**LM185/LM285/LM385**

Adjustable Micropower Voltage References

**General Description**

The LM185/LM285/LM385 are micropower 3-terminal adjustable band-gap voltage reference diodes. Operating from 1.24 to 5.3V and over a 10 μA to 20 mA current range, they feature exceptionally low dynamic impedance and good temperature stability. On-chip trimming is used to provide tight voltage tolerance. Since the LM185 band-gap reference uses only transistors and resistors, low noise and good long-term stability result.

Careful design of the LM185 has made the device tolerant of capacitive loading, making it easy to use in almost any reference application. The wide dynamic operating range allows its use with widely varying supplies with excellent regulation.

The extremely low power drain of the LM185 makes it useful for micropower circuitry. This voltage reference can be used to make portable meters, regulators or general purpose analog circuitry with battery life approaching shelf life. Further, the wide operating current allows it to replace older references with a tighter tolerance part.

The LM185 is rated for operation over a –55°C to 125°C temperature range, while the LM285 is rated −40°C to 85°C and the LM385 0°C to 70°C. The LM185 is available in a hermetic TO-46 package and a leadless chip carrier package, while the LM285/LM385 are available in a low-cost TO-92 molded package, as well as S.O.

**Features**

- Adjustable from 1.24V to 5.30V
- Operating current of 10 μA to 20 mA
- 1% and 2% initial tolerance
- 1 μA dynamic impedance
- Low temperature coefficient

**Connection Diagrams**

- **TO-92 Plastic Package**

  ![Bottom View](image1)


  See NS Package Number Z03A

- **TO-46 Metal Can Package**

  ![Bottom View](image2)

  Order Number LM185BH, LM185BH/883, LM185BYH or LM185BYH/883

  See NS Package Number H03H

- **SO Package**

  ![Bottom View](image3)

  Order Number LM285M, LM285BYM, LM385BM or LM385M

  See NS Package Number M08A

**Block Diagram**

**Typical Applications**

1. **1.2V Reference**

   ![1.2V Reference](image4)

   \[ V_{OUT} = 1.24 \left( \frac{R_3}{R_2} + 1 \right) \]

   TL/H/5250–14

2. **5.0V Reference**

   ![5.0V Reference](image5)

   TL/H/5250–2
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 2)

Reverse Current 30 mA
Forward Current 10 mA

Operating Temperature Range (Note 3)
LM185 Series −55°C to 125°C
LM285 Series −40°C to 85°C
LM385 Series 0°C to 70°C
Storage Temperature −55°C to 150°C

Soldering Information
TO-92 Package (10 sec.) 260°C
TO-46 Package (10 sec.) 300°C
SO Package 215°C

