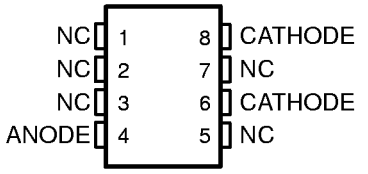
MICROPOWER INTEGRATED VOLTAGE REFERENCES

SLVS022F – JANUARY 1989 – REVISED MARCH 1998

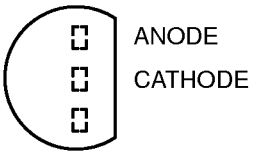
- **Initial Accuracy**
  - **±4 mV for LT1004-1.2**
  - **±20 mV for LT1004-2.5**
- **Micropower Operation**
- **Operates up to 20 mA**
- **Very Low Reference Impedance**
- **Applications:**
  - **Portable Meter Reference**
  - **Portable Test Instruments**
  - **Battery-Operated Systems**
  - **Current-Loop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

D PACKAGE
(TOP VIEW)



Terminals 6 and 8 are internally connected.

LP PACKAGE
(TOP VIEW)

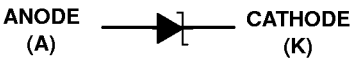


NC – No internal connection

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.

symbol



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

AVAILABLE OPTIONS†

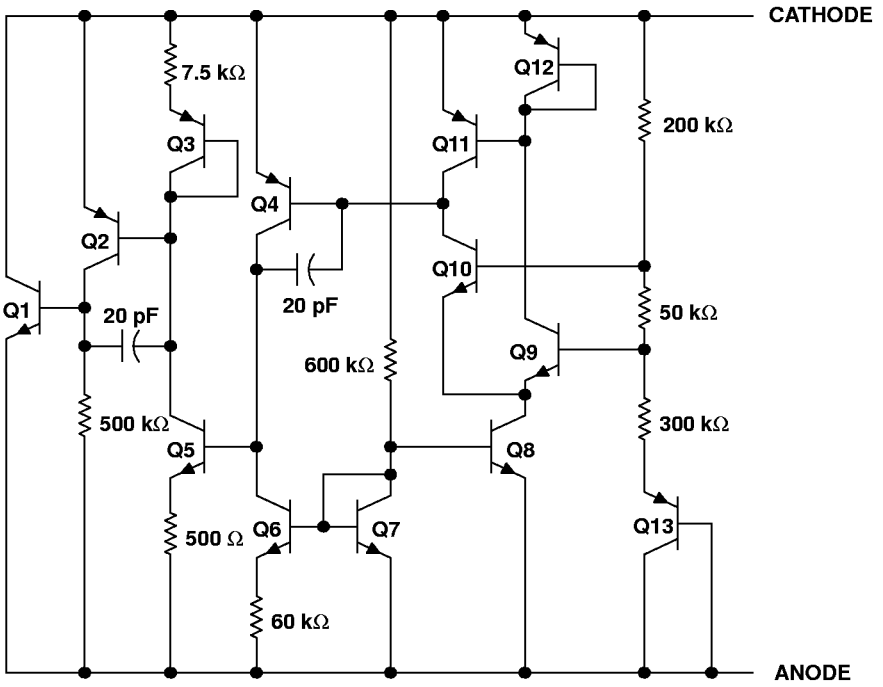
T_A	PACKAGED DEVICES‡			CHIP FORM (Y)
	V_Z TYP	SMALL-OUTLINE (D)	PLASTIC (LP)	
0°C to 70°C	1.2 V	LT1004CD-1.2	LT1004CLP-1.2	LT1004Y-1.2
	2.5 V	LT1004CD-2.5	LT1004CLP-2.5	LT1004Y-2.5
–40°C to 85°C	1.2 V	LT1004ID-1.2	LT1004ILP-1.2	—
	2.5 V	LT1004ID-2.5	LT1004ILP-2.5	
–55°C to 125°C	1.2 V	LT1004MD-1.2	LT1004MLP-1.2	—
	2.5 V	LT1004MD-2.5	LT1004MLP-2.5	

† 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).

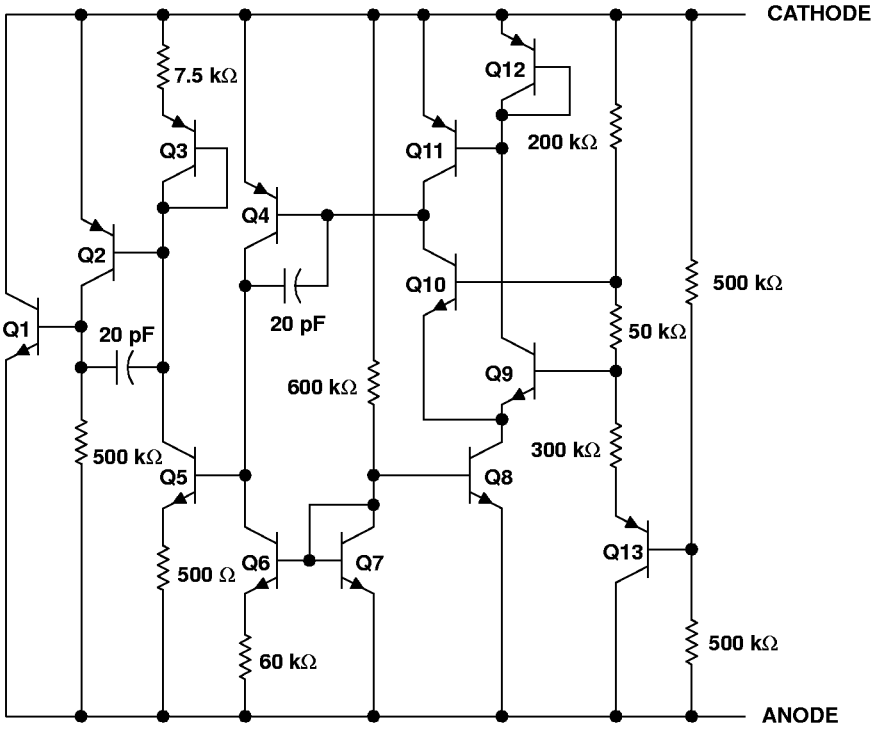
‡ The packages are available taped and reeled. Add the R suffix to the device type (e.g., LT1004CDR).

