TAK CHEONG ®

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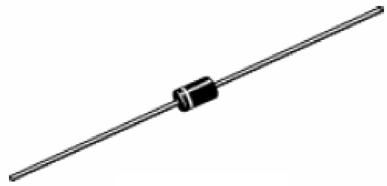
500 mW DO-35 Hermetically Sealed Glass Zener Voltage Regulators



AXIAL LEAD
DO35

Maximum Ratings (Note 1)

Rating	Symbol	Value	Units
Maximum Steady State Power Dissipation @TL≤75℃, Lead Length = 3/8”	P_D	500	mW
Derate Above 75℃		4.0	mW/℃
Operating and Storage Temperature Range	T_J, T_{stg}	-65 to +200	°C

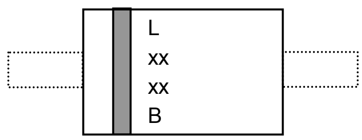
Note 1: Some part number series have lower JEDEC registered ratings.

Specification Features:

- Zener Voltage Range = 2.4V to 110V
- ESD Rating of Clas 3 (>6 KV) per Human Body Model
- DO-35 Package (DO-204AH)
- Double Slug Type Construction
- Metallurgical Bonded Construction

Specification Features:

Case : Double slug type, hermetically sealed glass
Finish : All external surfaces are corrosion resistant and leads are readily solderable
Polarity : Cathode indicated by polarity band
Mounting: Any



L = Logo
xxxx = 1NxxxxB Device Code

Maximum Lead Temperature for Soldering Purposes
230℃, 1/16” from the case for 10 seconds

Ordering Information

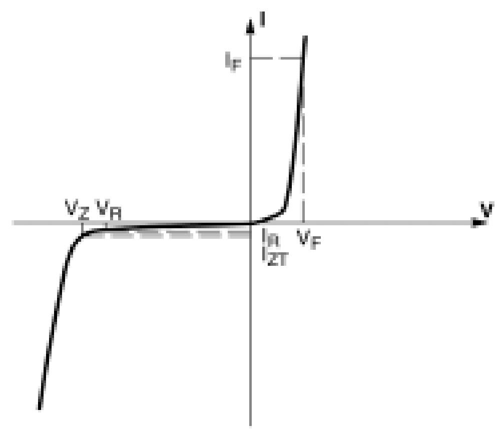
Device	Package	Quantity
1NxxxxB	Axial Lead	3000 Units / Box
1NxxxxBRL	Axial Lead	5000 Units / Tape & Reel
1NxxxxBRL2*	Axial Lead	5000 Units / Tape & Reel
1NxxxxBRR1 !	Lead Form	3000 Units / Radial Tape & Reel
1NxxxxBRR2 i	Lead Form	3000 Units / Radial Tape & Reel
1NxxxxBTA	Axial Lead	5000 Units / Tape & Ammo
1NxxxxBTA2*	Axial Lead	5000 Units / Tape & Ammo
1NxxxxBRA1 !	Axial Lead	3000 Units / Radial Tape & Ammo
1NxxxxBRA2 i	Axial Lead	3000 Units / Radial Tape & Ammo

* The “2” suffix refer to 26mm tape spacing.
! “1”: Polarity band **up** with cathode lead off first.
i “2”: Polarity band **down** with cathode lead off first.

Devices listed in **bold italic** are Tak Cheong **Preferred** devices. **Preferred** devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25ºC unless otherwise noted. V_F = 1.5 V Max @ I_F = 100mA for all types)

Symbol	Parameter
V_Z	Reverse Zener Voltage @ I_{ZT}
I_{ZT}	Reverse Zener Current
Z_{ZT}	Maximum Zener Impedance @ I_{ZT}
I_{Zk}	Reverse Zener Current
I_R	Reverse Leakage Current @ V_R
V_R	Reverse Voltage
I_F	Forward Current
V_F	Forward Voltage @ I_F
I_{ZM}	Maximum DC Zener Current



