1N5221B Series

500 mW DO-35 Hermetically Sealed Glass Zener Voltage Regulators

This is a complete series of 500 mW Zener diodes with limits and excellent operating characteristics that reflect the superior capabilities of silicon–oxide passivated junctions. All this in an axial–lead hermetically sealed glass package that offers protection in all common environmental conditions.

Specification Features:

- Zener Voltage Range – 2.4 V to 91 V
- ESD Rating of Class 3 (>16 KV) per Human Body Model
- DO–204AH (DO–35) Package – Smaller than Conventional DO–204AA Package
- Double Slug Type Construction
- Metallurgical Bonded Construction

Mechanical Characteristics:

CASE: Double slug type, hermetically sealed glass
FINISH: All external surfaces are corrosion resistant and leads are readily solderable
MAXIMUM LEAD TEMPERATURE FOR SOLDERING PURPOSES: 230°C, 1/16″ from the case for 10 seconds
POLARITY: Cathode indicated by polarity band
MOUNTING POSITION: Any

MAXIMUM RATINGS (Note 1.)

Rating	Symbol	Value	Unit
Max. Steady State Power Dissipation @ $T_L \leq 75°C$, Lead Length = 3/8″ Derate above 75°C	P_D	500 4.0	mW mW/°C
Operating and Storage Temperature Range	T_J, T_{stg}	–65 to +200	°C

1. Some part number series have lower JEDEC registered ratings.

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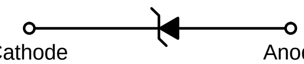
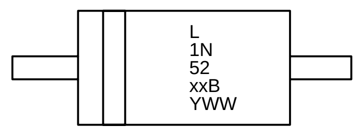


Cathode Anode

AXIAL LEAD
CASE 299
GLASS

MARKING DIAGRAM



L = Assembly Location
1N52xxB = Device Code (See Table Next Page)
Y = Year
WW = Work Week

ORDERING INFORMATION

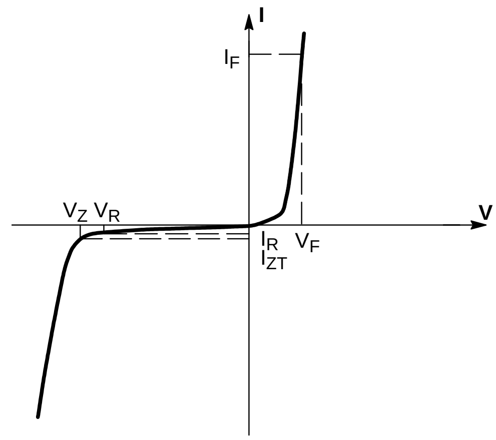
Device	Package	Shipping
1N52xxB	Axial Lead	3000 Units/Box
1N52xxBRL	Axial Lead	5000/Tape & Reel
1N52xxBRL2 *	Axial Lead	5000/Tape & Reel
1N52xxBRA1	Axial Lead	3000/Ammo Pack
1N52xxBTA	Axial Lead	5000/Ammo Pack
1N52xxBTA2 *	Axial Lead	5000/Ammo Pack
1N52xxBRR1 †	Axial Lead	3000/Tape & Reel
1N52xxBRR2 ‡	Axial Lead	3000/Tape & Reel

* The "2" suffix refers to 26 mm tape spacing.
† Polarity band **up** with cathode lead off first
‡ Polarity band **down** with cathode lead off first

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

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 V Max @ I_F = 200 mA for all types)

Symbol	Parameter
V_Z	Reverse Zener Voltage @ I_{ZT}
I_{ZT}	Reverse Current
Z_{ZT}	Maximum Zener Impedance @ I_{ZT}
I_{ZK}	Reverse Current
Z_{ZK}	Maximum Zener Impedance @ I_{ZK}
I_R	Reverse Leakage Current @ V_R
V_R	Breakdown Voltage
I_F	Forward Current
V_F	Forward Voltage @ I_F
θ_{VZ}	Maximum Zener Voltage Temperature Coefficient



Zener Voltage Regulator

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 V Max @ I_F = 200 mA for all types)

