1N5333
thru
1N5388

MOTOROLA

Designers Data Sheet

5.0 WATT SURMETIC 40 SILICON ZENER DIODES (SILICON OXIDE PASSIVATED)

.... a complete series of 5.0 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.

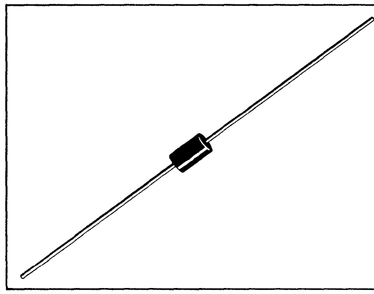
- Up to 180 Watt Surge Rating @ 8.3 ms
- Maximum Limits Guaranteed on Seven Electrical Parameters

5M3.3ZS10 thru 5M200ZS10
1N5333A thru 1N5388A

5M3.3ZS5 thru 5M200ZS5
1N5333B thru 1N5388B

5.0 WATT
ZENER REGULATOR DIODES

3.3 — 200 VOLTS



MAXIMUM RATINGS

4

Junction and Storage Temperature: -65 to +200 °C

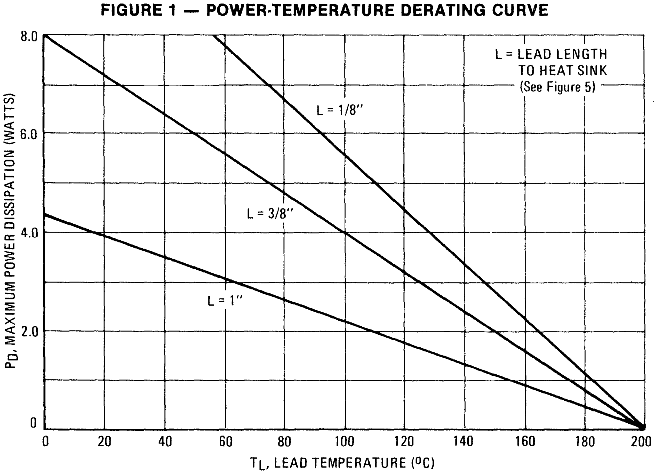
Lead Temperature not less than 1/16" from the case for 10 seconds: 230 °C

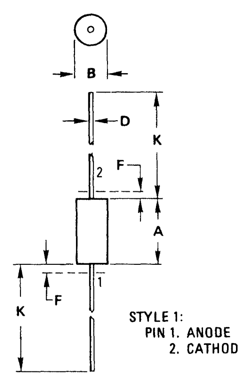
DC Power Dissipation: 5.0 W @ $T_L = 75\,°C$, Lead Length = 3/8" (Derate 40 mW/°C above 75 °C)

MECHANICAL CHARACTERISTICS

CASE: Void-free, transfer-molded, thermosetting plastic
FINISH: All external surfaces are corrosion resistant. 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





