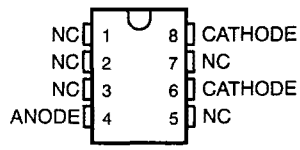
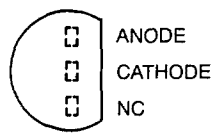
D3190, JANUARY 1989–REVISED JULY 1991

- **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**

LT1004C . . . D PACKAGE
(TOP VIEW)



LT1004C . . . LP PACKAGE
(TOP VIEW)

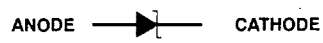


NC–No internal connection

description

The LT1004 micropower voltage reference is a 2-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.

symbol



The LT1004 is a pin-for-pin replacement for the LM185 series of references with improved specifications. The LT1004 is an attractive 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 LT1004M is characterized for operation over the full military temperature range of −55°C to 125°C.

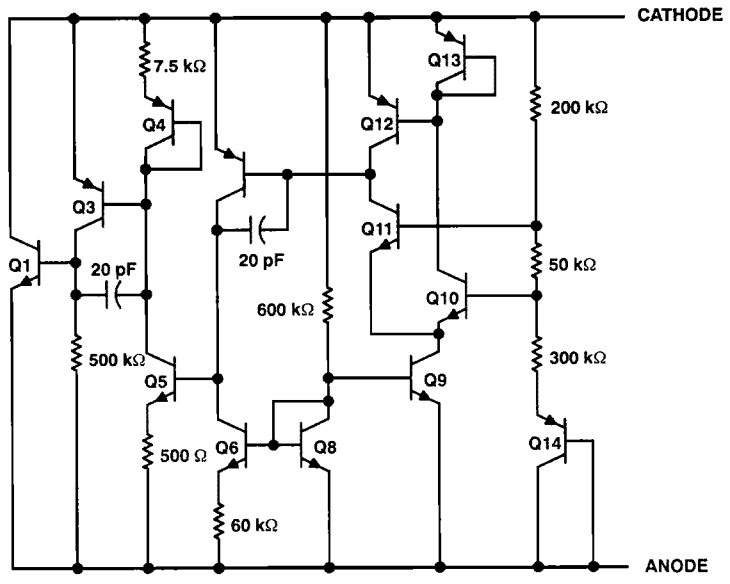
AVAILABLE OPTIONS

T_A	NOM V_Z	PACKAGE	
		SMALL OUTLINE (D)	PLASTIC (LP)
0°C to 70°C	1.2 V	LT1004CD-1.2	LT1004CLP-1.2
	2.5 V	LT1004CD-2.5	LT1004CLP-2.5
−55°C to 125°C	1.2 V	LT1004MD-1.2	LT1004MLP-1.2
	2.5 V	LT1004MD-2.5	LT1004MLP-2.5

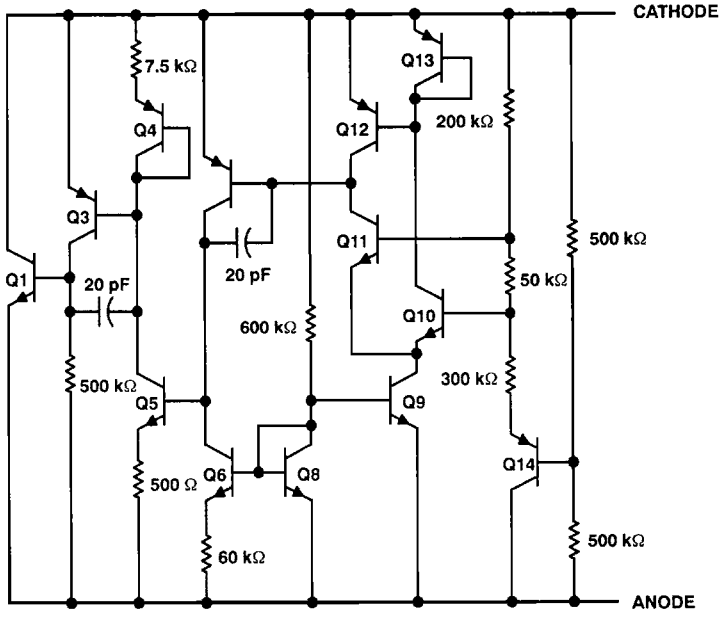
The D and LP packages are available taped and reeled. Add suffix R to the device type (i.e., LT1004CDR).

schematic

LT1004-1.2



LT1004-2.5



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
Operating free-air temperature range: LT1004C ..... 0°C to 70°C
LT1004M ..... −55°C to 125°C
Storage temperature range ..... −65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds ..... 260°C

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 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	
				LT1004M	1.22		1.245	2.46		2.535	
α_{VZ}	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 −55°C to 125°C for the LT1004M.
‡ The average temperature coefficient of reference voltage is defined as the total change in reference voltage divided by the specified temperature range.

