

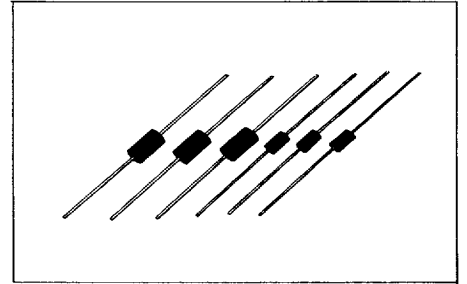
# VRD

T-62-11

VRD is a new type of transient voltage suppressor used for protecting electronic circuits from surge voltage and thus preventing breakdown.

VRD possesses superior surge suppression characteristics, such as an extremely short response time, very low clamping voltage, and high surge capacity.

Unlike metal oxide varistors, VRD does not have characteristics change with surge variations within the rated capacity. This feature comprises another superior characteristics of the VRD as a transient voltage suppressors.

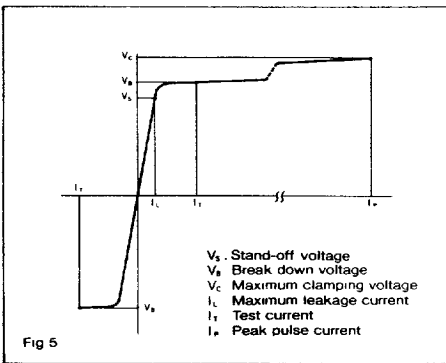


### Electrical characteristics

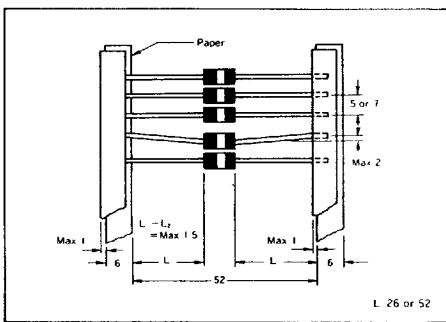
Figure 5 shows the electrical characteristics. Z type has almost symmetrical breakdown voltage ( $V_B$ ) and ratio in between forward ( $V_{BR}$ ) and reverse breakdown voltage ( $V_{BR}$ ) is

$$0.9 \leq \frac{V_{BR}}{V_{BR}} \leq 1.10$$

The reverse breakdown voltage of the ZD type VRD is 2,000 volts or more at 10  $\mu$ A DC.



**Taping**  
Standard taping is applicable for VRD as shows in Figure



### Surge capacity

Surge capacity (P) is determined by the following equation:

$$P = \int I(t) \cdot V(t) dt$$

$I$ : Pulse current wave

$V$ : clamping voltage wave

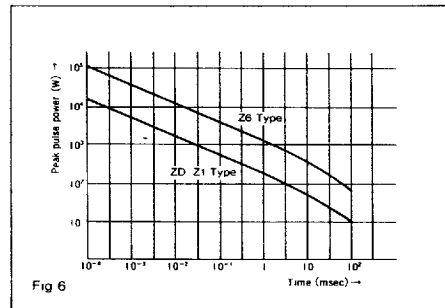
Allowable surge capacity ( $P_m$ ) is determined by the following equation:

$$P_m = I_p \cdot V_c$$

$I_p$ : Peak current

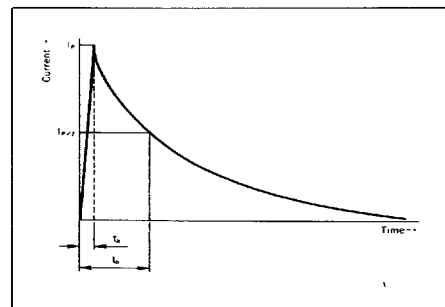
$V_c$ : Maximum clamping voltage

The allowable surge capacity (peak pulse power) of VRD is shown in Figure 6 and the surge capability derating characteristics are shown in Figure 8



