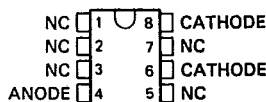


LT1004 MICROPOWER INTEGRATED VOLTAGE REFERENCE

D3190, JANUARY 1989

- 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 References
 - Portable Test Instruments
 - Battery Operated Systems
 - Current-Loop Instrumentation

LT1004C ... D PACKAGE
(TOP VIEW)



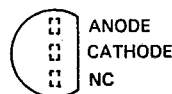
NC—No internal connection

LT1004M, LT1004C ... LD PACKAGE
(TOP VIEW)



The anode is in electrical contact with the case.

LT1004C ... LP PACKAGE
(TOP VIEW)



NC—No internal connection

symbol



description

The LT1004 micropower voltage references are two-terminal bandgap reference diodes 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 devices results in specifications previously attainable only with selected units.

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 LT1004M is characterized for operation over the full military temperature range of -55°C to 125°C . The LT1004C is characterized for operation from 0°C to 70°C .

AVAILABLE OPTIONS

TA	NOM V _Z	PACKAGE		
		SMALL OUTLINE (D)	METAL CAN (LD)	PLASTIC (LP)
0°C to 70°C	1.2 V	LT1004CD-1.2	LT1004CLD-1.2	LT1004CLP-1.2
	2.5 V	LT1004CD-2.5	LT1004CLD-2.5	LT1004CLP-2.5
-55°C to 125°C	1.2 V		LT1004MLD-1.2	
	2.5 V		LT1004MLD-2.5	

The D package is available taped and reeled. Add suffix R to the device type (i.e., LT1004CDR0).

 2
Data Sheets

PRODUCTION DATA documents contain information 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.

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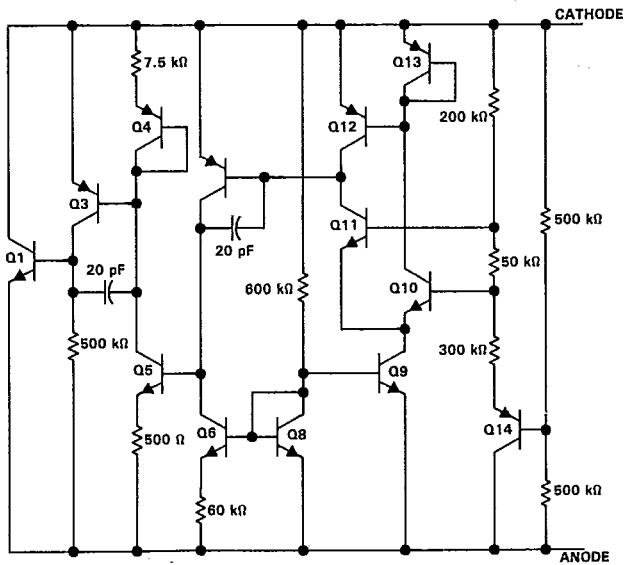
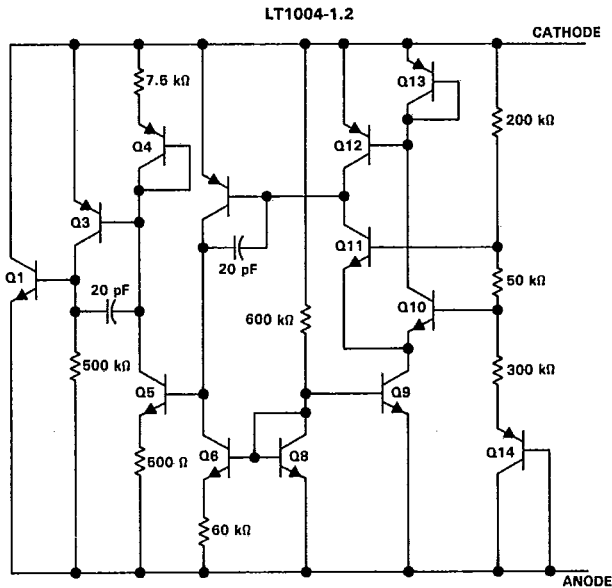
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LT1004
MICROPOWER INTEGRATED VOLTAGE REFERENCE

T-58-07

schematic



All component values shown are nominal.

