3.Instruction Of Little Components

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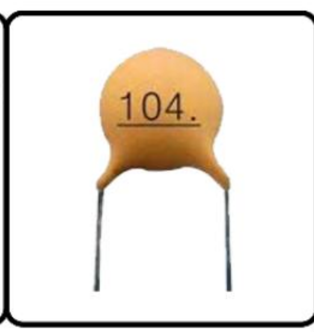
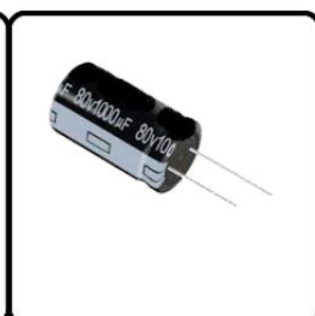
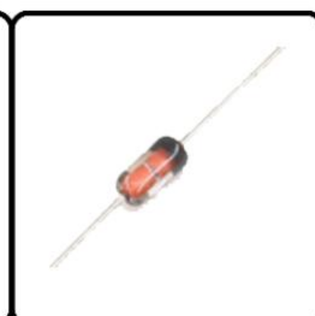
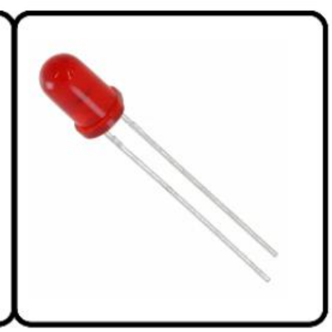
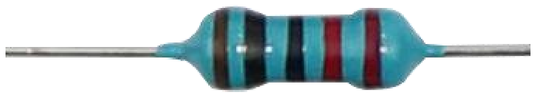



1. Resistance：



1.1 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.

1.2 How is the resistance calculated?

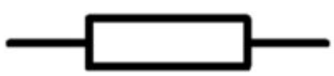
For a resistor with a uniform cross section, the resistance value is:

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

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:：

or



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

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

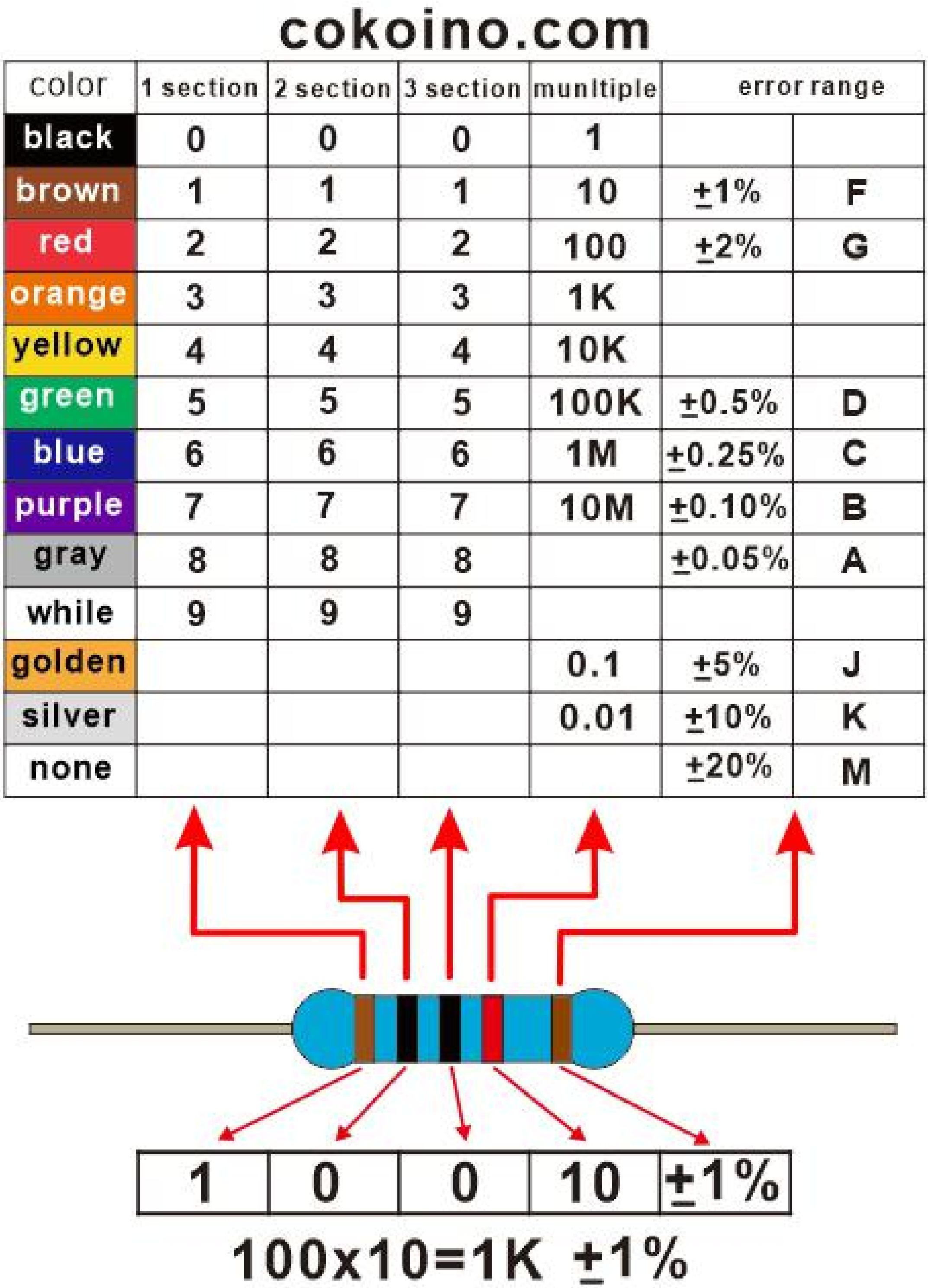
I is the current, U is the voltage across the resistor, and R is the resistance.

