10TH ANNIVERSARY MASTERS 25

EMPOWERING INNOVATION

十年精英聚首，共創技術未來

25004 MCU1
Lab Manual

MICROCHIP

Lab 1 – Introduction Lab

MPLAB® X IDE project creation & Systick

Lab 1 Objectives

CREATE A PROJECT IN MPLAB® X IDE

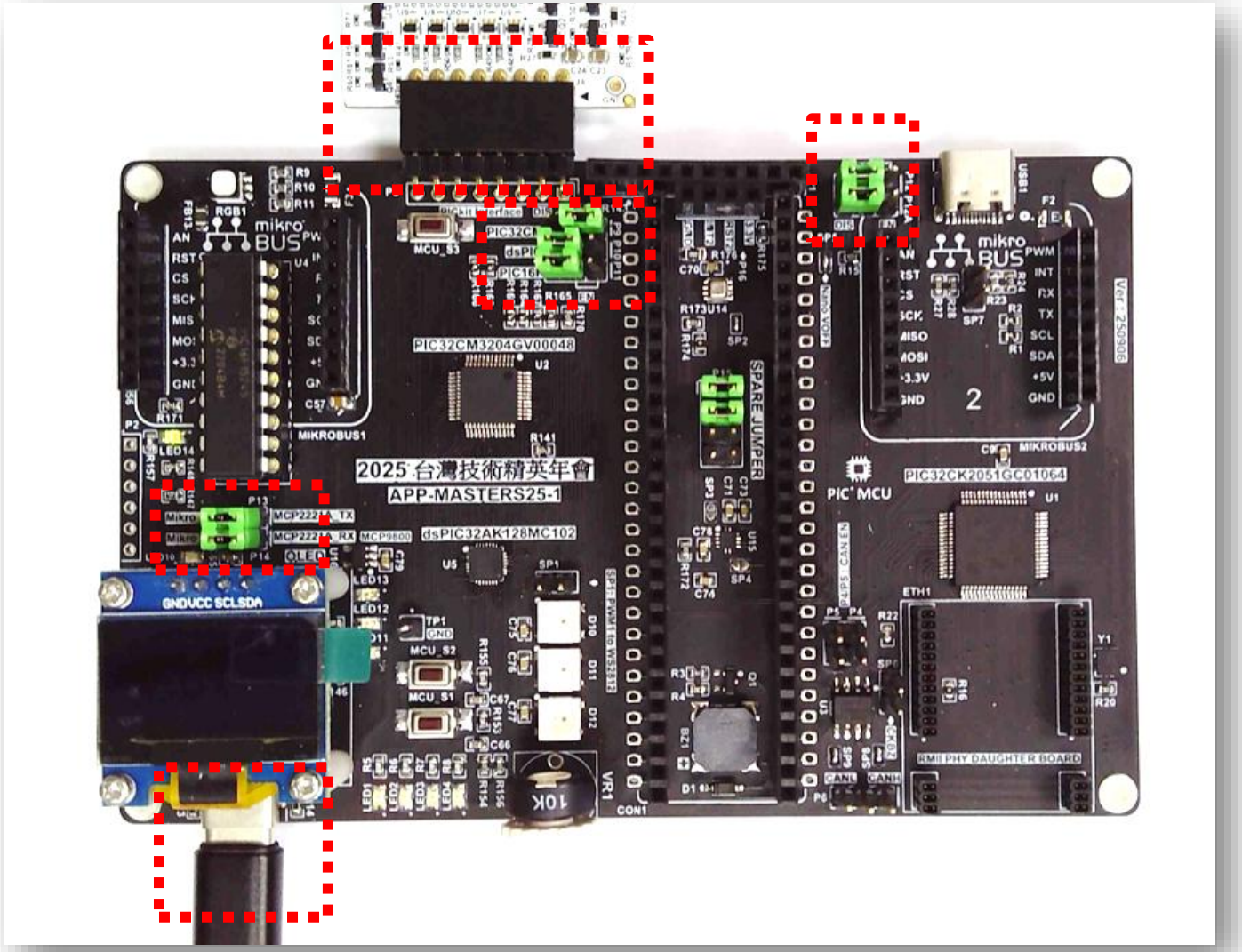
SET UP CLOCKS USING MCC HARMONY V3

設定 SysTick 來獲得一個 100ms 的時間來源並使用其中斷來驅動 LED1

練習燒錄成是並且觀察實際執行結果與相關的檔案

Lab1 – MPLAB® X IDE project creation & Systick

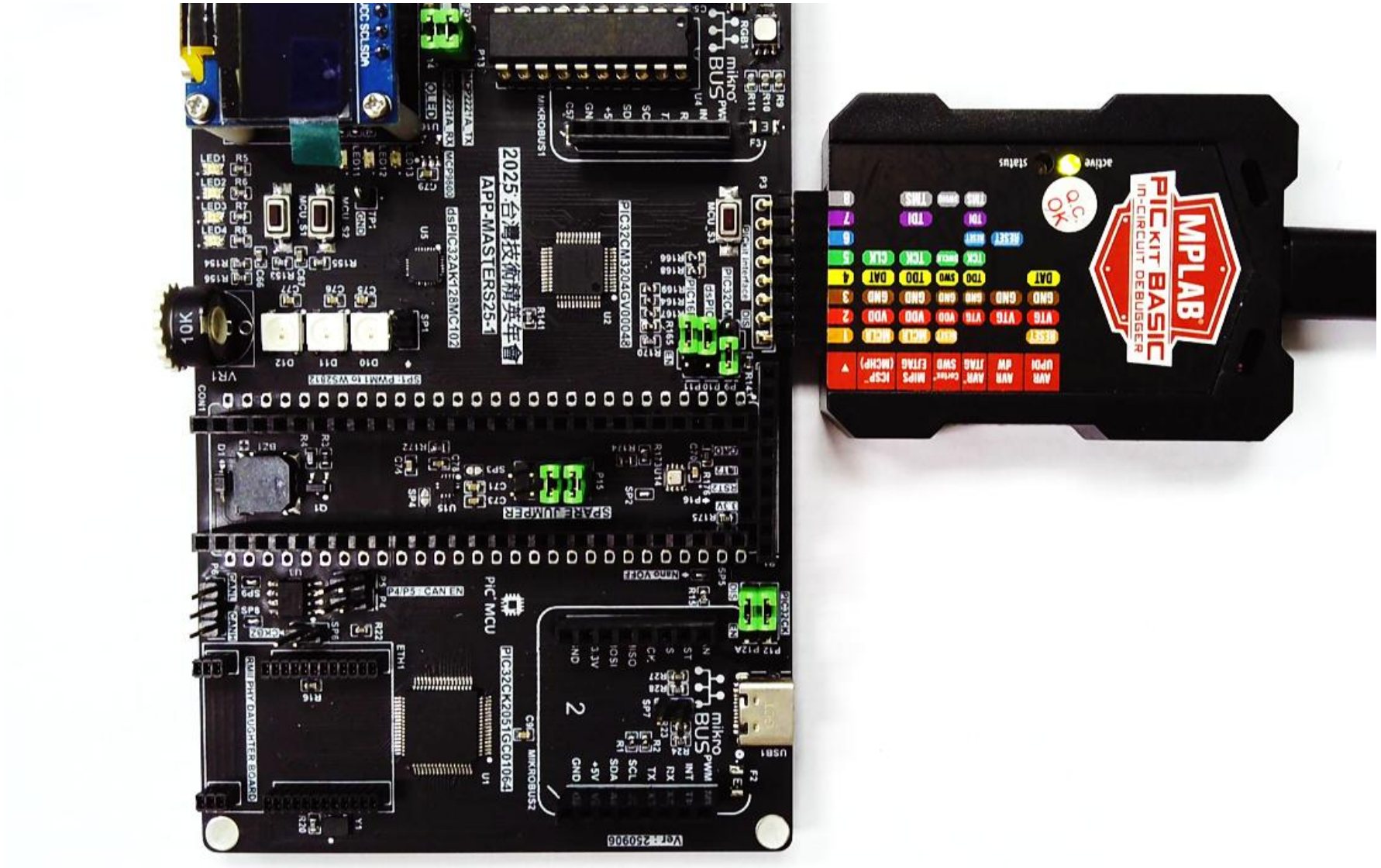
APP-MASTERS25-1 實驗板的 Jumper 設定以及燒錄器連接方式



- **USB2 Connector 以 Type-C Cable 連接到電腦**
- **P3 : 連結到 Programmer**
  - SNAP, PICkit-Basic, PICkit-5
- **P9 : 插接 1&2 來 Enable PIC32CM3204GV00048**
- **P10, P11, P12, P12A 都插接在 2&3 的位置來 DISABLE 其它的 MCU**
- **P13 & P14 要 Close，MCP2221A 才能獲得 MCU 的 UART 信號**

Lab1 – MPLAB® X IDE project creation & Systick

如果您有自己購買的 PICkit BASIC or PICkit-5 也能使用



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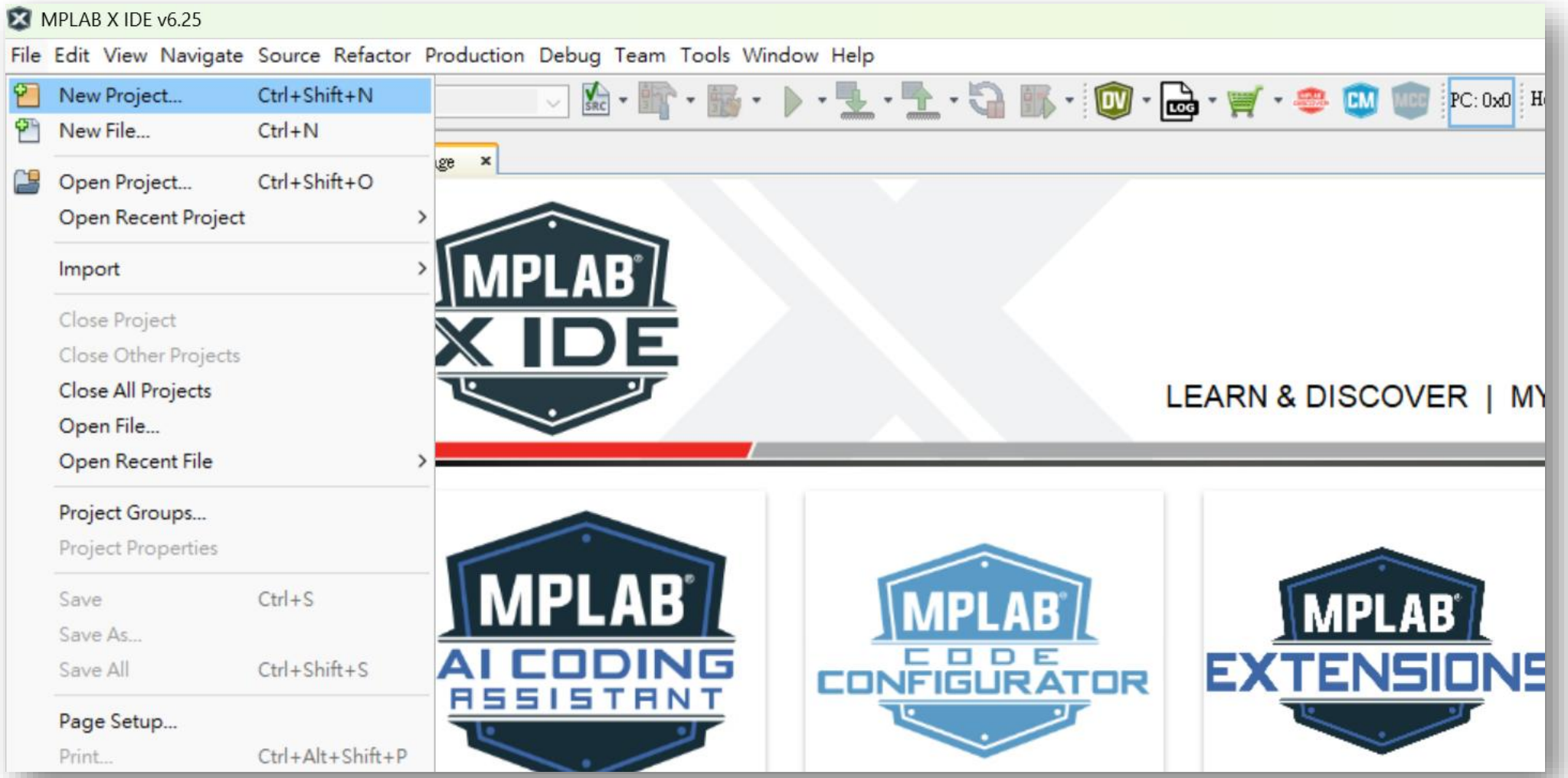
Lab1 – MPLAB® X IDE project creation & Systick

File -> New Project



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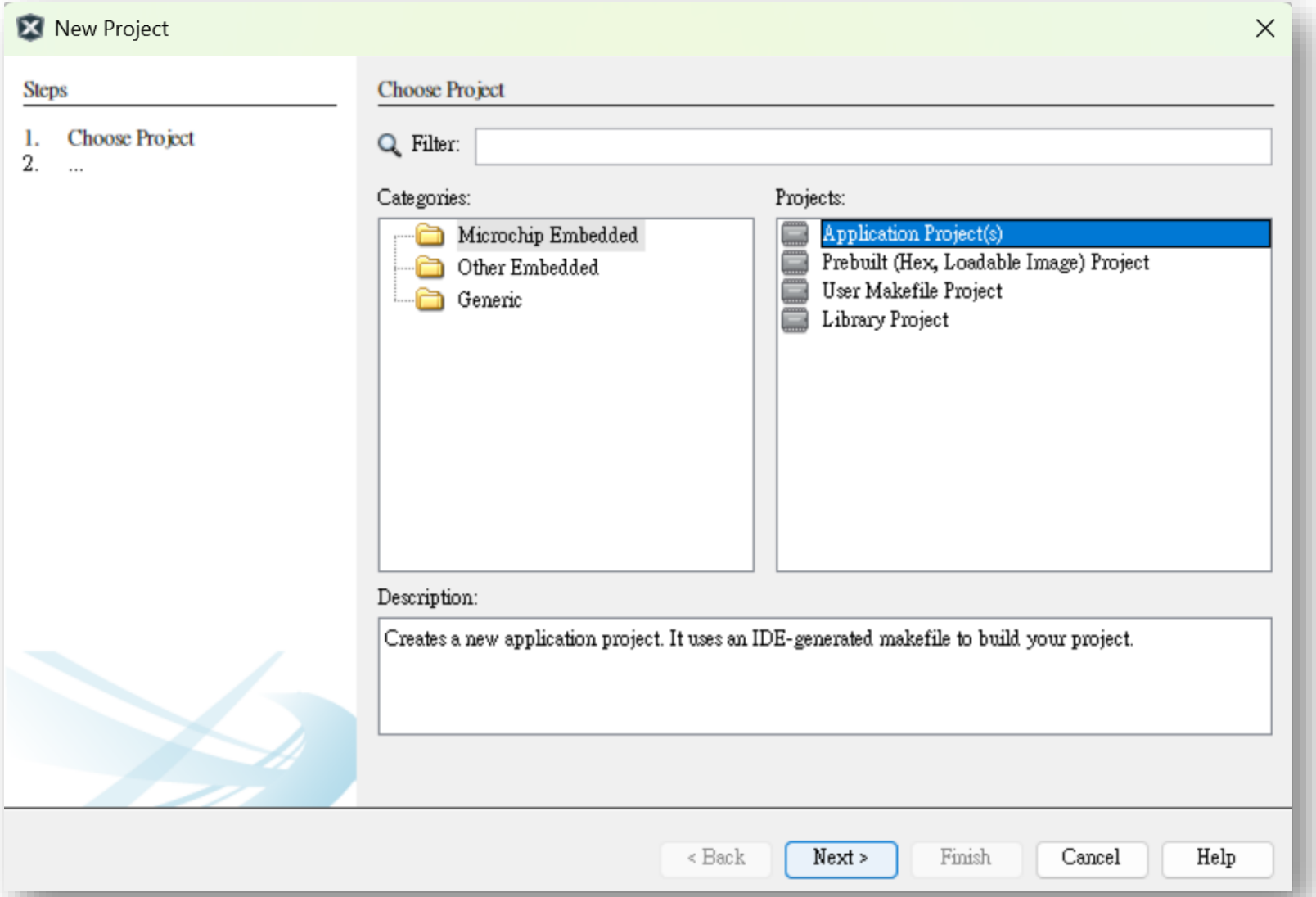
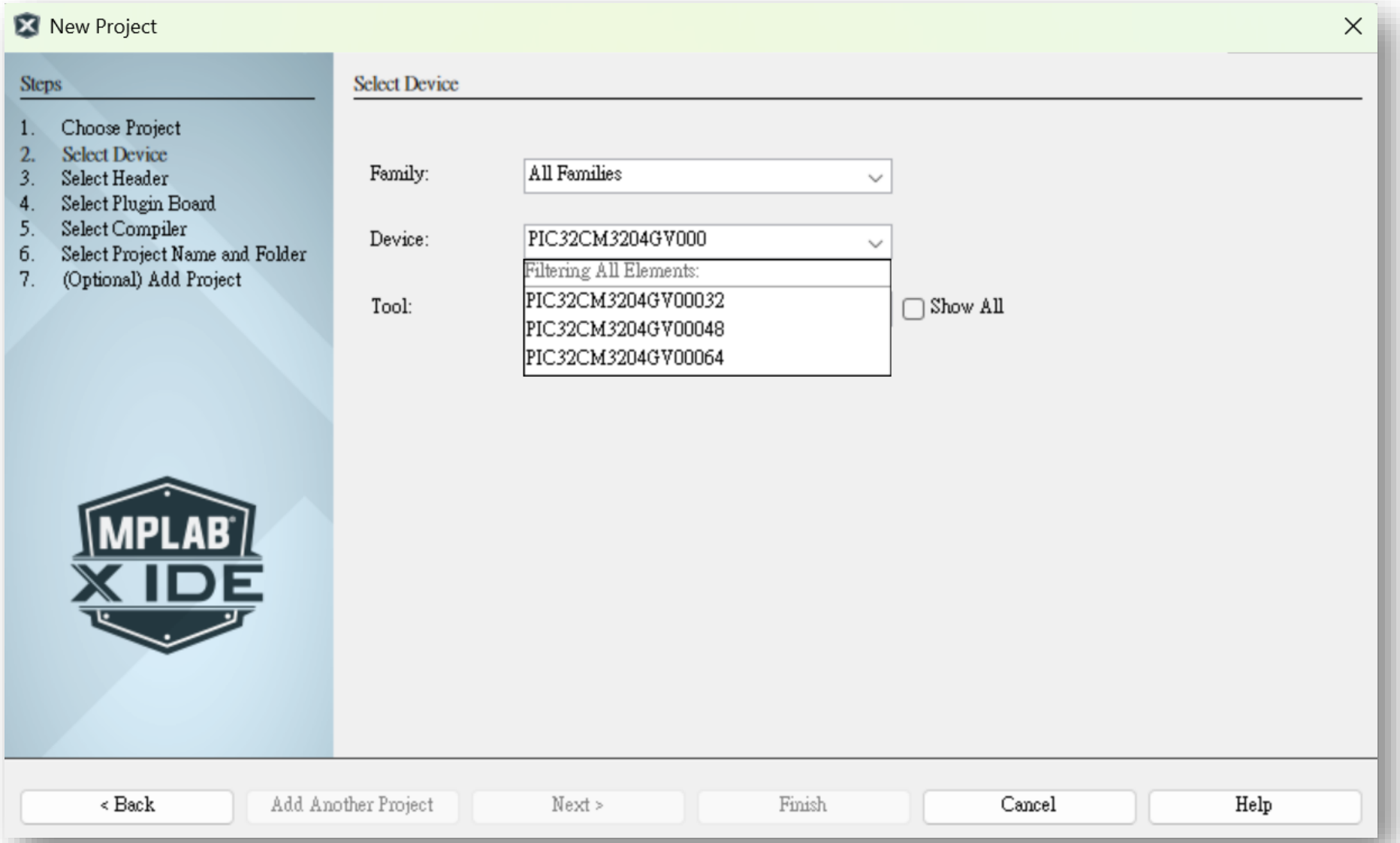
Lab1 – MPLAB® X IDE project creation & Systick

Select “Application Project(s)



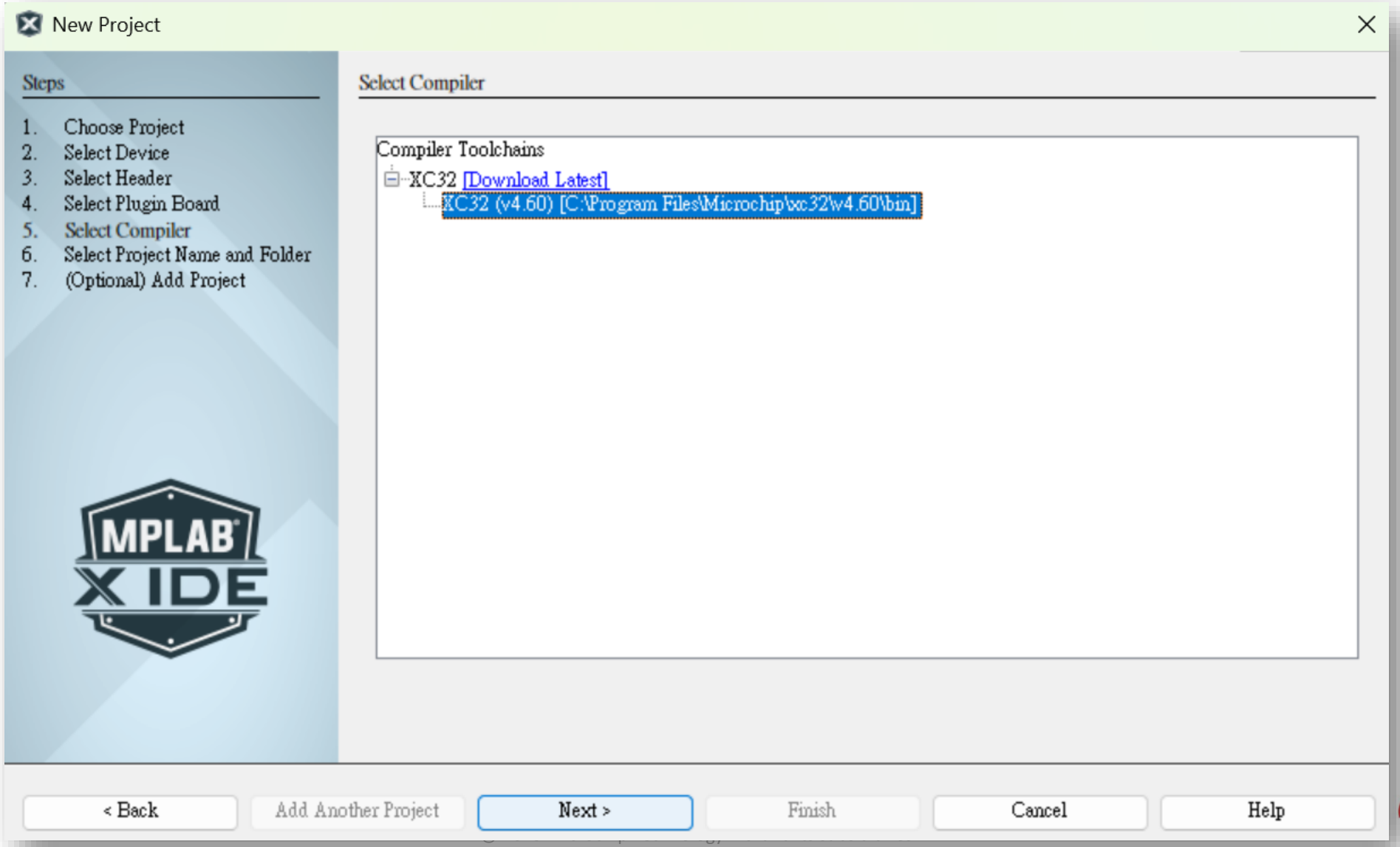
Lab1 – MPLAB® X IDE project creation & Systick

Select Device as PIC32CM3204GV00048 – You can select Tool later ..