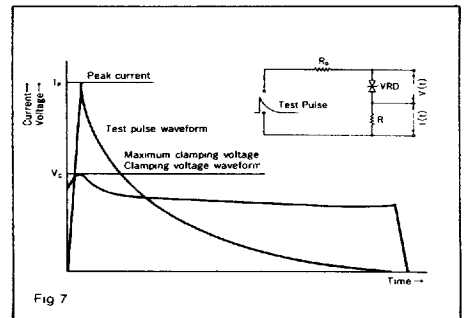
### Surge waveform

There are many types of surge waveform depending on the source of the surge. For the VRD surge suppression characteristics test, the EXP waveform shown below is used. The EXP waveform is shown as  $t_a$  to  $t_b$  depending on the time width, however 10 to 1000 waveform is used as the standard test waveform

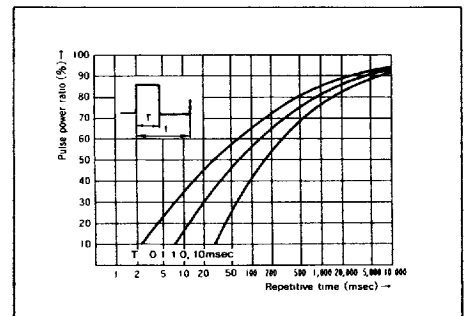
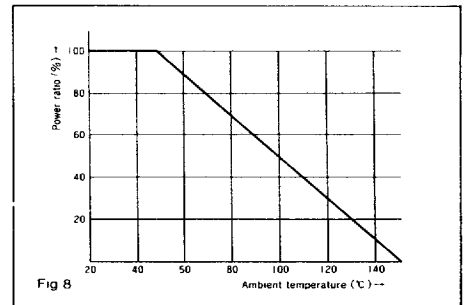


### Surge suppression characteristics

When EXP waveform is applied to the circuit below, the surge suppression waveform shown in the figure 7 can be observed.  $R_0$  is the surge impedance while resistor  $R_1$  allows current to be measured

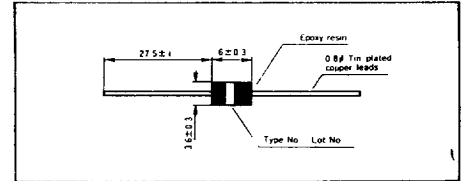


### Power derating



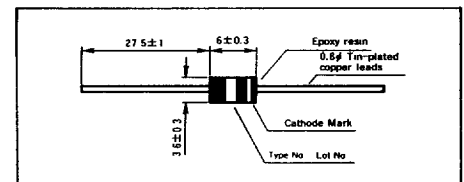
Bi-polar type	Stand-off voltage $V_s$ V	Maximum leakage current $I_L$	Breakdown voltage $V_B$ V	Test current $I_T$ mA	Maximum clamping voltage & Maximum peak pulse current				Max. temp. coef. of $V_B$ %/°C
					10/1000 $\mu$ sec		8/20 $\mu$ sec		
					$V_C$ V	$I_P$ A	$V_C$ V	$I_P$ A	
Z1015	12.1	5	13.5-16.5	1	22.0	11.4	28.5	106	0.076
Z1016	12.9	5	14.4-17.6	1	23.5	10.6	30.5	99.3	0.078
Z1018	14.5	5	16.2-19.8	1	26.5	9.43	34.4	88.0	0.079
Z1020	16.2	5	18.0-22.0	1	29.1	8.59	37.7	80.3	0.081
Z1022	17.8	5	19.8-24.2	1	31.9	7.84	41.4	73.1	0.082
Z1024	19.4	5	21.6-26.4	1	34.7	7.20	45.0	67.3	0.084
Z1027	21.8	5	24.3-29.7	1	39.1	6.39	50.7	59.7	0.085
Z1030	24.3	5	27.0-33.0	1	43.5	5.75	56.4	53.7	0.086
Z1033	26.8	5	29.7-36.3	1	47.7	5.24	61.8	49.0	0.087
Z1036	29.1	5	32.4-39.6	1	52.0	4.81	67.4	44.9	0.089
Z1039	31.6	5	35.1-42.9	1	56.4	4.43	73.1	41.4	0.090
Z1043	34.8	5	38.7-47.3	1	61.9	4.04	80.2	37.7	0.091
Z1047	38.1	5	42.3-51.7	1	67.8	3.69	88.1	34.4	0.092
Z1051	41.3	5	45.9-56.1	1	73.5	3.40	95.3	31.8	0.093
Z1056	45.4	5	50.4-61.6	1	80.5	3.11	104	29.1	0.094
Z1062	50.2	5	55.8-68.2	1	89.0	2.81	115	26.3	0.095
Z1068	55.1	5	61.2-74.8	1	98.0	2.55	127	23.8	0.096
Z1075	60.7	5	67.5-82.5	1	108	2.31	140	21.6	0.098
Z1082	66.4	5	73.8-90.2	1	118	2.12	153	19.8	0.099
Z1091	73.7	5	81.9-100	1	131	1.91	170	17.8	0.100
Z1100	81.0	5	90.0-110	1	144	1.74	187	16.2	0.101
Z1110	89.2	5	99.0-121	1	158	1.58	205	14.8	0.102
Z1120	97.0	5	108-132	1	173	1.45	224	13.5	0.103
Z1130	105	5	117-143	1	187	1.34	242	12.5	0.104
Z1150	121	5	135-165	1	215	1.16	279	10.8	0.105

Z1 type VRD has bipolar electrical characteristics.  
 Maximum ratings  
 Peak pulse power: 250 Watt (10/1000 $\mu$ sec.)  
 3.03 KWatt (8/20 $\mu$ sec.)  
 Steady state power dissipation: 500 mWatt  
 Operating and storage temperature: -40°C to 150°C  
 Symbol mark



VRD type No.	Stand-off voltage $V_s$ V	Maximum leakage current $I_L$ $\mu$ A	Breakdown voltage $V_B$ V	Test current $I_T$ mA	Maximum clamping voltage & Maximum peak pulse current				Max. temp. coef. of $V_B$ %/°C
					10/1000 $\mu$ sec		8/20 $\mu$ sec		
					$V_C$ V	$I_P$ A	$V_C$ V	$I_P$ A	
ZD015	12.1	5	13.5-16.5	1	22.0	11.4	28.5	106	0.076
ZD016	12.9	5	14.4-17.6	1	23.5	10.6	30.5	99.3	0.078
ZD018	14.5	5	16.2-19.8	1	26.5	9.43	34.4	88.0	0.079
ZD020	16.2	5	18.0-22.0	1	29.1	8.59	37.7	80.3	0.081
ZD022	17.8	5	19.8-24.2	1	31.9	7.84	41.4	73.1	0.082
ZD024	19.4	5	21.6-26.4	1	34.7	7.20	45.0	67.3	0.084
ZD027	21.8	5	24.3-29.7	1	39.1	6.39	50.7	59.7	0.085
ZD030	24.3	5	27.0-33.0	1	43.5	5.75	56.4	53.7	0.086
ZD033	26.8	5	29.7-36.3	1	47.7	5.24	61.8	49.0	0.087
ZD036	29.1	5	32.4-39.6	1	52.0	4.81	67.4	44.9	0.089
ZD039	31.6	5	35.1-42.9	1	56.4	4.43	73.1	41.4	0.090
ZD043	34.8	5	38.7-47.3	1	61.9	4.04	80.2	37.7	0.091
ZD047	38.1	5	42.3-51.7	1	67.8	3.69	88.1	34.4	0.092
ZD051	41.3	5	45.9-56.1	1	73.5	3.40	95.3	31.8	0.093
ZD056	45.4	5	50.4-61.6	1	80.5	3.11	104	29.1	0.094
ZD062	50.2	5	55.8-68.2	1	89.0	2.81	115	26.3	0.095
ZD068	55.1	5	61.2-74.8	1	98.0	2.55	127	23.8	0.096

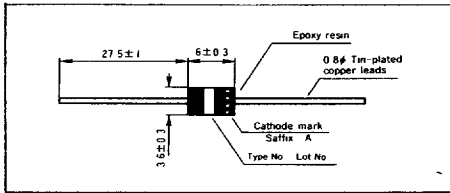
Low capacitance type  
 Maximum ratings  
 Reverse voltage: 200 VDC  
 Peak pulse power: 250 Watt (10/1000 $\mu$ sec.)  
 3.03 KWatt (8/20 $\mu$ sec.)  
 Steady state power dissipation: 500 mWatt  
 Operating and storage temperature: -40°C to 150°C  
 Symbol mark



Z2 type VRD has bipolar or unipolar electrical characteristics.

Maximum ratings  
 Peak pulse power 600 Watt (10/1000 $\mu$ sec)  
 7.28 KWatt (8/20 $\mu$ sec)  
 Steady state power dissipation, 1 Watt

Operating and storage temperature: -40°C to 150°C  
 Symbol mark



Bi-polar type	Uni-polar type	Stand-off voltage $V_s$ V	Maximum leakage current $I_L$ $\mu$ A	Breakdown voltage $V_B$ V	Test current $I_T$ mA	Maximum clamping voltage & Maximum peak pulse current			
						10/1000 $\mu$ sec		8/20 $\mu$ sec	
						$V_C$ V	$I_p$ A	$V_C$ V	$I_p$ A
	Z2008U	6.63	500	7.38-9.02	10	12.5	48.0	16.2	449
	Z2008UA	7.02	500	7.79-8.61	10	12.1	49.5	15.7	463
Z2009	Z2009U	7.37	50	8.19-10.0	1	13.8	43.4	17.9	406
Z2009A	Z2009UA	7.78	50	8.65-9.55	1	13.4	44.7	17.4	418
Z2010	Z2010U	8.10	10	9.00-11.0	1	15.0	40.0	19.4	375
Z2010A	Z2010UA	8.55	10	9.50-10.5	1	14.5	41.3	18.8	387
Z2011	Z2011U	8.92	5	9.90-12.1	1	16.2	37.0	21.0	346
Z2011A	Z2011UA	9.40	5	10.5-11.6	1	15.6	38.4	20.2	360
Z2012	Z2012U	9.72	5	10.8-13.2	1	17.3	34.6	22.4	325
Z2012A	Z2012UA	10.2	5	11.4-12.6	1	16.7	35.9	21.6	337
Z2013	Z2013U	10.5	5	11.7-14.3	1	19.0	31.5	24.6	295
Z2013A	Z2013UA	11.1	5	12.4-13.7	1	18.2	32.9	23.6	308
Z2015	Z2015U	12.1	5	13.5-16.5	1	22.0	27.2	28.5	255
Z2015A	Z2015UA	12.8	5	14.3-15.8	1	21.2	28.3	27.5	264
Z2016	Z2016U	12.9	5	14.4-17.6	1	23.5	25.5	30.5	238
Z2016A	Z2016UA	13.6	5	15.2-16.8	1	22.5	26.6	29.2	249
Z2018	Z2018U	14.5	5	16.2-19.8	1	26.5	22.6	34.4	298
Z2018A	Z2018UA	15.3	5	17.1-18.0	1	25.2	23.8	32.7	222
Z2020	Z2020U	16.2	5	18.0-22.0	1	29.1	20.6	37.7	193
Z2020A	Z2020UA	17.1	5	19.0-21.0	1	27.7	21.6	35.9	206
Z2022	Z2022U	17.8	5	19.8-24.2	1	31.9	18.8	41.4	175
Z2022A	Z2022UA	18.8	5	20.9-23.1	1	30.6	19.6	39.7	183
Z2024	Z2024U	19.4	5	21.6-26.4	1	34.7	17.2	45.0	161
Z2024A	Z2024UA	20.5	5	22.8-25.2	1	33.2	18.0	43.0	169
Z2027	Z2027U	21.8	5	24.3-29.7	1	39.1	15.3	50.7	143
Z2027A	Z2027UA	23.1	5	25.7-28.4	1	37.5	16.0	48.6	149
Z2030	Z2030U	24.3	5	27.0-33.0	1	43.5	13.7	56.4	129
Z2030A	Z2030UA	25.6	5	28.5-31.5	1	41.4	14.4	53.7	135
Z2033	Z2033U	26.8	5	29.7-36.3	1	47.7	12.5	61.8	117
Z2033A	Z2033UA	28.2	5	31.4-34.7	1	45.2	13.2	58.6	124
Z2036	Z2036U	29.1	5	32.4-39.6	1	52.0	11.5	67.4	108
Z2036A	Z2036UA	30.8	5	34.2-37.8	1	49.9	12.0	64.7	112
Z2039	Z2039U	31.6	5	35.1-42.9	1	56.4	10.6	73.1	99.5
Z2039A	Z2039UA	33.3	5	37.1-41.0	1	53.9	11.1	69.9	104
Z2043	Z2043U	34.8	5	38.7-47.3	1	61.9	9.69	80.2	90.7
Z2043A	Z2043UA	36.8	5	40.9-45.2	1	59.3	10.1	76.9	94.6
Z2047	Z2047U	38.1	5	42.3-51.7	1	67.8	8.84	78.9	92.2
Z2047A	Z2047UA	40.2	5	44.7-49.4	1	64.8	9.25	74.0	98.3
Z2051	Z2051U	41.3	5	45.9-56.1	1	73.5	8.16	95.3	76.3
Z2051A	Z2051UA	43.6	5	48.5-53.6	1	70.1	8.55	90.9	80.0
Z2056	Z2056U	45.4	5	50.4-61.6	1	80.5	7.45	104	70.0
Z2056A	Z2056UA	47.8	5	53.2-58.8	1	77.0	7.79	99.8	72.9
Z2062	Z2062U	50.2	5	55.8-68.2	1	89.0	6.74	115	63.3
Z2062A	Z2062UA	53.0	5	58.9-65.1	1	85.0	7.05	110	66.1
Z2068	Z2068U	55.1	5	61.2-74.8	1	98.0	6.12	127	60.6
Z2068A	Z2068UA	58.1	5	64.6-71.4	1	92.0	6.52	119	61.1
Z2075	Z2075U	60.7	5	67.5-82.5	1	108	5.55	140	52.0
Z2075A	Z2075UA	64.1	5	71.3-78.8	1	103	5.82	134	54.3
Z2082	Z2082U	66.4	5	73.8-90.2	1	118	5.08	153	47.5
Z2082A	Z2082UA	70.1	5	77.9-86.1	1	113	5.30	146	49.8
Z2091	Z2091U	73.7	5	81.9-100	1	131	4.58	170	42.8
Z2091A	Z2091UA	77.8	5	86.5-95.5	1	125	4.80	162	44.9
Z2100	Z2100U	81.0	5	90.0-110	1	144	4.16	187	38.9
Z2100A	Z2100UA	85.5	5	95.0-105	1	137	4.37	178	40.8
Z2110	Z2110U	89.2	5	99.0-121	1	158	3.79	205	35.5
Z2110A	Z2110UA	94.0	5	105-116	1	152	3.94	197	36.9
Z2120	Z2120U	97.2	5	108-132	1	173	3.46	224	32.5
Z2120A	Z2120UA	102	5	114-126	1	165	3.63	214	34.0
Z2130	Z2130U	105	5	117-143	1	187	3.20	242	30.0
Z2130A	Z2130UA	111	5	124-137	1	179	3.35	232	31.3
Z2150	Z2150U	121	5	135-165	1	215	2.79	279	26.0
Z2150A	Z2150UA	128	5	143-158	1	207	2.89	268	27.1
Z2160	Z2160U	130	5	144-176	1	230	2.30	298	24.4
Z2160A	Z2160UA	136	5	152-168	1	219	2.73	284	25.6
Z2170	Z2170U	138	5	153-187	1	244	2.45	316	23.0
Z2170A	Z2170UA	145	5	161-179	1	234	2.56	303	24.0
Z2180	Z2180U	146	5	162-198	1	258	2.32	335	21.7
Z2180A	Z2180UA	154	5	171-189	1	246	2.43	319	22.8
Z2200	Z2200U	162	5	180-220	1	287	2.09	372	22.2
Z2200A	Z2200UA	111	5	190-210	1	274	2.18	355	20.5
Z2220	Z2220U	175	5	198-242	1	344	1.74	408	17.8
Z2220A	Z2220UA	185	5	209-231	1	328	1.82	390	18.6

NOTE: Nonsuffix Vz  $\pm$  10% and Bi-polar, "A" Vz  $\pm$  5%, suffix "U" Uni-polar

