

## Resistors

Resistors are made of some semiconductor material. The objective is to limit or control the amount of current that flows in a circuit. Typically resistors are made of Carbon or a metal oxide. Let's take a view of history for a paragraph, or two.

### Carbon composition resistors

These were little more than a carbon rod with a wire contact at each end. This was coated with a plastic (phenolic) case, usually brown, and colored stripes were painted on it to indicate its resistance. Default percentage value was 20%. For a little higher price you could get 10%, or even 5% if cost were not an objective. These had a serious disadvantage of changing resistance at higher frequencies. A phenomenon called Skin Effect causes current to stick to the outer area of the resistor at higher frequencies. Carbon composition resistors changed their resistance with different signal frequencies.

These are easily identifiable by their distinctive clearly cylindrical shape.

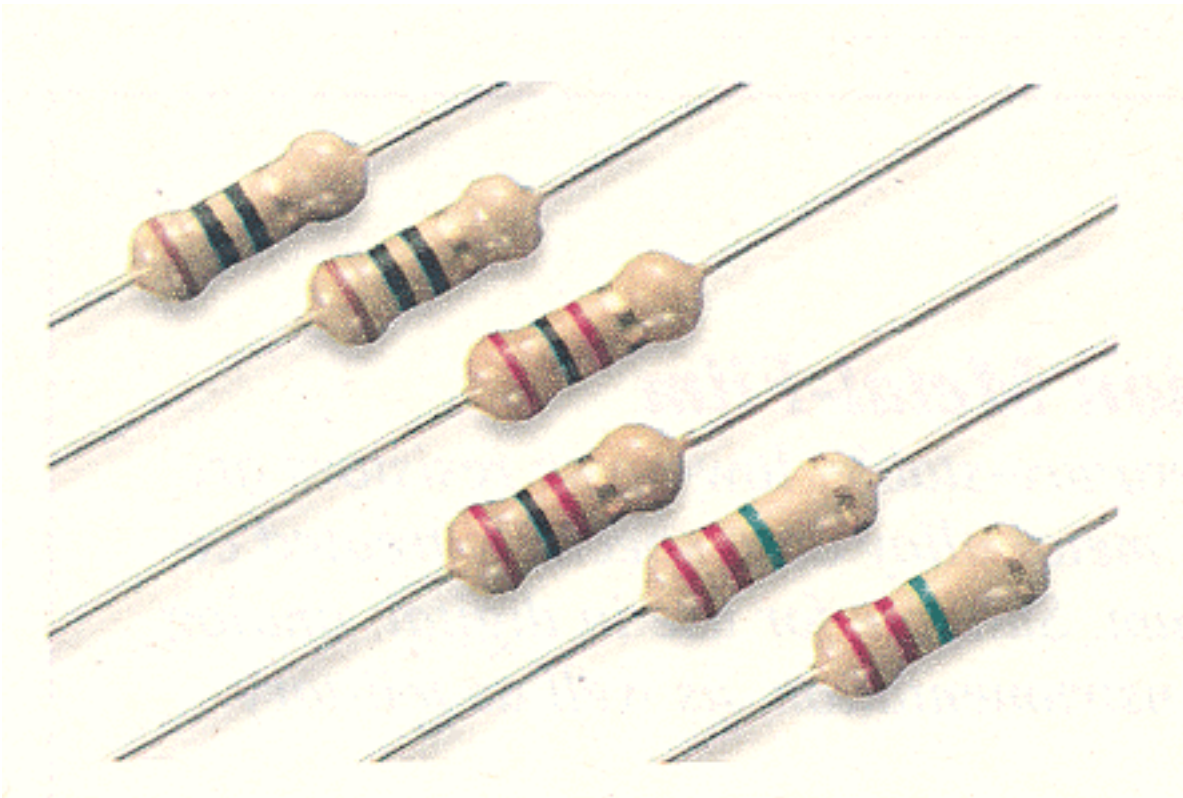
### Carbon film resistors

The Skin Effect was done away with by using a ceramic rod and coating it with a carbon film. Most resistors are made this way these days. Default tolerance of these devices is 5%, with 2% available at a slightly higher price.