Lab1 – MPLAB® X IDE project creation & Systick

Select Compiler Toolchains – 使用 XC32 v4.60 版



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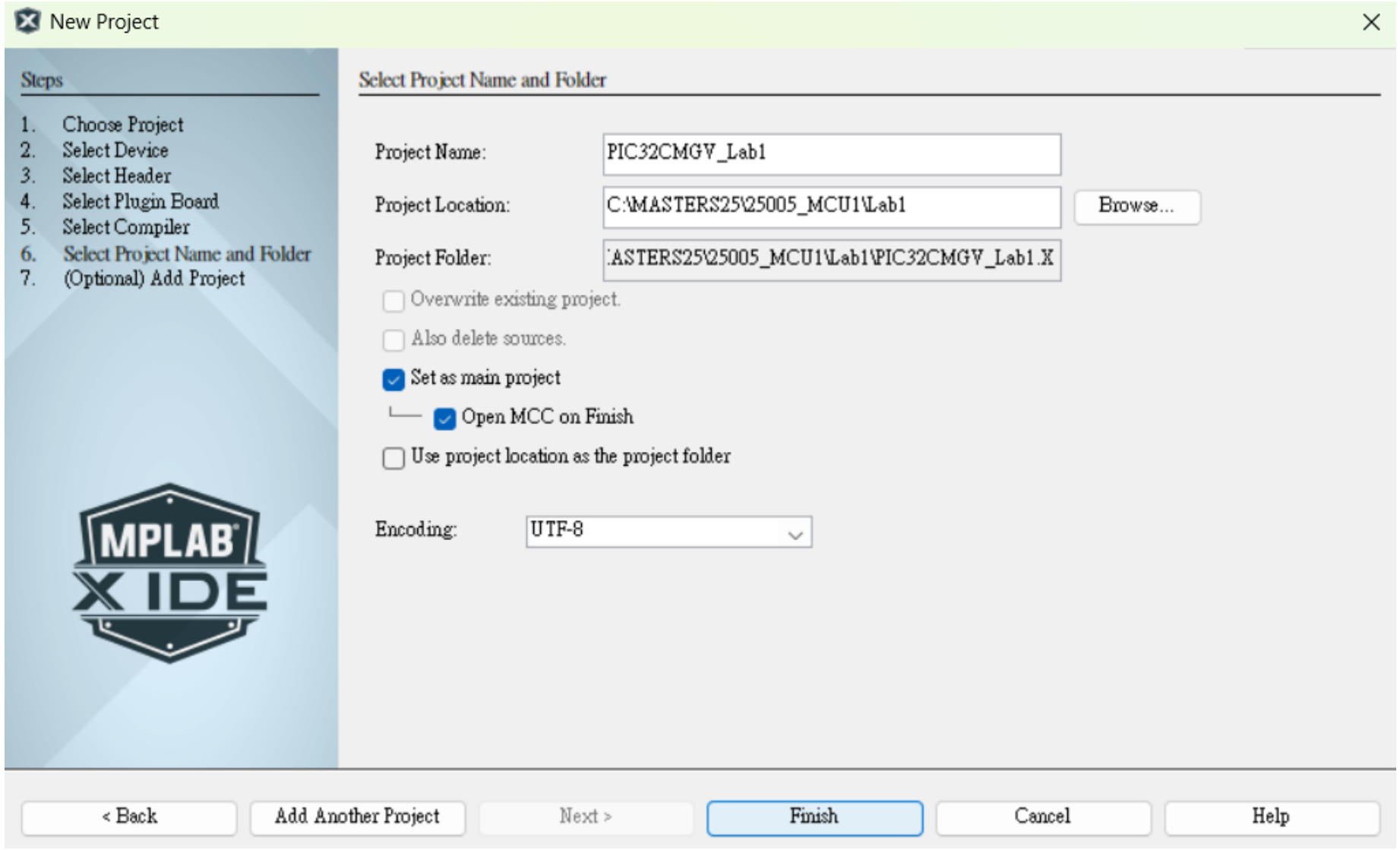
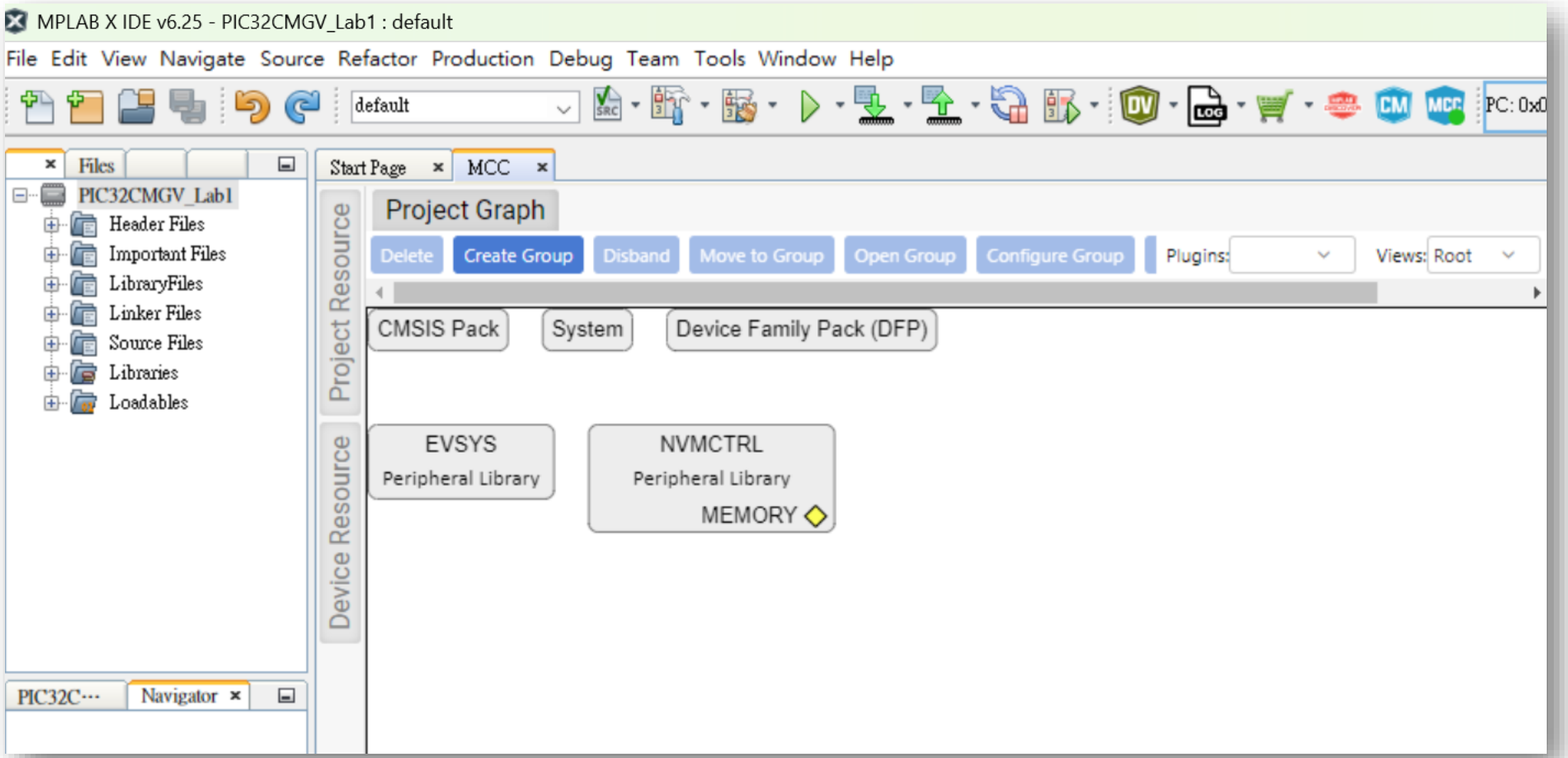
Lab1 – MPLAB® X IDE project creation & Systick

確定 Project Location & Name, 並且將編碼方式設定為 UTF-8 以便正確顯示中文



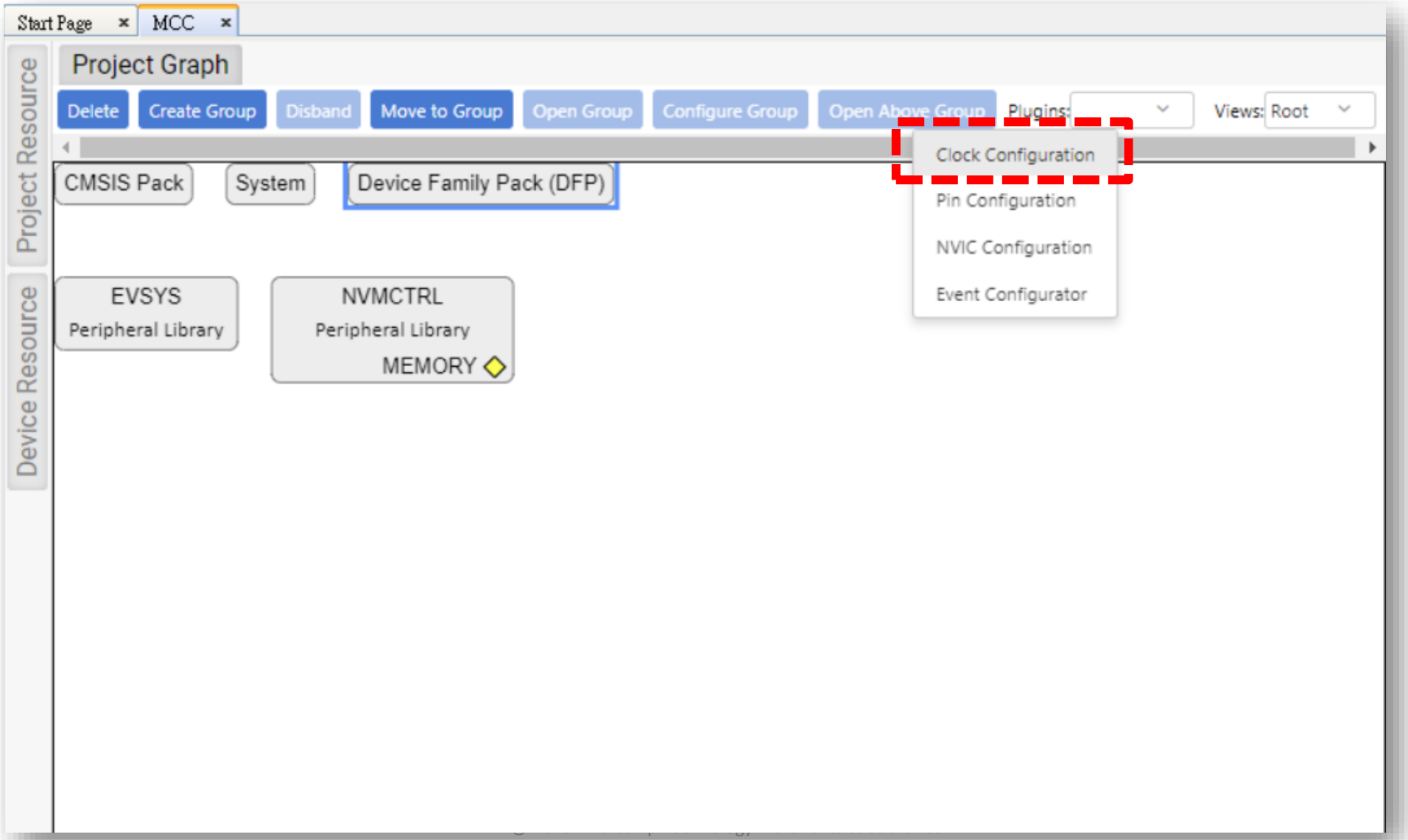
Lab1 – MPLAB® X IDE project creation & Systick

按下 Finish 之後 MCC 會被自動開啟並下載必要的軟體元件



Lab1 – MPLAB® X IDE project creation & Systick

使用 “Clock Configuration” Plugin 來觀察及設定 Clock



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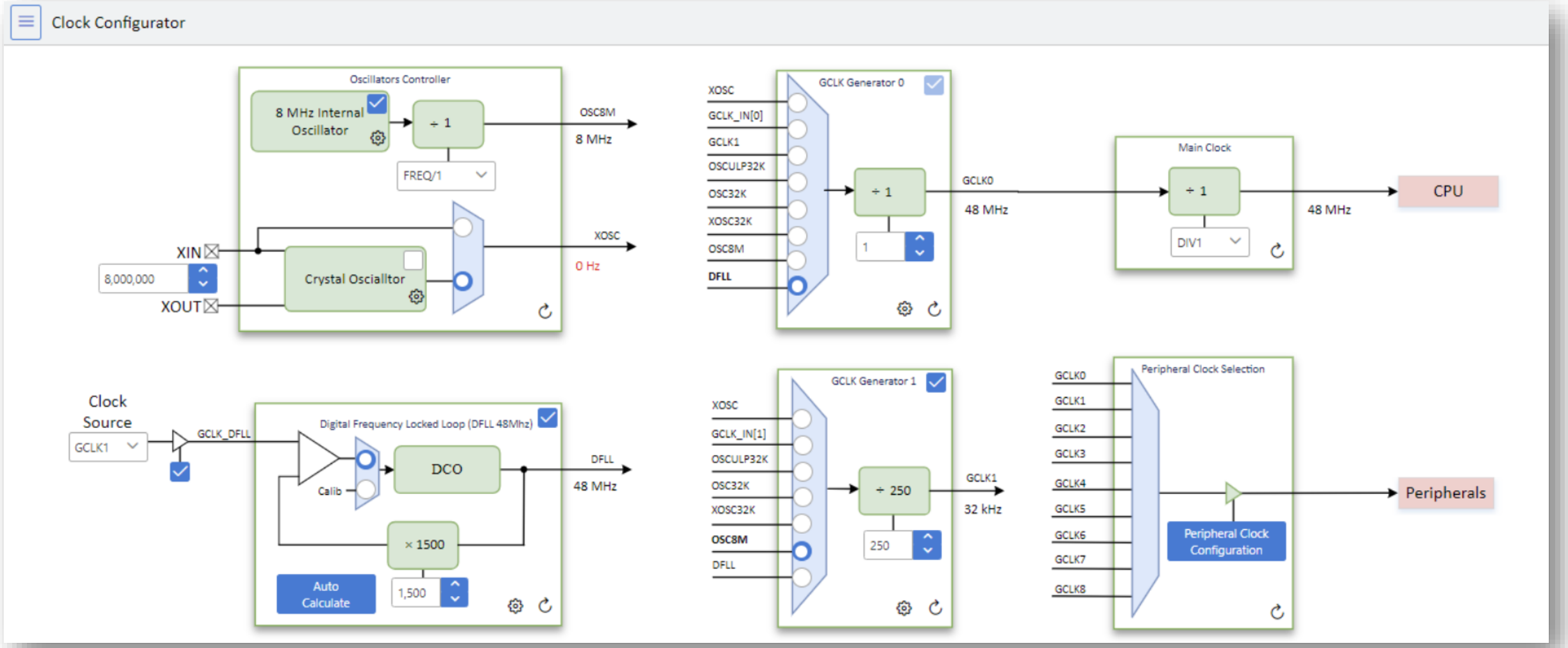
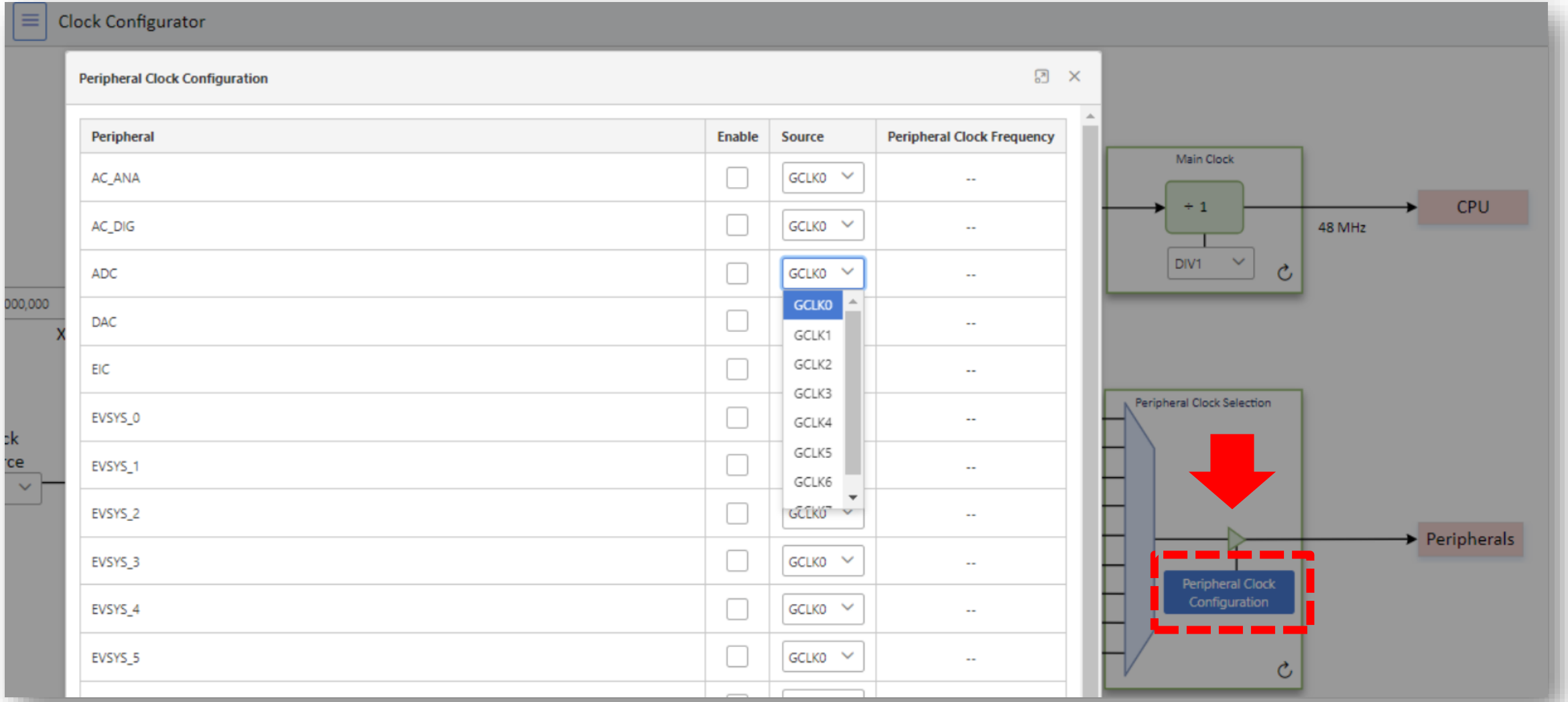
Lab1 – MPLAB® X IDE project creation & Systick

預設的 CPU Clock 已經是 48 Mhz，如有必要可議根據需求再調整



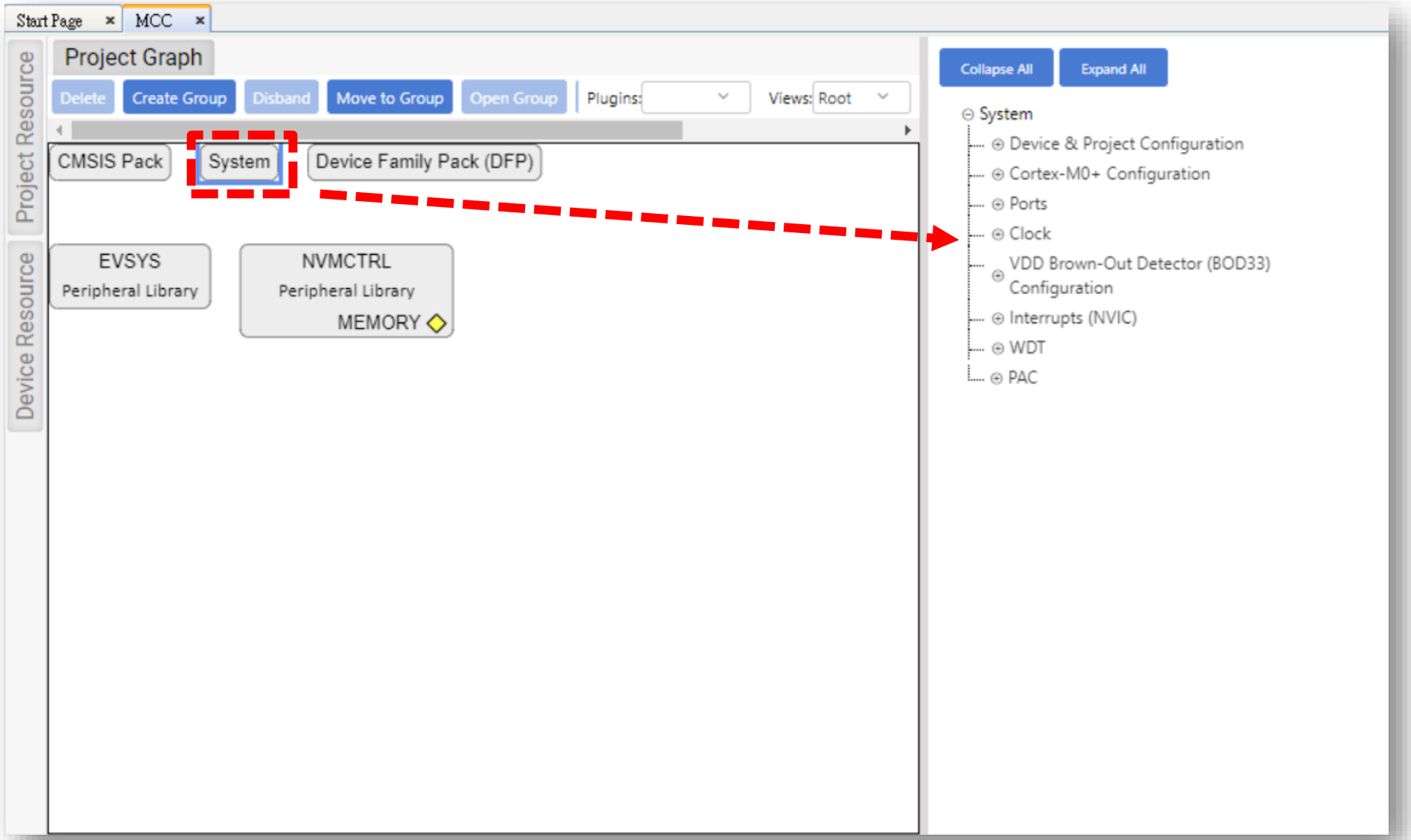
Lab1 – MPLAB® X IDE project creation & Systick

