ISL70219ASEH

Neutron Testing of the ISL70219SEH Dual, Low-Power Precision Amplifier

Introduction

This report summarizes results of 1MeV equivalent neutron testing of the ISL70219ASEH dual operational amplifier. The test was conducted to determine the sensitivity of the part to Displacement Damage (DD) caused by neutron or proton environments. Planned neutron fluences ranged from $5x10^{11}n/cm^2$ to $1x10^{14}n/cm^2$ with actual fluences coming within ±15% of that. This project was carried out in collaboration with Honeywell Aerospace Corporation in Clearwater, FL and their support is gratefully acknowledged.

Product Description

The ISL70219ASEH is a precision dual operational amplifier featuring competitive low noise vs. power consumption characteristics, low offset voltage, low input bias current and low temperature drift, making this device an excellent choice for hardened applications requiring high DC accuracy and moderate AC performance. 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.

Related Literature

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

- ISL70219ASEH device page
- MIL-STD-883 test method 1017

Contents

1. Test Description

1.1 Irradiation Facility

Neutron fluence irradiations were performed on the test samples on June 25, 2018, at the WSMR Fast Burst Reactor (FBR) per Mil-STD-883G, Method 1017.2, with each part unpowered during irradiation and all leads shorted. The target irradiation levels were $5x10^{11}n/cm^2$, $1x10^{12}n/cm^2$, $1x10^{13}n/cm^2$, and $1x10^{14}n/cm^2$. As neutron irradiation activates many of the heavier elements found in a packaged integrated circuit, the parts exposed at the higher neutron levels required (as expected) some cooldown time before being shipped back to Renesas (Palm Bay, FL) for electrical testing.

1.2 Test Fixturing

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

1.3 Radiation Dosimetry

Table 1 shows the TLD and Sulfur pellet dosimetry from WSMR indicating the total accumulated gamma dose and actual neutron fluence exposure levels for each sets of samples. This dosimetry process is traceable to NIST (IAW ASTM E722).

Table 1. ISL70219ASEH Neutron Fluence Dosimetry Data

TLD		Sulfur Pellet						
TLD #	cGy(Si)[1]	Pellet #	Distance (inches)	Exposure ID	Flu >3MeV (n/cm^2)	% Unc[2]	Total Fluence (n/cm^2)	1Mev Si (n/cm^2)
288	1.170E+02	6474	26.6	Free Field	7.302E+10	7.1%	5.904E+11	5.079E+11
284	3.903E+02	6420	13.45	Free Field	3.180E+11	7.1%	2.509E+12	2.225E+12
267	2.267E+03	6492	24	Free Field	1.456E+13	7.1%	1.168E+14	1.011E+13
252	1.909E+04	6467	8	Free Field	1.213E+13	7.1%	9.525E+14	8.509E+13

1. 1cGy(Si) = 1rad(Si)
2. The Uncertainty (% Unc) column is applicable only to the Fluence > 3MeV,

1.4 Characterization Equipment and Procedures

Electrical testing was performed before and after irradiation using the production Automated Test Equipment (ATE). All electrical testing was performed at room temperature.

1.5 Experimental Matrix

Testing proceeded in general accordance with the guidelines of MIL-STD-883 TM 1017. The experimental matrix consisted of five samples to be irradiated at $5x10^{11}n/cm^2$, five to be irradiated at $1x10^{12}n/cm^2$, five to be irradiated at $1x10^{13}n/cm^2$, and five to be irradiated at $1x10^{14}n/cm^2$. The actual levels achieved (shown in Table 2) were $5.1x10^{11}n/cm^2$, $2.2x10^{12}n/cm^2$, $1.0x10^{13}n/cm^2$, and $8.5x10^{13}n/cm^2$. Two control units were used.

ISL70219ASEH samples were drawn from lots X0M0JCDA and X0M0JCADA. Samples were packaged in the standard hermetic 10 Ld ceramic flatpack (CFP) production package. Samples were processed through burn-in before irradiation and were screened to the SMD limits at room, low, and high temperatures before the start of neutron testing.

2. Results

Neutron testing of the ISL70219ASEH is complete and the results are reported in the balance of this report. It should be understood when interpreting the data that each neutron irradiation was performed on a different set of samples; this is not total dose testing, where the damage is cumulative.

2.1 Attributes Data

Table 2. Attributes Data

1MeV Fluence, (n/cm^2)		Sample Size	Pass[1]	Fail	Notes
Planned	Actual				
$5x10^{11}$	$5.079x10^{11}$	5	5	0	All passed
$2x10^{12}$	$2.225x10^{12}$	5	5	0	All passed
$1x10^{13}$	$1.011x10^{13}$	5	5	0	All passed
$1x10^{14}$	$8.509x10^{13}$	5	0	5	Failed AVOL; PSRR

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 plots show the mean of each parameter as a function of neutron irradiation. The plots also include error bars at each downpoint, representing the minimum and maximum measured values of the samples, although in some plots the error bars might not be visible due to their values compared to the scale of the graph. The applicable electrical limits taken from the SMD are also shown.

All samples passed the post-irradiation SMD limits after all exposures up to and including $1x10^{13}n/cm^2$, but after $8.5x10^{13}n/cm^2$ all five units failed at least one of the Open-Loop Gain (A_{VOL}) measurements at V_S = ±5V (Figure 12), with a worst-case value of 1794V/mV to a 3000V/mV minimum limit. Also, the B output on two units failed the post-irradiation limits for Power Supply Rejection Ratio (PSRR) at V_S = ±18V (Figure 13) after $8.5x10^{13}n/cm^2$ and the B output on four units failed at V_S = ±5V (Figure 14). The minimum measurement was 112dB as compared to a 120dB minimum limit. All units remained fully functional.

