

## 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  $\pm 4\text{mV}$ .

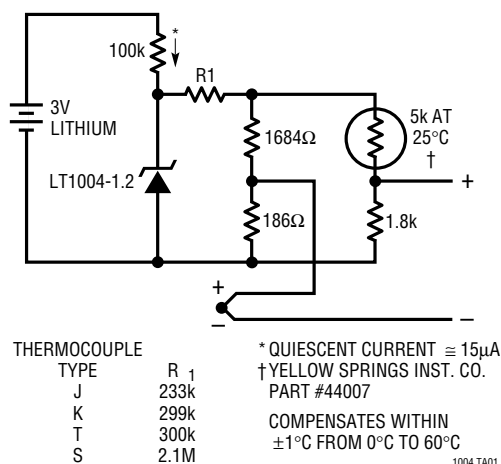
The LT1004 is a pin-for-pin replacement for the LM185/LM385 series of references with improved accuracy specifications. More important, the LT1004 is an attractive device for use in systems where accuracy was previously obtained at the expense of power consumption and trimming.

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

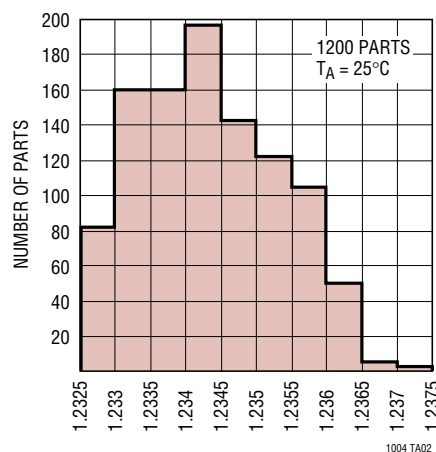
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## TYPICAL APPLICATION

### Micropower Cold Junction Compensation for Thermocouples



Typical Distribution of  
 Reference Voltage (LT1004-1.2)

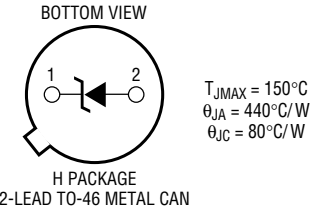
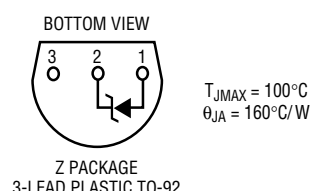
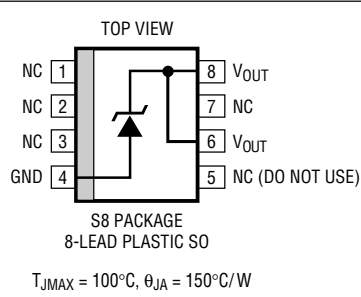


## ABSOLUTE MAXIMUM RATINGS

(Note 1)

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

## PACKAGE/ORDER INFORMATION

 <p>H PACKAGE 2-LEAD TO-46 METAL CAN</p>	ORDER PART NUMBER
	 <p>Z PACKAGE 3-LEAD PLASTIC TO-92</p>
LT1004CZ-1.2 LT1004CZ-2.5 LT1004IZ-1.2 LT1004IZ-2.5	
 <p>S8 PACKAGE 8-LEAD PLASTIC SO</p> <p><math>T_{JMAX} = 100^{\circ}C, \theta_{JA} = 150^{\circ}C/W</math></p>	LT1004CS8-1.2 LT1004CS8-2.5 LT1004IS8-1.2 LT1004IS8-2.5
	S8 PART MARKING
	0412      0425 0412I    0425I

