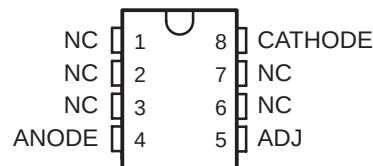


# LM236-2.5, LM336-2.5, LM336B-2.5 2.5-V INTEGRATED REFERENCE CIRCUITS

SLVS063E – NOVEMBER 1988 – REVISED OCTOBER 2003

- Low Temperature Coefficient
- Wide Operating Current . . . 400  $\mu$ A to 10 mA
- 0.27- $\Omega$  Dynamic Impedance
- $\pm 1\%$  Tolerance Available
- Specified Temperature Stability
- Easily Trimmed for Minimum Temperature Drift
- Fast Turnon

D PACKAGE  
(TOP VIEW)



NC – No internal connection

LM336-2.5, LM336B-2.5 . . . LP PACKAGE  
(TOP VIEW)



## description/ordering information

The LM236-2.5, LM336-2.5, and LM336B-2.5 integrated circuits are precision 2.5-V shunt regulator diodes. These reference circuits operate as low-temperature-coefficient 2.5-V Zener diodes with a 0.2- $\Omega$  dynamic impedance. A third terminal provided on the circuit allows the reference voltage and temperature coefficient to be trimmed easily.

The series is useful as precision 2.5-V low-voltage references ( $V_Z$ ) for digital voltmeters, power supplies, or operational-amplifier circuitry. The 2.5-V voltage reference makes it convenient to obtain a stable reference from 5-V logic supplies. Devices in this series operate as shunt regulators, and can be used as either positive or negative voltage references.

The LM236-2.5 is characterized for operation from  $-25^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ . The LM336-2.5 and LM336B-2.5 are characterized for operation from  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ .

## ORDERING INFORMATION

| $T_A$                                         | PACKAGE <sup>†</sup> |              | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|-----------------------------------------------|----------------------|--------------|-----------------------|------------------|
| $0^{\circ}\text{C}$ to $70^{\circ}\text{C}$   | SOIC (D)             | Tube of 75   | LM336D-2-5            | 336-25           |
|                                               |                      | Reel of 2500 | LM336DR-2-5           |                  |
|                                               |                      | Tube of 75   | LM336BD-2-5           | 336B25           |
|                                               |                      | Reel of 2500 | LM336BDR-2-5          |                  |
|                                               | TO-226 / TO-92 (LP)  | Bulk of 1000 | LM336LP-2-5           | 336-25           |
|                                               |                      | Reel of 2000 | LM336LPR-2-5          |                  |
|                                               |                      | Bulk of 1000 | LM336BLP-2-5          | 336B25           |
|                                               |                      | Reel of 2000 | LM336BLPR-2-5         |                  |
| $-25^{\circ}\text{C}$ to $85^{\circ}\text{C}$ | SOIC (D)             | Tube of 75   | LM236D-2-5            | 236-25           |
|                                               |                      | Reel of 2500 | LM236DR-2-5           |                  |

<sup>†</sup> Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/package).



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 **TEXAS  
INSTRUMENTS**

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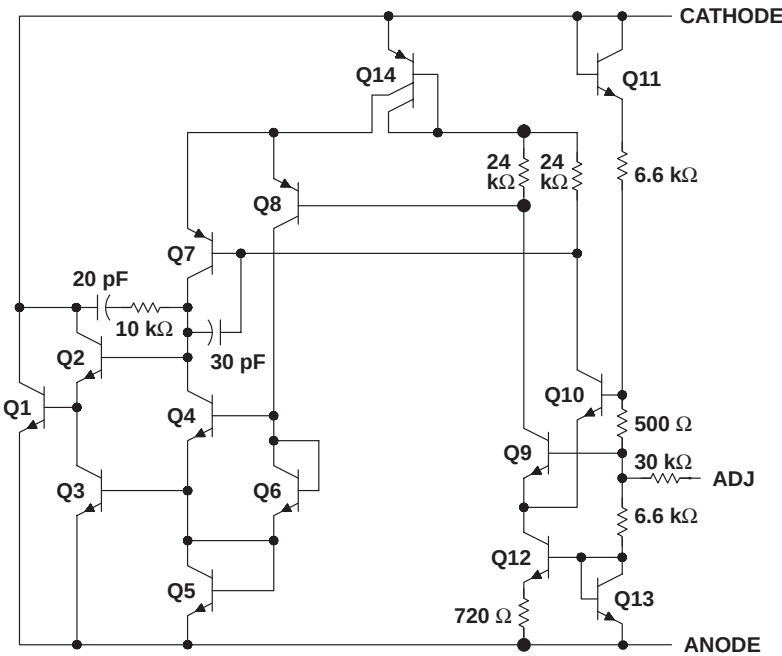
LM236-2.5, LM336-2.5, LM336B-2.5  
2.5-V INTEGRATED REFERENCE CIRCUITS

SLVS063E – NOVEMBER 1988 – REVISED OCTOBER 2003

symbol



schematic diagram



NOTE A: All component values are nominal.

