HARRIS

HA-2520/883
HA-2522/883

Uncompensated, High Slew Rate Operational Amplifiers

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/μs Min 120V/μs 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).... 50MΩ Min 100MΩ 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

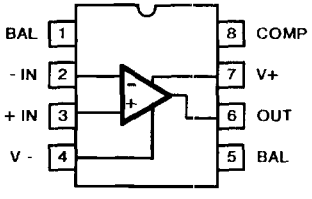
The HA-2520/883 and HA-2522/883 are monolithic operational amplifiers which deliver an unsurpassed combination of specifications for slew rate, bandwidth and settling time. These dielectrically isolated amplifiers are designed for closed loop gains of 3 or greater without external compensation. In addition,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

The 100V/μs (min) slew rate (80V/μs 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.

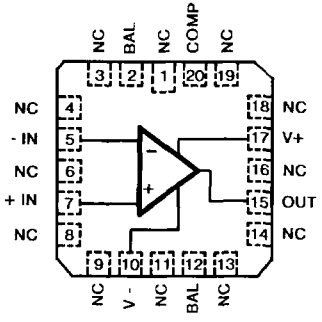
The HA-2520/883 and HA-2522/883 are available as MIL-STD-883 compliant devices screened to class B level. These devices are sensitive to electrostatic discharge and are in microcircuit group number 49 (see MIL-M-38510, Appendix E). The HA-2520/883 and HA-2522/883 have guaranteed operation over the military 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

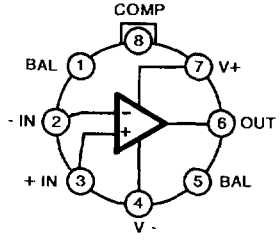
HA7-2520/883 (CERAMIC MINI-DIP)
HA7-2522/883 (CERAMIC MINI-DIP)
TOP VIEW



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_J) ..... +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	θ_{ja}	θ_{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 $T_J \leq +175°C$
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
Operating Supply Voltage ..... ±15V
$V_{INCm} \leq 1/2 (V+ - V-)$
$R_L \geq 2k\Omega$

TABLE 1. D.C. ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: Supply Voltage = ±15V, $R_{SOURCE} = 100\Omega$, $R_{LOAD} = 500k\Omega$, $V_{OUT} = 0V$, Unless Otherwise Specified.

D.C. PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUP	TEMPERATURE	HA-2520/883 MIN	HA-2520/883 MAX	HA-2522/883 MIN	HA-2522/883 MAX	UNITS
Input Offset Voltage	V_{IO}	$V_{CM} = 0V$	1	+25°C	-8	8	-10	10	mV
			2, 3	+125°C, -55°C	-10	10	-14	14	mV
Input Bias Current	$+I_B$	$V_{CM} = 0V$ $+R_S = 100k\Omega$ $-R_S = 100\Omega$	1	+25°C	-200	200	-250	250	nA
			2, 3	+125°C, -55°C	-400	400	-500	500	nA
	$-I_B$	$V_{CM} = 0V$ $+R_S = 100\Omega$ $-R_S = 100k\Omega$	1	+25°C	-200	200	-250	250	nA
			2, 3	+125°C, -55°C	-400	400	-500	500	nA
Input Offset Current	I_{IO}	$V_{CM} = 0V$ $+R_S = 100k\Omega$ $-R_S = 100k\Omega$	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	$+A_{VOL}$	$V_{OUT} = 0V$ and $+10V$ $R_L = 2k\Omega$	4	+25°C	10	-	7.5	-	kV/V
			5, 6	+125°C, -55°C	7.5	-	5	-	kV/V
	$-A_{VOL}$	$V_{OUT} = 0V$ and $-10V$ $R_L = 2k\Omega$	4	+25°C	10	-	7.5	-	kV/V
			5, 6	+125°C, -55°C	7.5	-	5	-	kV/V
Common Mode Rejection Ratio	+CMRR	$\Delta V_{CM} = +10V$ $+V = +5V$ $-V = -25V$ $V_{OUT} = -10V$	1	+25°C	80	-	74	-	dB
			2, 3	+125°C, -55°C	80	-	74	-	dB
	-CMRR	$\Delta V_{CM} = -10V$ $+V = +25V$ $-V = -5V$ $V_{OUT} = +10V$	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.

