

## 5 Watt Surmetic 40 Silicon Zener Diodes

This is a complete series of 5 Watt Zener Diodes with tight limits and better operating characteristics that reflect the superior capabilities of silicon-oxide-passivated junctions. All this is in an axial-lead, transfer-molded plastic package that offers protection in all common environmental conditions.

### Specification Features:

- Up to 180 Watt Surge Rating @ 8.3 ms
- Maximum Limits Guaranteed on Seven Electrical Parameters

### Mechanical Characteristics:

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

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

**POLARITY:** Cathode indicated by color band. When operated in zener mode, cathode will be positive with respect to anode

**MOUNTING POSITION:** Any

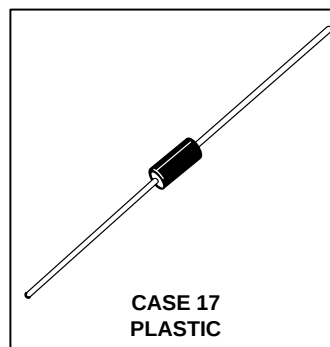
**WEIGHT:** 0.7 gram (approx)

**WAFER FAB LOCATION:** Phoenix, Arizona

**ASSEMBLY/TEST LOCATION:** Seoul, Korea

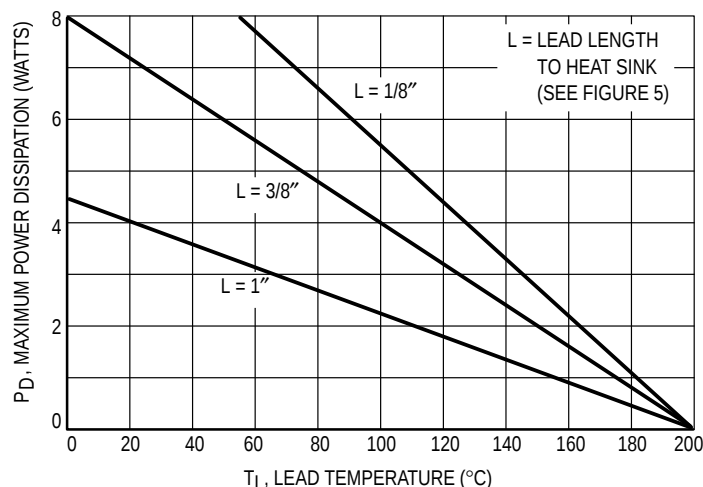
**1N5333B  
through  
1N5388B**

**5 WATT  
ZENER REGULATOR  
DIODES  
3.3-200 VOLTS**



### MAXIMUM RATINGS

| Rating                                                                                                      | Symbol         | Value       | Unit                          |
|-------------------------------------------------------------------------------------------------------------|----------------|-------------|-------------------------------|
| DC Power Dissipation @ $T_L = 75^\circ\text{C}$<br>Lead Length = $3/8''$<br>Derate above $75^\circ\text{C}$ | $P_D$          | 5<br>40     | Watts<br>mW/ $^\circ\text{C}$ |
| Operating and Storage Junction Temperature Range                                                            | $T_J, T_{stg}$ | -65 to +200 | $^\circ\text{C}$              |



**Figure 1. Power Temperature Derating Curve**

# 1N5333B through 1N5388B

**ELECTRICAL CHARACTERISTICS** ( $T_A = 25^\circ\text{C}$  unless otherwise noted,  $V_F = 1.2$  Max @  $I_F = 1$  A for all types)

