

January 1989

### Features

- This Circuit Is Processed in Accordance to Mil-Std-883 and Is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- High Slew Rate (HA-2520/883)..... 100V/ $\mu$ s Min  
120V/ $\mu$ s Typ
- Wide Power Bandwidth (HA-2520/883).... 1.5MHz Min
- Wide Gain Bandwidth (HA-2520/883) .... 10MHz Min  
20MHz Typ
- High Input Impedance (HA-2520/883).... 50M $\Omega$  Min  
100M $\Omega$  Typ
- Low Offset Current (HA-2520/883)..... 25nA Min  
10nA Typ
- Fast Settling (0.1% of 10V Step)..... 200ns Typ
- Low Quiescent Supply Current..... 6mA Max

### Applications

- Data Acquisition Systems
- R. F. Amplifiers
- Video Amplifiers
- Signal Generators
- Pulse Amplifiers

### Description

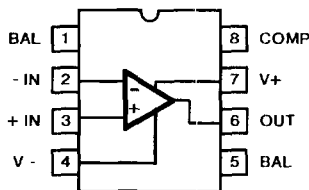
The HA-2520/883 and HA-2522/883 are monolithic operational amplifiers which deliver an unsurpassed combination of specifications for slew rate, bandwidth and settling time. These dielectrically isolated amplifiers are designed for closed loop gains of 3 or greater without external compensation. In addition, these high performance components also provide low offset current and high input impedance.

The 100V/ $\mu$ s (min) slew rate (80V/ $\mu$ s for HA-2522/883) and fast settling time of these amplifiers make them ideal components for pulse amplification and data acquisition designs. To insure compliance with slew rate and transient response specifications, all devices are 100% tested for A.C. performance characteristics over full temperature. These devices are valuable components for R. F. and video circuitry requiring wideband operation. For accurate signal conditioning designs, the HA-2520/883's superior dynamic specifications are complemented by 25nA (max) offset current (50nA for HA-2522/883) and offset voltage trim capability.

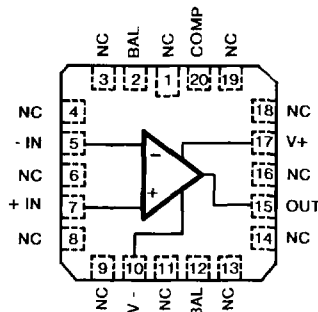
The HA-2520/883 and HA-2522/883 are available as MIL-STD-883 compliant devices screened to class B level. These devices are sensitive to electrostatic discharge and are in microcircuit group number 49 (see MIL-M-38510, Appendix E). The HA-2520/883 and HA-2522/883 have guaranteed operation over the military temperature range from -55°C to +125°C and are available in TO-99 Metal Can and Ceramic Mini-DIP packages. The HA-2522/883 is also available in a 20 pin LCC package.

### Pinouts

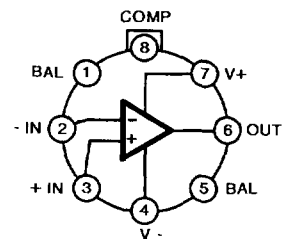
HA7-2520/883 (CERAMIC MINI-DIP)  
HA7-2522/883 (CERAMIC MINI-DIP)  
TOP VIEW



HA4-2522/883 (CERAMIC LCC)  
TOP VIEW



HA2-2520/883 (METAL CAN)  
HA2-2522/883 (METAL CAN)  
TOP VIEW



**Absolute Maximum Ratings**

Voltage Between V+ and V- Terminals	40V
Differential Input Voltage	15V
Voltage at Either Input Terminal	V+ to V-
Peak Output Current	50mA
Junction Temperature (T <sub>J</sub> )	+175°C
Storage Temperature Range	-65°C to +150°C
ESD Rating	< 2000V
Lead Temperature (Soldering 10 sec)	275°C

CAUTION: Absolute maximum ratings are limiting values, applied individually beyond which the serviceability of the circuit may be impaired. Functional operability under any of these conditions is not necessarily implied.

**Thermal Information**

Thermal Resistance	$\theta_{ja}$	$\theta_{jc}$
Ceramic DIP Package	140°C/W	65°C/W
Ceramic LCC Package	76°C/W	26°C/W
Metal Can Package	148°C/W	45°C/W
Package Power Dissipation Limit at +75°C for T <sub>J</sub> ≤ +175°C		
Ceramic DIP Package	710mW	
Ceramic LCC Package	1.3W	
Metal Can Package	670mW	
Package Power Dissipation Derating Factor Above +75°C		
Ceramic DIP Package	7.1mW/°C	
Ceramic LCC Package	13.1mW/°C	
Metal Can Package	6.7mW/°C	

**Recommended Operating Conditions**

Operating Temperature Range	-55°C to +125°C	V <sub>I(Ncm)</sub> ≤ 1/2 (V+ - V-)
Operating Supply Voltage	±15V	R <sub>L</sub> ≥ 2kΩ

**TABLE 1. D.C. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: Supply Voltage = ±15V, R<sub>SOURCE</sub> = 100Ω, R<sub>LOAD</sub> = 500kΩ, V<sub>OUT</sub> = 0V, Unless Otherwise Specified.

