



## LMx85-1.2, LM385B-1.2 Micropower Voltage References

### 1 Features

- Operating Current Range
  - LM285-1.2: 10  $\mu$ A to 20 mA
  - LM385-1.2: 15  $\mu$ A to 20 mA
  - LM385B-1.2: 15  $\mu$ A to 20 mA
- 1% and 2% Initial Voltage Tolerance
- Reference Impedance
  - LM385-1.2: 1  $\Omega$  MAX at 25°C
  - All devices: 1.5  $\Omega$  MAX over Full Temperature Range
- Very Low Power Consumption
- Interchangeable with Industry Standard LM285-1.2 and LM385-1.2

### 2 Applications

- Portable Meter References
- Portable Test Instruments
- Battery-Operated Systems
- Current-Loop Instrumentation
- Panel Meters

### 3 Description

These micropower, two-terminal, band-gap voltage references operate over a 10- $\mu$ A to 20-mA current range and feature exceptionally low dynamic impedance and good temperature stability. On-chip trimming provides tight voltage tolerance. The band-gap reference for these devices has low noise and long-term stability.

The design makes these devices exceptionally tolerant of capacitive loading and, thus, easier to use in most reference applications. The wide dynamic operating temperature range accommodates varying current supplies, with excellent regulation.

The extremely low power drain of this series makes them useful for micropower circuitry. These voltage references can be used to make portable meters, regulators, or general-purpose analog circuitry, with battery life approaching shelf life. The wide operating current range allows them to replace older references with tighter-tolerance parts.

#### Device Information<sup>(1)</sup>

| PART NUMBER | PACKAGE (PIN) | BODY SIZE (NOM)          |
|-------------|---------------|--------------------------|
| LMx85-1.2   | SOIC (8)      | 4.90 mm $\times$ 3.91 mm |
|             | SOP (8)       | 6.20 mm $\times$ 5.30 mm |
|             | TSSOP (8)     | 3.00 mm $\times$ 4.40 mm |
|             | TO-226 (3)    | 4.30 mm $\times$ 4.30 mm |

(1) For all available packages, see the orderable addendum at the end of the datasheet.

### 4 Simplified Schematic



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## 5 Revision History

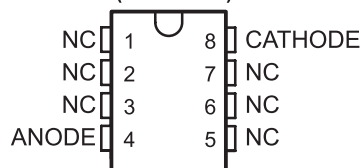
### Changes from Revision I (December 2005) to Revision J

### Page

- Added *Applications*, *Device Information* table, *Pin Functions* table, *ESD Ratings* table, *Thermal Information* table, *Typical Characteristics*, *Feature Description* section, *Device Functional Modes*, *Application and Implementation* section, *Power Supply Recommendations* section, *Layout* section, *Device and Documentation Support* section, and *Mechanical, Packaging, and Orderable Information* section. .... **1**
- Deleted *Ordering Information* table. .... **1**

## 6 Pin Configuration and Functions

**LM285-1.2 . . . D PACKAGE  
LM385-1.2 . . . D, PS, OR PW PACKAGE  
LM385B-1.2 . . . D OR PW PACKAGE  
(TOP VIEW)**



NC – No internal connection

**LM285-1.2, LM385-1.2, LM385B-1.2 . . . LP PACKAGE  
(TOP VIEW)**



NC – No internal connection

### Pin Functions

| PIN     |    |                  | TYPE | DESCRIPTION                              |
|---------|----|------------------|------|------------------------------------------|
| NAME    | LP | D, PS or PW      |      |                                          |
| ANODE   | 1  | 4                | I    | Shunt Current/Voltage input              |
| CATHODE | 2  | 8                | O    | Common pin, normally connected to ground |
| NC      | 3  | 1, 2, 3, 5, 6, 7 | —    | No internal connection                   |

## 7 Specifications

### 7.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup>

|           |                                        | MIN | MAX | UNIT |
|-----------|----------------------------------------|-----|-----|------|
| $I_R$     | Reverse Current                        |     | 30  | mA   |
| $I_F$     | Forward Current                        |     | 10  | mA   |
| $T_J$     | Operating virtual junction temperature |     | 150 | °C   |
| $T_{stg}$ | Storage temperature                    | –65 | 150 | °C   |

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

### 7.2 ESD Ratings

|             |                         |                                                                                          | VALUE | UNIT |
|-------------|-------------------------|------------------------------------------------------------------------------------------|-------|------|
| $V_{(ESD)}$ | Electrostatic discharge | Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins <sup>(1)</sup>              | ±2000 | V    |
|             |                         | Charged device model (CDM), per JEDEC specification JESD22-C101, all pins <sup>(2)</sup> | ±1000 |      |

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

- (2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

### 7.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

|          |                                |                       | MIN  | MAX | UNIT |
|----------|--------------------------------|-----------------------|------|-----|------|
| $I_{ZZ}$ | Reference current              |                       | 0.01 | 20  | mA   |
| $T_A$    | Operating free-air temperature | LM285-1.2             | –40  | 85  | °C   |
|          |                                | LM385-1.2, LM385B-1.2 | 0    | 70  |      |

### 7.4 Thermal Information

| THERMAL METRIC <sup>(1)</sup> |                                        | LMx85-1.2 |        |        |        | UNIT |
|-------------------------------|----------------------------------------|-----------|--------|--------|--------|------|
|                               |                                        | D         | LP     | PS     | PW     |      |
|                               |                                        | 8 PINS    | 3 PINS | 8 PINS | 8 PINS |      |
| R <sub>θJA</sub>              | Junction-to-ambient thermal resistance | 97        | 140    | 95     | 149    | °C/W |

- (1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, [SPRA953](#).

## 7.5 Electrical Characteristics

over operating free-air temperature range (unless otherwise noted)

