Maglev production and debugging instructions. This

instruction is divided into two parts. The first part is the installation graphic instructions, and the second part is debugging.

Before assembling the magnetic levitation control circuit board,

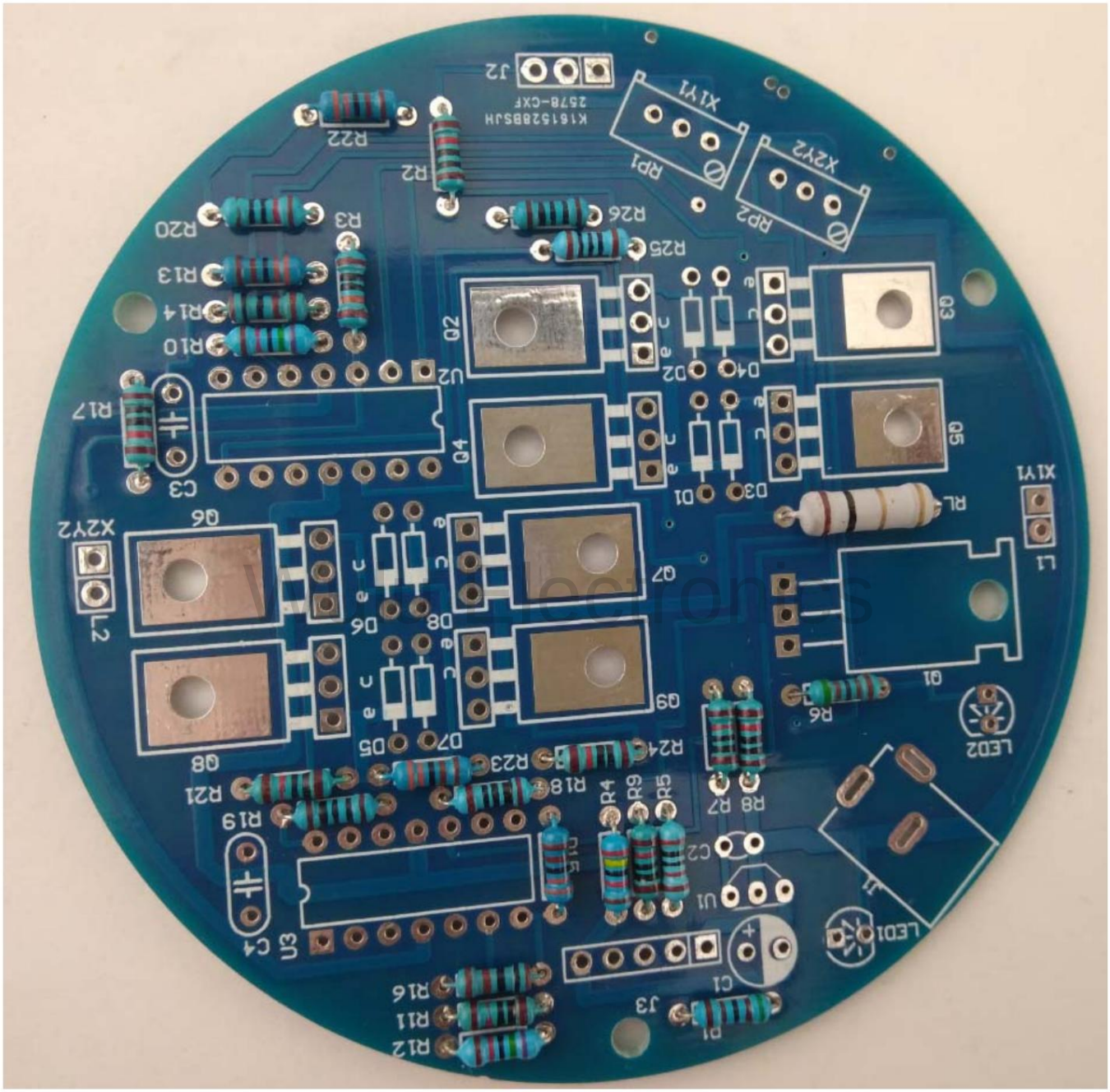
count and identify each component according to the component list in the document, and distinguish between polarized and non-polar components. According to the size and height of the components,

Install in order from small to large, from low to high. 1. Install the

color ring resistor. The color ring

resistor has no polarity. Use a multimeter to measure the resistance before installation. There are many types of resistors, so be careful to avoid incorrect installation. Put one below

The installation diagram of the color ring resistor is used as a reference

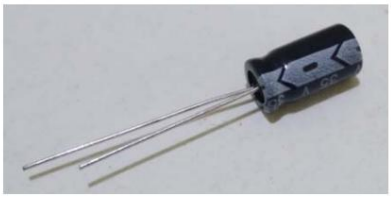


2. Install the capacitor control

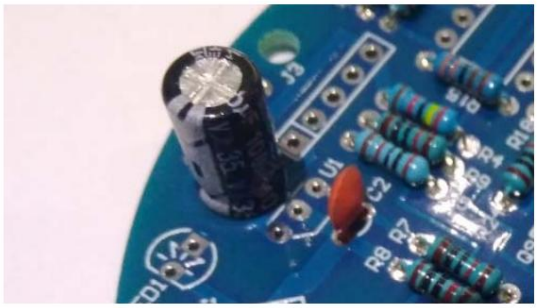
circuit board. There are three types of capacitors: monolithic capacitors, ceramic capacitors, and in-line aluminum electrolytic capacitors. Monolithic capacitors and ceramic capacitors are not divided into positive and negative.

pole, the long leg of the directly inserted aluminum electrolytic capacitor is positive, and the short leg is negative. At the installation position of the electrolytic capacitor, there is a '+' sign on the positive side. Negative side

is a solid semicircle.



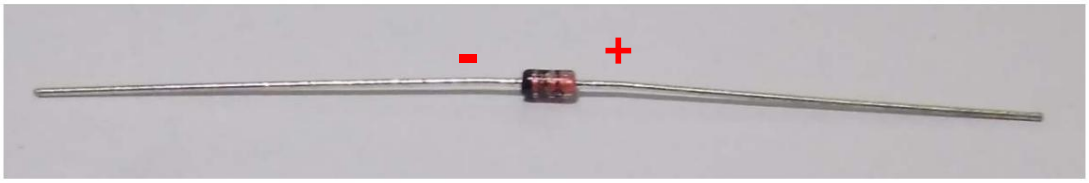
Installed aluminum electrolytic and ceramic capacitors



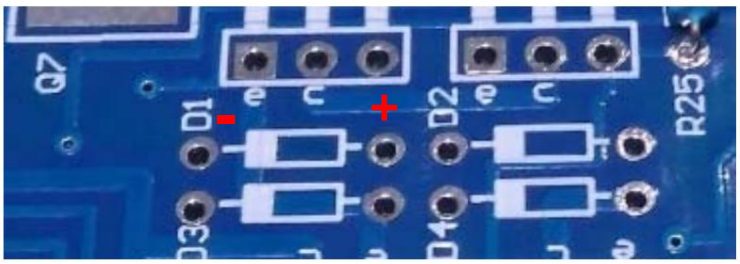
Two monolithic capacitors

3. Install the diode 1N4148. The end with the black

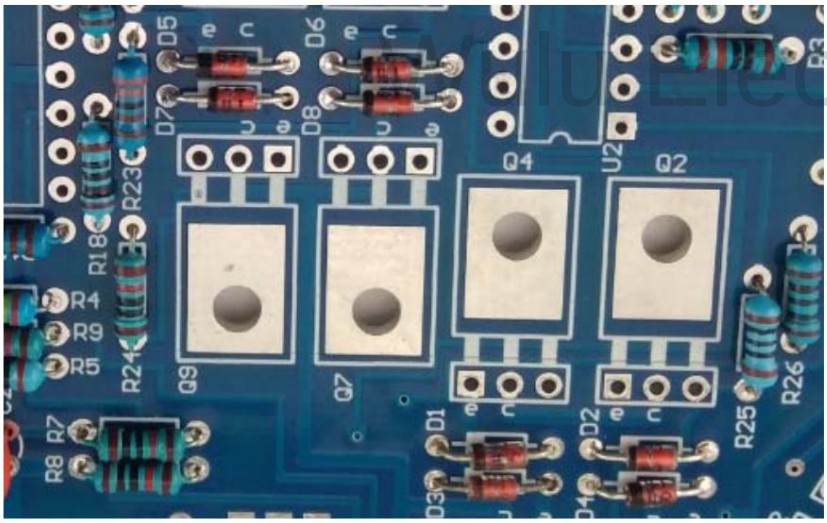
ring mark on the diode body is the negative pole, and the other side is the positive pole.



Install the negative electrode on one side of the thick wire on the circuit board



Install 8 diodes

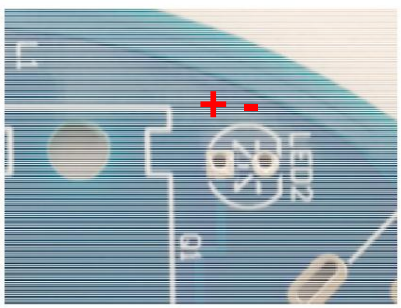


4. Install LEDs

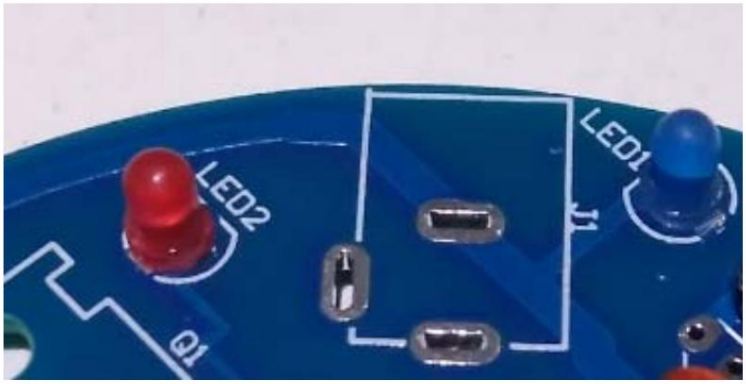
Direct plug-in light-emitting diodes are similar to direct-plug aluminum electrolytic capacitors.

The long leg is the positive pole and the short leg is the negative pole.

The following graphics are printed at the installation position of the light-emitting diodes. The flat side is the negative pole

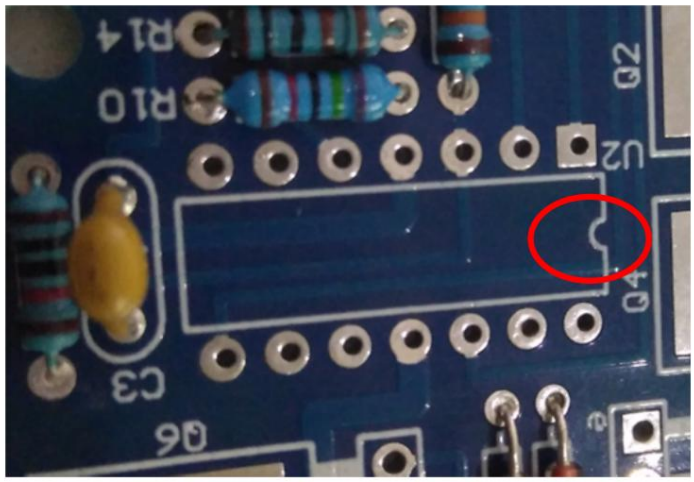


There are two colors of LEDs allocated in the kit, so there is no need to distinguish between colors when installing.



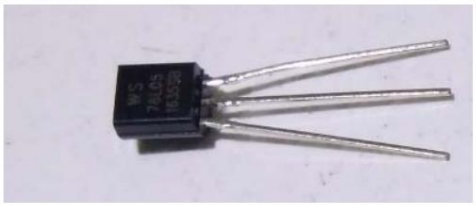
5. Install the IC holder

When installing, please note that there is a semicircular notch on the IC holder, which should be consistent with the semicircular notch printed on the circuit board.



6. Install the three-terminal integrated voltage regulator 78L05

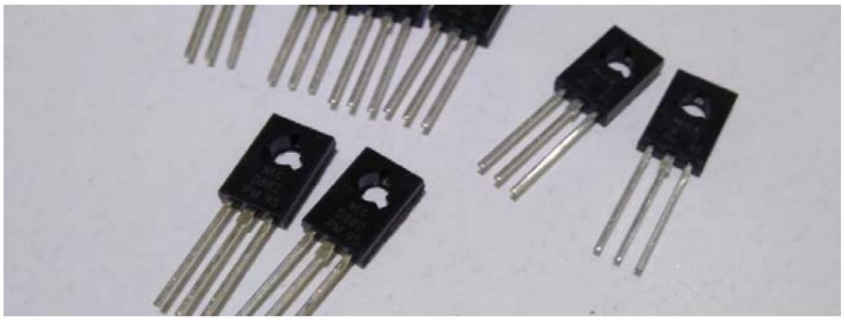
When installing, the side with the words on 78L05 faces the aluminum electrolytic capacitor.



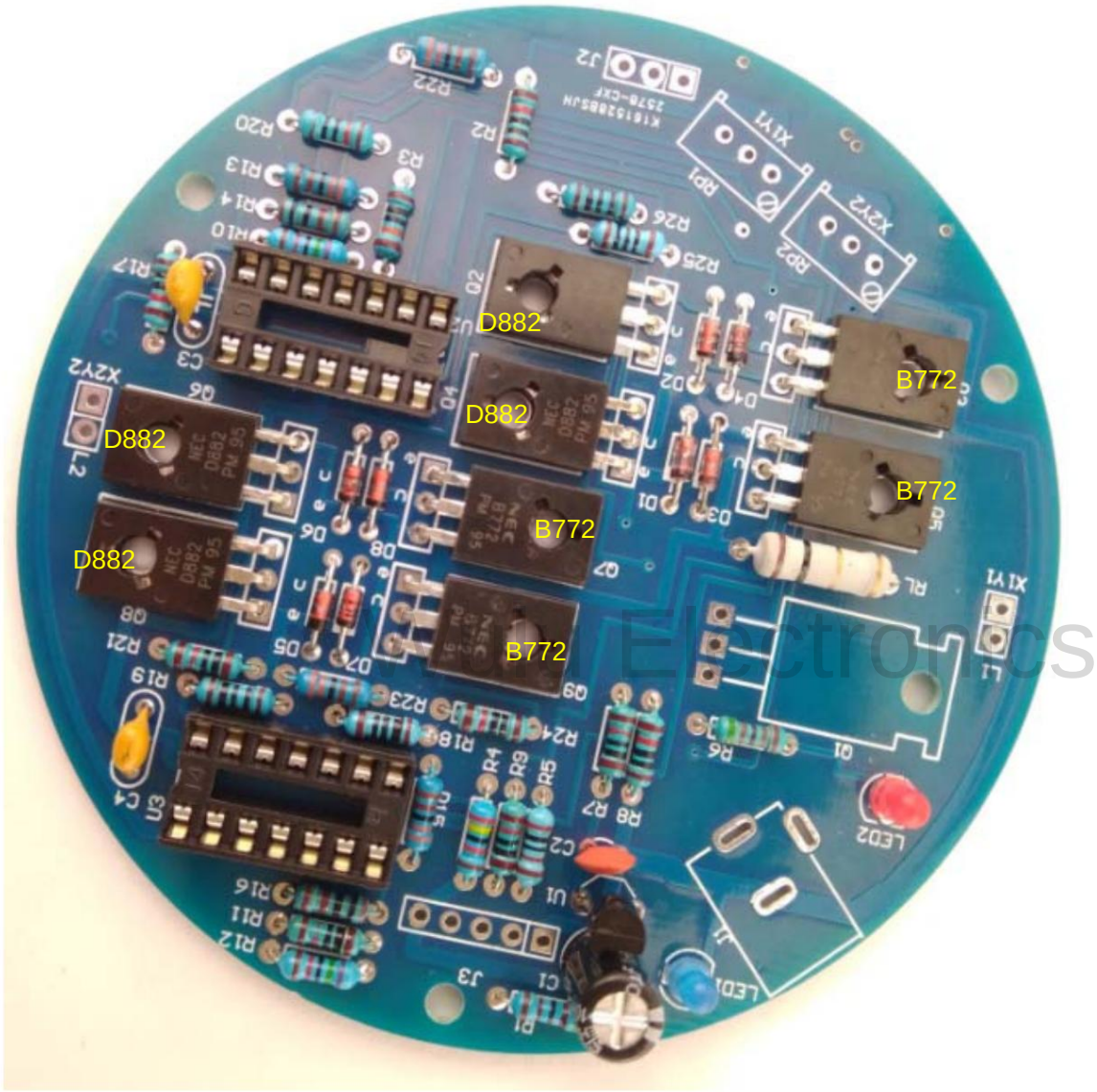
7. Install transistors D882 and B772

Transistors D882 and B772 have the same appearance, but they are two transistors with different polarities. D882 is an NPN type, and B772 is a PNP type. When installing

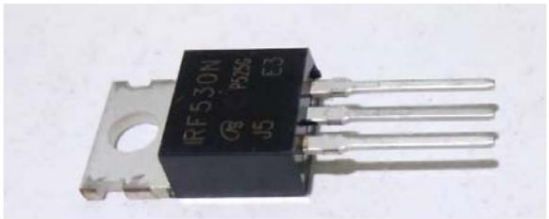
Be sure to confirm the installation position of the two transistors according to the component list. If installed incorrectly, it may easily cause damage to the transistor.



