

# REF1004

## 1.2V and 2.5V Micropower VOLTAGE REFERENCE

### FEATURES

- **INITIAL ACCURACY:**  
REF1004-1.2  $\pm 4\text{mV}$   
REF1004-2.5  $\pm 20\text{mV}$
- **MINIMUM OPERATING CURRENT:**  
REF1004-1.2  $10\mu\text{A}$   
REF1004-2.5  $20\mu\text{A}$
- **EXCELLENT LONG TERM TEMPERATURE STABILITY**
- **VERY LOW DYNAMIC IMPEDANCE**
- **OPERATES UP TO 20mA**
- **PACKAGE: 8-Lead SOIC**

### APPLICATIONS

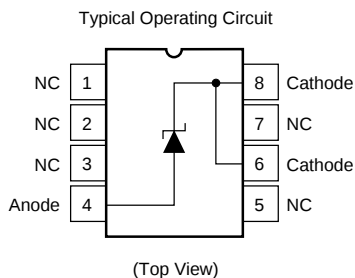
- **BATTERY POWERED TEST EQUIPMENT**
- **PORTABLE MEDICAL INSTRUMENTATION**
- **PORTABLE COMMUNICATIONS DEVICES**
- **A/D AND D/A CONVERTERS**
- **NOTEBOOK AND PALMTOP COMPUTERS**

### 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  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$  and the REF1004I is characterized for operation from  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ .

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



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Tel: (520) 746-1111 • Twx: 910-952-1111 • Cable: BBRCORP • Telex: 066-6491 • FAX: (520) 889-1510 • Immediate Product Info: (800) 548-6132

# SPECIFICATIONS

## ELECTRICAL

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

| PARAMETER                                                                 | CONDITIONS                                                                          | REF1004-1.2             |                         |                                                    | REF1004-2.5             |                         |                                                    | UNITS                   |
|---------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------|-------------------------|----------------------------------------------------|-------------------------|-------------------------|----------------------------------------------------|-------------------------|
|                                                                           |                                                                                     | MIN                     | TYP                     | MAX                                                | MIN                     | TYP                     | MAX                                                |                         |
| REFERENCE VOLTAGE<br>REF1004C <sup>(1)</sup><br>REF1004I <sup>(2)</sup>   | $I_R = 100\mu\text{A}$                                                              | 1.231<br>1.229<br>1.225 | 1.235<br>1.235<br>1.235 | 1.239<br>1.239<br>1.239                            | 2.490<br>2.487<br>2.480 | 2.500<br>2.500<br>2.500 | 2.511<br>2.511<br>2.511                            | V                       |
| AVERAGE TEMPERATURE COEFFICIENT                                           | $I_{\text{MIN}} \leq I_R \leq 20\text{mA}$                                          |                         | 20                      |                                                    |                         | 20                      |                                                    | ppm/ $^{\circ}\text{C}$ |
| MINIMUM OPERATION CURRENT <sup>(3)</sup>                                  |                                                                                     |                         | 8                       | 10                                                 |                         | 12                      | 20                                                 | $\mu\text{A}$           |
| REVERSE BREAKDOWN VOLTAGE CHANGE WITH CURRENT                             | $I_{\text{MIN}} \leq I_R \leq 1\text{mA}$<br>$1\text{mA} \leq I_R \leq 20\text{mA}$ |                         |                         | 1<br>1.5 <sup>(3)</sup><br>10<br>20 <sup>(3)</sup> |                         |                         | 1<br>1.5 <sup>(3)</sup><br>10<br>20 <sup>(3)</sup> | mV                      |
| REVERSE DYNAMIC IMPEDANCE <sup>(3)</sup>                                  | $I_R = 100\mu\text{A}$                                                              |                         | 0.2                     | 0.6                                                |                         | 0.2                     | 0.6                                                | $\Omega$                |
| WIDE BAND NOISE (RMS)<br>10Hz $\leq I_R \leq 10\text{kHz}$                | $I_R = 100\mu\text{A}$                                                              |                         | 60                      |                                                    |                         | 120                     |                                                    | $\mu\text{V}$           |
| LONG TERM STABILITY<br>$T_A = 25^{\circ}\text{C} \pm 0.1^{\circ}\text{C}$ | $I_R = 100\mu\text{A}$                                                              |                         | 20                      |                                                    |                         | 20                      |                                                    | ppm/KHr                 |

NOTES: (1) This specification applies over the full operating temperature range of  $0^{\circ}\text{C} \leq T_A \leq 70^{\circ}\text{C}$ . (2) This specification applies over the full operating temperature range of  $40^{\circ}\text{C} \leq T_A \leq +85^{\circ}\text{C}$ . (3) Denotes the specifications which apply over the full operating temperature range.

