OBSOLETE PRODUCT
POSSIBLE SUBSTITUTE PRODUCT
HA-5104

July 2001 File Number 2926.4

4MHz, Precision, Quad Operational Amplifier

The HA-5134 is a precision quad operational amplifier that is pin compatible with the OP-400, LT1014, OP11, RM4156, and LM148 as well as the HA-4741. Each amplifier features guaranteed maximum values for offset voltage of 200μV, offset voltage drift of 2μV/^{o}C, and offset current of 75nA over the full temperature range while CMRR/PSRR is guaranteed greater than 94dB and A_{VOL} is guaranteed above 500kV/V over the full temperature range.

Precision performance of the HA-5134 is enhanced by a noise voltage density of 7nV/$\sqrt{Hz}$ at 1kHz, noise current density of 1pA/$\sqrt{Hz}$ at 1kHz and channel separation of 120dB. Each unity-gain stable quad amplifier is fabricated using the dielectric isolation process to assure performance in the most demanding applications.

The HA-5134 is ideal for compact circuits such as instrumentation amplifiers, state-variable filters, and low-level transducer amplifiers. Other applications include precision data acquisition, precision integrators, and accurate threshold detectors in designs where board space is a limitation.

For military grade product, refer to the HA-5134/883 data sheet.

Part Number Information

PART NUMBER	TEMP. RANGE (^{o}C)	PACKAGE	PKG. NO.
HA1-5134-5	0 to 75	14 Ld CERDIP	F14.3

Features

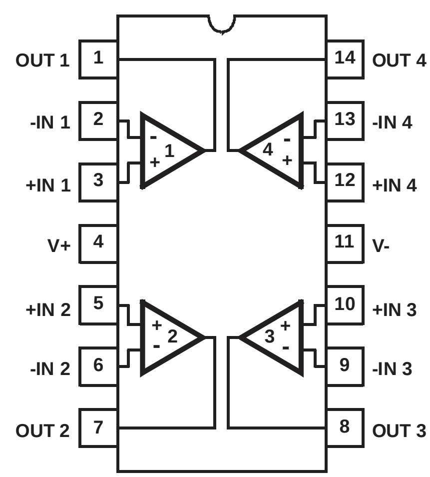
- Low Offset Voltage . . . . .200μV (Max)
- Low Offset Voltage Drift . . . . 2μV/^{o}C (Max)
- High Channel Separation 120dB
- Low Noise . . . . 7nV/$\sqrt{Hz}$
- Unity Gain Bandwidth. 4MHz
- High CMRR/PSRR . . . . 120dB (Typ)

Applications

- Instrumentation Amplifiers
- State-Variable Filters
- Precision Integrators
- Threshold Detectors
- Precision Data Acquisition Systems
- Low-Level Transducer Amplifiers

Pinout

HA-5134
(CERDIP)
TOP VIEW



Absolute Maximum Ratings

Voltage Between V+ and V- Terminals 40V
Differential Input Voltage (Note 2) 6V
Output Current . . . . Full Short Circuit Protection

Operating Conditions

Temperature Range
HA-5134-5 . . . . 0^oC to 75^oC

Thermal Information

Thermal Resistance (Typical, Note 1) θ_{JA} (^oC/W) θ_{JC} (^oC/W)
CERDIP Package. 80 30
Maximum Junction Temperature (Note 3) . . . . 175^oC
Maximum Storage Temperature Range . . . . -65^oC to 150^oC
Maximum Lead Temperature (Soldering 10s) . . . . 300^oC

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

NOTES:

1. θ_{JA} is measured with the component mounted on an evaluation PC board in free air.
2. For differential input voltages greater than 6V, the input current must be limited to 25mA to protect the back-to-back input diodes.
3. Maximum power dissipation, including output load, must be designed to maintain the maximum junction temperature below 175^oC.

Electrical Specifications

V_{SUPPLY} = ±15V, R_L = 2kΩ, C_L = 50pF, $R_S \le 100\Omega$, Unless Otherwise Specified