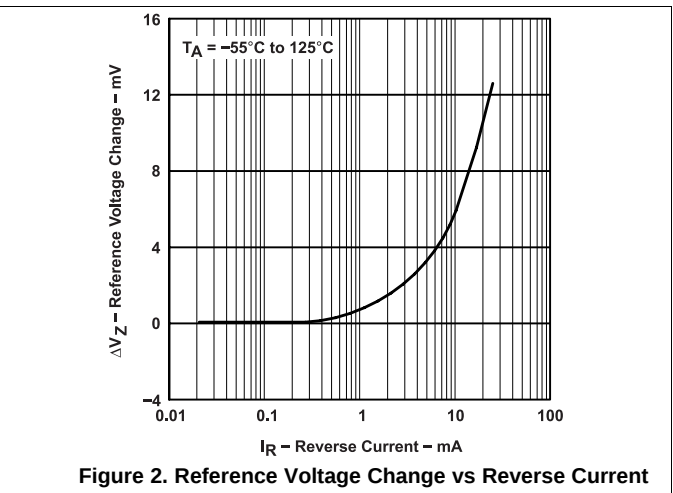
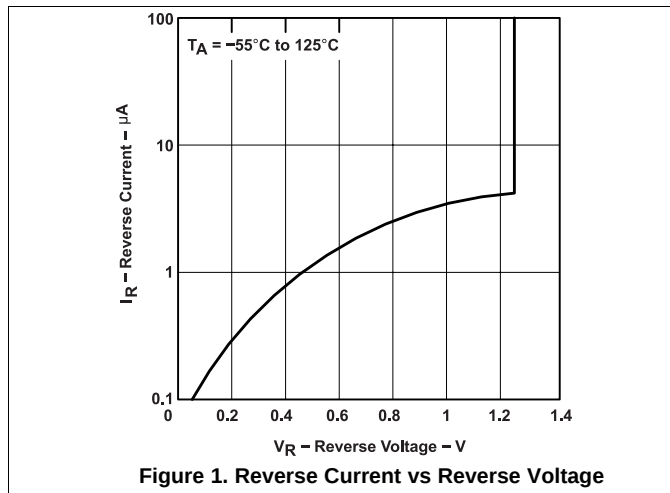
| PARAMETER            |                                                                     | TEST CONDITIONS                                 | T <sub>A</sub> <sup>(1)</sup> | LM285-1.2 |       |       | LM385-1.2 |       |      | LM385B-1.2 |       |       | UNIT     |
|----------------------|---------------------------------------------------------------------|-------------------------------------------------|-------------------------------|-----------|-------|-------|-----------|-------|------|------------|-------|-------|----------|
|                      |                                                                     |                                                 |                               | MIN       | TYP   | MAX   | MIN       | TYP   | MAX  | MIN        | TYP   | MAX   |          |
| V <sub>Z</sub>       | Reference voltage                                                   | I <sub>Z</sub> = I(min) to 20 mA <sup>(2)</sup> | 25°C                          | 1.223     | 1.235 | 1.247 | 1.21      | 1.235 | 1.26 | 1.223      | 1.235 | 1.247 | V        |
| α <sub>VZ</sub>      | Average temperature coefficient of reference voltage <sup>(3)</sup> | I <sub>Z</sub> = I(min) to 20 mA <sup>(2)</sup> | Full Range                    | ±20       |       |       | ±20       |       |      | ±20        |       |       | ppm/°C   |
| Δ <sub>VZ</sub>      | Change in reference voltage with current                            | I <sub>Z</sub> = I(min) to 1 mA <sup>(2)</sup>  | 25°C                          | 1         |       |       | 1         |       |      | 1          |       |       | mV       |
|                      |                                                                     |                                                 | Full Range                    | 1.5       |       |       | 1.5       |       |      | 1.5        |       |       |          |
|                      |                                                                     | I <sub>Z</sub> = I(min) to 20 mA                | 25°C                          | 12        |       |       | 20        |       |      | 20         |       |       |          |
|                      |                                                                     |                                                 | Full Range                    | 30        |       |       | 30        |       |      | 30         |       |       |          |
| ΔV <sub>Z</sub> /Δt  | Long-term change in reference voltage                               | I <sub>Z</sub> = 100 μA                         | 25°C                          | ±20       |       |       | ±20       |       |      | ±20        |       |       | ppm/k hr |
| I <sub>Z</sub> (min) | Minimum reference current                                           |                                                 | Full Range                    | 8 10      |       |       | 8 15      |       |      | 8 15       |       |       | μA       |
| Z <sub>Z</sub>       | Reference impedance                                                 | I <sub>Z</sub> = 100 μA, f = 25 Hz              | 25°C                          | 0.2 0.6   |       |       | 0.4 1     |       |      | 0.4 1      |       |       | Ω        |
|                      |                                                                     |                                                 | Full Range                    | 1.5       |       |       | 1.5       |       |      | 1.5        |       |       |          |
| V <sub>n</sub>       | Broadband noise voltage                                             | I <sub>Z</sub> = 100 μA, f = 10 Hz to 10 kHz    | 25°C                          | 60        |       |       | 60        |       |      | 60         |       |       | μV       |

(1) Full range is –40°C to 85°C for the LM285-1.2 and 0°C to 70°C for the LM385-1.2 and LM385B-1.2.

(2) I(min) = 10 μA for the LM285-1.2 and 15 μA for the LM385-1.2 and LM385B-1.2

(3) The average temperature coefficient of reference voltage is defined as the total change in reference voltage divided by the specified temperature range.

