

Theory & Application of Zener Diode in Electrical & Electronics Circuits

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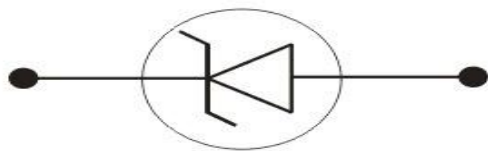
Abstract:

Zener diode –voltage regulator when it undergoes reversed bias and a normal diode in forward bias.

Purpose to study the characteristics of zener diode

Introduction

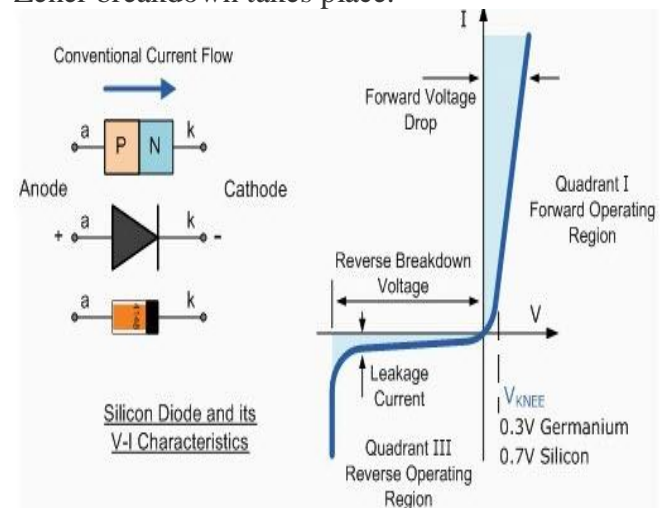
The diode is one of the basic components in electronic circuits. When you want to know about voltage considerations you should know about the diodes. The diode is basically made up of semiconductors, which have two characteristics, 'P' type and 'N' type. The 'P' type and 'N' type semiconductors represent positive and negative type semiconductors. 'P' type semiconductor will have excess amount of holes in configuration and 'N' type semiconductor will have excess amount of electrons. If both types of characteristics present in a single crystal then it can be termed as a diode. The positive terminal of the battery connects with the 'P' side and the negative side is connected with the 'N' side. Let's discuss about Zener diode working. It is nothing but a simple diode connecting in reverse bias.



Zener Diode

It is mainly a special property of the diode rather than any special type of equipment.

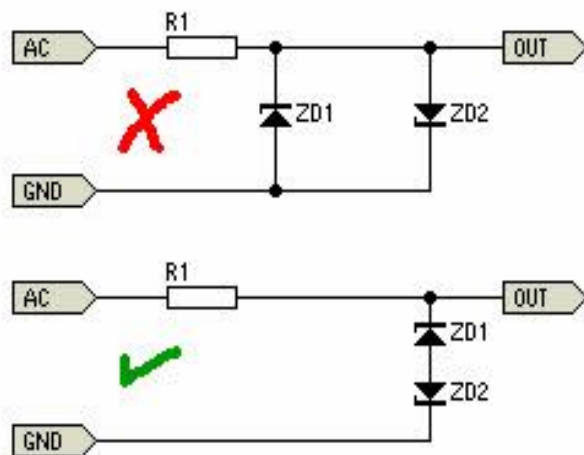
The person named Clarence Zener invented this property of the diode that's why it is named after him as a remembrance. The special property of the diode is that there will be a breakdown in the circuit if the voltage applied across a reversely biased circuit. This does not allow the current to flow across it. When the voltage across the diode is increased, temperature also increases and the crystal ions vibrate with greater amplitude and all these leads to the breakdown of the depletion layer. The layer at the junction of 'P' type and 'N' type. When the applied voltage exceeds an specific amount Zener breakdown takes place.



Zener Diode V-I Characteristics

Zener diode is nothing but a single diode connected in a reverse bias mode and Zener diode can be connected in reverse bias positive in a circuit as shown as picture. We can connect it for different applications.

The circuit symbol of Zener diode is as shown in the figure. For convenience it is used normally. When discussing about the diode circuits we should look through the graphical representation of the operation of the Zener diode. It is called the V-I characteristics of a general p – n junction diode.

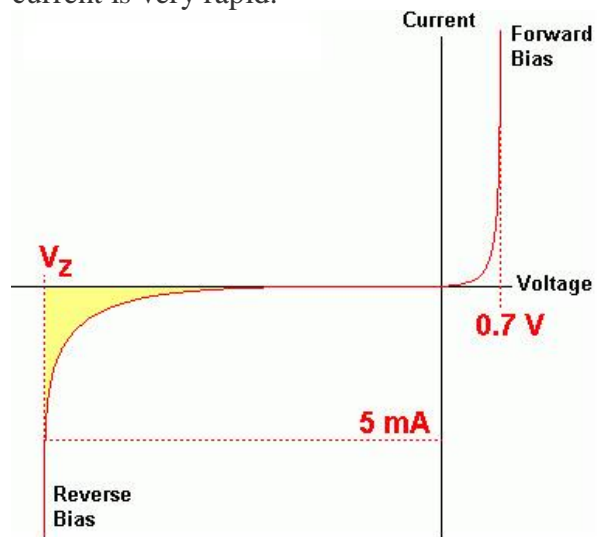


Zener Diode connection

Characteristics of a Zener Diode

The above diagram shows the V-I characteristics of the Zener diode behavior. When the diode is connected in forward bias diode acts as a normal diode. When the reverse bias voltage is greater than a predetermined voltage then the Zener breakdown voltage occurs. To get breakdown voltage sharp and

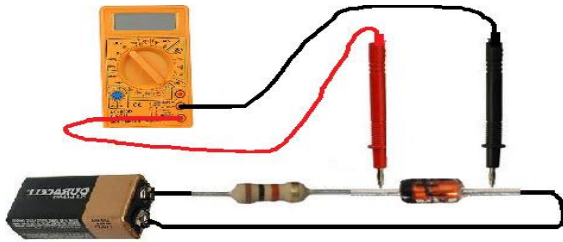
distinct doping is controlled and the surface imperfections are avoided. In the V-I characteristics above V_z is the Zener voltage. And also the knee voltage because at this point the current is the current is very rapid.



