# 1N4728A Series

## 1 Watt DO-41 Hermetically Sealed Glass Zener Voltage Regulator Diodes

This is a complete series of 1 Watt Zener diode 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 – 3.3 V to 91 V
- ESD Rating of Class 3 (>16 KV) per Human Body Model
- DO–41 (DO–204AL) Package
- Double Slug Type Construction
- Metallurgical Bonded Construction
- Oxide Passivated Die

**Mechanical Characteristics:**

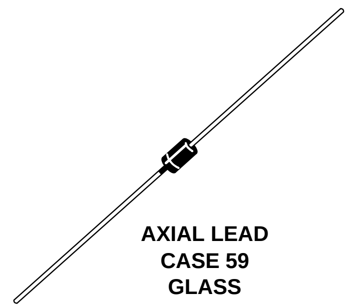
**CASE:** Double slug type, hermetically sealed glass
**FINISH:** All external surfaces are corrosion resistant and leads are readily solderable
**MAXIMUM LEAD TEMPERATURE FOR SOLDERING PURPOSES:** 230°C, 1/16″ from the case for 10 seconds
**POLARITY:** Cathode indicated by polarity band
**MOUNTING POSITION:** Any

**MAXIMUM RATINGS**

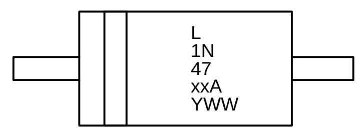
| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Max. Steady State Power Dissipation @ $T_L \le 50°C$, Lead Length = 3/8″ Derated above 50°C | $P_D$ | 1.0<br>6.67 | Watt<br>mW/°C |
| Operating and Storage Temperature Range | $T_J$, $T_{stg}$ | – 65 to +200 | °C |

**ON Semiconductor™**

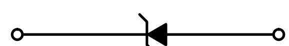
http://onsemi.com



**AXIAL LEAD**
**CASE 59**
**GLASS**




L = Assembly Location
1N47xxA = Device Code
Y = Year
WW = Work Week




**ORDERING INFORMATION** (1.)(NO TAG)

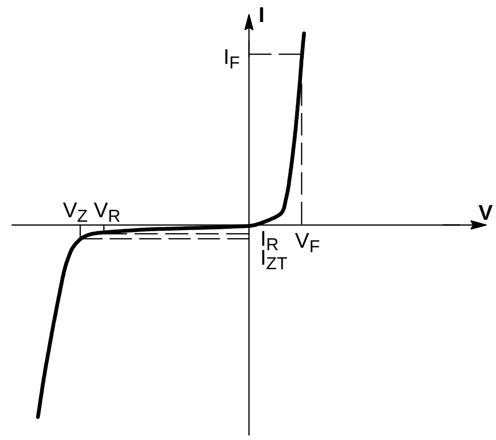
| Device | Package | Shipping |
|---|---|---|
| 1N47xxA | Axial Lead | 2000 Units/Box |
| 1N47xxARL | Axial Lead | 6000/Tape & Reel |
| 1N47xxARL2 | Axial Lead | 6000/Tape & Reel |
| 1N47xxATA | Axial Lead | 4000/Ammo Pack |
| 1N47xxATA2 | Axial Lead | 4000/Ammo Pack |

NOTES:
1. The “2” suffix refers to 26 mm tape spacing.

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

**ELECTRICAL CHARACTERISTICS** ($T_A$ = 25°C unless otherwise noted, $V_F$ = 1.2 V Max., $I_F$ = 200 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 @ $I_F$ |
| $I_r$ | Surge Current @ $T_A$ = 25°C |




