1N5333B Series

Preferred Device

5 Watt Surmetic™ 40 Zener Voltage Regulators

This is a complete series of 5 Watt Zener diodes with tight limits and better operating characteristics that reflect the superior capabilities of silicon−oxide passivated junctions. All this in an axial lead, transfer−molded plastic package that offers protection in all common environmental conditions.

Features

- Zener Voltage Range − 3.3 V to 200 V
- ESD Rating of Class 3 (>16 kV) per Human Body Model
- Surge Rating of up to 180 W @ 8.3 ms
- Maximum Limits Guaranteed on up to Six Electrical Parameters
- These devices are manufactured with a Pb−Free external lead finish only*

Mechanical Characteristics

CASE: Void free, transfer−molded, thermosetting plastic
FINISH: All external surfaces are corrosion resistant and leads are readily solderable
MAXIMUM LEAD TEMPERATURE FOR SOLDERING PURPOSES: 230°C, 1/16 in. from the case for 10 seconds
POLARITY: Cathode indicated by polarity band
MOUNTING POSITION: Any

MAXIMUM RATINGS

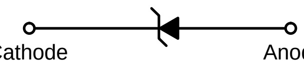
Rating	Symbol	Value	Unit
Max. Steady State Power Dissipation @ T_L = 75°C, Lead Length = 3/8 in Derate above 75°C	P_D	5 40	W mW/°C
Operating and Storage Temperature Range	T_J, T_{stg}	−65 to +200	°C

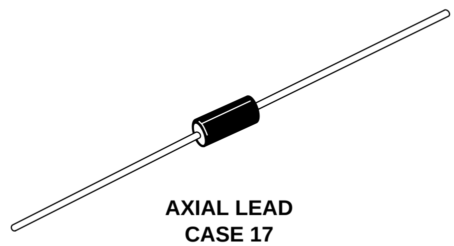
Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

ON Semiconductor®

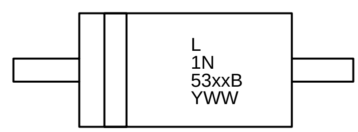
http://onsemi.com





AXIAL LEAD
CASE 17
PLASTIC

MARKING DIAGRAM



L = Assembly Location
1N53xxB = Device Code (See Table Next Page)
Y = Year
WW = Work Week

ORDERING INFORMATION

Device	Package	Shipping†
1N53xxB	Axial Lead	1000 Units/Box
1N53xxBRL	Axial Lead	4000/Tape & Reel
1N53xxBTA*	Axial Lead	2000/Ammo Pack

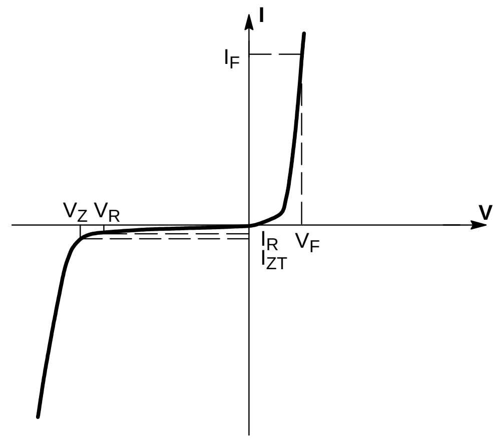
*1N5361B Not Available in 2000/Ammo Pack

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted, V_F = 1.2 V Max @ I_F = 1.0 A 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_R	Maximum Surge Current @ T_A = 25°C
ΔV_Z	Reverse Zener Voltage Change
I_{ZM}	Maximum DC Zener Current



Zener Voltage Regulator

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted, V_F = 1.2 V Max @ I_F = 1.0 A for all types)

