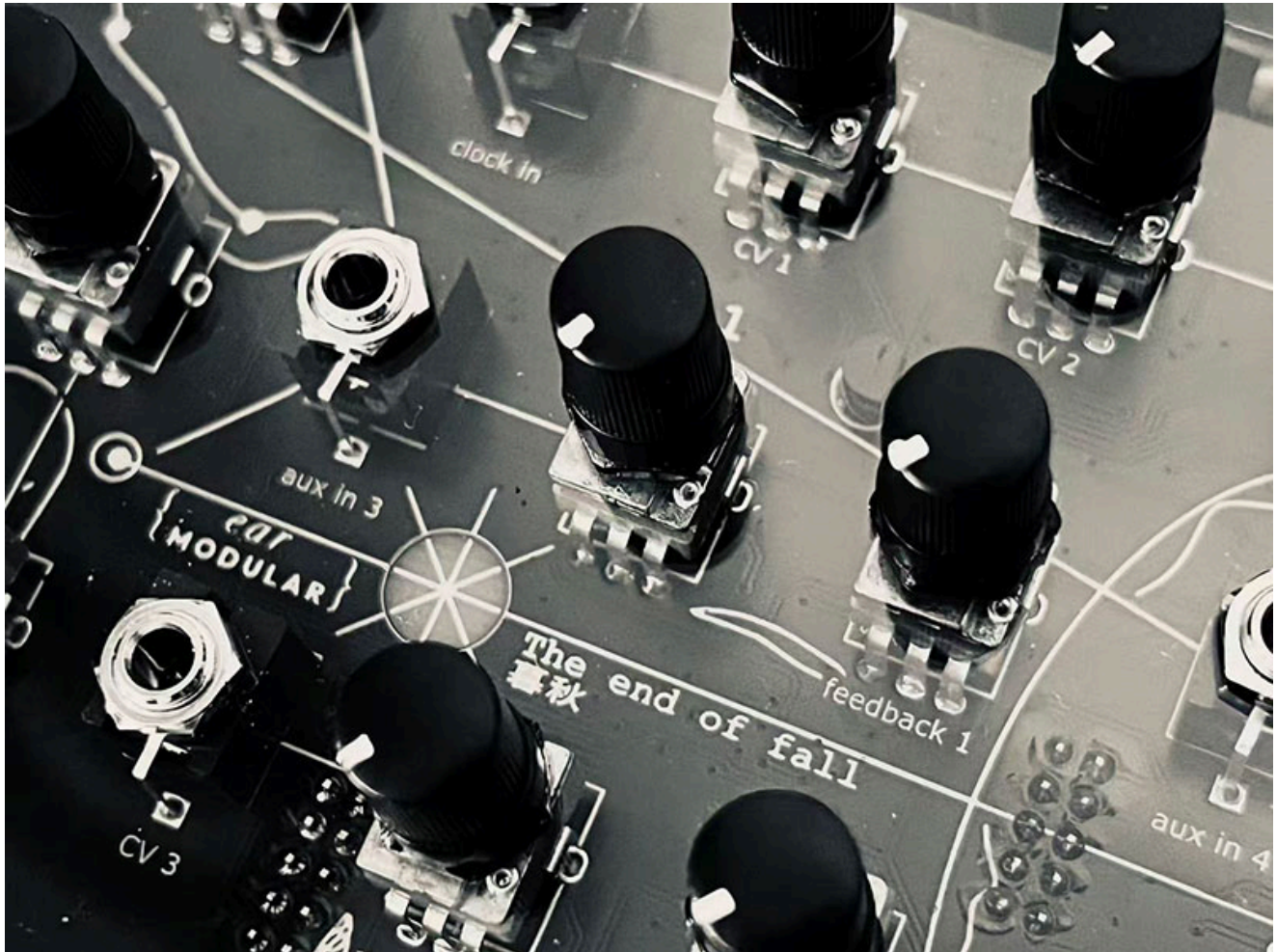


# The End of Fall 组装指南

## The End of Fall · 暮秋 — 组装指南



### 📘 关于本文档

本指南为暮秋（The End of Fall）效果器的组装说明文档，包含中英双语对照。主体为 40hp Eurorack 格式，可通过两块扩展板和面板更换变为独立设备。

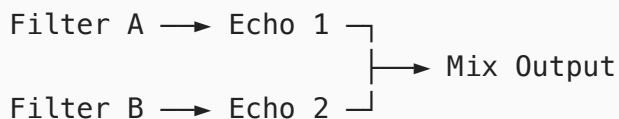
## 一、产品介绍 / Introduction

### 关于暮秋

暮秋是一台充满回授的效果器，主体是 **40hp eurorack** 格式，增加两个扩展板并更换面板后可组成独立设备。

### 信号链路

暮秋的主体由两个阶梯滤波器和两个回声效果器组成，链路方式为：



滤波器各有一个 CV 控制点可控制 cutoff，回声效果器各有一个 CV 控制点控制 time。

## 回授链路设计

以上看起来是一个很基础的组合，但是暮秋不止于此。它里面充满了各种各样的回授链路：

1. **滤波器内部回授**：滤波器各自内部的回授链路由滤波器出到滤波器进，构成了 Resonator，可自激发声；
2. **回声内部回授**：回声效果器内部的回授链路是构成回声效果的重要部分，过大的回授会产生连绵不断的声音；
3. **滤波器交叉回授**：滤波器 A 输出回授到滤波器 B 输入，同样滤波器 B 的输出也回授到滤波器 A 的输入。这个设计思路来自于我制作 solar card type VII 时的尝试，它在卡片上取得了超出想象的效果，各种奇怪的声音交织产生。我把它移植到了暮秋上；
4. **全局回授**：回声效果器 1 的输出分别回授到效果器 A 和效果器 B 的输入，同样回声效果器 2 的输出分别回授到效果器 A 和效果器 B 的输入。这两个全局回授链路让暮秋变为一个环形结构，没有前后级之分，声音在这个环路中交织。

## 增加的两个设计

1. **独立输入与多种链路组合**：每个滤波器和每个回声效果器都有自己单独的输入，在不使用回授时，回授链路成为了一个内部桥接的通路，我们可以让暮秋的通路变为回声到滤波、滤波到回声、回声到回声（多点回声）、滤波到滤波（多级滤波）等等多种组合。在增加扩展后，输出可以从任何一个效果器结尾处得到，利用这些链路可以构成立体声效果器；
2. **噪音源与内部 CV**：暮秋主体里有一个噪音源，这个噪音源有两个作用，一是它输送给两个滤波器的输入作为音源，另一是它为内部 CV 的生成提供了振荡源。

## 内部 CV 系统

暮秋内置了四个 CV 源分别给到四个效果器：

- 当没有外部 CV 的时候，它为这四个效果器提供随机变化的 CV
- 当有外部 CV 进入时，对应的内部 CV 断开
- 这四个内部 CV 信号通过对噪音源进行采样保持产生
- 四个采样保持分别由右上的四个旋钮控制采样间隔，它们彼此独立，让控制变得混乱无序
- **CLK 输入**会对这四个采样保持进行干扰，让它们部分统一，但混乱依然存在

### 提示

暮秋在没有输出的时候会有轻微底噪，不影响正常使用。

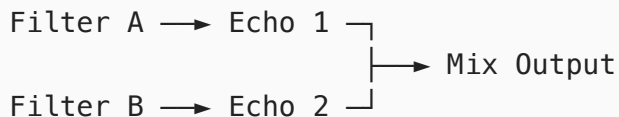
---

## About The End Of Fall

The End Of Fall is a feedback-filled effects unit in a **40hp Eurorack format**. By adding two expansion boards and replacing the front panel, it can be reconfigured as a standalone device.

### Signal Chain

The core of The End Of Fall consists of two ladder filters and two echo effects:



Each filter features a CV control input for cutoff frequency, while each echo has a CV control input for delay time.

### Feedback Pathways

At first glance, this may seem like a basic setup, but The End Of Fall offers much more. It is filled with various feedback pathways:

1. **Internal filter feedback** — from output back to input, creates a resonator capable of self-oscillation.
2. **Internal echo feedback** — essential for creating the echo effect; excessive feedback results in endlessly decaying echoes.
3. **Cross filter feedback** — Filter A's output feeds into Filter B's input, and vice versa. This design was inspired by experiments during the creation of Solar Card Type VII, where it produced unexpectedly complex and intriguing sounds.
4. **Global feedback** — Echo 1's output is fed into both Filter A and Filter B inputs; Echo 2 does the same. These two global loops transform The End Of Fall into a **circular structure** without a clear front or back end.

### Additional Design Features

1. **Dedicated inputs & flexible routing** — Each filter and each echo has its own dedicated input. When feedback is not utilized, the feedback pathways serve as internal bridges, enabling various signal routing configurations such as echo-to-filter, filter-to-echo, echo-to-echo (multi-tap delay), or filter-to-filter (multi-stage filtering). With expansions, outputs can be taken from the end of any effect, allowing the unit to be used as a stereo effects processor.
2. **Noise source with dual function** — supplies audio to both filters and serves as oscillation source for internal CV generation.

## Internal CV System

The unit features four internal CV sources, each assigned to one of the four effects:

- When no external CV is present, internal CVs provide randomly varying control voltages
- If an external CV is connected, the corresponding internal CV is disconnected
- These signals are generated by **sample-and-hold** circuits sampling the noise source
- Four knobs in the upper-right corner independently control the sample intervals, introducing chaotic and unpredictable modulation
- A **CLK input** can interfere with these four sample-and-hold circuits, partially synchronizing them while maintaining underlying chaos

### Note

There is a slight background noise from The End Of Fall when there is no output, but it does not affect normal use.

---

## 二、独立设备扩展 / Expander for Standalone Operation

### 作为独立设备时的扩展

#### 扩展 1：MIC 输入与包络跟随

扩展 1 为暮秋提供了：

- **PSU 电源** — 为整机供电
- **外部音源输入** — 可对 LINE 音频进行增益，也可使用被动式麦克风或者接触式麦克风收声
- **三个输出**：
  1. 增益后的音源
  2. 包络跟随的正向输出
  3. 包络跟随的反向输出
- **方波生成器** — 可作为暮秋的 clock 源，也为扩展 2 的采样保持提供触发信号

### Tip

包络跟随的存在为暮秋提供了多一个的控制可能性。

#### 扩展 2：采样保持与输出

扩展 2 包含：

- **独立采样保持功能** — 接受外部采样源和外部触发信号；当以上都没有时，使用扩展 1 的方波作为触发，扩展 1 的音源作为采样源；输出采样保持信号；同时将触发信号变为脉冲信号单独输出
- **每个效果器的单独输出** — 这是最重要的功能，让暮秋的内部环路在每个节点都同时具有输入和输出功能
- **可调音量立体声输出口**

立体声输出的基本链路：

```
Filter A → Echo 1 → Left Channel  
Filter B → Echo 2 → Right Channel
```

### **Warning**

同样，回授的存在让这个链路变得非常不稳定，随时可以将它打破。

---

## Expander for Standalone Operation

### Expander 1: MIC Input & Envelope Follower

Expander 1 provides:

- **PSU power supply**
- **External audio input** — Boosts LINE-level audio or works with passive/piezoelectric microphones
- **Three outputs:**
  1. Amplified audio source
  2. Positive envelope follower output
  3. Inverted envelope follower output
- **Independent square wave generator** — Serves as a clock source for The End Of Fall and provides trigger signals for the sample-and-hold circuit on Expander 2

### **Tip**

The inclusion of the envelope follower adds an additional layer of control possibilities.

### Expander 2: Sample-Hold & Output

Expander 2 includes:

- **Independent sample-and-hold function** — accepts external sample sources and trigger signals; when not connected, uses Expander 1's square wave as trigger and audio source. Outputs both the S&H signal and a converted pulse trigger output
- **Individual outputs for each effect unit** — most critical function; enables internal feedback loops to have both input and output functionality at every node
- **Separate stereo output with adjustable volume**

The basic stereo signal path:

```
Filter A → Echo 1 → Left Channel  
Filter B → Echo 2 → Right Channel
```

### ⚠ Warning

However, the presence of feedback makes this signal path highly unstable, capable of being disrupted at any moment.

## 三、制作准备 / Preparation Before Assembly

### 推荐制作顺序

有制作经验的朋友可以按照后续正常步骤进行；对于 0 焊接经验或需要练手适应的朋友，建议制作顺序为：

**盒子 → 扩展板 1 → 扩展板 2 → 主板**

测试调节步骤可以分开进行，也可以全部制作完成后进行。

For friends with production experience, you can proceed according to the standard steps. For those with zero soldering experience or who need practice to adapt, the recommended production sequence is:

**Box → Expander 1 → Expander 2 → Mainboard**

Testing and adjustment steps can be performed separately or after all production is completed.

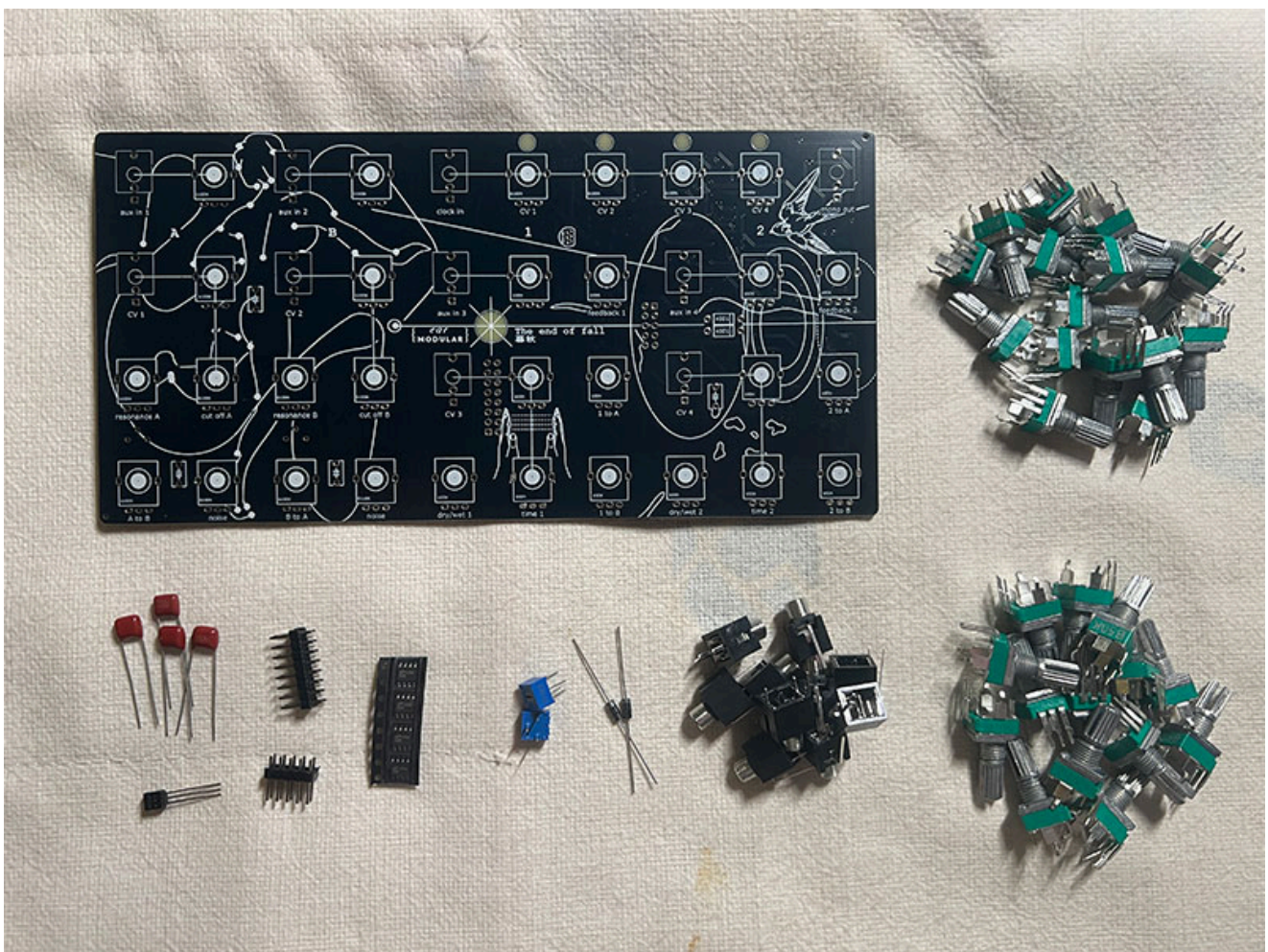
### ⚠ 重要提醒 / IMPORTANT NOTES

#### 🔗 提醒 / NOTE

- 面板在最后组合之前都不要去除两面的保护膜！  
*Do not remove the protective film from either side of the panel until final assembly!*

- 安装电位器一定要注意 A/B 型、阻值!  
*Pay close attention to the resistance values and A/B type when installing potentiometers!*
- 有方向的元件一定要注意方向!  
*Be sure to observe the correct orientation for directional components!*
- 确保所有连线方向正确，错误的连线很可能会烧毁设备!  
*Make sure all wires are connected in the correct direction. Incorrect wiring may likely burn out the equipment!*

## 四、主板 / Mainboard



## 元件清单 / Bill of Materials

元件 / Component	规格 / Specification	数量 / Qty
PCB	—	1
LF398S IC	SOP-8	4
CBB 电容 / Capacitor	10nF	4
1N4001 二极管 / Diode	插件 / Through-hole	2

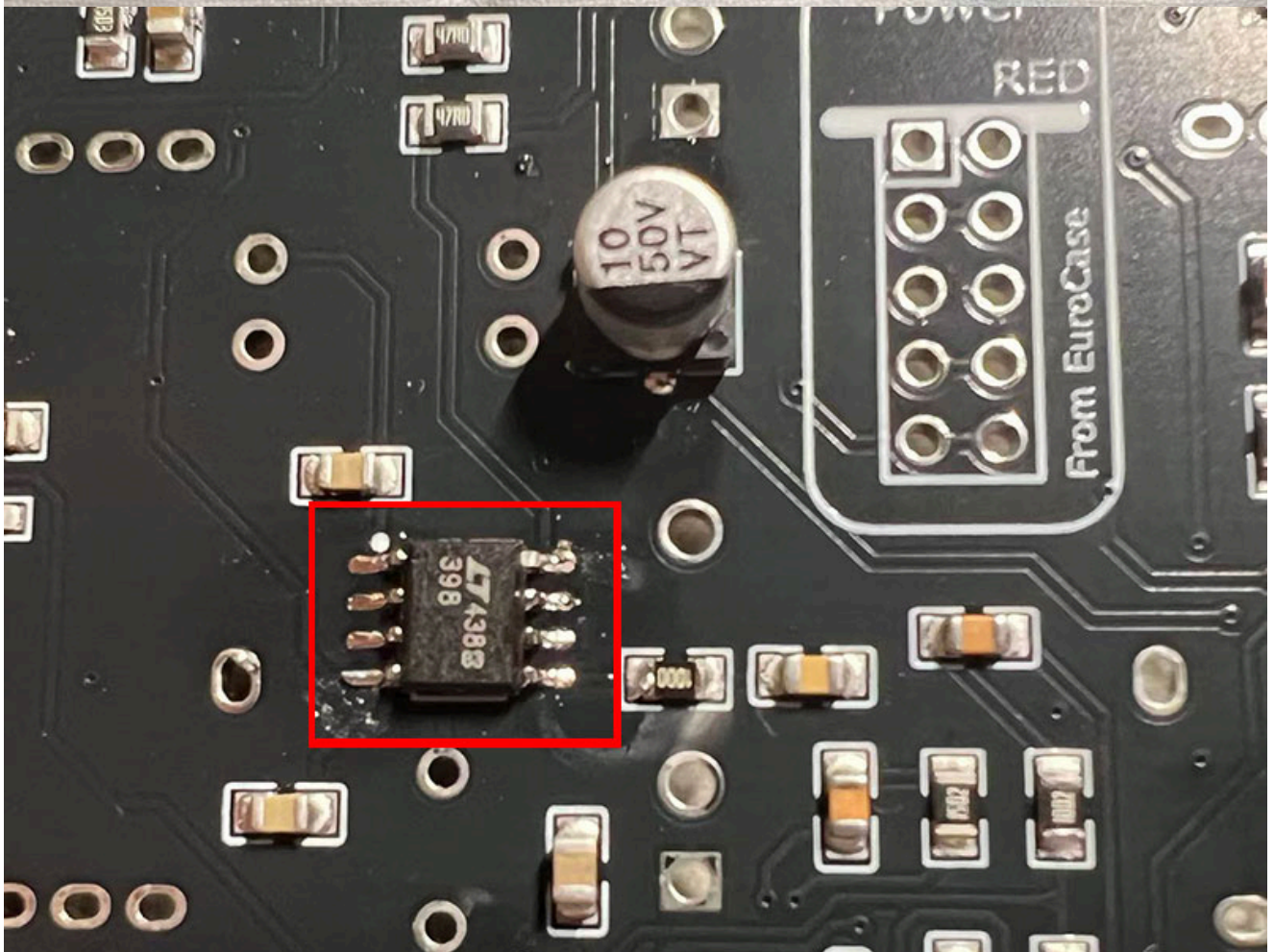
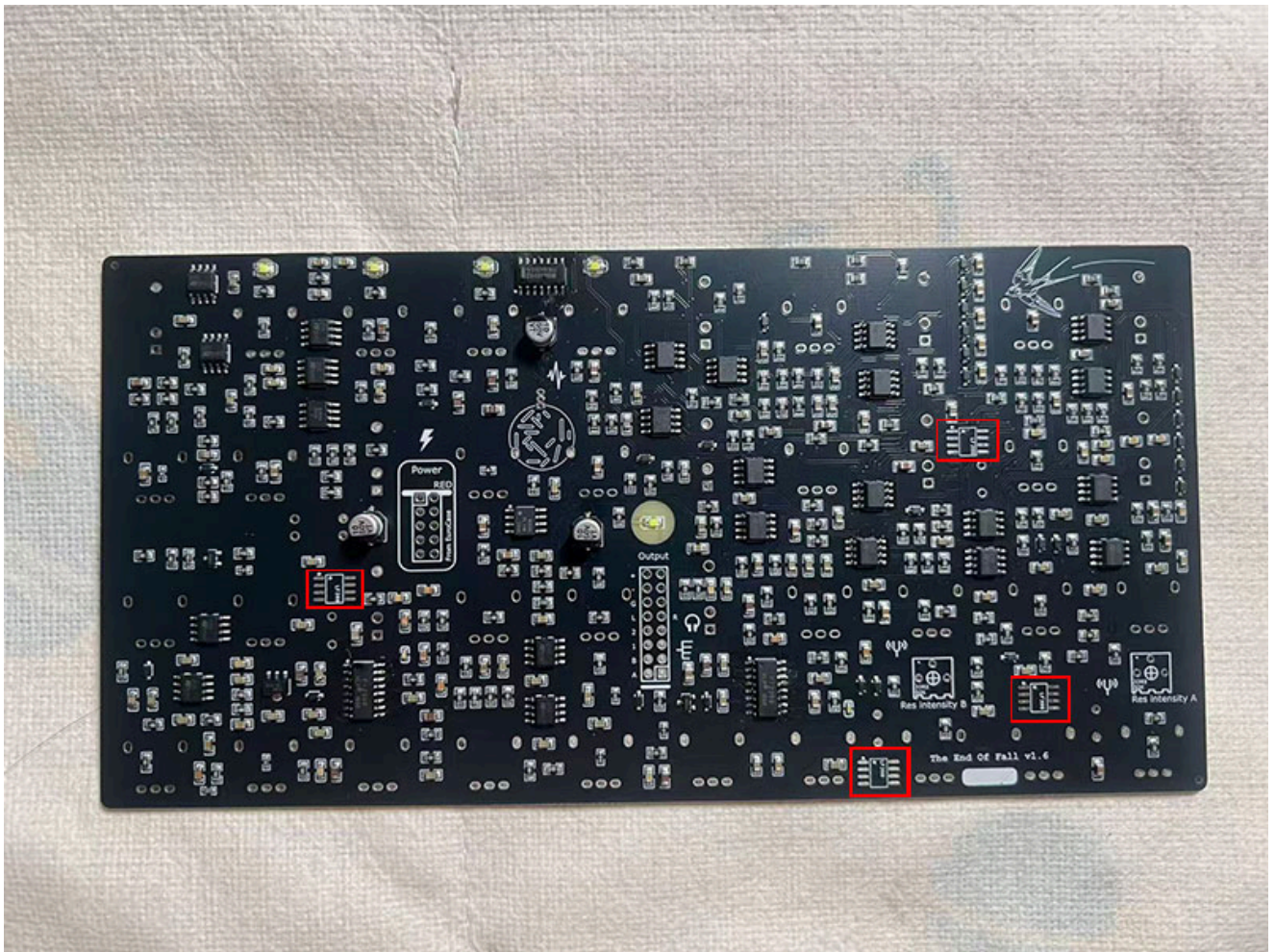
元件 / Component	规格 / Specification	数量 / Qty
BC548 三极管 / Transistor	插件 / Through-hole	1
3362P 电位器 (蓝色)	B503 (B50k)	2
排针 / Pin Header	2×5P P2.54	1
排针 / Pin Header	2×8P P2.54	1
PJ301-M 插口 / Jack	—	10
RK097 电位器	B503 (B50K)	14
RK097 电位器	B104 (B100K)	14
RK097 电位器	A104 (A100K)	2

## 制作步骤 / Assembly

### 1. 焊接 LF398S 贴片 IC

焊接背面四个 LF398S 贴片 IC，注意方向。

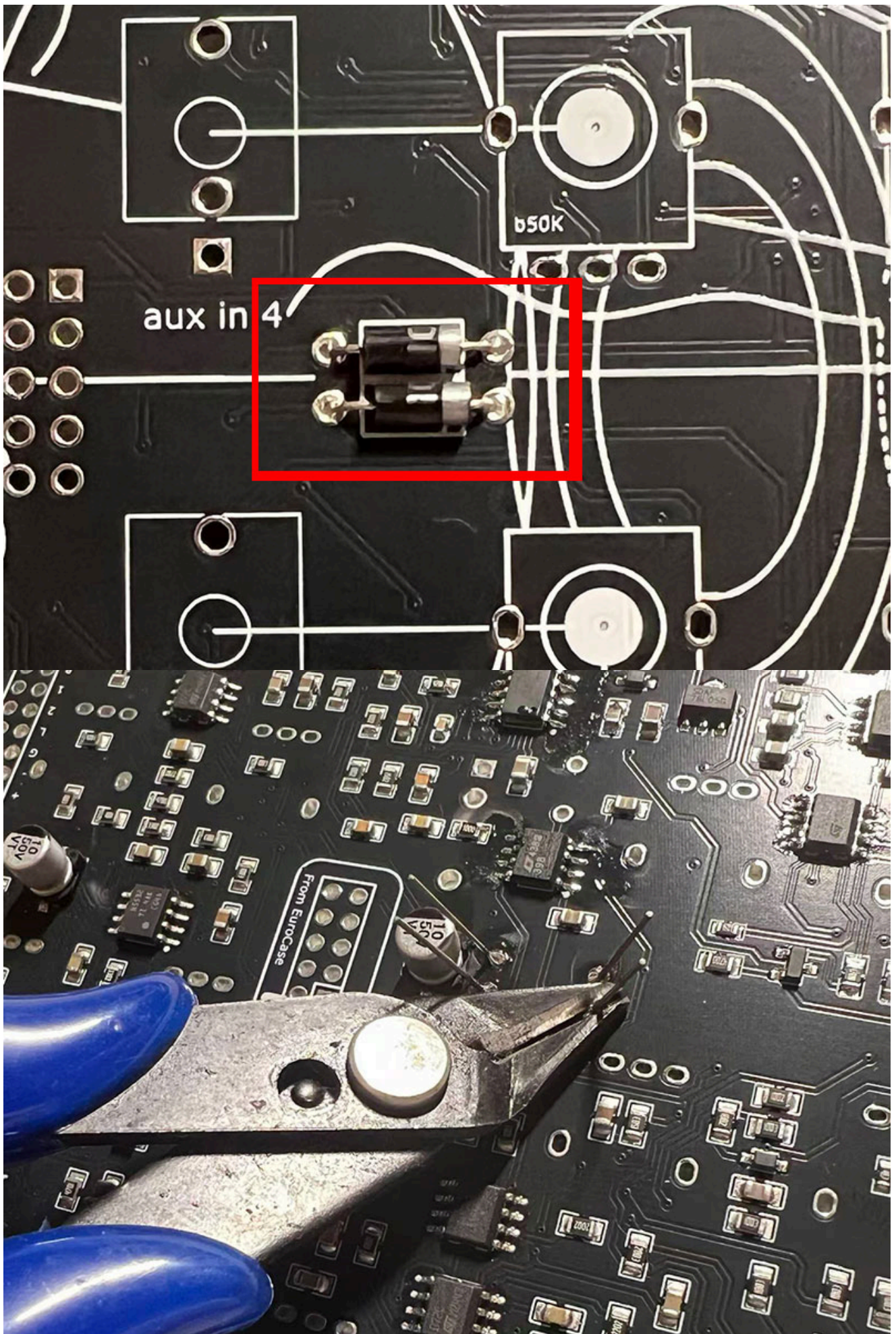
Solder the four LF398S surface-mount ICs on the bottom side, **paying attention to their orientation.**



