
Lesson 2 - Instruction Of Little Components

1. Resistance:



What is a resistor?

Resistors are the passive components used in the electrical circuits to reduce the flow of electric current to certain level. The ability to restrict the flow of electric current is called resistance. The resistors with high resistance value will restricts large amount of electric current whereas the resistors with low resistance value will restricts only a small amount of electric current. The resistance of a resistor is measured in ohms. Actual devices such as bulbs, heating wires, resistors, etc. can be represented as resistor elements. The resistor usually functions as a partial pressure or a shunt in the circuit. Both AC and DC signals can pass through the resistor.

Why color codes are used in resistors instead of directly printing the resistance value?

Printing the numbers on large electronic components is very easy, but it is very difficult to print the numbers or resistance values on tiny components. Hence, instead of directly printing the numbers, we print the color codes or color bands.

Representing the resistance of a resistor by using color bands

In a color coding technique, the resistors value is marked on the resistors body by using colors. The colors painted on the resistors body are called color bands. All the color bands painted on the resistor body are used to indicate the resistance value and tolerance. Each color on the resistors body represents a different number.

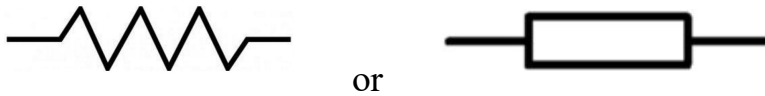
How is the resistance calculated?

For a resistor with a uniform cross section, the resistance value is:

$$R = \rho \frac{L}{A} \quad (\Omega)$$

ρ is the resistivity of the resistive material (ohm·cm); L is the length of the resistor (cm); A is the cross-sectional area of the resistor (square centimeter)。

Symbols commonly used in resistors in circuits:



The relationship between resistance and voltage and current (Ohm's law):

$$I = \frac{U}{R}$$

I is the current, U is the voltage across the resistor, and R is the resistance.

Nominal resistance:

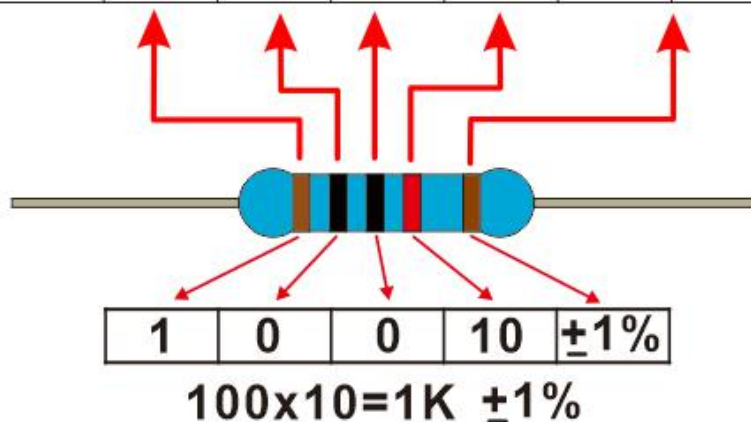
The design resistance of the mark on the resistor with a number or color scale in euros (Ω), kilohms (k Ω), megohms (M Ω).

$$1\text{M}\Omega = 1000\text{K}\Omega, 1\text{K}\Omega = 1000\Omega$$

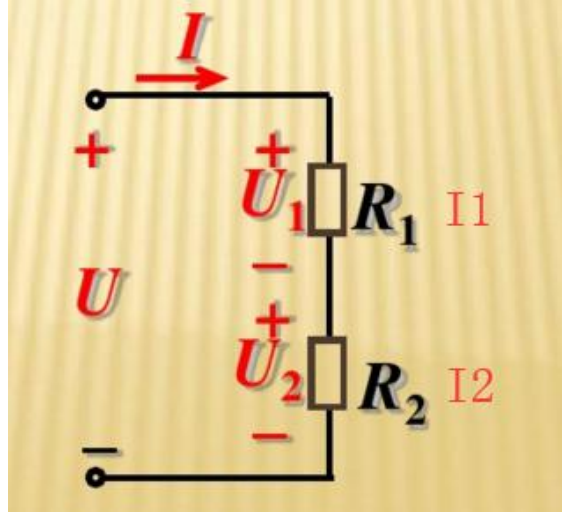
Five-Color-Ring Resistor Calculator

cokoino.com

color	1 section	2 section	3 section	muntiple	error range	
black	0	0	0	1		
brown	1	1	1	10	$\pm 1\%$	F
red	2	2	2	100	$\pm 2\%$	G
orange	3	3	3	1K		
yellow	4	4	4	10K		
green	5	5	5	100K	$\pm 0.5\%$	D
blue	6	6	6	1M	$\pm 0.25\%$	C
purple	7	7	7	10M	$\pm 0.10\%$	B
gray	8	8	8		$\pm 0.05\%$	A
while	9	9	9			
golden				0.1	$\pm 5\%$	J
silver				0.01	$\pm 10\%$	K
none					$\pm 20\%$	M



1.2、 series circuit:



Equal current intensity throughout the circuit:

$$I=I_1=I_2$$

The total voltage across the circuit is equal to the sum of the voltages across the circuit:

$$U=U_1+U_2$$

The total resistance is equal to the sum of the resistors:

$$R_{\text{sum}}=R_1+R_2$$

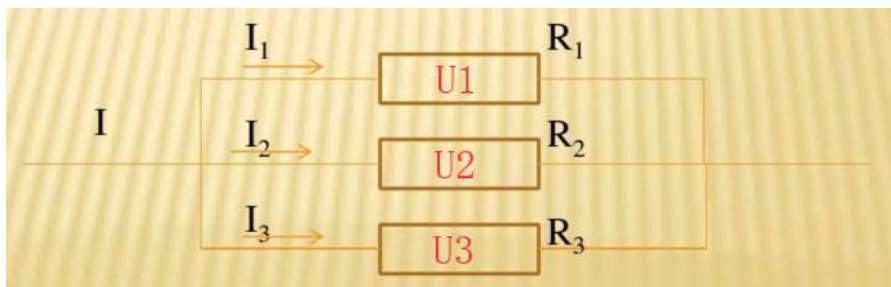
The voltage across the series resistor is proportional to the resistance:

$$\frac{U_1}{R_1} = \frac{U_2}{R_2} = \dots = \frac{U_n}{R_n} = I$$

If N resistors are connected in series, the total resistance formula is:

$$R_{\text{sum}}=R_1+R_2+R_3+\dots+R_N$$

1.3、 Parallel circuit:



The voltages at the ends of each branch in the circuit are equal:

$$U_1=U_2=U_3$$

The total current intensity is equal to the sum of the current intensities of the branches:

$$I=I_1+I_2+I_3$$

The reciprocal of the total resistance value is equal to the sum of the reciprocals of the resistance values:

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$$

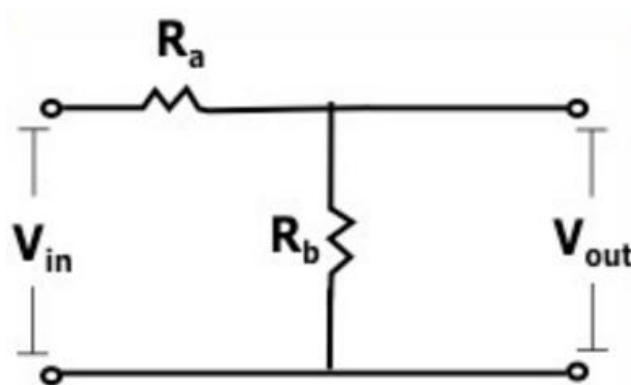
The current distribution on the resistor is inversely proportional to the resistance value (the shunt formula when two resistors are connected in parallel):

$$I_1 = \frac{R_2}{R_1 + R_2} I \quad I_2 = \frac{R_1}{R_1 + R_2} I$$

If N resistors R are connected in parallel, the formula is:

$$1/R = 1/R_1 + 1/R_2 + \dots + 1/R_N$$

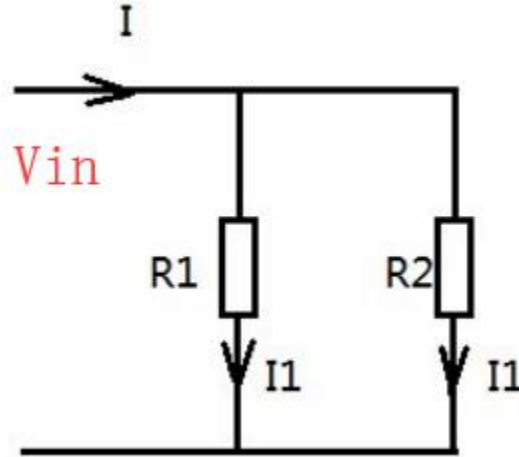
1.4、 Example of resistance series voltage division:



As shown in the figure above, the two resistors R_a and R_b are connected in series, V_{in} is the voltage applied to the two resistors of R_a and R_b , and V_{out} is the voltage of the resistor of R_b . The relationship between the three is:

$$V_{out} = V_{in} \times R_b / (R_a + R_b)$$

1.5、 Application of parallel shunting of resistors:



As shown in the figure above, the two resistors R_1 and R_2 are connected together. V_{in} is the voltage applied to the two resistors R_1 and R_2 . The relationship between I and I_1 and I_2 is as follows:

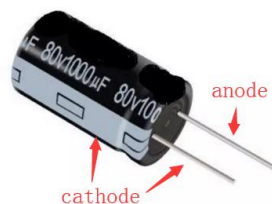
$$I = I_1 + I_2$$

2. Capacitance:

Ceramic capacitor is a capacitor made of a ceramic material, coated with a metal film on the surface of the ceramic, and sintered at a high temperature. It is commonly used in high-stability oscillator circuits as loops, bypass capacitors, and pad capacitors. The ceramic capacitor does not need to distinguish between positive and negative.



Electrolytic capacitors are a type of capacitor. The metal foil (aluminum or tantalum) is the positive electrode of the electrolytic capacitor, the oxide film (aluminum oxide or tantalum pentoxide) which is in close contact with the positive electrode is a dielectric, the cathode is made of a conductive material, the electrolyte (liquid or a solid), and other materials. Since the electrolyte is the main part of the cathode, it is called an electrolytic capacitor. The electrolytic capacitor should distinguish between positive and negative electrodes, and it can not be connected incorrectly:



Cathode: The pin is a little shorter than the anode and there is a ribbon on the capacitor.

Anode: the pin is a little longer than the cathode

The effect of the capacitor on the signal: connecting the AC signal and blocking the DC signal.
The higher the frequency of the AC signal, the smaller the capacitance hinders it;
The capacitor blocks the DC signal and the circuit can be considered as an open circuit.

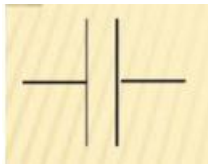
Capacitance capacitance identification method: The method is basically the same as the method of identifying the resistance.

It is divided into three types: direct mark, color mark and number mark.

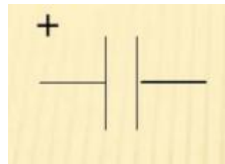
The basic unit of capacitance is pulled (F), and other units are: millifarad (mF), microfarad (μF)/mju:/, nanofarad (nF), picofarad (pF)。

$$1\text{F}=1000\text{mF}, 1\text{mF}=1000\mu\text{F}, 1\mu\text{F}=1000\text{ nF}, 1\text{nF}=1000\text{pF}$$

The symbol of the capacitor in the circuit:



General capacitance



Polar capacitance



Variable capacitance

For capacitors with large capacity, the capacitance value is directly indicated on the capacitor, such as 10 μF /400V electrolytic capacitor:



For a capacitor with a small capacity, its capacity value is expressed in letters or numbers.

Letter representation: 1m=1000 μF 1P2=1.2PF 1n=1000PF

Digital representation: The three-digit representation is also called the digital representation of the capacitance. The first two digits of the three digits are the significant digits of the nominal capacity, and the third digit represents the number of zeros following the significant digit. Their units are all pF.

For example: 102 indicates a nominal capacity of 1000 pF.

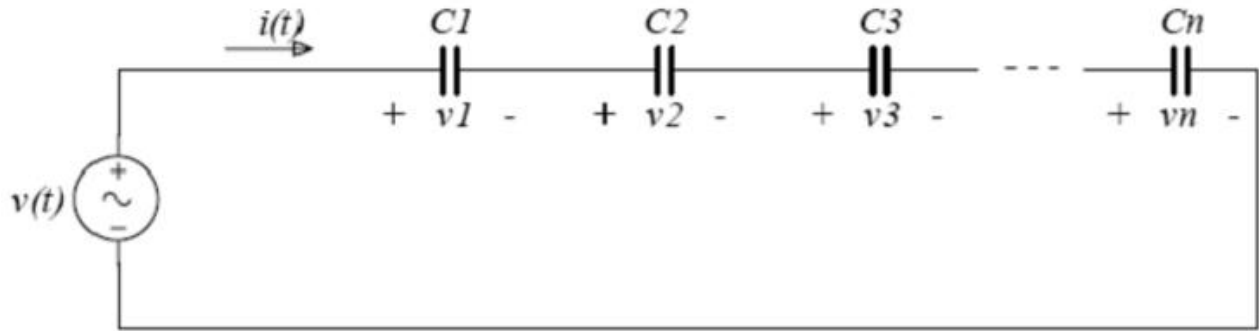
101 indicates a nominal capacity of 100 pF.

104 indicates a nominal capacity of 1×10^4 pF, as shown in the following figure:



There is a special case where the third digit is represented by "9", indicating that the significant digit is multiplied by 10 to the power of -1 to indicate the capacity.
 For example, 229 indicates that the nominal capacity is $22 \times (10^{-1}) \text{ pF} = 2.2 \text{ pF}$.
 Allowable error $\pm 1\% \pm 2\% \pm 5\% \pm 10\% \pm 15\% \pm 20\%$

2.0、Capacitor series circuit:



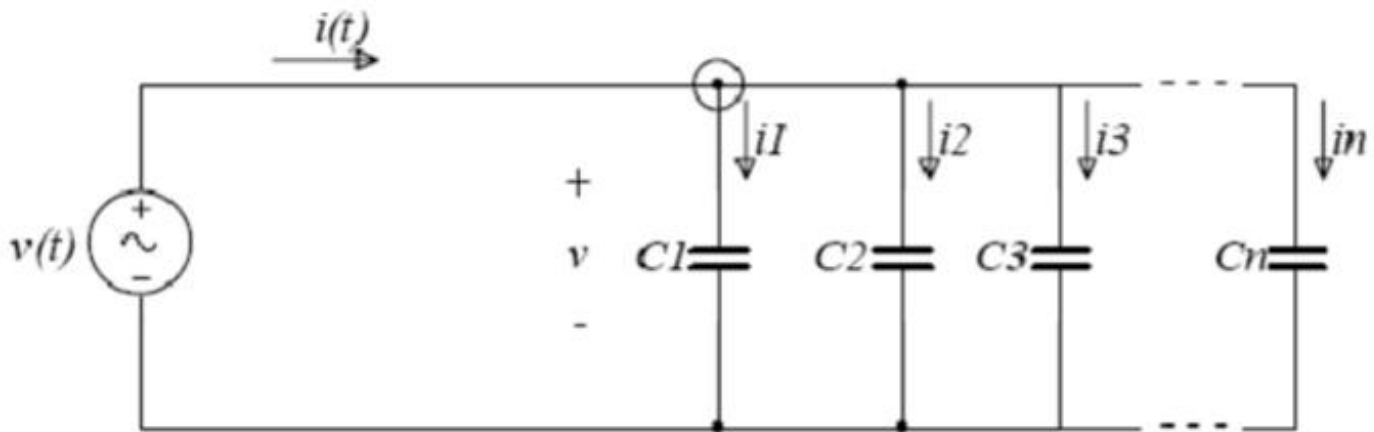
The reciprocal of the total capacitance is equal to the sum of the reciprocal of each capacitance:

$$1/C = 1/C1 + 1/C2 + 1/C3 + \dots + 1/CN$$

The total withstand voltage is equal to the sum of the withstand voltage values of each capacitor:

$$V = v1 + v2 + v3 + \dots + vN$$

2.1、Capacitor parallel circuit:



The total value is equal to the sum of the capacitance values of the capacitors:

$$C = C1 + C2 + C3 + \dots + CN$$

The withstand voltage is equal to the minimum withstand voltage of the parallel capacitor.

3.LEDs:



Light-emitting diodes, also known as LED lights, are a type of diode. There are three main colors, the voltage drop values are as follows: the voltage drop of the red LED is 2.0--2.2V, the voltage drop of the yellow LED is 1.8-2.0V, and the voltage drop of the green LED is 3.0-3.2V. The rated current is approximately 10 mA.

The pin of the LED negative pole is shorter than the positive pole, and the lamp body has a gap, as shown below:

