LM185/LM285/LM385 Adjustable Micropower Voltage References

Check for Samples: LM185-ADJ, LM285-ADJ, LM385-ADJ

FEATURES

- **Adjustable from 1.24V to 5.30V**
- **Operating Current of 10µA to 20mA**
- **1% and 2% Initial Tolerance**
- **1Ω Dynamic Impedance**
- **Low Temperature Coefficient**

DESCRIPTION

The LM185/LM285/LM385 are micropower 3-terminal adjustable band-gap voltage reference diodes. Operating from 1.24 to 5.3V and over a 10µA 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 band-gap reference uses only transistors and resistors, low noise and good long-term stability result.

Careful design of the LM185 has made the device 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 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 is rated for operation over a −55°C to 125°C temperature range, while the LM285 is rated −40°C to 85°C and the LM385 0°C to 70°C. The LM185 is available in a hermetic TO package and a LCCC package, while the LM285/LM385 are available in a low-cost TO-92 package, as well as SOIC.

Connection Diagram

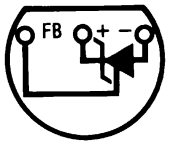


Figure 1. TO-92 Package
Bottom View

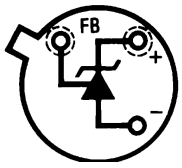


Figure 2. TO Package
Bottom View

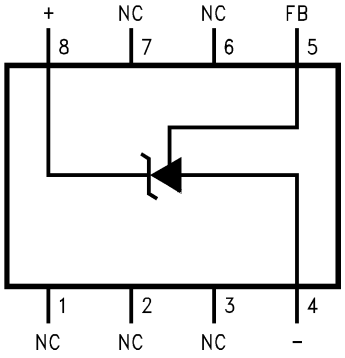


Figure 3. SOIC Package
Top View

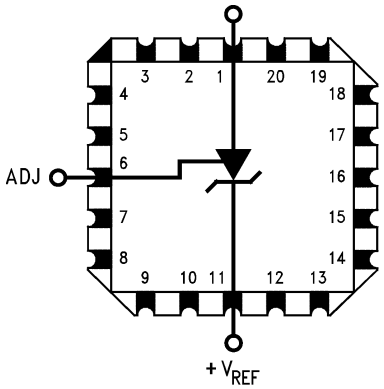
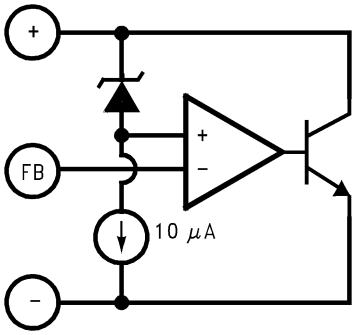


Figure 4. 20-LCCC
Top View

Block Diagram



Typical Applications

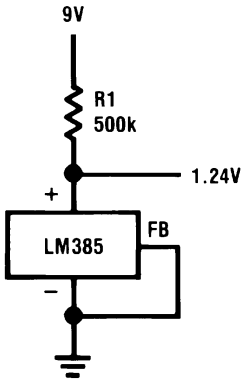
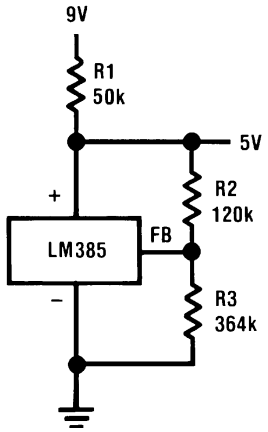


Figure 5. 1.2V Reference



$$V_{OUT} = 1.24 \left(\frac{R3}{R2} + 1 \right)$$

Figure 6. 5.0V Reference

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)(3)

Reverse Current	30mA
Forward Current	10mA
Operating Temperature Range (4)	
LM185 Series	−55°C to 125°C
LM285 Series	−40°C to 85°C
LM385 Series	0°C to 70°C
ESD Susceptibility (5)	2kV
Storage Temperature	−55°C to 150°C
Soldering Information	
TO-92 Package (10 sec.)	260°C
TO Package (10 sec.)	300°C
SOIC Package	
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 for military specifications.
(3) If Military/Aerospace specified devices are required, please contact the TI Sales Office/Distributors for availability and specifications.
(4) For elevated temperature operation, $T_J$max is shown in Thermal Characteristics.
(5) The human body model is a 100 pF capacitor discharged through a 1.5 kΩ resistor into each pin.

Thermal Characteristics

over operating free-air temperature range (unless otherwise noted)

	LM185 LM285 LM385	150°C 125°C 100°C		
Thermal Resistance	**TO-92**		**TO**	**SOIC**
θ_{JA} (Junction to Ambient)	180°C/W (0.4″ leads)		440°C/W	165°C/W
	170°C/W (0.125″ leads)			
θ_{JC} (Junction to Case)	N/A		80°C/W	N/A

Electrical Characteristics (1)

Parameter	Conditions		LM185, LM285					LM385					Units (Limit)
			Typ	LM185BX, LM185BY LM185B, LM285BX, LM285BY		LM285		Typ	LM385BX, LM385BY		LM385		
				Tested Limit (2)	Design Limit (3)	Tested Limit (2)	Design Limit (3)		Tested Limit (2)	Design Limit (3)	Tested Limit (2)	Design Limit (3)	
Reference Voltage	I_R = 100µA		1.240	1.252 **1.255** 1.228 **1.215**		1.265 1.215	**1.270** **1.205**	1.240	1.252 1.228	**1.255** **1.215**	1.265 1.215	**1.270** **1.205**	V (max) V (min)
Reference Voltage Change with Current	I_{MIN}< I_R < 1mA 1mA < I_R < 20mA		0.2 4	1 10	**1.5** **20**	1 10	**1.5** **20**	0.2 5	1 15	**1.5** **25**	1 15	**1.5** **25**	mV (max)
Dynamic Output Impedance	I_R = 100µA, I_{AC} = 0.1 I_R	f = 100Hz V_{OUT} = V_{REF} V_{OUT} = 5.3V	 0.3 0.7					 0.4 1					Ω
Reference Voltage Change with Output Voltage	I_R = 100µA		1	3	**6**	3	**6**	2	5	**10**	5	**10**	mV (max)
Feedback Current			13	20	**25**	20	**25**	16	30	**35**	30	**35**	nA (max)
Minimum Operating Current (see curve)	V_{OUT} = V_{REF} V_{OUT} = 5.3V		6 30	9 45	**10** **50**	9 45	**10** **50**	7 35	11 55	**13** **60**	11 55	**13** **60**	µA (max)
Output Wideband Noise	I_R = 100µA, 10Hz < f < 10kHz V_{OUT} = V_{REF} V_{OUT} = 5.3V		 50 170					 50 170					μV_{rms}
Average Temperature Coefficient (4)	I_R = 100µA	X Suffix Y Suffix All Others		**30** **50**	 **150**		 **150**		**30** **50**	 **150**		 **150**	ppm/°c (max)
Long Term Stability	I_R = 100µA, T = 1000 Hr, T_A = 25°C ± 0.1°C		20					20					ppm

(1) Parameters identified with **boldface type** apply at temperature extremes. All other numbers apply at T_A = T_J = 25°C. Unless otherwise specified, all parameters apply for V_{REF} < V_{OUT} < 5.3V.
(2) Guaranteed and 100% production tested.
(3) Guaranteed, but not 100% production tested. These limits are not to be used to calculate average outgoing quality levels.
(4) The average temperature coefficient is defined as the maximum deviation of reference voltage at all measured temperatures from T_{MIN} to T_{MAX}, divided by T_{MAX} − T_{MIN}. The measured temperatures are −55, −40, 0, 25, 70, 85, 125°C.