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MICROPOWER INTEGRATED VOLTAGE REFERENCE

TEXAS INSTR (LIN/INTFC)

T-58-07

absolute maximum ratings over operating free-air temperature range

Reverse current	30 mA
Forward current	10 mA
Operating free-air temperature range: LT1004M	-55°C to 125°C
LT1004C	0°C to 70°C
Storage temperature range	-65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D or LP package	260°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: LD package	300°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, See Note 1	25°C	1.231	1.235	1.239	2.48	2.5	2.52	V
			0°C to 70°C	1.225		1.245	2.47		2.53	
			−55°C to 125°C	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 = 10 μA 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			
ΔV _Z /Δt	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 -55°C to 125°C for the LT1004M and 0°C to 70°C for the LT1004C.

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

NOTE 1: The 0°C to 70°C limits apply for both M- and C-suffix devices. The -55°C to 125°C limits apply only for M-suffix devices.

2

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TEXAS INSTR (LIN/INTFC)

TYPICAL CHARACTERISTICS†

REVERSE CHARACTERISTICS

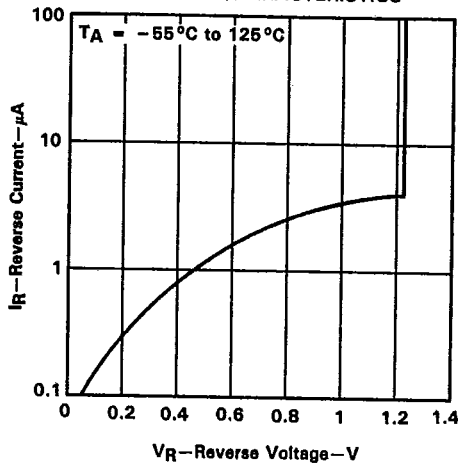


FIGURE 1

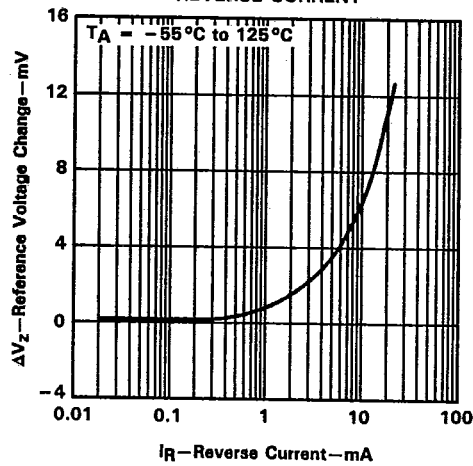
REFERENCE VOLTAGE CHANGE
vs
REVERSE CURRENT

FIGURE 2

FORWARD CHARACTERISTICS

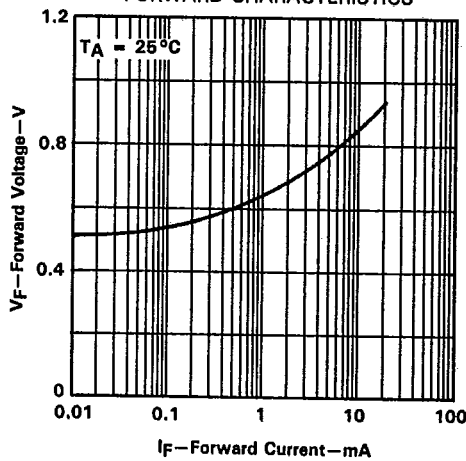


FIGURE 3

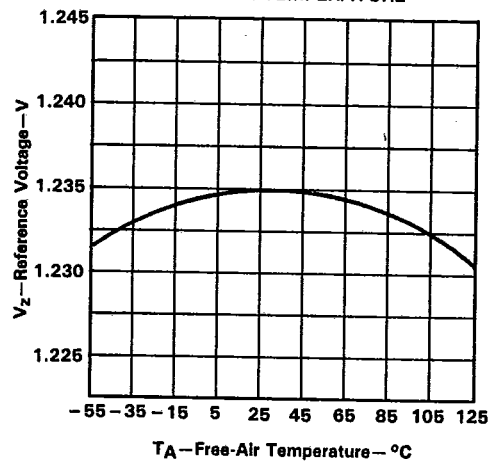
REFERENCE VOLTAGE
vs
FREE-AIR TEMPERATURE