Nominal resistance:

The design resistance of the mark on the resistor with a number or color scale in Ohm (Ω), kiloohms (kΩ), megohms (MΩ).

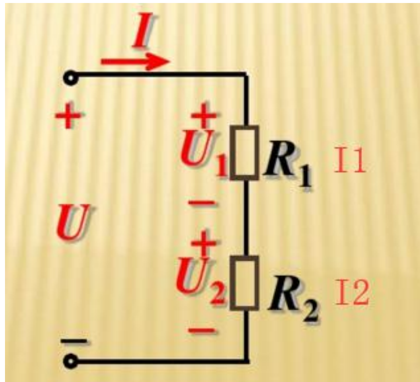
1MΩ=1000KΩ,1KΩ=1000Ω

Five-Color-Ring Resistor Calculator



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

1.3 Series circuit：



Equal current intensity throughout the circuit：

I=I1=I2

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

U=U1+U2

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

R=R1+R2

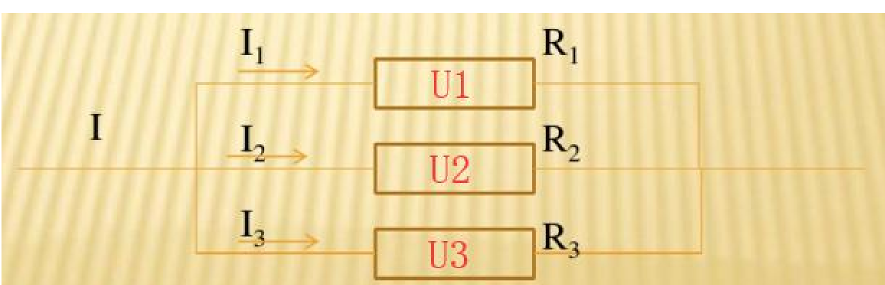
The voltage across the series resistor is proportional to the resistance：

