

# LM111/LH2111

## Voltage Comparators

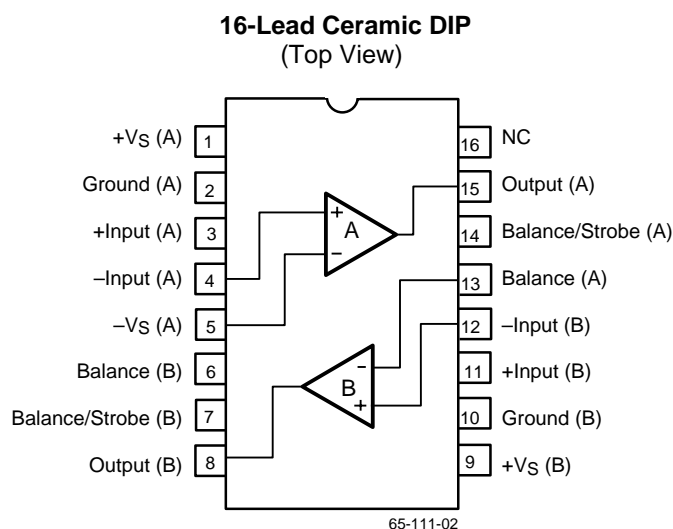
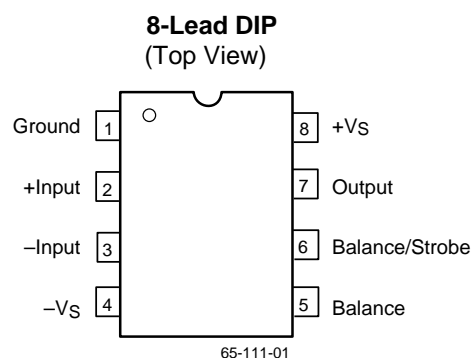
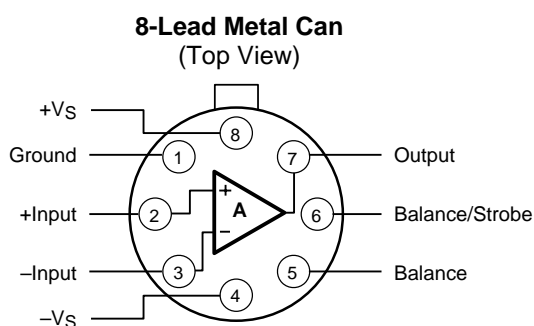
### Features

- Low input offset current — 4 nA
- Low input bias current — 60 nA
- Operates from a single +5V supply
- Response Time — 200 ns

### Description

These low input current voltage comparators are designed to operate over a wide range of supply voltages, including +15V and single +5V supplies. Their outputs are compatible with DTL, RTL, TTL and MOS devices, and can be connected in “wire-OR” configuration. The LH2111 consists of two LM111 ICs packaged in a 16-lead DIP. The LH2111 is available with MIL-STD 883B screening.

## Pin Assignments



## Absolute Maximum Ratings

| Parameter                               | Min. | Max.  | Unit    |
|---|------|-------|---------|
| Supply Voltage                          | -18  | +18   | V       |
| Output to -Vs                           |      | 50    | V       |
| Ground to -Vs                           |      | 30    | V       |
| Differential Input Voltage              |      | 30    | V       |
| Input Voltage <sup>1</sup>              | -15  | +15   | V       |
| Power Dissipation <sup>2</sup>          |      | 500   | mW      |
| Output Short Circuit Duration           |      | 10    | seconds |
| Storage Temperature Range               | -65  | +150  | °C      |
| Operating Temperature Range             | -55  | +125  | °C      |
| Voltage at Strobe Pin                   |      | +Vs-5 | V       |
| Lead Soldering Temperature (60 seconds) |      | +300  | °C      |

### Notes:

- For supply voltages other than  $\pm 15\text{V}$ , the maximum input is equal to the supply voltage.
- Observe package thermal characteristics.

