

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 10 μ A to 20mA
- 1% and 2% Initial Tolerance
- 1 Ω 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 10 μ 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 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

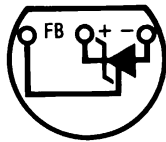


Figure 1. TO-92 Package Bottom View

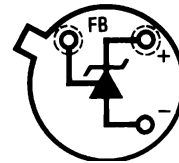


Figure 2. TO Package Bottom View

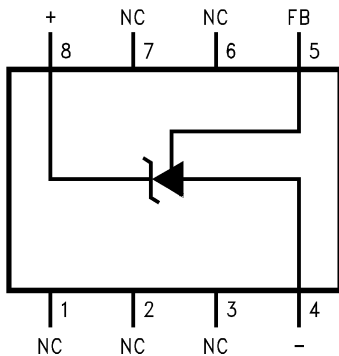


Figure 3. SOIC Package Top View

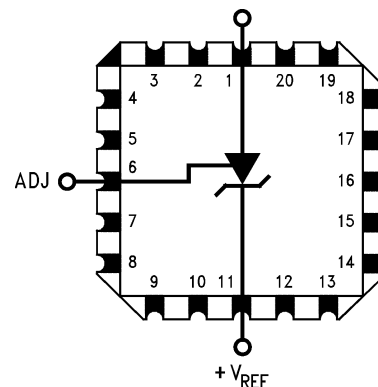


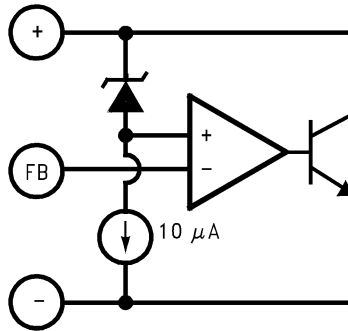
Figure 4. 20-LCCC Top View



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Block Diagram



Typical Applications

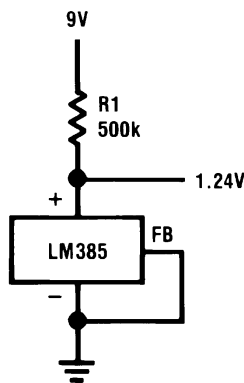
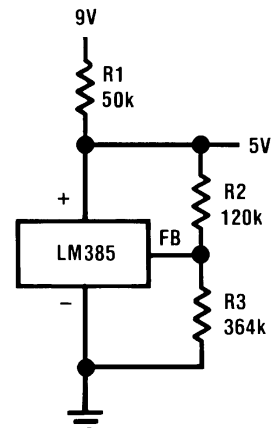


Figure 5. 1.24V Reference



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

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. For specifications and test conditions, see the Electrical Characteristics. The 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, see [Table 1](#) and [Thermal Characteristics](#).
- (5) The human body model is a 100 pF capacitor discharged through a 1.5 kΩ resistor into each pin.

Table 1. $T_{J(max)}$ for Elevated Temperature Operation

| DEVICE | $T_{J(max)}$ (°C) |
|--------|-------------------|
| LM185 | 150 |
| LM285 | 125 |
| LM385 | 100 |

Thermal Characteristics

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

| Thermal Resistance | TO-92 | TO-46 | 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 | $I_R = 100\mu A$ | 1.240 | 1.252 | | 1.265 | 1.270 | 1.240 | 1.252 | 1.255 | 1.265 | 1.270 | V (max) |
| | | | 1.228 | | 1.215 | 1.205 | | 1.228 | 1.215 | 1.215 | 1.205 | V (min) |
| Reference Voltage Change with Current | $I_{MIN} < I_R < 1mA$ | 0.2 | 1 | 1.5 | 1 | 1.5 | 0.2 | 1 | 1.5 | 1 | 1.5 | mV (max) |
| | $1mA < I_R < 20mA$ | 4 | 10 | 20 | 10 | 20 | 5 | 15 | 25 | 15 | 25 | |
| Dynamic Output Impedance | $I_R = 100\mu A, f = 100Hz$ $I_{AC} = 0.1 I_R$ $V_{OUT} = V_{REF}$ $V_{OUT} = 5.3V$ | 0.3 | | | | | 0.4 | | | | | Ω |
| | | 0.7 | | | | | 1 | | | | | |
| Reference Voltage Change with Output Voltage | $I_R = 100\mu A$ | 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) | $V_{OUT} = V_{REF}$ | 6 | 9 | 10 | 9 | 10 | 7 | 11 | 13 | 11 | 13 | μA (max) |
| | $V_{OUT} = 5.3V$ | 30 | 45 | 50 | 45 | 50 | 35 | 55 | 60 | 55 | 60 | |
| Output Wideband Noise | $I_R = 100\mu A, 10Hz < f < 10kHz$ $V_{OUT} = V_{REF}$ $V_{OUT} = 5.3V$ | 50 | | | | | 50 | | | | | μV_{rms} |
| | | 170 | | | | | 170 | | | | | |
| Average Temperature Coefficient ⁽⁴⁾ | $I_R = 100\mu A$ | X Suffix | 30 | | | | | 30 | | | | ppm/ $^{\circ}C$ (max) |
| | | Y Suffix | 50 | | | | | 50 | | | | |
| | | All Others | | 150 | | 150 | | | 150 | | 150 | |
| Long Term Stability | $I_R = 100\mu A, T = 1000 Hr,$ $T_A = 25^{\circ}C \pm 0.1^{\circ}C$ | 20 | | | | | 20 | | | | | ppm |

- (1) Parameters identified with **boldface type** apply at temperature extremes. All other numbers apply at $T_A = T_J = 25^{\circ}C$. Unless otherwise specified, all parameters apply for $V_{REF} < V_{OUT} < 5.3V$.
- (2) Production tested.
- (3) Not 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 $^{\circ}C$.

