

# 1N5913B Series

## 3 W DO-41 Surmetic 30 Zener Voltage Regulators

This is a complete series of 3 W Zener diodes with limits and excellent operating characteristics that reflect the superior capabilities of silicon-oxide passivated junctions. All this in an axial-lead, transfer-molded plastic package that offers protection in all common environmental conditions.

### Features

- Zener Voltage Range - 3.3 V to 200 V
- ESD Rating of Class 3 (>16 KV) per Human Body Model
- Surge Rating of 98 W @ 1 ms
- Maximum Limits Guaranteed on up to Six Electrical Parameters
- Package No Larger than the Conventional 1 W Package
- Pb-Free Packages are Available

### Mechanical Characteristics

**CASE:** Void free, transfer-molded, thermosetting plastic

**FINISH:** All external surfaces are corrosion resistant and leads are readily solderable

**MAXIMUM LEAD TEMPERATURE FOR SOLDERING PURPOSES:** 260°C, 1/16" from the case for 10 seconds

**POLARITY:** Cathode indicated by polarity band

**MOUNTING POSITION:** Any

### MAXIMUM RATINGS

| Rating  | Symbol         | Value       | Unit  |
|---|----------------|-------------|-------|
| Max. Steady State Power Dissipation<br>@ $T_L = 75^\circ\text{C}$ , Lead Length = 3/8"<br>Derate above 75°C | $P_D$          | 3           | W     |
|   |                | 24          | mW/°C |
| Steady State Power Dissipation<br>@ $T_A = 50^\circ\text{C}$<br>Derate above 50°C                           | $P_D$          | 1           | W     |
|   |                | 6.67        | mW/°C |
| Operating and Storage Temperature Range   | $T_J, T_{stg}$ | -65 to +200 | °C    |

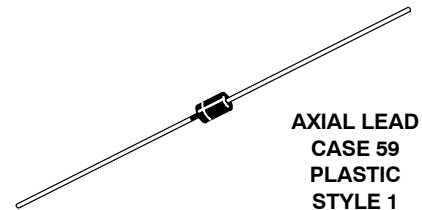
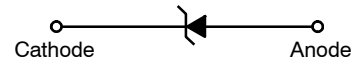
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

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

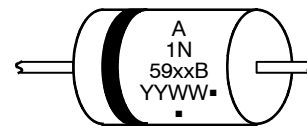


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### MARKING DIAGRAM



A = Assembly Location  
 1N59xxB = Device Number  
 YY = Year  
 WW = Work Week  
 ■ = Pb-Free Package  
 (Note: Microdot may be in either location)

### ORDERING INFORMATION

| Device       | Package              | Shipping†        |
|--------------|----------------------|------------------|
| 1N59xxB, G   | Axial Lead (Pb-Free) | 2000 Units/Box   |
| 1N59xxBRL, G | Axial Lead (Pb-Free) | 6000/Tape & Reel |

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

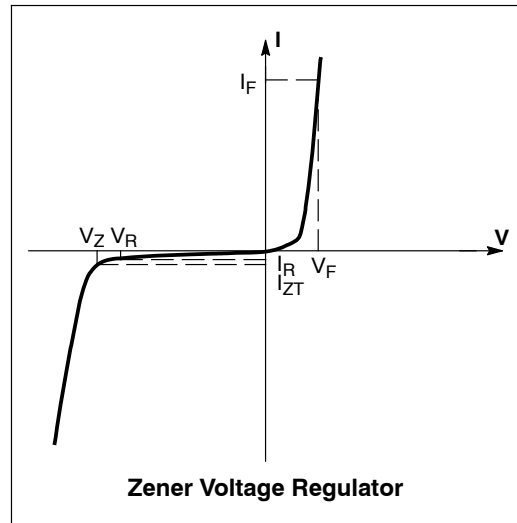
# 1N5913B Series

## ELECTRICAL CHARACTERISTICS

( $T_L = 30^\circ\text{C}$  unless otherwise noted,

$V_F = 1.5\text{ V Max @ } I_F = 200\text{ mAdc}$  for all types)

| Symbol   | Parameter                          |
|----------|------------------------------------|
| $V_Z$    | Reverse Zener Voltage @ $I_{ZT}$   |
| $I_{ZT}$ | Reverse Current                    |
| $Z_{ZT}$ | Maximum Zener Impedance @ $I_{ZT}$ |
| $I_{ZK}$ | Reverse Current                    |
| $Z_{ZK}$ | Maximum Zener Impedance @ $I_{ZK}$ |
| $I_R$    | Reverse Leakage Current @ $V_R$    |
| $V_R$    | Breakdown Voltage                  |
| $I_F$    | Forward Current                    |
| $V_F$    | Forward Voltage @ $I_F$            |
| $I_{ZM}$ | Maximum DC Zener Current           |



