2.5-V INTEGRATED REFERENCE CIRCUIT

Check for Samples: LT1009M

FEATURES

- **Excellent Temperature Stability**
- **Initial Tolerance: 0.2% Typical**
- **Dynamic Impedance: 0.6 Ω Typical**
- **Wide Operating Current Range**
- **Directly Interchangeable With LM136**
- **Needs No Adjustment for Minimum Temperature Coefficient**
- **Available in Military (–55°C/125°C) Temperature Range** (1)

(1) Custom temperature ranges available

DESCRIPTION/ORDERING INFORMATION

The LT1009 reference circuit is a precision-trimmed 2.5-V shunt regulator featuring low dynamic impedance and a wide operating current range. 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.

The LT1009 uses include 5-V system references, 8-bit analog-to-digital converter (ADC) and digital-to-analog converter (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 LT1009 is characterized for operation from –55°C to 125°C.

Figure 1. SYMBOL

ORDERING INFORMATION(1)

T_A	PACKAGE(BARE DIE)(2)	ORDERABLE PART NUMBER
–55°C to 125°C	CHIPTRAY	LT1009MKGD1

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.
(2) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.

BARE DIE INFORMATION

DIE THICKNESS	BACKSIDE FINISH	BOND PAD METALIZATION COMPOSITION
15 Mils	Silicon with backgrind	AlCu/TiW

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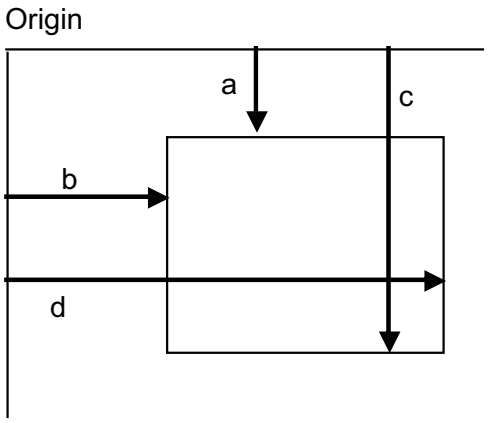

Table 1. Bond Pad Coordinates in Microns - Rev A

DISCRIPTION	PAD NUMBER	a	b	c	d
ANODE	1	127.000	127.000	243.840	243.840
ANODE	2	335.280	127.000	439.420	231.140
ADJ	3	716.280	130.810	833.120	243.840
Do not connect	4	1073.150	133.350	1169.670	229.870
Do not connect	5	1217.930	133.350	1314.450	229.870
Do not connect	6	1075.690	316.230	1172.210	412.750
Do not connect	7	1197.610	420.370	1294.130	516.890
Do not connect	8	1073.150	567.690	1169.670	664.210
Do not connect	9	1200.150	890.270	1296.670	986.790
Do not connect	10	1116.330	1032.510	1212.850	1129.030
CATHODE	11	902.970	929.640	1004.570	1066.800
CATHODE	12	703.580	1115.060	820.420	1229.360

