

## The Resistors.



The Resistor is possibly the most basic of components you are likely to find in a circuit.

A Passive component, produced in three basic types. The "*Rod*" type now obsolete but can be found in equipment up to the mid 1980's. The "*Film*" type, these come in two main constructions the carbon film and the metal oxide film (usually just called "metal film") and the "*wire wound*".

A German scientist discovered that, at constant temperature the current flowing in a conductor is directly proportional to the potential difference across it. This constant is the resistance and is measured in Ohms after the German scientist.

You will find two basic circuit symbols, the zigzag line and the box type.



The box type is now the preferred symbol, but there are still lots of people/companies using the zigzag symbol.

They are produced in many different values (Ohms), depending on what you require their values are normally displayed on the component, by the use of coloured bands. Some manufactures use 3 evenly spaced coloured bands to denote its value and then a fourth band spaced slightly further apart to tell you the % tolerance of the value.

There are some manufactures however, who print four coloured bands for the value and then a fifth for the tolerance.



The diagram above shows a basic resistor.

There value can be worked out from the following table.

Colour	1 <sup>st</sup> Band	2 <sup>nd</sup> Band	3 <sup>rd</sup> Band	4 <sup>th</sup> Band
	1 <sup>st</sup> digit	2 <sup>nd</sup> digit	Multiplier	Tolerance
Black	=	0	X1	-
Brown	1	1	X10	+/-1%
Red	2	2	X100	+/-2%
Orange	3	3	X1000	
Yellow	4	4	X10000	
Green	5	5	X100000	+/-0.5%
Blue	6	6	X1000000	+/-0.25%
Violet	7	7		+/-0.1%
Grey	8	8		
White	9	9		
Gold			X0.1	+/-5%
Silver			X0.01	+/-10%
Blank				+/-20%

Therefore the resistor above will have a value of

Brown Red Orange Gold  
1 2 x1000 ±5%

expressed as 12000 ohms

or 12KΩ

Resistors are marketed in preferred value series. There is the E6 series, which has just 6 values in each decade multiplier. The numerical values are 1.0, 1.5, 2.2, 3.3, 4.7, and 6.8 therefore the next decade multiplier values will be 10, 15, 22, 33, 47 and 68Ω etc. The next series is the E12 where there are 12 resistors instead of 6 as in the E6. This time the numerical values are 1.0, 1.2, 1.5, 1.8, 2.2, 2.7, 3.3, 3.9, 4.7, 5.6, and 8.2 and once again they can be multiplied by any decade, to obtain a value e.g. 100, 120, 150, 180, 220.... etc.

The next series has 24 values so is called the E24 series. These are 1.0, 1.1, 1.2, 1.3, 1.5, 1.6, 1.8, 2.0, 2.2, 2.4, 2.7, 3.0, 3.3, 3.6, 3.9, 4.3, 4.7, 5.1, 5.6, 6.2, 6.8, 7.5, 8.2 and 9.1. The same theory for larger values applies as with the E6 and E12 series. This is possibly the most used series for general use.

There is another series the E96, which is a much bigger series altogether.

Any value of resistance can be produced with the E24 series by placing resistors in series, parallel or a combination of series and parallel. The basic calculation for series network is as follows: -



$$\text{Total Resistance } R_T = R_1 + R_2$$

The basic calculation for Parallel network is as follows: -



$$\text{Total Resistance } \frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$$