

# LM236-2.5, LM336-2.5, LM336B-2.5 2.5-V INTEGRATED REFERENCE CIRCUITS

SLVS063E – NOVEMBER 1988 – REVISED OCTOBER 2003

- Low Temperature Coefficient
- Wide Operating Current . . . 400  $\mu$ A to 10 mA
- 0.27- $\Omega$  Dynamic Impedance
- $\pm$ 1% Tolerance Available
- Specified Temperature Stability
- Easily Trimmed for Minimum Temperature Drift
- Fast Turnon

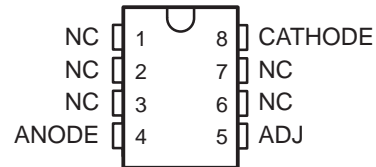
## description/ordering information

The LM236-2.5, LM336-2.5, and LM336B-2.5 integrated circuits are precision 2.5-V shunt regulator diodes. These reference circuits operate as low-temperature-coefficient 2.5-V Zener diodes with a 0.2- $\Omega$  dynamic impedance. A third terminal provided on the circuit allows the reference voltage and temperature coefficient to be trimmed easily.

The series is useful as precision 2.5-V low-voltage references ( $V_Z$ ) for digital voltmeters, power supplies, or operational-amplifier circuitry. The 2.5-V voltage reference makes it convenient to obtain a stable reference from 5-V logic supplies. Devices in this series operate as shunt regulators, and can be used as either positive or negative voltage references.

The LM236-2.5 is characterized for operation from  $-25^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ . The LM336-2.5 and LM336B-2.5 are characterized for operation from  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ .

D PACKAGE  
(TOP VIEW)



NC – No internal connection

LM336-2.5, LM336B-2.5 . . . LP PACKAGE  
(TOP VIEW)



## ORDERING INFORMATION

$T_A$	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
$0^{\circ}\text{C}$ to $70^{\circ}\text{C}$	SOIC (D)	Tube of 75	LM336D-2-5	336-25
		Reel of 2500	LM336DR-2-5	
		Tube of 75	LM336BD-2-5	336B25
		Reel of 2500	LM336BDR-2-5	
	TO-226 / TO-92 (LP)	Bulk of 1000	LM336LP-2-5	336-25
		Reel of 2000	LM336LPR-2-5	
		Bulk of 1000	LM336BLP-2-5	336B25
		Reel of 2000	LM336BLPR-2-5	
$-25^{\circ}\text{C}$ to $85^{\circ}\text{C}$	SOIC (D)	Tube of 75	LM236D-2-5	236-25
		Reel of 2500	LM236DR-2-5	

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



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 **TEXAS  
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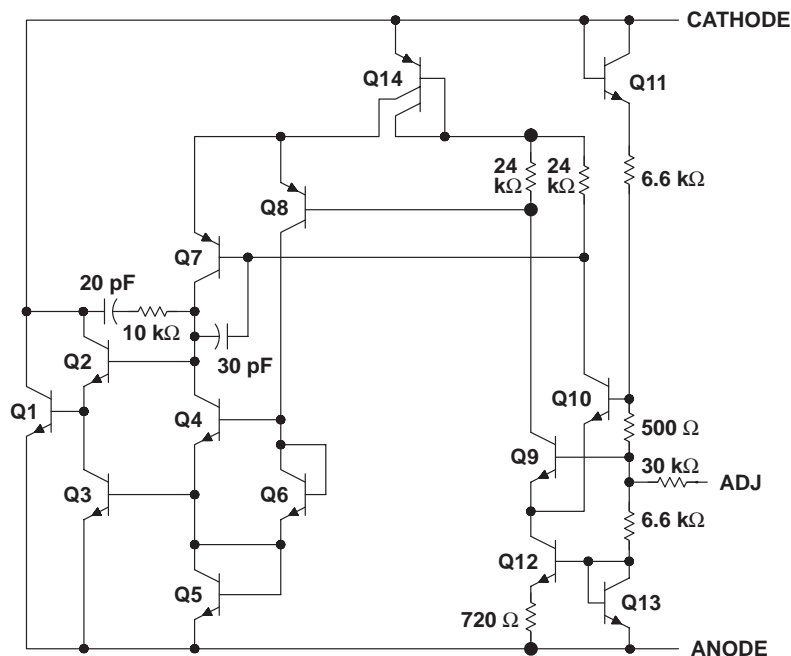
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## symbol



