Ministry of Higher Education and Scientific Research

Al-Mustaqbal University College

Department of Medical Physics

Analog Electronics

Lecture 1

Introduction, Conductors, Insulators, and Semiconductors

By

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Electronics

Electronics is a science that studies electronic chips and circuits in electronic devices and their principle of operation. It mainly depends on the study of the flow of electric charges (electronics) and their flow through mediums such as Air, gas and semiconductors.

There are many electronic components and devices, but they all share one characteristic that unites them, which is the internal response to the movement of electrons in one way or another. Electrons modify their path, oscillation, or frequency, form circuits among themselves, and perform various electronic functions.

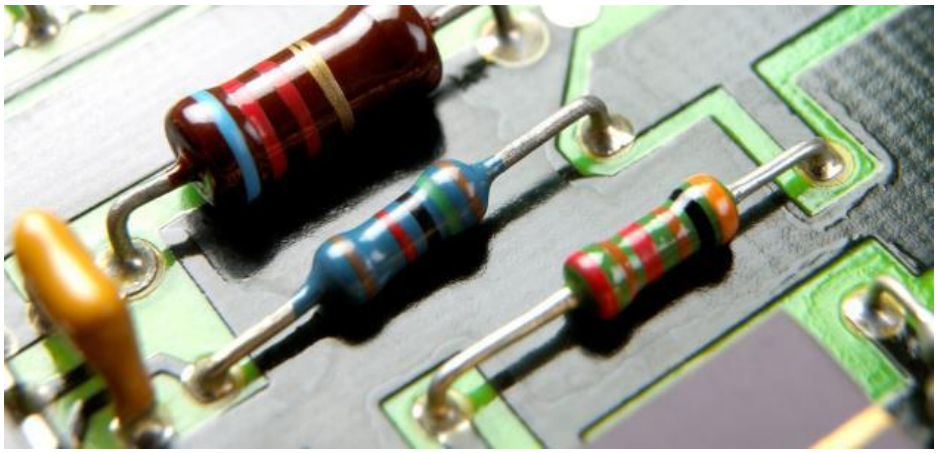
Electronic Components

There are a lot of electronic components that are used in different fields, but the most common and used are:

Picture (1) Electrical components.

- **Resistance**

Resistors are one of the most common components, the most important in electronic devices, and are used to control the potential difference between two or more electronic components, as well as a voltage divider, ampere, and the unit of resistance is the ohm Ω and is denoted by the symbol R on the board, or electronic circuit, and there are several types of them, which are fixed, variable, acoustic, and thermal resistance.



Picture (2) Resistance.

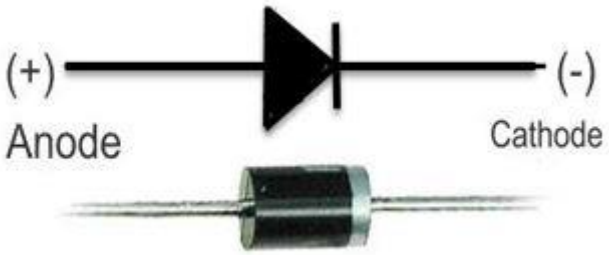
- **File Coil**

It is an insulated metal wire, of different diameters and lengths, that is wrapped around an axis of iron, iron filings, insulating material, or even around itself, forming circles stacked on top of each other, and is used to make magnetic induction in the electronic circuit, especially audio and radio circuits. Its unit is measured in Henry, it is denoted by the symbol L in the circle.

Picture (3) The electrical coil.

- **Diode**

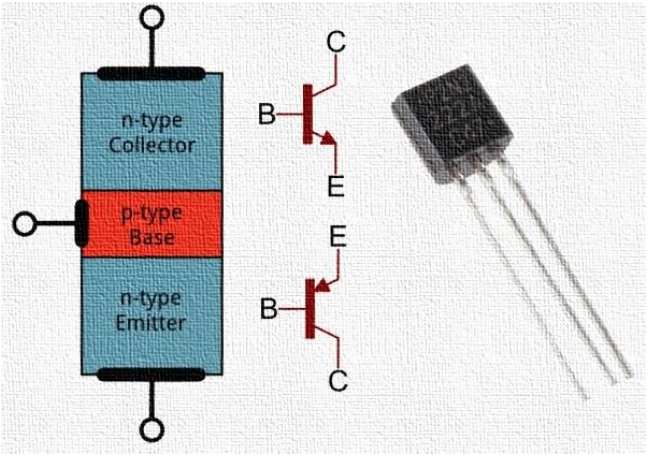
It is made of silicon crystals with some impurities added to it .The diode consists of two crystals, one negative and the other positive.



Picture (4) The diode.

- **Transistor**

The transistor is a semiconductor, which is made of positive and negative silicon crystals. Transistor that made of two positive crystals and a negative crystal called the transistor PNP .Another type consists of two crystals, negative and one positive, this type is called the transistor NPN.



