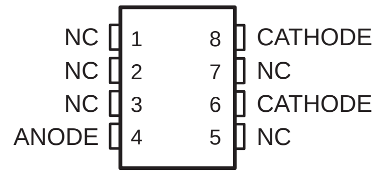
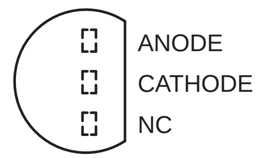
- **Initial Accuracy**
  - **±4 mV for LT1004-1.2**
  - **±20 mV for LT1004-2.5**
- **Micropower Operation**
- **Operates up to 20 mA**
- **Very Low Reference Impedance**
- **Applications:**
  - **Portable Meter Reference**
  - **Portable Test Instruments**
  - **Battery-Operated Systems**
  - **Current-Loop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

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

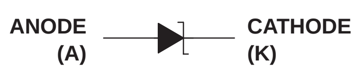
description

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



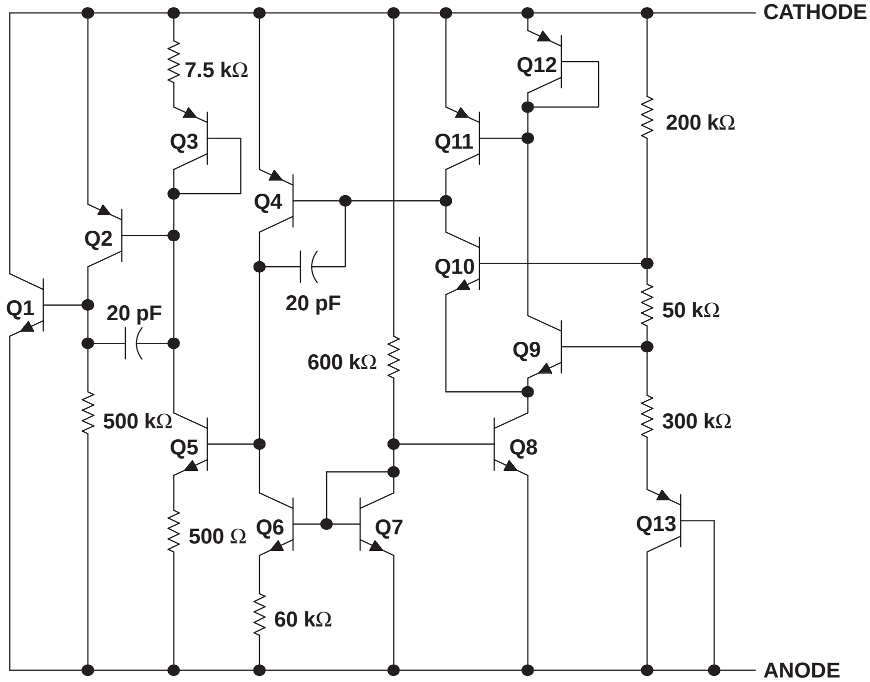
AVAILABLE OPTIONS

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

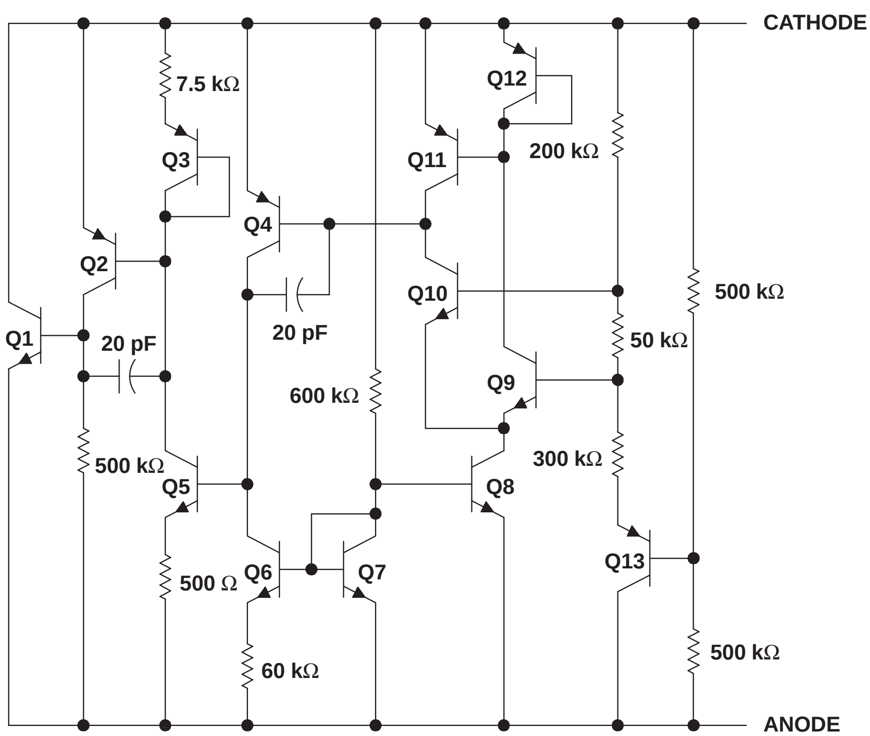
For ordering purposes, the decimal point in the part number must be replaced with a hyphen (e.g., show the -1.2 suffix as -1-2 and the -2.5 suffix as -2-5). The D package is available taped and reeled. Add the R suffix to the device type (e.g., LT1004CDR-1-2). The PW package is only available taped and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

schematic

LT1004-1.2



LT1004-2.5



NOTE A: All component values shown are nominal.

