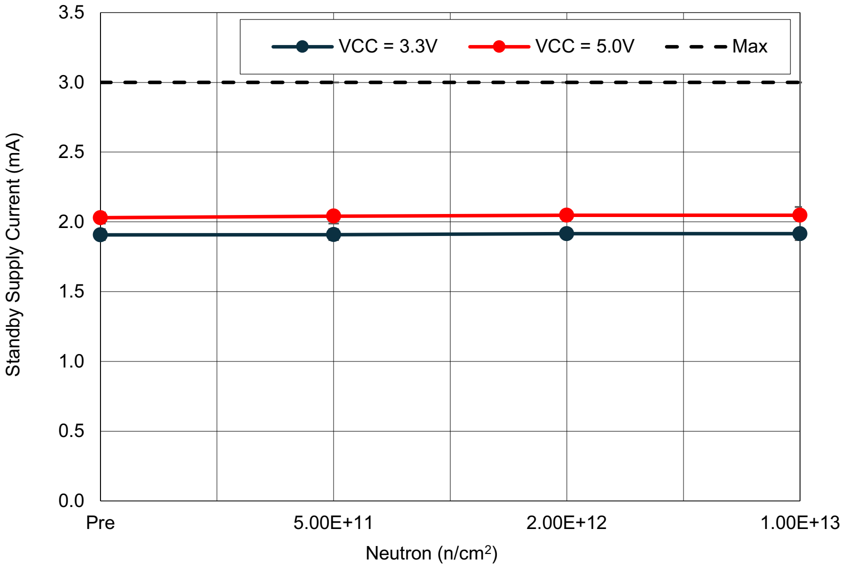

Figure 2. Standby supply current (I_{CC_STBY}) at V_{CC} = 3.3V and 5.0V as a function of neutron fluence. The error bars represent the minimum and maximum measured values. The post-irradiation datasheet limit is 3mA maximum.

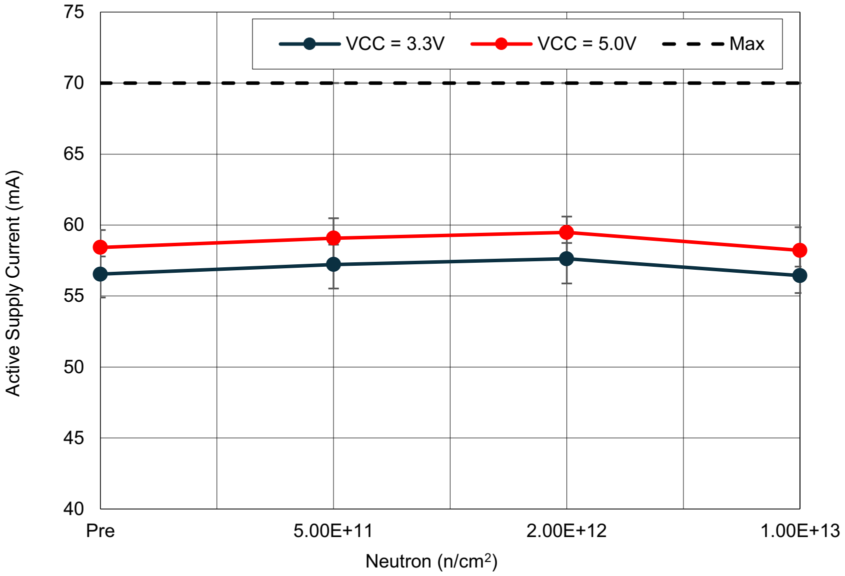

Figure 3. Active supply current (I_{CC}) for the high bias setting at V_{CC} = 3.3V and 5.0V as a function of neutron fluence. The error bars represent the minimum and maximum measured values. The post-irradiation datasheet limit is 70mA maximum.

