100MHz, Dual, Low Noise, Precision Operational Amplifier

The HA-5222 is a dual, high performance, dielectrically isolated op amp, featuring precision DC characteristics while providing excellent AC characteristics. Designed for audio, video, and other demanding applications, noise (3.4nV/$\sqrt{Hz}$ at 1kHz), total harmonic distortion (<0.005%), and DC errors are kept to a minimum.

The precision performance is shown by low offset voltage (0.3mV), low bias currents (40nA), low offset currents (15nA), and high open loop gain (128dB). The combination of these excellent DC characteristics with the fast settling time (0.4µs) makes the HA-5222 ideally suited for precision signal conditioning.

The unique design of the HA-5222 gives it outstanding AC characteristics not normally associated with precision op amps, high unity gain bandwidth (35MHz) and high slew rate (25V/µs). Other key specifications include high CMRR (95dB) and high PSRR (100dB). The combination of these specifications will allow the HA-5222 to be used in RF signal conditioning as well as video amplifiers.

For MIL-STD-883C compliant product, consult the HA-5222/883C data sheet. (Intersil AnswerFAX (321-724-7800) Document #3717.)

Part Number Information

PART NUMBER (BRAND)	TEMP. RANGE (°C)	PACKAGE	PKG. NO.
HA7-5222-5	0 to 75	8 Ld CERDIP	F8.3A

Features

- Gain Bandwidth Product. 100MHz
- Unity Gain Bandwidth. 35MHz
- Slew Rate 25V/µs
- Low Offset Voltage 0.3mV
- High Open Loop Gain. 128dB
- Low Noise Voltage at 1kHz. . . . . 3.4nV/$\sqrt{Hz}$
- High Output Current 56mA
- Low Supply Current 8mA

Applications

- Precision Test Systems
- Active Filtering
- Small Signal Video
- Accurate Signal Processing
- RF Signal Conditioning

Pinout

HA-5221
(CERDIP, SOIC)
TOP VIEW

Pin	Name		Pin	Name
1	OUT 1		8	V+
2	-IN 1		7	OUT 2
3	+IN 1		6	-IN 2
4	V-		5	+IN 2
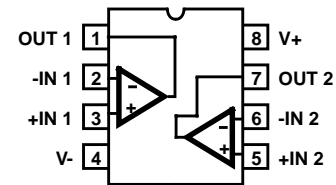
HA-5222

Absolute Maximum Ratings

Supply Voltage Between V+ and V- Terminals. 35V
Differential Input Voltage (Note 1) 5V
Output Current Short Circuit Duration . . . . Indefinite

Operating Conditions

Temperature Range
HA-5222-5 . . . . 0°C to 75°C

Thermal Information

Thermal Resistance (Typical, Note 2) θ_{JA} (^{o}C/W) θ_{JC} (^{o}C/W)
   CERDIP Package.   115   50
Maximum Junction Temperature (Hermetic Package) . . . . 175°C
Maximum Storage Temperature Range. . . . . -65°C to 150°C
Maximum Lead Temperature (Soldering 10s) . . . . 300°C

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. Input is protected by back-to-back zener diodes. See applications section.

2. θ_{JA} is measured with the component mounted on an evaluation PC board in free air.

Electrical Specifications V_{SUPPLY} = ±15V, Unless Otherwise Specified

PARAMETER	TEST CONDITIONS	TEMP. (^{o}C)	HA-5222-5			UNITS
			MIN	TYP	MAX	
INPUT CHARACTERISTICS						
Input Offset Voltage		25	-	0.30	0.75	mV
		Full	-	0.35	1.5	mV
Average Offset Voltage Drift		Full	-	0.5	-	µV/^{o}C
Input Bias Current		25	-	40	100	nA
		Full	-	70	200	nA
Input Offset Current		25	-	15	100	nA
		Full	-	30	150	nA
Input Offset Voltage Match		25	-	400	750	µV
		Full	-	-	1500	µV
Common Mode Range		25	±12	-	-	V
Differential Input Resistance		25	-	70	-	kΩ
Input Noise Voltage	f = 0.1Hz to 10Hz	25	-	0.25	-	µV$_{P-P}$
Input Noise Voltage Density (Notes 3, 12)	f = 10Hz	25	-	6.2	10	nV/√Hz
	f = 100Hz	25	-	3.6	6	nV/√Hz
	f = 1000Hz	25	-	3.4	4.0	nV/√Hz
Input Noise Current Density (Notes 3, 12)	f = 10Hz	25	-	4.7	8.0	pA/√Hz
	f = 100Hz	25	-	1.8	2.8	pA/√Hz
	f = 1000Hz	25	-	0.97	1.8	pA/√Hz
THD+N	Note 4	25	-	<0.005	-	%
TRANSFER CHARACTERISTICS						
Large Signal Voltage Gain	Note 5	25	106	128	-	dB
		Full	100	120	-	dB
CMRR	V_{CM} = ±10V	Full	86	95	-	dB

