Low Temperature Coefficient
Wide Operating Current . . . 400 µA to 10 mA
0.27-Ω Dynamic Impedance
±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.

**ORDERING INFORMATION**

<table>
<thead>
<tr>
<th>T_A</th>
<th>PACKAGE†</th>
<th>ORDERABLE PART NUMBER</th>
<th>TOP-SIDE MARKING</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°C to 70°C</td>
<td>SOIC (D)</td>
<td>Tube of 75 LM336D-2-5</td>
<td>336-25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reel of 2500 LM336DR-2-5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TO-226 / TO-92 (LP)</td>
<td>Tube of 75 LM336BD-2-5</td>
<td>336B25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reel of 2500 LM336BDR-2-5</td>
<td></td>
</tr>
<tr>
<td>−25°C to 85°C</td>
<td>SOIC (D)</td>
<td>Tube of 75 LM236D-2-5</td>
<td>236-25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reel of 2500 LM236DR-2-5</td>
<td></td>
</tr>
</tbody>
</table>

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

Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.
symbol

schematic diagram

NOTE A: All component values are nominal.

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

<table>
<thead>
<tr>
<th></th>
<th>MIN</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reverse current, IR</td>
<td></td>
<td>20 mA</td>
<td></td>
</tr>
<tr>
<td>Forward current, IF</td>
<td></td>
<td>10 mA</td>
<td></td>
</tr>
<tr>
<td>Package thermal impedance, θJA (see Notes 1 and 2): D package</td>
<td>97°C/W</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>LP package</td>
<td>140°C/W</td>
<td></td>
</tr>
<tr>
<td>Operating virtual junction temperature, TJ</td>
<td>150°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage temperature range, Tstg</td>
<td>−65°C to 150°C</td>
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</table>

† 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 TJ(max), θJA, and TA. The maximum allowable power dissipation at any allowable ambient temperature is PD = (TJ(max) – TA)/θJA. Operating at the absolute maximum TJ of 150°C can impact reliability.
2. The package thermal impedance is calculated in accordance with JESD 51-7.

recommended operating conditions

<table>
<thead>
<tr>
<th>TA</th>
<th>Operating free-air temperature</th>
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<tr>
<td>LM236-2.5</td>
<td>−25 to 85 °C</td>
</tr>
<tr>
<td>LM336-2.5</td>
<td>0 to 70 °C</td>
</tr>
<tr>
<td>LM336B-2.5</td>
<td>0 to 70 °C</td>
</tr>
</tbody>
</table>
### Electrical Characteristics at Specified Free-Air Temperature (Unless Otherwise Noted)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Conditions</th>
<th>$T_A \dagger$</th>
<th>LM236-2.5</th>
<th></th>
<th>LM336-2.5</th>
<th></th>
<th>LM336B-2.5</th>
<th></th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_Z$ Reference Voltage</td>
<td>$I_Z = 1 \ mA$</td>
<td>25°C</td>
<td>2.44</td>
<td>2.49</td>
<td>2.54</td>
<td>2.39</td>
<td>2.49</td>
<td>2.59</td>
<td>V</td>
</tr>
<tr>
<td>$\Delta V_Z(\Delta T)$ Change in reference voltage with temperature</td>
<td>$V_Z$ adjusted to 2.490 V, $I_Z = 1 \ mA$</td>
<td>Full range</td>
<td>3.5</td>
<td>9</td>
<td>1.8</td>
<td>6</td>
<td></td>
<td></td>
<td>mV</td>
</tr>
<tr>
<td>$\Delta V_Z(\Delta I)$ Change in reference voltage with current</td>
<td>$I_Z = 400 \ \mu A$ to 10 mA</td>
<td>25°C</td>
<td>2.6</td>
<td>6</td>
<td>2.6</td>
<td>10</td>
<td></td>
<td></td>
<td>mV</td>
</tr>
<tr>
<td>$\Delta V_Z(\Delta t)$ Long-term change in reference voltage</td>
<td>$I_Z = 1 \ mA$</td>
<td>25°C</td>
<td>20</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ppm/khr</td>
</tr>
<tr>
<td>$Z_Z$ Reference impedance</td>
<td>$I_Z = 1 \ mA$, $f = 1 \ kHz$</td>
<td>25°C</td>
<td>0.2</td>
<td>0.6</td>
<td>0.2</td>
<td>1</td>
<td></td>
<td></td>
<td>W</td>
</tr>
</tbody>
</table>