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

Device Tested at: Supply Voltage = ±15V, R_{SOURCE} = 100Ω, R_{LOAD} = 500kΩ, V_{OUT} = 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	$+V_{OUT}$	R_L = 2kΩ	4	+25°C	10	-	10	-	V
			5, 6	+125°C, -55°C	10	-	10	-	V
	$-V_{OUT}$	R_L = 2kΩ	4	+25°C	-	-10	-	-10	V
			5, 6	+125°C, -55°C	-	-10	-	-10	V
Output Current	$+I_{OUT}$	V_{OUT} = -10V	4	+25°C	10	-	10	-	mA
			5, 6	+125°C, -55°C	7.5	-	7.5	-	mA
	$-I_{OUT}$	V_{OUT} = +10V	4	+25°C	-	-10	-	-10	mA
			5, 6	+125°C, -55°C	-	-7.5	-	-7.5	mA
Quiescent Power Supply Current	$+I_{CC}$	V_{OUT} = 0V I_{OUT} = 0mA	1	+25°C	-	6	-	6	mA
			2, 3	+125°C, -55°C	-	6.5	-	7	mA
	$-I_{CC}$	V_{OUT} = 0V I_{OUT} = 0mA	1	+25°C	-6	-	-6	-	mA
			2, 3	+125°C, -55°C	-6.5	-	-7	-	mA
Power Supply Rejection Ratio	+PSRR	ΔV_{SUP} = 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_{SUP} = 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	$+V_{IO}$Adj	Note 4	1	+25°C	V_{IO}-1	-	V_{IO}-1	-	mV
			2, 3	+125°C, -55°C	V_{IO}-1	-	V_{IO}-1	-	mV
	$-V_{IO}$Adj	Note 4	1	+25°C	V_{IO}+1	-	V_{IO}+1	-	mV
			2, 3	+125°C, -55°C	V_{IO}+1	-	V_{IO}+1	-	mV

TABLE 2. A.C. ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: Supply Voltage = ±15V, R_{SOURCE} = 50Ω, R_{LOAD} = 2kΩ, C_{LOAD} = 50pF, A_{VCL} = +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_{OUT} = -5V to +5V	7	+25°C	100	-	80	-	V/µs
			8A, 8B	+125°C, -55°C	84	-	60	-	V/µs
	-SR	V_{OUT} = +5V to -5V	7	+25°C	100	-	80	-	V/µs
			8A, 8B	+125°C, -55°C	84	-	60	-	V/µs
Rise & Fall Time	T_R	V_{OUT} = 0 to +200mV 10% ≤ T_R ≤ 90%	7	+25°C	-	50	-	50	ns
			8A, 8B	+125°C, -55°C	-	55	-	60	ns
	T_F	V_{OUT} = 0 to -200mV 10% ≤ T_F ≤ 90%	7	+25°C	-	50	-	50	ns
			8A, 8B	+125°C, -55°C	-	55	-	60	ns
Overshoot	+OS	V_{OUT} = 0 to +200mV	7	+25°C	-	40	-	50	%
			8A, 8B	+125°C, -55°C	-	45	-	60	%
	-OS	V_{OUT} = 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_{LOAD} = 2kΩ, C_{LOAD} = 50pF, $A_V \geq 3$, C_{COMP} = 0pF, Unless Otherwise Specified.