## schematic diagram



NOTE A: All component values 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, $\theta_{JA}$ (see Notes 1 and 2): D package .....	97°C/W
LP package .....	140°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  $T_{J(max)}$ ,  $\theta_{JA}$ , 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 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	LM236-2.5	-25	85	°C
	LM336-2.5, LM336B-2.5	0	70	



# LM236-2.5, LM336-2.5, LM336B-2.5 2.5-V INTEGRATED REFERENCE CIRCUITS

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## electrical characteristics at specified free-air temperature (unless otherwise noted)

PARAMETER	TEST CONDITIONS	$T_A$ †	LM236-2.5			LM336-2.5			UNIT			
			MIN	TYP	MAX	MIN	TYP	MAX				
$V_Z$ Reference voltage	$I_Z = 1 \text{ mA}$	25°C	LM236, LM336			2.44	2.49	2.54	2.39	2.49	2.59	V
			LM336B						2.44	2.49	2.54	
$\Delta V_Z(\Delta T)$ Change in reference voltage with temperature	$V_Z$ adjusted to 2.490 V, $I_Z = 1 \text{ mA}$	Full range		3.5	9		1.8	6			mV	
$\Delta V_Z(\Delta I)$ Change in reference voltage with current	$I_Z = 400 \mu\text{A}$ to 10 mA	25°C		2.6	6		2.6	10			mV	
		Full range		3	10		3	12				
$\Delta V_Z(\Delta t)$ Long-term change in reference voltage	$I_Z = 1 \text{ mA}$	25°C		20			20				ppm/khr	
$z_z$ Reference impedance	$I_Z = 1 \text{ mA}$ , $f = 1 \text{ kHz}$	25°C		0.2	0.6		0.2	1			W	
		Full range		0.4	1		0.4	1.4				

† Full range is -25°C to 85°C for the LM236-2.5 and 0°C to 70°C for the LM336-2.5 and LM336B-2.5.