$\dagger$ 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.
TYPICAL CHARACTERISTICS

CHANGE IN REFERENCE VOLTAGE vs REFERENCE CURRENT

\[ \Delta V_Z = \text{Change in Reference Voltage} - \text{mV} \]

\[ I_Z = \text{Reference Current} - \text{mA} \]

\[ T_A = 25^\circ C \]

Figure 1

NOISE VOLTAGE vs FREQUENCY

\[ V_n = \text{Noise Voltage} - \text{mV/Hz} \]

\[ f = \text{Frequency} - \text{Hz} \]

\[ I_Z = 1 \text{ mA} \]

\[ T_A = 25^\circ C \]

Figure 2

REFERENCE IMPEDANCE vs FREQUENCY

\[ Z_r = \text{Reference Impedance} - \Omega \]

\[ f = \text{Frequency} - \text{kHz} \]

\[ I_Z = 1 \text{ mA} \]

\[ T_A = -55^\circ C \text{ to } 125^\circ C \]

Figure 3
APPLICATION INFORMATION

**Figure 4. 2.5-V Reference**

- 5 V
- 2.49 kΩ
- 2.5 V

LM236-2.5
LM336-2.5
LM336B-2.5
NC

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

- 5 V
- 2.49 kΩ
- 2.5 V
- IN457†
- 10 kΩ‡
- IN457†

LM236-2.5
LM336-2.5
LM336B-2.5

† Any silicon signal diode
‡ Adjust to 2.49 V

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

- 3.5 V to 40 V
- V+
- V−
- 68.1 Ω
- LM34
- V+ = 2.5 V
- LM336-2.5
- LM336-2.5
- LM336B-2.5
- NC
## PACKAGING INFORMATION

<table>
<thead>
<tr>
<th>Orderable Device</th>
<th>Status (1)</th>
<th>Package Type</th>
<th>Package Drawing</th>
<th>Pins</th>
<th>Package Qty</th>
<th>Eco Plan (2)</th>
<th>Lead finish/ Ball material (6)</th>
<th>MSL Peak Temp (3)</th>
<th>Op Temp (°C)</th>
<th>Device Marking (4/5)</th>
<th>Samples</th>
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<tbody>
<tr>
<td>LM236D-2-5</td>
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<td>SOIC</td>
<td>D</td>
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<td>75</td>
<td>RoHS &amp; Green</td>
<td>NIPDAU</td>
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<td>NIPDAU</td>
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<td>Samples</td>
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<td>RoHS &amp; Green</td>
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<td>-25 to 85</td>
<td>236-25</td>
<td>Samples</td>
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<td>D</td>
<td>8</td>
<td>2500</td>
<td>RoHS &amp; Green</td>
<td>NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
<td>-25 to 85</td>
<td>236-25</td>
<td>Samples</td>
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<tr>
<td>LM336-2.5 MDC</td>
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<td>DIESALE</td>
<td>Y</td>
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<td>400</td>
<td>RoHS &amp; Green</td>
<td>Call TI</td>
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<td>75</td>
<td>RoHS &amp; Green</td>
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<td>0 to 70</td>
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<td>NIPDAU</td>
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<td>D</td>
<td>8</td>
<td>2500</td>
<td>RoHS &amp; Green</td>
<td>NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
<td>0 to 70</td>
<td>336B25</td>
<td>Samples</td>
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<td>LP</td>
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<td>1000</td>
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<td>SN</td>
<td>N / A for Pkg Type</td>
<td>0 to 70</td>
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<td>Samples</td>
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<td>TO-92</td>
<td>LP</td>
<td>3</td>
<td>1000</td>
<td>RoHS &amp; Non-Green</td>
<td>SN</td>
<td>N / A for Pkg Type</td>
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<td>LP</td>
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<td>2000</td>
<td>RoHS &amp; Non-Green</td>
<td>SN</td>
<td>N / A for Pkg Type</td>
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<td>Samples</td>
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<td>75</td>
<td>RoHS &amp; Green</td>
<td>NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
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<td>Samples</td>
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<td>75</td>
<td>RoHS &amp; Green</td>
<td>NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
<td>0 to 70</td>
<td>336-25</td>
<td>Samples</td>
</tr>
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<td>SOIC</td>
<td>D</td>
<td>8</td>
<td>2500</td>
<td>RoHS &amp; Green</td>
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<td>0 to 70</td>
<td>336-25</td>
<td>Samples</td>
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<td>TO-92</td>
<td>LP</td>
<td>3</td>
<td>1000</td>
<td>RoHS &amp; Non-Green</td>
<td>SN</td>
<td>N / A for Pkg Type</td>
<td>0 to 70</td>
<td>336-25</td>
<td>Samples</td>
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<tr>
<td>LM336LPE3-2-5</td>
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<td>TO-92</td>
<td>LP</td>
<td>3</td>
<td>1000</td>
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<td>0 to 70</td>
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<td>TO-92</td>
<td>LP</td>
<td>3</td>
<td>2000</td>
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<td>SN</td>
<td>N / A for Pkg Type</td>
<td>0 to 70</td>
<td>336-25</td>
<td>Samples</td>
</tr>
</tbody>
</table>

