# Basic Electronics Part 1

by

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The purpose of this article is to introduce some basic electronics. For some it may be boring, however, I hope some will find it interesting. If there is enough interest, there will be follow-up articles at the same level. Some of this material is taken from “Understanding Basic Electronics” by Larry Wolfgang, WR1B.

All materials present some opposition to the flow of electrons. If that opposition is relatively small, the material is called a conductor. If the opposition is large, the material is called an insulator. Some materials have too much opposition to be good conductors, yet they allow too much current to be insulators. Such materials are useful in electronics circuits because of their opposition to electron flow. We call materials like these resistors. The material resists the flow of electrons through them. You can control the amount of current in an electronics circuit by carefully selecting the amount of resistance in that circuit. Carefully selected and properly placed, resistors will guide exactly the right amount of current to each part of a circuit. Current flowing through any resistance will produce heat. There will be more heat when there is a larger current. Most of the time this heat is a waste product that we must remove from the circuit.

The resistance in a piece of wire depends on the type of metal used to make the wire, the length of the wire, and the diameter of the wire. We can construct a resistor by winding a length of wire around a piece of wooden dowel or other form. The exact amount of resistance depends on the type of wire and on its length and diameter. Such resistors are called wirewound resistors.

Carbon has a resistance that is quite a bit greater than copper. Manufacturers mix carbon with clay and form it into thin cylinders, or pellets. Then they attach wire leads to the ends, forming resistors that we can conveniently connect into an electronics circuit. The clay serves to hold the powdery carbon together. By changing the amount of clay in the mixture, manufacturers can also control the resistance. Such resistors are called carbon-composition resistors.

If we start with a cylinder of ceramic material, which is an insulator, place a thin film of carbon over the ceramic, attach leads, and coat the resistor with a layer of epoxy sealer to insulate and protect it, we have a carbon-film resistor. A similar construction method uses a thin film of metal on the ceramic base. Resistors made in this way are metal-film types.

We now want to talk about an electronic circuit. What is an electronic circuit? One simple definition is that an electronic circuit is a path that electrons follow. We probably would like to have such a circuit do something useful, so we are talking about more than just a wire from the negative to the positive side of a voltage source. To make an electronic circuit we need a voltage source, the electrical pressure to move electrons through the circuit. Next we need some wire or other conductor for the electrons. Finally, there should be some purpose for the circuit such as lighting a light bulb. We often refer to the part that gives a purpose to the circuit as the load. Any useful electronic circuit has at least these three parts. We often draw a resistor to represent the load in a circuit. Sometimes a resistor also represents the combined resistance of all the other parts of a circuit. This resistor can include the resistance of the wire that connects the various parts. Even batteries, often used as the voltage source for circuits, have some resistance to the flow of electrons. All of these resistances represent the unavoidable natural resistance of the materials in a circuit.

If a circuit is such that all electrons that leave the negative battery terminal must follow the same path, going through every part of the circuit, to reach the positive battery terminal, then we call the circuit a series circuit (See Fig. 1).

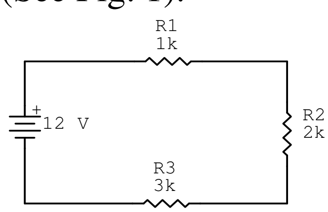


Fig. 1

In this case, the current in one part of the circuit is the same as in every other part of the circuit. If you measure the current at any place in a series circuit, you'll know the current everywhere in the circuit. You can have more than one load in an electronics circuit. If you connect several loads so the same current must flow through each load, you have a series circuit. A Christmas light string with several small bulbs may be connected in series. The big disadvantage of such an arrangement is if one bulb burns out no electrons can flow. That means that all bulbs go out. Finding the one that is burned out may be a problem.

Many electronic circuits include alternate paths for the current to follow. Such a circuit is called a parallel circuit. Each possible electron path forms a branch of a parallel circuit. The current that flows through each individual path may be different (See Fig. 2).

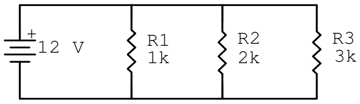


Fig. 2

Ohm's Law is a tool that is used to study most electronic circuits. It is usually written as E = I x R or E = I R, where E is the voltage in volts, R is the resistance in ohms, and I is the current in amperes. When you know any two of the three quantities in a circuit, you can calculate the third quantity. We can use Ohm's Law to calculate the voltage drop across any resistor in a series circuit. The only requirement is that we know the resistance and the current through the series circuit. For example, if we measure the current in the series circuit in Fig. 1 as 2 milliamps or 0.002 A, then the voltage drop across each resistor may be calculated as follows:

For R1, the voltage is E1 = (0.002)(1000) = 2 volts.
For R2, the voltage is E2 = (0.002)(2000) = 4 volts.
For R3, the voltage is E3 = (0.002)(3000) = 6 volts.

Notice that the sum of the voltage drops across the three resistors is the total voltage of the series circuit.

The parallel circuit presents a slightly different problem. The current through each branch of the circuit is different. Notice that the full battery voltage is applied to each parallel branch. This means that we can use Ohm's Law to calculate the amount of current through each branch. In this case we use Ohm's Law in the form I = E / R.

If we denote the current through R1 as I1, then

I1 = E / R1 = 12 / 1000 = 0.012 A or 12 milliamps (mA).

Similarly, I2 = 6 mA, and I3 = 4 mA.