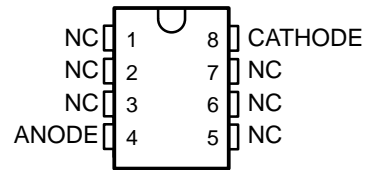


# LM185-2.5, LM285-2.5, LM385-2.5, LM385B-2.5, LM385Y-2.5 MICROPOWER VOLTAGE REFERENCES

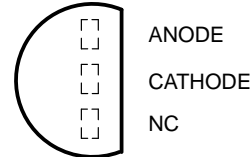
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- Operating Current Range . . . 20  $\mu$ A to 20 mA
- 1.5% and 3% Initial Voltage Tolerance
- Reference Impedance
  - LM185 . . . 0.6  $\Omega$  Max at 25°C
  - LM385 . . . 1  $\Omega$  Max at 25°C
  - All Devices . . . 1.5  $\Omega$  Max Over Full Temperature Range
- Very Low Power Consumption
- Applications:
  - Portable Meter References
  - Portable Test Instruments
  - Battery-Operated Systems
  - Current-Loop Instrumentation
  - Panel Meters
- Designed to be Interchangeable With National LM185-2.5, LM285-2.5, and LM385-2.5

**D PACKAGE  
(TOP VIEW)**



**LP PACKAGE  
(TOP VIEW)**



NC—No internal connection

**symbol**



## description

These micropower two-terminal band-gap voltage references operate over a 20- $\mu$ A to 20-mA current range and feature exceptionally low dynamic impedance and good temperature stability. On-chip trimming provides tight voltage tolerance. The LM185-2.5 series band-gap reference has low noise and long-term stability.

The LM185-2.5 series design makes these devices exceptionally tolerant of capacitive loading and thus easier to use in most reference applications. The wide dynamic operating temperature range accommodates varying current supplies with excellent regulation.

The extremely low power drain of the LM185-2.5 series makes them useful for micropower circuitry. These voltage references can make portable meters, regulators, or general-purpose analog circuitry with battery life approaching shelf life. The wide operating current range allows them to replace older references with tighter tolerance parts.

The LM385-2.5 and LM385B-2.5 are characterized for operation from 0°C to 70°C. The LM285-2.5 is characterized for operation from –40°C to 85°C. The LM185-2.5 is characterized for operation over the full military temperature range of –55°C to 125°C.

**AVAILABLE OPTIONS**

T <sub>A</sub>	V <sub>Z</sub> TOLERANCE	PACKAGED DEVICES†		CHIP FORM (Y)
		SMALL OUTLINE (D)	PLASTIC (LP)	
0°C to 70°C	3%	LM385D-2.5	LM385LP-2.5	LM385Y-2.5
	1.5%	LM385BD-2.5	LM385BLP-2.5	
–40°C to 85°C	1.5%	LM285D-2.5	LM285LP-2.5	
–55°C to 125°C	1.5%	LM185D-2.5	LM185LP-2.5	