When installing, the transistor should have its face facing upwards, and the pins should be bent 90° downwards at the appropriate position to be close to the circuit board.

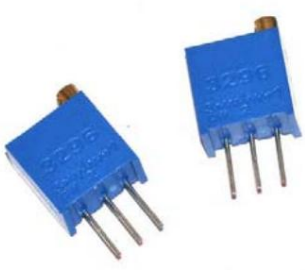


8. Install the field effect transistor IRF530

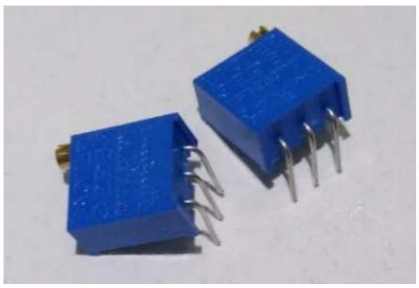


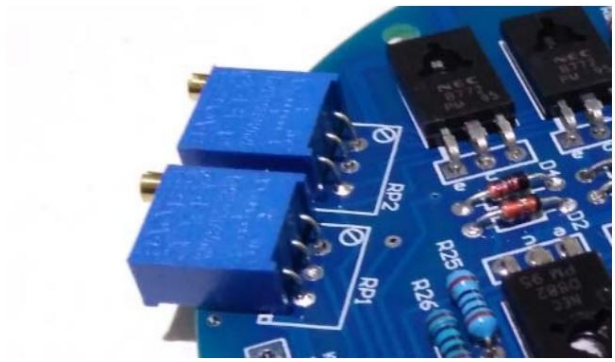
The face of IRF530 faces upward, and the pins are bent downward at 90° to be installed closely against the circuit board.

9. Install 3296 precision adjustable resistor

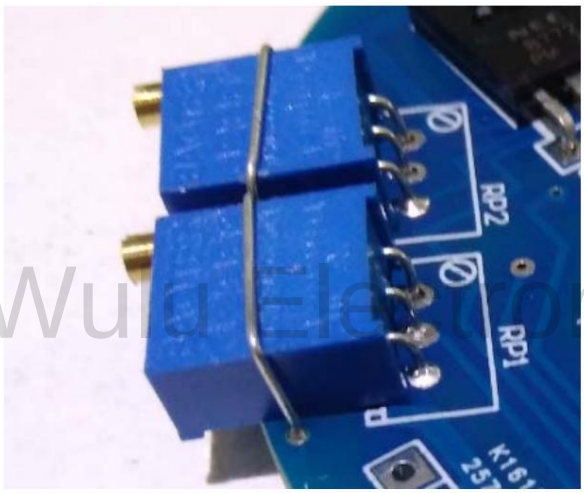


The face of the adjustable resistor faces upward and the pins are bent downward at 90°. Install closely to the circuit board

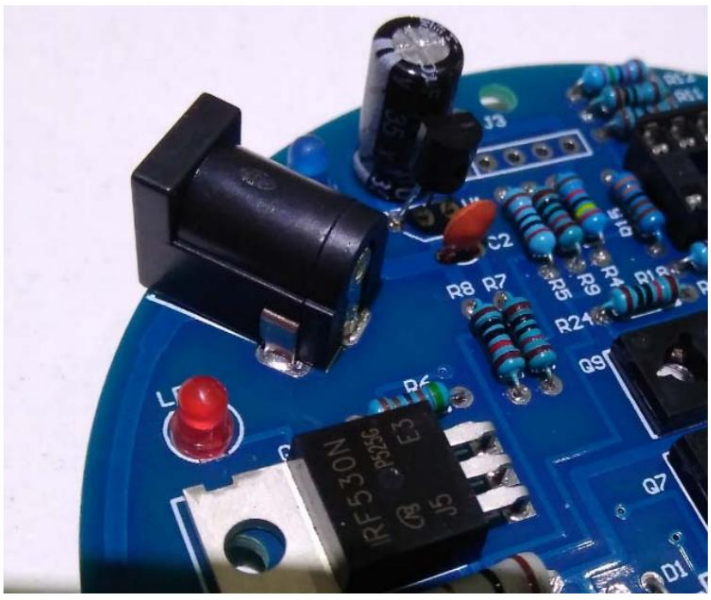




Use the scissored legs of the resistor to make two clips to fix the 3296 adjustable resistor, which can facilitate the adjustment of the 3296 adjustable resistor during later debugging.



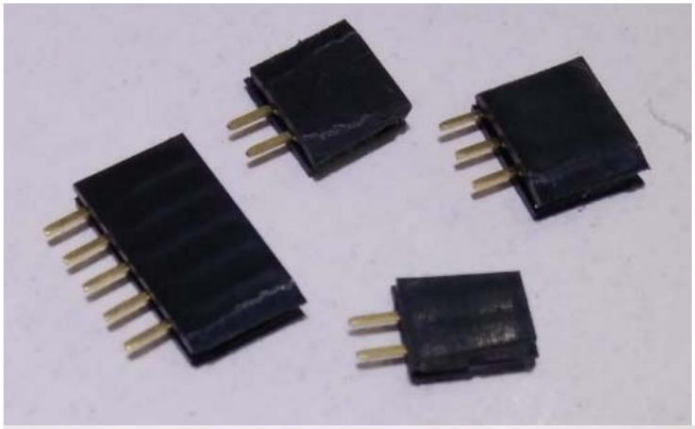
10 Install the DC socket

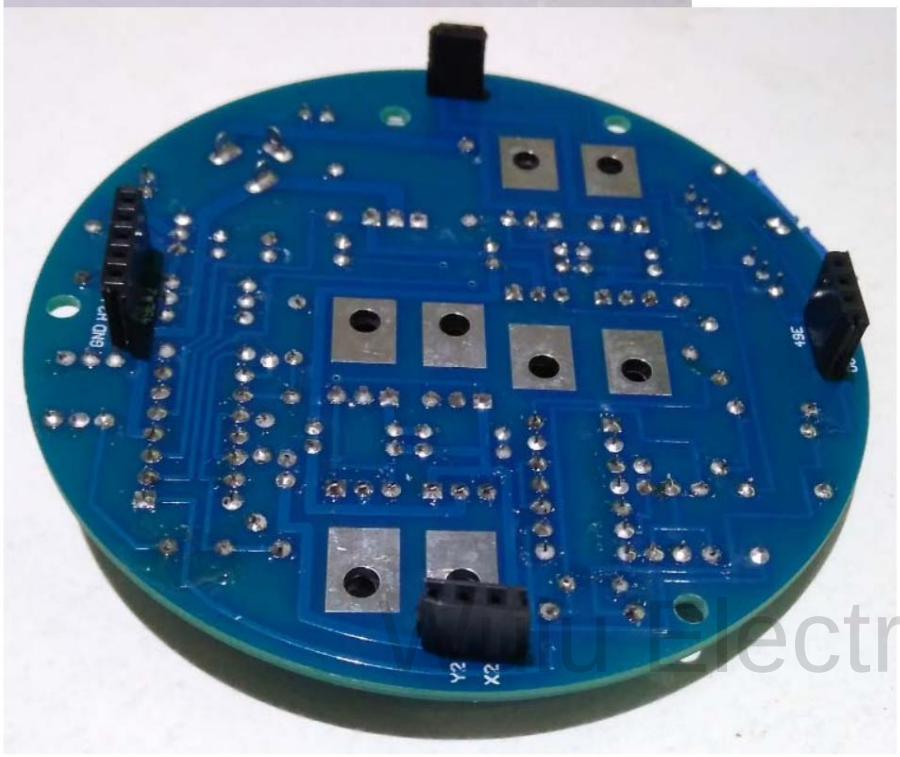


11. Install single row female

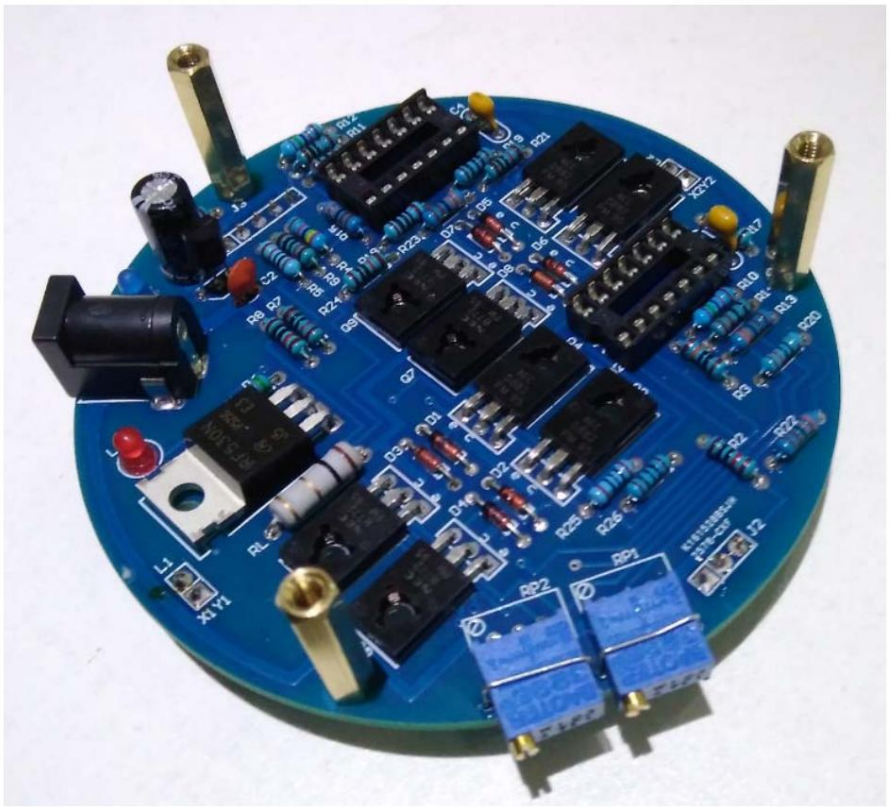
Machine Translated by Google

Cut 3 types of single-row females, two of 2P, one of 3P, and one of 5P, and install them on the back of the control circuit board.



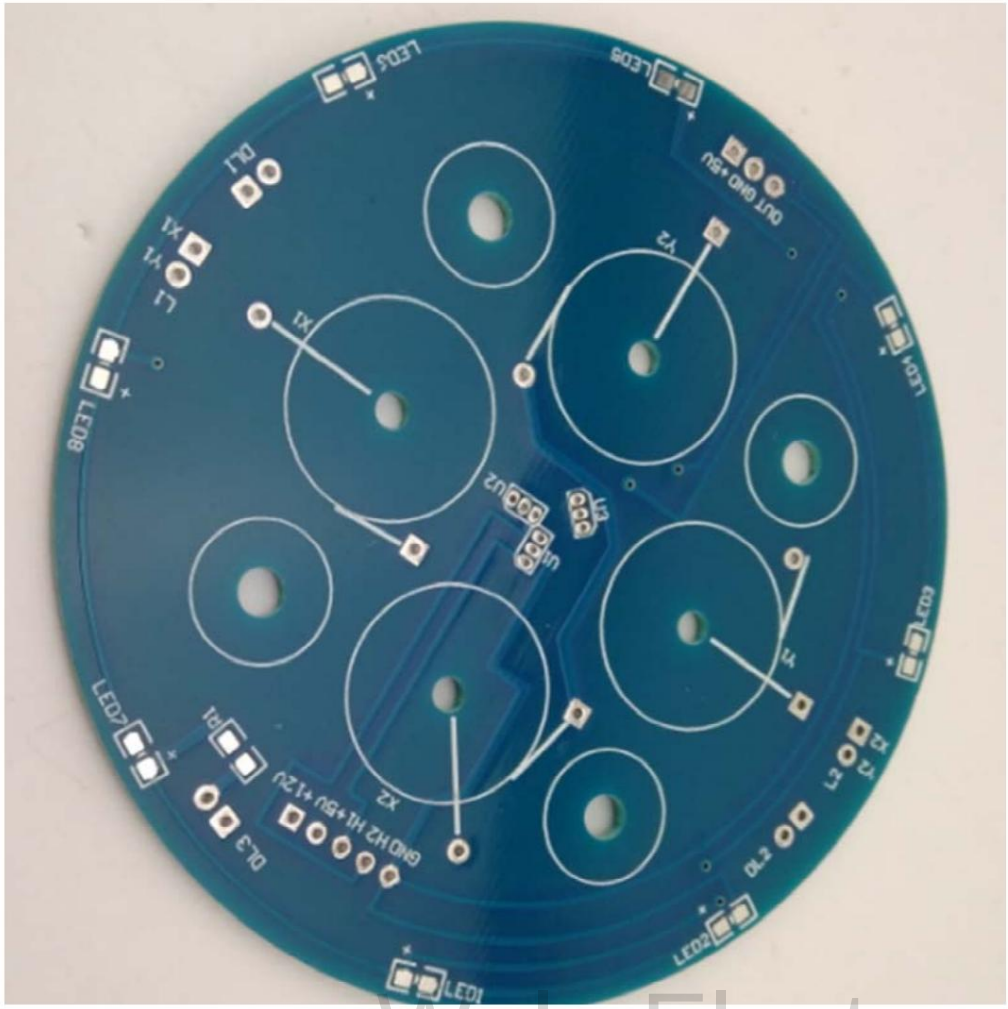


Install the three copper pillars, and the control circuit board is installed.



