

# Micropower Voltage Reference

## FEATURES

- **Guaranteed**  $\pm 4\text{mV}$  Initial Accuracy LT1004-1.2
- **Guaranteed**  $\pm 20\text{mV}$  Accuracy LT1004-2.5
- **Guaranteed**  $10\mu\text{A}$  Operating Current
- **Guaranteed** Temperature Performance
- Operates up to  $20\text{mA}$
- Very Low Dynamic Impedance

## APPLICATIONS

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

## DESCRIPTION

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

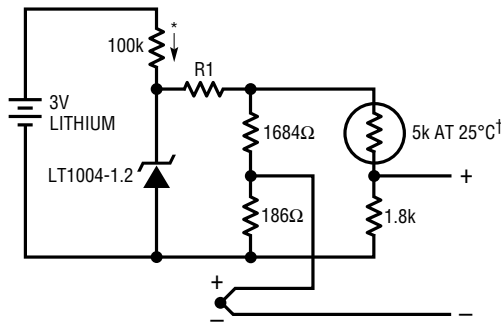
The LT1004 is a pin-for-pin replacement for the LM185/LM385 series of references with improved accuracy specifications. More important, the LT1004 is an attractive device for use in systems where accuracy was previously obtained at the expense of power consumption and trimming.

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

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## TYPICAL APPLICATION

### Micropower Cold Junction Compensation for Thermocouples

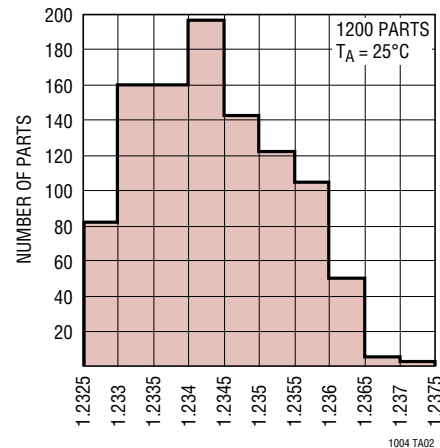


THERMOCOUPLE TYPE	R1
J	233k
K	299k
T	300k
S	2.1M

\* QUIESCENT CURRENT  $\approx 15\text{A}$   
 † YELLOW SPRINGS INST. CO. PART #44007  
 COMPENSATES WITHIN  $\pm 1^\circ\text{C}$  FROM  $0^\circ\text{C}$  TO  $60^\circ\text{C}$

1004 TA01

Typical Distribution of Reference Voltage (LT1004-1.2)



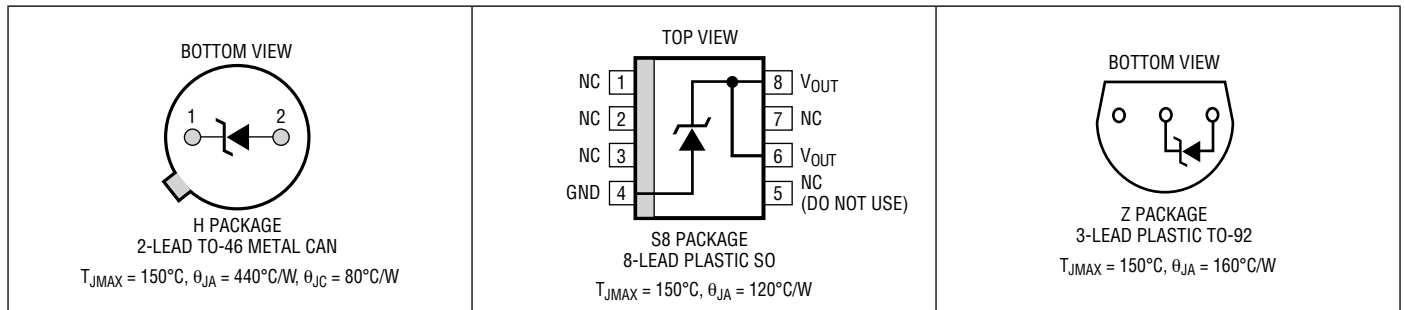
# LT1004

## ABSOLUTE MAXIMUM RATINGS

(Note 1)

