



**MICROCHIP**

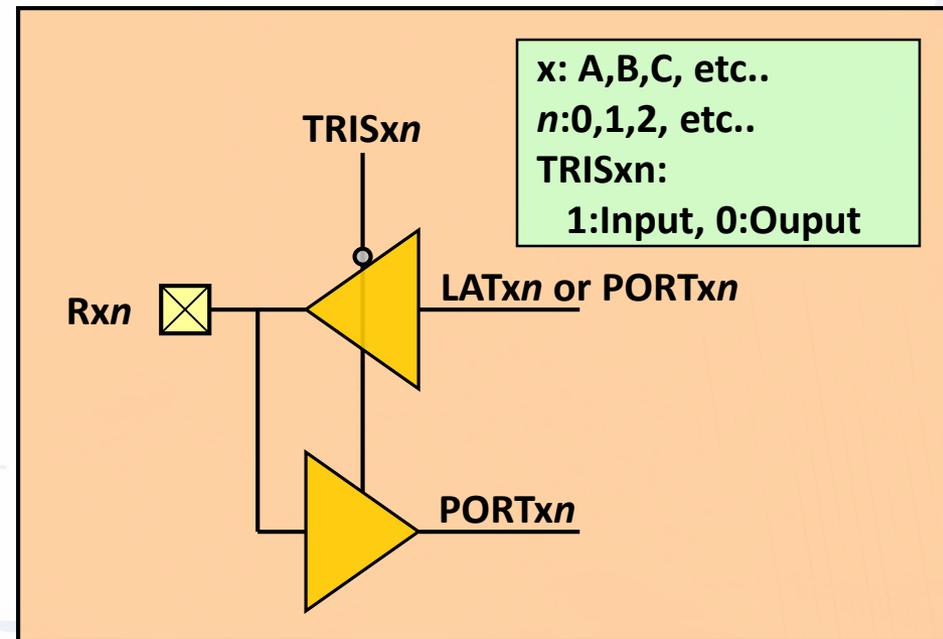
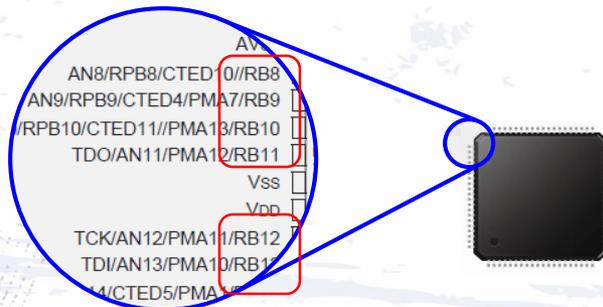
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***Regional Training Centers***

