# Optical Communication Systems

Communication is a vital part of modern society. Information has been communicated over distances using smoke signals, beacons and flags which are seen. These systems became obsolete with the coming of the telephone and radio but now light is being used not to send signals to the eye but to send messages to electrical devices such as computers.

We gather information from the Internet, television and radio. We use telephones, e - mail, mobile phones, pagers, faxes, navigational systems and video confere ncing to communicate with each other. Communication systems are used to carry information such as:

- Pictures both still and video
- Sound such as music and voices
- Computer data (bits)

The information is carried in a variety of ways including through free spa ce, through optical fibres and as electricity through metal wires.

Communication systems have common stages:

| | |
|---|---|
| **Input** | Converts message into signals |
| **Encoder** | Generates a coded signal for each character |
| **Transmitter** | Converts coded signals into a form that can be transmitted (modulation) |
| **Link** | Carries signal from transmitter to receiver |
| **Receiver** | Recovers coded signals from transmitted signal (demodulation) |
| **Decoder** | Converts coded signals back into readable characters |
| **Output** | Displays characters to reproduce message |

# Electrical Transmitters and Receivers of Light

Optical communication systems use light to send the information from one place to another. To design an optical communication system you need to understand how to turn electrical signals into light signals and how to turn light signals back into electrical signals.

An optical communication system aims to send and receive messages using light. To do this we need to use electrical transmitters and receivers of light.

## Transmitters of Light

**Electrical transmitters of light convert an electrical signal into a light signal.**

Messages sent using white light become distorted with distance due to the large variety of wavelengths (colours) in white light. This problem is overcome by sending a signal made up of one wavelength only (a single colour). If a signal is to be sent over a long distance the colour should be pure, and the transmitter powerful.

In order to send a clear message, the transmitter should be able to be turned on and off quickly. Failure to do this could result in the end of one signal overlapping with the start of the next - causing a 'blurred' message.

The signal could become weak if transmitted over long distances. To overcome this, repeater stations are needed - these receive a weak signal and transmit a strong signal.

| Name | How does it work? |
|---|---|
| Lamp (light bulb) | A light bulb is an electrical transmitter of light. It converts an electrical signal into a light signal. The light bulb emits white light, which is not good in optical communication systems as it is easily distorted. Light bulbs take some time to become hot enough to emit light, which will slow down the speed at which a message can be sent. Electrical energy is also lost as heat. Light bulbs need a relatively high current to run them.<br>To improve the light, it can be:<br>• Concentrated into a beam so it does not diverge – this is collimating<br>• Contained in a light pipe – optical fibre is as thin as hair and as flexible. It is made of a narrow core of pure glass which is clad by pure glass but of a slightly lower refractive index. The light rays inside the core |

| | |
|---|---|
| | will be totally internally reflected along the fibre. |
| LED | A light emitting diode (LED) is an electrical transmitter of light. It converts an electrical signal into a fairly pure colour of light (red, green or yellow). Because of this, LED's are more useful in optical communication systems than light bulbs. They only need a small current to work, but they must be connected the correct way around in a circuit. Protective resistors are often connected in series with them to prevent them from being damaged. LEDs are small, reliable, need only a small current and last much longer than a filament light bulb. They can be also be different colours. |
| Laser | A laser (Light Amplification by Stimulated Emission of Radiation) is an electrical transmitter of light. It converts an electrical signal into a very concentrated and well-collimated beam of pure light. All the laser light travels in the same direction, with the same wavelength and all the waves are in step. Lasers are very useful in optical communication systems as they can be transmitted long distances before the signal needs to be boosted. Powerful lasers are used in our telephone network to transmit optical signals through many kilometres of optical fibres; less powerful lasers are used in supermarkets for reading bar codes. However, lasers are expensive, and can cause damage to the eyes if shined directly into them. |

## Receivers of Light

**Electrical receivers of light conve rt a light signal into an electrical signal.**

| Name | How does it work? |
|---|---|
| Photocell | A photocell is an electrical receiver of light. It converts a light signal into an electrical signal. A photocell does not need to be connected to a battery as it produces its own voltage dependent on the intensity of the light falling on it. Examples of photocells include the light detector on data - loggers and solar powered calculators. |
| LDR | An LDR is an electrical receiver of light. Unlike the photocell, the LDR does not generate electricity, so must be connected to a power source. The LDR has a high resistance in the dark which prevents current from flowing. In the light, the resistance of the LDR falls which allows a current to flow. |