Typical Performance Characteristics

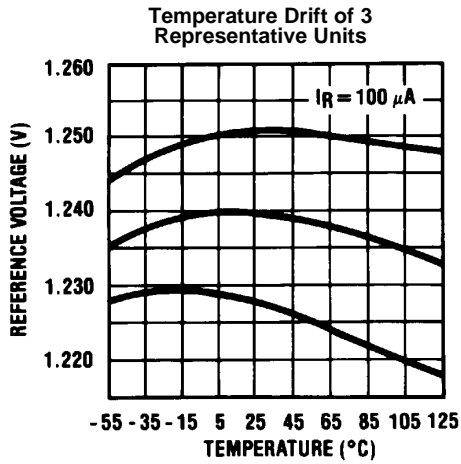


Figure 7.

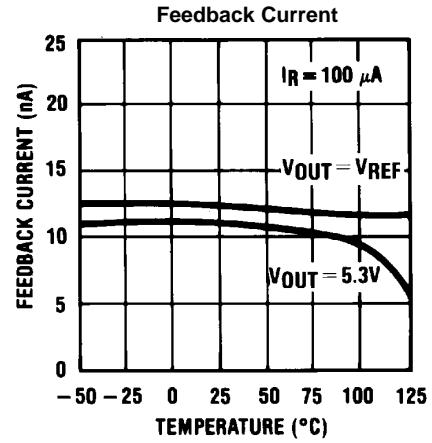


Figure 8.

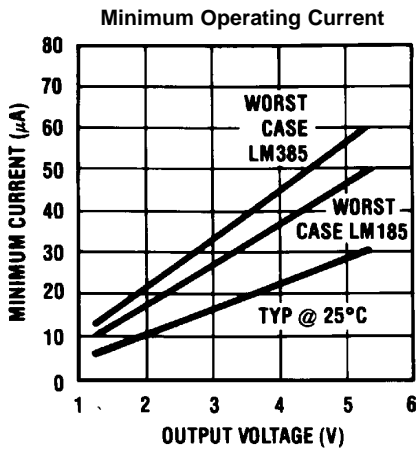


Figure 9.

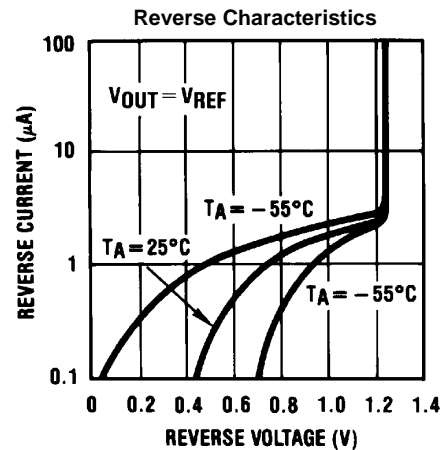


Figure 10.

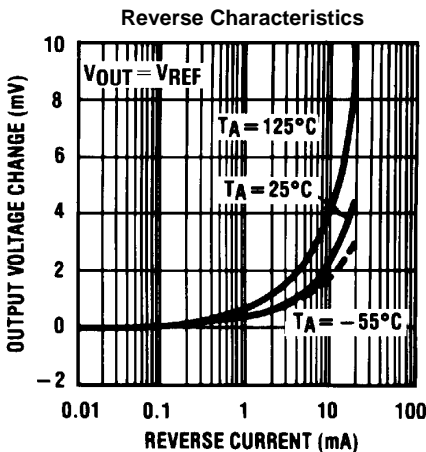


Figure 11.

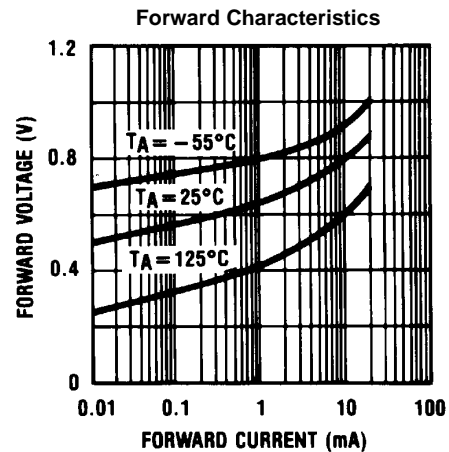


Figure 12.

Typical Performance Characteristics (continued)

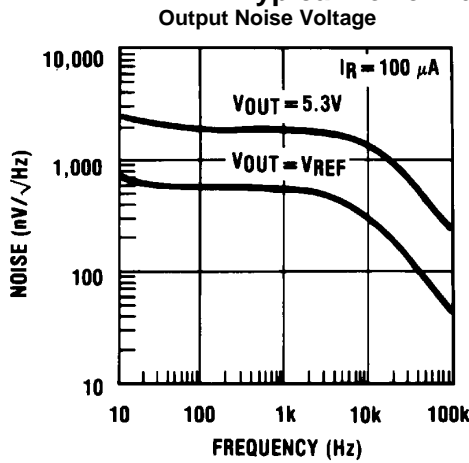


Figure 13.

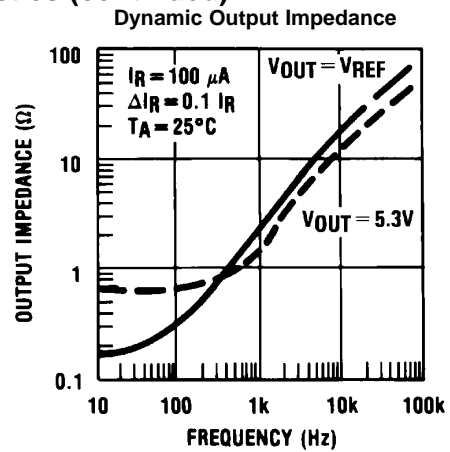


Figure 14.