## Thermal Characteristics

| Parameter                              | 8-Lead Metal Can | 8-Lead Ceramic DIP | 16-Lead Ceramic DIP |
|--|------------------|--------------------|---------------------|
| Maximum Junction Temperature           | +175°C           | +175°C             | +175°C              |
| Maximum PD $T_A < 50^\circ\text{C}$    | 658 mW           | 833 mW             | 1042 mW             |
| Thermal Resistance, $\theta_{JC}$      | 50°C/W           | 45°C/W             | 60°C/W              |
| Thermal Resistance, $\theta_{JA}$      | 190°C/W          | 150°C/W            | 120°C/W             |
| For $T_A > 50^\circ\text{C}$ Derate at | 5.26 mW/°C       | 8.33 mW/°C         | 8.38 mW/°C          |

## Electrical Characteristics

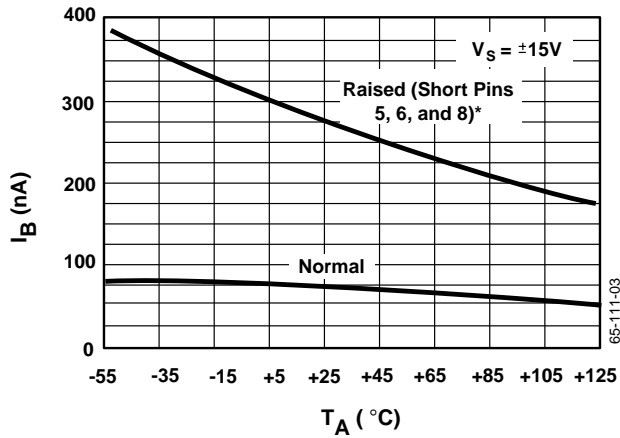
$V_S = \pm 15\text{V}^1$  and  $-55^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$  unless otherwise noted.

| Parameters                        | Test Conditions  | Min.  | Typ. | Max. | Units |
|-----------------------------------|--|-------|------|------|-------|
| Input Offset Voltage <sup>2</sup> | $T_A = +25^\circ\text{C}$ , $R_S = 50\text{ k}\Omega$  |       | 0.7  | 3.0  | mV    |
| Input Offset Current <sup>2</sup> | $T_A = +25^\circ\text{C}$  |       | 4.0  | 10   | nA    |
| Input Bias Current                | $T_A = +25^\circ\text{C}$  |       | 60   | 100  | nA    |
| Large Signal Voltage Gain         | $T_A = +25^\circ\text{C}$  | 40    | 200  |      | V/mV  |
| Response Time                     | $T_A = +25^\circ\text{C}$ , 100 mV step, 5 mV overdrive  |       | 200  |      | ns    |
| Output Voltage Low (VOL)          | $V_{IN} \leq 5\text{ mV}$ , $I_L = 50\text{ mA}$ , $T_A = +25^\circ\text{C}$                                 |       | 3.0  |      | mA    |
| Output Leakage current            | $V_{IN} = 25\text{ mV}$ , $V_{OUT} = 35\text{V}$ ,<br>$T_A = +25^\circ\text{C}$ , $I_{STROBE} = 3\text{ mA}$ |       | 0.2  | 10   | nA    |
| Input Offset Voltage <sup>2</sup> | $R_S \leq 50\text{ K}\Omega$   |       | 1.5  | 4.0  | mV    |
| Input Offset Current <sup>2</sup> |  |       | 5.0  | 20   | nA    |
| Input Bias Current                |  |       | 100  | 150  | nA    |
| Input Voltage Range               | Pin 7 pull up may go to +5V  | -14.5 |      | 13.0 | V     |
| Output Voltage Low (VOL)          | $+V_S = 4.5\text{V}$ , $-V_S = 0\text{V}$ , $V_{IN} \leq -6\text{ mV}$ ,<br>$I_{OUT} = 8.0\text{ mA}$        |       | 0.23 | 0.4  | V     |
| Output Leakage Current            | $V_{IN} \geq 5\text{ mV}$ , $V_{OUT} = 35\text{V}$   |       | 100  | 500  | nA    |
| Positive Supply Current           | $T_A = +25^\circ\text{C}$ , each amplifier   |       | 5.1  | 6.0  | mA    |
| Negative Supply Current           | $T_A = +25^\circ\text{C}$ , each amplifier   |       | 4.1  | 5.0  | mA    |

