LM136-2.5/LM236-2.5/LM336-2.5V Reference Diode

General Description
The LM136-2.5/LM236-2.5 and LM336-2.5 integrated circuits are precision 2.5V shunt regulator diodes. These monolithic IC voltage references operate as a low-temperature-coefficient 2.5V zener with 0.2Ω dynamic impedance. A third terminal on the LM136-2.5 allows the reference voltage and temperature coefficient to be trimmed easily.

The LM136-2.5 series is useful as a precision 2.5V low voltage reference for digital voltmeters, power supplies or op amp circuits. The 2.5V make it convenient to obtain a stable reference from 5V logic supplies. Further, since the LM136-2.5 operates as a shunt regulator, it can be used as either a positive or negative voltage reference.

The LM136-2.5 is rated for operation over −55°C to +125°C while the LM236-2.5 is rated over a −25°C to +85°C temperature range.

Features
- Low temperature coefficient
- Wide operating current of 400 µA to 10 mA
- 0.2Ω dynamic impedance
- ±1% initial tolerance available
- Guaranteed temperature stability
- Easily trimmed for minimum temperature drift
- Fast turn-on
- Three lead transistor package

The LM336-2.5 is rated for operation over a 0°C to +70°C temperature range. See the connection diagrams for available packages.

Connection Diagrams

- TO-92 Plastic Package
- TO-46 Metal Can Package

Order Numbers:
- LM236Z-2.5, LM236AZ-2.5, LM336Z-2.5 or LM336BZ-2.5

See NS Package Numbers Z03A or H03H
Connection Diagrams (Continued)

SO Package

Top View
Order Number LM236M-2.5,
LM236AM-2.5, LM336M-2.5
or LM336BM-2.5
See NS Package Number M08A

Typical Applications

2.5V Reference

2.5V Reference with Minimum Temperature Coefficient

Wide Input Range Reference

\[ \text{Adjust to 2.490V} \]

*Any silicon signal diode
### Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

- Reverse Current: 15 mA
- Forward Current: 10 mA
- Storage Temperature: −60˚C to +150˚C

Soldering Information:
- TO-92 Package (10 sec.): 260˚C
- TO-46 Package (10 sec.): 300˚C
- SO Package:
  - Vapor Phase (60 sec.): 215˚C
  - Infrared (15 sec.): 220˚C

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Electrical specifications do not apply when operating the device beyond its specified operating conditions.

### Operating Temperature Range (Note 2)

- LM136: −55˚C to +150˚C
- LM236: −25˚C to +85˚C
- LM336: 0˚C to +70˚C

### Reverse Current

- 15 mA

### Forward Current

- 10 mA

### Storage Temperature

- −60˚C to +150˚C

### Electrical Characteristics (Note 3)

#### Table

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>Units</th>
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</thead>
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<tr>
<td>Reverse Breakdown Change</td>
<td>TA=25˚C,</td>
<td>2.465</td>
</tr>
<tr>
<td>With Current</td>
<td>400 μA≤I&lt;10 mA</td>
<td></td>
</tr>
<tr>
<td>Reverse Dynamic Impedance</td>
<td>TA=25˚C,</td>
<td>2.6</td>
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<tr>
<td></td>
<td>IR=1 mA, f=100 Hz</td>
<td>0.2</td>
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<tr>
<td>Temperature Stability</td>
<td>V&lt;sub&gt;r&lt;/sub&gt; Adjusted to 2.490V</td>
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<tr>
<td>(Note 4)</td>
<td>IA=1 mA, Figure 2</td>
<td></td>
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<tr>
<td></td>
<td>0˚C≤TA≤70˚C (LM336)</td>
<td></td>
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<tr>
<td></td>
<td>−25˚C≤TA≤+85˚C (LM236H, LM236Z)</td>
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<tr>
<td></td>
<td>−25˚C≤TA≤+85˚C (LM236M)</td>
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<tr>
<td></td>
<td>−55˚C≤TA≤+125˚C (LM136)</td>
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<tr>
<td>Reverse Breakdown Change</td>
<td>400 μA≤IR≤10 mA</td>
<td>3</td>
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<tr>
<td>With Current</td>
<td>IA=1 mA</td>
<td>0.4</td>
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<tr>
<td>Reverse Dynamic Impedance</td>
<td>IR=1 mA</td>
<td></td>
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<tr>
<td>Long Term Stability</td>
<td>TA=25˚C ±0.1˚C, IR=1 mA, t=1000 hrs</td>
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</tbody>
</table>