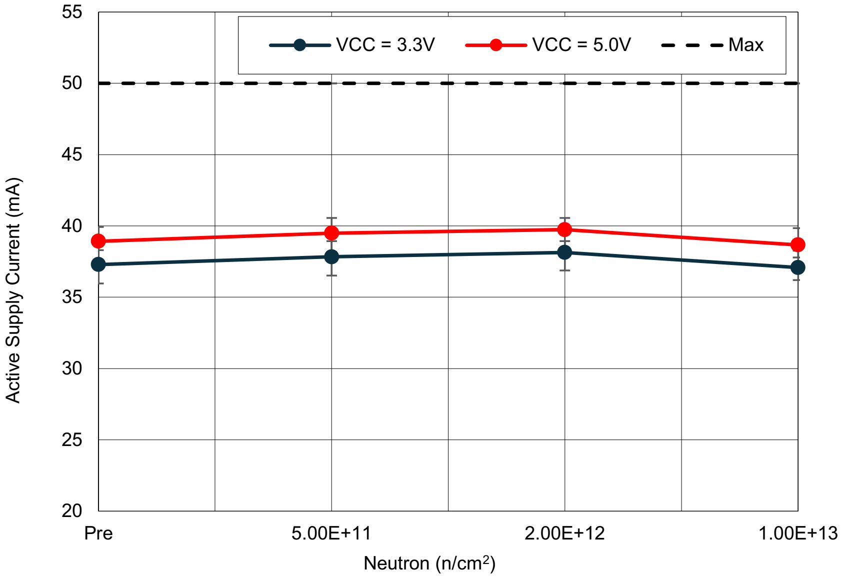

Figure 4. Active supply current (I_{CC}) for the low bias setting at V_{CC} = 3.3V and 5.0V as a function of neutron fluence. The error bars represent the minimum and maximum measured values. The post-irradiation datasheet limit is 50mA maximum.

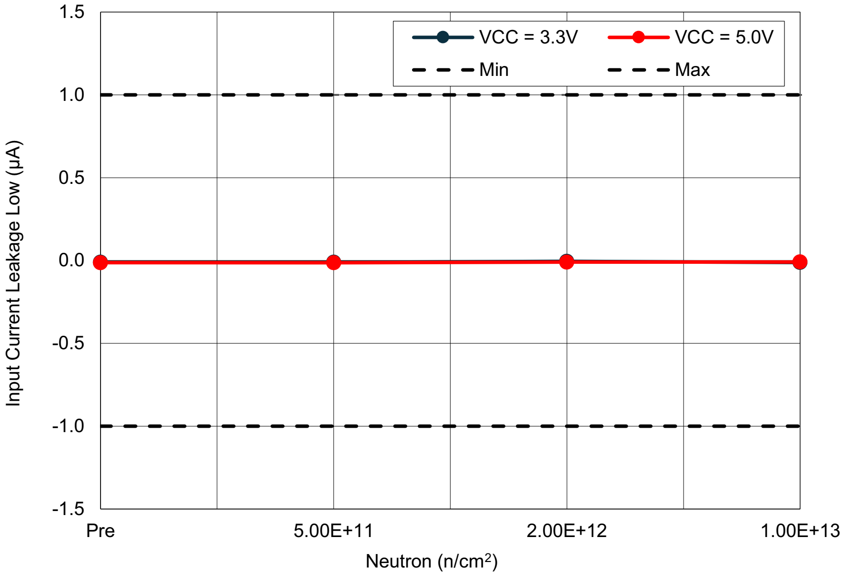

Figure 5. Input leakage current low (I_{IL}) at V_{CC} = 3.3V and 5.0V as a function of neutron fluence. The error bars represent the minimum and maximum measured values. The post-irradiation datasheet limits are -1.0µA minimum and 1.0µA maximum.

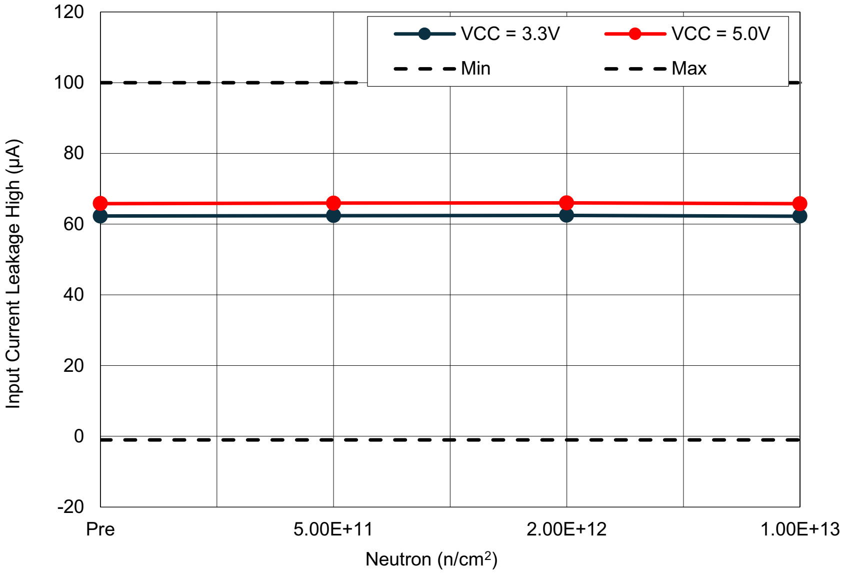

Figure 6. Input leakage current high (I_{IH}) at V_{CC} = 3.3V and 5.0V as a function of neutron fluence. The error bars represent the minimum and maximum measured values. The post-irradiation datasheet limits are -1µA minimum and 100µA maximum. *Note*: This measurement is done through a pulldown resistor, which is why the measurements are high compared to I_{IL}.

