

# 1N5985B Series

## 500 mW DO-35 Hermetically Sealed Glass Zener Voltage Regulators

This is a complete series of 500 mW Zener diodes with limits and excellent operating characteristics that reflect the superior capabilities of silicon-oxide passivated junctions. All this in an axial-lead hermetically sealed glass package that offers protection in all common environmental conditions.

### Specification Features:

- Zener Voltage Range – 2.4 V to 20 V
- ESD Rating of Class 3 (>16 KV) per Human Body Model
- DO-204AH (DO-35) Package – Smaller than Conventional DO-204AA Package
- Double Slug Type Construction
- Metallurgical Bonded Construction

### Mechanical Characteristics:

**CASE:** Double slug type, hermetically sealed glass

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

**MAXIMUM LEAD TEMPERATURE FOR SOLDERING PURPOSES:** 230°C, 1/16" from the case for 10 seconds

**POLARITY:** Cathode indicated by polarity band

**MOUNTING POSITION:** Any

### MAXIMUM RATINGS (Note 1.)

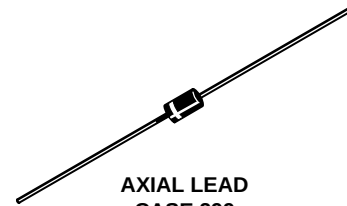
| Rating                                                                                                         | Symbol         | Value          | Unit        |
|----------------------------------------------------------------------------------------------------------------|----------------|----------------|-------------|
| Max. Steady State Power Dissipation<br>@ $T_L \leq 75^\circ\text{C}$ , Lead Length = 3/8"<br>Derate above 75°C | $P_D$          | 500<br>4.0     | mW<br>mW/°C |
| Operating and Storage<br>Temperature Range                                                                     | $T_J, T_{stg}$ | -65 to<br>+200 | °C          |

1. Some part number series have lower JEDEC registered ratings.



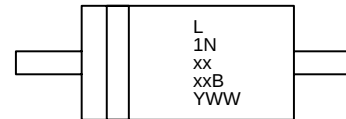
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AXIAL LEAD  
CASE 299  
GLASS

### MARKING DIAGRAM



L = Assembly Location  
1NxxxxB = Device Code  
(See Table Next Page)  
Y = Year  
WW = Work Week

### ORDERING INFORMATION

| Device       | Package    | Shipping         |
|--------------|------------|------------------|
| 1NxxxxB      | Axial Lead | 3000 Units/Box   |
| 1NxxxxBRL    | Axial Lead | 5000/Tape & Reel |
| 1NxxxxBRL2 * | Axial Lead | 5000/Tape & Reel |
| 1NxxxxBTA    | Axial Lead | 5000/Ammo Pack   |
| 1NxxxxBTA2 * | Axial Lead | 5000/Tape & Reel |
| 1NxxxxBRR1 † | Axial Lead | 3000/Tape & Reel |
| 1NxxxxBRR2 ‡ | Axial Lead | 3000/Tape & Reel |

\* The "2" suffix refers to 26 mm tape spacing.

† Polarity band **up** with cathode lead off first

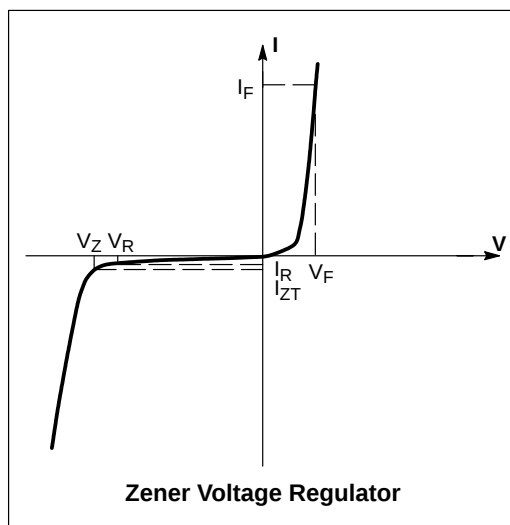
‡ Polarity band **down** with cathode lead off first

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

# 1N5985B Series

**ELECTRICAL CHARACTERISTICS** ( $T_L = 30^\circ\text{C}$  unless otherwise noted,  $V_F = 1.5\text{ V Max @ } I_F = 100\text{ mA}$  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           |