FIGURE 4

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

MICROPOWER INTEGRATED VOLTAGE REFERENCE

TEXAS INSTR (LIN/INTFC)

T-58-07

TYPICAL CHARACTERISTICS

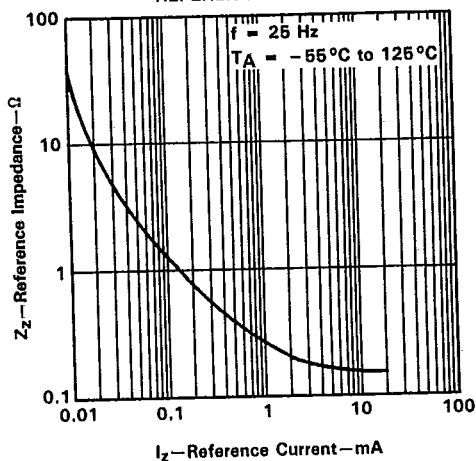
REFERENCE IMPEDANCE
vs
REFERENCE CURRENT

FIGURE 5

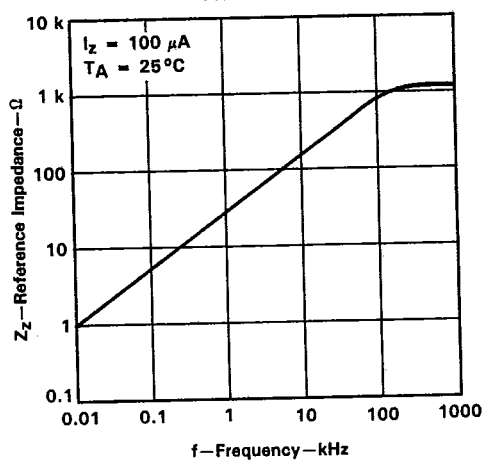
REFERENCE IMPEDANCE
vs
FREQUENCY

FIGURE 6

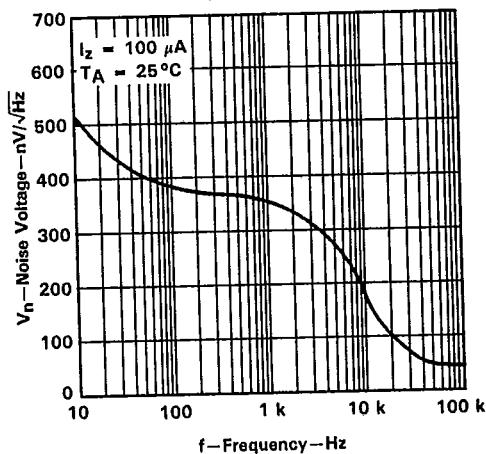
NOISE VOLTAGE
vs
FREQUENCY

FIGURE 7

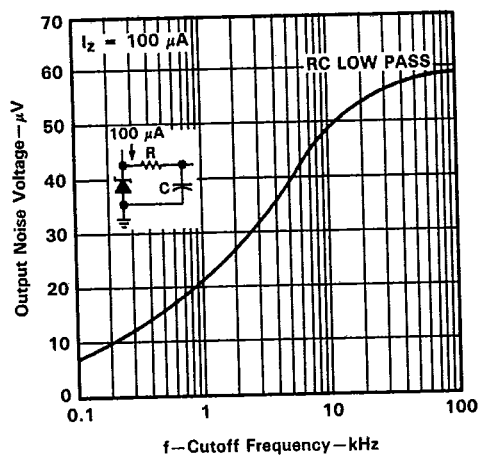
OUTPUT NOISE VOLTAGE
vs
CUTOFF FREQUENCY