## ELECTRICAL CHARACTERISTICS (Note 2)

SYMBOL	PARAMETER	CONDITIONS	LT1004-1.2			LT1004-2.5			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
V <sub>Z</sub>	Reverse Breakdown Voltage	I <sub>R</sub> = 100μA	1.231	1.235	1.239	2.480	2.500	2.520	V
		LT1004M: -55°C ≤ T <sub>A</sub> ≤ 125°C	● 1.220	1.230	1.245	2.460	2.500	2.535	V
		LT1004C: 0°C ≤ T <sub>A</sub> ≤ 70°C	● 1.225	1.235	1.245	2.470	2.500	2.530	V
		LT1004I: -40°C ≤ T <sub>A</sub> ≤ 85°C	● 1.220	1.230	1.245	2.460	2.500	2.530	V
$\frac{\Delta V_Z}{\Delta Temp}$	Average Temperature Coefficient	I <sub>MIN</sub> ≤ I <sub>R</sub> ≤ 20mA (Note 3)	50			50			ppm/°C
I <sub>MIN</sub>	Minimum Operating Current		● 8	10		12	20	μA	
$\frac{\Delta V_Z}{\Delta I_R}$	Reverse Breakdown Voltage Change with Current	I <sub>MIN</sub> ≤ I <sub>R</sub> ≤ 1mA			1.0			1.0	mV
		1mA ≤ I <sub>R</sub> ≤ 20mA	●		1.5			1.5	mV
			●		10		10		mV
r <sub>Z</sub>	Reverse Dynamic Impedance	I <sub>R</sub> = 100μA	●	0.2	0.6	0.2	0.6	Ω	
			●		1.5		1.5	Ω	
e <sub>n</sub>	Wide Band Noise (RMS)	I <sub>R</sub> = 100μA 10Hz ≤ f ≤ 10kHz		60		120		μV	
$\frac{\Delta V_Z}{\Delta Time}$	Long Term Stability	I <sub>R</sub> = 100μA T <sub>A</sub> = 25°C ± 0.1°C		20		20		ppm/kHz	

The ● denotes the specifications which apply over the full operating temperature range.

**Note 1:** Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

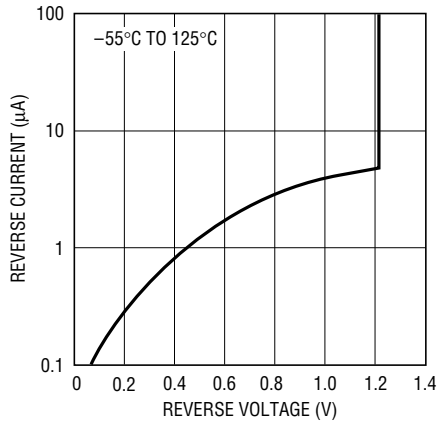
**Note 2:** All specifications are for T<sub>A</sub> = 25°C unless otherwise noted.

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

For MIL-STD components, please refer to LTC 883C data sheet for test listing and parameters.

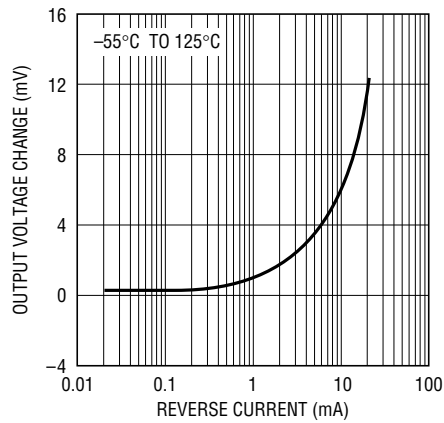
# TYPICAL PERFORMANCE CHARACTERISTICS (1.2V)