**ELECTRICAL CHARACTERISTICS** ( $T_L = 30^\circ\text{C}$  unless otherwise noted,  $V_F = 1.5\text{ V Max @ } I_F = 100\text{ mA}$  for all types)

| Device<br>(Note 2.) | Device<br>Marking | Zener Voltage (Note 3.) |            |             |                   | Zener Impedance (Note 4.)         |                                   |             | Leakage Current                 |            | I <sub>ZM</sub><br>(Note 5.) |
|---------------------|-------------------|-------------------------|------------|-------------|-------------------|-----------------------------------|-----------------------------------|-------------|---------------------------------|------------|------------------------------|
|                     |                   | 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                              | Volts      | mA                           |
| 1N5985B             | 1N5985B           | 2.28                    | 2.4        | 2.52        | 5                 | 100                               | 1800                              | 0.25        | 100                             | 1.0        | 208                          |
| 1N5987B             | 1N5987B           | 2.85                    | 3.0        | 3.15        | 5                 | 95                                | 2000                              | 0.25        | 50                              | 1.0        | 167                          |
| 1N5988B             | 1N5988B           | 3.13                    | 3.3        | 3.46        | 5                 | 95                                | 2200                              | 0.25        | 25                              | 1.0        | 152                          |
| 1N5990B             | 1N5990B           | 3.7                     | 3.9        | 4.09        | 5                 | 90                                | 2400                              | 0.25        | 10                              | 1.0        | 128                          |
| 1N5991B             | 1N5991B           | 4.08                    | 4.3        | 4.51        | 5                 | 88                                | 2500                              | 0.25        | 5.0                             | 1.0        | 116                          |
| 1N5992B             | 1N5992B           | 4.46                    | 4.7        | 4.93        | 5                 | 70                                | 2200                              | 0.25        | 3.0                             | 1.5        | 106                          |
| <b>1N5993B</b>      | <b>1N5993B</b>    | <b>4.84</b>             | <b>5.1</b> | <b>5.35</b> | <b>5</b>          | <b>50</b>                         | <b>2050</b>                       | <b>0.25</b> | <b>2.0</b>                      | <b>2.0</b> | <b>98</b>                    |
| <b>1N5994B</b>      | <b>1N5994B</b>    | <b>5.32</b>             | <b>5.6</b> | <b>5.88</b> | <b>5</b>          | <b>25</b>                         | <b>1800</b>                       | <b>0.25</b> | <b>2.0</b>                      | <b>3.0</b> | <b>89</b>                    |
| 1N5995B             | 1N5995B           | 5.89                    | 6.2        | 6.51        | 5                 | 10                                | 1300                              | 0.25        | 1.0                             | 4.0        | 81                           |
| 1N5996B             | 1N5996B           | 6.46                    | 6.8        | 7.14        | 5                 | 8.0                               | 750                               | 0.25        | 1.0                             | 5.2        | 74                           |
| 1N5997B             | 1N5997B           | 7.12                    | 7.5        | 7.87        | 5                 | 7.0                               | 600                               | 0.25        | 0.5                             | 6.0        | 67                           |
| <b>1N5998B</b>      | <b>1N5998B</b>    | <b>7.79</b>             | <b>8.2</b> | <b>8.61</b> | <b>5</b>          | <b>7.0</b>                        | <b>600</b>                        | <b>0.25</b> | <b>0.5</b>                      | <b>6.5</b> | <b>61</b>                    |
| 1N5999B             | 1N5999B           | 8.64                    | 9.1        | 9.55        | 5                 | 10                                | 600                               | 0.25        | 0.1                             | 7.0        | 55                           |
| 1N6000B             | 1N6000B           | 9.5                     | 10         | 10.5        | 5                 | 15                                | 600                               | 0.25        | 0.1                             | 8.0        | 50                           |
| 1N6001B             | 1N6001B           | 10.45                   | 11         | 11.55       | 5                 | 18                                | 600                               | 0.25        | 0.1                             | 8.4        | 45                           |
| 1N6002B             | 1N6002B           | 11.4                    | 12         | 12.6        | 5                 | 22                                | 600                               | 0.25        | 0.1                             | 9.1        | 42                           |
| 1N6004B             | 1N6004B           | 14.25                   | 15         | 15.75       | 5                 | 32                                | 600                               | 0.25        | 0.1                             | 11         | 33                           |
| 1N6007B             | 1N6007B           | 19                      | 20         | 21          | 5                 | 48                                | 600                               | 0.25        | 0.1                             | 15         | 25                           |

## 2. TOLERANCE AND VOLTAGE DESIGNATION

Tolerance designation – Device tolerance of  $\pm 5\%$  is indicated by a "B" suffix.

## 3. ZENER VOLTAGE ( $V_Z$ ) MEASUREMENT

The zener voltage is measured with the device junction in the thermal equilibrium at the lead temperature ( $T_L$ ) at  $30^\circ\text{C} \pm 1^\circ\text{C}$  and 3/8" lead length.

## 4. ZENER IMPEDANCE ( $Z_Z$ ) DERIVATION

$Z_{ZT}$  and  $Z_{ZK}$  are measured by dividing the ac voltage drop across the device by the ac current applied. The specified limits are for  $I_{Z(ac)} = 0.1 I_{Z(dc)}$  with the ac frequency = 1.0 kHz.

