

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-2500/883)..... 25V/ μ s Min
30V/ μ s Typ
- Wide Power Bandwidth (HA-2500/883) 350kHz Min
- High Input Impedance (HA-2500/883)..... 25M Ω Min
50M Ω Typ
- Low Offset Current (HA-2500/883) 25nA Max
10nA Typ
- Low Quiescent Current..... 6mA Max
- Fast Settling Time (0.1% of 10V Step) 330ns Typ
- High Gain Bandwidth Product 12MHz Typ
- Internally Compensated For Unity Gain Stability

Applications

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

Description

HA-2500/883 and HA-2502/883 comprise a series of monolithic operational amplifiers whose designs are optimized to deliver excellent slew rate, bandwidth, and settling time specifications. The outstanding dynamic features of this internally compensated device are complemented with low offset voltage and offset current.

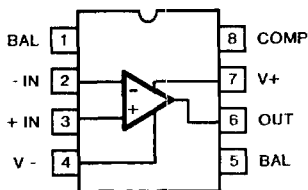
These dielectrically isolated amplifiers are ideally suited for applications such as data acquisition, R.F., video, and pulse conditioning circuits. Guaranteed slew rates of ± 25 V/ μ s minimum (HA-2500/883) and ± 20 V/ μ s minimum (HA-2502/883) make these devices excellent components in fast, accurate data acquisition and pulse amplification designs. To insure compliance, all devices are 100% tested for A.C. performance characteristics over the full temperature limits.

A typical 12MHz gain bandwidth product and 500kHz full power bandwidth make these devices well suited to R.F. and video applications. With guaranteed offset voltages of 5mV (HA-2500/883) and 8mV (HA-2502/883) plus external offset trim flexibility and low offset current, these amplifiers are particularly useful components in signal conditioning designs.

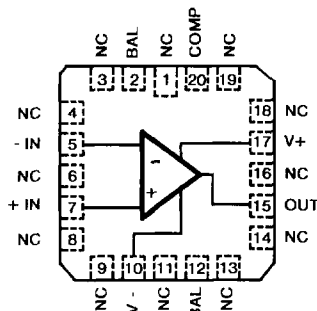
HA-2500/883 and HA-2502/883 are specified over the -55°C to $+125^{\circ}\text{C}$ temperature range. Both devices are available in 8 pin Metal Cans (TO-99) and 8 pin Ceramic Mini-DIP. The HA-2502/883 is also available in a 20 pin Ceramic Leadless Chip Carrier (LCC) package.

Pinouts

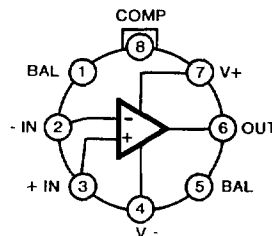
HA7-2500/883 (CERAMIC MINI-DIP)
HA7-2502/883 (CERAMIC MINI-DIP)
TOP VIEW



HA4-2502/883 (CERAMIC LCC)
TOP VIEW



HA2-2500/883 (METAL CAN)
HA2-2502/883 (METAL CAN)
TOP VIEW



Specifications HA-2500/883 HA-2502/883

Absolute Maximum Ratings

Voltage Between V+ and V- Terminals	40.0V
Differential Input Voltage	15.0V
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	137°C/W	59°C/W
Ceramic LCC Package	74°C/W	24°C/W
Metal Can Package	139°C/W	42°C/W
Package Power Dissipation Limit at +75°C for T _J ≤ +175°C		
Ceramic DIP Package	730mW	
Ceramic LCC Package	1.35W	
Metal Can Package	730mW	
Package Power Dissipation Derating Factor Above +75°C		
Ceramic DIP Package	7.4mW/°C	
Ceramic LCC Package	13.5mW/°C	
Metal Can Package	7.3mW/°C	