D.C. PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUP	TEMPERATURE	HA-2520/883		HA-2522/883		UNITS
					MIN	MAX	MIN	MAX	
Input Offset Voltage	V <sub>IO</sub>	V <sub>CM</sub> = 0V	1	+25°C	-8	8	-10	10	mV
			2, 3	+125°C, -55°C	-10	10	-14	14	mV
Input Bias Current	+I <sub>B</sub>	V <sub>CM</sub> = 0V +R <sub>S</sub> = 100kΩ -R <sub>S</sub> = 100Ω	1	+25°C	-200	200	-250	250	nA
			2, 3	+125°C, -55°C	-400	400	-500	500	nA
	-I <sub>B</sub>	V <sub>CM</sub> = 0V +R <sub>S</sub> = 100Ω -R <sub>S</sub> = 100kΩ	1	+25°C	-200	200	-250	250	nA
			2, 3	+125°C, -55°C	-400	400	-500	500	nA
Input Offset Current	I <sub>IO</sub>	V <sub>CM</sub> = 0V +R <sub>S</sub> = 100kΩ -R <sub>S</sub> = 100kΩ	1	+25°C	-25	25	-50	50	nA
			2, 3	+125°C, -55°C	-50	50	-100	100	nA
Common Mode Range	+CMR	V+ = 5V V- = -25V	1	+25°C	+10	-	+10	-	V
			2, 3	+125°C, -55°C	+10	-	+10	-	V
	-CMR	V+ = 25V V- = -5V	1	+25°C	-	-10	-	-10	V
			2, 3	+125°C, -55°C	-	-10	-	-10	V
Large Signal Voltage Gain	+A <sub>VOL</sub>	V <sub>OUT</sub> = 0V and +10V R <sub>L</sub> = 2kΩ	4	+25°C	10	-	7.5	-	kV/V
			5, 6	+125°C, -55°C	7.5	-	5	-	kV/V
	-A <sub>VOL</sub>	V <sub>OUT</sub> = 0V and -10V R <sub>L</sub> = 2kΩ	4	+25°C	10	-	7.5	-	kV/V
			5, 6	+125°C, -55°C	7.5	-	5	-	kV/V
Common Mode Rejection Ratio	+CMRR	ΔV <sub>CM</sub> = +10V +V = +5V -V = -25V V <sub>OUT</sub> = -10V	1	+25°C	80	-	74	-	dB
			2, 3	+125°C, -55°C	80	-	74	-	dB
	-CMRR	ΔV <sub>CM</sub> = -10V +V = +25V -V = -5V V <sub>OUT</sub> = +10V	1	+25°C	80	-	74	-	dB
			2, 3	+125°C, -55°C	80	-	74	-	dB

CAUTION: This device is sensitive to electrostatic discharge. Proper I.C. handling procedures should be followed.

**HA-2520/883 HA-2522/883**

**TABLE 1. D.C. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: Supply Voltage = ±15V, R<sub>SOURCE</sub> = 100Ω, R<sub>LOAD</sub> = 500kΩ, V<sub>OUT</sub> = 0V, Unless Otherwise Specified.

D.C. PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUP	TEMPERATURE	HA-2520/883		HA-2522/883		UNITS
					MIN	MAX	MIN	MAX	
Output Voltage Swing	+V <sub>OUT</sub>	R <sub>L</sub> = 2kΩ	4	+25°C	10	-	10	-	V
			5, 6	+125°C, -55°C	10	-	10	-	V
	-V <sub>OUT</sub>	R <sub>L</sub> = 2kΩ	4	+25°C	-	-10	-	-10	V
			5, 6	+125°C, -55°C	-	-10	-	-10	V
Output Current	+I <sub>OUT</sub>	V <sub>OUT</sub> = -10V	4	+25°C	10	-	10	-	mA
			5, 6	+125°C, -55°C	7.5	-	7.5	-	mA
	-I <sub>OUT</sub>	V <sub>OUT</sub> = +10V	4	+25°C	-	-10	-	-10	mA
			5, 6	+125°C, -55°C	-	-7.5	-	-7.5	mA
Quiescent Power Supply Current	+I <sub>CC</sub>	V <sub>OUT</sub> = 0V I <sub>OUT</sub> = 0mA	1	+25°C	-	6	-	6	mA
			2, 3	+125°C, -55°C	-	6.5	-	7	mA
	-I <sub>CC</sub>	V <sub>OUT</sub> = 0V I <sub>OUT</sub> = 0mA	1	+25°C	-6	-	-6	-	mA
			2, 3	+125°C, -55°C	-6.5	-	-7	-	mA
Power Supply Rejection Ratio	+PSRR	ΔV <sub>SUP</sub> = 10V +V = +20V, -V = -15V +V = +10V, -V = -15V	1	+25°C	80	-	74	-	dB
			2, 3	+125°C, -55°C	80	-	74	-	dB
	-PSRR	ΔV <sub>SUP</sub> = 10V +V = +15V, -V = -20V +V = +15V, -V = -10V	1	+25°C	80	-	74	-	dB
			2, 3	+125°C, -55°C	80	-	74	-	dB
Offset Voltage Adjustment	+V <sub>IOAdj</sub>	Note 4	1	+25°C	V <sub>IO-1</sub>	-	V <sub>IO-1</sub>	-	mV
			2, 3	+125°C, -55°C	V <sub>IO-1</sub>	-	V <sub>IO-1</sub>	-	mV
	-V <sub>IOAdj</sub>	Note 4	1	+25°C	V <sub>IO+1</sub>	-	V <sub>IO+1</sub>	-	mV
			2, 3	+125°C, -55°C	V <sub>IO+1</sub>	-	V <sub>IO+1</sub>	-	mV