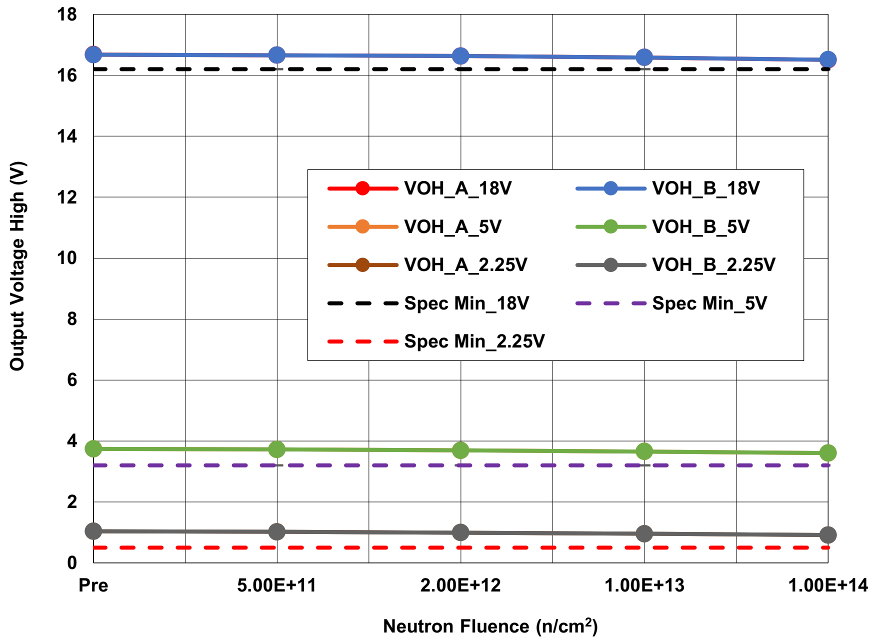

Figure 1. ISL70219ASEH Output Voltage High (V_{OH}), Channels A and B, with V_S = ±18V, ±5V, and ±2.25V, R_L = 10kΩ, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are 16.2V minimum for V_S = ±18V, 3.2V minimum for V_S = ±5V, and 0.5V minimum for V_S = ±2.25V.

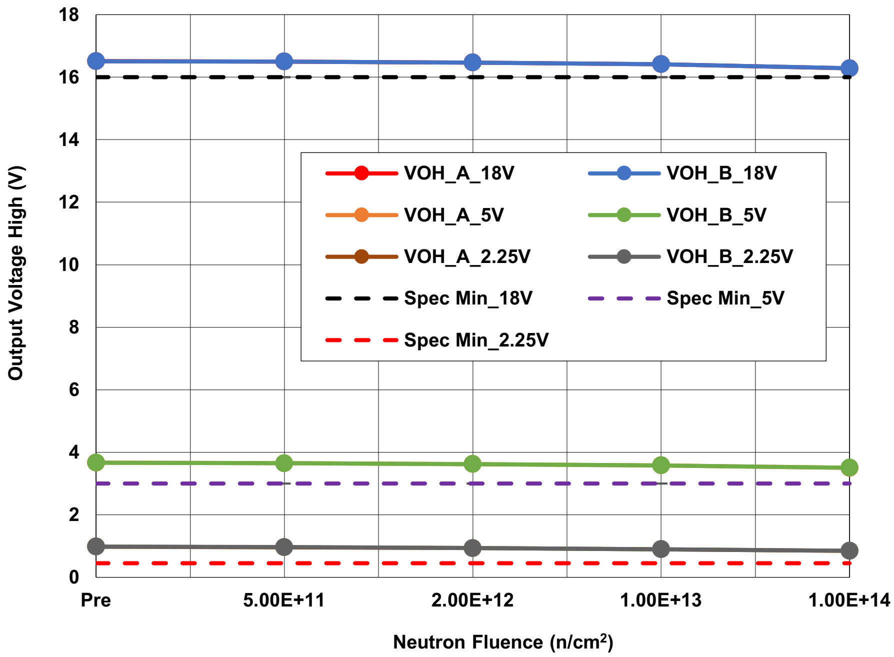

Figure 2. ISL70219ASEH Output Voltage High (V_{OH}), Channels A and B, with V_S = ±18V, ±5V, and ±2.25V, R_L = 2kΩ, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are 16V minimum for V_S = ±18V, 3V minimum for V_S = ±5V, and 0.45V minimum for V_S = ±2.25V.

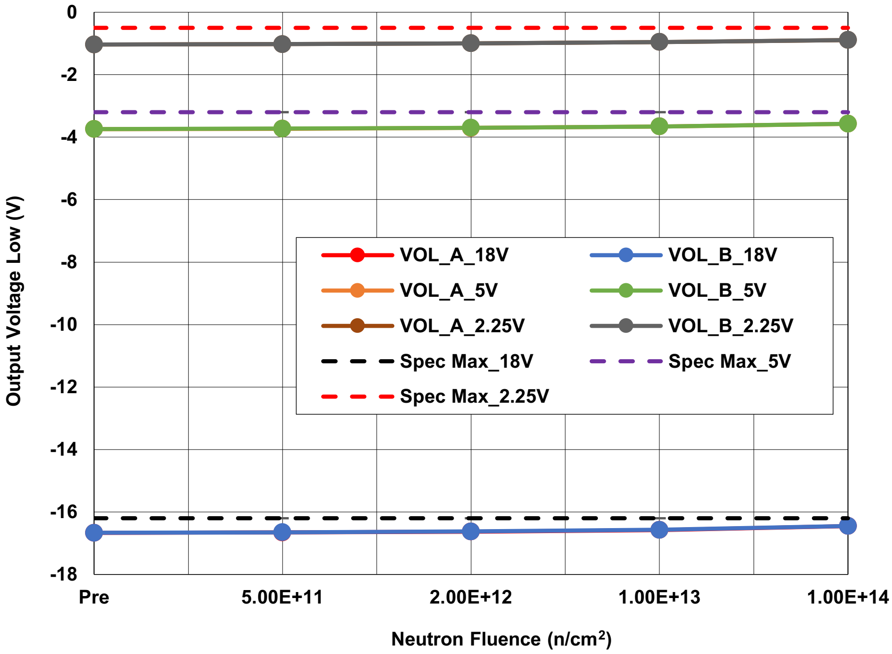

Figure 3. ISL70219ASEH Output Voltage Low (V_{OL}), Channels A and B, with V_S = ±18V, ±5V, and ±2.25V, R_L = 10kΩ, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are -16.2V maximum for V_S = ±18V, -3.2V maximum for V_S = ±5V, and -0.5V maximum for V_S = ±2.25V.

