

# LT1004-1.2, LT1004-2.5 MICROPOWER INTEGRATED VOLTAGE REFERENCES

SLVS022M – JANUARY 1989 – REVISED MAY 2008

- **Initial Accuracy**
  - $\pm 4$  mV for LT1004-1.2
  - $\pm 20$  mV for LT1004-2.5
- **Micropower Operation**
- **Operates up to 20 mA**
- **Very Low Reference Impedance**
- **Applications:**
  - **Portable Meter Reference**
  - **Portable Test Instruments**
  - **Battery-Operated Systems**
  - **Current-Loop Instrumentation**

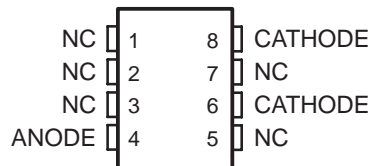
## description/ordering information

The LT1004 micropower voltage reference is a two-terminal band-gap reference diode designed to provide high accuracy and excellent temperature characteristics at very low operating currents. Optimizing the key parameters in the design, processing, and testing of the device results in specifications previously attainable only with selected units.

The LT1004 is a pin-for-pin replacement for the LM285 and LM385 series of references, with improved specifications. It is an excellent device for use in systems in which accuracy previously was attained at the expense of power consumption and trimming.

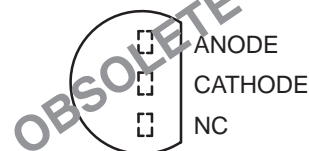
The LT1004C is characterized for operation from 0°C to 70°C. The LT1004I is characterized for operation from –40°C to 85°C.

**D OR PW PACKAGE  
(TOP VIEW)**



NC – No internal connection  
Terminals 6 and 8 are internally connected.

**LP PACKAGE  
(TOP VIEW)**



NC – No internal connection



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

 **TEXAS  
INSTRUMENTS**

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## description/ordering information (continued)

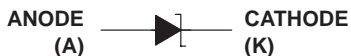
### ORDERING INFORMATION†

| TA            | VZ<br>TYP | PACKAGE‡     |                | ORDERABLE<br>PART NUMBER | TOP-SIDE<br>MARKING |
|---------------|-----------|--------------|----------------|--------------------------|---------------------|
| 0°C to 70°C   | 1.2 V     | SOIC (D)     | Tube of 75     | LT1004CD-1-2             | 4C-12               |
|               |           |              | Reel of 2500   | LT1004CDR-1-2            |                     |
|               |           | TSSOP (PW)   | Tube of 150    | LT1004CPW-1-2            | 4C-12               |
|               |           |              | Reel of 2000   | LT1004CPWR-1-2           |                     |
|               | 2.5 V     | SOIC (D)     | Tube of 75     | LT1004CD-2-5             | 4C-25               |
|               |           |              | Reel of 2500   | LT1004CDR-2-5            |                     |
| TSSOP (PW)    |           | Tube of 150  | LT1004CPW-2-5  | 4C-25                    |                     |
|               |           | Reel of 2000 | LT1004CPWR-2-5 |                          |                     |
| -40°C to 85°C | 1.2 V     | SOIC (D)     | Tube of 75     | LT1004ID-1-2             | 4I-12               |
|               |           |              | Reel of 2500   | LT1004IDR-1-2            |                     |
|               |           | TSSOP (PW)   | Tube of 150    | LT1004IPW-1-2            | 4I-12               |
|               |           |              | Reel of 2000   | LT1004IPWR-1-2           |                     |
|               | 2.5 V     | SOIC (D)     | Tube of 75     | LT1004ID-2-5             | 4I-25               |
|               |           |              | Reel of 2500   | LT1004IDR-2-5            |                     |
|               |           | TSSOP (PW)   | Tube of 150    | LT1004IPW-2-5            | 4I-25               |
|               |           |              | Reel of 2000   | LT1004IPWR-2-5           |                     |

† For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at <http://www.ti.com>.

‡ Package drawings, thermal data, and symbolization are available at <http://www.ti.com/packaging>.

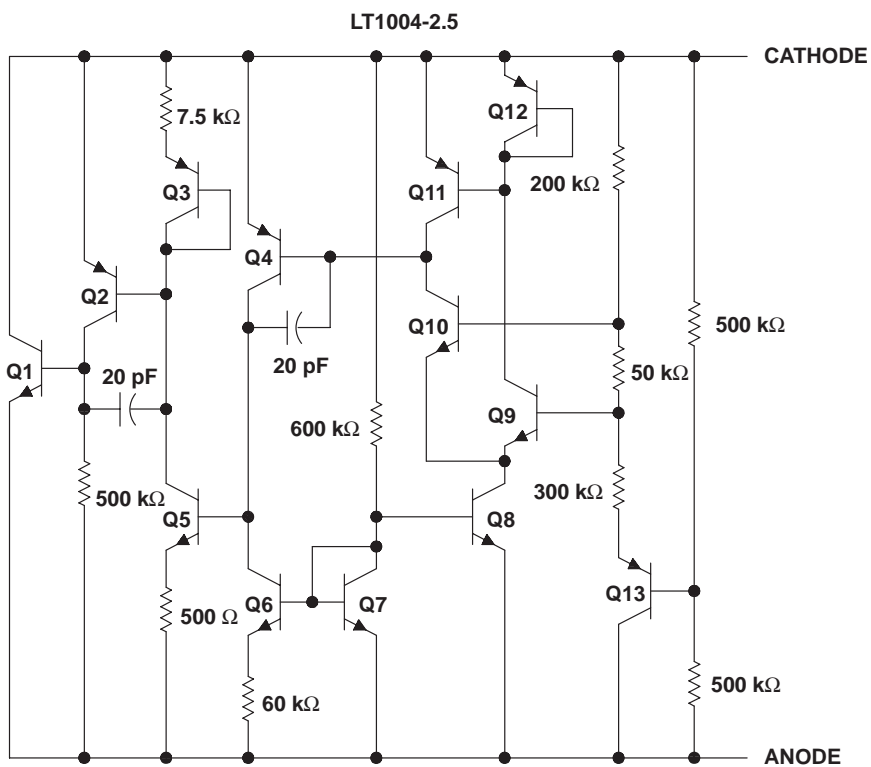
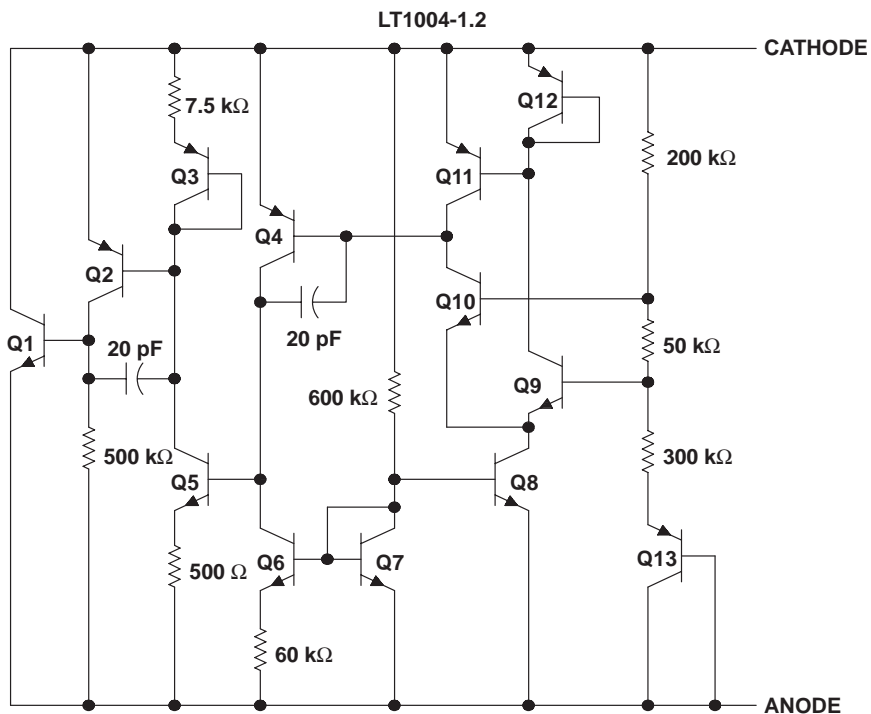
## symbol



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## schematic



NOTE A: All component values shown are nominal.

