

# LM285, LM385B

## Micropower Voltage Reference Diodes

The LM285/LM385 series are micropower two-terminal bandgap voltage regulator diodes. Designed to operate over a wide current range of 10  $\mu$ A to 20 mA, these devices feature exceptionally low dynamic impedance, low noise and stable operation over time and temperature. Tight voltage tolerances are achieved by on-chip trimming. The large dynamic operating range enables these devices to be used in applications with widely varying supplies with excellent regulation. Extremely low operating current make these devices ideal for micropower circuitry like portable instrumentation, regulators and other analog circuitry where extended battery life is required.

The LM285/LM385 series are packaged in a low cost TO-226 plastic case and are available in two voltage versions of 1.235 V and 2.500 V as denoted by the device suffix (see Ordering Information table). The LM285 is specified over a  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  temperature range while the LM385 is rated from  $0^{\circ}\text{C}$  to  $+70^{\circ}\text{C}$ .

The LM385 is also available in a surface mount plastic package in voltages of 1.235 V and 2.500 V.

### Features

- Pb-Free Packages are Available
- Operating Current from 10  $\mu$ A to 20 mA
- 1.0%, 1.5%, 2.0% and 3.0% Initial Tolerance Grades
- Low Temperature Coefficient
- 1.0  $\Omega$  Dynamic Impedance
- Surface Mount Package Available

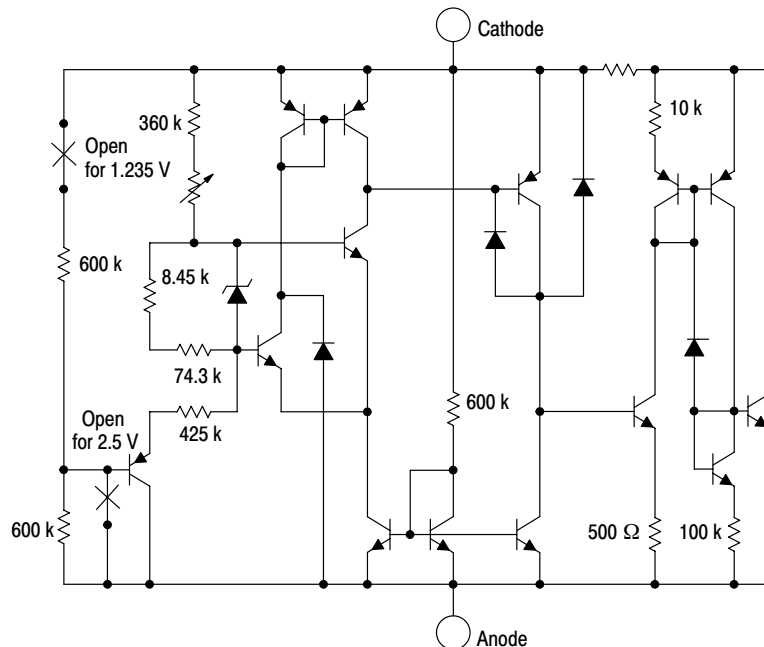


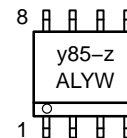
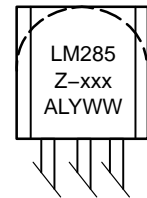
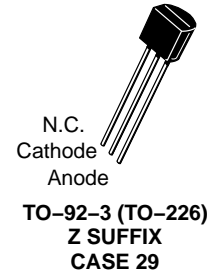
Figure 1. Representative Schematic Diagram



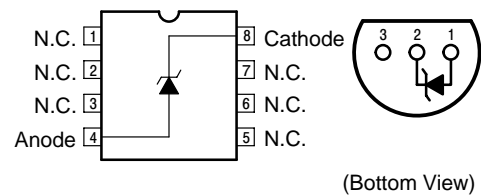
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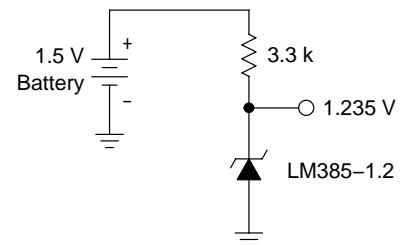
### MARKING DIAGRAMS



xxx = 1.2 or 2.5  
y = 2 or 3  
z = 1 or 2  
A = Assembly Location  
L = Wafer Lot  
Y = Year  
W, WW = Work Week



### Standard Application



### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 6 of this data sheet.