schematic

LT1004-1.2



LT1004-2.5

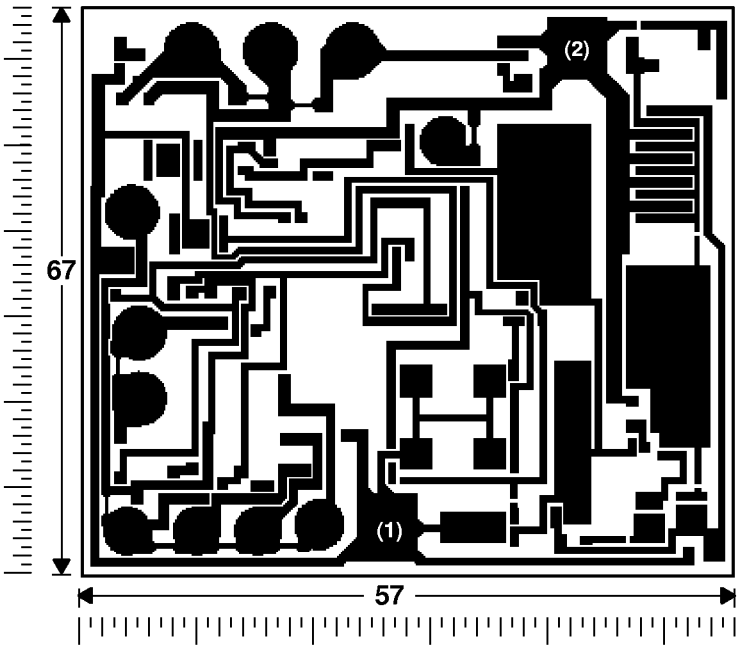


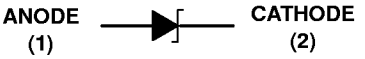
NOTE A: All component values shown are nominal.

LT1004Y-1.2 and LT1004Y-2.5 chip information

This chip, when properly assembled, displays characteristics similar to those of the LT1004C. Thermal compression or ultrasonic bonding may be used on the doped aluminum bonding pads. The chip may be mounted with conductive epoxy or a gold-silicon preform.

BONDING PAD ASSIGNMENTS





CHIP THICKNESS:
15 MILS TYPICAL

BONDING PADS:
4 × 4 MILS MINIMUM

$T_J$max = 150°C

TOLERANCES ARE ±10%.

ALL DIMENSIONS ARE IN MILS.

TERMINAL NUMBERS APPLY TO LP PACKAGE ONLY

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, T_A: LT1004C	0°C to 70°C
LT1004I	–40°C to 85°C
LT1004M	–55°C to 125°C
Storage temperature range, T_{stg}	–65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	260°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.

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	
				LT1004M	1.215		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, −40°C to 85°C for LT1004I, 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.

electrical characteristics, T_A = 25°C

PARAMETER		TEST CONDITIONS	LT1004Y-1.2 MIN	LT1004Y-1.2 TYP	LT1004Y-1.2 MAX	LT1004Y-2.5 MIN	LT1004Y-2.5 TYP	LT1004Y-2.5 MAX	UNIT
V_Z	Reference voltage	I_Z = 100 μA	1.231	1.235	1.239	2.48	2.5	2.52	V
α_{VZ}	Average temperature coefficient of reference voltage†	I_Z = 10 μA		20					ppm/°C
		I_Z = 20 μA					20		
$\Delta V_Z/\Delta t$	Long-term change in reference voltage	I_Z = 100 μA		20			20		ppm/khr
$I_Z$min	Minimum reference current			8			12		μA
z_z	Reference impedance	I_Z = 100 μA		0.2	0.6		0.2	0.6	Ω
V_n	Broadband noise voltage	I_Z = 100 μA, f = 10 Hz to 10 kHz		60			120		μV