### Notes:

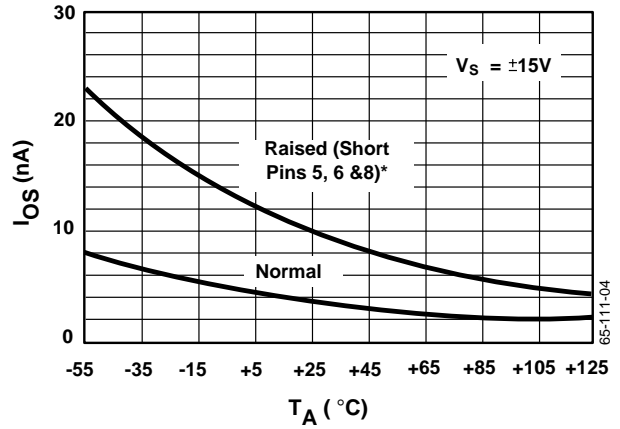
1.  $V_{OS}$ ,  $I_{OS}$  and  $I_B$  specifications apply for  $V_S = +5\text{V}$  to  $V_S = \pm 15\text{V}$ .
2.  $V_{OS}$  and  $I_{OS}$  are maximum values required to drive the output to within 1V of either supply with a 1 mA load.
3. Do not short circuit the strobe pin to ground—drive it with a 3 to 5 mA current. Instead.
4. If the strobe and balance pins are unused, short them together for maximum AC stability.

