

LM185-1.2-N/LM285-1.2-N/LM385-1.2-N 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-N/LM285-1.2-N/LM385-1.2-N 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-N band-gap reference uses only transistors and resistors, low noise and good long term stability result.

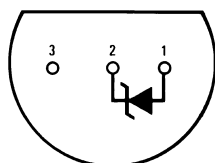
Careful design of the LM185-1.2-N has made the device exceptionally tolerant of capacitive loading, making it easy to use in almost any reference application. The wide dynamic operating range allows its use with widely varying supplies with excellent regulation.

The extremely low power drain of the LM185-1.2-N 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.

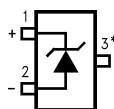
Further, the wide operating current allows it to replace older references with a tighter tolerance part.

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

CONNECTION DIAGRAM



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



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

Figure 2. SOT-23

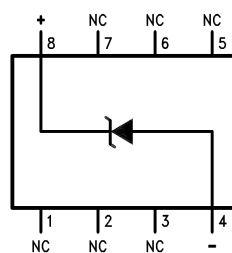
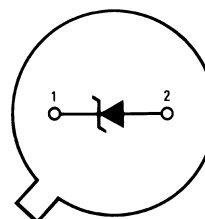


Figure 3. SOIC Package



**Figure 4. TO Package (NDV)
(Bottom View)**



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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⁾	
LM185-1.2-N	-55°C to +125°C
LM285-1.2-N	-40°C to +85°C
LM385-1.2-N	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 and SOT-23 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) 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: LM185 150°C LM285 125°C LM385 100°C
- (5) The human body model is a 100 pF capacitor discharged through a 1.5 k Ω resistor into each pin.

ELECTRICAL CHARACTERISTICS⁽¹⁾

Parameter	Conditions	Typ	LM185-1.2-N LM185BX-1.2-N LM185BY-1.2-N LM285-1.2-N LM285BX-1.2-N LM285BY-1.2-N		LM385B-1.2-N LM385BX-1.2-N LM385BY-1.2-N		LM385-1.2-N		Units (Limit)
			Tested Limit ⁽³⁾	Design Limit ⁽⁴⁾	Tested Limit ⁽²⁾	Design Limit ⁽⁴⁾	Tested Limit ⁽²⁾	Design Limit ⁽⁴⁾	
Reverse Breakdown Voltage	$T_A = 25^\circ\text{C}$, $10\mu\text{A} \leq I_R \leq 20\text{mA}$	1.23 5	1.223		1.223		1.205		V(Min)
			1.247		1.247		1.260		V(Max)
Minimum Operating Current		8	10	20	15	20	15	20	μA
	LM385M3-1.2-N						10	15	(Max)
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 (Max)
	$1\text{mA} \leq I_R \leq 20\text{mA}$		10	20	20	25	20	25	mV (Max)
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⁾	$I_R = 100\mu\text{A}$ X Suffix Y Suffix All Others		30 50		30 50			150	ppm/ $^\circ\text{C}$ ppm/ $^\circ\text{C}$ 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	SOIC	SOT-23
θ_{JA} (junction to ambient)	180 $^\circ\text{C}/\text{W}$ (0.4" leads) 170 $^\circ\text{C}/\text{W}$ (0.125" leads)	440 $^\circ\text{C}/\text{W}$	165 $^\circ\text{C}/\text{W}$	283 $^\circ\text{C}/\text{W}$
θ_{JC} (junction to case)	N/A	80 $^\circ\text{C}/\text{W}$	N/A	N/A

TYPICAL PERFORMANCE CHARACTERISTICS

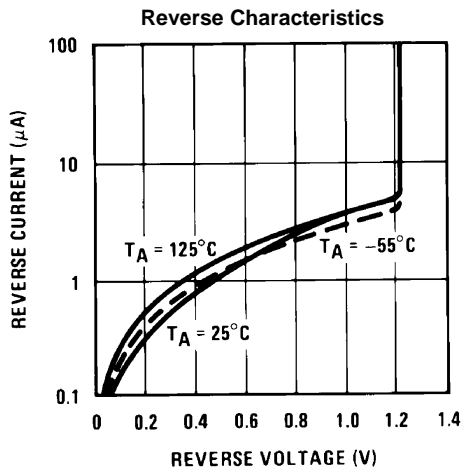


Figure 5.

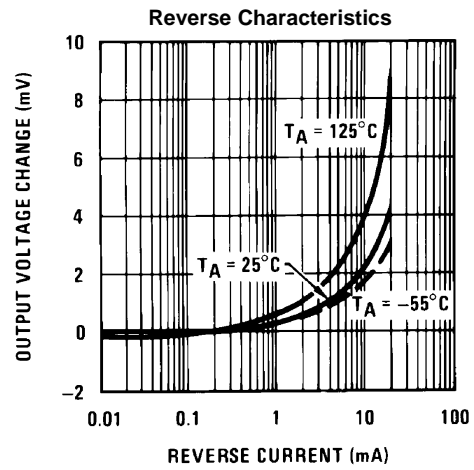


Figure 6.