**Section 5**  
**GPIO Architecture**

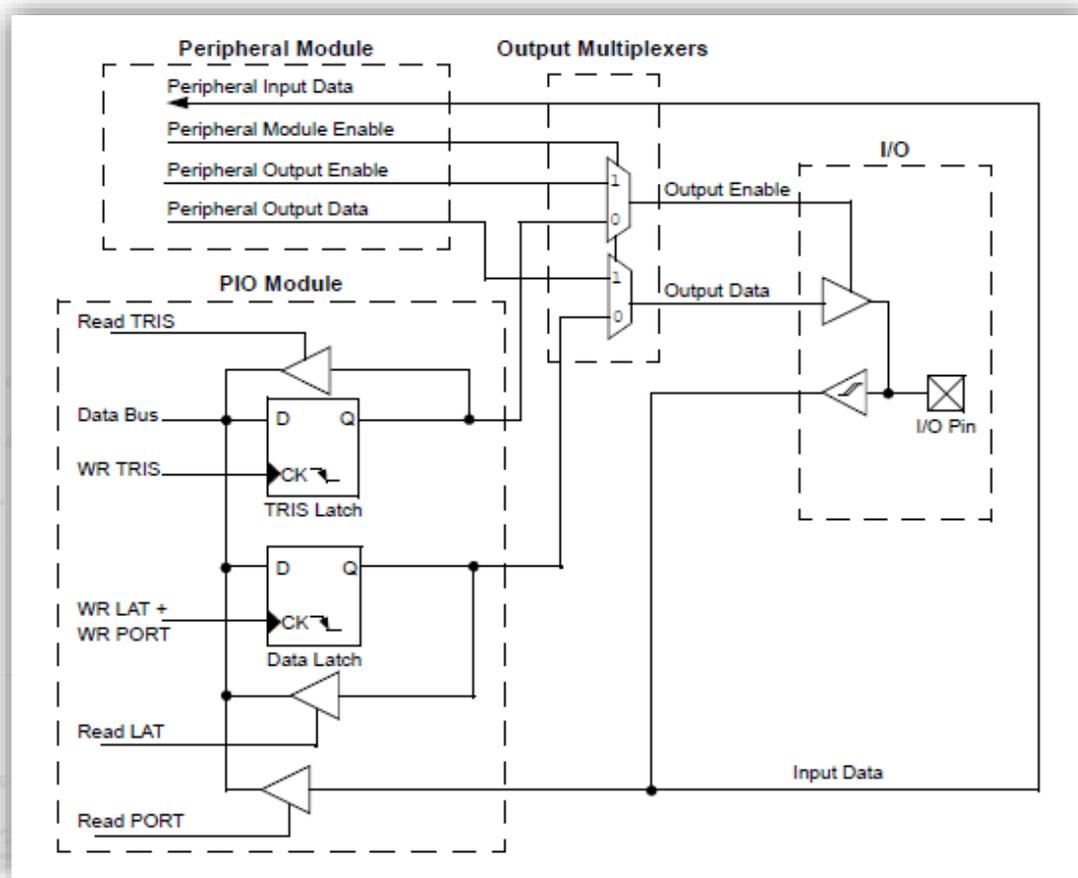
# GPIO Block Diagram

- ◆ Please refer to the block diagram, this is the concept for programming model. The real and detail block diagram please refer to the following slide.
- ◆ **TRIS:** use to determine in or out. 1 for input, 0 for output.
- ◆ **LAT:** set output drive value for Output pins.
- ◆ **PORT:** reaction logical level from Input pins.



# GPIO Block Diagram

## ◆ PIC24FJGB Family GPIO Block Diagram



# Lab1 GPIO Output



# Lab1 GPIO Output

- ◆ Try to use MCC to generate your first MCC style code and control GPIO base on MCC style.
- ◆ Try to set **RB7** to digital output mode and output high, low level and toggle level (period around 500ms ~ 1S), individually.
- ◆ Please connect **RB7** to **LED(D1)** to observe pin status.

◆ **How to start ?**

# Lab1 GPIO Output

## Step 1

- ◆ Create New Project again

Project Name : **Lab1\_GPIOOutput**

Project Location : **C:\PIC24\_Exercises\Exams\**

New Project

**Steps**

1. Choose Project
2. Select Device
3. Select Header
4. Select Tool (Optional)
5. Select Plugin Board
6. Select Compiler
- 7. Select Project Name and Folder**

**Select Project Name and Folder**

Project Name: Lab1\_GPIOOutput

Project Location: C:\PIC24\_Exercises\Exams\ Browse...

Project Folder: C:\PIC24\_Exercises\Exams\Lab1\_GPIOOutput.X

Overwrite existing project.

Also delete sources.