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

## PIN CONFIGURATION



## ORDER INFORMATION <http://www.linear.com/product/LT1004#orderinfo>

LEAD FREE FINISH	TAPE AND REEL	PART MARKING	PACKAGE DESCRIPTION	TEMPERATURE RANGE
LT1004MH-2.5#PBF	LT1004MH-2.5#TRPBF		2-Lead TO-46 Metal Can	-55°C to 125°C
LT1004CS8-1.2#PBF	LT1004CS8-1.2#TRPBF	0412	8-Lead Plastic SO	0°C to 70°C
LT1004CS8-2.5#PBF	LT1004CS8-2.5#TRPBF	0425	8-Lead Plastic SO	0°C to 70°C
LT1004IS8-1.2#PBF	LT1004IS8-1.2#TRPBF	0412I	8-Lead Plastic SO	-40°C to 85°C
LT1004IS8-2.5#PBF	LT1004IS8-2.5#TRPBF	0425I	8-Lead Plastic SO	-40°C to 85°C
LT1004CZ-1.2#PBF	LT1004CZ-1.2#TRPBF		3-Lead Plastic TO-92	0°C to 70°C
LT1004CZ-2.5#PBF	LT1004CZ-2.5#TRPBF		3-Lead Plastic TO-92	0°C to 70°C
LT1004IZ-1.2#PBF	LT1004IZ-1.2#TRPBF		3-Lead Plastic TO-92	-40°C to 85°C
LT1004IZ-2.5#PBF	LT1004IZ-2.5#TRPBF		3-Lead Plastic TO-92	-40°C to 85°C

Consult LTC Marketing for parts specified with wider operating temperature ranges.

For more information on lead free part marking, go to: <http://www.linear.com/leadfree/>

For more information on tape and reel specifications, go to: <http://www.linear.com/tapeandreel/>. Some packages are available in 500 unit reels through designated sales channels with #TRMPBF suffix.

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

SYMBOL	PARAMETER	CONDITIONS	C, I SUFFIXES			H SUFFIX			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
$V_Z$	Reverse Breakdown Voltage	$I_R = 100\mu\text{A}$	1.231	1.235	1.239	2.480	2.500	2.520	V
		LT1004M: $-55^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$	● 1.220	1.230	1.245	2.460	2.500	2.535	V
		LT1004C: $0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$	● 1.225	1.235	1.245	2.470	2.500	2.530	V
		LT1004I: $-40^\circ\text{C} \leq T_A \leq 85^\circ\text{C}$	● 1.220	1.230	1.245	2.460	2.500	2.530	V
$\frac{\Delta V_Z}{\Delta \text{Temp}}$	Average Temperature Coefficient	$I_{\text{MIN}} \leq I_R \leq 20\text{mA}$ (Note 3)	20			20			ppm/ $^\circ\text{C}$
$I_{\text{MIN}}$	Minimum Operating Current		●	8	10	12	20	$\mu\text{A}$	
$\frac{\Delta V_Z}{\Delta I_R}$	Reverse Breakdown Voltage Change with Current	$I_{\text{MIN}} \leq I_R \leq 1\text{mA}$	●	1.0		1.0		mV	
		$1\text{mA} \leq I_R \leq 20\text{mA}$	●	1.5		1.5		mV	
$r_Z$	Reverse Dynamic Impedance	$I_R = 100\mu\text{A}$	●	0.2	0.6	0.2	0.6	$\Omega$	
					1.5		1.5	$\Omega$	
$e_n$	Wide Band Noise (RMS)	$I_R = 100\mu\text{A}$ , $10\text{Hz} \leq f \leq 10\text{kHz}$		60		120		$\mu\text{V}$	
$\frac{\Delta V_Z}{\Delta \text{Time}}$	Long Term Stability	$I_R = 100\mu\text{A}$ , $T_A = 25^\circ\text{C} \pm 0.1^\circ\text{C}$		20		20		ppm/kHr	

**Note 1:** Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

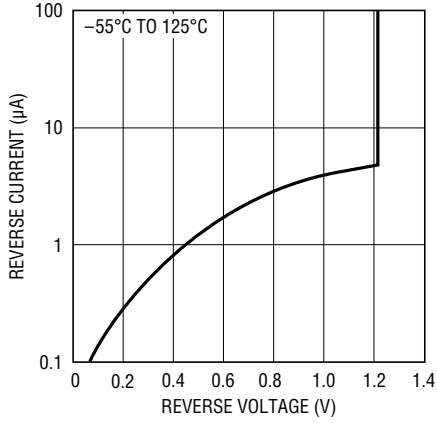
**Note 2:** All specifications are for  $T_A = 25^\circ\text{C}$  unless otherwise noted.