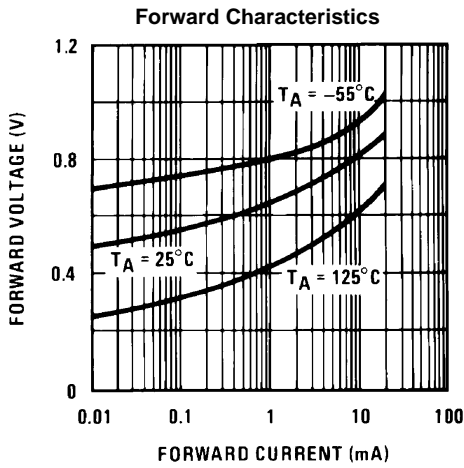


Figure 7.

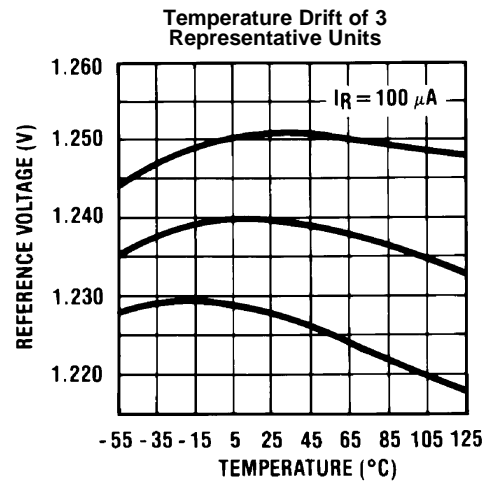


Figure 8.

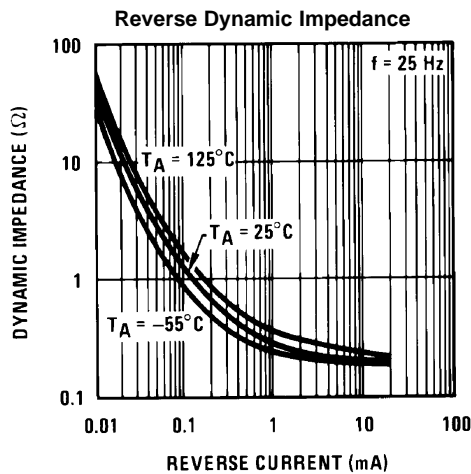


Figure 9.

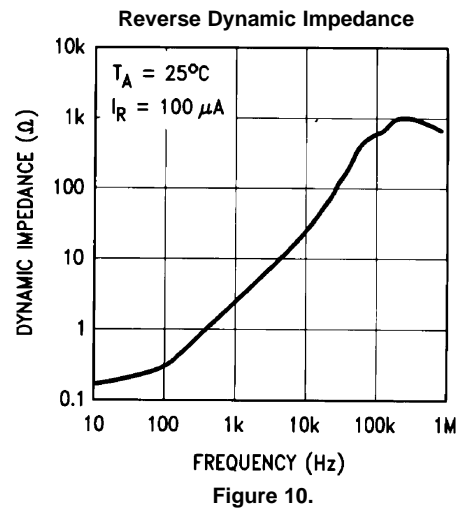
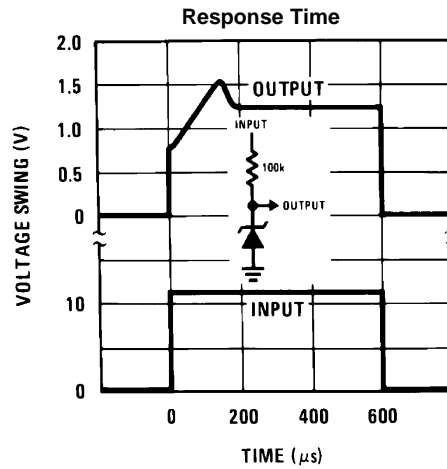
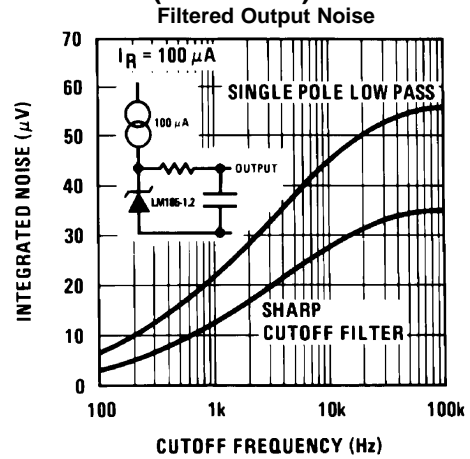
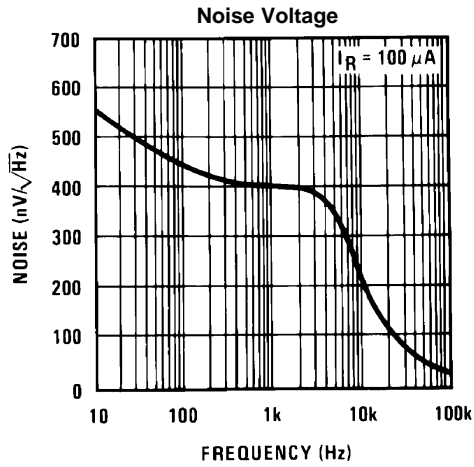