(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) RoHS: TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

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In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.
## TAPE AND REEL INFORMATION

### TAPE DIMENSIONS

- **A0**: Dimension designed to accommodate the component width
- **B0**: Dimension designed to accommodate the component length
- **K0**: Dimension designed to accommodate the component thickness
- **W**: Overall width of the carrier tape
- **P1**: Pitch between successive cavity centers

### QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE

- **Q1**
- **Q2**
- **Q3**
- **Q4**

*All dimensions are nominal.*

<table>
<thead>
<tr>
<th>Device</th>
<th>Package Type</th>
<th>Package Drawing</th>
<th>Pins</th>
<th>SPQ</th>
<th>Reel Diameter (mm)</th>
<th>Reel Width W1 (mm)</th>
<th>A0 (mm)</th>
<th>B0 (mm)</th>
<th>K0 (mm)</th>
<th>P1 (mm)</th>
<th>W (mm)</th>
<th>Pin1 Quadrant</th>
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<tbody>
<tr>
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<td>8</td>
<td>2500</td>
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<td>8.0</td>
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<td>2500</td>
<td>330.0</td>
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### TAPE AND REEL BOX DIMENSIONS

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<th>Width (mm)</th>
<th>Height (mm)</th>
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<td>2500</td>
<td>340.5</td>
<td>338.1</td>
<td>20.6</td>
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<tr>
<td>LM336DR-2-5</td>
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<td>D</td>
<td>8</td>
<td>2500</td>
<td>340.5</td>
<td>338.1</td>
<td>20.6</td>
</tr>
</tbody>
</table>

*All dimensions are nominal.*
NOTES:

1. Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches. 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 .006 [0.15] per side.
4. This dimension does not include interlead flash.
5. Reference JEDEC registration MS-012, variation AA.
EXAMPLE BOARD LAYOUT

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.
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.
Images above are just a representation of the package family, actual package may vary. Refer to the product data sheet for package details.
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. Lead dimensions are not controlled within this area.
4. Reference JEDEC TO-226, variation AA.
5. Shipping method:
   a. Straight lead option available in bulk pack only.
   b. Formed lead option available in tape and reel or ammo pack.
   c. Specific products can be offered in limited combinations of shipping medium and lead options.
   d. Consult product folder for more information on available options.
EXAMPLE BOARD LAYOUT

LP0003A

TO-92 - 5.34 mm max height

LAND PATTERN EXAMPLE
STRAIGHT LEAD OPTION
NON-SOLDER MASK DEFINED
SCALE:15X

LAND PATTERN EXAMPLE
FORMED LEAD OPTION
NON-SOLDER MASK DEFINED
SCALE:15X
TAPE SPECIFICATIONS

LP0003A

TO-92 - 5.34 mm max height

FOR FORMED LEAD OPTION PACKAGE
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