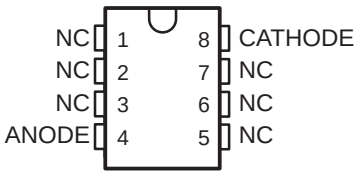
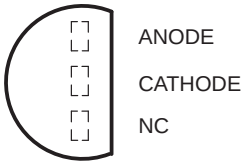
SLVS023D – JANUARY 1989 – REVISED OCTOBER 1995

- **Operating Current Range . . . 20 μA to 20 mA**
- **1.5% and 3% Initial Voltage Tolerance**
- **Reference Impedance**
  - **LM185 . . . 0.6 Ω Max at 25°C**
  - **LM385 . . . 1 Ω Max at 25°C**
  - **All Devices . . . 1.5 Ω 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-μA 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.

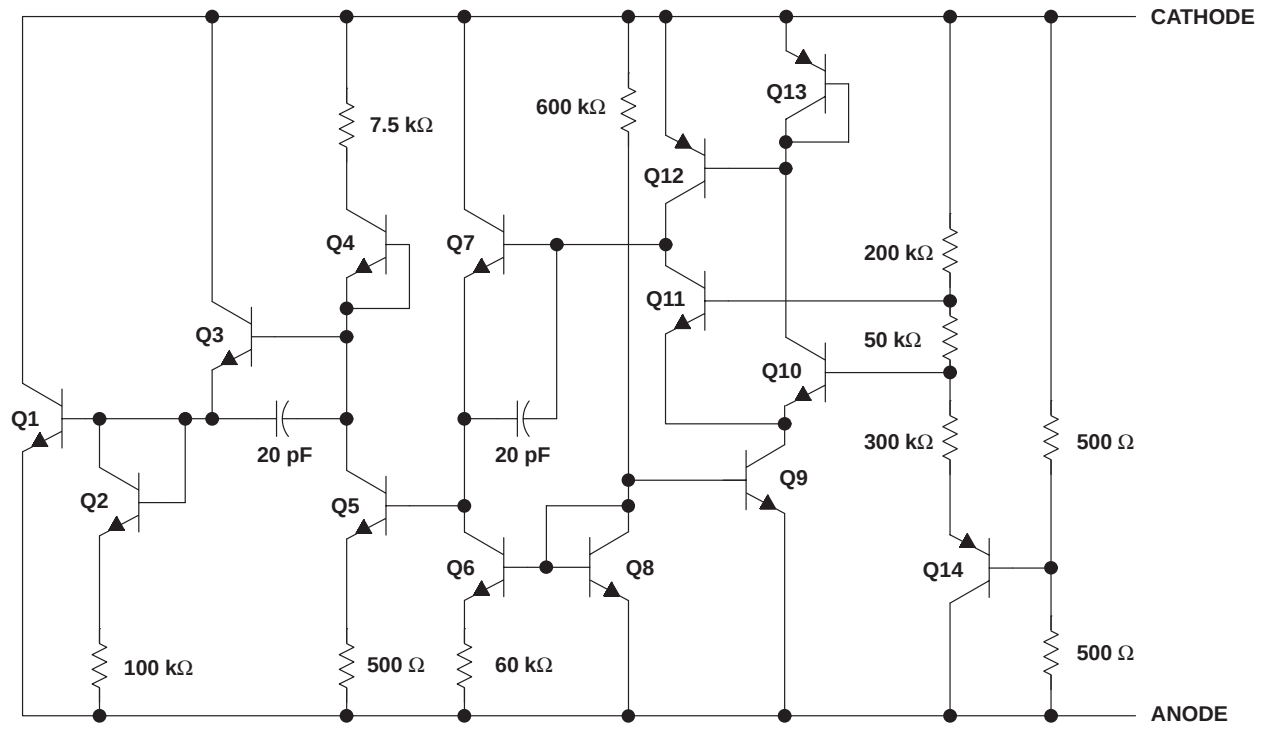
The LM385-2.5 and LM385B-2.5 are characterized for operation from 0°C to 70°C. The LM285-2.5 is characterized for operation from –40°C to 85°C. The LM185-2.5 is characterized for operation over the full military temperature range of –55°C to 125°C.

