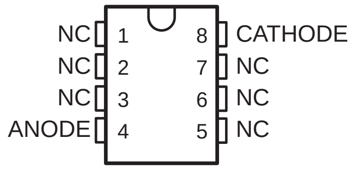
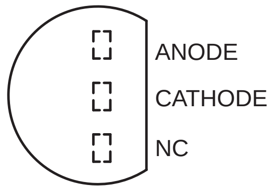
- **Operating Current Range**
  - **LM285 . . . 10 µA to 20 mA**
  - **LM385 . . . 15 µA to 20 mA**
  - **LM385B . . . 15 µA to 20 mA**
- **1% and 2% Initial Voltage Tolerance**
- **Reference Impedance**
  - **LM385 . . . 1 Ω Max at 25°C**
  - **All Devices . . . 1.5 Ω Max Over Full Temperature Range**
- **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 LM285-1.2 and LM385-1.2**

D PACKAGE
(TOP VIEW)



LP PACKAGE
(TOP VIEW)



NC–No internal connection

description

These micropower, two-terminal, band-gap voltage references operate over a 10-µA to 20-mA current range and feature exceptionally low dynamic impedance and good temperature stability. On-chip trimming provides tight voltage tolerance. The band-gap reference for these devices has low noise and long-term stability.

The 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 this series makes them useful for micropower circuitry. These voltage references can be used to 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.

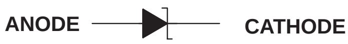
The LM285-1.2 is characterized for operation from –40°C to 85°C. The LM385-1.2 and LM385B-1.2 are characterized for operation from 0°C to 70°C.

AVAILABLE OPTIONS

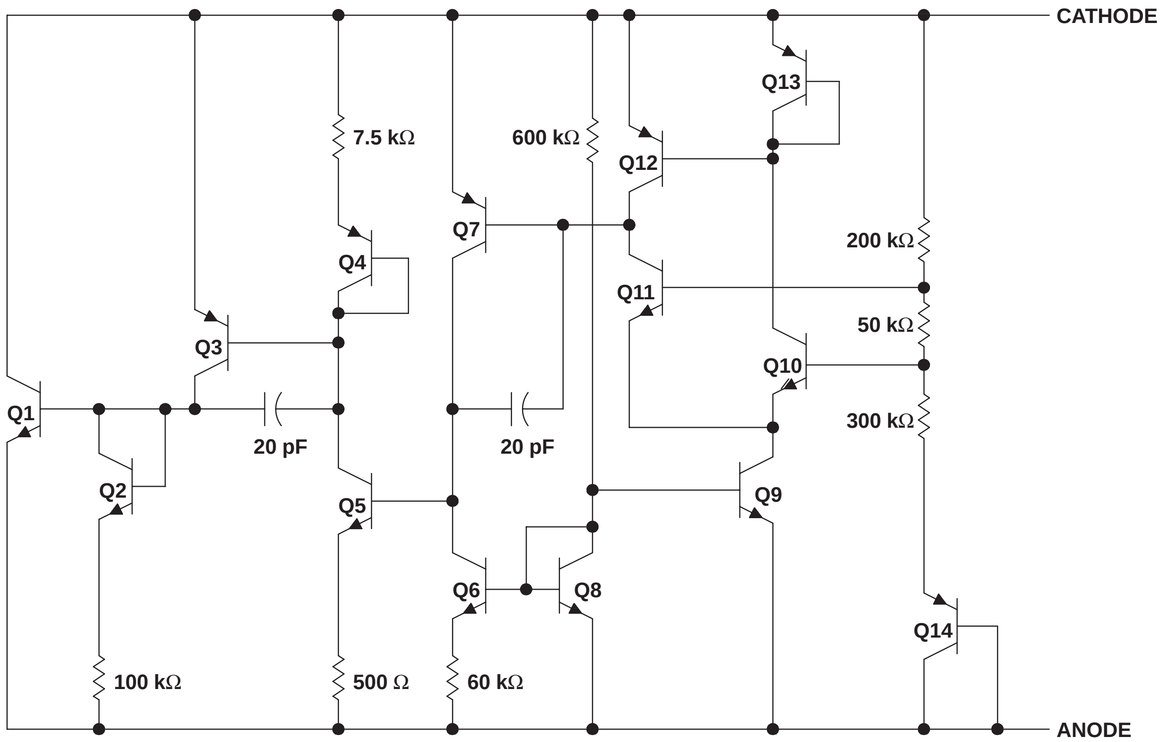
T_A	V_Z TOLERANCE	PACKAGED DEVICES†		CHIP FORM (Y)
		SMALL OUTLINE (D)	PLASTIC (LP)	
0°C to 70°C	2%	LM385D-1.2	LM385LP-1.2	LM385Y-1.2
	1%	LM385BD-1.2	LM385BLP-1.2	
–40°C to 85°C	1%	LM285D-1.2	LM285LP-1.2	