## ORDERING INFORMATION

| MODEL        | $T_A$                                          | $V_Z$ | PACKAGE     |
|--------------|------------------------------------------------|-------|-------------|
| REF1004C-1.2 | $0^{\circ}\text{C}$ to $+70^{\circ}\text{C}$   | 1.2V  | 8-Lead SOIC |
| REF1004C-2.5 | $0^{\circ}\text{C}$ to $+70^{\circ}\text{C}$   | 2.5V  | 8-Lead SOIC |
| REF1004I-1.2 | $-40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ | 1.2V  | 8-Lead SOIC |
| REF1004I-2.5 | $-40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ | 2.5V  | 8-Lead SOIC |

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 .....                          | $0^{\circ}\text{C}$ to $+70^{\circ}\text{C}$    |
| REF1004I .....                          | $-40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$  |
| Storage Temperature                     |                                                 |
| REF1004C .....                          | $-65^{\circ}\text{C}$ to $+150^{\circ}\text{C}$ |
| REF1004I .....                          | $-65^{\circ}\text{C}$ to $+150^{\circ}\text{C}$ |
| Lead Temperature (soldering, 10s) ..... | $+300^{\circ}\text{C}$                          |

## ORDERING INFORMATION

| MODEL        | PART MARKING |
|--------------|--------------|
| REF1004C-1.2 | BBREF0412    |
| REF1004C-2.5 | BBREF0425    |
| REF1004I-1.2 | BBREF0412    |
| REF1004I-2.5 | BBREF0425    |

## PACKAGE INFORMATION

| MODEL        | PACKAGE    | PACKAGE DRAWING NUMBER <sup>(1)</sup> |
|--------------|------------|---------------------------------------|
| REF1004C-1.2 | 8-Pin SOIC | 182                                   |
| REF1004C-2.5 | 8-Pin SOIC | 182                                   |
| REF1004I-1.2 | 8-Pin SOIC | 182                                   |
| REF1004I-2.5 | 8-Pin SOIC | 182                                   |

NOTE: (1) For detailed drawing and dimension table, please see end of data sheet, or Appendix D of Burr-Brown IC Data Book.

