Part 3: Types of diodes

The most popular types of diodes are:

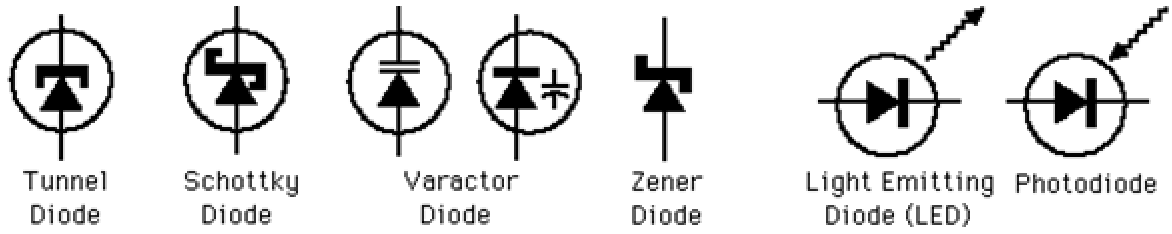

Fig.2.16.1. Types of diodes

1. Schottky diode

A Schottky diode, also known as a hot carrier diode, is a semiconductor diode which has a low forward voltage drop and a very fast switching action. There is a small voltage drop across the diode terminals when current flows through a diode. A Schottky diode voltage drop is usually between 0.15 and 0.45 volts. This lower voltage drop provides better system efficiency and higher switching speed. The most evident limitation of Schottky diodes are their relatively low reverse voltage ratings.

2. Varicap diode (tuning diode)

It, also, known as varactor diode or variable capacitance diode. This type of diode has the particularity to behave like a capacitor. Its capacitance value varies with the reverse voltage applied to its terminals. Varicap diodes are used in radio frequency (change in capacitance $\Rightarrow$change in frequency).

3. Tunnel diode (Esaki diode)

Tunnel diode (Fig.2.16.2) is capable of very fast operation in the microwave frequency region. It conducts in reverse bias polarization, its reverse breakdown voltage is zero volts, and in this case it's called back diode or "backward" diode.

In the forward bias, the tunnel effect occurs giving to the diode a characteristic. A region where the increase of the voltage across the diode causes a decrease in current passing through it corresponds to a negative resistance.

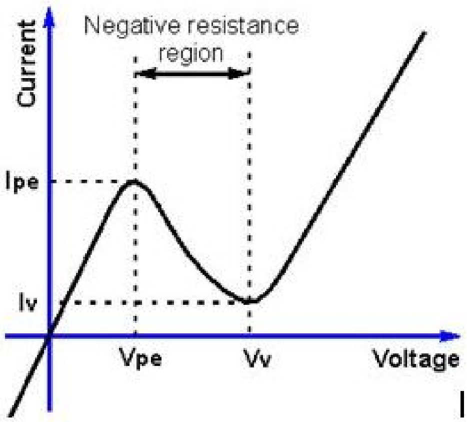

Fig.2.16.2. Tunnel diode characteristic

4. Light emitting diode (LED)

This type is used as indicator lamp. When a LED is switched on, electrons are able to recombine with holes releasing energy in the form of "photons".

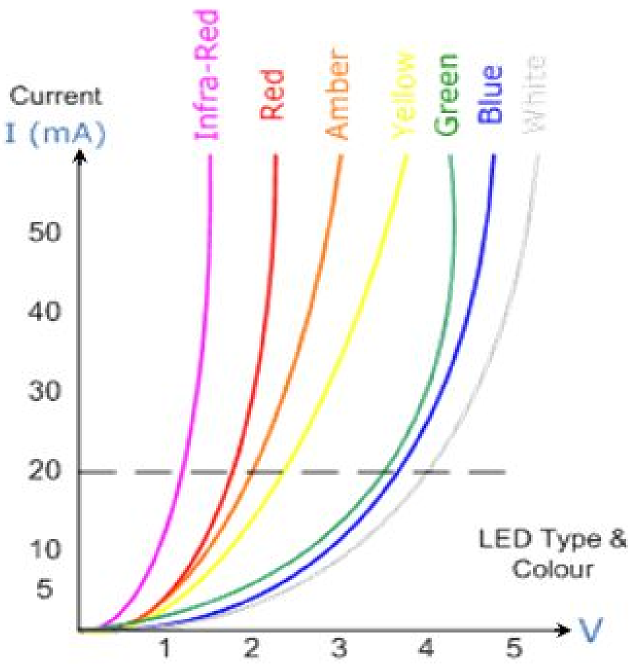

Fig.2.16.3. Light emitting diode characteristics

5. Photodiode

Photodiode is a type of photo-detector capable of converting light into either current or voltage (ex: Solar cells).

6. Zener diode Diodes and Voltage Regulation

Zener diodes are diodes that conduct in avalanche breakdown region. When high reverse voltage is applied to the p-n junction diode, the free electrons (minority carriers) gain large amount of energy and will accelerate with greater velocities. The free electrons moving at high speed will collide with the atoms and knock off more electrons. Because of this continuous collision with the atoms, a large number, of free electrons, is generated. As a result, electric current in the diode increases rapidly (avalanche). This sudden increase in electric current may permanently destroys the normal diode. However, Zener diodes may not be destroyed because they are carefully designed to operate in avalanche breakdown region.

