

# Workshop on Designing and Making a Solar Tracking Device

## 設計與製作太陽追蹤裝置工作坊

Time 時間	Content/Activity 內容/活動	Speaker 講者
14:30 – 14:50	Introduction <ul style="list-style-type: none"> <li>• Application of Solar Tracking Device in STEAM projects</li> <li>• Related learning elements in the Technology Education Key Learning Area</li> </ul> 簡介 <ul style="list-style-type: none"> <li>• 應用太陽追蹤裝置於STEAM 專題研習</li> <li>• 相關的科技教育學習領域學習元素</li> </ul>	Curriculum Development Officer, Technology Education Section / Project Manager of STEM Education Centre 科技教育組課程發展主任/ STEM 教育中心項目經理
14:50 – 16:50	Hands-on activities: <ul style="list-style-type: none"> <li>• Assembling the mechanical parts of the device</li> <li>• Wiring the electronic components of the device</li> <li>• Programming the device</li> <li>• Testing the functionality of the device and optimise its performance</li> </ul> 動手做活動: <ul style="list-style-type: none"> <li>• 組裝裝置的機械部分</li> <li>• 裝置電子元件的接線</li> <li>• 為裝置進行編程</li> <li>• 測試裝置的運作效能並作出優化</li> </ul>	
16:50 – 17:00	Q&A 問與答	

# 與科技教育學習領域相關的學習元素

學習階段	課題	學生應可學習到
KS3	系統概念	<ul style="list-style-type: none"><li>• 輸入、處理及 輸出</li><li>• 開環式及閉環式控制系統</li><li>• 系統組件</li></ul>
	系統應用	<ul style="list-style-type: none"><li>• 機動式、電機式、電子式及氣動式控制系統</li><li>• 控制系統模式</li></ul>
KS4	控制系統的基本原理	<ul style="list-style-type: none"><li>• 循序控制系統</li><li>• 閉環系統</li><li>• 子系統</li></ul>
	可編程控制系統	<ul style="list-style-type: none"><li>• 可編程控制系統的使用</li></ul>

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設計與製作太陽追蹤裝置工作坊



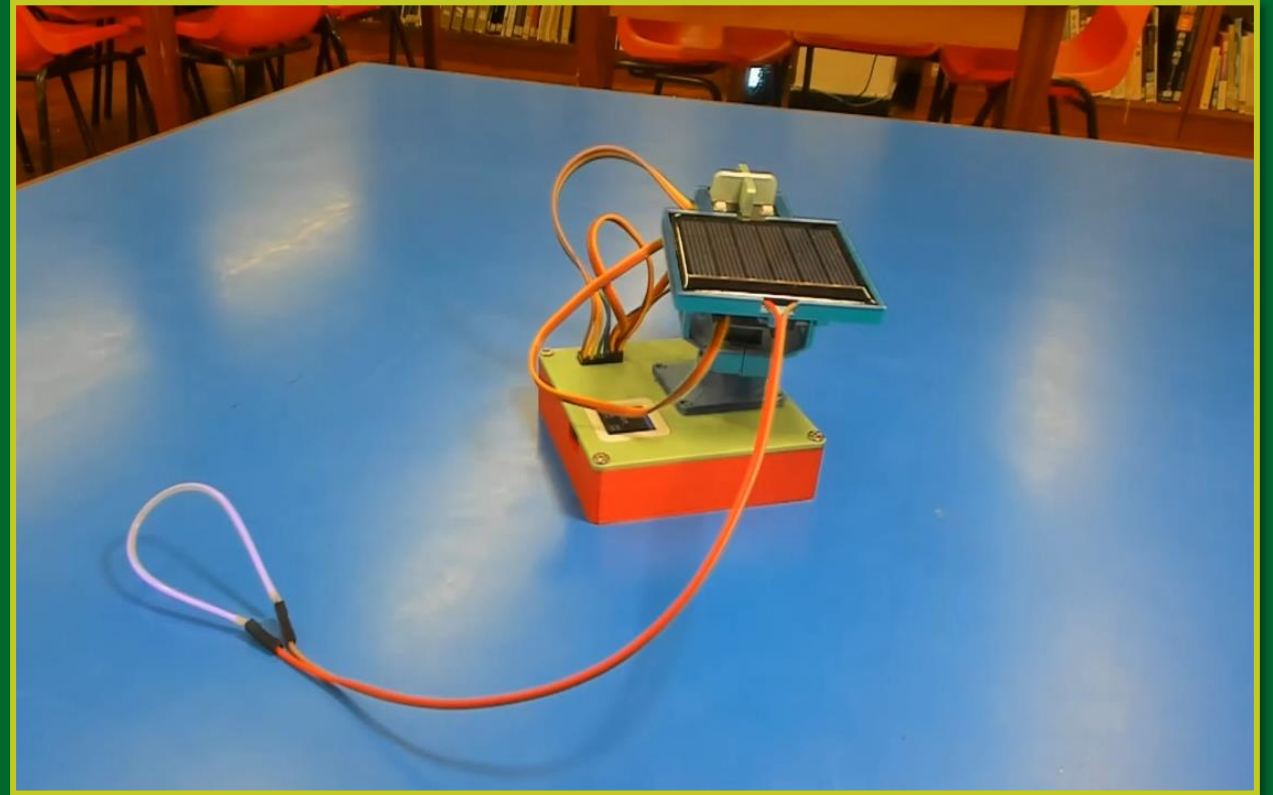
Au-Yeung Fu  
STEM Education Centre  
7 Nov 2025

# Workshop on Designing and Making a Solar Tracking Device

## 設計與製作太陽追蹤裝置工作坊

### 熱身討論：

- 除了追蹤光源之外，試提出一項你最期望今天完成的裝置能具備的功能？
- 你預算如何運用這一項功能進行STEAM相關活動？

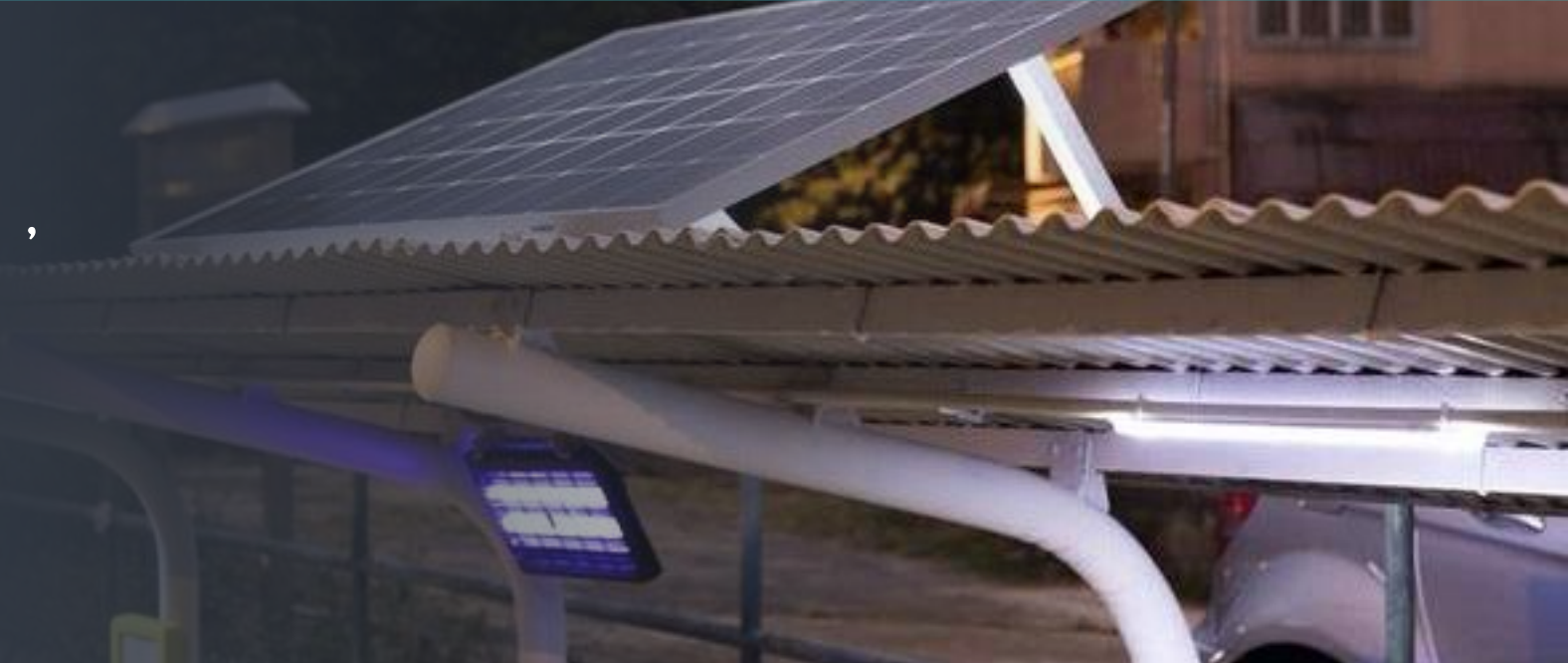




嘗試利用完成的裝置去設計一項 STEAM 相關活動例子

為何太陽能電池板要傾斜擺放？

其中一個原因是希望太陽能板可攝取最多陽光，如果用學校現有的設施可以怎樣考量這個最佳傾斜角度？



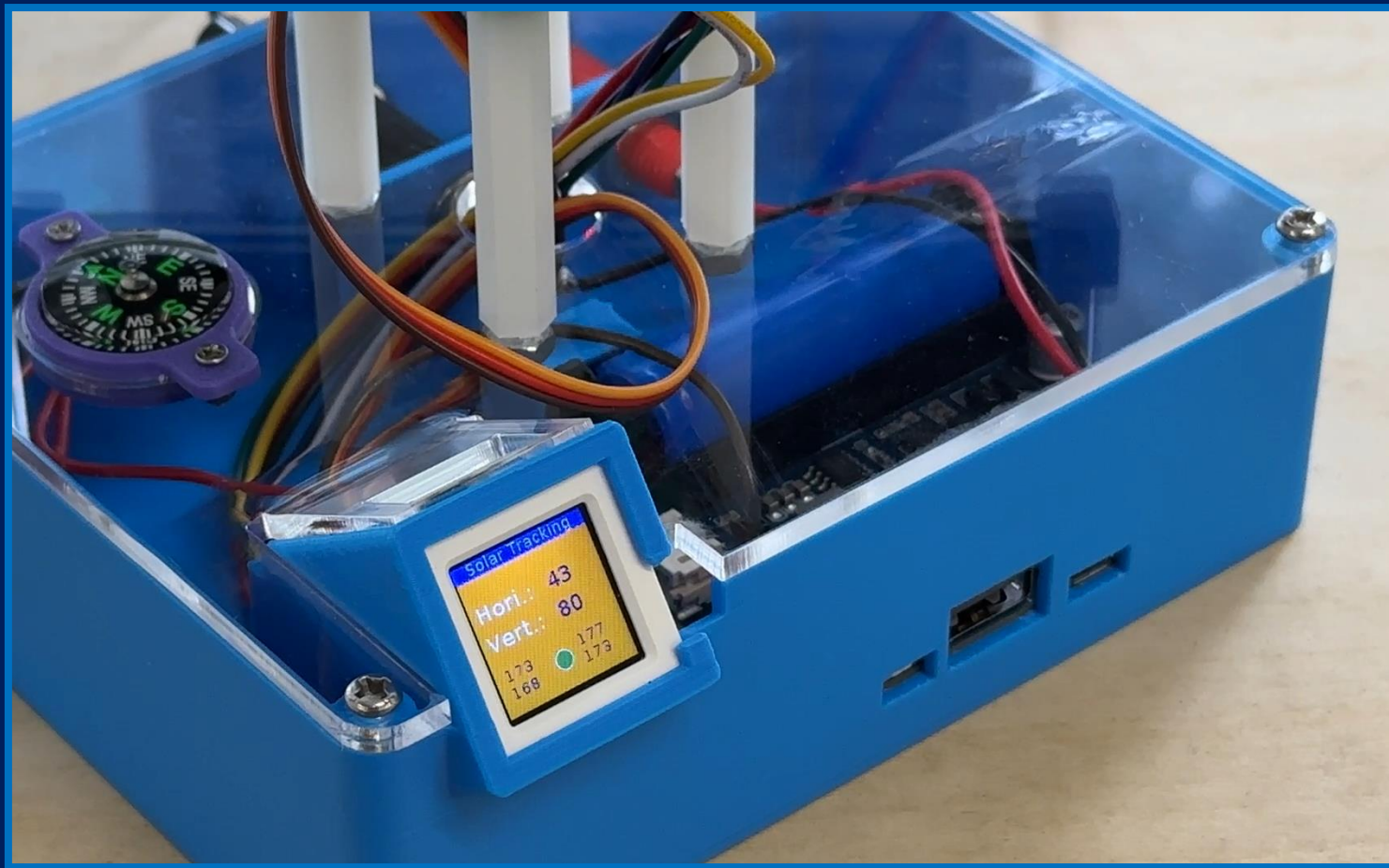
# 嘗試利用完成的裝置去設計一項 STEAM 相關活動例子

學生可每天**定時**記錄以下資料：

- 太陽能電池板的方向
- 太陽能電池板的傾斜角
- 當天的天氣(晴天、陰天或雨天)
- 溫度及相對濕度
- ..... **尋找規律、分類**

以圖表組織圖展示數據 / 資料：

- 顯示最常的傾斜角度範圍
- 不同季節會否出現不同規律
- 不同天氣情況對太陽能電池板的傾斜角有否關鍵影響？
- .....



太陽能追蹤裝置運作演示

# 網上相關STEAM活動例子參考

## 科學(中一至中三)STEAM學習單元 — 創新科技

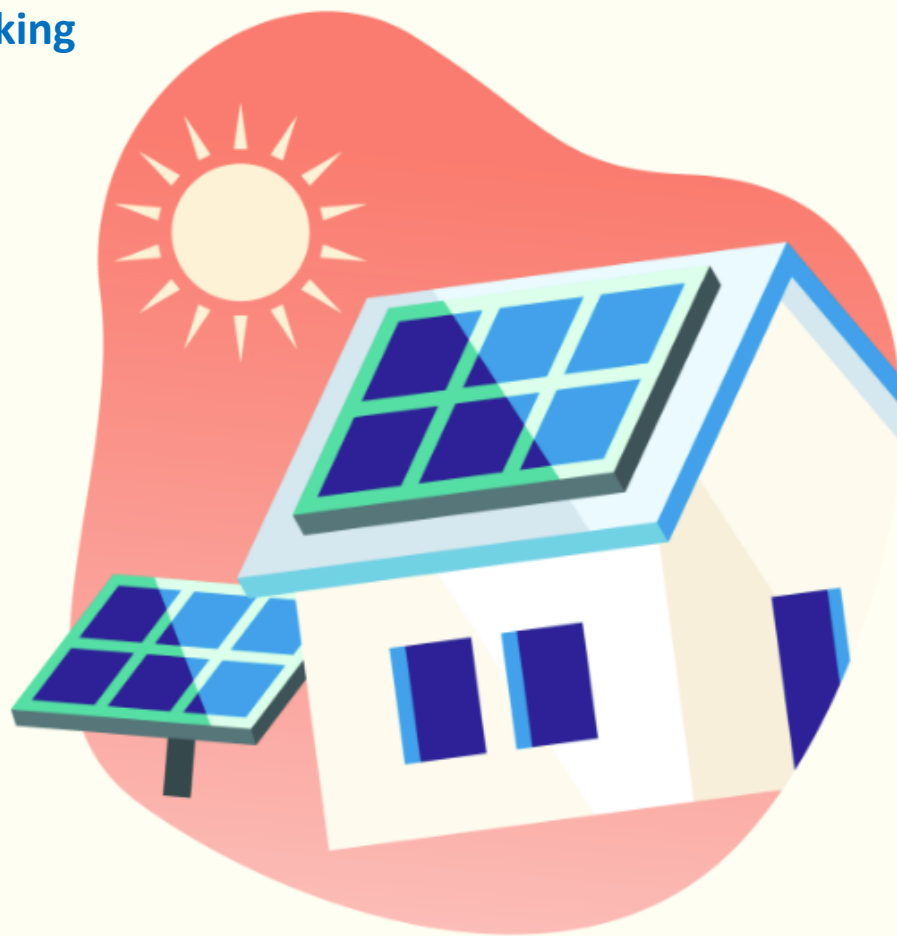
<https://steamforfuture.edb.edcity.hk/tc/Sun-Trajectory-and-Solar-Tracking>

### 主題 4

## 太陽路徑與太陽追蹤

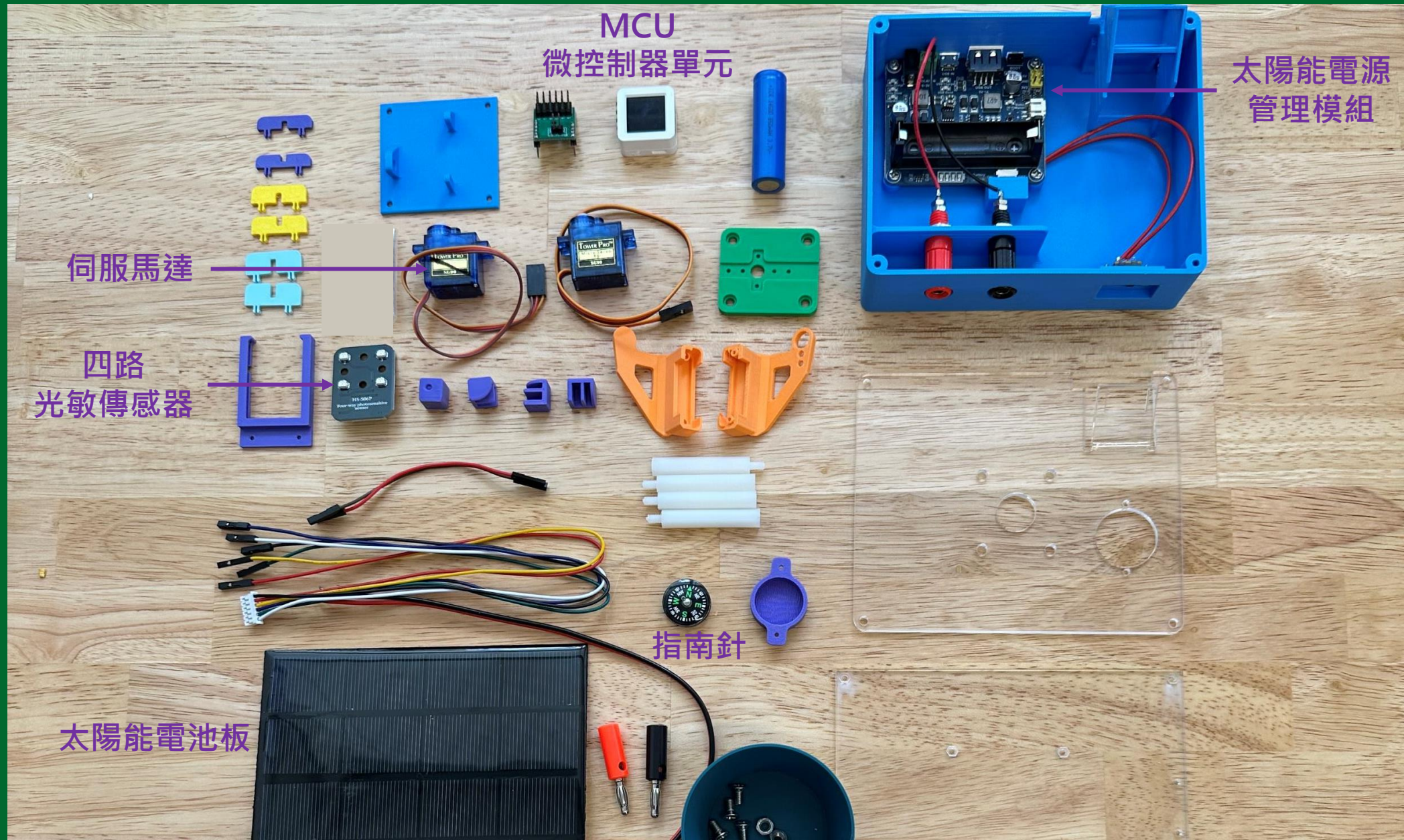
綠色建築設計是一種強調環境可持續性和資源效率的建築和施工方法。在本課題中，我們將透過以下活動探討如何運用科學知識和創新科技來追蹤太陽路徑，藉以減少能源消耗。

進入

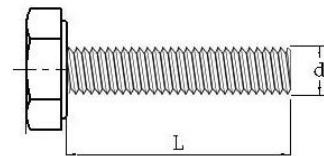




# 裝置所需的電子元件及其他組件



# 螺絲數目



d: 螺紋直徑

L: 長度

## M3螺絲

(直徑: 3mm, 長: 6mm)

## M3 x 6

種類	長度	數目
M3 螺絲	6mm	8
M2 螺絲	6mm	11
M2 螺絲	8mm	6
M2 螺絲	14mm	2
M2 螺絲母	--	13
M4 六角柱	40mm	4
M4 螺絲	8mm	4
M4 螺絲母	--	4
伺服馬達螺絲	4mm	2



1a

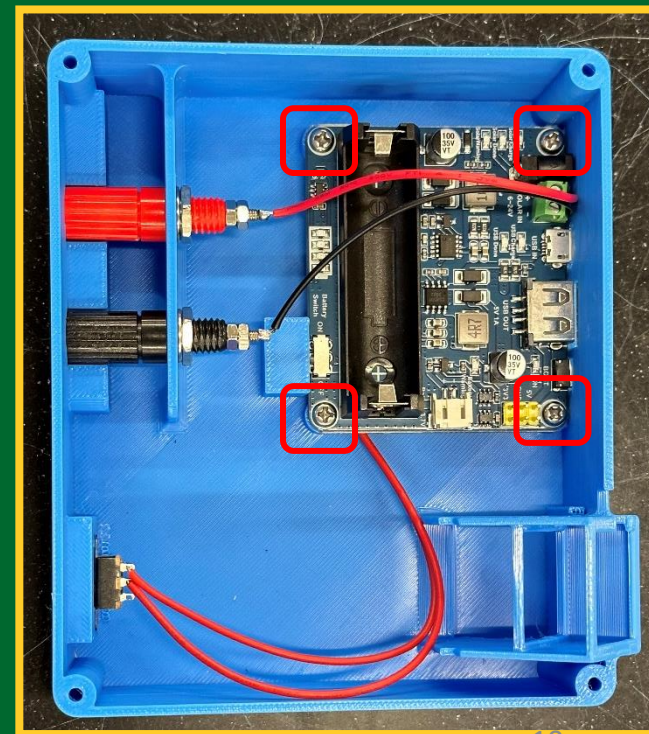
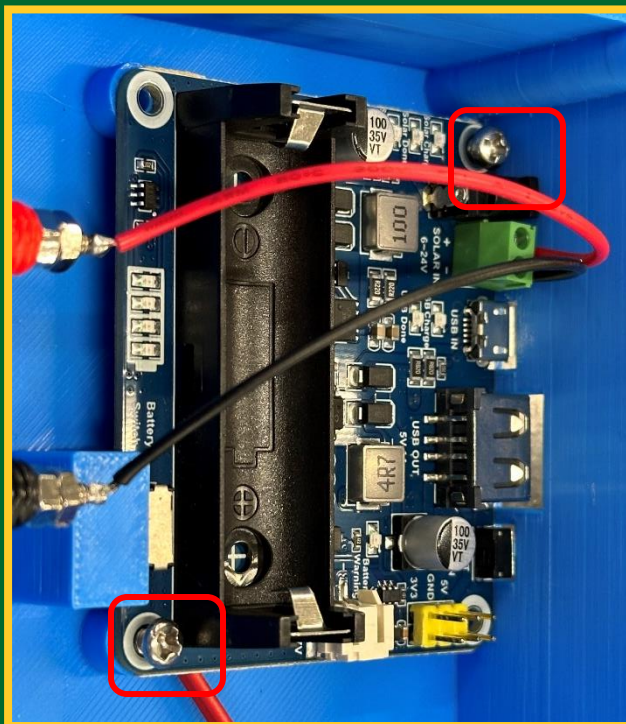
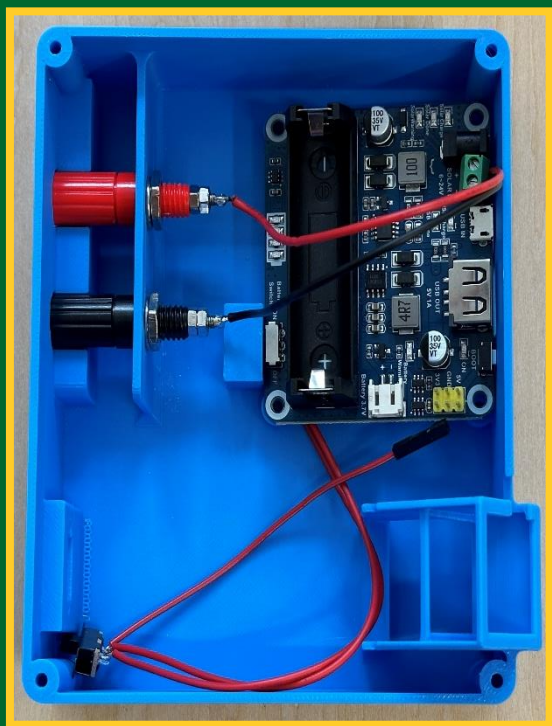
# 固定太陽能電源管理模組

M3螺絲(6mm長) 4粒



M3 x 6:

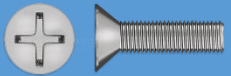
代表直徑 3mm 及 長 6mm 的螺絲



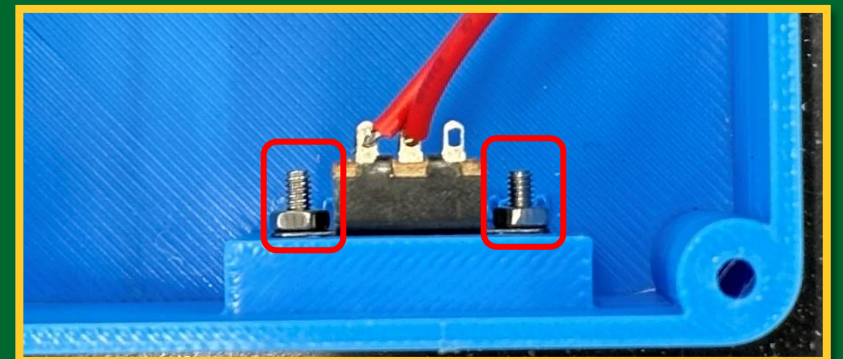
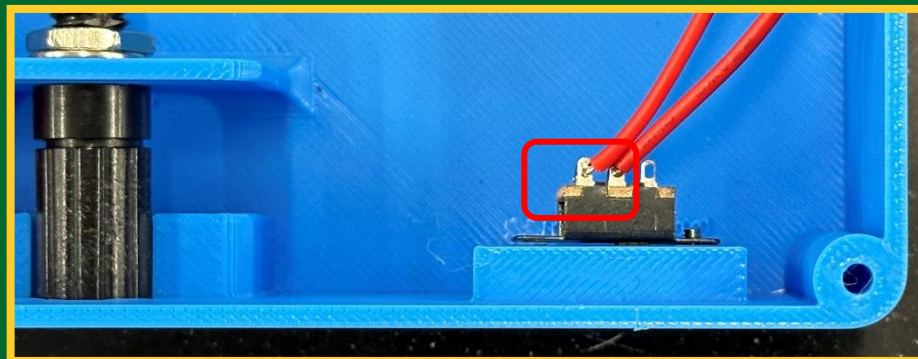
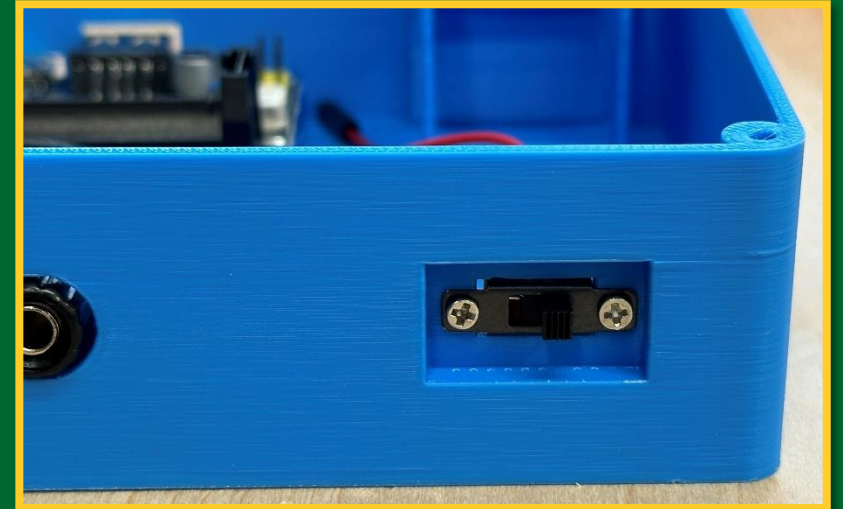
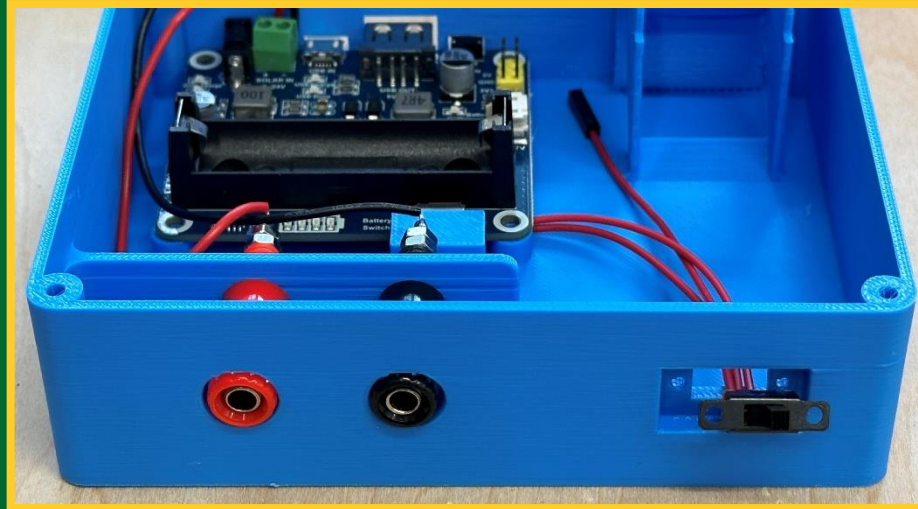
1b

# 固定裝置開關

M2螺絲(8mm長)



