ISL75051SEH

1MeV Equivalent Neutron Testing of the ISL75051SEH Low Dropout Regulator

Introduction

This report summarizes results of 1MeV equivalent neutron testing of the ISL75051SEH Low Dropout (LDO) voltage linear regulator. 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 $2x10^{12}n/cm^2$ to $1x10^{14}n/cm^2$. This project was carried out in collaboration with Boeing (El Segundo, CA), whose support is gratefully acknowledged. This report is also applicable to the other variants (ISL75051SRH, ISL75051ASEH, ISL73051ASEH).

Related Literature

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

- ISL75051SEH, ISL75051SRH, ISL75051ASEH, ISL73051ASEH device pages

Part Description

The ISL75051SEH is a radiation hardened, low-voltage, high-current, single-output LDO specified for up to 3.0A of continuous output current. The part operates over an input voltage range of 2.2V to 6.0V and is capable of providing output voltages of 0.8V to 5.0V set by an external resistor network. Dropout voltages as low as 65mV can be realized.

The Overcurrent Protection (OCP) pin allows the short-circuit output current limit threshold to be programmed by means of a resistor from the OCP pin to GND. The OCP setting range is from 0.5A minimum to 8.5A maximum. The resistor sets the constant current threshold for the output under fault conditions. The thermal shutdown disables the output if the device temperature exceeds the specified value, and the part subsequently enters an ON/OFF ‘hiccup’ cycle until the fault is removed. The ENABLE feature allows the part to be placed into a low-current Shutdown mode that typically draws about 1µA. When enabled, the device operates with a typical ground current of 11mA, which provides low-quiescent power operation.

The device is optimized for fast transient response and single-event effects. This reduces the magnitude of Single-Event Transients (SET) seen on the output. Additional protection diodes and filters are not needed. The device is stable with tantalum capacitors as low as 47µF and provides excellent regulation all the way from no load to full load. Programmable soft-start allows the user to program the inrush current by means of the decoupling capacitor value used on the Bypass (BYP) pin.

The ISL75051SEH is implemented in the Renesas 0.6µm, P6 BiCMOS power management process, which is in volume production under MIL-PRF-38535 certification and is used for a range of commercial power management devices. Table 1 shows a pin assignment table for the part.

Table 1. Pin Assignments

Terminal Number	Terminal Symbol	Terminal Number	Terminal Symbol
1	GND	10	EN
2	VOUT	11	OCP
3	VOUT	12	VIN
4	VOUT	13	VIN
5	VOUT	14	VIN
6	VOUT	15	V_{IN}
7	VOUT	16	VIN
8	ADJ	17	VIN
9	BYP	18	PGOOD

The ISL75051SEH is specified in the SMD for a total dose (TID) tolerance of 100krad(Si) at high (50-300rad(Si)/s) dose rate and at 50krad(Si) at low (<0.01rad(Si)/s) dose rate, as specified in MIL-STD-883 test method 1019. The part is acceptance tested on a wafer-by-wafer basis at low dose rate to 50krad(Si) and at high dose rate to 100krad(Si).

The ISL75051SEH is also Single-Event Effects (SEE) tolerant to a Linear Energy Transfer (LET) value of 86.4MeV.cm^2/mg. Single-Event Transients (SET) have evolved into a major issue in power management parts driving voltage-sensitive loads, and the part provides superior performance in this environment.

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.

Contents

1. Test Description

1.1 Irradiation Facilities

1MeV equivalent neutron irradiation was performed by the Boeing team at the Survivability and Vulnerability Assessment Directorate, US Army, White Sands Missile Range fast burst reactor (White Sands Missile Range, NM 88002). Dosimetry data can be furnished upon request. Parts were tested in an unbiased configuration with all leads shorted together in general accordance with TM 1017 of MIL-STD-883. Samples exposed at the higher neutron levels required considerable “cooldown” time before being shipped back to Renesas for electrical testing.

1.2 Test Fixturing

No formal irradiation test fixturing was involved, as these DD tests are “bag tests” in the sense that the parts are irradiated in an electrically inactive state with all leads shorted together.

1.3 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.

1.4 Experimental Matrix

Testing proceeded in general accordance with the guidelines of MIL-STD-883 Test Method 1017. The experimental matrix consisted of 5 samples irradiated at $2x10^{12}n/cm^2$, 5 irradiated at $1x10^{13}n/cm^2$, 5 irradiated at $3x10^{13}n/cm^2$, and 5 irradiated at $1x10^{14}n/cm^2$. Five control units were used.

ISL75051SEHF/PROTO samples were drawn from fabrication lot WXW7CE. Samples were packaged in the standard hermetic 18 Ld ceramic flatpack production package and were screened to the SMD limits over temperature before the start of neutron testing.

2. Results

Neutron testing of the ISL75051SEH is complete and the results are reported in the balance of this report. It should be carefully realized when interpreting the data that each neutron irradiation was performed on a different five-unit sample; this is *not* total dose testing, where the damage is cumulative over a number of downpoints.

2.1 Attributes Data

Table 2. ISL75051SEH Attributes Data

Part	Serial	Sample Size	FLUENCE, n/cm^2	Pass[1]	Fail	Notes
ISL75051SEH	1-5	5	$2x10^{12}$	5	0	All passed
ISL75051SEH	6-10	5	$1x10^{13}$	5	0	All passed
ISL75051SEH	11-15	5	$3x10^{13}$	5	0	All passed
ISL75051SEH	16-20	5	$1x10^{14}$	0	5	All failed parametrically: adjust pin voltage at 0.52V, 1.5V, 1.8V, and 5.0V out and output voltage at 5V out and 6V in.

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

2.2 Variables Data

The plots in Figure 1 through Figure 19 show data plots for key parameters before and after irradiation to each level. The reported parameters and their SMD, datasheet, or ATE limits are shown in the Appendix. The plots show the population median of each parameter as a function of neutron irradiation as well as the population minimum and maximum. The median was plotted because of the small sample sizes (five per cell) involved. The applicable electrical limits taken from the SMD are also shown.