Device (Note 1)	Device Marking	Zener Voltage (Note 2) V_Z (Volts) Min	Nom	Max	@ I_{ZT} mA	Zener Impedance (Note 2) Z_{ZT} @ I_{ZT} Ω	Z_{ZK} @ I_{ZK} Ω	I_{ZK} mA	Leakage Current I_R @ V_R μA Max	Volts	I_R (Note 3) A	ΔV_Z (Note 4) Volts	I_{ZM} (Note 5) mA
1N5333B	***1N5333B***	***3.14***	***3.3***	***3.47***	***380***	***3***	***400***	***1***	***300***	***1***	***20***	***0.85***	***1440***
1N5334B	1N5334B	3.42	3.6	3.78	350	2.5	500	1	150	1	18.7	0.8	1320
1N5335B	1N5335B	3.71	3.9	4.10	320	2	500	1	50	1	17.6	0.54	1220
1N5336B	1N5336B	4.09	4.3	4.52	290	2	500	1	10	1	16.4	0.49	1100
1N5337B	***1N5337B***	***4.47***	***4.7***	***4.94***	***260***	***2***	***450***	***1***	***5***	***1***	***15.3***	***0.44***	***1010***
1N5338B	***1N5338B***	***4.85***	***5.1***	***5.36***	***240***	***1.5***	***400***	***1***	***1***	***1***	***14.4***	***0.39***	***930***
1N5339B	***1N5339B***	***5.32***	***5.6***	***5.88***	***220***	***1***	***400***	***1***	***1***	***2***	***13.4***	***0.25***	***865***
1N5340B	1N5340B	5.70	6.0	6.30	200	1	300	1	1	3	12.7	0.19	790
1N5341B	***1N5341B***	***5.89***	***6.2***	***6.51***	***200***	***1***	***200***	***1***	***1***	***3***	***12.4***	***0.1***	***765***
1N5342B	***1N5342B***	***6.46***	***6.8***	***7.14***	***175***	***1***	***200***	***1***	***10***	***5.2***	***11.5***	***0.15***	***700***
1N5343B	1N5343B	7.13	7.5	7.88	175	1.5	200	1	10	5.7	10.7	0.15	630
1N5344B	1N5344B	7.79	8.2	8.61	150	1.5	200	1	10	6.2	10	0.2	580
1N5345B	1N5345B	8.27	8.7	9.14	150	2	200	1	10	6.6	9.5	0.2	545
1N5346B	1N5346B	8.65	9.1	9.56	150	2	150	1	7.5	6.9	9.2	0.22	520
1N5347B	***1N5347B***	***9.50***	***10***	***10.5***	***125***	***2***	***125***	***1***	***5***	***7.6***	***8.6***	***0.22***	***475***
1N5348B	1N5348B	10.45	11	11.55	125	2.5	125	1	5	8.4	8.0	0.25	430
1N5349B	***1N5349B***	***11.4***	***12***	***12.6***	***100***	***2.5***	***125***	***1***	***2***	***9.1***	***7.5***	***0.25***	***395***
1N5350B	***1N5350B***	***12.35***	***13***	***13.65***	***100***	***2.5***	***100***	***1***	***1***	***9.9***	***7.0***	***0.25***	***365***
1N5351B	1N5351B	13.3	14	14.7	100	2.5	75	1	1	10.6	6.7	0.25	340
1N5352B	***1N5352B***	***14.25***	***15***	***15.75***	***75***	***2.5***	***75***	***1***	***1***	***11.5***	***6.3***	***0.25***	***315***
1N5353B	***1N5353B***	***15.2***	***16***	***16.8***	***75***	***2.5***	***75***	***1***	***1***	***12.2***	***6.0***	***0.3***	***295***
1N5354B	1N5354B	16.15	17	17.85	70	2.5	75	1	0.5	12.9	5.8	0.35	280
1N5355B	1N5355B	17.1	18	18.9	65	2.5	75	1	0.5	13.7	5.5	0.4	264
1N5356B	1N5356B	18.05	19	19.95	65	3	75	1	0.5	14.4	5.3	0.4	250
1N5357B	1N5357B	19	20	21	65	3	75	1	0.5	15.2	5.1	0.4	237
1N5358B	***1N5358B***	***20.9***	***22***	***23.1***	***50***	***3.5***	***75***	***1***	***0.5***	***16.7***	***4.7***	***0.45***	***216***
1N5359B	***1N5359B***	***22.8***	***24***	***25.2***	***50***	***3.5***	***100***	***1***	***0.5***	***18.2***	***4.4***	***0.55***	***198***
1N5360B	1N5360B	23.75	25	26.25	50	4	110	1	0.5	19	4.3	0.55	190
1N5361B*	***1N5361B***	***25.65***	***27***	***28.35***	***50***	***5***	***120***	***1***	***0.5***	***20.6***	***4.1***	***0.6***	***176***
1N5362B	1N5362B	26.6	28	29.4	50	6	130	1	0.5	21.2	3.9	0.6	170