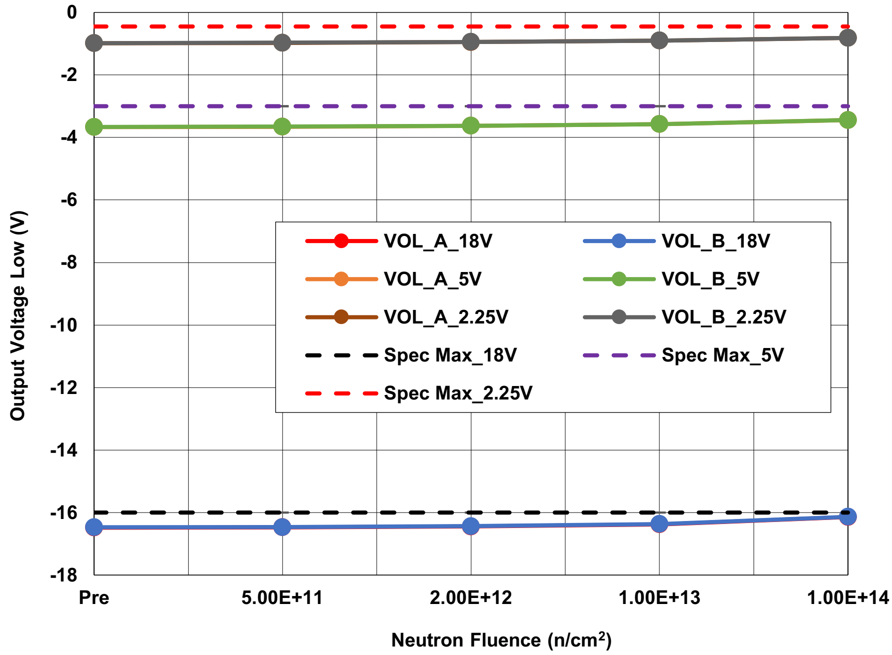

Figure 4. ISL70219ASEH Output Voltage Low (V_{OL}), Channels A and B, with V_S = ±18V, ±5V, and ±2.25V, R_L = 2kΩ, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are -16V maximum for V_S = ±18V, -3V maximum for V_S = ±5V, and -0.45V maximum for V_S = ±2.25V.

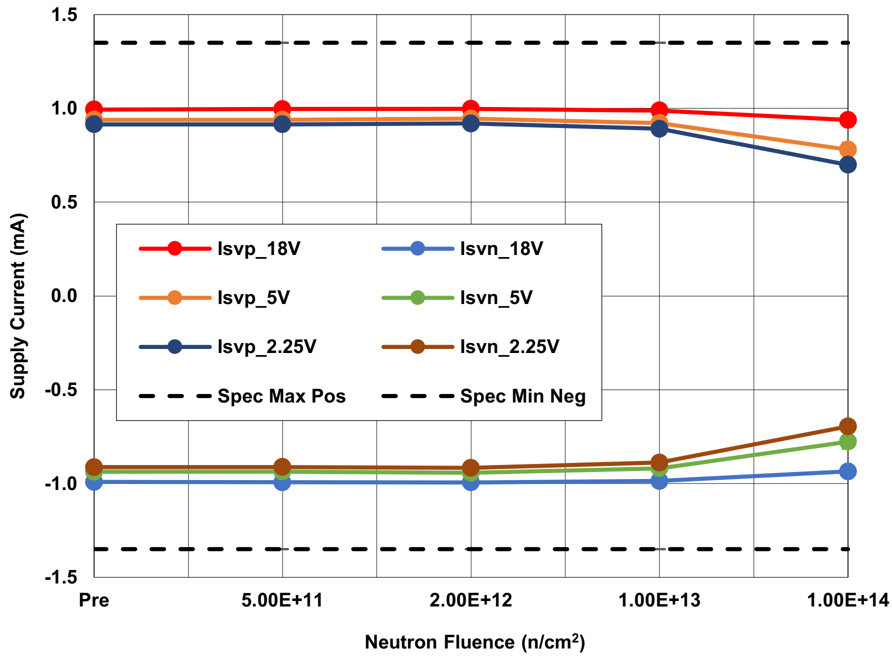

Figure 5. ISL70219ASEH Positive and Negative Supply Current (I_{SVP} and I_{SVN}), for Channels A + B, with V_S = ±18V, ±5V, and ±2.25V, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are -1.35mA minimum and 1.35mA maximum.

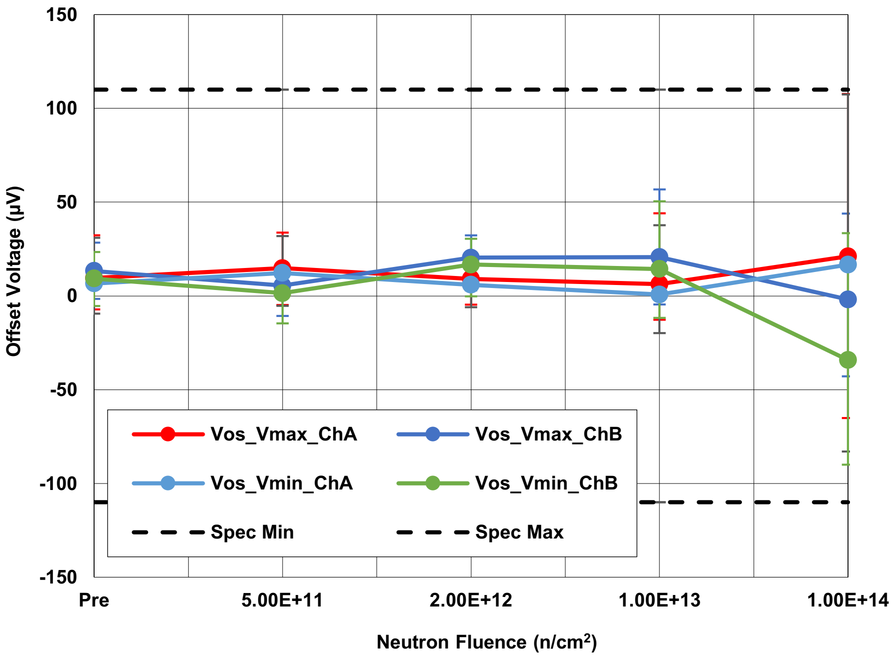

Figure 6. ISL70219ASEH Input Offset Voltage (V_{OS}), Channels A and B, with V_S = ±18V and ±2.25V, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits -110µV minimum and 110µV maximum.

