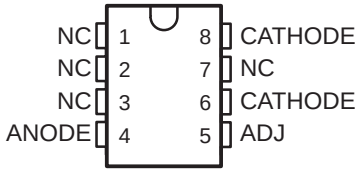
SLVS013G – MAY 1987 – REVISED NOVEMBER 1999

- **Excellent Temperature Stability**
- **Initial Tolerance . . . 0.2% Max**
- **Dynamic Impedance . . . 0.6 Ω Max**
- **Wide Operating Current Range**
- **Directly Interchangeable With LM136**
- **Needs No Adjustment for Minimum Temperature Coefficient**
- **Surface-Mount Three-Lead Package**

D PACKAGE
(TOP VIEW)



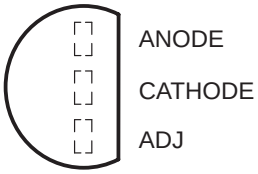
NC – No internal connection

description

The LT1009 reference circuit is a precision-trimmed 2.5-V shunt regulator featuring low dynamic impedance and a wide operating current range. The maximum initial tolerance is ±5 mV in the LP package and ±10 mV in the D package. The reference tolerance is achieved by on-chip trimming, which minimizes the initial voltage tolerance and the temperature coefficient α_{VZ}.

Although the LT1009 needs no adjustments, a third terminal (ADJ) allows the reference voltage to be adjusted ±5% to eliminate system errors. In many applications, the LT1009 can be used as a terminal-for-terminal replacement for the LM136-2.5, which eliminates the external trim network.

LP PACKAGE
(TOP VIEW)



logic symbol

The LT1009 uses include 5-V system references, 8-bit ADC and DAC references, and power-supply monitors. The device also can be used in applications such as digital voltmeters and current-loop measurement and control systems.

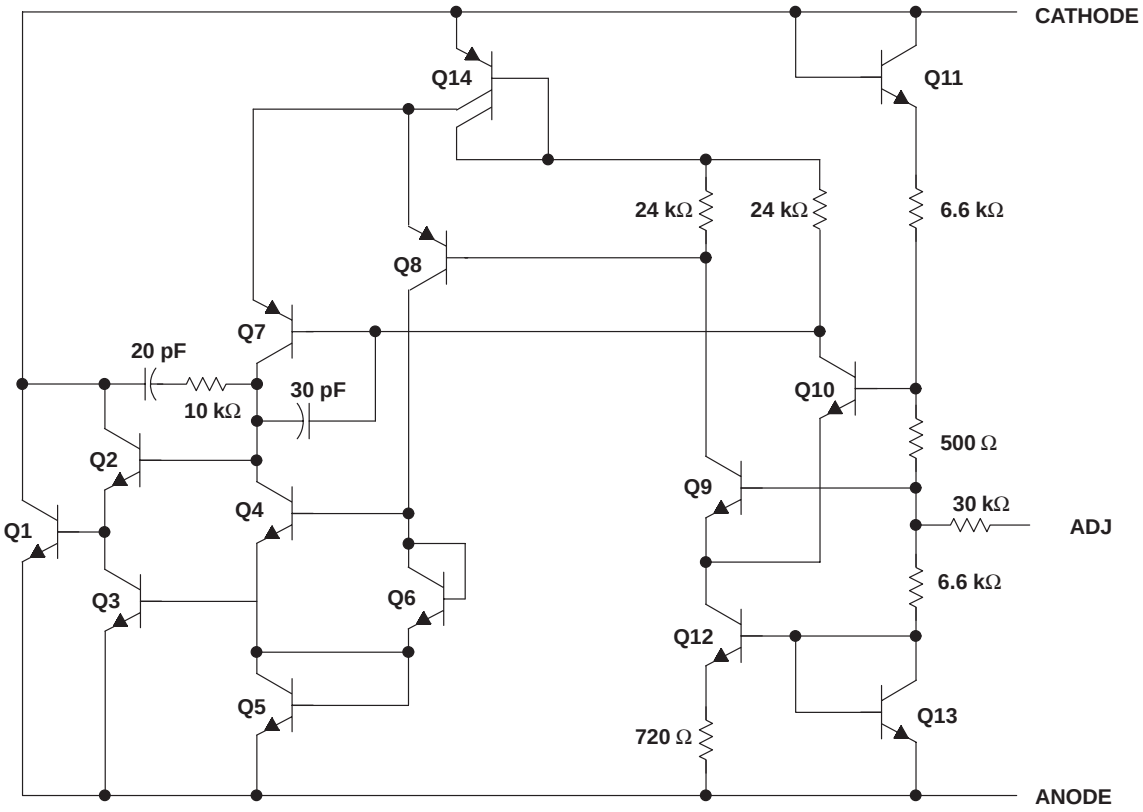
The LT1009C is characterized for operation from 0°C to 70°C. The LT1009I is characterized for operation from –40°C to 85°C.