**Reverse Characteristics**



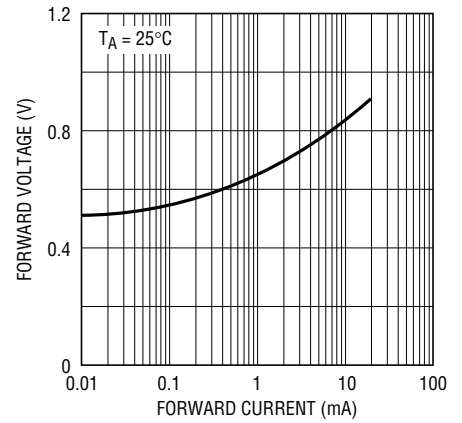
1004 G01

**Reverse Voltage Change**



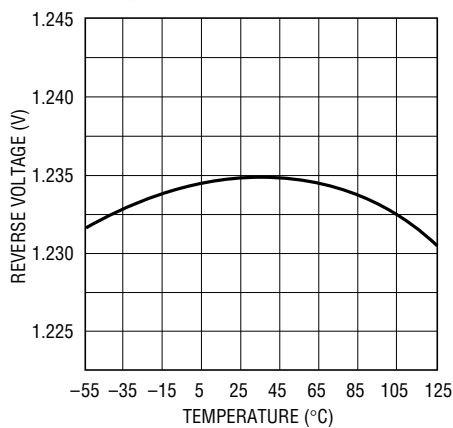
1004 G02

**Forward Characteristics**



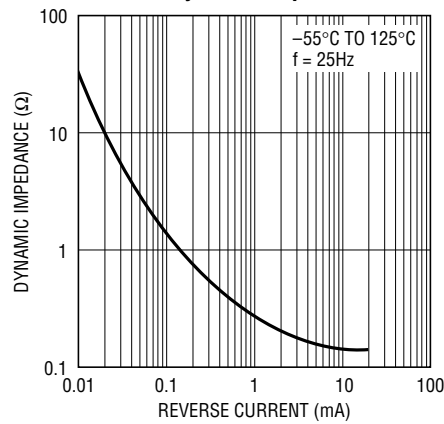
1004 G11

**Temperature Drift**



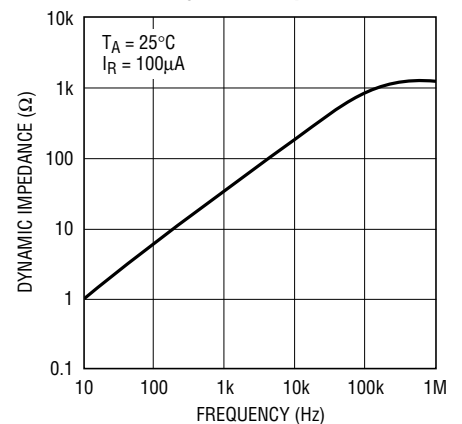
1004 G04

**Reverse Dynamic Impedance**



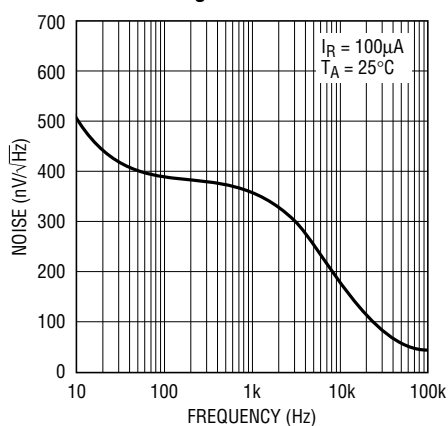
1004 G05

**Reverse Dynamic Impedance**



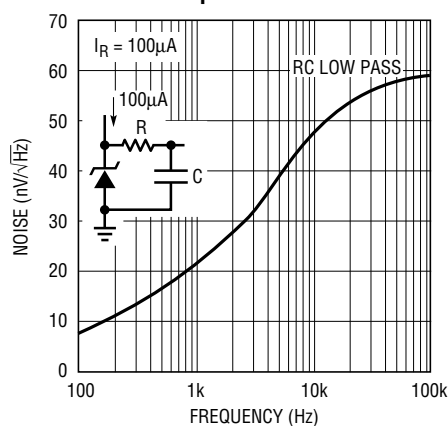
1004 G06

**Noise Voltage**



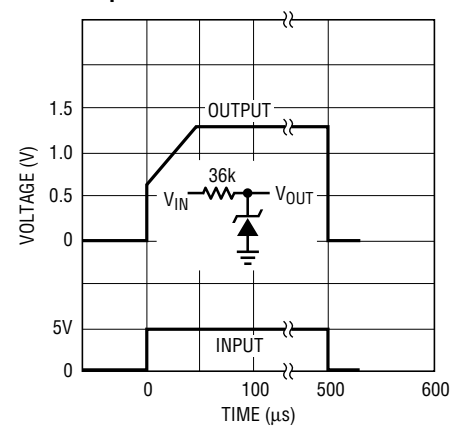
1004 G07

**Filtered Output Noise**



1004 G08

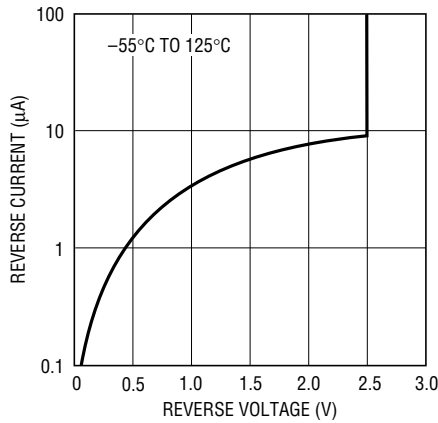
**Reponse Time**



1004 G09

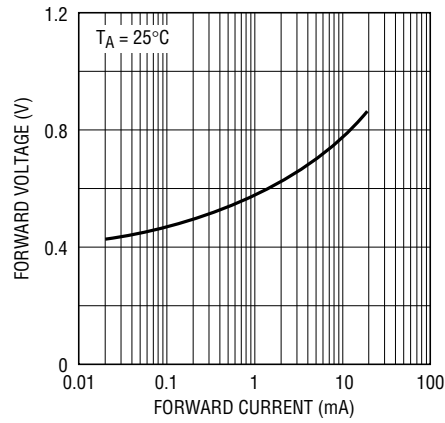
# TYPICAL PERFORMANCE CHARACTERISTICS (2.5V)