**TABLE 2. A.C. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: Supply Voltage = ±15V, R<sub>SOURCE</sub> = 50Ω, R<sub>LOAD</sub> = 2kΩ, C<sub>LOAD</sub> = 50pF, A<sub>VCL</sub> = +3V/V, Unless Otherwise Specified.

PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUP	TEMPERATURE	HA-2520/883		HA-2522/883		UNITS
					MIN	MAX	MIN	MAX	
Slew Rate	+SR	V <sub>OUT</sub> = -5V to +5V	7	+25°C	100	-	80	-	V/μs
			8A, 8B	+125°C, -55°C	84	-	60	-	V/μs
	-SR	V <sub>OUT</sub> = +5V to -5V	7	+25°C	100	-	80	-	V/μs
			8A, 8B	+125°C, -55°C	84	-	60	-	V/μs
Rise & Fall Time	T <sub>R</sub>	V <sub>OUT</sub> = 0 to +200mV 10% ≤ T <sub>R</sub> ≤ 90%	7	+25°C	-	50	-	50	ns
			8A, 8B	+125°C, -55°C	-	55	-	60	ns
	T <sub>F</sub>	V <sub>OUT</sub> = 0 to -200mV 10% ≤ T <sub>F</sub> ≤ 90%	7	+25°C	-	50	-	50	ns
			8A, 8B	+125°C, -55°C	-	55	-	60	ns
Overshoot	+OS	V <sub>OUT</sub> = 0 to +200mV	7	+25°C	-	40	-	50	%
			8A, 8B	+125°C, -55°C	-	45	-	60	%
	-OS	V <sub>OUT</sub> = 0 to -200mV	7	+25°C	-	40	-	50	%
			8A, 8B	+125°C, -55°C	-	45	-	60	%

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: Supply Voltage = ±15V, R<sub>LOAD</sub> = 2kΩ, C<sub>LOAD</sub> = 50pF, A<sub>V</sub> ≥ 3, C<sub>COMP</sub> = 0pF, Unless Otherwise Specified.

PARAMETERS	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	HA-2520/883		HA-2522/883		UNITS
					MIN	MAX	MIN	MAX	
Differential Input Resistance	R <sub>IN</sub>	V <sub>CM</sub> = 0V	1	+25°C	50	-	40	-	MΩ
Gain Bandwidth Product	GBWP	V <sub>O</sub> = 200mV, f <sub>O</sub> = 10kHz	1	+25°C	10	-	10	-	MHz
		V <sub>O</sub> = 200mV, f <sub>O</sub> = 1MHz	1	+25°C	10	-	10	-	MHz
Full Power Bandwidth	FPBW	V <sub>PEAK</sub> = 10V	1, 2	+25°C	1.6	-	1.2	-	MHz
Minimum Closed Loop Stable Gain	CLSG	R <sub>L</sub> = 2kΩ, C <sub>L</sub> = 50pF	1	-55°C to +125°C	+3	-	+3	-	V/V
Quiescent Power Consumption	PC	V <sub>OUT</sub> = 0V, I <sub>OUT</sub> = 0mA	1, 3	-55°C to +125°C	-	195	-	210	mW

NOTES: 1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.

- 2. Full Power Bandwidth guarantee based on Slew Rate measurement using FPBW = Slew Rate/(2πV<sub>PEAK</sub>).
- 3. Quiescent Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.)
- 4. Offset adjustment range is [ V<sub>IQ(Measured)</sub> ± 1mV ] minimum referred to output. This test is for functionality only to assure adjustment through 0V.

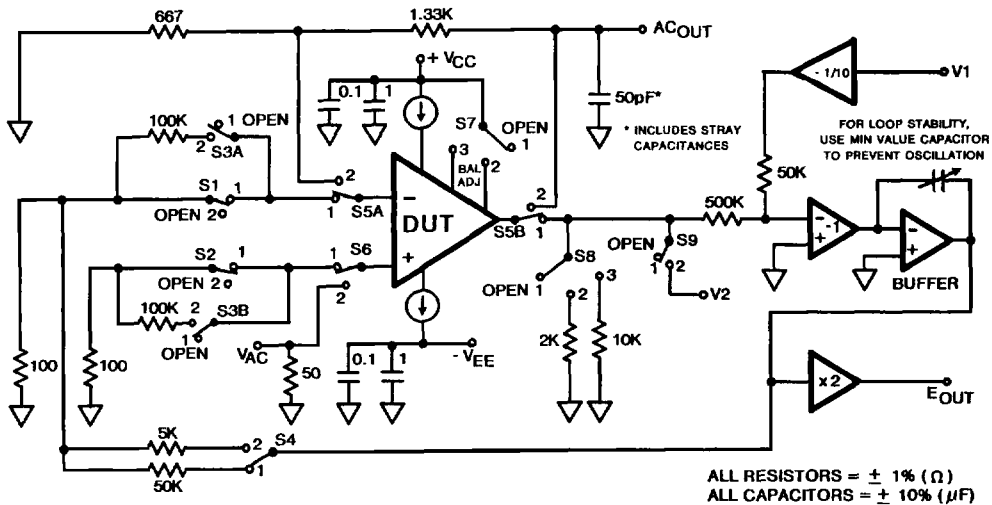
**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