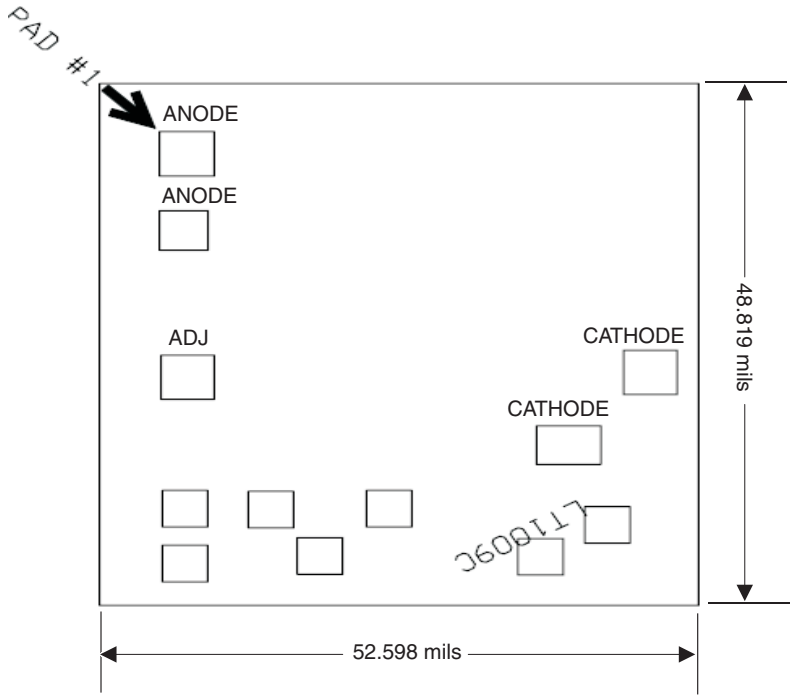

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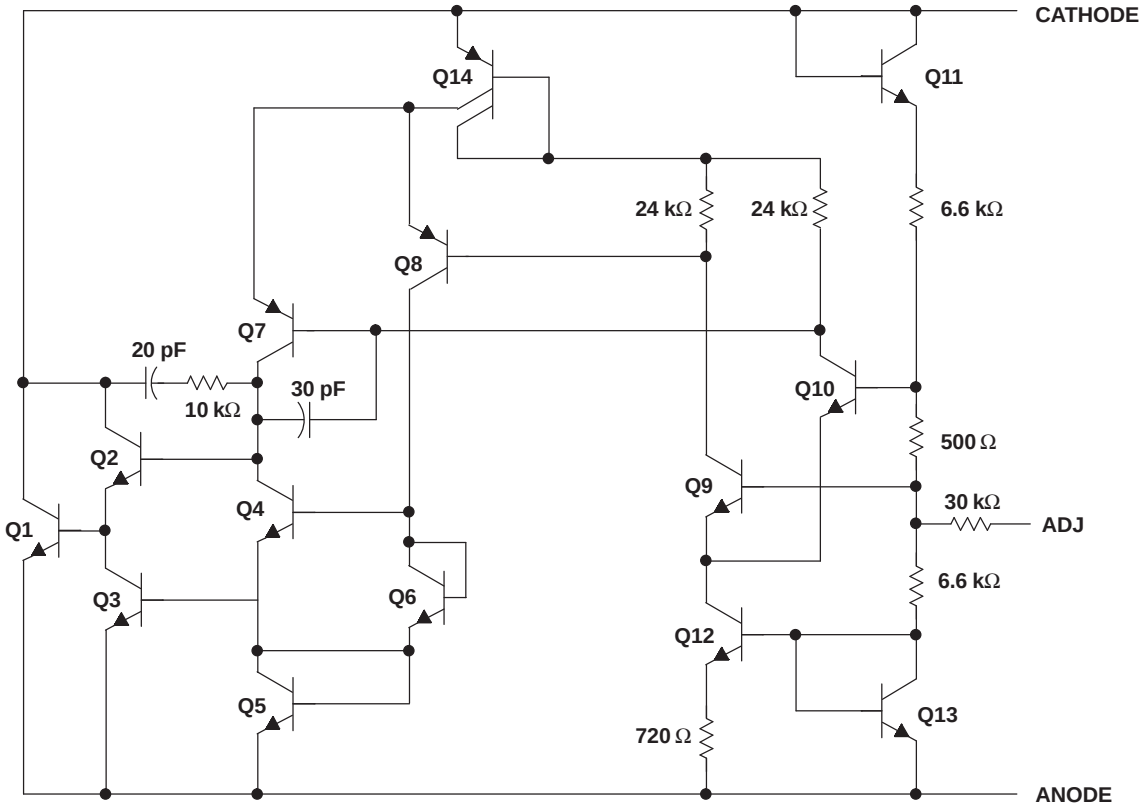
Figure 2. SCHEMATIC



NOTE: All component values shown are nominal.

ABSOLUTE MAXIMUM RATINGS(1)

over operating free-air temperature range (unless otherwise noted)

		MIN	MAX	UNIT
I_R	Reverse current		20	mA
I_F	Forward current		10	mA
T_J	Operating virtual junction temperature(2)		150	°C
T_{stg}	Storage temperature range	–65	150	°C

(1) 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.

(2) 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 $P_D = (T_J(max) – T_A)/\theta_{JA}$. Operating at the absolute maximum T_J of 150°C can affect reliability.