PARAMETER	TEST CONDITIONS	TEMP (^oC)	HA-5134-5			UNITS
			MIN	TYP	MAX	
INPUT CHARACTERISTICS						
Offset Voltage		25	-	50	200	μV
		Full	-	75	350	μV
Average Offset Voltage Drift		Full	-	0.3	2	μV/^oC
Bias Current		25	-	±10	±50	nA
		Full	-	±20	±75	nA
Offset Current		25	-	10	50	nA
		Full	-	15	75	nA
Average Offset Current Drift		Full	-	0.05	-	nA/^oC
Common Mode Range		Full	±10	-	-	V
Differential Input Resistance		25	-	30	-	MΩ
Input Noise Voltage	0.1Hz to 10Hz	25	-	0.2	-	μV_{P-P}
Input Noise Voltage Density	f = 10Hz	25	-	10	-	nV/$\sqrt{Hz}$
	f = 100Hz		-	7.5	-	nV/$\sqrt{Hz}$
	f = 1kHz		-	7	-	nV/$\sqrt{Hz}$
Input Noise Current Density	f = 10Hz	25	-	3	-	pA/$\sqrt{Hz}$
	f = 100Hz		-	1.5	-	pA/$\sqrt{Hz}$
	f = 1kHz		-	1	-	pA/$\sqrt{Hz}$
TRANSFER CHARACTERISTICS						
Large Signal Voltage Gain	V_{OUT} = ±10V	25	800	1200	-	kV/V
		Full	500	750	-	kV/V
Common Mode Rejection Ratio	V_{CM} = ±10V	25	100	120	-	dB
		Full	94	115	-	dB
Minimum Stable Gain		25	1	-	-	V/V
Unity-Gain Bandwidth		25	-	4	-	MHz
OUTPUT CHARACTERISTICS						
Output Voltage Swing		Full	12	13.5	-	V
Output Current		25	-	20	-	mA

Electrical Specifications V_{SUPPLY} = ±15V, R_L = 2kΩ, C_L = 50pF, R_S ≤ 100Ω, Unless Otherwise Specified **(Continued)**

PARAMETER	TEST CONDITIONS	TEMP (°C)	HA-5134-5			UNITS
			MIN	TYP	MAX	
Full Power Bandwidth (Note 4)		25	12	16	-	kHz
Channel Separation (Note 7)	V_{OUT} = ±10V	25	120	136	-	dB
TRANSIENT RESPONSE (Note 5)						
Rise Time	A_V = +1, V_{OUT} = 200mV	25	-	200	400	ns
Slew Rate	A_V = +1	25	0.75	1.0	-	V/µs
Overshoot	A_V = +1	25	-	20	40	%
Settling Time (Note 6)		25	-	13	-	µs
POWER SUPPLY CHARACTERISTICS						
Supply Current	All Amps	Full	-	6.5	8	mA
Power Supply Rejection Ratio	V_S = ±5V to ±18V	25	100	120	-	dB
		Full	94	115	-	dB

NOTES:

4. Full power bandwidth guaranteed based on slew rate measurement using: $FPBW = \frac{\text{Slew Rate}}{2\pi V_{PEAK}}$; $V_{PEAK} = 10V$.
5. Refer to Test Circuits section of the data sheet.
6. Specified to 0.01% of a 10V step, A_V = -1.
7. Guaranteed but not tested.

Test Circuits and Waveforms

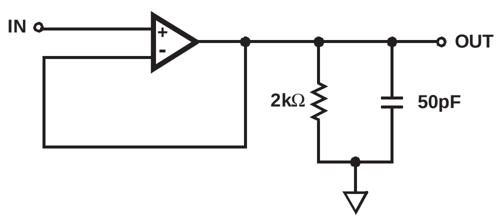
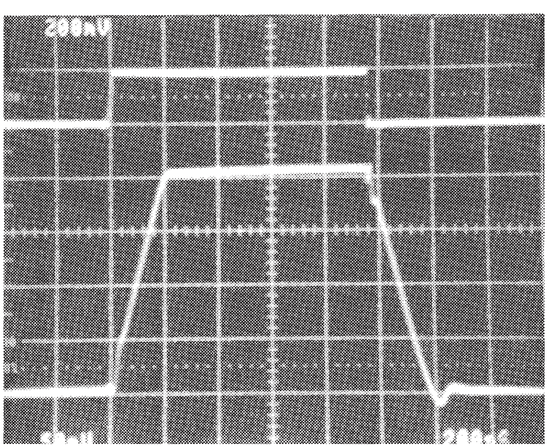
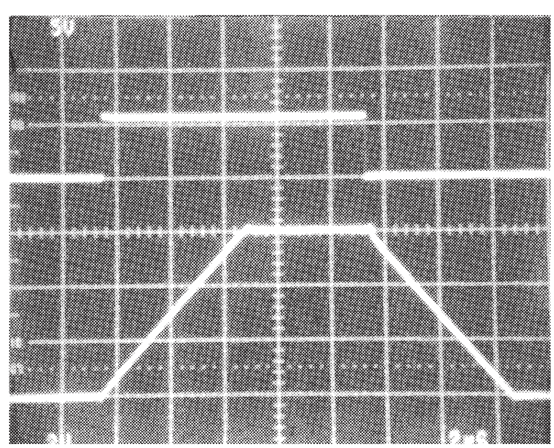


FIGURE 1. SLEW RATE AND TRANSIENT RESPONSE TEST CIRCUIT



Vertical: 50mV/Div., Horizontal: 200ns/Div.
T_A = 25°C, V_S = ±15V, A_V = +1, R_L = 2kΩ, C_L = 50pF

