

LT1004-1.2, LT1004-2.5 MICROPOWER INTEGRATED VOLTAGE REFERENCES

SLVS022I – JANUARY 1989 – REVISED JANUARY 2002

- **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

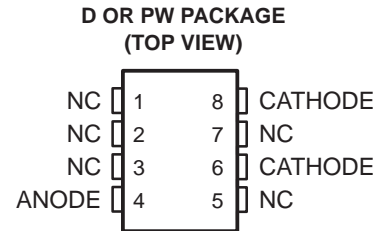
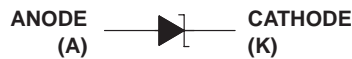
description

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 was previously attained at the expense of power consumption and trimming.

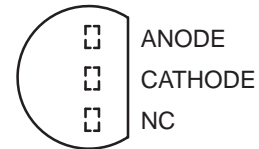
The LT1004C is characterized for operation from 0°C to 70°C. The LT1004I is characterized for operation from -40°C to 85°C.

symbol



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

**LP PACKAGE
(TOP VIEW)**



NC – No internal connection

AVAILABLE OPTIONS

T _A	V _Z TYP	PACKAGED DEVICES		
		SMALL OUTLINE (D)	PLASTIC THROUGH HOLE (LP)	PLASTIC THIN SHRINK SMALL OUTLINE (PW)
0°C to 70°C	1.2 V	LT1004CD-1.2	LT1004CLP-1.2	LT1004CPW-1.2
	2.5 V	LT1004CD-2.5	LT1004CLP-2.5	LT1004CPW-2.5
-40°C to 85°C	1.2 V	LT1004ID-1.2	LT1004ILP-1.2	LT1004IPW-1.2
	2.5 V	LT1004ID-2.5	—	LT1004IPW-2.5

For ordering purposes, the decimal point in the part number must be replaced with a hyphen (e.g., show the -1.2 suffix as -1-2 and the -2.5 suffix as -2-5). The D package is available taped and reeled. Add the R suffix to the device type (e.g., LT1004CDR-1-2). The PW package is only available taped and reeled.



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**

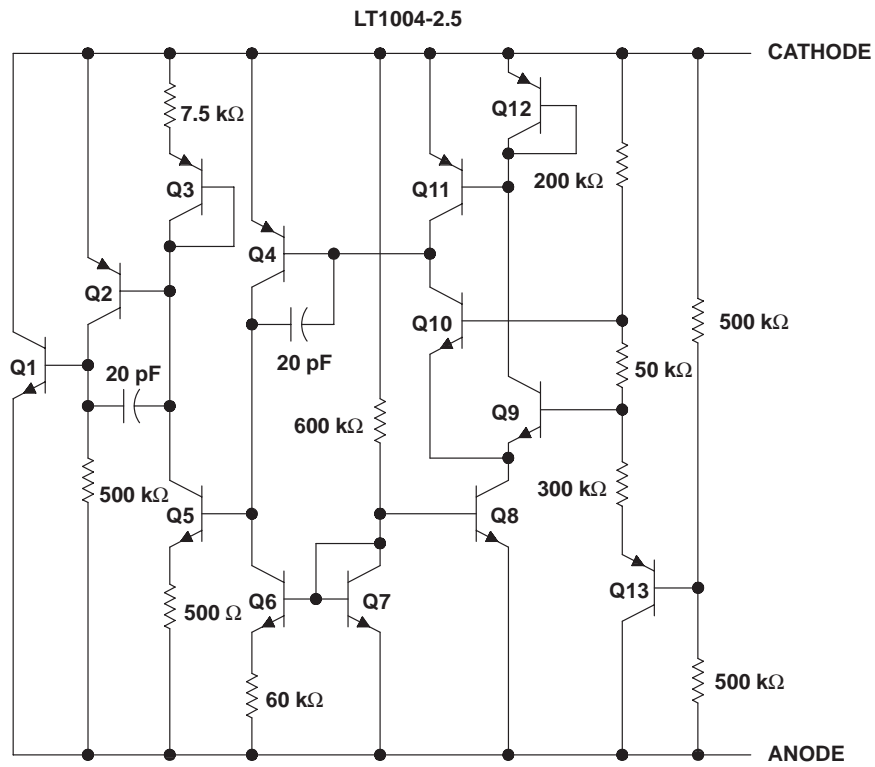
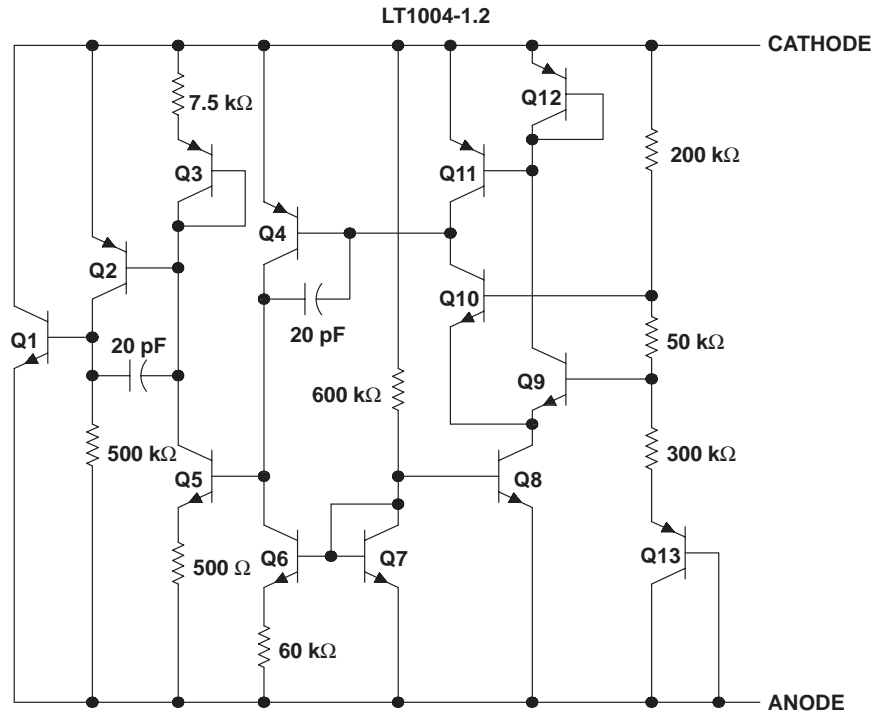
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schematic



