

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.
- Low Supply Current @  $V_S = +5V$  .. (+25°C) 80 $\mu A$  (Max)  
(Full) 100 $\mu A$  (Max)
- Wide Supply Voltage Range..... Single 3V to 30V  
or Dual  $\pm 1.5$  to  $\pm 15V$
- High Slew Rate .....+S.R. 0.8V/ $\mu s$  (Min)  
1.5V/ $\mu s$  (Typ)
- High Gain .....20kV/V (Min)  
75kV/V (Typ)
- Low Noise (1kHz)..... 20nV/ $\sqrt{Hz}$  (Typ)
- 100% Tested at  $\pm 15V$  and 0V, +5V Power Supplies
- Unity Gain Stable
- Dielectric Isolation

### Applications

- Portable Instruments
- Meter Amplifiers
- Telephone Headsets
- Microphone Amplifiers
- Instrumentation
- For Further Design Ideas See App. Note 544

### Description

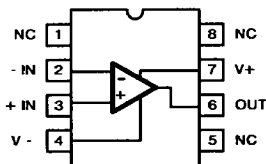
The HA-5141/883 single, ultra-low power operational amplifier provide AC and DC performance characteristics similar to, or better than most general purpose amplifiers while only drawing 1/30 of the supply current of most general purpose amplifiers. This amplifier is well suited to applications which require low power dissipation and good electrical characteristics.

The HA-5141/883 provides accurate signal processing by virtue of their low input offset voltage (6mV), low input bias current (100nA), high open loop gain (20kV/V) and low noise (20nV/ $\sqrt{Hz}$ ). These characteristics coupled with a 1.5V/ $\mu s$  slew rate and a 24kHz bandwidth make the HA-5141/883 ideal for use in low power instrumentation, audio amplifier and active filter designs. The wide range of supply voltages (3V to 30V) also allow these amplifier and active filter designs. The wide range of supply voltages (3V to 30V) also allow these amplifiers to be very useful in low voltage battery powered equipment.

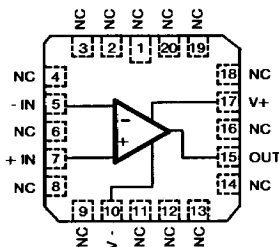
The HA-5141/883 offers tested specifications at both single ended levels (0V, +5V) and dual supplies ( $\pm 15V$ ). Packaging is offered in the Ceramic Mini-DIP, 20 pad Ceramic LCC or 8 pin (TO-99) Metal Can, and operation is specified at the full military -55°C to +125°C temperature range.

### Pinouts

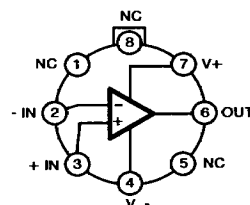
HA7-5141/883 (CERAMIC MINI-DIP)  
TOP VIEW



HA4-5141/883 (CERAMIC LCC)  
TOP VIEW



HA2-5141/883 (METAL CAN)  
TOP VIEW



### Absolute Maximum Ratings

|                                        |                                                |
|----------------------------------------|------------------------------------------------|
| Voltage Between V+ and V- Terminals    | 35V                                            |
| Differential Input Voltage             | 7V                                             |
| Voltage at Either Input Terminal       | V+ to V-                                       |
| Output Current                         | Full Short Circuit Protection                  |
| Output Current Duration                | Indefinite,<br>One Amplifier Shorted to Ground |
| 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                                                  | 83°C/W        | 28°C/W        |
| Ceramic LCC Package                                                  | 74°C/W        | 20°C/W        |
| Metal Can Package                                                    | 149°C/W       | 45°C/W        |
| Package Power Dissipation Limit at +75°C For T <sub>J</sub> ≤ +175°C |               |               |
| Ceramic DIP Package                                                  | 1.21W         |               |
| Ceramic LCC Package                                                  | 1.34W         |               |
| Metal Can Package                                                    | 670mW         |               |
| Package Power Dissipation Derating Factor Above +75°C                |               |               |
| Ceramic DIP Package                                                  | 12.1mW/°C     |               |
| Ceramic LCC Package                                                  | 13.4mW/°C     |               |
| Metal Can Package                                                    | 6.7mW/°C      |               |

### Recommended Operating Conditions

|                             |                               |                                   |
|-----------------------------|-------------------------------|-----------------------------------|
| Operating Temperature Range | -55°C to +125°C               | V <sub>INCM</sub> ≤ 1/2 (V+ - V-) |
| Operating Supply Voltage    | ±1.5V to ±15V<br>or 3V to 30V | R <sub>L</sub> ≥ 50kΩ             |

TABLE 1. D.C. ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: R<sub>SOURCE</sub> = 100Ω, R<sub>LOAD</sub> = 500kΩ, V<sub>OUT</sub> = 0V, Unless Otherwise Specified.  
Subscript 1 Refers to Supply Voltages (±V<sub>S</sub>) = ±15V, Subscript 2 Refers to +V<sub>S</sub> = 5.0V, -V<sub>S</sub> = 0.0V.