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## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)<sup>†</sup>

|                                                                         |                |
|-------------------------------------------------------------------------|----------------|
| Reverse current, $I_R$                                                  | 30 mA          |
| Forward current, $I_F$                                                  | 10 mA          |
| Package thermal impedance, $\theta_{JA}$ (see Notes 1 and 2): D package | 97°C/W         |
| PW package                                                              | 149°C/W        |
| Operating virtual junction temperature, $T_J$                           | 150°C          |
| Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds            | 260°C          |
| Storage temperature range, $T_{stg}$                                    | -65°C to 150°C |

<sup>†</sup> Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTES: 1. Maximum power dissipation is a function of  $T_{J(max)}$ ,  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_{J(max)} - T_A)/\theta_{JA}$ . Operating at the absolute maximum  $T_J$  of 150°C can affect reliability.  
2. The package thermal impedance is calculated in accordance with JESD 51-7.

## recommended operating conditions

|       |                                | MIN     | MAX | UNIT |    |
|-------|--------------------------------|---------|-----|------|----|
| $T_A$ | Operating free-air temperature | LT1004C | 0   | 70   | °C |
|       |                                | LT1004I | -40 | 85   |    |

## electrical characteristics at specified free-air temperature

| PARAMETER             | TEST CONDITIONS                                                   | $T_A$ <sup>‡</sup>                           | LT1004-1.2 |         |       | LT1004-2.5 |       |      | UNIT |         |         |         |          |
|-----------------------|-------------------------------------------------------------------|----------------------------------------------|------------|---------|-------|------------|-------|------|------|---------|---------|---------|----------|
|                       |                                                                   |                                              | MIN        | TYP     | MAX   | MIN        | TYP   | MAX  |      |         |         |         |          |
| $V_Z$                 | Reference voltage                                                 | $I_Z = 100 \mu A$                            | 25°C       |         | 1.231 | 1.235      | 1.239 | 2.48 | 2.5  | 2.52    | V       |         |          |
|                       |                                                                   |                                              | Full range | LT1004C | 1.225 | 1.245      | 2.47  | 2.53 |      |         |         |         |          |
|                       |                                                                   | LT1004I                                      |            | 1.225   | 1.245 | 2.47       | 2.53  |      |      |         |         |         |          |
| $\alpha_{V_Z}$        | Average temperature coefficient of reference voltage <sup>§</sup> | $I_Z = 10 \mu A$<br>$I_Z = 20 \mu A$         | 25°C       |         | 20    |            |       | 20   |      | ppm/°C  |         |         |          |
|                       |                                                                   |                                              | 25°C       |         | 1     |            |       | 1    |      |         |         |         |          |
| $\Delta V_Z$          | Change in reference voltage with current                          | $I_Z = I_Z(min)$ to 1 mA                     | 25°C       |         | 1     |            |       | 1    |      | mV      |         |         |          |
|                       |                                                                   |                                              | Full range |         | 1.5   |            |       | 1.5  |      |         |         |         |          |
|                       |                                                                   | $I_Z = 1$ mA to 20 mA                        | 25°C       |         | 10    |            |       | 10   |      |         |         |         |          |
|                       |                                                                   |                                              | Full range |         | 20    |            |       | 20   |      |         |         |         |          |
| $\Delta V_Z/\Delta t$ | Long-term change in reference voltage                             | $I_Z = 100 \mu A$                            | 25°C       |         | 20    |            |       | 20   |      | ppm/khr |         |         |          |
| $I_Z(min)$            | Minimum reference current                                         |                                              | Full range |         | 8     |            |       | 10   |      | 12      | 20      | $\mu A$ |          |
| $z_Z$                 | Reference impedance                                               | $I_Z = 100 \mu A$                            | 25°C       |         | 0.2   |            |       | 0.6  |      | 0.2     |         | 0.6     | $\Omega$ |
|                       |                                                                   |                                              | Full range |         | 1.5   |            |       | 1.5  |      |         |         |         |          |
| $V_n$                 | Broadband noise voltage                                           | $I_Z = 100 \mu A$ ,<br>$f = 10$ Hz to 10 kHz | 25°C       |         | 60    |            |       | 120  |      |         | $\mu V$ |         |          |

<sup>‡</sup> Full range is 0°C to 70°C for the LT1004C and -40°C to 85°C for the LT1004I.

<sup>§</sup> The average temperature coefficient of reference voltage is defined as the total change in reference voltage divided by the specified temperature range.



TYPICAL CHARACTERISTICS

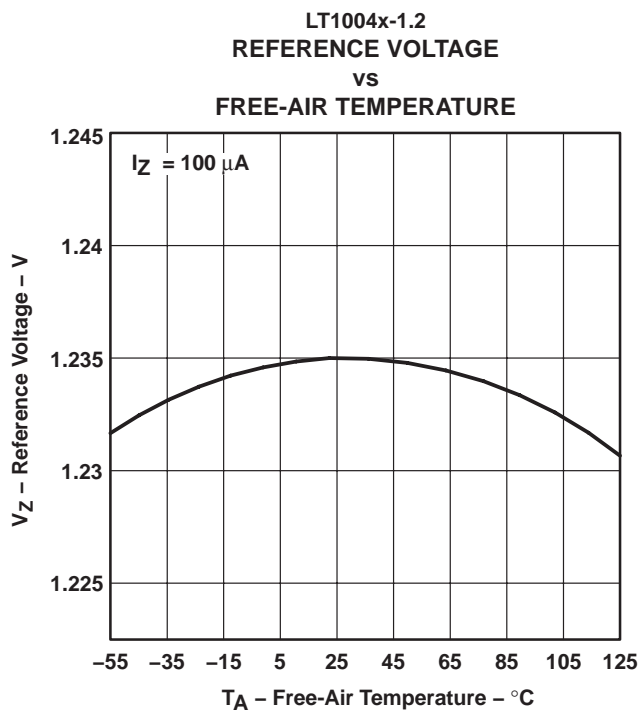
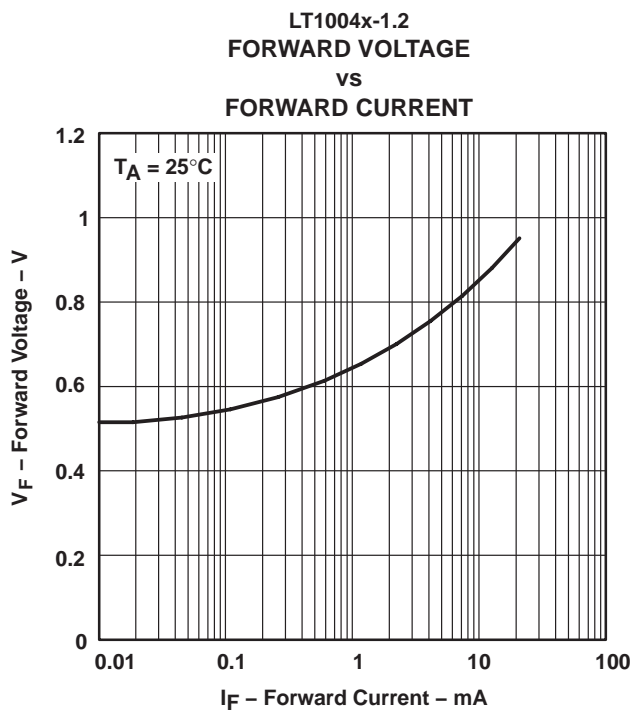
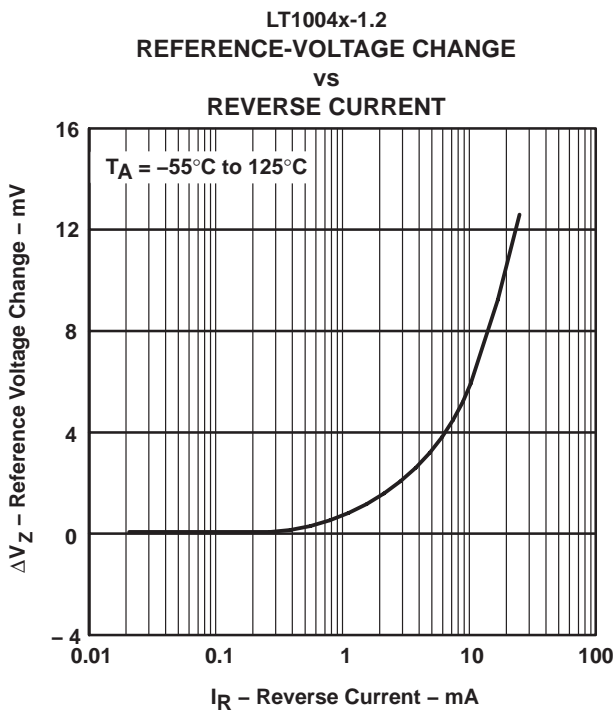
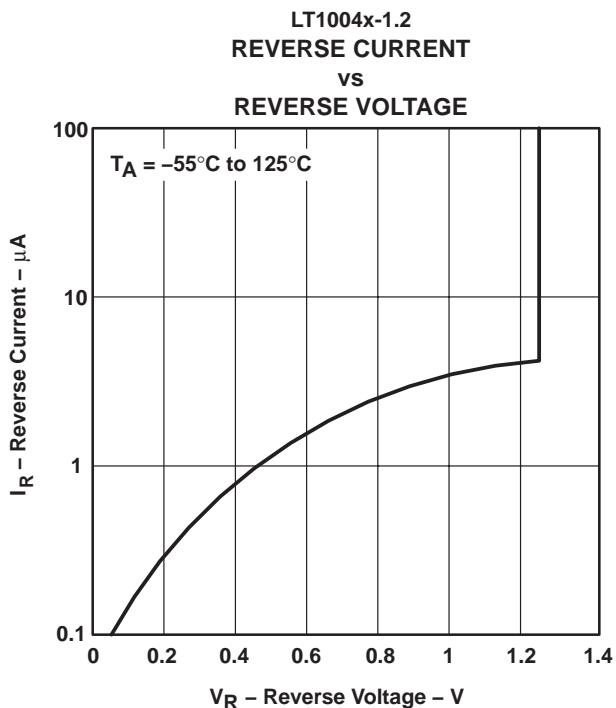
Table of Graphs

