

July 1994

### 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 . . . . . 8.0mA (Max)
- Low Offset Voltage . . . . . 2.0mV (Max)
- High Slew Rate . . . . . 340V/μs (Typ)
- Open Loop Gain . . . . . 20kV/V (Min)
- Wide Gain-Bandwidth ( $A_V \geq 10$ ) . . . . . 470MHz (Typ)
- Input Noise Voltage at 1kHz . . . . . 11nV/√Hz (Typ)
- Lower Power Replacement for HA-2540/883, AD840

### Applications

- Pulse and Video Amplifiers
- Wideband Amplifiers
- High Speed Sample-Hold Circuits
- Fast, Precise D/A Converters

### Description

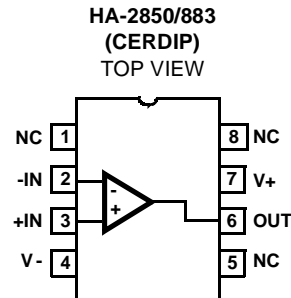
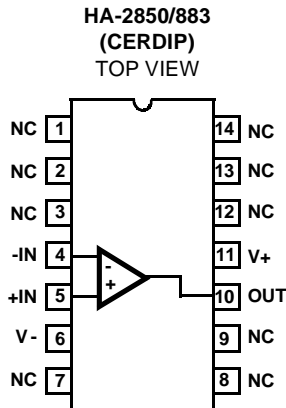
The HA-2850/883 is a wideband, high slew rate, operational amplifier featuring superior speed and bandwidth characteristics. It also features trimmed supply current, which minimizes supply current (and thus AC parameter) variation over process and temperature extremes. For example, the  $I_{CC}$  variation over the entire military temperature range is typically less than 0.5mA. Bipolar construction, coupled with dielectric isolation, delivers outstanding performance in circuits with closed loop gains  $\geq 10$ .

The 340V/μs slew rate, and 470MHz gain bandwidth product ensure high performance in video and wideband amplifier designs. Differential gain and phase are a low 0.04% and 0.04 degrees, respectively, making the HA-2850/883 ideal for video applications. A full  $\pm 10V$  output swing, high open loop gain, and outstanding AC parameters make the HA-2850/883 an excellent choice for data acquisition systems.

### Ordering Information

PART NUMBER	TEMPERATURE RANGE	PACKAGE
HA1-2850/883	-55°C to +125°C	14 Lead CerDIP
HA7-2850/883	-55°C to +125°C	8 Lead CerDIP

### Pinouts



## Specifications HA-2850/883

### Absolute Maximum Ratings

Voltage between V+ and V- Terminals . . . . .	35V
Differential Input Voltage . . . . .	6V
Voltage at Either Input Terminal . . . . .	V+ to V-
Peak Output Current ( $\leq 10\%$ Duty Cycle) . . . . .	50mA
Junction Temperature ( $T_J$ ) . . . . .	+175°C
Storage Temperature Range . . . . .	-65°C to +150°C
ESD Classification . . . . .	<2000V
Lead Temperature (Soldering 10s) . . . . .	+300°C

### Thermal Information

Thermal Resistance	$\theta_{JA}$	$\theta_{\psi}$
14 Lead CerDIP Package . . . . .	81°C/W	26°C/W
8 Lead CerDIP Package . . . . .	115°C/W	30°C/W
Package Power Dissipation Limit at +75°C for $T_J \leq +175^\circ\text{C}$		
14 Lead CerDIP Package . . . . .	1.23W	
8 Lead CerDIP Package . . . . .	0.87W	
Package Power Dissipation Derating Factor Above +75°C		
14 Lead CerDIP Package . . . . .	12.3mW/°C	
8 Lead CerDIP Package . . . . .	8.7mW/°C	

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

### Operating Conditions

Operating Temperature Range . . . . .	-55°C to +125°C	$V_{INCM} \leq 1/2 (V+ - V-)$
Operating Supply Voltage . . . . .	$\pm 12\text{V}$ to $\pm 15\text{V}$	$R_L \geq 1\text{k}\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

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

PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUP	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Input Offset Voltage	$V_{IO}$	$V_{CM} = 0\text{V}$	1	+25°C	-2	2	mV
			2, 3	+125°C, -55°C	-6	6	mV
Input Bias Current	+ $I_B$	$V_{CM} = 0\text{V}$ , $+R_S = 1.1\text{k}\Omega$ $-R_S = 100\Omega$	1	+25°C	-14.5	14.5	$\mu\text{A}$
			2, 3	+125°C, -55°C	-20	20	$\mu\text{A}$
	- $I_B$	$V_{CM} = 0\text{V}$ , $+R_S = 100\Omega$ $-R_S = 1.1\text{k}\Omega$	1	+25°C	-14.5	14.5	$\mu\text{A}$
			2, 3	+125°C, -55°C	-20	20	$\mu\text{A}$
Input Offset Current	$I_{IO}$	$V_{CM} = 0\text{V}$ , $+R_S = 1.1\text{k}\Omega$ $-R_S = 1.1\text{k}\Omega$	1	+25°C	-4	4	$\mu\text{A}$
			2, 3	+125°C, -55°C	-8	8	$\mu\text{A}$
Common Mode Range	+CMR	$V+ = 5\text{V}$ , $V- = -25\text{V}$	1	+25°C	10	-	V
			2, 3	+125°C, -55°C	10	-	V
	-CMR	$V+ = 25\text{V}$ , $V- = -5\text{V}$	1	+25°C	-	-10	V
			2, 3	+125°C, -55°C	-	-10	V
Large Signal Voltage Gain	+ $A_{VOL}$	$V_{OUT} = 0\text{V}$ and +10V $R_L = 1\text{k}\Omega$	4	+25°C	20	-	kV/V
			5, 6	+125°C, -55°C	10	-	kV/V
	- $A_{VOL}$	$V_{OUT} = 0\text{V}$ and -10V $R_L = 1\text{k}\Omega$	4	+25°C	20	-	kV/V
			5, 6	+125°C, -55°C	10	-	kV/V
Common Mode Rejection Ratio	+CMRR	$\Delta V_{CM} = 10\text{V}$ , $V_{OUT} = -10\text{V}$ $V+ = 5\text{V}$ , $V- = -25\text{V}$	1	+25°C	75	-	dB
			2,3	+125°C, -55°C	75	-	dB
	-CMRR	$\Delta V_{CM} = -10\text{V}$ , $V_{OUT} = 10\text{V}$ $V+ = 25\text{V}$ , $V- = -5\text{V}$	1	+25°C	75	-	dB
			2, 3	+125°C, -55°C	75	-	dB

