

## Uncompensated, High Slew Rate High Output Current, Operational Amplifier

July 1997

### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- High Slew Rate ..... 135V/ $\mu$ s (Min)  
150V/ $\mu$ s (Typ)
- High Output Current .....  $\pm$ 30mA (Min)
- High Gain-Bandwidth Product ..... 15MHz (Min)  
20MHz(Typ)
- Wide Power Bandwidth ..... 2.1MHz (Min)
- High Input Impedance ..... 50M $\Omega$  (Min)  
130M $\Omega$  (Typ)
- Low Offset Current ..... 25nA (Max)  
5nA (Typ)
- Fast Settling (10V Step to 0.1%) ..... 200ns (Typ)
- Low Quiescent Supply Current ..... 6mA (Max)

### Applications

- Data Acquisition Systems
- RF Amplifiers
- Video Amplifiers
- Signal Generators
- Pulse Amplification

### Description

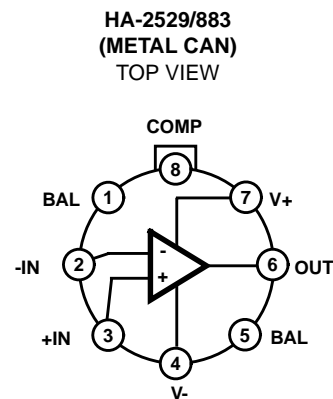
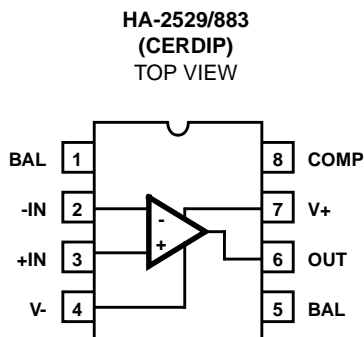
The HA-2529/883 is a monolithic operational amplifier which typifies excellence of design. With a design based on years of experience coupled with the reliable dielectric isolation process, these amplifiers provide an outstanding combination of DC and AC parameters at closed loop gains of 3 or greater without external compensation.

The HA-2529/883 offers 135V/ $\mu$ s (min) slew rate and fast settling time (200ns typ), while consuming a mere 6mA (max) quiescent supply current, making these amplifiers ideal components for video circuitry and data acquisition designs. With 15MHz minimum gain-bandwidth product combined with 7.5kV/V minimum open loop gain, the HA-2529/883 is an ideal component for demanding signal conditioning designs. These devices provide  $\pm$ 30mA (min) output current drive with an output voltage swing of  $\pm$ 10V (min), making them suited for pulse amplifier and RF amplifier components. HA-2529/883 will upgrade a system presently using the HA-2520/22/883 or EHA-2520/22/883 in regards to output current, slew rate, offset voltage drift, and offset current drift. To insure compliance with slew rate and transient response specifications, all devices are 100% tested for AC performance characteristics over full temperature.

### Ordering Information

| PART NUMBER  | TEMP. RANGE (°C) | PACKAGE         | PKG. NO. |
|--------------|------------------|-----------------|----------|
| HA2-2529/883 | -55 to 125       | 8 Pin Metal Can | T8.C     |
| HA7-2529/883 | -55 to 125       | 8 Ld CERDIP     | F8.3A    |

### Pinouts



# HA-2529/883

## Absolute Maximum Ratings $T_A = 25^\circ\text{C}$

|                                     |          |
|-------------------------------------|----------|
| Voltage Between V+ and V- Terminals | 40V      |
| Differential Input Voltage          | 15V      |
| Voltage at Either Input Terminal    | V+ to V- |
| Peak Output Current                 | .50mA    |
| ESD Rating                          | <2000V   |

## Operating Conditions

|                               |                  |
|-------------------------------|------------------|
| Temperature Range             | -55°C to 125°C   |
| Supply Voltage                | $\pm 15\text{V}$ |
| $V_{INCM} \leq 1/2 (V+ - V-)$ |                  |
| $R_L \geq 500\Omega$          |                  |