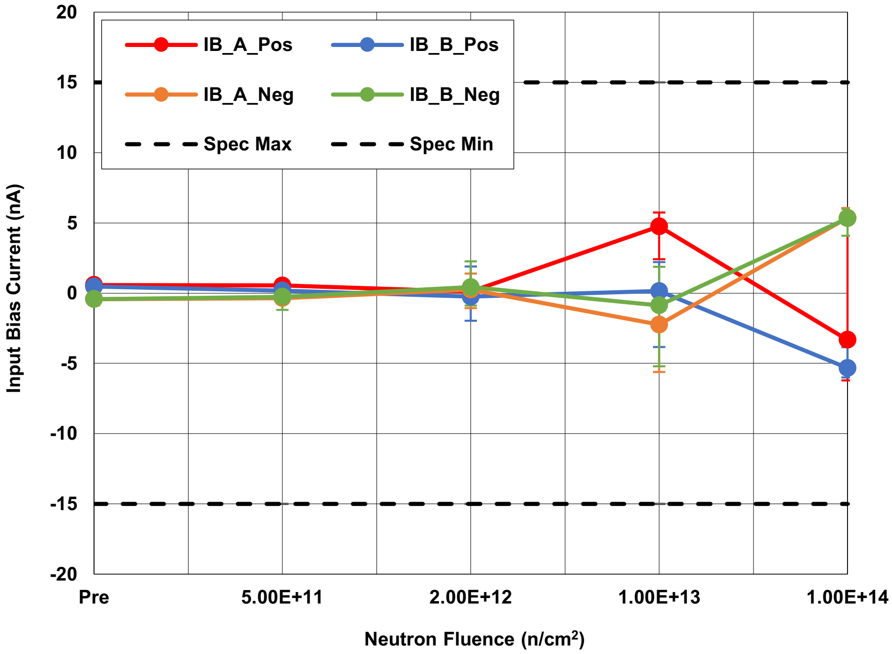

Figure 7. ISL70219ASEH Input Bias Current (I_B), Channels A and B, with V_S = ±18V, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are -15nA minimum and 15nA maximum.

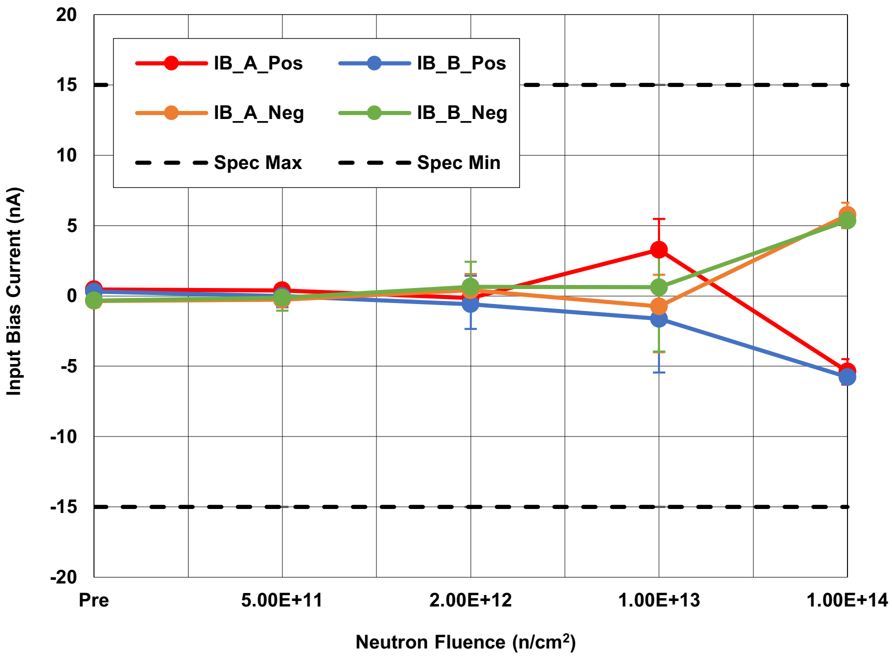

Figure 8. ISL70219ASEH Input Bias Current (I_B), Channels A and B, with V_S = ±5V, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are -15nA minimum and 15nA maximum.

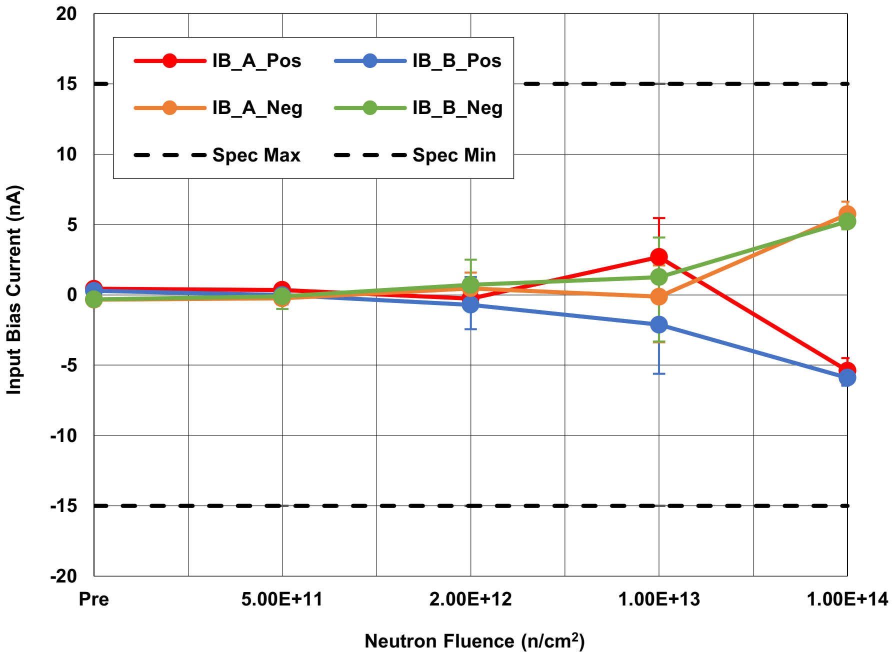

Figure 9. ISL70219ASEH Input Bias Current (I_B), Channels A and B, with V_S = ±2.25V, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are -15nA minimum and 15nA maximum.

