

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.
- Supply Current..... 15.0mA (Max)
- Low Offset Voltage..... 2.0mV (Max)
- Very High Slew Rate ..... 600V/μs (Typ)
- Open Loop Gain..... 20kV/V (Min)
- Wide Gain-Bandwidth ( $A_V \geq 10$ ) ..... 600MHz (Typ)
- Input Noise Voltage at 1kHz ..... 6nV/√Hz (Typ)
- Enhanced Replacement for HA-2540/883 and AD840

**Applications**

- Pulse and Video Amplifiers
- Wideband Amplifiers
- RF/IF Signal Processing
- High Speed Sample-Hold Circuits
- Fast, Precise D/A Converters
- RF Oscillators

**Description**

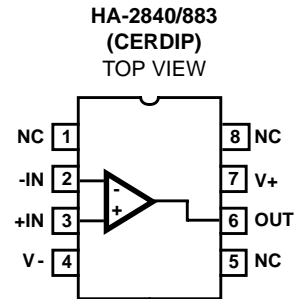
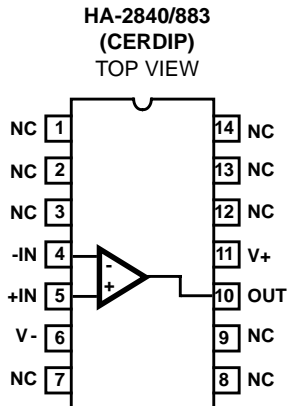
The HA-2840/883 is a wideband, very high slew rate, operational amplifier featuring superior speed and bandwidth characteristics. It also features trimmed supply current, which minimizes supply current (and thus A.C. parameter) variation over process and temperature extremes. For example, the  $I_{CC}$  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 600V/μs slew rate, and 600MHz gain bandwidth product ensure high performance in video and wideband amplifier designs. Differential gain and phase are a low 0.03% and 0.03 degrees, respectively, making the HA-2840/883 ideal for video applications. A full  $\pm 10V$  output swing, high open loop gain, and outstanding A.C. parameters make the HA2840/883 an excellent choice for data acquisition systems.

**Ordering Information**

| PART NUMBER  | TEMPERATURE RANGE | PACKAGE        |
|--------------|-------------------|----------------|
| HA1-2840/883 | -55°C to +125°C   | 14 Lead CerDIP |
| HA7-2840/883 | -55°C to +125°C   | 8 Lead CerDIP  |

**Pinouts**



# Specifications HA-2840/883

## 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 Rating                                    | <2000V          |
| Lead Temperature (Soldering 10s)              | +300°C          |

## Thermal Information

|  |               |               |
|--|---------------|---------------|
| Thermal Resistance   | $\theta_{JA}$ | $\theta_{JC}$ |
| 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          | + $I_B$     | $V_{CM} = 0\text{V}$ , + $R_S = 1.1\text{k}\Omega$<br>- $R_S = 100\Omega$                          | 1                | +25°C         | -14.5  | 14.5 | $\mu\text{A}$ |
|                             |             |  | 2, 3             | +125°C, -55°C | -20    | 20   | $\mu\text{A}$ |
|                             | - $I_B$     | $V_{CM} = 0\text{V}$ , + $R_S = 100\Omega$<br>- $R_S = 1.1\text{k}\Omega$                          | 1                | +25°C         | -14.5  | 14.5 | $\mu\text{A}$ |
|                             |             |  | 2, 3             | +125°C, -55°C | -20    | 20   | $\mu\text{A}$ |
| Input Offset Current        | $I_{IO}$    | $V_{CM} = 0\text{V}$ , + $R_S = 1.1\text{k}\Omega$<br>- $R_S = 1.1\text{k}\Omega$                  | 1                | +25°C         | -4     | 4    | $\mu\text{A}$ |
|                             |             |  | 2, 3             | +125°C, -55°C | -8     | 8    | $\mu\text{A}$ |
| Common Mode Range           | +CMR        | $V+ = 5\text{V}$<br>$V- = -25\text{V}$   | 1                | +25°C         | 10     | -    | V             |
|                             |             |  | 2, 3             | +125°C, -55°C | 10     | -    | V             |
|                             | -CMR        | $V+ = 25\text{V}$<br>$V- = -5\text{V}$   | 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<br>$R_L = 1\text{k}\Omega$  | 4                | +25°C         | 20     | -    | kV/V          |
|                             |             |  | 5, 6             | +125°C, -55°C | 10     | -    | kV/V          |
|                             | - $A_{VOL}$ | $V_{OUT} = 0\text{V}$ and -10V<br>$R_L = 1\text{k}\Omega$  | 4                | +25°C         | 20     | -    | kV/V          |
|                             |             |  | 5, 6             | +125°C, -55°C | 10     | -    | kV/V          |
| Common Mode Rejection Ratio | +CMRR       | $\Delta V_{CM} = 10\text{V}$ ,<br>$V_{OUT} = -10\text{V}$<br>$V+ = 5\text{V}$ , $V- = -25\text{V}$ | 1                | +25°C         | 75     | -    | dB            |
|                             |             |  | 2, 3             | +125°C, -55°C | 75     | -    | dB            |
|                             | -CMRR       | $\Delta V_{CM} = -10\text{V}$ ,<br>$V_{OUT} = 10\text{V}$<br>$V+ = 25\text{V}$ , $V- = -5\text{V}$ | 1                | +25°C         | 75     | -    | dB            |
|                             |             |  | 2, 3             | +125°C, -55°C | 75     | -    | dB            |

