1N5234B–1N5261B

TYPE	MATERIAL	REPLACEMENT	PAGE NUMBER	IDENTIFICATION	RECTIFIERS: V_R (volts) / SIGNAL DIODES: PRV (volts)	V_F (volts) / V_F (volts) @	I_O (Amps) / I_F	I_R (mA) / I_R	I_{surge} (Amps) / t_{rr} (μs)	ZENER DIODES: V_Z (min) / REFERENCE DIODES: TC %/°C	V_Z (nom) * / V_Z (max) / V_Z	Tol V_Z % / T (min) °C	P_D / T (max) °C
1N5234B	S		2-32	ZD							6.2*	5.0	500M
1N5235	S		2-32	ZD							6.8*	10	500M
1N5235A	S		2-32	ZD							6.8*	10	500M
1N5235B	S		2-32	ZD							6.8*	5.0	500M
1N5236	S		2-32	ZD							7.5*	10	500M
1N5236A	S		2-32	ZD							7.5*	10	500M
1N5236B	S		2-32	ZD							7.5*	5.0	500M
1N5237	S		2-32	ZD							8.2*	10	500M
1N5237A	S		2-32	ZD							8.2*	10	500M
1N5237B	S		2-32	ZD							8.2*	5.0	500M
1N5238	S		2-32	ZD							8.7*	10	500M
1N5238A	S		2-32	ZD							8.7*	10	500M
1N5238B	S		2-32	ZD							8.7*	5.0	500M
1N5239	S		2-32	ZD							9.1*	10	500M
1N5239A	S		2-32	ZD							9.1*	10	500M
1N5239B	S		2-32	ZD							9.1*	5.0	500M
1N5240	S		2-32	ZD							10*	10	500M
1N5240A	S		2-32	ZD							10*	10	500M
1N5240B	S		2-32	ZD							10*	5.0	500M
1N5241	S		2-32	ZD							11*	10	500M
1N5241A	S		2-32	ZD							11*	10	500M
1N5241B	S		2-32	ZD							11*	5.0	500M
1N5242	S		2-32	ZD							12*	10	500M
1N5242A	S		2-32	ZD							12*	10	500M
1N5242B	S		2-32	ZD							12*	5.0	500M
1N5243	S		2-32	ZD							13*	10	500M
1N5243A	S		2-32	ZD							13*	10	500M
1N5243B	S		2-32	ZD							13*	5.0	500M
1N5244	S		2-32	ZD							14*	10	500M
1N5244A	S		2-32	ZD							14*	10	500M
1N5244B	S		2-32	ZD							14*	5.0	500M
1N5245	S		2-32	ZD							15*	10	500M
1N5245A	S		2-32	ZD							15*	10	500M
1N5245B	S		2-32	ZD							15*	5.0	500M
1N5246	S		2-32	ZD							16*	10	500M
1N5246A	S		2-32	ZD							16*	10	500M
1N5246B	S		2-32	ZD							16*	5.0	500M
1N5247	S		2-32	ZD							17*	10	500M
1N5247A	S		2-32	ZD							17*	10	500M
1N5247B	S		2-32	ZD							17*	5.0	500M
1N5248	S		2-32	ZD							18*	10	500M
1N5248A	S		2-32	ZD							18*	10	500M
1N5248B	S		2-32	ZD							18*	5.0	500M
1N5249	S		2-32	ZD							19*	10	500M
1N5249A	S		2-32	ZD							19*	10	500M
1N5249B	S		2-32	ZD							19*	5.0	500M
1N5250	S		2-32	ZD							20*	10	500M
1N5250A	S		2-32	ZD							20*	10	500M
1N5250B	S		2-32	ZD							20*	5.0	500M
1N5251	S		2-32	ZD							22*	10	500M
1N5251A	S		2-32	ZD							22*	10	500M
1N5251B	S		2-32	ZD							22*	5.0	500M
1N5252	S		2-32	ZD							24*	10	500M
1N5252A	S		2-32	ZD							24*	10	500M
1N5252B	S		2-32	ZD							24*	5.0	500M
1N5253	S		2-32	ZD							25*	10	500M
1N5253A	S		2-32	ZD							25*	10	500M
1N5253B	S		2-32	ZD							25*	5.0	500M
1N5254	S		2-32	ZD							27*	10	500M
1N5254A	S		2-32	ZD							27*	10	500M
1N5254B	S		2-32	ZD							27*	5.0	500M
1N5255	S		2-32	ZD							28*	10	500M
1N5255A	S		2-32	ZD							28*	10	500M
1N5255B	S		2-32	ZD							28*	5.0	500M
1N5256	S		2-32	ZD							30*	10	500M
1N5256A	S		2-32	ZD							30*	10	500M
1N5256B	S		2-32	ZD							30*	5.0	500M
1N5257	S		2-32	ZD							33*	10	500M
1N5257A	S		2-32	ZD							33*	10	500M
1N5257B	S		2-32	ZD							33*	5.0	500M
1N5258	S		2-32	ZD							36*	10	500M
1N5258A	S		2-32	ZD							36*	10	500M
1N5258B	S		2-32	ZD							36*	5.0	500M
1N5259	S		2-32	ZD							39*	10	500M
1N5259A	S		2-32	ZD							39*	10	500M
1N5259B	S		2-32	ZD							39*	5.0	500M
1N5260	S		2-32	ZD							43*	10	500M
1N5260A	S		2-32	ZD							43*	10	500M
1N5260B	S		2-32	ZD							43*	5.0	500M
1N5261	S		2-32	ZD							47*	10	500M
1N5261A	S		2-32	ZD							47*	10	500M
1N5261B	S		2-32	ZD							47*	5.0	500M