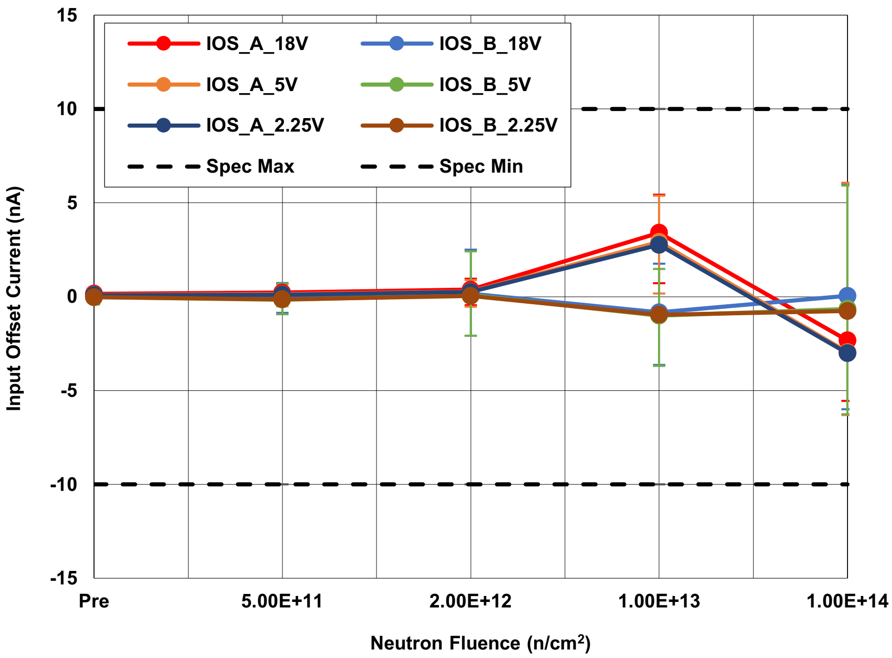

Figure 10. ISL70219ASEH Input Offset Current (I_{OS}), Channels A and B, with V_S = ±18V, ±5V, and ±2.25V, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limits are -10nA minimum and 10nA maximum.

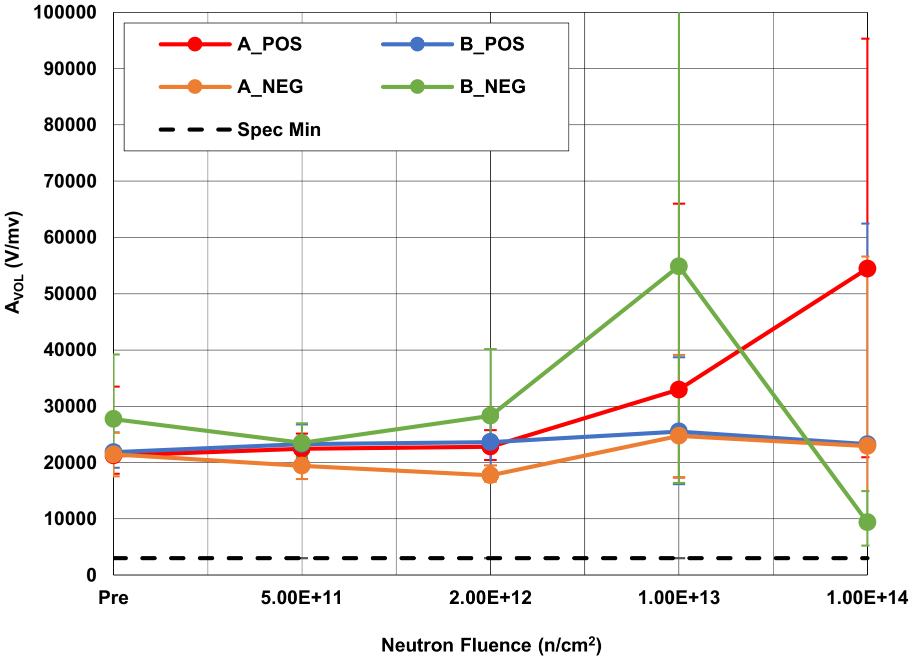

Figure 11. ISL70219ASEH Open-Loop Gain (A_{VOL}), Channels A and B, with V_S = ±18V, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limit is 3000V/mV minimum.

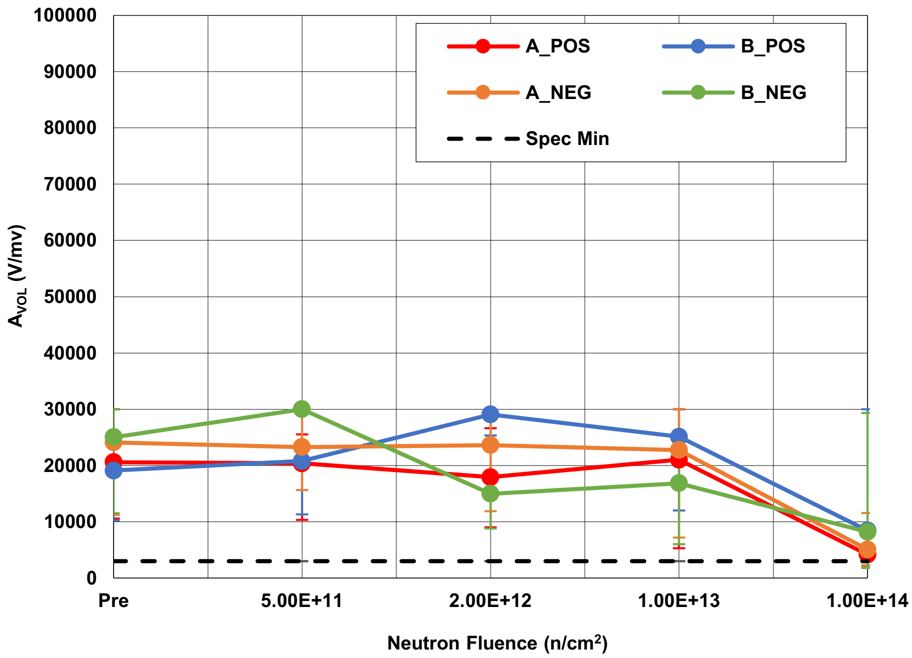

Figure 12. ISL70219ASEH Open-Loop Gain (A_{VOL}), Channels A and B, with V_S = ±5V, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limit is 3000V/mV minimum.