RECOMMENDED OPERATING CONDITIONS

		MIN	MAX	UNIT
T_A	Operating free-air temperature range	–55	125	°C

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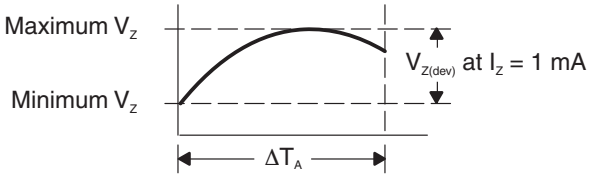
ELECTRICAL CHARACTERISTICS

at specified free-air temperature

PARAMETER		TEST CONDITIONS	T_A	LT1009M			UNIT
				MIN	TYP	MAX	
V_Z	Reference voltage	I_Z = 1 mA	25°C	2.49	2.5	2.51	V
			Full range	2.46		2.535	
V_F	Forward voltage	I_F = 2 mA	25°C	0.4		1	V
	Adjustment range	I_Z = 1 mA, V_{ADJ} = GND to V_Z	25°C	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		Full range			15	mV
αV_Z	Average temperature coefficient of reference voltage(1)	I_Z = 1 mA, V_{ADJ} = open	Full range		20	35	ppm/ °C
ΔV_Z	Change in reference voltage with current	I_Z = 400 µA to 10 mA	25°C		6	10	mV
			Full range			12	
$\Delta V_Z/\Delta t$	Long-term change in reference voltage	I_Z = 1 mA	25°C		20		ppm/ khr
Z_Z	Reference impedance	I_Z = 1 mA	25°C		0.6	1.6	Ω
			Full range			1.8	

(1) The deviation parameter $V_{Z(dev)}$ is defined as the difference between the maximum and minimum values obtained over the recommended operating temperature range, measured at I_Z = 1 mA. The average full-range temperature coefficient of the reference voltage (αV_Z) is defined as:

$$|\alpha V_z| \left(\frac{ppm}{°C}\right) = \frac{\left(\frac{V_{Z(dev)}}{V_Z \text{ at } 25°C}\right) \times 10^6}{\Delta T_A}$$



αV_Z can be positive or negative, depending upon whether the minimum V_Z or maximum V_Z, respectively, occurs at the lower temperature.

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TYPICAL CHARACTERISTICS

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

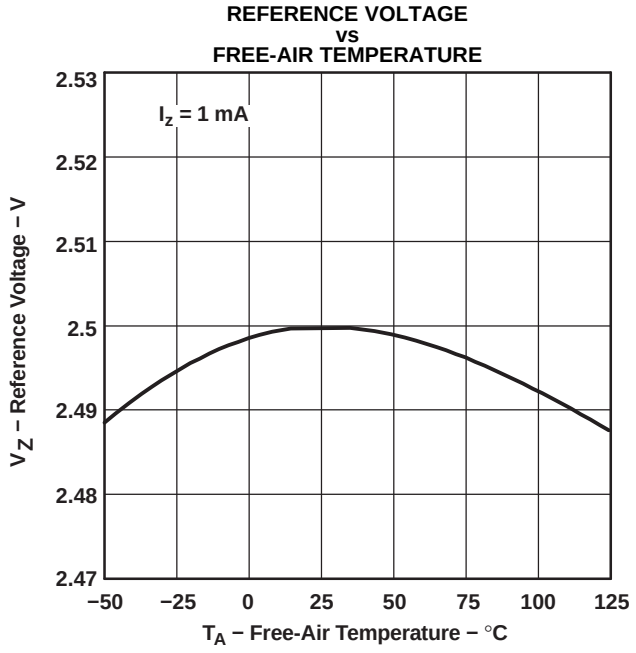

Figure 3.