MIL-STD-883 TEST REQUIREMENTS	SUBGROUPS (SEE TABLES 1 & 2)
Interim Electrical Parameters (Pre Burn-in)	1
Final Electrical Test Parameters	1*, 2, 3, 4, 5, 6, 7, 8A, 8B
Group A Test Requirements	1, 2, 3, 4, 5, 6, 7, 8A, 8B
Groups C & D End Points	1

\* PDA applies to Subgroup 1 only.

The Subgroup assignments of the parameters in these tables were patterned after MIL-M-38510/122, device type 06.

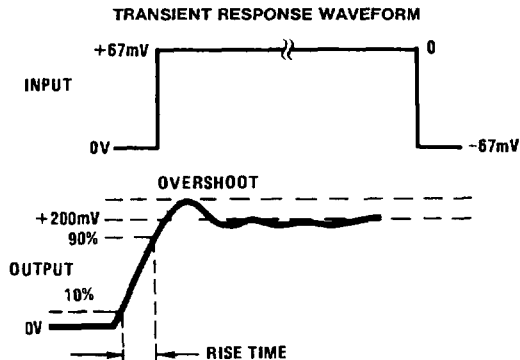
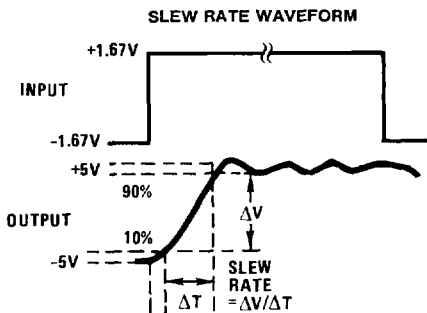
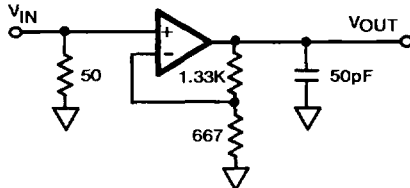
**Test Circuit** (Applies to Tables 1 and 2)



For Detailed Information, Refer to HA-2520/883; HA-2522/883 Test Tech Brief

**Test Waveforms**

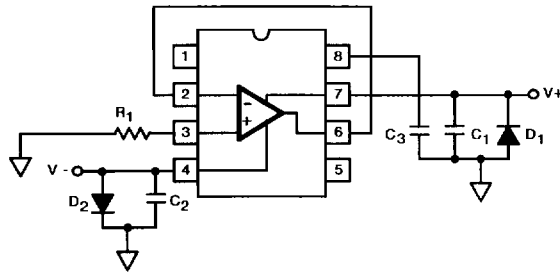
**SIMPLIFIED TEST CIRCUIT** (Applies to Table 2)



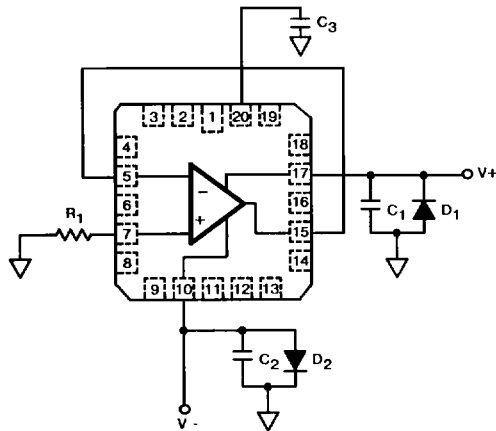
NOTE: Measured on both positive and negative transitions.  
Capacitance at Compensation pin should be minimized.