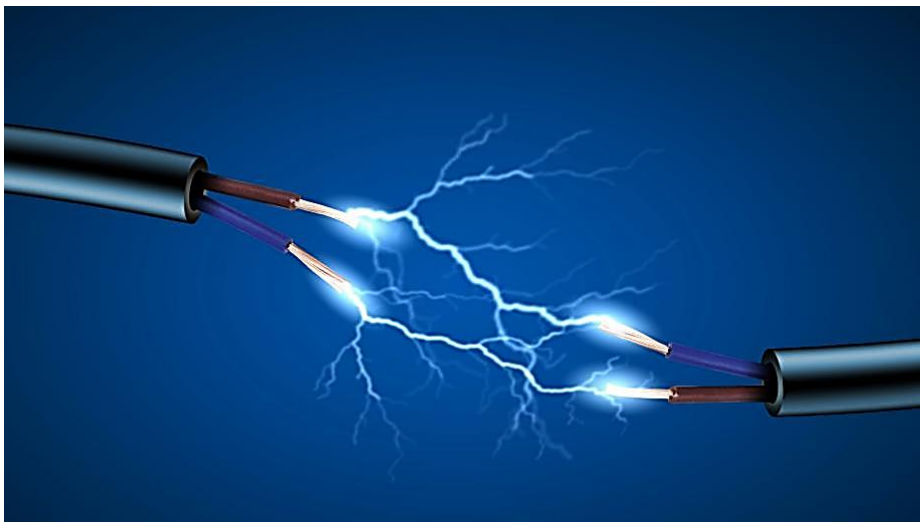
Picture (5) The transistor.

Electronic Components Jobs

The electronic components perform many functional roles, so that each component does not have a single function only, but each component has a single function that it is independent of, and infinite other functions, which depend on the rest of the components that share with it in the electronic circuit with which it works and each group of the electronic circuits, they form a group of devices that perform one of the tasks.

Conductors

Conductors are materials that charges can pass through without resistance capable of passing an electric current and are also good conductors of heat .The opposite is an electrical insulator that often surrounds it to form an electrical wire.



Picture (6) Template for conduction.

Matter consists of atoms, and atoms contain very small molecules known as electrons, and these electrons are responsible for conduction, due to their ability to move.

Conductivity used to express materials through which charges can pass without hindrances and difficulties, depending on the nature of the electrons present in the outer orbital of the atoms of the materials.

In general, metals are electrically conductive, silver, copper, and gold, but because of their high cost, silver and gold are rarely used as conductors of electricity .However, gold is used in computers and electronics and as a thin film to cover and protect the corrosion of copper or silver wires for printed circuits.

How conductors work

It is stated that charges pass through them easily and this is done as follows:

- The movement of electrons within the material.
- Electrons move between atoms in contact when the material is conductive.
- Electrons remain in free motion unless collisions occur and that is exactly what is said to be the easy passage of an electron.
- As the electrons move, the material continues to conduct.
- When a collision occurs, this decrease the conductor and reduces its efficiency.

Factors affecting conductors

The electrical conductivity of conductors is affected by several factors, either increasing or decreasing. The most important of these factors are the following:

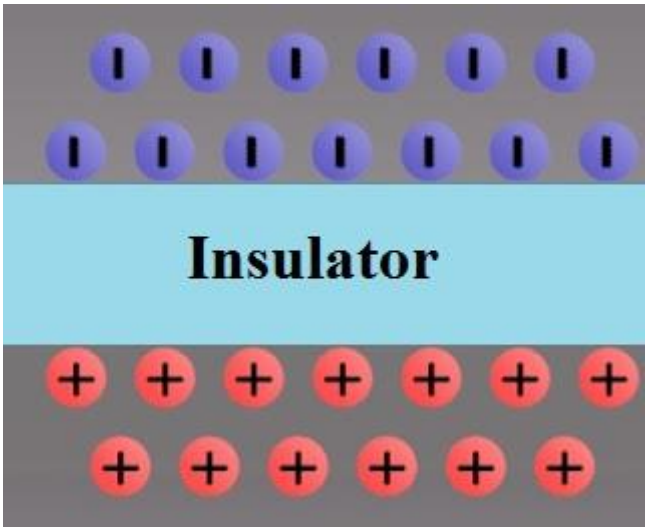
- **Temperature :**Temperature is inversely and linearly proportional to the conductivity of electrical conductors in general.
- **Impurities:** Impurities hander the movement of electrons within electrical conductors, so the amount of impurities is also inversely proportional to the conductivity of the conductor, as the best are completely pure conductors.
- **The crystal structure:** The material has states, solid, liquid and gas, and the conductor can be converted from

one state to another, and the conductivity of the material varies according to the state, as the transformation process affects the conductivity as well.

- **Electromagnetic field:** A conductor naturally has its own magnetic field in a direction perpendicular to the electric field that passes through it, and when this conductor is placed next to an external electromagnetic field, it may negatively affect and reduce the amount and speed of the electric field within it.