Electrical Specifications $V_{SUPPLY} = \pm 15V$, Unless Otherwise Specified   **(Continued)**

| PARAMETER | TEST CONDITIONS | TEMP. (^{o}C) | HA-5222-5 | | | UNITS |
			MIN	TYP	MAX	
Unity Gain Bandwidth	-3dB	25	-	35	-	MHz
Gain Bandwidth Product	1kHz to 400kHz	25	-	100	-	MHz
Minimum Stable Gain		Full	1	-	-	V/V
OUTPUT CHARACTERISTICS						
Output Voltage Swing	$R_L = 333\Omega$	Full	± 10	-	-	V
	$R_L = 1k\Omega$	25	± 12	± 12.5	-	V
	$R_L = 1k\Omega$	Full	± 11.5	± 12.1	-	V
Output Current	$V_{OUT} = \pm 10V$	Full	± 30	± 56	-	mA
Output Resistance		25	-	10	-	Ω
Full Power Bandwidth	Note 6	25	239	398	-	kHz
Channel Separation	Note 7	25	-	110	-	dB
TRANSIENT RESPONSE (Note 11)						
Slew Rate	Notes 8, 12	Full	15	25	-	V/μs
Rise Time	Notes 9, 12	Full	-	13	20	ns
Overshoot	Notes 9, 12	Full	-	28	50	%
Settling Time (Note 10)	0.1%	25	-	0.4	-	μs
	0.01%	25	-	1.5	-	μs
POWER SUPPLY						
PSRR	$V_S = \pm 10V$ to $\pm 20V$	Full	86	100	-	dB
Supply Current		Full	-	8	11	mA/Op Amp

NOTES:

3. Refer to typical performance curve in data sheet.

4. $A_{VCL} = 10$, $f_O = 1kHz$, $V_O = 5V_{RMS}$, $R_L = 600\Omega$, 10Hz to 100kHz, minimum resolution of test equipment is 0.005%.

5. $V_{OUT} = 0$ to $\pm 10V$, $R_L = 1k\Omega$, $C_L = 50pF$.

6. Full Power Bandwidth is calculated by: $FPBW = \dfrac{Slew\ Rate}{2\pi V_{PEAK}}$, $V_{PEAK} = 10V$.

7. $f = 10kHz$, $R_L = 1k\Omega$, $C_L = 50pF$.

8. $V_{OUT} = \pm 2.5V$, $R_L = 1k\Omega$, $C_L = 50pF$.

9. $V_{OUT} = \pm 100mV$, $R_L = 1k\Omega$, $C_L = 50pF$.

10. Settling time is specified for a 10V step and $A_V = -1$.

11. See Test Circuits.

12. Guaranteed by characterization.

Test Circuits and Waveforms
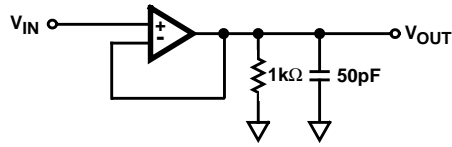
FIGURE 1. TRANSIENT RESPONSE TEST CIRCUIT
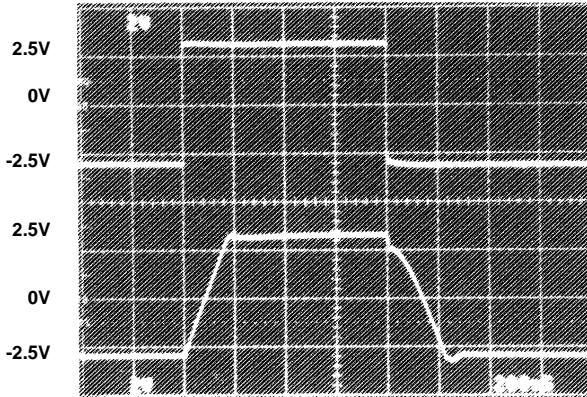
$V_{OUT} = 2.5V$
Vertical Scale = 2V/Div.,
Horizontal Scale = 200ns/Div.

FIGURE 2. LARGE SIGNAL RESPONSE
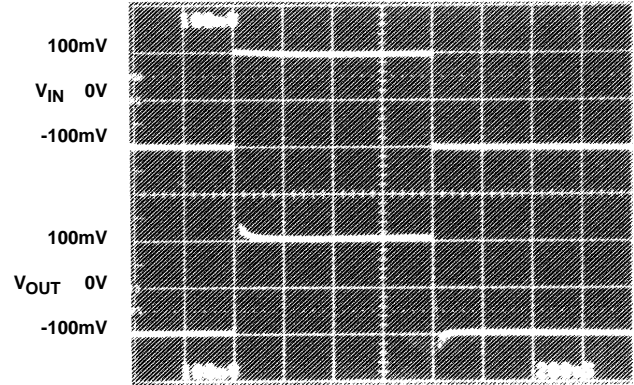
$V_{OUT} = \pm100mV$
Vertical Scale = 100mV/Div.,
Horizontal Scale = 200ns/Div.

FIGURE 3. SMALL SIGNAL RESPONSE
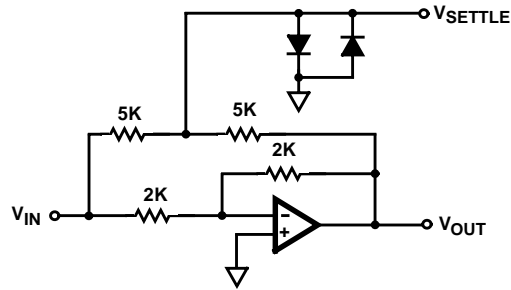
NOTES:

13. $A_V = -1$.