# LM285, LM385B

## MAXIMUM RATINGS (T<sub>A</sub> = 25°C, unless otherwise noted)

| Rating  | Symbol           | Value                  | Unit |
|---|------------------|------------------------|------|
| Reverse Current   | I <sub>R</sub>   | 30                     | mA   |
| Forward Current   | I <sub>F</sub>   | 10                     | mA   |
| Operating Ambient Temperature Range   | T <sub>A</sub>   | -40 to +85<br>0 to +70 | °C   |
| Operating Junction Temperature  | T <sub>J</sub>   | +150                   | °C   |
| Storage Temperature Range   | T <sub>stg</sub> | -65 to + 150           | °C   |
| Electrostatic Discharge Sensitivity (ESD)<br>Human Body Model (HBM)<br>Machine Model (MM)<br>Charged Device Model (CDM) | ESD              | 4000<br>400<br>2000    | V    |

Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.

## ELECTRICAL CHARACTERISTICS (T<sub>A</sub> = 25°C, unless otherwise noted)

| Characteristic  | Symbol                  | LM285-1.2      |            |                        | LM385-1.2/LM385B-1.2 |            |                        | Unit    |
|---|-------------------------|----------------|------------|------------------------|----------------------|------------|------------------------|---------|
|   |                         | Min            | Typ        | Max                    | Min                  | Typ        | Max                    |         |
| Reverse Breakdown Voltage (I <sub>Rmin</sub> ≤ I <sub>R</sub> ≤ 20 mA)<br>LM285-1.2/LM385B-1.2<br>T <sub>A</sub> = T <sub>low</sub> to T <sub>high</sub> (Note 1)<br>LM385-1.2<br>T <sub>A</sub> = T <sub>low</sub> to T <sub>high</sub> (Note 1)   | V <sub>(BR)R</sub>      | 1.223<br>1.200 | 1.235<br>- | 1.247<br>1.270         | 1.223<br>1.210       | 1.235<br>- | 1.247<br>1.260         | V       |
| Minimum Operating Current<br>T <sub>A</sub> = 25°C<br>T <sub>A</sub> = T <sub>low</sub> to T <sub>high</sub> (Note 1)   | I <sub>Rmin</sub>       | -<br>-         | 8.0<br>-   | 10<br>20               | -<br>-               | 8.0<br>-   | 15<br>20               | μA      |
| Reverse Breakdown Voltage Change with Current<br>I <sub>Rmin</sub> ≤ I <sub>R</sub> ≤ 1.0 mA, T <sub>A</sub> = +25°C<br>T <sub>A</sub> = T <sub>low</sub> to T <sub>high</sub> (Note 1)<br>1.0 mA ≤ I <sub>R</sub> ≤ 20 mA, T <sub>A</sub> = +25°C<br>T <sub>A</sub> = T <sub>low</sub> to T <sub>high</sub> (Note 1) | ΔV <sub>(BR)R</sub>     | -<br>-         | -<br>-     | 1.0<br>1.5<br>10<br>20 | -<br>-               | -<br>-     | 1.0<br>1.5<br>20<br>25 | mV      |
| Reverse Dynamic Impedance<br>I <sub>R</sub> = 100 μA, T <sub>A</sub> = +25°C  | Z                       | -              | 0.6        | -                      | -                    | 0.6        | -                      | Ω       |
| Average Temperature Coefficient<br>10 μA ≤ I <sub>R</sub> ≤ 20 mA, T <sub>A</sub> = T <sub>low</sub> to T <sub>high</sub> (Note 1)  | ΔV <sub>(BR)R</sub> /ΔT | -              | 80         | -                      | -                    | 80         | -                      | ppm/°C  |
| Wideband Noise (RMS)<br>I <sub>R</sub> = 100 μA, 10 Hz ≤ f ≤ 10 kHz   | n                       | -              | 60         | -                      | -                    | 60         | -                      | μV      |
| Long Term Stability<br>I <sub>R</sub> = 100 μA, T <sub>A</sub> = +25°C ± 0.1°C  | S                       | -              | 20         | -                      | -                    | 20         | -                      | ppm/kHR |
| Reverse Breakdown Voltage (I <sub>Rmin</sub> ≤ I <sub>R</sub> ≤ 20 mA)<br>LM285-2.5/LM385B-2.5<br>T <sub>A</sub> = T <sub>low</sub> to T <sub>high</sub> (Note 1)<br>LM385-2.5<br>T <sub>A</sub> = T <sub>low</sub> to T <sub>high</sub> (Note 1)   | V <sub>(BR)R</sub>      | 2.462<br>2.415 | 2.5<br>-   | 2.538<br>2.585         | 2.462<br>2.436       | 2.5<br>-   | 2.538<br>2.564         | V       |
| Minimum Operating Current<br>T <sub>A</sub> = 25°C<br>T <sub>A</sub> = T <sub>low</sub> to T <sub>high</sub> (Note 1)   | I <sub>Rmin</sub>       | -<br>-         | 13<br>-    | 20<br>30               | -<br>-               | 13<br>-    | 20<br>30               | μA      |

