

April 2002

## High Slew Rate Operational Amplifier

### 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 ..... **50V/μs (Min)**  
**65V/μs (Typ)**
- Wide Power Bandwidth ..... **750kHz (Min)**
- Low Offset Current ..... **25nA (Min)**  
**10nA (Typ)**
- High Input Impedance ..... **50MΩ (Min)**  
**100MΩ (Typ)**
- Wide Small Signal Bandwidth ..... **12MHz (Typ)**
- Fast Settling Time (0.1% of 10V Step) .... **250ns (Typ)**
- Low Quiescent Supply Current ..... **6mA (Max)**
- Internally Compensated For Unity Gain Stability

### Applications

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

### Description

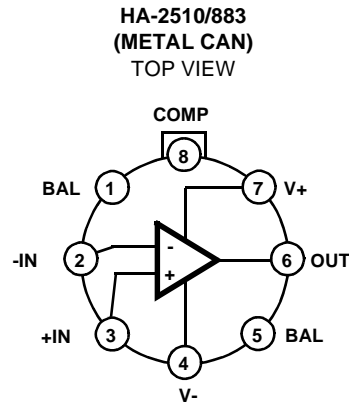
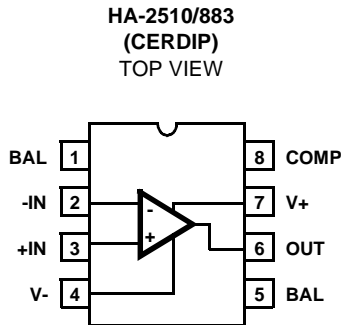
The HA-2510/883 is a high performance operational amplifier which sets the standards for maximum slew rate and wide bandwidth operation in moderately powered, internally compensated, monolithic devices. In addition to excellent dynamic characteristics, this dielectrically isolated amplifier also offers low offset current and high input impedance.

The  $\pm 50\text{V}/\mu\text{s}$  minimum slew rate and fast settling time of the HA-2510/883 are ideally suited for high speed D/A, A/D, and pulse amplification designs. The HA-2510/883's superior bandwidth and 750kHz minimum full power bandwidth are extremely useful in RF and video applications. To insure compliance with slew rate and transient response specifications, all devices are 100% tested for AC performance characteristics over full temperature limits. To improve signal conditioning accuracy, the HA-2510/883 provides a maximum offset current of 25nA and a minimum input impedance of 50MΩ, both at 25°C, as well as offset voltage adjust capability.

### Ordering Information

| PART NUMBER  | TEMP. RANGE (°C) | PACKAGE     | PKG. NO. |
|--------------|------------------|-------------|----------|
| HA2-2510/883 | -55 to 125       | 8 Pin Can   | T8.C     |
| HA7-2510/883 | -55 to 125       | 8 Ld CERDIP | F8.3A    |

### Pinouts



**Absolute Maximum Ratings**

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 ..... ±15V  
 $V_{INCM} \leq 1/2 (V+ - V-)$   
 $R_L \geq 2k\Omega$

**Thermal Information**

Thermal Resistance (Typical, Note 1)  $\theta_{JA}$   $\theta_{JC}$   
 CERDIP Package ..... 120°C/W 30°C/W  
 Metal Can Package ..... 160°C/W 75°C/W  
 Package Power Dissipation Limit at 75°C for  $T_J \leq 175^\circ C$   
 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 a low effective thermal conductivity test board in free air. See Tech Brief TB379 for details.

