# MMSZ2V4ET1 Series

# Zener Voltage Regulators

## 500 mW SOD−123 Surface Mount

Three complete series of Zener diodes are offered in the convenient, surface mount plastic SOD−123 package. These devices provide a convenient alternative to the leadless 34−package style.

**Specification Features:**

- 500 mW Rating on FR−4 or FR−5 Board
- Wide Zener Reverse Voltage Range − 2.4 V to 56 V
- Package Designed for Optimal Automated Board Assembly
- Small Package Size for High Density Applications
- ESD Rating of Class 3 (>16 KV) per Human Body Model
- Peak Power − 225 Watt (8 X 20 μs)

**Mechanical Characteristics:**

**CASE:** Void-free, transfer-molded, thermosetting plastic case
**FINISH:** Corrosion resistant finish, easily solderable
**MAXIMUM CASE TEMPERATURE FOR SOLDERING PURPOSES:**
260°C for 10 Seconds
**POLARITY:** Cathode indicated by polarity band
**FLAMMABILITY RATING:** UL94 V−0

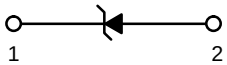
**MAXIMUM RATINGS**

| Rating | Symbol | Max | Unit |
|---|---|---|---|
| Peak Power Dissipation @ 20 μs (Note 1) @ $T_L \le 25°C$ | $P_{pk}$ | 225 | Watts |
| Total Power Dissipation on FR−5 Board, (Note 2) @ $T_L = 75°C$<br>Derated above 75°C | $P_D$ | 500<br>6.7 | mW<br>mW/°C |
| Thermal Resistance − Junction to Ambient (Note 3) | $R_{\theta JA}$ | 340 | °C/W |
| Thermal Resistance − Junction to Lead (Note 3) | $R_{\theta JL}$ | 150 | °C/W |
| Junction and Storage Temperature Range | $T_J$, $T_{stg}$ | −55 to +150 | °C |

1. Non−repetitive current pulse per Figure 11
2. FR−5 = 3.5 X 1.5 inches, using the On minimum recommended footprint as shown in Figure 12
3. Thermal Resistance measurement obtained via infrared Scan Method

ON Semiconductor®

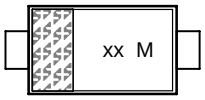
http://onsemi.com





**SOD−123**
**CASE 425**
**STYLE 1**

**MARKING DIAGRAM**




xx = Specific Device Code
M = Date Code

**ORDERING INFORMATION**

| Device † | Package | Shipping |
|---|---|---|
| MMSZxxxET1 | SOD−123 | 3000/Tape & Reel |
| MMSZxxxET3 | SOD−123 | 10,000/Tape & Reel |

**DEVICE MARKING INFORMATION**

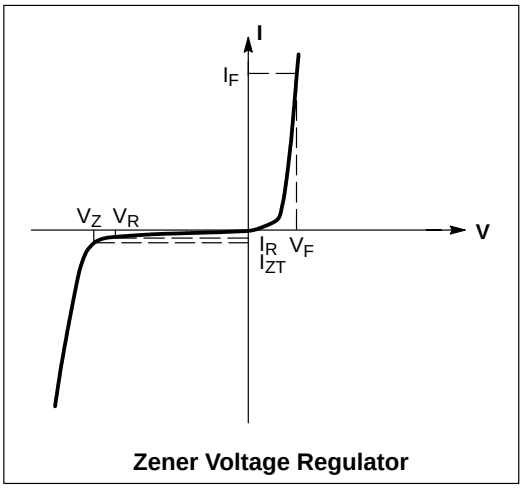
See specific marking information in the device marking column of the Electrical Characteristics table on page 2 of this data sheet.

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

†The "T1" suffix refers to an 8 mm, 7 inch reel.
The "T3" suffix refers to an 8 mm, 13 inch reel.