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 MIN	LT1004-1.2 TYP	LT1004-1.2 MAX	LT1004-2.5 MIN	LT1004-2.5 TYP	LT1004-2.5 MAX	UNIT
V_Z	Reference voltage	I_Z = 100 µA	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 µA	25°C			20					ppm/°C
		I_Z = 20 µA							20		
ΔV_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 µA	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 µA	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 µA, 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.

TYPICAL CHARACTERISTICS

Table of Graphs

GRAPH TITLE	FIGURE
LT1004x-1.2	
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
LT1004x-2.5	
Transient response	8
Reverse current vs Reverse voltage	9
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Noise voltage vs Frequency	13
Filtered output noise voltage vs Cutoff frequency	14
Transient response	15

TYPICAL CHARACTERISTICS†

LT1004x-1.2
REVERSE CURRENT vs REVERSE VOLTAGE

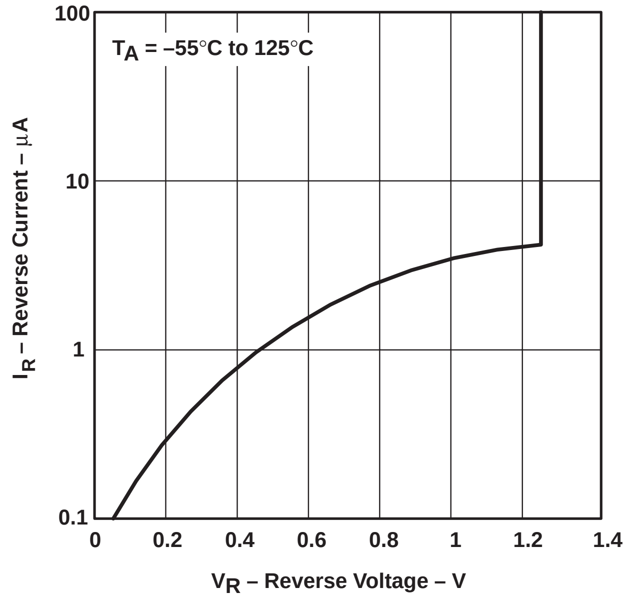


Figure 1

LT1004x-1.2
REFERENCE-VOLTAGE CHANGE vs REVERSE CURRENT

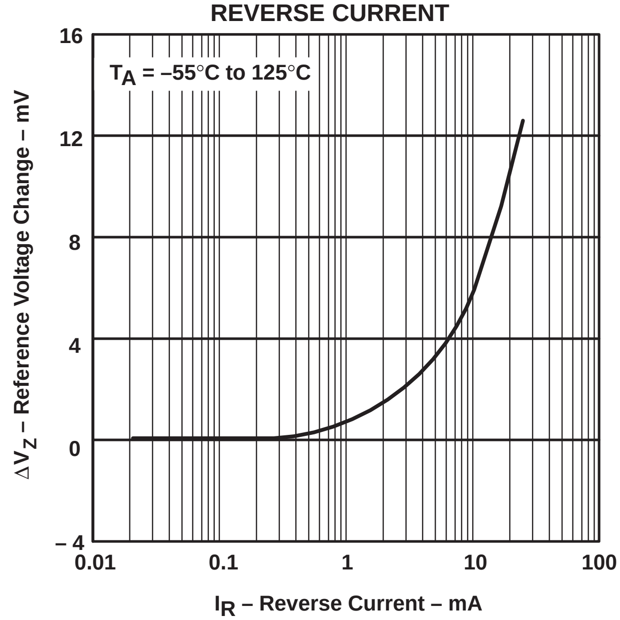


Figure 2

LT1004x-1.2