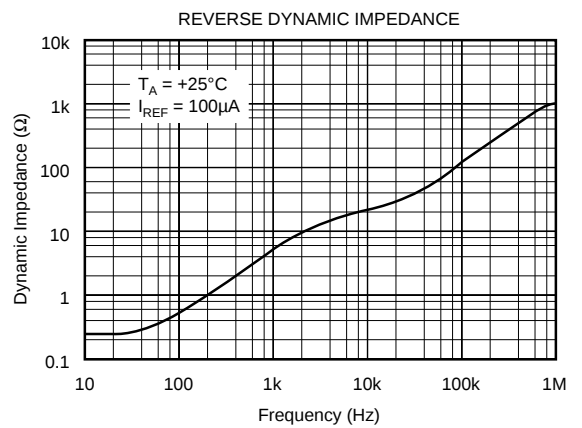
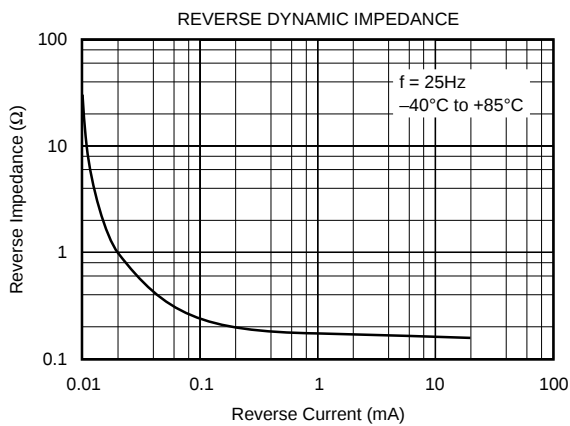
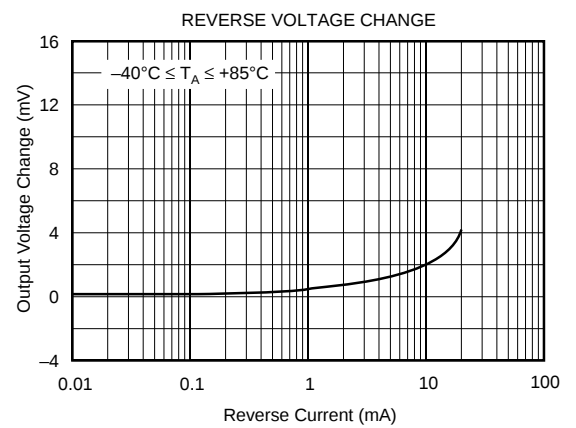
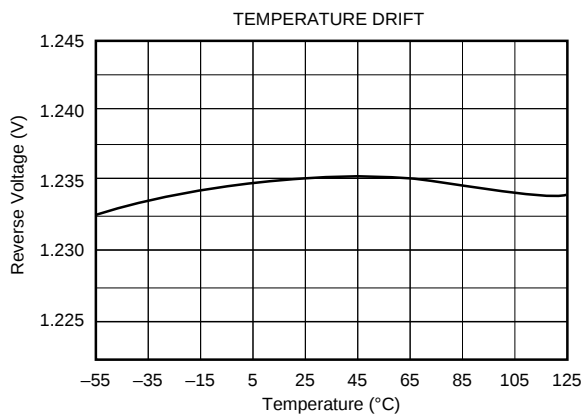
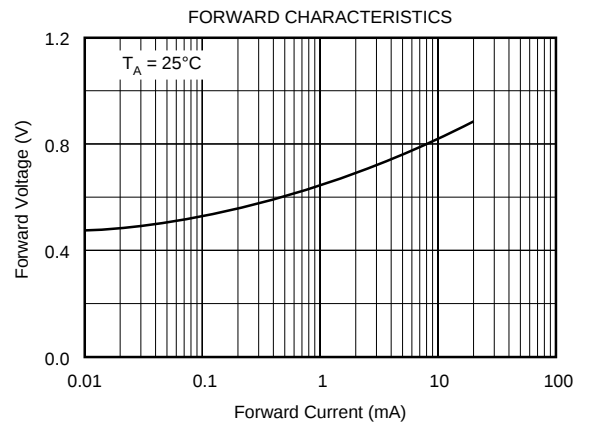
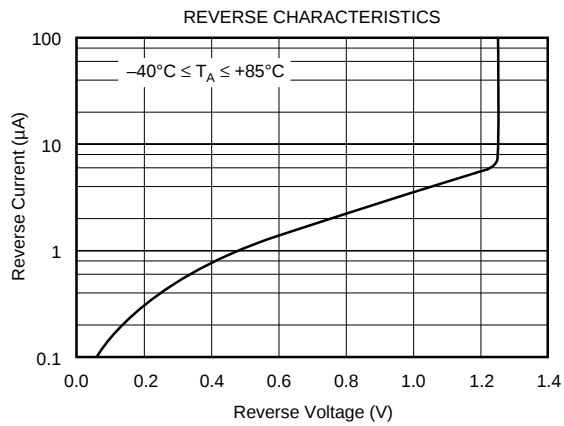
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REF1004

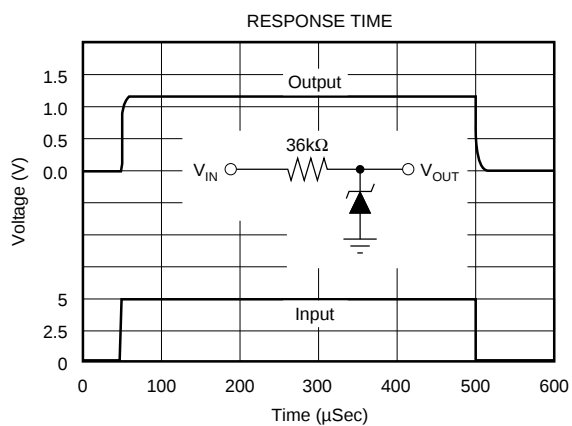
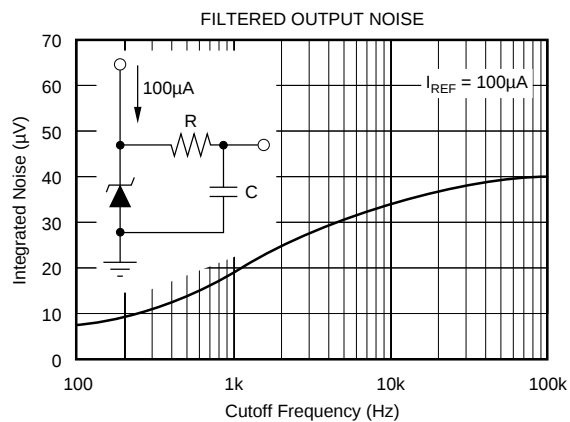
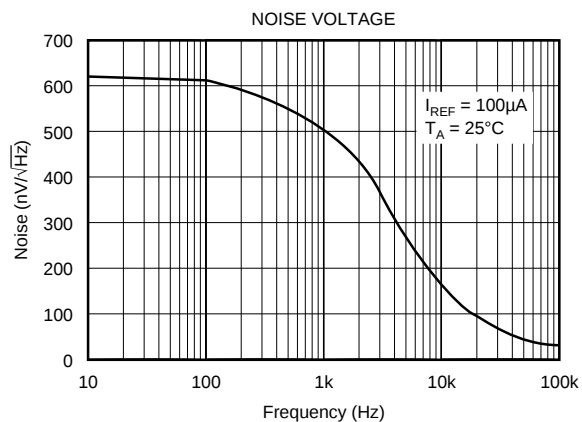
# TYPICAL PERFORMANCE CURVES 1.2V