# 1N5913B Series

**ELECTRICAL CHARACTERISTICS** ( $T_L = 30^\circ\text{C}$  unless otherwise noted,  $V_F = 1.5\text{ V Max}$  @  $I_F = 200\text{ mAdc}$  for all types)

| Device <sup>†</sup><br>(Note 1) | Device<br>Marking | Zener Voltage (Note 2) |            |              |                   | Zener Impedance (Note 3)          |                                   |             | Leakage Current                 |              | I <sub>ZM</sub><br>mA |
|---------------------------------|-------------------|------------------------|------------|--------------|-------------------|-----------------------------------|-----------------------------------|-------------|---------------------------------|--------------|-----------------------|
|                                 |                   | V <sub>Z</sub> (Volts) |            |              | @ I <sub>ZT</sub> | Z <sub>ZT</sub> @ I <sub>ZT</sub> | Z <sub>ZK</sub> @ I <sub>ZK</sub> |             | I <sub>R</sub> @ V <sub>R</sub> |              |                       |
|                                 |                   | Min                    | Nom        | Max          | mA                | Ω                                 | Ω                                 | mA          | μA Max                          | Volts        |                       |
| 1N5913B, G                      | 1N5913B           | 3.14                   | 3.3        | 3.47         | 113.6             | 10                                | 500                               | 1           | 100                             | 1            | 454                   |
| 1N5917B, G                      | 1N5917B           | 4.47                   | 4.7        | 4.94         | 79.8              | 5                                 | 500                               | 1           | 5                               | 1.5          | 319                   |
| 1N5919B, G                      | 1N5919B           | 5.32                   | 5.6        | 5.88         | 66.9              | 2                                 | 250                               | 1           | 5                               | 3            | 267                   |
| <b>1N5920B, G</b>               | <b>1N5920B</b>    | <b>5.89</b>            | <b>6.2</b> | <b>6.51</b>  | <b>60.5</b>       | <b>2</b>                          | <b>200</b>                        | <b>1</b>    | <b>5</b>                        | <b>4</b>     | <b>241</b>            |
| 1N5921B, G                      | 1N5921B           | 6.46                   | 6.8        | 7.14         | 55.1              | 2.5                               | 200                               | 1           | 5                               | 5.2          | 220                   |
| 1N5923B, G                      | 1N5923B           | 7.79                   | 8.2        | 8.61         | 45.7              | 3.5                               | 400                               | 0.5         | 5                               | 6.5          | 182                   |
| 1N5924B, G                      | 1N5924B           | 8.65                   | 9.1        | 9.56         | 41.2              | 4                                 | 500                               | 0.5         | 5                               | 7            | 164                   |
| 1N5925B, G                      | 1N5925B           | 9.50                   | 10         | 10.50        | 37.5              | 4.5                               | 500                               | 0.25        | 5                               | 8            | 150                   |
| 1N5926B, G                      | 1N5926B           | 10.45                  | 11         | 11.55        | 34.1              | 5.5                               | 550                               | 0.25        | 1                               | 8.4          | 136                   |
| 1N5927B, G                      | 1N5927B           | 11.40                  | 12         | 12.60        | 31.2              | 6.5                               | 550                               | 0.25        | 1                               | 9.1          | 125                   |
| <b>1N5929B, G</b>               | <b>1N5929B</b>    | <b>14.25</b>           | <b>15</b>  | <b>15.75</b> | <b>25.0</b>       | <b>9</b>                          | <b>600</b>                        | <b>0.25</b> | <b>1</b>                        | <b>11.4</b>  | <b>100</b>            |
| 1N5930B, G                      | 1N5930B           | 15.20                  | 16         | 16.80        | 23.4              | 10                                | 600                               | 0.25        | 1                               | 12.2         | 93                    |
| 1N5931B, G                      | 1N5931B           | 17.10                  | 18         | 18.90        | 20.8              | 12                                | 650                               | 0.25        | 1                               | 13.7         | 83                    |
| 1N5932B, G                      | 1N5932B           | 19.00                  | 20         | 21.00        | 18.7              | 14                                | 650                               | 0.25        | 1                               | 15.2         | 75                    |
| 1N5933B, G                      | 1N5933B           | 20.90                  | 22         | 23.10        | 17.0              | 17.5                              | 650                               | 0.25        | 1                               | 16.7         | 68                    |
