10MHz, 6V/μs, Quad Rail-to-Rail Input and Output Precision C-Load Op Amp

DESCRIPTION

The RH1499 is a quad, rail-to-rail input and output precision C-Load™ op amp with a 10MHz gain-bandwidth product and a 6V/μs slew rate.

The RH1499 is designed to maximize input dynamic range by delivering precision performance over the full supply voltage. Using a patented technique, the input stages of the RH1499 are trimmed, one at the negative supply and the other at the positive supply. The resulting guaranteed common mode rejection is much better than other rail-to-rail input op amps. When used as a unity-gain buffer in front of single supply 12-bit A-to-D converters, the RH1499 is guaranteed to add less than 1LSB of error even in single 3V supply systems.

With 110dB of supply rejection, the RH1499 maintains its performance over a supply range of 2.2V to 36V. The inputs can be driven beyond the supplies without damage or phase reversal of the output. These op amps remain stable while driving capacitive loads up to 10,000pF.

The wafer lots are processed to Linear Technology's in-house Class S flow to yield circuits usable in stringent military and space applications.

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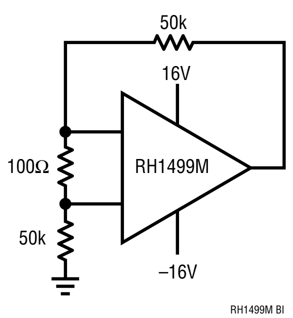
C-Load is a trademark of Linear Technology Corporation.

ABSOLUTE MAXIMUM RATINGS

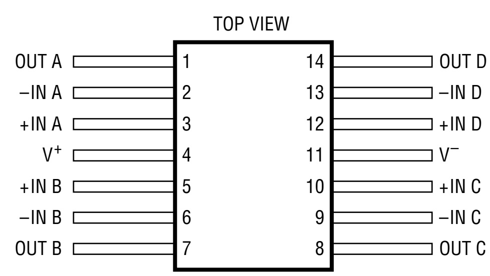
(Note 1)

Total Supply Voltage (V^+ to V^-) 36V
Input Current .... ±10mA
Output Short-Circuit Duration (Note 2) .... Continuous
Operating Temperature Range .... −55°C to 125°C
Specified Temperature Range .... −55°C to 125°C
Junction Temperature .... 150°C
Storage Temperature Range .... −65°C to 150°C
Lead Temperature (Soldering, 10 sec) .... 300°C

