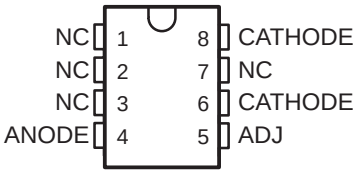
SLVS013J − MAY 1987 − REVISED SEPTEMBER 2003

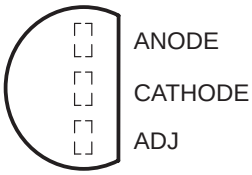
- **Excellent Temperature Stability**
- **Initial Tolerance . . . 0.2% Max**
- **Dynamic Impedance . . . 0.6 Ω Max**
- **Wide Operating Current Range**
- **Directly Interchangeable With LM136**
- **Needs No Adjustment for Minimum Temperature Coefficient**

D OR PW PACKAGE
(TOP VIEW)



NC − No internal connection

LP PACKAGE
(TOP VIEW)



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 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.

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.

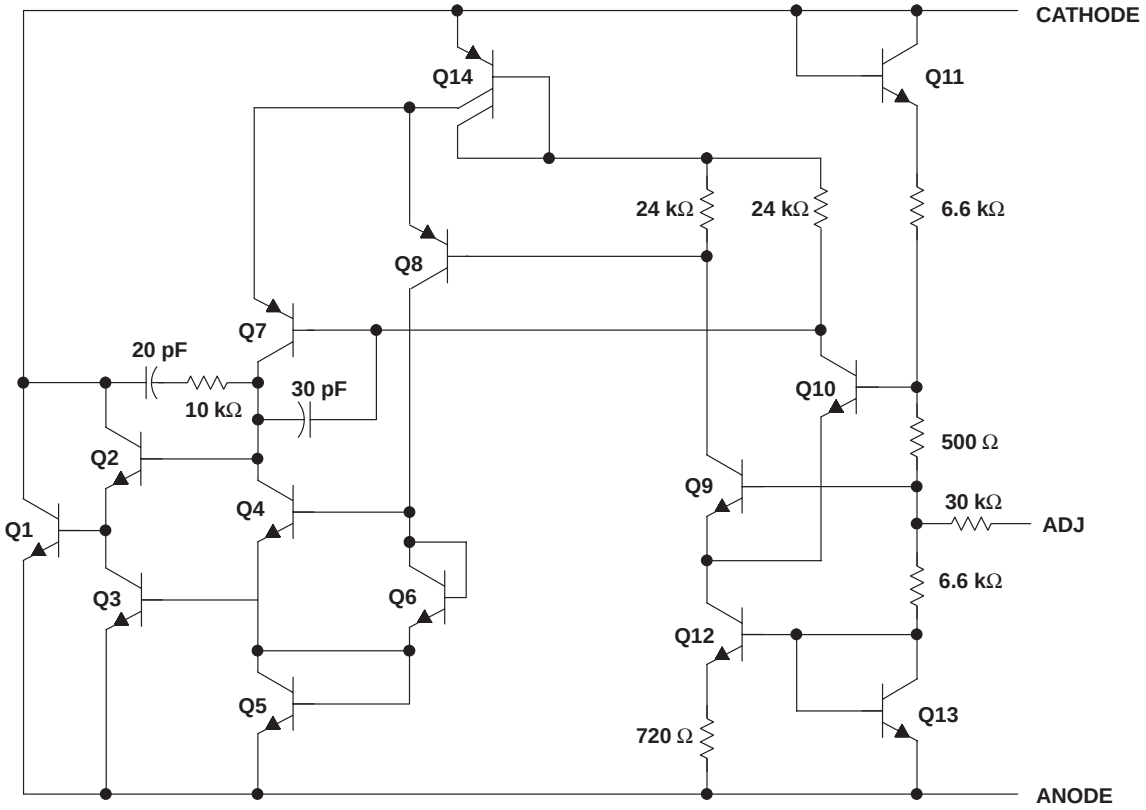
ORDERING INFORMATION

T_A	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	SOIC (D)	Tube of 75	LT1009CD	1009C
		Reel of 2500	LT1009CDR	
	TO-226 / TO-92 (LP)	Bulk of 1000	LT1009CLP	LT1009C
		Ammo of 2000	LT1009CLPM	
		Reel of 2000	LT1009CLPR	
	TSSOP (PW)	Tube of 150	LT1009CPW	1009C
		Reel of 2000	LT1009CPWR	
−40°C to 85°C	SOIC (D)	Tube of 75	LT1009ID	1009I
		Reel of 2500	LT1009IDR	
	TO-226 / TO-92 (LP)	Bulk of 1000	LT1009ILP	LT1009I
		Reel of 2000	LT1009ILPR	
	TSSOP (PW)	Tube of 150	LT1009IPW	1009I
		Reel of 2000	LT1009IPWR	

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

symbol

schematic



All component values shown are nominal.

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

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	140°C/W
PW package	149°C/W
Operating virtual junction temperature, T_J	150°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 51-7.

recommended operating conditions

			MIN	MAX	UNIT
T_A	Operating free-air temperature range	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.