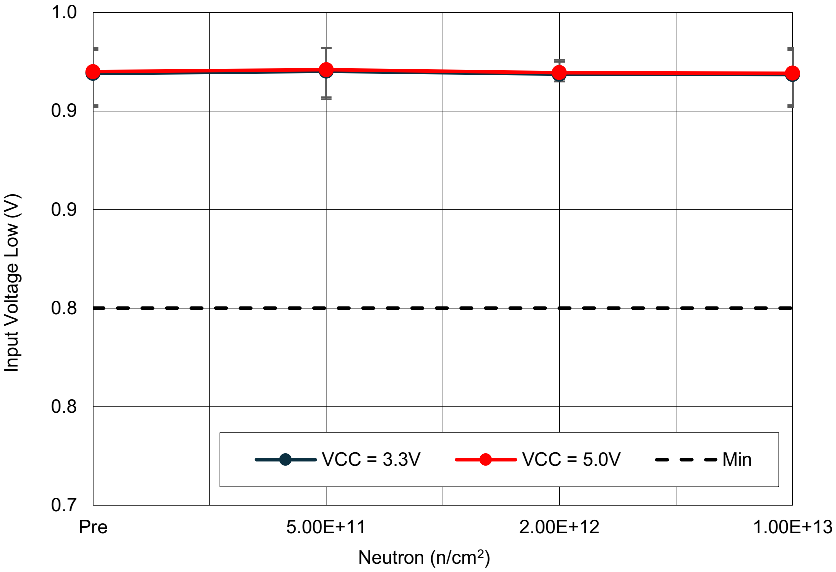

Figure 7. Logic input voltage low (V_{IL}) at V_{CC} = 3.3V and 5.0V as a function of neutron fluence. The error bars represent the minimum and maximum measured values. The post-irradiation datasheet limit is 0.8V minimum.

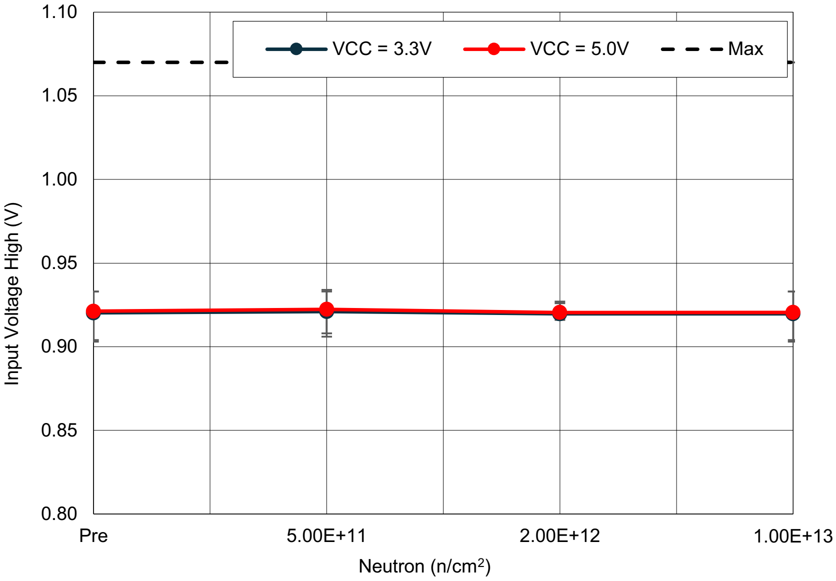

Figure 8. Logic input voltage high (V_{IH}) at V_{CC} = 3.3V and 5.0V as a function of neutron fluence. The error bars represent the minimum and maximum measured values. The post-irradiation datasheet limit is 1.07V maximum.