**Zener Voltage Regulator**

**ELECTRICAL CHARACTERISTICS** ($T_A$ = 25°C unless otherwise noted, $V_F$ = 1.2 V Max, $I_F$ = 200 mA for all types)

| JEDEC Device (2.) | Zener Voltage (3.)(4.) | | | | Zener Impedance (5.) | | | Leakage Current | | $I_r$ (6.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | $V_Z$ (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) | (mA) |
| 1N4728A | 3.14 | 3.3 | 3.47 | 76 | 10 | 400 | 1 | 100 | 1 | 1380 |
| 1N4729A | 3.42 | 3.6 | 3.78 | 69 | 10 | 400 | 1 | 100 | 1 | 1260 |
| 1N4730A | 3.71 | 3.9 | 4.10 | 64 | 9 | 400 | 1 | 50 | 1 | 1190 |
| 1N4731A | 4.09 | 4.3 | 4.52 | 58 | 9 | 400 | 1 | 10 | 1 | 1070 |
| 1N4732A | 4.47 | 4.7 | 4.94 | 53 | 8 | 500 | 1 | 10 | 1 | 970 |
| ***1N4733A*** | ***4.85*** | ***5.1*** | ***5.36*** | ***49*** | ***7*** | ***550*** | ***1*** | ***10*** | ***1*** | ***890*** |
| ***1N4734A*** | ***5.32*** | ***5.6*** | ***5.88*** | ***45*** | ***5*** | ***600*** | ***1*** | ***10*** | ***2*** | ***810*** |
| ***1N4735A*** | ***5.89*** | ***6.2*** | ***6.51*** | ***41*** | ***2*** | ***700*** | ***1*** | ***10*** | ***3*** | ***730*** |
| ***1N4736A*** | ***6.46*** | ***6.8*** | ***7.14*** | ***37*** | ***3.5*** | ***700*** | ***1*** | ***10*** | ***4*** | ***660*** |
| 1N4737A | 7.13 | 7.5 | 7.88 | 34 | 4 | 700 | 0.5 | 10 | 5 | 605 |
| ***1N4738A*** | ***7.79*** | ***8.2*** | ***8.61*** | ***31*** | ***4.5*** | ***700*** | ***0.5*** | ***10*** | ***6*** | ***550*** |
| 1N4739A | 8.65 | 9.1 | 9.56 | 28 | 5 | 700 | 0.5 | 10 | 7 | 500 |
| ***1N4740A*** | ***9.50*** | ***10*** | ***10.50*** | ***25*** | ***7*** | ***700*** | ***0.25*** | ***10*** | ***7.6*** | ***454*** |
| ***1N4741A*** | ***10.45*** | ***11*** | ***11.55*** | ***23*** | ***8*** | ***700*** | ***0.25*** | ***5*** | ***8.4*** | ***414*** |
| ***1N4742A*** | ***11.40*** | ***12*** | ***12.60*** | ***21*** | ***9*** | ***700*** | ***0.25*** | ***5*** | ***9.1*** | ***380*** |
| 1N4743A | 12.4 | 13 | 13.7 | 19 | 10 | 700 | 0.25 | 5 | 9.9 | 344 |
| ***1N4744A*** | ***14.3*** | ***15*** | ***15.8*** | ***17*** | ***14*** | ***700*** | ***0.25*** | ***5*** | ***11.4*** | ***304*** |
| ***1N4745A*** | ***15.2*** | ***16*** | ***16.8*** | ***15.5*** | ***16*** | ***700*** | ***0.25*** | ***5*** | ***12.2*** | ***285*** |

**TOLERANCE AND TYPE NUMBER DESIGNATION**

2. The JEDEC type numbers listed have a standard tolerance on the nominal zener voltage of ±5%.

**SPECIALS AVAILABLE INCLUDE:**

3. Nominal zener voltages between the voltages shown and tighter voltage tolerances. For detailed information on price, availability, and delivery, contact your nearest ON Semiconductor representative.

**ZENER VOLTAGE ($V_Z$) MEASUREMENT**

4. ON Semiconductor guarantees the zener voltage when measured at 90 seconds while maintaining the lead temperature ($T_L$) at 30°C ± 1°C, 3/8″ from the diode body.

