Zener diodes

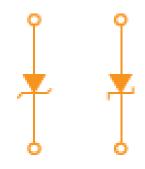


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Zener Diode

- Small-signal and rectifier diodes cannot be operated in the breakdown region as it may damage them.
- Zener diode operates in the breakdown region
- By varying the doping level of silicon diodes, a manufacturer can produce zener diodes with breakdown voltages from about 2 to over 1000 V.
- Zener diodes operate in any of three regions: forward, leakage, and breakdown.

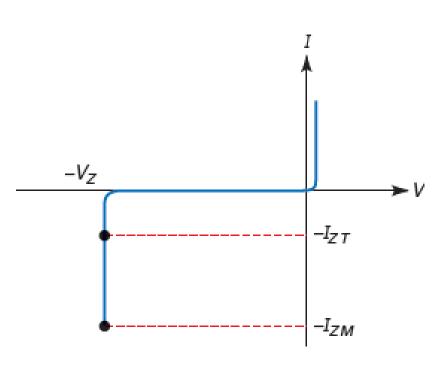






Characteristics of Zener Diode

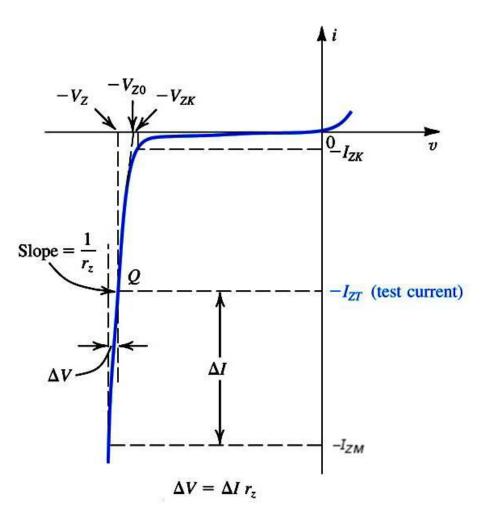
- Forward region conduction starts around 0.7 V, like a ordinary silicon diode.
- Leakage region (between zero and breakdown) only a small reverse current flows.
- Breakdown region has very sharp knee, followed by almost vertical increase in current.
- Voltage is almost constant, approximately equal to V_z over most of the breakdown region





Characteristics of Zener Diode

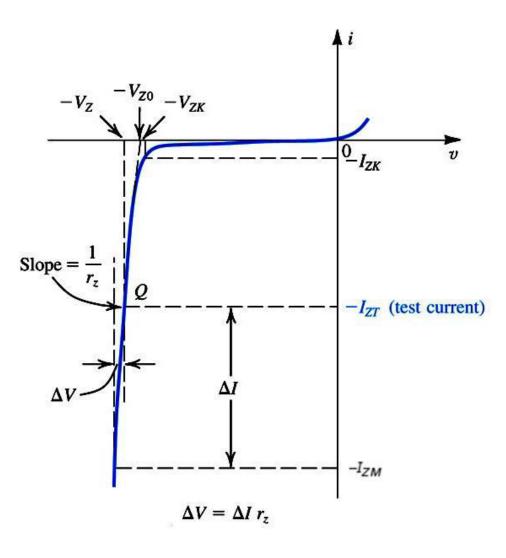
- V_Z at a particular test current I_{ZT}
- Maximum reverse current *I*_{ZM}
- As long as the reverse current is less than I_{ZM}, the diode is operating within its safe range.
- If the current is greater than I_{ZM}, the diode will be destroyed.
- To prevent excessive reverse current, a currentlimiting resistor must be used





Zener Resistance

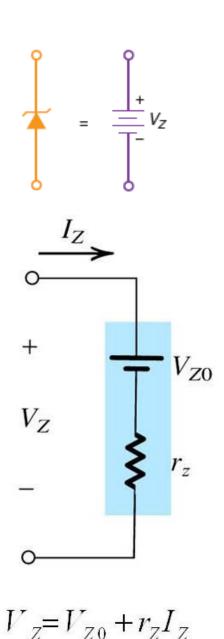
- Increase in reverse current produces a slight increase in reverse voltage.
- The increase in voltage is very small, typically only a few tenths of a volt
- Zener resistance equals the inverse of the slope in the breakdown region





Ideal Zener diode

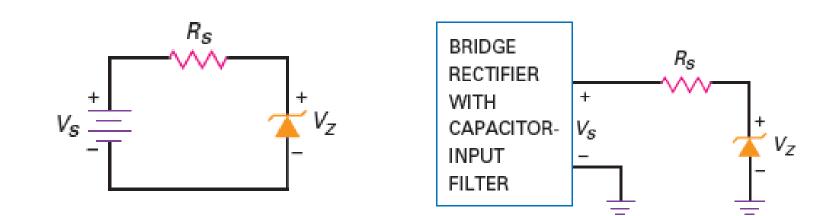
- Breakdown region can be approximated as vertical.
- Therefore, the voltage is constant even though the current changes, which is equivalent to ignoring the Zener resistance.
- A Zener diode operating in the breakdown region ideally acts like a battery