AVAILABLE OPTIONS

T_A	V_Z 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).

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.

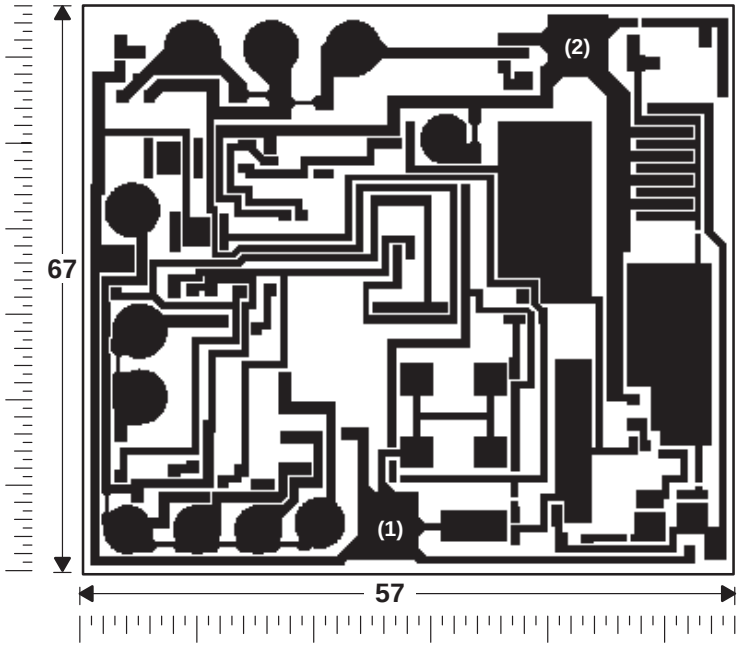
recommended operating conditions

		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.

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

electrical characteristics at specified free-air temperature

PARAMETER		TEST CONDITIONS	T_A†	LM185-2.5 LM285-2.5			LM385-2.5			LM385B-2.5			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_Z	Reference voltage	I_Z = 20 μA to 20 mA	25°C	2.462	2.5	2.538	2.425	2.5	2.575	2.462	2.5	2.538	V
α_{VZ}	Average temperature coefficient of reference voltage‡	I_Z = 20 μA to 20 mA	25°C		±20			±20			±20		ppm/°C
ΔV_Z	Change in reference voltage with current	I_Z = 20 μA to 1 mA	25°C			1			2			2	mV
			Full range			1.5			2			2	
		I_Z = 1 μA to 20 mA	25°C			10			20			20	
			Full range			30			30			30	
$\Delta V_Z/\Delta t$	Long-term change in reference voltage	I_Z = 100 μA	25°C		±20			±20			±20		ppm/khr
$I_{Z(min)}$	Minimum reference current		Full range		8	20		8	20		8	20	μA
z_z	Reference impedance	I_Z = 100 μA	25°C		0.2	0.6		0.4	1		0.4	1	Ω
			Full range			1.5			1.5			1.5	
V_n	Broadband noise voltage	I_Z = 100 μA, f = 10 Hz to 10 kHz	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.

TEXAS INSTRUMENTS
POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

electrical characteristics at T_A = 25°C

PARAMETER		TEST CONDITIONS	LM385Y-2.5			UNIT
			MIN	TYP	MAX	
V_Z	Reference voltage	I_Z = 20 μA to 20 mA	2.462	2.5	2.575	V
α_{VZ}	Average temperature coefficient of reference voltage †	I_Z = 20 μA to 20 mA		±20		ppm/°C
$\Delta V_Z/\Delta t$	Long-term change in reference voltage	I_Z = 100 μA		±20		ppm/khr
z_z	Reference impedance	I_Z = 100 μA		0.4	1	Ω
V_n	Broadband noise voltage	I_Z = 100 μA, f = 10 Hz to 10 kHz		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†