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)<sup>†</sup>

|                                                                         |                |
|-------------------------------------------------------------------------|----------------|
| Reverse current, $I_R$                                                  | 20 mA          |
| Forward current, $I_F$                                                  | 10 mA          |
| Package thermal impedance, $\theta_{JA}$ (see Notes 1 and 2): D package | 97°C/W         |
| LP package                                                              | 140°C/W        |
| Operating virtual junction temperature, $T_J$                           | 150°C          |
| Storage temperature range, $T_{Stg}$                                    | -65°C to 150°C |

<sup>†</sup> Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTES: 1. Maximum power dissipation is a function of  $T_J(\text{max})$ ,  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_J(\text{max}) - T_A)/\theta_{JA}$ . Operating at the absolute maximum  $T_J$  of 150°C can impact reliability.  
2. The package thermal impedance is calculated in accordance with JESD 51-7.

recommended operating conditions

|                                      |                       | MIN | MAX | UNIT |
|--------------------------------------|-----------------------|-----|-----|------|
| $T_A$ Operating free-air temperature | LM236-2.5             | -25 | 85  | °C   |
|                                      | LM336-2.5, LM336B-2.5 | 0   | 70  |      |

# LM236-2.5, LM336-2.5, LM336B-2.5 2.5-V INTEGRATED REFERENCE CIRCUITS

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## electrical characteristics at specified free-air temperature (unless otherwise noted)

| PARAMETER                                                           | TEST CONDITIONS                                    |                        | $T_A^\dagger$ | LM236-2.5 |      |      | LM336-2.5 |      |      | UNIT    |
|---------------------------------------------------------------------|----------------------------------------------------|------------------------|---------------|-----------|------|------|-----------|------|------|---------|
|                                                                     |                                                    |                        |               | MIN       | TYP  | MAX  | MIN       | TYP  | MAX  |         |
| $V_Z$ Reference voltage                                             | $I_Z = 1 \text{ mA}$                               | LM236, LM336<br>LM336B | 25°C          | 2.44      | 2.49 | 2.54 | 2.39      | 2.49 | 2.59 | V       |
| $\Delta V_Z(\Delta T)$ Change in reference voltage with temperature | $V_Z$ adjusted to 2.490 V,<br>$I_Z = 1 \text{ mA}$ |                        | Full range    |           | 3.5  | 9    |           | 1.8  | 6    | mV      |
| $\Delta V_Z(\Delta I)$ Change in reference voltage with current     | $I_Z = 400 \mu\text{A}$ to 10 mA                   |                        | 25°C          |           | 2.6  | 6    |           | 2.6  | 10   | mV      |
|                                                                     |                                                    |                        | Full range    |           | 3    | 10   |           | 3    | 12   |         |
| $\Delta V_Z(\Delta t)$ Long-term change in reference voltage        | $I_Z = 1 \text{ mA}$                               |                        | 25°C          |           | 20   |      |           | 20   |      | ppm/khr |
| $z_z$ Reference impedance                                           | $I_Z = 1 \text{ mA}, f = 1 \text{ kHz}$            |                        | 25°C          |           | 0.2  | 0.6  |           | 0.2  | 1    | W       |
|                                                                     |                                                    |                        | Full range    |           | 0.4  | 1    |           | 0.4  | 1.4  |         |

<sup>†</sup> Full range is -25°C to 85°C for the LM236-2.5 and 0°C to 70°C for the LM336-2.5 and LM336B-2.5.



