

LT1004-1.2, LT1004-2.5 MICROPOWER INTEGRATED VOLTAGE REFERENCES

SLVS022M – JANUARY 1989 – REVISED MAY 2008

- **Initial Accuracy**
 - ± 4 mV for LT1004-1.2
 - ± 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**

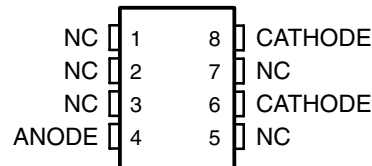
description/ordering information

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.

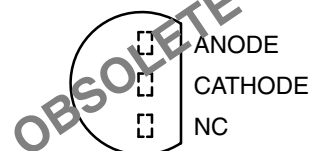
The LT1004C is characterized for operation from 0°C to 70°C. The LT1004I is characterized for operation from –40°C to 85°C.

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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LT1004-1.2, LT1004-2.5 MICROPOWER INTEGRATED VOLTAGE REFERENCES

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description/ordering information (continued)

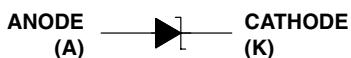
ORDERING INFORMATION†

| T _A | V _Z TYP | PACKAGE‡ | | ORDERABLE PART NUMBER | TOP-SIDE 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>.

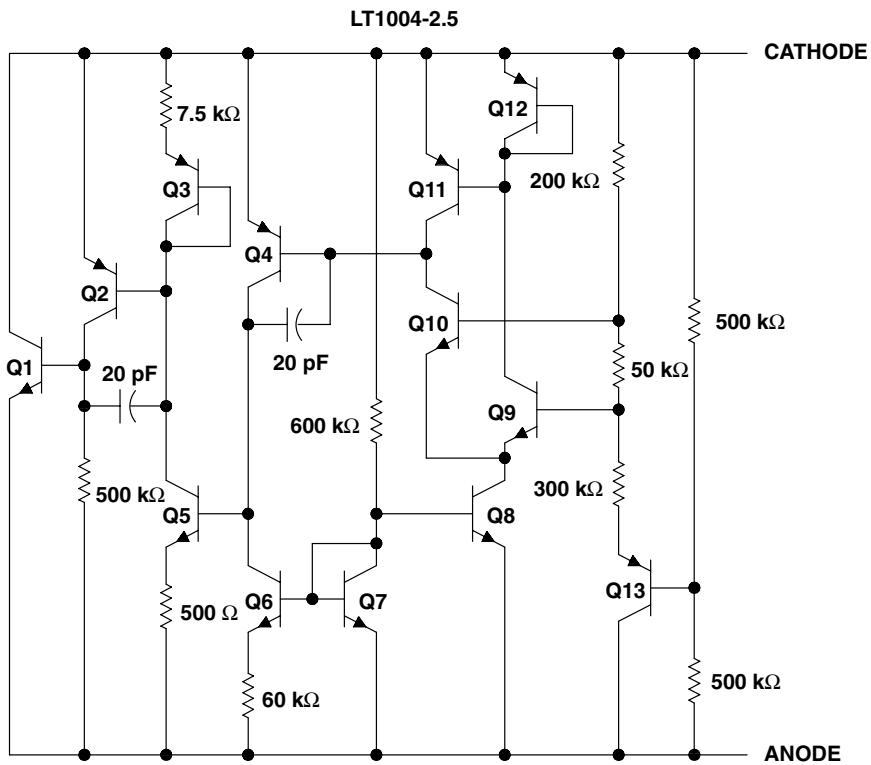
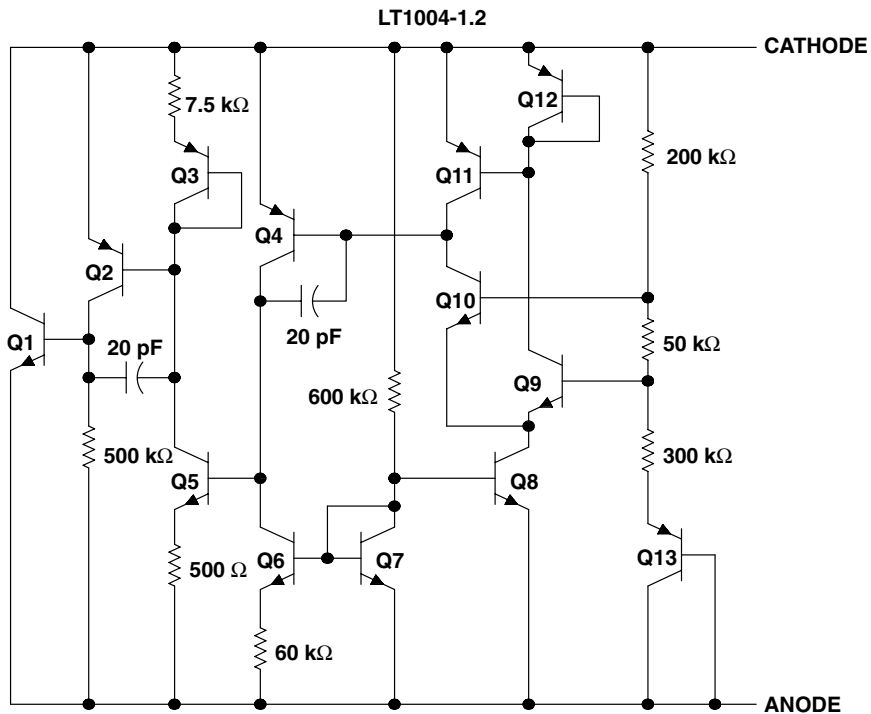
symbol



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schematic



NOTE A: All component values shown are nominal.

