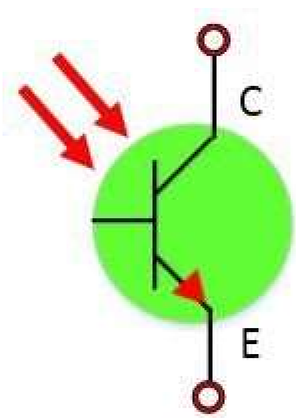
Phototransistor

Definition: 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}.

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

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

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

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.

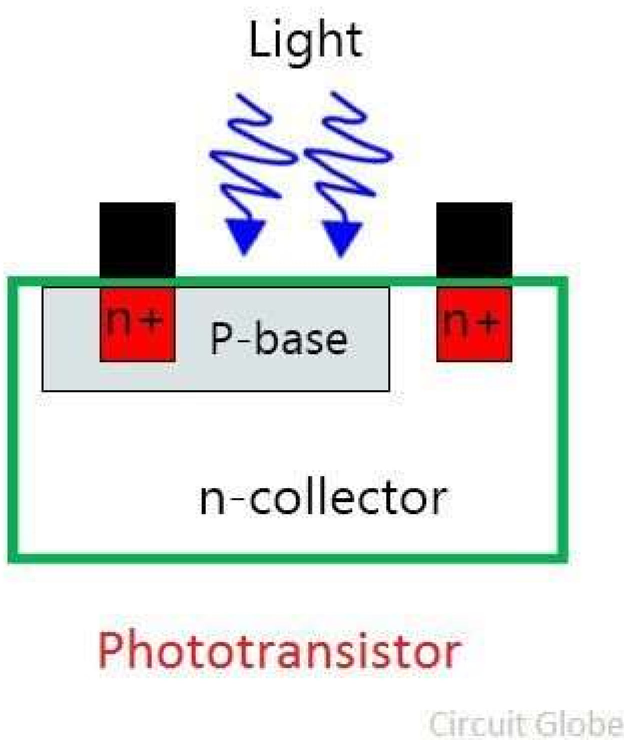
Phototransistor Operation

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.

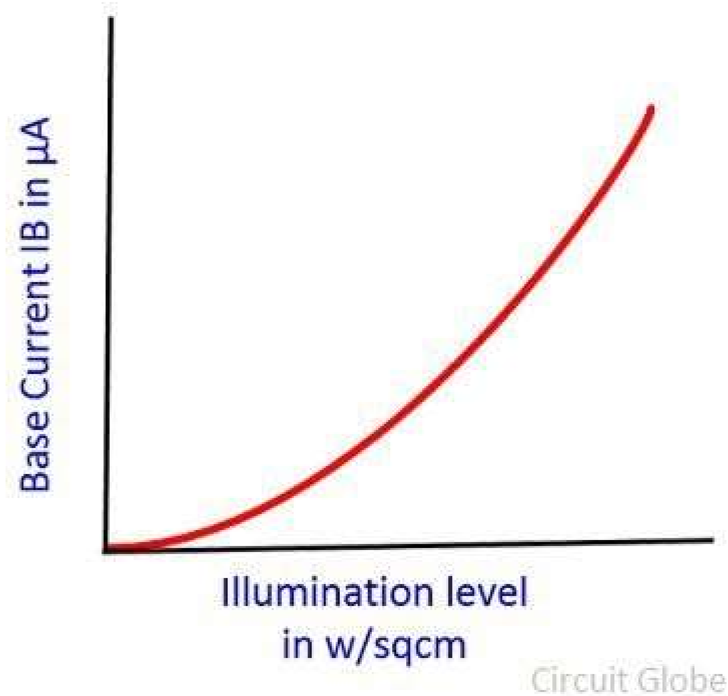
Phototransistor Construction

The construction of the phototransistor is quite similar to the ordinary transistor. Earlier, the germanium and silicon are used for fabricating the phototransistor. The small hole is made on the surface of the collector-base junction for placing the lens. The lens focuses the light on the surface.



Nowadays the transistor is made of a highly light effective material (like gallium and arsenides). The emitter-base junction is kept at forward biased, and the collector-base junction is at the reverse biased.

When no light falls on the surface of the transistor, the small reverse saturation current induces on the transistor. The reverse saturation current induces because of the few minority charge carriers. The light energy falls on the collector-base junction and generates the more majority charge carrier which adds the current to the reverse saturation current. The graph below shows the magnitude of current increases along with the intensity of light.



The phototransistor is widely used in electronics devices likes smoke detectors, infrared receiver, CD players, lasers etc. for sensing light.

Photodiode Vs Phototransistor

The photodiode and phototransistor both convert the light energy into the electrical energy. But the phototransistor is mostly preferred over the photodiode because of their following advantages.