Machine Translated by Google

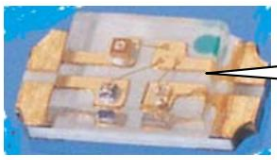
Assembly of magnetic levitation coil circuit board

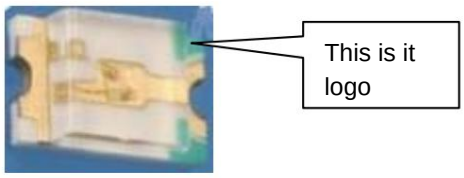


1. Install the chip resistor R1 and the chip light-emitting diodes LED1-8. Note: These chip components are for decoration and do not participate in the control of magnetic levitation. If you feel it does not look good, you can leave them empty.

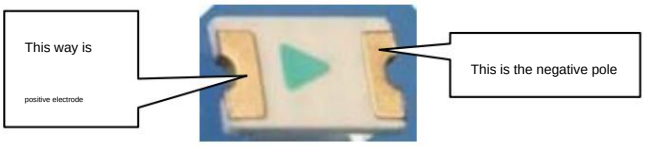
Distinguish between positive and negative electrodes of SMD LEDs

If you observe the LED from the front, you will see an obvious mark on the negative side. The mark will be as shown in the picture below:





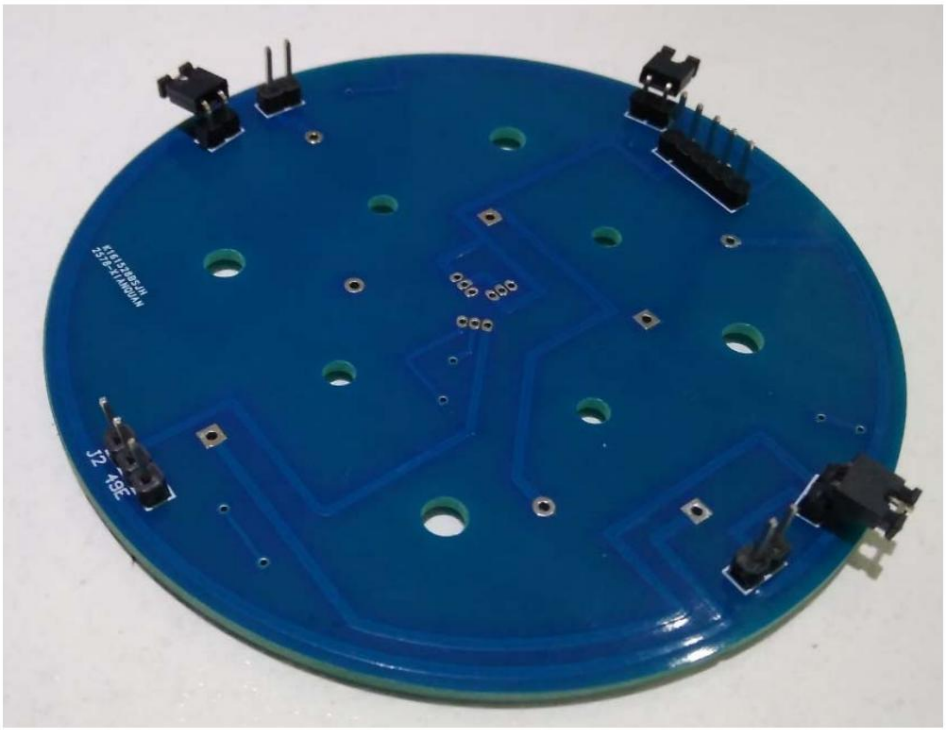
Observing the light-emitting diode from the back, you can see the following form



There is a '+' at the installation position of the SMD LED on the circuit board to indicate the positive pole.

2. Install the pin header.

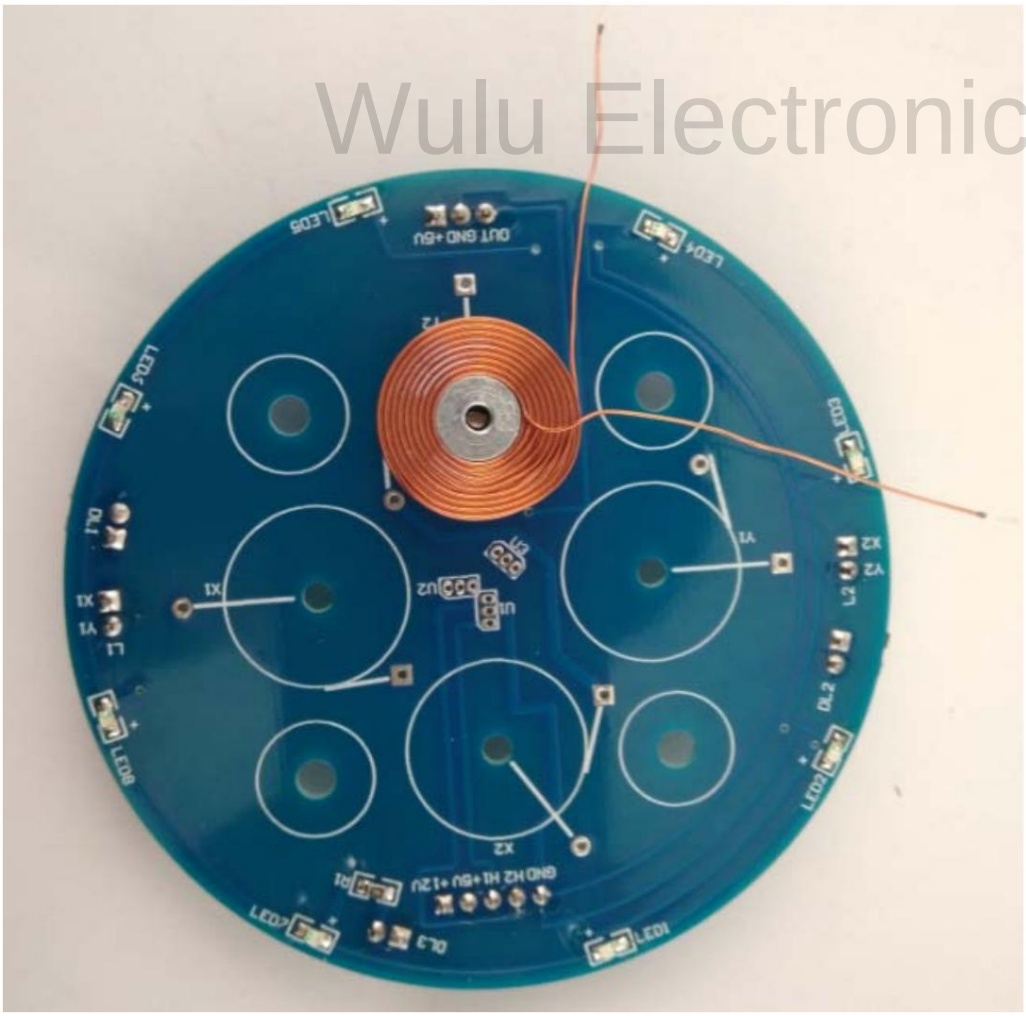
Install the single-row bent pins and single-row pointers to the back of the circuit board, and install the three short-circuit caps on the bent pins.



3. Install the Hall sensor and electromagnet coil. The electromagnet coil

should be installed in such a way that the copper wire leading out from the center of the coil is facing up. The back is fixed to the circuit board with M3*6 screws. Four

The up and down directions of the coils are the same. Install only one coil first, and then use this coil as a height reference to install the Hall sensor.

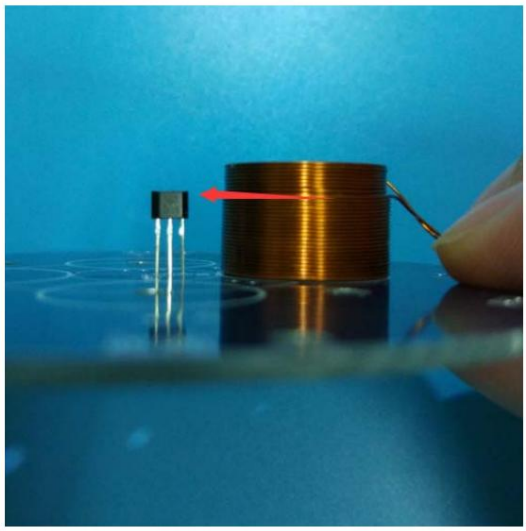


Hall sensors U1 and U2 are used to detect changes in the magnetic field in the X direction and Y direction respectively. U3 is used to detect whether the float above exists

The installation height of U1 and U2 is as shown in the figure below. Special attention should be paid to the height and direction of the sensor. If the position is too high, it will tremble if suspended. Generally,

First take the center position of the coil height. If the back is suspended and shakes, you can lower it slightly. The sensor should be installed perpendicular to the circuit board.

Don't tilt. U1 and U2 should be installed at the same height. The pins of the Hall element should not be shortened first to facilitate height adjustment later.

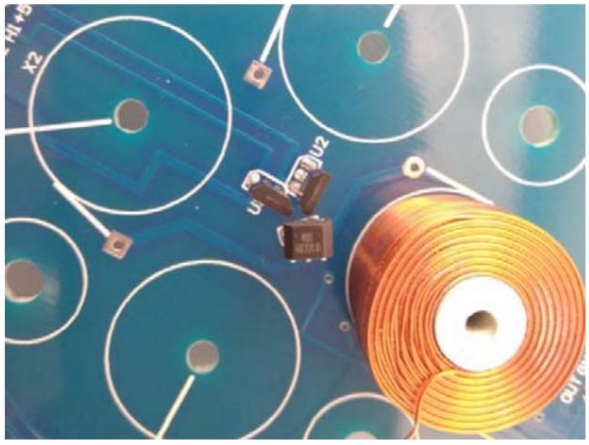


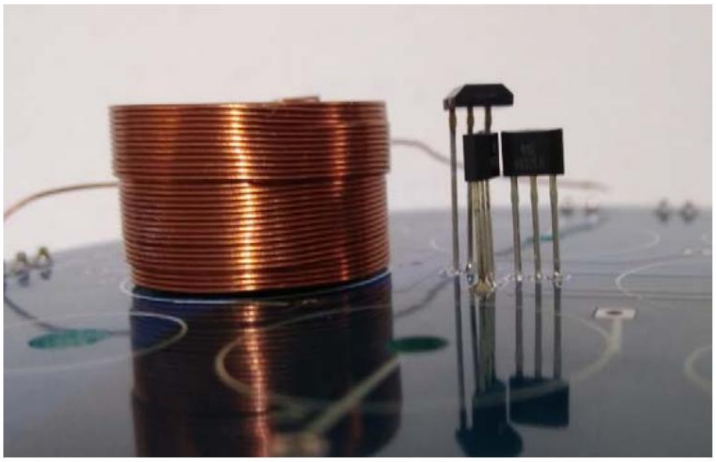
Put the remaining Hall sensor with the face facing up and fold the pin down 90° from the root, as shown below

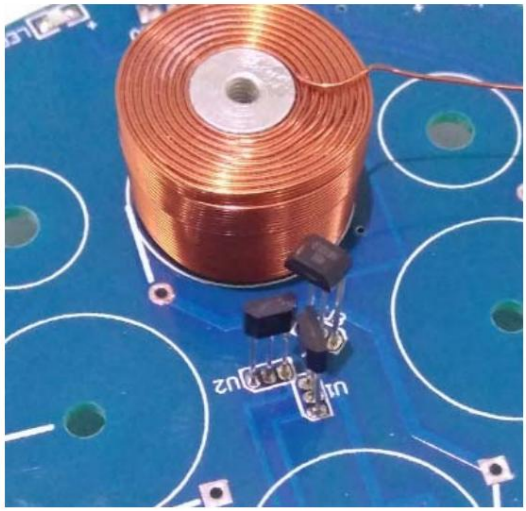
Install this bent Hall sensor to the U3 position. The installation height is greater than U1 and U2. The higher the position of U3, the more sensitive the detection float will be.

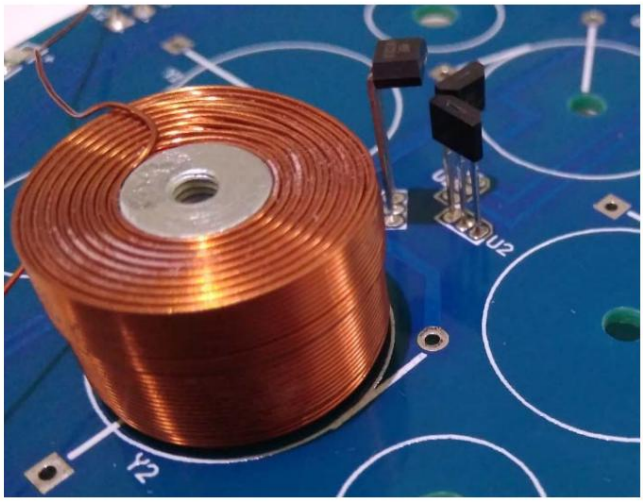
Sensitive. So try to install U3 as high as possible.

