HA-2400/883

PRAM Four Channel Programmable Operational Amplifier

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.
- Digital Programmability
- High Slew Rate (Uncompensated) ..... 20V/µs Min
  (Compensated) ..... 6V/µs Min
- Wide Gain Bandwidth
  (Uncompensated) ..... 20MHz Min
  (Compensated) ..... 4MHz Min
- High Gain ..... 50kV/V Min
- Low Offset Current ..... 50nA Max
- Single Capacitor Compensation For Unity Gain
- DTL/TTL Compatible Inputs

Applications

- Single Selection/Multiplexing
- Op Amp Gain Stage
- Frequency Oscillator
- Filter Characteristics
- Add-Subtract Functions
- Integrator Characteristics
- Comparator Levels

Description

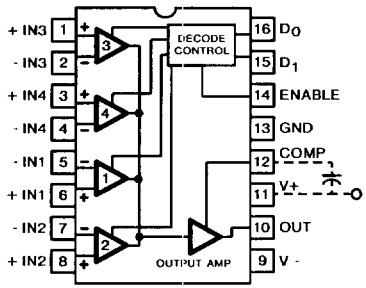
The HA-2400/883 is a four channel programmable amplifier providing a level of versatility unsurpassed by any other monolithic operational amplifier. Versatility is achieved by employing four input amplifier channels, any one (or none) of which may be electronically selected and connected to a single output stage through DTL/TTL compatible address inputs. The device formed by the output and the selected pair of inputs is an op amp which delivers excellent slew rate, gain bandwidth and power bandwidth performance. Other advantages features for these dielectrically isolated amplifiers include high voltage gain and input impedance coupled with low input offset voltage and offset current. External compensation is not required on this device at closed loop gains greater than 10.

Each channel of the HA-2400/883 can be controlled and operated with suitable feedback networks in any of the standard op amp configurations. This specialization makes these amplifiers excellent components for multiplexing, signal selection, and mathematical function designs. With 20V/µs slew rate, 20MHz gain bandwidth, and low input bias currents makes these devices ideal building blocks for signal generators, active filters, and data acquisition designs. Programmability coupled with 9mV maximum offset voltage and 50nA offset current makes these amplifiers outstanding components for the signal conditioning circuits.

The HA-2400/883 is available in the 16 pin Dual-in-Line Ceramic package and a 20 pin LCC package. The HA-2400/883 is specified from -55°C to +125°C.

Pinouts

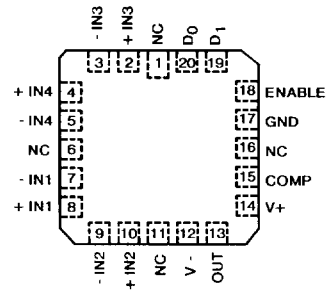
HA1-2400/883 (CERAMIC DIP)
TOP VIEW



TRUTH TABLE

D_1	D_0	EN	SELECTED CHANNEL
L	L	H	1
L	H	H	2
H	L	H	3
H	H	H	4
X	X	L	NONE

HA4-2400/883 (CERAMIC LCC)
TOP VIEW



Absolute Maximum Ratings

Voltage Between V+ and V- Terminals 45V
Differential Input Voltage ..... $\pm V_{SUPPLY}$
Voltage at Either Input Terminal ..... V+ to V-
Digital Input Voltage ..... -0.76V to +10V
Peak Output Current (Short Circuit Protected) ..... $I_{SC} < \pm 33mA$
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	91°C/W	25°C/W
Ceramic LCC Package	88°C/W	28°C/W

Internal Power Dissipation
Package Power Dissipation Limit at +75°C for $T_J \leq +175°C$
Ceramic DIP Package 1.11W
Ceramic LCC Package 1.14W
Package Power Dissipation Derating Factor Above +75°C
Ceramic DIP Package ..... 11.1mW/°C
Ceramic LCC Package ..... 11.4mW/°C

Recommended Operating Conditions

Operating Temperature Range ..... -55°C to +125°C
Operating Supply Voltage ..... +15V
Negative Supply Voltage ..... -15V

TABLE 1. D.C. ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: V+ = +15V, V- = -15V, R_S = 100Ω, R_L = 500kΩ, V_O = 0V Unless Otherwise Specified.
Digital Inputs: V_{IL} = +0.5V, V_{IH} = +2.4V, Limits Apply to Each of the Four Channels, When Addressed.

