

# Rad Hard 40V Quad Precision Low Power Operational Amplifiers

## ISL70417SEH

The ISL70417SEH contains four very high precision amplifiers featuring the perfect combination of low noise vs power consumption. Low offset voltage, low I<sub>BIAS</sub> current and low temperature drift making them the ideal choice for applications requiring both high DC accuracy and AC performance. The combination of high precision, low noise, low power and small footprint provides the user with outstanding value and flexibility relative to similar competitive parts.

Applications for these amplifiers include precision active filters, medical and analytical instrumentation, precision power supply controls, and industrial controls.

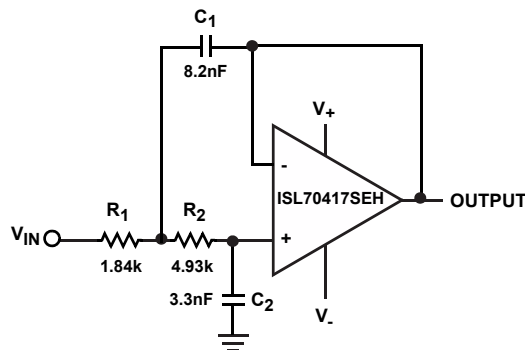
The ISL70417SEH is offered in a 14 lead hermetic ceramic flatpack package. The device is offered in an industry standard pin configuration and operates over the extended temperature range from -55°C to +125°C.

## Applications

- Precision Instrumentation
- Spectral Analysis Equipment
- Active Filter Blocks
- Thermocouples and RTD Reference Buffers
- Data Acquisition
- Power Supply Control

## Features

- Electrically Screened to DLA SMD# [5962-12228](#)
  - Low Input Offset Voltage .....  $\pm 110\mu\text{V}$ , Max.
  - Superb Offset Temperature Coefficient .....  $1\mu\text{V}/^\circ\text{C}$ , Max.
  - Input Bias Current .....  $\pm 5\text{nA}$ , Max.
  - Input Bias Current TC .....  $\pm 5\text{pA}/^\circ\text{C}$ , Max.
  - Low Current Consumption .....  $440\mu\text{A}$
  - Voltage Noise .....  $8\text{nV}/\sqrt{\text{Hz}}$
  - Wide Supply Range ..... 4.5V to 40V
  - Operating Temperature Range ..... -55°C to +125°C
  - Radiation Environment
    - SEL/SEB LET<sub>TH</sub> (V<sub>S</sub> = ±20V) .....  $73.9\text{ MeV} \cdot \text{cm}^2/\text{mg}$
    - Total Dose, High Dose Rate ..... 300krad(Si)
    - Total Dose, Low Dose Rate ..... 100krad(Si) \*
- \* Product capability established by initial characterization. The EH version is acceptance tested on a wafer by wafer basis to 50krad(Si) at low dose rate.



SALLEN-KEY LOW PASS FILTER ( $f_c = 10\text{kHz}$ )

FIGURE 1. TYPICAL APPLICATION

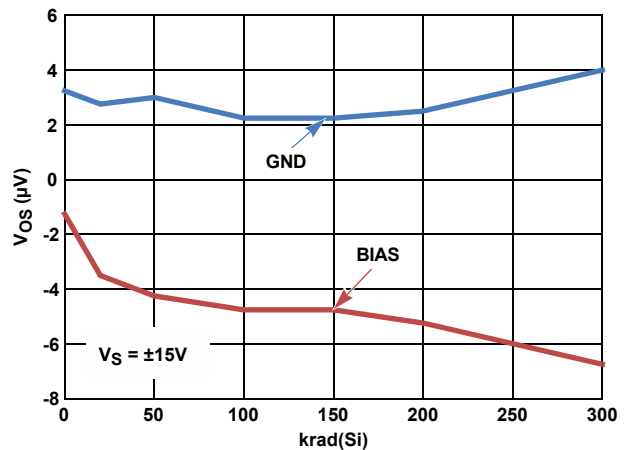


FIGURE 2. V<sub>OS</sub> SHIFT vs HIGH DOSE RATE RADIATION

# ISL70417SEH

## Ordering Information

ORDERING NUMBER	PART NUMBER (Notes 2, 3)	TEMPERATURE RANGE (°C)	PACKAGE (Pb-Free)	PKG. DWG. #
5962R1222801VXC	ISL70417SEHVF	-55 to +125	14 Ld Flatpack	K14.A
ISL70417SEHF/PROTO	ISL70417SEHF/PROTO	-55 to +125	14 Ld Flatpack	K14.A
5962R1222801V9AX	ISL70417SEHVX	-55 to +125	DIE	
ISL70417SEHX/SAMPLE	ISL70417SEHX/SAMPLE	-55 to +125	DIE	
ISL70417SEHEVAL1Z	Evaluation Board			

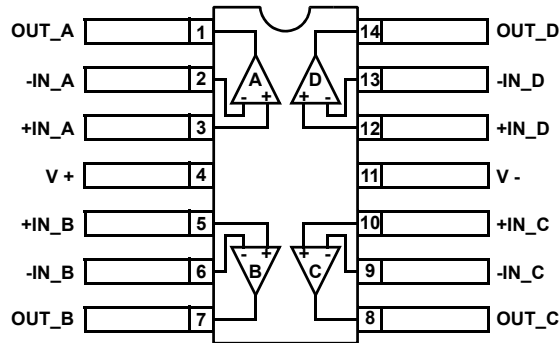
### NOTES:

1. These Intersil Pb-free Hermetic packaged products employ 100% Au plate - e4 termination finish, which is RoHS compliant and compatible with both SnPb and Pb-free soldering operations.
2. For Moisture Sensitivity Level (MSL), please see device information page for [ISL70417SEH](#). For more information on MSL please see tech brief [TB363](#).

# ISL70417SEH

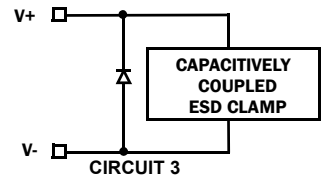
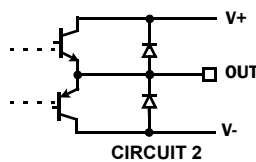
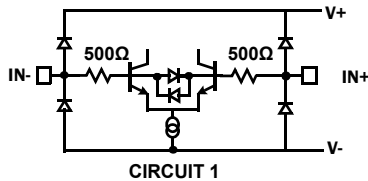
## Pin Configuration

ISL70417SEH  
(14 LD FLATPACK)  
TOP VIEW



## Pin Descriptions

ISL70417SEH (14 LD FLATPACK)	PIN NAME	EQUIVALENT CIRCUIT	DESCRIPTION
1	OUT_A	Circuit 2	Amplifier A output
2	-IN_A	Circuit 1	Amplifier A inverting input
3	+IN_A	Circuit 1	Amplifier A non-inverting input
4	V+	Circuit 3	Positive power supply
5	+IN_B	Circuit 1	Amplifier B non-inverting input
6	-IN_B	Circuit 1	Amplifier B inverting input
7	OUT_B	Circuit 2	Amplifier B output
8	OUT_C	Circuit 2	Amplifier C output
9	-IN_C	Circuit 1	Amplifier C inverting input
10	+IN_C	Circuit 1	Amplifier C non-inverting input
11	V-	Circuit 3	Negative power supply
12	+IN_D	Circuit 1	Amplifier D non-inverting input
13	-IN_D	Circuit 1	Amplifier D inverting input
14	OUT_D	Circuit 2	Amplifier D output



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## Absolute Maximum Ratings

Maximum Supply Voltage	42V
Maximum Supply Voltage (LET = 73.9 MeV • cm <sup>2</sup> /mg)	40V
Maximum Differential Input Current	20mA
Maximum Differential Input Voltage	20V
Min/Max Input Voltage	V <sub>-</sub> - 0.5V to V <sub>+</sub> + 0.5V
Max/Min Input current for Input Voltage >V <sub>+</sub> or <V <sub>-</sub>	±20mA
Output Short-Circuit Duration (1 output at a time)	Indefinite
ESD Rating	
Human Body Model (Tested per MIL-PRF-883 3015.7)	2kV
Machine Model (Tested per EIA/JESD22-A115-A)	300V
Charged Device Model (Tested per JESD22-C101D)	2kV

## Thermal Information

Thermal Resistance (Typical)	$\theta_{JA}$ (°C/W)	$\theta_{JC}$ (°C/W)
14 Ld Flatpack (Notes 3, 4)	105	15
Maximum Storage Temperature Range	-65°C to +150°C	
Maximum Junction Temperature (T <sub>JMAX</sub> )	+150°C	
Pb-Free Reflow Profile	see link below <a href="http://www.intersil.com/pbfree/Pb-FreeReflow.asp">http://www.intersil.com/pbfree/Pb-FreeReflow.asp</a>	

## Recommended Operating Conditions

Ambient Operating Temperature Range	-55°C to +125°C
Maximum Operating Junction Temperature	+150°C
Supply Voltage	4.5V (±2.25V) to 30V (±15V)

**CAUTION:** Do not operate at or near the maximum ratings listed for extended periods of time. Exposure to such conditions may adversely impact product reliability and result in failures not covered by warranty.

### NOTES:

- $\theta_{JA}$  is measured with the component mounted on a low effective thermal conductivity test board in free air. See Tech Brief [TB379](#) for details.
- For  $\theta_{JC}$ , the "case temp" location is the center of the ceramic on the package underside.

**Electrical Specifications** V<sub>S</sub> ± 15V, V<sub>CM</sub> = 0, V<sub>O</sub> = 0V, T<sub>A</sub> = +25°C, unless otherwise noted. **Boldface limits apply over the operating temperature range, -55°C to +125°C; over a total ionizing dose of 300krad(Si) with exposure at a high dose rate of 50 - 300krad(Si)/s; and over a total ionizing dose of 50krad(Si) with exposure a low dose rate of <10mrad(Si)/s.**

PARAMETER	DESCRIPTION	CONDITIONS	MIN (Note 5)	TYP	MAX (Note 5)	UNIT
V <sub>OS</sub>	Input Offset Voltage			10	75	μV
					<b>110</b>	μV
TCV <sub>OS</sub>	Offset Voltage Drift			0.1	<b>1</b>	μV/°C
I <sub>B</sub>	Input Bias Current		-1	0.08	<b>1</b>	nA
			<b>-5</b>		<b>5</b>	nA
TCI <sub>B</sub>	Input Bias Current Temperature Coefficient		<b>-5</b>	<b>1</b>	<b>5</b>	pA/°C
I <sub>OS</sub>	Input Offset Current		-1.5	0.08	1.5	nA
			<b>-3</b>		<b>3</b>	nA
TCI <sub>OS</sub>	Input Offset Current Temperature Coefficient		<b>-3</b>	<b>0.42</b>	<b>3</b>	pA/°C
V <sub>CM</sub>	Input Voltage Range	Guaranteed by CMRR test	<b>-13</b>		<b>13</b>	V
CMRR	Common-Mode Rejection Ratio	V <sub>CM</sub> = -13V to +13V	120	145		dB
			<b>120</b>			dB
PSRR	Power Supply Rejection Ratio	V <sub>S</sub> = ±2.25V to ±20V	120	145		dB
			<b>120</b>			dB
A <sub>VOL</sub>	Open-Loop Gain	V <sub>O</sub> = -13V to +13V, R <sub>L</sub> = 10kΩ to ground	3,000	14,000		V/mV
V <sub>OH</sub>	Output Voltage High	R <sub>L</sub> = 10kΩ to ground	13.5	13.7		V
			<b>13.2</b>			V
		R <sub>L</sub> = 2kΩ to ground	13.3	13.55		V
			<b>13.0</b>			V
V <sub>OL</sub>	Output Voltage Low	R <sub>L</sub> = 10kΩ to ground		-13.7	-13.5	V
					<b>-13.2</b>	V
		R <sub>L</sub> = 2kΩ to ground		-13.55	-13.3	V
					<b>-13.0</b>	V

