

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 ..... 250 $\mu$ A (Max)
- Wide Supply Voltage Range..... Single 3V to 30V or Dual  $\pm 1.5$  to  $\pm 15$ V
- High Slew Rate ..... +S.R. 4V/ $\mu$ s (Min) 6V/ $\mu$ s (Typ)
- Low  $V_{OS}$  Drift (Over Full Temp) ..... 3 $\mu$ V/ $^{\circ}$ C (Typ)
- Low Noise (1kHz)..... 15nV/ $\sqrt{\text{Hz}}$  (Typ)
- 100% Tested at  $\pm 15$ V and +5V Power Supplies
- Dielectric Isolation

### Applications

- Portable Instruments
- Meter Amplifiers
- Telephone Headsets
- Microphone Amplifiers
- Remote Sensor/Transmitter
- Battery Powered Equipment
- For Further Design Ideas See App. Note 544

### Description

The HA-5151/883 single operational amplifier is part of a family of dielectrically isolated bipolar amplifiers designed to provide excellent AC performance while drawing less than 250 $\mu$ A of supply current at +25 $^{\circ}$ C. This unity gain stable amplifier is especially well suited for portable and lightweight equipment where available power is limited.

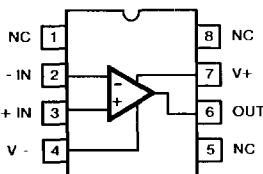
The HA-5151/883 combines superior low power AC performance with DC precision not usually found in general purpose amplifiers. The DC performance is centered around low input offset voltage (3mV), low offset voltage drift (3 $\mu$ V/ $^{\circ}$ C), and low input bias current (250nA). This is combined with a very low input noise voltage of 15nV/ $\sqrt{\text{Hz}}$  at 1kHz.

The AC performance of the HA-5151/883 surpasses that of typical low power amplifiers with 4V/ $\mu$ s slew rate and a full power bandwidth of 64kHz. This makes the HA-5151/883 an excellent choice for virtually all audio processing applications as well as remote sensor/transmitter designs requiring both low power and high speed. The suitability of the HA-5151/883 for remote and low power operation is further enhanced by the wide range of supply voltages ( $\pm 1.5$ V to  $\pm 15$ V) as well as single supply operation (3V to 30V).

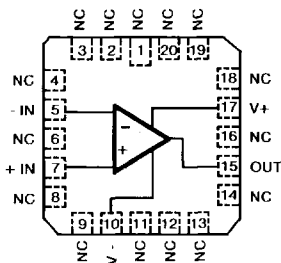
The HA-5151/883 is available in 8 pin Ceramic Mini-DIP, 20 pad Ceramic LCC or 8 pin (TO-99) Metal Can, and is interchangeable with most other operational amplifiers in their class.

### Pinouts

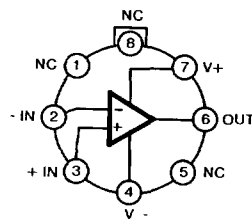
HA7-5151/883 (CERAMIC MINI-DIP)  
TOP VIEW



HA4-5151/883 (CERAMIC LCC)  
TOP VIEW



HA2-5151/883 (METAL CAN)  
TOP VIEW



## Specifications HA-5151/883

### 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, 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	30°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	$V_{INCM} \leq 1/2 (V+ - V-)$
Operating Supply Voltage .....	±1.5V to ±15V or 3V to 30V	$R_L \geq 10k\Omega$

**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 SUBGROUP	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Input Offset Voltage	V <sub>IO1</sub>	V <sub>CM</sub> = 0V	1	+25°C	-3	3	mV
			2, 3	+125°C, -55°C	-4	4	mV
	V <sub>IO2</sub>	V <sub>CM</sub> = 0V V <sub>OUT</sub> = 1.4V	1	+25°C	-3	3	mV
			2, 3	+125°C, -55°C	-4	4	mV
Input Bias Current	+I <sub>B1</sub>	V <sub>CM</sub> = 0V +R <sub>S</sub> = 10kΩ -R <sub>S</sub> = 100Ω	1	+25°C	-250	250	nA
			2, 3	+125°C, -55°C	-400	400	nA
	-I <sub>B1</sub>	V <sub>CM</sub> = 0V +R <sub>S</sub> = 100Ω -R <sub>S</sub> = 10kΩ	1	+25°C	-250	250	nA
			2, 3	+125°C, -55°C	-400	400	nA
	+I <sub>B2</sub>	V <sub>CM</sub> = 0V, V <sub>OUT</sub> = 1.4V +R <sub>S</sub> = 10kΩ -R <sub>S</sub> = 100Ω	1	+25°C	-250	250	nA
			2, 3	+125°C, -55°C	-400	400	nA
	-I <sub>B2</sub>	V <sub>CM</sub> = 0V, V <sub>OUT</sub> = 1.4V +R <sub>S</sub> = 100Ω -R <sub>S</sub> = 10kΩ	1	+25°C	-250	250	nA
			2, 3	+125°C, -55°C	-400	400	nA
Input Offset Current	I <sub>IO1</sub>	V <sub>CM</sub> = 0V +R <sub>S</sub> = 10kΩ -R <sub>S</sub> = 10kΩ	1	+25°C	-50	50	nA
			2, 3	+125°C, -55°C	-80	80	nA
	I <sub>IO2</sub>	V <sub>CM</sub> = 0V, V <sub>OUT</sub> = 1.4V +R <sub>S</sub> = 10kΩ -R <sub>S</sub> = 10kΩ	1	+25°C	-50	50	nA
			2, 3	+125°C, -55°C	-80	80	nA
Common Mode Range	+CMR <sub>1</sub>	V+ = 5V V- = -25V	1	+25°C	10	-	V
			2, 3	+125°C, -55°C	10	-	V
	-CMR <sub>1</sub>	V+ = 25V V- = -5V	1	+25°C	-	-10	V
			2, 3	+125°C, -55°C	-	-10	V
	+CMR <sub>2</sub>	V+ = 5V to 2V V- = 0V to -3V 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.