BURN-IN CIRCUIT



PACKAGE INFORMATION



W PACKAGE
14-LEAD CERAMIC FLATPAK

TABLE 1: ELECTRICAL CHARACTERISTICS

(Pre-Irradiation) $V_S = \pm 15V$, $V_{CM} = V_{OUT} = 0V$, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	NOTES	$T_A = 25°C$ MIN	TYP	MAX	SUB-GROUP	$-55°C \le T_A \le 125°C$ MIN	TYP	MAX	SUB-GROUP	UNITS
V_{OS}	Input Offset Voltage	$V_{CM} = V^+, V^-$ $V_{CM} = 14.5V, -14.5V$			200	800	 1		 350	 1100	 2, 3	µV µV
	Input Offset Voltage Match (Channel-to-Channel) (Note 3)	$V_{CM} = V^+$ to V^- $V_{CM} = 14.5V$ to $-14.5V$	3		250	1400			 450	 1800		µV µV
I_B	Input Bias Current	$V_{CM} = V^+$ $V_{CM} = 14.5V$ $V_{CM} = V^-$ $V_{CM} = -14.5V$		0 –715	250 –250	715 0	 1	 –1200	 500 –500	 1200 0	 2, 3	nA nA nA nA
	Input Bias Current Match (Channel-to-Channel) (Note 3)	$V_{CM} = V^+, V^-$ $V_{CM} = 14.5V, -14.5V$	3	0	12	120			 50	 400		nA nA
I_{OS}	Input Offset Current	$V_{CM} = V^+, V^-$ $V_{CM} = 14.5V, -14.5V$			6	70	 1		 40	 300	 2, 3	nA nA
	Input Voltage Range			–15		15		–14.5		14.5		V
	Input Noise Voltage	0.1Hz to 10Hz			400							nV_{P-P}
e_n	Input Noise Voltage Density	f = 1kHz			12							$nV/\sqrt{Hz}$
i_n	Input Noise Current Density	f = 1kHz			0.3							$pA/\sqrt{Hz}$
A_{VOL}	Large-Signal Voltage Gain	$V_O = -14.5V$ to $14.5V$, R1 = 10k $V_O = -10V$ to $10V$, R1 = 2k		1000 500	5200 2300		4	60 25	400 100		5, 6	V/mV V/mV
CMRR	Common Mode Rejection Ratio	$V_{CM} = V^+$ to V^- $V_{CM} = 14.5V$ to $-14.5V$		90	102		1	 86	 102		2, 3	dB dB
	CMRR Match (Channel-to-Channel) (Note 3)	$V_{CM} = V^+$ to V^- $V_{CM} = 14.5V$ to $-14.5V$	3	84	103			 80	 100			dB dB
PSRR	Power Supply Rejection Ratio	$V_S = \pm 2V$ to $\pm 16V$		90	110		1	88	100		2, 3	dB
	PSRR Match (Channel-to-Channel) (Note 3)	$V_S = \pm 2V$ to $\pm 16V$	3	83	110			82	100			dB
V_{OL}	Output Voltage Swing (Low) (Note 4)	No Load $I_{SINK} = 1mA$ $I_{SINK} = 10mA$ $I_{SINK} = 5mA$	 4		18 50 230	30 100 500	 4		25 70 180	75 150 500	 5, 6	mV mV mV mV
V_{OH}	Output Voltage Swing (High) (Note 4)	No Load $I_{SINK} = 1mA$ $I_{SINK} = 10mA$ $I_{SINK} = 5mA$	 4		2.5 75 420	10 150 800	 4		5 100 300	25 250 800	 5, 6	mV mV mV mV
I_{SC}	Short-Circuit Current			±15	±30		1	±7.5	±12		2, 3	mA
I_S	Supply Current per Amp				1.8	2.5	1		2.2	3	2, 3	mA
GBW	Gain-Bandwidth Product	f = 100kHz		6.8	10.5			5.8	8.5			MHz
SR	Slew Rate	$A_V = -1$, $R_L = 2k$, $V_O = \pm 10V$, Measure at $V_O = \pm 5V$		3.5	6		4	2.2	4		5, 6	V/µs

TABLE 1A: ELECTRICAL CHARACTERISTICS

(Post-Irradiation) V_S = ±15V, V_{CM} = 0V, T_A = 25°C, unless otherwise noted

SYMBOL	PARAMETER	CONDITIONS	NOTES	10Krad(Si) MIN	10Krad(Si) MAX	20Krad(Si) MIN	20Krad(Si) MAX	50Krad(Si) MIN	50Krad(Si) MAX	100Krad(Si) MIN	100Krad(Si) MAX	200Krad(Si) MIN	200Krad(Si) MAX	UNITS
V_{OS}	Input Offset Voltage	$V_{CM} = V^+, V^-$			950		950		950		950		950	µV
I_B	Input Bias Current	$V_{CM} = V^+, V^-$			765		815		865		915		965	nA
I_{OS}	Input Offset Current	$V_{CM} = V^+, V^-$			100		100		100		100		100	nA
	Input Voltage Range			V^-	V^+	V^-	V^+	V^-	V^+	V^-	V^+	V^-	V^+	V
A_{VOL}	Large-Signal Voltage Gain	V_O = –14.5V to 14.5V, R1 = 10k		500		500		500		500		500		V/mV
		V_O = –10V to 10V, R1 = 2k		250		250		250		250		250		V/mV
CMRR	Common Mode Rejection Ratio	$V_{CM} = V^+$ to V^-		86		86		86		86		86		dB
	CMRR Match (Channel-to-Channel)	$V_{CM} = V^+$ to V^-	3	83		83		83		83		83		dB
PSRR	Power Supply Rejection Ratio	V_S = ±2V to ±16V		90		90		90		90		90		dB
	PSRR Match (Channel-to-Channel)	V_S = ±2V to ±16V	3	83		83		83		83		83		dB
V_{OUT}	Output Voltage Swing Low	No Load I_{SINK} = 1mA I_{SINK} = 10mA	4		60 100 500		60 100 500		60 100 500		60 100 500		60 100 500	mV mV mV
	Output Voltage Swing High	No Load I_{SINK} = 1mA I_{SINK} = 10mA	4		20 150 800		20 150 800		20 150 800		20 150 800		20 150 800	mV mV mV
I_{SC}	Short-Circuit Current			±10		±10		±10		±10		±10		mA
I_S	Supply Current				2.5		2.5		2.5		2.5		2.5	mA
GBW	Gain-Bandwidth Product	f = 100kHz		4.5		4.5		4.5		4.5		4.5		MHz
SR	Slew Rate	A_V = –1, R_L = 10k, V_O = ±10V, Measure at V_O = ±5V		3		3		3		3		3		V/µs