## 5. MAXIMUM ZENER CURRENT RATINGS ( $I_{ZM}$ )

This data was calculated using nominal voltages. The maximum current handling capability on a worst case basis is limited by the actual zener voltage at the operation point and the power derating curve.

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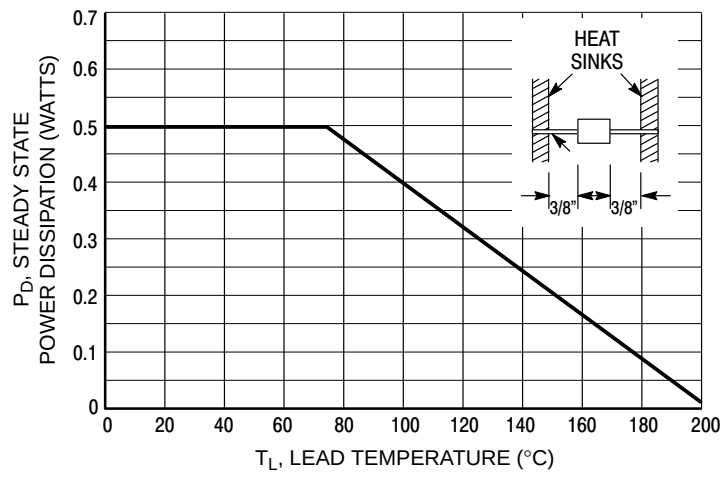


Figure 1. Steady State Power Derating

# APPLICATION NOTE — ZENER VOLTAGE

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 to  $40^{\circ}\text{C}/\text{W}$  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 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:

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

$\theta_{VZ}$ , the zener voltage temperature coefficient, is found from Figures 4 and 5.

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.

Surge limitations are given in Figure 7. 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 7 be exceeded.

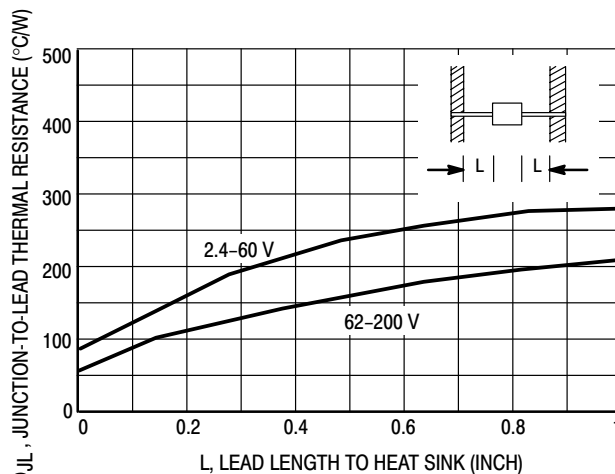


Figure 2. Typical Thermal Resistance

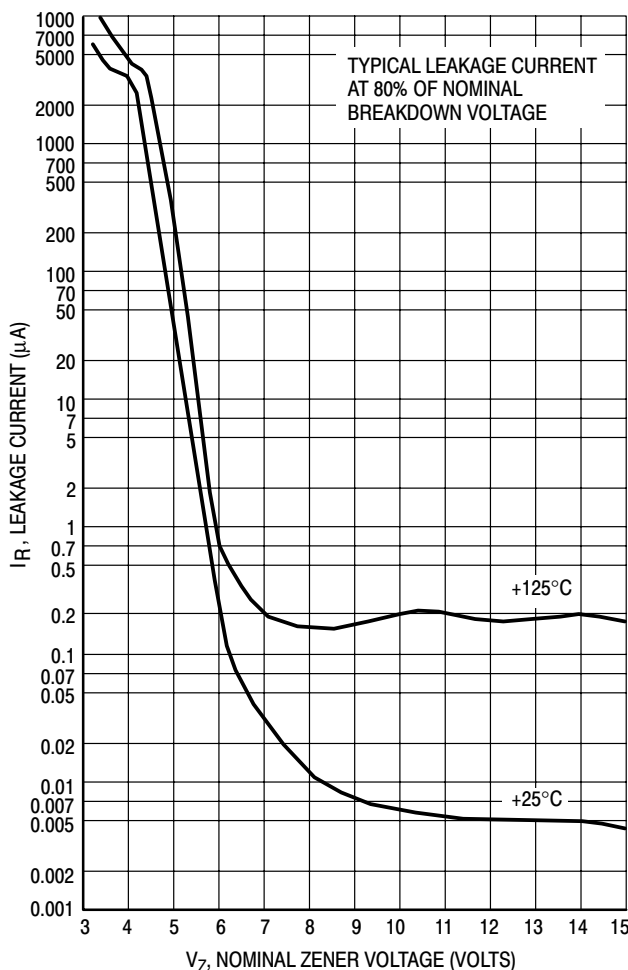


Figure 3. Typical Leakage Current

# 1N5985B Series

## TEMPERATURE COEFFICIENTS

(-55°C to +150°C temperature range; 90% of the units are in the ranges indicated.)