Typical Performance Characteristics

Temperature Drift of 3 Representative Units

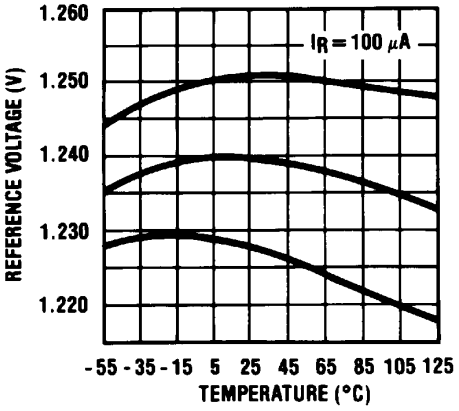


Figure 7.

Feedback Current

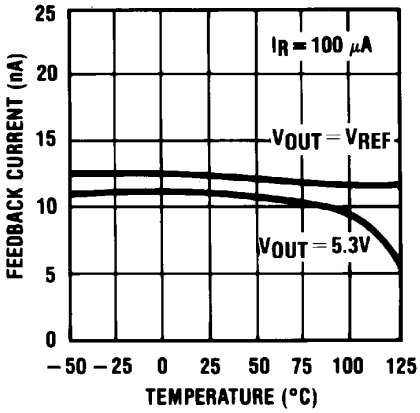


Figure 8.

Minimum Operating Current

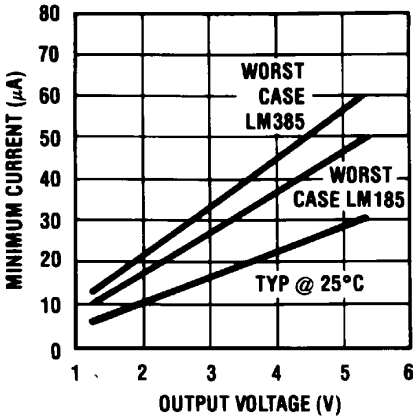


Figure 9.

Reverse Characteristics

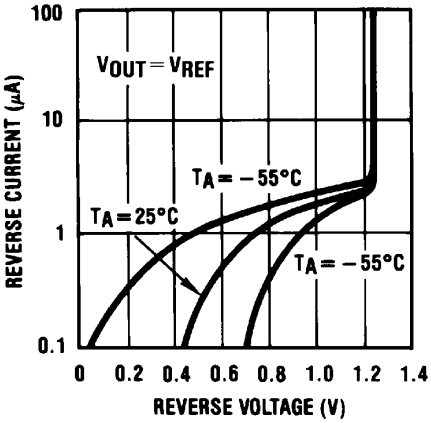


Figure 10.

Reverse Characteristics

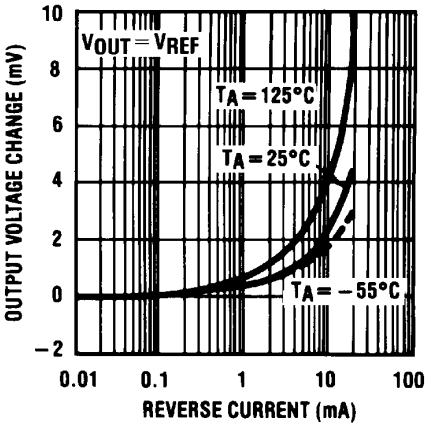


Figure 11.

Forward Characteristics

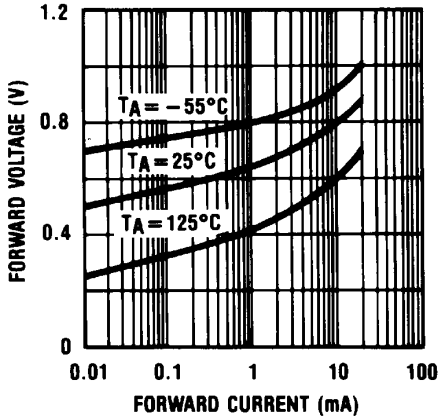


Figure 12.

Typical Performance Characteristics (continued)

Output Noise Voltage

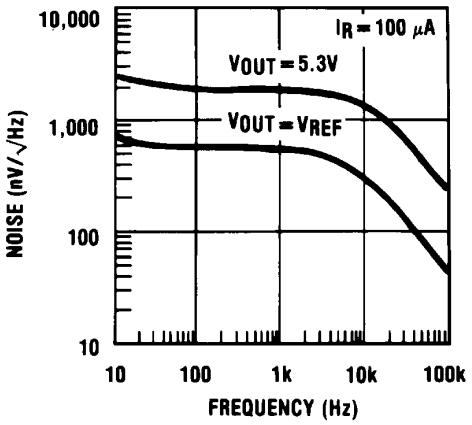


Figure 13.

Dynamic Output Impedance

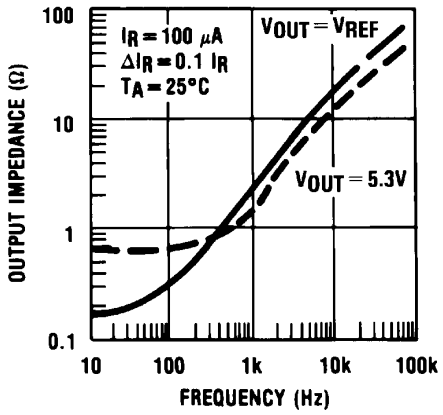


Figure 14.