個別的周邊可以選用不同有被 Activated 的 Clock



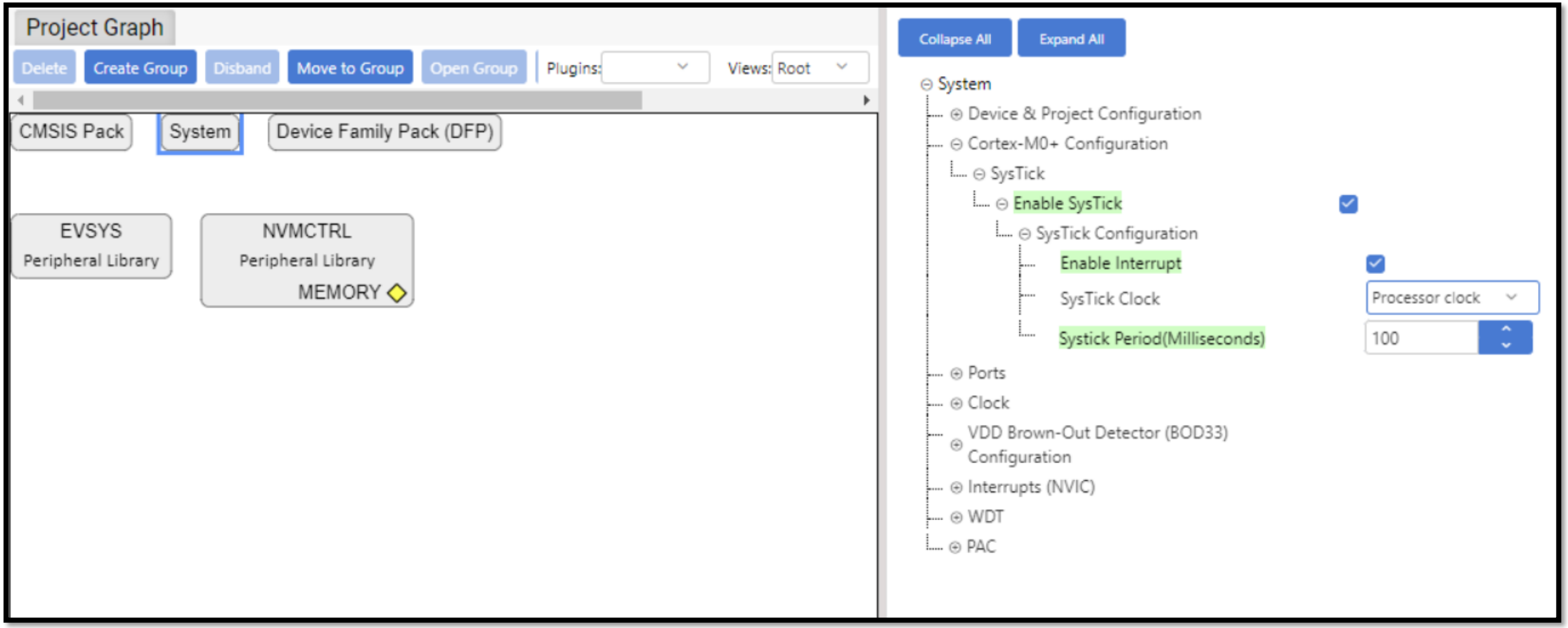
Lab1 – MPLAB® X IDE project creation & Systick

點選 System 來設定 SysTick 以及觀察其他重要選項



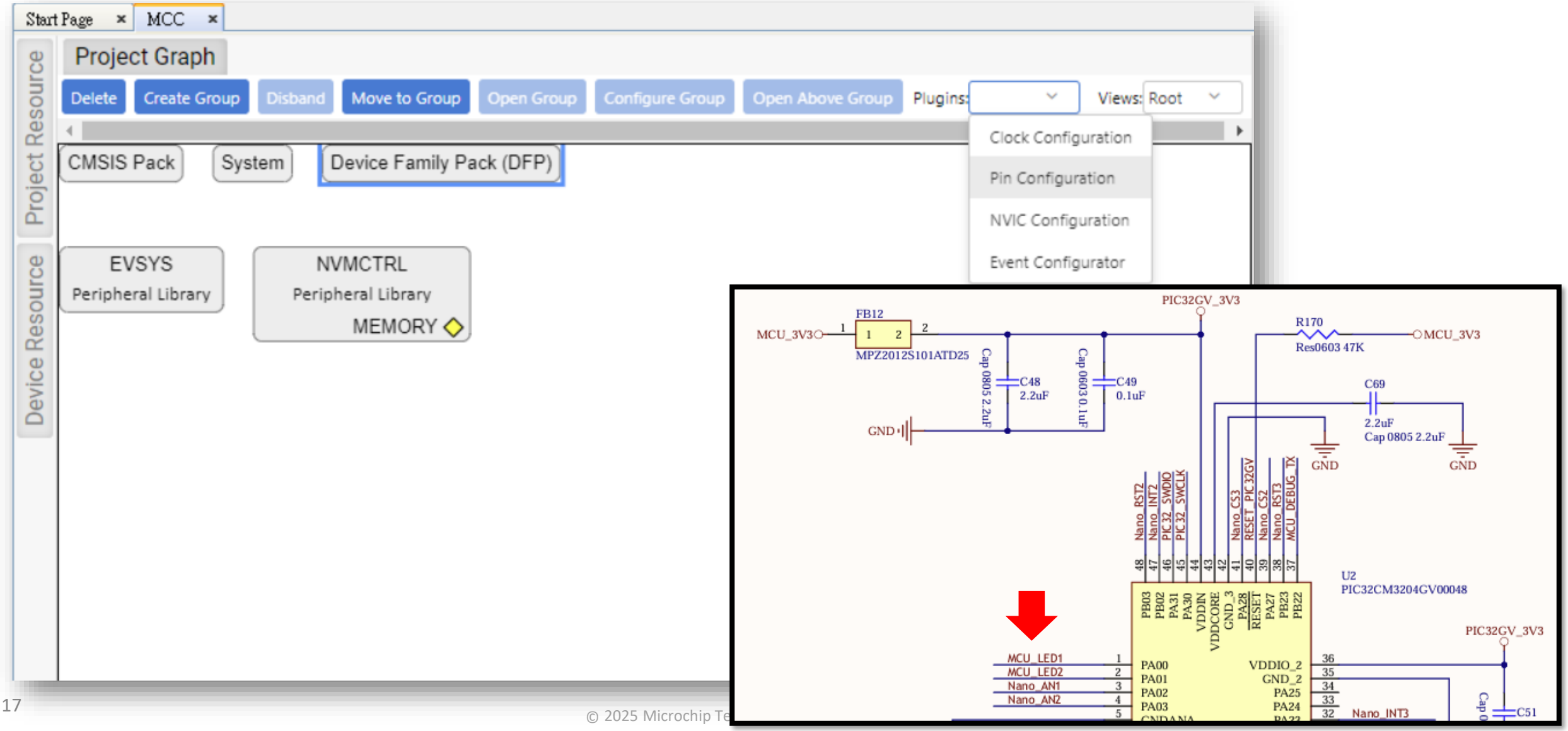
Lab1 – MPLAB® X IDE project creation & Systick

Enable SysTick 、啟用中斷並將 Systick Period 設定為 100 ms



Lab1 – MPLAB® X IDE project creation & Systick

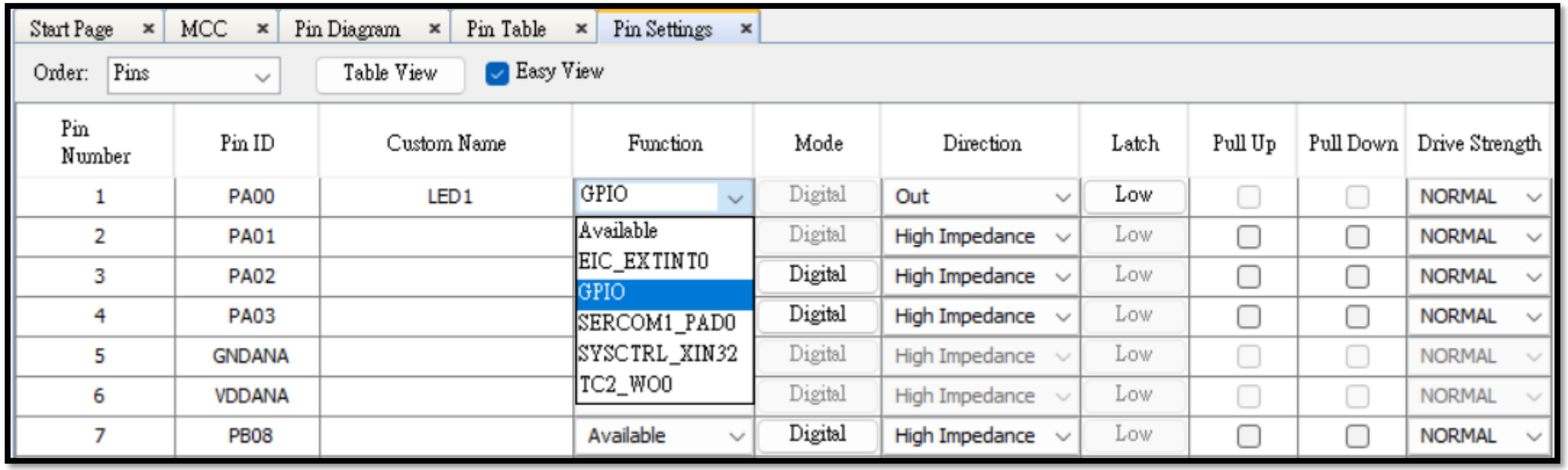
I/O Pin 的設定：選擇 Pin Configuration 這個 Plugin (LED1 @PA00)



Lab1 – MPLAB® X IDE project creation & Systick

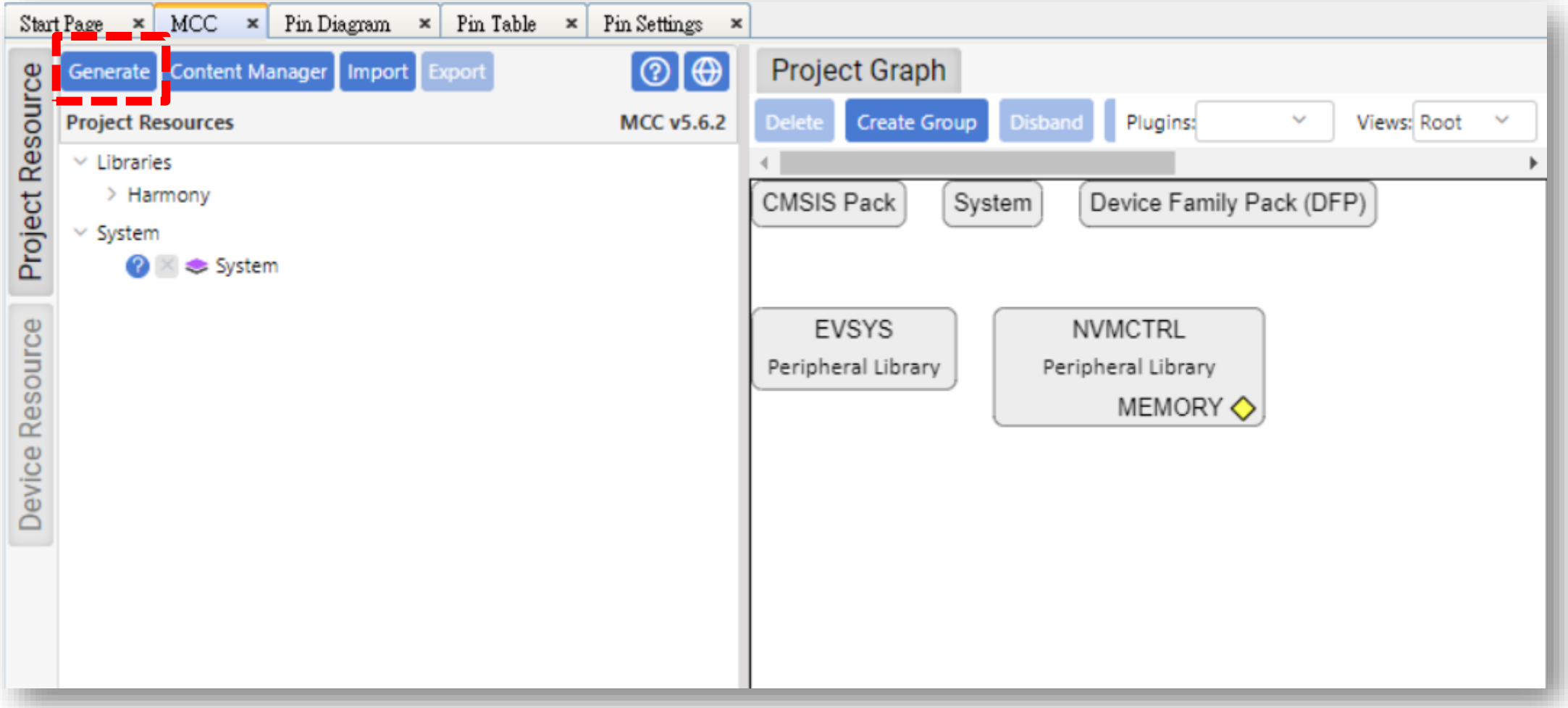
將 PA00 設定為可以做 Out 的 GPIO

- **Function**
- **Direction**
- **Custom Name (MCC 在產生 PLIB API 時會使用此名稱)**



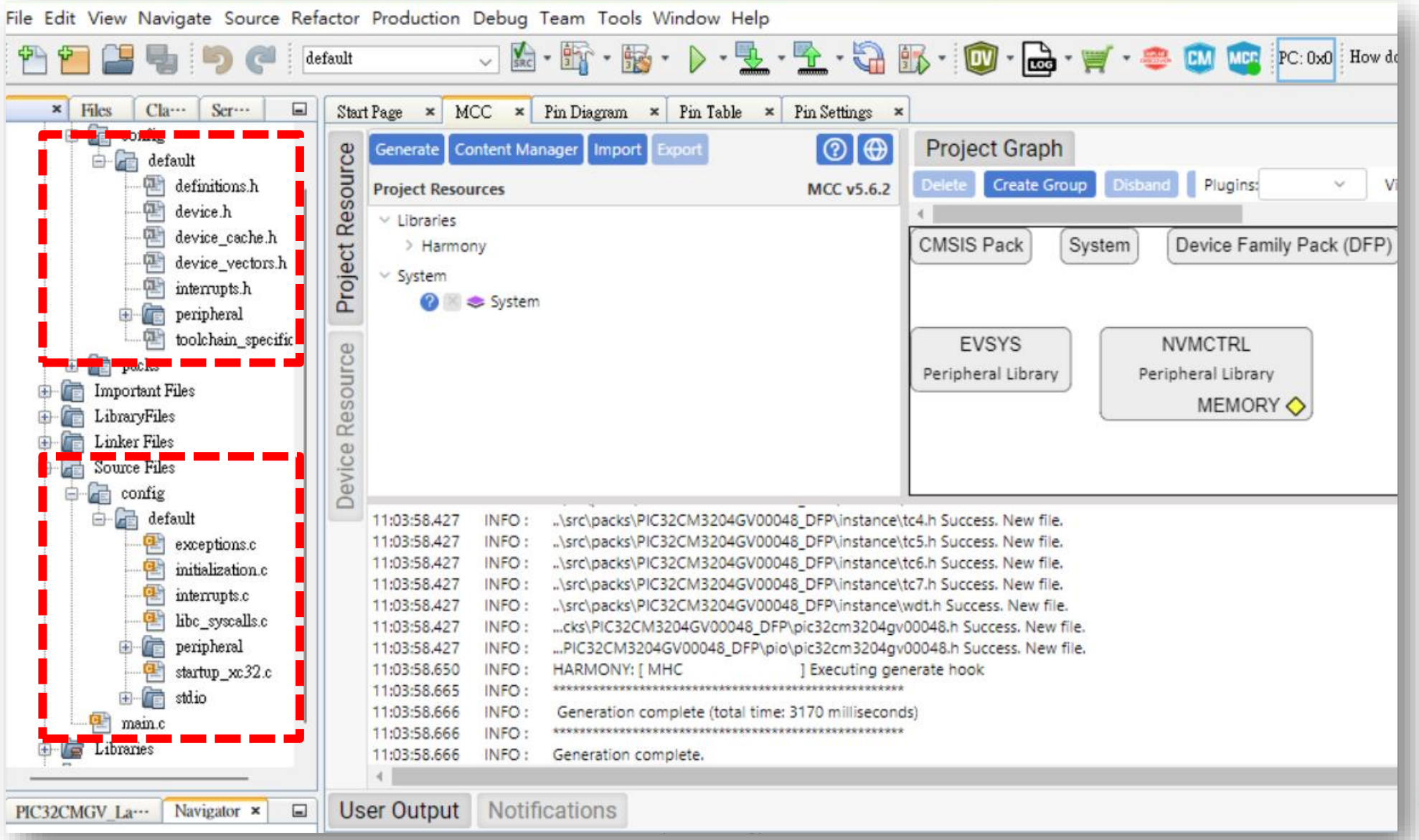
Lab1 – MPLAB® X IDE project creation & Systick

回到 MCC 頁面，點選 Project Resource 中的 Generate



Lab1 – MPLAB® X IDE project creation & Systick

User Output 視窗會輸出 Generate Code 的過程並且產生必要的檔案



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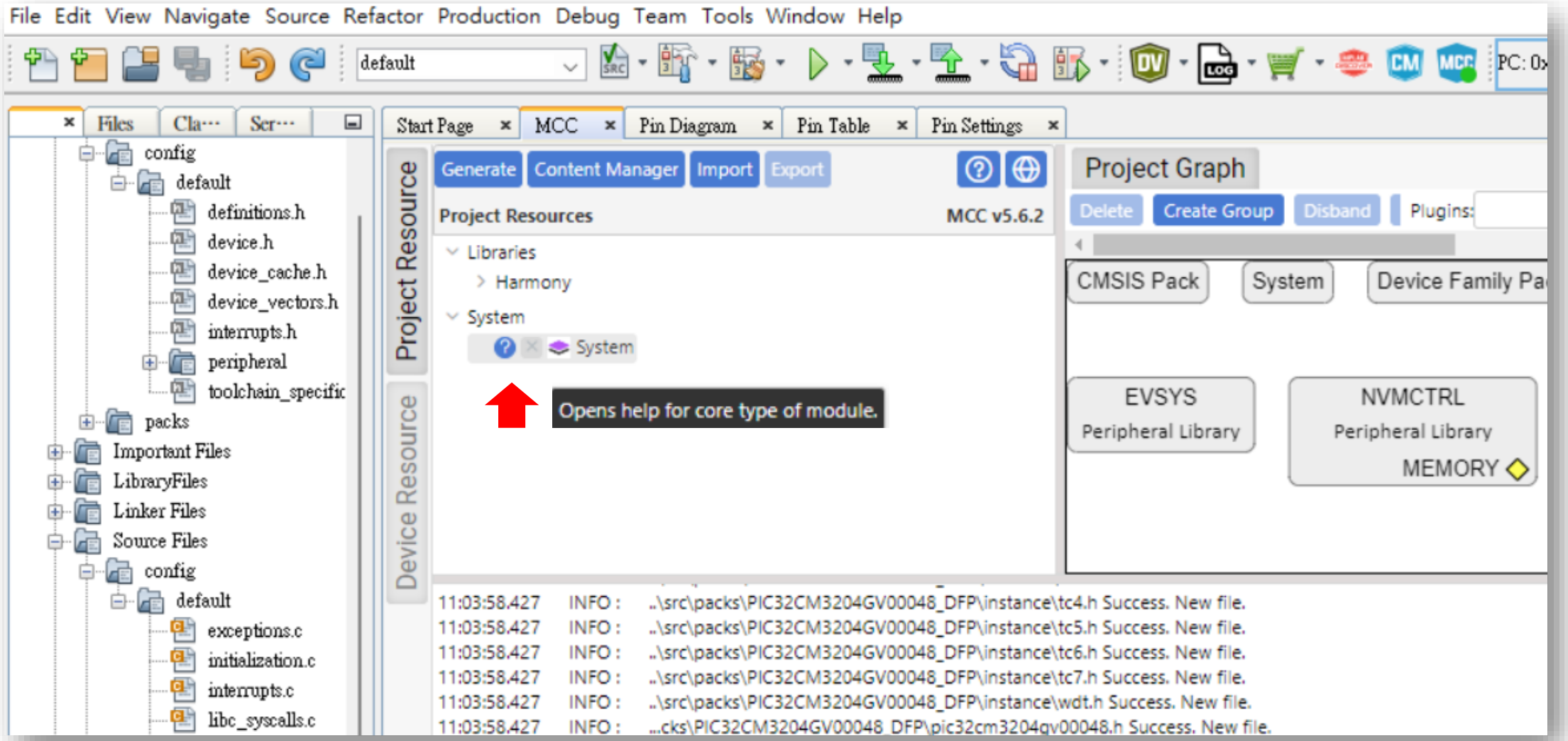
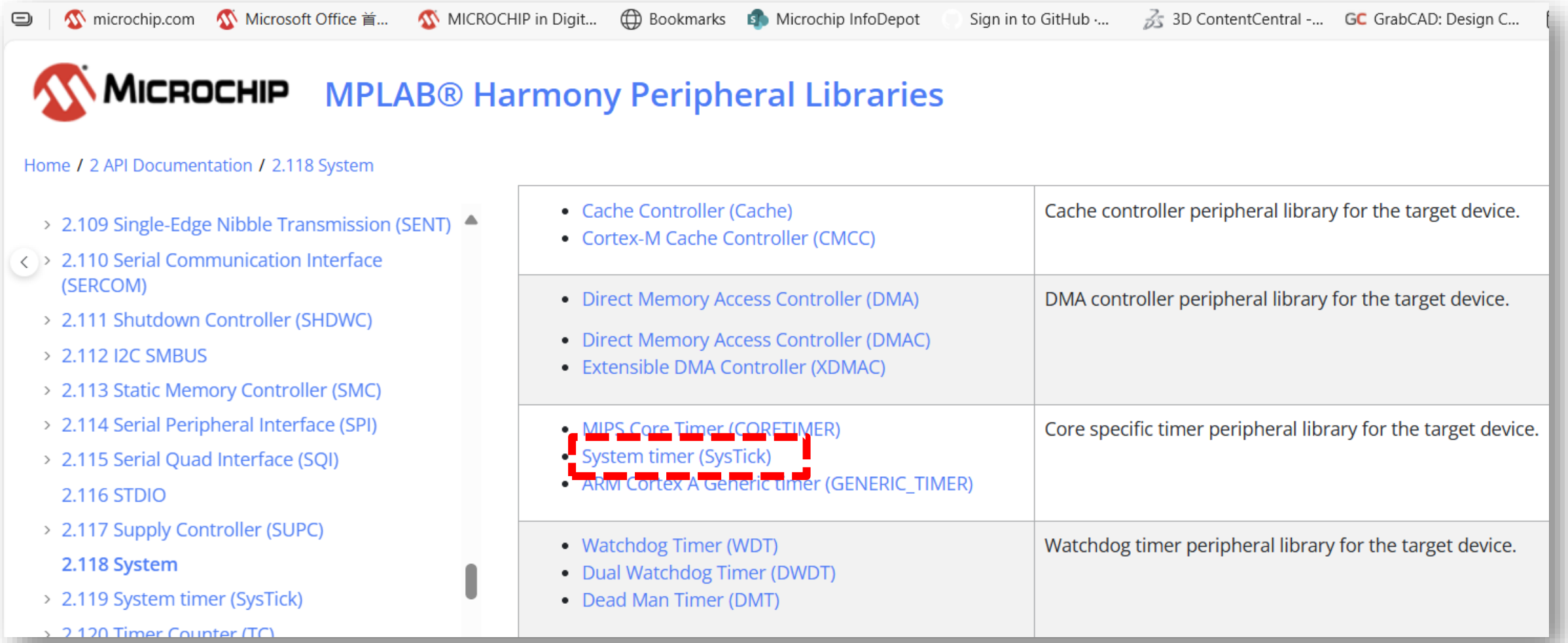
Lab1 – MPLAB® X IDE project creation & Systick

點選 System 模組左邊的 ❓ 即可連結到線上說明



Lab1 – MPLAB® X IDE project creation & Systick

點選 System timer 項目即可找到 SysTick 的應用說明



Lab1 – MPLAB® X IDE project creation & Systick

Lab1 希望使用中斷，所以參考 callback method

Callback method

This example demonstrates how to use SysTick to generate periodic callback.