Figure 10.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)



TYPICAL APPLICATIONS

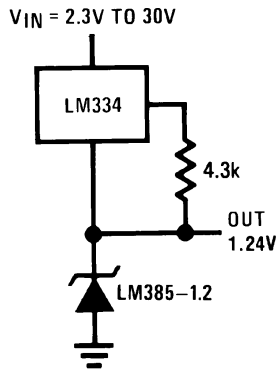


Figure 14. Wide Input Range Reference

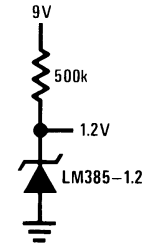


Figure 15. Micropower Reference from 9V Battery

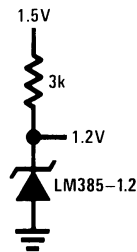
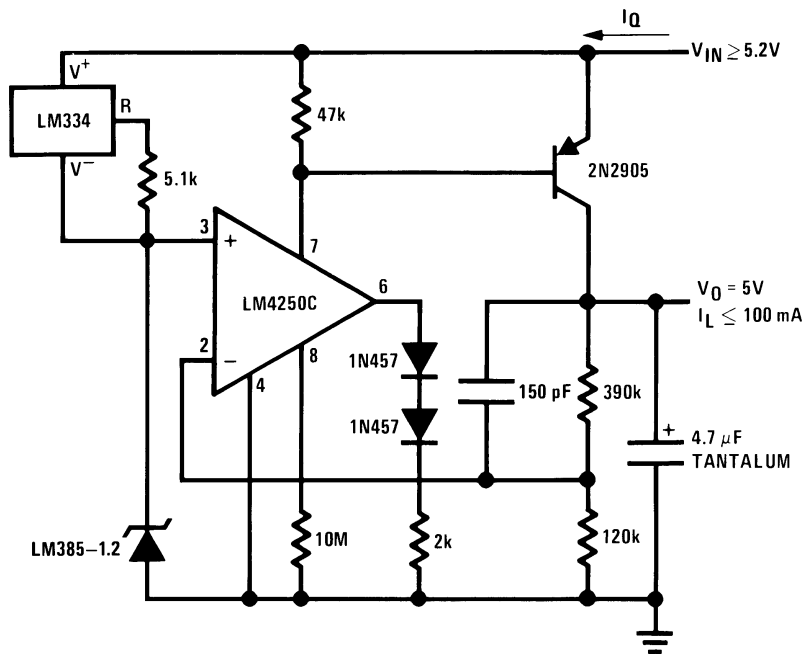
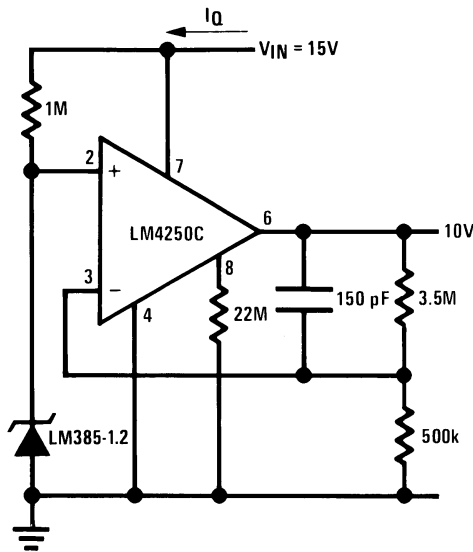