The D package is available taped and reeled. Add the suffix R to the device type (e.g., LM385DR-1-2). The chip form is tested at T_A = 25°C.
† For ordering purposes, the decimal point in the part number must be replaced with a hyphen (i.e., show the -1.2 suffix as “-1-2”).

symbol



schematic



NOTE A: 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
Package thermal impedance, θ_{JA} (see Notes 1 and 2): D package .... 197°C/W
LP package .... 156°C/W
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds .... 260°C
Storage temperature range, T_{stg} .... –65°C to 150°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.

NOTES: 1. Maximum power dissipation is a function of $T_{J(max)}$, θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_{J(max)} – T_A)/\theta_{JA}$. Operation at the absolute maximum T_J of 150°C can impact reliability.
2. The package thermal impedance is calculated in accordance with JESD51, except for through-hole packages which use a trace length of zero.

recommended operating conditions

		MIN	MAX	UNIT
Reference current, I_Z		0.01	20	mA
Operating free-air temperature range, T_A	LM285-1.2	–40	85	°C
	LM385-1.2, LM385B-1.2	0	70	

electrical characteristics at specified free-air temperature

PARAMETER		TEST CONDITIONS	T_A†	LM285-1.2			LM385-1.2			LM385B-1.2			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_Z	Reference voltage	I_Z = I(min) to 20 mA‡	25°C	1.223	1.235	1.247	1.21	1.235	1.26	1.223	1.235	1.247	V
α_{VZ}	Average temperature coefficient of reference voltage§	I_Z = I(min) to 20 mA‡	25°C		±20			±20			±20		ppm/°C
ΔV_Z	Change in reference voltage with current	I_Z = I(min) to 1 mA‡	25°C			1			1			1	mV
			Full range			1.5			1.5			1.5	
		I_Z = 1 mA to 20 mA	25°C			12			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	10		8	15		8	15	µA
z_Z	Reference impedance	I_Z = 100 µA, f = 25 Hz	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		60			60			60		µV

† Full range is –40°C to 85°C for the LM285-1.2, and 0°C to 70°C for the LM385-1.2 and LM385B-1.2.
‡ I(min) = 10 µA for the LM285-1.2 and 15 µA for the LM385-1.2 and LM385B-1.2.
§ 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	LM385Y-1.2			UNIT
			MIN	TYP	MAX	
V_Z	Reference voltage	I_Z = 15 µA to 20 mA	1.21	1.235	1.26	V
α_{VZ}	Average temperature coefficient of reference voltage§	I_Z = 15 µA to 20 mA		±20		ppm/°C
ΔV_Z	Change in reference voltage with current	I_Z = 15 µA to 1 mA			1	mV
		I_Z = 1 mA to 20 mA			20	
$\Delta V_Z/\Delta t$	Long-term change in reference voltage	I_Z = 100 µA		±20		ppm/khr
I_Z(min)	Minimum reference current			8	15	µA
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		60		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