Response Time

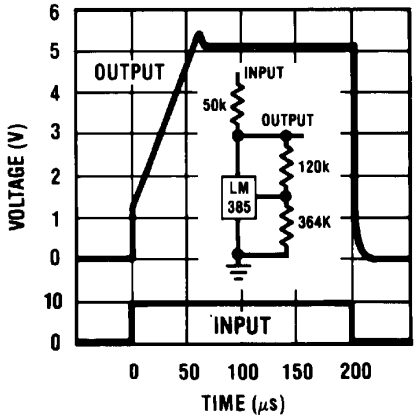
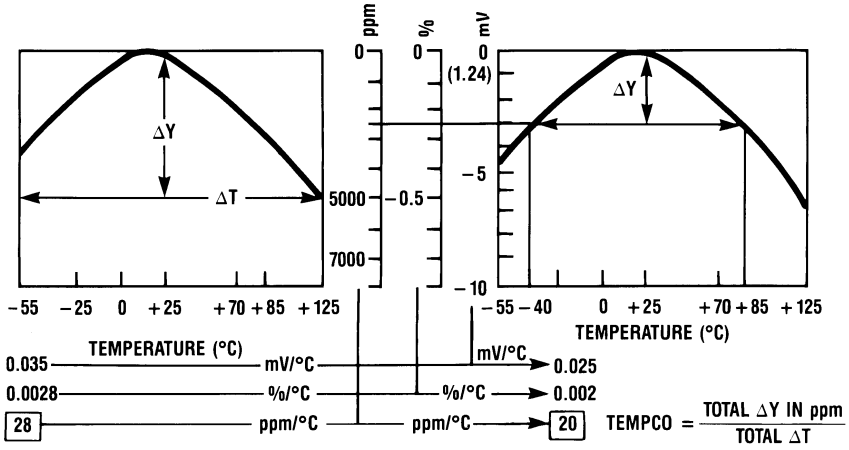


Figure 15.

Temperature Coefficient Typical

LM185 LM285 LM385



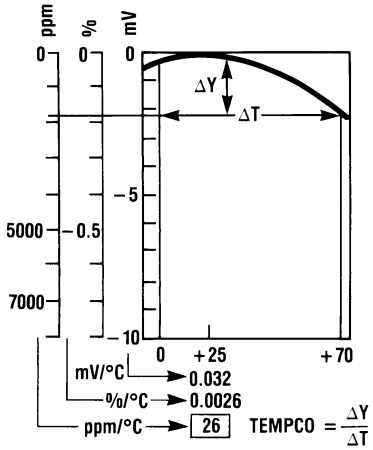


Figure 16.