REVERSE CURRENT vs REVERSE VOLTAGE

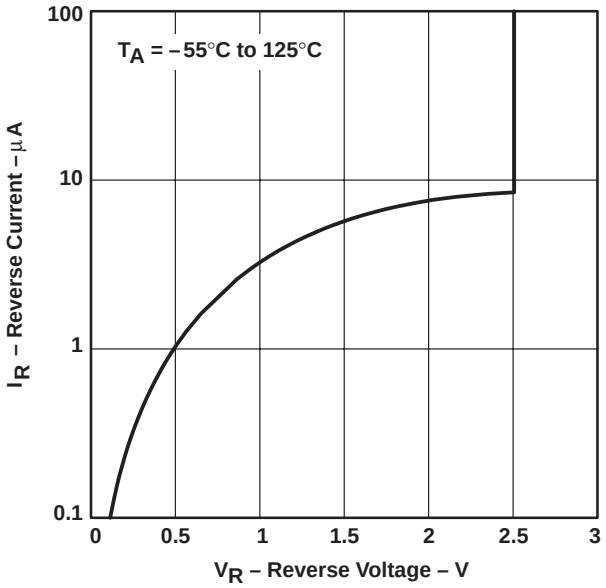


Figure 1

REFERENCE VOLTAGE CHANGE vs REVERSE CURRENT

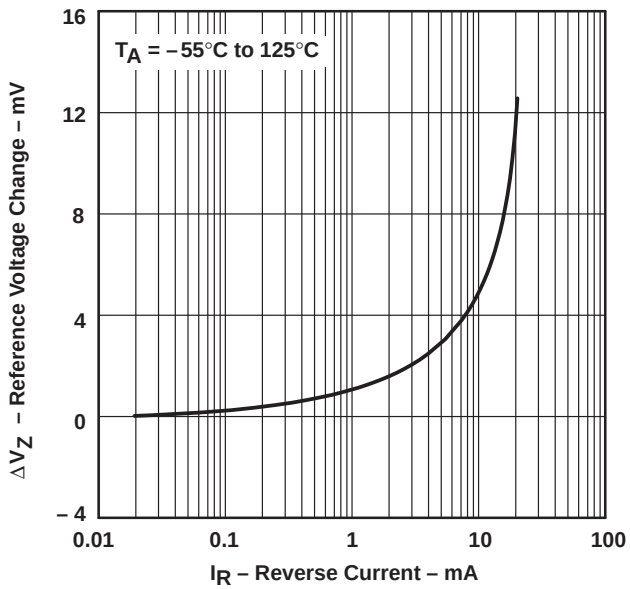


Figure 2

FORWARD VOLTAGE vs FORWARD CURRENT

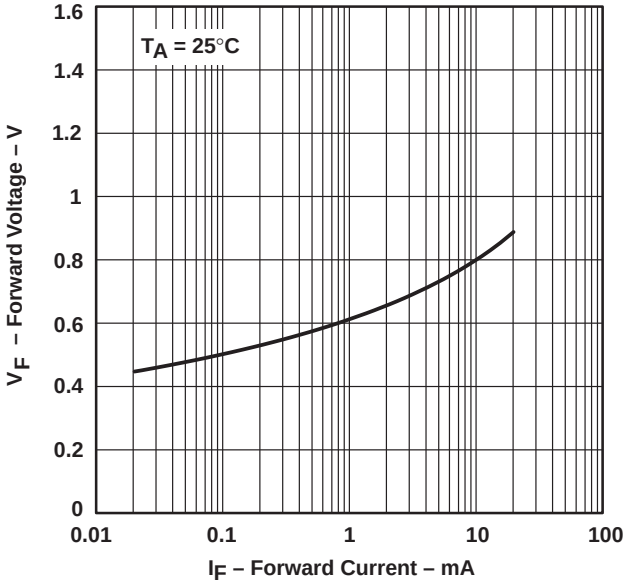