## Thermal Information

|  |                |               |
|--|----------------|---------------|
| Thermal Resistance (Typical, Note 1)                                     | $\theta_{JA}$  | $\theta_{JC}$ |
| CERDIP Package   | 115°C/W        | 28°C/W        |
| Metal Can Package  | 160°C/W        | 75°C/W        |
| Package Power Dissipation Limit at 75°C for $T_J \leq 175^\circ\text{C}$ |                |               |
| CERDIP Package   | 870mW          |               |
| Metal Can Package  | 625mW          |               |
| Package Power Dissipation Derating Factor Above 75°C                     |                |               |
| CERDIP Package   | 8.7mW/°C       |               |
| Metal Can Package  | 6.3mW/°C       |               |
| Maximum Junction Temperature   | 175°C          |               |
| Maximum Storage Temperature Range  | -65°C to 150°C |               |
| Maximum Lead Temperature (Soldering 10s)                                 | 300°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.

### NOTE:

- $\theta_{JA}$  is measured with the component mounted on an evaluation PC board in free air.

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at:  $V_{SUPPLY} = \pm 15\text{V}$ ,  $R_{SOURCE} = 100\Omega$ ,  $R_{LOAD} = 500\text{k}\Omega$ ,  $V_{OUT} = 0\text{V}$ , Unless Otherwise Specified.

| PARAMETER                   | SYMBOL      | CONDITIONS   | GROUP A SUBGROUPS | TEMP. (°C) | MIN  | MAX | UNITS |
|-----------------------------|-------------|--|-------------------|------------|------|-----|-------|
| Input Offset Voltage        | $V_{IO}$    | $V_{CM} = 0\text{V}$   | 1                 | 25         | -5   | 5   | mV    |
|                             |             |  | 2, 3              | 125, -55   | -8   | 8   | mV    |
| Input Bias Current          | + $I_B$     | $V_{CM} = 0\text{V}$ , $+R_S = 100\text{k}\Omega$ ,<br>$-R_S = 100\text{k}\Omega$                      | 1                 | 25         | -200 | 200 | nA    |
|                             |             |  | 2, 3              | 125, -55   | -400 | 400 | nA    |
|                             | - $I_B$     | $V_{CM} = 0\text{V}$ , $+R_S = 100\text{k}\Omega$ ,<br>$-R_S = 100\text{k}\Omega$                      | 1                 | 25         | -200 | 200 | nA    |
|                             |             |  | 2, 3              | 125, -55   | -400 | 400 | nA    |
| Input Offset Current        | $I_{IO}$    | $V_{CM} = 0\text{V}$ , $+R_S = 100\text{k}\Omega$ ,<br>$-R_S = 100\text{k}\Omega$                      | 1                 | 25         | -25  | 25  | nA    |
|                             |             |  | 2, 3              | 125, -55   | -50  | 50  | nA    |
| Common Mode Range           | +CMR        | $V+ = 5\text{V}$ , $V- = -25\text{V}$  | 1                 | 25         | +10  | -   | V     |
|                             |             |  | 2, 3              | 125, -55   | +10  | -   | V     |
|                             | -CMR        | $V+ = 25\text{V}$ , $V- = -5\text{V}$  | 1                 | 25         | -    | -10 | V     |
|                             |             |  | 2, 3              | 125, -55   | -    | -10 | V     |
| Large Signal Voltage Gain   | + $A_{VOL}$ | $V_{OUT} = 0\text{V}$ and +10V, $R_L = 2\text{k}\Omega$  | 4                 | 25         | 10   | -   | kV/V  |
|                             |             |  | 5, 6              | 125, -55   | 7.5  | -   | kV/V  |
|                             | - $A_{VOL}$ | $V_{OUT} = 0\text{V}$ and -10V, $R_L = 2\text{k}\Omega$  | 4                 | 25         | 10   | -   | kV/V  |
|                             |             |  | 5, 6              | 125, -55   | 7.5  | -   | kV/V  |
| Common Mode Rejection Ratio | +CMRR       | $\Delta V_{CM} = +10\text{V}$ , $V+ = +5\text{V}$ ,<br>$V- = -25\text{V}$ ,<br>$V_{OUT} = -10\text{V}$ | 1                 | 25         | 83   | -   | dB    |
|                             |             |  | 2, 3              | 125, -55   | 80   | -   | dB    |
|                             | -CMRR       | $\Delta V_{CM} = -10\text{V}$ , $V+ = +25\text{V}$ ,<br>$V- = -5\text{V}$ , $V_{OUT} = +10\text{V}$    | 1                 | 25         | 83   | -   | dB    |
|                             |             |  | 2, 3              | 125, -55   | 80   | -   | dB    |
| Output Voltage Swing        | + $V_{OUT}$ | $R_L = 2\text{k}\Omega$  | 4                 | 25         | 10   | -   | V     |
|                             |             |  | 5, 6              | 125, -55   | 10   | -   | V     |
|                             | - $V_{OUT}$ | $R_L = 2\text{k}\Omega$  | 4                 | 25         | -    | -10 | V     |
|                             |             |  | 5, 6              | 125, -55   | -    | -10 | V     |