- The current gain in the phototransistor is more than the phototransistor even if the same amount of light strike on it.
- The sensitivity of the phototransistor is higher than the photodiode.
- The photodiode can be converted into the phototransistor by removing their emitter terminals.

The response time of the photodiode is much higher than the phototransistor. The output current of the photodiode is in microamperes, and it can switch on or off in nanoseconds. While the response time of the phototransistor is in microseconds and it provides current in milliamperes.

Solar Cell: Working Principle & Construction (Diagrams Include Electrical4U

What is a Solar Cell?

A **solar cell** (also known as a photovoltaic cell or PV cell) is defined as an electrical device that converts light energy into electrical energy through the photovoltaic effect. A solar cell is basically a p-n junction diode. Solar cells are a form of photoelectric cell, defined as a device whose electrical characteristics – such as current, voltage, or resistance – vary when exposed to light.

Individual solar cells can be combined to form modules commonly known as solar panels. The common single junction silicon solar cell can produce a maximum open-circuit voltage of approximately 0.5 to 0.6 volts. By itself this isn't much – but remember these solar cells are tiny. When combined into a large solar panel, considerable amounts of renewable energy can be generated.

Construction of Solar Cell

A solar cell is basically a junction diode, although its construction it is little bit different from conventional p-n junction diodes. A very thin layer of p-type semiconductor is grown on a relatively thicker n-type semiconductor. We then apply a few finer electrodes on the top of the p-type semiconductor layer.

These electrodes do not obstruct light to reach the thin p-type layer. Just below the p-type layer there is a p-n junction. We also provide a current collecting electrode at the bottom of the n-type layer. We encapsulate the entire assembly by thin glass to protect the **solar cell** from any mechanical shock.

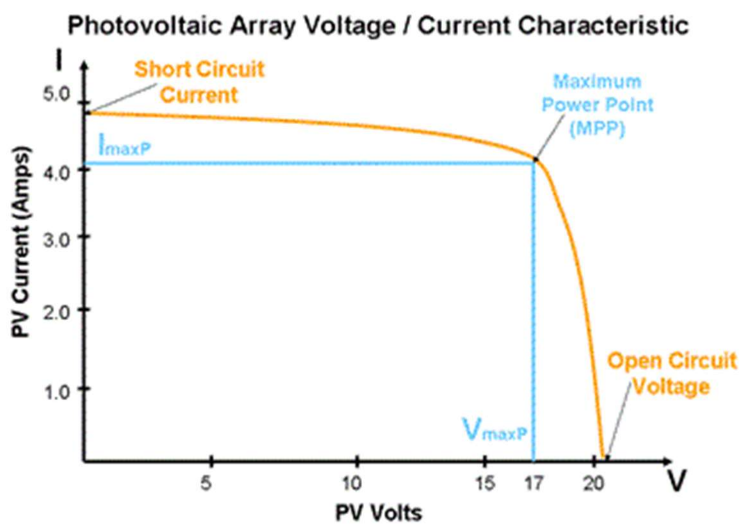
Working Principle of Solar Cell

When light reaches the p-n junction, the light photons can easily enter in the junction, through very thin p-type layer. The light energy, in the form of photons, supplies sufficient energy to the junction to create a number of electron-hole pairs. The incident light breaks the thermal equilibrium condition of the junction. The free electrons in the depletion region can quickly come to the n-type side of the junction.

Similarly, the holes in the depletion can quickly come to the p-type side of the junction. Once, the newly created free electrons come to the n-type side, cannot further cross the junction because of barrier potential of the junction.

Similarly, the newly created holes once come to the p-type side cannot further cross the junction became of same barrier potential of the junction. As the concentration of electrons becomes higher in one side, i.e. n-type side of the junction and concentration of holes becomes more in another side, i.e. the p-type side of the junction, the p-n junction will behave like a small battery cell. A voltage is set up which is known as photo voltage. If we connect a small load across the junction, there will be a tiny current flowing through it.

V-I Characteristics of a Photovoltaic Cell



Materials Used in Solar Cell

The materials which are used for this purpose must have band gap close to 1.5ev. Commonly used materials are-

1. Silicon.
2. GaAs.
3. CdTe.
4. $CuInSe_2$

Criteria for Materials to be Used in Solar Cell

1. Must have band gap from 1ev to 1.8ev.
2. It must have high optical absorption.
3. It must have high electrical conductivity.
4. The raw material must be available in abundance and the cost of the material must be low.

Advantages of Solar Cell

1. No pollution associated with it.
2. It must last for a long time.
3. No maintenance cost.

Disadvantages of Solar Cell

1. It has high cost of installation.
2. It has low efficiency.
3. During cloudy day, the energy cannot be produced and also at night we will not get solar energy.