- T<sub>low</sub> = -40°C for LM285-1.2, LM285-2.5  
 T<sub>high</sub> = +85°C for LM285-1.2, LM285-2.5  
 T<sub>low</sub> = 0°C for LM385-1.2, LM385B-1.2, LM385-2.5, LM385B-2.5  
 T<sub>high</sub> = +70°C for LM385-1.2, LM385B-1.2, LM385-2.5, LM385B-2.5

## LM285, LM385B

### ELECTRICAL CHARACTERISTICS ( $T_A = 25^\circ\text{C}$ , unless otherwise noted)

| Characteristic   | Symbol                     | LM285-1.2 |     |            | LM385-1.2/LM385B-1.2 |     |            | Unit                  |
|--|----------------------------|-----------|-----|------------|----------------------|-----|------------|-----------------------|
|  |                            | Min       | Typ | Max        | Min                  | Typ | Max        |                       |
| Reverse Breakdown Voltage Change with Current<br>$I_{Rmin} \leq I_R \leq 1.0 \text{ mA}$ , $T_A = +25^\circ\text{C}$<br>$T_A = T_{low}$ to $T_{high}$ (Note 2)<br>$1.0 \text{ mA} \leq I_R \leq 20 \text{ mA}$ , $T_A = +25^\circ\text{C}$<br>$T_A = T_{low}$ to $T_{high}$ (Note 2) | $\Delta V_{(BR)R}$         | -         | -   | 1.0<br>1.5 | -                    | -   | 2.0<br>2.5 | mV                    |
| Reverse Dynamic Impedance<br>$I_R = 100 \mu\text{A}$ , $T_A = +25^\circ\text{C}$   | Z                          | -         | 0.6 | -          | -                    | 0.6 | -          | $\Omega$              |
| Average Temperature Coefficient<br>$20 \mu\text{A} \leq I_R \leq 20 \text{ mA}$ , $T_A = T_{low}$ to $T_{high}$ (Note 2)   | $\Delta V_{(BR)}/\Delta T$ | -         | 80  | -          | -                    | 80  | -          | ppm/ $^\circ\text{C}$ |
| Wideband Noise (RMS)<br>$I_R = 100 \mu\text{A}$ , $10 \text{ Hz} \leq f \leq 10 \text{ kHz}$   | n                          | -         | 120 | -          | -                    | 120 | -          | $\mu\text{V}$         |
| Long Term Stability<br>$I_R = 100 \mu\text{A}$ , $T_A = +25^\circ\text{C} \pm 0.1^\circ\text{C}$   | S                          | -         | 20  | -          | -                    | 20  | -          | ppm/kHR               |

2.  $T_{low} = -40^\circ\text{C}$  for LM285-1.2, LM285-2.5  
 $T_{high} = +85^\circ\text{C}$  for LM285-1.2, LM285-2.5  
 $T_{low} = 0^\circ\text{C}$  for LM385-1.2, LM385B-1.2, LM385-2.5, LM385B-2.5  
 $T_{high} = +70^\circ\text{C}$  for LM385-1.2, LM385B-1.2, LM385-2.5, LM385B-2.5