LM236-2.5, LM336-2.5, LM336B-2.5  
2.5-V INTEGRATED REFERENCE CIRCUITS

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TYPICAL CHARACTERISTICS

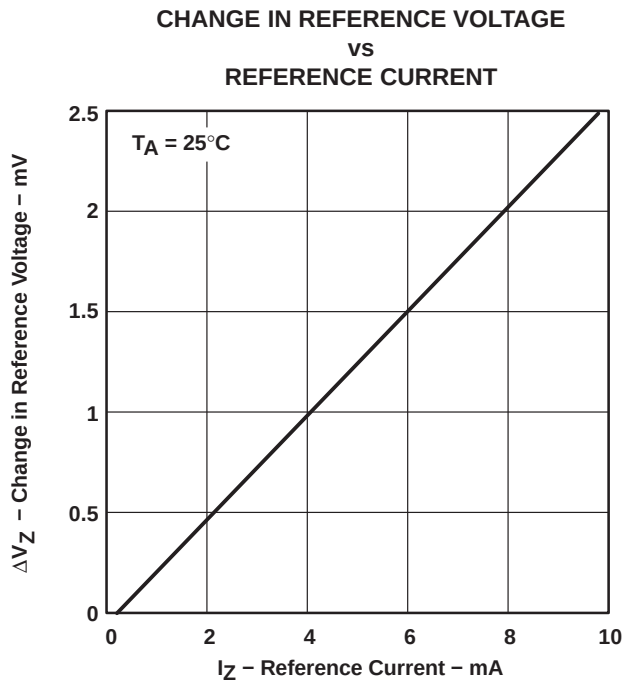


Figure 1

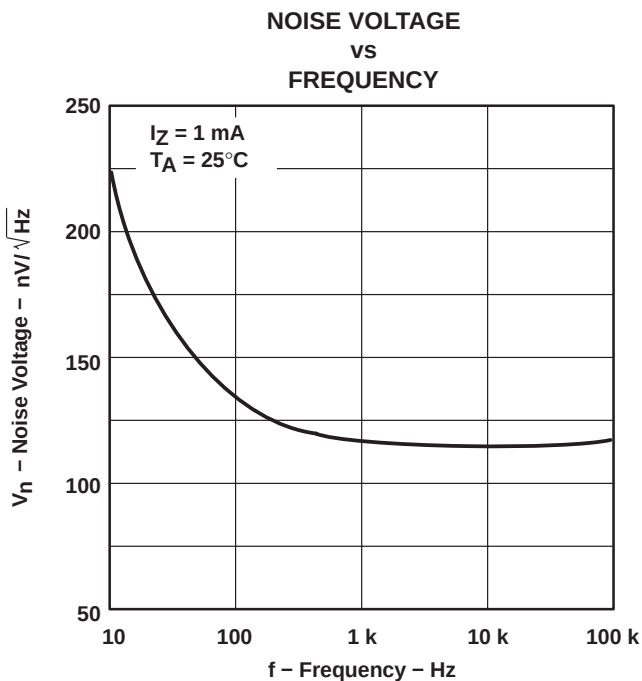


Figure 2

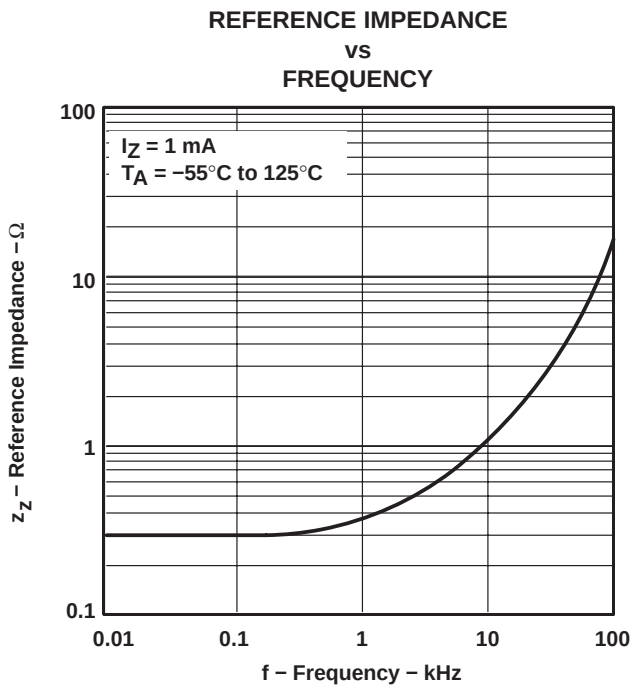


Figure 3

**APPLICATION INFORMATION**

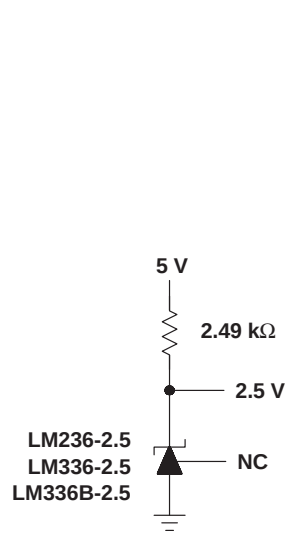


**Figure 4. 2.5-V Reference**

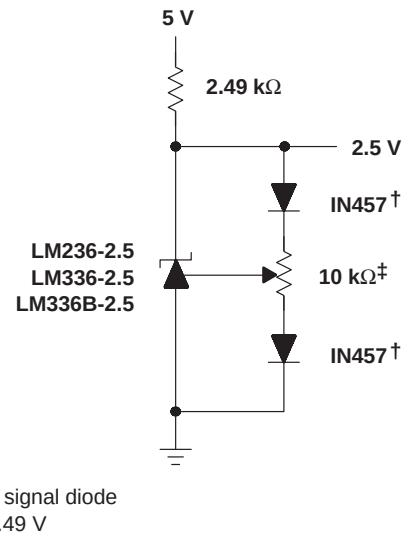


**Figure 5. 2.5-V Reference  
With Minimum Temperature Coefficient**

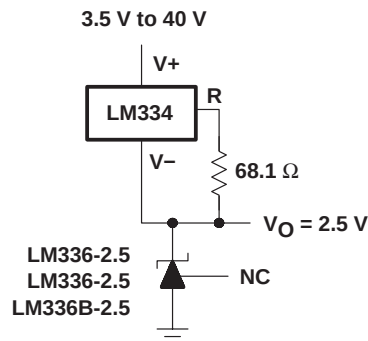


**Figure 6. Wide-Input-Range Reference**

**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                 |
|------------------|---------------|--------------|--------------------|------|----------------|----------------------------|-------------------------|----------------------|--------------|-------------------------|-------------------------|
| LM236D-2-5       | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -25 to 85    | 236-25                  | <a href="#">Samples</a> |
| LM236DE4-2-5     | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -25 to 85    | 236-25                  | <a href="#">Samples</a> |
| LM236DG4-2-5     | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -25 to 85    | 236-25                  | <a href="#">Samples</a> |
| LM236DR-2-5      | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -25 to 85    | 236-25                  | <a href="#">Samples</a> |
| LM236LP-2-5      | OBSOLETE      | TO-92        | LP                 | 3    |                | TBD                        | Call TI                 | Call TI              | -25 to 85    |                         |                         |
| LM336BD-2-5      | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | 336B25                  | <a href="#">Samples</a> |
| LM336BDG4-2-5    | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | 336B25                  | <a href="#">Samples</a> |
| LM336BDR-2-5     | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | 336B25                  | <a href="#">Samples</a> |
| LM336BLP-2-5     | ACTIVE        | TO-92        | LP                 | 3    | 1000           | Pb-Free<br>(RoHS)          | CU SN                   | N / A for Pkg Type   | 0 to 70      | 336B25                  | <a href="#">Samples</a> |