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

TYPICAL CHARACTERISTICS†

LT1004x-1.2
REVERSE CURRENT
vs
REVERSE VOLTAGE

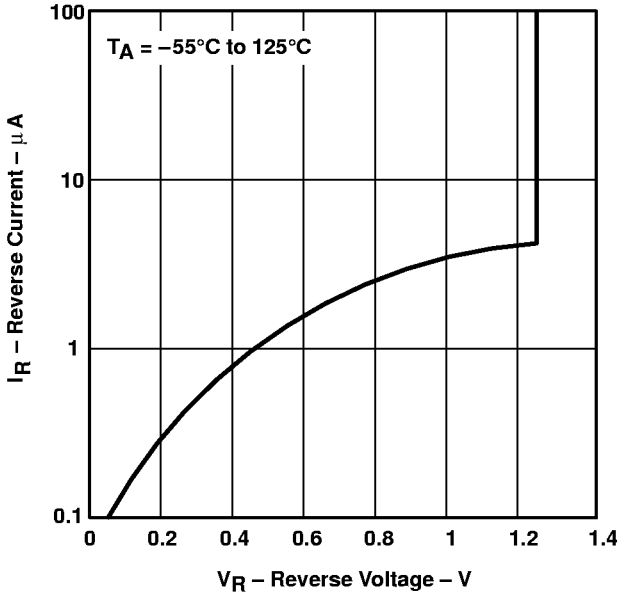


Figure 1

LT1004x-1.2
REFERENCE VOLTAGE CHANGE
vs
REVERSE CURRENT

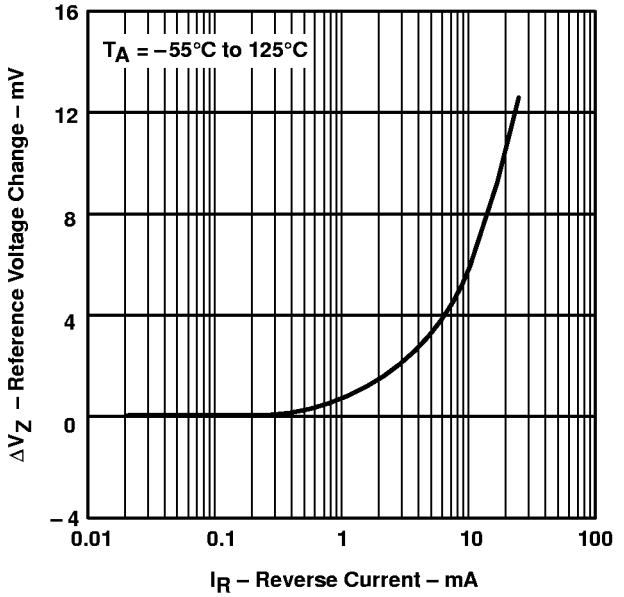


Figure 2

LT1004x-1.2
FORWARD VOLTAGE
vs
FORWARD CURRENT

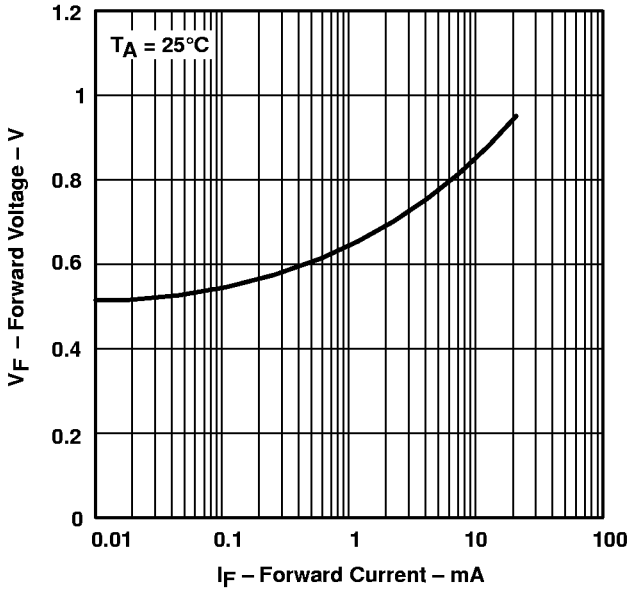


Figure 3

LT1004x-1.2
REFERENCE VOLTAGE
vs
FREE-AIR TEMPERATURE

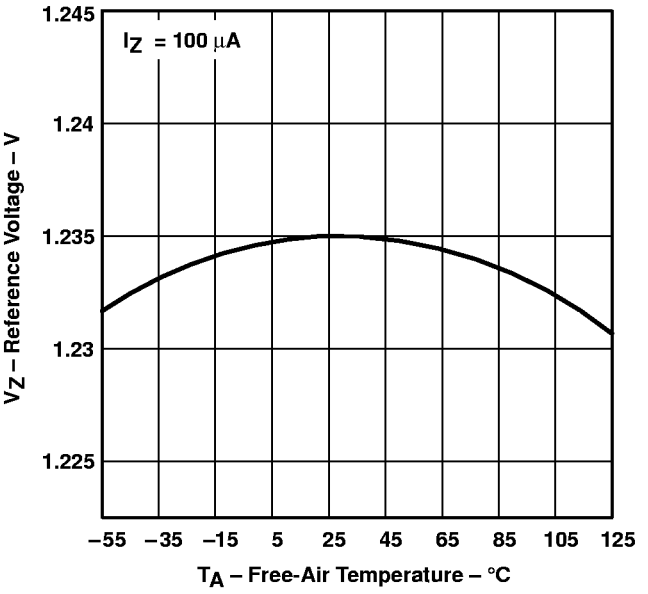


Figure 4

† 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