## Specifications HA-2850/883

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

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

PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUP	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Output Voltage Swing	+V <sub>OUT</sub>	R <sub>L</sub> = 1kΩ	1	+25°C	10	-	V
			2, 3	+125°C, -55°C	10	-	V
	-V <sub>OUT</sub>	R <sub>L</sub> = 1kΩ	1	+25°C	-	-10	V
			2, 3	+125°C, -55°C	-	-10	V
Output Current	+I <sub>OUT</sub>	V <sub>OUT</sub> = 10V	1	+25°C	10	-	mA
			2, 3	+125°C, -55°C	10	-	mA
	-I <sub>OUT</sub>	V <sub>OUT</sub> = -10V	1	+25°C	-	-10	mA
			2, 3	+125°C, -55°C	-	-10	mA
Quiescent Power Supply Current	+I <sub>CC</sub>	V <sub>OUT</sub> = 0V, I <sub>OUT</sub> = 0mA	1	+25°C	-	8	mA
			2, 3	+125°C, -55°C	-	8	mA
	-I <sub>CC</sub>	V <sub>OUT</sub> = 0V, I <sub>OUT</sub> = 0mA	1	+25°C	-8	-	mA
			2, 3	+125°C, -55°C	-8	-	mA
Power Supply Rejection Ratio	+PSRR	ΔV <sub>SUP</sub> = 10V V <sub>+</sub> = 10V, V <sub>-</sub> = -15V V <sub>+</sub> = 20V, V <sub>-</sub> = -15V	1	+25°C	75	-	dB
			2, 3	+125°C, -55°C	75	-	dB
	-PSRR	ΔV <sub>SUP</sub> = 10V V <sub>+</sub> = 15V, V <sub>-</sub> = -10V V <sub>+</sub> = 15V, V <sub>-</sub> = -20V	1	+25°C	75	-	dB
			2, 3	+125°C, -55°C	75	-	dB

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank. See A.C. Specifications in Table 3

## Specifications HA-2850/883

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at:  $V_{SUPPLY} = \square \pm 15V$ ,  $R_{SOURCE} = 50\Omega$ ,  $R_{LOAD} = 1k\Omega$ ,  $C_L \leq 10pF$ ,  $A_V = +10V/V$ , Unless Otherwise Specified.

PARAMETERS	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Gain Bandwidth Product	GBWP	$V_O = 200mV$ , $f_O = 5MHz$	1	+25°C	400	-	MHz
		$V_O = 200mV$ , $f_O = 45MHz$	1	+25°C	350	-	MHz
Slew Rate	+SR	$V_O = -5V$ to +5V	1, 4	+25°C	300	-	V/ $\mu$ s
	-SR	$V_O = +5V$ to -5V	1, 4	+25°C	300	-	V/ $\mu$ s
Full Power Bandwidth	FPBW	$V_{PEAK} = 10V$	1, 2	+25°C	4.8	-	MHz
Rise and Fall Time	$T_R$	$V_O = 0V$ to +200mV	1, 4	+25°C	-	15	ns
	$T_F$	$V_O = 0V$ to -200mV	1, 4	+25°C	-	15	ns
Minimum Closed Loop Stable Gain	CLSG	$R_L = 1k\Omega$ , $C_L \leq 10pF$	1	-55°C to +125°C	10	-	V/V
Overshoot	+OS	$V_O = 0V$ to +200mV	1	+25°C	-	30	%
	-OS	$V_O = 0V$ to -200mV	1	+25°C	-	30	%
Open Loop Output Resistance	$R_{OUT}$	$V_{OUT} = 0V$	1	+25°C	-	60	$\Omega$
Quiescent Power Consumption	PC	$V_{OUT} = 0V$ , $I_{OUT} = 0mA$	1, 3	-55°C to +125°C	-	240	mW

**NOTES:**

- 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.
- Full Power Bandwidth guarantee based on Slew Rate measurement using  $FPBW = \text{Slew Rate} / (2\pi V_{PEAK})$ .
- Quiescent Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.)
- Measured between 10% and 90% points.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

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

**NOTE:**

- PDA applies to Subgroup 1 only.

**Die Characteristics**

**DIE DIMENSIONS:**

65 x 52 x 19 mils  $\pm$  1 mils  
 1650 x 1310 x 483 $\mu$ m  $\pm$  25.4 $\mu$ m

**METALLIZATION:**

Type: Al, 1% Cu  
 Thickness: 16k $\text{\AA}$   $\pm$  2k $\text{\AA}$

**GLASSIVATION:**

Type: Nitride over Silox  
 Silox Thickness: 12k $\text{\AA}$   $\pm$  2k $\text{\AA}$   
 Nitride Thickness: 3.5k $\text{\AA}$   $\pm$  1.5k $\text{\AA}$

