



MOTOROLA

**500 MILLIWATT HERMETICALLY SEALED
GLASS SILICON ZENER DIODES**

- Complete Voltage Range — 2.4 to 110 Volts
- Leadless Package for Surface Mount Technology
- Double Slug Type Construction
- Metallurgically Bonded Construction
- Nitride Passivated Die
- Available in 8 mm Tape and Reel
T1 Cathode Facing Sprocket Holes
T2 Anode Facing Sprocket Holes

**MLL746
thru
MLL759**

**MLL957A
thru
MLL986A**

**MLL4370
thru
MLL4372**

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|----------------|-------------|----------------------------|
| DC Power Dissipation @ $T_A \leq 50^\circ\text{C}$ Derate above $T_A = 50^\circ\text{C}$ | P_D | 500 3.3 | mW mW/ $^\circ\text{C}$ |
| Operating and Storage Junction Temperature Range | T_J, T_{stg} | -65 to +200 | $^\circ\text{C}$ |

MECHANICAL CHARACTERISTICS

CASE: Double slug type, hermetically sealed glass

MAXIMUM LEAD TEMPERATURE FOR SOLDERING PURPOSES: 230°C, for 10 seconds

FINISH: All external surfaces are corrosion resistant and readily solderable

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

MOUNTING POSITION: Any

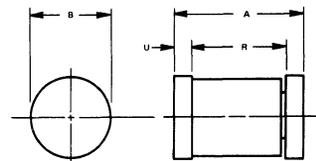
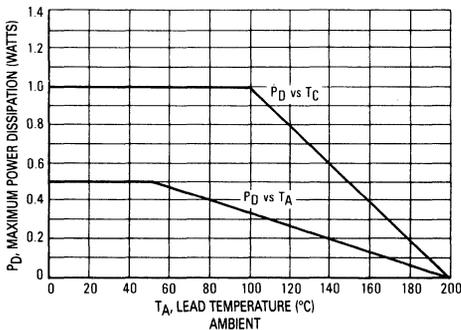
**LEADLESS
GLASS ZENER DIODES**

**500 MILLIWATTS
2.4-110 VOLTS**

4



STEADY STATE POWER DERATING



| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|------|--------|-------|
| | MIN | MAX | MIN | MAX |
| A | 3.30 | 3.70 | 0.130 | 0.146 |
| B | 1.60 | 1.70 | 0.063 | 0.067 |
| R | 2.49 | 2.59 | 0.098 | 0.102 |
| U | 0.41 | 0.55 | 0.016 | 0.022 |

CASE 362-01

MLL746 thru MLL759, MLL957A thru MLL986A, MLL4370 thru MLL4372

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$, $V_F = 1.5\text{ V Max @ 200 mA}$ for all types)

| Type Number (Note 1) | Nominal Zener Voltage V_Z @ I_{ZT} (Notes 1,2,3) Volts | Test Current I_{ZT} (Note 2) mA | Maximum Zener Impedance Z_{ZT} @ I_{ZT} (Note 4) Ohms | Maximum DC Zener Current I_{ZM} mA | | Maximum Reverse Leakage Current | |
|----------------------|--|-----------------------------------|---|--------------------------------------|-----|---|--|
| | | | | | | $T_A = 25^\circ\text{C}$ I_R @ $V_R = 1\text{ V}$ μA | $T_A = 150^\circ\text{C}$ I_R @ $V_R = 1\text{ V}$ μA |
| MLL4370 | 2.4 | 20 | 30 | 150 | 190 | 100 | 200 |
| MLL4371 | 2.7 | 20 | 30 | 135 | 165 | 75 | 150 |
| MLL4372 | 3.0 | 20 | 29 | 120 | 150 | 50 | 100 |
| MLL746 | 3.3 | 20 | 28 | 110 | 135 | 10 | 30 |
| MLL747 | 3.6 | 20 | 24 | 100 | 125 | 10 | 30 |
| MLL748 | 3.9 | 20 | 23 | 95 | 115 | 10 | 30 |
| MLL749 | 4.3 | 20 | 22 | 85 | 105 | 2 | 30 |
| MLL750 | 4.7 | 20 | 19 | 75 | 95 | 2 | 30 |
| MLL751 | 5.1 | 20 | 17 | 70 | 85 | 1 | 20 |
| MLL752 | 5.6 | 20 | 11 | 65 | 80 | 1 | 20 |
| MLL753 | 6.2 | 20 | 7 | 60 | 70 | 0.1 | 20 |
| MLL754 | 6.8 | 20 | 5 | 55 | 65 | 0.1 | 20 |
| MLL755 | 7.5 | 20 | 6 | 50 | 60 | 0.1 | 20 |
| MLL756 | 8.2 | 20 | 8 | 45 | 55 | 0.1 | 20 |
| MLL757 | 9.1 | 20 | 10 | 40 | 50 | 0.1 | 20 |
| MLL758 | 10 | 20 | 17 | 35 | 45 | 0.1 | 20 |
| MLL759 | 12 | 20 | 30 | 30 | 35 | 0.1 | 20 |