| JEDEC<br>Type No.<br>(Note 1) | Nominal<br>Zener<br>Voltage<br>$V_Z$ @ $I_{ZT}$<br>Volts<br>(Note 2) | Test<br>Current<br>$I_{ZT}$<br>mA | Max Zener Impedance                     |                                                | Max Reverse<br>Leakage Current |                  | Max<br>Surge<br>Current<br>$i_{FS}$ Amps<br>(Note 3) | Max Voltage<br>Regulation<br>$\Delta V_Z$ , Volt<br>(Note 4) | Maximum<br>Regulator<br>Current<br>$I_{ZM}$<br>mA<br>(Note 5) |
|-------------------------------|----------------------------------------------------------------------|-----------------------------------|-----------------------------------------|------------------------------------------------|--------------------------------|------------------|------------------------------------------------------|--------------------------------------------------------------|---------------------------------------------------------------|
|                               |                                                                      |                                   | $Z_{ZT}$ @ $I_{ZT}$<br>Ohms<br>(Note 2) | $Z_{ZK}$ @ $I_{ZK} = 1$ mA<br>Ohms<br>(Note 2) | $I_R$<br>$\mu\text{A}$         | @ $V_R$<br>Volts |                                                      |                                                              |                                                               |
| <b>1N5333B</b>                | <b>3.3</b>                                                           | <b>380</b>                        | <b>3</b>                                | <b>400</b>                                     | <b>300</b>                     | <b>1</b>         | <b>20</b>                                            | <b>0.85</b>                                                  | <b>1440</b>                                                   |
| 1N5334B                       | 3.6                                                                  | 350                               | 2.5                                     | 500                                            | 150                            | 1                | 18.7                                                 | 0.8                                                          | 1320                                                          |
| 1N5335B                       | 3.9                                                                  | 320                               | 2                                       | 500                                            | 50                             | 1                | 17.6                                                 | 0.54                                                         | 1220                                                          |
| 1N5336B                       | 4.3                                                                  | 290                               | 2                                       | 500                                            | 10                             | 1                | 16.4                                                 | 0.49                                                         | 1100                                                          |
| <b>1N5337B</b>                | <b>4.7</b>                                                           | <b>260</b>                        | <b>2</b>                                | <b>450</b>                                     | <b>5</b>                       | <b>1</b>         | <b>15.3</b>                                          | <b>0.44</b>                                                  | <b>1010</b>                                                   |
| <b>1N5338B</b>                | <b>5.1</b>                                                           | <b>240</b>                        | <b>1.5</b>                              | <b>400</b>                                     | <b>1</b>                       | <b>1</b>         | <b>14.4</b>                                          | <b>0.39</b>                                                  | <b>930</b>                                                    |
| <b>1N5339B</b>                | <b>5.6</b>                                                           | <b>220</b>                        | <b>1</b>                                | <b>400</b>                                     | <b>1</b>                       | <b>2</b>         | <b>13.4</b>                                          | <b>0.25</b>                                                  | <b>865</b>                                                    |
| 1N5340B                       | 6                                                                    | 200                               | 1                                       | 300                                            | 1                              | 3                | 12.7                                                 | 0.19                                                         | 790                                                           |
| <b>1N5341B</b>                | <b>6.2</b>                                                           | <b>200</b>                        | <b>1</b>                                | <b>200</b>                                     | <b>1</b>                       | <b>3</b>         | <b>12.4</b>                                          | <b>0.1</b>                                                   | <b>765</b>                                                    |
| <b>1N5342B</b>                | <b>6.8</b>                                                           | <b>175</b>                        | <b>1</b>                                | <b>200</b>                                     | <b>10</b>                      | <b>5.2</b>       | <b>11.5</b>                                          | <b>0.15</b>                                                  | <b>700</b>                                                    |
| 1N5343B                       | 7.5                                                                  | 175                               | 1.5                                     | 200                                            | 10                             | 5.7              | 10.7                                                 | 0.15                                                         | 630                                                           |
| 1N5344B                       | 8.2                                                                  | 150                               | 1.5                                     | 200                                            | 10                             | 6.2              | 10                                                   | 0.2                                                          | 580                                                           |
| 1N5345B                       | 8.7                                                                  | 150                               | 2                                       | 200                                            | 10                             | 6.6              | 9.5                                                  | 0.2                                                          | 545                                                           |
| 1N5346B                       | 9.1                                                                  | 150                               | 2                                       | 150                                            | 7.5                            | 6.9              | 9.2                                                  | 0.22                                                         | 520                                                           |
| <b>1N5347B</b>                | <b>10</b>                                                            | <b>125</b>                        | <b>2</b>                                | <b>125</b>                                     | <b>5</b>                       | <b>7.6</b>       | <b>8.6</b>                                           | <b>0.22</b>                                                  | <b>475</b>                                                    |