| 1N5934B, G                      | 1N5934B           | 22.80                  | 24         | 25.20        | 15.6              | 19                                | 700                               | 0.25        | 1                               | 18.2         | 62                    |
| 1N5935B, G                      | 1N5935B           | 25.65                  | 27         | 28.35        | 13.9              | 23                                | 700                               | 0.25        | 1                               | 20.6         | 55                    |
| <b>1N5936B, G</b>               | <b>1N5936B</b>    | <b>28.50</b>           | <b>30</b>  | <b>31.50</b> | <b>12.5</b>       | <b>28</b>                         | <b>750</b>                        | <b>0.25</b> | <b>1</b>                        | <b>22.8</b>  | <b>50</b>             |
| 1N5937B, G                      | 1N5937B           | 31.35                  | 33         | 34.65        | 11.4              | 33                                | 800                               | 0.25        | 1                               | 25.1         | 45                    |
| 1N5938B, G                      | 1N5938B           | 34.20                  | 36         | 37.80        | 10.4              | 38                                | 850                               | 0.25        | 1                               | 27.4         | 41                    |
| 1N5940B, G                      | 1N5940B           | 40.85                  | 43         | 45.15        | 8.7               | 53                                | 950                               | 0.25        | 1                               | 32.7         | 34                    |
| 1N5941B, G                      | 1N5941B           | 44.65                  | 47         | 49.35        | 8.0               | 67                                | 1000                              | 0.25        | 1                               | 35.8         | 31                    |
| 1N5942B, G                      | 1N5942B           | 48.45                  | 51         | 53.55        | 7.3               | 70                                | 1100                              | 0.25        | 1                               | 38.8         | 29                    |
| 1N5943B, G                      | 1N5943B           | 53.20                  | 56         | 58.80        | 6.7               | 86                                | 1300                              | 0.25        | 1                               | 42.6         | 26                    |
| 1N5944B, G                      | 1N5944B           | 58.90                  | 62         | 65.10        | 6.0               | 100                               | 1500                              | 0.25        | 1                               | 47.1         | 24                    |
| 1N5946B, G                      | 1N5946B           | 71.25                  | 75         | 78.75        | 5.0               | 140                               | 2000                              | 0.25        | 1                               | 56           | 20                    |
| 1N5947B, G                      | 1N5947B           | 77.90                  | 82         | 86.10        | 4.6               | 160                               | 2500                              | 0.25        | 1                               | 62.2         | 18                    |
| 1N5948B, G                      | 1N5948B           | 86.45                  | 91         | 95.55        | 4.1               | 200                               | 3000                              | 0.25        | 1                               | 69.2         | 16                    |
| 1N5950B, G                      | 1N5950B           | 104.5                  | 110        | 115.5        | 3.4               | 300                               | 4000                              | 0.25        | 1                               | 83.6         | 13                    |
| 1N5951B, G                      | 1N5951B           | 114                    | 120        | 126          | 3.1               | 380                               | 4500                              | 0.25        | 1                               | 91.2         | 12                    |
| 1N5952B, G                      | 1N5952B           | 123.5                  | 130        | 136.5        | 2.9               | 450                               | 5000                              | 0.25        | 1                               | 98.8         | 11                    |
| 1N5953B, G                      | 1N5953B           | 142.5                  | 150        | 157.5        | 2.5               | 600                               | 6000                              | 0.25        | 1                               | 114          | 10                    |
| 1N5954B, G                      | 1N5954B           | 152                    | 160        | 168          | 2.3               | 700                               | 6500                              | 0.25        | 1                               | 121.6        | 9                     |
| <b>1N5955B, G</b>               | <b>1N5955B</b>    | <b>171</b>             | <b>180</b> | <b>189</b>   | <b>2.1</b>        | <b>900</b>                        | <b>7000</b>                       | <b>0.25</b> | <b>1</b>                        | <b>136.8</b> | <b>8</b>              |
| 1N5956B, G                      | 1N5956B           | 190                    | 200        | 210          | 1.9               | 1200                              | 8000                              | 0.25        | 1                               | 152          | 7                     |

Devices listed in **bold, italic** are ON Semiconductor **Preferred** devices. **Preferred** devices are recommended choices for future use and best overall value.