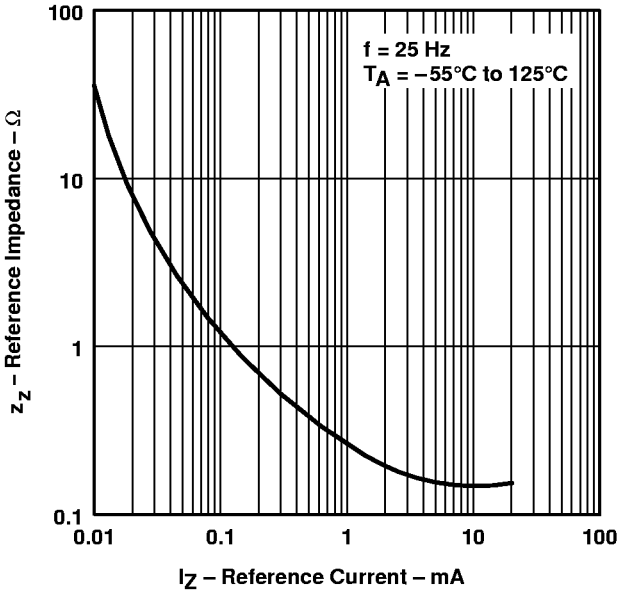


Figure 5

LT1004x-1.2
NOISE VOLTAGE
vs
FREQUENCY

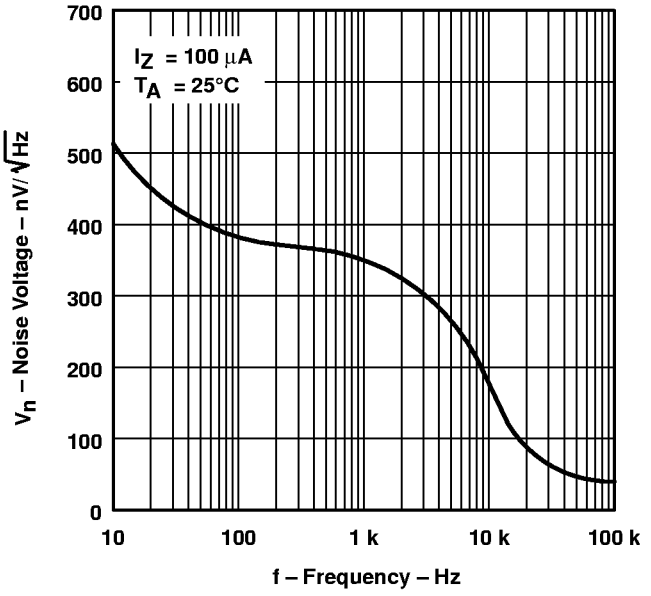


Figure 6

TL1004x-1.2
FILTERED OUTPUT NOISE VOLTAGE
vs
CUTOFF FREQUENCY

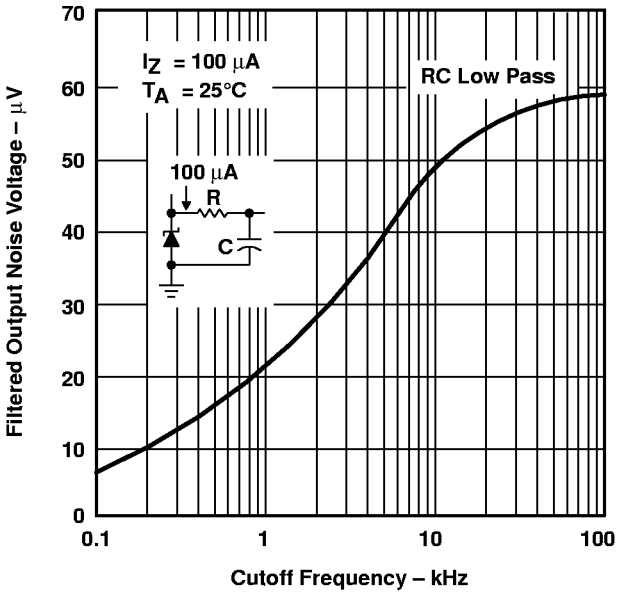


Figure 7

LT1004x-2.5
TRANSIENT RESPONSE

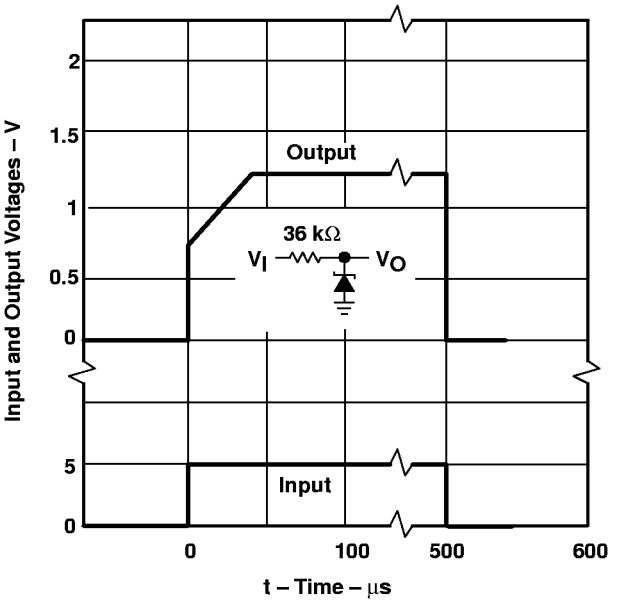


Figure 8

† 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

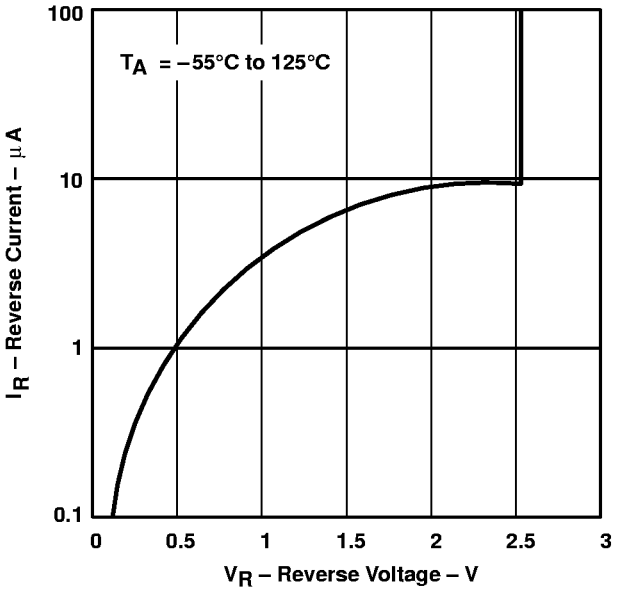


Figure 9

LT1004x-2.5
FORWARD VOLTAGE
vs
FORWARD CURRENT

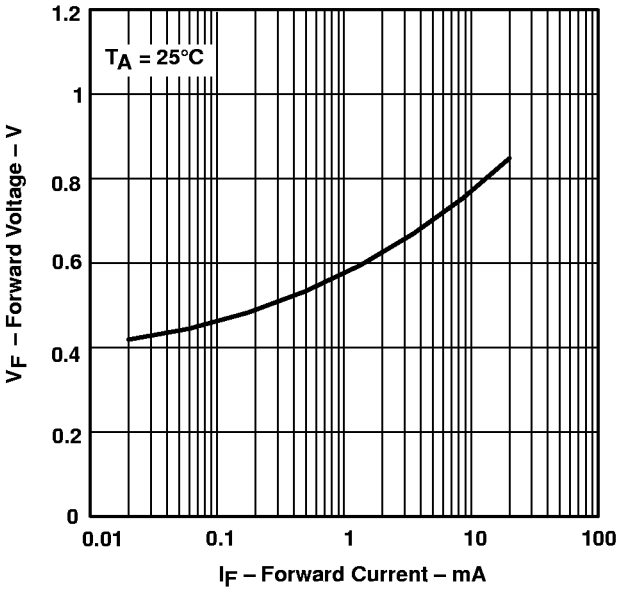