### Typical Performance Characteristics



\* Pin numbers are for 8-lead packages

Figure 1. Input Bias Current vs. Temperature



\* Pin numbers are for 8-lead packages

Figure 2. Input Offset Current vs. Temperature

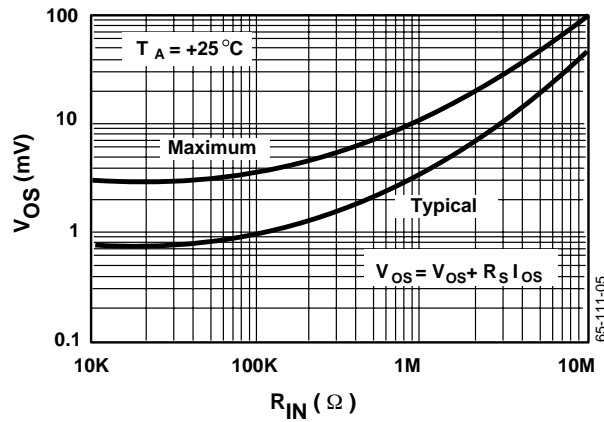


Figure 3. Equivalent Input Offset Voltage vs. Input Resistance

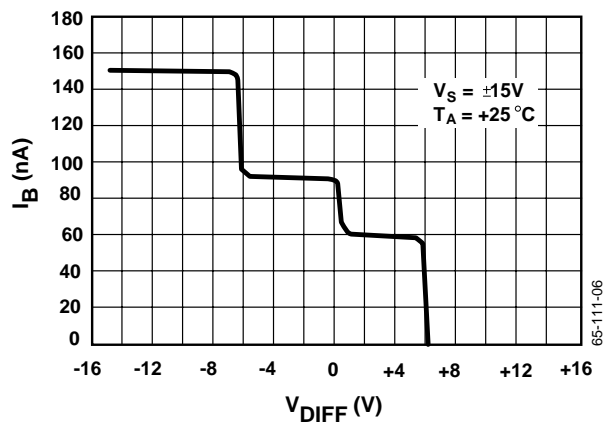


Figure 4. Input Bias Current vs. Differential Input Voltage

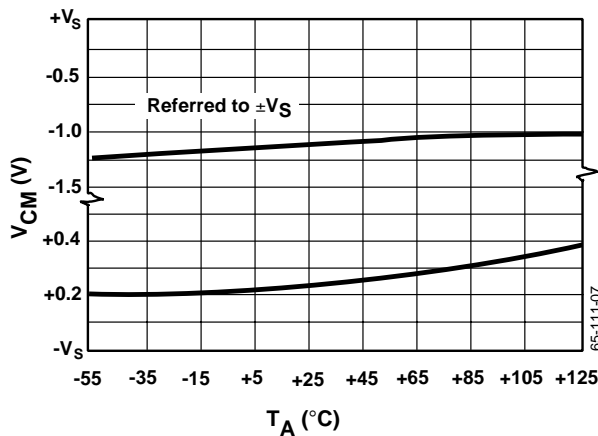


Figure 5. Common Mode Limits vs. Temperature

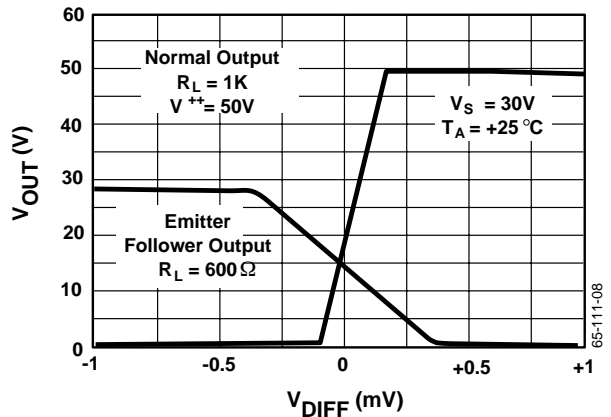


Figure 6. Output Voltage vs. Differential Input Voltage

Typical Performance Characteristics (continued)