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

1. **TOLERANCE AND TYPE NUMBER DESIGNATION**
   The JEDEC type numbers shown indicate a tolerance of ±5%.
2. **ZENER VOLTAGE (V_Z) and IMPEDANCE (I_{ZT} and I_{ZK})**
   Test conditions for zener voltage and impedance are as follows: I_Z is applied 40 ±10 ms prior to reading. Mounting contacts are located 3/8″ to 1/2″ from the inside edge of mounting clips to the body of the diode (T_A = 25°C +8°C, −2°C).
3. **SURGE CURRENT (I_R)**
   Surge current is specified as the maximum allowable peak, non−recurrent square−wave current with a pulse width, PW, of 8.3 ms. The data given in Figure 5 may be used to find the maximum surge current for a square wave of any pulse width between 1 ms and 1000 ms by plotting the applicable points on logarithmic paper. Examples of this, using the 3.3 V and 200 V zener are shown in Figure 6. Mounting contact located as specified in Note 2 (T_A = 25°C +8°C, −2°C).
4. **VOLTAGE REGULATION (ΔV_Z)**
   The conditions for voltage regulation are as follows: V_Z measurements are made at 10% and then at 50% of the I_Z max value listed in the electrical characteristics table. The test current time duration for each V_Z measurement is 40 ±10 ms. Mounting contact located as specified in Note 2 (T_A = 25°C +8°C, −2°C).
5. **MAXIMUM REGULATOR CURRENT (I_{ZM})**
   The maximum current shown is based on the maximum voltage of a 5% type unit, therefore, it applies only to the B−suffix device. The actual I_{ZM} for any device may not exceed the value of 5 watts divided by the actual V_Z of the device. T_L = 75°C at 3/8″ maximum from the device body.

*Not Available in the 2000/Ammo Pack.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted, V_F = 1.2 V Max @ I_F = 1.0 A for all types)