**ELECTRICAL CHARACTERISTICS** ($T_A$ = 25°C unless otherwise noted, $V_F$ = 0.95 V Max. @ $I_F$ = 10 mA)

| Symbol | Parameter |
|---|---|
| $V_Z$ | Reverse Zener Voltage @ $I_{ZT}$ |
| $I_{ZT}$ | Reverse Current |
| $Z_{ZT}$ | Maximum Zener Impedance @ $I_{ZT}$ |
| $I_R$ | Reverse Leakage Current @ $V_R$ |
| $V_R$ | Reverse Voltage |
| $I_F$ | Forward Current |
| $V_F$ | Forward Voltage @ $I_F$ |




**Zener Voltage Regulator**

**ELECTRICAL CHARACTERISTICS** ($T_A$ = 25°C unless otherwise noted, $V_F$ = 0.9 V Max. @ $I_F$ = 10 mA)

| Device | Device Marking | $V_{Z1}$ (Volts) (Notes 4 and 5) @ $I_{ZT1}$ = 5 mA | | | $Z_{ZT1}$ (Note 6) | $V_{Z2}$ (Volts) (Notes 4 and 5) @ $I_{ZT2}$ = 1 mA | | $Z_{ZT2}$ (Note 6) | Leakage Current $I_R$ @ $V_R$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Min | Nom | Max | Ω | Min | Max | Ω | μA | Volts |
| MMSZ2V4ET1 | T1 | 2.28 | 2.4 | 2.52 | 100 | 1.7 | 2.1 | 600 | 50 | 1 |
| MMSZ2V7ET1 | T2 | 2.57 | 2.7 | 2.84 | 100 | 1.9 | 2.4 | 600 | 20 | 1 |
| MMSZ3V0ET1 | T3 | 2.85 | 3.0 | 3.15 | 95 | 2.1 | 2.7 | 600 | 10 | 1 |
| MMSZ3V3ET1 | T4 | 3.14 | 3.3 | 3.47 | 95 | 2.3 | 2.9 | 600 | 5 | 1 |
| MMSZ3V6ET1 | T5 | 3.42 | 3.6 | 3.78 | 90 | 2.7 | 3.3 | 600 | 5 | 1 |
| MMSZ3V9ET1 | U1 | 3.71 | 3.9 | 4.10 | 90 | 2.9 | 3.5 | 600 | 3 | 1 |
| MMSZ4V3ET1 | U2 | 4.09 | 4.3 | 4.52 | 90 | 3.3 | 4.0 | 600 | 3 | 1 |
| MMSZ4V7ET1 | U3 | 4.47 | 4.7 | 4.94 | 80 | 3.7 | 4.7 | 500 | 3 | 2 |
| ***MMSZ5V1ET1*** | ***U4*** | ***4.85*** | ***5.1*** | ***5.36*** | ***60*** | ***4.2*** | ***5.3*** | ***480*** | ***2*** | ***2*** |
| ***MMSZ5V6ET1*** | ***U5*** | ***5.32*** | ***5.6*** | ***5.88*** | ***40*** | ***4.8*** | ***6.0*** | ***400*** | ***1*** | ***2*** |
| ***MMSZ6V2ET1*** | ***V1*** | ***5.89*** | ***6.2*** | ***6.51*** | ***10*** | ***5.6*** | ***6.6*** | ***150*** | ***3*** | ***4*** |
| MMSZ6V8ET1 | V2 | 6.46 | 6.8 | 7.14 | 15 | 6.3 | 7.2 | 80 | 2 | 4 |
| MMSZ7V5ET1 | V3 | 7.13 | 7.5 | 7.88 | 15 | 6.9 | 7.9 | 80 | 1 | 5 |
| MMSZ8V2ET1 | V4 | 7.79 | 8.2 | 8.61 | 15 | 7.6 | 8.7 | 80 | 0.7 | 5 |
| MMSZ9V1ET1 | V5 | 8.65 | 9.1 | 9.56 | 15 | 8.4 | 9.6 | 100 | 0.5 | 6 |
| MMSZ10ET1 | A1 | 9.50 | 10 | 10.50 | 20 | 9.3 | 10.6 | 150 | 0.2 | 7 |
| MMSZ11ET1 | A2 | 10.45 | 11 | 11.55 | 20 | 10.2 | 11.6 | 150 | 0.1 | 8 |
| MMSZ12ET1 | A3 | 11.40 | 12 | 12.60 | 25 | 11.2 | 12.7 | 150 | 0.1 | 8 |
| MMSZ13ET1 | A4 | 12.35 | 13 | 13.65 | 30 | 12.3 | 14.0 | 170 | 0.1 | 8 |
| MMSZ15ET1 | A5 | 14.25 | 15 | 15.75 | 30 | 13.7 | 15.5 | 200 | 0.05 | 10.5 |
| MMSZ16ET1 | X1 | 15.20 | 16 | 16.80 | 40 | 15.2 | 17.0 | 200 | 0.05 | 11.2 |
| ***MMSZ18ET1*** | ***X2*** | ***17.10*** | ***18*** | ***18.90*** | ***45*** | ***16.7*** | ***19.0*** | ***225*** | ***0.05*** | ***12.6*** |
| MMSZ20ET1 | X3 | 19.00 | 20 | 21.00 | 55 | 18.7 | 21.1 | 225 | 0.05 | 14 |
| MMSZ22ET1 | X4 | 20.90 | 22 | 23.10 | 55 | 20.7 | 23.2 | 250 | 0.05 | 15.4 |
| MMSZ24ET1 | X5 | 22.80 | 24 | 25.20 | 70 | 22.7 | 25.5 | 250 | 0.05 | 16.8 |