TABLE 2: ELECTRICAL CHARACTERISTICS

(Pre-Irradiation) V_S = 3V, 5V; $V_{CM} = V_{OUT}$ = half supply, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	NOTES	$T_A = 25°C$ MIN	TYP	MAX	SUB-GROUP	$-55°C \le T_A \le 125°C$ MIN	TYP	MAX	SUB-GROUP	UNITS
V_{OS}	Input Offset Voltage	$V_{CM} = V^+, V^-$ $V_{CM} = V^+ - 0.5V, V^- + 0.5V$			150	800	 1		 300	 1100	 2, 3	µV µV
	Input Offset Voltage Match (Channel-to-Channel) (Note 3)	$V_{CM} = V^+$ to V^- $V_{CM} = V^+ - 0.5V, V^- + 0.5V$	3		200	1400			 350	 1800		µV µV
I_B	Input Bias Current	$V_{CM} = V^+$ $V_{CM} = V^+ - 0.5V$ $V_{CM} = V^-$ $V_{CM} = V^- + 0.5V$		0 –650	250 –250	650 0	 1	 0 –1100	 450 –450	 1100 0	 2, 3	nA nA nA nA
	Input Bias Current Match (Channel-to-Channel) (Note 3)	$V_{CM} = V^+, V^-$ $V_{CM} = V^+ - 0.5V, V^- + 0.5V$	 3	0	10	100		 0	 30	 400		nA nA
I_{OS}	Input Offset Current	$V_{CM} = V^+, V^-$ $V_{CM} = V^+ - 0.5V, V^- + 0.5V$			5	65	 1		 15	 300	 2, 3	nA nA
	Input Voltage Range			V^-		V^+		$V^- + 0.5V$		$V^+ - 0.5V$		V
	Input Noise Voltage	0.1Hz to 10Hz			400							nV_{P-P}
e_n	Input Noise Voltage Density	f = 1kHz			12							$nV/\sqrt{Hz}$
i_n	Input Noise Current Density	f = 1kHz			0.3							$pA/\sqrt{Hz}$
C_{IN}	Input Capacitance				5							pF
A_{VOL}	Large-Signal Voltage Gain	$V_S = 5V, V_O = 75mV$ to 4.8V, $R_L = 10k$ $V_S = 3V, V_O = 75mV$ to 2.8V, $R_L = 10k$		600 500	3800 2000		4	60 25	210 210		5, 6	V/mV V/mV
CMRR	Common Mode Rejection Ratio	$V_S = 5V, V_{CM} = V^+$ to V^- $V_S = 3V, V_{CM} = V^+$ to V^- $V_S = 5V, V_{CM} = 0.5V$ to 4.5V $V_S = 3V, V_{CM} = 0.5V$ to 2.5V		76 72	90 86		 1	 68 65	 85 85		 2, 3	dB dB dB dB
	CMRR Match (Channel-to-Channel) (Note 3)	$V_S = 5V, V_{CM} = V^+$ to V^- $V_S = 3V, V_{CM} = V^+$ to V^- $V_S = 5V, V_{CM} = 0.5V$ to 4.5V $V_S = 3V, V_{CM} = 0.5V$ to 2.5V	 3	75 70	91 86		 1	 66 62	 82		 2, 3	dB dB dB dB
PSRR	Power Supply Rejection Ratio	$V_S = 2.2V$ to 12V, $V_{CM} = V_O = 0.5V$		88	105		1	86	104		2, 3	dB
	PSRR Match (Channel-to-Channel) (Note 3)	$V_S = 2.2V$ to 12V, $V_{CM} = V_O = 0.5V$	3	82	120			80	118			dB
V_{OL}	Output Voltage Swing (Low) (Note 4)	No Load $I_{SINK} = 1mA$ $I_{SINK} = 2.5mA$	 4		14 50 90	30 100 200	 4		25 65 110	75 150 220	 5, 6	mV mV mV
V_{OH}	Output Voltage Swing (High) (Note 4)	No Load $I_{SINK} = 1mA$ $I_{SINK} = 2.5mA$	 4		2.5 70 140	10 150 250	 4		5 100 180	25 250 300	 5, 6	mV mV mV
I_{SC}	Short-Circuit Current	$V_S = 5V$ $V_S = 3V$		±12.5 ±12.0	24 19		1	±5 ±5	±10 ±9.5		2, 3	mA mA
I_S	Supply Current per Amp				1.7	2.2	1		2	2.7	2, 3	mA