D.C. PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUP	TEMPERATURE	LIMITS MIN	LIMITS MAX	UNITS
Offset Voltage	V_{IO}	V_{CM} = 0V	1	+25°C	-9	9	mV
			2,3	+125°C, -55°C	-11	11	mV
Input Bias Current	$+I_B$	V_{CM} = 0V $+R_S$ = 100kΩ $-R_S$ = 100Ω	1	+25°C	-200	200	nA
			2,3	+125°C, -55°C	-400	400	nA
	$-I_B$	V_{CM} = 0V $+R_S$ = 100Ω $-R_S$ = 100kΩ	1	+25°C	-200	200	nA
			2,3	+125°C, -55°C	-400	400	nA
Input Offset Current	I_{IO}	V_{CM} = 0V $+R_S$ = 100kΩ $-R_S$ = 100kΩ	1	+25°C	-50	50	nA
			2,3	+125°C, -55°C	-100	100	nA
Common Mode Range	+CMR	V+ = +6V V- = -24V V_{OUT} = -9V	1	+25°C	9	-	V
			2,3	+125°C, -55°C	9	-	V
	-CMR	V+ = +24V V- = -6V V_{OUT} = +9V	1	+25°C	-	-9	V
			2,3	+125°C, -55°C	-	-9	V
Large Signal Voltage Gain	A_V	V_{OUT} = -10V to +10V R_L = 2kΩ	4	+25°C	50	-	kV/V
			5,6	+125°C, -55°C	25	-	kV/V
Common Mode Rejection Ratio	+CMRR	ΔV_{CM} = +5V +V = +10V -V = -20V V_{OUT} = -5V	1	+25°C	80	-	dB
			2,3	+125°C, -55°C	80	-	dB
	-CMRR	ΔV_{CM} = -5V +V = +20V -V = -10V V_{OUT} = +5V	1	+25°C	80	-	dB
			2,3	+125°C, -55°C	80	-	dB
Output Voltage Swing	$+V_{OUT}$	R_L = 2kΩ	4	+25°C	+10	-	V
			5,6	+125°C, -55°C	+10	-	V
	$-V_{OUT}$	R_L = 2kΩ	4	+25°C	-	-10	V
			5,6	+125°C, -55°C	-	-10	V

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: V+ = +15V, V- = -15V, R_S = 100Ω, R_L = 500kΩ, V_O = 0V Unless Otherwise Specified.
Digital Inputs: V_{IL} = +0.5V, V_{IH} = +2.4V, Limits Apply to Each of the Four Channels, When Addressed

PARAMETER	SYMBOL	CONDITIONS	GROUP A SUBGROUP	TEMPERATURE	LIMITS MIN	LIMITS MAX	UNITS
Output Current	$+I_{OUT}$	V_{OUT} = +10V	4	+25°C	+10	-	mA
	$-I_{OUT}$	V_{OUT} = -10V	4	+25°C	-	-10	mA
Supply Current	$+I_{CC}$	V_{OUT} = 0V	1	+25°C	-	6	mA
			2,3	+125°C, -55°C	-	7	mA
	$-I_{CC}$	V_{OUT} = 0V	1	+25°C	-6	-	mA
			2,3	+125°C, -55°C	-7	-	mA
Power Supply Rejection Ratio	+PSRR	ΔV_{SUP} = ±5V V+ = +20V, V- = -15V V+ = +10V, V- = -15V	1	+25°C	74	-	dB
			2,3	+125°C, -55°C	74	-	dB
	-PSRR	ΔV_{SUP} = ±5V V+ = +15V, V- = -20V V+ = +15V, V- = -10V	1	+25°C	74	-	dB
			2,3	+125°C, -55°C	74	-	dB
Crosstalk	C_T	V_{IN} = ±10V	1	+25°C	-80	-	dB
Digital Logic Current	I_{IL}	V_{IL} = 0V	1	+25°C	-	1.5	mA
			2,3	+125°C, -55°C	-	1.5	mA
	I_{IH}	V_{IH} = 5.0V	1	+25°C	-	1	µA
			2,3	+125°C, -55°C	-	1	µA

