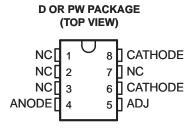


2.5-V INTEGRATED REFERENCE CIRCUIT

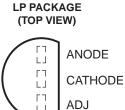
FEATURES

- 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



NC - No internal connection



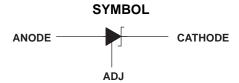
DESCRIPTION/ORDERING INFORMATION

The LT1009 reference circuit is a precision-trimmed 2.5-V shunt regulator featuring low dynamic impedance and a wide operating current range. The maximum initial tolerance is ± 5 mV in the LP package and ± 10 mV in the D and PW packages. 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 LT1009C is characterized for operation from 0°C to 70°C. The LT1009I is characterized for operation from –40°C to 85°C.





Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.



ORDERING INFORMATION(1)

T _A	PAC	KAGE ⁽²⁾	ORDERABLE PART NUMBER	TOP-SIDE MARKING
	SOIC - D	Tube of 75	LT1009CD	10000
	201C - D	Reel of 2500	LT1009CDR	- 1009C
		Bulk of 1000	LT1009CLP	
0°C to 70°C	TO-226/TO-92 – LP	Ammo of 2000	LT1009CLPM	LT1009C
	Reel of 2000 LT1009CLPR	LT1009CLPR		
	TCCOD DW	Tube of 150	LT1009CPW	40000
	TSSOP – PW	Reel of 2000	LT1009CPWR	- 1009C
	0010 D	Tube of 75	LT1009ID	40001
	SOIC – D	Reel of 2500	LT1009IDR	1009l
		Bulk of 1000	LT1009ILP	
-40°C to 85°C	TO-226/TO-92 – LP	Ammo of 2000	LT1009ILPM	LT1009I
		Reel of 2000	LT1009ILPR	
	TCCOD DW	Tube of 150	LT1009IPW	40001
	TSSOP – PW	Reel of 2000	LT1009IPWR	_ 1009l

- (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.

SCHEMATIC CATHODE Q14 Q11 **24 k**Ω **6.6** $\mathbf{k}\Omega$ **24 k**Ω ≷ Q8 Q7 20 pF Q10 10 $k\Omega$ $\mathbf{500}\,\Omega$ Q9 30 $\mathbf{k}\Omega$ Q4 ADJ Q1 6.6 $\mathbf{k}\Omega$ Q6 Q3 Q12 Q13 **720** Ω ≶ **ANODE**

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
		D package		97	
θ_{JA}	Package thermal impedance (2)(3)	LP package		140	°C/W
		PW package		149	
TJ	Operating virtual junction temperature			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.

RECOMMENDED OPERATING CONDITIONS

			MIN	MAX	UNIT
т	Operating free air temperature range	LT1009C	0	70	°C
I A	Operating free-air temperature range	LT1009I	-40	85	

⁽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.

⁽³⁾ The package thermal impedance is calculated in accordance with JESD 51-7.



ELECTRICAL CHARACTERISTICS

at specified free-air temperature

	PARAMETER	TEST CONDITIONS		T _A ⁽¹⁾	L	LT1009C			LT1009I			
PARAIVIETER		IEST	CNDITIONS	IA'''	MIN	TYP	MAX	MIN	TYP	MAX	UNIT	
			D/PW package	35°C	2.49	2.5	2.51	2.49	2.5	2.51	- V	
V	Reference voltage	I ₇ = 1 mA	LP package	25°C	2.495	2.5	2.505	2.495	2.5	2.505		
V _Z	Reference voltage	12 = 1 111A	D/PW package	Full range	2.485		2.515	2.475		2.525	V	
			LP package	Full range	2.491		2.509	2.48		2.52		
V_{F}	Forward voltage	$I_F = 2 \text{ mA}$	I _F = 2 mA		0.4		1	0.4		1	V	
	Adjustment range $ \begin{vmatrix} I_Z = 1 \text{ mA,} \\ V_{ADJ} = \text{GND to V}_Z \\ \hline I_Z = 1 \text{ mA,} \\ V_{ADJ} = 0.6 \text{ V to V}_Z - 0.6 \text{ V} \end{vmatrix} $ 25°C		25°C	125			125			mV		
			V to V _Z – 0.6 V	25°C	45			45				
	Change in reference	D/PW pack	age				5			15		
$\Delta V_{Z(temp)}$	voltage with temperature	LP package		Full range			4			15	mV	
	Average temperature			0°C to 70°C		15	25		15	25	ppm/	
αV_Z	coefficient of reference voltage (2)	$I_Z = 1 \text{ mA},$	V _{ADJ} = open	-40°C to 85°C					20	35	°C	
۸۱/	Change in reference	I - 400 · A	to 10 m/	25°C		2.6	10		2.6	6	mV	
ΔV_Z	voltage with current $I_Z = 400 \mu A$ to 10 mA		TIO TO THA	Full range		12				10	mv	
$\Delta V_Z/\Delta t$	Long-term change in reference voltage	I _Z = 1 mA		25°C		20			20		ppm/ khr	
7	Potoronoo impodonoo	1 - 1 m^		25°C		0.3	1		0.3	1	Ω	
Z_Z Reference impedance $I_Z = 1 \text{ mA}$		Full range			1.4			1.4	12			