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**Electrical Specifications**  $V_S \pm 15V$ ,  $V_{CM} = 0$ ,  $V_O = 0V$ ,  $T_A = +25^\circ C$ , unless otherwise noted. **Boldface limits apply over the operating temperature range,  $-55^\circ C$  to  $+125^\circ C$ ; over a total ionizing dose of 300krad(Si) with exposure at a high dose rate of 50 - 300krad(Si)/s; and over a total ionizing dose of 50krad(Si) with exposure at a low dose rate of  $<10$ mrad(Si)/s. (Continued)**

PARAMETER	DESCRIPTION	CONDITIONS	MIN (Note 5)	TYP	MAX (Note 5)	UNIT
$I_S$	Supply Current/Amplifier			0.44	0.53	mA
					<b>0.68</b>	mA
$I_{SC}$	Short-Circuit Current			43		mA
$V_{SUPPLY}$	Supply Voltage Range	Guaranteed by PSRR	<b><math>\pm 2.25</math></b>		<b><math>\pm 20</math></b>	V
<b>AC SPECIFICATIONS</b>						
GBWP	Gain Bandwidth Product	$A_V = 1k$ , $R_L = 2k\Omega$		1.5		MHz
$e_{nV_{p-p}}$	Voltage Noise $V_{p-p}$	0.1Hz to 10Hz		0.25		$\mu V_{p-p}$
$e_n$	Voltage Noise Density	$f = 10Hz$		10		nV/ $\sqrt{Hz}$
$e_n$	Voltage Noise Density	$f = 100Hz$		8.2		nV/ $\sqrt{Hz}$
$e_n$	Voltage Noise Density	$f = 1kHz$		8		nV/ $\sqrt{Hz}$
$e_n$	Voltage Noise Density	$f = 10kHz$		8		nV/ $\sqrt{Hz}$
$i_n$	Current Noise Density	$f = 1kHz$		0.1		pA/ $\sqrt{Hz}$
THD + N	Total Harmonic Distortion	1kHz, $G = 1$ , $V_O = 3.5V_{RMS}$ , $R_L = 2k\Omega$		0.0009		%
		1kHz, $G = 1$ , $V_O = 3.5V_{RMS}$ , $R_L = 10k\Omega$		0.0005		%
<b>TRANSIENT RESPONSE</b>						
SR	Slew Rate, $V_{OUT}$ 20% to 80%	$A_V = 11$ , $R_L = 2k\Omega$ , $V_O = 4V_{p-p}$	0.3	0.5		V/ $\mu s$
			<b>0.2</b>			V/ $\mu s$
$t_r$ , $t_f$ Small Signal	Rise Time 10% to 90% of $V_{OUT}$	$A_V = 1$ , $V_{OUT} = 50mV_{p-p}$ , $R_L = 10k\Omega$ to $V_{CM}$		130	450	ns
					<b>625</b>	ns
	Fall Time 90% to 10% of $V_{OUT}$	$A_V = 1$ , $V_{OUT} = 50mV_{p-p}$ , $R_L = 10k\Omega$ to $V_{CM}$		130	600	ns
					<b>700</b>	ns
$t_s$	Settling Time to 0.1% 10V Step; 10% to $V_{OUT}$	$A_V = -1$ , $V_{OUT} = 10V_{p-p}$ , $R_L = 5k\Omega$ to $V_{CM}$		21		$\mu s$
	Settling Time to 0.01% 10V Step; 10% to $V_{OUT}$	$A_V = -1$ , $V_{OUT} = 10V_{p-p}$ , $R_L = 5k\Omega$ to $V_{CM}$		24		$\mu s$
	Settling Time to 0.1% 4V Step; 10% to $V_{OUT}$	$A_V = -1$ , $V_{OUT} = 4V_{p-p}$ , $R_L = 5k\Omega$ to $V_{CM}$		13		$\mu s$
	Settling Time to 0.01% 4V Step; 10% to $V_{OUT}$	$A_V = -1$ , $V_{OUT} = 4V_{p-p}$ , $R_L = 5k\Omega$ to $V_{CM}$		18		$\mu s$
$t_{OL}$	Output Positive Overload Recovery Time	$A_V = -100$ , $V_{IN} = 0.2V_{p-p}$ , $R_L = 2k\Omega$ to $V_{CM}$		5.6		$\mu s$
	Output Negative Overload Recovery Time	$A_V = -100$ , $V_{IN} = 0.2V_{p-p}$ , $R_L = 2k\Omega$ to $V_{CM}$		10.6		$\mu s$
OS+	Positive Overshoot	$A_V = 1$ , $V_{OUT} = 10V_{p-p}$ , $R_f = 0\Omega$ , $R_L = 2k\Omega$ to $V_{CM}$		15		%
					<b>33</b>	%
OS-	Negative Overshoot	$A_V = 1$ , $V_{OUT} = 10V_{p-p}$ , $R_f = 0\Omega$ , $R_L = 2k\Omega$ to $V_{CM}$		15		%
					<b>33</b>	%

# ISL70417SEH

**Electrical Specifications**  $V_S \pm 5V$ ,  $V_{CM} = 0$ ,  $V_O = 0V$ ,  $T_A = +25^\circ C$ , unless otherwise noted. **Boldface limits apply over the operating temperature range,  $-55^\circ C$  to  $+125^\circ C$ ; over a total ionizing dose of 300krad(Si) with exposure at a high dose rate of 50 - 300krad(Si)/s; and over a total ionizing dose of 50krad(Si) with exposure a low dose rate of  $<10$ mrad(Si)/s.**

PARAMETER	DESCRIPTION	CONDITIONS	MIN (Note 5)	TYP	MAX (Note 5)	UNIT
V <sub>OS</sub>	Input Offset Voltage			10	150	μV
					<b>250</b>	μV
TCV <sub>OS</sub>	Offset Voltage Drift			0.1	<b>1</b>	μV/°C
I <sub>B</sub>	Input Bias Current		-1	0.18	1	nA
			<b>-5</b>		<b>5</b>	nA
TCI <sub>B</sub>	Input Bias Current Temperature Coefficient		<b>-5</b>	<b>1</b>	<b>5</b>	pA/°C
I <sub>OS</sub>	Input Offset Current		-1.5	0.3	1.5	nA
			<b>-3</b>		<b>3</b>	nA
TCI <sub>OS</sub>	Input Offset Current Temperature Coefficient		<b>-3</b>	<b>0.42</b>	<b>3</b>	pA/°C
V <sub>CM</sub>	Input Voltage Range		<b>-3</b>		<b>3</b>	V
CMRR	Common-Mode Rejection Ratio	V <sub>CM</sub> = -3V to +3V	120	145		dB
			<b>120</b>			dB
PSRR	Power Supply Rejection Ratio	V <sub>S</sub> = ±2.25V to ±5V	120	145		dB
			<b>120</b>			dB
A <sub>VOL</sub>	Open-Loop Gain	V <sub>O</sub> = -3.0V to +3.0V R <sub>L</sub> = 10kΩ to ground	3,000	14,000		V/mV
V <sub>OH</sub>	Output Voltage High	R <sub>L</sub> = 10kΩ to ground	3.5	3.7		V
			<b>3.2</b>			V
		R <sub>L</sub> = 2kΩ to ground	3.3	3.55		V
			<b>3.0</b>			V
V <sub>OL</sub>	Output Voltage Low	R <sub>L</sub> = 10kΩ to ground		-3.7	-3.5	V
					<b>-3.2</b>	V
		R <sub>L</sub> = 2kΩ to ground		-3.55	-3.3	V
					<b>-3.0</b>	V
I <sub>S</sub>	Supply Current/Amplifier			0.44	0.53	mA
					<b>0.68</b>	mA
I <sub>SC</sub>	Short-Circuit Current			43		mA
<b>AC SPECIFICATIONS</b>						
GBWP	Gain Bandwidth Product	A <sub>V</sub> = 1k, R <sub>L</sub> = 2kΩ		1.5		MHz
e <sub>np-p</sub>	Voltage Noise	0.1Hz to 10Hz		0.25		μV <sub>p-p</sub>
e <sub>n</sub>	Voltage Noise Density	f = 10Hz		12		nV/√Hz
e <sub>n</sub>	Voltage Noise Density	f = 100Hz		8.6		nV/√Hz
e <sub>n</sub>	Voltage Noise Density	f = 1kHz		8		nV/√Hz
e <sub>n</sub>	Voltage Noise Density	f = 10kHz		8		nV/√Hz
i <sub>n</sub>	Current Noise Density	f = 1kHz		0.1		pA/√Hz
<b>TRANSIENT RESPONSE</b>						
SR	Slew Rate, V <sub>OUT</sub> 20% to 80%	A <sub>V</sub> = 11, R <sub>L</sub> = 2kΩ, V <sub>O</sub> = 4V <sub>p-p</sub>		0.5		V/μs

# ISL70417SEH

**Electrical Specifications**  $V_S \pm 5V$ ,  $V_{CM} = 0$ ,  $V_O = 0V$ ,  $T_A = +25^\circ C$ , unless otherwise noted. **Boldface limits apply over the operating temperature range,  $-55^\circ C$  to  $+125^\circ C$ ; over a total ionizing dose of 300krad(Si) with exposure at a high dose rate of 50 - 300krad(Si)/s; and over a total ionizing dose of 50krad(Si) with exposure a low dose rate of  $<10\text{mrad(Si)}/s$ .** (Continued)

PARAMETER	DESCRIPTION	CONDITIONS	MIN (Note 5)	TYP	MAX (Note 5)	UNIT
$t_r$ , $t_f$ , Small Signal	Rise Time 10% to 90% of $V_{OUT}$	$A_V = 1$ , $V_{OUT} = 50\text{mV}_{P-P}$ , $R_L = 10\text{k}\Omega$ to $V_{CM}$		130		ns
	Fall Time 90% to 10% of $V_{OUT}$	$A_V = 1$ , $V_{OUT} = 50\text{mV}_{P-P}$ , $R_L = 10\text{k}\Omega$ to $V_{CM}$		130		ns
$t_s$	Settling Time to 0.1% 4V Step; 10% to $V_{OUT}$	$A_V = -1$ , $V_{OUT} = 4\text{V}_{P-P}$ , $R_L = 5\text{k}\Omega$ to $V_{CM}$		12		$\mu\text{s}$
	Settling Time to 0.01% 4V Step; 10% to $V_{OUT}$	$A_V = -1$ , $V_{OUT} = 4\text{V}_{P-P}$ , $R_L = 5\text{k}\Omega$ to $V_{CM}$		19		$\mu\text{s}$
$t_{OL}$	Output Positive Overload Recovery Time	$A_V = -100$ , $V_{IN} = 0.2\text{V}_{P-P}$ , $R_L = 2\text{k}\Omega$ to $V_{CM}$		7		$\mu\text{s}$
	Output Negative Overload Recovery Time	$A_V = -100$ , $V_{IN} = 0.2\text{V}_{P-P}$ , $R_L = 2\text{k}\Omega$ to $V_{CM}$		5.8		$\mu\text{s}$
OS+	Positive Overshoot	$A_V = 1$ , $V_{OUT} = 10\text{V}_{P-P}$ , $R_f = 0\Omega$ , $R_L = 2\text{k}\Omega$ to $V_{CM}$		15		%
OS-	Negative Overshoot	$A_V = 1$ , $V_{OUT} = 10\text{V}_{P-P}$ , $R_f = 0\Omega$ , $R_L = 2\text{k}\Omega$ to $V_{CM}$		15		%

NOTE:

- Compliance to datasheet limits is assured by one or more methods: production test, characterization and/or design.