| Type Number (Note 1) | Nominal Zener Voltage V_Z (Notes 1,2,3) Volts | Test Current I_{ZT} (Note 2) mA | Maximum Zener Impedance (Note 4) | | | Maximum DC Zener Current I_{ZM} mA | | Maximum Reverse Current | | |
|----------------------|---|-----------------------------------|----------------------------------|--------------------------|-------------|--------------------------------------|-----|-----------------------------|-----------------------|------|
| | | | Z_{ZT} @ I_{ZT} Ohms | Z_{ZK} @ I_{ZK} Ohms | I_{ZK} mA | | | I_R Maximum μA | Test Voltage V_{dc} | |
| | | | | | | | | 5% | 10% | |
| MLL957A | 6.8 | 18.5 | 4.5 | 700 | 1.0 | 47 | 61 | 150 | 5.2 | 4.9 |
| MLL958A | 7.5 | 16.5 | 5.5 | 700 | 0.5 | 42 | 55 | 75 | 5.7 | 5.4 |
| MLL959A | 8.2 | 15 | 6.5 | 700 | 0.5 | 38 | 50 | 50 | 6.2 | 5.9 |
| MLL960A | 9.1 | 14 | 7.5 | 700 | 0.5 | 35 | 45 | 25 | 6.9 | 6.6 |
| MLL961A | 10 | 12.5 | 8.5 | 700 | 0.25 | 32 | 41 | 10 | 7.6 | 7.2 |
| MLL962A | 11 | 11.5 | 9.5 | 700 | 0.25 | 28 | 37 | 5 | 8.4 | 8.0 |
| MLL963A | 12 | 10.5 | 11.5 | 700 | 0.25 | 26 | 34 | 5 | 9.1 | 8.6 |
| MLL964A | 13 | 9.5 | 13 | 700 | 0.25 | 24 | 32 | 5 | 9.9 | 9.4 |
| MLL965A | 15 | 8.5 | 16 | 700 | 0.25 | 21 | 27 | 5 | 11.4 | 10.8 |
| MLL966A | 16 | 7.8 | 17 | 700 | 0.25 | 19 | 37 | 5 | 12.2 | 11.5 |
| MLL967A | 18 | 7.0 | 21 | 750 | 0.25 | 17 | 23 | 5 | 13.7 | 13.0 |
| MLL968A | 20 | 6.2 | 25 | 750 | 0.25 | 15 | 20 | 5 | 15.2 | 14.4 |
| MLL969A | 22 | 5.6 | 29 | 750 | 0.25 | 14 | 18 | 5 | 16.7 | 15.8 |
| MLL970A | 24 | 5.2 | 33 | 750 | 0.25 | 13 | 17 | 5 | 18.2 | 17.3 |
| MLL971A | 27 | 4.6 | 41 | 750 | 0.25 | 11 | 15 | 5 | 20.6 | 19.4 |
| MLL972A | 30 | 4.2 | 49 | 1000 | 0.25 | 10 | 13 | 5 | 22.8 | 21.6 |
| MLL973A | 33 | 3.8 | 58 | 1000 | 0.25 | 9.2 | 12 | 5 | 25.1 | 23.8 |
| MLL974A | 36 | 3.4 | 70 | 1000 | 0.25 | 8.5 | 11 | 5 | 27.4 | 25.9 |
| MLL975A | 39 | 3.2 | 80 | 1000 | 0.25 | 7.8 | 10 | 5 | 29.7 | 28.1 |
| MLL976A | 43 | 3.0 | 93 | 1500 | 0.25 | 7.0 | 9.6 | 5 | 32.7 | 31.0 |
| MLL977A | 47 | 2.7 | 105 | 1500 | 0.25 | 6.4 | 8.8 | 5 | 35.8 | 33.8 |
| MLL978A | 51 | 2.5 | 125 | 1500 | 0.25 | 5.9 | 8.1 | 5 | 38.8 | 36.7 |
| MLL979A | 56 | 2.2 | 150 | 2000 | 0.25 | 5.4 | 7.4 | 5 | 42.6 | 40.3 |
| MLL980A | 62 | 2.0 | 185 | 2000 | 0.25 | 4.9 | 6.7 | 5 | 47.1 | 44.6 |
| MLL981A | 68 | 1.8 | 230 | 2000 | 0.25 | 4.5 | 6.1 | 5 | 51.7 | 49.0 |
| MLL982A | 75 | 1.7 | 270 | 2000 | 0.25 | 1.0 | 5.5 | 5 | 56.0 | 54.0 |
| MLL983A | 82 | 1.5 | 330 | 3000 | 0.25 | 3.7 | 5.0 | 5 | 62.2 | 59.0 |
| MLL984A | 91 | 1.4 | 400 | 3000 | 0.25 | 3.3 | 4.5 | 5 | 69.2 | 65.5 |
| MLL985A | 100 | 1.3 | 500 | 3000 | 0.25 | 3.0 | 4.5 | 5 | 76 | 72 |
| MLL986A | 110 | 1.1 | 750 | 4000 | 0.25 | 2.7 | 4.1 | 5 | 83.6 | 79.2 |