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



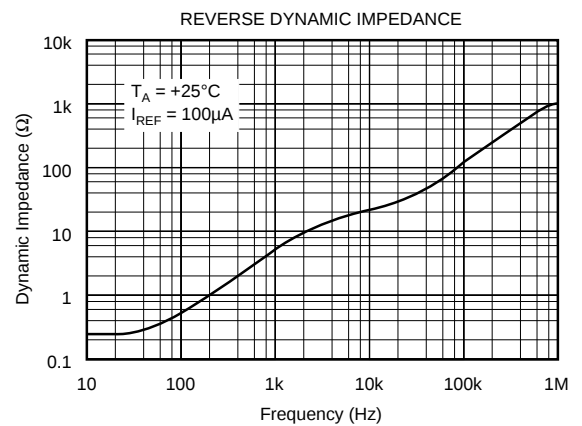
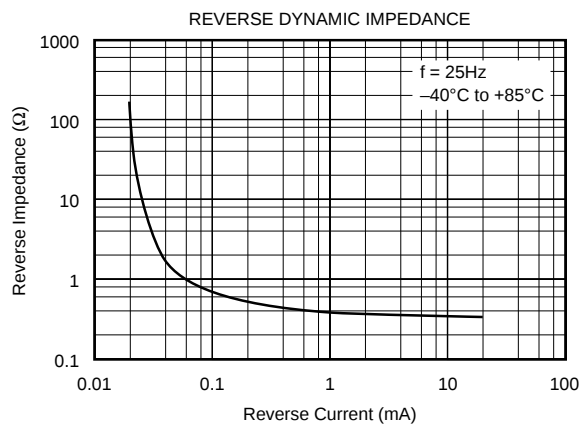
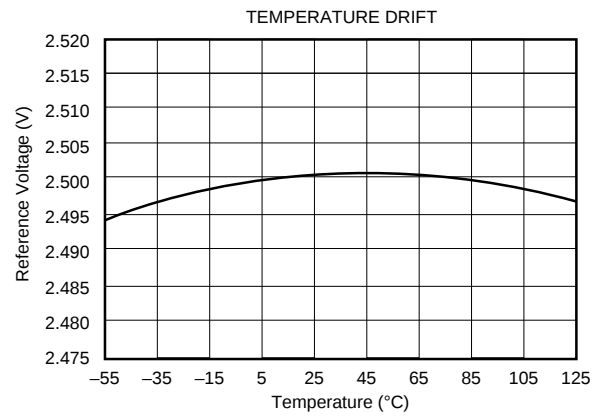
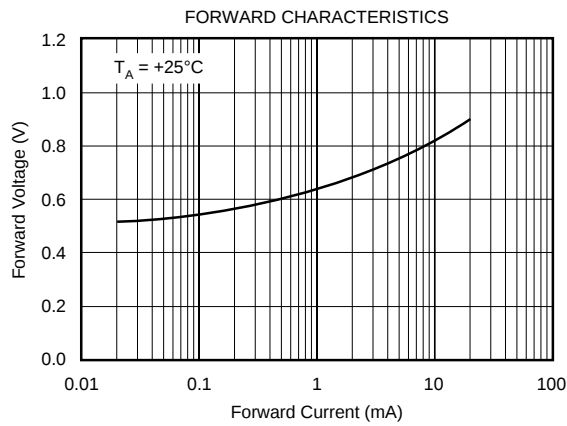
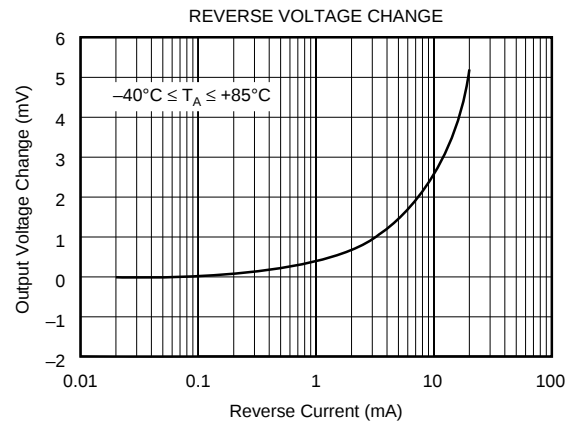
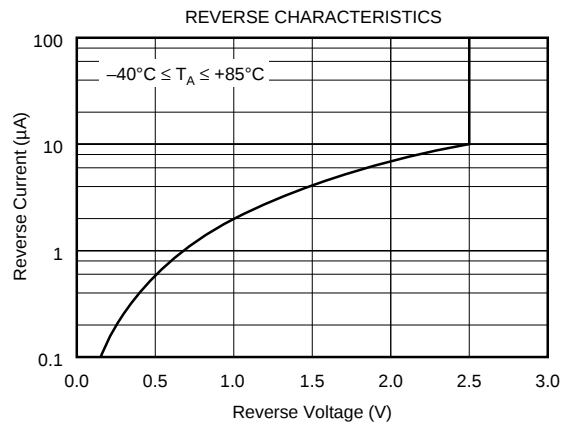
# TYPICAL PERFORMANCE CURVES 1.2V (CONT)