Figure 16. Reference from 1.5V Battery



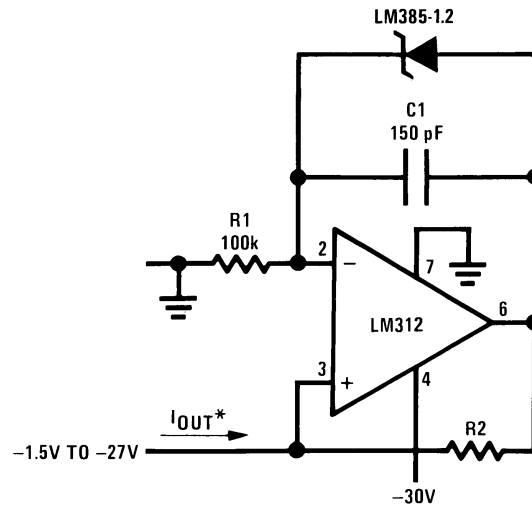
* $I_Q \approx 30\mu A$

Figure 17. Micropower* 5V Regulator



* $I_Q \approx 20\mu\text{A}$ standby current

Figure 18. Micropower* 10V Reference



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

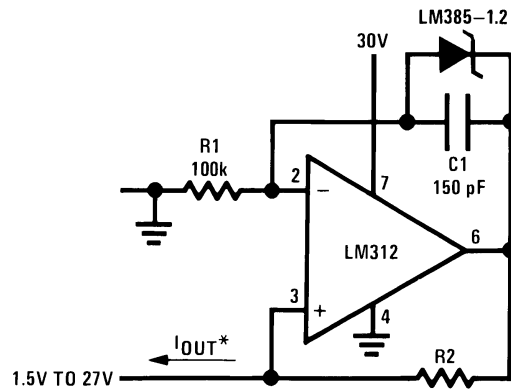
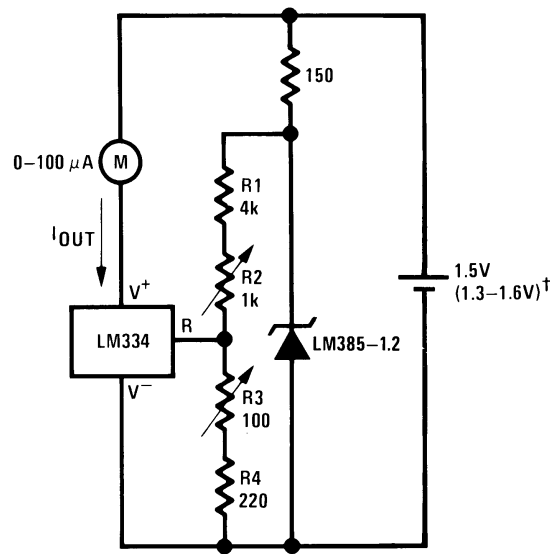