2. 焊接 1N4001 二极管

焊接正面两个 1N4001 插件二极管，注意方向。

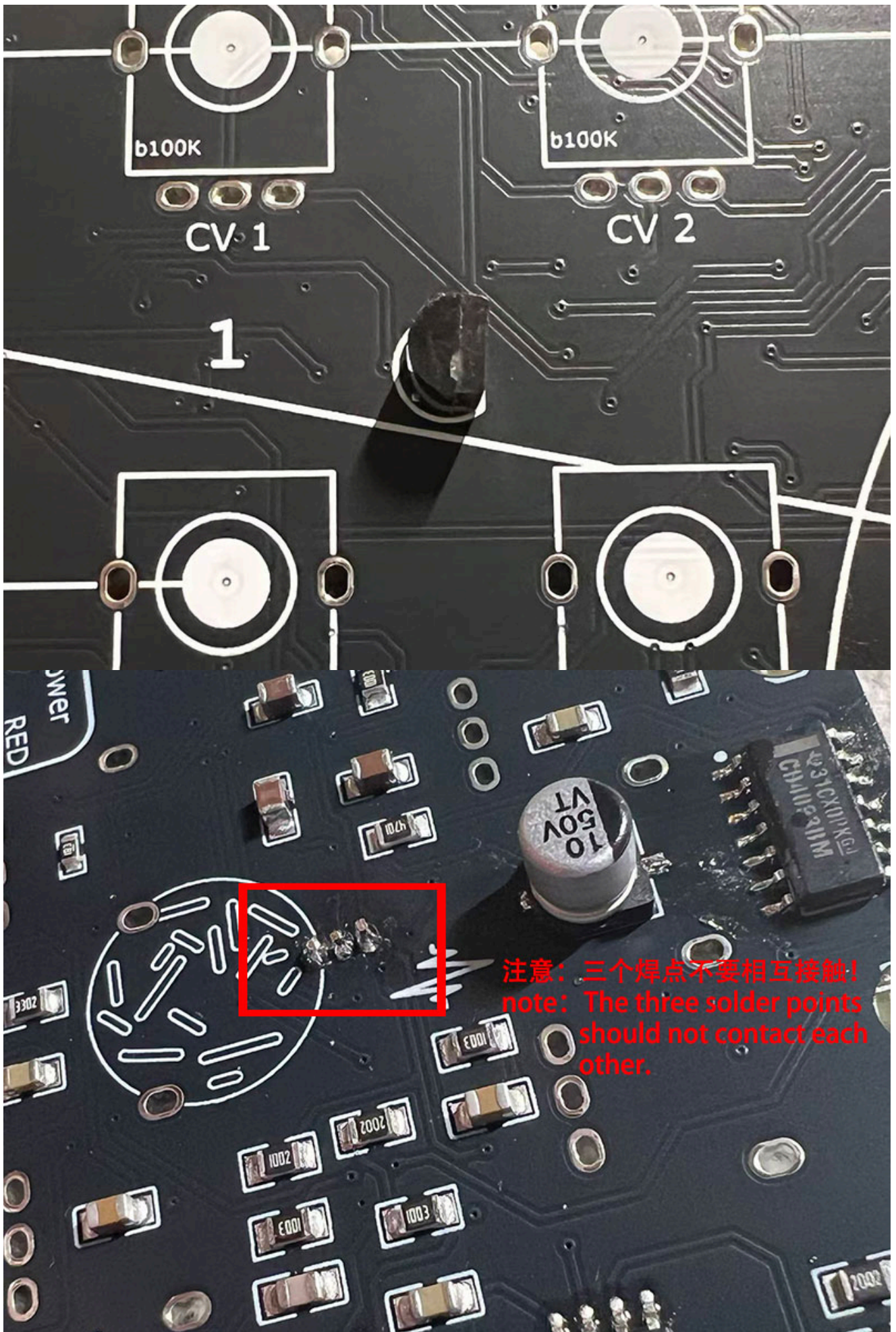
Solder the two through-hole 1N4001 diodes on the top side, **paying attention to their orientation.**



3. 焊接 BC548 三极管

焊接正面一个 BC548 插件三极管，注意方向。

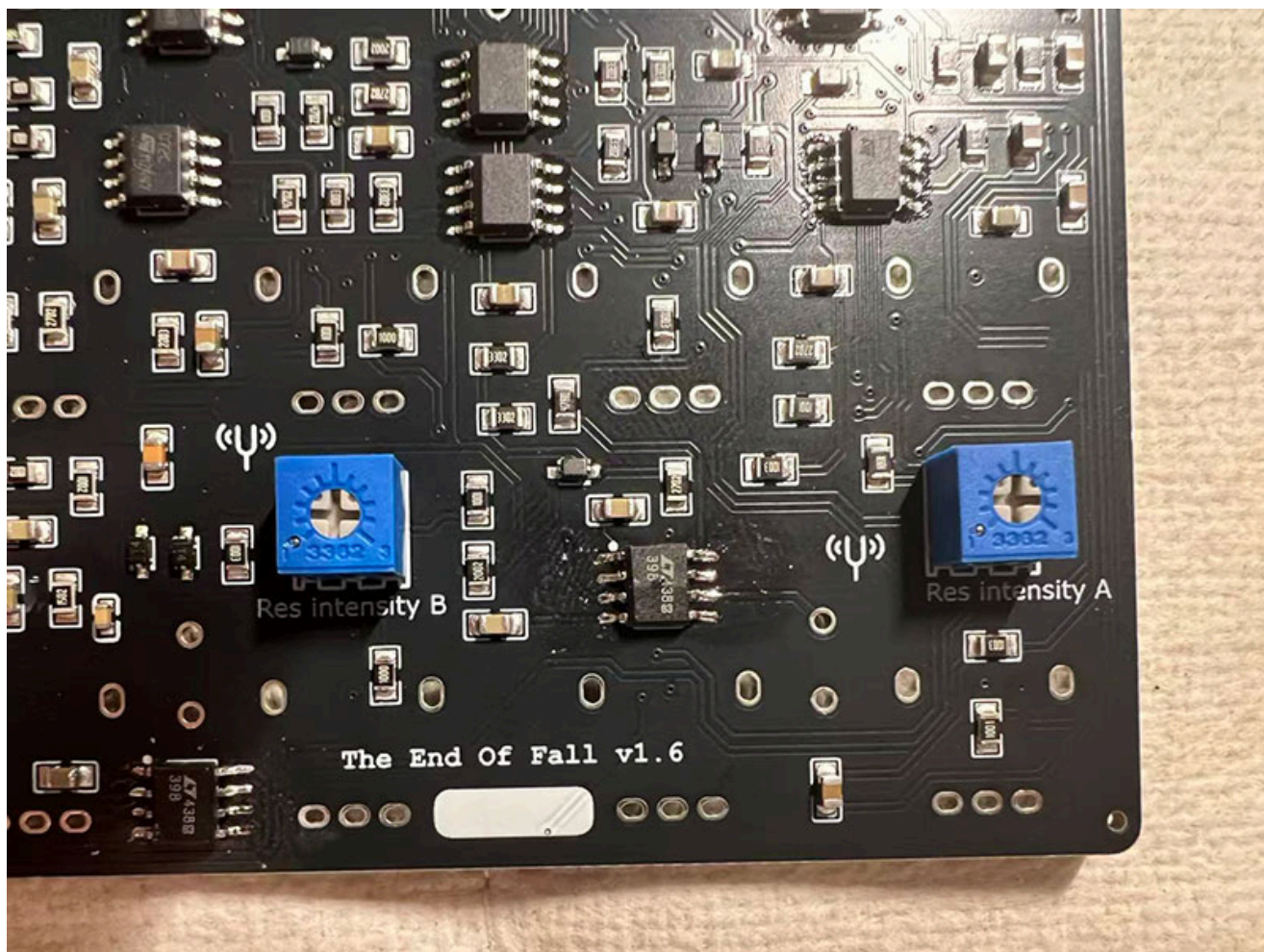
Solder one through-hole BC548 transistor on the top side, **paying attention to its orientation.**



4. 焊接 3362P 电位器

焊接背面两个 3362P 503 电位器（蓝色），注意阻值。

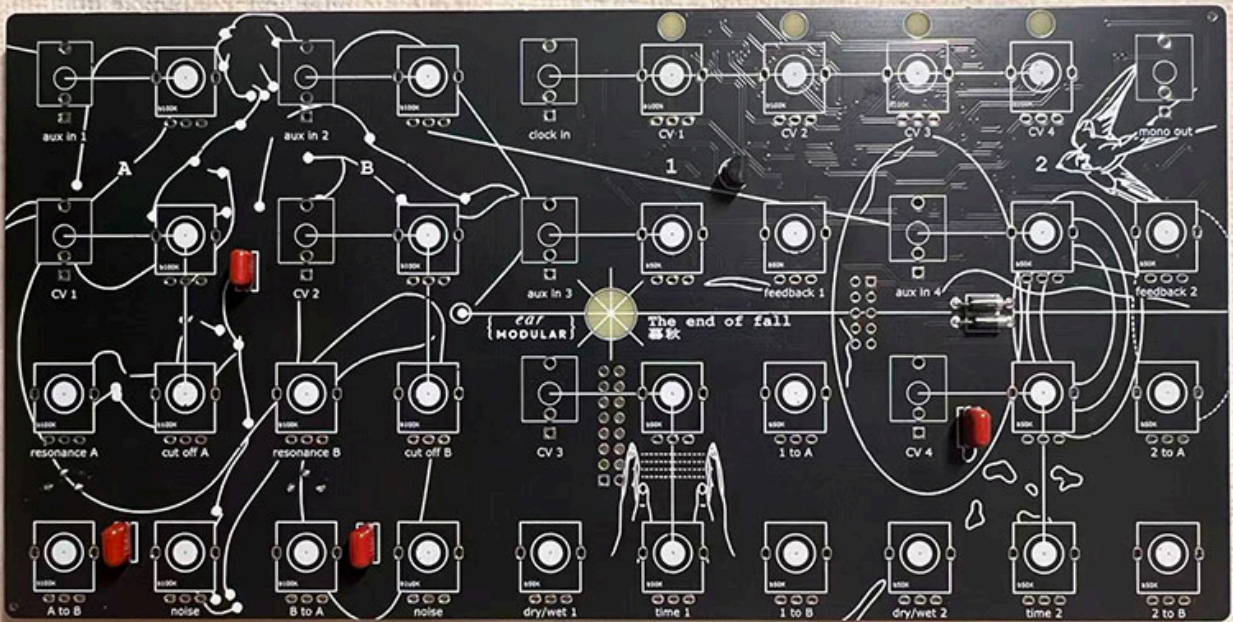
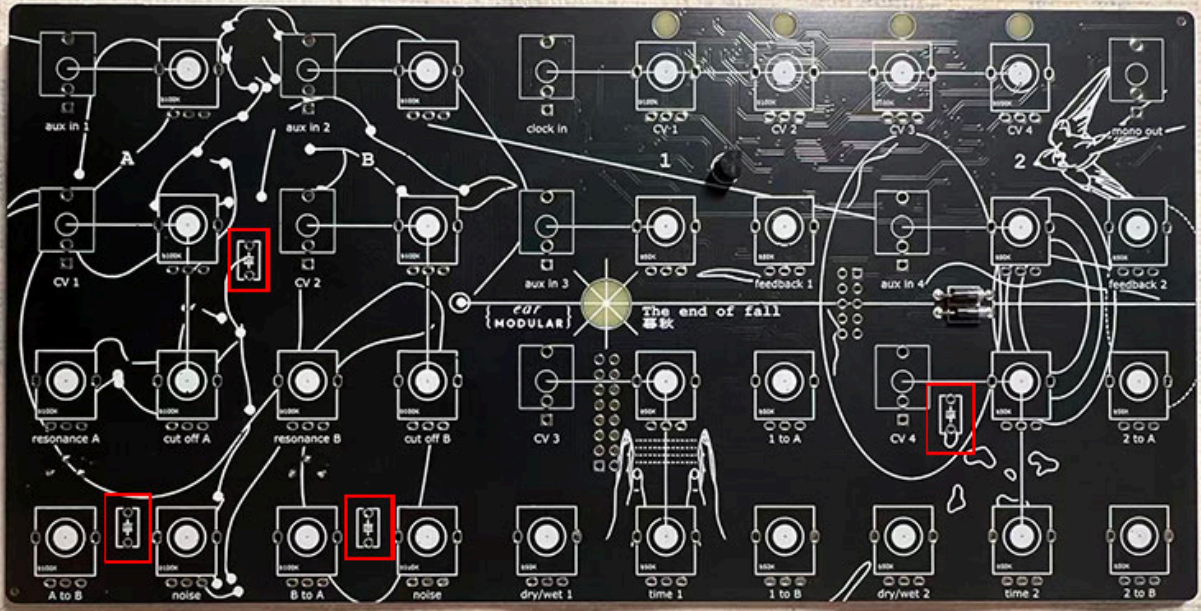
Solder the two 3362P 503 (50k) blue potentiometers on the bottom side, **paying attention to their resistance values.**



## 5. 焊接 10nF CBB 电容

焊接正面四个 10nF CBB 电容。

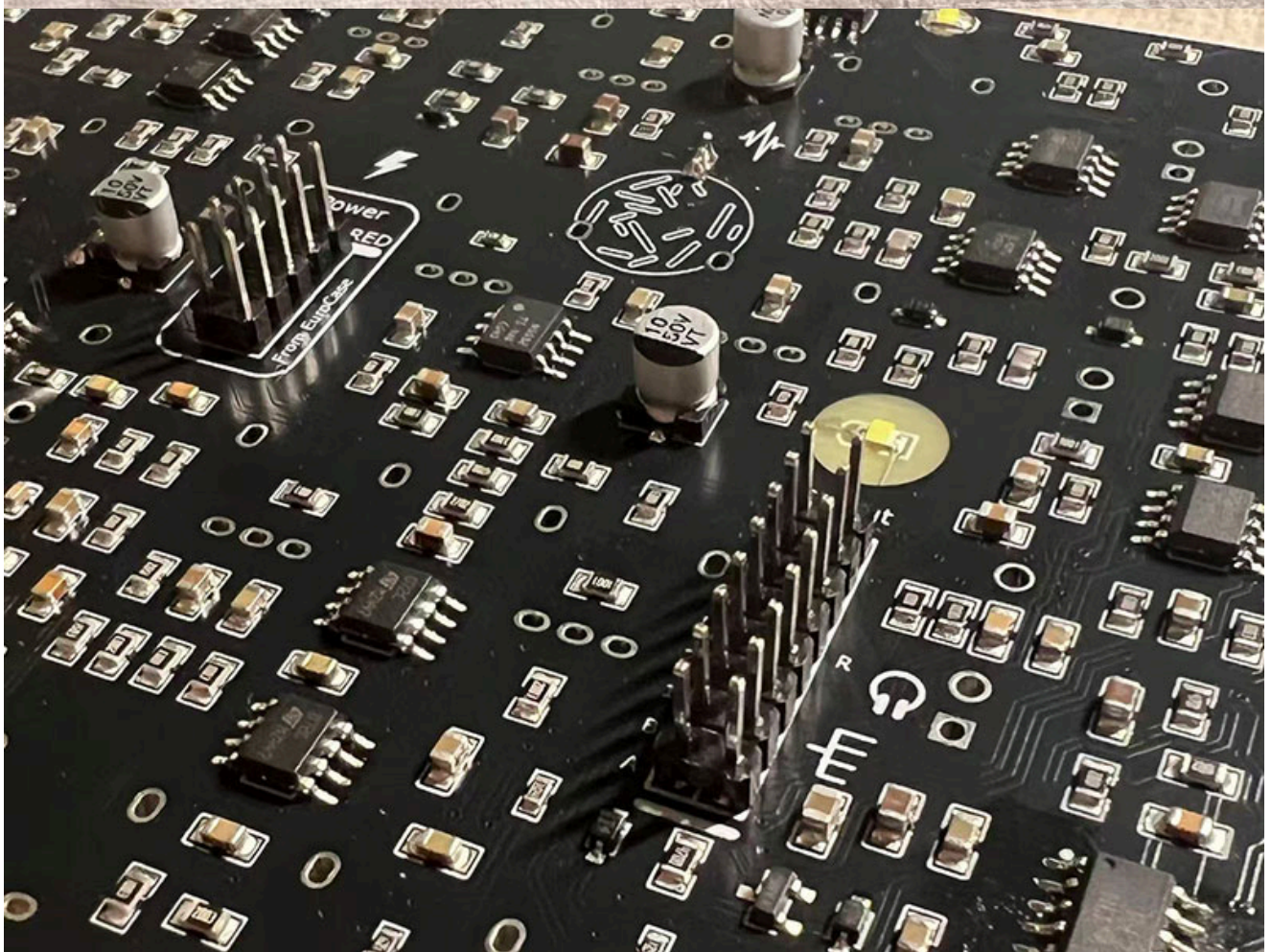
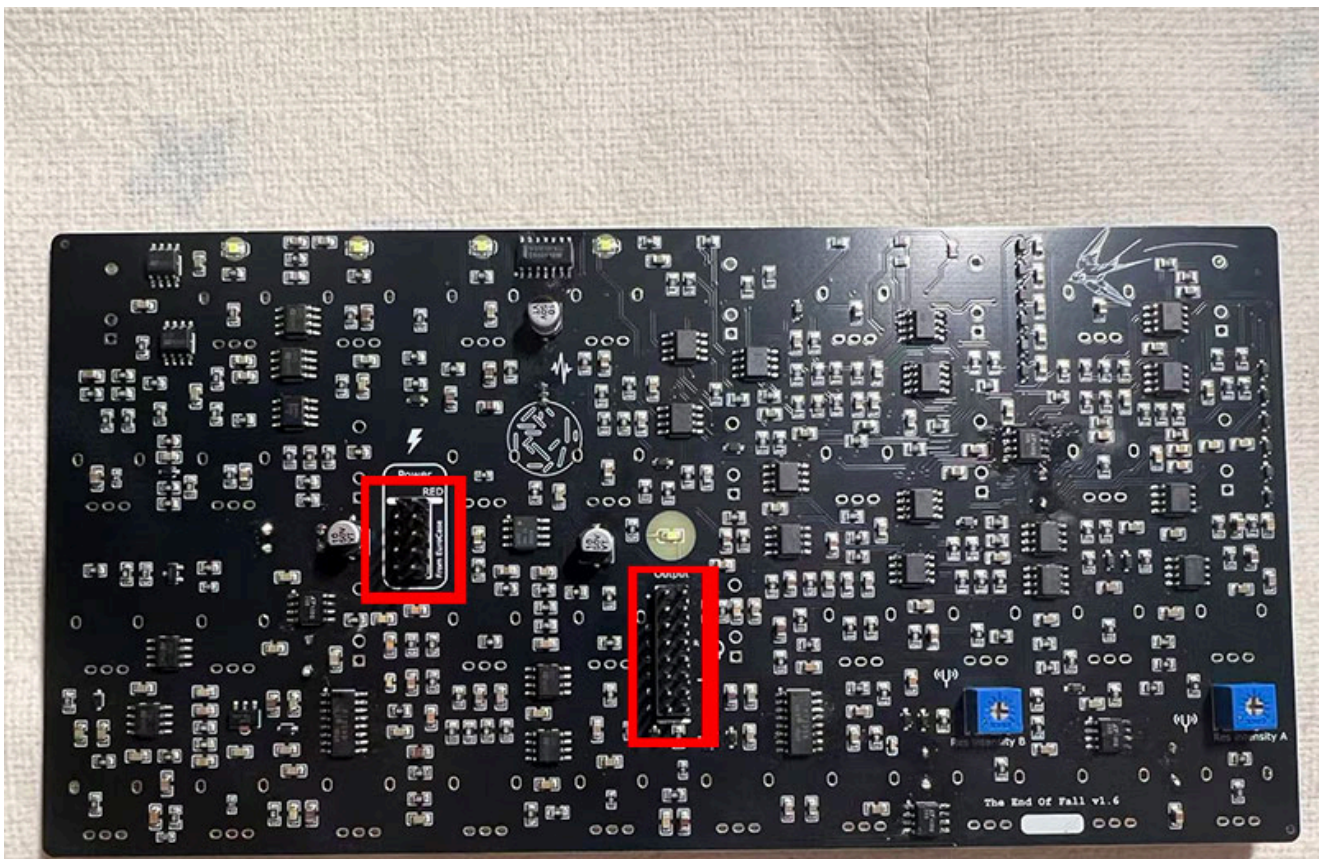
Solder the four 10nF CBB capacitors on the top side.



## 6. 焊接排针

焊接背面 2×5P 和 2×8P 排针，各一个。

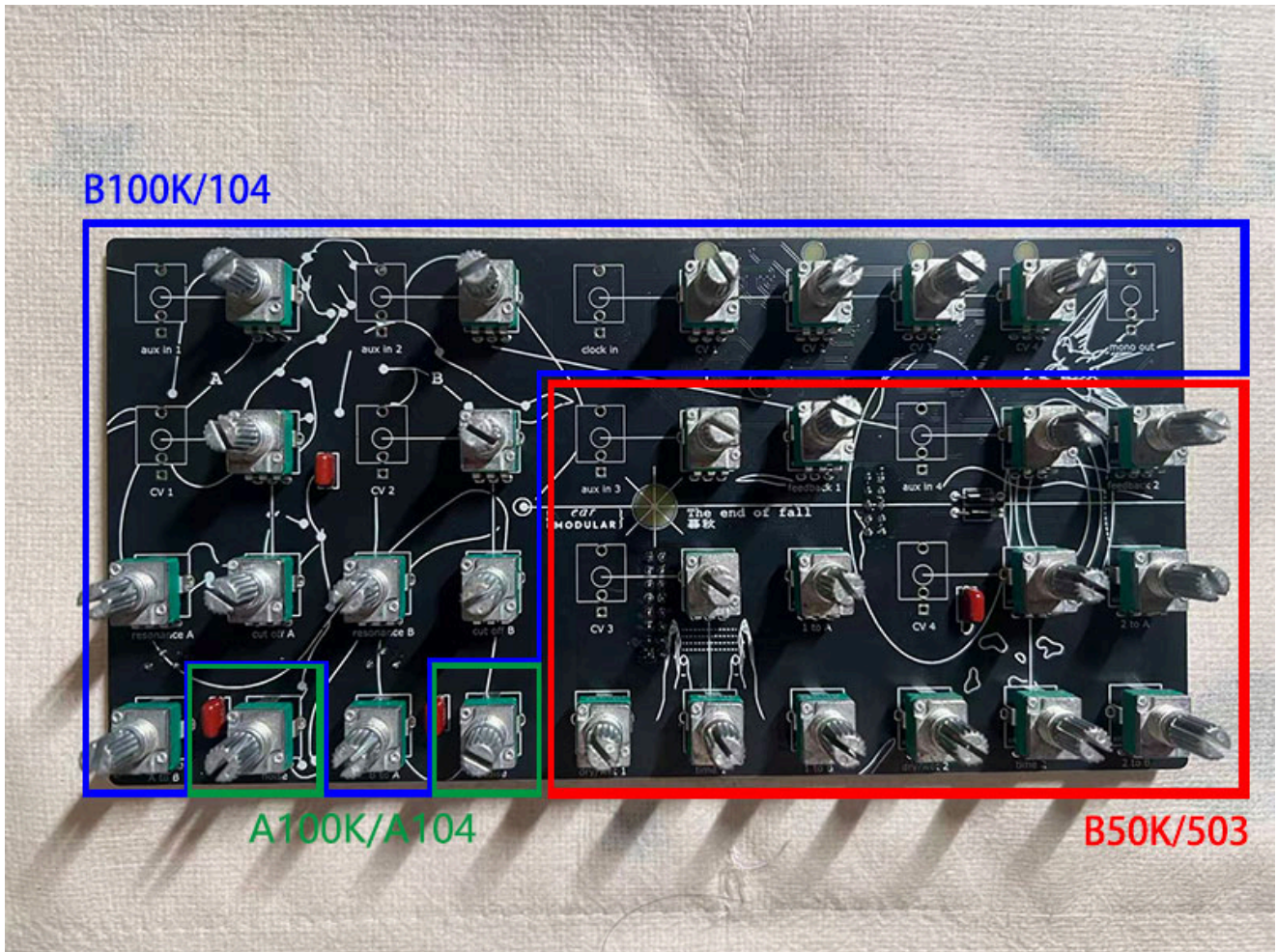
| Solder one 2×5P pin header and one 2×8P pin header on the bottom side.



7. 安装 RK097 电位器 (不焊接)

将 RK097 按阻值标识安装到主板正面，不要焊接。

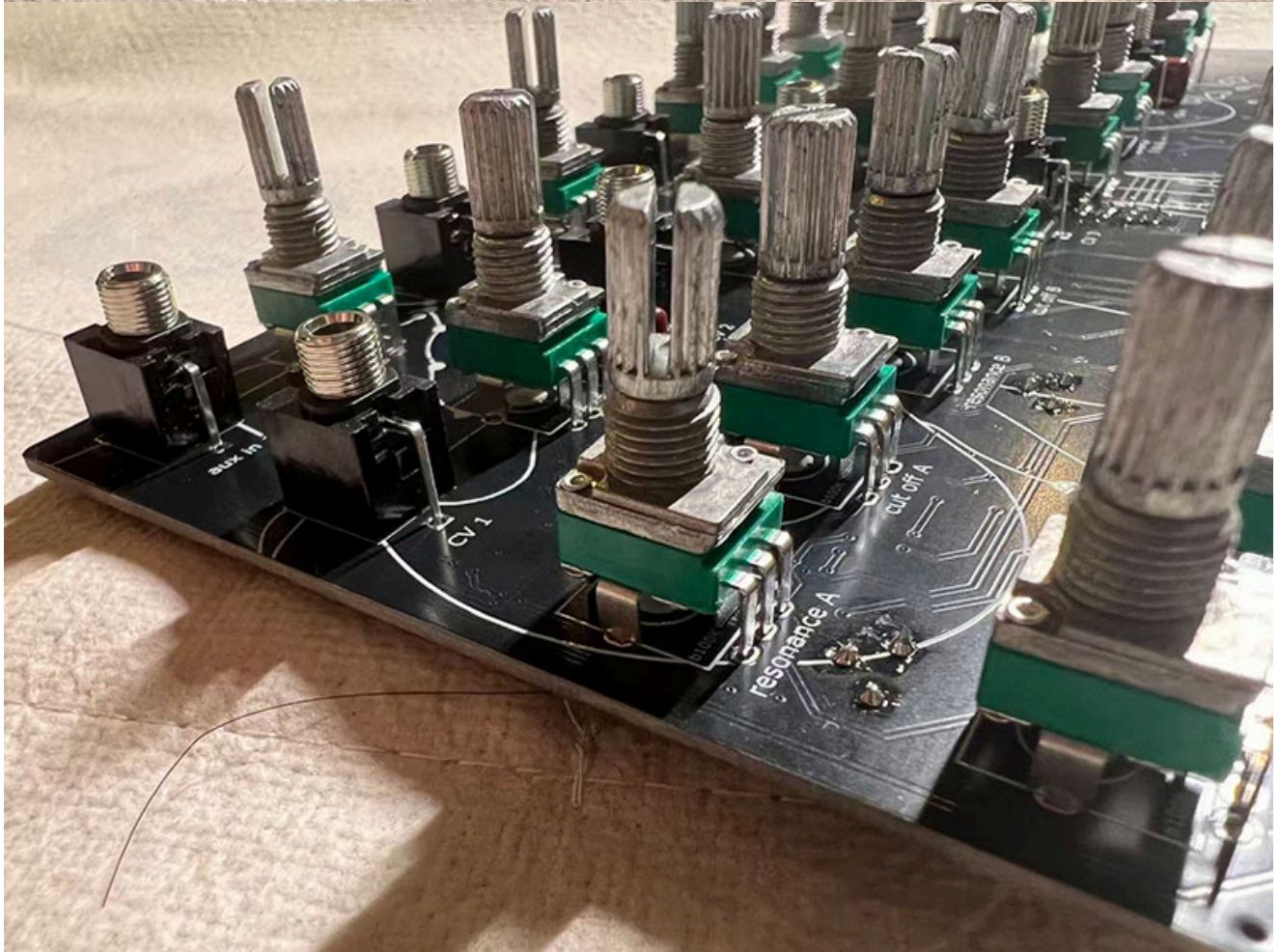
Install the RK097 potentiometers onto the front side of the mainboard according to their resistance value markings — **do not solder them at this stage.**



## 8. 安装 PJ301M 插口（不焊接）

将 PJ301M 安装到主板正面，不要焊接。

Install the PJ301M jacks onto the front side of the mainboard — **do not solder them yet.**



9. 确认面板方向

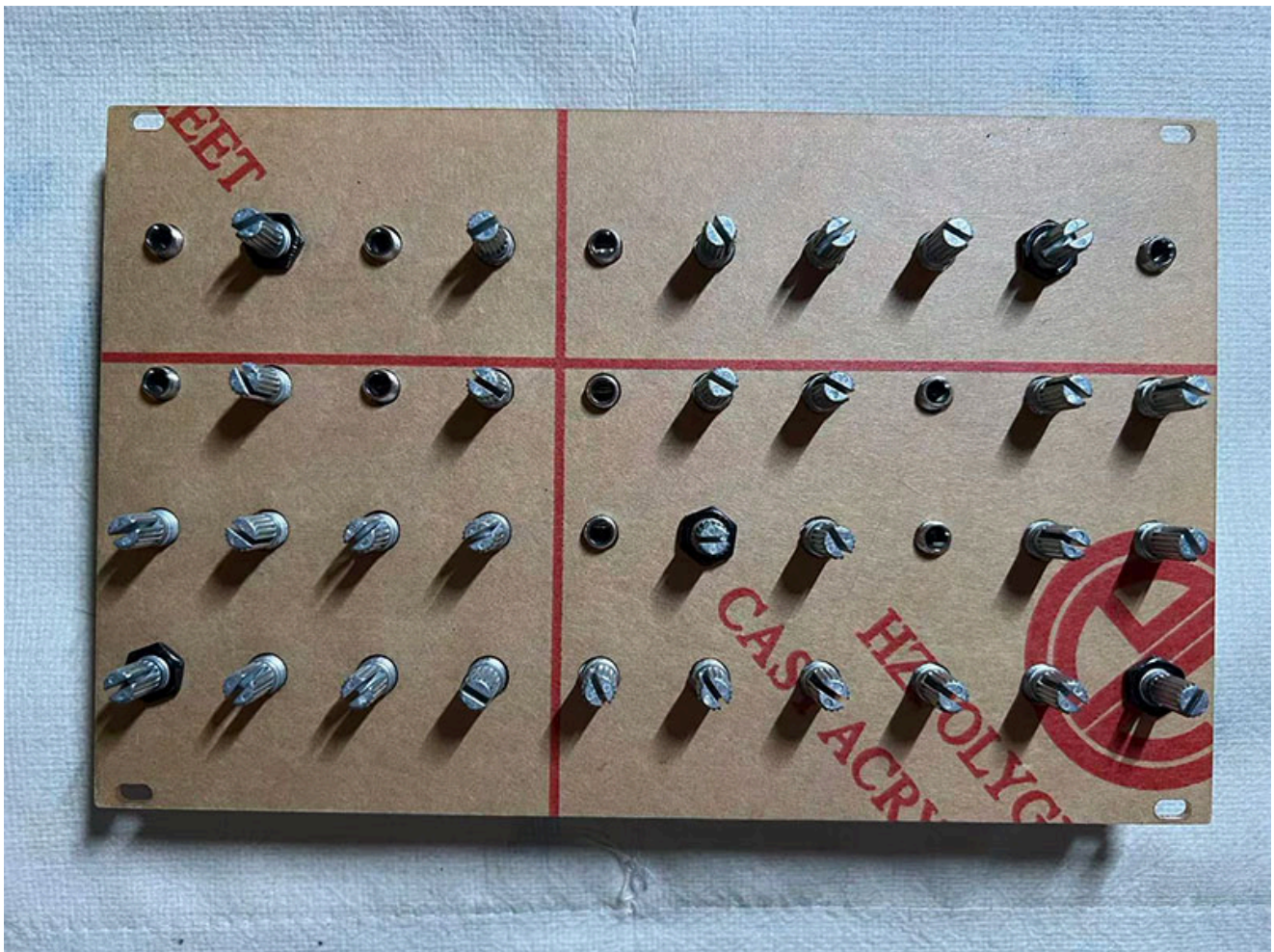
对照电位器和插口位置，确认面板方向，插口的孔径要稍微小于电位器的孔径，**不要撕保护膜**。

Align with the positions of the potentiometers and jacks to confirm the orientation of the panel. The aperture of the jacks should be slightly smaller than that of the potentiometers. **Do not remove the protective film.**

## 10. 安装面板

安装面板，确保所有电位器和插口都正确的从面板孔位穿过，使用至少 4 个电位器螺母固定面板到电位器上。**推荐选择使用四个角附近的电位器固定。**

Install the panel, ensuring all potentiometers and jacks correctly pass through the corresponding holes on the panel. Use nuts from at least 4 potentiometers to secure the panel to the potentiometers. It is recommended to use the potentiometers located near the four corners for fixation.

