MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N5333A, B, C, D thru 1N5388A, B, C, D

5-WATT ZENER REGULATOR DIODES 3.3–200 VOLTS

Designer's Data Sheet

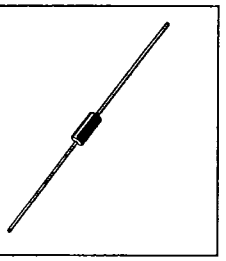
5-Watt Surmetic 40 Silicon Zener Diodes

. . . 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 offering protection in all common environmental conditions.

- Up to 180 Watt Surge Rating @ 8.3 ms
- Maximum Limits Guaranteed on Seven Electrical Parameters
- Offered in 10%, 5%, 2% and 1% V_Z Tolerance

Mechanical Characteristics:

CASE: Void-free, transfer-molded, thermosetting plastic
FINISH: All external surfaces are corrosion resistant and leads are readily solderable
POLARITY: Cathode indicated by color band. When operated in zener mode, cathode will be positive with respect to anode
MOUNTING POSITION: Any
WEIGHT: 0.7 gram (approx)



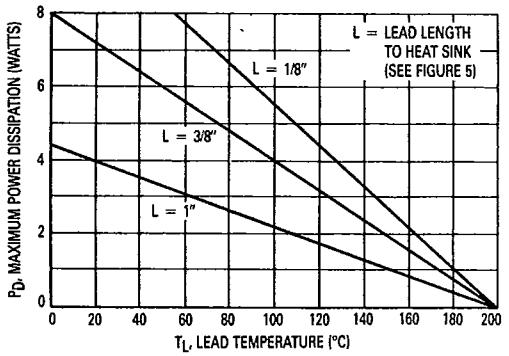
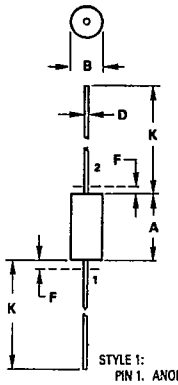


Figure 1. Power-Temperature Derating Curve

OUTLINE DIMENSIONS



NOTE:
1. LEAD DIAMETER & FINISH NOT CONTROLLED WITHIN DIM "F"

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

CASE 17-02 GLASS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Power Dissipation @ T_L = 75°C Lead Length = 3/8"	P_D	5	Watts
Derate above 75°C		40	mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

Designer's Data for "Worst Case" Conditions — The Designer's Data Sheet permits the design of most circuits entirely from the information presented. Limit curves — representing boundaries on device characteristics — are given to facilitate "worst case" design.

1N5333A, B, C, D thru 1N5388A, B, C, D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted, V_F = 1.2 Max @ I_F = 1 A for all types)

JEDEC Type No. (Note 1)	Nominal Zener Voltage V_Z @ I_{ZT} Volts (Note 2)	Test Current I_{ZT} mA	Max Zener Impedance A & B Suffix Only		Max Reverse Leakage Current			Applies to all Suffix	A & B Suffix Only	Maximum Regulator Current I_{ZM} mA (Note 5)
			Z_{ZT} @ I_{ZT} Ohms (Note 2)	Z_{ZK} @ I_{ZK} = 1 mA Ohms (Note 2)	I_R μA	@ V_R Volts		Max Surge Current I_r, Amps (Note 3)	Max Voltage Regulation ΔV_Z, Volts (Note 4)	
						Non & A Suffix	B-Suffix			
1N5333A	3.3	380	3	400	300	1	1	20	0.86	1440
1N5334A	3.6	350	2.5	500	150	1	1	18.7	0.8	1320
1N5335A	3.9	320	2	500	50	1	1	17.6	0.54	1220
1N5336A	4.3	290	2	500	10	1	1	16.4	0.49	1100
1N5337A	4.7	260	2	450	5	1	1	15.3	0.44	1010
1N5338A	5.1	240	1.5	400	1	1	1	14.4	0.39	930
1N5339A	5.6	220	1	400	1	2	2	13.4	0.25	865
1N5340A	6	200	1	300	1	3	3	12.7	0.19	790
1N5341A	6.2	200	1	200	1	4	3	12.4	0.1	765
1N5342A	6.8	175	1	200	10	4.9	5.2	11.5	0.15	700
1N5343A	7.5	175	1.5	200	10	5.4	5.7	10.7	0.15	630
1N5344A	8.2	150	1.5	200	10	5.9	6.2	10	0.2	580
1N5345A	8.7	150	2	200	10	6.3	6.6	9.5	0.2	545
1N5346A	9.1	150	2	150	7.5	6.6	6.9	9.2	0.22	520
1N5347A	10	125	2	125	5	7.2	7.6	8.6	0.22	475
1N5348A	11	125	2.5	125	5	8	8.4	8	0.25	430
1N5349A	12	100	2.5	125	2	8.6	9.1	7.5	0.25	395
1N5350A	13	100	2.5	100	1	9.4	9.9	7	0.25	365
1N5351A	14	100	2.5	75	1	10.1	10.6	6.7	0.25	340
1N5352A	15	75	2.5	75	1	10.8	11.5	6.3	0.25	315
1N5353A	16	75	2.5	75	1	11.5	12.2	6	0.3	295
1N5354A	17	70	2.5	75	0.5	12.2	12.9	5.8	0.35	280
1N5355A	18	65	2.5	75	0.5	13	13.7	5.5	0.4	265
1N5356A	19	65	3	75	0.5	13.7	14.4	5.3	0.4	250
1N5357A	20	65	3	75	0.5	14.4	15.2	5.1	0.4	237
1N5358A	22	50	3.5	75	0.5	15.8	16.7	4.7	0.45	216
1N5359A	24	50	3.5	100	0.5	17.3	18.2	4.4	0.55	198
1N5360A	25	50	4	110	0.5	18	19	4.3	0.55	190
1N5361A	27	50	5	120	0.5	19.4	20.6	4.1	0.6	176
1N5362A	28	50	6	130	0.5	20.1	21.2	3.9	0.6	170
1N5363A	30	40	8	140	0.5	21.6	22.8	3.7	0.6	158
1N5364A	33	40	10	150	0.5	23.8	25.1	3.5	0.6	144
1N5365A	36	30	11	160	0.5	25.9	27.4	3.3	0.65	132
1N5366A	39	30	14	170	0.5	28.1	29.7	3.1	0.65	122
1N5367A	43	30	20	190	0.5	31	32.7	2.8	0.7	110
1N5368A	47	25	25	210	0.5	33.8	35.8	2.7	0.8	100
1N5369A	51	25	27	230	0.5	36.7	38.8	2.5	0.9	93
1N5370A	56	20	35	280	0.5	40.3	42.6	2.3	1	86
1N5371A	60	20	40	350	0.5	43	42.5	2.2	1.2	79
1N5372A	62	20	42	400	0.5	44.6	47.1	2.1	1.35	76
1N5373A	68	20	44	500	0.5	49	51.7	2	1.5	70
1N5374A	75	20	45	620	0.5	54	56	1.9	1.6	63
1N5375A	82	15	65	720	0.5	59	62.2	1.8	1.8	58
1N5376A	87	15	75	760	0.5	63	66	1.7	2	54.5
1N5377A	91	15	75	760	0.5	65.5	69.2	1.6	2.2	52.5
1N5378A	100	12	90	800	0.5	72	76	1.5	2.5	47.5
1N5379A	110	12	125	1000	0.5	79.2	83.6	1.4	2.5	43
1N5380A	120	10	170	1150	0.5	86.4	91.2	1.3	2.5	39.5
1N5381A	130	10	190	1250	0.5	93.6	98.8	1.2	2.5	36.6
1N5382A	140	8	230	1500	0.5	101	106	1.2	2.5	34
1N5383A	150	8	330	1500	0.5	108	114	1.1	3	31.6
1N5384A	160	8	350	1650	0.5	115	122	1.1	3	29.4
1N5385A	170	8	380	1750	0.5	122	129	1	3	28
1N5386A	180	5	430	1750	0.5	130	137	1	4	26.4
1N5387A	190	5	450	1850	0.5	137	144	0.9	5	25
1N5388A	200	5	480	1850	0.5	144	152	0.9	5	23.6

NOTES:

(1) TOLERANCE AND VOLTAGE DESIGNATION — The JEDEC type numbers shown indicate a tolerance of ±10% with guaranteed limits on only V_Z, I_R, i_r, and V_F as shown in the electrical characteristics table. Units with guaranteed limits on all seven parameters are indicated by suffix "A" for ±10% tolerance and suffix "B" for ±5%, C for ±2% and D for ±1%.

(2) ZENER VOLTAGE (V_Z) AND IMPEDANCE (Z_{ZT} & Z_{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 $^{+8}_{-2}$°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 6 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 zeners, are shown in Figure 7. Mounting contact located as specified in Note 3. (T_A = 25°C $^{+8}_{-2}$°C).

(4) VOLTAGE REGULATION (ΔV_Z) — Test 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 currents are the same for the 5% and 10% tolerance devices. The test current time duration for each V_Z measurement is 40 ± 10 ms. (T_A = 25°C $^{+8}_{-2}$°C). Mounting contact located as specified in Note 2.

(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.

TEMPERATURE COEFFICIENTS

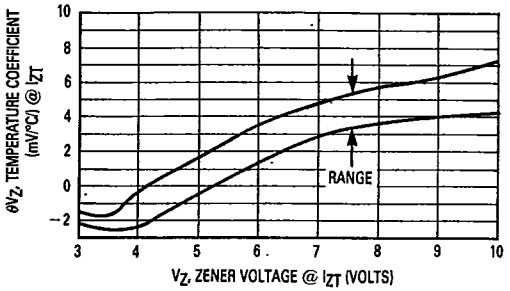


Figure 2. Temperature Coefficient-Range for Units 3 to 10 Volts

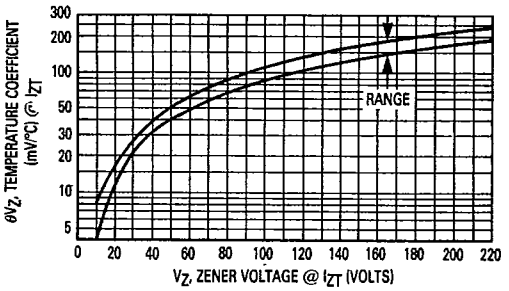


Figure 3. Temperature Coefficient-Range for Units 10 to 220 Volts

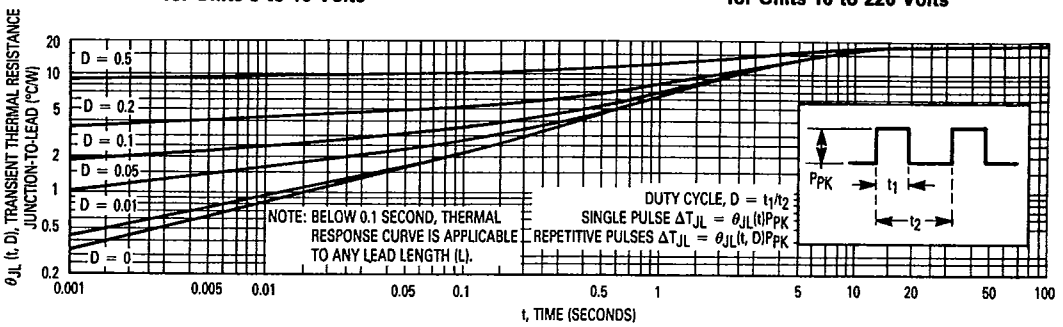


Figure 4. Typical Thermal Response L, Lead Length = 3.8 Inch

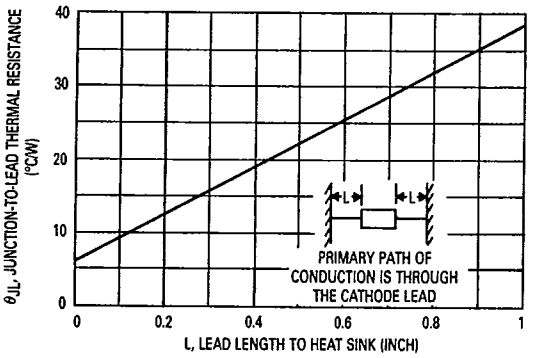


Figure 5. Typical Thermal Resistance

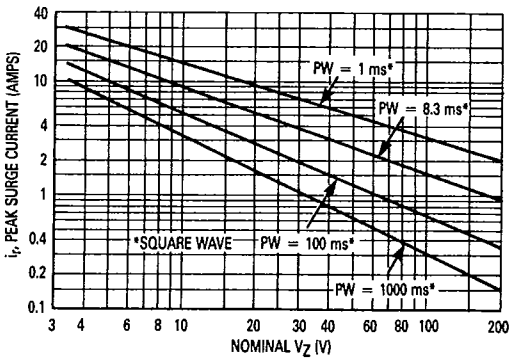


Figure 6. Maximum Non-Repetitive Surge Current versus Nominal Zener Voltage (See Note 3)

Data of Figure 4 should not be used to compute surge capability. Surge limitations are given in Figure 6. 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 6 be exceeded.

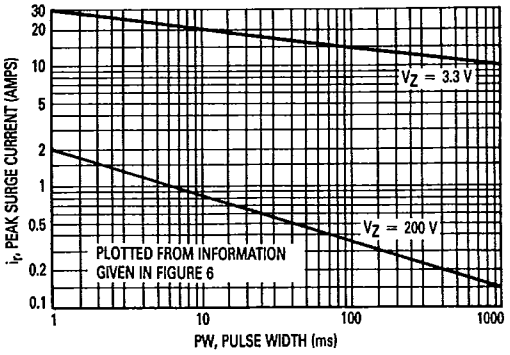


Figure 7. Peak Surge Current versus Pulse Width (See Note 3)

ZENER VOLTAGE versus ZENER CURRENT
(Figures 8, 9 and 10)

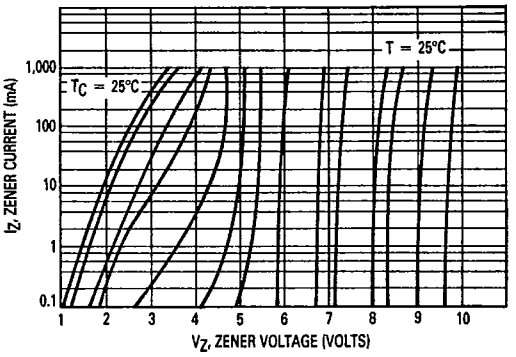


Figure 8. Zener Voltage versus Zener Current V_Z = 3.3 thru 10 Volts

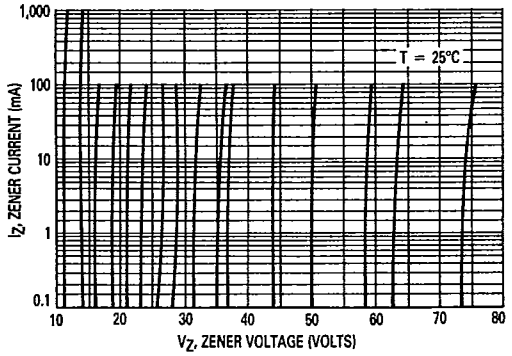


Figure 9. Zener Voltage versus Zener Current V_Z = 11 thru 75 Volts

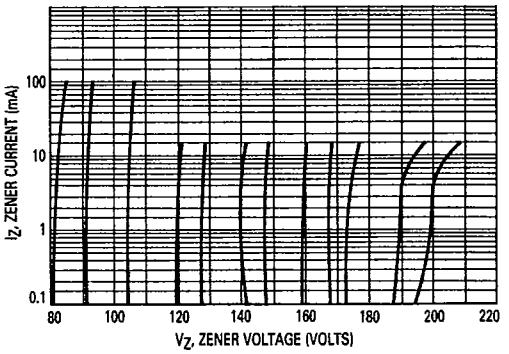


Figure 10. Zener Voltage versus Zener Current V_Z = 82 thru 200 Volts

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 5 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.