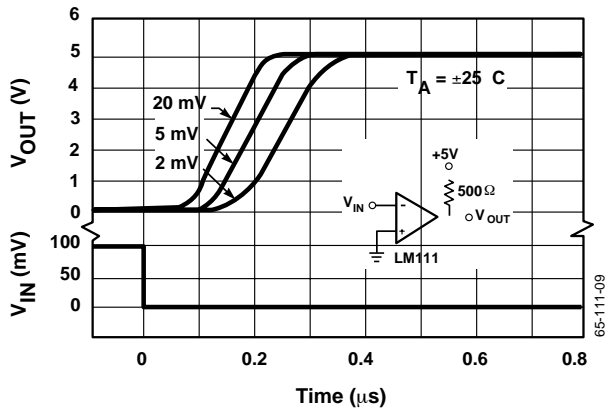


Figure 7. Input Overdrive vs. Response Times

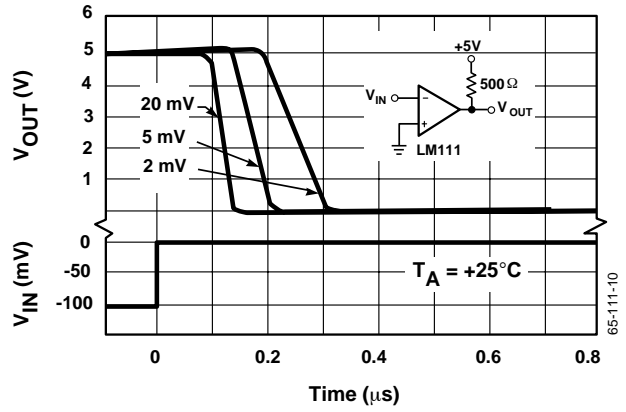


Figure 8. Input Overdrive vs. Response Times

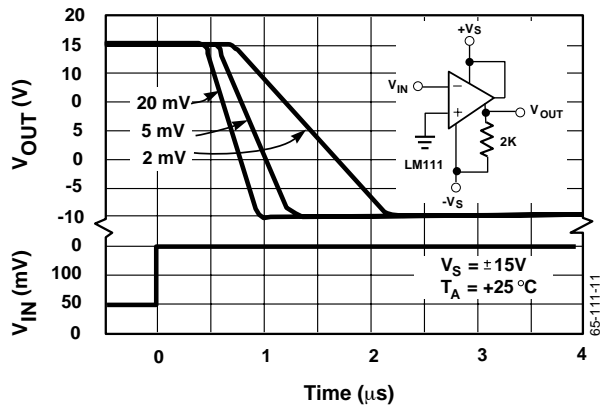


Figure 9. Input Overdrive vs. Response Times

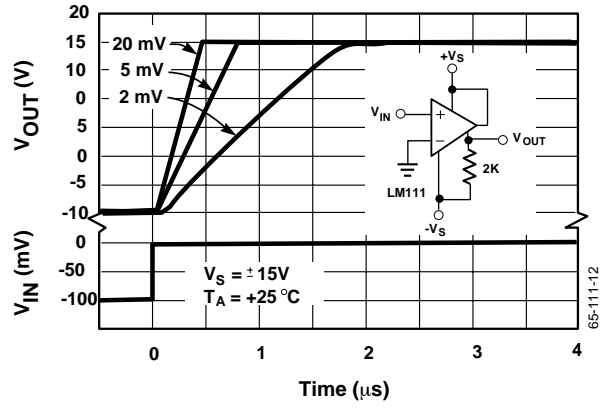


Figure 10. Input Overdrive vs. Response Times

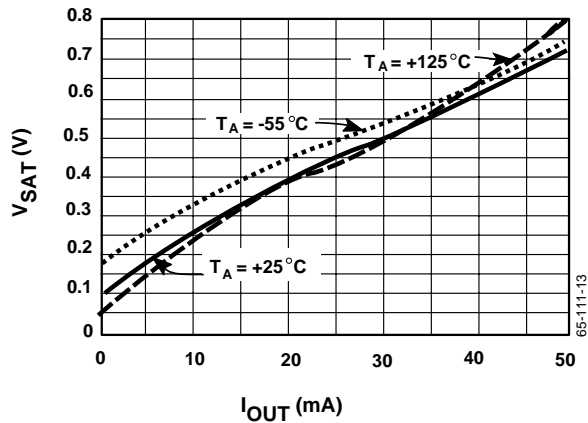


Figure 11. OpenSaturation Voltage vs. Output Current

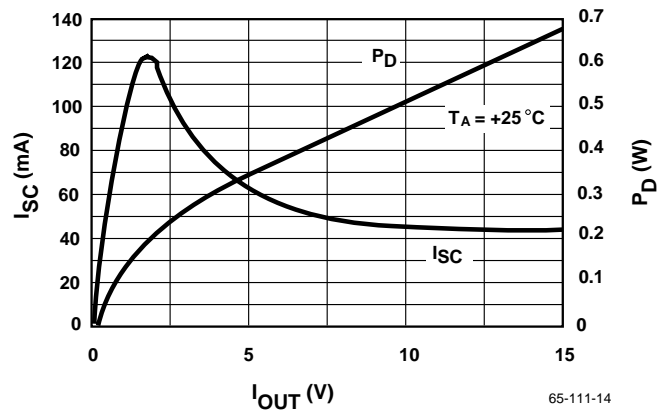


Figure 12. Short Circuit Current, Power Dissipation vs. Output Voltage

Typical Performance Characteristics (continued)