Set as main project

Use project location as the project folder

Encoding: UTF-8

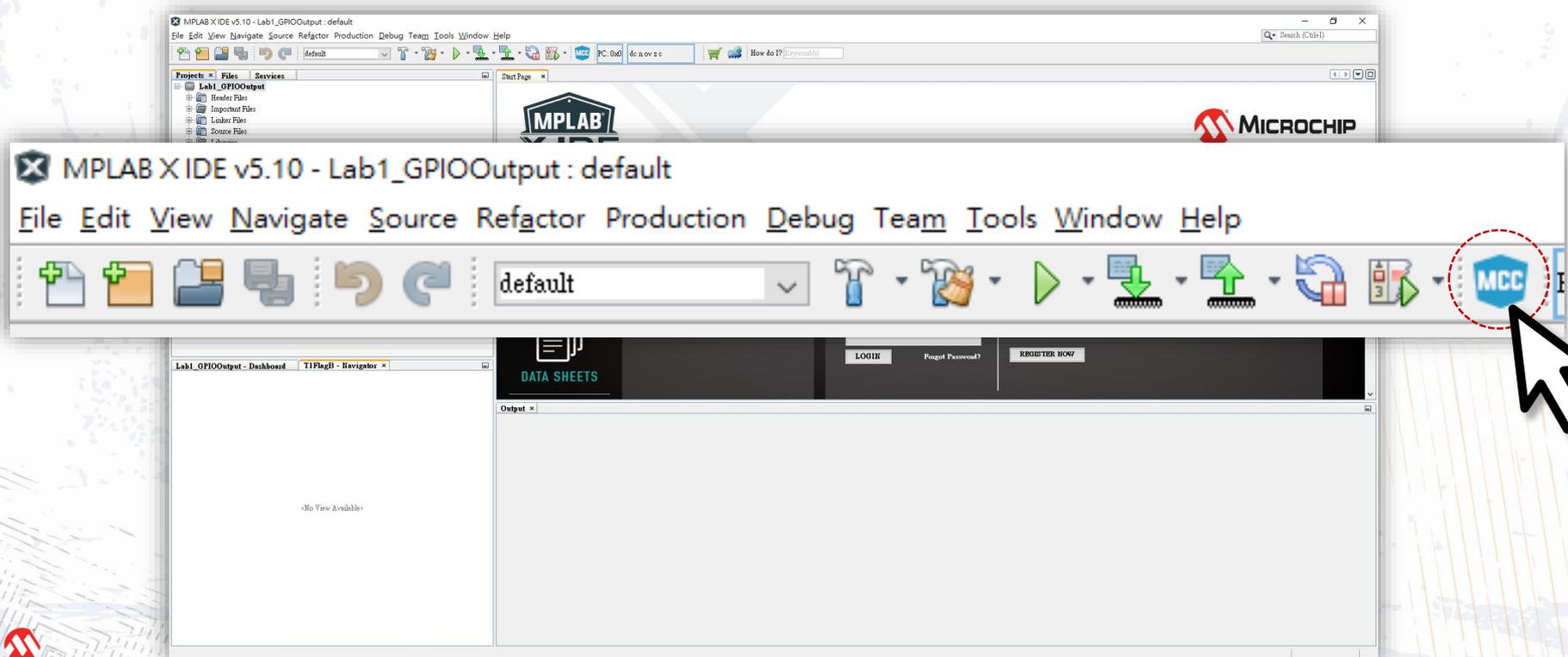
< Back Next > Finish Cancel Help

# Lab1 GPIO Output

## Step 2

- Execute MCC

Select **Tools** ► **Embedded** ► **MPLAB Code Configurator**  
or Click **icon** 



