

LM185-1.2/LM285-1.2/LM385-1.2 Micropower Voltage Reference Diode

 Check for Samples: [LM185-1.2-N](#), [LM285-1.2-N](#), [LM385-1.2-N](#)

FEATURES

- $\pm 1\%$ and 2% initial tolerance
- Operating current of $10\mu\text{A}$ to 20mA
- 1Ω dynamic impedance
- Low temperature coefficient
- Low voltage reference— 1.235V
- 2.5V device and adjustable device also available
- LM185-2.5 series and LM185 series, respectively

DESCRIPTION

The LM185-1.2/LM285-1.2/LM385-1.2 are micropower 2-terminal band-gap voltage regulator diodes. Operating over a $10\mu\text{A}$ to 20mA current range, they feature exceptionally low dynamic impedance and good temperature stability. On-chip trimming is used to provide tight voltage tolerance. Since the LM185-1.2 band-gap reference uses only transistors and resistors, low noise and good long term stability result.

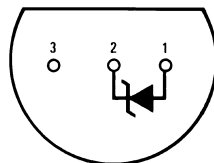
Careful design of the LM185-1.2 has made the device exceptionally tolerant of capacitive loading, making it easy to use in almost any reference application. The wide dynamic operating range allows its use with widely varying supplies with excellent regulation.

The extremely low power drain of the LM185-1.2 makes it useful for micropower circuitry. This voltage reference can be used to make portable meters, regulators or general purpose analog circuitry with battery life approaching shelf life.

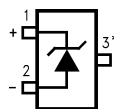
Further, the wide operating current allows it to replace older references with a tighter tolerance part.

The LM185-1.2 is rated for operation over a -55°C to 125°C temperature range while the LM285-1.2 is rated -40°C to 85°C and the LM385-1.2 0°C to 70°C . The LM185-1.2/LM285-1.2 are available in a hermetic TO-46 package and the LM285-1.2/LM385-1.2 are also available in a low-cost TO-92 molded package, as well as SO and SOT-23. The LM185-1.2 is also available in a hermetic leadless chip carrier package.

CONNECTION DIAGRAM



**Figure 1. T0-92 Plastic Package (Z)
Bottom View**



* Pin 3 is attached to the Die Attach Pad (DAP) and should be connected to Pin 2 or left floating.

Figure 2. SOT23



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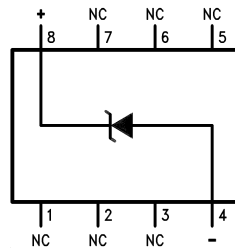


Figure 3. SO Package

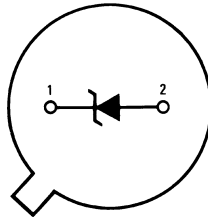


Figure 4. TO-46 Metal Can Package (H) Bottom View



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

ABSOLUTE MAXIMUM RATINGS^{(1) (2)}

Reverse Current	30mA
Forward Current	10mA
Operating Temperature Range ⁽³⁾	
LM185-1.2	-55°C to +125°C
LM285-1.2	-40°C to +85°C
LM385-1.2	0°C to 70°C
ESD Susceptibility ⁽⁴⁾	2kV
Storage Temperature	-55°C to +150°C
Soldering Information	
TO-92 package: 10 sec.	260°C
TO-46 package:10 sec.	300°C
SO and SOT Pkg.	
Vapor phase (60 sec.)	215°C
Infrared (15 sec.)	220°C
See AN-450 "Surface Mounting Methods and Their Effect on Product Reliability" for other methods of soldering surface mount devices.	

- (1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but do not guarantee specific performance limits. For guaranteed specifications and test conditions, see the Electrical Characteristics. The guaranteed specifications apply only for the test conditions listed.
- (2) Refer to RETS185H-1.2 for military specifications.
- (3) For elevated temperature operation, T_j max is: LM185 150°C LM285 125°C LM385 100°C
- (4) The human body model is a 100 pF capacitor discharged through a 1.5 kΩ resistor into each pin.