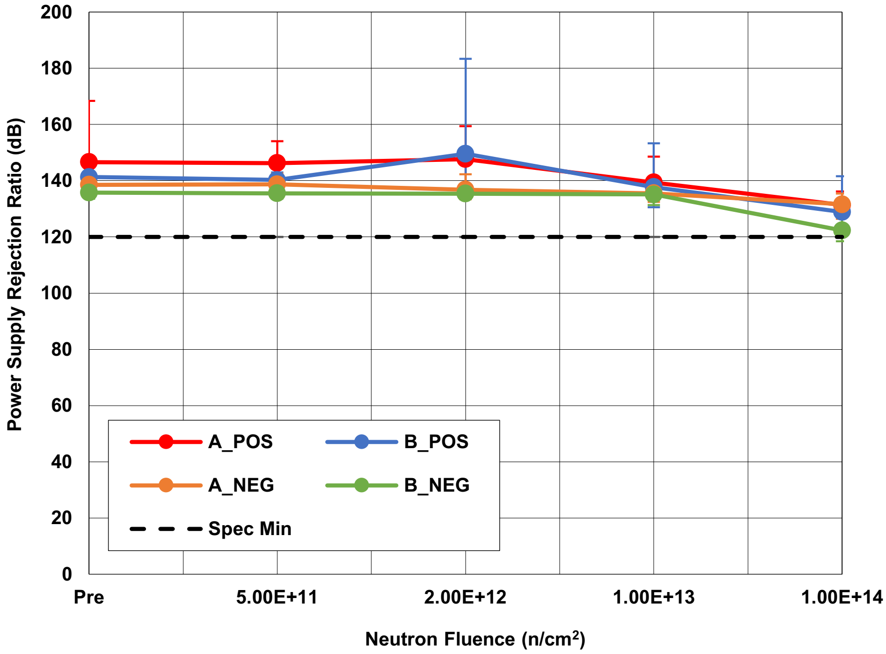

Figure 13. ISL70219ASEH Power Supply Rejection Ratio (PSRR), Channels A and B, with V_S = ±18V, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limit is 120dB minimum.

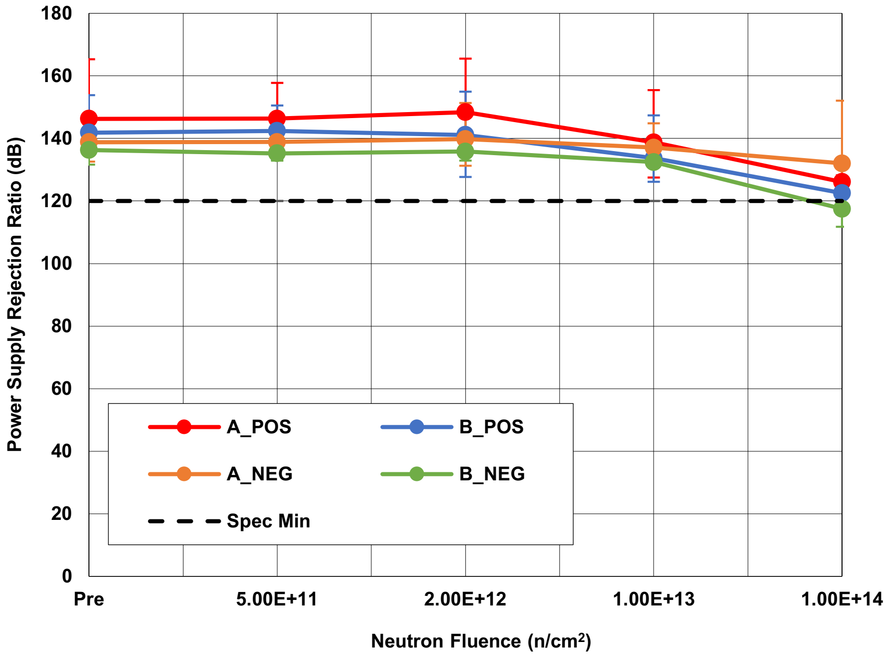

Figure 14. ISL70219ASEH Power Supply Rejection Ratio (PSRR), Channels A and B, with V_S = ±5V, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limit is 120dB minimum.

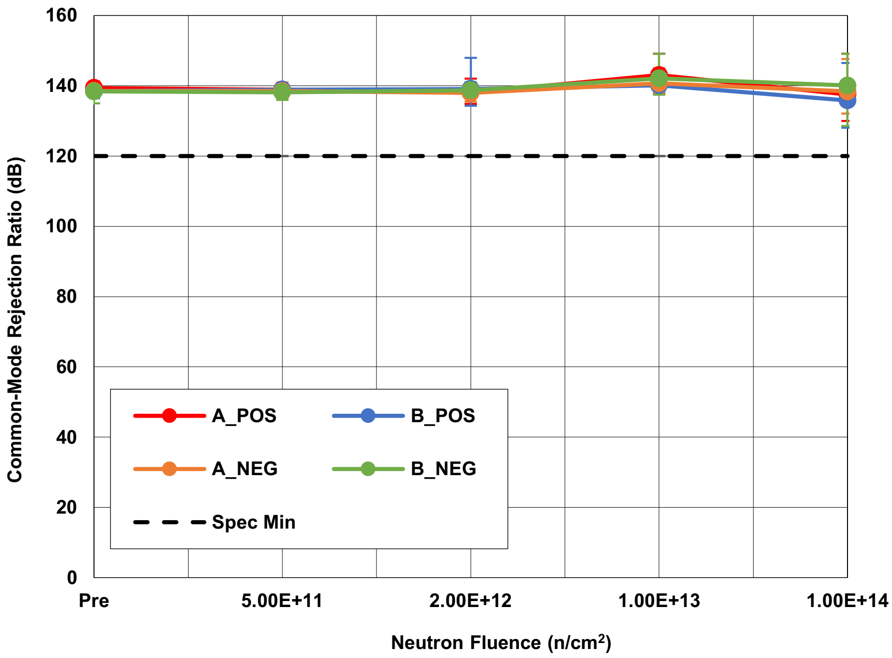

Figure 15. ISL70219ASEH Common-Mode Rejection Ratio (CMRR), Channels A and B, with V_S = ±18V, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limit is 120dB minimum.