PARAMETERS	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	HA-2520/883		HA-2522/883		UNITS
					MIN	MAX	MIN	MAX	
Differential Input Resistance	R_{IN}	V_{CM} = 0V	1	+25°C	50	-	40	-	MΩ
Gain Bandwidth Product	GBWP	V_O = 200mV, f_o = 10kHz	1	+25°C	10	-	10	-	MHz
		V_O = 200mV, f_o = 1MHz	1	+25°C	10		10		MHz
Full Power Bandwidth	FPBW	V_{PEAK} = 10V	1, 2	+25°C	1.6	-	1.2	-	MHz
Minimum Closed Loop Stable Gain	CLSG	R_L = 2kΩ, C_L = 50pF	1	-55°C to +125°C	+3	-	+3	-	V/V
Quiescent Power Consumption	PC	V_{OUT} = 0V, I_{OUT} = 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/($2\pi V_{PEAK}$).
3. Quiescent Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.)
4. Offset adjustment range is [$V_{IO(Measured)}$ ± 1mV] minimum referred to output. This test is for functionality only to assure adjustment through 0V.

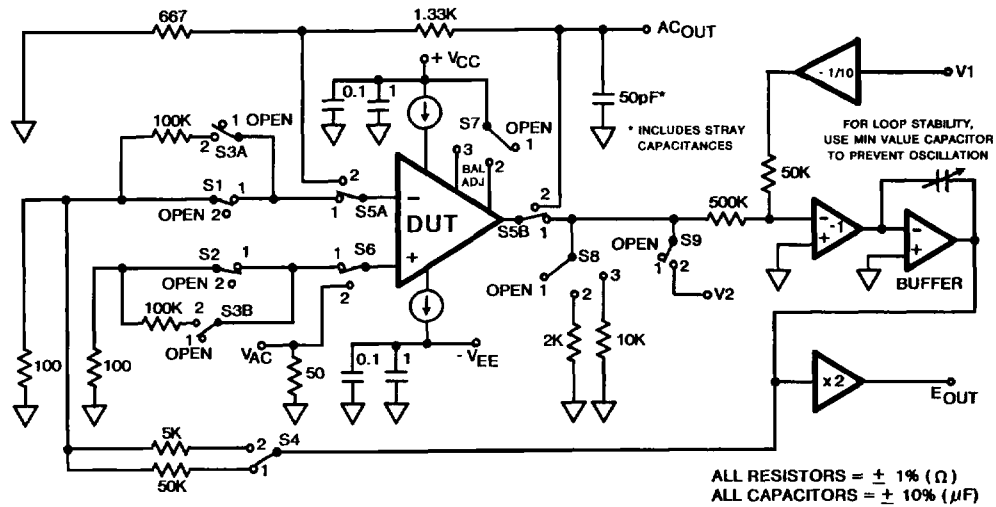
TABLE 4. ELECTRICAL TEST REQUIREMENTS

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.

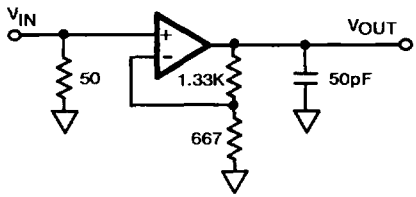
Test Circuit (Applies to Tables 1 and 2)



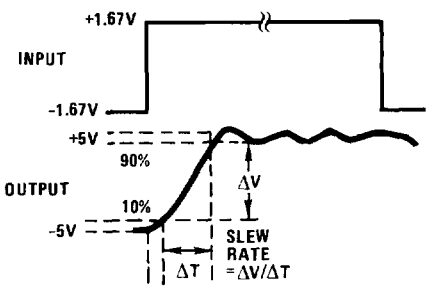
For Detailed Information, Refer to HA-2520/883; HA-2522/883 Test Tech Brief