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

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

R=R1+R2+R3+...+RN

1.4 Parallel circuit：



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

U1=U2=U3

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

I=I1+I2+I3

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

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

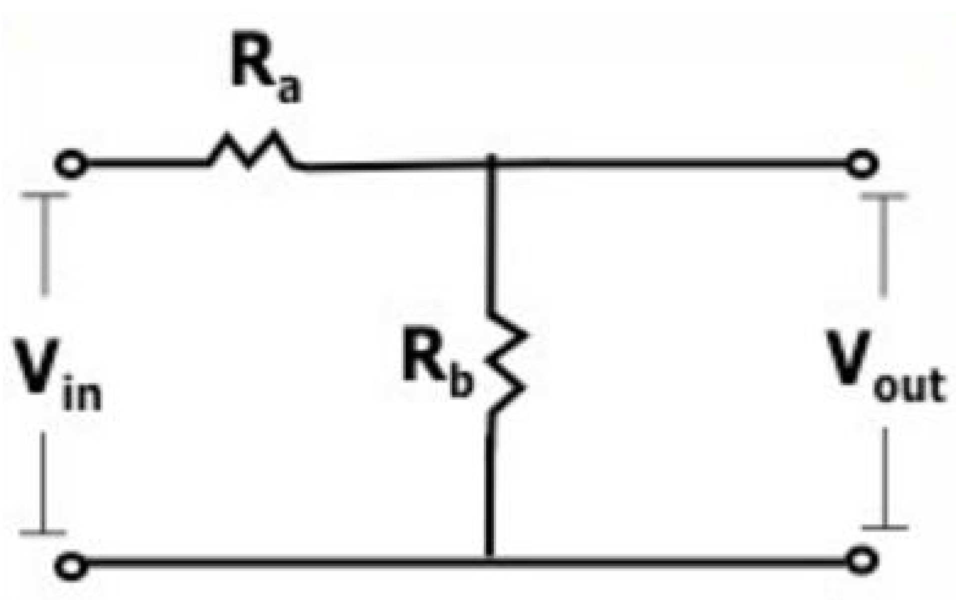
The current distribution on the resistor is inversely proportional to the resistance value (the shunt formula when two resistors are connected in parallel)：

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

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

Rsum=1/（1/R1+1/R2+...+1/RN）

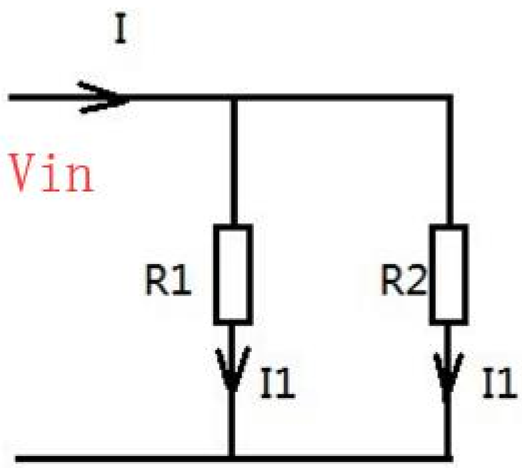
1.5 Example of resistance series voltage division：



As shown in the figure above, the two resistors Ra and Rb are connected in series, Vin is the voltage applied to the two resistors of Ra and Rb, and Vout is the voltage of the resistor of Rb. The relationship between the three is：

Vout = Vin x Rb/(Ra+Rb)

1.6 Application of parallel shunting of resistors：



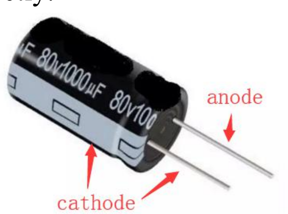
As shown in the figure above, the two resistors R1 and R2 are connected together. Vin is the voltage applied to the two resistors R1 and R1. The relationship between I and I1 and I2 is as follows:

I=I1+I2

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;

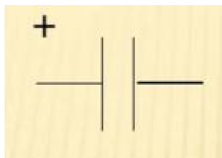
The capacitor blocks the DC signal and the circuit can be considered as an open circuit.

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)。

1F=1000mF，1mF=1000μF，1μF=1000 nF，1nF=1000pF

The symbol of the capacitor in the circuit:


General capacitance



Polar capacitance

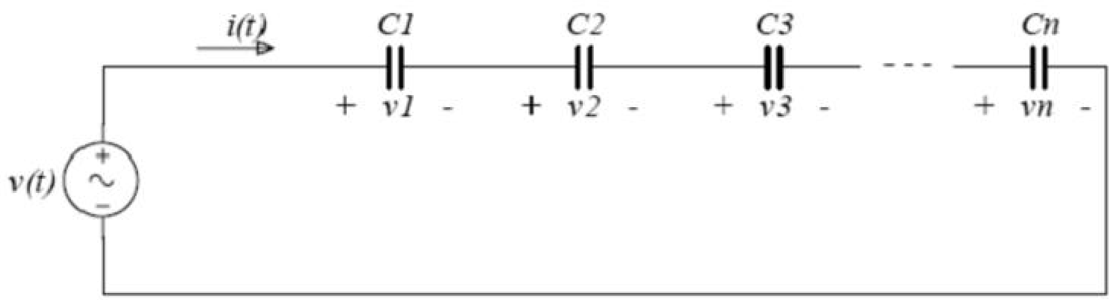

Variable capacitance

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 1x10(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 22x (10-1) pF = 2.2 pF.
Allowable error ±1% ±2% ±5% ±10% ±15% ±20%