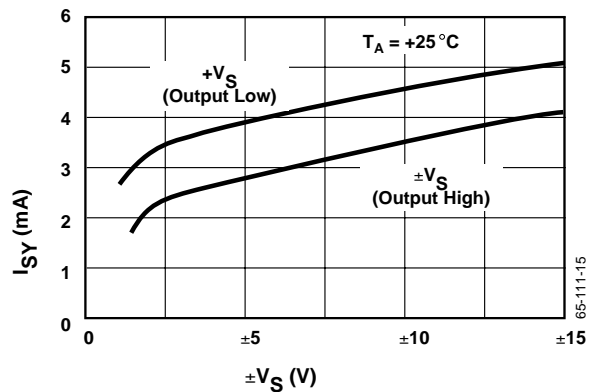


Figure 13. Supply Current vs. Supply Voltage

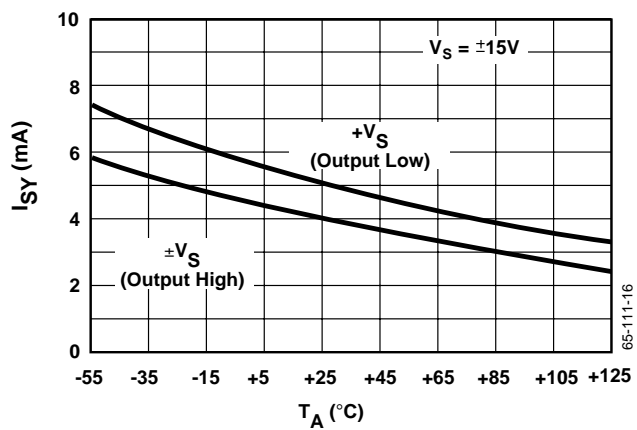


Figure 14. Supply Current vs. Temperature

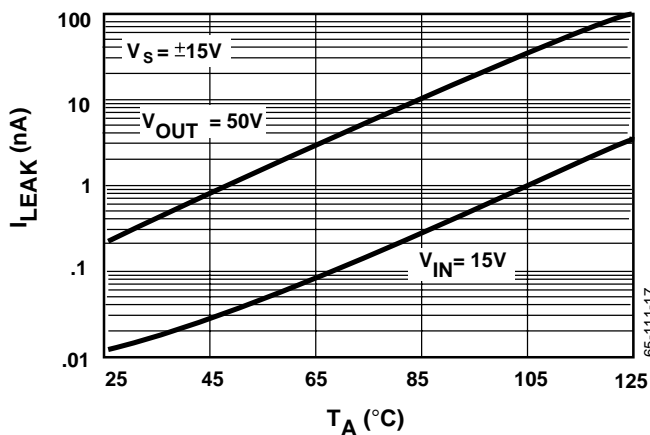


Figure 15. Leakage Current vs. Temperature

**Notes:**

**Notes:**



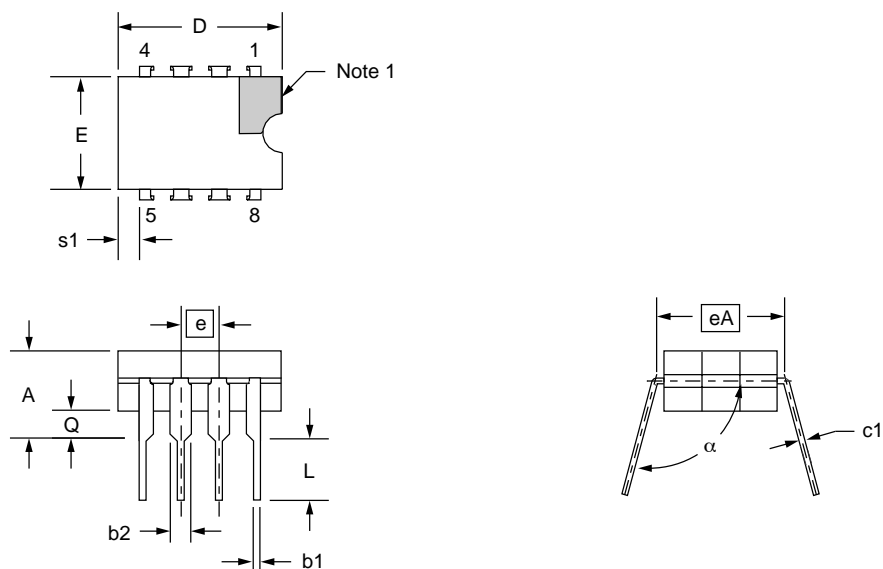
# Mechanical Dimensions

## 8-Lead Ceramic DIP

| Symbol   | Inches   |      | Millimeters |       | Notes |
|----------|----------|------|-------------|-------|-------|
|          | Min.     | Max. | Min.        | Max.  |       |
| A        | —        | .200 | —           | 5.08  |       |
| b1       | .014     | .023 | .36         | .58   | 8     |
| b2       | .045     | .065 | 1.14        | 1.65  | 2, 8  |
| c1       | .008     | .015 | .20         | .38   | 8     |
| D        | —        | .405 | —           | 10.29 | 4     |
| E        | .220     | .310 | 5.59        | 7.87  | 4     |
| e        | .100 BSC |      | 2.54 BSC    |       | 5, 9  |
| eA       | .300 BSC |      | 7.62 BSC    |       | 7     |
| L        | .125     | .200 | 3.18        | 5.08  |       |
| Q        | .015     | .060 | .38         | 1.52  | 3     |
| s1       | .005     | —    | .13         | —     | 6     |
| $\alpha$ | 90°      | 105° | 90°         | 105°  |       |

**Notes:**

1. Index area: a notch or a pin one identification mark shall be located adjacent to pin one. The manufacturer's identification shall not be used as pin one identification mark.
2. The minimum limit for dimension "b2" may be .023 (.58mm) for leads number 1, 4, 5 and 8 only.
3. Dimension "Q" shall be measured from the seating plane to the base plane.
4. This dimension allows for off-center lid, meniscus and glass overrun.
5. The basic pin spacing is .100 (2.54mm) between centerlines. Each pin centerline shall be located within  $\pm .010$  (.25mm) of its exact longitudinal position relative to pins 1 and 8.
6. Applies to all four corners (leads number 1, 4, 5, and 8).
7. "eA" shall be measured at the center of the lead bends or at the centerline of the leads when " $\alpha$ " is 90°.
8. All leads – Increase maximum limit by .003 (.08mm) measured at the center of the flat, when lead finish applied.
9. Six spaces.