Device (Note 6)	Device Marking	Zener Voltage (Note 7)				Zener Impedance (Note 7)			Leakage Current		I_R (Note 8)	ΔV_Z (Note 9)	I_{ZM} (Note 10)
		V_Z (Volts)			@ I_{ZT}	Z_{ZT} @ I_{ZT}	Z_{ZK} @ I_{ZK}	I_{ZK}	I_R @ V_R				
		Min	Nom	Max	mA	Ω	Ω	mA	μA Max	Volts	A	Volts	mA
1N5363B	1N5363B	28.5	30	31.5	40	8	140	1	0.5	22.8	3.7	0.6	158
1N5364B	1N5364B	31.35	33	34.65	40	10	150	1	0.5	25.1	3.5	0.6	144
1N5365B	***1N5365B***	***34.2***	***36***	***37.8***	***30***	***11***	***160***	***1***	***0.5***	***27.4***	***3.5***	***0.65***	***132***
1N5366B	1N5366B	37.05	39	40.95	30	14	170	1	0.5	29.7	3.1	0.65	122
1N5367B	1N5367B	40.85	43	45.15	30	20	190	1	0.5	32.7	2.8	0.7	110
1N5368B	***1N5368B***	***44.65***	***47***	***49.35***	***25***	***25***	***210***	***1***	***0.5***	***35.8***	***2.7***	***0.8***	***100***
1N5369B	1N5369B	48.45	51	53.55	25	27	230	1	0.5	38.8	2.5	0.9	93
1N5370B	1N5370B	53.2	56	58.8	20	35	280	1	0.5	42.6	2.3	1.0	86
1N5371B	1N5371B	57	60	63	20	40	350	1	0.5	45.5	2.2	1.2	79
1N5372B	1N5372B	58.9	62	65.1	20	42	400	1	0.5	47.1	2.1	1.35	76
1N5373B	1N5373B	64.6	68	71.4	20	44	500	1	0.5	51.7	2.0	1.52	70
1N5374B	1N5374B	71.25	75	78.75	20	45	620	1	0.5	56	1.9	1.6	63
1N5375B	1N5375B	77.9	82	86.1	15	65	720	1	0.5	62.2	1.8	1.8	58
1N5376B	1N5376B	82.65	87	91.35	15	75	760	1	0.5	66	1.7	2.0	54.5
1N5377B	1N5377B	86.45	91	95.55	15	75	760	1	0.5	69.2	1.6	2.2	52.5
1N5378B	1N5378B	95	100	105	12	90	800	1	0.5	76	1.5	2.5	47.5
1N5379B	1N5379B	104.5	110	115.5	12	125	1000	1	0.5	83.6	1.4	2.5	43
1N5380B	1N5380B	114	120	126	10	170	1150	1	0.5	91.2	1.3	2.5	39.5
1N5381B	1N5381B	123.5	130	136.5	10	190	1250	1	0.5	98.8	1.2	2.5	36.6
1N5382B	1N5382B	133	140	147	8	230	1500	1	0.5	106	1.2	2.5	34
1N5383B	***1N5383B***	***142.5***	***150***	***157.5***	***8***	***330***	***1500***	***1***	***0.5***	***114***	***1.1***	***3.0***	***31.6***
1N5384B	1N5384B	152	160	168	8	350	1650	1	0.5	122	1.1	3.0	29.4
1N5385B	1N5385B	161.5	170	178.5	8	380	1750	1	0.5	129	1.0	3.0	28
1N5386B	1N5386B	171	180	189	5	430	1750	1	0.5	137	1.0	4.0	26.4
1N5387B	1N5387B	180.5	190	199.5	5	450	1850	1	0.5	144	0.9	5.0	25
1N5388B	1N5388B	190	200	210	5	480	1850	1	0.5	152	0.9	5.0	23.6

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

6. **TOLERANCE AND TYPE NUMBER DESIGNATION**
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7. **ZENER VOLTAGE (V_Z) and IMPEDANCE (I_{ZT} and I_{ZK})**
   Test conditions for zener voltage and impedance are as follows: I_Z is applied 40 ±10 ms prior to reading. Mounting contacts are located 3/8″ to 1/2″ from the inside edge of mounting clips to the body of the diode (T_A = 25°C +8°C, −2°C).
8. **SURGE CURRENT (I_R)**
   Surge current is specified as the maximum allowable peak, non−recurrent square−wave current with a pulse width, PW, of 8.3 ms. The data given in Figure 5 may be used to find the maximum surge current for a square wave of any pulse width between 1 ms and 1000 ms by plotting the applicable points on logarithmic paper. Examples of this, using the 3.3 V and 200 V zener are shown in Figure 6. Mounting contact located as specified in Note 7 (T_A = 25°C +8°C, −2°C).
9. **VOLTAGE REGULATION (ΔV_Z)**
   The conditions for voltage regulation are as follows: V_Z measurements are made at 10% and then at 50% of the I_Z max value listed in the electrical characteristics table. The test current time duration for each V_Z measurement is 40 ±10 ms. Mounting contact located as specified in Note 7 (T_A = 25°C +8°C, −2°C).
10. **MAXIMUM REGULATOR CURRENT (I_{ZM})**
    The maximum current shown is based on the maximum voltage of a 5% type unit, therefore, it applies only to the B−suffix device. The actual I_{ZM} for any device may not exceed the value of 5 watts divided by the actual V_Z of the device. T_L = 75°C at 3/8″ maximum from the device body.