Copy

```
/* This function is called after Timer expires */
void SYSTICK_EventHandler(uintptr_t context)
{
    /* Toggle LED */
    LED_Toggle();
}

int main(void)
{
    /* Initialize all modules */
    SYS_Initialize ( NULL );

    /* Register Callback */
    SYSTICK_TimerCallbackSet(SYSTICK_EventHandler, (uintptr_t) NULL);

    /* Start the Timer */
    SYSTICK_TimerStart();
}
```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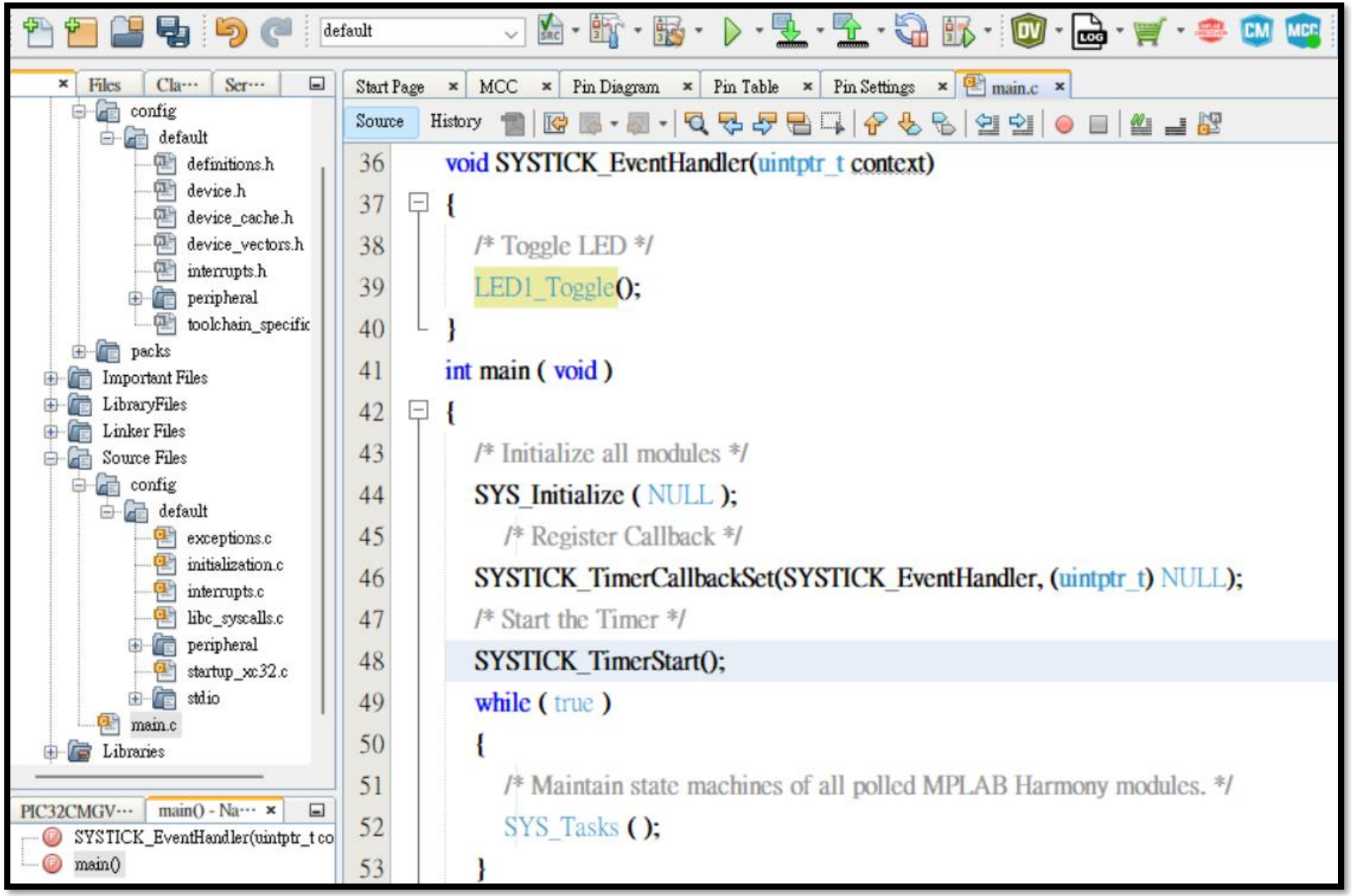
Lab1 – MPLAB® X IDE project creation & Systick

修改後的 main.c -> 請注意 LED1 的 Custom Name 已被用上



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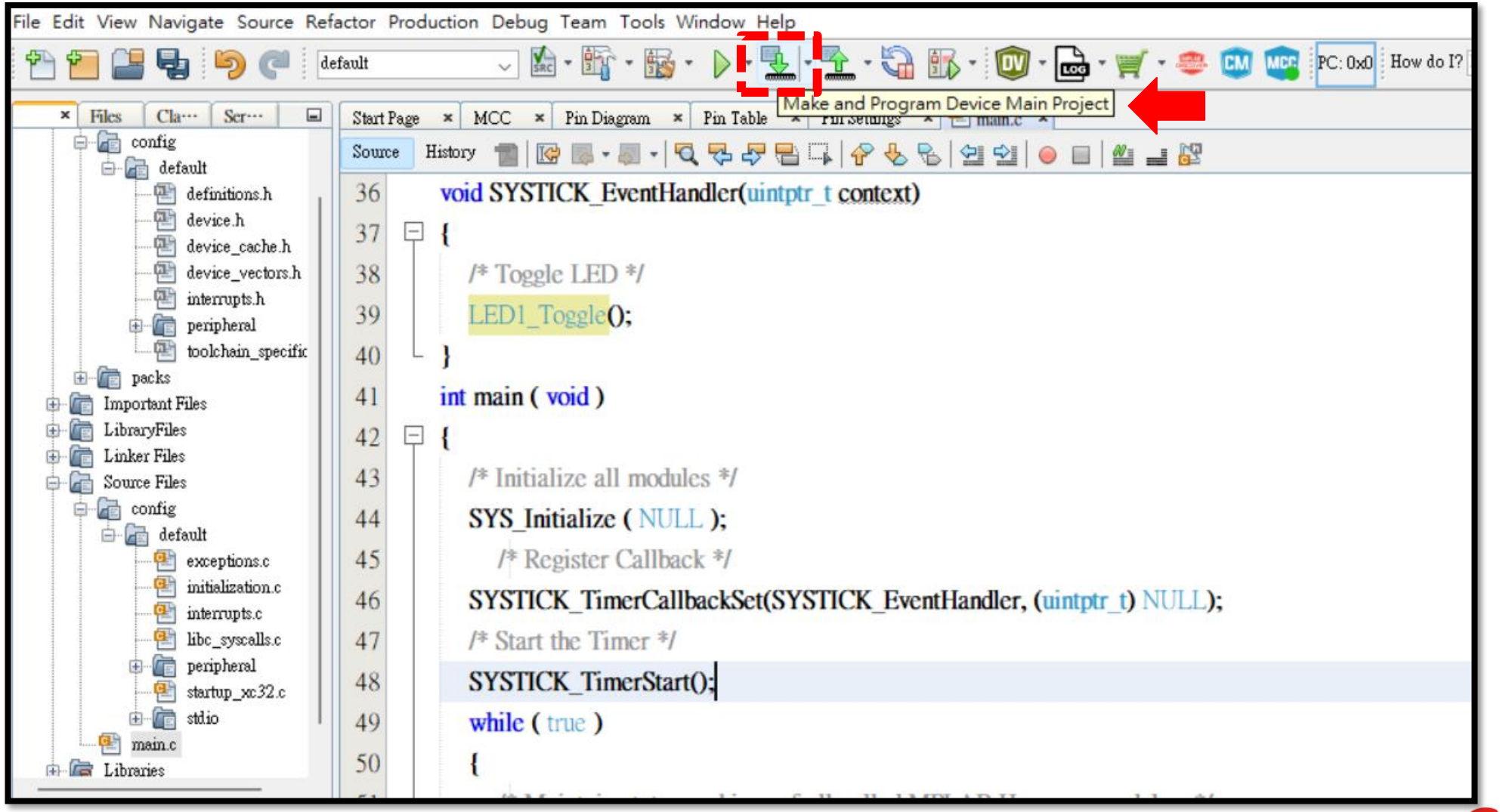
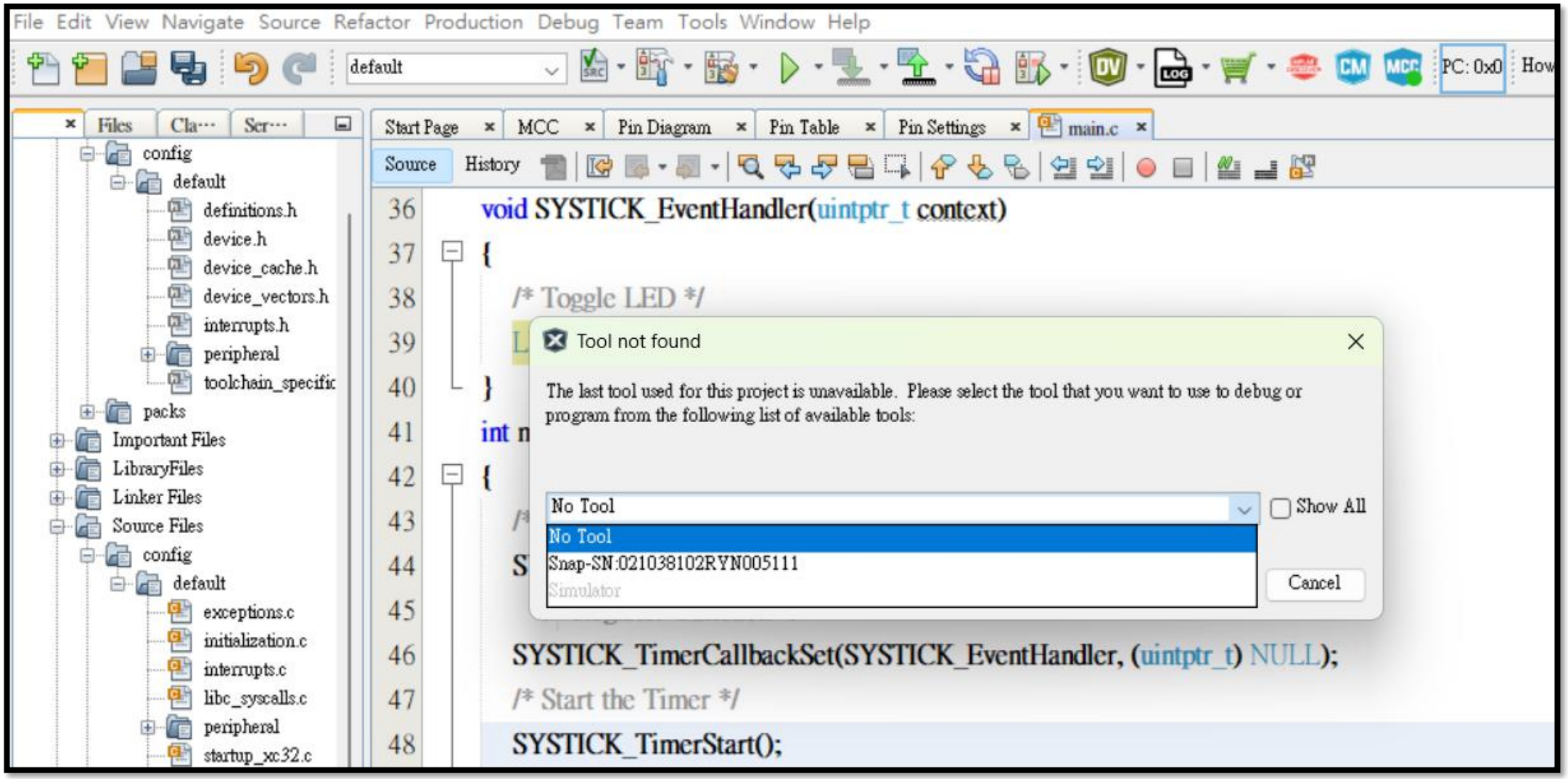
Lab1 – MPLAB® X IDE project creation & Systick

點選 Make and Program Device Main Project 來進行燒錄作業



Lab1 – MPLAB® X IDE project creation & Systick

如果連接的 Tool 之前未被辨識過，MPLAB XIDE 會讓適用者確認並選擇

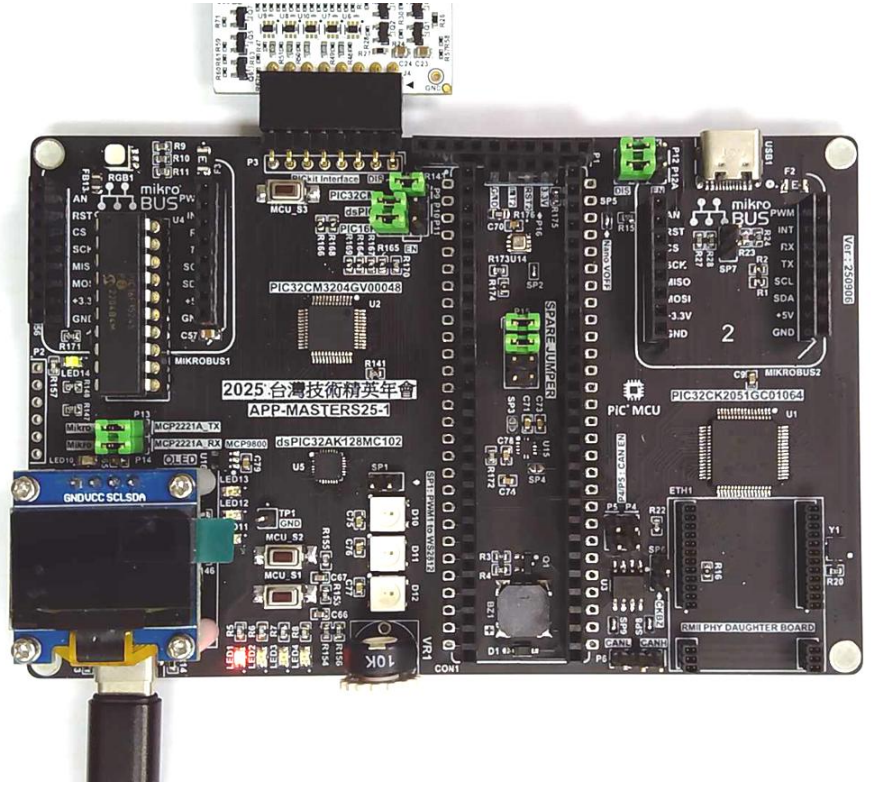


Lab1 – MPLAB® X IDE project creation & Systick

燒錄完成後的執行結果 – LED1 每 100 ms 轉態一次

```
Output ×
Scripting × | MPLAB® Code Configurator × | PIC32CMGV_Lab1 (Build, Load, ...) × | Snap × | Snap-PIC32CMGV_Lab1 ×
The following memory area(s) will be programmed:
program memory: start address = 0x0, end address = 0x4ff
configuration memory
User Id Memory

Due to the large memory ranges on this device, only the areas of memory that have been loaded with code (via the build process
Programming/Verify complete
```



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Lab 1 Summary

Successfully created a MPLAB® X IDE project using MCC Harmony v3

Check and Config Clock – Make sure CPU runs at 48 Mhz

Config SysTick and learn how to implement “Interrupt”