NOTE A: All component values shown are nominal.



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absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Reverse current, I_R	30 mA
Forward current, I_F	10 mA
Package thermal impedance, θ_{JA} (see Notes 1 and 2): D package	97°C/W
LP package	156°C/W
PW package	149°C/W
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

† 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 $T_J(\max)$, θ_{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 ‡	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
α_{V_Z}	Average temperature coefficient of reference voltage§ $I_Z = 10 \mu A$ $I_Z = 20 \mu A$	25°C	20						ppm/°C	
						20				
ΔV_Z	Change in reference voltage with current $I_Z = I_Z(\min)$ to 1 mA $I_Z = 1$ mA to 20 mA	25°C	1			1			mV	
		Full range	1.5			1.5				
		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			μA	
z_Z	Reference impedance $I_Z = 100 \mu A$	25°C	0.2 0.6			0.2 0.6			Ω	
		Full range	1.5			1.5				
V_n	Broadband noise voltage $I_Z = 100 \mu A$, $f = 10$ Hz to 10 kHz	25°C	60			120			μV	

‡ Full range is 0°C to 70°C for the LT1004C and –40°C to 85°C for the LT1004I.

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



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TYPICAL CHARACTERISTICS

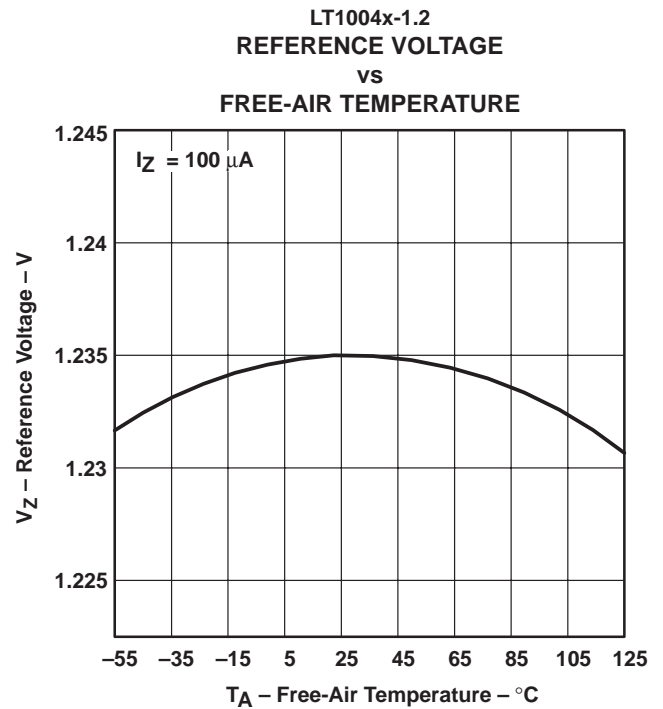
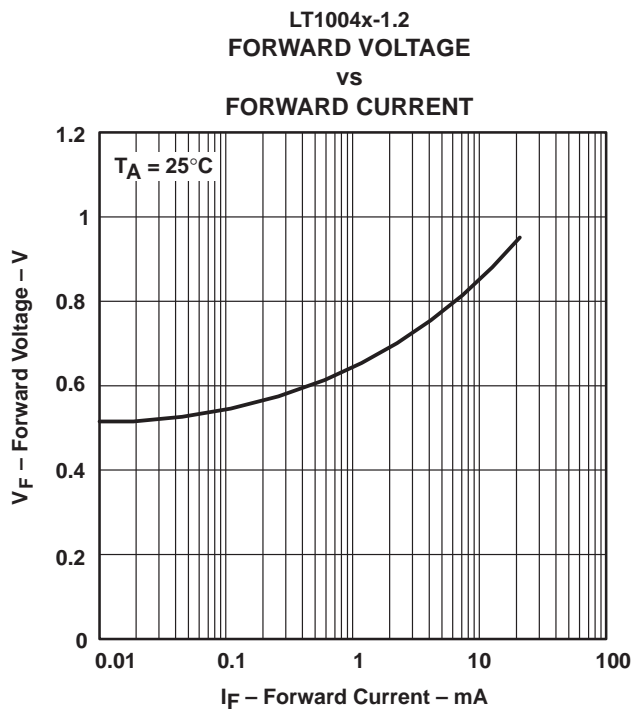
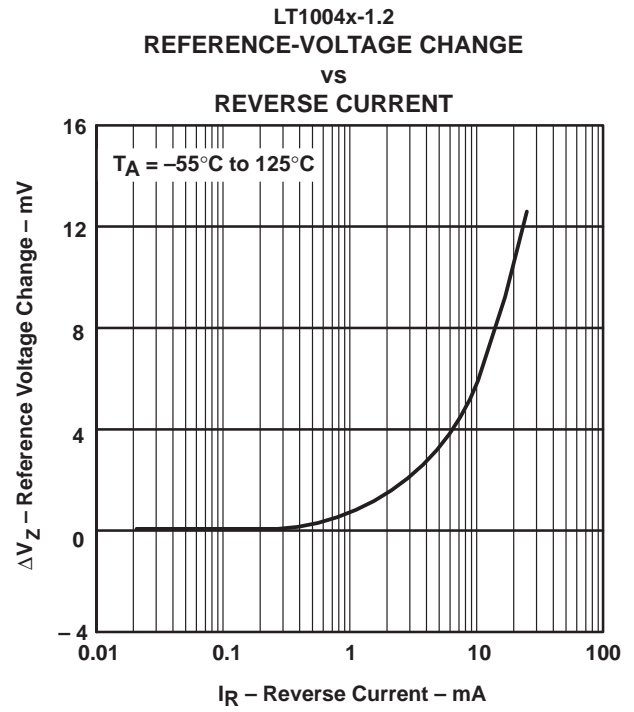
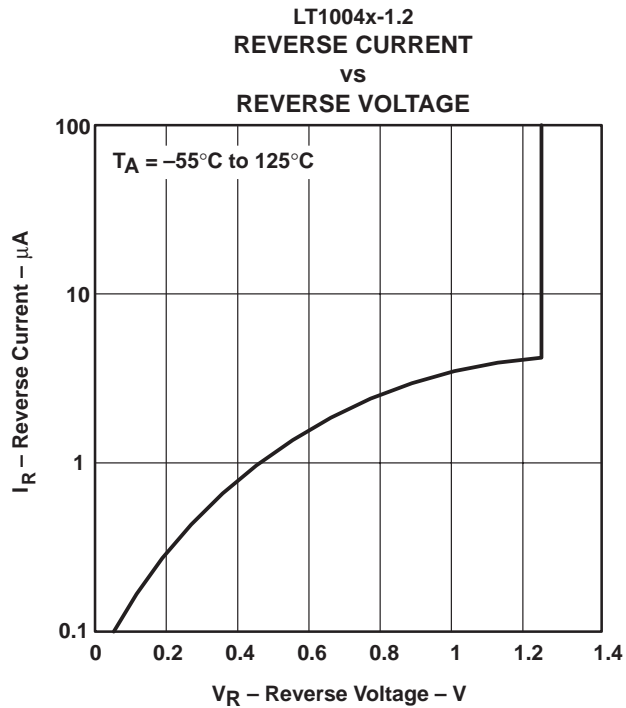
Table of Graphs