## Typical Performance Curves $V_S = \pm 15V, V_{CM} = 0V, R_L = \text{Open}, T_A = +25^\circ\text{C}$ , unless otherwise specified.

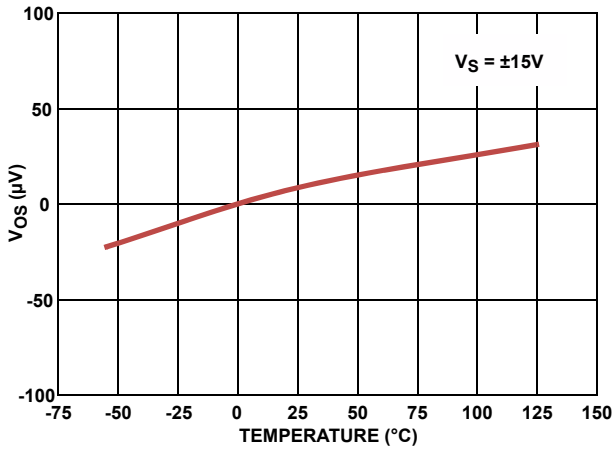


FIGURE 3.  $V_{OS}$  vs TEMPERATURE

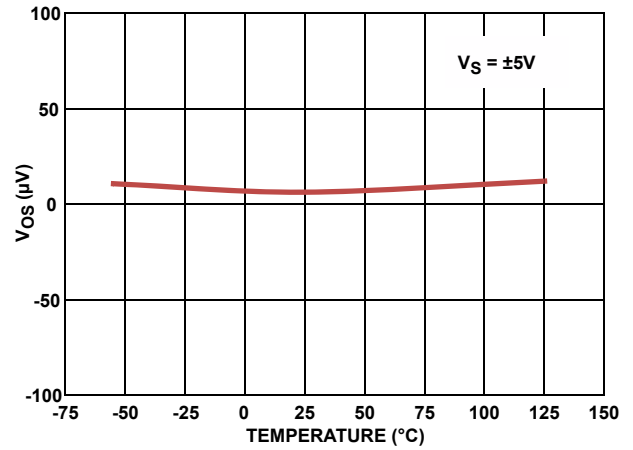


FIGURE 4.  $V_{OS}$  vs TEMPERATURE

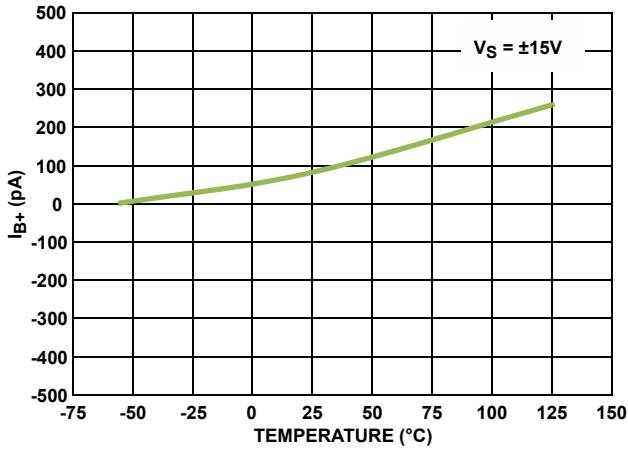


FIGURE 5.  $I_{B+}$  vs TEMPERATURE

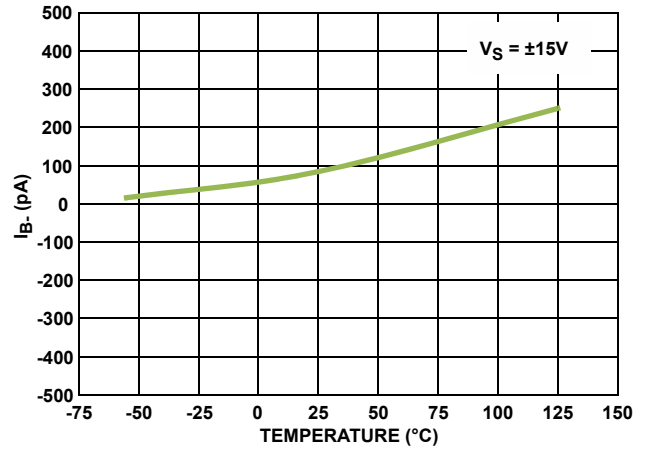


FIGURE 6.  $I_{B-}$  vs TEMPERATURE

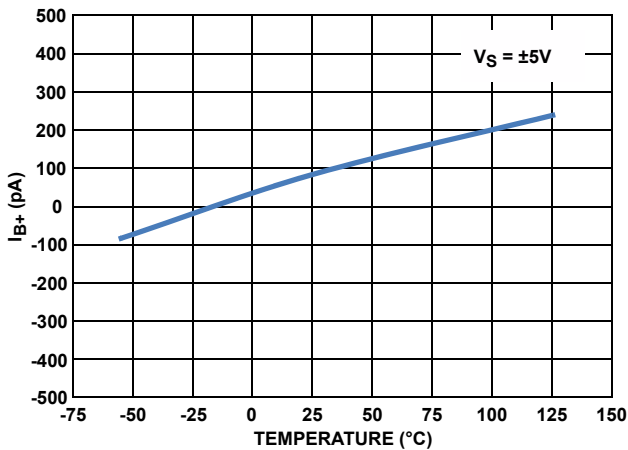


FIGURE 7.  $I_{B+}$  vs TEMPERATURE

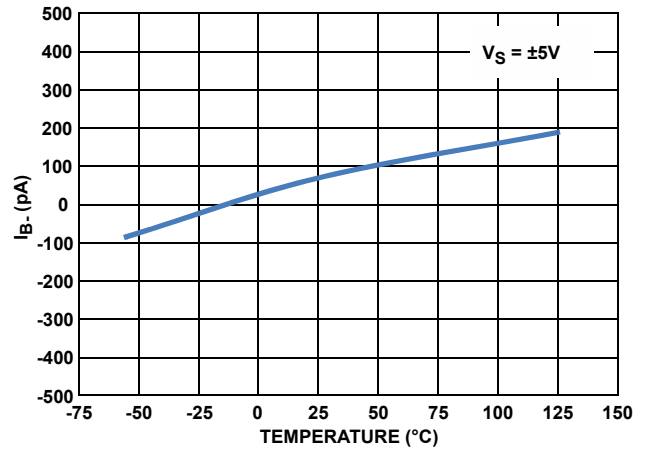


FIGURE 8.  $I_{B-}$  vs TEMPERATURE



# ISL70417SEH

## Typical Performance Curves $V_S = \pm 15V, V_{CM} = 0V, R_L = \text{Open}, T_A = +25^\circ\text{C}$ , unless otherwise specified. (Continued)

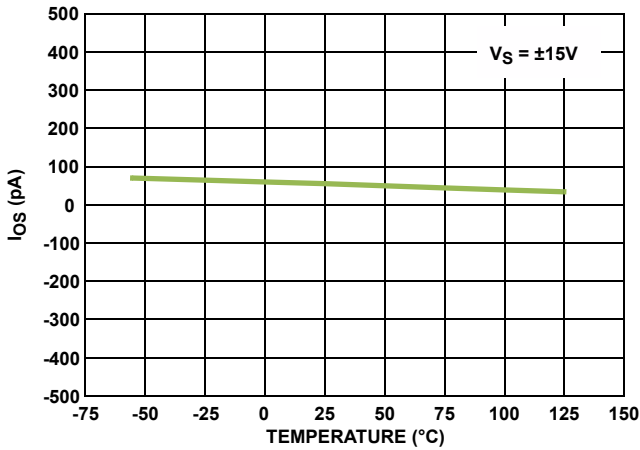


FIGURE 9.  $I_{OS}$  vs TEMPERATURE

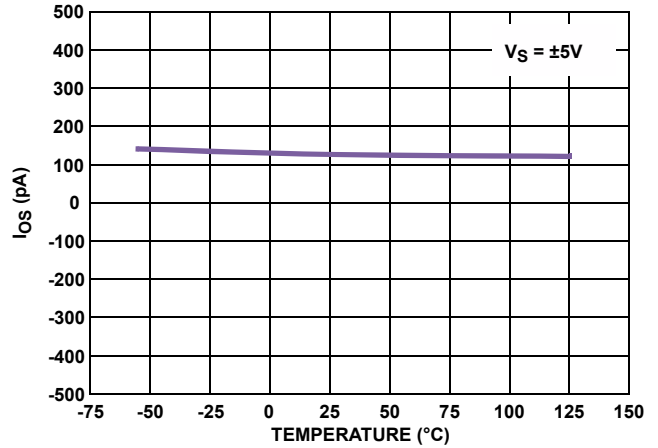


FIGURE 10.  $I_{OS}$  vs TEMPERATURE

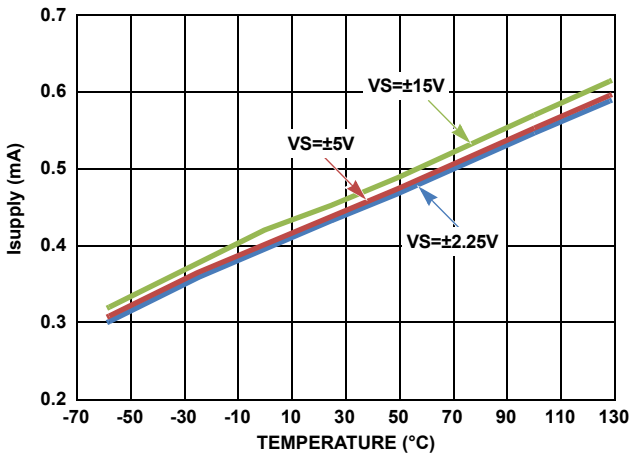


FIGURE 11. SUPPLY CURRENT PER AMP vs TEMPERATURE

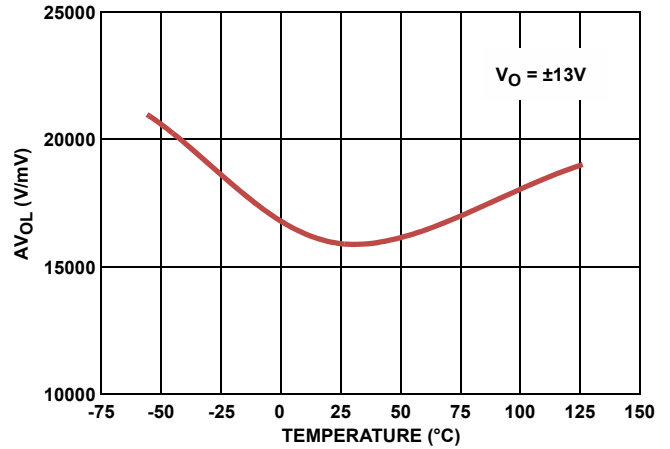


FIGURE 12.  $AV_{OL}$  vs TEMPERATURE

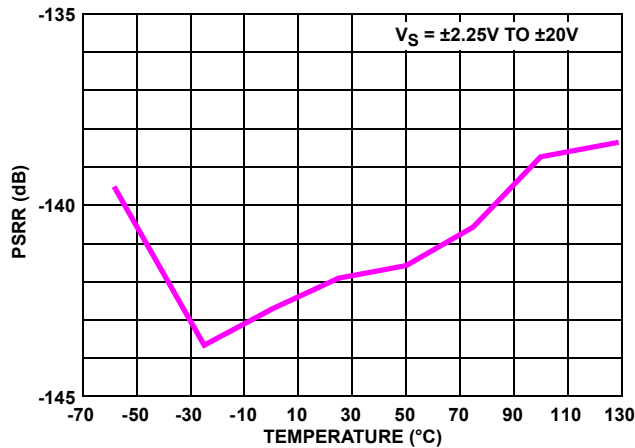


FIGURE 13. PSRR vs TEMPERATURE

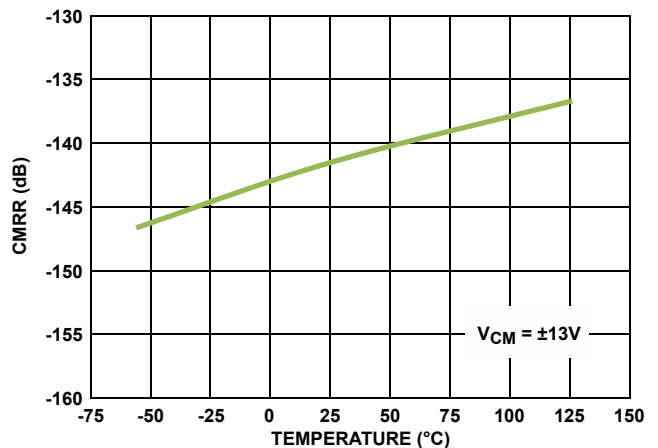


FIGURE 14. CMRR vs TEMPERATURE

# ISL70417SEH

## Typical Performance Curves $V_S = \pm 15V, V_{CM} = 0V, R_L = \text{Open}, T_A = +25^\circ C$ , unless otherwise specified. (Continued)