## HA-2529/883

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

Device Tested at:  $V_{SUPPLY} = \pm 15V$ ,  $R_{SOURCE} = 100\Omega$ ,  $R_{LOAD} = 500k\Omega$ ,  $V_{OUT} = 0V$ , Unless Otherwise Specified.

| PARAMETER                      | SYMBOL              | CONDITIONS  | GROUP A SUBGROUPS | TEMP. (°C) | MIN               | MAX | UNITS |
|--------------------------------|---------------------|---|-------------------|------------|-------------------|-----|-------|
| Output Current                 | +I <sub>OUT</sub>   | V <sub>OUT</sub> = -10V   | 4                 | 25         | 30                | -   | mA    |
|                                |                     |   | 5, 6              | 125, -55   | 20                | -   | mA    |
|                                | -I <sub>OUT</sub>   | V <sub>OUT</sub> = +10V   | 4                 | 25         | -                 | -30 | mA    |
|                                |                     |   | 5, 6              | 125, -55   | -                 | -20 | mA    |
| Quiescent Power Supply Current | +I <sub>CC</sub>    | V <sub>OUT</sub> = 0V, I <sub>OUT</sub> = 0mA   | 1                 | 25         | -                 | 6   | mA    |
|                                |                     |   | 2, 3              | 125, -55   | -                 | 7   | mA    |
|                                | -I <sub>CC</sub>    | V <sub>OUT</sub> = 0V, I <sub>OUT</sub> = 0mA   | 1                 | 25         | -6                | -   | mA    |
|                                |                     |   | 2, 3              | 125, -55   | -7                | -   | mA    |
| Power Supply Rejection Ratio   | +PSRR               | $\Delta V_{SUP} = 10V$ , V <sub>+</sub> = +20V, V <sub>-</sub> = -15V, V <sub>+</sub> = +10V, V <sub>-</sub> = -15V | 1                 | 25         | 80                | -   | dB    |
|                                |                     |   | 2, 3              | 125, -55   | 80                | -   | dB    |
|                                | -PSRR               | $\Delta V_{SUP} = 10V$ , V <sub>+</sub> = +15V, V <sub>-</sub> = -20V, V <sub>+</sub> = +15V, V <sub>-</sub> = -10V | 1                 | 25         | 80                | -   | dB    |
|                                |                     |   | 2, 3              | 125, -55   | 80                | -   | dB    |
| Offset Voltage Adjustment      | +V <sub>IOAdj</sub> | Note 2  | 1                 | 25         | V <sub>IO-1</sub> | -   | mV    |
|                                |                     |   | 2, 3              | 125, -55   | V <sub>IO-1</sub> | -   | mV    |
|                                | -V <sub>IOAdj</sub> | Note 2  | 1                 | 25         | V <sub>IO+1</sub> | -   | mV    |
|                                |                     |   | 2, 3              | 125, -55   | V <sub>IO+1</sub> | -   | mV    |

NOTE:

- Offset adjustment range is [V<sub>IO</sub> (Measured) ±1mV] minimum referred to output. This test is for functionality only to assure adjustment through 0V.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at:  $V_{SUPPLY} = \pm 15V$ ,  $R_{SOURCE} = 50\Omega$ ,  $R_{LOAD} = 2k\Omega$ ,  $C_{LOAD} = 50pF$ ,  $A_{VCL} = +3V/V$ , Unless Otherwise Specified.