4

MLL746 thru MLL759, MLL957A thru MLL986A, MLL4370 thru MLL4372

NOTE 1. Tolerance Designation — The type numbers shown have tolerance designations as follows:

- MLL4370 series: $\pm 10\%$, suffix A for $\pm 5\%$ units.
- MLL746 series: $\pm 10\%$, suffix A for $\pm 5\%$ units.
- MLL957 series: suffix A for $\pm 10\%$ units, suffix B for $\pm 5\%$ units.

NOTE 2. Special Selections† Available Include:

1. Nominal zener voltages between those shown.
2. Two or more units for series connection with specified tolerance on total voltage. Series matched sets make zener voltages in excess of 200 volts possible as well as providing lower temperature coefficients, lower dynamic impedance and greater power handling ability.
3. Nominal voltages at non-standard test currents.

NOTE 3. Zener Voltage (V_Z) Measurement — Nominal zener voltage is measured with the device junction in thermal equilibrium at the case temperature of $30^\circ\text{C} \pm 1^\circ\text{C}$.

NOTE 4. Zener Impedance (Z_Z) Derivation — Z_{ZT} is measured by dividing the ac voltage drop across the device by the ac current applied. The specified limits are for $I_Z(\text{ac}) = 0.1 \times I_Z(\text{dc})$ with the ac frequency = 1.0 kHz.

†For more information on special selections contact your nearest Motorola representative.

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:

Case Temperature, T_C , should be determined from:

$$T_C = \theta_{CA} P_D + T_A$$

θ_{CA} is the case-to-ambient thermal resistance ($^\circ\text{C}/\text{W}$) and P_D is the power dissipation. The value for θ_{CA} will vary and depends on the device mounting method. θ_{CA} is generally $200^\circ\text{C}/\text{W}$ for the various clips and tie points in common use and for printed circuit board wiring.