In power supplies, Zener diodes are widely used to provide a reference voltage.

A typical DC power supply is made up of the components shown in Figure.2.17.1. Following the **Step-down transformer** are a **Bridge rectifier**, a **Filter capacitor**, a **voltage Regulator**, and, finally, the **Load**.

The most common device employed in **voltage regulation** schemes is the Zener diode.

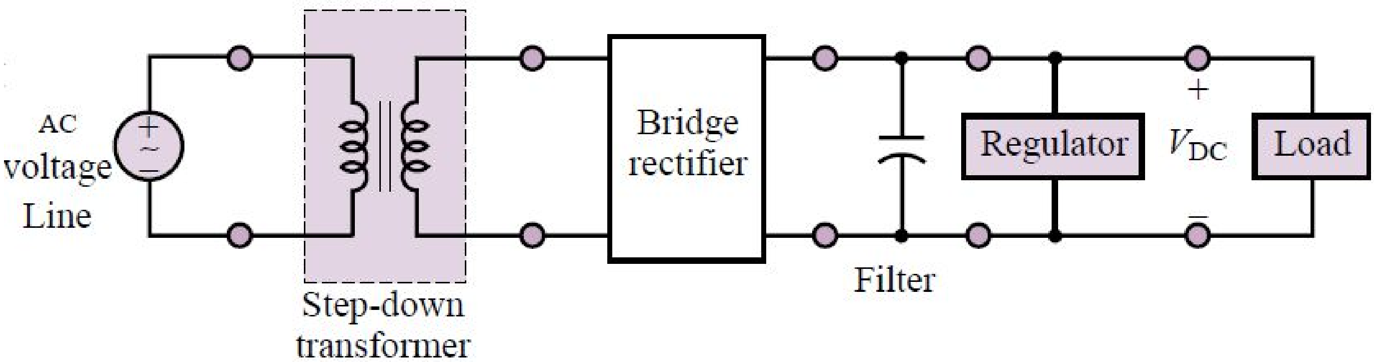

Fig.2.17.1. A typical DC power supply

Zener diodes function on the reverse portion of the I-V characteristic of the diode discussed in the previous sections; which illustrates the general characteristic of a diode, with forward offset voltage V_D and **reverse breakdown voltage** which is **the Zener voltage** V_Z in the case of Zener diode.

In the Zener breakdown region the diode can hold a very nearly constant voltage for a large range of currents. This property makes it possible to use the Zener diode as a **voltage regulator** or as a **voltage reference**.

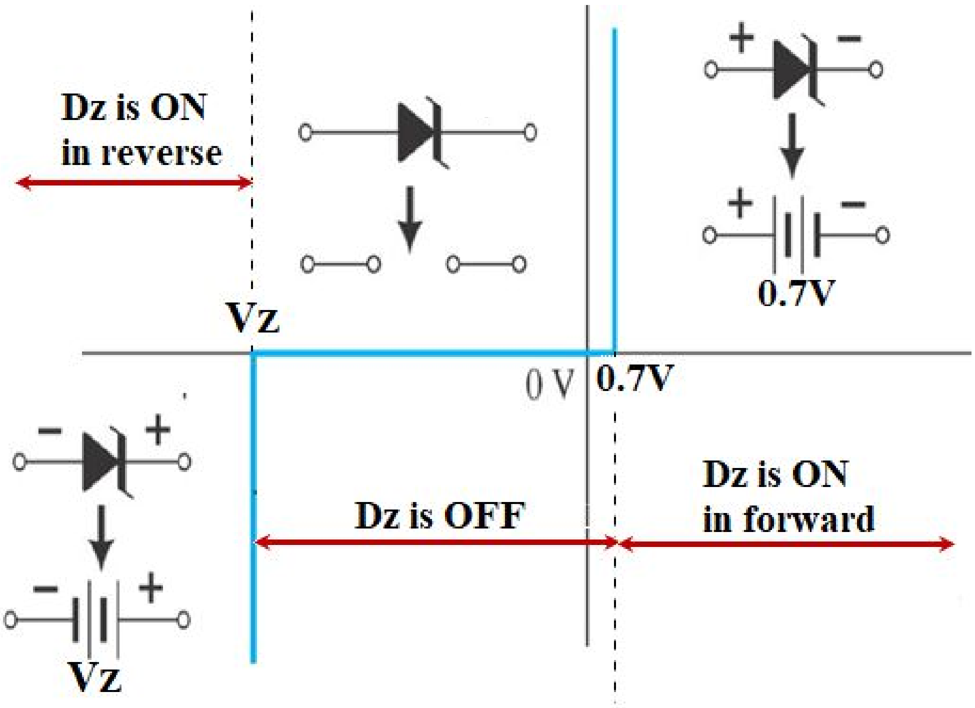

Fig.2.17.2. The equivalent circuit in each case in I-V characteristic

The operation of the Zener diode may be analyzed by considering three modes of operation (see Figure 2.17.2):

1. For VDz ≥0.7V , the device acts as a conventional forward-biased diode.
2. For VZ < VDz < 0.7V , the diode is reverse-biased but Zener breakdown has not taken place yet. Thus, it acts as an open circuit.
3. For VDz ≤ VZ, Zener breakdown occurs and the device holds a nearly constant voltage, $-VZ$.