ELECTRICAL CHARACTERISTICS⁽¹⁾

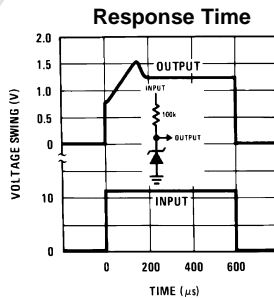
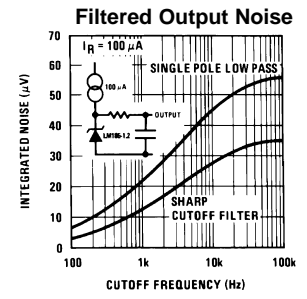
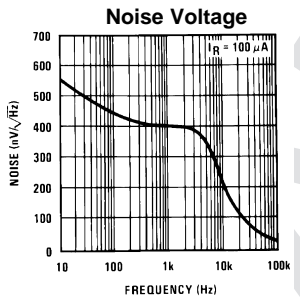
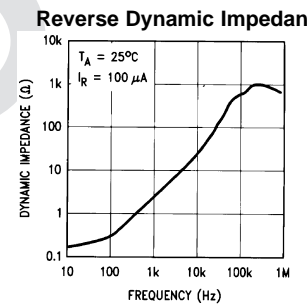
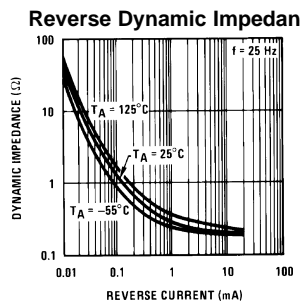
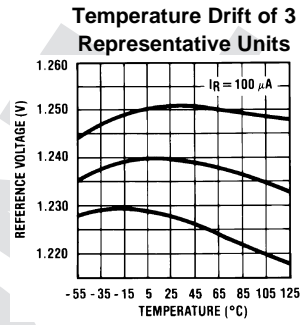
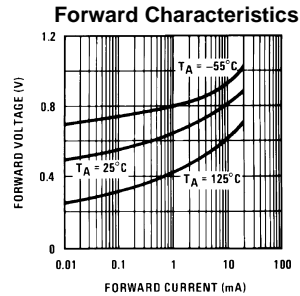
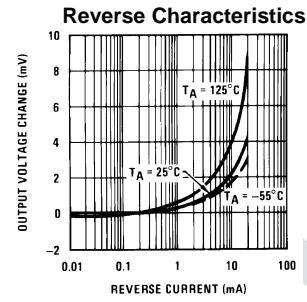
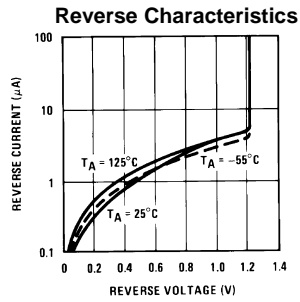
		LM185-1.2							
		LM185BX-1.2		LM385B-1.2					
		LM185BY-1.2		LM385BX-1.2		LM385-1.2			
		LM285-1.2		LM385BY-1.2					
Parameter	Conditions	Typ	LM285BX-1.2						Units
				LM285BY-1.2					
				Tested	Design	Tested	Design	Tested	Design
				Limit	Limit	Limit	Limit	Limit	Limit
				(2)(3) (4)	(2)	(2)	(4)	(2)	(4)
Reverse Breakdown	$T_A = 25^\circ\text{C}$,	1.23 5	1.223		1.223		1.205		V(Min)
Voltage	$10\mu\text{A} \leq I_R \leq 20\text{mA}$		1.247		1.247		1.260		V(Max)
Minimum Operating Current	LM385M3-1.2	8	10	20	15	20	15	20	μA
Reverse Breakdown Voltage Change with Current	$10\mu\text{A} \leq I_R \leq 1\text{mA}$		1	1.5	1	1.5	1	1.5	mV
Reverse Dynamic Impedance	$I_R = 100\mu\text{A}$, $f = 20\text{Hz}$	1							Ω
Wideband Noise (rms)	$I_R = 100\mu\text{A}$, $10\text{Hz} \leq f \leq 10\text{kHz}$	60							μV
Long Term Stability	$I_R = 100\mu\text{A}$, $T = 1000\text{ Hr}$, $T_A = 25^\circ\text{C} \pm 0.1^\circ\text{C}$	20							ppm
Average Temperature Coefficient ⁽⁵⁾	$I_R = 100\mu\text{A}$								ppm/ $^\circ\text{C}$
	X Suffix		30		30				ppm/ $^\circ\text{C}$
	Y Suffix		50		50				ppm/ $^\circ\text{C}$
	All Others		150		150		150	150	ppm/ $^\circ\text{C}$
									(Max)

- (1) Parameters identified with boldface type apply at temperature extremes. All other numbers apply at $T_A = T_J = 25^\circ\text{C}$.
 (2) Guaranteed and 100% production tested.
 (3) A military RETS electrical specification is available on request.
 (4) Guaranteed, but not 100% production tested. These limits are not used to calculate average outgoing quality levels.
 (5) The average temperature coefficient is defined as the maximum deviation of reference voltage at all measured temperatures between the operating T_{MAX} and T_{MIN} , divided by $T_{\text{MAX}} - T_{\text{MIN}}$. The measured temperatures are -55°C , -40°C , 0°C , 25°C , 70°C , 85°C , 125°C .