The temperature of the case can also be measured using a thermocouple placed at the case end 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_C , the junction temperature may be determined by:

$$T_J = T_C + \Delta T_{JC}$$

ΔT_{JC} is the increase in junction temperature above the case temperature and may be found by using:

$$\Delta T_{JC} = \theta_{JC} P_D$$

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:

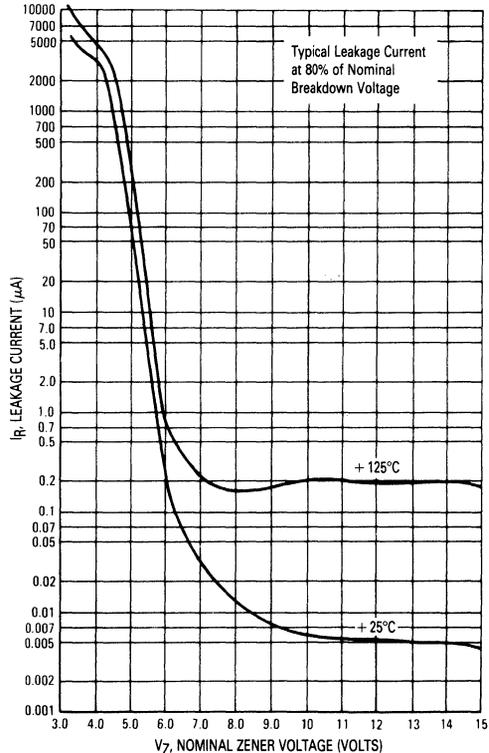
$$\Delta V = \theta_{VZ} \Delta T_J$$

θ_{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.

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.

FIGURE 1 — TYPICAL LEAKAGE CURRENT



MLL746 thru MLL759, MLL957A thru MLL986A, MLL4370 thru MLL4372

FIGURE 2 — TEMPERATURE COEFFICIENTS
 (-55°C to +150°C temperature range; 90% of the units are in the ranges indicated.)

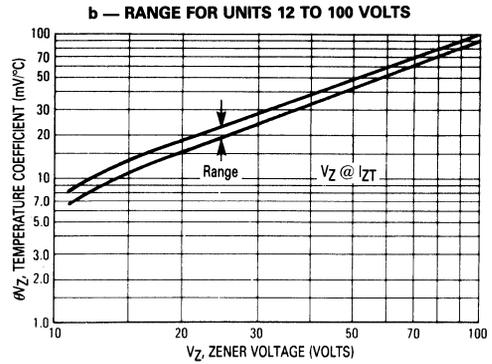
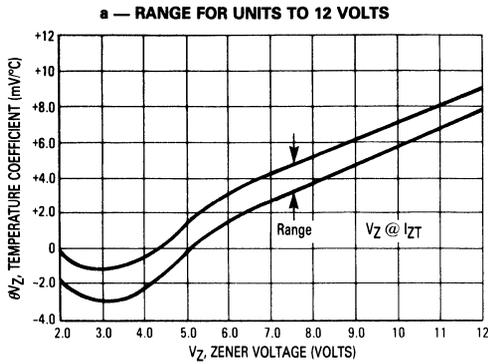