**ZENER IMPEDANCE ($Z_Z$) DERIVATION**

5. The zener impedance is derived from the 60 cycle 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 $I_{ZK}$.

**SURGE CURRENT ($I_R$) NON-REPETITIVE**

6. The rating listed in the electrical characteristics table is maximum peak, non-repetitive, reverse surge current of 1/2 square wave or equivalent sine wave pulse of 1/120 second duration superimposed on the test current, $I_{ZT}$, per JEDEC registration; however, actual device capability is as described in Figure 5 of the General Data – DO-41 Glass.

**ELECTRICAL CHARACTERISTICS** ($T_A$ = 25°C unless otherwise noted, $V_F$ = 1.2 V Max, $I_F$ = 200 mA for all types) (continued)

| JEDEC Device (7.) | Zener Voltage (8.)(9.) | | | | Zener Impedance (10.) | | | Leakage Current | | $I_r$ (11.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | $V_Z$ (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) | (mA) |
| ***1N4746A*** | ***17.1*** | ***18*** | ***18.9*** | ***14*** | ***20*** | ***750*** | ***0.25*** | ***5*** | ***13.7*** | ***250*** |
| ***1N4747A*** | ***19.0*** | ***20*** | ***21.0*** | ***12.5*** | ***22*** | ***750*** | ***0.25*** | ***5*** | ***15.2*** | ***225*** |
| ***1N4748A*** | ***20.9*** | ***22*** | ***23.1*** | ***11.5*** | ***23*** | ***750*** | ***0.25*** | ***5*** | ***16.7*** | ***205*** |
| ***1N4749A*** | ***22.8*** | ***24*** | ***25.2*** | ***10.5*** | ***25*** | ***750*** | ***0.25*** | ***5*** | ***18.2*** | ***190*** |
| ***1N4750A*** | ***25.7*** | ***27*** | ***28.4*** | ***9.5*** | ***35*** | ***750*** | ***0.25*** | ***5*** | ***20.6*** | ***170*** |
| ***1N4751A*** | ***28.5*** | ***30*** | ***31.5*** | ***8.5*** | ***40*** | ***1000*** | ***0.25*** | ***5*** | ***22.8*** | ***150*** |
| ***1N4752A*** | ***31.4*** | ***33*** | ***34.7*** | ***7.5*** | ***45*** | ***1000*** | ***0.25*** | ***5*** | ***25.1*** | ***135*** |
| 1N4753A | 34.2 | 36 | 37.8 | 7 | 50 | 1000 | 0.25 | 5 | 27.4 | 125 |
| 1N4754A | 37.1 | 39 | 41.0 | 6.5 | 60 | 1000 | 0.25 | 5 | 29.7 | 115 |
| 1N4755A | 40.9 | 43 | 45.2 | 6 | 70 | 1500 | 0.25 | 5 | 32.7 | 110 |
| 1N4756A | 44.7 | 47 | 49.4 | 5.5 | 80 | 1500 | 0.25 | 5 | 35.8 | 95 |
| 1N4757A | 48.5 | 51 | 53.6 | 5 | 95 | 1500 | 0.25 | 5 | 38.8 | 90 |
| 1N4758A | 53.2 | 56 | 58.8 | 4.5 | 110 | 2000 | 0.25 | 5 | 42.6 | 80 |
| 1N4759A | 58.9 | 62 | 65.1 | 4 | 125 | 2000 | 0.25 | 5 | 47.1 | 70 |
| 1N4760A | 64.6 | 68 | 71.4 | 3.7 | 150 | 2000 | 0.25 | 5 | 51.7 | 65 |
| 1N4761A | 71.3 | 75 | 78.8 | 3.3 | 175 | 2000 | 0.25 | 5 | 56 | 60 |
| 1N4762A | 77.9 | 82 | 86.1 | 3 | 200 | 3000 | 0.25 | 5 | 62.2 | 55 |
| 1N4763A | 86.5 | 91 | 95.6 | 2.8 | 250 | 3000 | 0.25 | 5 | 69.2 | 50 |

**TOLERANCE AND TYPE NUMBER DESIGNATION**

7. The JEDEC type numbers listed have a standard tolerance on the nominal zener voltage of ±5%.

**SPECIALS AVAILABLE INCLUDE:**

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9. ON Semiconductor guarantees the zener voltage when measured at 90 seconds while maintaining the lead temperature ($T_L$) at 30°C ± 1°C, 3/8″ from the diode body.