## Specifications HA-5151/883

**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 SUBGROUP	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Large Signal Voltage Gain	+AVOL1	$V_{OUT} = 0V$ and $10V$ $R_L = 10k\Omega$	4	+25°C	50	-	kV/V
			5, 6	+125°C, -55°C	25	-	kV/V
	-AVOL1	$V_{OUT} = 0V$ and $-10V$ $R_L = 10k\Omega$	4	+25°C	50	-	kV/V
			5, 6	+125°C, -55°C	25	-	kV/V
	+AVOL2	$V_{OUT} = 1.4V$ and $2.5V$ $R_L = 10k\Omega$	4	+25°C	50	-	kV/V
			5, 6	+125°C, -55°C	25	-	kV/V
Common Mode Rejection Ratio	+CMRR1	$\Delta V_{CM} = 10V$ $+V = 5V$ $-V = -25V$ $V_{OUT} = -10V$	1	+25°C	80	-	dB
			2, 3	+125°C, -55°C	80	-	dB
	-CMRR1	$\Delta V_{CM} = 10V$ $+V = 25V$ $-V = -5V$ $V_{OUT} = 10V$	1	+25°C	80	-	dB
			2, 3	+125°C, -55°C	80	-	dB
	+CMRR2	$\Delta V_{CM} = 0V$ to $3V$ $+V = 2V$ $-V = -3V$ $V_{OUT} = -3V$	1	+25°C	80	-	dB
			2, 3	+125°C, -55°C	80	-	dB
Output Voltage Swing	+VOUT1	$R_L = 10k\Omega$	1	+25°C	10	-	V
			2, 3	+125°C, -55°C	10	-	V
	-VOUT1	$R_L = 10k\Omega$	1	+25°C	-	-10	V
			2, 3	+125°C, -55°C	-	-10	V
	+VOUT2	$R_L = 10k\Omega$ Terminated at 2.5V	1	+25°C	3.2	-	V
			2, 3	+125°C, -55°C	2.9	-	V
	-VOUT2	$R_L = 10k\Omega$ Terminated at 2.5V	1	+25°C	-	1	V
			2, 3	+125°C, -55°C	-	1.2	V
Quiescent Power Supply Current	+ICC1	$V_{OUT} = 0V$ $I_{OUT} = 0mA$	1	+25°C	-	250	$\mu A$
			2, 3	+125°C, -55°C	-	275	$\mu A$
	-ICC1	$V_{OUT} = 0V$ $I_{OUT} = 0mA$	1	+25°C	-250	-	$\mu A$
			2, 3	+125°C, -55°C	-275	-	$\mu A$
	+ICC2	$V_{OUT} = 1.4V$ $I_{OUT} = 0mA$	1	+25°C	-	250	$\mu A$
			2, 3	+125°C, -55°C	-	275	$\mu A$
Power Supply Rejection Ratio	+PSRR1	$\Delta V_{SUP} = 10V$ $+V = 10V, -V = -15V$ $+V = 20V, -V = -15V$	1	+25°C	80	-	dB
			2, 3	+125°C, -55°C	80	-	dB
	-PSRR1	$\Delta V_{SUP} = 10V$ $+V = 15V, -V = -10V$ $+V = 15V, -V = -20V$	1	+25°C	80	-	dB
			2, 3	+125°C, -55°C	80	-	dB
	+PSRR2	$\Delta V_{SUP} = 10V$ $+V = 5V, -V = 0V$ $+V = 15V, -V = 0V$	1	+25°C	80	-	dB
			2, 3	+125°C, -55°C	80	-	dB

3

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

Device Tested at:  $R_{SOURCE} = 50\Omega$ ,  $R_{LOAD} = 10k\Omega$ ,  $C_{LOAD} = 100pF$ ,  $V_{OUT} = 0V$ , 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 SUBGROUP	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Slew Rate	+SR <sub>1</sub>	$V_{OUT} = -3V$ to $3V$ $V_{IN}$ S.R. $\leq 25V/\mu s$	4	+25°C	4	-	V/ $\mu s$
	-SR <sub>1</sub>	$V_{OUT} = 3V$ to $-3V$ $V_{IN}$ S.R. $\leq 25V/\mu s$	4	+25°C	4	-	V/ $\mu s$
	+SR <sub>2</sub>	$V_{OUT} = 0V$ to $3V$ $V_{IN}$ S.R. $\leq 25V/\mu s$	4	+25°C	2	-	V/ $\mu s$
	-SR <sub>2</sub>	$V_{OUT} = 3V$ to $0V$ $V_{IN}$ S.R. $\leq 25V/\mu s$	4	+25°C	2	-	V/ $\mu s$