14. Feedback and summing resistors must be matched (0.1%).

15. HP5082-2810 clipping diodes recommended.

16. Tektronix P6201 FET probe used at settling point.

FIGURE 4. SETTLING TIME TEST CIRCUIT

Application Information

Operation at Various Supply Voltages

The HA-5222 operates over a wide range of supply voltages with little variation in performance. The supplies may be varied from ±5V to ±15V. See typical performance curves for variations in supply current, slew rate and output voltage swing.

Capacitive Loading Considerations

When driving capacitive loads >80pF, a small resistor, 50Ω to 100Ω, should be connected in series with the output and inside the feedback loop.

Saturation Recovery

When an op amp is over driven, output devices can saturate and sometimes take a long time to recover. By clamping the input, output saturation can be avoided. If output saturation can not be avoided, the maximum recovery time when overdriven into the positive rail is 10.6µs. When driven into the negative rail the maximum recovery time is 3.8µs.

Input Protection

The HA-5222 has built in back-to-back protection diodes which limit the maximum allowable differential input voltage

to approximately 5V. If the HA-5222 will be used in circuits where the maximum differential voltage may be exceeded, then current limiting resistors must be used. The input current should be limited to a maximum of 10mA.
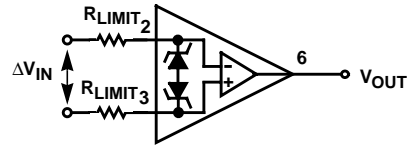
PC Board Layout Guidelines

When designing with the HA-5222, good high frequency (RF) techniques should be used when building a PC board. Use of ground plane is recommended. Power supply decoupling is very important. A 0.01µF to 0.1µF high quality ceramic capacitor at each power supply pin with a 2.2µF to 10µF tantalum close by will provide excellent decoupling. Chip capacitors produce the best results due to ease of placement next to the op amp and basically no lead inductance. If leaded capacitors are used, the leads should be kept as short as possible to minimize lead inductance.

Typical Performance Curves $V_S = \pm15V$, $T_A = 25^oC$
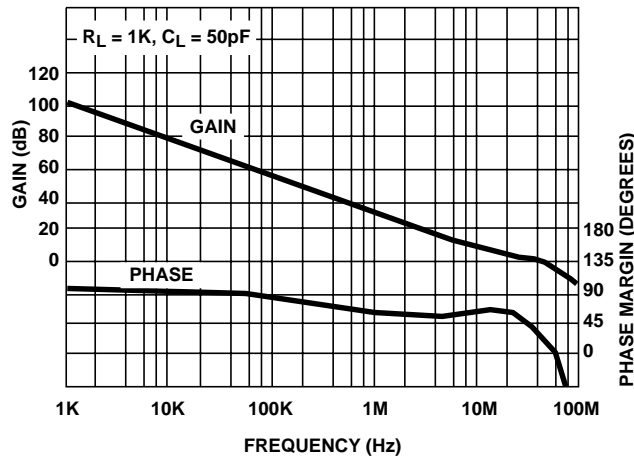
FIGURE 5. OPEN LOOP GAIN AND PHASE vs FREQUENCY
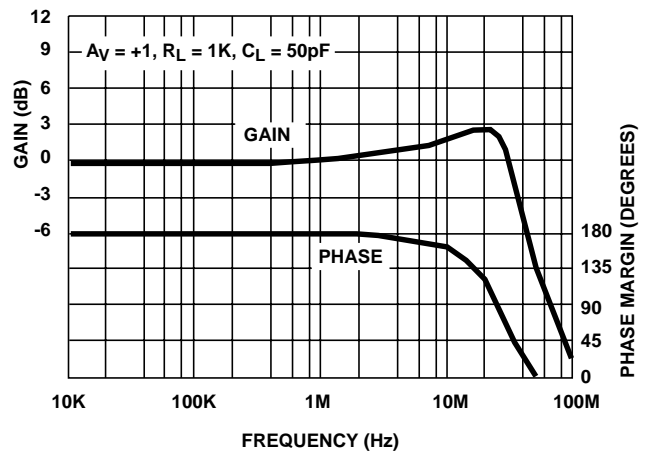
FIGURE 6. CLOSED LOOP GAIN vs FREQUENCY