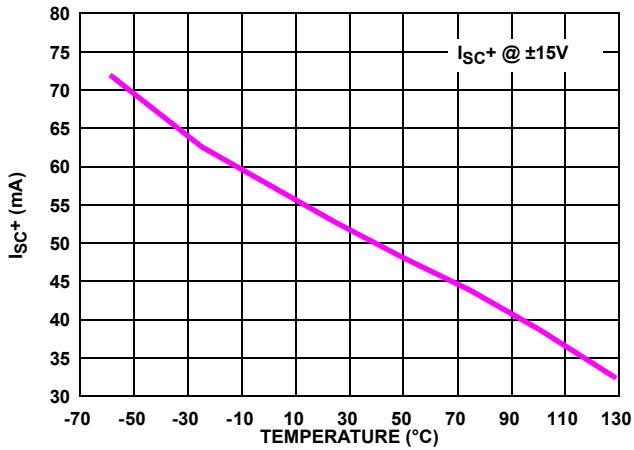


FIGURE 15. SHORT CIRCUIT CURRENT vs TEMPERATURE

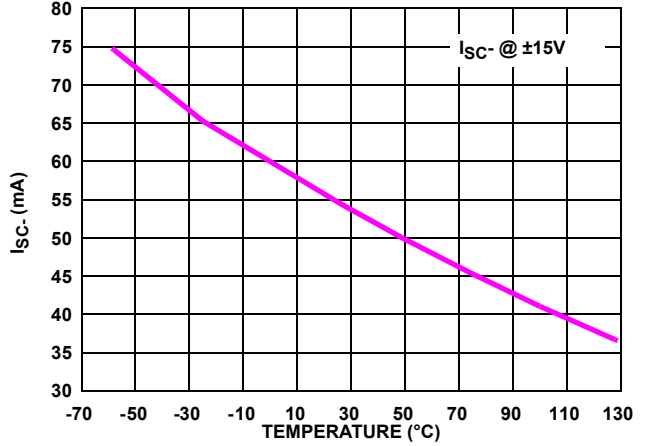


FIGURE 16. SHORT CIRCUIT CURRENT vs TEMPERATURE

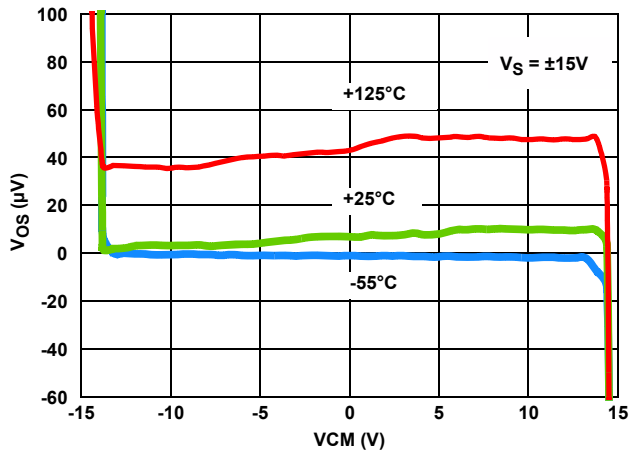


FIGURE 17. INPUT  $V_{OS}$  vs INPUT COMMON MODE VOLTAGE,  $V_S = \pm 15V$

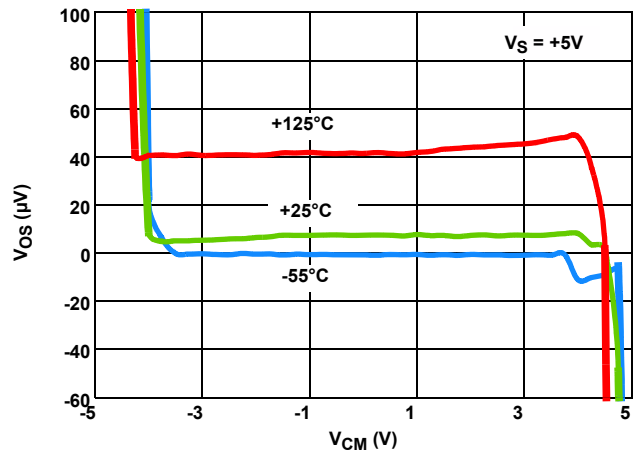


FIGURE 18. INPUT  $V_{OS}$  vs INPUT COMMON MODE VOLTAGE,  $V_S = \pm 5V$

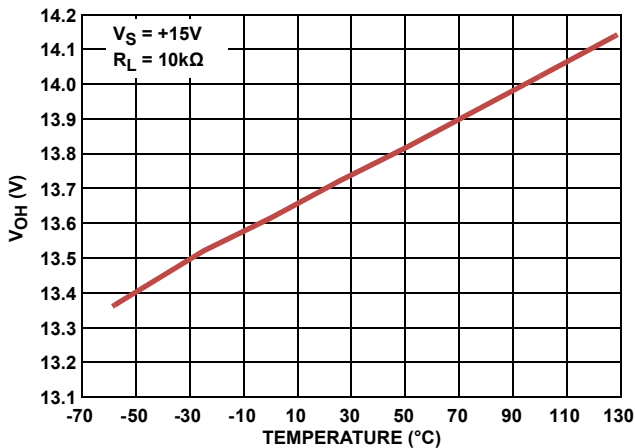


FIGURE 19.  $V_{OH}$  vs TEMPERATURE

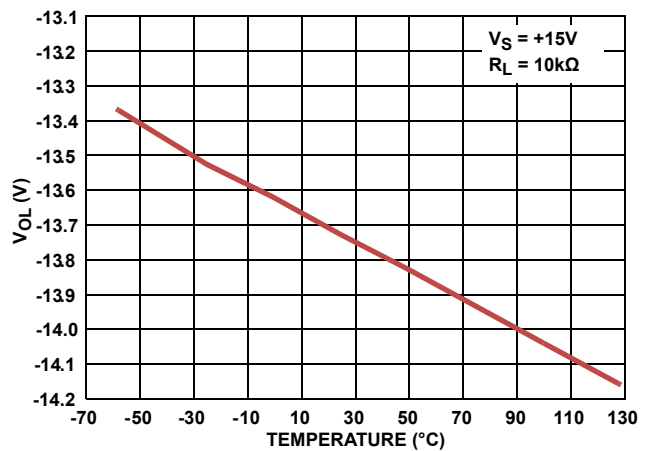


FIGURE 20.  $V_{OL}$  vs TEMPERATURE

## Typical Performance Curves $V_S = \pm 15V, V_{CM} = 0V, R_L = \text{Open}, T_A = +25^\circ\text{C}$ , unless otherwise specified. (Continued)

