

## Small Signal Zener Diodes



### FEATURES

- Saving space
- Hermetic sealed parts
- Electrical data identical with the devices BZT55..series, TZM..series
- Fits onto SOD-323
- Very sharp reverse characteristic
- Low reverse current level
- Very high stability
- Low noise
- AEC-Q101 qualified
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



**RoHS**  
COMPLIANT  
HALOGEN  
**FREE**

### DESIGN SUPPORT TOOLS AVAILABLE



| PRIMARY CHARACTERISTICS      |               |      |
|------------------------------|---------------|------|
| PARAMETER                    | VALUE         | UNIT |
| V <sub>Z</sub> range nom.    | 2.4 to 75     | V    |
| Test current I <sub>ZT</sub> | 2.5; 5        | mA   |
| V <sub>Z</sub> specification | Pulse current |      |
| Circuit configuration        | Single        |      |

### APPLICATIONS

- Voltage stabilization

| ORDERING INFORMATION |                  |                                |                        |
|----------------------|------------------|--------------------------------|------------------------|
| DEVICE NAME          | ORDERING CODE    | TAPED UNITS PER REEL           | MINIMUM ORDER QUANTITY |
| BZM55-series         | BZM55-series-TR3 | 10 000 (8 mm tape on 13" reel) | 10 000                 |
| BZM55-series         | BZM55-series-TR  | 2500 (8 mm tape on 7" reel)    | 12 500                 |

| PACKAGE      |        |                                         |                                      |                             |
|--------------|--------|-----------------------------------------|--------------------------------------|-----------------------------|
| PACKAGE NAME | WEIGHT | MOLDING COMPOUND<br>FLAMMABILITY RATING | MOISTURE SENSITIVITY<br>LEVEL        | SOLDERING CONDITIONS        |
| MicroMELF    | 12 mg  | UL 94 V-0                               | MSL level 1<br>(according J-STD-020) | Peak temperature max. 260°C |

| ABSOLUTE MAXIMUM RATINGS (T <sub>amb</sub> = 25 °C, unless otherwise specified) |                                                                  |                   |                                  |      |
|---------------------------------------------------------------------------------|------------------------------------------------------------------|-------------------|----------------------------------|------|
| PARAMETER                                                                       | TEST CONDITION                                                   | SYMBOL            | VALUE                            | UNIT |
| Power dissipation                                                               | R <sub>thJA</sub> ≤ 300 K/W                                      | P <sub>tot</sub>  | 500                              | mW   |
| Junction to ambient air                                                         | Mounted on epoxy-glass hard tissue, fig. 1                       | R <sub>thJA</sub> | 500                              | K/W  |
| Junction tie point                                                              | 35 µm copper clad, 0.9 mm <sup>2</sup> copper area per electrode | R <sub>thJL</sub> | 300                              | K/W  |
| Junction temperature                                                            |                                                                  | T <sub>j</sub>    | 175                              | °C   |
| Storage temperature range                                                       |                                                                  | T <sub>stg</sub>  | -65 to +175                      | °C   |
| Zener current                                                                   |                                                                  | I <sub>Z</sub>    | P <sub>tot</sub> /V <sub>Z</sub> | mA   |
| Forward voltage                                                                 | I <sub>F</sub> = 200 mA                                          | V <sub>F</sub>    | 1.5                              | V    |