TYPICAL CHARACTERISTICS†

REVERSE CURRENT
vs
REVERSE VOLTAGE

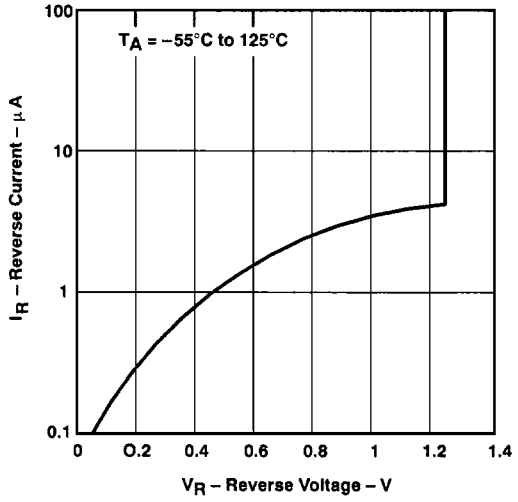


Figure 1

REFERENCE VOLTAGE CHANGE
vs
REVERSE CURRENT

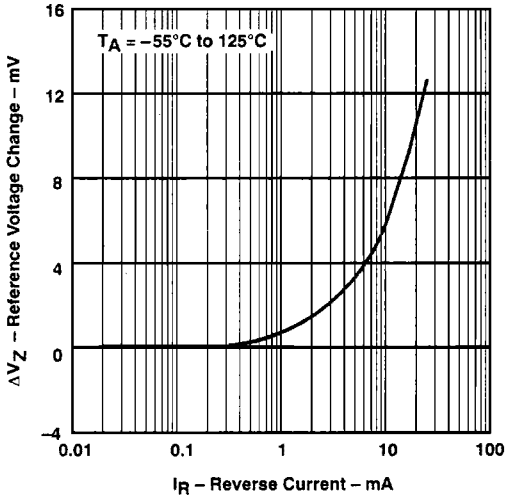


Figure 2

FORWARD VOLTAGE
vs
FORWARD CURRENT

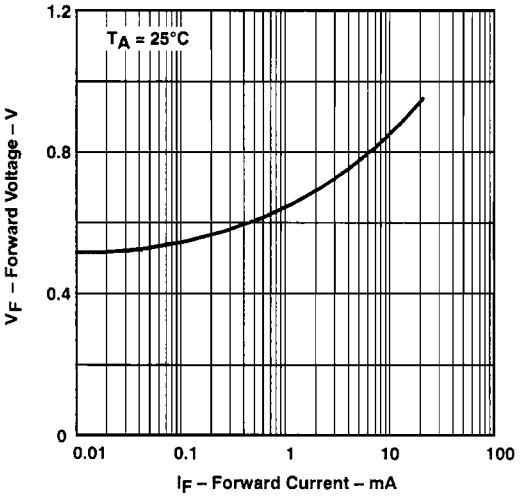


Figure 3

REFERENCE VOLTAGE
vs
FREE-AIR TEMPERATURE

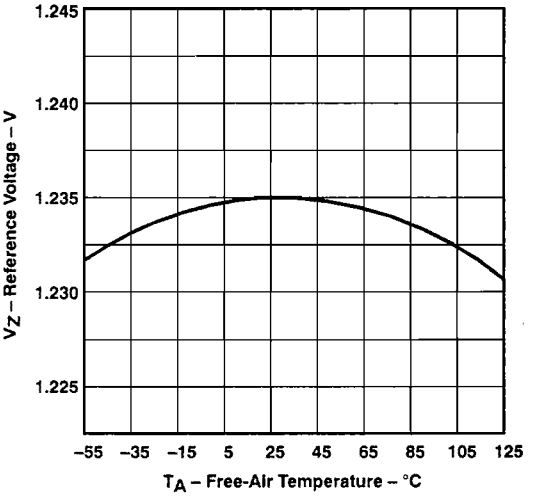


Figure 4

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