| D.C. PARAMETERS      | SYMBOL            | CONDITIONS                                                                                        | GROUP A<br>SUBGROUP | TEMPERATURE   | LIMITS |     | UNITS |
|----------------------|-------------------|---------------------------------------------------------------------------------------------------|---------------------|---------------|--------|-----|-------|
|                      |                   |                                                                                                   |                     |               | MIN    | MAX |       |
| Input Offset Voltage | V <sub>IO1</sub>  | V <sub>CM</sub> = 0V                                                                              | 1                   | +25°C         | -6     | 6   | mV    |
|                      |                   |                                                                                                   | 2, 3                | +125°C, -55°C | -8     | 8   | mV    |
|                      | V <sub>IO2</sub>  | V <sub>CM</sub> = 0V<br>V <sub>OUT</sub> = 1.4V                                                   | 1                   | +25°C         | -6     | 6   | mV    |
|                      |                   |                                                                                                   | 2, 3                | +125°C, -55°C | -8     | 8   | mV    |
| Input Bias Current   | +I <sub>B1</sub>  | V <sub>CM</sub> = 0V<br>+R <sub>S</sub> = 10kΩ<br>-R <sub>S</sub> = 100Ω                          | 1                   | +25°C         | -100   | 100 | nA    |
|                      |                   |                                                                                                   | 2, 3                | +125°C, -55°C | -125   | 125 | nA    |
|                      | -I <sub>B1</sub>  | V <sub>CM</sub> = 0V<br>+R <sub>S</sub> = 100Ω<br>-R <sub>S</sub> = 10kΩ                          | 1                   | +25°C         | -100   | 100 | nA    |
|                      |                   |                                                                                                   | 2, 3                | +125°C, -55°C | -125   | 125 | nA    |
|                      | +I <sub>B2</sub>  | V <sub>CM</sub> = 0V, V <sub>OUT</sub> = 1.4V<br>+R <sub>S</sub> = 10kΩ<br>-R <sub>S</sub> = 100Ω | 1                   | +25°C         | -100   | 100 | nA    |
|                      |                   |                                                                                                   | 2, 3                | +125°C, -55°C | -125   | 125 | nA    |
|                      | -I <sub>B2</sub>  | V <sub>CM</sub> = 0V, V <sub>OUT</sub> = 1.4V<br>+R <sub>S</sub> = 100Ω<br>-R <sub>S</sub> = 10kΩ | 1                   | +25°C         | -100   | 100 | nA    |
|                      |                   |                                                                                                   | 2, 3                | +125°C, -55°C | -125   | 125 | nA    |
| Input Offset Current | I <sub>IO1</sub>  | V <sub>CM</sub> = 0V<br>+R <sub>S</sub> = 10kΩ<br>-R <sub>S</sub> = 10kΩ                          | 1                   | +25°C         | -10    | 10  | nA    |
|                      |                   |                                                                                                   | 2, 3                | +125°C, -55°C | -20    | 20  | nA    |
|                      | I <sub>IO2</sub>  | V <sub>CM</sub> = 0V, V <sub>OUT</sub> = 1.4V<br>+R <sub>S</sub> = 10kΩ<br>-R <sub>S</sub> = 10kΩ | 1                   | +25°C         | -10    | 10  | nA    |
|                      |                   |                                                                                                   | 2, 3                | +125°C, -55°C | -20    | 20  | nA    |
| Common Mode Range    | +CMR <sub>1</sub> | V+ = 5V<br>V- = -25V                                                                              | 1                   | +25°C         | 10     | -   | V     |
|                      |                   |                                                                                                   | 2, 3                | +125°C, -55°C | 10     | -   | V     |
|                      | -CMR <sub>1</sub> | V+ = 25V<br>V- = -5V                                                                              | 1                   | +25°C         | -      | -10 | V     |
|                      |                   |                                                                                                   | 2, 3                | +125°C, -55°C | -      | -10 | V     |
|                      | +CMR <sub>2</sub> | V+ = 5V to 2V<br>V- = 0V to -3V<br>V <sub>OUT</sub> = 1.4V to -1.6V                               | 1                   | +25°C         | 0 to 3 | -   | V     |
|                      |                   |                                                                                                   | 2, 3                | +125°C, -55°C | 0 to 3 | -   | 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:  $R_{SOURCE} = 100\Omega$ ,  $R_{LOAD} = 500k\Omega$ ,  $V_{OUT} = 0V$ , Unless Otherwise Specified.

Subscript 1 Refers to Supply Voltages ( $\pm V_S$ ) =  $\pm 15V$ ; Subscript 2 Refers to  $+V_S = 5.0V$ ,  $-V_S = 0.0V$ .