Device (Note 2.)	**Device Marking**	**Zener Voltage** (Note 3.) V_Z (Volts) Min	Nom	Max	@ I_{ZT} mA	**Zener Impedance** (Note 4.) Z_{ZT} @ I_{ZT} Ω	Z_{ZK} @ I_{ZK} Ω	mA	**Leakage Current** I_R @ V_R µA	Volts	θ_{VZ} (Note 5.) %/°C
1N5221B	1N5221B	2.28	2.4	2.52	20	30	1200	0.25	100	1	–0.085
1N5222B	1N5222B	2.375	2.5	2.625	20	30	1250	0.25	100	1	–0.085
1N5223B	1N5223B	2.565	2.7	2.835	20	30	1300	0.25	75	1	–0.08
1N5224B	1N5224B	2.66	2.8	2.94	20	30	1400	0.25	75	1	–0.08
1N5225B	1N5225B	2.85	3.0	3.15	20	29	1600	0.25	50	1	–0.075
1N5226B	***1N5226B***	***3.14***	***3.3***	***3.46***	***20***	***28***	***1600***	***0.25***	***25***	***1***	***–0.07***
1N5227B	1N5227B	3.42	3.6	3.78	20	24	1700	0.25	15	1	–0.065
1N5228B	***1N5228B***	***3.71***	***3.9***	***4.09***	***20***	***23***	***1900***	***0.25***	***10***	***1***	***–0.06***
1N5229B	1N5229B	4.09	4.3	4.51	20	22	2000	0.25	5	1	±0.055
1N5230B	1N5230B	4.47	4.7	4.93	20	19	1900	0.25	5	2	±0.03
1N5231B	***1N5231B***	***4.85***	***5.1***	***5.35***	***20***	***17***	***1600***	***0.25***	***5***	***2***	***±0.03***
1N5232B	***1N5232B***	***5.32***	***5.6***	***5.88***	***20***	***11***	***1600***	***0.25***	***5***	***3***	***0.038***
1N5233B	1N5233B	5.7	6.0	6.3	20	7	1600	0.25	5	3.5	0.038
1N5234B	***1N5234B***	***5.89***	***6.2***	***6.51***	***20***	***7***	***1000***	***0.25***	***5***	***4***	***0.045***
1N5235B	***1N5235B***	***6.46***	***6.8***	***7.14***	***20***	***5***	***750***	***0.25***	***3***	***5***	***0.05***

2. **TOLERANCE**
The JEDEC type numbers shown indicate a tolerance of ±5%.
3. **ZENER VOLTAGE (V_Z) MEASUREMENT**
The zener voltage is measured with the device junction in the thermal equilibrium at the lead temperature (T_L) at 30°C ± 1°C and 3/8″ lead length.
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.
5. **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.

* For more information on special selections contact your nearest ON Semiconductor representative.

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 V Max @ I_F = 200 mA for all types) (continued)

Device (Note 6.)	Device Marking	**Zener Voltage** (Note 7.)				**Zener Impedance** (Note 8.)			**Leakage Current**		θ_{VZ} (Note 9.)
		V_Z (Volts)			@ I_{ZT}	Z_{ZT} @ I_{ZT}	Z_{ZK} @ I_{ZK}		I_R @ V_R		
		Min	**Nom**	**Max**	**mA**	**Ω**	**Ω**	**mA**	**µA**	**Volts**	**%/°C**
1N5236B	1N5236B	7.13	7.5	7.87	20	6	500	0.25	3	6	0.058
1N5237B	***1N5237B***	***7.79***	***8.2***	***8.61***	***20***	***8***	***500***	***0.25***	***3***	***6.5***	***0.062***
1N5238B	1N5238B	8.265	8.7	9.135	20	8	600	0.25	3	6.5	0.065
1N5239B	1N5239B	8.65	9.1	9.55	20	10	600	0.25	3	7	0.068
1N5240B	***1N5240B***	***9.5***	***10***	***10.5***	***20***	***17***	***600***	***0.25***	***3***	***8***	***0.075***
1N5241B	1N5241B	10.45	11	11.55	20	22	600	0.25	2	8.4	0.076
1N5242B	***1N5242B***	***11.4***	***12***	***12.6***	***20***	***30***	***600***	***0.25***	***1***	***9.1***	***0.077***
1N5243B	1N5243B	12.35	13	13.65	9.5	13	600	0.25	0.5	9.9	0.079
1N5244B	1N5244B	13.3	14	14.7	9	15	600	0.25	0.1	10	0.082
1N5245B	***1N5245B***	***14.25***	***15***	***15.75***	***8.5***	***16***	***600***	***0.25***	***0.1***	***11***	***0.082***
1N5246B	***1N5246B***	***15.2***	***16***	***16.8***	***7.8***	***17***	***600***	***0.25***	***0.1***	***12***	***0.083***
1N5247B	1N5247B	16.15	17	17.85	7.4	19	600	0.25	0.1	13	0.084
1N5248B	1N5248B	17.1	18	18.9	7	21	600	0.25	0.1	14	0.085
1N5249B	1N5249B	18.05	19	19.95	6.6	23	600	0.25	0.1	14	0.086
1N5250B	***1N5250B***	***19***	***20***	***21***	***6.2***	***25***	***600***	***0.25***	***0.1***	***15***	***0.086***
1N5251B	1N5251B	20.9	22	23.1	5.6	29	600	0.25	0.1	17	0.087
1N5252B	1N5252B	22.8	24	25.2	5.2	33	600	0.25	0.1	18	0.088
1N5253B	1N5253B	23.75	25	26.25	5.0	35	600	0.25	0.1	19	0.089
1N5254B	1N5254B	25.65	27	28.35	4.6	41	600	0.25	0.1	21	0.090
1N5255B	1N5255B	26.6	28	29.4	4.5	44	600	0.25	0.1	21	0.091
1N5256B	1N5256B	28.5	30	31.5	4.2	49	600	0.25	0.1	23	0.091
1N5257B	1N5257B	31.35	33	34.65	3.8	58	700	0.25	0.1	25	0.092
1N5258B	1N5258B	34.2	36	37.8	3.4	70	700	0.25	0.1	27	0.093
1N5259B	1N5259B	37.05	39	40.95	3.2	80	800	0.25	0.1	30	0.094
1N5260B	1N5260B	40.85	43	45.15	3.0	93	900	0.25	0.1	33	0.095
1N5261B	1N5261B	44.65	47	49.35	2.7	105	1000	0.25	0.1	36	0.095
1N5262B	1N5262B	48.45	51	53.55	2.5	125	1100	0.25	0.1	39	0.096
1N5263B	1N5263B	53.2	56	58.8	2.2	150	1300	0.25	0.1	43	0.096
1N5264B	1N5264B	57	60	63	2.1	170	1400	0.25	0.1	46	0.097
1N5265B	1N5265B	58.9	62	65.1	2.0	185	1400	0.25	0.1	47	0.097
1N5266B	1N5266B	64.6	68	71.4	1.8	230	1600	0.25	0.1	52	0.097
1N5267B	1N5267B	71.25	75	78.75	1.7	270	1700	0.25	0.1	56	0.098
1N5268B	1N5268B	77.9	82	86.1	1.5	330	2000	0.25	0.1	62	0.098
1N5269B	1N5269B	82.65	87	91.35	1.4	370	2200	0.25	0.1	68	0.099
1N5270B	1N5270B	86.45	91	95.55	1.4	400	2300	0.25	0.1	69	0.099

6. **TOLERANCE**
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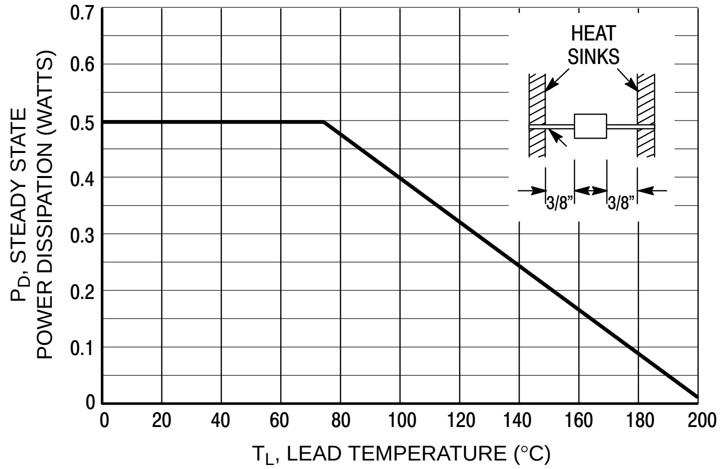

Figure 1. Steady State Power Derating

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.

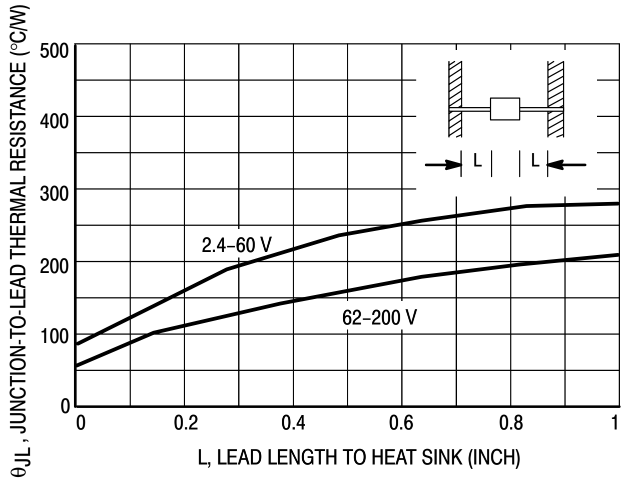

Figure 2. Typical Thermal Resistance

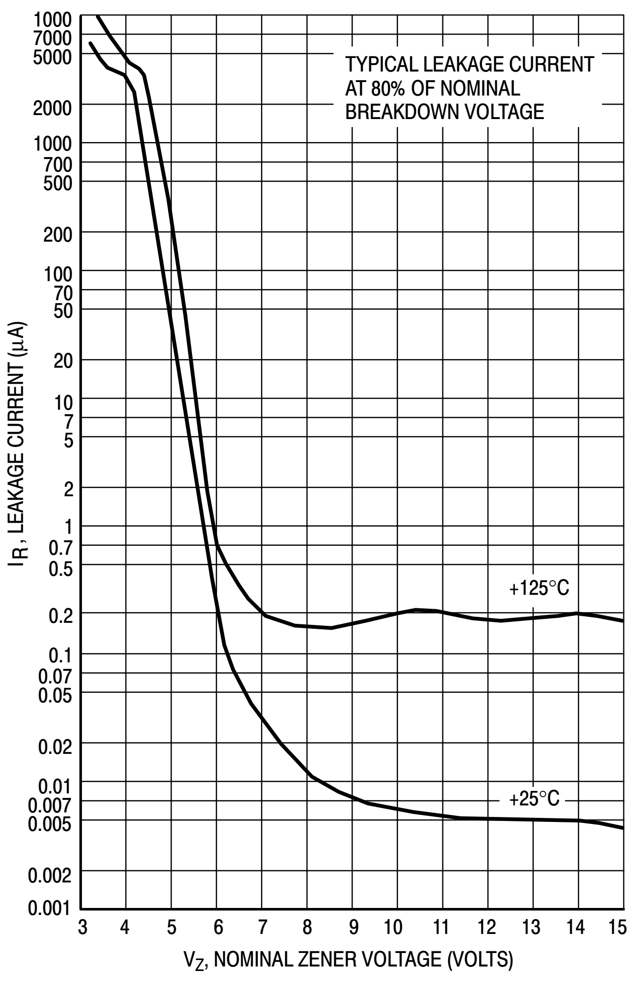

Figure 3. Typical Leakage Current

TEMPERATURE COEFFICIENTS

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

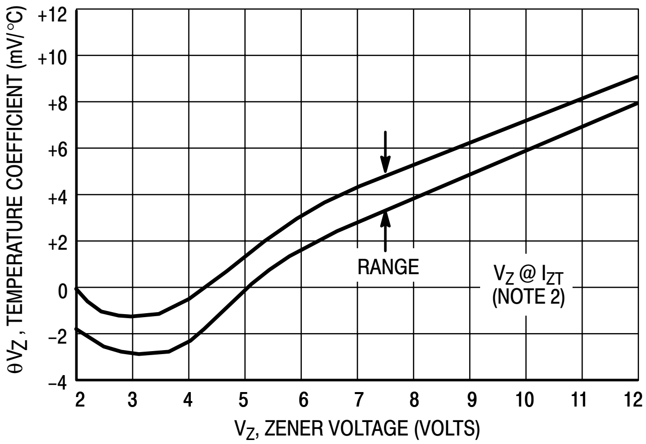

Figure 4a. Range for Units to 12 Volts

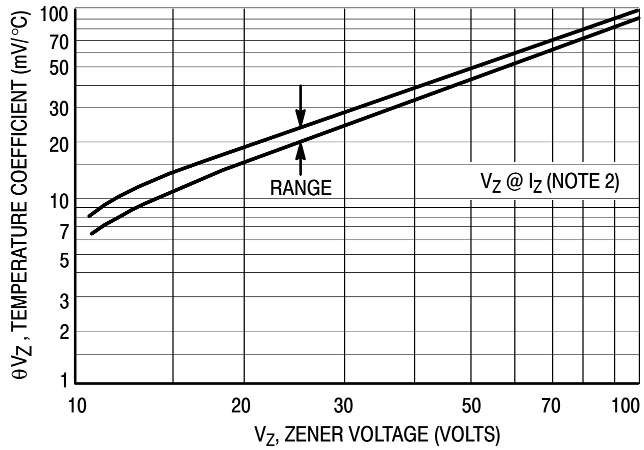

Figure 4b. Range for Units 12 to 100 Volts

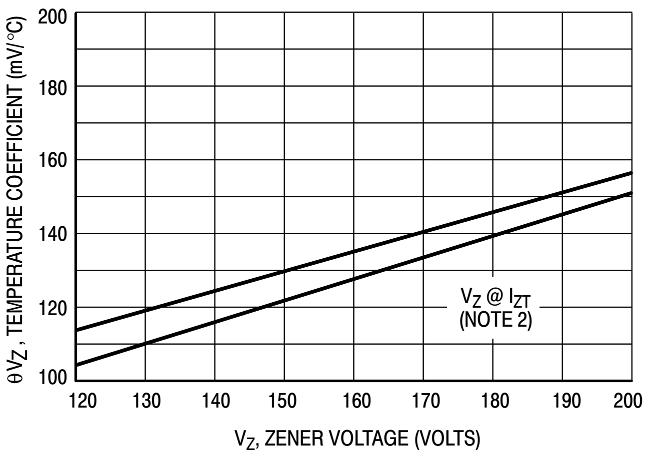

Figure 4c. Range for Units 120 to 200 Volts

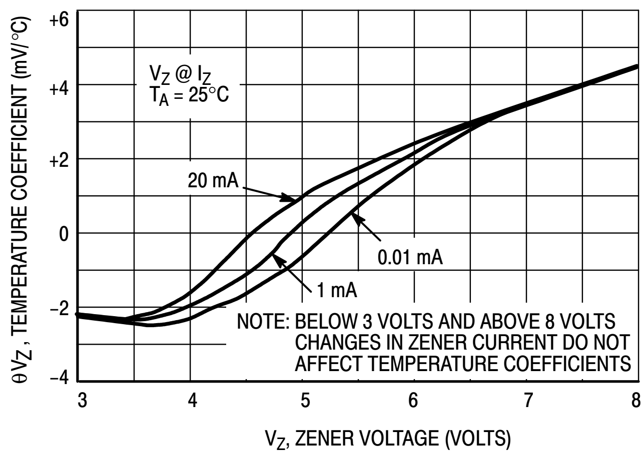