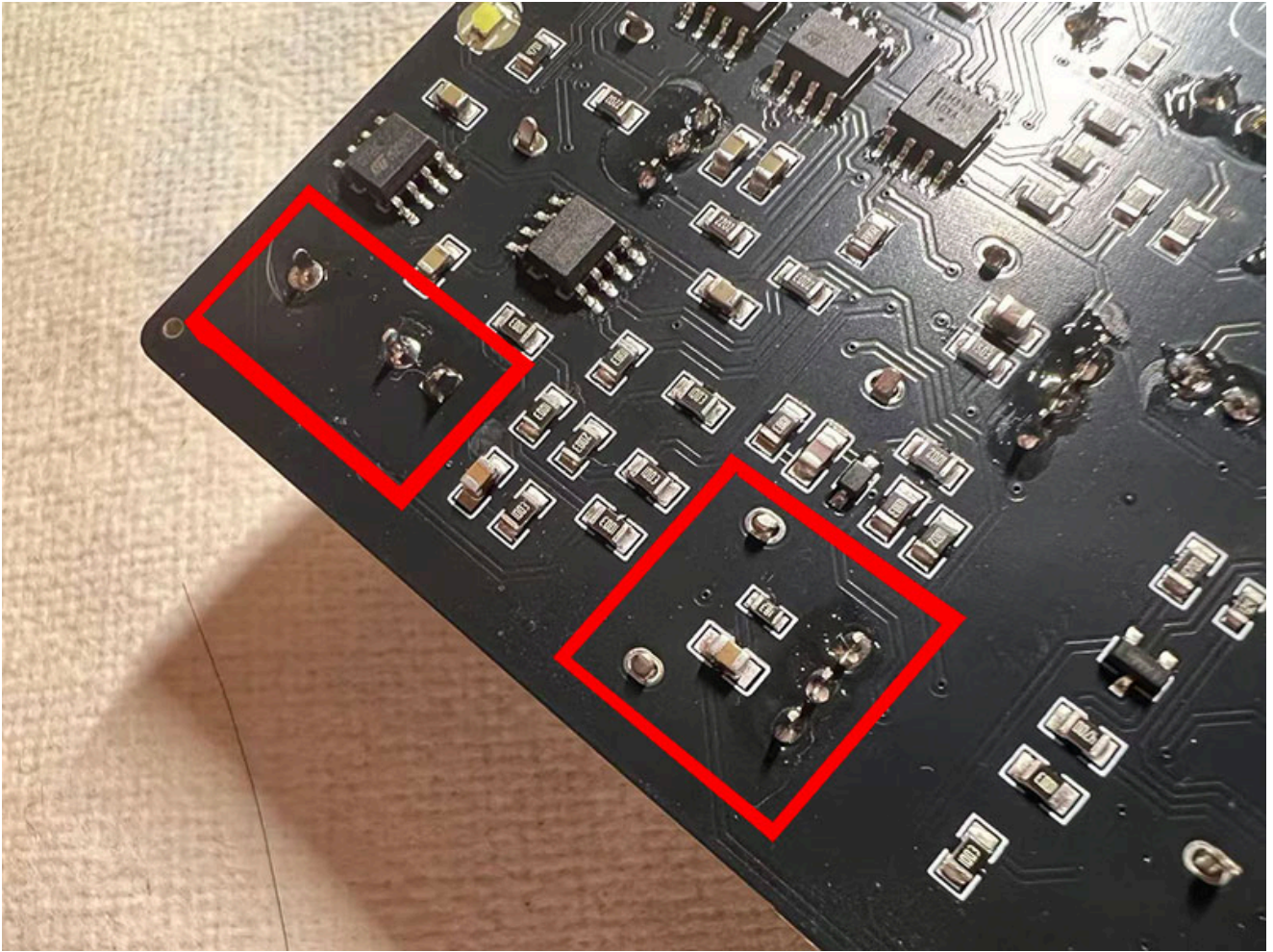


## 11. 焊接 PJ301M 与 RK097

依次焊接 PJ301M 插口和 RK097 电位器的各三个插脚，电位器两侧的支撑脚可不焊接。焊接过程中确保每一个 PJ301M 和 RK097 都安装到位。

Solder the three pins of each PJ301M jack and RK097 potentiometer sequentially. The support tabs on both sides of the potentiometers may be left unsoldered. During the

soldering process, ensure every PJ301M and RK097 is properly seated in place.



## 测试和调节 / Testing and Adjustment

### 1. 接电源

将背面 2×5P 的电源排针通过连接线连接到 eurorack 电源，注意方向。

Connect the 2×5P power header on the back to the Eurorack power supply via a cable, paying attention to the polarity.

### 2. 检查 LED

主板中心的灯会长亮。右上方四个灯会闪亮，旋转四个灯对应的四个旋钮，灯闪烁频率会变化。

The central LED on the mainboard will light up steadily. The four LEDs in the upper right will blink. Rotate the four corresponding knobs — the blinking frequency will change.

### 3. 测试 A 组滤波器（噪音源）

将所有旋钮旋转至逆时针位，mono out 连接到模块系统的输出，将 A 组的 cut off A 旋转到中心位（12 点钟方向），顺时针旋转 A 组对应的 noise 电位器，听到噪音，完全逆时针旋转 noise 电位器。

Turn all knobs fully counterclockwise. Connect the MONO OUT to your modular system's output. Turn the A CUT OFF A knob to the 12 o'clock position. Slowly turn the A corresponding NOISE potentiometer clockwise until you hear noise, then turn it fully counterclockwise again.

#### 4. 调节谐振

逐步顺时针旋转 resonance A 直至听到滤波器谐振音，调整背面蓝色电位器 **Res intensity A** 直至谐振声满意。

Gradually turn the RESONANCE A knob clockwise until you hear the filter resonate. Adjust the blue RES INTENSITY A trimmer potentiometer on the back until the resonance is satisfactory.

#### Note

拧动 resonance A 电位器时可能会有干扰声，是正常现象，不用理会它。

*When adjusting the RESONANCE A knob, some interference noise may occur. This is normal and can be ignored.*

#### 5. 测试 cut off CV

逐步顺时针旋转 cut off A 上方电位器，听到谐振音音高变化，旋转右上方 **CV 1** 电位器，音高改变速率会变化。**A 组滤波器测试完毕。**

Gradually turn the potentiometer above CUT OFF A clockwise — you will hear the pitch of the resonance change. Rotate the CV 1 knob in the upper right — the rate of the pitch change will vary. The A group filter test is now complete.

#### 6. 测试 1 组 echo

在 mono out 有输出的情况下，测试 1 组 echo：顺时针旋转 dry/wet 1、time 1、feedback 1，听 mono out 的声音会有 echo 效果并会随旋转电位器改变。将 time 1 上方电位器逐步顺时针旋转，听到 time 会自动改变，调整右上方 **CV3** 电位器，time 变化速率随之改变。至此 1 组 echo 测试完成，将所有旋钮逆时针复位。

With MONO OUT connected, test Echo 1. Turn the DRY/WET 1, TIME 1, and FEEDBACK 1 knobs clockwise. Listen to the output from MONO OUT — you should hear echo effects that change as you adjust the knobs. Gradually turn the potentiometer above TIME 1 clockwise — you will hear the delay time change automatically. Adjust the CV 3 knob in the upper right — the rate of the time change will vary. The test for Echo 1 is now complete. Turn all knobs back fully counterclockwise.

#### 7. 测试 B 组与 echo 2

针对 B 组滤波器和 2 组 echo，重复 3-7 步骤，旋转对应电位器。

For the B filter and Echo 2, repeat steps 3-7, using the corresponding knobs for each group.

## 8. 测试交叉反馈

继续测试交叉反馈：

- 将 A、B 组滤波器均调整到谐振状态，旋转 **A to B** 和 **B to A** 电位器，听声音变化
- 调整 1、2 组 echo 到工作状态，旋转 **1 to A**、**1 to B**、**2 to A**、**2 to B** 旋钮，听声音变化

Set both the A and B filters to a resonant state. Turn the A TO B and B TO A knobs and listen to the changes in sound. Set both Echo 1 and 2 to an active state. Turn the 1 TO A, 1 TO B, 2 TO A, and 2 TO B knobs and listen to the changes in sound.

## 9. 进一步测试

测试基本结束。若要进一步测试，可：

- 将音频信号分别送进 **aux in 1、2、3、4**
- 将 CV 信号送进 **CV 1、2、3、4**
- 将时钟或方波信号送进 **clock in**
- 观察变化

Send audio signals to AUX IN 1, 2, 3, and 4. Send CV signals to CV 1, 2, 3, and 4. Send a clock or square wave signal to CLOCK IN and observe the changes.

## 10. 最终安装选择

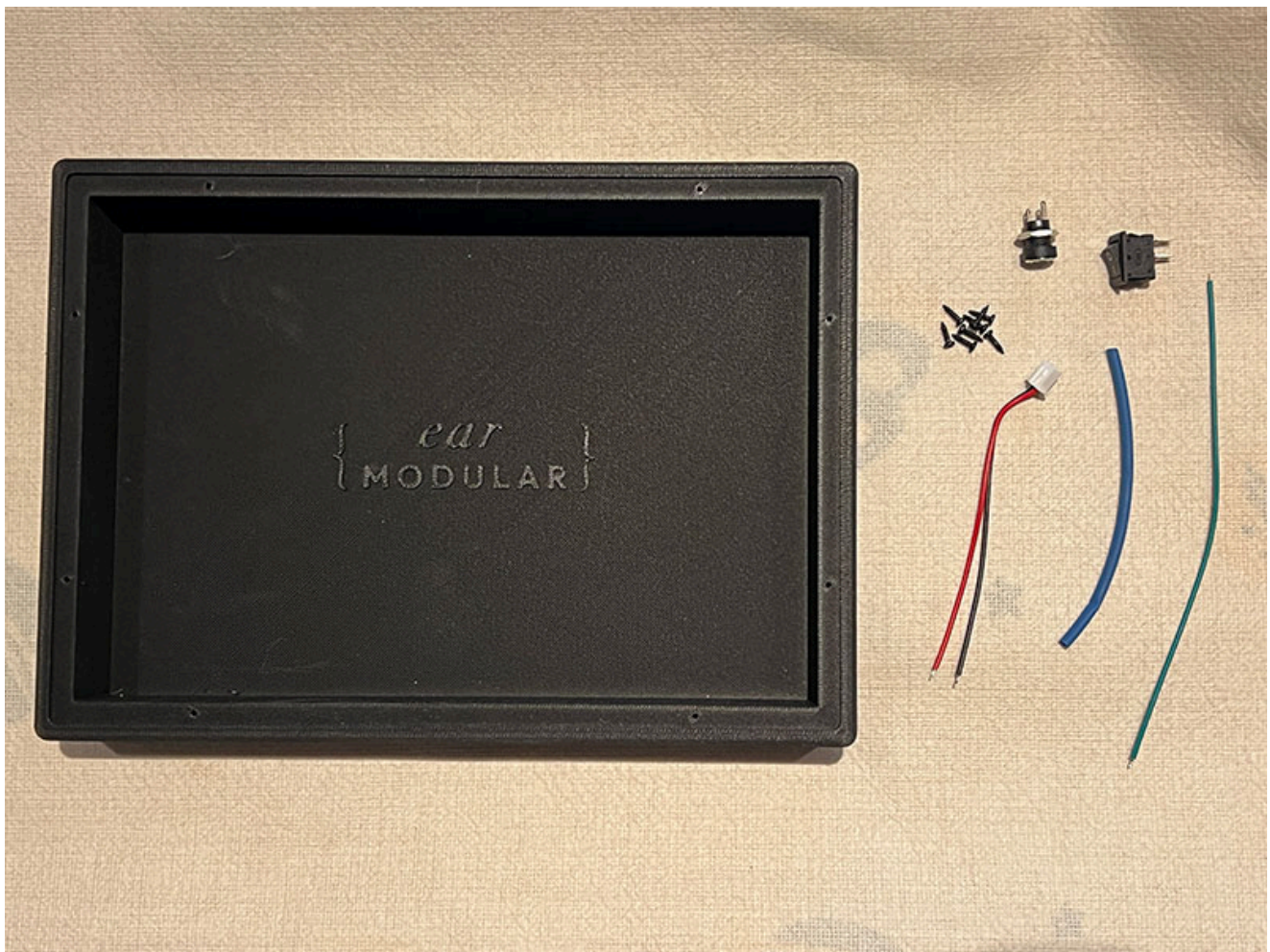
拆下电位器固定螺母，拆下面板：

- **若要将暮秋安装到 eurorack 系统：**将 eurorack 面板双侧保护膜撕掉，并安装到主板上，制作结束
- **若要制作独立设备：**面板和主板待用，继续制作盒子和两块扩展板

If installing The End Of Fall into a Eurorack system: Remove the protective film from both sides of the Eurorack panel, attach it to the mainboard, and the build is complete. If building the standalone device: Set the panel and mainboard aside for now. Continue by building the enclosure and the two expander boards.

---

## 五、盒子 / Box



## 元件清单 / Bill of Materials

元件 / Component	数量 / Qty
盒子 / Box	1
船型开关 / Rocker Switch	1
DC5.5×2.1 电源母座 / Power Socket	1
XH254 2P 单头端子 / Terminal Connector	1
导线 / Wire	1
热缩管 / Heat Shrink Tubing	1
M2 自攻螺丝 / M2 Self-tapping Screws	8

## 制作步骤 / Assembly

### 1. 电源极性约定

#### 🔗 电源约定 / Power Convention

以下均按照内正外负电源制作（即模块系统电源）。

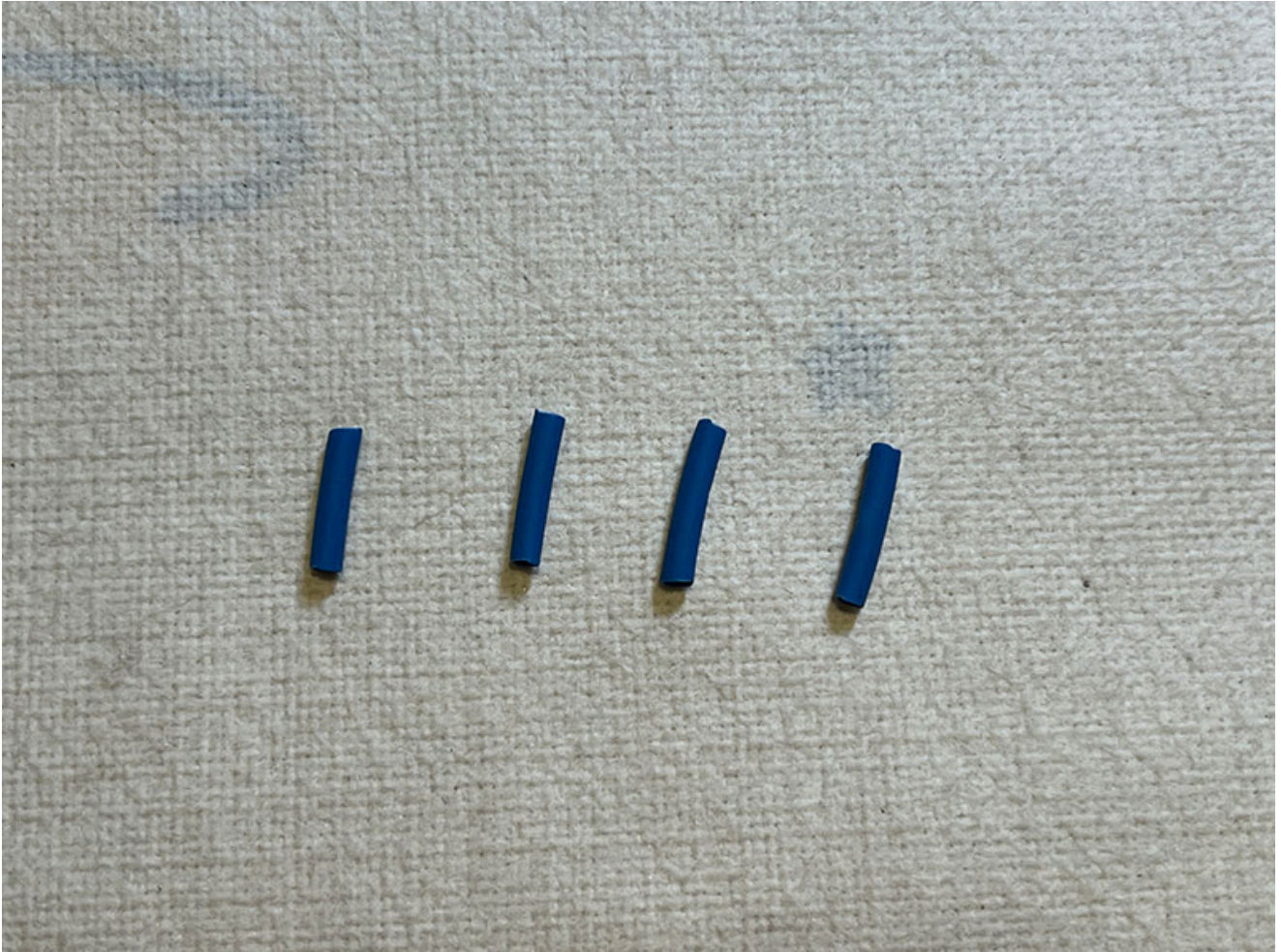
有经验有需要按内负外正（效果器电源）电源制作的朋友请参考以下步骤自行制作。

All following steps assume a "**Center-Positive**" power supply configuration (standard for modular systems). Experienced builders who require a "**Center-Negative**" configuration (common for guitar pedals) should adapt the following steps accordingly.

## 2. 准备热缩管

将热缩管剪下大约 **1.2-1.5 CM** 长度的四段待用。

Cut four segments of heat shrink tubing, each approximately 1.2-1.5 cm in length, and set them aside for later use.



## 3. 焊接电源母座短脚

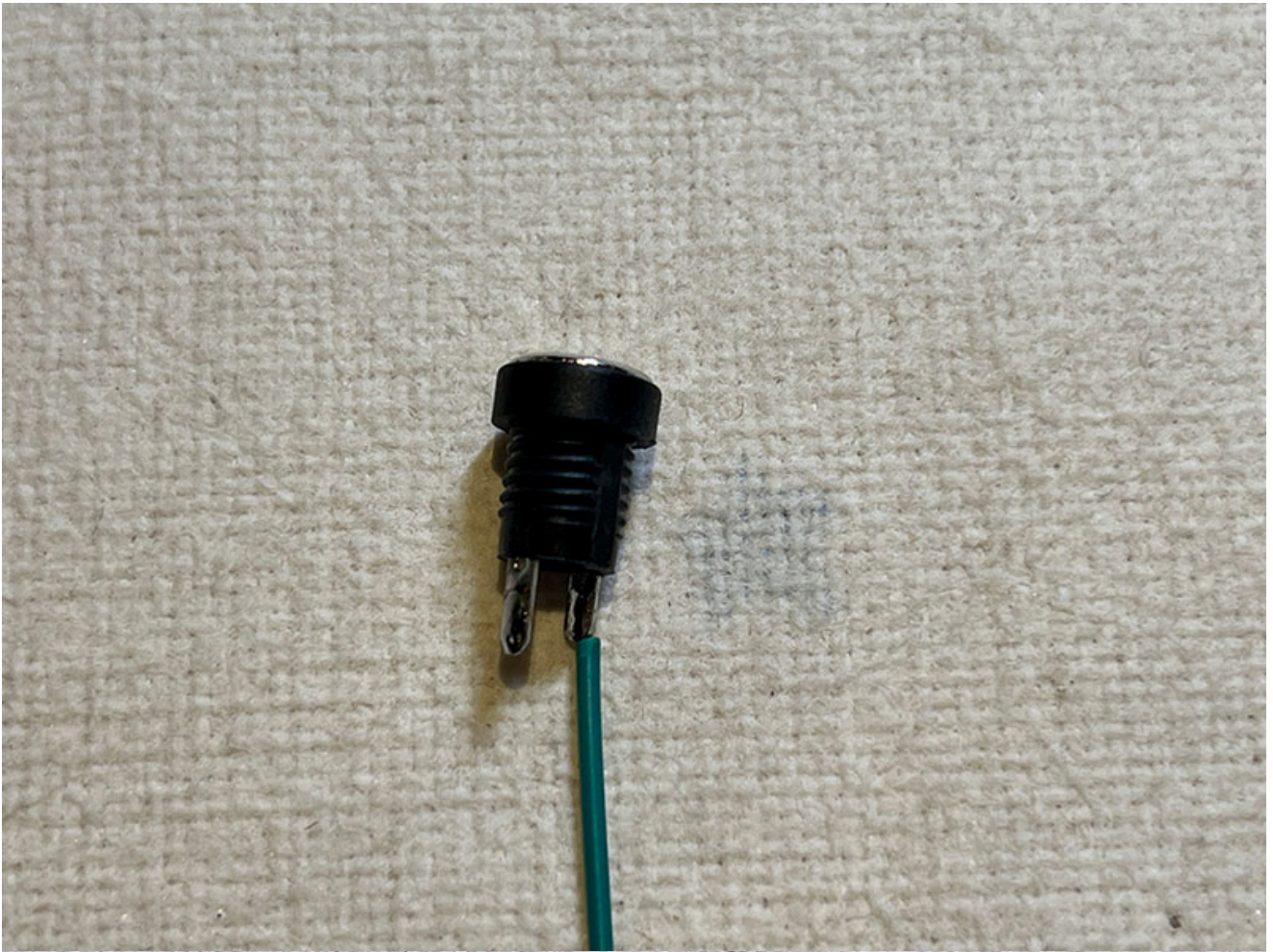
将导线一端焊接至电源母座的**短脚**，套上热缩管，加热使热缩管收缩。

Solder one end of the wire to the shorter pin of the power socket. Slide a piece of heat shrink tubing over the joint, then apply heat to shrink it into place.

