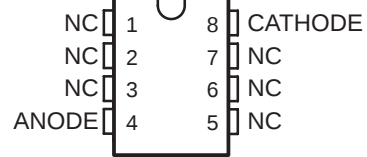


LM285-1.2, LM385-1.2, LM385B-1.2 MICROPOWER VOLTAGE REFERENCES

SLVS0751 – APRIL 1989 – REVISED DECEMBER 2005

- **Operating Current Range**
 - LM285 . . . 10 μ A to 20 mA
 - LM385 . . . 15 μ A to 20 mA
 - LM385B . . . 15 μ A to 20 mA
- **1% and 2% Initial Voltage Tolerance**
- **Reference Impedance**
 - LM385 . . . 1 Ω Max at 25°C
 - All Devices . . . 1.5 Ω Max Over Full Temperature Range
- **Very Low Power Consumption**
- **Applications**
 - Portable Meter References
 - Portable Test Instruments
 - Battery-Operated Systems
 - Current-Loop Instrumentation
 - Panel Meters
- **Interchangeable With Industry Standard**
LM285-1.2 and LM385-1.2

LM285-1.2 . . . D PACKAGE
LM385-1.2 . . . D, PS, OR PW PACKAGE
LM385B-1.2 . . . D OR PW PACKAGE
(TOP VIEW)



NC – No internal connection

LM285-1.2, LM385-1.2, LM385B-1.2 . . . LP PACKAGE
(TOP VIEW)



NC – No internal connection

description/ordering information

These micropower, two-terminal, band-gap voltage references operate over a 10- μ A to 20-mA current range and feature exceptionally low dynamic impedance and good temperature stability. On-chip trimming provides tight voltage tolerance. The band-gap reference for these devices has low noise and long-term stability.

ORDERING INFORMATION

T _A	V _Z TOLERANCE	PACKAGE [†]		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	2%	SOIC (D)	Tube of 75	LM385D-1-2	385-12
			Reel of 2000	LM385DR-1-2	
		SOP (PS)	Reel of 2000	LM385PSR-1-2	L385-12
		TO-226 / TO-92 (LP)	Tube of 1000	LM385LP-1-2	385-12
			Reel of 2000	LM385LPR-1-2	
		TSSOP (PW)	Tube of 150	LM385PW-1-2	385-12
			Reel of 2000	LM385PWR-1-2	
	1%	SOIC (D)	Tube of 75	LM385BD-1-2	385B12
			Reel of 2000	LM385BDR-1-2	
		TO-226 / TO-92 (LP)	Tube of 1000	LM385BLP-1-2	385B12
			Reel of 2000	LM385BLPR-1-2	
		TSSOP (PW)	Tube of 150	LM385BPW-1-2	385B12
			Reel of 2000	LM385BPWR-1-2	
–40°C to 85°C	1%	SOIC (D)	Tube of 75	LM285D-1-2	285-12
			Reel of 2000	LM285DR-1-2	
		TO-226 / TO-92 (LP)	Tube of 1000	LM285LP-1-2	285-12

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



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PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

**TEXAS
INSTRUMENTS**

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LM285-1.2, LM385-1.2, LM385B-1.2 MICROPOWER VOLTAGE REFERENCES

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description/ordering information (continued)

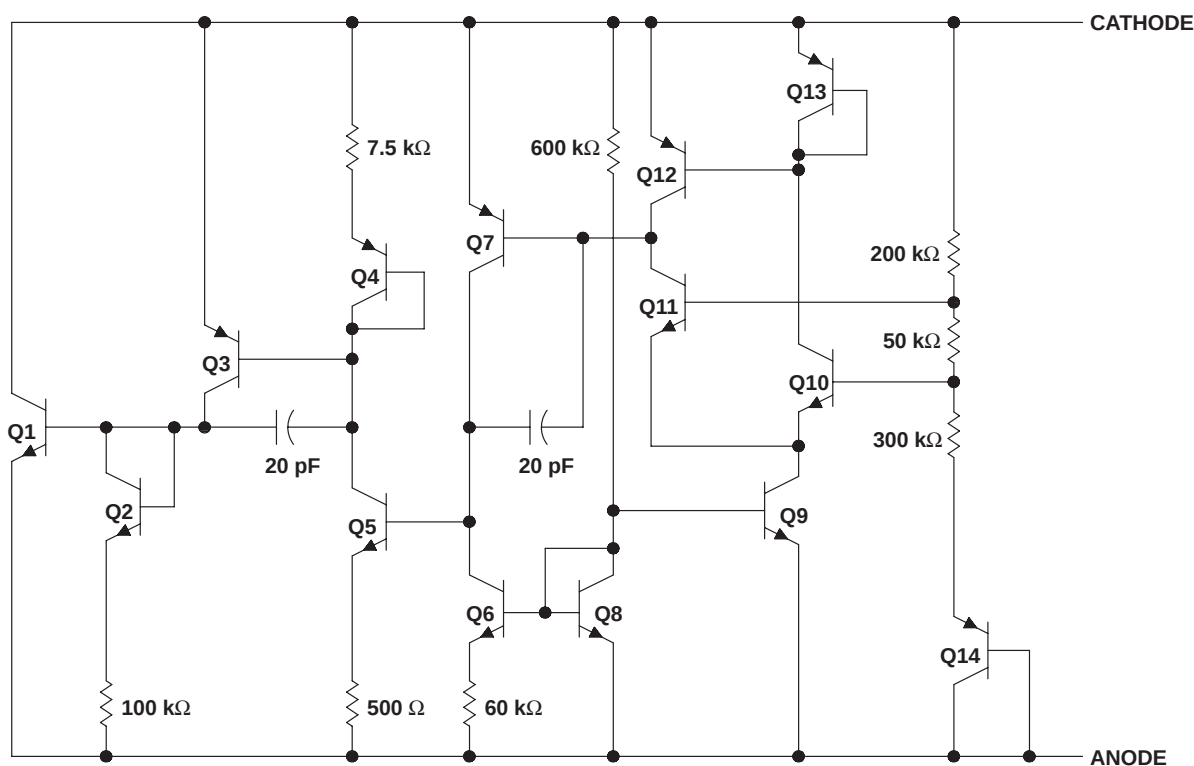
The design makes these devices exceptionally tolerant of capacitive loading and, thus, easier to use in most reference applications. The wide dynamic operating temperature range accommodates varying current supplies, with excellent regulation.