DIM	MILLIMETERS		INCHES	
	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

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

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

JEDEC Type No. (Note 1 & 2)	Nominal Zener Voltage V_Z @ I_{ZT} Volts (Note 3)	Test Current I_{ZT} mA	Max Zener Impedance A & B Suffix Only: Z_{ZT} @ I_{ZT} Ohms (Note 3)	Max Zener Impedance A & B Suffix Only: Z_{ZK} @ I_{ZK} = 1.0 mA Ohms (Note 3)	Max Reverse Leakage Current: I_R µA	Max Reverse Leakage Current: @ V_R Volts, Non & A Suffix	Max Reverse Leakage Current: @ V_R Volts, B-Suffix	Applies to all Suffix: Max Surge Current i_r, Amps (Note 4)	A & B Suffix Only: Max Voltage Regulation ΔV_Z, Volts (Note 5)	Maximum Regulator Current I_{ZM} mA (Note 6)
1N5333	3.3	380	3.0	400	300	1.0	1.0	20.0	0.85	1440
1N5334	3.6	350	2.5	500	150	1.0	1.0	18.7	0.80	1320
1N5335	3.9	320	2.0	500	50	1.0	1.0	17.6	0.54	1220
1N5336	4.3	290	2.0	500	10	1.0	1.0	16.4	0.49	1100
1N5337	4.7	260	2.0	450	5.0	1.0	1.0	15.3	0.44	1010
1N5338	5.1	240	1.5	400	1.0	1.0	1.0	14.4	0.39	930
1N5339	5.6	220	1.0	400	1.0	2.0	2.0	13.4	0.25	865
1N5340	6.0	200	1.0	300	1.0	3.0	3.0	12.7	0.19	790
1N5341	6.2	200	1.0	200	1.0	3.0	3.0	12.4	0.10	765
1N5342	6.8	175	1.0	200	10	4.9	5.2	11.5	0.15	700
1N5343	7.5	175	1.5	200	10	5.4	5.7	10.7	0.15	630
1N5344	8.2	150	1.5	200	10	5.9	6.2	10.0	0.20	580
1N5345	8.7	150	2.0	200	10	6.3	6.6	9.5	0.20	545
1N5346	9.1	150	2.0	150	7.5	6.6	6.9	9.2	0.22	520
1N5347	10	125	2.0	125	5.0	7.2	7.6	8.6	0.22	475
1N5348	11	125	2.5	125	5.0	8.0	8.4	8.0	0.25	430
1N5349	12	100	2.5	125	2.0	8.6	9.1	7.5	0.25	395
1N5350	13	100	2.5	100	1.0	9.4	9.9	7.0	0.25	365
1N5351	14	100	2.5	75	1.0	10.1	10.6	6.7	0.25	340
1N5352	15	75	2.5	75	1.0	10.8	11.5	6.3	0.25	315
1N5353	16	75	2.5	75	1.0	11.5	12.2	6.0	0.30	295
1N5354	17	70	2.5	75	0.5	12.2	12.9	5.8	0.35	280
1N5355	18	65	2.5	75	0.5	13.0	13.7	5.5	0.40	264
1N5356	19	65	3.0	75	0.5	13.7	14.4	5.3	0.40	250
1N5357	20	65	3.0	75	0.5	14.4	15.2	5.1	0.40	237
1N5358	22	50	3.5	75	0.5	15.8	16.7	4.7	0.45	216
1N5359	24	50	3.5	100	0.5	17.3	18.2	4.4	0.55	198
1N5360	25	50	4.0	110	0.5	18.0	19.0	4.3	0.55	190
1N5361	27	50	5.0	120	0.5	19.4	20.6	4.1	0.60	176
1N5362	28	50	6.0	130	0.5	20.1	21.2	3.9	0.60	170
1N5363	30	40	8.0	140	0.5	21.6	22.8	3.7	0.60	158
1N5364	33	40	10	150	0.5	23.8	25.1	3.5	0.60	144
1N5365	36	30	11	160	0.5	25.9	27.4	3.3	0.65	132
1N5366	39	30	14	170	0.5	28.1	29.7	3.1	0.65	122
1N5367	43	30	20	190	0.5	31.0	32.7	2.8	0.70	110
1N5368	47	25	25	210	0.5	33.8	35.8	2.7	0.80	100
1N5369	51	25	27	230	0.5	36.7	38.8	2.5	0.90	93.0
1N5370	56	20	35	280	0.5	40.3	42.6	2.3	1.00	86.0
1N5371	60	20	40	350	0.5	43.0	45.5	2.2	1.20	79.0
1N5372	62	20	42	400	0.5	44.6	47.1	2.1	1.35	76.0
1N5373	68	20	44	500	0.5	49.0	51.7	2.0	1.50	70.0
1N5374	75	20	45	620	0.5	54.0	56.0	1.9	1.60	63.0
1N5375	82	15	65	720	0.5	59.0	62.2	1.8	1.80	58.0
1N5376	87	15	75	760	0.5	63.0	66.0	1.7	2.00	54.5
1N5377	91	15	75	760	0.5	65.5	69.2	1.6	2.20	52.5
1N5378	100	12	90	800	0.5	72.0	76.0	1.5	2.50	47.5
1N5379	110	12	125	1000	0.5	79.2	83.6	1.4	2.50	43.0
1N5380	120	10	170	1150	0.5	86.4	91.2	1.3	2.50	39.5
1N5381	130	10	190	1250	0.5	93.6	98.8	1.2	2.50	36.6
1N5382	140	8.0	230	1500	0.5	101	106	1.2	2.50	34.0
1N5383	150	8.0	330	1500	0.5	108	114	1.1	3.00	31.6
1N5384	160	8.0	350	1650	0.5	115	122	1.1	3.00	29.4
1N5385	170	8.0	380	1750	0.5	122	129	1.0	3.00	28.0
1N5386	180	5.0	430	1750	0.5	130	137	1.0	4.00	26.4
1N5387	190	5.0	450	1850	0.5	137	144	0.9	5.00	25.0
1N5388	200	5.0	480	1850	0.5	144	152	0.9	5.00	23.6

NOTE 1 – TOLERANCE AND VOLTAGE DESIGNATION

TOLERANCE DESIGNATION – The JEDEC type numbers shown indicate a tolerance of ±20% 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 ±5.0% units.

NOTE 2 – SPECIALS AVAILABLE INCLUDE:

(A) NOMINAL ZENER VOLTAGES BETWEEN THE VOLTAGES SHOWN AND TIGHTER VOLTAGE TOLERANCES: To designate units with zener voltages other than those assigned JEDEC numbers and/or tight voltage tolerances (±3%, ±2%, ±1%), the Mfg. type number should be used.

5 – Device Description
M – Manufacturer
90 – Nominal Voltage
Z – Zener Diode
S – "Surmetic"
3 – Tolerance (±%)

Example: **5M90ZS3**

(B) MATCHED SETS: (Standard Tolerances are ±5.0%, ±2.0%, ±1.0%).

Zener diodes can be obtained in sets consisting of two or more matched devices. The method for specifying such matched sets is similar to the one described in (A) for specifying units with a special voltage and/or tolerance except that two extra suffixes are added to the code number described.

These units are marked with code letters to identify the matched sets and, in addition, each unit in a set is marked with the same serial number, which is different for each set being ordered.

5 – Device Description
M – Manufacturer
51 – 51 Volts (each device)
Z – Zener Diodes
S – "Surmetic"
5 – Tolerance per device (±5%) (omit for ±20% units)
B – Code*
1 – Overall Tolerance of set (±1%)

*Code:
B – Two devices in series
C – Three devices in series
D – Four devices in series
(A-Not used)

Example: **5M51ZS5B1**

(C) ZENER CLIPPERS: (Standard Tolerance ±10% and ±5%).

Special clipper diodes with opposing Zener junctions built into the device are available by using the following nomenclature:

5 – Device Description
M – Manufacturer
20, – Nominal Voltage
Z – Zener Diodes
Z – Clipper
10 – Tolerance for each of the two Zener voltages (not a matching requirement)

Example: **5M20ZZ10**

NOTE 3 – 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. ($T_A = 25^oC\ ^{+8}_{-2}{}^oC$).

NOTE 4 – 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 1.0 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 soecified in Note 3. ($T_A = 25^oC\ ^{+8}_{-2}{}^oC$).

NOTE 5 – 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. ($T_A = 25^oC\ ^{+8}_{-2}{}^oC$). Mounting contact located as specified in Note 3.

NOTE 6 – 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 5.0 watts divided by the actual V_Z of the device. $T_L = 75^oC$ at 3/8" maximum from the device body.