Uses of Solar Generation Systems

1. It may be used to charge batteries.
2. Used in light meters.
3. It is used to power calculators and wrist watches.
4. It can be used in spacecraft to provide electrical energy.

Conclusion: Though **solar cell** has some disadvantage associated it, but the disadvantages are expected to overcome as the technology advances, since the technology is advancing, the cost of solar plates, as well as the installation cost, will decrease down so that everybody can effort to install the system. Furthermore, the government is laying much emphasis on the solar energy so after some years we may expect that every household and also every electrical system is powered by solar or the renewable energy source.

What is the difference between LED & LCD?
LED stands for Light Emitting Diode while **LCD** is short for Liquid Crystal Display. The **difference between** the two is the placement and type of light used. **LEDs** use diodes while **LCDs** use fluorescent lights. **LEDs** are also slimmer than **LCDs** and provide a better quality, clearer picture with high definition output

Photocoupler:
A photocoupler is a device incorporating a light-emitting diode (LED) and a photodetector in one package. Unlike other optical devices, light is not emitted outside the package. The external appearance is similar to that of non-optical semiconductor devices. Although a photocoupler is an optical device, it does not handle light, but handles electrical signals.

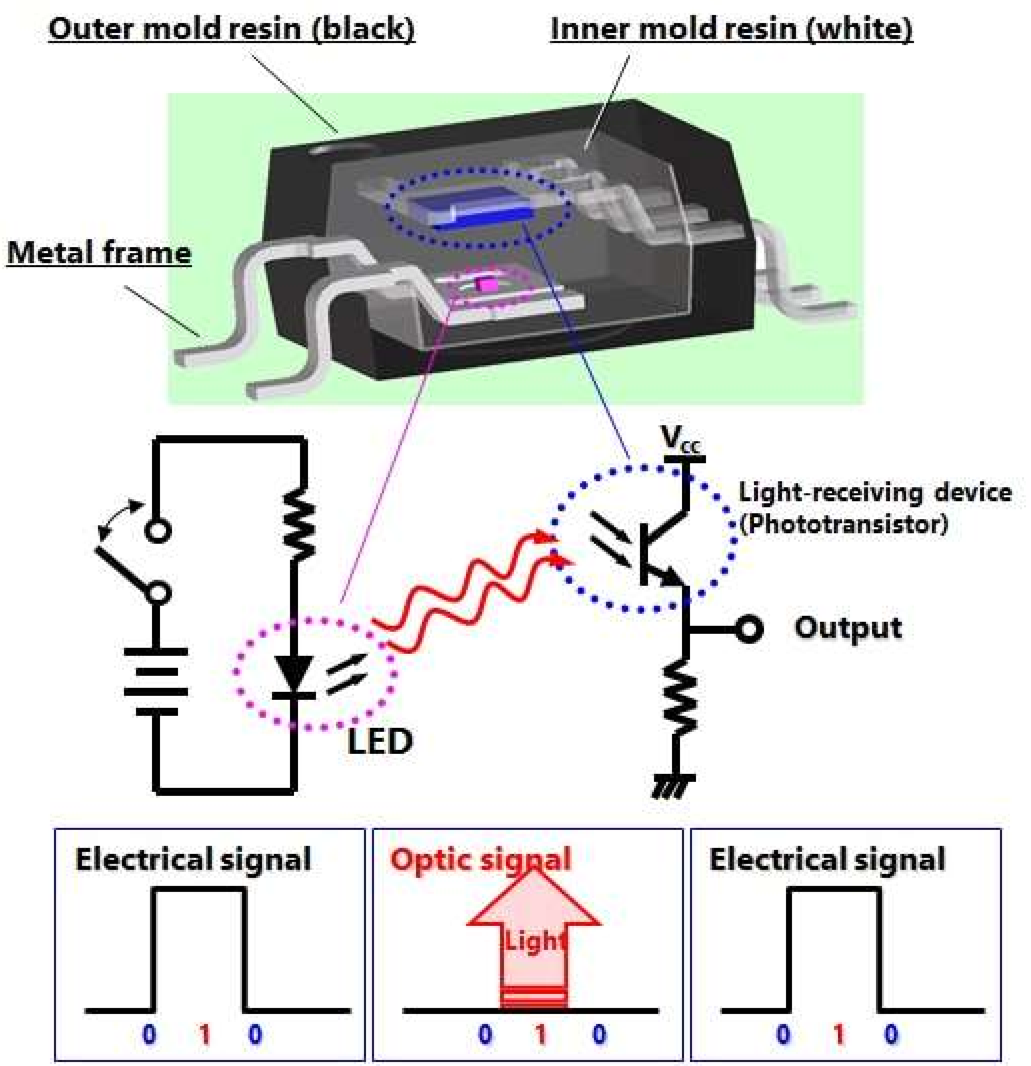
Examples of a photocoupler's operation:

(1)The LED turns on ($0 \Rightarrow 1$).
(2)The LED light enters the phototransistor.