Test Waveforms

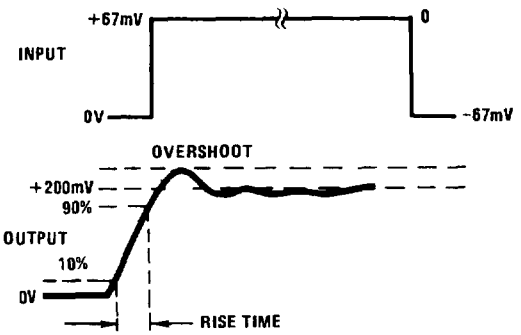
SIMPLIFIED TEST CIRCUIT (Applies to Table 2)



SLEW RATE WAVEFORM



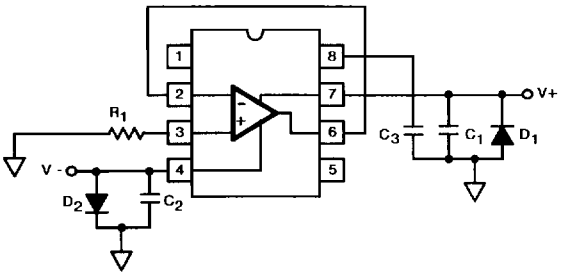
TRANSIENT RESPONSE WAVEFORM



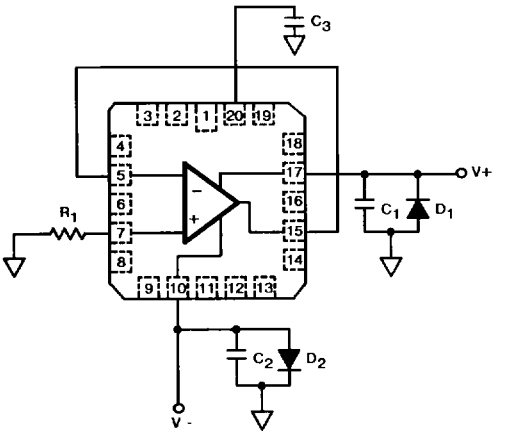
NOTE: Measured on both positive and negative transitions.
Capacitance at Compensation pin should be minimized.

Burn-In Circuits

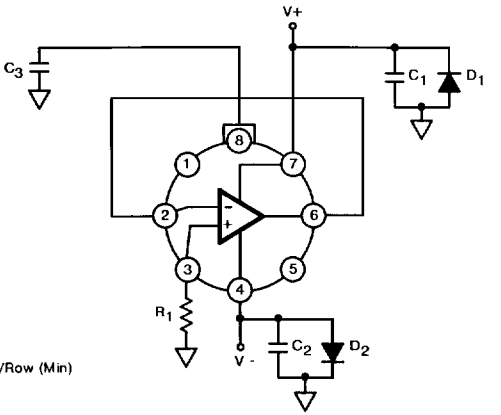
HA7-2520/883 CERAMIC MINI-DIP
HA7-2522/883 CERAMIC MINI-DIP