R—Rectifier, **RD**—Reference Diode, **ZD**—Zener Diode, **GP**—General Purpose, **HC**—High Conductance (≥ 20 mA @ ≤ 1 V), **HS**—High Speed Switch (Max t_{rr} < 0.3 μs), **CS**—High Conductance, High Speed Switch, **MS**—Medium Speed Switch, **PA**—Parametric Amplifier, **SP**—Special Purpose.

1N5221 thru 1N5281 series

P_D = 500 mW
V_Z = 2.4-200 V

CASE 51
(DO-7)

500 Milliwatt surmetic 20 silicon zener diodes-a complete new series of Zener Diodes in the popular DO-7 case with higher ratings, tighter limits, better operating characteristics and a full set of designers' curves 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.

MAXIMUM RATINGS

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: 500 mW @ T_L = 75°C, Lead Length = 3/8"
(Derate 4.0 mW/°C above 75°C)

Surge Power: 10 Watts (Non-recurrent square wave @ PW = 8.3 ms, T_J = 55°C, Figure 16)

MECHANICAL CHARACTERISTICS

CASE: Void free, transfer molded, thermosetting plastic.

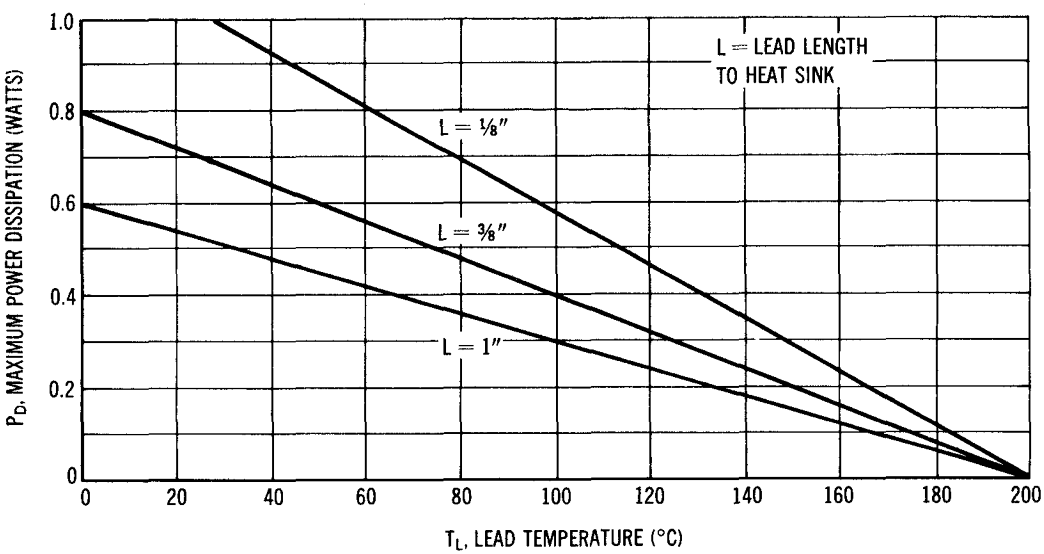
FINISH: All external surfaces are corrosion resistant. Leads are readily solderable and weldable.