2.0 Capacitor series circuit：



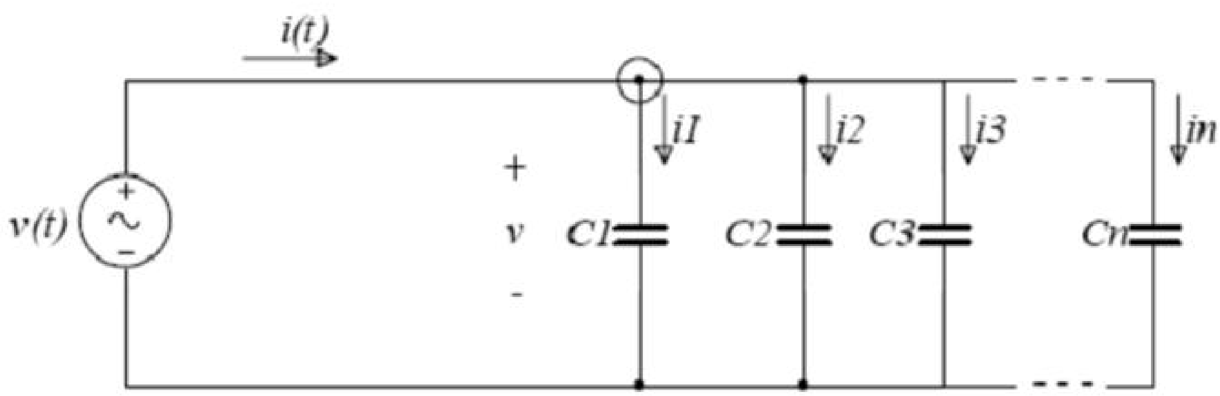
The reciprocal of the total capacitance is equal to the sum of the reciprocal of each capacitance：

1/C=1/C1+1/C2+1/C3+...+1/CN

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

V=v1+v2+v3+...+vN

2.1 Capacitor parallel circuit：



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

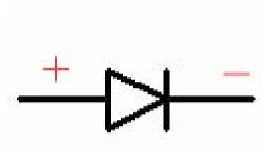
C 总=C1+C2+C3+...+CN

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

3. Diode：

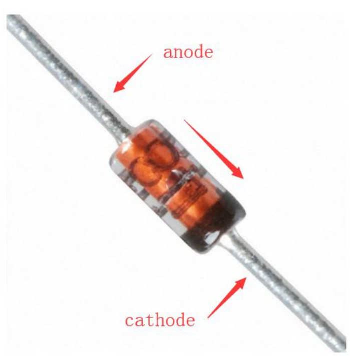
A diode is a device with two electrodes that allows current to flow only in a single direction, many of which are applied to its rectification function.The varactor diode (Varicap Diode) is used as an electronically tunable capacitor.The current directionality of most diodes is commonly referred to as the "Rectifying" function. The most common function of a diode is to allow current to pass only in one direction (called forward bias) and to block current in reverse (called reverse bias).

The symbol in the circuit is：



3.0 Positive：

When the forward voltage is applied, the forward voltage is small.
Not enough to overcome the blocking effect of the electric field in the PN junction, the forward current is almost zero, this section is called the dead zone.This forward voltage that does not turn the diode on is called the deadband voltage.When the forward voltage is greater than the deadband voltage, the electric field in the PN junction is overcome, the diode is forward-conducting, and the current rises rapidly as the voltage increases.In the current range of normal use, the terminal voltage of the diode remains almost unchanged. This voltage is called the forward voltage of the diode.When the forward voltage across the diode exceeds a certain value, the internal electric field is quickly weakened, the characteristic current increases rapidly, and the diode is conducting.This voltage is also called the threshold voltage. The forward voltage drop of the silicon diode is about 0.6~0.8V, and the forward voltage drop of the germanium diode is about 0.2~0.3V.



Current is flowed by anode to cathode

3.1 Current is flowed by anode to cathode：

When the applied reverse voltage does not exceed a certain range, the current through the diode forms a reverse current.Since the reverse current is small, the diode is in an off state. This reverse current is also called reverse saturation current or leakage current, and the reverse saturation current of the diode is greatly affected by temperature.In general, the reverse current of a silicon tube is much smaller than that of a tantalum tube. The reverse saturation current of a small power tantalum tube is on the order of nA, and the low power tube is on the order of μA. When the temperature rises, the semiconductor is excited by heat, the number of minority carriers increases, and the reverse saturation current also increases.