TYPICAL APPLICATIONS

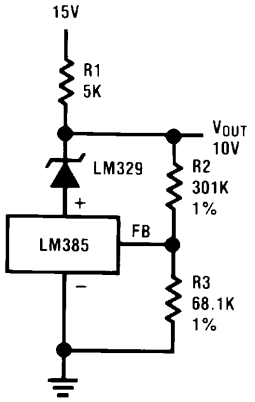


Figure 17. Precision 10V Reference

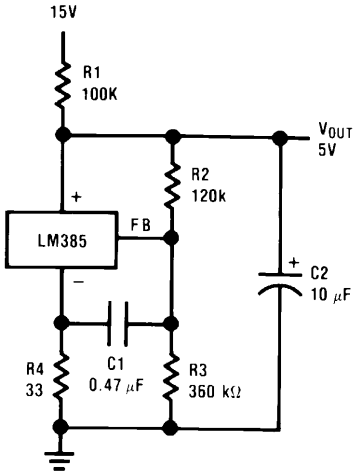


Figure 18. Low AC Noise Reference

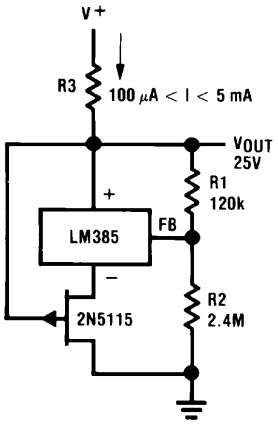


Figure 19. 25V Low Current Shunt Regulator

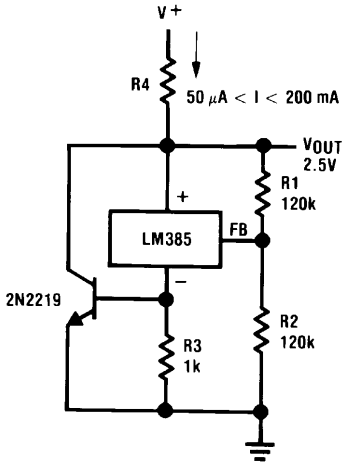


Figure 20. 200 mA Shunt Regulator

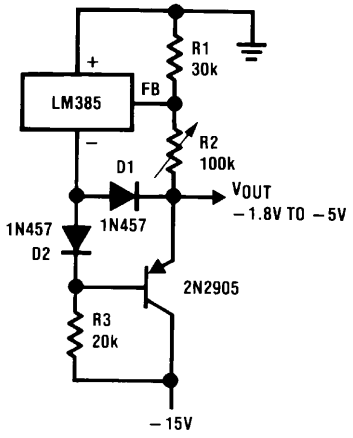


Figure 21. Series-Shunt 20 mA Regulator

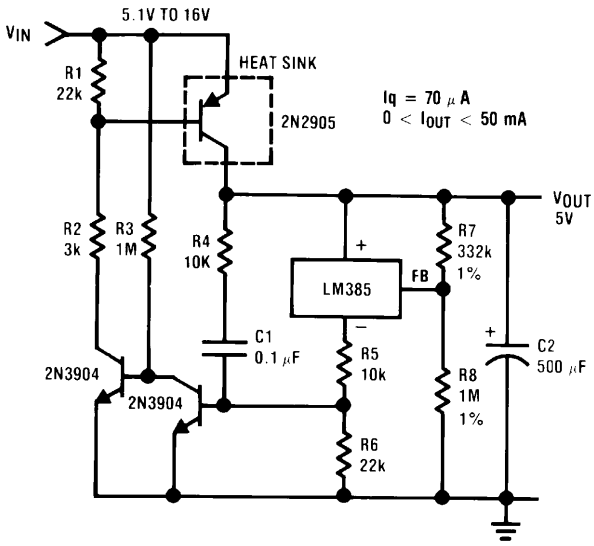


Figure 22. High Efficiency Low Power Regulator

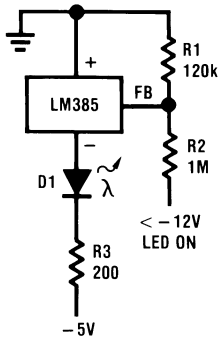


Figure 23. Voltage Level Detector

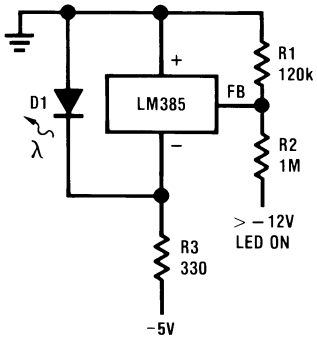


Figure 24. Voltage Level Detector

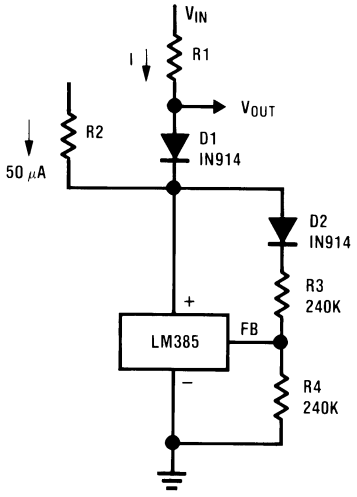


Figure 25. Fast Positive Clamp
$2.4V + \Delta V_{D1}$

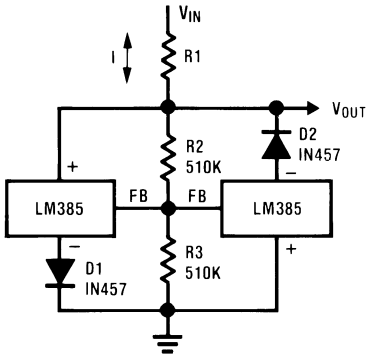


Figure 26. Bidirectional Clamp
±2.4V

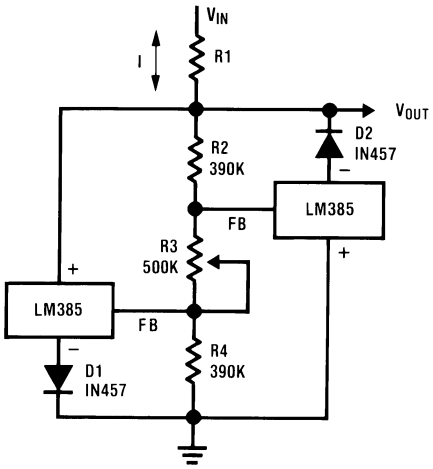


Figure 27. Bidirectional Adjustable Clamp ±1.8V to ±2.4V

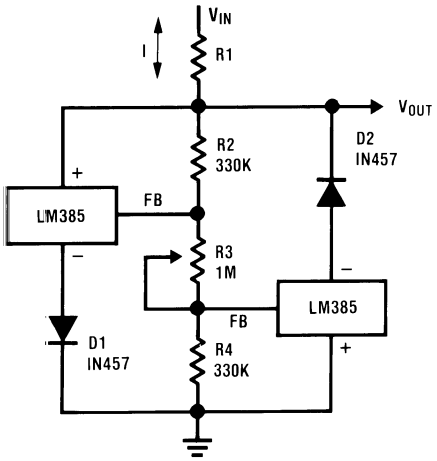


Figure 28. Bidirectional Adjustable Clamp ±2.4V to ±6V

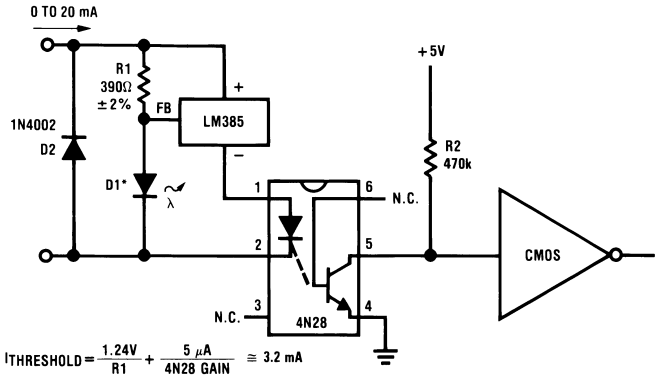


Figure 29. Simple Floating Current Detector

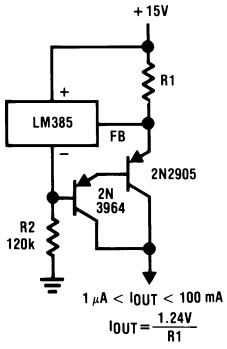
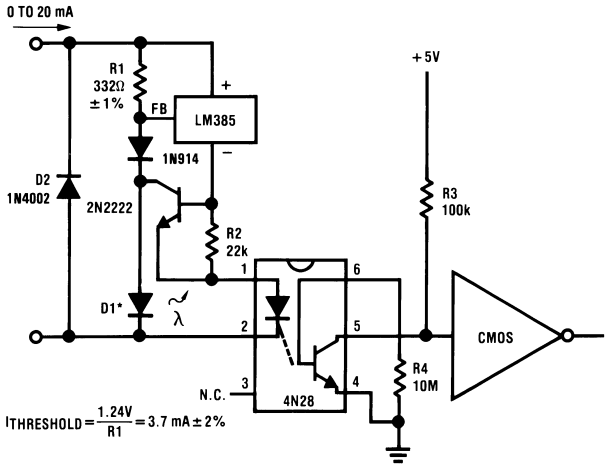


Figure 30. Current Source



*D1 can be any LED, V_F=1.5V to 2.2V at 3 mA. D1 may act as an indicator. D1 will be on if $I_{THRESHOLD}$ falls below the threshold current, except with I=O.