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



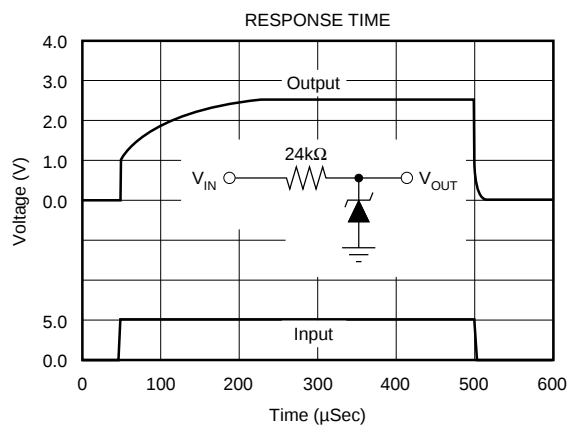
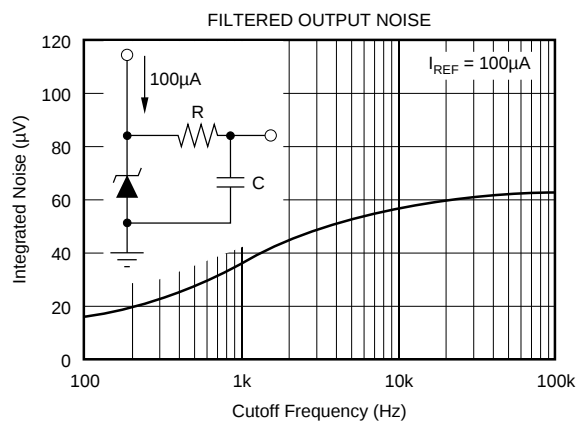
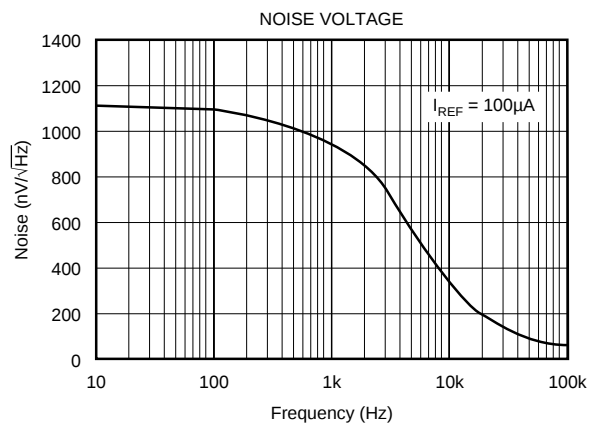
# TYPICAL PERFORMANCE CURVES 2.5V