| LM336BLPE3-2-5   | ACTIVE        | TO-92        | LP                 | 3    | 1000           | Pb-Free<br>(RoHS)          | CU SN                   | N / A for Pkg Type   | 0 to 70      | 336B25                  | <a href="#">Samples</a> |
| LM336BLPR-2-5    | ACTIVE        | TO-92        | LP                 | 3    | 2000           | Pb-Free<br>(RoHS)          | CU SN                   | N / A for Pkg Type   | 0 to 70      | 336B25                  | <a href="#">Samples</a> |
| LM336D-2-5       | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | 336-25                  | <a href="#">Samples</a> |
| LM336DG4-2-5     | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | 336-25                  | <a href="#">Samples</a> |
| LM336DR-2-5      | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | 336-25                  | <a href="#">Samples</a> |
| LM336LP-2-5      | ACTIVE        | TO-92        | LP                 | 3    | 1000           | Pb-Free<br>(RoHS)          | CU SN                   | N / A for Pkg Type   | 0 to 70      | 336-25                  | <a href="#">Samples</a> |
| LM336LPE3-2-5    | ACTIVE        | TO-92        | LP                 | 3    | 1000           | Pb-Free<br>(RoHS)          | CU SN                   | N / A for Pkg Type   | 0 to 70      | 336-25                  | <a href="#">Samples</a> |
| LM336LPR-2-5     | ACTIVE        | TO-92        | LP                 | 3    | 2000           | Pb-Free<br>(RoHS)          | CU SN                   | N / A for Pkg Type   | 0 to 70      | 336-25                  | <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                 |
|------------------|---------------|--------------|--------------------|------|----------------|-------------------|-------------------------|----------------------|--------------|-------------------------|-------------------------|
| LM336LPRE3-2-5   | ACTIVE        | TO-92        | LP                 | 3    | 2000           | Pb-Free<br>(RoHS) | CU SN                   | N / A for Pkg Type   | 0 to 70      | 336-25                  | <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.

**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.

(2) 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)