**ELECTRICAL CHARACTERISTICS** ( $T_{amb} = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified)

| PART NUMBER | ZENER VOLTAGE RANGE <sup>(1)</sup> |      |      | TEST CURRENT     |                  | REVERSE LEAKAGE CURRENT          |                              |     | DYNAMIC RESISTANCE                 |                                     | TEMPERATURE COEFFICIENT |        |
|-------------|------------------------------------|------|------|------------------|------------------|----------------------------------|------------------------------|-----|------------------------------------|-------------------------------------|-------------------------|--------|
|             | V <sub>Z</sub> at I <sub>ZT1</sub> |      |      | I <sub>ZT1</sub> | I <sub>ZT2</sub> | I <sub>R</sub> at V <sub>R</sub> |                              |     | Z <sub>Z</sub> at I <sub>ZT1</sub> | Z <sub>ZK</sub> at I <sub>ZT2</sub> | TK <sub>VZ</sub>        |        |
|             |                                    |      |      |                  |                  | at T <sub>amb</sub> = 25 °C      | at T <sub>amb</sub> = 125 °C |     | f = 1 kHz                          |                                     |                         |        |
|             | V                                  |      |      | mA               |                  | μA                               |                              | V   | Ω                                  |                                     | % / K                   |        |
|             | MIN.                               | NOM. | MAX. |                  |                  |                                  |                              |     | MAX.                               | MAX.                                | MIN.                    | MAX.   |
| BZM55C2V4   | 2.28                               | 2.4  | 2.56 | 5                | 1                | < 50                             | < 100                        | 1   | < 85                               | < 600                               | - 0.09                  | - 0.06 |
| BZM55C2V7   | 2.5                                | 2.7  | 2.9  | 5                | 1                | < 10                             | < 50                         | 1   | < 85                               | < 600                               | - 0.09                  | - 0.06 |
| BZM55C3V0   | 2.8                                | 3.0  | 3.2  | 5                | 1                | < 4                              | < 40                         | 1   | < 90                               | < 600                               | - 0.08                  | - 0.05 |
| BZM55C3V3   | 3.1                                | 3.3  | 3.5  | 5                | 1                | < 2                              | < 40                         | 1   | < 90                               | < 600                               | - 0.08                  | - 0.05 |
| BZM55C3V6   | 3.4                                | 3.6  | 3.8  | 5                | 1                | < 2                              | < 40                         | 1   | < 90                               | < 600                               | - 0.08                  | - 0.05 |
| BZM55C3V9   | 3.7                                | 3.9  | 4.1  | 5                | 1                | < 2                              | < 40                         | 1   | < 90                               | < 600                               | - 0.08                  | - 0.05 |
| BZM55C4V3   | 4                                  | 4.3  | 4.6  | 5                | 1                | < 1                              | < 20                         | 1   | < 90                               | < 600                               | - 0.06                  | - 0.03 |
| BZM55C4V7   | 4.4                                | 4.7  | 5    | 5                | 1                | < 0.5                            | < 10                         | 1   | < 80                               | < 600                               | - 0.05                  | 0.02   |
| BZM55C5V1   | 4.8                                | 5.1  | 5.4  | 5                | 1                | < 0.1                            | < 2                          | 1   | < 60                               | < 550                               | - 0.02                  | 0.02   |
| BZM55C5V6   | 5.2                                | 5.6  | 6    | 5                | 1                | < 0.1                            | < 2                          | 1   | < 40                               | < 450                               | - 0.05                  | 0.05   |
| BZM55C6V2   | 5.8                                | 6.2  | 6.6  | 5                | 1                | < 0.1                            | < 2                          | 2   | < 10                               | < 200                               | 0.03                    | 0.06   |
| BZM55C6V8   | 6.4                                | 6.8  | 7.2  | 5                | 1                | < 0.1                            | < 2                          | 3   | < 8                                | < 150                               | 0.03                    | 0.07   |
| BZM55C7V5   | 7                                  | 7.5  | 7.9  | 5                | 1                | < 0.1                            | < 2                          | 5   | < 7                                | < 50                                | 0.03                    | 0.07   |
| BZM55C8V2   | 7.7                                | 8.2  | 8.7  | 5                | 1                | < 0.1                            | < 2                          | 6.2 | < 7                                | < 50                                | 0.03                    | 0.08   |
| BZM55C9V1   | 8.5                                | 9.1  | 9.6  | 5                | 1                | < 0.1                            | < 2                          | 6.8 | < 10                               | < 50                                | 0.03                    | 0.09   |