Zener Voltage Regulator

ELECTRICAL CHARACTERISTICS (T_A = 25ºC unless otherwise noted, V_F = 1.5 V Max @ I_F = 100mA 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)	I_{ZM} (Note 5.) (mA)
1N5985B	1N5985B	2.28	2.4	2.52	5	100	1800	0.25	100	1	208
1N5986B	1N5986B	2.565	2.7	2.835	5	100	1900	0.25	75	1	185
1N5987B	1N5987B	2.85	3	3.15	5	95	2000	0.25	50	1	167
1N5988B	1N5988B	3.135	3.3	3.465	5	95	2200	0.25	25	1	152
1N5989B	1N5989B	3.42	3.6	3.78	5	90	2300	0.25	15	1	139
1N5990B	1N5990B	3.705	3.9	4.095	5	90	2400	0.25	10	1	128
1N5991B	1N5991B	4.085	4.3	4.515	5	88	2500	0.25	5	1	116
1N5992B	1N5992B	4.465	4.7	4.935	5	70	2200	0.25	3	1.5	106
1N5993B	1N5993B	4.845	5.1	5.355	5	50	2050	0.25	2	2	98
1N5994B	1N5994B	5.32	5.6	5.88	5	25	1800	0.25	2	3	89
1N5995B	1N5995B	5.89	6.2	6.51	5	10	1300	0.25	1	4	81
1N5996B	1N5996B	6.46	6.8	7.14	5	8	750	0.25	1	5.2	74
1N5997B	1N5997B	7.125	7.5	7.875	5	7	600	0.25	0.5	6	67
1N5998B	1N5998B	7.79	8.2	8.61	5	7	600	0.25	0.5	6.5	61
1N5999B	1N5999B	8.645	9.1	9.555	5	10	600	0.25	0.1	7	55
1N6000B	1N6000B	9.5	10	10.5	5	15	600	0.25	0.1	8	50
1N6001B	1N6001B	10.45	11	11.55	5	18	600	0.25	0.1	8.4	45
1N6002B	1N6002B	11.4	12	12.6	5	22	600	0.25	0.1	9.1	42
1N6003B	1N6003B	12.35	13	13.65	5	25	600	0.25	0.1	9.9	38
1N6004B	1N6004B	14.25	15	15.75	5	32	600	0.25	0.1	11	33

2. TOLERANCE AND TYPE NUMBER DESIGNATION (V_Z)
The type numbers listed have a standard tolerance on the nominal zener voltage of ±5%.

3. ZENER VOLTAGE (V_Z) MEASUREMENT
Nominal 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 AC frequency = 60Hz.

5. MAXIMUM ZENER CURRENT RATINGS (I_{ZM})
This data was calculated using nominal voltages. The maximum current handling capability on a worst case basis is limited by the actual zener voltage at the operation point and the power derating curve.

ELECTRICAL CHARACTERISTICS (T_A = 25ºC unless otherwise noted, V_F = 1.5 V Max @ I_F = 100mA for all types)

Device (Note 6.)	Device Marking	Zener Voltage (Note 7.) V_Z (Volts) Min	Nom	Max	@ I_{ZT} (mA)	Zener Impedance (Note 8.) Z_{ZT} @ I_{ZT} (Ω)	Z_{ZK} @ I_{ZK} (Ω)	(mA)	Leakage Current I_R @ V_R (μA)	(Volts)	I_{ZM} (Note 9.) (mA)
1N6005B	1N6005B	15.2	16	16.8	5	36	600	0.25	0.1	12	31
1N6006B	1N6006B	17.1	18	18.9	5	42	600	0.25	0.1	14	28
1N6007B	1N6007B	19	20	21	5	48	600	0.25	0.1	15	25
1N6008B	1N6008B	20.9	22	23.1	5	55	600	0.25	0.1	17	23
1N6009B	1N6009B	22.8	24	25.2	5	62	600	0.25	0.1	18	21
1N6010B	1N6010B	25.65	27	28.35	5	70	600	0.25	0.1	21	19
1N6011B	1N6011B	28.5	30	31.5	5	78	600	0.25	0.1	23	17
1N6012B	1N6012B	31.35	33	34.65	5	88	700	0.25	0.1	25	15
1N6013B	1N6013B	34.2	36	37.8	5	95	700	0.25	0.1	27	14
1N6014B	1N6014B	37.05	39	40.95	2	130	800	0.25	0.1	30	13
1N6015B	1N6015B	40.85	43	45.15	2	150	900	0.25	0.1	33	12
1N6016B	1N6016B	44.65	47	49.35	2	170	1000	0.25	0.1	36	11
1N6017B	1N6017B	48.45	51	53.55	2	180	1300	0.25	0.1	39	9.8
1N6018B	1N6018B	53.2	56	58.8	2	200	1400	0.25	0.1	43	8.9
1N6019B	1N6019B	58.9	62	65.1	2	225	1400	0.25	0.1	47	8
1N6020B	1N6020B	64.6	68	71.4	2	240	1600	0.25	0.1	52	7.4
1N6021B	1N6021B	71.25	75	78.75	2	265	1700	0.25	0.1	56	6.7
1N6022B	1N6022B	77.9	82	86.1	2	280	2000	0.25	0.1	62	6.1
1N6023B	1N6023B	86.45	91	95.55	2	300	2300	0.25	0.1	69	5.5
1N6024B	1N6024B	95	100	105	1	500	2600	0.25	0.1	76	5
1N6025B	1N6025B	104.5	110	115.5	1	650	3000	0.25	0.1	84	4.5