2.3 Variables Data Plots

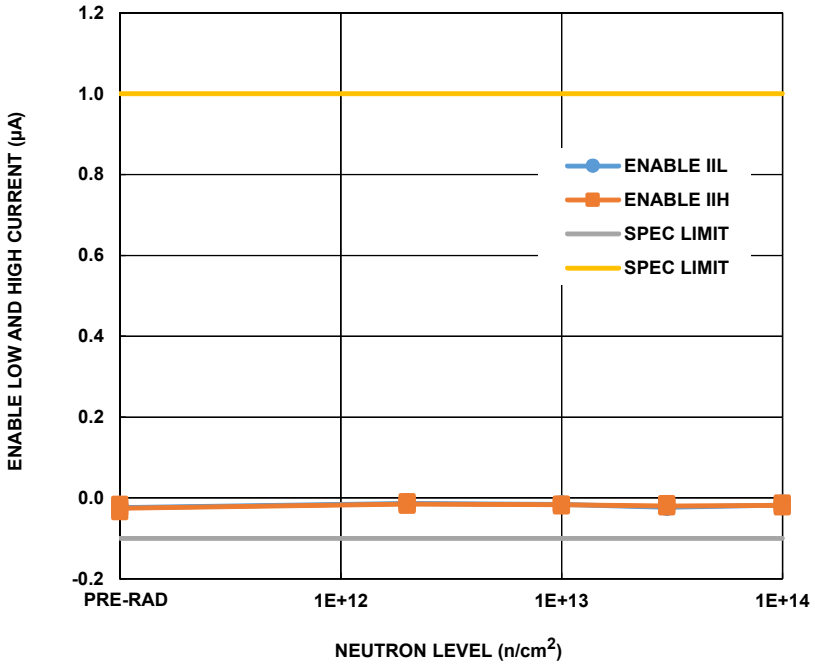

Figure 1. ISL75051SEH enable LOW and enable HIGH current as a function of 1MeV equivalent neutron irradiation at $2x10^{12}n/cm^2$, $1x10^{13}n/cm^2$, $3x10^{13}n/cm^2$, and $1x10^{14}n/cm^2$. The plot shows the population median, minimum, and maximum at each downpoint. Sample size for each cell was five. The enable HIGH SMD limit is 1.0µA maximum; the enable LOW current is not specified. The -0.1µA bound is an ATE limit.

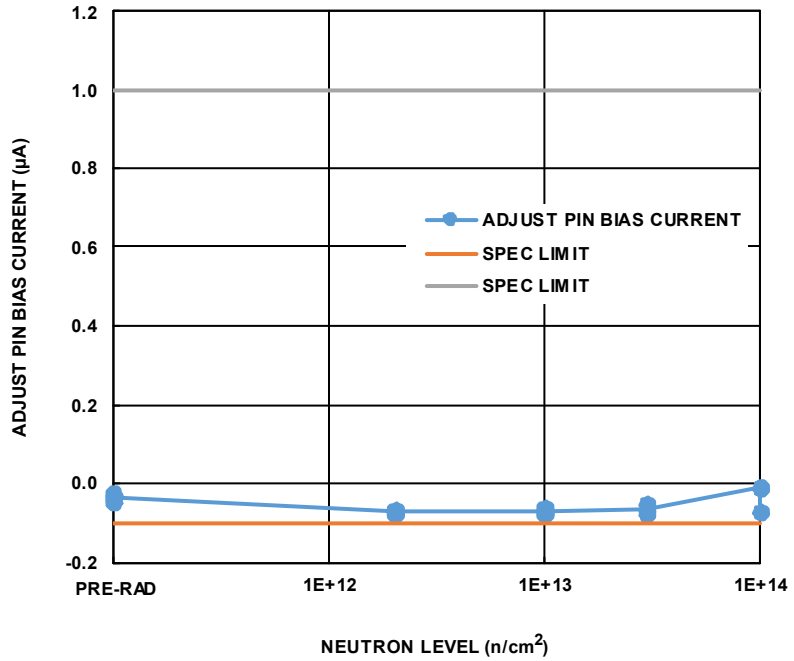

Figure 2. ISL75051SEH adjust ('feedback') pin bias current as a function of 1MeV equivalent neutron irradiation at $2x10^{12}n/cm^2$, $1x10^{13}n/cm^2$, $3x10^{13}n/cm^2$, and $1x10^{14}n/cm^2$. The plot shows the population median, minimum, and maximum at each downpoint. Sample size for each cell was five. The SMD limit is 1.0µA maximum; the -0.1µA bound is an ATE limit.

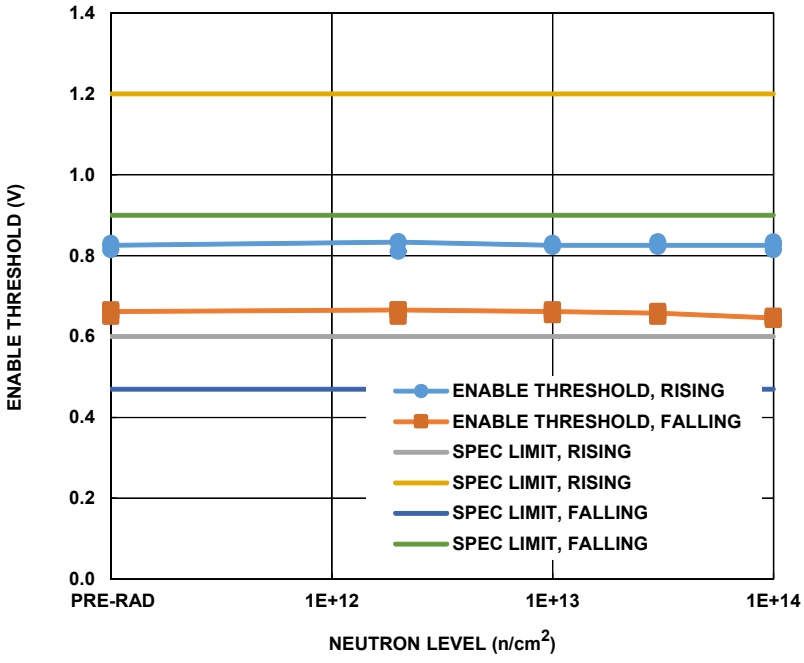

Figure 3. ISL75051SEH rising and falling enable threshold as a function of 1MeV equivalent neutron irradiation at $2x10^{12}n/cm^2$, $1x10^{13}n/cm^2$, $3x10^{13}n/cm^2$, and $1x10^{14}n/cm^2$. The plot shows the population median, minimum, and maximum at each downpoint. Sample size for each cell was five. The SMD limits are 0.6V to 1.2V (rising) and 0.47V to 0.9V (falling).

