Direct Current Circuits Fundamentals

An Online Continuing Education Course for Engineers

Course Number: E-6003

Credit: 6 Hours / 6 PDH / 6 CPD

THE BASIC ELECTRIC CIRCUIT

The flashlight is an example of a basic electric circuit. It contains a source of electrical energy (the dry cells in the flashlight), a load (the bulb) which changes the electrical energy into a more useful form of energy (light), and a switch to control the energy delivered to the load.

Before you study a schematic representation of the flashlight, it is necessary to define certain terms. The LOAD is any device through which an electrical current flows and which changes this electrical energy into a more useful form. Some common examples of loads are a lightbulb, which changes electrical energy to light energy; an electric motor, which changes electrical energy into mechanical energy; and the speaker in a radio, which changes electrical energy into sound. The SOURCE is the device which furnishes the electrical energy used by the load. It may consist of a simple dry cell (as in a flashlight), a storage battery (as in an automobile), or a power supply (such as a battery charger). The SWITCH, which permits control of the electrical device, interrupts the current delivered to the load.

SCHEMATIC REPRESENTATION

The main aid in troubleshooting a circuit in a piece of equipment is the SCHEMATIC DIAGRAM. The schematic diagram is a "picture" of the circuit that uses symbols to represent the various circuit components; physically large or complex circuits can be shown on a relatively small diagram. Before studying the basic schematic, look at figure 1. This figure shows the symbols that are used in this course. These, and others like them, are referred to and used throughout the study of electricity and electronics.

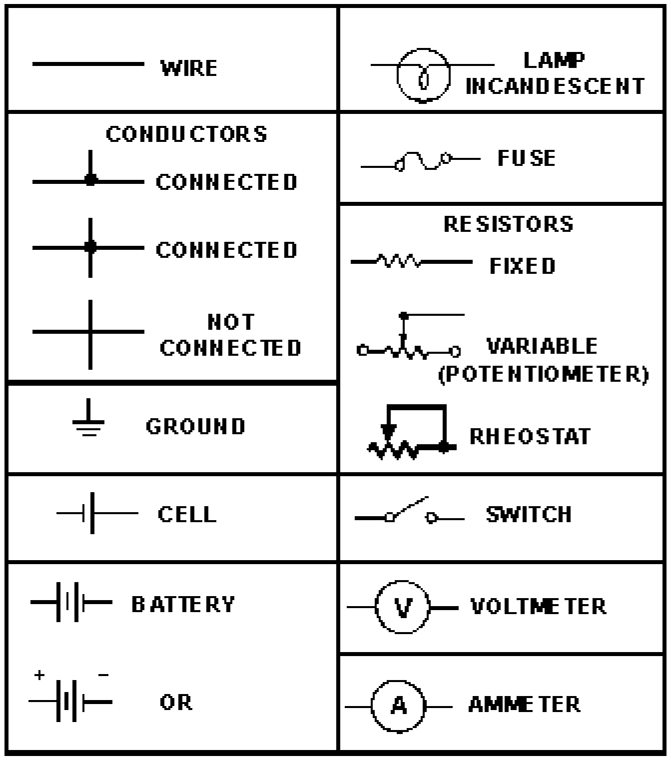

Figure 1.—Symbols commonly used in electricity.

The schematic in figure 2 represents a flashlight. View A of the figure shows the flashlight in the off or deenergized state. The switch (S1) is open. There is no complete path for current (I) through the circuit, and the bulb (DS1) does not light. In figure 2 view B, switch S1 is closed. Current flows in the direction of the arrows from the negative terminal of the battery (BAT), through the switch (S1), through the lamp (DS1), and back to the positive terminal of the battery. With the switch closed the path for current is complete. Current will continue to flow until the switch (S1) is moved to the open position or the battery is completely discharged.

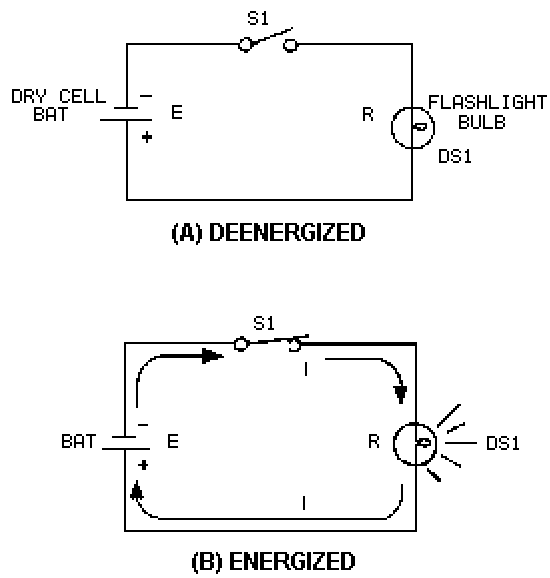

Figure 2.—Basic flashlight schematic.