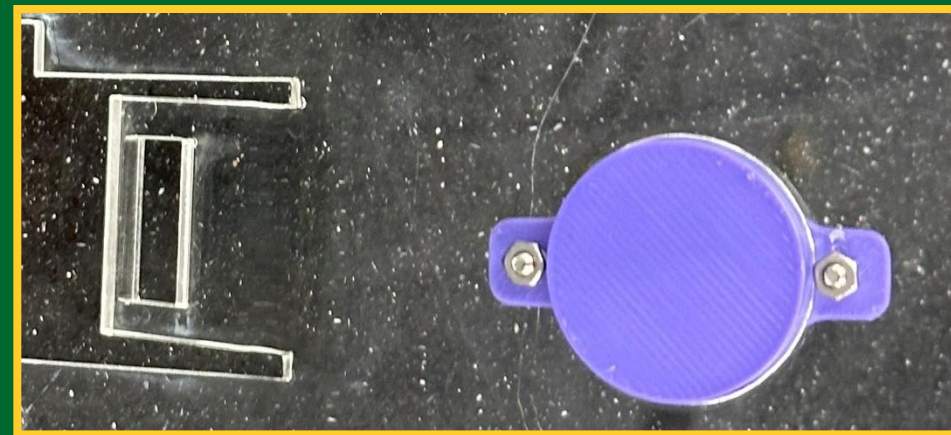
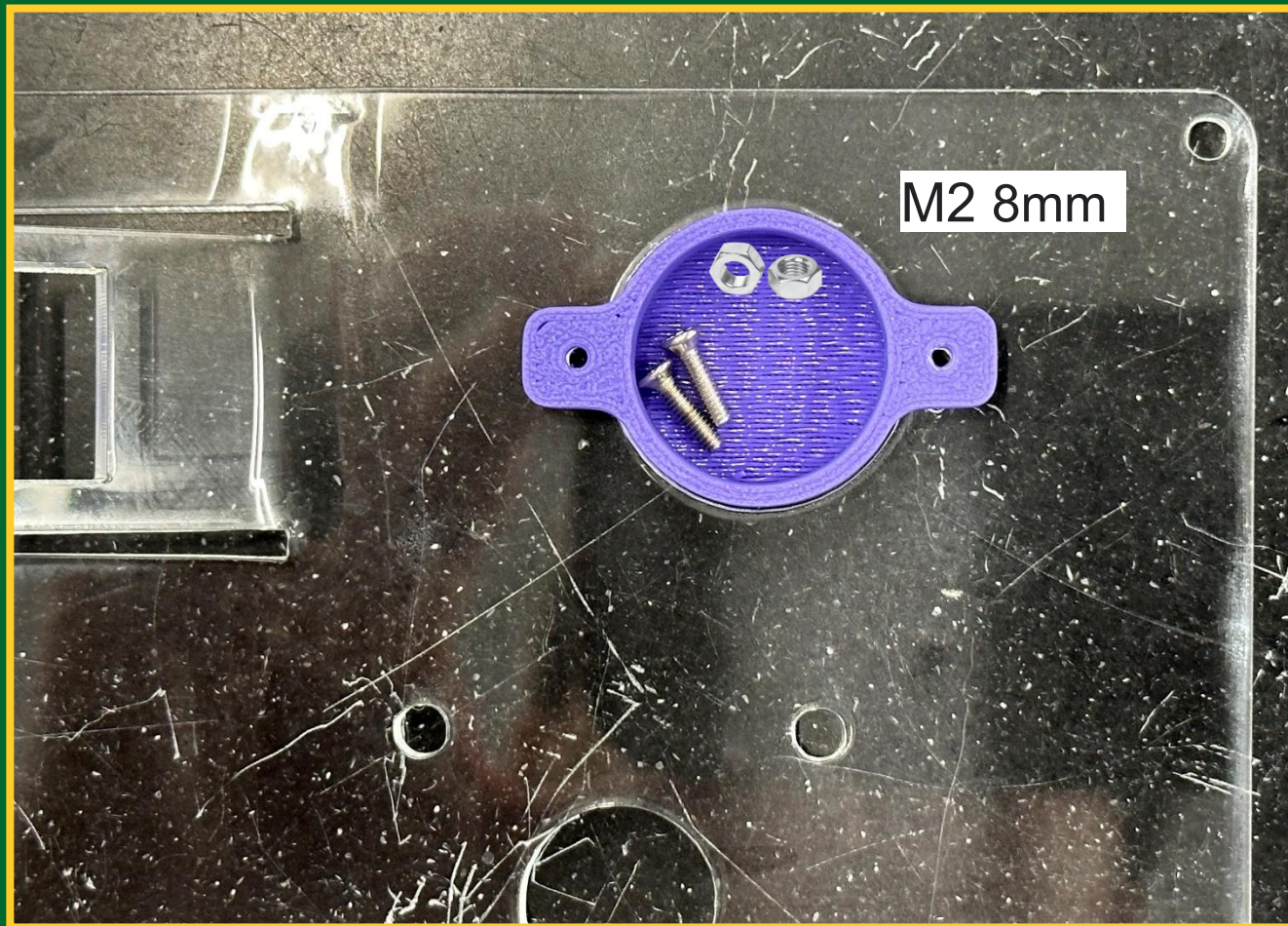
螺絲母





2a

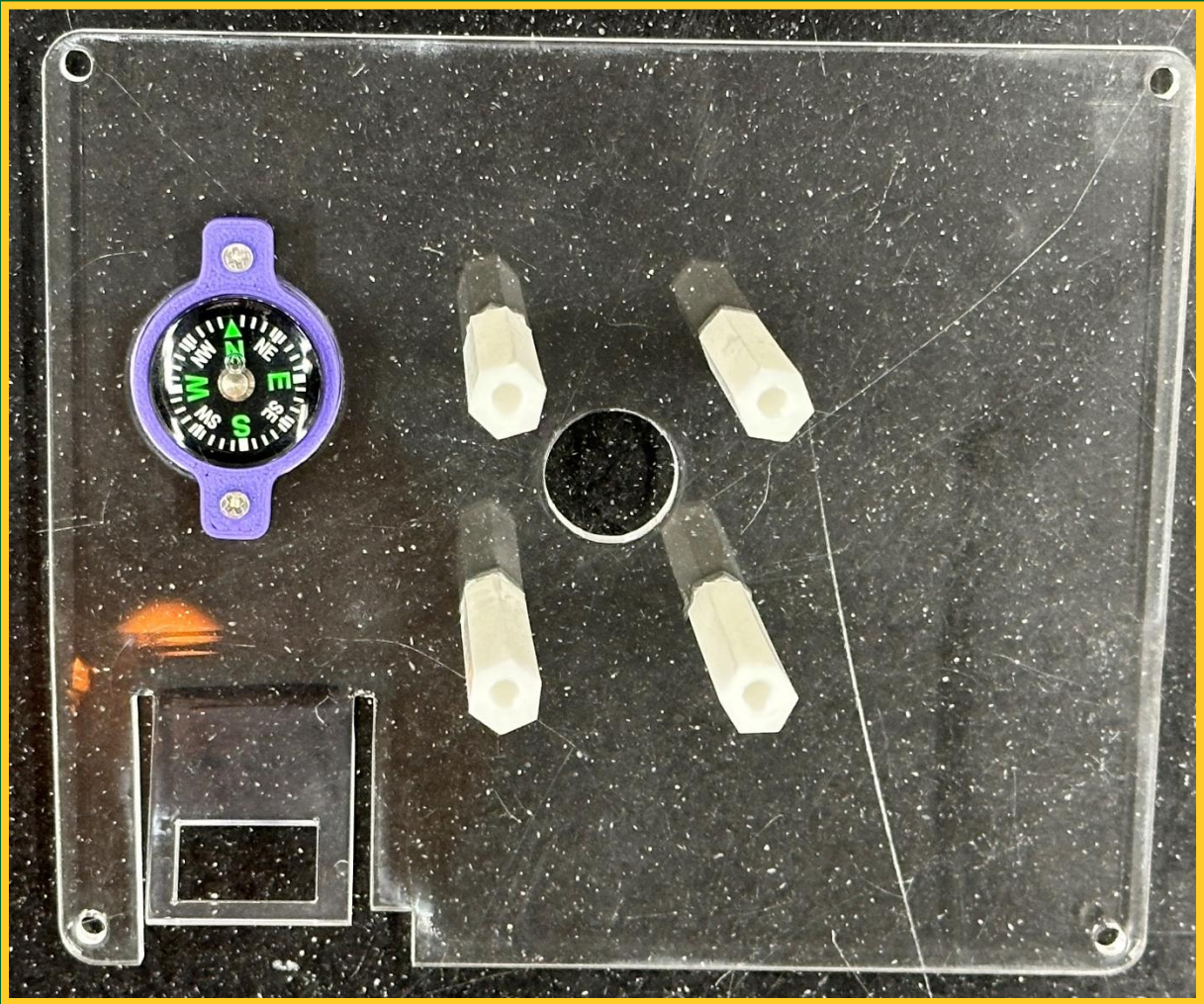
## 固定小羅盤在裝置面板





2b

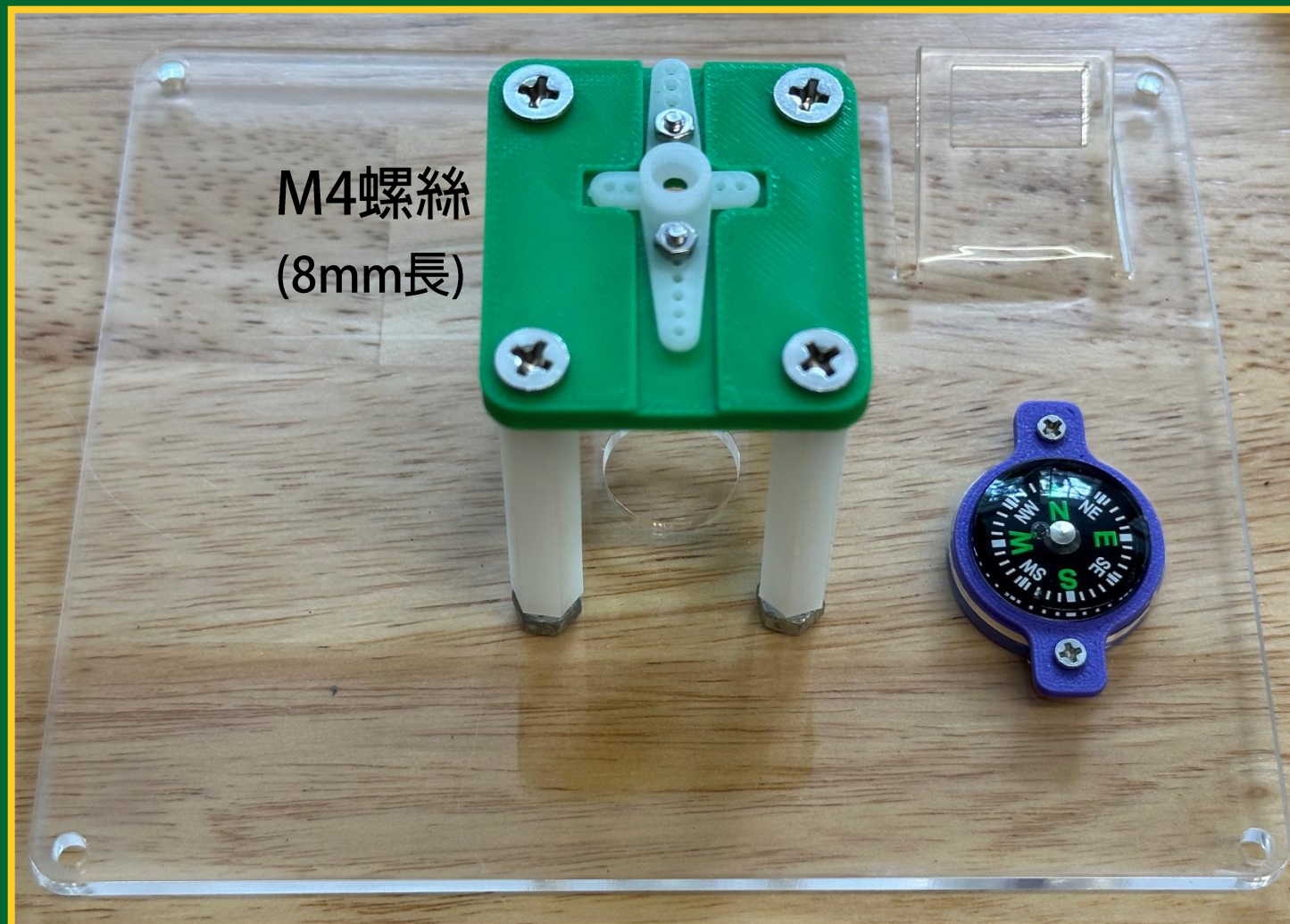
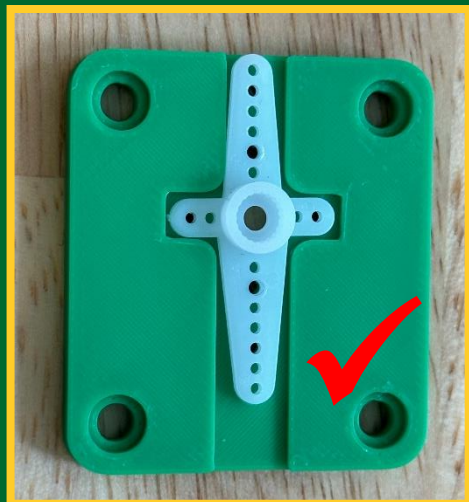
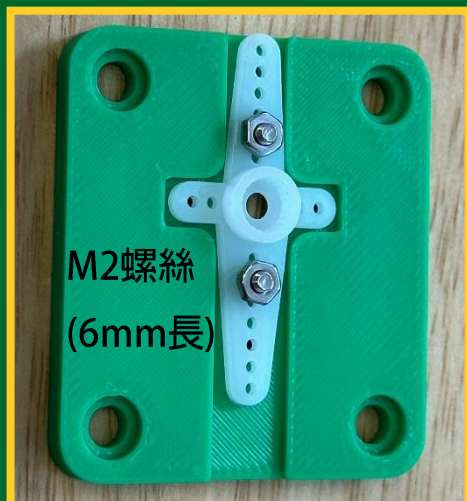
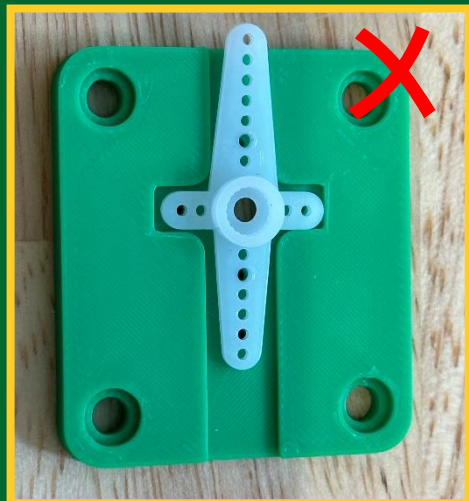
安裝40mm長的M4六角柱 (4 枝)





3

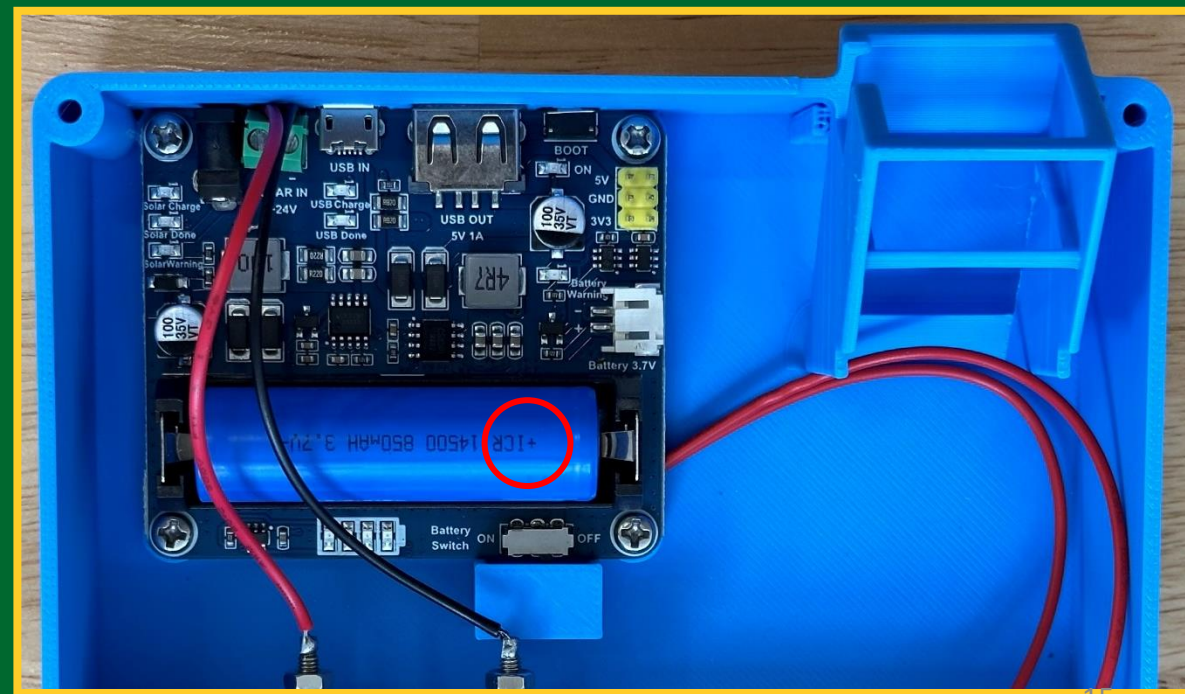
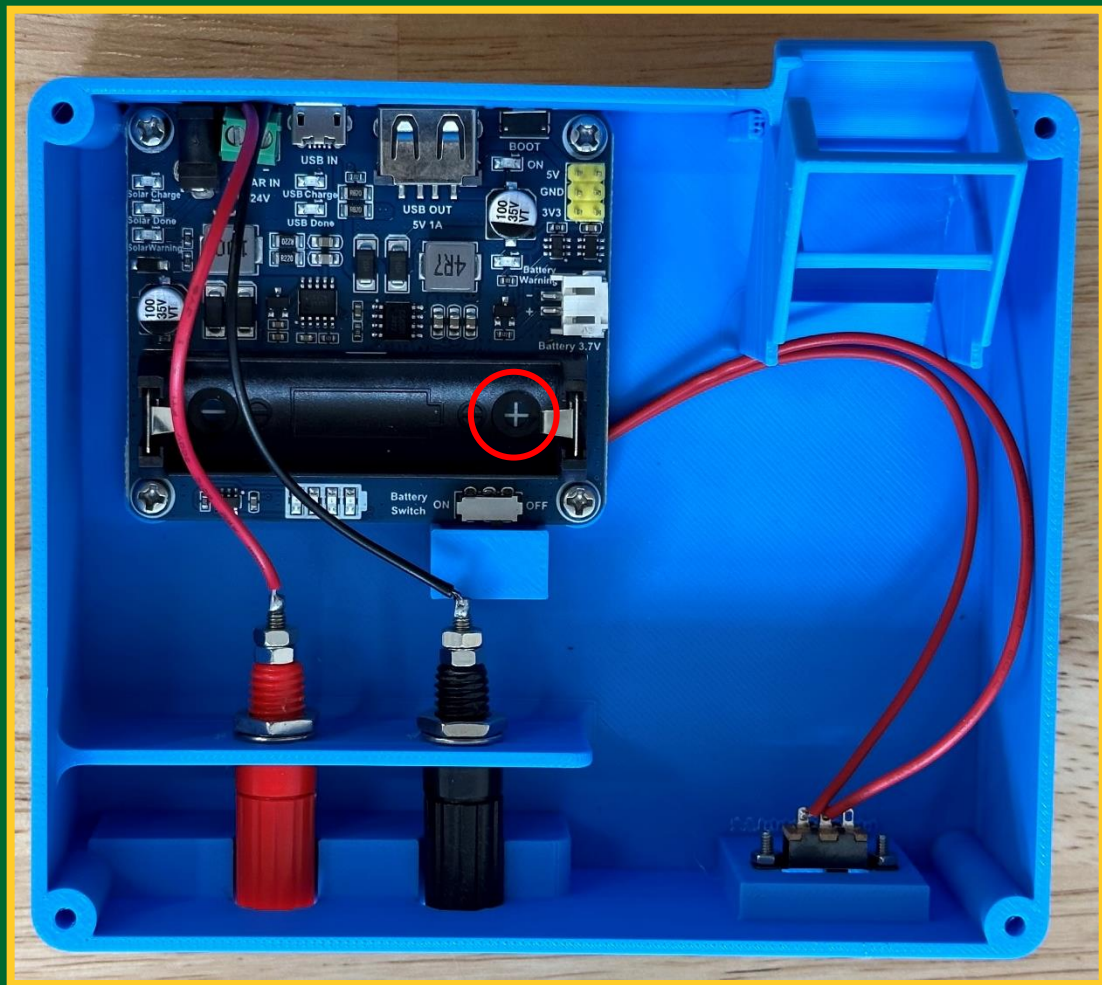
# 安裝伺服馬達支架





4

## 安裝可再充電的電池





5a

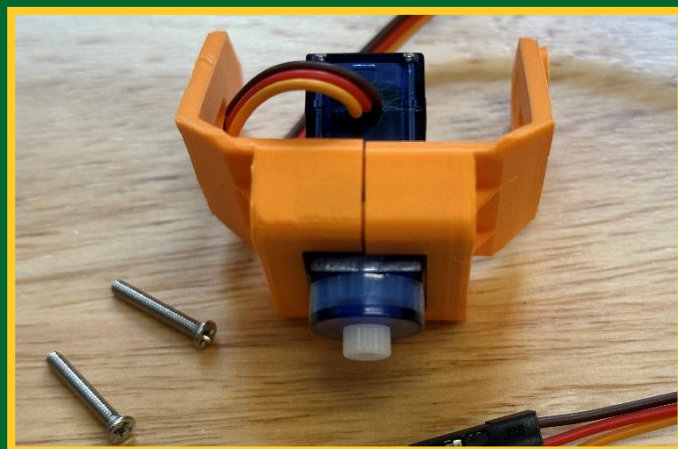
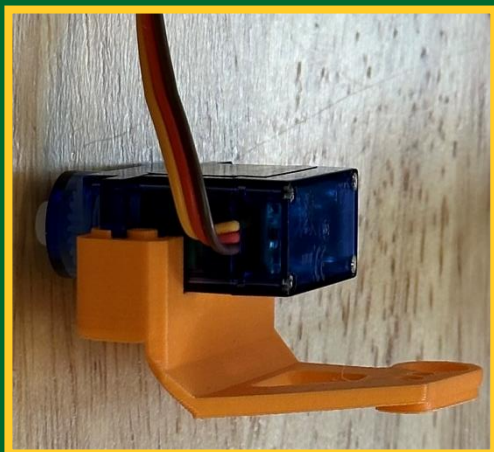
# 安裝水平旋轉支架



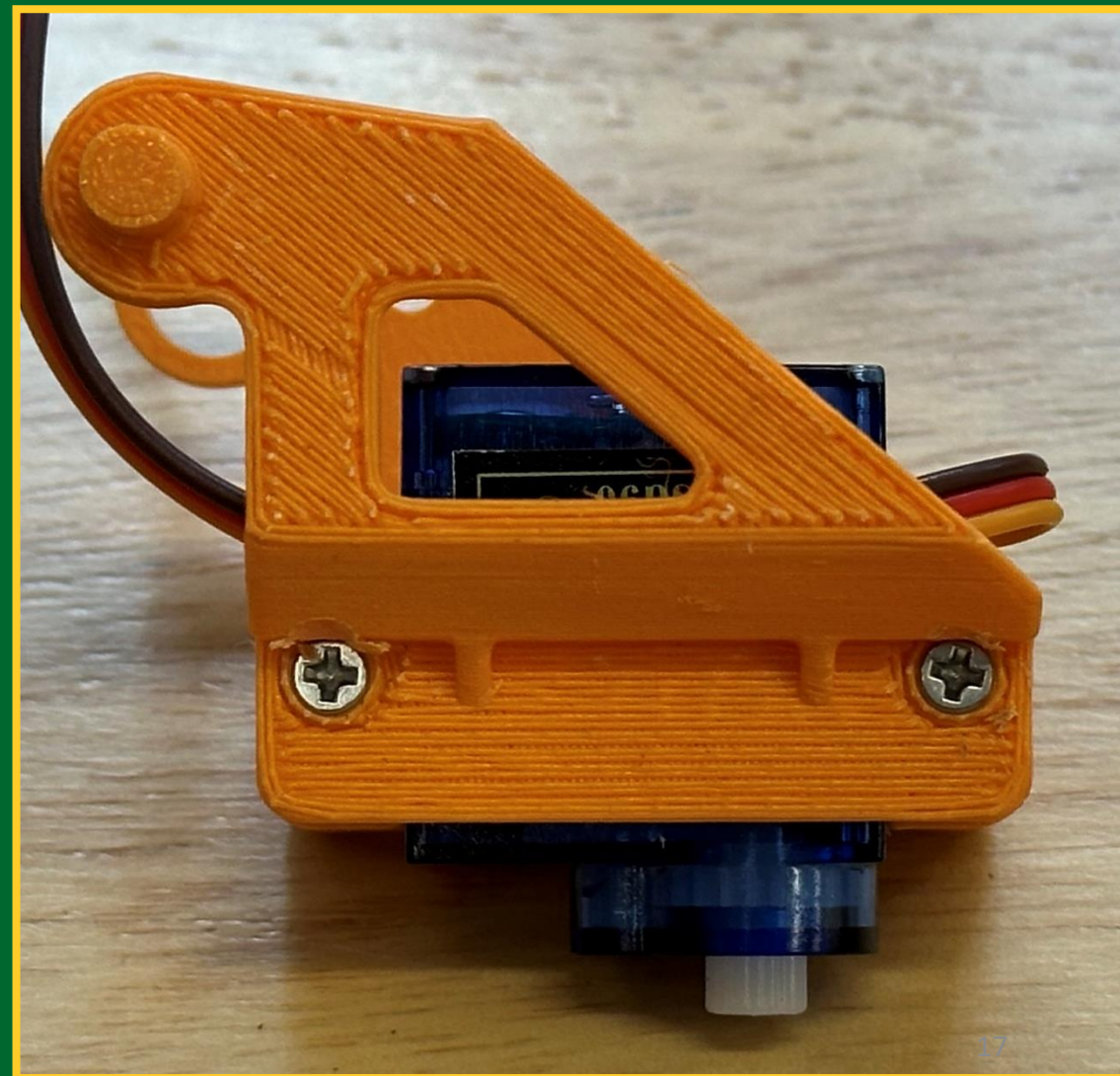
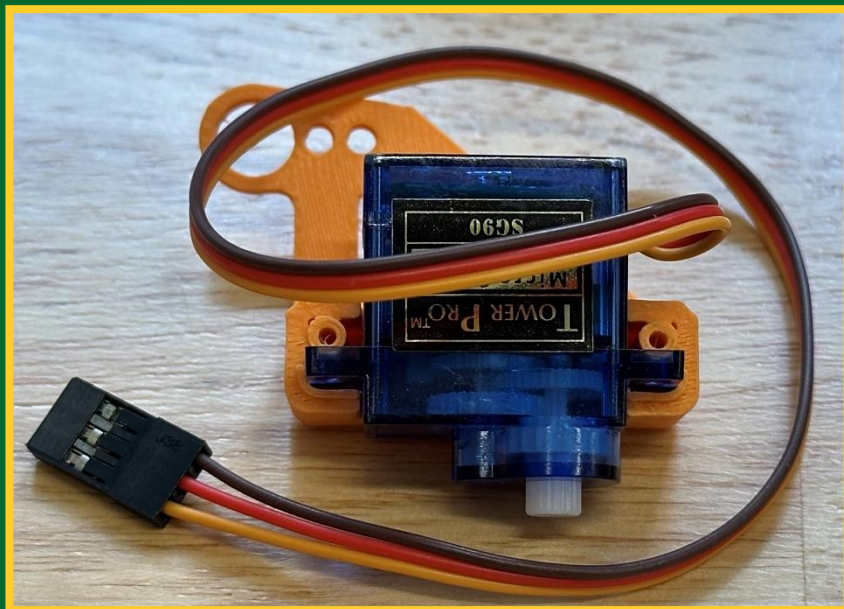