†The "G" suffix indicates Pb- Free package available.

**1. TOLERANCE AND TYPE NUMBER DESIGNATION**

Tolerance designation - device tolerance of  $\pm 5\%$  are indicated by a "B" suffix.

**2. ZENER VOLTAGE (V<sub>Z</sub>) MEASUREMENT**

ON Semiconductor guarantees the zener voltage when measured at 90 seconds while maintaining the lead temperature ( $T_L$ ) at  $30^\circ\text{C} \pm 1^\circ\text{C}$ ,  $3/8"$  from the diode body.

**3. ZENER IMPEDANCE (Z<sub>Z</sub>) DERIVATION**

The zener impedance is derived from 60 seconds AC voltage, which results when an AC current having an rms value equal to 10% of the DC zener current ( $I_{ZT}$  or  $I_{ZK}$ ) is superimposed on  $I_{ZT}$  or  $I_{ZK}$ .

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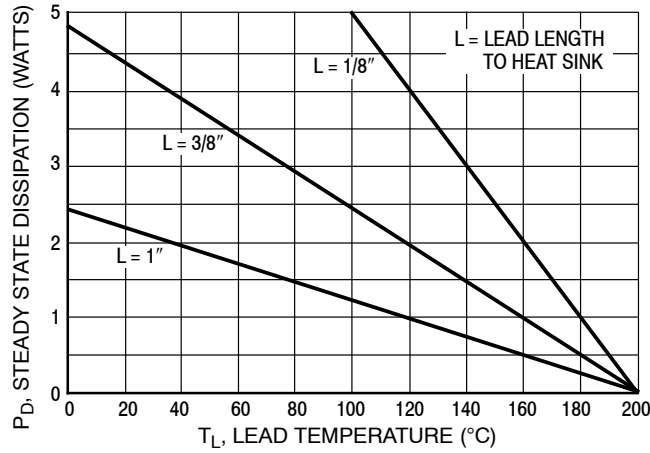