The extremely low power drain of this series makes them useful for micropower circuitry. These voltage references can be used to make portable meters, regulators, or general-purpose analog circuitry, with battery life approaching shelf life. The wide operating current range allows them to replace older references with tighter-tolerance parts.

symbol



schematic



NOTE A: Component values shown are nominal.

LM285-1.2, LM385-1.2, LM385B-1.2 MICROPOWER VOLTAGE REFERENCES

SLVS075I – APRIL 1989 – REVISED DECEMBER 2005

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

Reverse current, I_R	30 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
PS package	95°C/W
PW package	149°C/W
Operating virtual junction temperature, T_J	150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	260°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 affect reliability.
2. The package thermal impedance is calculated in accordance with JESD 51-7.

recommended operating conditions

			MIN	MAX	UNIT
I _Z	Reference current		0.01	20	mA
T _A	Operating free-air temperature range	LM285-1.2	−40	85	°C
		LM385-1.2, LM385B-1.2	0	70	



LM285-1.2, LM385-1.2, LM385B-1.2

MICROPOWER VOLTAGE REFERENCES

SLVS075I – APRIL 1989 – REVISED DECEMBER 2005

electrical characteristics at specified free-air temperature

PARAMETER		TEST CONDITIONS	T _A [†]	LM285-1.2			LM385-1.2			LM385B-1.2			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V _Z	Reference voltage	I _Z = I(min) to 20 mA [‡]	25°C	1.223	1.235	1.247	1.21	1.235	1.26	1.223	1.235	1.247	V
α _{VZ}	Average temperature coefficient of reference voltage [§]	I _Z = I(min) to 20 mA [‡]	Full range	±20			±20			±20			ppm/°C
ΔV _Z	Change in reference voltage with current	I _Z = I(min) to 1 mA [‡]	25°C	1			1			1			mV
			Full range	1.5			1.5			1.5			
		I _Z = 1 mA to 20 mA	25°C	12			20			20			
			Full range	30			30			30			
ΔV _Z /Δt	Long-term change in reference voltage	I _Z = 100 μA	25°C	±20			±20			±20			ppm/khr
I _Z (min)	Minimum reference current		Full range	8 10			8 15			8 15			μA
z _Z	Reference impedance	I _Z = 100 μA, f = 25 Hz	25°C	0.2 0.6			0.4 1			0.4 1			Ω
			Full range	1.5			1.5			1.5			
V _n	Broadband noise voltage	I _Z = 100 μA, f = 10 Hz to 10 kHz	25°C	60			60			60			μV

[†] Full range is -40°C to 85°C for the LM285-1.2 and 0°C to 70°C for the LM385-1.2 and LM385B-1.2.

[‡] $I(\min) = 10 \mu A$ for the LM285-1.2 and 15 μA for the LM385-1.2 and LM385B-1.2

[§] The average temperature coefficient of reference voltage is defined as the total change in reference voltage divided by the specified temperature range.



