MOTOROLA

500 MILLIWATT HERMETICALLY SEALED GLASS SILICON ZENER DIODES

● Complete Voltage Range — 2.4 to 91 Volts

● Leadless Package for Surface Mount Technology

● Double Slug Type Construction

● Metallurgically Bonded Construction

● Nitride Passivated Die

**LEADLESS
GLASS ZENER DIODES**

**500 MILLIWATTS
2.4-110 VOLTS**

MAXIMUM RATINGS

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

MECHANICAL CHARACTERISTICS

CASE: Double slug type, hermetically sealed glass

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

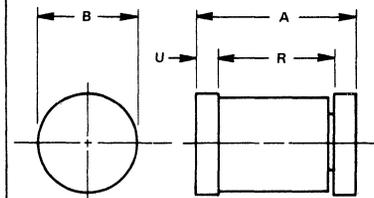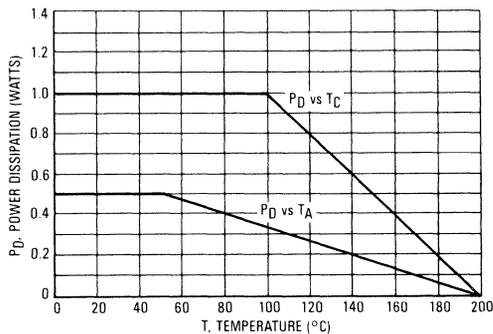**FINISH:** All external surfaces are corrosion resistant and readily solderable

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

MOUNTING POSITION: Any

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STEADY STATE POWER DERATING

P_D vs T_C

P_D vs T_A

P_D, POWER DISSIPATION (WATTS)

T, TEMPERATURE (°C)

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

ELECTRICAL CHARACTERISTICS

$(T_A = 25°C$ unless otherwise noted. Based on dc measurements at thermal equilibrium; case temperature maintained at $30\pm2°C$. $V_F = 1.1$ max @ $I_F = 200$ mA for all types.)

Type No. (Note 1)	Nominal Zener Voltage V_Z @ I_{ZT} Volts (Note 2)	Test Current I_{ZT} mA	Max Zener Impedance A and B Suffix only		Max Reverse Leakage Current				Max Zener Voltage Temperature Coeff. (A and B Suffix only) θ_{VZ} (%/°C) (Note 3)
					A and B Suffix only			Non-Suffix	
			Z_{ZT} @ I_{ZT} Ohms	Z_{ZK} @ $I_{ZK} = 0.25$ mA Ohms	I_R μA	@	V_R Volts	I_R @ V_R Used for Suffix A μA	
							A	B	
MLL5221	2.4	20	30	1200	100	0.95	1.0	200	−0.085
MLL5222	2.5	20	30	1250	100	0.95	1.0	200	−0.085
MLL5223	2.7	20	30	1300	75	0.95	1.0	150	−0.080
MLL5224	2.8	20	30	1400	75	0.95	1.0	150	−0.080
MLL5225	3.0	20	29	1600	50	0.95	1.0	100	−0.075
MLL5226	3.3	20	28	1600	25	0.95	1.0	100	−0.070
MLL5227	3.6	20	24	1700	15	0.95	1.0	100	−0.065
MLL5228	3.9	20	23	1900	10	0.95	1.0	75	−0.060
MLL5229	4.3	20	22	2000	5.0	0.95	1.0	50	±0.055
MLL5230	4.7	20	19	1900	5.0	1.9	2.0	50	±0.030
MLL5231	5.1	20	17	1600	5.0	1.9	2.0	50	±0.030
MLL5232	5.6	20	11	1600	5.0	2.9	3.0	50	+0.038
MLL5233	6.0	20	7.0	1600	5.0	3.3	3.5	50	+0.038
MLL5234	6.2	20	7.0	1000	5.0	3.8	4.0	50	+0.045
MLL5235	6.8	20	5.0	750	3.0	4.8	5.0	30	+0.050
MLL5236	7.5	20	6.0	500	3.0	5.7	6.0	30	+0.058
MLL5237	8.2	20	8.0	500	3.0	6.2	6.5	30	+0.062
MLL5238	8.7	20	8.0	600	3.0	6.2	6.5	30	+0.065
MLL5239	9.1	20	10	600	3.0	6.7	7.0	30	+0.068
MLL5240	10	20	17	600	3.0	7.6	8.0	30	+0.075
MLL5241	11	20	22	600	2.0	8.0	8.4	30	+0.076
MLL5242	12	20	30	600	1.0	8.7	9.1	10	+0.077
MLL5243	13	9.5	13	600	0.5	9.4	9.9	10	+0.079
MLL5244	14	9.0	15	600	0.1	9.5	10	10	+0.082
MLL5245	15	8.5	16	600	0.1	10.5	11	10	+0.082
MLL5246	16	7.8	17	600	0.1	11.4	12	10	+0.083
MLL5247	17	7.4	19	600	0.1	12.4	13	10	+0.084
MLL5248	18	7.0	21	600	0.1	13.3	14	10	+0.085
MLL5249	19	6.6	23	600	0.1	13.3	14	10	+0.086
MLL5250	20	6.2	25	600	0.1	14.3	15	10	+0.086
MLL5251	22	5.6	29	600	0.1	16.2	17	10	+0.087
MLL5252	24	5.2	33	600	0.1	17.1	18	10	+0.088
MLL5253	25	5.0	35	600	0.1	18.1	19	10	+0.089
MLL5254	27	4.6	41	600	0.1	20	21	10	+0.090
MLL5255	28	4.5	44	600	0.1	20	21	10	+0.091
MLL5256	30	4.2	49	600	0.1	22	23	10	+0.091
MLL5257	33	3.8	58	700	0.1	24	25	10	+0.092
MLL5258	36	3.4	70	700	0.1	26	27	10	+0.093
MLL5259	39	3.2	80	800	0.1	29	30	10	+0.094
MLL5260	43	3.0	93	900	0.1	31	33	10	+0.095
MLL5261	47	2.7	105	1000	0.1	34	36	10	+0.095
MLL5262	51	2.5	125	1100	0.1	37	39	10	+0.096
MLL5263	56	2.2	150	1300	0.1	41	43	10	+0.096
MLL5264	60	2.1	170	1400	0.1	44	46	10	+0.097
MLL5265	62	2.0	185	1400	0.1	45	47	10	+0.097
MLL5266	68	1.8	230	1600	0.1	49	52	10	+0.097
MLL5267	75	1.7	270	1700	0.1	53	56	10	+0.098
MLL5268	82	1.5	330	2000	0.1	59	62	10	+0.098
MLL5269	87	1.4	370	2200	0.1	65	68	10	+0.099
MLL5270	91	1.4	400	2300	0.1	66	69	10	+0.099