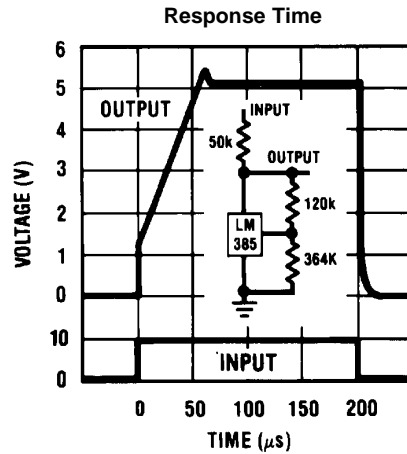


Figure 15.

Temperature Coefficient Typical
LM185 (left), LM285 (center), LM385 (right)

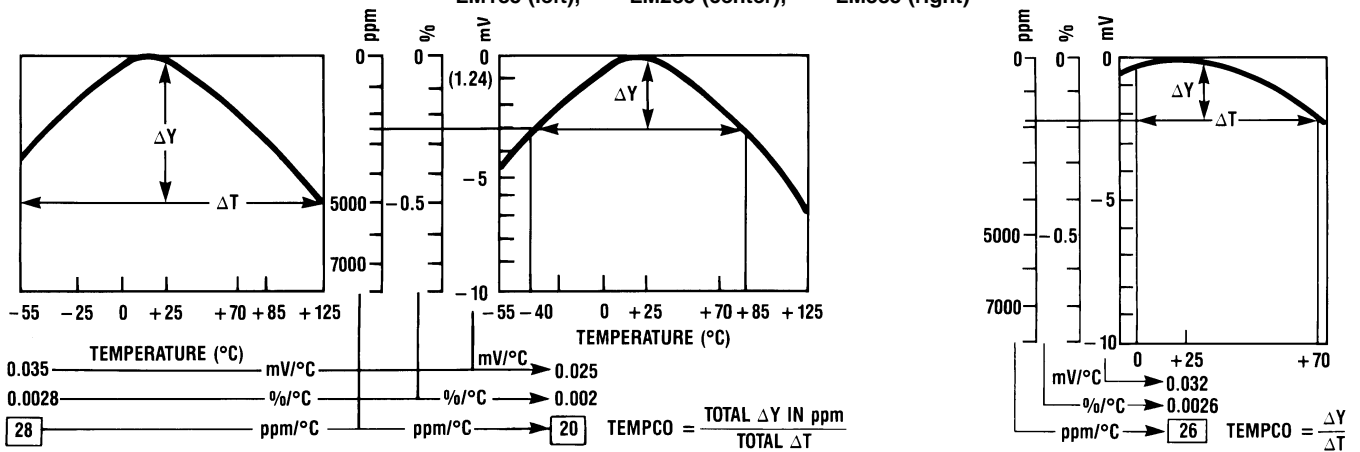


Figure 16.