## Specifications HA-2840/883

**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<br>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<br>Supply Current | +I <sub>CC</sub>  | V <sub>OUT</sub> = 0V<br>I <sub>OUT</sub> = 0mA   | 1                   | +25°C         | -      | 14.6 | mA    |
|                                   |                   |   | 2, 3                | +125°C, -55°C | -      | 15   | mA    |
|                                   | -I <sub>CC</sub>  | V <sub>OUT</sub> = 0V<br>I <sub>OUT</sub> = 0mA   | 1                   | +25°C         | -14.6  | -    | mA    |
|                                   |                   |   | 2, 3                | +125°C, -55°C | -15    | -    | mA    |
| Power Supply<br>Rejection Ratio   | +PSRR             | ΔV <sub>SUP</sub> = 10V<br>V <sub>+</sub> = 10V, V <sub>-</sub> = -15V<br>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<br>V <sub>+</sub> = 15V, V <sub>-</sub> = -10V<br>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-2840/883

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at:  $V_{SUPPLY} = \pm 15V$ ,  $R_{SOURCE} = 50\Omega$ ,  $R_{LOAD} = 1k\Omega$ ,  $C_L \leq 10pF$ ,  $A_V = +10V/V$ , 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           | 500    | -   | MHz        |
|                                 |           | $V_O = 200mV$ , $f_O = 45MHz$      | 1     | +25°C           | 450    | -   | MHz        |
| Slew Rate                       | +SR       | $V_O = -5V$ to +5V                 | 1, 4  | +25°C           | 550    | -   | V/ $\mu s$ |
|                                 | -SR       | $V_O = +5V$ to -5V                 | 1, 4  | +25°C           | 500    | -   | V/ $\mu s$ |
| Full Power Bandwidth            | FPBW      | $V_{PEAK} = 10V$                   | 1, 2  | +25°C           | 8.0    | -   | MHz        |
| Rise and Fall Time              | $T_R$     | $V_O = 0V$ to +200mV               | 1, 4  | +25°C           | -      | 10  | ns         |
|                                 | $T_F$     | $V_O = 0V$ to -200mV               | 1, 4  | +25°C           | -      | 10  | 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 | -      | 450 | 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 & D Endpoints                      | 1                         |

**NOTE:**

- PDA applies to Subgroup 1 only.

**Die Characteristics**

**DIE DIMENSIONS:**

65 x 52 x 19 mils ± 1 mils  
 1650 x 1310 x 483µm ± 25.4µm

**METALLIZATION:**

Type: Al, 1% Cu  
 Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**

Type: Nitride over Silox  
 Silox Thickness: 12kÅ ± 2kÅ  
 Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**

1.3 x 10<sup>5</sup> A/cm<sup>2</sup> at 3.4mA

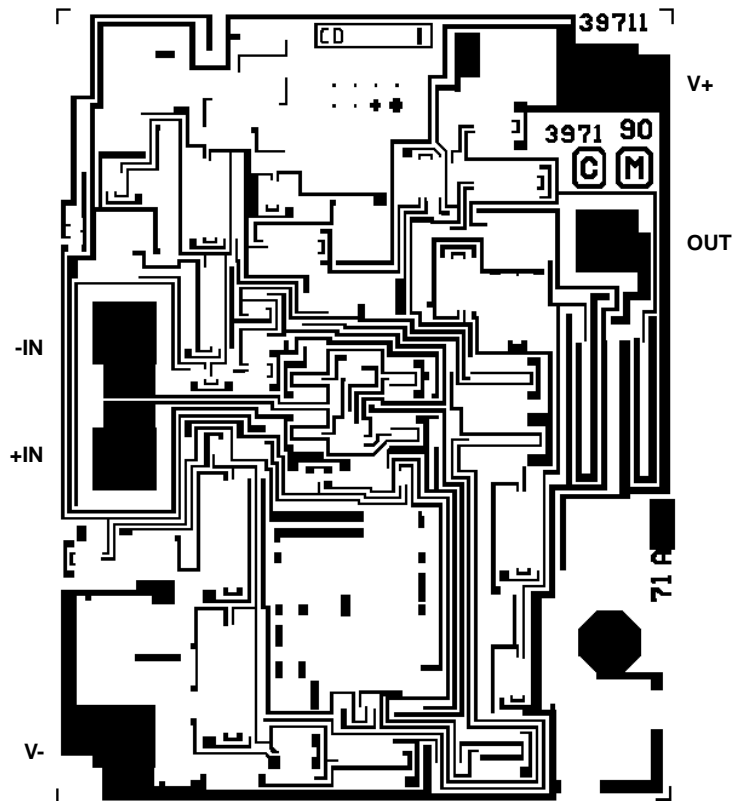
**SUBSTRATE POTENTIAL (Powered UP):** V-