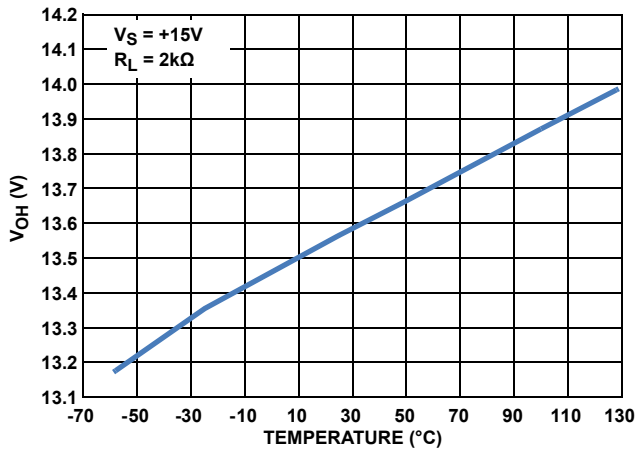


FIGURE 21.  $V_{OH}$  vs TEMPERATURE

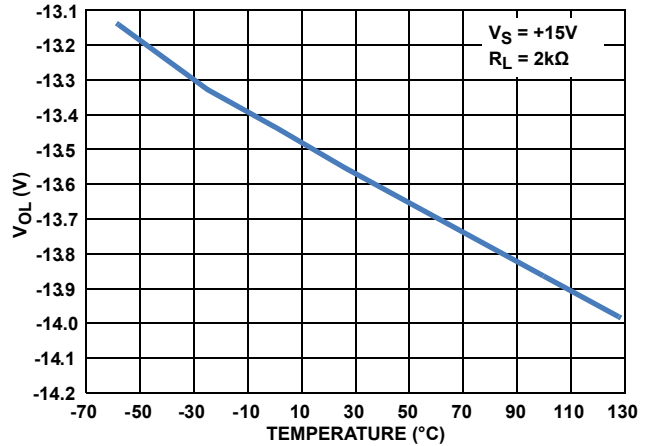


FIGURE 22.  $V_{OL}$  vs TEMPERATURE

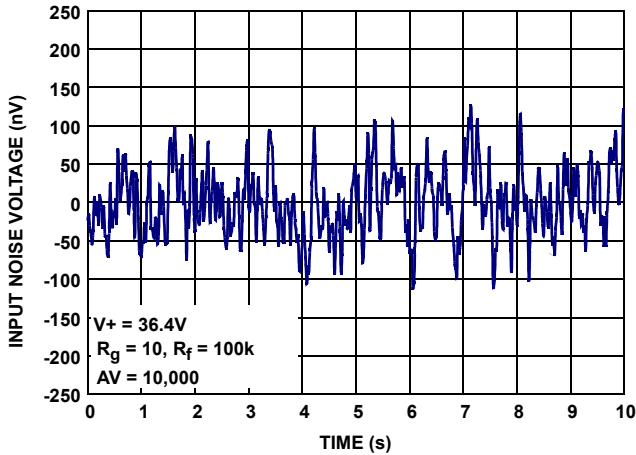


FIGURE 23. INPUT NOISE VOLTAGE 0.1Hz to 10Hz

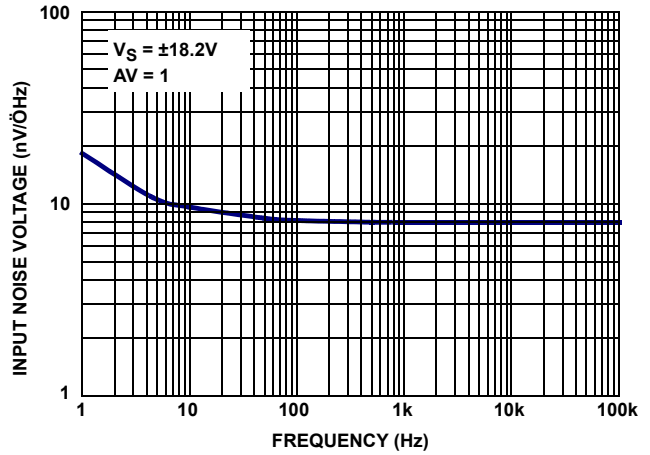


FIGURE 24. INPUT NOISE VOLTAGE SPECTRAL DENSITY

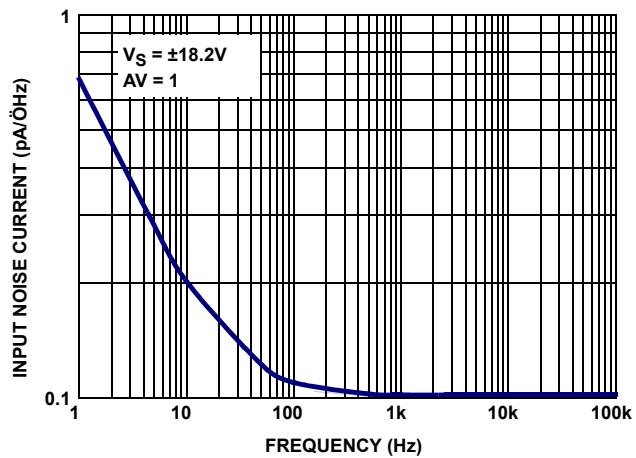


FIGURE 25. INPUT NOISE CURRENT SPECTRAL DENSITY

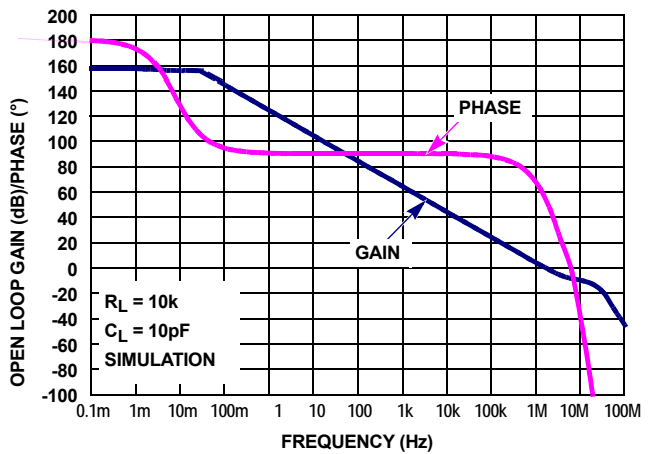


FIGURE 26. OPEN-LOOP GAIN, PHASE vs FREQUENCY,  $R_L = 10k\Omega, C_L = 10pF$

## Typical Performance Curves $V_S = \pm 15V, V_{CM} = 0V, R_L = \text{Open}, T_A = +25^\circ C$ , unless otherwise specified. (Continued)

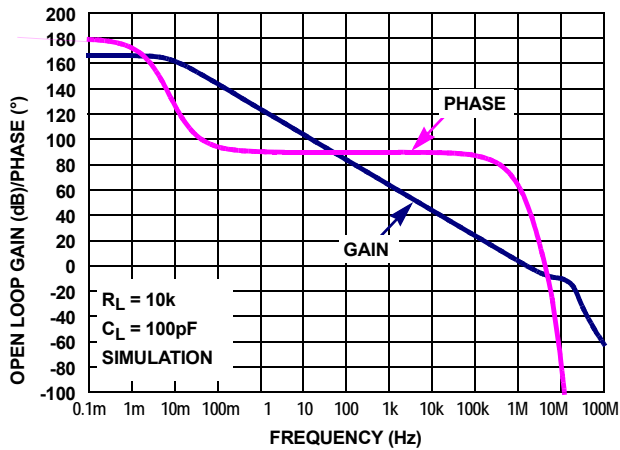


FIGURE 27. OPEN-LOOP GAIN, PHASE vs FREQUENCY,  $R_L = 10k\Omega, C_L = 100pF$

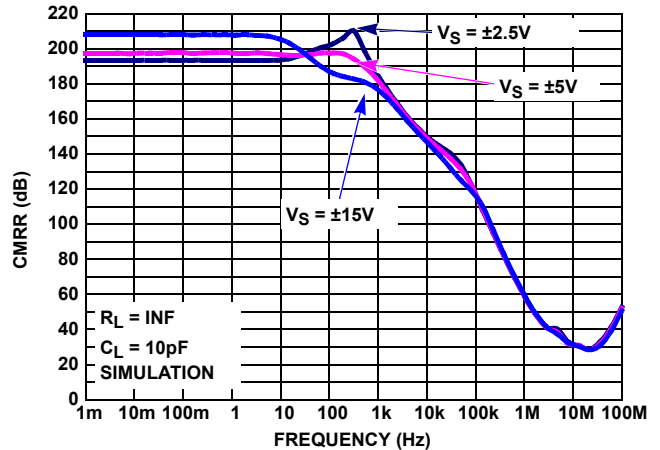


FIGURE 28. CMRR vs FREQUENCY,  $V_S = \pm 2.25, \pm 5V, \pm 15V$

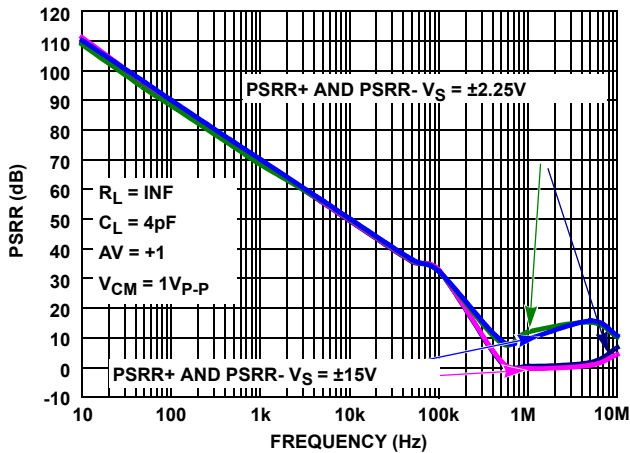


FIGURE 29. PSRR vs FREQUENCY,  $V_S = \pm 5V, \pm 15V$

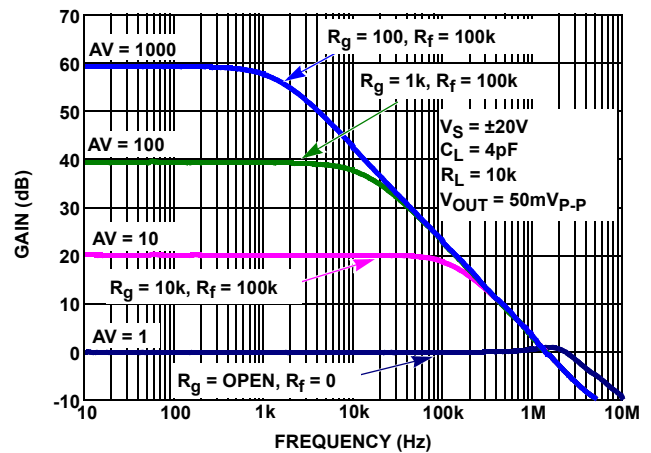


FIGURE 30. FREQUENCY RESPONSE vs CLOSED LOOP GAIN

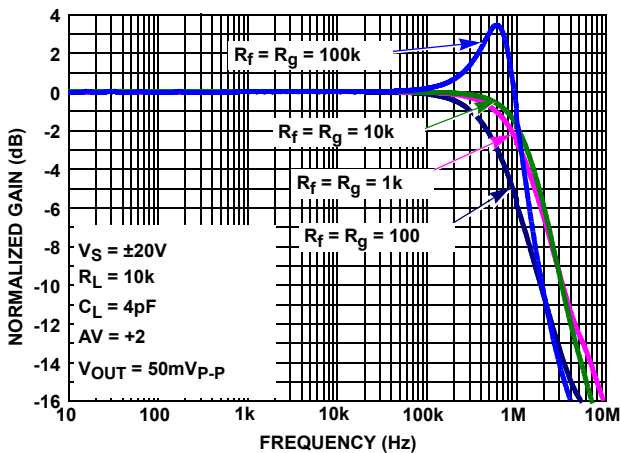


FIGURE 31. FREQUENCY RESPONSE vs FEEDBACK RESISTANCE  $R_f/R_g$

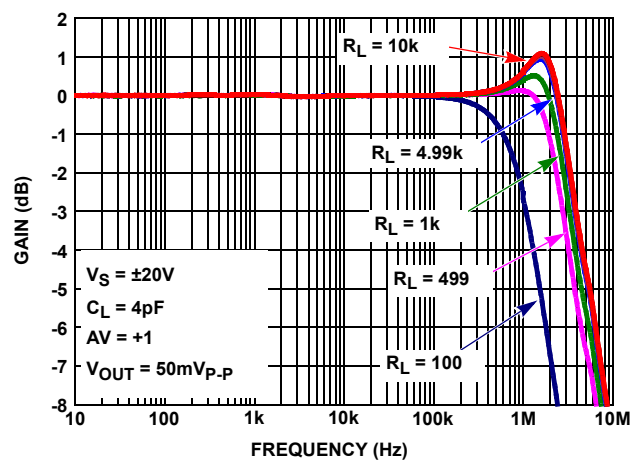


FIGURE 32. GAIN vs FREQUENCY vs  $R_L$

## Typical Performance Curves $V_S = \pm 15V, V_{CM} = 0V, R_L = \text{Open}, T_A = +25^\circ C$ , unless otherwise specified. (Continued)