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TYPICAL CHARACTERISTICS†

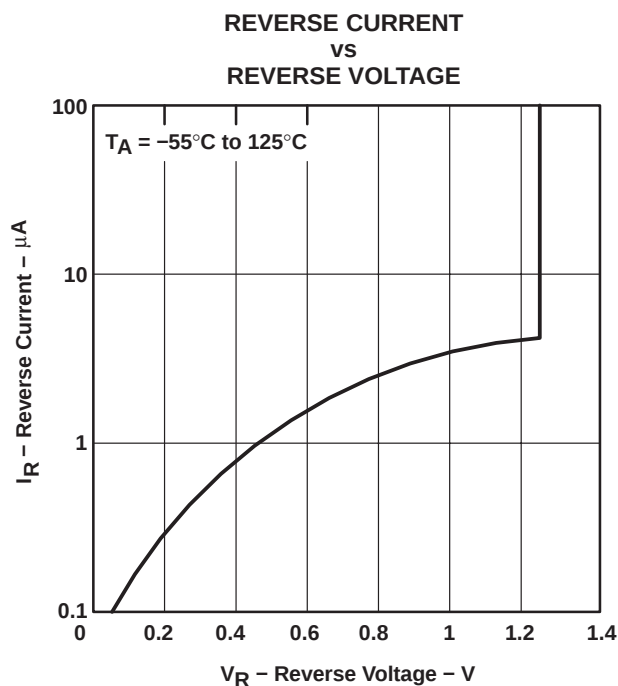


Figure 1

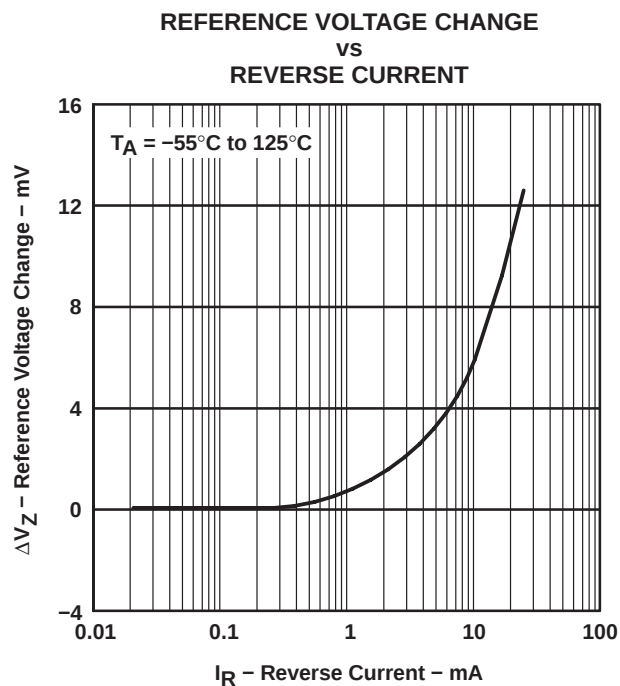


Figure 2

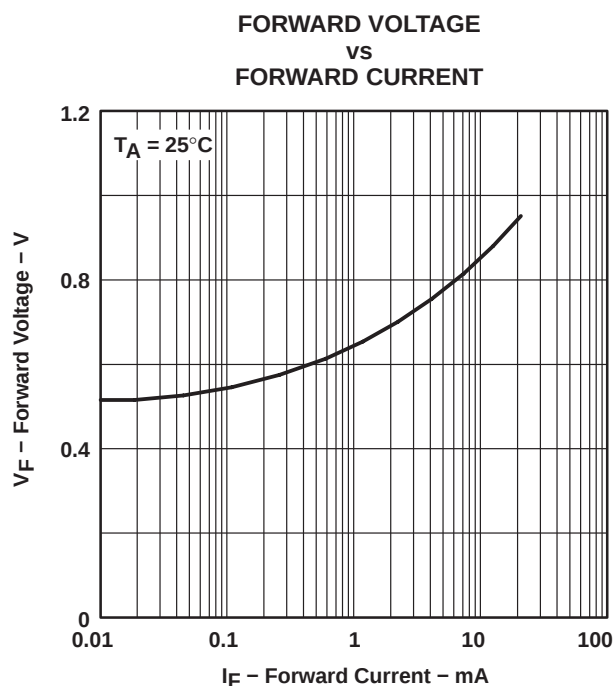


Figure 3

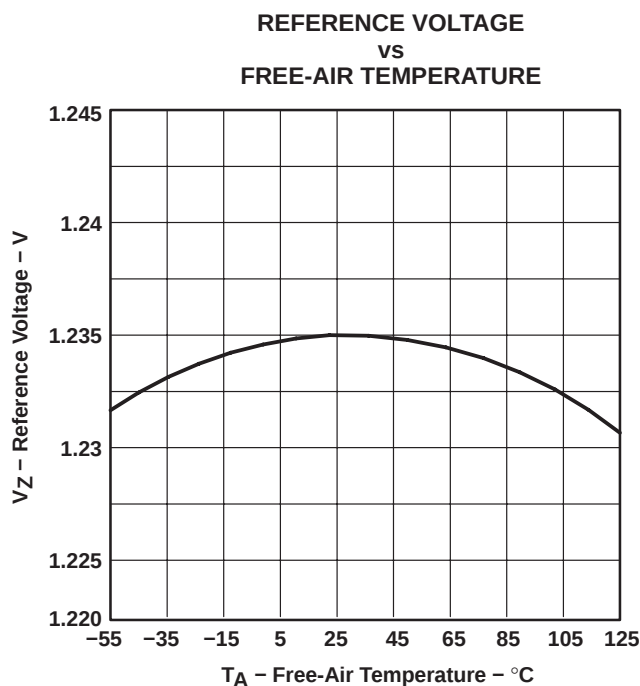


Figure 4

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

LM285-1.2, LM385-1.2, LM385B-1.2
MICROPOWER VOLTAGE REFERENCES

SLVS075I – APRIL 1989 – REVISED DECEMBER 2005

TYPICAL CHARACTERISTICS†

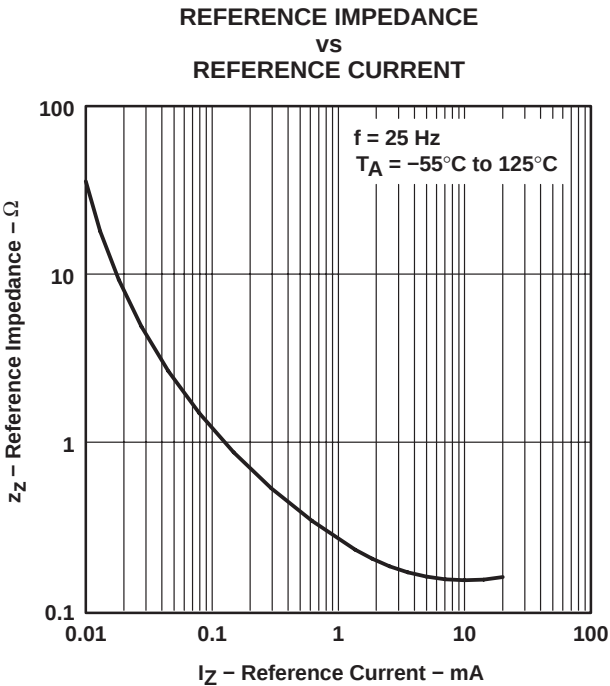


Figure 5

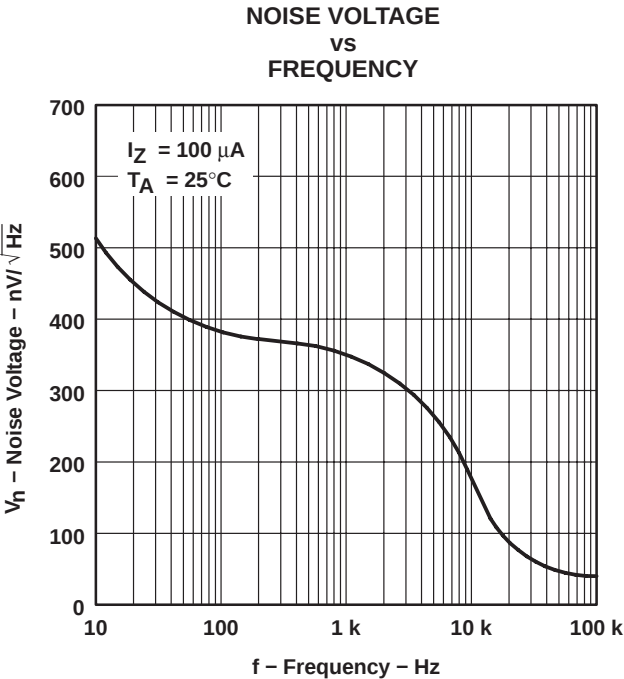


Figure 6

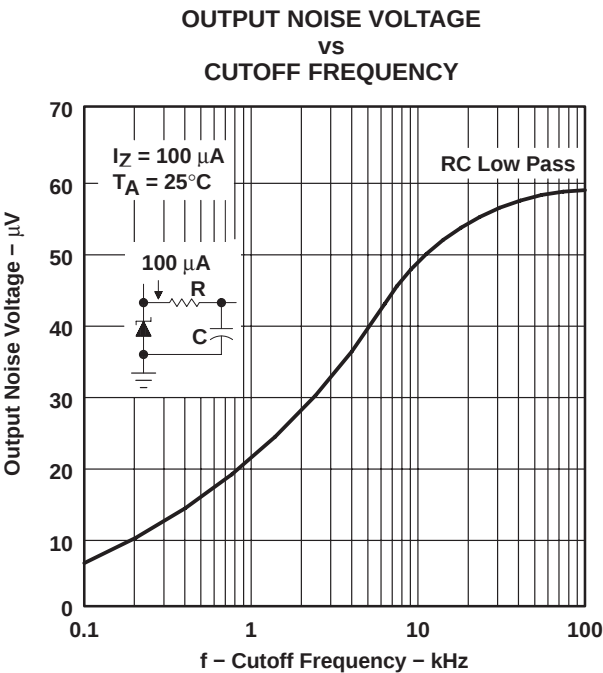


Figure 7

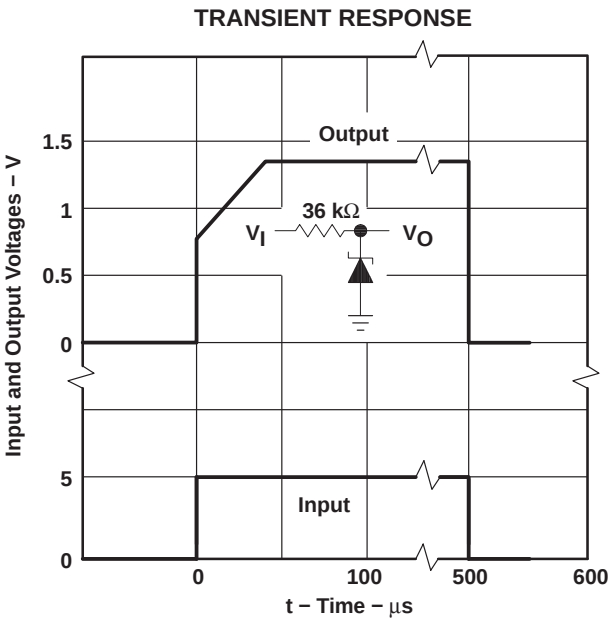


Figure 8

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

The diagram shows a circuit for calibrating a Type K thermocouple. It consists of two main parts: a precision voltage reference and a precision current source.

Voltage Reference Section (Left):

- A **Mercury Cell** provides a **1.345 V** source.
- The circuit is powered by a **5.1 kΩ** resistor connected to the positive terminal.
- The **LM385-1.2** precision centigrade centesimal diode is connected with its cathode to the positive supply and its anode to the negative supply.
- A **100 kΩ ±1%** resistor is connected between the positive supply and the non-inverting input of the **LM334** precision current source.
- The inverting input of the **LM334** is connected to the negative supply through a **10 kΩ** resistor.
- The **LM334** is configured as a current source, with its output connected to the positive supply through a **2.00 kΩ ±1%** resistor.