- (1) Full range is 0°C to 70°C for the LT1009C and -40°C to 85°C for the LT1009I.
- (2) 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:

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

$$Maximum V_z$$

$$V_{z(dev)} \text{ at } I_z = 1 \text{ mA}$$

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

For example, at I_Z = 1 mA, maximum V_Z = 2501 mV at 30°C, minimum V_Z = 2497 mV at 0°C, V_Z = 2500 mV at 25°C, ΔT_A = 70°C for LT1009C:

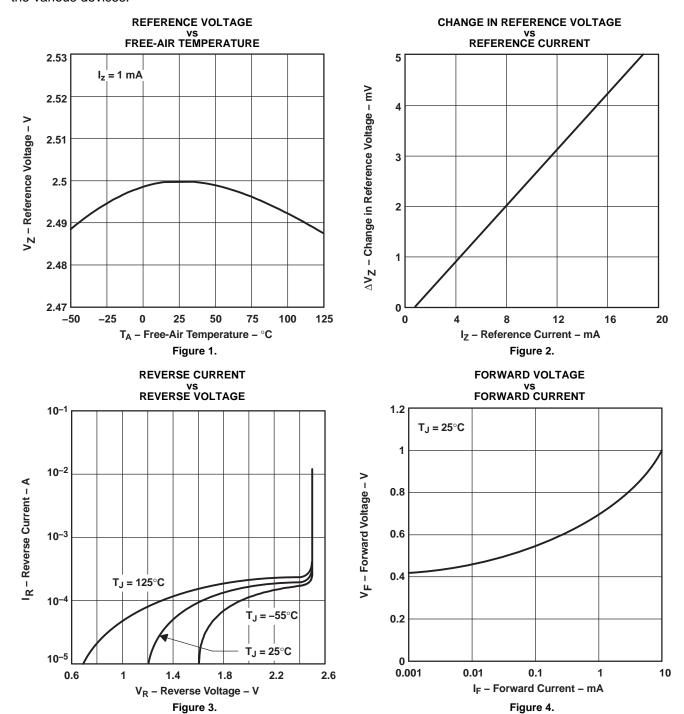
$$|\alpha V_z| = \frac{\left(\frac{4 \text{ mV}}{2500 \text{ mV}}\right) \times 10^6}{70^{\circ}\text{C}} \approx 23 \frac{\text{ppm}}{^{\circ}\text{C}}$$

Because minimum V₇ occurs at the lower temperature, the coefficient in this example is positive.



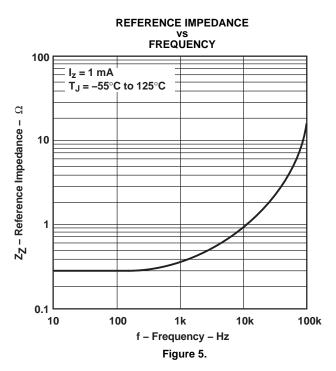
TYPICAL CHARACTERISTICS

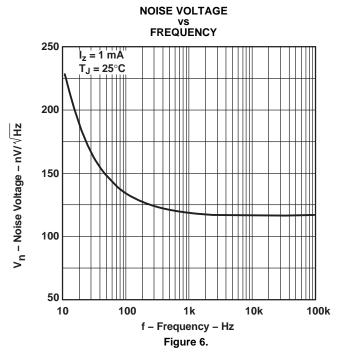
Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