THERMAL CHARACTERISTICS

Thermal Resistance	TO-92	TO-46	SO-8	SOT23
θ_{JA} (junction to ambient)	180 $^\circ\text{C}/\text{W}$ (0.4" leads)	440 $^\circ\text{C}/\text{W}$	165 $^\circ\text{C}/\text{W}$	283 $^\circ\text{C}/\text{W}$
	170 $^\circ\text{C}/\text{W}$ (0.125" leads)			
θ_{JC} (junction to case)	N/A	80 $^\circ\text{C}/\text{W}$	N/A	N/A

TYPICAL PERFORMANCE CHARACTERISTICS



TYPICAL APPLICATIONS

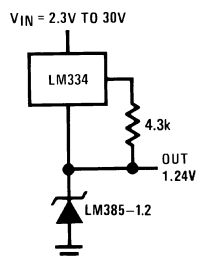


Figure 5. Wide Input Range Reference

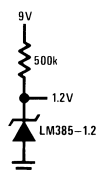


Figure 6. Micropower Reference from 9V Battery

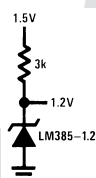
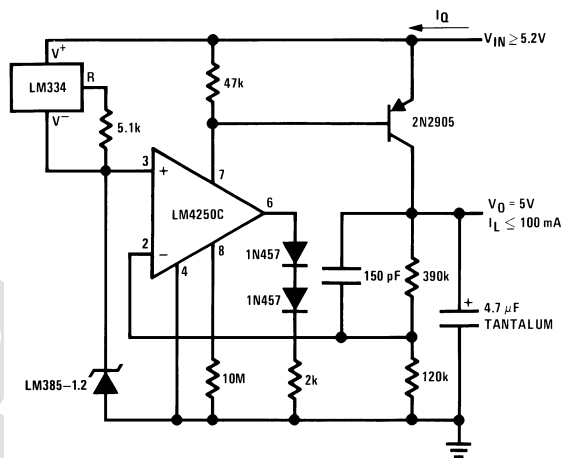
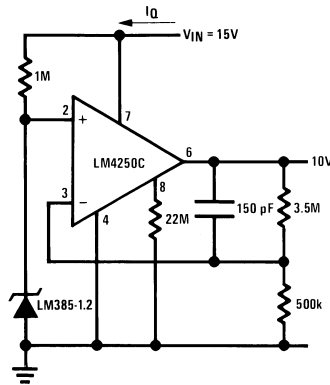


Figure 7. Reference from 1.5V Battery



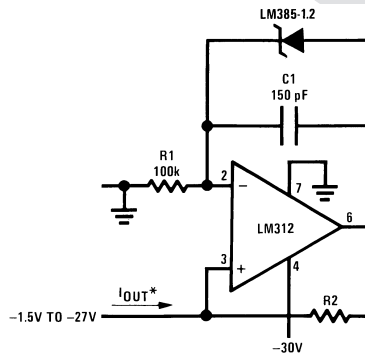
* $I_Q \approx 30\mu A$

Figure 8. Micropower* 5V Regulator



*I_Q ≈ 20μA standby current

Figure 9. Micropower* 10V Reference



$$*I_{OUT} = \frac{1.23V}{R2}$$

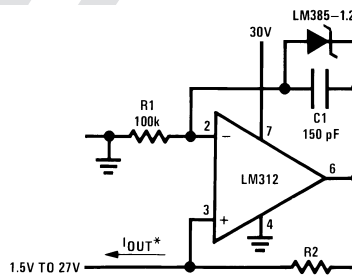
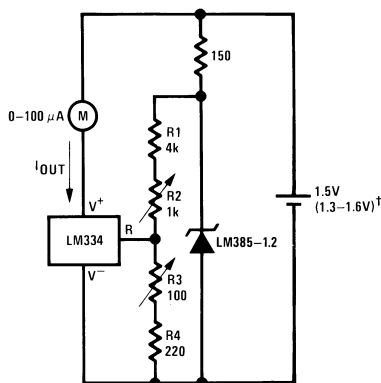


Figure 10. Precision 1μA to 1mA Current Sources

METER THERMOMETERS

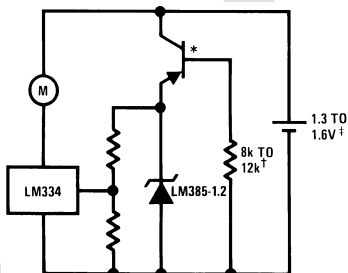


Calibration

1. Short LM385-1.2, adjust R3 for $I_{OUT} = \text{temp}$ at $1\mu\text{A}/^\circ\text{C}$
 2. Remove short, adjust R2 for correct reading in centigrade
- † I_Q at 1.3V=500 μA
 I_Q at 1.6V=2.4mA

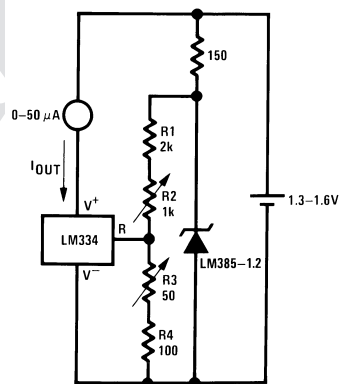
Figure 11. 0°C–100°C Thermometer

Figure 12.