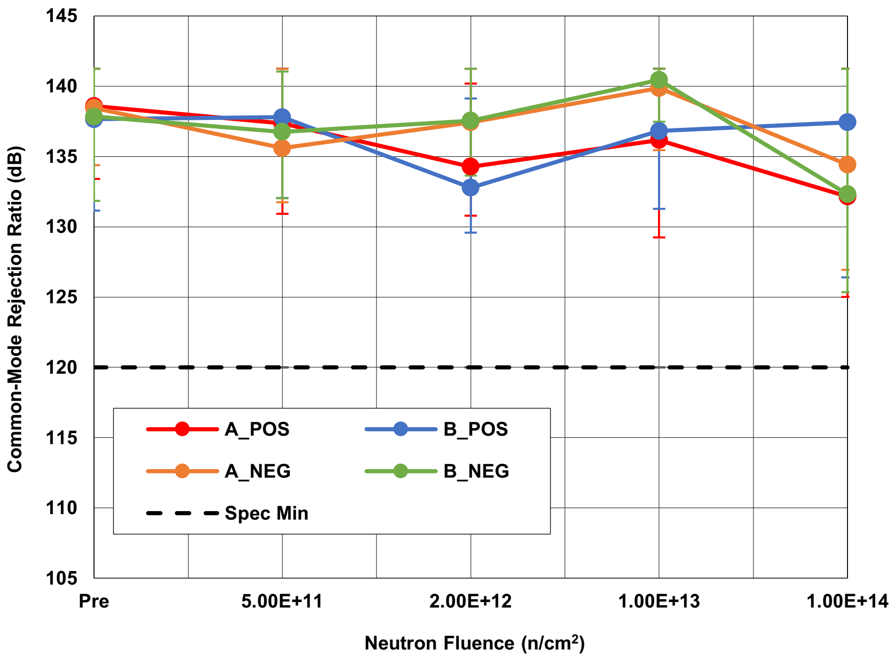

Figure 16. ISL70219ASEH Common-Mode Rejection Ratio (CMRR), Channels A and B, with V_S = ±5V, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limit is 120dB minimum.

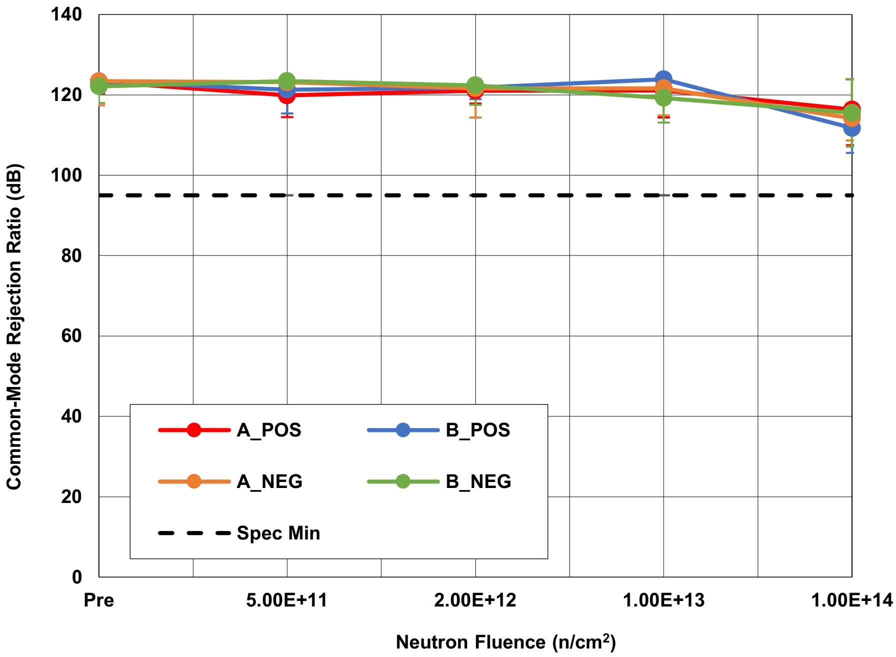

Figure 17. ISL70219ASEH Common-Mode Rejection Ratio (CMRR), Channels A and B, with V_S = ±2.25V, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limit is 95dB minimum.

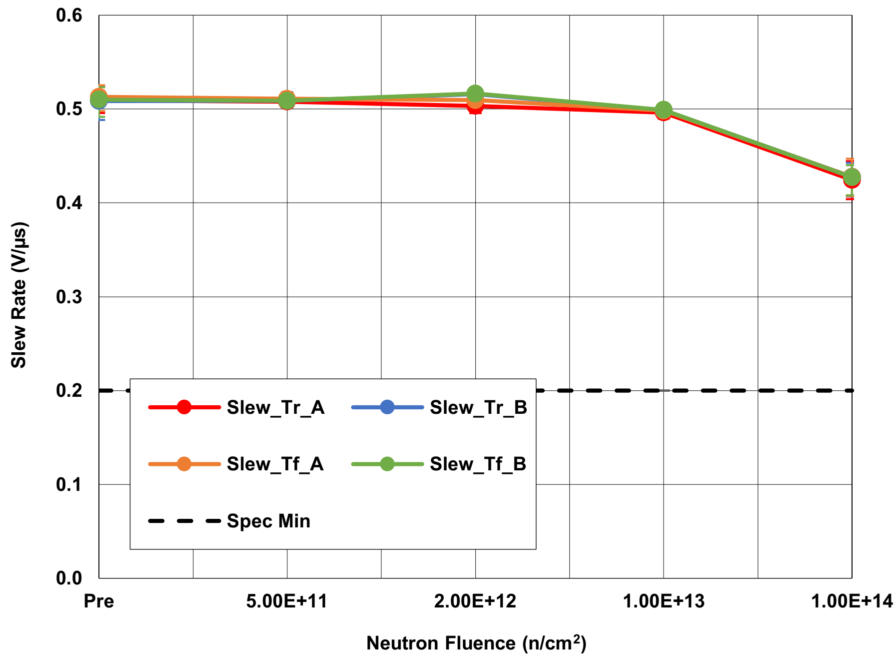

Figure 18. ISL70219ASEH Slew Rate (SR), Channels A and B, with V_S = ±18V, A_V = 1, R_L = 2kΩ, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limit is 0.2V/µs minimum.