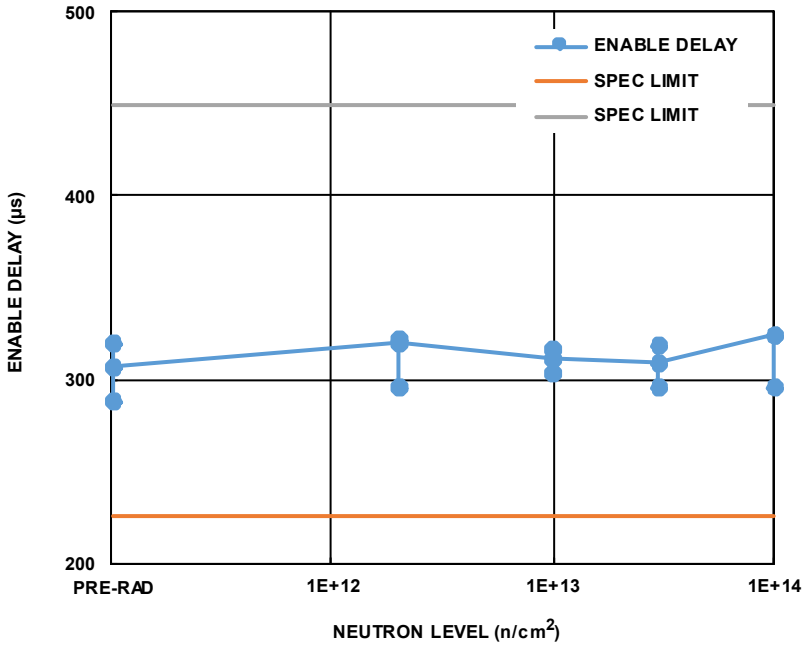

Figure 4. ISL75051SEH enable delay at 2.2V input voltage as a function of 1MeV equivalent neutron irradiation at $2x10^{12}n/cm^2$, $1x10^{13}n/cm^2$, $3x10^{13}n/cm^2$, and $1x10^{14}n/cm^2$. The plot shows the population median, minimum, and maximum at each downpoint. Sample size for each cell was five. The SMD limits are 225µs to 450µs.

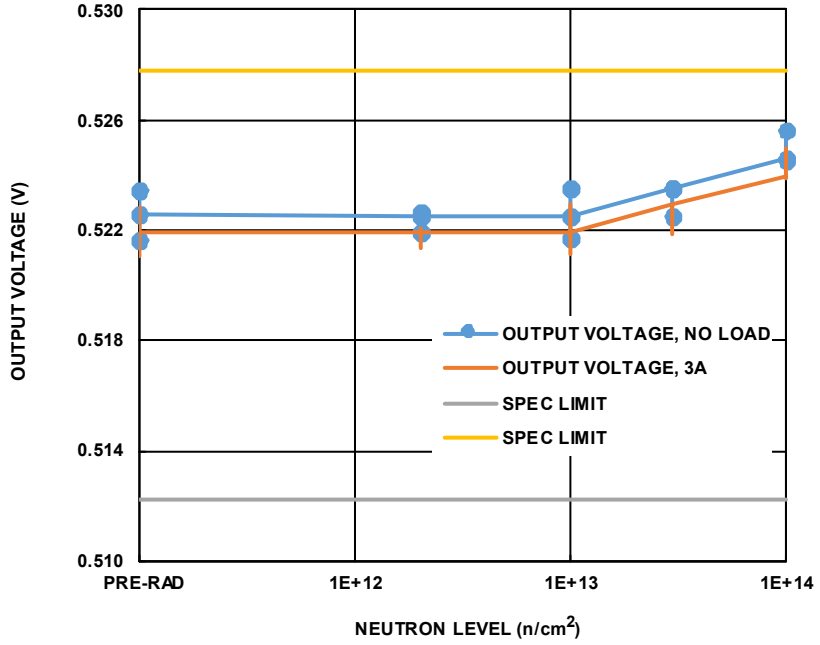

Figure 5. ISL75051SEH output voltage, 2.2V in and 0.52V out, no load and 3A load, as a function of 1MeV equivalent neutron irradiation at $2x10^{12}n/cm^2$, $1x10^{13}n/cm^2$, $3x10^{13}n/cm^2$, and $1x10^{14}n/cm^2$. The plot shows the population median, minimum, and maximum at each downpoint. Sample size for each cell was five. The SMD limits are 0.52V ±1.5%.

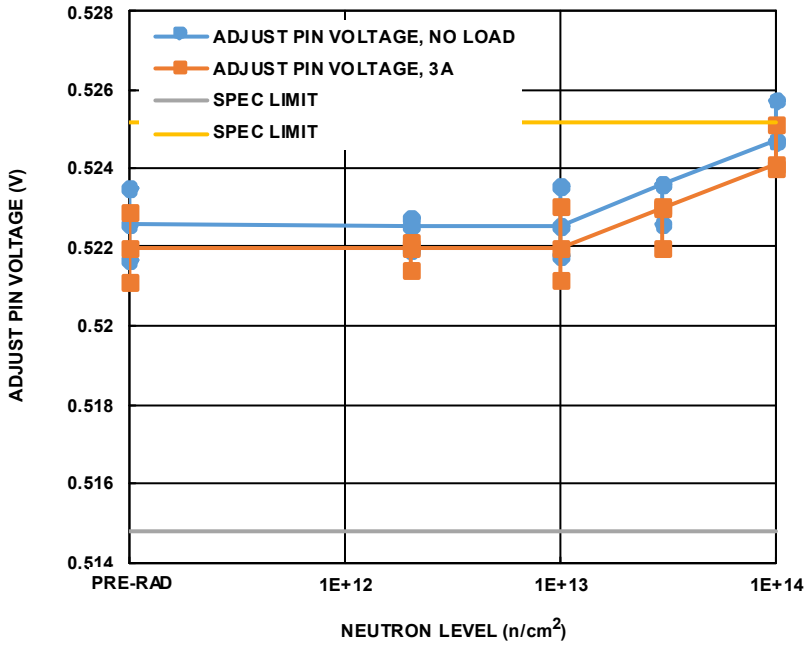

Figure 6. ISL75051SEH adjust pin voltage, 2.2V in and 0.52V out, no load and 3A load, as a function of 1MeV equivalent neutron irradiation at $2x10^{12}n/cm^2$, $1x10^{13}n/cm^2$, $3x10^{13}n/cm^2$, and $1x10^{14}n/cm^2$. The plot shows the population median, minimum, and maximum at each downpoint. Sample size for each cell was five. The SMD limits are 514.8mV to 525.2mV.