TYPICAL CHARACTERISTICS†

REFERENCE VOLTAGE vs FREE-AIR TEMPERATURE

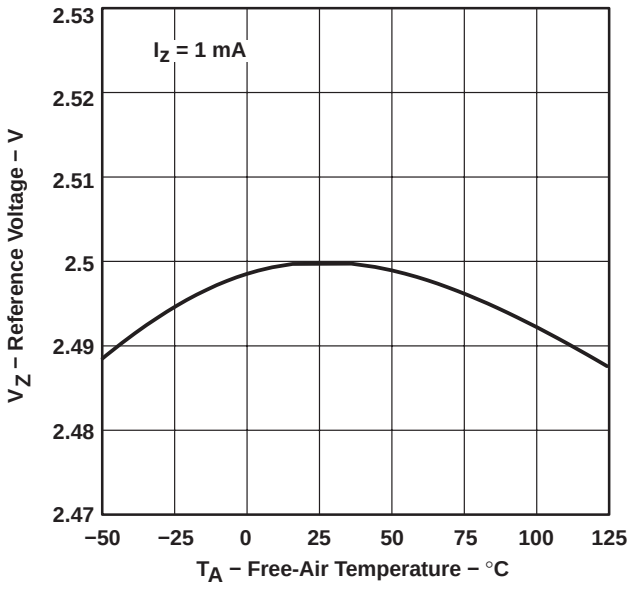


Figure 1

CHANGE IN REFERENCE VOLTAGE vs REFERENCE CURRENT

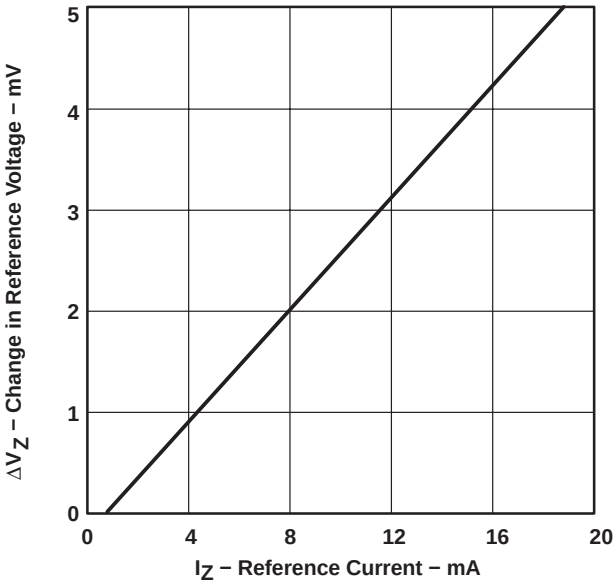


Figure 2

REVERSE CURRENT vs REVERSE VOLTAGE

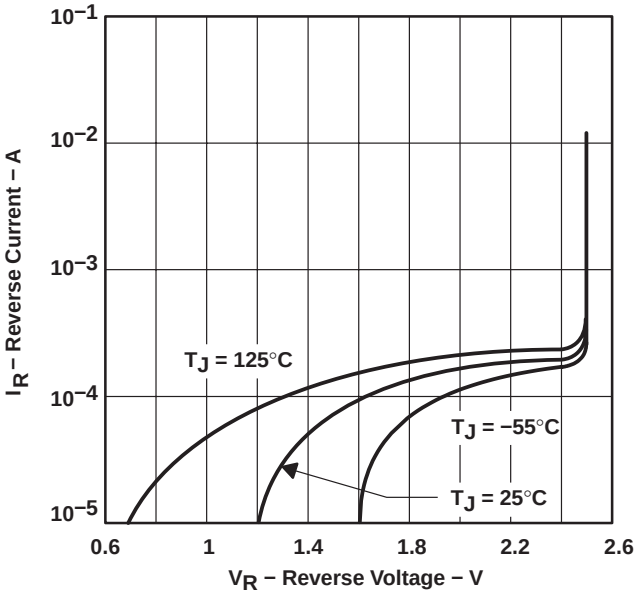


Figure 3

FORWARD VOLTAGE vs FORWARD CURRENT