| GRAPH TITLE                                       | FIGURE |
|---------------------------------------------------|--------|
| <b>LT1004x-1.2</b>                                |        |
| Reverse current vs Reverse voltage                | 1      |
| Reference-voltage change vs Reverse current       | 2      |
| Forward voltage vs Forward current                | 3      |
| Reference voltage vs Free-air temperature         | 4      |
| Reference impedance vs Reference current          | 5      |
| Noise voltage vs Frequency                        | 6      |
| Filtered output noise voltage vs Cutoff frequency | 7      |
| <b>LT1004x-2.5</b>                                |        |
| Transient response                                | 8      |
| Reverse current vs Reverse voltage                | 9      |
| Forward voltage vs Forward current                | 10     |
| Reference voltage vs Free-air temperature         | 11     |
| Reference impedance vs Reference current          | 12     |
| Noise voltage vs Frequency                        | 13     |
| Filtered output noise voltage vs Cutoff frequency | 14     |
| Transient response                                | 15     |

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## TYPICAL CHARACTERISTICS†



† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS†

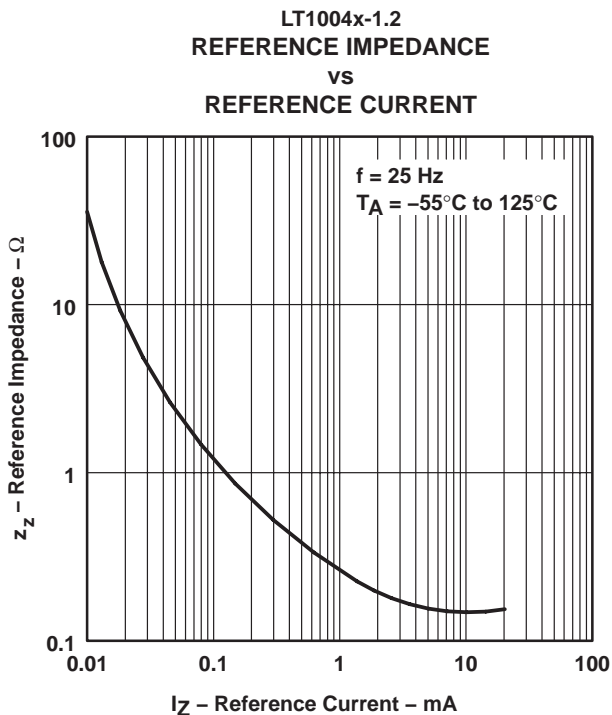


Figure 5

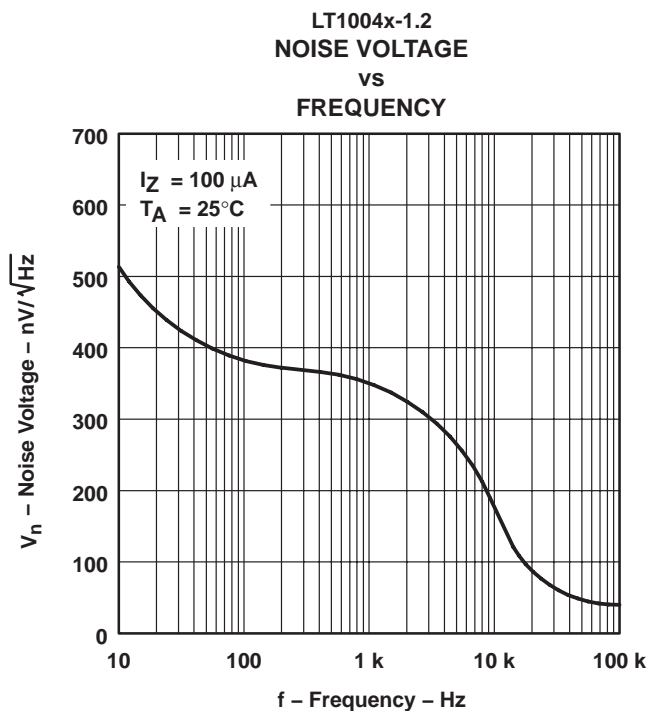


Figure 6

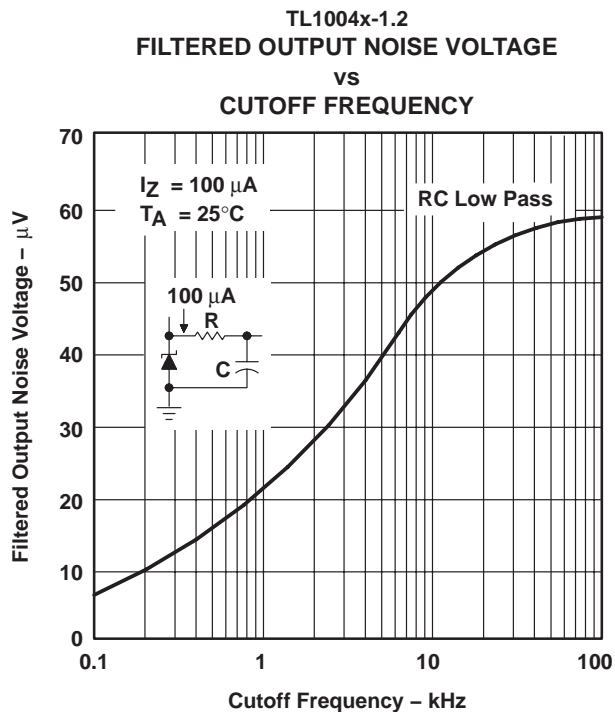


Figure 7

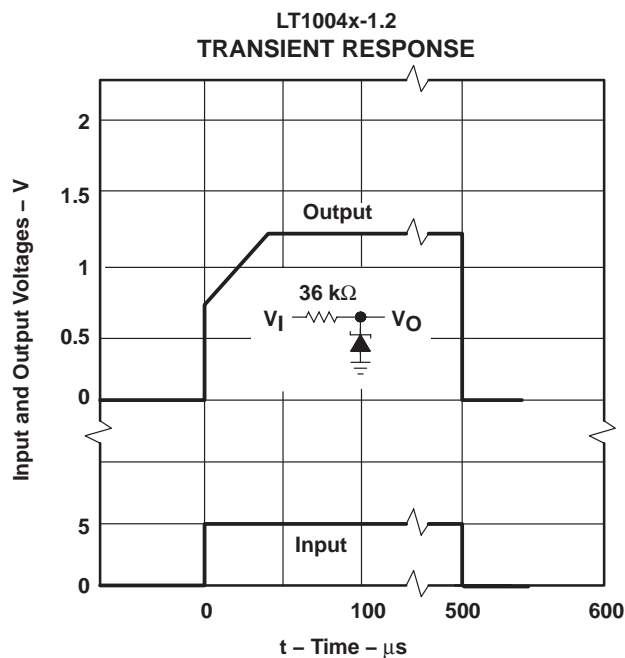


Figure 8

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

# LT1004-1.2, LT1004-2.5 MICROPOWER INTEGRATED VOLTAGE REFERENCES

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## TYPICAL CHARACTERISTICS†

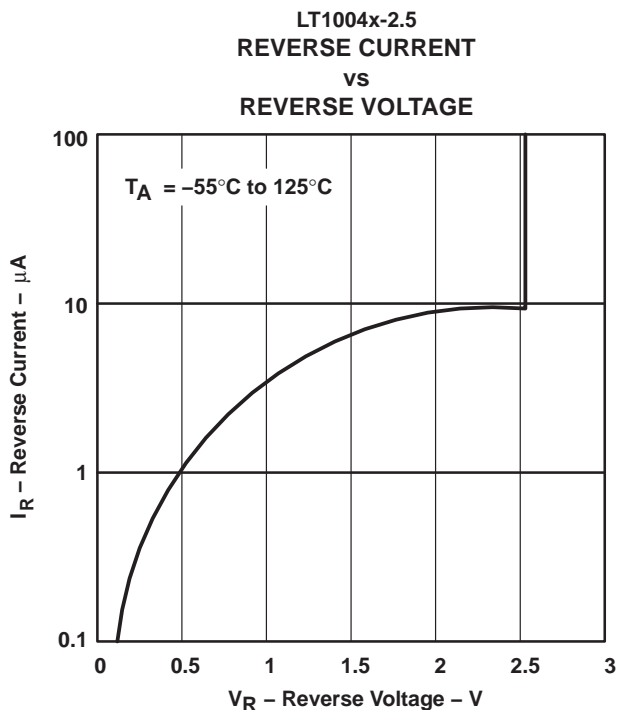


Figure 9

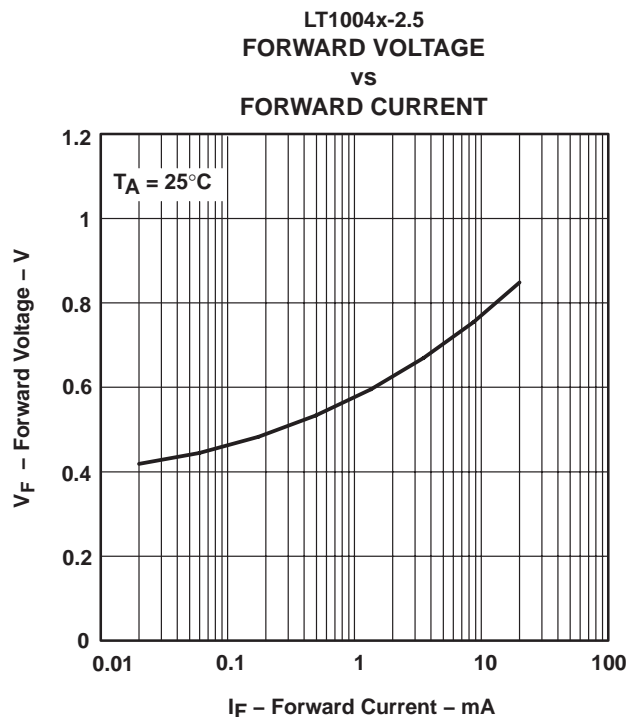


Figure 10

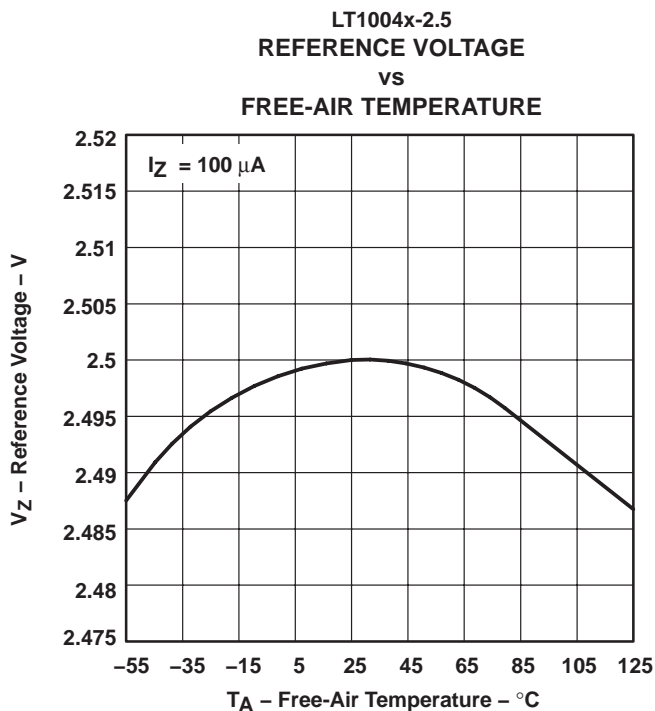
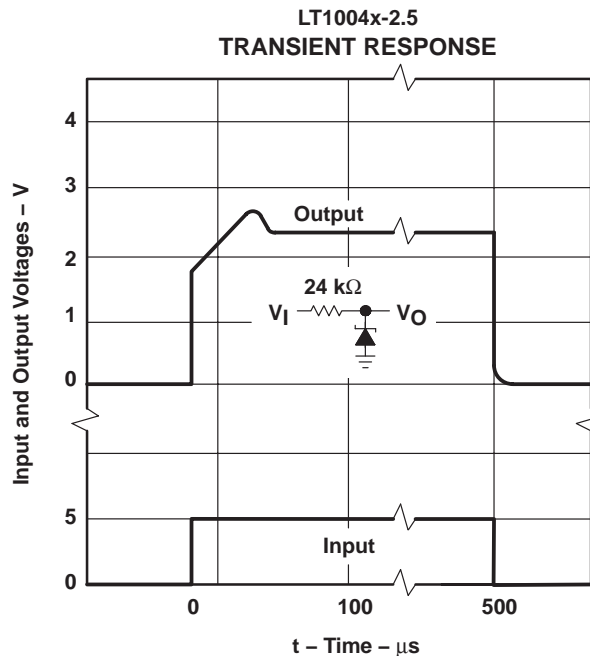
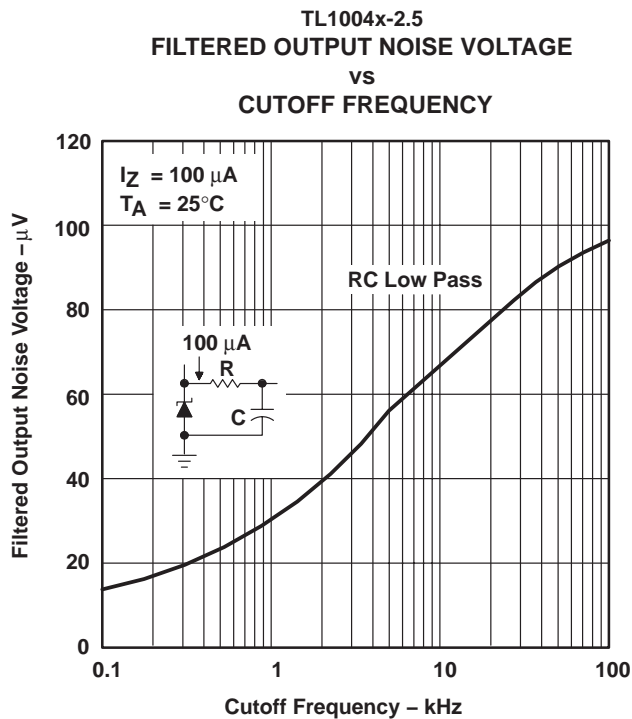
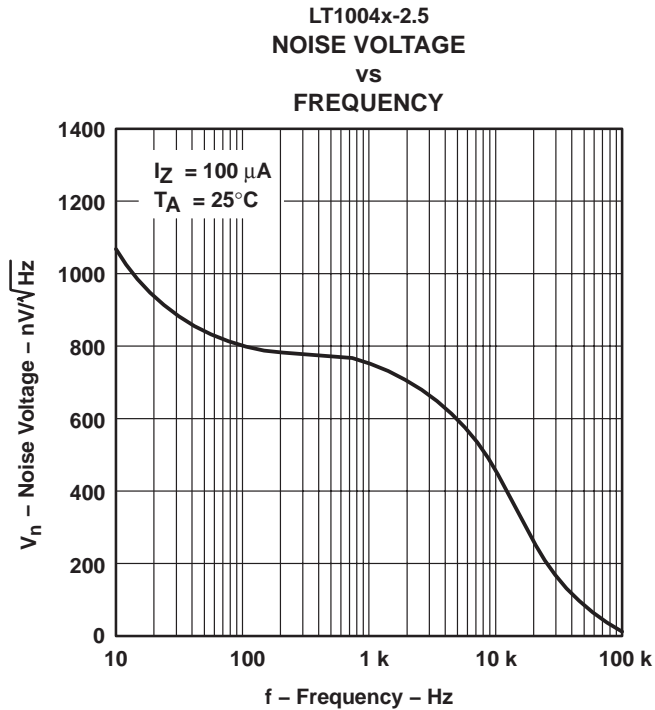
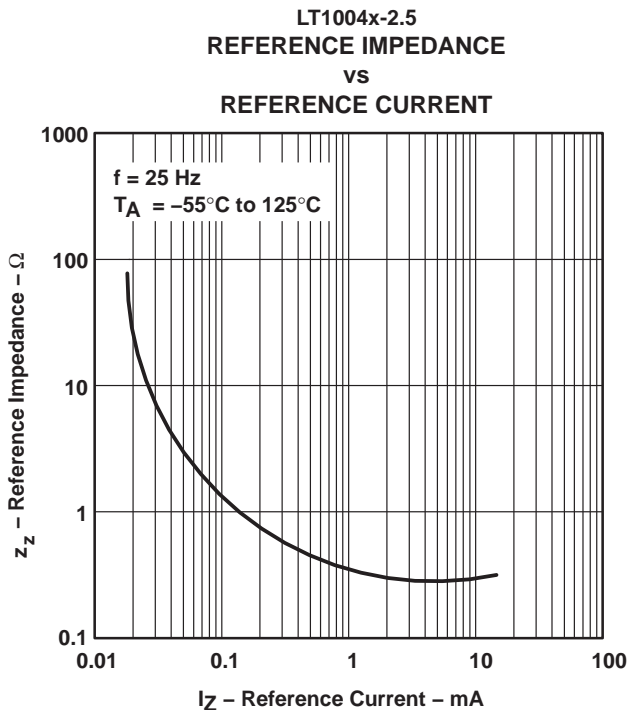