intersil

HA-5222

Typical Performance Curves $V_S = \pm15V$, $T_A = 25^oC$ **(Continued)**
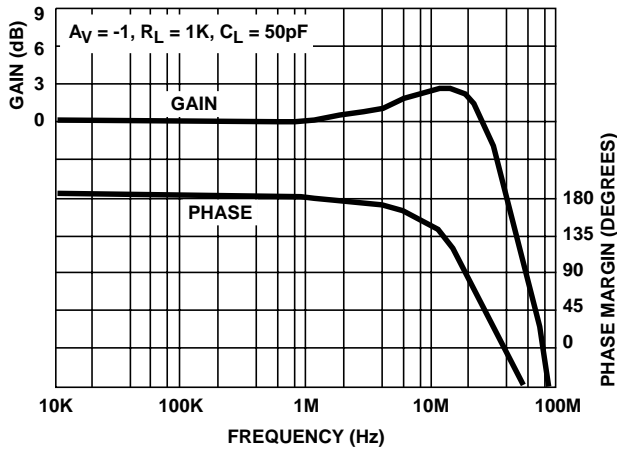
FIGURE 7. CLOSED LOOP GAIN vs FREQUENCY
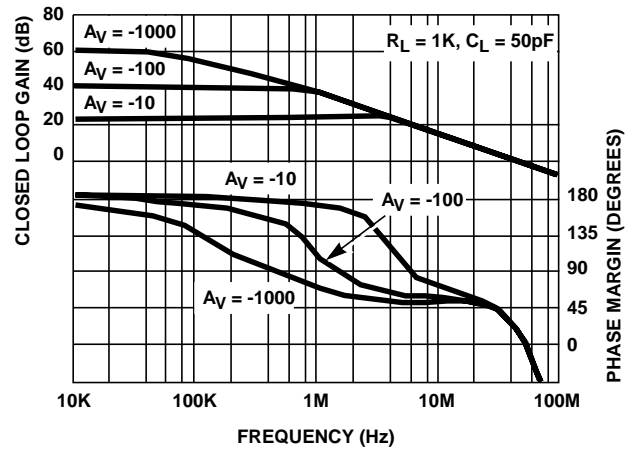
FIGURE 8. VARIOUS CLOSED LOOP GAINS vs FREQUENCY
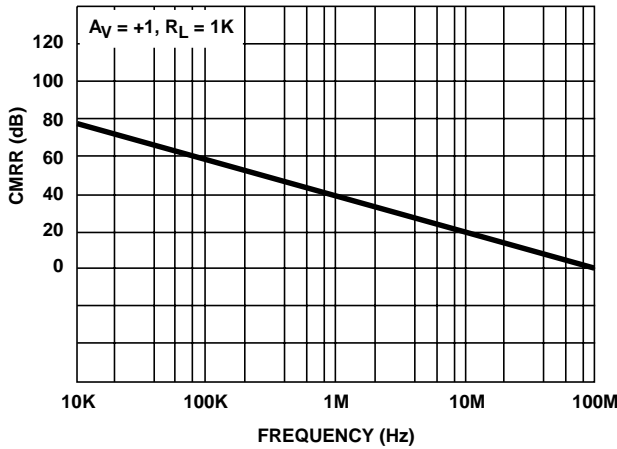
FIGURE 9. CMRR vs FREQUENCY

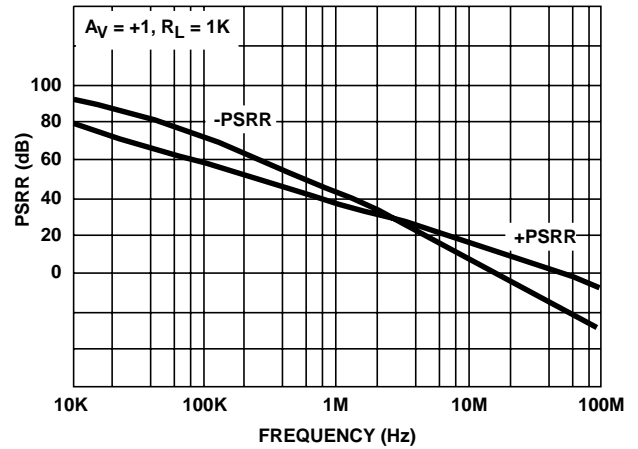**FIGURE 10. PSRR vs FREQUENCY**
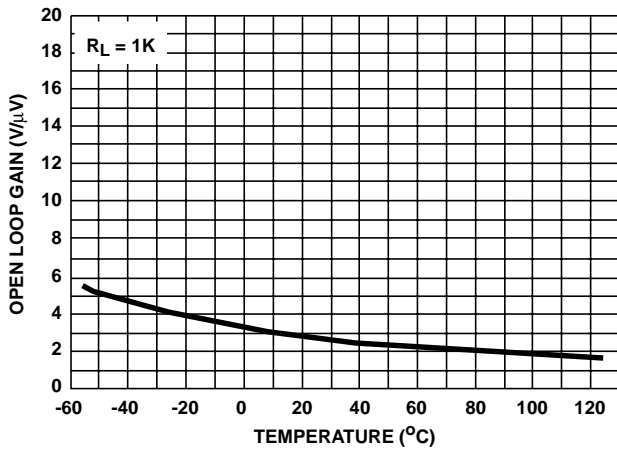
FIGURE 11. OPEN LOOP GAIN vs TEMPERATURE
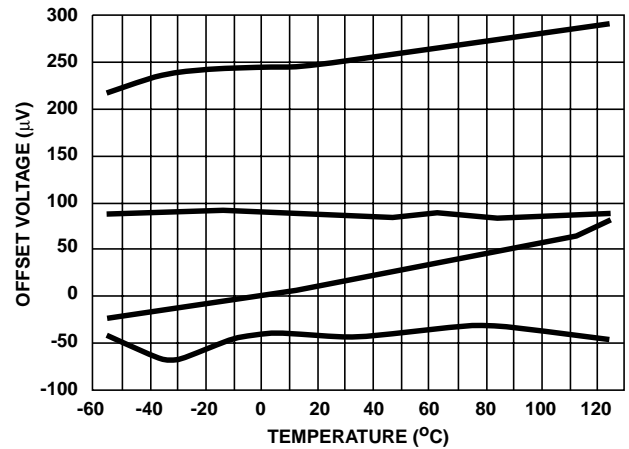
FIGURE 12. OFFSET VOLTAGE vs TEMPERATURE (4 REPRESENTATIVE UNITS)