Config I/O Pins and use Custom Name for easy access

Program the device by using Microchip Tool

Viewed the main device and component header files

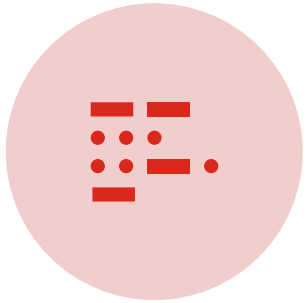
Lab 2 – Interface to the world

ADC read and UART communication

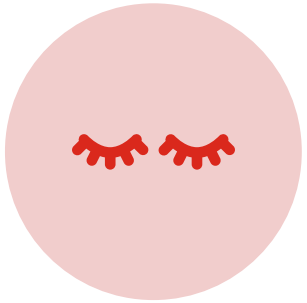
Lab 2 Objectives

Continue setup from Lab 1

Set up UART (115200,N,8,1) & ADC



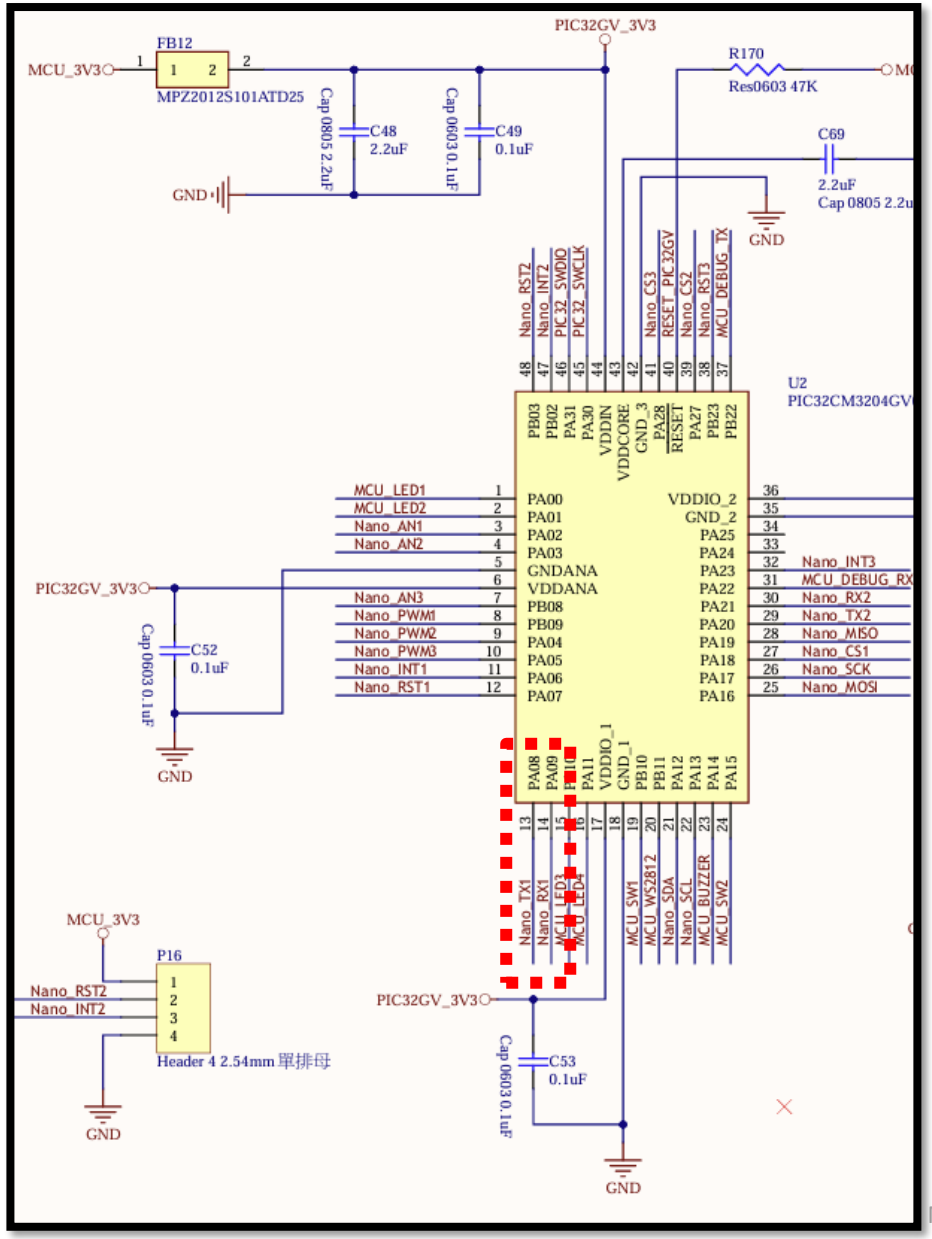
Review the generated PLIBs

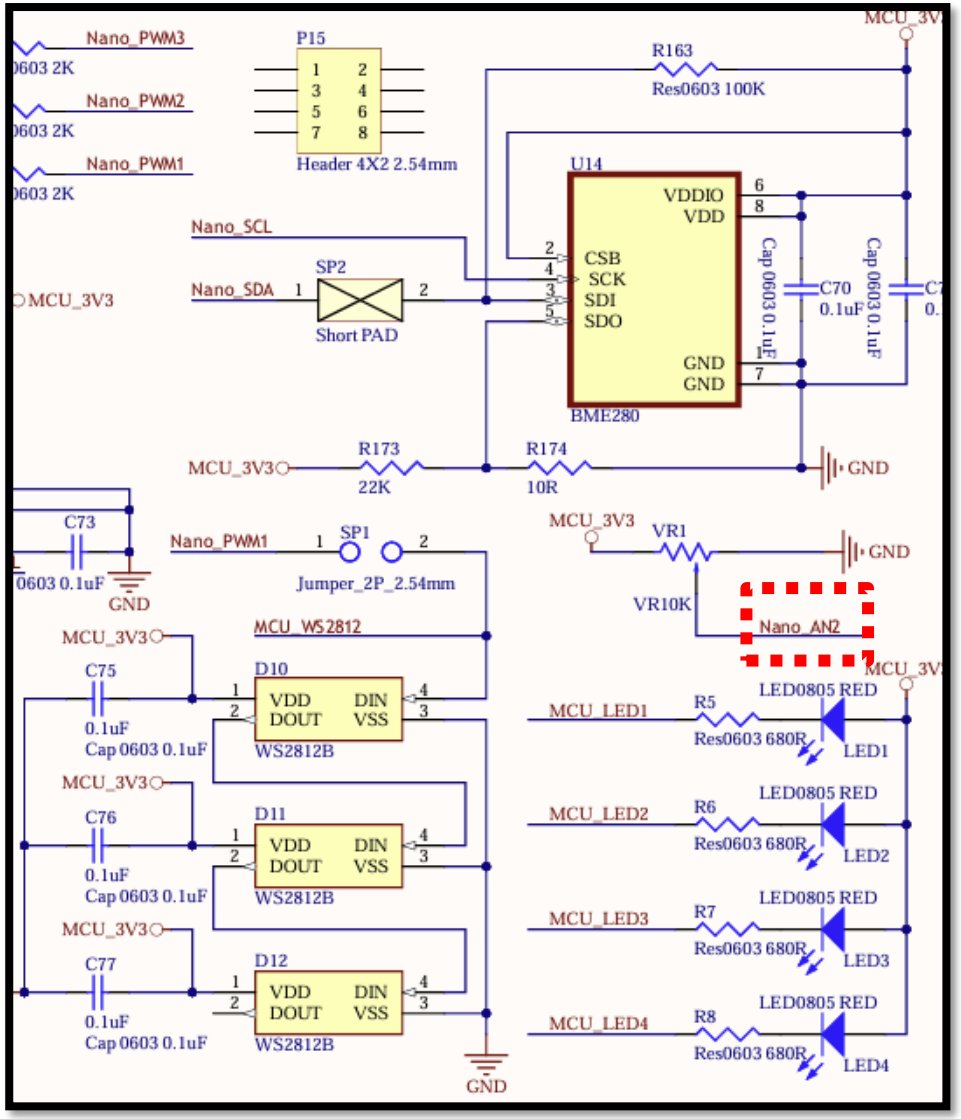


Send VR(ADC) result through UART to

MPLAB® Data Visualizer

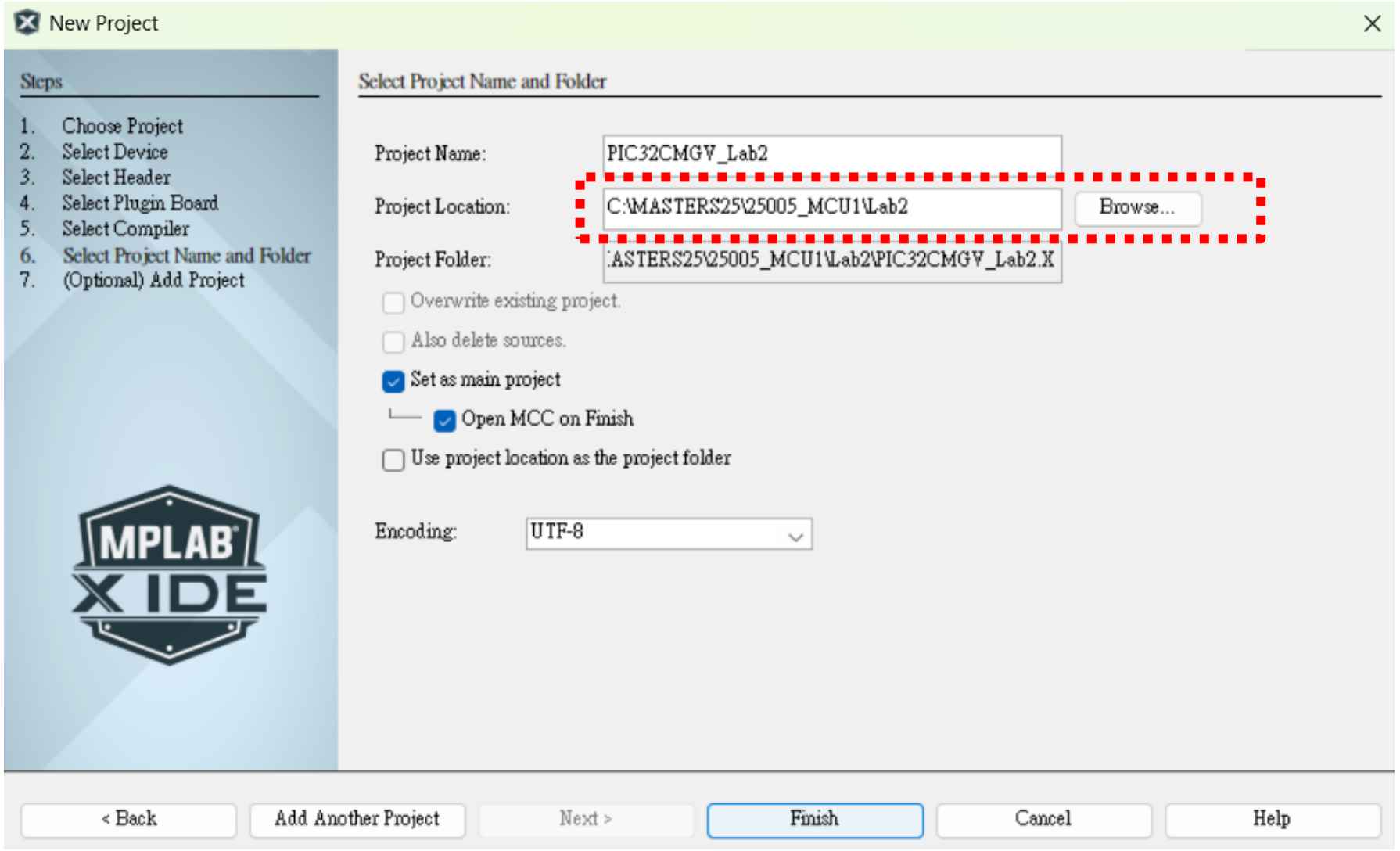
Lab2 – Interface to the World -> 使用到的接腳





Lab2 – Interface to the World

建立 Lab2 保留 Lab1 的部分, 讓 SysTick 以 200ms 的時間來中斷 MCU



Lab2 – Interface to the World

增加對 VR (PA03) 以及 UART (PA08&PA09) Pin 腳的設定

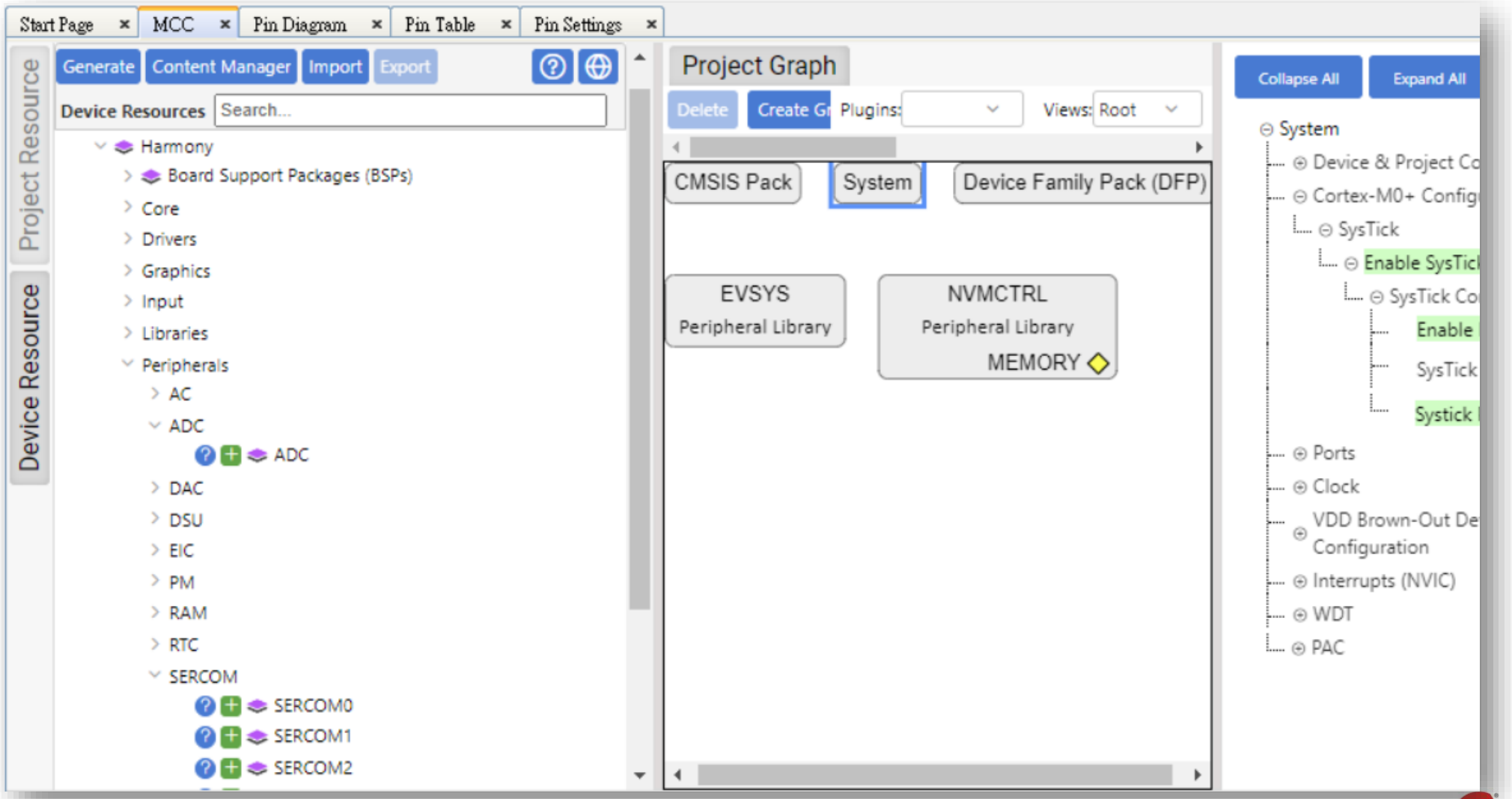
Start Page | MCC | Pin Diagram | Pin Table | Pin Settings

Order: Pins | Table View | Easy View

Pin Number	Pin ID	Custom Name	Function	Mode	Direction	Latch	Pull Up	Pull Down	Drive Strength
1	PA00	LED1	GPIO	Digital	Out	Low			NORMAL
2	PA01		Available	Digital	High Impedance	Low			NORMAL
3	PA02		Available	Digital	High Impedance	Low			NORMAL
4	PA03	VR1	ADC_AIN1	Analog	High Impedance	n/a			NORMAL
5	GNDANA			Digital	High Impedance	Low			NORMAL
6	VDDANA			Digital	High Impedance	Low			NORMAL
7	PB08		Available	Digital	High Impedance	Low			NORMAL
8	PB09		Available	Digital	High Impedance	Low			NORMAL
9	PA04		Available	Digital	High Impedance	Low			NORMAL
10	PA05		Available	Digital	High Impedance	Low			NORMAL
11	PA06		Available	Digital	High Impedance	Low			NORMAL
12	PA07		Available	Digital	High Impedance	Low			NORMAL
13	PA08		SERCOM0_PAD0	Digital	High Impedance	n/a			NORMAL
14	PA09		SERCOM2_PAD1	Digital	High Impedance	n/a			NORMAL
15	PA10		Available	Digital	High Impedance	Low			NORMAL
16	PA11		Available	Digital	High Impedance	Low			NORMAL
17	VDDIO			Digital	High Impedance	Low			NORMAL
18	GNDIO			Digital	High Impedance	Low			NORMAL
19	PB10		Available	Digital	High Impedance	Low			NORMAL

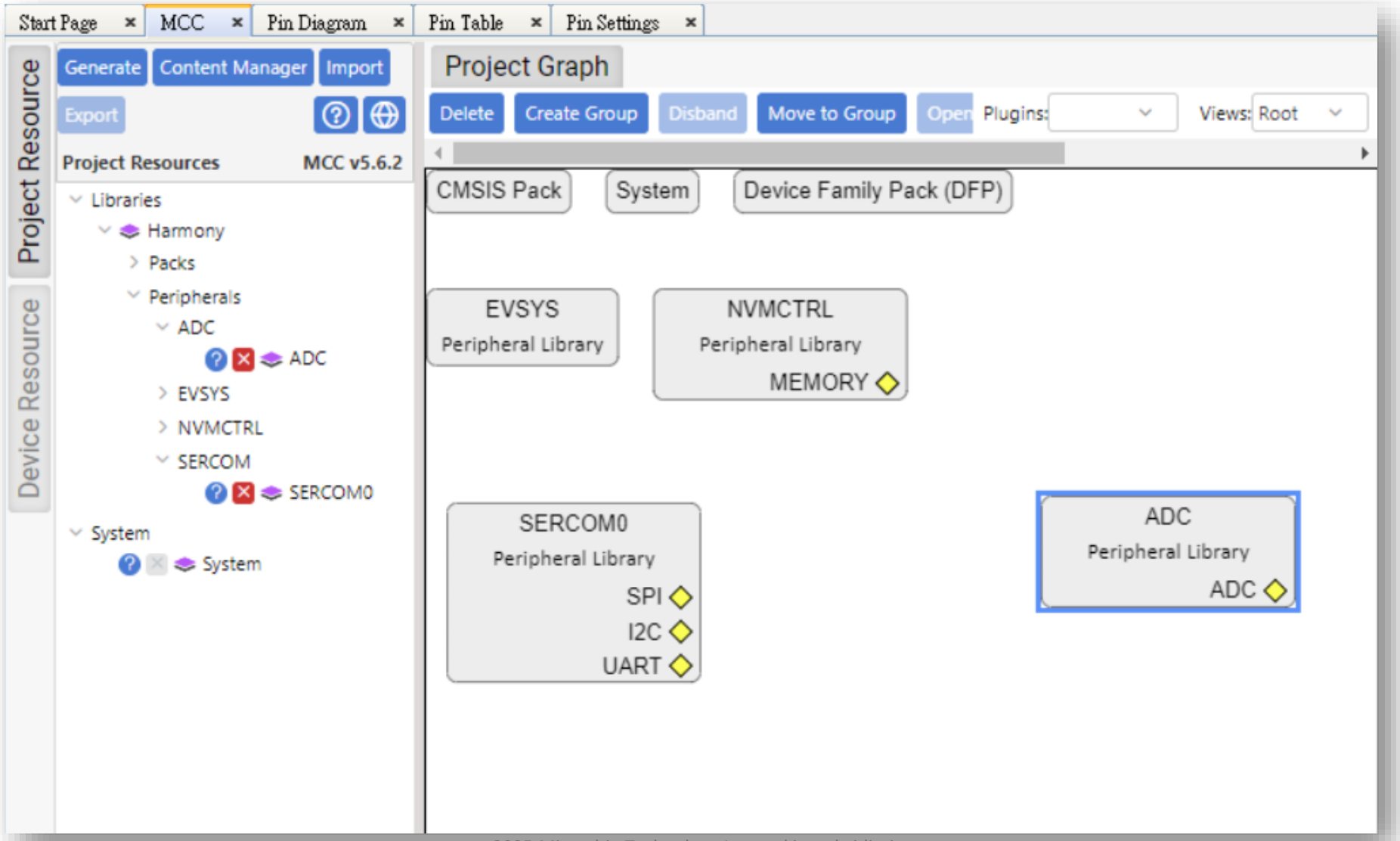
Lab2 – Interface to the World

在 Device Resource 中加入 ADC & SERCOM0



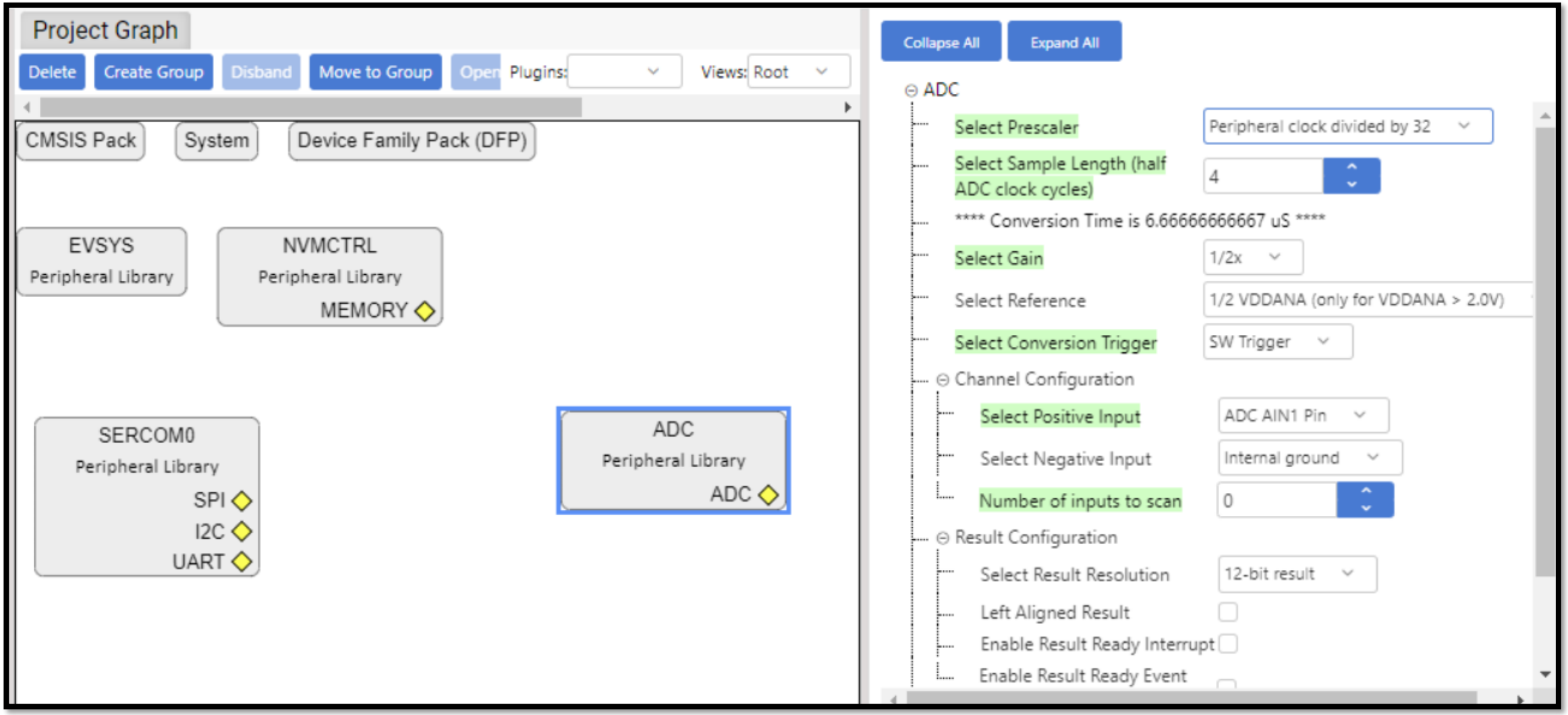
Lab2 – Interface to the World

在 Project Resource 中以及 MCC 視窗可以看到被加入的物件



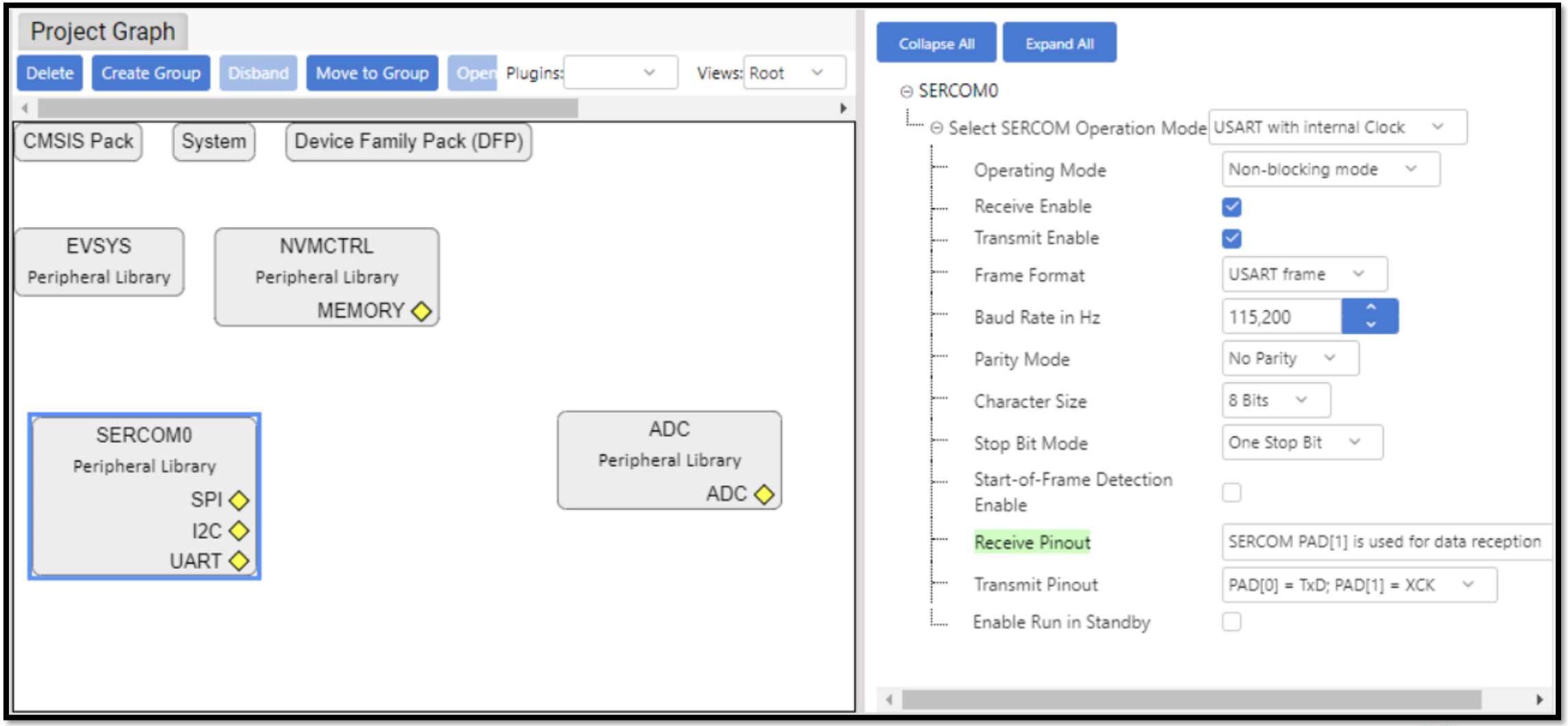
Lab2 – Interface to the World

ADC 的規劃 – 針對單一 channel 的規劃 (VR的上下限為 0~3.3V)