TYPICAL CHARACTERISTICS†

REFERENCE IMPEDANCE
vs
REFERENCE CURRENT

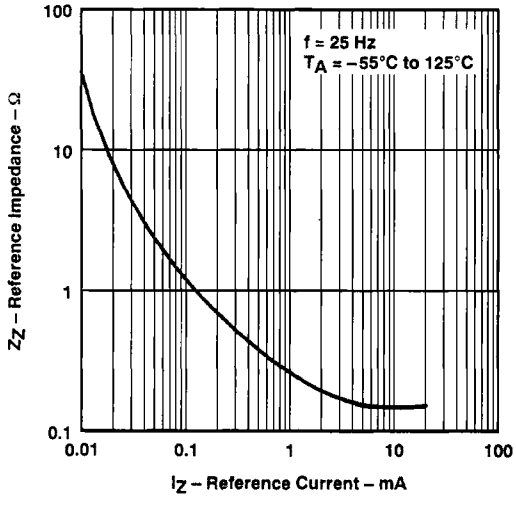


Figure 5

NOISE VOLTAGE
vs
FREQUENCY

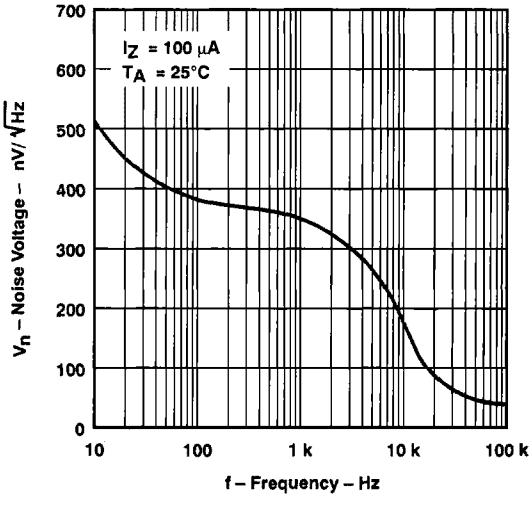


Figure 6

OUTPUT NOISE VOLTAGE
vs
CUTOFF FREQUENCY

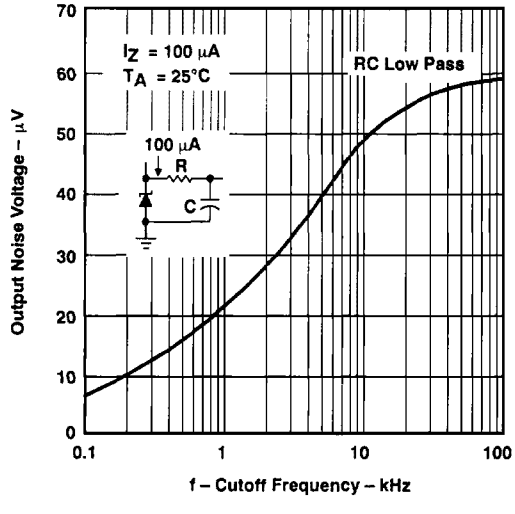


Figure 7

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

TYPICAL CHARACTERISTICS†

REVERSE CURRENT
vs
REVERSE VOLTAGE