TYPICAL APPLICATIONS

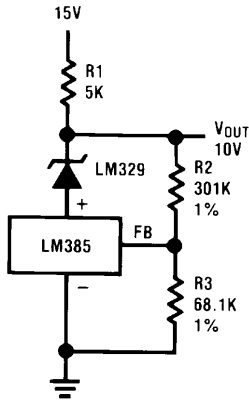


Figure 17. Precision 10V Reference

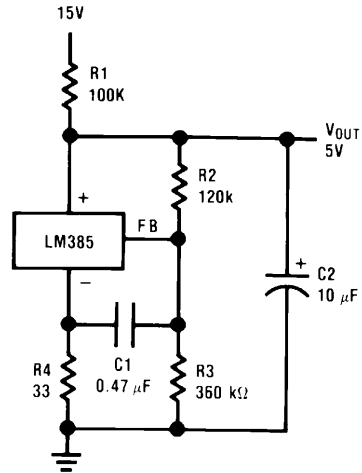


Figure 18. Low AC Noise Reference

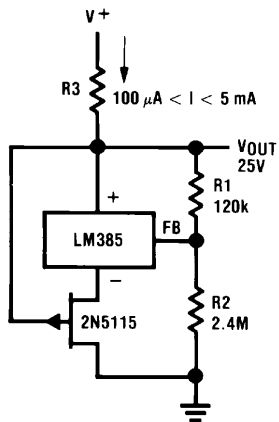


Figure 19. 25V Low Current Shunt Regulator

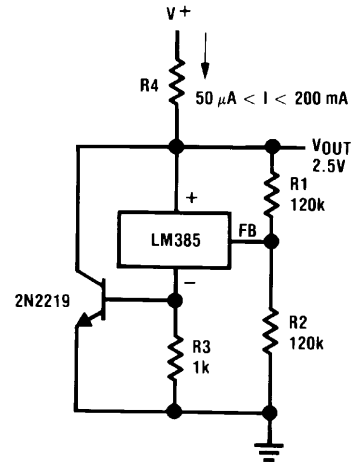


Figure 20. 200 mA Shunt Regulator

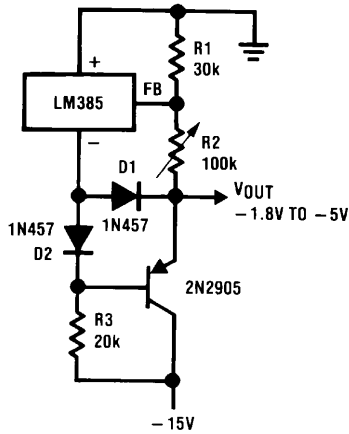


Figure 21. Series-Shunt 20 mA Regulator

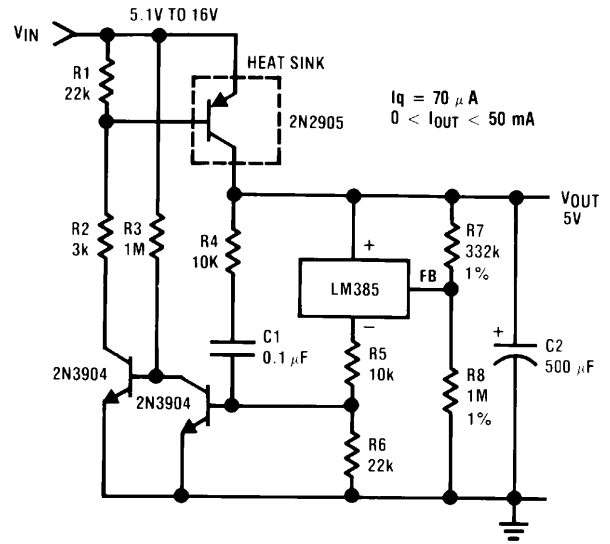


Figure 22. High Efficiency Low Power Regulator

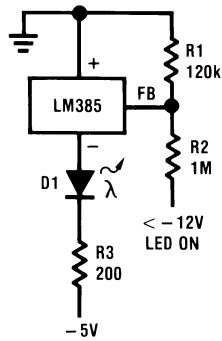


Figure 23. Voltage Level Detector

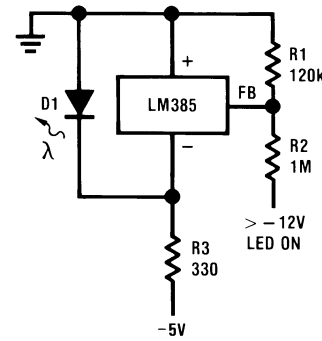


Figure 24. Voltage Level Detector

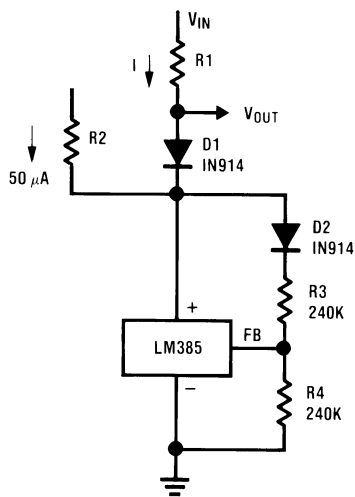


Figure 25. Fast Positive Clamp
 $2.4V + \Delta V_{D1}$

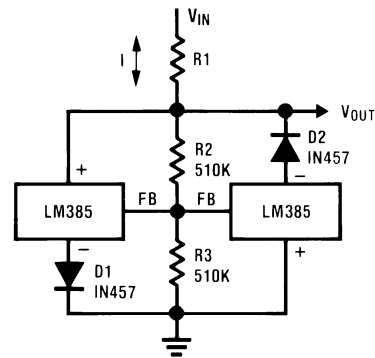


Figure 26. Bidirectional Clamp