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

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

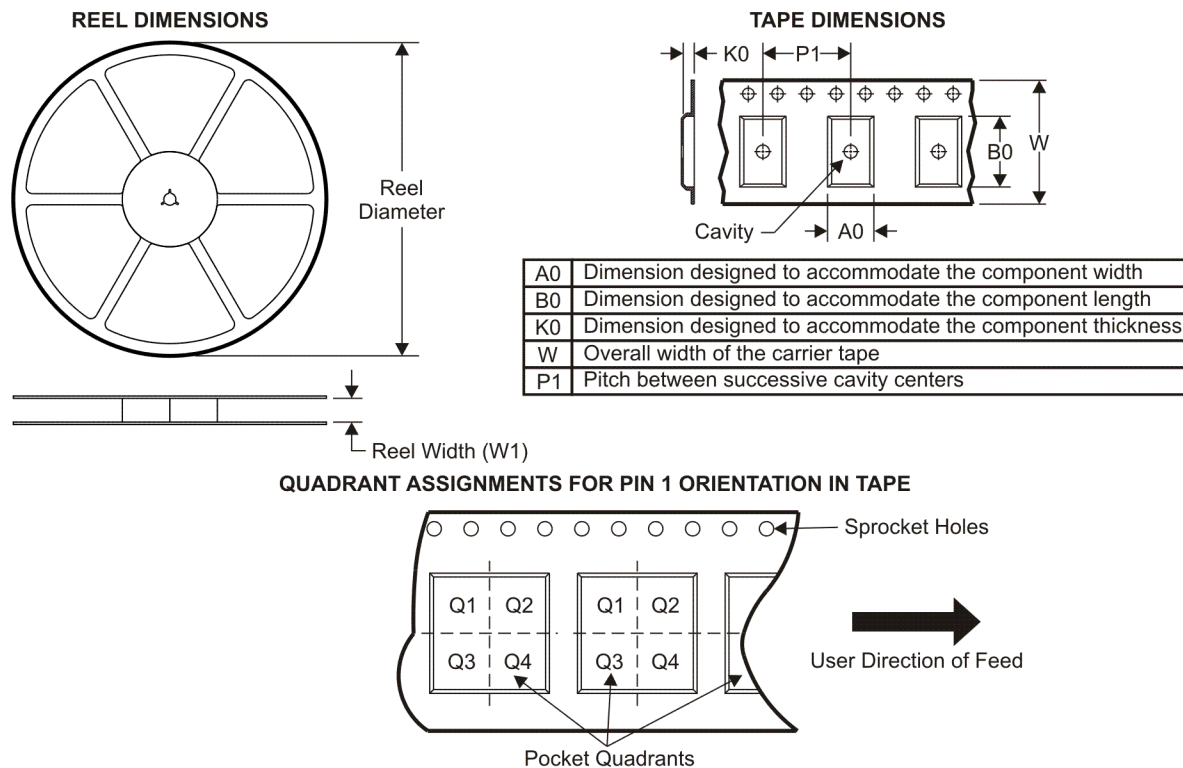
(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) 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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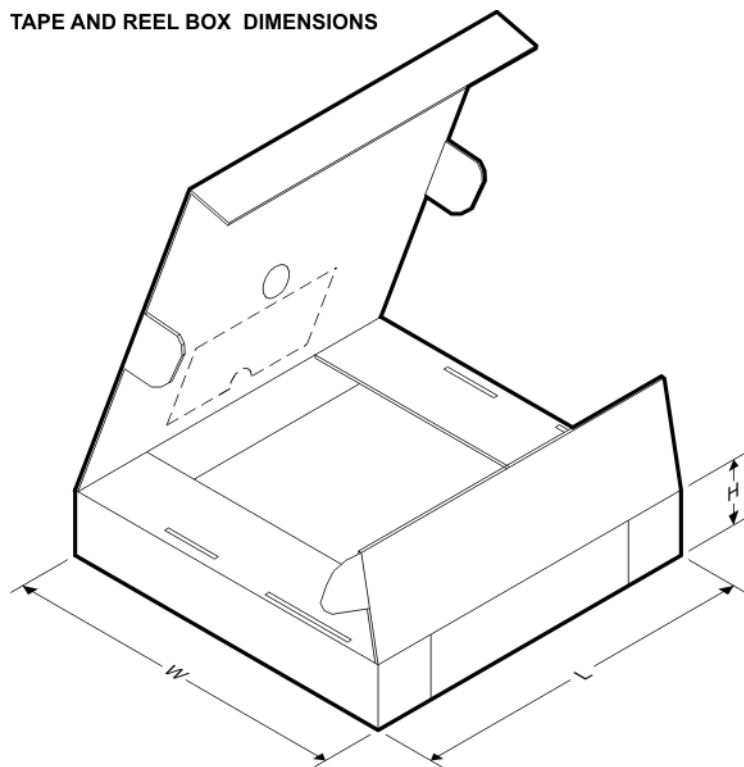
**TAPE AND REEL INFORMATION**



\*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 |
|--------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| LM236DR-2-5  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM336BDR-2-5 | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM336DR-2-5  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |

## TAPE AND REEL BOX DIMENSIONS

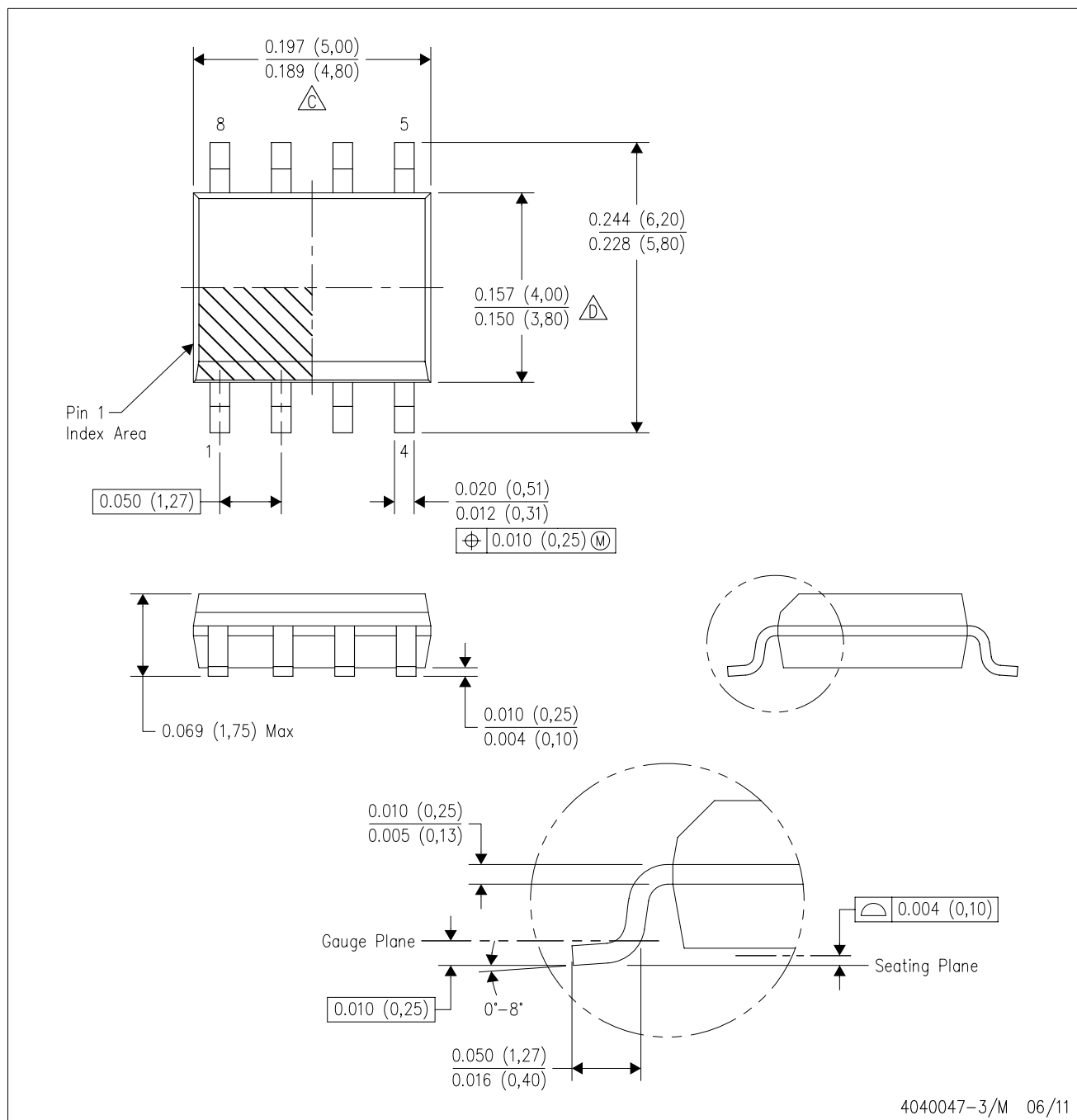


\*All dimensions are nominal

| Device       | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|--------------|--------------|-----------------|------|------|-------------|------------|-------------|
| LM236DR-2-5  | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| LM336BDR-2-5 | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| LM336DR-2-5  | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |

D (R-PDSO-G8)