Reverse Characteristics



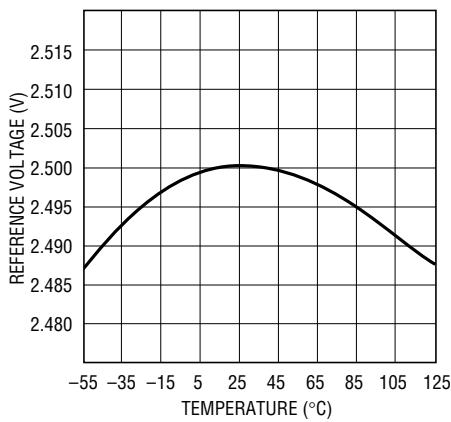
1004 G10

Forward Characteristics



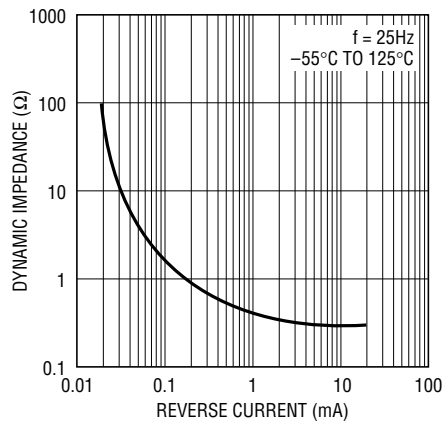
1004 G11

Temperature Drift



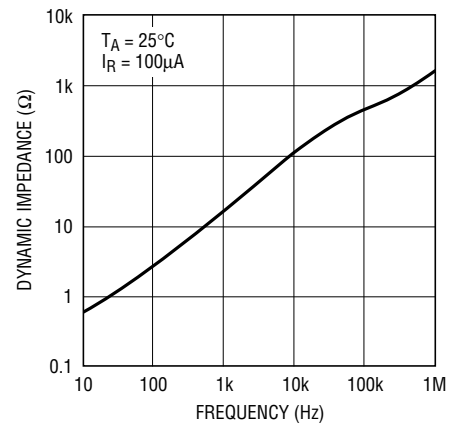
1004 G12

Reverse Dynamic Impedance



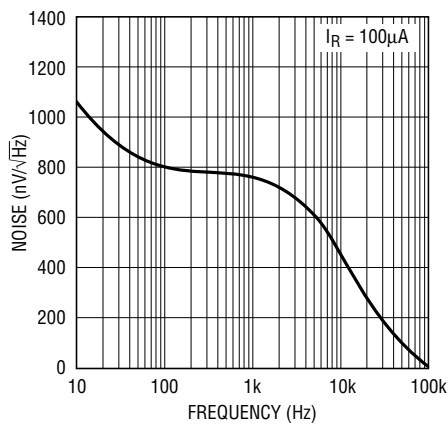
1004 G13

Reverse Dynamic Impedance



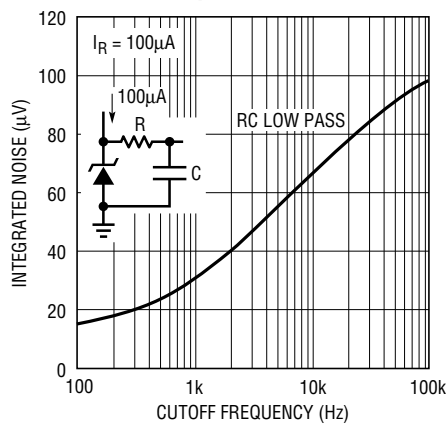
1004 G14

Noise Voltage



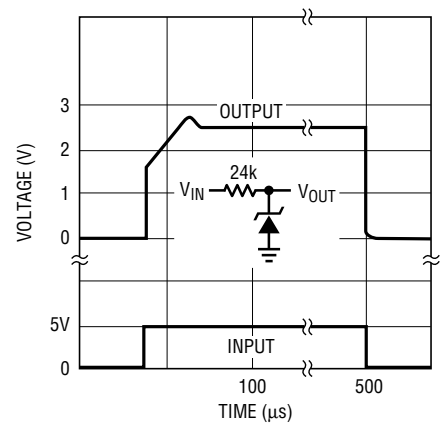
1004 G15

Filtered Output Noise



1004 G16

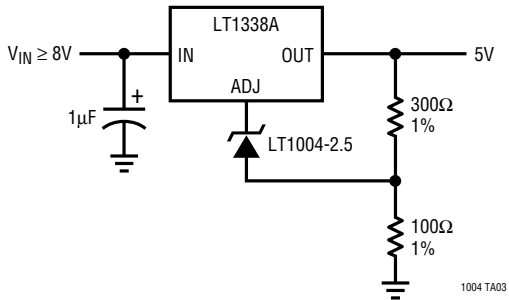
Reponse Time