(3)The phototransistor turns on.
(4)Output voltage changes 0 ⇒ 1.

(1)The LED turns off (1 ⇒ 0).
(2)The LED stops light emission to the phototransistor.
(3)The phototransistor turns off.
(4)Output voltage changes 1 ⇒ 0.

*The cutaway image on the right shows a transistor-output photocoupler of the transmissive type in a double-mold structure.

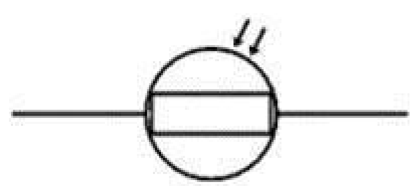


SENSOR: A **sensor** is a device that measures physical input from its environment and converts it into data that can be interpreted by either a human or a machine. Most **sensors** are electronic (the data is converted into electronic data), but some are simpler, such as a glass thermometer, which presents visual data.

What is an LDR (Light Dependent Resistor)?

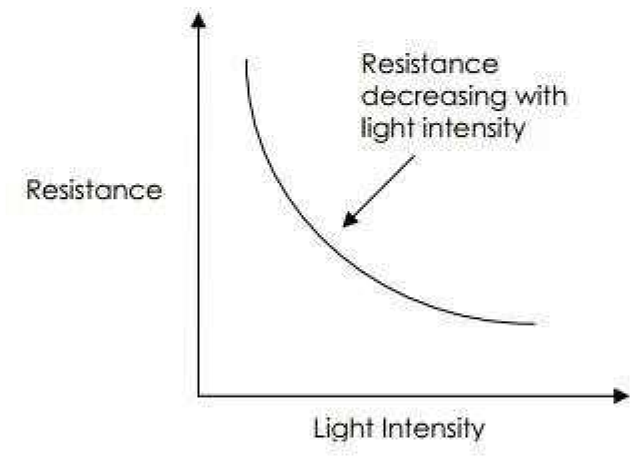
An LDR is a component that has a (variable) resistance that changes with the light intensity that falls upon it. This allows them to be used in light sensing circuits.

A typical LDR



LDR Circuit Symbol

Variation in resistance with changing light intensity



Typical LDR resistance vs light intensity graph

The most common type of LDR has a resistance that falls with an increase in the light intensity falling upon the device (as shown in the image above). The resistance of an LDR may typically have the following resistances:

Daylight

= 5000Ω

Dark

= 20000000Ω

You can therefore see that there is a large variation between these figures. If you plotted this variation on a graph you would get something similar to that shown by the graph shown above.

Applications of LDRs

There are many applications for Light Dependent Resistors. These include:

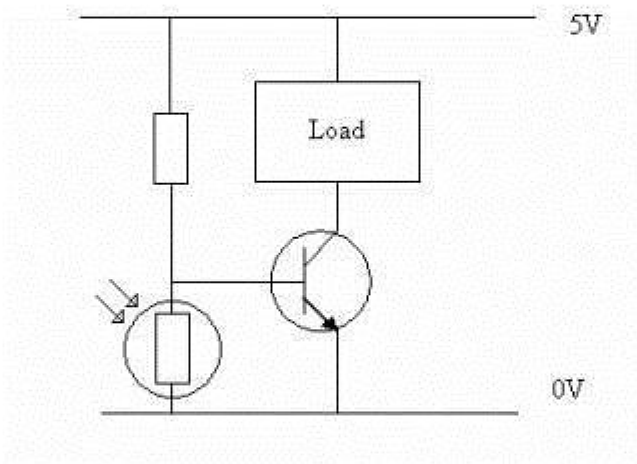
Lighting switch

The most obvious application for an LDR is to automatically turn on a light at a certain light level. An example of this could be a street light or a garden light.

Camera shutter control

LDRs can be used to control the shutter speed on a camera. The LDR would be used to measure the light intensity which then adjusts the camera shutter speed to the appropriate level.

Example - LDR controlled Transistor circuit



LDR controlled transistor circuit

The circuit shown above shows a simple way of constructing a circuit that turns on when it goes dark. In this circuit the LDR and the other Resistor form a simple 'Potential Divider' circuit, where the centre point of the Potential Divider is fed to the Base of the NPN Transistor. When the light level decreases, the resistance of the LDR increases. As this resistance increases in relation to the other Resistor, which has a fixed resistance, it causes the voltage dropped across the LDR to also increase. When this voltage is large enough (0.7V for a typical NPN Transistor), it will cause the Transistor to turn on. The value of the fixed resistor will depend on the LDR used, the transistor used and the supply voltage.