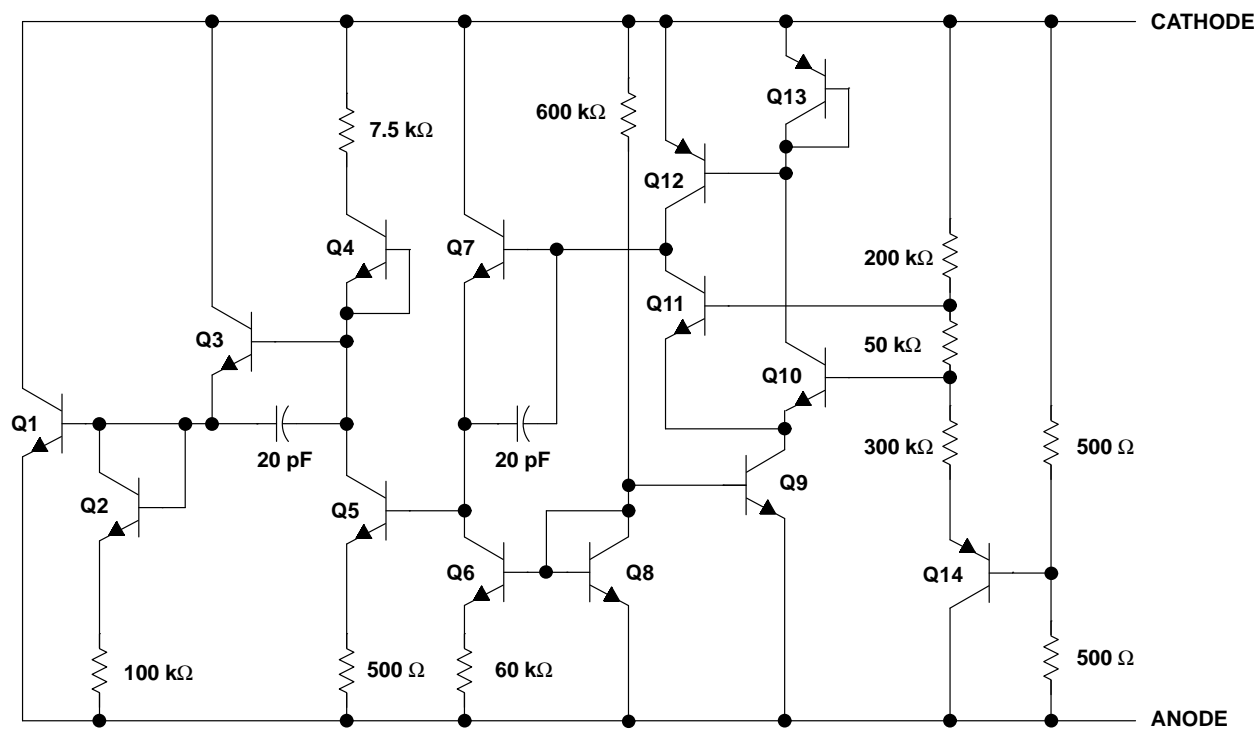
† For ordering purposes, the decimal point in the part number must be replaced with a hyphen (i.e., show the -2.5 suffix as “-2-5”).

The D package is available taped and reeled. Add the suffix R to the device type (e.g., LM385DR-2-5).

LM185-2.5, LM285-2.5, LM385-2.5, LM385B-2.5, LM385Y-2.5  
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schematic



NOTE A: All component values shown are nominal.

absolute maximum ratings over operating free-air temperature range†

Reverse current, $I_R$	30 mA
Forward current, $I_F$	10 mA
Operating free-air temperature range, $T_A$ : LM185-2.5	–55°C to 125°C
LM285-2.5	–40°C to 85°C
LM385-2.5, LM385B-2.5	0°C to 70°C
Storage temperature range, $T_{stg}$	–65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from cases for 10 seconds	260°C