1004 G17

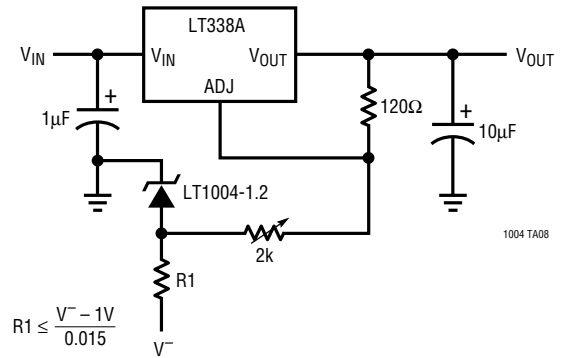
# TYPICAL APPLICATIONS

**High Stability 5V Regulator**



1004 TA03

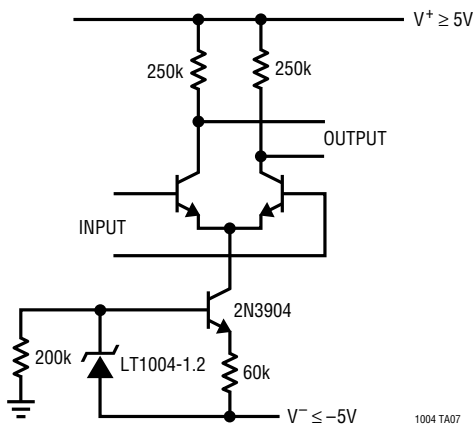
**Variable Output Supply**



1004 TA08

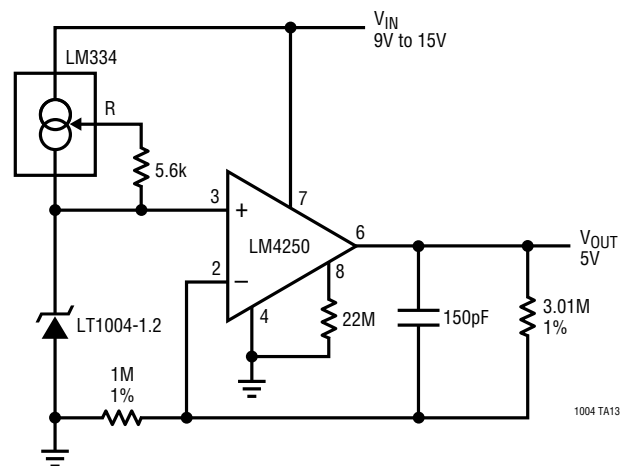
$$R1 \leq \frac{V^- - 1V}{0.015}$$

**Constant Gain Amplifier Over Temperature**



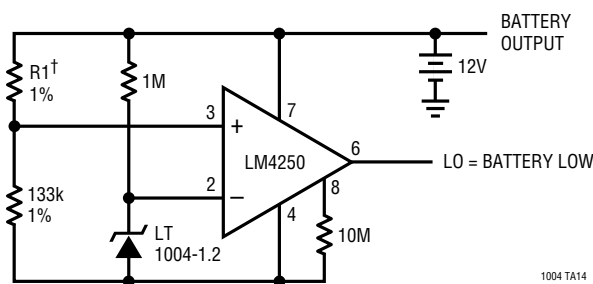
1004 TA07

**Micropower 5V Reference**



1004 TA13

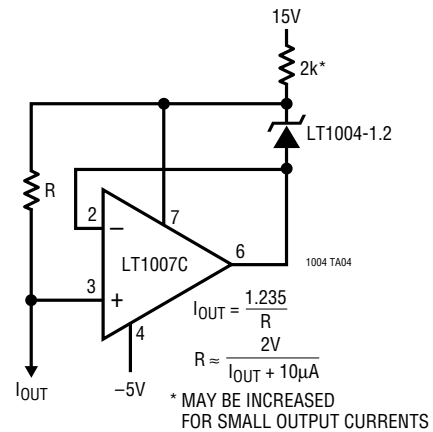
**Lead Acid Low Battery Detector**



1004 TA14

† R1 SETS TRIP POINT, 60.4k PER CELL FOR 1.8V/CELL