FIGURE 8

2

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TYPICAL CHARACTERISTICS†

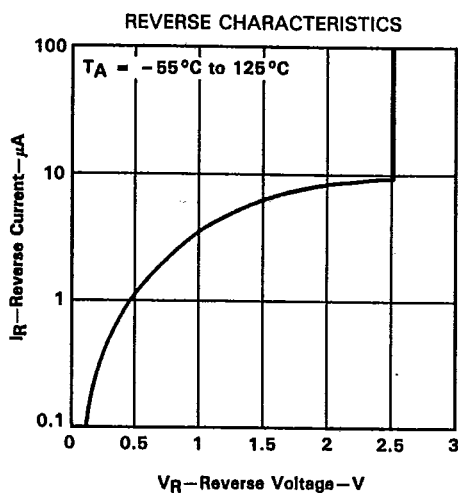


FIGURE 9

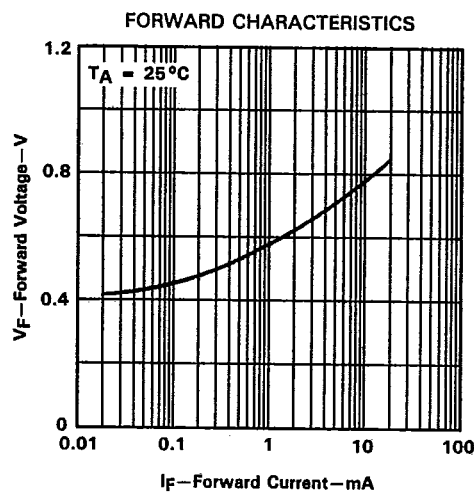


FIGURE 10

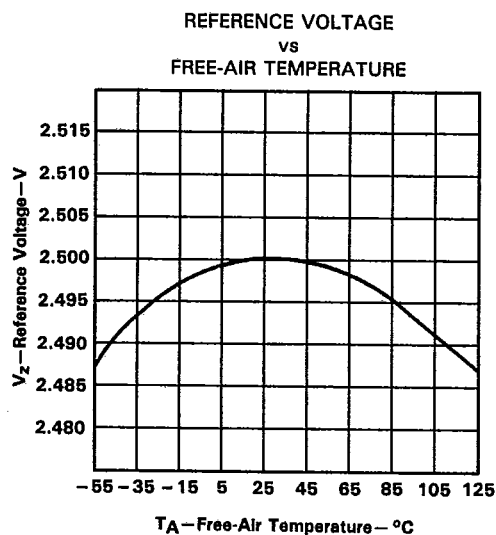


FIGURE 11

† 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

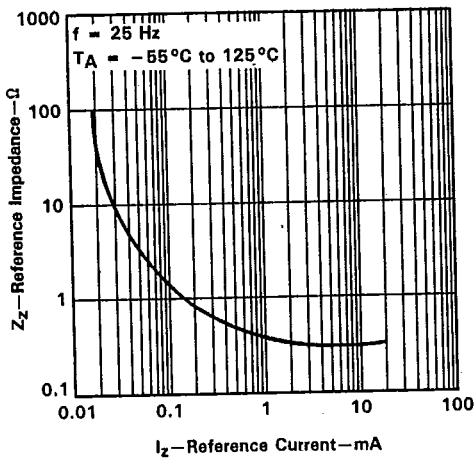
REFERENCE IMPEDANCE
vs
REFERENCE CURRENT