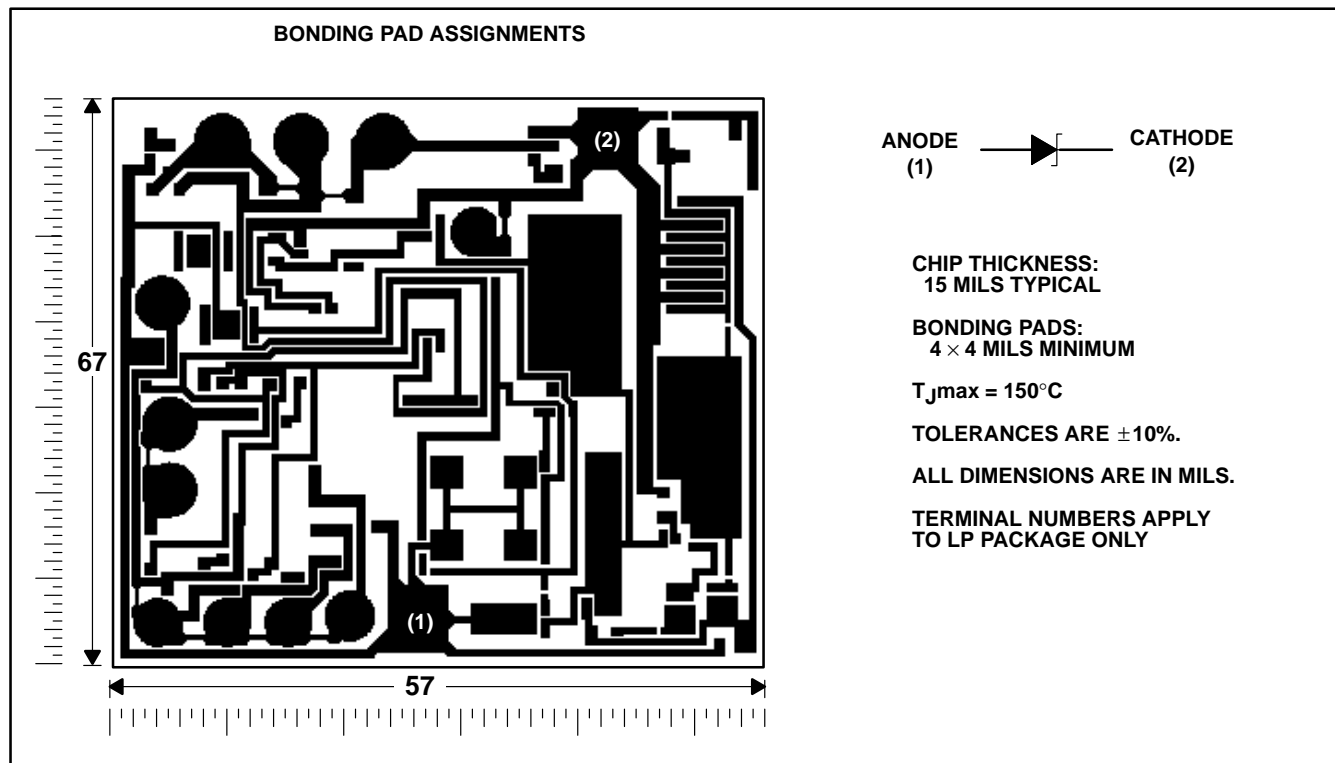
† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

recommended operating conditions

		MIN	MAX	UNIT
Reference current, $I_Z$		0.02	20	mA
Operating free-air temperature range, $T_A$	LM185-2.5	–55	125	°C
	LM285-2.5	–40	85	
	LM385-2.5, LM385B-2.5	0	70	

## LM385Y-2.5 chip information

This chip, when properly assembled, displays characteristics similar to the LM385-2.5 (see electrical tables). Thermal compression or ultrasonic bonding can be used on the doped aluminum bonding pads. The chip can be mounted with conductive epoxy or a gold-silicon preform.



# LM185-2.5, LM285-2.5, LM385B-2.5, LM385Y-2.5 MICROPOWER VOLTAGE REFERENCES

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electrical characteristics at specified free-air temperature

PARAMETER	TEST CONDITIONS	T <sub>A</sub> <sup>†</sup>	LM185-2.5 LM285-2.5			LM385-2.5			LM385B-2.5			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V <sub>Z</sub>	Reference voltage	25°C	2.462	2.5	2.538	2.425	2.5	2.575	2.462	2.5	2.538	V
α <sub>VZ</sub>	Average temperature coefficient of reference voltage <sup>‡</sup>	25°C	±20			±20			±20			ppm/°C
ΔV <sub>Z</sub>	Change in reference voltage with current	25°C	1			2			2			mV
		Full range	1.5			2			2			
		25°C	10			20			20			
		Full range	30			30			30			
ΔV <sub>Z</sub> /Δt	Long-term change in reference voltage	25°C	±20			±20			±20			ppm/khr
I <sub>Z(min)</sub>	Minimum reference current	Full range	8			8			8			μA
Z <sub>Z</sub>	Reference impedance	25°C	0.2			0.4			0.4			Ω
		Full range	1.5			1.5			1.5			
V <sub>n</sub>	Broadband noise voltage	25°C	120			120			120			μV

† Full range is 0°C to 70°C for the LM385-2.5 and LM385B-2.5, –40°C to 85°C for the LM285-2.5, and –55°C to 125°C for the LM185-2.5.