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Typical Performance Curves $V_S = \pm 15V$, $T_A = 25^oC$ **(Continued)**
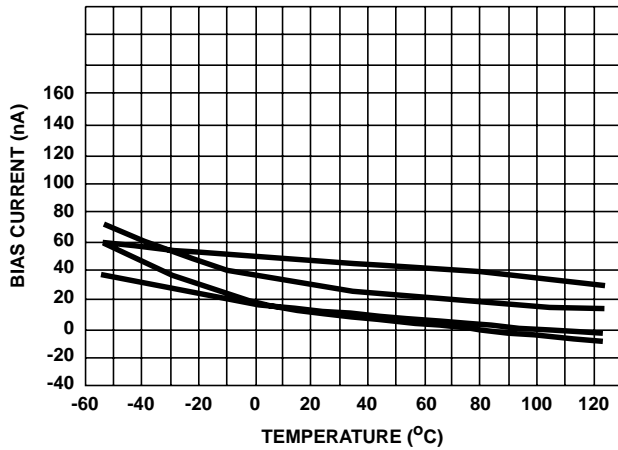
FIGURE 13. BIAS CURRENT vs TEMPERATURE (4 REPRESENTATIVE UNITS)
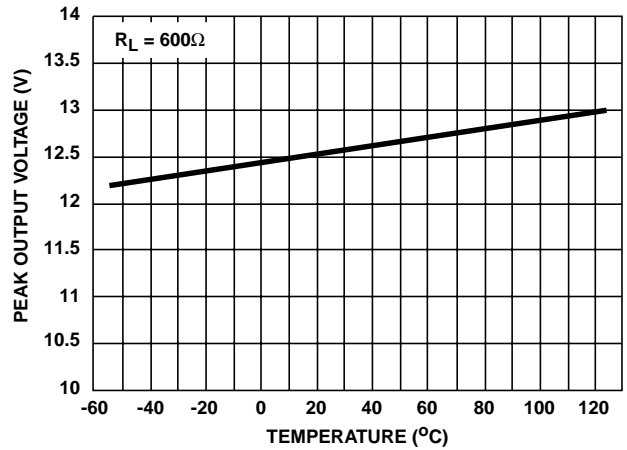
FIGURE 14. OUTPUT VOLTAGE SWING vs TEMPERATURE
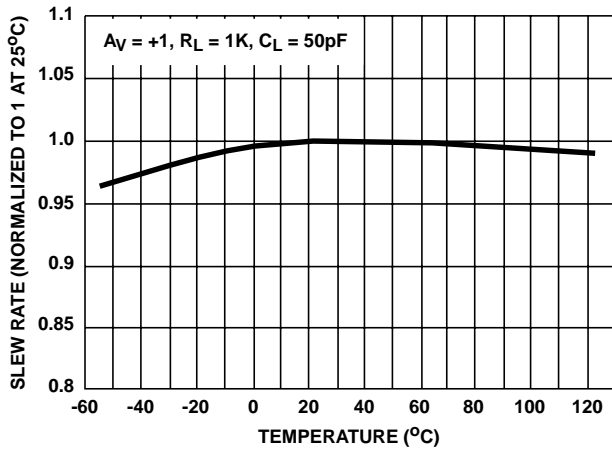
FIGURE 15. SLEW RATE vs TEMPERATURE
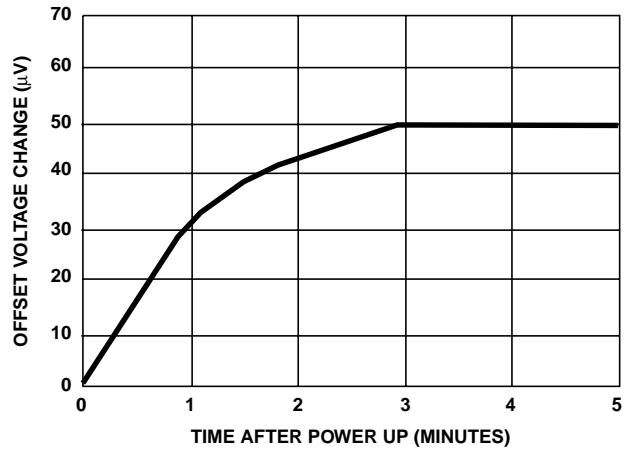
FIGURE 16. OFFSET VOLTAGE WARM-UP DRIFT (CERDIP PACKAGES)
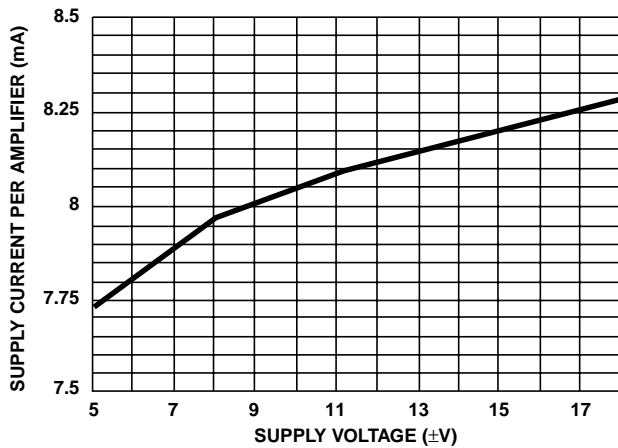
FIGURE 17. SUPPLY CURRENT vs SUPPLY VOLTAGE
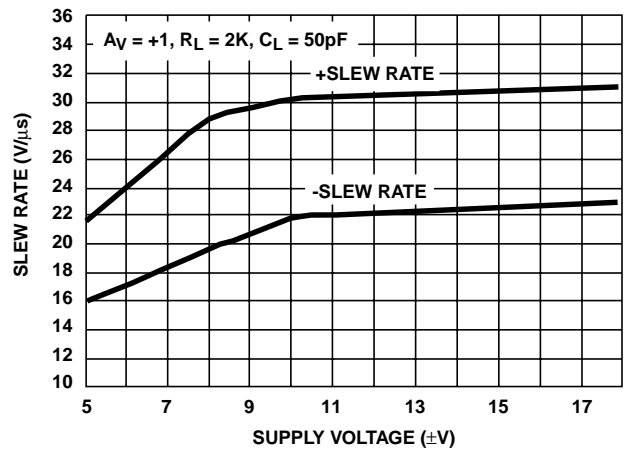
FIGURE 18. SLEW RATE vs SUPPLY VOLTAGE