## 7.6 Typical Characteristics



## Typical Characteristics (continued)

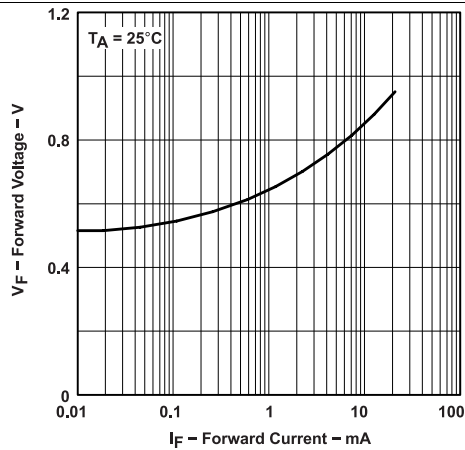


Figure 3. Forward Voltage vs Forward Current

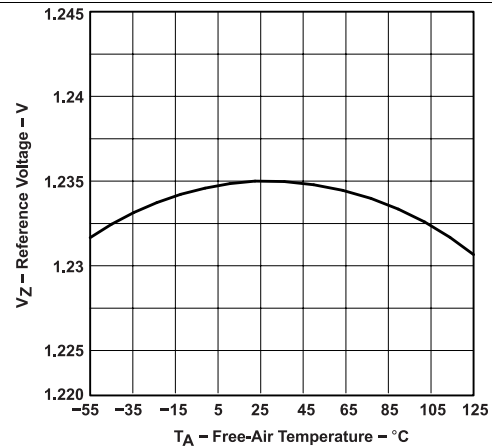


Figure 4. Reference Voltage vs Free-Air Temperature

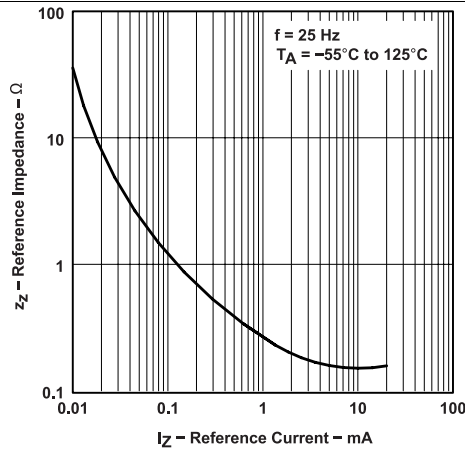


Figure 5. Reference Impedance vs Reference Current

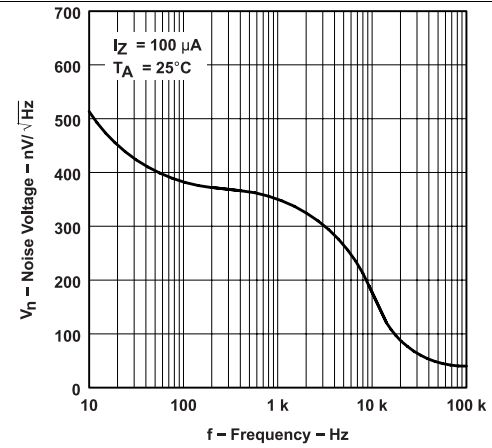


Figure 6. Noise Voltage vs Frequency

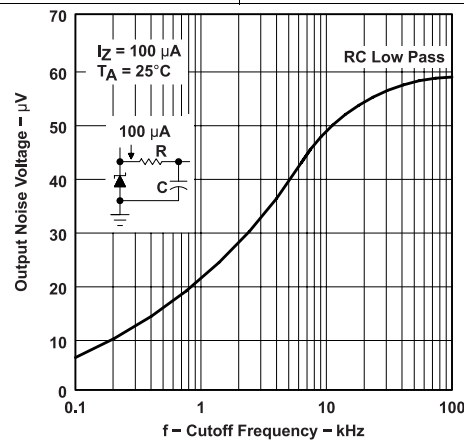


Figure 7. Output Noise Voltage vs Cutoff Frequency

## 8 Detailed Description

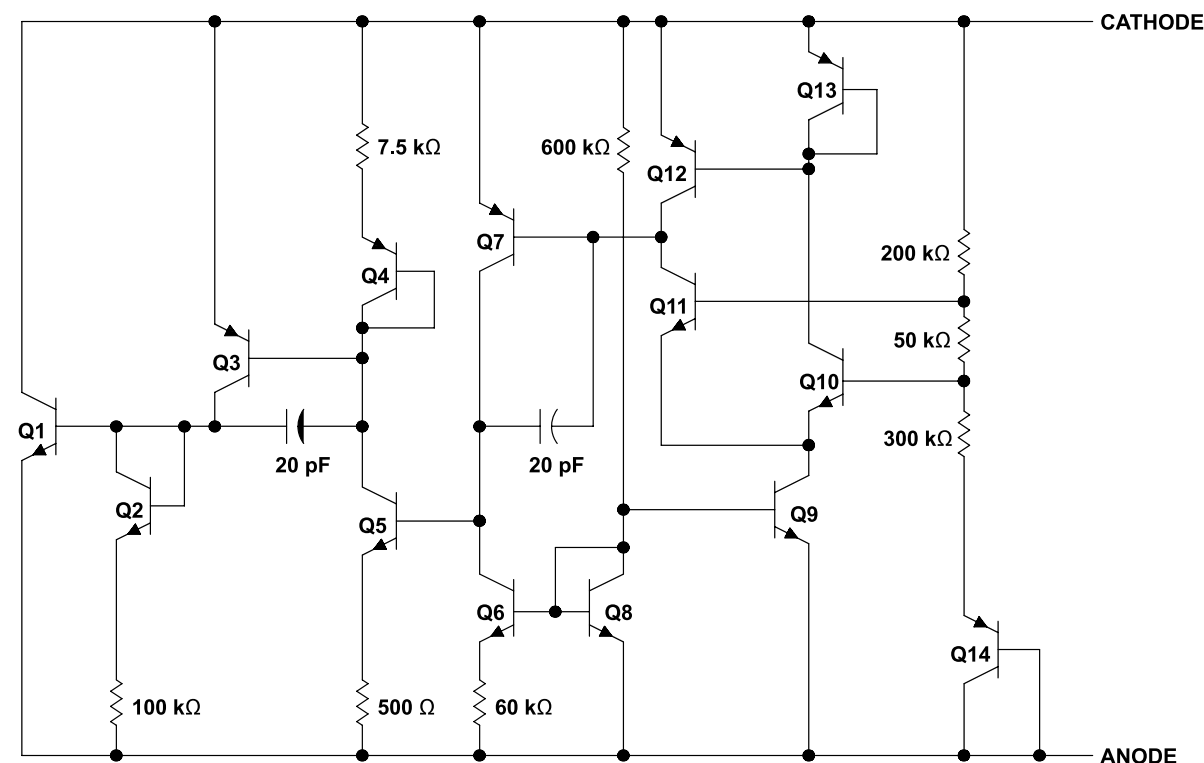
### 8.1 Overview

The LM285-1.2, LM385-1.2, and LM385B-1.2 devices are micropower, two-terminal, band-gap voltage references which operate over a 10- $\mu$ A to 20-mA current range. On-chip trimming provides tight voltage tolerance. The band-gap reference for these devices has low noise and long-term stability.

The design makes these devices exceptionally tolerant of capacitive loading and, thus, easier to use in most reference applications. The wide dynamic operating temperature range accommodates varying current supplies, with excellent regulation.

The extremely low power drain of this series makes them useful for micropower circuitry. These voltage references can be used to make portable meters, regulators, or general-purpose analog circuitry, with battery life approaching shelf life.

### 8.2 Functional Block Diagram



A. Component values shown are nominal.

### 8.3 Feature Description

A band gap voltage reference controls high gain amplifier and shunt pass element to maintain a nearly constant voltage between cathode and anode. Regulation occurs after a minimum current is provided to power the voltage divider and amplifier. Internal frequency compensation provides a stable loop for all capacitor loads. Floating shunt design is useful for both positive and negative regulation applications.

### 8.4 Device Functional Modes

LM285-1.2, LM385-1.2, and LM385B-1.2 devices will operate in one mode, which is as a fixed voltage reference that cannot be adjusted.

In order for a proper Reverse Voltage to be developed, current must be sourced into the cathode of LM285. The minimum current needed for proper regulation is denoted in *Electrical Characteristics* as  $I_{Z,min}$ .

## 9 Application and Implementation

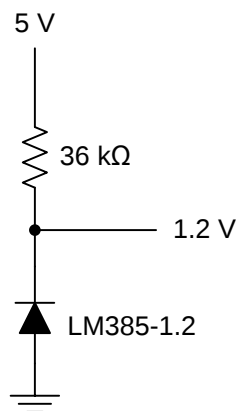
### NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

### 9.1 Application Information

The LM285-1.2, LM385-1.2, and LM385B-1.2 devices create a voltage reference for to be used for a variety of applications including amplifiers, power supplies, and current-sensing circuits. The following application shows how to use these devices to establish a voltage reference.

### 9.2 Typical Application



**Figure 8. Generating Reference Voltage with a Resistive Current Source**

#### 9.2.1 Design Requirements

The key design requirement when using this device as a voltage reference is to supply the LM385 with a minimum Cathode Current ( $I_Z$ ), as indicated in [Electrical Characteristics](#).

#### 9.2.2 Detailed Design Procedure

In order to generate a constant and stable reference voltage, a current greater than  $I_{Z(MIN)}$  must be sourced into the cathode of this device. This can be accomplished using a current regulating device such as LM334 or a simple resistor. For a resistor, its value should be equal to or greater than  $(V_{supply} - V_{reference}) \div I_{Z(MIN)}$ .

## Typical Application (continued)

### 9.2.3 Application Curves

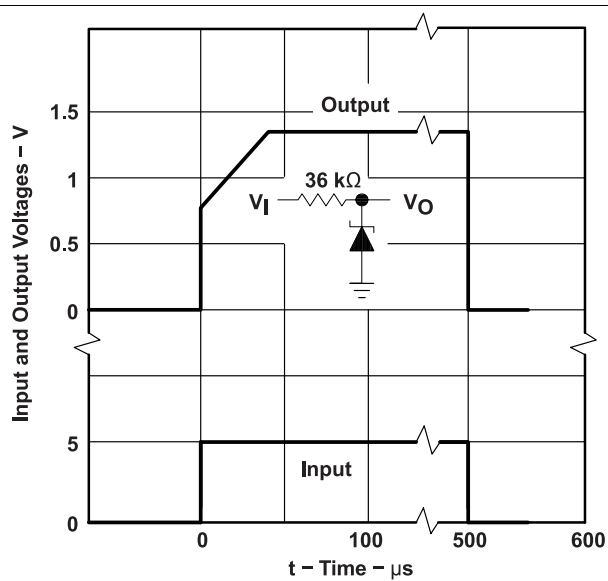
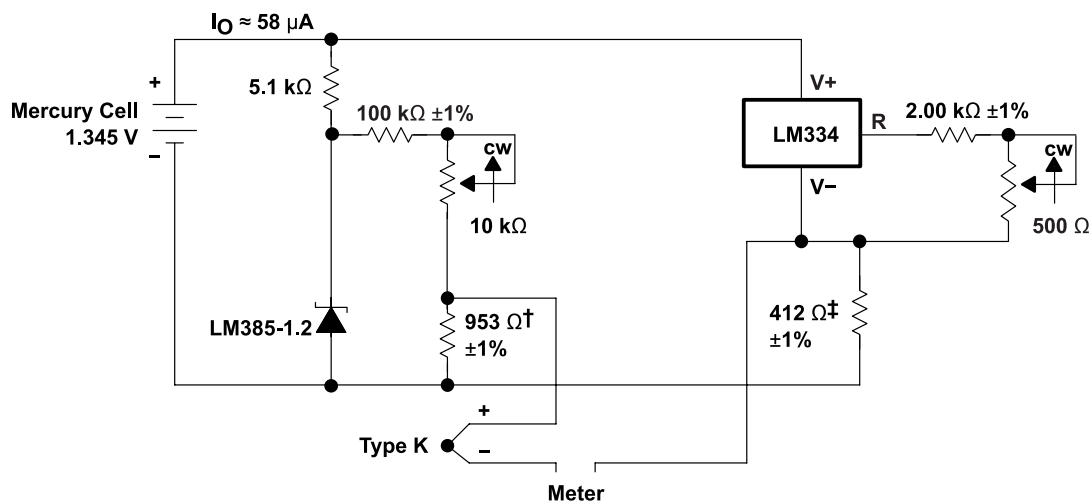


Figure 9. Transient Response

## 9.3 System Examples

### 9.3.1 Thermocouple Cold-Junction Compensator

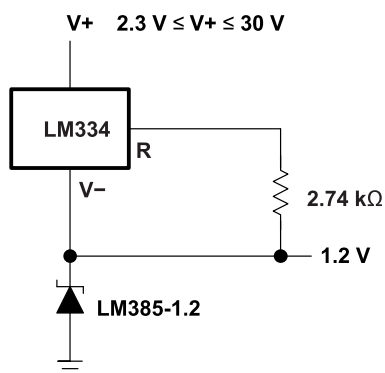


$^\dagger$  Adjust for 11.15 mV at 25°C across 953  $\Omega$

$^\ddagger$  Adjust for 12.17 mV at 25°C across 412  $\Omega$

**Figure 10. Thermocouple Cold-Junction Compensator**

### 9.3.2 Generating Reference Voltage with a Constant Current Source



**Figure 11. Generating Reference Voltage with a Constant Current Source Device**

## 10 Power Supply Recommendations

In order to not exceed the maximum cathode current, be sure that the supply voltage is current limited.

