

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 @ $T_L = 75^\circ\text{C}$, Lead Length = 3/8" Derate above 75°C | P_D | 3 | W |
| | | 24 | mW/°C |
| Steady State Power Dissipation @ $T_A = 50^\circ\text{C}$ 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 |

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.

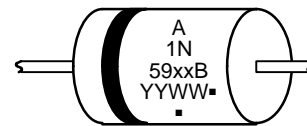


ON Semiconductor®

<http://onsemi.com>



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.

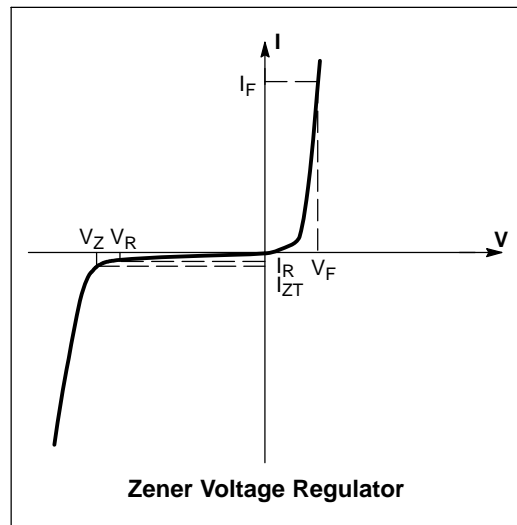
*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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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 |



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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 [†] (Note 1) | Device Marking | Zener Voltage (Note 2) | | | | Zener Impedance (Note 3) | | | Leakage Current | | I _{ZM} mA |
|---------------------------------|-------------------|------------------------|------------|--------------|-------------------|-----------------------------------|-----------------------------------|-------------|---------------------------------|--------------|-----------------------|
| | | V _Z (Volts) | | | @ I _{ZT} | Z _{ZT} @ I _{ZT} | Z _{ZK} @ I _{ZK} | | I _R @ V _R | | |
| | | 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 |
| 1N5920B, G | 1N5920B | 5.89 | 6.2 | 6.51 | 60.5 | 2 | 200 | 1 | 5 | 4 | 241 |
| 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 |
| 1N5929B, G | 1N5929B | 14.25 | 15 | 15.75 | 25.0 | 9 | 600 | 0.25 | 1 | 11.4 | 100 |
| 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 |
| 1N5936B, G | 1N5936B | 28.50 | 30 | 31.50 | 12.5 | 28 | 750 | 0.25 | 1 | 22.8 | 50 |
| 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 |
| 1N5955B, G | 1N5955B | 171 | 180 | 189 | 2.1 | 900 | 7000 | 0.25 | 1 | 136.8 | 8 |
| 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_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} .

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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

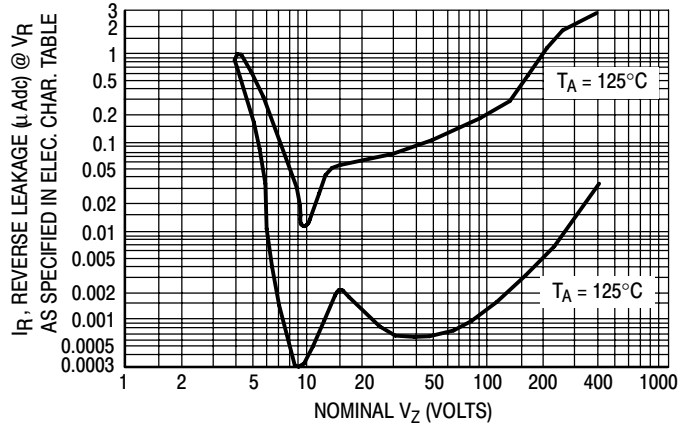


Figure 4. Typical Reverse Leakage

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:

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

θ_{LA} is the lead-to-ambient thermal resistance ($^{\circ}\text{C}/\text{W}$) and P_D is the power dissipation. The value for θ_{LA} will vary and depends on the device mounting method. θ_{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:

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

ΔT_{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 (ΔT_J) may be estimated. Changes in voltage, V_Z , can then be found from:

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

θ_{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.