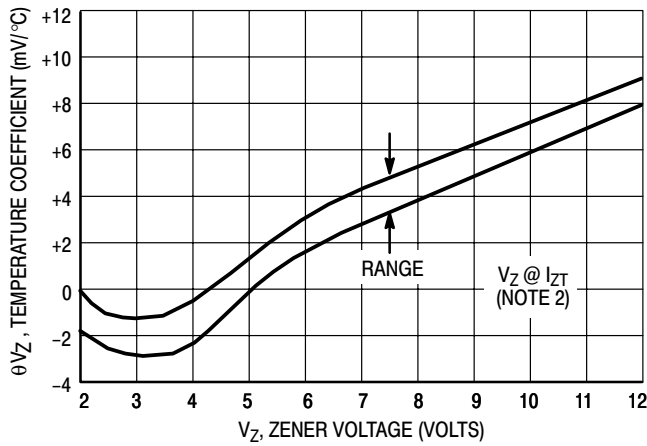


Figure 4a. Range for Units to 12 Volts

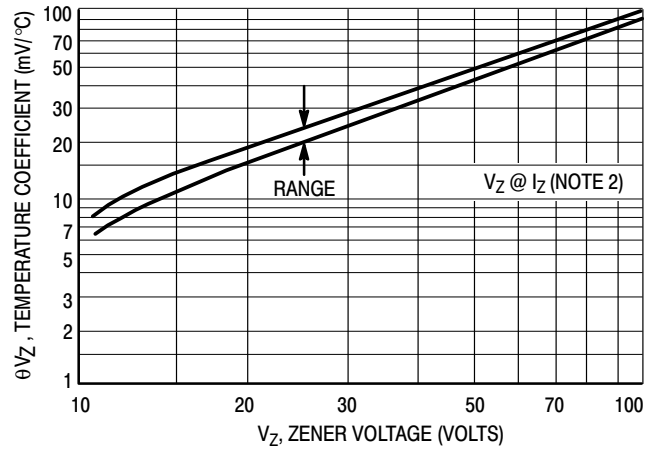


Figure 4b. Range for Units 12 to 100 Volts

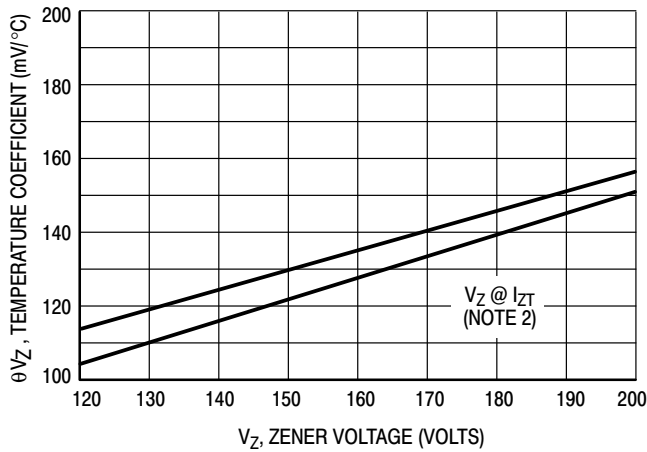


Figure 4c. Range for Units 120 to 200 Volts

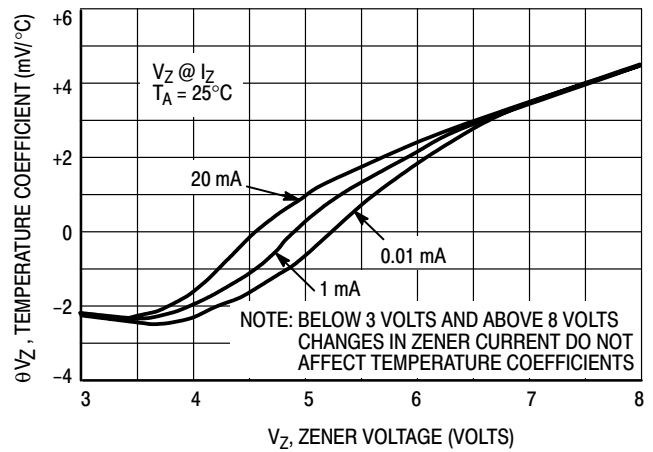


Figure 5. Effect of Zener Current

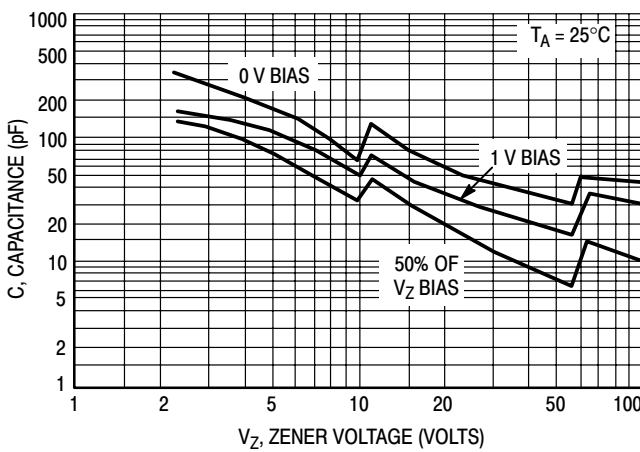