# LM285, LM385B

## TYPICAL PERFORMANCE CURVES FOR LM285-1.2/385-1.2/385B-1.2

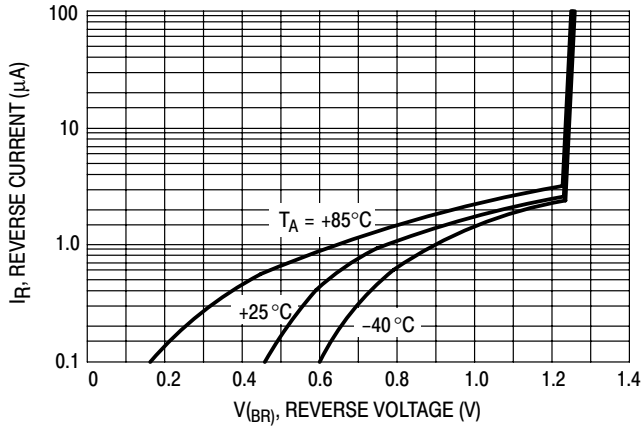


Figure 2. Reverse Characteristics

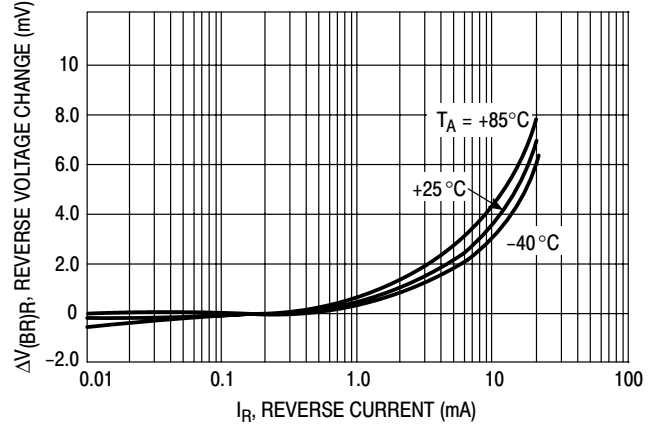


Figure 3. Reverse Characteristics

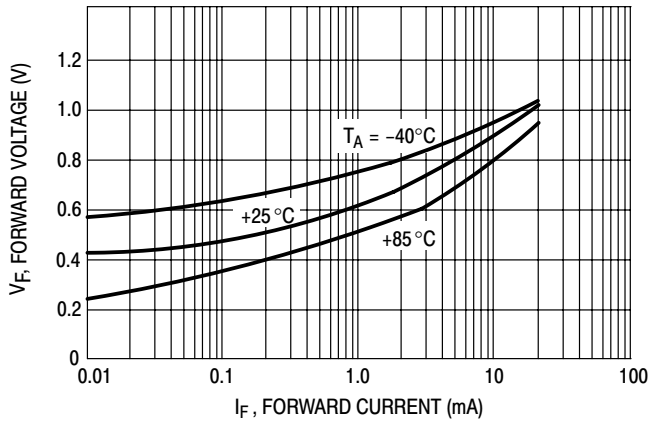


Figure 4. Forward Characteristics

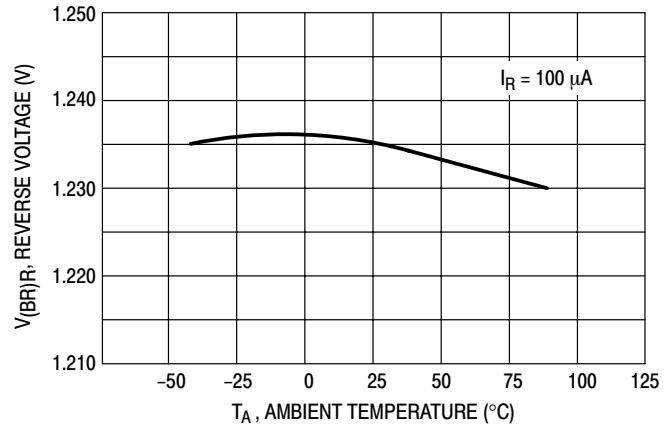


Figure 5. Temperature Drift

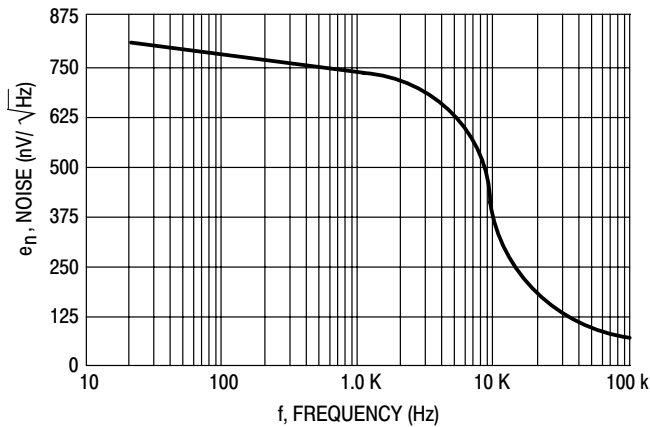


Figure 6. Noise Voltage

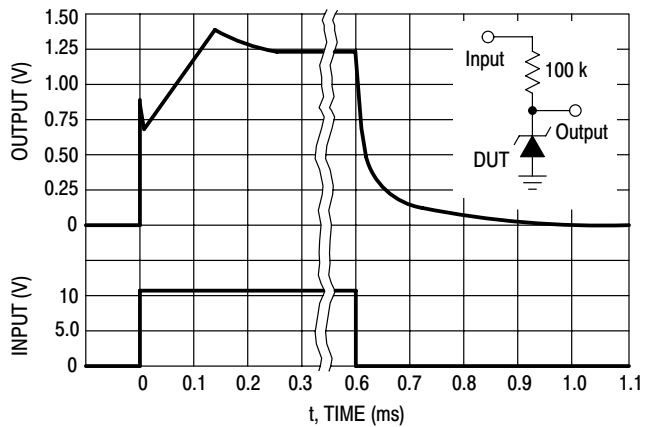


Figure 7. Response Time

# LM285, LM385B

## TYPICAL PERFORMANCE CURVES FOR LM285-2.5/385-2.5/385B-2.5

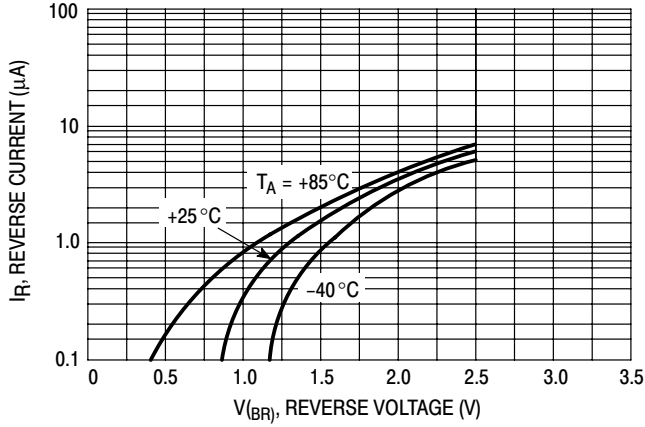


Figure 8. Reverse Characteristics

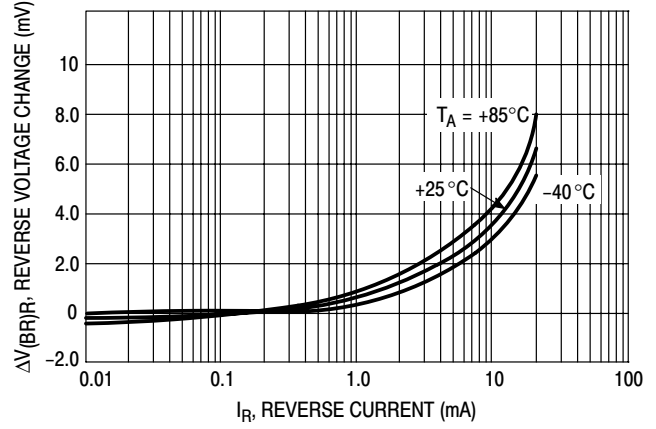


Figure 9. Reverse Characteristics

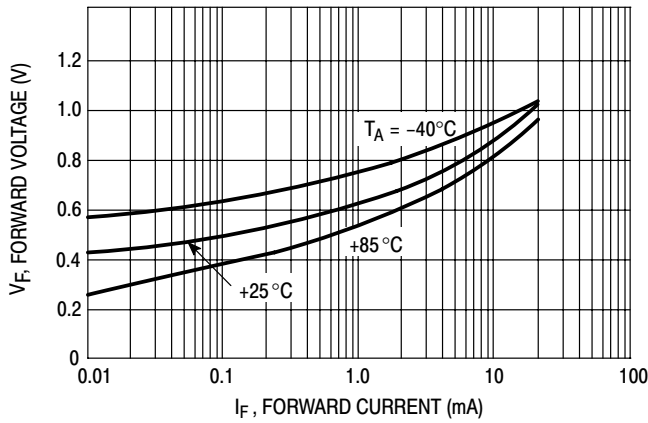


Figure 10. Forward Characteristics

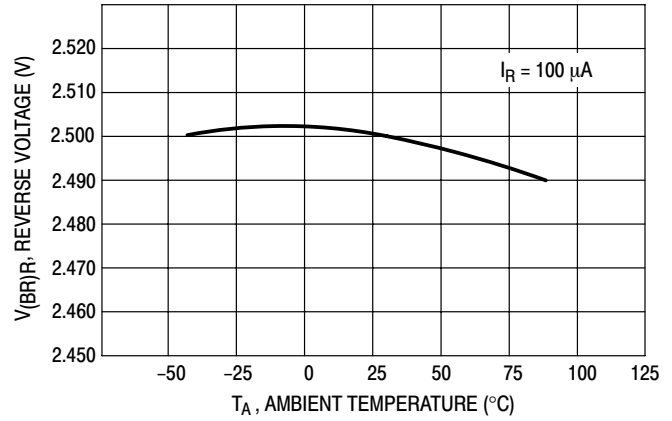


Figure 11. Temperature Drift

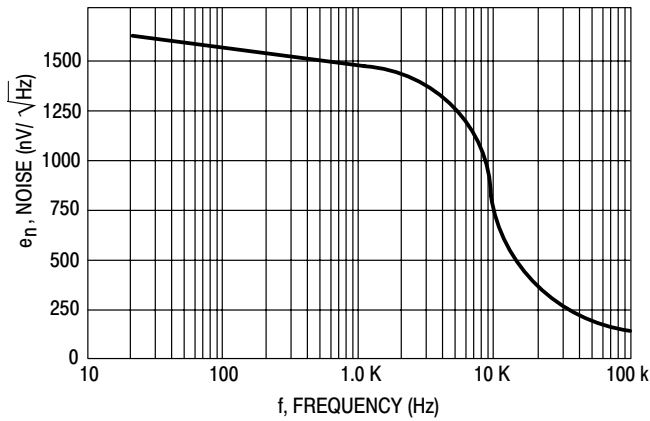


Figure 12. Noise Voltage

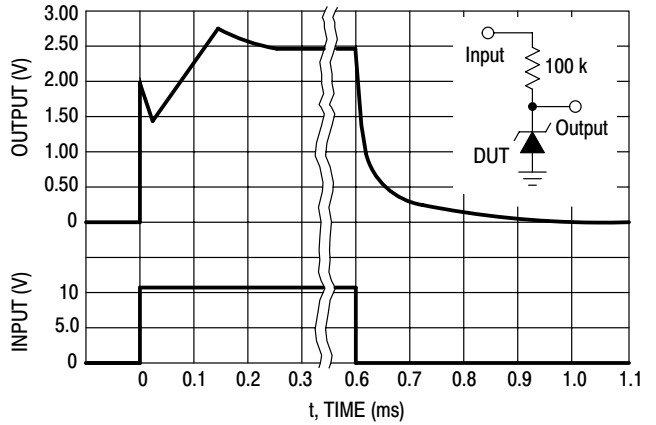


