FEATURES

- INITIAL ACCURACY:
  - REF1004-1.2 ±4mV
  - REF1004-2.5 ±20mV
- MINIMUM OPERATING CURRENT:
  - REF1004-1.2 10µA
  - REF1004-2.5 20µA
- EXCELLENT LONG TERM TEMPERATURE STABILITY
- VERY LOW DYNAMIC IMPEDANCE
- OPERATES UP TO 20mA
- PACKAGE: 8-Lead SOIC

APPLICATIONS

- BATTERY POWERED TEST EQUIPMENT
- PORTABLE MEDICAL INSTRUMENTATION
- PORTABLE COMMUNICATIONS DEVICES
- A/D AND D/A CONVERTERS
- NOTEBOOK AND PALMTOP COMPUTERS

DESCRIPTION

The REF1004-1.2 and REF1004-2.5 are two terminal bandgap reference diodes designed for high accuracy with outstanding temperature characteristics at low operating currents. Prior to the introduction of the REF1004 Micropower Voltage References, accuracy and stability specifications could only be attained by expensive screening of standard devices. The REF1004 is a cost effective solution when reference voltage accuracy, low power, and long term temperature stability are required.

REF1004 is a drop-in replacement for the LT1004 as well as an upgraded replacement of the LM185/385 series references. The REF1004C is characterized for operation from 0°C to 70°C and the REF1004I is characterized for operation from −40°C to +85°C.

The REF1004 is offered in an 8-lead Plastic SOIC package and shipped in anti-static rails or tape and reel.
## SPECIFICATIONS

### ELECTRICAL

\( T_A = +25^\circ C \) unless otherwise noted.

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>CONDITIONS</th>
<th>REF1004-1.2</th>
<th>REF1004-2.5</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>REFERENCE VOLTAGE</strong></td>
<td>( I_R = 100\mu A )</td>
<td>1.231</td>
<td>1.235</td>
<td>2.490</td>
</tr>
<tr>
<td><strong>REFERENCE VOLTAGE</strong> &lt;sup&gt;(1)&lt;/sup&gt;</td>
<td>( I_R = 100\mu A )</td>
<td>1.229</td>
<td>1.235</td>
<td>2.487</td>
</tr>
<tr>
<td><strong>REFERENCE VOLTAGE</strong> &lt;sup&gt;(2)&lt;/sup&gt;</td>
<td>( I_R = 100\mu A )</td>
<td>1.225</td>
<td>1.235</td>
<td>2.480</td>
</tr>
<tr>
<td><strong>AVERAGE TEMPERATURE</strong></td>
<td>( I_{MIN} \leq I_R \leq 20 mA )</td>
<td>20</td>
<td>20</td>
<td>ppm/°C</td>
</tr>
<tr>
<td><strong>MINIMUM OPERATION CURRENT</strong></td>
<td></td>
<td>8</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td><strong>REVERSE BREAKDOWN CURRENT</strong></td>
<td></td>
<td>1</td>
<td>1</td>
<td>1.5(3)</td>
</tr>
<tr>
<td><strong>VOLTAGE CHANGE WITH CURRENT</strong></td>
<td>1 mA ≤ ( I_R ) ≤ 20 mA</td>
<td>10</td>
<td>20(3)</td>
<td></td>
</tr>
<tr>
<td><strong>REVERSE DYNAMIC IMPEDANCE</strong></td>
<td>( I_R = 100\mu A )</td>
<td>0.2</td>
<td>0.6</td>
<td>0.2</td>
</tr>
<tr>
<td><strong>WIDE BAND NOISE (RMS)</strong></td>
<td>( I_R = 100\mu A )</td>
<td>60</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td><strong>LONG TERM STABILITY</strong></td>
<td>( I_R = 100\mu A )</td>
<td>20</td>
<td>20</td>
<td>ppm/KHr</td>
</tr>
</tbody>
</table>

Notes:
1. This specification applies over the full operating temperature range of 0°C ≤ \( T_A \) ≤ 70°C.
2. This specification applies over the full operating temperature range of 40°C ≤ \( T_A \) ≤ +85°C.
3. Denotes the specifications which apply over the full operating temperature range.

### ORDERING INFORMATION

<table>
<thead>
<tr>
<th>MODEL</th>
<th>( T_A )</th>
<th>( V_Z )</th>
<th>PACKAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>REF1004C-1.2</td>
<td>0°C to +70°C</td>
<td>1.2V</td>
<td>8-Lead SOIC</td>
</tr>
<tr>
<td>REF1004C-2.5</td>
<td>0°C to +70°C</td>
<td>2.5V</td>
<td>8-Lead SOIC</td>
</tr>
<tr>
<td>REF1004I-1.2</td>
<td>-40°C to +85°C</td>
<td>1.2V</td>
<td>8-Lead SOIC</td>
</tr>
<tr>
<td>REF1004I-2.5</td>
<td>-40°C to +85°C</td>
<td>2.5V</td>
<td>8-Lead SOIC</td>
</tr>
</tbody>
</table>

Note: Available in Tape and Reel, Add –TR to Model Number.