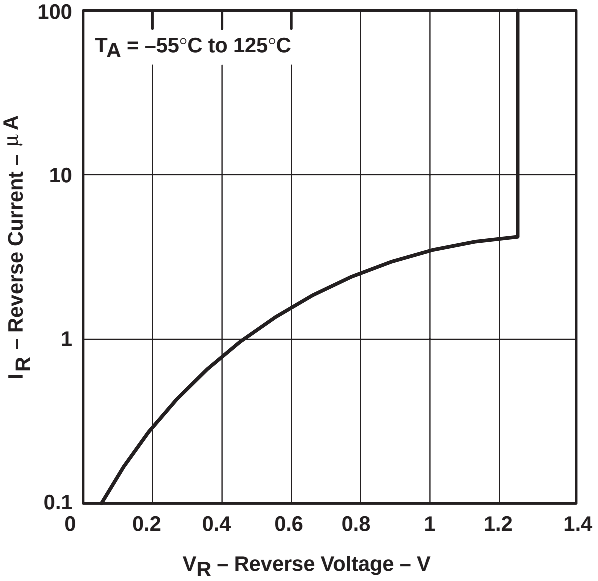


Figure 1

REFERENCE VOLTAGE CHANGE vs REVERSE CURRENT

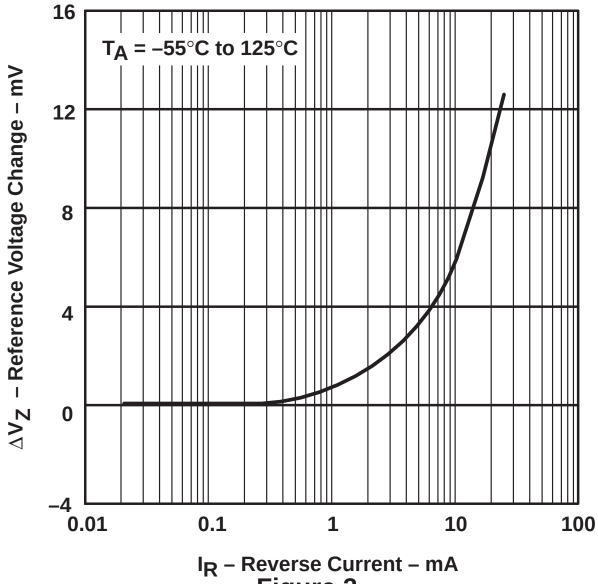


Figure 2

FORWARD VOLTAGE vs FORWARD CURRENT

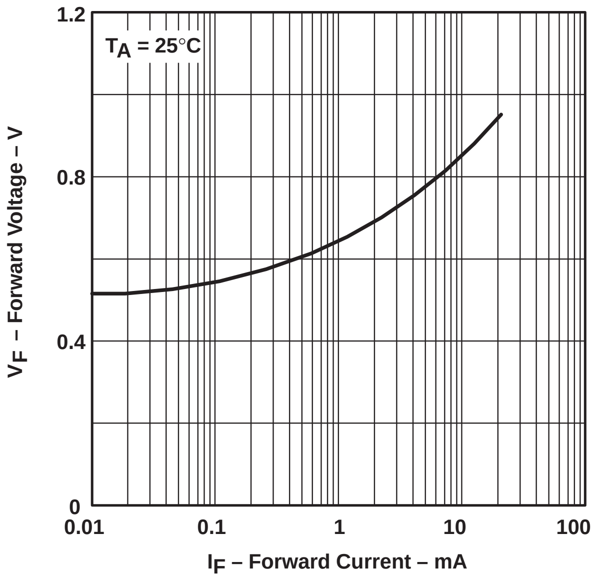


Figure 3

REFERENCE VOLTAGE vs FREE-AIR TEMPERATURE

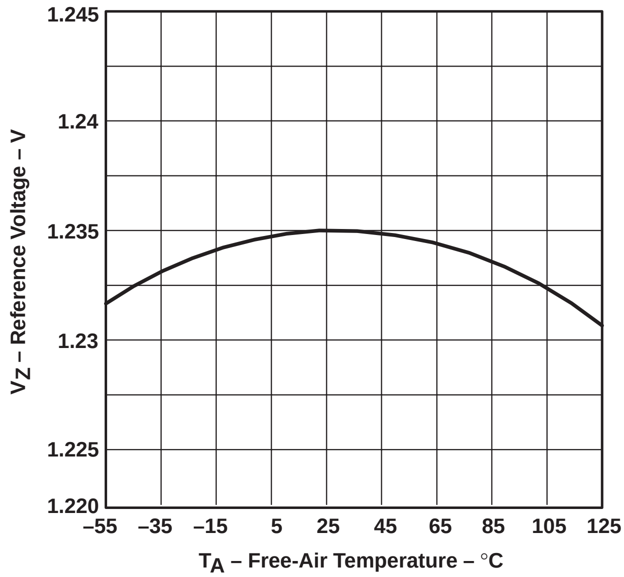


Figure 4

† 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