| 1N5348B                       | 11                                                                   | 125                               | 2.5                                     | 125                                            | 5                              | 8.4              | 8                                                    | 0.25                                                         | 430                                                           |
| <b>1N5349B</b>                | <b>12</b>                                                            | <b>100</b>                        | <b>2.5</b>                              | <b>125</b>                                     | <b>2</b>                       | <b>9.1</b>       | <b>7.5</b>                                           | <b>0.25</b>                                                  | <b>395</b>                                                    |
| <b>1N5350B</b>                | <b>13</b>                                                            | <b>100</b>                        | <b>2.5</b>                              | <b>100</b>                                     | <b>1</b>                       | <b>9.9</b>       | <b>7</b>                                             | <b>0.25</b>                                                  | <b>365</b>                                                    |
| 1N5351B                       | 14                                                                   | 100                               | 2.5                                     | 75                                             | 1                              | 10.6             | 6.7                                                  | 0.25                                                         | 340                                                           |
| <b>1N5352B</b>                | <b>15</b>                                                            | <b>75</b>                         | <b>2.5</b>                              | <b>75</b>                                      | <b>1</b>                       | <b>11.5</b>      | <b>6.3</b>                                           | <b>0.25</b>                                                  | <b>315</b>                                                    |
| <b>1N5353B</b>                | <b>16</b>                                                            | <b>75</b>                         | <b>2.5</b>                              | <b>75</b>                                      | <b>1</b>                       | <b>12.2</b>      | <b>6</b>                                             | <b>0.3</b>                                                   | <b>295</b>                                                    |
| 1N5354B                       | 17                                                                   | 70                                | 2.5                                     | 75                                             | 0.5                            | 12.9             | 5.8                                                  | 0.35                                                         | 280                                                           |
| 1N5355B                       | 18                                                                   | 65                                | 2.5                                     | 75                                             | 0.5                            | 13.7             | 5.5                                                  | 0.4                                                          | 265                                                           |
| 1N5356B                       | 19                                                                   | 65                                | 3                                       | 75                                             | 0.5                            | 14.4             | 5.3                                                  | 0.4                                                          | 250                                                           |
| 1N5357B                       | 20                                                                   | 65                                | 3                                       | 75                                             | 0.5                            | 15.2             | 5.1                                                  | 0.4                                                          | 237                                                           |
| <b>1N5358B</b>                | <b>22</b>                                                            | <b>50</b>                         | <b>3.5</b>                              | <b>75</b>                                      | <b>0.5</b>                     | <b>16.7</b>      | <b>4.7</b>                                           | <b>0.45</b>                                                  | <b>216</b>                                                    |
| <b>1N5359B</b>                | <b>24</b>                                                            | <b>50</b>                         | <b>3.5</b>                              | <b>100</b>                                     | <b>0.5</b>                     | <b>18.2</b>      | <b>4.4</b>                                           | <b>0.55</b>                                                  | <b>198</b>                                                    |
| 1N5360B                       | 25                                                                   | 50                                | 4                                       | 110                                            | 0.5                            | 19               | 4.3                                                  | 0.55                                                         | 190                                                           |
| <b>1N5361B</b>                | <b>27</b>                                                            | <b>50</b>                         | <b>5</b>                                | <b>120</b>                                     | <b>0.5</b>                     | <b>20.6</b>      | <b>4.1</b>                                           | <b>0.6</b>                                                   | <b>176</b>                                                    |
| 1N5362B                       | 28                                                                   | 50                                | 6                                       | 130                                            | 0.5                            | 21.2             | 3.9                                                  | 0.6                                                          | 170                                                           |
| 1N5363B                       | 30                                                                   | 40                                | 8                                       | 140                                            | 0.5                            | 22.8             | 3.7                                                  | 0.6                                                          | 158                                                           |
| 1N5364B                       | 33                                                                   | 40                                | 10                                      | 150                                            | 0.5                            | 25.1             | 3.5                                                  | 0.6                                                          | 144                                                           |