**Ground Referenced Current Source**



1004 TA04

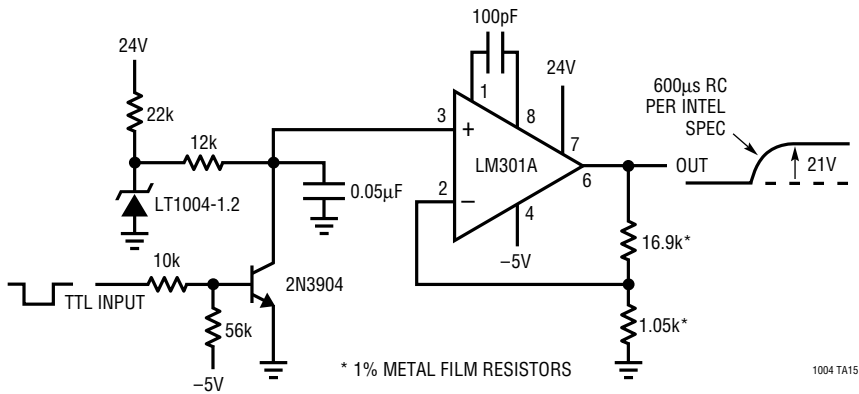
$$I_{OUT} = \frac{1.235}{R}$$

$$R = \frac{2V}{I_{OUT} + 10\mu A}$$

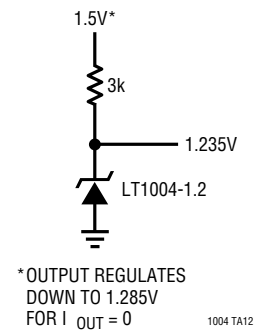
\* MAY BE INCREASED FOR SMALL OUTPUT CURRENTS

**TYPICAL APPLICATIONS**

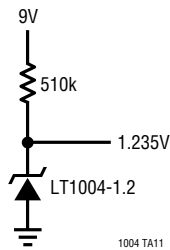
**VPP Generator for Eeproms — No Trim Required**



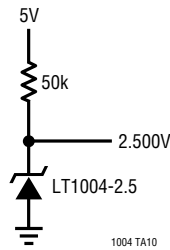
**1.2V Reference from 1.5V Battery**



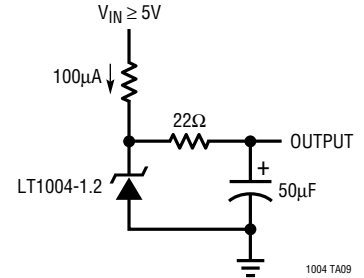
**Micropower Reference from 9V Battery**