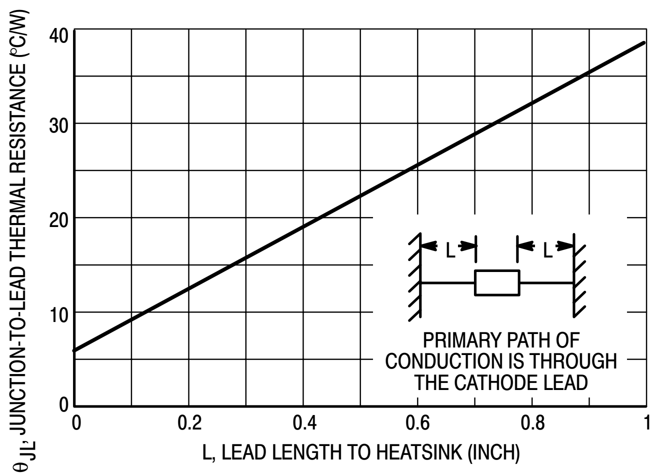


Figure 1. Typical Thermal Resistance

TEMPERATURE COEFFICIENTS

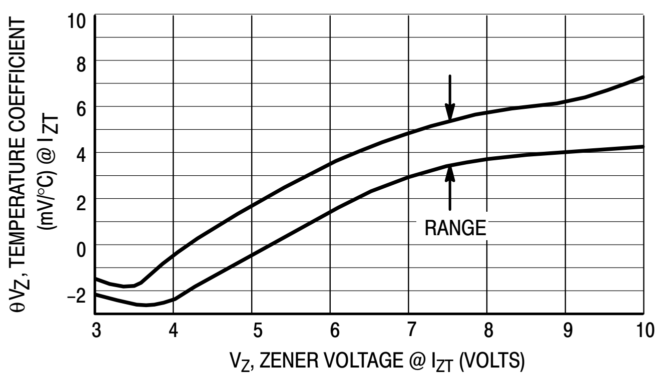


Figure 2. Temperature Coefficient-Range for Units 3 to 10 Volts

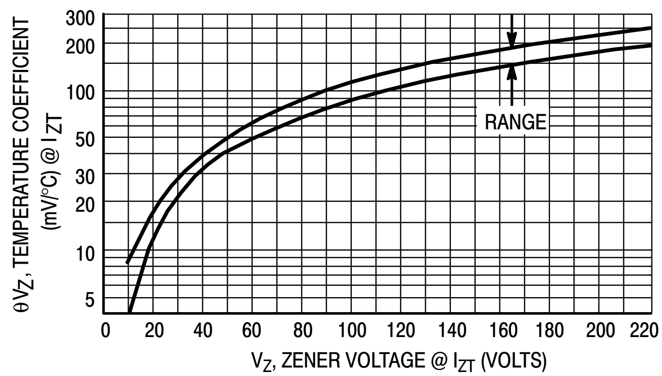


Figure 3. Temperature Coefficient-Range for Units 10 to 220 Volts