5b

# 安裝水平旋轉支架



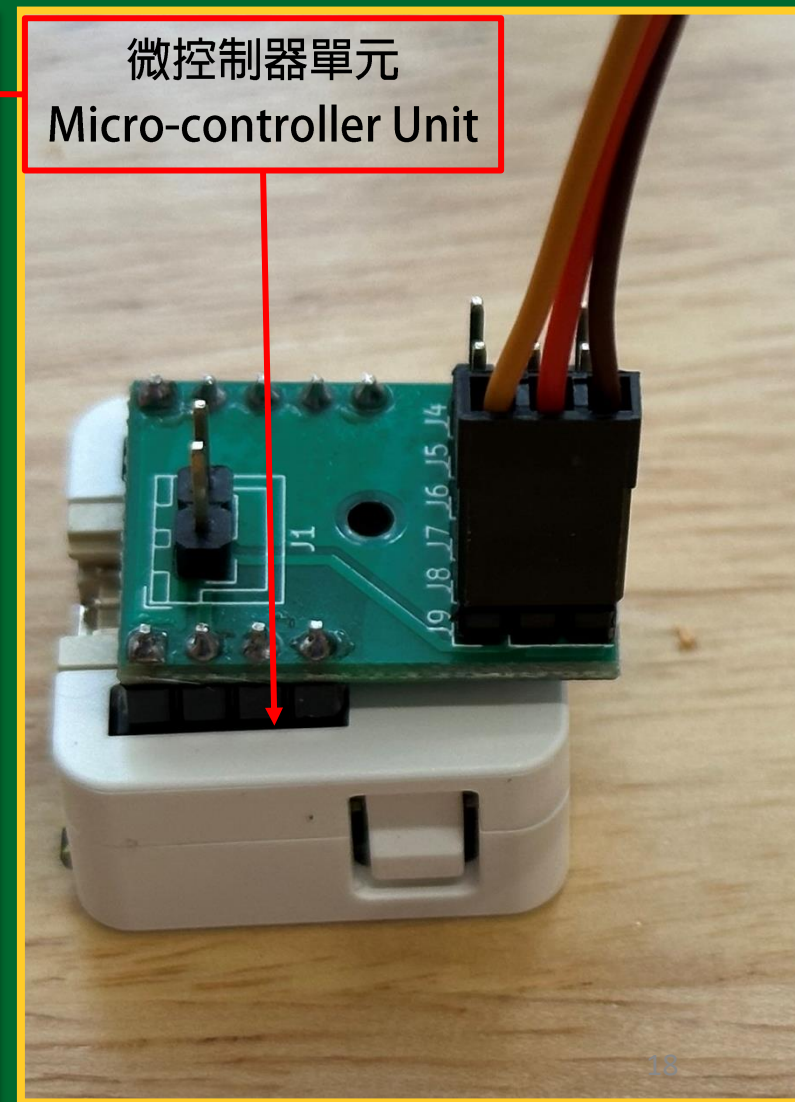
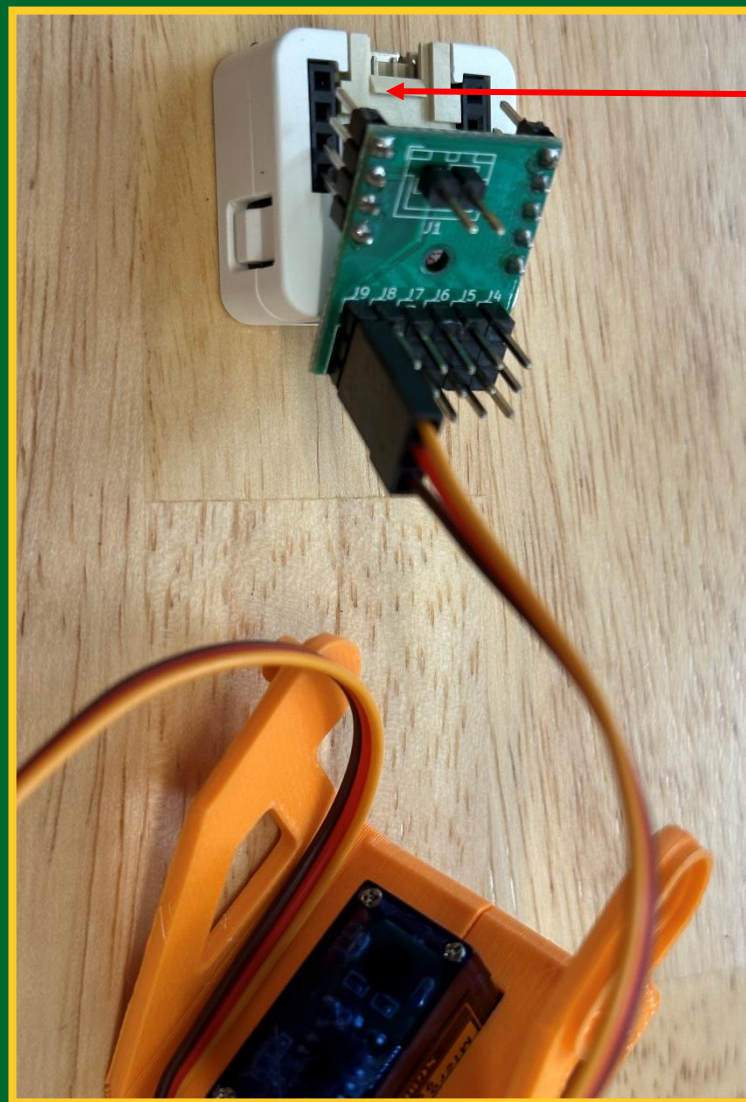
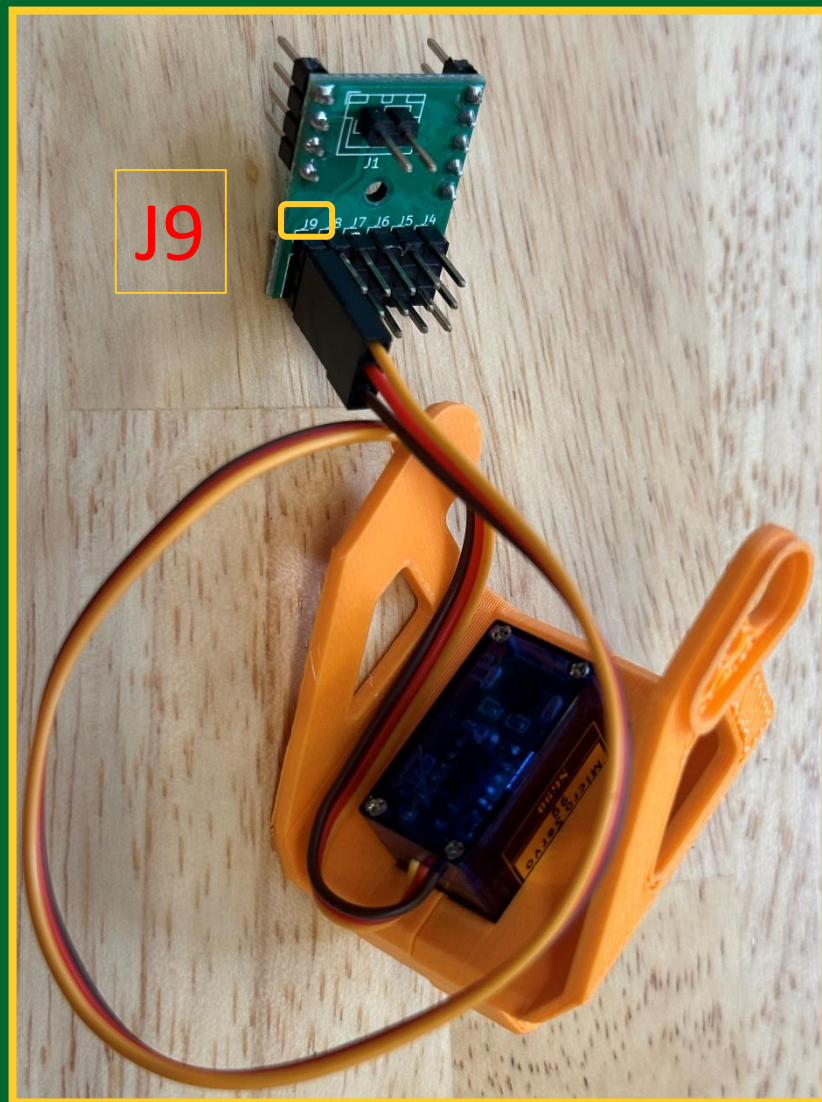
M2螺絲  
(14mm長)





5c

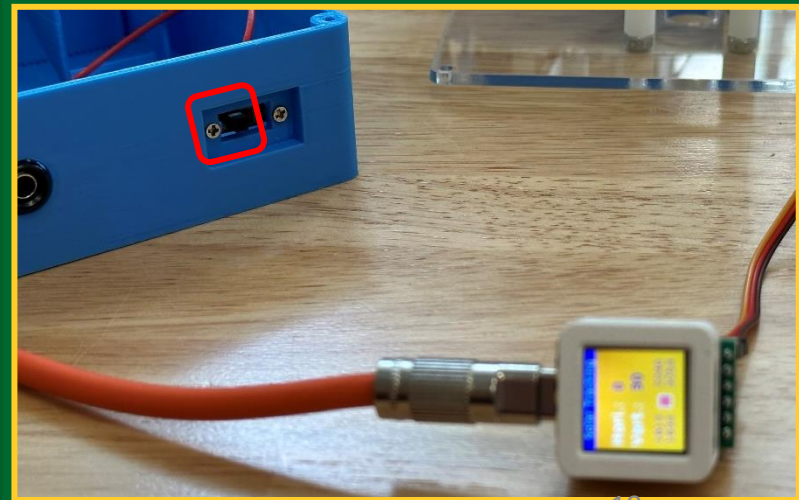
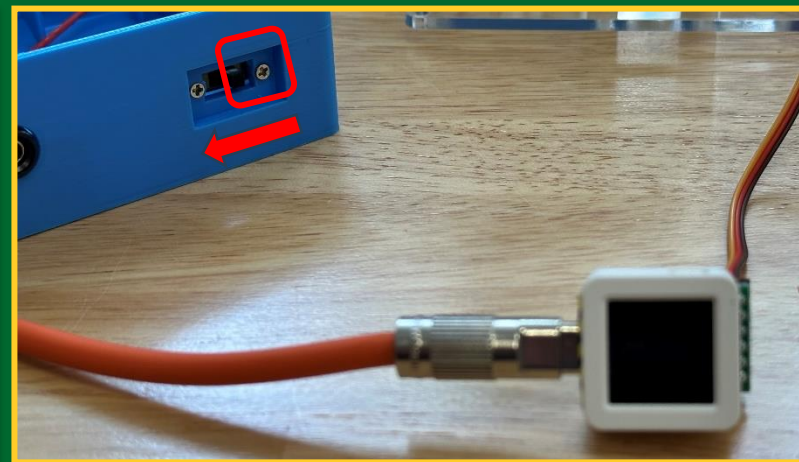
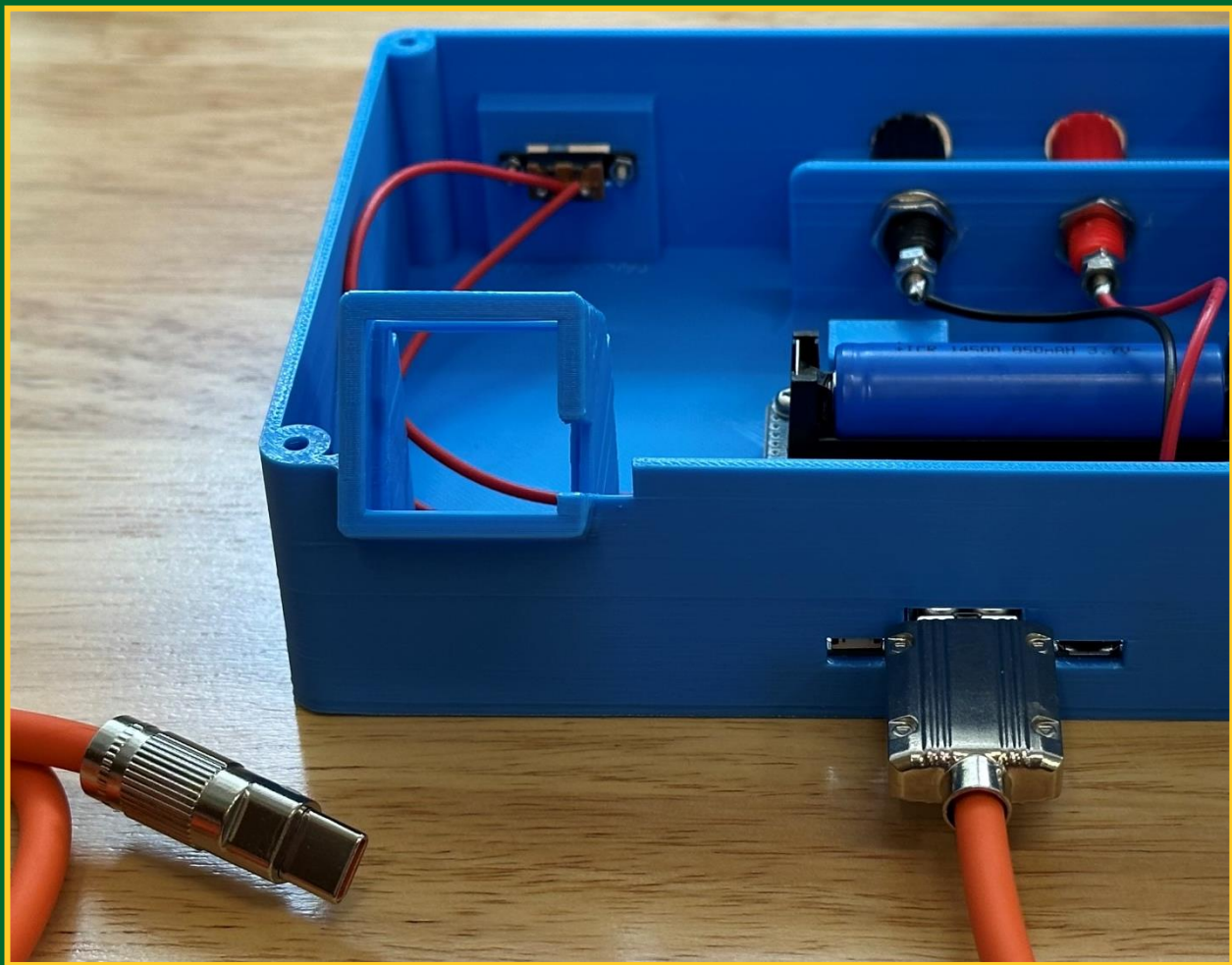
# 安裝水平旋轉支架





5d

# 安裝水平旋轉支架





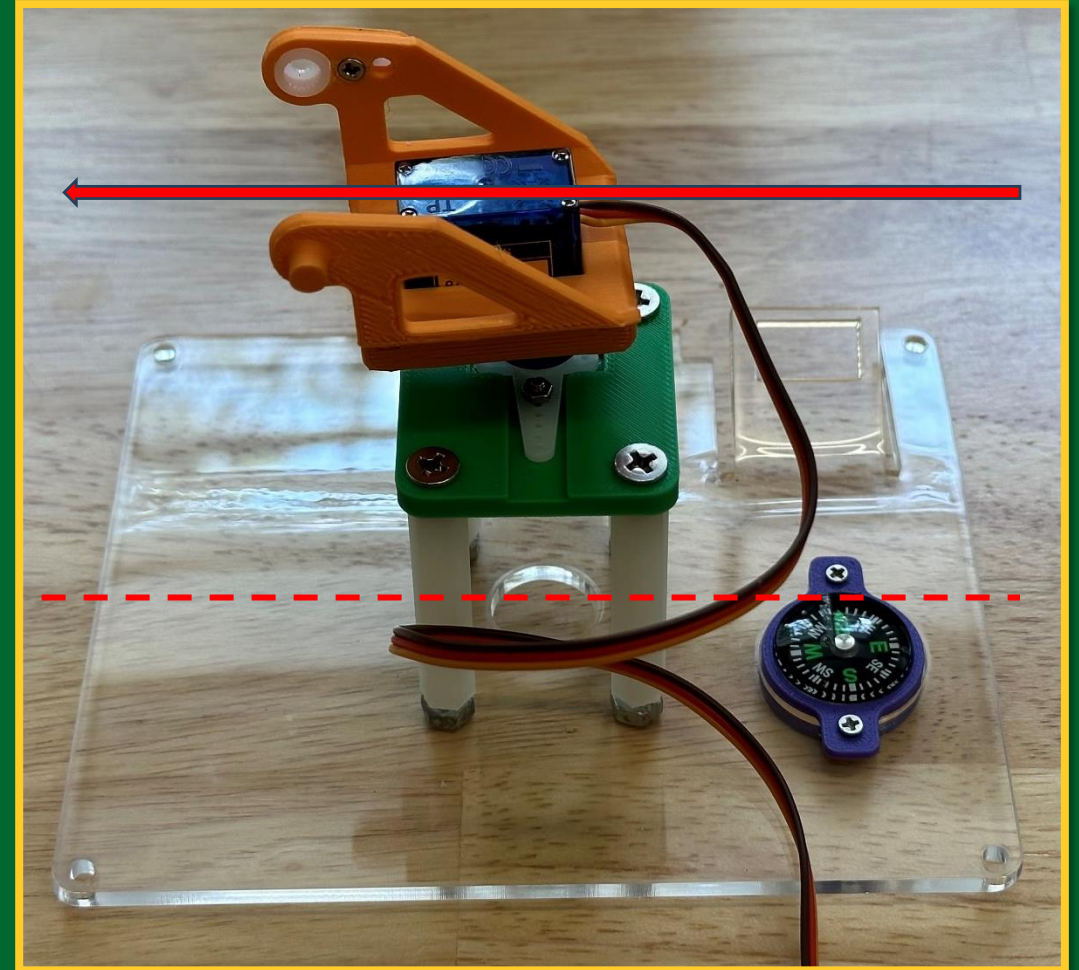
5e

## 安裝水平旋轉支架

重置伺服馬達至零度，然後關閉電源



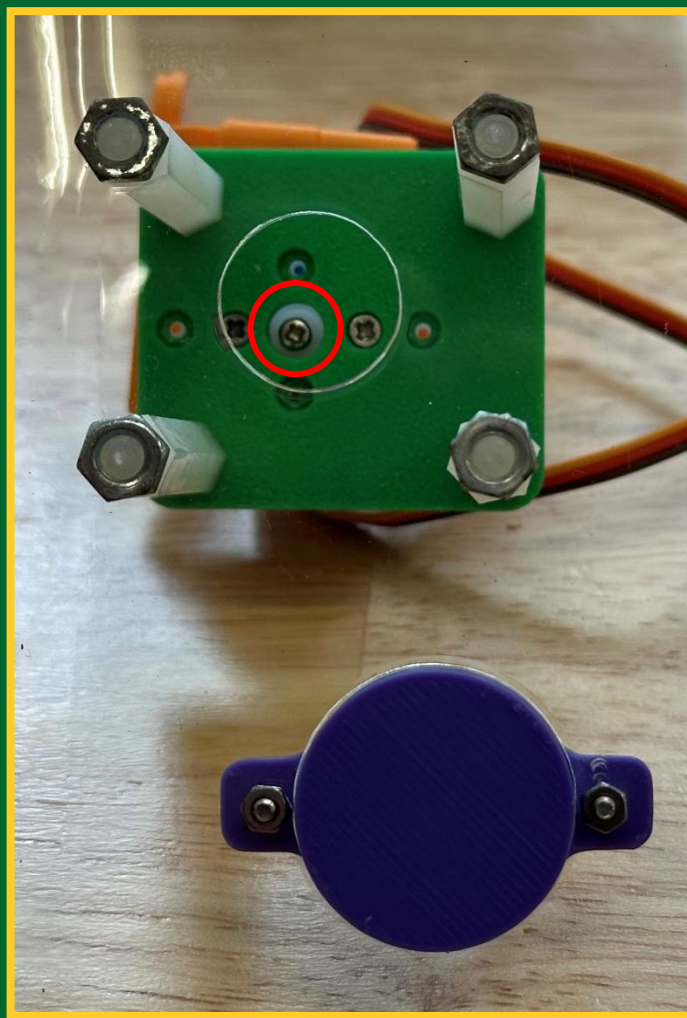
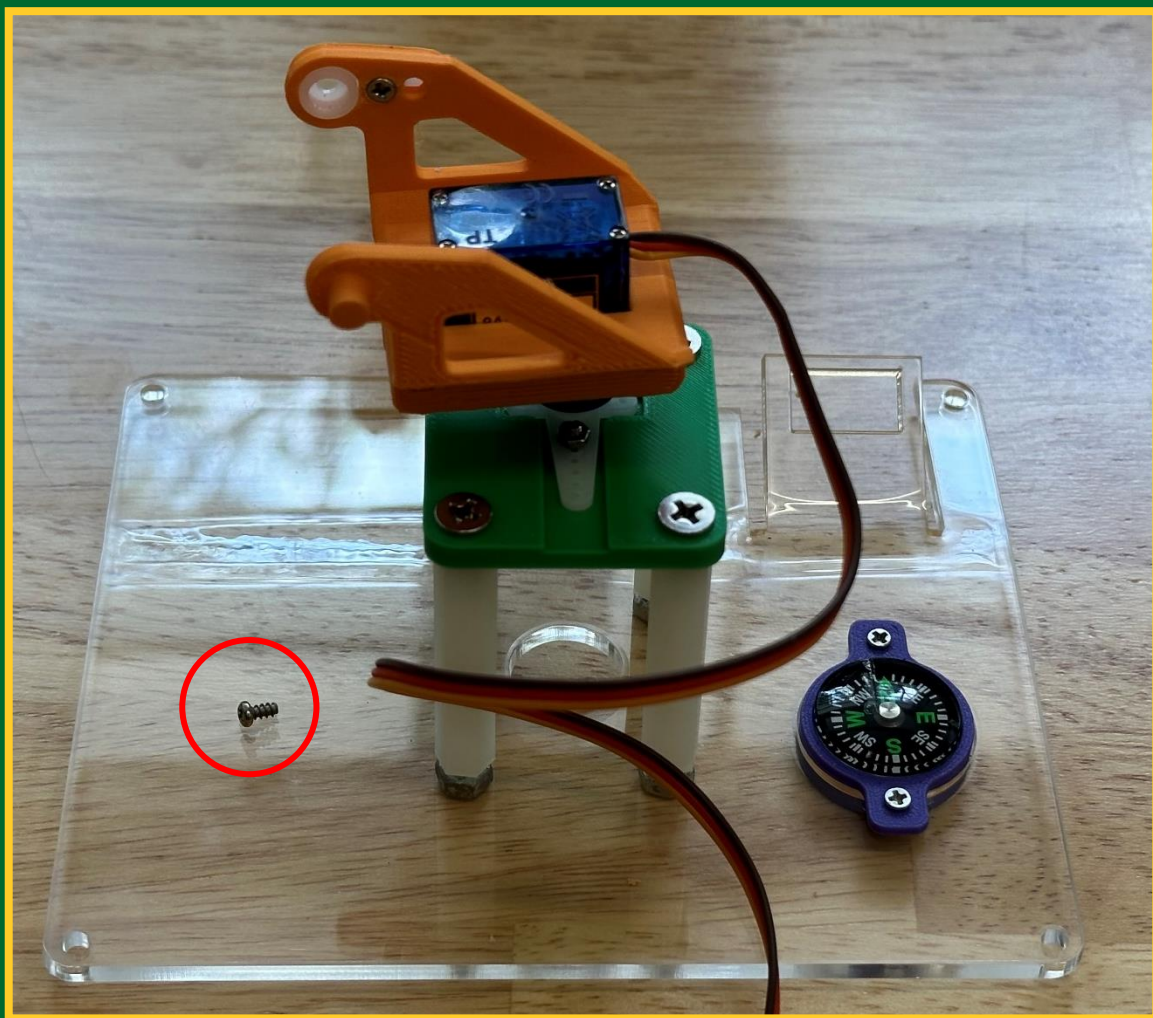
微控制器單元  
Micro-controller Unit





5f

# 安裝水平旋轉支架

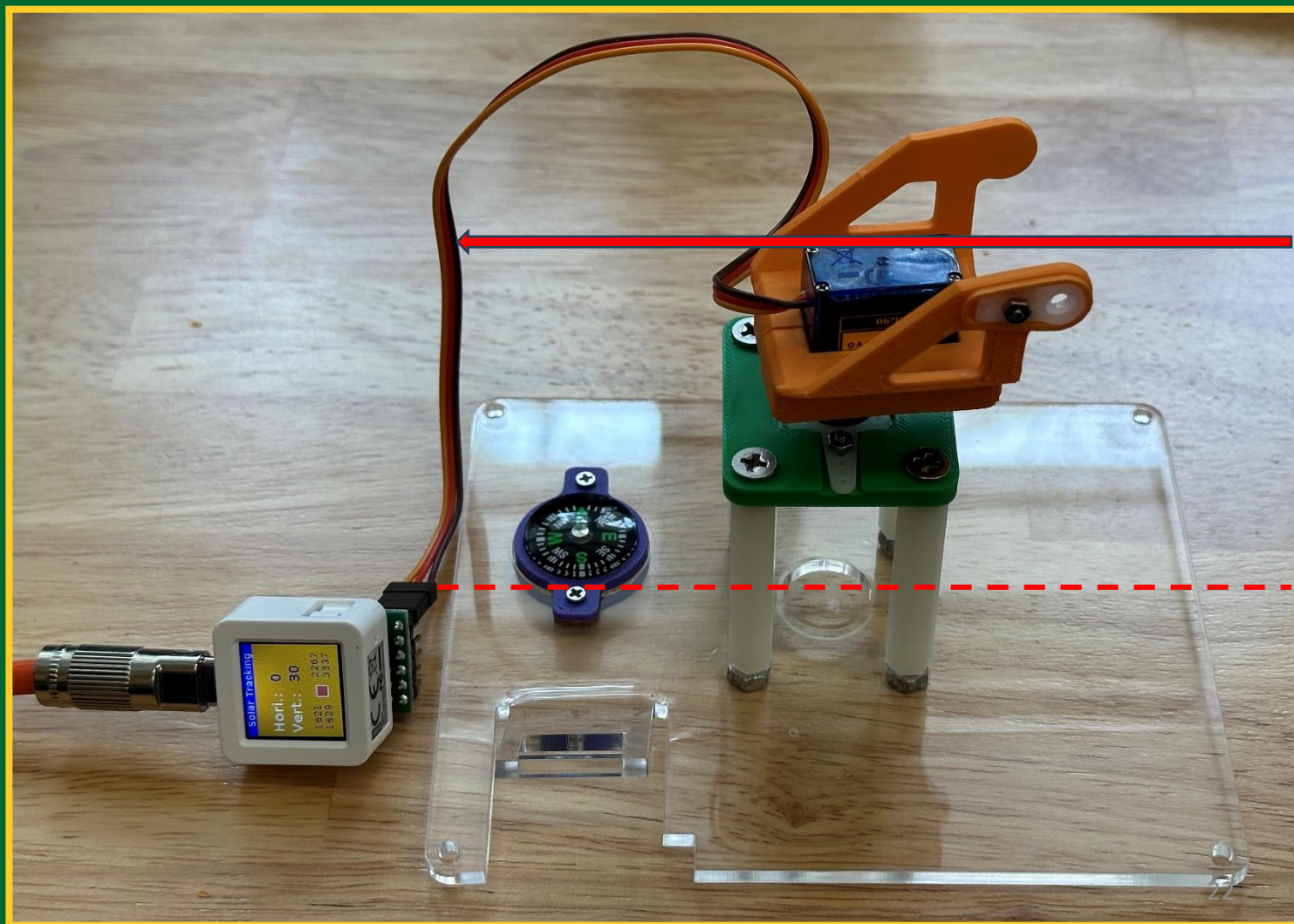




5g

# 安裝水平旋轉支架

重啟電源確保伺  
服馬達維持在正  
確方向

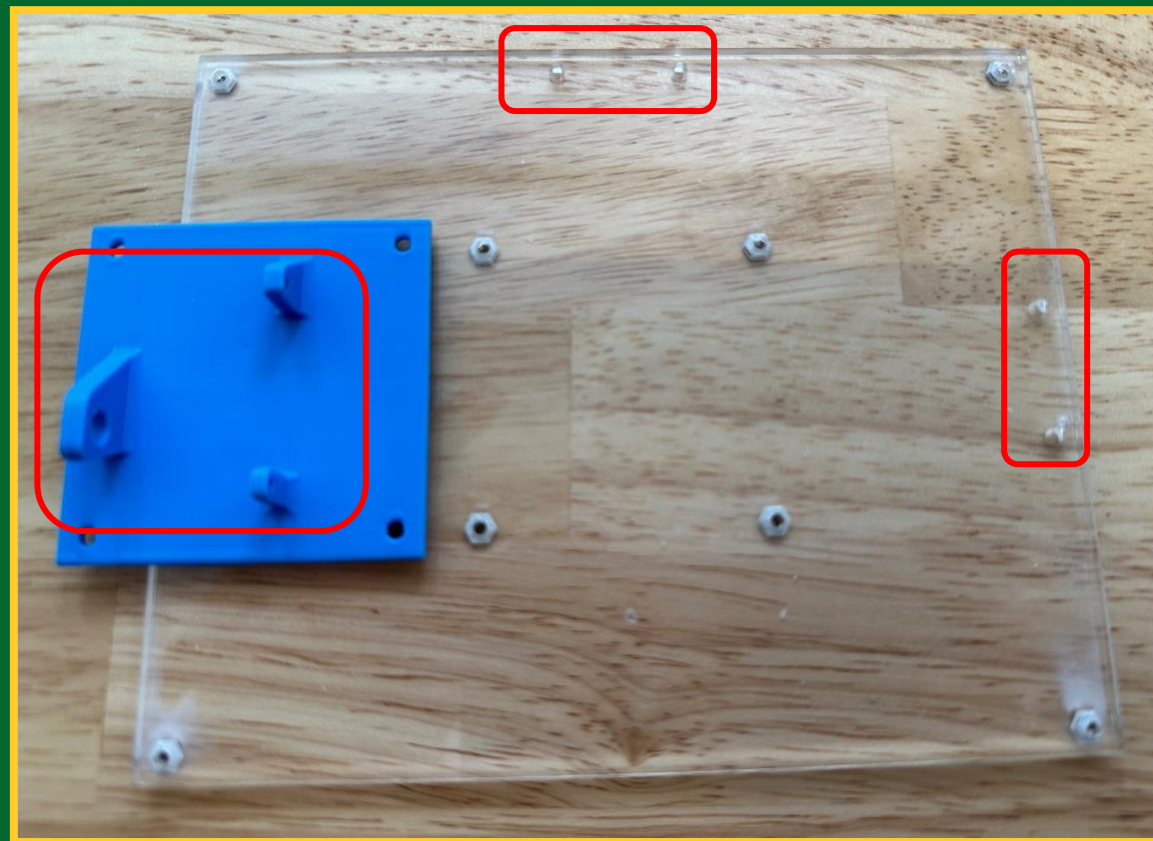


6a

# 安裝太陽能電池板



頂

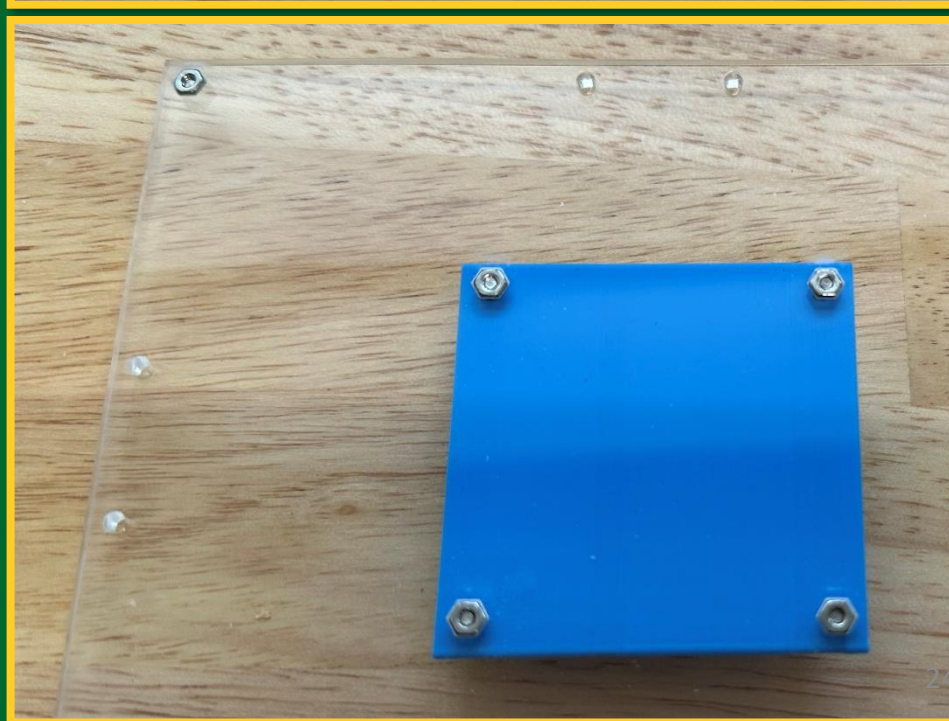
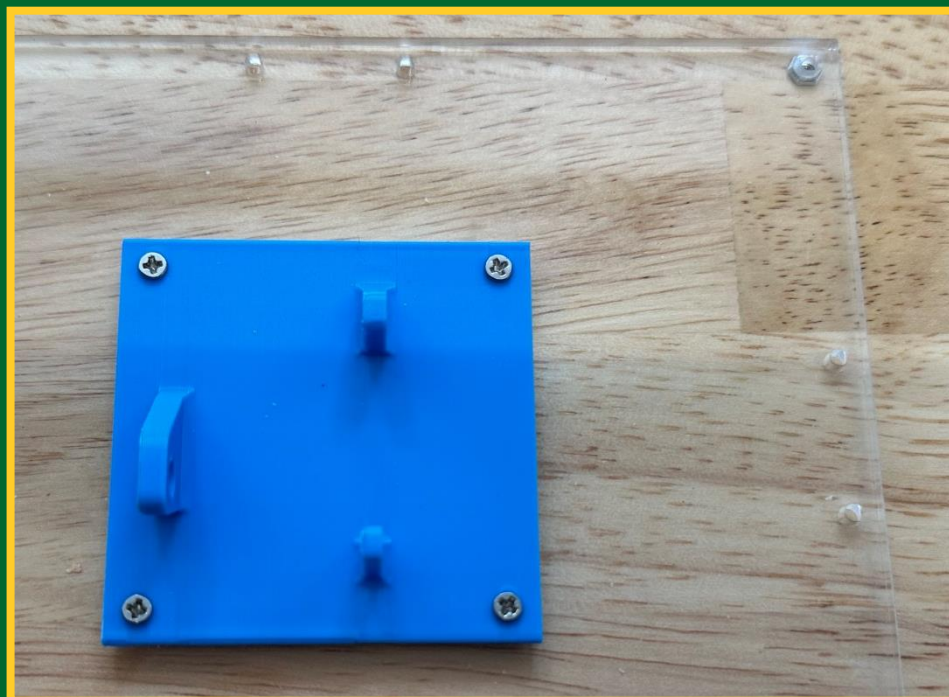
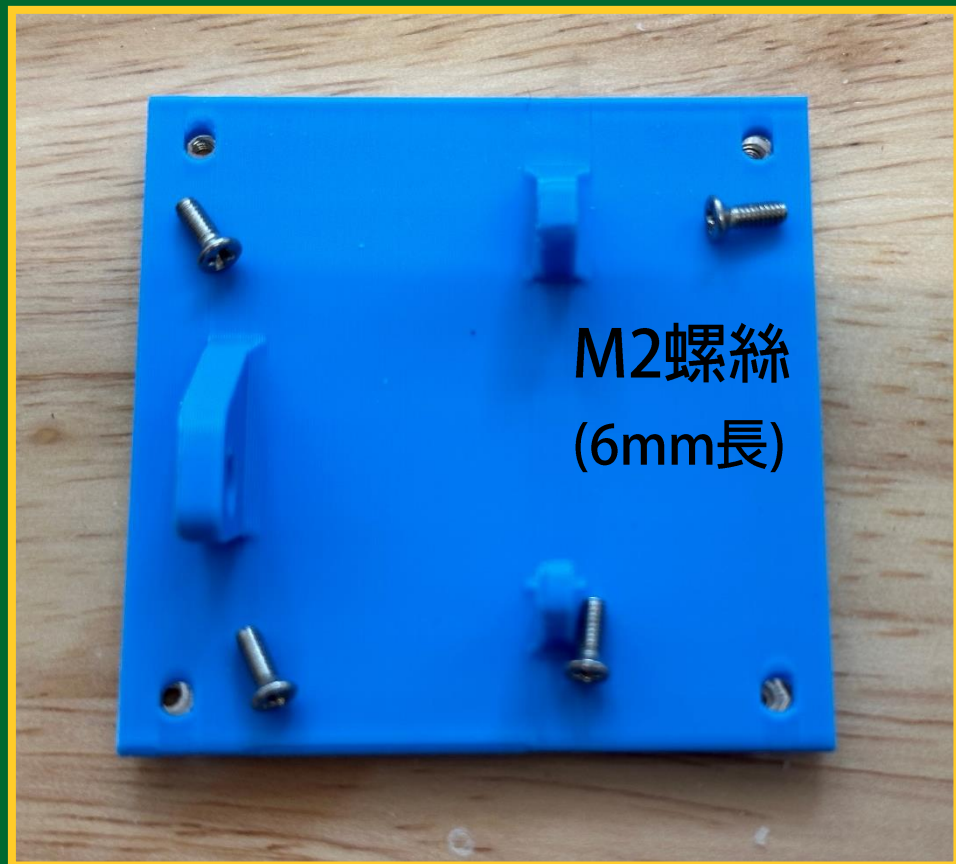