FORWARD VOLTAGE vs FORWARD CURRENT

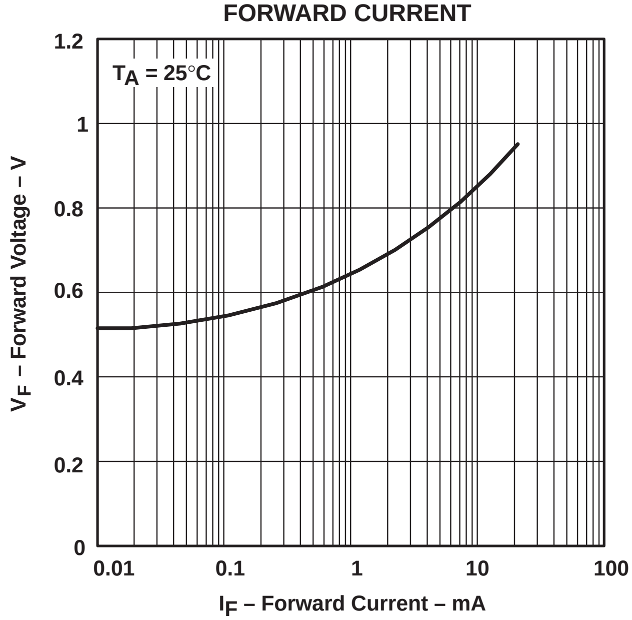


Figure 3

LT1004x-1.2
REFERENCE VOLTAGE vs FREE-AIR TEMPERATURE

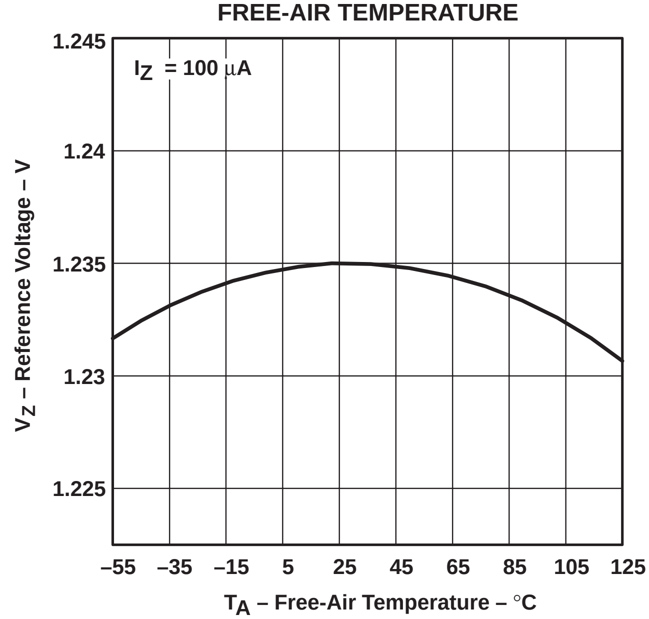


Figure 4

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

TYPICAL CHARACTERISTICS†

LT1004x-1.2
REFERENCE IMPEDANCE vs REFERENCE CURRENT

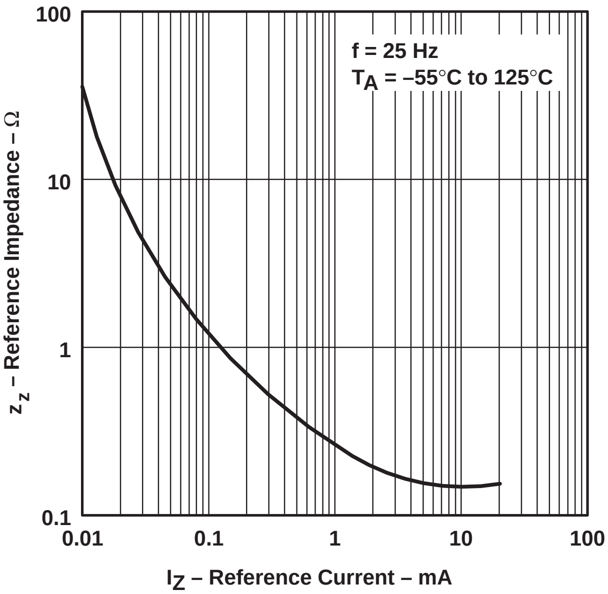


Figure 5

LT1004x-1.2
NOISE VOLTAGE vs FREQUENCY

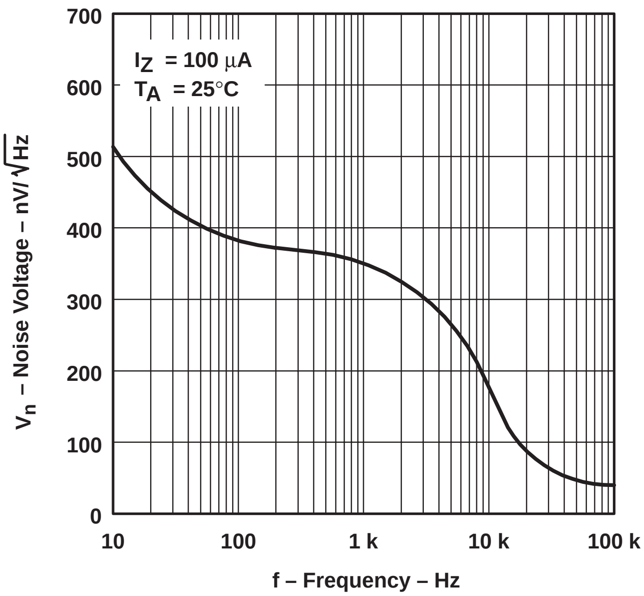


Figure 6

TL1004x-1.2
FILTERED OUTPUT NOISE VOLTAGE vs CUTOFF FREQUENCY