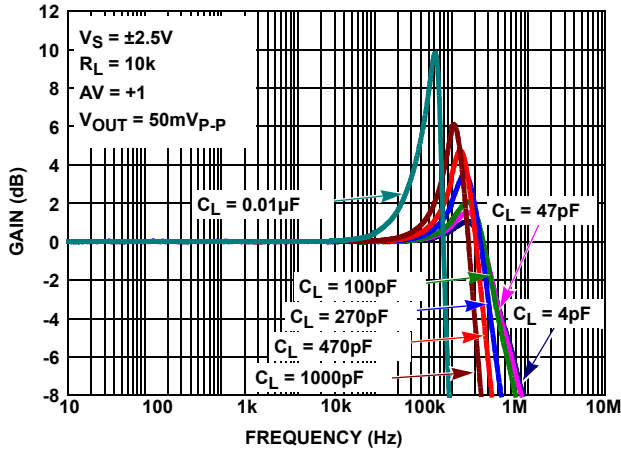


FIGURE 33. GAIN vs FREQUENCY vs  $C_L$

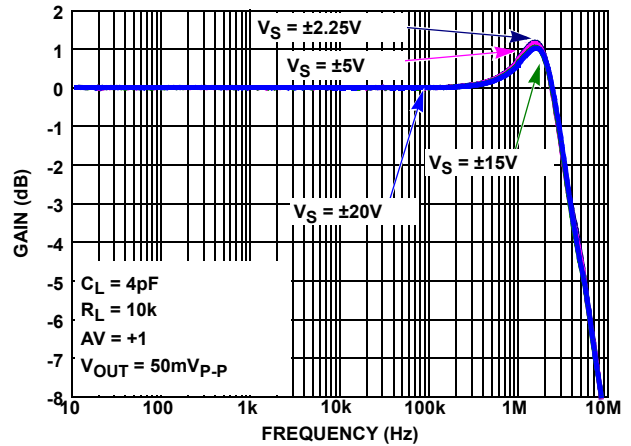


FIGURE 34. GAIN vs FREQUENCY vs SUPPLY VOLTAGE

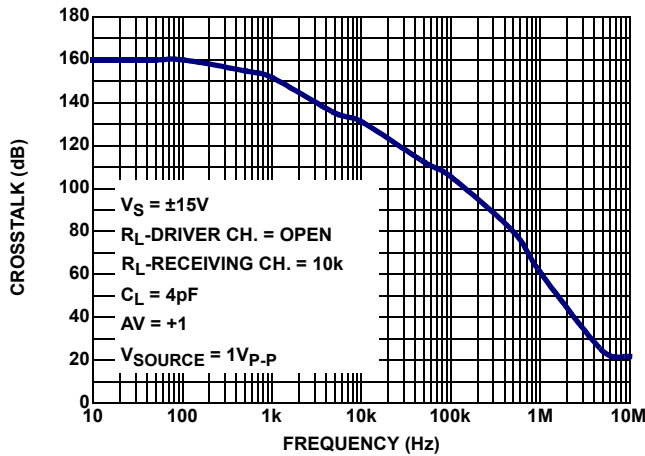


FIGURE 35. CROSSTALK,  $V_S = \pm 15V$

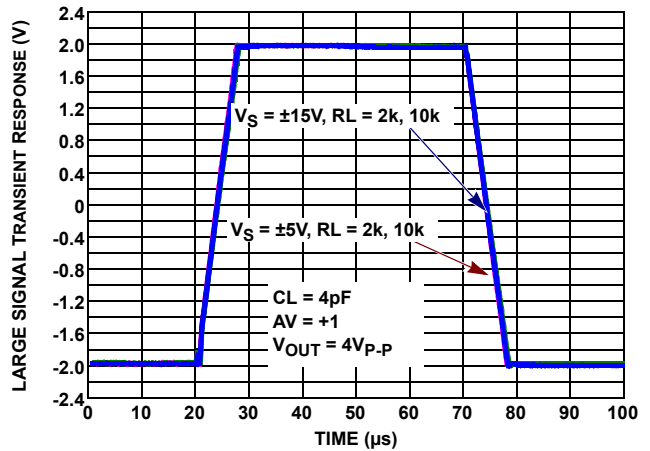


FIGURE 36. LARGE SIGNAL TRANSIENT RESPONSE vs  $R_L$   $V_S = \pm 5V, \pm 15V$

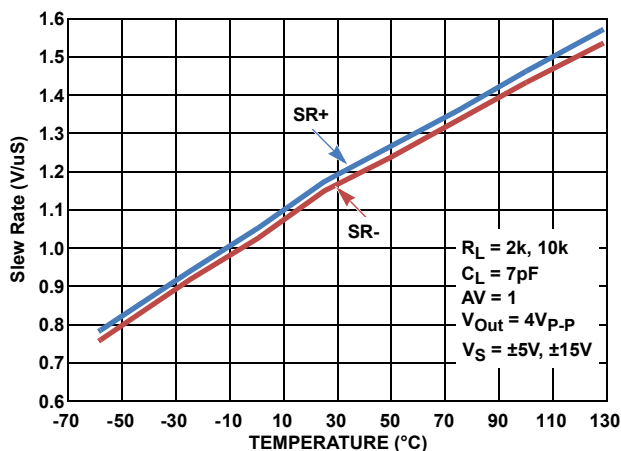


FIGURE 37. SLEW RATE vs TEMPERATURE  $V_S = \pm 5V, \pm 15V$

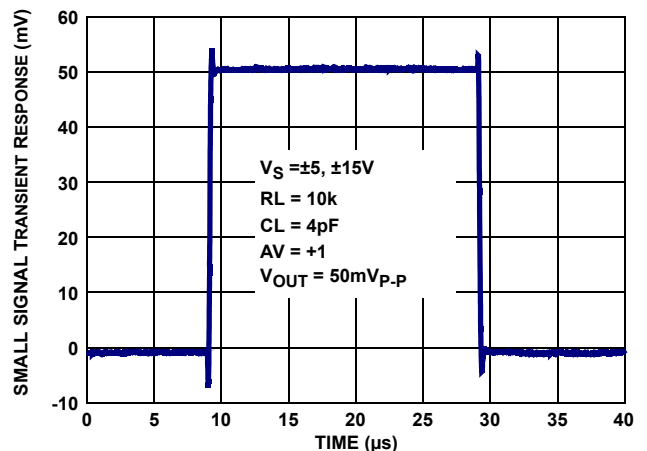


FIGURE 38. SMALL SIGNAL TRANSIENT RESPONSE,  $V_S = \pm 5V, \pm 15V$

## Typical Performance Curves $V_S = \pm 15V, V_{CM} = 0V, R_L = \text{Open}, T_A = +25^\circ C$ , unless otherwise specified. (Continued)

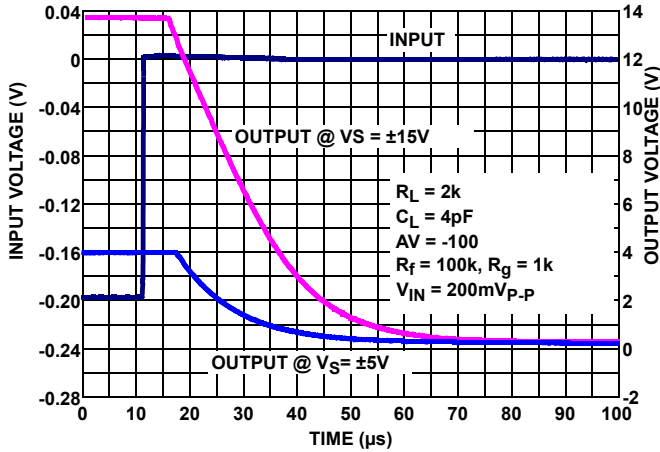


FIGURE 39. POSITIVE OUTPUT OVERLOAD RESPONSE TIME,  $V_S = \pm 5V, \pm 15V$

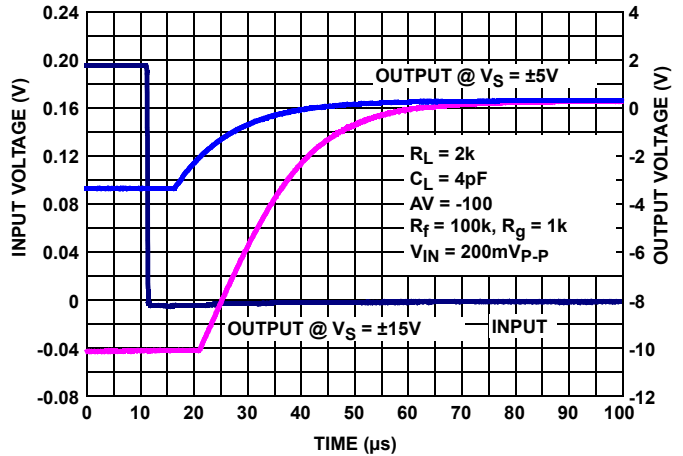


FIGURE 40. NEGATIVE OUTPUT OVERLOAD RESPONSE TIME,  $V_S = \pm 5V, \pm 15V$

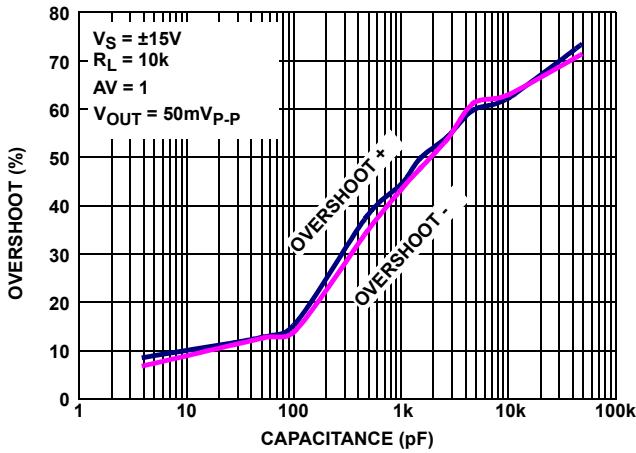


FIGURE 41. % OVERSHOOT vs LOAD CAPACITANCE,  $V_S = \pm 15V$

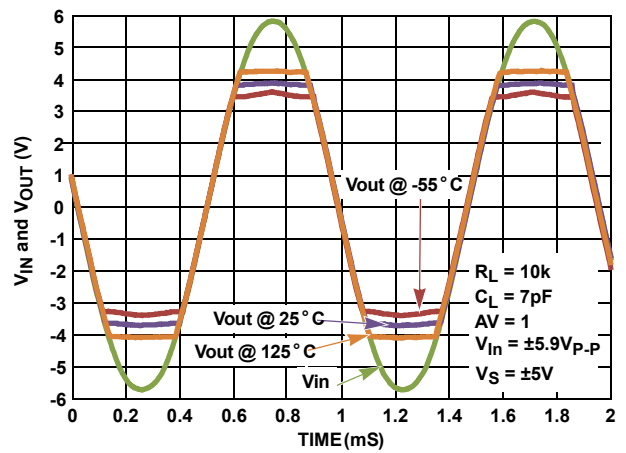


FIGURE 42. OUTPUT PHASE REVERSAL RESPONSE vs TEMPERATURE

# ISL70417SEH

**Post High Dose Radiation Characteristics** Unless otherwise specified,  $V_S \pm 15V$ ,  $V_{CM} = 0$ ,  $V_O = 0V$ ,  $T_A = +25^\circ C$ . This data is typical mean test data post radiation exposure at a high dose rate of 50 - 300rad(Si)/s. This data is intended to show typical parameter shifts due to high dose rate radiation. These are not limits nor are they guaranteed