| D.C. PARAMETERS                   | SYMBOL             | CONDITIONS                                                                 | GROUP A<br>SUBGROUP | TEMPERATURE   | LIMITS |     | UNITS |
|-----------------------------------|--------------------|----------------------------------------------------------------------------|---------------------|---------------|--------|-----|-------|
|                                   |                    |                                                                            |                     |               | MIN    | MAX |       |
| Large Signal<br>Voltage Gain      | +A <sub>VOL1</sub> | $V_{OUT} = 0V$ and $10V$<br>$R_L = 50k\Omega$                              | 4                   | +25°C         | 20     | -   | kV/V  |
|                                   |                    |                                                                            | 5, 6                | +125°C, -55°C | 15     | -   | kV/V  |
|                                   | -A <sub>VOL1</sub> | $V_{OUT} = 0V$ and $-10V$<br>$R_L = 50k\Omega$                             | 4                   | +25°C         | 20     | -   | kV/V  |
|                                   |                    |                                                                            | 5, 6                | +125°C, -55°C | 15     | -   | kV/V  |
|                                   | +A <sub>VOL2</sub> | $V_{OUT} = 1.4V$ and $2.5V$<br>$R_L = 50k\Omega$                           | 4                   | +25°C         | 20     | -   | kV/V  |
|                                   |                    |                                                                            | 5, 6                | +125°C, -55°C | 15     | -   | kV/V  |
| Common Mode<br>Rejection Ratio    | +CMRR <sub>1</sub> | $\Delta V_{CM} = 10V$<br>$+V = 5V$<br>$-V = -25V$<br>$V_{OUT} = -10V$      | 1                   | +25°C         | 77     | -   | dB    |
|                                   |                    |                                                                            | 2, 3                | +125°C, -55°C | 77     | -   | dB    |
|                                   | -CMRR <sub>1</sub> | $\Delta V_{CM} = 10V$<br>$+V = 25V$<br>$-V = -5V$<br>$V_{OUT} = 10V$       | 1                   | +25°C         | 77     | -   | dB    |
|                                   |                    |                                                                            | 2, 3                | +125°C, -55°C | 77     | -   | dB    |
|                                   | +CMRR <sub>2</sub> | $\Delta V_{CM} = 0V$ to $3V$<br>$+V = 2V$<br>$-V = -3V$<br>$V_{OUT} = -3V$ | 1                   | +25°C         | 77     | -   | dB    |
|                                   |                    |                                                                            | 2, 3                | +125°C, -55°C | 77     | -   | dB    |
| Output Voltage Swing              | +V <sub>OUT1</sub> | $R_L = 50k\Omega$                                                          | 1                   | +25°C         | 10     | -   | V     |
|                                   |                    |                                                                            | 2, 3                | +125°C, -55°C | 10     | -   | V     |
|                                   | -V <sub>OUT1</sub> | $R_L = 50k\Omega$                                                          | 1                   | +25°C         | -      | -10 | V     |
|                                   |                    |                                                                            | 2, 3                | +125°C, -55°C | -      | -10 | V     |
|                                   | +V <sub>OUT2</sub> | $R_L = 50k\Omega$<br>Terminated at 2.5V                                    | 1                   | +25°C         | 3.8    | -   | V     |
|                                   |                    |                                                                            | 2, 3                | +125°C, -55°C | 3.5    | -   | V     |
|                                   | -V <sub>OUT2</sub> | $R_L = 50k\Omega$<br>Terminated at 2.5V                                    | 1                   | +25°C         | -      | 1   | V     |
|                                   |                    |                                                                            | 2, 3                | +125°C, -55°C | -      | 1.2 | V     |
| Quiescent Power<br>Supply Current | +I <sub>CC1</sub>  | $V_{OUT} = 0V$<br>$I_{OUT} = 0mA$                                          | 1                   | +25°C         | -      | 150 | μA    |
|                                   |                    |                                                                            | 2, 3                | +125°C, -55°C | -      | 200 | μA    |
|                                   | -I <sub>CC1</sub>  | $V_{OUT} = 0V$<br>$I_{OUT} = 0mA$                                          | 1                   | +25°C         | -150   | -   | μA    |
|                                   |                    |                                                                            | 2, 3                | +125°C, -55°C | -200   | -   | μA    |
|                                   | +I <sub>CC2</sub>  | $V_{OUT} = 1.4V$<br>$I_{OUT} = 0mA$                                        | 1                   | +25°C         | -      | 80  | μA    |
|                                   |                    |                                                                            | 2, 3                | +125°C, -55°C | -      | 100 | μA    |
| Power Supply<br>Rejection Ratio   | +PSRR <sub>1</sub> | $\Delta V_{SUP} = 10V$<br>$+V = 10V, -V = -15V$<br>$+V = 20V, -V = -15V$   | 1                   | +25°C         | 77     | -   | dB    |
|                                   |                    |                                                                            | 2, 3                | +125°C, -55°C | 77     | -   | dB    |
|                                   | -PSRR <sub>1</sub> | $\Delta V_{SUP} = 10V$<br>$+V = 15V, -V = -10V$<br>$+V = 15V, -V = -20V$   | 1                   | +25°C         | 77     | -   | dB    |
|                                   |                    |                                                                            | 2, 3                | +125°C, -55°C | 77     | -   | dB    |
|                                   | +PSRR <sub>2</sub> | $\Delta V_{SUP} = 10V$<br>$+V = 5V, -V = 0V$<br>$+V = 15V, -V = 0V$        | 1                   | +25°C         | 77     | -   | dB    |
|                                   |                    |                                                                            | 2, 3                | +125°C, -55°C | 77     | -   | dB    |

TABLE 2. A.C. ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at:  $R_{SOURCE} = 50\Omega$ ,  $R_{LOAD} = 50k\Omega$ ,  $C_{LOAD} = 50pF$ ,  $V_{OUT} = 0V$ , Unless Otherwise Specified.  
 Subscript 1 Refers to Supply Voltages ( $\pm V_S$ ) =  $\pm 15V$ ; Subscript 2 Refers to  $+V_S = 5.0V$ ,  $-V_S = 0.0V$ .

| PARAMETERS | SYMBOL           | CONDITIONS                                                            | GROUP A<br>SUBGROUP | TEMPERATURE | LIMITS |     | UNITS      |
|------------|------------------|-----------------------------------------------------------------------|---------------------|-------------|--------|-----|------------|
|            |                  |                                                                       |                     |             | MIN    | MAX |            |
| Slew Rate  | +SR <sub>1</sub> | $V_{OUT} = -3V$ to $3V$<br>$V_{IN}$ S.R. $\leq 10V/\mu s$ @ $A_V = 1$ | 4                   | +25°C       | 0.8    | -   | V/ $\mu s$ |
|            | -SR <sub>1</sub> | $V_{OUT} = 3V$ to $-3V$<br>$V_{IN}$ S.R. $\leq 10V/\mu s$ @ $A_V = 1$ | 4                   | +25°C       | 0.8    | -   | V/ $\mu s$ |
|            | +SR <sub>2</sub> | $V_{OUT} = 0V$ to $3V$<br>$V_{IN}$ S.R. $\leq 10V/\mu s$ @ $A_V = 1$  | 4                   | +25°C       | 0.8    | -   | V/ $\mu s$ |
|            | -SR <sub>2</sub> | $V_{OUT} = 3V$ to $0V$<br>$V_{IN}$ S.R. $\leq 10V/\mu s$ @ $A_V = 1$  | 4                   | +25°C       | 0.8    | -   | V/ $\mu s$ |

TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at:  $R_{SOURCE} = 50\Omega$ ,  $R_{LOAD} = 50k\Omega$ ,  $C_{LOAD} = 50pF$ ,  $A_V = 1V/V$ , Unless Otherwise Specified.  
 Subscript 1 Refers to Supply Voltages ( $\pm V_S$ ) =  $\pm 15V$ ; Subscript 2 Refers to  $+V_S = 5.0V$ ,  $-V_S = 0.0V$ .

| PARAMETERS                         | SYMBOL            | CONDITIONS                            | NOTES | TEMPERATURE     | LIMITS |     | UNITS |
|------------------------------------|-------------------|---------------------------------------|-------|-----------------|--------|-----|-------|
|                                    |                   |                                       |       |                 | MIN    | MAX |       |
| Full Power Bandwidth               | FPBW <sub>1</sub> | $V_{PEAK} = 10V$                      | 1, 2  | +25°C           | 12.7   | -   | kHz   |
|                                    | FPBW <sub>2</sub> | $V_{PEAK} = 1.1V$<br>$V_{Ref} = 2.5V$ | 1, 2  | +25°C           | 115.8  | -   | kHz   |
| Minimum Closed Loop<br>Stable Gain | CLSG              | $R_L = 50k\Omega$ , $C_L = 50pF$      | 1     | -55°C to +125°C | 1      | -   | V/V   |
| Quiescent<br>Power Consumption     | PC <sub>1</sub>   | $V_{OUT} = 0V$ , $I_{OUT} = 0mA$      | 1, 3  | -55°C to +125°C | -      | 6   | mW    |
|                                    | PC <sub>2</sub>   | $V_{OUT} = 1.4V$ , $I_{OUT} = 0mA$    | 1, 3  | -55°C to +125°C | -      | 0.5 | mW    |

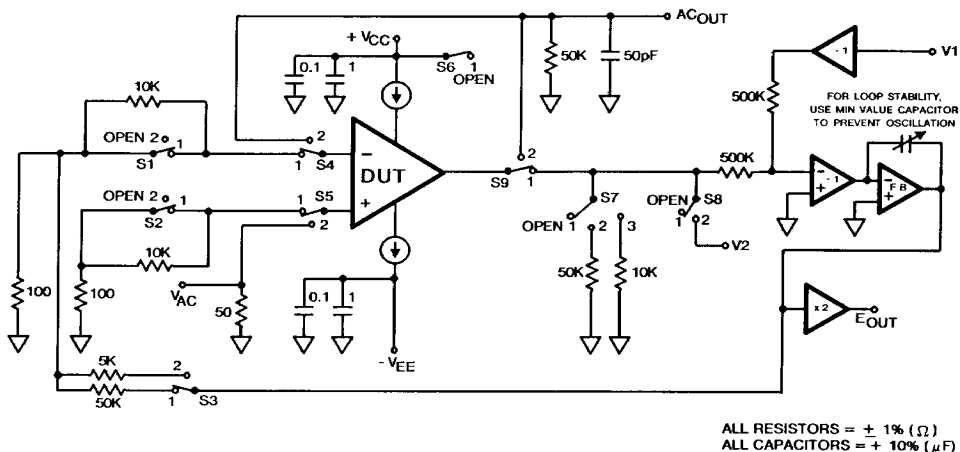
NOTES: 1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from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

2. Full Power Bandwidth guarantee based on Slew Rate measurement using  $FPBW = \text{Slew Rate} / (2\pi V_{PEAK})$ .  
 3. Quiescent Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.)

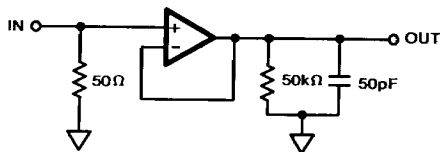
TABLE 4. ELECTRICAL TEST REQUIREMENTS

| 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            |
| Group A Test Requirements                   | 1, 2, 3, 4, 5, 6             |
| Groups C & D Endpoints                      | 1                            |

\* PDA applies to Subgroup 1 only.