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

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 |
|-----------------------------|-------------|--|-------------------|-----------|------|-----|-------|
| Input Offset Voltage        | $V_{IO}$    | $V_{CM} = 0V$  | 1                 | 25        | -8   | 8   | mV    |
|                             |             |  | 2, 3              | 125, -55  | -18  | 10  | mV    |
| Input Bias Current          | + $I_B$     | $V_{CM} = 0V$ , + $R_S = 100k\Omega$ , - $R_S = 100\Omega$           | 1                 | 25        | -200 | 200 | nA    |
|                             |             |  | 2, 3              | 125, -55  | -400 | 400 | nA    |
|                             | - $I_B$     | $V_{CM} = 0V$ , + $R_S = 100\Omega$ , - $R_S = 100k\Omega$           | 1                 | 25        | -200 | 200 | nA    |
|                             |             |  | 2, 3              | 125, -55  | -400 | 400 | nA    |
| Input Offset Current        | $I_{IO}$    | $V_{CM} = 0V$ , + $R_S = 100k\Omega$ , - $R_S = 100k\Omega$          | 1                 | 25        | -25  | 25  | nA    |
|                             |             |  | 2, 3              | 125, -55  | -50  | 50  | nA    |
| Common Mode Range           | +CMR        | $V+ = 5V$ , $V- = -25V$  | 1                 | 25        | +10  | -   | V     |
|                             |             |  | 2, 3              | 125, -55  | +10  | -   | V     |
|                             | -CMR        | $V+ = 25V$ , $V- = -5V$  | 1                 | 25        | -    | -10 | V     |
|                             |             |  | 2, 3              | 125, -55  | -    | -10 | V     |
| Large Signal Voltage Gain   | + $A_{VOL}$ | $V_{OUT} = 0V$ and +10V, $R_L = 2k\Omega$                            | 4                 | 25        | 10   | -   | kV/V  |
|                             |             |  | 5, 6              | 125, -55  | 7.5  | -   | kV/V  |
|                             | - $A_{VOL}$ | $V_{OUT} = 0V$ and -10V, $R_L = 2k\Omega$                            | 4                 | 25        | 10   | -   | kV/V  |
|                             |             |  | 5, 6              | 125, -55  | 7.5  | -   | kV/V  |
| Common Mode Rejection Ratio | +CMRR       | $\Delta V_{CM} = +10V$ , $V+ = +5V$ , $V- = -25V$ , $V_{OUT} = -10V$ | 1                 | 25        | 80   | -   | dB    |
|                             |             |  | 2, 3              | 125, -55  | 80   | -   | dB    |
|                             | -CMRR       | $\Delta V_{CM} = -10V$ , $V+ = +25V$ , $V- = -5V$ , $V_{OUT} = +10V$ | 1                 | 25        | 80   | -   | dB    |
|                             |             |  | 2, 3              | 125, -55  | 80   | -   | dB    |

## HA-2510/883

**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 Voltage Swing           | +V <sub>OUT</sub>   | R <sub>L</sub> = 2k $\Omega$   | 4                 | 25        | 10                | -    | V     |
|                                |                     |  | 5, 6              | 125, -55  | 10                | -    | V     |
|                                | -V <sub>OUT</sub>   | R <sub>L</sub> = 2k $\Omega$   | 4                 | 25        | -                 | -10  | V     |
|                                |                     |  | 5, 6              | 125, -55  | -                 | -10  | V     |
| Output Current                 | +I <sub>OUT</sub>   | V <sub>OUT</sub> = -10V  | 4                 | 25        | 10                | -    | mA    |
|                                |                     |  | 5, 6              | 125, -55  | 7.5               | -    | mA    |
|                                | -I <sub>OUT</sub>   | V <sub>OUT</sub> = +10V  | 4                 | 25        | -                 | -10  | mA    |
|                                |                     |  | 5, 6              | 125, -55  | -                 | -7.5 | mA    |
| Quiescent Power Supply Current | +I <sub>CC</sub>    | V <sub>OUT</sub> = 0V,<br>I <sub>OUT</sub> = 0mA                       | 1                 | 25        | -                 | 6    | mA    |
|                                |                     |  | 2, 3              | 125, -55  | -                 | 6.5  | mA    |
|                                | -I <sub>CC</sub>    | V <sub>OUT</sub> = 0V,<br>I <sub>OUT</sub> = 0mA                       | 1                 | 25        | -6                | -    | mA    |
|                                |                     |  | 2, 3              | 125, -55  | -6.5              | -    | mA    |
| Power Supply Rejection Ratio   | +PSRR               | $\Delta V_{SUP} = 10V$ , V+ = +20V, V- = -15V,<br>V+ = +10V, V- = -15V | 1                 | 25        | 80                | -    | dB    |
|                                |                     |  | 2, 3              | 125, -55  | 80                | -    | dB    |
|                                | -PSRR               | $\Delta V_{SUP} = 10V$ , V+ = +15V, V- = -20V,<br>V+ = +15V, V- = -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)  $\pm 1$ mV] minimum referred to output. This test is for functionality only to assure adjustment through 0V.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at:  $V_{SUPPLY} = \pm 15V$ ,  $R_{SOURCE} = 50\Omega$ ,  $R_{LOAD} = 2k\Omega$ ,  $C_{LOAD} = 50pF$ ,  $A_{VCL} = +1V/V$ , Unless Otherwise Specified.