For applications shunting high currents (30 mA max), pay attention to the cathode and anode trace lengths, adjusting the width of the traces to have the proper current density.

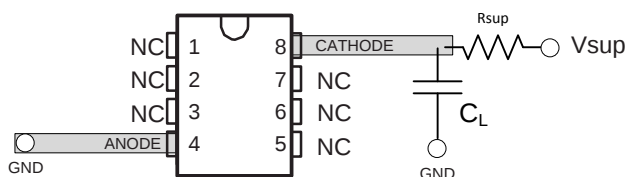
## 11 Layout

### 11.1 Layout Guidelines

Figure 12 shows an example of a PCB layout of LMx85x-1.2. Some key  $V_{ref}$  noise considerations are:

- Connect a low-ESR, 0.1- $\mu$ F ( $C_L$ ) ceramic bypass capacitor on the cathode pin node.
- Decouple other active devices in the system per the device specifications.
- Using a solid ground plane helps distribute heat and reduces electromagnetic interference (EMI) noise pickup.
- Place the external components as close to the device as possible. This configuration prevents parasitic errors (such as the Seebeck effect) from occurring.
- Do not run sensitive analog traces in parallel with digital traces. Avoid crossing digital and analog traces if possible and only make perpendicular crossings when absolutely necessary.

### 11.2 Layout Example



**Figure 12. Layout Diagram**

## 12 Device and Documentation Support

### 12.1 Related Links

The table below lists quick access links. Categories include technical documents, support and community resources, tools and software, and quick access to sample or buy.

**Table 1. Related Links**

| PARTS      | PRODUCT FOLDER             | SAMPLE & BUY               | TECHNICAL DOCUMENTS        | TOOLS & SOFTWARE           | SUPPORT & COMMUNITY        |
|------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| LM285-1.2  | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> |
| LM385-1.2  | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> |
| LM385B-1.2 | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> |

### 12.2 Trademarks

All trademarks are the property of their respective owners.

### 12.3 Electrostatic Discharge Caution



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

### 12.4 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

## 13 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

**PACKAGING INFORMATION**

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2)            | Lead/Ball Finish<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|------------------|---------------|--------------|--------------------|------|----------------|----------------------------|-------------------------|----------------------|--------------|-------------------------|-------------------------|
| LM285D-1-2       | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 85    | 285-12                  | <a href="#">Samples</a> |
| LM285DE4-1-2     | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 85    | 285-12                  | <a href="#">Samples</a> |
| LM285DG4-1-2     | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 85    | 285-12                  | <a href="#">Samples</a> |
| LM285DR-1-2      | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 85    | 285-12                  | <a href="#">Samples</a> |
| LM285DRE4-1-2    | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 85    | 285-12                  | <a href="#">Samples</a> |
| LM285DRG4-1-2    | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 85    | 285-12                  | <a href="#">Samples</a> |
| LM285LP-1-2      | ACTIVE        | TO-92        | LP                 | 3    | 1000           | Pb-Free<br>(RoHS)          | CU SN                   | N / A for Pkg Type   | -40 to 85    | 285-12                  | <a href="#">Samples</a> |
| LM285LPE3-1-2    | ACTIVE        | TO-92        | LP                 | 3    | 1000           | Pb-Free<br>(RoHS)          | CU SN                   | N / A for Pkg Type   | -40 to 85    | 285-12                  | <a href="#">Samples</a> |
| LM285LPRE3-1-2   | ACTIVE        | TO-92        | LP                 | 3    | 2000           | Pb-Free<br>(RoHS)          | CU SN                   | N / A for Pkg Type   | -40 to 85    | 285-12                  | <a href="#">Samples</a> |
| LM385-1.2-MWC    | ACTIVE        | WAFERSALE    | YS                 | 0    | 1              | Green (RoHS<br>& no Sb/Br) | Call TI                 | Level-1-NA-UNLIM     | -40 to 85    |                         | <a href="#">Samples</a> |
| LM385BD-1-2      | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | 385B12                  | <a href="#">Samples</a> |
| LM385BDE4-1-2    | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | 385B12                  | <a href="#">Samples</a> |
| LM385BDG4-1-2    | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | 385B12                  | <a href="#">Samples</a> |
| LM385BDR-1-2     | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | 385B12                  | <a href="#">Samples</a> |
| LM385BDRG4-1-2   | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | 385B12                  | <a href="#">Samples</a> |
| LM385BLP-1-2     | ACTIVE        | TO-92        | LP                 | 3    | 1000           | Pb-Free<br>(RoHS)          | CU SN                   | N / A for Pkg Type   | 0 to 70      | 385B12                  | <a href="#">Samples</a> |
| LM385BLPE3-1-2   | ACTIVE        | TO-92        | LP                 | 3    | 1000           | Pb-Free<br>(RoHS)          | CU SN                   | N / A for Pkg Type   | 0 to 70      | 385B12                  | <a href="#">Samples</a> |

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2)            | Lead/Ball Finish<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|------------------|---------------|--------------|--------------------|------|----------------|----------------------------|-------------------------|----------------------|--------------|-------------------------|-------------------------|
| LM385BLPR-1-2    | ACTIVE        | TO-92        | LP                 | 3    | 2000           | Pb-Free<br>(RoHS)          | CU SN                   | N / A for Pkg Type   | 0 to 70      | 385B12                  | <a href="#">Samples</a> |
| LM385BLPRE3-1-2  | ACTIVE        | TO-92        | LP                 | 3    | 2000           | Pb-Free<br>(RoHS)          | CU SN                   | N / A for Pkg Type   | 0 to 70      | 385B12                  | <a href="#">Samples</a> |
| LM385BPW-1-2     | ACTIVE        | TSSOP        | PW                 | 8    | 150            | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | 385B12                  | <a href="#">Samples</a> |
| LM385BPWR-1-2    | ACTIVE        | TSSOP        | PW                 | 8    | 2000           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | 385B12                  | <a href="#">Samples</a> |
| LM385D-1-2       | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | 385-12                  | <a href="#">Samples</a> |
| LM385DG4-1-2     | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | 385-12                  | <a href="#">Samples</a> |
| LM385DR-1-2      | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | 385-12                  | <a href="#">Samples</a> |
| LM385DRG4-1-2    | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | 385-12                  | <a href="#">Samples</a> |
| LM385LP-1-2      | ACTIVE        | TO-92        | LP                 | 3    | 1000           | Pb-Free<br>(RoHS)          | CU SN                   | N / A for Pkg Type   | 0 to 70      | 385-12                  | <a href="#">Samples</a> |
| LM385LPE3-1-2    | ACTIVE        | TO-92        | LP                 | 3    | 1000           | Pb-Free<br>(RoHS)          | CU SN                   | N / A for Pkg Type   | 0 to 70      | 385-12                  | <a href="#">Samples</a> |
| LM385LPR-1-2     | ACTIVE        | TO-92        | LP                 | 3    | 2000           | Pb-Free<br>(RoHS)          | CU SN                   | N / A for Pkg Type   | 0 to 70      | 385-12                  | <a href="#">Samples</a> |
| LM385LPRE3-1-2   | ACTIVE        | TO-92        | LP                 | 3    | 2000           | Pb-Free<br>(RoHS)          | CU SN                   | N / A for Pkg Type   | 0 to 70      | 385-12                  | <a href="#">Samples</a> |
| LM385PW-1-2      | ACTIVE        | TSSOP        | PW                 | 8    | 150            | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | 385-12                  | <a href="#">Samples</a> |
| LM385PWE4-1-2    | ACTIVE        | TSSOP        | PW                 | 8    | 150            | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | 385-12                  | <a href="#">Samples</a> |
| LM385PWR-1-2     | ACTIVE        | TSSOP        | PW                 | 8    | 2000           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | 385-12                  | <a href="#">Samples</a> |
| LM385PWRE4-1-2   | ACTIVE        | TSSOP        | PW                 | 8    | 2000           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | 385-12                  | <a href="#">Samples</a> |