FIGURE 3 — EFFECT OF ZENER CURRENT

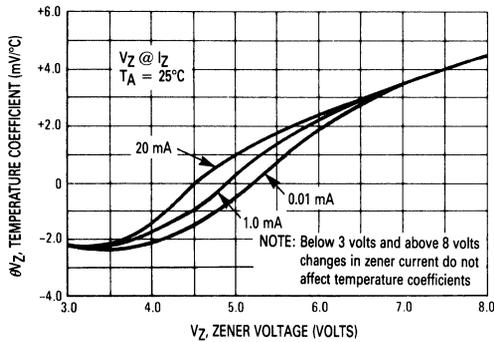


FIGURE 4 — TYPICAL CAPACITANCE

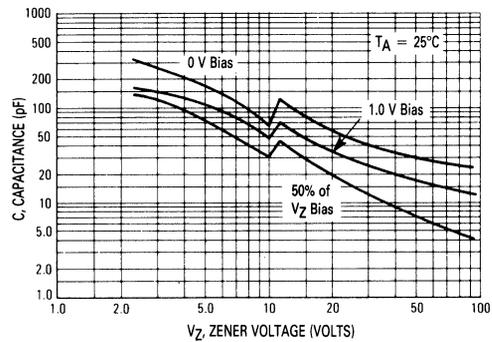
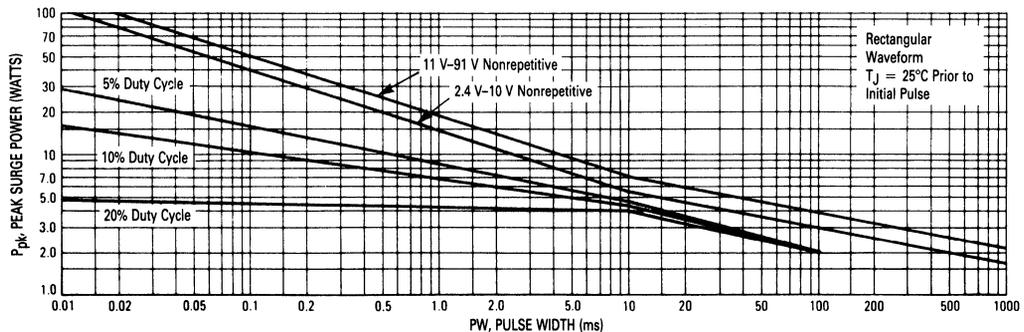


FIGURE 5 — MAXIMUM SURGE POWER



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

4

MLL746 thru MLL759, MLL957A thru MLL986A, MLL4370 thru MLL4372

FIGURE 6 — EFFECT OF ZENER CURRENT ON ZENER IMPEDANCE

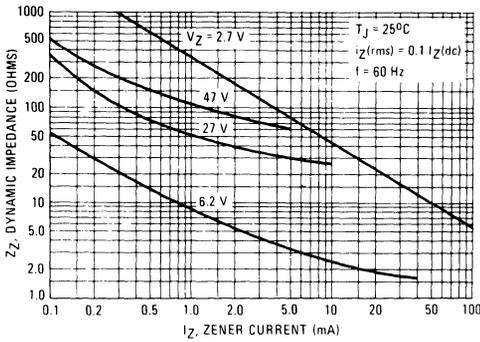


FIGURE 7 — EFFECT OF ZENER VOLTAGE ON ZENER IMPEDANCE

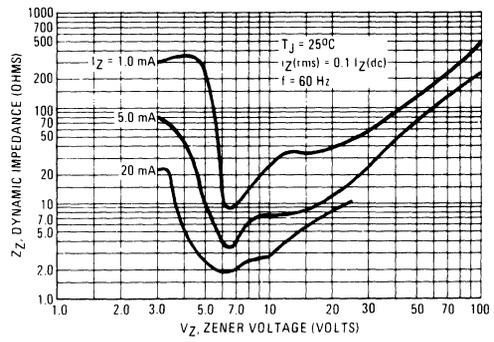


FIGURE 8 — TYPICAL NOISE DENSITY

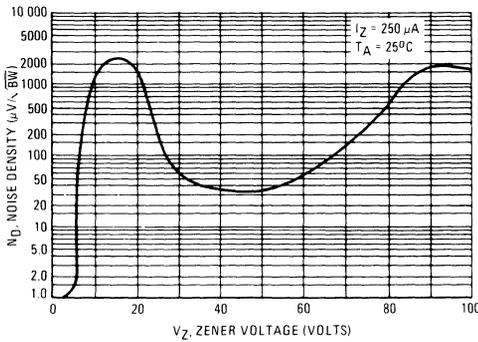


FIGURE 9 — NOISE DENSITY MEASUREMENT METHOD

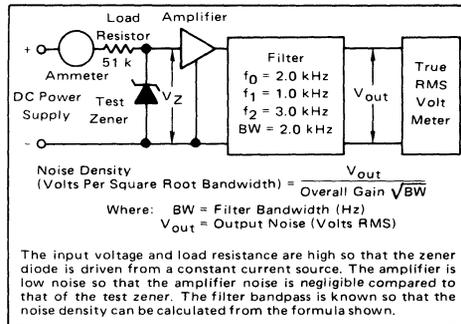


FIGURE 10 — TYPICAL FORWARD CHARACTERISTICS