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

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

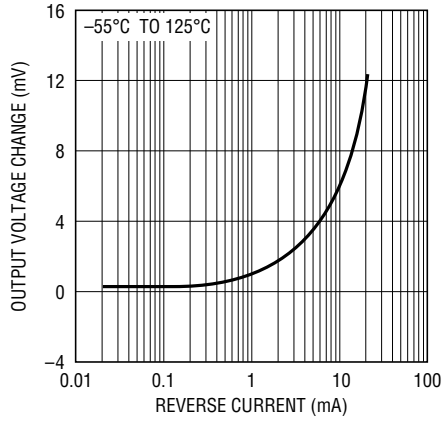
TYPICAL PERFORMANCE CHARACTERISTICS

Reverse Characteristics



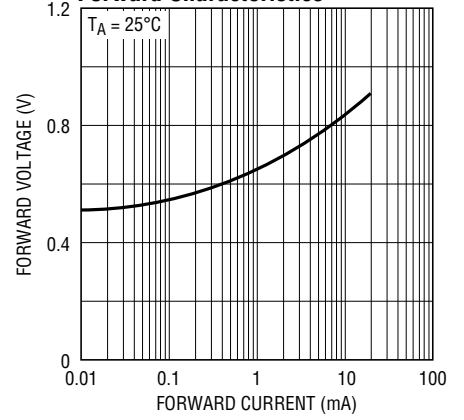
1004 G01

Reverse Voltage Change



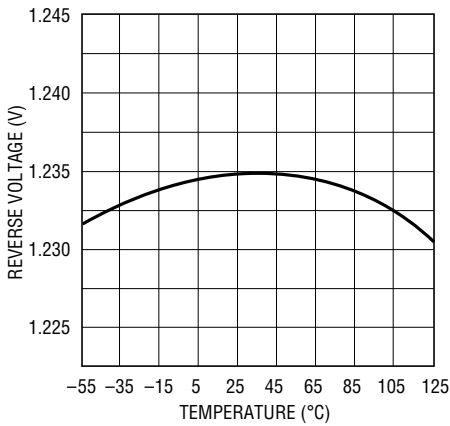
1004 G02

Forward Characteristics



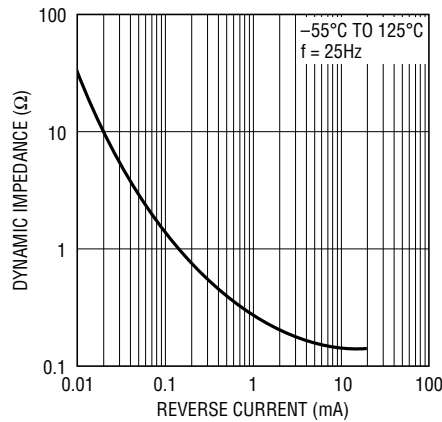
1004 G11

Temperature Drift



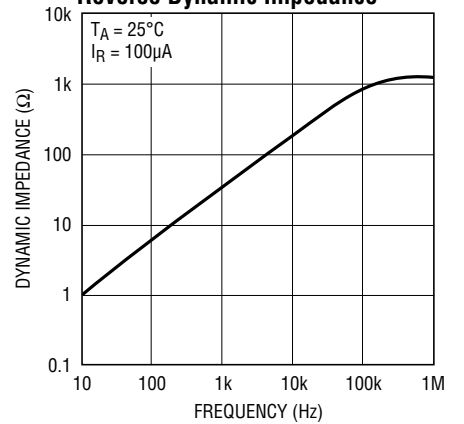
1004 G04

Reverse Dynamic Impedance



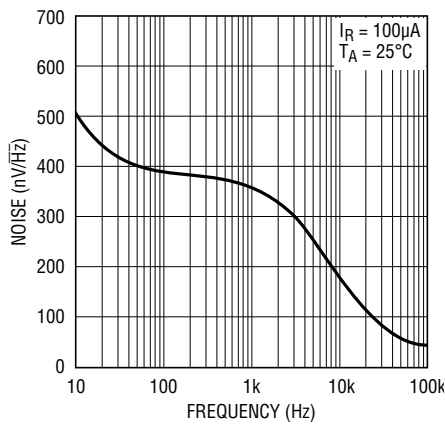
1004 G05

Reverse Dynamic Impedance



