SCHOOL OF ELECTRONICS ENGINEERING

LIGHT DEPENDENT RESISTOR

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INTRODUCTION

- A light dependant resistor(LDR) or a photoresistor or photocell is a light controlled variable resistor. Its resistance changes with the light intensity that falls on it.
- The resistance of a photoresistor decreases with increasing incident light intensity. In other words, it exhibits photoconductivity.
- The resistance range and sensitivity of a photoresistor can substantially differ among dissimilar devices.

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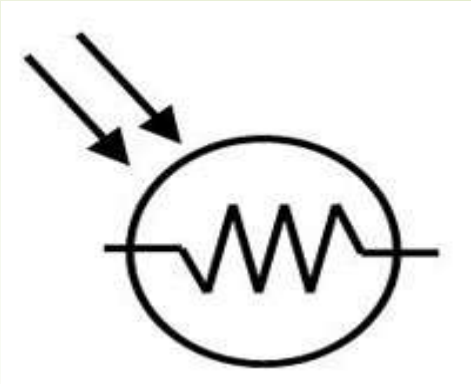
A typical LDR



Circuit symbol of LDR

- They are made up of semiconductor materials having high resistance.
- Photocells or LDRs are non linear devices. There sensitivity varies with the wavelength of light incident on them.
- Some photocells might not at all response to a certain range of wavelengths.

WORKING OF LDR

- A LDR works on the principle of photoconductivity.
- Photo conductivity is an optical phenomenon in which the materials conductivity reduces when light is absorbed by the material.
- When light falls i.e. when the photons fall on the device, the electrons in the valence band of the semiconductor material are excited to the conduction band.
- These photons in the incident light should have energy greater than the band gap of the semiconductor material to make the electrons jump from the valence band to the conduction band.

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When light having enough energy is incident on the device, more and more electrons are excited to the conduction band which results in large number of charge carriers.

- The result of this process is more and more current starts flowing and hence it is said that the resistance of the device has decreased.

TYPES OF LDR

There are two types of photocells:

1) **Intrinsic**: These are pure semiconductor materials such as silicon or germanium. Electrons get excited from valence band to conduction band when photons of enough energy falls on it and number of charge carriers increases.
2) **Extrinsic**: These are semiconductor materials doped with impurities which are called as dopants. These dopants create new energy bands above the valence band which are filled with electrons. Hence this reduces the band gap and less energy is required in exciting them. Extrinsic photo resistors are generally used for long wavelengths.

CHARACTERISTICS OF LDR

- LDRs are light dependent devices whose resistance decreases when light falls on them and increases in the dark.
- When a light dependent resistor is kept in dark, its resistance is very high. This resistance is called as **dark resistance**.
- It can be as high as 1012 Ω.
- If the device is allowed to absorb light its resistance will decrease drastically.

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- If a constant voltage is applied to it and intensity of light is increased the current starts increasing.

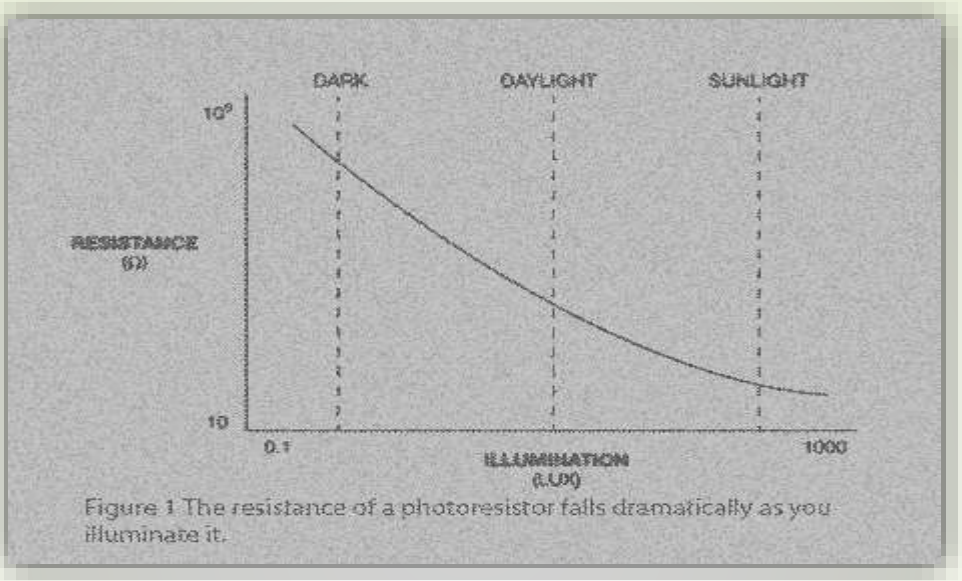

Figure 1 The resistance of a photoresistor falls dramatically as you illuminate it.

- When light is incident on a photocell it usually takes about 8 to 12ms for the change in resistance to take place, while it takes seconds for the resistance to rise back again to its initial value after removal of light. This phenomenon is called as **resistance recovery rate**.

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- LDRs are less sensitive than photo diodes and photo transistor.
- A photodiode and a photocell (LDR) are not the same, a photodiode is a p-n junction semiconductor device that converts light to electricity, whereas a photocell is a passive device, there is no p-n junction nor it converts light to electricity.
- If the light intensity is kept constant, the resistance may still vary significantly due to temperature changes, so they are sensitive to temperature changes as well.
- Extrinsic light dependent resistors are generally designed for longer wavelengths of light, with a tendency towards the infrared (IR). When working in the IR range, care must be taken to avoid heat build-up, which could affect measurements by changing the resistance of the device due to thermal effects.