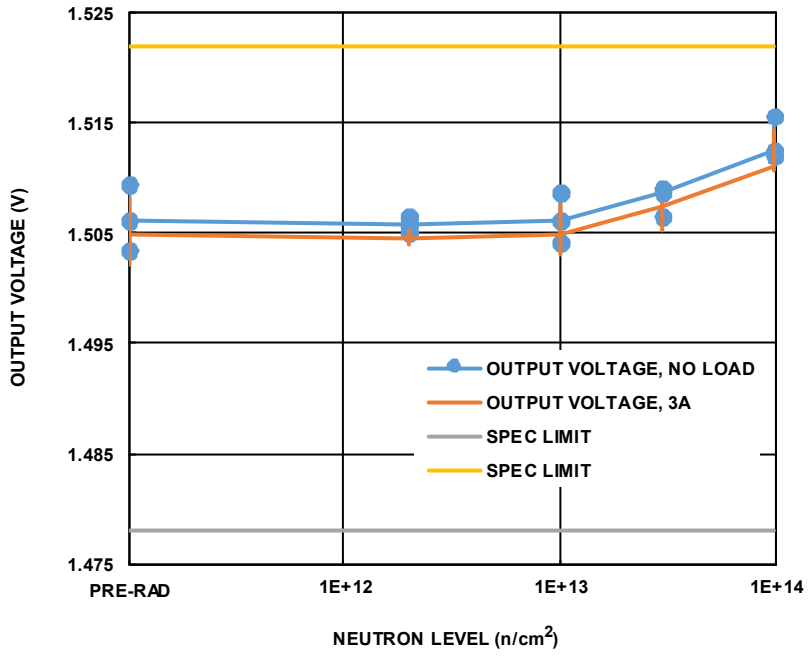

Figure 7. ISL75051SEH output voltage, 2.2V in and 1.5V out, no load and 3A load, as a function of 1MeV equivalent neutron irradiation at $2x10^{12}n/cm^2$, $1x10^{13}n/cm^2$, $3x10^{13}n/cm^2$, and $1x10^{14}n/cm^2$. The plot shows the population median, minimum, and maximum at each downpoint. Sample size for each cell was five. The SMD limits are 1.5V ±1.5%.

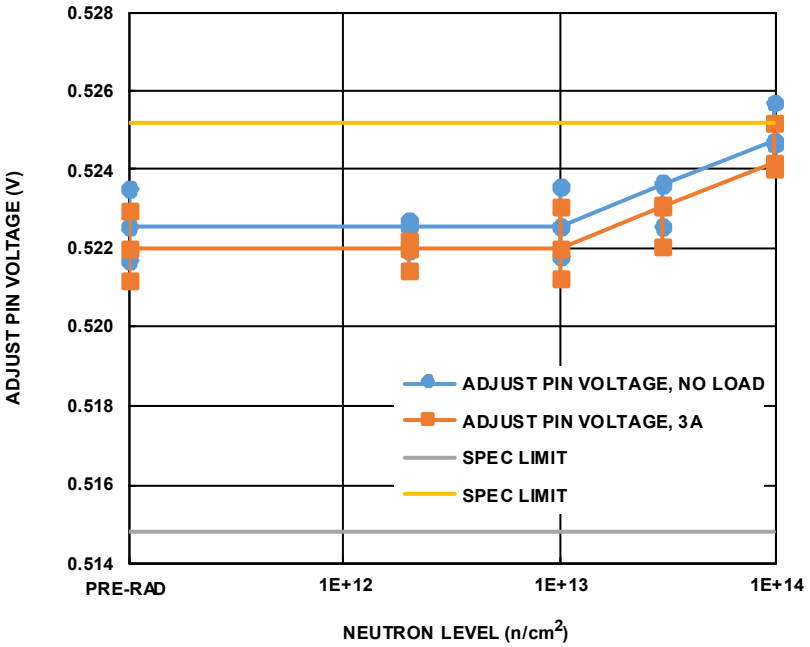

Figure 8. ISL75051SEH adjust pin voltage, 2.2V in and 1.5V out, no load and 3A load, as a function of 1MeV equivalent neutron irradiation at $2x10^{12}n/cm^2$, $1x10^{13}n/cm^2$, $3x10^{13}n/cm^2$, and $1x10^{14}n/cm^2$. The plot shows the population median, minimum, and maximum at each downpoint. Sample size for each cell was five. The SMD limits are 514.8mV to 525.2mV.

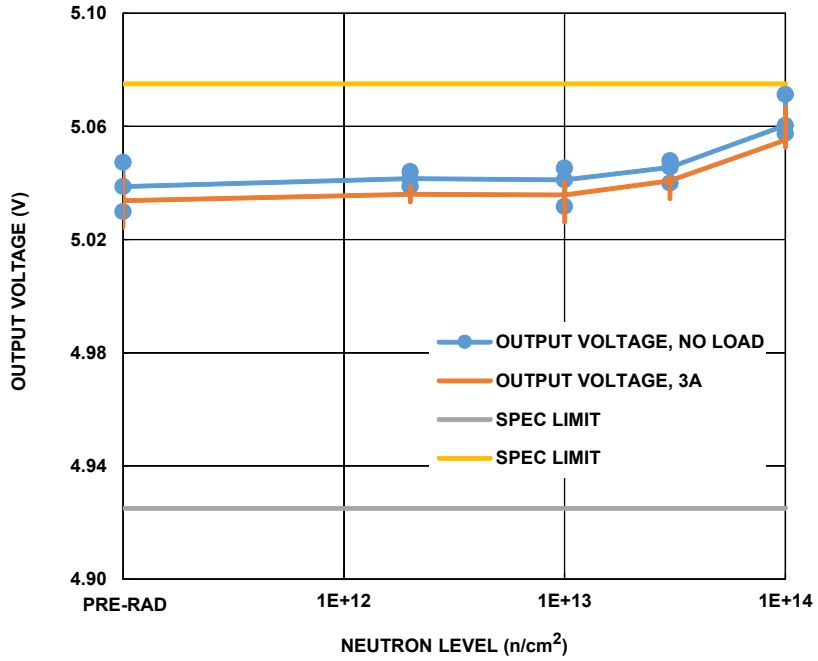

Figure 9. ISL75051SEH output voltage, 5.4V in and 5.0V out, no load and 3A load, as a function of 1MeV equivalent neutron irradiation at $2x10^{12}n/cm^2$, $1x10^{13}n/cm^2$, $3x10^{13}n/cm^2$, and $1x10^{14}n/cm^2$. The plot shows the population median, minimum, and maximum at each downpoint. Sample size for each cell was five. The SMD limits are 5.0V ±1.5%.