Figure 31. Precision Floating Current Detector

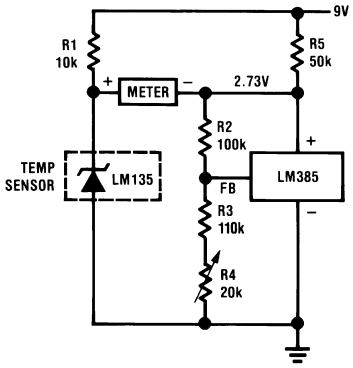


Figure 32. Centigrade Thermometer, 10mV/°C

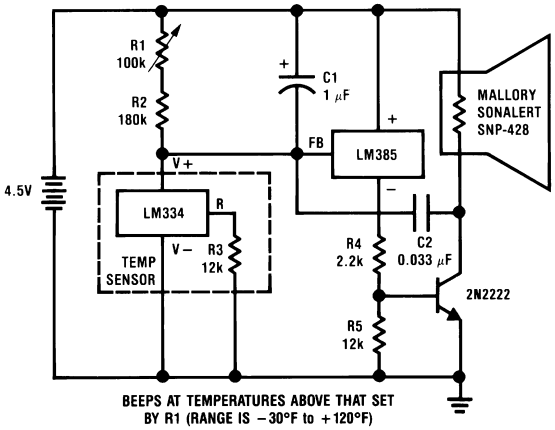
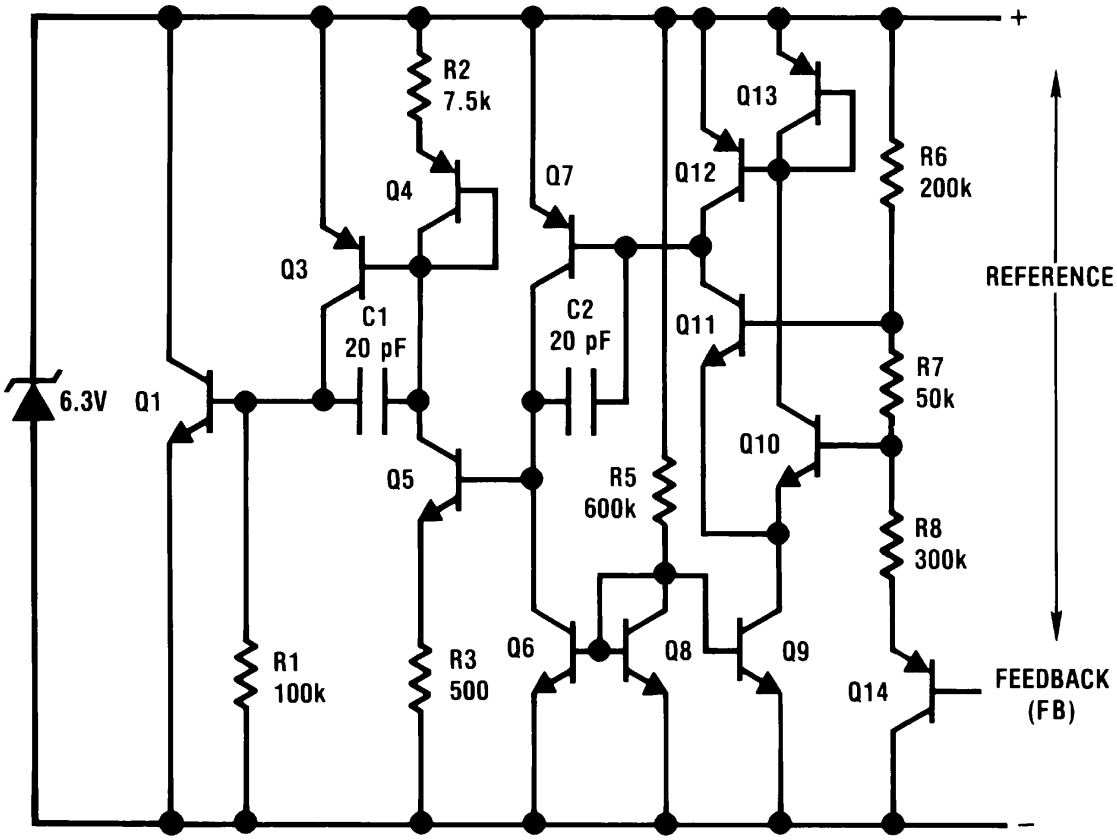


Figure 33. Freezer Alarm

Schematic Diagram



PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
LM185BH	ACTIVE	TO	NDV	3	1000	TBD	Call TI	Call TI	-55 to 125	LM185BH	Samples
LM185BH/NOPB	ACTIVE	TO	NDV	3	1000	Green (RoHS & no Sb/Br)	POST-PLATE	Level-1-NA-UNLIM	-55 to 125	LM185BH	Samples
LM185H-2.5	ACTIVE	TO	NDU	2	1000	TBD	Call TI	Call TI	-55 to 125	LM185H2.5	Samples
LM185H-2.5/NOPB	ACTIVE	TO	NDU	2	1000	Green (RoHS & no Sb/Br)	POST-PLATE	Level-1-NA-UNLIM	-55 to 125	LM185H2.5	Samples
LM285BXZ/NOPB	ACTIVE	TO-92	LP	3	1800	Green (RoHS & no Sb/Br)	SNCU	Level-1-NA-UNLIM	-40 to 85	LM285 BXZ	Samples
LM285BYM/NOPB	ACTIVE	SOIC	D	8	95	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	LM285 BYM	Samples
LM285BYMX/NOPB	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	LM285 BYM	Samples
LM285BYZ/NOPB	ACTIVE	TO-92	LP	3	1800	Green (RoHS & no Sb/Br)	SNCU	Level-1-NA-UNLIM	-40 to 85	LM285 BYZ	Samples
LM285M/NOPB	ACTIVE	SOIC	D	8	95	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	LM285 M	Samples
LM285MX/NOPB	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	LM285 M	Samples
LM285Z/NOPB	ACTIVE	TO-92	LP	3	1800	Green (RoHS & no Sb/Br)	SNCU	Level-1-NA-UNLIM	-40 to 85	LM285 Z	Samples
LM385BM	ACTIVE	SOIC	D	8	95	TBD	Call TI	Call TI	0 to 70	LM385 BM	Samples
LM385BM/NOPB	ACTIVE	SOIC	D	8	95	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	0 to 70	LM385 BM	Samples
LM385BMX/NOPB	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	0 to 70	LM385 BM	Samples
LM385BXZ/NOPB	ACTIVE	TO-92	LP	3	1800	Green (RoHS & no Sb/Br)	SNCU	Level-1-NA-UNLIM	0 to 70	LM385 BXZ	Samples
LM385BYZ/NOPB	ACTIVE	TO-92	LP	3	1800	Green (RoHS & no Sb/Br)	SNCU	Level-1-NA-UNLIM	0 to 70	LM385 BYZ	Samples
LM385BZ/NOPB	ACTIVE	TO-92	LP	3	1800	Green (RoHS & no Sb/Br)	SNCU	Level-1-NA-UNLIM	0 to 70	LM385 BZ	Samples

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
LM385M	ACTIVE	SOIC	D	8	95	TBD	Call TI	Call TI	0 to 70	LM385 M	Samples
LM385M/NOPB	ACTIVE	SOIC	D	8	95	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	0 to 70	LM385 M	Samples
LM385MX	ACTIVE	SOIC	D	8	2500	TBD	Call TI	Call TI	0 to 70	LM385 M	Samples
LM385MX/NOPB	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	0 to 70	LM385 M	Samples
LM385Z/NOPB	ACTIVE	TO-92	LP	3	1800	Green (RoHS & no Sb/Br)	SNCU	Level-1-NA-UNLIM	0 to 70	LM385 Z	Samples

(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.

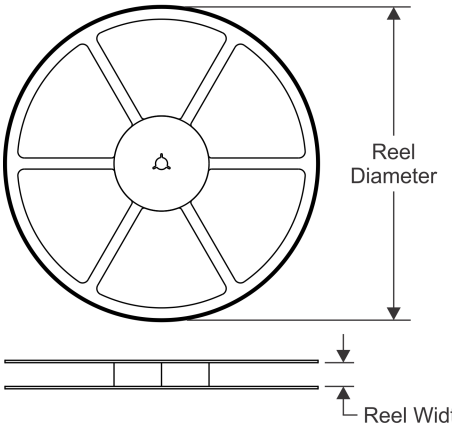
(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been 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.