| <b>1N5365B</b>                | <b>36</b>                                                            | <b>30</b>                         | <b>11</b>                               | <b>160</b>                                     | <b>0.5</b>                     | <b>27.4</b>      | <b>3.3</b>                                           | <b>0.65</b>                                                  | <b>132</b>                                                    |
| 1N5366B                       | 39                                                                   | 30                                | 14                                      | 170                                            | 0.5                            | 29.7             | 3.1                                                  | 0.65                                                         | 122                                                           |
| 1N5367B                       | 43                                                                   | 30                                | 20                                      | 190                                            | 0.5                            | 32.7             | 2.8                                                  | 0.7                                                          | 110                                                           |
| <b>1N5368B</b>                | <b>47</b>                                                            | <b>25</b>                         | <b>25</b>                               | <b>210</b>                                     | <b>0.5</b>                     | <b>35.8</b>      | <b>2.7</b>                                           | <b>0.8</b>                                                   | <b>100</b>                                                    |
| 1N5369B                       | 51                                                                   | 25                                | 27                                      | 230                                            | 0.5                            | 38.8             | 2.5                                                  | 0.9                                                          | 93                                                            |
| 1N5370B                       | 56                                                                   | 20                                | 35                                      | 280                                            | 0.5                            | 42.6             | 2.3                                                  | 1                                                            | 86                                                            |
| 1N5371B                       | 60                                                                   | 20                                | 40                                      | 350                                            | 0.5                            | 42.5             | 2.2                                                  | 1.2                                                          | 79                                                            |
| 1N5372B                       | 62                                                                   | 20                                | 42                                      | 400                                            | 0.5                            | 47.1             | 2.1                                                  | 1.35                                                         | 76                                                            |
| 1N5373B                       | 68                                                                   | 20                                | 44                                      | 500                                            | 0.5                            | 51.7             | 2                                                    | 1.5                                                          | 70                                                            |
| 1N5374B                       | 75                                                                   | 20                                | 45                                      | 620                                            | 0.5                            | 56               | 1.9                                                  | 1.6                                                          | 63                                                            |
| 1N5375B                       | 82                                                                   | 15                                | 65                                      | 720                                            | 0.5                            | 62.2             | 1.8                                                  | 1.8                                                          | 58                                                            |
| 1N5376B                       | 87                                                                   | 15                                | 75                                      | 760                                            | 0.5                            | 66               | 1.7                                                  | 2                                                            | 54.5                                                          |
| 1N5377B                       | 91                                                                   | 15                                | 75                                      | 760                                            | 0.5                            | 69.2             | 1.6                                                  | 2.2                                                          | 52.5                                                          |
| 1N5378B                       | 100                                                                  | 12                                | 90                                      | 800                                            | 0.5                            | 76               | 1.5                                                  | 2.5                                                          | 47.5                                                          |
| 1N5379B                       | 110                                                                  | 12                                | 125                                     | 1000                                           | 0.5                            | 83.6             | 1.4                                                  | 2.5                                                          | 43                                                            |
| 1N5380B                       | 120                                                                  | 10                                | 170                                     | 1150                                           | 0.5                            | 91.2             | 1.3                                                  | 2.5                                                          | 39.5                                                          |
| 1N5381B                       | 130                                                                  | 10                                | 190                                     | 1250                                           | 0.5                            | 98.8             | 1.2                                                  | 2.5                                                          | 36.6                                                          |
| 1N5382B                       | 140                                                                  | 8                                 | 230                                     | 1500                                           | 0.5                            | 106              | 1.2                                                  | 2.5                                                          | 34                                                            |