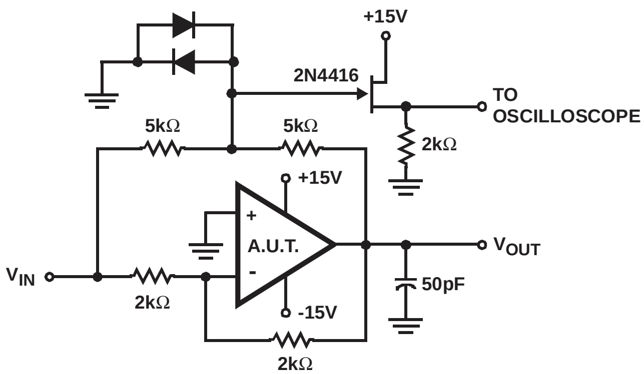
SMALL SIGNAL RESPONSE



Vertical: 2V/Div., Horizontal: 2µs/Div.
T_A = 25°C, V_S = ±15V, A_V = +1, R_L = 2kΩ, C_L = 50pF

LARGE SIGNAL RESPONSE

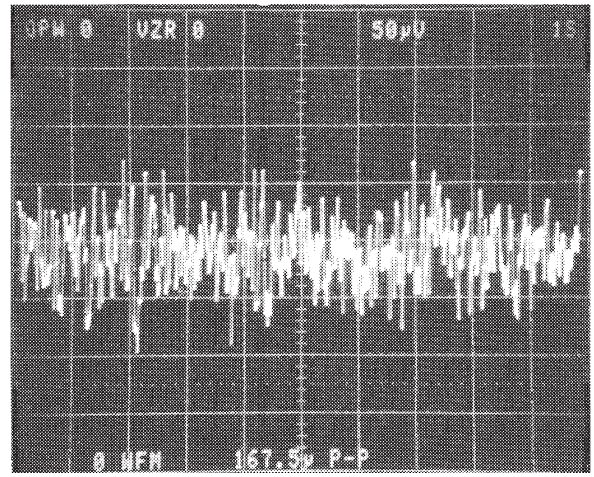
Test Circuits and Waveforms (Continued)



NOTES:

8. A_V = -1.
9. Feedback and summing resistors should be 0.1% matched.
10. Clipping diodes are optional. HP5082-2810 recommended.

