What is Zener Diode? Working Principle of Zener Diode

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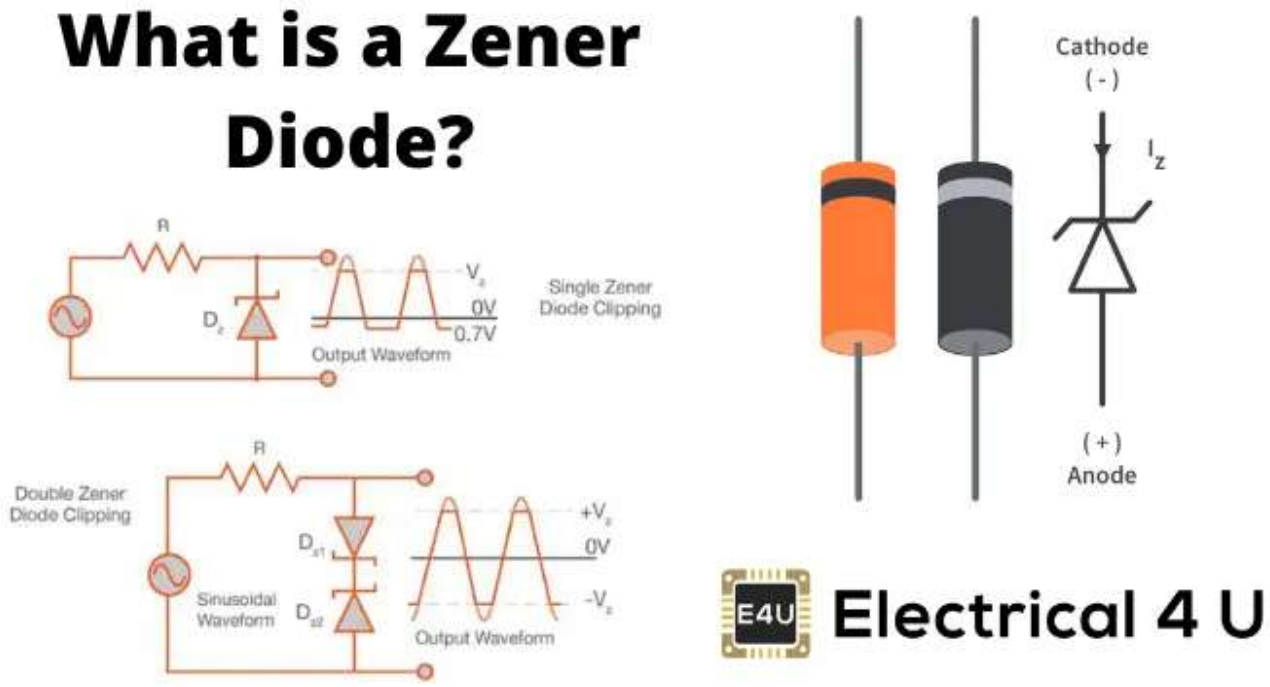


Zener diode is basically like an ordinary PN junction diode but normally operated in reverse biased condition. But ordinary PN junction diode connected in reverse biased condition is not used as Zener diode practically. A Zener diode is a specially designed, highly doped PN junction diode.

Working Principle of Zener Diode

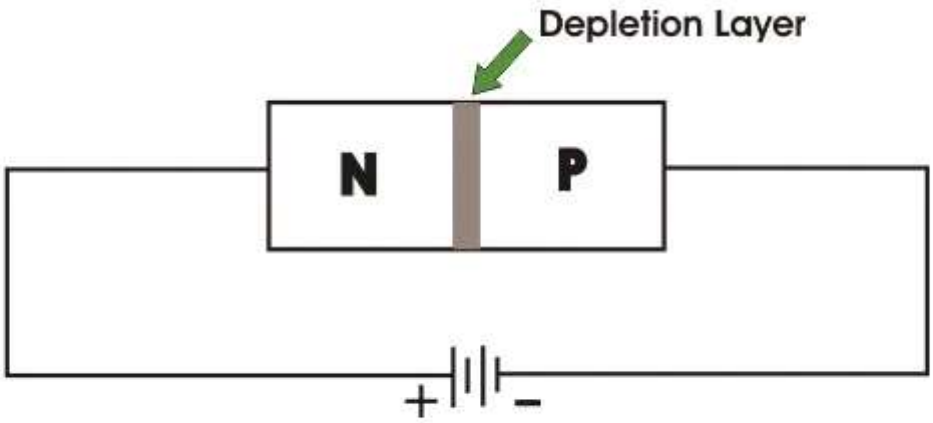
When a PN junction diode is reverse biased, the depletion layer becomes wider. If this reverse biased voltage across the diode is increased continually, the depletion layer becomes more and more wider. At the same time, there will be a constant reverse saturation current due to minority carriers.

After certain reverse voltage across the junction, the minority carriers get sufficient kinetic energy due to the strong electric field. Free electrons with sufficient kinetic energy collide with stationary ions of the depletion layer and knock out more free electrons. These newly created free electrons also get sufficient kinetic energy due to the same electric field, and they create more free electrons by collision cumulatively. Due to this commutative phenomenon, very soon, huge free electrons get created in the depletion layer, and the entire diode will become conductive. This type of breakdown of the depletion layer is known as avalanche breakdown, but this breakdown is not quite sharp. There is another type of breakdown in depletion layer which is sharper compared to avalanche breakdown, and this is called Zener breakdown. When a PN junction is diode is highly doped, the concentration of impurity atoms will be high in the crystal. This higher concentration of impurity atoms causes the higher concentration of ions in the depletion layer hence for same applied reverse biased voltage, the width of the depletion layer becomes thinner than that in a normally doped diode.

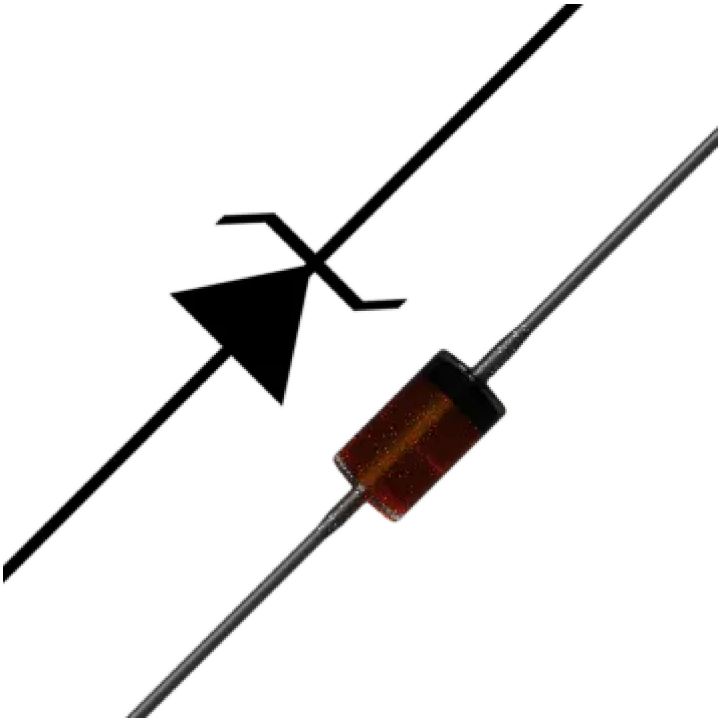
Due to this thinner depletion layer, voltage gradient or electric field strength across the depletion layer is quite high. If the reverse voltage is continued to increase, after a certain applied voltage, the electrons from the covalent bonds within the depletion region come out and make the depletion region conductive. This breakdown is called Zener breakdown. The voltage at which this breakdown occurs is called Zener voltage. If the applied reverse voltage across the diode is more than Zener voltage, the diode provides a conductive path to the current through it hence, there is no chance of further avalanche breakdown in it. Theoretically, Zener breakdown occurs at a lower voltage level then avalanche breakdown in a diode, especially doped for Zener breakdown. The Zener breakdown is much sharper than avalanche breakdown. The Zener voltage of the diode gets adjusted during manufacturing with the help of required and proper doping. When a **zener diode** is connected across a voltage source, and the source voltage is more than Zener voltage, the voltage across a Zener diode remain fixed irrespective of the source voltage. Although at that condition current through the diode can be of any value depending on the load connected with the diode. That is why we use a Zener diode mainly for controlling voltage in different circuits.

Zener Diode Circuit

Zener Diode is nothing but a single diode connected in a reverse bias, we have already stated that. A diode connected in reverse bias position in a circuit is shown below,

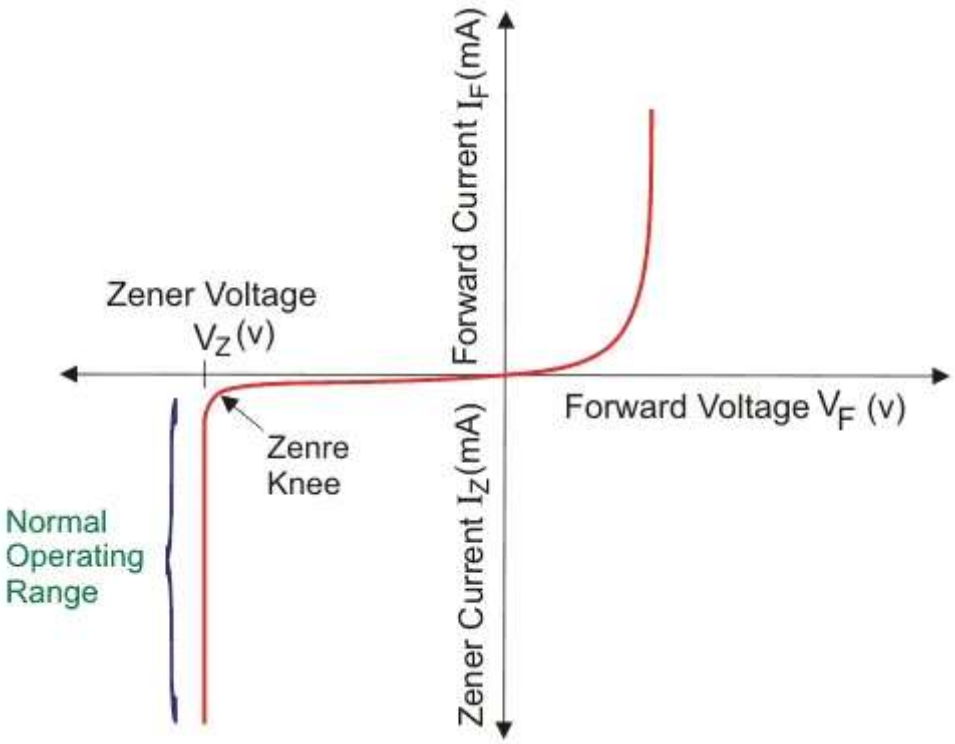


The circuit symbol of a **Zener diode** is also shown below.



Characteristics of a Zener Diode

Now, discussing about the diode circuits we should look through the graphical representation of the operation of the **zener diode**. Normally, it is called the V-I characteristics of a Zener diode.



The above diagram shows the V-I characteristics of a zener diode. When the diode is connected in forward bias, this diode acts as a normal diode but when the reverse bias voltage is greater than zener voltage, a sharp breakdown takes place. In the V-I characteristics above V_z is the zener voltage. It is also the knee voltage because at this point the current increases very rapidly.

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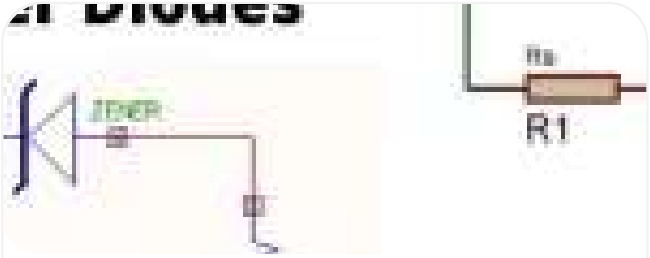

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