底



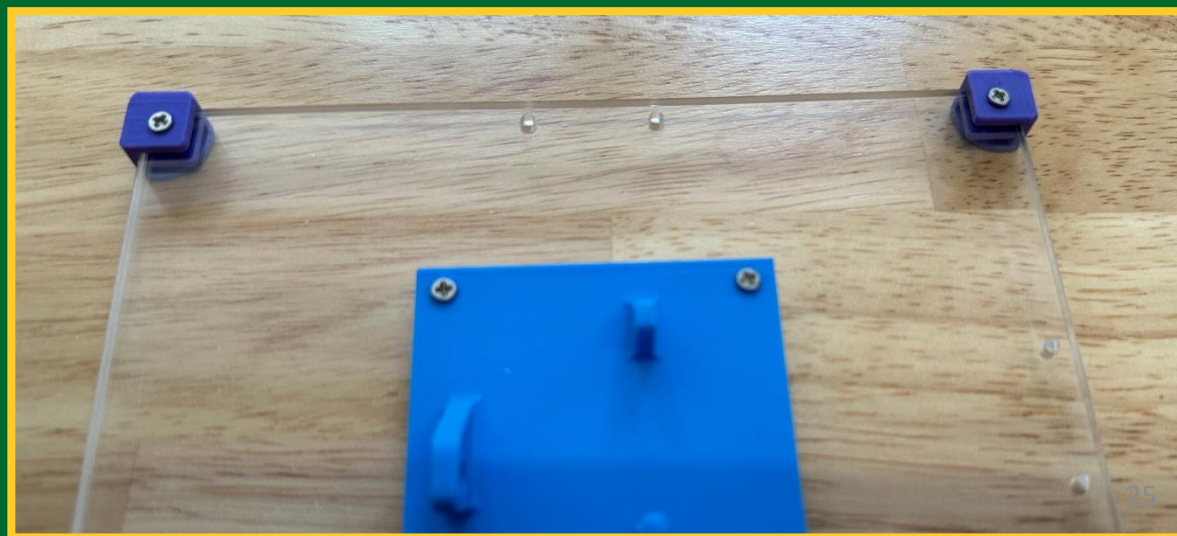
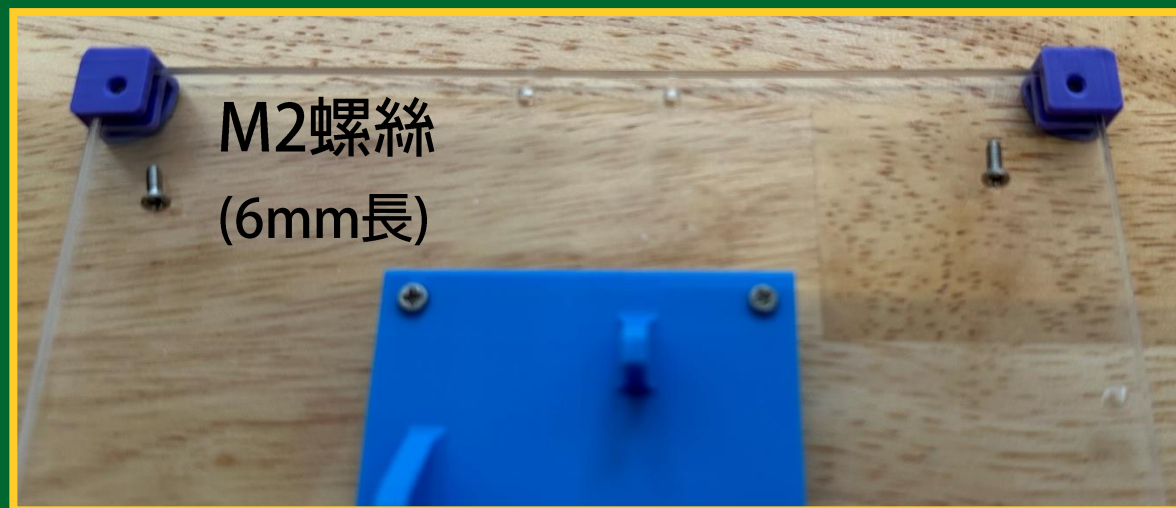
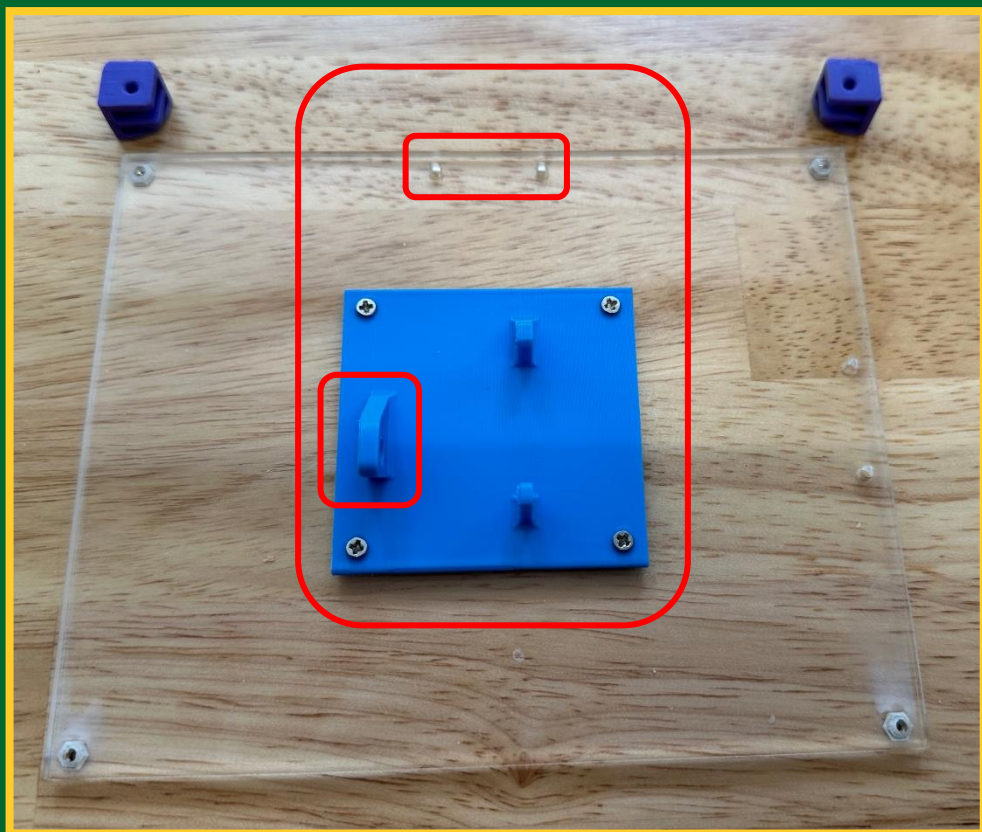
6b

# 安裝太陽能電池板



6c

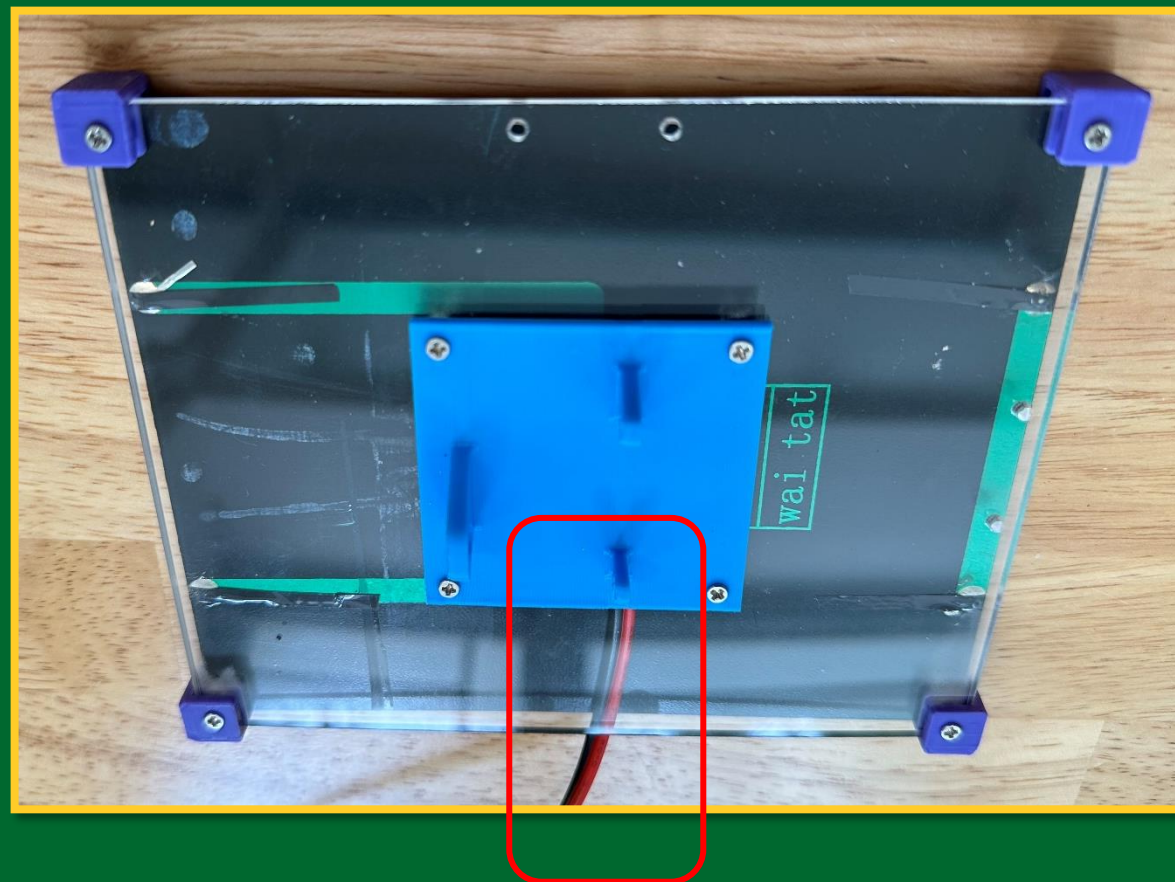
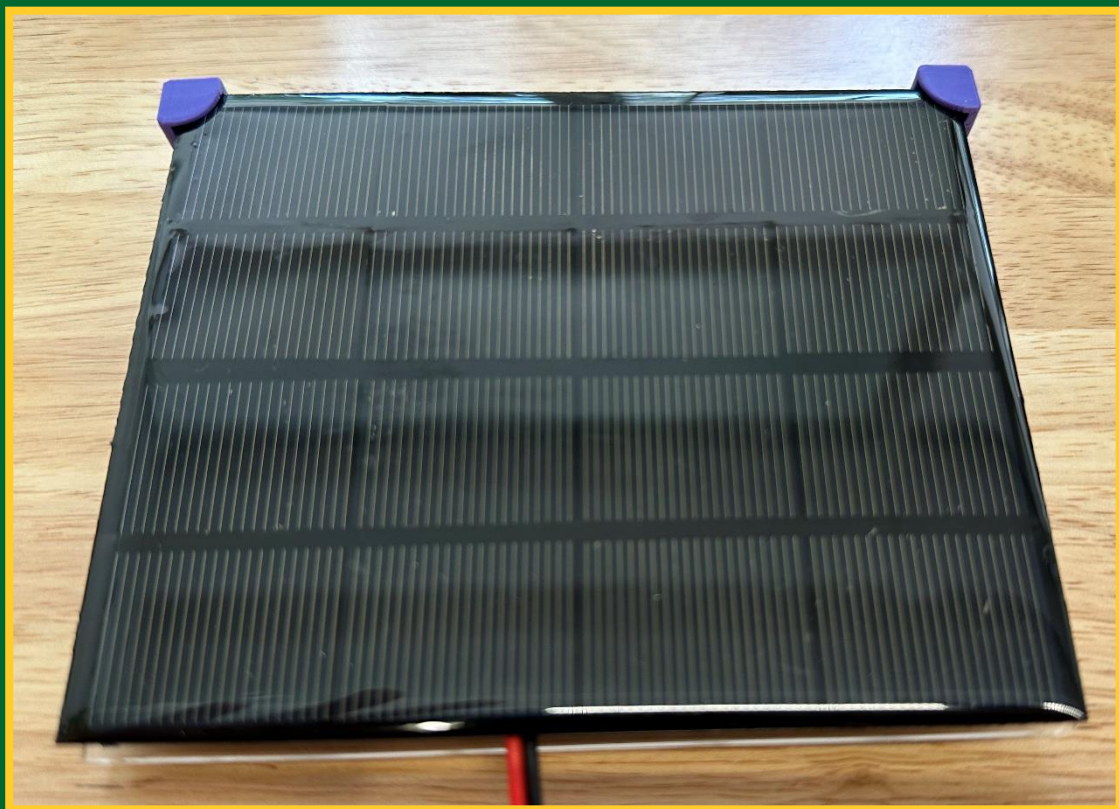
## 安裝太陽能電池板





6d

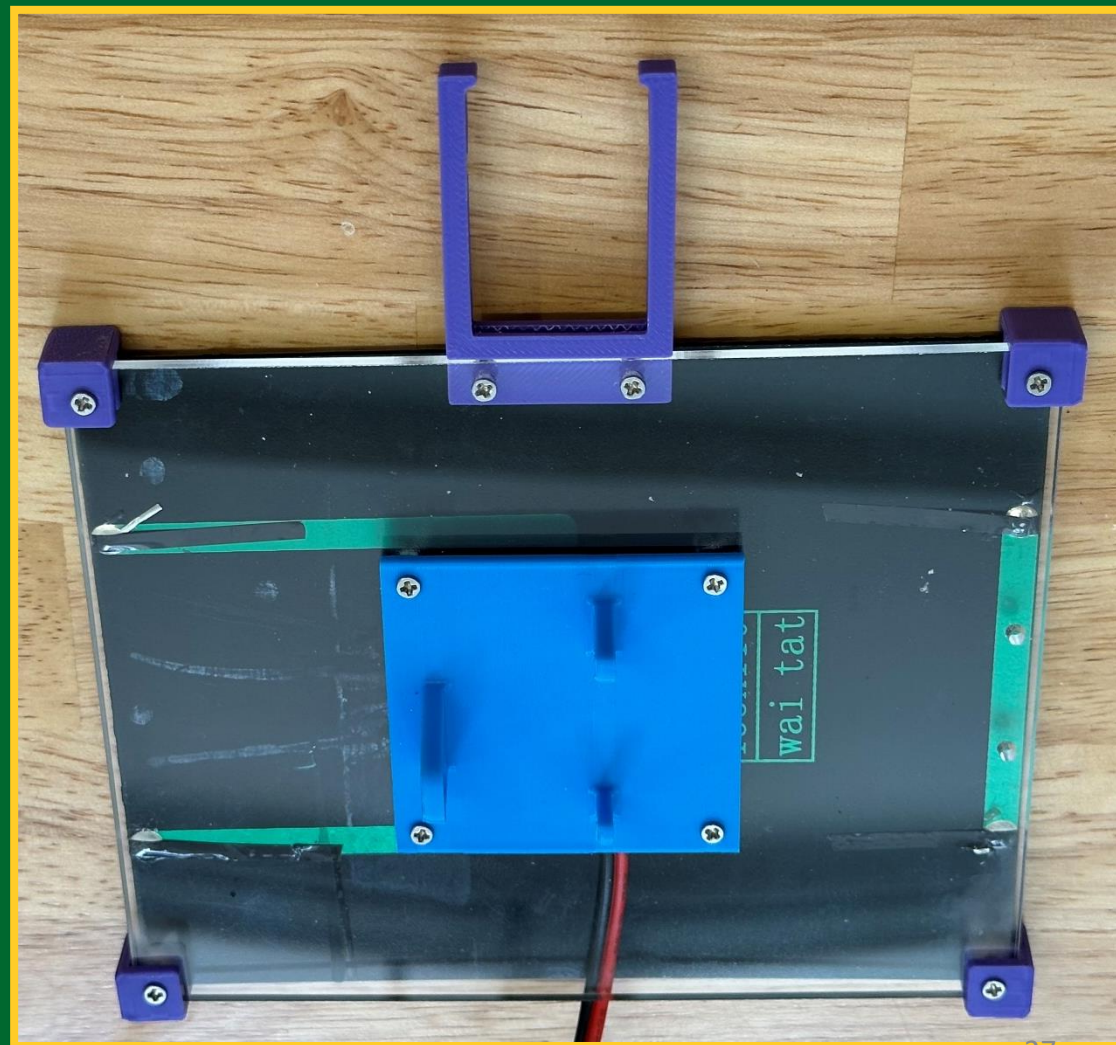
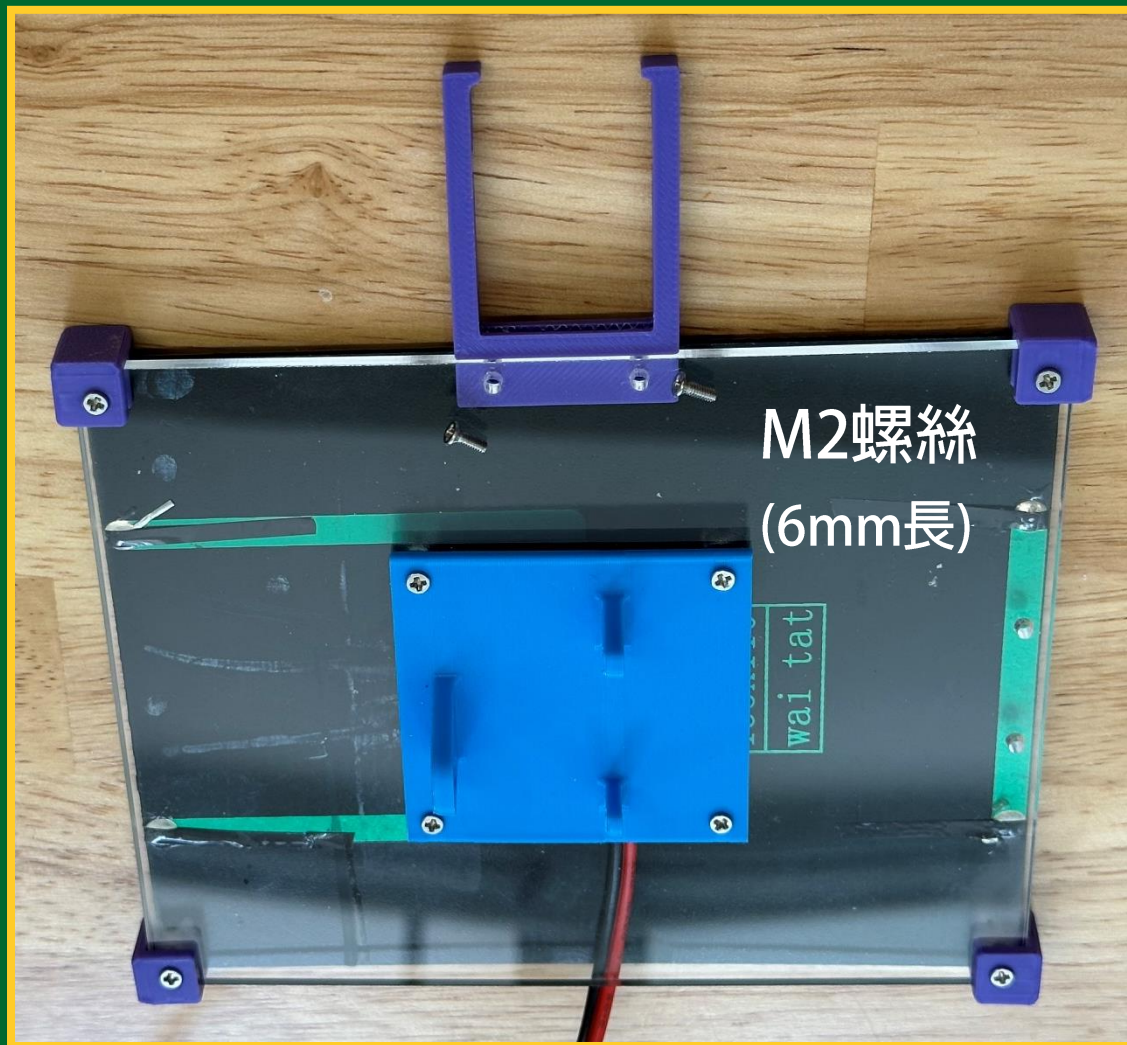
# 安裝太陽能電池板





7a

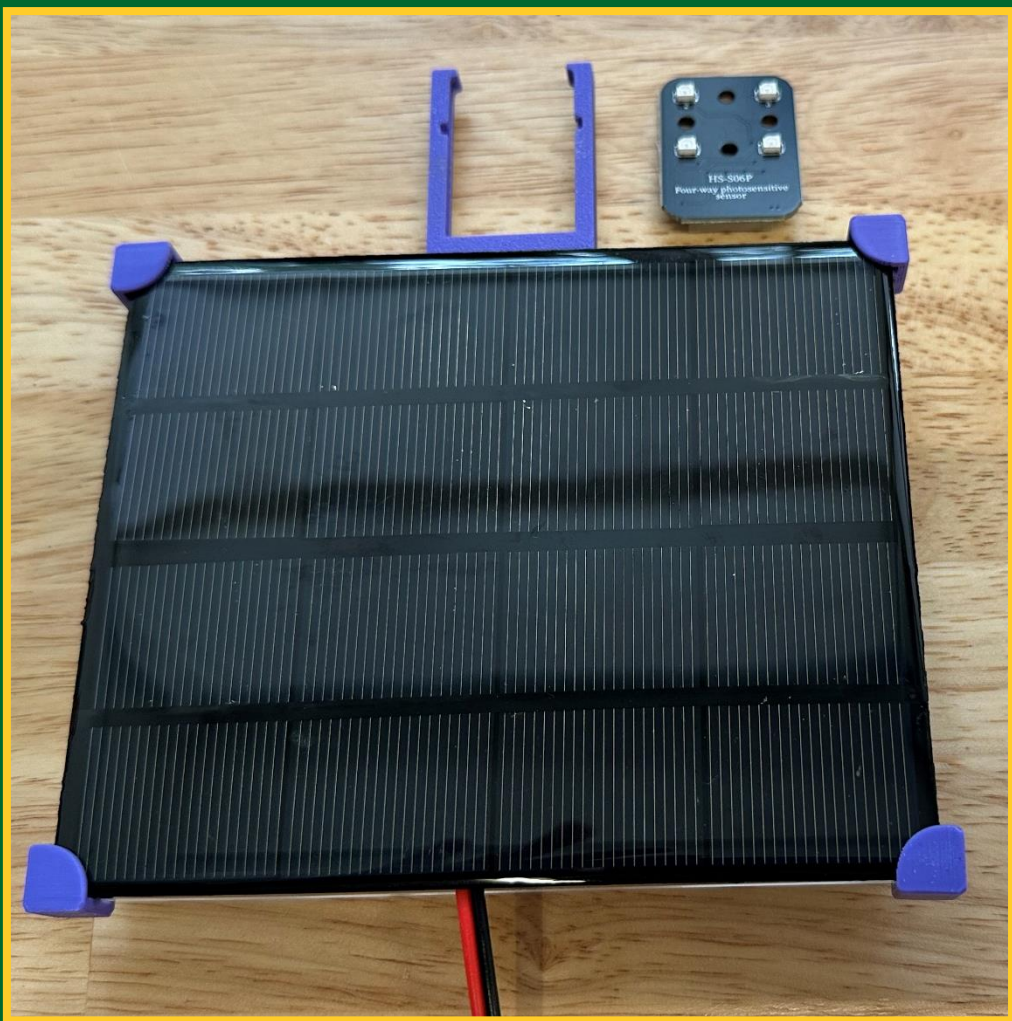
# 安裝四路光敏傳感器





7b

## 安裝四路光敏傳感器





8

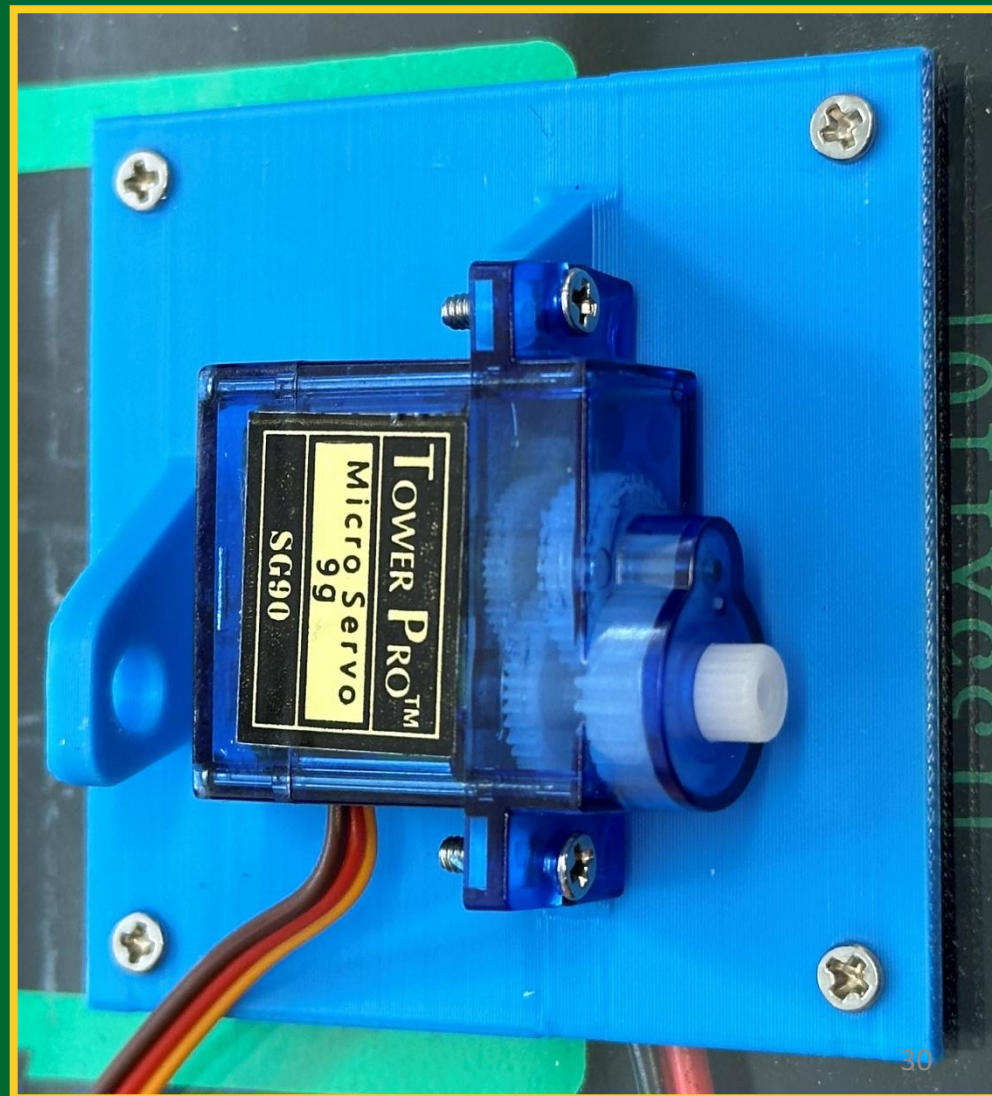
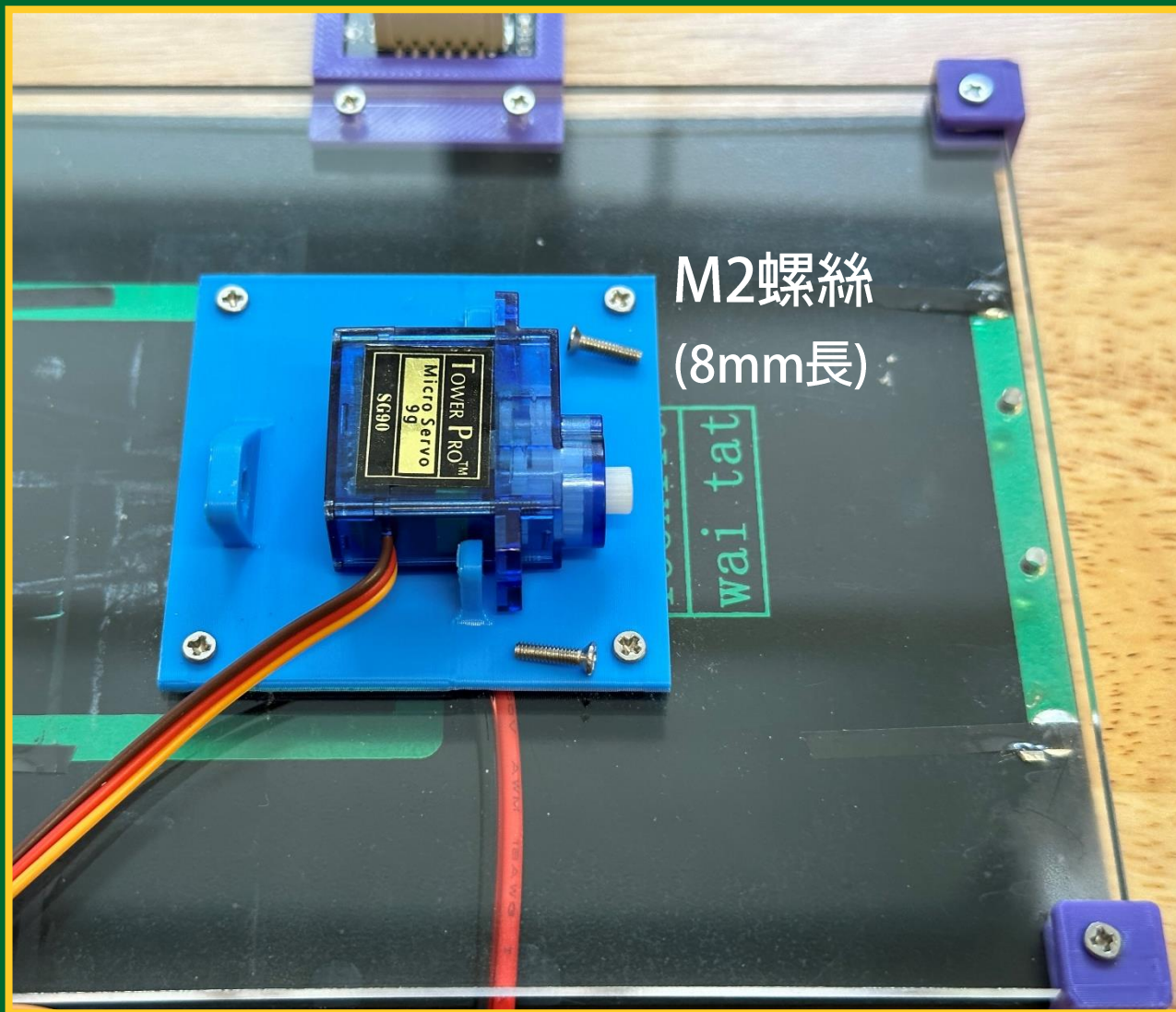
## 安放光敏傳感器的分隔組件