Recommended Operating Conditions

Operating Temperature Range	-55°C to +125°C	V _{INcm} ≤ 1/2 (V+ - V-)
Operating Supply Voltage	±15V	R _L ≥ 2kΩ

TABLE 1. D.C. ELECTRICAL PERFORMANCE CHARACTERISTICS

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-2500/883		HA-2502/883		UNITS
					MIN	MAX	MIN	MAX	
Input Offset Voltage	V _{IO}	V _{CM} = 0V	1	+25°C	-5	5	-8	8	mV
			2, 3	+125°C, -55°C	-8	8	-10	10	mV
Input Bias Current	+I _B	V _{CM} = 0V +R _S = 100kΩ -R _S = 100Ω	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 = 100Ω -R _S = 100kΩ	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 = 100kΩ -R _S = 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 _{VOL}	V _{OUT} = 0V and +10V R _L = 2kΩ	4	+25°C	20	-	15	-	kV/V
			5, 6	+125°C, -55°C	15	-	10	-	kV/V
	-A _{VOL}	V _{OUT} = 0V and -10V R _L = 2kΩ	4	+25°C	20	-	15	-	kV/V
			5, 6	+125°C, -55°C	15	-	10	-	kV/V
Common Mode Rejection Ratio	+CMRR	ΔV _{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	ΔV _{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.

HA-2500/883 HA-2502/883

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

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

D.C. PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUP	TEMPERATURE	HA-2500/883		HA-2502/883		UNITS
					MIN	MAX	MIN	MAX	
Output Voltage Swing	+V _{OUT}	R _L = 2k Ω	4	+25°C	10	-	10	-	V
			5, 6	+125°C, -55°C	10	-	10	-	V
	-V _{OUT}	R _L = 2k Ω	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	$\Delta V_{SUP} = 10V$ +V = +20V, -V = -15V +V = +10V, -V = -15V	1	+25°C	80	-	74	-	dB
			2, 3	+125°C, -55°C	80	-	74	-	dB
	-PSRR	$\Delta V_{SUP} = 10V$ +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 _{IOAdj}	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 _{IOAdj}	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 = $\pm 15V$, $R_{SOURCE} = 50\Omega$, $R_{LOAD} = 2k\Omega$, $C_{LOAD} = 50pF$, $\Delta V_{CL} = +1V$, Unless Otherwise Specified.

PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUP	TEMPERATURE	HA-2500/883		HA-2502/883		UNITS
					MIN	MAX	MIN	MAX	
Slew Rate	+SR	V _{OUT} = -5V to +5V	7	+25°C	25	-	20	-	V/ μ s
			8A, 8B	+125°C, -55°C	20	-	15	-	V/ μ s
	-SR	V _{OUT} = +5V to -5V	7	+25°C	25	-	20	-	V/ μ s
			8A, 8B	+125°C, -55°C	20	-	15	-	V/ μ s
Rise & Fall Time	T _R	V _{OUT} = 0 to +200mV 10% \leq T _R \leq 90%	7	+25°C	-	50	-	50	ns
			8A, 8B	+125°C, -55°C	-	60	-	60	ns
	T _F	V _{OUT} = 0 to -200mV 10% \leq T _F \leq 90%	7	+25°C	-	50	-	50	ns
			8A, 8B	+125°C, -55°C	-	60	-	60	ns
Overshoot	+OS	V _{OUT} = 0 to +200mV	7	+25°C	-	40	-	50	%
			8A, 8B	+125°C, -55°C	-	50	-	60	%
	-OS	V _{OUT} = 0 to -200mV	7	+25°C	-	40	-	50	%
			8A, 8B	+125°C, -55°C	-	50	-	60	%

TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Characterized at: Supply Voltage = ±15V, R_{LOAD} = 2kΩ, C_{LOAD} = 50pF, Unless Otherwise Specified.