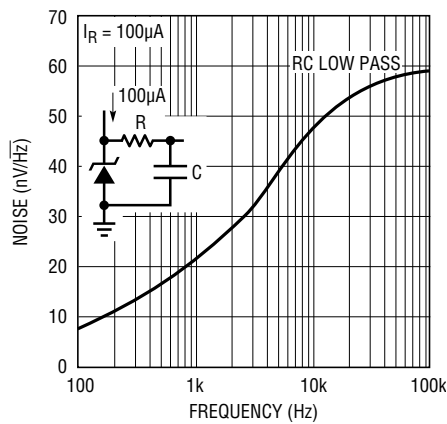
1004 G06

Noise Voltage



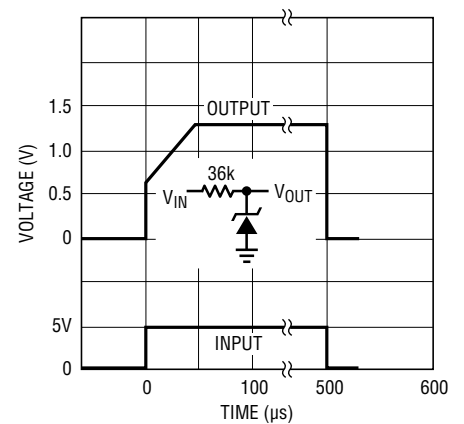
1004 G07

Filtered Output Noise



1004 G08

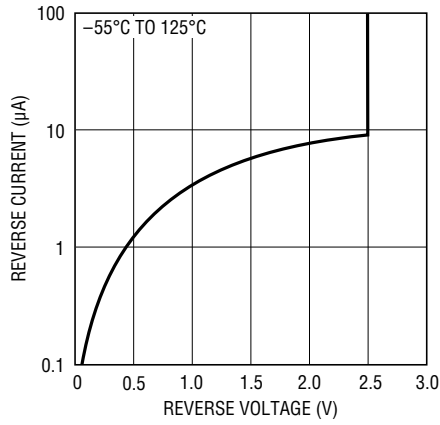
Reponse Time



1004 G09

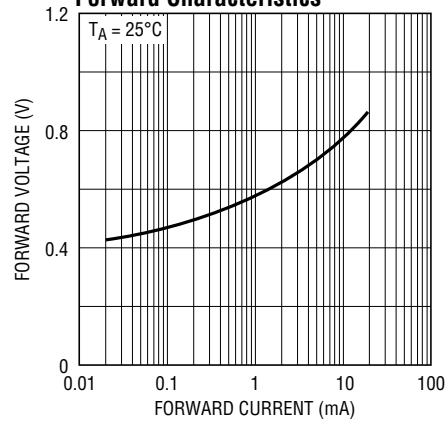
# PERFORMANCE CHARACTERISTICS

**Reverse Characteristics**



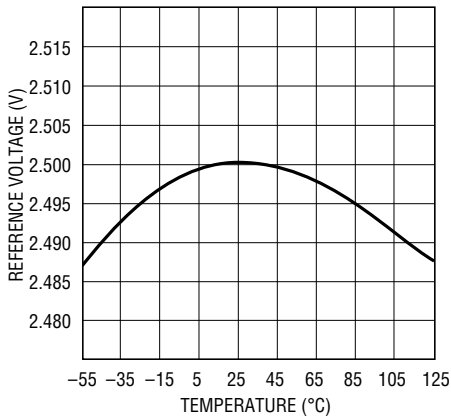
1004 G10

**Forward Characteristics**



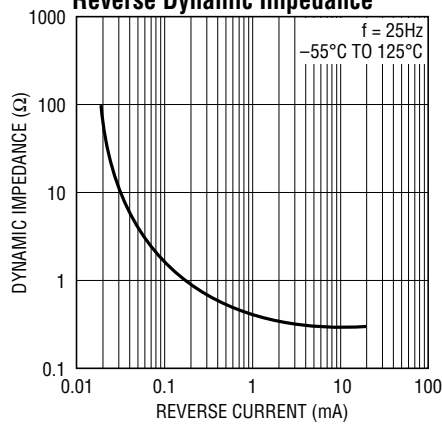
1004 G11

**Temperature Drift**



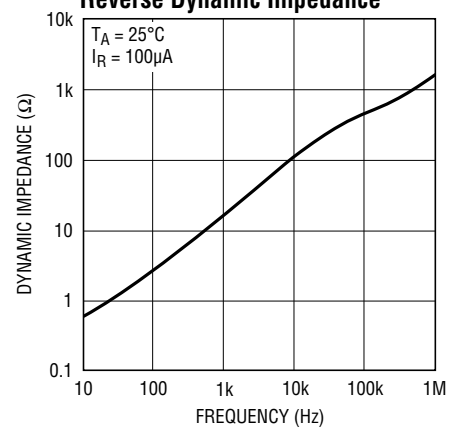
1004 G12

**Reverse Dynamic Impedance**



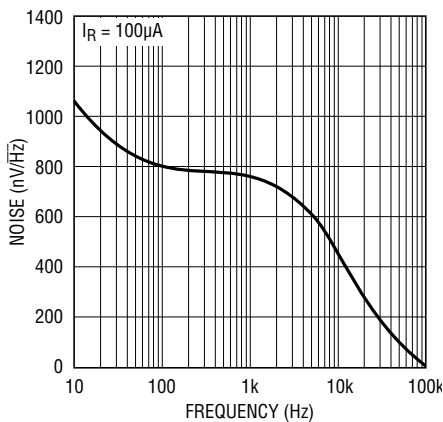