Figure 11

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.



TYPICAL CHARACTERISTICS†

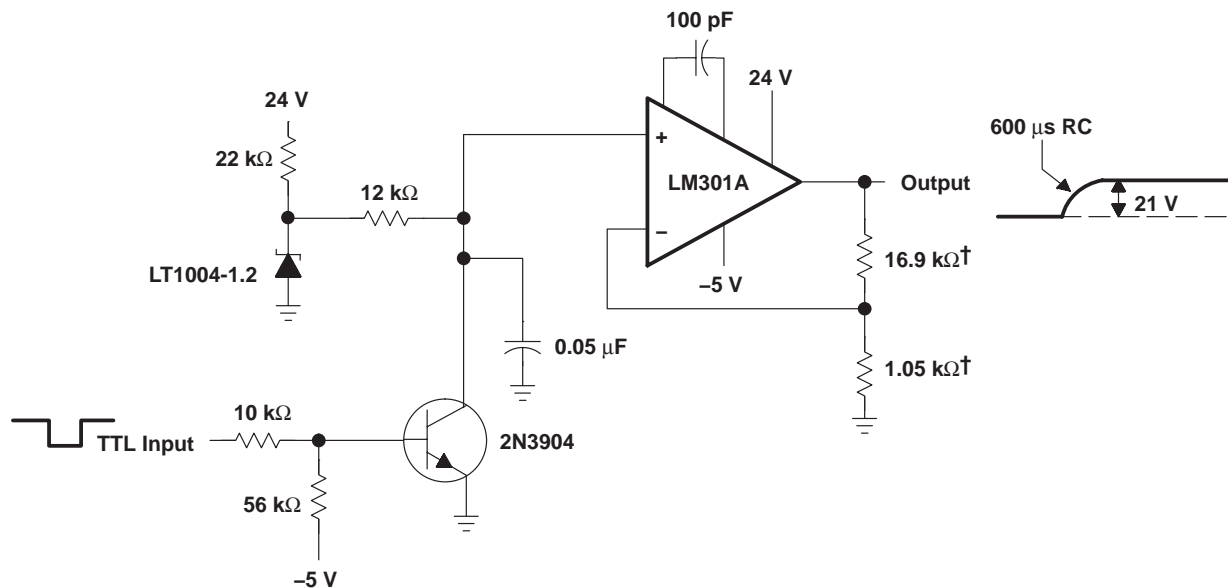


† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

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## APPLICATION INFORMATION



† 1% metal-film resistors

Figure 16.  $V_{I(PP)}$  Generator for EPROMs (No Trim Required)

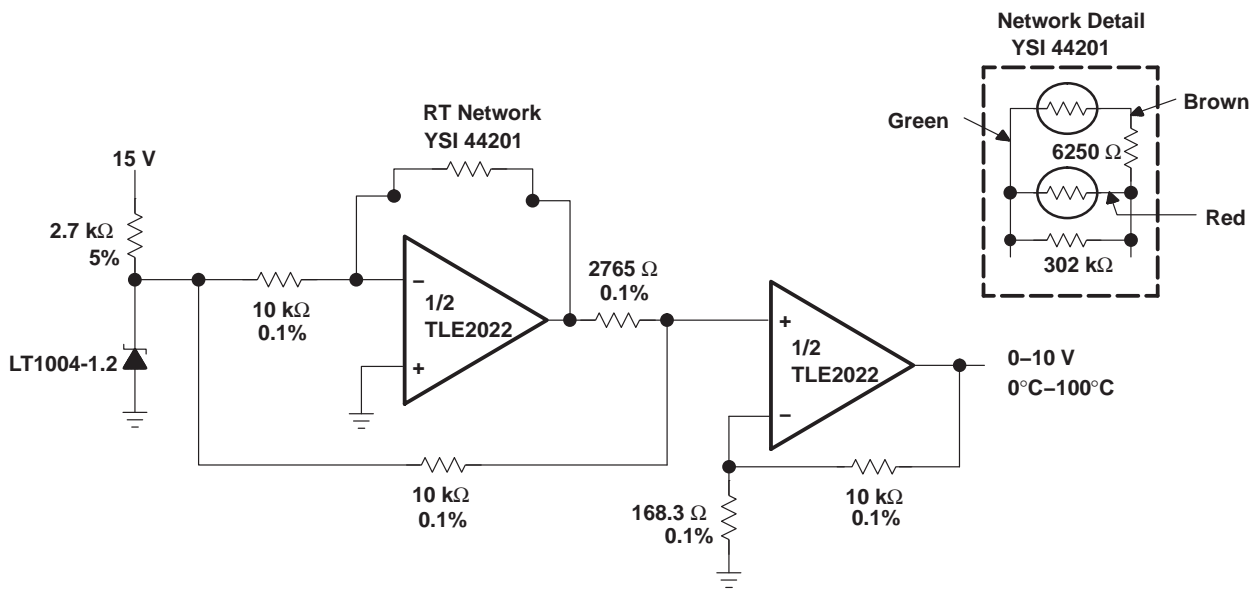


Figure 17. 0°C-to-100°C Linear-Output Thermometer

APPLICATION INFORMATION

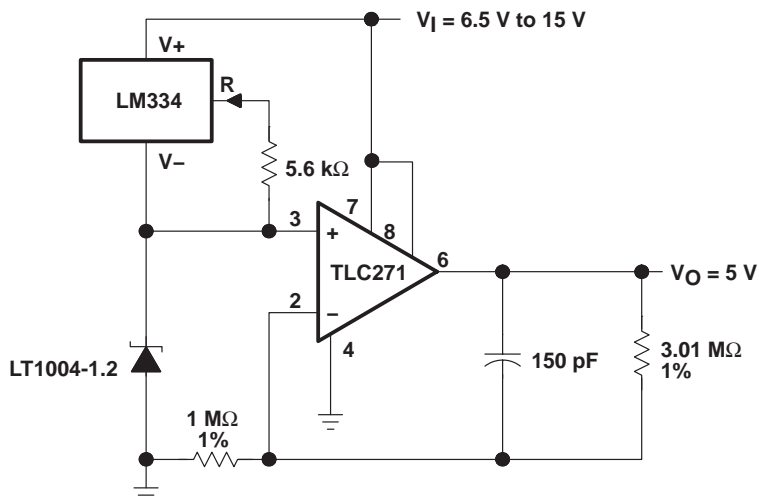


Figure 18. Micropower 5-V Reference

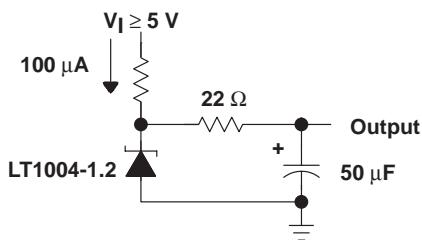


Figure 19. Low-Noise Reference

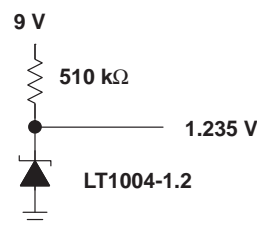
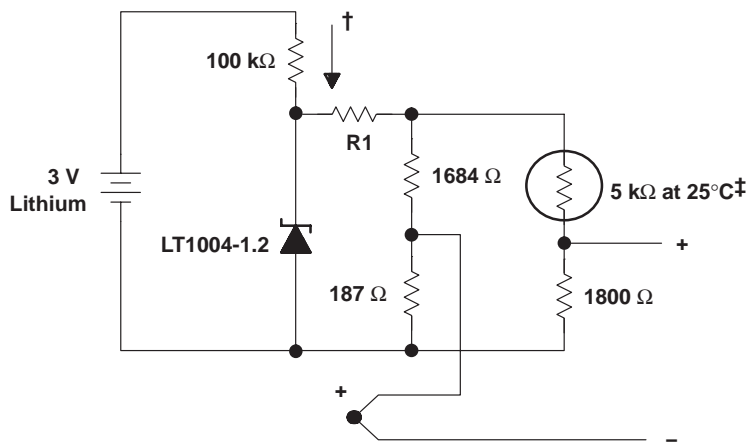