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Bi-polar type	Uni-polar type	Stand-off voltage V <sub>s</sub>	Maximum leakage current I <sub>L</sub> μA	Breakdown voltage V <sub>B</sub>	Test current I <sub>T</sub> mA	Maximum clamping voltage & Maximum peak pulse current			
						10/1000μsec		8/20μsec	
						V <sub>C</sub> V	I <sub>P</sub> A	V <sub>C</sub> V	I <sub>P</sub> A
	Z6008U	6.63	500	7.38-9.02	10	12.5	120	16.2	1124
	Z6008UA	7.02	500	7.79-8.61	10	12.1	124	15.7	1160
Z6009	Z6009U	7.37	50	8.19-10.0	1	13.8	109	17.9	1017
Z6009A	Z6009UA	7.78	50	8.65-9.55	1	13.4	112	17.4	1046
Z6010	Z6010U	8.10	10	9.00-11.0	1	15.0	100	19.4	938
Z6010A	Z6010UA	8.55	10	9.50-10.5	1	14.5	103	18.8	968
Z6011	Z6011U	8.92	5	9.90-12.1	1	16.2	93	21.0	867
Z6011A	Z6011UA	9.40	5	10.5-11.6	1	15.6	96	20.2	901
Z6012	Z6012U	9.72	5	10.8-13.2	1	17.3	87	22.4	813
Z6012A	Z6012UA	10.2	5	11.4-12.6	1	16.7	90	21.6	843
Z6013	Z6013U	10.5	5	11.7-14.3	1	19.0	79	24.6	740
Z6013A	Z6013UA	11.1	5	12.4-13.7	1	18.2	82	23.6	778
Z6015	Z6015U	12.1	5	13.5-16.5	1	22.0	68	28.5	639
Z6015A	Z6015UA	12.8	5	14.3-15.8	1	21.2	71	27.5	662
Z6016	Z6016U	12.9	5	14.4-17.6	1	23.5	64	30.5	597
Z6016A	Z6016UA	13.6	5	15.2-16.8	1	22.5	67	29.2	623
Z6018	Z6018U	14.5	5	16.2-19.8	1	26.5	56	34.4	529
Z6018A	Z6018UA	15.3	5	17.1-18.0	1	25.2	59	32.7	557
Z6020	Z6020U	16.2	5	18.0-22.0	1	29.1	51	37.7	483
Z6020A	Z6020UA	17.1	5	19.0-21.0	1	27.7	54	35.9	507
Z6022	Z6022U	17.8	5	19.8-24.2	1	31.9	47	41.4	440
Z6022A	Z6022UA	18.8	5	20.9-23.1	1	30.6	49	39.7	459
Z6024	Z6024U	19.4	5	21.6-26.4	1	34.7	43	45.0	404
Z6024A	Z6024UA	20.5	5	22.8-25.2	1	33.2	45	43.0	423
Z6027	Z6027U	21.8	5	24.3-29.7	1	39.1	38	50.7	359
Z6027A	Z6027UA	23.1	5	25.7-28.4	1	37.5	40	48.6	375
Z6030	Z6030U	24.3	5	27.0-33.0	1	43.5	34	56.4	323
Z6030A	Z6030UA	25.6	5	28.5-31.5	1	41.4	36	53.7	339
Z6033	Z6033U	26.8	5	29.7-36.3	1	47.7	31	61.8	295
Z6033A	Z6033UA	28.2	5	31.4-34.7	1	45.2	33	58.6	311
Z6036	Z6036U	29.1	5	32.4-39.6	1	52.0	29	67.4	270
Z6036A	Z6036UA	30.8	5	34.2-37.8	1	49.9	30	64.7	281
Z6039	Z6039U	31.6	5	35.1-42.9	1	56.4	26	73.1	249
Z6039A	Z6039UA	33.3	5	37.1-41.0	1	53.9	28	69.9	260
Z6043	Z6043U	34.8	5	38.7-47.3	1	61.9	24	80.2	227
Z6043A	Z6043UA	36.8	5	40.9-45.2	1	59.3	25	76.9	237