- *2N3638 or 2N2907 select for inverse $H_{FE} \approx 5$
 †Select for operation at 1.3V
 ‡ $I_Q \approx 600\mu\text{A}$ to $900\mu\text{A}$

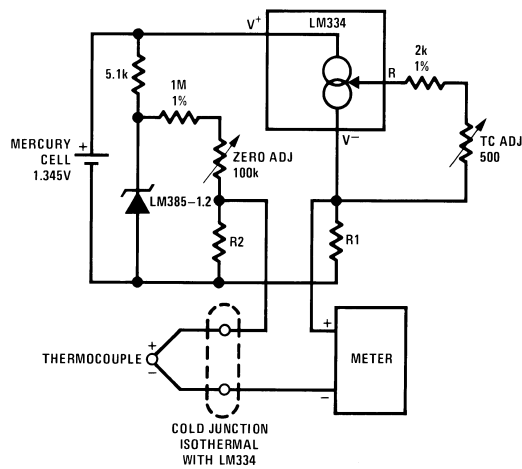
Figure 13. Lower Power Thermometer



Calibration

1. Short LM385-1.2, adjust R3 for $I_{OUT} = \text{temp}$ at $1.8\mu\text{A}/^\circ\text{C}$
2. Remove short, adjust R2 for correct reading in °F

Figure 14. 0°F–50°F Thermometer



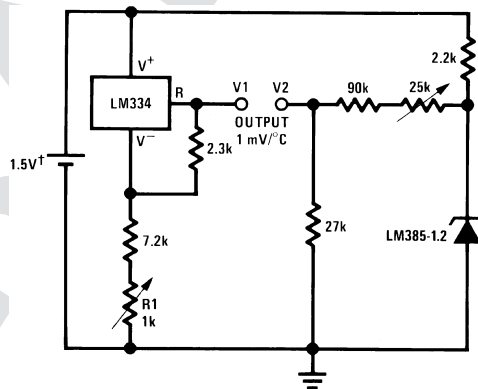
Adjustment Procedure

1. Adjust TC ADJ pot until voltage across R1 equals Kelvin temperature multiplied by the thermocouple Seebeck coefficient.
2. Adjust zero ADJ pot until voltage across R2 equals the thermocouple Seebeck coefficient multiplied by 273.2.

Figure 15. Micropower Thermocouple Cold Junction Compensator

Thermocouple Type	Seebeck Coefficient ($\mu\text{V}/^\circ\text{C}$)	R1 (Ω)	R2 (Ω)	Voltage Across R1 @ 25°C (mV)	Voltage Across R2 (mV)
J	52.3	523	1.24k	15.60	14.32
T	42.8	432	1k	12.77	11.78
K	40.8	412	953 Ω	12.17	11.17
S	6.4	63.4	150 Ω	1.908	1.766

