MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

500 mW DO-35 Glass Zener Voltage Regulator Diodes

GENERAL DATA APPLICABLE TO ALL SERIES IN THIS GROUP

500 Milliwatt Hermetically Sealed Glass Silicon Zener Diodes

1N5221B SERIES
500 mW DO-35 GLASS

GLASS ZENER DIODES
500 MILLIWATTS
1.8–200 VOLTS

CASE 299
DO-204AH
GLASS

Specification Features:

- Complete Voltage Range — 1.8 to 200 Volts
- DO-204AH Package — Smaller than Conventional DO-204AA Package
- Double Slug Type Construction
- Metallurgically Bonded Construction

Mechanical Characteristics:

CASE: Double slug type, hermetically sealed glass
MAXIMUM LEAD TEMPERATURE FOR SOLDERING PURPOSES: 230°C, 1/16″ from case for 10 seconds
FINISH: All external surfaces are corrosion resistant with readily solderable leads
POLARITY: Cathode indicated by color band. When operated in zener mode, cathode will be positive with respect to anode
MOUNTING POSITION: Any
WAFER FAB LOCATION: Phoenix, Arizona
ASSEMBLY/TEST LOCATION: Seoul, Korea

MAXIMUM RATINGS (Motorola Devices)*

Rating	Symbol	Value	Unit
DC Power Dissipation and $T_L \leq 75°C$ Lead Length = 3/8″ Derate above $T_L = 75°C$	P_D	 500 4	 mW mW/°C
Operating and Storage Temperature Range	T_J, T_{stg}	– 65 to +200	°C

* Some part number series have lower JEDEC registered ratings.

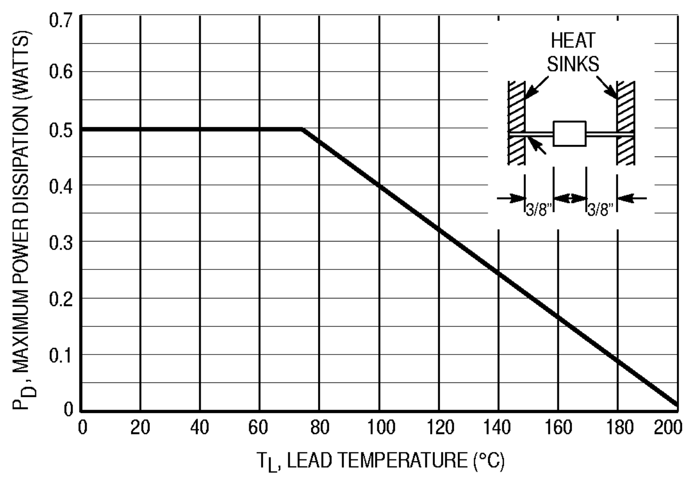


Figure 1. Steady State Power Derating

GENERAL DATA — 500 mW DO-35 GLASS

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted. Based on dc measurements at thermal equilibrium; lead length = 3/8″; thermal resistance of heat sink = 30°C/W) V_F = 1.1 Max @ I_F = 200 mA for all types.

JEDEC Type No. (Note 1)	Nominal Zener Voltage V_Z @ I_{ZT} Volts (Note 3)	Test Current I_{ZT} mA	Max Zener Impedance (Note 4)		Max Reverse Leakage Current		Max Zener Voltage Temperature Coeff. θ_{VZ} (%/°C) (Note 2)
			Z_{ZT} @ I_{ZT} Ohms	Z_{ZK} @ I_{ZK} = 0.25 mA Ohms	I_R µA	V_R Volts	
1N5221B	2.4	20	30	1200	100	1	–0.085
1N5222B	2.5	20	30	1250	100	1	–0.085
1N5223B	2.7	20	30	1300	75	1	–0.08
1N5224B	2.8	20	30	1400	75	1	–0.08
1N5225B	3	20	29	1600	50	1	–0.075
1N5226B	***3.3***	***20***	***28***	***1600***	***25***	***1***	***–0.07***
1N5227B	3.6	20	24	1700	15	1	–0.065
1N5228B	***3.9***	***20***	***23***	***1900***	***10***	***1***	***–0.06***
1N5229B	4.3	20	22	2000	5	1	±0.055
1N5230B	4.7	20	19	1900	5	2	±0.03
1N5231B	***5.1***	***20***	***17***	***1600***	***5***	***2***	***±0.03***
1N5232B	***5.6***	***20***	***11***	***1600***	***5***	***3***	***+0.038***
1N5233B	6	20	7	1600	5	3.5	+0.038
1N5234B	***6.2***	***20***	***7***	***1000***	***5***	***4***	***+0.045***
1N5235B	***6.8***	***20***	***5***	***750***	***3***	***5***	***+0.05***
1N5236B	7.5	20	6	500	3	6	+0.058
1N5237B	***8.2***	***20***	***8***	***500***	***3***	***6.5***	***+0.062***
1N5238B	8.7	20	8	600	3	6.5	+0.065
1N5239B	9.1	20	10	600	3	7	+0.068
1N5240B	***10***	***20***	***17***	***600***	***3***	***8***	***+0.075***
1N5241B	11	20	22	600	2	8.4	+0.076
1N5242B	***12***	***20***	***30***	***600***	***1***	***9.1***	***+0.077***
1N5243B	13	9.5	13	600	0.5	9.9	+0.079
1N5244B	14	9	15	600	0.1	10	+0.082
1N5245B	***15***	***8.5***	***16***	***600***	***0.1***	***11***	***+0.082***
1N5246B	***16***	***7.8***	***17***	***600***	***0.1***	***12***	***+0.083***
1N5247B	17	7.4	19	600	0.1	13	+0.084
1N5248B	18	7	21	600	0.1	14	+0.085
1N5249B	19	6.6	23	600	0.1	14	+0.086
1N5250B	***20***	***6.2***	***25***	***600***	***0.1***	***15***	***+0.086***
1N5251B	22	5.6	29	600	0.1	17	+0.087
1N5252B	24	5.2	33	600	0.1	18	+0.088
1N5253B	25	5	35	600	0.1	19	+0.089
1N5254B	27	4.6	41	600	0.1	21	+0.09
1N5255B	28	4.5	44	600	0.1	21	+0.091
1N5256B	30	4.2	49	600	0.1	23	+0.091
1N5257B	33	3.8	58	700	0.1	25	+0.092
1N5258B	36	3.4	70	700	0.1	27	+0.093
1N5259B	39	3.2	80	800	0.1	30	+0.094
1N5260B	43	3	93	900	0.1	33	+0.095
1N5261B	47	2.7	105	1000	0.1	36	+0.095
1N5262B	51	2.5	125	1100	0.1	39	+0.096
1N5263B	56	2.2	150	1300	0.1	43	+0.096
1N5264B	60	2.1	170	1400	0.1	46	+0.097
1N5265B	62	2	185	1400	0.1	47	+0.097

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_A = 25°C unless otherwise noted. Based on dc measurements at thermal equilibrium; lead length = 3/8″; thermal resistance of heat sink = 30°C/W) V_F = 1.1 Max @ I_F = 200 mA for all types.

JEDEC Type No. (Note 1)	Nominal Zener Voltage V_Z @ I_{ZT} Volts (Note 3)	Test Current I_{ZT} mA	Max Zener Impedance (Note 4)		Max Reverse Leakage Current		Max Zener Voltage Temperature Coeff. θ_{VZ} (%/°C) (Note 2)
			Z_{ZT} @ I_{ZT} Ohms	Z_{ZK} @ I_{ZK} = 0.25 mA Ohms	I_R µA	V_R Volts	
1N5266B	68	1.8	230	1600	0.1	52	+0.097
1N5267B	75	1.7	270	1700	0.1	56	+0.098
1N5268B	82	1.5	330	2000	0.1	62	+0.098
1N5270B	91	1.4	400	2300	0.1	69	+0.099
1N5271B	100	1.3	500	2600	0.1	76	+0.11
1N5272B	110	1.1	750	3000	0.1	84	+0.11
1N5273B	120	1	900	4000	0.1	91	+0.11
1N5274B	130	0.95	1100	4500	0.1	99	+0.11
1N5275B	140	0.9	1300	4500	0.1	106	+0.11
1N5276B	150	0.85	1500	5000	0.1	114	+0.11
1N5278B	170	0.74	1900	5500	0.1	129	+0.11
1N5279B	180	0.68	2200	6000	0.1	137	+0.11
1N5280B	190	0.66	2400	6500	0.1	144	+0.11
1N5281B	200	0.65	2500	7000	0.1	152	+0.11

NOTE 1. TOLERANCE

The JEDEC type numbers shown indicate a tolerance of ±5%. For tighter tolerance devices use suffixes "C" for ±2% and "D" for ±1%.

NOTE 2. 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 (1N5221B through 1N5242B).

b. I_{ZT} = Rated I_{ZT}, T_1 = 25°C,
 T_2 = 125°C (1N5243B through 1N5281B).

Device to be temperature stabilized with current applied prior to reading breakdown voltage at the specified ambient temperature.

NOTE 3. ZENER VOLTAGE (V_Z) MEASUREMENT

Nominal zener voltage is measured with the device junction in thermal equilibrium at the lead temperature of 30°C ±1°C and 3/8″ lead length.

NOTE 4. 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 = 60 Hz.

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

APPLICATION NOTE — ZENER VOLTAGE

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:

$$T_L = \theta_{LA} P_D + T_A.$$

θ_{LA} is the lead-to-ambient thermal resistance (°C/W) and P_D is the power dissipation. The value for θ_{LA} will vary and depends on the device mounting method. θ_{LA} is generally 30 to 40°C/W for the various clips and tie points in common use and for printed circuit board wiring.

The temperature of the lead can also be measured using a thermocouple placed on the lead 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_L, the junction temperature may be determined by:

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

ΔT_{JL} is the increase in junction temperature above the lead temperature and may be found from Figure 2 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:

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

θ_{VZ}, the zener voltage temperature coefficient, is found from Figures 4 and 5.

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 7. 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 7 be exceeded.

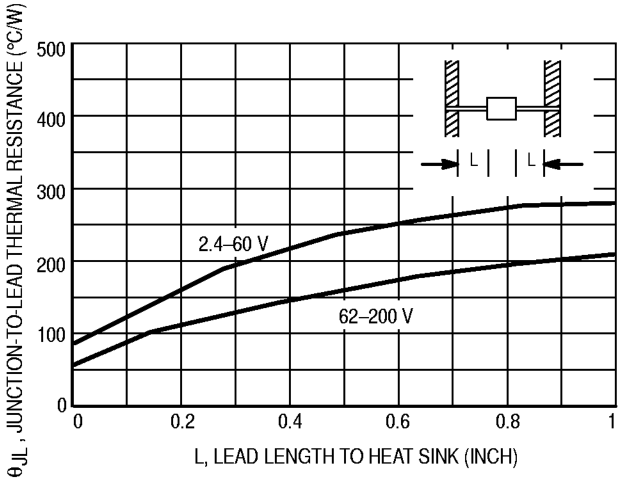


Figure 2. Typical Thermal Resistance

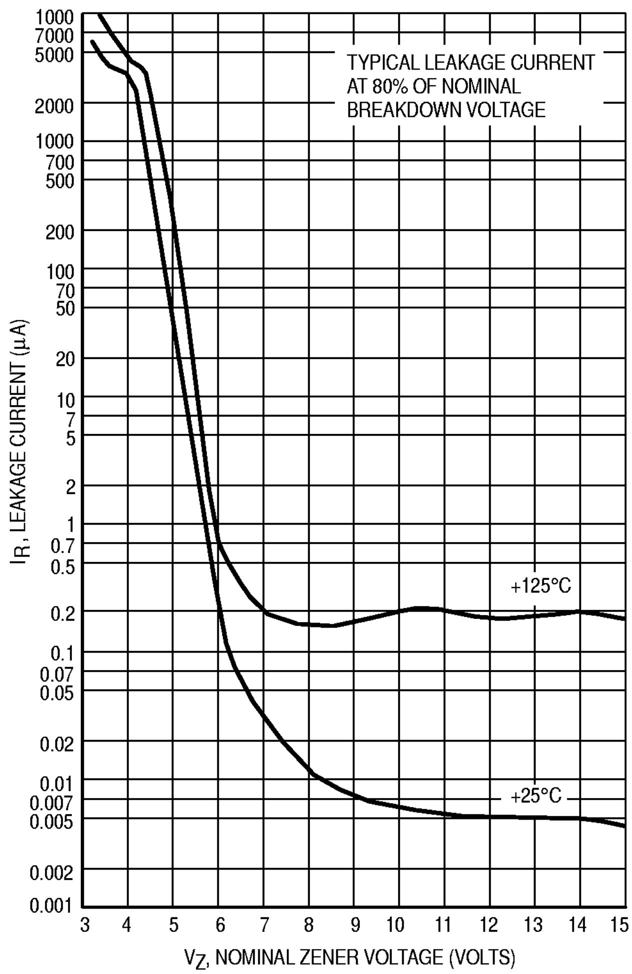


Figure 3. Typical Leakage Current

TEMPERATURE COEFFICIENTS

(–55°C to +150°C temperature range; 90% of the units are in the ranges indicated.)

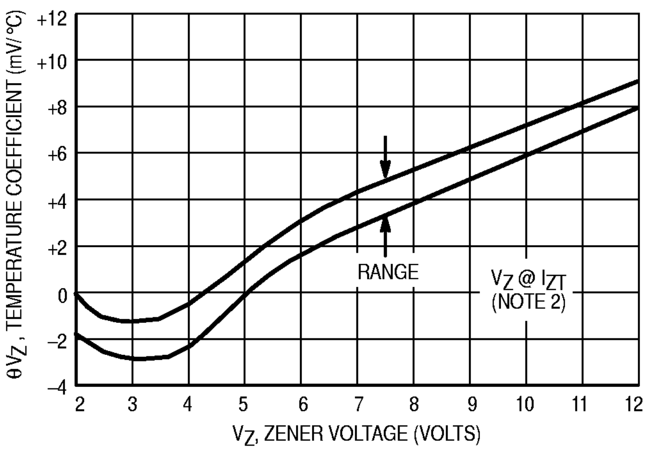


Figure 4a. Range for Units to 12 Volts

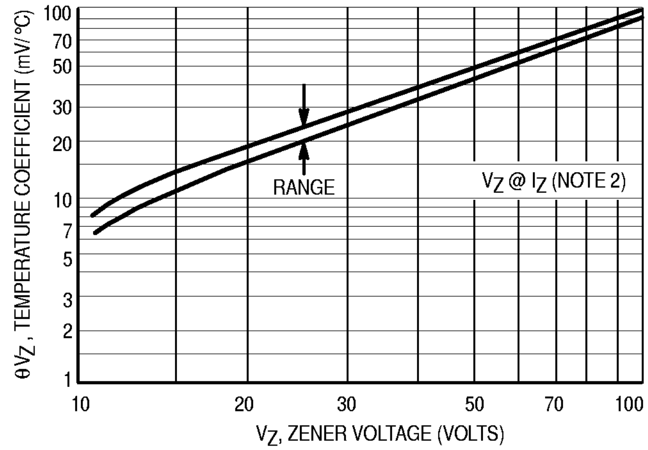


Figure 4b. Range for Units 12 to 100 Volts

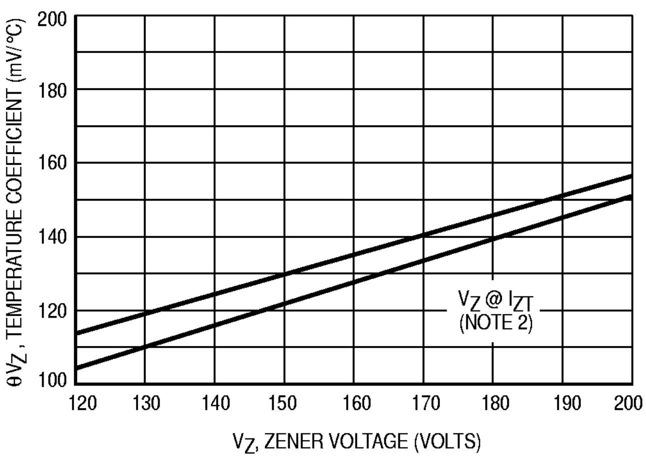


Figure 4c. Range for Units 120 to 200 Volts

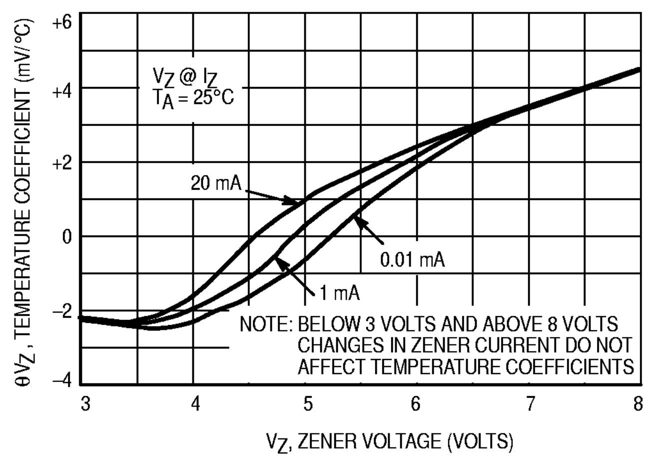


Figure 5. Effect of Zener Current

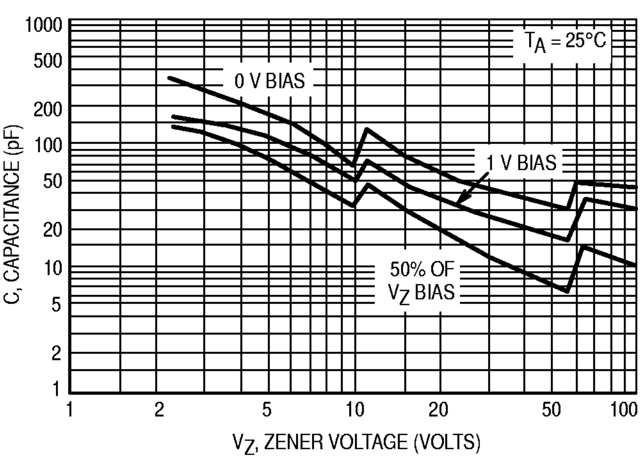


Figure 6a. Typical Capacitance 2.4–100 Volts

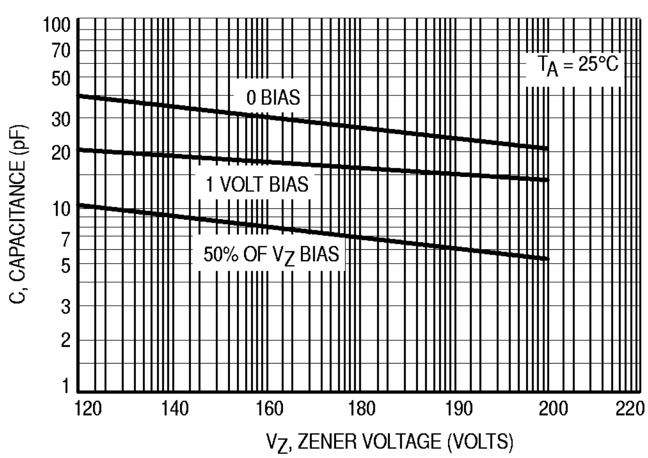