AVAILABLE OPTIONS

T_A	PACKAGED DEVICES		CHIP FORM (Y)
	SMALL OUTLINE (D)	PLASTIC CYLINDRICAL (LP)	
0°C to 70°C	LT1009CD	LT1009CLP	LT1009Y
–40°C to 85°C	LT1009ID	LT1009ILP	

The D and LP packages are available taped and reeled. Add the suffix R to device type (e.g., LT1009CDR). Chip forms are tested at 25°C.

schematic



All component values shown are nominal.

absolute maximum ratings over operating free-air temperature range†

Reverse current, I_R . . . . . 20 mA
Forward current, I_F . . . . . 10 mA
Package thermal impedance, θ_{JA}, (see Notes 1 and 2): D package . . . . . 97°C/W
LP package . . . . . 156°C/W
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D and LP packages . . . . . 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 JESD 51.

recommended operating conditions

		MIN	MAX	UNIT
Operating free-air temperature range, T_A	LT1009C	0	70	°C
	LT1009I	–40	85	

electrical characteristics at specified free-air temperature

PARAMETER		TEST CONDITIONS		T_A†	LT1009C			LT1009I			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
V_Z	Reference voltage	I_Z = 1 mA	D package	25°C	2.49	2.5	2.51	2.49	2.5	2.51	V
			LP package		2.495	2.5	2.505	2.495	2.5	2.505	
			D package	Full range	2.485		2.515	2.475		2.525	
			LP package		2.491		2.509	2.48		2.52	
V_F	Forward voltage	I_F = 2 mA		25°C	0.4		1	0.4		1	V
	Adjustment range	I_Z = 1 mA, V_{ADJ} = GND to V_Z		25°C	125			125			mV
		I_Z = 1 mA, V_{ADJ} = 0.6 V to V_Z – 0.6 V			45			45			
$\Delta V_{Z(temp)}$	Change in reference voltage with temperature		D package	Full range			5			15	mV
			LP package				4			15	
α_{VZ}	Average temperature coefficient of reference voltage‡			0°C to 70°C		15	25			30	ppm/°C
				–40°C to 85°C					20		
ΔV_Z	Change in reference voltage with current	I_Z = 400 μA to 10 mA		25°C		2.6	10		2.6	6	mV
				Full range			12			10	
$\Delta V_Z/\Delta t$	Long-term change in reference voltage	I_Z = 1 mA		25°C		20			20		ppm/khr
z_z	Reference impedance	I_Z = 1 mA		25°C		0.3	1		0.3	1	Ω
				Full range			1.4			1.4	

† Full range is 0°C to 70°C for the LT1009C and –40°C to 85°C for the LT1009I.
‡ The average temperature coefficient of reference voltage is defined as the total change in reference voltage divided by the specified temperature range.

electrical characteristics at T_A = 25°C

PARAMETER		TEST CONDITIONS	LT1009Y			UNIT
			MIN	TYP	MAX	
V_Z	Reference voltage	I_Z = 1 mA	2.49	2.5	2.51	V
V_F	Forward voltage	I_F = 2 mA	0.4		1	V
	Adjustment range	I_Z = 1 mA, V_{ADJ} = GND to V_Z	125			mV
		I_Z = 1 mA, V_{ADJ} = 0.6 V to V_Z – 0.6 V	45			
$\Delta V_{Z(temp)}$	Change in reference voltage with temperature			2.5		mV
α_{VZ}	Average temperature coefficient of reference voltage‡			15		ppm/°C
ΔV_Z	Change in reference voltage with current	I_Z = 400 μA to 10 mA		2.6		mV
$\Delta V_Z/\Delta t$	Long-term change in reference voltage	I_Z = 1 mA		20		ppm/khr
z_z	Reference impedance	I_Z = 1 mA		0.3	1	W