Figure 3

REFERENCE VOLTAGE vs FREE-AIR TEMPERATURE

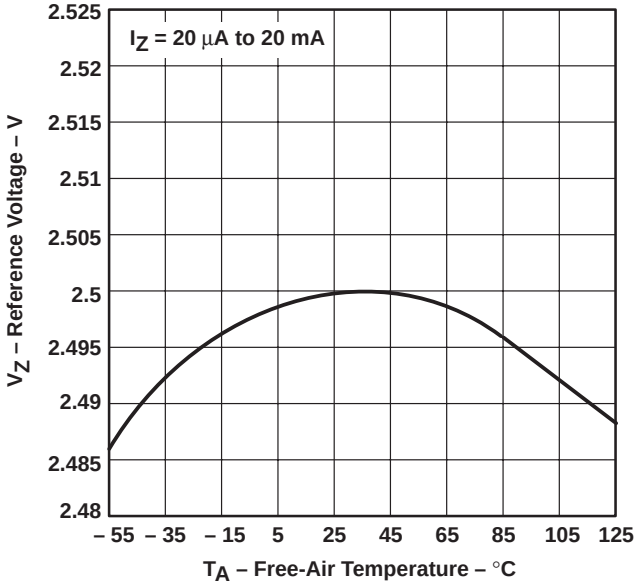


Figure 4

† 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

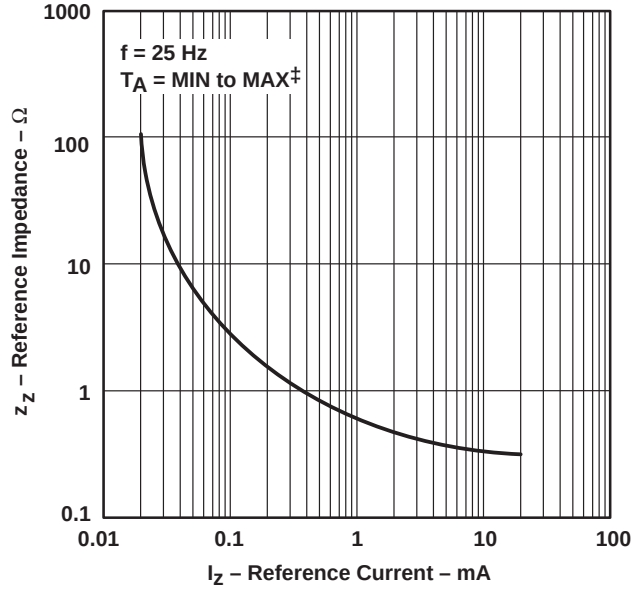


Figure 5

REFERENCE IMPEDANCE vs FREQUENCY

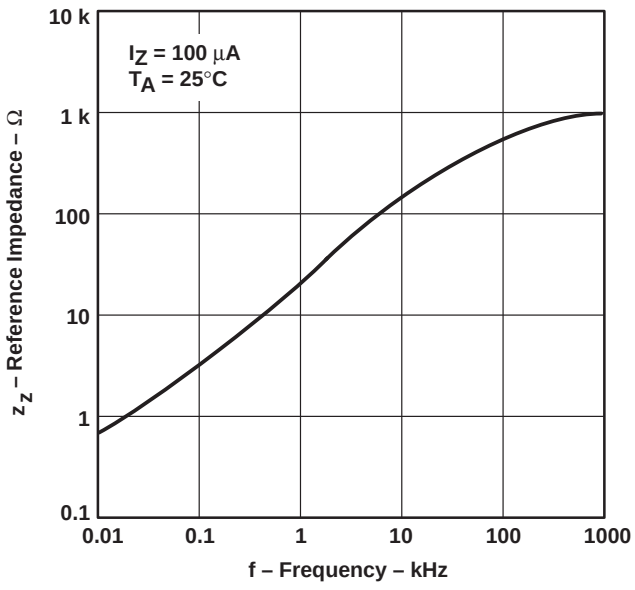