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10. The zener impedance is derived from the 60 cycle 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 $I_{ZK}$.

**SURGE CURRENT ($I_R$) NON-REPETITIVE**

11. The rating listed in the electrical characteristics table is maximum peak, non-repetitive, reverse surge current of 1/2 square wave or equivalent sine wave pulse of 1/120 second duration superimposed on the test current, $I_{ZT}$, per JEDEC registration; however, actual device capability is as described in Figure 5 of the General Data – DO-41 Glass.

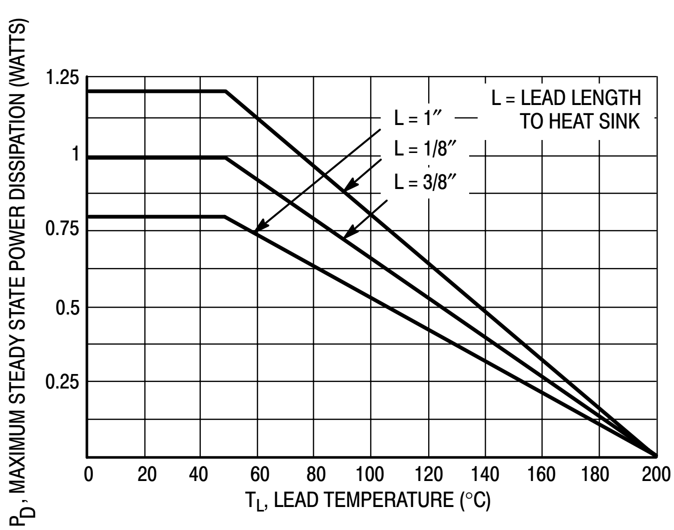



**Figure 1. Power Temperature Derating Curve**

**a. Range for Units to 12 Volts** **b. Range for Units to 12 to 100 Volts**

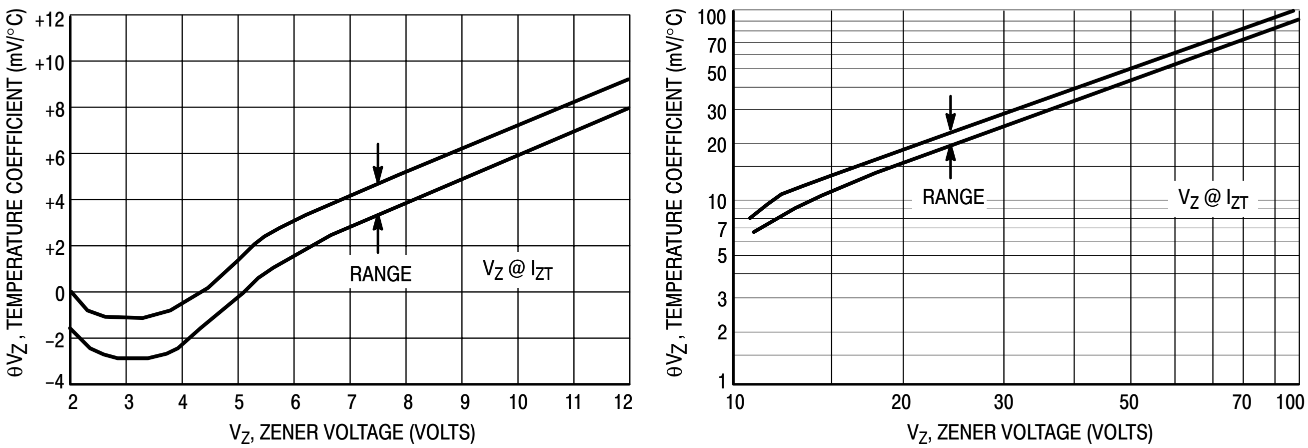



**Figure 2. Temperature Coefficients**
(–55°C to +150°C temperature range; 90% of the units are in the ranges indicated.)

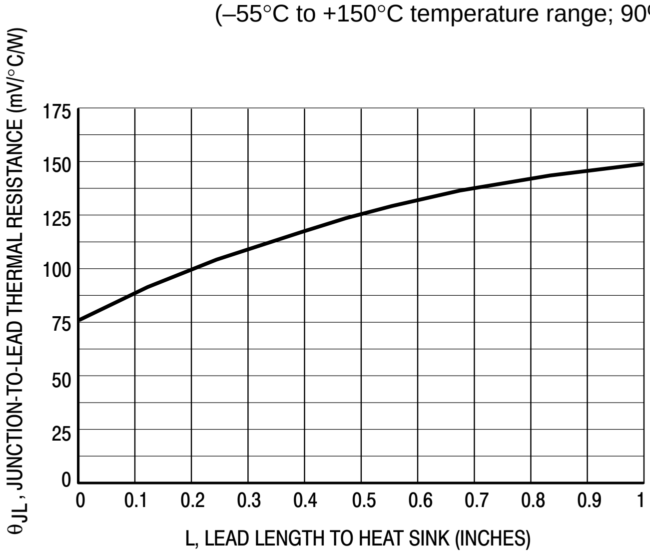



**Figure 3. Typical Thermal Resistance versus Lead Length**

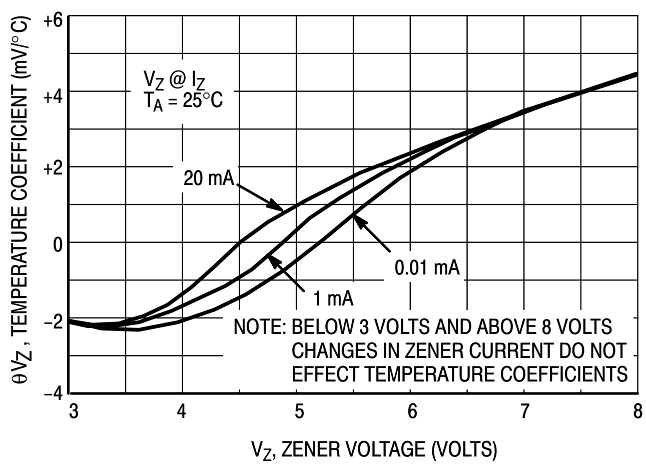
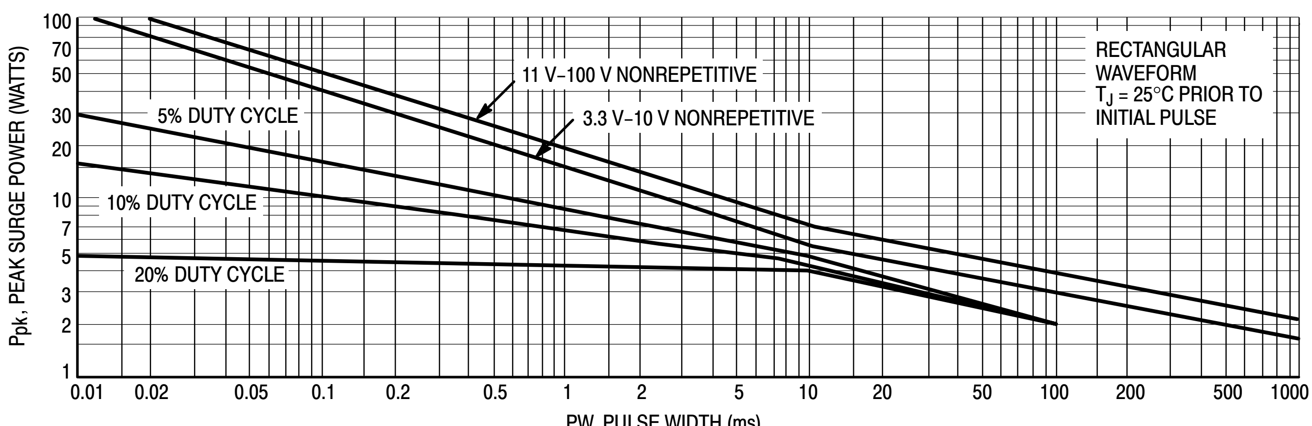



**Figure 4. Effect of Zener Current**




This graph represents 90 percentile data points.
For worst case design characteristics, multiply surge power by 2/3.

**Figure 5. Maximum Surge Power**

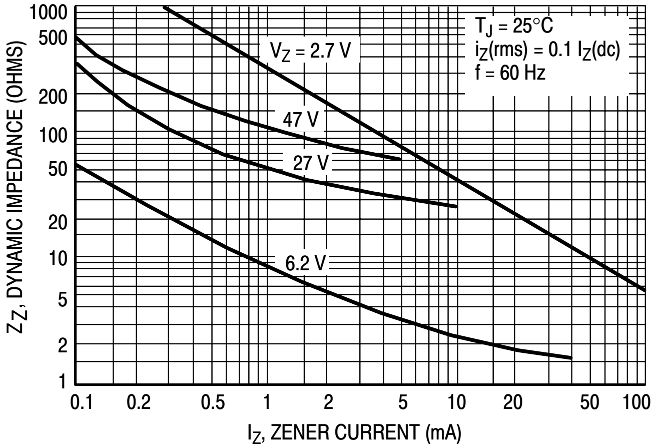



**Figure 6. Effect of Zener Current on Zener Impedance**

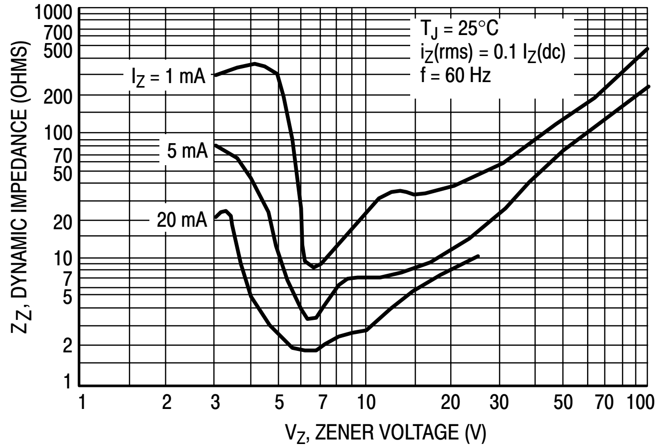



**Figure 7. Effect of Zener Voltage on Zener Impedance**

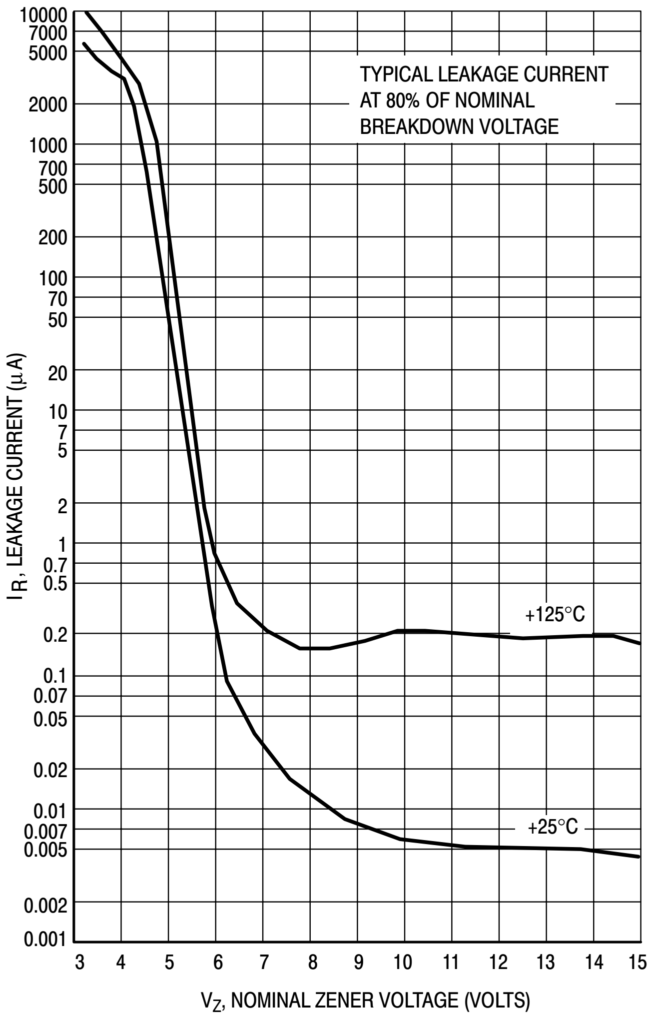



**Figure 8. Typical Leakage Current**

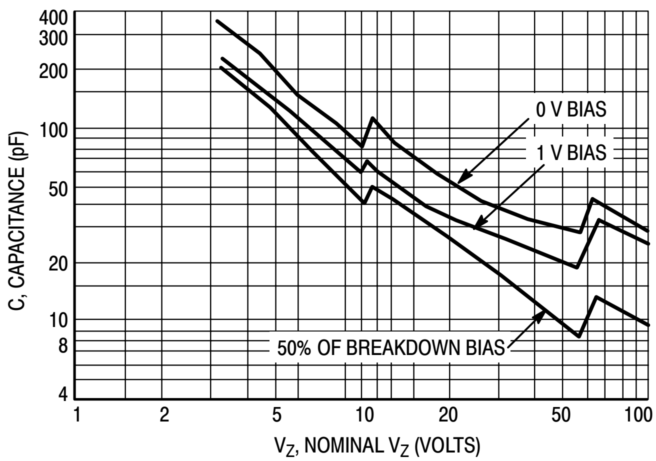



**Figure 9. Typical Capacitance versus $V_Z$**

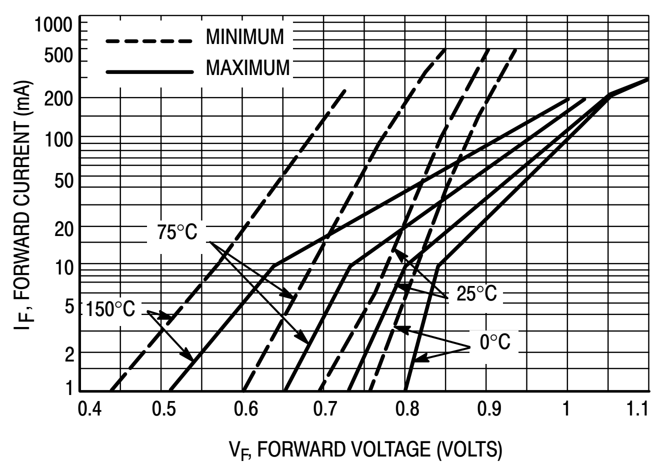



**Figure 10. Typical Forward Characteristics**

## 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 (°C/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°C/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 as follows:

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

$\theta_{JL}$ may be determined from Figure 3 for dc power conditions. 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 Figure 2.

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 5. 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 5 be exceeded.