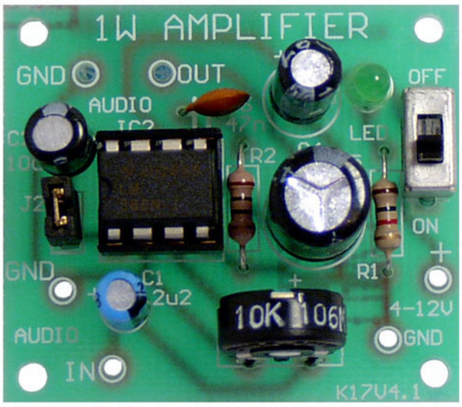
1 Electronic Component

An **electronic component** is a basic electronic element usually packaged in a discrete form with two or more connecting leads or metallic pads.

Various Components

Components are intended to be connected together, usually by soldering to a printed circuit board, to create an electronic circuit with a particular function (for example an amplifier, radio receiver, or MP3 player).



Amplifier Board

Mobile Charger 5V 2A

Components may be packaged separately (resistor, capacitor, transistor, diode etc.) or in more or less complex groups as integrated circuits (operational amplifier, resistor array, logic gate etc.)

Operational Amplifier IC

Resistor array

1.1 Function of Resistor, R

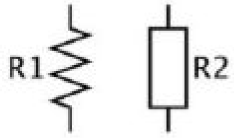
A component used to control current flow in an electric circuit by providing resistance.

The major applications of resistors are to limit current, to divide voltage and in some cases to generate heat.

1.2 Unit of Resistor

The unit of resistance is **ohms**, symbolized by Ω.

Symbols of Resistor



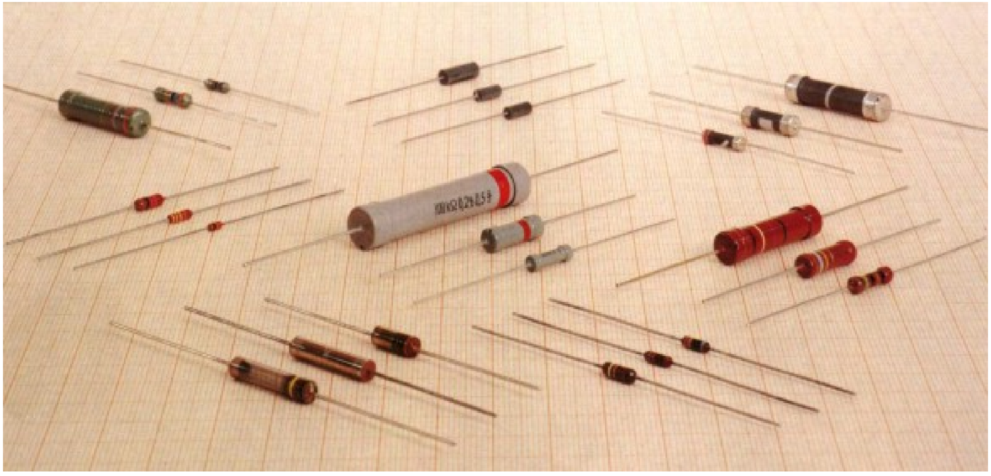
Resistors can be divided into one of two main categories : fixed or variable

1.3 Basic Types of Resistors

The basic types of resistor is **fixed** and **variable** resistors. The value is determined by its resistance and wattage eg 100Ω/½w.

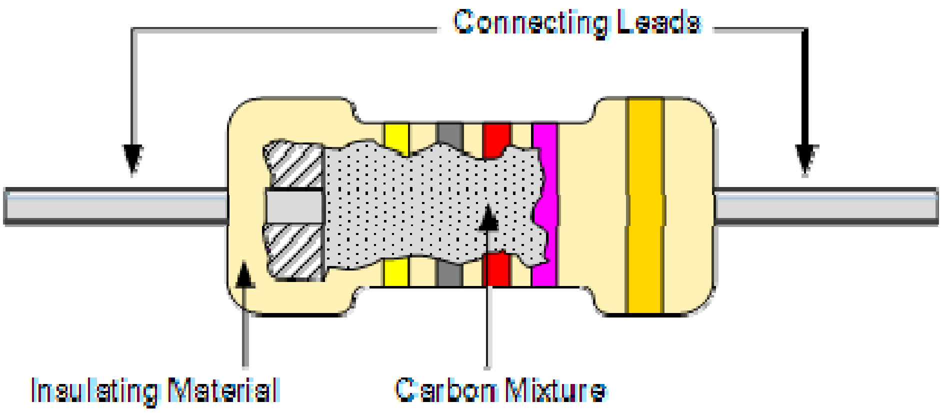
1.3.1 Fixed Resistor

The fixed resistor is available with a large selection of resistance values that are set during manufacturing and cannot be changed.