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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)

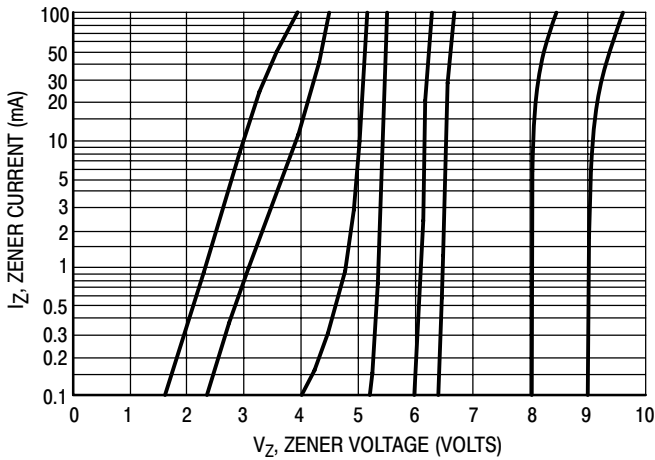


Figure 7. $V_Z = 3.3$ thru 10 Volts

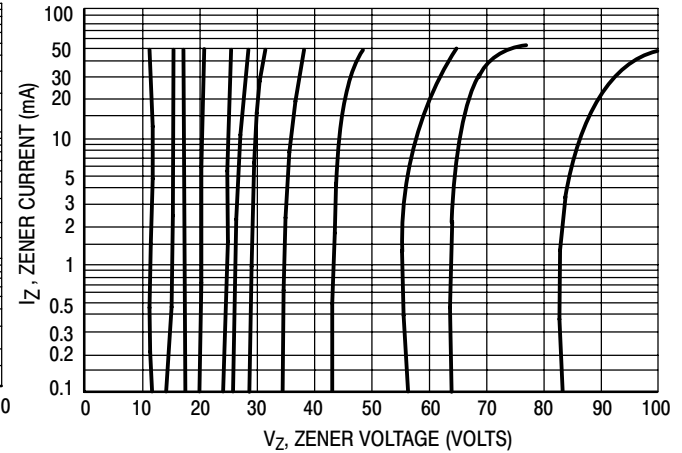


Figure 8. $V_Z = 12$ thru 82 Volts



Figure 9. $V_Z = 100$ thru 400 Volts

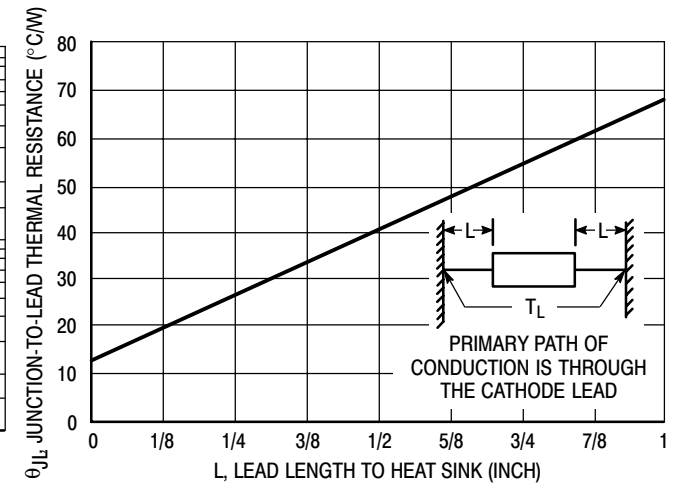


Figure 10. Typical Thermal Resistance

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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:

1. CATHODE (POLARITY BAND)
2. ANODE

1N5913B Series

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