Figure 6a. Typical Capacitance 2.4–100 Volts

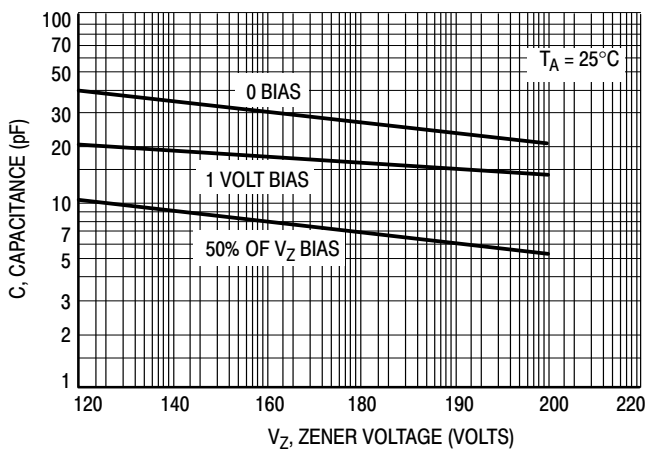


Figure 6b. Typical Capacitance 120–200 Volts

# 1N5985B Series

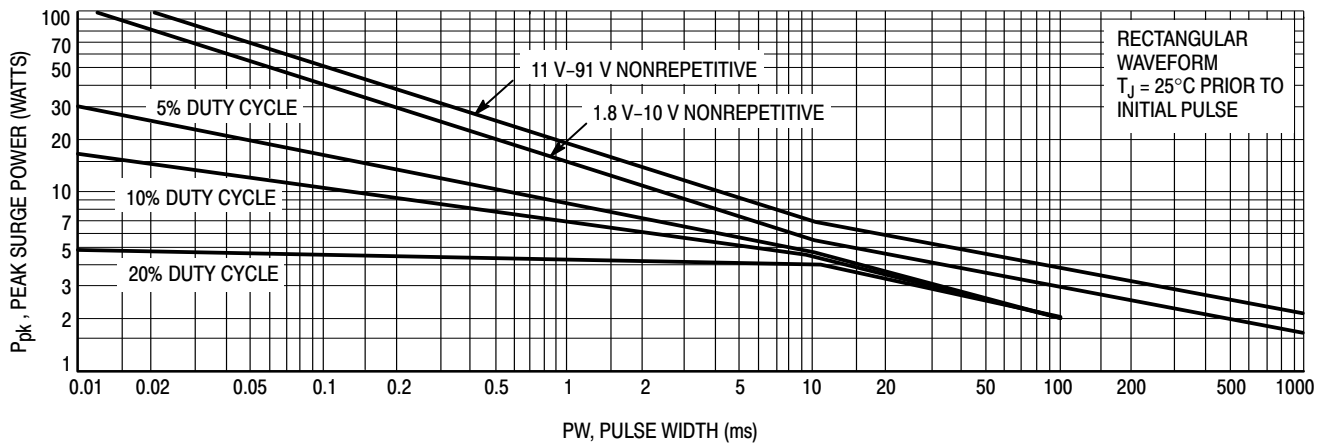


Figure 7a. Maximum Surge Power 1.8-91 Volts

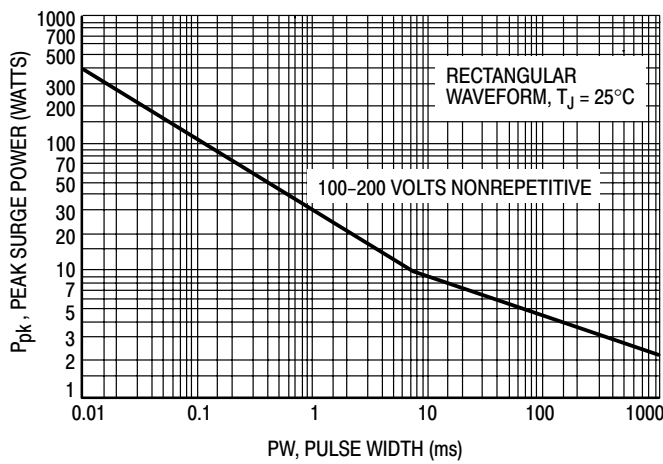


Figure 7b. Maximum Surge Power DO-204AH  
100-200 Volts