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



# LM185-2.5, LM285-2.5, LM385-2.5, LM385B-2.5, LM385Y-2.5 MICROPOWER VOLTAGE REFERENCES

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## electrical characteristics at $T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	LM385Y-2.5			UNIT
		MIN	TYP	MAX	
$V_Z$ Reference voltage	$I_Z = 20\ \mu\text{A to } 20\ \text{mA}$	2.462	2.5	2.575	V
$\alpha_{VZ}$ Average temperature coefficient of reference voltage <sup>†</sup>	$I_Z = 20\ \mu\text{A to } 20\ \text{mA}$	$\pm 20$			ppm/ $^\circ\text{C}$
$\Delta V_Z/\Delta t$ Long-term change in reference voltage	$I_Z = 100\ \mu\text{A}$	$\pm 20$			ppm/khr
$z_Z$ Reference impedance	$I_Z = 100\ \mu\text{A}$	0.4      1			$\Omega$
$V_n$ Broadband noise voltage	$I_Z = 100\ \mu\text{A},$ $f = 10\ \text{Hz to } 10\ \text{kHz}$	120			$\mu\text{V}$

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



# LM185-2.5, LM285-2.5, LM385-2.5, LM385B-2.5, LM385Y-2.5 MICROPOWER VOLTAGE REFERENCES

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## TYPICAL CHARACTERISTICS†

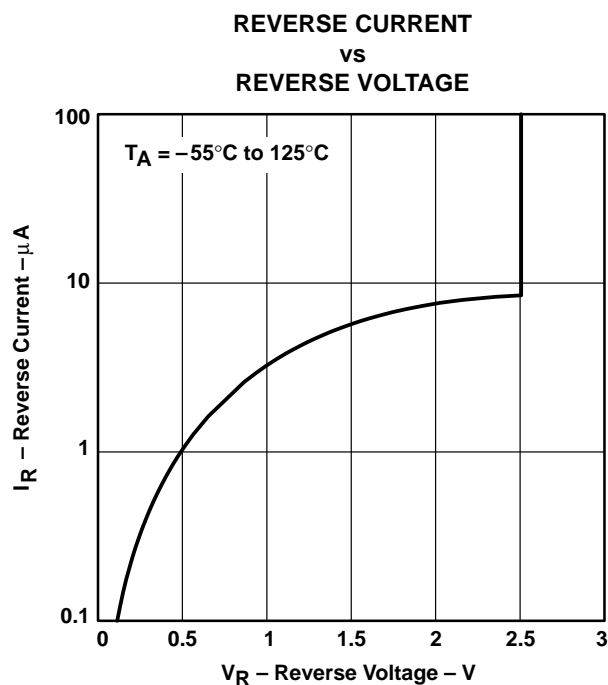


Figure 1

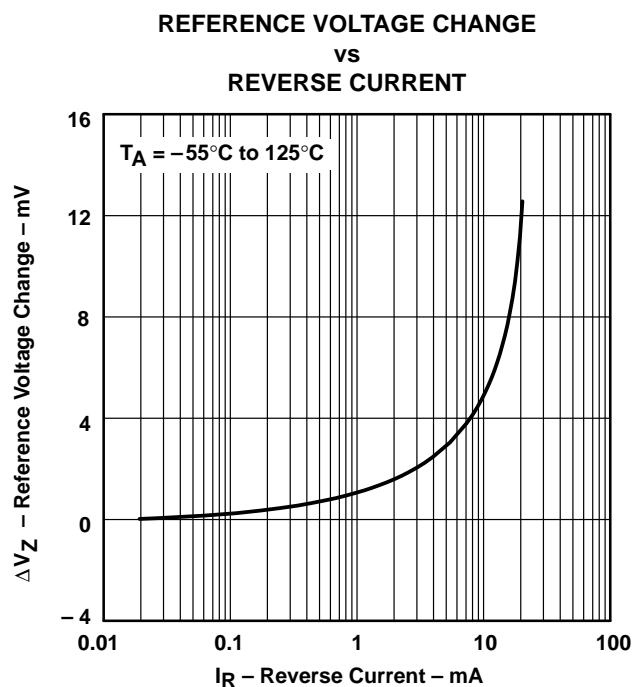


Figure 2

