**FEATURES**
- 6.95V Shunt Reference
- Guaranteed 0.5ppm/°C Temperature Coefficient
- Guaranteed 1Ω Maximum Dynamic Impedance
- Guaranteed 20μVRMS Maximum Noise
- Guaranteed Initial Tolerance of 2%
- Wide Operating Current Range
- Available in 4-Lead TO-46 Metal Can

**APPLICATIONS**
- Precision Voltage Reference for Multimeters
- Calibration Equipment Voltage Standards
- Laboratory Measurement Equipment
- Industrial Monitor/Control Instruments
- High Accuracy Data Converters

**DESCRIPTION**

The LM199/LM399 precision shunt reference features excellent temperature stability over a wide range of voltage, temperature and operating current conditions. A stabilizing heater is incorporated with the active Zener on a monolithic substrate which nearly eliminates changes in voltage with temperature. The subsurface Zener operates over a current range of 0.5mA to 10mA, and offers minimal noise and excellent long-term stability.

Ideal applications for the LM199/LM399 include digital voltmeters, precision calibration equipment, current sources and a variety of other precision low cost references. A 10V buffered reference application is shown below.

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**TYPICAL APPLICATION**

10V Buffered Reference

![10V Buffered Reference Diagram](image)

Reverse Voltage Change

![Reverse Voltage Change Graph](image)

---

\[ T_J = 25°C \]

\[ T_J = 90°C \]

For more information [visit www.linear.com/LM399](http://www.linear.com/LM399)
**LM199/LM399**
**LM199A/LM399A**

## Absolute Maximum Ratings

(Not 1)
- Temperature Stabilizer .............................................. 40V
- Reverse Breakdown Current ...................................... 20mA
- Forward Current .................................................. 1mA
- Reference to Substrate Voltage, \( V_{RS} \) (Note 2) ............ –0.1V

**Operating Temperature Range**
- LM199/LM199A (OBSOLETE) .................. –55°C to 125°C
- LM399/LM399A ........................................ 0°C to 70°C

**Storage Temperature Range**
- LM199/LM199A (OBSOLETE) .................. –65°C to 150°C
- LM399/LM399A ........................................ 0°C to 70°C

**Lead Temperature (Soldering, 10 sec) ...................... 300°C**

## Order Information

<table>
<thead>
<tr>
<th>LEAD FREE FINISH</th>
<th>TAPE AND REEL</th>
<th>PART MARKING</th>
<th>PACKAGE DESCRIPTION</th>
<th>TEMPERATURE RANGE</th>
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<tbody>
<tr>
<td>LM399H</td>
<td>LM399H#TRPBF</td>
<td>LM399H</td>
<td>4-Lead TO-46 Metal Can</td>
<td>0°C to 70°C</td>
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<td>LM399AH</td>
<td>LM399AH#TRPBF</td>
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<td>4-Lead TO-46 Metal Can</td>
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### OBSOLETE PACKAGE

<table>
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<tr>
<th>LEAD FREE FINISH</th>
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<th>PART MARKING</th>
<th>PACKAGE DESCRIPTION</th>
<th>TEMPERATURE RANGE</th>
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<tr>
<td>LM199H</td>
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<td>LM199H</td>
<td>4-Lead TO-46 Metal Can</td>
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<tr>
<td>LM199AH</td>
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<td>LM199AH</td>
<td>4-Lead TO-46 Metal Can</td>
<td>–55°C to 125°C</td>
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<tr>
<td>LM199AH-20</td>
<td>LM199AH-20#TRPBF</td>
<td>LM199AH-20#TRPBF</td>
<td>4-Lead TO-46 Metal Can</td>
<td>–55°C to 125°C</td>
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<tr>
<td>LM399AH-20</td>
<td>LM399AH-20#TRPBF</td>
<td>LM399AH-20#TRPBF</td>
<td>4-Lead TO-46 Metal Can</td>
<td>0°C to 70°C</td>
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<tr>
<td>LM399AH-50</td>
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<td>LM399AH-50#TRPBF</td>
<td>4-Lead TO-46 Metal Can</td>
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</tr>
</tbody>
</table>

Consult LTC Marketing for parts specified with wider operating temperature ranges.
Consult LTC Marketing for information on nonstandard lead based finish parts.
For more information on lead free part marking, go to: [http://www.linear.com/leadfree/](http://www.linear.com/leadfree/)
For more information on tape and reel specifications, go to: [http://www.linear.com/tapeandreel/](http://www.linear.com/tapeandreel/)

## Electrical Characteristics

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>PARAMETER</th>
<th>CONDITIONS</th>
<th>LM199/LM199A</th>
<th>LM399/LM399A</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_Z )</td>
<td>Reverse Breakdown Voltage</td>
<td>( 0.5, mA \leq I_F \leq 10, mA )</td>
<td>6.8 6.95 7.1</td>
<td>6.75 6.95 7.3</td>
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<tr>
<td>( \Delta V_Z )</td>
<td>Reverse Breakdown Voltage Change with Current</td>
<td>( 0.5, mA \leq I_F \leq 10, mA )</td>
<td>6 9</td>
<td>6 12</td>
</tr>
<tr>
<td>( r_Z )</td>
<td>Reverse Dynamic Impedance</td>
<td>( I_F = 1, mA ) (Note 6) (10Hz \leq f \leq 10kHz)</td>
<td>0.5 1</td>
<td>0.5 1.5</td>
</tr>
<tr>
<td>( \Delta V_Z / \Delta T )</td>
<td>Temperature Coefficient LM199/LM399</td>
<td>( -55°C \leq T_A \leq 85°C ) ( 85°C \leq T_A \leq 125°C ) ( 0°C \leq T_A \leq 70°C )</td>
<td>0.3 1 5 15 0.3 2</td>
<td>ppm°C ppm°C ppm°C</td>
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<tr>
<td>( \epsilon_n )</td>
<td>RMS Noise</td>
<td>( 10Hz \leq f \leq 10kHz )</td>
<td>7 20</td>
<td>7 50</td>
</tr>
</tbody>
</table>