Figure 10

LT1004x-2.5
REFERENCE VOLTAGE
vs
FREE-AIR TEMPERATURE

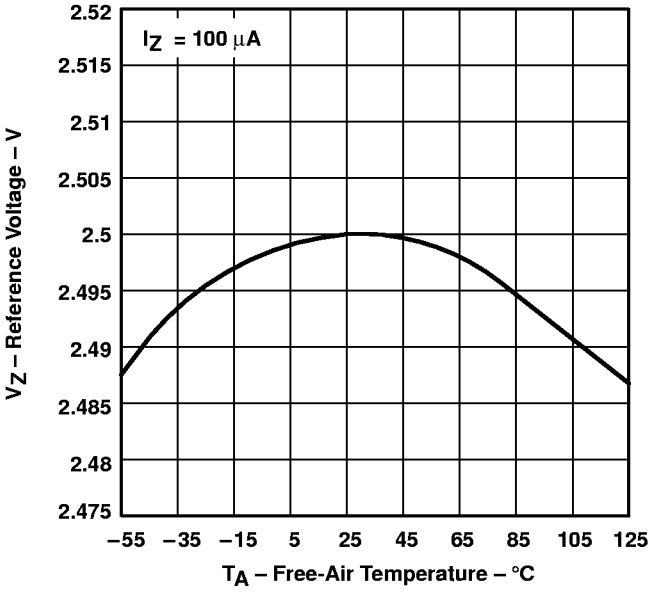


Figure 11

† 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

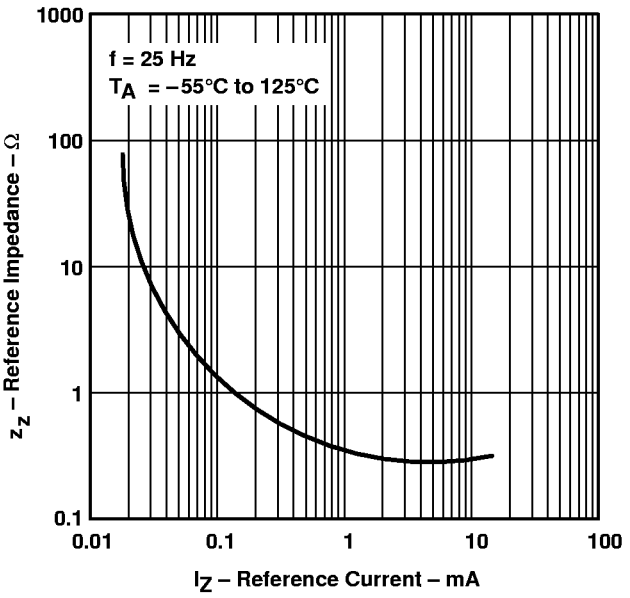


Figure 12

LT1004x-2.5
NOISE VOLTAGE
vs
FREQUENCY

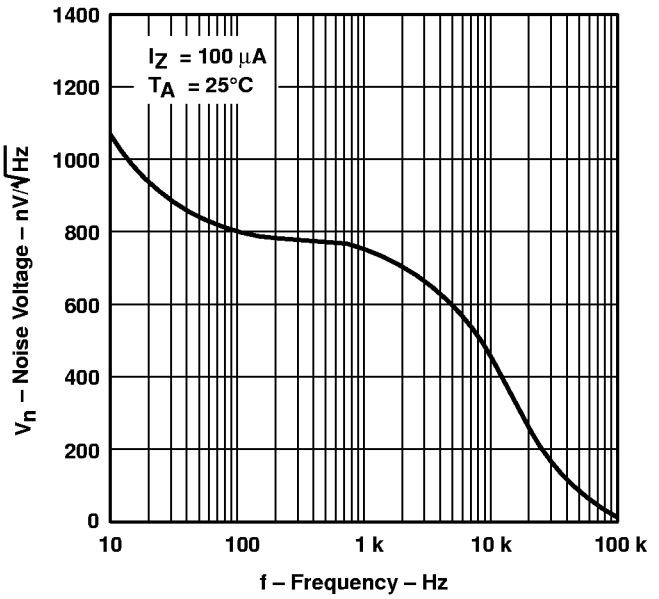


Figure 13

TL1004x-2.5
FILTERED OUTPUT NOISE VOLTAGE
vs
CUTOFF FREQUENCY

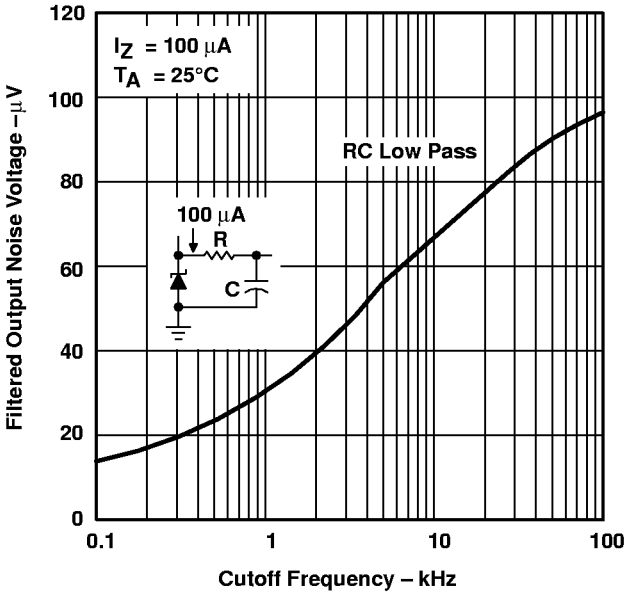


Figure 14

LT1004x-2.5
TRANSIENT RESPONSE

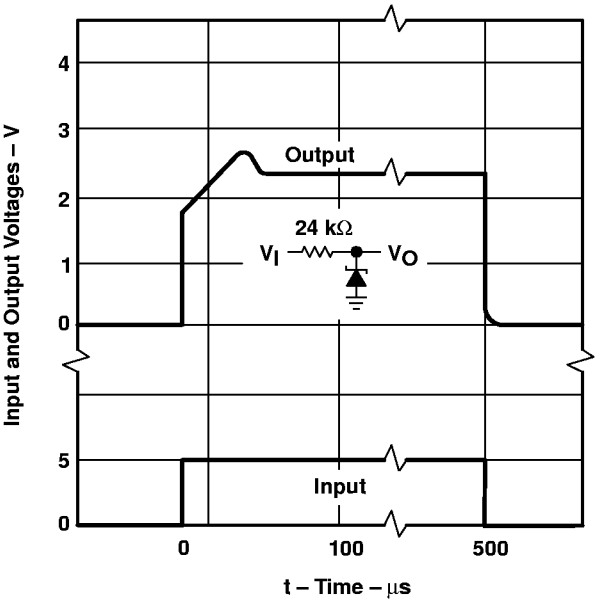
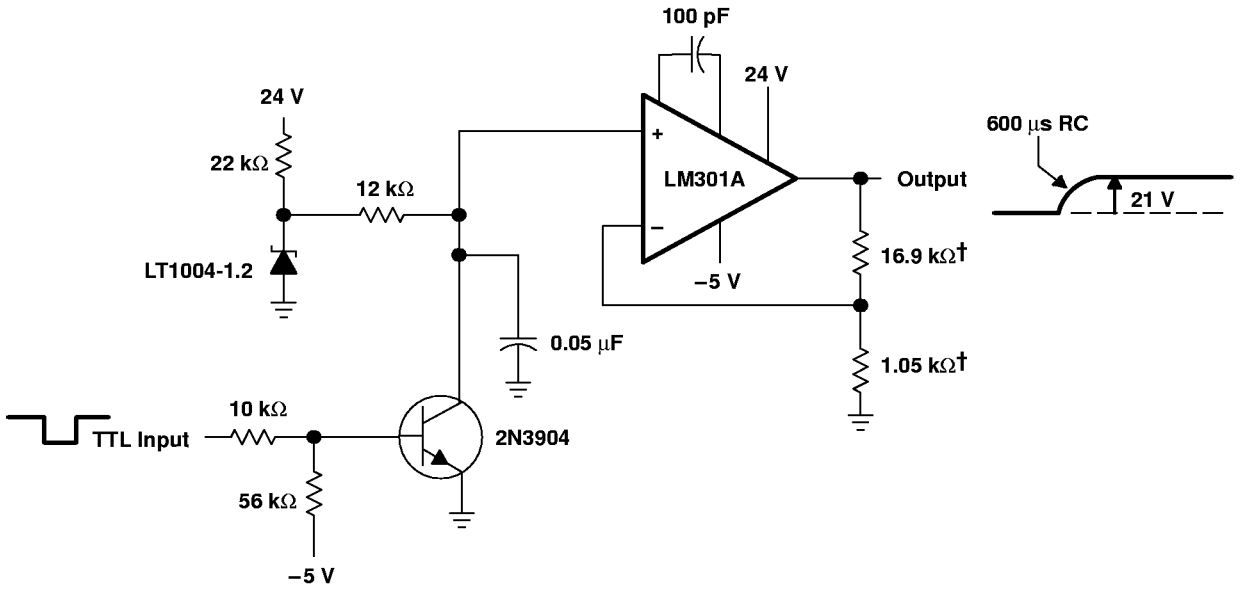