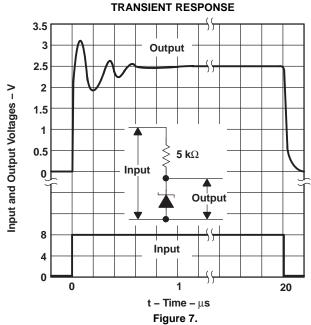




TYPICAL CHARACTERISTICS (continued)

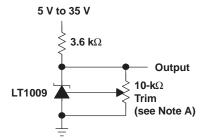








APPLICATION INFORMATION



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

Figure 8. 2.5-V Reference

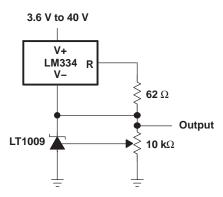


Figure 9. Adjustable Reference With Wide Supply Range

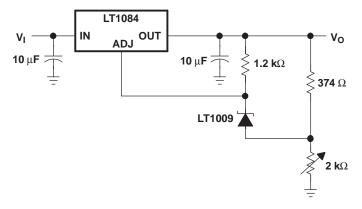


Figure 10. Power Regulator With Low Temperature Coefficient



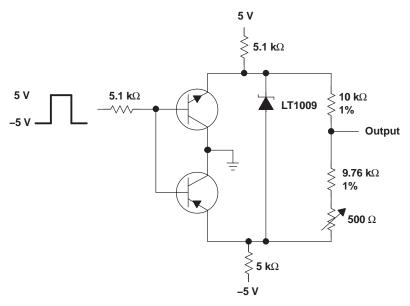


Figure 11. Switchable ±1.25-V Bipolar Reference

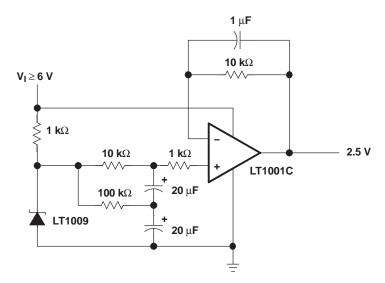


Figure 12. Low-Noise 2.5-V Buffered Reference





10-Jun-2014

PACKAGING INFORMATION

Orderable Device	Status	Package Type	Package	Pins	Package	Eco Plan	Lead/Ball Finish	MSL Peak Temp	Op Temp (°C)	Device Marking	Samples
	(1)		Drawing		Qty	(2)	(6)	(3)		(4/5)	
LT1009CD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	1009C	Samples
LT1009CDE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	1009C	Samples
LT1009CDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	1009C	Samples
LT1009CDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	1009C	Samples
LT1009CLP	ACTIVE	TO-92	LP	3	1000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type	0 to 70	LT1009C	Samples
LT1009CLPE3	ACTIVE	TO-92	LP	3	1000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type	0 to 70	LT1009C	Samples
LT1009CLPM	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type	0 to 70	LT1009C	Samples
LT1009CLPR	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type	0 to 70	LT1009C	Samples
LT1009CLPRE3	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type	0 to 70	LT1009C	Samples
LT1009CPK	OBSOLETE	SOT-89	PK	3		TBD	Call TI	Call TI	0 to 70		
LT1009CPWR	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	1009C	Samples
LT1009ID	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	10091	Samples
LT1009IDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	10091	Samples
LT1009IDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	10091	Samples
LT1009IDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	10091	Samples
LT1009ILP	ACTIVE	TO-92	LP	3	1000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type	-40 to 85	LT1009I	Samples
LT1009ILPE3	ACTIVE	TO-92	LP	3	1000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type	-40 to 85	LT1009I	Samples