CONSTRUCTION OF LDR

- Modern light dependent resistors are made of lead sulphide, lead selenide, indium antimonide and most commonly cadmium sulphide (CdS) and cadmium selenide.
- A light sensitive material is deposited on an insulating substrate such as ceramic.
- The material is deposited in zigzag pattern in order to obtain the desired resistance and power rating.
- This zigzag area separates the metal deposited areas into two regions. Then the ohmic contacts are made on the either sides of the area.

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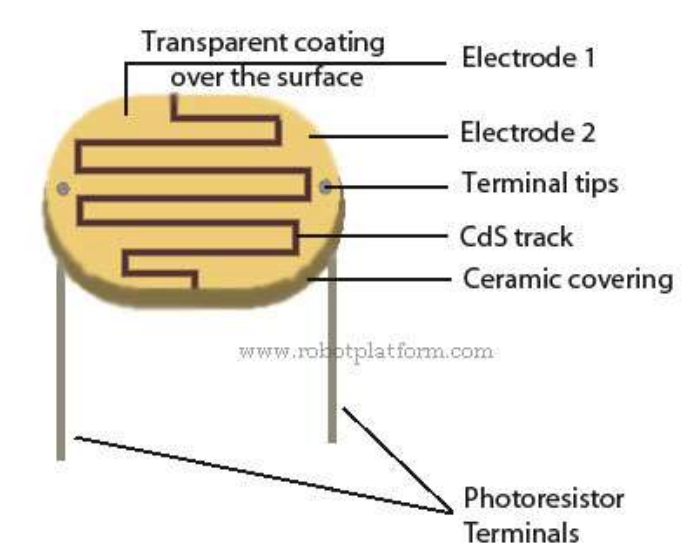
- The resistance of these ohmic contacts should be as less as possible to make sure that the resistance mainly changes due to the effect of light only.
- Highly purified cadmium sulphide powder and inert binding materials are mixed. This mixture is then pressed and sintered.
- The disc is then mounted in a glass envelope or encapsulated in transparent plastic to prevent surface contamination.



ADVANTAGES:

- LDRs are cheap and are readily available in many sizes and shapes.
- Practical LDRs are available in a variety of sizes and package styles, the most popular size having a face diameter of roughly 10 mm.
- They need very small power and voltage for its operation.

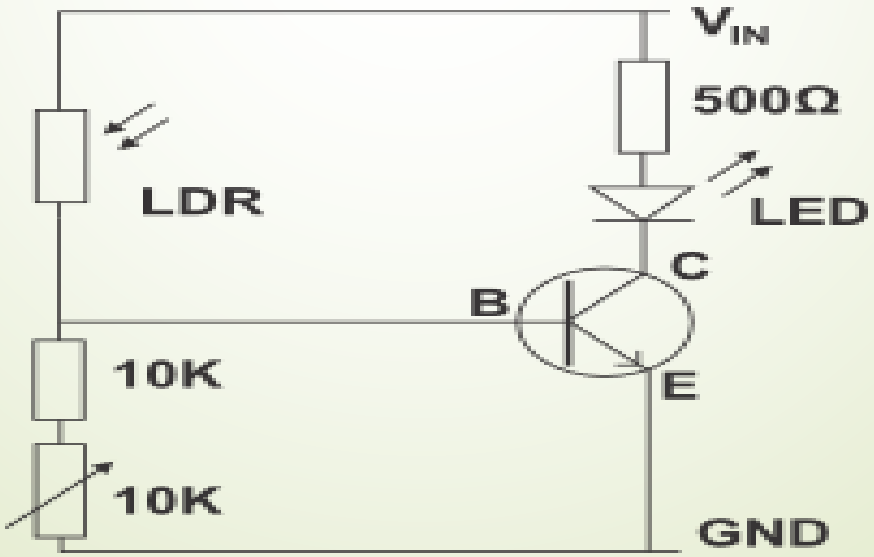
DISADVANTAGES:

- Highly inaccurate with a response time of about tens or hundreds of milliseconds.

APPLICATIONS OF LDR

1. **<u>Light sensor</u>:** The LED lights up when the intensity of the light reaching the LDR resistor is sufficient.

   Example is **Automatic Emergency Light**: It senses darkness/night and turns ON automatically. Similarly it senses day light and turns OFF automatically. Series of LEDs are connected.



2. Audio Compressor: Audio compressors are devices which reduce the gain of the audio amplifier when the amplitude of the signal is above a set value. This is done to amplify soft sounds while preventing the loud sounds from clipping. Some compressors use an LDR and a small lamp (LED) connected to the signal source to create changes in signal gain.

3. Fire Alarm: The alarm works by sensing the smoke produced during fire. When there is no smoke the light from the bulb will be directly falling on the LDR. The LDR resistance will be low and so the voltage across it (below 0.7 V). The transistor will be OFF and nothing happens. When there is sufficient smoke to mask the light from falling on LDR, the LDR resistance increases and so do the voltage across it. The transistor will switch ON which is connected to a tone player to play a music.

4. Automatic Street Light: It automatically switches ON when the night falls and turns OFF when the sun rises.

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