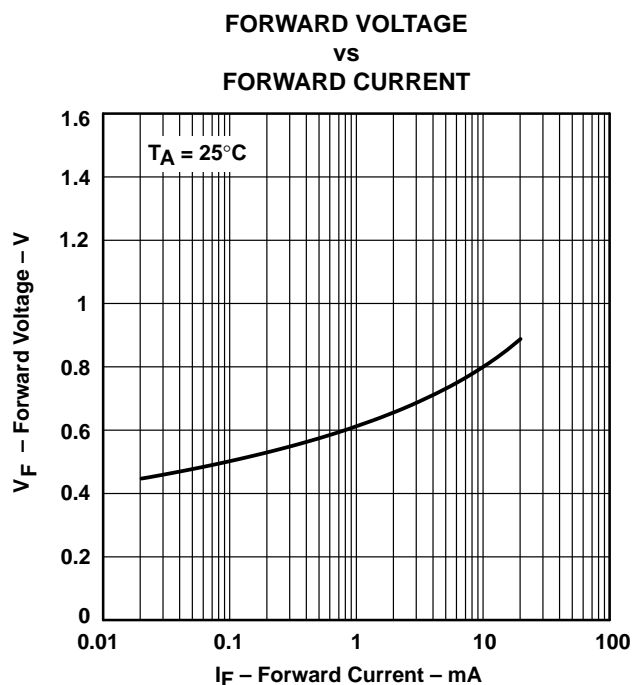


Figure 3

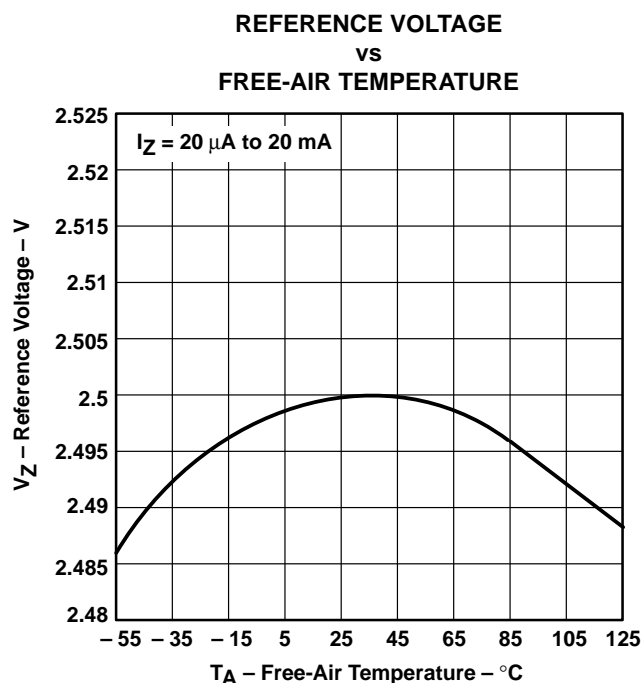


Figure 4

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

# TYPICAL CHARACTERISTICS†

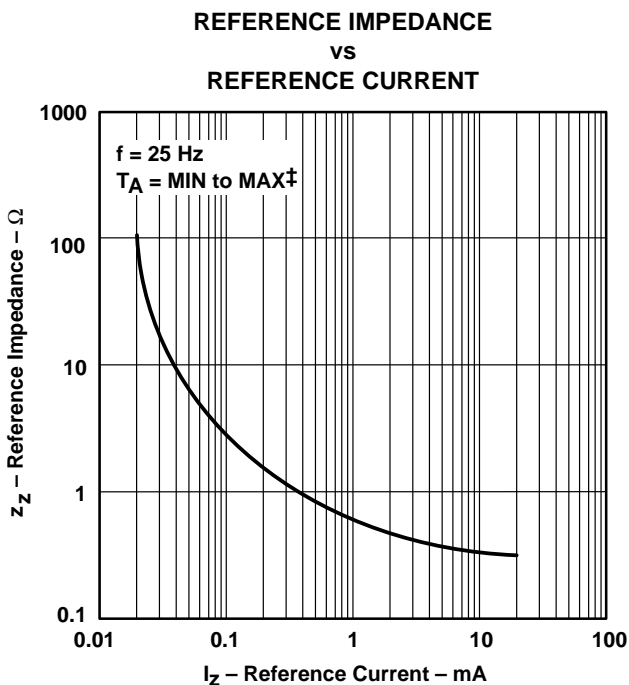


Figure 5

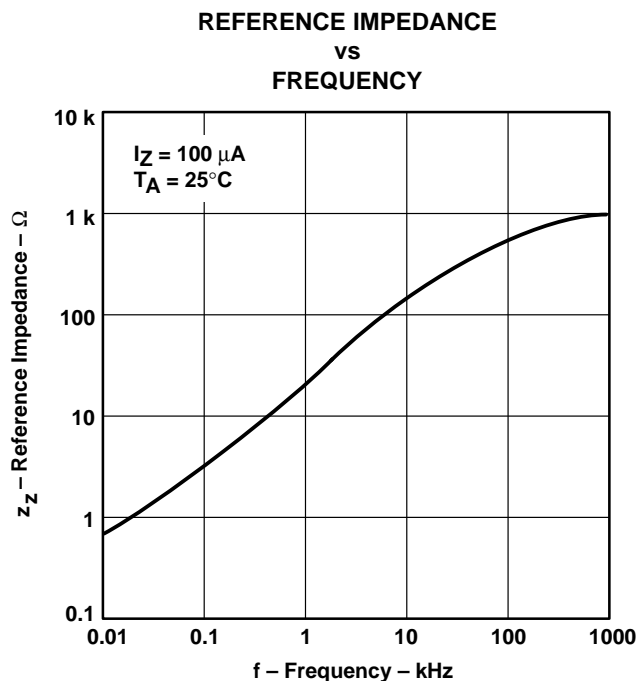


Figure 6

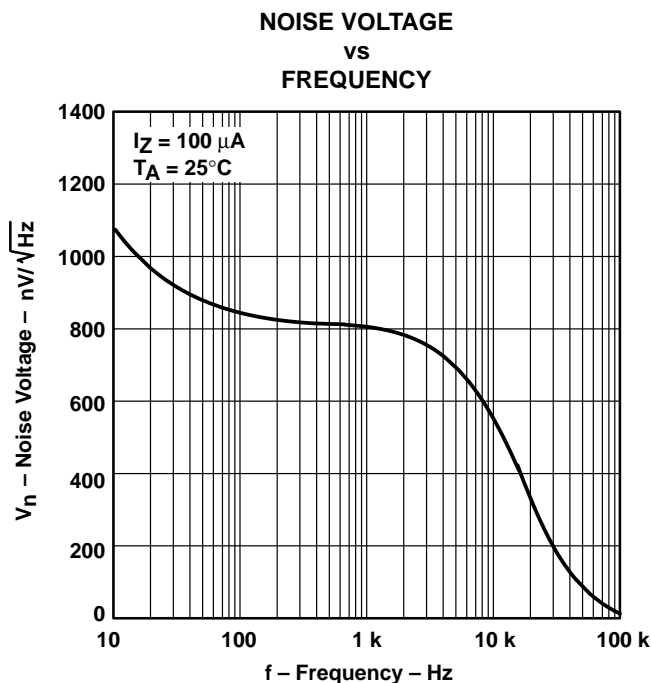


Figure 7

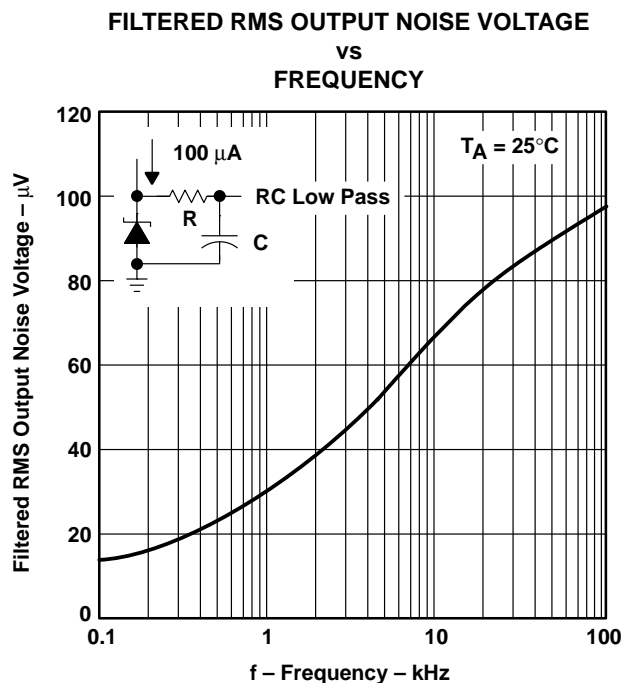


Figure 8

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

‡ For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

# LM185-2.5, LM285-2.5, LM385-2.5, LM385B-2.5, LM385Y-2.5 MICROPOWER VOLTAGE REFERENCES

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## TYPICAL CHARACTERISTICS†

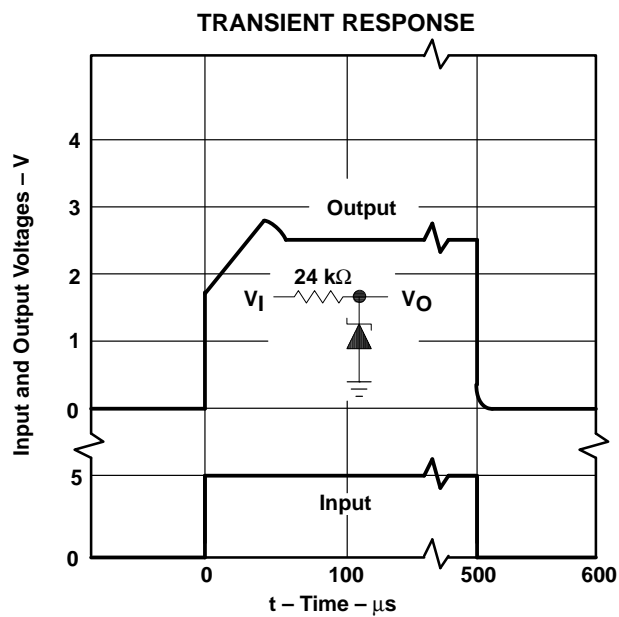
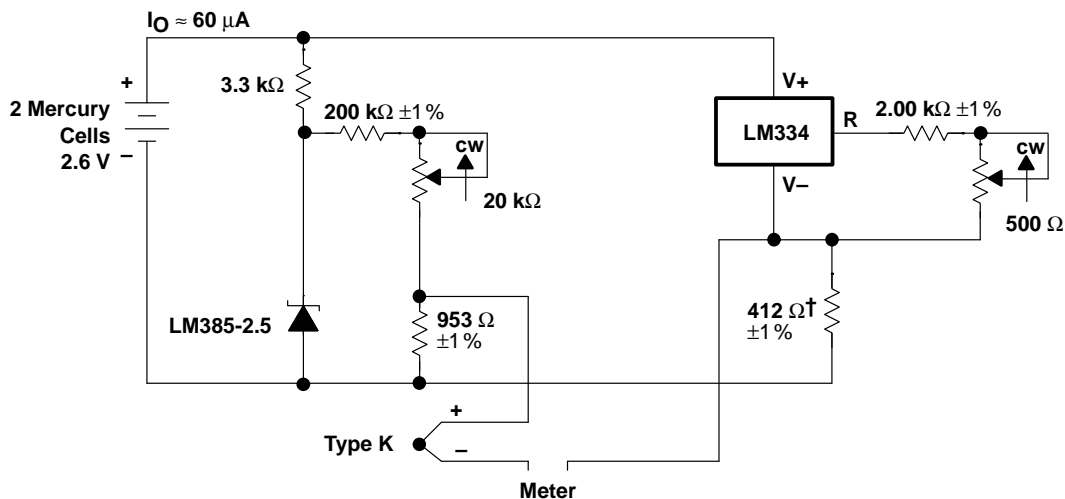


Figure 9

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

# APPLICATION INFORMATION



†Adjust for 12.17 mV at 25°C across 412  $\Omega$

Figure 10. Thermocouple Cold-Junction Compensator

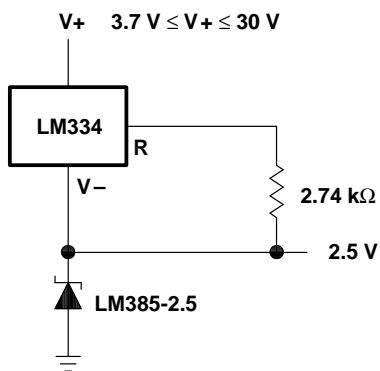


Figure 11. Operation Over a Wide Supply Range

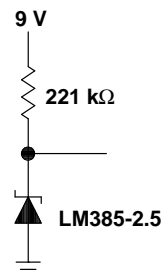


Figure 12. Reference From a 9-V Battery



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