Installation demonstration diagram of three Hall sensors

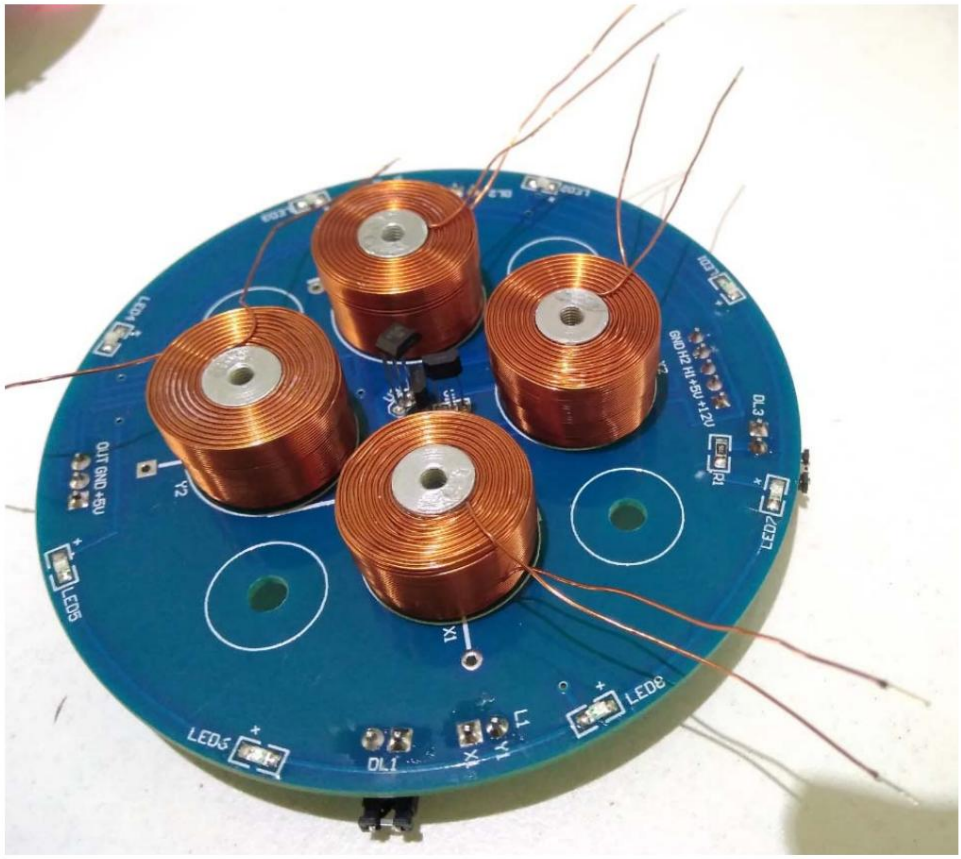




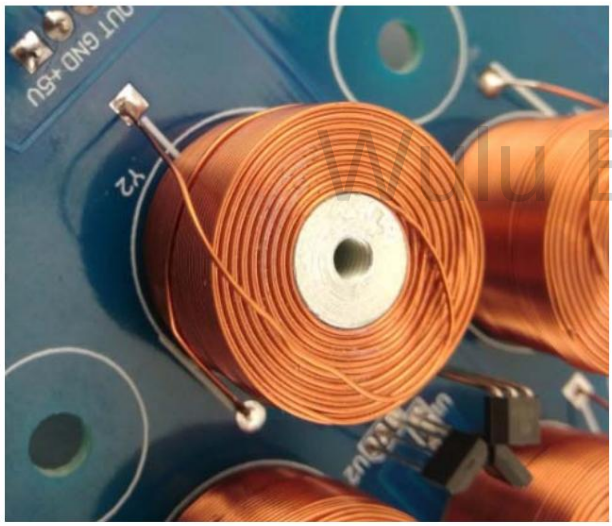


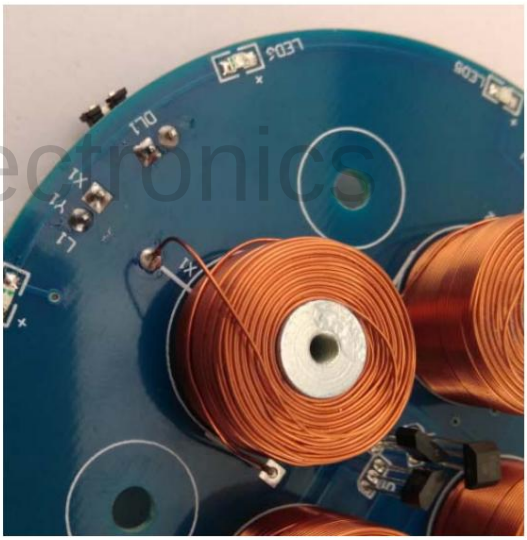


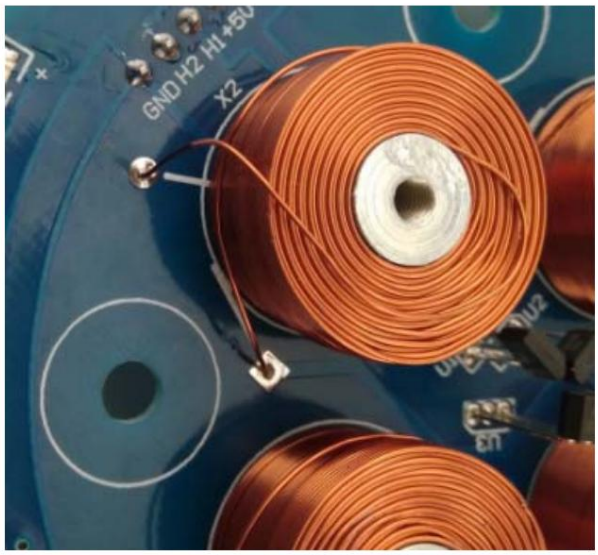
Use M3*6 screws to fix the remaining three coils to the circuit board

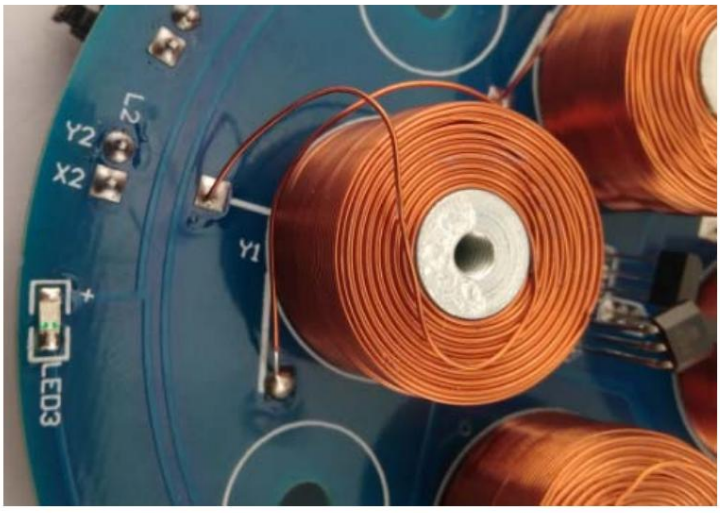


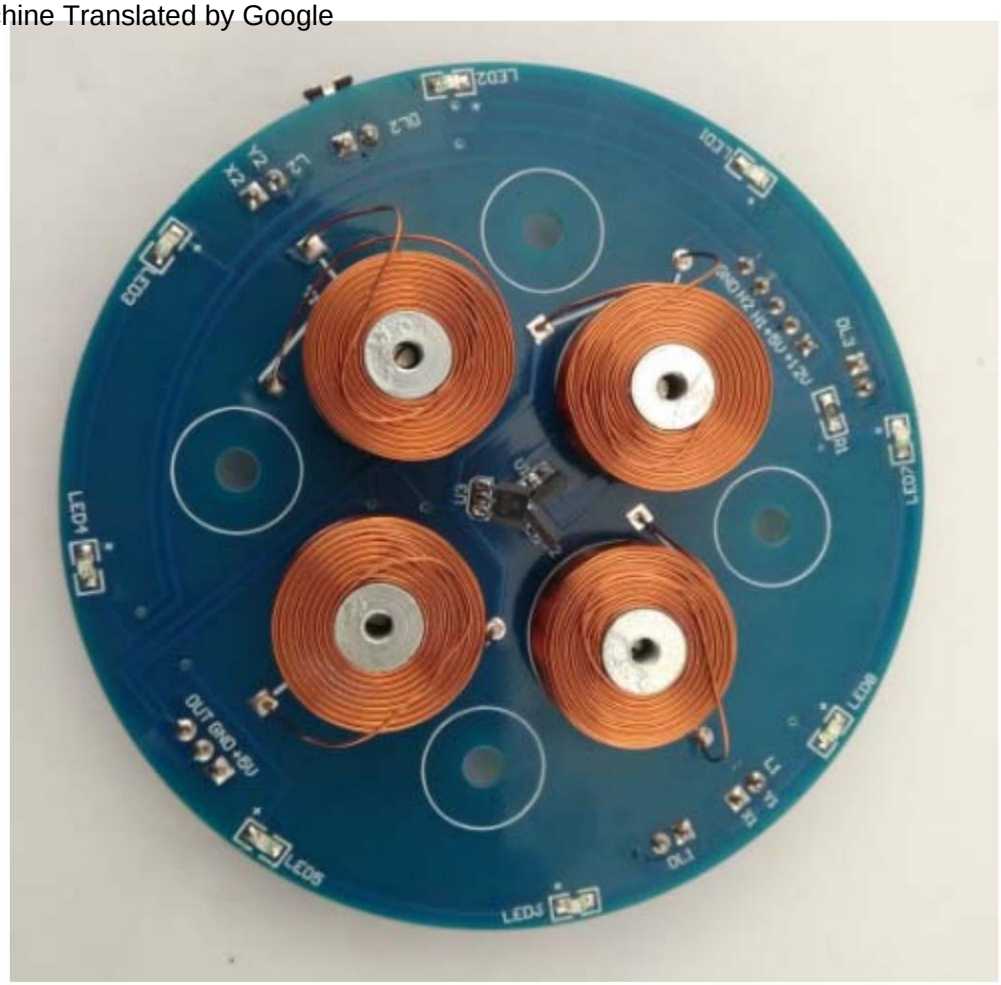
Solder the coil leads to the corresponding positions on the circuit board.



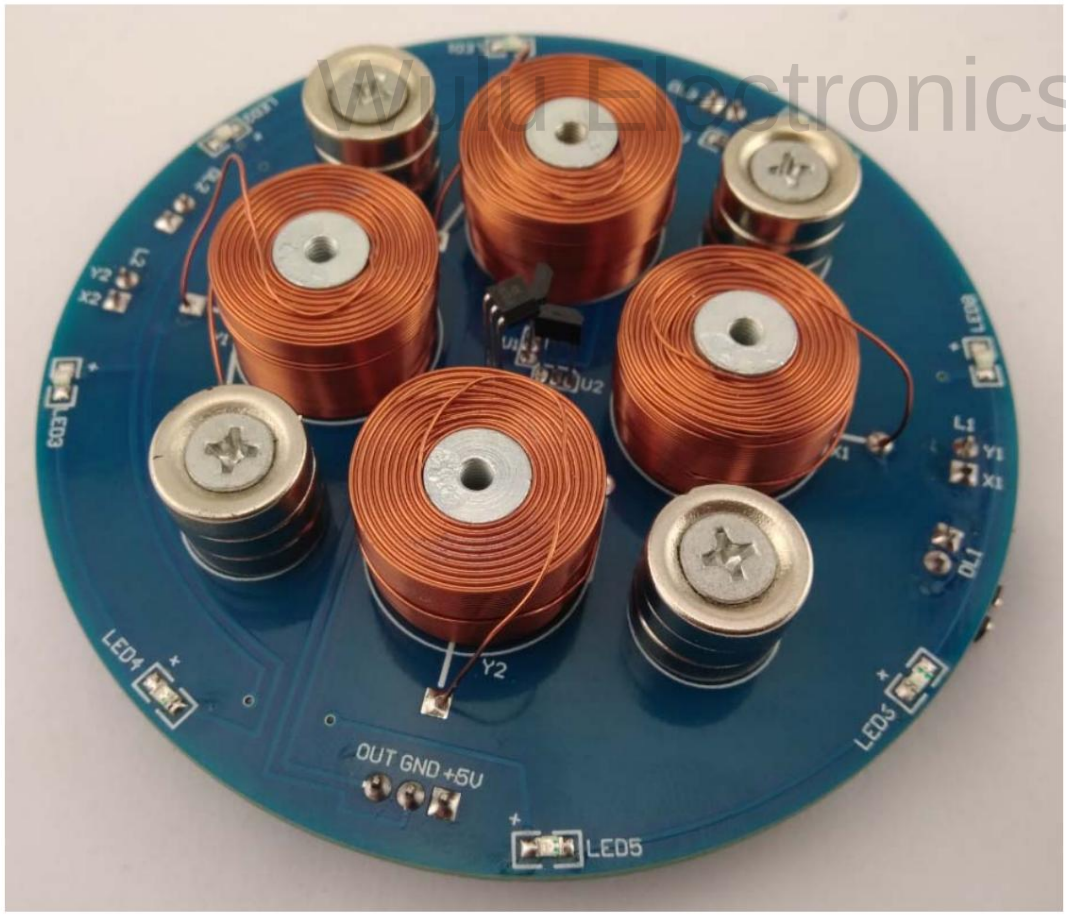




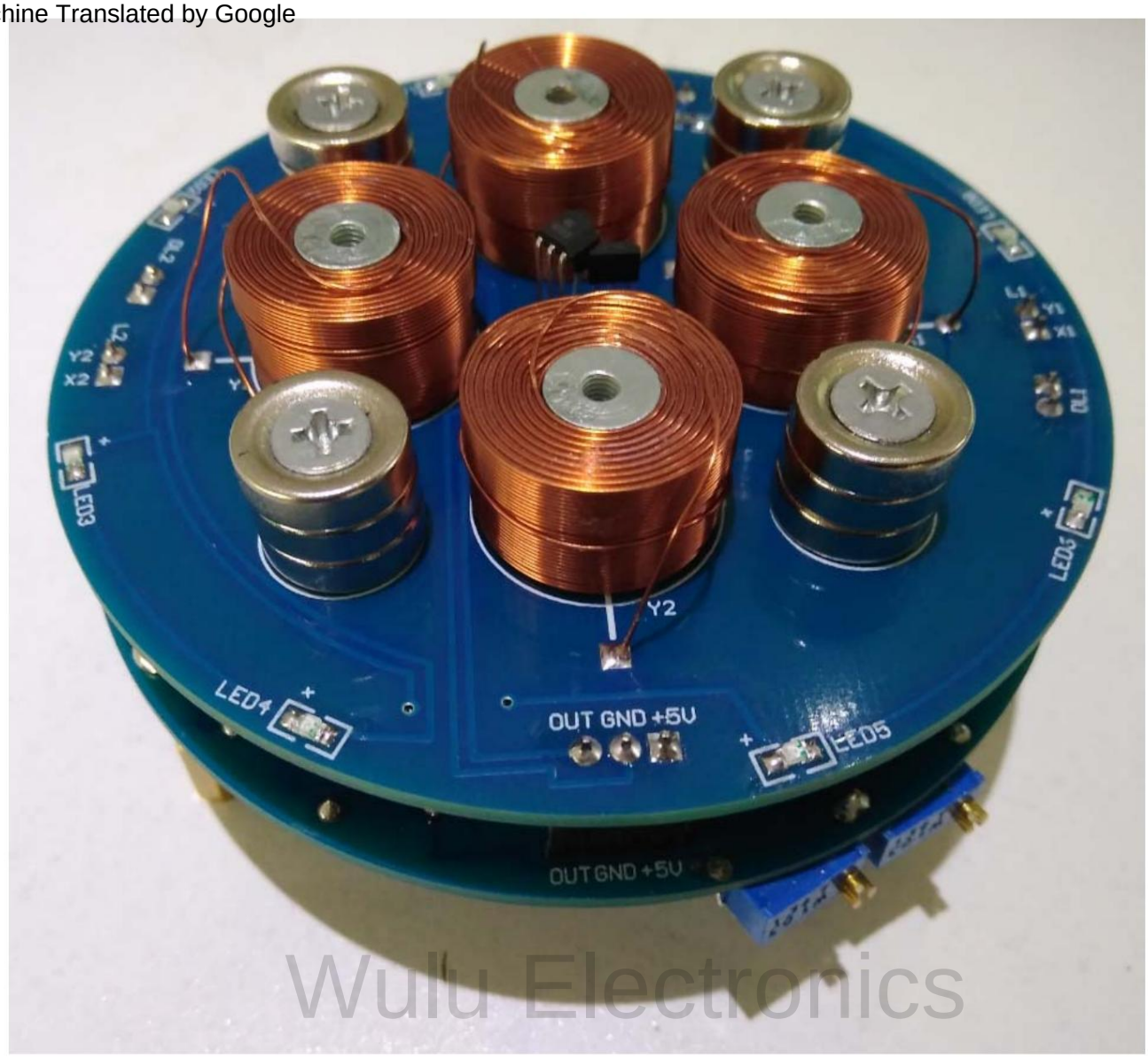




Fix the 4 permanent magnets on the circuit board with M4 nuts



Install the coil board onto the control circuit board and prepare for power on and debugging



When powering on and

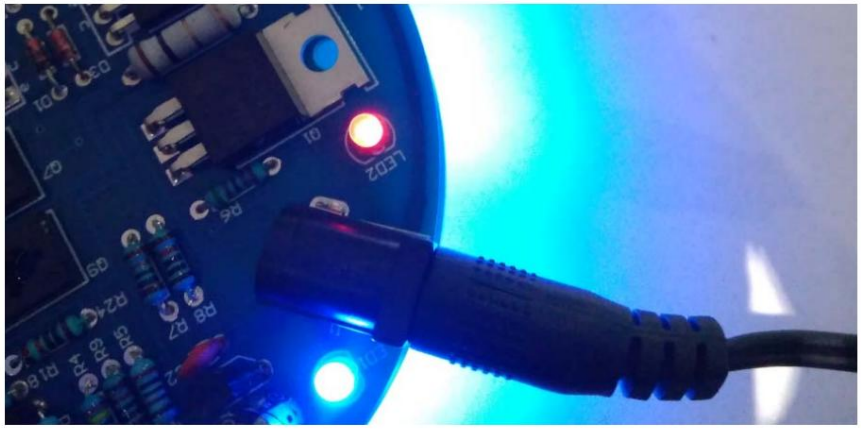
debugging , this kit can be powered by DC 7.5-12V. The power supply interface is a DC05 socket, with the inside positive and the outside negative. Before supplying

power, confirm the positive and negative poles of the power supply, and do not connect them reversely.