**TRANSISTOR COUNT:** 34

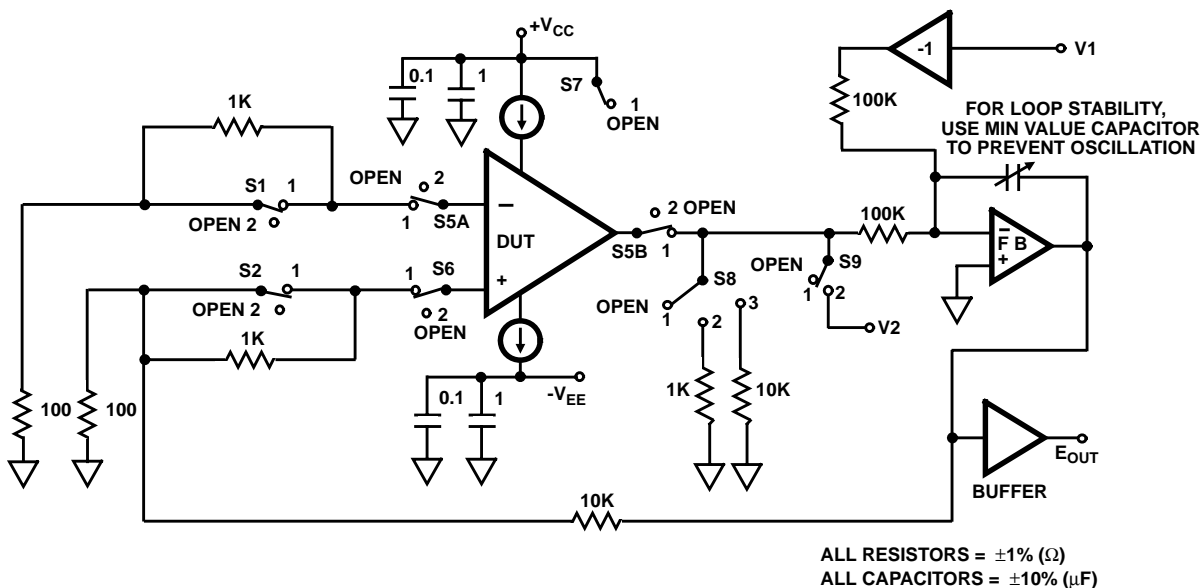
**PROCESS:** Bipolar Dielectric Isolation

**Metallization Mask Layout**

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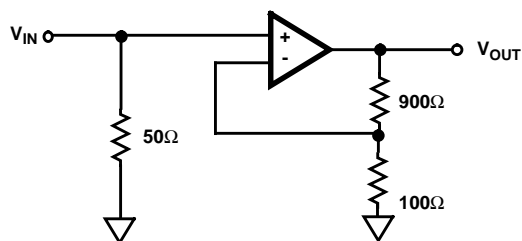


**Test Circuit** (Applies to Table 1)



**Test Waveforms**

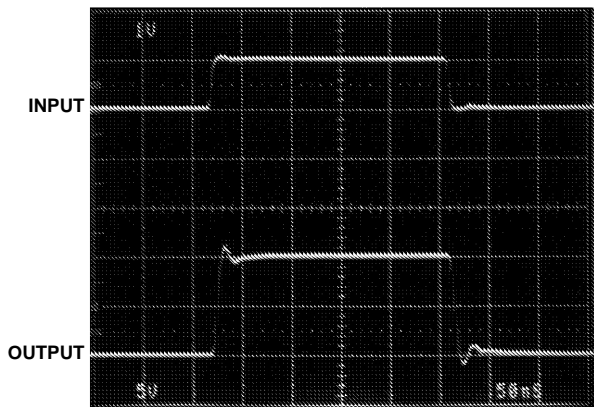
**SIMPLIFIED TEST CIRCUIT FOR LARGE AND SMALL SIGNAL RESPONSE** (APPLIES TO TABLE 3)