TABLE 2: ELECTRICAL CHARACTERISTICS

(Pre-Irradiation) V_S = 3V, 5V; V_{CM} = V_{OUT} = half supply, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	NOTES	T_A = 25°C MIN	TYP	MAX	SUB-GROUP	−55°C ≤ T_A ≤ 125°C MIN	TYP	MAX	SUB-GROUP	UNITS
GBW	Gain-Bandwidth Product	V_S = 5V, f = 100kHz		6.8	10.5			5.8	8.5			MHz
SR	Slew Rate	V_S = ±2.5V, A_V = –1, R_L = 2k,V_O = ±2V, Measure at V_O = ±1V		2.6	4.5		4	2	3.6		5, 6	V/µs

TABLE 2A: ELECTRICAL CHARACTERISTICS

(Post-Irradiation) V_S = 5V, 3V; V_{CM} = half supply, T_A = 25°C, unless otherwise noted

SYMBOL	PARAMETER	CONDITIONS	NOTES	10Krad(Si) MIN	MAX	20Krad(Si) MIN	MAX	50Krad(Si) MIN	MAX	100Krad(Si) MIN	MAX	200Krad(Si) MIN	MAX	UNITS
V_{OS}	Input Offset Voltage	V_{CM} = V^+, $V^–$			950		950		950		950		950	µV
I_B	Input Bias Current	V_{CM} = V^+, $V^–$			700		750		809		850		900	nA
I_{OS}	Input Offset Current	V_{CM} = V^+, $V^–$			65		65		65		65		65	nA
	Input Voltage Range			$V^–$	V^+	$V^–$	V^+	$V^–$	V^+	$V^–$	V^+	$V^–$	V^+	V
A_{VOL}	Large-Signal Voltage Gain	V_O = 75mV to V^+ – 0.2V R1= 10k		300		300		300		300		300		V/mV
CMRR	Common Mode Rejection Ratio	V_{CM} = V^+ to $V^–$		70		70		70		70		70		dB
	CMRR Match (Channel-to-Channel)	V_{CM} = V^+ to $V^–$	3	70		70		70		70		70		dB
PSRR	Power Supply Rejection Ratio	V_S = 2.2V to 12V, V_{CM} = V_O = 0.5V		88		88		88		88		88		dB
	PSRR Match (Channel-to-Channel)	V_S = 2.2V to 12V, V_{CM} = V_O = 0.5V	3	82		82		82		82		82		dB
V_{OUT}	Output Voltage Swing Low	No Load I_{SINK} = 1mA I_{SINK} = 2.5mA	4		60 100 200		60 100 200		60 100 200		60 100 200		60 100 200	mV mV mV
	Output Voltage Swing High	No Load I_{SINK} = 1mA I_{SINK} = 2.5mA	4		20 150 250		20 150 250		20 150 250		20 150 250		20 150 250	mV mV mV
I_{SC}	Short-Circuit Current			±8		±8		±8		±8		±8		mA
I_S	Supply Current				2.2		2.2		2.2		2.2		2.2	mA
SR	Slew Rate	V_S = ±2.5V,A_V = –1, R_L = 10k, V_O = ±2V, Measure at V_O = ±1V		2		2		2		2		2		V/µs

Note 1: Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

Note 2: A heat sink may be required to keep the junction temperature below this absolute maximum rating when the output is shorted indefinitely.

Note 3: Matching parameters are the difference between amplifiers A and D and between B and C.

Note 4: Output voltage swings are measured between the output and power supply rails.