# LM236-2.5, LM336-2.5, LM336B-2.5 2.5-V INTEGRATED REFERENCE CIRCUITS

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## TYPICAL CHARACTERISTICS

CHANGE IN REFERENCE VOLTAGE  
vs  
REFERENCE CURRENT

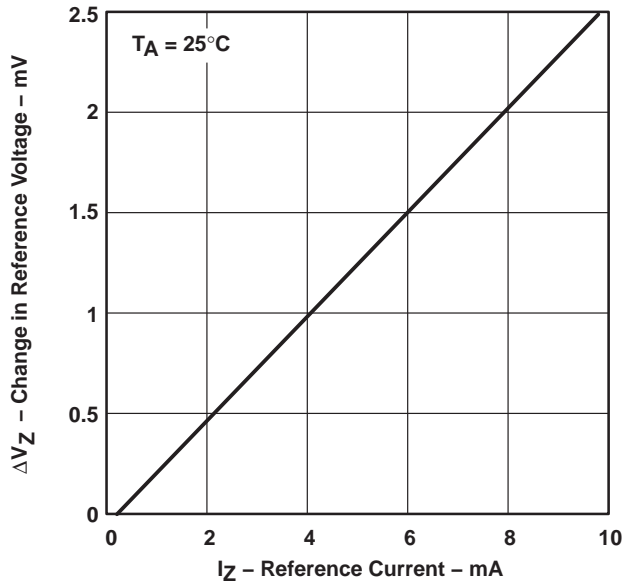


Figure 1

NOISE VOLTAGE  
vs  
FREQUENCY

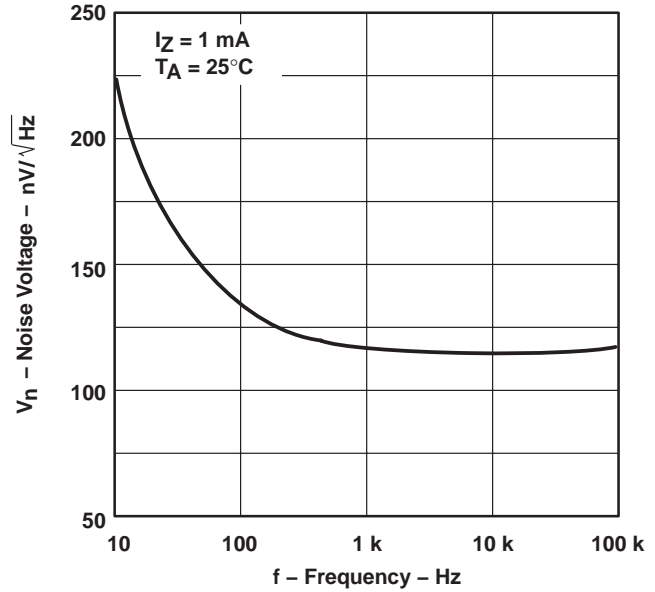


Figure 2

REFERENCE IMPEDANCE  
vs  
FREQUENCY

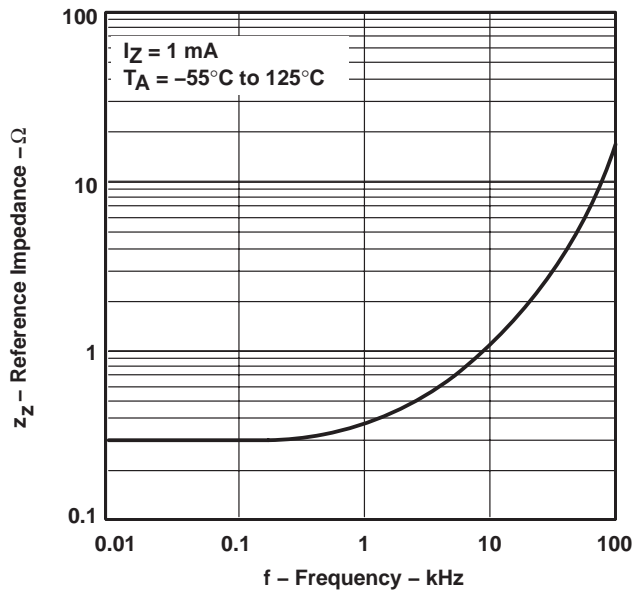


Figure 3

APPLICATION INFORMATION

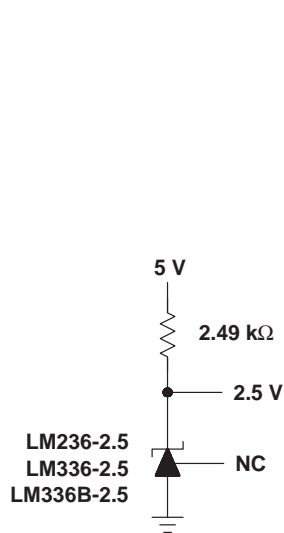
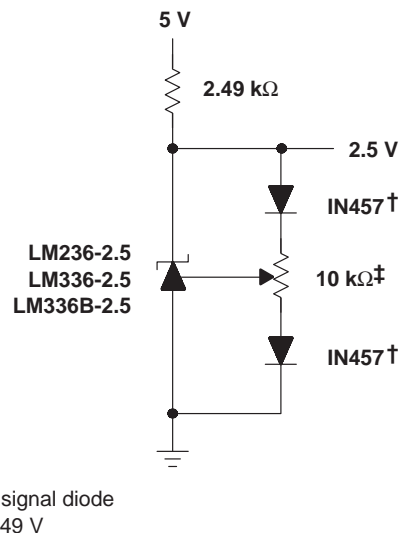


Figure 4. 2.5-V Reference



† Any silicon signal diode  
‡ Adjust to 2.49 V

Figure 5. 2.5-V Reference  
With Minimum Temperature Coefficient

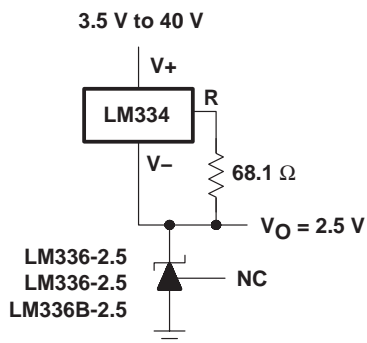


Figure 6. Wide-Input-Range Reference

**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
LM236D-2-5	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM236DE4-2-5	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM236DR-2-5	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM236DRE4-2-5	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM236LP-2-5	OBSOLETE	TO-92	LP	3		TBD	Call TI	Call TI
LM336BD-2-5	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM336BDE4-2-5	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM336BDR-2-5	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM336BDRE4-2-5	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM336BLP-2-5	ACTIVE	TO-92	LP	3	1000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
LM336BLPE3-2-5	ACTIVE	TO-92	LP	3	1000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
LM336BLPR-2-5	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
LM336BLPRE3-2-5	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
LM336D-2-5	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM336DE4-2-5	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM336DR-2-5	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM336DRE4-2-5	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM336LP-2-5	ACTIVE	TO-92	LP	3	1000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
LM336LPE3-2-5	ACTIVE	TO-92	LP	3	1000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
LM336LPR-2-5	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
LM336LPRE3-2-5	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type

<sup>(1)</sup> 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.