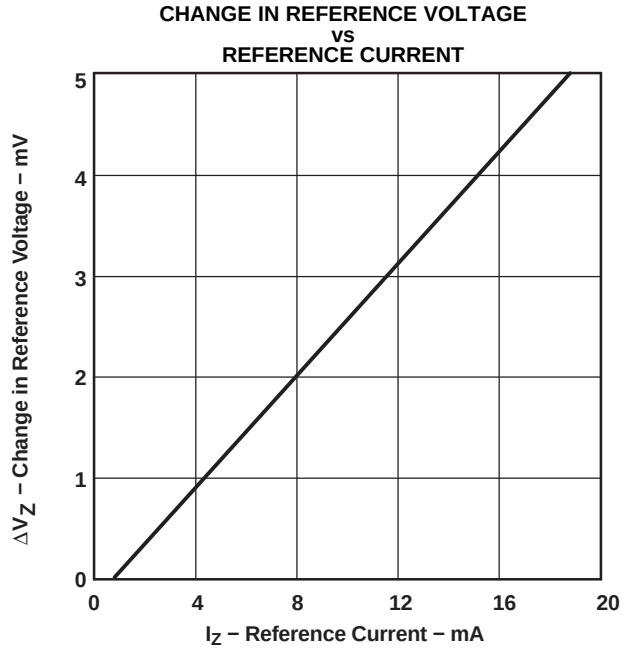

Figure 4.

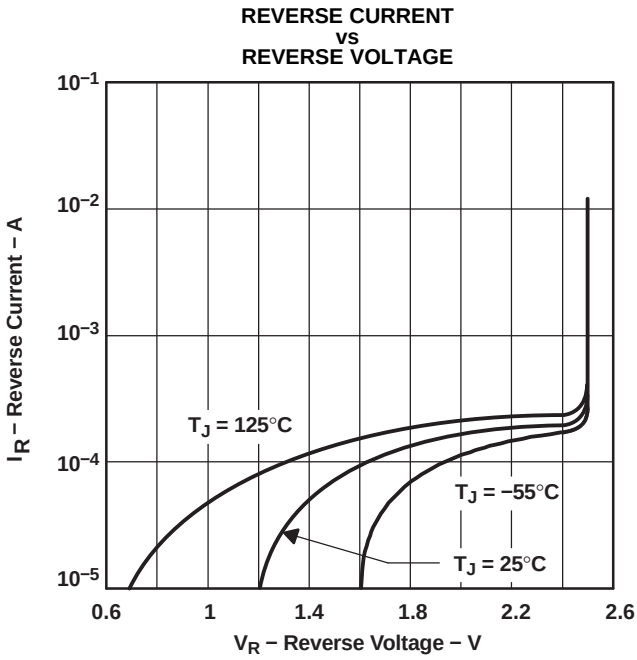

Figure 5.

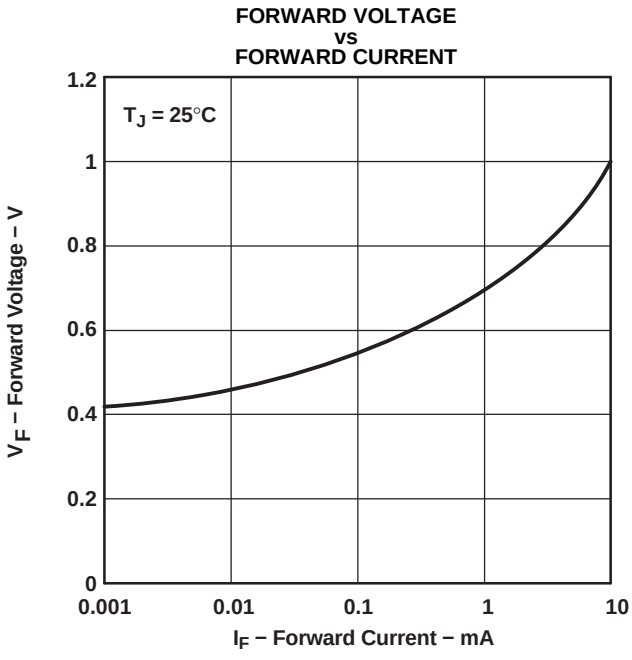

Figure 6.

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TYPICAL CHARACTERISTICS (continued)

REFERENCE IMPEDANCE
VS
FREQUENCY

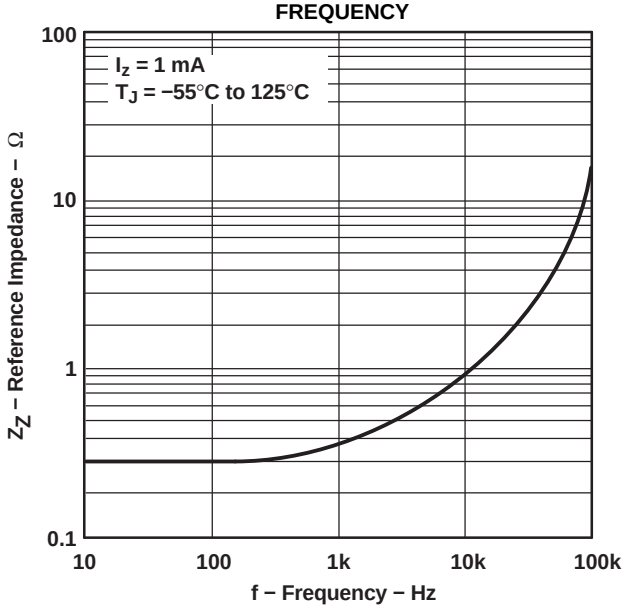

Figure 7.

NOISE VOLTAGE
VS
FREQUENCY

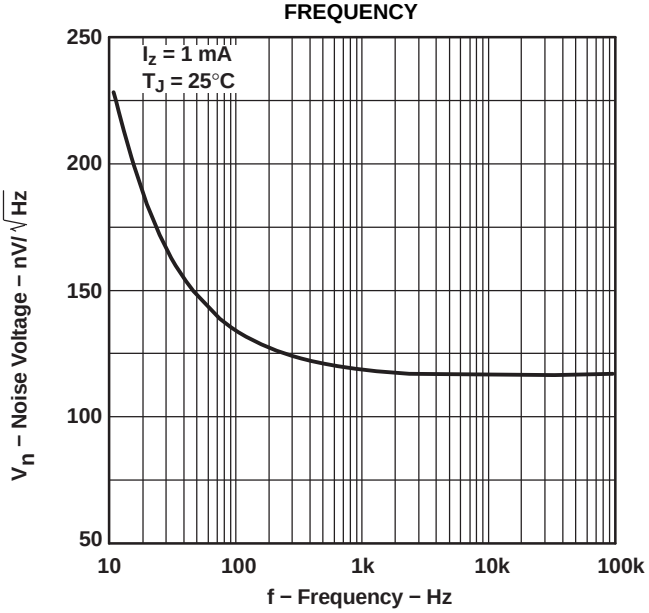

Figure 8.

TRANSIENT RESPONSE

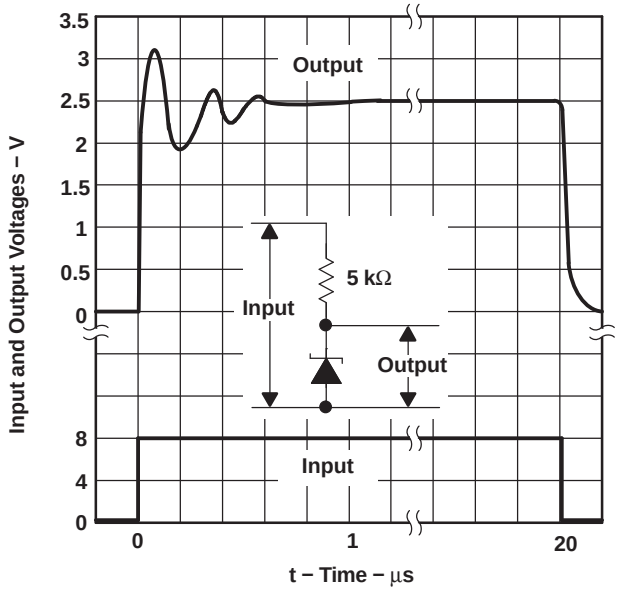

Figure 9.

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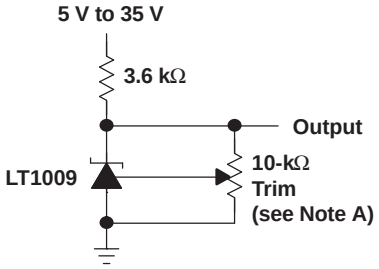
APPLICATION INFORMATION



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

Figure 10. 2.5-V Reference

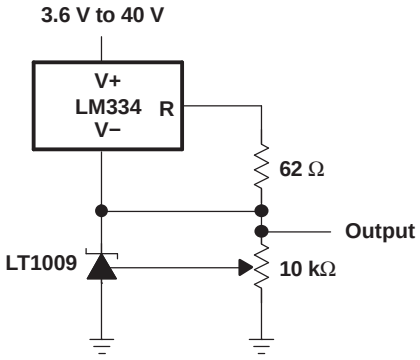


Figure 11. Adjustable Reference With Wide Supply Range

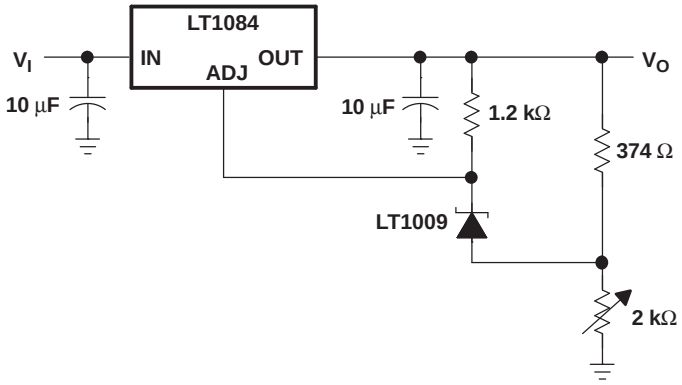


Figure 12. Power Regulator With Low Temperature Coefficient

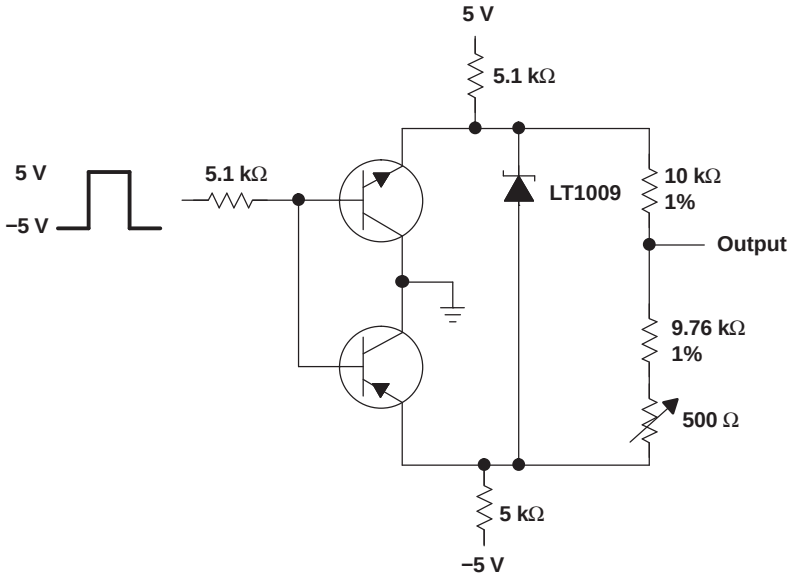


Figure 13. Switchable ±1.25-V Bipolar Reference

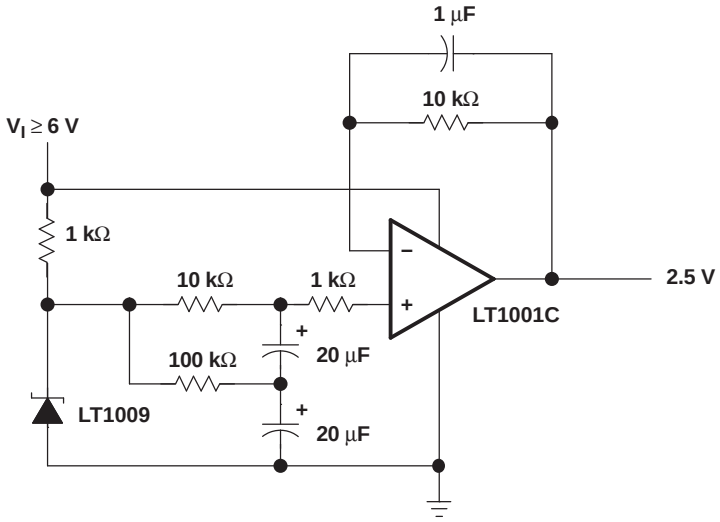


Figure 14. Low-Noise 2.5-V Buffered Reference

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PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LT1009MKGD1	ACTIVE	XCEPT	KGD	0	100	RoHS & Green	Call TI	N / A for Pkg Type	-55 to 125		Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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OTHER QUALIFIED VERSIONS OF LT1009M :

- Catalog: LT1009

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

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