| PARAMETERS         | SYMBOL         | CONDITIONS   | GROUP A SUBGROUPS | TEMP. (°C) | MIN | MAX | UNITS |
|--------------------|----------------|--|-------------------|------------|-----|-----|-------|
| Slew Rate          | +SR            | V <sub>OUT</sub> = -5V to +5V<br>25% ≤ +SR ≤ 75%             | 7                 | 25         | 135 | -   | V/μs  |
|                    |                |  | 8A, 8B            | 125, -55   | 125 | -   | V/μs  |
|                    | -SR            | V <sub>OUT</sub> = +5V to -5V<br>75% ≥ -SR ≥ 25%             | 7                 | 25         | 135 | -   | V/μs  |
|                    |                |  | 8A, 8B            | 125, -55   | 125 | -   | V/μs  |
| Rise and Fall Time | t <sub>r</sub> | V <sub>OUT</sub> = 0 to +200mV<br>10% ≤ t <sub>r</sub> ≤ 90% | 7                 | 25         | -   | 45  | ns    |
|                    |                |  | 8A, 8B            | 125, -55   | -   | 50  | ns    |
|                    | t <sub>f</sub> | V <sub>OUT</sub> = 0 to -200mV<br>10% ≤ t <sub>f</sub> ≤ 90% | 7                 | 25         | -   | 45  | ns    |
|                    |                |  | 8A, 8B            | 125, -55   | -   | 50  | ns    |
| Overshoot          | +OS            | V <sub>OUT</sub> = 0 to +200mV                               | 7                 | 25         | -   | 40  | %     |
|                    |                |  | 8A, 8B            | 125, -55   | -   | 40  | %     |
|                    | -OS            | V <sub>OUT</sub> = 0 to -200mV                               | 7                 | 25         | -   | 40  | %     |
|                    |                |  | 8A, 8B            | 125, -55   | -   | 40  | %     |

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at:  $V_{SUPPLY} = \pm 15V$ ,  $R_{LOAD} = 2k\Omega$ ,  $C_{LOAD} = 50pF$ ,  $C_{COMP} = 0pF$ , Unless Otherwise Specified.

| PARAMETERS                      | SYMBOL    | CONDITIONS                       | NOTES | TEMP. (°C) | MIN     | MAX | UNITS     |
|---------------------------------|-----------|----------------------------------|-------|------------|---------|-----|-----------|
| Differential Input Resistance   | $R_{IN}$  | $V_{CM} = 0V$                    | 3     | 25         | 50      | -   | $M\Omega$ |
| Gain Power Bandwidth            | GBWP      | $V_O = 200mV$ , $f_O \geq 10kHz$ | 3     | 25         | 15      | -   | MHz       |
| Full Power Bandwidth            | FPBW      | $V_{PEAK} = 10V$                 | 3, 4  | 25         | 2.1     | -   | MHz       |
| Minimum Closed Loop Stable Gain | CLSG      | $R_L = 2k\Omega$ , $C_L = 50pF$  | 3     | -55 to 125 | $\pm 3$ | -   | V/V       |
| Output Resistance               | $R_{OUT}$ | Open Loop                        | 3     | 25         | -       | 60  | $\Omega$  |
| Power Consumption               | PC        | $V_{OUT} = 0V$ , $I_{OUT} = 0mA$ | 3, 5  | -55 to 125 | -       | 210 | 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.)

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| MIL-STD-883 TEST REQUIREMENTS               | SUBGROUPS (SEE TABLES 1 AND 2)       |
|---|--------------------------------------|
| Interim Electrical Parameters (Pre Burn-In) | 1                                    |
| Final Electrical Test Parameters            | 1 (Note 6), 2, 3, 4, 5, 6, 7, 8A, 8B |
| Group A Test Requirements                   | 1, 2, 3, 4, 5, 6, 7, 8A, 8B          |
| Groups C and D Endpoints                    | 1                                    |

NOTE:

- PDA applies to Subgroup 1 only.