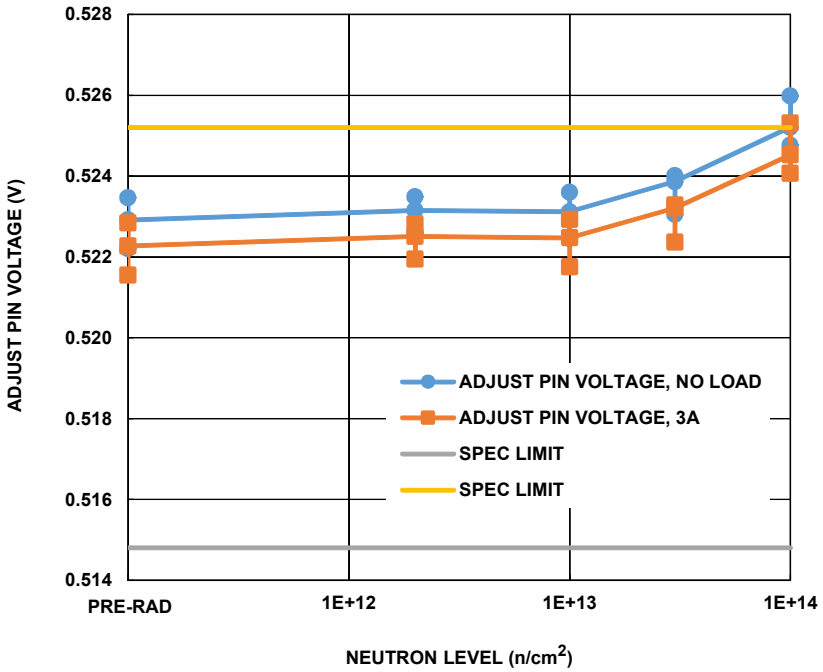

Figure 10. ISL75051SEH adjust pin voltage, 5.4V in and 5.0V out, no load and 3A load, as a function of 1MeV equivalent neutron irradiation at $2x10^{12}n/cm^2$, $1x10^{13}n/cm^2$, $3x10^{13}n/cm^2$, and $1x10^{14}n/cm^2$. The plot shows the population median, minimum, and maximum at each downpoint. Sample size for each cell was five. The SMD limits are 514.8mV to 525.2mV.

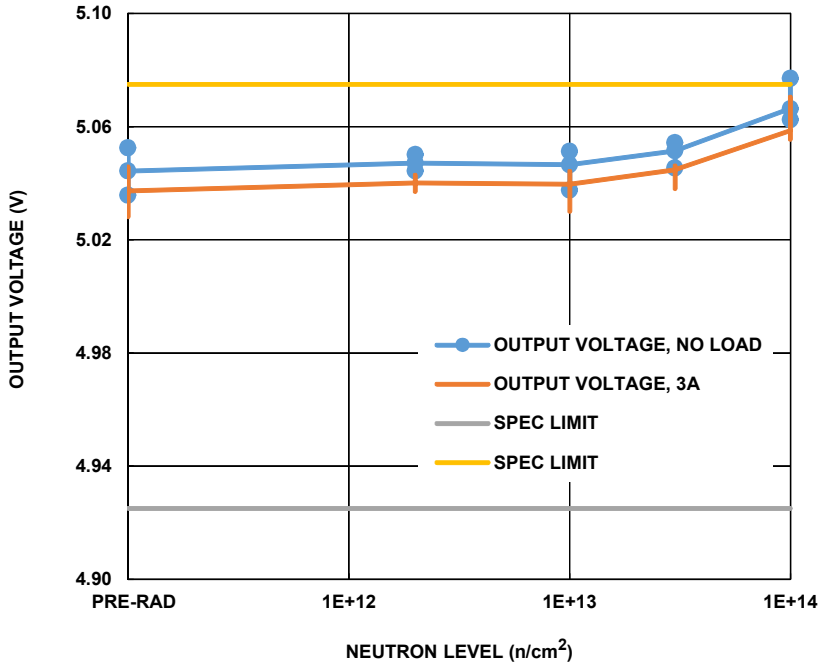

Figure 11. ISL75051SEH output voltage, 6.0V in and 5.0V out, no load and 3A load, as a function of 1MeV equivalent neutron irradiation at $2x10^{12}n/cm^2$, $1x10^{13}n/cm^2$, $3x10^{13}n/cm^2$, and $1x10^{14}n/cm^2$. The plot shows the population median, minimum, and maximum at each downpoint. Sample size for each cell was five. The SMD limits are 5.0V ±1.5%.

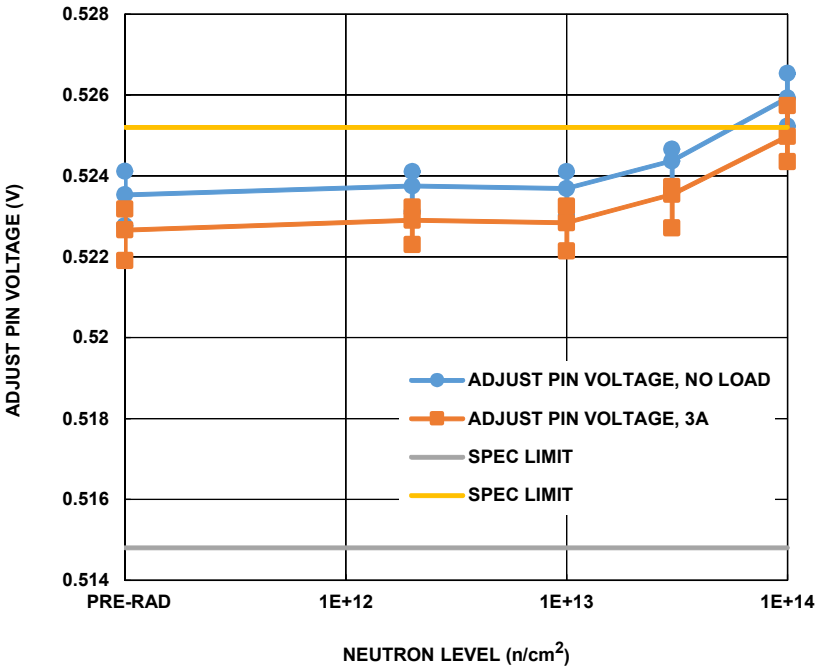

Figure 12. ISL75051SEH adjust pin voltage, 6.0V in and 5.0V out, no load and 3A load, as a function of 1MeV equivalent neutron irradiation at $2x10^{12}n/cm^2$, $1x10^{13}n/cm^2$, $3x10^{13}n/cm^2$, and $1x10^{14}n/cm^2$. The plot shows the population median, minimum, and maximum at each downpoint. Sample size for each cell was five. The SMD limits are 514.8mV to 525.2mV.