1004 G13

**Reverse Dynamic Impedance**



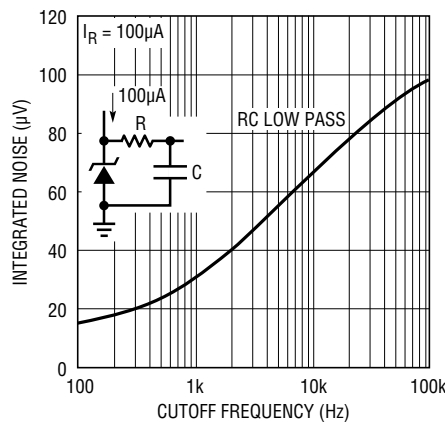
1004 G14

**Noise Voltage**



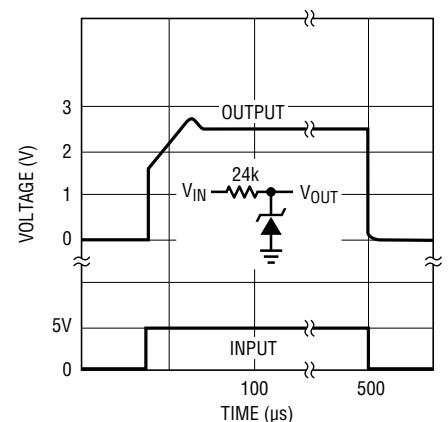
1004 G15

**Filtered Output Noise**



1004 G16

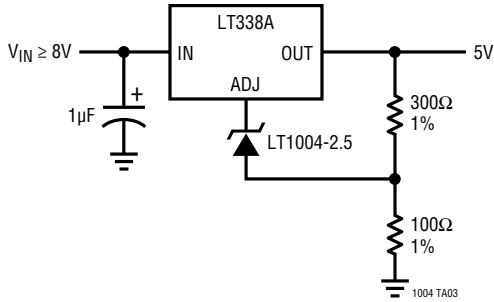
**Reponse Time**



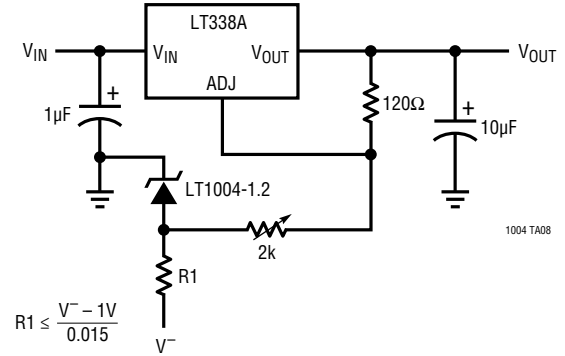
1004 G17

## TYPICAL APPLICATIONS

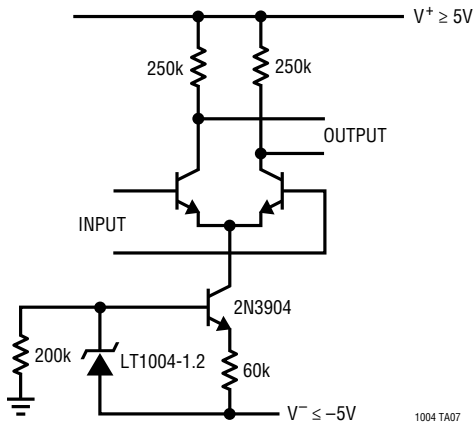
### High Stability 5V Regulator



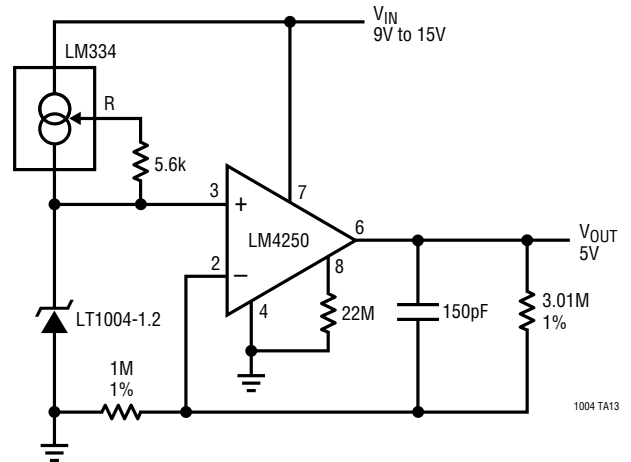
### Variable Output Supply



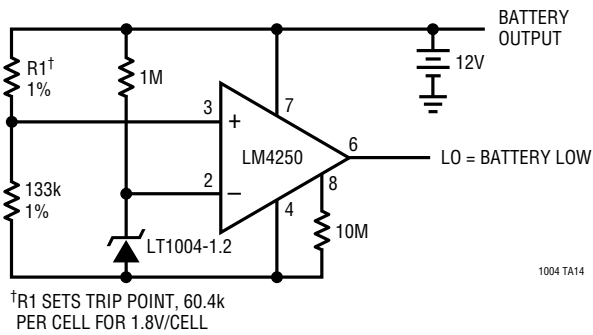
### Constant Gain Amplifier Over Temperature



