

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 μ A to 10 mA
- 0.27- Ω Dynamic Impedance
- \pm 1% Tolerance Available
- Specified Temperature Stability
- Easily Trimmed for Minimum Temperature Drift
- Fast Turnon

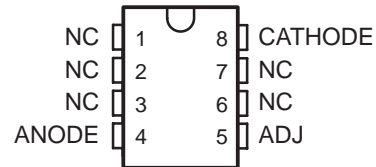
description/ordering information

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- Ω 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°C to 85°C . The LM336-2.5 and LM336B-2.5 are characterized for operation from 0°C to 70°C .

D PACKAGE
(TOP VIEW)



NC – No internal connection

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



ORDERING INFORMATION

| T_A | PACKAGE† | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|---|---------------------|--------------|-----------------------|------------------|
| 0°C to 70°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°C to 85°C | SOIC (D) | Tube of 75 | LM236D-2-5 | 236-25 |
| | | Reel of 2500 | LM236DR-2-5 | |

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.



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PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

 **TEXAS
INSTRUMENTS**

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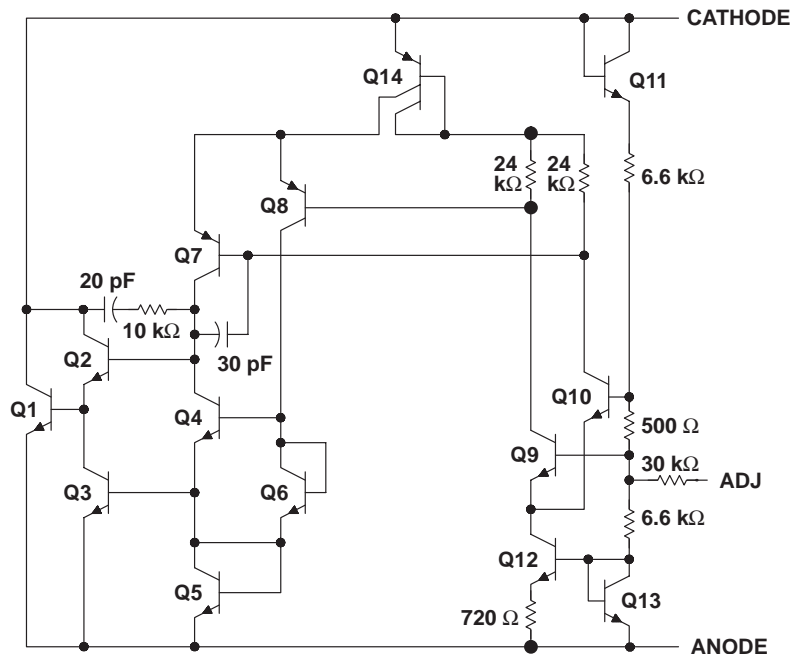
LM236-2.5, LM336-2.5, LM336B-2.5 2.5-V INTEGRATED REFERENCE CIRCUITS

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symbol



schematic diagram



NOTE A: All component values are nominal.

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

| | |
|---|----------------|
| Reverse current, I_R | 20 mA |
| Forward current, I_F | 10 mA |
| Package thermal impedance, θ_{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 |

† 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 $T_{J(max)}$, θ_{JA} , and T_A . The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_{J(max)} - T_A)/\theta_{JA}$. 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 † | LM236-2.5 | | | LM336-2.5 | | | UNIT | | | |
|---|---|------------|--------------|-----|-----|-----------|------|------|------|------|---------|---|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | | | | |
| V_Z Reference voltage | $I_Z = 1 \text{ mA}$ | 25°C | LM236, LM336 | | | 2.44 | 2.49 | 2.54 | 2.39 | 2.49 | 2.59 | V |
| | | | LM336B | | | | | | 2.44 | 2.49 | 2.54 | |
| $\Delta V_Z(\Delta T)$ Change in reference voltage with temperature | V_Z adjusted to 2.490 V, $I_Z = 1 \text{ mA}$ | 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 | | | | |