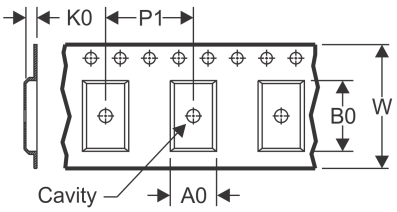
(4) Only one of markings shown within the brackets will appear on the physical device.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

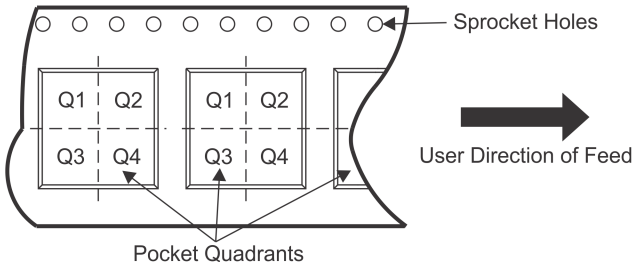


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
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

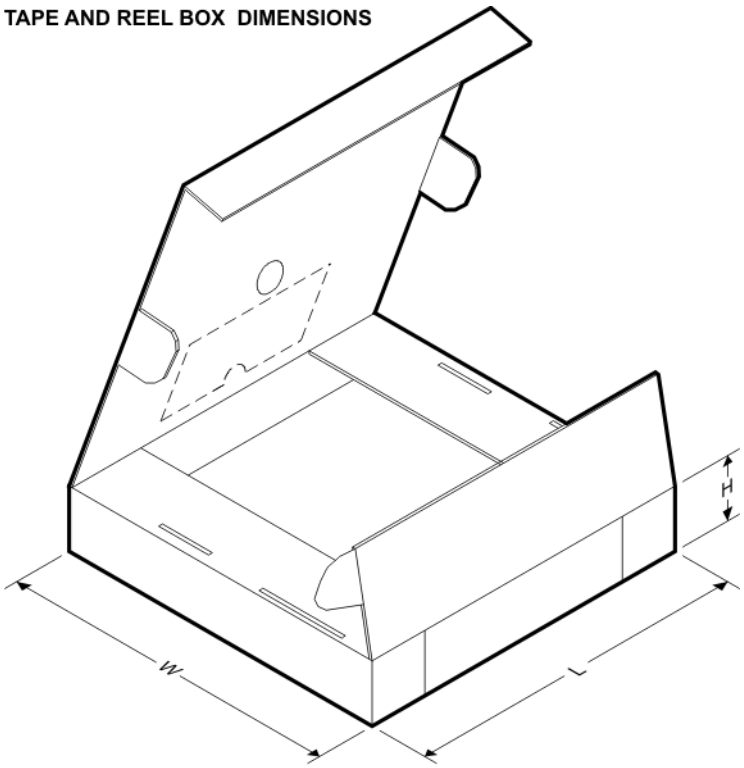
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LM285BYMX/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
LM285MX/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
LM385BMX/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
LM385MX	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
LM385MX/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1

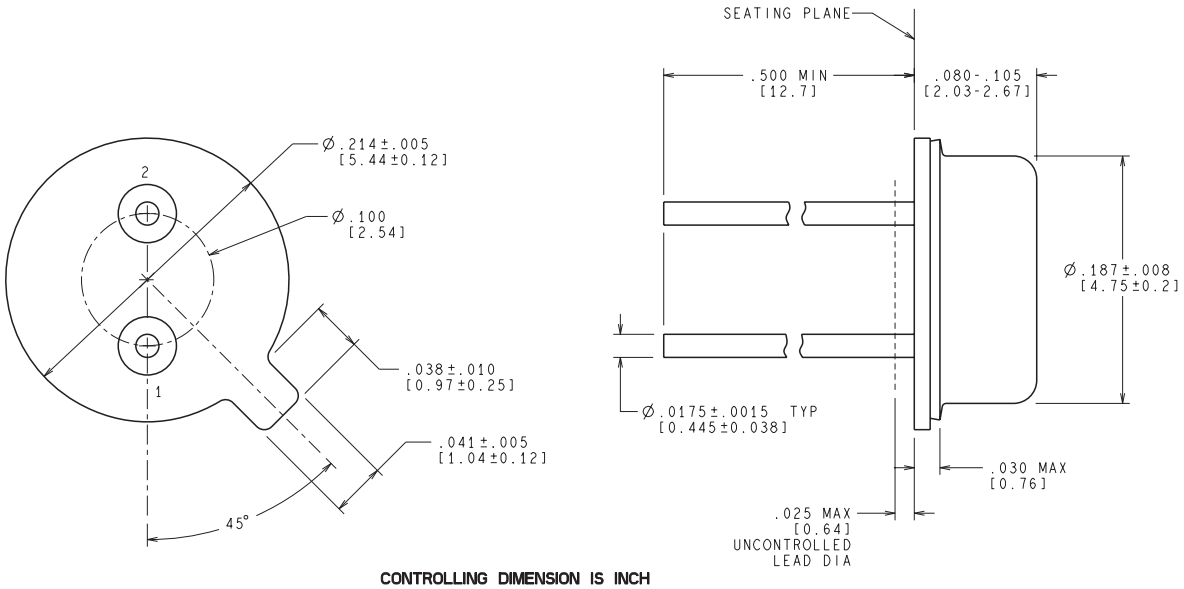
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM285BYMX/NOPB	SOIC	D	8	2500	349.0	337.0	45.0
LM285MX/NOPB	SOIC	D	8	2500	349.0	337.0	45.0
LM385BMX/NOPB	SOIC	D	8	2500	349.0	337.0	45.0
LM385MX	SOIC	D	8	2500	349.0	337.0	45.0
LM385MX/NOPB	SOIC	D	8	2500	349.0	337.0	45.0