 $\pm 2.4V$

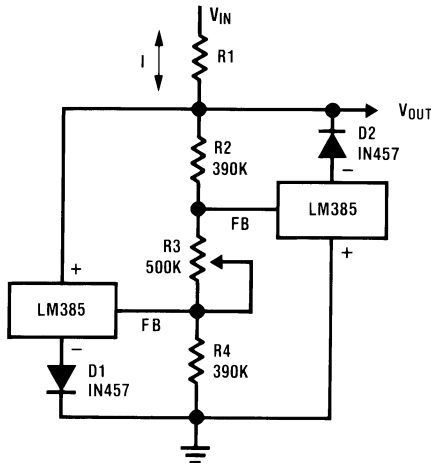


Figure 27. Bidirectional Adjustable Clamp
±1.8V to ±2.4V

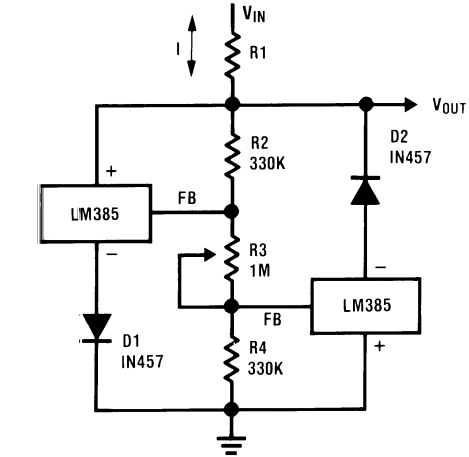


Figure 28. Bidirectional Adjustable Clamp
±2.4V to ±6V

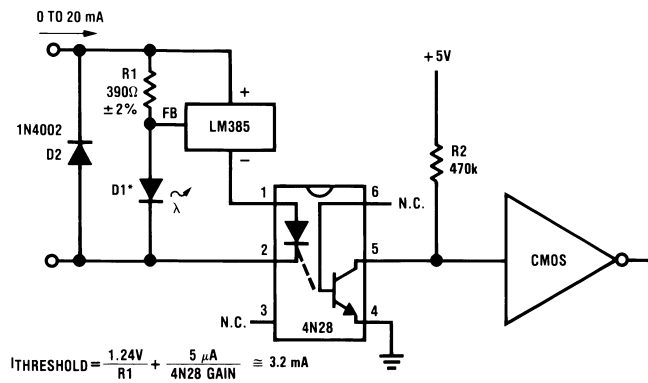


Figure 29. Simple Floating Current Detector

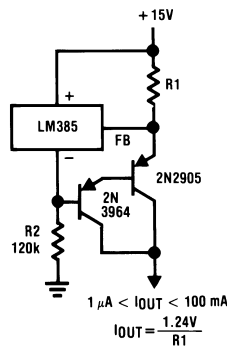
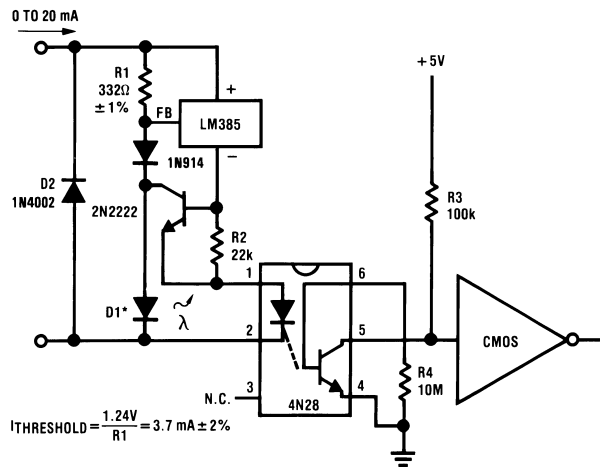


Figure 30. Current Source



*D1 can be any LED, $V_F=1.5\text{V to }2.2\text{V}$ at 3 mA . D1 may act as an indicator. D1 will be on if $I_{\text{THRESHOLD}}$ falls below the threshold current, except with $I=0$.

Figure 31. Precision Floating Current Detector

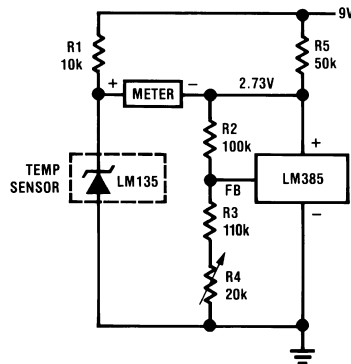


Figure 32. Centigrade Thermometer, 10mV/°C

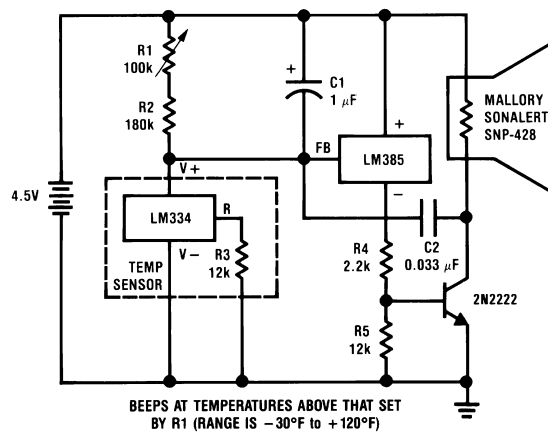
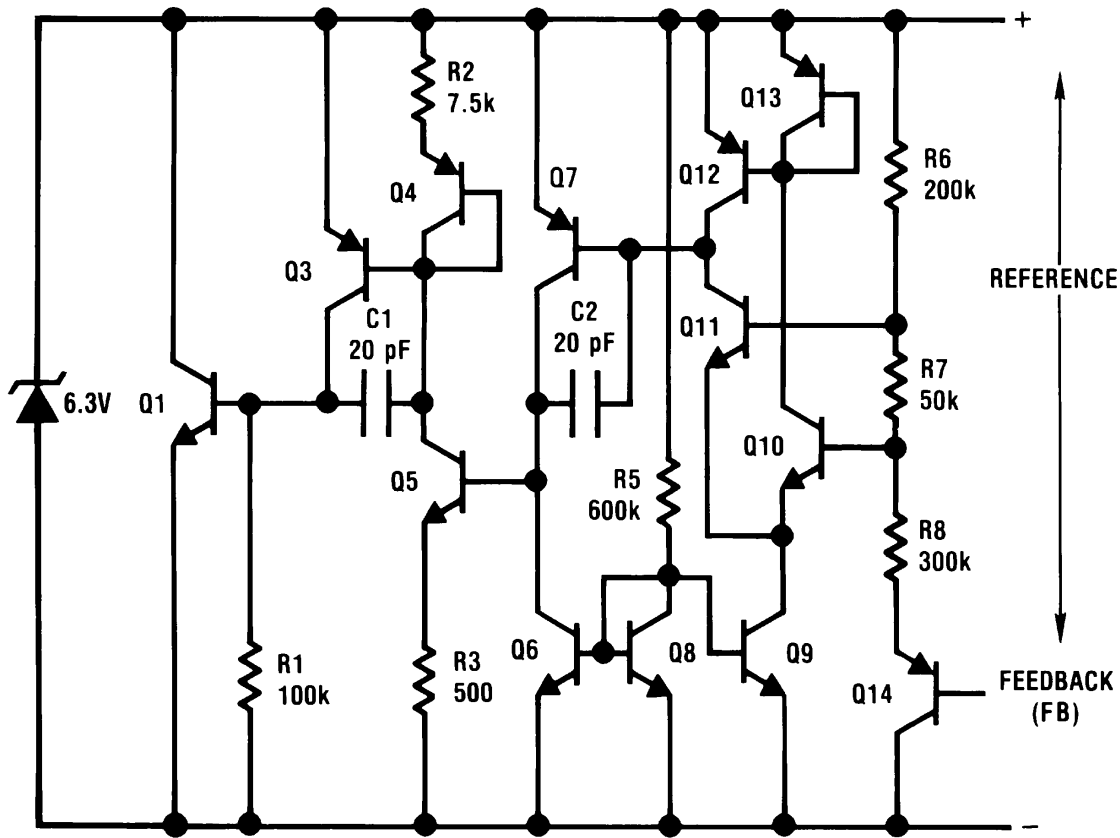