**Burn-In Circuits**

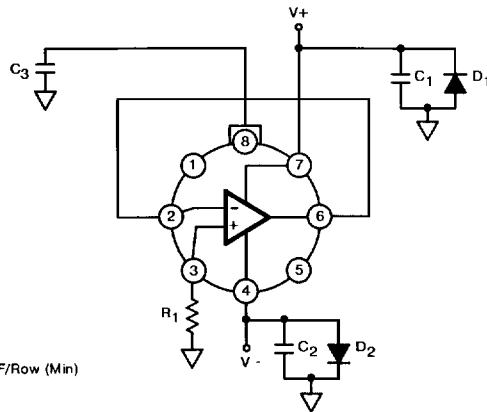
HA7-2520/883 CERAMIC MINI-DIP  
HA7-2522/883 CERAMIC MINI-DIP



HA4-2522/883 CERAMIC LCC



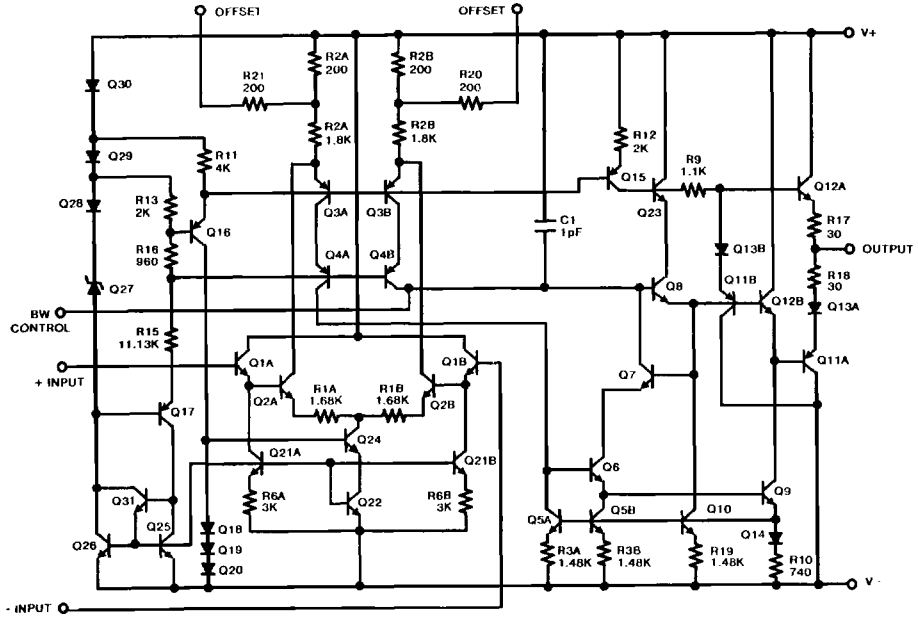
HA2-2520/883 (TO-99) METAL CAN  
HA2-2522/883 (TO-99) METAL CAN



**NOTES:**

- R<sub>1</sub> = 1MΩ, ±5%, 1/4W (Min)
- C<sub>1</sub> = C<sub>2</sub> = 0.01μF/Socket (Min) or 0.1μF/Row (Min)
- C<sub>3</sub> = 0.01μF (±10%)/Socket
- D<sub>1</sub> = D<sub>2</sub> = IN4002 or Equivalent/Board
- |V<sub>+</sub> - V<sub>-</sub>| = 30V

Schematic Diagram



**Die Characteristics**

**DIE DIMENSIONS:**

65 x 50 x 19 mils  
(1660 x 1270 x 483 μm)

**METALLIZATION:**

Type: Aluminum  
Thickness: 16kÅ ± 2kÅ

**WORST CASE CURRENT DENSITY:**

0.79 x 10<sup>5</sup>A/cm<sup>2</sup> @ 10mA

**SUBSTRATE POTENTIAL (Powered Up):**

Unbiased

**GLASSIVATION:**

Type: Nitride  
Thickness: 7kÅ ± 0.7kÅ

**TRANSISTOR COUNT:**

HA-2520/883: 40  
HA-2522/883: 40

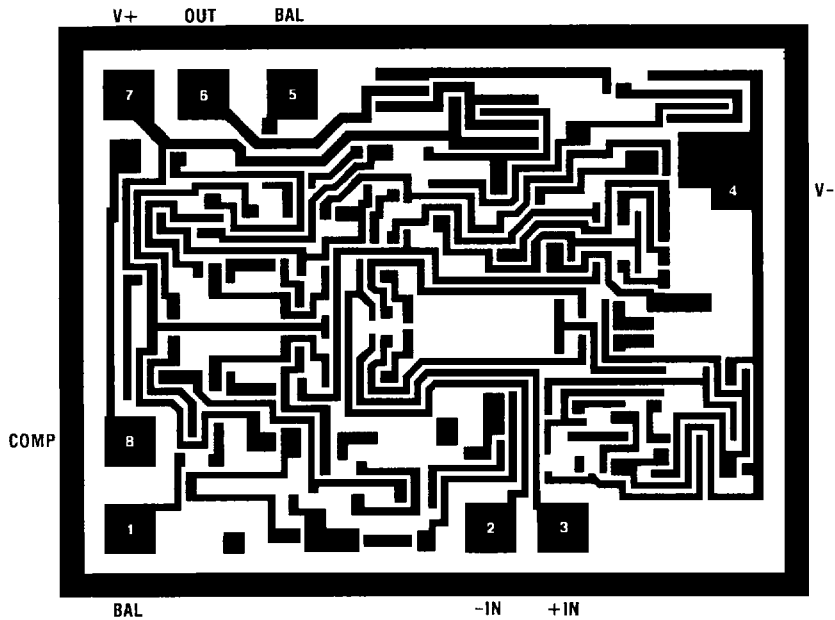
**PROCESS:** Std. Linear Bipolar Dielectric Isolation