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



# TYPICAL PERFORMANCE CURVES 2.5V (CONT)

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



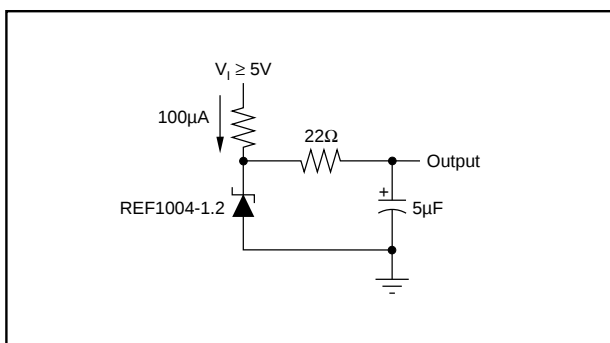


FIGURE 1. Low-Noise Reference.

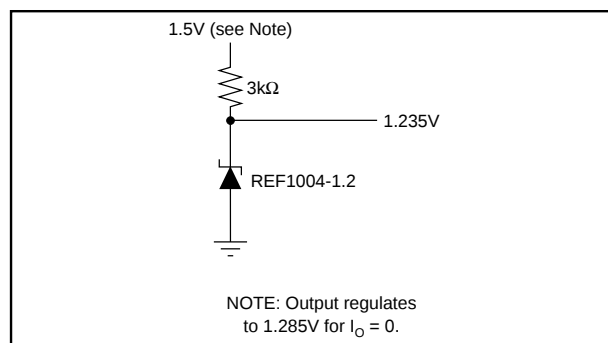


FIGURE 3. 1.2V Reference from 1.5V Battery.

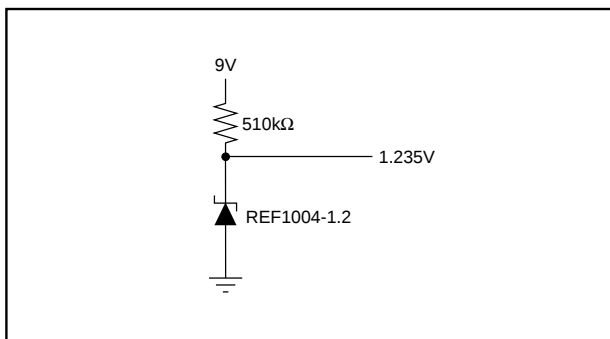


FIGURE 2. Micropower Reference from 9V Battery.

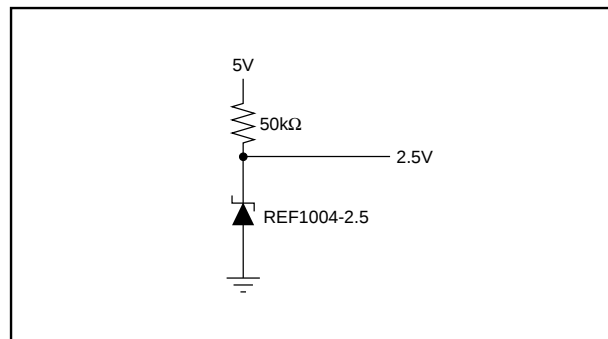


FIGURE 4. 2.5V Reference.

