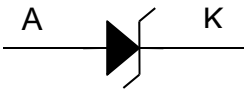
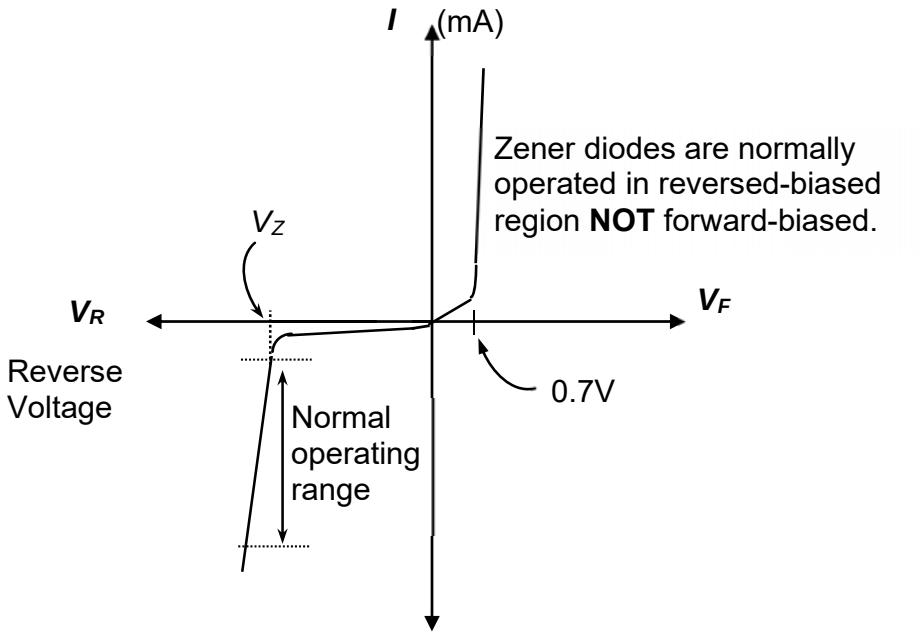
5.1 Zener Diode

Symbol :



The zener diode is a special type of diode designed to operate at the reversed biased condition.

5.2 Characteristic of the Zener Diode



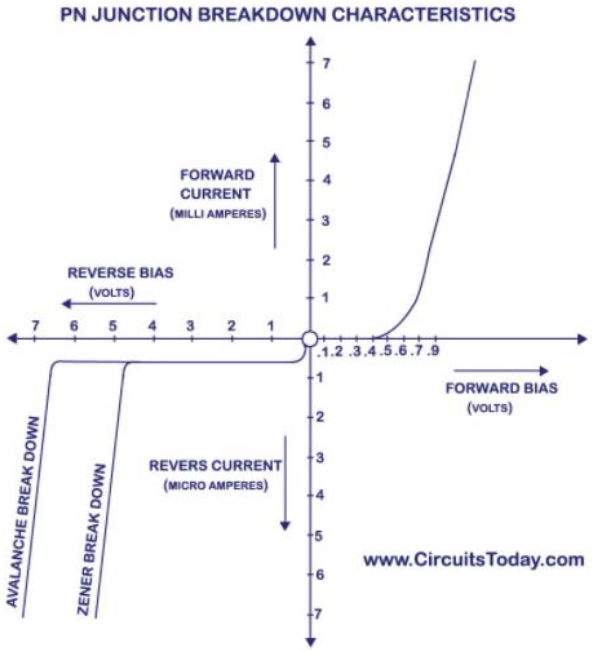
Zener diode is specially designed to operate at its reversed breakdown voltage region. This voltage is known as the Zener voltage, V_Z.

At this region, a change in zener diode current will cause only a small change in the zener voltage. The zener voltage is reasonably stable.

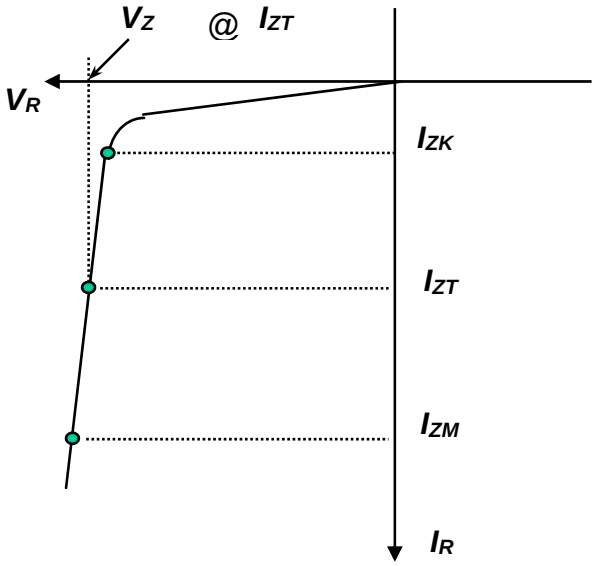
5.3 Zener Breakdown

The two types of reverse breakdown are **avalanche** and **zener breakdown.**

- **Avalanche** breakdown occurs at a sufficiently high reverse voltage while **Zener** breakdown occurs at a low reverse voltage.



5.4 Zener Breakdown Characteristic



As reverse voltage increases, zener begins to breakdown at I_{ZK}.

A minimum value of reverse current, I_{ZK}, must be maintained to keep the diode in breakdown.

Maximum current, I_{ZM}, must not be exceeded otherwise the diode will be damaged.

5.5 Zener Diode Data Sheet

Like the basic P-N junction diode's data sheet, a zener diode data sheet lists its characteristic and maximum and minimum operating values.

Exercise:

With reference to the data sheet below, determine the specifications of the 6.8V, 1N4736A zener diode with a zener test current (I_{ZT}) of 20 mA.

(a) Zener Voltage (V_Z) = _____
(b) Manufacturer's recommended Maximum Zener current (I_{ZM}) = _____
(c) Manufacturer's recommended Power Dissipation (P_D) = _____

DIODES INCORPORATED

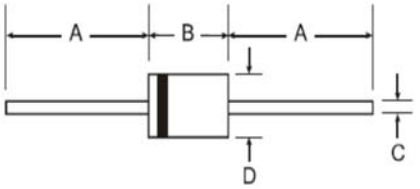
1N4728A - 1N4761A

1.0W ZENER DIODE

Please click here to visit our online spice models database.

Features

- 1.0 Watt Power Dissipation
- 3.3V - 75V Nominal Zener Voltage
- Standard V_Z Tolerance is 5%
- **Lead Free Finish, RoHS Compliant (Note 2)**



DO-41 Glass		
Dim	**Min**	**Max**
A	26.0	—
B	—	4.10
C	—	0.86
D	—	2.60
All Dimensions in mm		

Mechanical Data

- Case: DO-41
- Case Material: Glass. UL Flammability Classification Rating 94V-0
- Terminals: Finish — Sn96.5Ag3.5. Solderable per MIL-STD-202, Method 208
- Polarity: Cathode Band
- Marking: Type Number
- Weight: 0.35 grams (approximate)

Maximum Ratings @T_A = 25°C unless otherwise specified

Characteristic	Symbol	Value	Unit
Zener Current (see Table page 2)	I_Z	Pd / V_Z	mA
Power Dissipation Derate Above 50°C (Note 1)	P_d	1.0 6.67	W mW/°C
Thermal Resistance - Junction to Ambient Air	$R_{\theta JA}$	175	°C/W
Forward Voltage @ I_F = 200 mA	V_F	1.2	V
Operating and Storage Temperature Range	T_j, T_{STG}	-65 to + 175	°C

Notes:
1. Valid provided that leads are kept at TL @ 50°C with lead length = 9.5mm (3/8") from case.
2. EC Directive 2002/95/EC (RoHS) revision 13.2.2003. Glass and high temperature solder exemptions applied where applicable, see *EU Directive Annex Notes 5 and 7.*

Electrical Characteristics @T_A = 25°C unless otherwise specified

Type Number	Nominal Zener Voltage (Note 3)	Test Current	Maximum Zener Impedance (Note 4)			Maximum Reverse Leakage Current		Max Surge Current 8.3ms	Temperature Coefficient @ I_{ZT}
	V_Z @ I_{ZT}	I_{ZT}	Z_{ZT} @ I_{ZT}	Z_{ZK} @ I_{ZK}	I_{ZK}	I_R	@ V_R	I_{ZS}	
	(V)	(mA)	(Ω)	(Ω)	(mA)	(μA)	(V)	(mA)	%/°C
1N4728A	3.3	76	10	400	1.0	100	1.0	1380	-0.08 to -0.05
1N4729A	3.6	69	10	400	1.0	100	1.0	1260	-0.08 to -0.05
1N4730A	3.9	64	9.0	400	1.0	50	1.0	1190	-0.07 to -0.02
1N4731A	4.3	58	9.0	400	1.0	10	1.0	1070	-0.07 to -0.01
1N4732A	4.7	53	8.0	500	1.0	10	1.0	970	-0.03 to +0.04
1N4733A	5.1	49	7.0	550	1.0	10	1.0	890	-0.01 to +0.04
1N4734A	5.6	45	5.0	600	1.0	10	2.0	810	0 to +0.045
1N4735A	6.2	41	2.0	700	1.0	10	3.0	730	+0.01 to +0.055
1N4736A	6.8	37	3.5	700	1.0	10	4.0	660	+0.015 to +0.06
1N4737A	7.5	34	4.0	700	0.5	10	5.0	605	+0.02 to +0.065
1N4738A	8.2	31	4.5	700	0.5	10	6.0	550	0.03 to 0.07

5.6 Zener Diode Application

It is commonly used as a voltage regulator in DC power supplies.

Two types of regulation are:
- line regulation
- load regulation

5.7 Line Regulation

The Zener diode regulates a varying input power supply as shown in Fig 5.7.

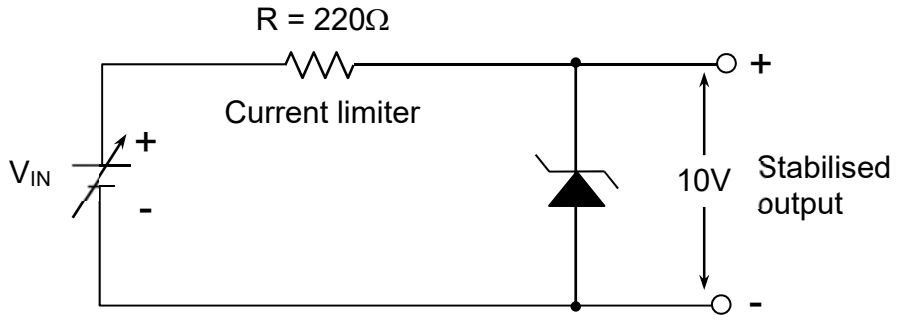


Fig 5.7

Refer to Figure 5.7. Given : I_{ZK} = 0.25 mA to I_{ZM} = 100 mA.

$$V_{IN} = V_R + V_Z$$

For minimum current:	**For maximum current:**
voltage across 220 Ω :-	voltage across 220 Ω :-
$V_R = I_{ZK} R = (0.25\ mA)(220\Omega)$ $= 55\ mV$	$V_R = I_{ZM} R = (100\ mA)(220\ \Omega)$ $= 22\ V$
Therefore:	Therefore:
$V_{IN} = V_R + V_Z = 55mV + 10\ V$ $= 10.055\ V$	$V_{IN} = 22\ V + 10\ V$ $= 32\ V$

The current limiting resistor is included to prevent the zener from overheating
Notice that the diode is reverse biased. The output voltage (across the zener diode) is constantly maintained.

5.8 Load Regulation

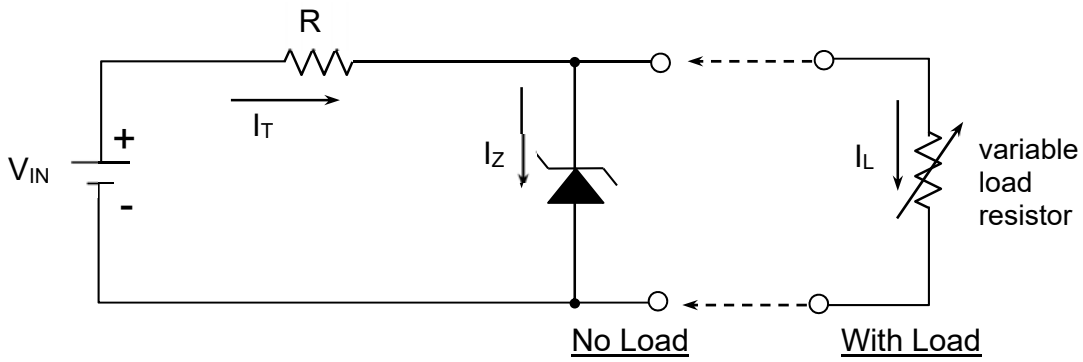


Fig 5.8

A zener regulator with variable load resistor. A zener diode maintains constant voltage across R_L as long as the zener current is greater than I_{ZK} and less than I_{ZM}.

At no load, $\mathbf{I_L} = 0$ & the total current, $\mathbf{I_T}$ will flow through the zener diode.

When $\mathbf{R_L}$ is connected, $\mathbf{I_T} = \mathbf{I_Z} + \mathbf{I_L}$.

When $\mathbf{I_Z}$ reaches its minimum, $\mathbf{I_{ZK}}$, load current is at its maximum.