Figure 1. Power Temperature Derating Curve

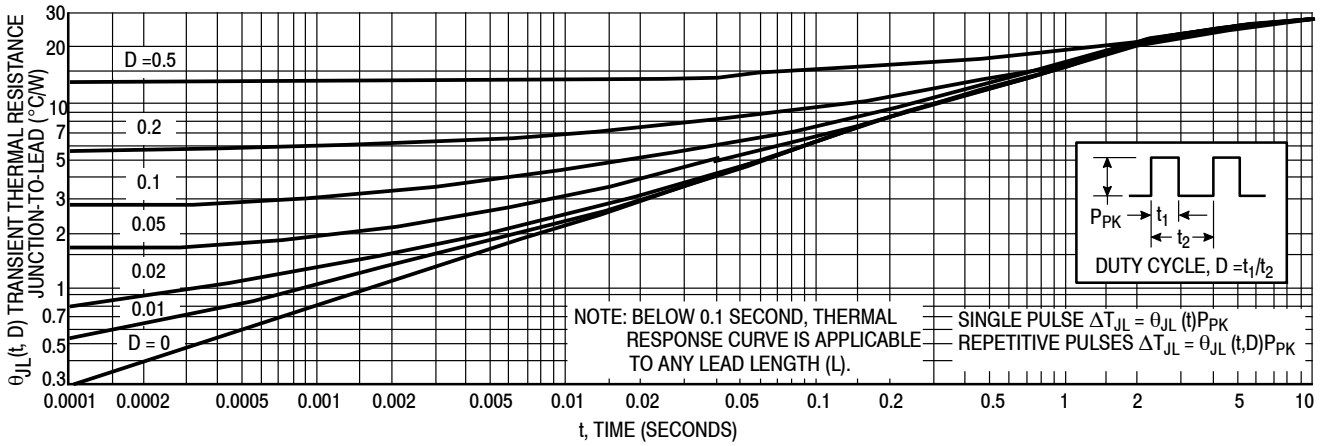


Figure 2. Typical Thermal Response L, Lead Length = 3/8 Inch

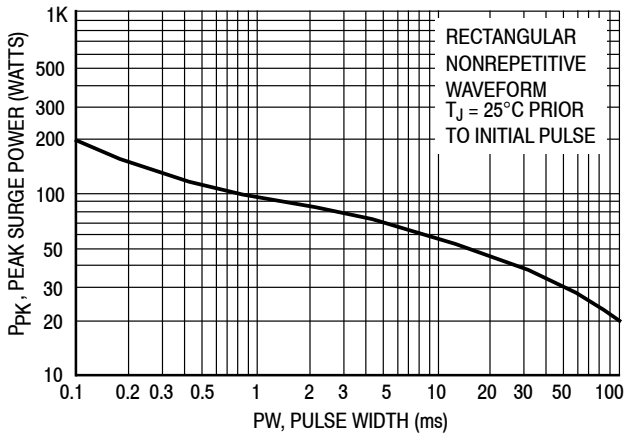


Figure 3. Maximum Surge Power

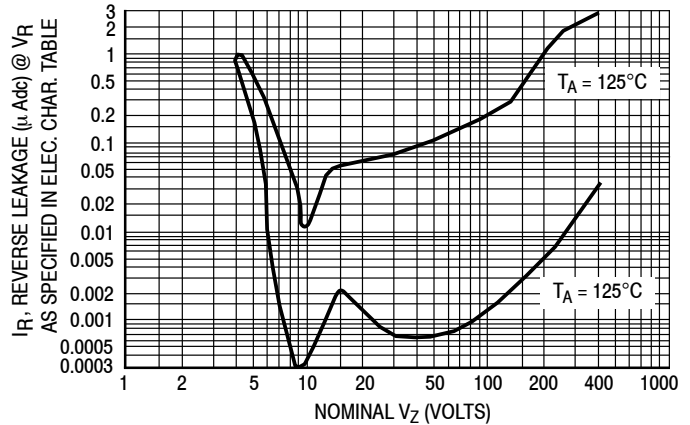


Figure 4. Typical Reverse Leakage

## APPLICATION NOTE

Since the actual voltage available from a given zener diode is temperature dependent, it is necessary to determine junction temperature under any set of operating conditions in order to calculate its value. The following procedure is recommended:

Lead Temperature,  $T_L$ , should be determined from:

$$T_L = \theta_{LA} P_D + T_A$$

$\theta_{LA}$  is the lead-to-ambient thermal resistance ( $^{\circ}\text{C}/\text{W}$ ) and  $P_D$  is the power dissipation. The value for  $\theta_{LA}$  will vary and depends on the device mounting method.  $\theta_{LA}$  is generally 30-40 $^{\circ}\text{C}/\text{W}$  for the various clips and tie points in common use and for printed circuit board wiring.

The temperature of the lead can also be measured using a thermocouple placed on the lead as close as possible to the tie point. The thermal mass connected to the tie point is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady-state conditions are achieved. Using the measured value of  $T_L$ , the junction temperature may be determined by:

$$T_J = T_L + \Delta T_{JL}$$

$\Delta T_{JL}$  is the increase in junction temperature above the lead temperature and may be found from Figure 2 for a train of power pulses ( $L = 3/8$  inch) or from Figure 10 for dc power.

$$\Delta T_{JL} = \theta_{JL} P_D$$

For worst-case design, using expected limits of  $I_Z$ , limits of  $P_D$  and the extremes of  $T_J$  ( $\Delta T_J$ ) may be estimated. Changes in voltage,  $V_Z$ , can then be found from:

$$\Delta V = \theta_{VZ} \Delta T_J$$

$\theta_{VZ}$ , the zener voltage temperature coefficient, is found from Figures 5 and 6.

Under high power-pulse operation, the zener voltage will vary with time and may also be affected significantly by the zener resistance. For best regulation, keep current excursions as low as possible.