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

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**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

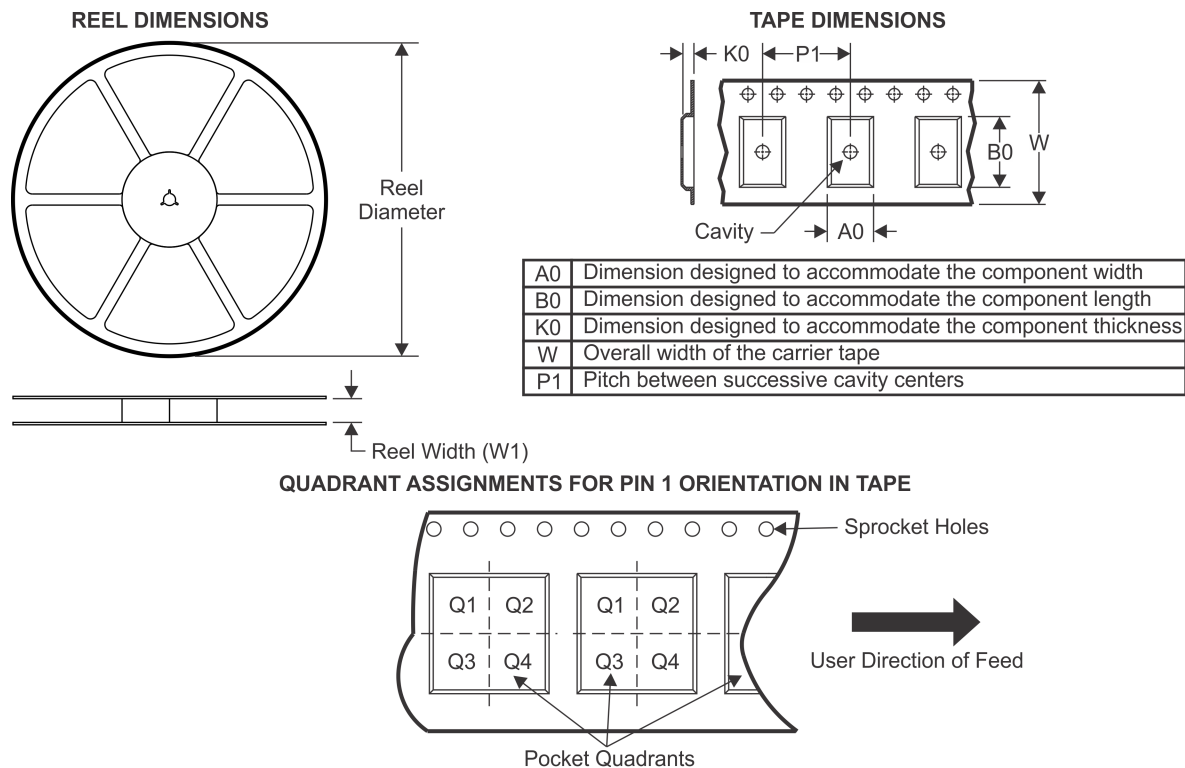
<sup>(4)</sup> There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

<sup>(5)</sup> Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

<sup>(6)</sup> Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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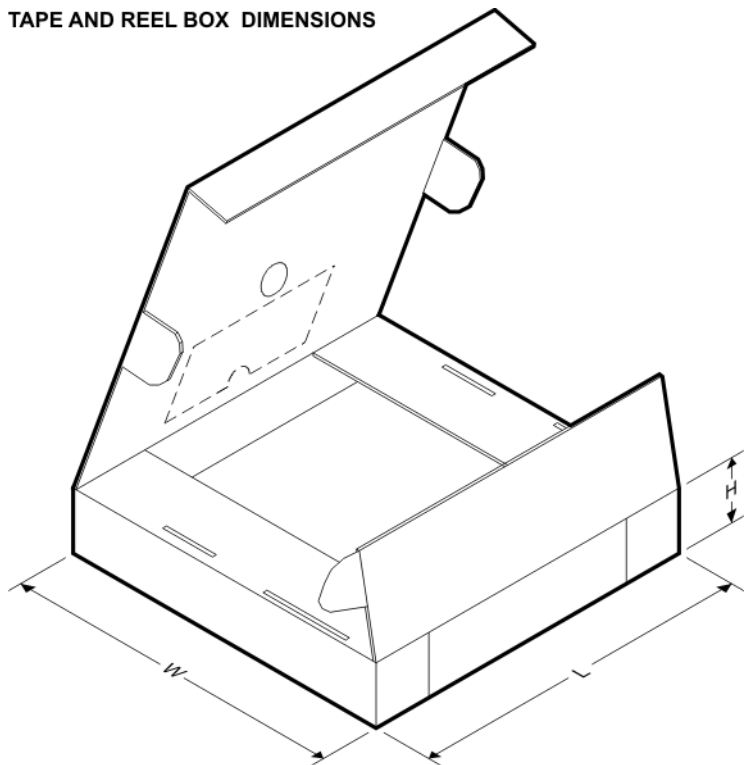
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**TAPE AND REEL INFORMATION**


\*All dimensions are nominal

| Device        | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|---------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| LM285DR-1-2   | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM385BDR-1-2  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM385BPWR-1-2 | TSSOP        | PW              | 8    | 2000 | 330.0              | 12.4               | 7.0     | 3.6     | 1.6     | 8.0     | 12.0   | Q1            |
| LM385DR-1-2   | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM385PWR-1-2  | TSSOP        | PW              | 8    | 2000 | 330.0              | 12.4               | 7.0     | 3.6     | 1.6     | 8.0     | 12.0   | Q1            |

## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

| Device        | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|---------------|--------------|-----------------|------|------|-------------|------------|-------------|
| LM285DR-1-2   | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| LM385BDR-1-2  | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| LM385BPWR-1-2 | TSSOP        | PW              | 8    | 2000 | 367.0       | 367.0      | 35.0        |
| LM385DR-1-2   | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| LM385PWR-1-2  | TSSOP        | PW              | 8    | 2000 | 367.0       | 367.0      | 35.0        |