HA4-2522/883 CERAMIC LCC

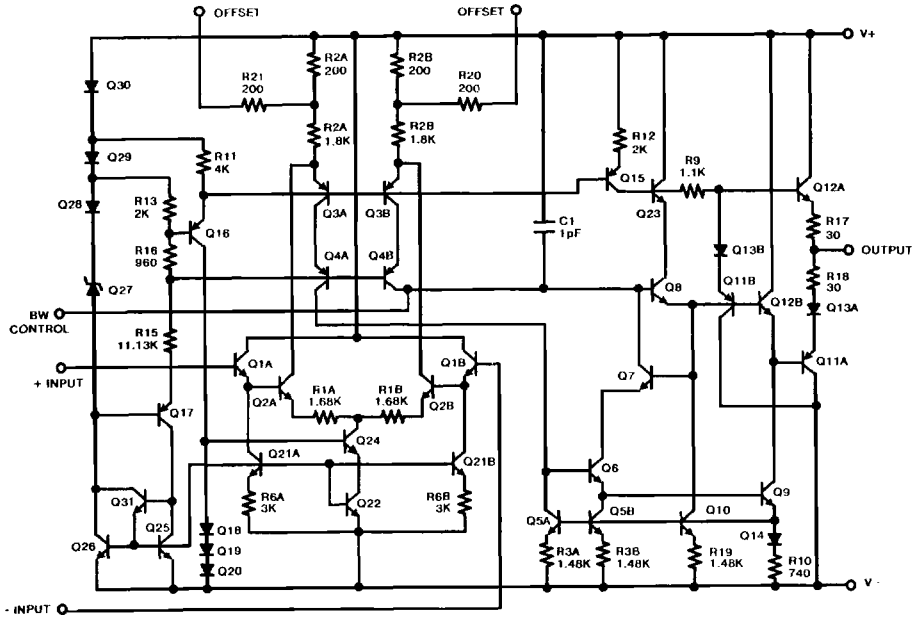


HA2-2520/883 (TO-99) METAL CAN
HA2-2522/883 (TO-99) METAL CAN



NOTES:
R_1 = 1MΩ, ±5%, 1/4W (Min)
C_1 = C_2 = 0.01μF/Socket (Min) or 0.1μF/Row (Min)
C_3 = 0.01μF (±10%)/Socket
D_1 = D_2 = IN4002 or Equivalent/Board
|(V+) - (V-)| = 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:
$0.79 \times 10^5 A/cm^2$ @ 10mA

SUBSTRATE POTENTIAL (Powered Up):
Unbiased

GLASSIVATION:
Type: Nitride
Thickness: 7kÅ ± 0.7kÅ

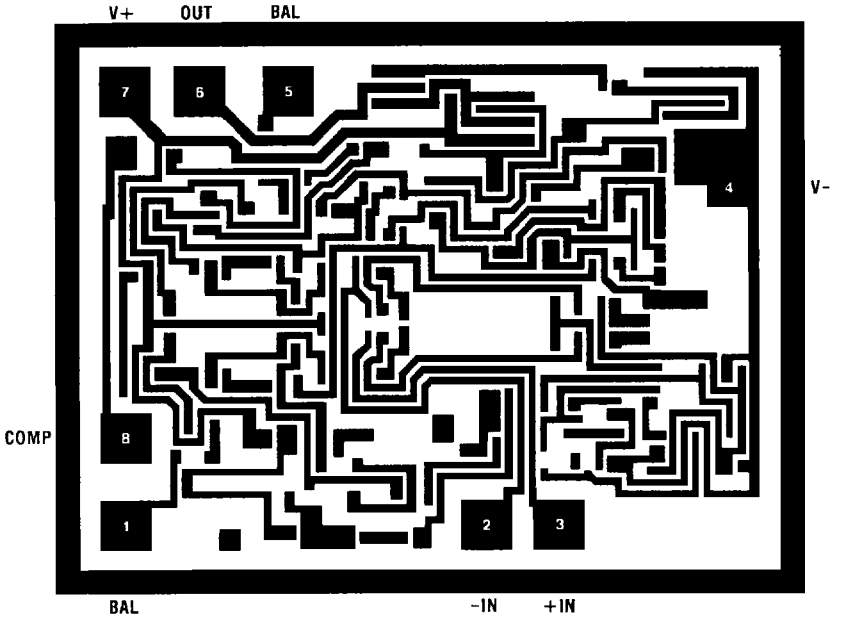
TRANSISTOR COUNT:
HA-2520/883: 40
HA-2522/883: 40