Typical supply current 50 μA

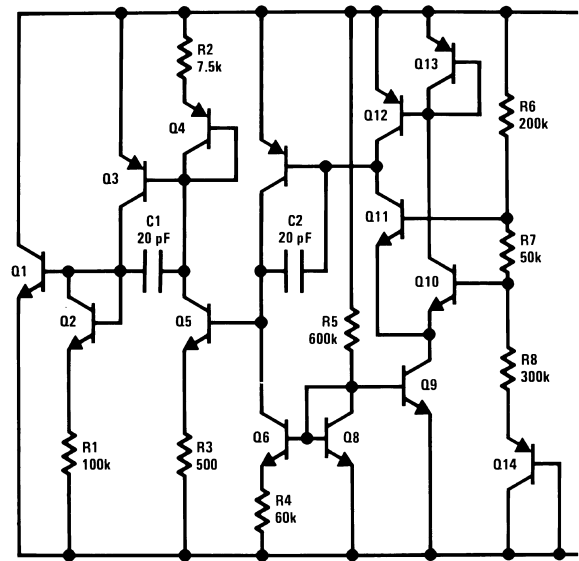


Calibration

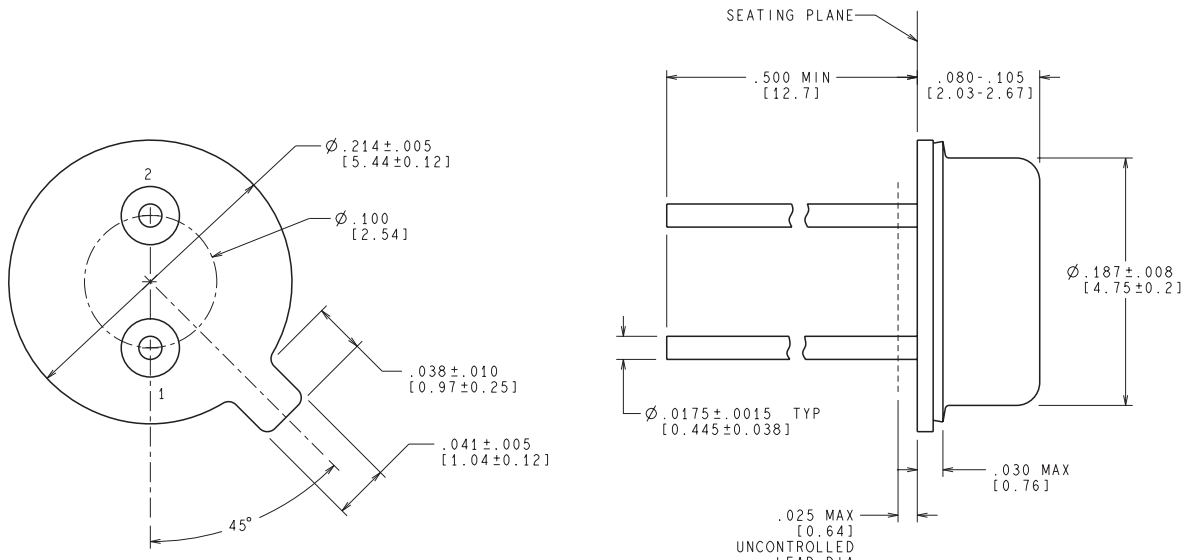
1. Adjust R1 so that V1 = temp at 1mV/°K
 2. Adjust V2 to 273.2mV
- $\dagger I_Q$ for 1.3V to 1.6V battery voltage = 50 μA to 150 μA