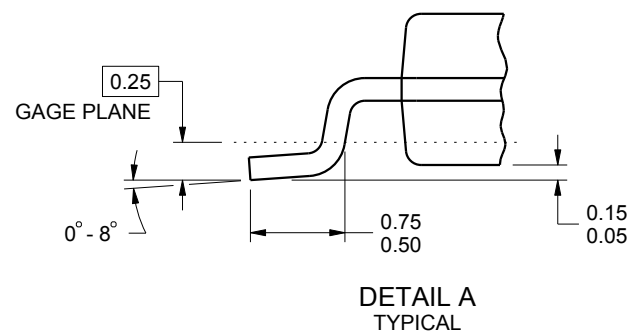
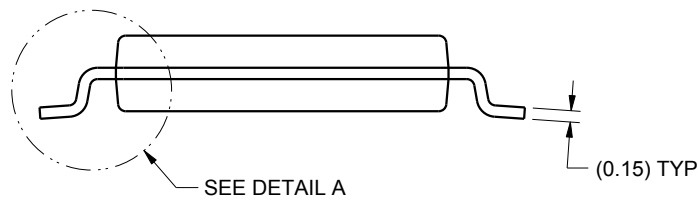
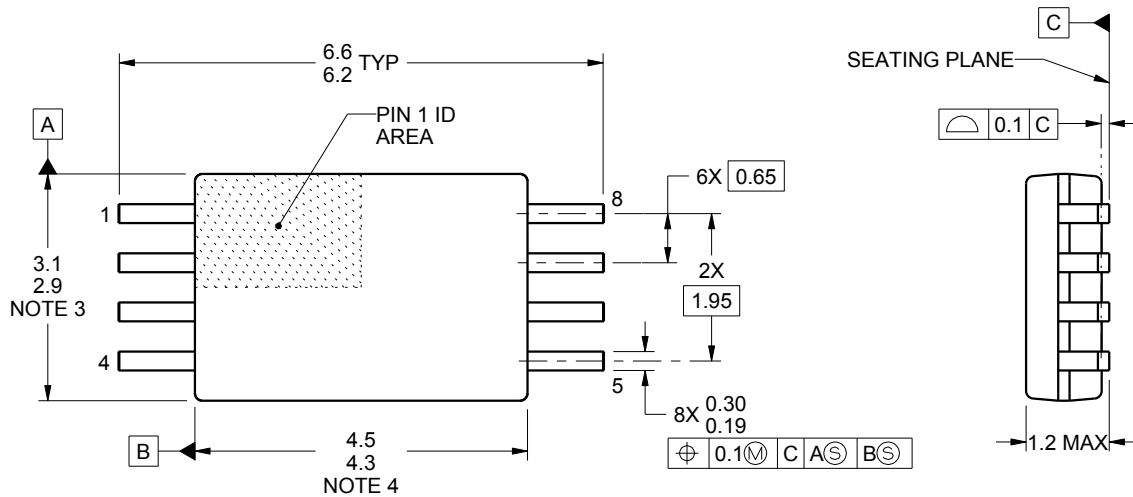
PW0008A



# PACKAGE OUTLINE

## TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



4221848/A 02/2015

### NOTES:

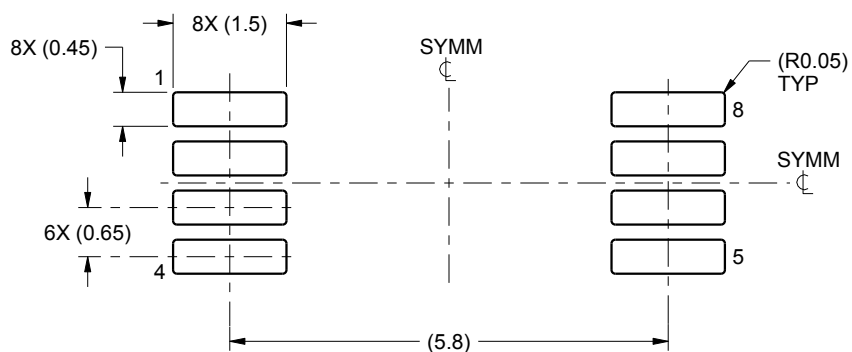
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-153, variation AA.

# EXAMPLE BOARD LAYOUT

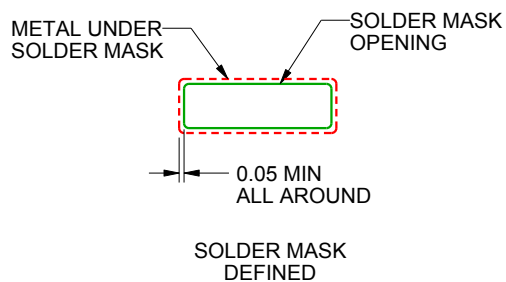
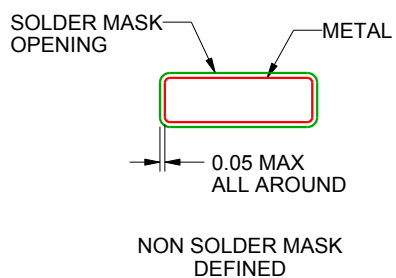
PW0008A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
SCALE:10X



SOLDER MASK DETAILS  
NOT TO SCALE

4221848/A 02/2015

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

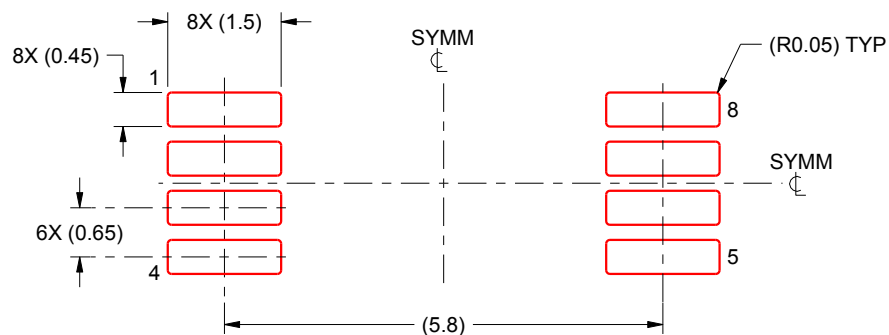
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