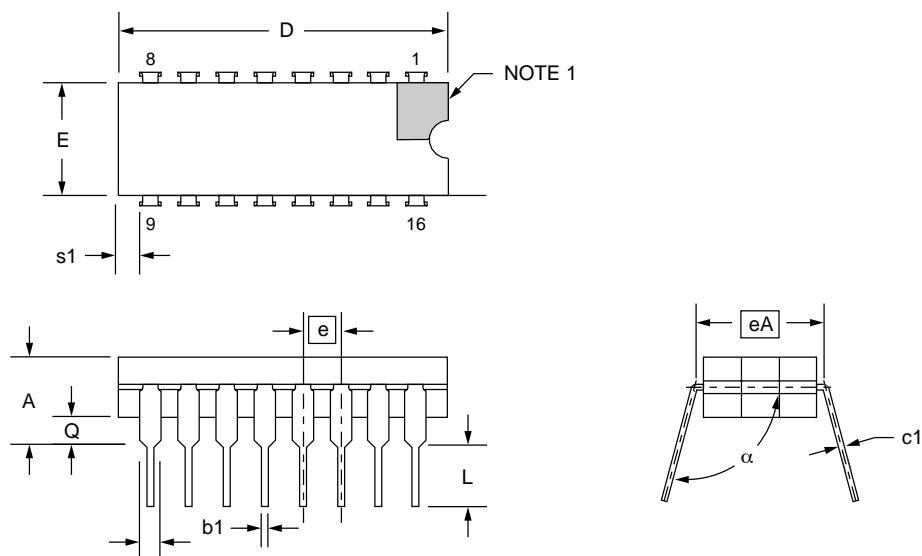
## Mechanical Dimensions (continued)

### 16-Lead Ceramic DIP

| Symbol   | Inches   |      | Millimeters |       | Notes |
|----------|----------|------|-------------|-------|-------|
|          | Min.     | Max. | Min.        | Max.  |       |
| A        | —        | .200 | —           | 5.08  |       |
| b1       | .014     | .023 | .36         | .58   | 8     |
| b2       | .050     | .065 | 1.27        | 1.65  | 2     |
| c1       | .008     | .015 | .20         | .38   | 8     |
| D        | .745     | .840 | 18.92       | 21.33 | 4     |
| E        | .220     | .310 | 5.59        | 7.87  | 4     |
| e        | .100 BSC |      | 2.54 BSC    |       | 5, 9  |
| eA       | .300 BSC |      | 7.62 BSC    |       | 7     |
| L        | .115     | .160 | 2.92        | 4.06  |       |
| Q        | .015     | .060 | .38         | 1.52  | 3     |
| s1       | .005     | —    | .13         | —     | 6     |
| $\alpha$ | 90°      | 105° | 90°         | 105°  |       |

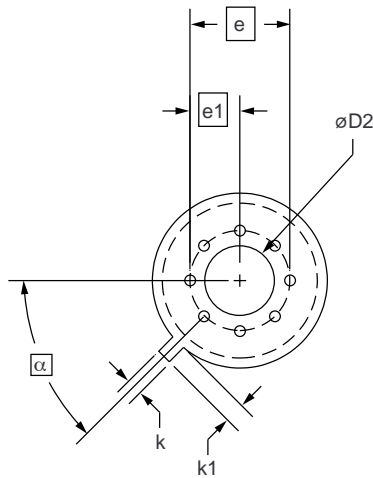
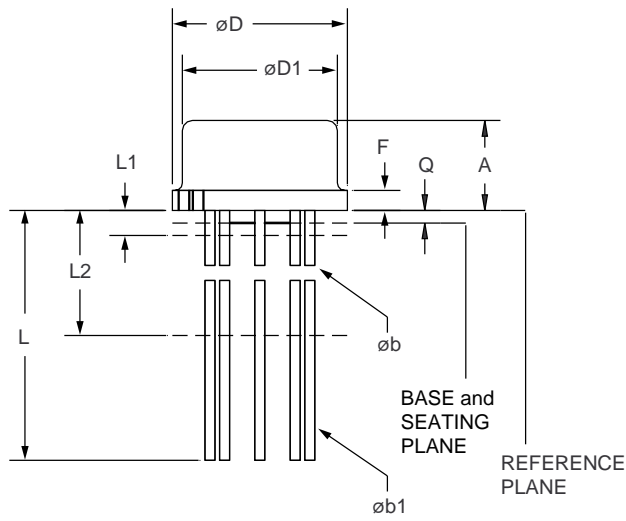
#### Notes:

1. Index area: a notch or a pin one identification mark shall be located adjacent to pin one. The manufacturer's identification shall not be used as pin one identification mark.
2. The minimum limit for dimension "b2" may be .023 (.58mm) for leads number 1, 8, 9 and 16 only.
3. Dimension "Q" shall be measured from the seating plane to the base plane.
4. This dimension allows for off-center lid, meniscus and glass overrun.
5. The basic pin spacing is .100 (2.54mm) between centerlines. Each pin centerline shall be located within  $\pm .010$  (.25mm) of its exact longitudinal position relative to pins 1 and 16.
6. Applies to all four corners (leads number 1, 8, 9, and 16).
7. "eA" shall be measured at the center of the lead bends or at the centerline of the leads when " $\alpha$ " is 90°.
8. All leads – Increase maximum limit by .003 (.08mm) measured at the center of the flat, when lead finish applied.
9. Fourteen spaces.



# Mechanical Dimensions (continued)

## 8-Lead Metal Can (TO-99)



| Symbol    | Inches   |      | Millimeters |       | Notes |
|-----------|----------|------|-------------|-------|-------|
|           | Min.     | Max. | Min.        | Max.  |       |
| A         | .165     | .185 | 4.19        | 4.70  |       |
| $\phi b$  | .016     | .019 | .41         | .48   | 1, 5  |
| $\phi b1$ | .016     | .021 | .41         | .53   | 1, 5  |
| $\phi D$  | .335     | .375 | 8.51        | 9.52  |       |
| $\phi D1$ | .305     | .335 | 7.75        | 8.51  |       |
| $\phi D2$ | .110     | .160 | 2.79        | 4.06  |       |
| e         | .200 BSC |      | 5.08 BSC    |       |       |
| e1        | .100 BSC |      | 2.54 BSC    |       |       |
| F         | —        | .040 | —           | 1.02  |       |
| k         | .027     | .034 | .69         | .86   |       |
| k1        | .027     | .045 | .69         | 1.14  | 2     |
| L         | .500     | .750 | 12.70       | 19.05 | 1     |
| L1        | —        | .050 | —           | 1.27  | 1     |
| L2        | .250     | —    | 6.35        | —     | 1     |
| Q         | .010     | .045 | .25         | 1.14  |       |
| $\alpha$  | 45° BSC  |      | 45° BSC     |       |       |

**Notes:**

1. (All leads)  $\phi b$  applies between L1 & L2.  $\phi b1$  applies between L2 & .500 (12.70mm) from the reference plane. Diameter is uncontrolled in L1 & beyond .500 (12.70mm) from the reference plane.
2. Measured from the maximum diameter of the product.
3. Leads having a maximum diameter .019 (.48mm) measured in gauging plane, .054 (1.37mm) +.001 (.03mm) -.000 (.00mm) below the reference plane of the product shall be within .007 (.18mm) of their true position relative to a maximum width tab.
4. The product may be measured by direct methods or by gauge.
5. All leads – increase maximum limit by .003 (.08mm) when lead finish is applied.

## Ordering Information

| Part Number  | Package                  | Operating Temperature Range |
|--------------|--------------------------|-----------------------------|
| LM111T/883B  | 8-Lead Metal Can (TO-99) | -55°C to +125°C             |
| LM111D/883B  | 8-Lead Ceramic DIP       | -55°C to +125°C             |
| LH2111D      | 16-Lead Ceramic DIP      | -55°C to +125°C             |
| LH2111D/883B | 16-Lead Ceramic DIP      | -55°C to +125°C             |

**Note:**

1. /883 B suffix denotes MIL-STD-883, Level B processing

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