Insulators

The opposite of the electrical conductor. Insulators have their electrons closely related to the nucleus, so their movement is not as easy as in conductors, and they have a high resistance to the passage of any current through them, and one of the most important uses of electrical insulators is to cover conductors is critical to safety, as if the wires were left bare it would be dangerous, and common examples in this field are rubber, glass and paper.



Picture (7) The idea of insulation.

Most non-metallic materials are poor conductors and therefore good insulators .They have no free electrons available to conduct electricity .Materials with higher resistance values offer greater resistance to the flow of electric current and are therefore better insulators.

Properties of insulators

1. The valence electrons are tightly bound together .They do not have free electrons to conduct electricity.
2. The ability of a material not to allow an electric current to pass through it is called electrical resistance .The resistance of the insulator per unit cross-sectional area per unit length is called resistance .Insulators have a very high resistance.
3. The resistance of the insulator decreases significantly in the presence of moisture and when there is an increase in temperature.
4. Insulators have great dielectric strength .The dielectric strength is the maximum range that an insulator can withstand without breaking down and becoming a conductor.

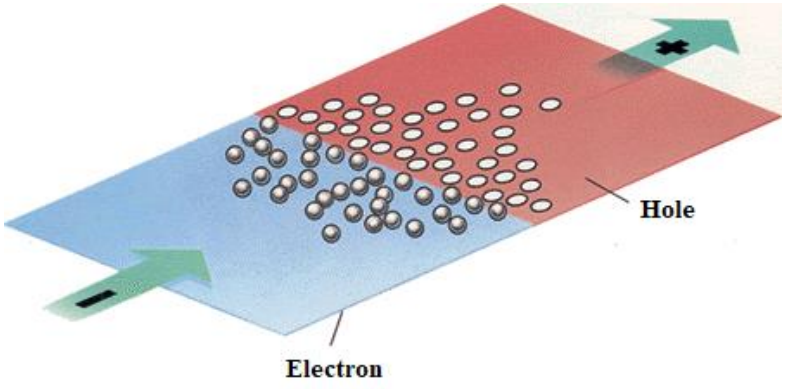
Picture (8) is a sample of the wires insulating layers.

Semiconductors

Semiconductor materials can be defined that they are materials whose electrical conductivity is medium, they are neither conductors nor insulators ،as they are located in the region between insulating materials and conductive materials. Semiconductors constitute the future of modern electronic systems, and examples of which are silicon (Si) and germanium (Ge).

Devices and equipment that manufacture semiconductor materials are the basis of modern electronics, which include radio, computer, telephone, television and many other devices. Semiconductor electronic parts include transistors, solar cells, diodes, LEDs, and analog and digital integrated circuits.

In metallic conductors, electrons transmit electric current, while in semiconductors, electric current is transmitted by a torrent of electrons (with negative charges) heading to the positive electrode, accompanied by a torrent of holes (Positively charged). During the atomic structure of the material it tends to the negative electrode .The positive electron gaps are formed by the impurity of a semiconductor material such as germanium with an impurity from another element.

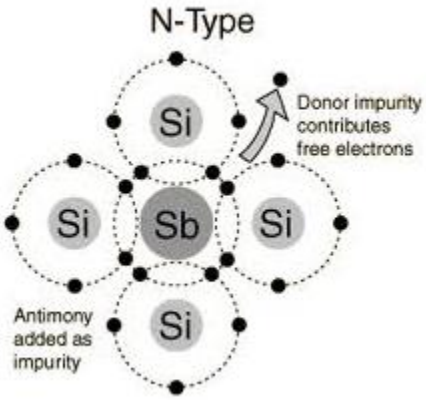


Picture (9) Semiconductor.

Semiconductors are characterized by their poor ability to transmit electric current, which made manufacturers add some impurities to them to improve their conductivity, and it is called Doping. The increase or decrease in the conductivity of the element depends on the amount and type of impurities added to it.

N-type semiconductor

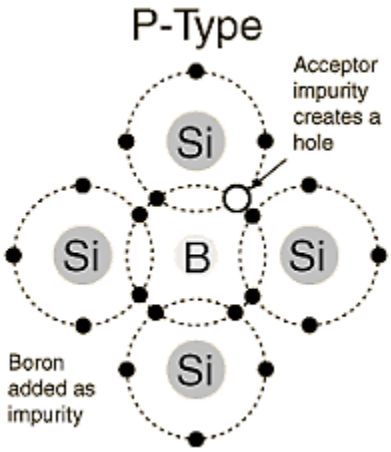
Which are semiconductors that contain a larger amount of free electrons, which means that they have a higher conductivity.



Picture (10) N-type semiconductor.

P-type semiconductor

Which are semiconductors that contain a smaller amount of free electrons, which means that they have a lower conductivity.



Picture (11) P-type semiconductor.

Uses of semiconductors

Semiconductors are used in many fields and practical applications, the most prominent of which are the following:

- Temperature sensor industry
- Manufacture of microchips for self-driving vehicles .
- Manufacture of electronic devices, such as calculators, solar panels, and computers.
- Manufacture of a piece of transistor used as a switch in electrical circuits.