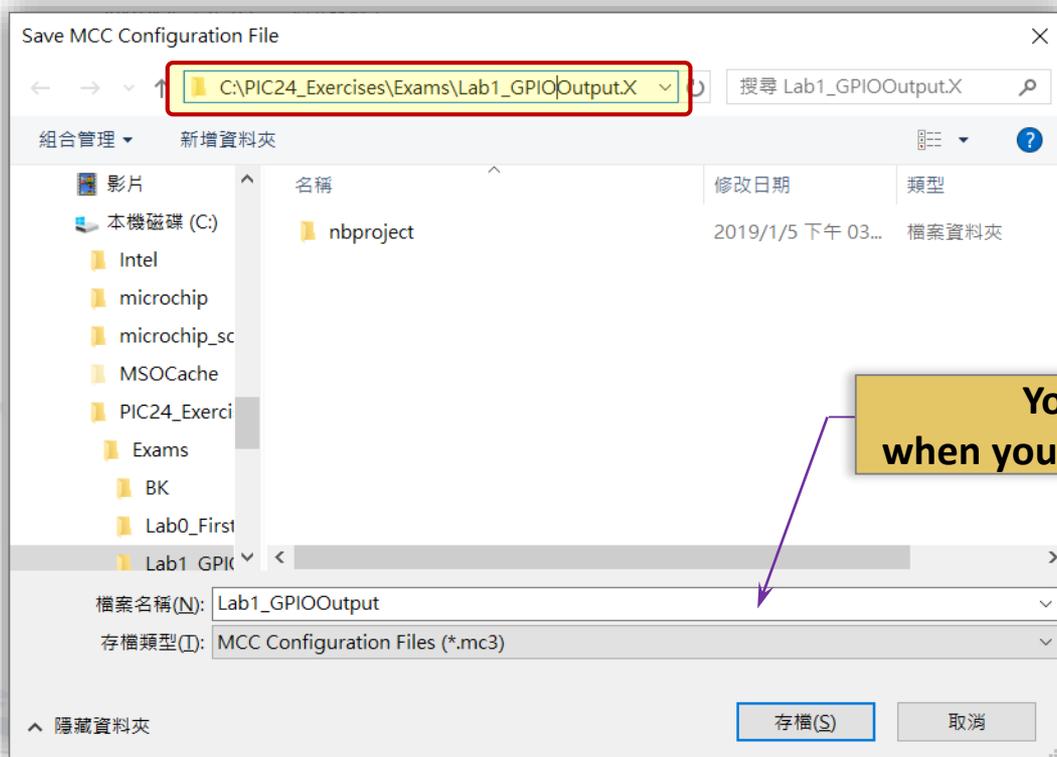
# Lab1 GPIO Output

## Step 3

### Save MCC Configuration File

Select save directory at your project folder.

E.g. **C:\PIC24\_Exercises\Exams\Lab1\_GPIOOutput.X\**



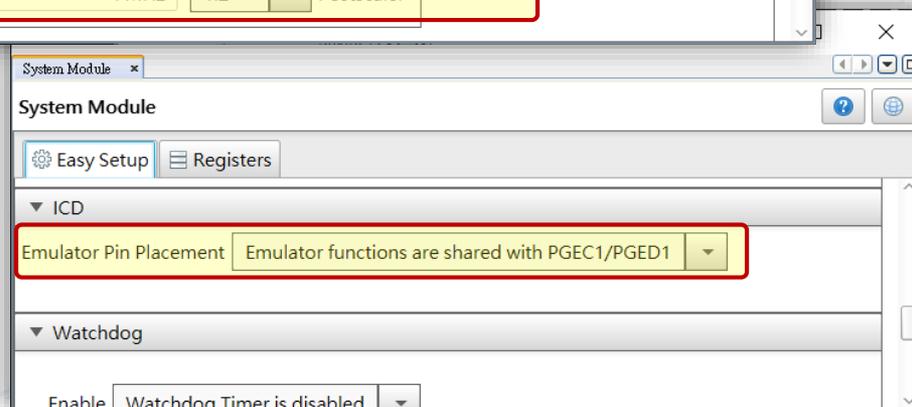
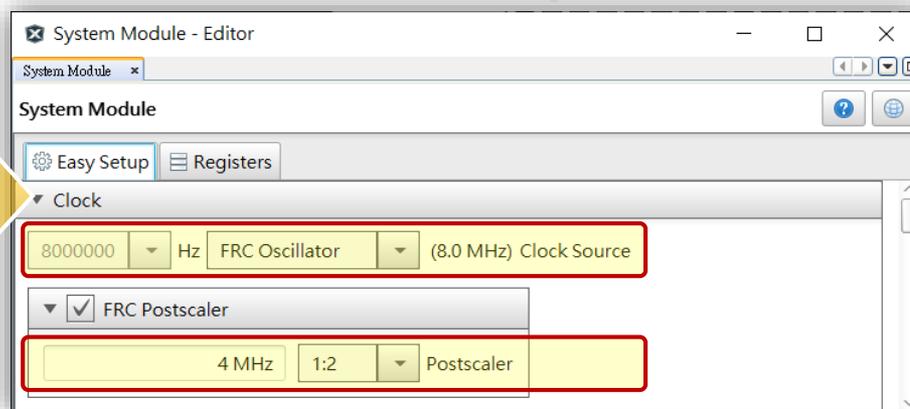
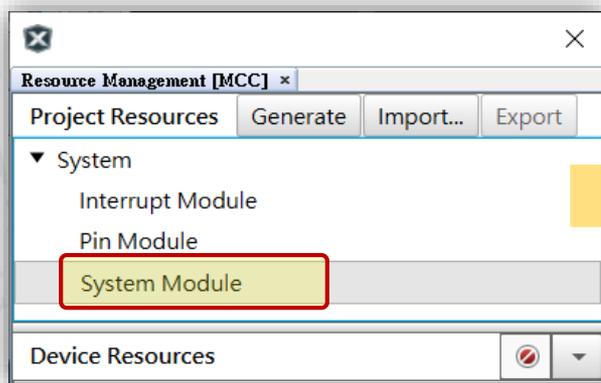
# Lab1 GPIO Output