Typical Performance Curves $V_S = \pm15V$, $T_A = 25^{O}C$ **(Continued)**
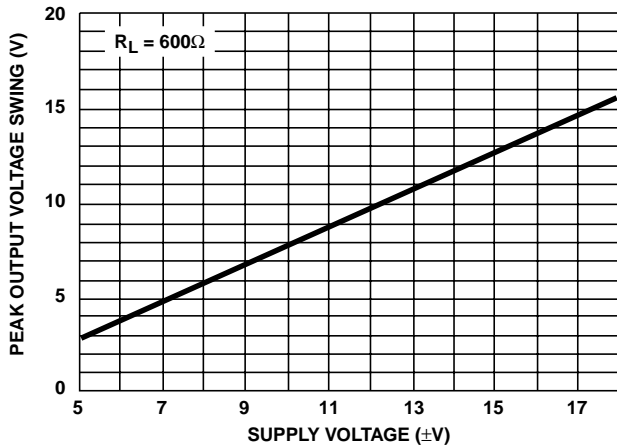
FIGURE 19. OUTPUT VOLTAGE SWING vs SUPPLY VOLTAGE
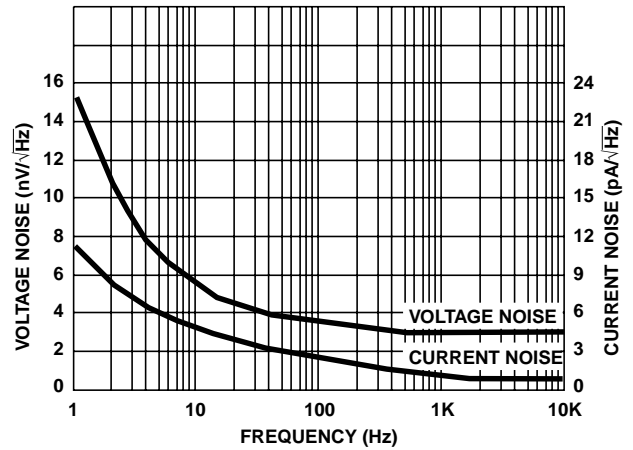
FIGURE 20. NOISE CHARACTERISTICS
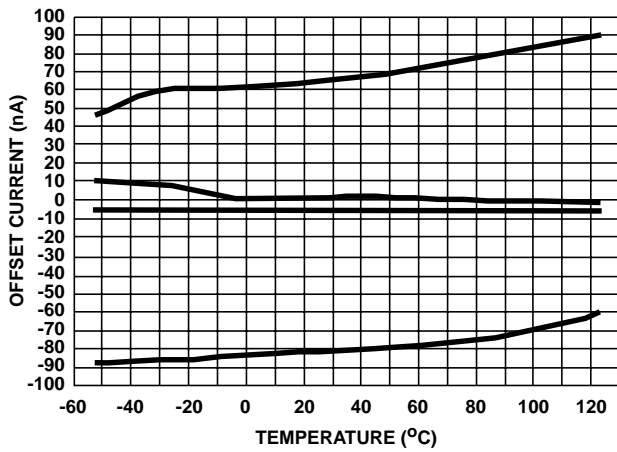
FIGURE 21. OFFSET CURRENT vs TEMPERATURE (4 REPRESENTATIVE UNITS)
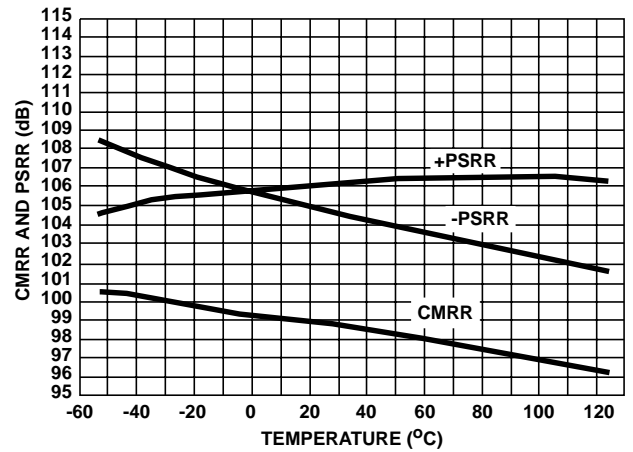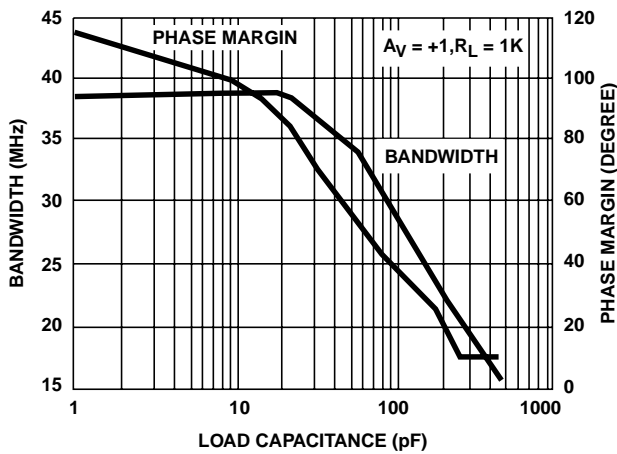