### Die Characteristics

**DIE DIMENSIONS:**

67 mils x 57 mils x 19 mils  
1700µm x 1440µm x 483µm

**METALLIZATION:**

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

**GLASSIVATION:**

Type: Nitride (Si3N4) over Silox (SiO2, 5% Phos.)  
Silox Thickness: 12kÅ ± 2kÅ  
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**

$0.78 \times 10^5 \text{ A/cm}^2$

**SUBSTRATE POTENTIAL (Powered Up):**

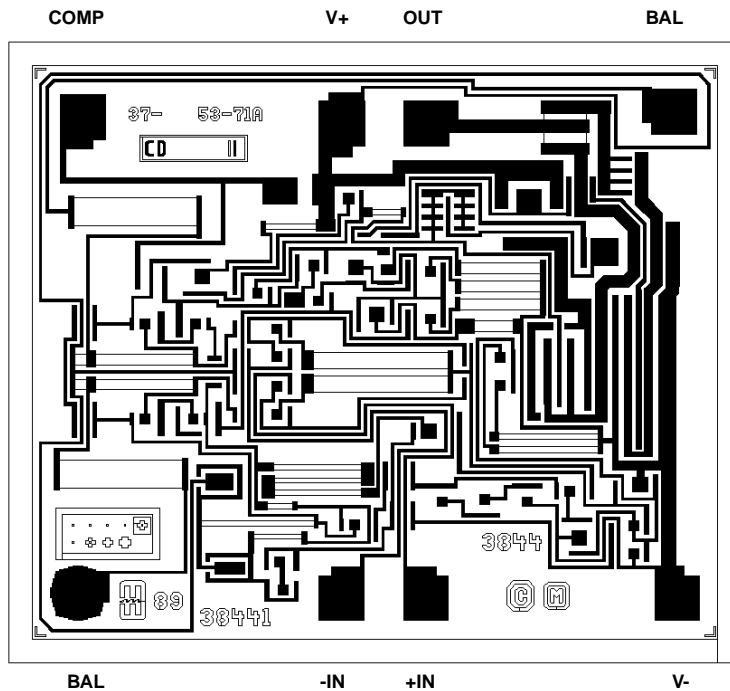
Unbiased

**TRANSISTOR COUNT: 40**

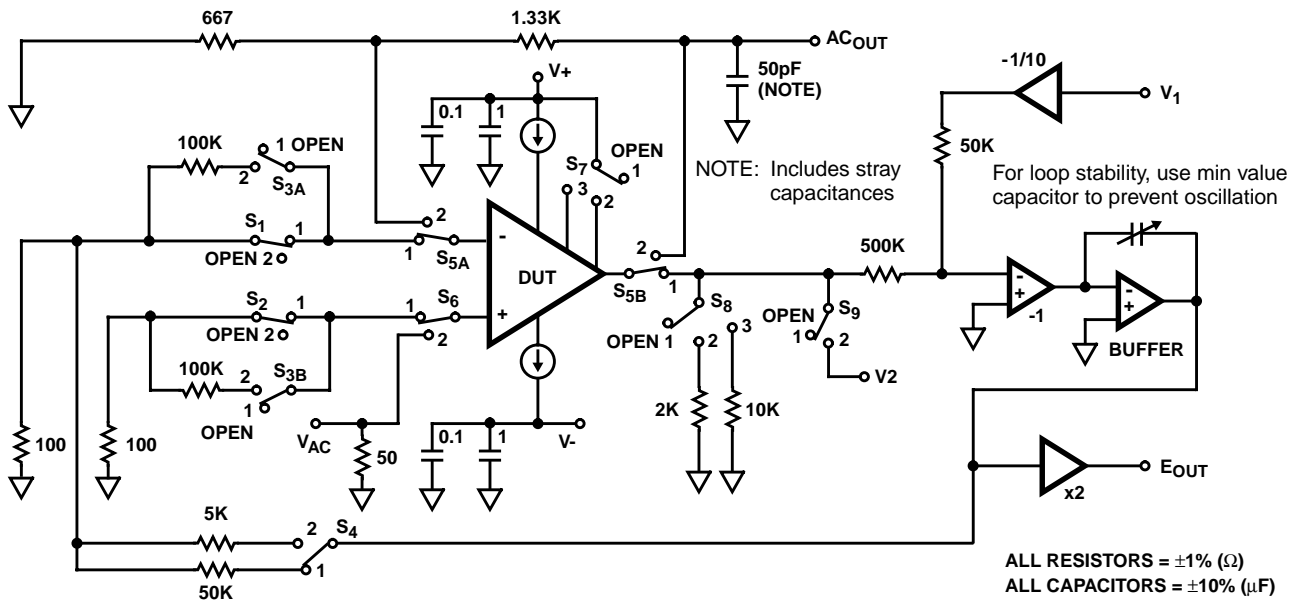
**PROCESS: Bipolar Dielectric Isolation**