PARAMETERS	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	HA-2500/883		HA-2502/883		UNITS
					MIN	MAX	MIN	MAX	
Differential Input Resistance	R _{IN}	V _{CM} = 0V	1	+25°C	25	-	20	-	MΩ
Full Power Bandwidth	FPBW	V _{PEAK} = 10V	1, 2	+25°C	350	-	300	-	kHz
Minimum Closed Loop Stable Gain	CLSG	R _L = 2kΩ, C _L = 50pF	1	-55°C to +125°C	1	-	1	-	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_{IQ(Measured)} ± 1mV] minimum referred to output.
This test is for functionality only to assure adjustment through 0V.

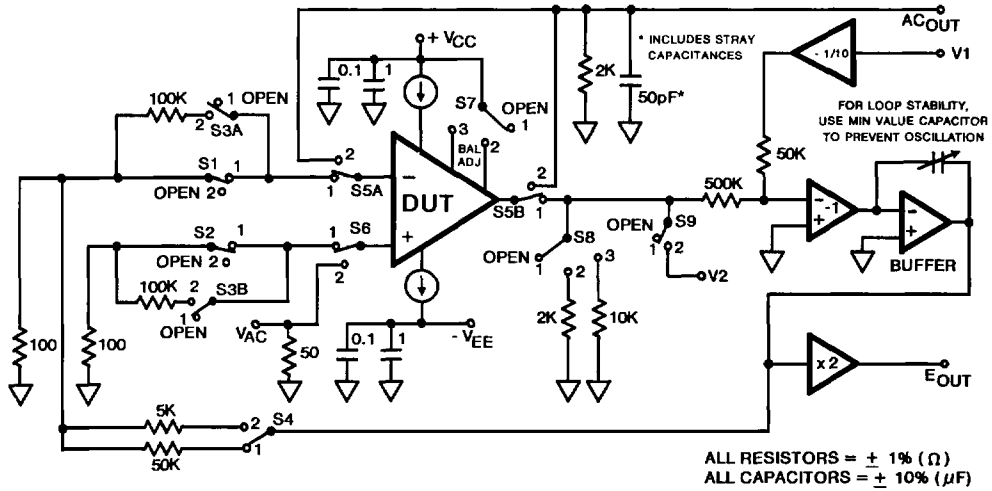
TABLE 4. ELECTRICAL TEST REQUIREMENTS

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 Endpoints	1

* PDA applies to Subgroup 1 only.

The Subgroup assignments of the parameters in these tables were patterned after MI-M-38510/122, device type 04.

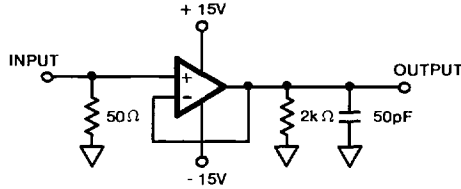
Test Circuit (Applies to Tables 1 and 2)



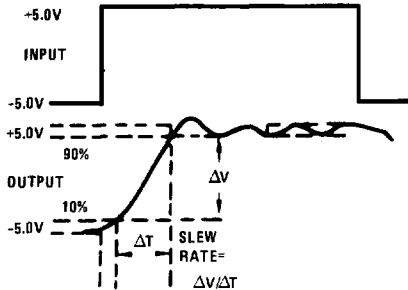
For Detailed Information, Refer to HA-2500/883; HA-2502/883 Test Tech Brief

Test Waveforms

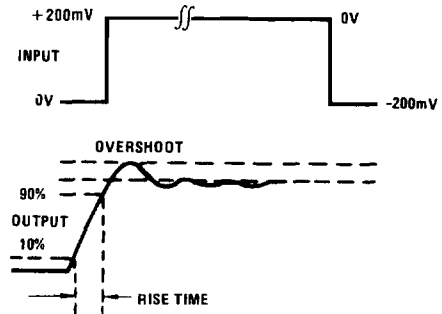
SIMPLIFIED TEST CIRCUIT (Applies to Table 2)