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MLL5221 thru MLL5270

NOTE 1. Tolerance — The type numbers shown indicate a tolerance of ±20% with guaranteed limits on only V_Z, I_R and V_F as shown in the electrical characteristics table. Units with guaranteed limits on all six parameters are indicated by suffix "A" for ±10% tolerance and suffix "B" for ±5.0% 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. Temperature Coefficient (θ_{VZ}) — Test conditions for temperature coefficient are as follows:
   a. I_{ZT} = 7.5 mA, T_1 = 25°C,
      T_2 = 125°C (MLL5221A,B through MLL5242A,B).
   b. I_{ZT} = Rated I_{ZT}, T_1 = 25°C,
      T_2 = 125°C (MLL5243A, B through MLL5270A,B).
Device to be temperature stabilized with current applied prior to reading breakdown voltage at the specified ambient temperature.

NOTE 4. Zener Voltage (V_Z) Measurement — Nominal zener voltage is measured with the device junction in thermal equilibrium at the case temperature of 30°C ±1°C.

NOTE 5. Zener Impedance (Z_Z) Derivation — 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 = 1.0 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 (°C/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°C/W for the various clips and tie points in common use and for printed circuit 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 3 and 4.
   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.
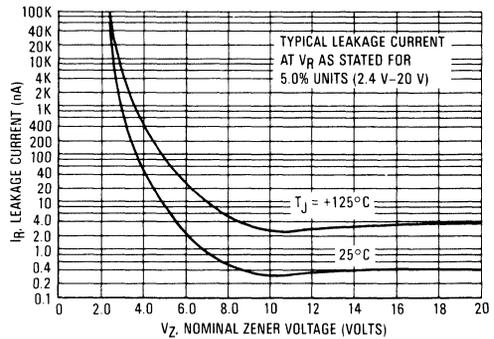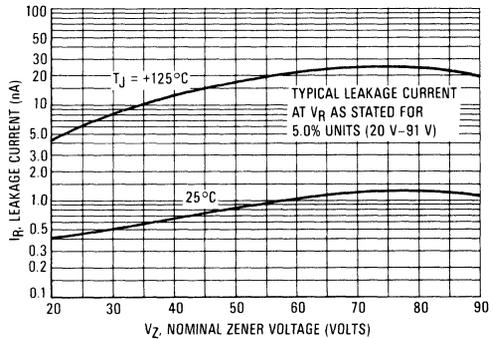
FIGURE 1 — TYPICAL LEAKAGE CURRENT