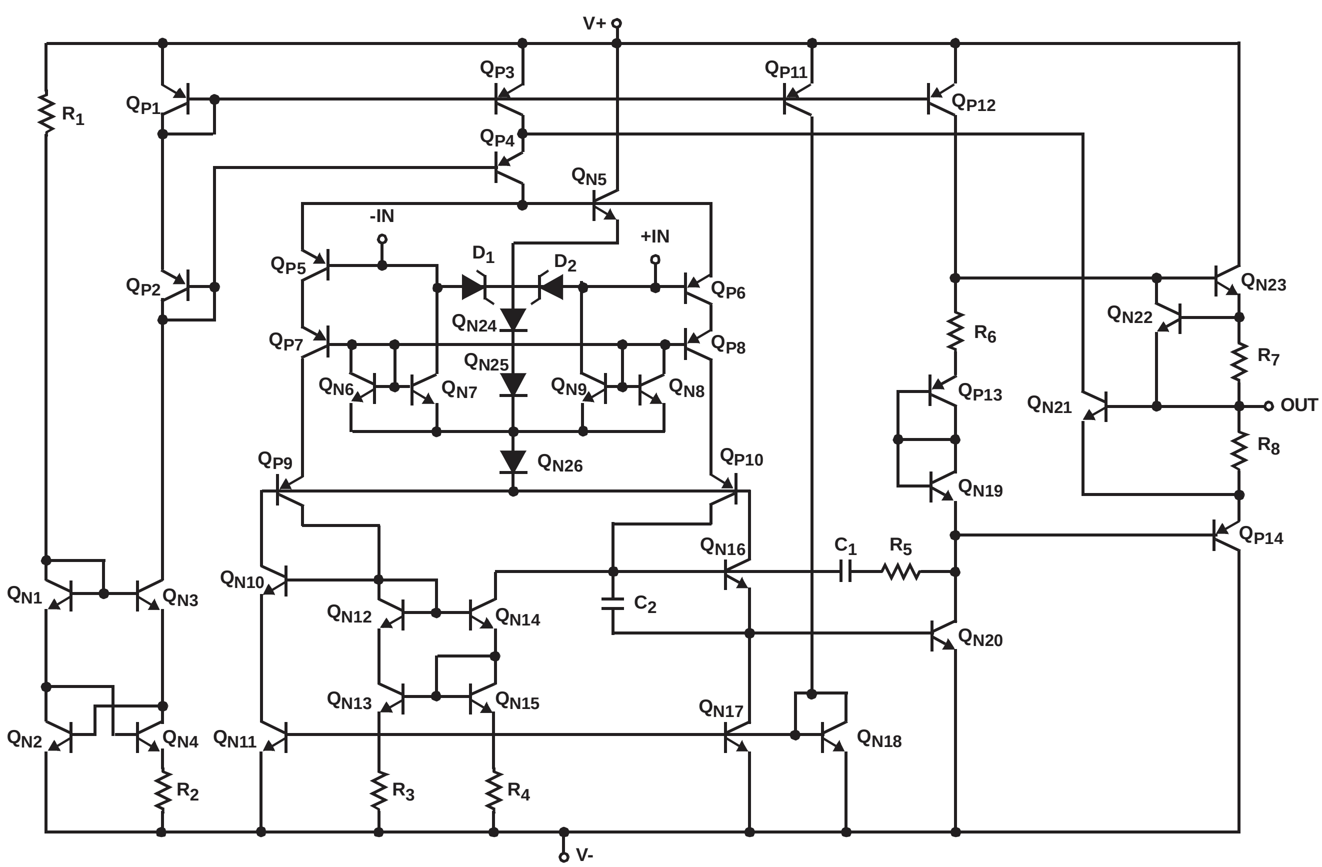
FIGURE 2. SETTLING TIME CIRCUIT



T_A = 25°C, V_S = ±15V, A_V = 1000
e_n = 0.167µV_{P-P}
0.05µV/Div., 1s/Div.

PEAK-TO-PEAK NOISE 0.1Hz TO 10Hz

Schematic Diagram (Each Amplifier)



Application Information

Power Supply Decoupling

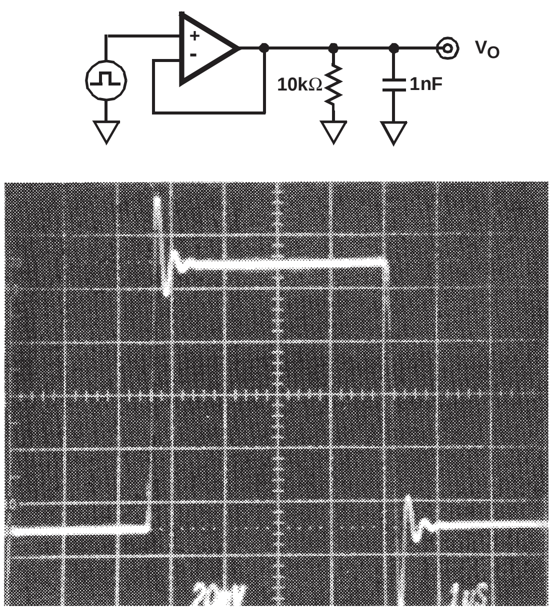
Although not absolutely necessary, it is recommended that all power supply lines be decoupled with 0.01µF ceramic capacitors to ground. Decoupling capacitors should be located as near to the amplifier terminals as possible.

Considerations For Prototyping

The following list of recommendations are suggested for prototyping.

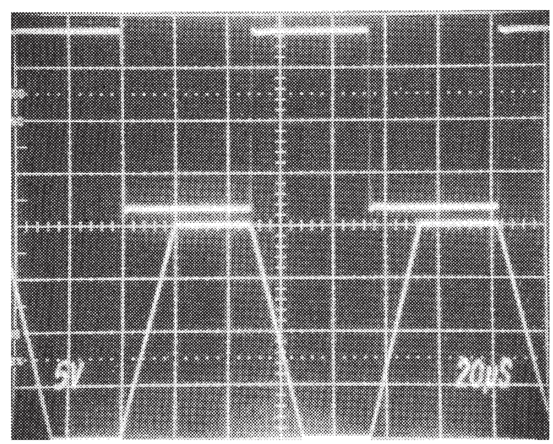
1. Resolving low level signals requires minimizing leakage currents caused by external circuitry. Use of quality insulating materials, thorough cleaning of insulating surfaces and implementation of moisture barriers when required is suggested.
2. Error voltages generated by thermocouples formed between dissimilar metals in the presence of temperature gradients should be minimized. Isolation of low level circuitry from heat generating components is recommended.
3. Shielded cable input leads, guard rings and shield drivers are recommended for the most critical applications.

Typical Applications



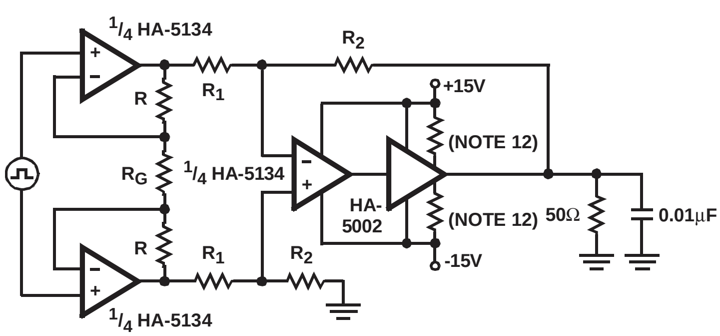
$T_A = 25^oC$, $V_S = \pm15V$, $A_V = 1$, $R_L = 10k\Omega$
20mV/Div., 1µs/Div.