**⚠ Warning**

若使用火机等简易设备加热请注意加热距离和时长，不要烧到导线和元件。

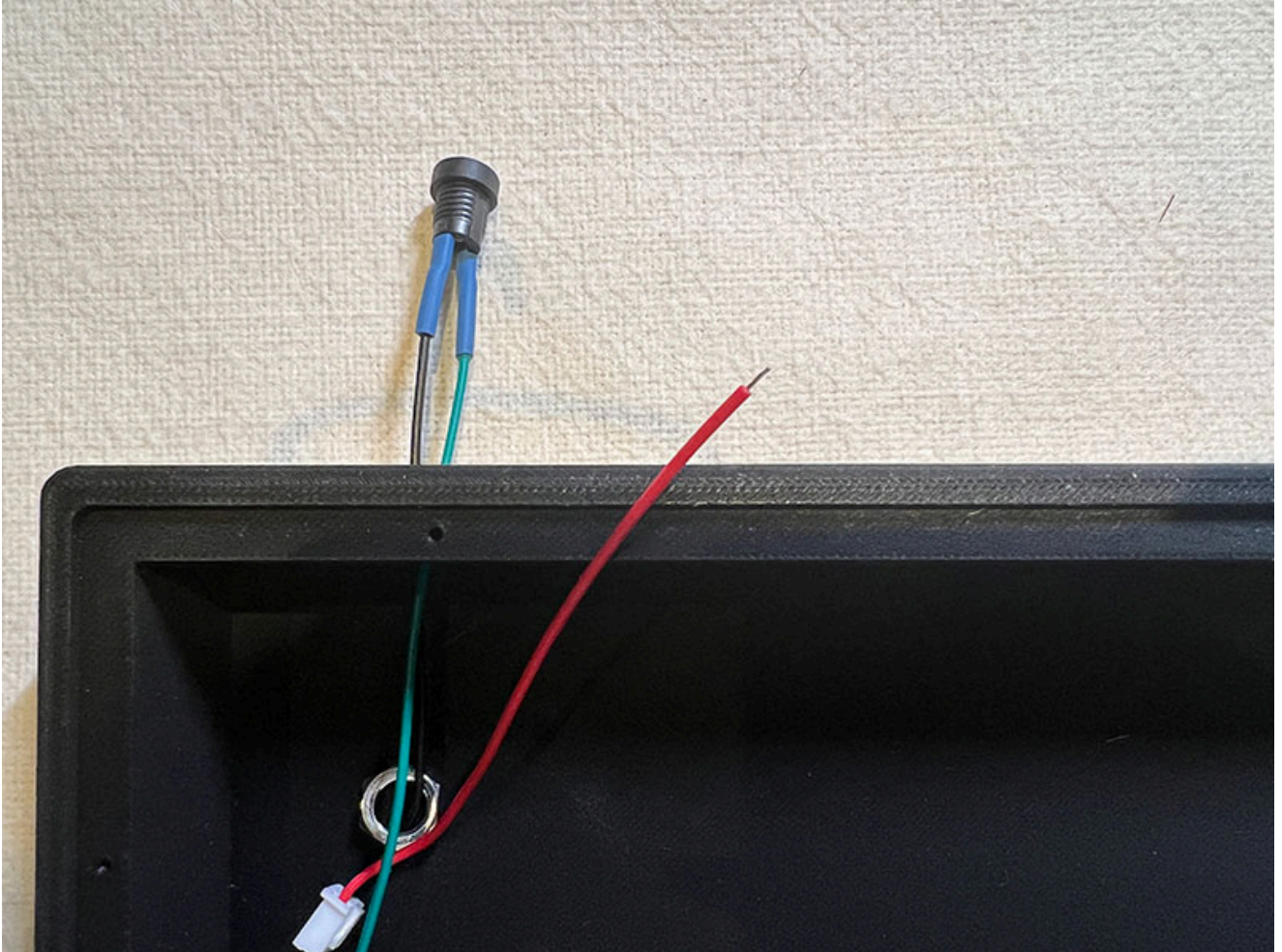
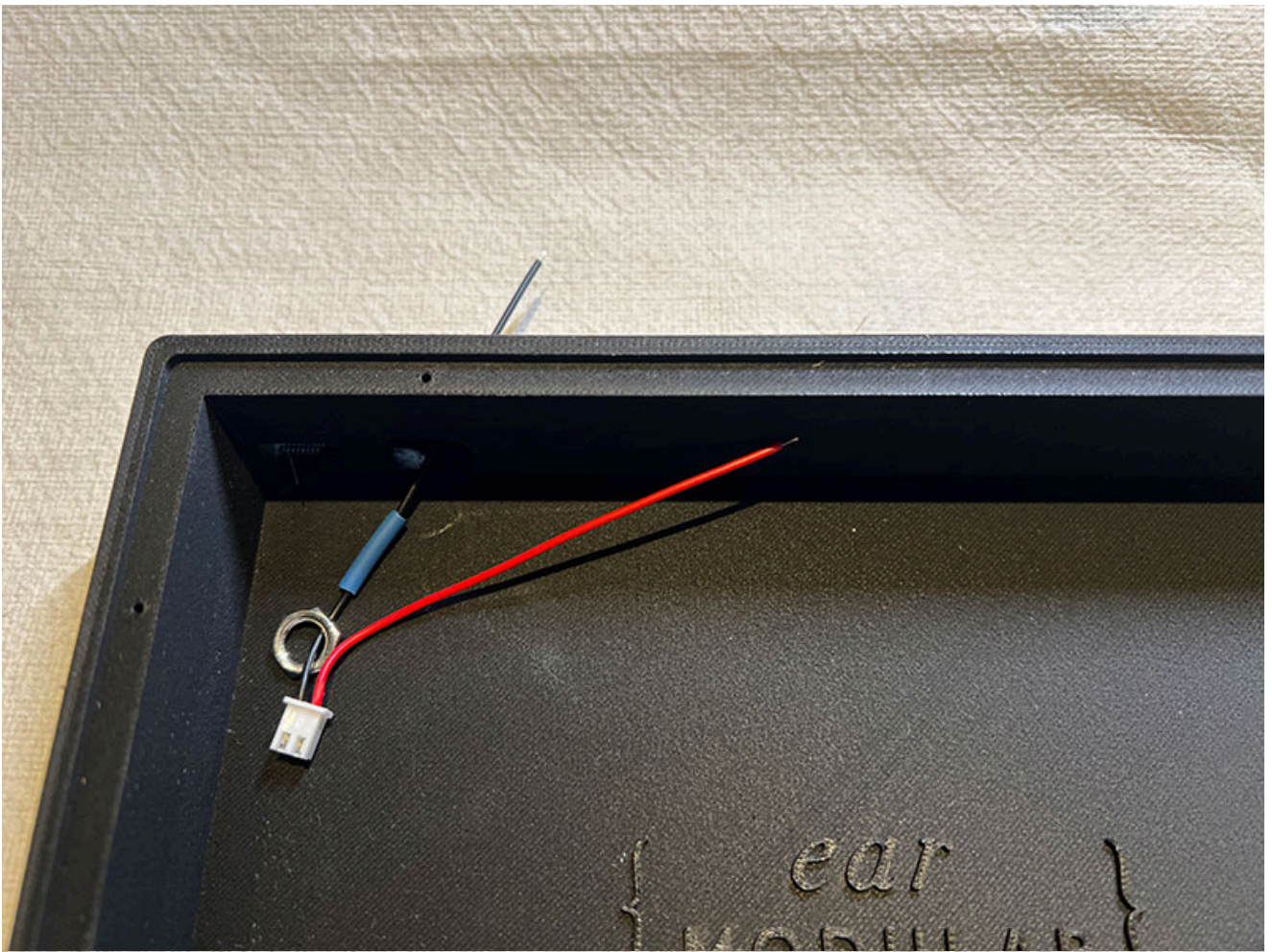
*If using simple equipment like a lighter for heating, maintain a safe distance and limit exposure time to avoid damaging the wire or component.*



4. 处理 2P 端子黑线

将 2P 单头端子的**黑线端**套进电源母座螺母和热缩管，将黑线从内向外穿过盒子的圆孔，之后焊接到电源母座的**长脚**，套上热缩管，加热使热缩管收缩。

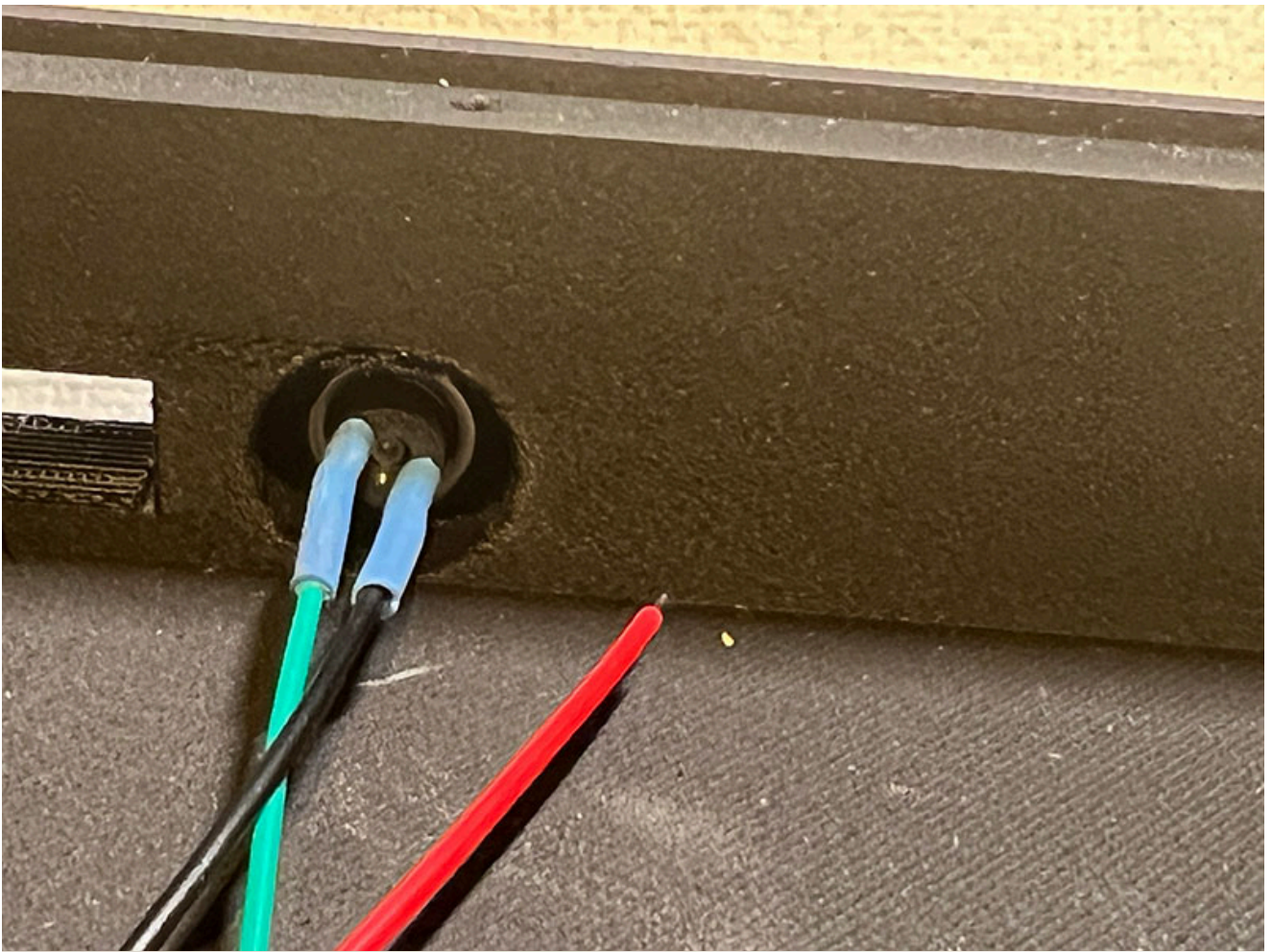
Slide the black wire of the 2P Terminal Connector through the power socket's nut and a piece of heat shrink tubing. Thread the black wire from the inside to the outside through the enclosure's round hole. Then, solder it to the longer pin of the power socket. Slide the pre-positioned heat shrink tubing over the solder joint and apply heat to shrink it securely.



5. 固定电源母座

将电源母座短脚的导线穿过盒子圆孔和螺母，用螺母固定电源母座到圆孔上（圆孔尺寸有可能需要轻微修一下）。

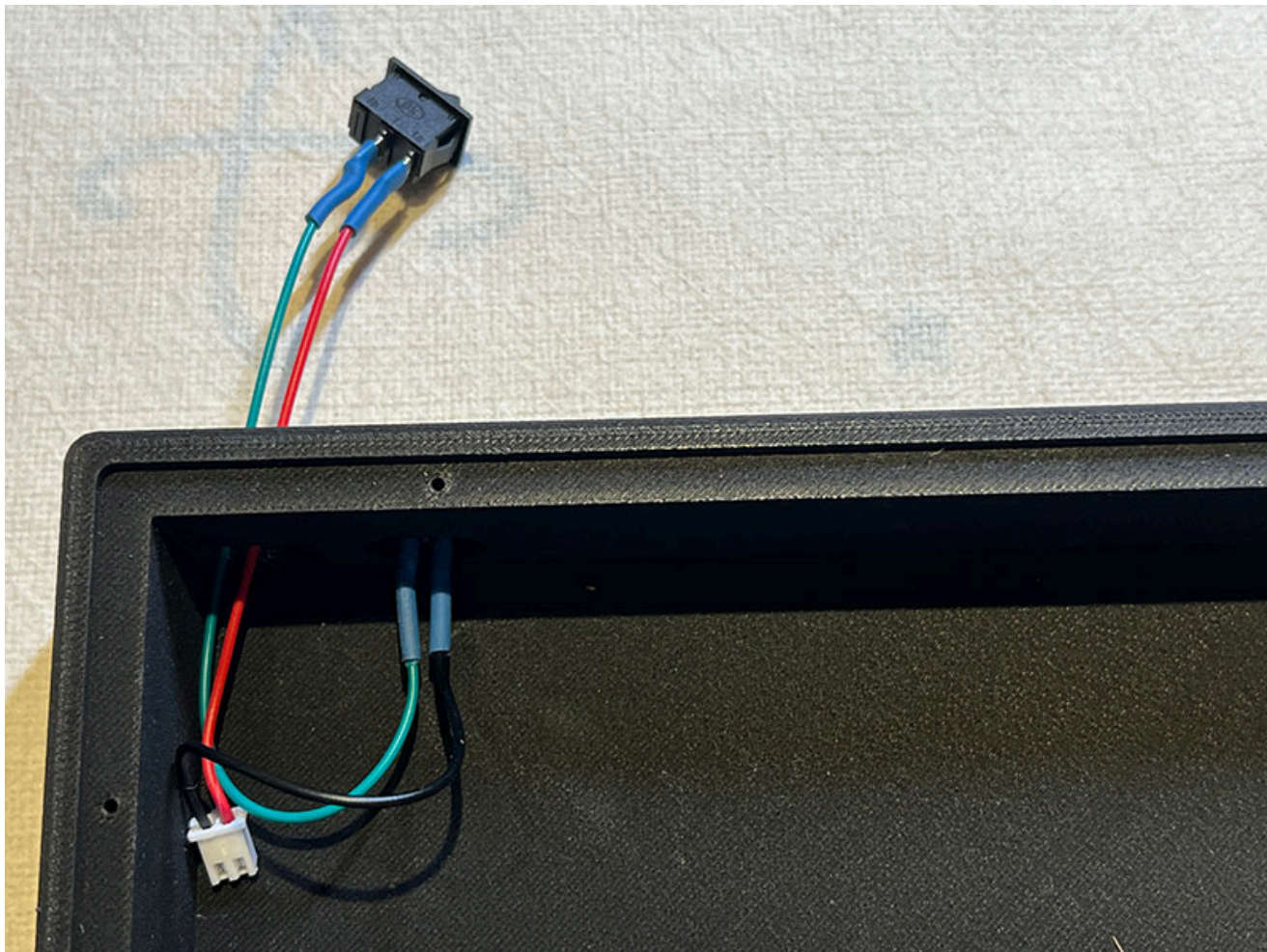
Feed the wire connected to the shorter pin of the power socket through the enclosure's round hole and its accompanying nut. Secure the power socket to the enclosure by tightening the nut. (Note: The round hole may require slight adjustment to achieve proper fit.)



6. 焊接船型开关

将单头端子的**红线**和电源母座短脚的导线分别套上热缩管，从内向外穿过盒子的方孔，套上热缩管，并分别焊接到船型开关的两个脚，加热使热缩管收缩。

Slide heat shrink tubing onto both the red wire of the single-ended terminal connector and the wire from the power socket's shorter pin. Route both wires from the inside to the outside through the enclosure's square hole. Position the heat shrink tubing over the solder joints. Solder them to the two terminals of the rocker switch and apply heat to shrink it securely.



## 7. 固定船型开关

将船型开关固定到方孔上。

Secure the rocker switch into the square hole.



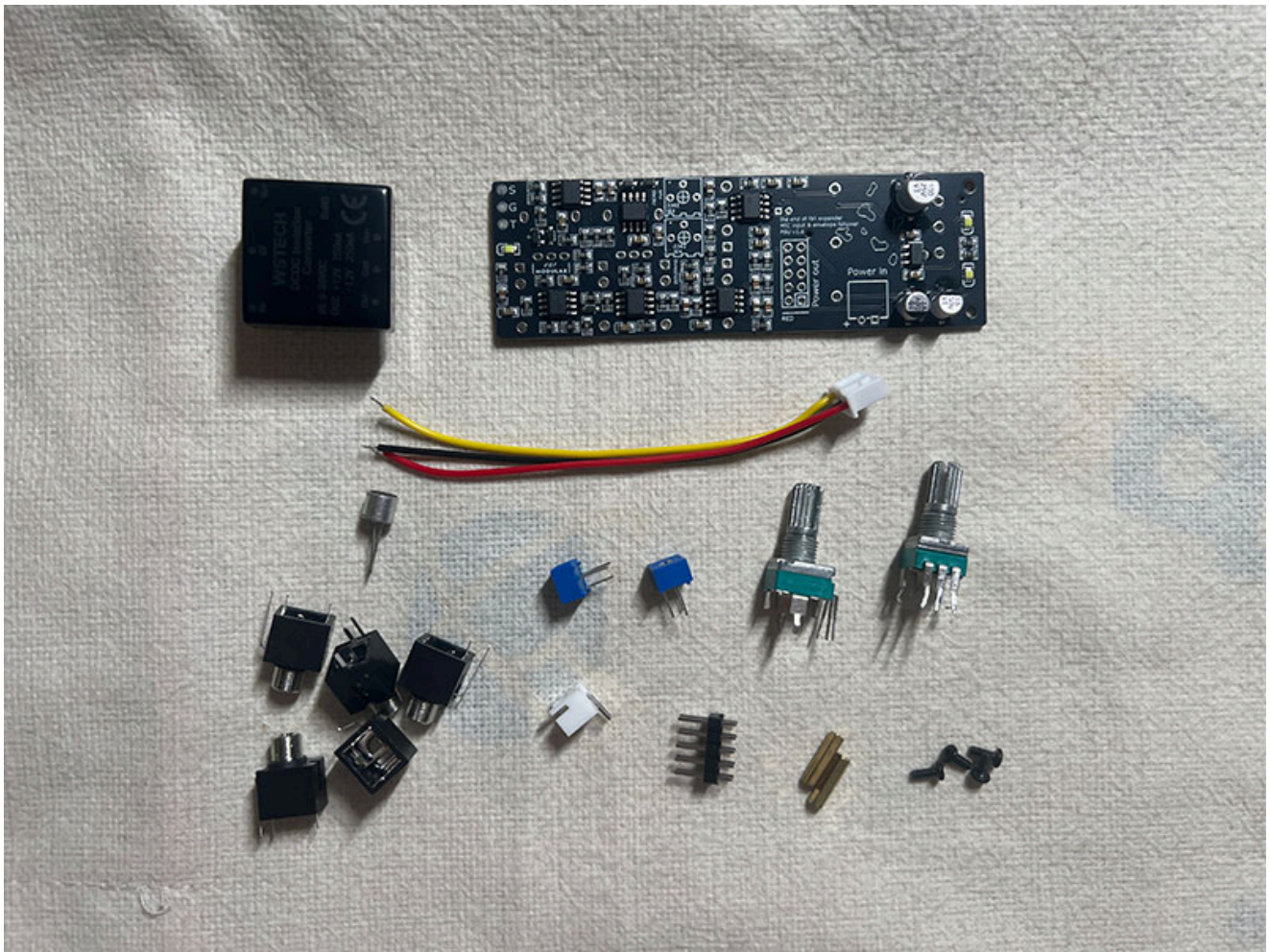
✓ 完成 / Complete

盒子制作完毕。

*Box assembly is now complete.*

---

## 六、扩展 1 — MIC 与包络跟随 / Expander 1 — MIC Input & Envelope Follower



## 元件清单 / Bill of Materials

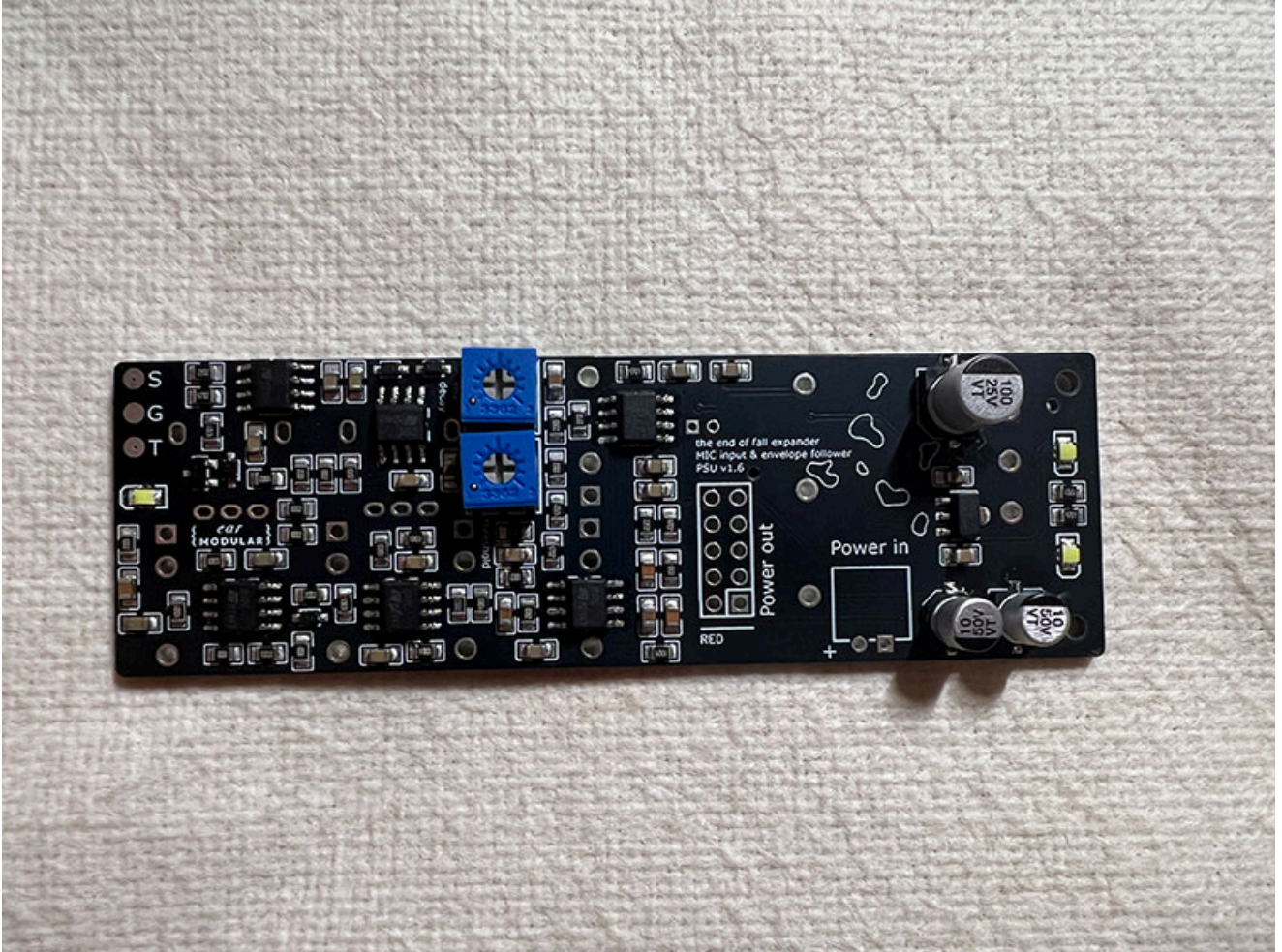
元件 / Component	规格 / Specification	数量 / Qty
PCB	—	1
±12V 6W PSU 电源模块	—	1
排针 / Pin Header	2×5P P2.54	1
长脚咪头 / Electret Mic	Long-Pin	1
PJ301-M 插口 / Jack	—	5
RK097 电位器	B503 (B50K)	1
RK097 电位器	B254 (B250K)	1
3362P 电位器 (蓝色)	B104 (B100K)	2
XH254 2P 端子母座	—	1
XH254 3P 单头端子	—	1
铜柱 / Standoff	2×11mm	2
M2 螺丝 / M2 Screw	—	4

## 制作步骤 / Assembly

## 1. 焊接 3362P 电位器

焊接背面两个蓝色 P3362 104 (100k) 电位器，注意阻值。

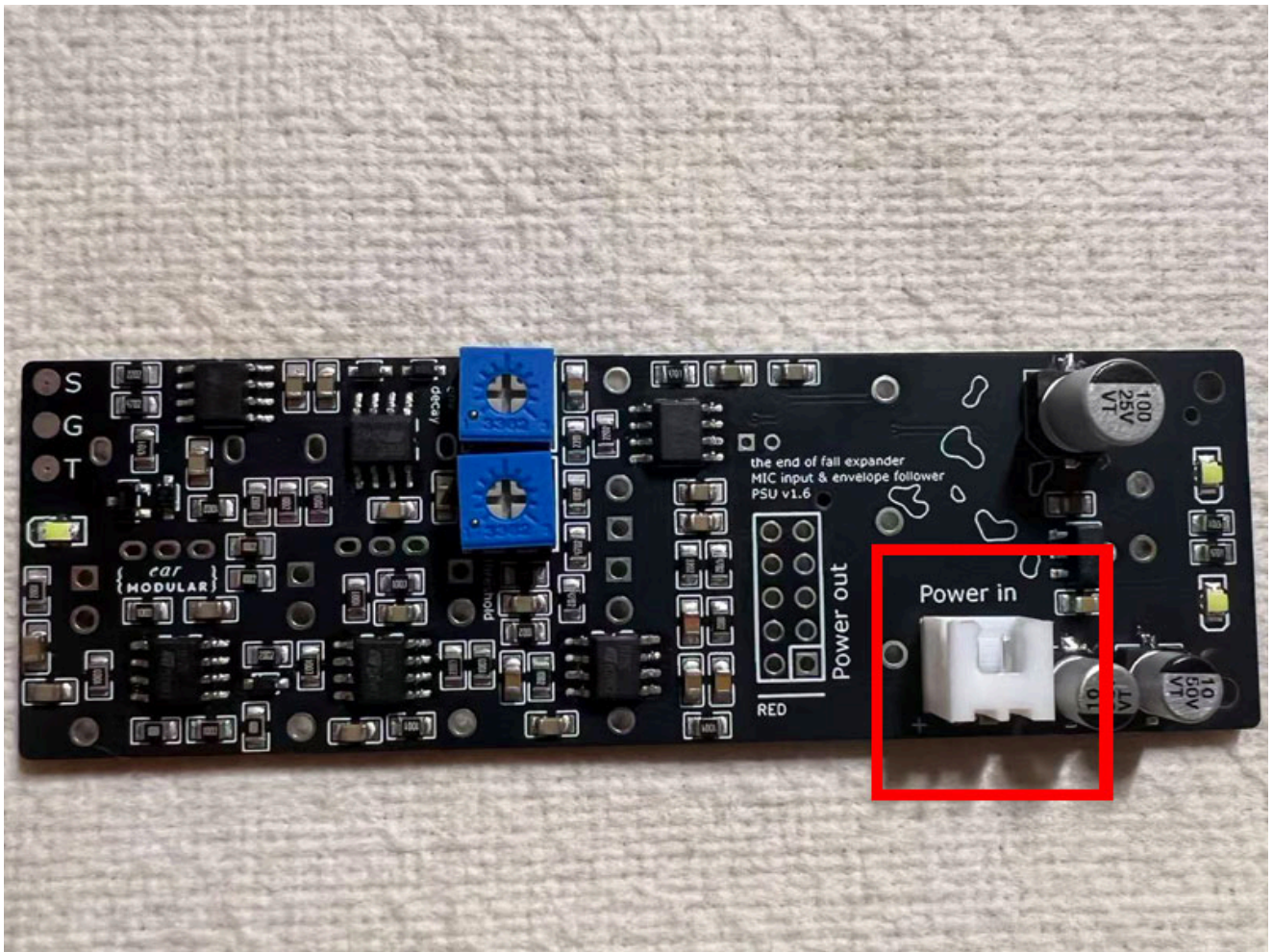
Solder the two blue 3362P 104 (100k) potentiometers onto the back of the board. **Pay attention to their resistance values.**



## 2. 焊接 XH254 2P 端子母座

焊接背面一个 XH254 2P 端子母座，注意方向。

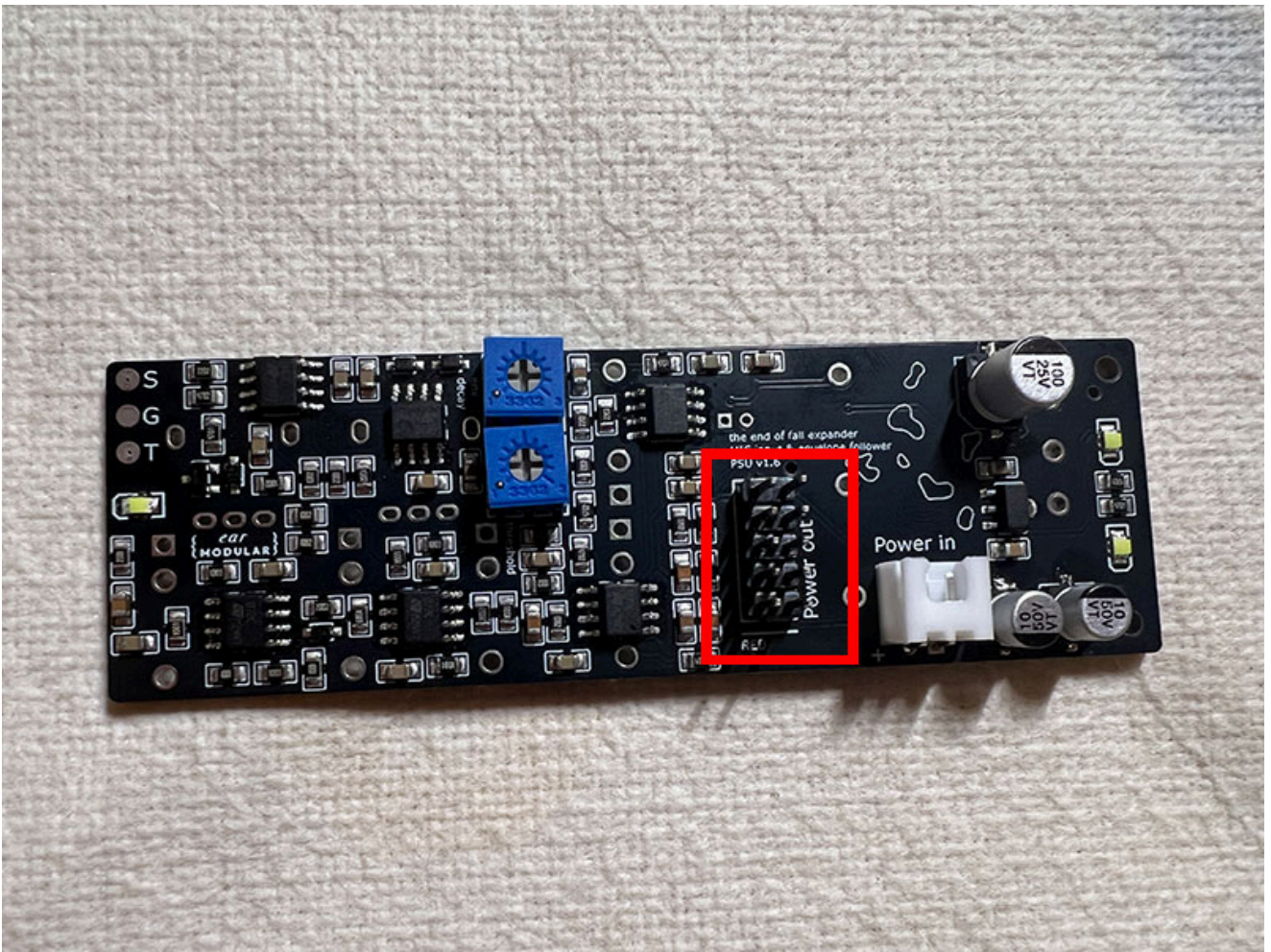
Solder one XH254 2P Female Socket Header to the back of the board, **paying attention to its orientation.**



### 3. 焊接 2×5P 排针

焊接背面一个 2×5P 排针。

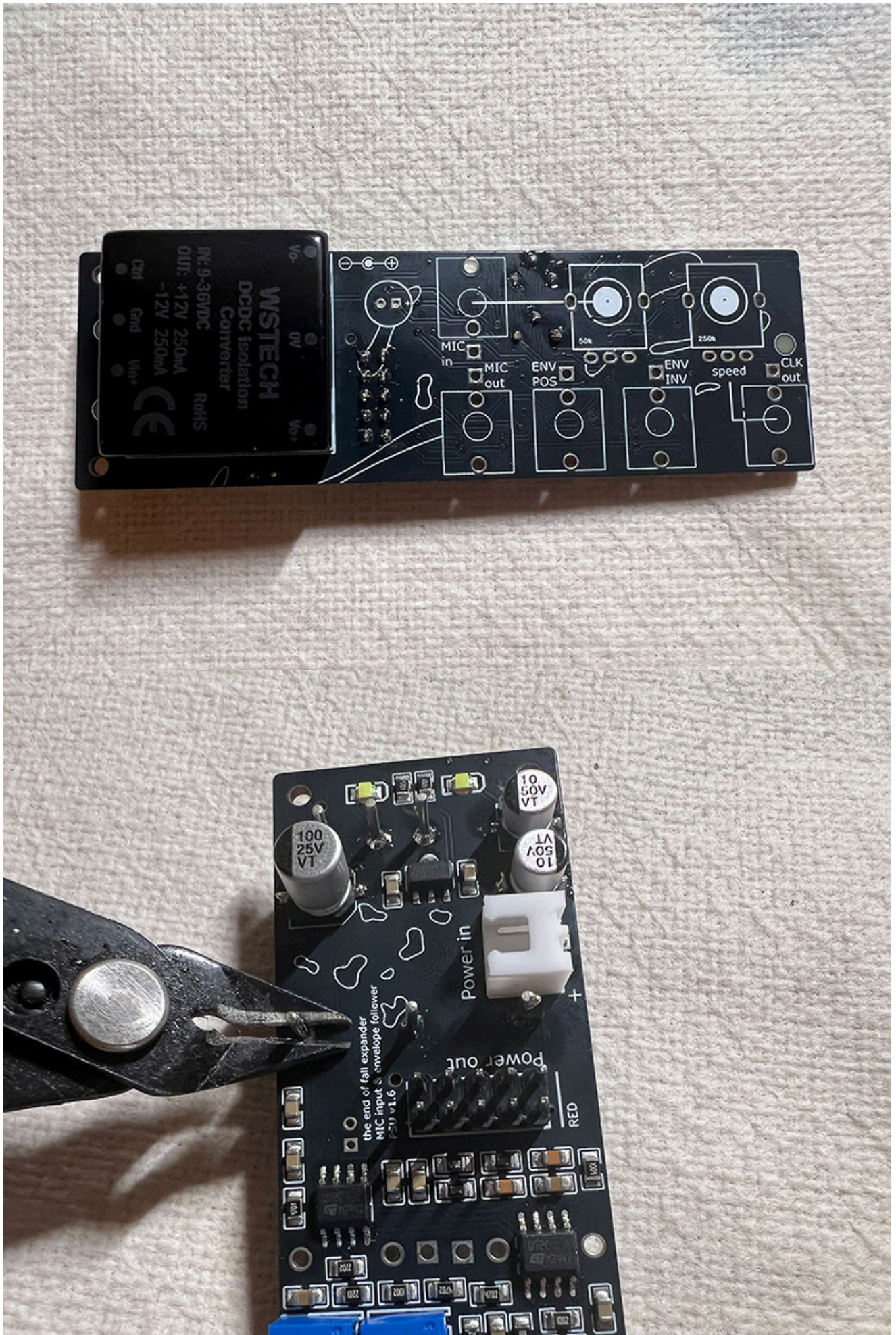
Solder one 2×5-pin pin header to the back of the board.