FIGURE 22. CMRR AND PSRR vs TEMPERATURE

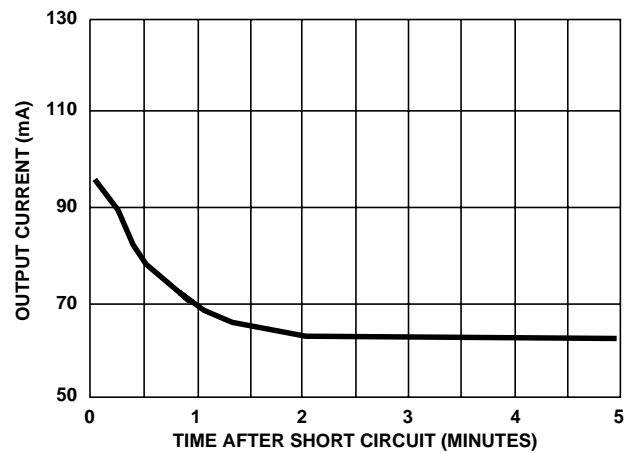
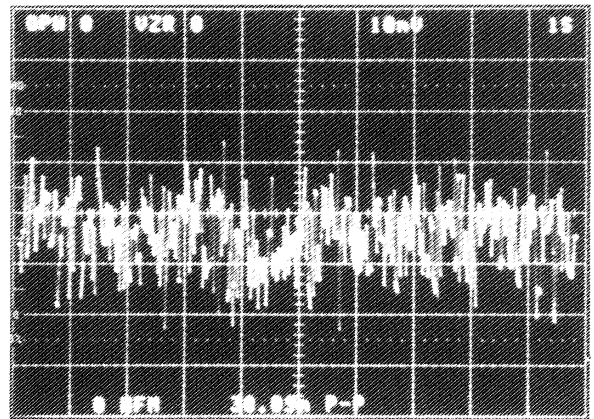**FIGURE 23. BANDWIDTH AND PHASE MARGIN vs LOAD CAPACITANCE**

FIGURE 24. SHORT CIRCUIT OUTPUT CURRENT vs TIME

Typical Performance Curves $V_S = \pm15V$, $T_A = 25^oC$ **(Continued)**
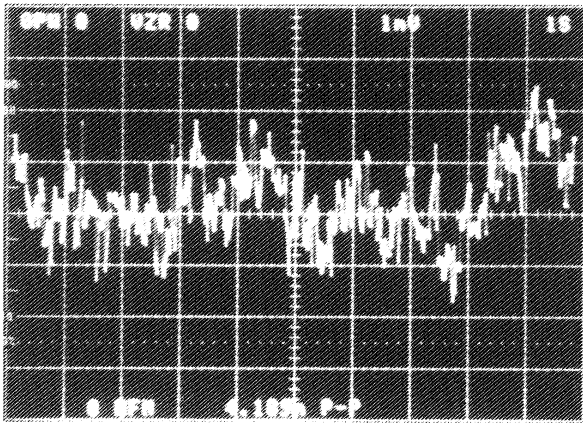
Vertical Scale = 1mV/Div.;   Horizontal Scale = 1s/Div.
$A_V = +25,000$; $E_N = 0.168\mu V_{P-P}$ RTI