6. TOLERANCE AND TYPE NUMBER DESIGNATION (V_Z)
The type numbers listed have a standard tolerance on the nominal zener voltage of ±5%.

7. ZENER VOLTAGE (V_Z) MEASUREMENT
Nominal 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.

8. 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 AC frequency = 60Hz.

9. MAXIMUM ZENER CURRENT RATINGS (I_{ZM})
This data was calculated using nominal voltages. The maximum current handling capability on a worst case basis is limited by the actual zener voltage at the operation point and the power derating curve.

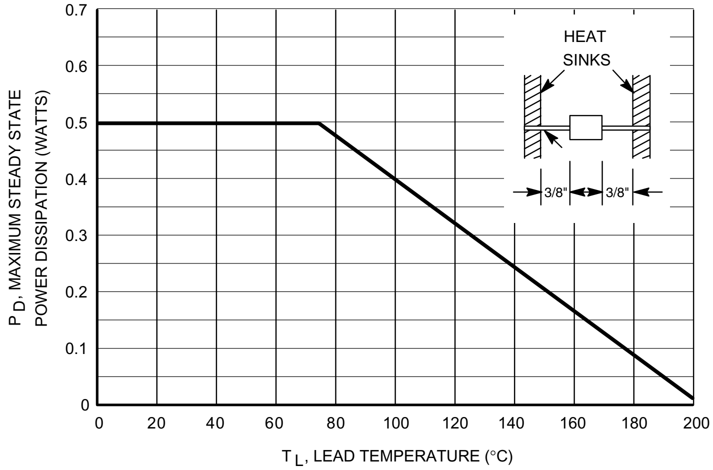


Figure 1. Steady State Power Derating

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.