#### 4. 焊接 6W PSU

焊接正面一个 6W PSU。

Solder the 6W PSU module to the front of the board.



5. 安装 RK097 (不焊接)

将 RK097 按阻值标识安装到正面，不要焊接。

Place the RK097 potentiometers onto the front of the board according to their marked resistance values. Do not solder them at this time.

## 6. 安装 PJ301（不焊接）

将 PJ301 安装到正面，不要焊接。

Place the PJ301 jacks onto the front of the board. Do not solder them at this time.

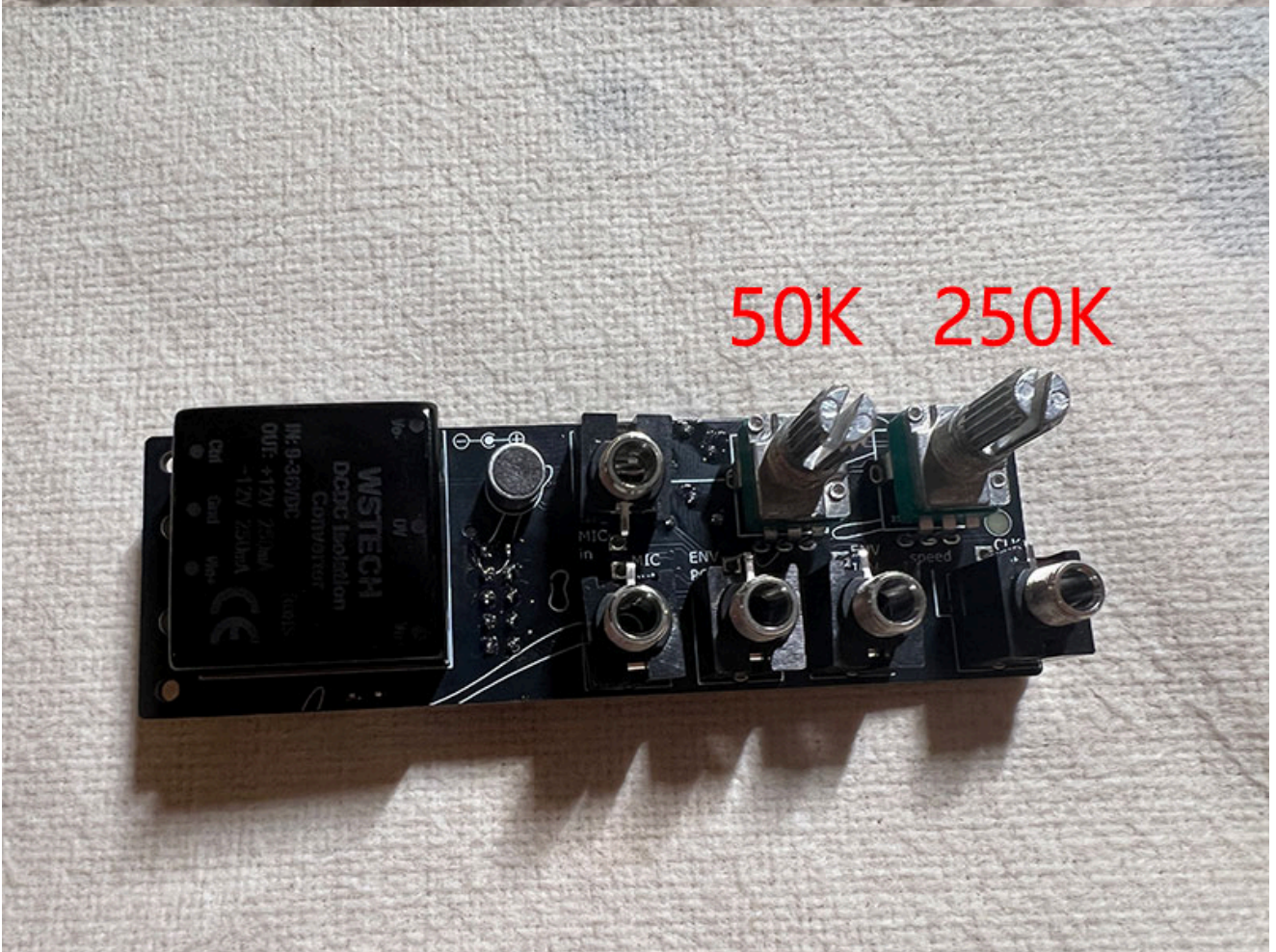
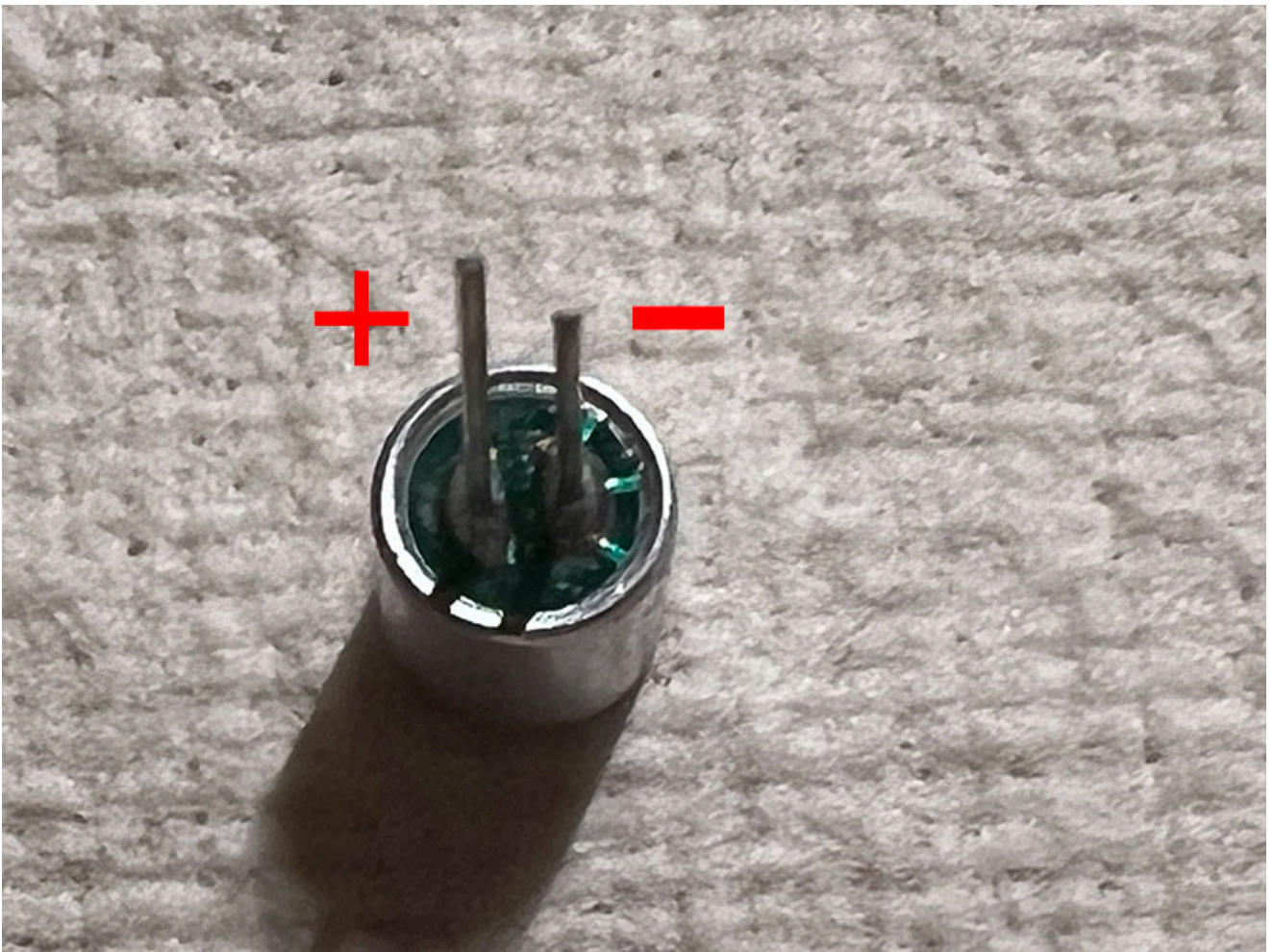
## 7. 安装咪头（不焊接）

安装咪头到正面，不要焊接，注意方向。

### 咪头方向 / Microphone Orientation

- 咪头标注 + 的脚为正
- 若没有标注，和外壳连接的脚为负，另一只脚为正

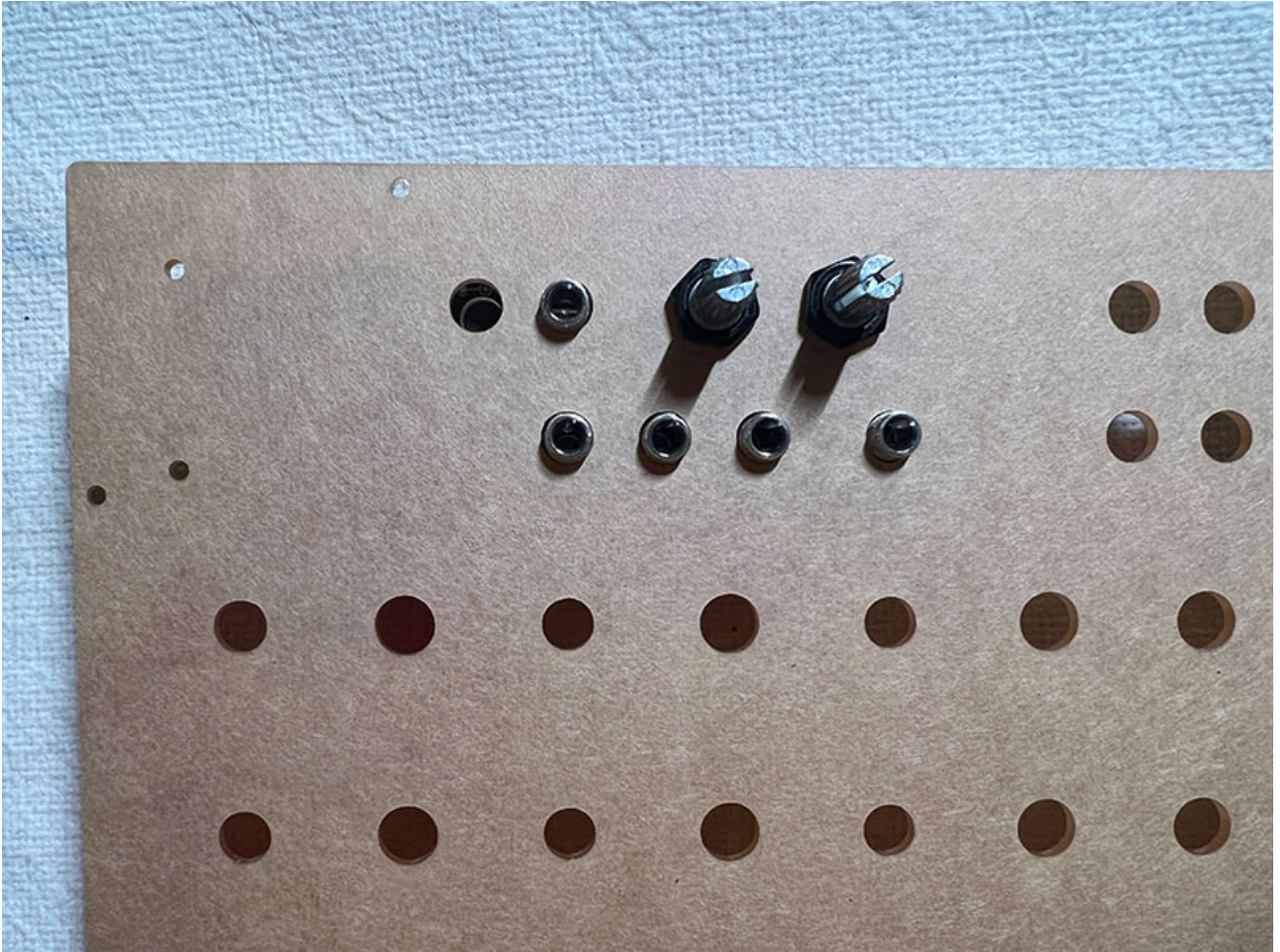
*The pin marked with a "+" is positive. If no marking is present, the pin connected to the case is negative, and the other pin is positive.*



8. 安装面板

安装面板，该扩展板位于面板左上侧，确保所有电位器和插口都正确的从面板孔位穿过，使用电位器螺母和插口螺母固定面板到电位器上。

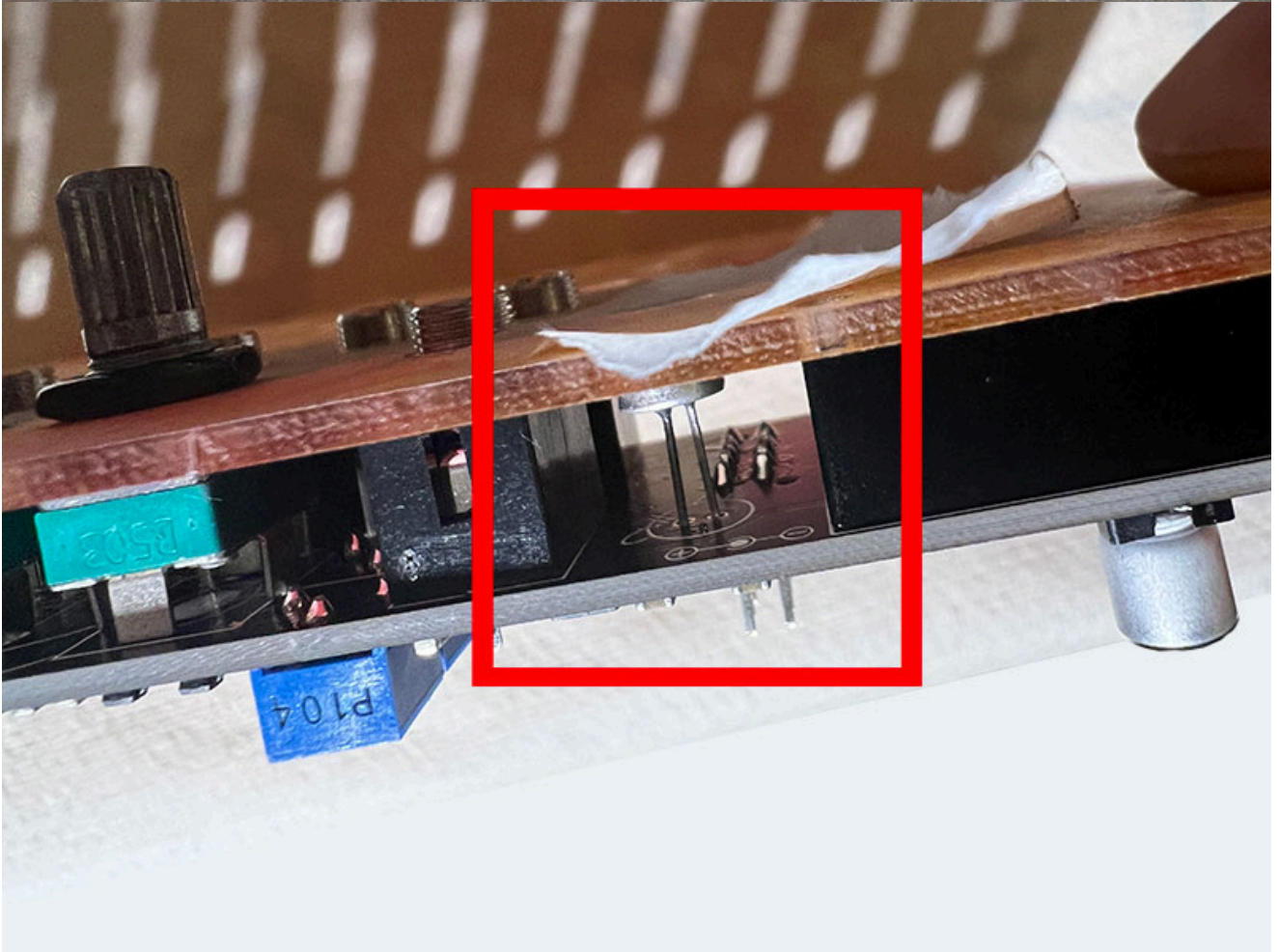
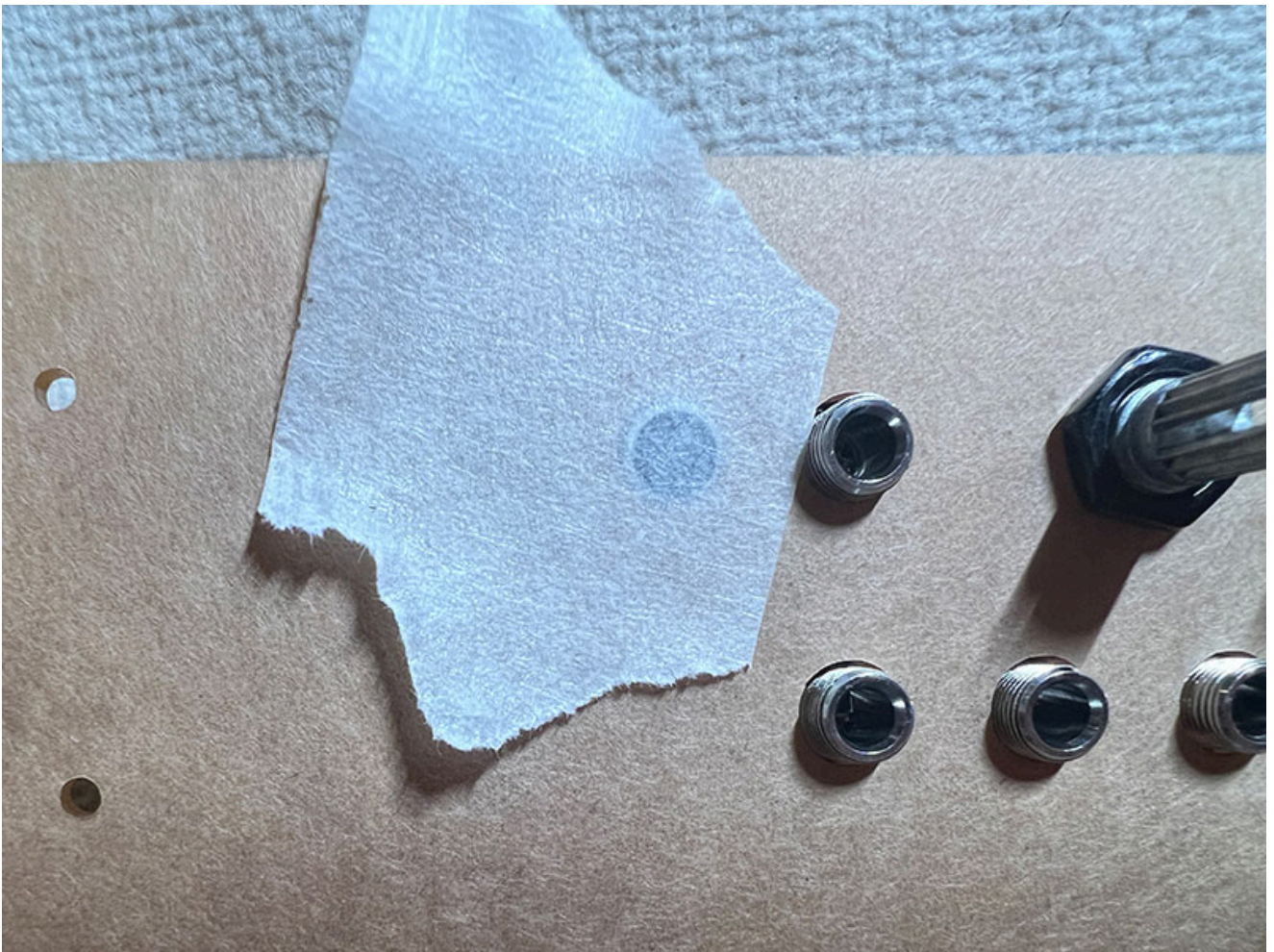
Install the front panel. Position the expansion board on the top-left side of the panel. Ensure all potentiometers and jacks correctly protrude through their corresponding holes on the panel. Secure the panel to the potentiometers using the provided nuts.



## 9. 焊接咪头

调整咪头高度和面板持平，可用纸胶带轻微固定，焊接咪头引脚，去除纸胶带。

Adjust the microphone height so it is flush with the panel. You may temporarily secure it in place with painter's tape. Solder the microphone pins, and then remove the tape.

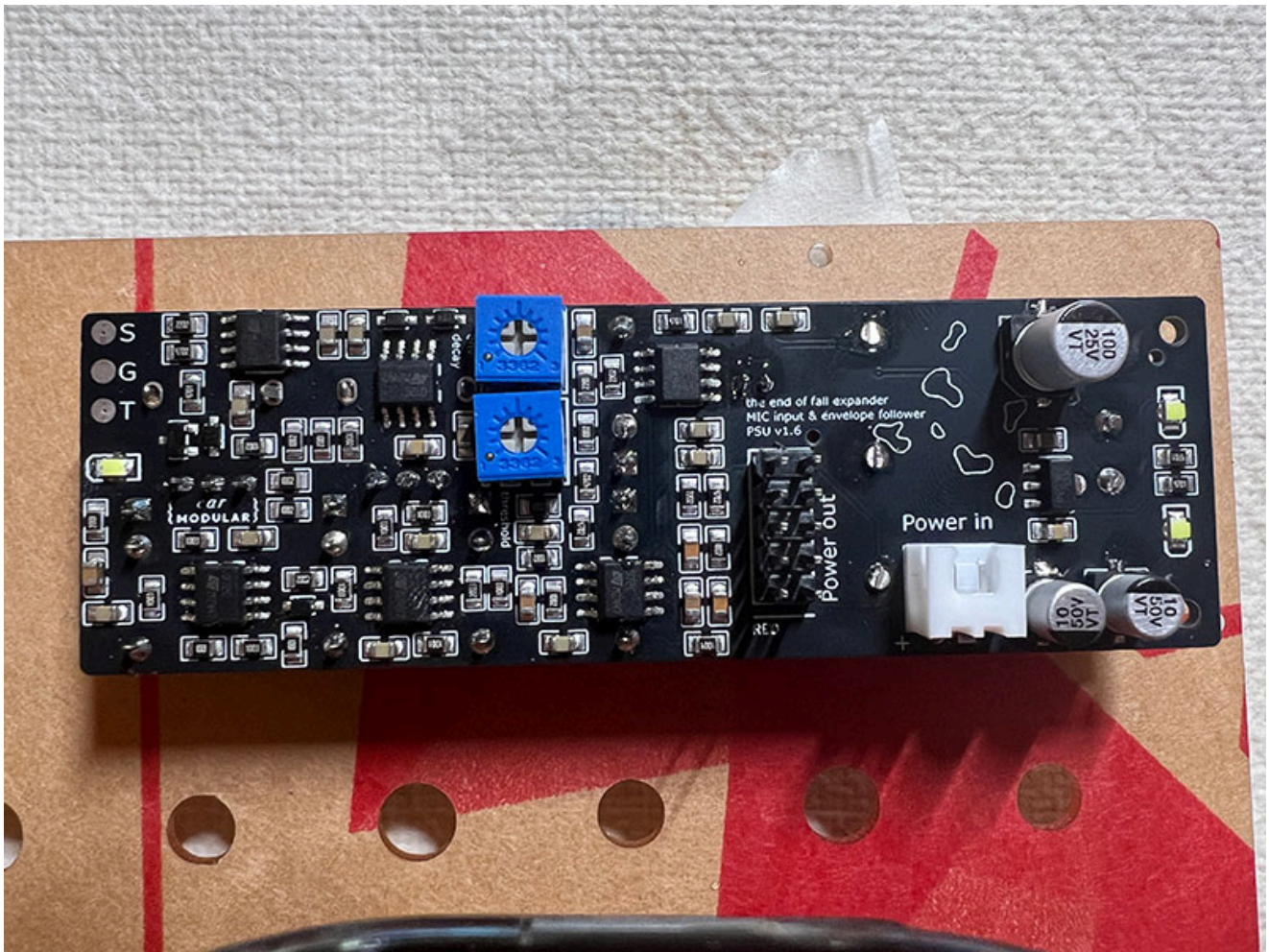




## 10. 焊接 PJ301 与 RK097

依次焊接 PJ301 插口和 RK097 电位器的各三个插脚，电位器两侧的支撑脚可不焊接。焊接过程中确保每一个 PJ301 和 RK097 都安装到位。

Solder the three pins of each PJ301 jack and RK097 potentiometer in sequence. The metal support tabs on the sides of the potentiometers do not need to be soldered. During the process, ensure every jack and potentiometer is fully seated against the board.