TABLE 2: ELECTRICAL TEST REQUIREMENTS

MIL-STD-883 TEST REQUIREMENTS	SUBGROUP
Final Electrical Test Requirements (Method 5004)	1*,2,3,4,5,6
Group A Test Requirements (Method 5005)	1,2,3,4,5,6
Group B and D for Class S, and End Point Electrical Parameters (Method 5005)	1,2,3

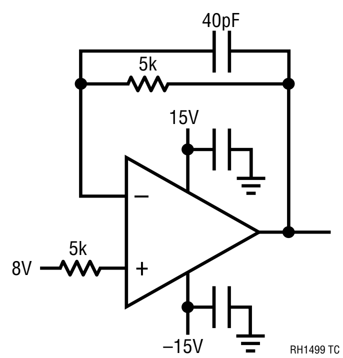
* PDA applies to subgroup 1. See PDA Test Notes.

PDA Test Notes

The PDA is specified as 5% based on failures from group A, subgroup 1, tests after cooldown as the final electrical test in accordance with method 5004 of MIL-STD-883. The verified failures of group A, subgroup 1, after burn-in divided by the total number of devices submitted for burn-in in that lot shall be used to determine the percent for the lot.

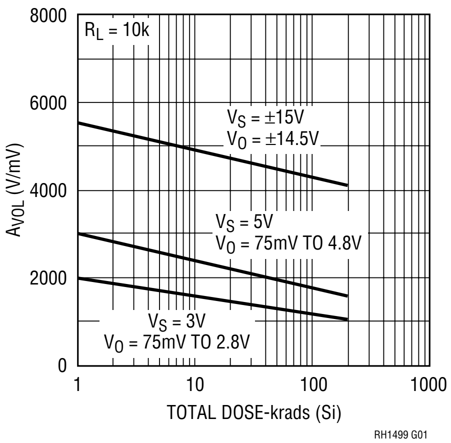
Linear Technology Corporation reserves the right to test to tighter limits than those given.