TYPICAL CHARACTERISTICS

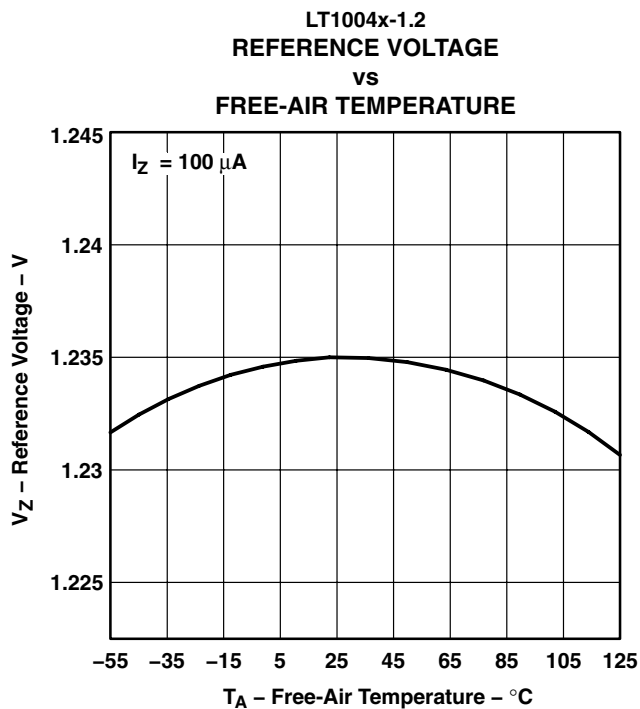
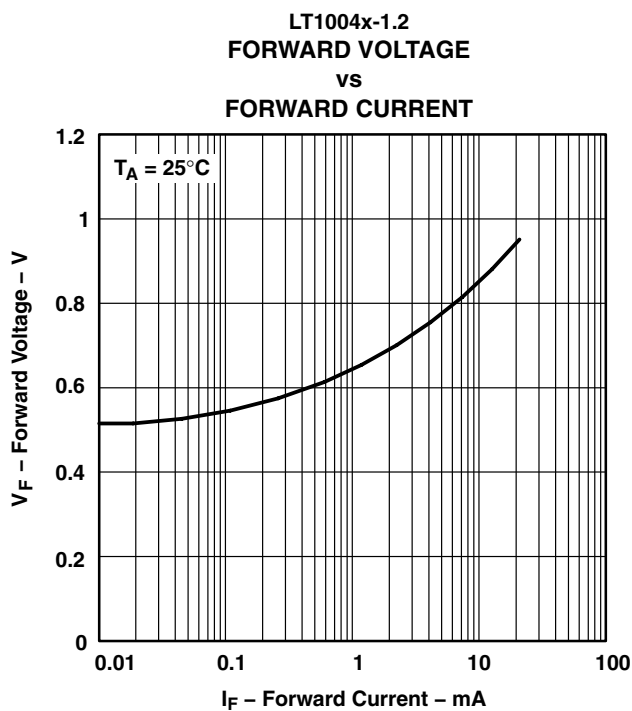
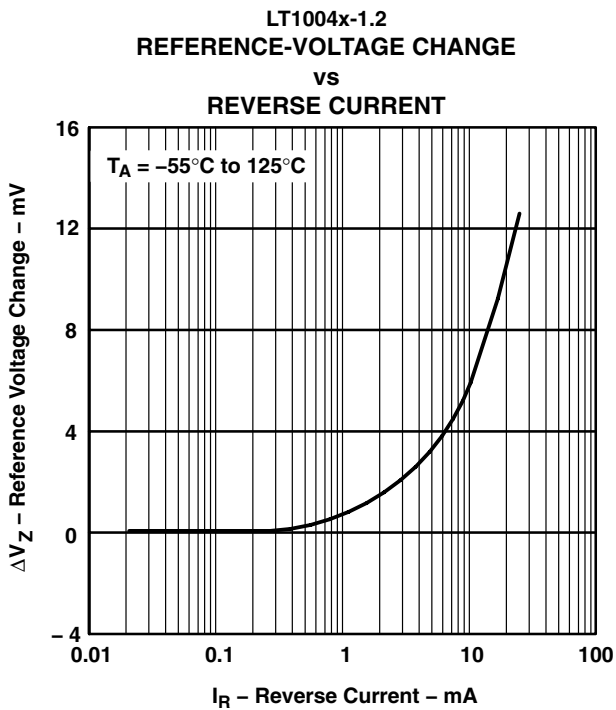
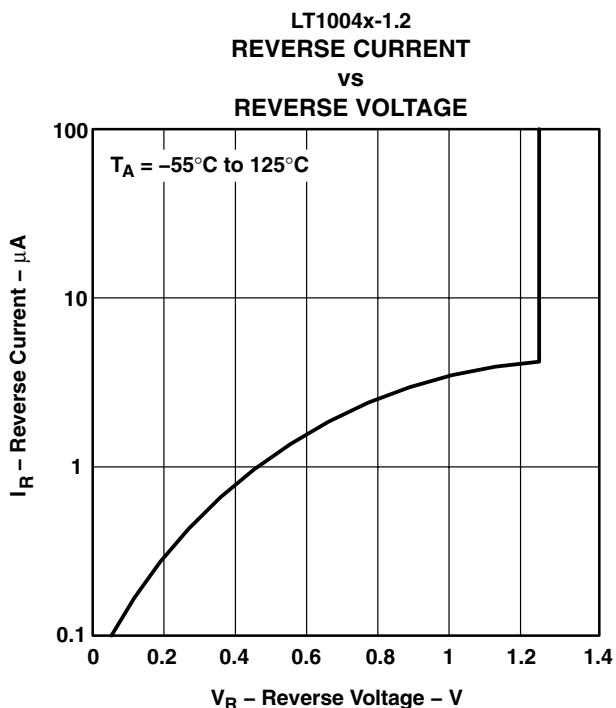
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| Forward voltage vs Forward current | 3 |
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| Reference impedance vs Reference current | 5 |
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| Filtered output noise voltage vs Cutoff frequency | 7 |
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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†