POLARITY: Cathode indicated by color band. When operated in zener mode, cathode will be positive with respect to anode.

MOUNTING POSITION: Any.

WEIGHT: 0.18 gram (approximately).

FIGURE 1 — POWER-TEMPERATURE DERATING CURVE



1N5221 thru 1N5281 series (continued)

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted. Based on dc measurements at thermal equilibrium; lead length = 3/8"; thermal resistance of heat sink = 30°C/W) **V_F = 1.1 Max @ I_F = 200 mA 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: Z_{ZT} @ I_{ZT} Ohms	Max Zener Impedance A & B Suffix Only: Z_{ZK} @ I_{ZK} = 0.25 mA Ohms	Max Reverse Leakage Current, A & B Suffix Only: I_R μA	@ V_R Volts A	@ V_R Volts B	Max Reverse Leakage Current, Non-Suffix: I_R @ V_R Used For Suffix A μA	Max Zener Voltage Temp. Coeff. (A & B Suffix Only) θ_{VZ} (%/°C) (Note 3)
1N5221	2.4	20	30	1200	100	0.95	1.0	200	-0.085
1N5222	2.5	20	30	1250	100	0.95	1.0	200	-0.085
1N5223	2.7	20	30	1300	75	0.95	1.0	150	-0.080
1N5224	2.8	20	30	1400	75	0.95	1.0	150	-0.080
1N5225	3.0	20	29	1600	50	0.95	1.0	100	-0.075
1N5226	3.3	20	28	1600	25	0.95	1.0	100	-0.070
1N5227	3.6	20	24	1700	15	0.95	1.0	100	-0.065
1N5228	3.9	20	23	1900	10	0.95	1.0	75	-0.060
1N5229	4.3	20	22	2000	5.0	0.95	1.0	50	±0.055
1N5230	4.7	20	19	1900	5.0	1.9	2.0	50	+0.030
1N5231	5.1	20	17	1600	5.0	1.9	2.0	50	±0.030
1N5232	5.6	20	11	1600	5.0	2.9	3.0	50	+0.038
1N5233	6.0	20	7.0	1600	5.0	3.3	3.5	50	+0.038
1N5234	6.2	20	7.0	1000	5.0	3.8	4.0	50	+0.045
1N5235	6.8	20	5.0	750	3.0	4.8	5.0	30	+0.050
1N5236	7.5	20	6.0	500	3.0	5.7	6.0	30	+0.058
1N5237	8.2	20	8.0	500	3.0	6.2	6.5	30	+0.062
1N5238	8.7	20	8.0	600	3.0	6.2	6.5	30	+0.065
1N5239	9.1	20	10	600	3.0	6.7	7.0	30	+0.068
1N5240	10	20	17	600	3.0	7.6	8.0	30	+0.075
1N5241	11	20	22	600	2.0	8.0	8.4	30	+0.076
1N5242	12	20	30	600	1.0	8.7	9.1	10	+0.077
1N5243	13	9.5	13	600	0.5	9.4	9.9	10	+0.079
1N5244	14	9.0	15	600	0.1	9.5	10	10	+0.082
1N5245	15	8.5	16	600	0.1	10.5	11	10	+0.082
1N5246	16	7.8	17	600	0.1	11.4	12	10	+0.083
1N5247	17	7.4	19	600	0.1	12.4	13	10	+0.084
1N5248	18	7.0	21	600	0.1	13.3	14	10	+0.085
1N5249	19	6.6	23	600	0.1	13.3	14	10	+0.086
1N5250	20	6.2	25	600	0.1	14.3	15	10	+0.086
1N5251	22	5.6	29	600	0.1	16.2	17	10	+0.087
1N5252	24	5.2	33	600	0.1	17.1	18	10	+0.088
1N5253	25	5.0	35	600	0.1	18.1	19	10	+0.089
1N5254	27	4.6	41	600	0.1	20	21	10	+0.090
1N5255	28	4.5	44	600	0.1	20	21	10	+0.091
1N5256	30	4.2	49	600	0.1	22	23	10	+0.091
1N5257	33	3.8	58	700	0.1	24	25	10	+0.092
1N5258	36	3.4	70	700	0.1	26	27	10	+0.093
1N5259	39	3.2	80	800	0.1	29	30	10	+0.094
1N5260	43	3.0	93	900	0.1	31	33	10	+0.095
1N5261	47	2.7	105	1000	0.1	34	36	10	+0.095
1N5262	51	2.5	125	1100	0.1	37	39	10	+0.096
1N5263	56	2.2	150	1300	0.1	41	43	10	+0.096
1N5264	60	2.1	170	1400	0.1	44	46	10	+0.097
1N5265	62	2.0	185	1400	0.1	45	47	10	+0.097
1N5266	68	1.8	230	1600	0.1	49	52	10	+0.097
1N5267	75	1.7	270	1700	0.1	53	56	10	+0.098
1N5268	82	1.5	330	2000	0.1	59	62	10	+0.098
1N5269	87	1.4	370	2200	0.1	65	68	10	+0.099
1N5270	91	1.4	400	2300	0.1	66	69	10	+0.099
1N5271	100	1.3	500	2600	0.1	72	76	10	+0.110
1N5272	110	1.1	750	3000	0.1	80	84	10	+0.110
1N5273	120	1.0	900	4000	0.1	86	91	10	+0.110
1N5274	130	0.95	1100	4500	0.1	94	99	10	+0.110
1N5275	140	0.90	1300	4500	0.1	101	106	10	+0.110
1N5276	150	0.85	1500	5000	0.1	108	114	10	+0.110
1N5277	160	0.80	1700	5500	0.1	116	122	10	+0.110
1N5278	170	0.74	1900	5500	0.1	123	129	10	+0.110
1N5279	180	0.68	2200	6000	0.1	130	137	10	+0.110
1N5280	190	0.66	2400	6500	0.1	137	144	10	+0.110
1N5281	200	0.65	2500	7000	0.1	144	152	10	+0.110

