PHOTORESISTOR

Photoresistor is the combination of words “photon” (meaning light particles) and “resistor”. True to its name, a photo-resistor is a device or we can say a resistor dependent on the light intensity. For this reason, they are also known as light dependent resistors or LDRs.

So to define a photo-resistor in a single line we can write it as:

“Photoresistor is a variable resistor whose resistance varies inversely with the intensity of light”

The resistance decreases when intensity of light increases, it simply implies that the conductance increases with increase in intensity of light falling on the photo-resistor or the LDR, owing to a property called photo-conductivity of the material.

Hence these Photoresistors are also known as photoconductive cells or just photocell.

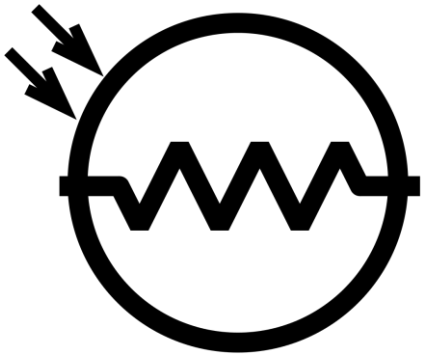


FIG: CIRCUIT SYMBOL OF PHOTORESISTOR

Working principle:

The light that falls on a photoconductive material is absorbed by it which in turn makes lots of free electrons from the valence electrons.

As the light energy falling on the photoconductive material increases, number of valence electrons that gain energy and leave the bonding with the

nucleus increases. This leads to a large number of valence electrons jump to the conduction band, ready to move with an application of any external force like an electric field.

Thus, as the light intensity increases, the number of free electrons increases. This means the photoconductivity increases that imply a decrease in photo resistivity of the material.

Uses & Applications:

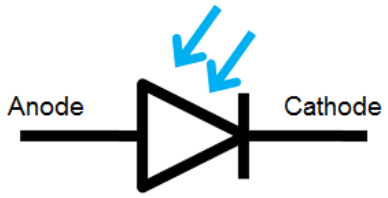
- ***Automatic Street Lights:*** One of the prominent uses of Photoresistor that we experience in daily life is in the circuits of automatic street lights.. Here they are so used in a circuit that the street lights turn on as it starts getting dark and turns off in the morning.
- Some of the Photoresistors are used in some of the consumer items like ***light meters in camera, light sensors*** like in robotic projects**,** ***clock radios etc.***
- They are also used ***to control the reduction in gain*** of dynamic compressors.
- They are also considered as a ***good infra-red detector*** and hence find application in infrared astronomy.

PHOTODIODE

A photodiode is one type of light detector, used to convert the light into current or voltage based on the mode of operation of the device.

A photodiode is a PN-junction diode that consumes light energy to produce electric current. Sometimes it is also called as photo-detector, a light detector, and photo-sensor. These diodes are particularly designed to work in reverse bias condition, it means that the P-side of the photodiode is associated with the negative terminal of the battery and n-side is connected to the positive terminal of the battery.

When light falls on the diode it easily changes light into electric current.



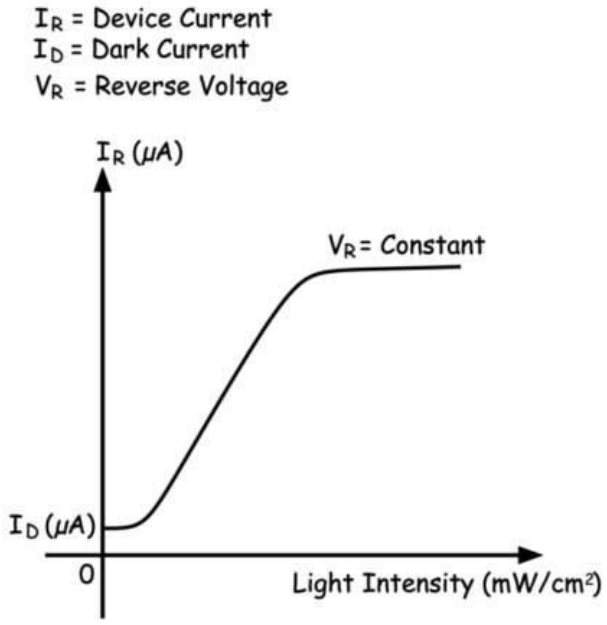
Photodiode symbol

Characteristic of Photodiode:

1. **Dark Resistance of Photodiode**

   It is true that there are always some minority charge carriers in the semiconductor crystal even in extreme dark condition — these minority charge carriers in the semiconductor crystal present due to unavoidable impurities and natural thermal excitation of the crystal. So even in dark condition, there would be a tiny and constant reverse saturation current in the diode. This current is fixed for a photodiode, and the current is known as dark current. When we apply light to the diode, the reverse current increase. This relation is linear. The value of reverse current is directly proportional to the intensity of incident light energy.

2. If we go on increasing the light intensity, after a certain value of reverse current. The current will not increase further with increasing light intensity. We call this maximum value of reverse current as **saturation current of the photodiode**.



Applications of Photodiode:

- These diodes are used in consumer electronics devices like smoke detectors, compact disc players, and televisions and remote controls in VCRs.
- In other consumer devices like clock radios, camera light meters, and street lights, photoconductors are more frequently used rather than photodiodes.
- Photodiodes are frequently used for exact measurement of the intensity of light in science & industry.
- These diodes are much faster & more complex than normal PN junction diodes and hence are frequently used for lighting regulation and in optical communications.

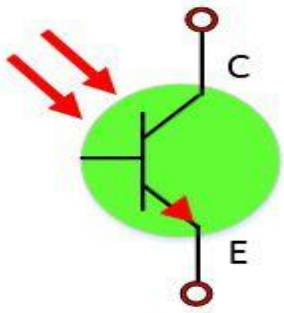
PHOTOTRANSISTOR

The phototransistor is a three-layer semiconductor device which has a light-sensitive base region. The base senses the light and converts it into the current which flows between the collector and the emitter region.

The construction of phototransistor is similar to the ordinary transistor, except the base terminal. In phototransistor, the base terminal is not provided, and instead of the base current, the light energy is taken as the input.

Symbol of Phototransistor:

The symbol of the phototransistor is similar to that of the ordinary transistor. The only difference is that of the two arrows which show the light incident on the base of the phototransistor.



Principle of Phototransistor:

Consider the conventional transistor is having open terminal base circuited. The collector base leakage current acts as a base current I_{CBO}.

$I_C = \beta I_B + (1+B)\, I_{CBO}$

As the base current $I_B = 0$, It acts as an open circuited. And the collector current becomes.

$I_C = (1+B)\, I_{CBO}$

The above equations shown that the collector current is directly proportional to the current base leakage current, i.e., the I_C increases with the increases of the collector base region.

Phototransistor Operation:

The phototransistor is made up of semiconductor material. When the light was striking on the material, the free electrons/holes of the semiconductor material causes the current which flows in the base region. The base of the phototransistor would only be used for biasing the transistor. In case of NPN transistor, the collector is made positive concerning emitter, and in PNP, the collector is kept negative.

The light enters into the base region of phototransistor generates the electron-hole pairs. The generation of electron-hole pairs mainly occurs into the reverse biasing. The movement of electrons under the influence of electric field causes the current in the base region. The base current injected the electrons in the emitter region. The major drawback of the phototransistor is that they have low-frequency response.