

SPECIAL DIODES

Zener Diode

It is a reverse-biased heavily-doped silicon (or germanium) P-N junction diode which is operated in the breakdown region where current is limited by both external resistance and power dissipation of the diode. Silicon is preferred to Ge because of its higher temperature and current capability.

When a diode breaks down, both Zener and avalanche effects are present although usually one or the other predominates depending on the value of reverse voltage. At reverse voltages less than 6 V, Zener effect predominates whereas above 6 V, avalanche effect is predominant. Strictly speaking, the first one should be called Zener diode and the second one as avalanche diode but the general practice is to call both types as Zener diodes.

Zener breakdown occurs due to breaking of covalent bonds by the strong electric field set up in the depletion region by the reverse voltage. It produces an extremely large number of electrons and holes which constitute the reverse saturation current (now called Zener current, I_z) whose value is limited only by the external resistance in the circuit. It is independent of the applied voltage.

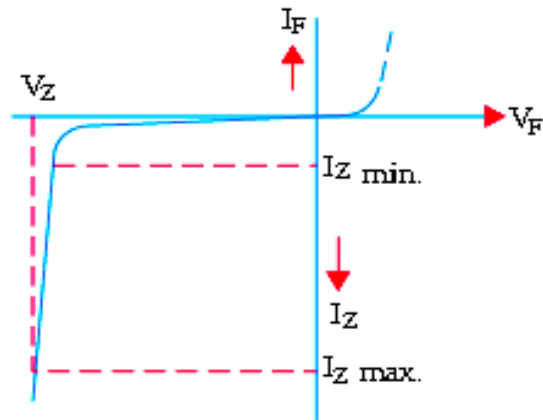
(a) V/I Characteristic

A typical characteristic is shown by Fig. below in the negative quadrant. The forward characteristic is simply that of an ordinary forward-biased junction diode. The important points on the reverse characteristic are:

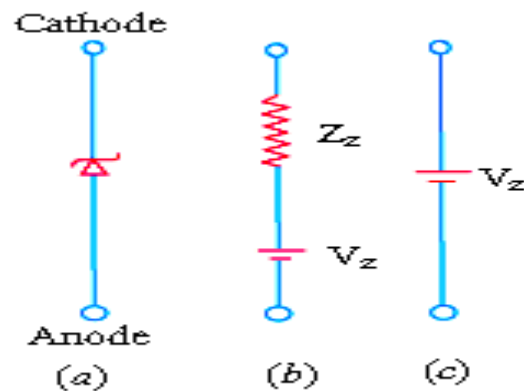
V_z = Zener breakdown voltage

$I_{z \text{ min}}$ = minimum current to sustain breakdown

$I_{z \text{ max}}$ = maximum Zener current limited by maximum power dissipation.



The schematic symbol of a Zener diode and its equivalent circuit are shown in Fig. below.



(b) Zener Voltages

Zener diodes are available having Zener voltages of 2.4 V to 200 V. Their power dissipation is given by the product $V_Z I_Z$. Maximum ratings vary from 150 mW to 50 W.

(c) Zener Biasing

For proper working of a Zener diode in any circuit, it is essential that it must

1. be reverse-biased.
2. Have voltage across it greater than V_z .
3. be in a circuit where current is less than $I_z \text{ max}$.

(d) Uses

Zener diodes find numerous applications in transistor circuitry. Some of their common uses are:

1. as voltage regulators.
2. as a fixed reference voltage in a network for biasing and comparison purposes and for calibrating voltmeters.
3. as peak clippers or voltage limiters.
4. for meter protection against damage from accidental application of excessive voltage.
5. for reshaping a waveform.