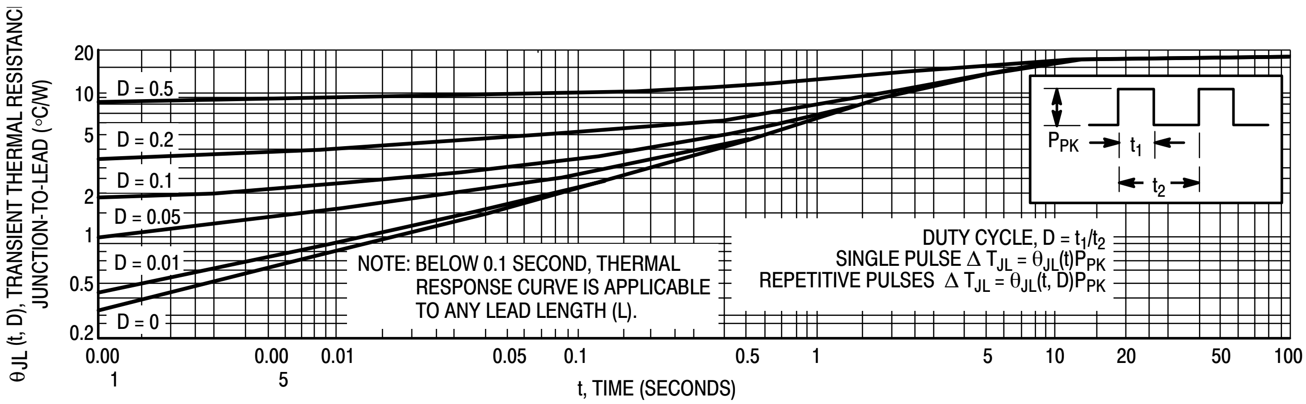


Figure 4. Typical Thermal Response
L, Lead Length = 3/8 Inch

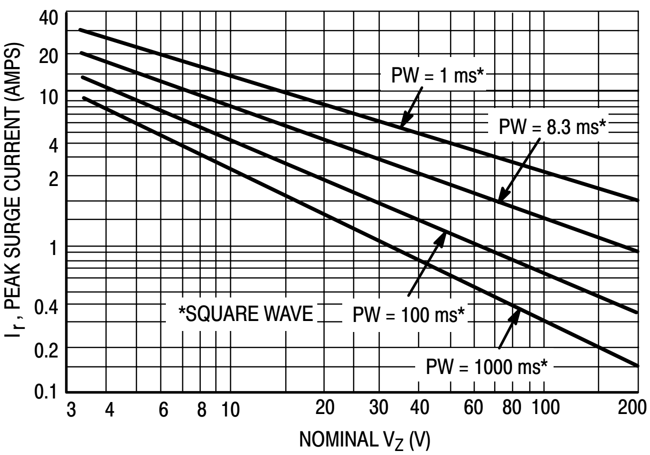


Figure 5. Maximum Non-Repetitive Surge Current versus Nominal Zener Voltage (See Note 3)

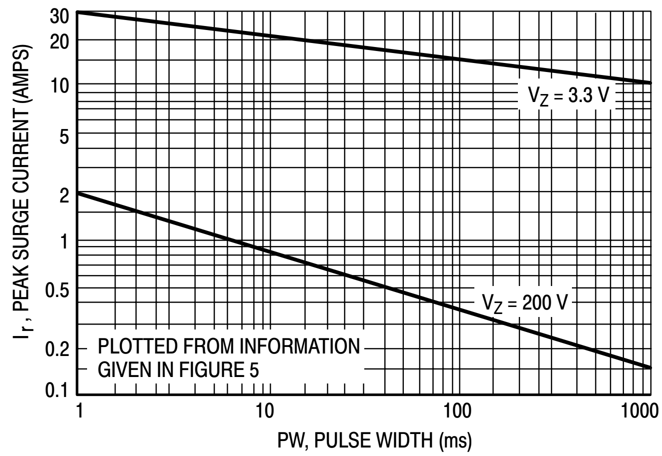


Figure 6. Peak Surge Current versus Pulse Width (See Note 3)