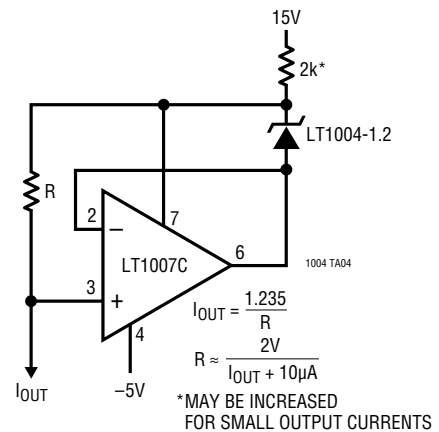
### Micropower 5V Reference



### Lead Acid Low-Battery Detector

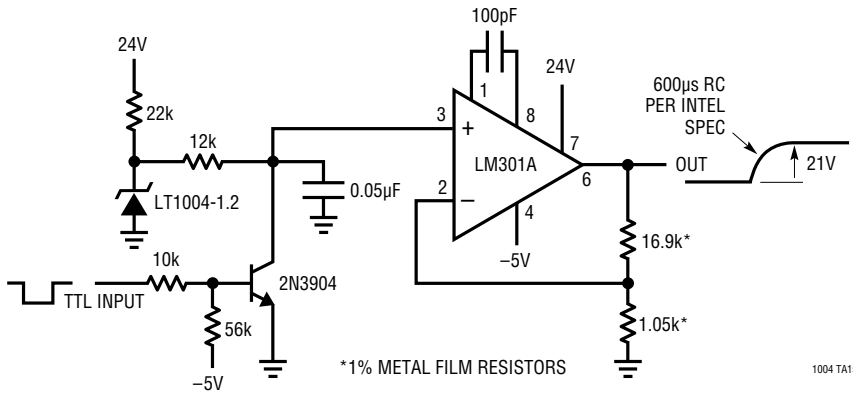


### Ground Referenced Current Source

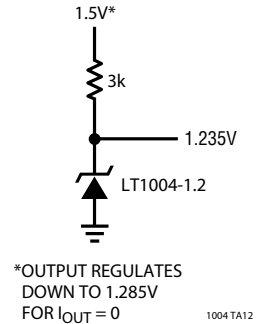


# TYPICAL APPLICATIONS

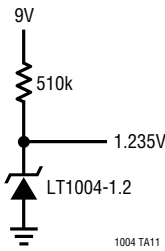
VPP Generator for Eeproms — No Trim Required