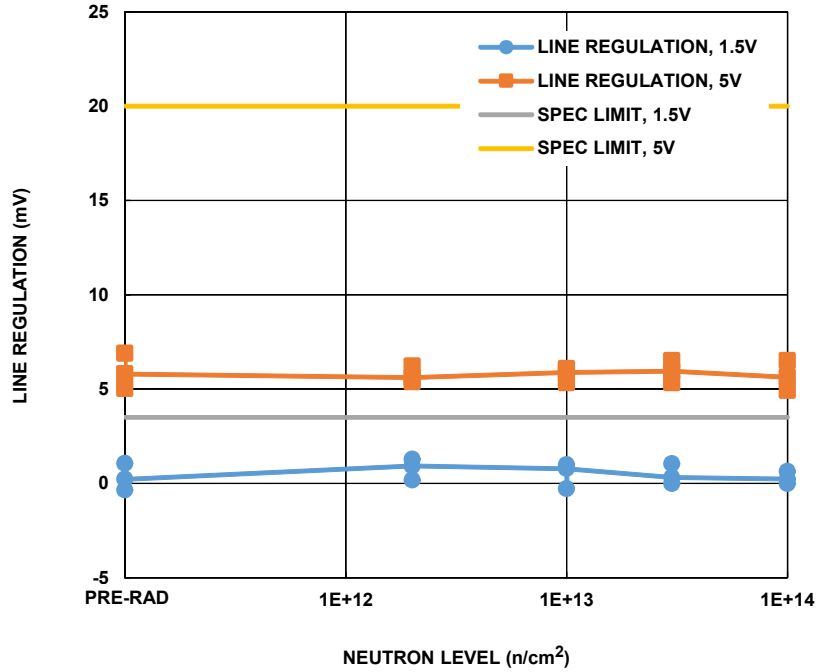

Figure 13. ISL75051SEH line regulation at 1.5V and 5V input voltage as a function of 1MeV equivalent neutron irradiation at $2x10^{12}n/cm^2$, $1x10^{13}n/cm^2$, $3x10^{13}n/cm^2$, and $1x10^{14}n/cm^2$. The plot shows the population median, minimum, and maximum at each downpoint. Sample size for each cell was five. The SMD limits are 3.5mV maximum (1.5V) and 20mV maximum (5V).

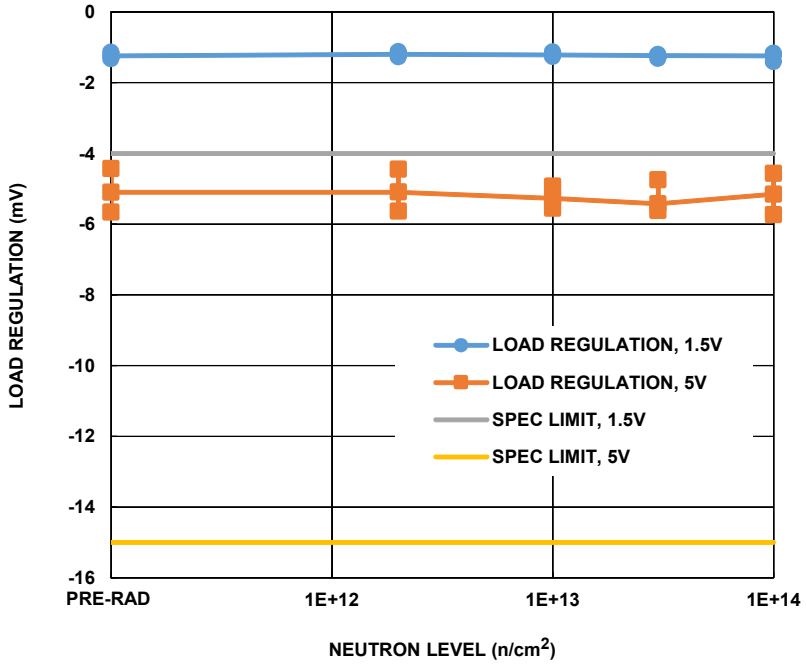

Figure 14. ISL75051SEH load regulation at 1.5V and 5V input voltage as a function of 1MeV equivalent neutron irradiation at $2x10^{12}n/cm^2$, $1x10^{13}n/cm^2$, $3x10^{13}n/cm^2$, and $1x10^{14}n/cm^2$. The plot shows the population median, minimum, and maximum at each downpoint. Sample size for each cell was five. The SMD limits are -4mV minimum (1.5V) and -15mV minimum (5V).

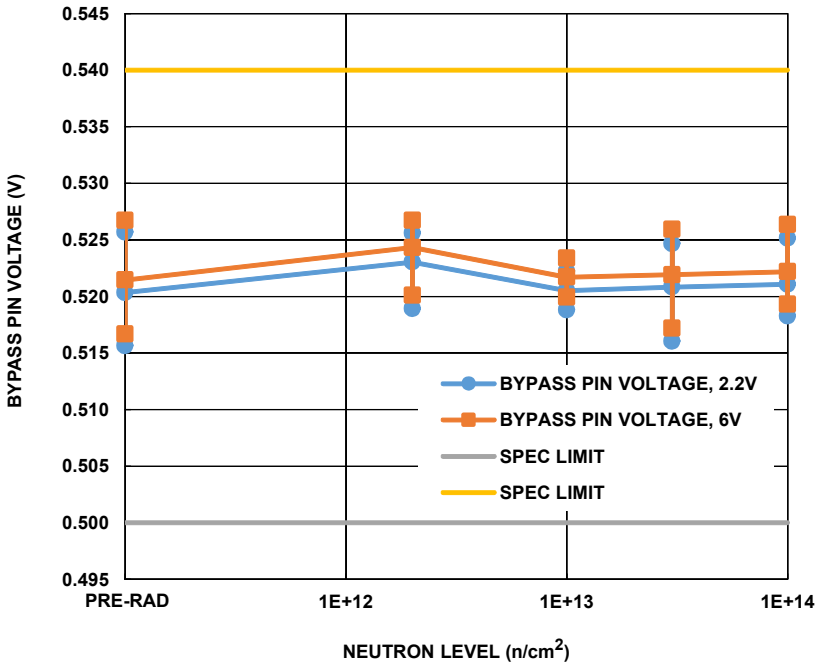

Figure 15. ISL75051SEH bypass pin voltage at 2.2V in and 6V in as a function of 1MeV equivalent neutron irradiation at $2x10^{12}n/cm^2$, $1x10^{13}n/cm^2$, $3x10^{13}n/cm^2$, and $1x10^{14}n/cm^2$. The plot shows the population median, minimum, and maximum at each downpoint. Sample size for each cell was five. The parameter is not specified in the SMD limits; the datasheet specifies a typical value of 520mV and the ATE limits are 0.5V to 0.54V.