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Noise voltage vs Frequency	13
Filtered output noise voltage vs Cutoff frequency	14
Transient response	15



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TYPICAL CHARACTERISTICS†

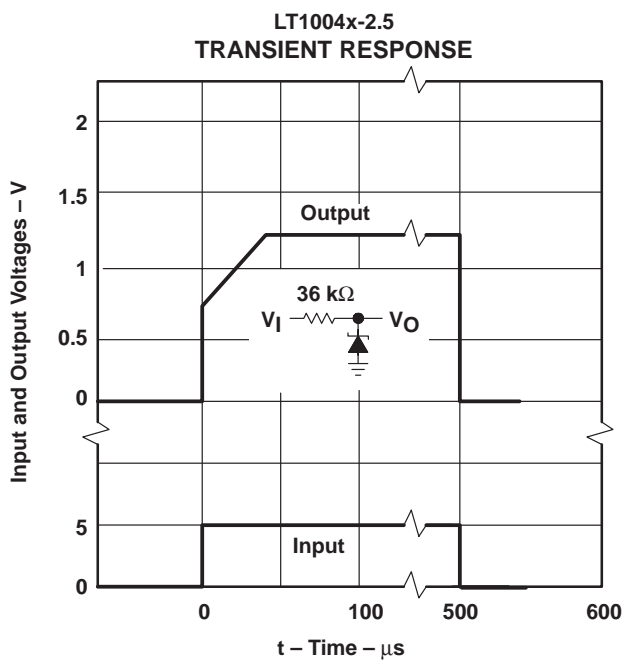
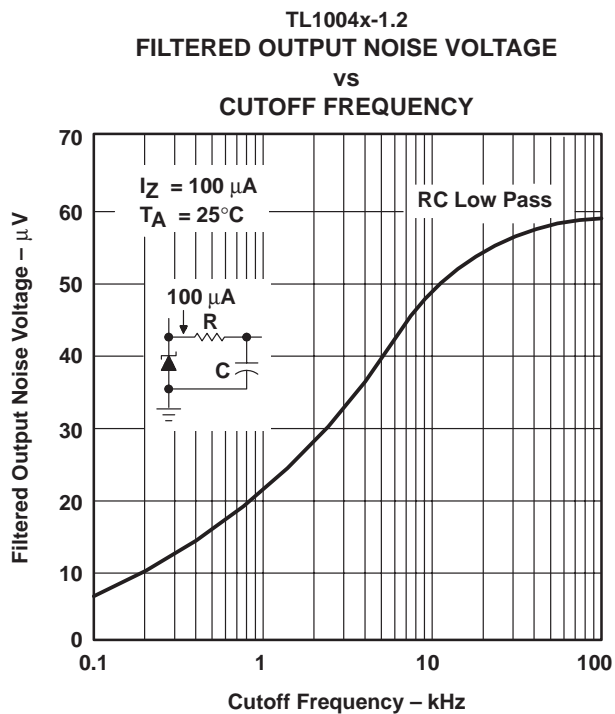
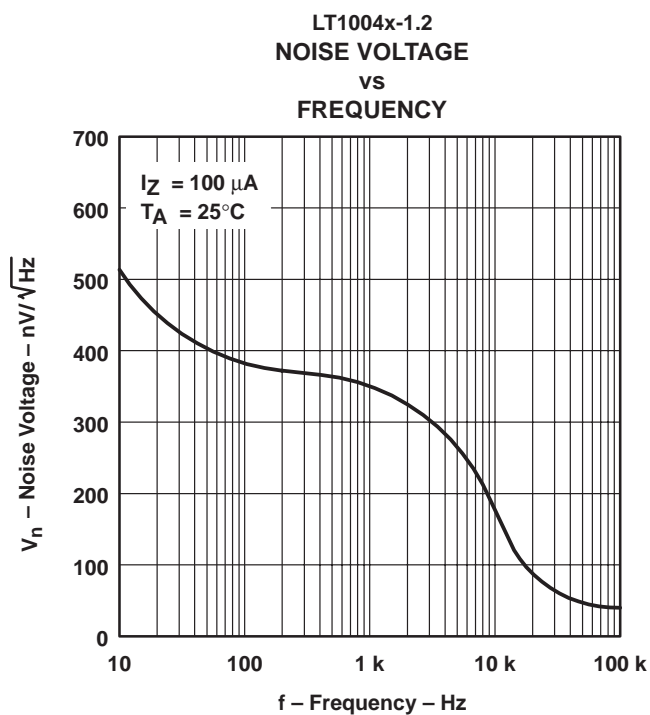
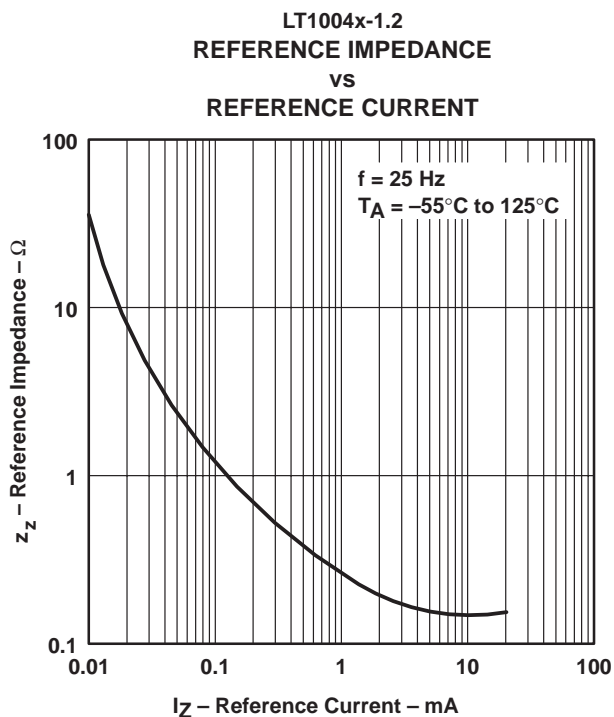


† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

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TYPICAL CHARACTERISTICS†

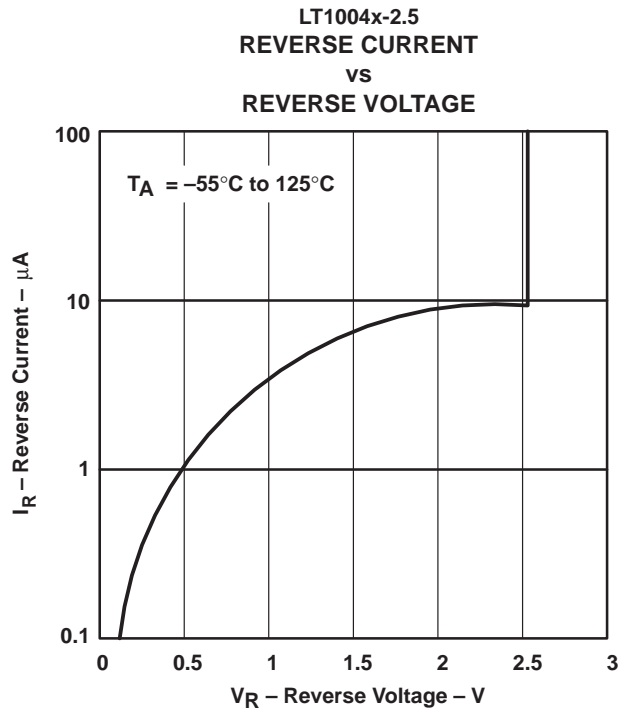


Figure 9

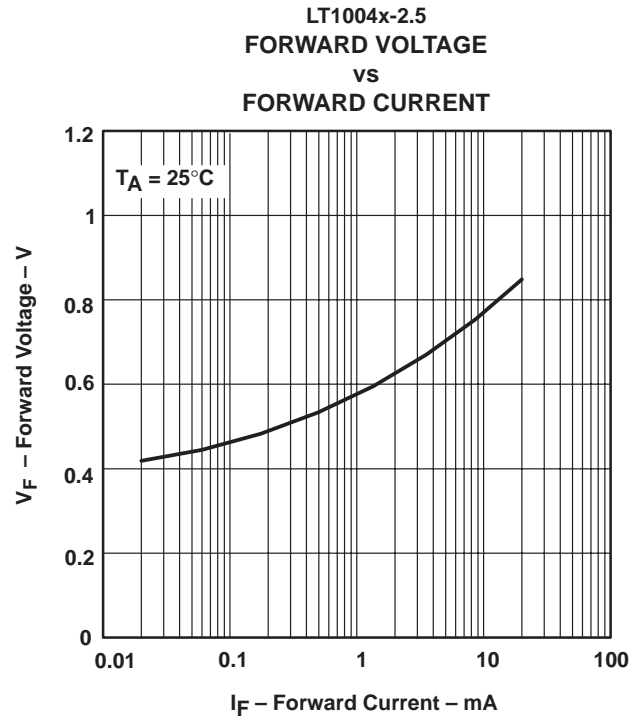


Figure 10

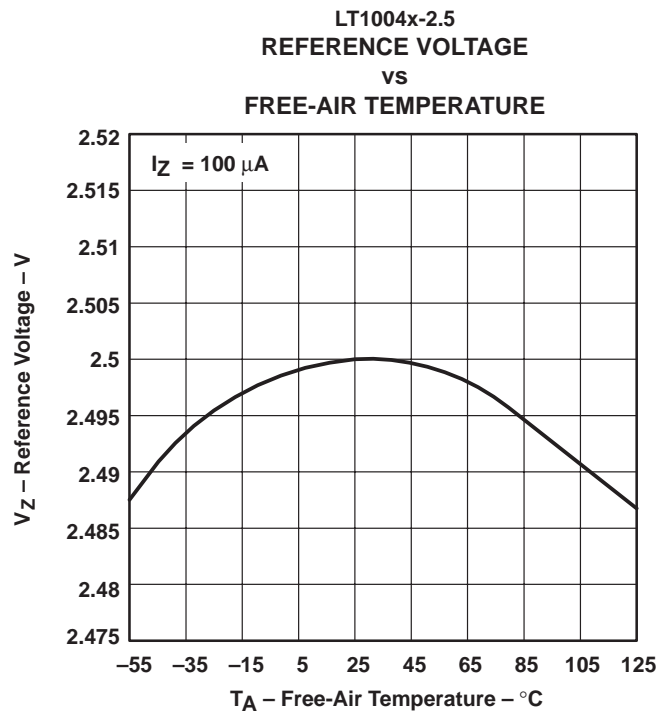


Figure 11

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

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TYPICAL CHARACTERISTICS†