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

TYPICAL CHARACTERISTICS†

REFERENCE VOLTAGE vs FREE-AIR TEMPERATURE

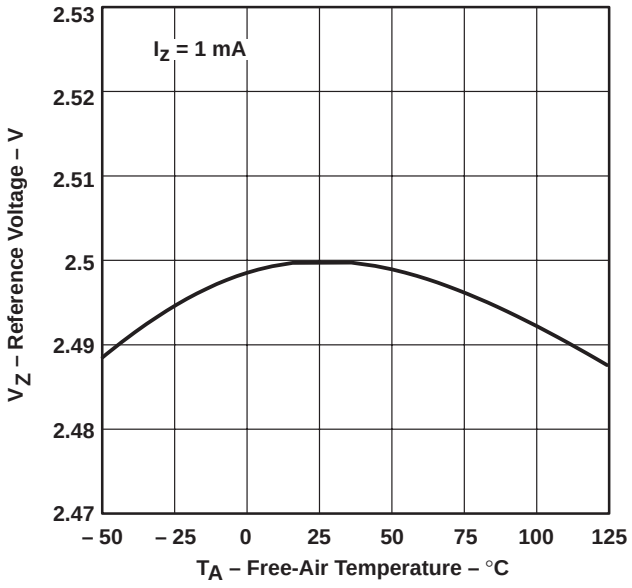


Figure 1

CHANGE IN REFERENCE VOLTAGE vs REFERENCE CURRENT

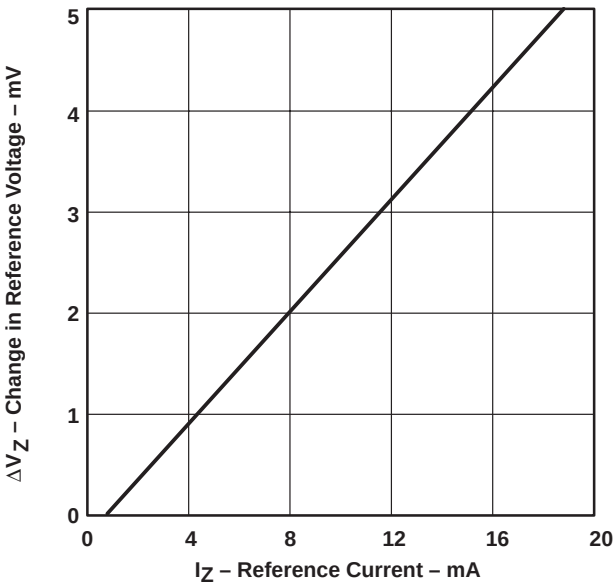


Figure 2

REVERSE CURRENT vs REVERSE VOLTAGE

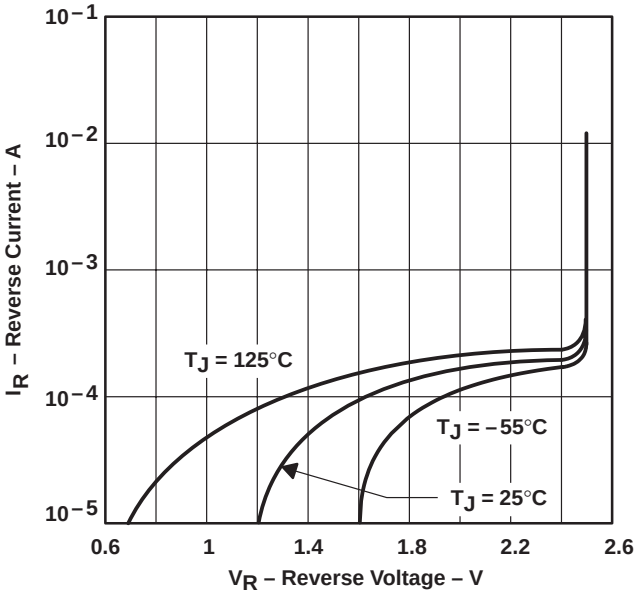


Figure 3

FORWARD VOLTAGE vs FORWARD CURRENT

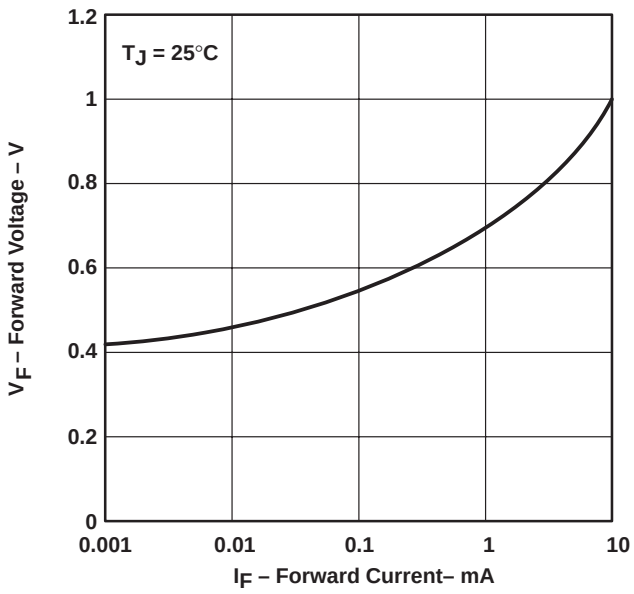