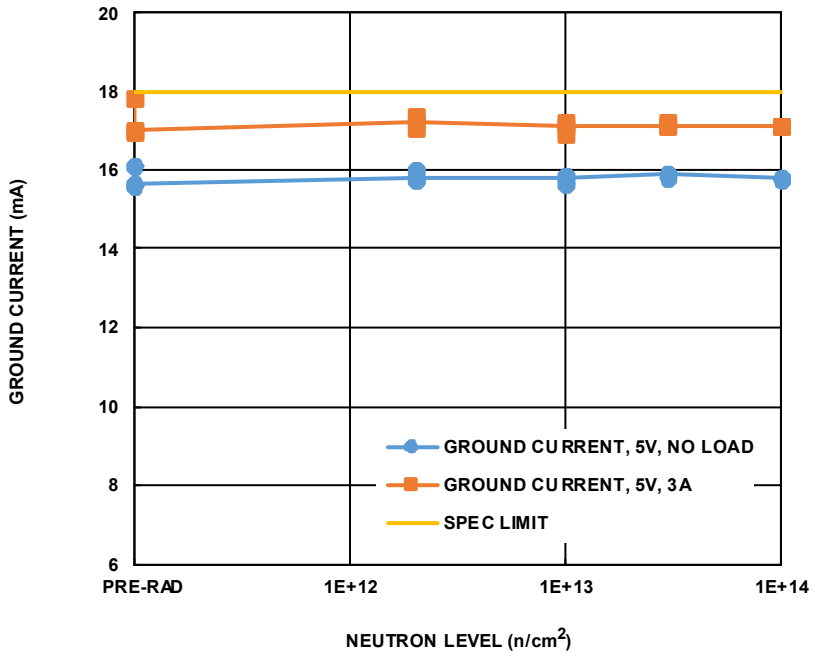

Figure 16. ISL75051SEH ground current at 5V out, no load and 3A load, as a function of 1MeV equivalent neutron irradiation at $2x10^{12}n/cm^2$, $1x10^{13}n/cm^2$, $3x10^{13}n/cm^2$, and $1x10^{14}n/cm^2$. The plot shows the population median, minimum, and maximum at each downpoint. Sample size for each cell was five. The SMD limit is 18mA maximum.

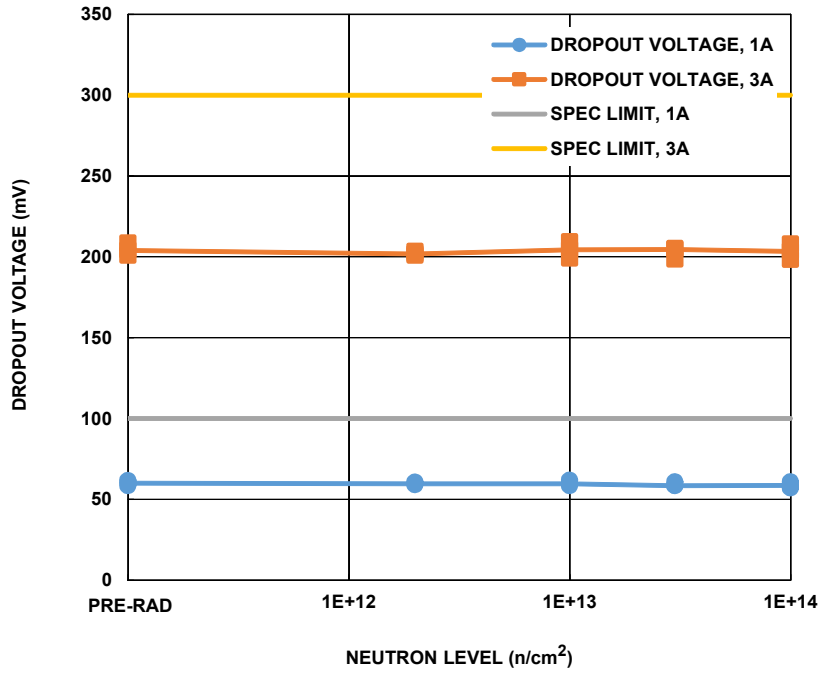

Figure 17. ISL75051SEH dropout voltage at 1A and 3A load current as a function of 1MeV equivalent neutron irradiation at $2x10^{12}n/cm^2$, $1x10^{13}n/cm^2$, $3x10^{13}n/cm^2$, and $1x10^{14}n/cm^2$. The plot shows the population median, minimum, and maximum at each downpoint. Sample size for each cell was five. The SMD limits are 100mV maximum (1A) and 300mV maximum (3A).

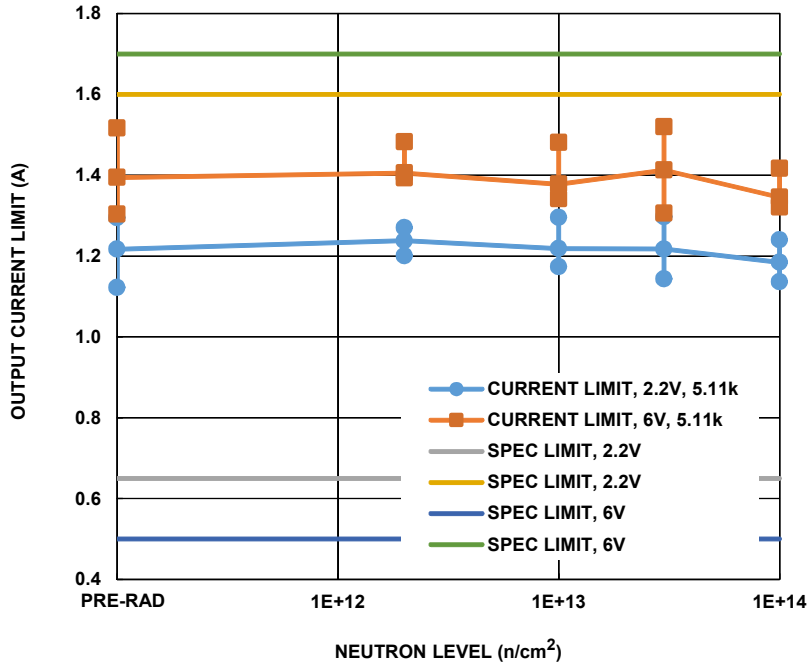

Figure 18. ISL75051SEH output current limit, 2.2V in and 6V in, 5.11kΩ current limit set resistor, as a function of 1MeV equivalent neutron irradiation at $2x10^{12}n/cm^2$, $1x10^{13}n/cm^2$, $3x10^{13}n/cm^2$, and $1x10^{14}n/cm^2$. The plot shows the population median, minimum, and maximum at each downpoint. Sample size for each cell was five. The parameter is not specified in the SMD; the datasheet limits are 1.1A typical (2.2V) and 1.2A typical (6V). The ATE limits are 0.65A to 1.6A (2.2V) and 0.5A to 1.7A (6V).