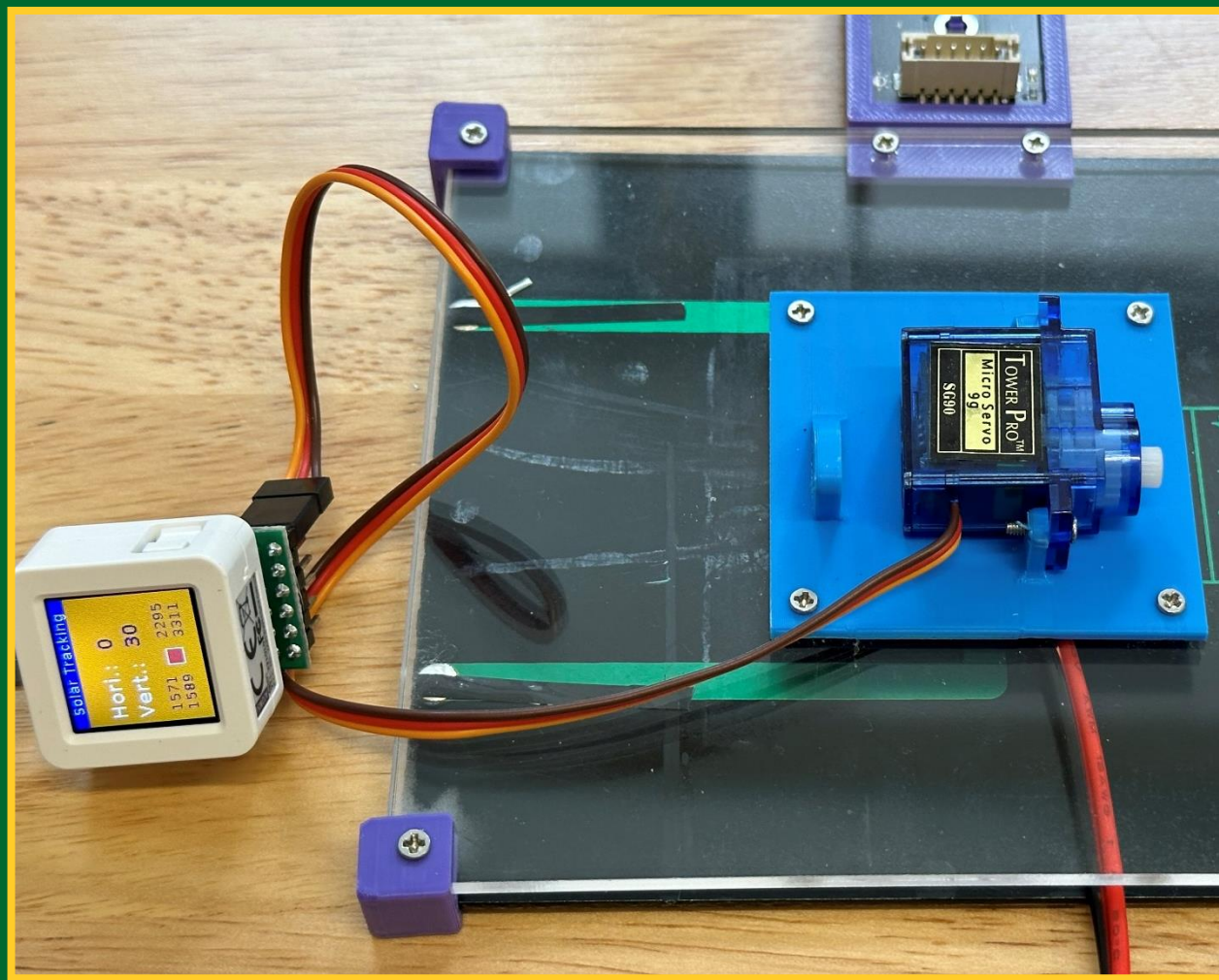
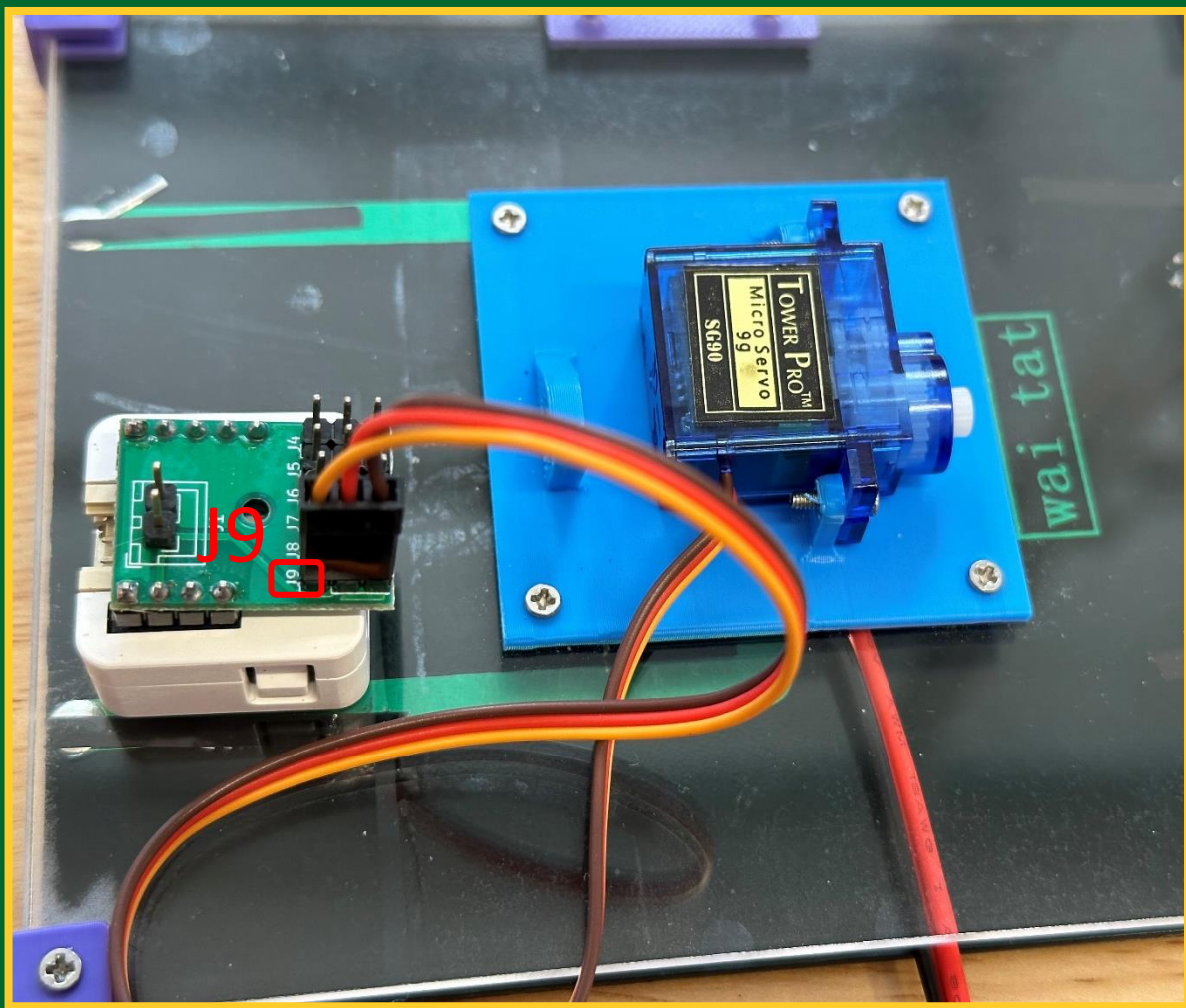
9a

## 安裝垂直旋轉支架





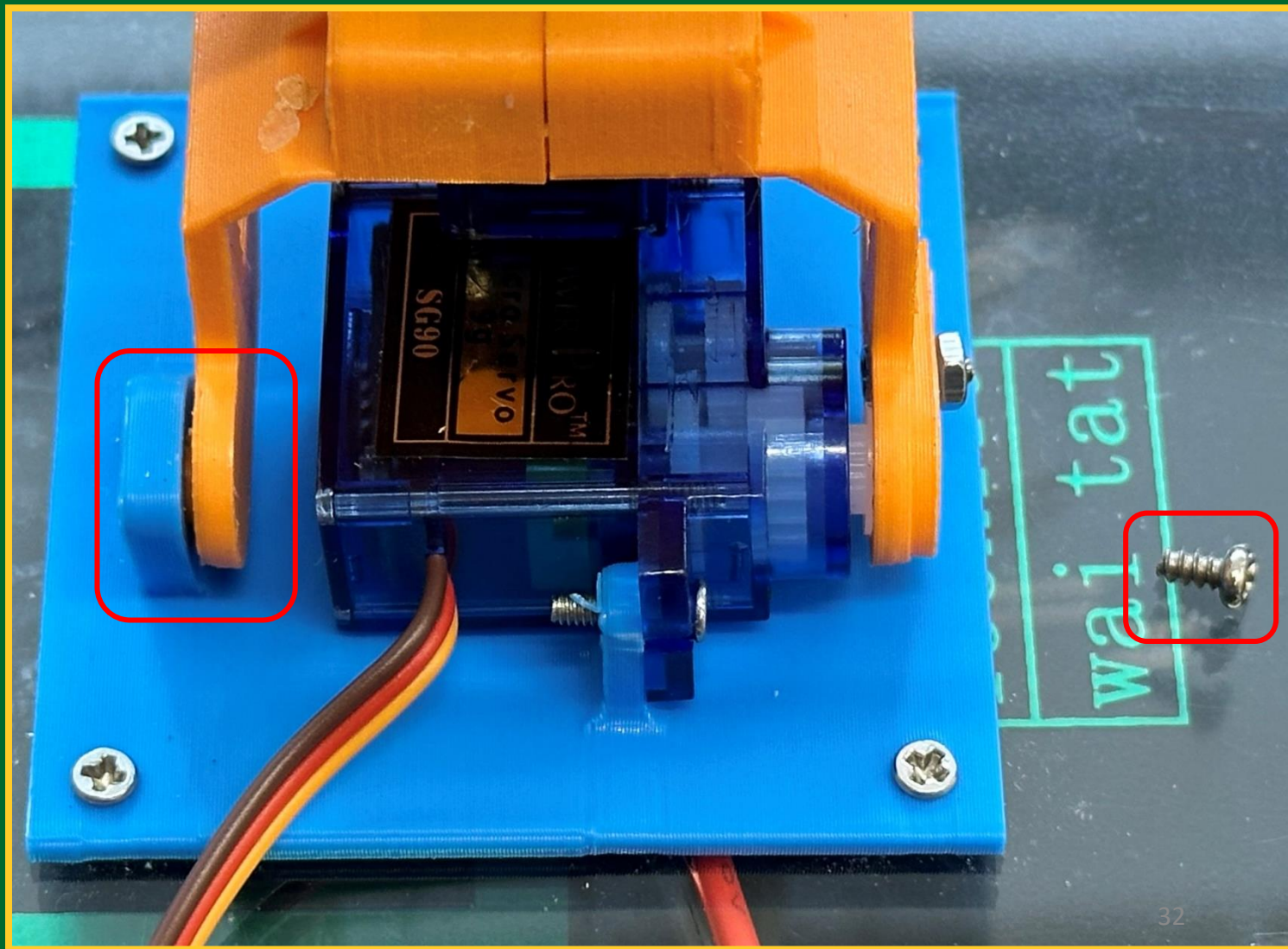
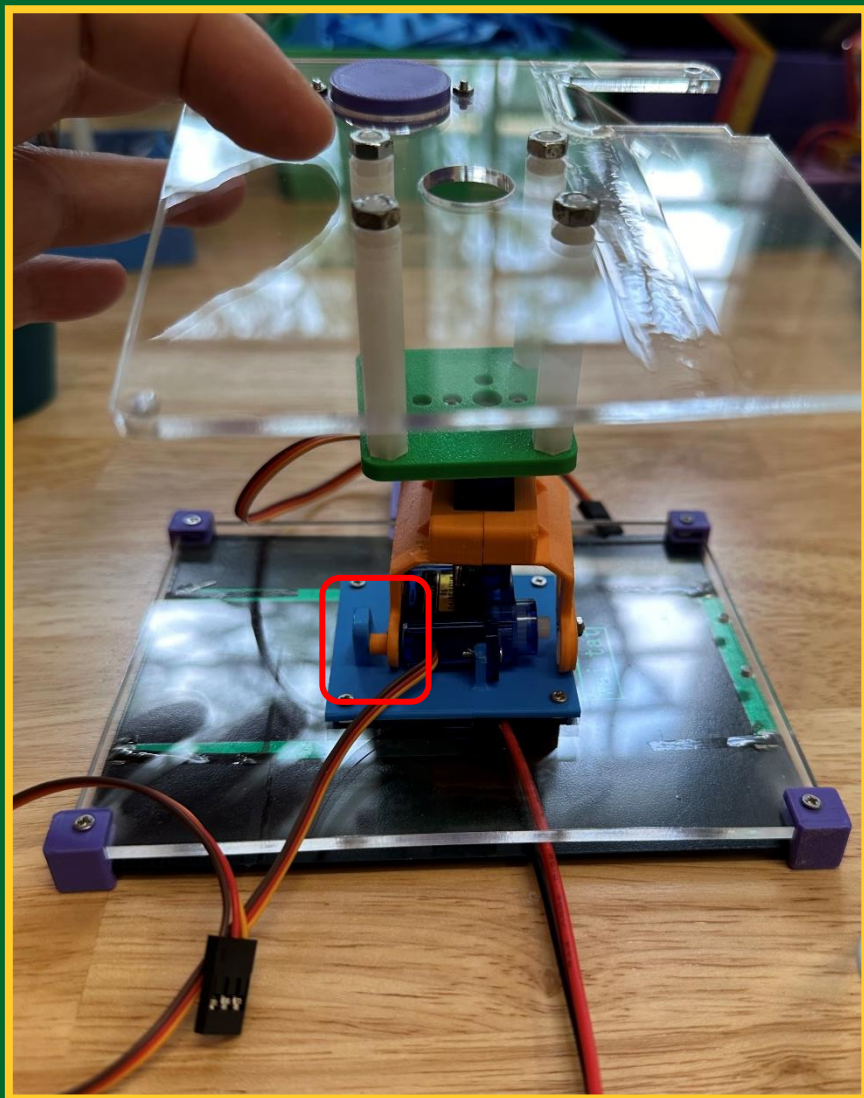
## 9b 安裝垂直旋轉支架





9c

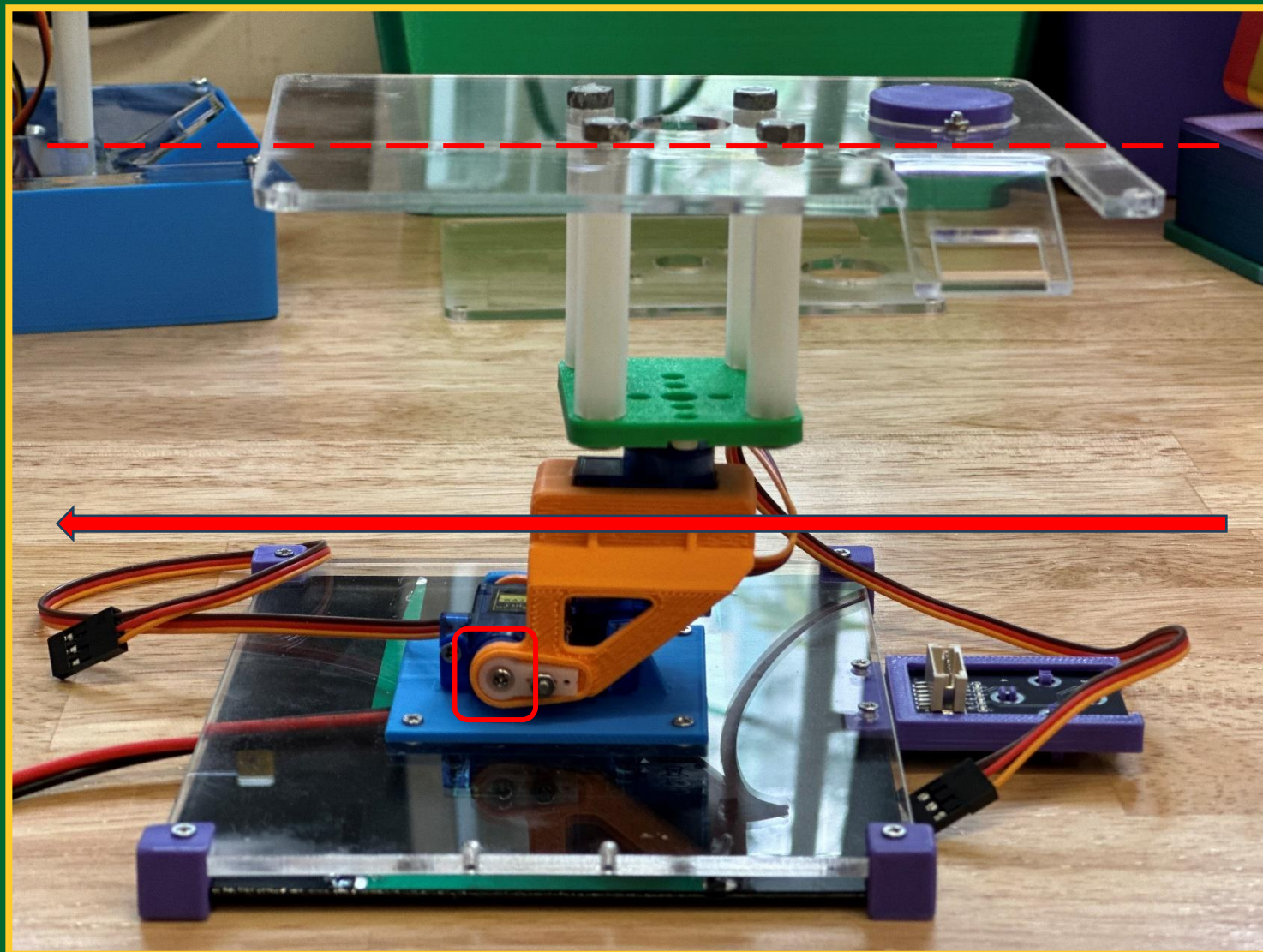
# 安裝垂直旋轉支架





9d

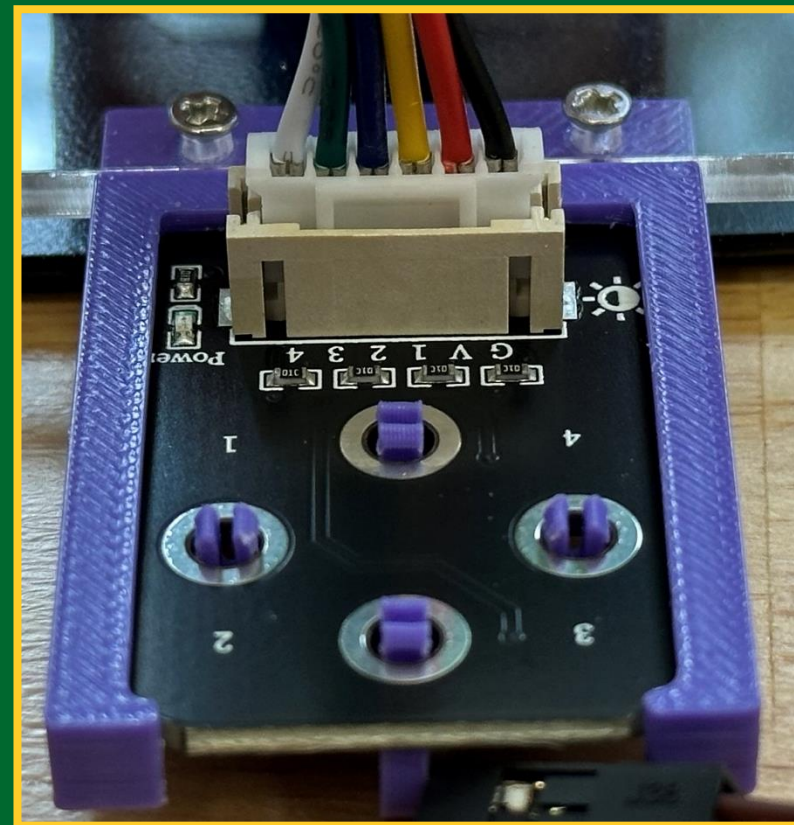
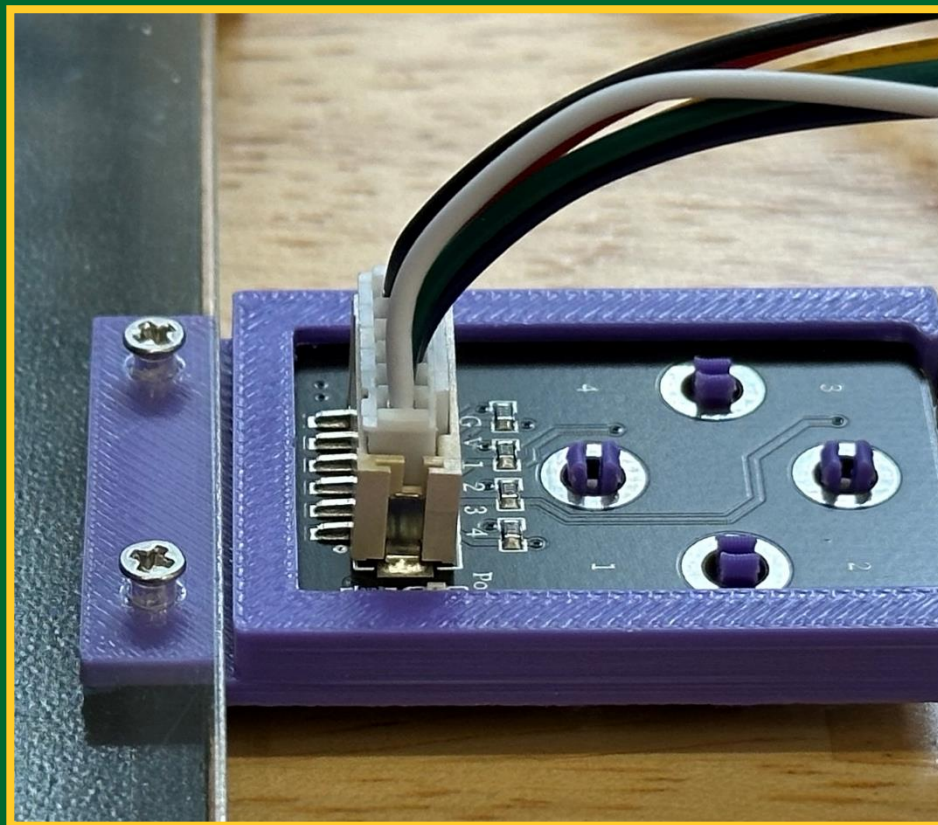
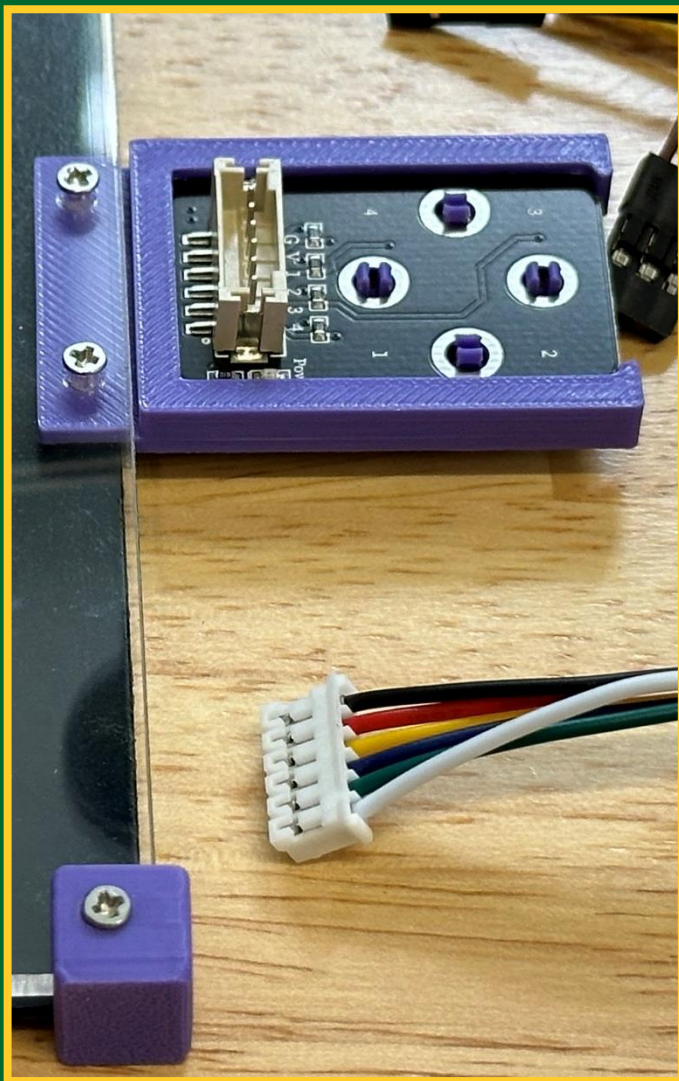
# 安裝垂直旋轉支架