FIGURE 25. 0.1Hz TO 10Hz NOISE

Vertical Scale = 10mV/Div.;   Horizontal Scale = 1s/Div.
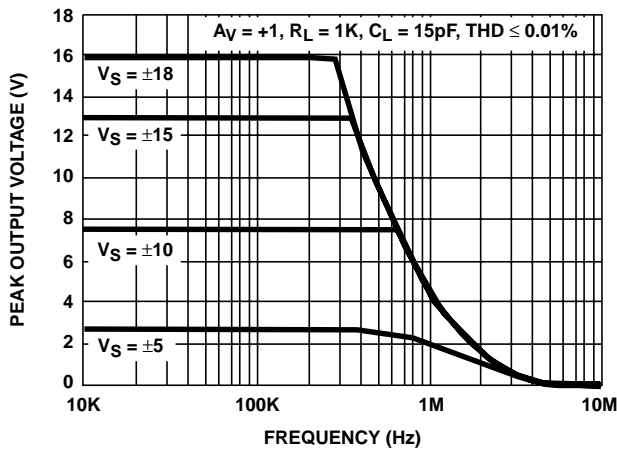$A_V = +25,000$; $E_N = 1.5\mu V_{P-P}$ RTI

FIGURE 26. 0.1Hz TO 1MHz
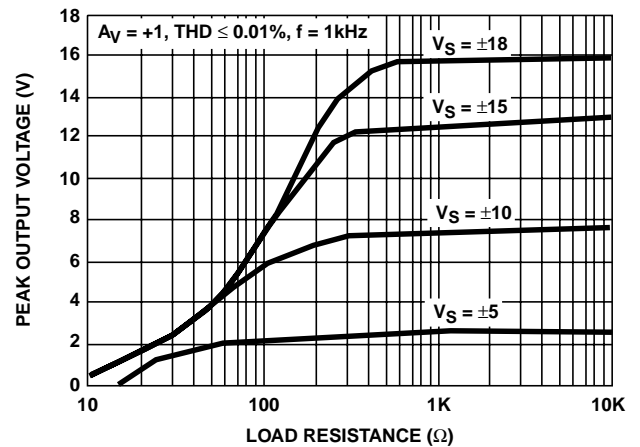

FIGURE 27. OUTPUT VOLTAGE SWING vs FREQUENCY

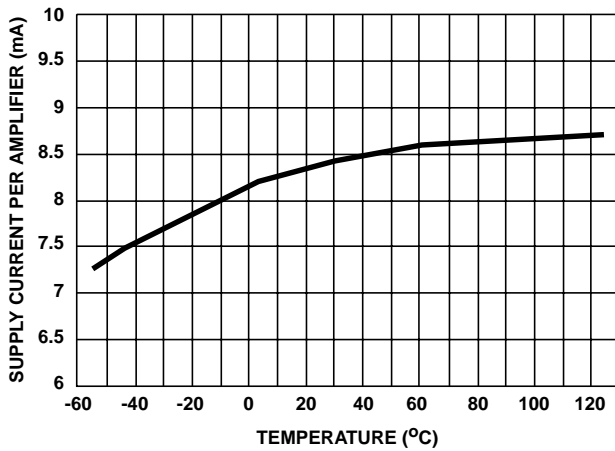**FIGURE 28. OUTPUT VOLTAGE SWING vs LOAD RESISTANCE**

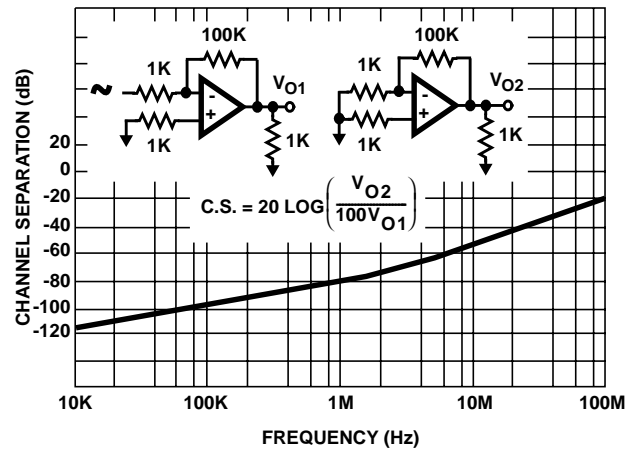**FIGURE 29. SUPPLY CURRENT/AMPLIFIER vs TEMPERATURE**

$$C.S. = 20 \; LOG\left(\frac{V_{O2}}{100V_{O1}}\right)$$

FIGURE 30. CHANNEL SEPARATION vs FREQUENCY

Die Characteristics

DIE DIMENSIONS:

78 mils x 185 mils
1980µm x 4690µm

METALLIZATION:

Type: Al, 1% Cu
Thickness: 16kÅ ±2kÅ

PASSIVATION:

Type: Nitride (Si$_3$N$_4$) over Silox (SiO$_2$ 5% Phos.)
Silox Thickness: 12kÅ ±2kÅ
Nitride Thickness: 3.5kÅ ±1.5kÅ

SUBSTRATE POTENTIAL (POWERED UP):

V-

TRANSISTOR COUNT:

128

PROCESS:

Bipolar Dielectric Isolation

Metallization Mask Layout

HA-5222