Figure 16. Centigrade Thermometer

SCHEMATIC DIAGRAM



NDU0002A

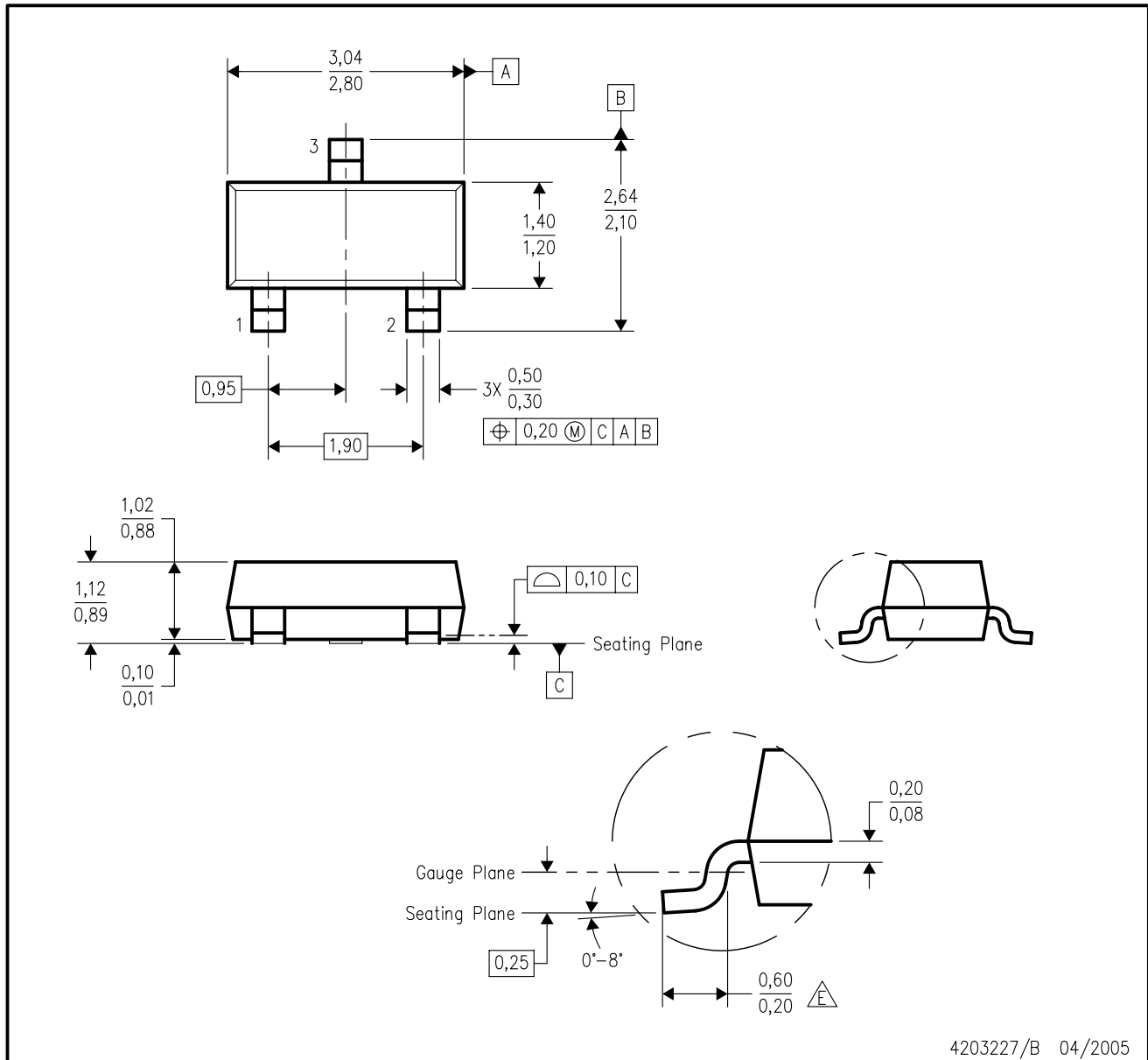


CONTROLLING DIMENSION IS INCH
VALUES IN [] ARE MILLIMETERS

H02A (Rev F)

DBZ (R-PDSO-G3)

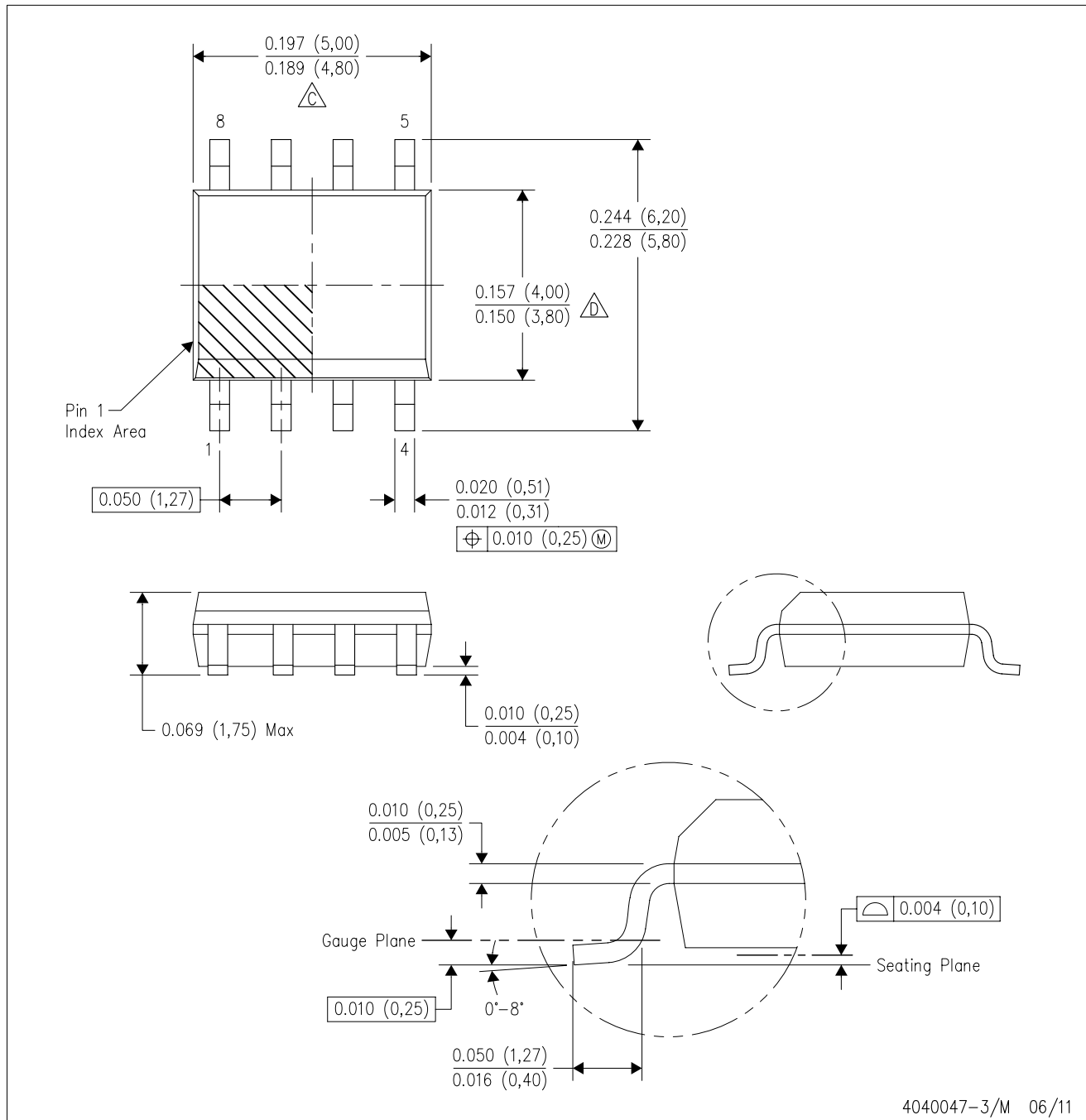
PLASTIC SMALL-OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
 - B. This drawing is subject to change without notice.
 - C. Lead dimensions are inclusive of plating.
 - D. Body dimensions are exclusive of mold flash and protrusion. Mold flash and protrusion not to exceed 0.25 per side.
 - Falls within JEDEC TO-236 variation AB, except minimum foot length.

D (R-PDSO-G8)

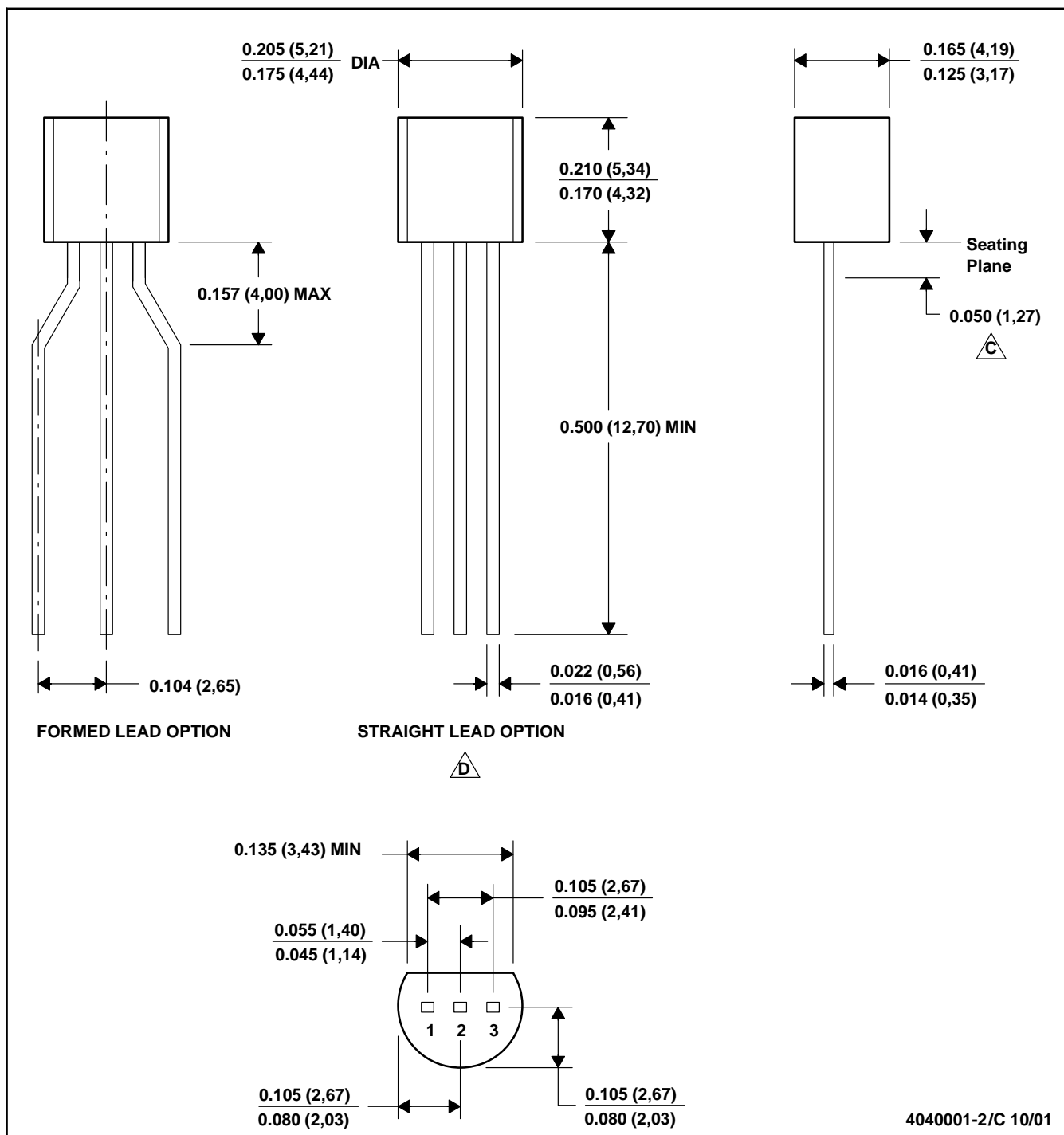
PLASTIC SMALL OUTLINE





- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. 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.
 - D. 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.