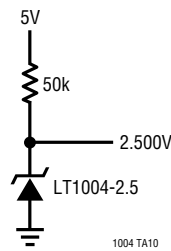
1.2V Reference from 1.5V Battery



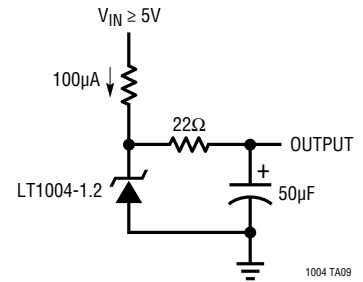
Micropower Reference from 9V Battery



2.5V Reference

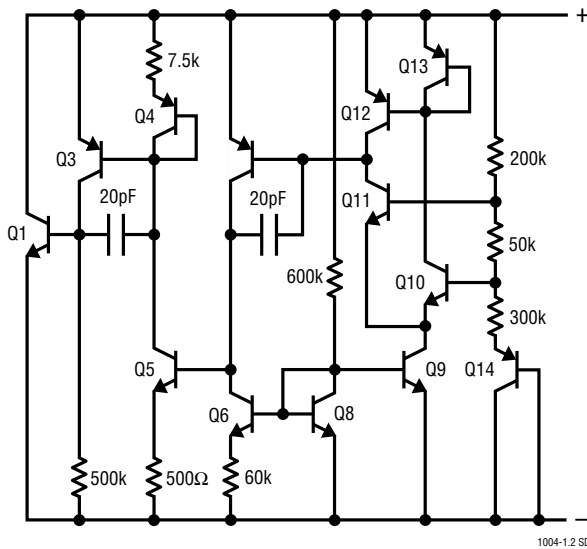


Low Noise Reference

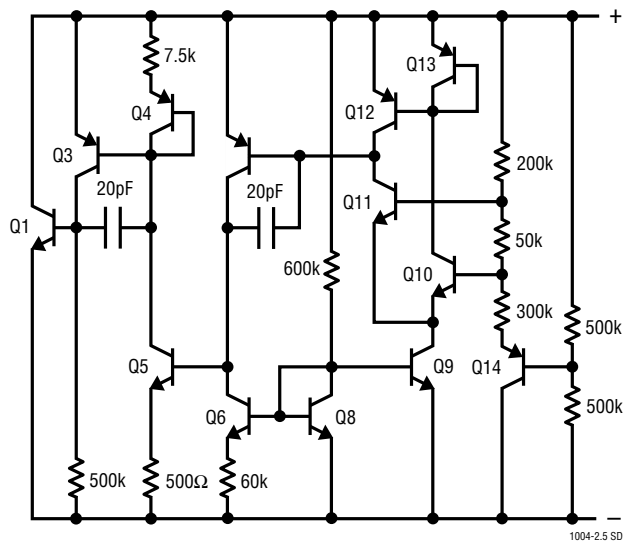


# SCHEMATIC DIAGRAMS

LT1004-1.2



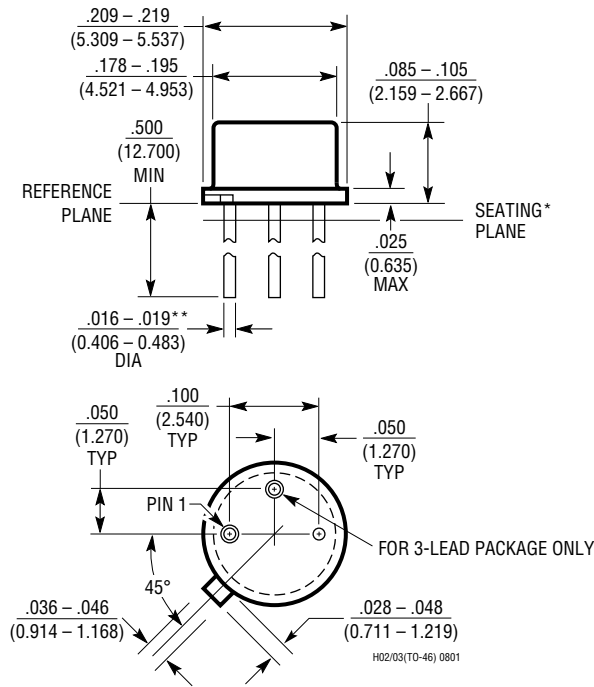
LT1004-2.5



**PACKAGE DESCRIPTION**

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

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



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

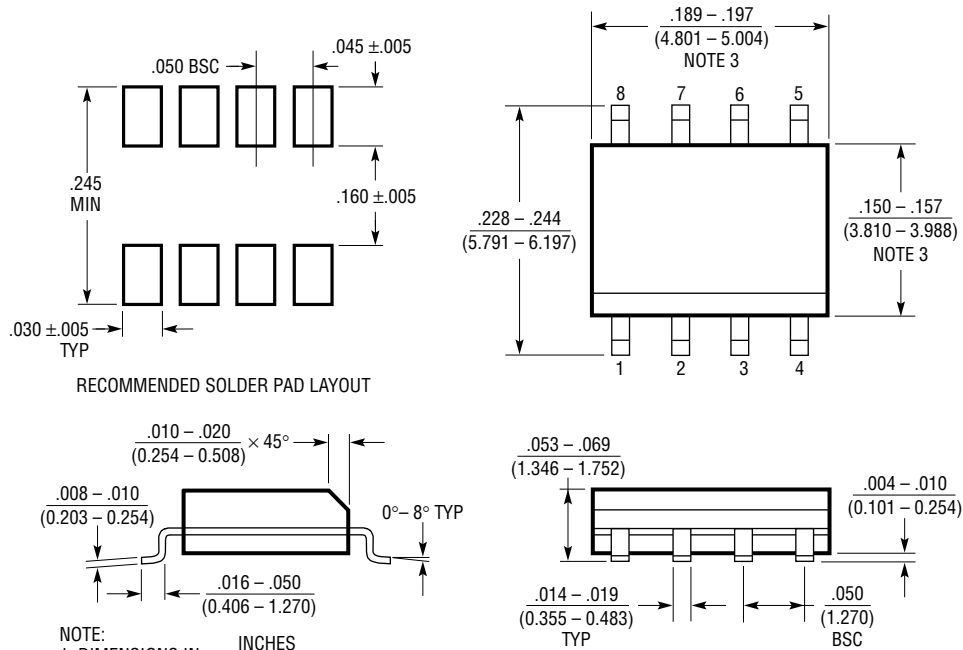
\*\*FOR SOLDER DIP LEAD FINISH, LEAD DIAMETER IS  $\frac{.016 - .024}{(0.406 - 0.610)}$



# PACKAGE DESCRIPTION

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

## S8 Package 8-Lead Plastic Small Outline (Narrow .150 Inch) (Reference LTC DWG # 05-08-1610 Rev G)



RECOMMENDED SOLDER PAD LAYOUT

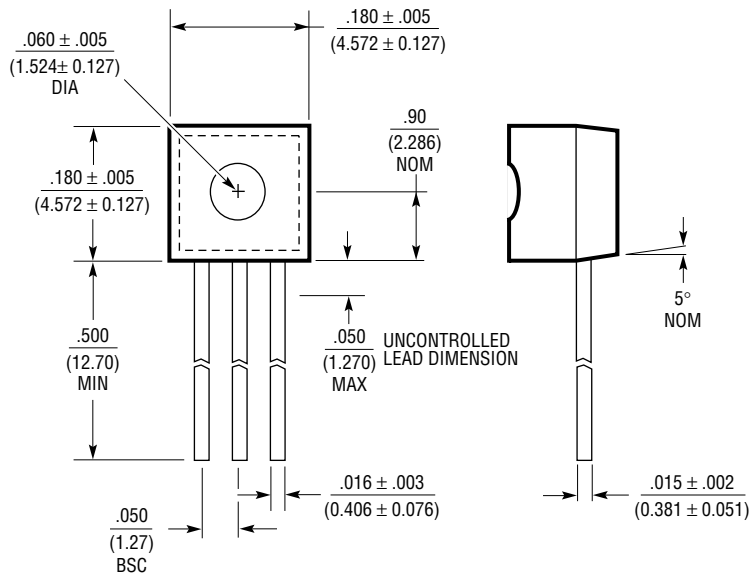
- NOTE:
1. DIMENSIONS IN  $\frac{\text{INCHES}}{\text{MILLIMETERS}}$
  2. DRAWING NOT TO SCALE
  3. THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS. MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED  $.006"$  (0.15mm)
  4. PIN 1 CAN BE BEVEL EDGE OR A DIMPLE