PACKAGE OPTION ADDENDUM

10-Jun-2014

Orderable Device	Status	Package Type	Package Drawing		Package Qty	Eco Plan	Lead/Ball Finish (6)	MSL Peak Temp	Op Temp (°C)	Device Marking (4/5)	Samples
LT1009ILPR	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type	-40 to 85	LT1009I	Samples
LT1009ILPRE3	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type	-40 to 85	LT1009I	Samples
LT1009IPWR	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	10091	Samples
LT1009IPWRG4	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	10091	Samples
LT1009QDR	OBSOLETE	SOIC	D	8		TBD	Call TI	Call TI	-40 to 125		
LT1009Y	OBSOLETE	DIESALE	Υ	0		TBD	Call TI	Call TI			

(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) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes. **Pb-Free** (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between

the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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



PACKAGE OPTION ADDENDUM

10-Jun-2014

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

OTHER QUALIFIED VERSIONS OF LT1009:

Military: LT1009M

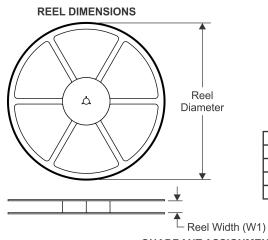
NOTE: Qualified Version Definitions:

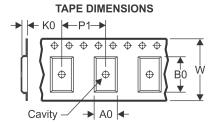
• Military - QML certified for Military and Defense Applications

PACKAGE MATERIALS INFORMATION

www.ti.com 6-Dec-2014

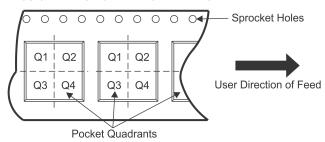
TAPE AND REEL INFORMATION





_	_	
		3
	B0	Dimension designed to accommodate the component length
	K0	Dimension designed to accommodate the component thickness
	W	Overall width of the carrier tape
	P1	Pitch between successive cavity centers

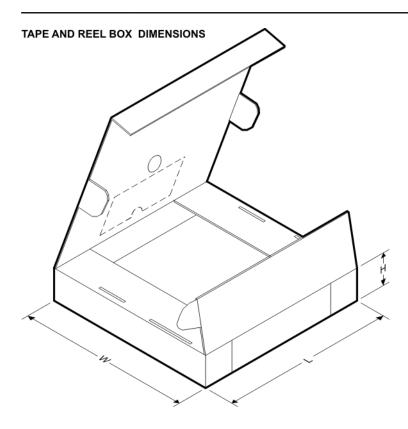
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing		SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LT1009CDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
LT1009IDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
LT1009IPWR	TSSOP	PW	8	2000	330.0	12.4	7.0	3.6	1.6	8.0	12.0	Q1

www.ti.com 6-Dec-2014

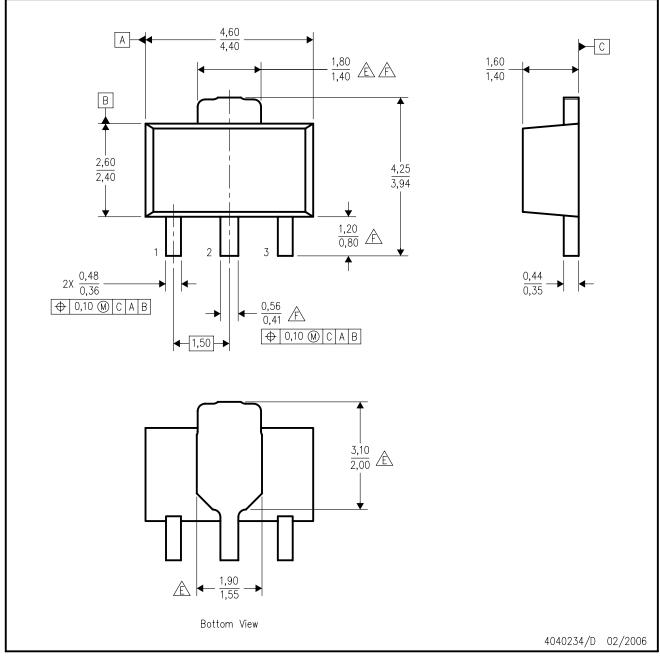


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LT1009CDR	SOIC	D	8	2500	340.5	338.1	20.6
LT1009IDR	SOIC	D	8	2500	340.5	338.1	20.6
LT1009IPWR	TSSOP	PW	8	2000	367.0	367.0	35.0

PK (R-PSSO-F3)