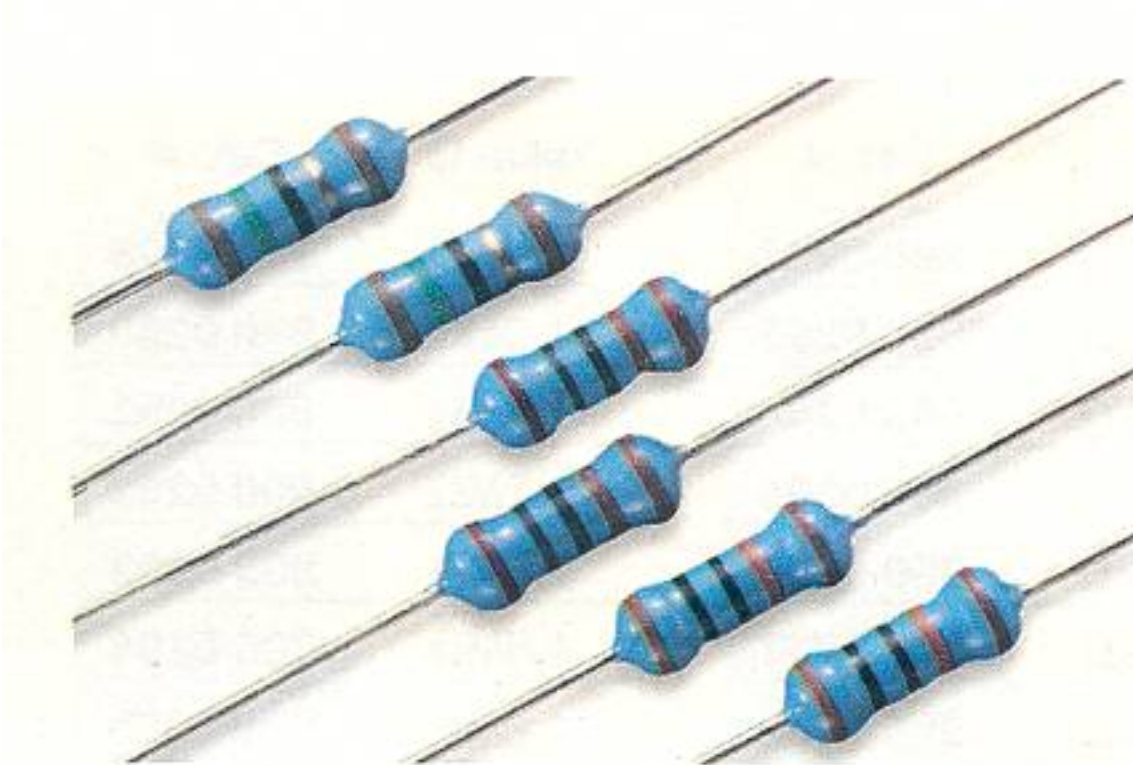
The colored stripes are still used to indicate the resistance of the resistor. The body is a ceramic rod, coated with carbon, with metal end caps the wires connect on to. This is covered in a plastic case, giving the resistor a "dog bone" shape.

Almost all resistors made today are of this structure.

Shown below is a typical 5% Carbon Film resistor. The colored stripes indicate resistance and tolerance percentage. Sometimes a fifth color is added indicating Failure Rate (usually yellow). For our purposes, this can be ignored. The physical size indicates the wattage of the resistor.



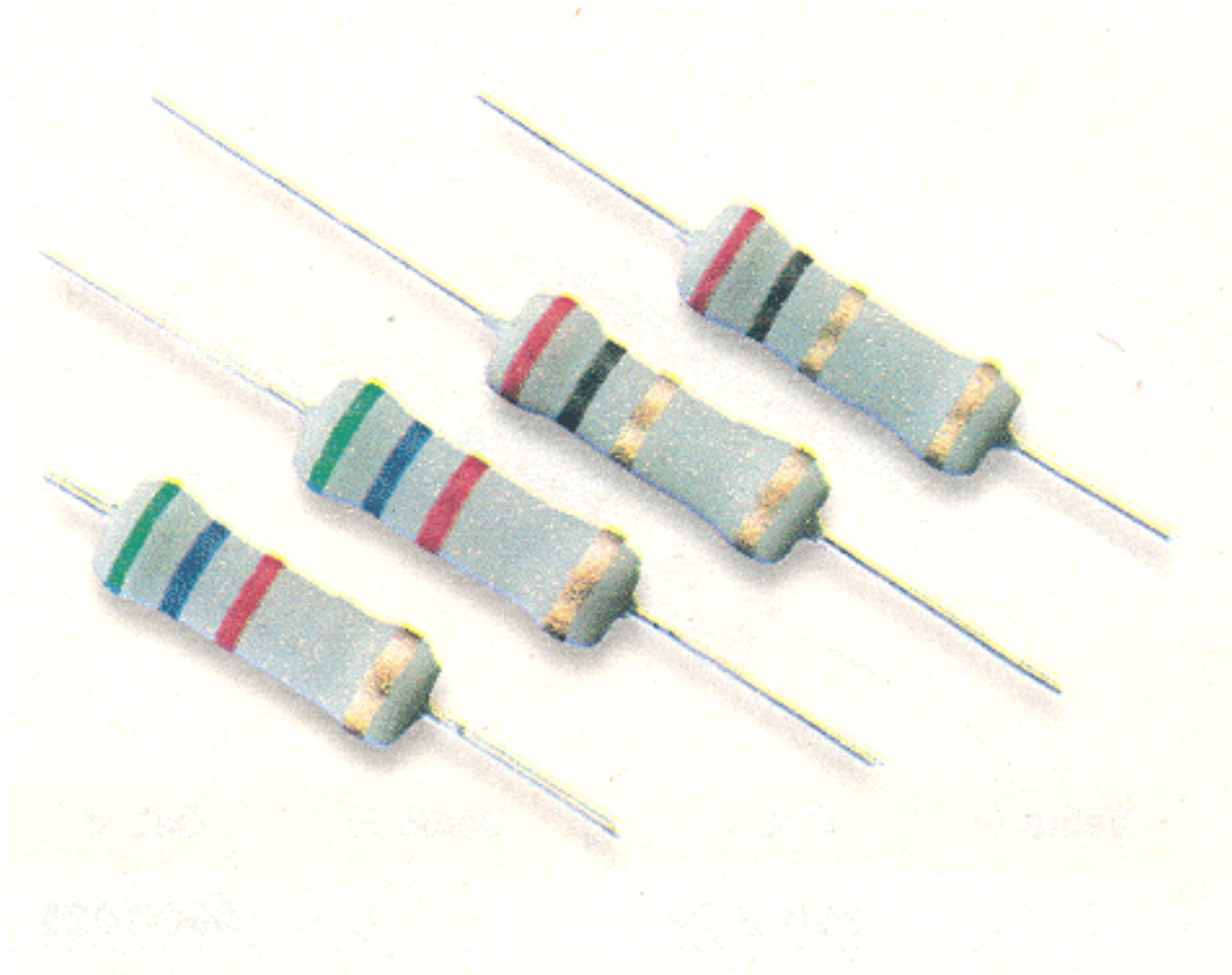
Similar in appearance is the 1% resistors. Four colored stripes are used to indicate the resistance value instead of using three colors 2% or 5% values use. The last band is Brown, indicating a 1% resistor.