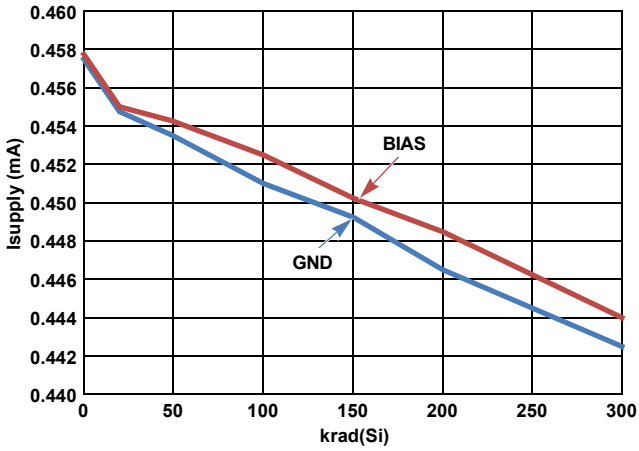


FIGURE 43. SUPPLY CURRENT PER AMP vs HIGH DOSE RATE RADIATION

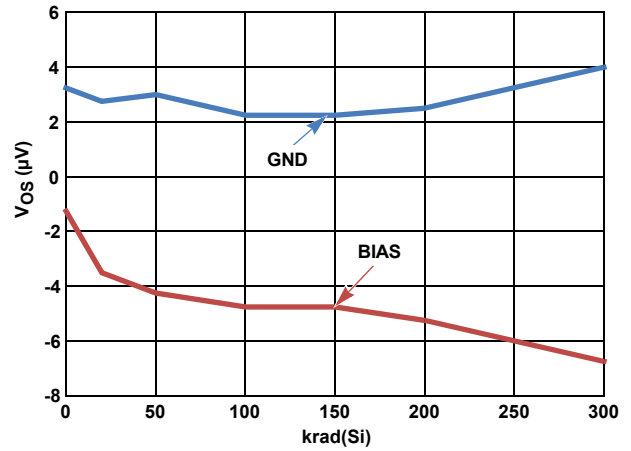


FIGURE 44.  $V_{OS}$  vs HIGH DOSE RATE RADIATION

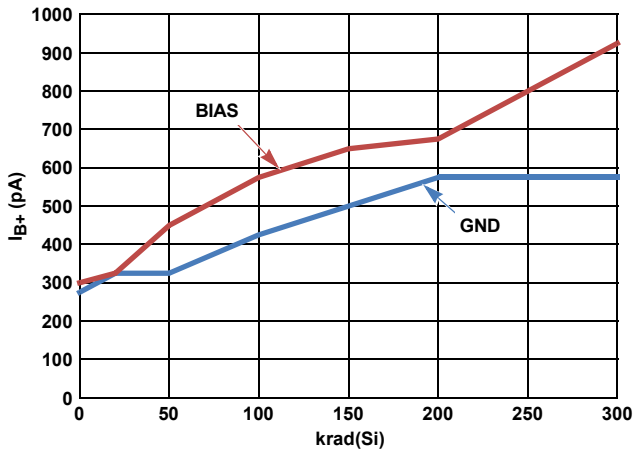


FIGURE 45.  $I_{B+}$  vs HIGH DOSE RATE RADIATION

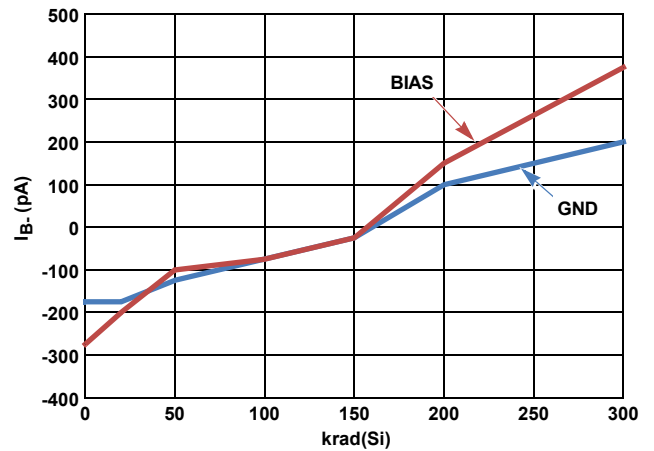


FIGURE 46.  $I_{B-}$  vs HIGH DOSE RATE RADIATION

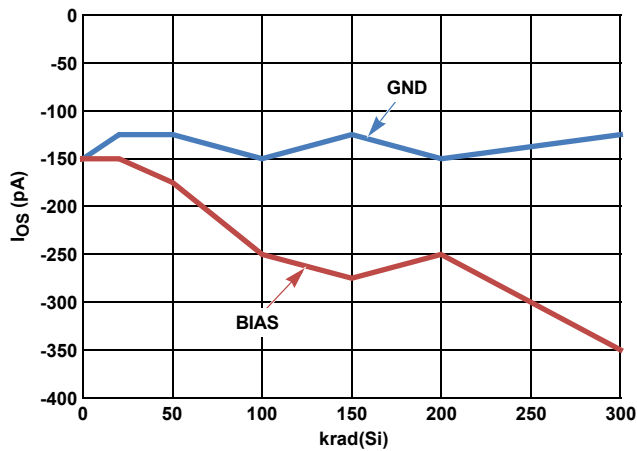


FIGURE 47.  $I_{OS}$  vs HIGH DOSE RATE RADIATION

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**Post Low Dose Radiation Characteristics** Unless otherwise specified,  $V_S \pm 15V$ ,  $V_{CM} = 0$ ,  $V_O = 0V$ ,  $T_A = +25^\circ C$ . This data is typical mean test data post radiation exposure at a low dose rate of  $<10\text{mrad}(\text{Si})/\text{s}$ . This data is intended to show typical parameter shifts due to low dose rate radiation. These are not limits nor are they guaranteed

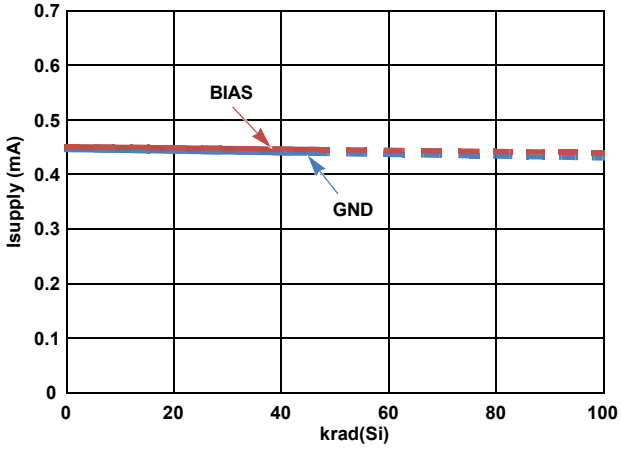


FIGURE 48. SUPPLY CURRENT PER AMP vs LOW DOSE RATE RADIATION

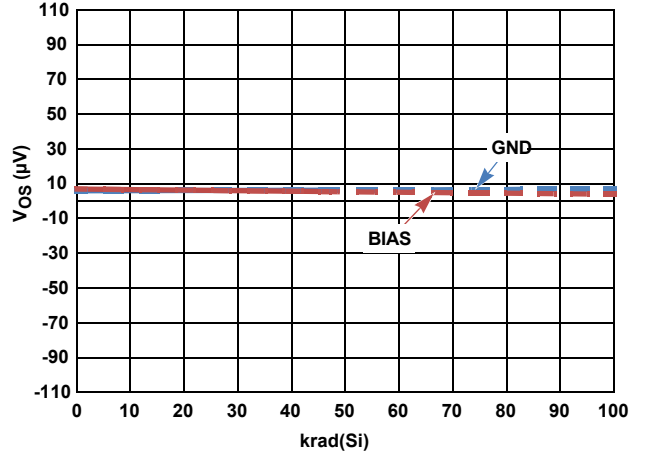


FIGURE 49.  $V_{OS}$  vs LOW DOSE RATE RADIATION

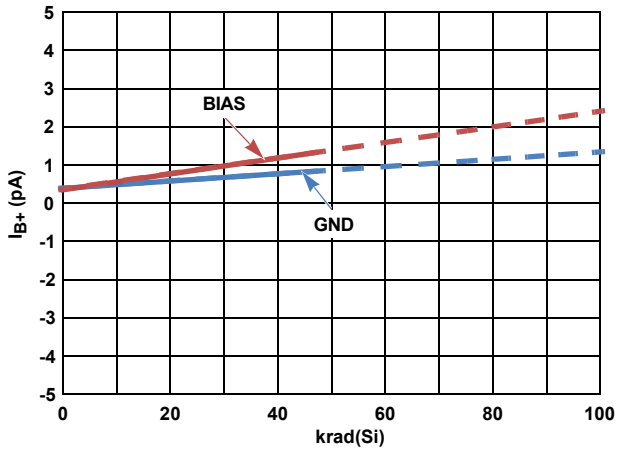


FIGURE 50.  $I_{B+}$  vs LOW DOSE RATE RADIATION

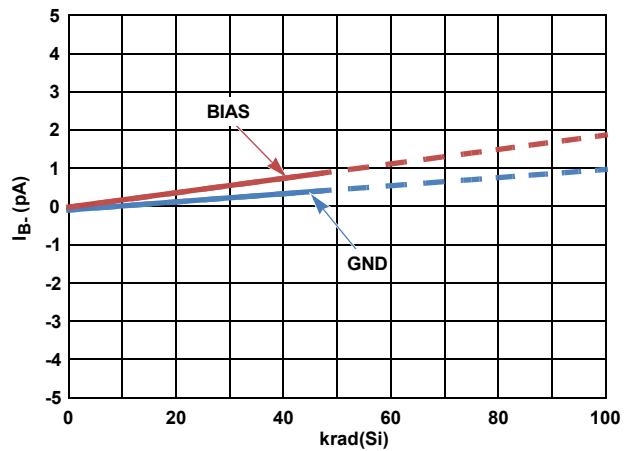


FIGURE 51.  $I_{B-}$  vs LOW DOSE RATE RADIATION

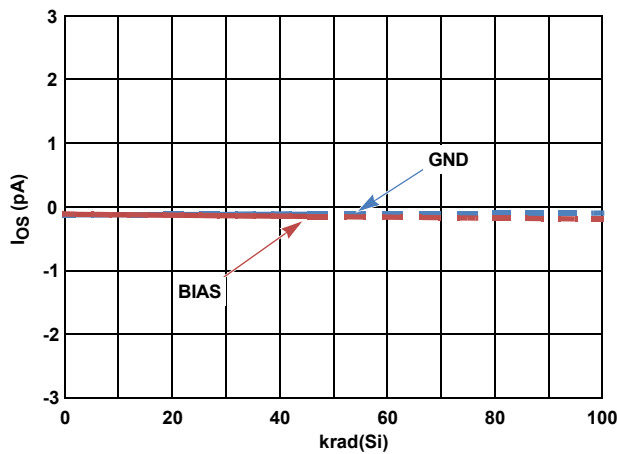


FIGURE 52.  $I_{OS}$  vs LOW DOSE RATE RADIATION



## Applications Information

### Functional Description

The ISL70417SEH contains four, low noise precision op amps. These devices are fabricated in a new precision 40V complementary bipolar DI process. A super-beta NPN input stage with input bias current cancellation provides low input bias current (180pA typical), low input offset voltage (13μV typical), low input noise voltage (8nV/√Hz), and low 1/f noise corner frequency (~8Hz). These amplifiers also feature high open loop gain (14kV/mV) for excellent CMRR (145dB) and THD+N performance (0.0005% @ 3.5V<sub>RMS</sub>, 1kHz into 2kΩ). A complementary bipolar output stage enables high capacitive load drive without external compensation.

### Operating Voltage Range

The devices are designed to operate over the 4.5V (±2.25V) to 40V (±20V) voltage range and are fully characterized at 10V (±5V) and 30V (±15V). The Power Supply Rejection Ratio typically exceeds 140dB over the full operating voltage range and 120dB minimum over the -55°C to +125°C temperature range. The worst case common mode input voltage range over temperature is 2V to each rail. With ±15V supplies, CMRR performance is typically >130dB over-temperature. The minimum CMRR performance over the -55°C to +125°C temperature range is >120dB for power supply voltages from ±5V (10V) to ±15V (30V).

### Input Performance

The super-beta NPN input pair provides excellent frequency response while maintaining high input precision. High NPN beta (>1000) reduces input bias current while maintaining good frequency response, low input bias current and low noise. Input bias cancellation circuits provide additional bias current reduction to <5nA, and excellent temperature stabilization. Figures 6 through 8 show the high degree of bias current stability at ±5V and ±15V supplies that is maintained across the -55°C to +125°C temperature range. The low bias current TC also produces very low input offset current TC, which reduces DC input offset errors in precision, high impedance amplifiers.

The +25°C maximum input offset voltage ( $V_{OS}$ ) is 75μV at ±15V supplies. Input offset voltage temperature coefficients ( $V_{OSTC}$ ) is a maximum of ±1.0μV/°C. The  $V_{OS}$  temperature behavior is smooth (Figures 3 through 4) maintaining constant TC across the entire temperature range.

### Input ESD Diode Protection

The input terminals (IN+ and IN-) have internal ESD protection diodes to the positive and negative supply rails, series connected 500Ω current limiting resistors and an anti-parallel diode pair across the inputs (Figure 53).

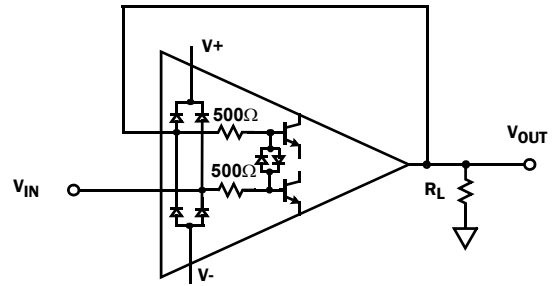


FIGURE 53. INPUT ESD DIODE CURRENT LIMITING- UNITY GAIN

The series resistors limit the high feed-through currents that can occur in pulse applications when the input  $dV/dT$  exceeds the 0.5V/μs slew rate of the amplifier. Without the series resistors, the input can forward-bias the anti-parallel diodes causing current to flow to the output resulting in severe distortion and possible diode failure.