Figure 13. Response Time

## LM285, LM385B

### ORDERING INFORMATION

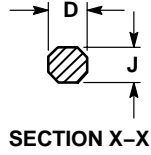
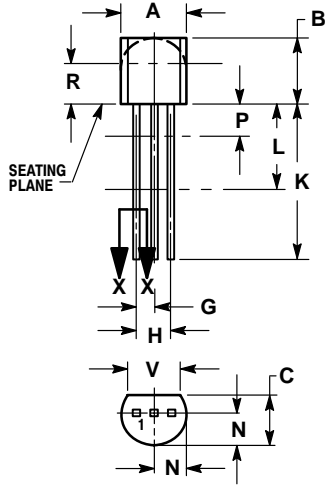
| Device         | Operating Temperature Range     | Reverse Break-Down Voltage | Package             | Shipping <sup>†</sup> |
|----------------|---------------------------------|----------------------------|---------------------|-----------------------|
| LM285Z-2.5     | T <sub>A</sub> = -40°C to +85°C | 2.500 V                    | TO-92               | 2000 Units / Bag      |
| LM285D-2.5     | T <sub>A</sub> = -40°C to +85°C | 2.500 V                    | SOIC-8              | 98 Units / Rail       |
| LM285Z-1.2     | T <sub>A</sub> = -40°C to +85°C | 1.235 V                    | TO-92               | 2000 Units / Bag      |
| LM285Z-1.2G    | T <sub>A</sub> = -40°C to +85°C | 1.235 V                    | TO-92<br>(Pb-Free)  | 2000 Units / Bag      |
| LM285D-1.2R2   | T <sub>A</sub> = -40°C to +85°C | 1.235 V                    | SOIC-8              | 2000 / Tape & Reel    |
