

# 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<br>24        | W<br>mW/°C |
| Steady State Power Dissipation<br>@ $T_A = 50^\circ\text{C}$<br>Derate above 50°C                           | $P_D$          | 1<br>6.67      | W<br>mW/°C |
| Operating and Storage<br>Temperature Range                                                                  | $T_J, T_{stg}$ | -65 to<br>+200 | °C         |

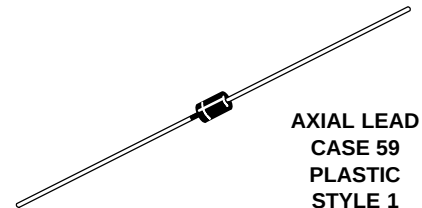
Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur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

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



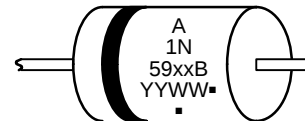
ON Semiconductor®

<http://onsemi.com>



AXIAL LEAD  
CASE 59  
PLASTIC  
STYLE 1

### 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<br>(Pb-Free) | 2000 Units/Box   |
| 1N59xxBRL, G | Axial Lead<br>(Pb-Free) | 6000/Tape & Reel |

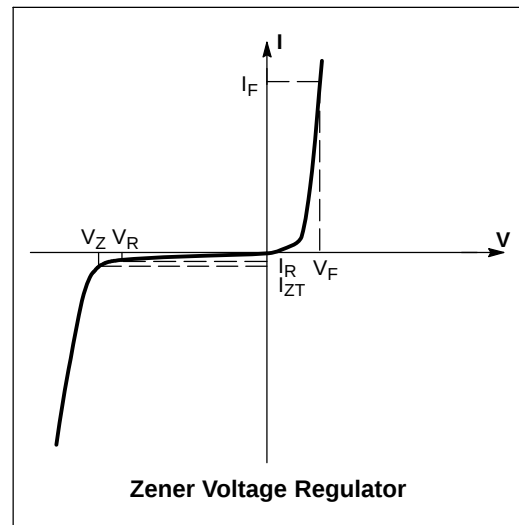
†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

## 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> |
|---------------------------------|-------------------|------------------------|------------|--------------|-------------------|-----------------------------------|-----------------------------------|-------------|---------------------------------|--------------|-----------------|
|                                 |                   | 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.

<sup>†</sup>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 ( $V_Z$ ) 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 ( $Z_Z$ ) 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  $I_{ZK}$ .