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at:  $R_{SOURCE} = 50\Omega$ ,  $R_{LOAD} = 10k\Omega$ ,  $C_{LOAD} = 100pF$ ,  $A_V = 1V/V$ , 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	
Gain Bandwidth Product	GBWP	$V_O = 200mV$ , $f_o = 10kHz$	1	+25°C	0.7	-	MHz
Full Power Bandwidth	FPBW <sub>1</sub>	$V_{PEAK} = 10V$	1, 2	+25°C	64	-	kHz
	FPBW <sub>2</sub>	$V_{PEAK} = 1.1V$ $V_{Ref} = 2.5V$	1, 2	+25°C	290	-	kHz
Minimum Closed Loop Stable Gain	CLSG	$R_L = 10k\Omega$ , $C_L = 100pF$	1	-55°C to +125°C	1	-	V/V
Quiescent Power Consumption	PC <sub>1</sub>	$V_{OUT} = 0V$ , $I_{OUT} = 0mA$	1, 3	-55°C to +125°C	-	8.25	mW
	PC <sub>2</sub>	$V_{OUT} = 1.4V$ , $I_{OUT} = 0mA$	1, 3	-55°C to +125°C	-	1.4	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.

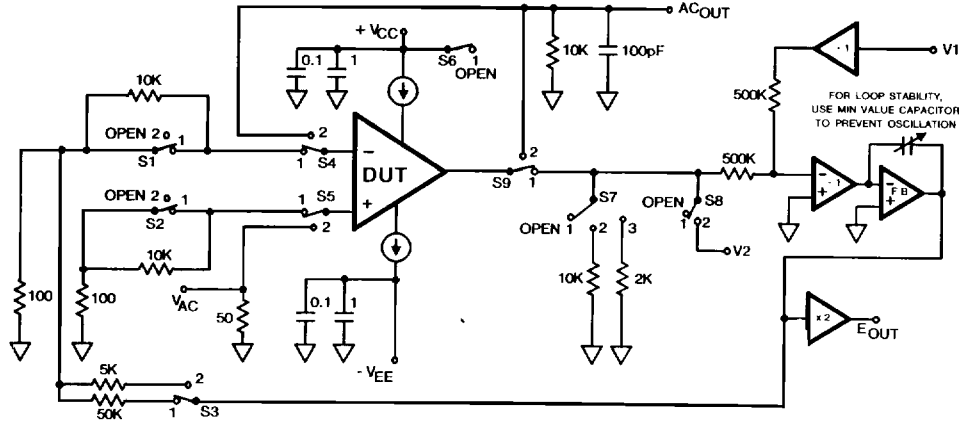
- 2. Full Power Bandwidth guarantee based on Slew Rate measurement using  $FPBW = Slew\ Rate / (2\pi V_{PEAK})$ .
- 3. Quiescent Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.)

**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)

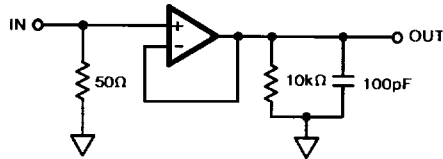


ALL RESISTORS =  $\pm 1\%$  ( $\Omega$ )  
ALL CAPACITORS =  $\pm 10\%$  ( $\mu$ F)

For Detailed Information, Refer to HA-5151/883 Test Tech Brief

**Test Waveforms**

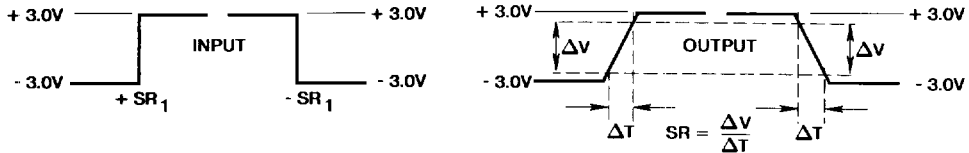
**SIMPLIFIED TEST CIRCUIT** (Applies to Table 2)



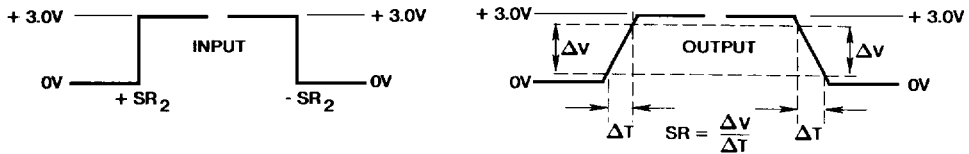
NOTE:  $\pm V_{SUPPLY}$  ( $\pm V_S$ ) Tested with  $\pm 15V$  and  $0V$ ,  $+5V$ .  $V_{IN}$  Slow Rate Maintained with Less Than  $10V/\mu s$  Input for Voltage Follower Configuration.