Application : Voltage regulation.

According to the circuit of Figure 2.17.3:

Dz is ON in forward if VA-VK >0.7V ⇒ **Vi < - 0.7V ⇒ Vo= - 0.7V**

Dz is ON in Reverse if VK-VA >Vz ⇒ **Vi >Vz ⇒ Vo= Vz**

Dz is OFF if **-0.7V<Vi <Vz ⇒ Vo=Vi**

Among the following cases of Vz which case gives us the best regulation (Vi is shown in figure 2.17.3)?

Vz1 = 4V, Vz2 = 3.5V and Vz3 = 2.8V

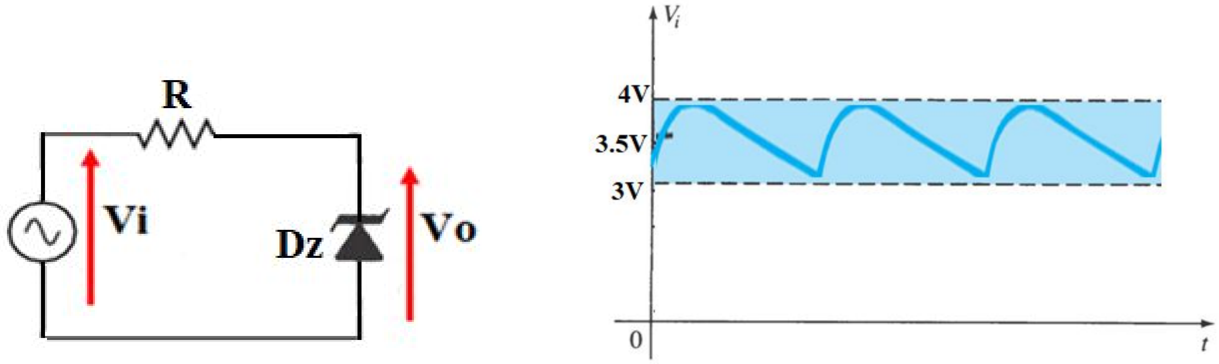

Fig.2.17.3. Voltage regulation

In this case we are going to take in consideration only the positive levels because Vi>0:

Vi >Vz ⇒ Vo= Vz **and** **Vi <Vz ⇒ Vo=Vi**

From the outputs (see Fig.2.17.4), the best regulation is given by the the zener diode with Vz=2.8V, because the output voltage in this case is a signal without ripple (smooth signal) ⇒ perfect regulation and **pure DC signal**.

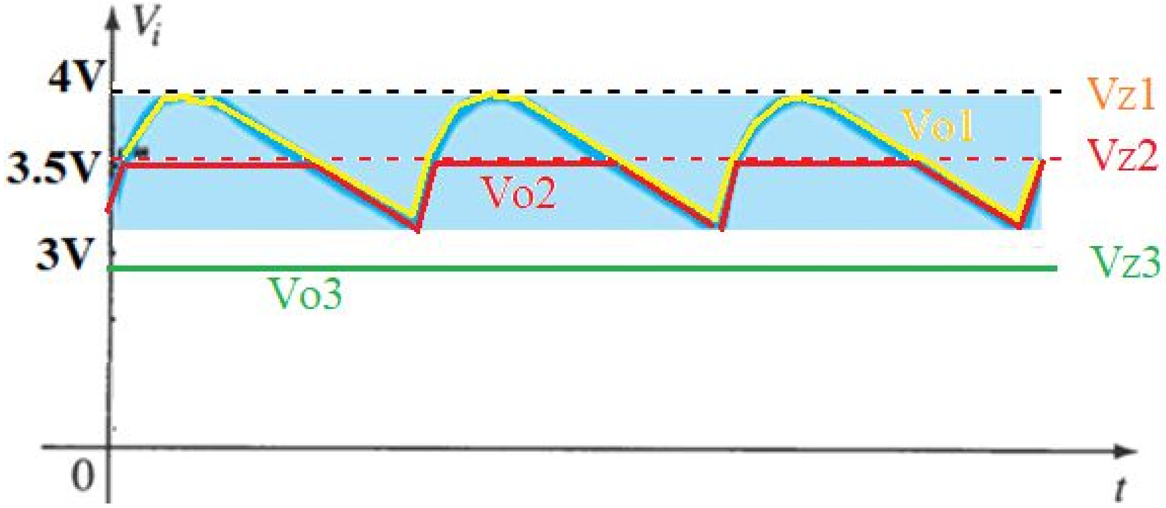

Fig.2.17.4. The output voltage for each value of Vz