Figure 6

NOISE VOLTAGE vs FREQUENCY

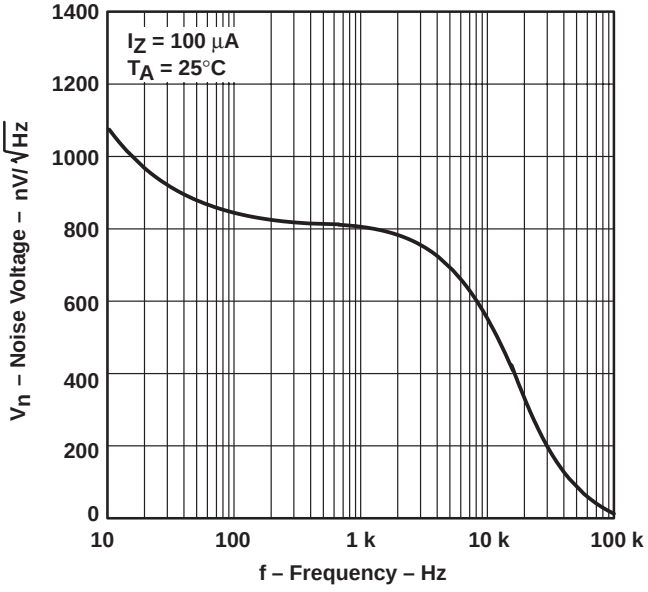


Figure 7

FILTERED RMS OUTPUT NOISE VOLTAGE vs FREQUENCY

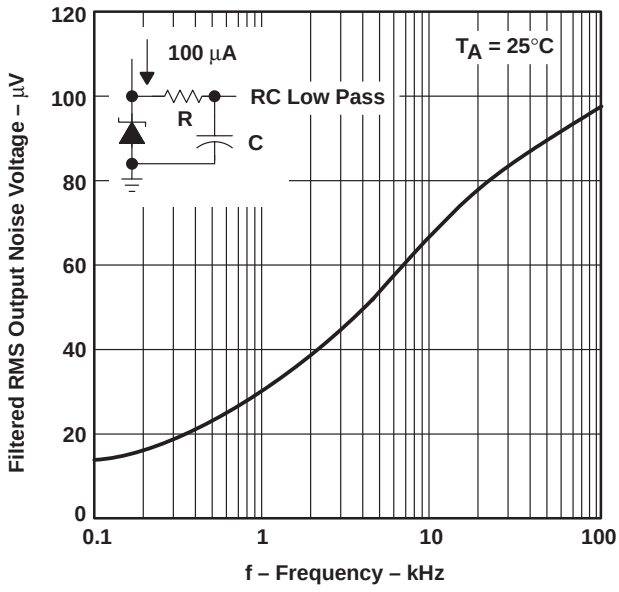


Figure 8

† 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.