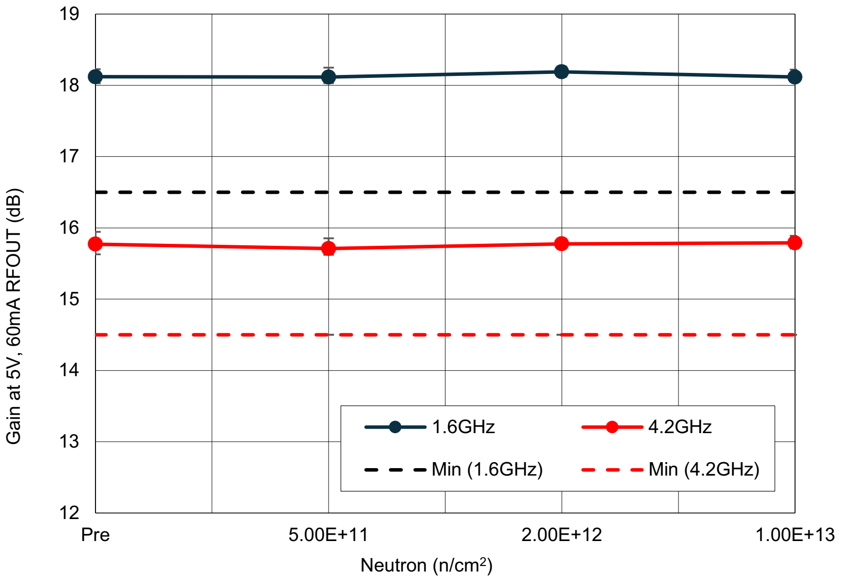

Figure 9. Gain (G) at V_{CC} = 5.0V, I_{CC} = 60mA, with F_{RF} = 1.6GHz and 4.2GHz as a function of neutron fluence. The error bars represent the minimum and maximum measured values. The post-irradiation datasheet limits are 16.5dB minimum at 1.6GHZ and 14.5dB minimum at 4.2GHz.

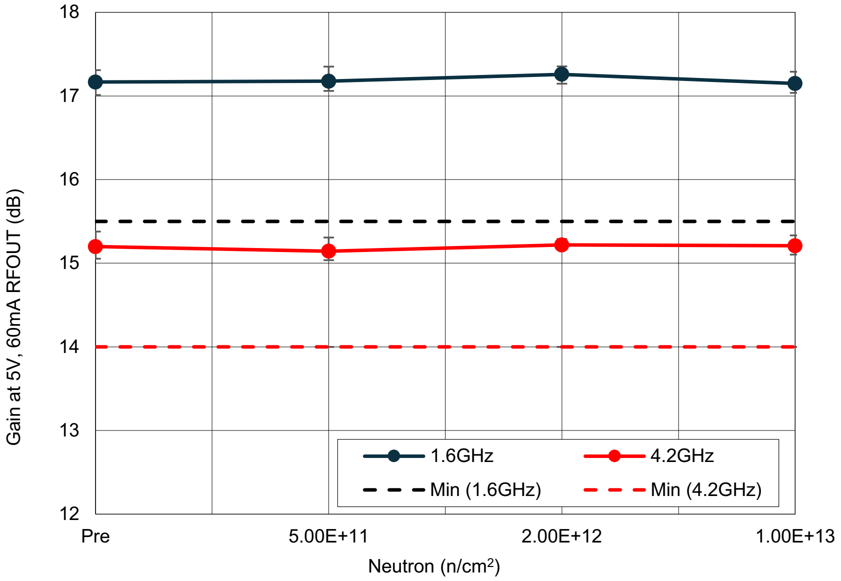

Figure 10. Gain (G) at V_{CC} = 5.0V, I_{CC} = 40mA, with F_{RF} = 1.6GHz and 4.2GHz as a function of neutron fluence. The error bars represent the minimum and maximum measured values. The post-irradiation datasheet limits are 15.5dB minimum at 1.6GHZ and 14dB minimum at 4.2GHz.

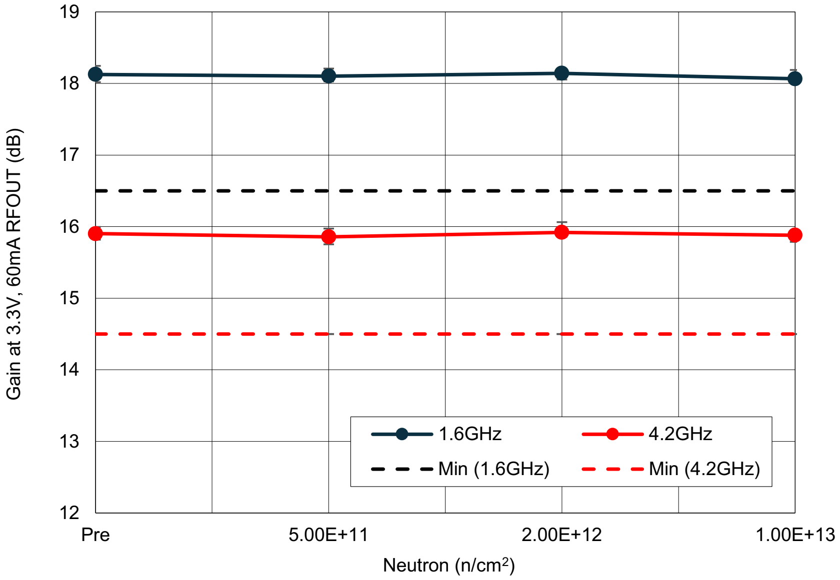

Figure 11. Gain (G) at V_{CC} = 3.3V, I_{CC} = 60mA, with F_{RF} = 1.6GHz and 4.2GHz as a function of neutron fluence. The error bars represent the minimum and maximum measured values. The post-irradiation datasheet limits are 16.5dB minimum at 1.6GHZ and 14.5dB minimum at 4.2GHz.