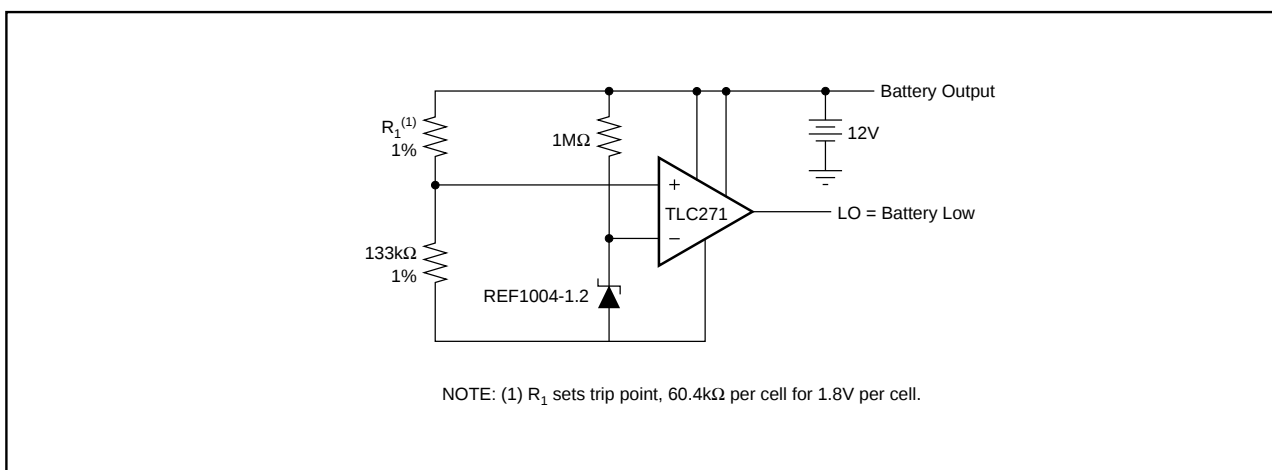


FIGURE 5. Lead-Acid Low-Battery-Voltage Detector.

**PACKAGING INFORMATION**

| Orderable Device   | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup> | Lead/Ball Finish | MSL Peak Temp <sup>(3)</sup> |
|--------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| REF1004C-1.2       | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-3-260C-168 HR          |
| REF1004C-1.2/2K5   | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-3-260C-168 HR          |
| REF1004C-1.2/2K5E4 | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-3-260C-168 HR          |
| REF1004C-1.2E4     | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-3-260C-168 HR          |
| REF1004C-2.5       | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-3-260C-168 HR          |
| REF1004C-2.5/2K5   | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-3-260C-168 HR          |
| REF1004C-2.5/2K5E4 | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-3-260C-168 HR          |
| REF1004C-2.5E4     | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-3-260C-168 HR          |
| REF1004I-1.2       | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-3-260C-168 HR          |
| REF1004I-1.2/2K5   | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-3-260C-168 HR          |
| REF1004I-1.2/2K5E4 | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-3-260C-168 HR          |
| REF1004I-1.2E4     | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-3-260C-168 HR          |
| REF1004I-2.5       | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-3-260C-168 HR          |
| REF1004I-2.5/2K5   | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-3-260C-168 HR          |
| REF1004I-2.5/2K5E4 | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-3-260C-168 HR          |
| REF1004I-2.5E4     | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-3-260C-168 HR          |