TYPICAL CHARACTERISTICS†

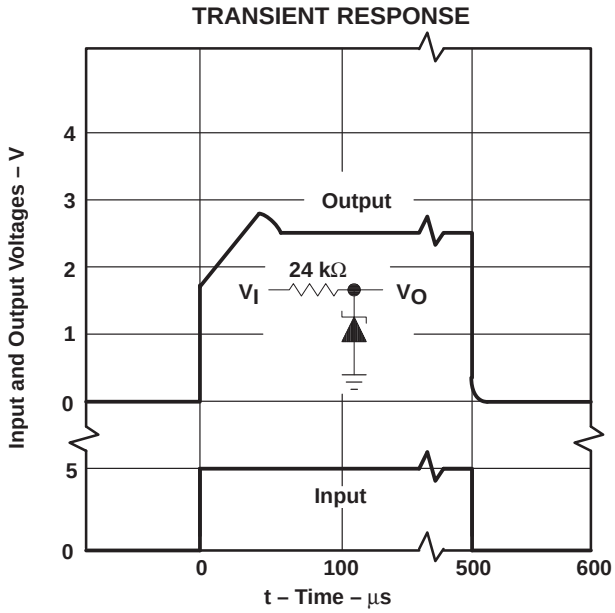
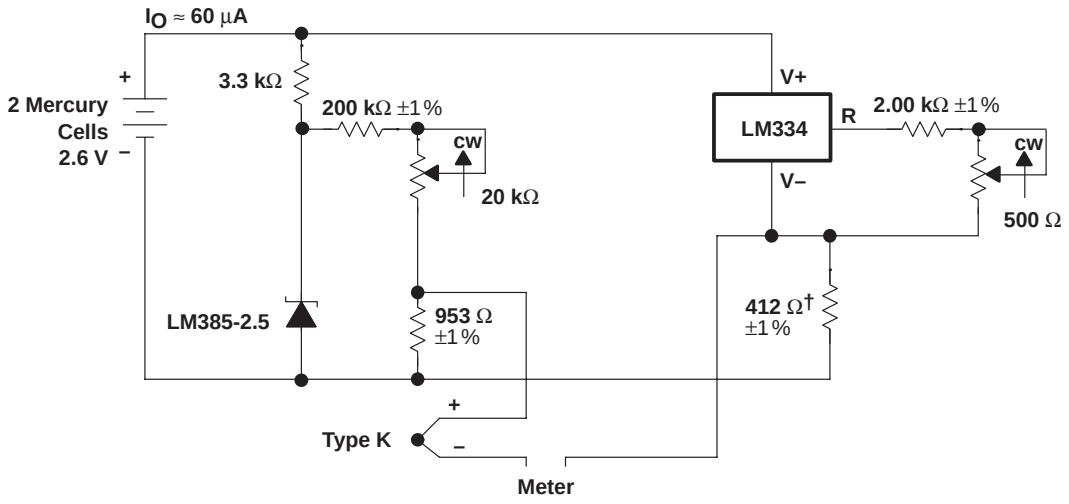


Figure 9

† 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 Ω

Figure 10. Thermocouple Cold-Junction Compensator

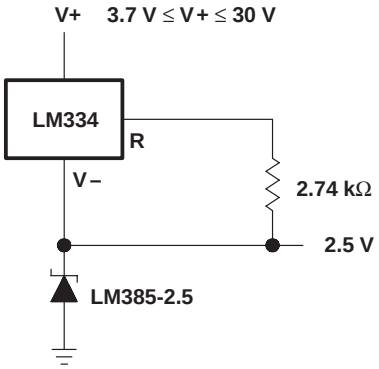


Figure 11. Operation Over a Wide Supply Range

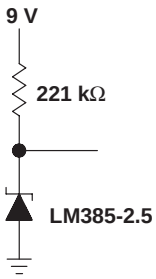


Figure 12. Reference From a 9-V Battery

IMPORTANT NOTICE

Texas Instruments and its subsidiaries (TI) reserve the right to make changes to their products or to discontinue any product or service without notice, and advise customers to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgement, including those pertaining to warranty, patent infringement, and limitation of liability.

TI warrants performance of its semiconductor products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are utilized to the extent TI deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except those mandated by government requirements.

CERTAIN APPLICATIONS USING SEMICONDUCTOR PRODUCTS MAY INVOLVE POTENTIAL RISKS OF DEATH, PERSONAL INJURY, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE ("CRITICAL APPLICATIONS"). TI SEMICONDUCTOR PRODUCTS ARE NOT DESIGNED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT DEVICES OR SYSTEMS OR OTHER CRITICAL APPLICATIONS. INCLUSION OF TI PRODUCTS IN SUCH APPLICATIONS IS UNDERSTOOD TO BE FULLY AT THE CUSTOMER'S RISK.

In order to minimize risks associated with the customer's applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance or customer product design. TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of TI covering or relating to any combination, machine, or process in which such semiconductor products or services might be or are used. TI's publication of information regarding any third party's products or services does not constitute TI's approval, warranty or endorsement thereof.