Figure 4

† 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 FREQUENCY

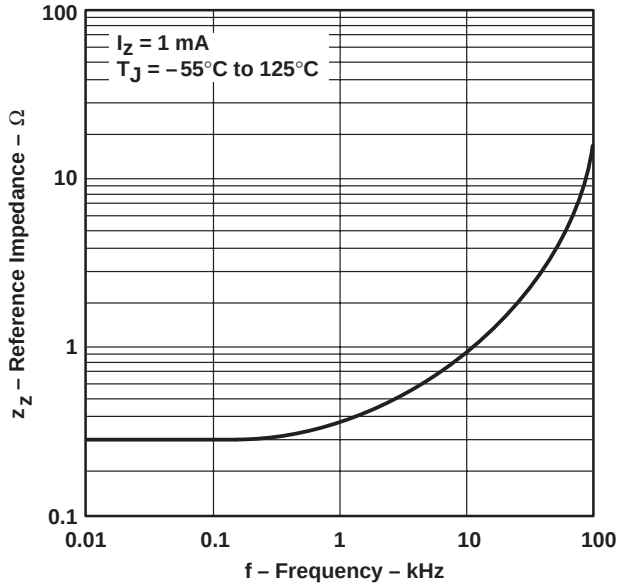


Figure 5

NOISE VOLTAGE vs FREQUENCY

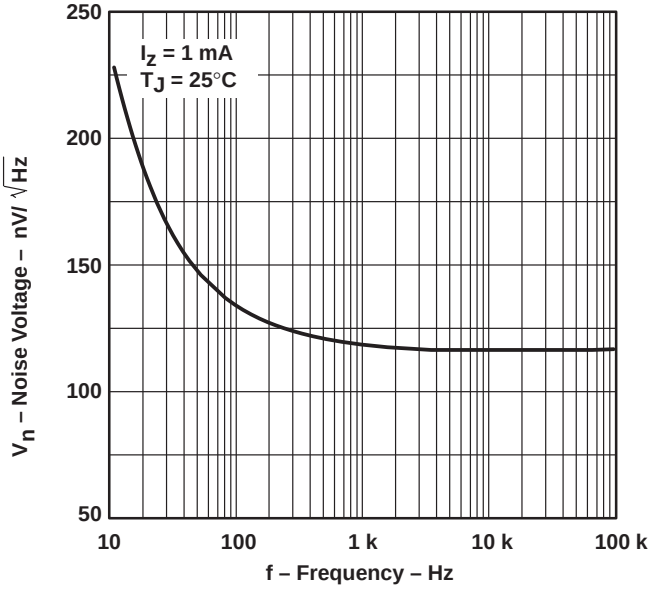


Figure 6

TRANSIENT RESPONSE

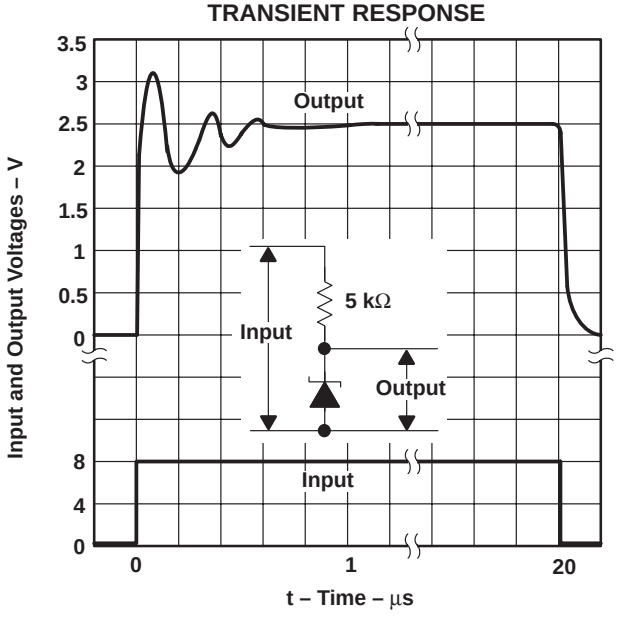
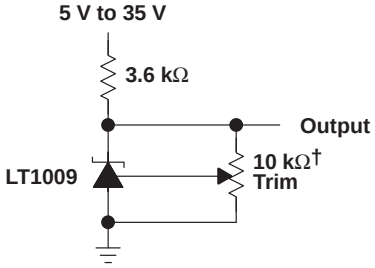


Figure 7

APPLICATION INFORMATION



†This does not affect temperature coefficient. It provides ±5% trim range.