## 测试及调节 / Testing and Adjustment

### 1. 接电与基础检查

将盒子的 2P 端子连到扩展板的 **power in 2P 端子母座**，确认红线连到带有 **+** 号的一侧。通电，确认：

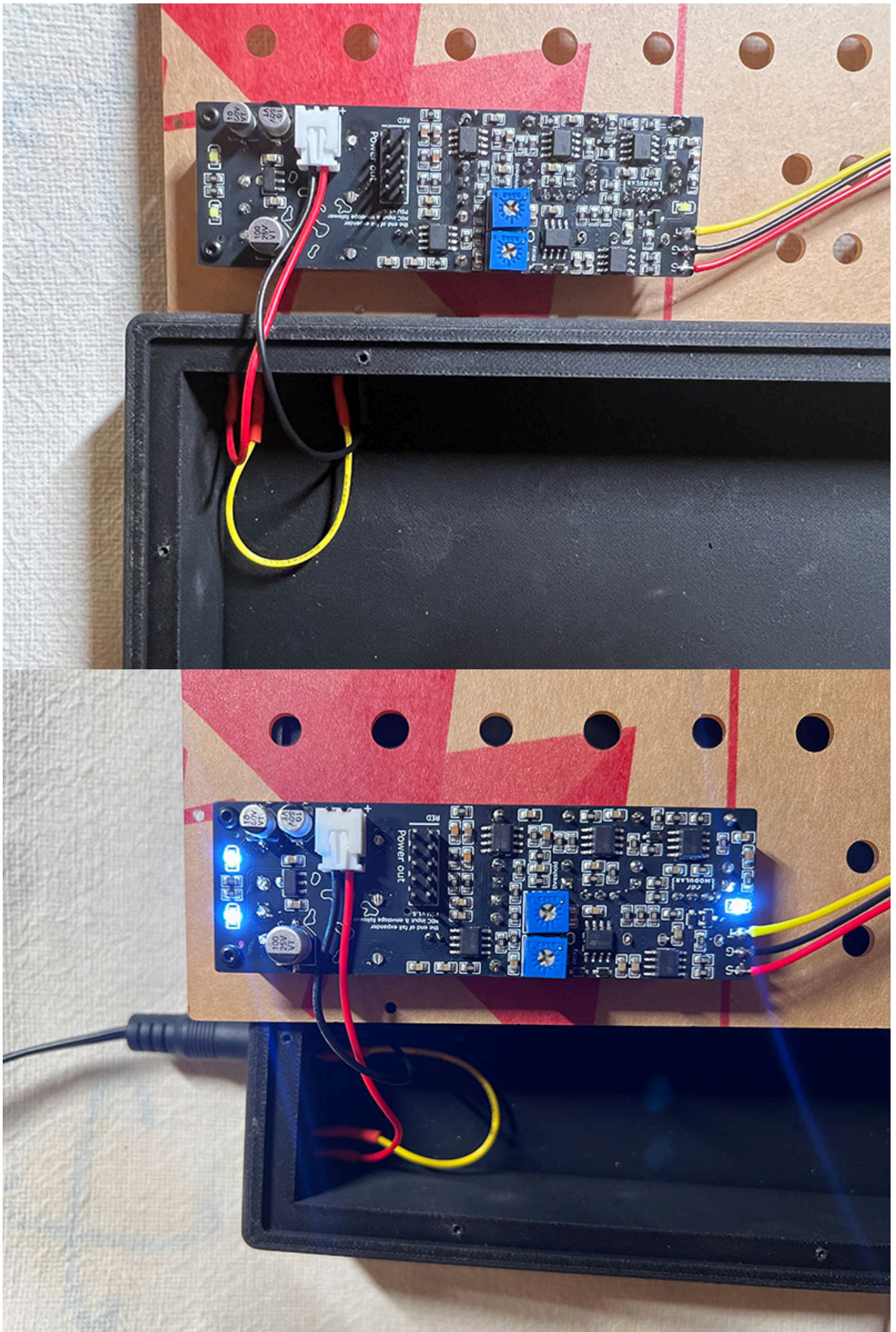
- 扩展板左侧两个标注 **+/-** 的灯常亮
- 右侧 **CLK** 灯闪烁
- 旋转 **speed** 电位器，闪烁频率改变

Connect the 2P terminal from the box to the "POWER IN" 2P female terminal socket on the expansion board. Ensure the red wire is connected to the terminal marked with a "+". Apply power. Verify that the two LEDs marked "+" and "-" on the left side of the expansion board are steadily lit, and the "CLK" LED on the right is blinking. Rotate the "SPEED" potentiometer and confirm that the blinking frequency of the CLK LED changes.

#### ⚠ 注意电源极性 / Power Polarity Warning

通过开关，红线将电源母座的短脚（内）和扩展板电源进的正极（+）连在了一起。若是没有严格按步骤操作，请注意电源正负极方向。

*The red wire connects the short pin (inner) of the power socket to the positive (+) terminal of the expander's power input via a switch. If the procedure was not strictly followed, please verify the polarity of the power supply.*

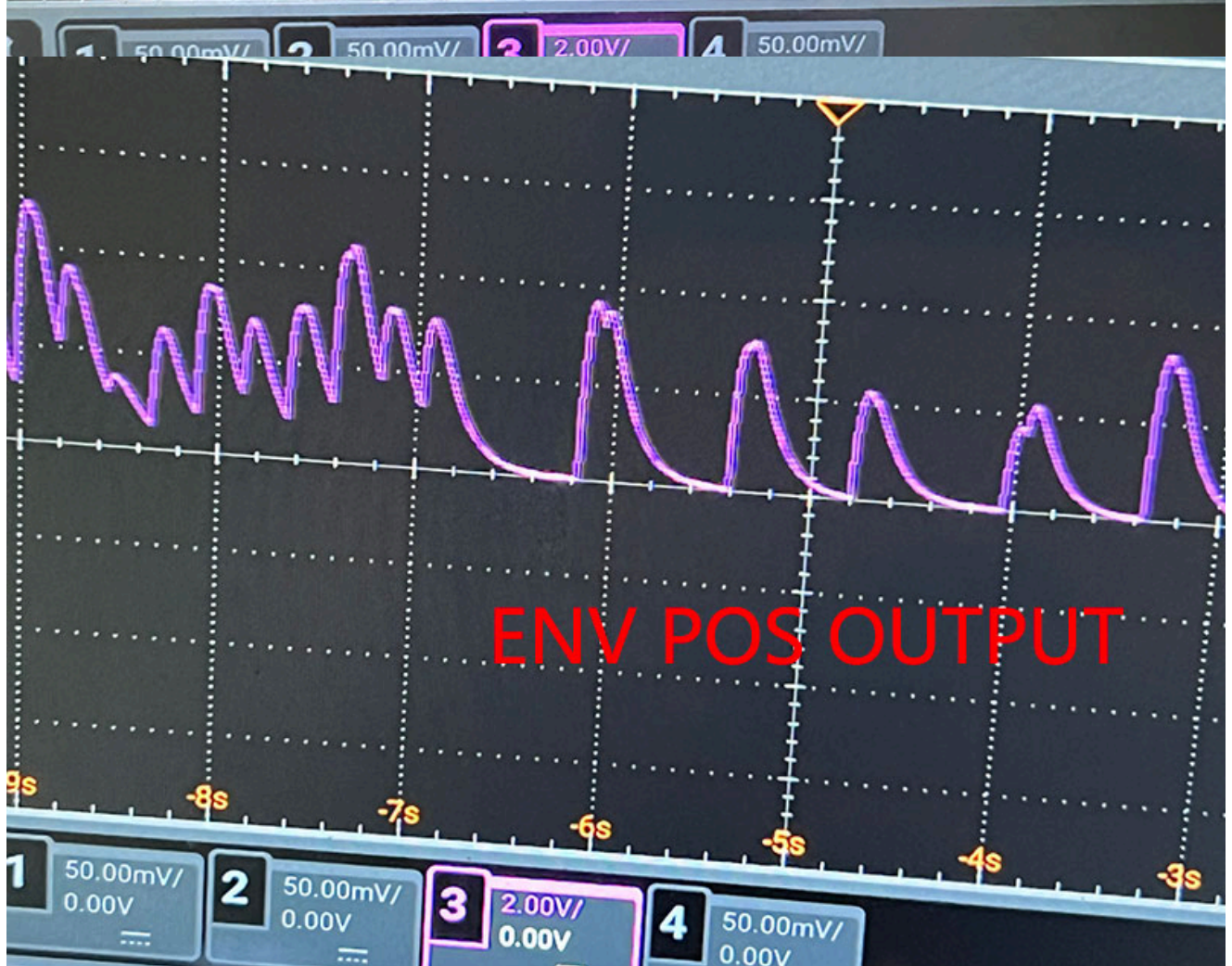


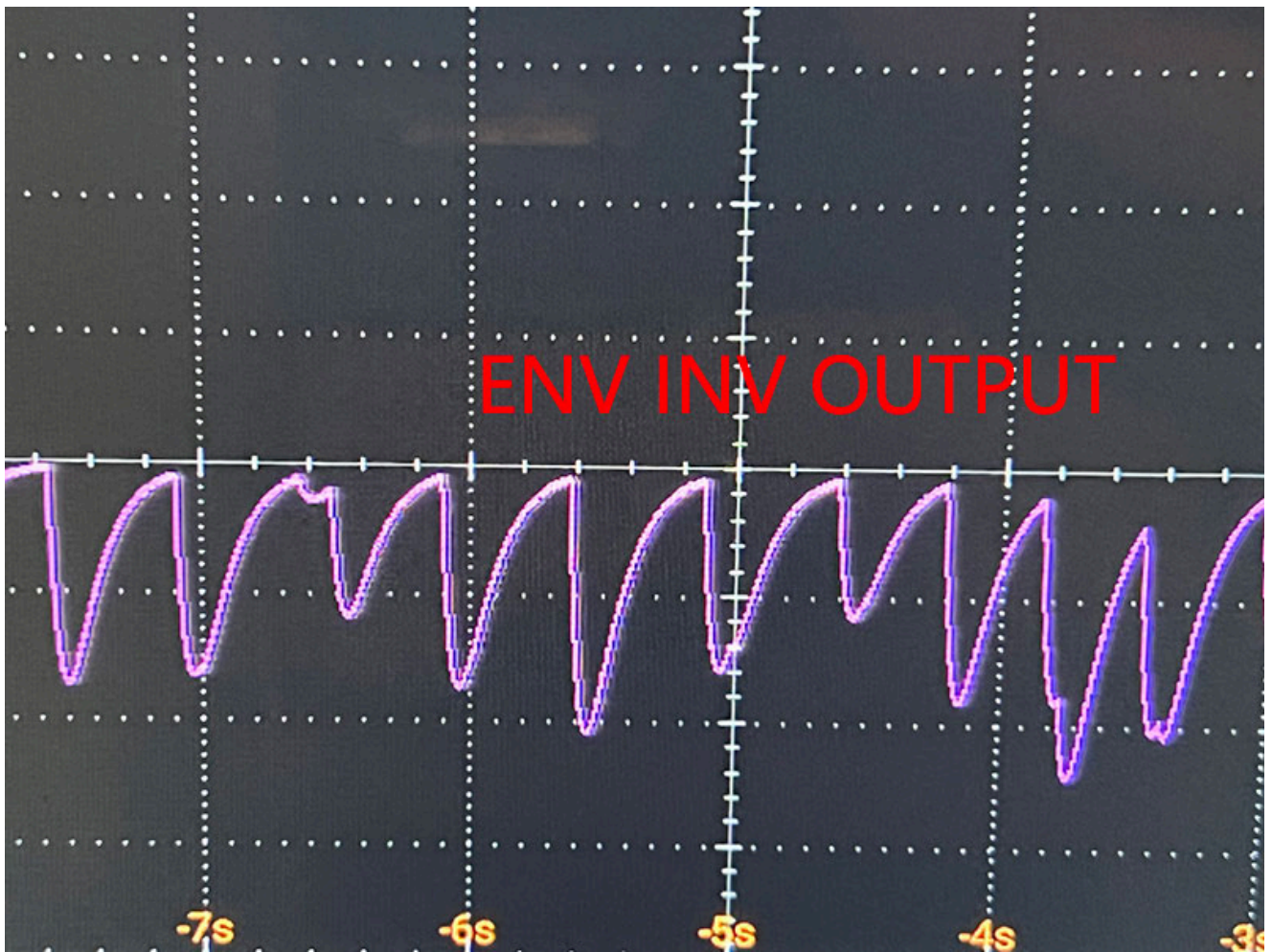
## 2. 示波器测试 (如有)

若有示波器：

1. 将 **mic out** 输出连至示波器，调整 MIC 电位器，敲打咪头，看示波器是否有显示
2. 之后 **MIC in** 接入一个 line 水平的音频（如手机音频），调整 MIC 电位器，看示波器是否有显示
3. 将 **env pos** 输出连至示波器
4. 调整背面蓝色电位器改变 **env decay** 和 **threshold** 至示波器得到满意曲线

If an oscilloscope is available: Connect the "MIC OUT" output to the oscilloscope. Adjust the "MIC" potentiometer while tapping the microphone. Check the oscilloscope for a corresponding display. Subsequently, connect a line-level audio signal (e.g., from a smartphone) to the "MIC IN" jack. Adjust the "MIC" potentiometer and check the oscilloscope for a corresponding display. Connect the "ENV POS" or "ENV INV" output to the oscilloscope. Adjust the blue potentiometers on the back of the board (which control "ENV DECAY" and "THRESHOLD") until the oscilloscope displays a satisfactory envelope curve.





### 3. 无示波器替代方案

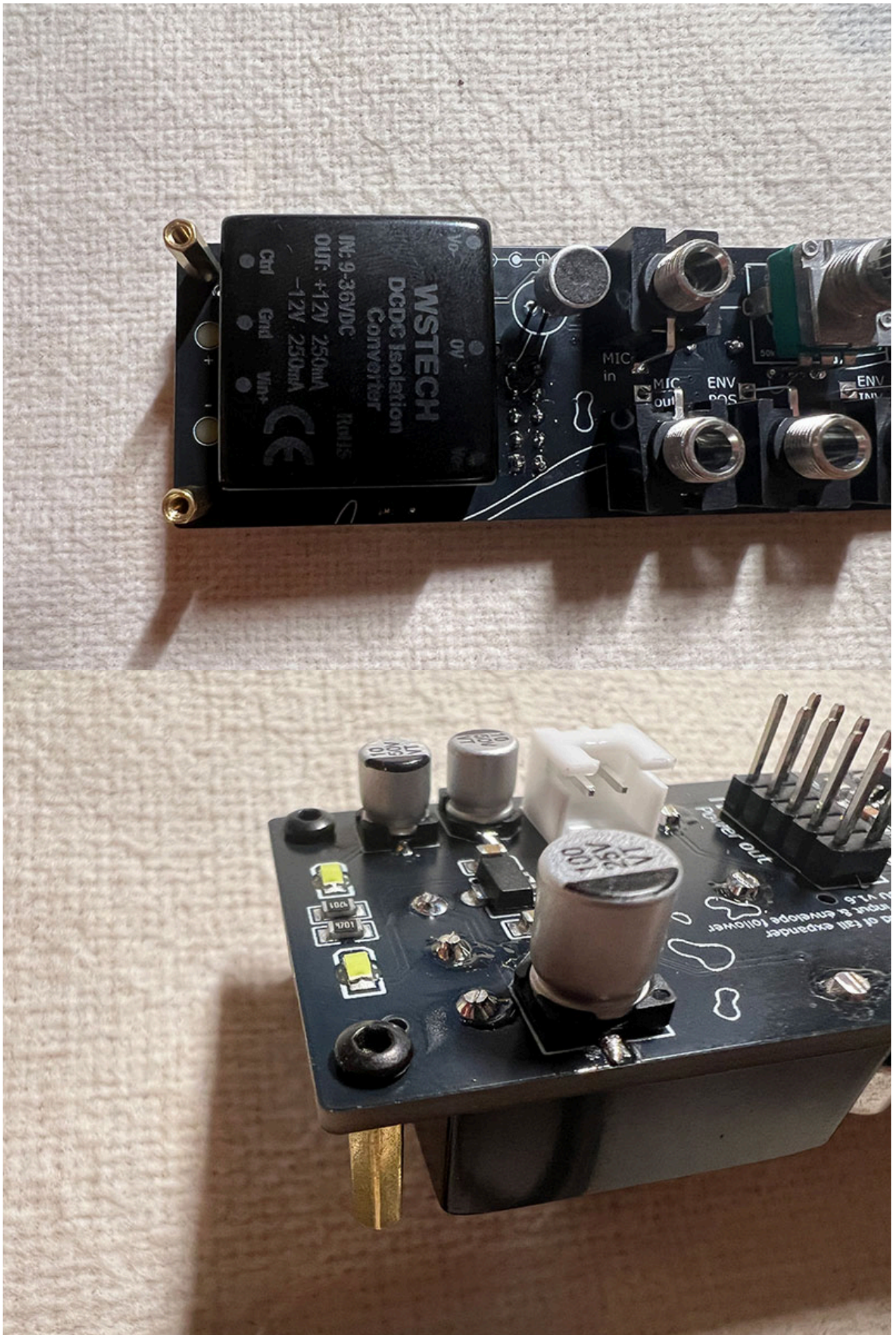
若无示波器：在安装完成后将 **env pos** 给到任意 CV 插口，通过听觉来调整至满意效果。

If an oscilloscope is not available: After installation, patch the "ENV POS" output to any CV input jack. Adjust the settings based on auditory feedback until a satisfactory effect is achieved.

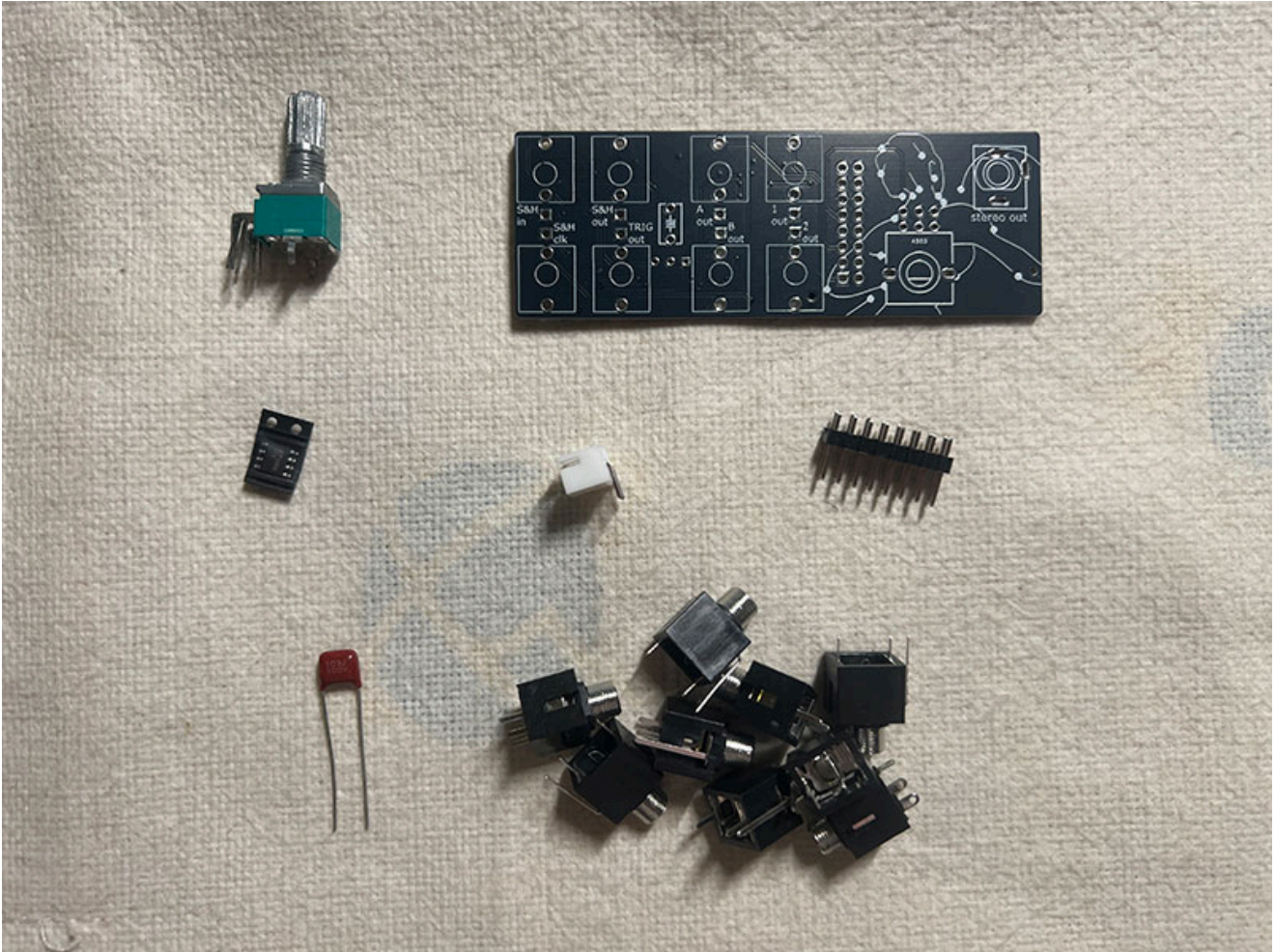
### 4. 安装铜柱

将扩展板从面板上拆下，使用两颗 M2 螺丝从电路板左侧孔位穿过，将两个铜柱固定在正面，待用。

Uninstall the expansion board from the front panel. Take two M2 screws, insert them through the mounting holes on the left side of the circuit board from the rear. Fasten the two standoffs onto the screws from the component (front) side. Set the assembled unit aside for now.



## 七、扩展 2 — 采样保持与输出 / Expander 2 — Sample-Hold & Output



### 元件清单 / Bill of Materials

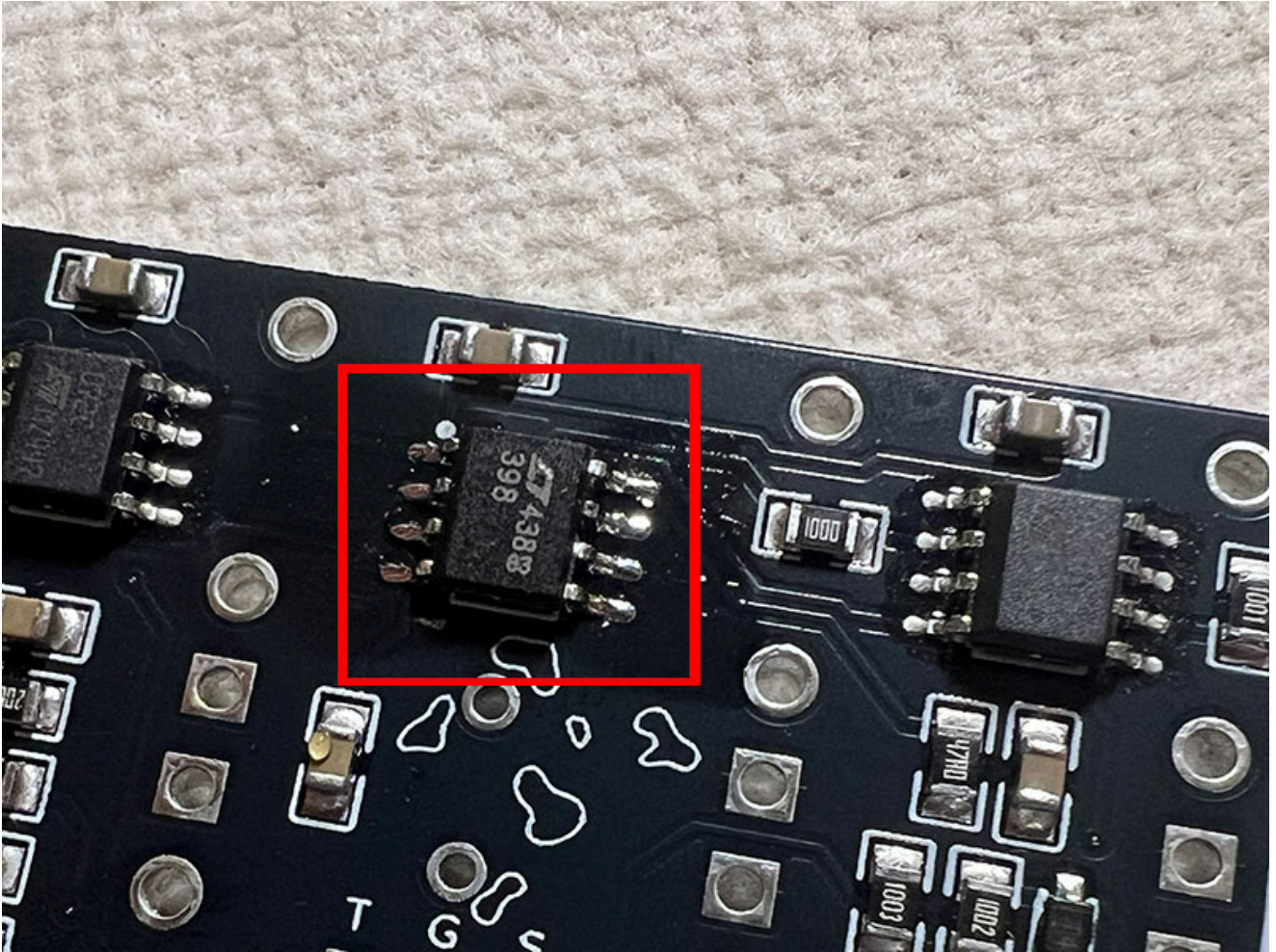
元件 / Component	规格 / Specification	数量 / Qty
PCB	—	1
LF398S IC	SOP-8	1
CBB 电容 / Capacitor	10nF	1
XH254 3P 端子母座	—	1
排针 / Pin Header	2×8P P2.54	1
PJ301-M 插口 / Jack	—	8
PJ301-C 立体声插口 / Stereo Jack	—	1
RK097 双联电位器	A503 (A50K)	1

### 制作步骤 / Assembly

#### 1. 焊接 LF398S

焊接背面一个 LF398S 贴片 IC，注意方向。

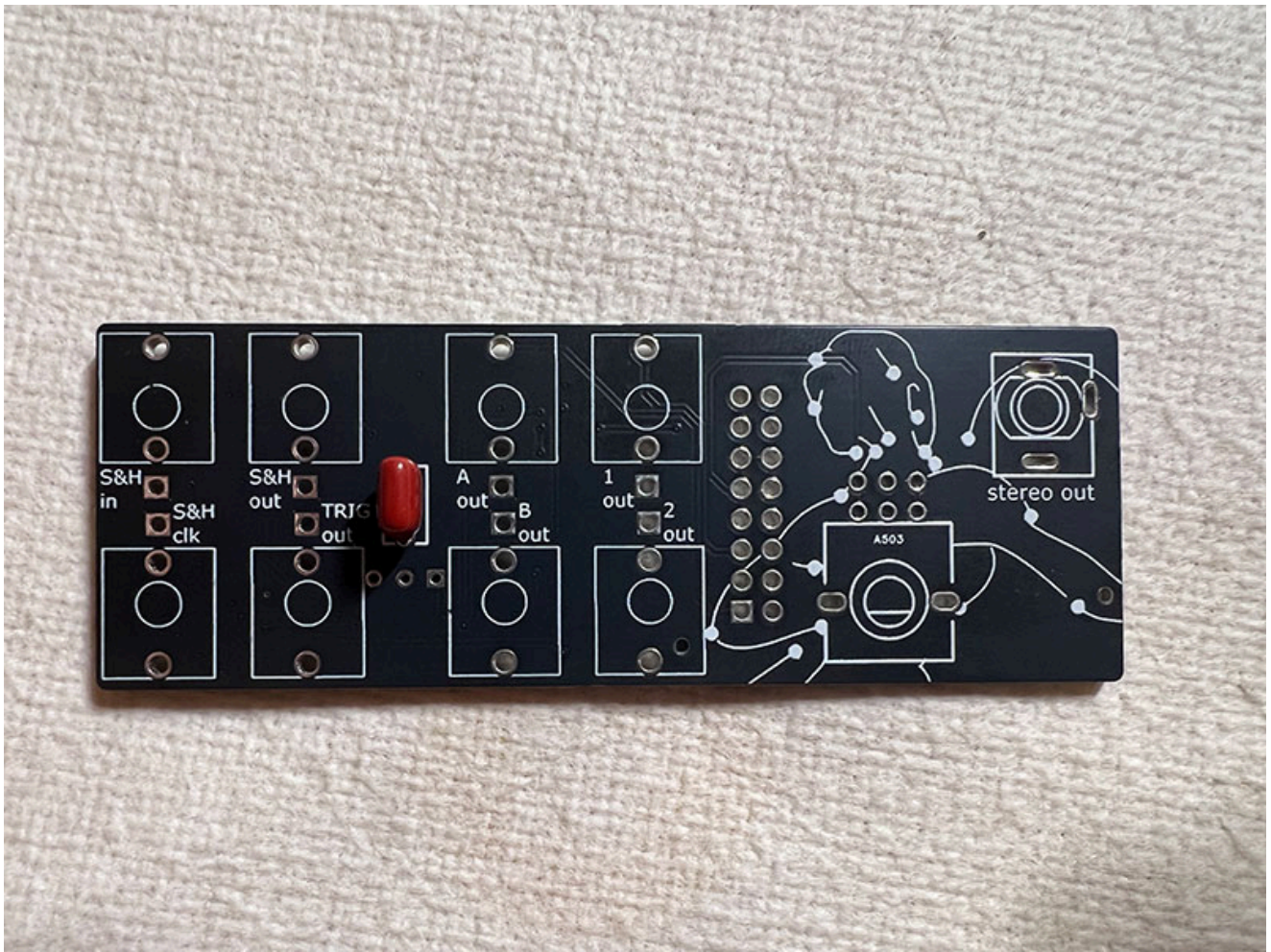
Solder the LF398S surface-mount IC to the back of the board, **observing correct orientation**.