Data of Figure 2 should not be used to compute surge capability. Surge limitations are given in Figure 3. They are lower than would be expected by considering only junction temperature, as current crowding effects cause temperatures to be extremely high in small spots resulting in device degradation should the limits of Figure 3 be exceeded.

# 1N5913B Series

## TEMPERATURE COEFFICIENT RANGES

(90% of the Units are in the Ranges Indicated)

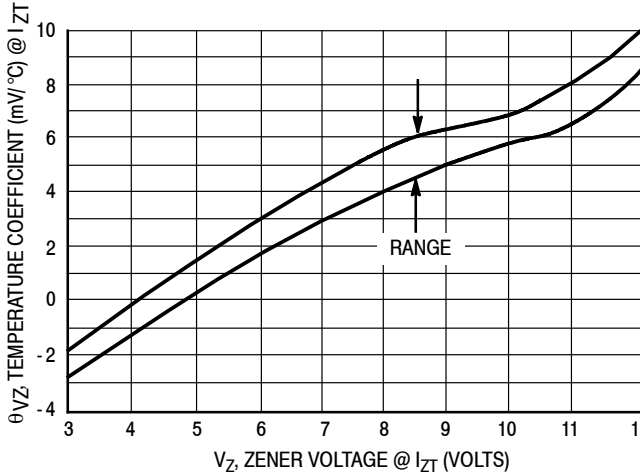


Figure 5. Units To 12 Volts

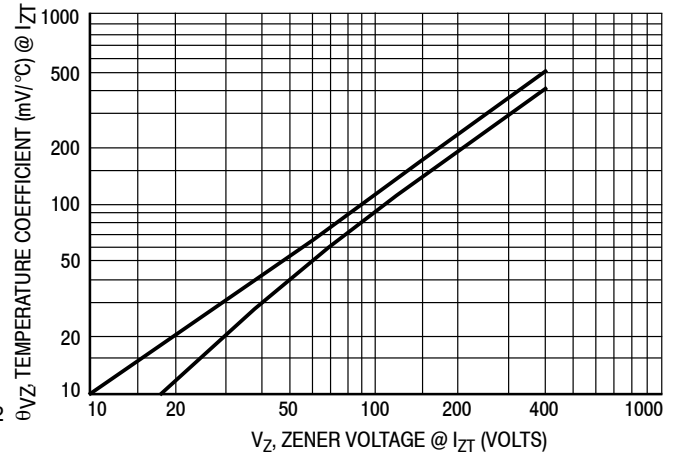


Figure 6. Units 10 To 400 Volts

## ZENER VOLTAGE versus ZENER CURRENT

(Figures 7, 8 and 9)