Figure 6b. Typical Capacitance 120–200 Volts

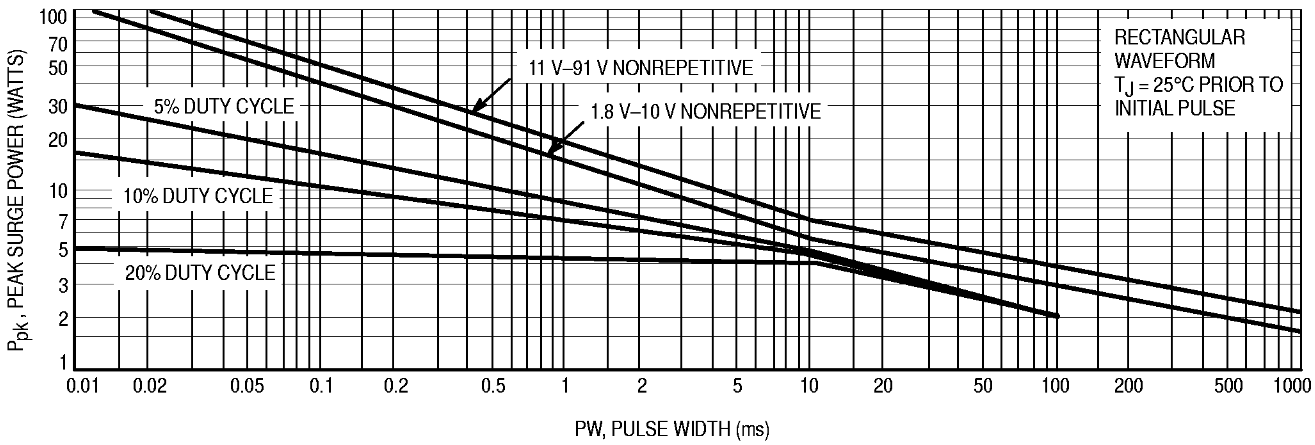


Figure 7a. Maximum Surge Power 1.8–91 Volts

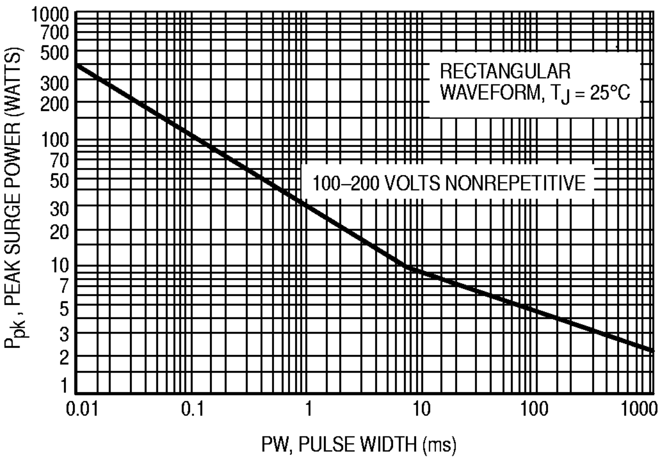


Figure 7b. Maximum Surge Power DO-204AH 100–200 Volts

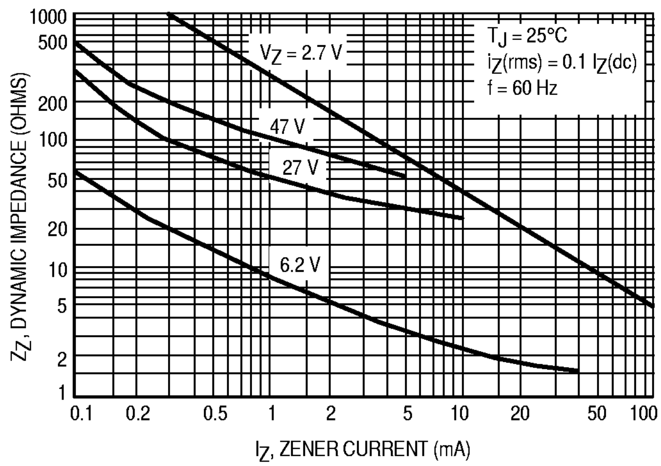


Figure 8. Effect of Zener Current on Zener Impedance

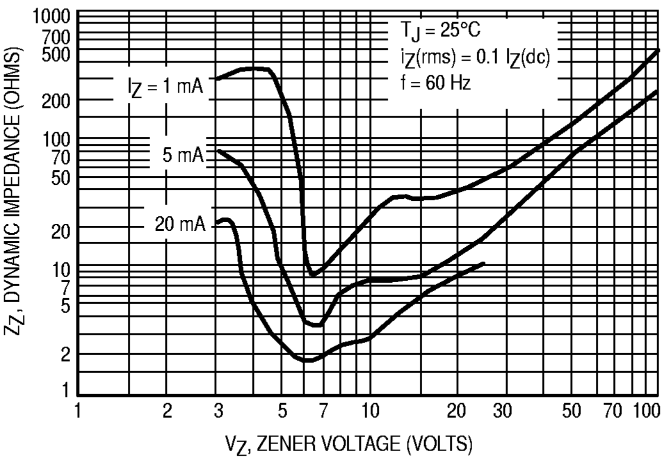


Figure 9. Effect of Zener Voltage on Zener Impedance

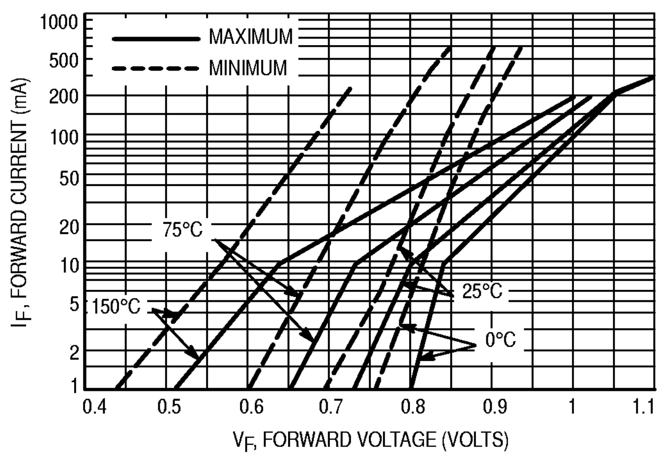


Figure 10. Typical Forward Characteristics

