Micropower Voltage Reference

FEATURES
- Guaranteed ±4mV Initial Accuracy LT1004-1.2
- Guaranteed ±20mV Accuracy LT1004-2.5
- Guaranteed 10μA Operating Current
- Guaranteed Temperature Performance
- Operates up to 20mA
- Very Low Dynamic Impedance

APPLICATIONS
- Portable Meter References
- Portable Test Instruments
- Battery-Operated Systems
- Current Loop Instrumentation

DESCRIPTION
The LT®1004 micropower voltage reference is a 2-terminal bandgap reference diode designed to provide high accuracy and excellent temperature characteristics at very low operating currents. Optimization of the key parameters in the design, processing and testing of the device results in accuracy specifications previously attainable only with selected units. Below is a distribution plot of reference voltage for a typical lot of LT1004-1.2. Virtually all of the units fall well within the prescribed limits of ±4mV.

The LT1004 is a pin-for-pin replacement for the LM185/LM385 series of references with improved accuracy specifications. More important, the LT1004 is an attractive device for use in systems where accuracy was previously obtained at the expense of power consumption and trimming.

For a low drift micropower reference with guaranteed temperature coefficient, see the LT1034 data sheet.

APPLICATIONS
- Guaranteed ±4mV Initial Accuracy LT1004-1.2
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TYPICAL APPLICATION
Micropower Cold Junction Compensation for Thermocouples

![Typical Distribution of Reference Voltage (LT1004-1.2)](image)

For more information [www.linear.com/LT1004](http://www.linear.com/LT1004)
**LT1004**

**ABSOLUTE MAXIMUM RATINGS**  
*(Note 1)*

Reverse Breakdown Current .................................. 30mA  
Forward Current ................................................... 10mA  
Storage Temperature Range .................. –65 °C to 150 °C  
Lead Temperature (Soldering, 10 sec) ................. 300°C  
Operating Temperature Range  
LT1004M ...................................................... –55°C to 125°C  
LT1004I ...................................................... –40°C to 85°C  
LT1004C ........................................................ 0°C to 70°C  

**PIN CONFIGURATION**

**ORDER INFORMATION** [http://www.linear.com/product/LT1004#orderinfo](http://www.linear.com/product/LT1004#orderinfo)

<table>
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<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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</thead>
<tbody>
<tr>
<td>LT1004MH-2.5#PBF</td>
<td>LT1004MH-2.5#TRPBF</td>
<td>0412</td>
<td>2-Lead TO-46 Metal Can</td>
<td>–55°C to 125°C</td>
</tr>
<tr>
<td>LT1004CS8-1.2#PBF</td>
<td>LT1004CS8-1.2#TRPBF</td>
<td>0412I</td>
<td>8-Lead Plastic S0</td>
<td>0°C to 70°C</td>
</tr>
<tr>
<td>LT1004CS8-2.5#PBF</td>
<td>LT1004CS8-2.5#TRPBF</td>
<td>0425</td>
<td>8-Lead Plastic S0</td>
<td>0°C to 70°C</td>
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<tr>
<td>LT1004IS8-1.2#PBF</td>
<td>LT1004IS8-1.2#TRPBF</td>
<td>0425I</td>
<td>8-Lead Plastic S0</td>
<td>–40°C to 85°C</td>
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<td>8-Lead Plastic S0</td>
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<tr>
<td>LT1004CZ-1.2#PBF</td>
<td>LT1004CZ-1.2#TRPBF</td>
<td>0425</td>
<td>3-Lead Plastic TO-92</td>
<td>0°C to 70°C</td>
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<tr>
<td>LT1004CZ-2.5#PBF</td>
<td>LT1004CZ-2.5#TRPBF</td>
<td>0425</td>
<td>3-Lead Plastic TO-92</td>
<td>0°C to 70°C</td>
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<tr>
<td>LT1004IZ-1.2#PBF</td>
<td>LT1004IZ-1.2#TRPBF</td>
<td>0425</td>
<td>3-Lead Plastic TO-92</td>
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<td>–40°C to 85°C</td>
</tr>
</tbody>
</table>

Consult LTC Marketing for parts specified with wider operating temperature ranges.  
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/). Some packages are available in 500 unit reels through designated sales channels with #TRMPBF suffix.
### ELECTRICAL CHARACTERISTICS

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

<table>
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<tr>
<th>SYMBOL</th>
<th>PARAMETER</th>
<th>CONDITIONS</th>
<th>C, I SUFFIXES</th>
<th>H SUFFIX</th>
<th>UNITS</th>
</tr>
</thead>
</table>
| $V_Z$  | Reverse Breakdown Voltage | $I_R = 100\mu A$
LT1004M: $-55^\circ C \leq T_A \leq 125^\circ C$
LT1004C: $0^\circ C \leq T_A \leq 70^\circ C$
LT1004I: $-40^\circ C \leq T_A \leq 85^\circ C$
| MIN  | TYP | MAX | MIN  | TYP | MAX |
| 1.231 | 1.235 | 1.239 | 2.480 | 2.500 | 2.520 |
| $\frac{\Delta V_Z}{\Delta \text{Temp}}$ | Average Temperature Coefficient | $I_{\text{MIN}} \leq I_R \leq 20\text{mA}$ (Note 3) | 20 | 20 | ppm/$^\circ C$ |
| $I_{\text{MIN}}$ | Minimum Operating Current | ● | 8 | 10 | 12 | 20 | µA |
| $\frac{\Delta V_Z}{\Delta I_R}$ | Reverse Breakdown Voltage Change with Current | $I_{\text{MIN}} \leq I_R \leq 1\text{mA}$
1mA $\leq I_R \leq 20\text{mA}$ | ● | 1.0 | 1.0 | mV |
| $r_Z$ | Reverse Dynamic Impedance | $I_R = 100\mu A$
| | ● | 0.2 | 0.6 | 0.2 | 0.6 | Ω |
| $\theta_n$ | Wide Band Noise (RMS) | $I_R = 100\mu A$, 10Hz $\leq f \leq 10\text{kHz}$ | 60 | 120 | µV |
| $\frac{\Delta V_Z}{\Delta \text{Time}}$ | Long Term Stability | $I_R = 100\mu A$, $T_A = 25^\circ C \pm 0.1^\circ C$ | 20 | 20 | ppm/kHr |

**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:** All specifications are for $T_A = 25^\circ C$ unless otherwise noted.