FIGURE 3. SMALL SIGNAL TRANSIENT RESPONSE (C_{LOAD} = 1nF)



$V_{OUT} = \pm10V$, $R_{LOAD} = 50\Omega$ $C_{LOAD} = 0.01\mu F$, $A_V = 3$, $V_S = \pm15V$
Top: Input, 2V/Div., 20µs/Div. Bottom: Output, 5V/Div, 20µs/Div.

TRANSIENT RESPONSE OF APPLICATION CIRCUIT #1

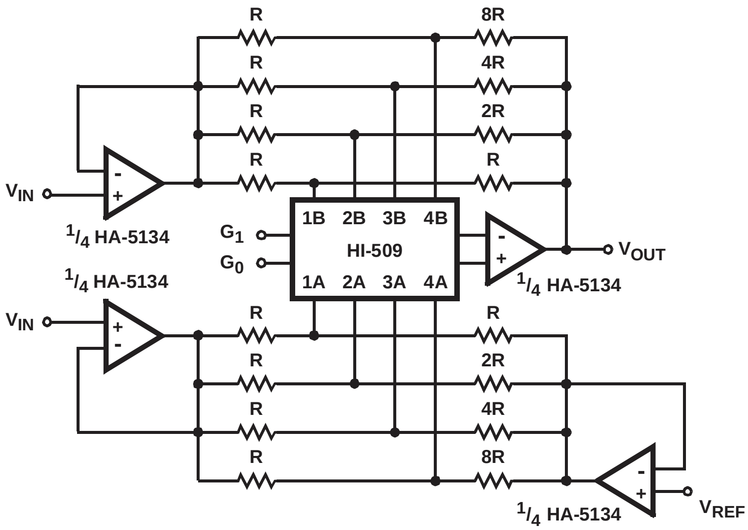


NOTES:

11. $-A_V = \left(1 + \frac{2R}{R_G}\right)\left(\frac{R_2}{R_1}\right)$.
12. 10Ω - 100Ω recommended for short circuit limiting.
13. When driving heavy loads the HA-5002 may contribute to thermal errors. Proper thermal shielding is recommended.

FIGURE 4. APPLICATION CIRCUIT #1: INSTRUMENTATION AMPLIFIER WITH POWER OUTPUT

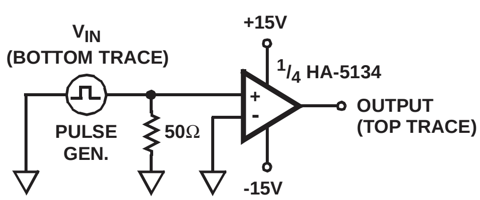
Typical Applications (Continued)

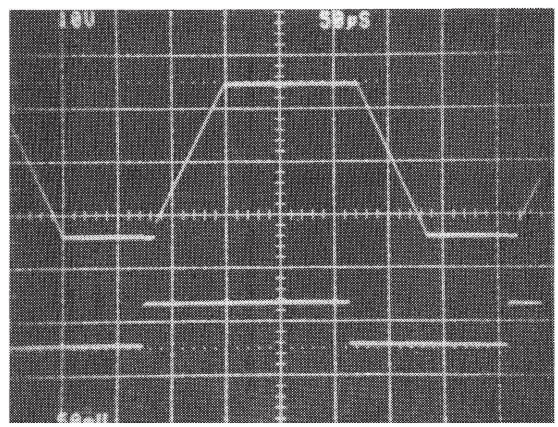


G_1	G_0	A_V
0	0	-1
0	1	-2
1	0	-4
1	1	-8

High A_{VOL} of HA-5134 reduces gain error.
Gain Error ≅ 0.004% at A_V = 8.

FIGURE 5. APPLICATION CIRCUIT #2: PROGRAMMABLE GAIN AMPLIFIER





NOTE: If differential input voltages greater than 6V are present, input current must be limited to less than 25mA.