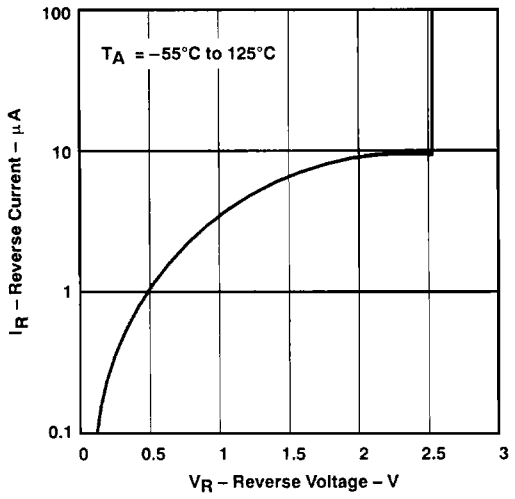


Figure 8

FORWARD VOLTAGE
vs
FORWARD CURRENT

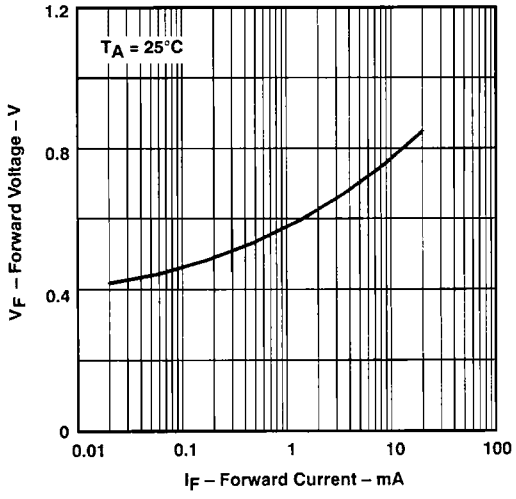


Figure 9

REFERENCE VOLTAGE
vs
FREE-AIR TEMPERATURE

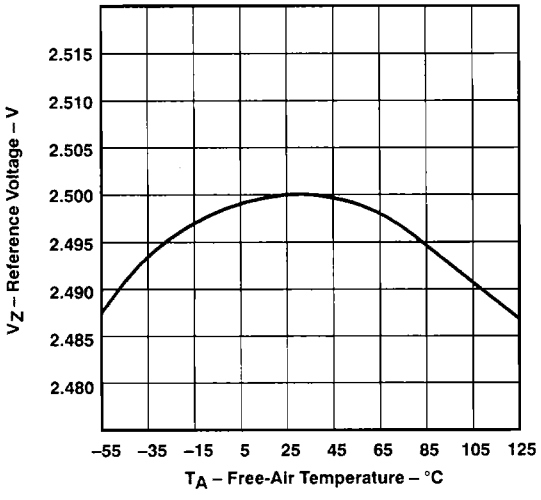


Figure 10

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

TYPICAL CHARACTERISTICS†

REFERENCE IMPEDANCE
vs
REFERENCE CURRENT

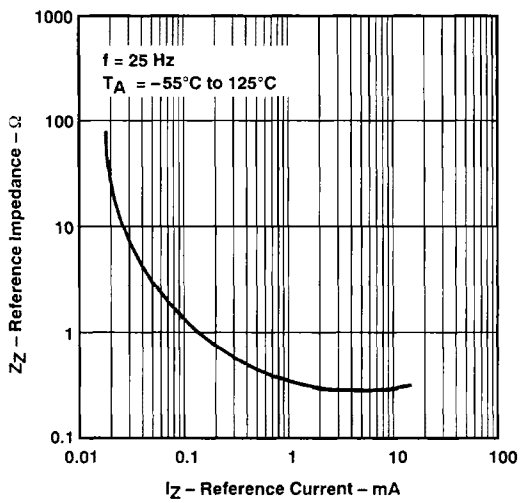


Figure 11

NOISE VOLTAGE
vs
FREQUENCY