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

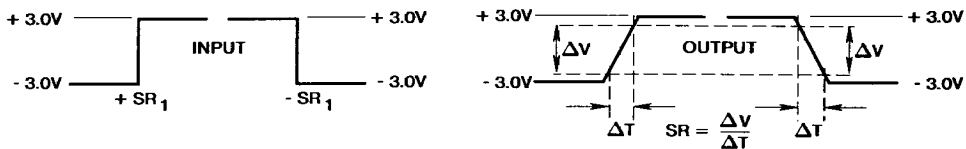
For Detailed Information, Refer to HA-5141/883 Test Tech Brief

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

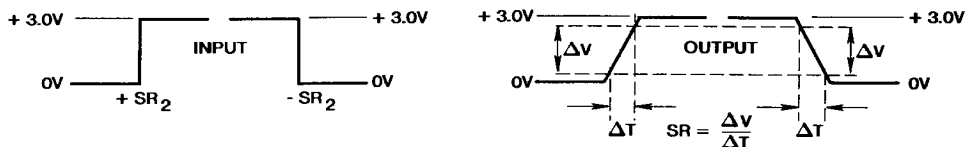
NOTE:  $\pm V_{SUPPLY}$  ( $\pm V_S$ ) Tested with  $\pm 15V$  and  $0V$ ,  $+5V$ .  $V_{IN}$  Slew Rate Maintained with Less Than  $10V/\mu s$  Input for Voltage Follower Configuration.

**SLEW RATE WAVEFORMS,  $A_V = 1V/V$** 

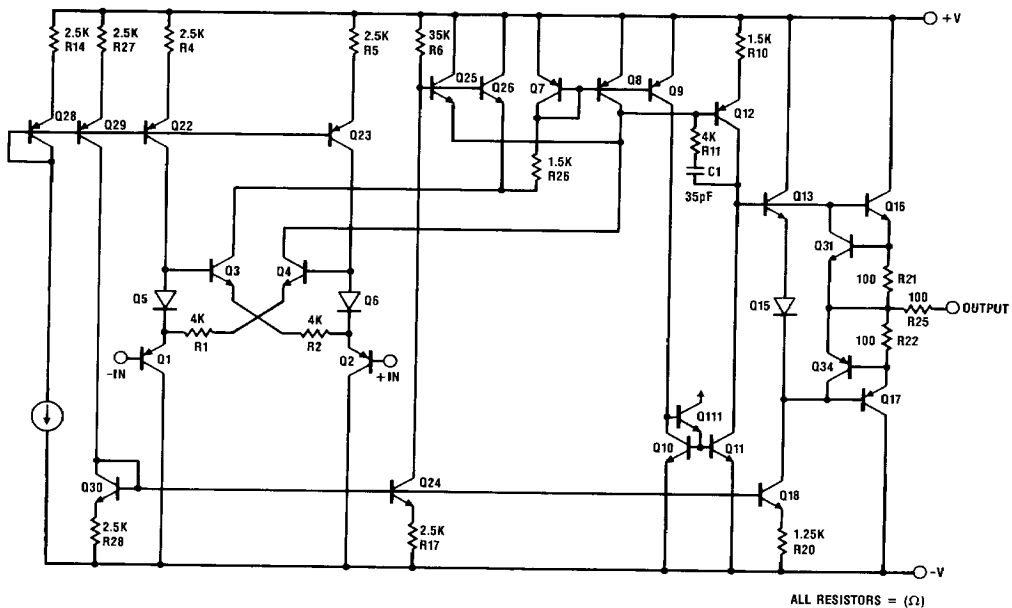
$$\pm V_{SUPPLY} = \pm 15V$$



$$+V_{SUPPLY} = 5V, -V_{SUPPLY} = 0V$$





**Schematic Diagram**

**Die Characteristics****DIE DIMENSIONS:**

53.1 x 58.7 x 19 mils  
(1350 x 1490 x 483  $\mu\text{m}$ )

**METALLIZATION:**

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

**WORST CASE CURRENT DENSITY:**

$0.6 \times 10^5 \text{A/cm}^2$  @ 2.5mA

**SUBSTRATE POTENTIAL (Powered Up):** V-

**GLASSIVATION:**

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

**TRANSISTOR COUNT: 36**

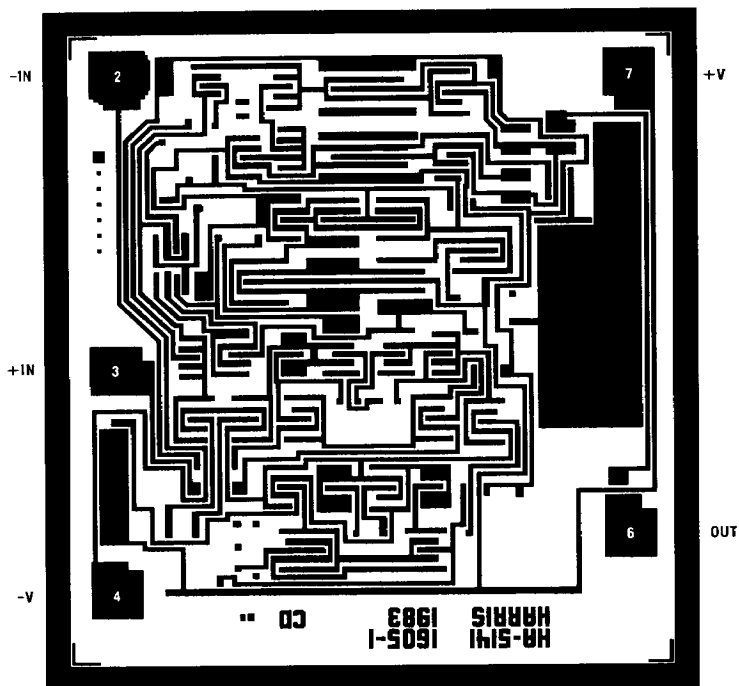
**PROCESS:** HFSB Bipolar/JFET Dielectric Isolation