Figure 5. Effect of Zener Current

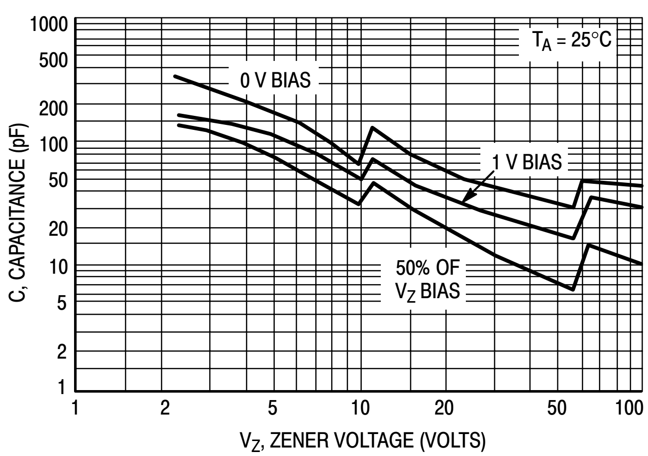

Figure 6a. Typical Capacitance 2.4–100 Volts

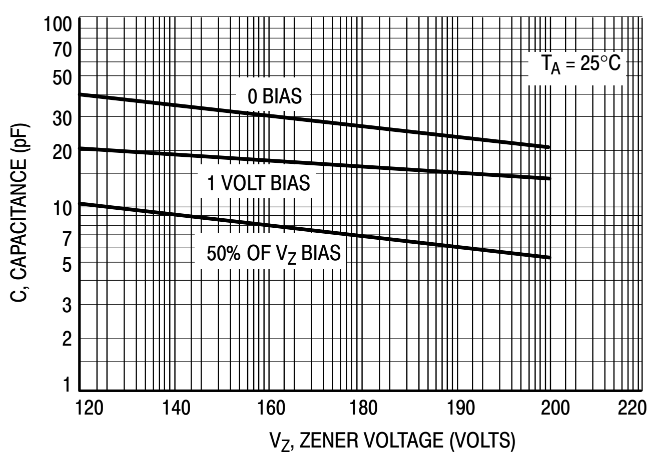

Figure 6b. Typical Capacitance 120–200 Volts

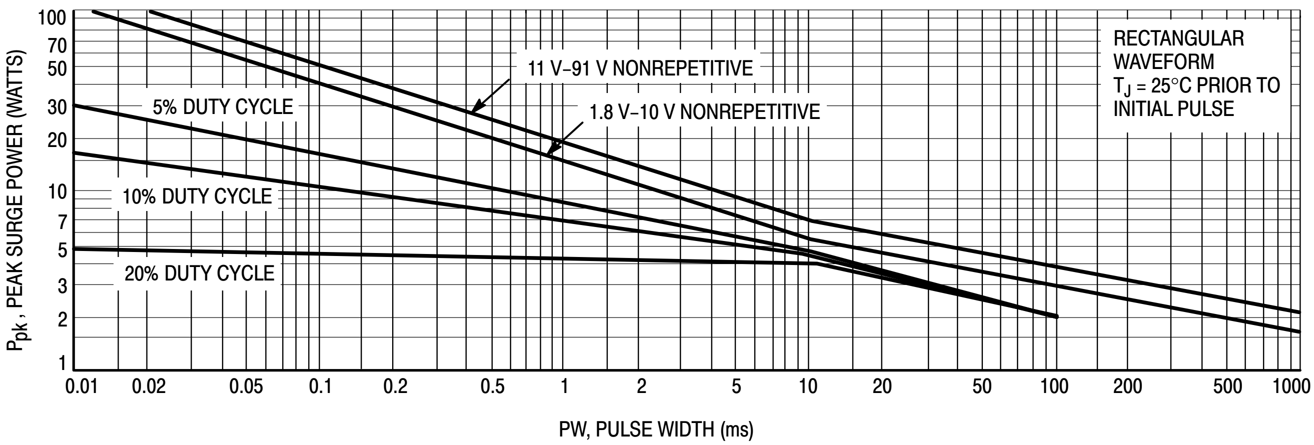

Figure 7a. Maximum Surge Power 1.8–91 Volts

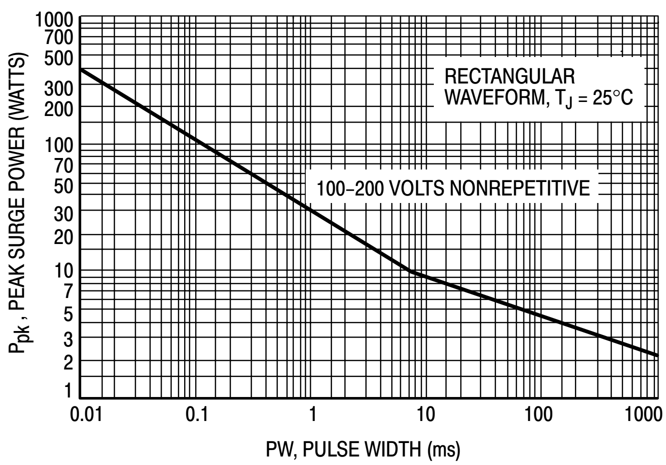

Figure 7b. Maximum Surge Power DO-204AH 100–200 Volts

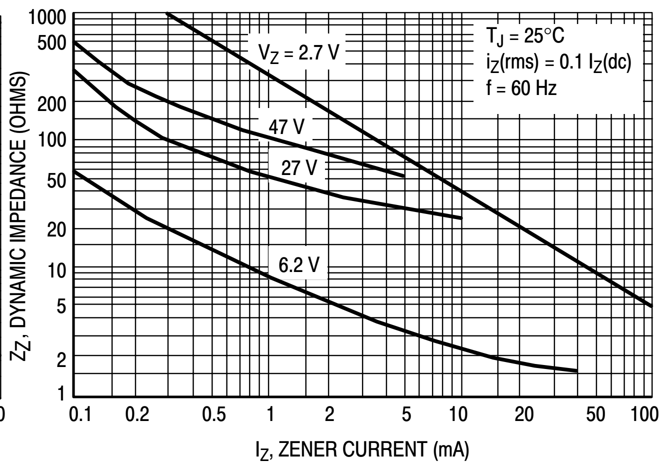

Figure 8. Effect of Zener Current on Zener Impedance

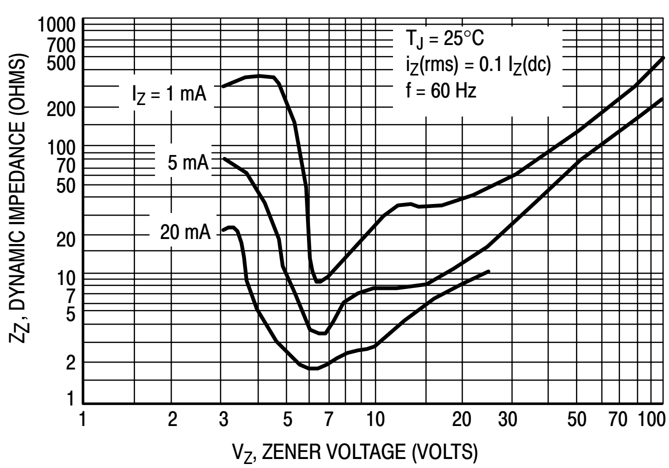

Figure 9. Effect of Zener Voltage on Zener Impedance

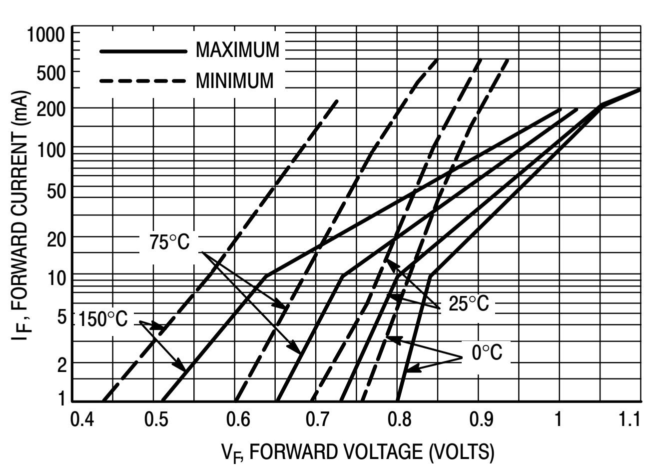

Figure 10. Typical Forward Characteristics

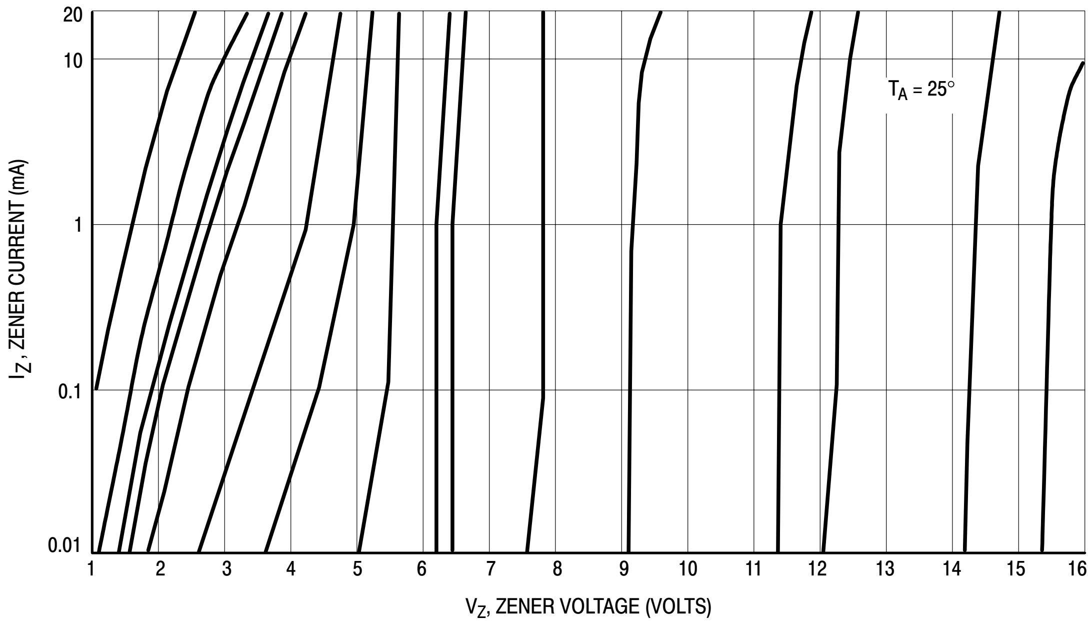

Figure 11. Zener Voltage versus Zener Current — V_Z = 1 thru 16 Volts

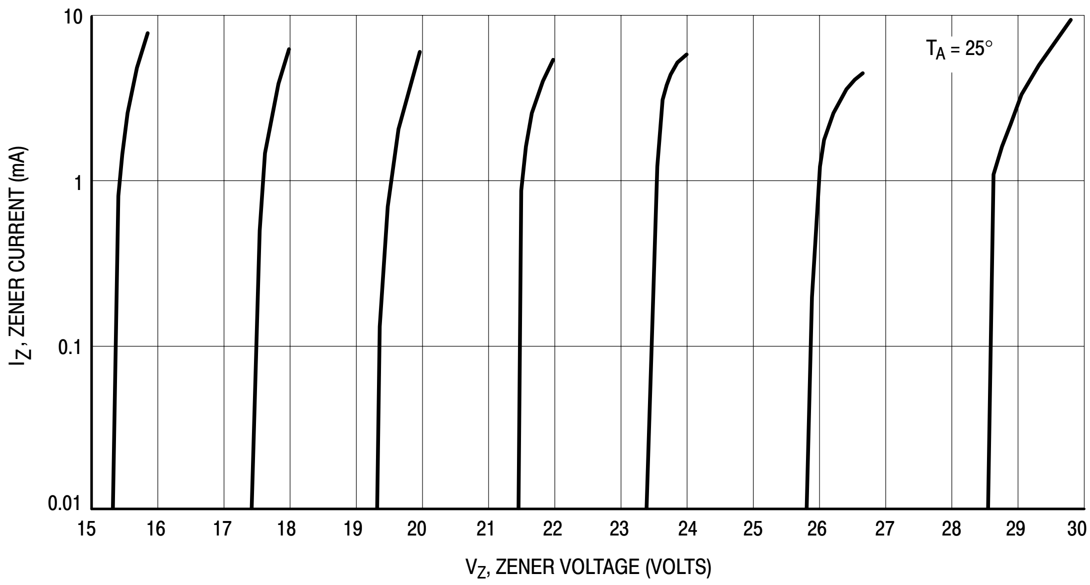

Figure 12. Zener Voltage versus Zener Current — V_Z = 15 thru 30 Volts

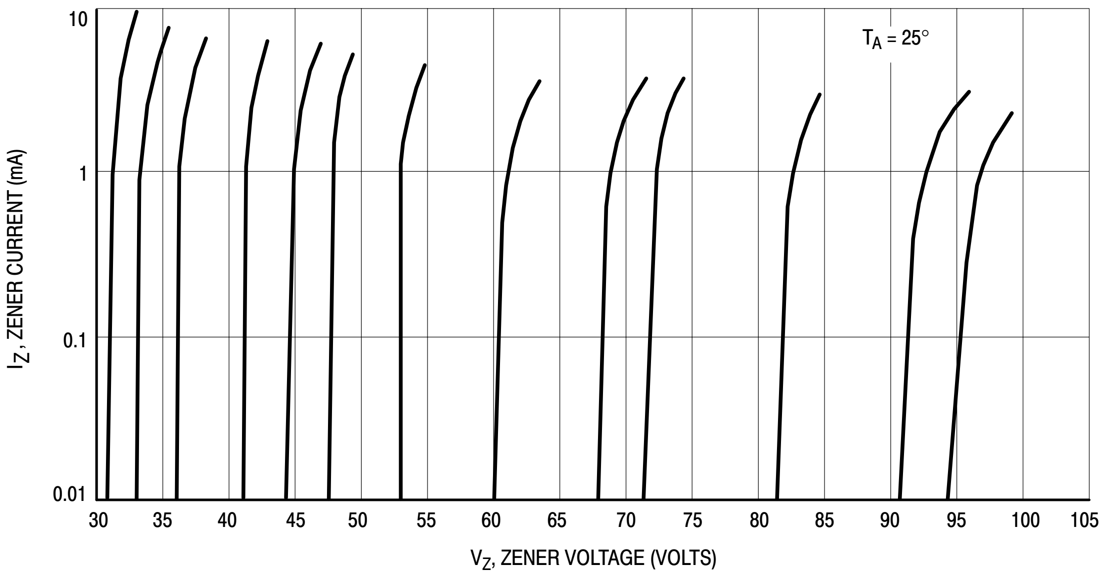

Figure 13. Zener Voltage versus Zener Current — V_Z = 30 thru 105 Volts

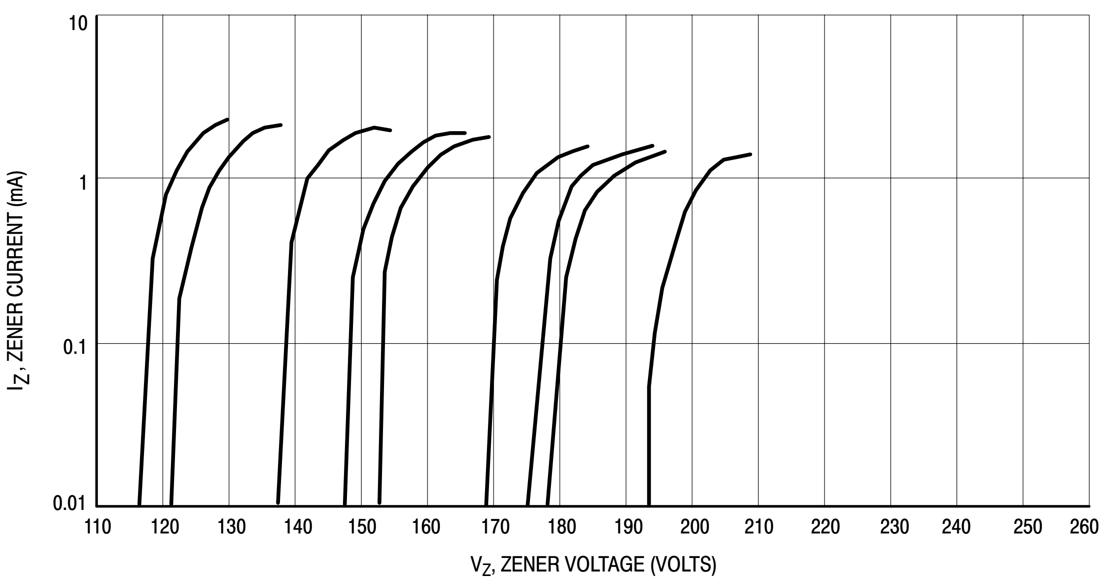

Figure 14. Zener Voltage versus Zener Current — V_Z = 110 thru 220 Volts