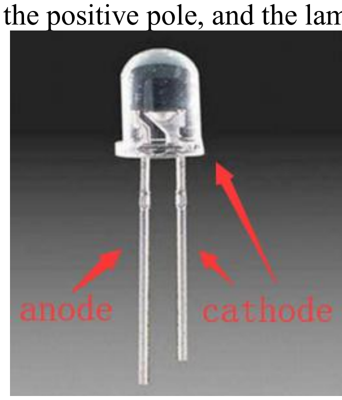
3.2 Breakdown:

When the applied reverse voltage exceeds a certain value, the reverse current suddenly increases. This phenomenon is called electrical breakdown.
The threshold voltage that causes electrical breakdown is called the diode reverse breakdown voltage. The diode loses unidirectional conductivity during electrical breakdown.
If the diode does not cause overheating due to electrical breakdown, the unidirectional conductivity will not be permanently destroyed. After the voltage is removed, the performance can still be restored, otherwise the diode will be damaged.
Therefore, the reverse voltage applied to the diode should be prevented from being too high.

3.3 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:



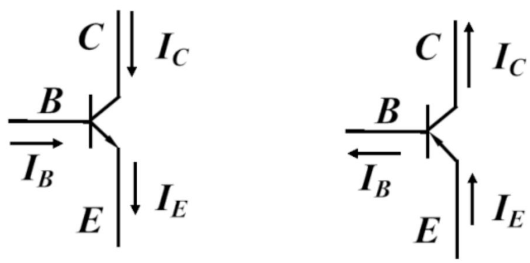
4. Transistor:

The triode, the full name should be a semiconductor triode, also known as a bipolar transistor, a crystal triode, is a semiconductor device that controls current. Its function is to amplify the weak signal into an electrical signal with a large amplitude value, and also as a non-contact switch.

Transistor is one of the basic components of semiconductors. It has the function of amplifying current and is the core component of electronic circuits. The triode is made up of two closely spaced PN junctions on a semiconductor substrate. The two PN junctions divide the monolithic semiconductor into three parts, the middle part is the base area, and the two sides are the emitter area and the collector area, and the arrangement is PNP and NPN two.

There are two types of crystal transistors according to the material: the germanium and the silicon tube. Each of them has two structural forms of NPN and PNP, but most of them are silicon NPN triodes and germanium PNP triodes(where N is the meaning of the negative electrode and P is the positive electrode). In addition to the different polarity of the power supply, the two work the same principle.

4.0 Transistor symbol:

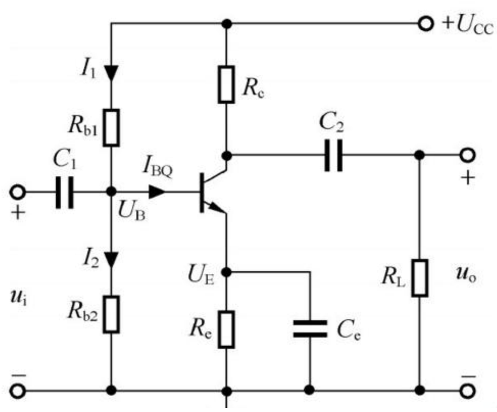


NPN Transistor　　*PNP* Transistor

B: base of the triode,　C: collector of the triode,　E: emitter of the triode

4.1 The NPN transistor can amplify a small current signal into a relatively large current signal

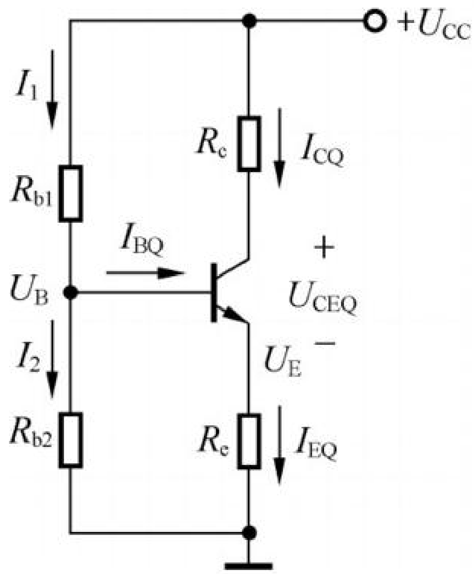
(β is the amplification factor of the triode):



In order to ensure the stability of the static Q point, the circuit I1>>IBQ is required, and I1>>(5~10) IBQ is generally taken.