FIGURE 12

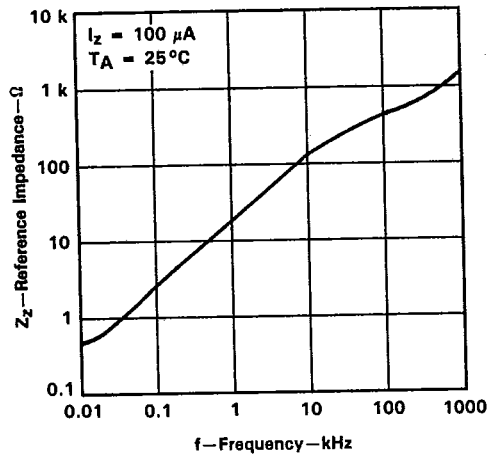
REFERENCE IMPEDANCE
vs
FREQUENCY

FIGURE 13

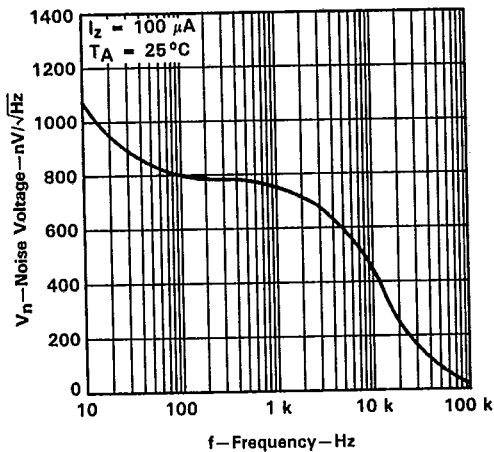
NOISE VOLTAGE
vs
FREQUENCY

FIGURE 14

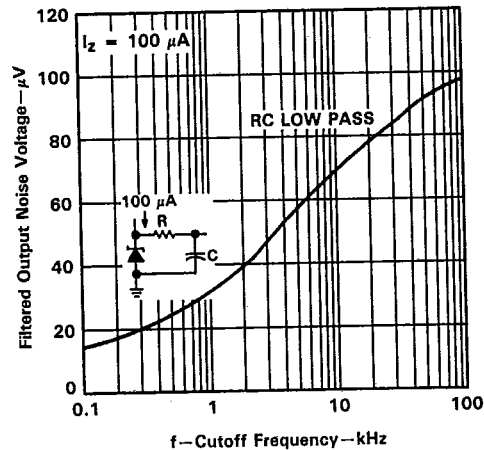
FILTERED OUTPUT NOISE VOLTAGE
vs
CUTOFF FREQUENCY

FIGURE 15

2

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LT1004
MICROPOWER INTEGRATED VOLTAGE REFERENCE

TEXAS INSTR (LIN/INTFC)

T-58-07

TYPICAL CHARACTERISTICS

LT1004-1.2
TRANSIENT RESPONSE

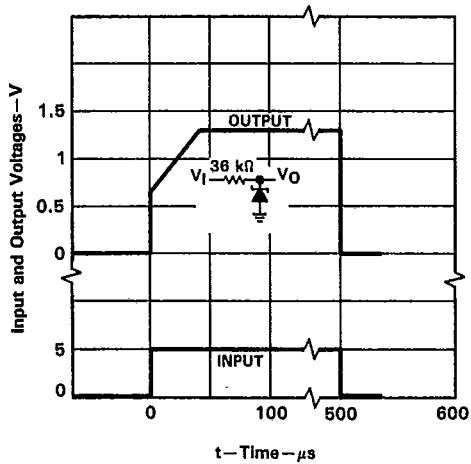


FIGURE 16

LT1004-2.5
TRANSIENT RESPONSE

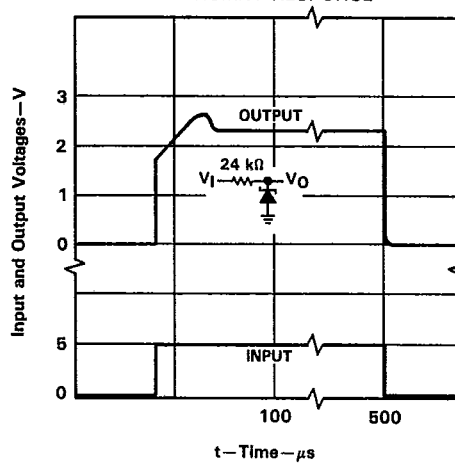
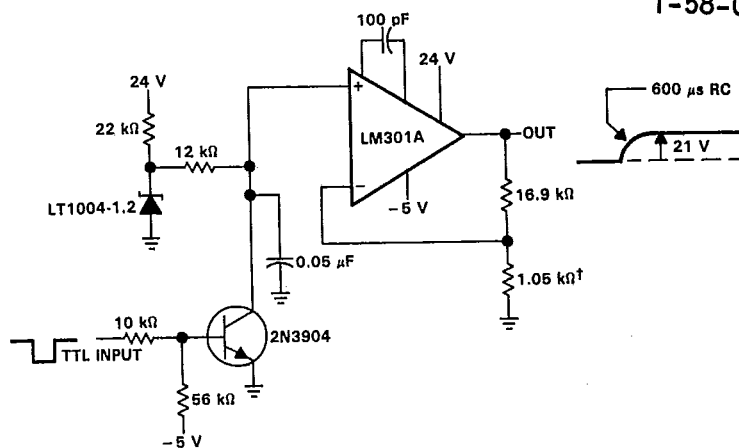