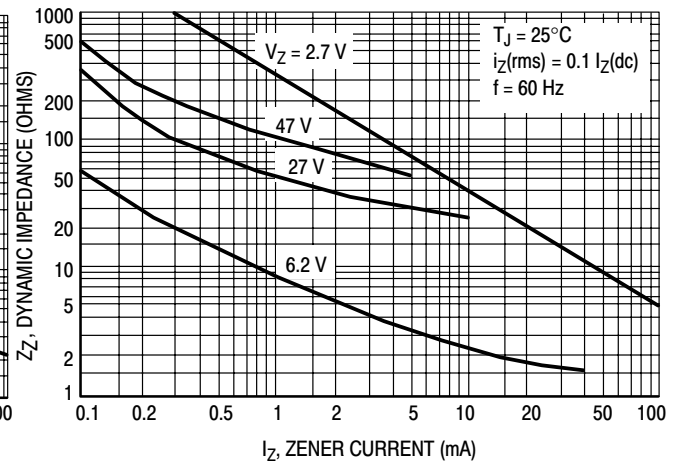


Figure 8. Effect of Zener Current on  
Zener Impedance

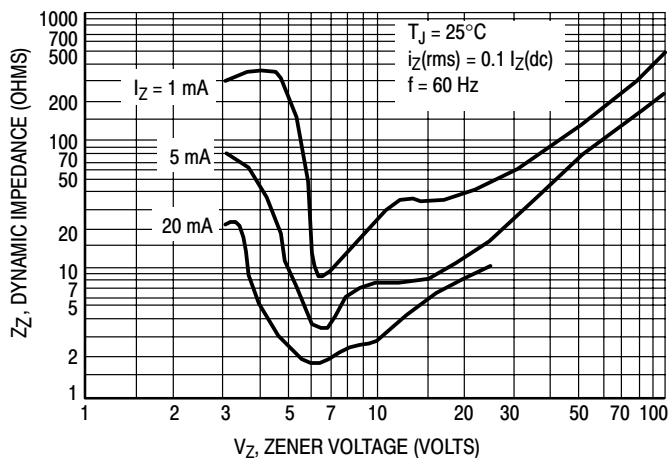


Figure 9. Effect of Zener Voltage on Zener Impedance

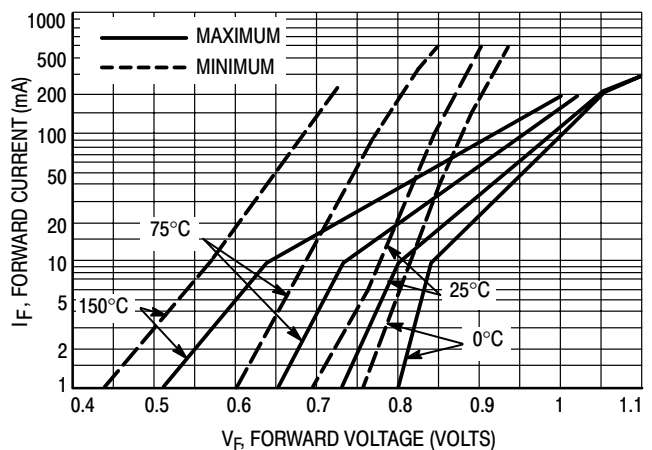


Figure 10. Typical Forward Characteristics

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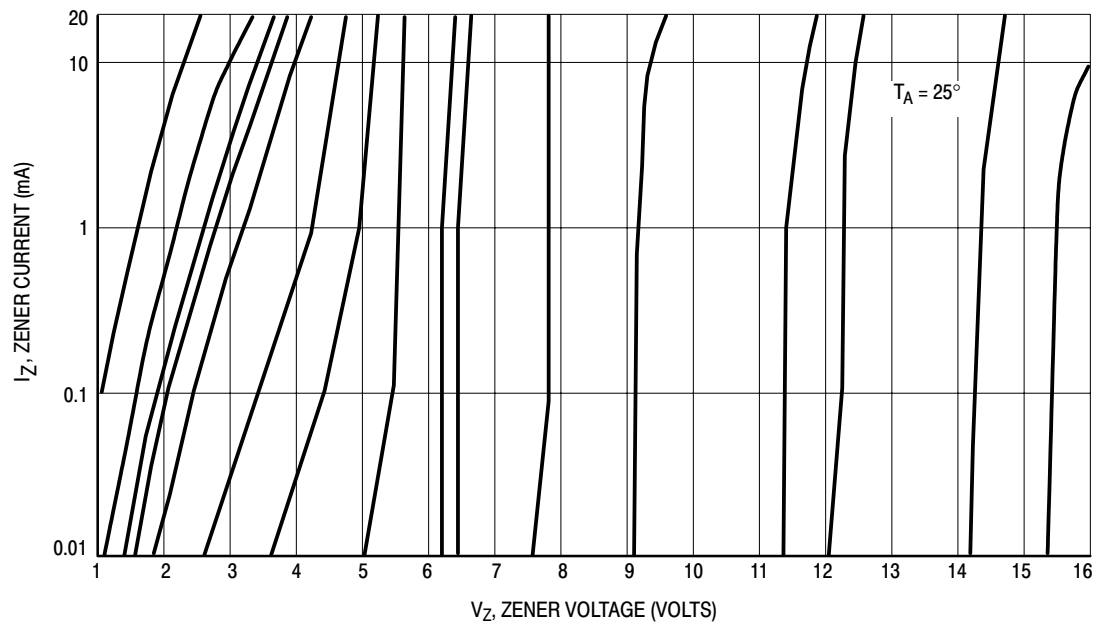