LT1004x-2.5
REFERENCE IMPEDANCE
vs
REFERENCE CURRENT

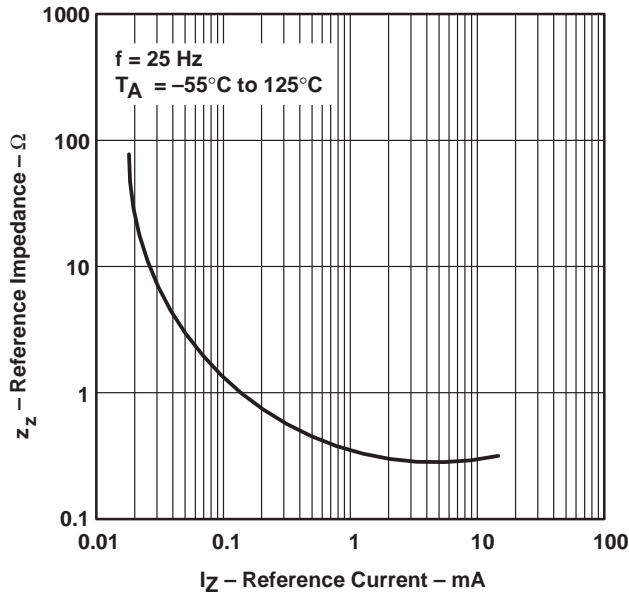


Figure 12

LT1004x-2.5
NOISE VOLTAGE
vs
FREQUENCY

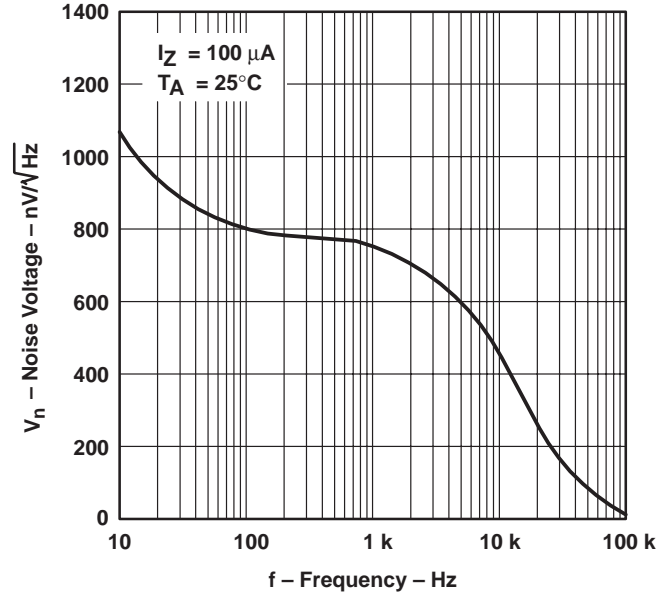


Figure 13

LT1004x-2.5
FILTERED OUTPUT NOISE VOLTAGE
vs
CUTOFF FREQUENCY

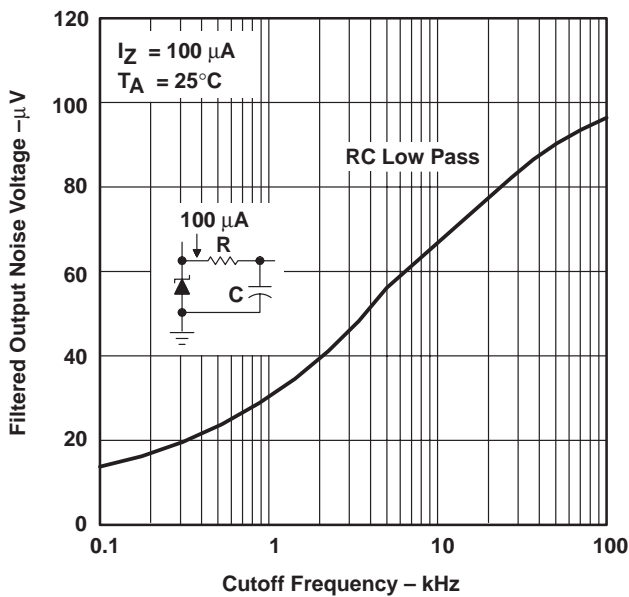


Figure 14

LT1004x-2.5
TRANSIENT RESPONSE

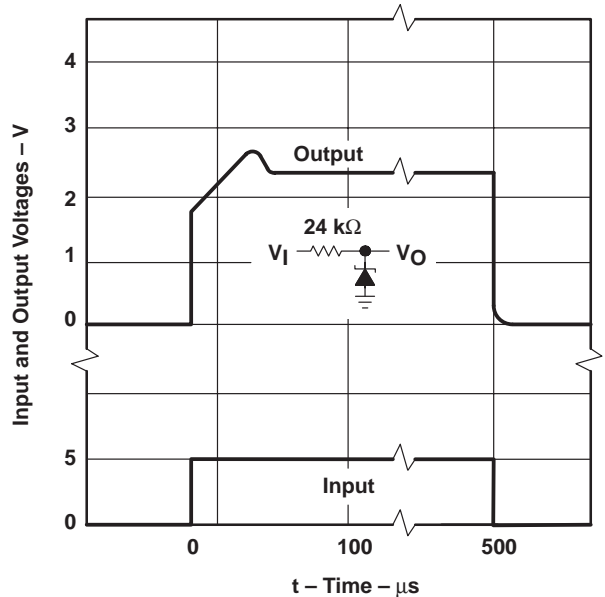
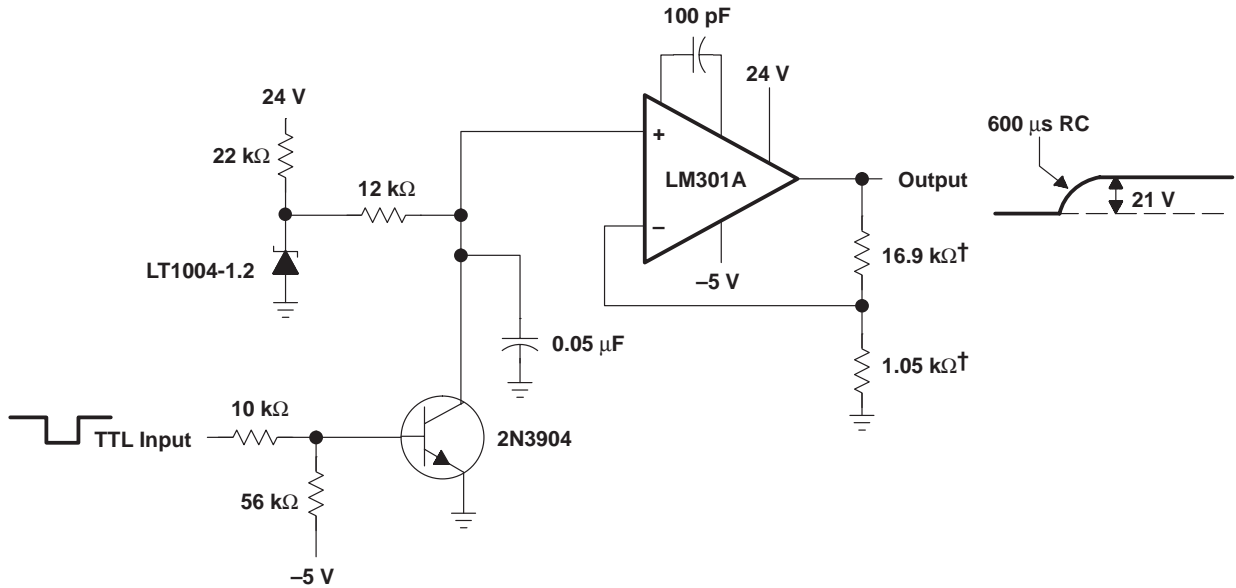