### Metallization Mask Layout

HA-2529/883



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



**Test Circuits and Waveforms**

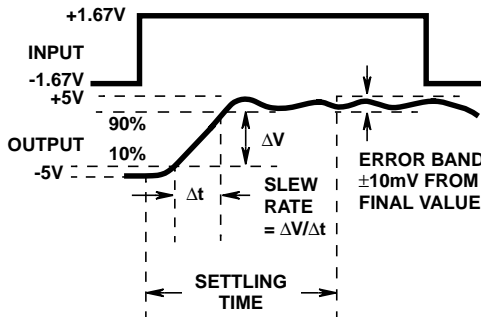
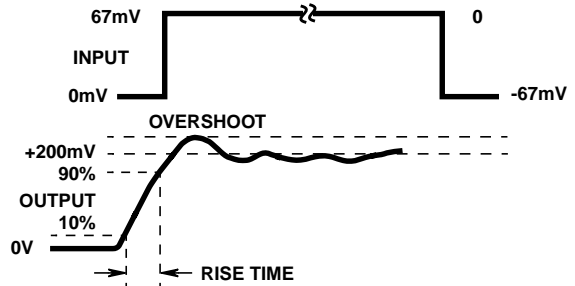


FIGURE 1. SLEW RATE AND SETTling TIME



NOTE: Measured on both positive and negative transitions from 0V to +200mV and 0V to -200mV at the output.

FIGURE 2. TRANSIENT RESPONSE

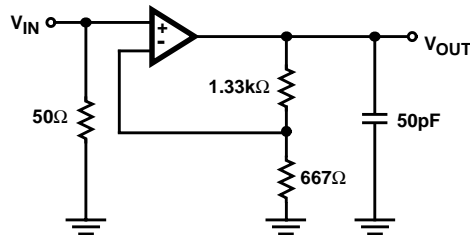
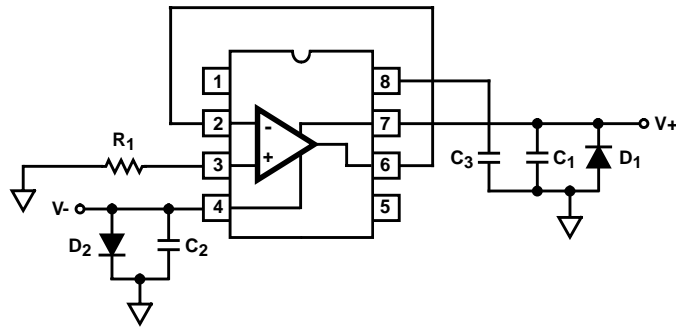


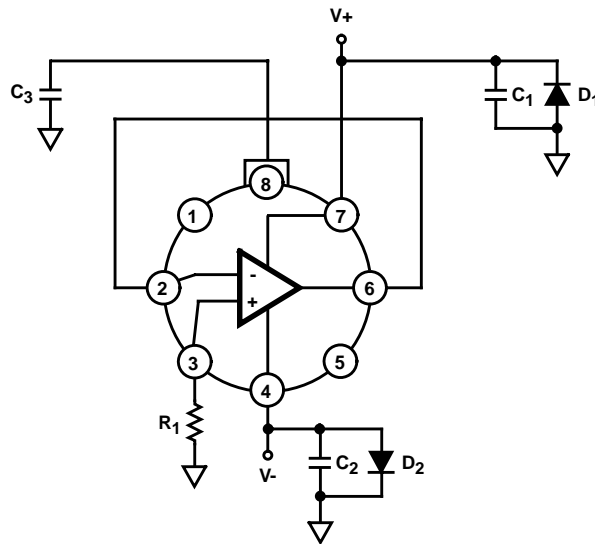
FIGURE 3. SIMPLIFIED TEST CIRCUIT (APPLIES TO TABLE 2)

## Burn-In Circuits

HA7-2529/883 Cerdip



HA2-2529/883 METAL CAN



### NOTES:

$R_1 = 1M\Omega, \pm 5\%, 1/4W$  (Min)