| LM285D-1.2R2G  | T <sub>A</sub> = -40°C to +85°C | 1.235 V                    | SOIC-8<br>(Pb-Free) | 2000 / Tape & Reel    |
| LM285Z-2.5RA   | T <sub>A</sub> = -40°C to +85°C | 2.500 V                    | TO-92               | 2000 / Tape & Reel    |
| LM285Z-1.2RA   | T <sub>A</sub> = -40°C to +85°C | 1.235 V                    | TO-92               | 2500 / Tape & Reel    |
| LM285Z-2.5RP   | T <sub>A</sub> = -40°C to +85°C | 2.500 V                    | TO-92               | 2000 Units / Fan-Fold |
| LM285D-1.2     | T <sub>A</sub> = -40°C to +85°C | 1.235 V                    | SOIC-8              | 98 Units / Rail       |
| LM285D-2.5R2   | T <sub>A</sub> = -40°C to +85°C | 2.500 V                    | SOIC-8              | 2500 / Tape & Reel    |
| LM285D-2.5R2G  | T <sub>A</sub> = -40°C to +85°C | 2.500 V                    | SOIC-8<br>(Pb-Free) | 2500 / Tape & Reel    |
| LM385BD-1.2    | T <sub>A</sub> = 0°C to +70°C   | 1.235 V                    | SOIC-8              | 98 Units / Rail       |
| LM385BD-1.2G   | T <sub>A</sub> = 0°C to +70°C   | 1.235 V                    | SOIC-8<br>(Pb-Free) | 98 Units / Rail       |
| LM385BD-1.2R2  | T <sub>A</sub> = 0°C to +70°C   | 1.235 V                    | SOIC-8              | 2500 / Tape & Reel    |
| LM385BD-1.2R2G | T <sub>A</sub> = 0°C to +70°C   | 1.235 V                    | SOIC-8<br>(Pb-Free) | 2500 / Tape & Reel    |
| LM385BD-2.5    | T <sub>A</sub> = 0°C to +70°C   | 2.500 V                    | SOIC-8              | 98 Units / Rail       |
| LM385BD-2.5R2  | T <sub>A</sub> = 0°C to +70°C   | 2.500 V                    | SOIC-8              | 2500 / Tape & Reel    |
| LM385BZ-1.2    | T <sub>A</sub> = 0°C to +70°C   | 1.235 V                    | SOIC-8              | 98 Units / Rail       |

<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

# LM285, LM385B

## PACKAGE DIMENSIONS

TO-92 (TO-226)  
Z SUFFIX  
CASE 29-11  
ISSUE AL



NOTES:

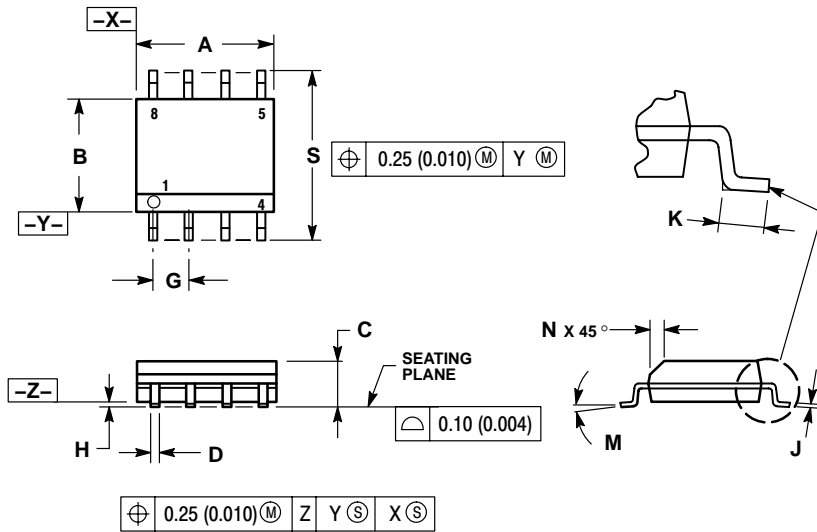
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

| DIM | INCHES |       | MILLIMETERS |       |
|-----|--------|-------|-------------|-------|
|     | MIN    | MAX   | MIN         | MAX   |
| A   | 0.175  | 0.205 | 4.45        | 5.20  |
| B   | 0.170  | 0.210 | 4.32        | 5.33  |
| C   | 0.125  | 0.165 | 3.18        | 4.19  |
| D   | 0.016  | 0.021 | 0.407       | 0.533 |
| G   | 0.045  | 0.055 | 1.15        | 1.39  |
| H   | 0.095  | 0.105 | 2.42        | 2.66  |
| J   | 0.015  | 0.020 | 0.39        | 0.50  |
| K   | 0.500  | ---   | 12.70       | ---   |
| L   | 0.250  | ---   | 6.35        | ---   |
| N   | 0.080  | 0.105 | 2.04        | 2.66  |
| P   | ---    | 0.100 | ---         | 2.54  |
| R   | 0.115  | ---   | 2.93        | ---   |
| V   | 0.135  | ---   | 3.43        | ---   |

# LM285, LM385B

## PACKAGE DIMENSIONS

SOIC-8 NB  
CASE 751-07  
ISSUE AB

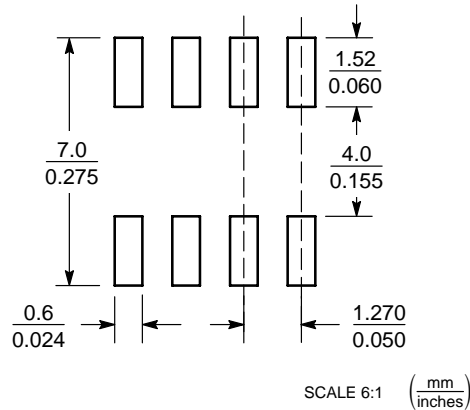


**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. 751-01 THRU 751-06 ARE OBSOLETE. NEW STANDARD IS 751-07.

| DIM | MILLIMETERS |      | INCHES    |       |
|-----|-------------|------|-----------|-------|
|     | MIN         | MAX  | MIN       | MAX   |
| A   | 4.80        | 5.00 | 0.189     | 0.197 |
| B   | 3.80        | 4.00 | 0.150     | 0.157 |
| C   | 1.35        | 1.75 | 0.053     | 0.069 |
| D   | 0.33        | 0.51 | 0.013     | 0.020 |
| G   | 1.27 BSC    |      | 0.050 BSC |       |
| H   | 0.10        | 0.25 | 0.004     | 0.010 |
| J   | 0.19        | 0.25 | 0.007     | 0.010 |
| K   | 0.40        | 1.27 | 0.016     | 0.050 |
| M   | 0°          | 8°   | 0°        | 8°    |
| N   | 0.25        | 0.50 | 0.010     | 0.020 |
| S   | 5.80        | 6.20 | 0.228     | 0.244 |

### SOLDERING FOOTPRINT\*



\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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