#### Notes:

1. Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Electrical specifications do not apply when operating the device beyond its specified operating conditions.
2. For elevated temperature operation, T<sub>j</sub> max is:
   - LM136: 150˚C
   - LM236: 125˚C
   - LM336: 100˚C

<table>
<thead>
<tr>
<th>Thermal Resistance</th>
<th>TO-92</th>
<th>TO-46</th>
<th>SO-8</th>
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</thead>
<tbody>
<tr>
<td>θ&lt;sub&gt;ja&lt;/sub&gt; (Junction to Ambient)</td>
<td>180˚C/W (0.4” leads)</td>
<td>440˚C/W</td>
<td>80˚C/W</td>
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<tr>
<td></td>
<td>170˚C/W (0.125” lead)</td>
<td>165˚C/W</td>
<td>n/a</td>
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</tbody>
</table>

#### Notes:

3. Unless otherwise specified, the LM136-2.5 is specified from −55˚C ≤ TA ≤ +125˚C, the LM236-2.5 from −25˚C ≤ TA ≤ +85˚C and the LM336-2.5 from 0˚C ≤ TA ≤ +70˚C.
4. Temperature stability for the LM336 and LM236 family is guaranteed by design. Design limits are guaranteed (but not 100% production tested) over the indicated temperature and supply voltage ranges. These limits are not used to calculate outgoing quality levels. Stability is defined as the maximum change in V<sub>r</sub> from 25˚C to TA (min) or TA (max).
Application Hints

The LM136 series voltage references are much easier to use than ordinary zener diodes. Their low impedance and wide operating current range simplify biasing in almost any circuit. Further, either the breakdown voltage or the temperature coefficient can be adjusted to optimize circuit performance.

Figure 1 shows an LM136 with a 10k potentiometer for adjusting the reverse breakdown voltage. With the addition of R1 the breakdown voltage can be adjusted without affecting the temperature coefficient of the device. The adjustment range is usually sufficient to adjust for both the initial device tolerance and inaccuracies in buffer circuitry.

If minimum temperature coefficient is desired, two diodes can be added in series with the adjustment potentiometer as shown in Figure 2. When the device is adjusted to 2.490V the temperature coefficient is minimized. Almost any silicon signal diode can be used for this purpose such as a 1N914, 1N4148 or a 1N457. For proper temperature compensation the diodes should be in the same thermal environment as the LM136. It is usually sufficient to mount the diodes near the LM136 on the printed circuit board. The absolute resistance of R1 is not critical and any value from 2k to 20k will work.

![Figure 1. LM136 With Pot for Adjustment of Breakdown Voltage (Trim Range = ±120 mV typical)](DS00671S-28)

![Figure 2. Temperature Coefficient Adjustment (Trim Range = ±70 mV typical)](DS00671S-29)

Low Cost 2 Amp Switching Regulator†

![Diagrams](DS00671S-5)

† L1 60 turns #16 wire on Arnold Core A-254168-2
† Efficiency = 80%
Application Hints (Continued)

Precision Power Regulator with Low Temperature Coefficient

5V Crowbar

Trimmed 2.5V Reference with Temperature Coefficient Independent of Breakdown Voltage

Adjustable Shunt Regulator

*Does not affect temperature coefficient

DS005715-14

DS005715-15

DS005715-6
Application Hints (Continued)

Linear Ohmmeter

![Diagram of a linear ohmmeter circuit](image-url)
Application Hints (Continued)

Op Amp with Output Clamped

2.5V Square Wave Calibrator

5V Buffered Reference

Low Noise Buffered Reference
Physical Dimensions in (millimeters) unless otherwise noted

NS Package Number H03H

Order Number LM236M-2.5, LM236AM-2.5, LM336M-2.5 or LM336BM-2.5
NS Package Number M06A

Small Outline (SO) Package (M)
Order Number LM236M-2.5, LM236AM-2.5, LM336M-2.5 or LM336BM-2.5
NS Package Number M06A
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