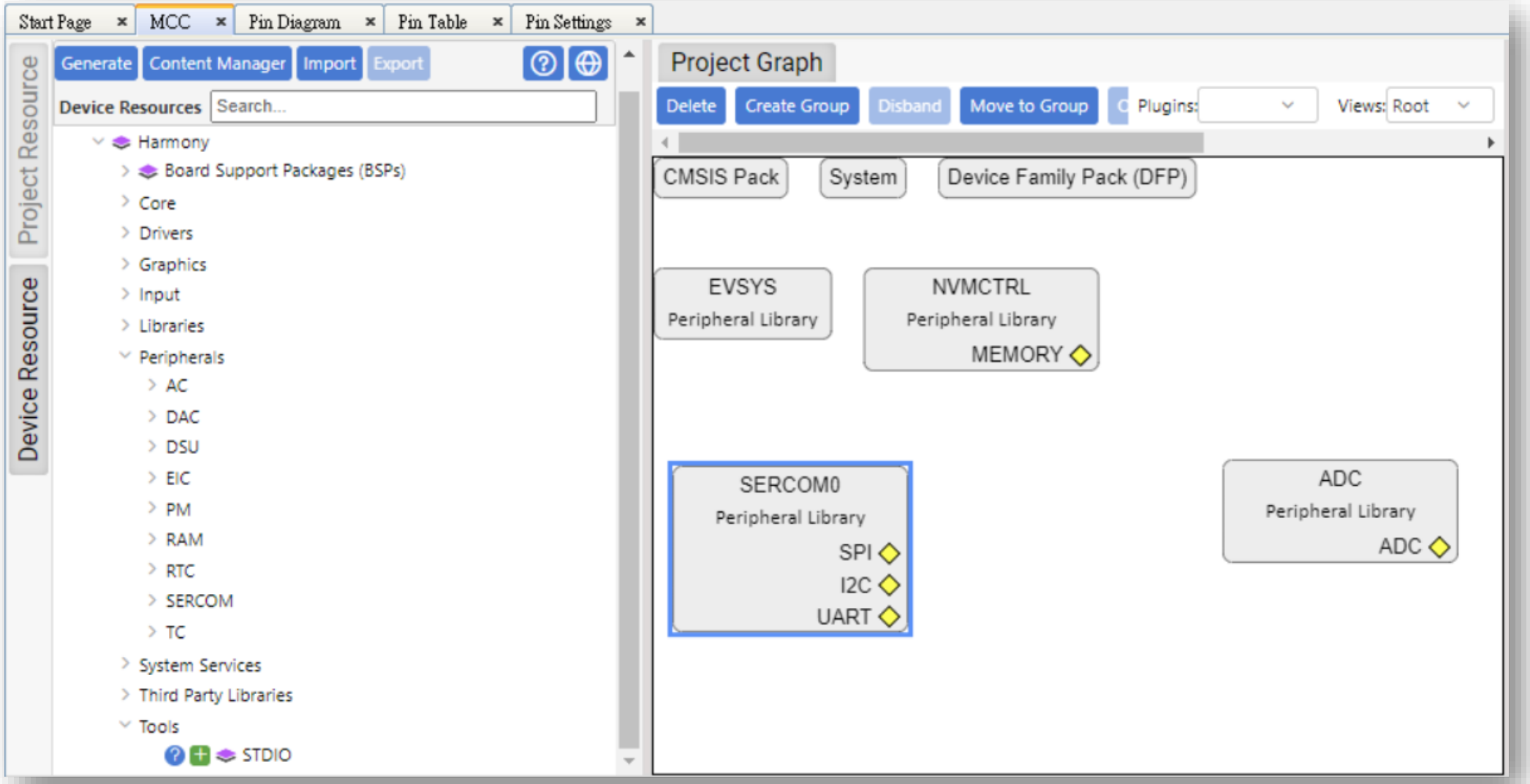
Lab2 – Interface to the World

UART 的規劃



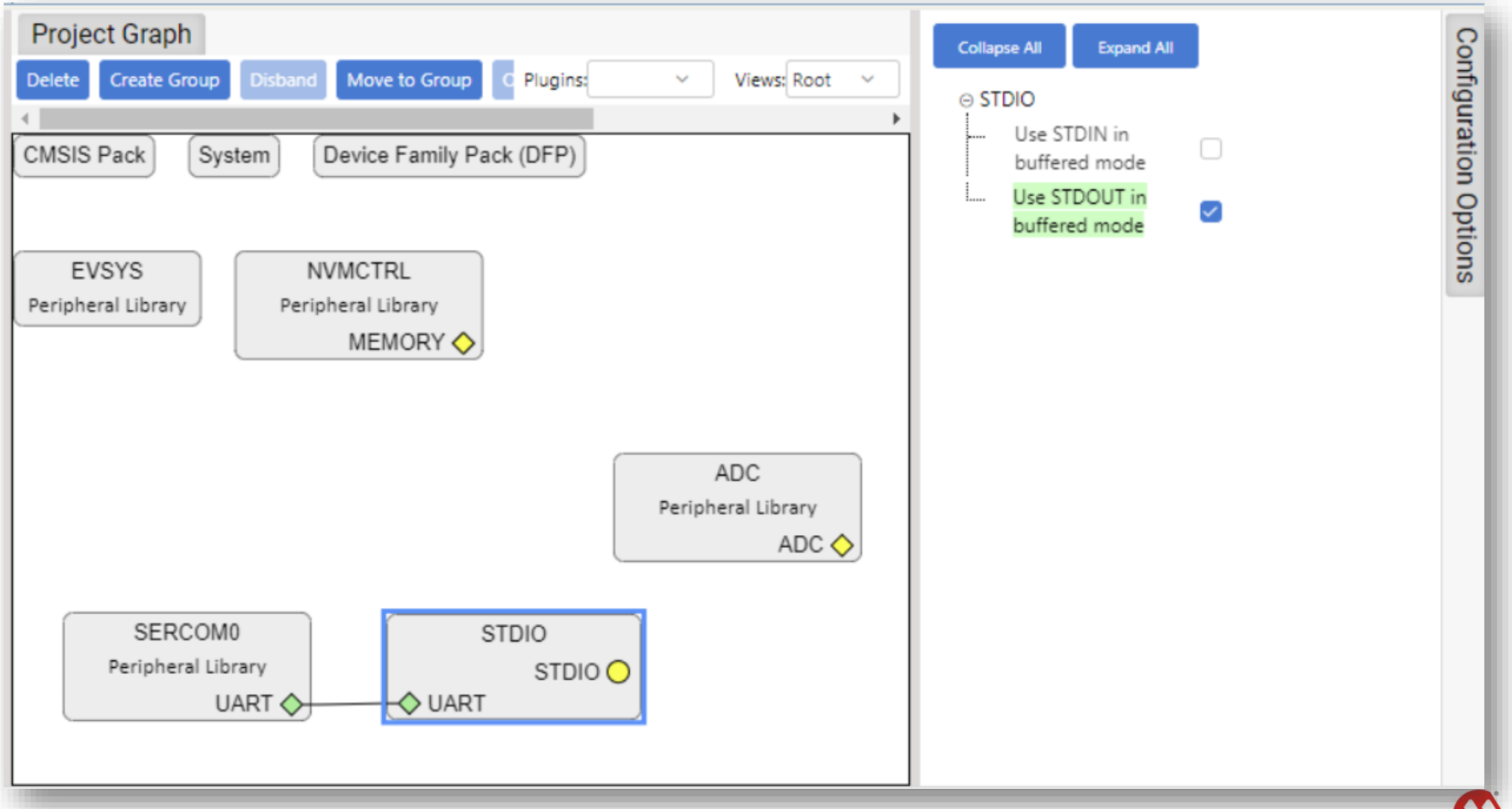
Lab2 – Interface to the World

將 STDIO 加入以便於將 UART 的資料導向 stdout



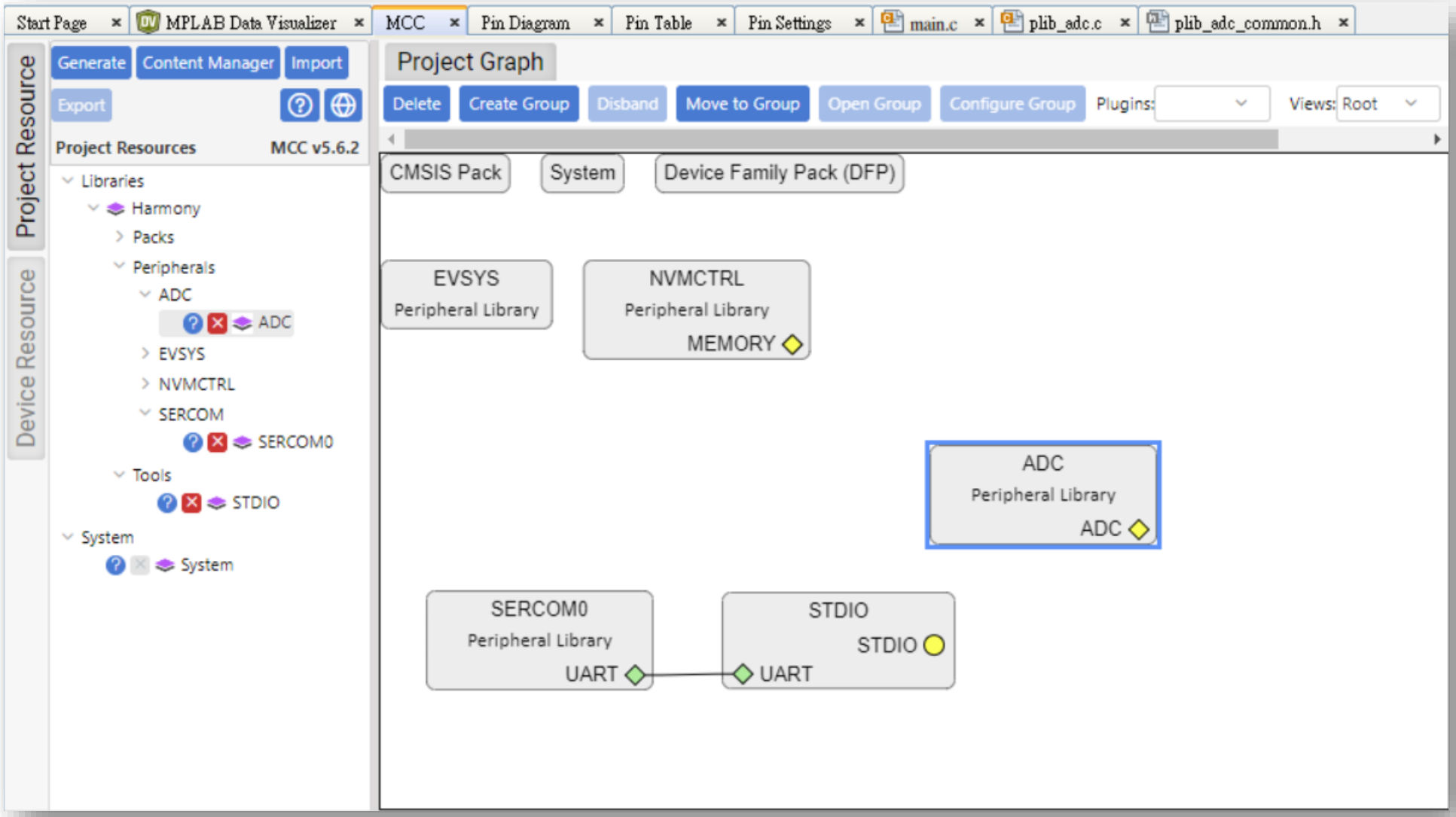
Lab2 – Interface to the World

將 SERCOM0 以滑鼠與 STDIO 做連結即可使用 printf 來輸出資料



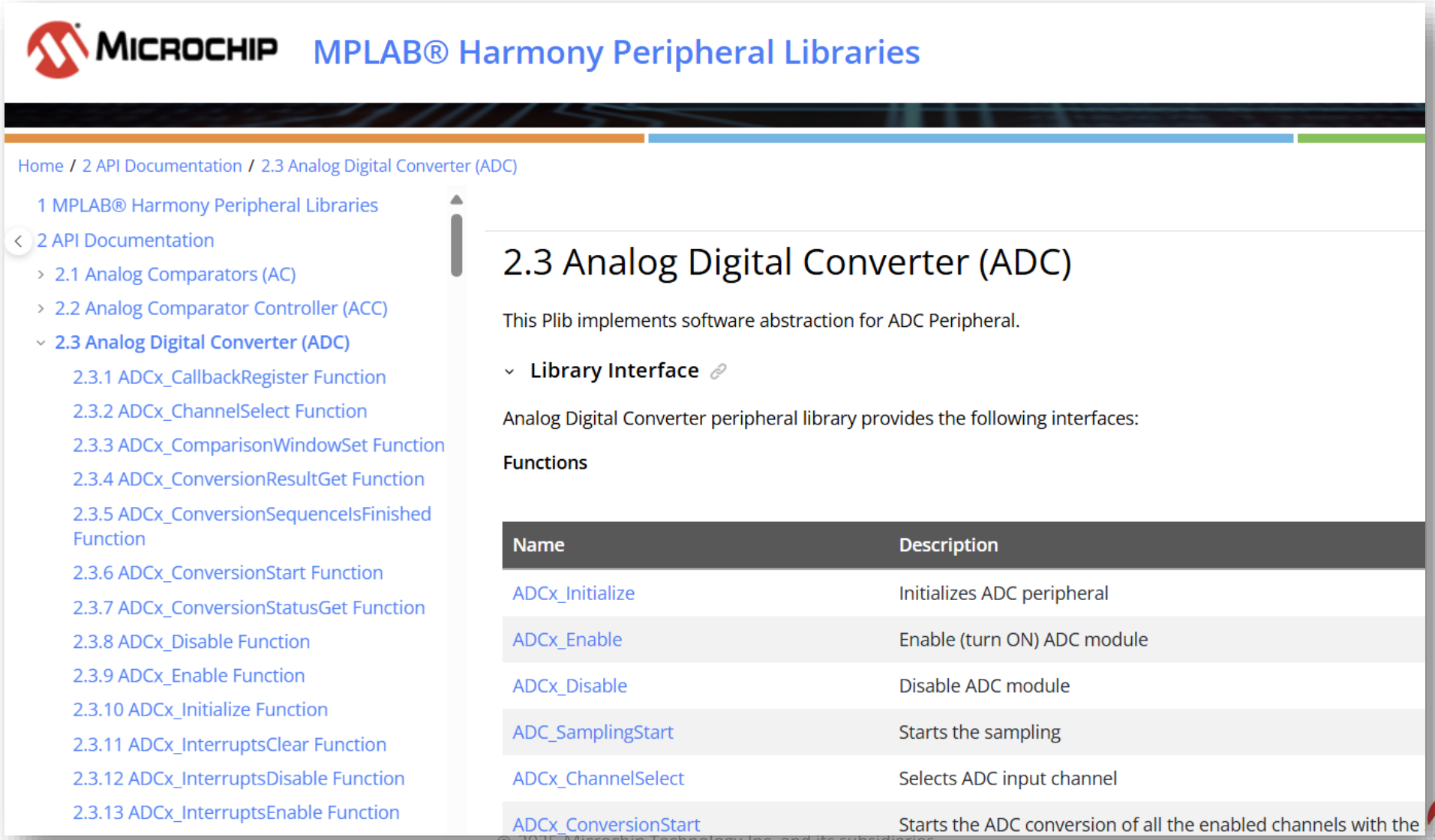
Lab2 – Interface to the World

點選 ADC module 左邊的問號 ADC 一樣可以連結到線上的說明文件



Lab2 – Interface to the World

ADC Module 的線上說明文件



Lab2 – Interface to the World

ADCx_ConversionResultGet Function 的使用範例

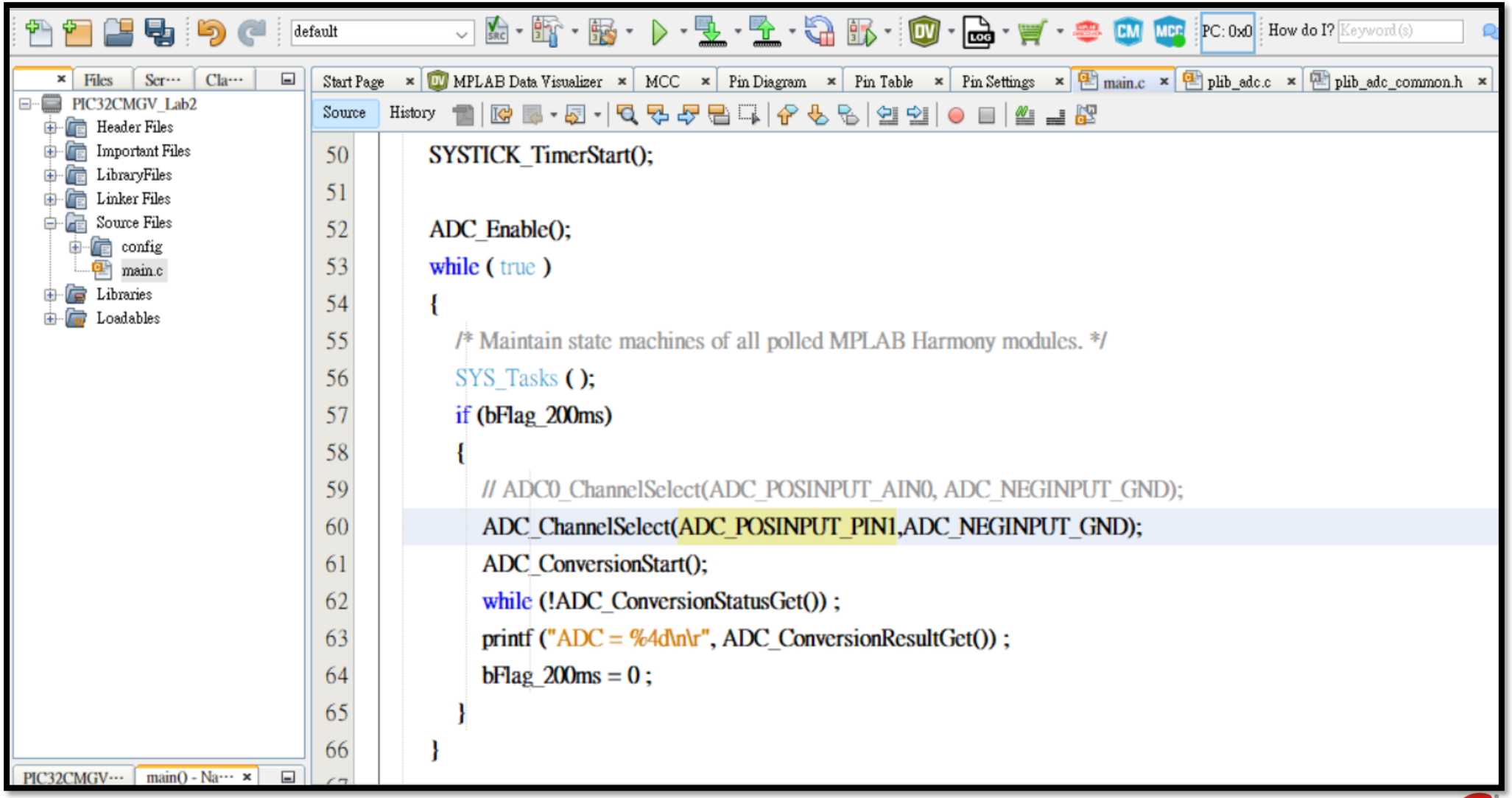
- 因為 **PIC32CM3204 GV** 系列只有一個 **ADC**，所以產生的 **API** 名稱為 **ADC_ConversionResultGet()**

Example

```
uint16_t adcResult = 0;
ADC0_Initialize();
ADC0_ConversionStart();
while(!ADC0_ConversionStatusGet());
adcResult = ADC0_ConversionResultGet();
```

Lab2 – Interface to the World

修改後的 main.c 主體，注意 bFlag_200ms 由 SysTick 的中斷設定



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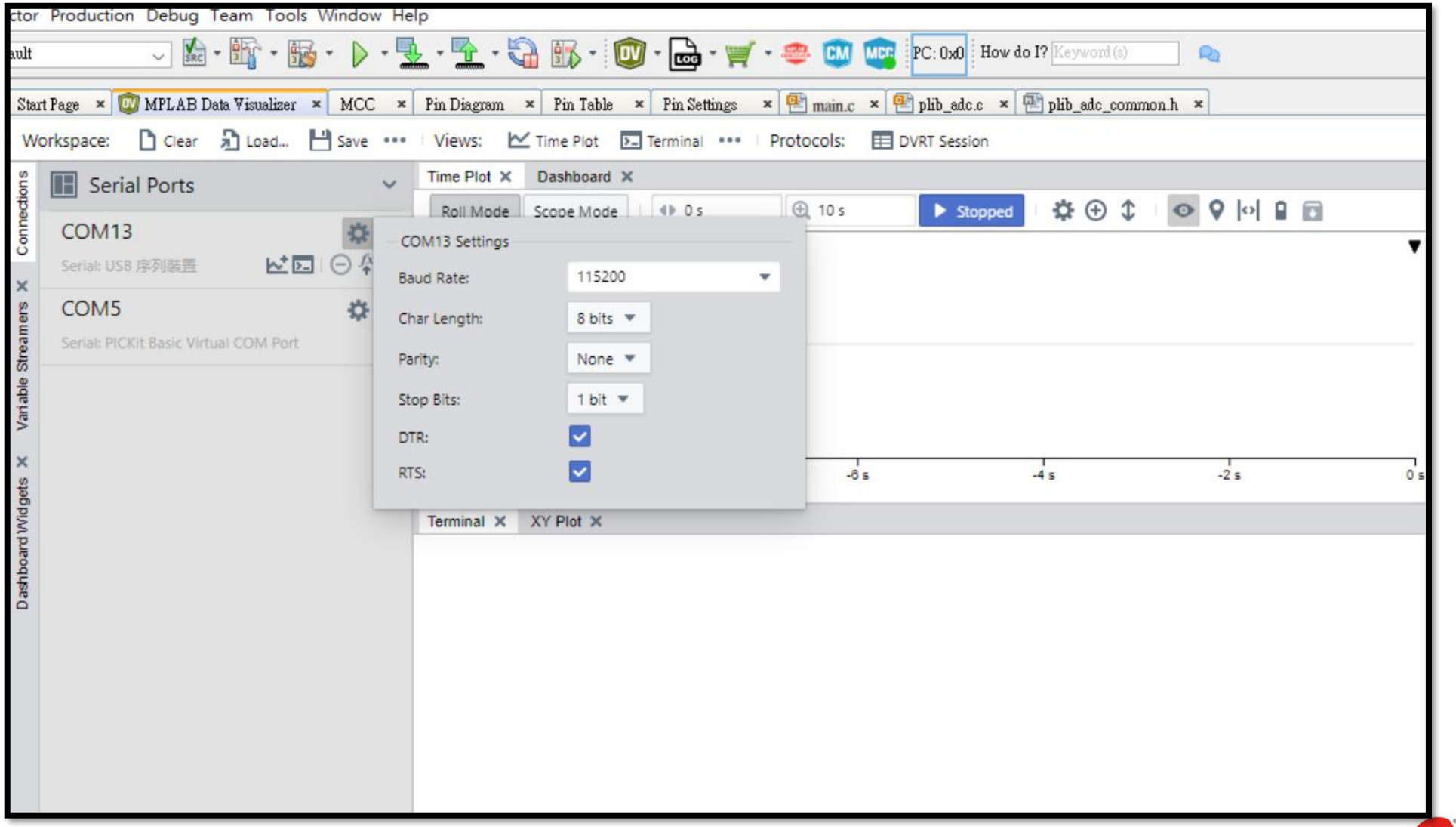
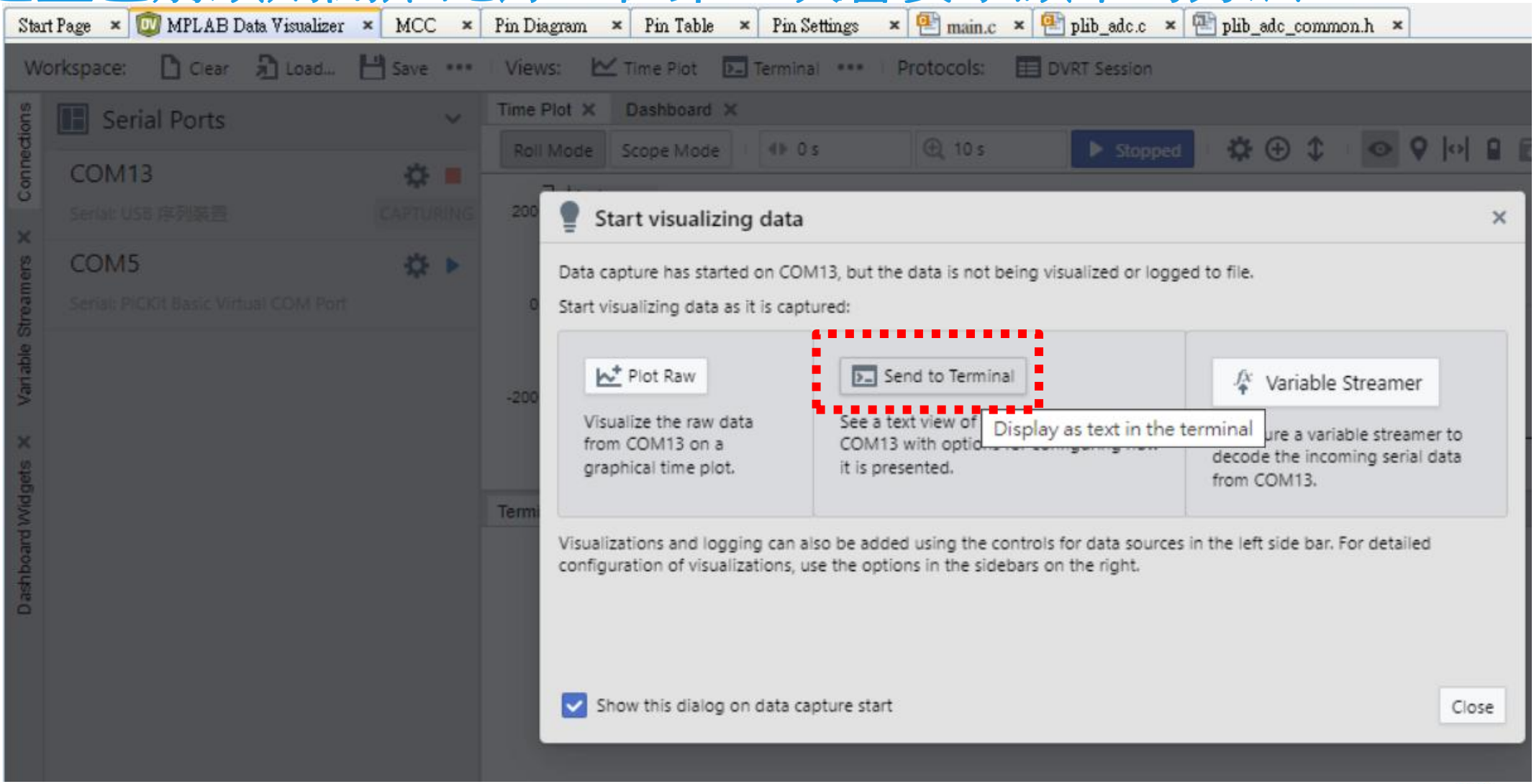
Lab2 – Interface to the World