| PARAMETER | SYMBOL | CONDITIONS   | GROUP A SUBGROUPS | TEMP (°C) | MIN | MAX | UNITS      |
|-----------|--------|--|-------------------|-----------|-----|-----|------------|
| Slew Rate | +SR    | V <sub>OUT</sub> = -5V to +5V, 25% $\leq$ +SR $\leq$ 75% | 7                 | 25        | 50  | -   | V/ $\mu$ s |
|           |        |  | 8A, 8B            | 125, -55  | 45  | -   | V/ $\mu$ s |
|           | -SR    | V <sub>OUT</sub> = +5V to -5V, 75% $\geq$ -SR $\geq$ 25% | 7                 | 25        | 50  | -   | V/ $\mu$ s |
|           |        |  | 8A, 8B            | 125, -55  | 45  | -   | V/ $\mu$ s |

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at:  $V_{SUPPLY} = \pm 15V$ ,  $R_{SOURCE} = 50\Omega$ ,  $R_{LOAD} = 2k\Omega$ ,  $C_{LOAD} = 50pF$ ,  $A_{VCL} = +1V/V$ , Unless Otherwise Specified.

| PARAMETER          | SYMBOL | CONDITIONS  | GROUP A SUBGROUPS | TEMP (°C) | MIN | MAX | UNITS |
|--------------------|--------|---|-------------------|-----------|-----|-----|-------|
| Rise and Fall Time | $t_r$  | $V_{OUT} = 0$ to $+200mV$ , $10\% \leq t_r \leq 90\%$ | 7                 | 25        | -   | 50  | ns    |
|                    |        |   | 8A, 8B            | 125, -55  | -   | 60  | ns    |
|                    | $t_f$  | $V_{OUT} = 0$ to $-200mV$ , $10\% \leq t_f \leq 90\%$ | 7                 | 25        | -   | 50  | ns    |
|                    |        |   | 8A, 8B            | 125, -55  | -   | 60  | ns    |
| Overshoot          | +OS    | $V_{OUT} = 0$ to $+200mV$                             | 7                 | 25        | -   | 40  | %     |
|                    |        |   | 8A, 8B            | 125, -55  | -   | 50  | %     |
|                    | -OS    | $V_{OUT} = 0$ to $-200mV$                             | 7                 | 25        | -   | 40  | %     |
|                    |        |   | 8A, 8B            | 125, -55  | -   | 50  | %     |

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

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

| PARAMETER                       | SYMBOL   | CONDITIONS                       | NOTES | TEMP (°C)  | MIN | MAX | UNITS     |
|---------------------------------|----------|----------------------------------|-------|------------|-----|-----|-----------|
| Differential Input Resistance   | $R_{IN}$ | $V_{CM} = 0V$                    | 3     | 25         | 50  | -   | $M\Omega$ |
| Full Power Bandwidth            | FPBW     | $V_{PEAK} = 10V$                 | 3, 4  | 25         | 750 | -   | kHz       |
| Minimum Closed Loop Stable Gain | CLSG     | $R_L = 2k\Omega$ , $C_L = 50pF$  | 3     | -55 to 125 | 1   | -   | V/V       |
| Quiescent Power Consumption     | PC       | $V_{OUT} = 0V$ , $I_{OUT} = 0mA$ | 3, 5  | -55 to 125 | -   | 195 | 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  $FPBW = Slew\ Rate / (2\pi V_{PEAK})$ .
- 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:**

65 mils x 57 mils x 19 mils  
1650 $\mu$ m x 1450 $\mu$ m x 483 $\mu$ m

**METALLIZATION:**

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

**GLASSIVATION:**

Type: Nitride (Si<sub>3</sub>N<sub>4</sub>) over Silox (SiO<sub>2</sub>, 5% Phos.)  
Silox Thickness: 12k $\text{Å}$   $\pm$  2k $\text{Å}$   
Nitride Thickness: 3.5k $\text{Å}$   $\pm$  1.5k $\text{Å}$