Zener Diode behavior

Application of Zener Diode

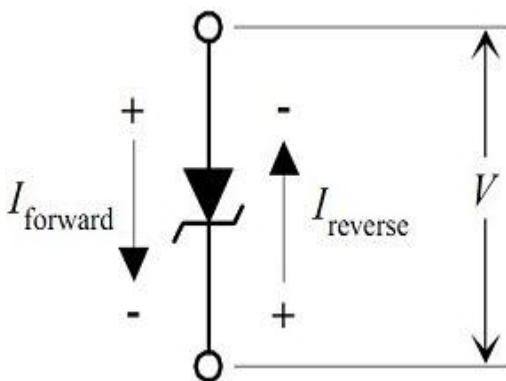
Zener diode is popularly used as Shunt Regulator or Voltage Regulator. As we have gone through the first part of the article we know what Zener diode is and what the basic principle of operation is. Here the question arises where this type of diodes can be useful. Main application of this type of diodes are as voltage regulator. Over voltage protector, as voltage reference.



Zener Diode checking

We have discussed the application of Zener diode as voltage regulator and now we will discuss the other two points.

Over voltage protection is done by using Zener diodes because there is current flowing through the diode after the reverse bias voltage exceeds a certain voltage. This circuit provides safety for the equipment connected at the terminals. Normally the current should not exceed normal value but if due to any fault in the circuit the current exceeds the maximum allowable voltage, then the equipment of the system can be damaged. A SCR is used, by it the output voltage is quickly cut down and a fuse blows which disconnects the input source power. The circuit arrangement is shown below for better understanding,



Diode connection

Zener

Voltage reference determines the constant supply of power current or voltage as the Zener voltage works. If the supply of current is same then to avoid unstable performance we use Zener diodes. These are used where voltage reference is required like ammeters, ohmmeters and voltmeters.

Zener Diode as Voltage Regulator

The term regulator means which regulates. The Zener diode can work as a voltage regulator if it is introduced in a circuit. The output across the diode will be constant. It is driven by a current source. As we know if the voltage across the diode exceeds a certain value it would draw excessive current from the supply. The basic diagram of Zener diode as voltage regulator is given below,

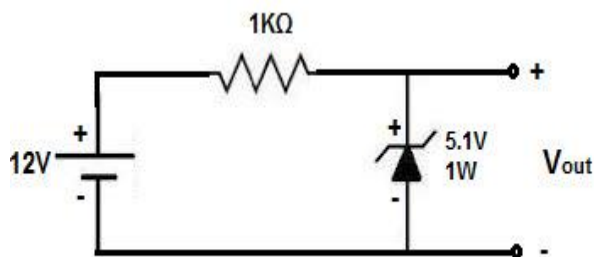
To fix the current through the Zener diode series resistance R is introduced whose value can be chosen from the following equation

$$\text{Resistor value (ohms)} = (V_1 - V_2) / (\text{Zener current} + \text{load current})$$

The above diagram is of a shunt regulators because the regulating element is parallel to the load element. The Zener diode produces a stable reference voltage across the load which fulfills the criteria of regulator requirement.

The Zener diode allows current to flow in the forward direction in the same manner as an ideal diode. It also permits to flow in the reverse direction when the voltage is above a certain value known as breakdown voltage.

This device is named after Zener. Zener discovered this electrical property. A Zener diode is one in which the reverse breakdown occurs due to electron quantum tunneling under high electric field strength called Zener effect. Many diodes described as Zener diodes rely instead on avalanche breakdown. Both types are used with the Zener effect predominating under 5.6 V and avalanche breakdown above. Regular applications include providing a reference voltage for voltage regulators. This is to protect devices from momentary voltage pulses.



Zener Diode Connectivity

These devices are also encountered in series with a base emitter junction. At transistor stages where selective choice of a device centered around the avalanche or Zener point. It can be used to introduce compensating temperature coefficient balancing of the transistor . DC error amplifier used in a

regulated power supply circuit feedback loop system is the on of the example.

These are also used in surge protectors to limit transient voltage spike systems and another application of the Zener diode is the use of noise caused by its avalanche breakdown in a random number generator.

Conclusion:

.Zener diodes are designed to operate at voltages greater than the breakdown voltage (peak reverse voltage).

- The breakdown voltage of a zener diode is determined by the resistivity of the diode.
- Zener diodes are manufactured with a specific breakdown (zener) voltage.
- Power dissipation of a zener diode is based on temperature and lead lengths.
- Zener diodes are packaged the same as P–N junction diodes.
- Zener diodes with a breakdown voltage greater than 5 V have a positive zener voltage- temperature coefficient.
- Zener diodes with a breakdown voltage less than 4 V have a negative zener voltage temperature coefficient.
- Zener diodes are used to stabilize or regulate voltage.
- Zener diode regulators provide a constant output voltage despite changes in the input voltage or output current.
- Zener diodes can be tested for opens, shorts, or leakage with an ohmmeter.
- To determine whether a zener diode is regulating at the proper voltage, a regulation test must be performed.

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