| BZM55C10    | 9.4                                | 10   | 10.6 | 5                | 1                | < 0.1                            | < 2                          | 7.5 | < 15                               | < 70                                | 0.03                    | 0.1    |
| BZM55C11    | 10.4                               | 11   | 11.6 | 5                | 1                | < 0.1                            | < 2                          | 8.2 | < 20                               | < 70                                | 0.03                    | 0.11   |
| BZM55C12    | 11.4                               | 12   | 12.7 | 5                | 1                | < 0.1                            | < 2                          | 9.1 | < 20                               | < 90                                | 0.03                    | 0.11   |
| BZM55C13    | 12.4                               | 13   | 14.1 | 5                | 1                | < 0.1                            | < 2                          | 10  | < 26                               | < 110                               | 0.03                    | 0.11   |
| BZM55C15    | 13.8                               | 15   | 15.6 | 5                | 1                | < 0.1                            | < 2                          | 11  | < 30                               | < 110                               | 0.03                    | 0.11   |
| BZM55C16    | 15.3                               | 16   | 17.1 | 5                | 1                | < 0.1                            | < 2                          | 12  | < 40                               | < 170                               | 0.03                    | 0.11   |
| BZM55C18    | 16.8                               | 18   | 19.1 | 5                | 1                | < 0.1                            | < 2                          | 13  | < 50                               | < 170                               | 0.03                    | 0.11   |
| BZM55C20    | 18.8                               | 20   | 21.2 | 5                | 1                | < 0.1                            | < 2                          | 15  | < 55                               | < 220                               | 0.03                    | 0.11   |
| BZM55C22    | 20.8                               | 22   | 23.3 | 5                | 1                | < 0.1                            | < 2                          | 16  | < 55                               | < 220                               | 0.04                    | 0.12   |
| BZM55C24    | 22.8                               | 24   | 25.6 | 5                | 1                | < 0.1                            | < 2                          | 18  | < 80                               | < 220                               | 0.04                    | 0.12   |
| BZM55C27    | 25.1                               | 27   | 28.9 | 5                | 1                | < 0.1                            | < 2                          | 20  | < 80                               | < 220                               | 0.04                    | 0.12   |
| BZM55C30    | 28                                 | 30   | 32   | 5                | 1                | < 0.1                            | < 2                          | 22  | < 80                               | < 220                               | 0.04                    | 0.12   |
| BZM55C33    | 31                                 | 33   | 35   | 5                | 1                | < 0.1                            | < 2                          | 24  | < 80                               | < 220                               | 0.04                    | 0.12   |
| BZM55C36    | 34                                 | 36   | 38   | 5                | 1                | < 0.1                            | < 2                          | 27  | < 80                               | < 220                               | 0.04                    | 0.12   |
| BZM55C39    | 37                                 | 39   | 41   | 2.5              | 0.5              | < 0.1                            | < 5                          | 30  | < 90                               | < 500                               | 0.04                    | 0.12   |
| BZM55C43    | 40                                 | 43   | 46   | 2.5              | 0.5              | < 0.1                            | < 5                          | 33  | < 90                               | < 600                               | 0.04                    | 0.12   |
| BZM55C47    | 44                                 | 47   | 50   | 2.5              | 0.5              | < 0.1                            | < 5                          | 36  | 110                                | < 700                               | 0.04                    | 0.12   |
| BZM55C51    | 48                                 | 51   | 54   | 2.5              | 0.5              | < 0.1                            | < 10                         | 39  | 125                                | < 700                               | 0.04                    | 0.12   |
| BZM55C56    | 52                                 | 56   | 60   | 2.5              | 0.5              | < 0.1                            | < 10                         | 43  | 135                                | < 1000                              | 0.04                    | 0.12   |
| BZM55C62    | 58                                 | 62   | 66   | 2.5              | 0.5              | < 0.1                            | < 10                         | 47  | 150                                | < 1000                              | 0.04                    | 0.12   |
| BZM55C68    | 64                                 | 68   | 72   | 2.5              | 0.5              | < 0.1                            | < 10                         | 51  | 200                                | < 1000                              | 0.04                    | 0.12   |
| BZM55C75    | 70                                 | 75   | 79   | 2.5              | 0.5              | < 0.1                            | < 10                         | 56  | 250                                | < 1500                              | 0.04                    | 0.12   |

**Notes**

- Additional measurement of voltage group 9V1 to 75 at 95 %  $V_{Zmin.} \leq 35\text{ nA}$  at  $T_j = 25\text{ }^{\circ}\text{C}$

<sup>(1)</sup>  $t_p \leq 10\text{ ms}$ ,  $T/t_p > 1000$

**ELECTRICAL CHARACTERISTICS** ( $T_{amb} = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified)

| PART NUMBER | ZENER VOLTAGE RANGE <sup>(1)</sup> |      |       | TEST CURRENT     |                  | REVERSE LEAKAGE CURRENT          |                              |     | DYNAMIC RESISTANCE                 |                                     | TEMPERATURE COEFFICIENT |       |
|-------------|------------------------------------|------|-------|------------------|------------------|----------------------------------|------------------------------|-----|------------------------------------|-------------------------------------|-------------------------|-------|
|             | V <sub>Z</sub> at I <sub>ZT1</sub> |      |       | I <sub>ZT1</sub> | I <sub>ZT2</sub> | I <sub>R</sub> at V <sub>R</sub> |                              |     | Z <sub>Z</sub> at I <sub>ZT1</sub> | Z <sub>ZK</sub> at I <sub>ZT2</sub> | TK <sub>VZ</sub>        |       |
|             |                                    |      |       |                  |                  | at T <sub>amb</sub> = 25 °C      | at T <sub>amb</sub> = 125 °C |     | f = 1 kHz                          |                                     |                         |       |
|             | V                                  |      |       | mA               |                  | μA                               |                              | V   | Ω                                  |                                     | % / K                   |       |
|             | MIN.                               | NOM. | MAX.  |                  |                  |                                  |                              |     | MAX.                               | MAX.                                | MIN.                    | MAX.  |
| BZM55B2V4   | 2.35                               | 2.4  | 2.45  | 5                | 1                | < 50                             | < 100                        | 1   | < 85                               | < 600                               | -0.09                   | -0.06 |
| BZM55B2V7   | 2.64                               | 2.7  | 2.76  | 5                | 1                | < 10                             | < 50                         | 1   | < 85                               | < 600                               | -0.09                   | -0.06 |
| BZM55B3V0   | 2.94                               | 3.0  | 3.06  | 5                | 1                | < 4                              | < 40                         | 1   | < 90                               | < 600                               | -0.08                   | -0.05 |
| BZM55B3V3   | 3.24                               | 3.3  | 3.36  | 5                | 1                | < 2                              | < 40                         | 1   | < 90                               | < 600                               | -0.08                   | -0.05 |
| BZM55B3V6   | 3.52                               | 3.6  | 3.68  | 5                | 1                | < 2                              | < 40                         | 1   | < 90                               | < 600                               | -0.08                   | -0.05 |
| BZM55B3V9   | 3.82                               | 3.9  | 3.98  | 5                | 1                | < 2                              | < 40                         | 1   | < 90                               | < 600                               | -0.08                   | -0.05 |
| BZM55B4V3   | 4.22                               | 4.3  | 4.38  | 5                | 1                | < 1                              | < 20                         | 1   | < 90                               | < 600                               | -0.06                   | -0.03 |
| BZM55B4V7   | 4.6                                | 4.7  | 4.8   | 5                | 1                | < 0.5                            | < 10                         | 1   | < 80                               | < 600                               | -0.05                   | 0.02  |
| BZM55B5V1   | 5                                  | 5.1  | 5.2   | 5                | 1                | < 0.1                            | < 2                          | 1   | < 60                               | < 550                               | -0.02                   | 0.02  |
| BZM55B5V6   | 5.48                               | 5.6  | 5.72  | 5                | 1                | < 0.1                            | < 2                          | 1   | < 40                               | < 450                               | -0.05                   | 0.05  |
| BZM55B6V2   | 6.08                               | 6.2  | 6.32  | 5                | 1                | < 0.1                            | < 2                          | 2   | < 10                               | < 200                               | 0.03                    | 0.06  |
| BZM55B6V8   | 6.66                               | 6.8  | 6.94  | 5                | 1                | < 0.1                            | < 2                          | 3   | < 8                                | < 150                               | 0.03                    | 0.07  |
| BZM55B7V5   | 7.35                               | 7.5  | 7.65  | 5                | 1                | < 0.1                            | < 2                          | 5   | < 7                                | < 50                                | 0.03                    | 0.07  |
| BZM55B8V2   | 8.04                               | 8.2  | 8.36  | 5                | 1                | < 0.1                            | < 2                          | 6.2 | < 7                                | < 50                                | 0.03                    | 0.08  |
| BZM55B9V1   | 8.92                               | 9.1  | 9.28  | 5                | 1                | < 0.1                            | < 2                          | 6.8 | < 10                               | < 50                                | 0.03                    | 0.09  |
| BZM55B10    | 9.8                                | 10   | 10.2  | 5                | 1                | < 0.1                            | < 2                          | 7.5 | < 15                               | < 70                                | 0.03                    | 0.1   |
| BZM55B11    | 10.78                              | 11   | 11.22 | 5                | 1                | < 0.1                            | < 2                          | 8.2 | < 20                               | < 70                                | 0.03                    | 0.11  |
| BZM55B12    | 11.76                              | 12   | 12.24 | 5                | 1                | < 0.1                            | < 2                          | 9.1 | < 20                               | < 90                                | 0.03                    | 0.11  |
| BZM55B13    | 12.74                              | 13   | 13.26 | 5                | 1                | < 0.1                            | < 2                          | 10  | < 26                               | < 110                               | 0.03                    | 0.11  |
| BZM55B15    | 14.7                               | 15   | 15.3  | 5                | 1                | < 0.1                            | < 2                          | 11  | < 30                               | < 110                               | 0.03                    | 0.11  |
| BZM55B16    | 15.7                               | 16   | 16.3  | 5                | 1                | < 0.1                            | < 2                          | 12  | < 40                               | < 170                               | 0.03                    | 0.11  |
| BZM55B18    | 17.64                              | 18   | 18.36 | 5                | 1                | < 0.1                            | < 2                          | 13  | < 50                               | < 170                               | 0.03                    | 0.11  |
| BZM55B20    | 19.6                               | 20   | 20.4  | 5                | 1                | < 0.1                            | < 2                          | 15  | < 55                               | < 220                               | 0.03                    | 0.11  |
| BZM55B22    | 21.55                              | 22   | 22.45 | 5                | 1                | < 0.1                            | < 2                          | 16  | < 55                               | < 220                               | 0.04                    | 0.12  |
| BZM55B24    | 23.5                               | 24   | 24.5  | 5                | 1                | < 0.1                            | < 2                          | 18  | < 80                               | < 220                               | 0.04                    | 0.12  |
| BZM55B27    | 26.4                               | 27   | 27.6  | 5                | 1                | < 0.1                            | < 2                          | 20  | < 80                               | < 220                               | 0.04                    | 0.12  |
| BZM55B30    | 29.4                               | 30   | 30.6  | 5                | 1                | < 0.1                            | < 2                          | 22  | < 80                               | < 220                               | 0.04                    | 0.12  |
| BZM55B33    | 32.4                               | 33   | 33.6  | 5                | 1                | < 0.1                            | < 2                          | 24  | < 80                               | < 220                               | 0.04                    | 0.12  |
| BZM55B36    | 35.3                               | 36   | 36.7  | 5                | 1                | < 0.1                            | < 2                          | 27  | < 80                               | < 220                               | 0.04                    | 0.12  |
| BZM55B39    | 38.2                               | 39   | 39.8  | 2.5              | 1                | < 0.1                            | < 5                          | 30  | < 90                               | < 500                               | 0.04                    | 0.12  |
| BZM55B43    | 42.1                               | 43   | 43.9  | 2.5              | 0.5              | < 0.1                            | < 5                          | 33  | < 90                               | < 600                               | 0.04                    | 0.12  |
| BZM55B47    | 46.1                               | 47   | 47.9  | 2.5              | 0.5              | < 0.1                            | < 5                          | 36  | < 110                              | < 700                               | 0.04                    | 0.12  |
| BZM55B51    | 50                                 | 51   | 52    | 2.5              | 0.5              | < 0.1                            | < 10                         | 39  | < 125                              | < 700                               | 0.04                    | 0.12  |
| BZM55B56    | 54.9                               | 56   | 57.1  | 2.5              | 0.5              | < 0.1                            | < 10                         | 43  | < 135                              | < 1000                              | 0.04                    | 0.12  |
| BZM55B62    | 60.8                               | 62   | 63.2  | 2.5              | 0.5              | < 0.1                            | < 10                         | 47  | < 150                              | < 1000                              | 0.04                    | 0.12  |
| BZM55B68    | 66.6                               | 68   | 69.4  | 2.5              | 0.5              | < 0.1                            | < 10                         | 51  | < 200                              | < 1000                              | 0.04                    | 0.12  |
| BZM55B75    | 73.5                               | 75   | 76.5  | 2.5              | 0.5              | < 0.1                            | < 10                         | 56  | < 250                              | < 1500                              | 0.04                    | 0.12  |

**Notes**

- Additional measurement of voltage group 9V1 to 75 at 95 %  $V_{Zmin.} \leq 35\text{ nA}$  at  $T_j = 25\text{ }^{\circ}\text{C}$

<sup>(1)</sup>  $t_p \leq 10\text{ ms}$ ,  $T/t_p > 1000$

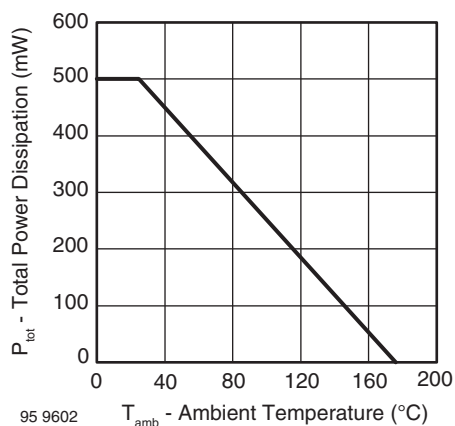
**BASIC CHARACTERISTICS** ( $T_{amb} = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified)


Fig. 1 - Total Power Dissipation vs. Ambient Temperature

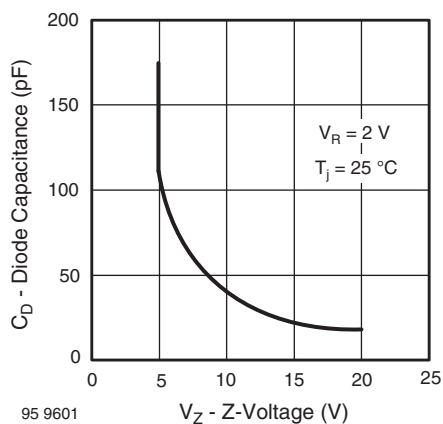


Fig. 4 - Diode Capacitance vs. Z-Voltage

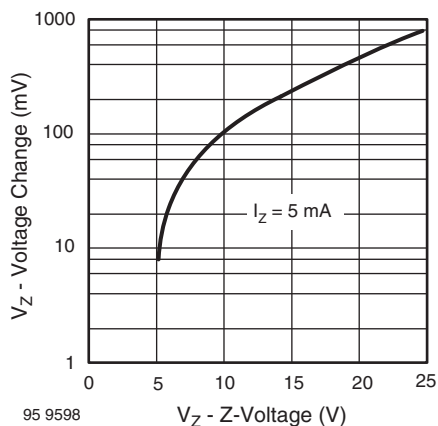
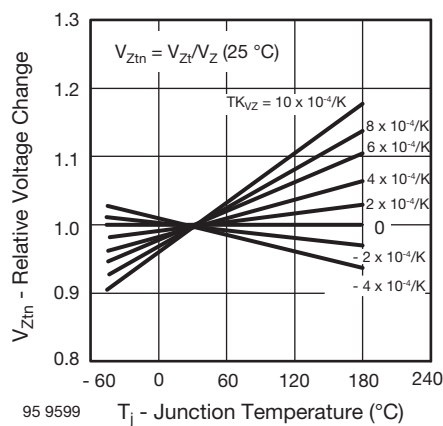

Fig. 2 - Typical Change of Working Voltage under Operating Conditions at  $T_{amb}=25^{\circ}\text{C}$ 


Fig. 5 - Typical Change of Working Voltage vs. Junction Temperature


Fig. 3 - Temperature Coefficient of  $V_Z$  vs. Z-Voltage


Fig. 6 - Forward Current vs. Forward Voltage

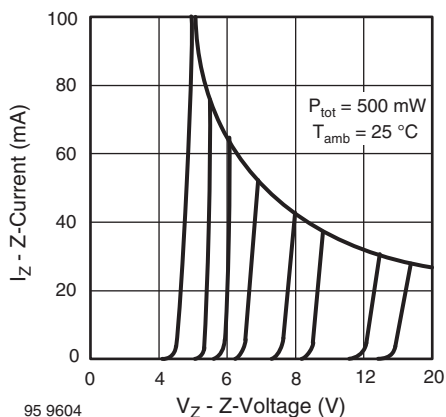


Fig. 7 - Z-Current vs. Z-Voltage

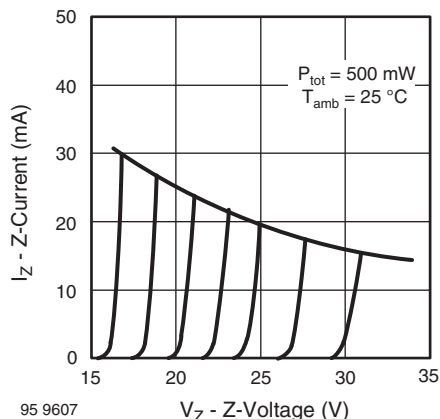


Fig. 8 - Z-Current vs. Z-Voltage

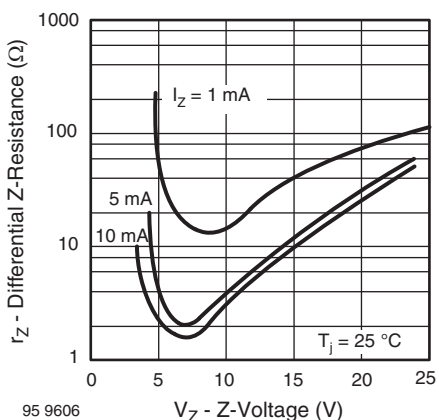


Fig. 9 - Differential Z-Resistance vs. Z-Voltage

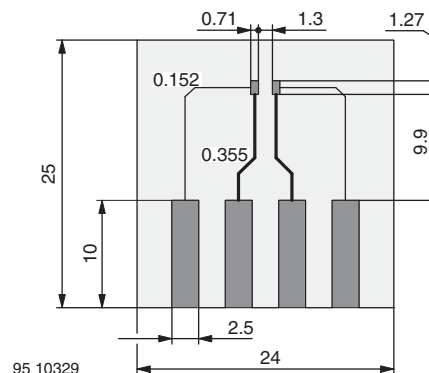
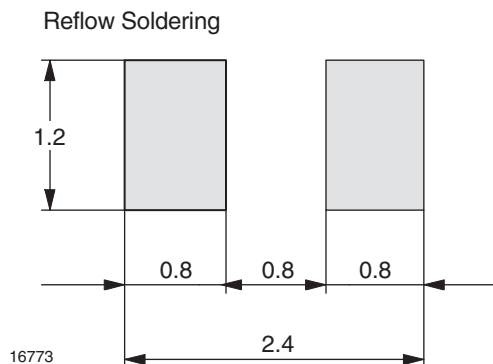

Fig. 10 - Board for  $R_{thJA}$  Definition (in mm)


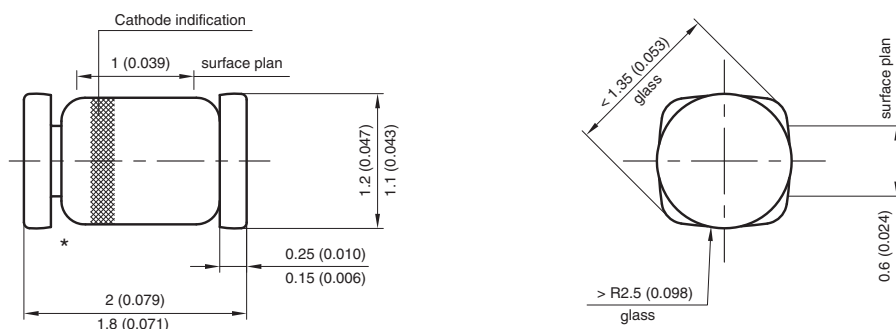
Fig. 11 - Recommended Foot Pads (in mm)



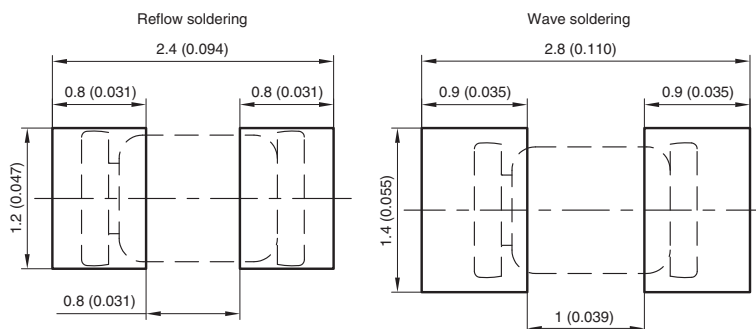
Fig. 12 - Recommended Foot Pads (in mm)



Fig. 13 - Thermal Response

**PACKAGE DIMENSIONS** in millimeters (inches): **MicroMELF (SOD-80)**


Foot print recommendation:



Created - Date: 26.July.1996  
Rev. 13 - Date: 07.June.2006  
Document no.: 6.560-5007.01-4  
96 12072



## Disclaimer

ALL PRODUCT, PRODUCT SPECIFICATIONS AND DATA ARE SUBJECT TO CHANGE WITHOUT NOTICE TO IMPROVE RELIABILITY, FUNCTION OR DESIGN OR OTHERWISE.

Vishay Intertechnology, Inc., its affiliates, agents, and employees, and all persons acting on its or their behalf (collectively, "Vishay"), disclaim any and all liability for any errors, inaccuracies or incompleteness contained in any datasheet or in any other disclosure relating to any product.

Vishay makes no warranty, representation or guarantee regarding the suitability of the products for any particular purpose or the continuing production of any product. To the maximum extent permitted by applicable law, Vishay disclaims (i) any and all liability arising out of the application or use of any product, (ii) any and all liability, including without limitation special, consequential or incidental damages, and (iii) any and all implied warranties, including warranties of fitness for particular purpose, non-infringement and merchantability.

Statements regarding the suitability of products for certain types of applications are based on Vishay's knowledge of typical requirements that are often placed on Vishay products in generic applications. Such statements are not binding statements about the suitability of products for a particular application. It is the customer's responsibility to validate that a particular product with the properties described in the product specification is suitable for use in a particular application. Parameters provided in datasheets and / or specifications may vary in different applications and performance may vary over time. All operating parameters, including typical parameters, must be validated for each customer application by the customer's technical experts. Product specifications do not expand or otherwise modify Vishay's terms and conditions of purchase, including but not limited to the warranty expressed therein.

Except as expressly indicated in writing, Vishay products are not designed for use in medical, life-saving, or life-sustaining applications or for any other application in which the failure of the Vishay product could result in personal injury or death. Customers using or selling Vishay products not expressly indicated for use in such applications do so at their own risk. Please contact authorized Vishay personnel to obtain written terms and conditions regarding products designed for such applications.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted by this document or by any conduct of Vishay. Product names and markings noted herein may be trademarks of their respective owners.