## EXAMPLE STENCIL DESIGN

PW0008A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE:10X

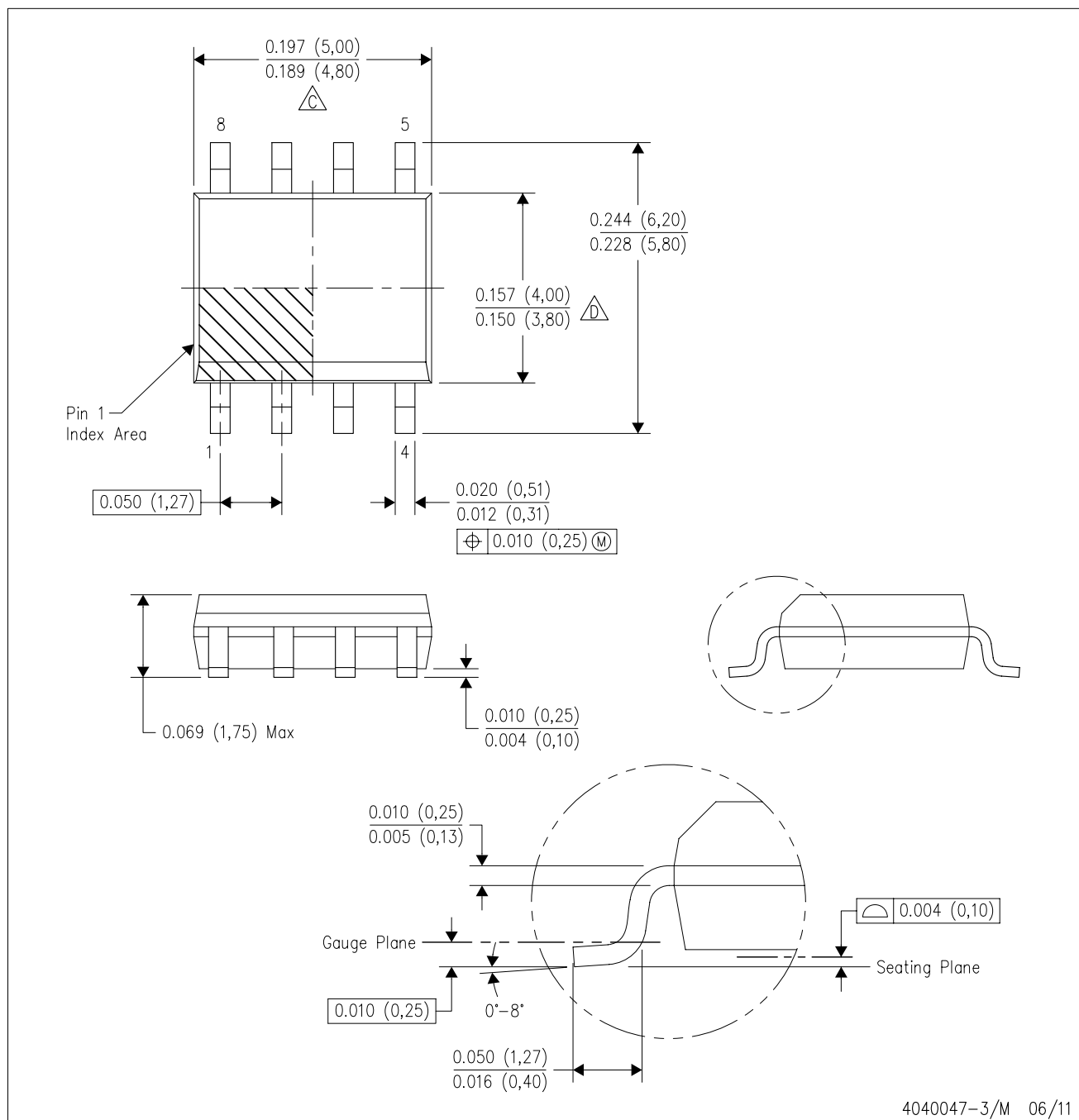
4221848/A 02/2015

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

D (R-PDSO-G8)

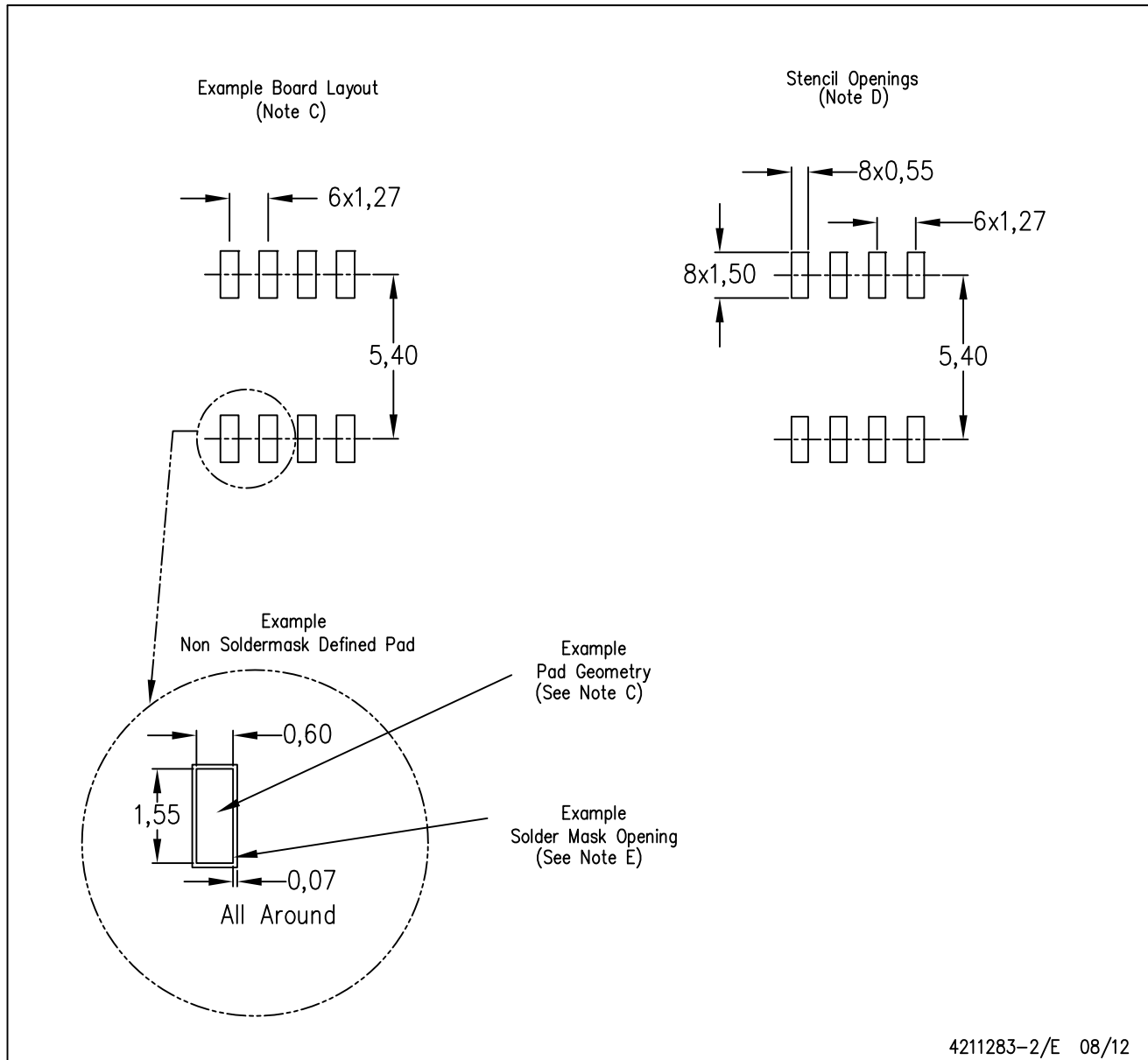
PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - $\triangle C$  Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
  - $\triangle D$  Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
  - E. Reference JEDEC MS-012 variation AA.

D (R-PDSO-G8)

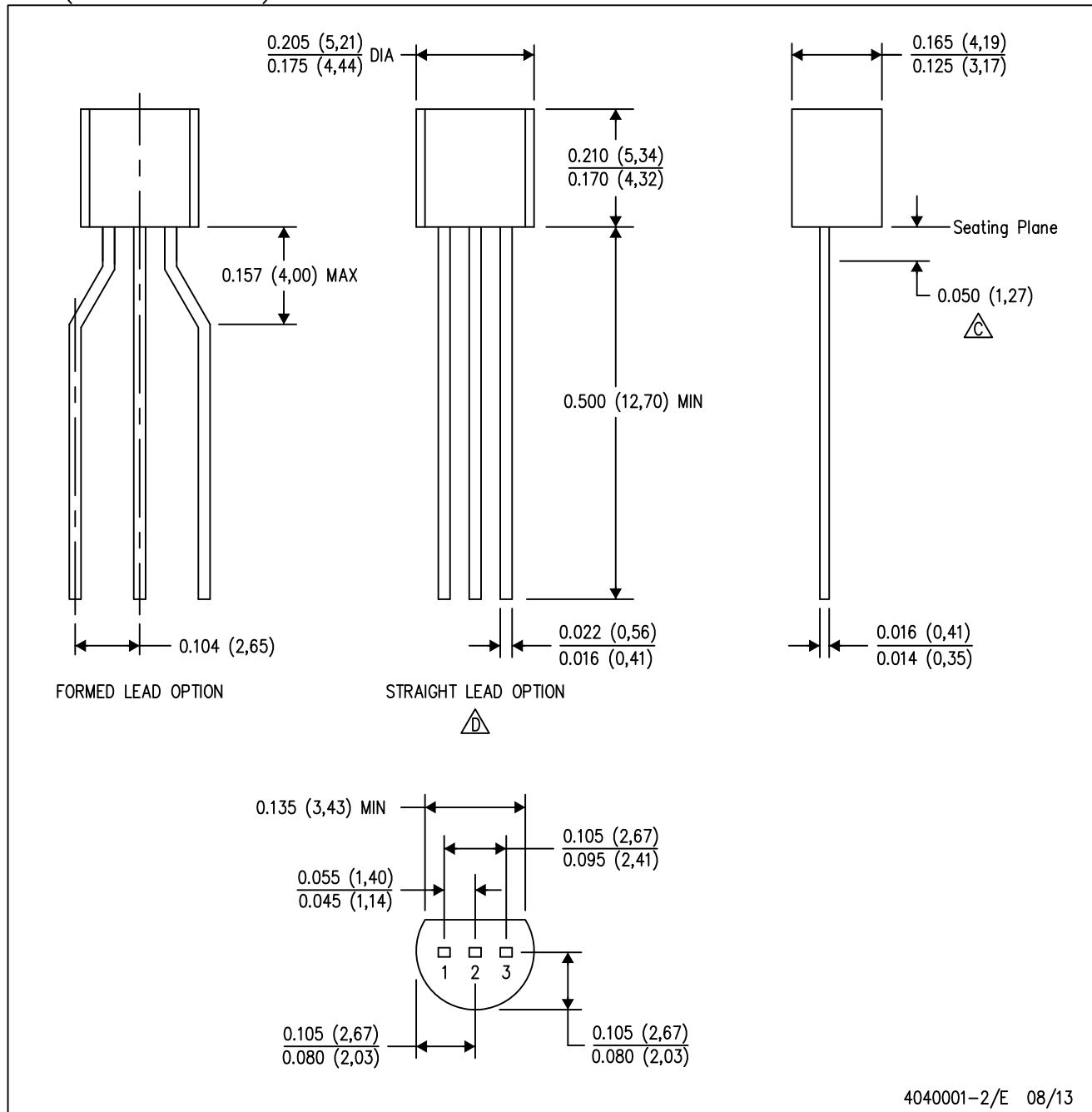
PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Publication IPC-7351 is recommended for alternate designs.
  - D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
  - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