Q1. In figure 2, what part of the circuit is the (a) load and (b) source?

Q2. What happens to the path for current when S1 is open as shown in figure 2(A)?

Q3. What is the name given to the "picture" of a circuit such as the one shown in figure 2?

OHM'S LAW

In the early part of the 19th century, George Simon Ohm proved by experiment that a precise relationship exists between current, voltage, and resistance. This relationship is called Ohm's law and is stated as follows:

The current in a circuit is DIRECTLY proportional to the applied voltage and INVERSELY proportional to the circuit resistance. Ohm's law may be expressed as an equation:

$$I = \frac{E}{R}$$

Where: I = current in amperes
E = voltage in volts
R = resistance in ohms

As stated in Ohm's law, current is inversely proportional to resistance. <u>This means, as the resistance in a circuit increases, the current decreases proportionately</u>.

In the equation

$$I = \frac{E}{R}$$

if any two quantities are known, the third one can be determined. Refer to figure 2(B), the schematic of the flashlight. If the battery (BAT) supplies a voltage of 1.5 volts and the lamp (DS1) has a resistance of 5 ohms, then the current in the circuit can be determined. Using this equation and substituting values:

$$I = \frac{E}{R} = \frac{1.5\ \text{volts}}{5\ \text{ohms}} = .3\ \text{ampere}$$

If the flashlight were a two-cell flashlight, we would have twice the voltage, or 3.0 volts, applied to the circuit. Using this voltage in the equation:

$$I = \frac{E}{R} = \frac{3.0\ \text{volts}}{5\ \text{ohms}} = .6\ \text{ampere}$$

You can see that the current has doubled as the voltage has doubled. This demonstrates that the current is directly proportional to the applied voltage.

If the value of resistance of the lamp is doubled, the equation will be:

[redacted]

The current has been reduced to one half of the value of the previous equation, or .3 ampere. This demonstrates that the current is inversely proportional to the resistance. Doubling the value of the resistance of the load reduces circuit current value to one half of its former value.

APPLICATION OF OHM'S LAW

By using Ohm's law, you are able to find the resistance of a circuit, knowing only the voltage and the current in the circuit.

In any equation, if all the variables (parameters) are known except one, that unknown can be found. For example, using Ohm's law, if current (I) and voltage (E) are known, resistance (R) the only parameter not known, can be determined:

1. Basic formula:

$$I = \frac{E}{R}$$

2. Remove the divisor by multiplying both sides by R:

$$R \times I = \frac{E}{\cancel{R}} \times \frac{\cancel{R}}{1}$$

3. Result of step 2: R x I = E

4. To get R alone (on one side of the equation) divide both sides by I:

$$\frac{R\cancel{I}}{\cancel{I}} = \frac{E}{I}$$

5. The basic formula, transposed for R, is:

Refer to figure 3 wh R, using the equation just explained.

Given:

Solution:

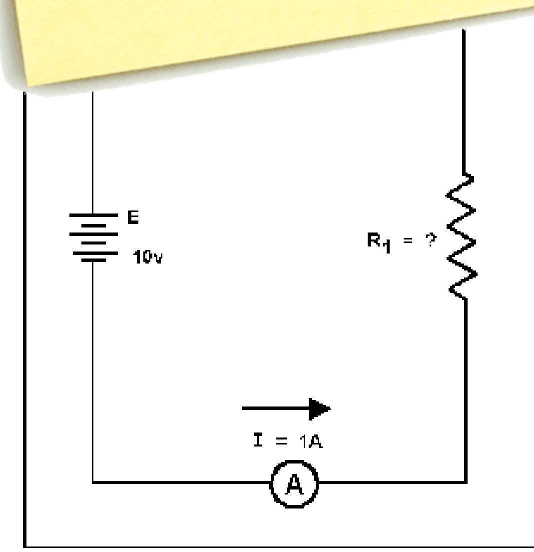

Figure 3.—Determining resistance in a basic circuit.