4.2 Principle of stabilizing static working points

Equivalent DC circuit:



The capacitance in the circuit is equal to the open circuit relative to the DC signal.

Base potential：

$$V_B \approx \frac{R_{B2}}{R_{B1}+R_{B2}} U_{CC}$$

The process of stabilizing the static working point and forming the current negative feedback by means of RE is:

$$T\uparrow \rightarrow I_C\uparrow \rightarrow I_E\uparrow \rightarrow V_E\uparrow \rightarrow U_{BE}\downarrow \rightarrow I_B\downarrow \rightarrow I_C\downarrow$$

4.3 Static analysis

According to the DC equivalent circuit：

$$U_B \approx \frac{R_{B2}}{R_{B1}+R_{B2}} U_{CC}$$

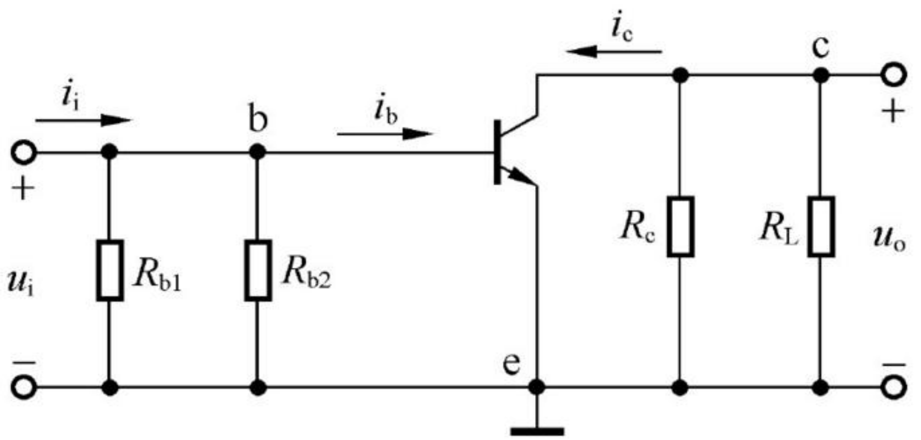
$$I_{CQ} \approx I_{EQ} = \frac{V_B - U_{BEQ}}{R_E}$$

$$I_{BQ} = \frac{I_{CQ}}{\beta}$$

$$U_{CEQ} = U_{CC} - I_C R_C - I_E R_E \approx U_{CC} - I_C(R_C + R_E)$$

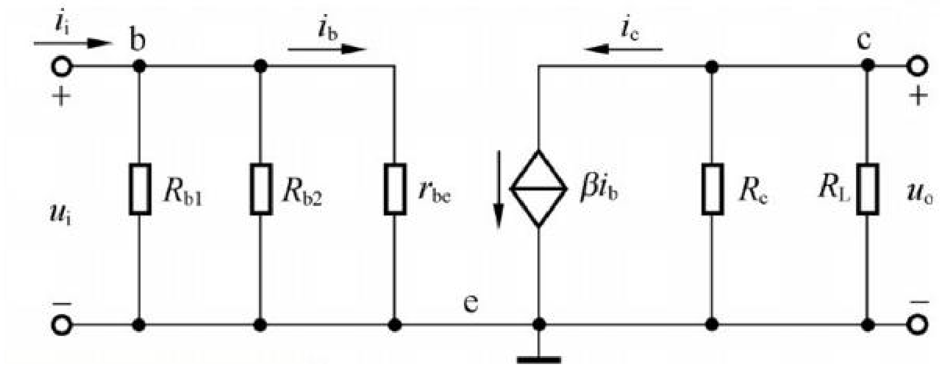
4.4 Dynamic Analysis

Equivalent AC circuit：



Capacitors are equivalent to short circuits in AC signals and DC power supplies.

Micro-variable AC equivalent circuit：



Voltage multiple：

a、When the load RL is connected： $A_u = -\beta \frac{R_L'}{r_{be}}$

b、When the load RL is broken： $A_u = -\beta \frac{R_C}{r_{be}}$

Input resistance： $R_i = R_{B1} // R_{B2} // r_{be}$

Output resistance： $R_0 = R_C$

4.5 Transistor operation and switching status

When the triode is operating in the saturated and off state, the triode is equivalent to the switch in the closed and open states. The following figure shows the circuit: