1N5985B 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 20 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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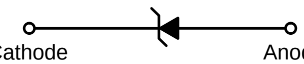
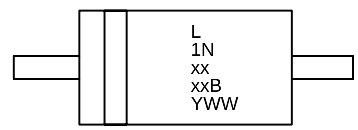


AXIAL LEAD
CASE 299
GLASS

MARKING DIAGRAM



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

ORDERING INFORMATION

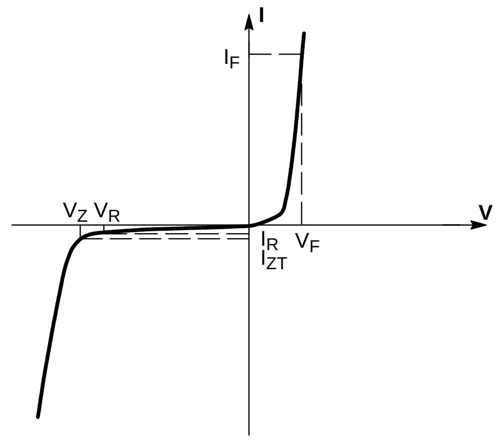
Device	Package	Shipping
1NxxxxB	Axial Lead	3000 Units/Box
1NxxxxBRL	Axial Lead	5000/Tape & Reel
1NxxxxBRL2 *	Axial Lead	5000/Tape & Reel
1NxxxxBTA	Axial Lead	5000/Ammo Pack
1NxxxxBTA2 *	Axial Lead	5000/Tape & Reel
1NxxxxBRR1 †	Axial Lead	3000/Tape & Reel
1NxxxxBRR2 ‡	Axial Lead	3000/Tape & Reel

* 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_L = 30°C unless otherwise noted, V_F = 1.5 V Max @ I_F = 100 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
I_{ZM}	Maximum DC Zener Current



Zener Voltage Regulator

ELECTRICAL CHARACTERISTICS (T_L = 30°C unless otherwise noted, V_F = 1.5 V Max @ I_F = 100 mA for all types)

Device (Note 2.)	**Device Marking**	**Zener Voltage** (Note 3.)				**Zener Impedance** (Note 4.)			**Leakage Current**		I_{ZM} (Note 5.)
		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**	**mA**
1N5985B	1N5985B	2.28	2.4	2.52	5	100	1800	0.25	100	1.0	208
1N5987B	1N5987B	2.85	3.0	3.15	5	95	2000	0.25	50	1.0	167
1N5988B	1N5988B	3.13	3.3	3.46	5	95	2200	0.25	25	1.0	152
1N5990B	1N5990B	3.7	3.9	4.09	5	90	2400	0.25	10	1.0	128
1N5991B	1N5991B	4.08	4.3	4.51	5	88	2500	0.25	5.0	1.0	116
1N5992B	1N5992B	4.46	4.7	4.93	5	70	2200	0.25	3.0	1.5	106
1N5993B	***1N5993B***	***4.84***	***5.1***	***5.35***	***5***	***50***	***2050***	***0.25***	***2.0***	***2.0***	***98***
1N5994B	***1N5994B***	***5.32***	***5.6***	***5.88***	***5***	***25***	***1800***	***0.25***	***2.0***	***3.0***	***89***
1N5995B	1N5995B	5.89	6.2	6.51	5	10	1300	0.25	1.0	4.0	81
1N5996B	1N5996B	6.46	6.8	7.14	5	8.0	750	0.25	1.0	5.2	74
1N5997B	1N5997B	7.12	7.5	7.87	5	7.0	600	0.25	0.5	6.0	67
1N5998B	***1N5998B***	***7.79***	***8.2***	***8.61***	***5***	***7.0***	***600***	***0.25***	***0.5***	***6.5***	***61***
1N5999B	1N5999B	8.64	9.1	9.55	5	10	600	0.25	0.1	7.0	55
1N6000B	1N6000B	9.5	10	10.5	5	15	600	0.25	0.1	8.0	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
1N6004B	1N6004B	14.25	15	15.75	5	32	600	0.25	0.1	11	33
1N6007B	1N6007B	19	20	21	5	48	600	0.25	0.1	15	25

2. **TOLERANCE AND VOLTAGE DESIGNATION**
   Tolerance designation – Device tolerance of ±5% is indicated by a “B” suffix.
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 = 1.0 kHz.
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.

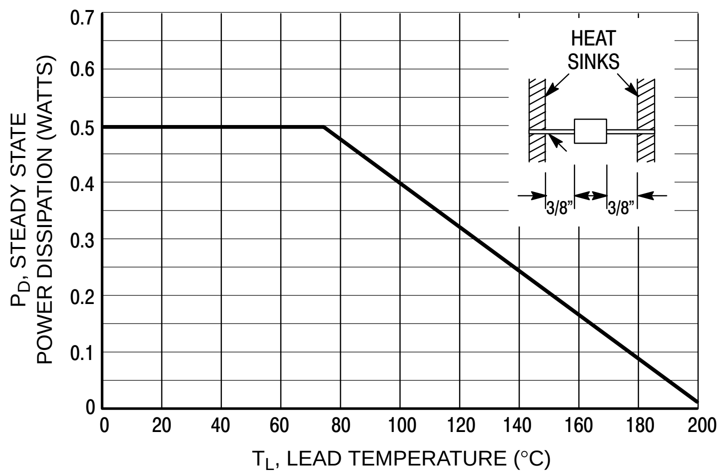


Figure 1. Steady State Power Derating

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.

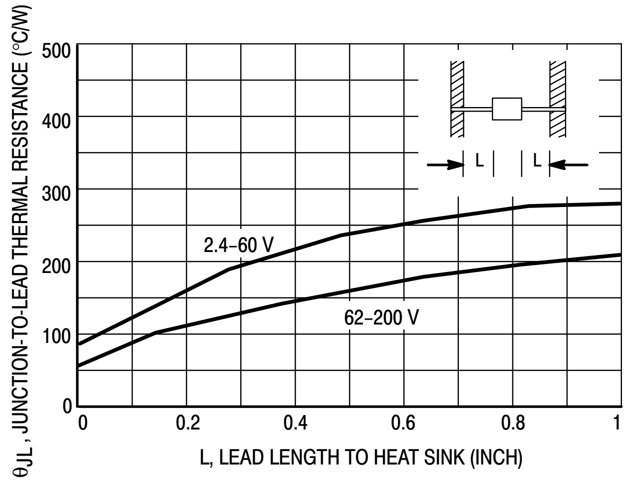


Figure 2. Typical Thermal Resistance

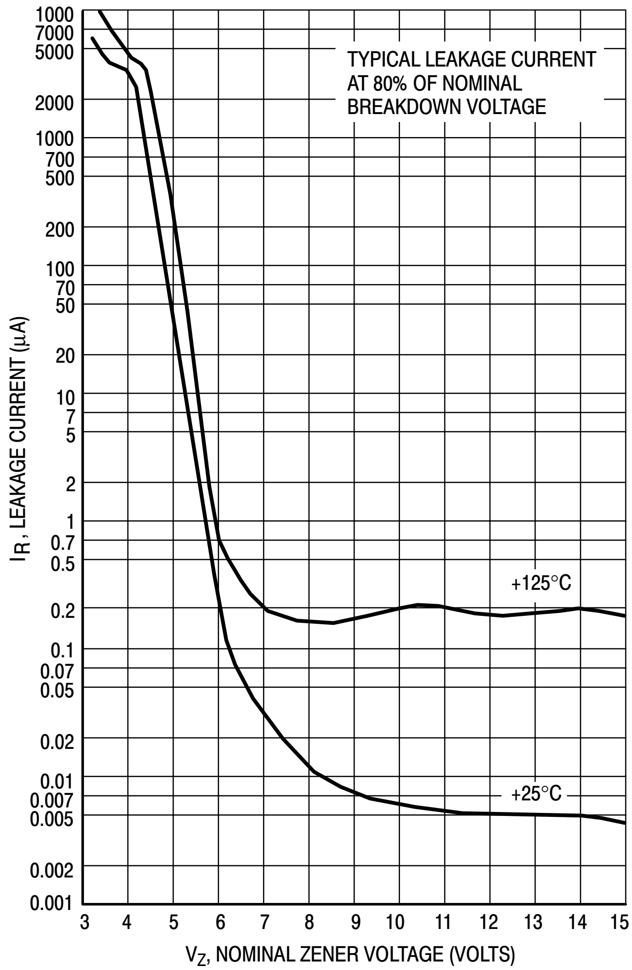


Figure 3. Typical Leakage Current

TEMPERATURE COEFFICIENTS

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

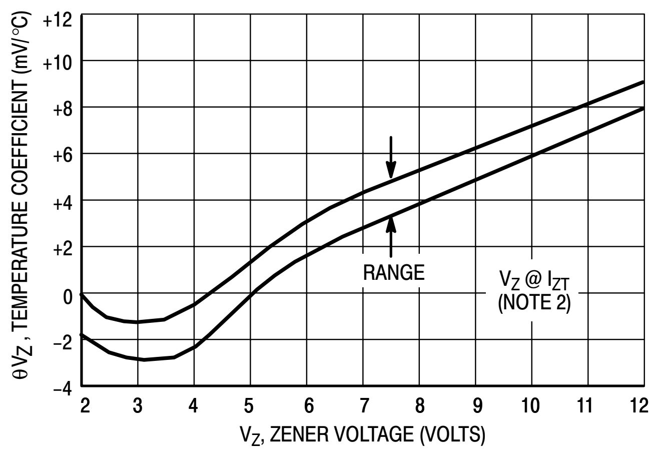


Figure 4a. Range for Units to 12 Volts

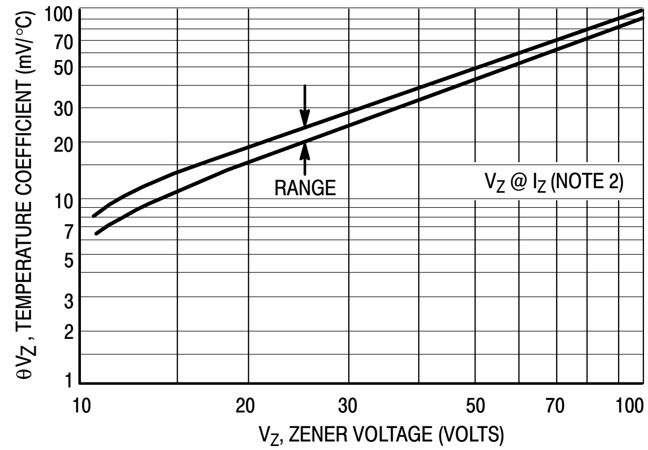


Figure 4b. Range for Units 12 to 100 Volts

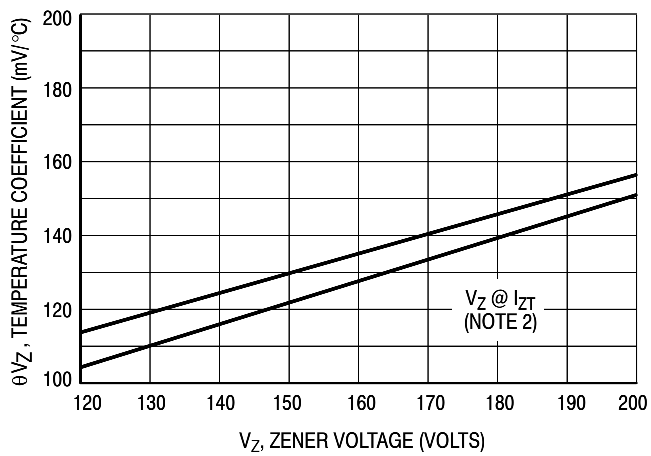


Figure 4c. Range for Units 120 to 200 Volts

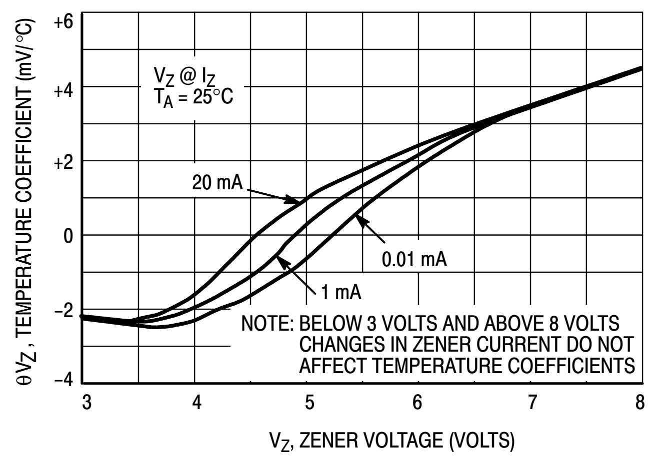


Figure 5. Effect of Zener Current

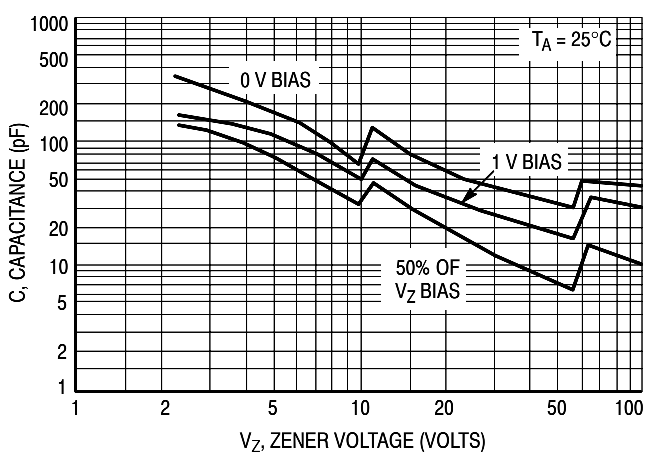


Figure 6a. Typical Capacitance 2.4–100 Volts

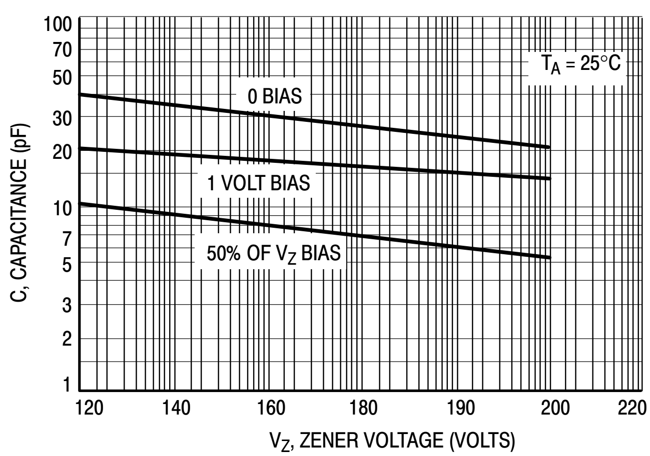


Figure 6b. Typical Capacitance 120–200 Volts

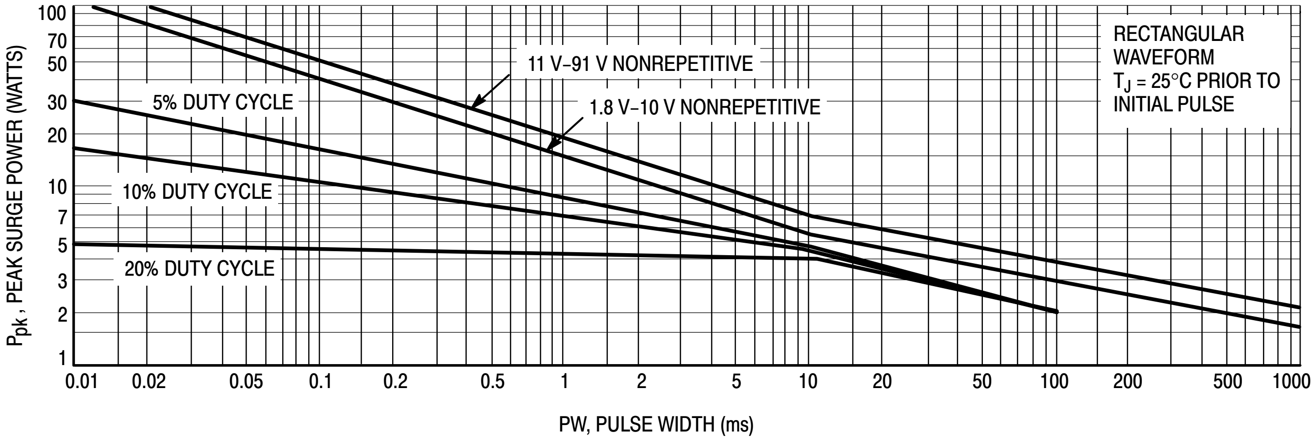


Figure 7a. Maximum Surge Power 1.8–91 Volts

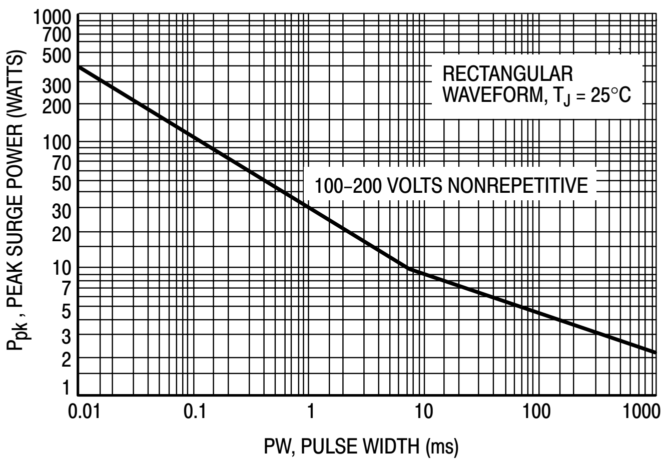


Figure 7b. Maximum Surge Power DO-204AH 100–200 Volts

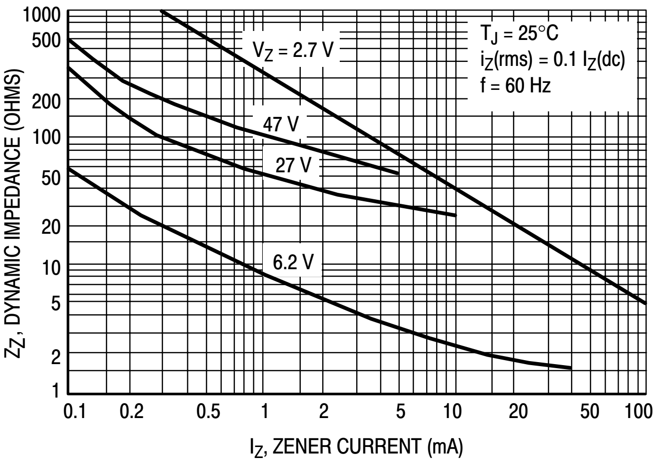


Figure 8. Effect of Zener Current on Zener Impedance

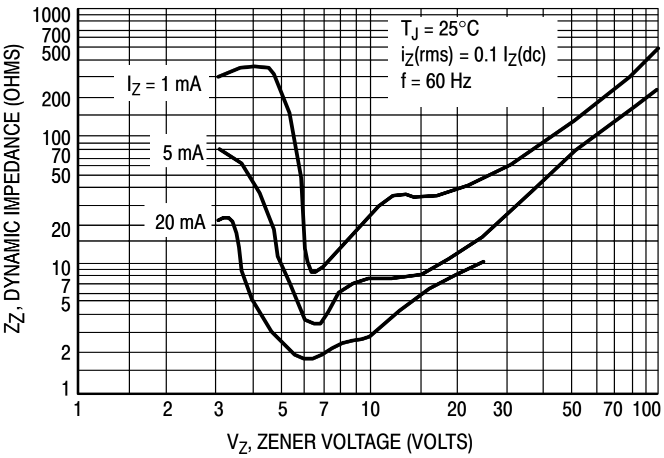


Figure 9. Effect of Zener Voltage on Zener Impedance

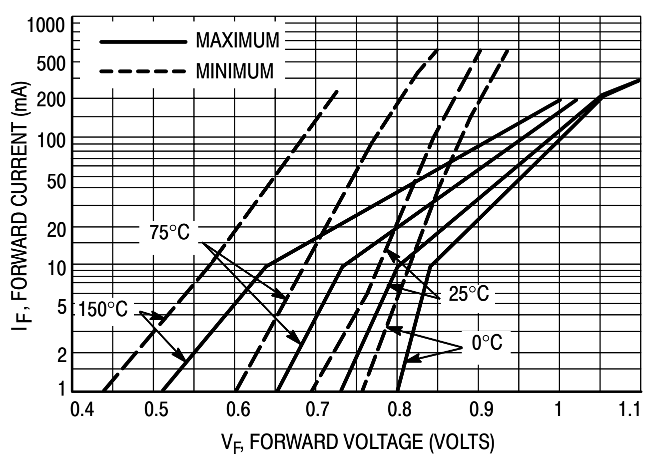


Figure 10. Typical Forward Characteristics

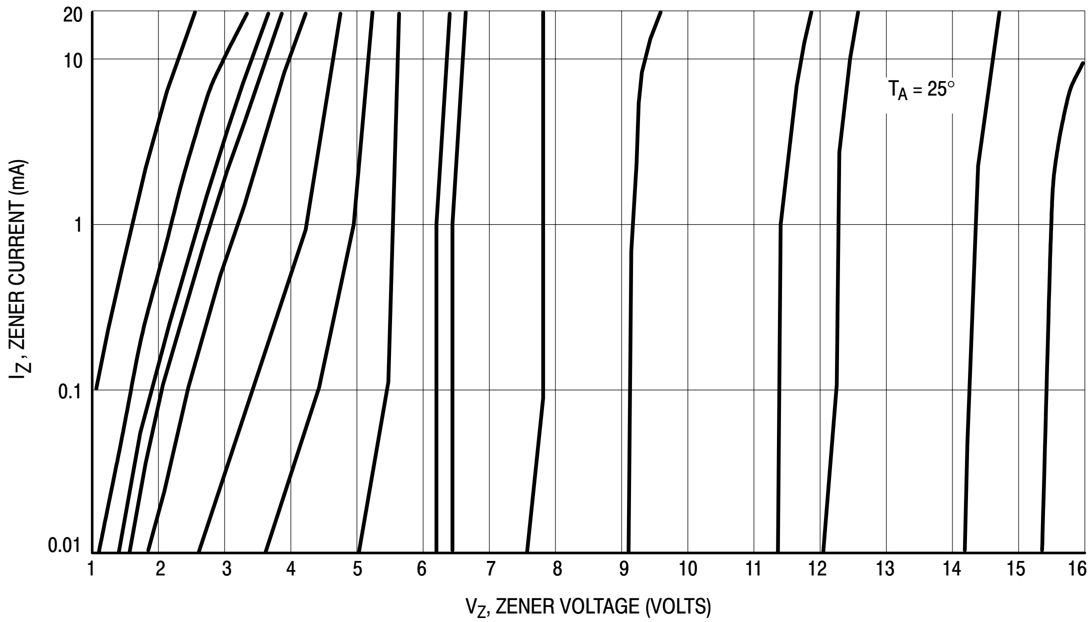


Figure 11. Zener Voltage versus Zener Current — V_Z = 1 thru 16 Volts

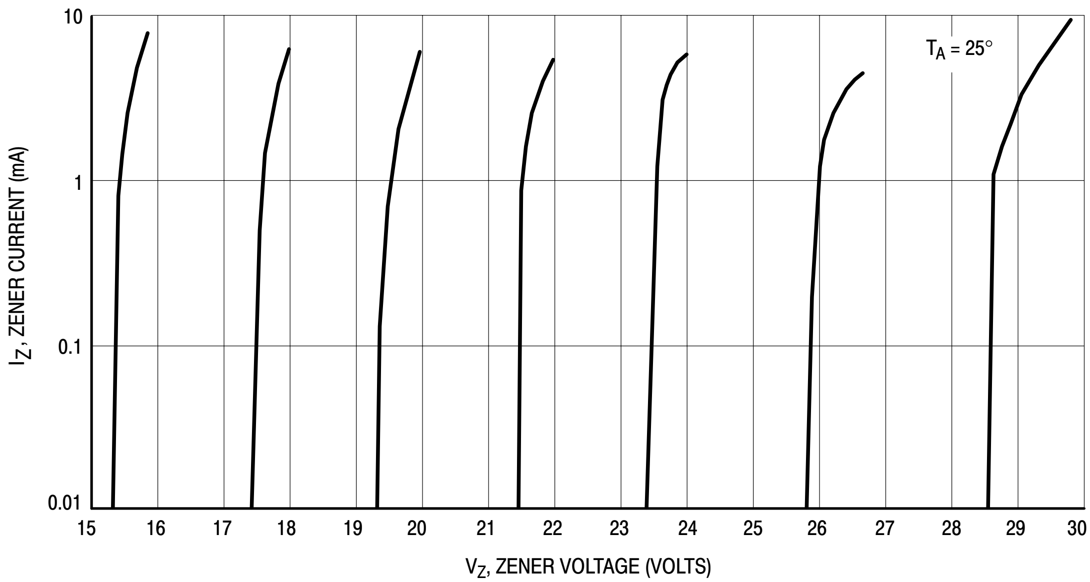


Figure 12. Zener Voltage versus Zener Current — V_Z = 15 thru 30 Volts

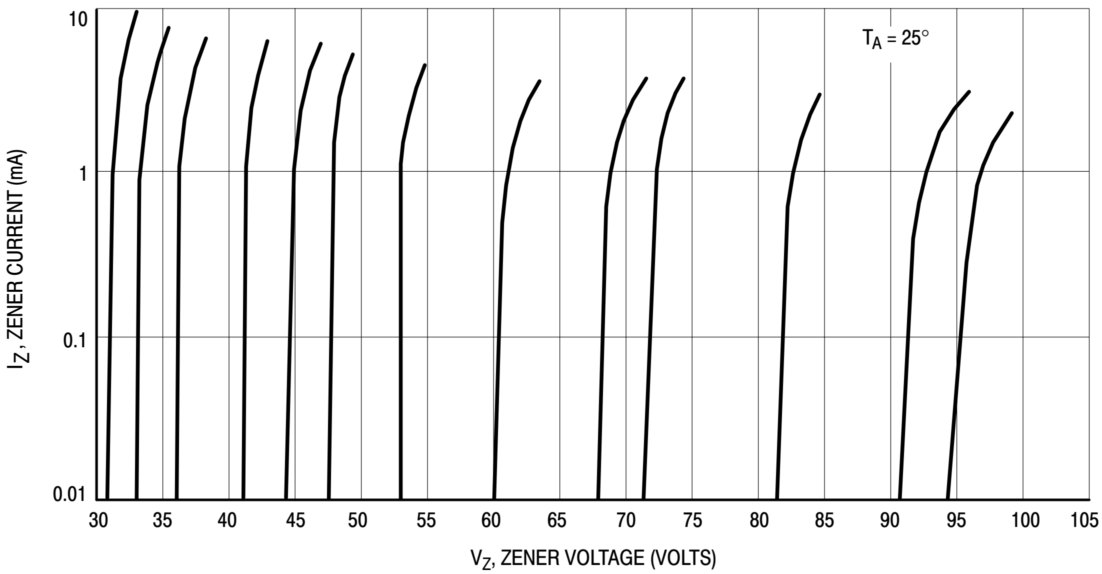


Figure 13. Zener Voltage versus Zener Current — V_Z = 30 thru 105 Volts

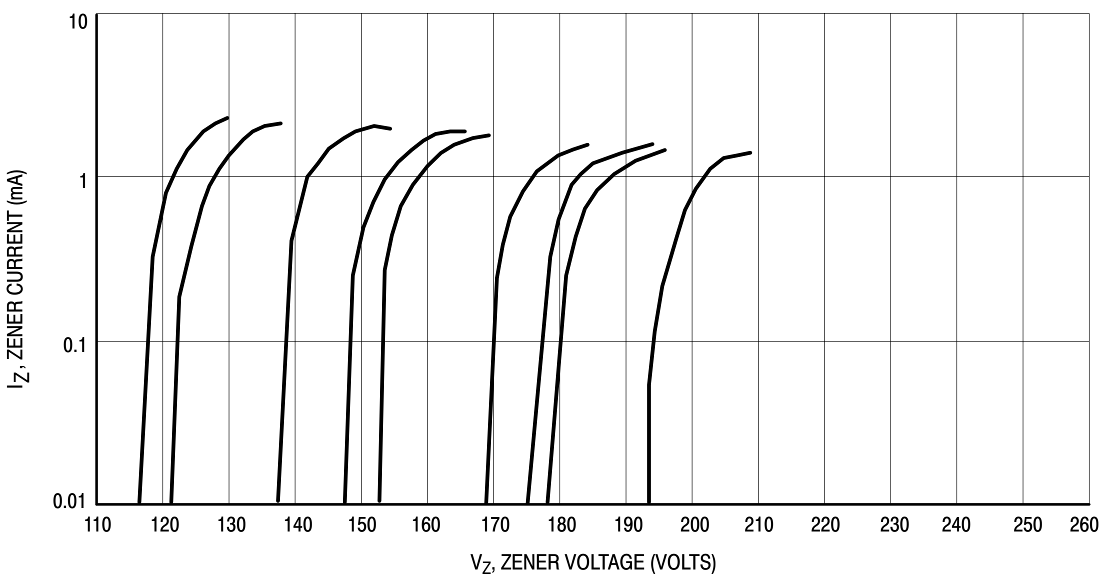


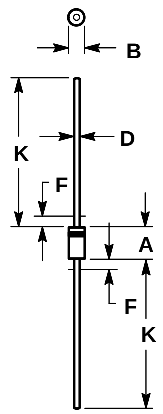
Figure 14. Zener Voltage versus Zener Current — V_Z = 110 thru 220 Volts

OUTLINE DIMENSIONS

Zener Voltage Regulators – Axial Leaded

500 mW DO–35 Glass

GLASS DO–35/D0–204AH
CASE 299–02
ISSUE A



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.

DIM	MILLIMETERS		INCHES	
	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.

Notes

Notes

PUBLICATION ORDERING INFORMATION

NORTH AMERICA Literature Fulfillment:
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