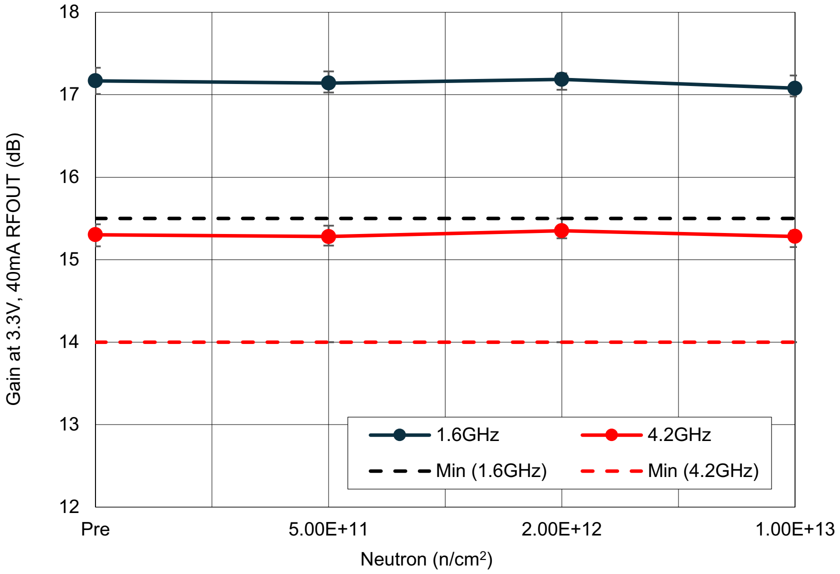

Figure 12. Gain (G) at V_{CC} = 3.3V, I_{CC} = 40mA, with F_{RF} = 1.6GHz and 4.2GHz as a function of neutron fluence. The error bars represent the minimum and maximum measured values. The post-irradiation datasheet limits are 15.5dB minimum at 1.6GHZ and 14dB minimum at 4.2GHz.

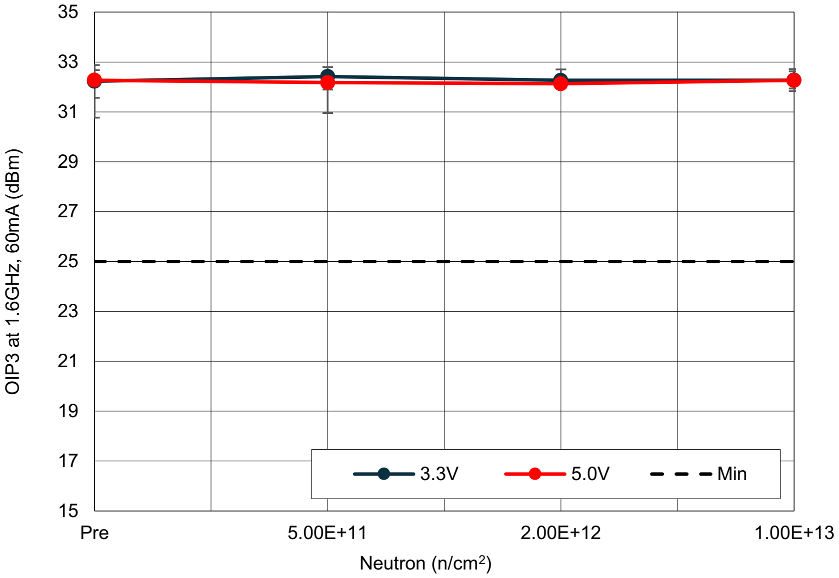

Figure 13. Output Third-Order Intercept Point (OIP3) at V_{CC} = 3.3V and 5.0V, with I_{CC} = 60mA and F_{RF} = 1.6GHz, as a function of neutron fluence. The error bars represent the minimum and maximum measured values. The post-irradiation datasheet limit is 25dBm minimum.