LP (O-PBCY-W3)

PLASTIC CYLINDRICAL PACKAGE

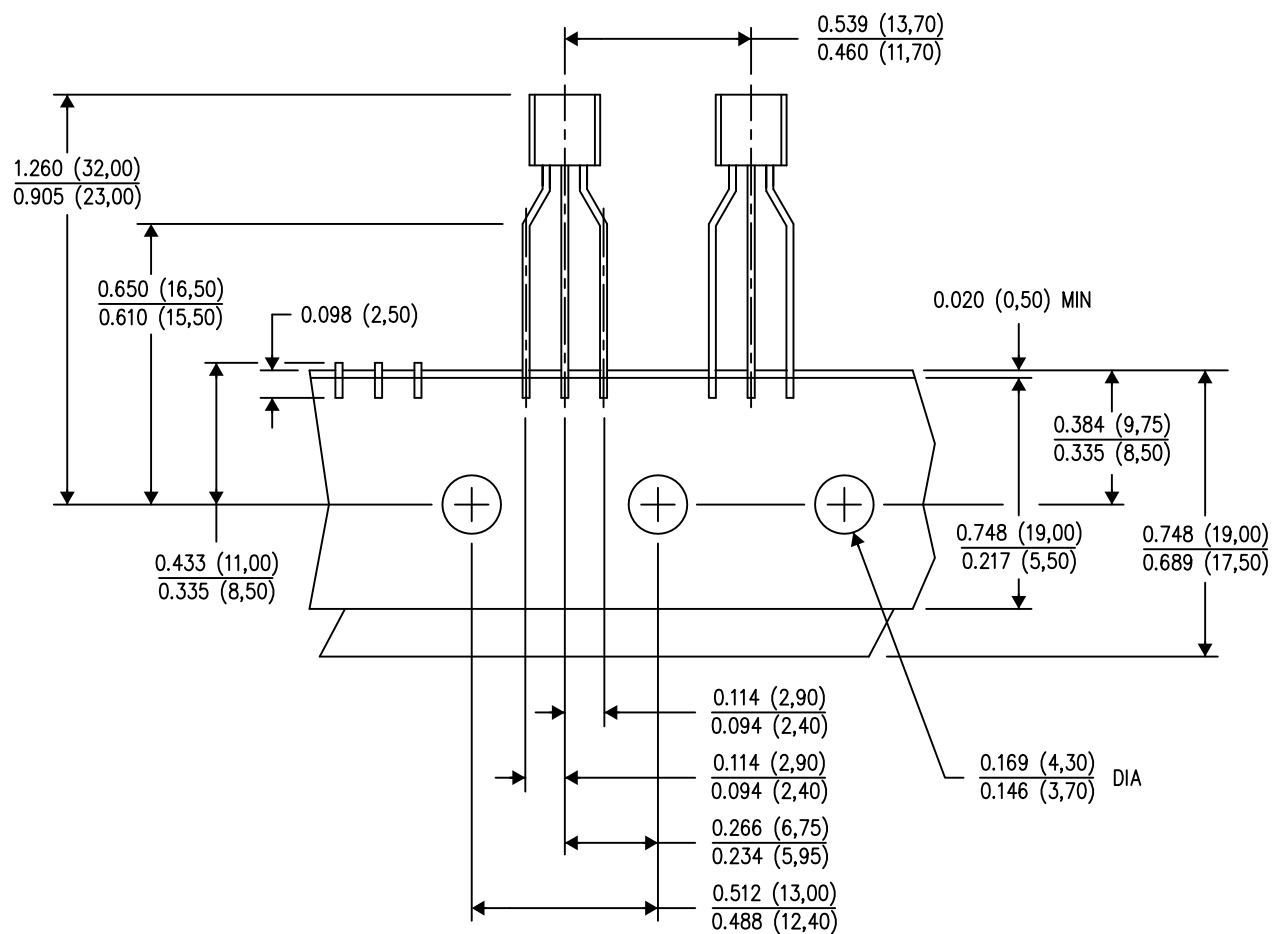


4040001-2/E 08/13

- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Lead dimensions are not controlled within this area.
  - D. Falls within JEDEC TO-226 Variation AA (TO-226 replaces TO-92).
  - E. Shipping Method:  
 Straight lead option available in bulk pack only.  
 Formed lead option available in tape & reel or ammo pack.  
 Specific products can be offered in limited combinations of shipping mediums and lead options.  
 Consult product folder for more information on available options.

LP (O-PBCY-W3)

PLASTIC CYLINDRICAL PACKAGE



TAPE &amp; REEL

4040001-3/E 08/13

- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Tape and Reel information for the Formed Lead Option package.

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| Data Converters              | <a href="http://dataconverter.ti.com">dataconverter.ti.com</a>                       |
| DLP® Products                | <a href="http://www.dlp.com">www.dlp.com</a>                                         |
| DSP                          | <a href="http://dsp.ti.com">dsp.ti.com</a>                                           |
| Clocks and Timers            | <a href="http://www.ti.com/clocks">www.ti.com/clocks</a>                             |
| Interface                    | <a href="http://interface.ti.com">interface.ti.com</a>                               |
| Logic                        | <a href="http://logic.ti.com">logic.ti.com</a>                                       |
| Power Mgmt                   | <a href="http://power.ti.com">power.ti.com</a>                                       |
| Microcontrollers             | <a href="http://microcontroller.ti.com">microcontroller.ti.com</a>                   |
| RFID                         | <a href="http://www.ti-rfid.com">www.ti-rfid.com</a>                                 |
| OMAP Applications Processors | <a href="http://www.ti.com/omap">www.ti.com/omap</a>                                 |
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### Applications

|                               |                                                                                          |
|-------------------------------|------------------------------------------------------------------------------------------|
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| Communications and Telecom    | <a href="http://www.ti.com/communications">www.ti.com/communications</a>                 |
| Computers and Peripherals     | <a href="http://www.ti.com/computers">www.ti.com/computers</a>                           |
| Consumer Electronics          | <a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>                   |
| Energy and Lighting           | <a href="http://www.ti.com/energy">www.ti.com/energy</a>                                 |
| Industrial                    | <a href="http://www.ti.com/industrial">www.ti.com/industrial</a>                         |
| Medical                       | <a href="http://www.ti.com/medical">www.ti.com/medical</a>                               |
| Security                      | <a href="http://www.ti.com/security">www.ti.com/security</a>                             |
| Space, Avionics and Defense   | <a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a> |
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