- The **LM334** is also connected to the negative supply through a **412 Ω ±1%** resistor.
- The **LM334** is labeled with **V+** and **V-** terminals.
- The **LM334** is also connected to the negative supply through a **953 Ω ±1%** resistor.
- The **LM334** is also connected to the negative supply through a **412 Ω ±1%** resistor.
- The **LM334** is also connected to the negative supply through a **412 Ω ±1%** resistor.

Thermocouple Section (Right):

- A **Type K** thermocouple is connected with its positive terminal to the positive supply and its negative terminal to the negative supply.
- The thermocouple is connected to a **Meter** for measurement.

Notes:

- † Adjust for 11.15 mV at 25°C across 953 Ω
- ‡ Adjust for 12.17 mV at 25°C across 412 Ω

9 V

499 kΩ

1.2 V

LM385-1.2



PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
LM285D-1-2	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM285DE4-1-2	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM285DR-1-2	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM285DRE4-1-2	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM285LP-1-2	ACTIVE	TO-92	LP	3	1000	TBD	CU SNPB	N / A for Pkg Type
LM285LPE3-1-2	ACTIVE	TO-92	LP	3	1000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
LM285LPRE3-1-2	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
LM385BD-1-2	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM385BDE4-1-2	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM385BDR-1-2	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM385BDR-1-2E4	ACTIVE	SOIC	D	8		TBD	Call TI	Call TI
LM385BDRE4-1-2	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM385BLP-1-2	ACTIVE	TO-92	LP	3	1000	TBD	CU SNPB	N / A for Pkg Type
LM385BLPE3-1-2	ACTIVE	TO-92	LP	3	1000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
LM385BLPR-1-2	ACTIVE	TO-92	LP	3	2000	TBD	CU SNPB	N / A for Pkg Type
LM385BLPRE3-1-2	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
LM385BPW-1-2	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM385BPWE4-1-2	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM385BPWR-1-2	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM385BPWRE4-1-2	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM385D-1-2	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM385DE4-1-2	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM385DR-1-2	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM385DRE4-1-2	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM385LP-1-2	ACTIVE	TO-92	LP	3	1000	TBD	CU SNPB	N / A for Pkg Type
LM385LPE3-1-2	ACTIVE	TO-92	LP	3	1000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
LM385LPR-1-2	ACTIVE	TO-92	LP	3	2000	TBD	CU SNPB	N / A for Pkg Type

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
LM385LPRE3-1-2	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
LM385PSR-1-2	ACTIVE	SO	PS	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM385PSRE4-1-2	ACTIVE	SO	PS	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM385PW-1-2	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM385PWE4-1-2	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM385PWR-1-2	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM385PWRE4-1-2	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

⁽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)