## 2. 焊接 10nF CBB 电容

焊接正面一个 10nF CBB 电容。

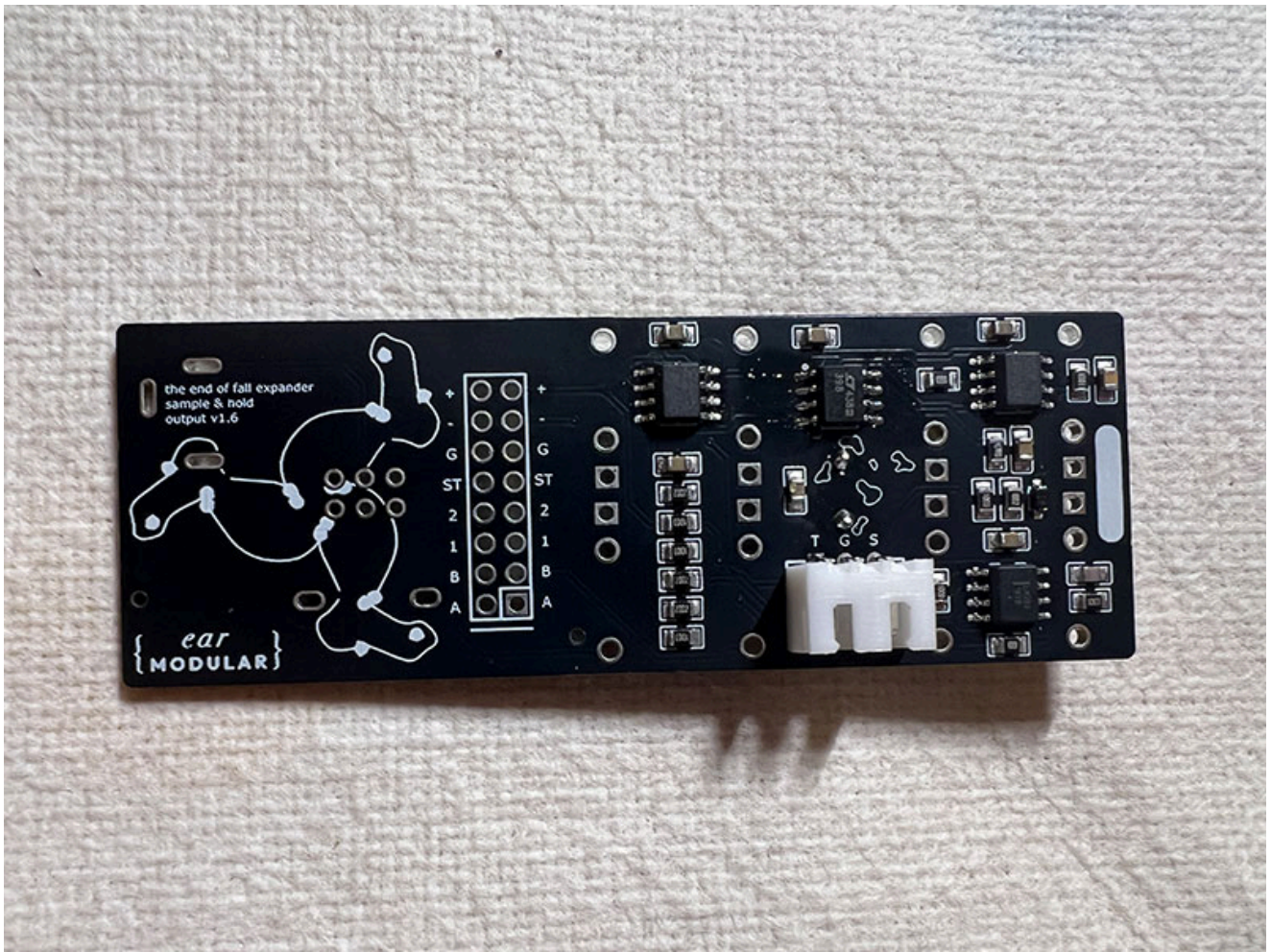
Solder one 10nF CBB capacitor to the front of the board.



### 3. 焊接 XH254 3P 端子母座

焊接背面一个 XH254 3P 端子母座，注意方向。

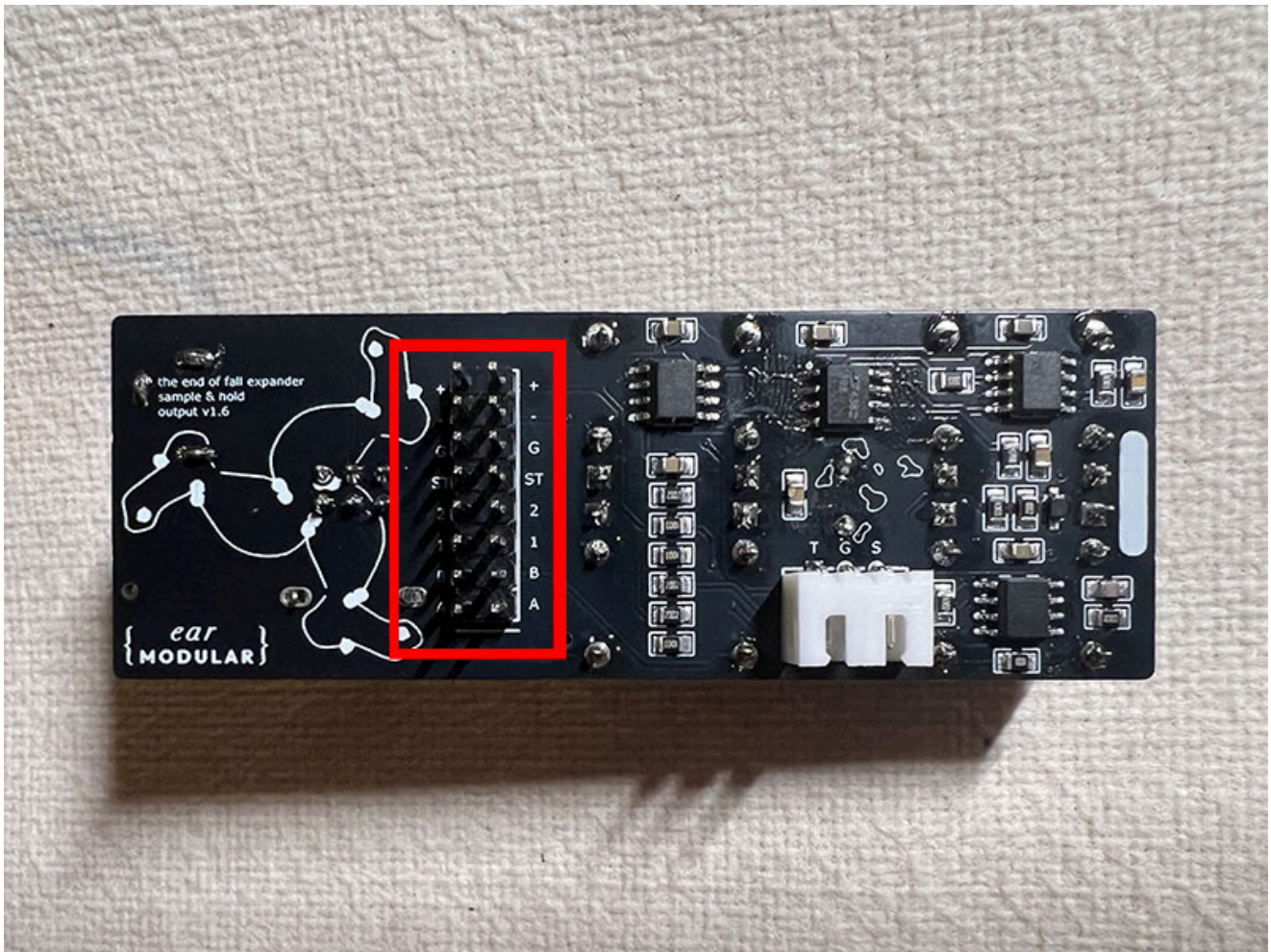
Solder one XH254 3P Female Socket Header to the back of the board, **observing correct orientation.**



#### 4. 焊接 2×8P 排针

焊接背面一个 2×8P 排针。

Solder one 2×8-pin pin header to the back of the board.



## 5. 安装 RK097 双联电位器（不焊接）

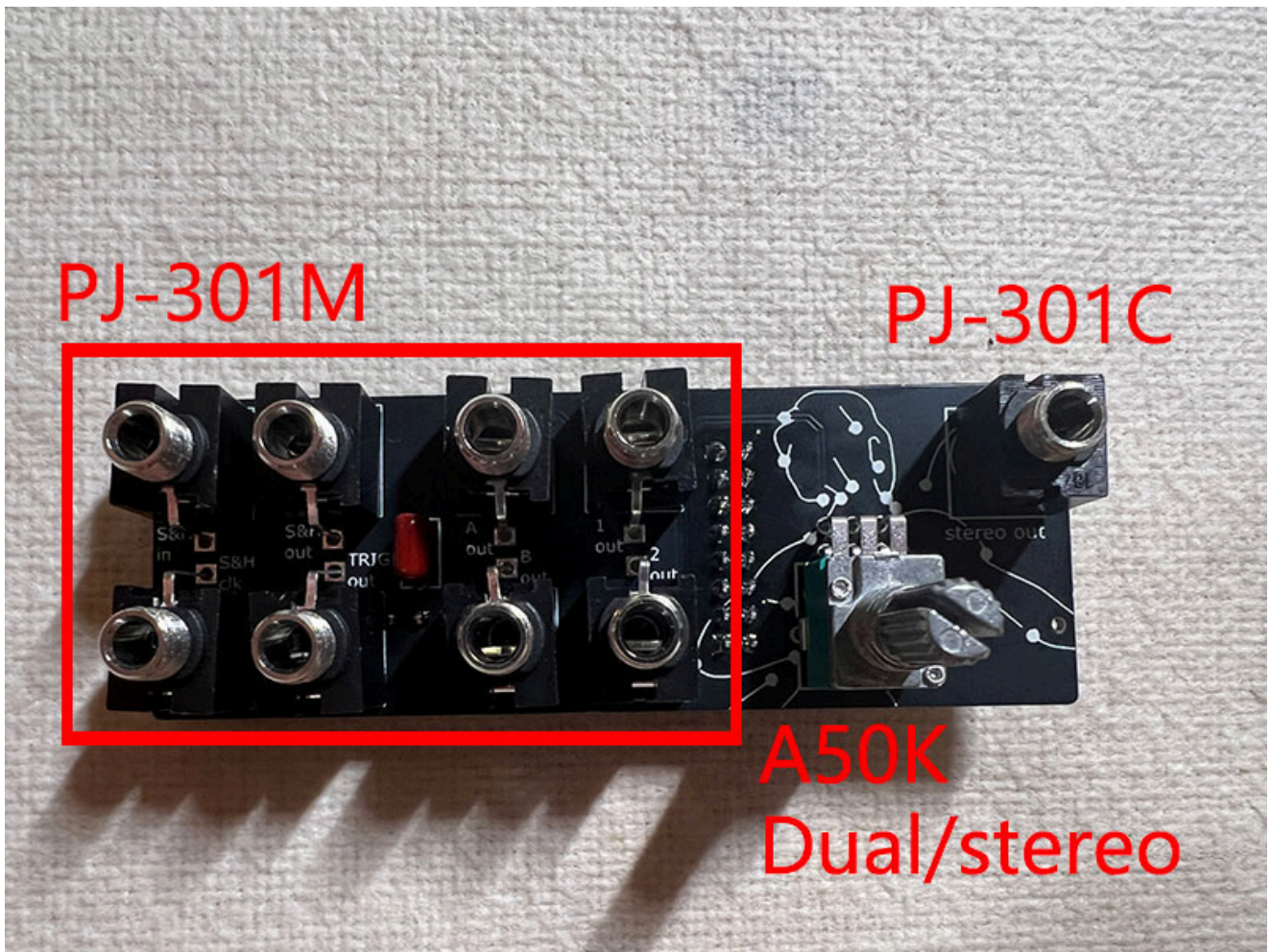
将 RK097 双联电位器安装到正面，注意阻值，不要焊接。

Install the RK097 dual/stereo potentiometer on the front of the board **according to its resistance value. Do not solder it at this stage.**

## 6. 安装 PJ301（不焊接）

将 PJ301 安装到正面，注意最右侧为 PJ301C 立体声插口，其它为 PJ301M，不要焊接。

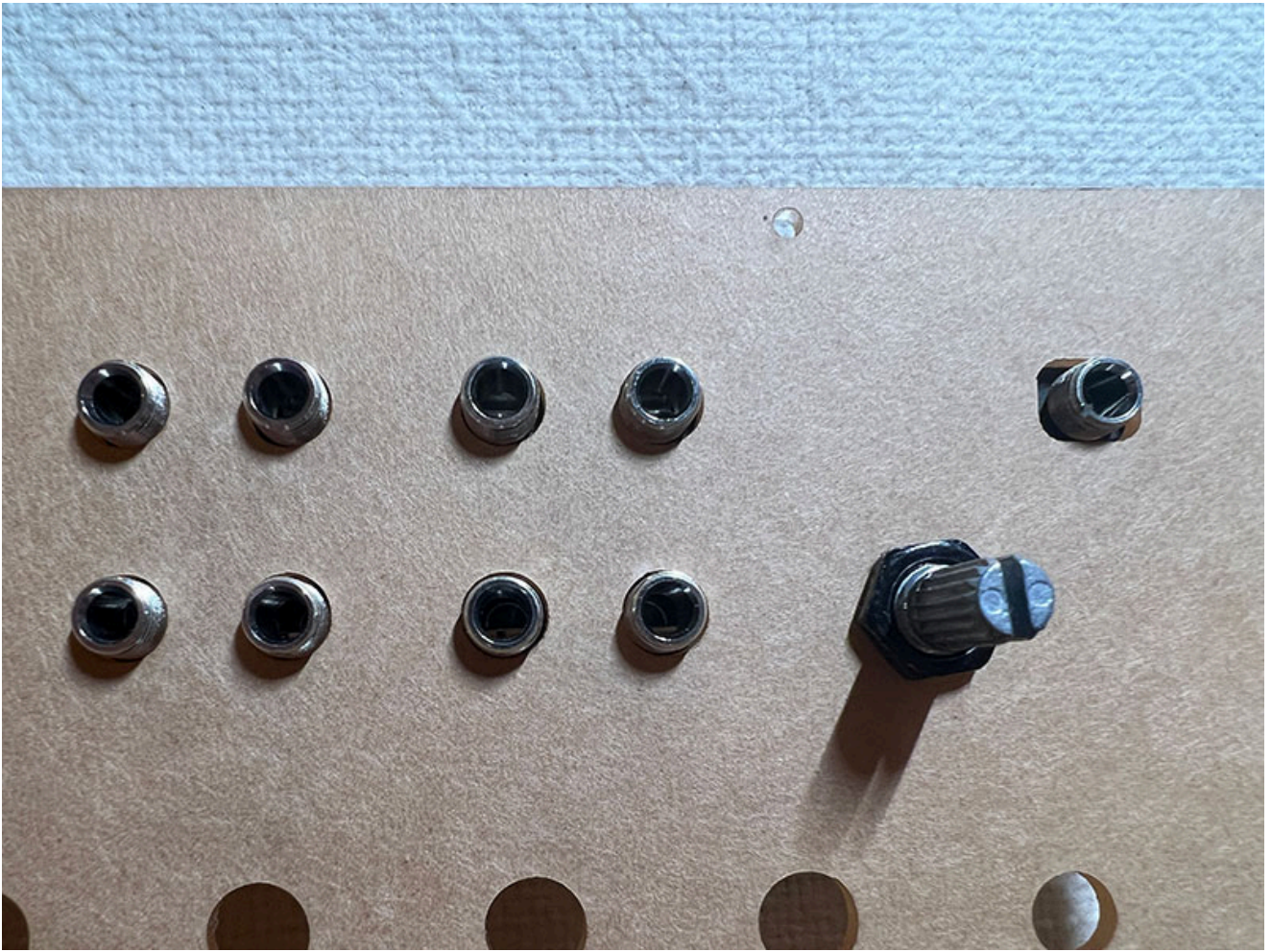
Install the PJ301 jacks on the front panel. Note that the rightmost jack is a PJ301C (stereo) type, while the others are PJ301M (mono). **Do not solder them at this time.**



## 7. 安装面板

安装面板，该扩展板位于面板左上侧，确保所有电位器和插口都正确的从面板孔位穿过，使用电位器螺母和插口螺母固定面板到电位器上。

Install the front panel. Position the expansion board at the top-left area of the panel. Ensure all potentiometers and jacks are properly aligned and protrude through their corresponding holes on the panel. Secure the panel by fastening the nuts onto the potentiometers and jacks.



## 8. 焊接 PJ301 与 RK097

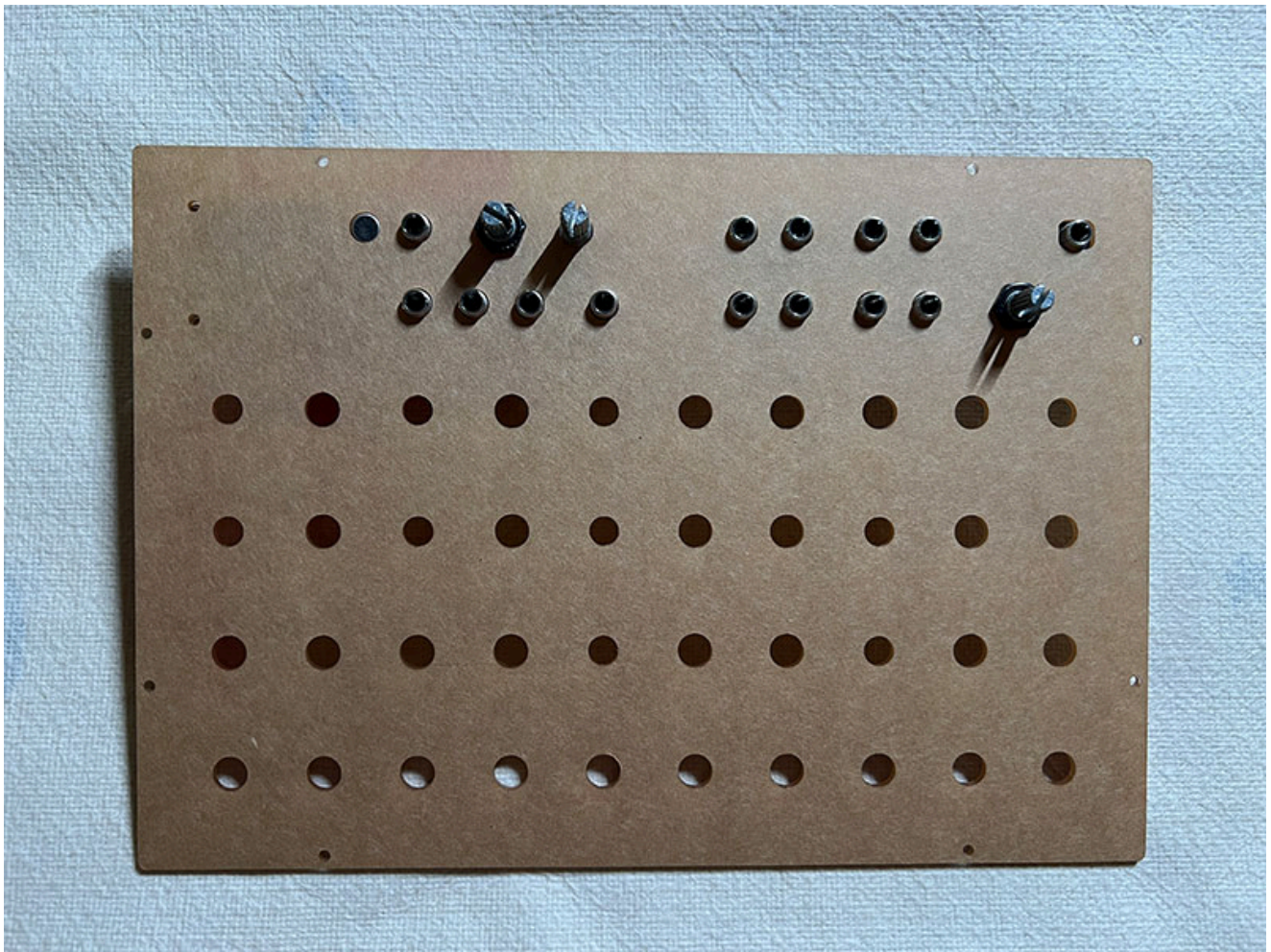
依次焊接 PJ301 插口和 RK097 电位器各插脚，电位器两侧的支撑脚可不焊接。焊接过程中确保每一个 PJ301 和 RK097 都安装到位。

Solder the pins of each PJ301 jack and RK097 potentiometer in sequence. The support tabs on the sides of the potentiometers do not need to be soldered. During soldering, ensure every PJ301 and RK097 is fully and properly seated against the board.

## 9. 安装第二块扩展板

将另一块制作好的扩展板简单固定到面板上，此时面板上有两块扩展板。

Securely mount the other prepared expander to the panel. There should now be two expanders installed on the panel.



## 10. 连接 T G S 端子

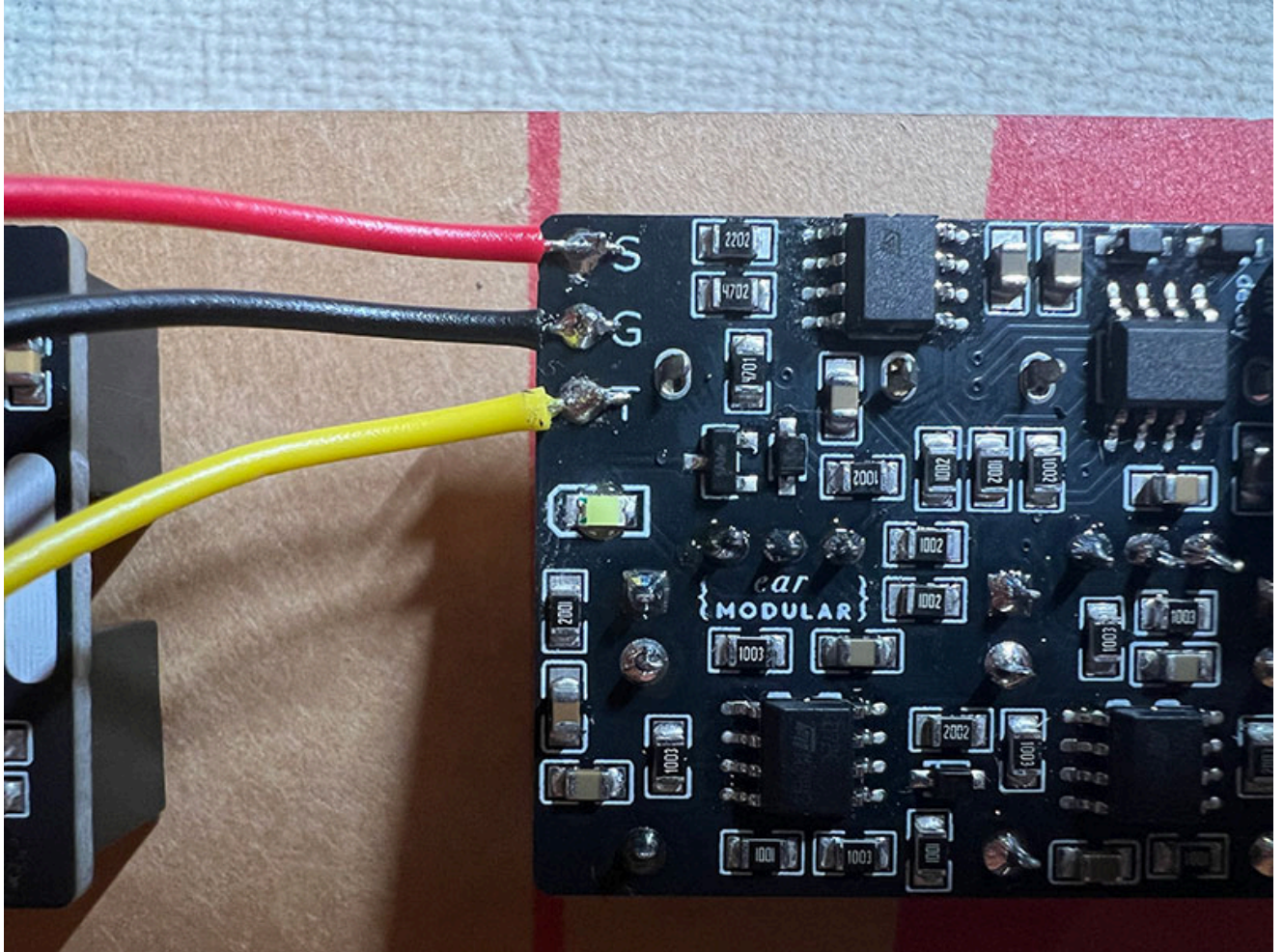
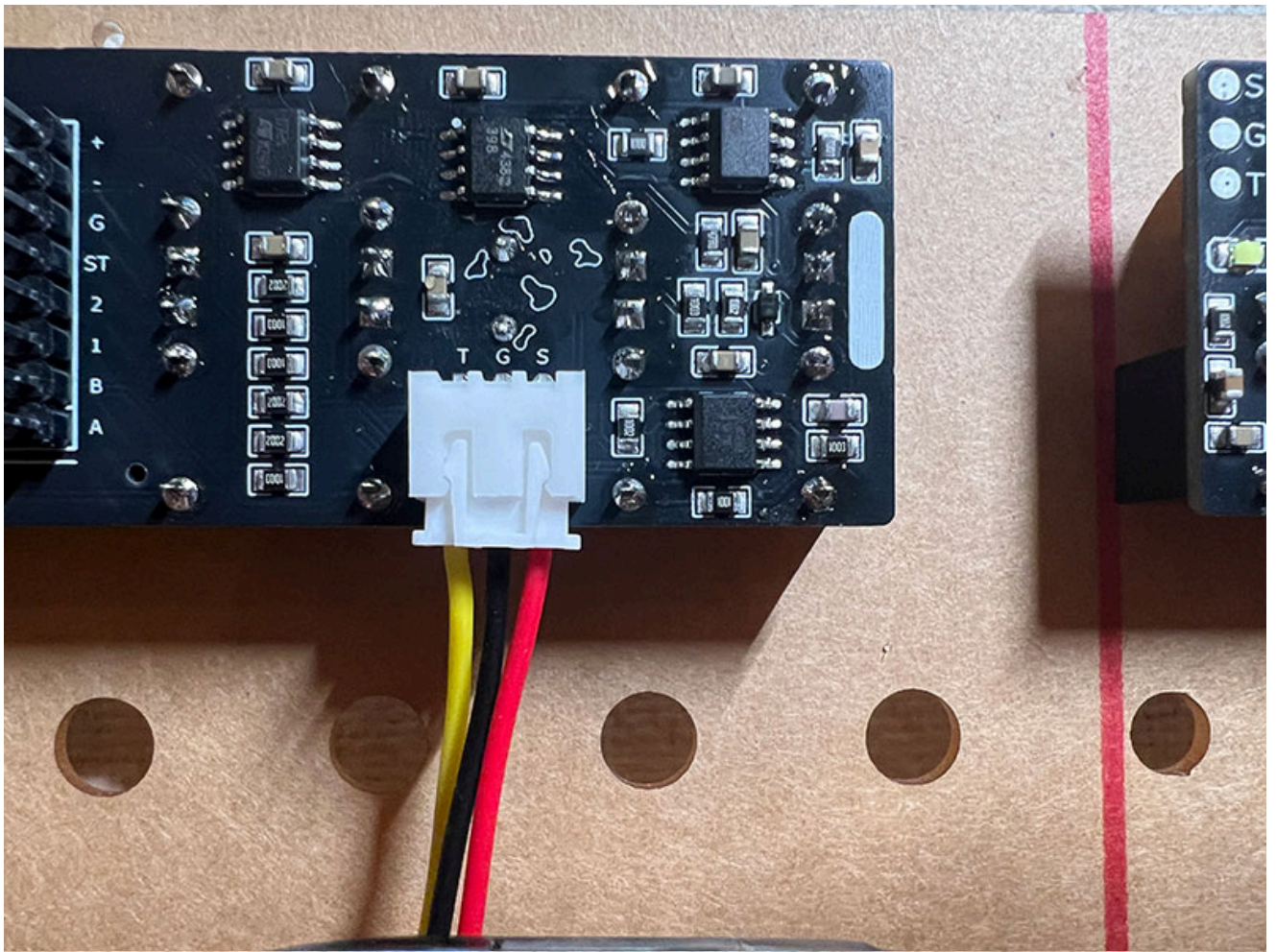
将 XH254 3P 单头端子插到扩展板 2 标有 **T G S** 的 3P 端子母座，三根线焊接到扩展板 1 背面标有 **T G S** 的焊点上。

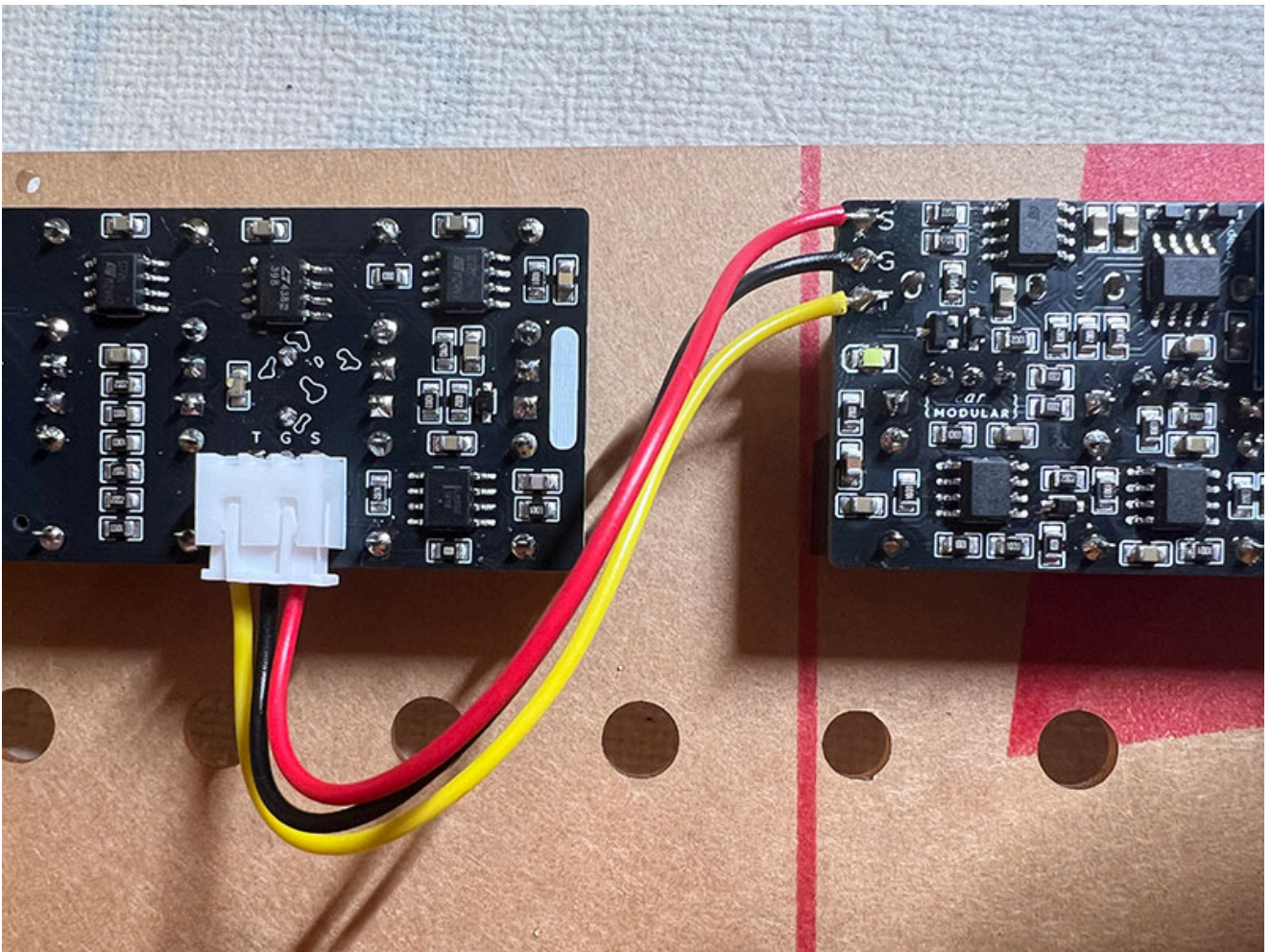
### T G S 对应 / T G S Mapping

三个字母要一一对应！

*Ensuring the letters correspond one-to-one!*

Connect the XH254 3P 3-pin Terminal Connector to the 3-Pin Female Socket Header labeled **T, G, S** on Expander 2. Solder the three wires to the pads marked **T, G, S** on the back of Expander 1.