**2.5V Reference**

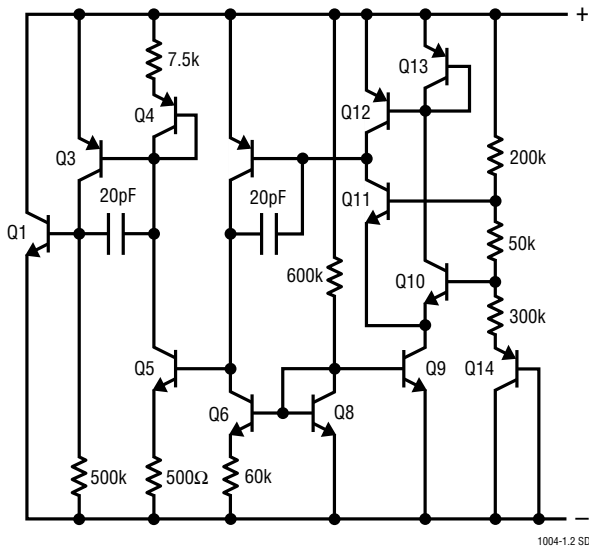


**Low Noise Reference**

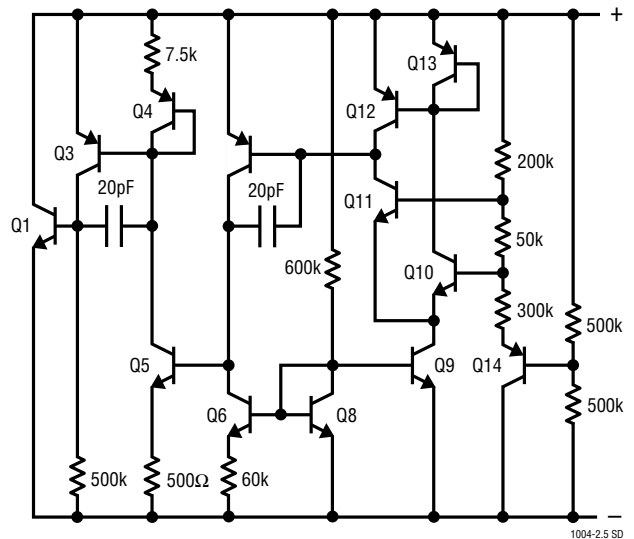


**SCHEMATIC DIAGRAMS**

**LT1004-1.2**

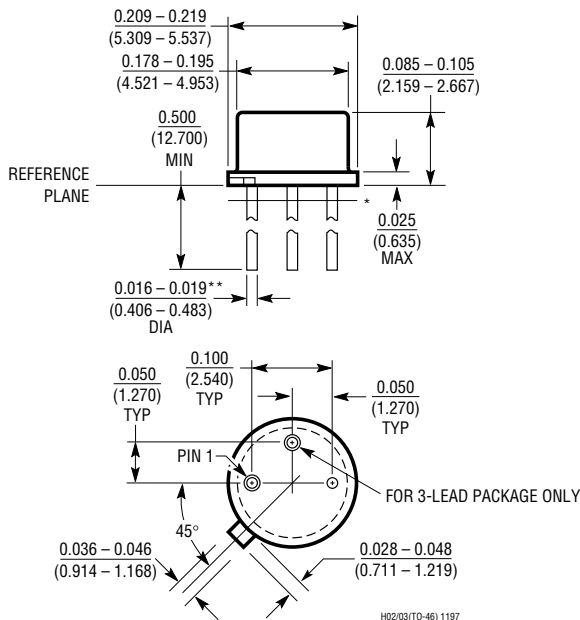


**LT1004-2.5**



**PACKAGE DESCRIPTION** Dimensions in inches (millimeters) unless otherwise noted.

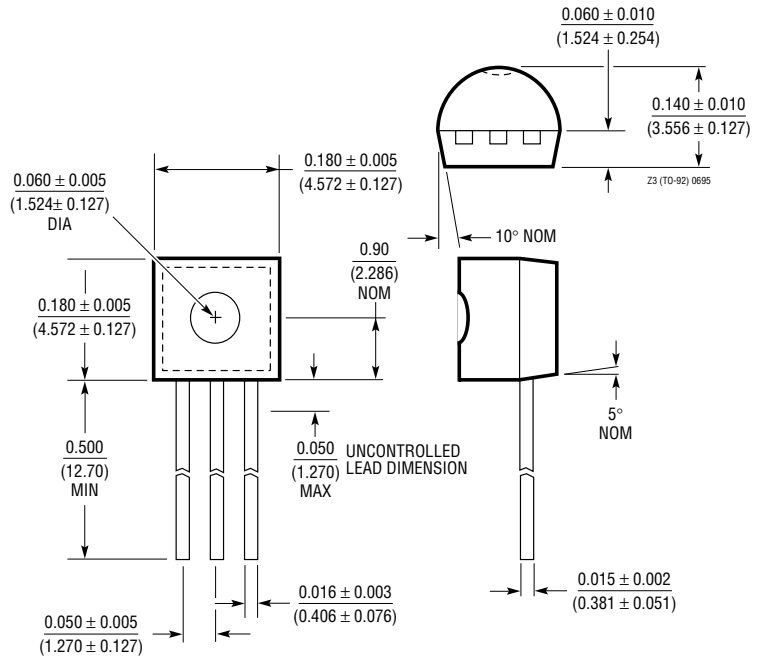
**H Package**  
**2-Lead and 3-Lead TO-46 Metal Can**  
 (LTC DWG # 05-08-1340)