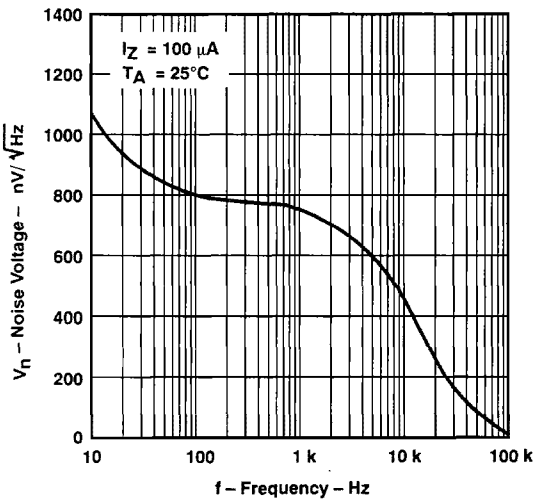


Figure 12

FILTERED OUTPUT NOISE VOLTAGE
vs
OUTPUT FREQUENCY

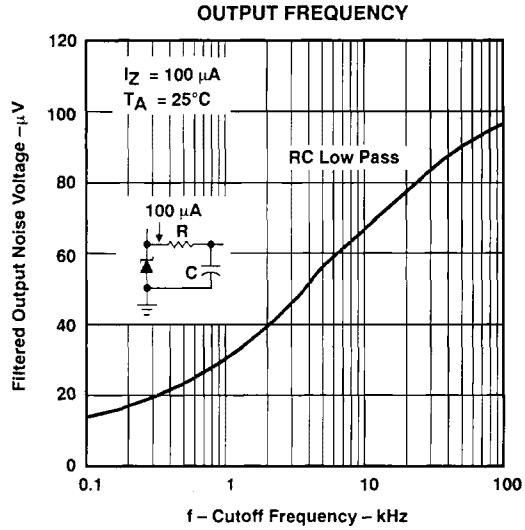


Figure 13

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

TYPICAL CHARACTERISTICS†

LT1004-1.2
TRANSIENT RESPONSE

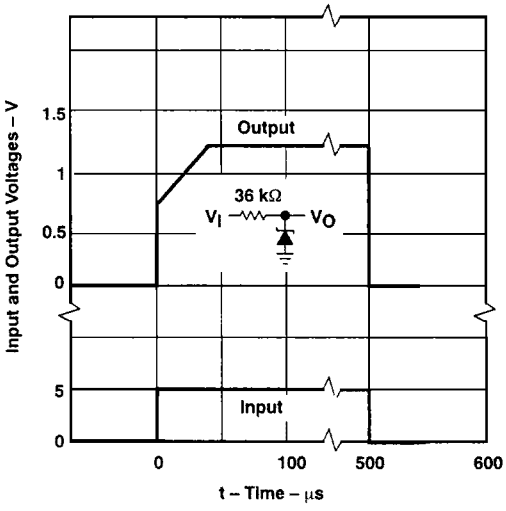


Figure 14

LT1004-2.5
TRANSIENT RESPONSE

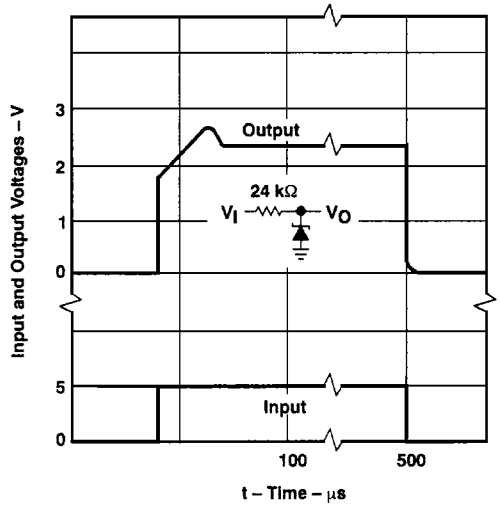
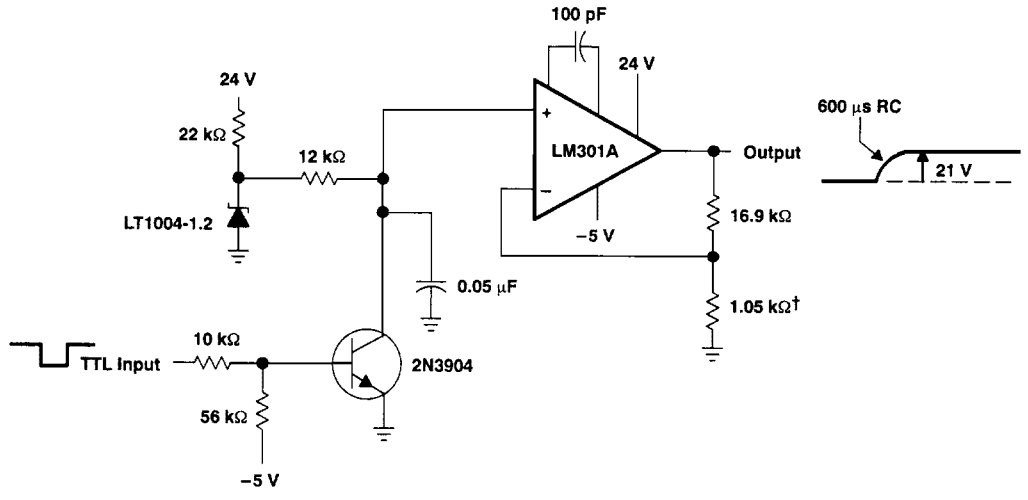