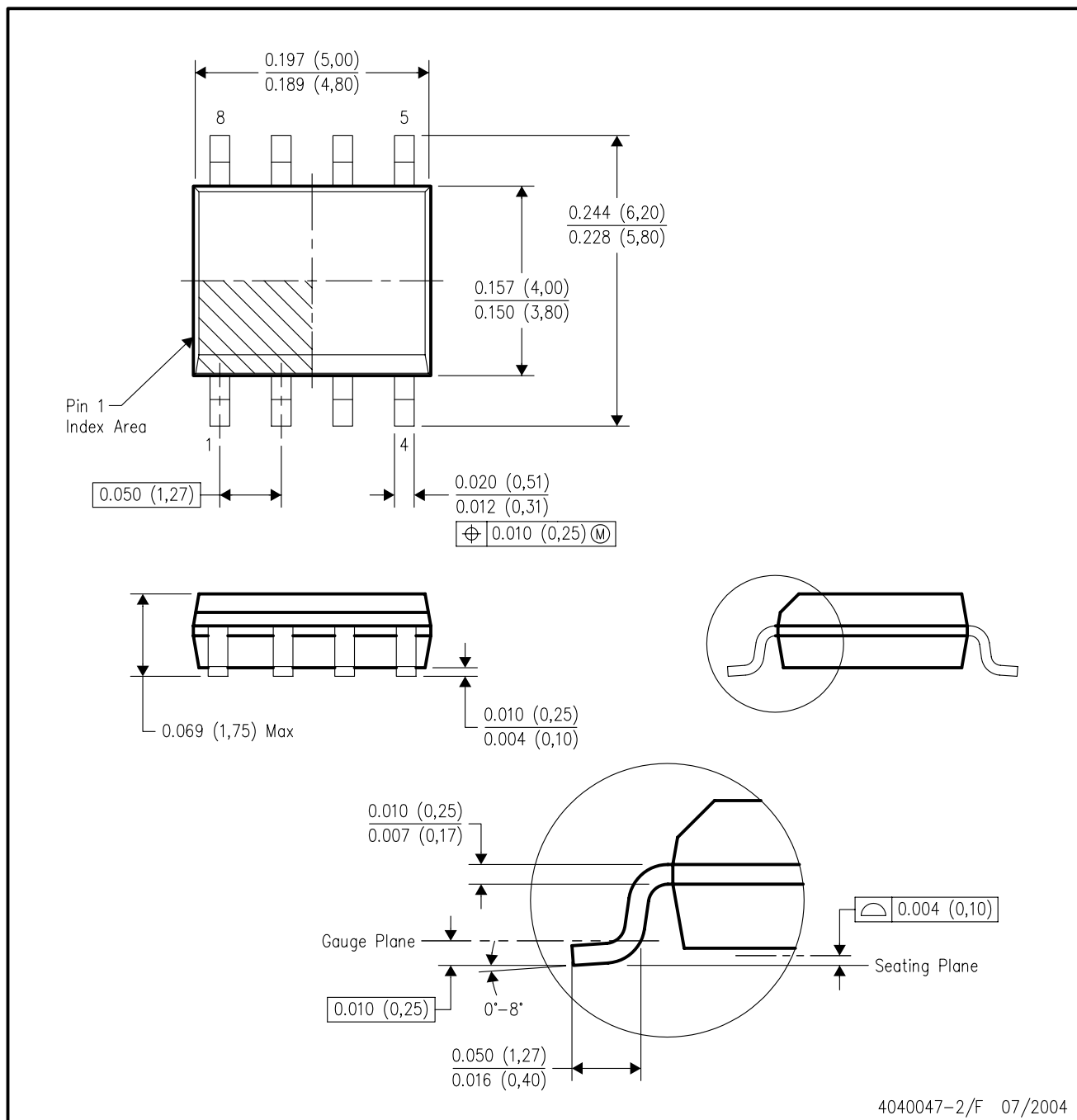
⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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D (R-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE

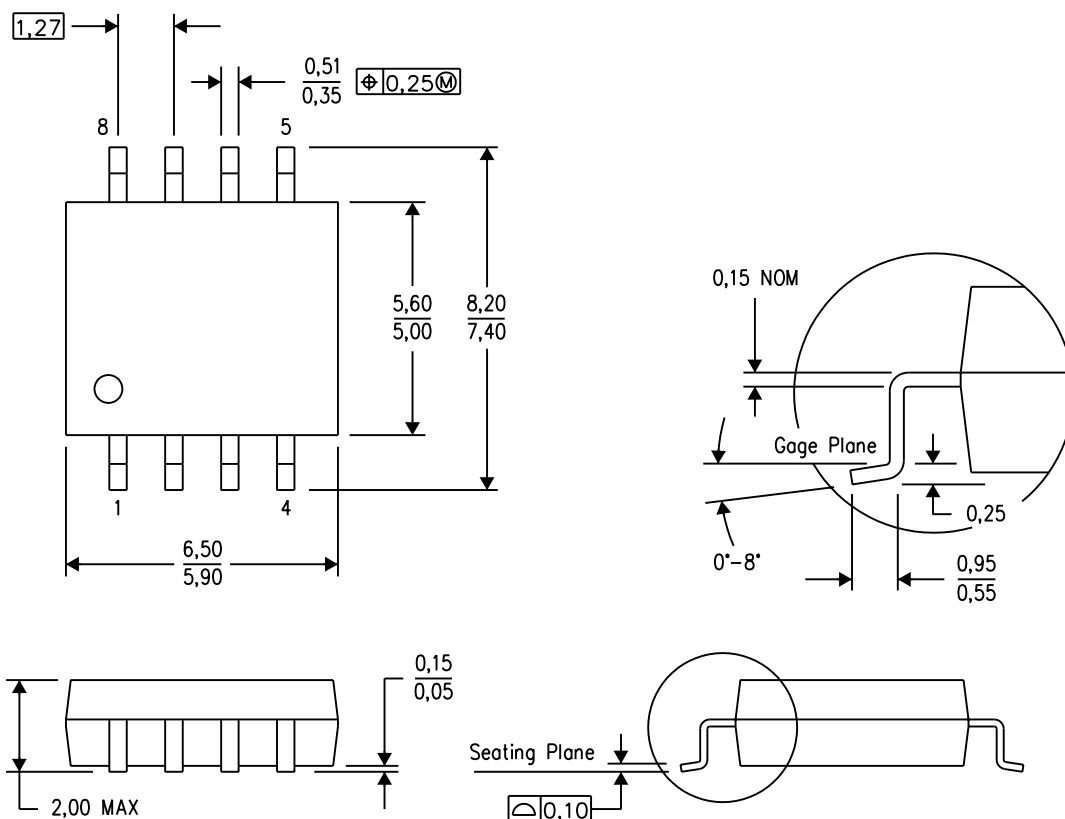


- NOTES:
- All linear dimensions are in inches (millimeters).
 - This drawing is subject to change without notice.
 - Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
 - Falls within JEDEC MS-012 variation AA.

MECHANICAL DATA

PS (R-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE

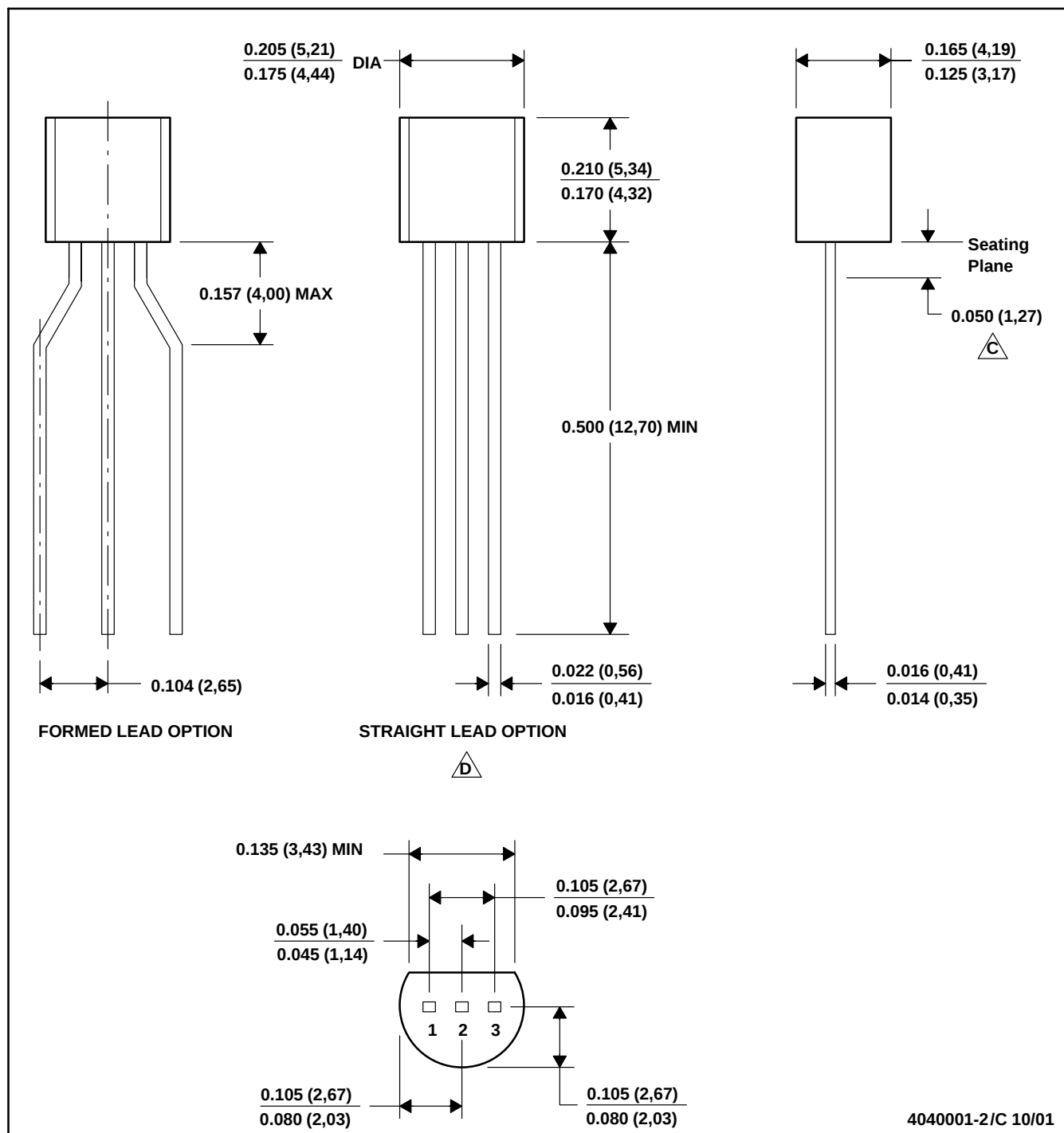


4040063/C 03/03

- 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.