**DIE ATTACH:**

Material: Gold/Silicon Eutectic Alloy  
Temperature: Ceramic Mini-DIP — 460°C (Max)  
Ceramic LCC — 420°C (Max)  
Metal Can — 420°C (Max)

**Metallization Mask Layout**

HA-2520/883 HA-2522/883



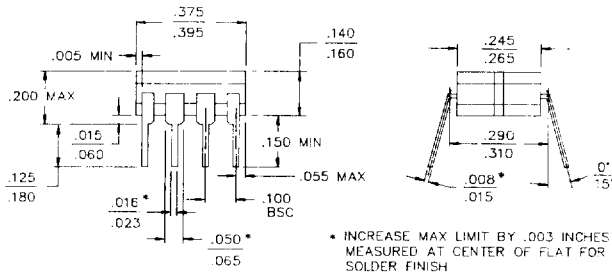
NOTE: Pin Numbers Correspond to 8 Lead Metal Can and Ceramic Mini-DIP Package Only.

**3**  
OP AMPS &  
COMPARATORS



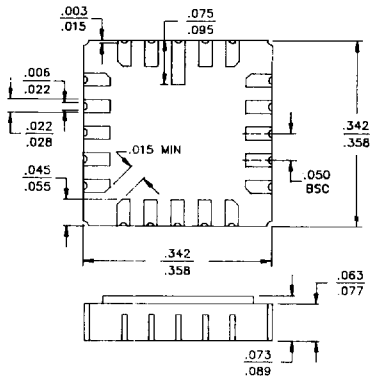
**Packaging †**

**8 PIN CERAMIC DIP**



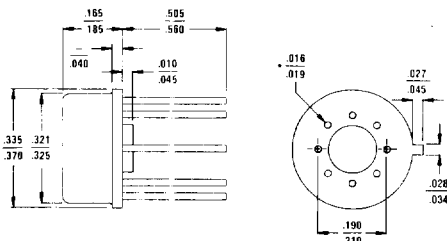
**LEAD MATERIAL:** Type B  
**LEAD FINISH:** Type A  
**PACKAGE MATERIAL:** Ceramic, 90% Alumina  
**PACKAGE SEAL:**  
 Material: Glass Frit  
 Temperature: 450°C ± 10°C  
 Method: Furnace Seal  
**INTERNAL LEAD WIRE:**  
 Material: Aluminum  
 Diameter: 1.25 Mil  
 Bonding Method: Ultrasonic  
**COMPLIANT OUTLINE:** 38510 D-4

**20 PAD CERAMIC LCC**



**PAD MATERIAL:** Type C  
**PAD FINISH:** Type A  
**FINISH DIMENSION:** Type A  
**PACKAGE MATERIAL:** Multilayer Ceramic, 90% Al<sub>2</sub>O<sub>3</sub>  
**PACKAGE SEAL:**  
 Material: Gold/Tin (80/20)  
 Temperature: 320°C ± 10°C  
 Method: Furnace Braze  
**INTERNAL LEAD WIRE:**  
 Material: Aluminum  
 Diameter: 1.25 Mil  
 Bonding Method: Ultrasonic  
**COMPLIANT OUTLINE:** 38510 C-2

**8 PIN TO-99 METAL CAN**



**LEAD MATERIAL:** Type A  
**LEAD FINISH:** Type C  
**PACKAGE MATERIAL:** Kovar Header with Nickel Can  
**PACKAGE SEAL:**  
 Material: No Seal Material  
 Temperature: Room Temperature  
 Method: Resistance Weld  
**INTERNAL LEAD WIRE:**  
 Material: Aluminum  
 Diameter: 1.25 Mil  
 Bonding Method: Ultrasonic Bonded  
**COMPLIANT OUTLINE:** 38510 A-1

\*Dimension Maximum Limits Are Increased by 0.003 inches for Solder Dip Finish

NOTE: All Dimensions are  $\frac{\text{Min}}{\text{Max}}$ , Dimensions are in inches.

†Mil-M-38510 Compliant Materials, Finishes, and Dimensions.

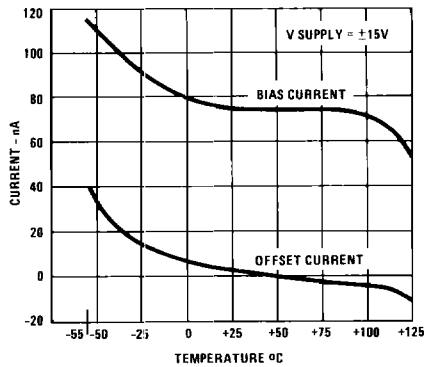
## DESIGN INFORMATION

## Uncompensated, High Slew Rate Operational Amplifiers

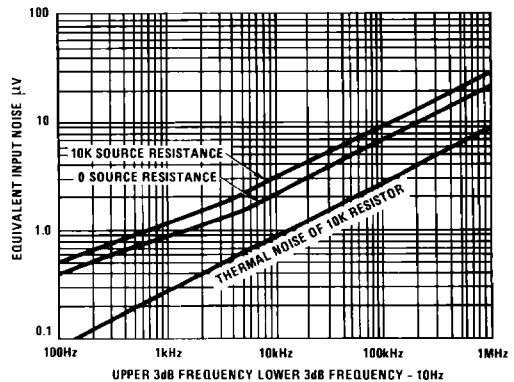
The information contained in this section has been developed through characterization by Harris Semiconductor and is for use as application and design aid only. These characteristics are not 100% tested and no product guarantee is implied.