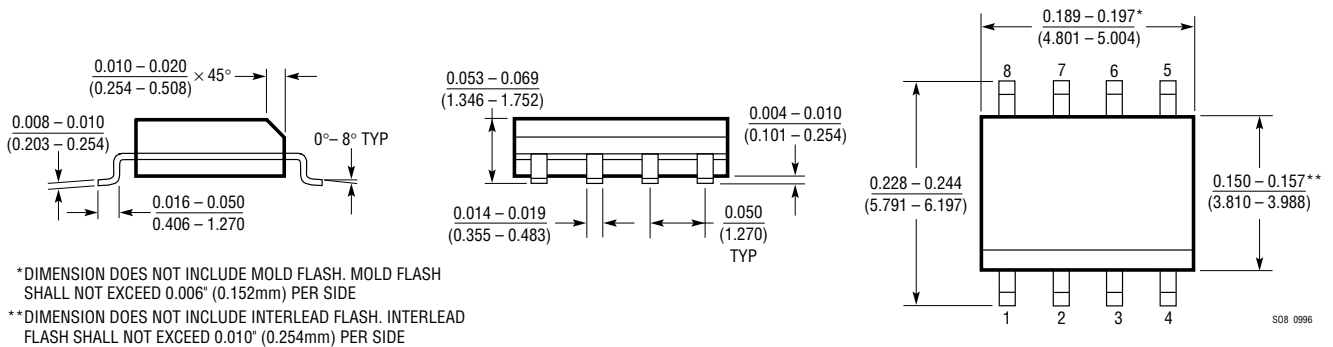
\*LEAD DIAMETER IS UNCONTROLLED BETWEEN THE REFERENCE PLANE AND 0.045" BELOW THE REFERENCE PLANE

\*\*FOR SOLDER DIP LEAD FINISH, LEAD DIAMETER IS  $\frac{0.016 - 0.024}{(0.406 - 0.610)}$

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



**S8 Package**  
**8-Lead Plastic Small Outline (Narrow 0.150)**  
 (LTC DWG # 05-08-1610)

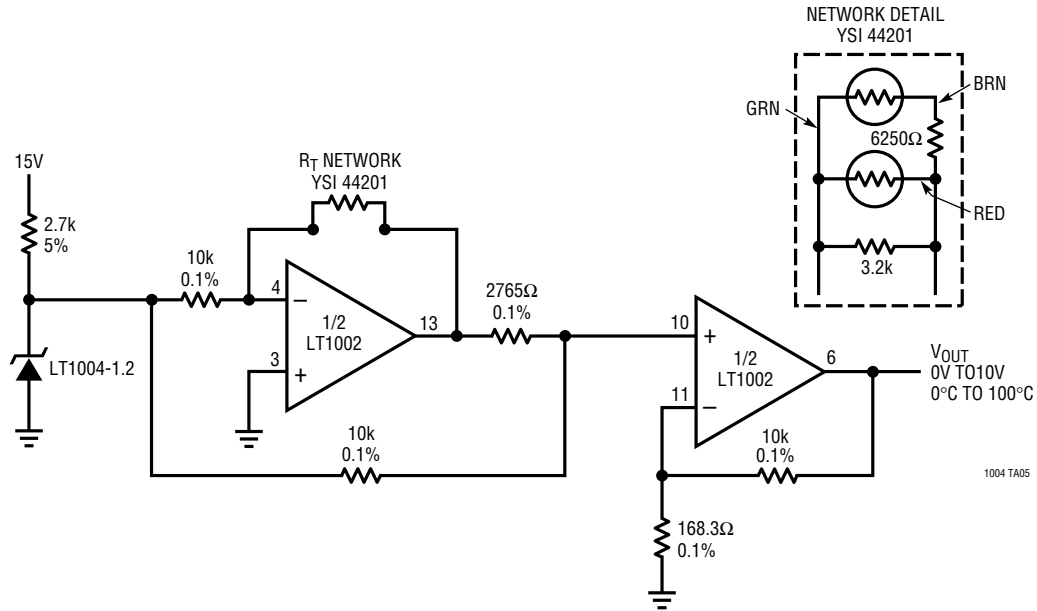


\*DIMENSION DOES NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.006" (0.152mm) PER SIDE

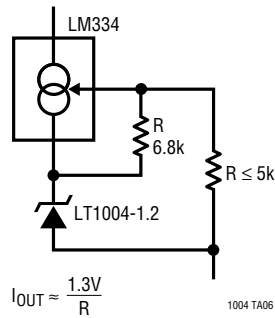
\*\*DIMENSION DOES NOT INCLUDE INTERLEAD FLASH. INTERLEAD FLASH SHALL NOT EXCEED 0.010" (0.254mm) PER SIDE

**TYPICAL APPLICATIONS**

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



**Low Temperature Coefficient  
2-Terminal Current Source**



**RELATED PARTS**

PART NUMBER	DESCRIPTION	COMMENTS
LT1634	Micropower Precision Shunt Reference	10µA Operating Current, 10ppm/°C Maximum Drift, 0.05% Initial Accuracy
LT1460S3-2.5	Micropower Series Reference in SOT-23	100µA Operating Current, 20ppm/°C Maximum Drift, 0.2% Initial Accuracy