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

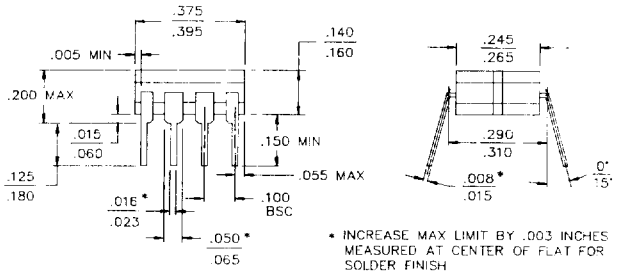
HA-2520/883 HA-2522/883



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

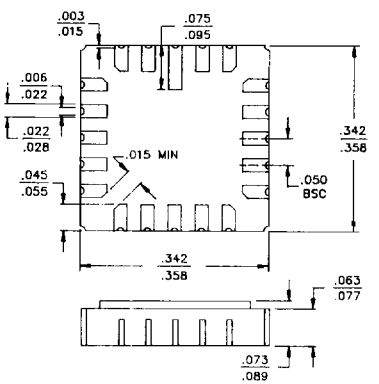
Packaging †

8 PIN CERAMIC DIP



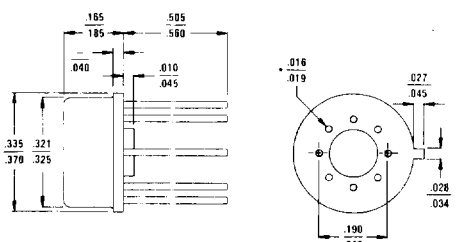
LEAD MATERIAL: Type B
LEAD FINISH: Type A
PACKAGE MATERIAL: Ceramic, 90% Alumina
PACKAGE SEAL:
Material: Glass Frit
Temperature: 450°C ± 10°C
Method: Furnace Seal
INTERNAL LEAD WIRE:
Material: Aluminum
Diameter: 1.25 Mil
Bonding Method: Ultrasonic
COMPLIANT OUTLINE: 38510 D-4

20 PAD CERAMIC LCC



PAD MATERIAL: Type C
PAD FINISH: Type A
FINISH DIMENSION: Type A
PACKAGE MATERIAL: Multilayer Ceramic, 90% Al_2O_3
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



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

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

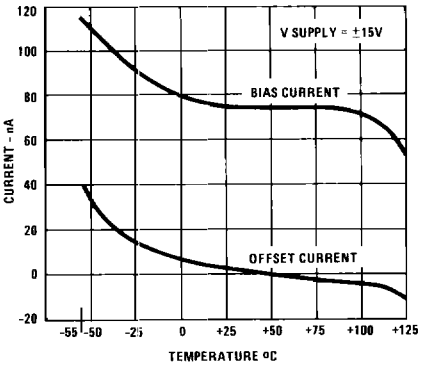
NOTE: All Dimensions are $\frac{\text{Min}}{\text{Max}}$, Dimensions are in inches.

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

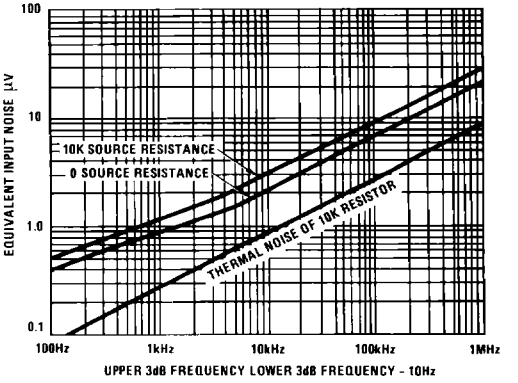
The information contained in this section has been developed through characterization by Harris Semiconductor and is for use as application and design aid only. These characteristics are not 100% tested and no product guarantee is implied.

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

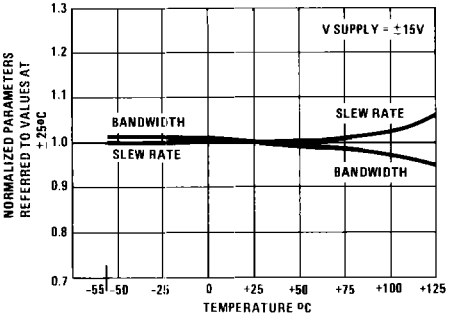
INPUT BIAS AND OFFSET CURRENT vs. TEMPERATURE