FIGURE 2 — TYPICAL LEAKAGE CURRENT

FIGURE 3 — TEMPERATURE COEFFICIENTS

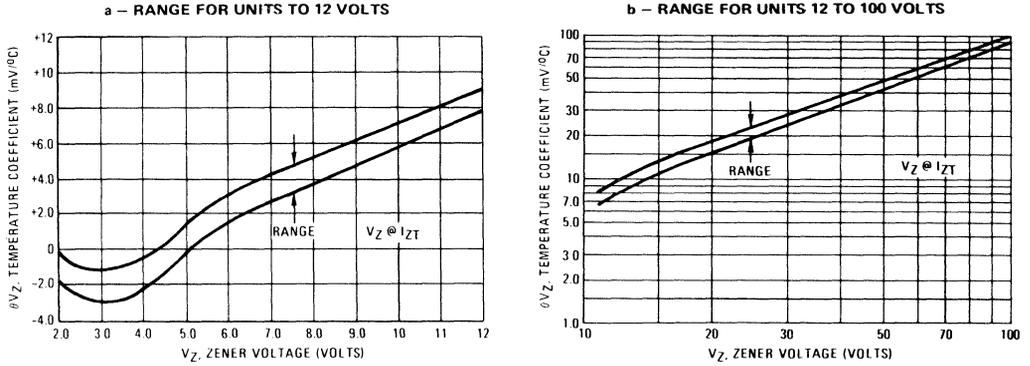(-55°C to +150°C temperature range; 90% of the units are in the ranges indicated.)
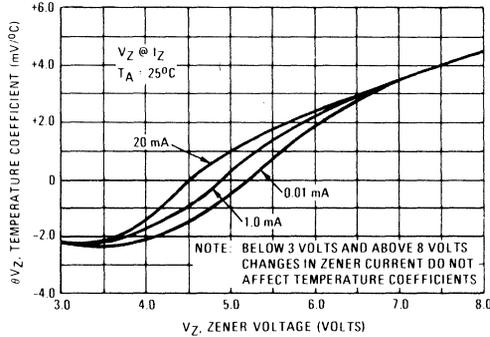
a — RANGE FOR UNITS TO 12 VOLTS

b — RANGE FOR UNITS 12 TO 100 VOLTS

FIGURE 4 — EFFECT OF ZENER CURRENT

NOTE: BELOW 3 VOLTS AND ABOVE 8 VOLTS CHANGES IN ZENER CURRENT DO NOT AFFECT TEMPERATURE COEFFICIENTS

FIGURE 5 — TYPICAL CAPACITANCE

FIGURE 6 — MAXIMUM SURGE POWER

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

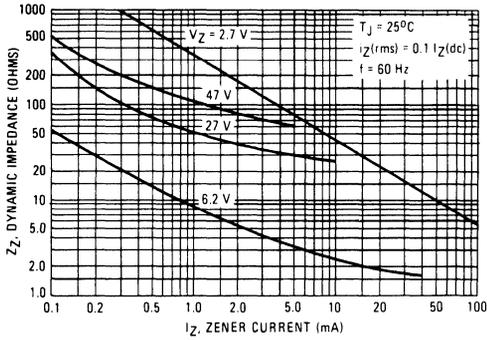## FIGURE 7 — EFFECT OF ZENER CURRENT ON ZENER IMPEDANCE

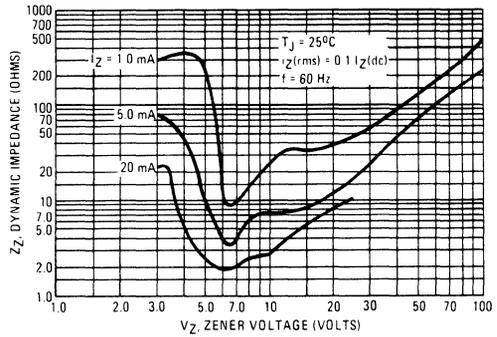## FIGURE 8 — EFFECT OF ZENER VOLTAGE ON ZENER IMPEDANCE
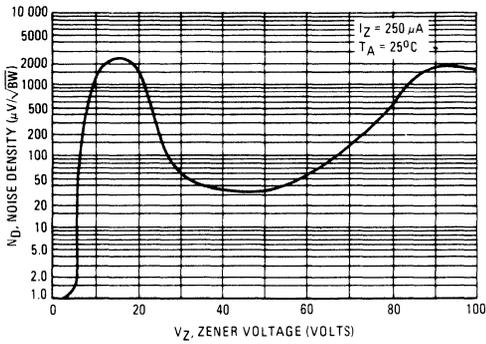