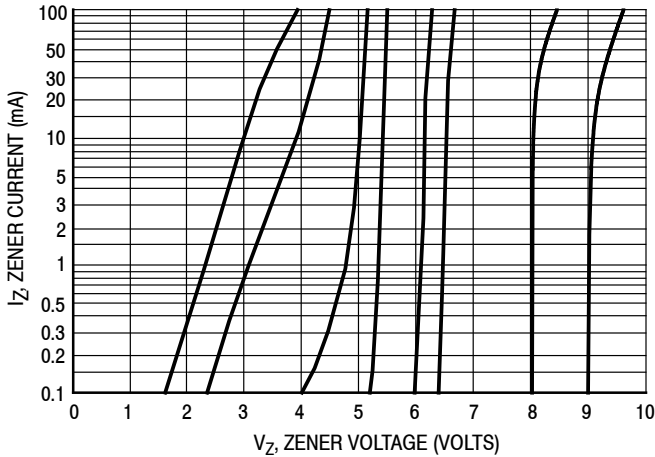


Figure 7.  $V_Z = 3.3$  thru 10 Volts

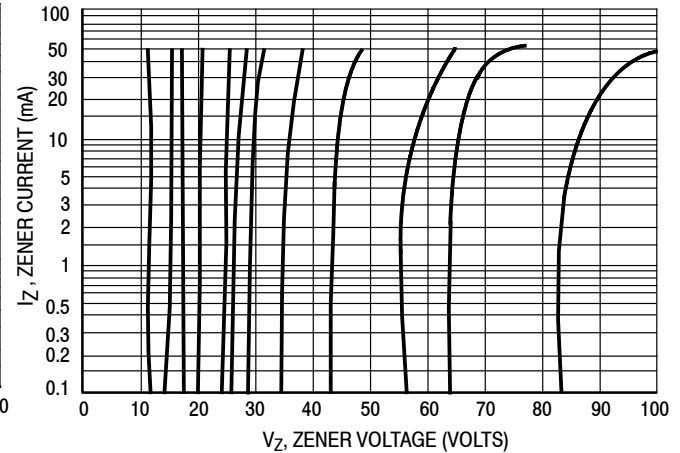


Figure 8.  $V_Z = 12$  thru 82 Volts

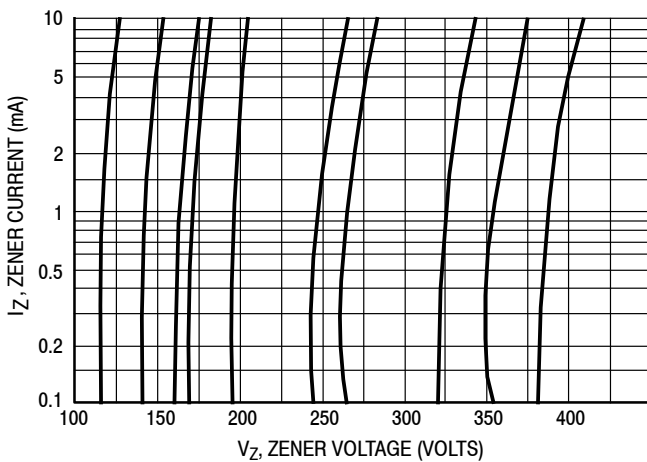


Figure 9.  $V_Z = 100$  thru 400 Volts

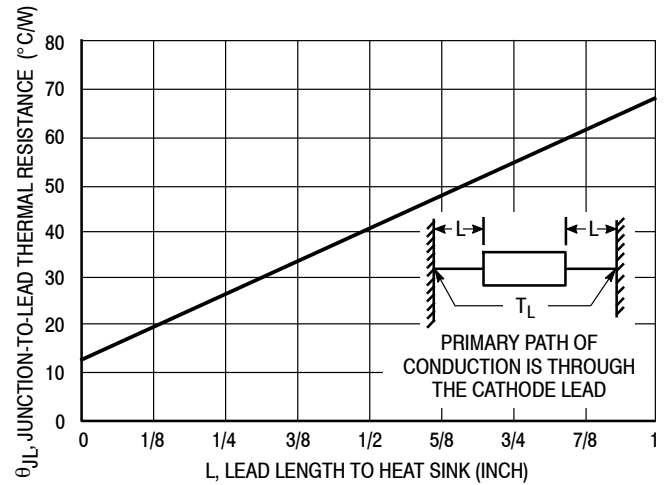


Figure 10. Typical Thermal Resistance

# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS



### AXIAL LEAD CASE 59-10 ISSUE U

DATE 15 FEB 2005



SCALE 1:1

POLARITY INDICATOR  
OPTIONAL AS NEEDED  
(SEE STYLES)

STYLE 1:  
PIN 1. CATHODE (POLARITY BAND)  
2. ANODE

STYLE 2:  
NO POLARITY

NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. ALL RULES AND NOTES ASSOCIATED WITH JEDEC DO-41 OUTLINE SHALL APPLY
4. POLARITY DENOTED BY CATHODE BAND.
5. LEAD DIAMETER NOT CONTROLLED WITHIN F DIMENSION.

| DIM | INCHES |       | MILLIMETERS |      |
|-----|--------|-------|-------------|------|
|     | MIN    | MAX   | MIN         | MAX  |
| A   | 0.161  | 0.205 | 4.10        | 5.20 |
| B   | 0.079  | 0.106 | 2.00        | 2.70 |
| D   | 0.028  | 0.034 | 0.71        | 0.86 |
| F   | ---    | 0.050 | ---         | 1.27 |
| K   | 1.000  | ---   | 25.40       | ---  |

### GENERIC MARKING DIAGRAM\*



- xxx = Specific Device Code
- A = Assembly Location
- YY = Year
- WW = Work Week

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present.

|                         |                    |  |
|-------------------------|--------------------|--|
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| <b>DESCRIPTION:</b>     | <b>AXIAL LEAD</b>  | <b>PAGE 1 OF 1</b>   |

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