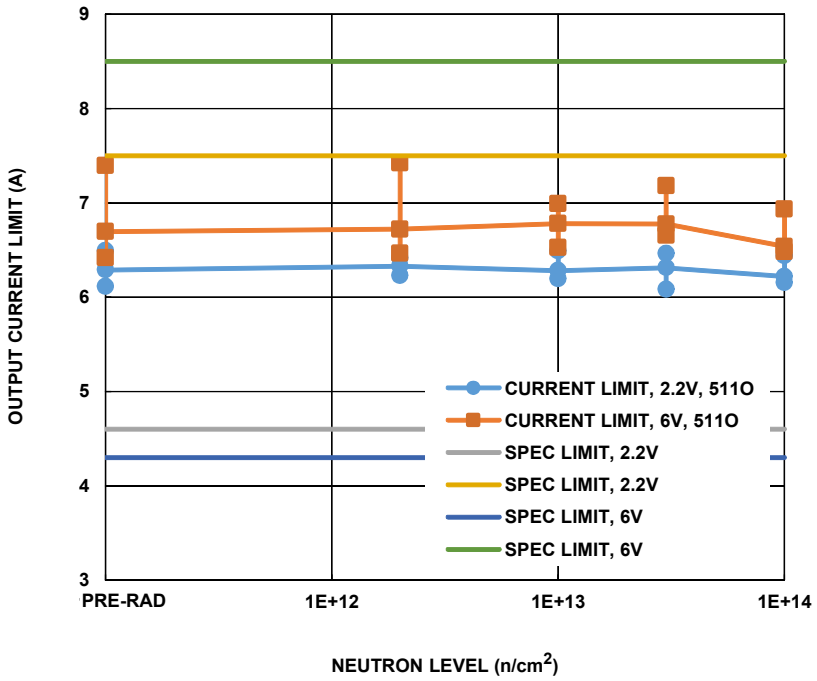

Figure 19. ISL75051SEH output current limit, 2.2V in and 6V in, 511Ω current limit set resistor, as a function of 1MeV equivalent neutron irradiation at $2x10^{12}n/cm^2$, $1x10^{13}n/cm^2$, $3x10^{13}n/cm^2$, and $1x10^{14}n/cm^2$. The plot shows the population median, minimum, and maximum at each downpoint. Sample size for each cell was five. The parameter is not specified in the SMD; the datasheet limits are 5.7A typical (2.2V) and 6.2A typical (6V). The ATE limits are 4.6A to 7.5A (2.2V) and 4.3A to 8.5A (6V).

3. Conclusion

This report summarizes results of 1MeV equivalent neutron testing of the ISL75051SEH low dropout voltage linear regulator. The test was conducted to determine the sensitivity of the part to Displacement Damage (DD) caused by neutron or proton environments in space. Neutron fluences ranged from $2x10^{12}n/cm^2$ to $1x10^{14}n/cm^2$. This project was carried out in collaboration with Boeing (El Segundo, CA), whose support is gratefully acknowledged.

The part performed very well. The $2x10^{12}n/cm^2$, $1x10^{13}n/cm^2$, and $3x10^{13}n/cm^2$ samples met all specifications (Bin 1) after irradiation. ATE testing showed five parametric rejects after irradiation to $1x10^{14}n/cm^2$. These samples marginally failed the output voltage and adjust pin voltage at the high end of the specification.

4. Revision History

Revision	Date	Description
1.01	May 28, 2026	▪ Applied latest template. ▪ Updated Variables Data and Reported Parameters sections.
1.00	Sep 25, 2019	▪ Added ISL75051SRH, ISL75051ASEH, ISL73051ASEH to page 1. ▪ Updated Related Literature section. ▪ Added Revision History. ▪ Updated disclaimer.
0.00	Dec 9, 2016	Initial release

A. Appendix

A.1 Reported Parameters

Reported parameters are shown Table 3. The limits are taken from the applicable SMD. The plots show the population median, minimum, and maximum at each downpoint.

Table 3. Reported Parameters

Figure	Parameter	Limit, Low	Limit, High	Unit	Notes
1	Enable LOW current	-	-	µA	
	Enable HIGH current	-	1	µA	
2	Adjust pin bias current	-	1	µA	
3	Enable threshold, rising	0.6	1.2	V	
	Enable threshold, falling	0.47	0.9	V	
4	Enable delay	225	450	µs	2.2V in
5	Output voltage, 0.52V	0.52V ±1.5%		V	No load, 2.2V in
	Output voltage, 0.52V	0.52V ±1.5%		V	3.0A load, 2.2V in
6	Adjust pin voltage, 0.52V, no load	514.8	525.2	mV	No load, 2.2V in
	Adjust pin voltage, 0.52V, 3A load	514.8	525.2	mV	3.0A load, 2.2V in
7	Output voltage, 1.5V	1.5V ±1.5%		V	No load, 2.2V in
	Output voltage, 1.5V	1.5V ±1.5%		V	3.0A load,2.2V in
8	Adjust pin voltage, 1.5V, no load	514.8	525.2	mV	1.5V out and 2.2V in
	Adjust pin voltage, 1.5V, 3A load	514.8	525.2	mV	1.5V out and 2.2V in
9	Output voltage, 5.0V	5.0V ±1.5%		V	No load, 5.4V in
	Output voltage, 5.0V	5.0V ±1.5%		V	3.0A load, 5.4V in
10	Adjust pin voltage, 5.0V, no load	514.8	525.2	mV	5.0V out and 5.4V in
	Adjust pin voltage, 5.0V, 3A load	514.8	525.2	mV	5.0V out and 5.4V in
11	Output voltage, 5.0V	5.0V ±1.5%		V	No load, 6.0V in
	Output voltage, 5.0V	5.0V ±1.5%		V	3.0A load,6.0V in
12	Adjust pin voltage, 5.0V, no load	514.8	525.2	mV	5.0V out and 5.4V in
	Adjust pin voltage, 5.0V, 3A load	514.8	525.2	mV	5.0V out and 5.4V in
13	Line regulation	-	3.5	mV	1.5V in
	Line regulation	-	20	mV	5.0V in
14	Load regulation	-4	-	mV	1.5V out
	Load regulation	-15	-	mV	5.0V out
15	Bypass pin voltage, 2.2V in	-	-	V	ATE limits 0.50V - 0.54V
	Bypass pin voltage, 6V in	-	-	V	ATE limits 0.50V - 0.54V
16	Ground current, 5.0V out	-	18	mA	No load, 6.0V in
	Ground current, 5.0V out	-	18	mA	3.0A load, 6.0V in
17	Dropout voltage, 1.0A	-	100	mV	
	Dropout voltage, 3.0A	-	300	mV	
18	Output current limit, 5.11kΩ	0.65	1.6	A	2.2V in
	Output current limit, 5.11kΩ	0.5	1.7	A	6.0V in
19	Output current limit, 511Ω	4.6	7.5	A	2.2V in
	Output current limit, 511Ω	4.3	8.5	A	6.0V in

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