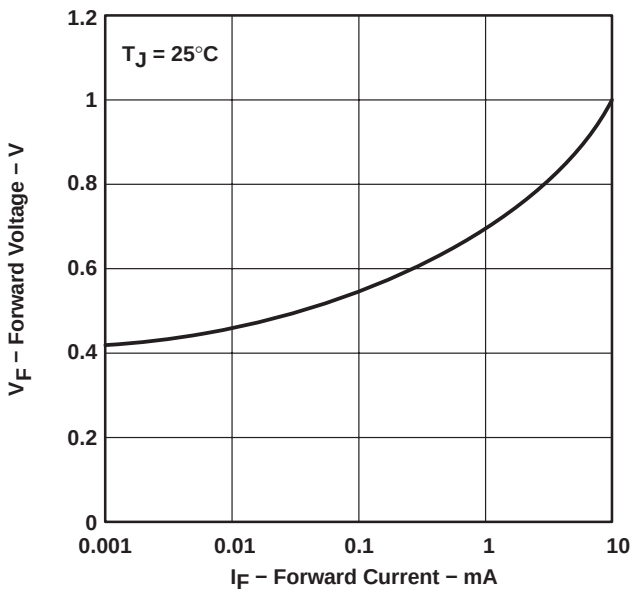


Figure 4

†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

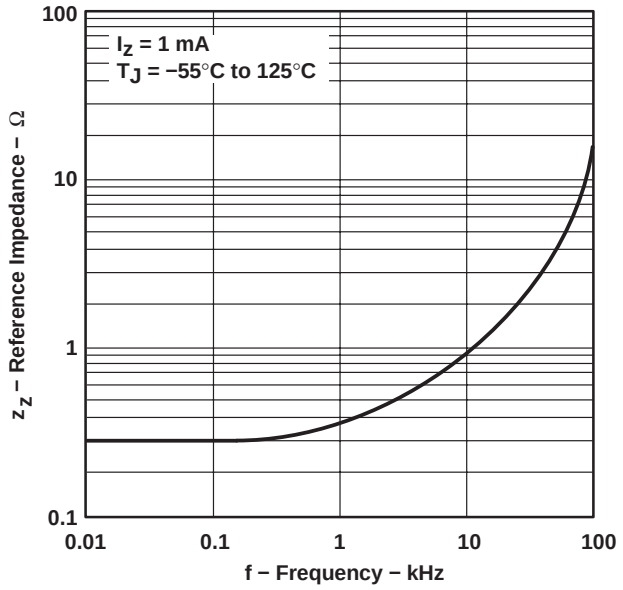


Figure 5

NOISE VOLTAGE vs FREQUENCY

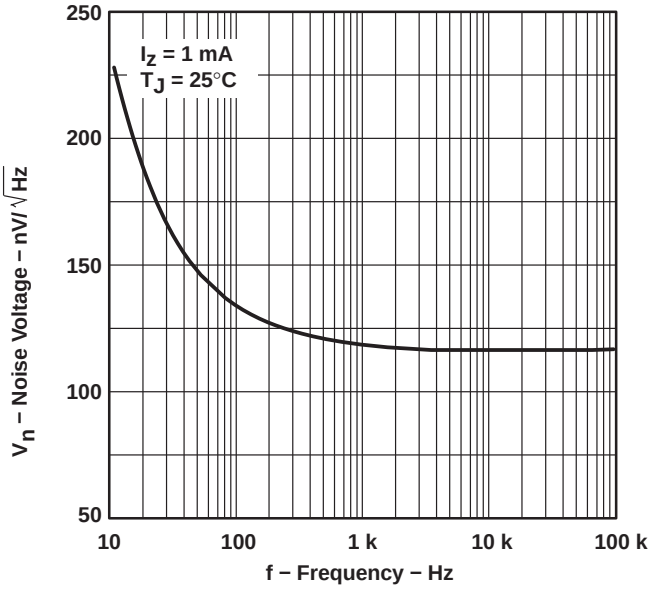


Figure 6

TRANSIENT RESPONSE

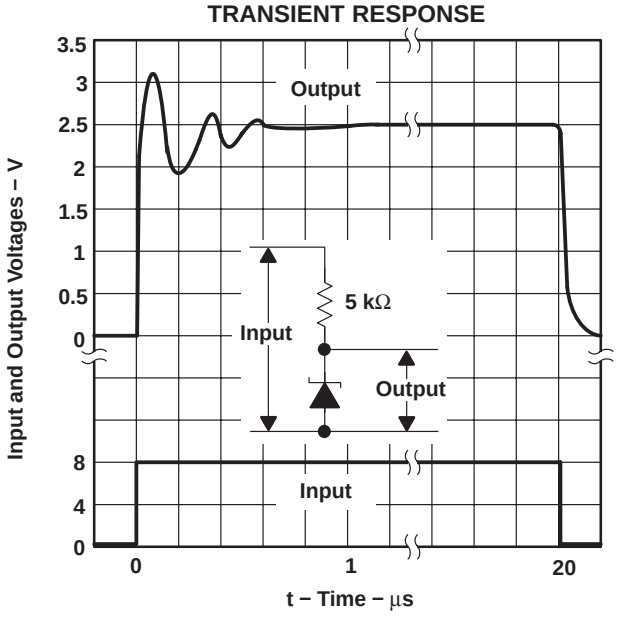
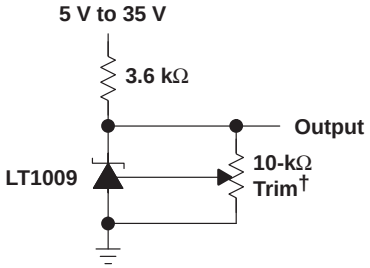