Horizontal: 50µs/Div.
V_{IN} = ±25mV, V_{OUT} = ±14V

FIGURE 6. APPLICATION CIRCUIT #3: PRECISION COMPARATOR

Typical Performance Curves

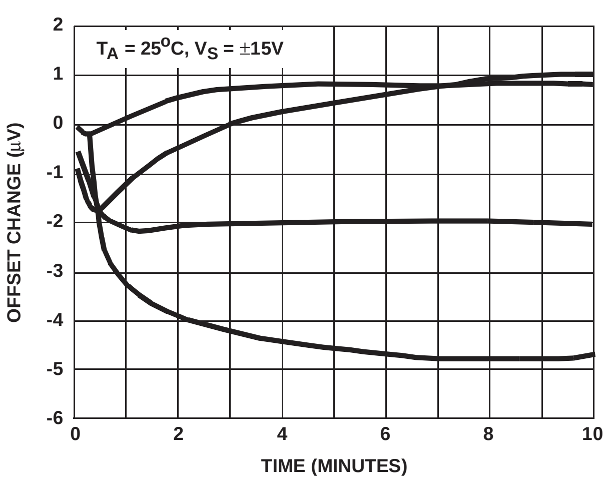


FIGURE 7. V_{IO} WARM-UP DRIFT

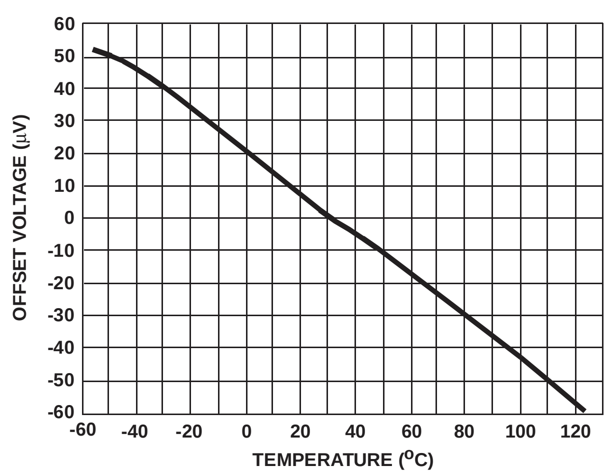


FIGURE 8. INPUT OFFSET VOLTAGE vs TEMPERATURE

Typical Performance Curves (Continued)