† 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

CHANGE IN REFERENCE VOLTAGE
vs
REFERENCE CURRENT

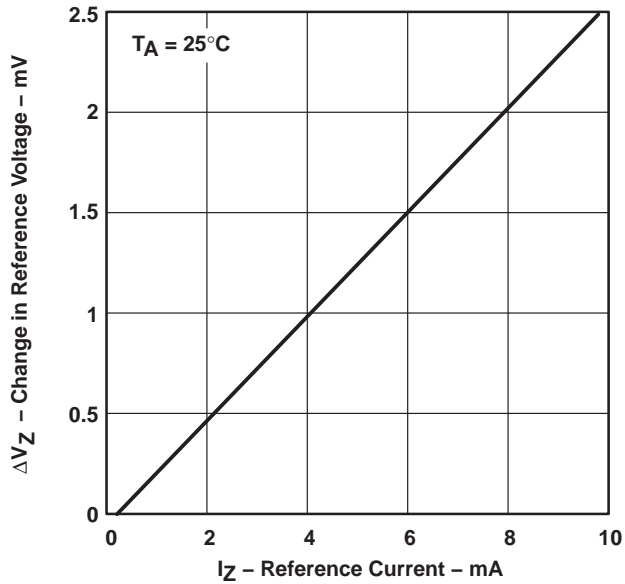


Figure 1

NOISE VOLTAGE
vs
FREQUENCY

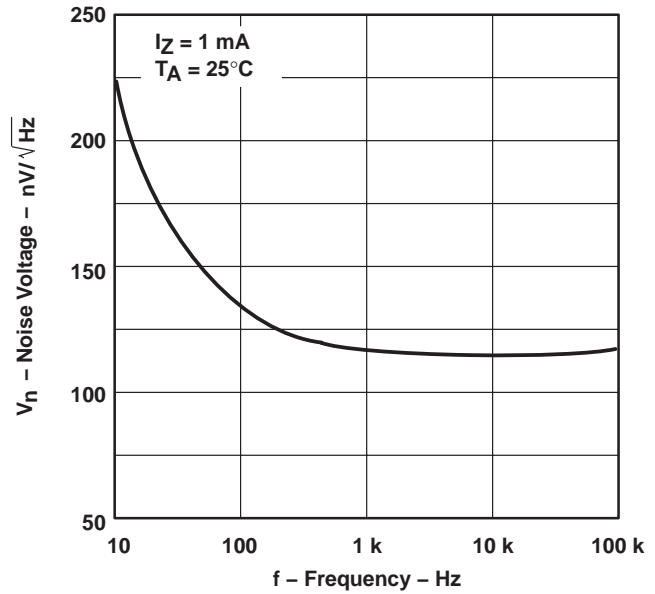


Figure 2

REFERENCE IMPEDANCE
vs
FREQUENCY

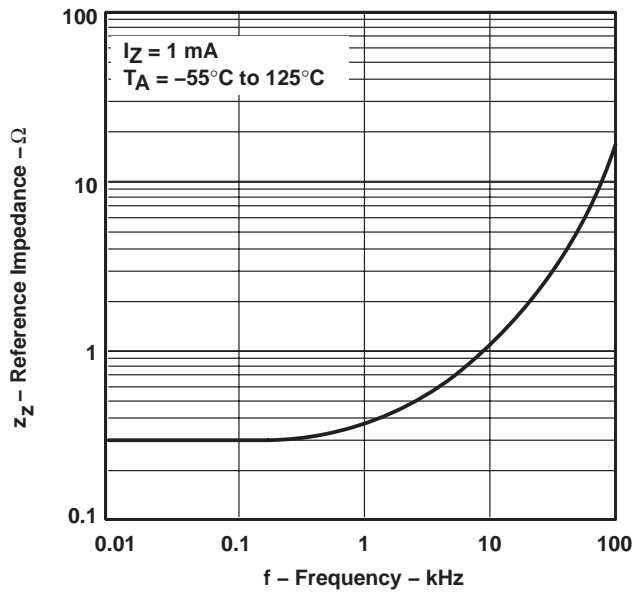


Figure 3

APPLICATION INFORMATION

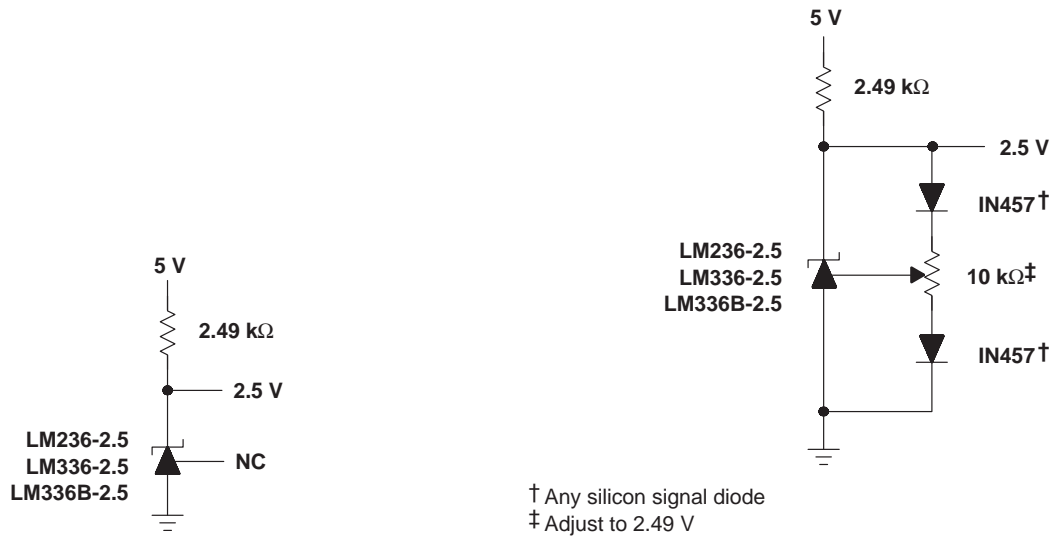


Figure 4. 2.5-V Reference

Figure 5. 2.5-V Reference With Minimum Temperature Coefficient

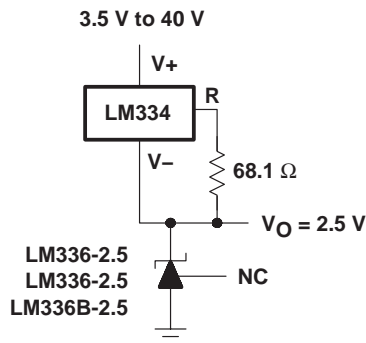


Figure 6. Wide-Input-Range Reference

PACKAGING INFORMATION

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/ Ball Finish | MSL Peak Temp ⁽³⁾ | Samples (Requires Login) |
|------------------|-----------------------|--------------|-----------------|------|-------------|----------------------------|----------------------|------------------------------|---|
| LM236D-2-5 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | Contact TI Distributor or Sales Office |
| LM236DE4-2-5 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | Contact TI Distributor or Sales Office |
| LM236DG4-2-5 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | Contact TI Distributor or Sales Office |
| LM236DR-2-5 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | Purchase Samples |
| LM236DRE4-2-5 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | Purchase Samples |
| LM236DRG4-2-5 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | Purchase Samples |
| LM236LP-2-5 | OBSOLETE | TO-92 | LP | 3 | | TBD | Call TI | Call TI | Samples Not Available |
| LM336BD-2-5 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | Contact TI Distributor or Sales Office |
| LM336BDE4-2-5 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | Contact TI Distributor or Sales Office |
| LM336BDG4-2-5 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | Contact TI Distributor or Sales Office |
| LM336BDR-2-5 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | Purchase Samples |
| LM336BDRE4-2-5 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | Purchase Samples |
| LM336BDRG4-2-5 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | Purchase Samples |
| LM336BLP-2-5 | ACTIVE | TO-92 | LP | 3 | 1000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | Contact TI Distributor or Sales Office |
| LM336BLPE3-2-5 | ACTIVE | TO-92 | LP | 3 | 1000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | Contact TI Distributor or Sales Office |
| LM336BLPR-2-5 | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | Purchase Samples |