Figure 33. Freezer Alarm

Schematic Diagram



REVISION HISTORY

| Changes from Revision E (April 2013) to Revision F | Page |
|------------------------------------------------------------|------|
| • Changed layout of National Data Sheet to TI format | 11 |

PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | 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) | SN CU SN | N / A for Pkg Type | -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) | SN 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) | SN CU SN | N / A for Pkg Type | -40 to 85 | LM285 BYZ | Samples |
| LM285M/NOPB | ACTIVE | SOIC | D | 8 | 95 | Green (RoHS & no Sb/Br) | SN CU SN | Level-1-260C-UNLIM | -40 to 85 | LM285 M | Samples |
| LM285MX/NOPB | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | SN 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) | SN CU SN | N / A for Pkg Type | -40 to 85 | LM285 Z | Samples |
| LM385BM | NRND | SOIC | D | 8 | 95 | TBD | Call TI | Call TI | 0 to 70 | LM385 BM | |
| LM385BM/NOPB | ACTIVE | SOIC | D | 8 | 95 | Green (RoHS & no Sb/Br) | SN CU SN | Level-1-260C-UNLIM | 0 to 70 | LM385 BM | Samples |
| LM385BMX/NOPB | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | SN 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) | SN CU SN | N / A for Pkg Type | 0 to 70 | LM385 BXZ | Samples |
| LM385BYZ/NOPB | ACTIVE | TO-92 | LP | 3 | 1800 | Green (RoHS & no Sb/Br) | SN CU SN | N / A for Pkg Type | 0 to 70 | LM385 BYZ | Samples |
| LM385BZ/NOPB | ACTIVE | TO-92 | LP | 3 | 1800 | Green (RoHS & no Sb/Br) | SN CU SN | N / A for Pkg Type | 0 to 70 | LM385 BZ | Samples |
| LM385M | NRND | SOIC | D | 8 | 95 | TBD | Call TI | Call TI | 0 to 70 | LM385 | |

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|------------------|---------------|--------------|-----------------|------|-------------|-------------------------|-------------------------|----------------------|--------------|-------------------------|-------------------------|
| | | | | | | | | | | M | |
| LM385M/NOPB | ACTIVE | SOIC | D | 8 | 95 | Green (RoHS & no Sb/Br) | SN CU SN | Level-1-260C-UNLIM | 0 to 70 | LM385 M | Samples |
| LM385MX | NRND | SOIC | D | 8 | 2500 | TBD | Call TI | Call TI | 0 to 70 | LM385 M | |
| LM385MX/NOPB | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | SN 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) | SN CU SN | N / A for Pkg Type | 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.

OBSELETE: 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) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION



QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

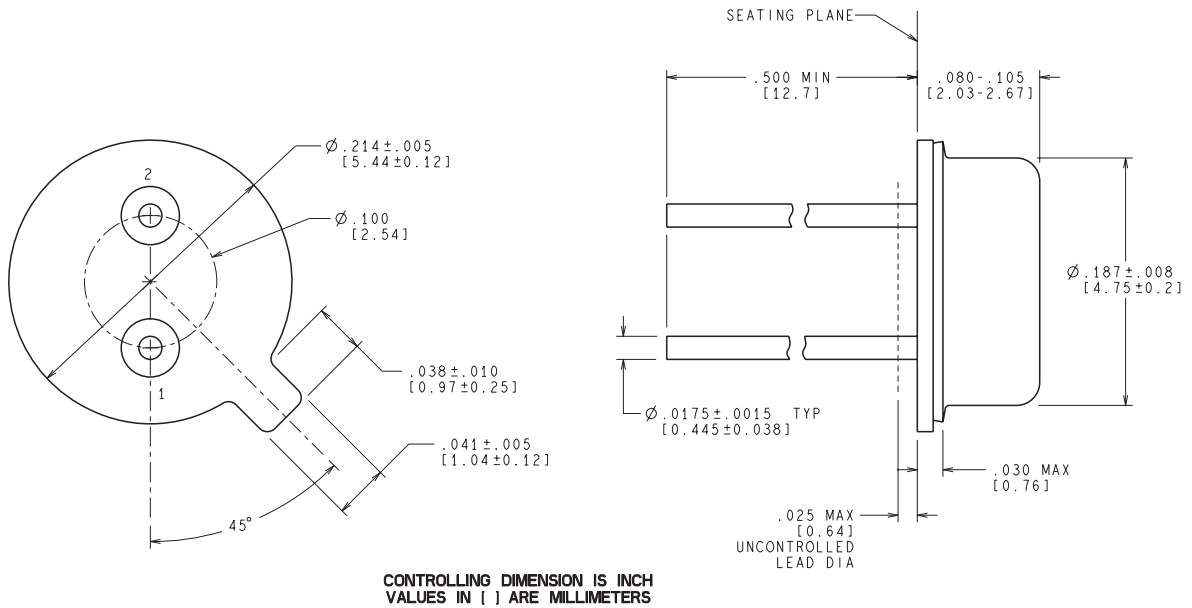
| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|----------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| 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