This instruction is powered by an adjustable power supply adjusted to 12V DC.

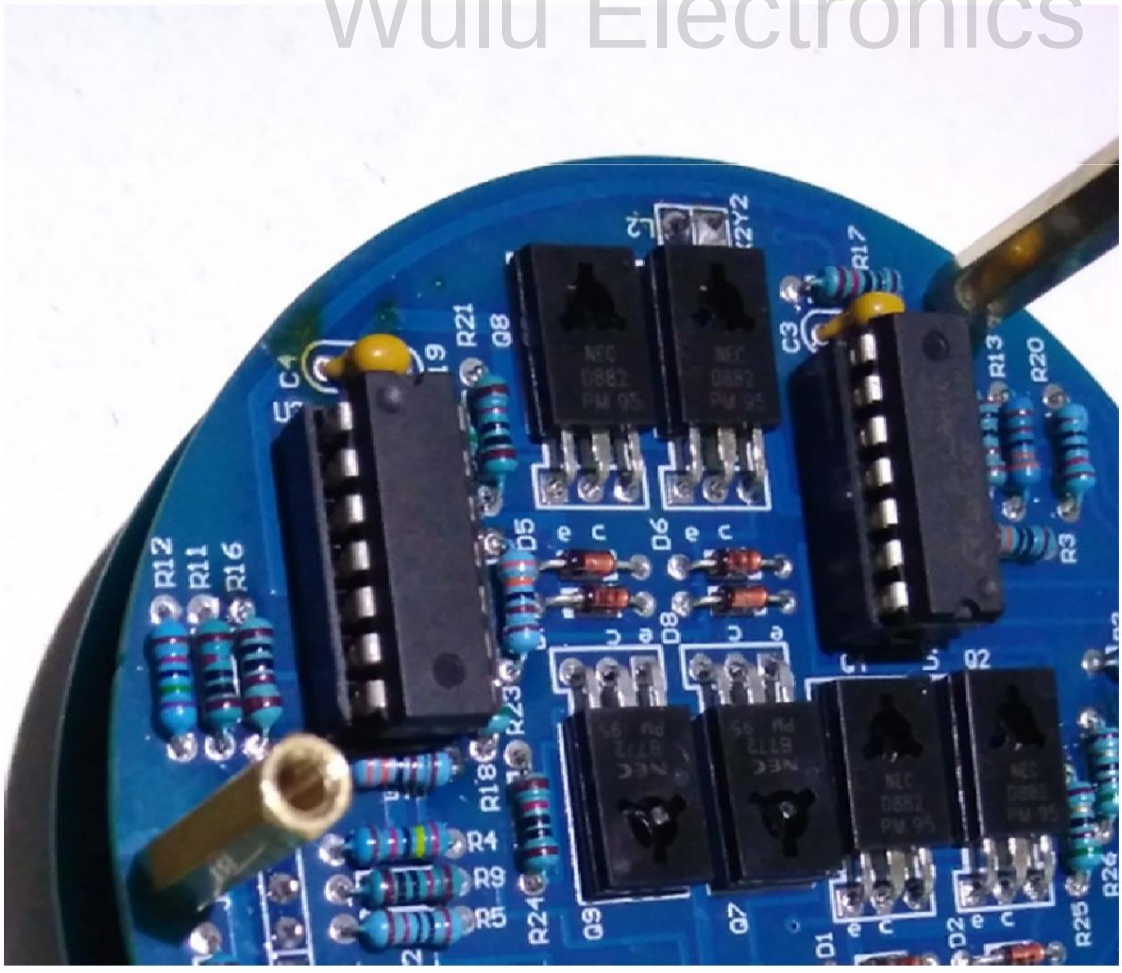
After the power is turned on, 8 SMD LEDs light up

LED1 is on and LED2 is dimly lit. If the LED does not light up after powering on, disconnect the power supply immediately and check whether the positive and negative poles are connected reversely.



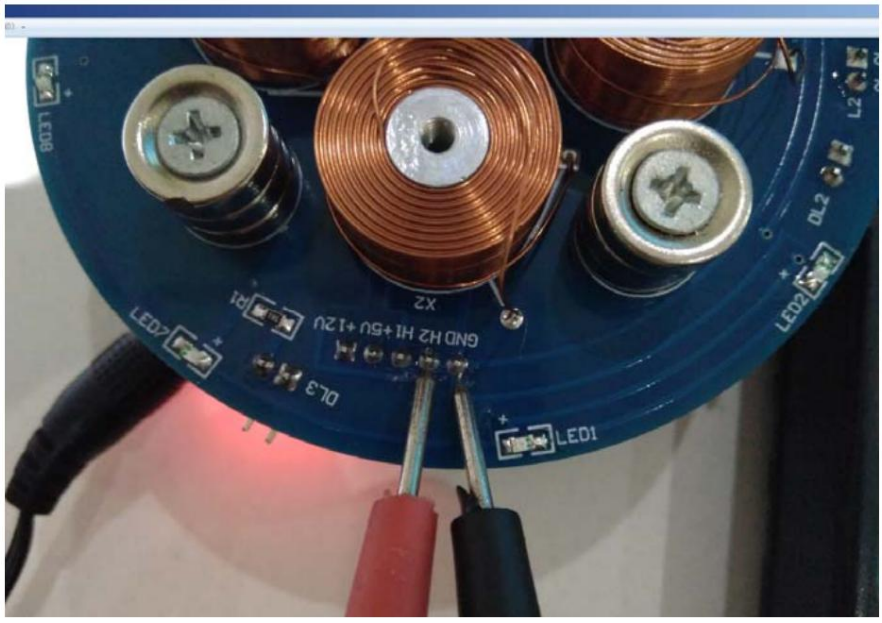
Disconnect the power supply and install the two LM324s on the IC holder. Pay attention to the direction when installing. The semicircular notch on the LM324 and the semicircular notch on the IC holder are square.

towards the same. Then turn on the power.

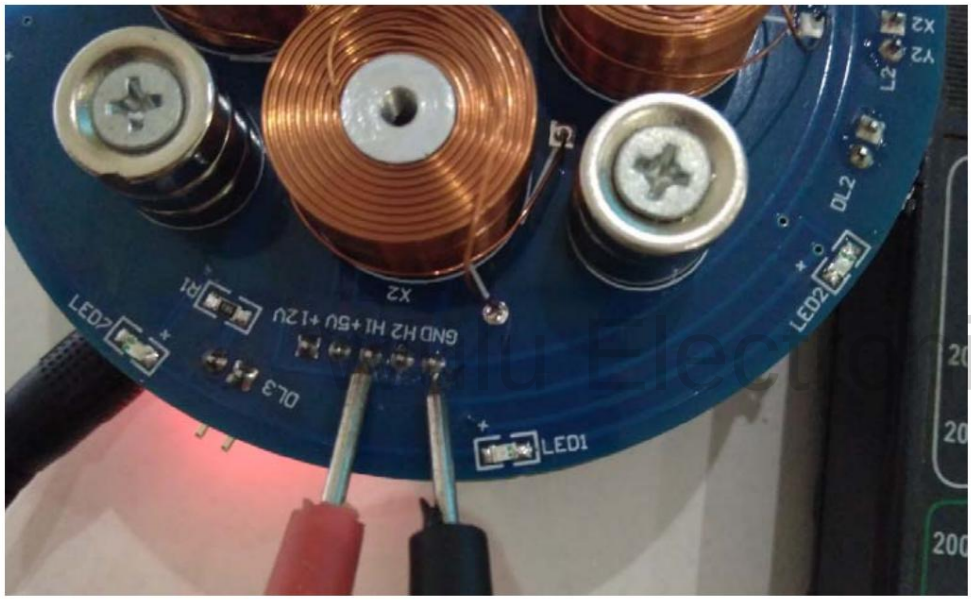


1. Use a multimeter to measure the voltage to ground at the H1 and H2 positions on the coil board and record it.

Measure H2 voltage

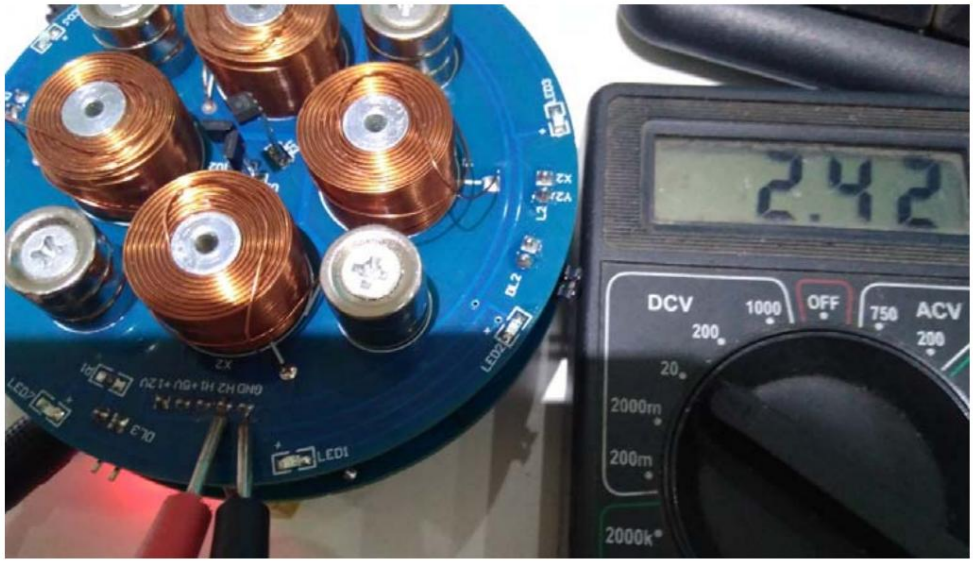


Measure the voltage of H1



The measured H1 voltage is 2.43V

The measured H2 voltage is 2.42V.



The H1 and H2 position voltages are the output voltages of Hall sensors U1 and U2. Without the float, the output voltage is around 2.5V,

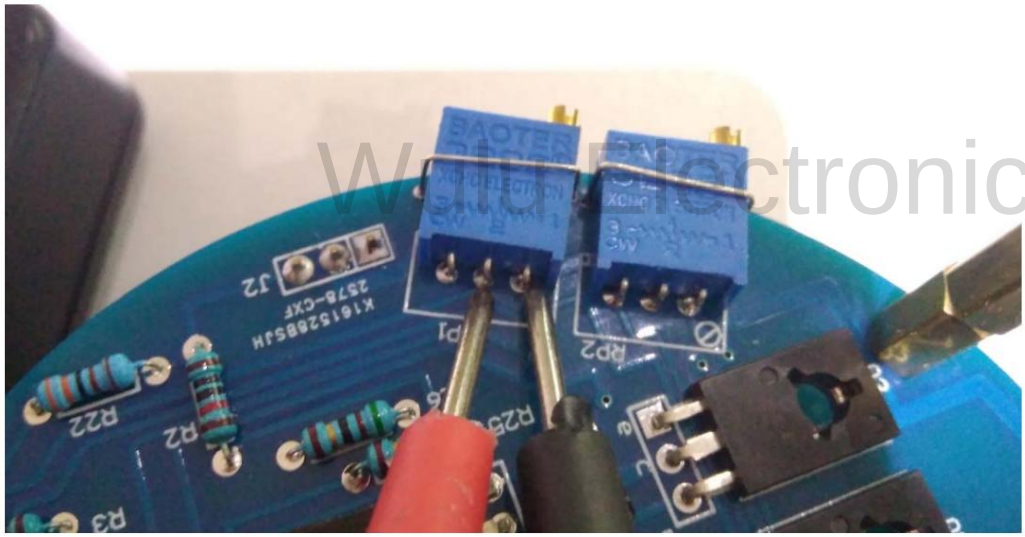
The measured voltage value indicates that U1 and U2 are normal.

2. Measure and adjust the midpoint voltage of precision adjustable resistors RP1 and RP2.

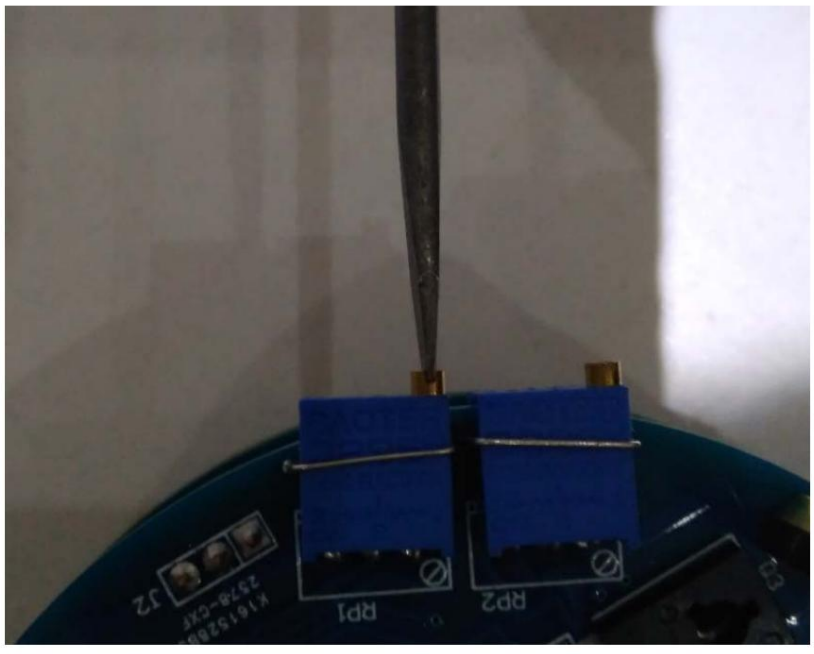
The midpoint voltage is the voltage between pin 2 (middle pin) of the precision adjustable resistor. Measure and adjust RP1 and RP2 respectively, so that RP1

The midpoint voltage of RP is equal to the H1 voltage measured previously, and the midpoint voltage of RP2 is equal to the H2 voltage.

Measure the midpoint voltage of RP1

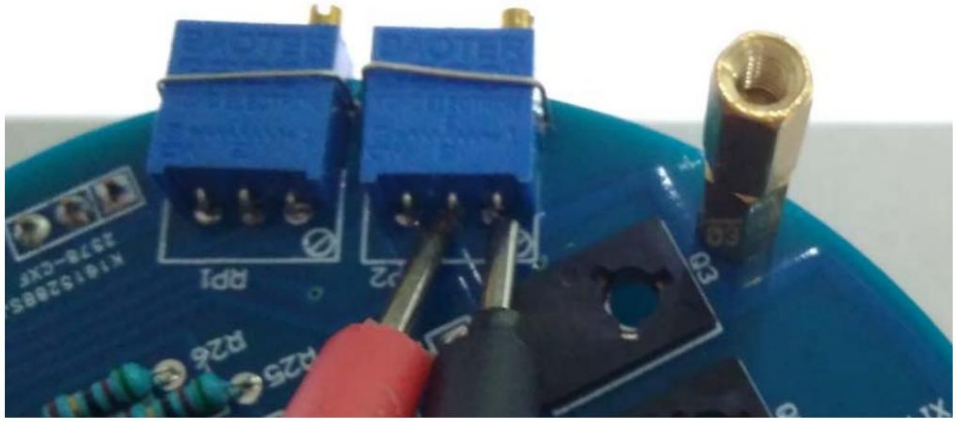


Use a '-' screwdriver to adjust RP1, clockwise to increase the voltage, and counterclockwise to decrease the voltage.