Figure 36 provides an example of distortion free large signal response using a 4V<sub>P-P</sub> input pulse with an input rise time of <1ns. The series resistors enable the input differential voltage to be equal to the maximum power supply voltage (40V) without damage.

In applications where one or both amplifier input terminals are at risk of exposure to high voltages beyond the power supply rails, current limiting resistors may be needed at the input terminal to limit the current through the power supply ESD diodes to 20mA max.

### Output Current Limiting

The output current is internally limited to approximately ±45mA at +25°C and can withstand a short circuit to either rail as long as the power dissipation limits are not exceeded. This applies to only 1 amplifier at a time for the quad op amp. Continuous operation under these conditions may degrade long term reliability. Figures 15 and 16 show the current limit variation with temperature.

### Output Phase Reversal

Output phase reversal is a change of polarity in the amplifier transfer function when the input voltage exceeds the supply voltage. The ISL70417SEH is immune to output phase reversal, even when the input voltage is 1V beyond the supplies.

### Power Dissipation

It is possible to exceed the +150°C maximum junction temperatures under certain load and power supply conditions. It is therefore important to calculate the maximum junction temperature ( $T_{JMAX}$ ) for all applications to determine if power supply voltages, load conditions, or package type need to be modified to remain in the safe operating area. These parameters are related using Equation 1:

$$T_{JMAX} = T_{MAX} + \theta_{JA} \times P_{D_{MAXTOTAL}} \quad (EQ. 1)$$

where:

- $P_{D_{MAXTOTAL}}$  is the sum of the maximum power dissipation of each amplifier in the package ( $P_{D_{MAX}}$ )

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- $PD_{MAX}$  for each amplifier can be calculated using Equation 2:

$$PD_{MAX} = V_S \times I_{qMAX} + (V_S - V_{OUTMAX}) \times \frac{V_{OUTMAX}}{R_L} \quad (EQ. 2)$$

where:

- $T_{MAX}$  = Maximum ambient temperature
- $\theta_{JA}$  = Thermal resistance of the package
- $PD_{MAX}$  = Maximum power dissipation of 1 amplifier
- $V_S$  = Total supply voltage
- $I_{qMAX}$  = Maximum quiescent supply current of 1 amplifier
- $V_{OUTMAX}$  = Maximum output voltage swing of the application

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## Package Characteristics

### Weight of Packaged Device

0.6043 Grams (Typical)

### Lid Characteristics

Finish: Gold

Potential: Unbiased

Case Isolation to Any Lead:  $20 \times 10^9 \Omega$  (min)

## Die Characteristics

### Die Dimensions

$2028\mu\text{m} \times 2568\mu\text{m}$  (80mils x 101mils)

Thickness:  $483\mu\text{m} \pm 25\mu\text{m}$  (19mils  $\pm$  1 mil)

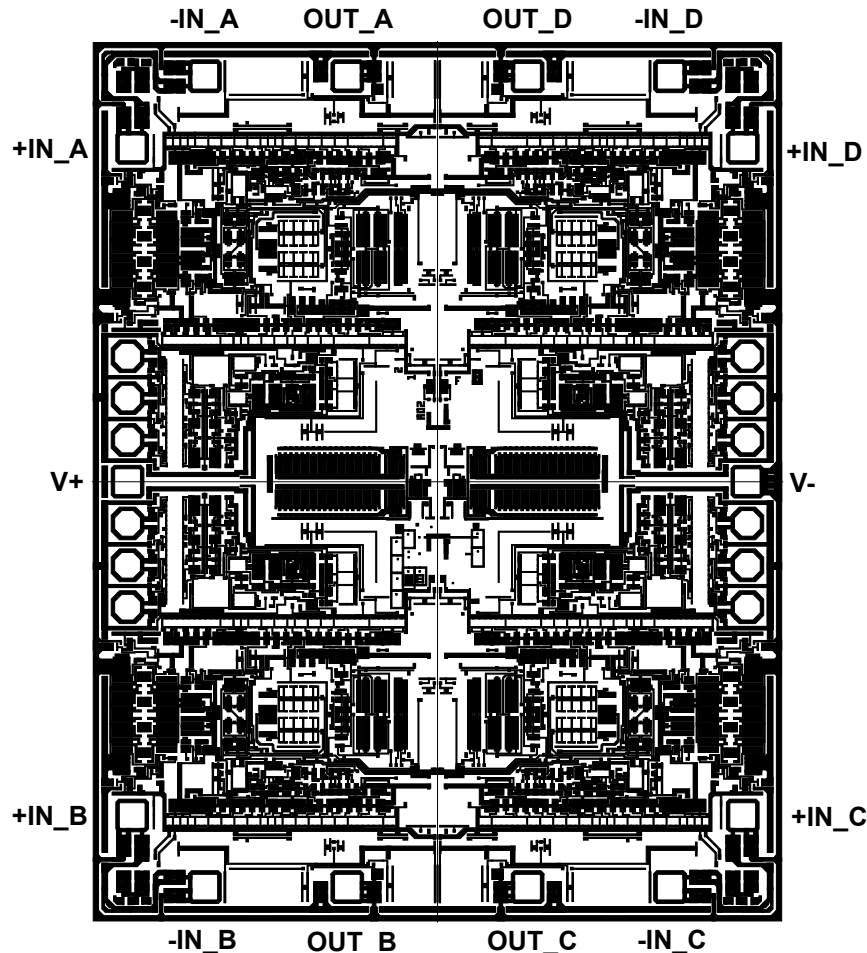
### Interface Materials

#### GLASSIVATION

Type: Nitrox

Thickness:  $15\text{k}\text{\AA}$

## Metallization Mask Layout



### TOP METALLIZATION

Type: AlCu (99.5%/0.5%)

Thickness:  $30\text{k}\text{\AA}$

### BACKSIDE FINISH

Silicon

### PROCESS

Dielectrically Isolated Complementary Bipolar - PR40

## ASSEMBLY RELATED INFORMATION

### SUBSTRATE POTENTIAL

Floating

## ADDITIONAL INFORMATION

### WORST CASE CURRENT DENSITY

$< 2 \times 10^5 \text{ A/cm}^2$

# ISL70417SEH

TABLE 1. DIE LAYOUT X-Y COORDINATES

PAD NAME	PAD NUMBER	X ( $\mu\text{m}$ )	Y ( $\mu\text{m}$ )	dX ( $\mu\text{m}$ )	dY ( $\mu\text{m}$ )	BOND WIRES PER PAD
OUT_A	3	-256	1152	70	70	1
-IN_A	4	-661	1152	70	70	1
+IN_A	5	-867.5	948.5	70	70	1
V+	9	-880.5	0	70	70	1
+IN_B	13	-867.5	-948.5	70	70	1
-IN_B	14	-661	-1152	70	70	1
OUT_B	15	-256	-1152	70	70	1
OUT_C	16	256	-1152	70	70	1
-IN_C	17	661	-1152	70	70	1
+IN_C	18	867.5	-948.5	70	70	1
V-	22	880.5	0	70	70	1
+IN_D	26	867.5	948.5	70	70	1
-IN_D	1	661	1152	70	70	1
OUT_D	2	256	1152	70	70	1

NOTE:

6. Origin of coordinates is the center of die.

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## Revision History

The revision history provided is for informational purposes only and is believed to be accurate, but not warranted. Please go to web to make sure you have the latest Revision.

DATE	REVISION	CHANGE
July 2, 2012	FN7962.0	Initial Release

## Products

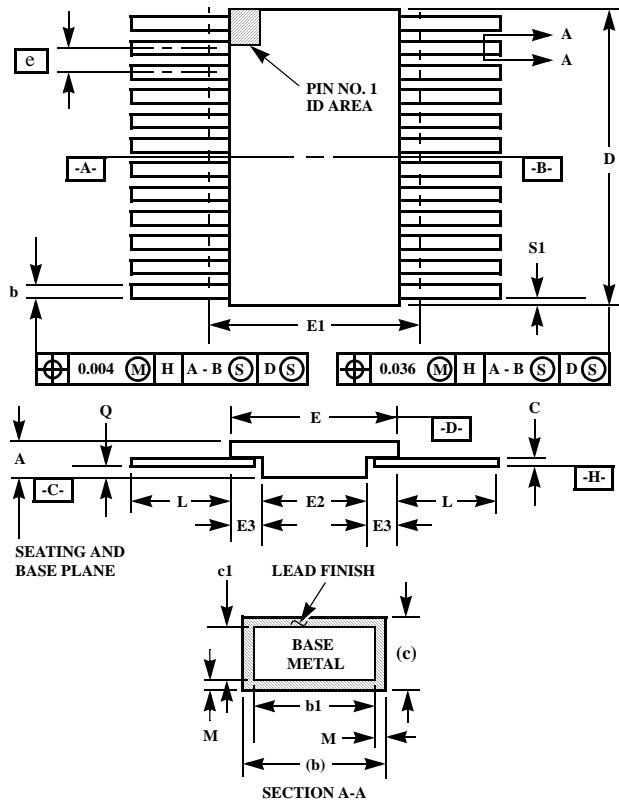
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For a complete listing of Applications, Related Documentation and Related Parts, please see the respective device information page on intersil.com: [ISL70417SEH](http://www.intersil.com/ISL70417SEH)

To report errors or suggestions for this datasheet, please go to [www.intersil.com/askourstaff](http://www.intersil.com/askourstaff)

FITs are available from our website at <http://rel.intersil.com/reports/search.php>

## Package Outline Drawing Ceramic Metal Seal Flatpack Packages (Flatpack)



**K14.A MIL-STD-1835 CDFP3-F14 (F-2A, CONFIGURATION B)  
14 LEAD CERAMIC METAL SEAL FLATPACK PACKAGE**

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	0.045	0.115	1.14	2.92	-
b	0.015	0.022	0.38	0.56	-
b1	0.015	0.019	0.38	0.48	-
c	0.004	0.009	0.10	0.23	-
c1	0.004	0.006	0.10	0.15	-
D	-	0.390	-	9.91	3
E	0.235	0.260	5.97	6.60	-
E1	-	0.290	-	7.11	3
E2	0.125	-	3.18	-	-
E3	0.030	-	0.76	-	7
e	0.050 BSC		1.27 BSC		-
k	0.008	0.015	0.20	0.38	2
L	0.270	0.370	6.86	9.40	-
Q	0.026	0.045	0.66	1.14	8
S1	0.005	-	0.13	-	6
M	-	0.0015	-	0.04	-
N	14		14		-

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**NOTES:**

1. Index area: A notch or a pin one identification mark shall be located adjacent to pin one and shall be located within the shaded area shown. The manufacturer's identification shall not be used as a pin one identification mark. Alternately, a tab (dimension k) may be used to identify pin one.
2. If a pin one identification mark is used in addition to a tab, the limits of dimension k do not apply.
3. This dimension allows for off-center lid, meniscus, and glass overrun.
4. Dimensions b1 and c1 apply to lead base metal only. Dimension M applies to lead plating and finish thickness. The maximum limits of lead dimensions b and c or M shall be measured at the centroid of the finished lead surfaces, when solder dip or tin plate lead finish is applied.
5. N is the maximum number of terminal positions.
6. Measure dimension S1 at all four corners.
7. For bottom-brazed lead packages, no organic or polymeric materials shall be molded to the bottom of the package to cover the leads.
8. Dimension Q shall be measured at the point of exit (beyond the meniscus) of the lead from the body. Dimension Q minimum shall be reduced by 0.0015 inch (0.038mm) maximum when solder dip lead finish is applied.
9. Dimensioning and tolerancing per ANSI Y14.5M - 1982.
10. Controlling dimension: INCH.