SLEW RATE WAVEFORM



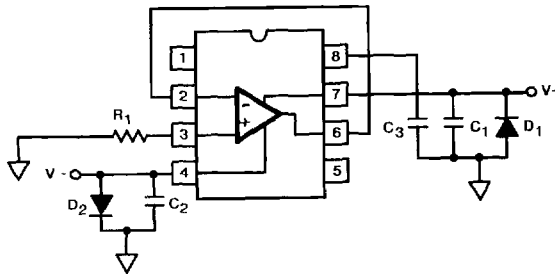
TRANSIENT RESPONSE WAVEFORM



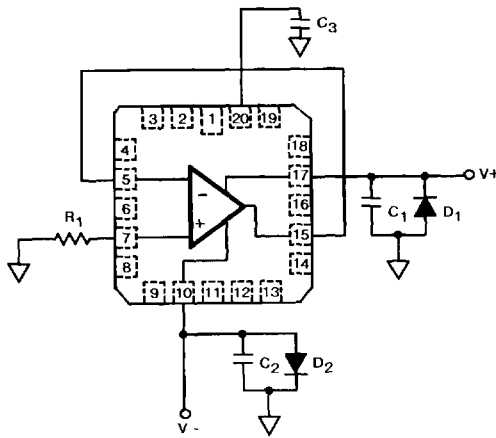
NOTE: Measured on both positive and negative transitions.
Capacitance at Compensation pin should be minimized.

Burn-In Circuits

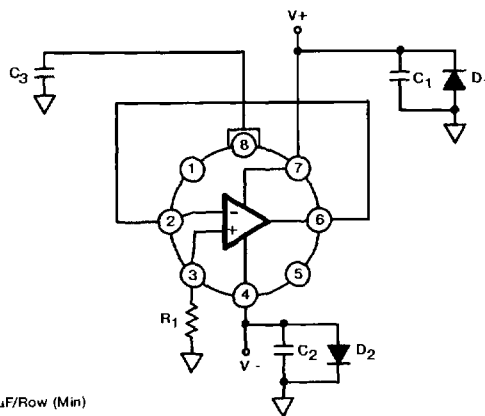
HA7-2500/883 CERAMIC DIP
HA7-2502/883 CERAMIC DIP



HA4-2502/883 CERAMIC LCC



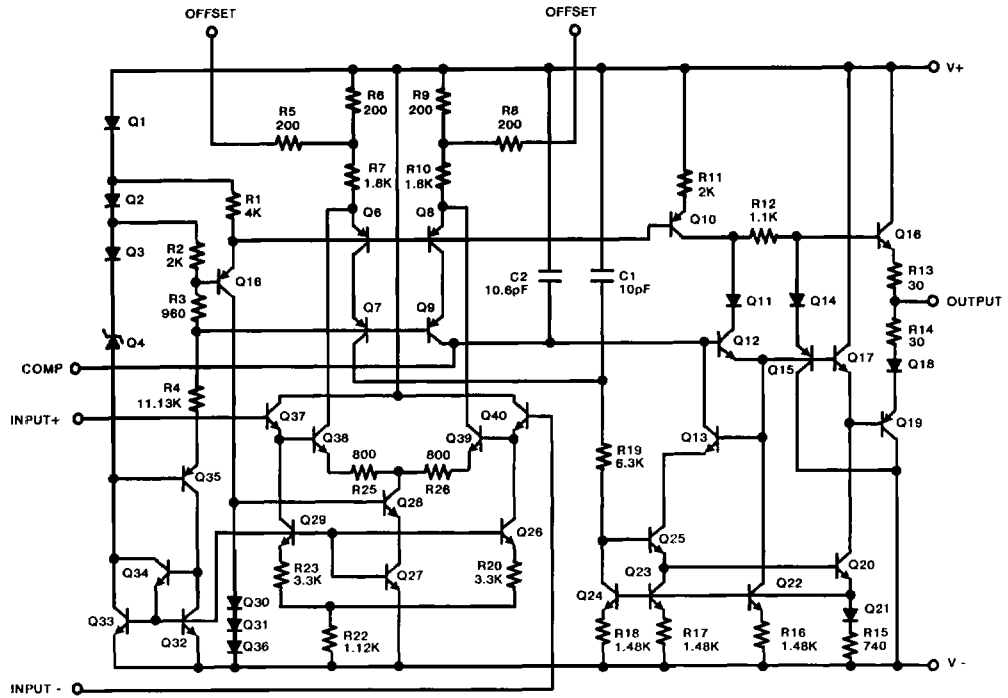
HA2-2500/883 (TO-99) METAL CAN
HA2-2502/883 (TO-99) METAL CAN



NOTES:

- R₁ = 1MΩ, ±5%, 1/4W (Min)
- C₁ = C₂ = 0.01μF/Socket (Min) or 0.1μF/Row (Min)
- C₃ = 0.01μF/Socket (10%)
- D₁ = D₂ = IN4002 or Equivalent/Board
- |V₍₊₎ - V₍₋₎| = 30V

Schematic Diagram



Die Characteristics

DIE DIMENSIONS:

65 x 57 x 19 mils
(1660 x 1950 x 483 μ m)

METALLIZATION:

Type: Aluminum
Thickness: $16\text{k}\text{\AA} \pm 2\text{k}\text{\AA}$

WORST CASE CURRENT DENSITY:

$0.3 \times 10^5 \text{A/cm}^2$

SUBSTRATE POTENTIAL (Powered Up):

Unbiased

GLASSIVATION:

Type: Nitride
Thickness: $7\text{k}\text{\AA} \pm 0.7\text{k}\text{\AA}$

TRANSISTOR COUNT:

HA-2500/883: 40
HA-2502/883: 40

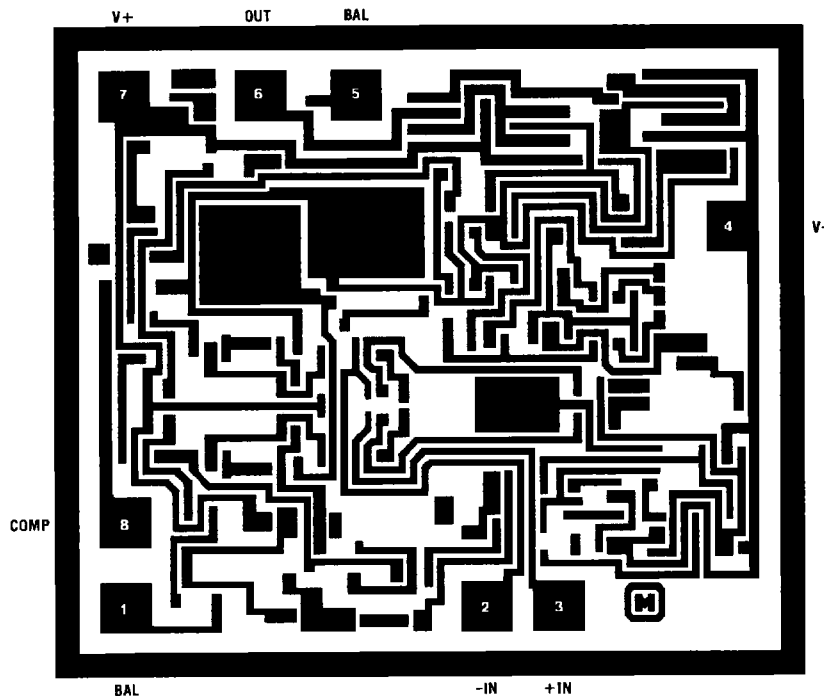
PROCESS: Std. Linear Bipolar Dielectric Isolation

DIE ATTACH:

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

Metallization Mask Layout

HA-2500/883 HA-2502/883



NOTE: Pad Numbers Correspond to 8 Lead Metal Can and Mini-DIP Packages Only.

3
OP AMPs &
COMPARATORS

DESIGN INFORMATION

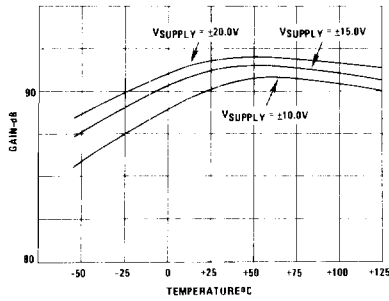
Precision High Slew Rate Operational Amplifiers

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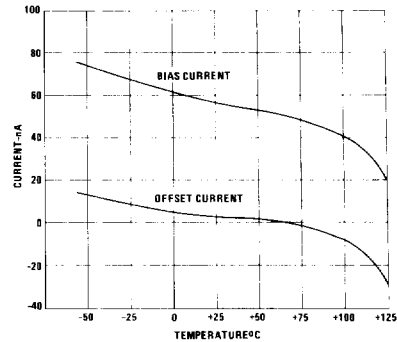
Typical Performance Curves

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

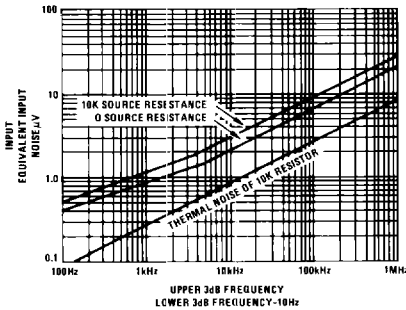
OPEN LOOP VOLTAGE GAIN vs. TEMPERATURE



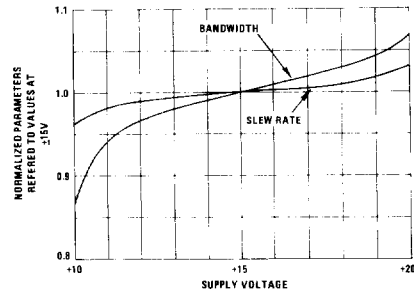
INPUT BIAS AND OFFSET CURRENT vs. TEMPERATURE



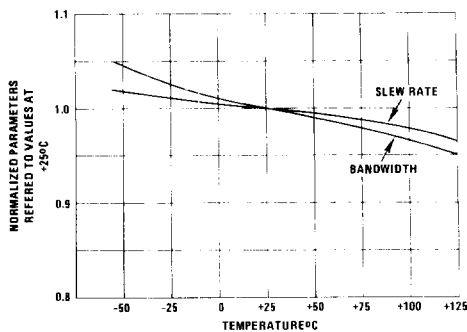
EQUIVALENT INPUT NOISE vs. BANDWIDTH



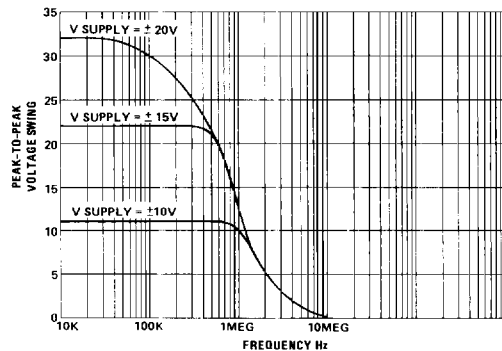
NORMALIZED A.C. PARAMETERS vs. SUPPLY VOLTAGE @ +25°C



NORMALIZED A.C. PARAMETERS vs. TEMPERATURE



OUTPUT VOLTAGE SWING vs. FREQUENCY @ +25°C

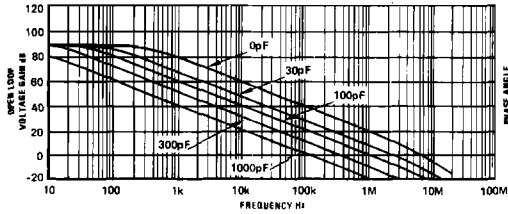


DESIGN INFORMATION (Continued)

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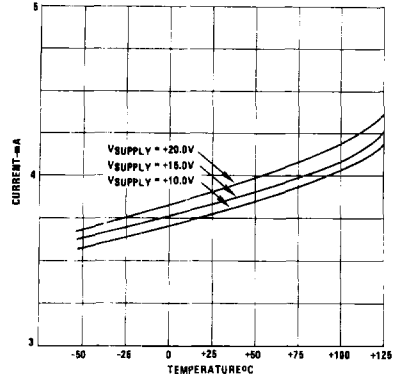
Typical Performance Curves Unless Otherwise Specified: $T_A = +25^\circ\text{C}$, $V_{\text{SUPPLY}} = \pm 15\text{V}$

OPEN LOOP FREQUENCY RESPONSE FOR VARIOUS VALUES OF CAPACITORS FROM COMPENSATION PIN TO GROUND

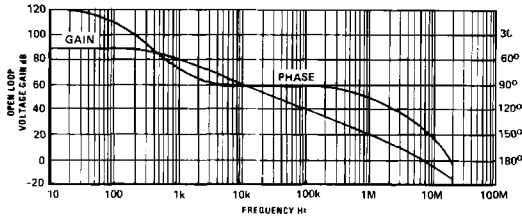


NOTE: External compensation components are not required for stability, but may be added to reduce bandwidth if desired.

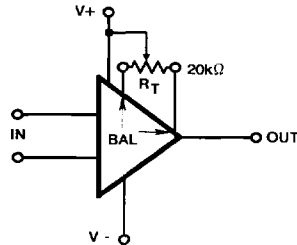
POWER SUPPLY CURRENT vs. TEMPERATURE



OPEN-LOOP FREQUENCY AND PHASE RESPONSE

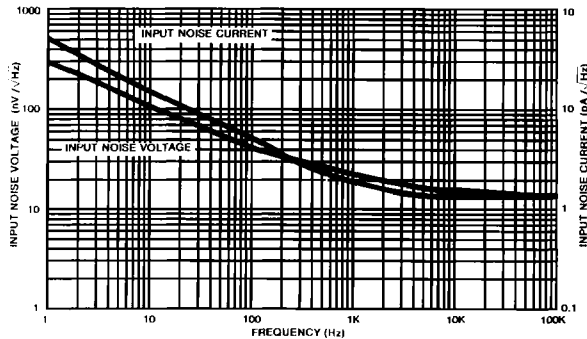


SUGGESTED V_{OS} ADJUSTMENT



Tested Offset Adjustment is $|V_{OS} + 1\text{mV}|$
 Minimum Referred to Output.
 Typical Range is $\pm 8\text{mV}$ for $R_T = 20\text{k}\Omega$

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-2500	HA-2502	DESIGN LIMIT	UNITS
			TYPICAL	TYPICAL		
Offset Voltage	$V_{CM} = 0V$	+25°C	2	4	Table 1	mV
Offset Voltage Average Drift	$V_{CM} = 0V$	Full	20	20	30	$\mu V/^\circ C$
Input Impedance		+25°C	50	50	Table 3	$M\Omega$
Large Signal Voltage Gain	$V_{OUT} = \pm 10V$	+25°C	30	25	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
Gain Bandwidth Product	$A_V = \geq 10$	+25°C	12	12	10	MHz
Unity Gain Bandwidth	Small Signal ($\leq 200mV$)	Full	8	8	6	MHz
Output Current	$V_O = \pm 10V$	+25°C	± 20	± 20	Table 1	mA
Full Power Bandwidth	$V_O = \pm 10V$, (Table 3, Note 2)	+25°C	500	500	Table 3	kHz
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	± 30	± 30	Table 2	V/ μs
Settling Time	10V Step to 0.1%	+25°C	330	330	500	ns
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