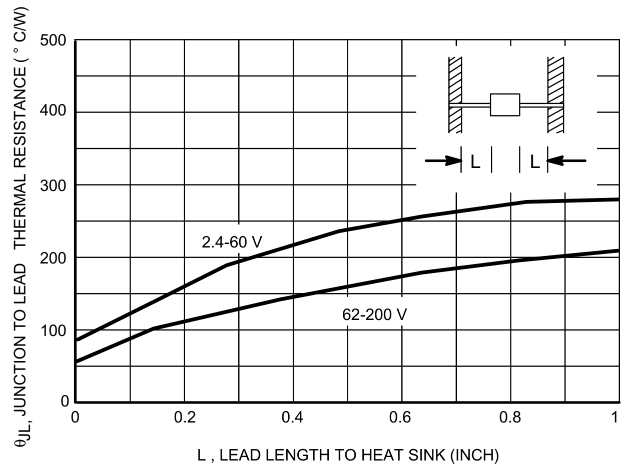


Figure 2. Typical Thermal Resistance

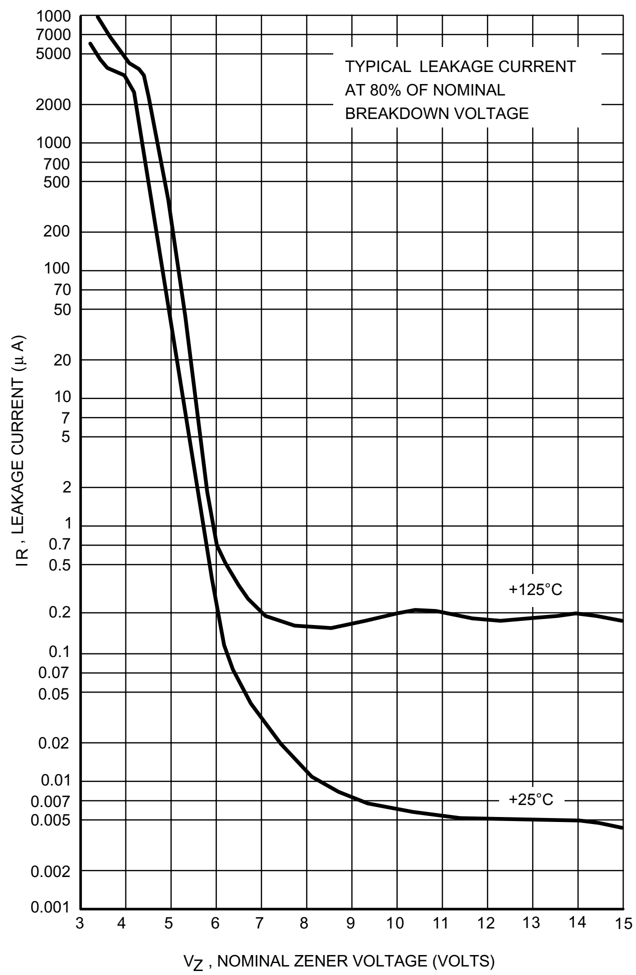


Figure 3. Typical Leakage Current

TEMPERATURE COEFFICIENTS

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

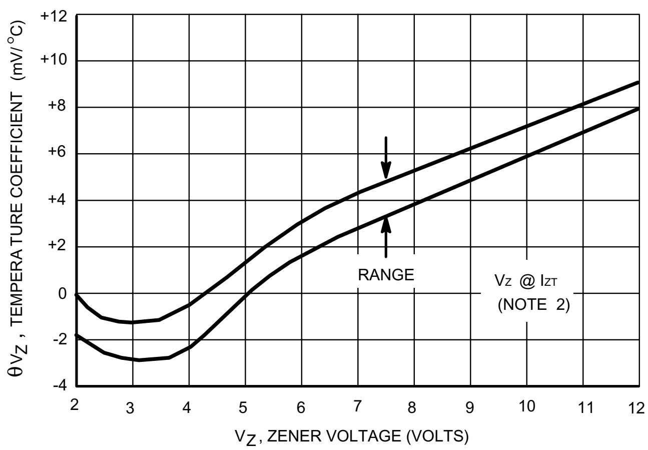


Figure 4a. Range for Units to 12 Volts

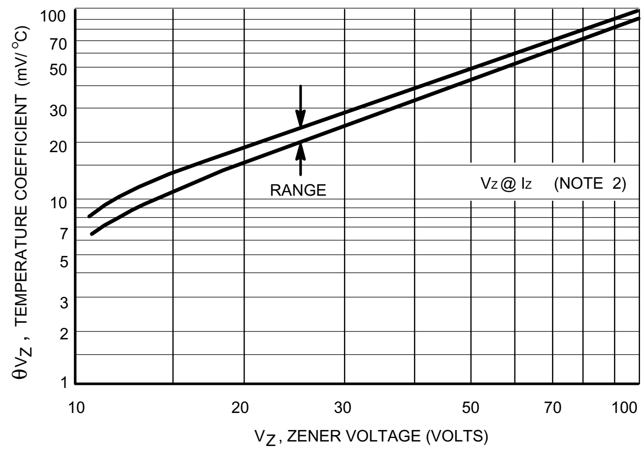


Figure 4b. Range for Units 12 to 100 Volts

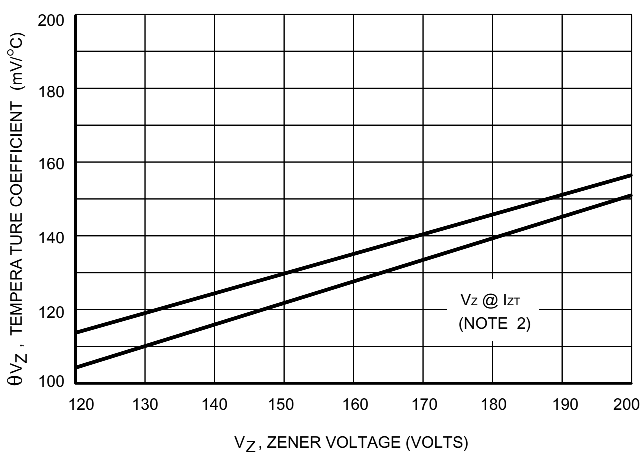


Figure 4c. Range for Units 120 to 200 Volts

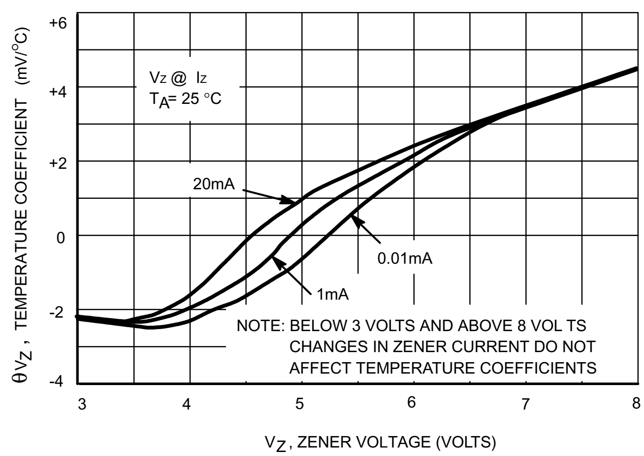


Figure 5. Effect of Zener Current

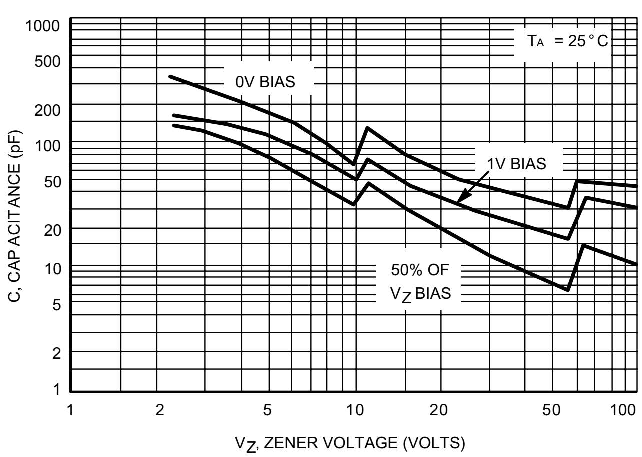


Figure 6a. Typical Capacitance 2.4-100 Volts