**Typical Performance Curves** Unless Otherwise Specified:  $T_A = +25^\circ\text{C}$ ,  $\pm V_{\text{SUPPLY}} = \pm 15\text{V}$

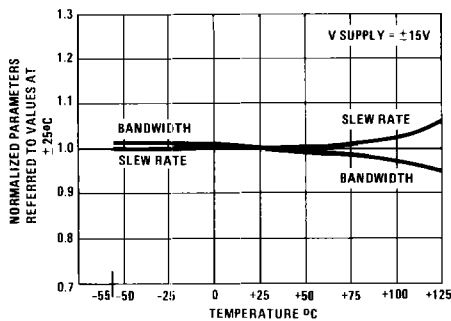
**INPUT BIAS AND OFFSET CURRENT vs. TEMPERATURE**



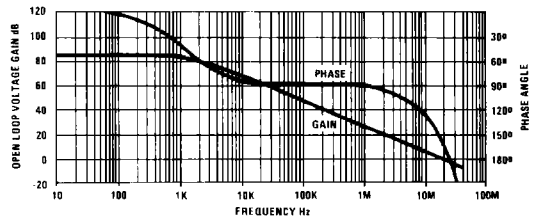
**EQUIVALENT INPUT NOISE vs. BANDWIDTH**



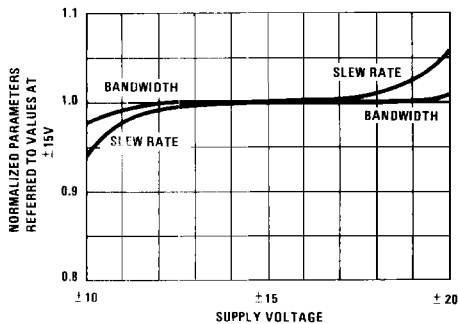
**NORMALIZED A.C. PARAMETERS vs. TEMPERATURE**



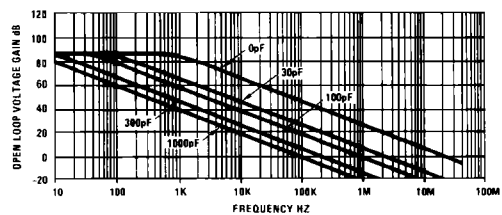
**OPEN-LOOP FREQUENCY AND PHASE RESPONSE**



**NORMALIZED A.C. PARAMETERS vs.  
SUPPLY VOLTAGE @ +25°C**



**OPEN-LOOP FREQUENCY RESPONSE FOR  
VARIOUS VALUES OF CAPACITORS FROM  
BANDWIDTH CONTROL PIN TO GROUND**

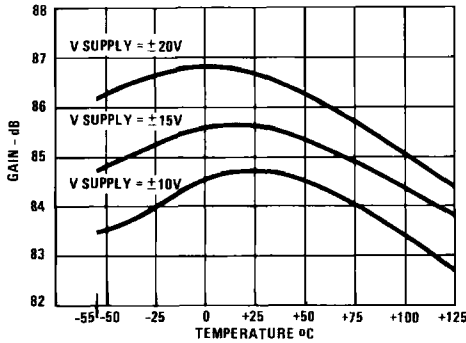


**DESIGN INFORMATION** (Continued)

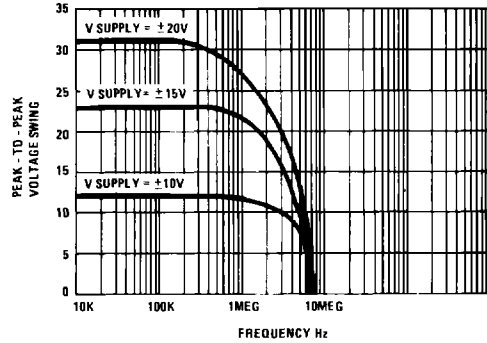
The information contained in this section has been developed through characterization by Harris Semiconductor and is for use as application and design aid only. These characteristics are not 100% tested and no product guarantee is implied.