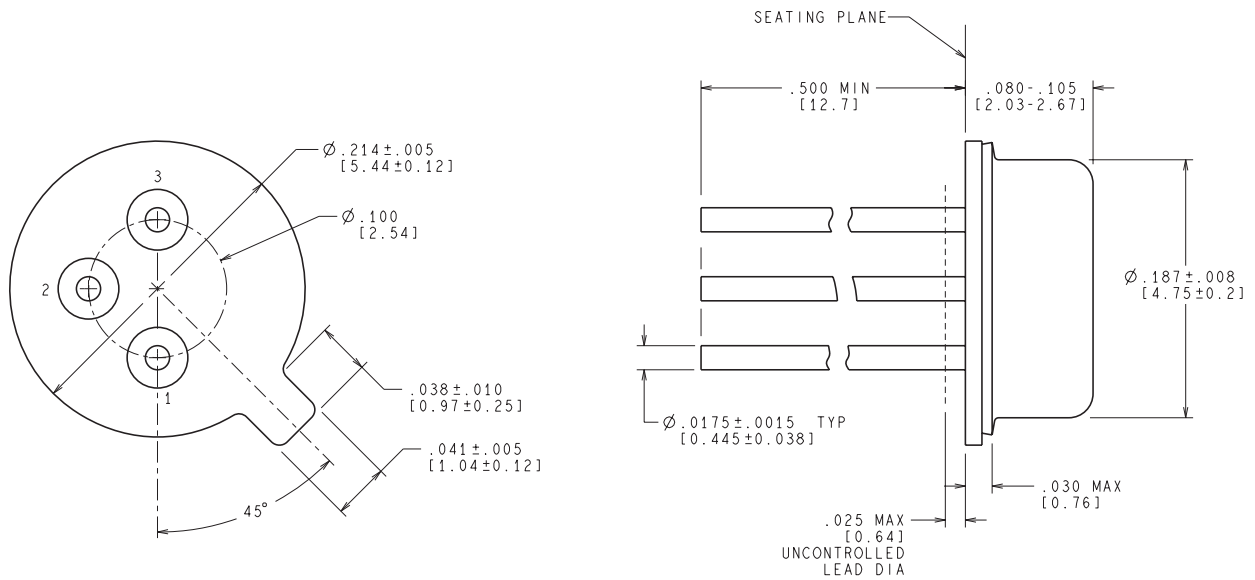
| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|----------------|--------------|-----------------|------|------|-------------|------------|-------------|
| LM285BYMX/NOPB | SOIC | D | 8 | 2500 | 367.0 | 367.0 | 35.0 |
| LM285MX/NOPB | SOIC | D | 8 | 2500 | 367.0 | 367.0 | 35.0 |
| LM385BMX/NOPB | SOIC | D | 8 | 2500 | 367.0 | 367.0 | 35.0 |
| LM385MX | SOIC | D | 8 | 2500 | 367.0 | 367.0 | 35.0 |
| LM385MX/NOPB | SOIC | D | 8 | 2500 | 367.0 | 367.0 | 35.0 |

NDU0002A



H02A (Rev F)

NDV0003H

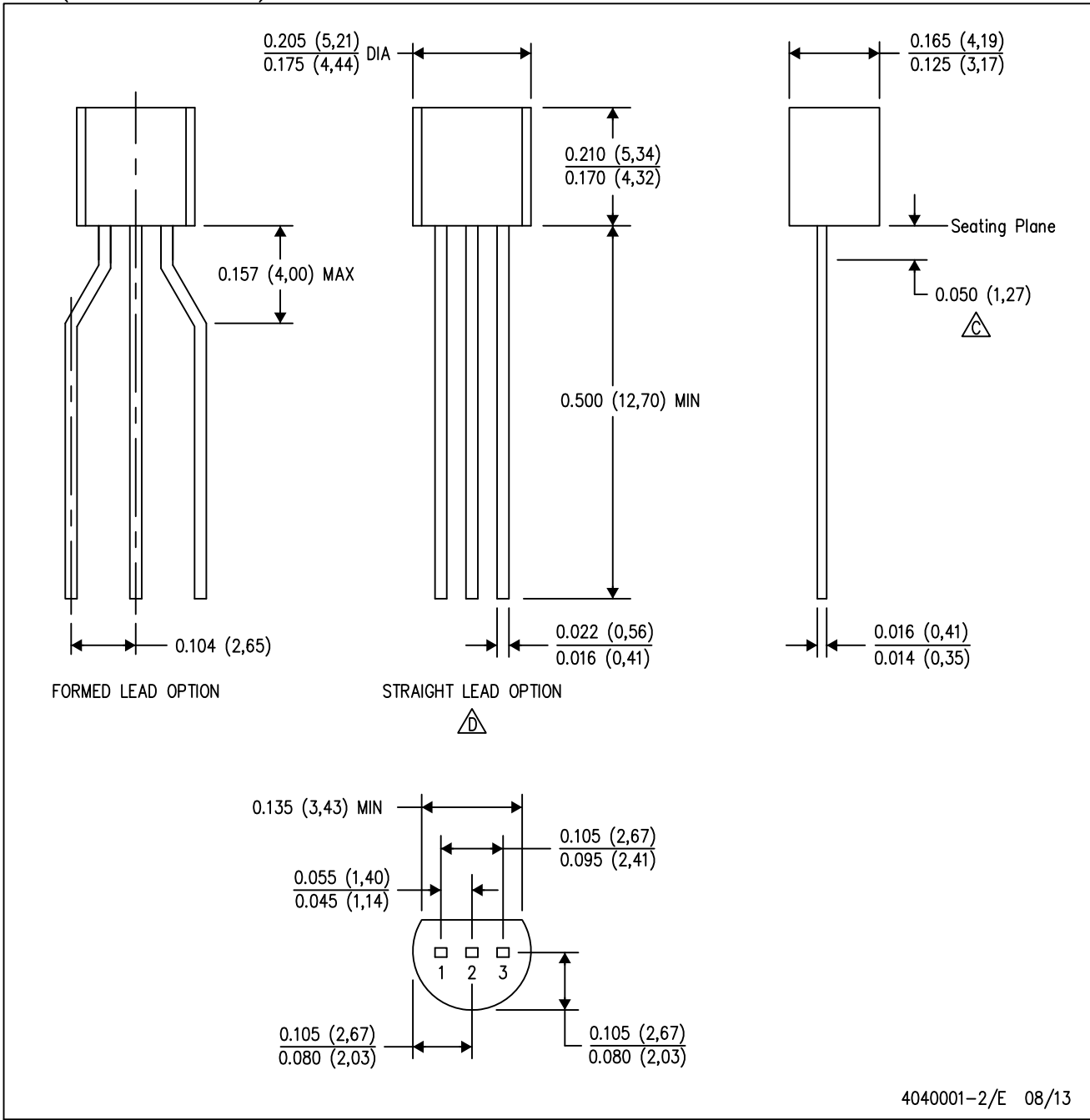


CONTROLLING DIMENSION IS INCH
VALUES IN [] ARE IN MILLIMETERS

H03H (Rev F)

LP (O-PBCY-W3)

PLASTIC CYLINDRICAL PACKAGE



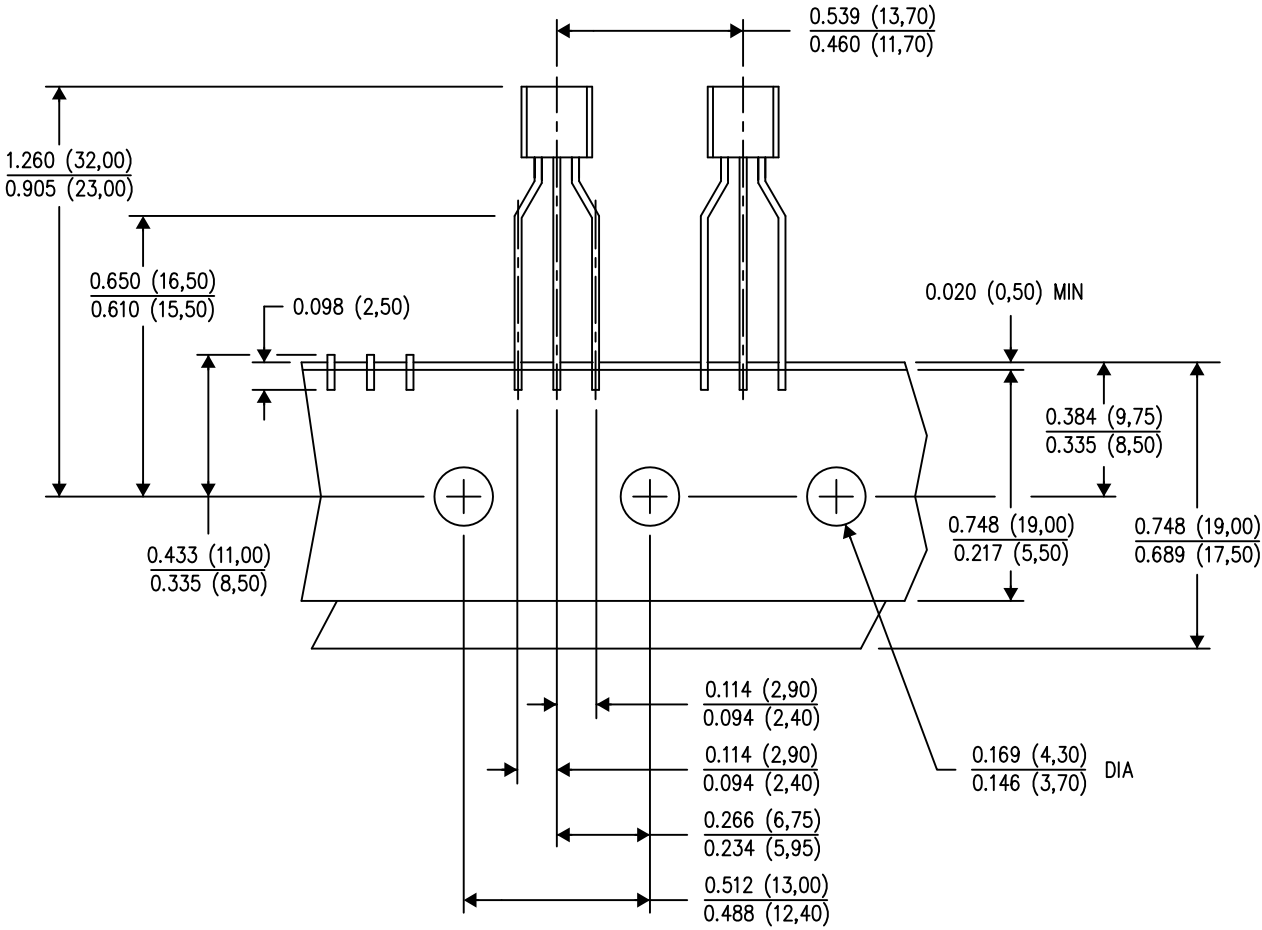
4040001-2/E 08/13

- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - Lead dimensions are not controlled within this area.
 - 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.
 Specific products can be offered in limited combinations of shipping mediums and lead options.
 Consult product folder for more information on available options.

MECHANICAL DATA

LP (O-PBCY-W3)

PLASTIC CYLINDRICAL PACKAGE



TAPE & REEL

4040001-3/E 08/13

- 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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