TOTAL DOSE BIAS CIRCUIT

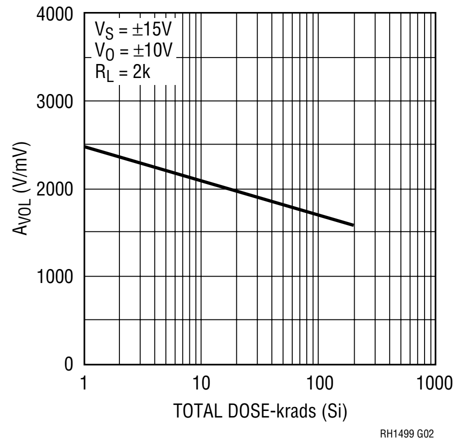


TYPICAL PERFORMANCE CHARACTERISTICS

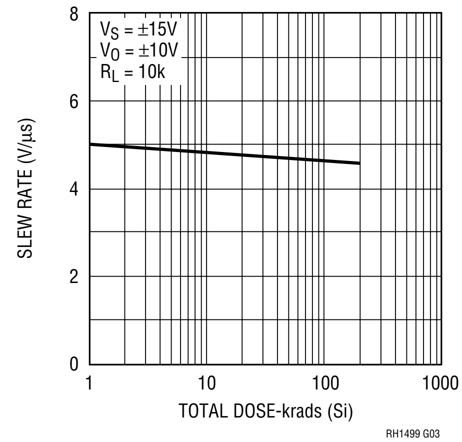
Large Signal Voltage Gain



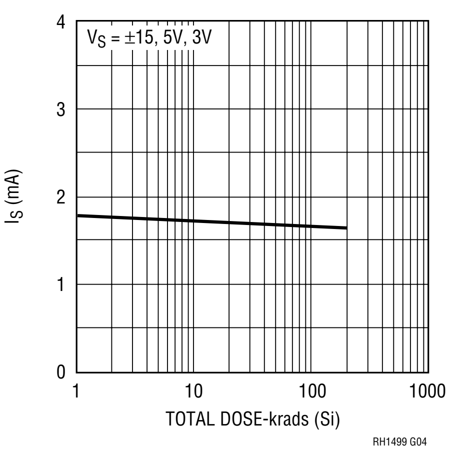
Large Signal Voltage Gain



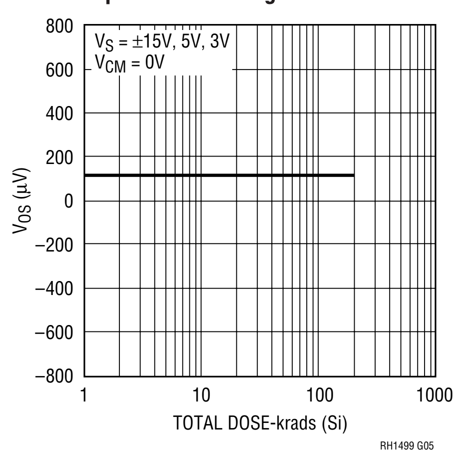
Slew Rate



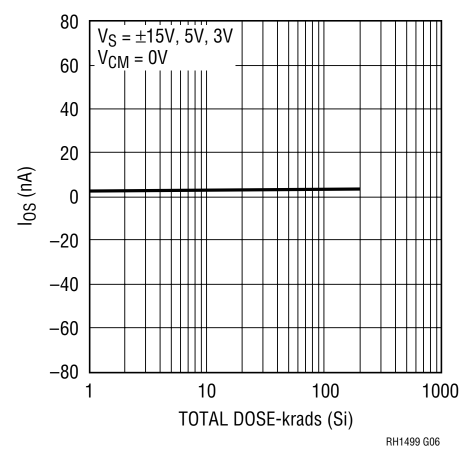
Supply Current per Amp



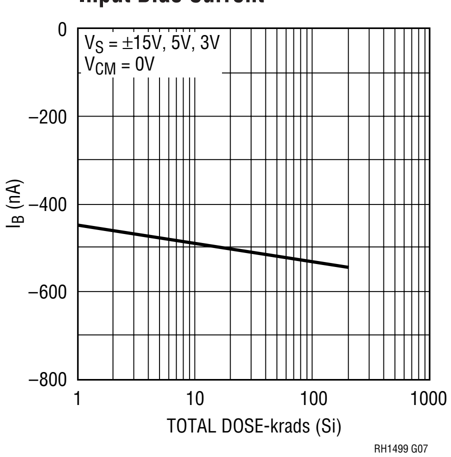
Input Offset Voltage



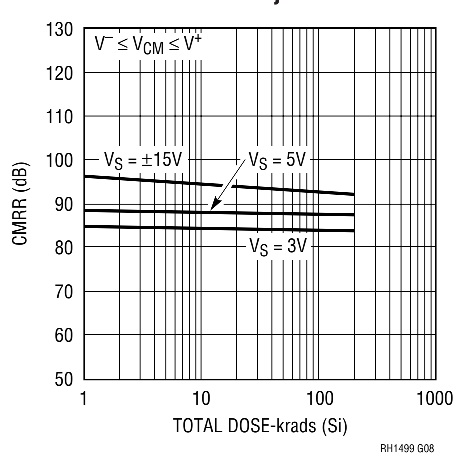
Input Offset Current



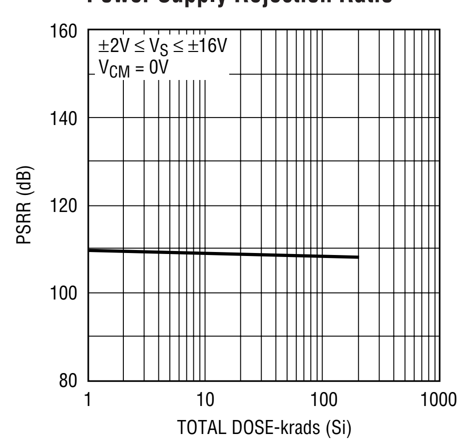
Input Bias Current



Common Mode Rejection Ratio

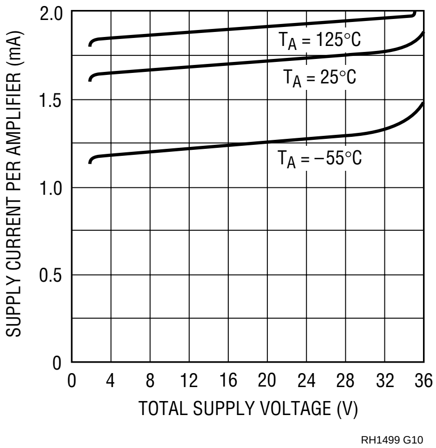


Power Supply Rejection Ratio