**Typical Performance Curves** Unless Otherwise Specified:  $T_A = +25^\circ\text{C}$ ,  $\pm V_{\text{SUPPLY}} = \pm 15\text{V}$

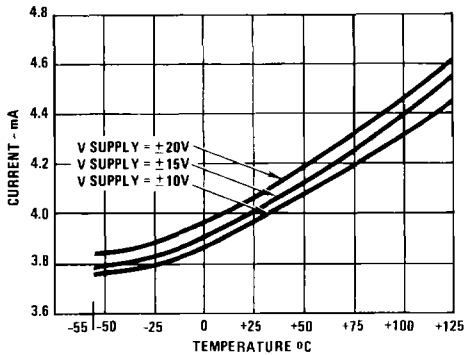
**OPEN-LOOP VOLTAGE GAIN vs. TEMPERATURE**



**OUTPUT VOLTAGE SWING vs. FREQUENCY @ +25°C**

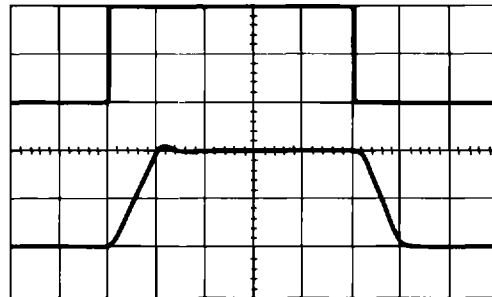


**POWER SUPPLY CURRENT vs. TEMPERATURE**

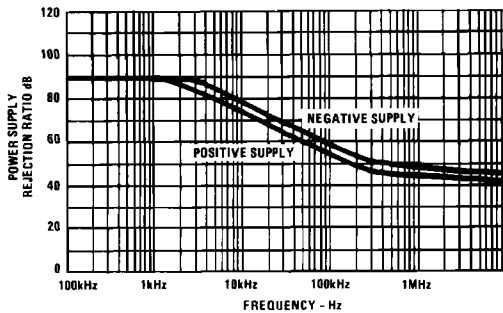


**VOLTAGE FOLLOWER PULSE RESPONSE**

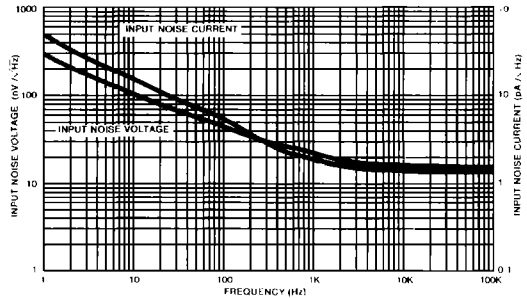
$R_L = 2\text{K}\Omega$ ,  $C_L = 50\text{pF}$ , Horizontal = 100ns/Div.  
 Upper Trace: Input; 1.67V/Div.  $T_A = +25^\circ\text{C}$ ,  $V_S = +15\text{V}$   
 Lower Trace: Output; 5V/Div.



**POWER SUPPLY REJECTION RATIO vs. FREQUENCY**



**INPUT NOISE DENSITY vs. FREQUENCY**



**DESIGN INFORMATION** (Continued)

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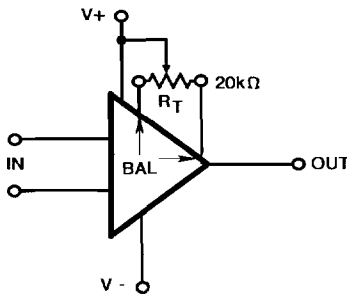
**TYPICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at:  $V_S = \pm 15V$ ,  $R_L = 2K$ ,  $C_L = 50pF$ , Unless Otherwise Specified.

PARAMETERS	CONDITIONS	TEMP	HA-2520	HA-2522	DESIGN LIMIT	UNITS
			TYPICAL	TYPICAL		
Offset Voltage	$V_{CM} = 0V$	+25°C	4	5	Table 1	mV
Offset Voltage Average Drift	Versus Temperature	Full	20	25	30	$\mu V/^\circ C$
Offset Current Average Drift	Versus Temperature	Full	200	300	500	$pA/^\circ C$
Differential Input Resistance		+25°C	100	100	Table 3	$M\Omega$
Large Signal Voltage Gain	$V_{OUT} = \pm 10V$	+25°C	15	15	Table 1	kV/V
CMRR	$V_{CM} = \pm 10V$	Full	90	90	Table 1	dB
PSRR	$\Delta V_{Supply} = \pm 10V$	Full	90	90	Table 1	dB
Output Current	$V_{OUT} = \pm 10V$	+25°C	$\pm 20$	$\pm 20$	Table 1	mA
Gain Bandwidth Product	$A_V = \geq 10$ Small Signal ( $\leq 200mV$ )	+25°C	20	20	Table 3	MHz
Rise/Fall Time	$V_O = \pm 200mV$	+25°C	25	25	Table 2	ns
Overshoot	$V_O = \pm 200mV$	+25°C	25	25	Table 2	%
Slew Rate	$V_O = \pm 5V$	+25°C	120	120	Table 2	$V/\mu s$
Settling Time	10V Step to 0.1%	+25°C	0.2	0.2	1.1	$\mu s$
Output Resistance	Open Loop	+25°C	30	30	50	$\Omega$
Minimum Supply Voltage	Functional Operation Only Other Parameters Will Vary	+25°C	$\pm 4$	$\pm 4$	$\pm 5$	V

**3**  
OP AMPS & COMPARATORS

**Suggested  $V_{OS}$  Adjustment**



Tested Offset Adjustment Range is  $|V_{OS} + 1mV|$  minimum referred to output. Typical range is +20mV to -18mV with  $R_T = 20k\Omega$ .