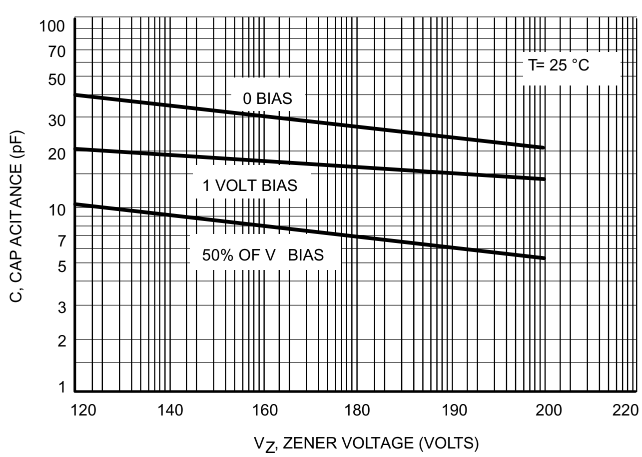


Figure 6b. Typical Capacitance 120-200 Volts

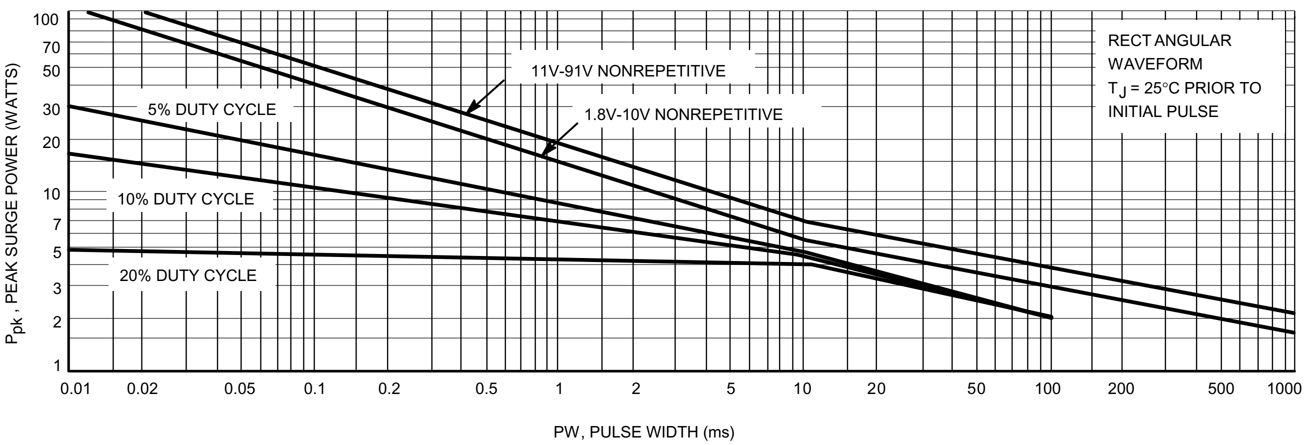


Figure 7a. Maximum Surge Power 1.8-91 Volts

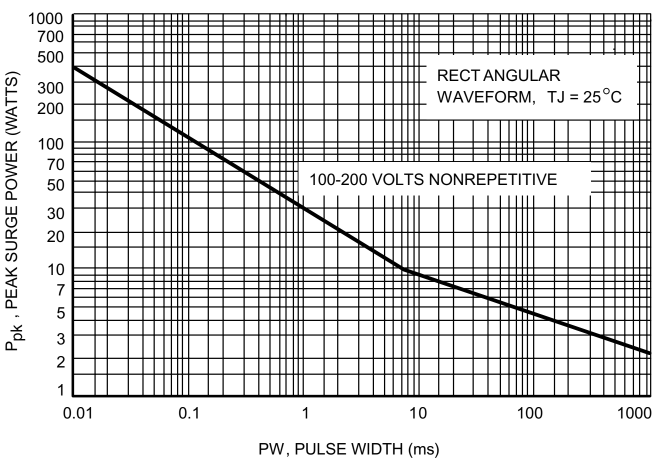


Figure 7b. Maximum Surge Power DO-35 100-200Volts

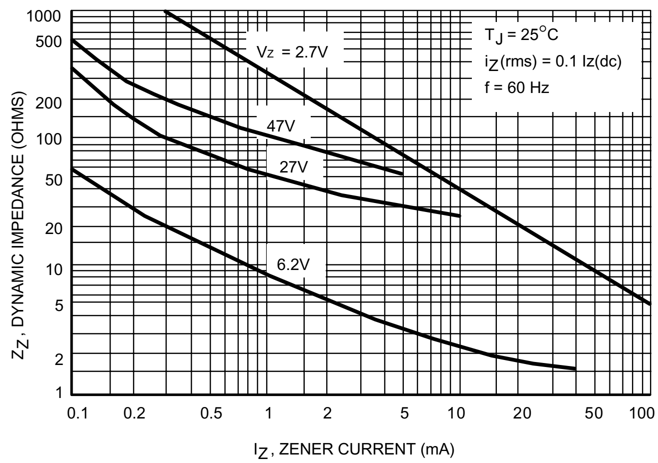


Figure 8. Effect of Zener Current on Zener Impedance

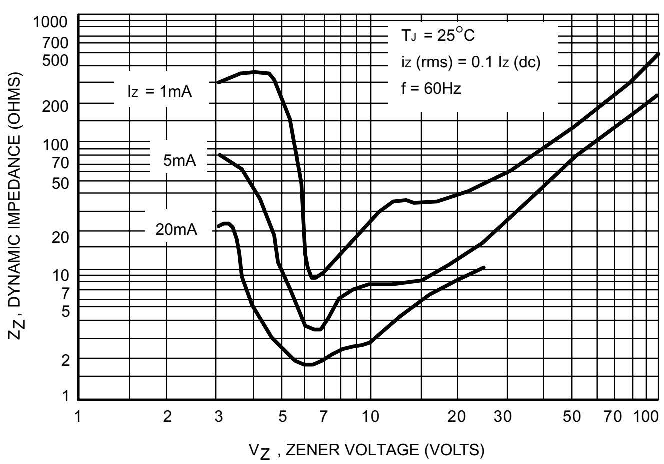


Figure 9. Effect of Zener Voltage on Zener Impedance

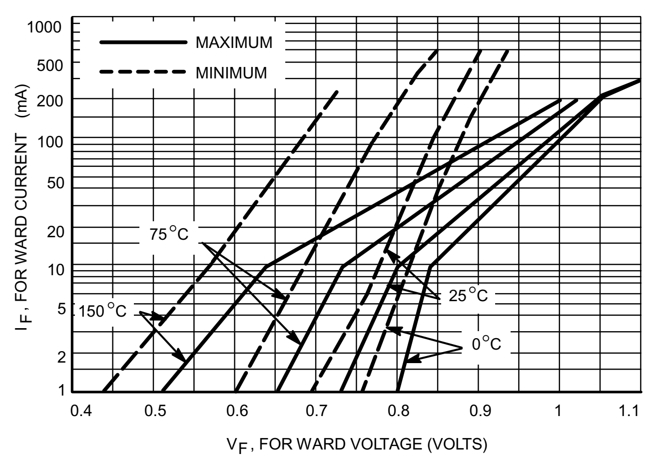


Figure 10. Typical Forward Characteristics

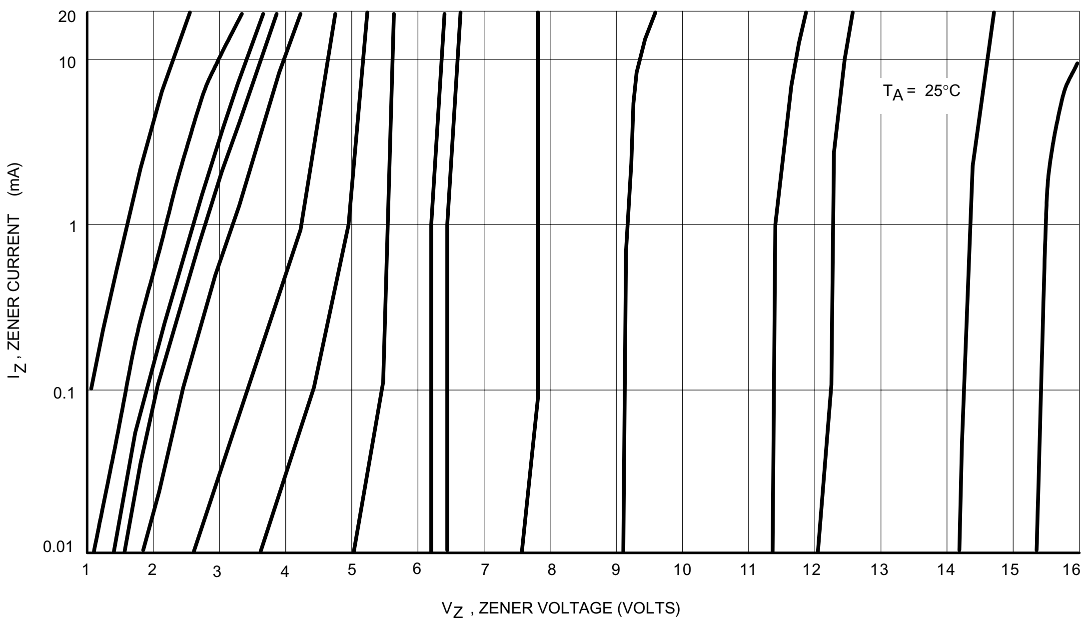


Figure 1 1. Zener Voltage versus Zener Current - V_Z = 1 thru 16 Volts