Figure 15

† 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_{PP} Generator for EPROMs (no trim required)

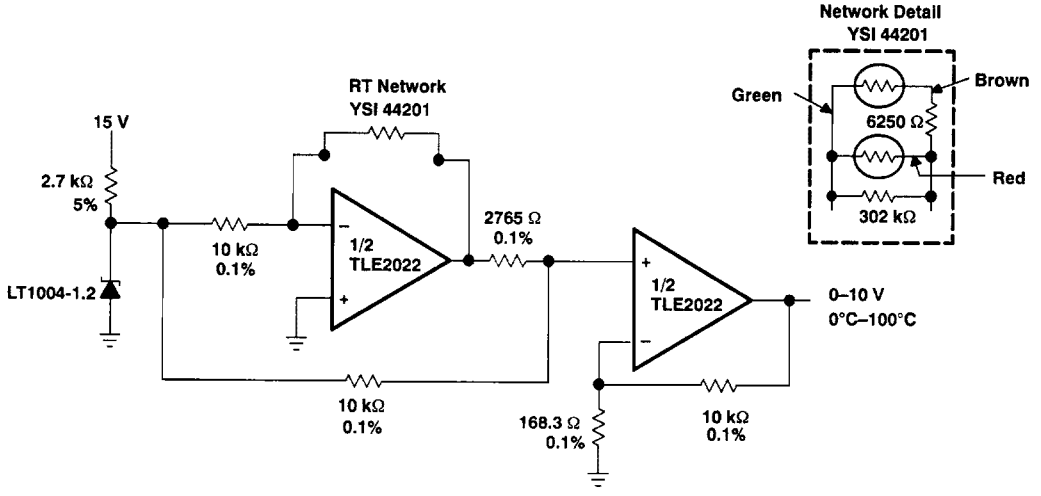


Figure 17. 0°C to 100°C Linear Output Thermometer

APPLICATION INFORMATION

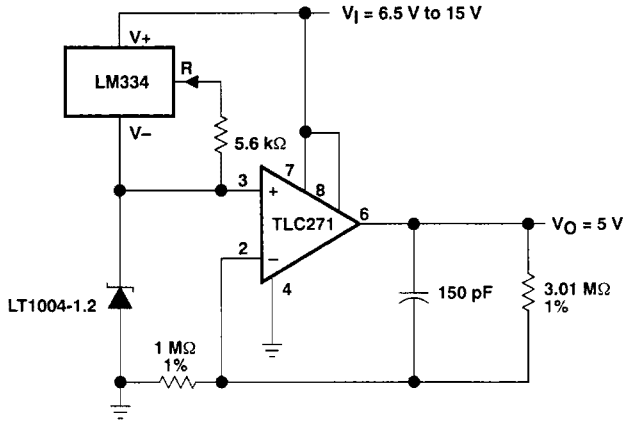


Figure 18. Micropower 5-V Reference

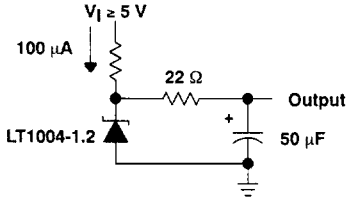


Figure 19. Low-Noise Reference

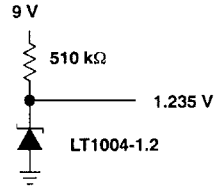
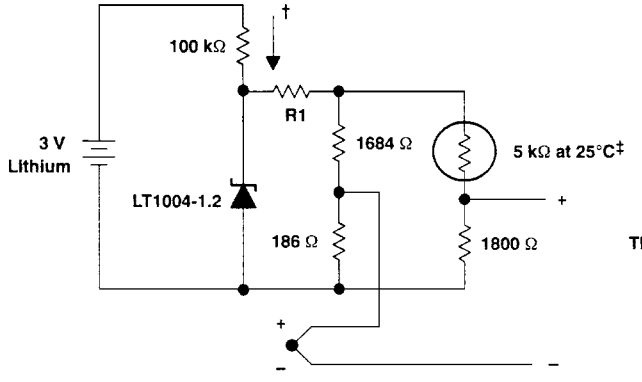


