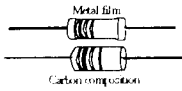
The Resistor



symbol

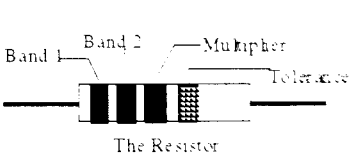
The resistor "resists" the flow of current in an electronic circuit. The resistor will be found in hundreds of different values measured in 'ohms'. You will see ten ohm resistors, 1,000 ohm resistors and 10 meg resistors (and so on...). The last one is 'megohms' which means millions of ohms. And you will see 47 ohm resistors and about one hundred other common values, all stated in *ohms*. You can figure out the value of a resistor by a *color code* in stripes around the body of the resistor

Shorthand is often used for resistors' values on drawings. "K" means 1,000 so a 10K resistor is ten thousand ohms. The "K" is short for kilo, or kilohm. A million ohms is called a megohm. And this is often abbreviated as an "M". Then a 1M resistor is one megohm or one million ohms.

The resistor is not a polarized device; which means that the resistor can be placed in a circuit "facing" either direction. It has no "face' or front or back. It simply does not matter which lead wire is connected to positive or negative in a circuit. You will see 1/4 watt resistors mostly; be aware that there are some that are bigger around with higher power ratings, such as 1/2 watt, 1 watt etc. In a schematic, the resistor is shown either as a zigzag line or sometimes as a rectangle (European). Either way the value (resistance) of the resistor should be either on the schematic or, more often, the component number so that you can find the value on the parts list. This number would look like: R1 or R2 and you find the value in the parts list as you saw in the first chapter about *reading the schematic*.

Also, be aware that you can put resistors in parallel to decrease the value, or in series to increase resistance. We have put the formulae for doing this in the formulae section. But you will want to read about this in your other books; just to be sure this is very clear. It's important.

Resistors come in different power handling capacities; or SIZES. You'll see very small ones that are 1/8 watt, and then ¼ watt and ½, 1 and 2 watt sizes. As today's circuits are often low power, you'll probably not work



Note the illustration above. Hold a resistor up in front of your face. Note that the color bands are closer to one end; put that end on your left. On your right, the last band will usually be silver or gold . The colors will tell you the value (or resistance) of the resistor. For Example: a resistor coded yellow, violet and red is a 4700 ohm resistor. That's because the yellow is a four, the violet is a seven and the multiplier band colored red is one hundred. To your left is a chart containing the resistor color code; make a photo copy and paste it near your workbench.

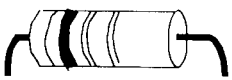
If there is no fourth band, the tolerance is 20% (a really cheap resistor). That means the resistor value in ohms may be 20% higher than its coded value or 20% lower or anywhere in between. If the fourth band is silver the tolerance is 10% and a gold band means 5% tolerance. The 5% tolerance is getting to be a standard, and you may not see any other tolerance.

RESISTOR VALUES COLOR CODE CHART

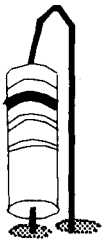
Band three is the "multiplier band", the X means to multiply by the number shown in that column. A resistor with three brown bands would be 110 ohms and so on.
Gold fourth band, 5% tolerance. Silver fourth band, 10% tolerance
No fourth band, 20% tolerance.

Color	Band 1	Band 2	Band 3	tolerance band 4
Black	0	0	X1	
Brown	1	1	X10	1%
Red	2	2	X100	2%
Orange	3	3	X1,000	3%
Yellow	4	4	X10,000	4%
Green	5	5	X100,000	
Blue	6	6	X1,000,000	
Violet	7	7	X10,000,000	
Gray	8	8	X100,000,000	
White	9	9	(none)	

The resistor leads are a soft copper wire, plated with tin to keep the copper from corroding and also because tin is easy to solder to. Resistors may be mounted on a PC board "flat", like the illustration at the right. The leads are bent and pushed through the holes in a PC board and soldered on the *other side of the board.*



Or they may be stood on end like the sketch on the left.



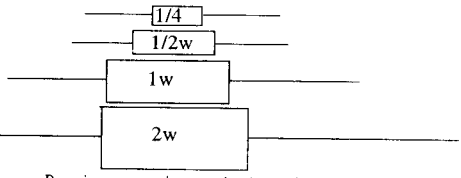
This J-lead mounting is sometimes needed when parts are jammed close together on a PC board.

←J-lead mounting.

A wide first band denotes a wire-wound resistor.

Wide first with blue fifth band, denotes flameproof wirewound resistor.

There are variations on the basic system for marking resistors. Here is one of them that may at first confuse you. The color code chart still applies; but something has been added as you can see here.



Resistors, size relationship

Values: Can you see that a 650 ohm resistor is marked with bands Blue, Green, Brown? And that a one megohm (1 meg) resistor is marked Brown, Black, Green?

We will mention that surface mount resistors are shaped differently and marked differently (or not marked at all). We won't deal with them at this time.

You might have some fun checking the value of resistors with your multimeter set on 'ohms' and see how close the true value comes to the marked value. Keep in mind that the markings may be more accurate than a low cost ohm meter.

Finally, don't get concerned about what resistors are made of when you start building circuits. Most will be *carbon composition or metal film types.* Sometimes you'll run into *wirewound* resistors. Don't worry about those details right now, just use whatever the circuit calls for and you'll soon understand the fine differences and when you need to use them.

About ***Tolerance***. This is a good place to talk about tolerance for just a minute. All "passive" components, which includes resistors and capacitors, have a rated value which is only "close" to the actual value. The manufactures can make a part that is "pretty close" to the rated value, or they can make one that is "really" close but the cost is going to be higher. The "tighter" the tolerance, the higher the cost of the materials and cost of the manufacturing process.

You could buy a 390 ohm resistor with a tolerance of 20% or 10% or 5% or even 1%. Resistors have become so low in cost these days that we don't often see "twenty-percenters". Even the bargain packs from hobby stores often contain 10% or 5% resistors.

Here's how it works: a 390 ohm resistor with a 5% tolerance could actually be 19.5 (5% of 390) ohms higher or lower in value. OR, our 390 ohm resistor could be as low as 370.5 ohms or as high as 409.5 ohms; or anywhere in between. And you have probably figured out by now, you can always substitute a tight tolerance resistor for one that is sloppier; 5% is always better than 20% etc..

About ***wattage***: our 390 ohm resistor can not only be purchased in Sloppy or Tight tolerance-types, they can also be purchased with different *power ratings.* You could buy a 390 ohm resistor rated at 2 watts or 1 watt or ½ watt or ¼ watt and even 1/8 watt. As the wattage gets smaller, so does the size (see illustration above). The smaller sizes, such as ¼ watt, are very popular as that is all that many circuits require and they are smaller and less costly than a 1 or 2 watt resistor. Usually the only way to tell the difference is size; a 2 watt is bigger than a ¼ watt by a lot. Be sure that you don't someday replace a part with a big wattage rating with a smaller, light-weight; it will probably burn up!