Figure 20. Micropower Reference From 9-V Battery



| THERMOCOUPLE TYPE | R1     |
|-------------------|--------|
| J                 | 232 kΩ |
| K                 | 298 kΩ |
| T                 | 301 kΩ |
| S                 | 2.1 MΩ |

† Quiescent current  $\cong 15 \mu\text{A}$

‡ Yellow Springs Inst. Co., Part #44007

NOTE A: This application compensates within  $\pm 1^\circ\text{C}$  from  $0^\circ\text{C}$  to  $60^\circ\text{C}$ .

Figure 21. Micropower Cold-Junction Compensation for Thermocouples

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## APPLICATION INFORMATION

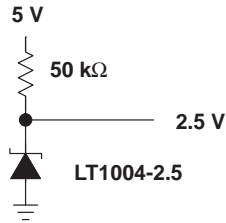


Figure 22. 2.5-V Reference

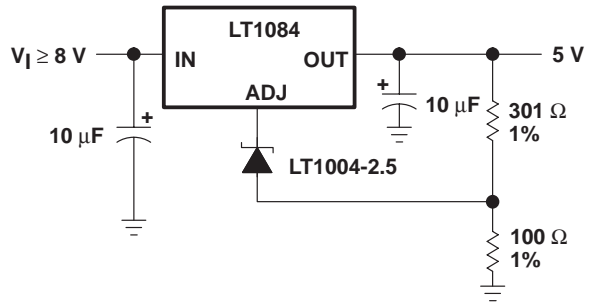
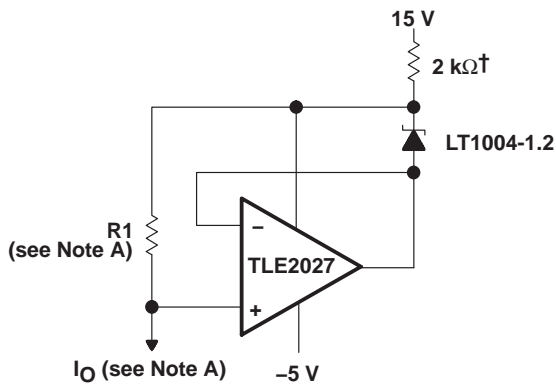


Figure 23. High-Stability 5-V Regulator



† May be increased for small output currents  
NOTE A:  $R1 \approx \frac{2V}{I_O + 10\mu A}$ ;  $I_O = \frac{1.235V}{R1}$

Figure 24. Ground-Referenced Current Source

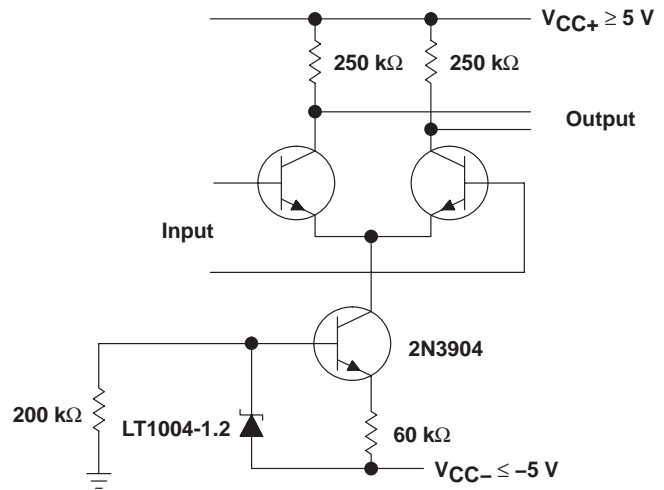
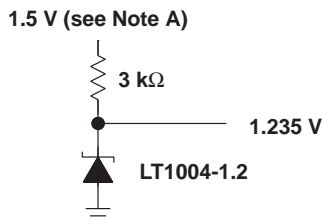


Figure 25. Amplifier With Constant Gain Over Temperature



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

Figure 26. 1.2-V Reference From 1.5-V Battery

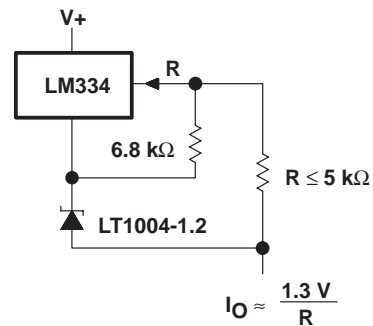
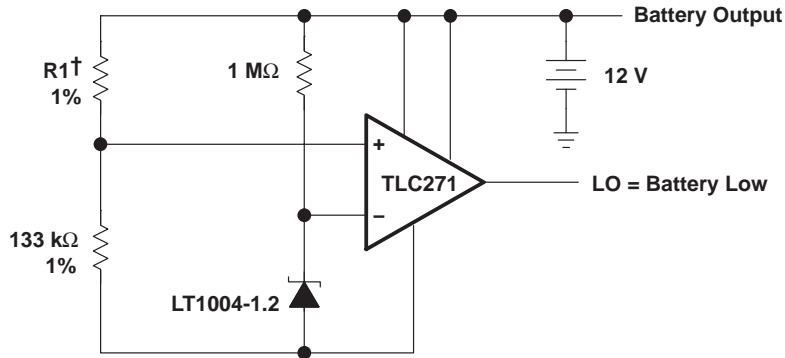


Figure 27. Terminal Current Source With Low Temperature Coefficient

APPLICATION INFORMATION



† R1 sets trip point, 60.4 kΩ per cell for 1.8 V per cell.

Figure 28. Lead-Acid Low-Battery-Voltage Detector

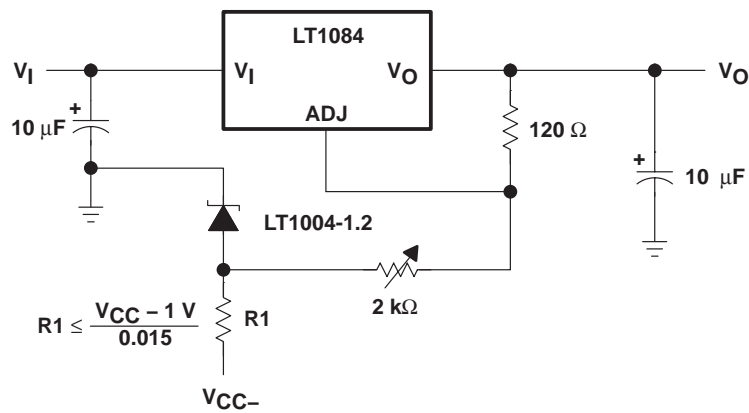


Figure 29. Variable-Voltage Supply

**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> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| LT1004CD-1-2     | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004CD-2-5     | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004CD-2-5G4   | ACTIVE                | SOIC         | D               | 8    |             | TBD                     | Call TI          | Call TI                      |
| LT1004CDE4-1-2   | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004CDE4-2-5   | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004CDG4-1-2   | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004CDG4-2-5   | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004CDR-1-2    | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004CDR-2-5    | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004CDRE4-1-2  | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004CDRE4-2-5  | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004CDRG4-1-2  | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004CDRG4-2-5  | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004CLP-1-2    | OBSOLETE              | TO-92        | LP              | 3    |             | TBD                     | Call TI          | Call TI                      |
| LT1004CLP-2-5    | OBSOLETE              | TO-92        | LP              | 3    |             | TBD                     | Call TI          | Call TI                      |
| LT1004CPW-1-2    | ACTIVE                | TSSOP        | PW              | 8    | 150         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004CPW-2-5    | ACTIVE                | TSSOP        | PW              | 8    | 150         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004CPWE4-1-2  | ACTIVE                | TSSOP        | PW              | 8    | 150         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004CPWE4-2-5  | ACTIVE                | TSSOP        | PW              | 8    | 150         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004CPWG4-1-2  | ACTIVE                | TSSOP        | PW              | 8    | 150         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004CPWG4-2-5  | ACTIVE                | TSSOP        | PW              | 8    | 150         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004CPWR-1-2   | ACTIVE                | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004CPWR-2-5   | ACTIVE                | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004CPWRE4-1-2 | ACTIVE                | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004CPWRE4-2-5 | ACTIVE                | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004CPWRG4-1-2 | ACTIVE                | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |

| 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> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| LT1004CPWRG4-2-5 | ACTIVE                | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004ID-1-2     | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004ID-2-5     | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004IDE4-1-2   | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004IDE4-2-5   | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004IDG4-1-2   | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004IDG4-2-5   | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004IDR-1-2    | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004IDR-2-5    | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004IDRE4-1-2  | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004IDRE4-2-5  | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004IDRG4-1-2  | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004IDRG4-2-5  | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004ILP-2-5    | OBSOLETE              | TO-92        | LP              | 3    |             | TBD                     | Call TI          | Call TI                      |
| LT1004IPW-1-2    | ACTIVE                | TSSOP        | PW              | 8    | 150         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004IPW-2-5    | ACTIVE                | TSSOP        | PW              | 8    | 150         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004IPWE4-1-2  | ACTIVE                | TSSOP        | PW              | 8    | 150         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004IPWE4-2-5  | ACTIVE                | TSSOP        | PW              | 8    | 150         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004IPWG4-1-2  | ACTIVE                | TSSOP        | PW              | 8    | 150         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004IPWG4-2-5  | ACTIVE                | TSSOP        | PW              | 8    | 150         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004IPWR-1-2   | ACTIVE                | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004IPWR-2-5   | ACTIVE                | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004IPWRE4-1-2 | ACTIVE                | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004IPWRE4-2-5 | ACTIVE                | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004IPWRG4-1-2 | ACTIVE                | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LT1004IPWRG4-2-5 | ACTIVE                | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |

| 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> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| LT1004MD-1-2     | OBSOLETE              | SOIC         | D               | 8    |             | TBD                     | Call TI          | Call TI                      |
| LT1004MD-2-5     | OBSOLETE              | SOIC         | D               | 8    |             | TBD                     | Call TI          | Call TI                      |
| LT1004MDR-1-2    | OBSOLETE              | SOIC         | D               | 8    |             | TBD                     | Call TI          | Call TI                      |
| LT1004MDR-2-5    | OBSOLETE              | SOIC         | D               | 8    |             | TBD                     | Call TI          | Call TI                      |
| LT1004MLP-1-2    | OBSOLETE              | TO-92        | LP              | 3    |             | TBD                     | Call TI          | Call TI                      |
| LT1004MLP-2-5    | OBSOLETE              | TO-92        | LP              | 3    |             | TBD                     | Call TI          | Call TI                      |

<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**



**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**



\*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 |
|----------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| LT1004CDR-1-2  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LT1004CDR-1-2  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LT1004CDR-2-5  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LT1004CPWR-1-2 | TSSOP        | PW              | 8    | 2000 | 330.0              | 12.4               | 7.0     | 3.6     | 1.6     | 8.0     | 12.0   | Q1            |
| LT1004CPWR-2-5 | TSSOP        | PW              | 8    | 2000 | 330.0              | 12.4               | 7.0     | 3.6     | 1.6     | 8.0     | 12.0   | Q1            |
| LT1004IDR-1-2  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LT1004IDR-2-5  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LT1004IPWR-1-2 | TSSOP        | PW              | 8    | 2000 | 330.0              | 12.4               | 7.0     | 3.6     | 1.6     | 8.0     | 12.0   | Q1            |
| LT1004IPWR-2-5 | TSSOP        | PW              | 8    | 2000 | 330.0              | 12.4               | 7.0     | 3.6     | 1.6     | 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) |
|----------------|--------------|-----------------|------|------|-------------|------------|-------------|
| LT1004CDR-1-2  | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| LT1004CDR-1-2  | SOIC         | D               | 8    | 2500 | 346.0       | 346.0      | 29.0        |
| LT1004CDR-2-5  | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| LT1004CPWR-1-2 | TSSOP        | PW              | 8    | 2000 | 346.0       | 346.0      | 29.0        |
| LT1004CPWR-2-5 | TSSOP        | PW              | 8    | 2000 | 346.0       | 346.0      | 29.0        |
| LT1004IDR-1-2  | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| LT1004IDR-2-5  | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| LT1004IPWR-1-2 | TSSOP        | PW              | 8    | 2000 | 346.0       | 346.0      | 29.0        |
| LT1004IPWR-2-5 | TSSOP        | PW              | 8    | 2000 | 346.0       | 346.0      | 29.0        |

PW (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

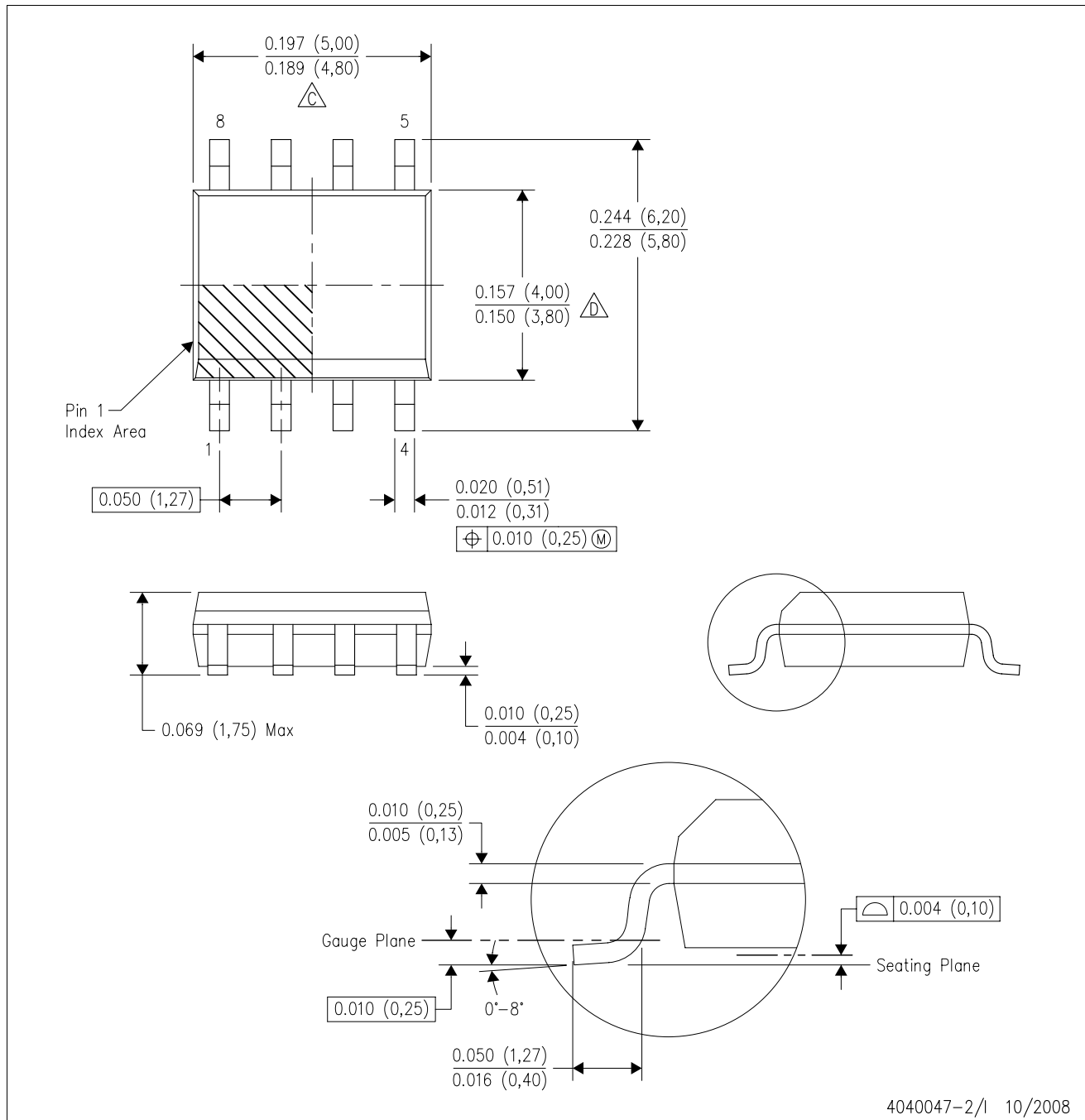
14 PINS SHOWN



- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.  
 D. Falls within JEDEC MO-153

D (R-PDSO-G8)

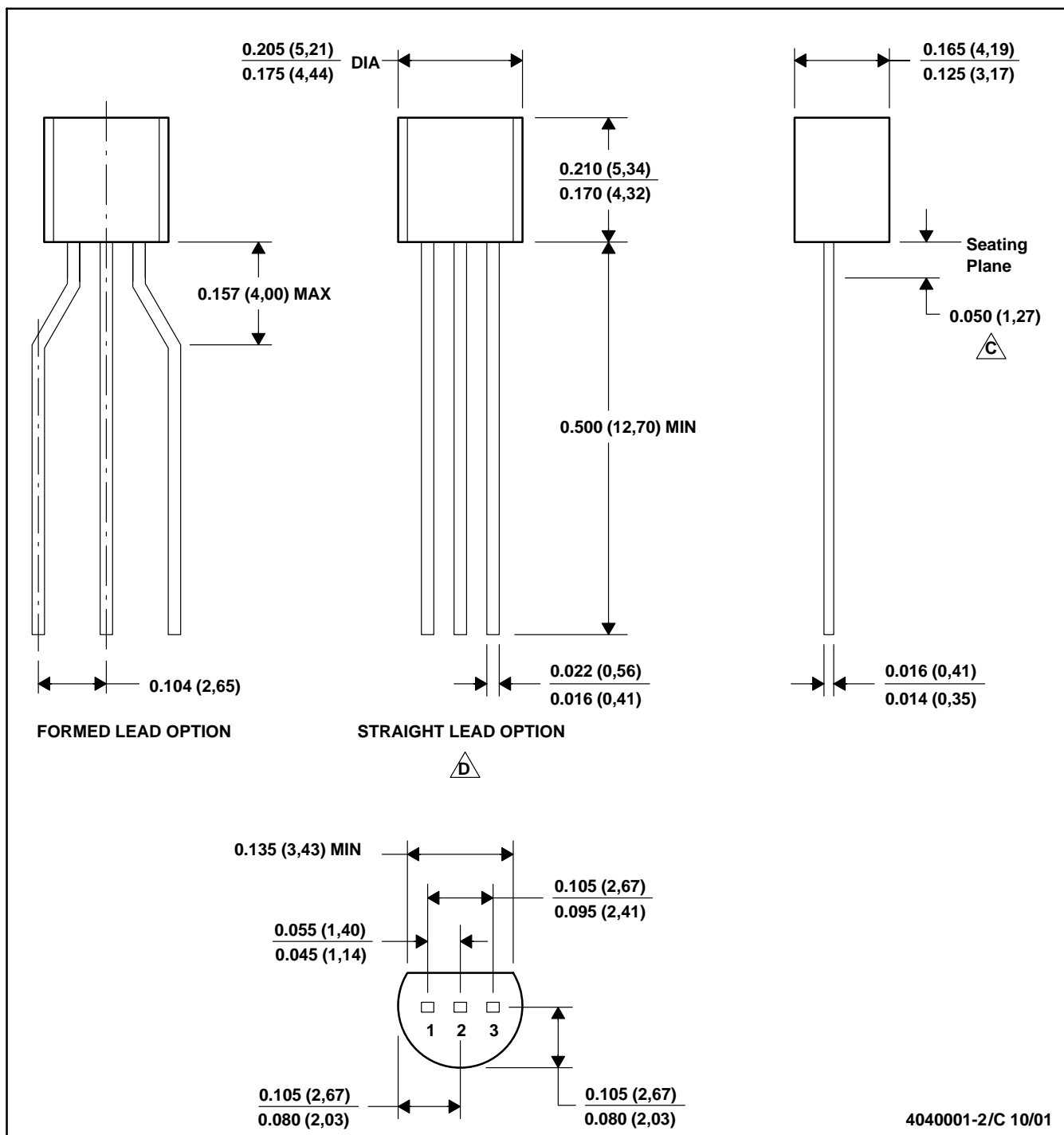
PLASTIC SMALL-OUTLINE PACKAGE



NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 (0,15) per end.  
 D. Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.  
 E. Reference JEDEC MS-012 variation AA.

LP (O-PBCY-W3)

PLASTIC CYLINDRICAL PACKAGE



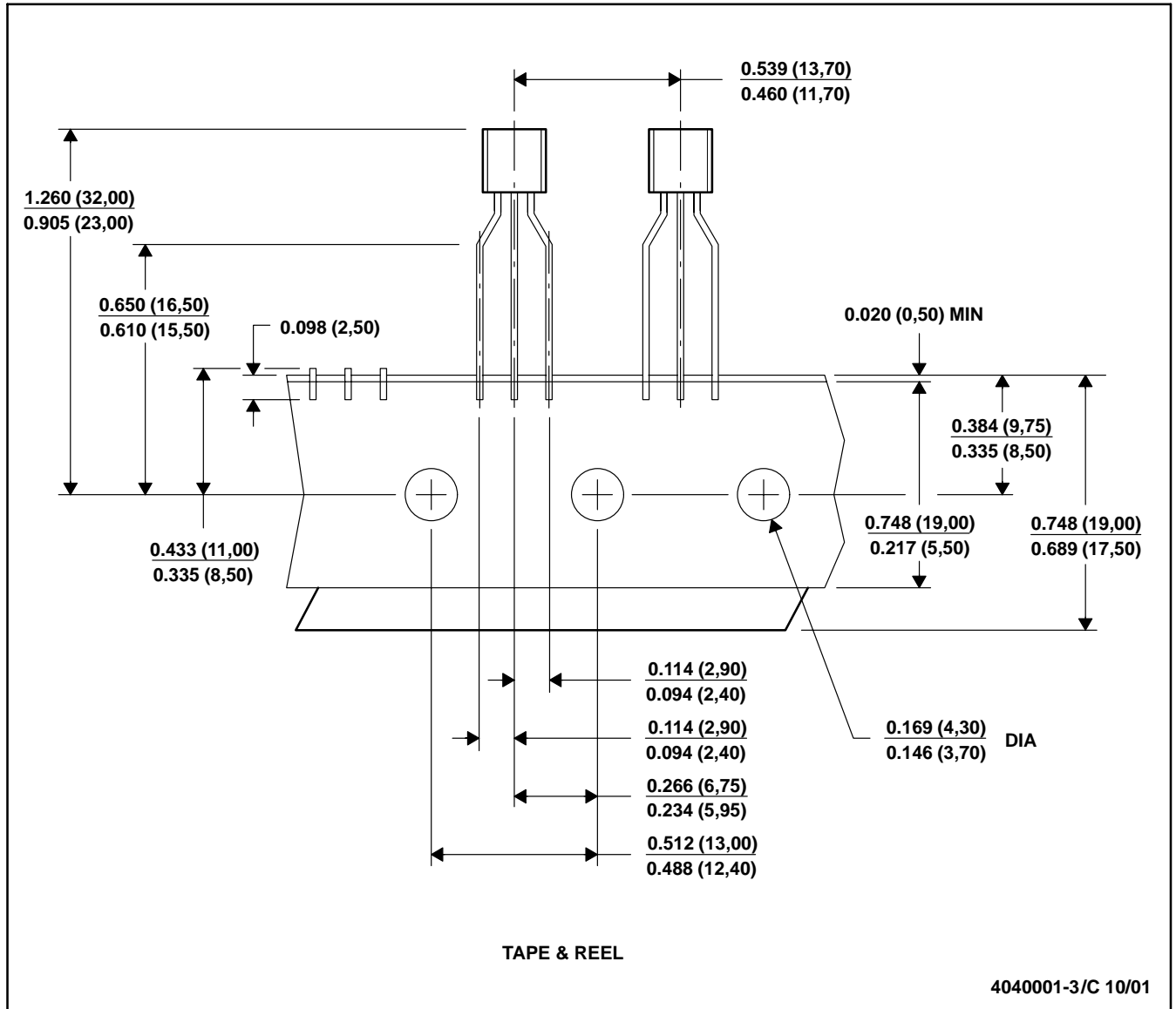
- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Lead dimensions are not controlled within this area  
 D. Falls within JEDEC TO -226 Variation AA (TO-226 replaces TO-92)  
 E. Shipping Method:  
 Straight lead option available in bulk pack only.  
 Formed lead option available in tape & reel or ammo pack.

# MECHANICAL DATA

MSOT002A – OCTOBER 1994 – REVISED NOVEMBER 2001

LP (O-PBCY-W3)

PLASTIC CYLINDRICAL PACKAGE



- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Tape and Reel information for the Format Lead Option package.

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