FIGURE 17

MICROPOWER INTEGRATED VOLTAGE REFERENCE

TEXAS INSTR (LIN/INTFC)
TYPICAL APPLICATION DATA

T-58-07



† 1% metal film resistors

FIGURE 18. Vpp GENERATOR FOR EPROMS (NO TRIM REQUIRED)

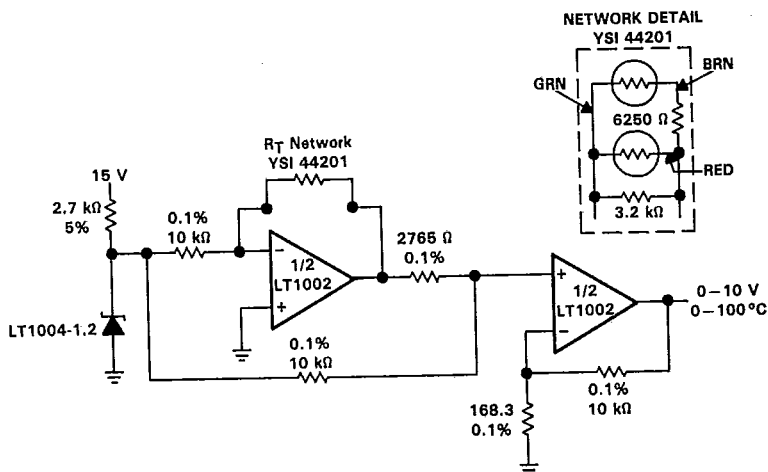


FIGURE 19. 0°C TO 100°C LINEAR OUTPUT THERMOMETER

2

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LT1004
MICROPOWER INTEGRATED VOLTAGE REFERENCE

TEXAS INSTR (LIN/INTFC)

TYPICAL APPLICATION DATA

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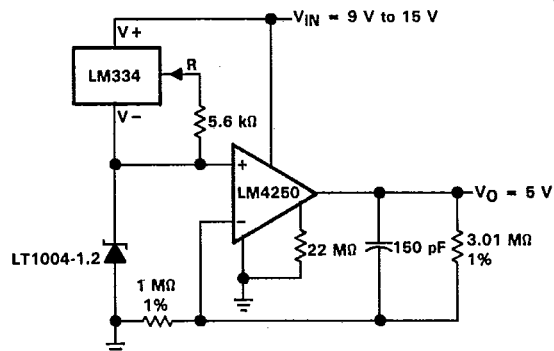


FIGURE 20. MICROPOWER 5-V REFERENCE

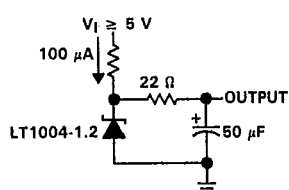


FIGURE 21. LOW-NOISE REFERENCE

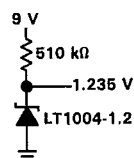
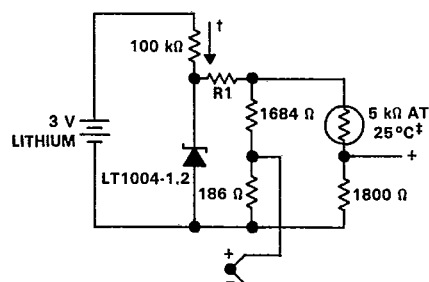


FIGURE 22. MICROPOWER REFERENCE FROM 9-V BATTERY

† Quiescent current $\approx 15 \mu\text{A}$

‡ Yellow Springs Inst. Co., Part #44007

NOTE: This application compensates within $\pm 1^\circ\text{C}$ from 0°C to 60°C .