Figure 15

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

APPLICATION INFORMATION



† 1% metal-film resistors

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

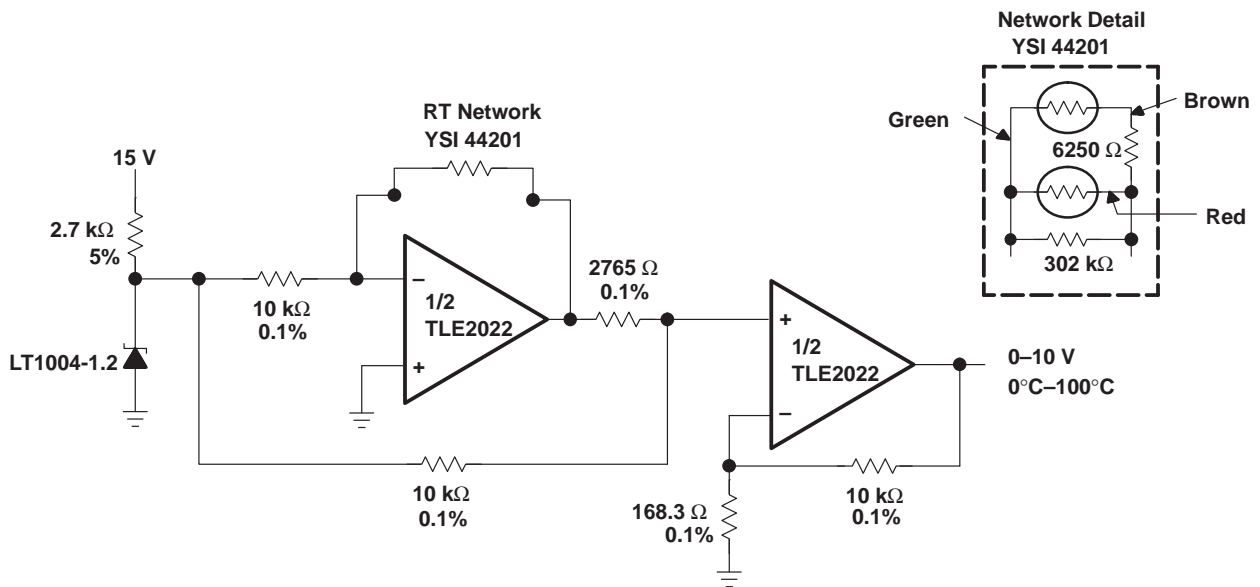


Figure 17. 0°C-to-100°C Linear-Output Thermometer

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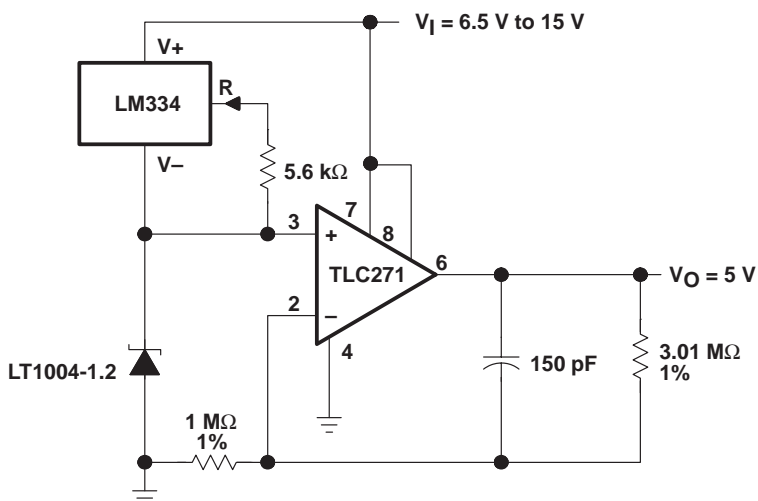


Figure 18. Micropower 5-V Reference

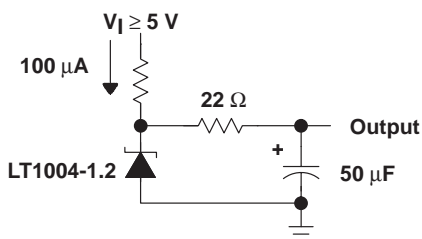


Figure 19. Low-Noise Reference

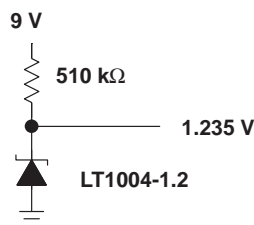
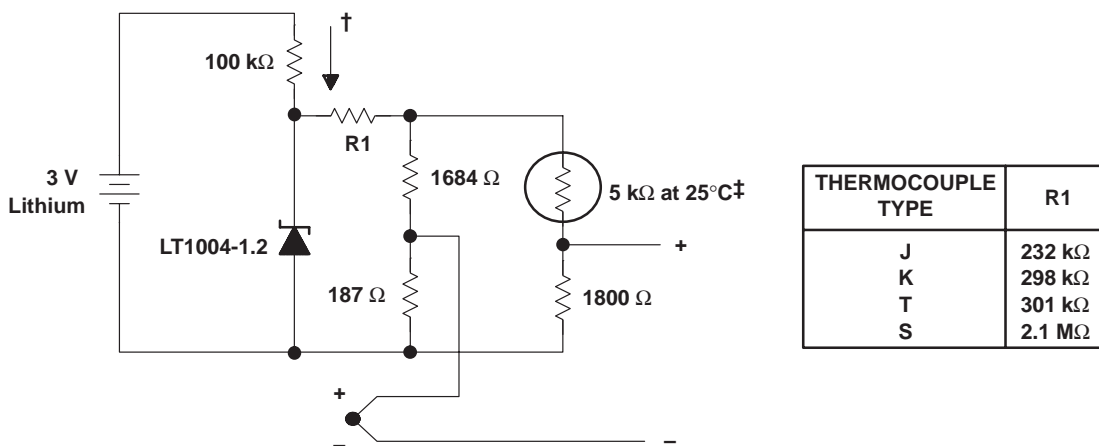


Figure 20. Micropower Reference From 9-V Battery



† 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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APPLICATION INFORMATION

