How-To #4: Read Resistor Values

Many of the experiments and projects in these lessons use resistors. Resistors come in different values, representing the amount of resistance offered the flow of electrons. The unit of measure is the ohm, named after the German physicist and mathematician Georg Simon Ohm.

The value of any particular resistor is usually indicated by a set of colored stripes on the body. This How-To illustrates how to determine a resistor's value by reading these colors.

Figure HT4-1. Georg Ohm
(Wikipedia*)

Background:

Electricity is the flow of electrons through some conductive medium. For the circuits made in the lessons in this book and on the website LearnCSE.com, the medium is usually copper wire or copper foil on a printed circuit board. Electrons flow through copper very easily, so easily we can think of them as meeting no resistance.

But there are times when we want electrons to meet with resistance. This might be to protect an electronic device. Too many electrons through a light-emitting diode, for example, can cause its internal components to overheat and melt or burn.

Other times we want a voltage that is somewhere between zero and some value. This is called a voltage divider; and Lesson 9: Analog IO uses a voltage divider to determine the position of a knob that can be turned.

The important point is that a resistor is a device that presents "resistance" to the flow of electrons. This resistance results in a measurable voltage across the resistor. The relationship between resistance of a resistor, the quantity of electrons that flow through that resistor, and the voltage measurable across that resistor was determined by Herr Ohm and is expressed in the law that bears his name, Ohm's Law.

Figure HT4-2 shows a resistor of value 220 ohms connected across a 9-volt battery. Notice current (I) flows through the resistor and encounters resistance (R). This results in the voltage (V) that can be measured across the resistor.

*Image of Georg Simon Ohm: Public domain, Wikimedia Commons via German Wikipedia. {{PD-1923}}

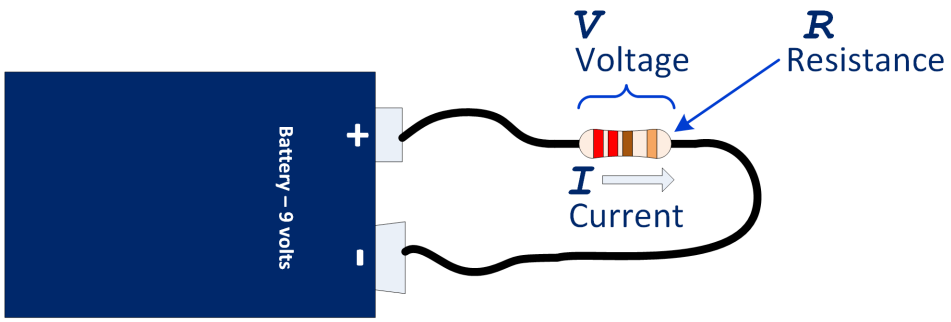


Figure HT4-2. Resistor connected across a 9-volt battery

The relation of voltage to resistance and current is expressed by Ohm's Law: ***V=IR***

Description:

Reading the colors

Consider the resistor shown in Figure HT4-3. Remember, an actual resistor is less than ½-inch in length. To make reading instructions easier to understand, resistor images are magnified greatly in this How-To.

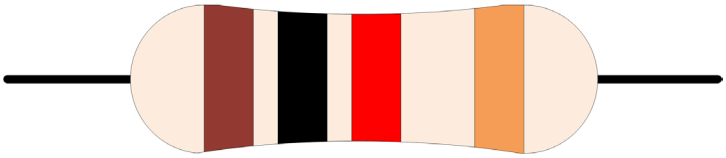


Figure HT4-3: Resistor (expanded greatly from actual size)

Notice that this resistor, like a typical resistor, has four stripes. Three are close together, as seen in Figure HT4-3. The fourth is by itself and is a metallic color, usually silver or gold. The colored stripes indicate the value, whereas the metallic color indicates the tolerance, an estimate of how close the actual value of the resistor comes to the indicated value.

The colors are read from left to right, with the metallic color on the right-hand side. A gold band indicates that the actual value of the resistor is within 5 percent of what the stripes indicate. A silver band indicates that the actual value is within 10 percent.

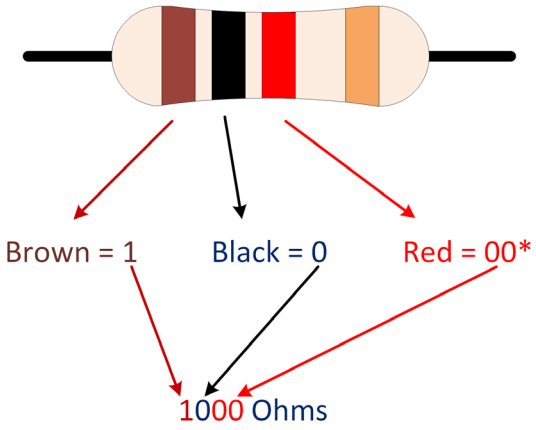
The value of a resistor is expressed in ohms and encoded in the colors. Each color is associated with a number, as shown in Table HT4-1.

Table HT4-1. Resistor color codes

Color	Value
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

The first two colors on the resistor shown in Figure HT4-3 are actual numbers, read directly from the color table, as shown in Table HT4-1. In this case the colors are brown (with a value of 1) followed by black (value of 0). Together, they produce the number 10.

The third color is red. But instead of being read as the number 2, it is interpreted as the number of zeros to be added to the number produced by the first two colors. In this case, red is 2, meaning two zeroes are added. The final resistance is 1000 ohms.

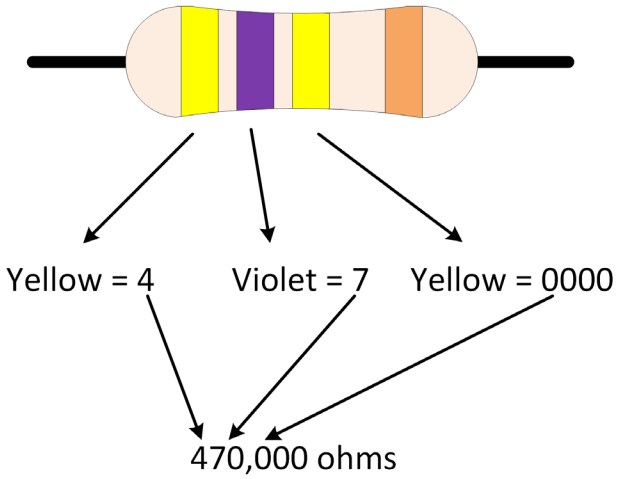


*The third stripe is the number of zeroes.

Note: The gold stripe at the end means the actual value is 1000 ohms with a possible error of up to 5%.

Figure HT4-4. Diagram for reading 1000 ohm resistor

Figure HT4-5 is another example of a resistor, this time a resistor with colors yellow-violet- yellow. The resulting value, 470,000 ohms, can also be written 470k ohms, where the letter k is representing three zeros.



*The third stripe is the number of zeroes.

Note: The gold stripe at the end means the actual value is 470,000 ohms with a possible error of up to 5%.

Figure HT4-5. Diagram for reading 470,000 ohm resistor