**WORST CASE CURRENT DENSITY:**

0.3 x 10<sup>5</sup> A/cm<sup>2</sup>

**SUBSTRATE POTENTIAL (Powered Up):**

Unbiased

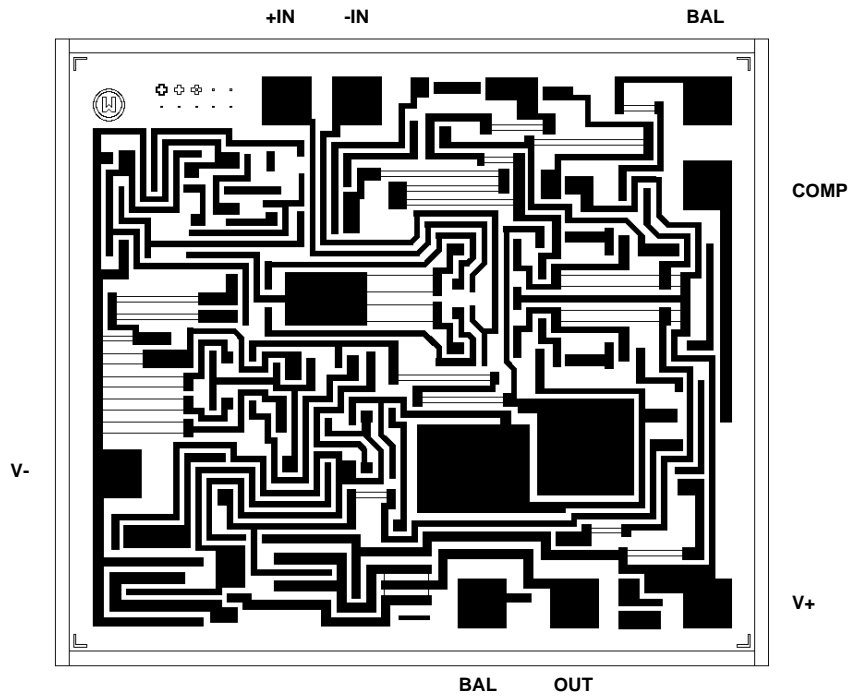
**TRANSISTOR COUNT:**

HA-2510/883: 40

**PROCESS:** Bipolar Dielectric Isolation

**Metallization Mask Layout**

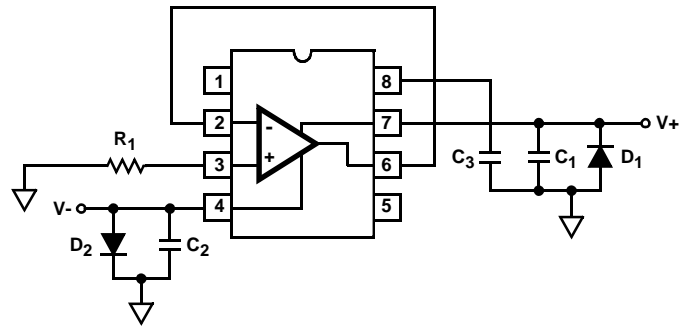
HA-2510/883



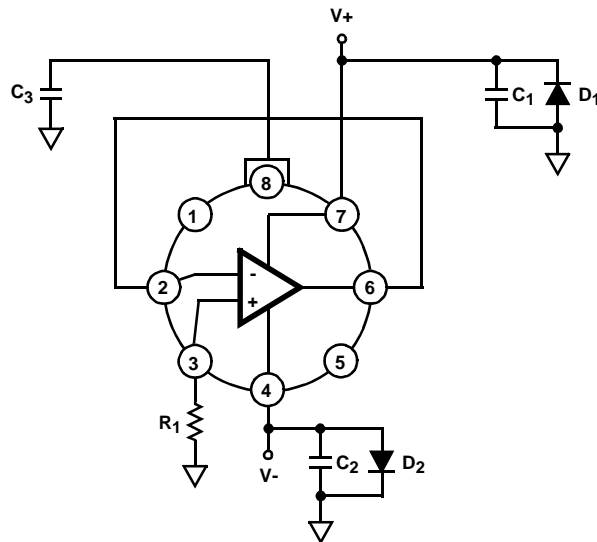
# HA-2510/883

## Burn-In Circuits

HA7-2510/883 CERDIP



HA2-2510/883 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)