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

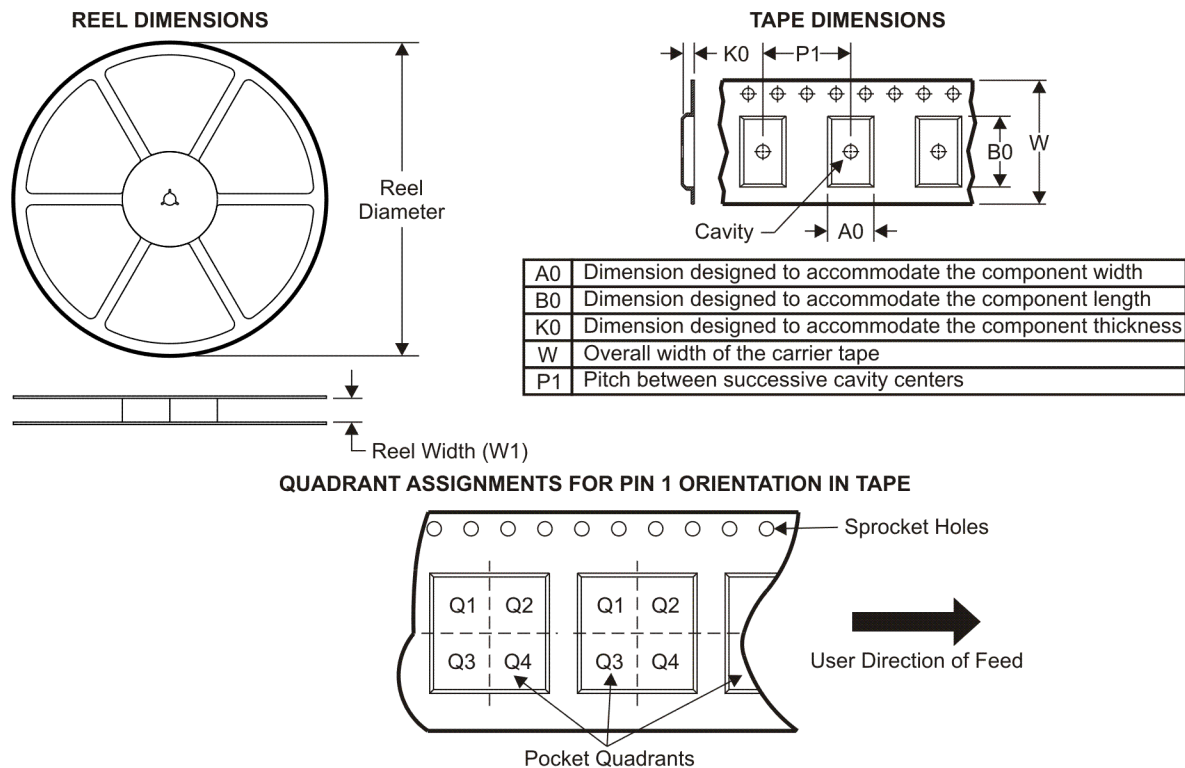
**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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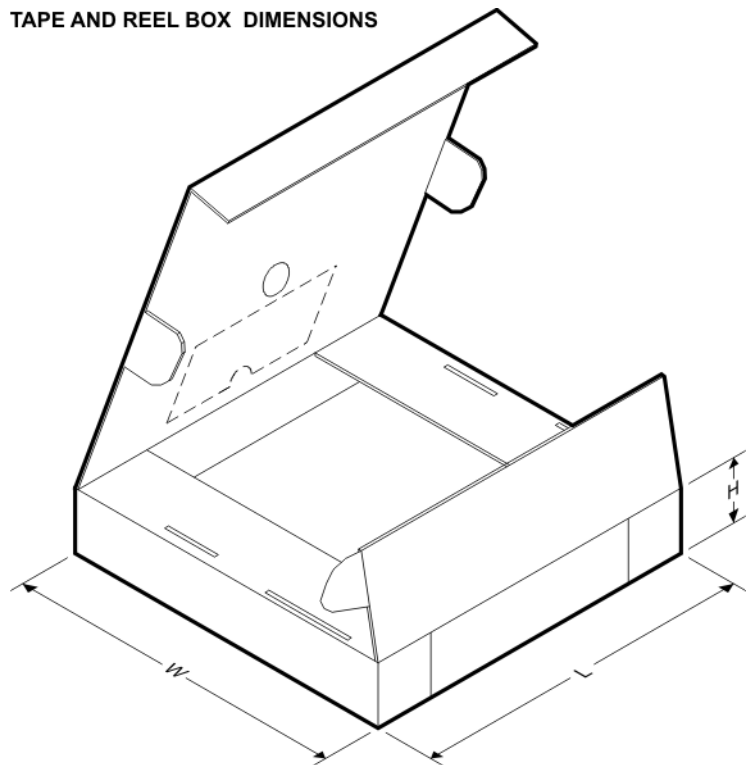
**TAPE AND REEL INFORMATION**



\*All dimensions are nominal

| Device           | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| REF1004C-1.2/2K5 | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| REF1004C-2.5/2K5 | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| REF1004I-1.2/2K5 | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| REF1004I-2.5/2K5 | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |

## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

| Device           | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| REF1004C-1.2/2K5 | SOIC         | D               | 8    | 2500 | 346.0       | 346.0      | 29.0        |
| REF1004C-2.5/2K5 | SOIC         | D               | 8    | 2500 | 346.0       | 346.0      | 29.0        |
| REF1004I-1.2/2K5 | SOIC         | D               | 8    | 2500 | 346.0       | 346.0      | 29.0        |
| REF1004I-2.5/2K5 | SOIC         | D               | 8    | 2500 | 346.0       | 346.0      | 29.0        |

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### Products

|                             |                                                                    |
|-----------------------------|--------------------------------------------------------------------|
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| Data Converters             | <a href="http://dataconverter.ti.com">dataconverter.ti.com</a>     |
| DSP                         | <a href="http://dsp.ti.com">dsp.ti.com</a>                         |
| Clocks and Timers           | <a href="http://www.ti.com/clocks">www.ti.com/clocks</a>           |
| Interface                   | <a href="http://interface.ti.com">interface.ti.com</a>             |
| Logic                       | <a href="http://logic.ti.com">logic.ti.com</a>                     |
| Power Mgmt                  | <a href="http://power.ti.com">power.ti.com</a>                     |
| Microcontrollers            | <a href="http://microcontroller.ti.com">microcontroller.ti.com</a> |
| RFID                        | <a href="http://www.ti-rfid.com">www.ti-rfid.com</a>               |
| RF/IF and ZigBee® Solutions | <a href="http://www.ti.com/lprf">www.ti.com/lprf</a>               |

### Applications

|                    |                                                                          |
|--------------------|--------------------------------------------------------------------------|
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| Medical            | <a href="http://www.ti.com/medical">www.ti.com/medical</a>               |
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