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

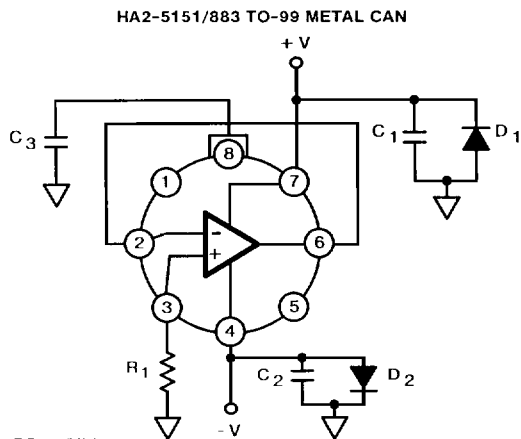
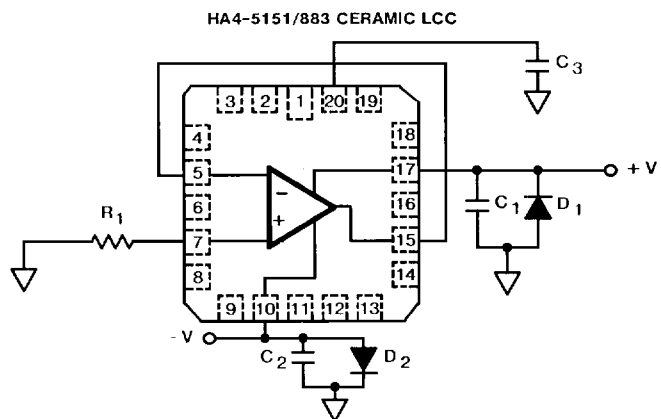
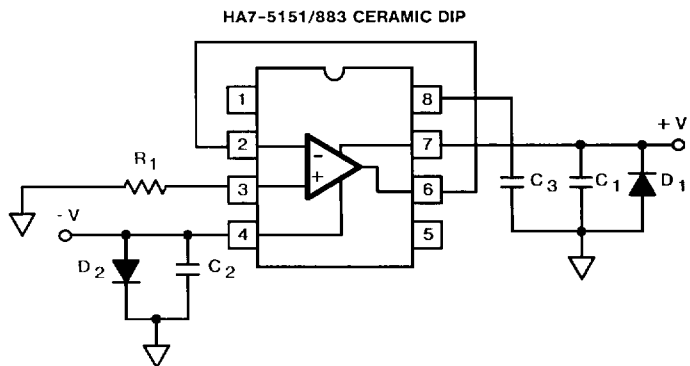
$\pm V_{SUPPLY} = \pm 15V$



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



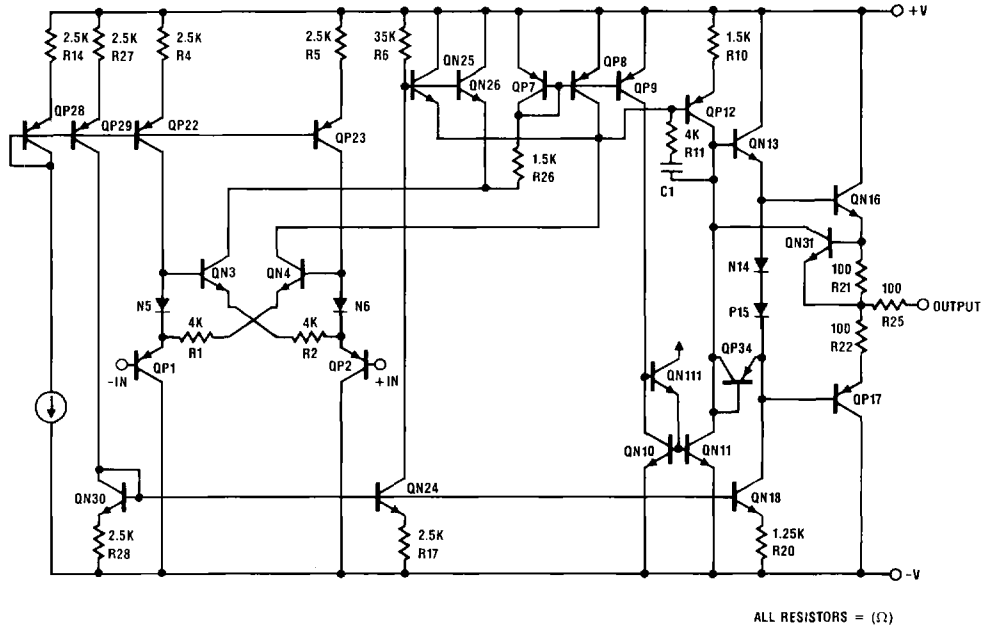
**Burn-In Circuits**



**NOTES:**

- R<sub>1</sub> = 1MΩ, ±5%, 1/4W (Min)
- C<sub>1</sub> = C<sub>2</sub> = 0.01μF/Socket (Min) or 0.1μF/Row, (Min)
- C<sub>3</sub> = 0.01μF/Socket, 10% (Not Required)
- D<sub>1</sub> = D<sub>2</sub> = IN4002 or Equivalent/Board
- |V<sub>+</sub> - V<sub>-</sub>| = 30V

Schematic Diagram



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**Die Characteristics**

**DIE DIMENSIONS:**

58.7 x 53.1 x 19 mils  
(1490 x 1350 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:  $7\text{k}\text{\AA} \pm 0.7\text{k}\text{\AA}$

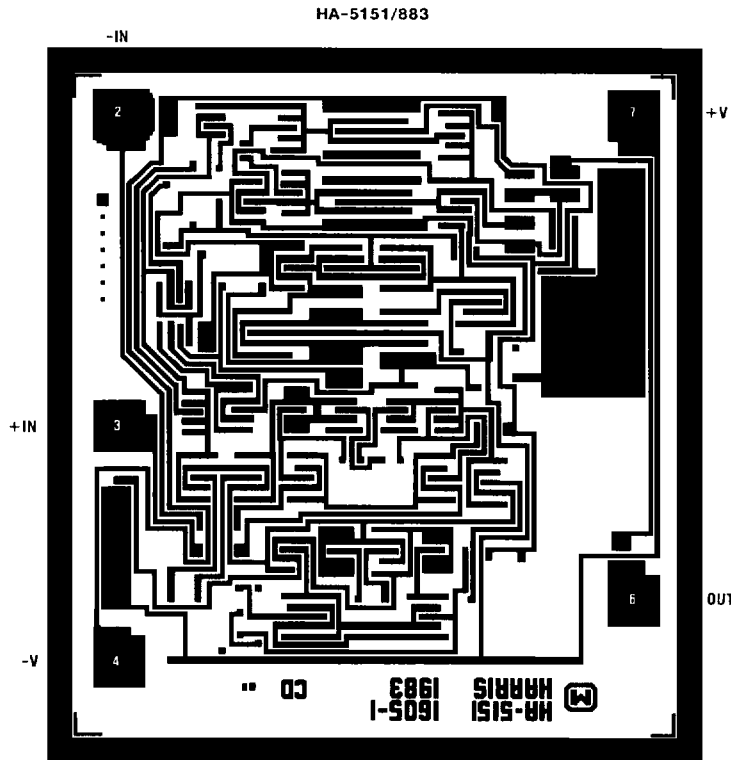
**TRANSISTOR COUNT:** 36

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

**DIE ATTACH:**

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

**Metallization Mask Layout**

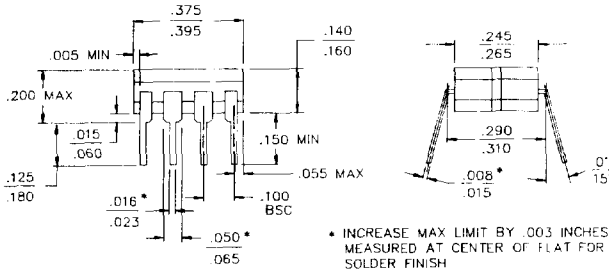


NOTE: Pad Numbers Refer to 8 Pin Ceramic Mini-DIP or Metal Can Package Pinouts Only.



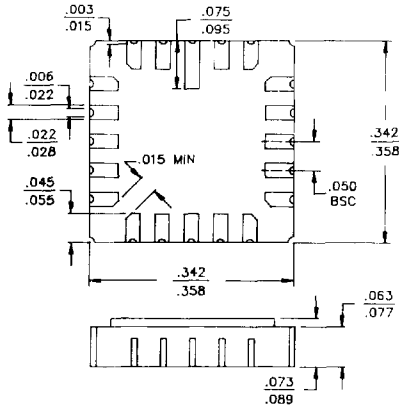
**Packaging †**

**8 PIN CERAMIC DIP**



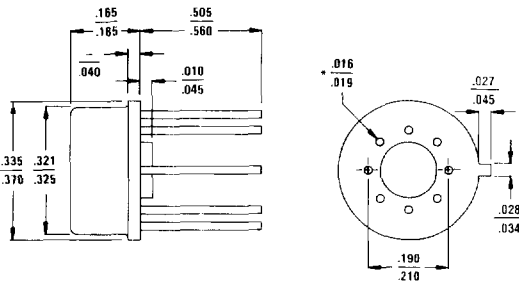
**LEAD MATERIAL:** Type B  
**LEAD FINISH:** Type A  
**PACKAGE MATERIAL:** Ceramic, 90% Alumina  
**PACKAGE SEAL:**  
 Material: Glass Frit  
 Temperature: 450°C ± 10°C  
 Method: Furnace Seal  
**INTERNAL LEAD WIRE:**  
 Material: Aluminum  
 Diameter: 1.25 Mil  
 Bonding Method: Ultrasonic  
**COMPLIANT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

**20 PAD CERAMIC LCC**



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

**8 PIN TO-99 METAL CAN**



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

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

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

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

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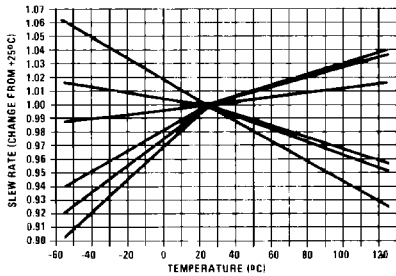
## DESIGN INFORMATION

## Single, Low Power Operational Amplifier

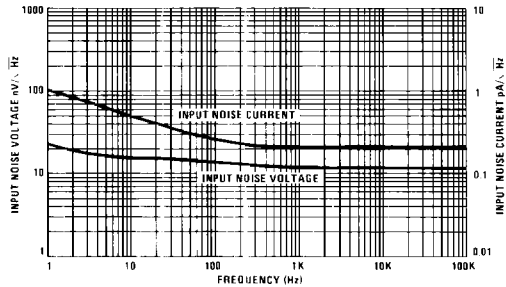
The information contained in this section has been developed through characterization by Harris Semiconductor and is for use as application and design aid only. These characteristics are not 100% tested and no product guarantee is implied.

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

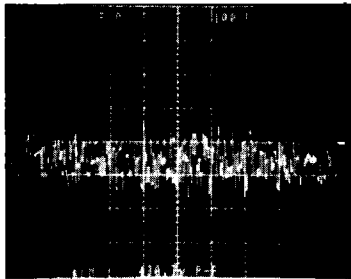
**SLEW RATE vs. TEMPERATURE**  
Normalized to Unity at +25°C, 6 Representative Units



**NOISE SPECTRAL DENSITY**

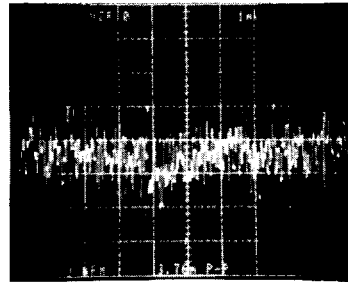


**PEAK-TO-PEAK NOISE 0.1Hz TO 10Hz**  
 $T_A = +25^\circ\text{C}$ ,  $A_V = 1000\text{V/V}$



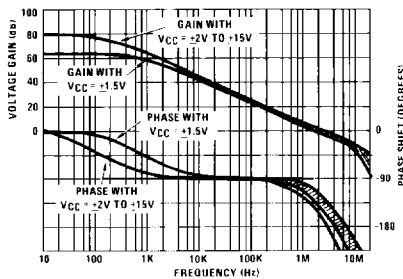
Vertical Scale: (Volts: 100 $\mu\text{s}/\text{Div.}$ )  
Horizontal Scale: (Time: 1sec/Div.)  
430nV $_{\text{p-p}}$  RTI

**PEAK-TO-PEAK 0.1Hz TO 1MHz**  
 $T_A = +25^\circ\text{C}$ ,  $A_V = 1000\text{V/V}$

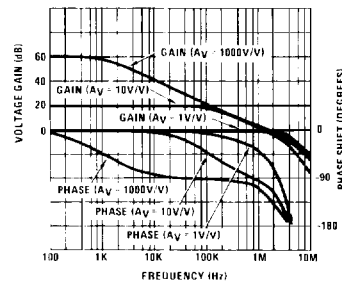


Vertical Scale: (Volts: 1mV/Div.)  
Horizontal Scale: (Time: 1sec/Div.)  
3.7 $\mu\text{V}_{\text{p-p}}$  RTI

**FREQUENCY RESPONSE vs. SUPPLY VOLTAGE**  
 $T_A = +25^\circ\text{C}$ ,  $R_L = 10\text{K}$ ,  $C_L = 100\text{pF}$



**FREQUENCY RESPONSE AT VARIOUS GAINS**  
 $T_A = +25^\circ\text{C}$ ,  $V_{\text{CC}} = \pm 15\text{V}$ ,  $R_L = 10\text{K}$ ,  $C_L = 100\text{pF}$

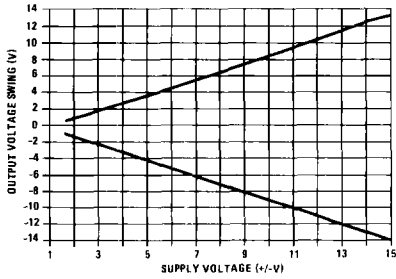


**DESIGN INFORMATION** (Continued)

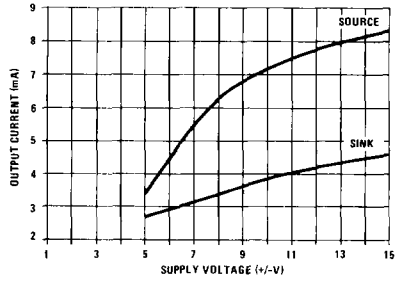
The information contained in this section has been developed through characterization by Harris Semiconductor and is for use as application and design aid only. These characteristics are not 100% tested and no product guarantee is implied.

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

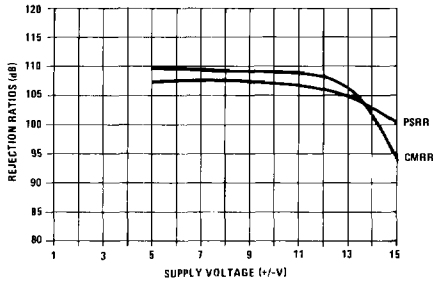
**OUTPUT VOLTAGE SWING vs. SUPPLY VOLTAGE**  
(+25°C)



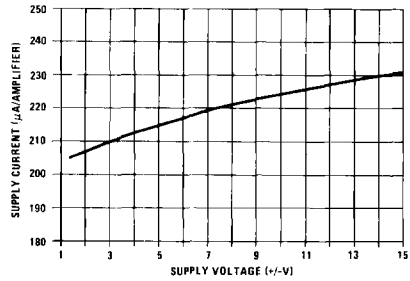
**OUTPUT CURRENT vs. SUPPLY VOLTAGE**  
(+25°C)



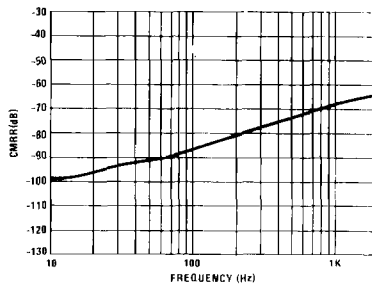
**CMRR AND PSRR vs. SUPPLY VOLTAGE**  
(+25°C)



**SUPPLY CURRENT vs. SUPPLY VOLTAGE**  
Per Amplifier (+25°C)



**CMRR vs. FREQUENCY**  
 $T_A = +25^\circ\text{C}$ ,  $V_{CC} = \pm 15\text{V}$



3  
OP AMPS &  
COMPARATORS

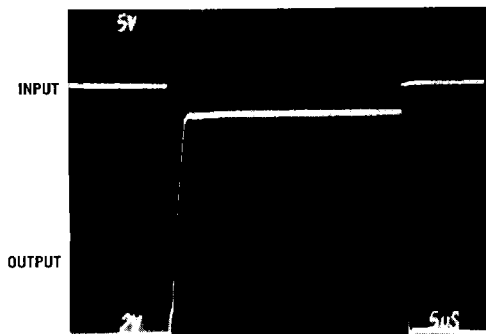
**DESIGN INFORMATION** (Continued)

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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**

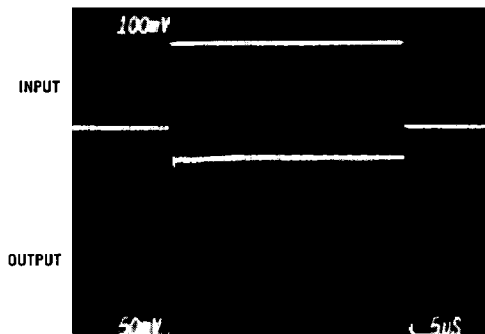
Vertical Scale: (Volts: Input = 5V/Div.; Output = 2V/Div.)  
Horizontal Scale: (Time: 5 $\mu\text{s}$ /Div.)



+VSUPPLY = +15V, -VSUPPLY = -15V

**MEASURED SMALL SIGNAL RESPONSE**

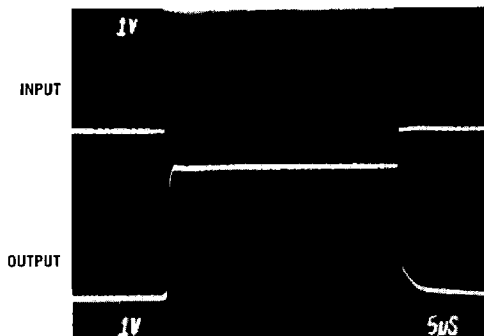
Vertical Scale: (Volts: Input = 100mV/Div.; Output = 50mV/Div.)  
Horizontal Scale: (Time: 5 $\mu\text{s}$ /Div.)



+VSUPPLY = +15V, -VSUPPLY = -15V

**MEASURED LARGE SIGNAL RESPONSE**

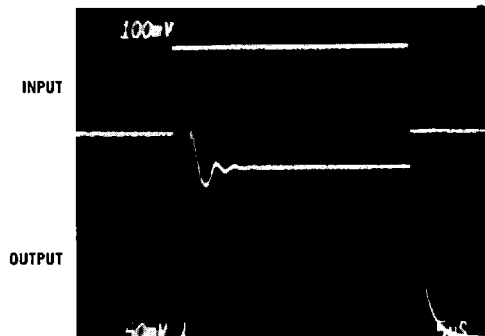
Vertical Scale: (Volts: Input = 1V/Div.; Output = 1V/Div.)  
Horizontal Scale: (Time: 5 $\mu\text{s}$ /Div.)