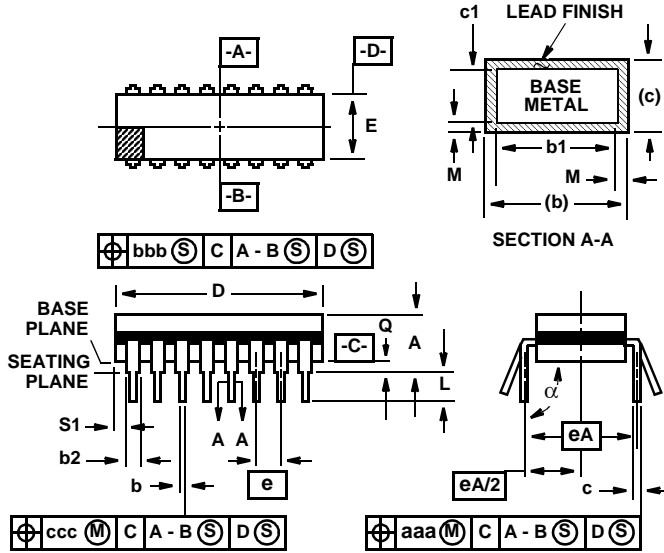
$C_3 = 0.01\mu F$ /Socket (10%)

$D_1 = D_2 = 1N4002$  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**



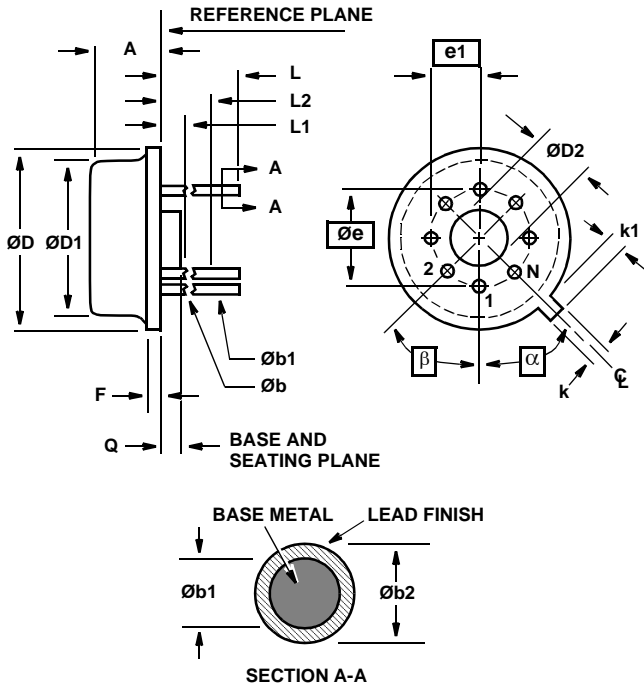
| SYMBOL   | INCHES    |        | MILLIMETERS |       | NOTES |
|----------|-----------|--------|-------------|-------|-------|
|          | MIN       | MAX    | MIN         | MAX   |       |
| A        | -         | 0.200  | -           | 5.08  | -     |
| b        | 0.014     | 0.026  | 0.36        | 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     |
| $\alpha$ | 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)**



**NOTES:**

1. (All leads)  $\varnothing b$  applies between L1 and L2.  $\varnothing b1$  applies between L2 and 0.500 from the reference plane. Diameter is uncontrolled in L1 and beyond 0.500 from the reference plane.
2. Measured from maximum diameter of the product.
3.  $\alpha$  is the basic spacing from the centerline of the tab to terminal 1 and  $\beta$  is the basic spacing of each lead or lead position (N - 1 places) from  $\alpha$ , looking at the bottom of the package.
4. N is the maximum number of terminal positions.
5. Dimensioning and tolerancing per ANSI Y14.5M - 1982.
6. Controlling dimension: INCH.

**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  | -     |
| $\varnothing b$  | 0.016     | 0.019 | 0.41        | 0.48  | 1     |
| $\varnothing b1$ | 0.016     | 0.021 | 0.41        | 0.53  | 1     |
| $\varnothing b2$ | 0.016     | 0.024 | 0.41        | 0.61  | -     |
| $\varnothing D$  | 0.335     | 0.375 | 8.51        | 9.40  | -     |
| $\varnothing D1$ | 0.305     | 0.335 | 7.75        | 8.51  | -     |
| $\varnothing D2$ | 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  | -     |
| $\alpha$         | 45° BSC   |       | 45° BSC     |       | 3     |
| $\beta$          | 45° BSC   |       | 45° BSC     |       | 3     |
| N                | 8         |       | 8           |       | 4     |

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