4. The type numbers shown have a standard tolerance of ±5% on the nominal Zener Voltage.
5. Tolerance and Voltage Designation: Zener Voltage (VZ) is measured with the Zener Current applied for PW = 1 ms.
6. $Z_{ZT}$ 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 kHz.

**ELECTRICAL CHARACTERISTICS** ($T_A$ = 25°C unless otherwise noted, $V_F$ = 0.9 V Max. @ $I_F$ = 10 mA)

| Device | Device Marking | $V_{Z1}$ (Volts) (Notes 7 and 8) @ $I_{ZT1}$ = 2 mA | | | $Z_{ZT1}$ (Note 9) | $V_{Z2}$ (Volts) (Notes 7 and 8) @ $I_{ZT2}$ = 0.1 mA | | $Z_{ZT2}$ (Note 9) @ $I_{ZT3}$ = 0.5 mA | Leakage Current $I_R$ @ $V_R$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Min | Nom | Max | Ω | Min | Max | Ω | μA | Volts |
| MMSZ27ET1 | Y1 | 25.65 | 27 | 28.35 | 80 | 25 | 28.9 | 300 | 0.05 | 18.9 |
| MMSZ30ET1 | Y2 | 28.50 | 30 | 31.50 | 80 | 27.8 | 32 | 300 | 0.05 | 21 |
| MMSZ33ET1 | Y3 | 31.35 | 33 | 34.65 | 80 | 30.8 | 35 | 325 | 0.05 | 23.1 |
| MMSZ36ET1 | Y4 | 34.20 | 36 | 37.80 | 90 | 33.8 | 38 | 350 | 0.05 | 25.2 |
| ***MMSZ39ET1*** | ***Y5*** | ***37.05*** | ***39*** | ***40.95*** | ***130*** | ***36.7*** | ***41*** | ***350*** | ***0.05*** | ***27.3*** |
| MMSZ43ET1 | Z1 | 40.85 | 43 | 45.15 | 150 | 39.7 | 46 | 375 | 0.05 | 30.1 |
| MMSZ51ET1 | Z3 | 48.45 | 51 | 53.55 | 180 | 47.6 | 54 | 400 | 0.05 | 35.7 |
| MMSZ56ET1 | Z4 | 53.20 | 56 | 58.80 | 200 | 51.5 | 60 | 425 | 0.05 | 39.2 |

7. The type numbers shown have a standard tolerance of ±5% on the nominal Zener Voltage.
8. Tolerance and Voltage Designation: Zener Voltage (VZ) is measured with the Zener Current applied for PW = 1 ms.
9. $Z_{ZT}$ 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 kHz.