# 1N5913B Series

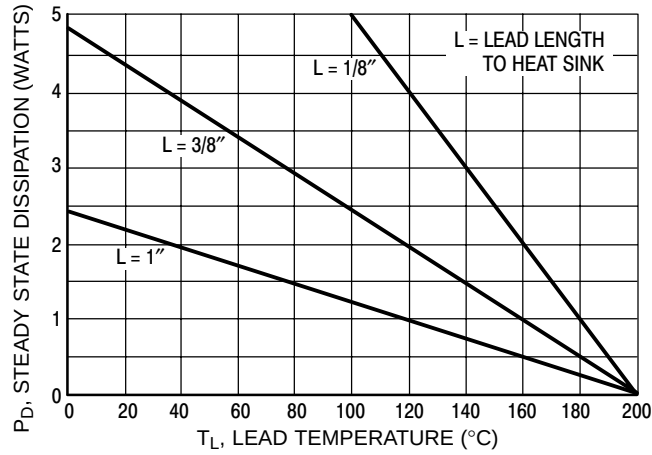


Figure 1. Power Temperature Derating Curve

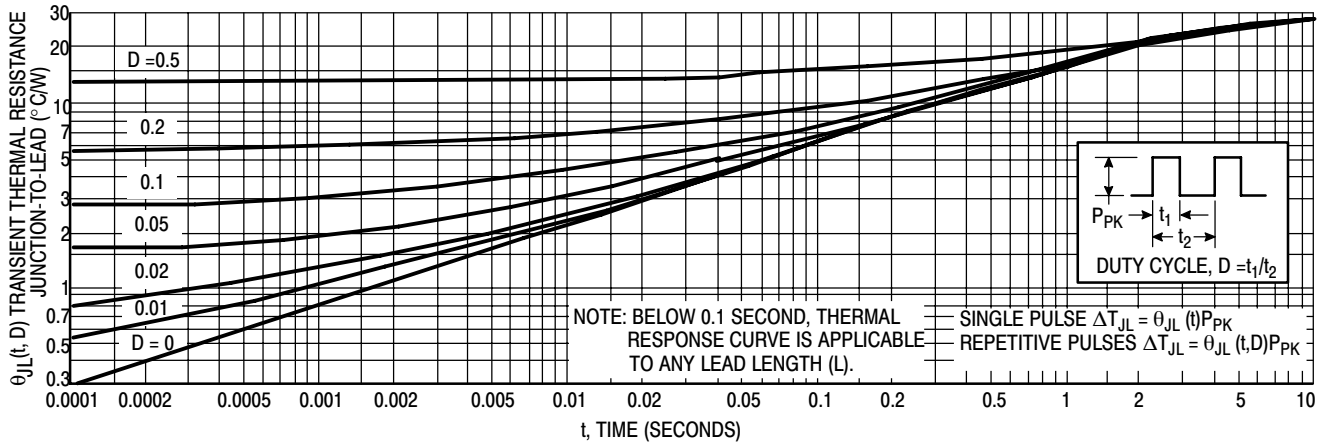


Figure 2. Typical Thermal Response L, Lead Length = 3/8 Inch

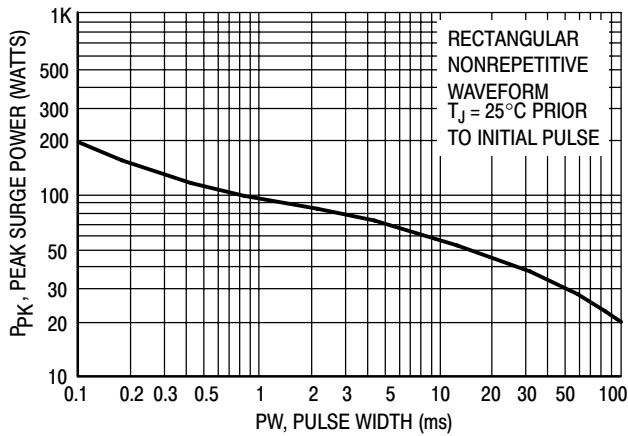


Figure 3. Maximum Surge Power

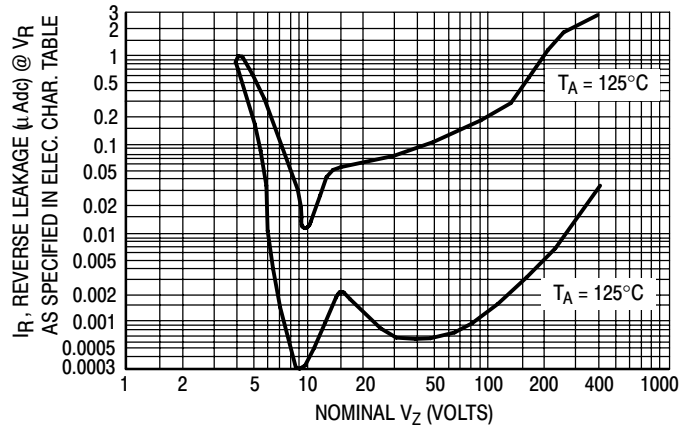


Figure 4. Typical Reverse Leakage

**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  $30\text{--}40^{\circ}\text{C}/\text{W}$  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)