**WORST CASE CURRENT DENSITY:**

0.7 x 10<sup>5</sup> A/cm<sup>2</sup> at 1.8mA

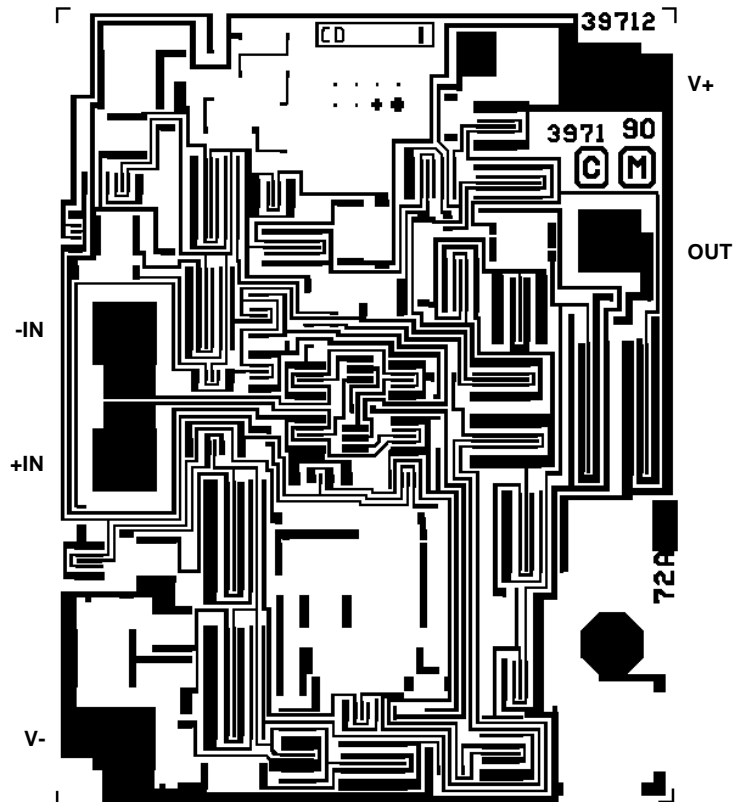
**SUBSTRATE POTENTIAL (Powered Up):** V-

**TRANSISTOR COUNT:** 34

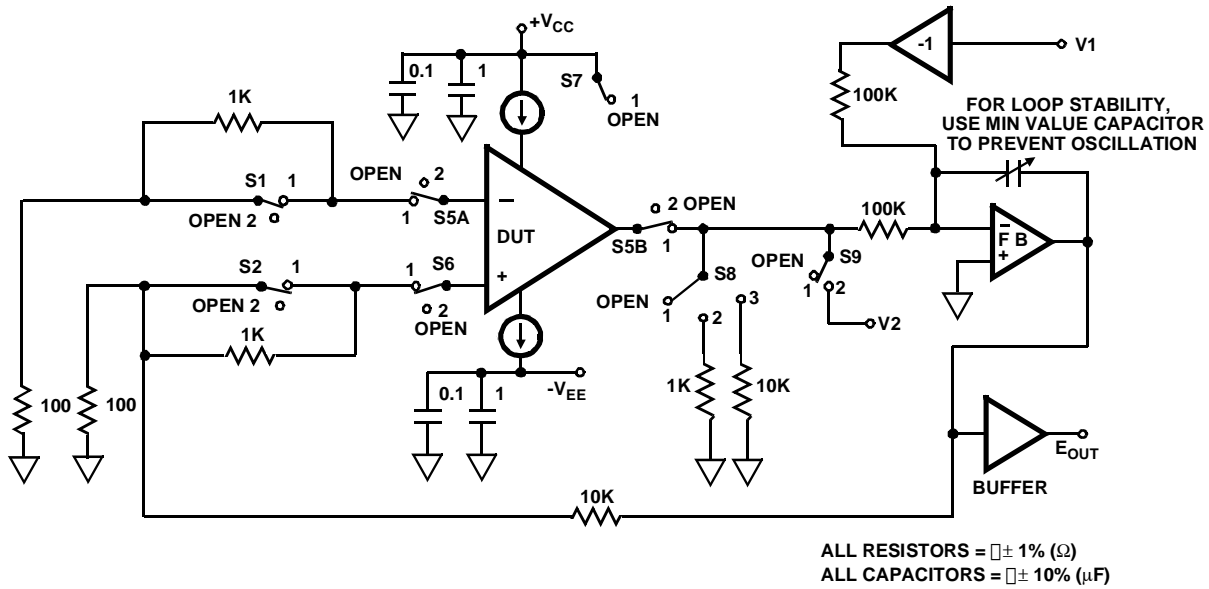
**PROCESS:** Bipolar Dielectric Isolation

**Metallization Mask Layout**

HA-2850/883

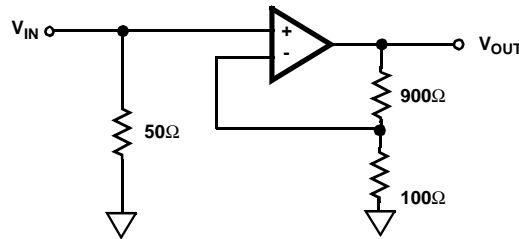


**Test Circuit** (Applies to Table 1)



**Test Waveforms**

SIMPLIFIED TEST CIRCUIT FOR LARGE AND SMALL SIGNAL RESPONSE (APPLIES TO TABLE 3)

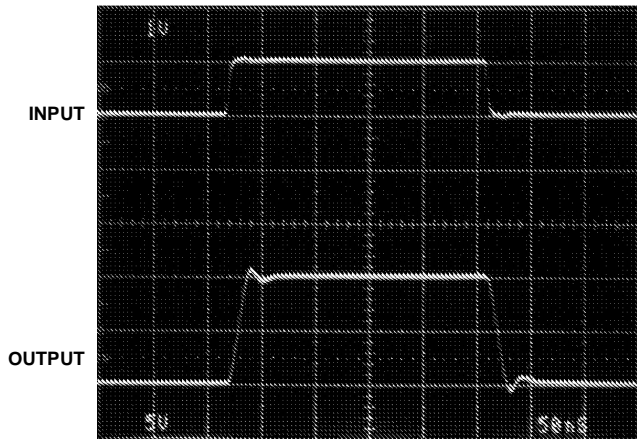


NOTES:

1.  $V_S = \pm 15\text{V}$
2.  $A_V = +10$
3.  $C_L \leq 10\text{pF}$

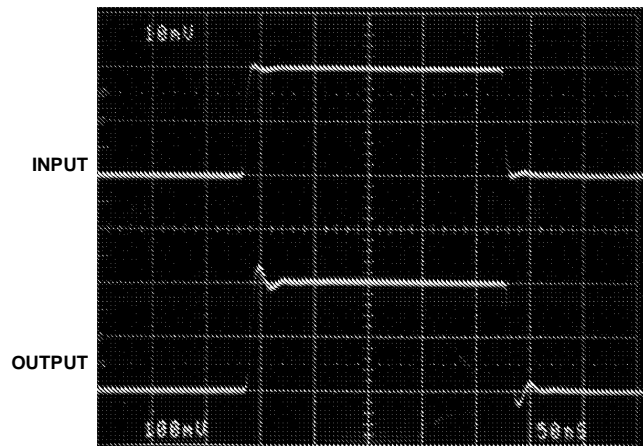
**MEASURED LARGE SIGNAL RESPONSE**

Vertical Scale: Input = 1V/Div., Output = 5V/Div.  
 Horizontal Scale: 50ns/Div.



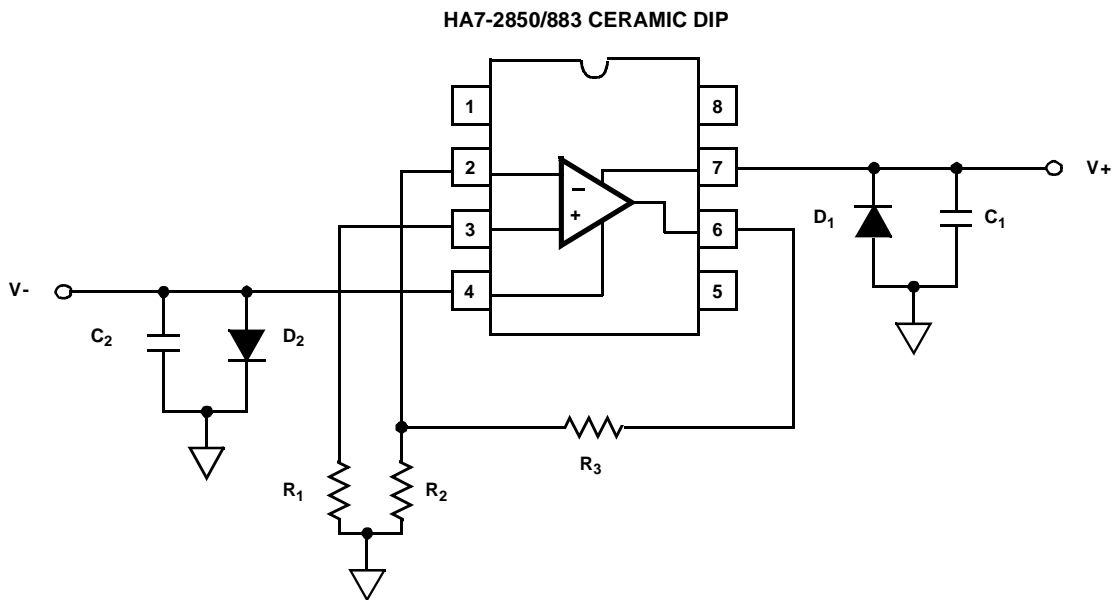
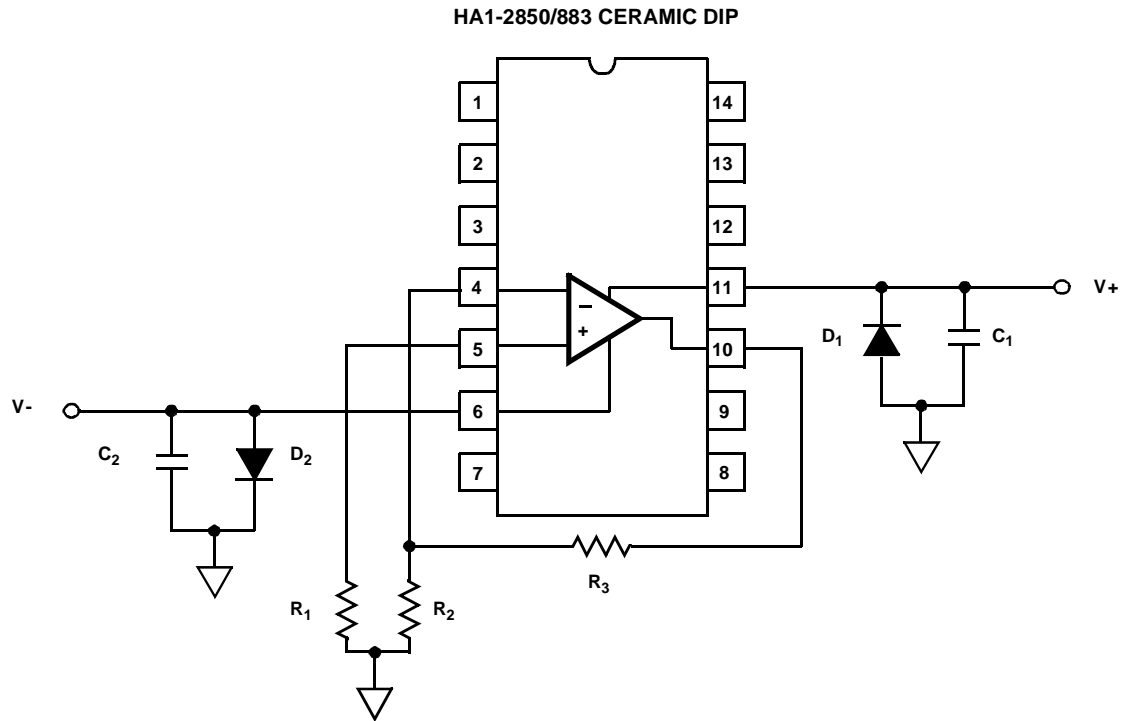
**MEASURED SMALL SIGNAL RESPONSE**

Vertical Scale: Input = 10mV/Div., Output=100mV/Div.  
 Horizontal Scale: 50ns/Div.