Adjust the midpoint voltage of RP1 to 2.43V.

Measure the midpoint voltage of RP2



Use the same method to adjust the midpoint voltage of RP2 to equal the H2 voltage 2.42V.

3. After placing the float

and adjusting the voltage, you can place the float. This kit is a push-down magnetic levitation, so when placing the float, the float and the magnet below must be

The repelling side faces down. To be able to levitate. First, use

two floats that are sucked together to test. The magnetic force of two floats is stronger and the success rate of initial placement is higher. After you become familiar with it, you can use only one float.

The sub can also be levitated.

Aim the float from high to the center of the four coils below, and slowly move it downwards. After moving closer to a certain position, U3 will sense the presence of the float.

Now, the brightness of LED2 on the control board becomes higher, and the circuit will flow through the four coils, generating electromagnetic force to control the float above to keep it in the center position. NOTE:

Use one hand to hold the underlying circuit board in place while placing the float. The circuit board should be placed on a level table. The float must be held firmly.

Generally speaking, as long as the midpoint voltage of RP1 and RP2 and the voltage of H1 H2 are adjusted to be consistent, the float can be placed and suspended normally. if

When you lower the float and feel that the float is leaning to one side, it is likely that the Hall sensors U1 and U2 are not installed in the center of the coil.

For example, when placing the float and feeling that the float is biased towards the X1 coil, it means that the Hall sensor U1 is not installed in the center of the coils X1 and Y1.

Since you feel that the float is biased toward the X1 coil, move U1 slightly toward the Y1 coil. If the float deflects toward Y1 direction, then move U1

Move it slightly in the direction of the X1 coil. In the same way, if the float

deviates in the direction of the X2 and Y2 coils, turn the Hall sensor U2. The method is the same as above. There is a video in the information demonstrating the process of

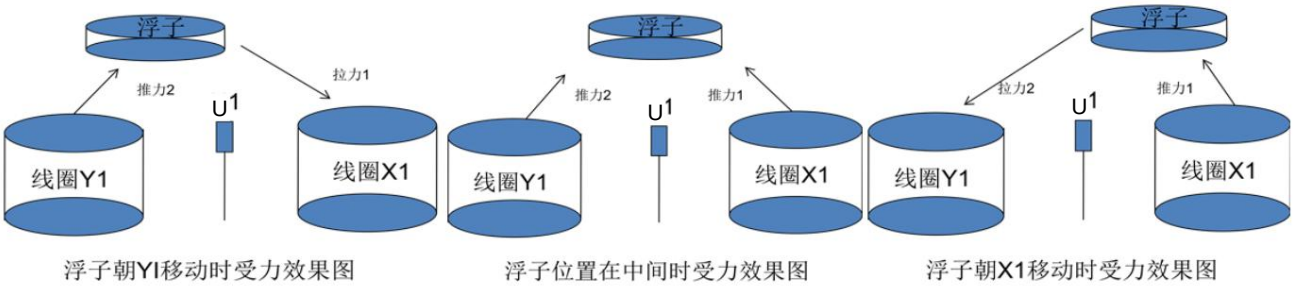
placing the float. You can watch it before placing it. The principle is briefly introduced below. Coil working principle: The magnetic levitation has two sets of coils. The U1 sensor collects

the magnetic field change

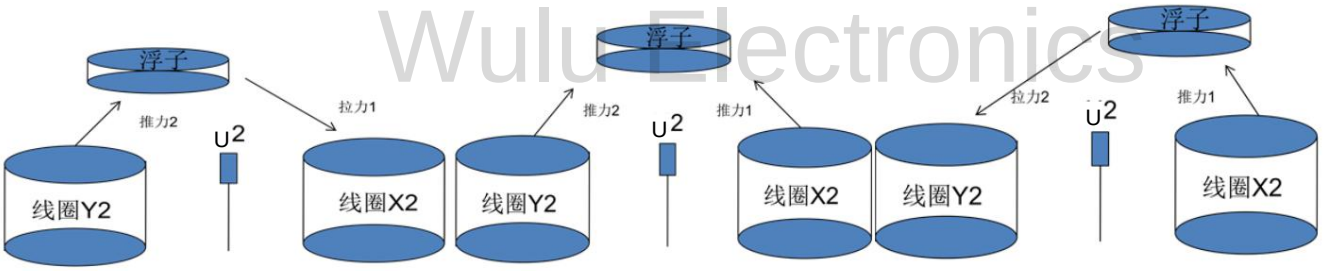
value between coil X1 and coil Y1, and the U2 sensor collects the magnetic field change value between coil X2 and coil Y2.

Magnetic field change value, the change of magnetic field comes from the displacement of the float

above. The force diagram of the float:

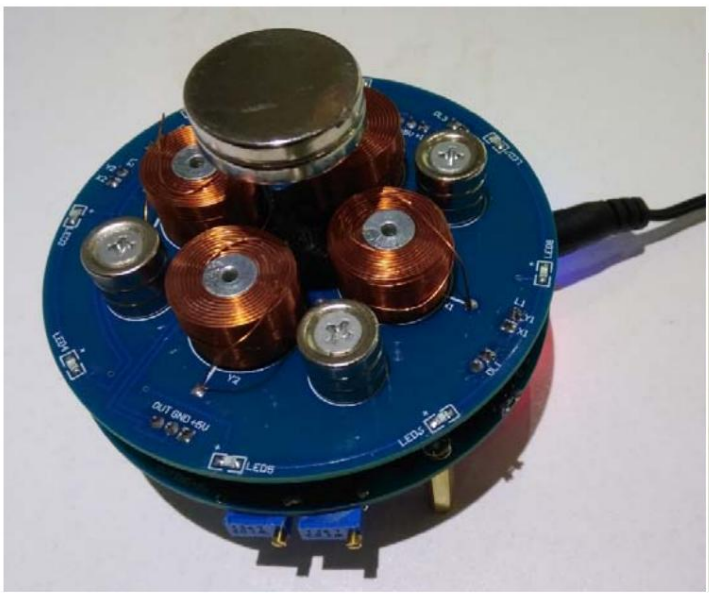


浮子朝YI移动时受力效果图　　浮子位置在中间时受力效果图　　浮子朝X1移动时受力效果图



浮子朝Y2移动时受力效果图　　浮子位置在中间时受力效果图　　浮子朝X2移动时受力效果图

After the float can be suspended, fine-tune RP1 and RP2 (note that it is fine-tuning). You can find that the float moves above with the adjustment, and the current also changes.



Machine Translated by Google

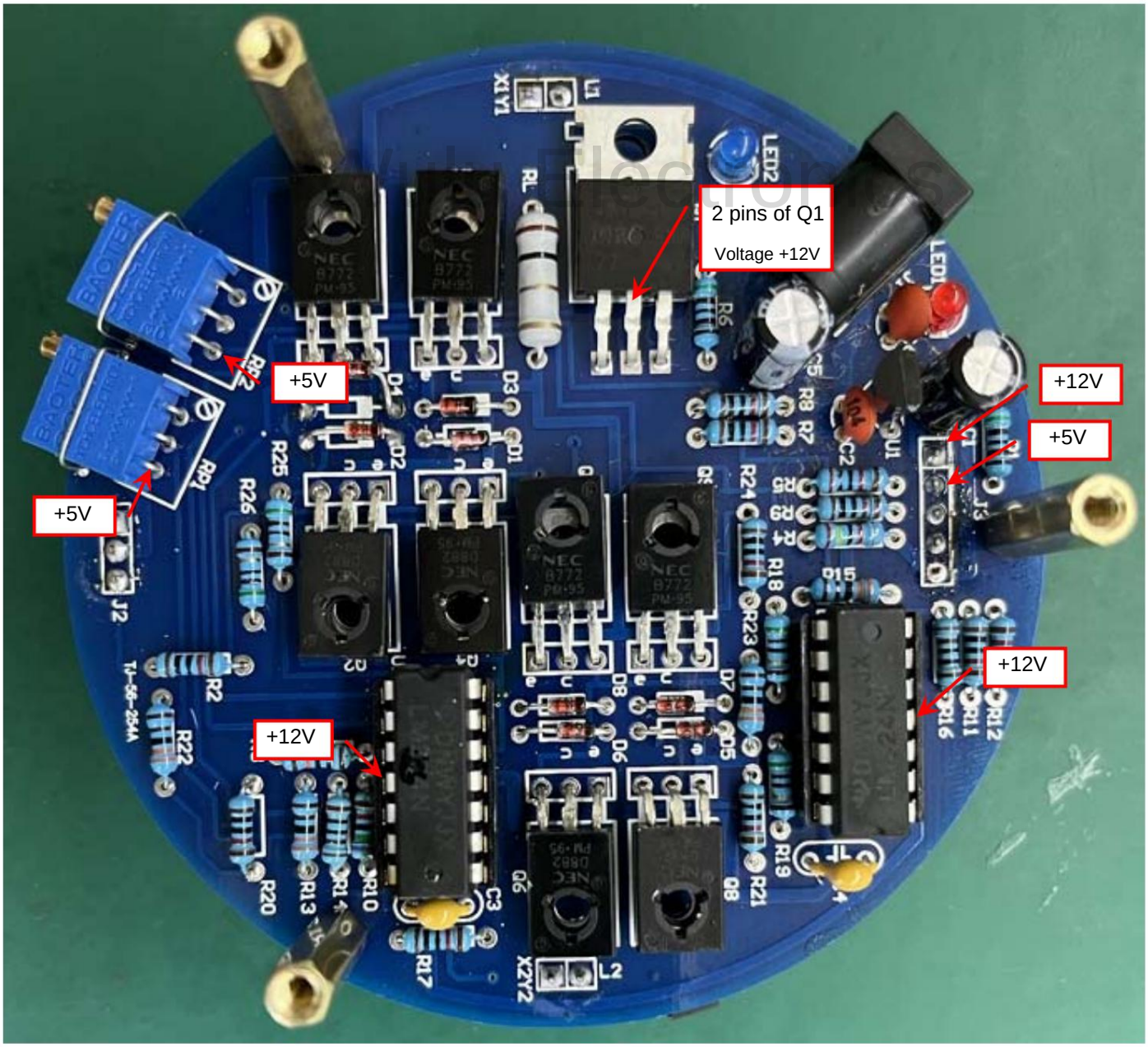
Carefully adjust RP1 and RP2 to reduce the power supply current as much as possible. Under 12V power supply, the actual measured current can be reduced to 40mA.

If the power supply is not powered by an adjustable power supply and the supply current cannot be seen, you can lead wires from both ends of the power resistor RL and measure it with a multimeter at the low voltage range.

The voltage across RL is converted into current, and the resistance of RL is 1 ohm.

Here are some solutions to problems where levitation cannot be achieved

After power-on, the voltage reference of key points of the control circuit board to ground (test condition: 12V DC power supply)



ÿ There is +12V voltage on the board, but +5V is abnormal. You can separate the upper and lower circuit boards first. The +5V voltage is mainly provided to the three Hall elements on the coil board. point

After opening the upper and lower circuit boards, if the +5V voltage recovers, it means there is a problem with the installation of the three Hall elements, such as the reverse direction and a short circuit between the pins (the three pins of the Hall element are

If the distance is relatively close, it is very likely that welding will cause a short circuit). Please check carefully according to the previous graphic installation tutorial. Also, if the 78L05 is installed in the opposite direction, there will be no +5V.

Voltage. If

the +12V voltage cannot be detected after the power is turned on, there may be a short circuit, for example, the LM324 is installed in the wrong direction. The electrolytic capacitor is installed in the wrong direction.

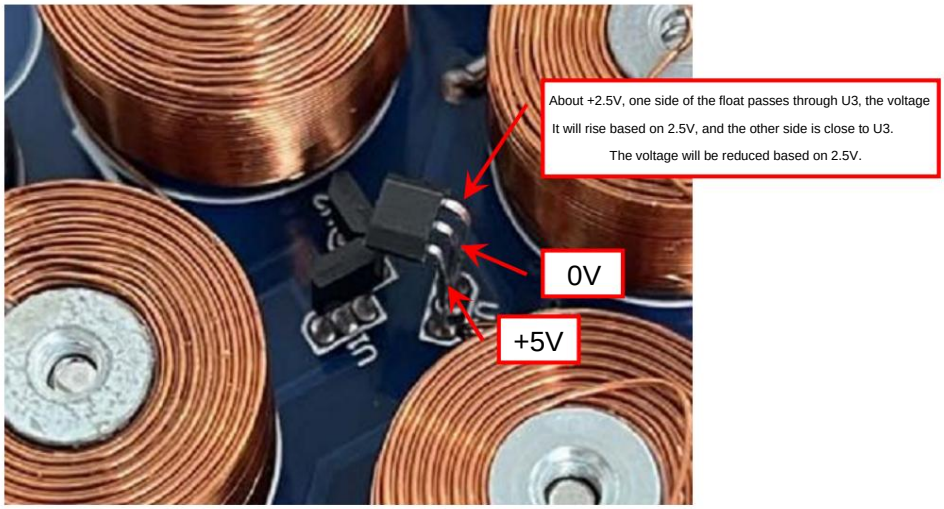
ÿDetermine whether the Hall element is working properly. Determine whether the Hall element

U3 is working properly.

U3 senses the upper float. When the float is close, if the light-emitting diode LED2 can become brightly illuminated (when the float is not detected, LED2 will be in a dim state)

The change in brightness is noticeable. Then you can directly judge that U3 is normal. Note that only one side of the float can cause the LED brightness to change, and the other side has no effect.

The voltage at each point of U3 is as shown below



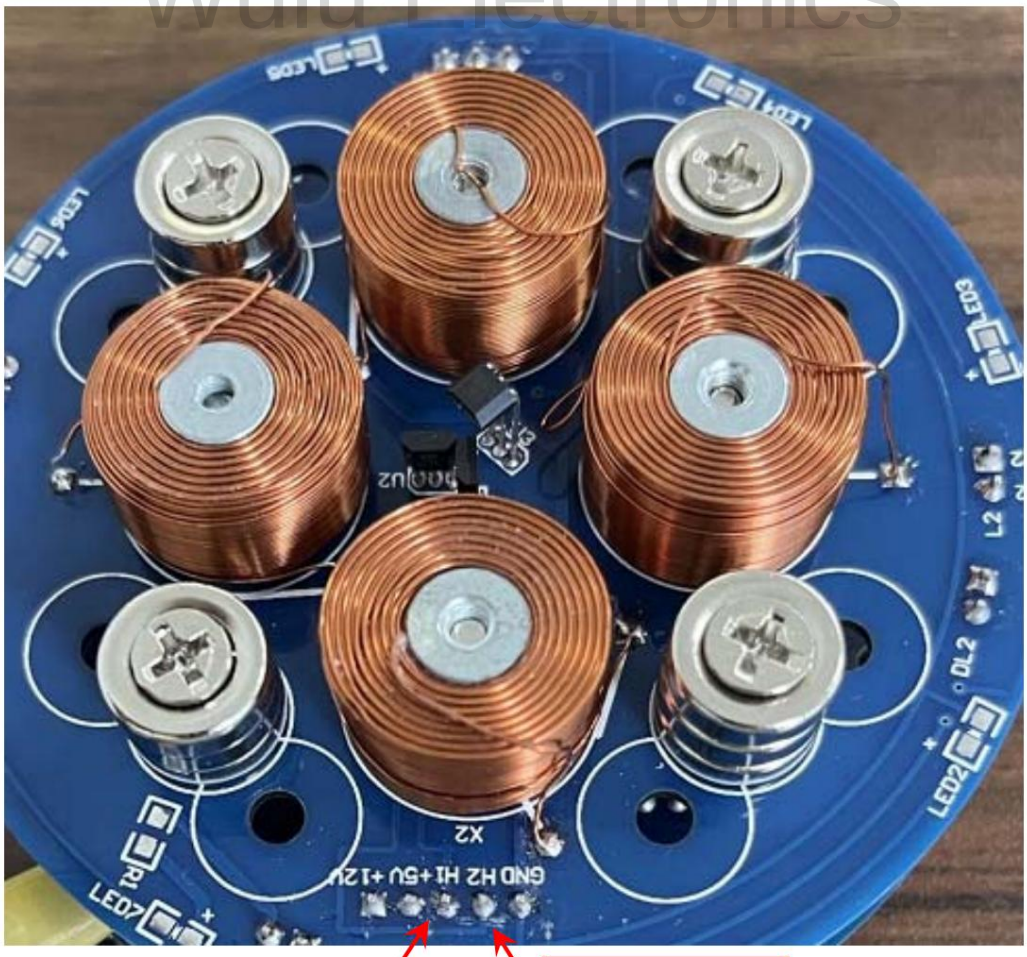
As shown in the picture above, when the float is close to U3, the voltage can change based on 2.5V, and the change is relatively small (up to a fluctuation range of 0.3V, the multimeter is measured at the DC 5V range).