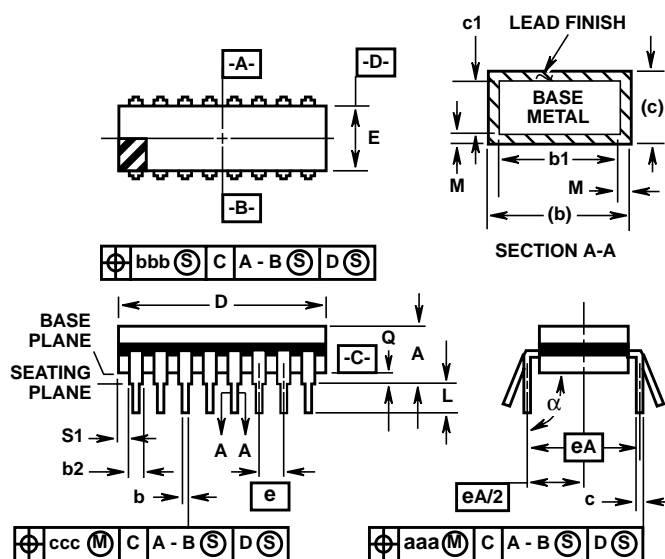
$C_1 = C_2 = 0.01\mu F$ /Socket (Min) or  $0.1\mu F$ /Row (Min)

$C_3 = 0.01\mu F$ /Socket (10%)

$D_1 = D_2 = 1N4002$  or Equivalent/Board

$|(V+) - (V-)| = 30V$

**Ceramic Dual-In-Line Frit Seal Packages (CERDIP)**



**F8.3A MIL-STD-1835 GDIP1-T8 (D-4, CONFIGURATION A)  
8 LEAD CERAMIC DUAL-IN-LINE FRIT SEAL PACKAGE**

| SYMBOL | INCHES    |        | MILLIMETERS |       | NOTES |
|--------|-----------|--------|-------------|-------|-------|
|        | MIN       | MAX    | MIN         | MAX   |       |
| A      | -         | 0.200  | -           | 5.08  | -     |
| b      | 0.014     | 0.026  | 0.36        | 0.66  | 2     |
| b1     | 0.014     | 0.023  | 0.36        | 0.58  | 3     |
| b2     | 0.045     | 0.065  | 1.14        | 1.65  | -     |
| b3     | 0.023     | 0.045  | 0.58        | 1.14  | 4     |
| c      | 0.008     | 0.018  | 0.20        | 0.46  | 2     |
| c1     | 0.008     | 0.015  | 0.20        | 0.38  | 3     |
| D      | -         | 0.405  | -           | 10.29 | 5     |
| E      | 0.220     | 0.310  | 5.59        | 7.87  | 5     |
| e      | 0.100 BSC |        | 2.54 BSC    |       | -     |
| eA     | 0.300 BSC |        | 7.62 BSC    |       | -     |
| eA/2   | 0.150 BSC |        | 3.81 BSC    |       | -     |
| L      | 0.125     | 0.200  | 3.18        | 5.08  | -     |
| Q      | 0.015     | 0.060  | 0.38        | 1.52  | 6     |
| S1     | 0.005     | -      | 0.13        | -     | 7     |
| α      | 90°       | 105°   | 90°         | 105°  | -     |
| aaa    | -         | 0.015  | -           | 0.38  | -     |
| bbb    | -         | 0.030  | -           | 0.76  | -     |
| ccc    | -         | 0.010  | -           | 0.25  | -     |
| M      | -         | 0.0015 | -           | 0.038 | 2, 3  |
| N      | 8         |        | 8           |       | 8     |