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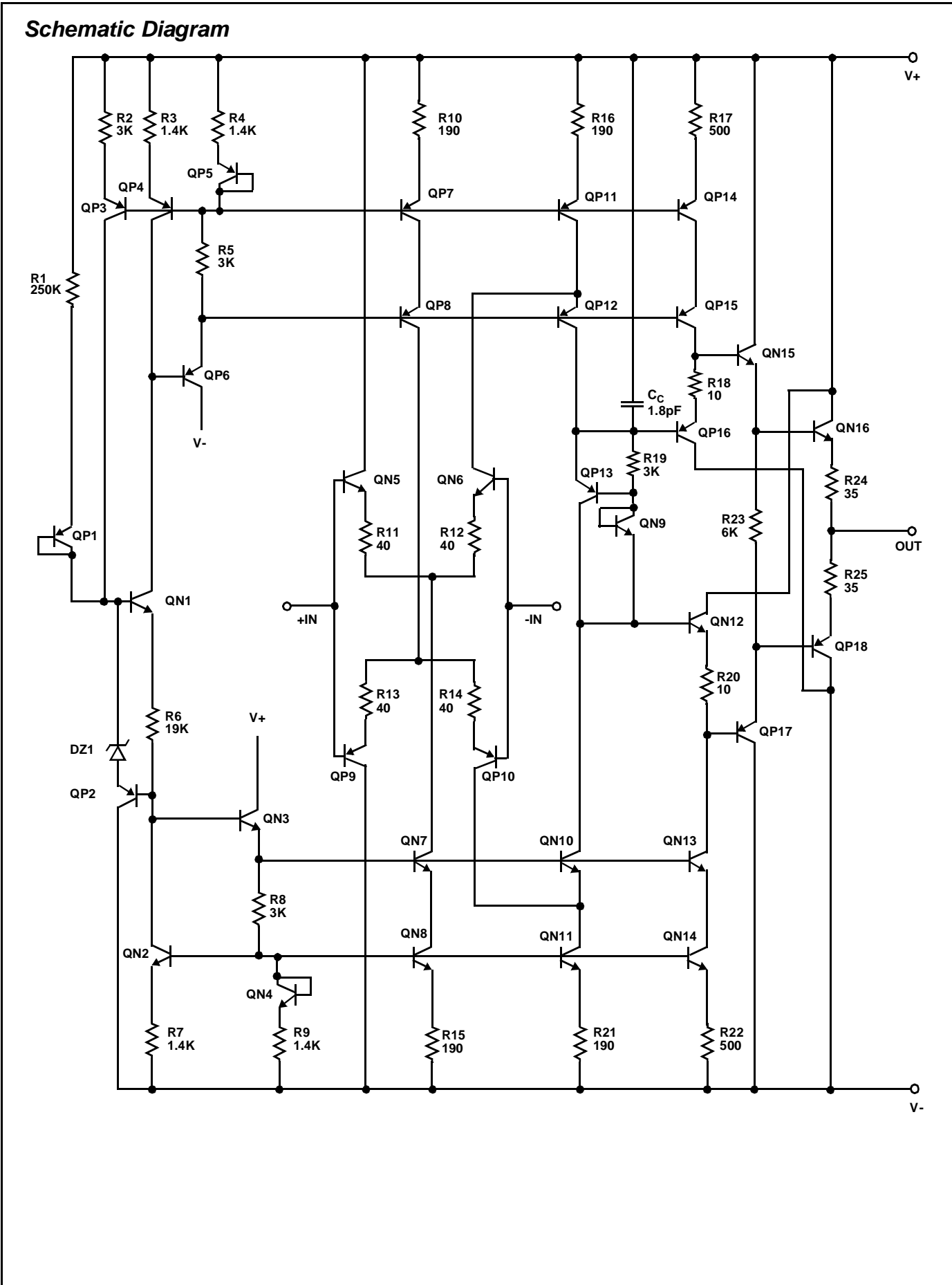
## Burn-In Circuits



### NOTES:

1.  $R_1 = 1k\Omega, \pm 5\%, 1/4W$  (Min)
2.  $R_2 = 1k\Omega, \pm 5\%, 1/4W$  (Min)
3.  $R_3 = 10k\Omega, \pm 5\%, 1/4W$  (Min)
4.  $C_1 = C_2 = 0.01\mu F/\text{Socket}$  (Min) or  $0.1\mu F/\text{Row}$ , (Min)
5.  $D_1 = D_2 = 1N4002$  or Equivalent/Board
6.  $|V_+ - V_-| = 31V \pm 1V$

Schematic Diagram



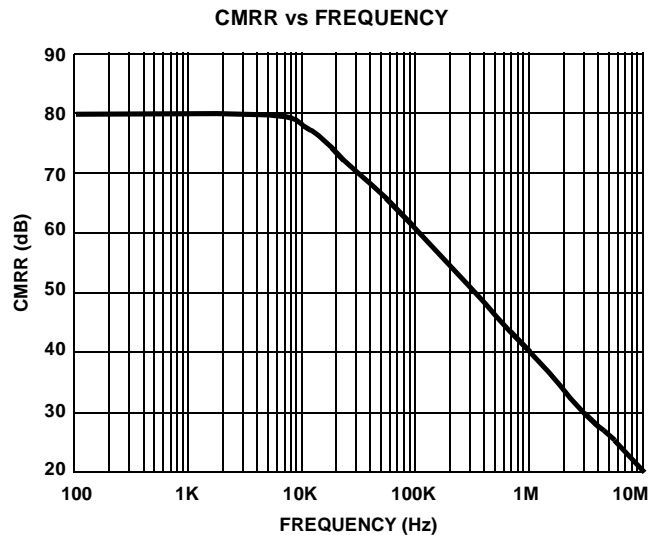
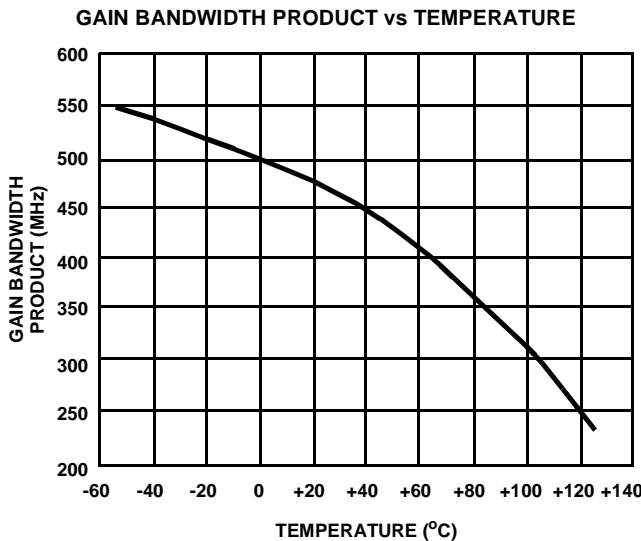
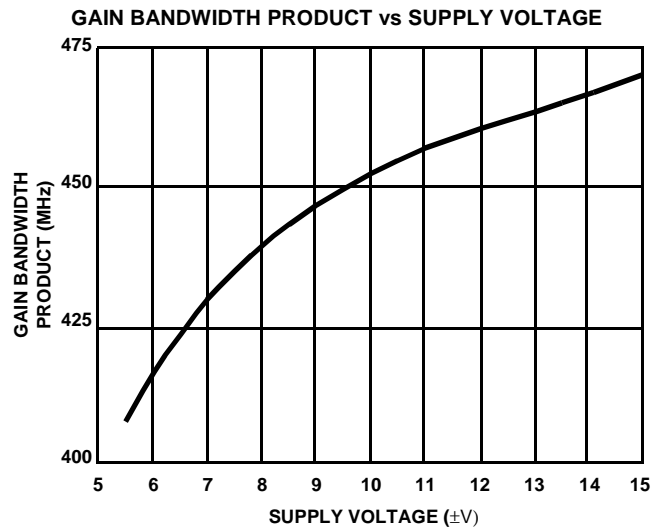
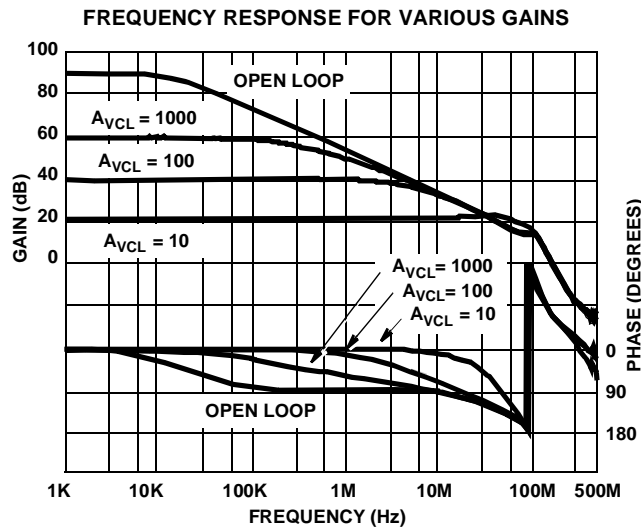


## DESIGN INFORMATION

## Low Power, High Slew Rate, Wideband Operational Amplifier

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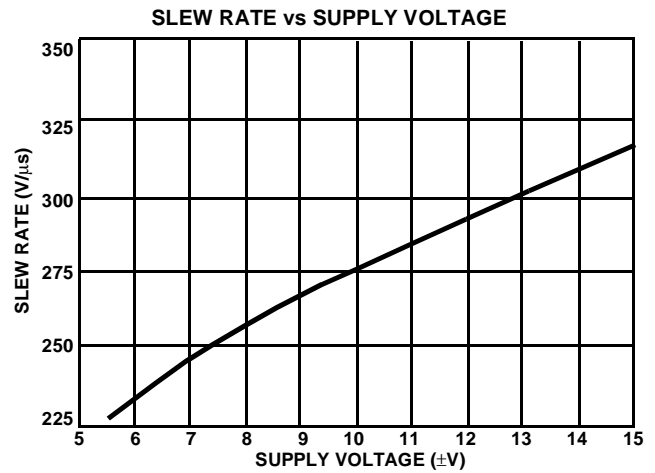
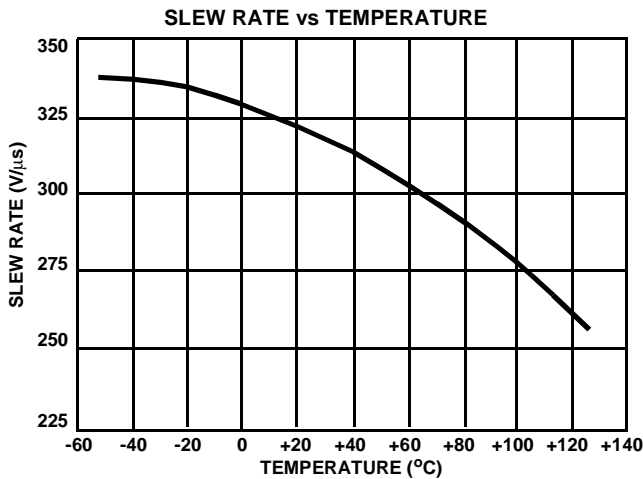
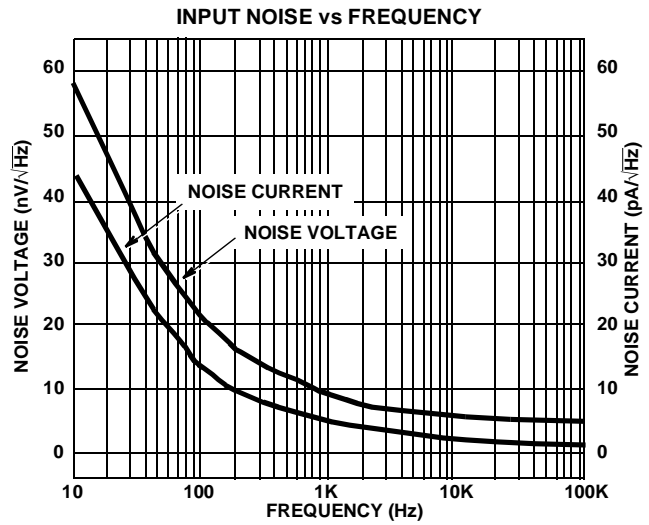
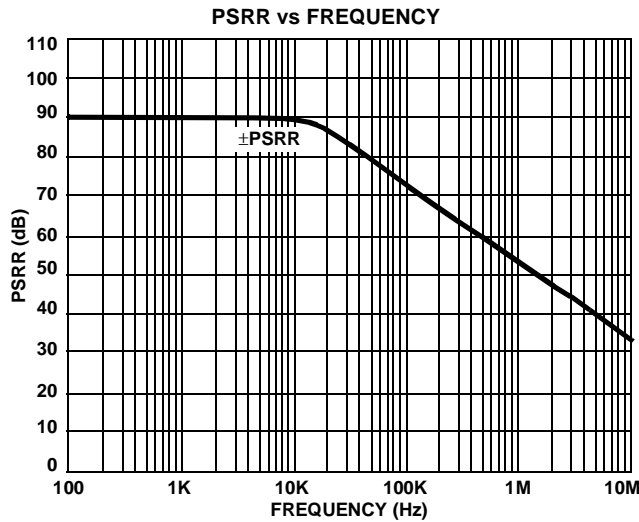
**Typical Performance Curves**  $V_{SUPPLY} = \pm 15V$ ,  $A_V = +10$ ,  $R_L = 1k\Omega$ ,  $C_L \leq 10pF$ ,  $T_A = +25^\circ C$ , Unless Otherwise Specified



## DESIGN INFORMATION (Continued)

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**Typical Performance Curves**  $V_{SUPPLY} = \pm 15V$ ,  $A_V = +10$ ,  $R_L = 1k\Omega$ ,  $C_L \leq 10pF$ ,  $T_A = +25^\circ C$ , Unless Otherwise Specified  
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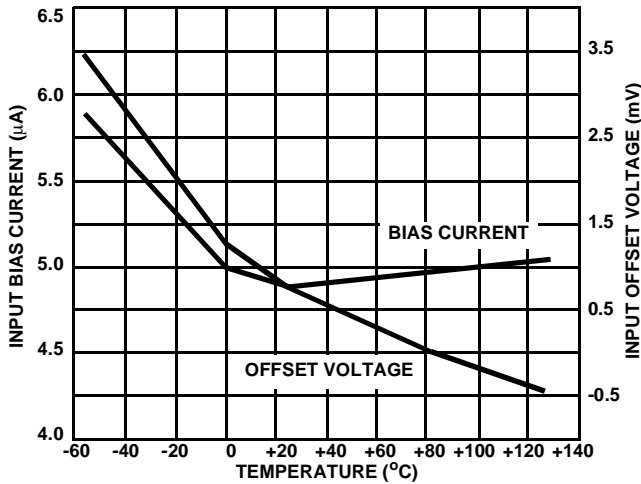


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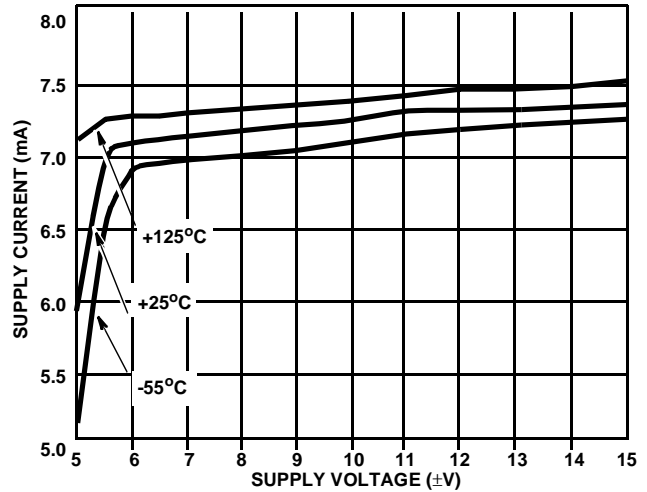
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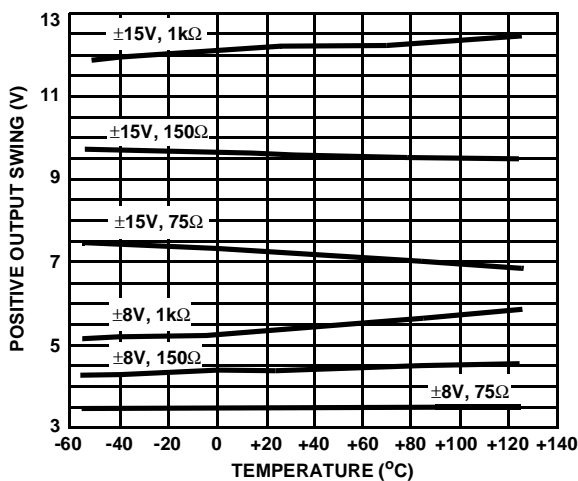
**INPUT OFFSET VOLTAGE AND INPUT BIAS CURRENT vs TEMPERATURE**