**DIE ATTACH:**

Material: Gold/Silicon Eutectic Alloy  
Temperature: Ceramic DIP —  $460^\circ\text{C}$  (Max)  
Ceramic LCC —  $420^\circ\text{C}$  (Max)  
Metal Can —  $420^\circ\text{C}$  (Max)

**Metallization Mask Layout**

HA-5141/883

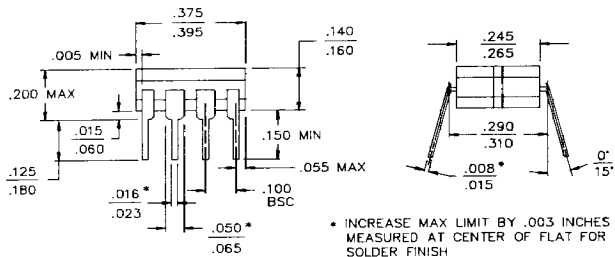


NOTE: Pad Numbers Refer to 8 Pin Ceramic Mini-DIP or Metal Can Package Pinouts Only.

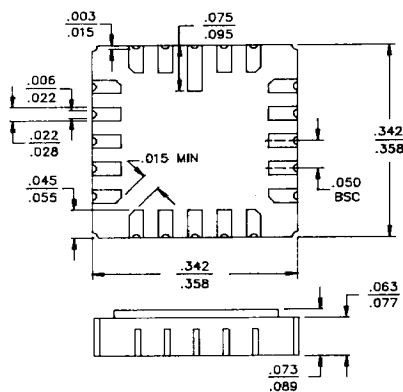
**3**

OP AMPS &  
COMPARATORS

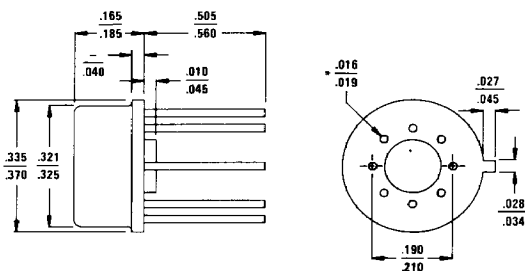


**Packaging †****8 PIN CERAMIC DIP**

**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:** 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 Min Max Dimensions are in inches.

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

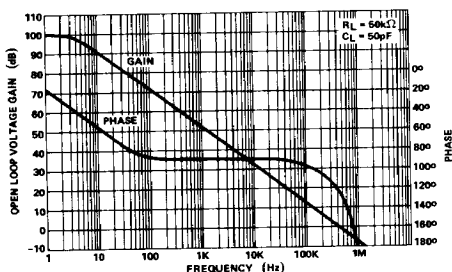
## DESIGN INFORMATION

## Single, Ultra-Low Power Operational Amplifier

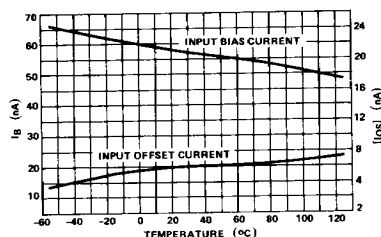
The information contained in this section has been developed through characterization by Harris Semiconductor and is for use as application and design aid only. These characteristics are not 100% tested and no product guarantee is implied.

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

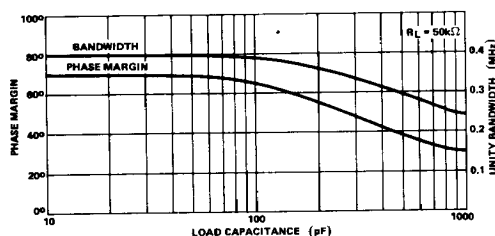
**OPEN LOOP FREQUENCY RESPONSE**



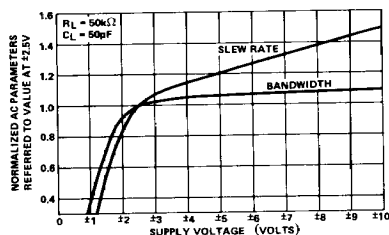
**INPUT OFFSET CURRENT AND BIAS CURRENT vs. TEMPERATURE**



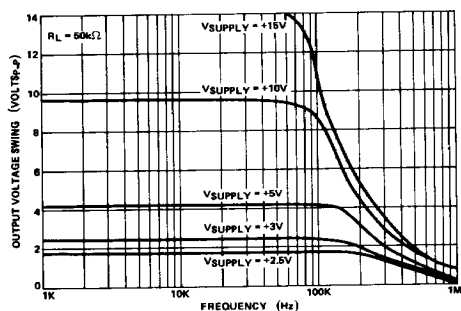
**BANDWIDTH AND PHASE MARGIN vs. LOAD CAPACITANCE**