PLASTIC SINGLE-IN-LINE PACKAGE



NOTES:

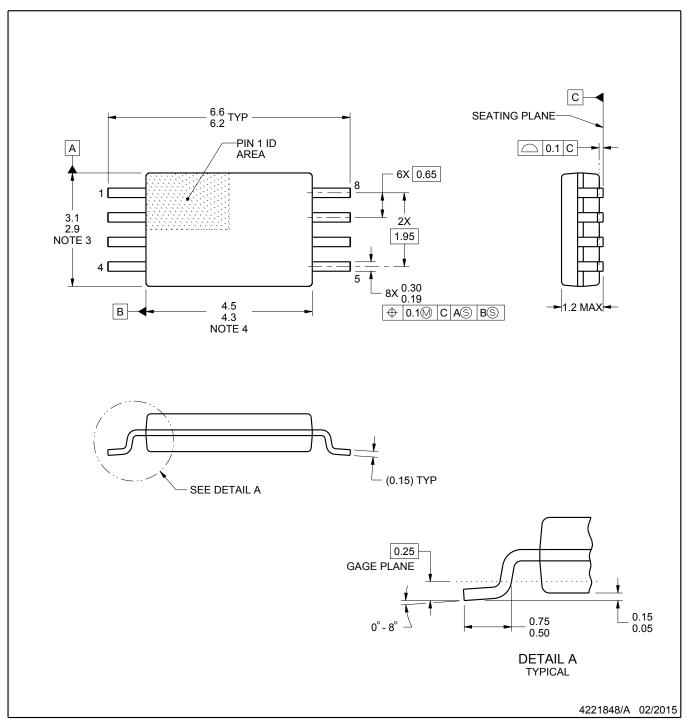
All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.

- This drawing is subject to change without notice.
- The center lead is in electrical contact with the tab.
- Body dimensions do not include mold flash or protrusion. Mold flash and protrusion not to exceed 0.15 per side.
- Thermal pad contour optional within these dimensions.
- Falls within JEDEC T0-243 variation AA, except minimum lead length, pin 2 minimum lead width, minimum tab width.





SMALL OUTLINE PACKAGE



NOTES:

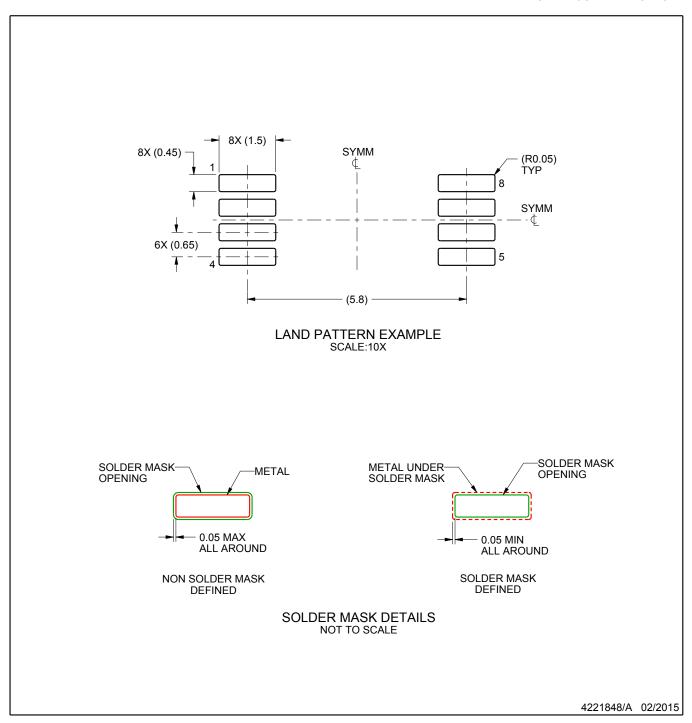
- 1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.

 2. This drawing is subject to change without notice.

 3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not
- exceed 0.15 mm per side.
- 4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
- 5. Reference JEDEC registration MO-153, variation AA.