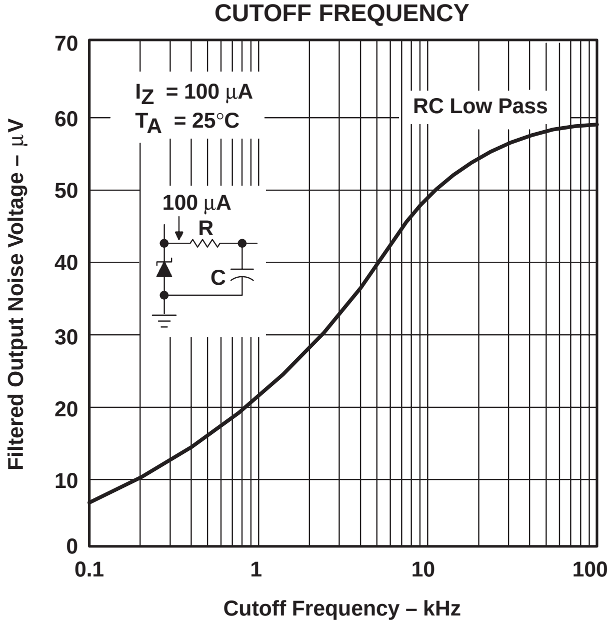


Figure 7

LT1004x-2.5
TRANSIENT RESPONSE

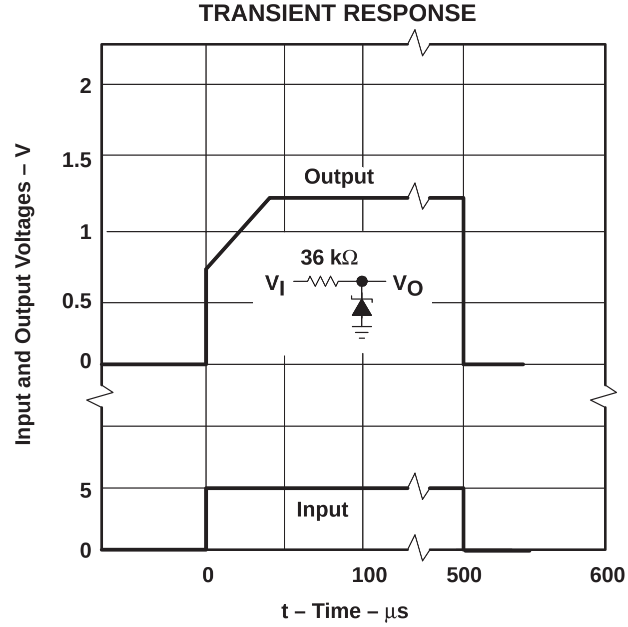


Figure 8

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

TYPICAL CHARACTERISTICS†

LT1004x-2.5
REVERSE CURRENT
vs
REVERSE VOLTAGE

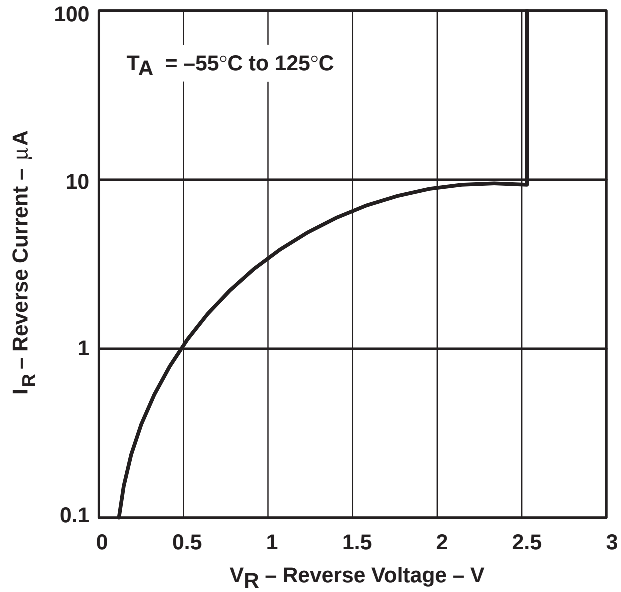


Figure 9

LT1004x-2.5
FORWARD VOLTAGE
vs
FORWARD CURRENT

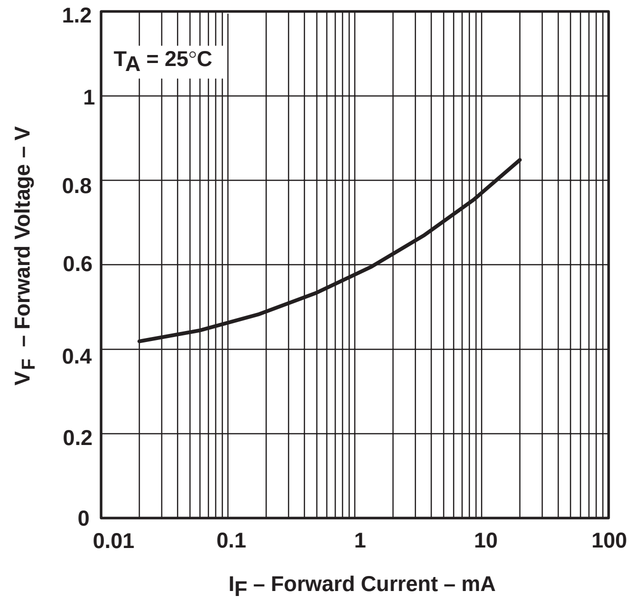


Figure 10

LT1004x-2.5
REFERENCE VOLTAGE
vs
FREE-AIR TEMPERATURE

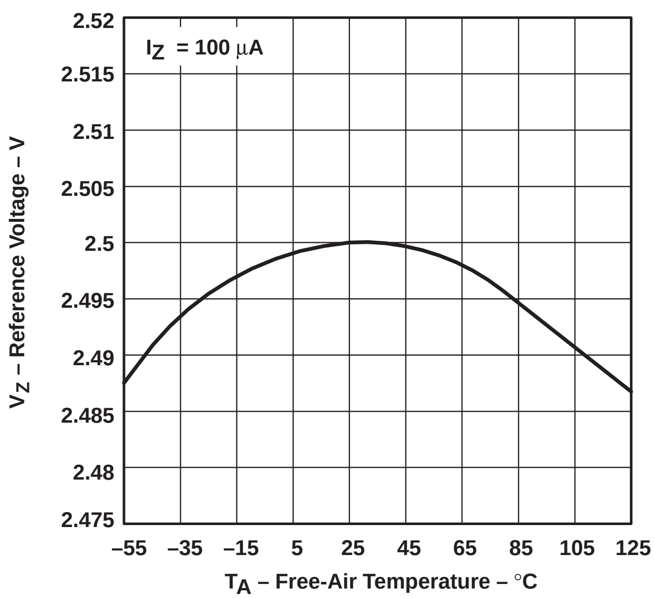


Figure 11

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