Figure 19. Precision 1µA to 1mA Current Sources

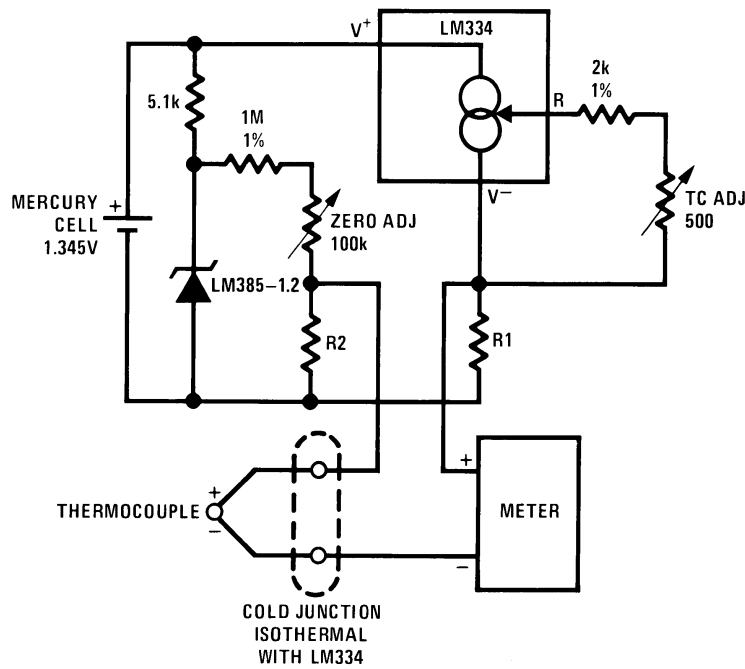
METER THERMOMETERS



Calibration

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

Figure 20. 0°C–100°C Thermometer



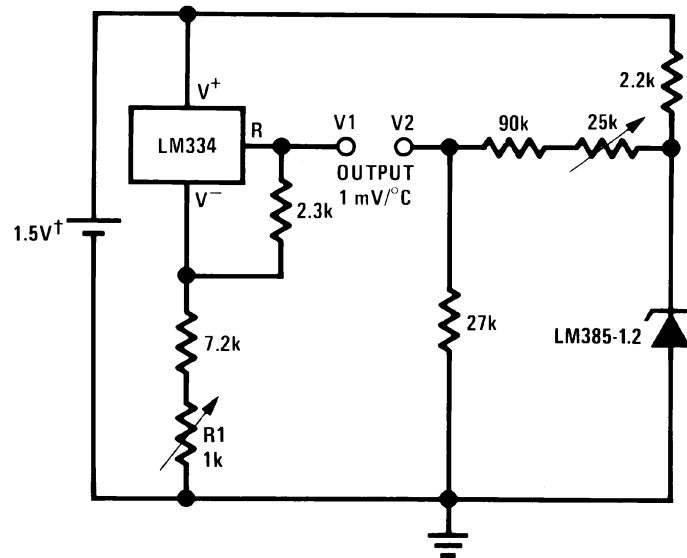
Adjustment Procedure

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 24. 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