10a

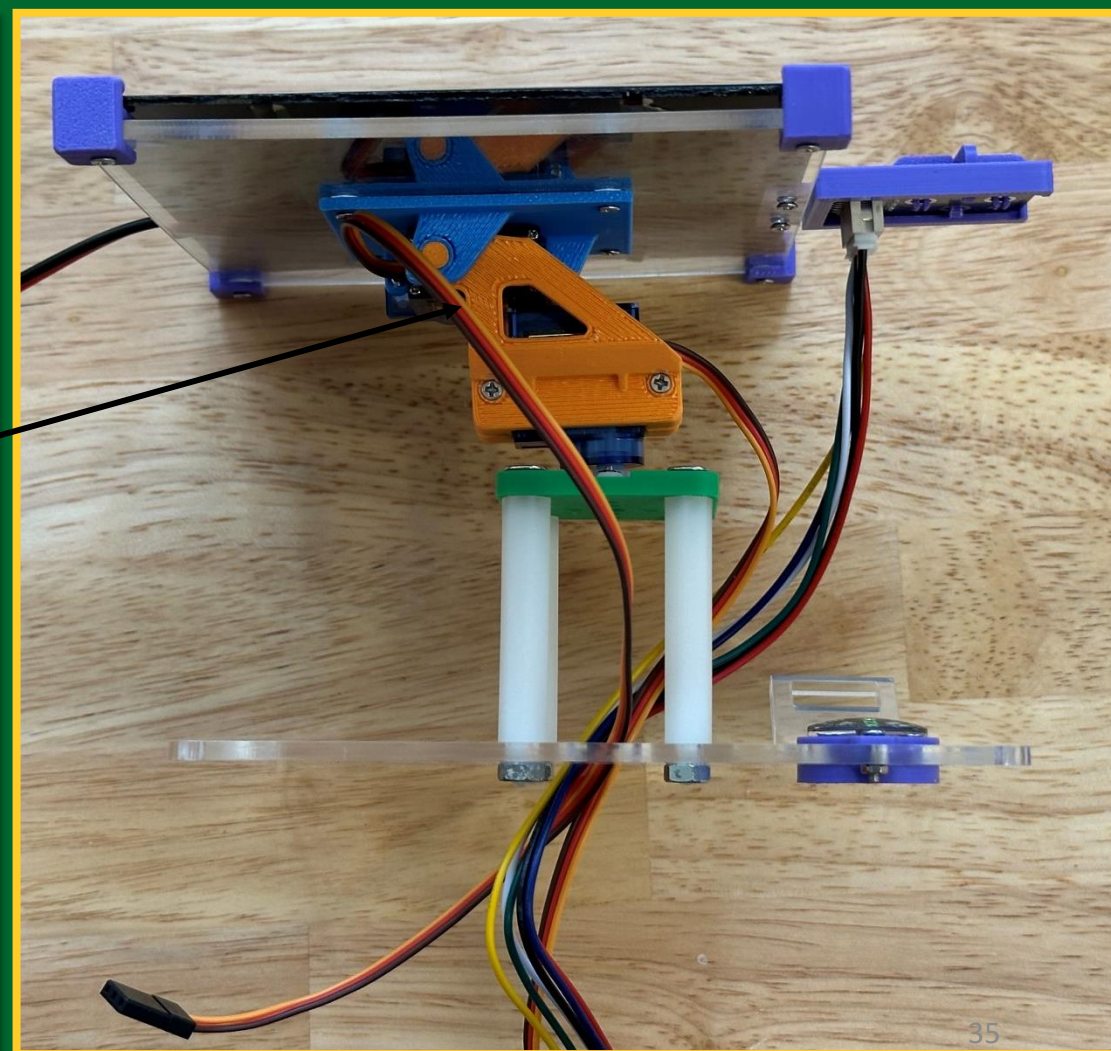
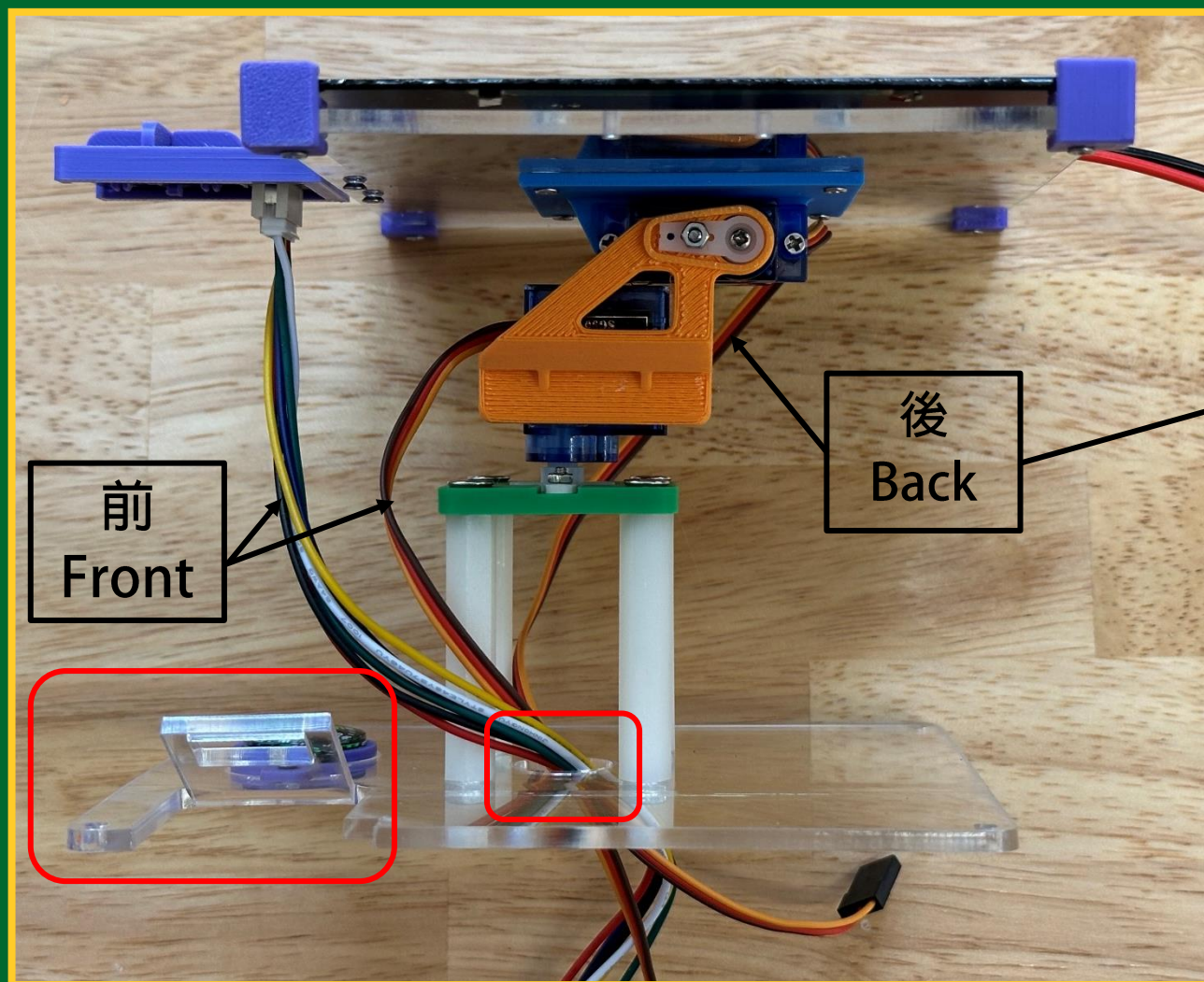
# 連接所有電子部件至印刷電路板(PCB)





10b

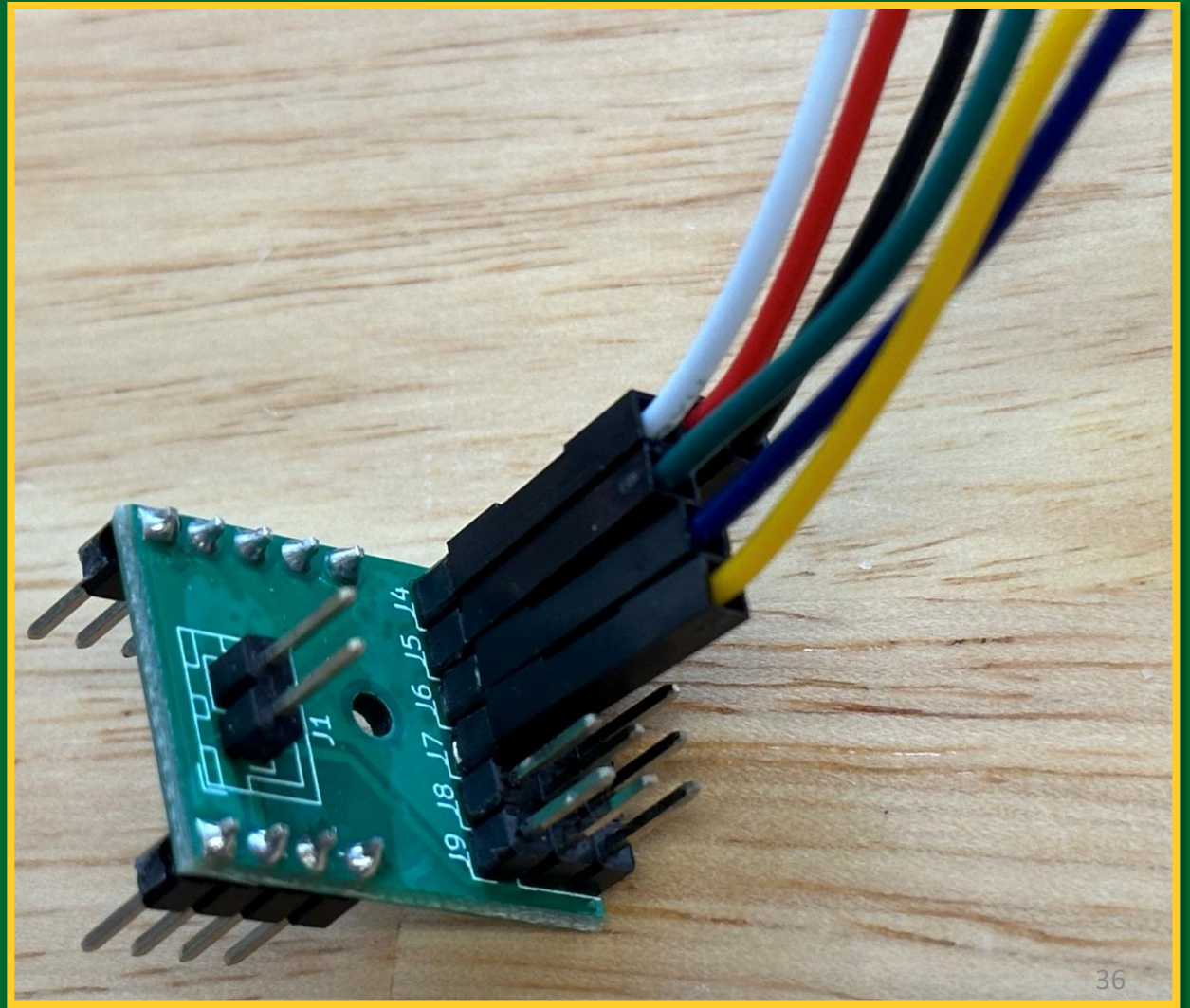
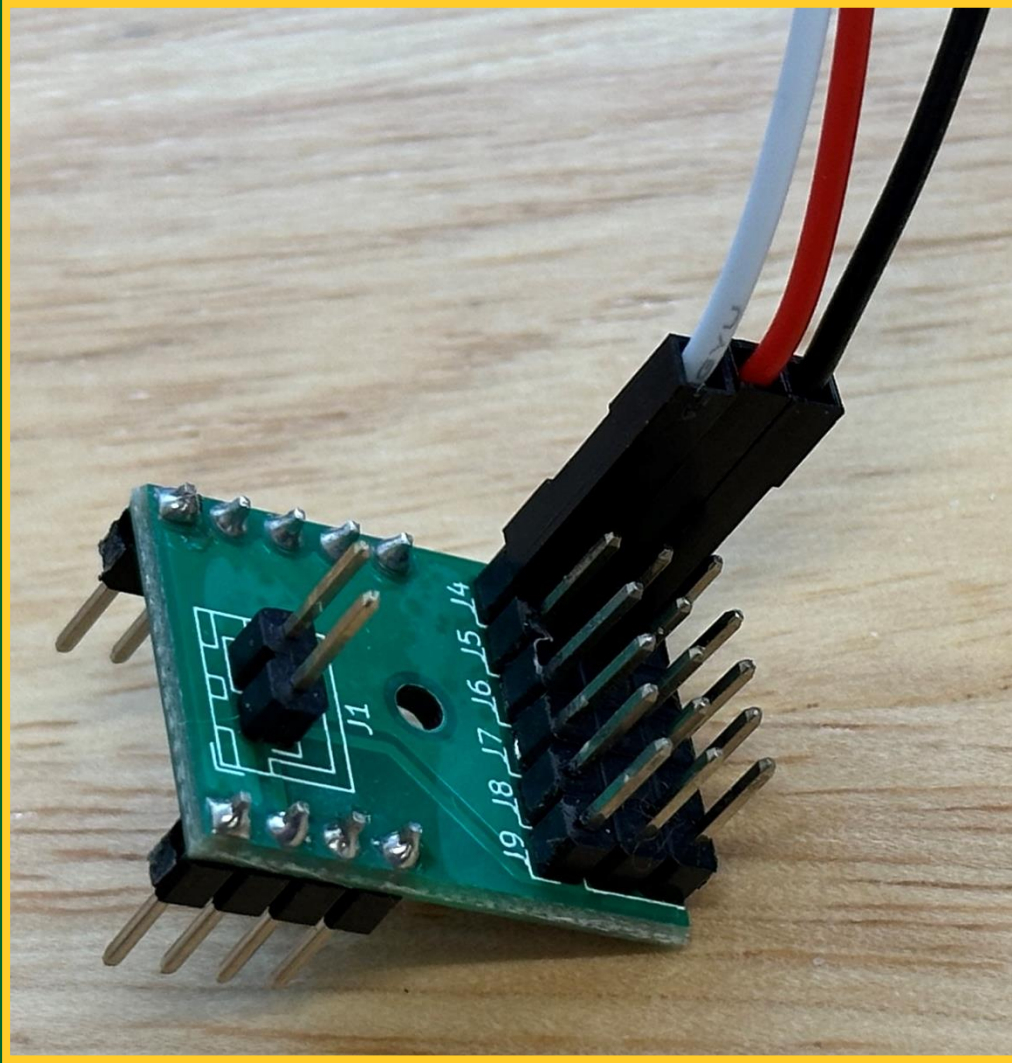
# 連接所有電子部件至印刷電路板(PCB)





10c

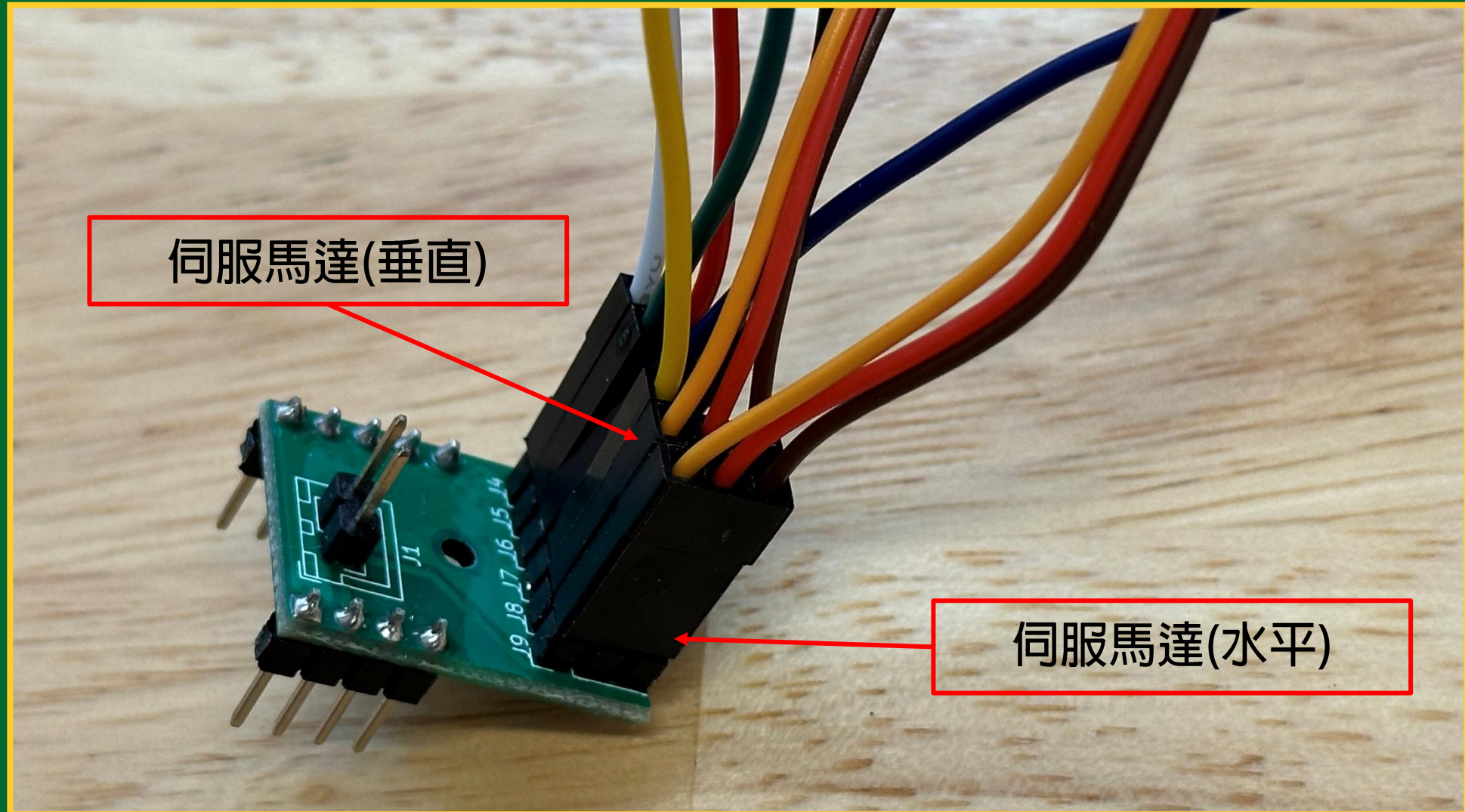
# 連接所有電子部件至印刷電路板(PCB)





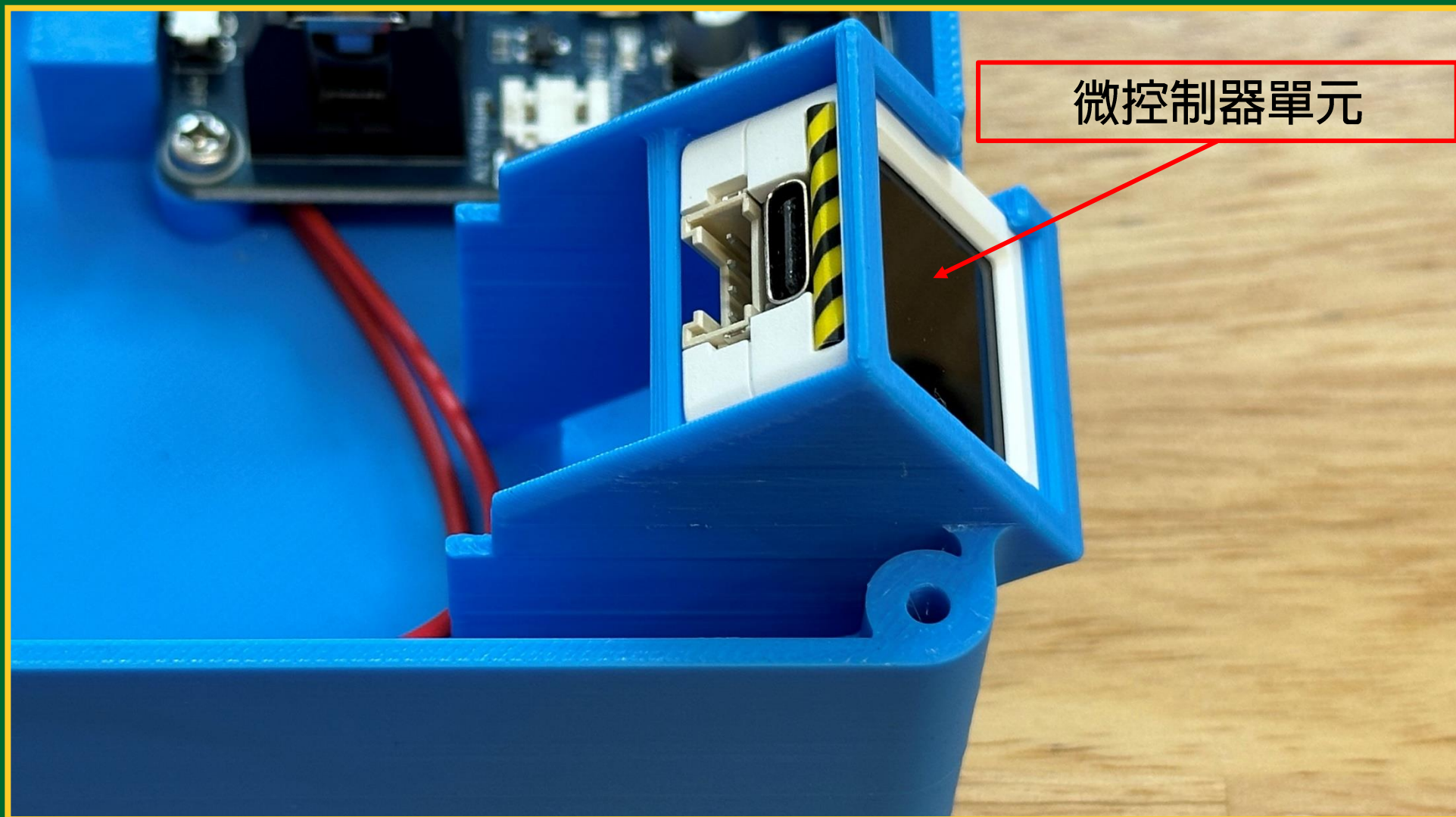
10d

# 連接所有電子部件至印刷電路板(PCB)



11a

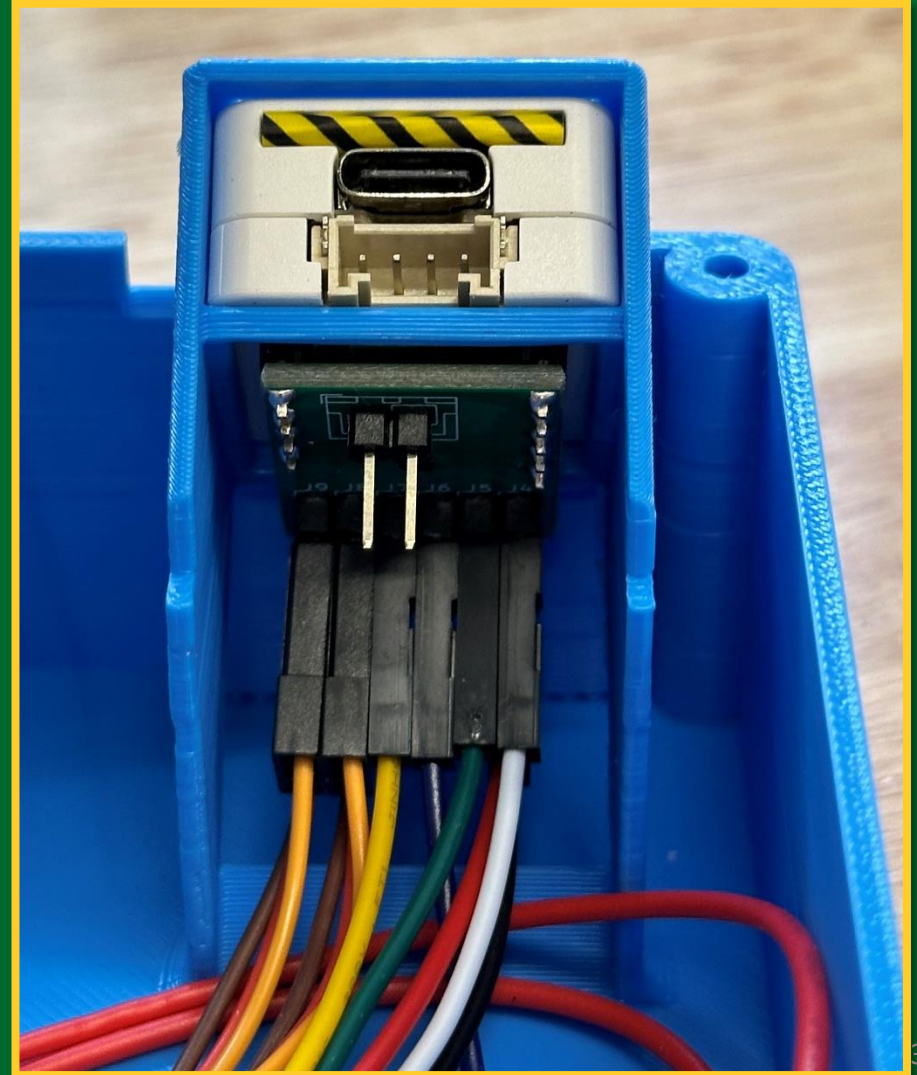
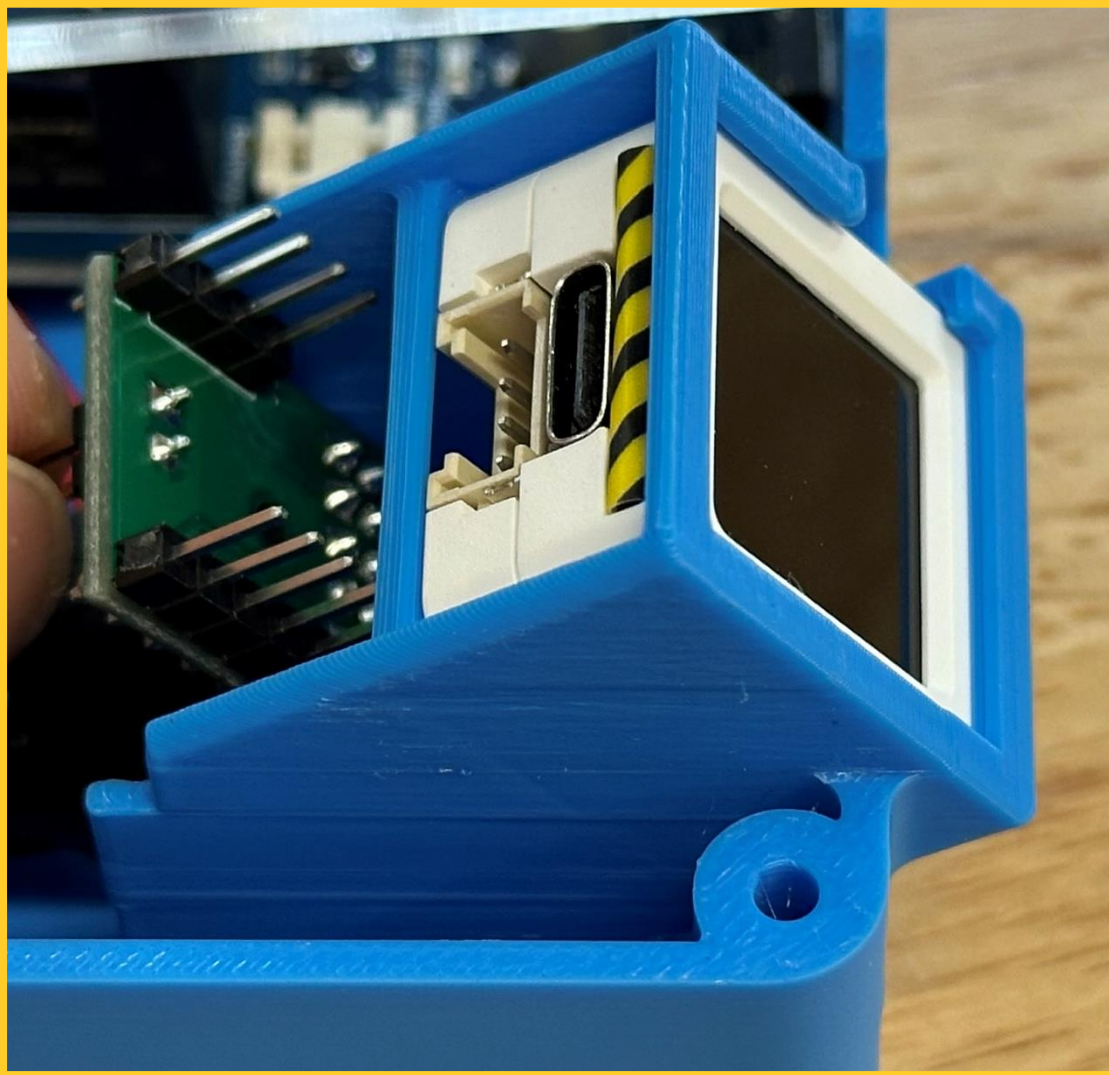
# 連接微控制器單元至印刷電路板的接腳





11b

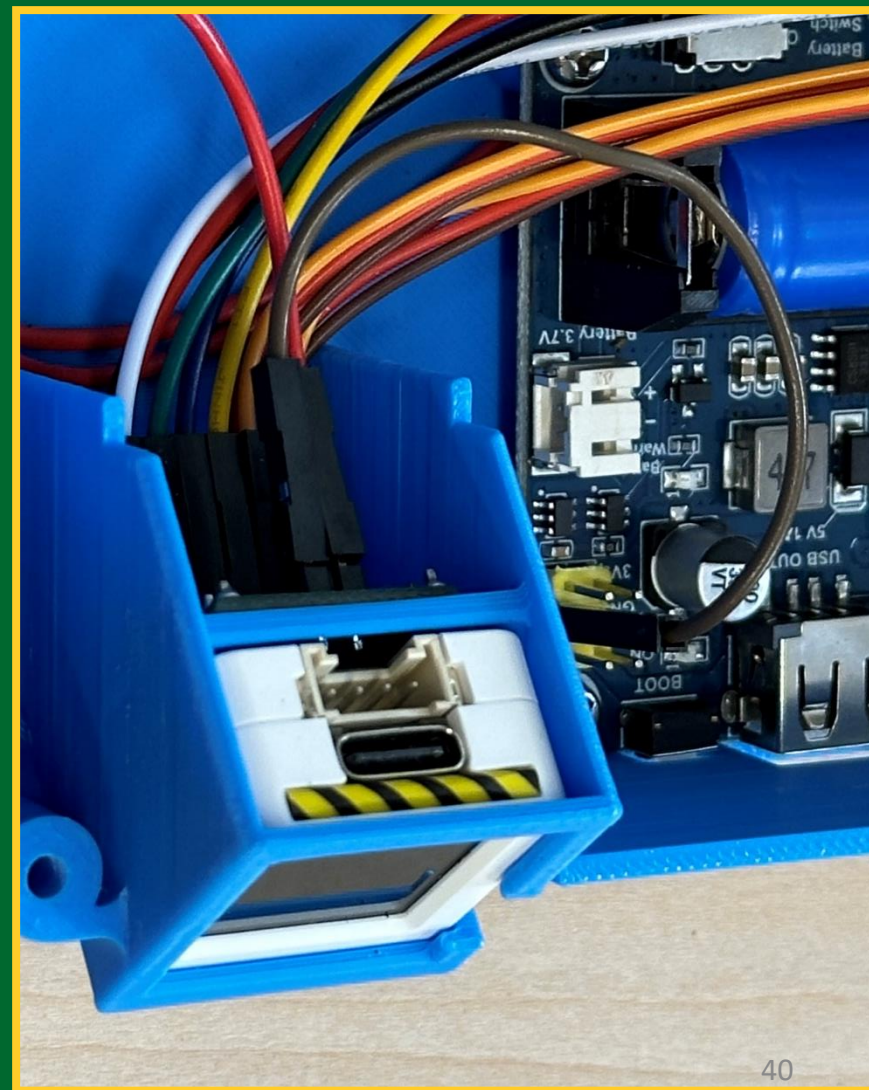
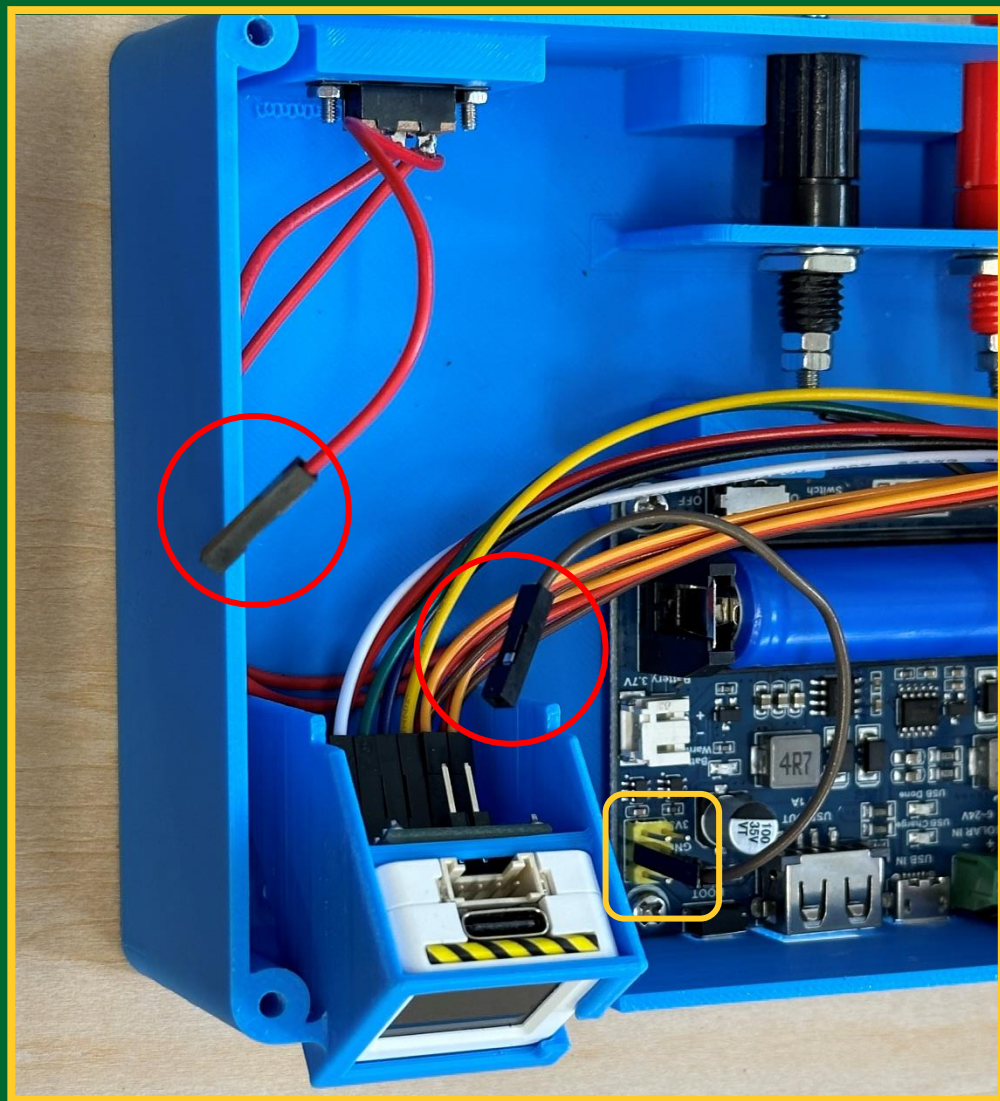
# 連接微控制器單元至印刷電路板的接腳