SMALL OUTLINE PACKAGE



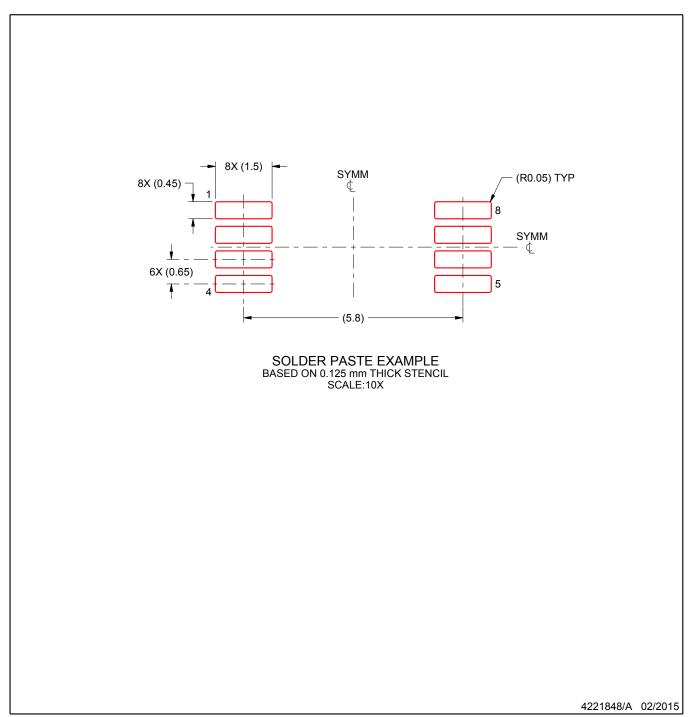
NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



SMALL OUTLINE PACKAGE



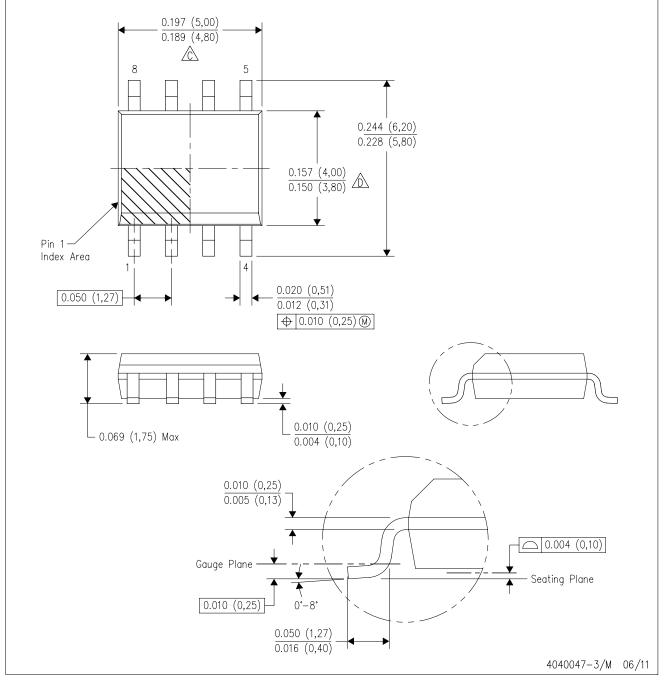
NOTES: (continued)

- 8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
- 9. Board assembly site may have different recommendations for stencil design.



D (R-PDSO-G8)

PLASTIC SMALL OUTLINE



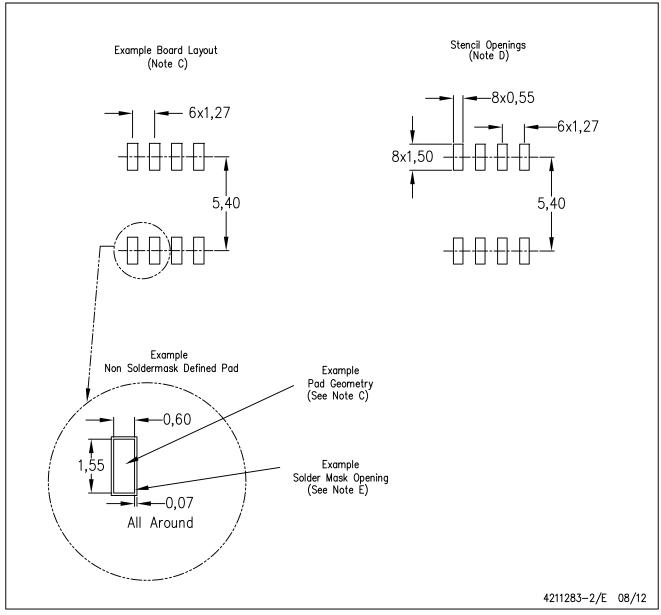
NOTES:

- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.
- Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
- Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
- E. Reference JEDEC MS-012 variation AA.



D (R-PDSO-G8)

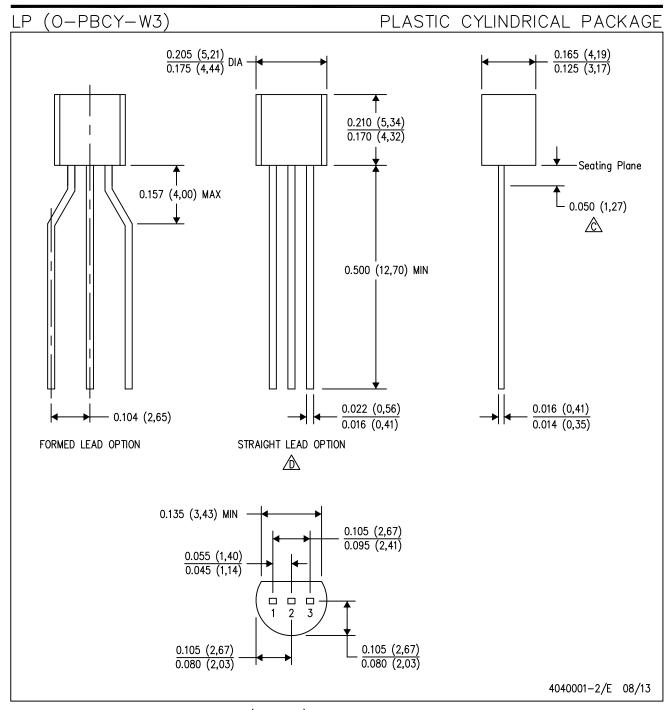
PLASTIC SMALL OUTLINE



NOTES:

- A. All linear dimensions are in millimeters.
- B. This drawing is subject to change without notice.
- C. Publication IPC-7351 is recommended for alternate designs.
- D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
- E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.





NOTES: A. All linear dimensions are in inches (millimeters).

B. This drawing is subject to change without notice.

Lead dimensions are not controlled within this area.

Falls within JEDEC TO−226 Variation AA (TO−226 replaces TO−92).

E. Shipping Method:

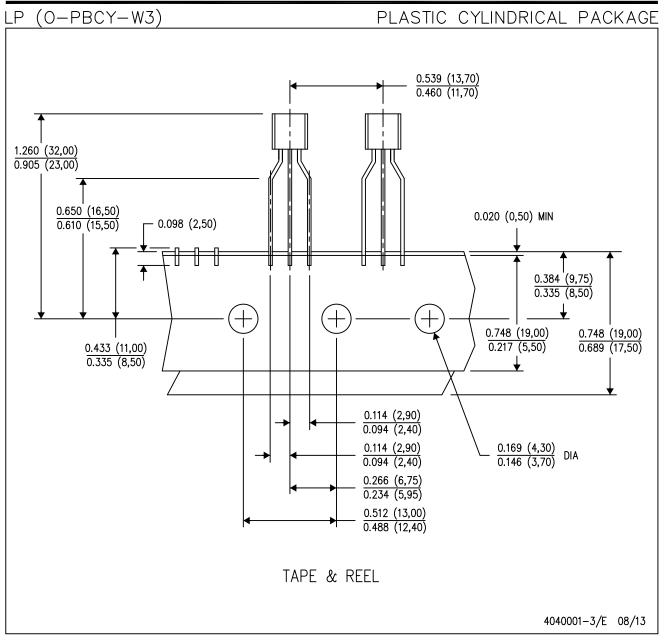
Straight lead option available in bulk pack only.

Formed lead option available in tape & reel or ammo pack.

Specific products can be offered in limited combinations of shipping mediums and lead options.

Consult product folder for more information on available options.





NOTES:

- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.
- C. Tape and Reel information for the Formed Lead Option package.

IMPORTANT NOTICE

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