### ABSOLUTE MAXIMUM RATINGS

- Reverse Breakdown Current: 30mA
- Forward Current: 10mA
- Operating Temperature Range:
  - REF1004C: 0°C to +70°C
  - REF1004I: -40°C to +85°C
- Storage Temperature:
  - REF1004C: -65°C to +150°C
  - REF1004I: -65°C to +150°C
- Lead Temperature (soldering, 10s): +300°C

### PACKAGE INFORMATION

<table>
<thead>
<tr>
<th>MODEL</th>
<th>PACKAGE</th>
<th>PACKAGE DRAWING NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>REF1004C-1.2</td>
<td>8-Pin SOIC</td>
<td>182</td>
</tr>
<tr>
<td>REF1004C-2.5</td>
<td>8-Pin SOIC</td>
<td>182</td>
</tr>
<tr>
<td>REF1004I-1.2</td>
<td>8-Pin SOIC</td>
<td>182</td>
</tr>
<tr>
<td>REF1004I-2.5</td>
<td>8-Pin SOIC</td>
<td>182</td>
</tr>
</tbody>
</table>

Note: For detailed drawing and dimension table, please see end of data sheet, or Appendix D of Burr-Brown IC Data Book.

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TYPICAL PERFORMANCE CURVES 1.2V

Ta = +25°C unless otherwise noted.

REVERSE CHARACTERISTICS

Reverse Voltage (V)

0.0 0.2 0.4 0.6 0.8 1.0 1.2 1.4

Reverse Current (µA)

100 10 1 0.1

TEMPERATURE DRIFT

Reverse Voltage (V)

12.25 12.30 12.35 12.40 12.45

Temperature (°C)

-55 -35 -15 5 25 45 65 85 105 125

REVERSE VOLTAGE CHANGE

Output Voltage Change (mV)

16 12 8 4 0

Reverse Current (mA)

0.01 0.1 1 10 100

-40°C ≤ Ta ≤ +85°C

FORWARD CHARACTERISTICS

Forward Voltage (V)

1.2 0.8 0.4 0.0

Forward Current (mA)

0.01 0.1 1 10 100

Ta = +25°C

REVERSE DYNAMIC IMPEDANCE

Reverse Impedance (Ω)

100 10 1

Reverse Current (mA)

0.01 0.1 1 10 100

-40°C to +85°C

f = 25Hz

REVERSE DYNAMIC IMPEDANCE

Dynamic Impedance (Ω)

10k 1k 100

Frequency (Hz)

10 100 1k 10k 100k 1M

Ta = +25°C

IREF = 100µA
TYPICAL PERFORMANCE CURVES 1.2V (CONT)

$T_A = +25^\circ C$ unless otherwise noted.

**Noise Voltage**

- Frequency (Hz): 10, 100, 1k, 10k, 100k
- Noise (nV/√Hz): 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100

**Filtered Output Noise**

- Cutoff Frequency (Hz): 100, 1k, 10k, 100k
- Integrated Noise (µV): 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100

**Response Time**

- Voltage (V): 0, 2.5, 5, 7.5, 10
- Time (µSec): 0, 100, 200, 300, 400, 500, 600
TYPICAL PERFORMANCE CURVES 2.5V

T_A = +25°C unless otherwise noted.

REVERSE CHARACTERISTICS

Reverse Voltage (V)

–40°C ≤ T_A ≤ +85°C

Reverse Current (µA)

0.0 0.5 1.0 1.5 2.0 2.5 3.0

REVERSE VOLTAGE CHANGE

–40°C ≤ T_A ≤ +85°C

Output Voltage Change (mV)

0.01 0.1 1 10 100

FORWARD CHARACTERISTICS

Forward Voltage (V)

0.01 0.1 1 10 100

TEMPERATURE DRIFT

Temperature (°C)

–55 –35 –15 5 25 45 65 85 105 125

Reference Voltage (V)

2.520 2.515 2.510 2.505 2.500 2.495 2.490 2.485 2.480 2.475

REVERSE DYNAMIC IMPEDANCE

Reverse Impedance (Ω)

0.01 0.1 1 10 100

Frequency (Hz)

10 100 1k 10k 100k 1M

Reference Voltage (V)

T_A = +25°C

TREF = 100µA

REVERSE DYNAMIC IMPEDANCE

Dynamic Impedance (Ω)

0.1 1 10 100 1k 10k 100k 1M

Frequency (Hz)

10 100 1k 10k 100k 1M

T_A = +25°C

TREF = 100µA
TYPICAL PERFORMANCE CURVES 2.5V (CONT)

$T_A = +25^\circ C$ unless otherwise noted.

**NOISE VOLTAGE**

**FILTERED OUTPUT NOISE**

**RESPONSE TIME**
FIGURE 1. Low-Noise Reference.

FIGURE 2. Micropower Reference from 9V Battery.

FIGURE 3. 1.2V Reference from 1.5V Battery.

FIGURE 4. 2.5V Reference.

FIGURE 5. Lead-Acid Low-Battery-Voltage Detector.

NOTE: Output regulates to 1.285V for I_O = 0.

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NOTE: Output regulates to 1.285V for I_O = 0.

NOTE: (1) R_1 sets trip point, 60.4k\Omega per cell for 1.8V per cell.