11c

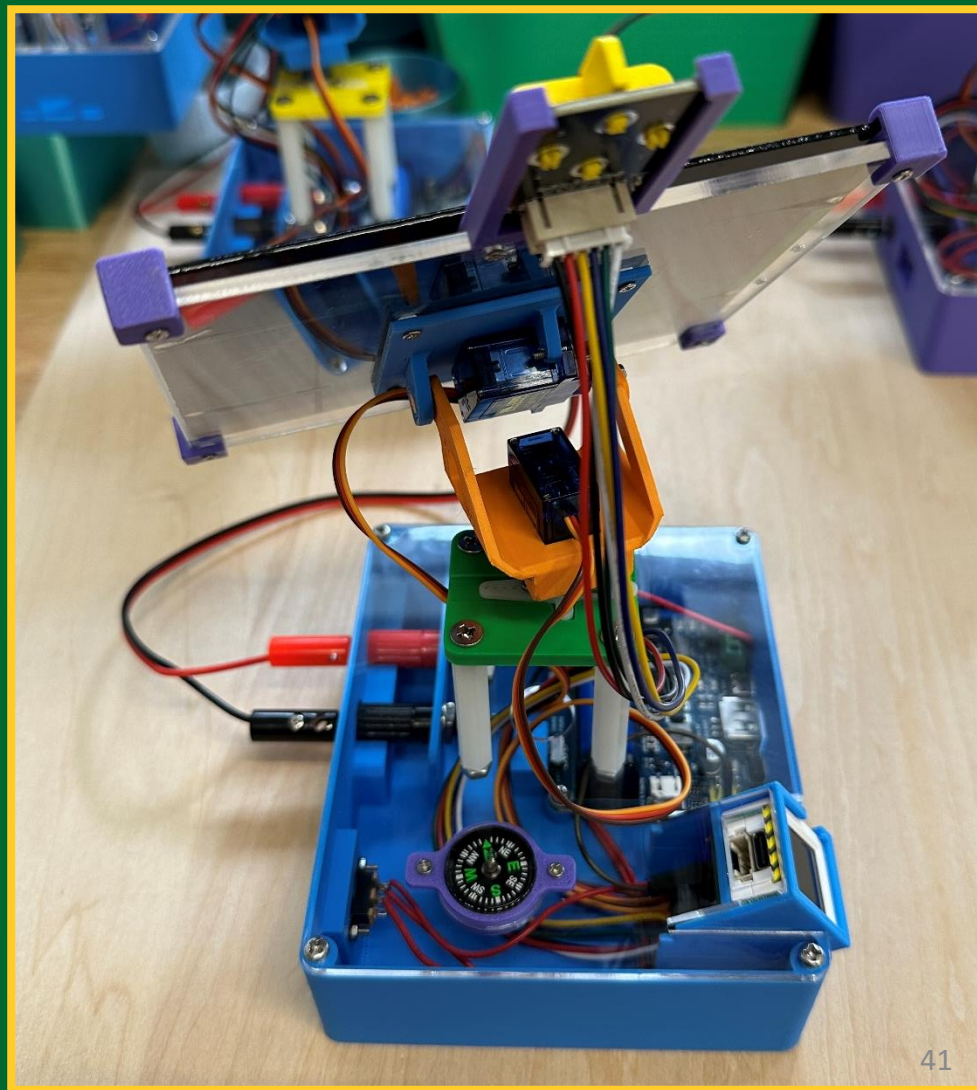
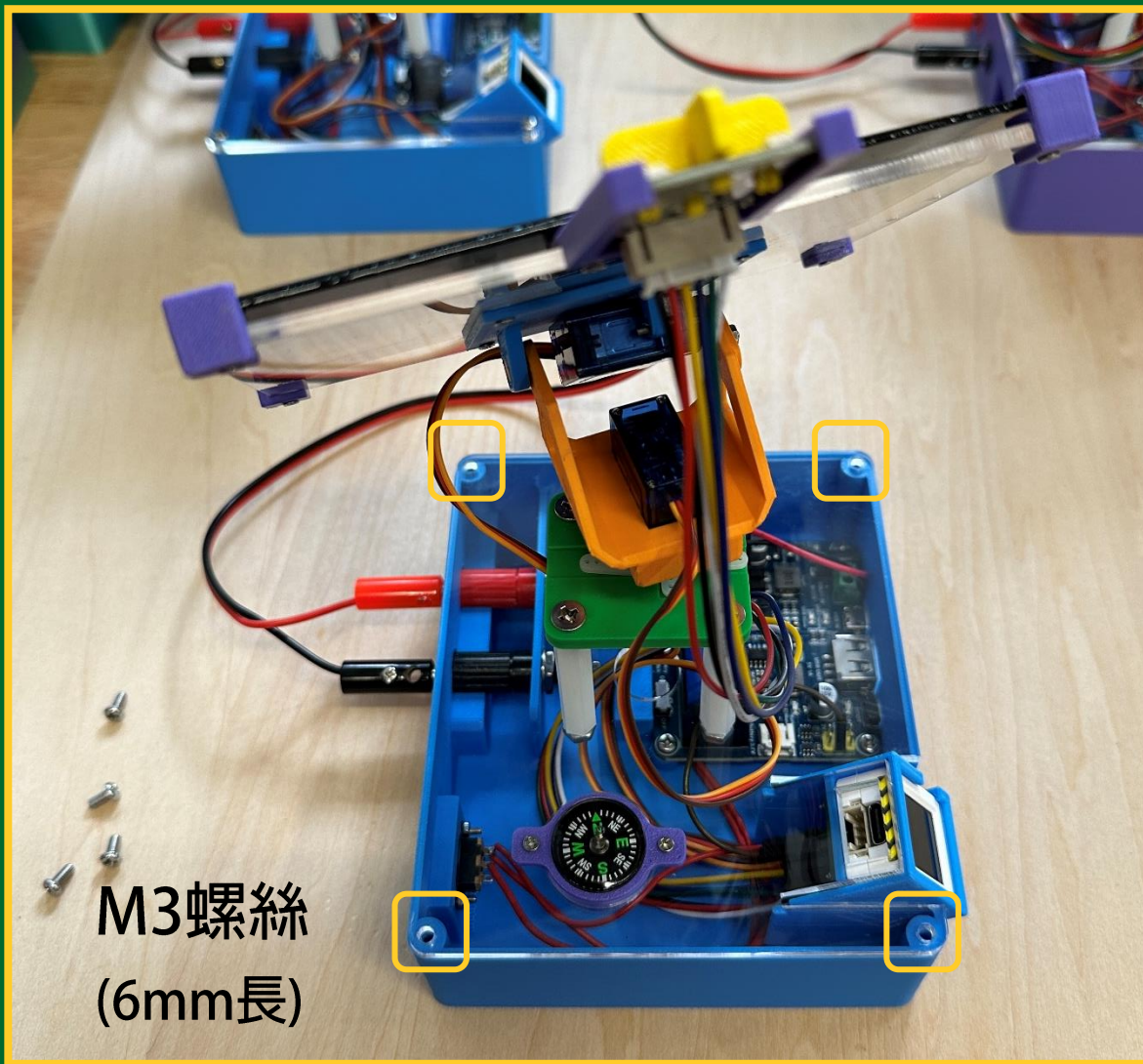
# 連接微控制器單元至印刷電路板的接腳





12

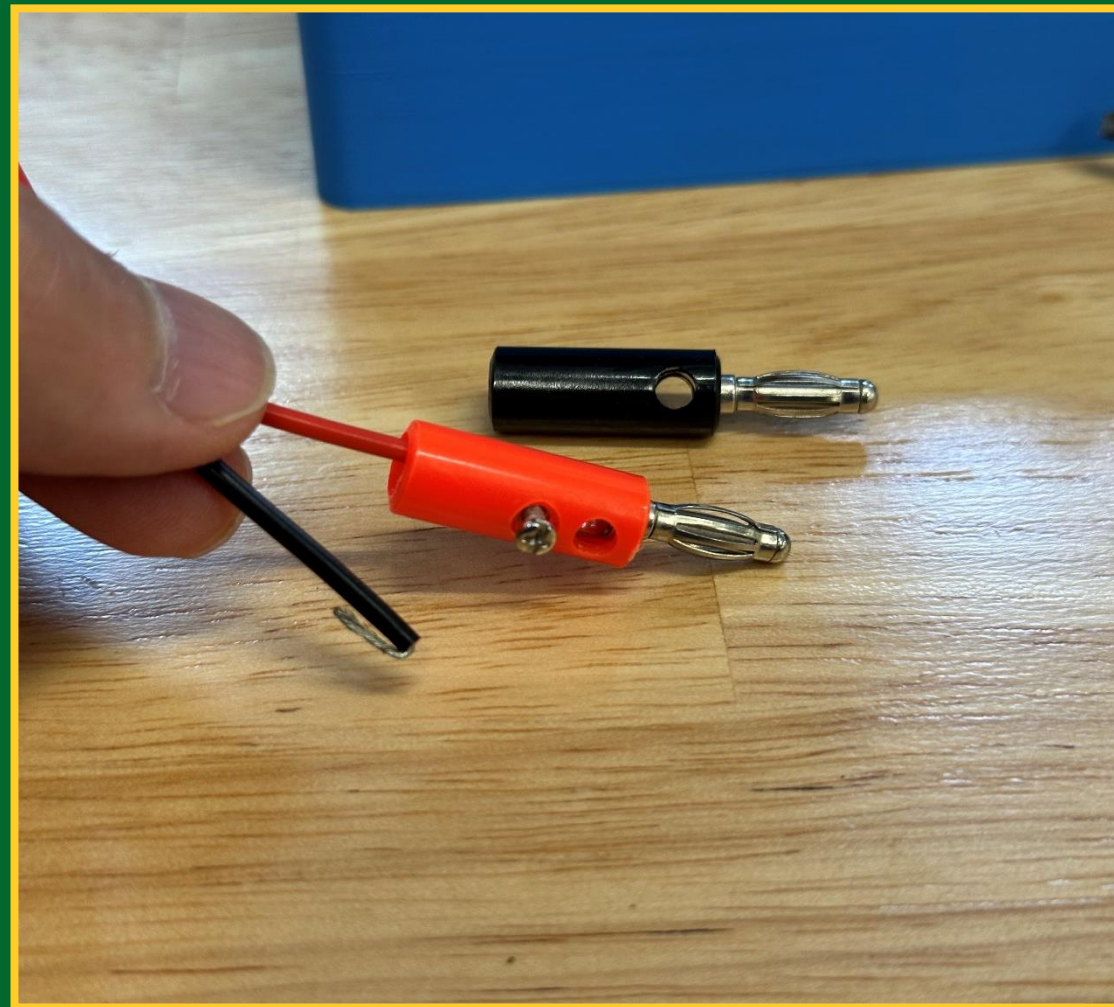
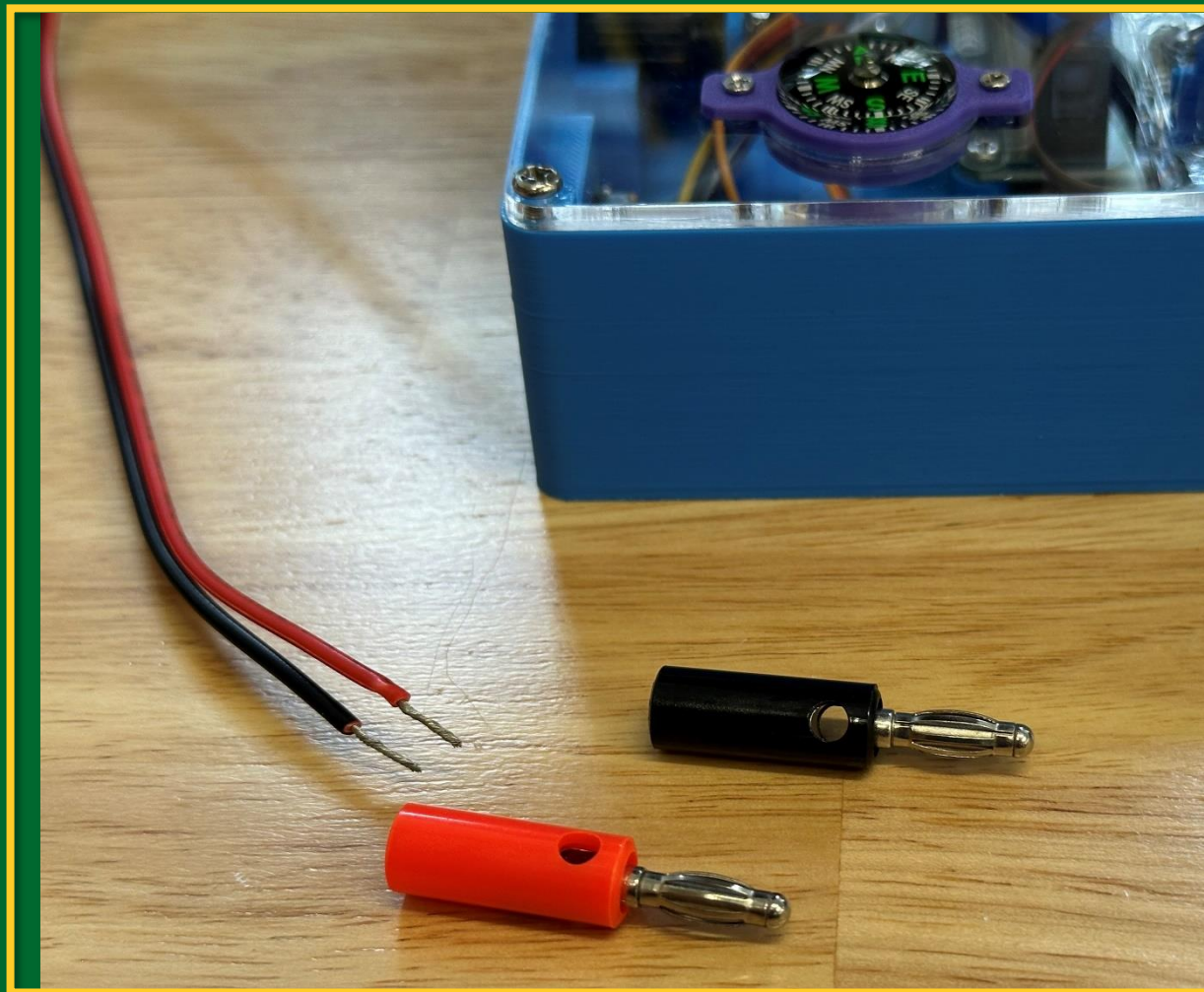
## 擺放及固定裝置基座面板





13a

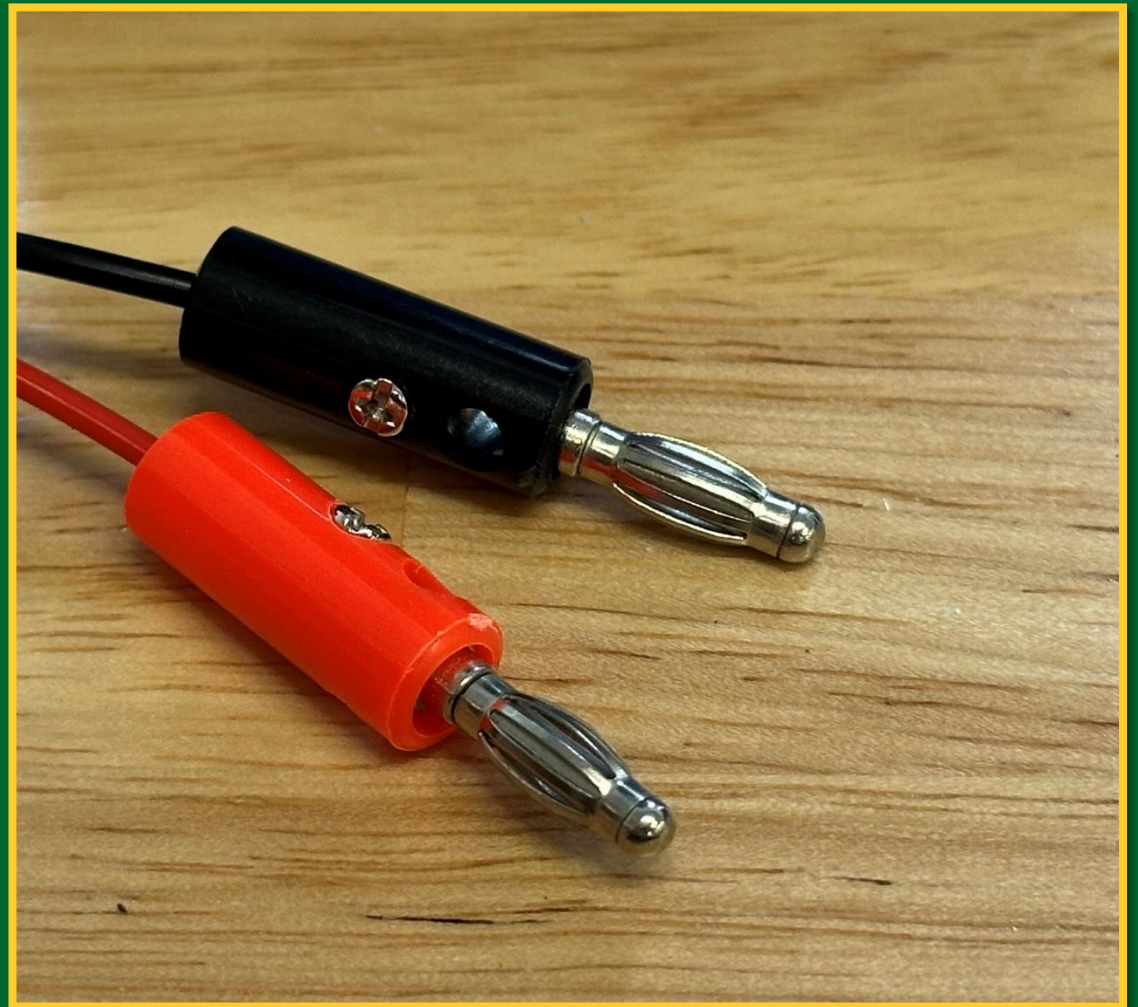
# 連接太陽能電池板供電線至香蕉插





13b

# 連接太陽能電池板供電線至香蕉插





# Workshop on Designing and Making a Solar Tracking Device

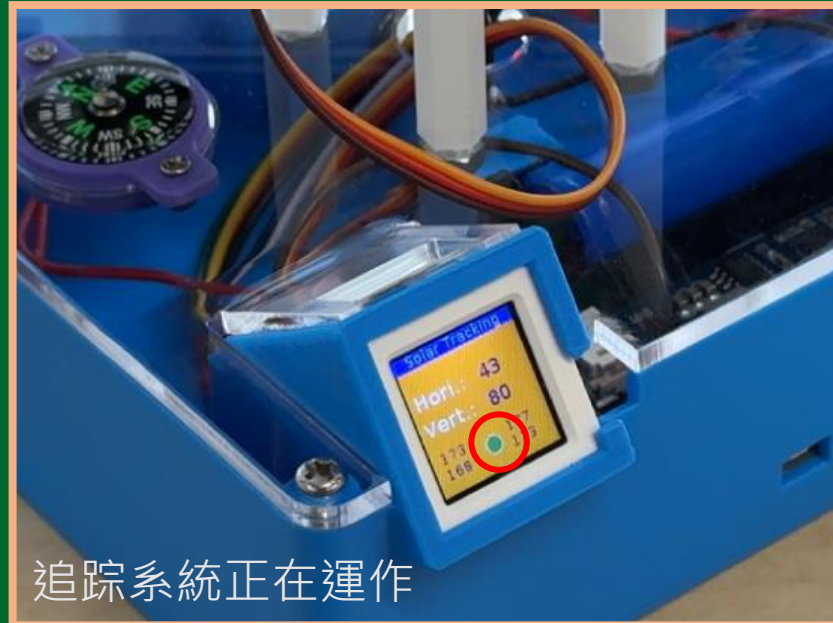
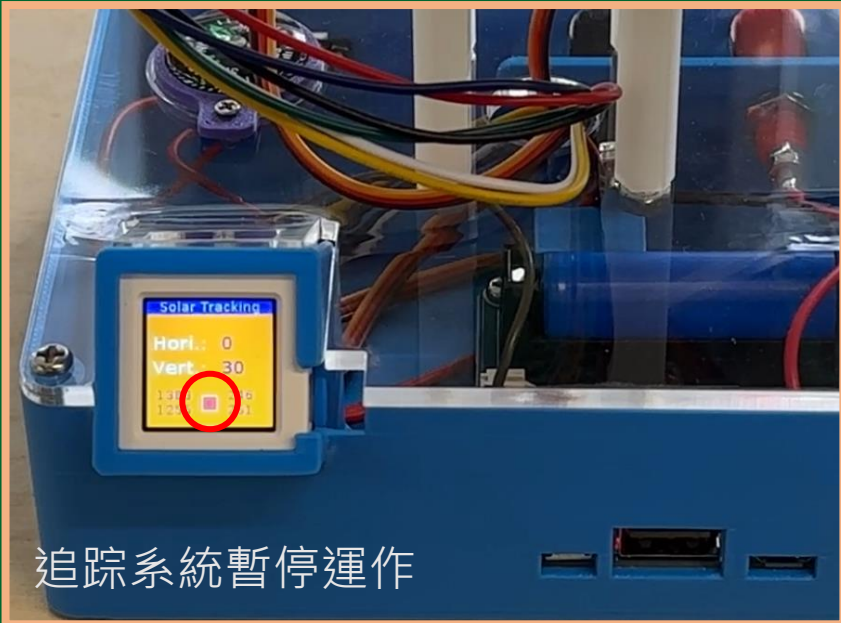
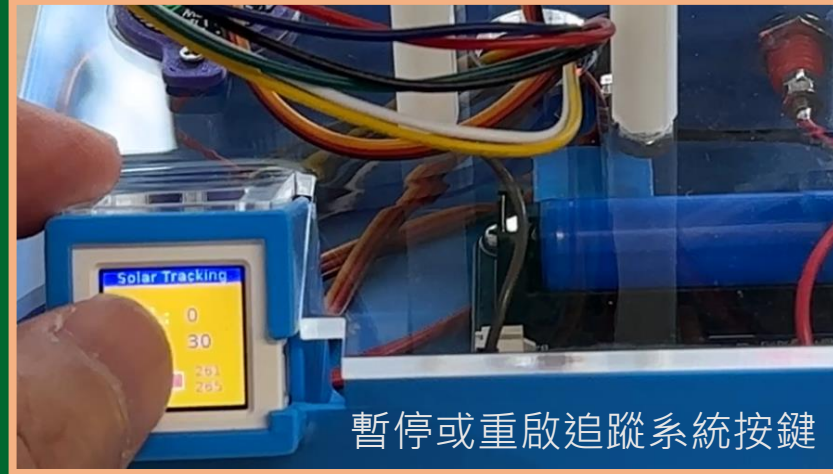
## 設計與製作太陽追蹤裝置工作坊

裝置運作演示



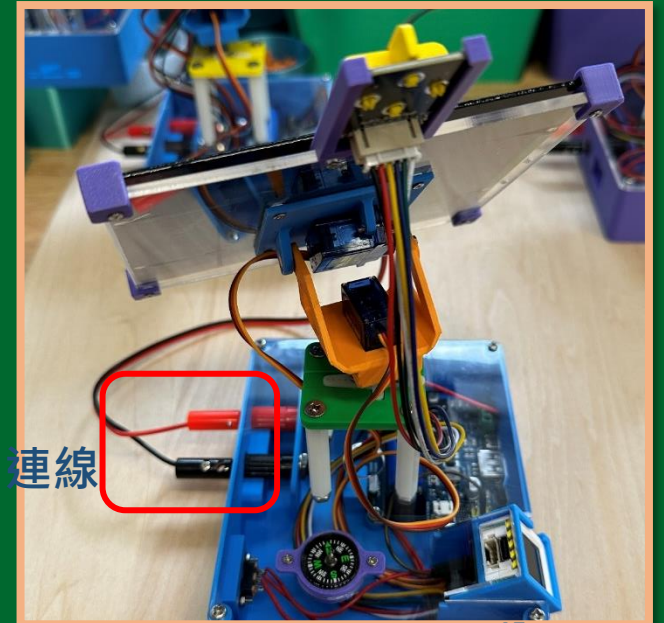


# 裝置操作簡介



## 注意事項：

裝置無需開啟即可在有光線的環境下充電，只需確保太陽能電池板已正確連接（見下圖）。但請避免長時間將電池暴露於太陽下，以防引發安全風險。



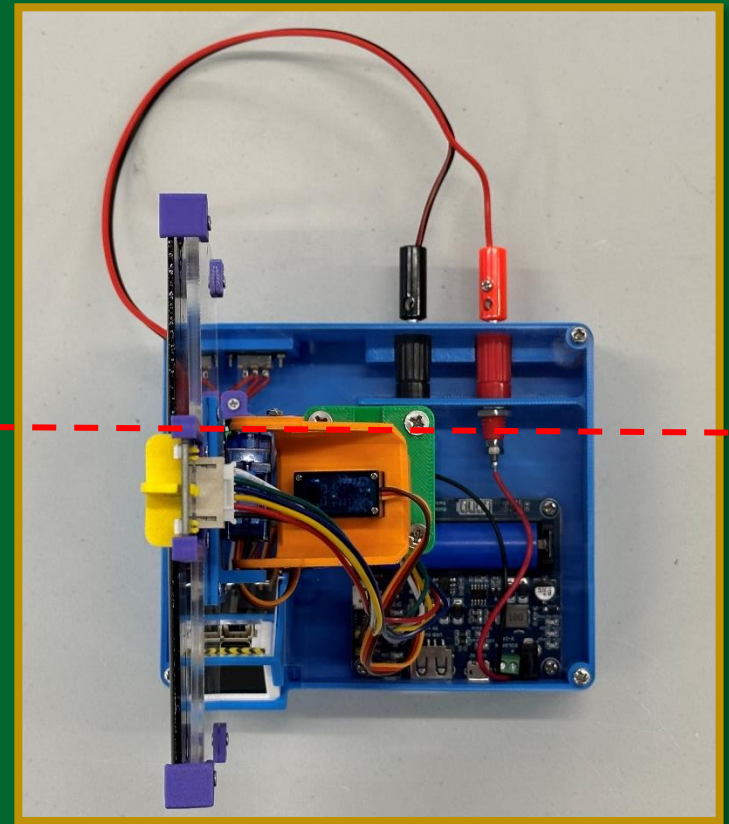
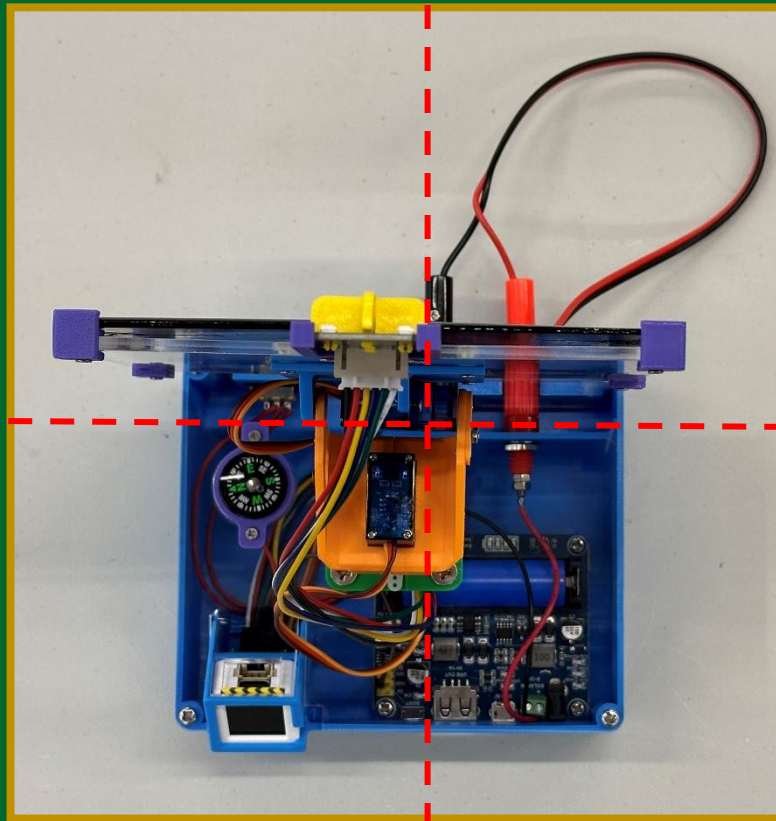
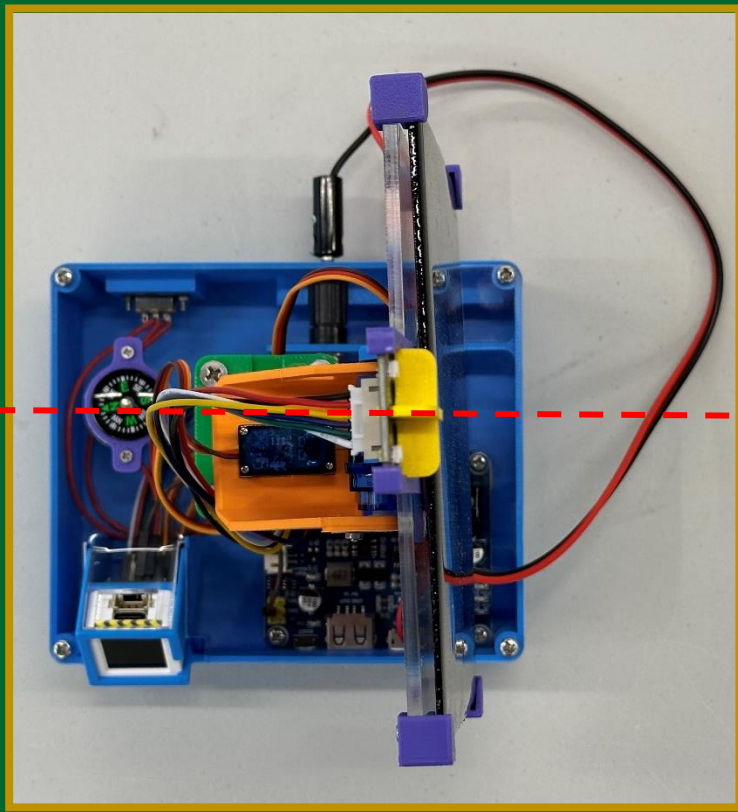