Figure 15

† 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)

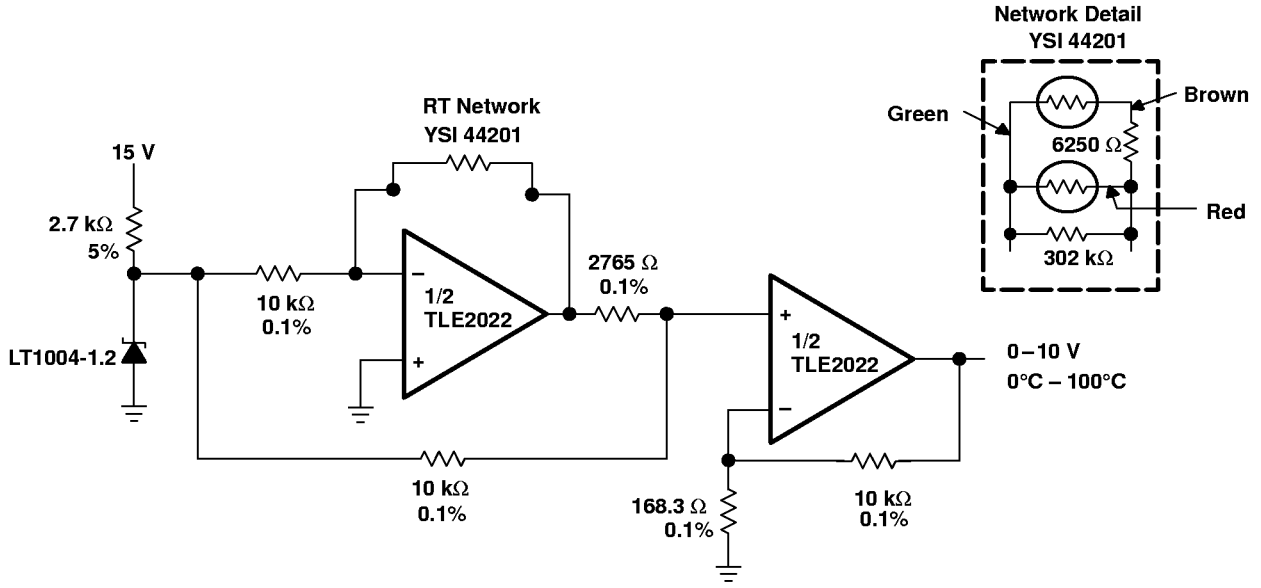


Figure 17. 0°C to 100°C Linear Output Thermometer

APPLICATION INFORMATION

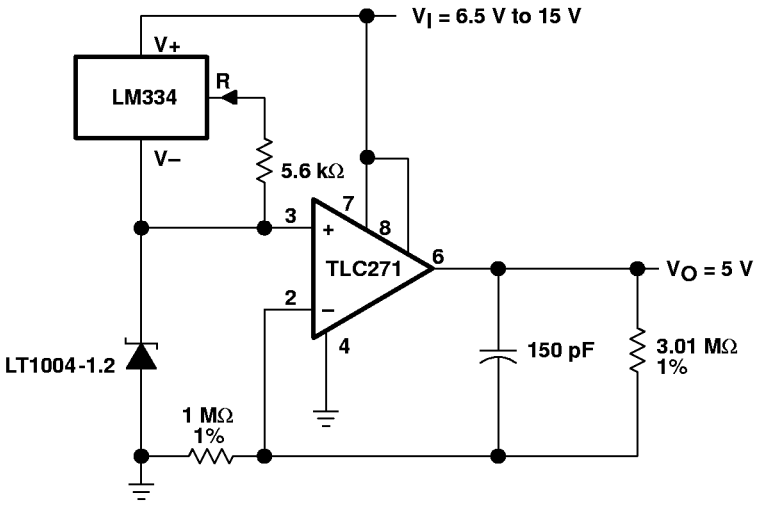


Figure 18. Micropower 5-V Reference

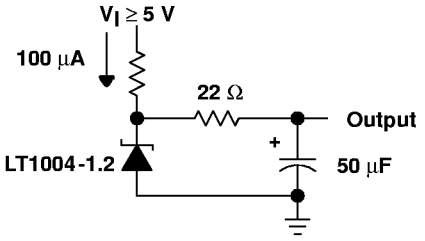


Figure 19. Low-Noise Reference

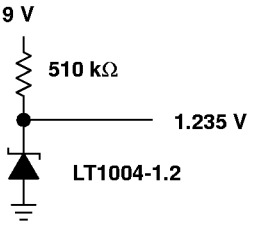
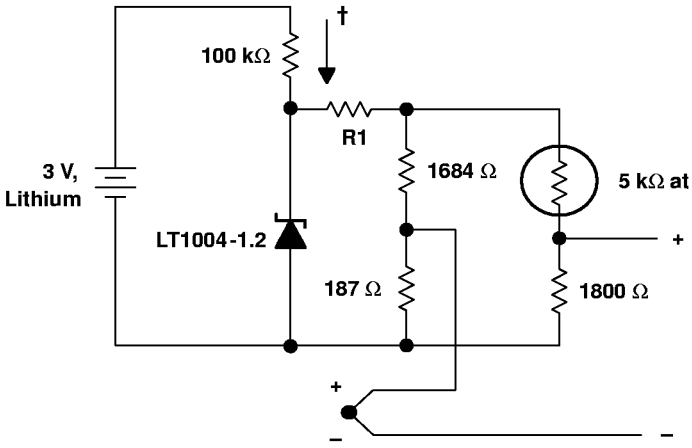