TYPICAL CHARACTERISTICS†

LT1004x-2.5
REFERENCE IMPEDANCE
vs
REFERENCE CURRENT

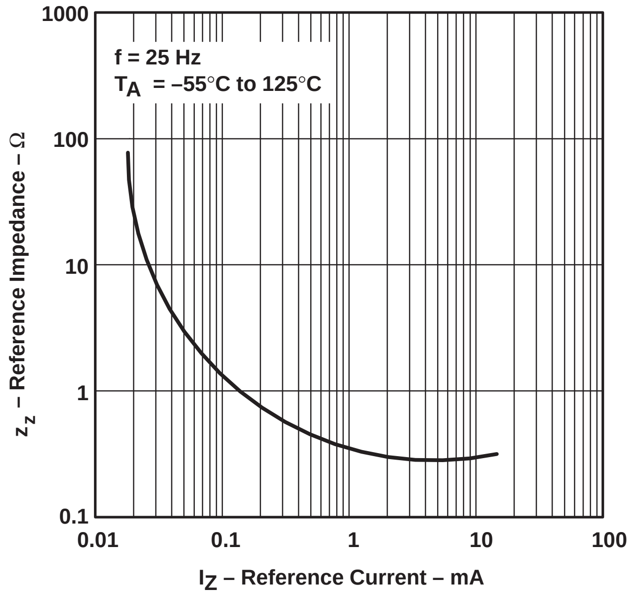


Figure 12

LT1004x-2.5
NOISE VOLTAGE
vs
FREQUENCY

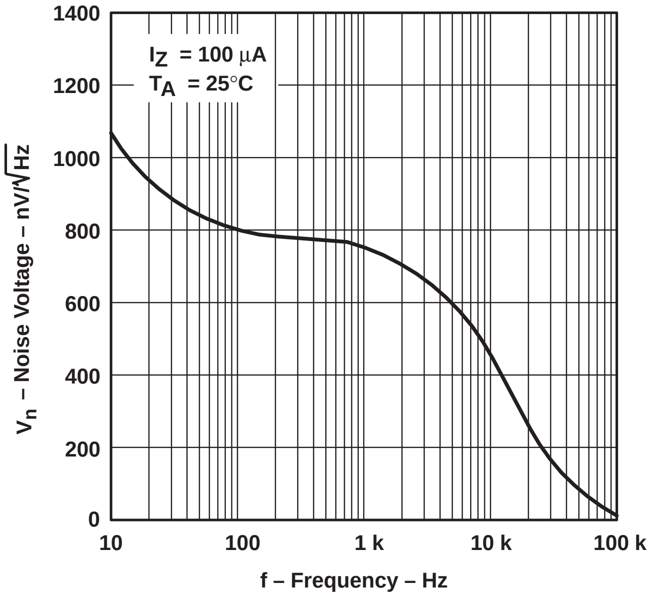


Figure 13

TL1004x-2.5
FILTERED OUTPUT NOISE VOLTAGE
vs
CUTOFF FREQUENCY

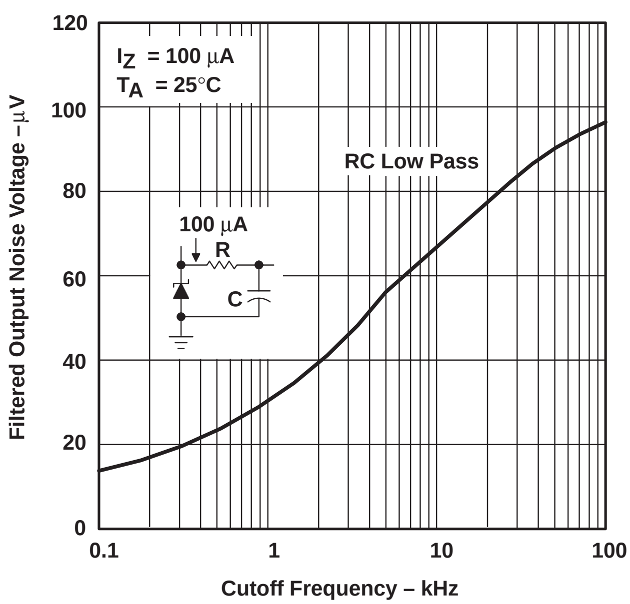


Figure 14

LT1004x-2.5
TRANSIENT RESPONSE

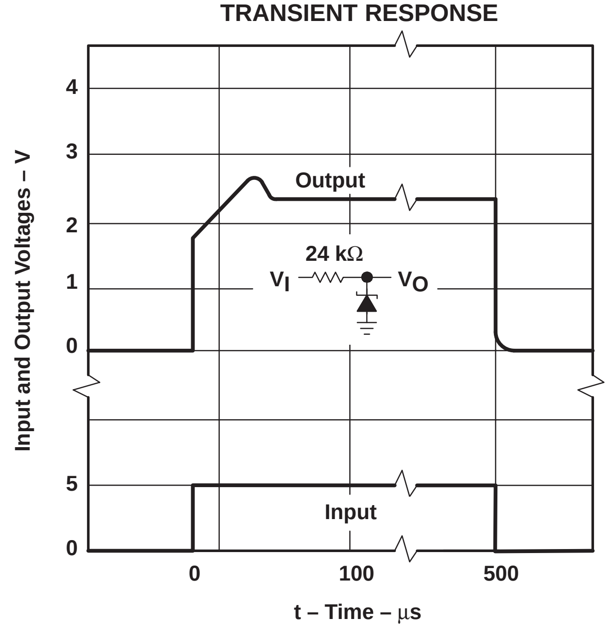
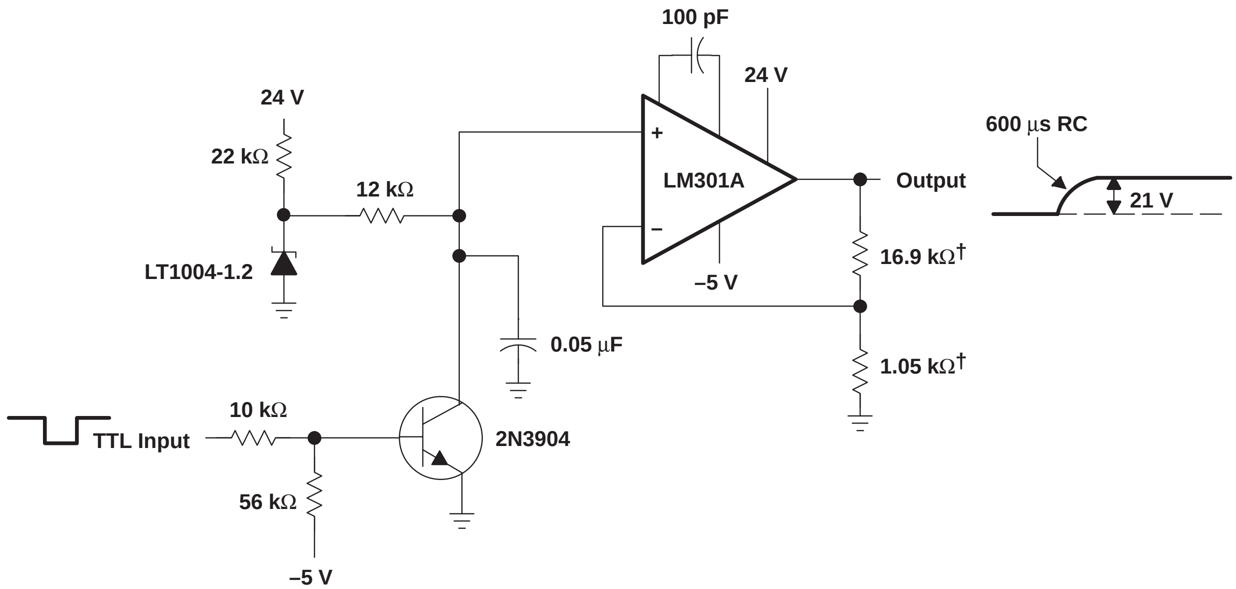


Figure 15

† 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)