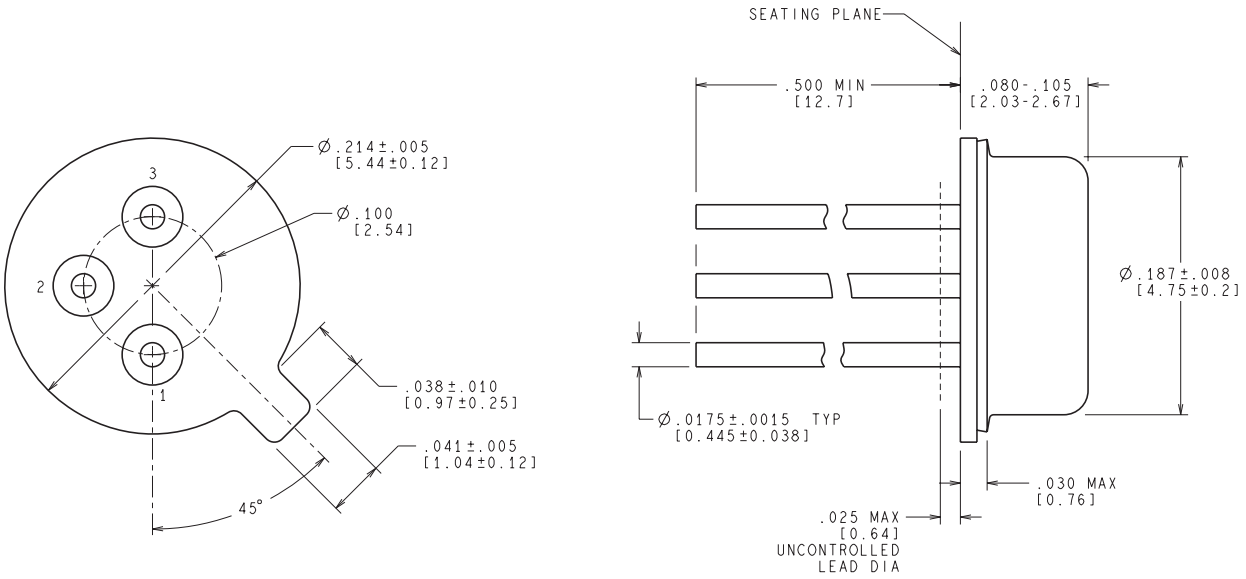
NDU0002A



CONTROLLING DIMENSION IS INCH
VALUES IN [ ] ARE MILLIMETERS

H02A (Rev F)