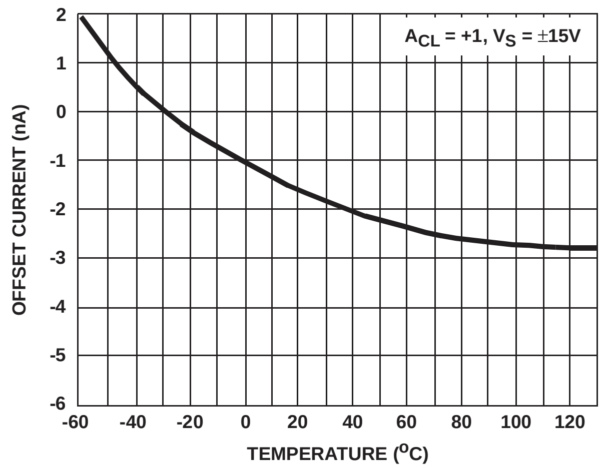


FIGURE 9. OFFSET CURRENT vs TEMPERATURE

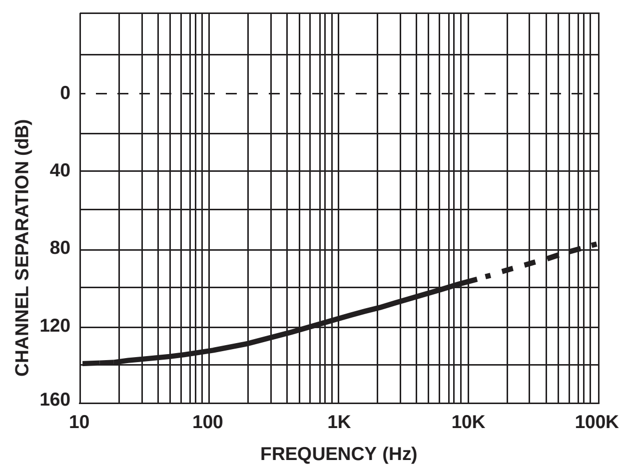


FIGURE 10. CHANNEL SEPARATION vs FREQUENCY

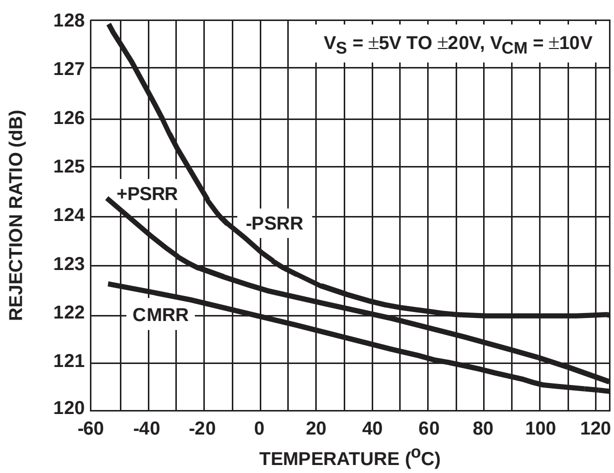


FIGURE 11. REJECTION RATIOS vs TEMPERATURE

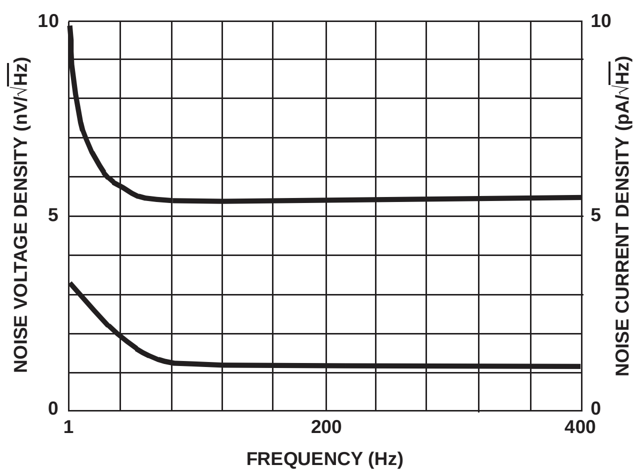


FIGURE 12. NOISE DENSITY vs FREQUENCY

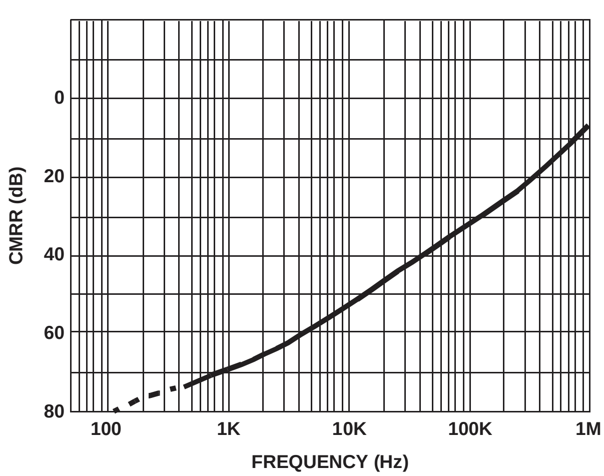


FIGURE 13. CMRR vs FREQUENCY

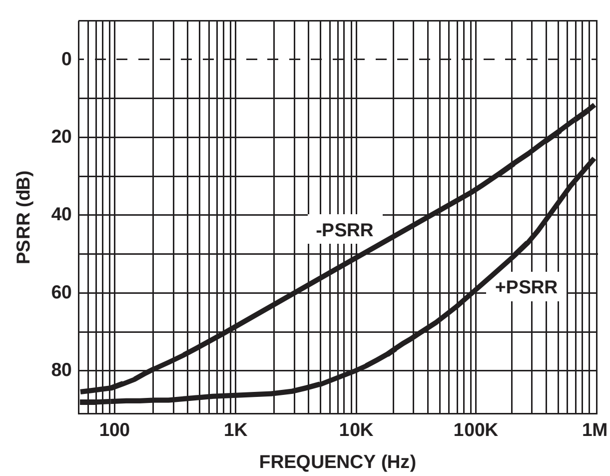


FIGURE 14. PSRR vs FREQUENCY

Typical Performance Curves (Continued)