S08 REV G 0212

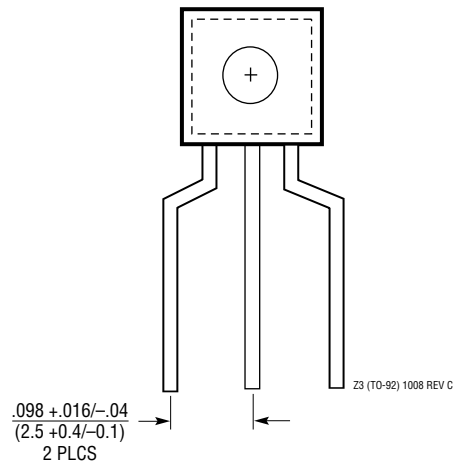
# PACKAGE DESCRIPTION

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

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

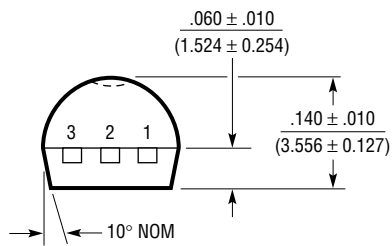


**BULK PACK**



**TO-92 TAPE AND REEL**

REFER TO TAPE AND REEL SECTION OF LTC DATA BOOK FOR ADDITIONAL INFORMATION

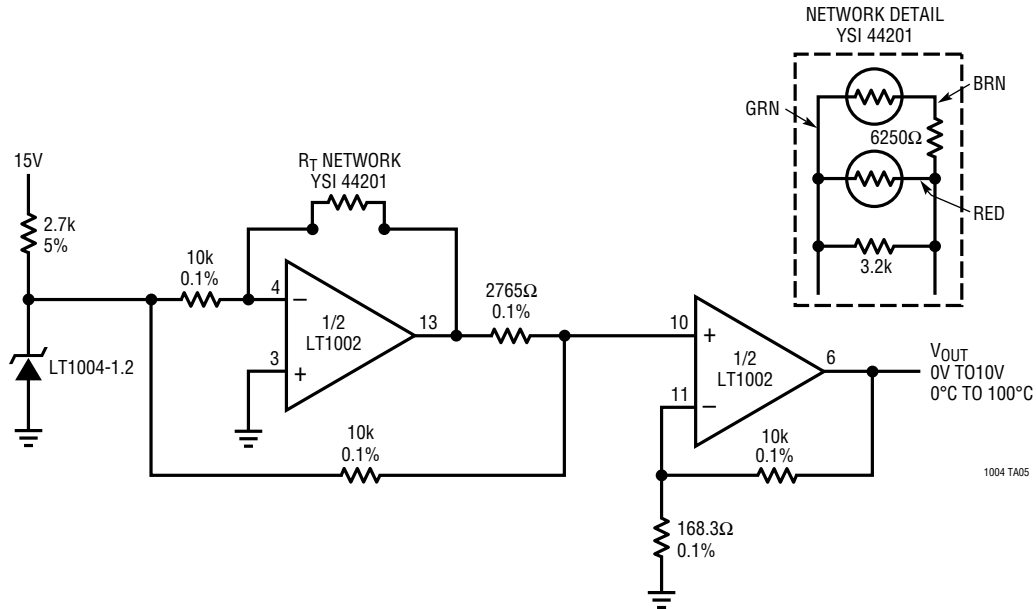


**REVISION HISTORY** (Revision history begins at Rev C)

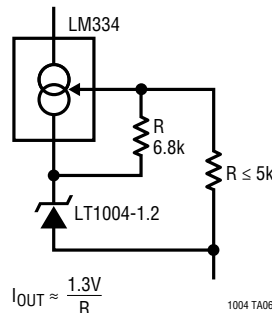
REV	DATE	DESCRIPTION	PAGE NUMBER
C	07/17	Added Web Links Package Order Information Updated: $T_{JMAX}$ changed to 150°C for S8 and TO-92 package. Thermal resistance (Junction to Ambient) changed to 120°C/W	All 2

## TYPICAL APPLICATION

### 0°C to 100°C Linear Output Thermometer



### Low Temperature Coefficient 2-Terminal Current Source



## RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
<a href="#">LT1634</a>	Micropower Precision Shunt Reference	10µA Operating Current, 10ppm/°C Maximum Drift, 0.05% Initial Accuracy
<a href="#">LT1460S3-2.5</a>	Micropower Series Reference in SOT-23	100µA Operating Current, 20ppm/°C Maximum Drift, 0.2% Initial Accuracy
<a href="#">LT1790</a>	Precision Micropower LDO Reference in SOT-23	10ppm/°C Max Drift, 0.05% Initial Accuracy