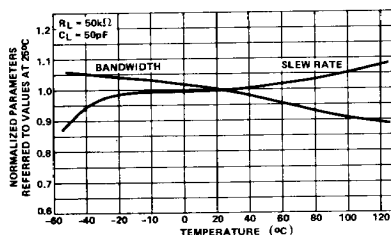
**NORMALIZED AC PARAMETERS vs. SUPPLY VOLTAGE**



**OUTPUT VOLTAGE SWING vs. FREQUENCY AND SINGLE SUPPLY VOLTAGE**



**NORMALIZED AC PARAMETERS vs. TEMPERATURE**

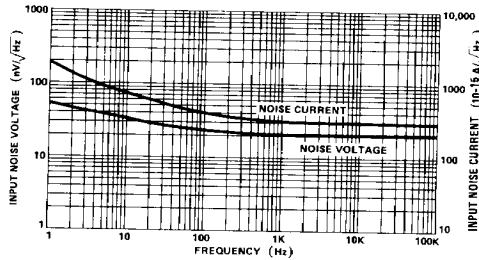


## DESIGN INFORMATION (Continued)

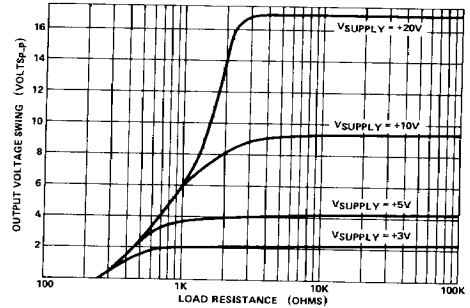
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**Typical Performance Curves** Unless Otherwise Specified:  $T_A = +25^\circ\text{C}$ ,  $V_{\text{SUPPLY}} = \pm 15\text{V}$

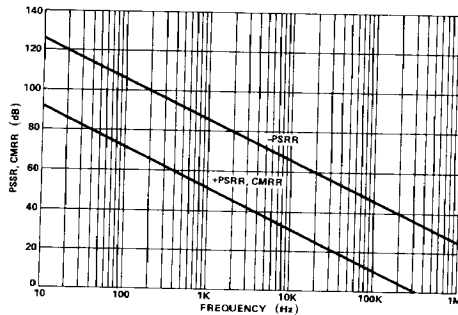
**INPUT NOISE vs. FREQUENCY**



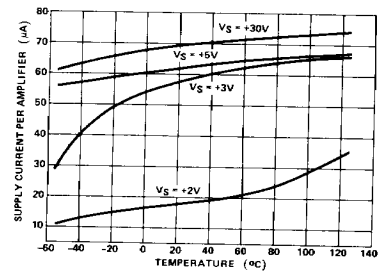
**MAXIMUM OUTPUT VOLTAGE SWING vs. LOAD RESISTANCE AND SINGLE SUPPLY VOLTAGE**



**PSRR AND CMRR vs. FREQUENCY**



**POWER SUPPLY CURRENT vs. TEMPERATURE AND SINGLE SUPPLY VOLTAGE**



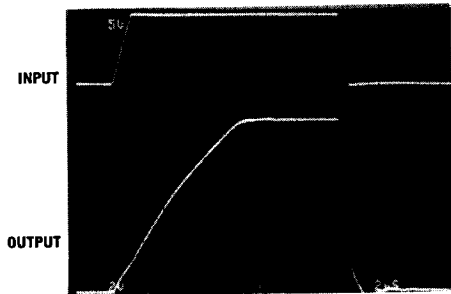
**DESIGN INFORMATION (Continued)**

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

**MEASURED LARGE SIGNAL RESPONSE**

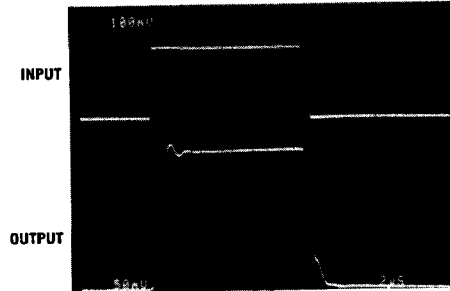
Vertical Scale: (Volts: Input = 5V/Div.; Output = 2V/Div.)  
Horizontal Scale: (Time: 2 $\mu\text{s}$ /Div.)



$+V_{\text{SUPPLY}} = +15\text{V}$ ,  $-V_{\text{SUPPLY}} = -15\text{V}$

**MEASURED SMALL SIGNAL RESPONSE**

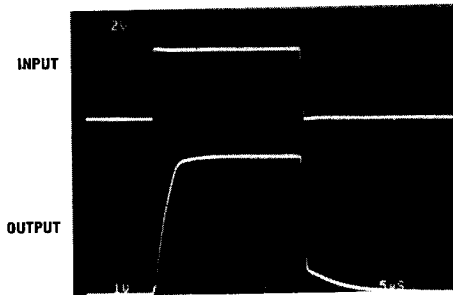
Vertical Scale: (Volts: Input = 100mV/Div.; Output = 50mV/Div.)  
Horizontal Scale: (Time: 2 $\mu\text{s}$ /Div.)



$+V_{\text{SUPPLY}} = +15\text{V}$ ,  $-V_{\text{SUPPLY}} = -15\text{V}$

**MEASURED LARGE SIGNAL RESPONSE**

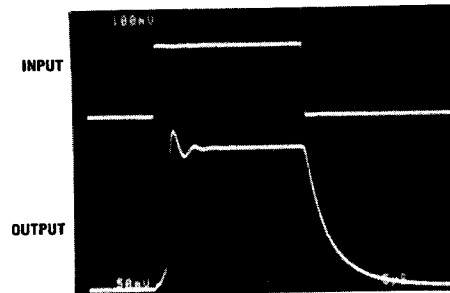
Vertical Scale: (Volts: Input = 2V/Div.; Output = 1V/Div.)  
Horizontal Scale: (Time: 5 $\mu\text{s}$ /Div.)



$+V_{\text{SUPPLY}} = +5\text{V}$ ,  $-V_{\text{SUPPLY}} = 0\text{V}$

**MEASURED SMALL SIGNAL RESPONSE**

Vertical Scale: (Volts: Input = 100mV/Div.; Output = 50mV/Div.)  
Horizontal Scale: (Time: 5 $\mu\text{s}$ /Div.)



$+V_{\text{SUPPLY}} = +5\text{V}$ ,  $-V_{\text{SUPPLY}} = 0\text{V}$

**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 CHARACTERISTICS**

Device Characterized at: Supply Voltage = 0V, 5 to  $\pm 15$ V,  $R_L = 50k\Omega$ ,  $C_L = 50pF$ , Unless Otherwise Specified.

| PARAMETERS                    | CONDITIONS                       | TEMP                             | TYPICAL | DESIGN LIMIT | UNITS            |
|-------------------------------|----------------------------------|----------------------------------|---------|--------------|------------------|
| Offset Voltage                | $V_{CM} = 0V$                    | Full                             | 0.5     | Table 1      | mV               |
| Offset Voltage Drift          | Versus Temperature               | Full                             | 3       | 6            | $\mu V/^\circ C$ |
| Bias Current                  | $V_{CM} = 0V$                    | +25 $^\circ C$ , +125 $^\circ C$ | 50      | Table 1      | nA               |
|                               |                                  | -55 $^\circ C$                   | 75      | Table 1      | nA               |
| Offset Current                | $V_{CM} = 0V$                    | Full                             | 5       | Table 1      | nA               |
| Differential Input Resistance |                                  | +25 $^\circ C$                   | 0.6     | 0.4          | M $\Omega$       |
| Input Noise Voltage           | $f_o = 10Hz$                     | +25 $^\circ C$                   | 40      | 80           | $nV/\sqrt{Hz}$   |
|                               | $f_o = 100Hz$                    | +25 $^\circ C$                   | 30      | 60           | $nV/\sqrt{Hz}$   |
|                               | $f_o = 1kHz$                     | +25 $^\circ C$                   | 20      | 40           | $nV/\sqrt{Hz}$   |
| Input Noise Current           | $f_o = 10Hz$                     | +25 $^\circ C$                   | 0.7     | 1            | $pA/\sqrt{Hz}$   |
|                               | $f_o = 100Hz$                    | +25 $^\circ C$                   | 0.25    | 0.8          | $pA/\sqrt{Hz}$   |
|                               | $f_o = 1kHz$                     | +25 $^\circ C$                   | 0.2     | 0.5          | $pA/\sqrt{Hz}$   |
| Large Signal Voltage Gain     | $R_L = 50k\Omega$                | +25 $^\circ C$ , +125 $^\circ C$ | 75K     | Table 1      | V/V              |
|                               |                                  | -55 $^\circ C$                   | 30K     | Table 1      | V/V              |
| CMRR                          |                                  | Full                             | 105     | Table 1      | dB               |
| PSRR                          |                                  | Full                             | 100     | Table 1      | dB               |
| Unity Gain Bandwidth          | $f @ -3dB$                       | +25 $^\circ C$                   | 400     | 300          | kHz              |
| + Slew Rate                   | $V_S = 0V, 5V$                   | -55 $^\circ C$                   | 1       | 0.6          | V/ $\mu s$       |
|                               | $V_S = 0V, 5V$ to $\pm 15V$      | +25 $^\circ C$ , +125 $^\circ C$ | 1.5     | 0.8          | V/ $\mu s$       |
| - Slew Rate                   | $V_S = 0V, 5V$ to $\pm 15V$      | Full                             | 15      | 0.8          | V/ $\mu s$       |
| + $I_{OUT}$                   |                                  | +25 $^\circ C$ , +125 $^\circ C$ | 2       | 0.4          | mA               |
|                               |                                  | -55 $^\circ C$                   | 0.8     | 0.4          | mA               |
| - $I_{OUT}$                   |                                  | -55 $^\circ C$ , +25 $^\circ C$  | -7.5    | -6           | mA               |
|                               |                                  | +125 $^\circ C$                  | -4.5    | -3.5         | mA               |
| Rise Time                     | $V_S = \pm 15V, V_O = 200mV$     | Full                             | 0.8     | 1.5          | $\mu s$          |
| Fall Time                     | $V_S = \pm 15V, V_O = -200mV$    | Full                             | 0.9     | 1.5          | $\mu s$          |
| Overshoot                     | $V_S = \pm 15V, V_O = \pm 200mV$ | Full                             | 5       | 10           | %                |
| Supply Current                | $V_S = 0V, 5V$                   | +25 $^\circ C$                   | 64      | Table 1      | $\mu A$          |
|                               | $V_S = \pm 15V$                  | +25 $^\circ C$                   | 70      | Table 1      | $\mu A$          |