### Metal Oxide, Flame Proof resistors

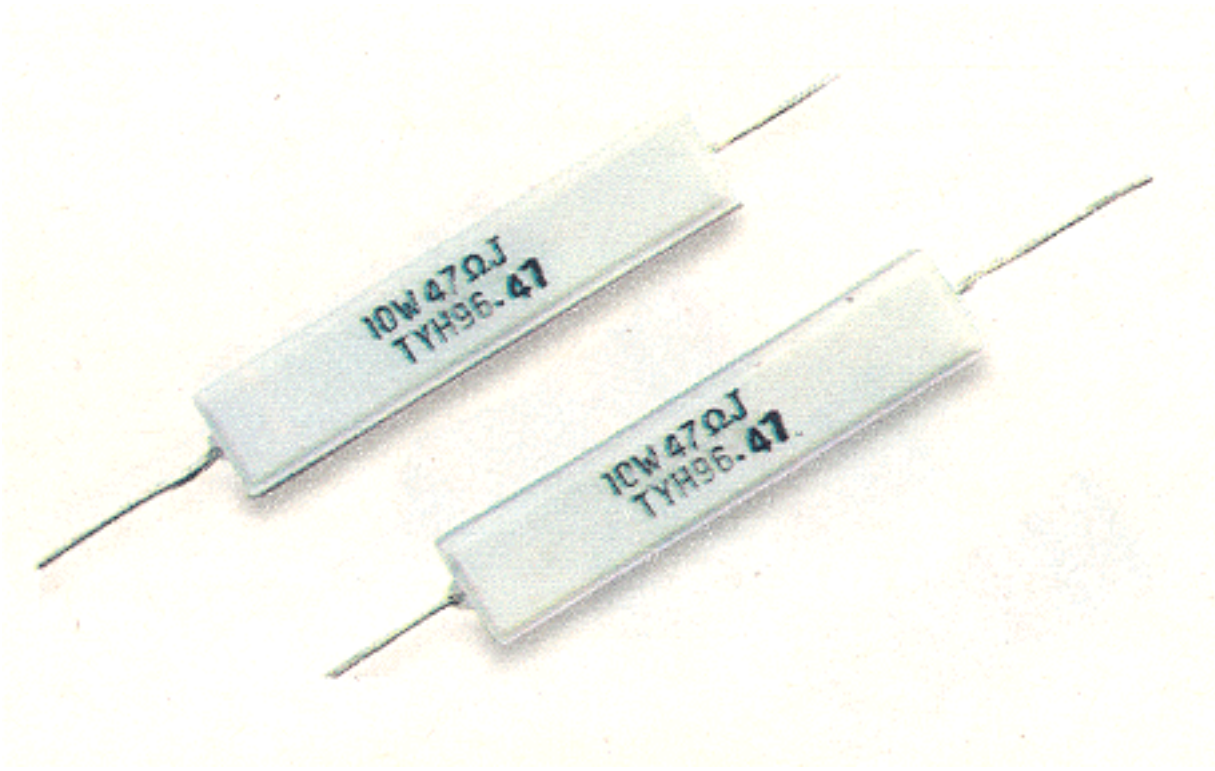
Similar in appearance are the Metal Oxide Flame Proof resistors. The body covering is a colored ceramic material instead of plastic. These are best for higher wattage resistors (1 Watt, but less than 5 Watt). Otherwise their structure is the same.

### Metal Oxide, Flame Proof resistors



### Power resistors

Beyond the 3 Watt limit our resistor takes different physical forms, of which there are many. This is just one of the more popular. The resistive element is usually a high resistance wire, usually a metal alloy. The body must tolerate the high temperature, so ceramic is used most often.



The resistance, tolerance and wattage are usually printed in English on these devices. What isn't obvious by language may be discerned by referencing the manufacturer's data sheet. Most all manufacturers have a web site these days.

## Color Codes