LM129/LM329
Precision Reference

General Description
The LM129 and LM329 family are precision multi-current temperature-compensated 6.9V zener references with dynamic impedances a factor of 10 to 100 less than discrete diodes. Constructed in a single silicon chip, the LM129 uses active circuitry to buffer the internal zener allowing the device to operate over a 0.5 mA to 15 mA range with virtually no change in performance. The LM129 and LM329 are available with selected temperature coefficients of 0.001, 0.002, 0.005 and 0.01%/˚C. These references also have excellent long term stability and low noise.

A new subsurface breakdown zener used in the LM129 gives lower noise and better long-term stability than conventional IC zeners. Further the zener and temperature compensating transistor are made by a planar process so they are immune to problems that plague ordinary zeners. For example, there is virtually no voltage shift in zener voltage due to temperature cycling and the device is insensitive to stress on the leads.

The LM129 can be used in place of conventional zeners with improved performance. The low dynamic impedance simplifies biasing and the wide operating current allows the replacement of many zener types.

The LM129 is packaged in a 2-lead TO-46 package and is rated for operation over a −55˚C to +125˚C temperature range. The LM329 for operation over 0˚C to 70˚C is available in both a hermetic TO-46 package and a TO-92 epoxy package.

Features
- 0.6 mA to 15 mA operating current
- 0.6Ω dynamic impedance at any current
- Available with temperature coefficients of 0.001%/˚C
- 7μV wideband noise
- 5% initial tolerance
- 0.002% long term stability
- Low cost
- Subsurface zener

Connection Diagrams
Typical Applications

Simple Reference

9V TO 40V

R_s

LM129

6.9V

DS005714-1
Absolute Maximum Ratings (Note 1)

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

(Note 3)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reverse Breakdown Current</td>
<td></td>
<td>30</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Forward Current</td>
<td></td>
<td>2</td>
<td>mA</td>
<td></td>
</tr>
</tbody>
</table>

| Operating Temperature Range| LM129      | −55°C to +125°C |
|                           | LM329      | 0°C to +70°C    |

| Storage Temperature Range  | −55°C to +150°C |

Soldering Information

| TO-92 package: 10 sec.   | 260°C |
| TO-46 package: 10 sec.   | 300°C |

Electrical Characteristics (Note 2)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reverse Breakdown Voltage</td>
<td>TA = 25°C, 0.6 mA ≤ IR ≤ 15 mA</td>
<td>Min 6.7 Typ 6.9 Max 7.2</td>
</tr>
<tr>
<td>Reverse Breakdown Change with Current (Note 4)</td>
<td>TA = 25°C, 0.6 mA ≤ IR ≤ 15 mA</td>
<td>9 mV 14 mV 9 mV 20 mV</td>
</tr>
<tr>
<td>Reverse Dynamic Impedance (Note 4)</td>
<td>TA = 25°C, IR = 1 mA</td>
<td>0.6 Ω 1 Ω 0.8 Ω 2 Ω</td>
</tr>
<tr>
<td>RMS Noise</td>
<td>TA = 25°C, 10 Hz ≤ F ≤ 10 kHz</td>
<td>7 µV 20 µV 7 µV 100 µV</td>
</tr>
<tr>
<td>Long Term Stability (1000 hours)</td>
<td>TA = 45°C ± 0.1°C, IR = 1 mA ± 0.3%</td>
<td>20 ppm 20 ppm</td>
</tr>
<tr>
<td>Temperature Coefficient</td>
<td>IR = 1 mA</td>
<td>LM129A, LM329A 6 ppm/°C 10 ppm/°C</td>
</tr>
<tr>
<td>LM129B, LM329B 15 ppm/°C 20 ppm/°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LM129C, LM329C 30 ppm/°C 50 ppm/°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LM329D 50 ppm/°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in Reverse Breakdown Temperature Coefficient</td>
<td>1 mA ≤ IR ≤ 15 mA</td>
<td>1 ppm/°C</td>
</tr>
<tr>
<td>Reverse Breakdown Change with Current</td>
<td>1 mA ≤ IR ≤ 15 mA</td>
<td>12 mV 12 mV</td>
</tr>
<tr>
<td>Reverse Dynamic Impedance</td>
<td>1 mA ≤ IR ≤ 15 mA</td>
<td>0.8 Ω 1 Ω</td>
</tr>
</tbody>
</table>

Note 1: “Absolute Maximum Ratings” indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits.

Note 2: These specifications apply for −55°C ≤ TA ≤ +125°C for the LM129 and 0°C ≤ TA ≤ +70°C for the LM329 unless otherwise specified. The maximum junction temperature for an LM129 is 150°C and LM329 is 100°C. For operating at elevated temperature, devices in TO-46 package must be derated based on a thermal resistance of 440°C/W junction to ambient or 80°C/W junction to case. For the TO-92 package, the derating is based on 180°C/W junction to ambient with 0.4” leads from a PC board and 160°C/W junction to ambient with 0.125” lead length to a PC board.

Note 3: Refer to RETS129H for LM129 family military specifications.

Note 4: These changes are tested on a pulsed basis with a low duty-cycle. For changes versus temperature, compute in terms of tempco.
Typical Applications

Low Cost 0–25V Regulator

Adjustable Bipolar Output Reference
Typical Applications (Continued)

0V to 20V Power Reference

External Reference for Temperature Transducer
Typical Applications (Continued)

Positive Current Source

Buffered Reference with Single Supply
Schematic Diagram

Typical Performance Characteristics

Reverse Characteristics

Response Time

Forward Characteristics

Dynamic Impedance

Reverse Voltage Change

Zener Noise Voltage
Typical Performance Characteristics (Continued)

Low Frequency Noise Voltage

![Graph of Low Frequency Noise Voltage]

DS065714-5
Physical Dimensions inches (millimeters) unless otherwise noted

Metal Can Package
NS Package H02A
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