## TYPICAL CHARACTERISTICS

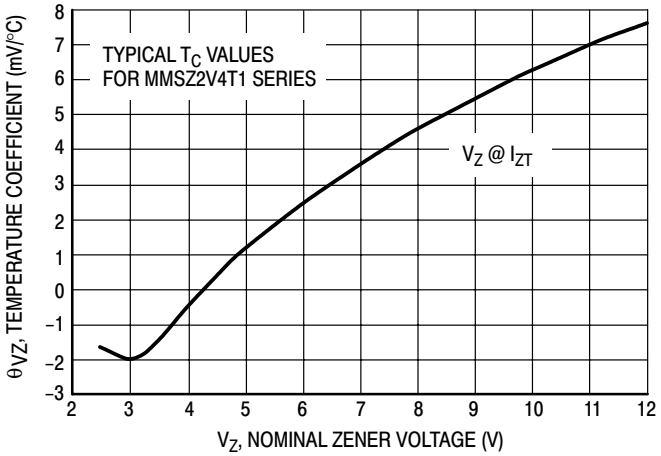



**Figure 1. Temperature Coefficients (Temperature Range −55°C to +150°C)**

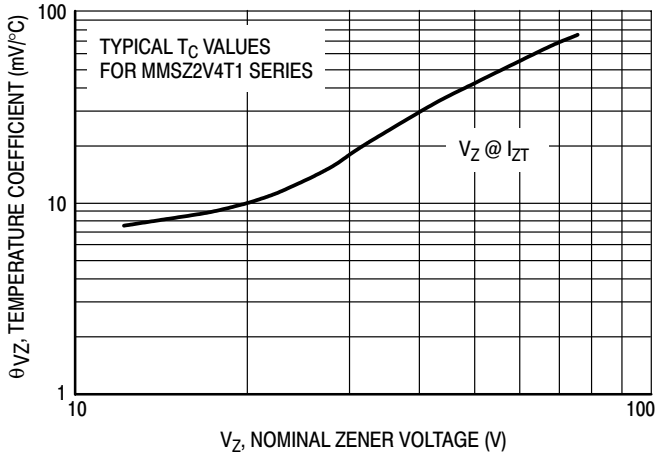



**Figure 2. Temperature Coefficients (Temperature Range −55°C to +150°C)**

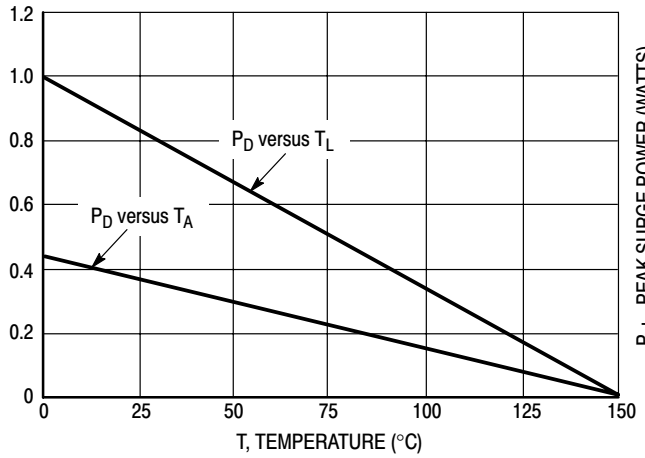



**Figure 3. Steady State Power Derating**

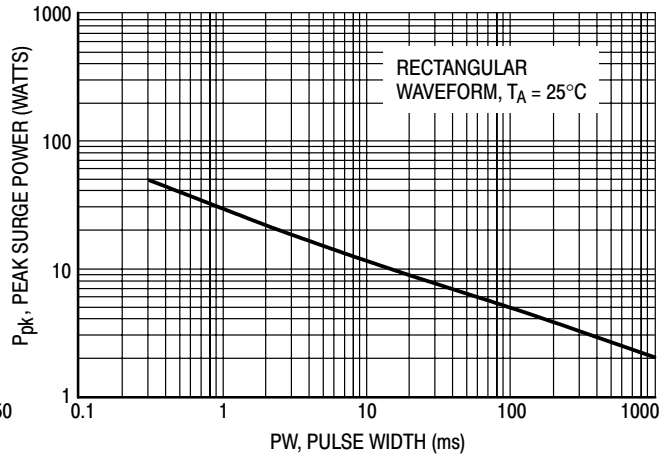



**Figure 4. Maximum Nonrepetitive Surge Power**

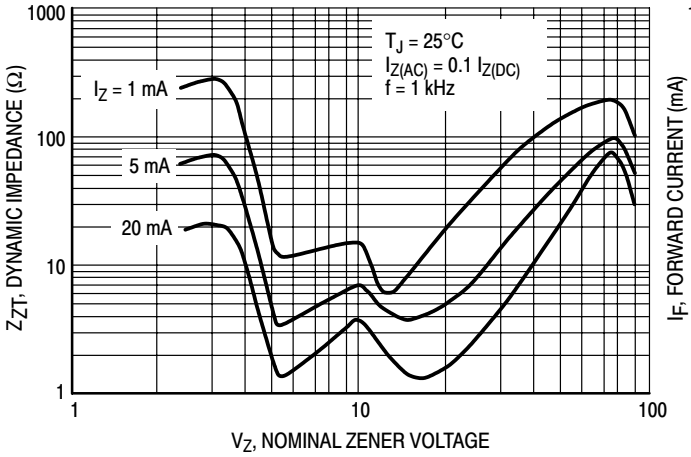



**Figure 5. Effect of Zener Voltage on Zener Impedance**

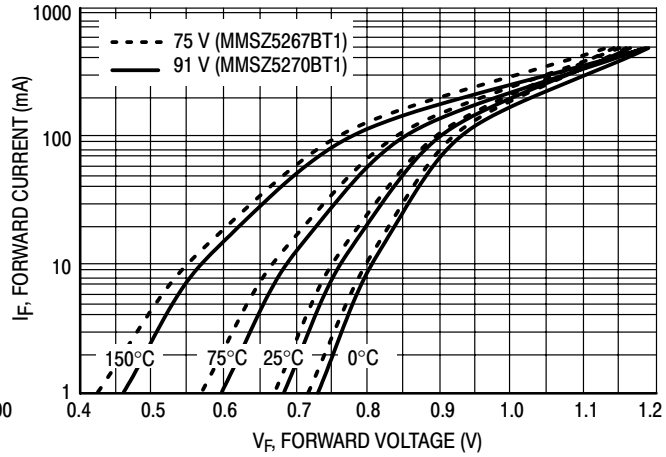