Figure 11. Zener Voltage versus Zener Current —  $V_Z = 1$  thru 16 Volts

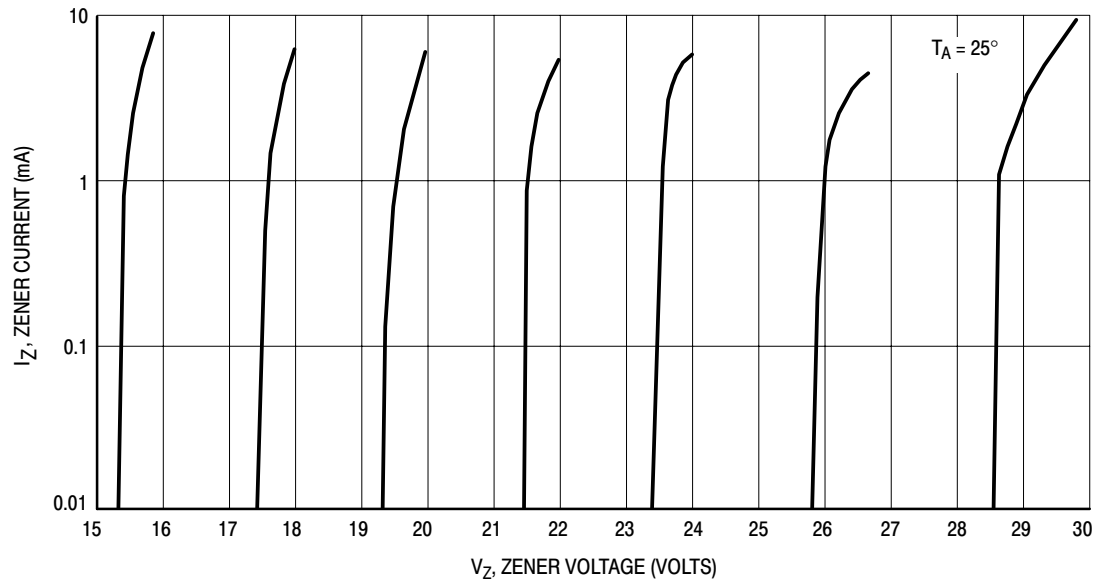


Figure 12. Zener Voltage versus Zener Current —  $V_Z = 15$  thru 30 Volts

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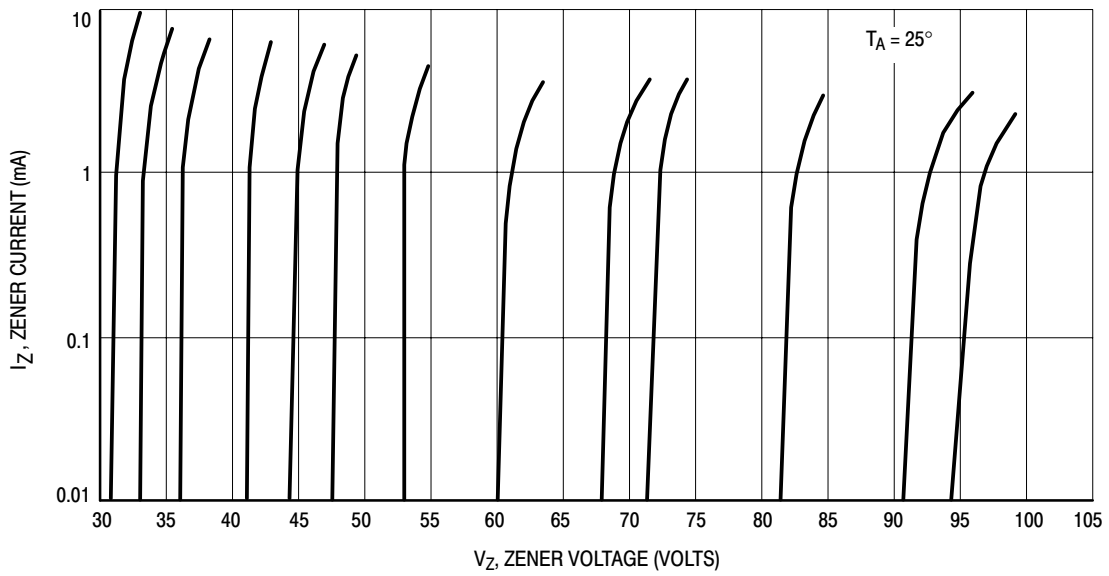