Figure 8. 2.5-V Reference

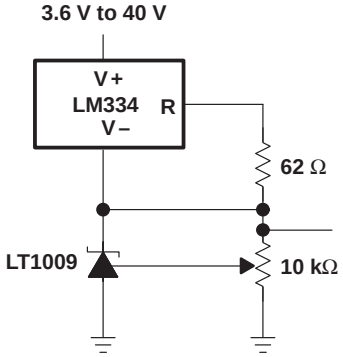


Figure 9. Adjustable Reference With Wide Supply Range

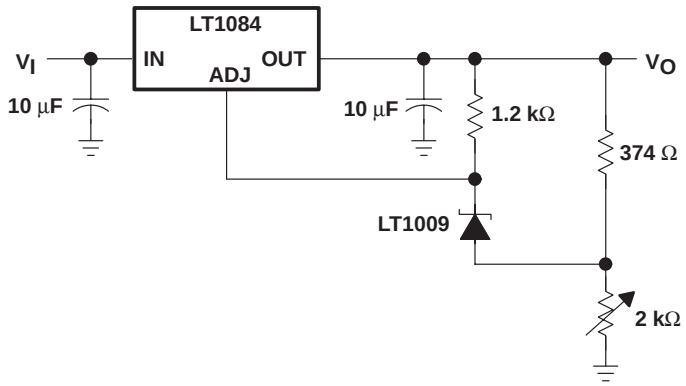


Figure 10. Power Regulator With Low Temperature Coefficient

APPLICATION INFORMATION

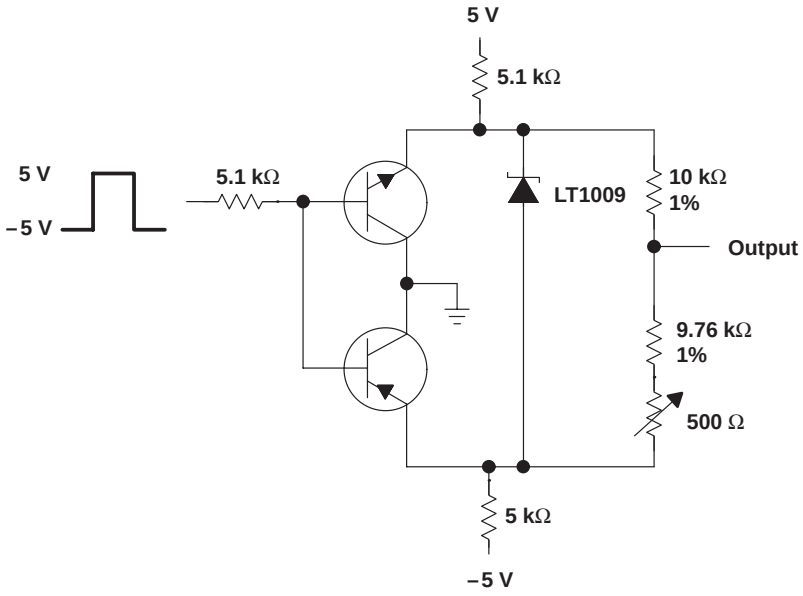


Figure 11. Switchable ±1.25-V Bipolar Reference

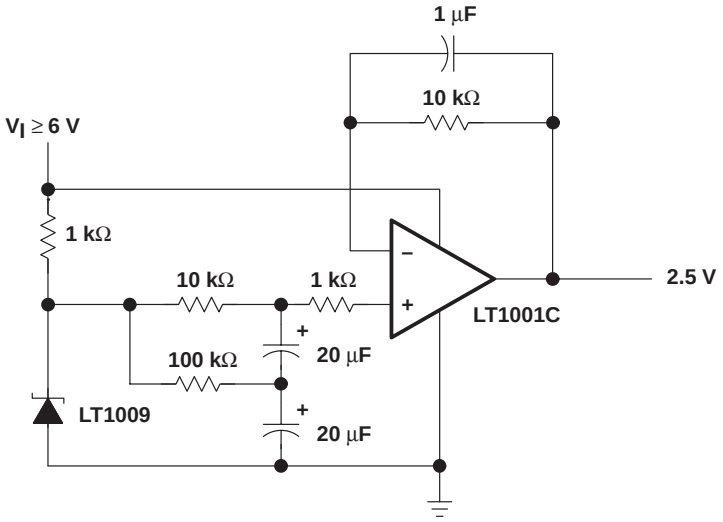


Figure 12. Low-Noise 2.5-V Buffered Reference

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