## Step 4

### ◆ Set System Clock & Debug Interface.

System Module ▶ Clock ▶ FRC Oscillator, Postscaler:1:2

System Module ▶ ICD ▶ PGEC1/PGED1



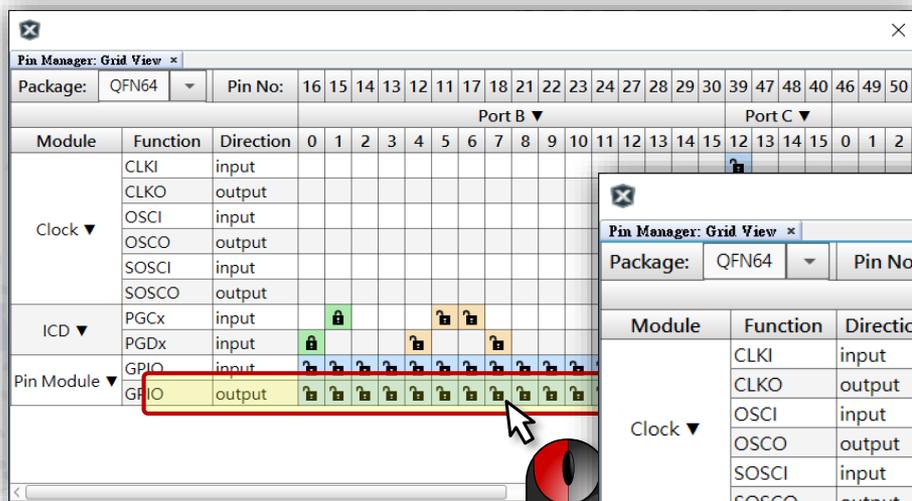
# Lab1 GPIO Output

## Step 5

- Set **RB7** to digital output mode

**Pin Manager :**

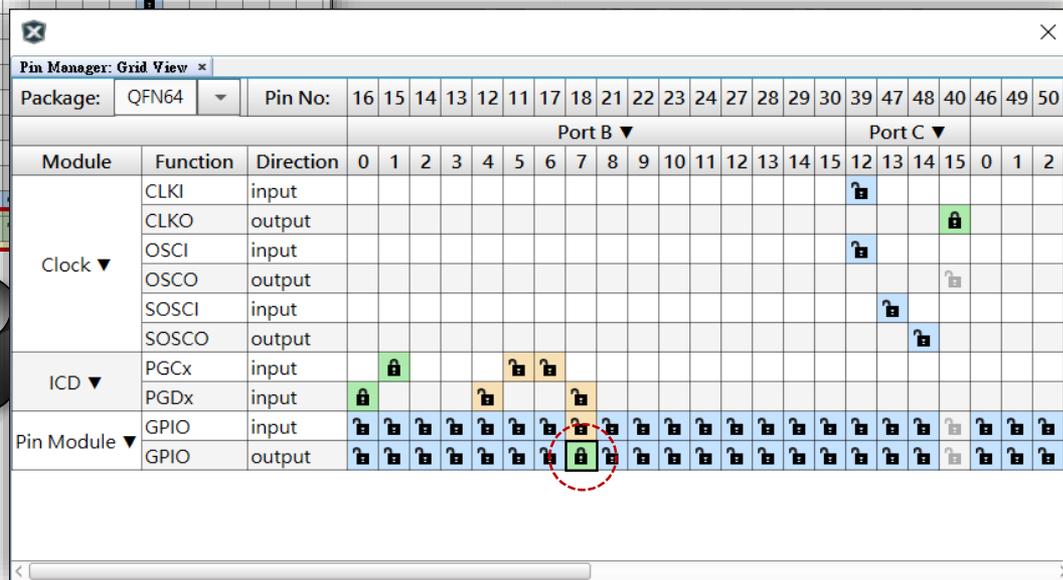
**Gird View ▶ Click RB7 to lock to GPIO output**



Pin Manager: Grid View x

Package: QFN64 Pin No: 16 15 14 13 12 11 17 18 21 22 23 24 27 28 29 30 39 47 48 40 46 49 50

			Port B ▼								Port C ▼														
Module	Function	Direction	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	12	13	14	15	0	1	2
Clock ▼	CLKI	input																							
	CLKO	output																							
	OSCI	input																							
	OSCO	output																							
	SOSCI	input																							
	SOSCO	output																							
ICD ▼	PGCx	input		🔒																					
	PGDx	input	🔒																						
Pin Module ▼	GPIO	input	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	
	GPIO	output	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	



Pin Manager: Grid View x

Package: QFN64 Pin No: 16 15 14 13 12 11 17 18 21 22 23 24 27 28 29 30 39 47 48 40 46 49 50

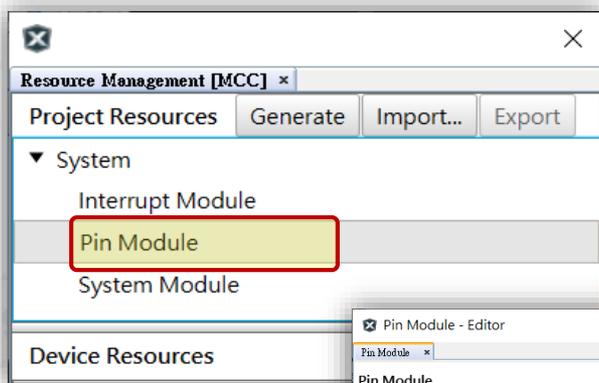
			Port B ▼								Port C ▼														
Module	Function	Direction	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	12	13	14	15	0	1	2
Clock ▼	CLKI	input																	🔒						
	CLKO	output																							
	OSCI	input																	🔒						
	OSCO	output																							
	SOSCI	input																		🔒					
	SOSCO	output																				🔒			
ICD ▼	PGCx	input		🔒																					
	PGDx	input	🔒																						
Pin Module ▼	GPIO	input	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	
	GPIO	output	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	🔒	

# Lab1 GPIO Output

## Step 6

### ◆ Set Alias for RB7

**uncheck Analog, check Output & Start high  
Alias (Custom Name) : D1**



Pin Module - Editor

Pin Module x

Pin Module

Easy Setup Registers

Selected Package : QFN64

Pin Name	Module	Function	Custom Name	Start High	Analog	Output	WPU	WPD	OD	IOC
RB0	ICD	PGED1		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	none
RB1	ICD	PGEC1		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	none
RB7	Pin Module	GPIO	D1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	none

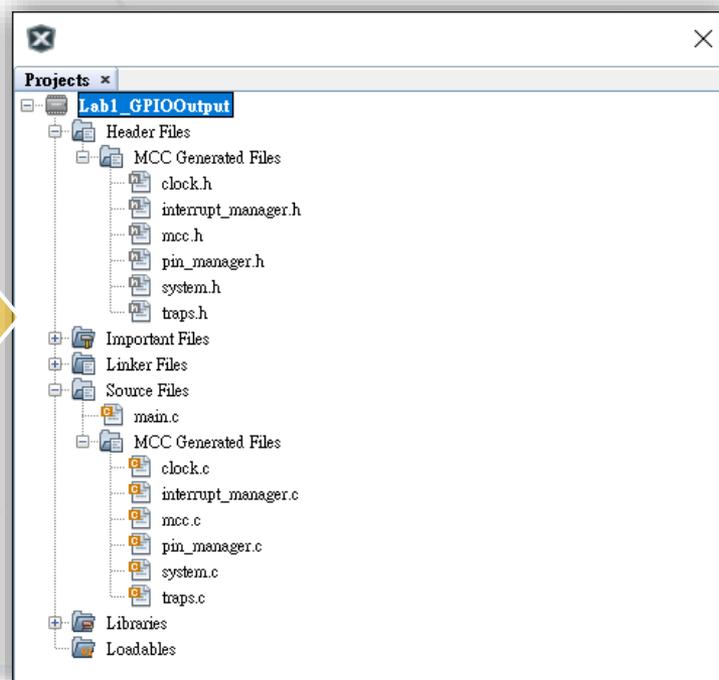
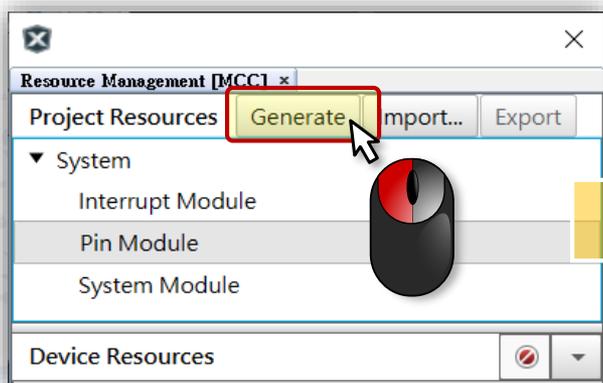
# Lab1 GPIO Output

## Step 7

### Generate Code

Click Generate Code Button to generate your first MCC's style Project.