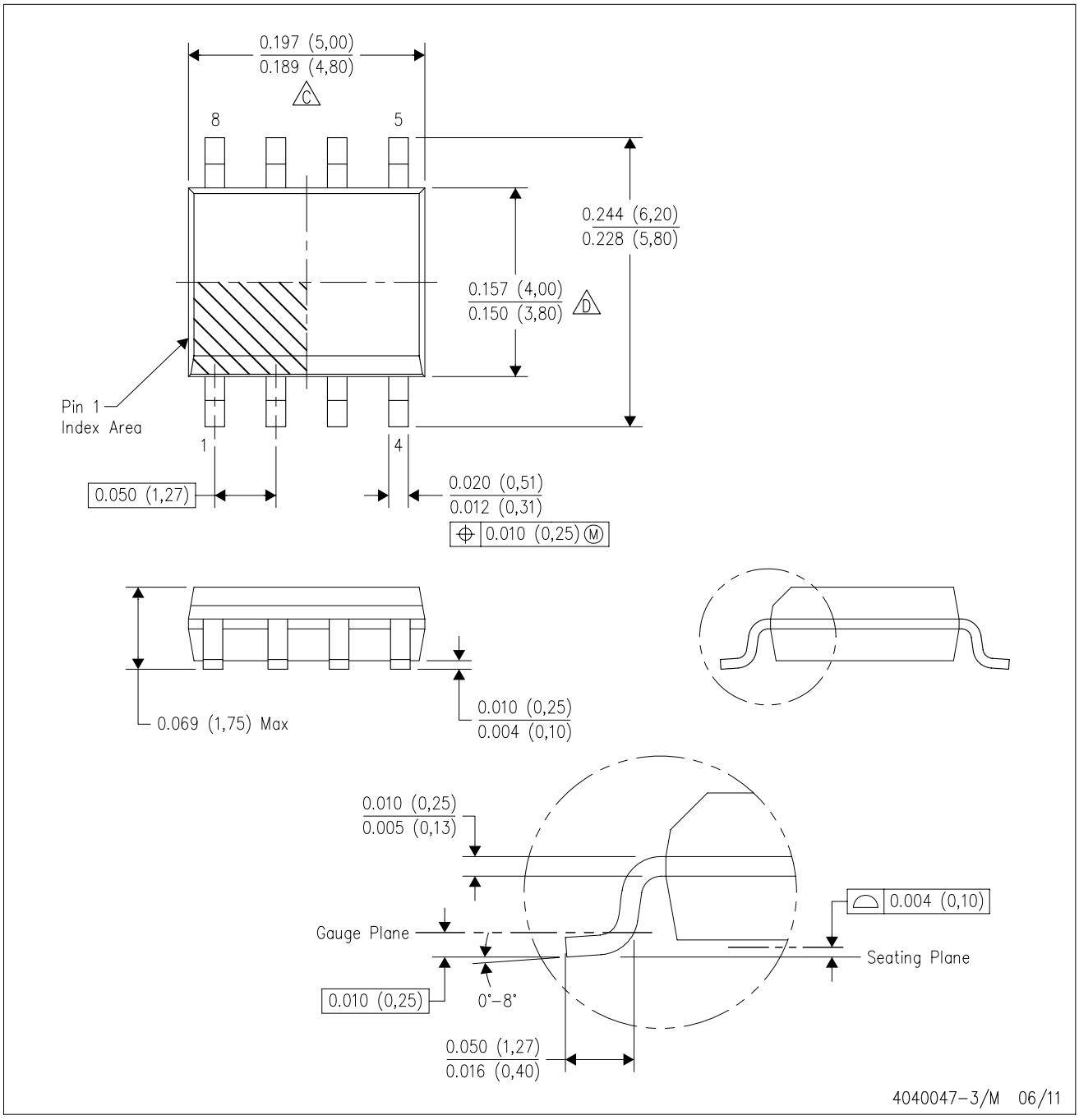
NDV0003H



CONTROLLING DIMENSION IS INCH
VALUES IN [ ] ARE IN MILLIMETERS

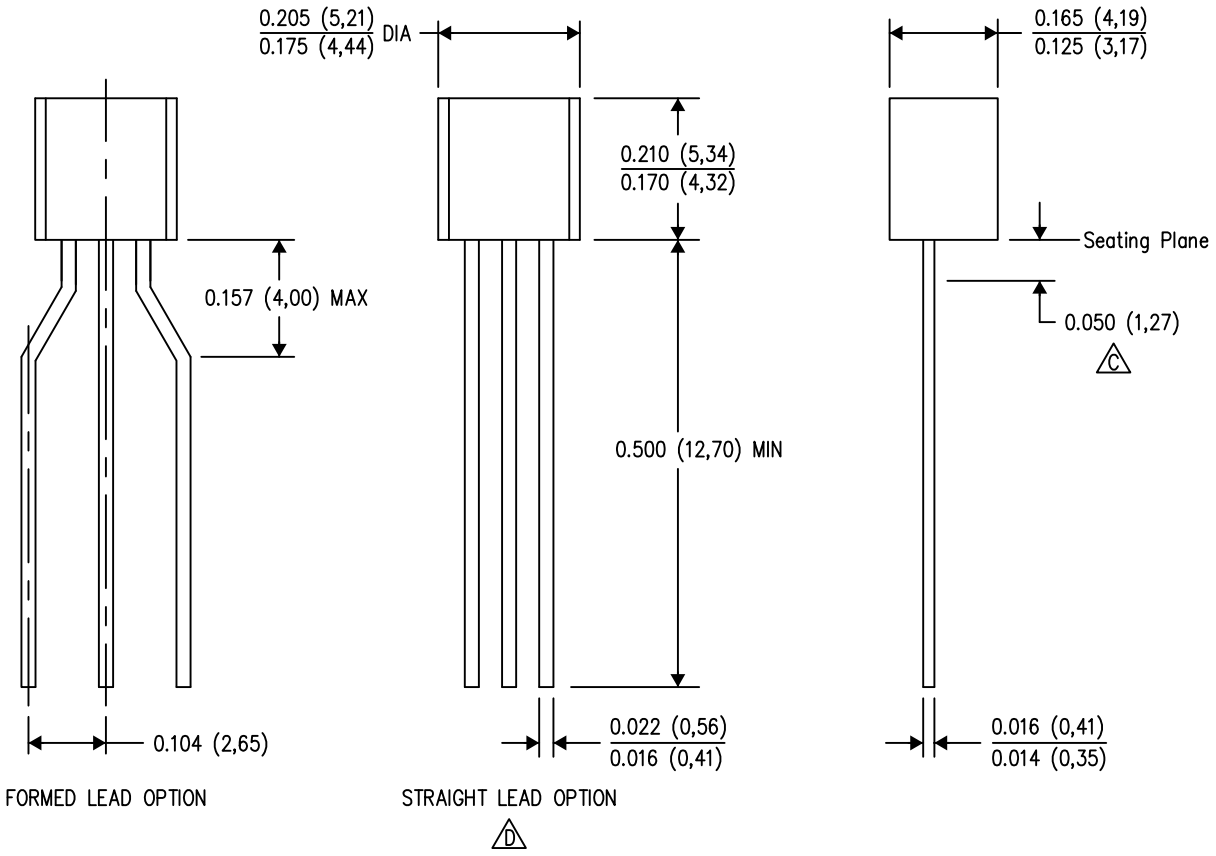
H03H (Rev F)

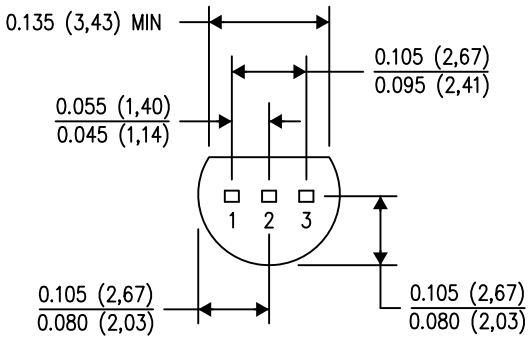
D (R–PDSO–G8) PLASTIC SMALL OUTLINE



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

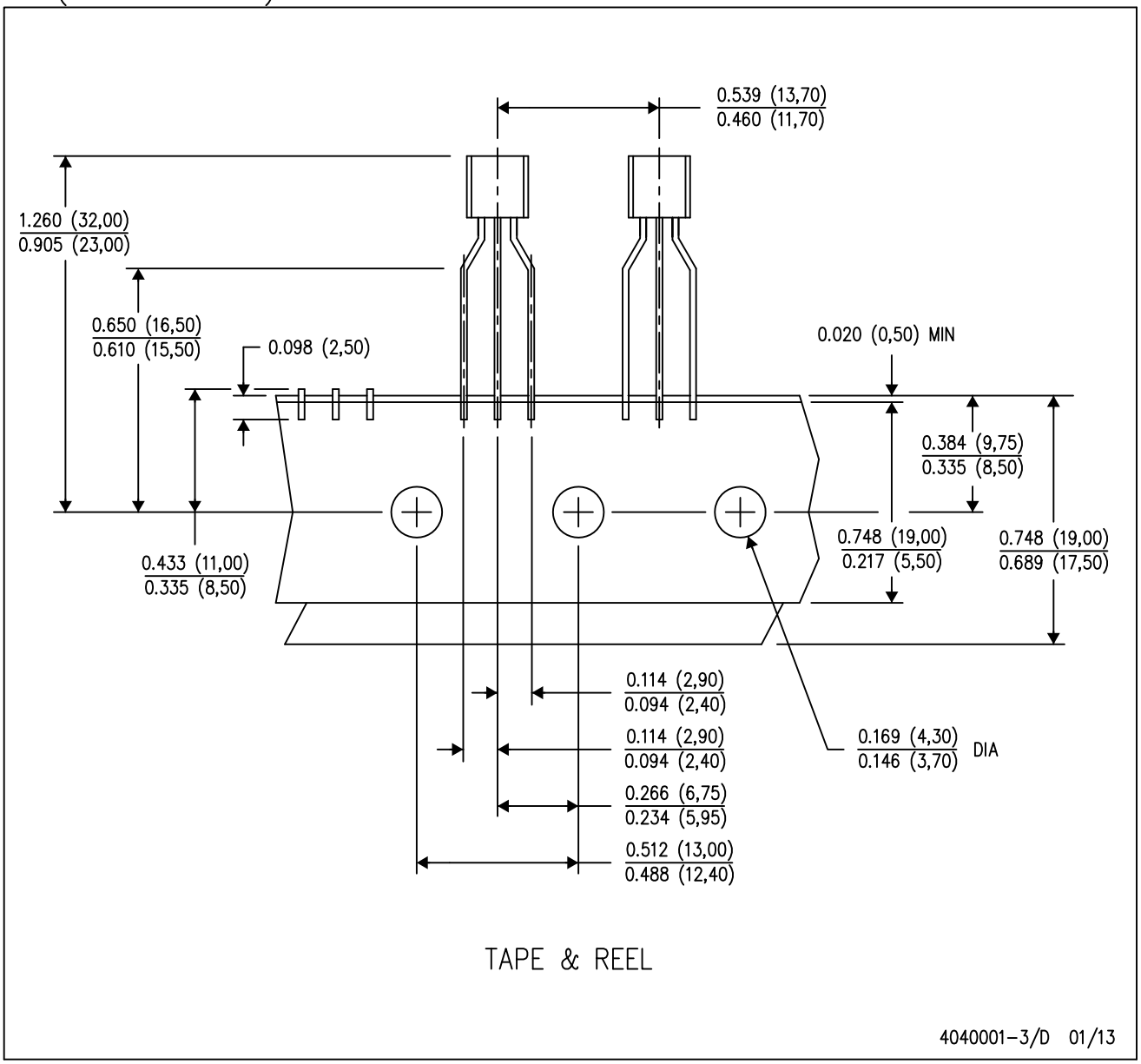




4040001–2/D 01/13

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 either bulk pack or tape & reel.
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.

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 Formed Lead Option package.

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