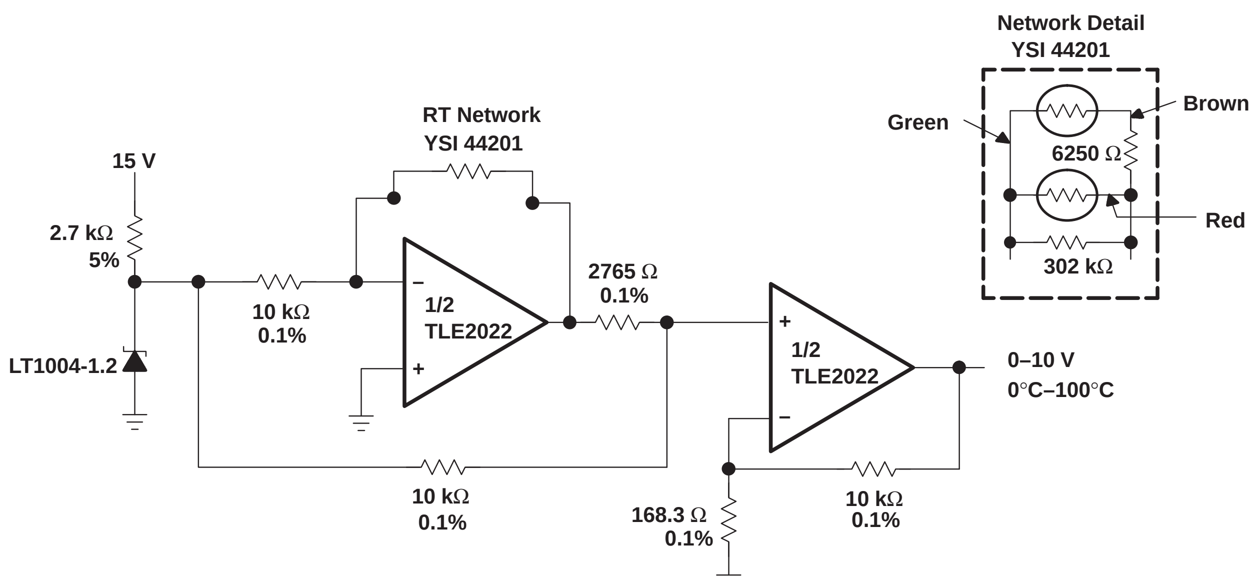


Figure 17. 0°C-to-100°C Linear-Output Thermometer

APPLICATION INFORMATION

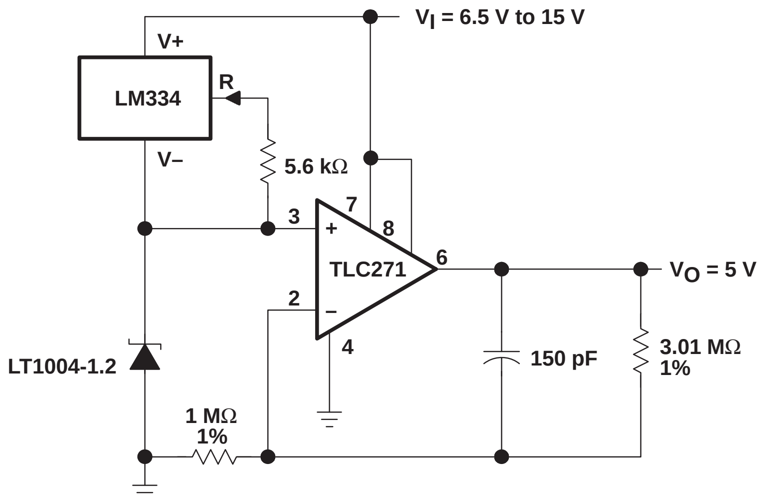


Figure 18. Micropower 5-V Reference

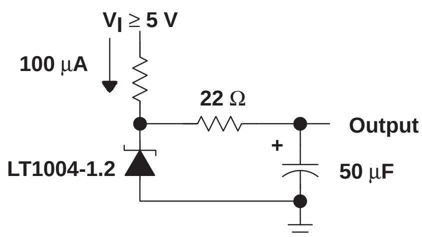


Figure 19. Low-Noise Reference

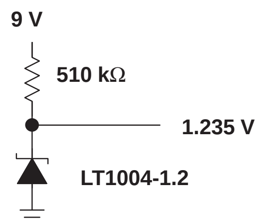
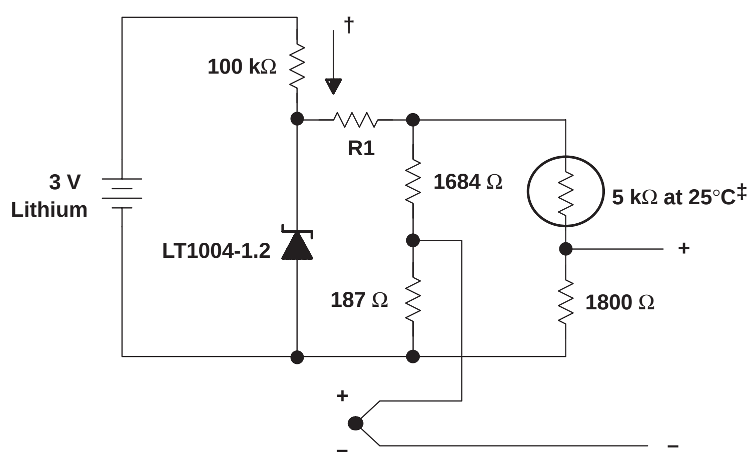


Figure 20. Micropower Reference From 9-V Battery



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

† Quiescent current ≅ 15 µA
‡ Yellow Springs Inst. Co., Part #44007
NOTE A: This application compensates within ±1°C from 0°C to 60°C.