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at \( T_A = 25°C \). (Note 3)

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For more information [www.linear.com/LM399](http://www.linear.com/LM399)

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199399c
ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at $T_A = 25^\circ C$. (Note 3)

<table>
<thead>
<tr>
<th>SYMBOL</th>
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<th>CONDITIONS</th>
<th>LM199/LM199A</th>
<th>LM399/LM399A</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta V_Z / \Delta T$</td>
<td>Long-Term Stability</td>
<td>Stabilized, $22^\circ C \leq T_A \leq 28^\circ C$, 1000 Hours, $I_R = 1mA \pm 0.1%$</td>
<td>8 (Note 4)</td>
<td>8 (Note 4)</td>
</tr>
<tr>
<td>$I_H$</td>
<td>Temperature Stabilizer Supply Current</td>
<td>$T_A = 25^\circ C$, Still Air, $V_H = 30V$</td>
<td>8.5</td>
<td>8.5</td>
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<tr>
<td></td>
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<td>$T_A = -55^\circ C$ (Note 5)</td>
<td>22</td>
<td>15</td>
</tr>
<tr>
<td>$V_H$</td>
<td>Temperature Stabilizer Supply Voltage</td>
<td>●</td>
<td>9</td>
<td>9</td>
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<tr>
<td></td>
<td></td>
<td>$V_H = 30V$</td>
<td>40</td>
<td>40</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Warm-Up Time to ±0.05% $V_Z$</td>
<td>3</td>
<td>3</td>
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<tr>
<td></td>
<td></td>
<td>$V_H = 30V$</td>
<td></td>
<td>Seconds</td>
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<tr>
<td></td>
<td></td>
<td>Initial Turn-On Current</td>
<td>140</td>
<td>140</td>
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<tr>
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<td></td>
<td>9V $\leq V_H \leq 40V$ (Note 5)</td>
<td>200</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>mA</td>
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Note 1: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

Note 2: The substrate is electrically connected to the negative terminal of the temperature stabilizer. The voltage that can be applied to either terminal of the reference is 40V more positive or 0.1V more negative than the substrate.

Note 3: These specifications apply for 30V applied to the temperature stabilizer and $-55^\circ C \leq T_A \leq 125^\circ C$ for the LM199; and $0^\circ C \leq T_A \leq 70^\circ C$ for the LM399.

Note 4: Devices with maximum guaranteed long-term stability of 20ppm/$\sqrt{kHz}$ are available. Drift decreases with time.

Note 5: This initial current can be reduced by adding an appropriate resistor and capacitor to the heater circuit. See the Typical Performance Characteristics graphs to determine values.

Note 6: Guaranteed by “Reverse Breakdown Change with Current.”

TYPICAL PERFORMANCE CHARACTERISTICS

Reverse Characteristics

Dynamic Impedance

Stabilization Time
LM199/LM399
LM199A/LM399A

TYPICAL PERFORMANCE CHARACTERISTICS

Initial Heater Current

Heater Current

Heater Current

Zener Noise Voltage

Response Time

Limiting Surge Current

Long-Term Reference Performance, 44 Units Tested

Low Frequency Noise Voltage
**FUNCTIONAL BLOCK DIAGRAM**

**TYPICAL APPLICATIONS**

**Single Supply Operation**

9V TO 40V

**Split Supply Operation**

15V

**Negative Heater Supply with Positive Reference**

15V

**Standard Cell Replacement**

15V TO 20V 1% REGULATED

For more information www.linear.com/LM399
**TYPICAL APPLICATIONS**

![Portable Calibrator Diagram]

**SCHEMATIC DIAGRAMS**

**Temperature Stabilizer**

**Reference**

For more information [www.linear.com/LM399](http://www.linear.com/LM399)
**PACKAGE DESCRIPTION**


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**REV C**

12/14

Package/Order Information updated

Thermal shield dimensions corrected

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<table>
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<td>Thermal shield dimensions corrected</td>
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However, no responsibility is assumed for its use. Linear Technology Corporation makes no representation that the interconnection of its circuits as described herein will not infringe on existing patent rights.
## RELATED PARTS

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<tr>
<th>PART NUMBER</th>
<th>DESCRIPTION</th>
<th>COMMENTS</th>
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<tbody>
<tr>
<td>LT®1021</td>
<td>Precision References for Series or Shunt Operation</td>
<td>Industry Standard Pinout, –40°C to 125°C</td>
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<tr>
<td>LT1389</td>
<td>1.25V, 2.5V, 4V and 5V Nanopower Shunt Reference</td>
<td>800nA, 0.05% Accuracy, 10ppm/°C Drift</td>
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<tr>
<td>LT1634</td>
<td>1.25 and 2.5V Micropower Shunt Reference</td>
<td>0.05%, 10ppm/°C, 10μA Current</td>
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<tr>
<td>LTZ1000</td>
<td>7V Ultra Precision, Stable Shunt Reference</td>
<td>0.05ppm/°C, 1.2mVp-p Noise</td>
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