點選 Data Visualizer，選擇正確的 COM 並確定通信速率及格式正確



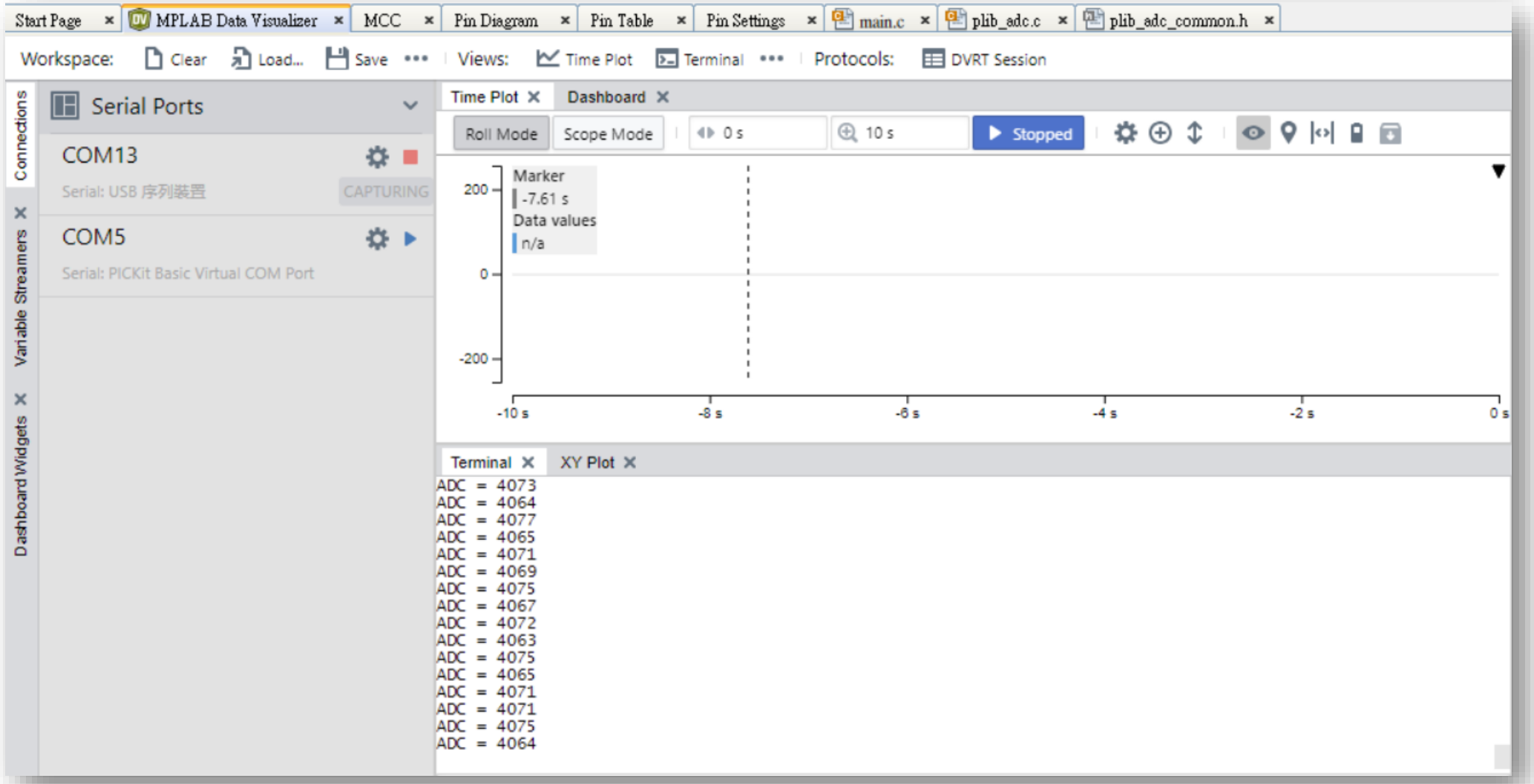
Lab2 – Interface to the World

點選藍色箭頭則開始記錄，但第一次會要求顯示的方法



Lab2 – Interface to the World

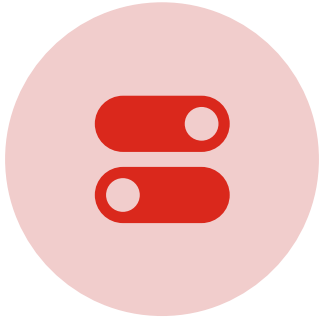
ADC 的讀值被 Serial Port 輸出的結果 (轉動 VR 會看到變化)



Lab 3 – OLED Display for ADC Result

Lab 3 Objectives

Continue setup from Lab 2 (Reserve all function)

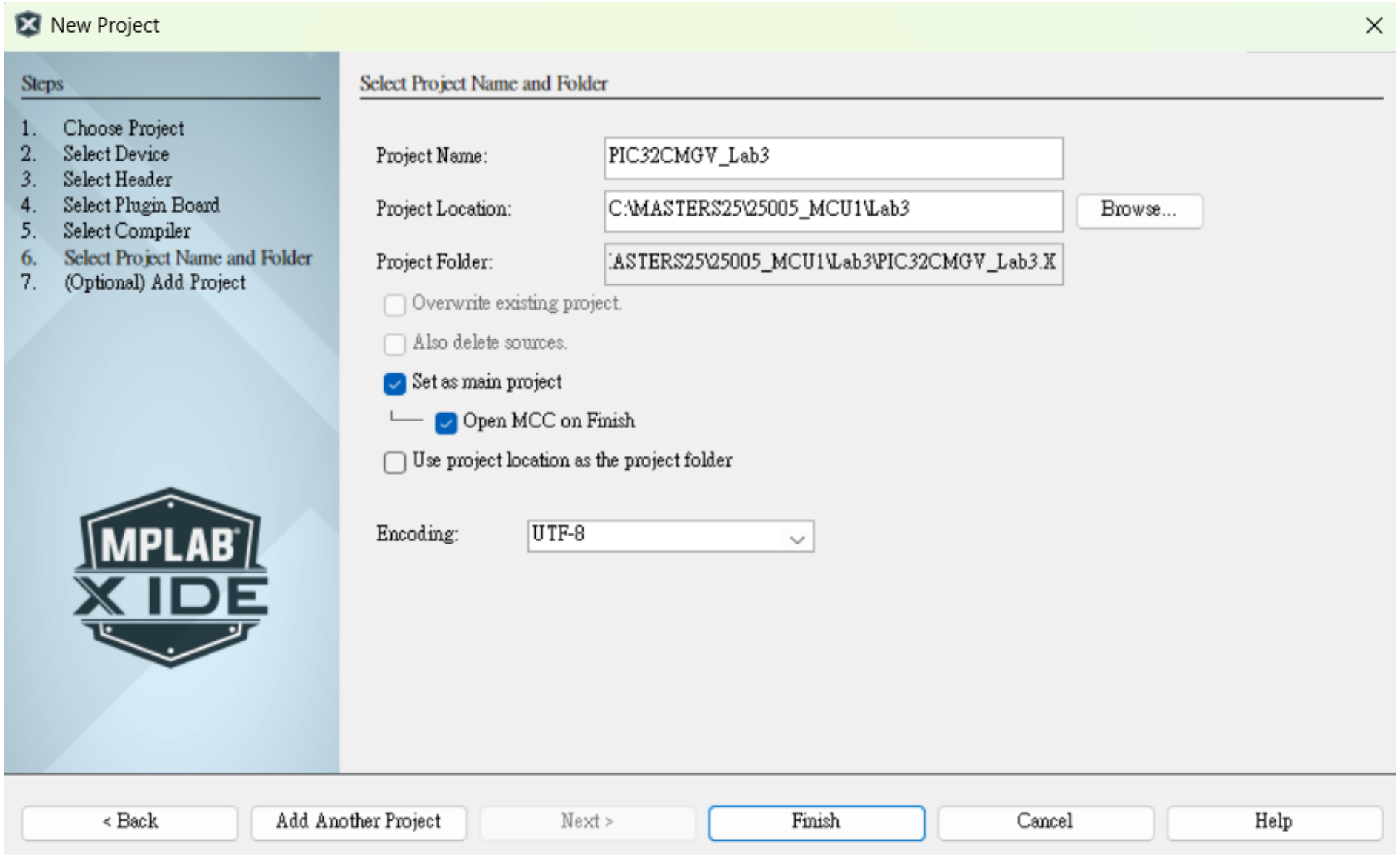


Set up SERCOM for I^2C Master support

Initialize and operate OLED display by using Library

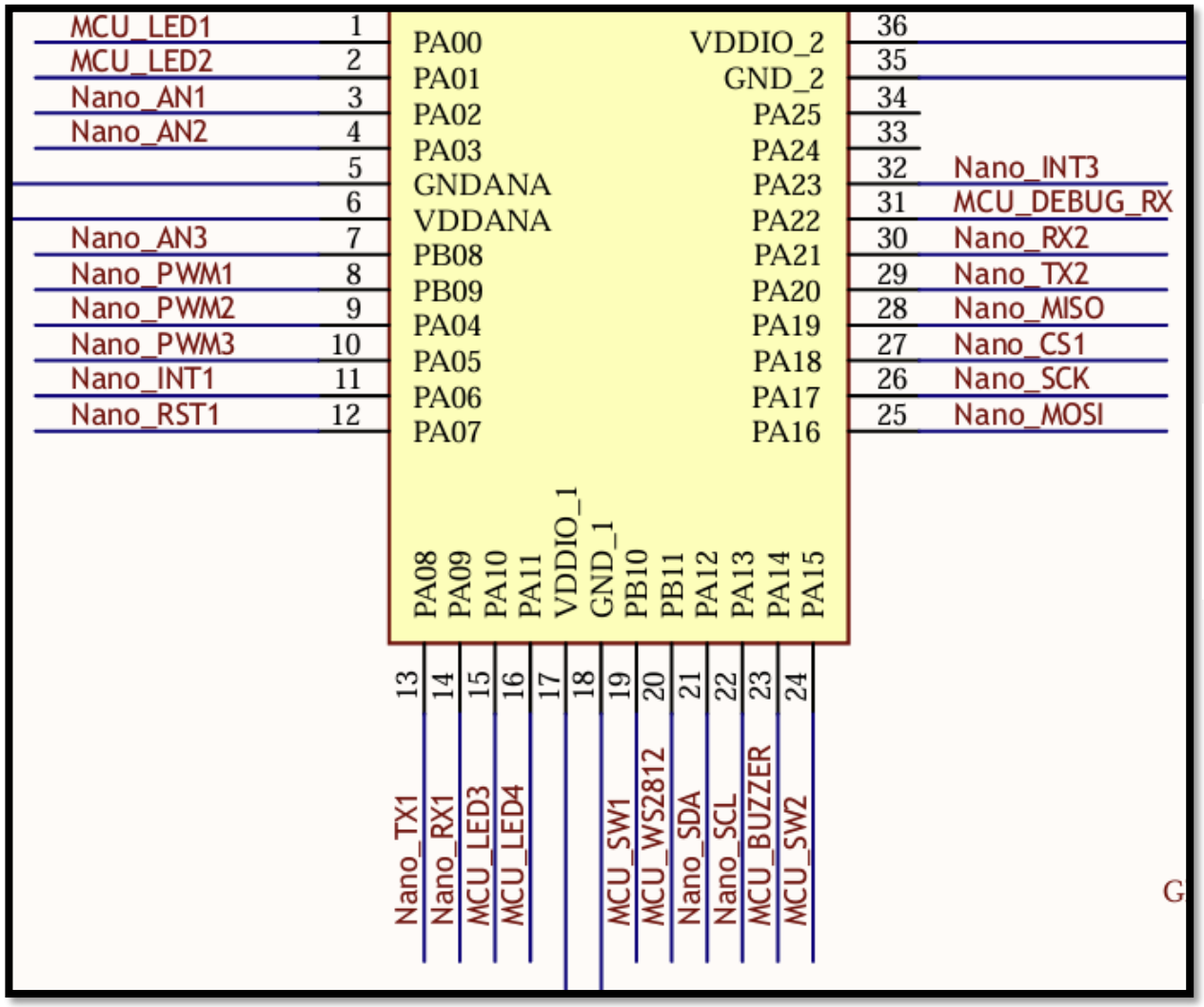
Additionally update ADC result to OLED periodically (200ms)

Lab 3 – OLED Display for ADC Result



Lab 3 – OLED Display for ADC Result

SDA & SCL are located @ PA12 & PA13



Signal Name	Type	Description
PAD[0]	Digital I/O	SDA
PAD[1]	Digital I/O	SCL
PAD[2]	Digital I/O	SDA_OUT (4-wire operation)
PAD[3]	Digital I/O	SCL_OUT (4-wire operation)

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Lab 3 – OLED Display for ADC Result

Set SERCOM2 for I2C function (PAD0 = SDA, PAD1=SCL)

Start Page | MPLAB Data Visualizer | main.c | plib_adc.c | plib_adc_common.h | MCC | Pin Diagram | Pin Table | Pin Setting

Order: Pins | Table View | Easy View

Pin Number	Pin ID	Custom Name	Function	Mode	Direction	Latch	Pull Up	Pull Down	Drive Strength
10	PA05		Available	Digital	High Impedance	Low	☐	☐	NORMAL
11	PA06		Available	Digital	High Impedance	Low	☐	☐	NORMAL
12	PA07		Available	Digital	High Impedance	Low	☐	☐	NORMAL
13	PA08		SERCOM0_PAD0	Digital	High Impedance	n/a	☐	☐	NORMAL
14	PA09		SERCOM0_PAD1	Digital	High Impedance	n/a	☐	☐	NORMAL
15	PA10		Available	Digital	High Impedance	Low	☐	☐	NORMAL
16	PA11		Available	Digital	High Impedance	Low	☐	☐	NORMAL
17	VDDIO			Digital	High Impedance	Low	☐	☐	NORMAL
18	GNDIO			Digital	High Impedance	Low	☐	☐	NORMAL
19	PB10		Available	Digital	High Impedance	Low	☐	☐	NORMAL
20	PB11		Available	Digital	High Impedance	Low	☐	☐	NORMAL
21	PA12		SERCOM2_PAD0	Digital	High Impedance	n/a	☐	☐	NORMAL
22	PA13		SERCOM2_PAD1	Digital	High Impedance	n/a	☐	☐	NORMAL
23	PA14		Available	Digital	High Impedance	Low	☐	☐	NORMAL
24	PA15		Available	Digital	High Impedance	Low	☐	☐	NORMAL
25	PA16		Available	Digital	High Impedance	Low	☐	☐	NORMAL
26	PA17		Available	Digital	High Impedance	Low	☐	☐	NORMAL
27	PA18		Available	Digital	High Impedance	Low	☐	☐	NORMAL

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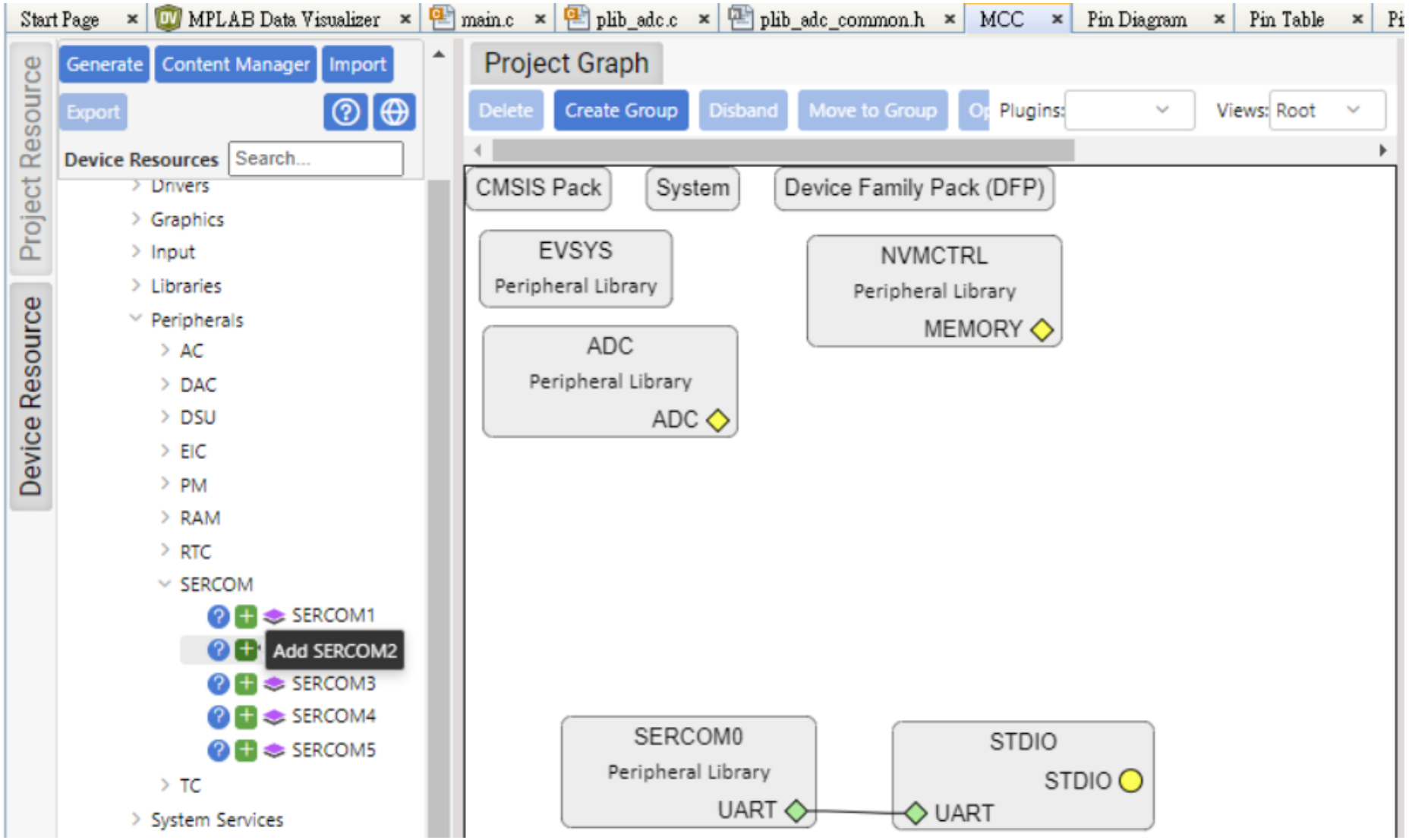
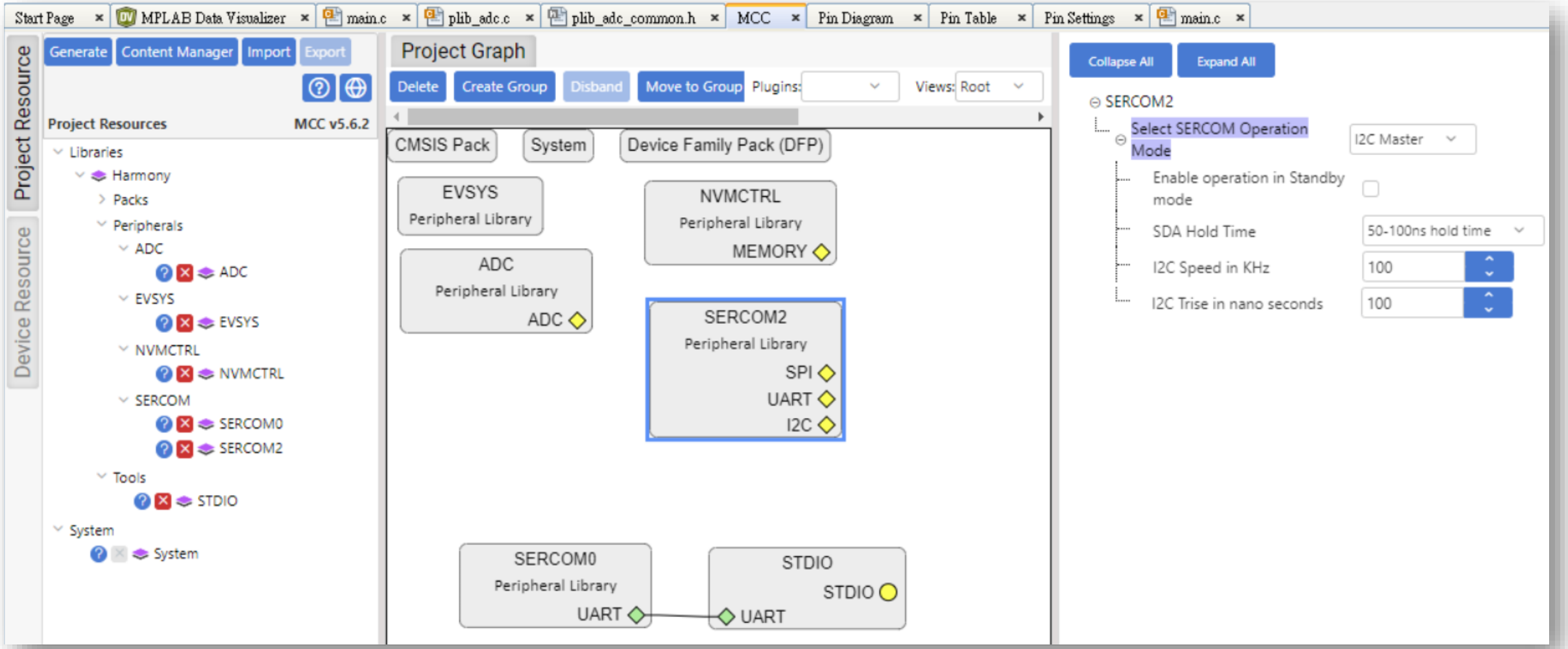
Lab 3 – OLED Display for ADC Result