Zener Regulator

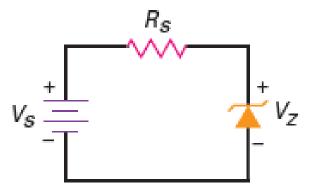
- Known as Voltage-regulator diode as it maintains a constant output voltage even though the current through it changes.
- For normal operation, Zener is reverse-biased
- To get breakdown operation, the source voltage V_S must be greater than the zener breakdown voltage V_Z .
- A series resistor R_S is always used to limit the zener current to less than its maximum current rating, otherwise, diode will burn out due to too much power dissipation





Zener Regulator

- Zener voltage regulator, or zener regulator
- The voltage across the series or current-limiting resistor equals the difference between the source voltage and the Zener voltage



$$I_S = \frac{V_S - V_Z}{R_S}$$

$$R_{S(\max)} = \frac{V_{S(\min)} - V_Z}{I_{L(\max)}}$$



Loaded Zener Regulator

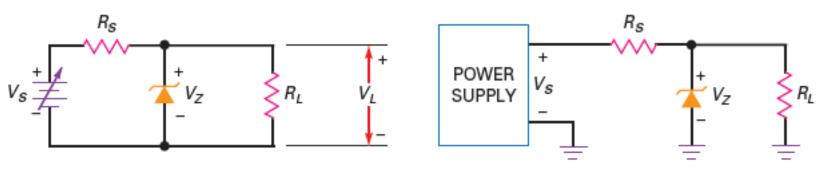
Breakdown operation

$$V_{TH} = \frac{R_L}{R_S + R_L} V_S$$

Thevenin voltage has to be greater than the zener voltage; otherwise, breakdown cannot occur

• Load Current - the load voltage equals the zener voltage because the load resistor is in parallel with the zener diode.

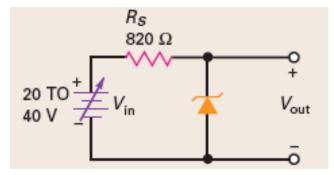
$$V_L = V_Z \qquad I_L = \frac{V_L}{R_L}$$





Problem #1

Suppose the zener diode shown has a breakdown voltage of 10 V. What are the minimum and maximum zener currents?



Solution:

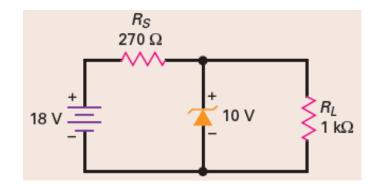
$$I_S = \frac{10 \text{ V}}{820 \Omega} = 12.2 \text{ mA}$$

 $I_S = \frac{30 \text{ V}}{820 \Omega} = 36.6 \text{ mA}$



Problem #2

Is the zener diode shown below operating in the breakdown region?



Solution:

$$V_{TH} = \frac{1 \text{ k}\Omega}{270 \ \Omega + 1 \text{ k}\Omega} (18 \text{ V}) = 14.2 \text{ V}$$

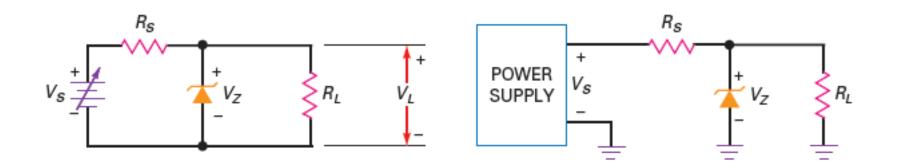
zener diode is operating in the breakdown region



Loaded Zener Regulator

• Zener Current – With Kirchhoff's current law

 $I_S = I_Z + I_L$ $I_Z = I_S - I_L$

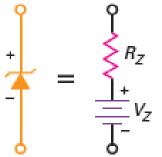




Zener Equivalent Circuit

Zener current flows through the zener resistance, the load voltage is given by

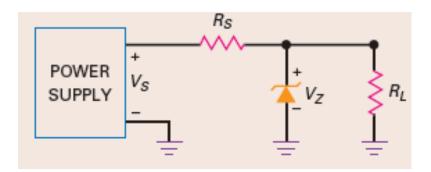
$$V_L = V_Z + I_Z R_Z$$





Problem #3

The zener diode Shown has a breakdown voltage of 10 V and a zener resistance of 8.5 Ω . Calculate the load voltage when the zener current is 20 mA.



Solution:

 $V_L = 10 \text{ V} + 0.17 \text{ V} = 10.17 \text{ V}$



Reading a Data Sheet

N5221 Zener I			030	/							1N472 Zener	19 20 20 20	12120	475	8A						
					Glass case		1				38 I				т	olerance	= 5%				
bsolute I	Maximu	im Rati							1		. Ze					-	/				
Symbol	Symbol Pa Power Dissipation			rameter			25	Value	-	Units	ne					5-					
PD		and the second	2.2				Value Units 500 mW														
		above 50°	17.0		4.0 mW°C -65 to +200 °C 0 -65 to +200 0 °C 0 °C 0 °C 0 °C 0 °C 0 °C																
T _{STG}		1	ture Range	STATE OF A DESCRIPTION OF A DESCRIPTION OF A DESCRIPTIONO			1.55	5 to +200	_	°C	ă l					0-41 Glass					
Т.,	Operating Junction Temperature Range Lead Temperature (1/16 inch from case for 10 s)				-65	5 to +200	_	°C	Se				COLO	R BAND DENOTE	S CATHODE						
-	The second second			n from ca	se for 10 s)			+230		°C	Absolute	e Maxi	imum	Ratin	gs * T _a = 25°C uni	ess otherwise i	bolod				
Electrical				tod							Symbol	-			Parameter			Valu	Je		Units
diues are at	$T_A = 25^{\circ}C$ unless otherwise noted . $V_Z(V) @ I_Z^{(2)}$ $Z_{(D)} @ I_{(D)} @ I_{(D)}$							-		Power Dissipation						1.0		-	W		
Device -	Min. Typ. Max.		$Z_{Z}(\Omega) @ I_{Z}(mA)$		Z _{ZK} (Ω) @ I _{ZK} (mA)		I _R (μΑ) @ V _R (V		T _C (%/°C)		@ TL ≤ 50°C, Lead Length = 3/8"										
1N5221B	2.28	2.4	2.52	30	20	1,200	0.25	100	1.0	-0.085		Derate	above 5	0°C				6.6	7		mW/°C
1N5222B	2.375	2.5	2.625	30	20	1,250	0.25	100	1.0	-0.085	TJ, TSTG	Opera	ting and a	Storage 1	emperature Range	e		-65 to +	+200		°C
1N5223B	2.565	2.7	2.835	30	20	1,300	0.25	75	1.0	-0.080	* These ratings ar	e limitino va	lues above a	which the se	rviceability of the diode n	nav be impaire	4			-	
1N5224B	2.66	2.8	2.94	30	20	1,400	0.25	75	1.0	-0.080	144004 (1440 - 04 (1460 - 04						1 57				
1N5225B	2.85	3	3.15	29	20	1,600	0.25	50	1.0	-0.075	Electrica	I Cha	racter	istics	$T_a = 25^{\circ}C$ unless other	rwise noted					
1N5226B 1N5227B	3.135 3.42	3.3 3.6	3.465 3.78	28 24	20 20	1,600	0.25	25 15	1.0	-0.07		V A	0.001	000000000		Mary 7		a den es	Lea	kage	Non-Repe
1N5228B	3.705	3.9	4.095	23	20	1,900	0.25	10	1.0	-0.06	Device	vz (v	/)@Iz	(Note 1)	Test Current	wax. Z	ener imp	mpedance Cur		rent	Peak Revers
1N5229B	4.085	4.3	4.515	22	20	2,000	0.25	5.0	1.0	+/-0.055	Device	Min.	тур.	Max.	I _Z (mA)	Zz@lz	Z _{ZK} @	IZK	IR	VR	Currer
1N5230B	4.465	4.7	4.935	19	20	1,900	0.25	2.0	1.0	+/-0.03						(Ω)	I _{ZK} (Ω)	(mA)	(µA)	(V)	IZSM (mA)
1N5231B	4.845	5.1	5.355	17	20	1,600	0.25	5.0	2.0	+/-0.03	1N4728A 1N4729A	3.135 3.42	3.3 3.6	3.465 3.78	76 69	10	400 400	1	100 100	1	1380 1260
	5.32	5.6	5.88	11	20	1,600	0.25	5.0	3.0	0.038	1N4730A 1N4731A	3.705 4.085	3.9 4.3	4.095	64 58	9	400	1	50 10	1	1190 1070
1N5232B	an	6	6.3 6.51	7.0 7.0	20 20	1,600	0.25	5.0 5.0	3.5	0.038 0.045	1N4732A	4.465	4.5	4.935	53	8	500	1	10	i	970
1N5233B	5.7	6.0		1.0		750	0.25	3.0	4.0 5.0	0.045	1N4733A	4.845	5.1	5.355	49	7	550	1	10	1	890
1N5233B 1N5234B	5.89	6.2		5.0	20				9.0			5.32	5.6	5.88	45	5	600	1	10 10	23	810 730
1N5233B 1N5234B 1N5235B	5.89 6.46	6.8	7.14	5.0	20	21.651.05		3.0	60	0.058	1N4734A 1N4735A	5.89	62		41	2					
1N5233B 1N5234B 1N5235B 1N5236B	5.89 6.46 7.125	6.8 7.5	7.14 7.875	6.0	20	500	0.25	3.0 3.0	6.0 6.5	0.058	1N4735A 1N4736A	5.89 6.46	6.2 6.8	6.51 7.14	41 37	2 3.5	700	i	10	-4	660
1N5233B 1N5234B 1N5235B	5.89 6.46	6.8	7.14			21.651.05		3.0 3.0 3.0	6.0 6.5 6.5	0.058 0.062 0.065	1N4735A 1N4736A 1N4737A	6.46 7.125	6.8 7.5	7.14 7.875	37 34	3.5 4	700 700	0.5	10 10	4 5	605
1N5233B 1N5234B 1N5235B 1N5236B 1N5237B	5.89 6.46 7.125 7.79	6.8 7.5 8.2	7.14 7.875 8.61	6.0 8.0	20 20	500 500	0.25 0.25	3.0	6.5	0.062	1N4735A 1N4736A	6.46	6.8	7.14	37 34 31	3.5	700		10	-4	
1N5233B 1N5234B 1N5235B 1N5235B 1N5236B 1N5237B 1N5238B	5.89 6.46 7.125 7.79 8.265	6.8 7.5 8.2 8.7	7.14 7.875 8.61 9.135	6.0 8.0 8.0	20 20 20	500 500 600	0.25 0.25 0.25	3.0 3.0	6.5 6.5	0.062 0.065	1N4735A 1N4736A 1N4737A 1N4737A 1N4739A 1N4739A 1N4740A	6.46 7.125 7.79 8.645 9.5	6.8 7.5 8.2 9.1 10	7.14 7.875 8.61 9.555 10.5	37 34 31 28 25	3.5 4 4.5 5 7	700 700 700 700 700 700	0.5 0.5 0.5 0.25	10 10 10 10 10	4 5 7 7.6	605 550 500 454
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1N5233B 1N5234B 1N5235B 1N5236B 1N5237B 1N5238B 1N5238B 1N5239B 1N5240B 1N5241B 1N5242B 1N5242B	5.89 6.46 7.125 7.79 8.265 8.645 9.5 10.45 11.4 12.35	6.8 7.5 8.2 8.7 9.1 10 11 12 13	7.14 7.875 8.61 9.135 9.555 10.5 11.55 12.6 13.65	6.0 8.0 8.0 10 17 22 30 13	20 20 20 20 20 20 20 20 20 20 9.5	500 500 600 600 600 600 600 600	0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25	3.0 3.0 3.0 2.0 1.0 0.5	6.5 6.5 7.0 8.0 9.1 9.9	0.062 0.065 0.068 0.075 0.076 0.077 0.079	1N4735A 1N4736A 1N4737A 1N4737A 1N4739A 1N4740A 1N4740A 1N4741A 1N4742A 1N4743A	6.46 7.125 7.79 8.645 9.5 10.45 11.4 12.35 14.25	6.8 7.5 9.1 10 11 12 13 15	7.14 7.875 8.61 9.555 10.5 11.55 12.6 13.65 15.75	37 34 31 28 25 23 21 19 17	3.5 4 5 7 8 9 10 14	700 700 700 700 700 700 700 700 700	0.5 0.5 0.25 0.25 0.25 0.25 0.25 0.25	10 10 10 5 5 5 5	4 5 7 7.6 8.4 9.1 9.9 11.4	605 550 454 414 380 344 304
1N5233B 1N5234B 1N5236B 1N5236B 1N5238B 1N5238B 1N5240B 1N5241B 1N5242B 1N5242B 1N5242B 1N5244B	5.89 6.46 7.125 7.79 8.265 8.645 9.5 10.45 11.4 12.35 13.3	6.8 7.5 8.2 8.7 9.1 10 11 12 13 14	7.14 7.875 8.61 9.135 9.555 10.5 11.55 12.6 13.65 14.7	6.0 8.0 10 17 22 30 13 15	20 20 20 20 20 20 20 20 20 9.5 9.0	500 500 600 600 600 600 600 600 600	0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25	3.0 3.0 3.0 3.0 2.0 1.0 0.5 0.1	6.5 6.5 7.0 8.0 8.4 9.1 9.9 10	0.062 0.065 0.068 0.075 0.076 0.077 0.079 0.080	1N4735A 1N4736A 1N4736A 1N4738A 1N4739A 1N4740A 1N4741A 1N4742A 1N4744A 1N4744A 1N47445A 1N4745A	8.46 7.125 7.79 8.645 9.5 10.45 11.4 12.35 14.25 15.2 17.1	6.8 7.5 9,1 10 11 12 13 15 16 18	7.14 7.875 8.61 9.555 10.5 11.55 12.6 13.65 15.75 16.8 18.9	37 34 28 25 23 21 19 17 15,5 14	3.5 4 4.5 5 7 8 9 10 14 16 20	700 700 700 700 700 700 700 700 700 700	0.5 0.5 0.25 0.25 0.25 0.25 0.25 0.25 0.	10 10 10 10 5 5 5 5 5 5 5 5	4 5 7 7.6 8.4 9.1 9.9 11.4 12.2 13.7	605 550 500 454 414 380 344 304 285 250
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1N5233B 1N5234B 1N5235B 1N5237B 1N5237B 1N5238B 1N5239B 1N5240B 1N5242B 1N5242B 1N52428 1N5244B 1N5244B 1N5245B	5.89 6.46 7.125 7.79 8.265 8.645 9.5 10.45 11.4 12.35 13.3 14.25 15.2	6.8 7.5 8.2 8.7 9.1 10 11 12 13 14 15 16	7.14 7.875 8.61 9.135 9.555 10.5 11.55 12.6 13.65 14.7 15.75 16.8	6.0 8.0 8.0 10 17 22 30 13 15 16 17	20 20 20 20 20 20 20 9.5 9.0 8.5 7.8	500 500 600 600 600 600 600 600 600 600	0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25	3.0 3.0 3.0 2.0 1.0 0.5 0.1 0.1 0.1	6.5 6.5 7.0 8.0 8.4 9.1 9.9 10 11 12	0.062 0.065 0.075 0.075 0.077 0.077 0.079 0.080 0.082 0.083	1N4735A 1N4735A 1N4735A 1N4735A 1N4735A 1N4745A 1N4745A 1N4745A 1N4745A 1N4745A 1N4745A 1N4745A	8.46 7.125 7.79 8.645 9.5 10.45 11.4 12.35 14.25 14.25 15.2 17.1 19 20.9	6.8 7.5 8.2 9.1 10 11 12 13 15 16 18 20 22	7.14 7.875 8.61 9.555 10.5 11.55 12.6 13.65 15.75 16.8 18.9 21 23.1	37 34 31 28 25 23 21 19 17 15,5 14 12,5 11,5	3.5 4 4.5 5 7 8 9 10 14 16 20 22 23	700 700 700 700 700 700 700 700 700 700	0.5 0.5 0.25 0.25 0.25 0.25 0.25 0.25 0.	10 10 10 10 55 5 5 5 5 5 5 5 5 5 5	4 5 7,6 8,4 9,1 9,9 11,4 12,2 13,7 15,2 16,7	605 550 454 414 380 344 285 250 225 205
1N5233B 1N5234B 1N5236B 1N5236B 1N5237B 1N5238B 1N5239B 1N5240B 1N5241B 1N5242B 1N5242B 1N5244B 1N5246B 1N5246B 1N5246B	5.89 6.46 7.125 7.79 8.265 8.645 9.5 10.45 11.4 12.35 13.3 14.25	6.8 7.5 8.2 8.7 9.1 10 11 12 13 14 15	7.14 7.875 8.61 9.135 9.555 10.5 11.55 12.6 13.65 14.7 15.75	6.0 8.0 10 17 22 30 13 15 16	20 20 20 20 20 20 20 9.5 9.0 8.5	500 500 600 600 600 600 600 600 600 600	0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25	3.0 3.0 3.0 3.0 1.0 0.5 0.1 0.1	6.5 6.5 7.0 8.0 9.1 9.9 10 11	0.062 0.065 0.068 0.075 0.076 0.077 0.079 0.080 0.082	1N4735A 1N4736A 1N4736A 1N4737A 1N4739A 1N4730A 1N4740A 1N4740A 1N4742A 1N4745A 1N4745A 1N4745A 1N4745A 1N4745A 1N4745A	8.46 7.125 7.79 8.645 9.5 10.45 11.4 12.35 14.25 15.2 17.1 19 20.9 22.8 25.65	6.8 7.5 8.2 9.1 10 11 12 13 15 16 18 20 22 24 27	7.14 7.875 8.61 9.555 10.55 11.55 12.6 13.65 15.75 16.8 18.9 21 23.1 25.2 28.35	37 34 31 28 25 23 21 19 17 15.5 14 12.5 11.5 10.5 9.5	3.5 4 4.5 5 7 8 9 10 14 16 20 22 23 25 35	700 700 700 700 700 700 700 700 700 750 75	0.5 0.5 0.25 0.25 0.25 0.25 0.25 0.25 0.	10 10 10 10 5 5 5 5 5 5 5 5 5 5 5 5 5 5	4 5 7 7 6 8 4 9.1 9.9 11.4 12.2 13.7 15.2 16.7 18.2 20.6	805 550 454 414 380 244 285 250 225 205 225 205 190 170
1N5233B 1N5234B 1N5235B 1N5237B 1N5237B 1N5238B 1N5239B 1N5240B 1N5242B 1N5242B 1N52428 1N5244B 1N5244B 1N5245B	5.89 6.46 7.125 7.79 8.265 8.645 9.5 10.45 11.4 12.35 13.3 14.25 15.2 16.15	6.8 7.5 8.2 8.7 9.1 10 11 12 13 14 15 16 17	7.14 7.875 8.61 9.135 9.555 10.5 11.55 12.6 13.65 14.7 15.75 16.8 17.85	6.0 8.0 8.0 10 17 22 30 13 15 16 17 19	20 20 20 20 20 20 9.5 9.0 8.5 7.8 7.4	500 500 600 600 600 600 600 600 600 600	0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25	3.0 3.0 3.0 2.0 1.0 0.5 0.1 0.1 0.1 0.1	6.5 6.5 7.0 8.0 8.4 9.1 9.9 10 11 12 13	0.062 0.065 0.075 0.076 0.077 0.079 0.080 0.082 0.083 0.083	1N4735A 1N4736A 1N4737A 1N4737A 1N4739A 1N4740A 1N4740A 1N4742A 1N4745A 1N4745A 1N4745A 1N4745A 1N4745A	6.46 7.125 7.79 8.645 9.5 10.45 11.4 12.35 14.25 15.2 17.1 19 20.9 22.8 25.65 28.5	6.8 7.5 8.2 9.1 10 11 12 13 15 16 18 20 22 24 27 30	7.14 7.875 8.61 9.555 10.5 11.55 12.6 13.65 15.75 16.8 18.9 21 23.1 25.2 28.35 31.5	37 34 31 28 25 23 21 17 15,5 16,5 10,5 9,5 8,5	3.5 4 4.5 5 7 8 9 10 14 16 20 22 23 25 35 40	700 700 700 700 700 700 700 700 700 750 75	0.5 0.5 0.25 0.25 0.25 0.25 0.25 0.25 0.	10 10 10 10 5 5 5 5 5 5 5 5 5 5 5 5 5 5	4 5 7 7,6 8,4 9,1 9,9 11,4 12,2 13,7 15,2 16,7 18,2 20,6 22,8	605 550 454 414 380 344 285 250 225 205 190 170 150
1N5233B 1N5234B 1N5236B 1N5236B 1N5237B 1N5238B 1N5238B 1N5242B 1N5242B 1N5242B 1N5244B 1N5246B 1N5246B 1N5246B	5.89 6.46 7.125 7.79 8.265 8.645 9.5 10.45 11.4 12.35 13.3 14.25 15.2 16.15 17.1	6.8 7.5 8.2 8.7 9.1 10 11 12 13 14 15 16 17 18	7.14 7.875 8.61 9.135 9.555 10.5 11.55 12.6 13.65 14.7 15.75 16.8 17.85 18.9	6.0 8.0 10 17 22 30 13 15 16 17 19 21	20 20 20 20 20 20 20 9.5 9.0 8.5 7.8 7.8 7.0	500 500 600 600 600 600 600 600 600 600	0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25	3.0 3.0 3.0 2.0 1.0 0.5 0.1 0.1 0.1 0.1 0.1	6.5 6.5 7.0 8.0 8.4 9.1 9.9 10 11 12 13 14	0.062 0.065 0.068 0.075 0.077 0.079 0.080 0.080 0.082 0.083 0.084 0.085	1N4735A 1N4735A 1N4735A 1N4735A 1N4735A 1N4740A 1N4741A 1N4741A 1N4742A 1N4745A 1N4745A 1N4745A 1N4745A 1N4745A	8.46 7.125 8.645 9.5 10.45 11.4 12.35 14.25 15.2 17.1 19 20.9 22.8 25.65 28.5 31.35	6.8 7.5 8.2 9.1 10 11 12 13 15 16 18 20 22 24 27 30 33	7.14 7.875 8.61 9.555 10.5 11.55 12.6 13.65 15.75 16.8 18.9 21 23.1 25.2 28.35 31.5 34.65	37 34 31 28 25 23 21 19 15.5 14 12.5 11.5 9.5 8.5 7.5	3.5 4 5 7 8 9 10 14 16 20 22 25 35 35 40 45	700 700 700 700 700 700 700 700 700 700	0.5 0.5 0.25 0.25 0.25 0.25 0.25 0.25 0.	10 10 10 10 5 5 5 5 5 5 5 5 5 5 5 5 5 5	4 5 7 7,6 8,4 9,1 9,9 11.4 12.2 13,7 15.2 16,7 18.2 20.6 22.8 25,1	605 550 454 414 380 344 286 250 225 205 190 170 150
1N5233B 1N5234B 1N5236B 1N5236B 1N5237B 1N5238B 1N5240B 1N5240B 1N5242B 1N5243B 1N5244B 1N5244B 1N5246B 1N5246B 1N5248B 1N5248B 1N5248B	5.89 6.46 7.125 7.79 8.265 8.645 9.5 10.45 11.4 12.35 13.3 14.25 15.2 16.15 17.1 18.05 19.	6.8 7.5 8.2 8.7 9.1 10 11 12 13 14 15 16 17 18 19 20	7.14 7.875 8.61 9.135 10.5 11.55 12.6 13.65 14.7 15.75 16.8 17.85 18.9 19.95 21	6.0 8.0 8.0 10 17 22 30 13 15 16 17 19 21 23 25	20 20 20 20 20 20 20 9.5 9.0 8.5 7.8 7.8 7.4 7.0 6.6	500 500 600 600 600 600 600 600 600 600	0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25	3.0 3.0 3.0 3.0 2.0 1.0 0.5 0.1 0.1 0.1 0.1 0.1	6.5 6.5 7.0 8.0 9.1 9.9 10 11 12 13 14 14	0.062 0.065 0.065 0.075 0.077 0.079 0.080 0.082 0.083 0.084 0.085 0.085	1N4735A 1N4735A 1N4735A 1N4735A 1N4735A 1N4740A 1N4740A 1N4742A 1N4742A 1N4745A 1N4745A 1N4745A 1N4745A 1N4755A	8.46 7.125 7.79 8.645 9.5 10.45 11.4 12.35 11.4 12.35 14.25 15.2 17.1 19 20.9 22.8 25.65 28.5 31.35 34.2 37.05	6.8 7.5 8.2 9.1 10 11 12 13 15 16 18 20 22 24 24 27 30 33 36 39	7.14 7.875 8.61 9.555 10.5 11.55 12.6 13.65 15.75 16.8 18.9 21 23.1 25.2 28.35 31.5 34.65 37.8	37 34 31 28 25 23 21 19 17 15.6 14 12.5 10.5 9.5 8.5 7.5 7.5 7.5	3.5 4 4.5 5 7 8 9 10 14 16 20 22 23 25 35 40 45 50 60	700 700 700 700 700 700 700 700 700 700	0.5 0.5 0.25 0.25 0.25 0.25 0.25 0.25 0.	10 10 10 10 10 55 5 5 5 5 5 5 5 5 5 5 5	4 5 7 7.6 8.4 9.1 9.9 11.4 12.2 13.7 15.2 16.7 18.2 20.6 22.8 25.1 27.4 29.7	605 550 454 414 380 344 285 250 225 205 190 170 150 135 125 115
1N5233B 1N5234B 1N5236B 1N5236B 1N5237B 1N5238B 1N5240B 1N5247B 1N5242B 1N5244B 1N5244B 1N5244B 1N5244B 1N5248B 1N5248B 1N5248B 1N5248B 1N5248B 1N5248B	5.89 6.46 7.125 7.79 8.265 8.645 9.5 10.45 11.4 12.35 13.3 14.25 15.2 16.15 17.1 18.05 19.	6.8 7.5 8.2 8.7 9.1 10 11 12 13 14 15 16 17 18 19 20	7.14 7.875 8.61 9.135 10.5 11.55 12.6 13.65 14.7 15.75 16.8 17.85 18.9 19.95 21	6.0 8.0 8.0 10 17 22 30 13 15 16 17 19 21 23 25	20 20 20 20 20 20 20 9.5 9.0 8.5 7.8 7.8 7.4 7.0 6.6	500 500 600 600 600 600 600 600 600 600	0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25	3.0 3.0 3.0 3.0 2.0 1.0 0.5 0.1 0.1 0.1 0.1 0.1	6.5 6.5 7.0 8.0 9.1 9.9 10 11 12 13 14 14	0.062 0.065 0.065 0.075 0.077 0.079 0.080 0.082 0.083 0.084 0.085 0.085	1N4735A 1N4736A 1N4736A 1N4737A 1N4739A 1N4740A 1N4740A 1N4740A 1N4742A 1N4745A 1N4745A 1N4745A 1N4755A	6.46 7.125 9.645 9.645 9.65 10.45 10.45 11.4 12.36 14.25 15.2 17.1 19 20.9 22.8 25.65 28.5 31.35 34.2	6.8 7.5 8.2 9.1 10 11 12 13 15 16 18 20 22 24 27 30 33 36	7.14 7.875 8.61 9.555 10.5 11.55 12.6 13.65 15.75 16.8 18.9 21 23.1 25.2 28.35 31.5 31.5 33.4.65	37 34 31 28 25 23 21 17 15,5 14 12,5 10,5 9,5 8,5 7,5 7	3.5 4 4.5 5 7 8 9 10 14 16 20 22 23 25 35 40 45 50	700 700 700 700 700 700 700 700 700 750 75	0.5 0.5 0.25 0.25 0.25 0.25 0.25 0.25 0.	10 10 10 10 5 5 5 5 5 5 5 5 5 5 5 5 5 5	4 5 7 7.6 8.4 9.1 9.9 11.4 12.2 13.7 15.2 16.7 18.2 20.6 22.8 25.1 27.4	605 550 454 414 380 285 250 225 205 190 170 150 135

Non-recurrent square wave Pulse Width = 8.3 ms, TA = 50°C

2. Zener Voltage (Vz)

The zener voltage is measured with the device junction in the thermal equilibrium at the lead temperature (TL) at 30°C ± 1°C and 3/8" lead length.

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1N4728A - 1N4758A Rev. H3



1N4728A -1N4758A Zener Diodes

Symbol	Parameter	Value	Units	
PD	Power Dissipation @ TL ≤ 50°C, Lead Length = 3/8°	1.0	W	
	Derate above 50°C	6.67	mW/°C	
TJ. TSTG	Operating and Storage Temperature Range	-65 to +200	°C	

Device	Vz (V)@Iz	(Note 1)	Test Current I _Z (mA)	Max. Z	ener Imp	edance	Leal	kage rent	Non-Repe Peak Rev
	Min.	Тур.	Max.		Z _Z @I _Z (Ω)	Z _{ZK} @ I _{ZK} (Ω)	l _{ZK} (mA)	Ι _R (μΑ)	V _R (V)	Curren I _{ZSM} (mA)
1N4728A	3.135	3.3	3.465	76	10	400	1	100	1	1380
1N4729A	3.42	3.6	3.78	69	10	400	1	100	1	1260
1N4730A	3.705	3.9	4.095	64	9	400	1	50	1	1190
1N4731A	4.085	4.3	4.515	58	9	400	1	10	1	1070
1N4732A	4.465	4.7	4.935	53	8	500	1	10	1	970
1N4733A	4.845	5.1	5.355	49	7	550	1	10	1	890
1N4734A	5.32	5.6	5.88	45	5	600	1	10	2	810
1N4735A	5.89	6.2	6.51	41	2	700	1	10	3	730
1N4736A	6.46	6.8	7.14	37	3.5	700	1	10	4	660
1N4737A	7.125	7.5	7.875	34	4	700	0.5	10	5	605
1N4738A	7.79	8.2	8.61	31	4.5	700	0.5	10	6	550
1N4739A	8.645	9.1	9.555	28	5	700	0.5	10	7	500
1N4740A	9.5	10	10.5	25	7	700	0.25	10	7.6	454
1N4741A	10.45	11	11.55	23	8	700	0.25	5	8.4	414
1N4742A	11.4	12	12.6	21	9	700	0.25	5	9.1	380
1N4743A	12.35	13	13.65	19	10	700	0.25	5	9.9	344
1N4744A	14.25	15	15.75	17	14	700	0.25	5	11.4	304
1N4745A	15.2	16	16.8	15.5	16	700	0.25	5	12.2	285
1N4746A	17.1	18	18.9	14	20	750	0.25	5	13.7	250
1N4747A	19	20	21	12.5	22	750	0.25	5	15.2	225
1N4748A	20.9	22	23.1	11.5	23	750	0.25	5	16.7	205
1N4749A	22.8	24	25.2	10.5	25	750	0.25	5	18.2	190
1N4750A	25.65	27	28.35	9.5	35	750	0.25	5	20.6	170
1N4751A	28.5	30	31.5	8.5	40	1000	0.25	5	22.8	150
1N4752A	31.35	33	34.65	7.5	45	1000	0.25	5	25.1	135
1N4753A	34.2	36	37.8	7	50	1000	0.25	5	27.4	125
1N4754A	37.05	39	40.95	6.5	60	1000	0.25	5	29.7	115
1N4755A	40.85	43	45.15	6	70	1500	0.25	5	32.7	110
1N4756A	44.65	47	49.35	5.5	80	1500	0.25	5	35.8	95
1N4757A	48.45	51	53.55	5	95	1500	0.25	5	38.8	90
1N4758A	53.2	56	58.8	4.5	110	2000	0.25	5	42.6	80

1. Zener Voltage (Vz)

The zener voltage is measured with the device junction in the thermal equilibrium at the lead temperature (TL) at 30°C ± 1°C and 3/8' lead length. 2. 2 Square wave Reverse Surge at 8.3 msec soak time.

Device Specifications

Maximum Power dissipation

• equals the product of its voltage and current

$$P_Z = V_Z I_Z$$

Maximum Current, I_{ZM}

zener diode can handle without exceeding its power rating

$$I_{ZM} = \frac{P_{ZM}}{V_Z}$$

Derating Factor

• Reduce the power rating of a device.