NOTE 1 — TOLERANCE AND VOLTAGE DESIGNATION

Tolerance designation — The JEDEC type numbers shown indicate a tolerance of ±10% with guaranteed limits on only V_Z, I_R and V_F as shown in the above table. Units with guaranteed limits on all six parameters are indicated by suffix "A" for ±10% tolerance and suffix "B" for ±5.0% units.

Non-Standard voltage designation — To designate units with zener voltages other than those assigned JEDEC numbers, the type number should be used.

EXAMPLE:

0.5 M 90 Z S 5

0.5 Watt
Manufacturer
Nominal Voltage
Zener Diodes
Surmetic
Tolerance (±%)

NOTE 2 — SPECIAL SELECTIONS AVAILABLE INCLUDE:

1 — Nominal zener voltages between those shown.

2 — **Matched sets: (Standard Tolerances are ±5.0%, ±3.0%, ±2.0%, ±1.0%) depending on voltage per device.**

a. Two or more units for series connection with specified tolerance on total voltage. Series matched sets make zener voltages in excess of 200 volts possible as well as providing lower temperature coefficients, lower dynamic impedance and greater power handling ability.

b. Two or more units matched to one another with any specified tolerance.

3 — Tight voltage tolerances: 1.0%, 2.0%, 3.0%.

NOTE 3 — TEMPERATURE COEFFICIENT (θ_{VZ})

Test conditions for temperature coefficient are as follows:

a. I_{ZT} = 7.5 mA, T_1 = 25°C,
T_2 = 125°C (1N5221A, B thru 1N5242A, B.)

b. I_{ZT} = Rated I_{ZT}, T_1 = 25°C,
T_2 = 125°C (1N5243A, B thru 1N5281A, B.)

Device to be temperature stabilized with current applied prior to reading breakdown voltage at the specified ambient temperature.

1N5221 thru 1N5281 series *(continued)*

TYPICAL REVERSE CHARACTERISTICS FOR SELECTED ZENER DIODES

Curves marked T_A were obtained from dc measurements at thermal equilibrium; lead length = 3/8"; thermal resistance of heat sink = 30°C/W.
Curves marked T_J were obtained from pulse tests; mounting conditions are not a factor.

$V_{Z(Nominal)}$ = 3.3 Volts

FIGURE 2

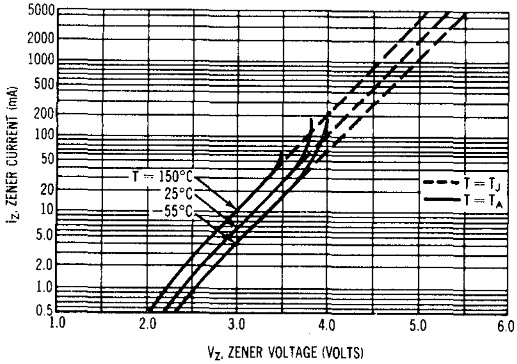
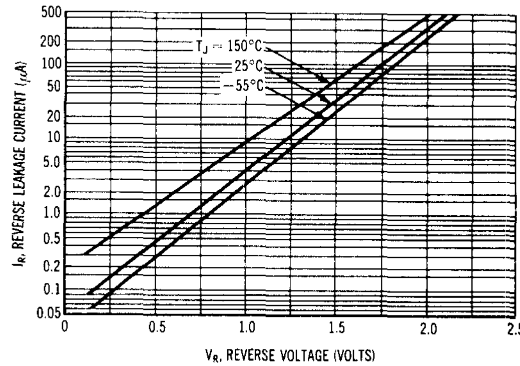


FIGURE 3



$V_{Z(Nominal)}$ = 5.1 Volts

FIGURE 4

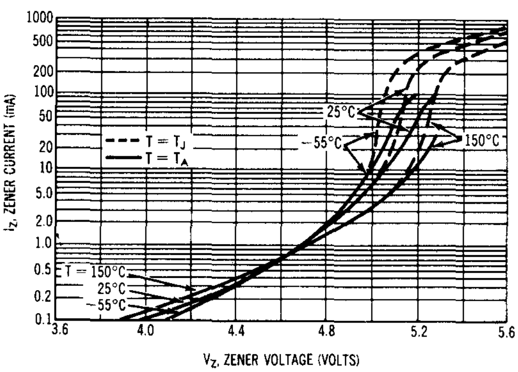
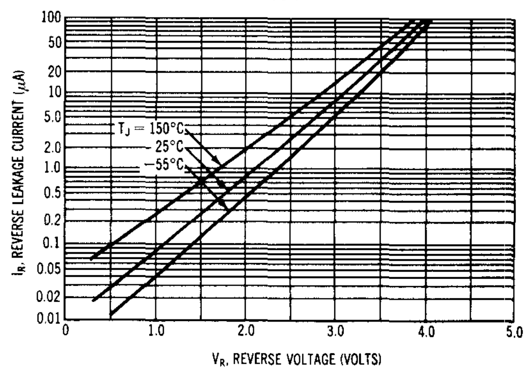


FIGURE 5



$V_{Z(Nominal)}$ = 27 Volts

FIGURE 6

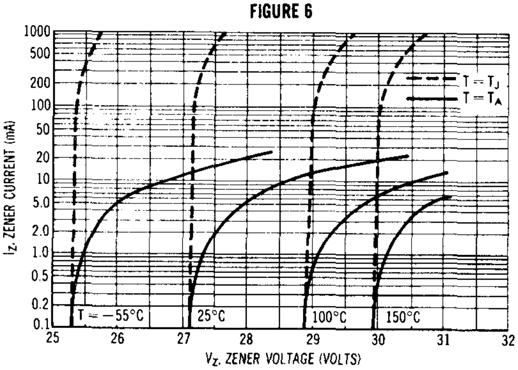
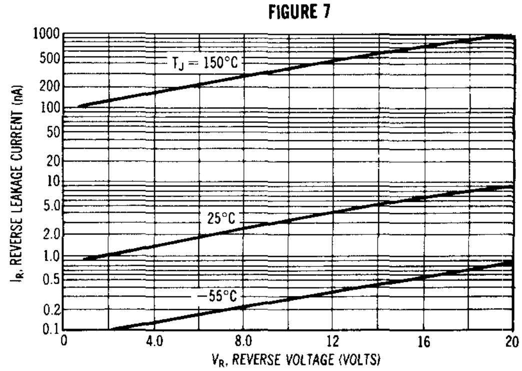


FIGURE 7



1N5221 thru 1N5281 series (continued)

TEMPERATURE COEFFICIENTS AND VOLTAGE REGULATION

(90% of the units are in the ranges indicated)

FIGURE 8 — RANGE FOR UNITS TO 12 VOLTS

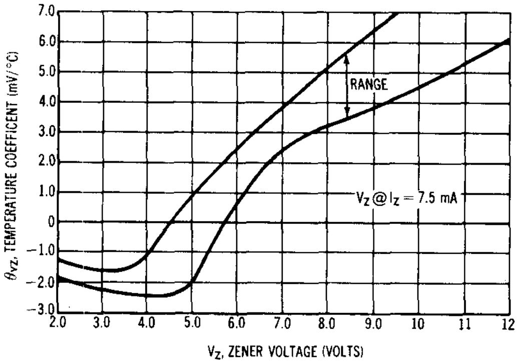


FIGURE 9 — RANGE FOR UNITS 12 TO 200 VOLTS

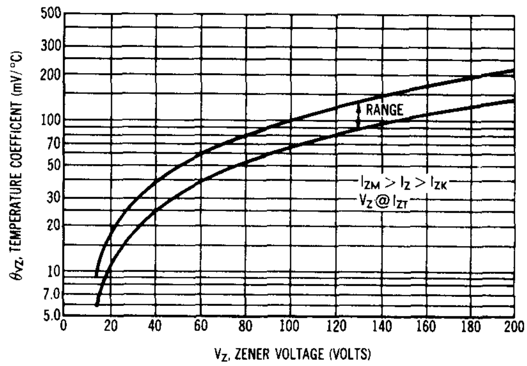


FIGURE 10 — EFFECT OF ZENER CURRENT

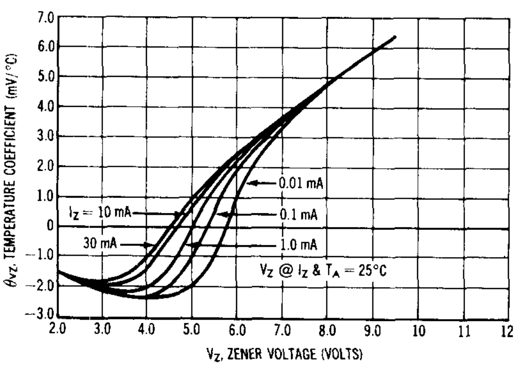
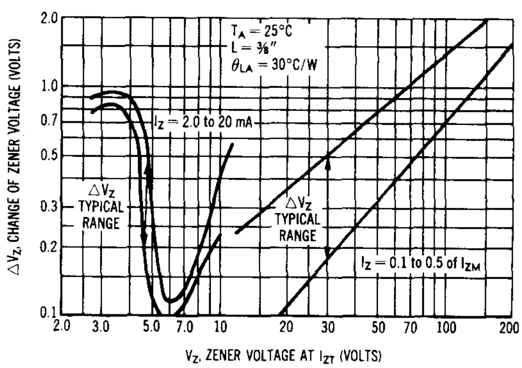


FIGURE 11 — VOLTAGE REGULATION



TYPICAL ZENER IMPEDANCE

FIGURE 12 — EFFECT OF ZENER CURRENT

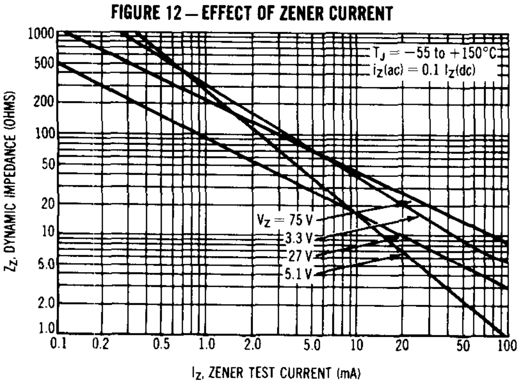
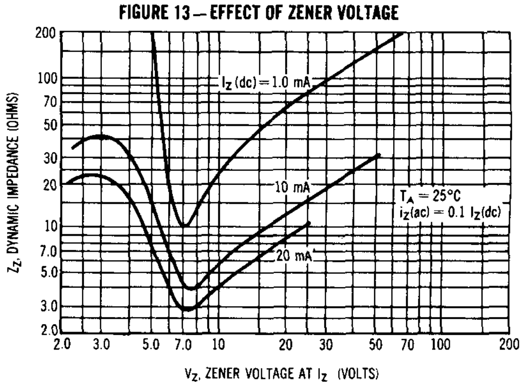


FIGURE 13 — EFFECT OF ZENER VOLTAGE



1N5221 thru 1N5281 Series (continued)

FIGURE 14 — TYPICAL THERMAL RESPONSE

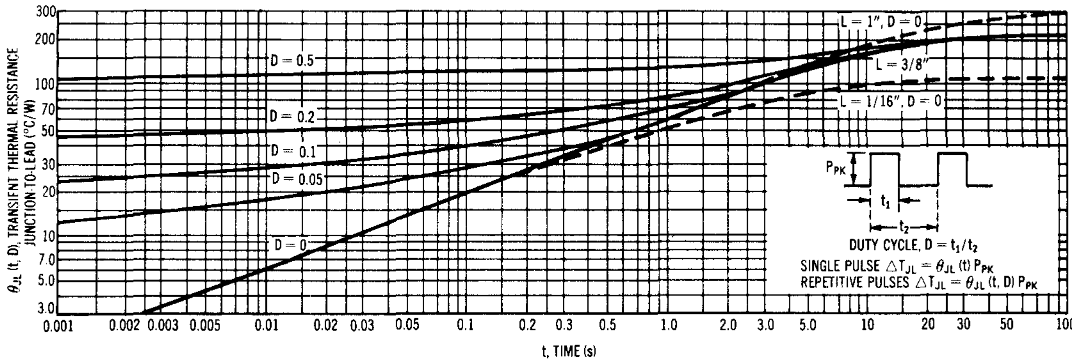


FIGURE 15 — TYPICAL THERMAL RESISTANCE

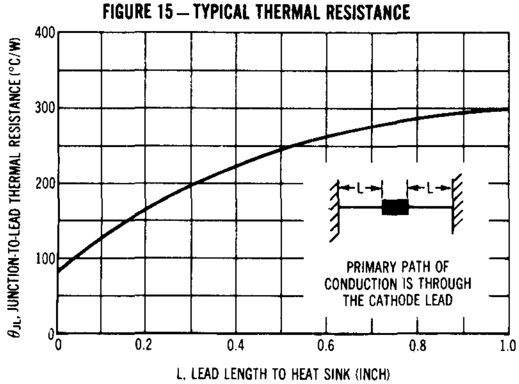
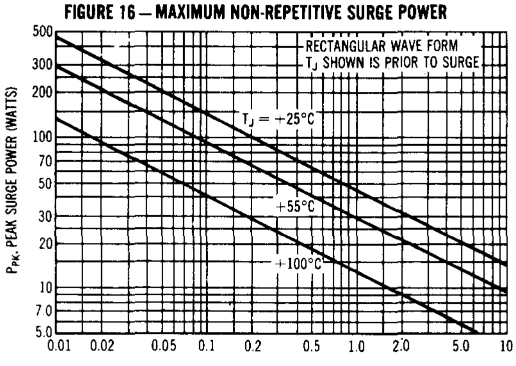


FIGURE 16 — MAXIMUM NON-REPETITIVE SURGE POWER



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. θ_{LA} is generally 30-40°C/W for the various clips and tie points in common use and for printed circuit board wiring.

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 14 for a train of power pulses or from Figure 15 for dc power.

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 8, 9, and 10.

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, use short leads, especially to the cathode, and keep current excursions as low as possible.

Data of Figure 14 should not be used to compute surge capability. Surge limitations are given in Figure 16. 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 16 be exceeded.

1N5221 thru 1N5281 Series (continued)

FIGURE 17 — TYPICAL CAPACITANCE

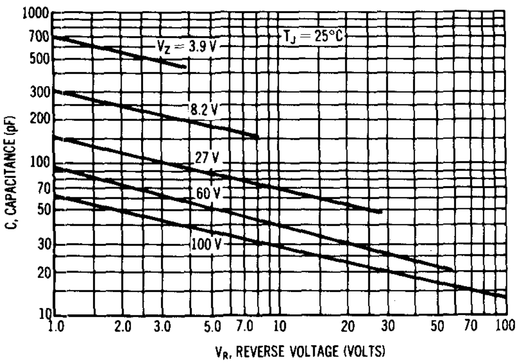


FIGURE 18 — TYPICAL FORWARD CHARACTERISTICS

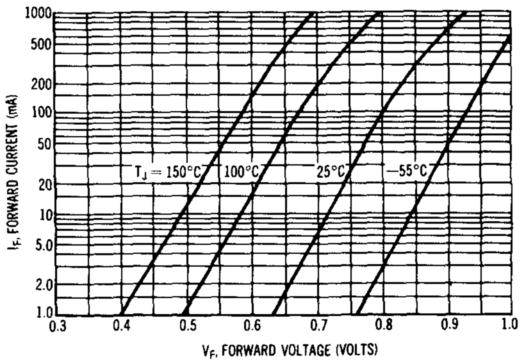


FIGURE 19 — TYPICAL NOISE DENSITY

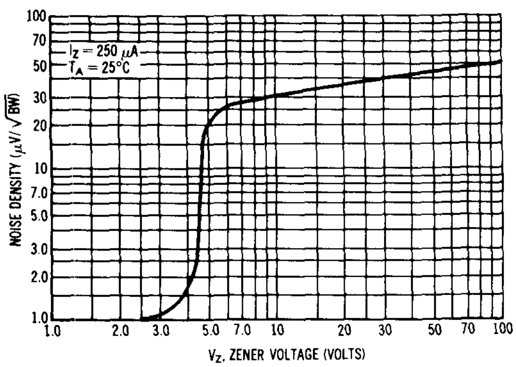
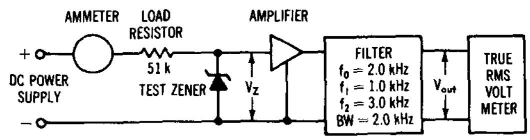


FIGURE 20 — NOISE DENSITY MEASUREMENT METHOD



NOISE DENSITY (VOLTS PER SQUARE ROOT BANDWIDTH) = $\frac{V_{out}}{\text{OVERALL GAIN} \sqrt{BW}}$

WHERE: BW = FILTER BANDWIDTH (Hz)
V_{out} = OUTPUT NOISE (VOLTS RMS)

The input voltage and load resistance are high so that the zener diode is driven from a constant current source. The amplifier is low noise so that the amplifier noise is negligible compared to that of the test zener. The filter bandpass is known so that the noise density can be calculated from the formula shown. The data of Figure 19 and the formula can also be used to find noise for any system bandwidth.