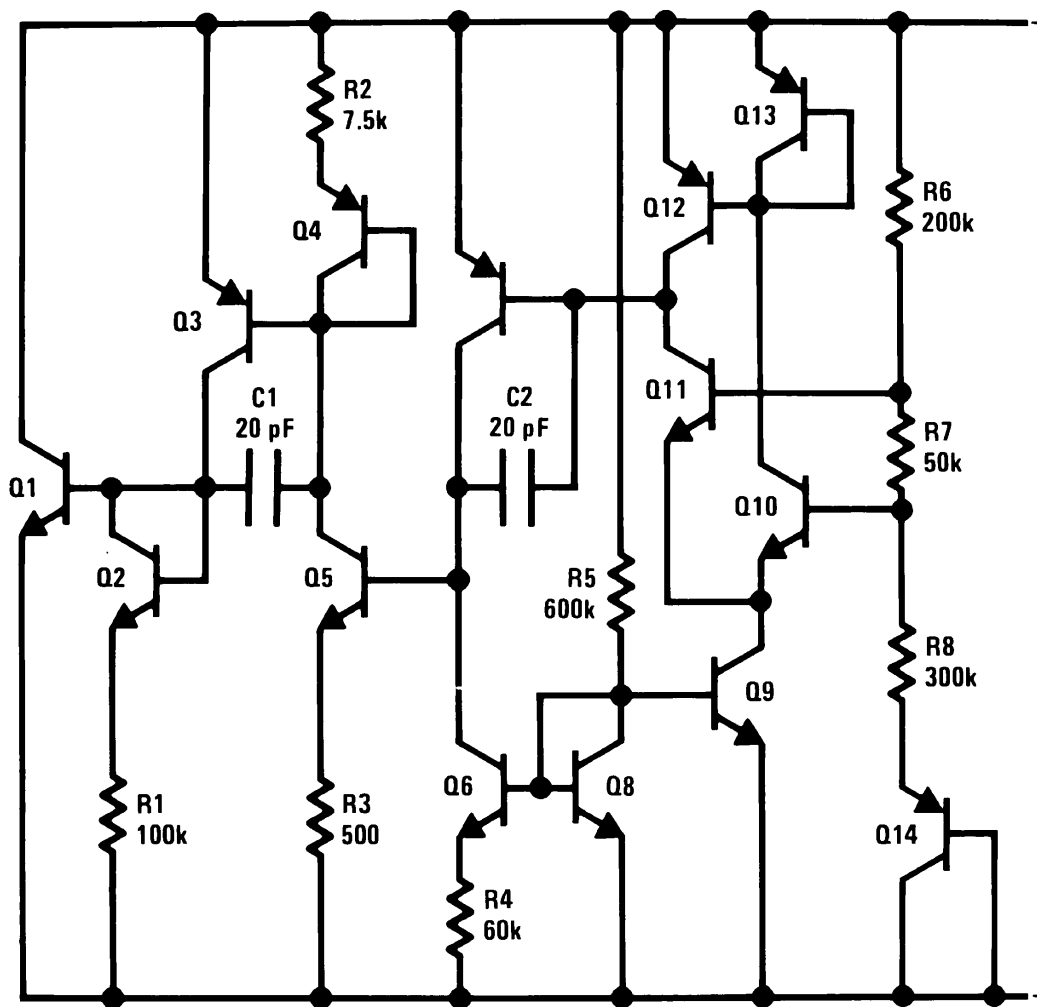


Calibration

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

Figure 25. Centigrade Thermometer



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
LM185BYH-1.2	ACTIVE	TO	NDU	2	1000	TBD	POST-PLATE	Level-1-NA-UNLIM	-55 to 125	LM185BYH1.2	Samples
LM185BYH-1.2/NOPB	ACTIVE	TO	NDU	2	1000	Green (RoHS & no Sb/Br)	POST-PLATE	Level-1-NA-UNLIM	-55 to 125	LM185BYH1.2	Samples
LM185H-1.2	ACTIVE	TO	NDU	2	1000	TBD	POST-PLATE	Level-1-NA-UNLIM	-55 to 125	LM185H1.2	Samples
LM185H-1.2/NOPB	ACTIVE	TO	NDU	2	1000	Green (RoHS & no Sb/Br)	POST-PLATE	Level-1-NA-UNLIM	-55 to 125	LM185H1.2	Samples
LM285BXM-1.2/NOPB	ACTIVE	SOIC	D	8	95	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	285BX M1.2	Samples
LM285BXM-1.2/NOPB	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	285BX M1.2	Samples
LM285BXZ-1.2/LFT4	ACTIVE	TO-92	LP	3	2000	Green (RoHS & no Sb/Br)	SNCU	Level-1-NA-UNLIM		285BX Z-1.2	Samples
LM285BXZ-1.2/NOPB	ACTIVE	TO-92	LP	3	1800	Green (RoHS & no Sb/Br)	SNCU	Level-1-NA-UNLIM	-40 to 85	285BX Z-1.2	Samples
LM285BYM-1.2/NOPB	ACTIVE	SOIC	D	8	95	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	285BY M1.2	Samples
LM285BYM-1.2/NOPB	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	285BY M1.2	Samples
LM285H-1.2	ACTIVE	TO	NDU	2	1000	TBD	POST-PLATE	Level-1-NA-UNLIM	-40 to 85	LM285H1.2	Samples
LM285H-1.2/NOPB	ACTIVE	TO	NDU	2	1000	Green (RoHS & no Sb/Br)	POST-PLATE	Level-1-NA-UNLIM	-40 to 85	LM285H1.2	Samples
LM285M-1.2/NOPB	ACTIVE	SOIC	D	8	95	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	LM285 M1.2	Samples
LM285MX-1.2/NOPB	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	LM285 M1.2	Samples
LM285Z-1.2/NOPB	ACTIVE	TO-92	LP	3	1800	Green (RoHS & no Sb/Br)	SNCU	Level-1-NA-UNLIM	-40 to 85	LM28 5Z-1.2	Samples
LM385BM-1.2	ACTIVE	SOIC	D	8	95	TBD	CU SNPB	Level-1-235C-UNLIM	0 to 70	LM385 BM1.2	Samples
LM385BM-1.2/NOPB	ACTIVE	SOIC	D	8	95	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	0 to 70	LM385 BM1.2	Samples
LM385BMX-1.2	ACTIVE	SOIC	D	8	2500	TBD	CU SNPB	Level-1-235C-UNLIM	0 to 70	LM385	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
										BM1.2	
LM385BMX-1.2/NOPB	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	0 to 70	LM385 BM1.2	Samples
LM385BXM-1.2/NOPB	ACTIVE	SOIC	D	8	95	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	0 to 70	385BX M1.2	Samples
LM385BXM-1.2/NOPB	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	0 to 70	385BX M1.2	Samples
LM385BXZ-1.2/NOPB	ACTIVE	TO-92	LP	3	1800	Green (RoHS & no Sb/Br)	SNCU	Level-1-NA-UNLIM	0 to 70	385BX Z-1.2	Samples
LM385BYM-1.2/NOPB	ACTIVE	SOIC	D	8	95	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	0 to 70	385BY M1.2	Samples
LM385BYM-1.2	ACTIVE	SOIC	D	8	2500	TBD	CU SNPB	Level-1-235C-UNLIM	0 to 70	385BY M1.2	Samples
LM385BYM-1.2/NOPB	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	0 to 70	385BY M1.2	Samples
LM385BYZ-1.2/NOPB	ACTIVE	TO-92	LP	3	1800	Green (RoHS & no Sb/Br)	SNCU	Level-1-NA-UNLIM	0 to 70	385BY Z-1.2	Samples
LM385BZ-1.2/NOPB	ACTIVE	TO-92	LP	3	1800	Green (RoHS & no Sb/Br)	SNCU	Level-1-NA-UNLIM	0 to 70	LM385 BZ1.2	Samples
LM385M-1.2	ACTIVE	SOIC	D	8	95	TBD	CU SNPB	Level-1-235C-UNLIM	0 to 70	LM385 M1.2	Samples
LM385M-1.2/NOPB	ACTIVE	SOIC	D	8	95	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	0 to 70	LM385 M1.2	Samples
LM385M3-1.2	ACTIVE	SOT-23	DBZ	3	1000	TBD	CU SNPB	Level-1-260C-UNLIM	0 to 70	R11	Samples
LM385M3-1.2/NOPB	ACTIVE	SOT-23	DBZ	3	1000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	0 to 70	R11	Samples
LM385M3X-1.2	ACTIVE	SOT-23	DBZ	3	3000	TBD	CU SNPB	Level-1-260C-UNLIM	0 to 70	R11	Samples
LM385M3X-1.2/NOPB	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	0 to 70	R11	Samples
LM385MX-1.2	ACTIVE	SOIC	D	8	2500	TBD	CU SNPB	Level-1-235C-UNLIM	0 to 70	LM385 M1.2	Samples
LM385MX-1.2/NOPB	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	0 to 70	LM385 M1.2	Samples
LM385Z-1.2/LFT3	ACTIVE	TO-92	LP	3	2000	Green (RoHS & no Sb/Br)	SNCU	Level-1-NA-UNLIM		LM385 Z-1.2	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
LM385Z-1.2/LFT4	ACTIVE	TO-92	LP	3	2000	Green (RoHS & no Sb/Br)	SNCU	Level-1-NA-UNLIM		LM385 Z-1.2	
LM385Z-1.2/NOPB	ACTIVE	TO-92	LP	3	1800	Green (RoHS & no Sb/Br)	SNCU	Level-1-NA-UNLIM	0 to 70	LM385 Z-1.2	