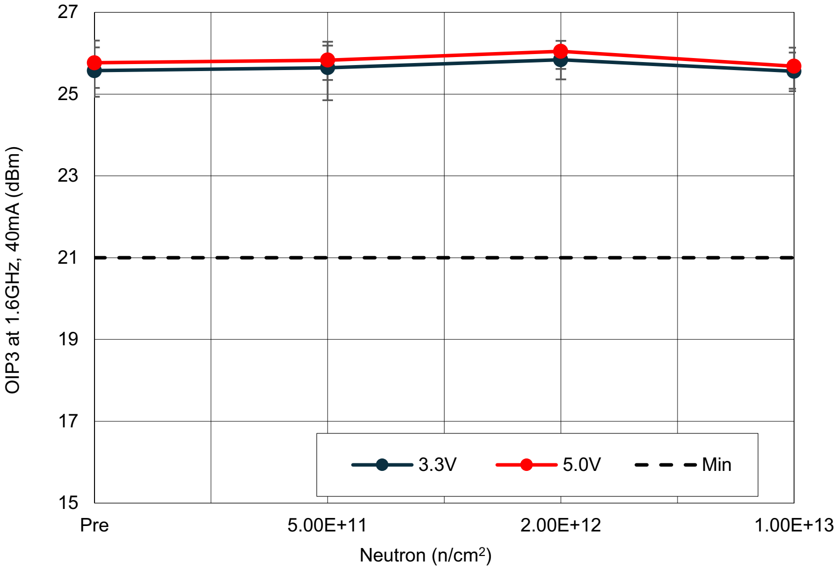

Figure 14. Output Third-Order Intercept Point (OIP3) at V_{CC} = 3.3V and 5.0V, with I_{CC} = 40mA and F_{RF} = 1.6GHz, as a function of neutron fluence. The error bars represent the minimum and maximum measured values. The post-irradiation datasheet limit is 21dBm minimum.

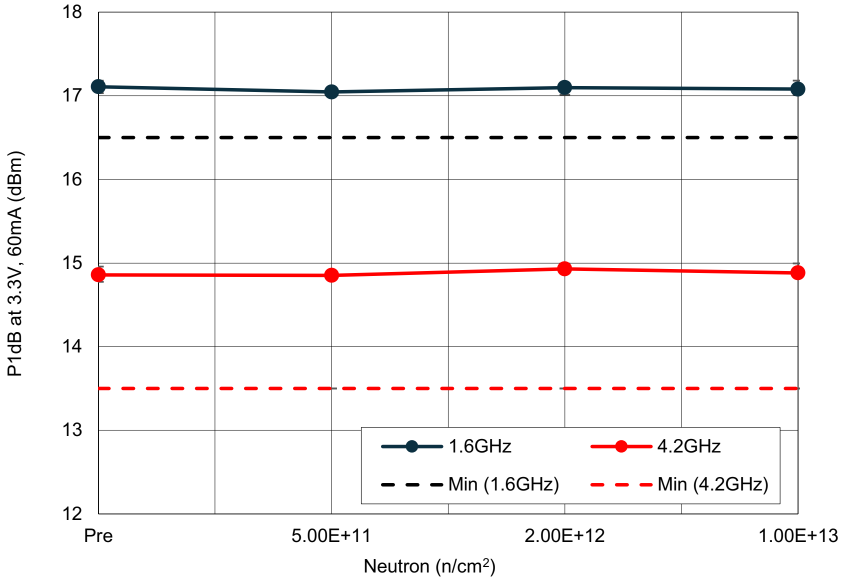

Figure 15. Output P1dB Compression (OP_{1dB}) at V_{CC} = 3.3V, I_{CC} = 60mA, with F_{RF} = 1.6GHz and 4.2GHz, as a function of neutron fluence. The error bars represent the minimum and maximum measured values. The post-irradiation datasheet limits are 16.5dBm minimum at 1.6GHZ and 13.5dBm minimum at 4.2GHz.