| LM336BLPRE3-2-5 | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | Purchase Samples |
| LM336D-2-5 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | Contact TI Distributor or Sales Office |

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/ Ball Finish | MSL Peak Temp ⁽³⁾ | Samples (Requires Login) |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|----------------------|------------------------------|--|
| LM336DE4-2-5 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | Contact TI Distributor or Sales Office |
| LM336DG4-2-5 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | Contact TI Distributor or Sales Office |
| LM336DR-2-5 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | Purchase Samples |
| LM336DRE4-2-5 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | Purchase Samples |
| LM336DRG4-2-5 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | Purchase Samples |
| LM336LP-2-5 | ACTIVE | TO-92 | LP | 3 | 1000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | Purchase Samples |
| LM336LPE3-2-5 | ACTIVE | TO-92 | LP | 3 | 1000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | Purchase Samples |
| LM336LPR-2-5 | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | Purchase Samples |
| LM336LPRE3-2-5 | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | Purchase Samples |

⁽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.

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TAPE AND REEL INFORMATION



QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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.
 - 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.
 - 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:
- All linear dimensions are in millimeters.
 - This drawing is subject to change without notice.
 - Publication IPC-7351 is recommended for alternate designs.
 - 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.
 - 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/C 10/01

- 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.



MECHANICAL DATA

MSOT002A – OCTOBER 1994 – REVISED NOVEMBER 2001

LP (O-PBCY-W3)

PLASTIC CYLINDRICAL PACKAGE



- 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 Format Lead Option package.

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| Energy and Lighting | www.ti.com/energy |
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| Security | www.ti.com/security |
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