PLASTIC SMALL OUTLINE

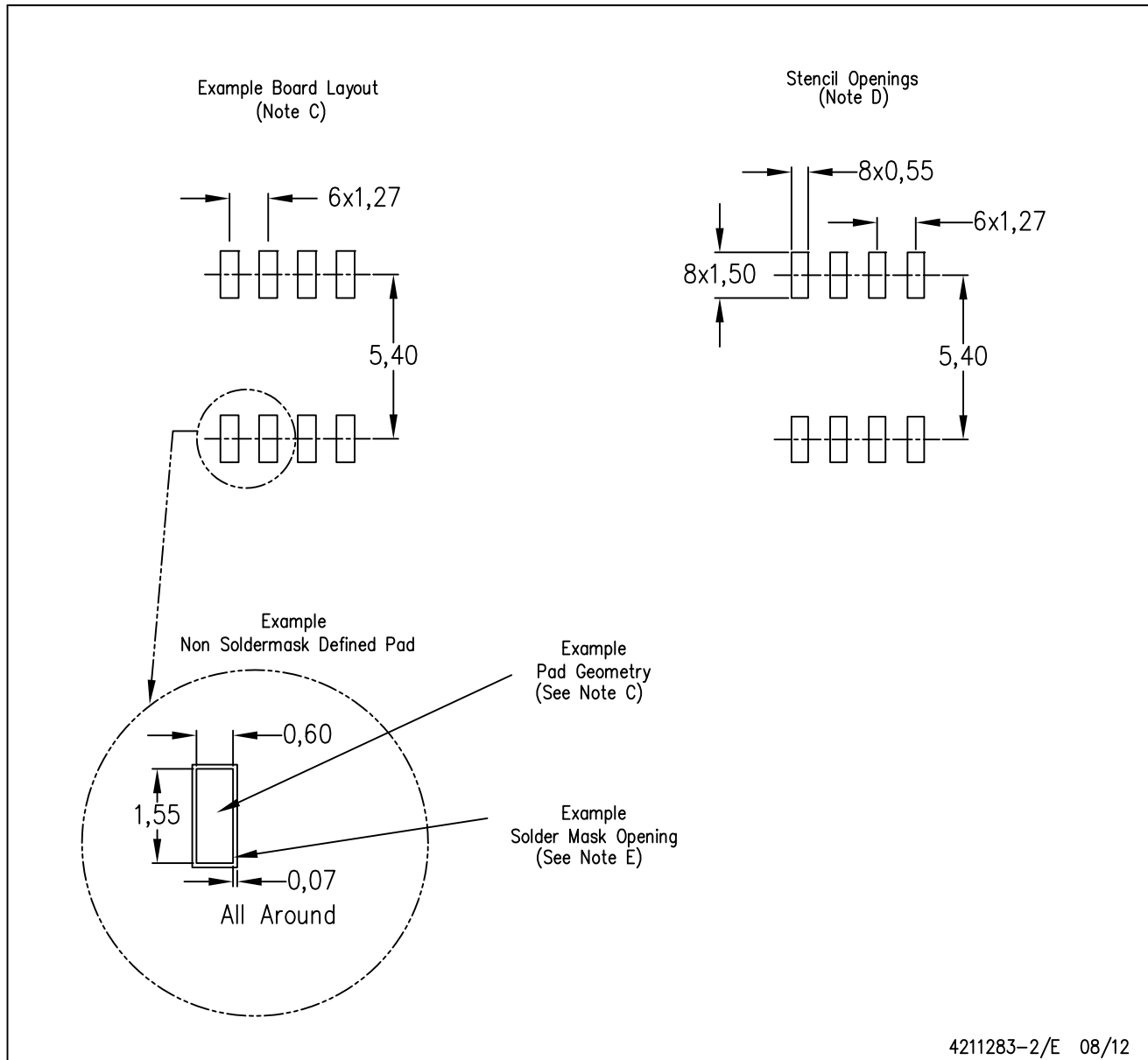


## NOTES:

- 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)