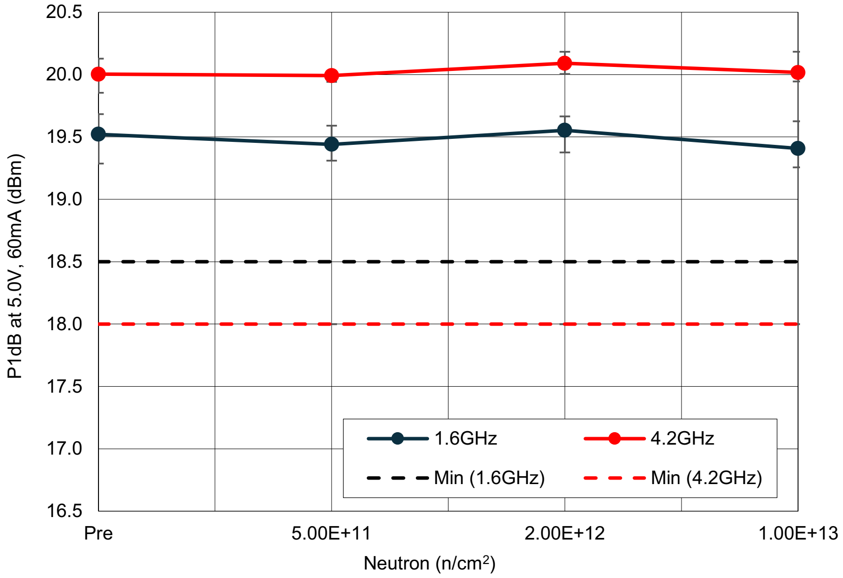

Figure 16. Output P1dB Compression (OP_{1dB}) at V_{CC} = 5.0V, I_{CC} = 60mA, with F_{RF} = 1.6GHz and 4.2GHz, as a function of neutron fluence. The error bars represent the minimum and maximum measured values. The post-irradiation datasheet limits are 18.5dBm minimum at 1.6GHZ and 18.0dBm minimum at 4.2GHz.

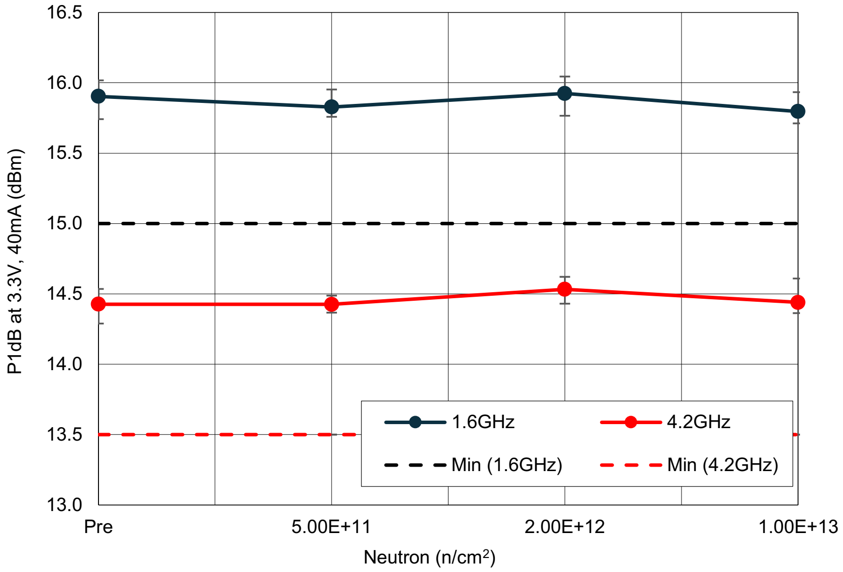

Figure 17. Output P1dB Compression (OP_{1dB}) at V_{CC} = 3.3V, I_{CC} = 40mA, with F_{RF} = 1.6GHz and 4.2GHz, as a function of neutron fluence. The error bars represent the minimum and maximum measured values. The post-irradiation datasheet limits are 15.0dBm minimum at 1.6GHZ and 13.5dBm minimum at 4.2GHz.

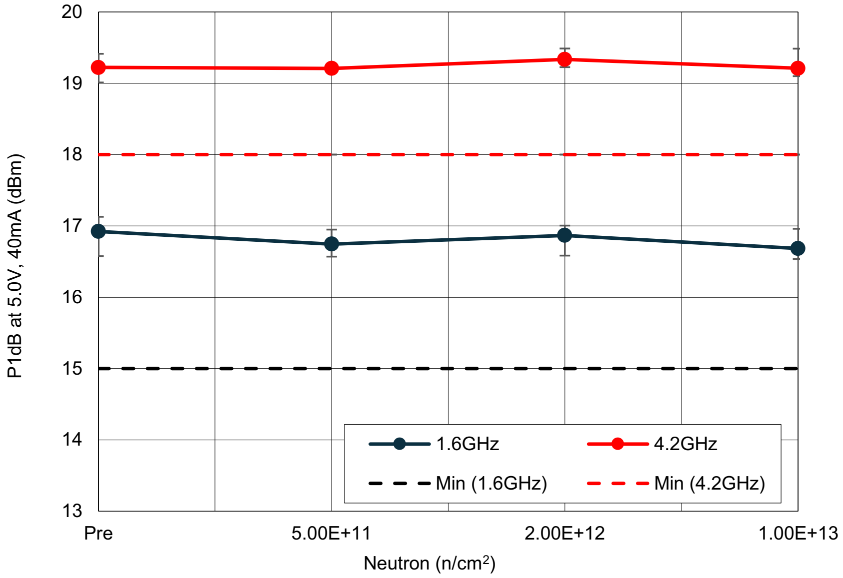

Figure 18. Output P1dB Compression (OP_{1dB}) at V_{CC} = 5.0V, I_{CC} = 40mA, with F_{RF} = 1.6GHz and 4.2GHz, as a function of neutron fluence. The error bars represent the minimum and maximum measured values. The post-irradiation datasheet limits are 15dBm minimum at 1.6GHZ and 18dBm minimum at 4.2GHz.