LP (O-PBCY-W3)

PLASTIC CYLINDRICAL PACKAGE



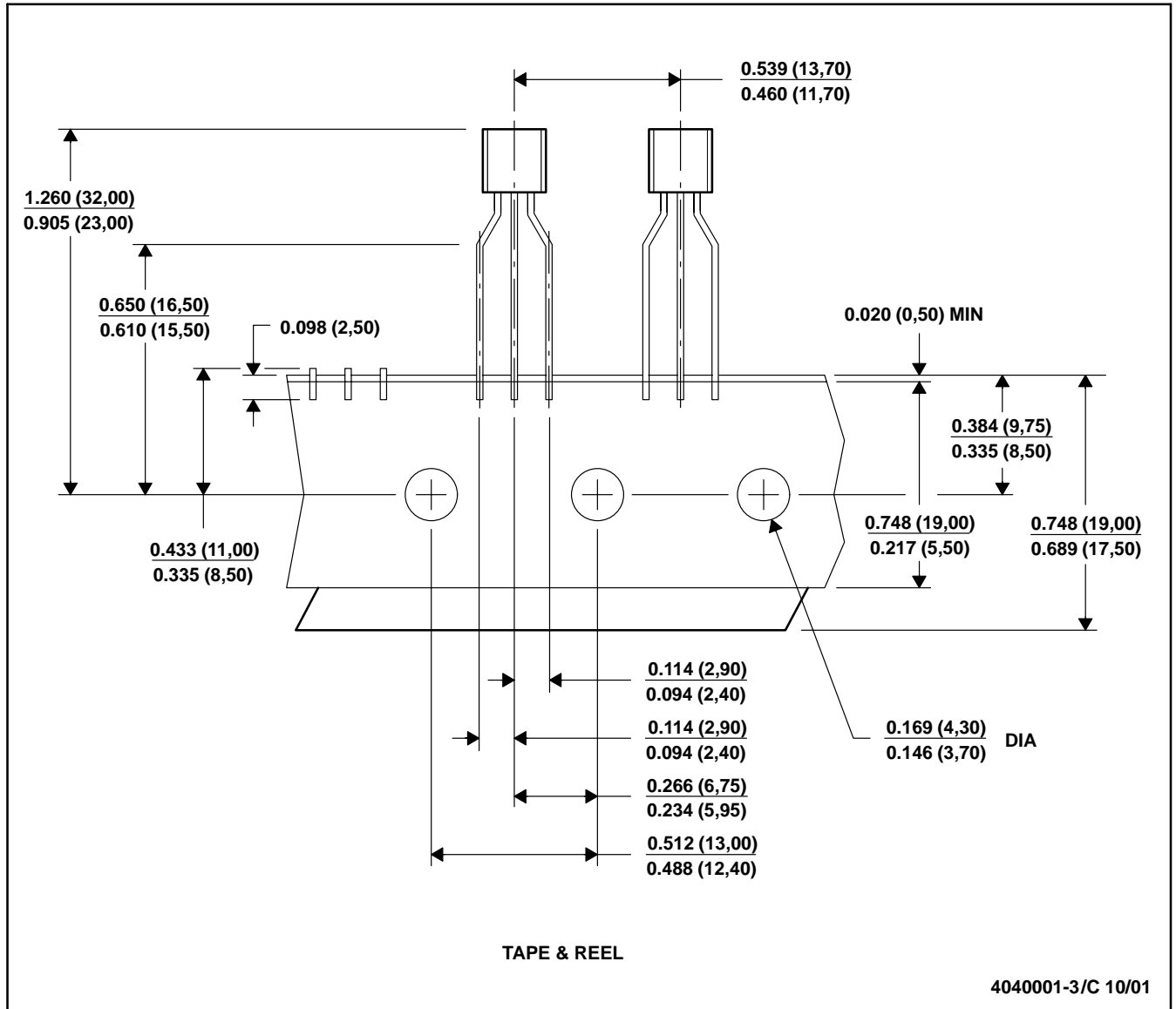
- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 -  C. Lead dimensions are not controlled within this area
 -  D. Falls within JEDEC TO -226 Variation AA (TO-226 replaces TO-92)
 - E. Shipping Method:
 Straight lead option available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