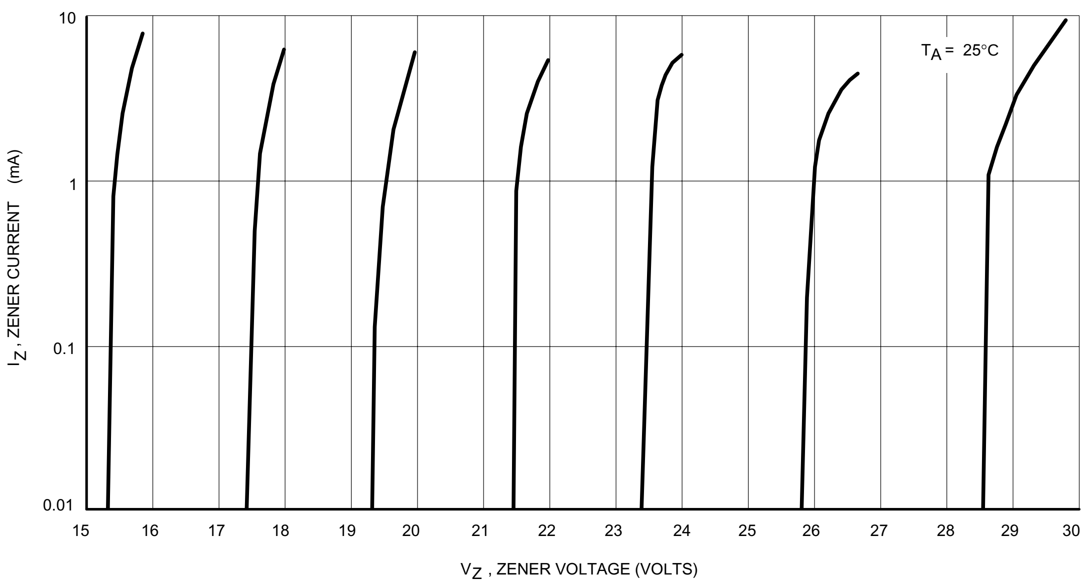


Figure 12. Zener Voltage versus Zener Current - V_Z = 15 thru 30 Volts

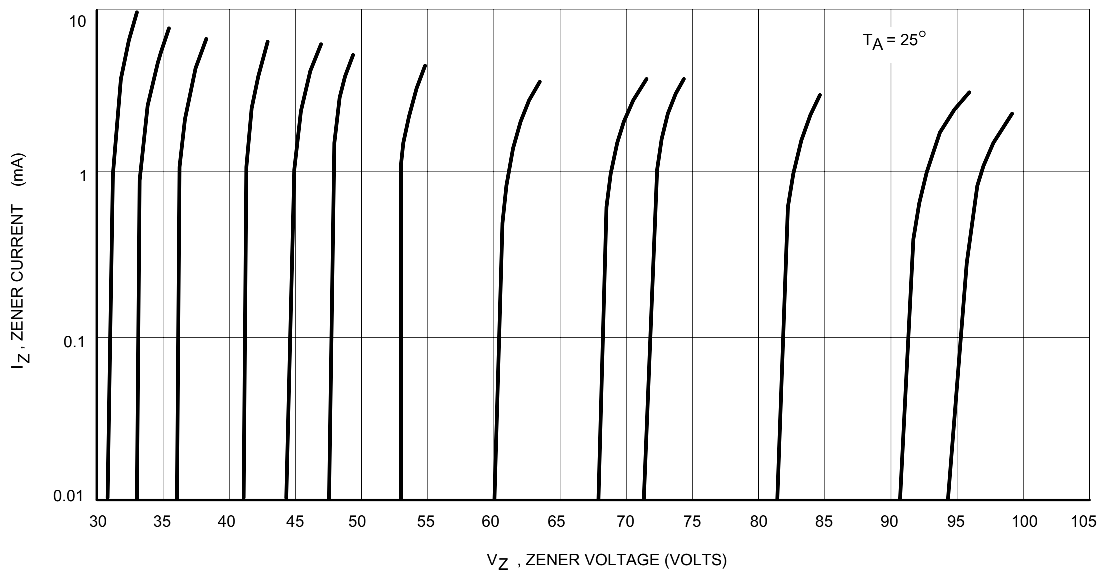


Figure 13. Zener Voltage versus Zener Current - V_Z = 30 thru 105 Volts

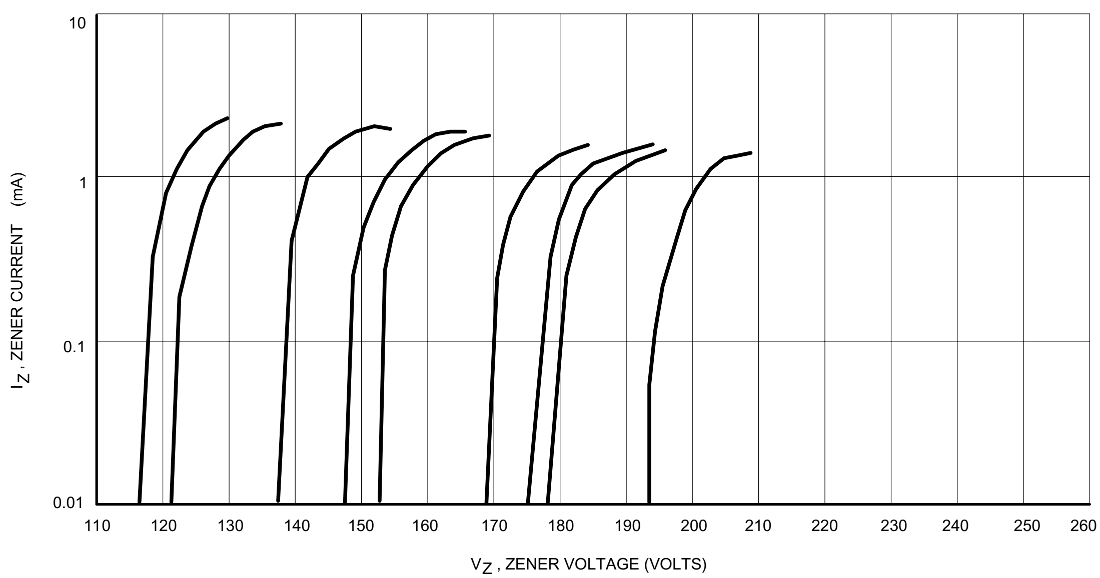


Figure 14. Zener Voltage versus Zener Current - V_Z = 110 thru 220 Volts