3. Discussion and Conclusion

The results of 1MeV equivalent neutron testing of the ISL74324M, a High-Gain Broadband RF Amplifier are reported. Parts were tested at actual fluences of 6.12×10^{11}n/cm^2, 2.38×10^{12}n/cm^2 and 1.19×10^{13}n/cm^2. The results of key parameters before and after irradiation to each level are plotted in Figure 2 through Figure 18.

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. Each marker represents a separate set of five samples. The line connecting them is for trend visualization only. The figures also show the applicable electrical limits taken from the datasheet.

All tested datasheet parameters passed at all down-points up to and including 1.19×10^{13}n/cm^2. These results are applicable to all versions of this part.

4. Revision History

Revision	Date	Description
1.00	Nov 7, 2025	Initial release.

A. Reported Parameters

Table 4 below lists the datasheet parameters that are considered indicative of part performance. These parameters are plotted in Figure 2 through Figure 18. All limits are taken from the ISL74324M datasheet, which may also have more details on test conditions.

Table 4. Datasheet Total Dose Parameters (T_A = 25°C)

Fig.	Parameter	Symbol	Conditions	Low Limit	High Limit	Unit
2	Standby Supply Current	I_{DDO}	V_{CC} = 3.3V and 5.0V	-	3	mA
3	Active Supply Current	I_{CC}	High Bias Setting	-	70	mA
4			Low Bias Setting	-	50	µA
5	Logic Current Low	I_{IL}	Applied STBY voltage = 3.6V	-1	1	µA
6	Logic Current High	I_{IH}	-	-1	100	µA
7	Logic Input Low Threshold	V_{IL}	V_{CC} = 3.3V and 5.0V	0.8	-	V
8	Logic Input High Threshold	V_{IH}	V_{CC} = 3.3V and 5.0V	-	1.07	V
9	Gain	G	V_{CC} = 5.0V, I_{CC} = 60mA, F_{RF} = 1.6GHz	16.5	-	dB
			V_{CC} = 5.0V, I_{CC} = 60mA, F_{RF} = 4.2GHz	14.5	-	dB
10			V_{CC} = 5.0V, I_{CC} = 40mA, F_{RF} = 1.6GHz	15.5	-	dB
			V_{CC} = 5.0V, I_{CC} = 40mA, F_{RF} = 4.2GHz	14	-	dB
11			V_{CC} = 3.3V, I_{CC} = 60mA, F_{RF} = 1.6GHz	16.5	-	dB
			V_{CC} = 3.3V, I_{CC} = 60mA, F_{RF} = 4.2GHz	14.5	-	dB
12			V_{CC} = 3.3V, I_{CC} = 40mA, F_{RF} = 1.6GHz	15.5	-	dB
			V_{CC} = 3.3V, I_{CC} = 40mA, F_{RF} = 4.2GHz	14	-	dB
13	Third Order Intercept Point	OIP3	V_{CC} = 3.3V and 5.0V, I_{CC} = 60mA, F_{RF} = 1.6GHz	25	-	dBm
14			V_{CC} = 3.3V, and 5.0V, I_{CC} = 40mA, F_{RF} = 1.6GHz	21	-	dBm
15	1 dB Compression Point	OP_{1dB}	V_{CC} = 3.3V, I_{CC} = 60mA, F_{RF} = 1.6GHz	16.5	-	dBm
			V_{CC} = 3.3V, I_{CC} = 60mA, F_{RF} = 4.2GHz	13.5	-	dBm
16			V_{CC} = 5.0V, I_{CC} = 60mA, F_{RF} = 1.6GHz	18.5	-	dBm
			V_{CC} = 5.0V, I_{CC} = 60mA, F_{RF} = 4.2GHz	18	-	dBm
17			V_{CC} = 3.3V, I_{CC} = 40mA, F_{RF} = 1.6GHz	15	-	dBm
			V_{CC} = 3.3V, I_{CC} = 40mA, F_{RF} = 4.2GHz	13.5	-	dBm
18			V_{CC} = 5.0V, I_{CC} = 40mA, F_{RF} = 1.6GHz	15	-	dBm
			V_{CC} = 5.0V, I_{CC} = 40mA, F_{RF} = 4.2GHz	18	-	dBm

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