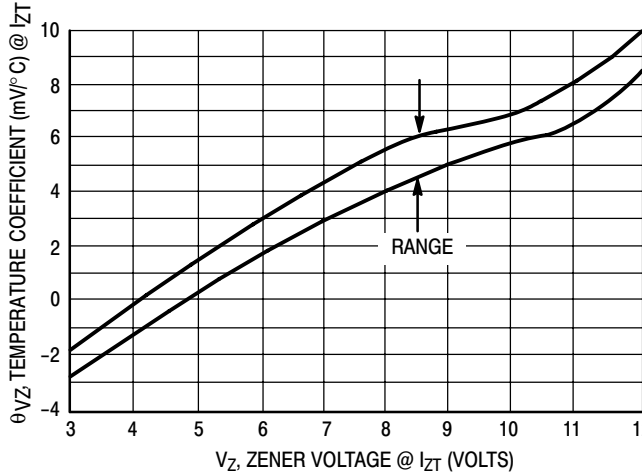


Figure 5. Units To 12 Volts

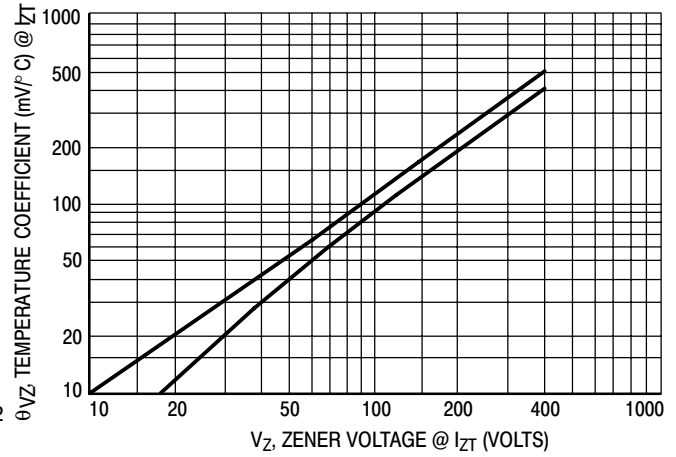


Figure 6. Units 10 To 400 Volts

## ZENER VOLTAGE versus ZENER CURRENT

(Figures 7, 8 and 9)