(continued)

Devices listed in bold, italic are Motorola preferred devices.

# 1N5333B through 1N5388B

## ELECTRICAL CHARACTERISTICS — continued ( $T_A = 25^\circ\text{C}$ unless otherwise noted, $V_F = 1.2$ Max @ $I_F = 1$ A for all types)

| JEDEC<br>Type No.<br>(Note 1) | Nominal<br>Zener<br>Voltage<br>$V_Z$ @ $I_{ZT}$<br>Volts<br>(Note 2) | Test<br>Current<br>$I_{ZT}$<br>mA | Max Zener Impedance                     |                                                | Max Reverse<br>Leakage Current |                  | Max<br>Surge<br>Current<br>$i_F$ Amps<br>(Note 3) | Max Voltage<br>Regulation<br>$\Delta V_Z$ , Volt<br>(Note 4) | Maximum<br>Regulator<br>Current<br>$I_{ZM}$<br>mA<br>(Note 5) |
|-------------------------------|----------------------------------------------------------------------|-----------------------------------|-----------------------------------------|------------------------------------------------|--------------------------------|------------------|---------------------------------------------------|--------------------------------------------------------------|---------------------------------------------------------------|
|                               |                                                                      |                                   | $Z_{ZT}$ @ $I_{ZT}$<br>Ohms<br>(Note 2) | $Z_{ZK}$ @ $I_{ZK} = 1$ mA<br>Ohms<br>(Note 2) | $I_R$<br>$\mu\text{A}$         | @ $V_R$<br>Volts |                                                   |                                                              |                                                               |
| <b>1N5333B</b>                | <b>150</b>                                                           | <b>8</b>                          | <b>330</b>                              | <b>1500</b>                                    | <b>0.5</b>                     | <b>114</b>       | <b>1.1</b>                                        | <b>3</b>                                                     | <b>31.6</b>                                                   |
| 1N5384B                       | 160                                                                  | 8                                 | 350                                     | 1650                                           | 0.5                            | 122              | 1.1                                               | 3                                                            | 29.4                                                          |
| 1N5385B                       | 170                                                                  | 8                                 | 380                                     | 1750                                           | 0.5                            | 129              | 1                                                 | 3                                                            | 28                                                            |
| 1N5386B                       | 180                                                                  | 5                                 | 430                                     | 1750                                           | 0.5                            | 137              | 1                                                 | 4                                                            | 26.4                                                          |
| 1N5387B                       | 190                                                                  | 5                                 | 450                                     | 1850                                           | 0.5                            | 144              | 0.9                                               | 5                                                            | 25                                                            |
| 1N5388B                       | 200                                                                  | 5                                 | 480                                     | 1850                                           | 0.5                            | 152              | 0.9                                               | 5                                                            | 23.6                                                          |

### NOTE 1. TOLERANCE AND TYPE NUMBER DESIGNATION

The JEDEC type numbers shown indicate a tolerance of  $\pm 5\%$ .

### NOTE 2. ZENER VOLTAGE ( $V_Z$ ) AND IMPEDANCE ( $Z_{ZT}$ & $Z_{ZK}$ )

Test conditions for zener voltage and impedance are as follows:  $I_Z$  is applied  $40 \pm 10$  ms prior to reading. Mounting contacts are located  $3/8"$  to  $1/2"$  from the inside edge of mounting clips to the body of the diode. ( $T_A = 25^\circ\text{C} +8, -2^\circ\text{C}$ ).

### NOTE 3. SURGE CURRENT ( $i_F$ )

Surge current is specified as the maximum allowable peak, non-recurrent square-wave current with a pulse width, PW, of 8.3 ms. The data given in Figure 6 may be used to find the maximum surge current for a square wave of any pulse width between 1ms and 1000 ms by plotting the applicable points on logarithmic paper. Examples of this, using the 3.3 V and 200 V zeners, are shown in Figure 7. Mounting contact located as specified in Note 3. ( $T_A = 25^\circ\text{C} +8, -2^\circ\text{C}$ ).

### NOTE 4. VOLTAGE REGULATION ( $\Delta V_Z$ )

Test conditions for voltage regulation are as follows:  $V_Z$  measurements are made at 10% and then at 50% of the  $I_Z$  max value listed in the electrical characteristics table. The test current time duration for each  $V_Z$  measurement is  $40 \pm 10$  ms. ( $T_A = 25^\circ\text{C} +8, -2^\circ\text{C}$ ). Mounting contact located as specified in Note 2.

### NOTE 5. MAXIMUM REGULATOR CURRENT ( $I_{ZM}$ )

The maximum current shown is based on the maximum voltage of a 5% type unit, therefore, it applies only to the B-suffix device. The actual  $I_{ZM}$  for any device may not exceed the value of 5 watts divided by the actual  $V_Z$  of the device.  $T_L = 75^\circ\text{C}$  at  $3/8"$  maximum from the device body.

### NOTE 6. SPECIALS AVAILABLE INCLUDE:

Nominal zener voltages between the voltages shown and tighter voltage tolerance such as  $\pm 1\%$  and  $\pm 2\%$ . Consult factory.