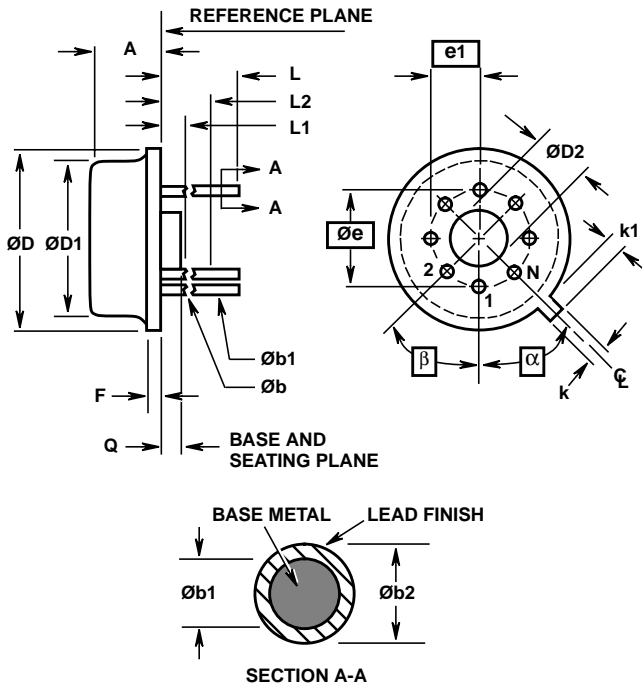
**NOTES:**

1. Index area: A notch or a pin one identification mark shall be located adjacent to pin one and shall be located within the shaded area shown. The manufacturer's identification shall not be used as a pin one identification mark.
2. The maximum limits of lead dimensions b and c or M shall be measured at the centroid of the finished lead surfaces, when solder dip or tin plate lead finish is applied.
3. Dimensions b1 and c1 apply to lead base metal only. Dimension M applies to lead plating and finish thickness.
4. Corner leads (1, N, N/2, and N/2+1) may be configured with a partial lead paddle. For this configuration dimension b3 replaces dimension b2.
5. This dimension allows for off-center lid, meniscus, and glass overrun.
6. Dimension Q shall be measured from the seating plane to the base plane.
7. Measure dimension S1 at all four corners.
8. N is the maximum number of terminal positions.
9. Dimensioning and tolerancing per ANSI Y14.5M - 1982.
10. Controlling dimension: INCH.

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**Metal Can Packages (Can)**



**T8.C MIL-STD-1835 MACY1-X8 (A1)  
8 LEAD METAL CAN PACKAGE**

| SYMBOL | INCHES    |       | MILLIMETERS |       | NOTES |
|--------|-----------|-------|-------------|-------|-------|
|        | MIN       | MAX   | MIN         | MAX   |       |
| A      | 0.165     | 0.185 | 4.19        | 4.70  | -     |
| Øb     | 0.016     | 0.019 | 0.41        | 0.48  | 1     |
| Øb1    | 0.016     | 0.021 | 0.41        | 0.53  | 1     |
| Øb2    | 0.016     | 0.024 | 0.41        | 0.61  | -     |
| ØD     | 0.335     | 0.375 | 8.51        | 9.40  | -     |
| ØD1    | 0.305     | 0.335 | 7.75        | 8.51  | -     |
| ØD2    | 0.110     | 0.160 | 2.79        | 4.06  | -     |
| e      | 0.200 BSC |       | 5.08 BSC    |       | -     |
| e1     | 0.100 BSC |       | 2.54 BSC    |       | -     |
| F      | -         | 0.040 | -           | 1.02  | -     |
| k      | 0.027     | 0.034 | 0.69        | 0.86  | -     |
| k1     | 0.027     | 0.045 | 0.69        | 1.14  | 2     |
| L      | 0.500     | 0.750 | 12.70       | 19.05 | 1     |
| L1     | -         | 0.050 | -           | 1.27  | 1     |
| L2     | 0.250     | -     | 6.35        | -     | 1     |
| Q      | 0.010     | 0.045 | 0.25        | 1.14  | -     |
| α      | 45° BSC   |       | 45° BSC     |       | 3     |
| β      | 45° BSC   |       | 45° BSC     |       | 3     |
| N      | 8         |       | 8           |       | 4     |

**NOTES:**

- (All leads) Øb applies between L1 and L2. Øb1 applies between L2 and 0.500 from the reference plane. Diameter is uncontrolled in L1 and beyond 0.500 from the reference plane.
- Measured from maximum diameter of the product.
- α is the basic spacing from the centerline of the tab to terminal 1 and β is the basic spacing of each lead or lead position (N - 1 places) from α, looking at the bottom of the package.
- N is the maximum number of terminal positions.
- Dimensioning and tolerancing per ANSI Y14.5M - 1982.
- Controlling dimension: INCH.

Rev. 0 5/18/94

All Intersil semiconductor products are manufactured, assembled and tested under **ISO9000** quality systems certification.

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