Figure 21. Micropower Cold-Junction Compensation for Thermocouples

APPLICATION INFORMATION

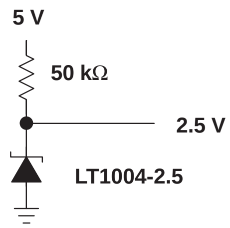


Figure 22. 2.5-V Reference

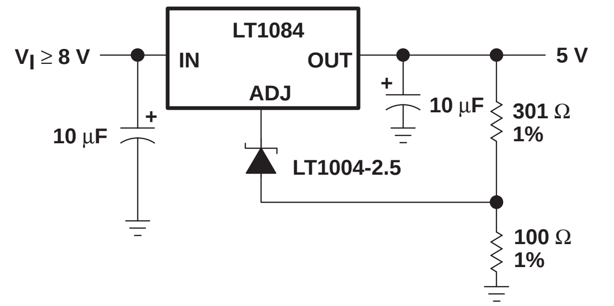
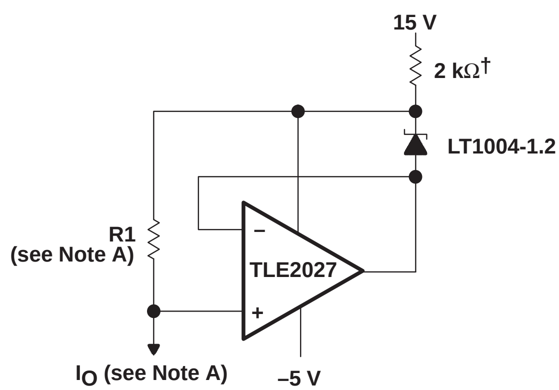


Figure 23. High-Stability 5-V Regulator



† May be increased for small output currents

NOTE A: $R1 \approx \frac{2\ V}{I_O + 10\ \mu A}$, $I_O = \frac{1.235\ V}{R1}$

Figure 24. Ground-Referenced Current Source

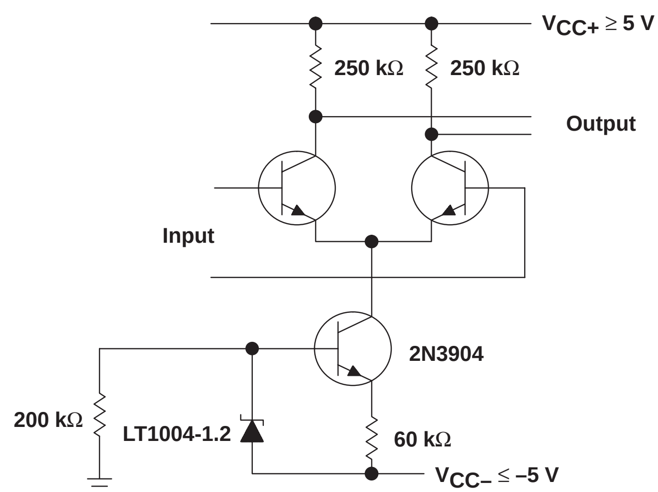
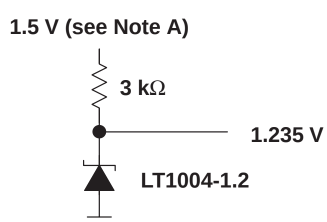
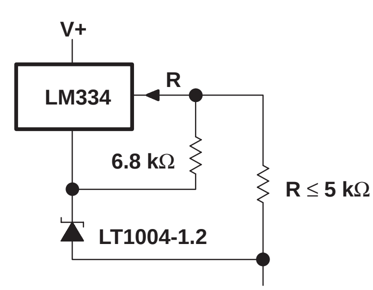


Figure 25. Amplifier With Constant Gain Over Temperature



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

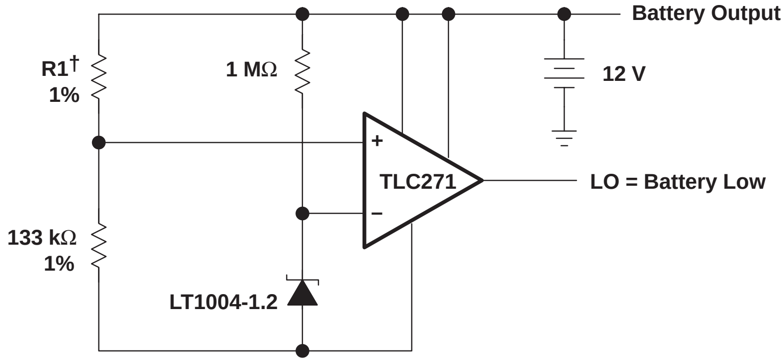
Figure 26. 1.2-V Reference From 1.5-V Battery



$I_O \approx \frac{1.3\ V}{R}$

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

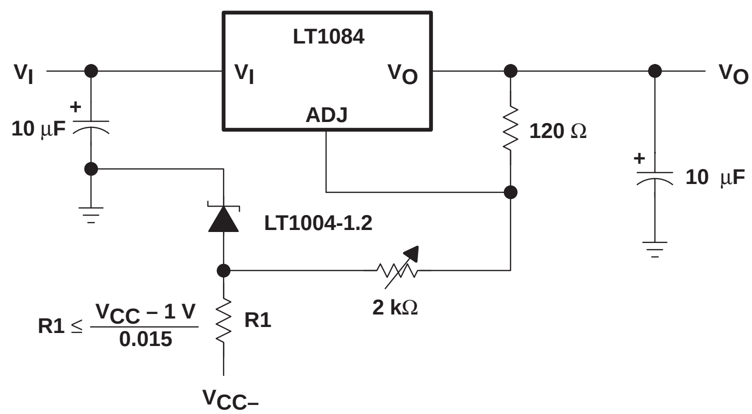


Figure 29. Variable-Voltage Supply

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