<sup>(2)</sup> 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)

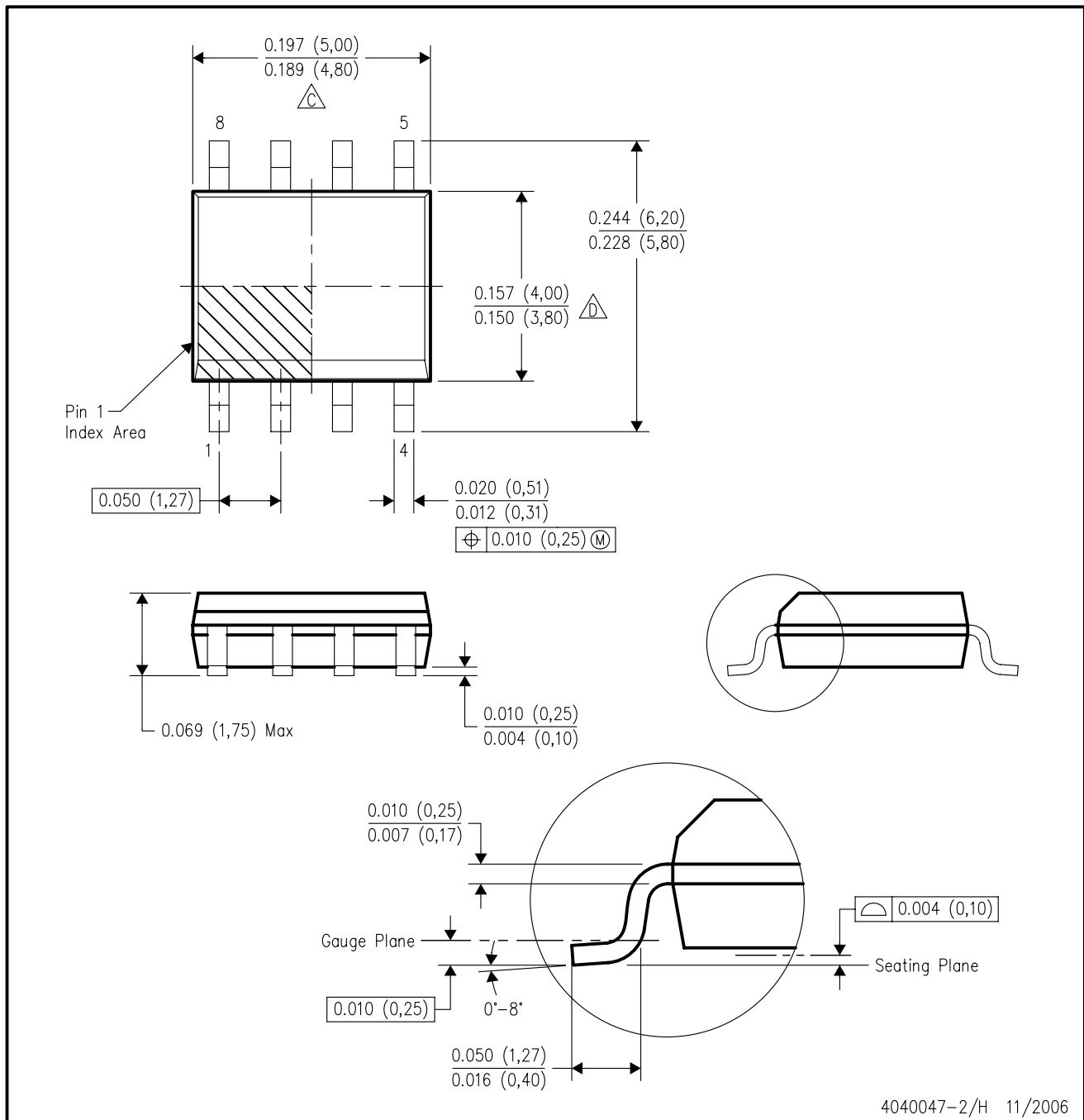
<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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D (R-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE





LP (O-PBCY-W3)

PLASTIC CYLINDRICAL PACKAGE



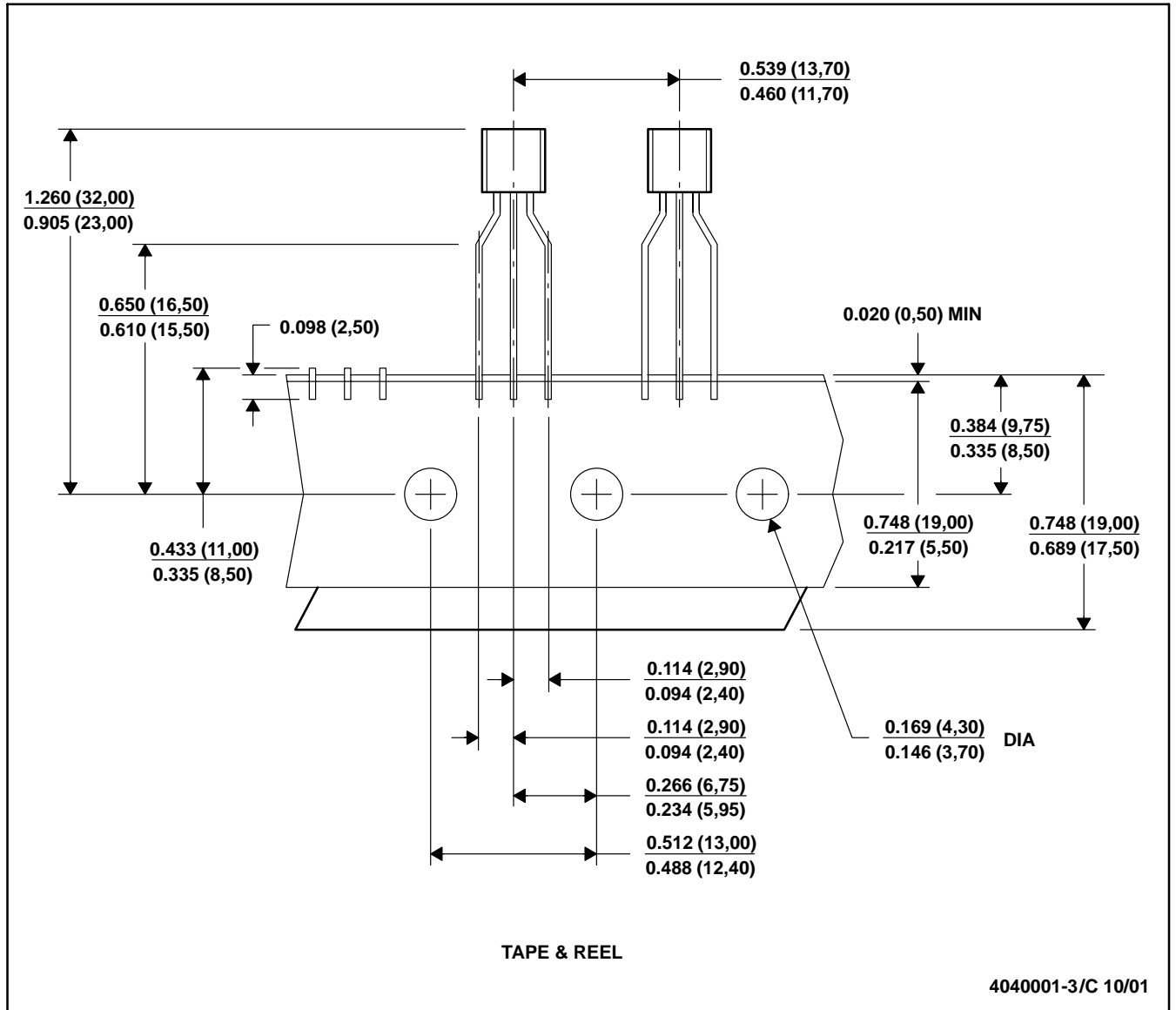
- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Lead dimensions are not controlled within this area  
 D. Falls within JEDEC TO -226 Variation AA (TO-226 replaces TO-92)  
 E. Shipping Method:  
 Straight lead option available in bulk pack only.  
 Formed lead option available in tape & reel or ammo pack.

# MECHANICAL DATA

MSOT002A – OCTOBER 1994 – REVISED NOVEMBER 2001

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.

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