Figure 20. Micropower Reference From 9-V Battery



Thermocouple Type	R1
J	233 kΩ
K	299 kΩ
T	300 kΩ
S	2.1 MΩ

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

Figure 21. Micropower Cold-Junction Compensation for Thermocouples

APPLICATION INFORMATION

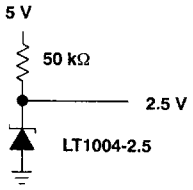


Figure 22. 2.5-V Reference

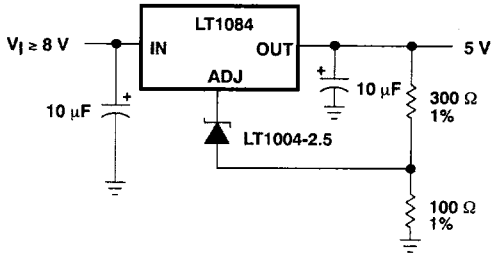
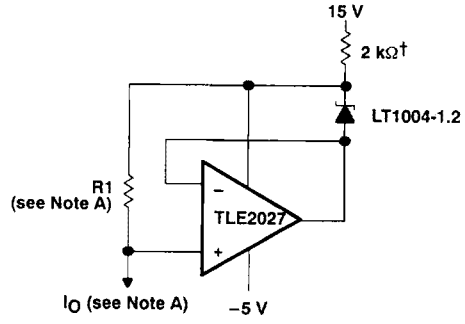


Figure 23. High-Stability 5-V Regulator



† 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

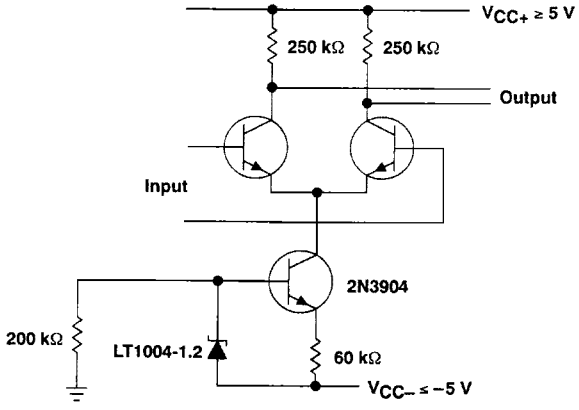
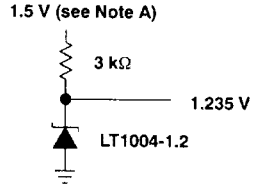


Figure 25. Amplifier With Constant Gain Over Temperature



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

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

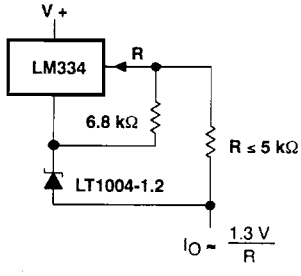
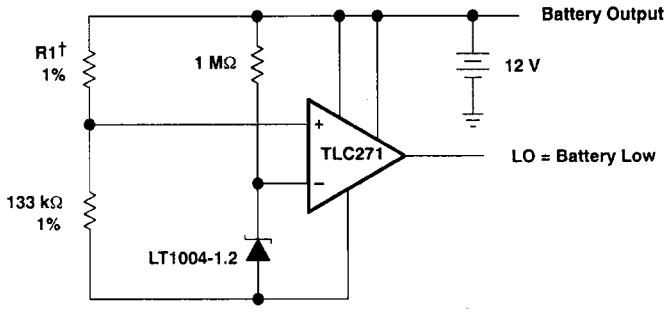


Figure 27. Terminal Current Source With Low Temperature Coefficient

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

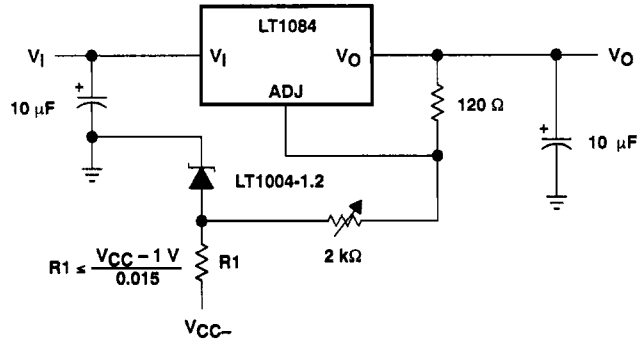


Figure 29. Variable-Voltage Supply