加入 SERCOM2



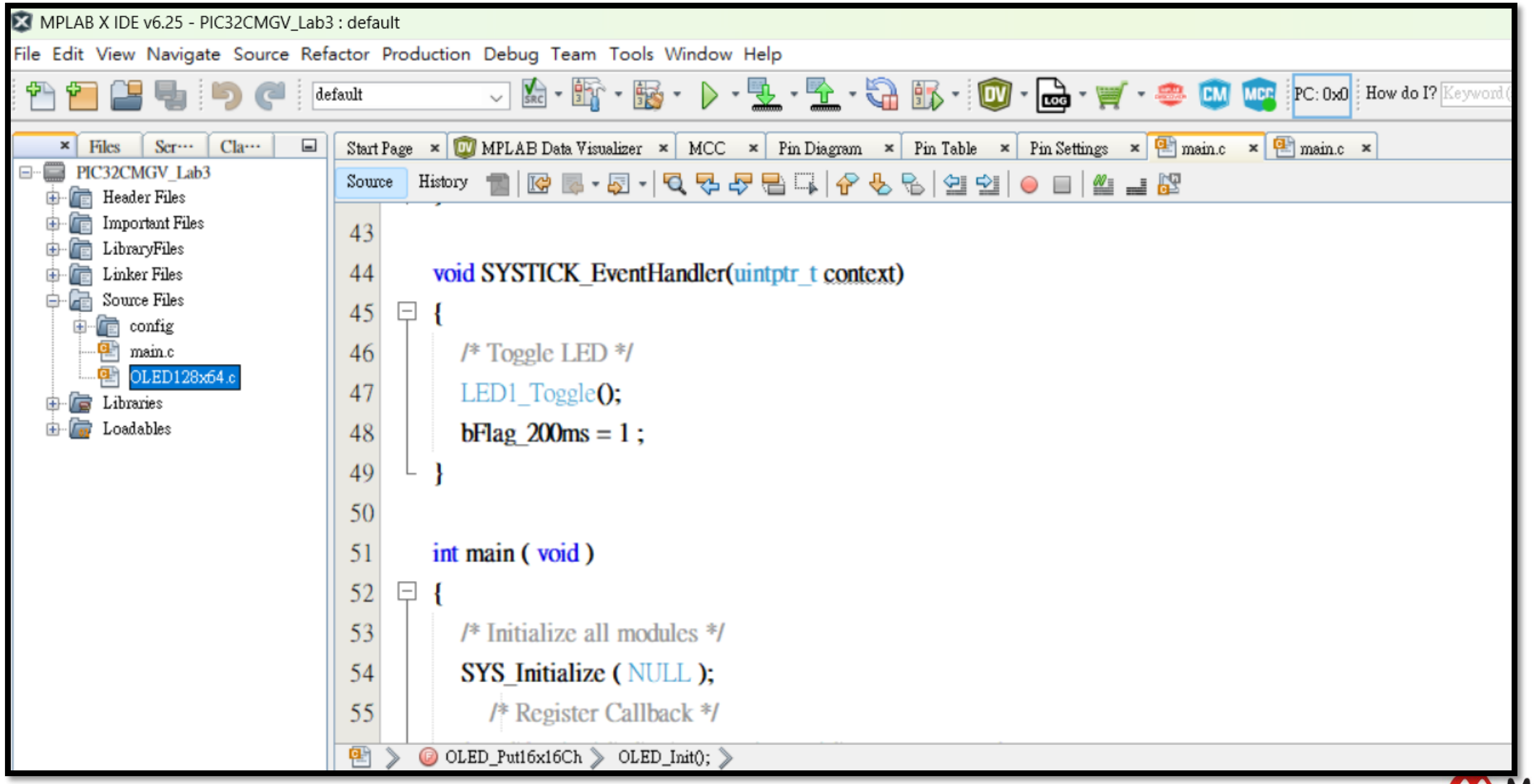
Lab 3 – OLED Display for ADC Result

Config SERCOM2 as I2C Master



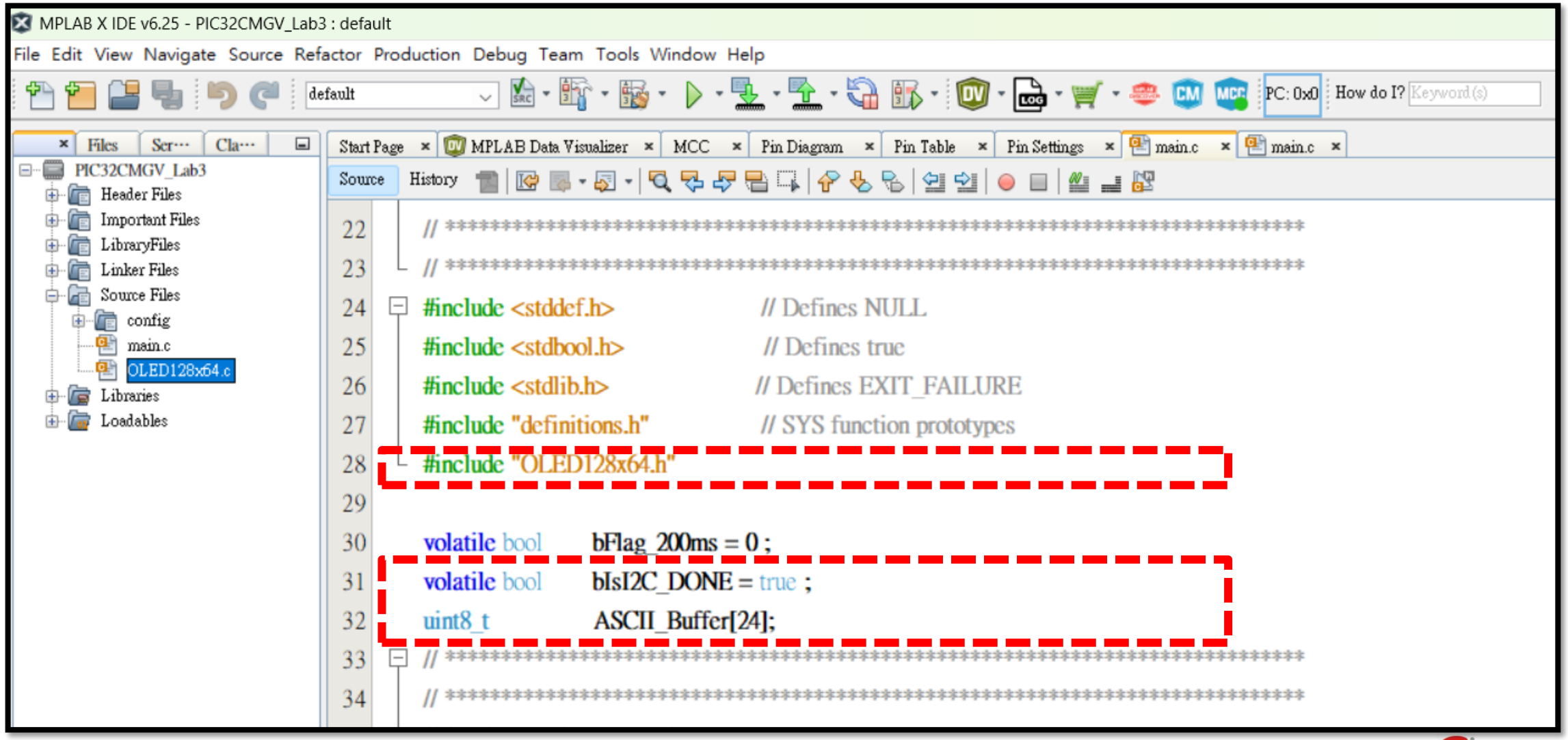
Lab 3 – OLED Display for ADC Result

Copy all library files to \src folder and add OLED128x64.c to project



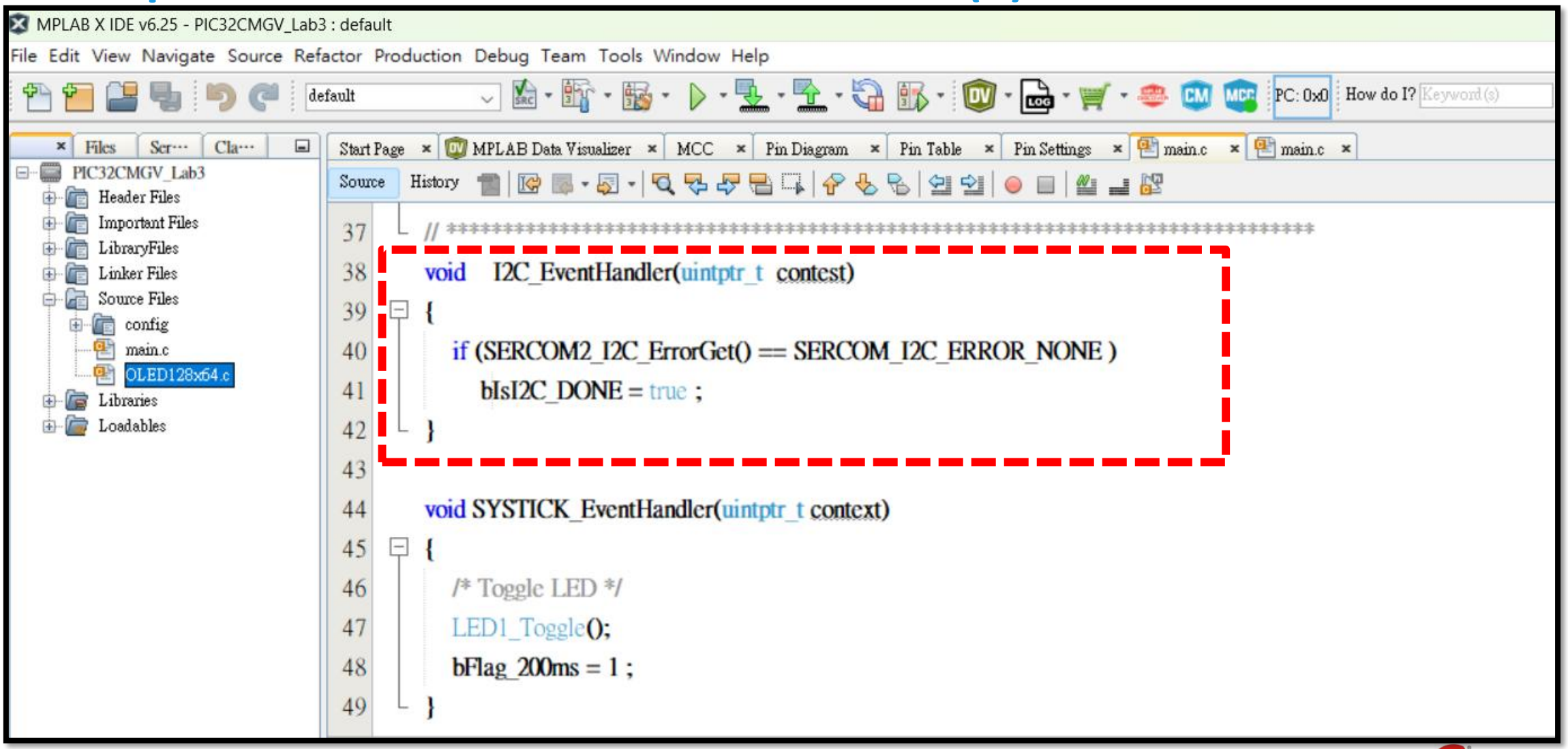
Lab 3 – OLED Display for ADC Result

Add required code and definition to main.c (1)



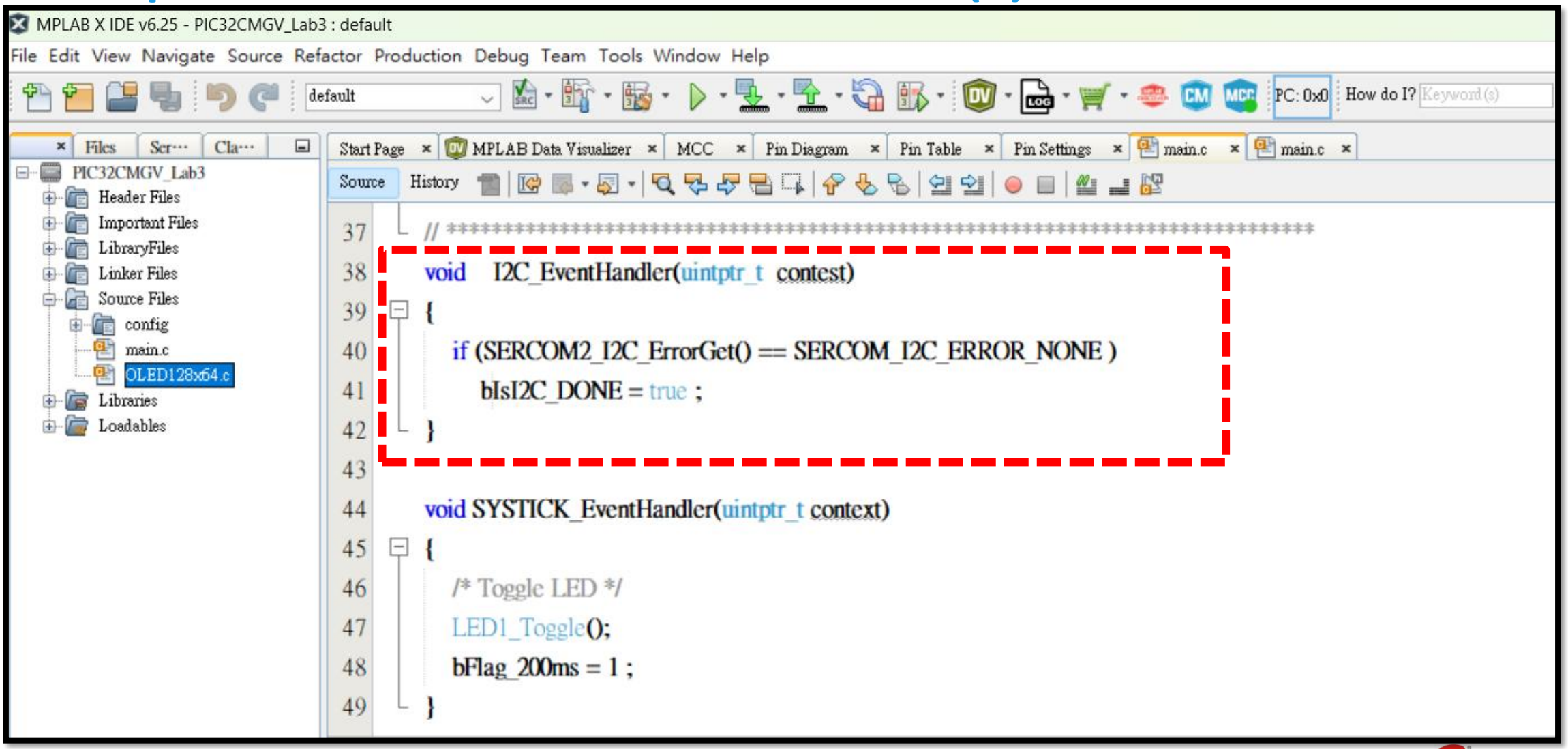
Lab 3 – OLED Display for ADC Result

Add required code and definition to main.c (2)



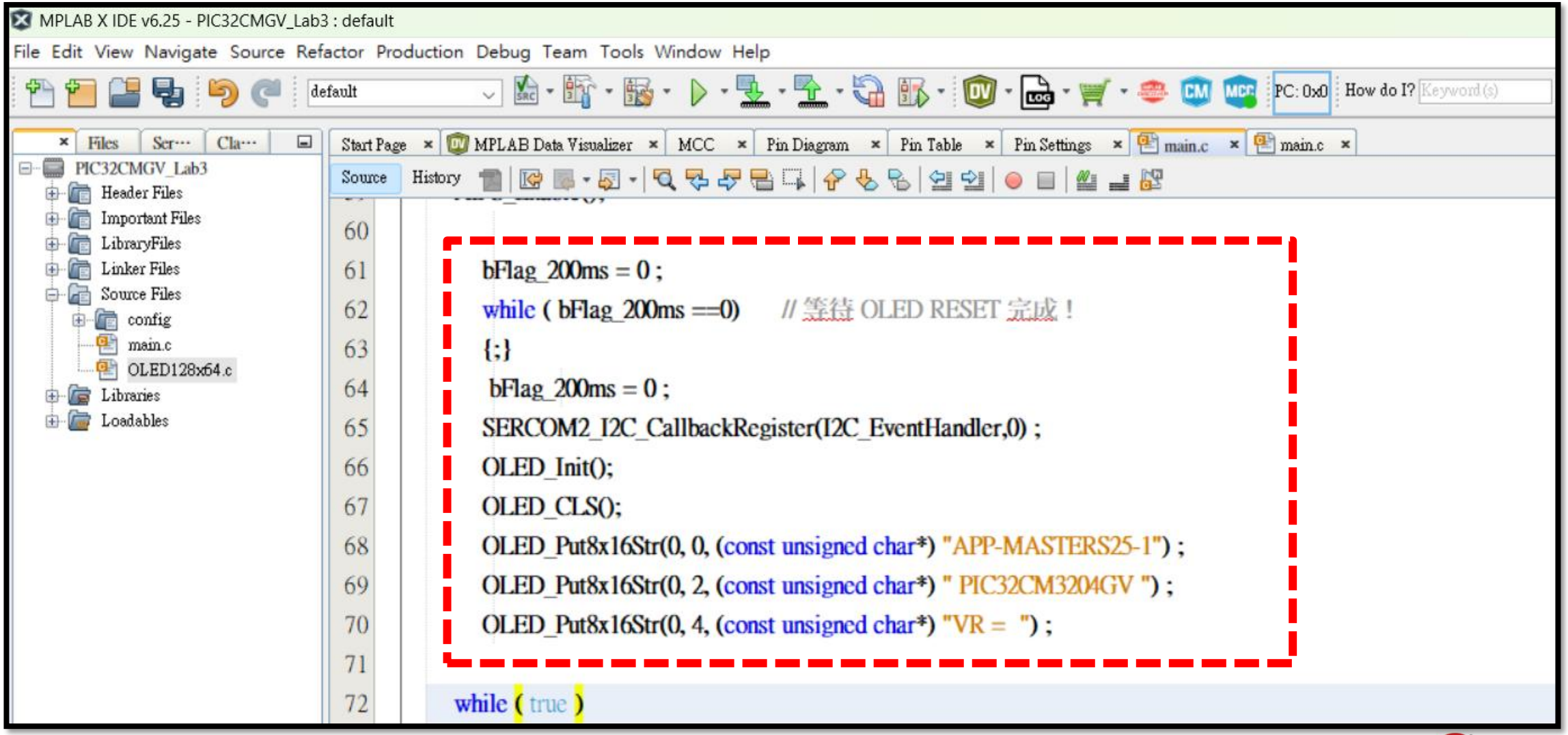
Lab 3 – OLED Display for ADC Result

Add required code and definition to main.c (3)



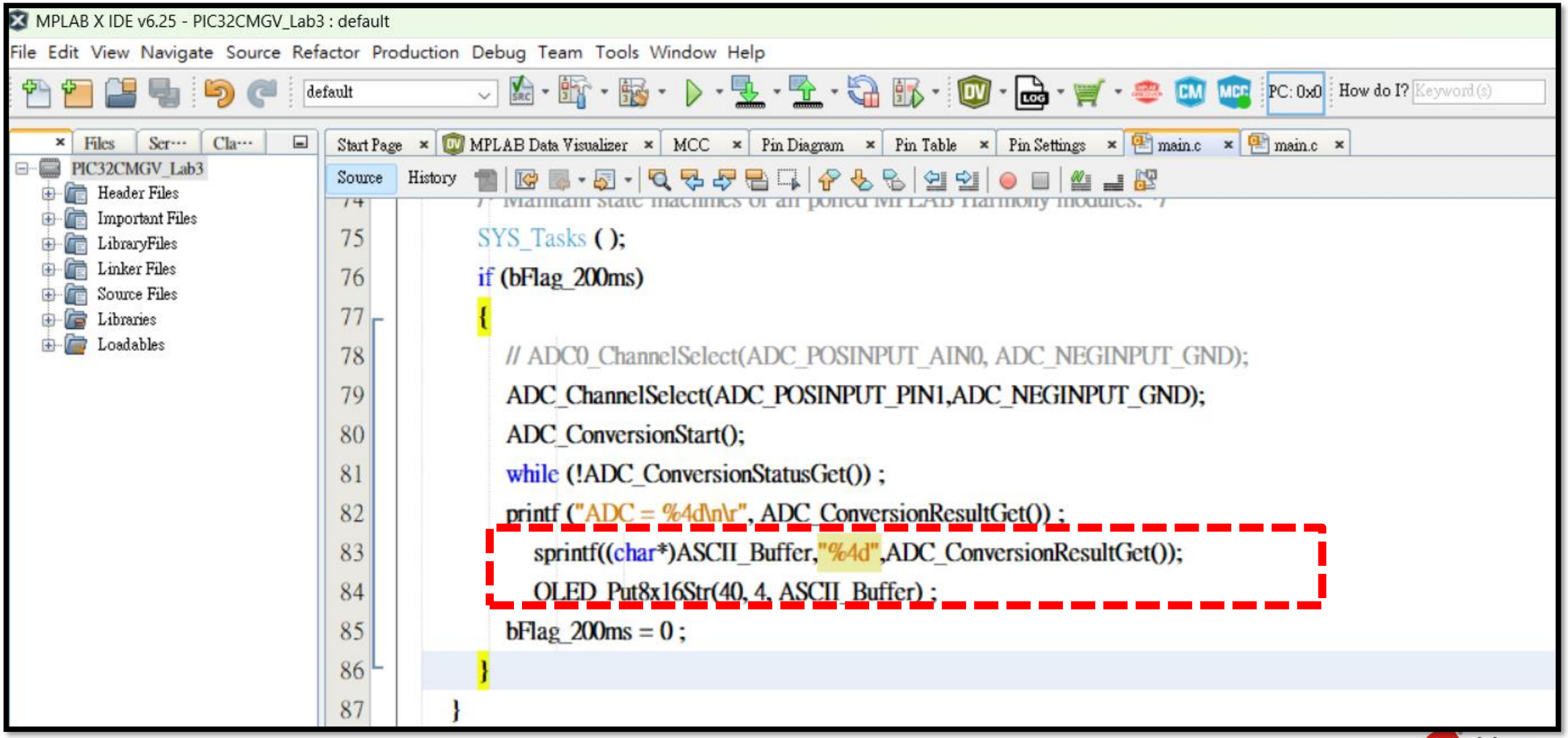
Lab 3 – OLED Display for ADC Result

Add required code and definition to main.c (4)



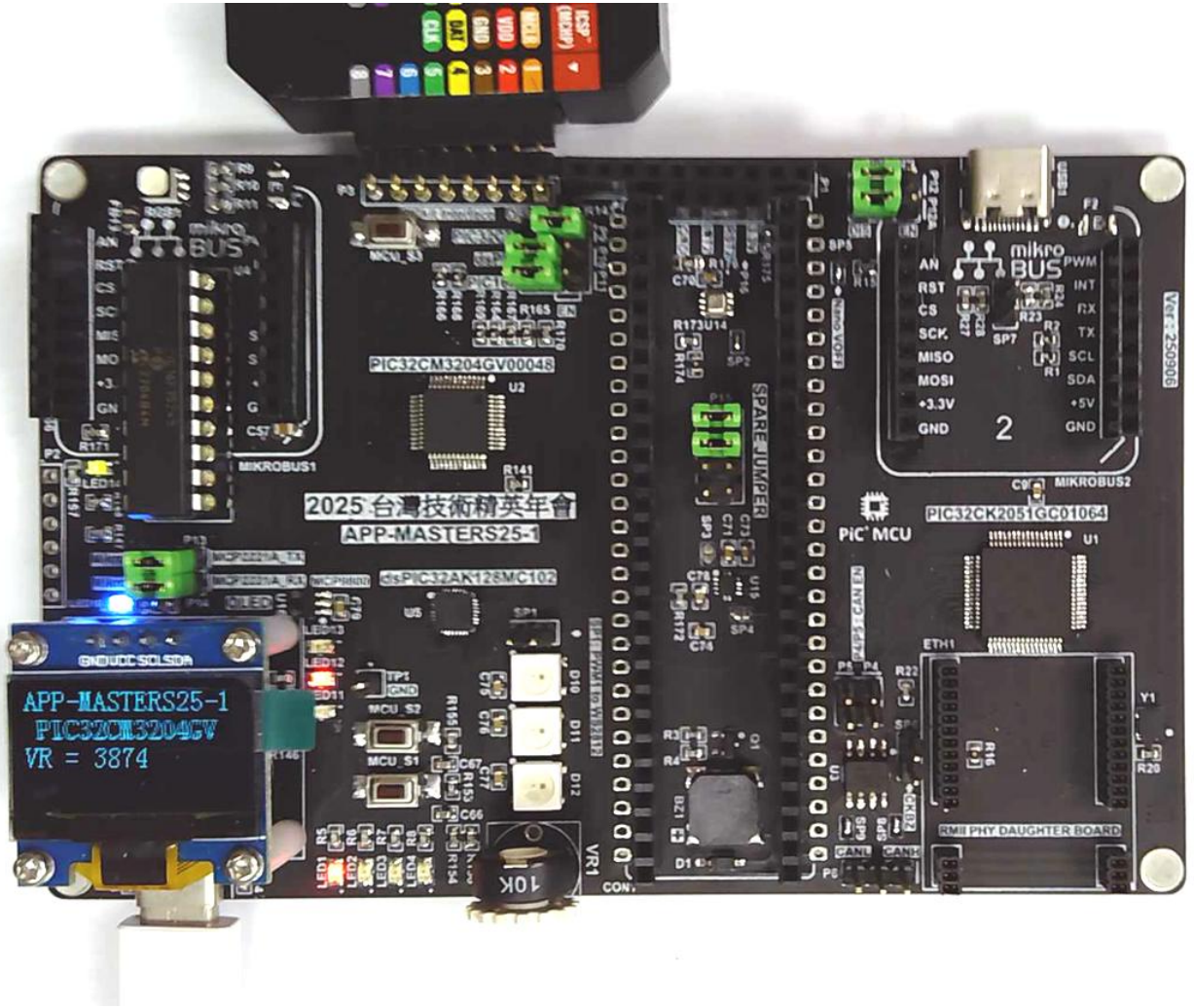
Lab 3 – OLED Display for ADC Result

Add required code and definition to main.c (5)

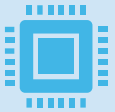


Lab 3 – OLED Display for ADC Result

Lab3 實際執行結果



Lab 3 Summary



Properly set up SERCOM to implement I^2C MASTER Function

Add Library into your project

Config OLED Display by using Library

Display ADC read result to Line-3 of OLED

The End

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