Electrical Characteristics (Note 4)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>LM185, LM285</th>
<th>LM385</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Tested Design</td>
<td>Tested Design</td>
</tr>
<tr>
<td>Reference Voltage</td>
<td>I&lt;sub&gt;R&lt;/sub&gt; = 100 µA</td>
<td>1.240</td>
<td>1.252</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.252</td>
<td>1.228</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.265</td>
<td>1.265</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.270</td>
<td>1.270</td>
</tr>
<tr>
<td>Reference Voltage</td>
<td>I&lt;sub&gt;R&lt;/sub&gt; &lt; 1 mA</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Change with Current</td>
<td>I&lt;sub&gt;F&lt;/sub&gt; &lt; 20 mA</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Dynamic Output Impedance</td>
<td>I&lt;sub&gt;AC&lt;/sub&gt; = 0.1 I&lt;sub&gt;R&lt;/sub&gt;</td>
<td>0.3</td>
<td>0.4</td>
</tr>
<tr>
<td>Reference Voltage Change with Output Voltage</td>
<td>I&lt;sub&gt;R&lt;/sub&gt; = 100 µA</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Feedback Current</td>
<td>I&lt;sub&gt;R&lt;/sub&gt; &lt; 150 mA, T&lt;sub&gt;JE&lt;/sub&gt; = 0°C, ± 0.1°C</td>
<td>60</td>
<td>90</td>
</tr>
<tr>
<td>Minimum Operating Current (see curve)</td>
<td>V&lt;sub&gt;OUT&lt;/sub&gt; = V&lt;sub&gt;REF&lt;/sub&gt;</td>
<td>9</td>
<td>9</td>
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<tr>
<td>Output Wideband Noise</td>
<td>V&lt;sub&gt;OUT&lt;/sub&gt; = V&lt;sub&gt;REF&lt;/sub&gt;</td>
<td>45</td>
<td>45</td>
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<tr>
<td>Average Temperature Coefficient (Note 7)</td>
<td>I&lt;sub&gt;R&lt;/sub&gt; = 100 µA, X Suffix, Y Suffix</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Long Term Stability</td>
<td>I&lt;sub&gt;R&lt;/sub&gt; = 100 µA, T = 1000 Hr, T&lt;sub&gt;JE&lt;/sub&gt; = 0°C</td>
<td>20</td>
<td>20</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 intended to be functional, but do not guarantee specific performance limits. For guaranteed specifications and test conditions, see the Electrical Characteristics. The guaranteed specifications apply only for the test conditions listed.

Note 2: Refer to RETS185H for military specifications.

Note 3: For elevated temperature operation, T<sub>J</sub> max is:
LM185 150°C
LM285 125°C
LM385 100°C

Note 4: Parameters identified with boldface type apply at temperature extremes. All other numbers apply at T<sub>A</sub> = T<sub>J</sub> = 25°C. Unless otherwise specified, all parameters apply for V<sub>REF</sub> = 5.3V, T<sub>A</sub> = 25°C, ± 0.1°C.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>LM185, LM285</th>
<th>LM385</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal Resistance</td>
<td>TO-92</td>
<td>180°C/W (0.4” leads)</td>
<td>440°C/W</td>
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<tr>
<td></td>
<td>TO-46</td>
<td>170°C/W (0.125” leads)</td>
<td>165°C/W</td>
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<tr>
<td></td>
<td>SO-8</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Note 5: Guaranteed and 100% production tested.
Typical Applications (Continued)

Precision 10V Reference

Low AC Noise Reference

25V Low Current Shunt Regulator

200 mA Shunt Regulator

Series-Shunt 20 mA Regulator

High Efficiency Low Power Regulator
Typical Applications (Continued)

Voltage Level Detector

Fast Positive Clamp
2.4V \pm 0.6V_{D1}

Bidirectional Clamp
\pm 2.4V

Bidirectional Adjustable Clamp
\pm 1.8V to \pm 2.4V

Bidirectional Adjustable Clamp
\pm 2.4V to \pm 6V
Typical Applications (Continued)

Simple Floating Current Detector

Current Source

Precision Floating Current Detector

* D1 can be any LED. V_f = 1.5V to 2.2V at 3 mA. D1 may act as an indicator. D1 will be on if I_THRESHOLD falls below the threshold current, except with I = 0.
Typical Applications (Continued)

**Centigrade Thermometer, 10 mV/°C**

- R1: 10k
- R2: 100n
- R3: 1k
- R4: 20k

**Freezer Alarm**

- C1: 1μF
- R4: 2.2k
- C2: 0.033μF

Beeps at temperatures above that set by R1 (Range is −30°F to +120°F)

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**Schematic Diagram**

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**Connection Diagrams (Continued)**

Order Number LM185BE/883
See NS Package Number E20A
Physical Dimensions inches (millimeters)

Top View

Side View

Bottom View

20-Leadless Chip Carrier (E)
Order Number LM185BE/883
NS Package Number E20A
Physical Dimensions inches (millimeters) (Continued)

TO-92 Plastic Package (Z)
NS Package Number Z03A

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