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

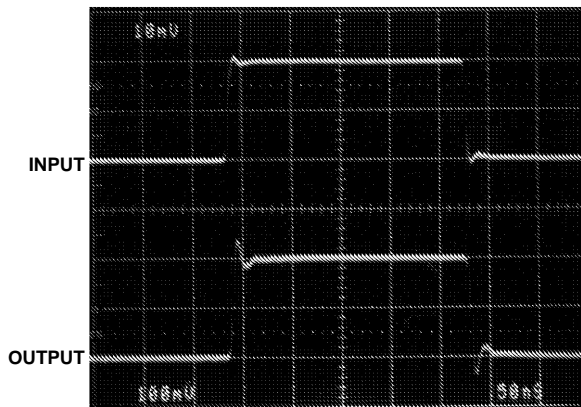
**MEASURED LARGE SIGNAL RESPONSE**

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



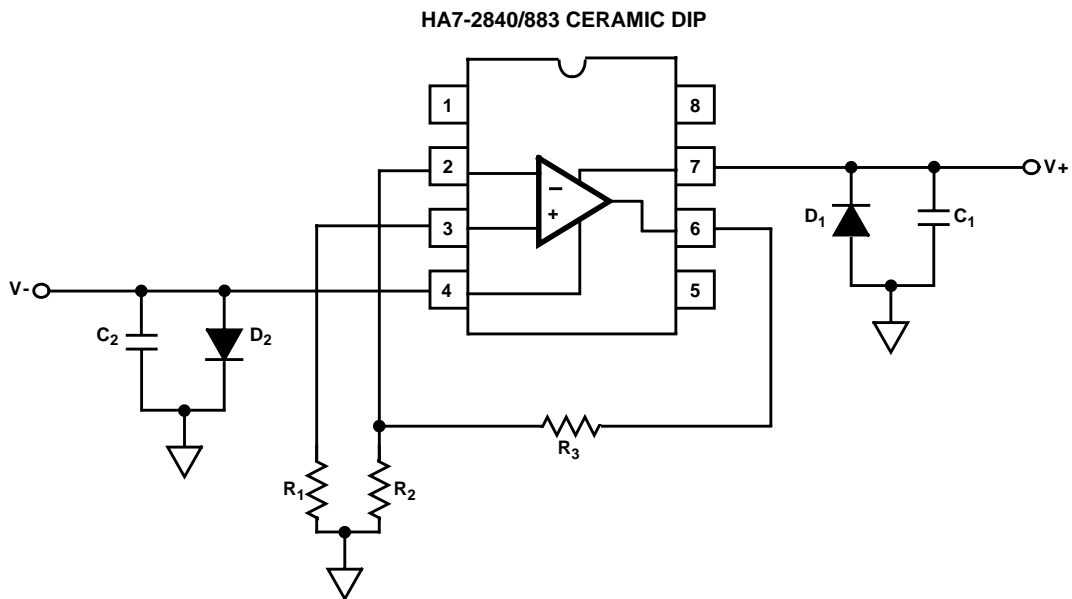
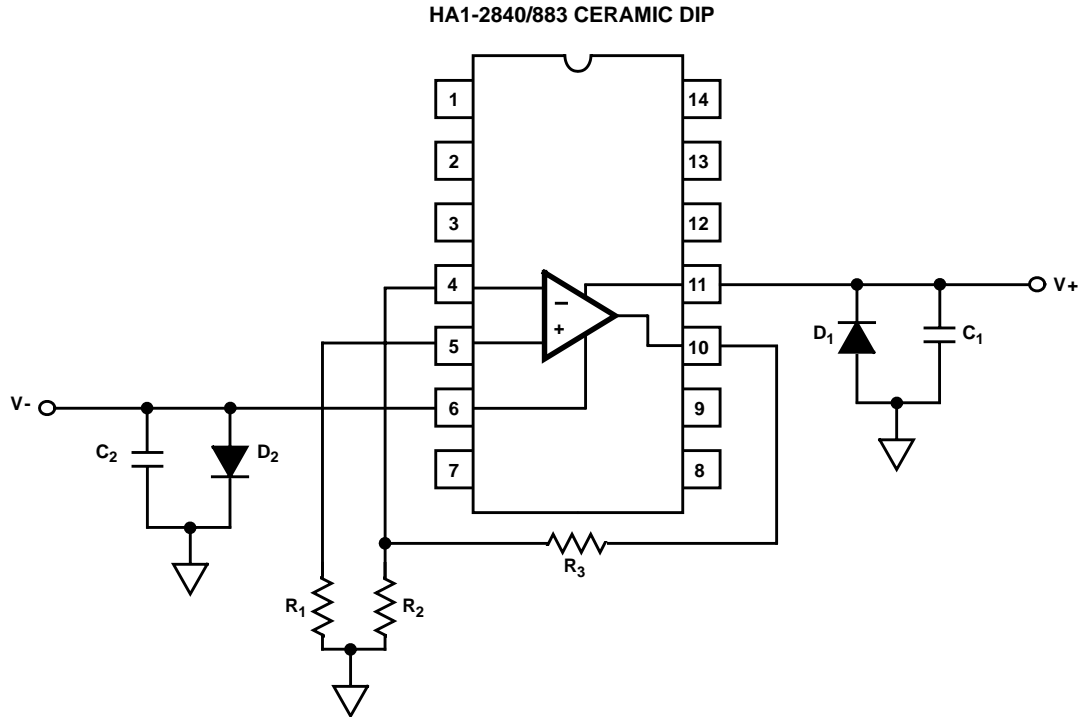
**MEASURED SMALL SIGNAL RESPONSE**

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



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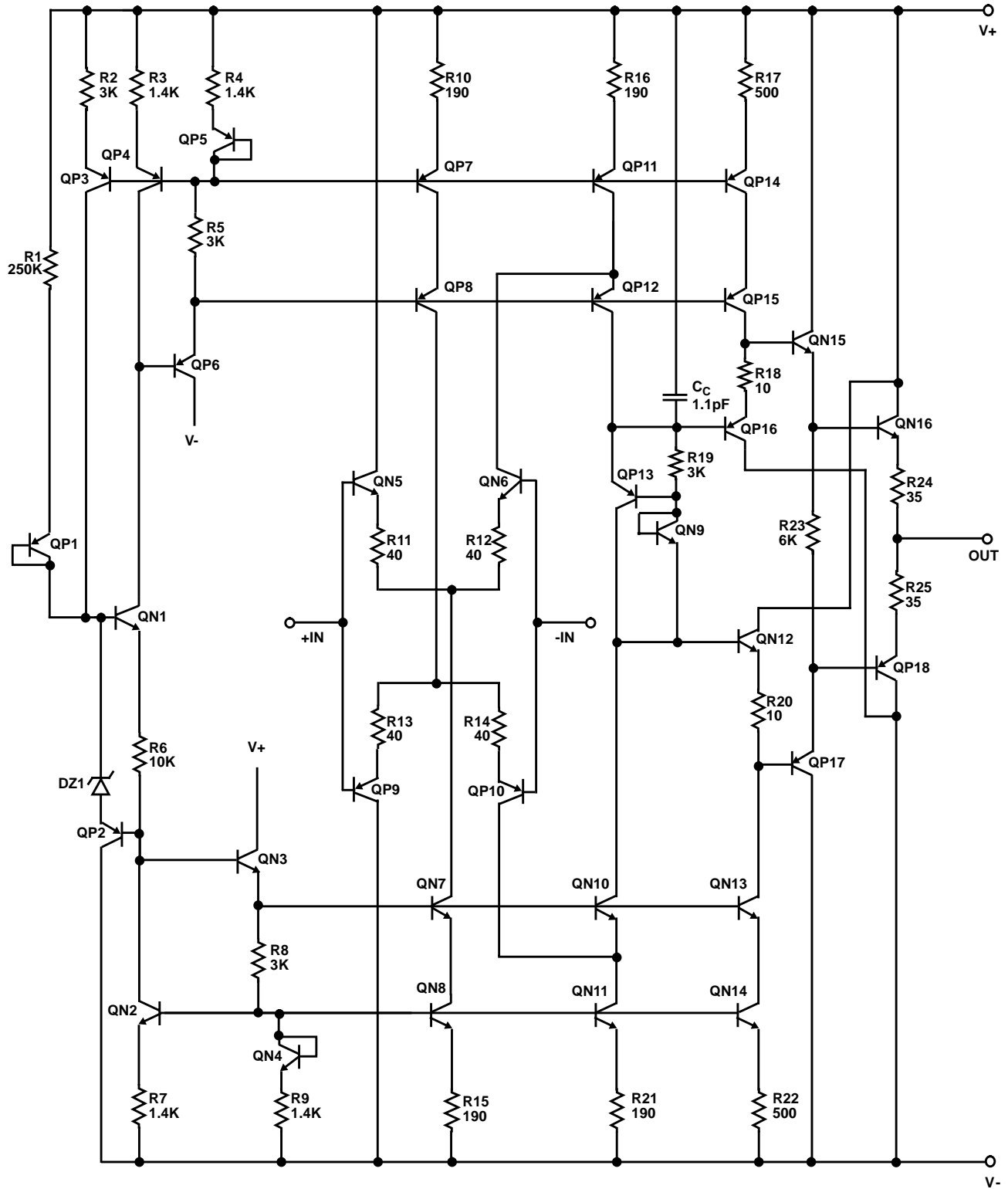
## Burn-In Circuits



### NOTES:

1.  $R_1 = 1\text{k}\Omega, \pm 5\%, 1/4\text{W (Min)}$
2.  $R_2 = 1\text{k}\Omega, \pm 5\%, 1/4\text{W (Min)}$
3.  $R_3 = 10\text{k}\Omega, \pm 5\%, 1/4\text{W (Min)}$
4.  $C_1 = C_2 = 0.01\mu\text{F/Socket (Min)}$  or  $0.1\mu\text{F/Row, (Min)}$
5.  $D_1 = D_2 = 1\text{N}4002$  or Equivalent/Board
6.  $|V_+ - V_-| = 31\text{V} \pm 1\text{V}$

Schematic Diagram



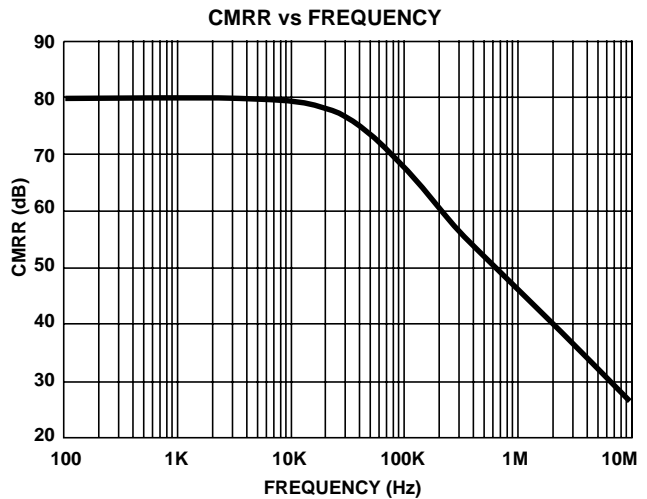
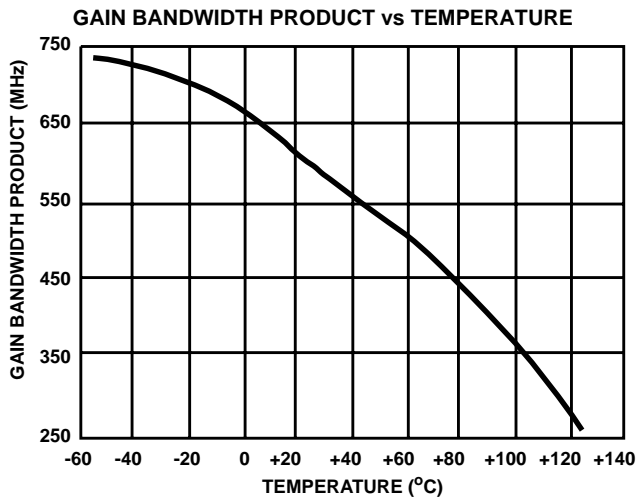
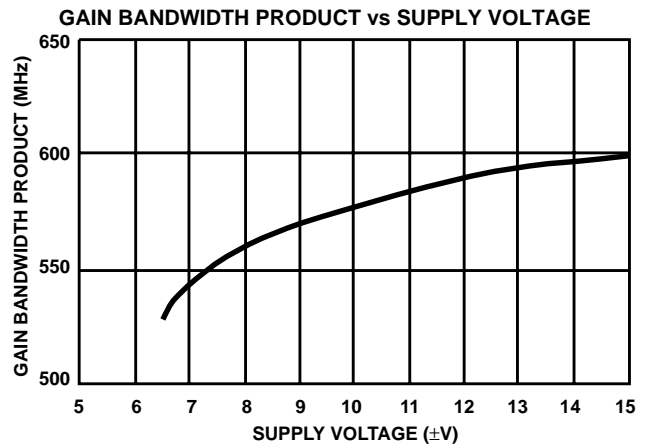
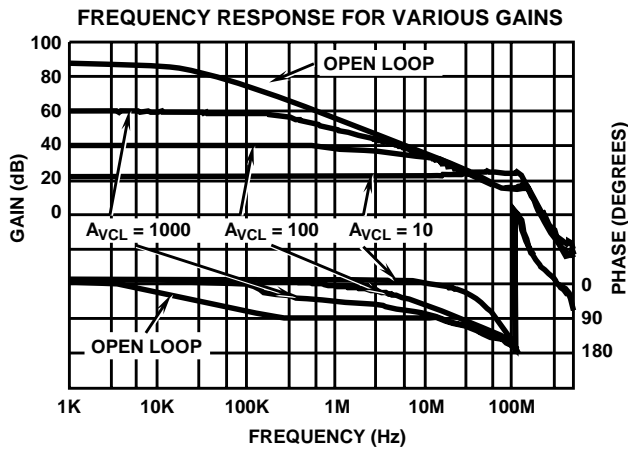


## DESIGN INFORMATION

## Very High Slew Rate, Wideband Operational Amplifier

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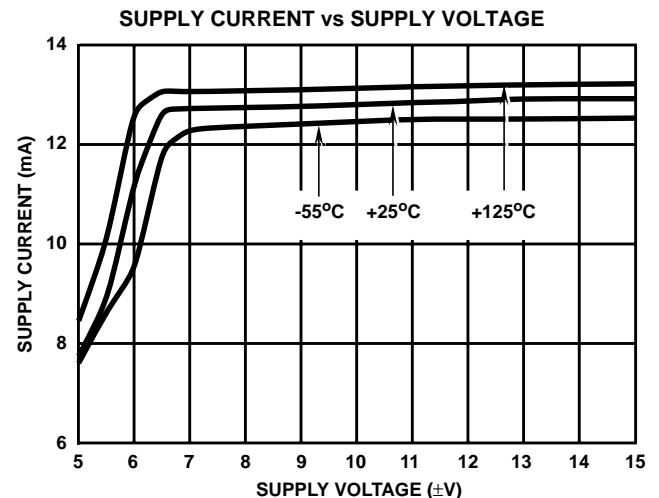
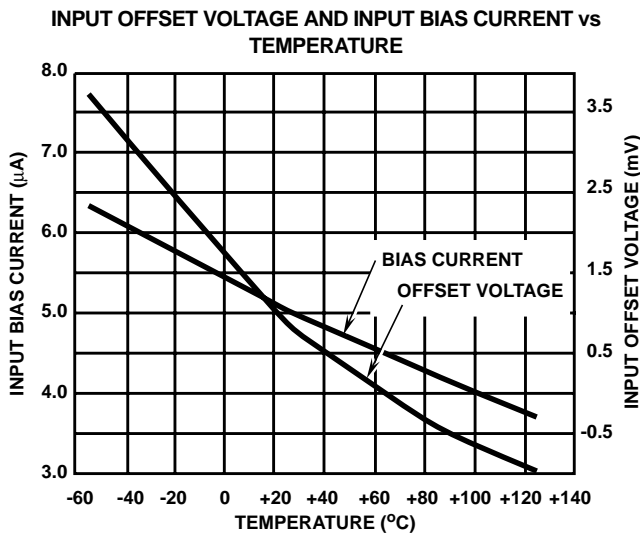
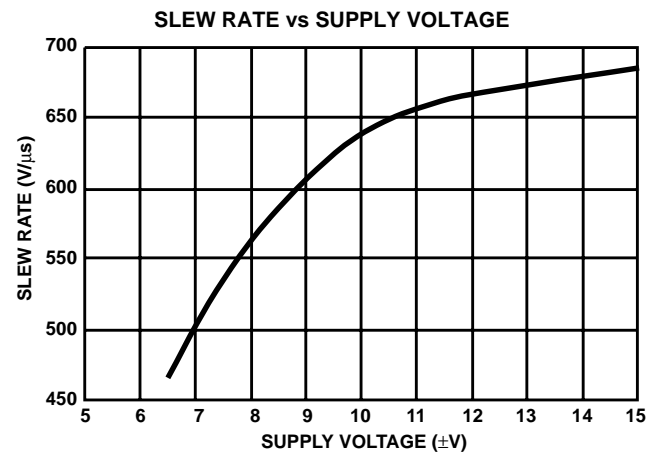
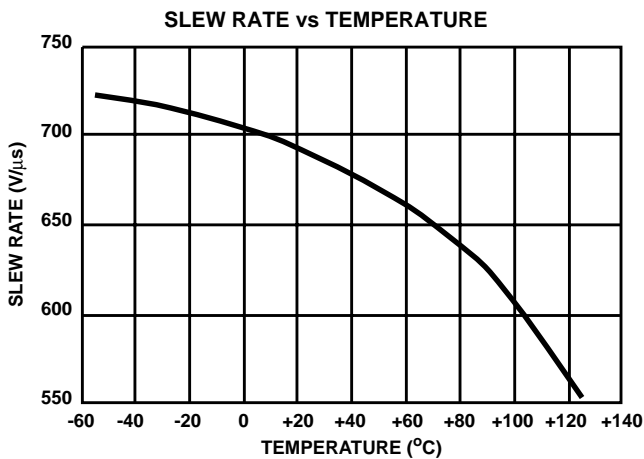
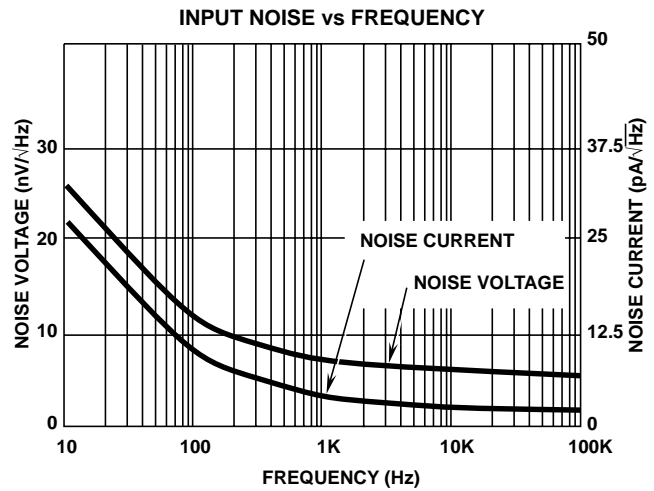
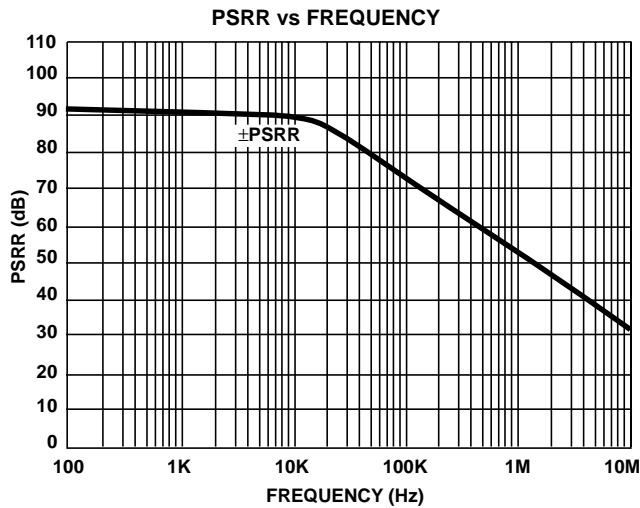
**Typical Performance Curves**  $V_{SUPPLY} = \pm 15V$ ,  $A_V = +10$ ,  $R_L = 1k\Omega$ ,  $C_L < 10pF$ ,  $T_A = +25^\circ C$ , Unless Otherwise Specified



## DESIGN INFORMATION (Continued)

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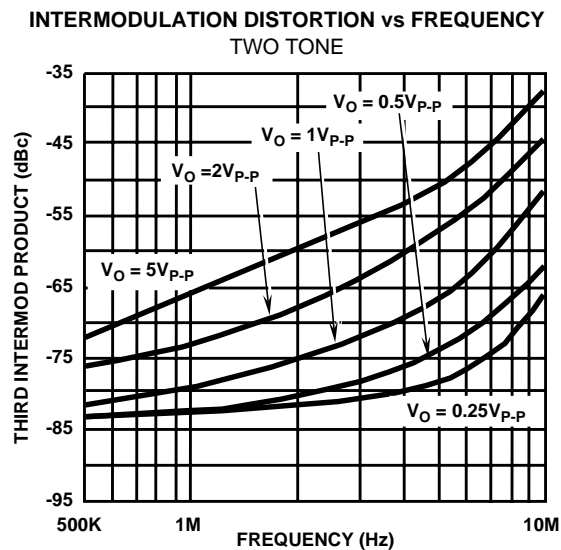
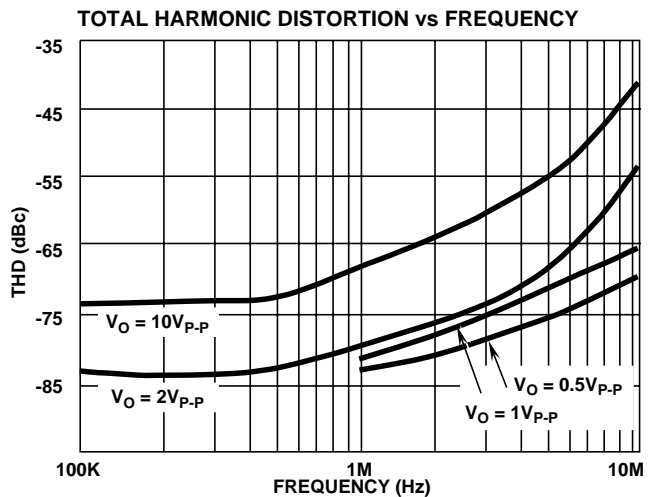
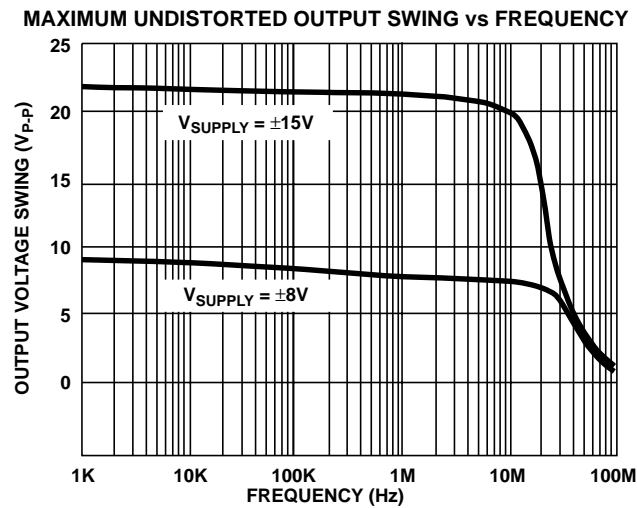
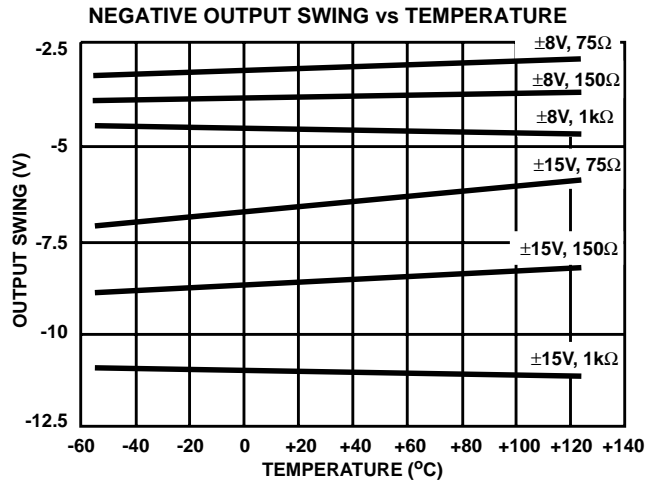
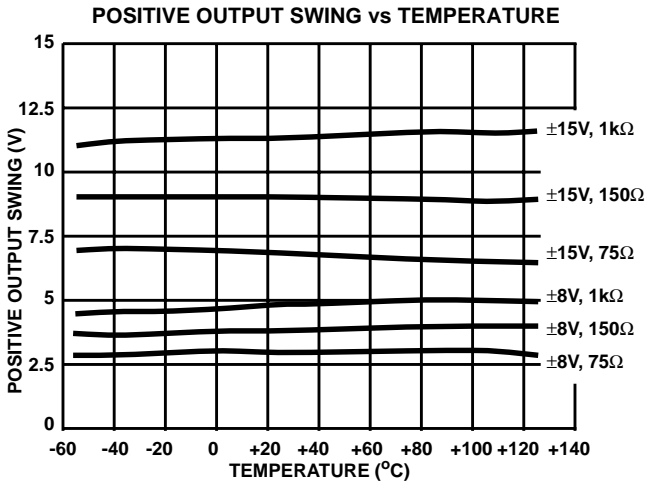
**Typical Performance Curves**  $V_{SUPPLY} = \pm 15V$ ,  $A_V = +10$ ,  $R_L = 1k\Omega$ ,  $C_L < 10pF$ ,  $T_A = +25^\circ C$ , Unless Otherwise Specified



# DESIGN INFORMATION (Continued)

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



# HA-2840

## 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       | 6.0      | 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       | 600      | MHz              |
| 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       | 9.6      | MHz              |
| Slew Rate                     | $V_{OUT} = \pm 10V$ , $A_V = +10$               | +25°C       | 600      | V/ $\mu s$       |
| Rise Time                     | $V_{OUT} = \pm 100mV$ , $A_V = +10$             | +25°C       | 4        | ns               |
| Overshoot                     | $V_{OUT} = \pm 100mV$ , $A_V = +10$             | +25°C       | 20       | %                |
| PSRR                          | Delta $V_S = \pm 10V$ to $\pm 20V$              | Full        | 90       | dB               |
| Supply Current                | No Load   | Full        | 13       | mA               |
| Differential Gain             | $A_V = +10$ , NTSC                              | +25°C       | 0.03     | %                |
| Differential Phase            | $A_V = +10$ , NTSC                              | +25°C       | 0.03     | Degrees          |
| Harmonic Distortion           | $A_V = +10$ , $f = 1MHz$ , $V_{OUT} = 2V_{P-P}$ | +25°C       | -79      | dBc              |

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