## 11. 暂停待装

测试待安装完成后进行。断开 3P 端子接头，将扩展板从面板拆下，待用。

Testing will be performed after the installation is complete. Disconnect the 3-pin Terminal Connector, then remove the expanders from the panel and set it aside for future use.

---

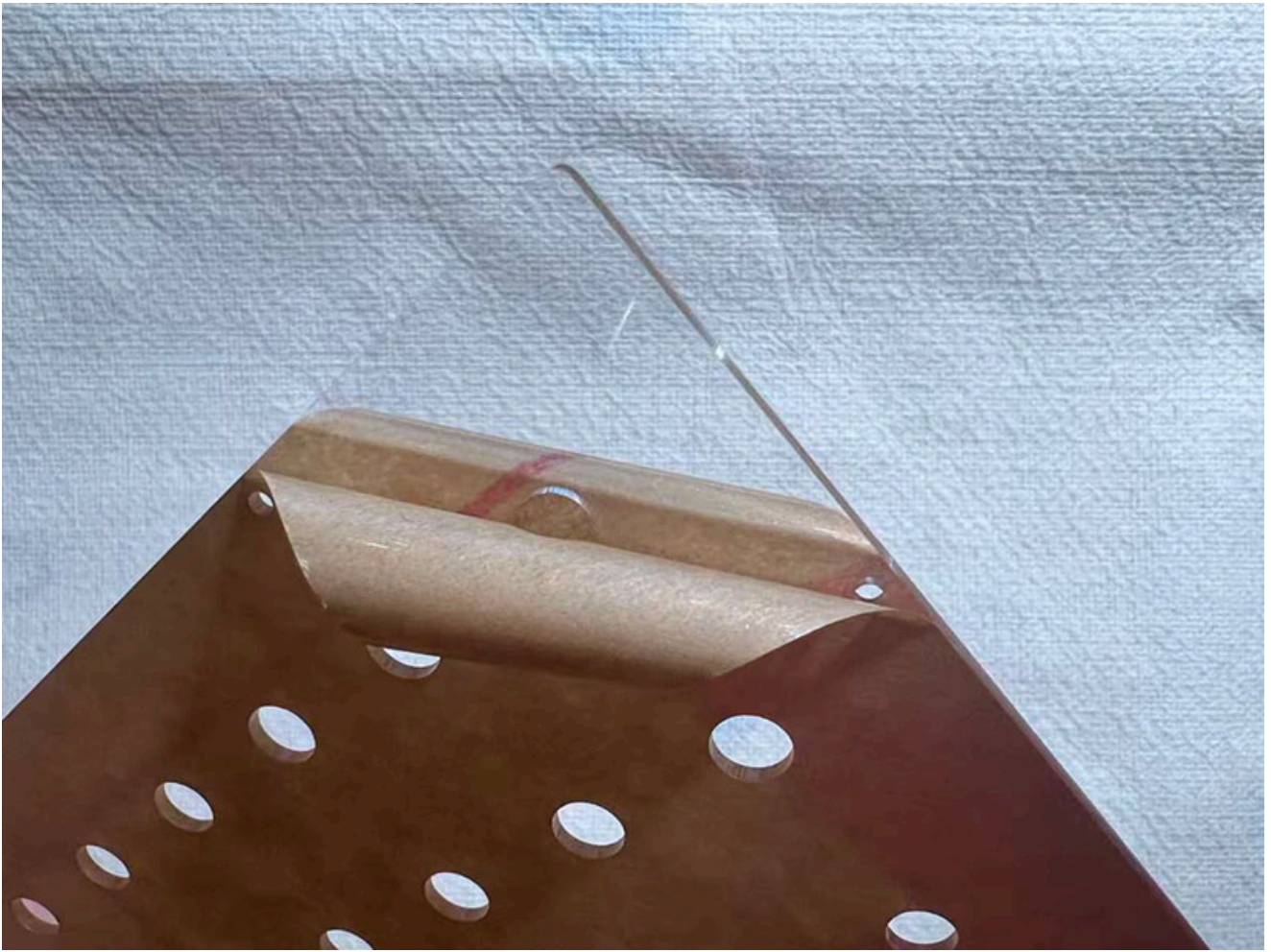
## 八、组合最后步骤 / Final Assembly Steps



## 1. 撕除保护膜

去除面板两面的保护膜。

Remove the protective film from both sides of the panel.

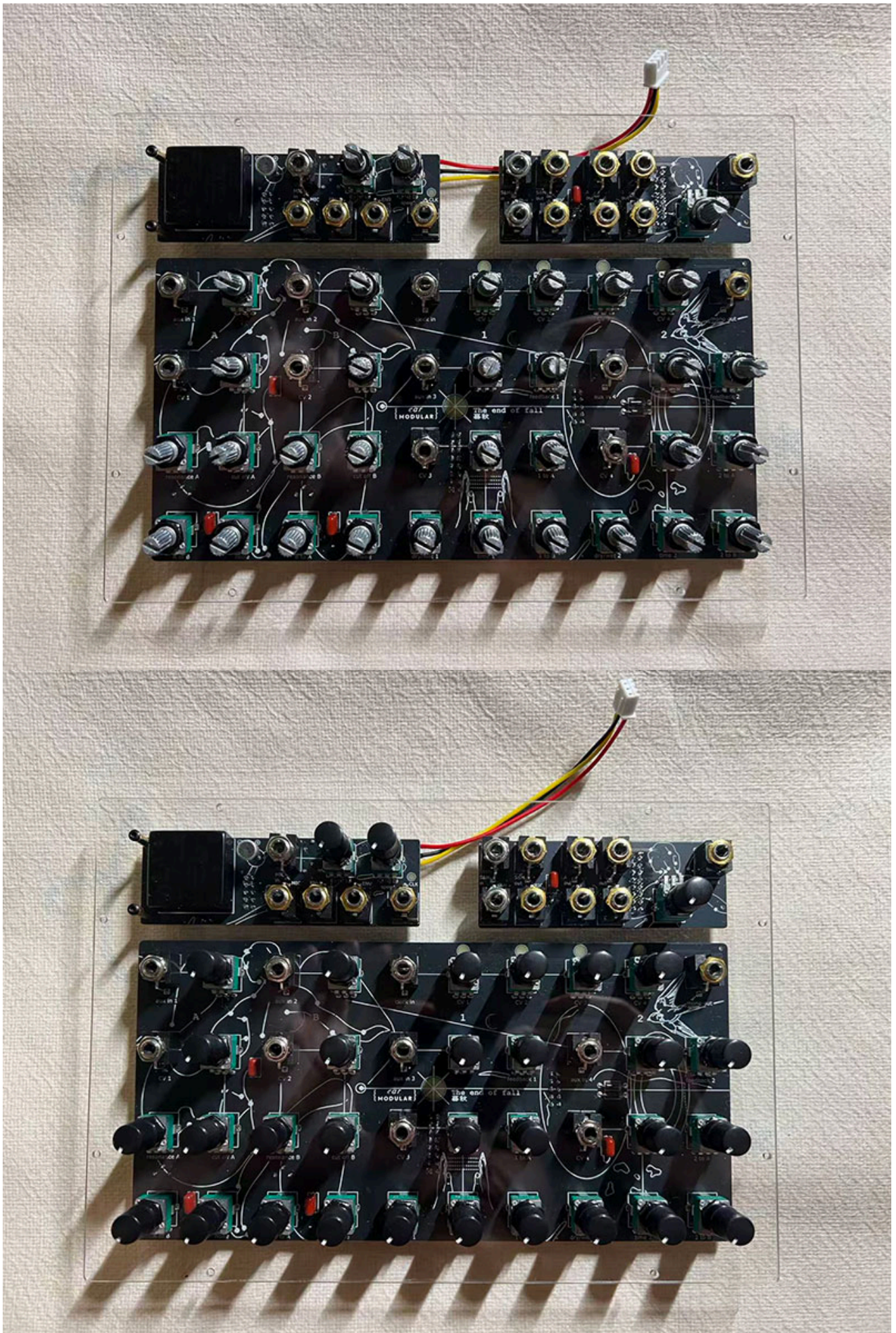


## 2. 安装主板与扩展板

将主板和两块扩展板分别安装到面板对应位置：

- 使用电位器和插口螺母固定（输入为银色，输出为金色）
- 扩展板 1 的两个铜柱用 M2 螺丝固定于面板上
- 安装所有旋钮的旋钮帽

Install the main board and two expansion boards into their designated positions on the panel. Secure them using the nuts for the potentiometers and jacks (silver nuts for inputs, gold nuts for outputs). Fix the two standoffs of Expander 1 to the panel using M2 screws. Finally, attach all knob caps.



### 3. 连接排线

排线 / Cable	连接 / Connection
2×5P 排线	扩展板 1 ↔ 主板 2×5P 排针
2×8P 排线	扩展板 2 ↔ 主板 2×8P 排针

### ⚠ Warning

连接时注意方向。

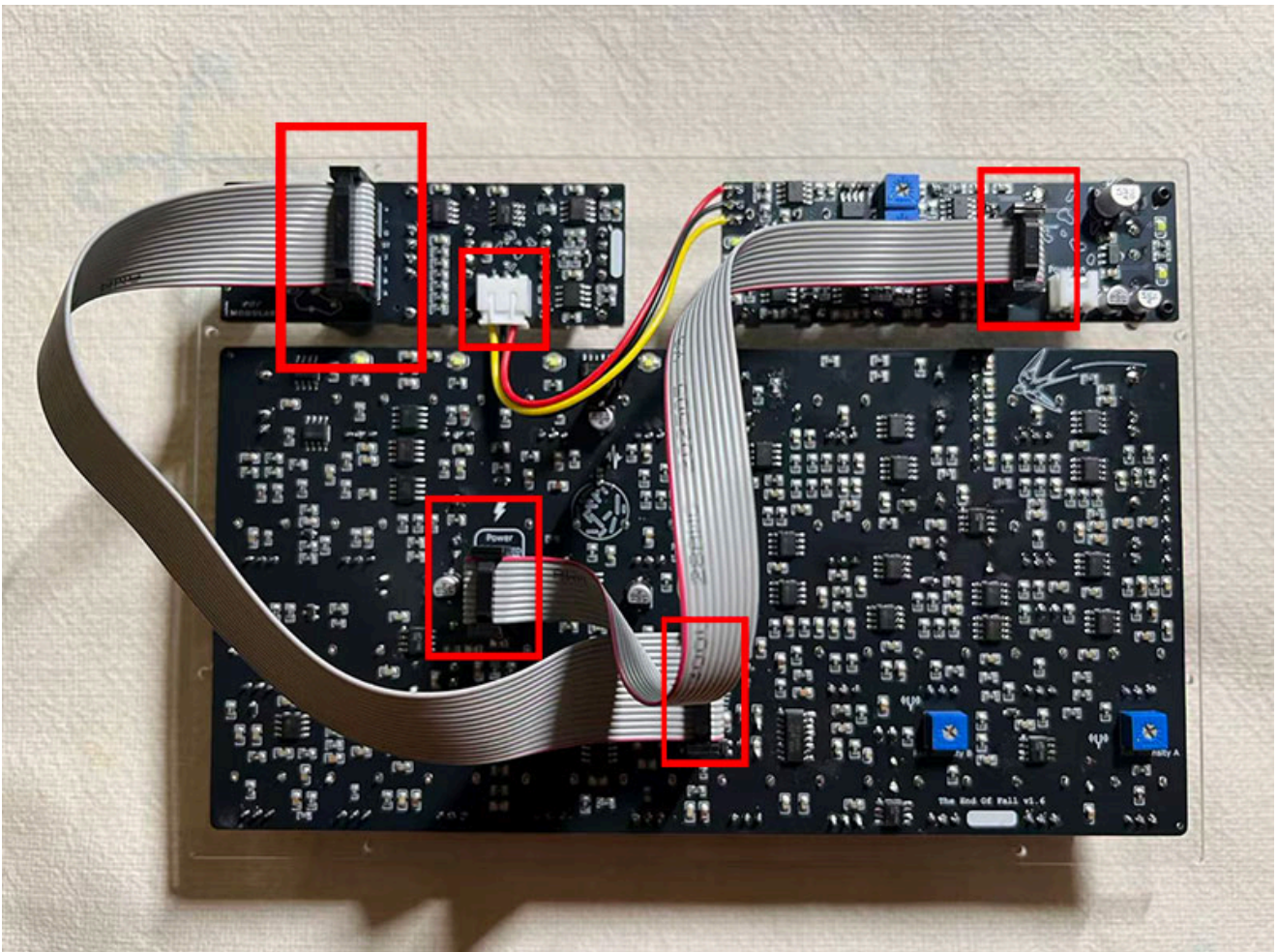
*Observe correct orientation when connecting.*

Connect Expander 1 to the main board's 2×5-pin header using a 2×5-pin ribbon cable, observing correct orientation. Connect Expander 2 to the main board's 2×8-pin header using a 2×8-pin ribbon cable, observing correct orientation.

## 4. 连接 3P 端子线

将扩展板 1 的 3P 端子线接到扩展板 2 的 3P 端子母座。

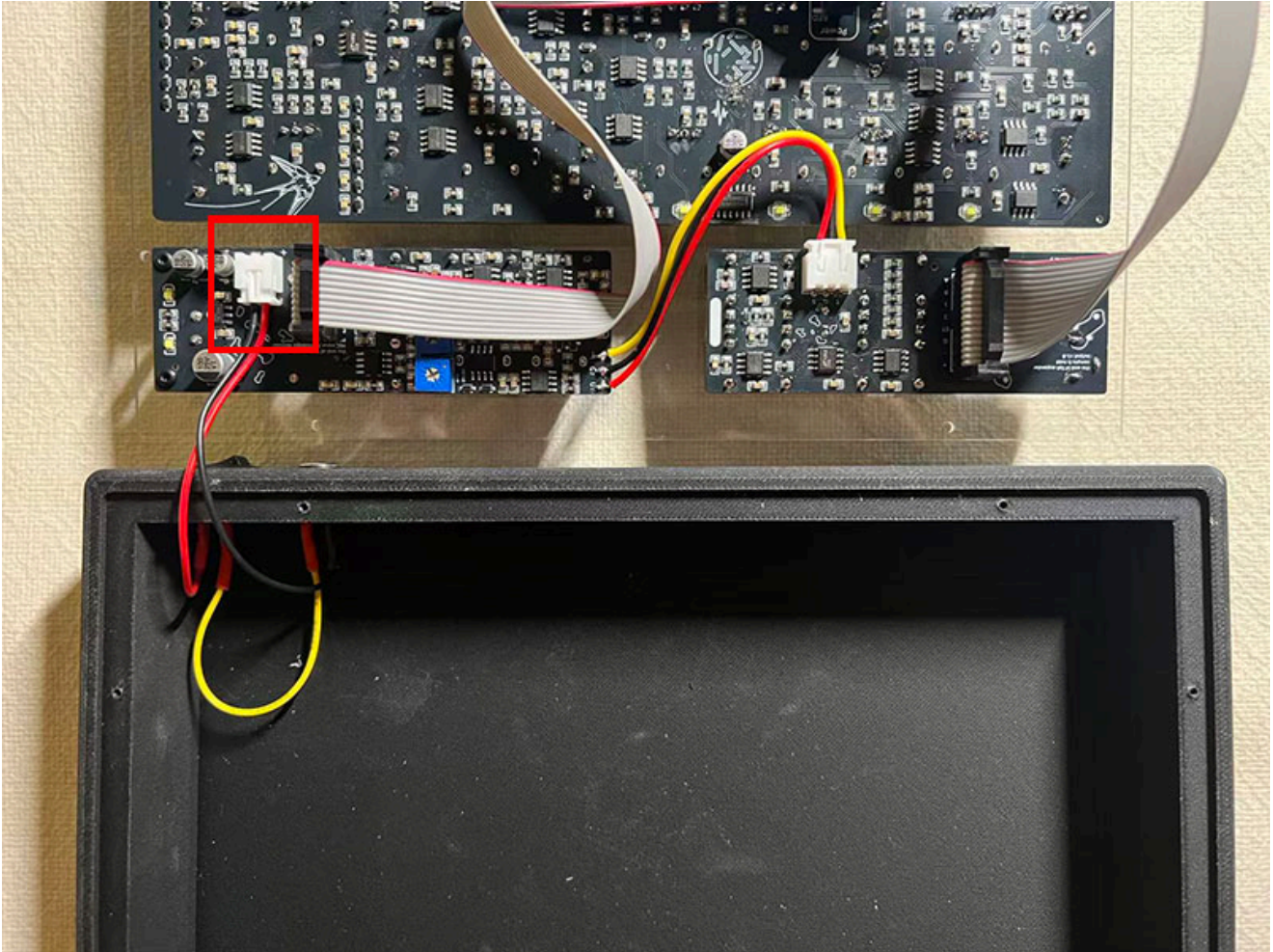
Connect the 3-pin Terminal Connector from Expander 1 to the 3-pin Female Socket Header on Expander 2.



## 5. 连接电源

连接盒子 2P 电源端子线到扩展板 1 的 2P 端子母座。

Connect the 2-pin power terminal Connector from the box to the 2-pin Female Socket Header on Expander 1.



## 测试扩展板 2 / Testing Expander 2

1. 使用示波器或将 **S&H out** 连接到任意 CV 插口，当 **MIC in** 有输入时，观察输出变化
2. 当主板工作时，确认 **A out**、**B out**、**1 out**、**2 out** 是否有输出
3. 顺时针旋转扩展板 2 上的双联电位器，确认 **stereo out** 有没有衰减后的立体声输出

测试完毕。

Use an oscilloscope or connect the S&H OUT to any CV input jack. Observe the output changes when a signal is present at MIC IN. While the main board is operating, verify that A OUT, B OUT, 1 OUT, and 2 OUT all produce an output signal. Rotate the dual/stereo potentiometer on Expander 2 clockwise and confirm that STEREO OUT produces a correspondingly attenuated stereo signal. Testing is now complete.

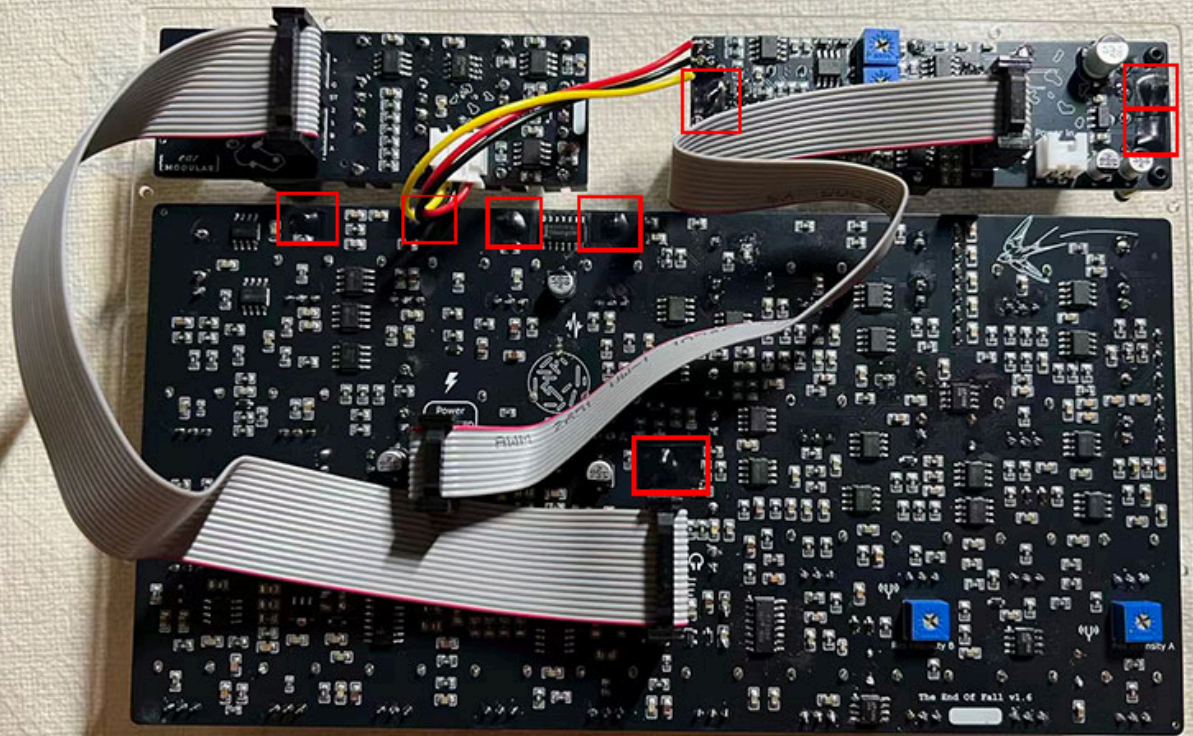
## 关于 LED 透光 / About LED Light Bleed

### 🔗 个性化选择 / Personal Preference

因为是透明的面板，各个常亮或闪烁的灯光会有余光透出来：

- 喜欢这个氛围的朋友可以**保持现状**
- 若不喜欢可在背面用适量黑色电工胶带（绝缘胶布）盖住 LED 灯，可避免余光的影响

*Due to the transparent nature of the panel, light from the always-on or blinking LEDs may cause some bleed-through. If you appreciate this ambient effect, no further action is needed. If you prefer to minimize it, apply small pieces of black electrical tape over the LEDs on the back of the panel to effectively block the light bleed.*

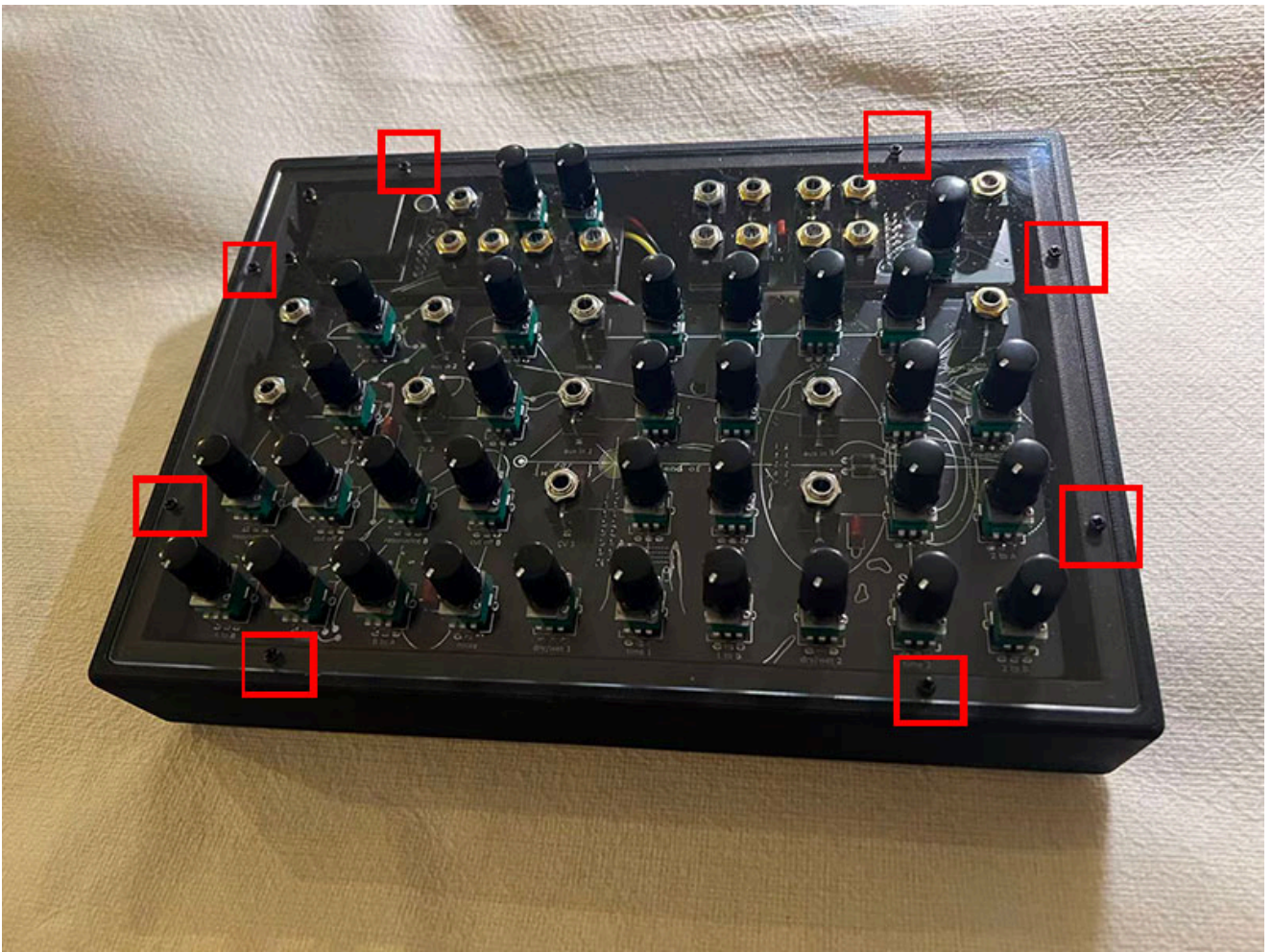




## 6. 固定面板

使用 8 颗自攻螺丝将面板固定到盒子上。

Secure the front panel to the enclosure using the eight (8) self-tapping screws.



✓ 制作全部完成! / **Assembly Complete!**

🎉 恭喜! 你已经完成了暮秋 (The End of Fall) 的全部组装!

*Congratulations! You have completed the entire assembly of The End of Fall!*



## 九、配件总清单 / Complete Parts List

类别	元件 / Component	数量 / Qty
板子	PCB	3
	盒子 / Box	1
	面板 / Panel	2
<b>IC</b>	LF398S	5
<b>电位器 RK097</b>	A100k	2
	B100k	14
	B50K	15
	B250K	1
	A50K (双联 / Dual)	1
<b>电位器 P3362</b>	B50K	2
	B100K	2
电容	10nF CBB	5
插口	PJ301M	23

类别	元件 / Component	数量 / Qty
	PJ301C	1
铜柱	2×11 Standoff	2
端子	2P 单头端子 / Terminal Connector	1
	3P 单头端子 / Terminal Connector	1
	2P 母座 / Female Socket Header	1
	3P 母座 / Female Socket Header	1
排针	2×5P 排针 / Pin Header	2
	2×8P 排针 / Pin Header	2
排线	2×5P 线 / Cable	1
	2×8P 线 / Cable	1
其他	咪头 / Microphone Element	1
	6W PSU	1
	船型开关 / Rocker Switch	1
	导线 / Wire	1
	热缩管 / Heat Shrink Tubing	1
	电源母座 / Power Socket	1
	半导体	1N4001 二极管 / Diode
	BC548 三极管 / Transistor	1
螺丝	M2 螺丝 / M2 Screw	4
	M2 自攻螺丝 / Self-tapping Screw	8
旋钮配件	旋钮帽 / Knob Cap	33
	黑色旋钮螺母 / Black Knob Nut	33
	插口螺母-银色 / Silver Jack Nut	12
	插口螺母-金色 / Gold Jack Nut	12

## 羽 后记

暮秋是一个充满“混乱与有序”的设计。它的环形回授结构让每一次旋钮的微调都可能带来截然不同的声音体验。

享受组装，享受声音的探索。