(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.

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TAPE AND REEL INFORMATION

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE


*All dimensions are nominal

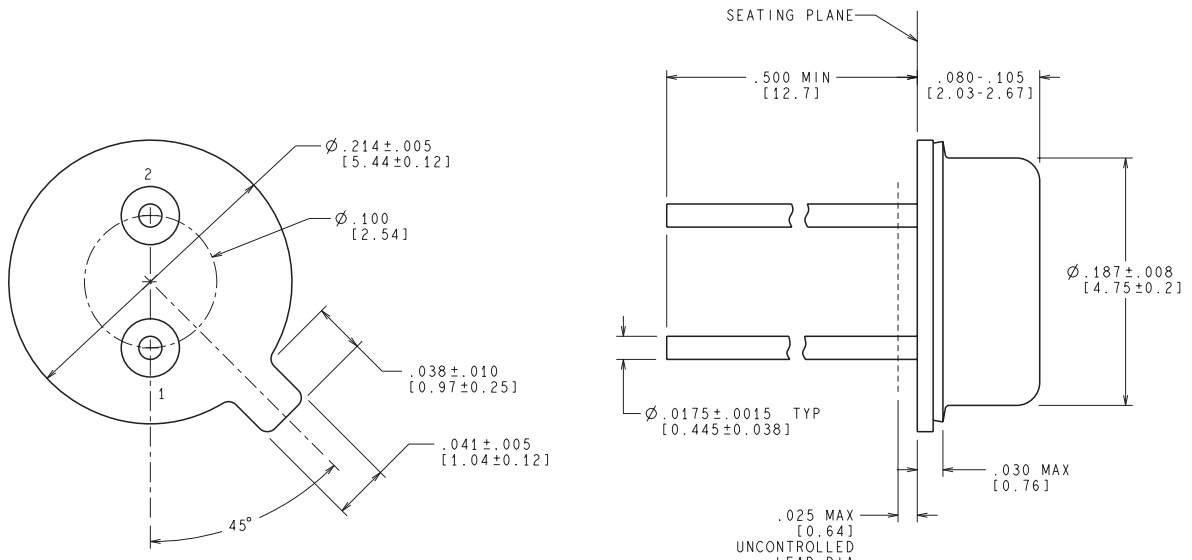
Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LM285BXM-1.2/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
LM285BYM-1.2/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
LM285M-1.2/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
LM385BM-1.2	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
LM385BM-1.2/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
LM385BXM-1.2/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
LM385BYM-1.2	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
LM385BYM-1.2/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
LM385M3-1.2	SOT-23	DBZ	3	1000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM385M3-1.2/NOPB	SOT-23	DBZ	3	1000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM385M3X-1.2	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM385M3X-1.2/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM385M-1.2	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
LM385M-1.2/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)
LM285BXM-1.2/NOPB	SOIC	D	8	2500	349.0	337.0	45.0
LM285BYM-1.2/NOPB	SOIC	D	8	2500	349.0	337.0	45.0
LM285M-1.2/NOPB	SOIC	D	8	2500	349.0	337.0	45.0
LM385BM-1.2	SOIC	D	8	2500	349.0	337.0	45.0
LM385BM-1.2/NOPB	SOIC	D	8	2500	349.0	337.0	45.0
LM385BXM-1.2/NOPB	SOIC	D	8	2500	349.0	337.0	45.0
LM385BYM-1.2	SOIC	D	8	2500	349.0	337.0	45.0
LM385BYM-1.2/NOPB	SOIC	D	8	2500	349.0	337.0	45.0
LM385M3-1.2	SOT-23	DBZ	3	1000	203.0	190.0	41.0
LM385M3-1.2/NOPB	SOT-23	DBZ	3	1000	203.0	190.0	41.0
LM385M3X-1.2	SOT-23	DBZ	3	3000	206.0	191.0	90.0
LM385M3X-1.2/NOPB	SOT-23	DBZ	3	3000	206.0	191.0	90.0
LM385M-1.2	SOIC	D	8	2500	349.0	337.0	45.0
LM385M-1.2/NOPB	SOIC	D	8	2500	349.0	337.0	45.0