Z6047	Z6047U	38.1	5	42.3-51.7	1	67.8	22.2	78.9	231
Z6047A	Z6047UA	40.2	5	44.7-49.4	1	64.8	21.2	74.0	246
Z6051	Z6051U	41.3	5	45.9-56.1	1	73.5	20.4	95.3	191
Z6051A	Z6051UA	43.6	5	48.5-53.6	1	70.1	21.4	90.9	200
Z6056	Z6056U	45.4	5	50.4-61.6	1	80.5	18.6	104	175
Z6056A	Z6056UA	47.8	5	53.2-58.8	1	77.0	19.5	99.8	182
Z6062	Z6062U	50.2	5	55.8-68.2	1	89.0	16.9	115	158
Z6062A	Z6062UA	53.0	5	58.9-65.1	1	85.0	17.7	110	165
Z6068	Z6068U	55.1	5	61.2-74.8	1	98.0	15.3	127	143
Z6068A	Z6068UA	58.1	5	64.6-71.4	1	92.0	16.3	119	153
Z6075	Z6075U	60.7	5	67.5-82.5	1	108	13.9	140	130
Z6075A	Z6075UA	64.1	5	71.3-78.8	1	103	14.6	134	136
Z6082	Z6082U	66.4	5	73.8-90.2	1	118	12.7	153	119
Z6082A	Z6082UA	70.1	5	77.9-86.1	1	113	13.3	146	125
Z6091	Z6091U	73.7	5	81.9-100	1	131	11.4	170	107
Z6091A	Z6091UA	77.8	5	86.5-95.5	1	125	12.0	162	112
Z6100	Z6100U	81.0	5	90.0-110	1	144	10.4	187	97.4
Z6100A	Z6100UA	85.5	5	95.0-105	1	137	11.0	178	102
Z6110	Z6110U	89.2	5	99.0-121	1	158	9.5	205	88.8
Z6110A	Z6110UA	94.0	5	105-116	1	152	9.9	197	92.4
Z6120	Z6120U	97.2	5	108-132	1	173	8.7	224	81.3
Z6120A	Z6120UA	102	5	114-126	1	165	9.1	214	85.1
Z6130	Z6130U	105	5	117-143	1	187	8.0	242	75.2
Z6130A	Z6130UA	111	5	124-137	1	179	8.4	232	78.5
Z6150	Z6150U	121	5	135-165	1	215	7.0	279	65.2
Z6150A	Z6150UA	128	5	143-158	1	207	7.2	268	67.9
Z6160	Z6160U	130	5	144-176	1	230	6.52	298	61.0
Z6160A	Z6160UA	136	5	152-168	1	219	6.84	284	64.0
Z6170	Z6170U	138	5	153-187	1	244	6.14	316	57.5
Z6170A	Z6170UA	145	5	161-179	1	234	6.41	303	60.0
Z6180	Z6180U	146	5	162-198	1	258	5.81	335	54.3
Z6180A	Z6180UA	154	5	171-189	1	246	6.09	319	57.0
Z6200	Z6200U	162	5	180-220	1	287	5.22	372	48.9
Z6200A	Z6200UA	171	5	190-210	1	274	5.47	355	51.2
Z6220	Z6220U	175	5	198-242	1	344	4.36	408	44.6
Z6220A	Z6220UA	185	5	209-231	1	328	4.57	390	46.6

NOTE: Nonsuffix V<sub>s</sub> ±10% and Bi-polar, suffix "A" V<sub>s</sub> ±5%, suffix "U" Uni-polar

Z6 type VRD has bipolar or unipolar electrical characteristics

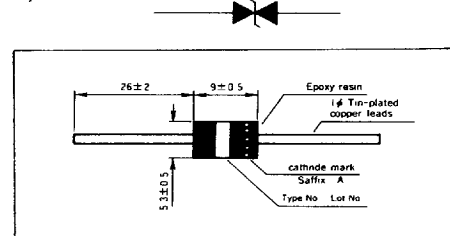
Maximum ratings

Peak pulse power 15 KWatt (10/1000μsec)  
18.2 KWatt (8/20μsec)

Steady state power dissipation: 3 Watt

Operating and storage temperature: -40°C to 150°C

Symbol mark



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