**Figure 6. Typical Forward Voltage**

## TYPICAL CHARACTERISTICS

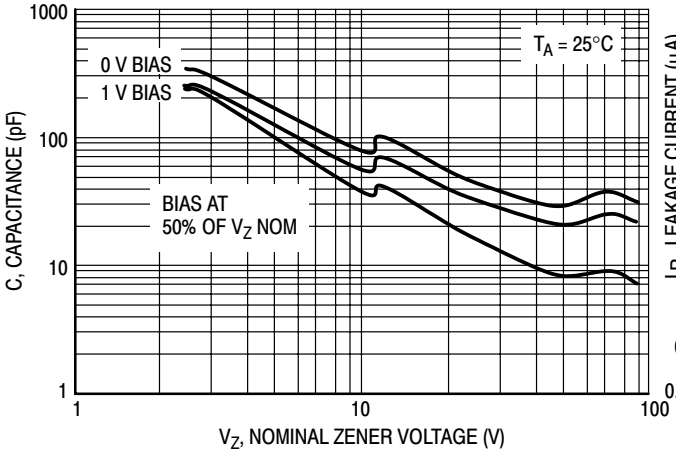



**Figure 7. Typical Capacitance**

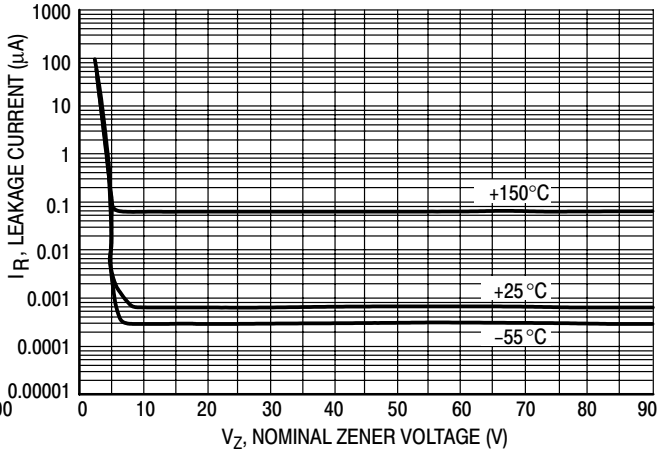



**Figure 8. Typical Leakage Current**

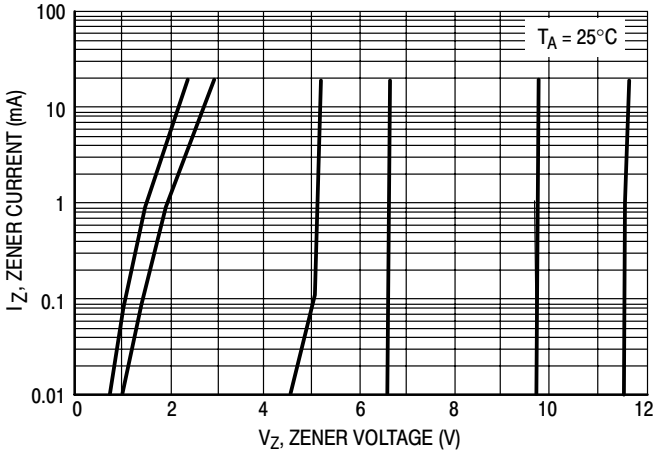



**Figure 9. Zener Voltage versus Zener Current ($V_Z$ Up to 12 V)**

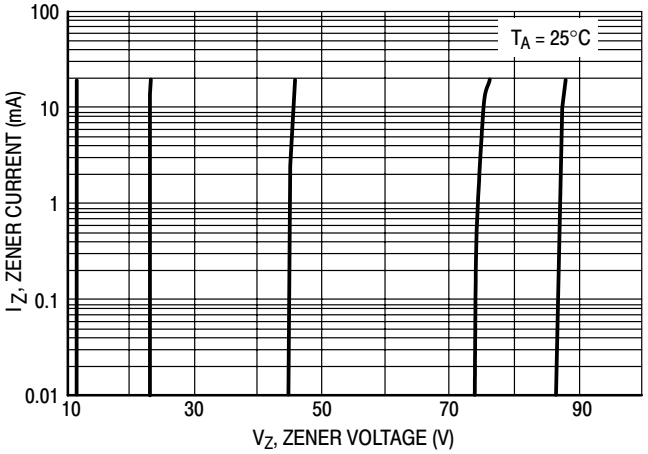



**Figure 10. Zener Voltage versus Zener Current (12 V to 91 V)**

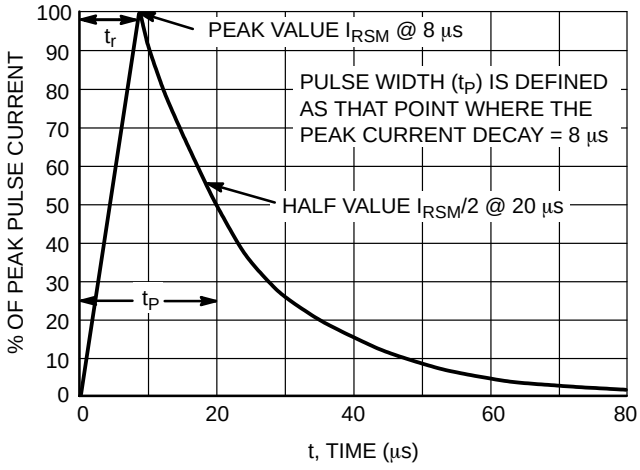



**Figure 11. 8 × 20 μs Pulse Waveform**

# INFORMATION FOR USING THE SOD-123 SURFACE MOUNT PACKAGE

## MINIMUM RECOMMENDED FOOTPRINTS FOR SURFACE MOUNT APPLICATIONS

Surface mount board layout is a critical portion of the total design. The footprint for the semiconductor packages must be the correct size to ensure proper solder connection interface between the board and the package.

The minimum recommended footprint for the SOD-123 is shown at the right.

The SOD-123 package can be used on existing surface mount boards which have been designed for the leadless 34 package style. The footprint compatibility makes conversion from leadless 34 to SOD-123 straightforward.

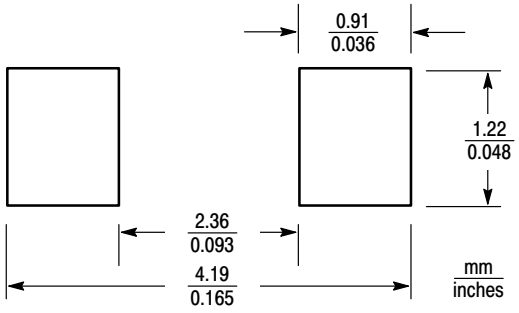



**Figure 12. Minimum Recommended Footprint**

## SOD-123 POWER DISSIPATION

The power dissipation of the SOD-123 is a function of the pad size. This can vary from the minimum pad size for soldering to a pad size given for maximum power dissipation. Power dissipation for a surface mount device is determined by $T_{J(max)}$, the maximum rated junction temperature of the die, $R_{\theta JA}$, the thermal resistance from the device junction to ambient; and the operating temperature, $T_A$. Using the values provided on the data sheet for the SOD-123 package, $P_D$ can be calculated as follows:

$$P_D = \frac{T_{J(max)} - T_A}{R_{\theta JA}}$$

The values for the equation are found in the maximum ratings table on the data sheet. Substituting these values into the equation for an ambient temperature $T_A$ of 25°C, one can calculate the power dissipation of the device which in this case is 0.37 watts.

$$P_D = \frac{150°C - 25°C}{340°C/W} = 0.37 \text{ watts}$$

The 340°C/W for the SOD-123 package assumes using recommended footprint shown on FR-4 glass epoxy printed circuit board. Another alternative is to use a ceramic substrate or an aluminum core board such as Thermal Clad®. By using an aluminum core board material such as Thermal Clad, the power dissipation can be doubled using the same footprint.

## GENERAL SOLDERING PRECAUTIONS

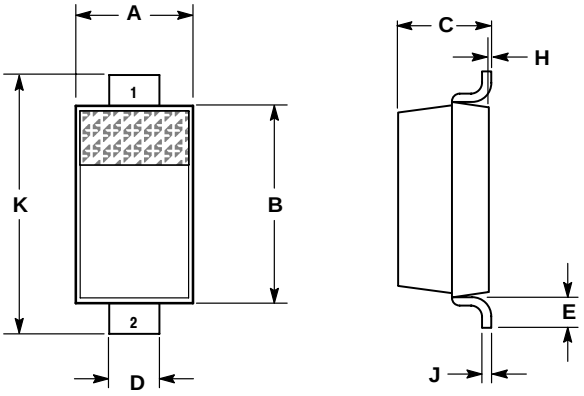
The melting temperature of solder is higher than the rated temperature of the device. When the entire device is heated to a high temperature, failure to complete soldering within a short time could result in device failure. Therefore, the following items should always be observed in order to minimize the thermal stress to which the devices are subjected.

- Always preheat the device.
- The delta temperature between the preheat and soldering should be 100°C or less.*
- When preheating and soldering, the temperature of the leads and the case must not exceed the maximum temperature ratings as shown on the data sheet. When using infrared heating with the reflow soldering method, the difference shall be a maximum of 10°C.
- The soldering temperature and time shall not exceed 260°C for more than 10 seconds.
- When shifting from preheating to soldering, the maximum temperature gradient shall be 5°C or less.
- After soldering has been completed, the device should be allowed to cool naturally for at least three minutes. Gradual cooling should be used as the use of forced cooling will increase the temperature gradient and result in latent failure due to mechanical stress.
- Mechanical stress or shock should not be applied during cooling

* Soldering a device without preheating can cause excessive thermal shock and stress which can result in damage to the device.

## PACKAGE DIMENSIONS

**SOD−123**
CASE 425−04
ISSUE C




NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 0.055 | 0.071 | 1.40 | 1.80 |
| B | 0.100 | 0.112 | 2.55 | 2.85 |
| C | 0.037 | 0.053 | 0.95 | 1.35 |
| D | 0.020 | 0.028 | 0.50 | 0.70 |
| E | 0.01 | −−− | 0.25 | −−− |
| H | 0.000 | 0.004 | 0.00 | 0.10 |
| J | −−− | 0.006 | −−− | 0.15 |
| K | 0.140 | 0.152 | 3.55 | 3.85 |

STYLE 1:
PIN 1. CATHODE
2. ANODE

Thermal Clad is a registered trademark of the Bergquist Company



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