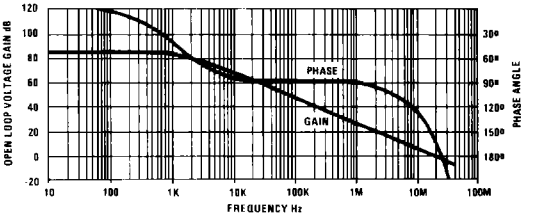
EQUIVALENT INPUT NOISE vs. BANDWIDTH



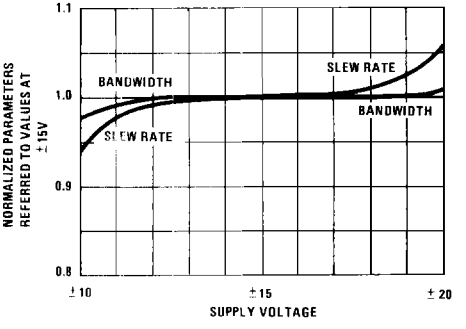
NORMALIZED A.C. PARAMETERS vs. TEMPERATURE



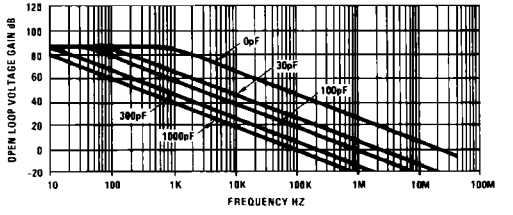
OPEN-LOOP FREQUENCY AND PHASE RESPONSE



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)

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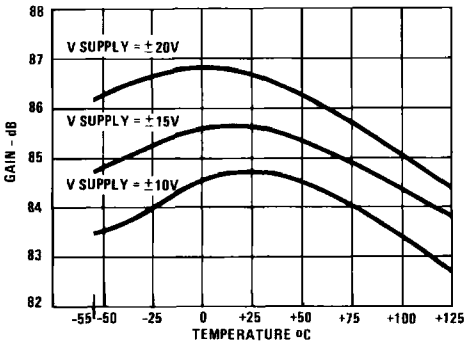
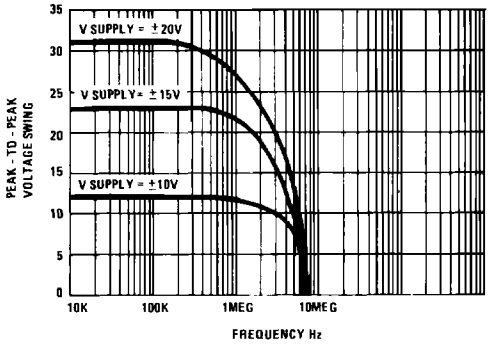
Typical Performance Curves Unless Otherwise Specified: $T_A = +25^oC$, $\pm V_{SUPPLY} = \pm 15V$