FIGURE 9 — TYPICAL NOISE DENSITY

FIGURE 10 — NOISE DENSITY MEASUREMENT METHOD

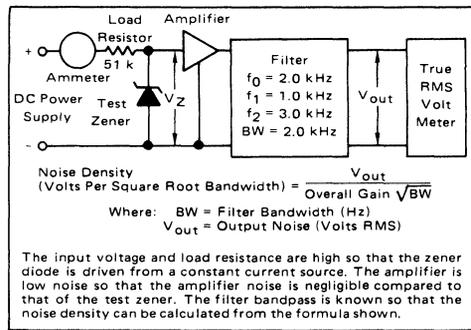Noise Density
(Volts Per Square Root Bandwidth) = $\dfrac{V_{out}}{\text{Overall Gain } \sqrt{BW}}$

Where: BW = Filter Bandwidth (Hz)
V_{out} = Output Noise (Volts RMS)

The input voltage and load resistance are high so that the zener diode is driven from a constant current source. The amplifier is low noise so that the amplifier noise is negligible compared to that of the test zener. The filter bandpass is known so that the noise density can be calculated from the formula shown.
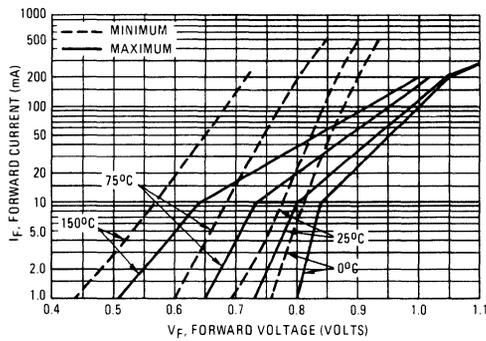
FIGURE 11 — TYPICAL FORWARD CHARACTERISTICS

FIGURE 12 — ZENER VOLTAGE versus ZENER CURRENT — V$_Z$ = 1 THRU 16 VOLTS

I$_Z$, ZENER CURRENT (mA)
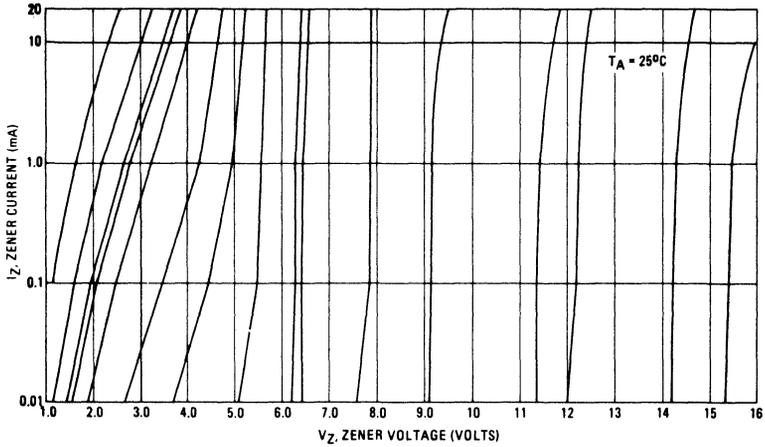
T$_A$ = 25°C

V$_Z$, ZENER VOLTAGE (VOLTS)

FIGURE 13 — ZENER VOLTAGE versus ZENER CURRENT — V$_Z$ = 15 THRU 30 VOLTS

I$_Z$, ZENER CURRENT (mA)

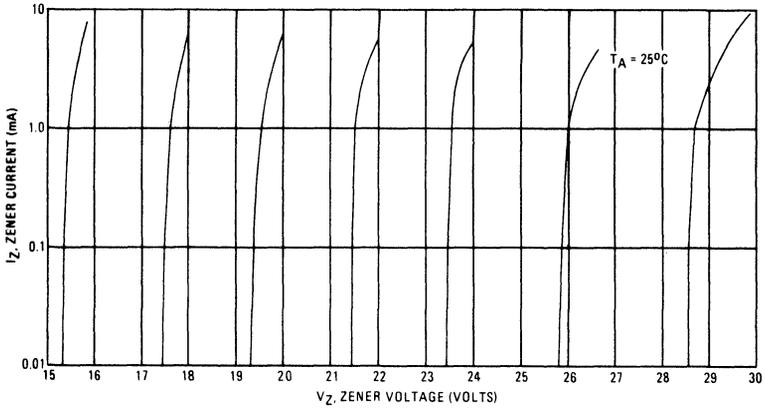T$_A$ = 25°C

V$_Z$, ZENER VOLTAGE (VOLTS)

FIGURE 14 — ZENER VOLTAGE versus ZENER CURRENT — V$_Z$ = 30 THRU 105 VOLTS

I$_Z$, ZENER CURRENT (mA)

T$_A$ = 25°C

V$_Z$, ZENER VOLTAGE (VOLTS)

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