Figure 13. Zener Voltage versus Zener Current —  $V_Z = 30$  thru 105 Volts

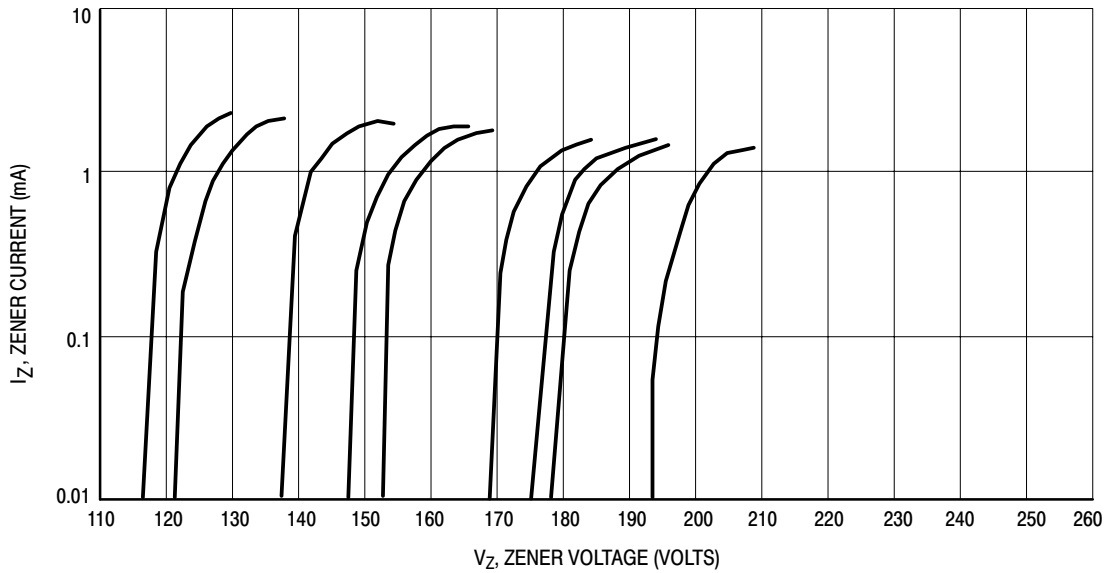


Figure 14. Zener Voltage versus Zener Current —  $V_Z = 110$  thru 220 Volts

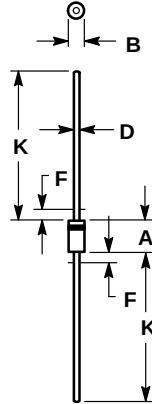
## 1N5985B Series

### OUTLINE DIMENSIONS

# Zener Voltage Regulators – Axial Leaded

## 500 mW DO-35 Glass

GLASS DO-35/D0-204AH  
CASE 299-02  
ISSUE A



#### NOTES:

1. PACKAGE CONTOUR OPTIONAL WITHIN A AND B HEAT SLUGS, IF ANY, SHALL BE INCLUDED WITHIN THIS CYLINDER, BUT NOT SUBJECT TO THE MINIMUM LIMIT OF B.
2. LEAD DIAMETER NOT CONTROLLED IN ZONE F TO ALLOW FOR FLASH, LEAD FINISH BUILDUP AND MINOR IRREGULARITIES OTHER THAN HEAT SLUGS.
3. POLARITY DENOTED BY CATHODE BAND.
4. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.

| DIM | MILLIMETERS |       | INCHES |       |
|-----|-------------|-------|--------|-------|
|     | MIN         | MAX   | MIN    | MAX   |
| A   | 3.05        | 5.08  | 0.120  | 0.200 |
| B   | 1.52        | 2.29  | 0.060  | 0.090 |
| D   | 0.46        | 0.56  | 0.018  | 0.022 |
| F   | ---         | 1.27  | ---    | 0.050 |
| K   | 25.40       | 38.10 | 1.000  | 1.500 |

All JEDEC dimensions and notes apply.

## **Notes**

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