NDU0002A



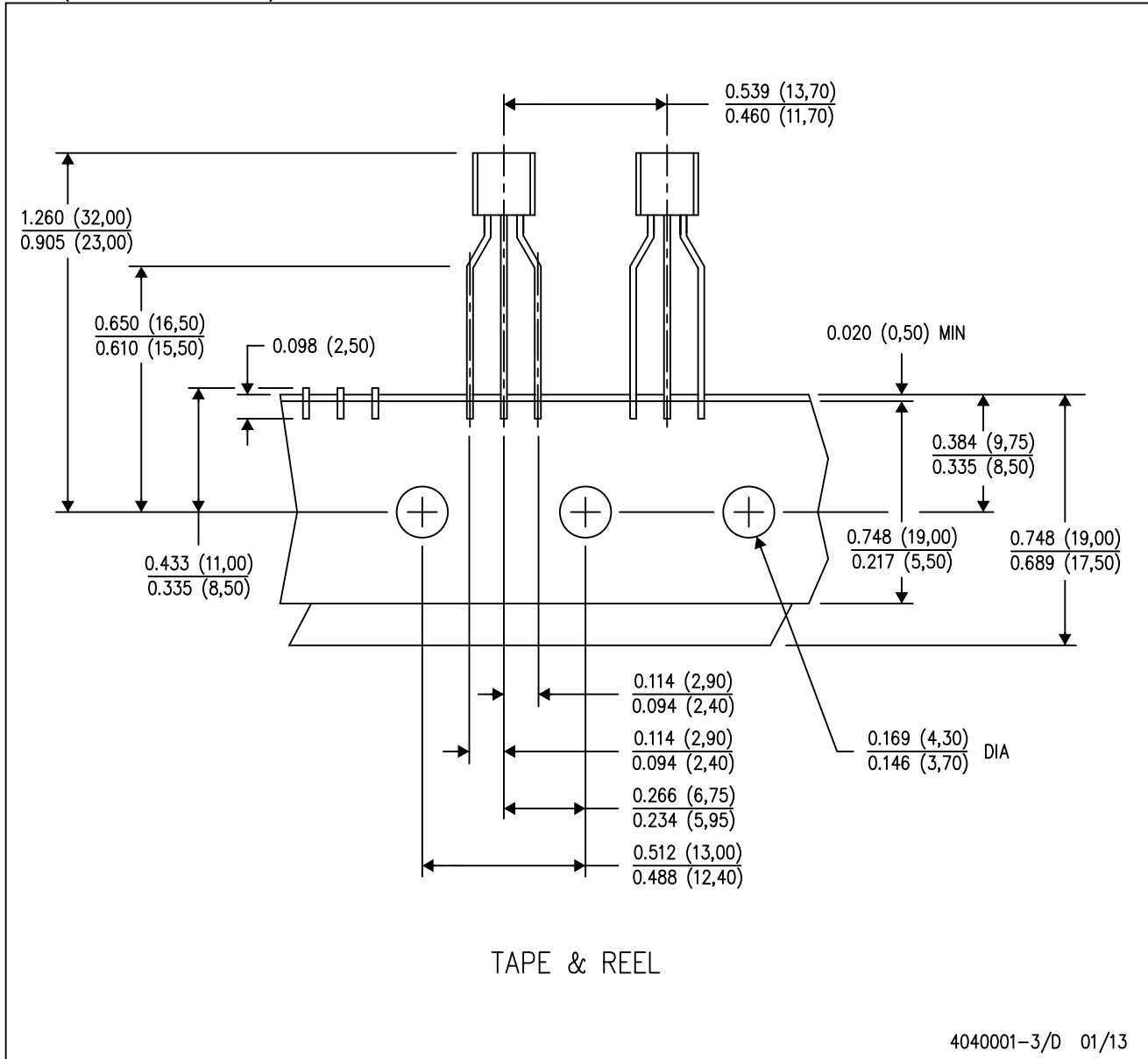
CONTROLLING DIMENSION IS INCH
VALUES IN [] ARE MILLIMETERS

H02A (Rev F)

MECHANICAL DATA

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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