4

TEMPERATURE COEFFICIENTS

FIGURE 2 – TEMPERATURE COEFFICIENT-RANGE FOR UNITS 3.0 TO 10 VOLTS

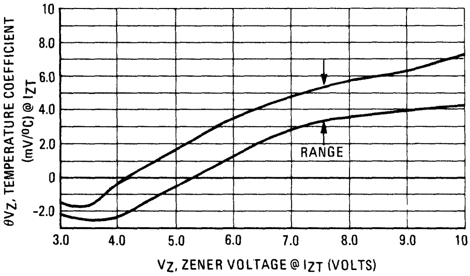


FIGURE 3 – TEMPERATURE COEFFICIENT-RANGE FOR UNITS 10 TO 220 VOLTS

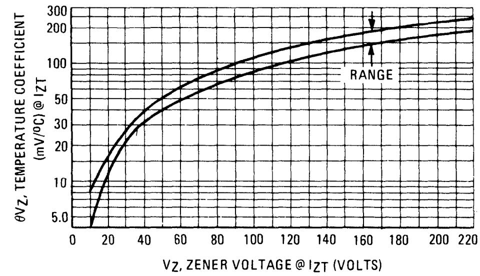


FIGURE 4 – TYPICAL THERMAL RESPONSE
L, LEAD LENGTH = 3/8 INCH

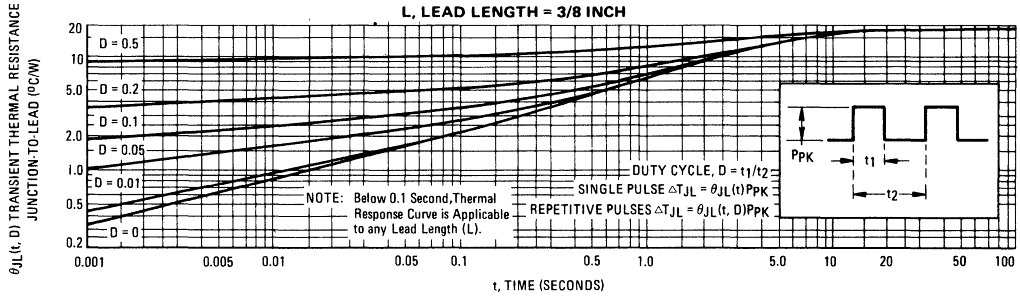


FIGURE 5 – TYPICAL THERMAL RESISTANCE

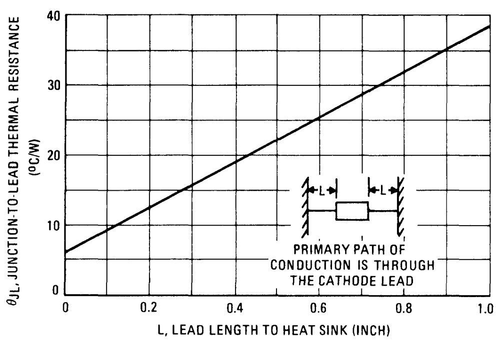
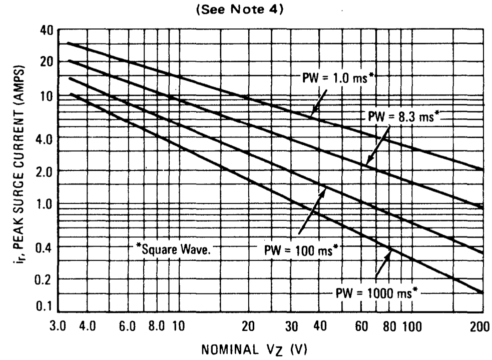


FIGURE 6 – MAXIMUM NON-REPETITIVE SURGE CURRENT versus NOMINAL ZENER VOLTAGE
(See Note 4)



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.

$$\Delta T_{JL} = \theta_{JL} P_D$$

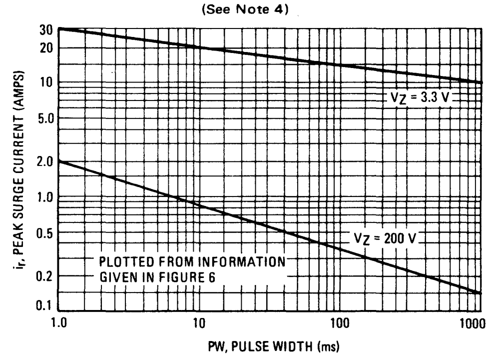
For worst-case design, using expected limits of I_Z, limits of P_D and the extremes of $T_J(\Delta T_J)$ may be estimated. Changes in voltage, V_Z, can then be found from:

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

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.

FIGURE 7 – PEAK SURGE CURRENT versus PULSE WIDTH
(See Note 4)



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.