THERMOCOUPLE TYPE	R1
J	233 kΩ
K	299 kΩ
T	300 kΩ
S	2.1 MΩ

FIGURE 23. MICROPOWER COLD-JUNCTION COMPENSATION FOR THERMOCOUPLES

LT1004
MICROPOWER INTEGRATED VOLTAGE REFERENCE
TEXAS INSTR (LIN/INTFC)

TYPICAL APPLICATION DATA

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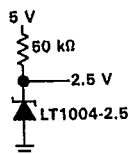
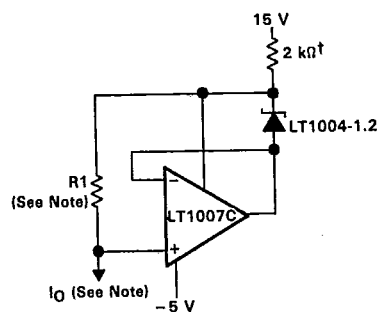


FIGURE 24. 2.5-V REFERENCE



† May be increased for small output currents.

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

FIGURE 25. GROUND-REFERENCED CURRENT SOURCE

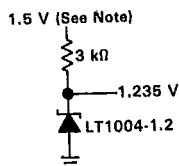
NOTE: Output regulates down to 1.285 V for $I_Q = 0$.

FIGURE 26. 1.2-V REFERENCE FROM 1.5-V BATTERY

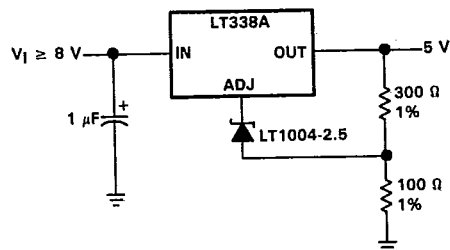


FIGURE 27. HIGH-STABILITY 5-V REGULATOR

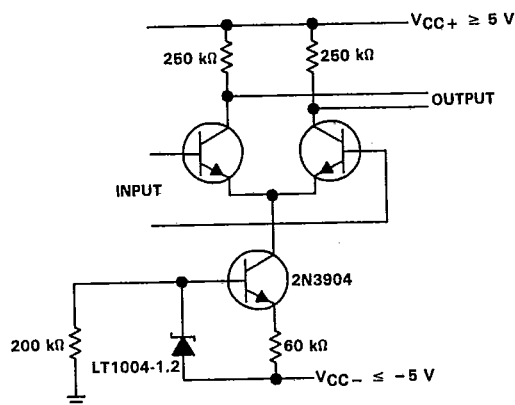
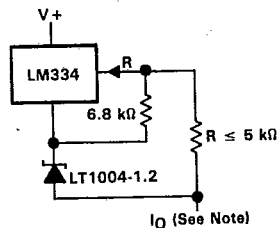


FIGURE 28. AMPLIFIER WITH CONSTANT GAIN OVER TEMPERATURE



$$\text{NOTE: } I_Q \approx \frac{1.3 \text{ V}}{R}$$

FIGURE 29. 2-TERMINAL CURRENT SOURCE WITH LOW TEMPERATURE COEFFICIENT

2

Data Sheets

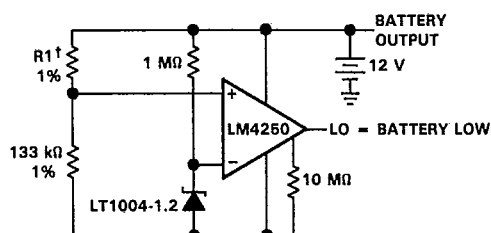
LT1004

MICROPOWER INTEGRATED VOLTAGE REFERENCE

TEXAS INSTR (LIN/INTFC)

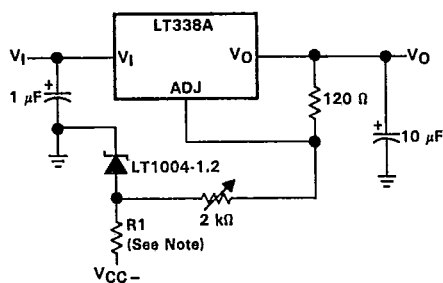
TYPICAL APPLICATION DATA

T-58-07



† R1 sets trip point, 60.4 kΩ per cell for 1.8 V per cell.

FIGURE 30. LEAD-ACID LOW-BATTERY-VOLTAGE DETECTOR



NOTE: $R1 \leq \frac{V_{CC} - 1 \text{ V}}{0.015}$

FIGURE 31. VARIABLE-VOLTAGE SUPPLY