Figure 20. Micropower Reference From 9-V Battery



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

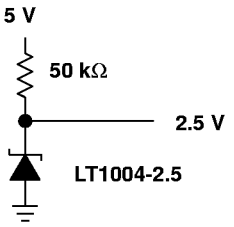


Figure 22. 2.5-V Reference

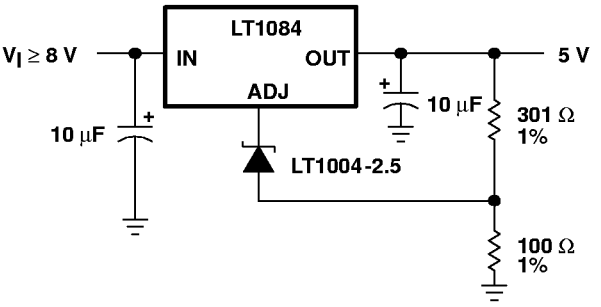
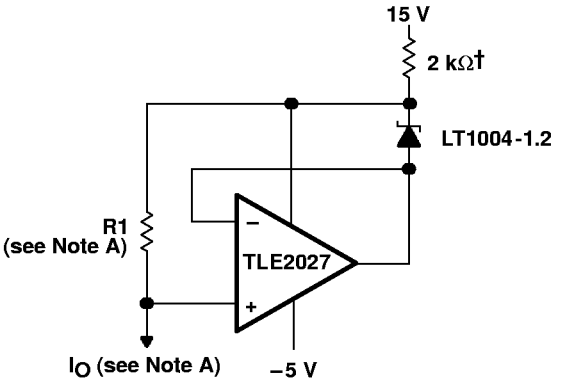


Figure 23. High-Stability 5-V Regulator



† 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

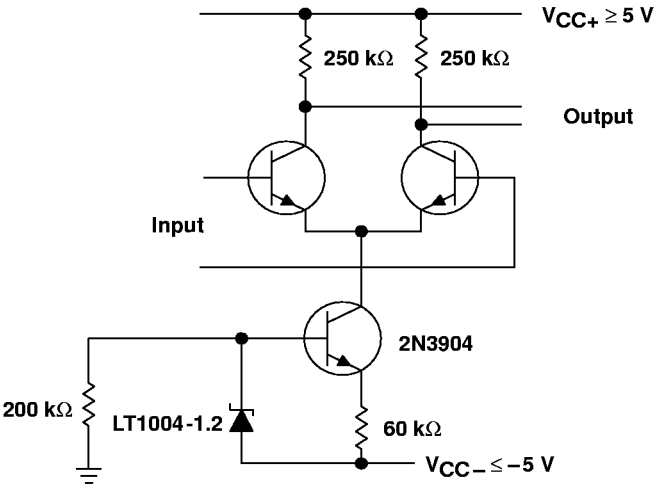
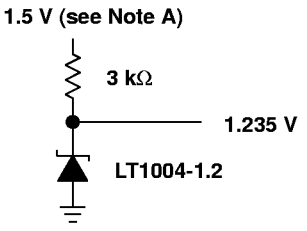


Figure 25. Amplifier With Constant Gain Over Temperature



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

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

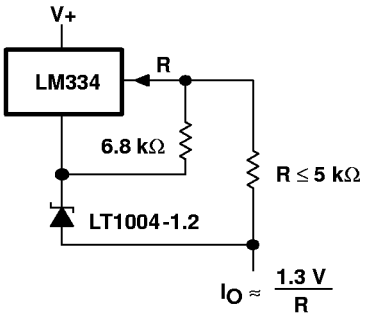
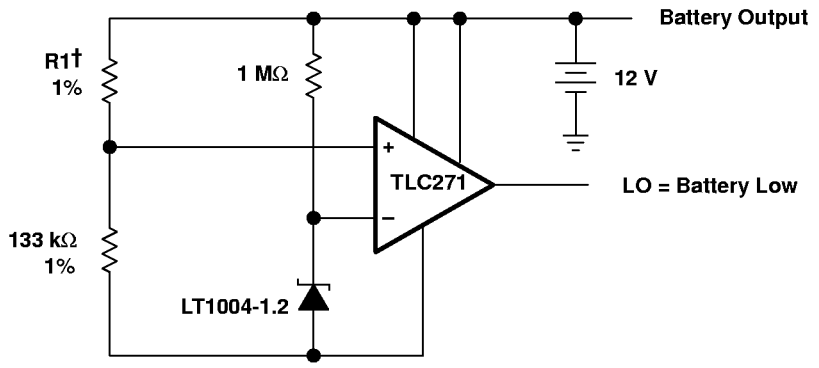


Figure 27. Terminal Current Source With Low Temperature Coefficient

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

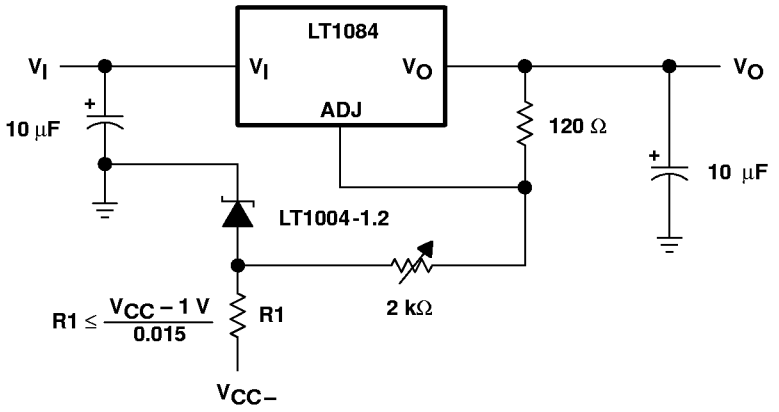
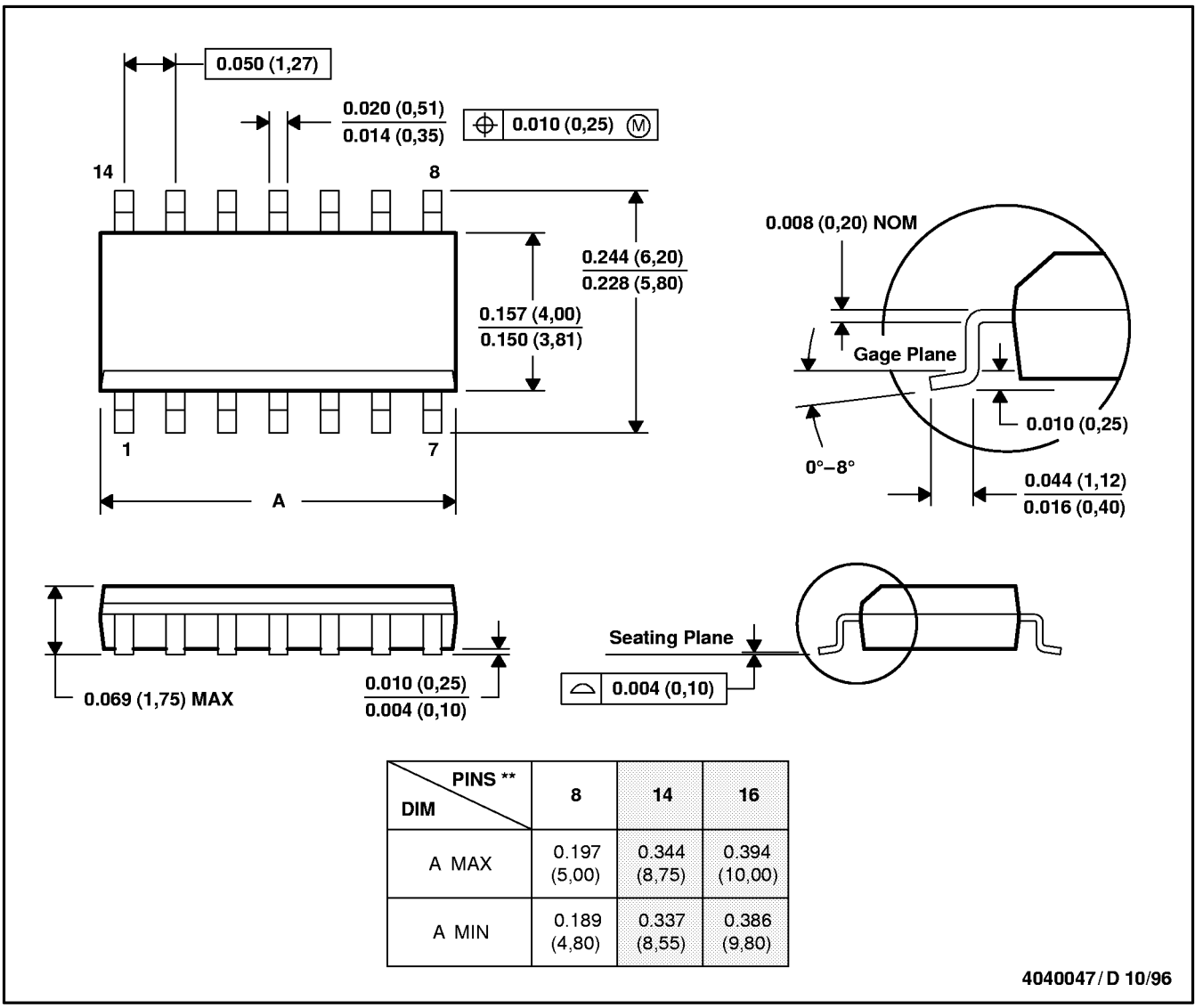