TABLE 2. A.C. ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: V+ = +15V, V- = -15V, R_L = 2kΩ, C_{LOAD} = 50pF, Unless Otherwise Specified.
Subscript 1 Refers to A_V = +1, C_{COMP} = 15pF
Digital Inputs: V_{IL} = +0.5V, V_{IH} = +2.4V, Limits Apply to Each of the Four Channels, When Addressed.

PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUP	TEMPERATURE	LIMITS MIN	LIMITS MAX	UNITS
Slew Rate$_1$	$+SR_1$	V_{OUT} = -5V to +5V	7	+25°C	6	-	V/µs
	$-SR_1$	V_{OUT} = +5V to -5V	7	+25°C	6	-	V/µs
Rise & Fall Time	T_{R1}	V_{OUT} = 0 to +200mV	7	+25°C	-	45	ns
	T_{F1}	V_{OUT} = 0 to -200mV	7	+25°C	-	45	ns
Overshoot	$+OS_1$	V_{OUT} = 0 to +200mV	7	+25°C	-	40	%
	$-OS_1$	V_{OUT} = 0 to -200mV	7	+25°C	-	40	%

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

TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Characterized at: V+ = +15V, V- = -15V, Unless Otherwise Specified.
Subscript 2 Refers to A_V = +10, C_{COMP} = 0pF

PARAMETERS	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	LIMITS MIN	LIMITS MAX	UNITS
Unity Gain Bandwidth	$UGBW_1$	A_V = +1, C_{COMP} = 15pF, R_L = 2kΩ, C_L = 50pF	1	+25°C	4	-	MHz
Gain Bandwidth Product	$GBWP_2$	A_V = +10, C_{COMP} = 0pF, R_L = 2kΩ, C_L = 50pF	1	+25°C	20	-	MHz
Full Power Bandwidth$_1$	$FPBW_1$	R_L = 2kΩ, A_V = +1V, V_O = ±10V, C_L = 50pF, C_{COMP} = 15pF	1, 2	+25°C	95	-	kHz
Full Power Bandwidth$_2$	$FPBW_2$	R_L = 2kΩ, A_V = +10V, V_O = ±10V, C_L = 50pF, C_{COMP} = 0pF	1, 2	+25°C	300	-	kHz
Settling Time	T_{SET1}	A_V = +1, C_{COMP} = 15pF, R_L = 2kΩ, C_L = 50pF, V_O = $10V_{p-p}$, to 0.1% F.V. Logic Control = +5.0V	1	+25°C	-	2.5	µs
Slew Rate$_2$	$+SR_2$	V_{OUT} = -5V to +5V, R_L = 2kΩ, C_L = 50pF, A_V = +10, C_{COMP} = 0pF	1	+25°C	20	-	V/µs
	$-SR_2$	V_{OUT} = +5V to -5V, R_L = 2kΩ, C_L = 50pF, A_V = +10, C_{COMP} = 0pF	1	+25°C	20	-	V/µs
Output Delay	T_{DEL}	R_L = 2kΩ, C_L = 50pF, C_{COMP} = 15pF, V_{IN} = +5V	1	+25°C	-	250	ns
Minimum Closed Loop Stability	CLS_1	R_L = 2kΩ, C_L = 50pF, C_{COMP} = 15pF	1	+25°C	1	-	V/V
	CLS_2	R_L = 2kΩ, C_L = 50pF, C_{COMP} = 0pF	1	+25°C	10	-	V/V

NOTES: 1. The parameters listed in this table 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. $FPBW = \frac{S.R.}{2\pi\ Vpeak}$

TABLE 4. ELECTRICAL TEST REQUIREMENTS

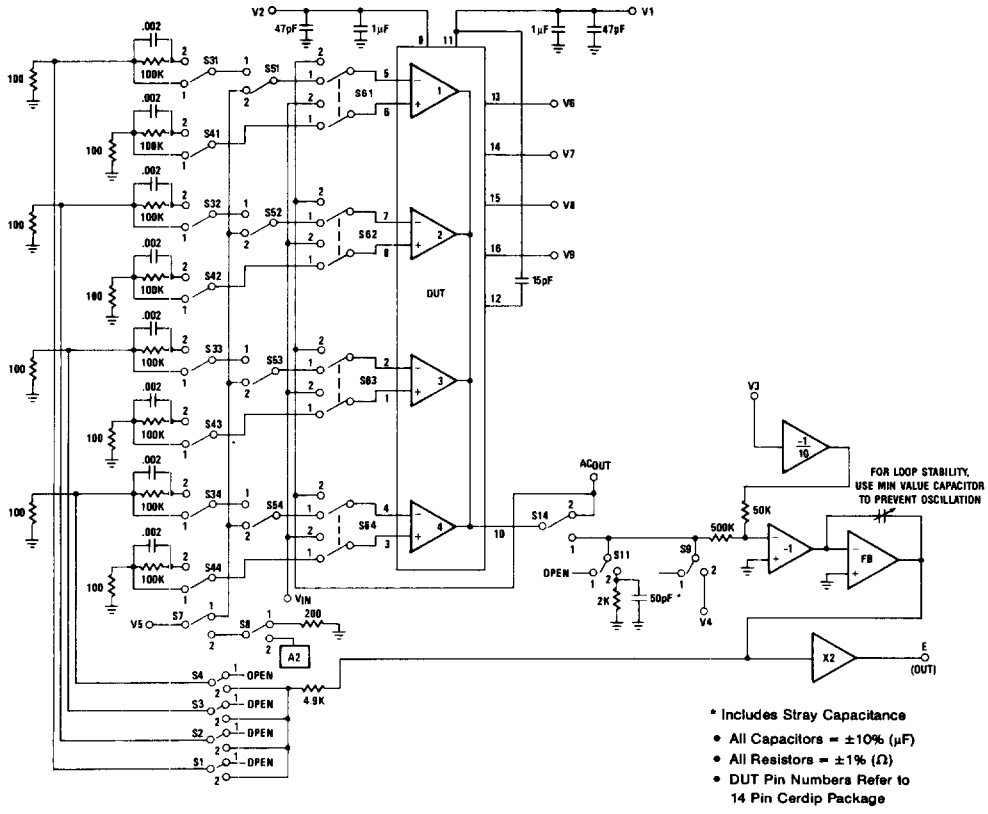
MIL-STD-883 TEST REQUIREMENTS	SUBGROUPS (SEE TABLES 1 & 2)
Interim Electrical Parameters (Pre Burn-In)	1
Final Electrical Test Parameters	1*, 2, 3, 4, 5, 6, 7
Group A Test Requirements	1, 2, 3, 4, 5, 6, 7
Groups C & D Endpoints	1

* PDA applies to Subgroup 1 only.

The subgroup assignments of the parameters in these tables were patterned after DESC SMD #5962-87783.

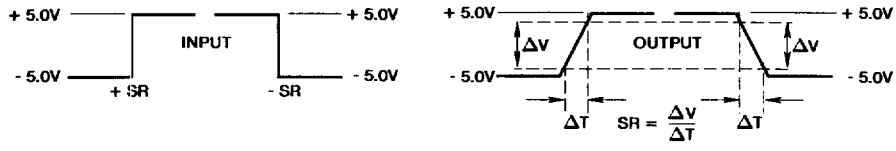
CAUTION: This device is sensitive to electrostatic discharge. Proper I.C. handling procedures should be followed.

Test Circuit

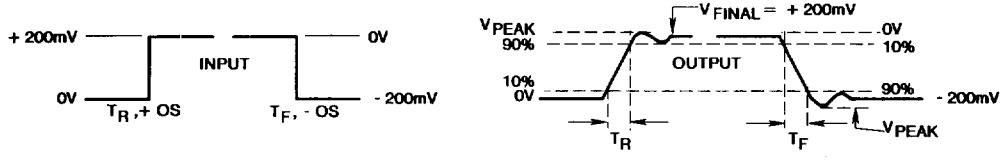


For Detailed Information, Refer to HA-2400/883 Test Tech Brief

Test Waveforms



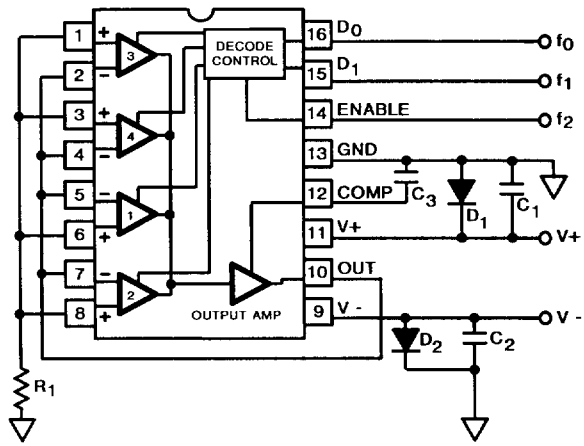
SLEW RATE WAVEFORMS



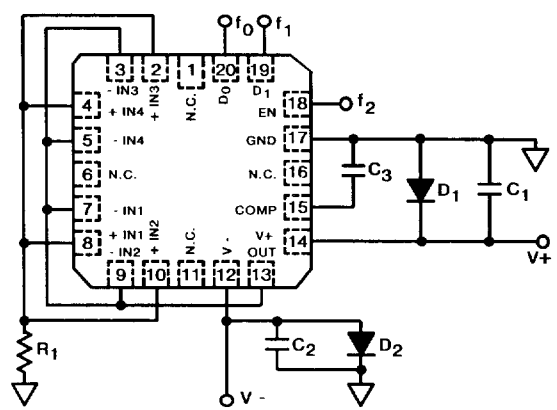
OVERSHOOT, RISE & FALL TIME WAVEFORMS

Burn-In Circuits

HA-2400/883 CERAMIC DIP



HA-2400/883 CERAMIC LCC



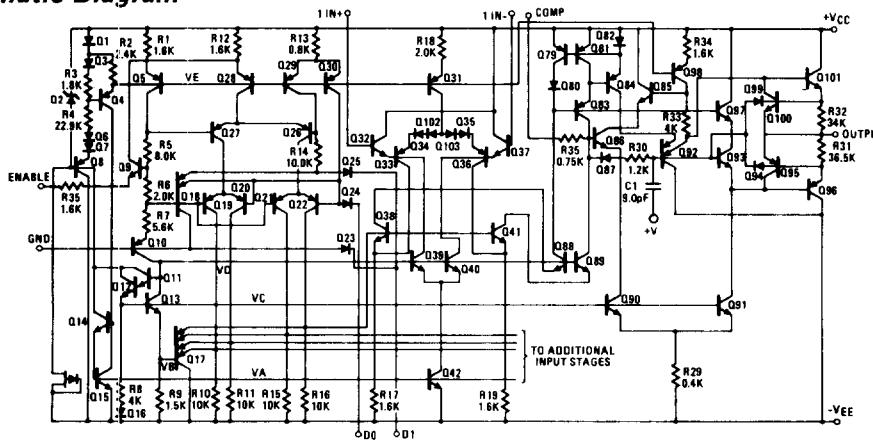
NOTES:

R_1 = 100kΩ/Socket, 5%, 1/4W (Min)
$C_1 = C_2$ = 0.01μF/Socket (Min) or 0.1μF/Row (Min)
C_3 = 0.001μF/Socket, 10%
$D_1 = D_2$ = 1N4002 or Equivalent/Board
$|(V+) - (V-)| = 30V$

f_0 = 100kHz
f_1 = 50kHz
f_2 = 25kHz

} 50% Duty Cycle

Schematic Diagram



Die Characteristics

DIE DIMENSIONS:
88 x 67 x 19 mils
(2240 x 1710 x 483µm)

METALLIZATION:
Type: Aluminum
Thickness: 16kÅ ± 2kÅ

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

SUBSTRATE POTENTIAL (POWERED UP): Unbiased

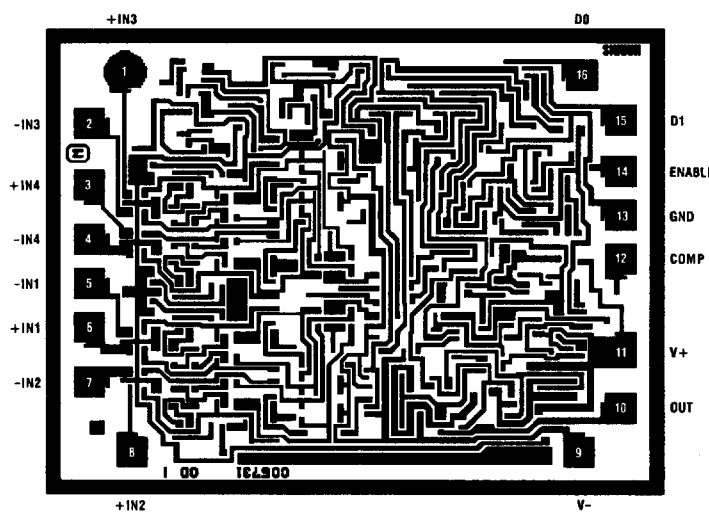
DIE ATTACH:
Material: Gold/Silicon Eutectic Alloy
Temperature: Ceramic DIP — 460°C (Max)
Ceramic LCC — 420°C (Max)

WORST CASE CURRENT DENSITY:
$0.7 \times 10^5 A/cm^2$

ACTIVE DEVICE COUNT: 251

Metallization Mask Layout

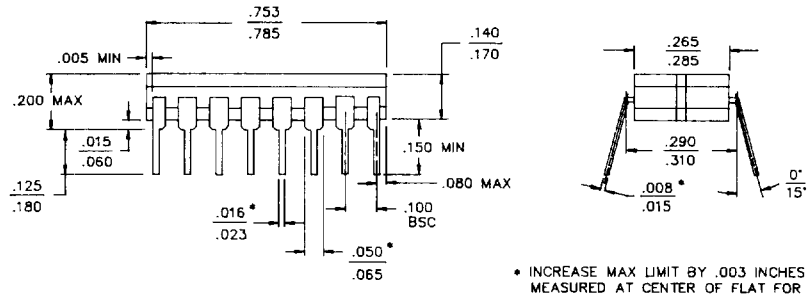
HA-2400/883



NOTE: Pin Numbers Correspond to DIP Package Only.

Packaging†

16 PIN CERAMIC DIP

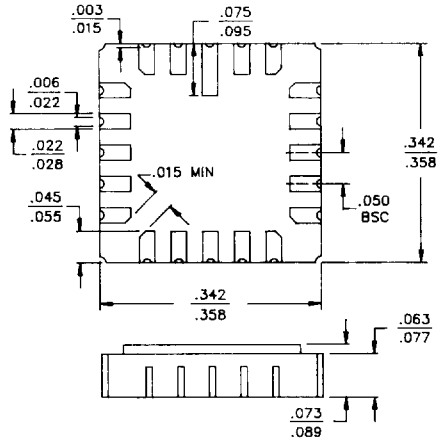


* INCREASE MAX LIMIT BY .003 INCHES MEASURED AT CENTER OF FLAT FOR SOLDER FINISH

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-2

20 PAD CERAMIC LCC



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

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

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

DESIGN INFORMATION

PRAM Four Channel Programmable Operational Amplifier

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TYPICAL PERFORMANCE CHARACTERISTICS

Devices Characterized at: $V_S = \pm 15V$, $V_{IL} = +0.5V$, $V_{IH} = +2.4V$. Values Apply to Each of Four Channels When Addressed.

PARAMETERS	CONDITIONS	TEMP	TYP	UNITS
Offset Voltage	$V_{CM} = 0V$	+25°C	4	mV
Bias Current	$V_{CM} = 0V$	+25°C	50	nA
Offset Current	$V_{CM} = 0V$	+25°C	5	nA
Input Resistance		+25°C	30	MΩ
Large Signal Voltage Gain	$R_L = 2k\Omega$, $V_O = 20V_{p-p}$	+25°C	150	kV/V
Common Mode Rejection Ratio	$V_{CM} = \pm 5VDC$	Full	100	dB
Gain Bandwidth Product	$R_L = 2k\Omega$, $C_L = 50pF$, $C_{COMP} = 0pF$, $A_V = +10$	+25°C	40	MHz
Unity Gain Bandwidth	$R_L = 2k\Omega$, $C_L = 50pF$, $C_{COMP} = 15pF$, $A_V = +1$	+25°C	8	MHz
Output Voltage Swing	$R_L = 2k\Omega$	Full	±12	V
Output Current	$V_{OUT} = \pm 10V$	+25°C	20	mA
$FPBW_1$	Note 2, $V_P = 10V$	+25°C	475	kHz
$FPBW_2$	Note 2, $V_P = 10V$	+25°C	125	kHz
Rise Time	$R_L = 2k\Omega$, $C_L = 50pF$, $C_{COMP} = 15pF$, $A_V = +1$	+25°C	20	ns
Overshoot	$R_L = 2k\Omega$, $C_L = 50pF$, $C_{COMP} = 15pF$, $A_V = +1$	+25°C	25	%
$Slew\ Rate_1$	$A_V = +1V/V$	+25°C	8	V/μs
$Slew\ Rate_2$	$A_V = +10V/V$	+25°C	30	V/μs
$Settling\ Time_1$	$V_O = 10V_{p-p}$ to 0.1%	+25°C	1.5	μs
Digital Logic Current	$V_{IN} = +5.0V$	Full	5	nA
	$V_{IN} = 0V$	Full	1	mA
Output Delay	To 10% of Final Value	+25°C	100	ns
Crosstalk	Unselected Input to Output, $V_{IN} = \pm 10VDC$	+25°C	-110	dB
Supply Current	Not Loaded	+25°C	4.8	mA
PSRR	$\Delta V_S = \pm 10V$	Full	90	dB

DESIGN INFORMATION (Continued)

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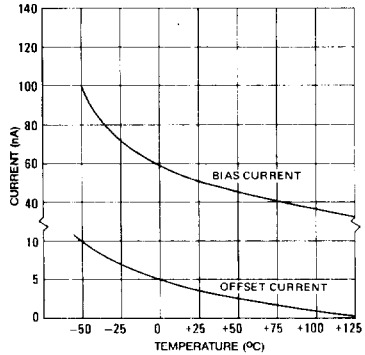
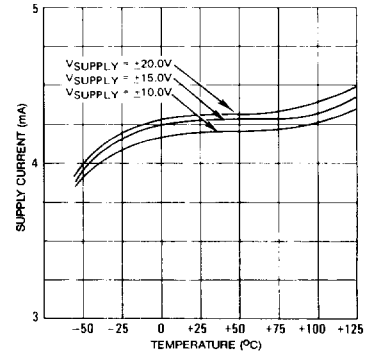
Typical Performance Curves Unless Otherwise Specified: V± = ±15V, T_A = +25°C

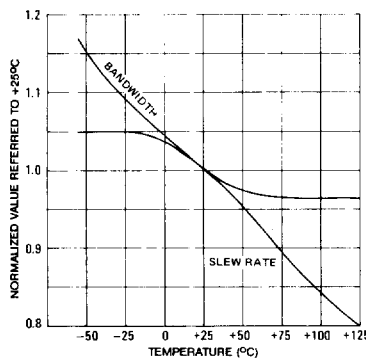
INPUT BIAS CURRENT AND OFFSET CURRENT AS A FUNCTION OF TEMPERATURE



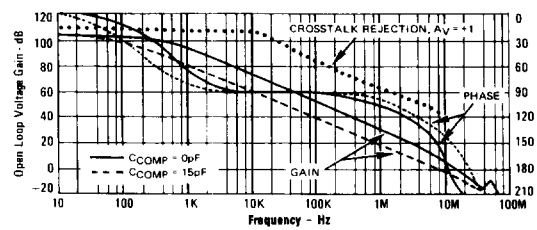
POWER SUPPLY CURRENT DRAIN AS A FUNCTION OF TEMPERATURE



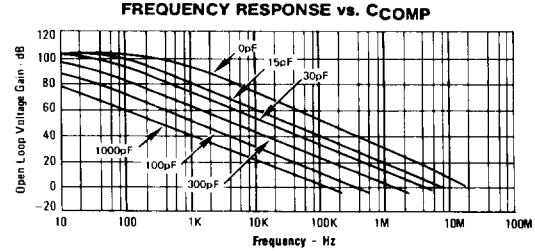
NORMALIZED A.C. PARAMETERS vs. TEMPERATURE



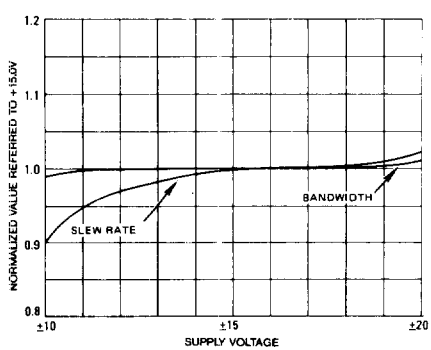
OPEN LOOP FREQUENCY AND PHASE RESPONSE



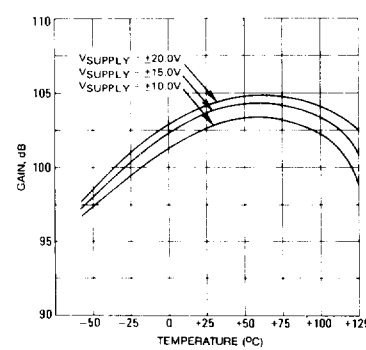
FREQUENCY RESPONSE vs. C_{COMP}



NORMALIZED A.C. PARAMETERS vs. SUPPLY VOLTAGE



OPEN LOOP VOLTAGE GAIN vs. TEMPERATURE

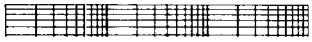


DESIGN INFORMATION (Continued)

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: $V\pm = \pm15V$, $T_A = +25^oC$

OUTPUT VOLTAGE SWING



EQUIVALENT INPUT NOISE vs. BANDWIDTH