+VSUPPLY = +5V, -VSUPPLY = 0V

**MEASURED SMALL SIGNAL RESPONSE**

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



+VSUPPLY = +5V, -VSUPPLY = 0V

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

**Loading**

Although the standard load is  $10\text{k}\Omega$ , the HA-5151 is capable of driving resistive loads down to  $2\text{k}\Omega$  and capacitive loads beyond  $300\text{pF}$ .

**Input Stage**

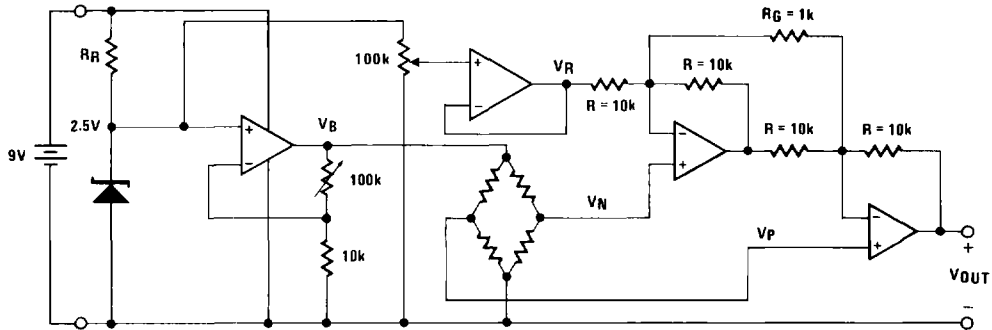
This amplifier uses a current amplifying input stage (see Application Note 544) and is not recommended for use in applications which involve large differential input voltages such as open-loop comparators. Most op amp applications use feedback and keep the input terminals at approximately the same voltage. The HA-5151 will perform well in these circuits as long as the input terminals see less than 7 volts differential.

**Typical Applications**

The low power consumption of the HA-5151 makes it ideal for applications like battery-powered instrumentation where the bridge amplifier circuit below would be used.

Choose a low-current zener voltage reference such as LM285Z-2.5 and select  $R_P$  accordingly. This circuit was evaluated using the resistor values shown and a laboratory voltage source for the 2.5V reference. With unmatched, off-the-shelf, 1% resistors, a gain accuracy of 1% to 2% can be expected. Temperature testing indicated a voltage offset tempco of less than  $100\mu\text{V}/^\circ\text{C}$  referred to output.

$$V_{\text{OUT}} = (V_P - V_N) \left[ 2 \left( 1 + \frac{R}{R_G} \right) \right] + V_R$$



**DESIGN INFORMATION** (Continued)

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**TYPICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at: Supply Voltage = 0V, 5 to  $\pm 15$ V,  $R_L = 10k\Omega$ ,  $C_L = 100pF$ , 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 $^\circ C$	130	Table 1	nA
		-55 $^\circ C$	150	Table 1	nA
Offset Current	$V_{CM} = 0V$	Full	5	Table 1	nA
Differential Input Resistance		+25 $^\circ C$	1.5	1	$M\Omega$
Input Noise Voltage	$f_o = 10Hz$	+25 $^\circ C$	18	25	$nV/\sqrt{Hz}$
	$f_o = 100Hz$	+25 $^\circ C$	15	20	$nV/\sqrt{Hz}$
	$f_o = 1kHz$	+25 $^\circ C$	14.8	18	$nV/\sqrt{Hz}$
Input Noise Current	$f_o = 10Hz$	+25 $^\circ C$	0.5	0.7	$pA/\sqrt{Hz}$
	$f_o = 100Hz$	+25 $^\circ C$	0.3	0.6	$pA/\sqrt{Hz}$
	$f_o = 1kHz$	+25 $^\circ C$	0.25	0.4	$pA/\sqrt{Hz}$
Large Signal Voltage Gain	$R_L = 10k\Omega$	+25 $^\circ C$ , +125 $^\circ C$	150K	Table 1	V/V
		-55 $^\circ C$	100K	Table 1	V/V
CMRR		Full	105	Table 1	dB
PSRR		Full	105	Table 1	dB
Unity Gain Bandwidth	$f @ -3dB$	+25 $^\circ C$	1.3	0.7	MHz
+ Slew Rate	$V_S = 0V, 5V$	-55 $^\circ C$	4	2	$V/\mu s$
	$V_S = 0V, 5V$ to $\pm 15V$	+25 $^\circ C$ , +125 $^\circ C$	6.5	4	$V/\mu s$
- Slew Rate	$V_S = 0V, 5V$	Full	12	2	$V/\mu s$
	$V_S = \pm 15V$	Full	25	4	$V/\mu s$
+ $I_{OUT}$		+25 $^\circ C$ , +125 $^\circ C$	3	1.5	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	250	500	ns
Fall Time	$V_S = \pm 15V, V_O = -200mV$	-55 $^\circ C$ , +25 $^\circ C$	110	300	ns
		+125 $^\circ C$	200	400	ns
Overshoot	$V_S = \pm 15V, V_O = \pm 200mV$	Full	2	10	%
Supply Current	$V_S = 0V, 5V$	+25 $^\circ C$	180	Table 1	$\mu A$
	$V_S = \pm 15V$	+25 $^\circ C$	200	Table 1	$\mu A$