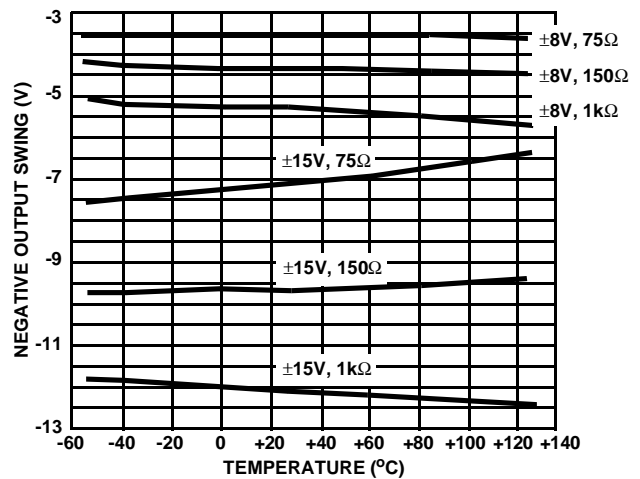
**SUPPLY CURRENT vs SUPPLY VOLTAGE**



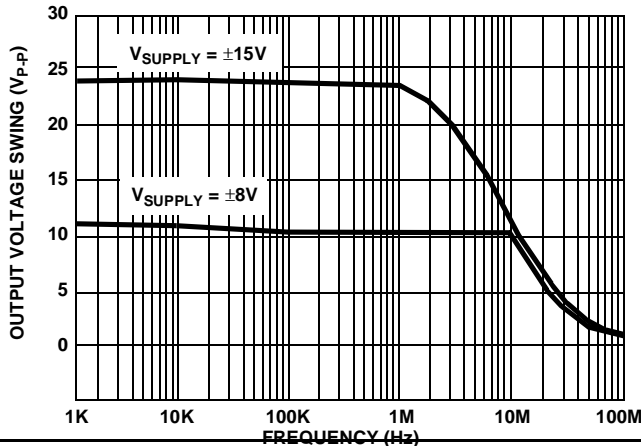
**POSITIVE OUTPUT SWING vs TEMPERATURE**



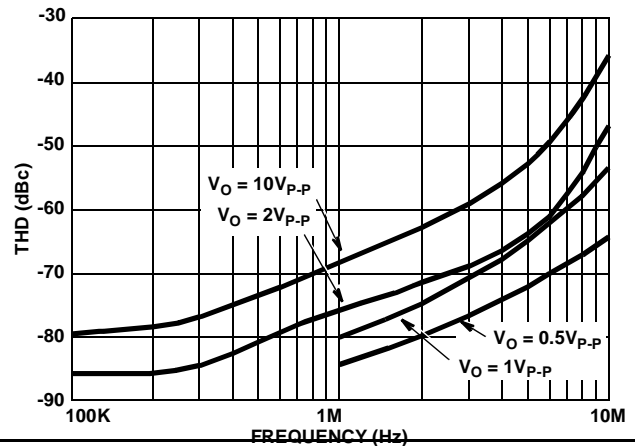
**NEGATIVE OUTPUT SWING vs TEMPERATURE**



**MAXIMUM UNDISTORTED OUTPUT SWING vs FREQUENCY**



**TOTAL HARMONIC DISTORTION vs FREQUENCY**



# HA-2850

## TYPICAL PERFORMANCE CHARACTERISTICS

Device Characterized at:  $V_{SUPPLY} = \pm 15V$ ,  $R_L = 1k\Omega$ ,  $C_L \leq 10pF$ , Unless Otherwise Specified

PARAMETERS	CONDITIONS	TEMPERATURE	TYPICAL	UNITS
Input Offset Voltage	$V_{CM} = 0V$	+25°C	0.6	mV
		Full	2.0	mV
Average Offset Voltage Drift	Versus Temperature	Full	20	$\mu V/^\circ C$
Input Bias Current	$V_{CM} = 0V$	+25°C	5.0	$\mu A$
		Full	8.0	$\mu A$
Input Offset Current	$V_{CM} = 0V$	+25°C	1.0	$\mu A$
Differential Input Resistance		+25°C	10	k $\Omega$
Input Noise Voltage Density	$f_O = 1000Hz$	+25°C	11	$nV/\sqrt{Hz}$
Input Noise Current Density	$f_O = 1000Hz$	+25°C	6.0	$pA/\sqrt{Hz}$
Large Signal Voltage Gain	$V_{OUT} = \pm 10V$	+25°C	25	kV/V
		Full	20	kV/V
CMRR	$V_{CM} = \pm 10V$	Full	80	dB
Gain Bandwidth Product		+25°C	470	MHz
Output Voltage Swing	$R_L = 1k\Omega$	Full	$\pm 11$	V
Output Current	$V_{OUT} \geq 10V$	Full	$\pm 20$	mA
Output Resistance	Open Loop	+25°C	30	$\Omega$
Full Power Bandwidth	$FPBW = SR/2\pi V_P$ , $V_P = 10V$	+25°C	5.4	MHz
Slew Rate	$V_{OUT} = \pm 10V$ , $A_V = +10$	+25°C	340	V/ $\mu s$
Rise and Fall Time	$V_{OUT} = \pm 100mV$ , $A_V = +10$	+25°C	5	ns
Overshoot	$V_{OUT} = \pm 100mV$ , $A_V = +10$	+25°C	25	%
PSRR	Delta $V_S = \pm 10V$ to $\pm 20V$	Full	90	dB
Supply Current	No Load	Full	7.5	mA
Differential Gain	$A_V = +10$ , NTSC	+25°C	0.04	%
Differential Phase	$A_V = +10$ , NTSC	+25°C	0.04	Degrees
Harmonic Distortion	$A_V = +10$ , $f = 1MHz$ , $V_{OUT} = 2V_{P-P}$	+25°C	-74	dBc

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