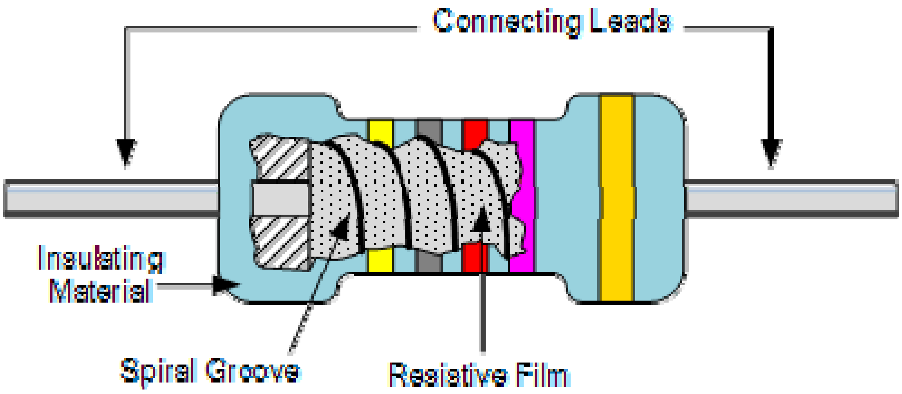


Different Types of Fixed Resistor

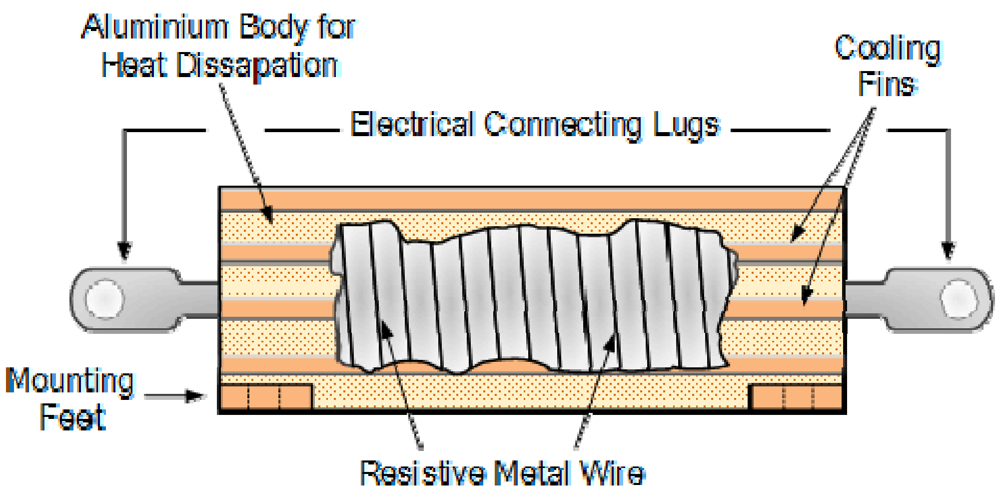
Carbon Resistor



Film Resistor



Wirewound Resistor



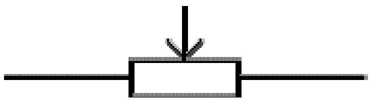
1.3.2 Variable Resistor

A variable resistor is designed so that its resistance values can be changed by adjusting the shaft.

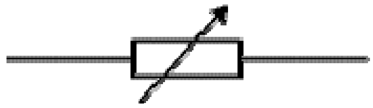
Variable resistors may be used as a <u>rheostat</u> with **two** connections (the wiper adjust one end of the track) or as a <u>potentiometer</u> with all **three** connections in use.

Potentiometer

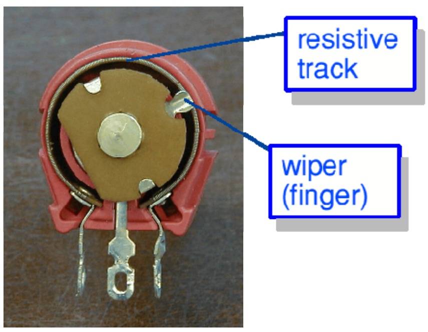
Rheostat



Symbol of Potentiometer



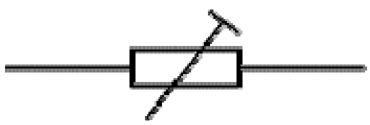
Symbol of Rheostat



Inside of a typical potentiometer

Applications : They can be found in computer monitors for color or positioning as well as the dimming switch for your lamps.

Miniature versions called <u>presets</u> are made for setting up circuits which will not require further adjustment.



Symbol of Preset

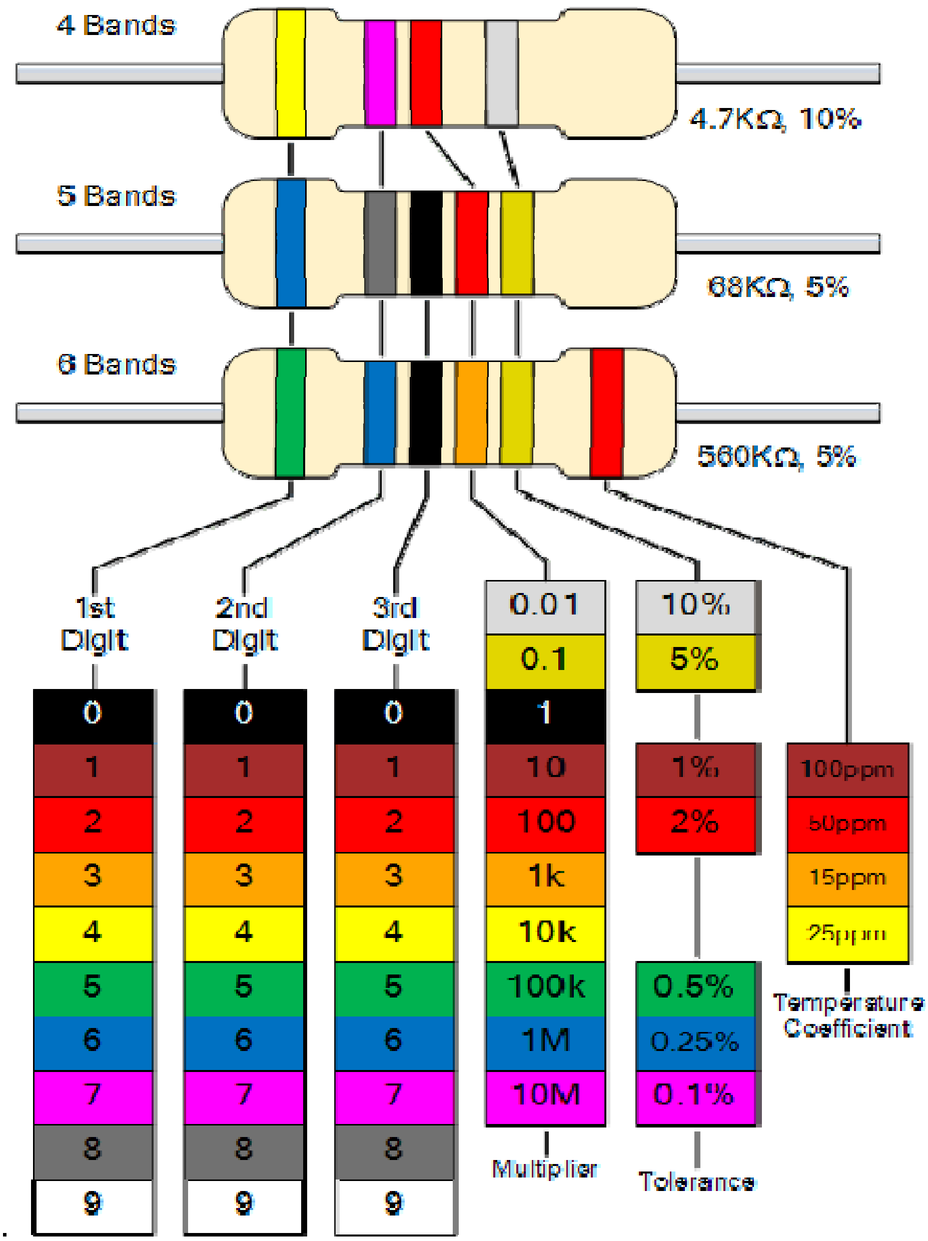
Preset

Resistor colour code in terms of value and tolerance.

The value in ohms of a resistor is indicated by the colour bands around one end of the resistor or printed on its body.

1.4 Resistor color code

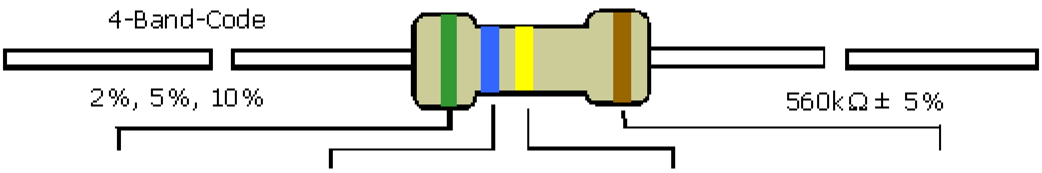
The value in ohms of a resistor is indicated by the colour bands around one end of the resistor or printed on its body.



Most resistors have 4 bands.

The first 3 bands indicate the value in ohms while the fourth band indicates the tolerance as shown in Table 1.

Higher tolerance resistors use 5 bands, with three significant digits.



COLOR	1st BAND	2nd BAND	3rd BAND	MULTIPLIER	TOLERANCE
Black	0	0	0	1Ω	
Brown	1	1	1	10Ω	± 1% (F)
Red	2	2	2	100Ω	± 2% (G)
Orange	3	3	3	1KΩ	
Yellow	4	4	4	10KΩ	
Green	5	5	5	100KΩ	±0.5% (D)
Blue	6	6	6	1MΩ	±0.25% (C)
Violet	7	7	7	10MΩ	±0.10% (B)
Grey	8	8	8		±0.05%
White	9	9	9		
Gold				0.1	± 5% (J)
Silver				0.01	± 10% (K)

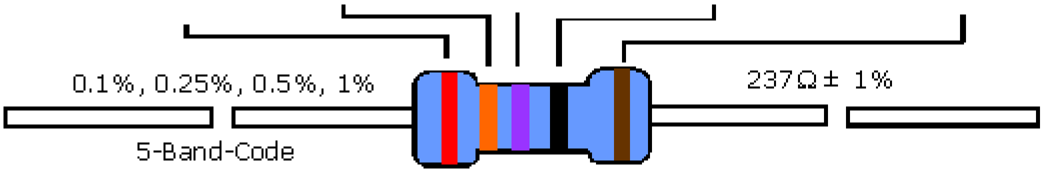


Table 1 Resistor colour code guide

Larger Units of Resistance (kΩ and MΩ)

In electronics, resistance values of thousands of ohms or even millions of ohms are common. These large values of resistance are indicated by the metric system prefixes **kilo** (k) and **mega** (M).
That is,

1000Ω (one thousand) --- 1kΩ
1000,000Ω (one million) --- 1MΩ

1.5 Power Rating

Wattage rating refers to the maximum amount of power or heat that the resistor can dissipate without burning up or changing value.

The larger the physical size of the resistor, the more power it can dissipate and the higher the wattage.

Ratings of **2 watt, 1 watt, 1/2 watt, 1/4 and 1/8 watt** are the most common.

1.6 Resistors in Series

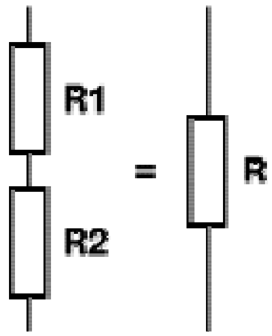


Fig 1.5 Resistors connected in series

1.6.1 Total series resistance

When resistors are connected in series their combined resistance is equal to the sum of individual resistances added together.

For example, if resistors R1 and R2 are connected in series their combined resistance, R, is given by:

Combined resistance in **series**: **R = R1 + R2**

This can be extended for more resistors: **R = R1 + R2 + R3 + R4 + ...**

Note that the **combined resistance in series** will always be **greater** than any of the individual resistances.

Exercise

1. Find the total resistance, $R_{T,}$ of eight 33 Ω resistors in series.

2. Calculatethe total resistance, R_T , for three 1 kΩ and one 720 Ω resistors in series.

1.7 Resistors in parallel

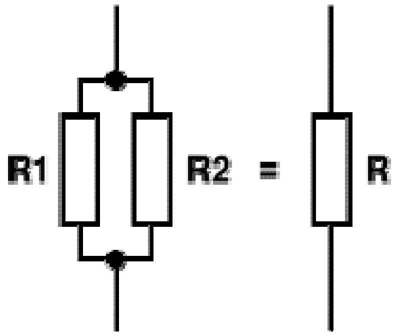


Fig 1.6 Resistors connected in parallel

1.7.1 Total parallel resistance

When resistors are connected in parallel their combined resistance is less than any of the individual resistances.

There is a special equation for the combined resistance of **two** resistors R1 and R2:

Combined resistance of **two resistors in parallel**: $$R_T = \frac{R1 \times R2}{R1 + R2}$$

Another special equation of parallel circuits is the parallel connection of several resistors (n) having the same value (R).

$$R_T = \frac{R}{n}$$

For more than two resistors connected in parallel a more difficult equation must be used. This adds up the **reciprocal** ("one over") of each resistance to give the **reciprocal** of the combined resistance, R:

$$\frac{1}{R_T} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3} + \ldots$$

The simpler equation for **two** resistors in parallel is much easier to use!

Note that the **combined resistance in parallel** will always be **less** than any of the individual resistances.

Exercise

Find the equivalent resistance for three 100 kΩ resistors in parallel.

1.8 Series-Parallel Circuit

Series-parallel circuit comprises of both the series and parallel circuit. It is important to identify the series and parallel components in a circuit.

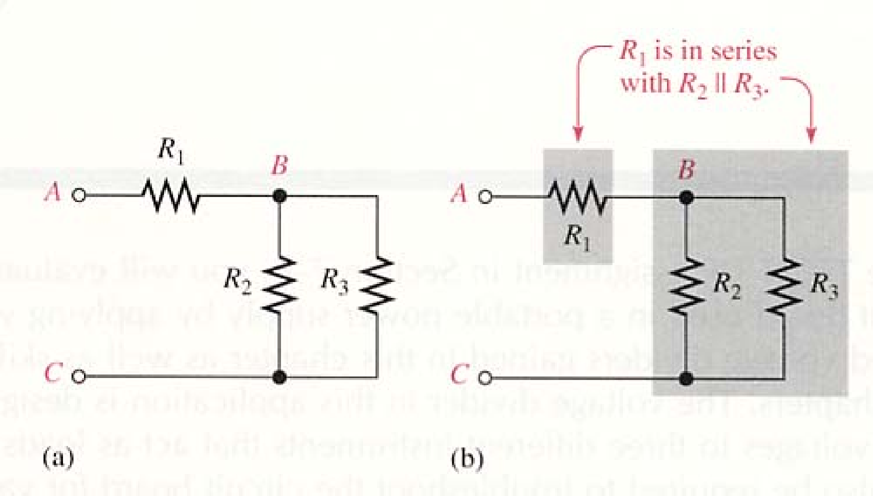


Fig 1.7 A simple series-parallel circuit.

1.8.1 Total resistance of a series -parallel combination

Fig 1.7(a) shows a simple series-parallel combination of resistors.

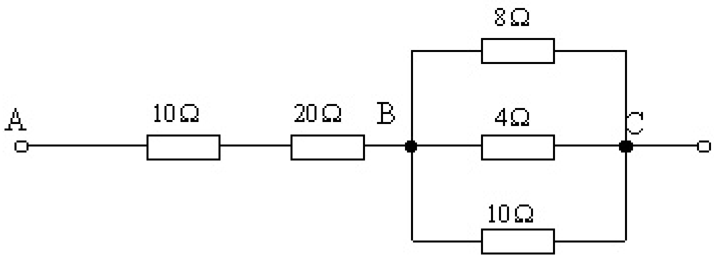
Notice that the resistance from point A to point B is R_1.

The resistance from point B to point C is R_2 and R_3 in parallel ($R_2 \parallel R_3$).

The resistance from point A to point C is R1 in series with the parallel combination of R_2 and R_3, as indicated in Fig 1.7(b).

Example

Calculate the total resistance of the arrangement as shown.



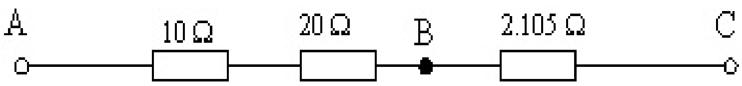
Solution:

The resistance between the points B and C is calculated as,

$$\frac{1}{R_{BC}} = \frac{1}{8} + \frac{1}{4} + \frac{1}{10} = 0.475$$

$$R_{BC} = \frac{1}{0.475} = 2.105\,\Omega$$

So the resulting circuit can be simplified as:



Total resistance, that is, resistance between points A and C is,
R_{AC} = 10 + 20 + 2.105
= 32.105 Ω