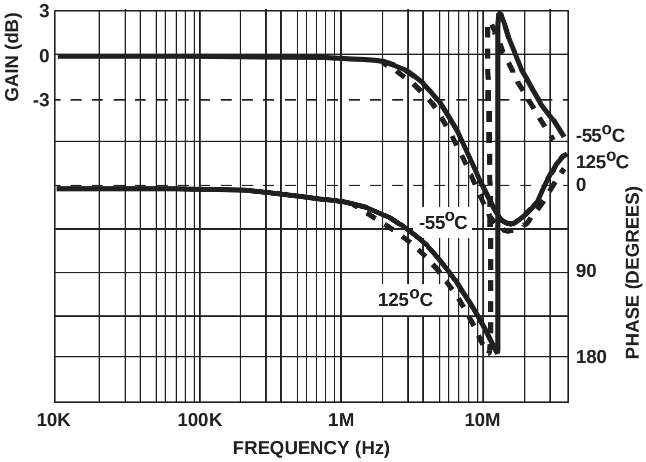


FIGURE 15. CLOSED LOOP FREQUENCY RESPONSE

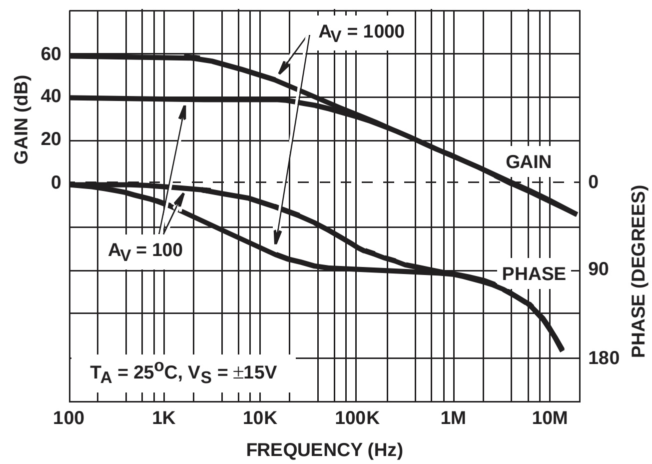


FIGURE 16. CLOSED LOOP GAIN/PHASE vs FREQUENCY

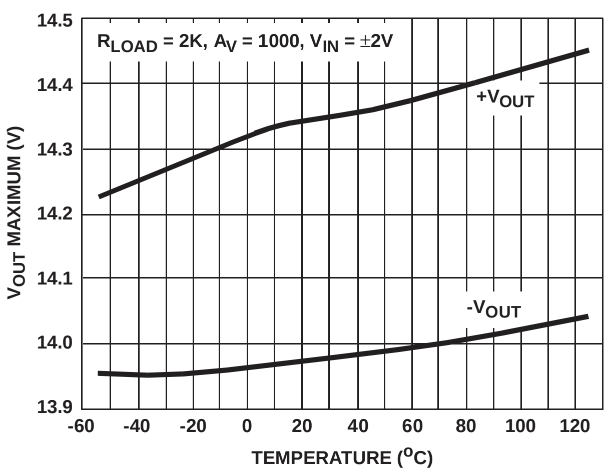


FIGURE 17. MAXIMUM OUTPUT VOLTAGE vs TEMPERATURE

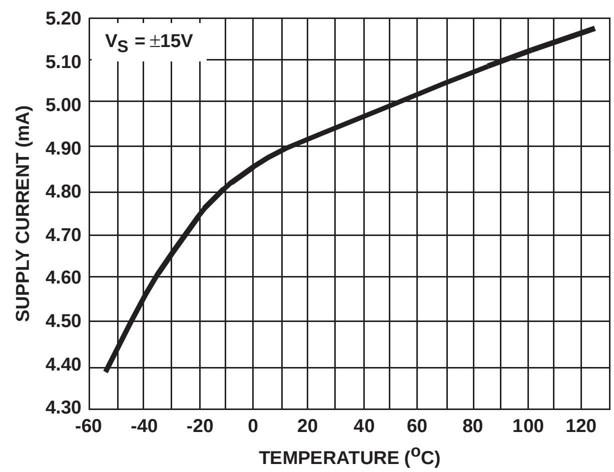


FIGURE 18. SUPPLY CURRENT vs TEMPERATURE

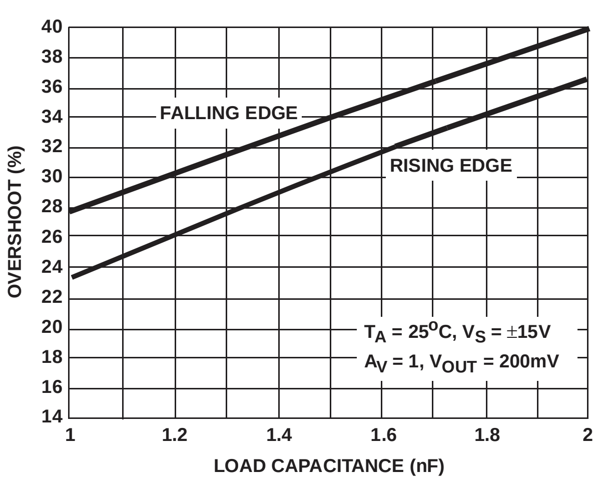


FIGURE 19. OVERSHOOT vs C_{LOAD}

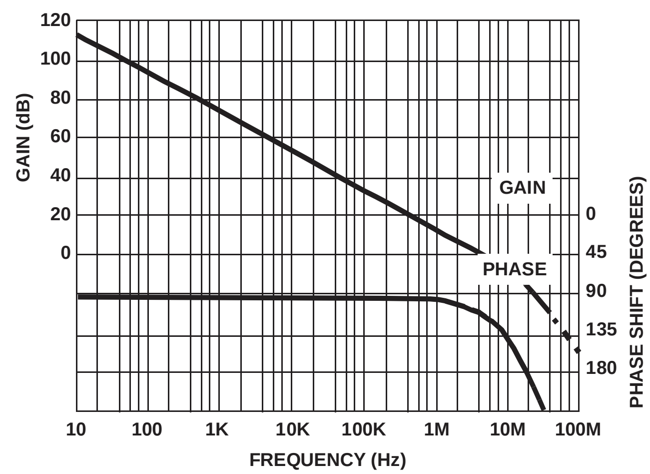


FIGURE 20. OPEN LOOP GAIN AND PHASE vs FREQUENCY

Sales Office Headquarters

NORTH AMERICA
Intersil Corporation
2401 Palm Bay Rd.
Palm Bay, FL 32905
TEL: (321) 724-7000
FAX: (321) 724-7240

EUROPE
Intersil SA
Mercure Center
100, Rue de la Fusee
1130 Brussels, Belgium
TEL: (32) 2.724.2111
FAX: (32) 2.724.22.05

ASIA
Intersil Ltd.
8F-2, 96, Sec. 1, Chien-kuo North,
Taipei, Taiwan 104
Republic of China
TEL: 886-2-2515-8508
FAX: 886-2-2515-8369