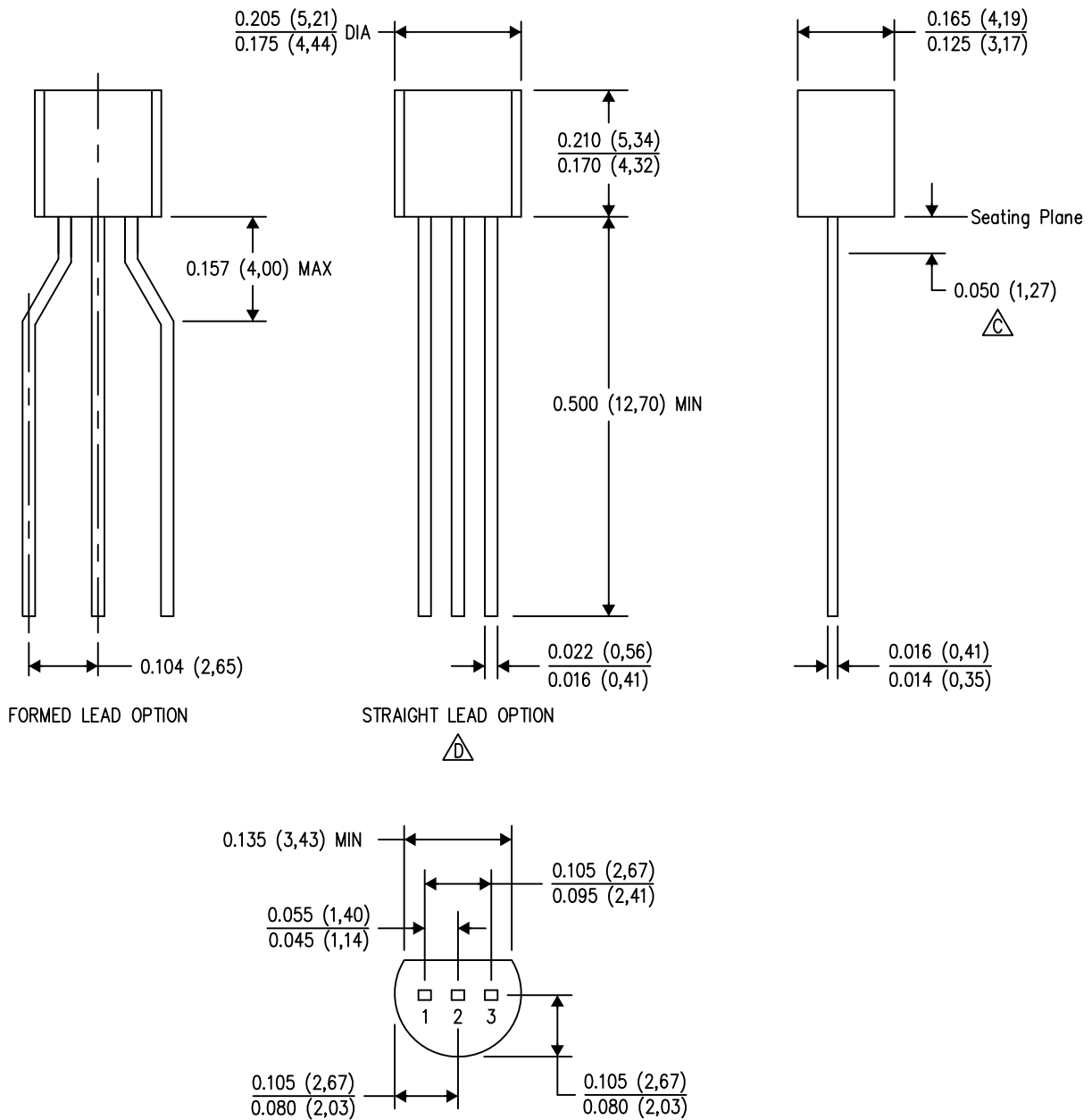
PLASTIC SMALL OUTLINE



- 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

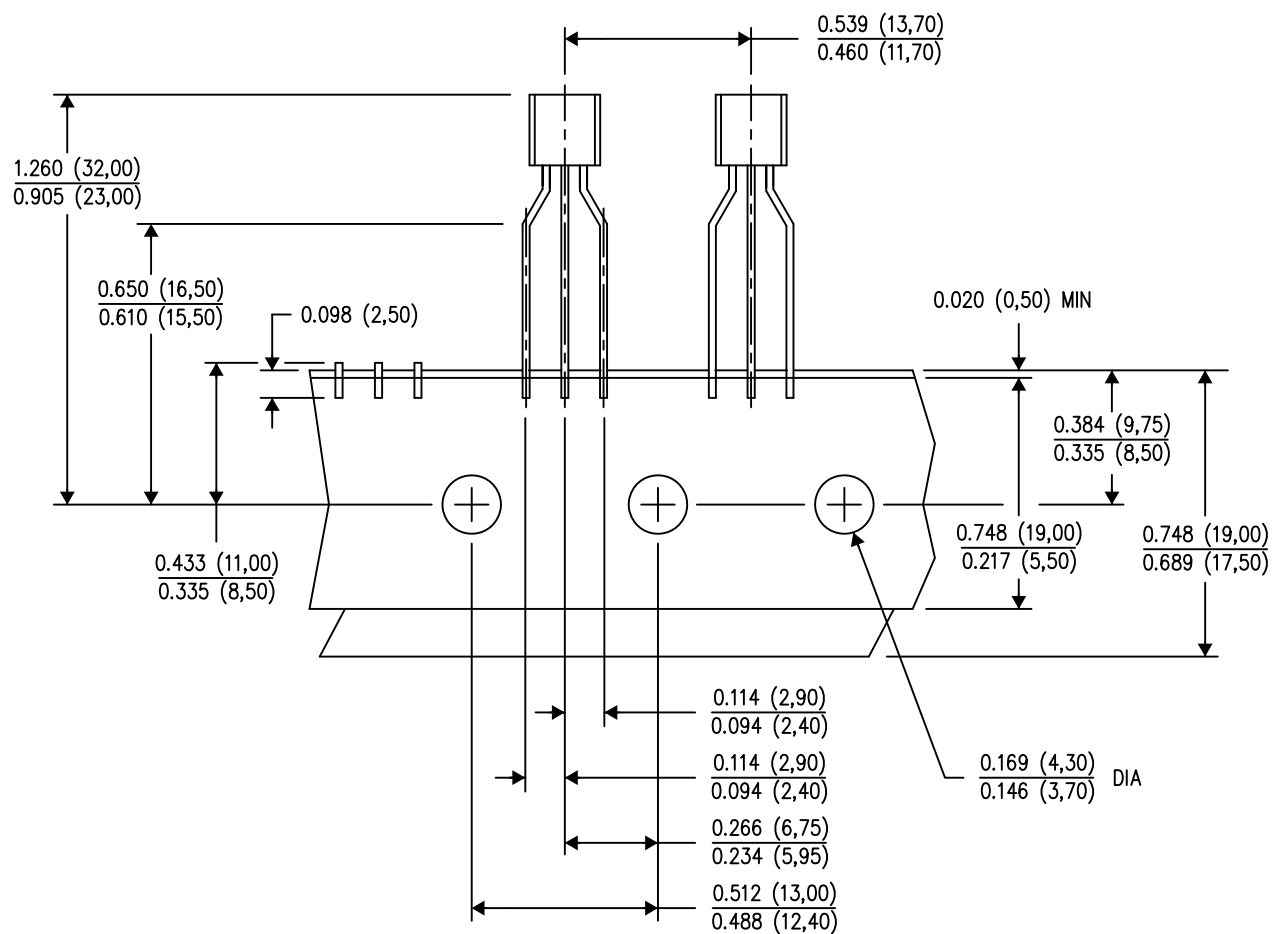


4040001-2/E 08/13

- 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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Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

### Products

|                              |                                                                                      |
|------------------------------|--------------------------------------------------------------------------------------|
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| Amplifiers                   | <a href="http://amplifier.ti.com">amplifier.ti.com</a>                               |
| 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>                                 |
| Wireless Connectivity        | <a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a> |

### Applications

|                               |                                                                                          |
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