Figure 29. Variable Voltage Supply

MECHANICAL DATA

D (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

14 PIN SHOWN



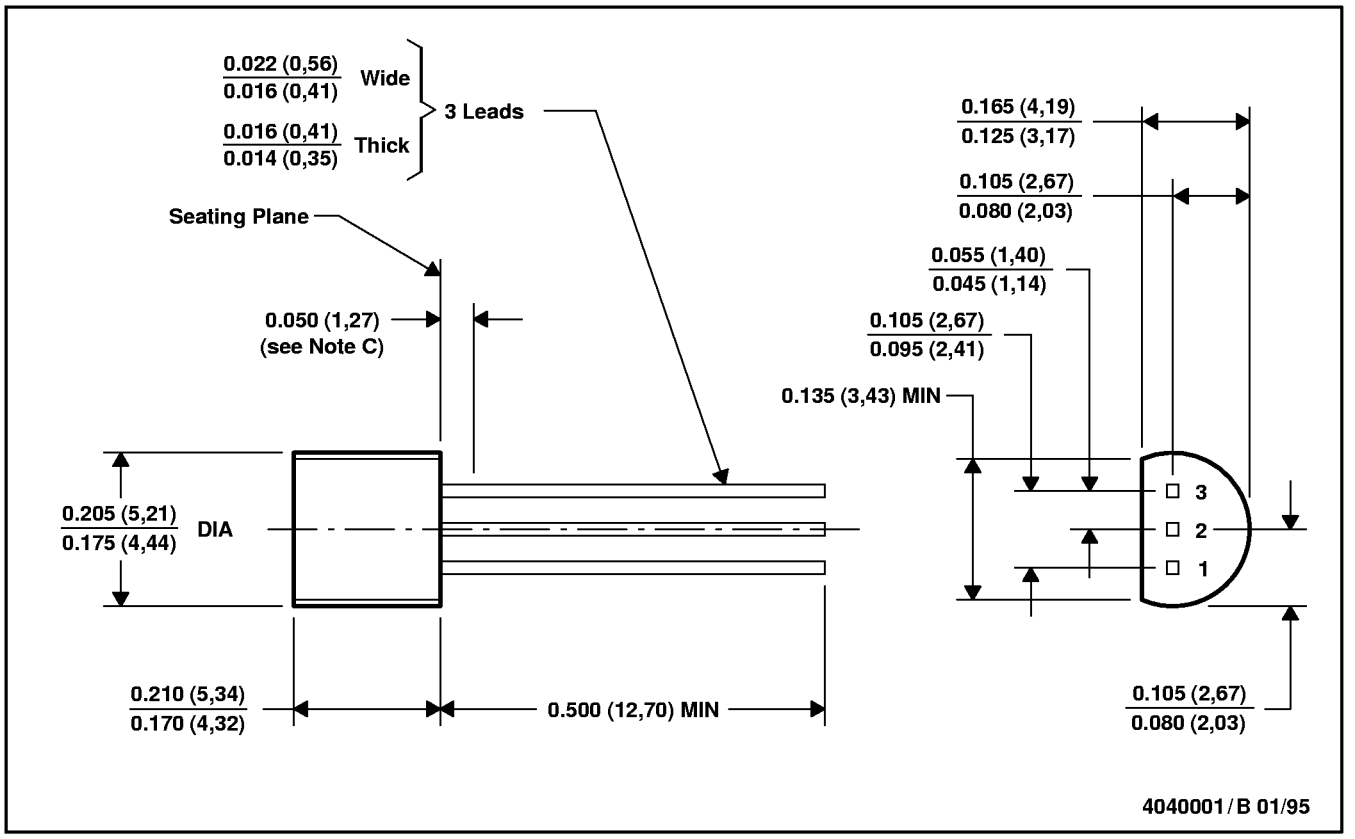
DIM \ PINS **	8	14	16
A MAX	0.197 (5,00)	0.344 (8,75)	0.394 (10,00)
A MIN	0.189 (4,80)	0.337 (8,55)	0.386 (9,80)

4040047/D 10/96

NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion, not to exceed 0.006 (0,15).
D. Falls within JEDEC MS-012

MECHANICAL DATA

LP (O-PBCY-W3) **PLASTIC CYLINDRICAL PACKAGE**



NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Lead dimensions are not controlled within this area.
D. Falls within JEDEC TO-226AA (TO-226AA replaces TO-92)

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