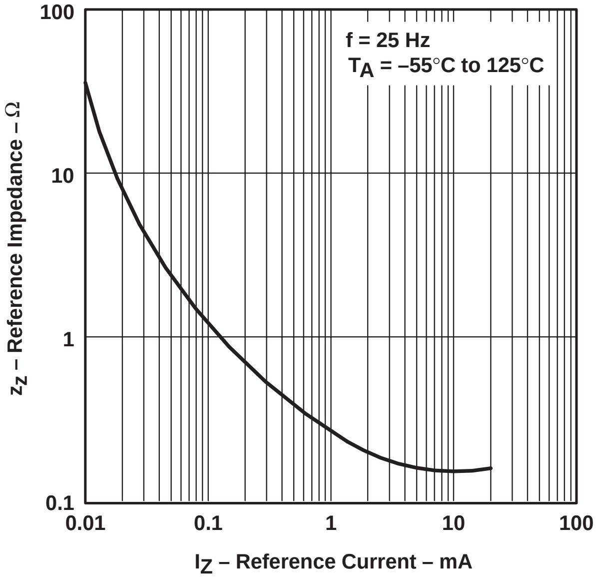


Figure 5

NOISE VOLTAGE vs FREQUENCY

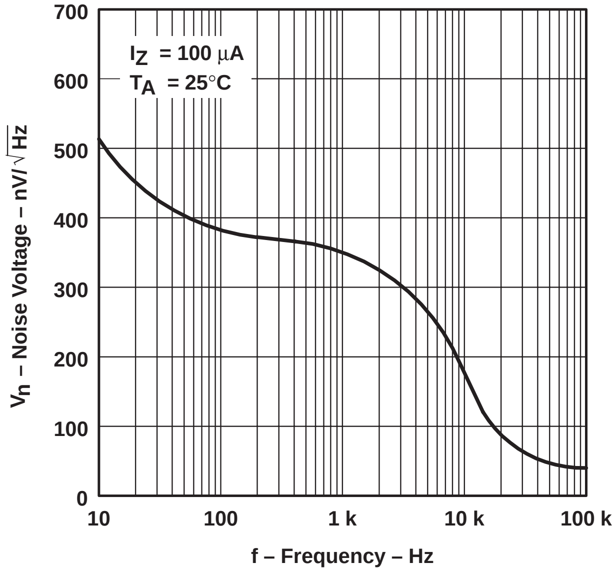


Figure 6

OUTPUT NOISE VOLTAGE vs CUTOFF FREQUENCY

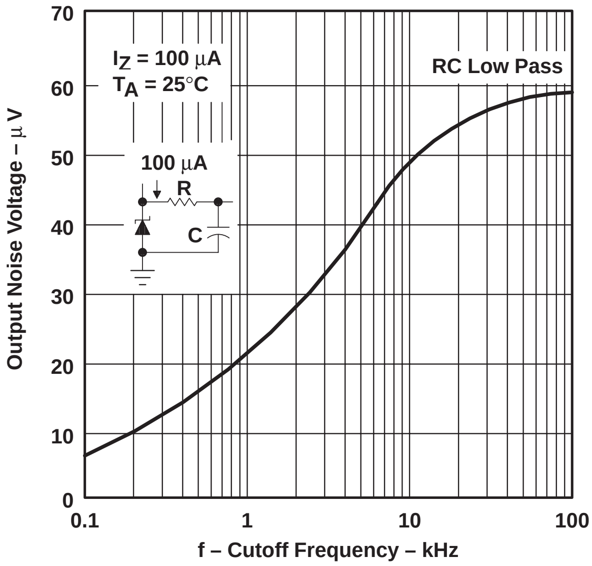


Figure 7

TRANSIENT RESPONSE

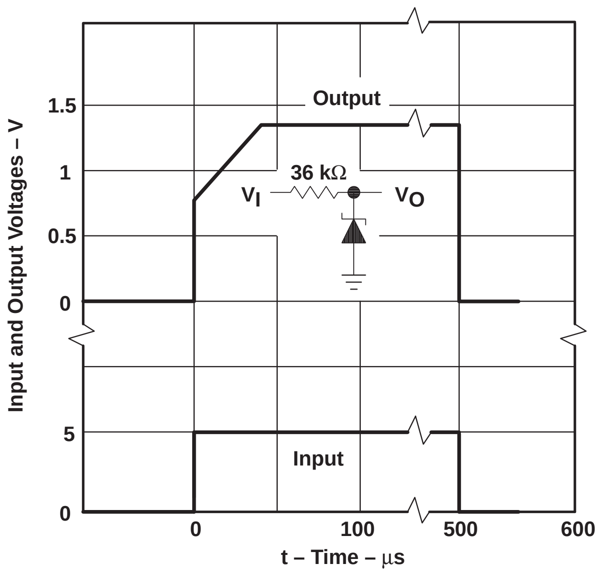
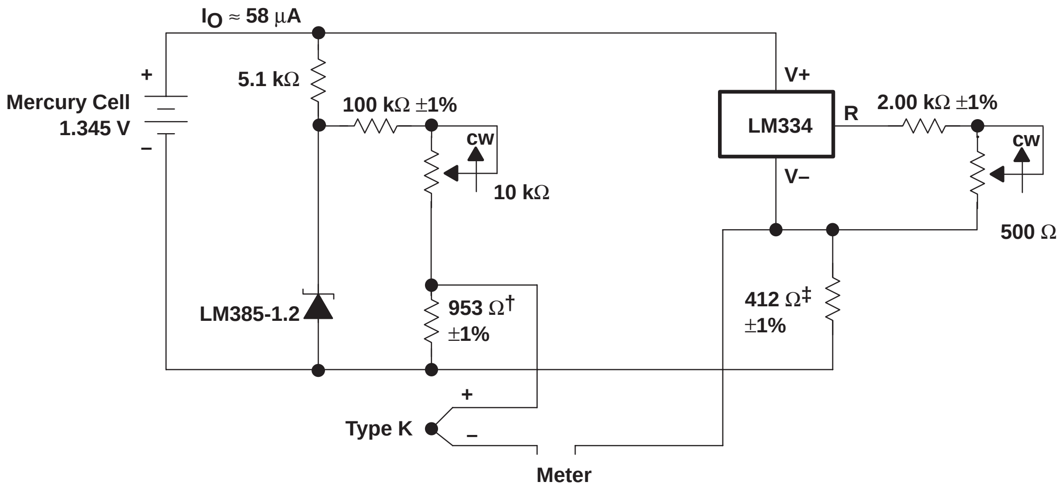


Figure 8

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

APPLICATION INFORMATION



† Adjust for 11.15 mV at 25°C across 953 Ω
‡ Adjust for 12.17 mV at 25°C across 412 Ω

Figure 9. Thermocouple Cold-Junction Compensator

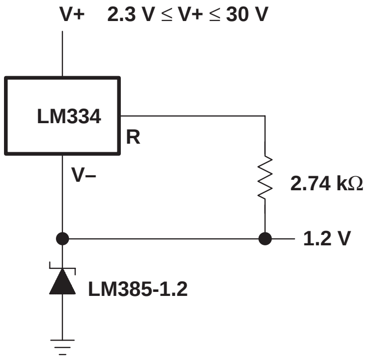


Figure 10. Operation Over a Wide Supply Range

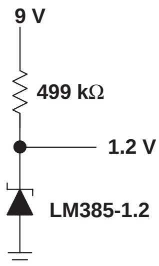


Figure 11. Reference From a 9-V Battery

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