# 太陽能電池板在水平方向上的可擺動範圍

$\sim 0^\circ$

$\sim 90^\circ$

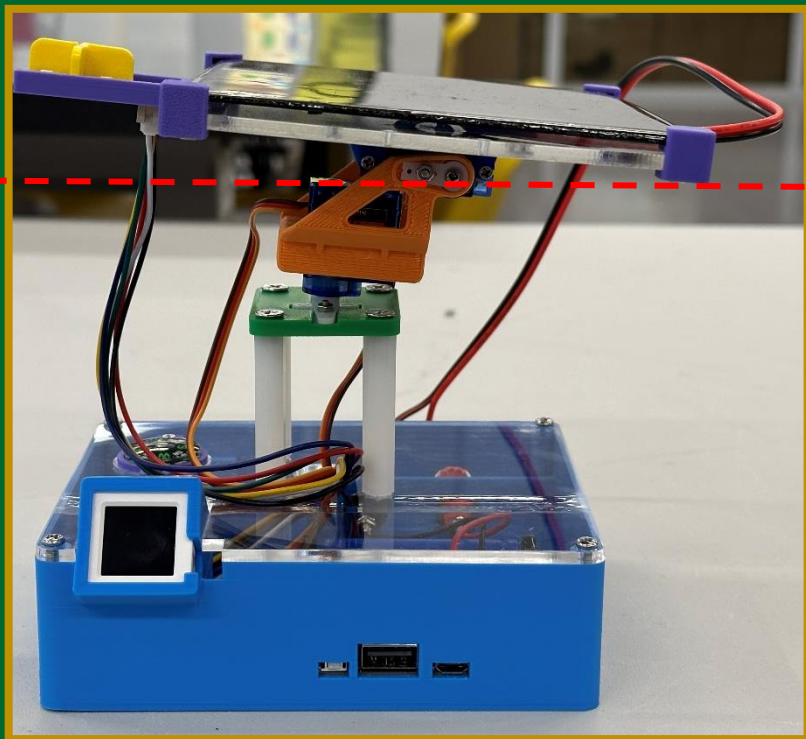
$\sim 180^\circ$



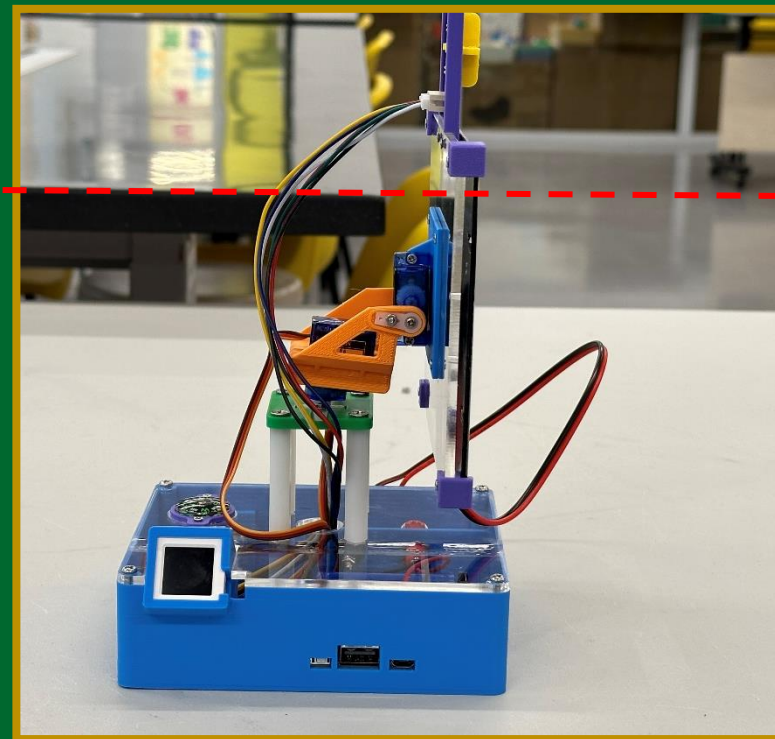


# 太陽能電池板在垂直方向上的可擺動範圍

$\sim 0^\circ$



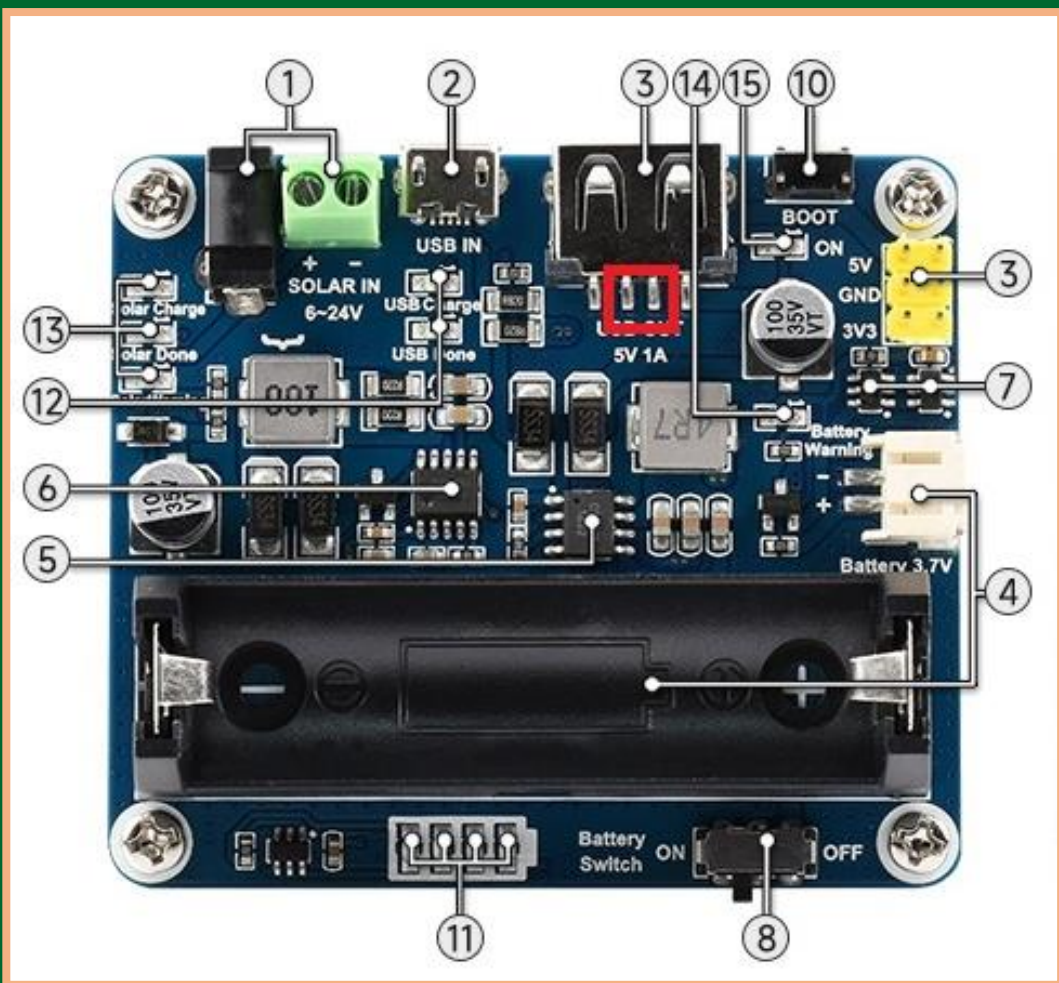
$\sim 90^\circ$





# 太陽能電源管理模組

## Solar power management module



[www.waveshare.net/wiki/Solar\\_Power\\_Manager](http://www.waveshare.net/wiki/Solar_Power_Manager)

### 【接口简介】

1. 太阳能充电接口  
可通过 DC-002 电源插座或接线端子接入太阳能板进行充电
2. USB 充电接口  
可通过 Micro USB 口接 5V 电源适配器进行充电
3. 5V/1A 电源输出接口  
可通过 USB 口或 2.54mm 排针对外输出稳定 5V/1A 电源
4. 电池接口  
可通过 PH2.0 端子或 14500 电池座接入 3.7V 锂电池
5. CS8501  
USB 电源管理芯片，用于 USB 充电和升压 5V/1A 输出
6. CN3791  
太阳能管理芯片，用于太阳能板充电和降压输入
7. 锂电池保护芯片  
锂电池过充/过放保护
8. 电池开关
9. MPPTSET 设置开关 (背面)  
支持 6V/9V/12V/18V/24V 档位设置，切换至接近输入电压的档位，充电效率更高
10. BOOT 按键
11. 电池电量指示灯

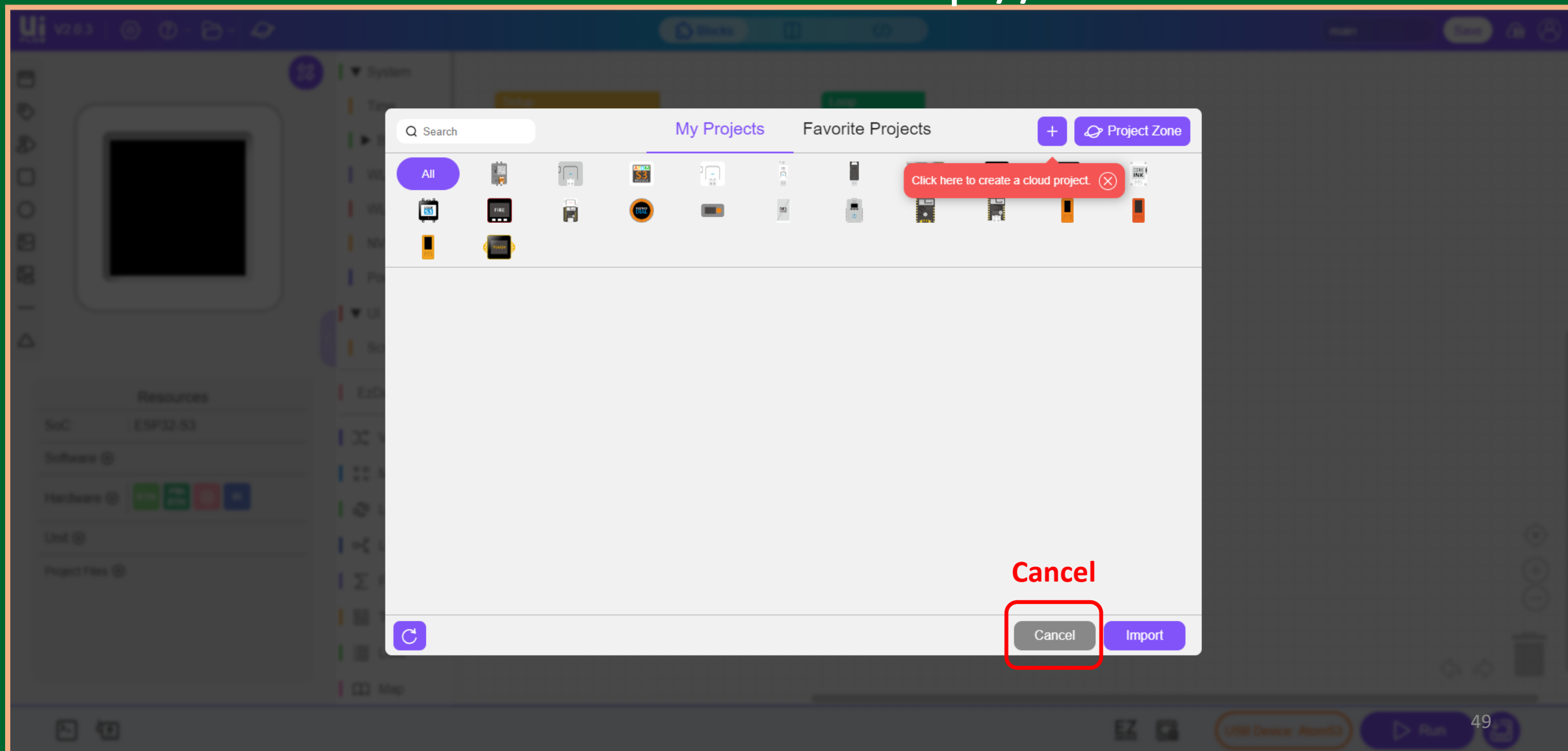
### 【器件简介】

5. CS8501  
USB 电源管理芯片，用于 USB 充电和升压 5V/1A 输出
6. CN3791  
太阳能管理芯片，用于太阳能板充电和降压输入
7. 锂电池保护芯片  
锂电池过充/过放保护
12. USB 充电指示灯  
USB Charge: 通过 USB 充电时亮灯  
USB Done : 通过 USB 充满后亮灯
13. 太阳能板状态灯  
Solar Charge: 通过太阳能板充电时亮灯  
Solar Done : 通过太阳能板充满后亮灯  
Solar Warning: 太阳能板反接时亮灯
14. 电池警示灯  
电池反接时亮灯
15. 电源输出状态灯  
5V/1A 输出



# 裝置內的程式碼

<http://uiflow2.m5stack.com>







# 裝置內的程式碼

The screenshot shows the UIFlow V2.0.3 web interface. The top navigation bar includes a file icon, which is highlighted with a red box. A dropdown menu is open, showing options: New Project, Import, Save, Save as..., **Import project from local file** (highlighted with a red box), and Export project to local file. The main workspace displays a project for an ESP32-S3 with a 'Setup' block (Begin initialization, Init built-in hardware at beginning) and a 'Loop' block (Update button, touch, etc. in loop, Update). The left sidebar shows the 'Resources' section with SoC: ESP32-S3, Software, Hardware (BTN, PIN BTN, IR), Unit, and Project Files. The bottom status bar shows 'EZ DATAZ', 'USB Device: AtomS3', and a 'Run' button.

**Import project from local file**

<http://uiflow2.m5stack.com>



# 裝置內的程式碼

檔案名稱:  
SolarTrackingS3-7.m5f2

UiFlow V2.0.3

SolarTrackingS3-7

Save

Solar Tracking

Hori.: ---  
Vert.: ---

label label label label

Resources

SoC: ESP32-S3

Software: MQTT

Hardware: ADC PWM BTN

Unit

Project Files

System

- Time
- BLE UART
- WLAN STA
- WLAN AP
- NVS
- Power

UI

- Screen
- Title
- Label
- Rect
- Circle
- EzData2.0
- Variables
- Math
- Loops
- Logic

Setup

Begin initialization True

Set screen rotation 180° Built-in

Init Pin 5 attenuation 11DB(0 ~ 3.3V)

Init Pin 6 attenuation 11DB(0 ~ 3.3V)

Init Pin 7 attenuation 11DB(0 ~ 3.3V)

Init Pin 8 attenuation 11DB(0 ~ 3.3V)

Init built-in hardware at beginning

set angle\_Horizontal to 0

set angle\_Vertical to 30

set HlimitLow to 0

set HlimitHigh to 180

set VlimitLow to 0

set VlimitHigh to 90

set step\_split to 5

Init Pin 38 freq 50 Hz (1 ~ 4000000) duty angleV\_duty (0 ~ 1023)

Init Pin 39 freq 50 Hz (1 ~ 4000000) duty angleH\_duty (0 ~ 1023)

set reactHlevel to 30

set reactVlevel to 20

set reactTime to 100

set operate to 0

Set label1 text convert to str angle\_Horizontal

Set label3 text convert to str angle\_Vertical

Set circle0 hide

Set rect0 show

When button BtnA was clicked

Loop

Update

to servo\_set with: angleDif

to angleH\_duty set duty\_ma

to angleV\_duty set duty\_ma

可因應不同環境而作數值改變 (後續)

可因應不同環境而作數值改變 (後續)

ATOM S3 LITE

ESP32-S3FN8

BTN: RGB: G41 G35

M2 HOLE

PORT.A

EZ DATA

USB Device: AtomS3

Run

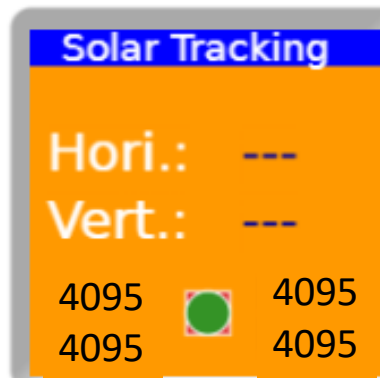
51





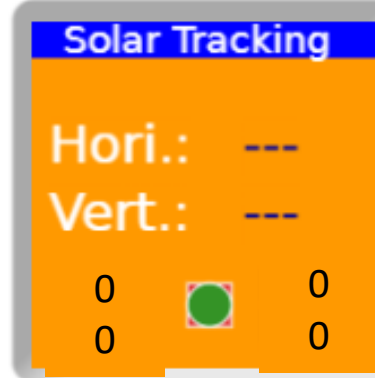
四路光敏傳感器

完全沒有光源的情況



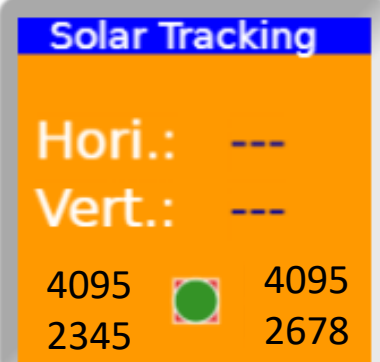
四路光敏傳感器

在極強光線照射下的情況



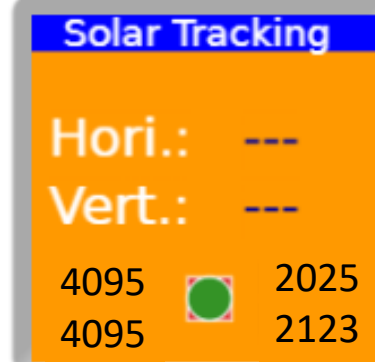
四路光敏傳感器

上方的光敏傳感器被遮擋的情況



四路光敏傳感器

其中一邊的光敏傳感器被遮擋的情況





# 裝置內的程式碼

檔案名稱:  
SolarTrackingS3-7.m5f2

**Init built-in hardware at beginning**

- set angle\_Horizontal to 0  
太陽能板在水平方向的初始角度 ( $0^{\circ} - 180^{\circ}$ )
- set angle\_Vertical to 30  
太陽能板在垂直方向的初始角度 ( $0^{\circ} - 90^{\circ}$ )
- set HlimitLow to 0  
太陽能板水平方向的可變幅度 ( $0^{\circ} - 180^{\circ}$ )
- set HlimitHigh to 180
- set VlimitLow to 0  
太陽能板垂直方向的可變幅度 ( $0^{\circ} - 90^{\circ}$ )
- set VlimitHigh to 90
- set step\_split to 5  
每次要變動時分幾個階段進行 (1 代表一次過完成)

**Init Pin 38 freq 50 Hz (1 ~ 40000000) duty angleV\_duty (0 ~ 1023)**

**Init Pin 39 freq 50 Hz (1 ~ 40000000) duty angleH\_duty (0 ~ 1023)**

- set reactHlevel to 30  
靈敏度的設定: 4 個光敏傳感器的顯示數值均為 0 - 4095 , 左右相差 30 就會引發水平方向的移動 ,
- set reactVlevel to 20  
下相差 20 就會引發垂直方向的移動為 20 .
- set reactTime to 100  
每隔 100 ms 更新數據一次
- set operate to 0

**Set label1 text convert to str angle\_Horizontal**

**Set label3 text convert to str angle\_Vertical**





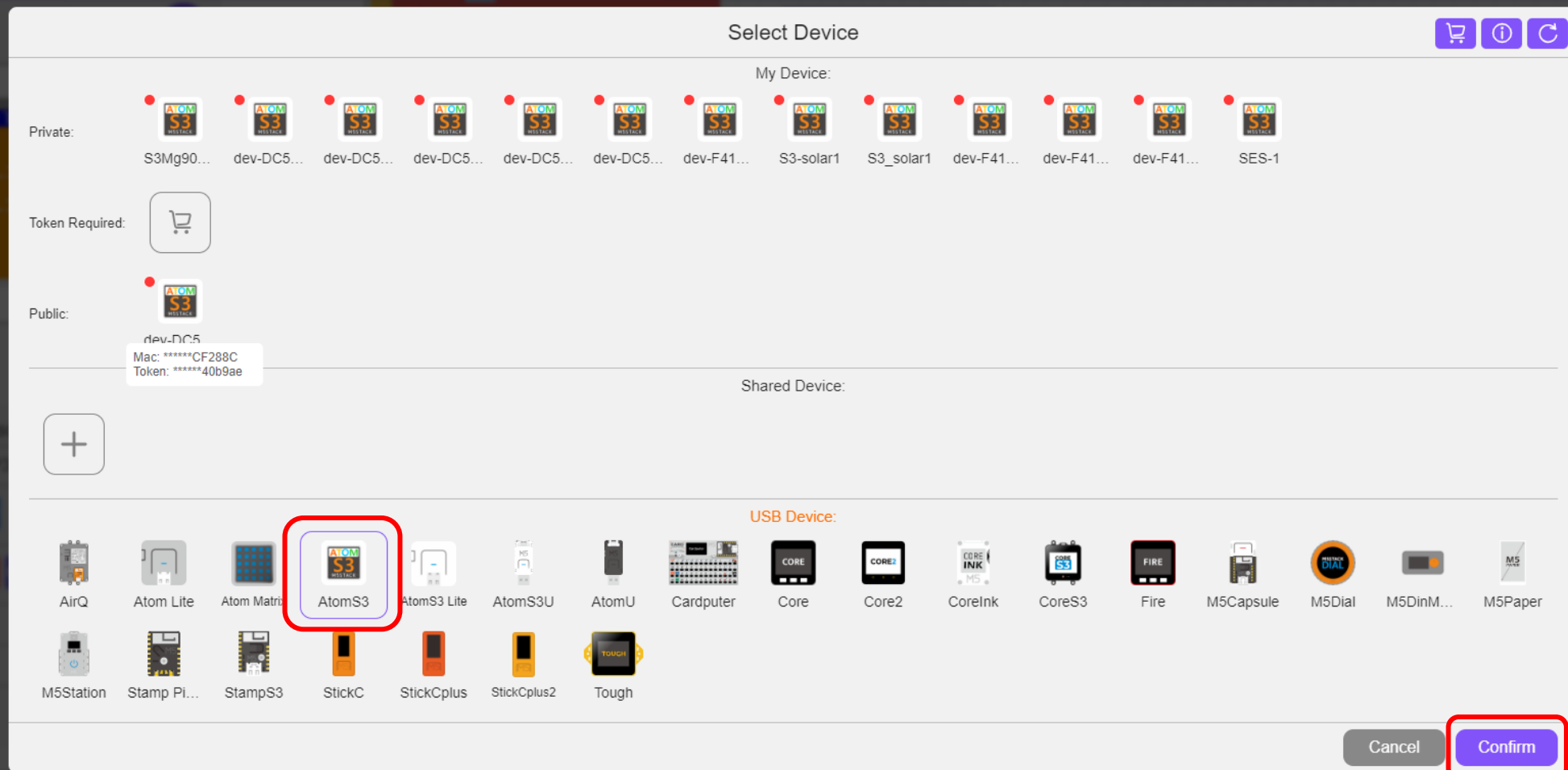
## 下載程式至微控制器單元





# 裝置內的程式碼

## 下載程式至微控制器單元







## 下載程式至微控制器單元





# 裝置內的程式碼

# 下載程式至微控制器單元

uiflow2.m5stack.com wants to connect to a serial port

M5Stack AtomS3(UiFlow2) (COM20) - Paired

Connect Cancel

Remember to save your project. (X)

When... Loop... Upda...

to servo\_set with: angleDif...

to angleH\_duty set duty\_ma...

to angleV\_duty set duty\_ma...

Row 24 Col 94

Set label1 text convert to str angle\_Horizontal

Set label3 text convert to str angle\_Vertical

Set circle0 hide

Set rect0 show

USB Device: AtomS3

Run





# 裝置內的程式碼

## 下載程式至微控制器單元

The screenshot displays the ATOM S3 IDE interface. On the left, there is a sidebar with a 'Resources' panel showing 'P32-S3' and a 'UI' panel with various components like 'Screen', 'Title', 'Label', 'Rect', and 'Circle'. The main workspace shows a block-based programming environment with a 'WebTerminal' window open. The 'WebTerminal' window has a toolbar with icons for 'Run', 'Download', 'Copy', and 'File'. The 'Download' icon, which shows a computer with a downward arrow, is highlighted with a red rectangle. The terminal window displays the text 'Connected to Serial Port!' in green. The background shows a block of code with 'Init Pin' and 'attenuation' settings.



# 裝置內的程式碼

# 下載程式至微控制器單元

Ui  
FLUX V2.0.3

⚙️ ? 📁 ☁️

Blocks

📄

</>

SolarTrackingS3- Save 🔒 👤

Solar Tracking

Hori.: ---  
Vert.: ---

label label label label

Resources

SoC: ESP32-S3

Software ⊕ MQTT

Hardware ⊕ ADC PWM BTN 🌞

Unit ⊕

Project Files ⊕

▼ System

Time

▶ BLE UART

WLAN STA

WLAN AP

NVS

Power

▼ UI

Screen

Title

Label

Rect

Circle

EzData2.0

Variables

Math

Loops

Logic

Setup

Begin initialization ☒ True

Set screen rotation 180° Built-in

Init Pin 5 attenuation 11DB(0 ~ 3.3V)

Init Pin 6 attenuation 11DB(0 ~ 3.3V)

WebTerminal

Row 24 Col 94

Progress:

When

Remember to save your project. ⌵

Loop Upda...

to servo\_set with: angleDif...

to angleH\_duty set duty\_ma...

to angleV\_duty set duty\_ma...

Set label1 text convert to str angle\_Horizontal

Set label3 text convert to str angle\_Vertical

Set circle0 hide

Set rect0 show

📄 ⚡

EZ DATAZ 📄

USB Device: AtomS3

Run

📄

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# 運用裝置進行活動或比賽的經驗分享

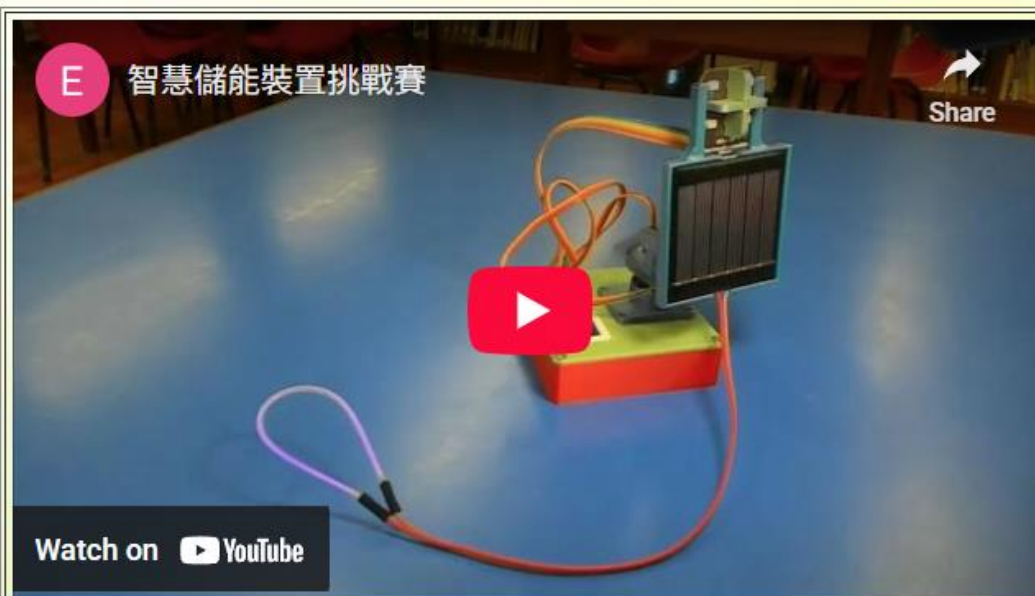


## 智慧儲能裝置挑戰賽

STEM Education Centre and Arts & Technology Education Centre

最新消息	理念	比賽詳情及規則	日程	入圍名單及分組	下載	查詢	賽果	回本中心
------	----	---------	----	---------	----	----	----	------

## 最 新 消 息 NEWS



這是一個由大會設計的微型燈光追蹤裝置，並配上太陽能板直接將光能轉化為電能。若加上適當的電子元件及充電式電池，便可變成一個可循環使用的儲電裝置。至於裝置的效能及可用性，當然取決於多種因素，是次比賽的其中一個重要目的正是希望同學在製作及探究過程中掌握及活用這些發現，為裝置作進一步的優化。