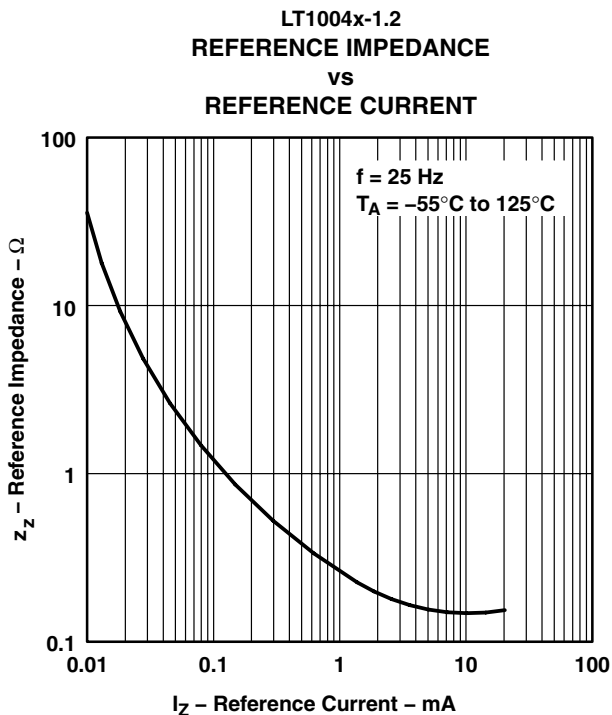


Figure 5

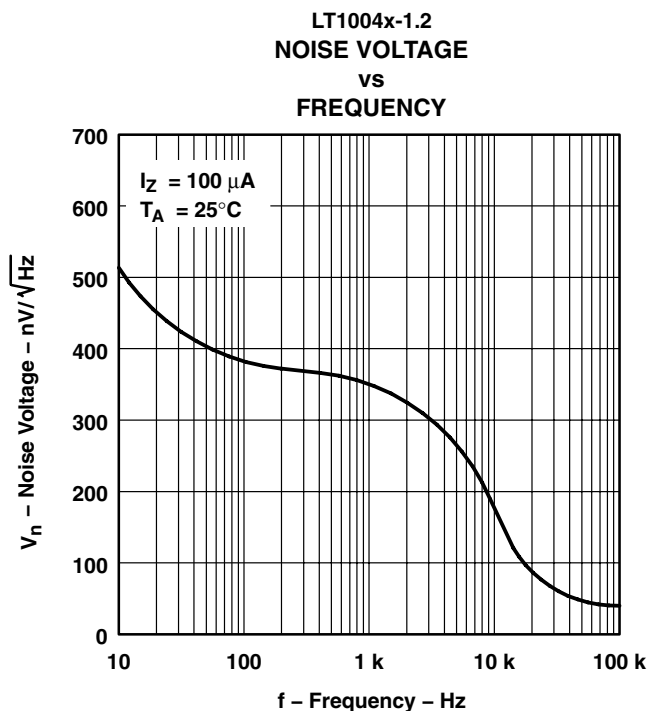


Figure 6

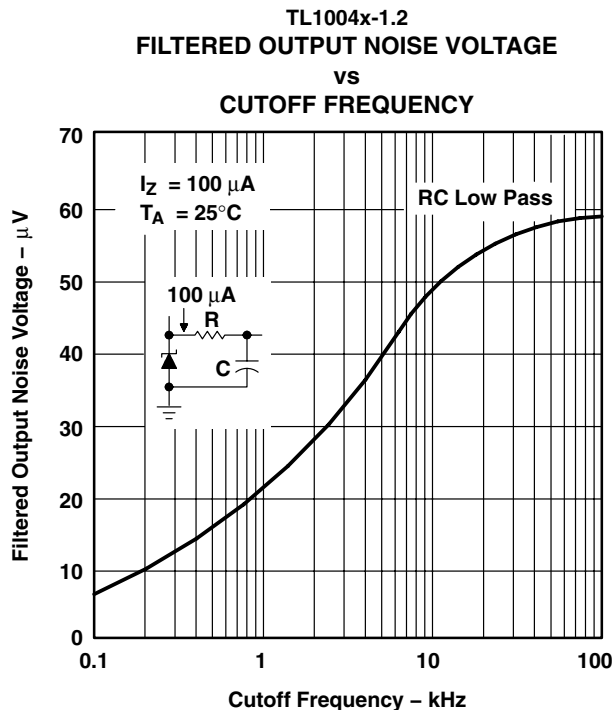


Figure 7

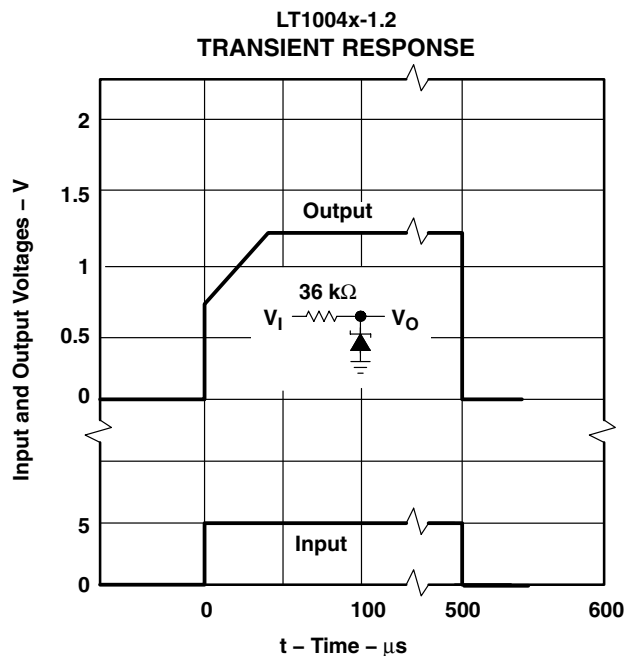


Figure 8

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

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TYPICAL CHARACTERISTICS†

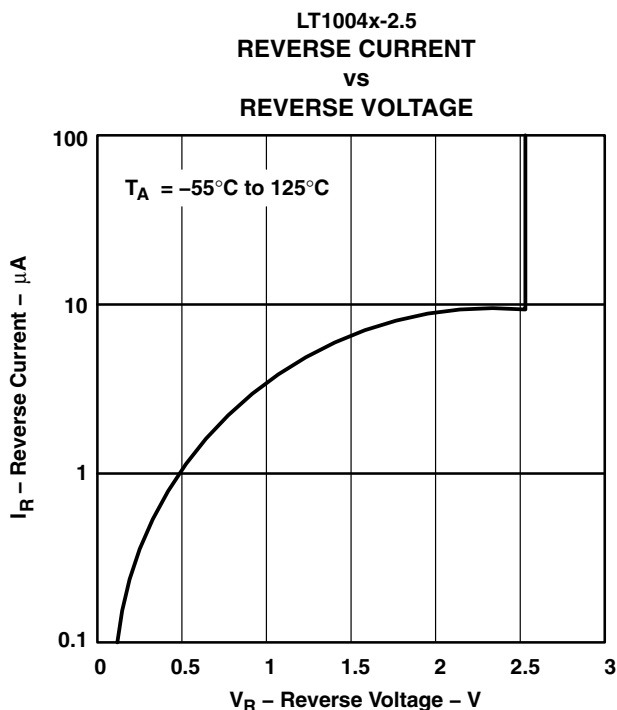


Figure 9

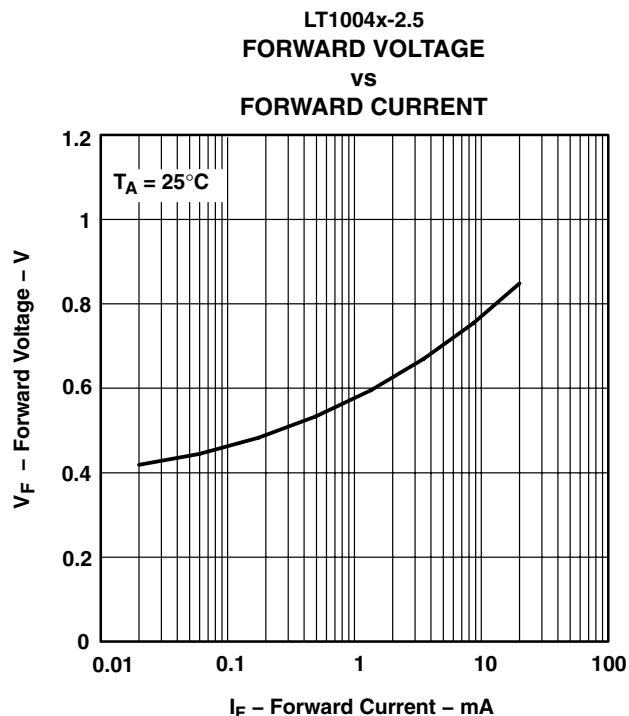


Figure 10

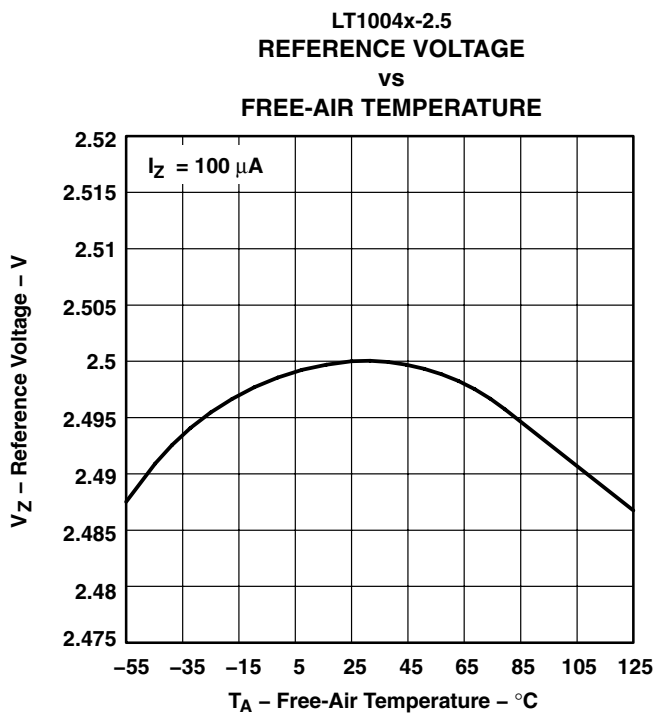
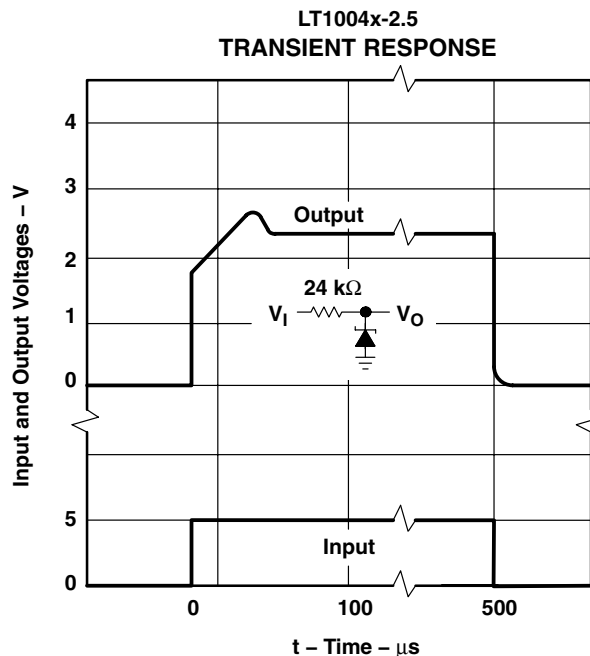
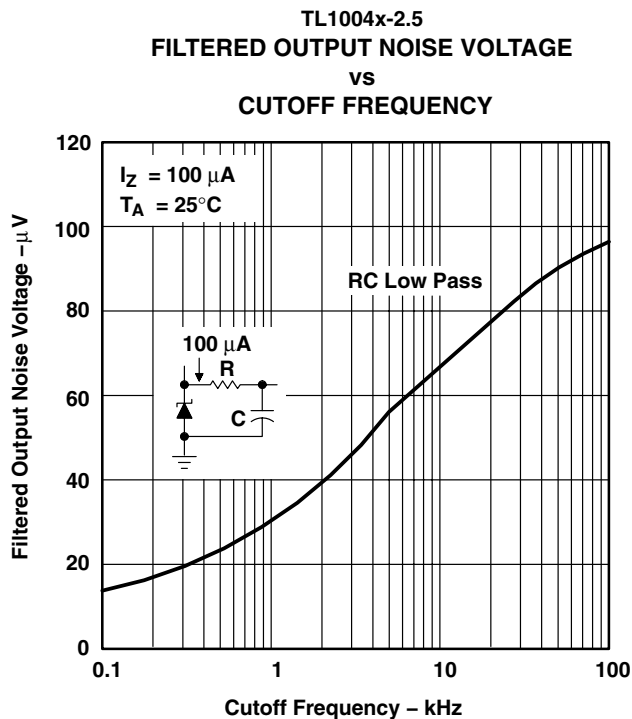
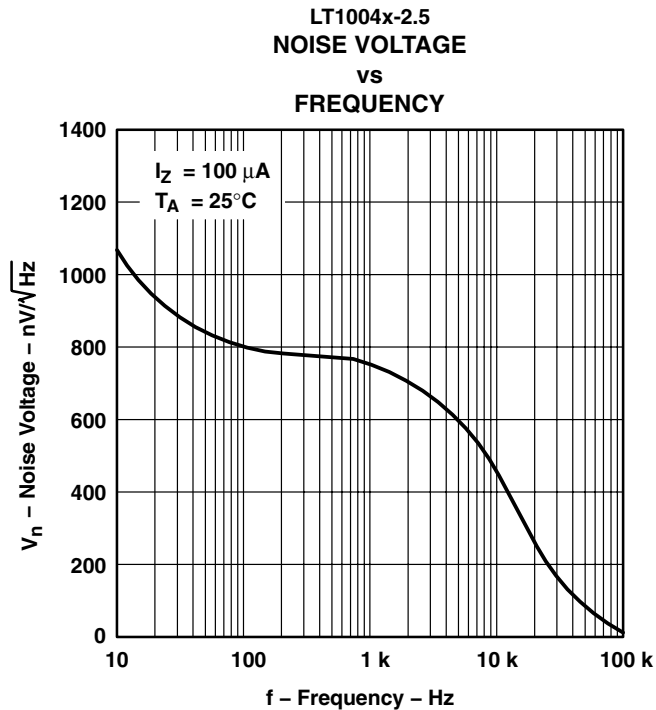
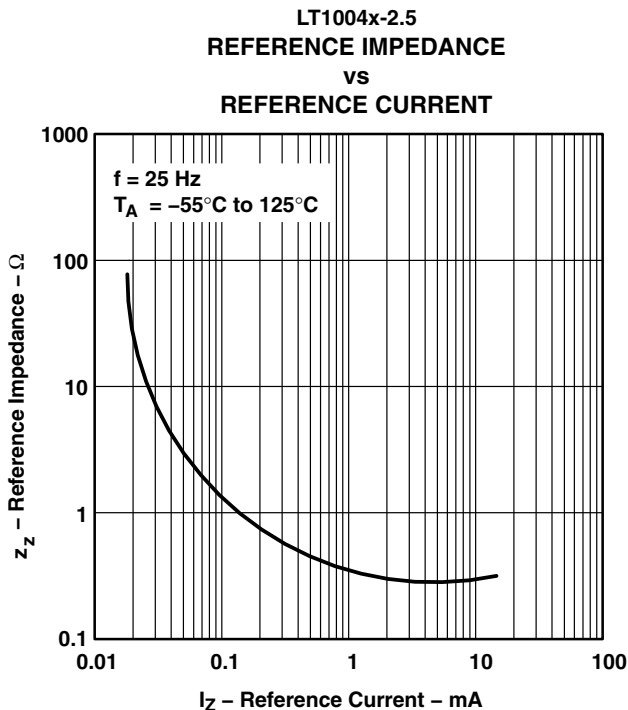


Figure 11

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

TYPICAL CHARACTERISTICS†

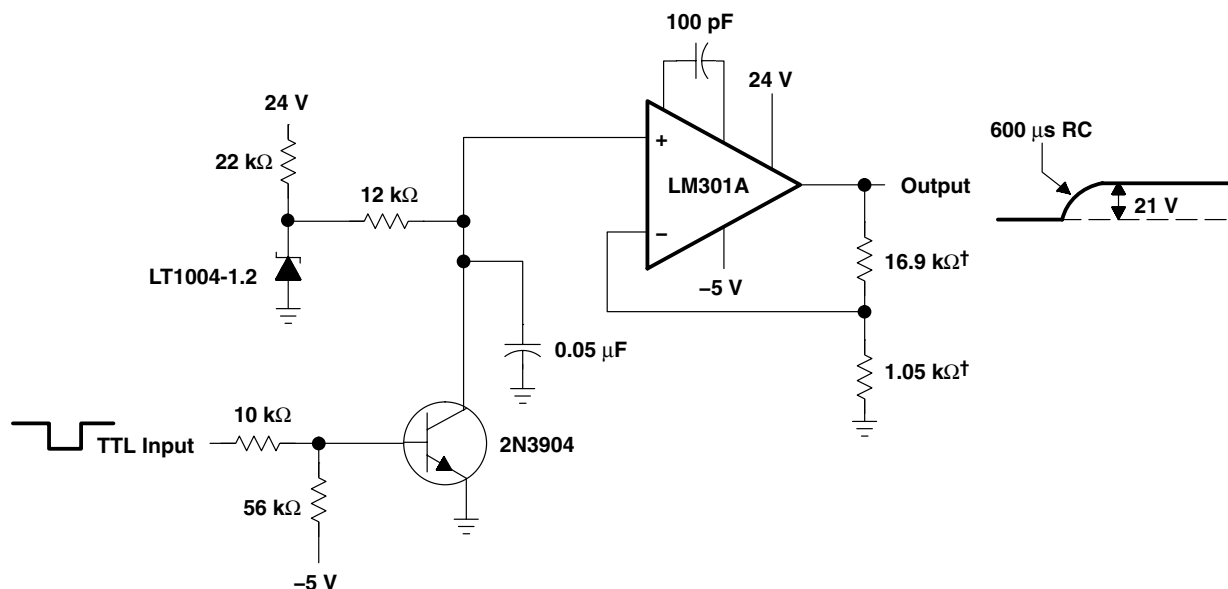


† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

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APPLICATION INFORMATION



† 1% metal-film resistors

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

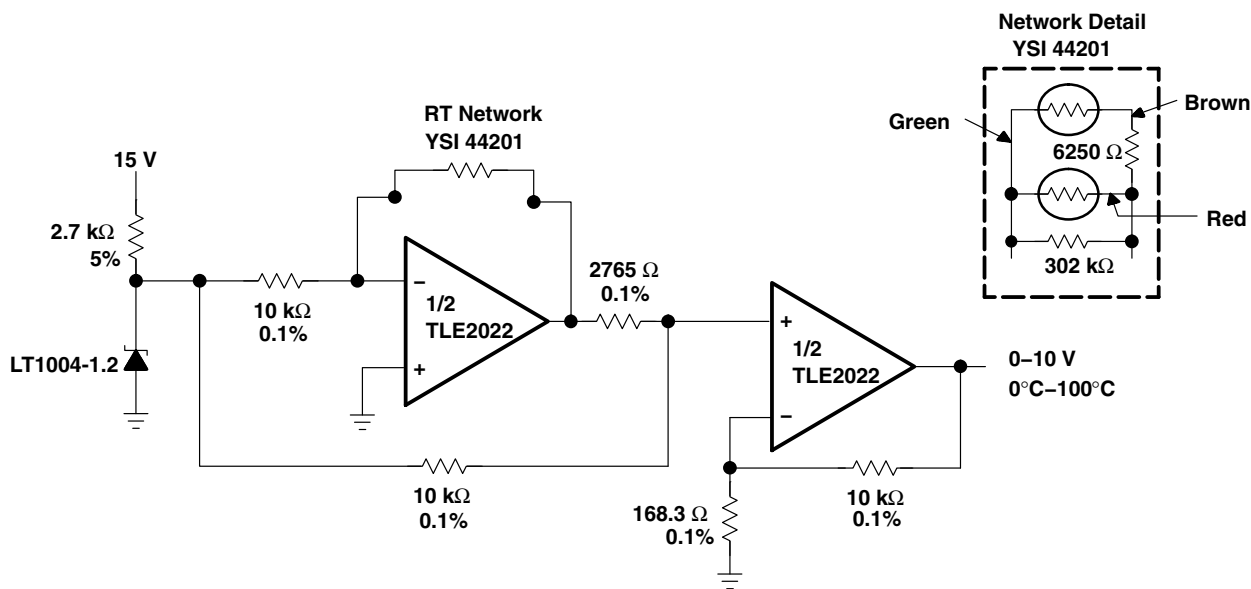


Figure 17. 0°C-to-100°C Linear-Output Thermometer

APPLICATION INFORMATION

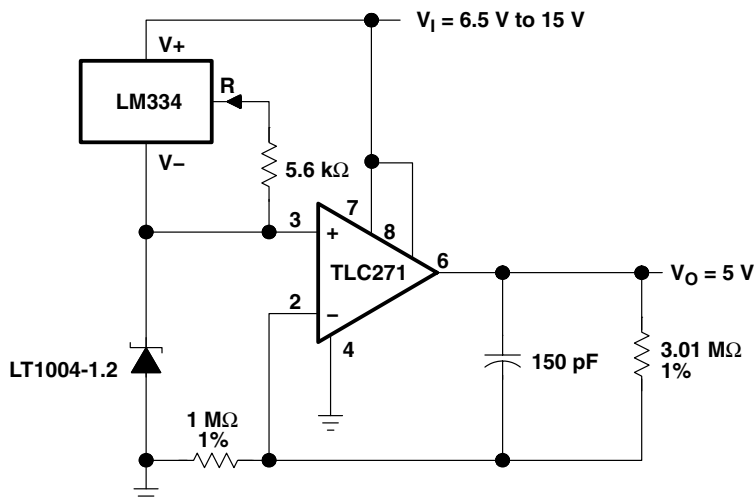


Figure 18. Micropower 5-V Reference

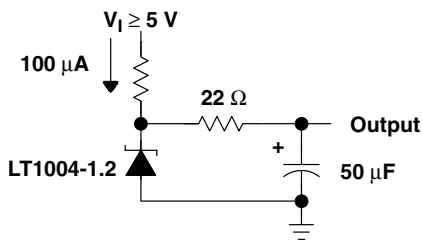


Figure 19. Low-Noise Reference

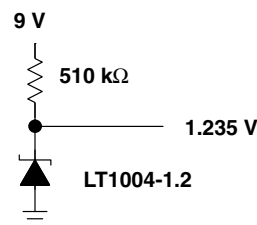
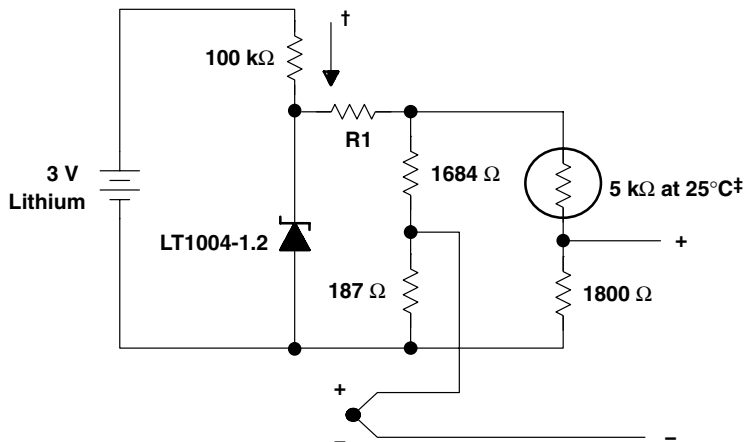


Figure 20. Micropower Reference From 9-V Battery



| 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°C to 60°C .

Figure 21. Micropower Cold-Junction Compensation for Thermocouples

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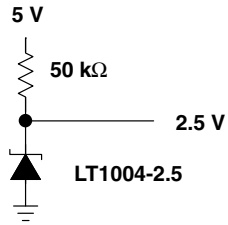


Figure 22. 2.5-V Reference

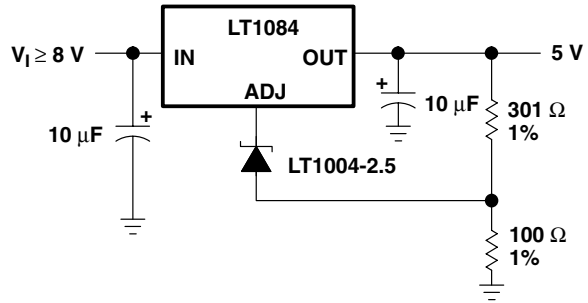
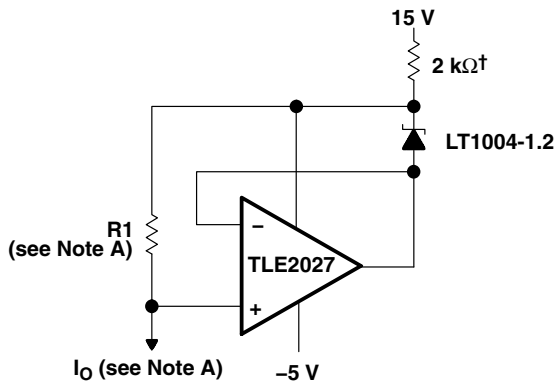


Figure 23. High-Stability 5-V Regulator



† 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

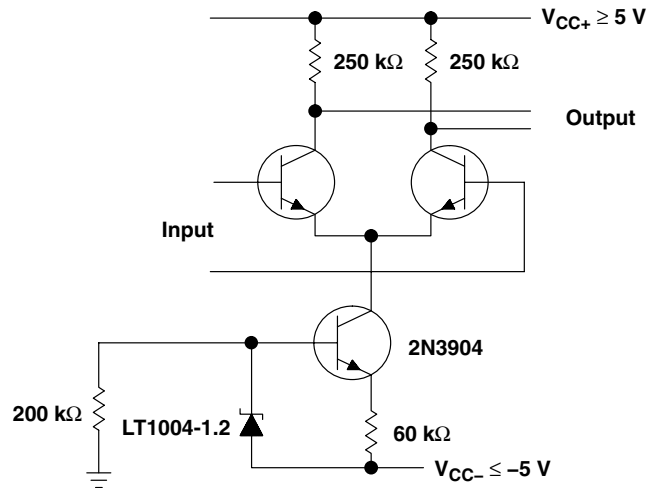
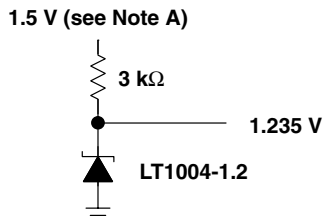


Figure 25. Amplifier With Constant Gain Over Temperature



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

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

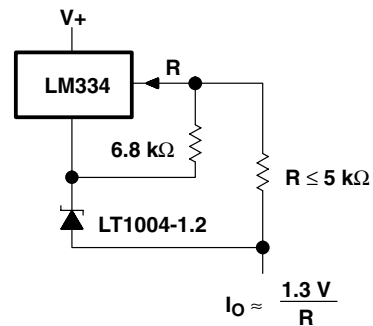
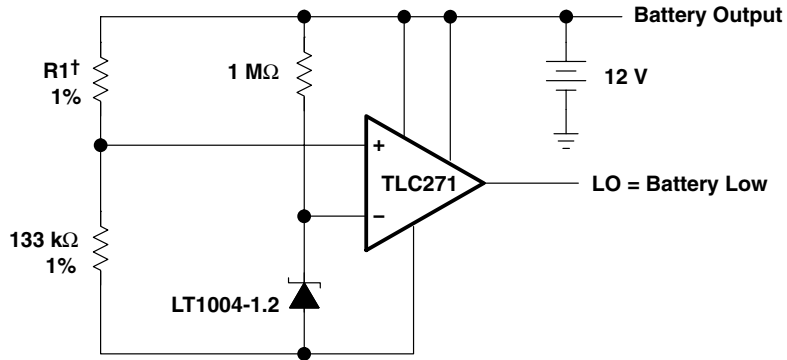


Figure 27. Terminal Current Source With Low Temperature Coefficient

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

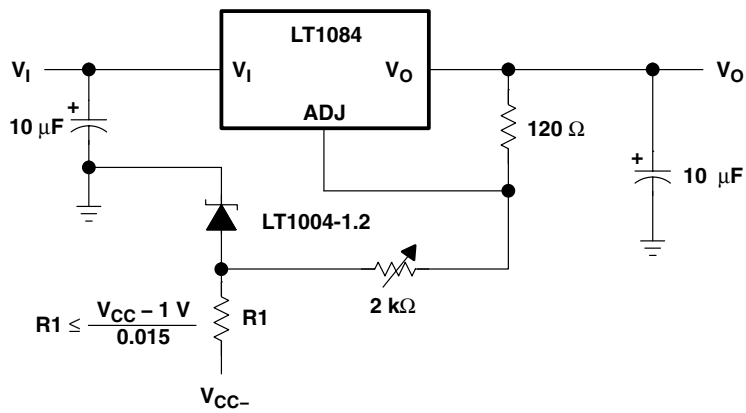


Figure 29. Variable-Voltage Supply

PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead finish/ Ball material (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|------------------|---------------|--------------|-----------------|------|-------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|-------------------------|
| LT1004CD-1-2 | ACTIVE | SOIC | D | 8 | 75 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | | 4C-12 | Samples |
| LT1004CD-2-5 | ACTIVE | SOIC | D | 8 | 75 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | | 4C-25 | Samples |
| LT1004CDR-1-2 | ACTIVE | SOIC | D | 8 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | | 4C-12 | Samples |
| LT1004CDR-2-5 | ACTIVE | SOIC | D | 8 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | | 4C-25 | Samples |
| LT1004CDRG4-2-5 | LIFEBUY | SOIC | D | 8 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | 4C-25 | |
| LT1004CPW-1-2 | ACTIVE | TSSOP | PW | 8 | 150 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | 4C-12 | Samples |
| LT1004CPWR-1-2 | ACTIVE | TSSOP | PW | 8 | 2000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | 4C-12 | Samples |
| LT1004CPWR-2-5 | ACTIVE | TSSOP | PW | 8 | 2000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | 4C-25 | Samples |
| LT1004ID-1-2 | ACTIVE | SOIC | D | 8 | 75 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | | 4I-12 | Samples |
| LT1004ID-2-5 | ACTIVE | SOIC | D | 8 | 75 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | | 4I-25 | Samples |
| LT1004IDG4-2-5 | LIFEBUY | SOIC | D | 8 | 75 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | 4I-25 | |
| LT1004IDR-1-2 | ACTIVE | SOIC | D | 8 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | 4I-12 | Samples |
| LT1004IDR-2-5 | ACTIVE | SOIC | D | 8 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | | 4I-25 | Samples |
| LT1004IDRE4-2-5 | LIFEBUY | SOIC | D | 8 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | 4I-25 | |
| LT1004IDRG4-1-2 | LIFEBUY | SOIC | D | 8 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | 4I-12 | |
| LT1004IPW-1-2 | ACTIVE | TSSOP | PW | 8 | 150 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | 4I-12 | Samples |
| LT1004IPW-2-5 | ACTIVE | TSSOP | PW | 8 | 150 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | 4I-25 | Samples |
| LT1004IPWR-1-2 | ACTIVE | TSSOP | PW | 8 | 2000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | 4I-12 | Samples |
| LT1004IPWR-2-5 | ACTIVE | TSSOP | PW | 8 | 2000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | 4I-25 | Samples |

(1) 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.

(2) RoHS: TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of ≤ 1000 ppm threshold. Antimony trioxide based flame retardants must also meet the ≤ 1000 ppm threshold requirement.

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

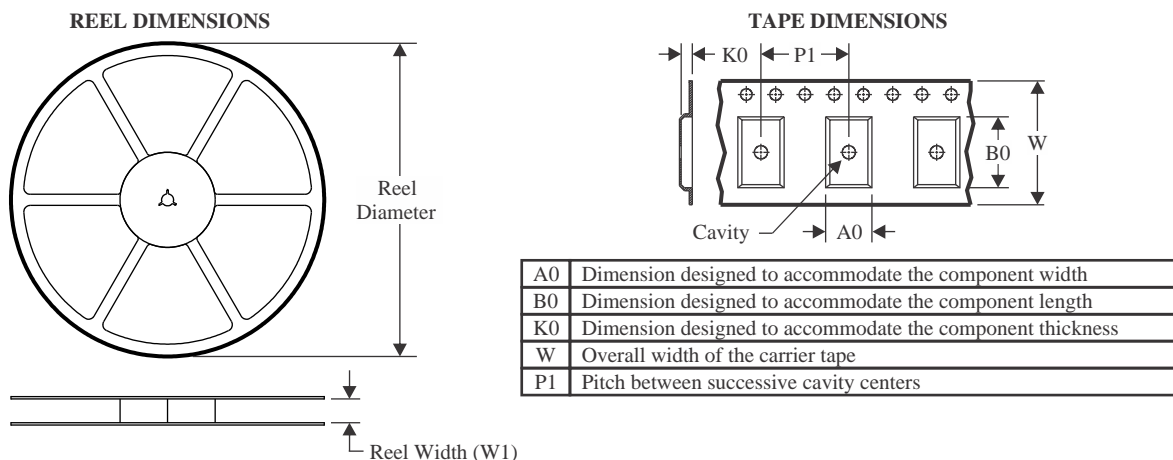
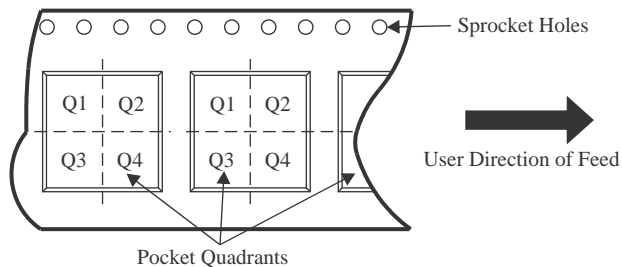
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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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-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-2-5 | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| LT1004CPWR-1-2 | TSSOP | PW | 8 | 2000 | 367.0 | 367.0 | 35.0 |
| LT1004CPWR-2-5 | TSSOP | PW | 8 | 2000 | 367.0 | 367.0 | 35.0 |
| 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 | 367.0 | 367.0 | 35.0 |
| LT1004IPWR-2-5 | TSSOP | PW | 8 | 2000 | 367.0 | 367.0 | 35.0 |

TUBE


*All dimensions are nominal

| Device | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T (μm) | B (mm) |
|----------------|--------------|--------------|------|-----|--------|--------|--------|--------|
| LT1004CD-1-2 | D | SOIC | 8 | 75 | 507 | 8 | 3940 | 4.32 |
| LT1004CD-1-2 | D | SOIC | 8 | 75 | 506.6 | 8 | 3940 | 4.32 |
| LT1004CD-2-5 | D | SOIC | 8 | 75 | 507 | 8 | 3940 | 4.32 |
| LT1004CPW-1-2 | PW | TSSOP | 8 | 150 | 530 | 10.2 | 3600 | 3.5 |
| LT1004ID-1-2 | D | SOIC | 8 | 75 | 507 | 8 | 3940 | 4.32 |
| LT1004ID-2-5 | D | SOIC | 8 | 75 | 507 | 8 | 3940 | 4.32 |
| LT1004IDG4-2-5 | D | SOIC | 8 | 75 | 507 | 8 | 3940 | 4.32 |
| LT1004IPW-1-2 | PW | TSSOP | 8 | 150 | 530 | 10.2 | 3600 | 3.5 |
| LT1004IPW-2-5 | PW | TSSOP | 8 | 150 | 530 | 10.2 | 3600 | 3.5 |



D0008A

PACKAGE OUTLINE

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



4214825/C 02/2019

NOTES:

- Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches. Dimensioning and tolerancing per ASME Y14.5M.
- This drawing is subject to change without notice.
- This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 [0.15] per side.
- This dimension does not include interlead flash.
- Reference JEDEC registration MS-012, variation AA.

EXAMPLE BOARD LAYOUT

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:8X



SOLDER MASK DETAILS

4214825/C 02/2019

NOTES: (continued)

- 6. Publication IPC-7351 may have alternate designs.
- 7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



SOLDER PASTE EXAMPLE
BASED ON .005 INCH [0.125 MM] THICK STENCIL
SCALE:8X

4214825/C 02/2019

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

PW0008A



PACKAGE OUTLINE
TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-153, variation AA.

EXAMPLE BOARD LAYOUT

PW0008A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
SCALE:10X



SOLDER MASK DETAILS
NOT TO SCALE

4221848/A 02/2015

NOTES: (continued)

- 6. Publication IPC-7351 may have alternate designs.
- 7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

PW0008A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:10X

4221848/A 02/2015

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

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