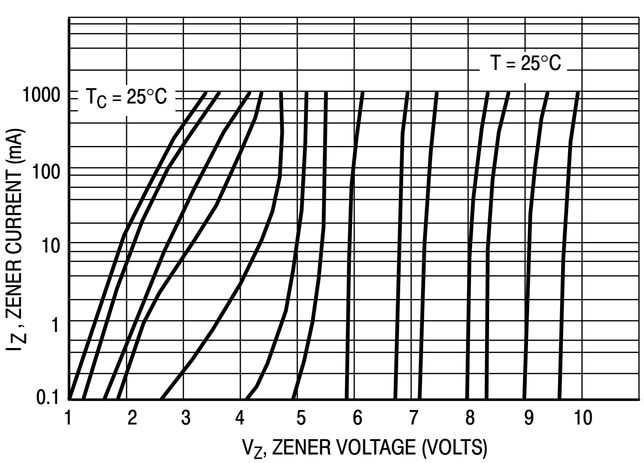


Figure 7. Zener Voltage versus Zener Current
V_Z = 3.3 thru 10 Volts

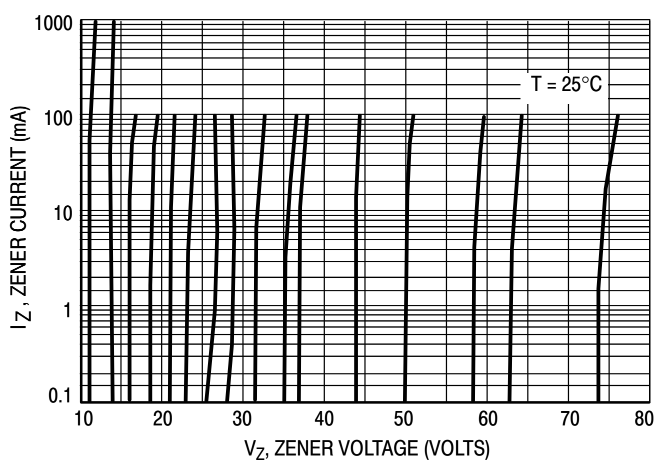


Figure 8. Zener Voltage versus Zener Current
V_Z = 11 thru 75 Volts

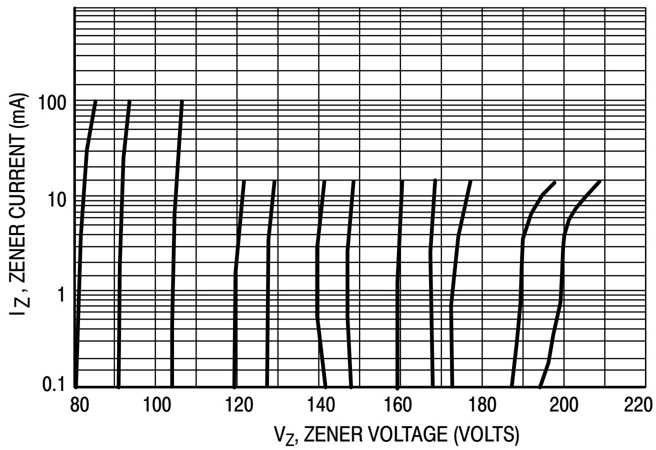


Figure 9. Zener Voltage versus Zener Current
V_Z = 82 thru 200 Volts

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:

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 and P_D is the power dissipation.

Junction Temperature, T_J, may be found from:

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

ΔT_{JL} is the increase in junction temperature above the lead temperature and may be found from Figure 4 for a train of power pulses or from Figure 1 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 (ΔT_J) may be estimated. Changes in voltage, V_Z, can then be found from:

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

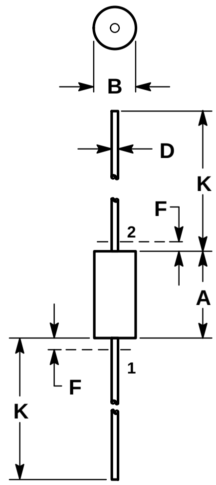
θ_{VZ}, the Zener voltage temperature coefficient, is found from Figures 2 and 3.

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.

Data of Figure 4 should not be used to compute surge capability. Surge limitations are given in Figure 5. 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 5 be exceeded.

PACKAGE DIMENSIONS

AXIAL LEAD
CASE 17−02
ISSUE C



NOTES:
1. LEAD DIAMETER AND FINISH NOT CONTROLLED WITHIN DIMENSION F.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.330	0.350	8.38	8.89
B	0.130	0.145	3.30	3.68
D	0.037	0.043	0.94	1.09
F	---	0.050	---	1.27
K	1.000	1.250	25.40	31.75

STYLE 1:
PIN 1. ANODE
2. CATHODE

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PUBLICATION ORDERING INFORMATION

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