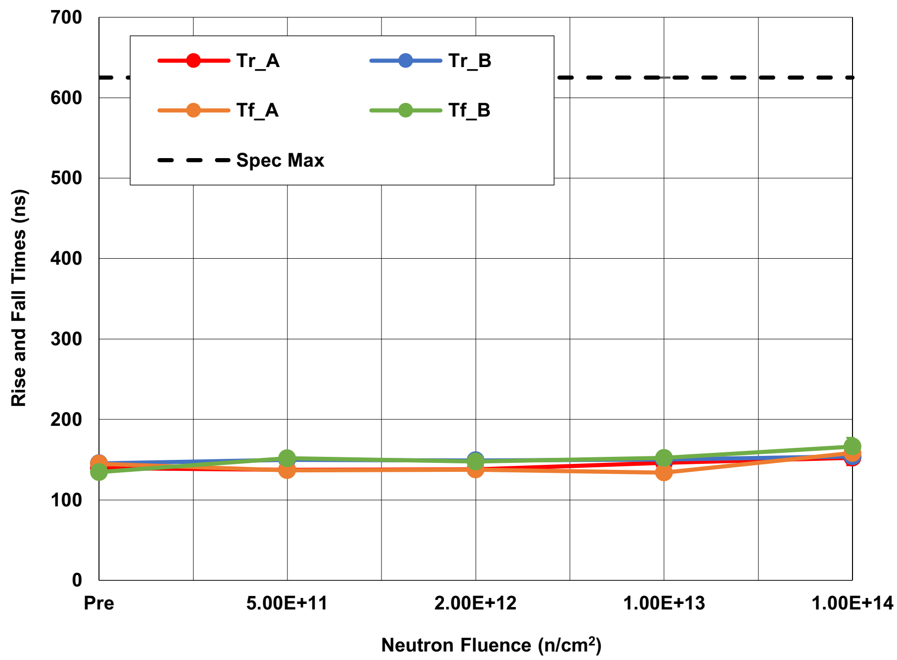

Figure 19. ISL70219ASEH Rise Time (t_r) and Fall Time (t_f), Channels A and B, with V_S = ±18V, following irradiation to each level. The error bars (if visible) represent the minimum and maximum measured values. The SMD limit is 625ns maximum.

3. Discussion and Conclusion

This document reports the results of 1MeV equivalent neutron testing of the ISL70219ASEH dual, low-power precision amplifier. Parts were tested at $5.1x10^{11}$n/cm^2, $2.2x10^{12}$n/cm^2, $1.0x10^{13}$n/cm^2, and $8.5x10^{13}$n/cm^2. The results of key parameters before and after irradiation to each level are plotted in Figure 1 through Figure 19. 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. The figures also show the applicable electrical limits taken from the SMD. All samples passed the post-irradiation SMD limits after all exposures up to and including $1x10^{13}$n/cm^2, but after $8.5x10^{13}$n/cm^2 all five units failed at least one of the Open-Loop Gain (A_{VOL}) measurements at V_S = ±5V (see Figure 12) and some units failed Power Supply Rejection Ratio (PSRR), as can be seen in Figure 13 and Figure 14, even though they all remained fully functional.

4. Revision History

Rev.	Date	Description
1.01	Jun 5, 2025	Applied the latest template. Minor update to the Variables Data and Discussion and Conclusion sections.
1.00	Apr 6, 2020	Initial release

5. Appendices

5.1 Reported Parameters

Figure	Parameter	Symbol	Low Limit	High Limit	Units	Notes
1	Output Voltage High (R_L = 10kΩ)	V_{OH}	16.2	-	V	V_S = ±18V
			3.2	-		V_S = ±5V
			0.5	-		V_S = ±2.25V
2	Output Voltage High (R_L = 2kΩ)	V_{OH}	16	-	V	V_S = ±18V
			3	-		V_S = ±5V
			0.45	-		V_S = ±2.25V
3	Output Voltage Low (R_L = 10kΩ)	V_{OL}	-	-16.2	V	V_S = ±18V
			-	-3.2		V_S = ±5V
			-	-0.5		V_S = ±2.25V
4	Output Voltage Low (R_L = 2kΩ)	V_{OL}	-	-16	V	V_S = ±18V
			-	-3		V_S = ±5V
			-	-0.45		V_S = ±2.25V
5	Supply Current	I_{SVN}	-1.35	-	mA	Sum of both Ch
		I_{SVP}		1.35		
6	Input Offset Voltage (V_S = ±2.25V; 18V)	V_{OS}	-110	110	µV	Ch A and B
7	Input Bias Current	I_B	-15	15	nA	V_S = ±18V
8						V_S = ±5V
9						V_S = ±2.25V
10	Input Offset Current	I_{OS}	-10	10	nA	Ch A and B
11	Open-Loop Gain (VO = -3V to +3V, RL = 10kΩ to ground)	A_{VOL}	3000	-	V/mV	V_S = ±18V
12						V_S = ±5V
13	Power Supply Rejection Ratio	PSRR	120	-	dB	V_S = ±18V
14						V_S = ±5V
15	Common-Mode Rejection Ratio	CMRR	120	-	dB	V_S = ±18V
16			120	-		V_S = ±5V
17			95	-		V_S = ±2.25V
18	Slew Rate (V_{OUT} 20% to 80%, A_V = 1, R_L = 2kΩ, V = 4VPP)	SR	0.2	-	V/µs	V_S = ±18V
19	Rise Time (10% to 90% of VOUT)	t_r	625	-	ns	Ch A and B
	Fall Time (90% to 10% of VOUT)	t_f	625	-	ns	Ch A and B

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