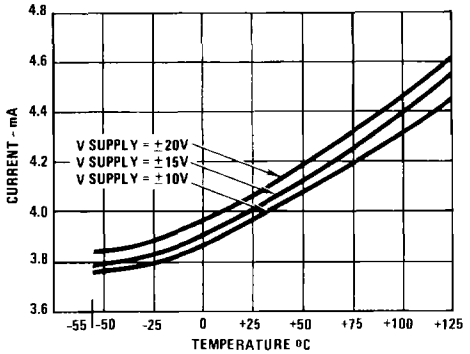
OPEN-LOOP VOLTAGE GAIN vs. TEMPERATURE



OUTPUT VOLTAGE SWING vs. FREQUENCY @ +25°C

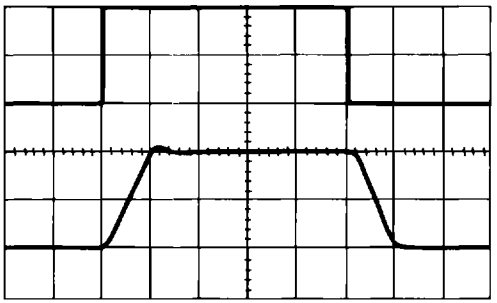


POWER SUPPLY CURRENT vs. TEMPERATURE

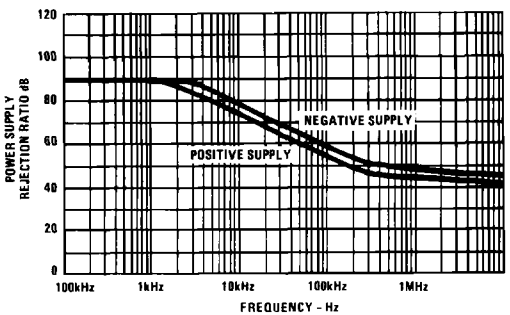


VOLTAGE FOLLOWER PULSE RESPONSE

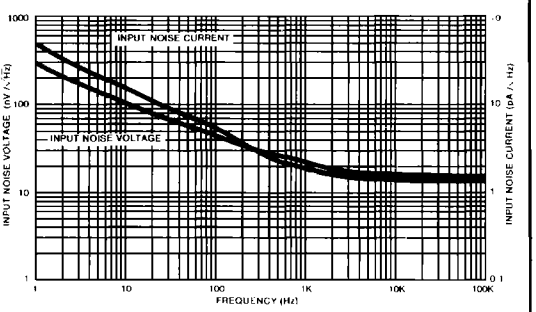
$R_L = 2K\Omega$, $C_L = 50pF$, Horizontal = 100ns/Div.
Upper Trace: Input; 1.67V/Div. $T_A = +25^oC$, $V_S = +15V$
Lower Trace: Output; 5V/Div.



POWER SUPPLY REJECTION RATIO vs. FREQUENCY



INPUT NOISE DENSITY vs. FREQUENCY



DESIGN INFORMATION (Continued)

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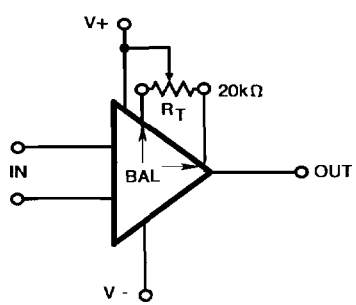
TYPICAL PERFORMANCE CHARACTERISTICS

Device Characterized at: $V_S = \pm15V$, $R_L = 2K$, $C_L = 50pF$, Unless Otherwise Specified.

PARAMETERS	CONDITIONS	TEMP	HA-2520 TYPICAL	HA-2522 TYPICAL	DESIGN LIMIT	UNITS
Offset Voltage	$V_{CM} = 0V$	+25°C	4	5	Table 1	mV
Offset Voltage Average Drift	Versus Temperature	Full	20	25	30	µV/°C
Offset Current Average Drift	Versus Temperature	Full	200	300	500	pA/°C
Differential Input Resistance		+25°C	100	100	Table 3	MΩ
Large Signal Voltage Gain	$V_{OUT} = \pm10V$	+25°C	15	15	Table 1	kV/V
CMRR	$V_{CM} = \pm10V$	Full	90	90	Table 1	dB
PSRR	$\Delta V_{Supply} = \pm10V$	Full	90	90	Table 1	dB
Output Current	$V_{OUT} = \pm10V$	+25°C	±20	±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	$V_O = \pm200mV$	+25°C	25	25	Table 2	ns
Overshoot	$V_O = \pm200mV$	+25°C	25	25	Table 2	%
Slew Rate	$V_O = \pm5V$	+25°C	120	120	Table 2	V/µs
Settling Time	10V Step to 0.1%	+25°C	0.2	0.2	1.1	µs
Output Resistance	Open Loop	+25°C	30	30	50	Ω
Minimum Supply Voltage	Functional Operation Only Other Parameters Will Vary	+25°C	±4	±4	±5	V

Suggested V_{OS} Adjustment



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