**Note 3:** Selected devices with guaranteed maximum temperature coefficient are available upon request.

For MIL-STD components, please refer to LTC883C data sheet for test listing and parameters.

For more information [www.linear.com/LT1004](http://www.linear.com/LT1004)
TYPICAL PERFORMANCE CHARACTERISTICS

Reverse Characteristics

Reverse Voltage Change

Forward Characteristics

Temperature Drift

Reverse Dynamic Impedance

Noise Voltage

Filtered Output Noise

Response Time

For more information www.linear.com/LT1004
Performance Characteristics

Reverse Characteristics

Forward Characteristics

Temperature Drift

Reverse Dynamic Impedance

Reverse Dynamic Impedance

Noise Voltage

Filtered Output Noise

Response Time

For more information www.linear.com/LT1004
**High Stability 5V Regulator**

Vin ≥ 8V  

![Circuit Diagram](image)

- LT338A
- IN
- OUT
- 5V
- 1µF
- 300Ω 1%
- 100Ω 1%
- LT1004-2.5

**Variable Output Supply**

Vin  

![Circuit Diagram](image)

- LT338A
- VIN
- OUT
- VOUT
- 120Ω
- 10µF
- R1
- V–

R1 ≤ (V– – 1V / 0.015)

**Constant Gain Amplifier Over Temperature**

Vin ≥ 5V  

![Circuit Diagram](image)

- 250k
- 250k
- OUTPUT
- INPUT
- 2N3904
- 200k
- LT1004-1.2
- 60k

V– ≤ –5V  

V+ ≥ 5V

**Micropower 5V Reference**

Vin 9V to 15V  

![Circuit Diagram](image)

- LM334
- R
- 5.6k
- 1M
- 1%
- 1004 TA07
- VOUT
- 150pF
- 3.01M 1%

**Lead Acid Low-Battery Detector**

Vin 12V  

![Circuit Diagram](image)

- R1† 1%
- 1M
- 133k 1%
- LT1004-1.2
- LM4250

†R1 SETS TRIP POINT, 60.4k PER CELL FOR 1.8V/CELL

**Ground Referenced Current Source**

Vin –5V  

![Circuit Diagram](image)

- R
- 2k*
- LT1007C
- 150pF
- 22M
- VOUT

*MAY BE INCREASED FOR SMALL OUTPUT CURRENTS

For more information [www.linear.com/LT1004](http://www.linear.com/LT1004)
TYPICAL APPLICATIONS

VPP Generator for Eproms — No Trim Required

1.2V Reference from 1.5V Battery

Micropower Reference from 9V Battery

2.5V Reference

Low Noise Reference

SCHEMATIC DIAGRAMS

LT1004-1.2

LT1004-2.5
PACKAGE DESCRIPTION

Please refer to http://www.linear.com/product/LT1004#packaging for the most recent package drawings.

H Package
2-Lead and 3-Lead TO-46 Metal Can
(Reference LTC DWG # 05-08-1340)

*LEAD DIAMETER IS UNCONTROLLED BETWEEN THE REFERENCE PLANE AND .050" BELOW THE REFERENCE PLANE

**FOR SOLDER DIP LEAD FINISH, LEAD DIAMETER IS .016 – .024 (0.406 – 0.610)

For more information www.linear.com/LT1004
PACKAGE DESCRIPTION

Please refer to http://www.linear.com/product/LT1004#packaging for the most recent package drawings.

S8 Package

8-Lead Plastic Small Outline (Narrow .150 Inch)

(Reference LTC DWG # 05-08-1610 Rev G)

**RECOMMENDED SOLDER PAD LAYOUT**

**NOTE:**
1. DIMENSIONS IN INCHES (MILLIMETERS)
2. DRAWING NOT TO SCALE
3. THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.
   MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED .006" (0.15mm)
4. PIN 1 CAN BE BEVEL EDGE OR A DIMPLE

For more information www.linear.com/LT1004
Z Package
3-Lead Plastic TO-92 (Similar to TO-226)
(Reference LTC DWG # 05-08-1410 Rev C)

Z Package
3-Lead Plastic TO-92 (Similar to TO-226)
(Reference LTC DWG # 05-08-1410 Rev C)
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TYPICAL APPLICATION

0°C to 100°C Linear Output Thermometer

Low Temperature Coefficient
2-Terminal Current Source

RELATED PARTS

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>DESCRIPTION</th>
<th>COMMENTS</th>
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<tbody>
<tr>
<td>LT1634</td>
<td>Micropower Precision Shunt Reference</td>
<td>10µA Operating Current, 10ppm/°C Maximum Drift, 0.05% Initial Accuracy</td>
</tr>
<tr>
<td>LT1460S3-2.5</td>
<td>Micropower Series Reference in SOT-23</td>
<td>100µA Operating Current, 20ppm/°C Maximum Drift, 0.2% Initial Accuracy</td>
</tr>
<tr>
<td>LT1790</td>
<td>Precision Micropower LDO Reference in SOT-23</td>
<td>10ppm/°C Max Drift, 0.05% Initial Accuracy</td>
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</table>