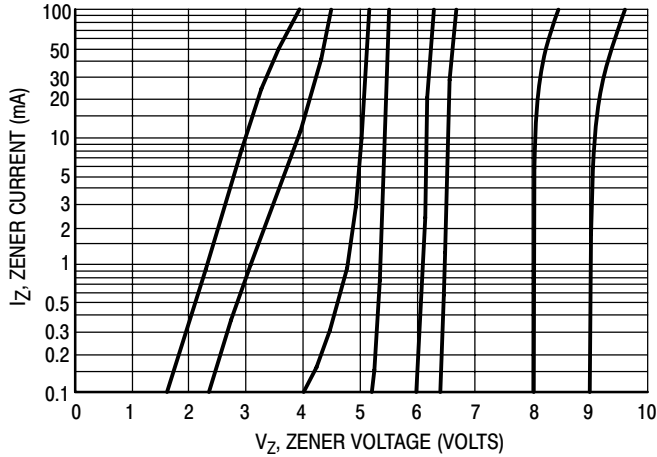


Figure 7.  $V_Z = 3.3$  thru 10 Volts

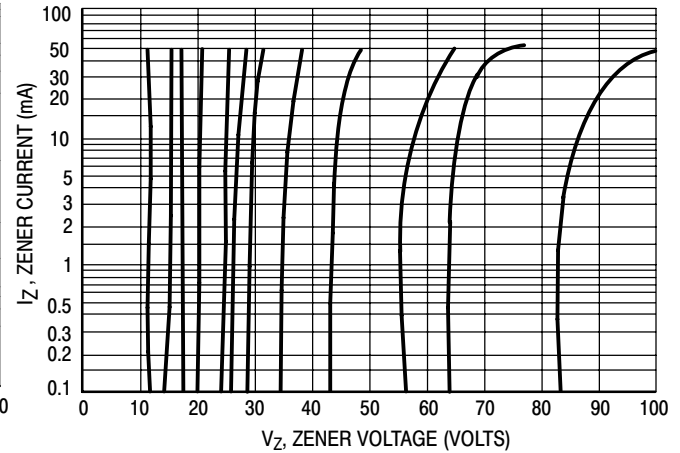


Figure 8.  $V_Z = 12$  thru 82 Volts

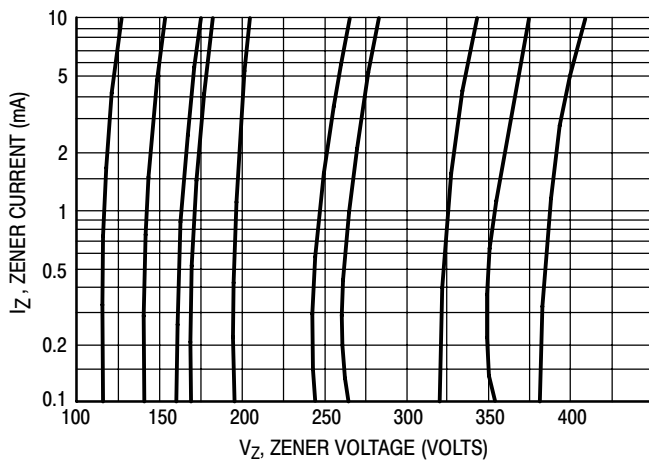


Figure 9.  $V_Z = 100$  thru 400 Volts

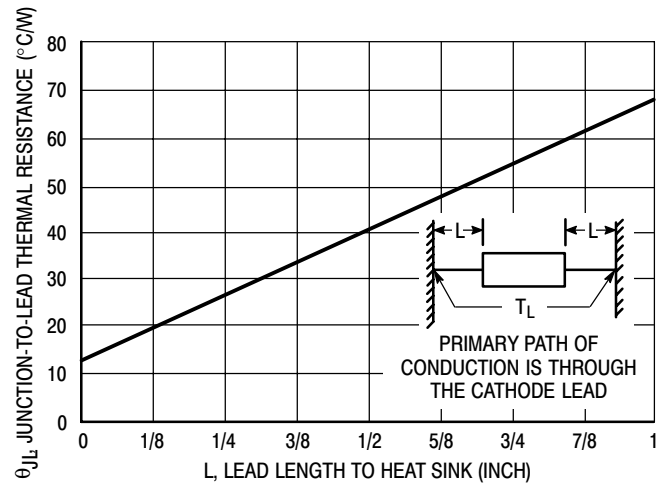
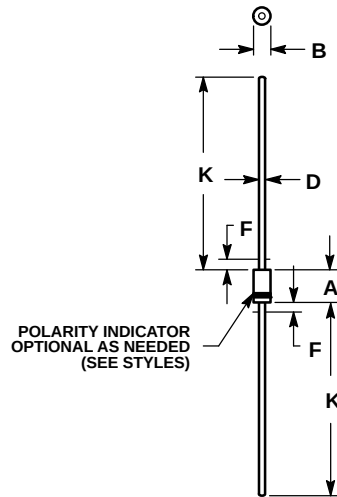


Figure 10. Typical Thermal Resistance

# 1N5913B Series

## PACKAGE DIMENSIONS

### AXIAL LEAD CASE 59-10 ISSUE U



#### 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       | ---  |

#### STYLE 1:

- PIN 1. CATHODE (POLARITY BAND)
2. ANODE

# 1N5913B Series

SURMETIC is a trademark of Semiconductor Components Industries, LLC (SCILLC).

**ON Semiconductor** and  are registered trademarks of Semiconductor Components Industries, LLC (SCILLC). SCILLC reserves the right to make changes without further notice to any products herein. SCILLC makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does SCILLC assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. "Typical" parameters which may be provided in SCILLC data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. SCILLC does not convey any license under its patent rights nor the rights of others. SCILLC products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the SCILLC product could create a situation where personal injury or death may occur. Should Buyer purchase or use SCILLC products for any such unintended or unauthorized application, Buyer shall indemnify and hold SCILLC and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that SCILLC was negligent regarding the design or manufacture of the part. SCILLC is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

## PUBLICATION ORDERING INFORMATION

### LITERATURE FULFILLMENT:

Literature Distribution Center for ON Semiconductor  
P.O. Box 61312, Phoenix, Arizona 85082-1312 USA  
**Phone:** 480-829-7710 or 800-344-3860 Toll Free USA/Canada  
**Fax:** 480-829-7709 or 800-344-3867 Toll Free USA/Canada  
**Email:** [orderlit@onsemi.com](mailto:orderlit@onsemi.com)

**N. American Technical Support:** 800-282-9855 Toll Free  
USA/Canada

**Japan:** ON Semiconductor, Japan Customer Focus Center  
2-9-1 Kamimeguro, Meguro-ku, Tokyo, Japan 153-0051  
**Phone:** 81-3-5773-3850

**ON Semiconductor Website:** <http://onsemi.com>

**Order Literature:** <http://www.onsemi.com/litorder>

For additional information, please contact your  
local Sales Representative.