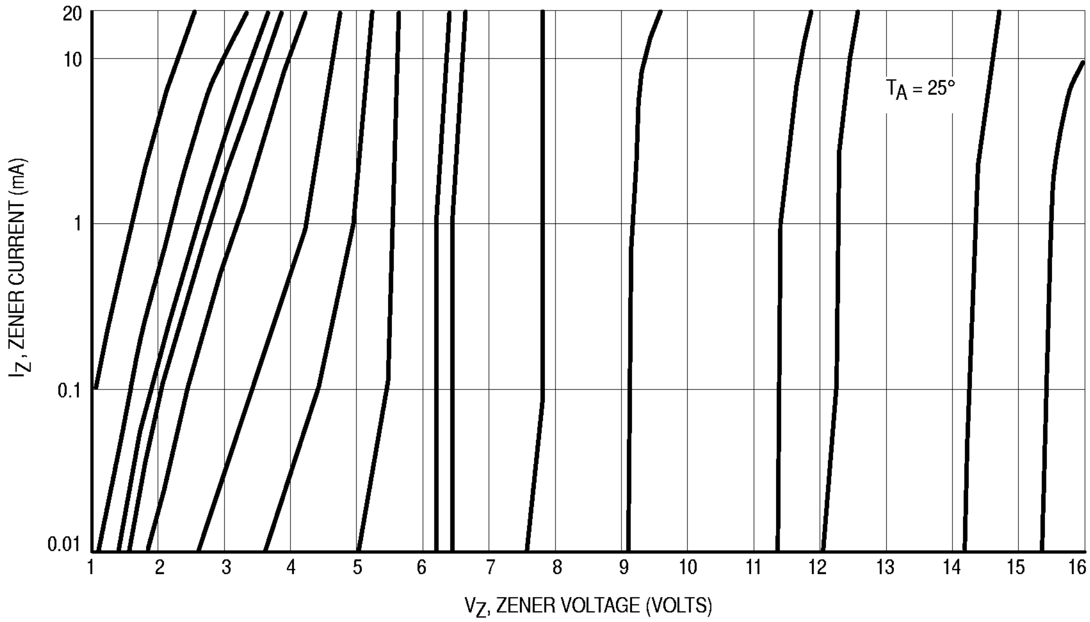


Figure 11. Zener Voltage versus Zener Current — V_Z = 1 thru 16 Volts

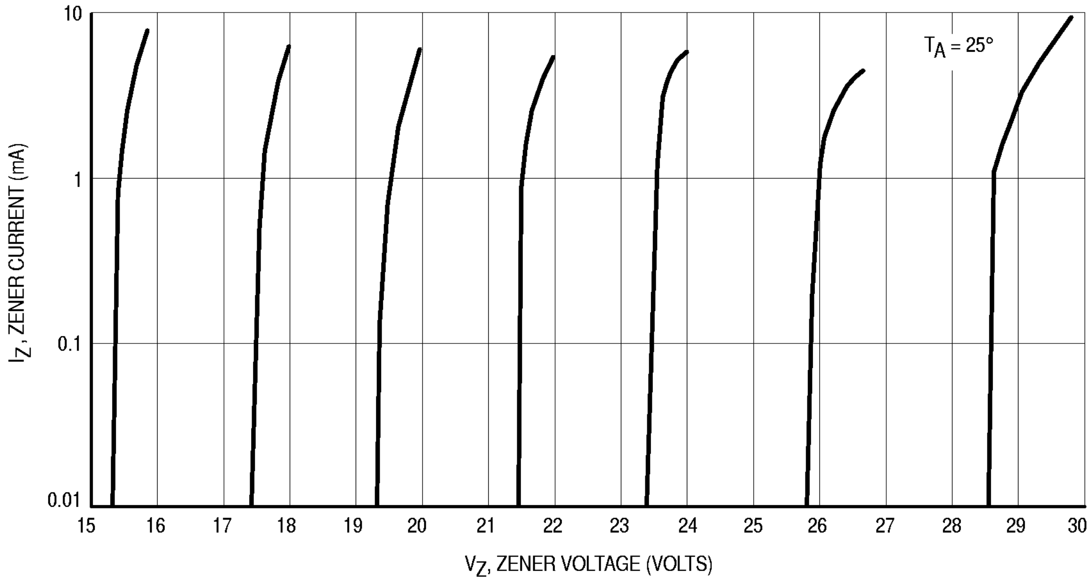


Figure 12. Zener Voltage versus Zener Current — V_Z = 15 thru 30 Volts

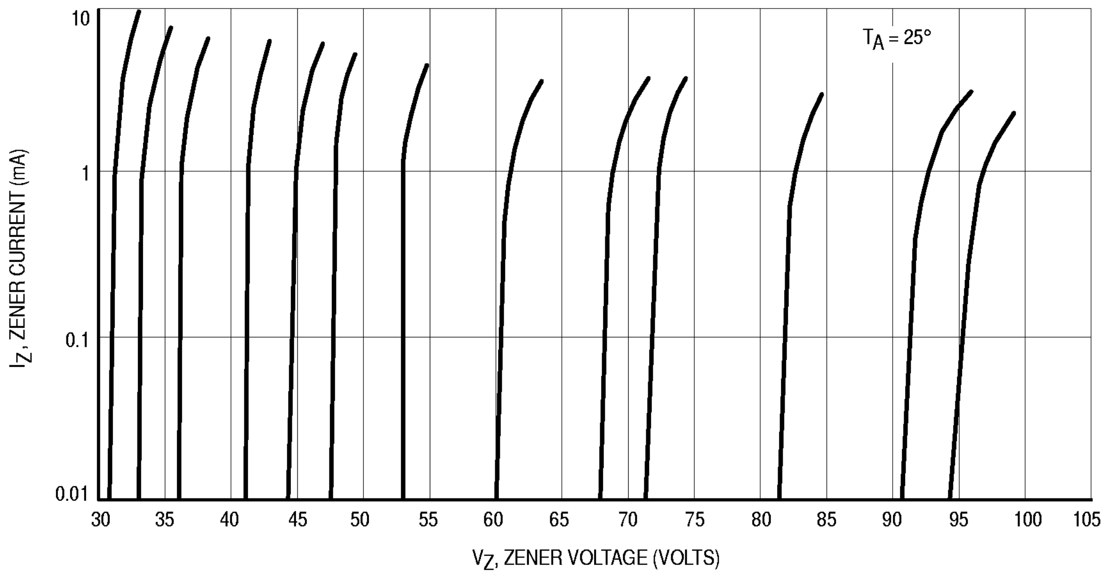


Figure 13. Zener Voltage versus Zener Current — V_Z = 30 thru 105 Volts

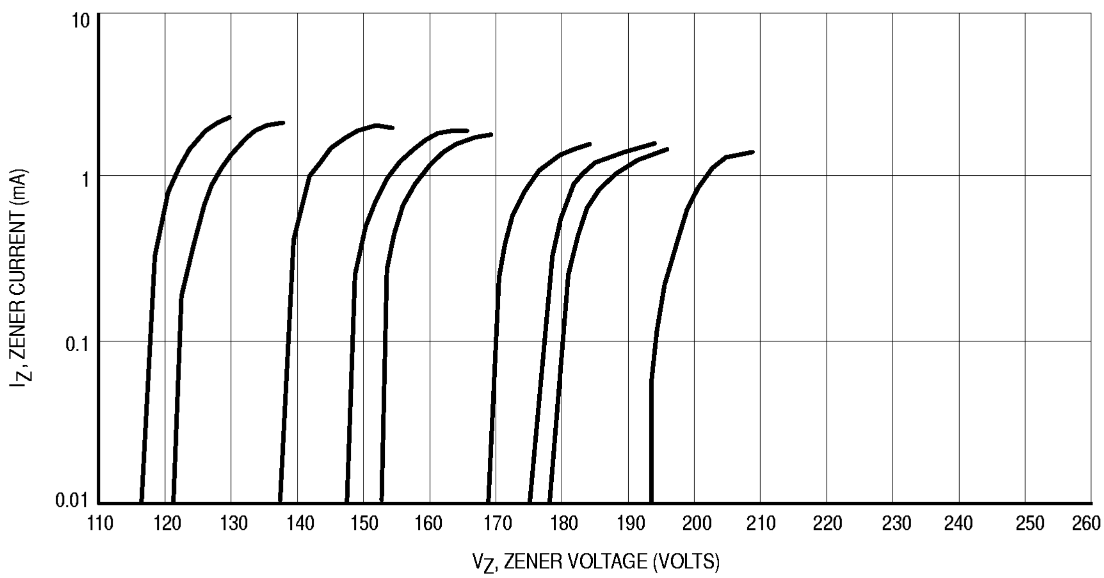
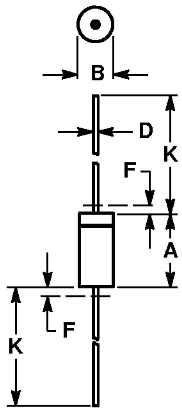


Figure 14. Zener Voltage versus Zener Current — V_Z = 110 thru 220 Volts

Zener Voltage Regulator Diodes — Axial Leaded

500 mW DO-35 Glass



NOTES:
1. PACKAGE CONTOUR OPTIONAL WITHIN A AND B HEAT SLUGS, IF ANY, SHALL BE INCLUDED WITHIN THIS CYLINDER, BUT NOT SUBJECT TO THE MINIMUM LIMIT OF B.
2. LEAD DIAMETER NOT CONTROLLED IN ZONE F TO ALLOW FOR FLASH, LEAD FINISH BUILDUP AND MINOR IRREGULARITIES OTHER THAN HEAT SLUGS.
3. POLARITY DENOTED BY CATHODE BAND.
4. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	3.05	5.08	0.120	0.200
B	1.52	2.29	0.060	0.090
D	0.46	0.56	0.018	0.022
F	—	1.27	—	0.050
K	25.40	38.10	1.000	1.500

All JEDEC dimensions and notes apply.

CASE 299-02
DO-204AH
GLASS

(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, RL2(1)	5K
Tape and Ammo	TA, TA2(1)	5K

NOTES: 1. The “2” suffix refers to 26 mm tape spacing.
2. Radial Tape and Reel may be available. Please contact your Motorola representative.

Refer to Section 10 for more information on Packaging Specifications.