LP (O-PBCY-W3)

PLASTIC CYLINDRICAL PACKAGE



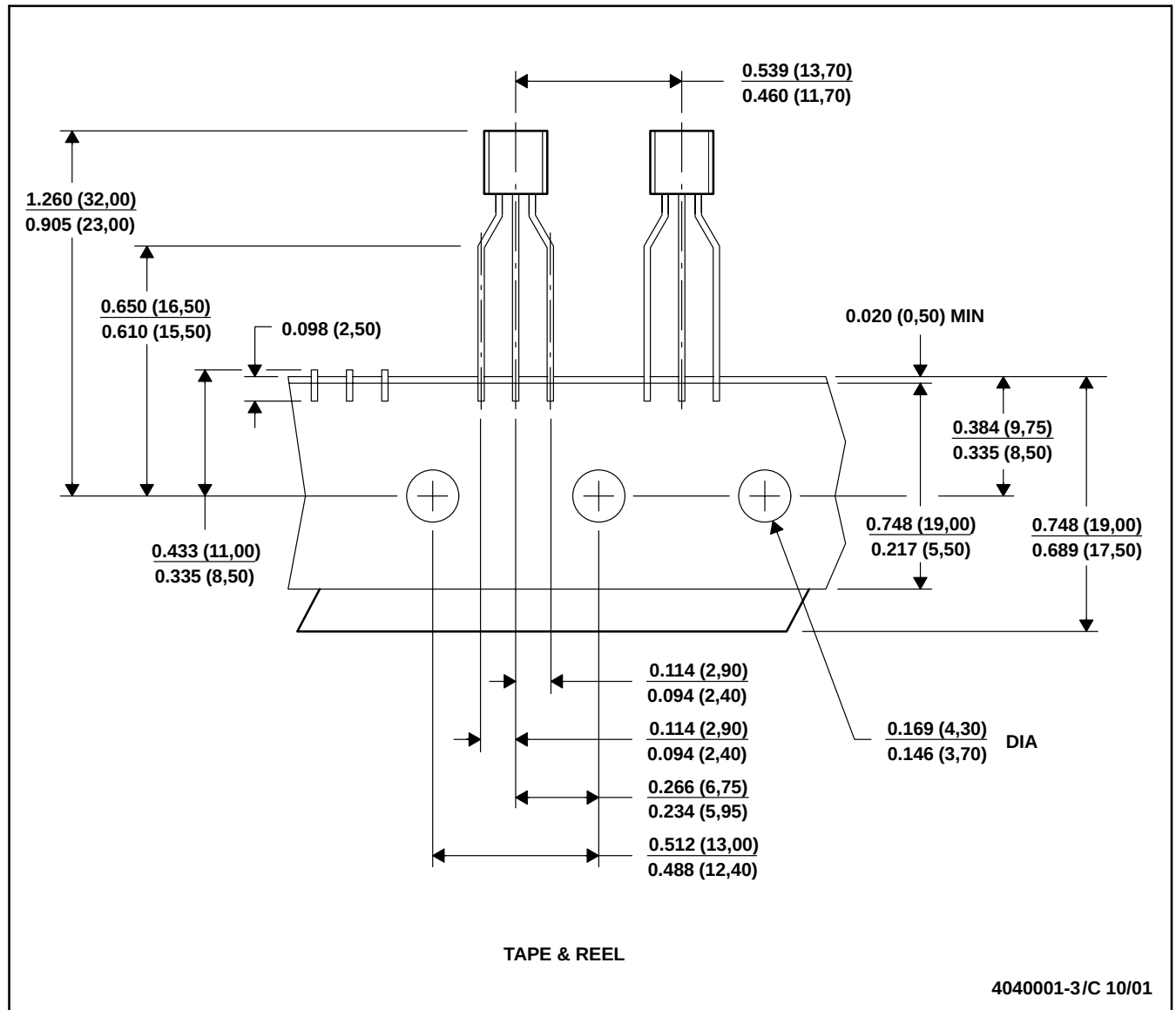
- NOTES: A. All linear dimensions are in inches (millimeters).
 B. This drawing is subject to change without notice.
 C. Lead dimensions are not controlled within this area.
 D. Falls within JEDEC TO -226 Variation AA (TO-226 replaces TO-92).
 E. Shipping Method:
 Straight lead option available in bulk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

PW (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



- 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

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