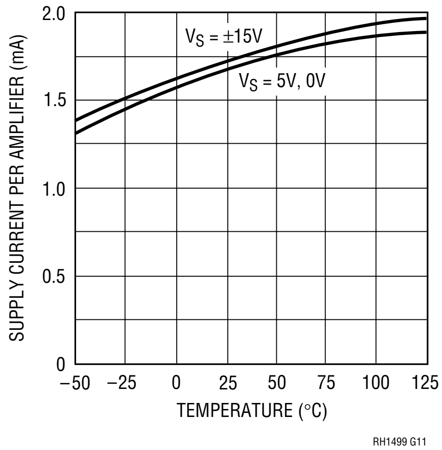


TYPICAL PERFORMANCE CHARACTERISTICS

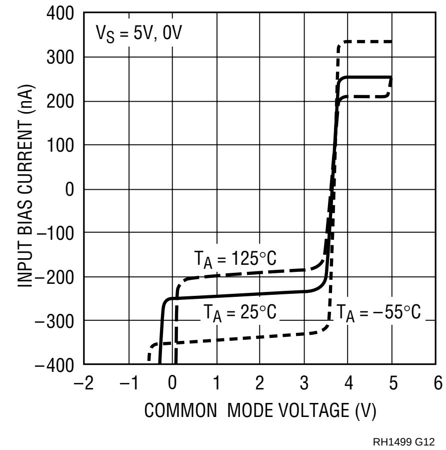
Supply Current vs Supply Voltage



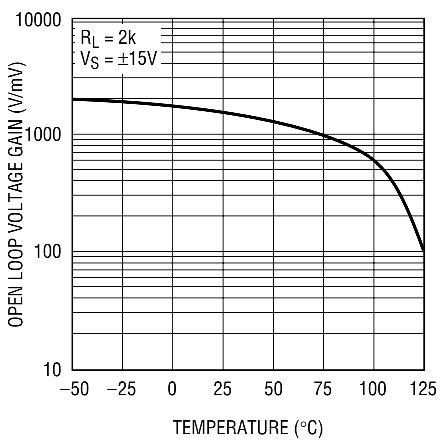
Supply Current vs Temperature



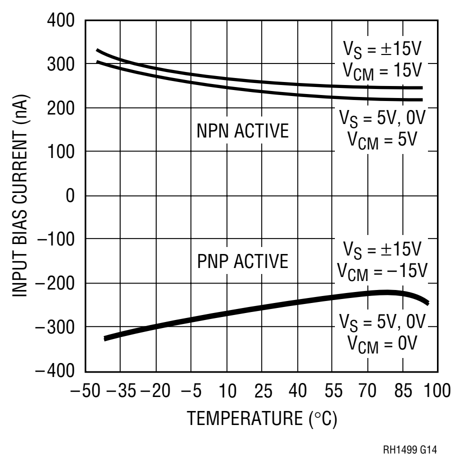
Input Bias Current vs Common Mode Voltage



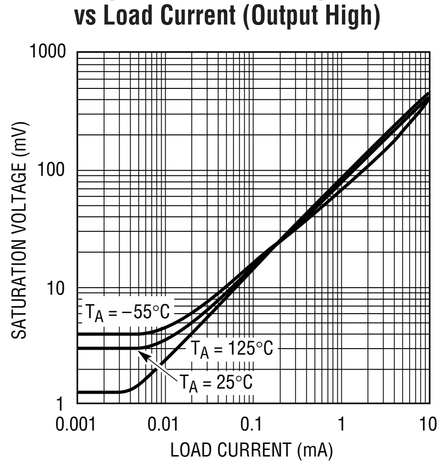
Open-Loop Voltage Gain vs Temperature



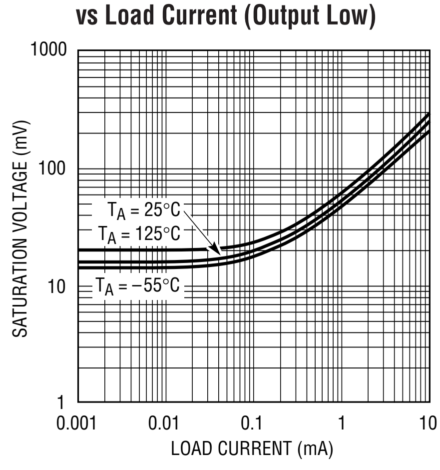
Input Bias Current vs Temperature



Output Saturation Voltage vs Load Current (Output High)



Output Saturation Voltage vs Load Current (Output Low)



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