It means U3 is normal. The side of the float that can reduce the 2.5V voltage is the side that works normally. This side faces the coil when floating.

U1 and U2 sense magnetic field changes in the X and Y directions respectively. Place the float at the center of the four coils (manually simulate the normal suspension state), and measure H1 and U2 respectively.

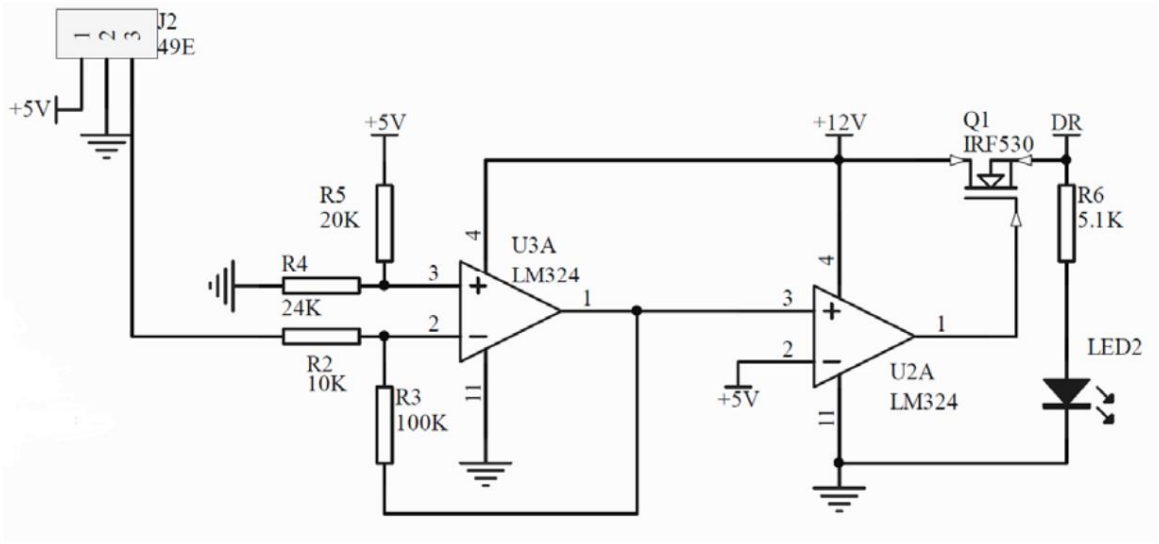
The voltage at H2 point (H1 corresponds to U1 output, H2 corresponds to U2 output), the float sways in the left and right directions of U1 (the float can be in any direction at this time), and the voltage at H1 point can be measured.

Slight fluctuations at the 2.5V position (up to 0.2V fluctuations) indicate that U1 is normal. The method for testing U2 is the same and will not be repeated here.

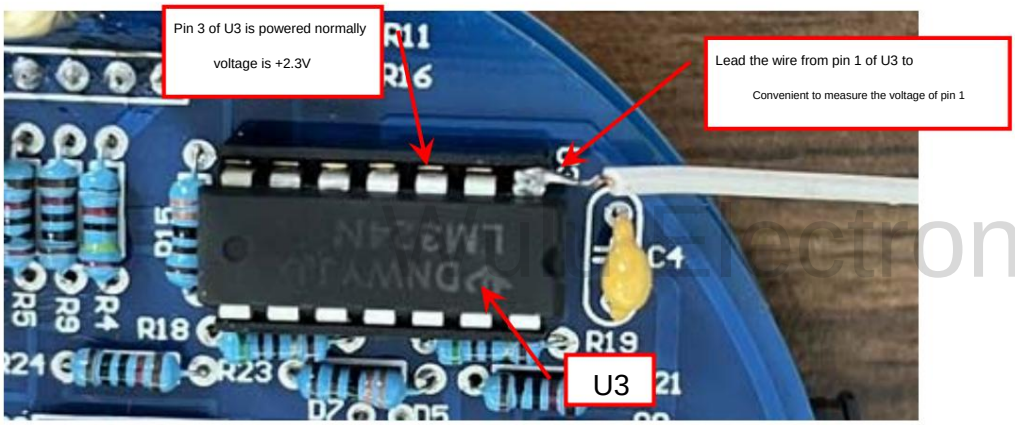


ÿJudge whether the op amp is working properly.

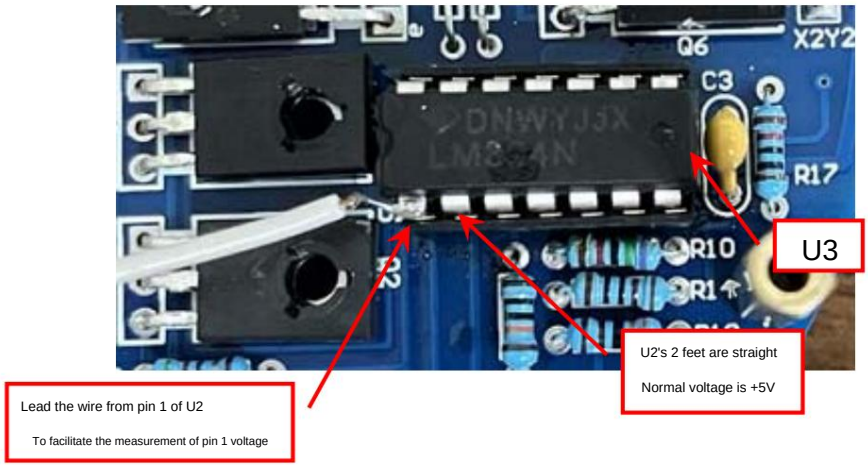
LM324 is a 4-op amp. There are 2 LM324s on the circuit board, which is 8 op-amps. Two of the op-amps (one each for U2 and U3) are used in the float circuit above the detection.
), one each for the X-axis and Y-axis Hall element output signal amplification, and two each for the coil drive circuit on the X-axis and Y-axis. Float detection circuit



U3A is a reverse proportional amplification circuit, which performs reverse proportional amplification on the output of the Hall element to increase the sensitivity of float detection. Lead a wire from the output pin 1 of U3A
to facilitate voltage measurement. After power on, the float is close to U3, and a large change in the voltage of pin 1 can be measured, indicating that U3A is working normally. (The floating side of the float is close to the Hall element U3,
The voltage changes from 2.5-10V, the other side of the float is close, the voltage changes from 2.5-0V)



U2A is a voltage comparator. When the voltage of pin 3 is higher than the voltage of pin 2, it outputs 12V, otherwise it outputs 0. The floating side of the float is close to the Hall element U3, and one leg of U2 has a 12V output.
When there is no float, the output is 0 volts. It means U2A is working normally.

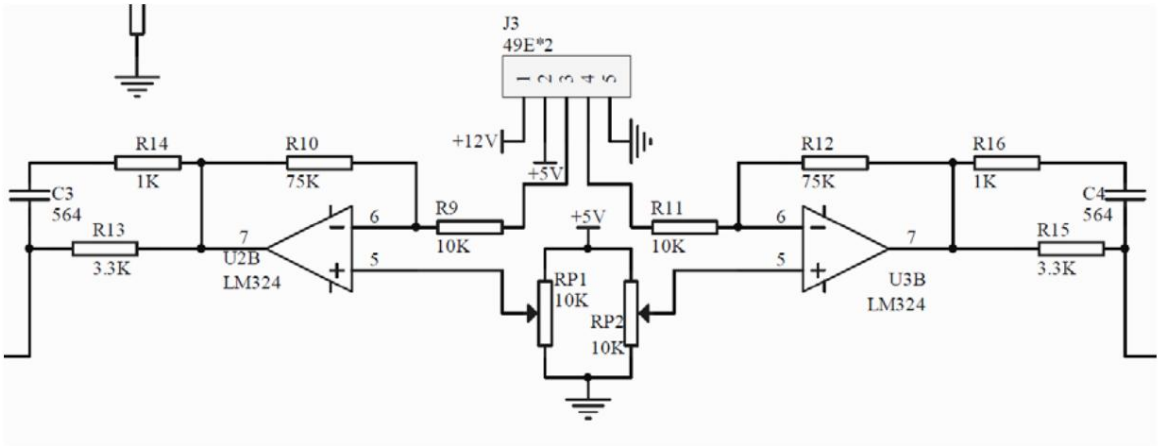


If U2A and U3A do not have the functions described above, it means they are damaged and need to be replaced with a new LM324. (Under the condition of ensuring that the installation is correct)

Determine whether the field effect transistor Q1 is damaged.

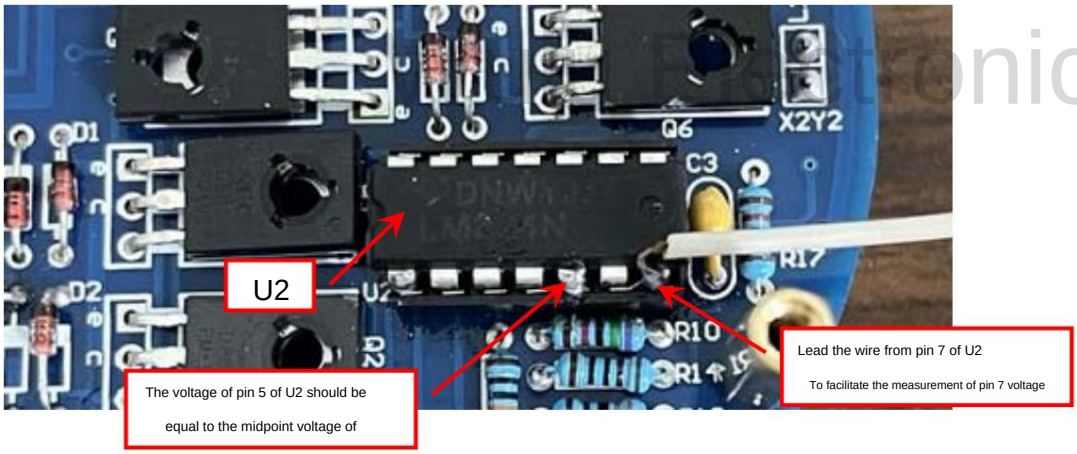
Q1 is an N-channel field effect transistor IRF530. When the first pin inputs high voltage, it is turned on and vice versa. LED2 can emit light only after Q1 is turned on. The first pin of the op amp U2 is directly connected to the first pin of Q1. Measure
the first pin of Q1. When the float is placed correctly, the voltage of 12V can be measured. If the float is not placed, the voltage is 0. If the voltage measured is 12V. LED2 still no
If it glows, you can judge that Q1 is damaged or not installed properly.

X and Y axis Hall element signal amplification circuit



The X-axis and Y-axis amplification circuits are two completely symmetrical circuits, taking the X-axis as an

example. First, adjust the midpoint voltage of RP1 to be the same as the voltage of H1 point (see the previous graphic installation tutorial to describe how to adjust)



RP1 . After powering on, use a float to approach (Hall element U1) and shake it on both sides of (Hall element U1) (U1 refers to U1 on the coil board above). It should be able to Measure the voltage on pin 7 of U2

changes (the voltage change range is about 1V on the left and right).

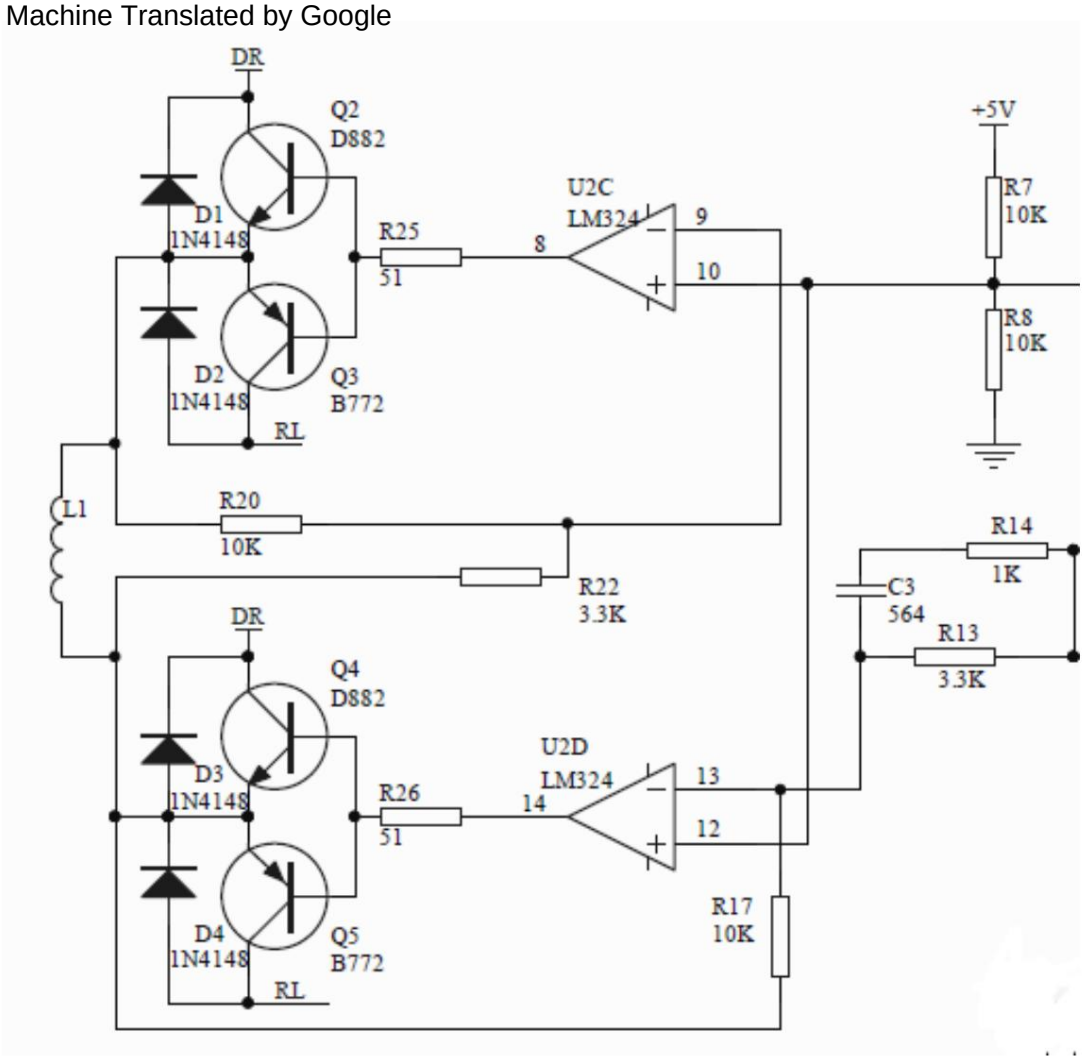
According to this method, measure the Y-axis amplifier circuit. The Y-axis uses U3B, which is on an op amp of U3. Please refer to the signal amplification circuit diagram for details.