Figure 7

APPLICATION INFORMATION



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

Figure 8. 2.5-V Reference

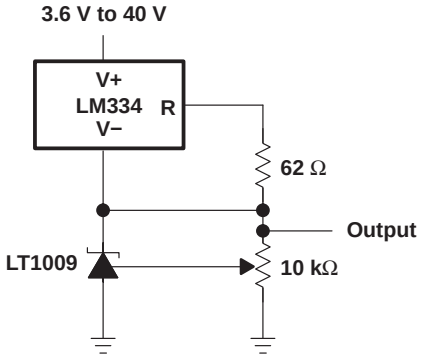


Figure 9. Adjustable Reference With Wide Supply Range

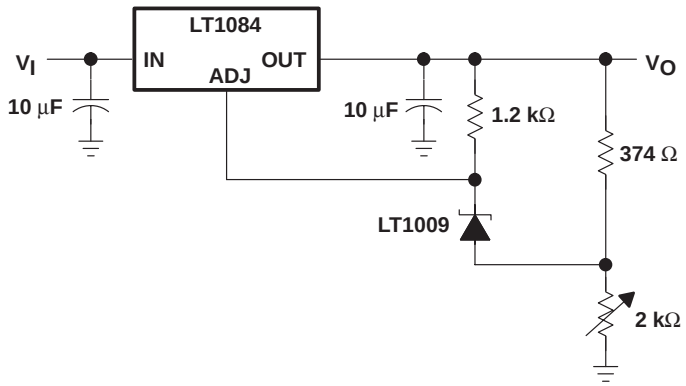


Figure 10. Power Regulator With Low Temperature Coefficient

APPLICATION INFORMATION

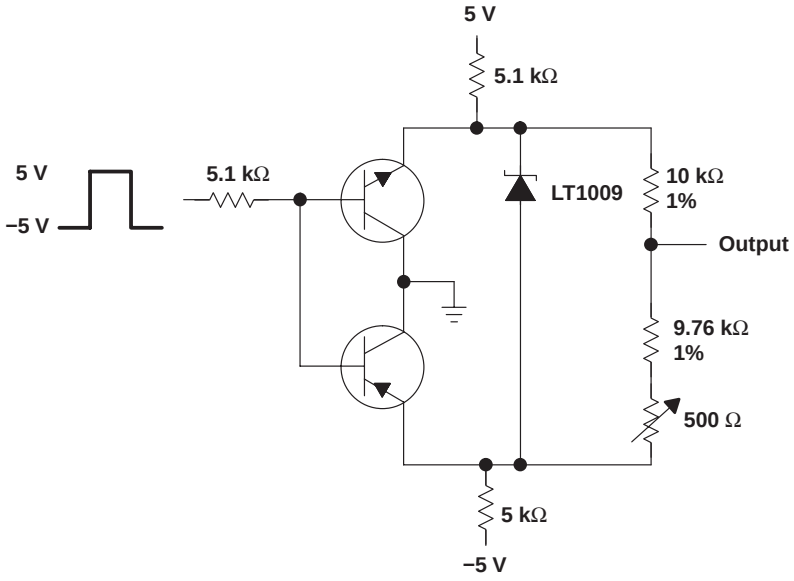


Figure 11. Switchable ±1.25-V Bipolar Reference

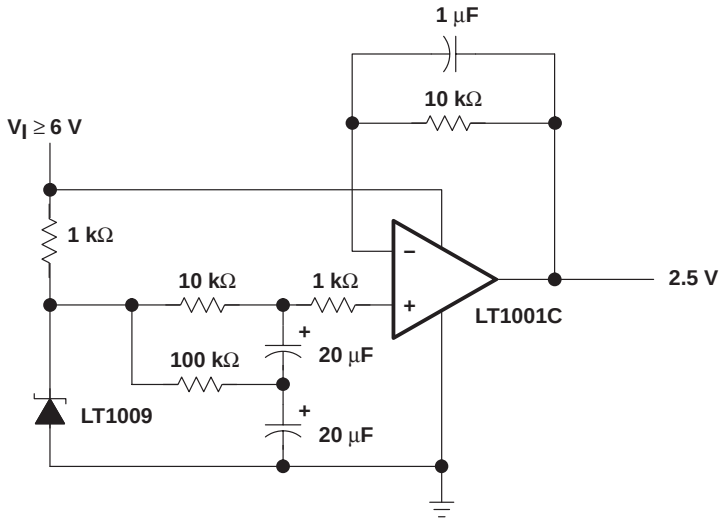


Figure 12. Low-Noise 2.5-V Buffered Reference

PACKAGING INFORMATION

Orderable Device	Status [1]	Package Type	Package Drawing	Pins	Package Qty	Eco Plan [2]	Lead/Ball Finish	MSL Peak Temp [3]
LT1009CD	ACTIVE	SOIC	D	8	75	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
LT1009CDR	ACTIVE	SOIC	D	8	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
LT1009CLP	ACTIVE	TO-92	LP	3	1000	None	CU SNPB	Level-NC-NC-NC
LT1009CLPM	ACTIVE	TO-92	LP	3	2000	None	CU SNPB	Level-NC-NC-NC
LT1009CLPR	ACTIVE	TO-92	LP	3	2000	None	CU SNPB	Level-NC-NC-NC
LT1009CPK	OBSOLETE	SOT-89	PK	3		None	Call TI	Call TI
LT1009CPW	ACTIVE	TSSOP	PW	8	150	Pb-Free (RoHS)	CU NIPDAU	Level-1-250C-UNLIM
LT1009CPWR	ACTIVE	TSSOP	PW	8	2000	Pb-Free (RoHS)	CU NIPDAU	Level-1-250C-UNLIM
LT1009ID	ACTIVE	SOIC	D	8	75	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
LT1009IDR	ACTIVE	SOIC	D	8	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
LT1009ILP	ACTIVE	TO-92	LP	3	1000	None	CU SNPB	Level-NC-NC-NC
LT1009ILPR	ACTIVE	TO-92	LP	3	2000	None	CU SNPB	Level-NC-NC-NC
LT1009IPW	ACTIVE	TSSOP	PW	8	150	Pb-Free (RoHS)	CU NIPDAU	Level-1-250C-UNLIM
LT1009IPWR	ACTIVE	TSSOP	PW	8	2000	Pb-Free (RoHS)	CU NIPDAU	Level-1-250C-UNLIM
LT1009QDR	OBSOLETE	SOIC	D	8		None	Call TI	Call TI
LT1009Y	OBSOLETE	XCEPT	Y	0		None	Call TI	Call TI

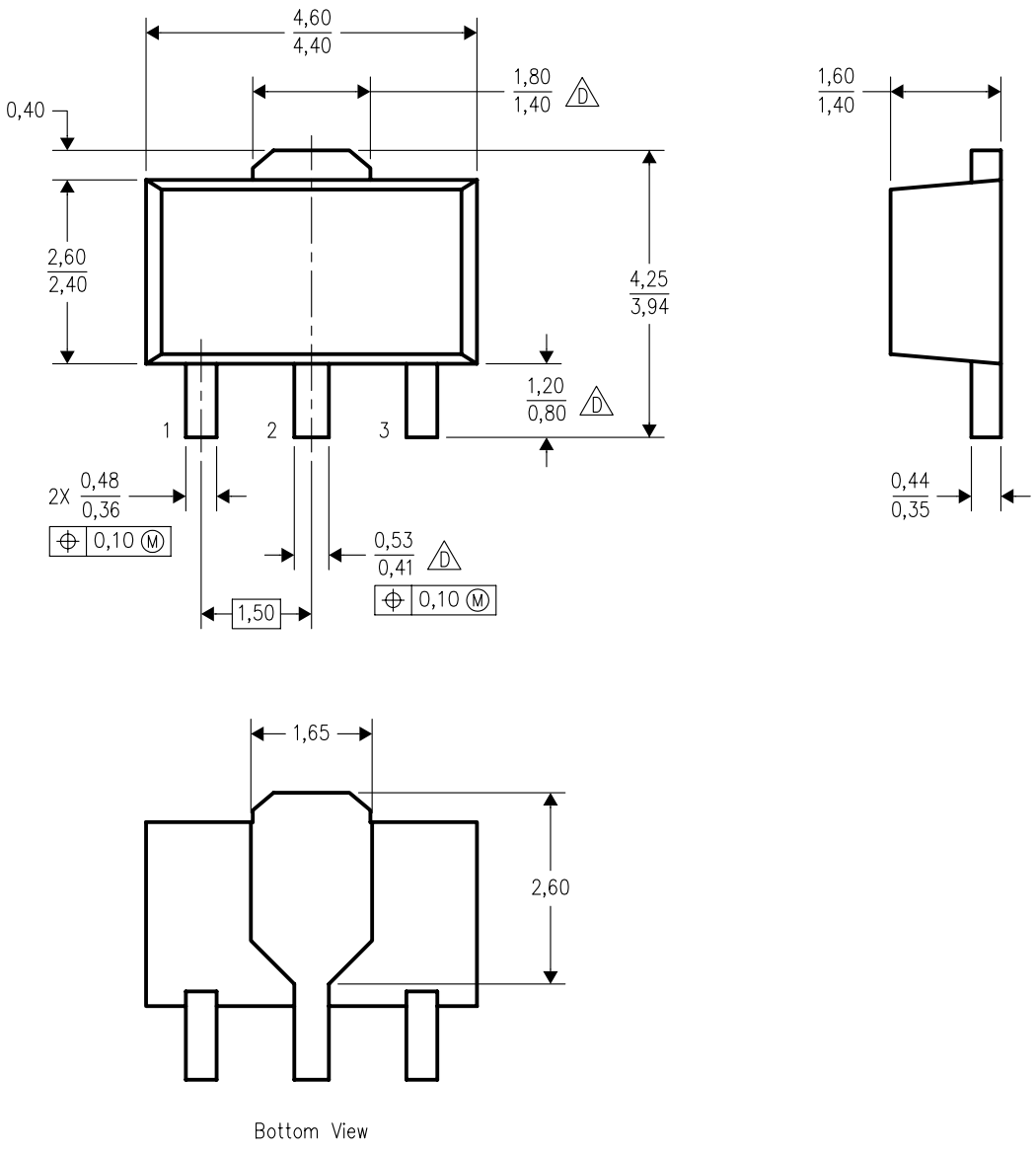
[1] The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, 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 - May not be currently available - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
None: Not yet available Lead (Pb-Free).
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.
Green (RoHS & no Sb/Br): TI defines "Green" to mean "Pb-Free" and in addition, uses package materials that do not contain halogens, including bromine (Br) or antimony (Sb) above 0.1% of total product weight.

[3] MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDECindustry standard classifications, and peak solder temperature.

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.

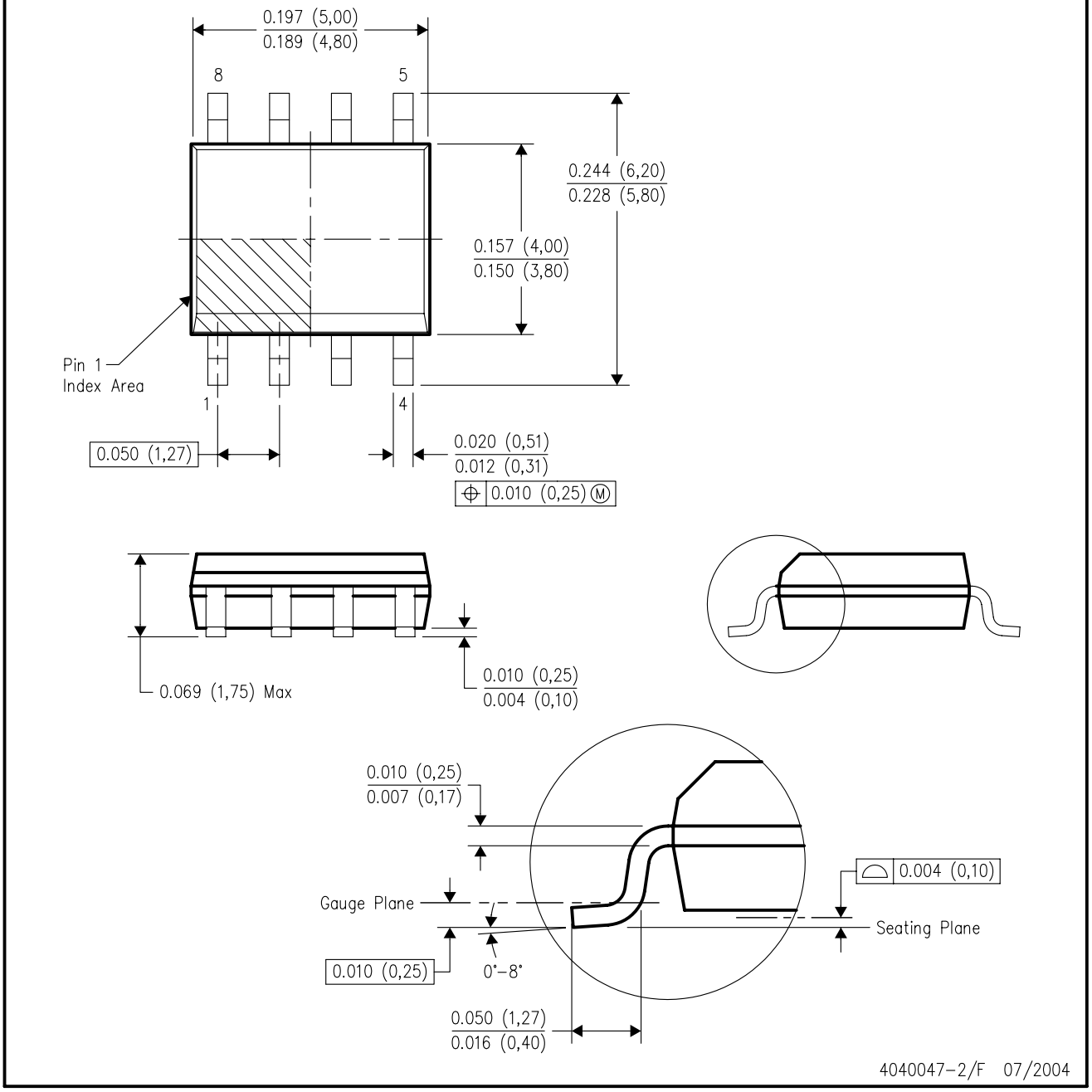
PK (R–PSSO–F3) PLASTIC SINGLE–IN–LINE PACKAGE



4040234/C 07/2004

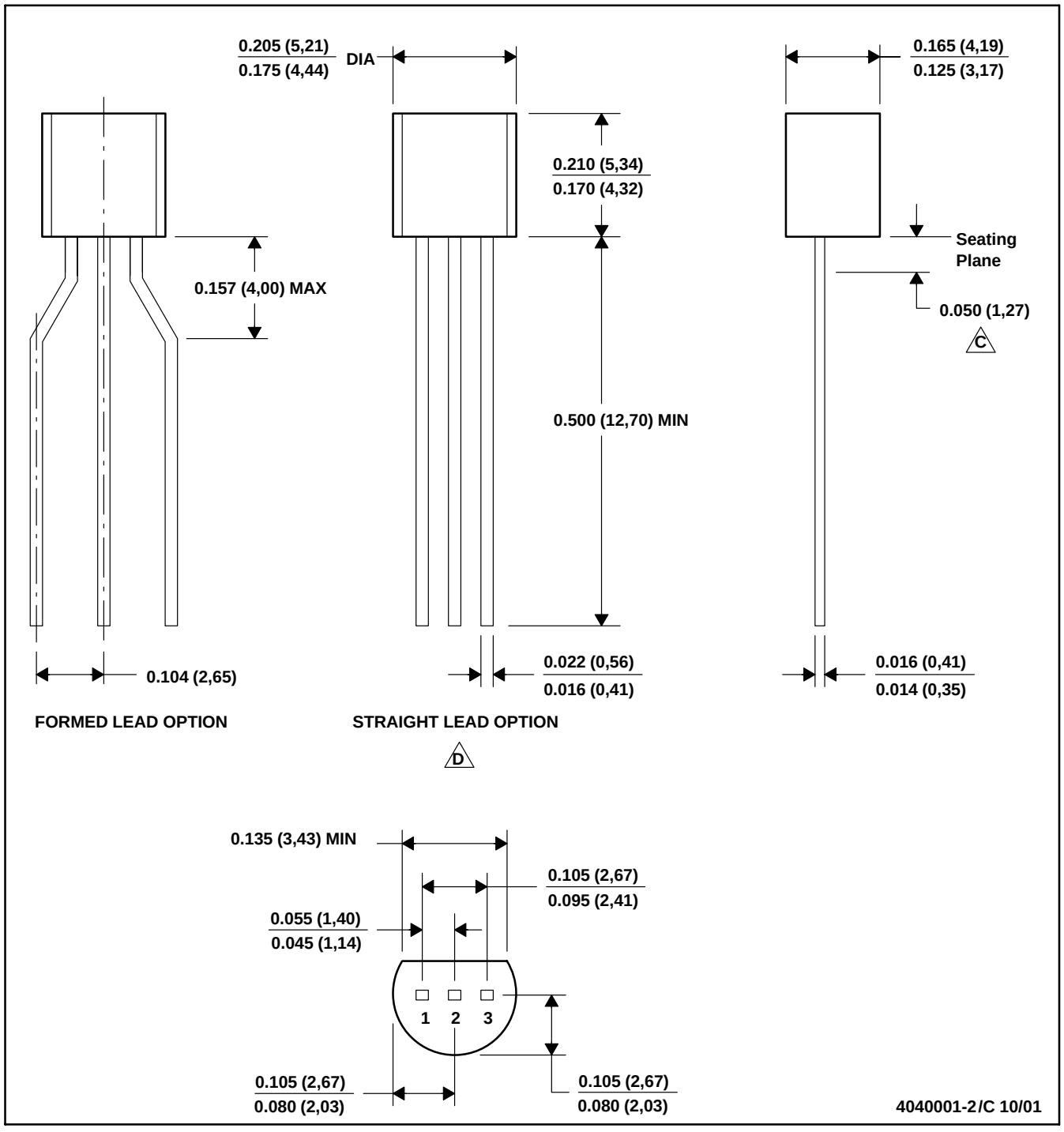
NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5–1994.
B. This drawing is subject to change without notice.
C. The center lead is in electrical contact with the tab.
D. Falls within JEDEC TO–243 variation AA, except minimum lead length, pin 2 minimum lead width, and minimum tab width.

D (R–PDSO–G8) PLASTIC SMALL–OUTLINE PACKAGE



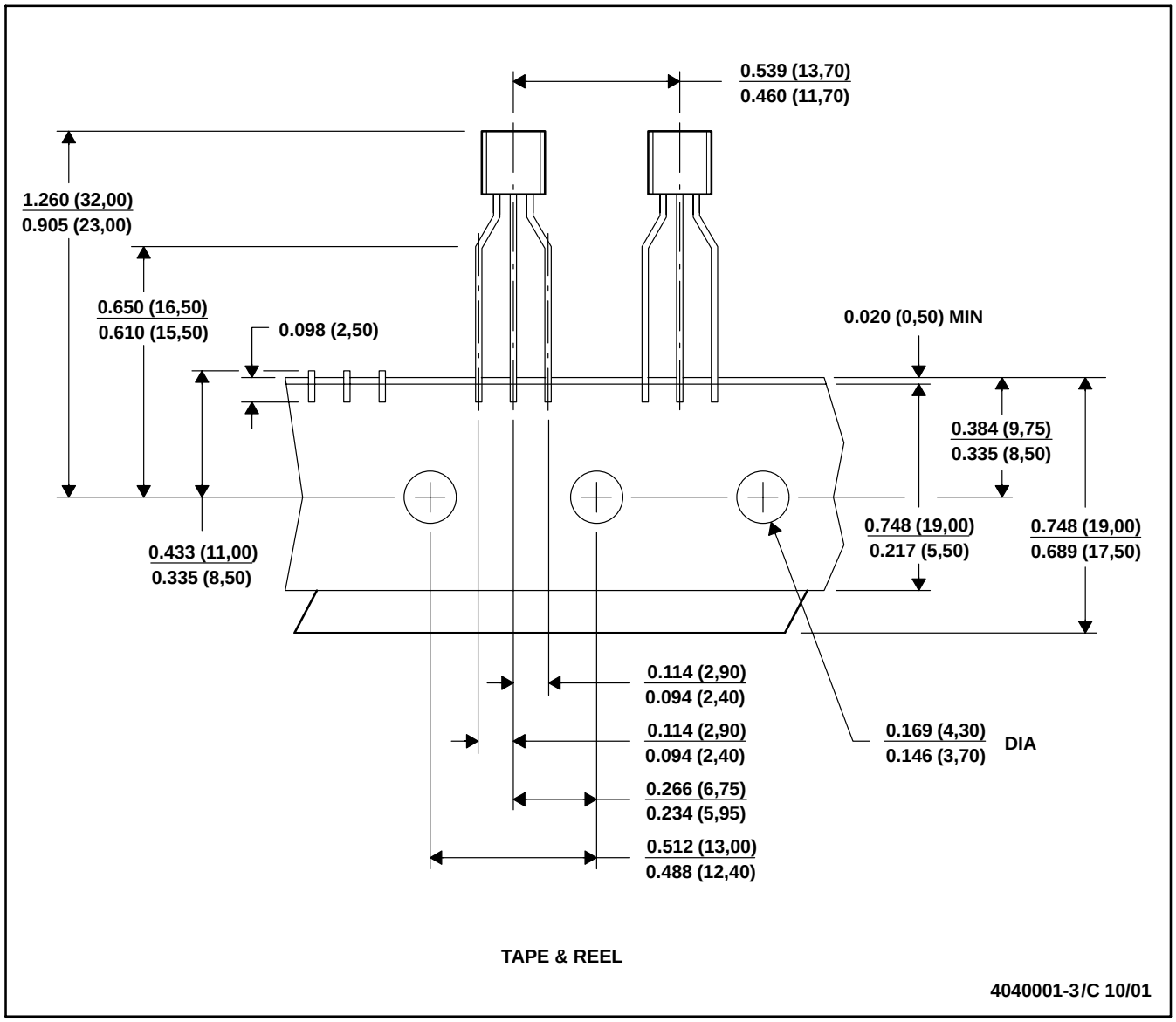
NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
D. Falls within JEDEC MS–012 variation AA.

LP (O-PBCY-W3) **PLASTIC CYLINDRICAL PACKAGE**



NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Lead dimensions are not controlled within this area
D. 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.

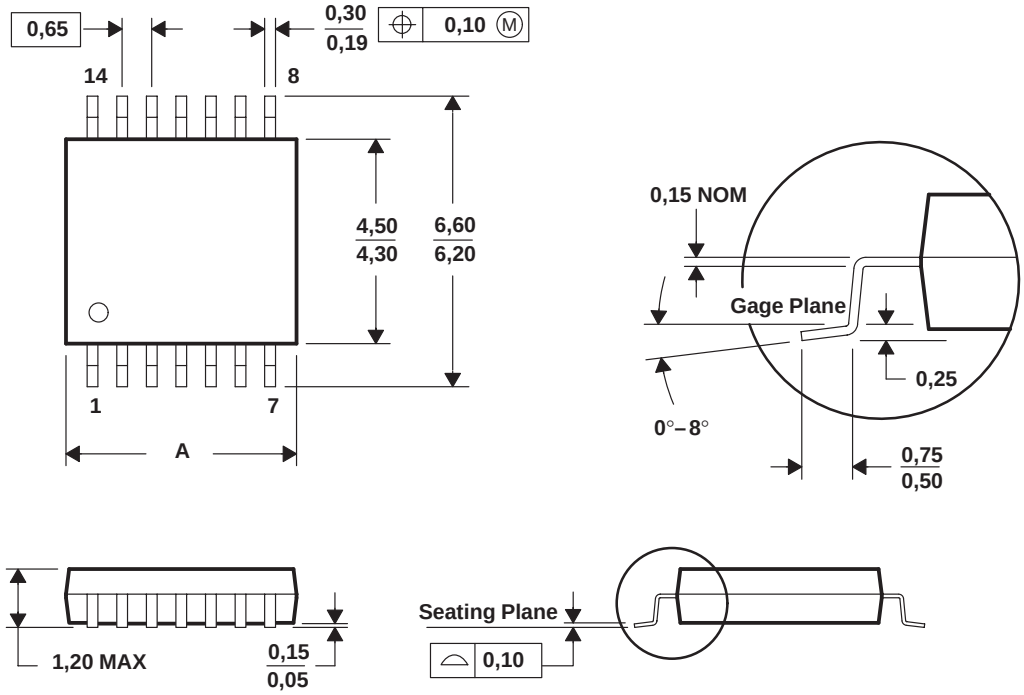
LP (O-PBCY-W3) **PLASTIC CYLINDRICAL PACKAGE**



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 Format Lead Option package.

PW (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

14 PINS SHOWN



DIM \ PINS **	8	14	16	20	24	28
A MAX	3,10	5,10	5,10	6,60	7,90	9,80
A MIN	2,90	4,90	4,90	6,40	7,70	9,60

4040064/F 01/97

NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
D. Falls within JEDEC MO-153

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

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

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		**Applications**	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DSP	dsp.ti.com	Broadband	www.ti.com/broadband
Interface	interface.ti.com	Digital Control	www.ti.com/digitalcontrol
Logic	logic.ti.com	Military	www.ti.com/military
Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
		Telephony	www.ti.com/telephony
		Video & Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments
Post Office Box 655303 Dallas, Texas 75265