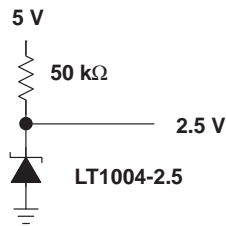


Figure 22. 2.5-V Reference

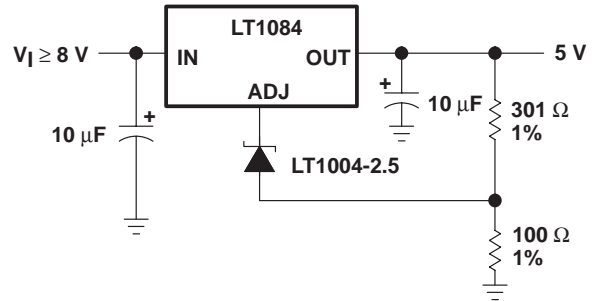
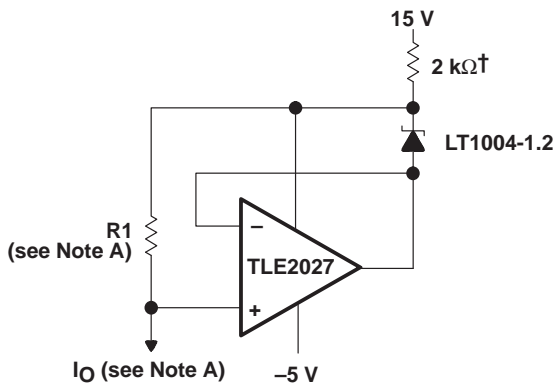


Figure 23. High-Stability 5-V Regulator



† 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

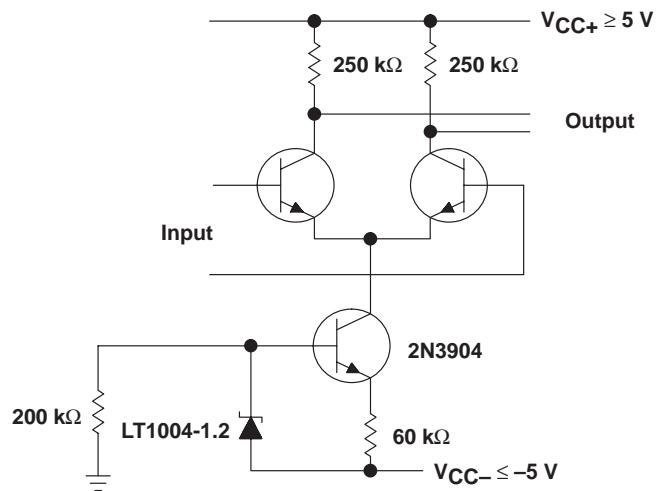
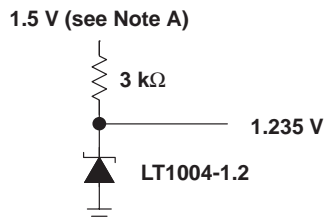


Figure 25. Amplifier With Constant Gain Over Temperature



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

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

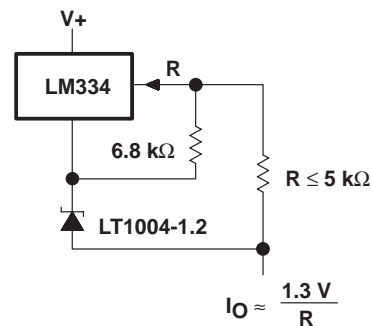
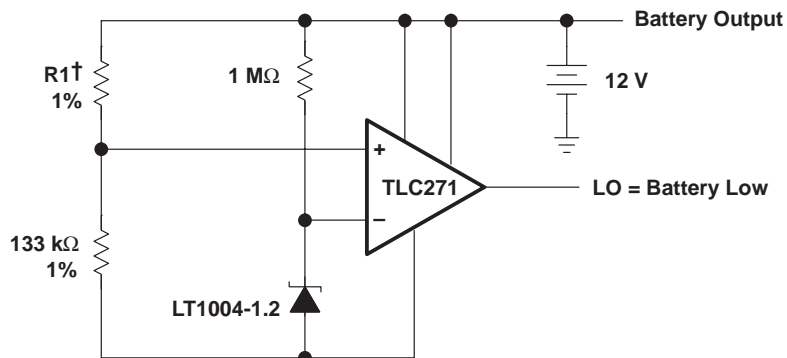


Figure 27. Terminal Current Source With Low Temperature Coefficient

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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

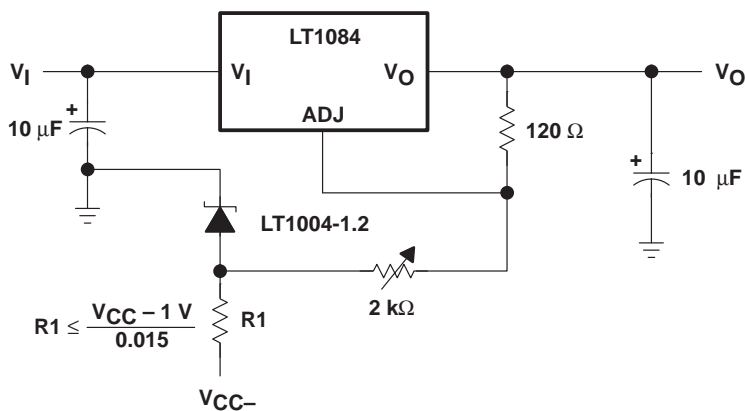


Figure 29. Variable-Voltage Supply

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