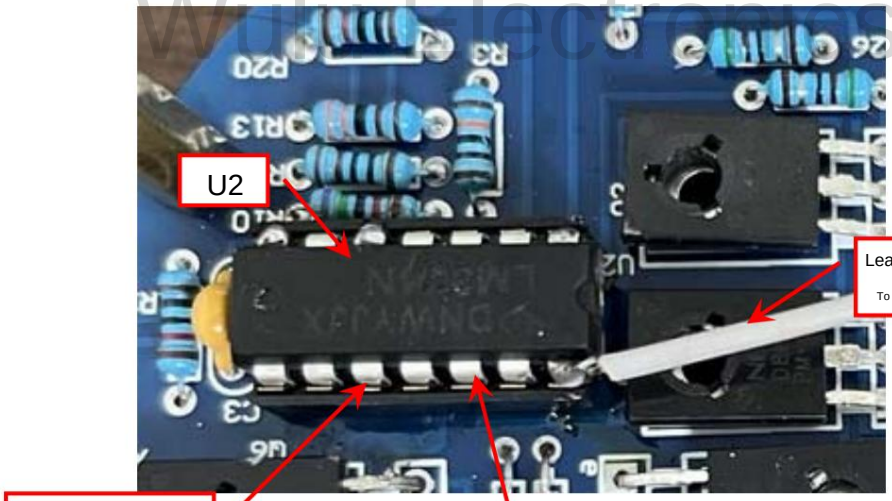
X and Y axis power amplifier circuit

The power amplifier circuit is used to provide current to a total of 4 coils on the X-axis and Y-axis to generate electromagnetic force to control the upper float. The power amplifier circuit can control the output current according to the input signal. magnitude and direction of

current flow. The following also takes the X-axis circuit

as an example. Note: If the previous signal amplifier circuit does not pass the test, the power amplifier circuit cannot be tested.





After powering on, use a float close to (Hall element U1) and shake it on both sides of (Hall element U1) (U1 refers to U1 on the coil board above), and you should be able to detect pin 16 of U2 Change in voltage (voltage change range is about 2V). Pin 8 of U2 has also changed in this way. Follow this method to measure the Y-axis power amplifier circuit, and use U3 for the Y-axis. See the circuit diagram of the power amplifier above for details.

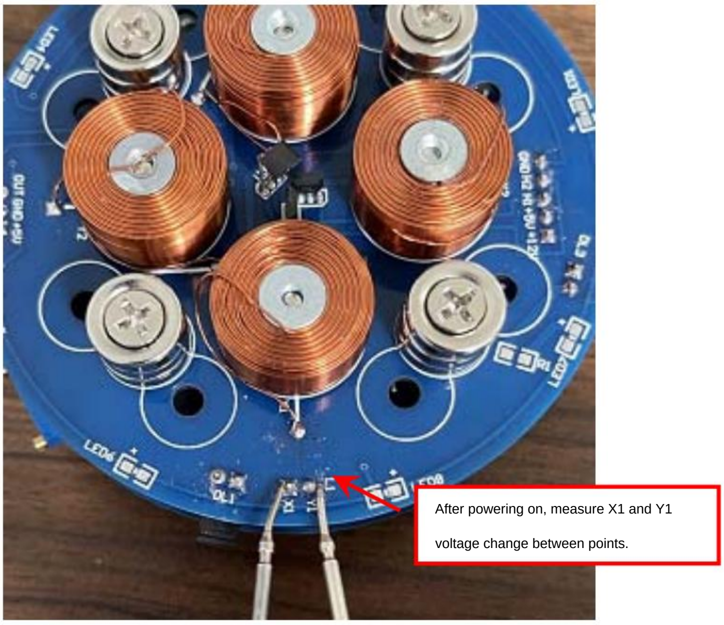
Note: The judgment of the quality of the op amp must be made on the premise that the components are installed correctly. For example, resistors cannot be mixed, the direction of the integrated circuit, and the Hall effect must be correct. The sensor is installed correctly. If the components are installed incorrectly, it will not be effective to perform these measurements. During the measurement process, the circuit diagram must be combined to Can achieve good results. Pay attention to the measurement mentioned first is to adjust RP1 and installation method (point 1 voltage) The midpoint voltage of RP2 is the same as the voltage at the sum point How to adjust), this is very important, from the X and Y axis signal amplification circuit to the X and Y axis power amplifier circuit, and even the subsequent transistor detection.... Everything depends on this. When the components are installed correctly, if the op amp cannot perform the functions described above, it can be considered damaged and needs to be replaced.

Determine the working condition of transistors Q2-Q9

The transistor is divided into two groups Q2-Q5 for the X-axis direction and Q6-Q9 for the Y-axis direction.

The circuit composed of Q2-Q5 can change the direction of the current in the coil and measure the voltage at both ends of the coil. When the float swings left and right in the center of the X-axis, it should be able to be used at both ends of the coil.

The multi-pen detects positive and negative changes in voltage.



Use a float to swing on both sides of the Hall element U1, and measure the voltage between X1 and Y1. It should be able to change between positive and negative voltages. If the voltage does not move, it can be judged that this group

There is a problem with 4 transistors, the wrong model is installed, or one of the transistors is broken.

The method for the other set of transistors Q6-Q9 is the same.

ÿ Some tips for placing the float can be to

adjust only one axis direction at a time, and then adjust the next axis direction after this axis is adjusted.

For example, if you only adjust the X-axis first, you can remove the short-circuit cap at the DL2 position so that the Y-axis direction will not interfere with the float. Then just focus on the X axis

After you find the feeling, remove the short-circuit cap at DL1, connect DL2, and then focus on adjusting the Y-axis direction to find the feeling on the Y-axis. When the two axes are square

After you find the feeling of moving upwards, check the short-circuit caps of DL1 and DL2, and finally slightly adjust RP1 and RP2 to finally achieve suspension.

Taking the X-axis as an example, the important steps are repeated here adjust RP1 midpoint voltage and H1 (the voltage of the points is the same, see the previous graphic installation tutorial which describes how to adjust it.

Insert the short-circuit cap of DL1 and remove the short-circuit cap of DL2. After placing the float at a certain distance from U3, LED2 will light up. Use one hand to fix the float between coil X1 and

Float in the central area between Y1, and gently shake the float to make the float move slightly within the straight line distance from coil X1 to coil Y1. Feel the float carefully with your fingers

Changes in force (now that the short-circuit cap on DL2 has been removed, the float will only receive the force from coil X1 and coil Y1). When you first come into contact with this kind of magnetic levitation, you may feel

It's normal to not find this feeling. So do we. It takes several attempts. After a long test, touch the temperature of each transistor on the circuit board. If it is hot to your hands,

Stop and cool down for a while.

At the same time, imagine the control principle of magnetic levitation. The electromagnetic force generated by coils X1 and Y1 should keep the float at the center position (center position) between coils X1 and Y1.

The setting is an ideal situation. Generally, there is more on one side and less on the other side. This needs to be adjusted to the center position by fine-tuning RP1 later. The key is to learn to feel this force). When the float

When it deviates from this position, a force will appear to prevent the float from deviating from the center position. What we need to feel is the force that prevents the float from deviating from the center position. Of course, this

Your personality is not very strong, so you have to feel carefully ÿ. This is actually the core point of placing a float. It is similar to riding a bicycle or swimming. Once you learn it, you will never forget it again.

No ÿ.

The specific steps are described again: slowly lower the float from the center of coil X1 and coil Y1 until LED2 lights up, then slowly move the float toward coil X1

Move one side of the float and carefully feel the force on the float with your fingers. There is a force that prevents the float from moving to coil X1. Then move the float slowly toward the direction of coil Y1, and use your finger

Carefully feel the force on the float. There will be a force that prevents the float from moving to coil Y1. Hold the float with five fingers and form a circle. The inside of the circle is slightly larger than the outside of the float.

diameter, let the float swing freely in this circle

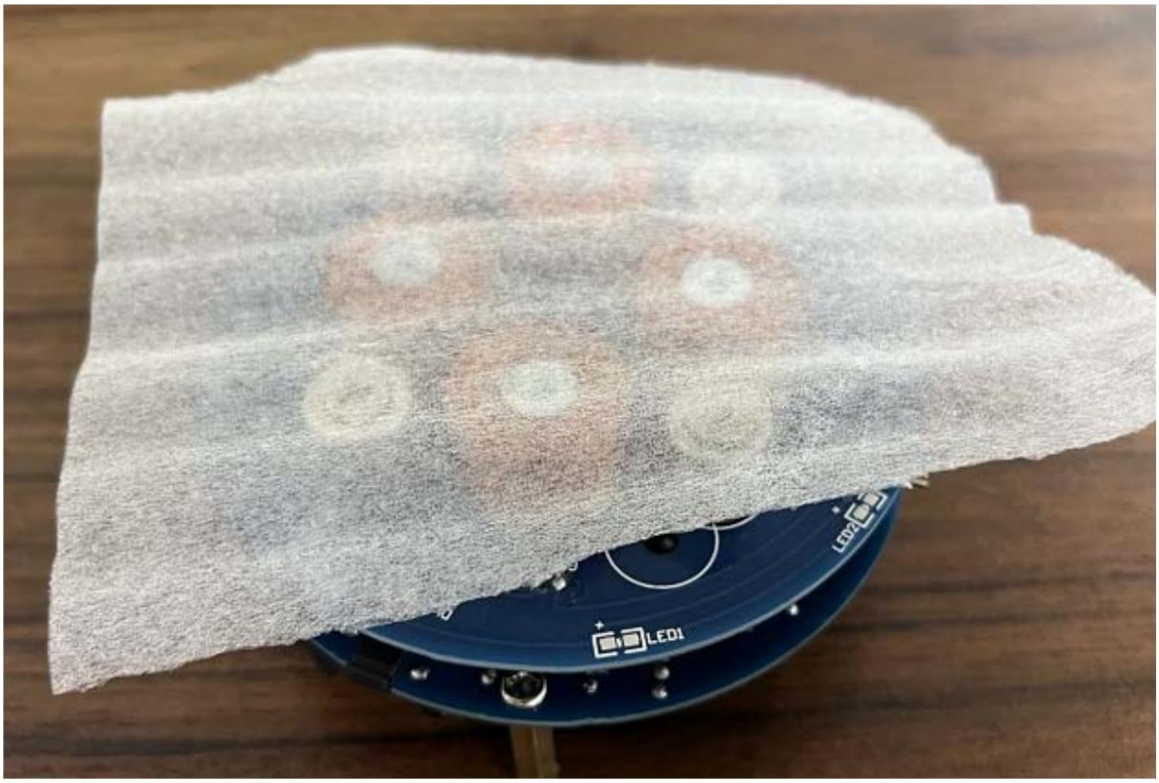
After feeling this force, let the float be in this force-bearing position, and then adjust the adjustable resistor RP1 very slightly, and you can feel the change in the force on the float.

Just adjust RP1 so that the stress point is located at the center of X1 and Y1. *(Note that this is an extremely slight adjustment, the amplitude does not exceed 1/4 turn. If the adjustment is too much, the stress point will disappear. It needs to be

To readjust the midpoint voltage of RP1 equal to H1, and then feel the force point).

After adjusting the X-axis, adjust the Y-axis separately. After adjusting the directions of both axes, insert the short-circuit caps of DL1 and DL2. Can maintain suspension.

Covering the coil surface with a thin layer of cardboard, foam board or the like can prevent the float from being smashed due to repeated unsuccessful operations. As shown below

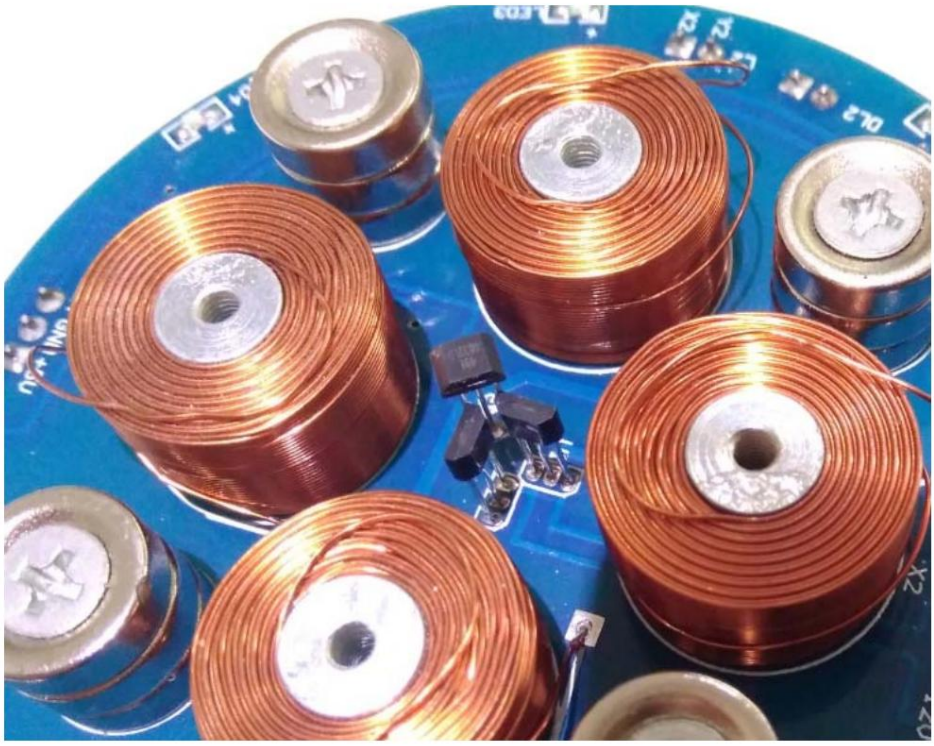


ÿ Can be suspended but unstable solution. The float

floats but jitters. Reason 1: The positions

of the Hall elements U1 and U2 are too high. The higher the positions of the Hall elements U1 and U2, the more sensitive the induced magnetic field changes, and the amplitude of the output signal is large, resulting in large changes in the coil drive current. , the float will vibrate. You can lower the height of the Hall element and try floating it again. Note that if the float jitter does not improve after lowering the height, it is not a height problem. Do not lower the height any further. Reference reason 2

When welding U1 and U2, make sure that the Hall element and the circuit board are vertical. The two Hall elements cannot be close together. If U1 and U2 are installed vertically If it's good, you won't be exposed to it.



The float floats but jitters. Reason 2: The monolithic capacitors C3 and C4 have large errors, and the capacity of C3 and C4 is insufficient, which will also cause jitter. These two capacitors are damping capacitors, and their function is It is to eliminate shaking. If possible, you can remove the capacitor and actually measure the capacity. If the capacity is insufficient, it needs to be replaced.