## TEMPERATURE COEFFICIENTS

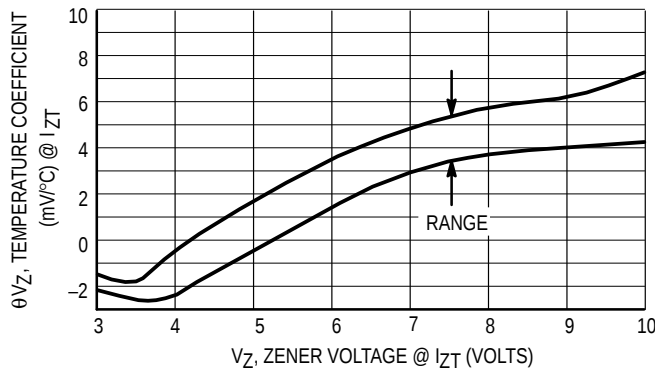


Figure 2. Temperature Coefficient-Range for Units 3 to 10 Volts

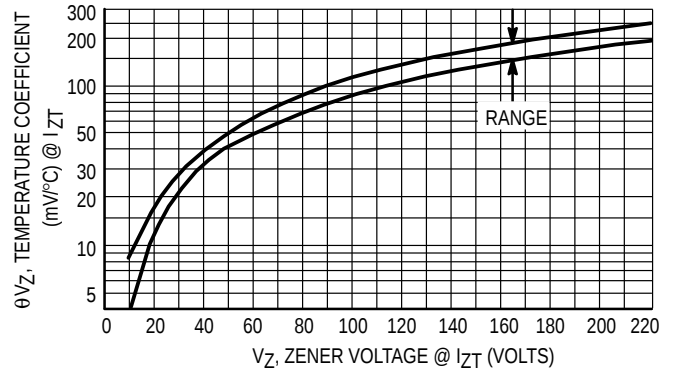
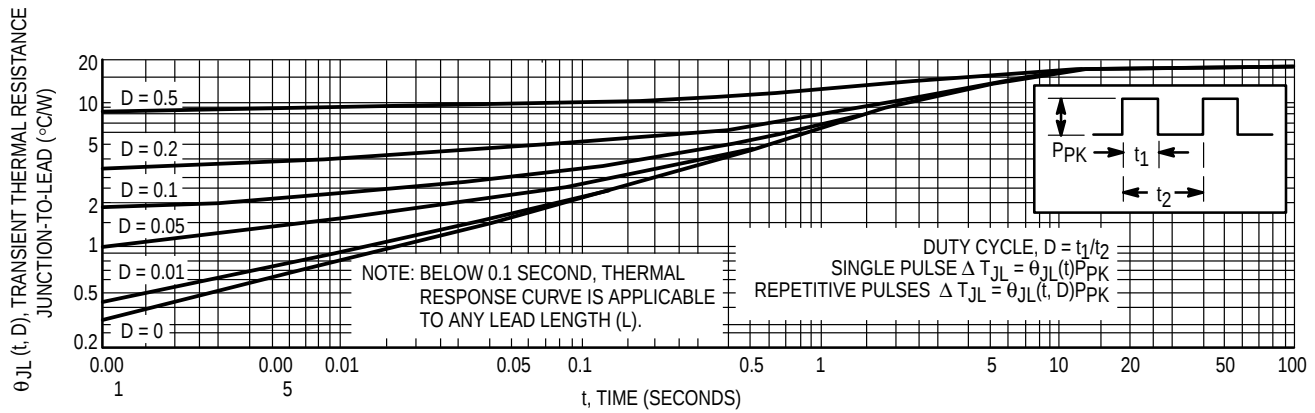


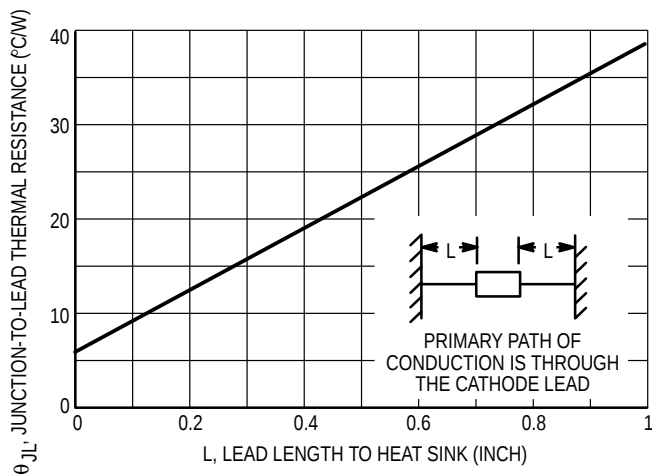
Figure 3. Temperature Coefficient-Range for Units 10 to 220 Volts

Devices listed in bold, italic are Motorola preferred devices.

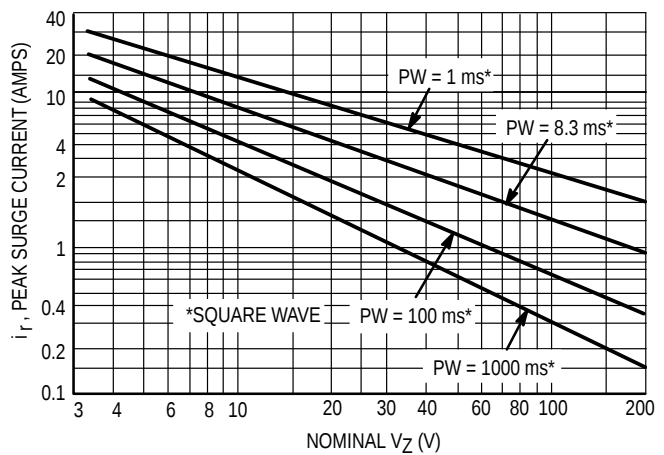
# 1N5333B through 1N5388B



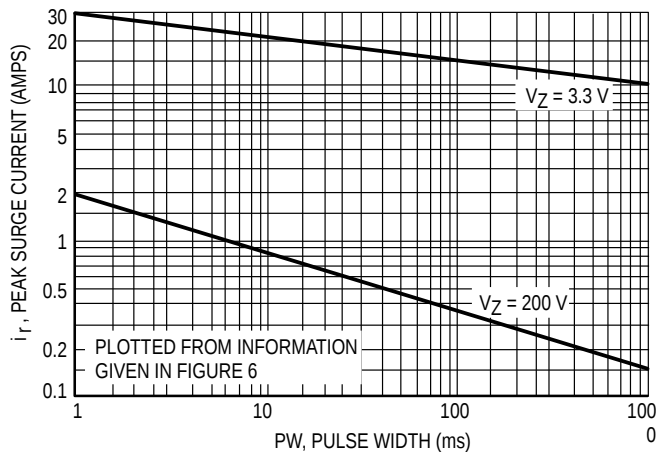
**Figure 4. Typical Thermal Response**  
**L, Lead Length = 3/8 Inch**



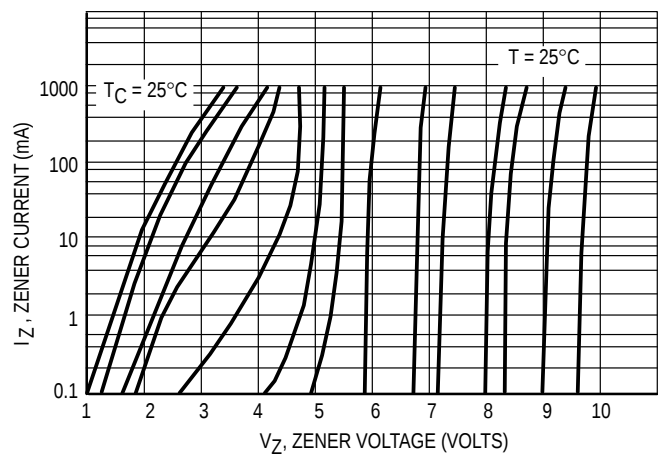
**Figure 5. Typical Thermal Resistance**



**Figure 6. Maximum Non-Repetitive Surge Current**  
**versus Nominal Zener Voltage**  
**(See Note 3)**

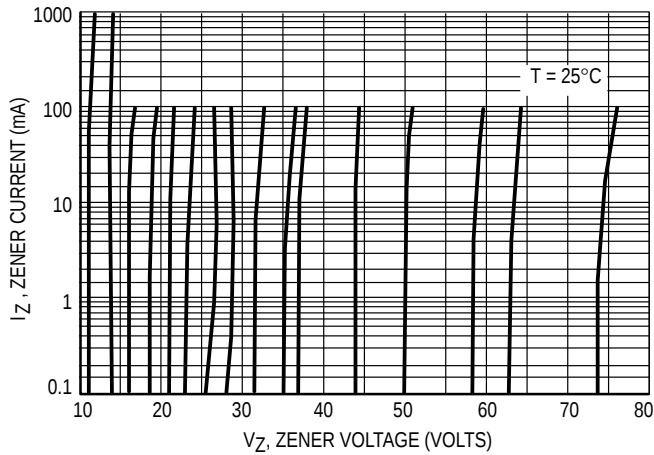


**Figure 7. Peak Surge Current versus Pulse Width**  
**(See Note 3)**

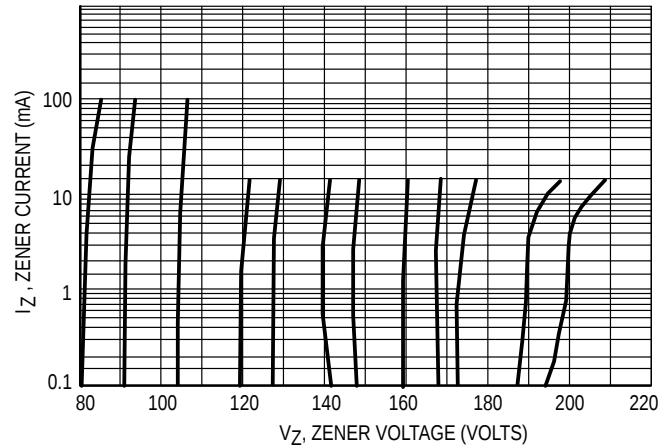


**Figure 8. Zener Voltage versus Zener Current**  
 **$V_Z = 3.3$  thru 10 Volts**

# 1N5333B through 1N5388B



**Figure 9. Zener Voltage versus Zener Current**  
 **$V_Z = 11$  thru  $75$  Volts**



**Figure 10. Zener Voltage versus Zener Current**  
 **$V_Z = 82$  thru  $200$  Volts**

## 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 and  $P_D$  is the power dissipation.

Junction Temperature,  $T_J$ , may be found from:

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

$\Delta T_{JL}$  is the increase in junction temperature above the lead temperature and may be found from Figure 4 for a train of power pulses or from Figure 5 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:

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

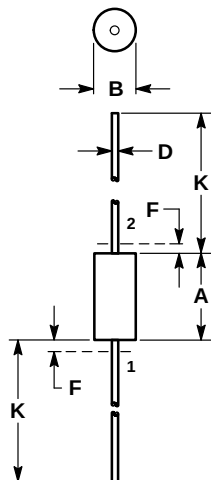
$\theta_{VZ}$ , the zener voltage temperature coefficient, is found from Figures 2 and 3.

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 4 should not be used to compute surge capability. Surge limitations are given in Figure 6. 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 6 be exceeded.

# Zener Voltage Regulator Diodes — Axial Leaded

## 5 Watt Surmetic 40



NOTE:  
1. LEAD DIAMETER & FINISH NOT CONTROLLED  
WITHIN DIM F.

| DIM | INCHES |       | MILLIMETERS |       |
|-----|--------|-------|-------------|-------|
|     | MIN    | MAX   | MIN         | MAX   |
| A   | 0.330  | 0.350 | 8.38        | 8.89  |
| B   | 0.130  | 0.145 | 3.30        | 3.68  |
| D   | 0.037  | 0.043 | 0.94        | 1.09  |
| F   | —      | 0.050 | —           | 1.27  |
| K   | 1.000  | 1.250 | 25.40       | 31.75 |

CASE 17-02  
PLASTIC

(Refer to Section 10 for Surface Mount, Thermal Data and Footprint Information.)

### MULTIPLE PACKAGE QUANTITY (MPQ) REQUIREMENTS

| Package Option | Type No. Suffix | MPQ (Units) |
|----------------|-----------------|-------------|
| Tape and Reel  | RL              | 4K          |
| Tape and Ammo  | TA              | 2K          |

(Refer to Section 10 for more information on Packaging Specifications.)

Devices listed in bold, italic are Motorola preferred devices.