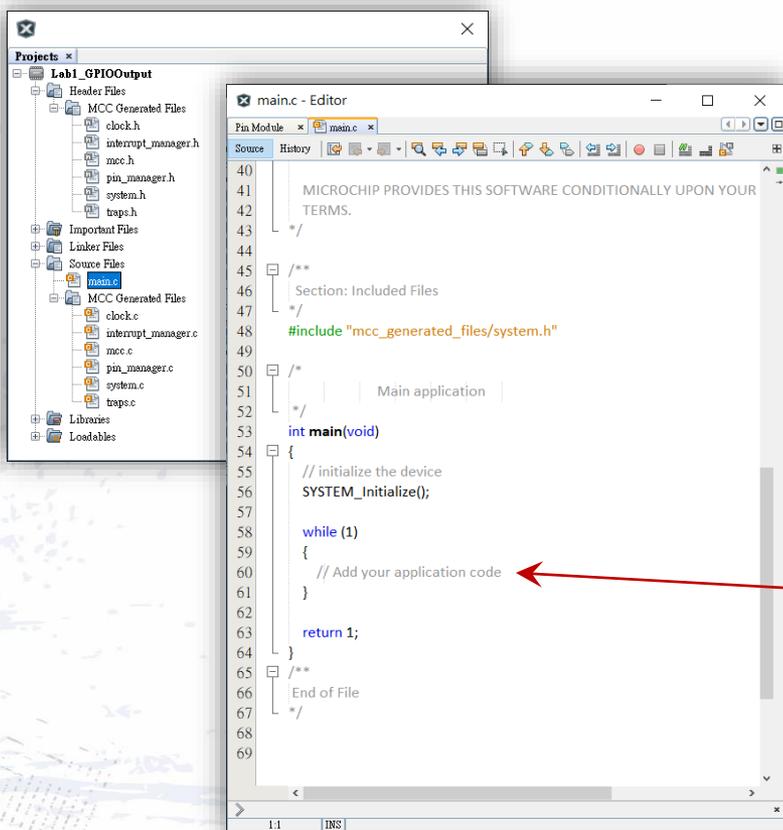
All files generate by MCC include main.c automatically.



# Lab1 GPIO Output

## Step 8

- Try to add code to main function  
Double Click **main.c** to view & add below code to main().



Add below code to main()

```
#include "mcc_generated_files/system.h"  
#include "mcc_generated_files/pin_manager.h"  
  
unsigned long i = 0;  
  
int main(void)  
{  
    // initialize the device  
    SYSTEM_Initialize();  
  
    while (1)  
    {  
        // Add your application code  
        D1_Toggle();  
        for (i = 0; i < 80000; i++);  
    }  
    return -1;  
}
```

# MPLAB X IDE Hints

## Hot key “Ctrl+Alt+\ ”

Type D1 first then use “Ctrl+Alt+\  
” to find you want.

The image consists of three sequential screenshots of the MPLAB X IDE editor window, titled 'main.c - Editor'.  
1. The first screenshot shows the source code with the cursor at line 63, where the user has typed 'D1'. A status bar at the bottom left shows the error: '64:11 |INS| Unable to resolve identifier D1'.  
2. The second screenshot shows the IDE's auto-completion menu open, listing several options: 'D1\_GetValue', 'D1\_SetDigitalInput', 'D1\_SetDigitalOutput', 'D1\_SetHigh', 'D1\_SetLow', and 'D1\_Toggle'. A yellow arrow points from the first screenshot to this menu.  
3. The third screenshot shows the IDE automatically adding the header file '#include "mcc\_generated\_files/pin\_manager.h"' to the code at line 49. A yellow arrow points from the second screenshot to this new line. A purple arrow points from the 'D1\_Toggle' option in the second screenshot to the newly added header file in the third screenshot. The status bar at the bottom right shows the error: '68:18 |INS| Unexpected token: ;'.  
A yellow box at the bottom center contains the text: 'Add header file automatically.'

Ctrl+Alt+\

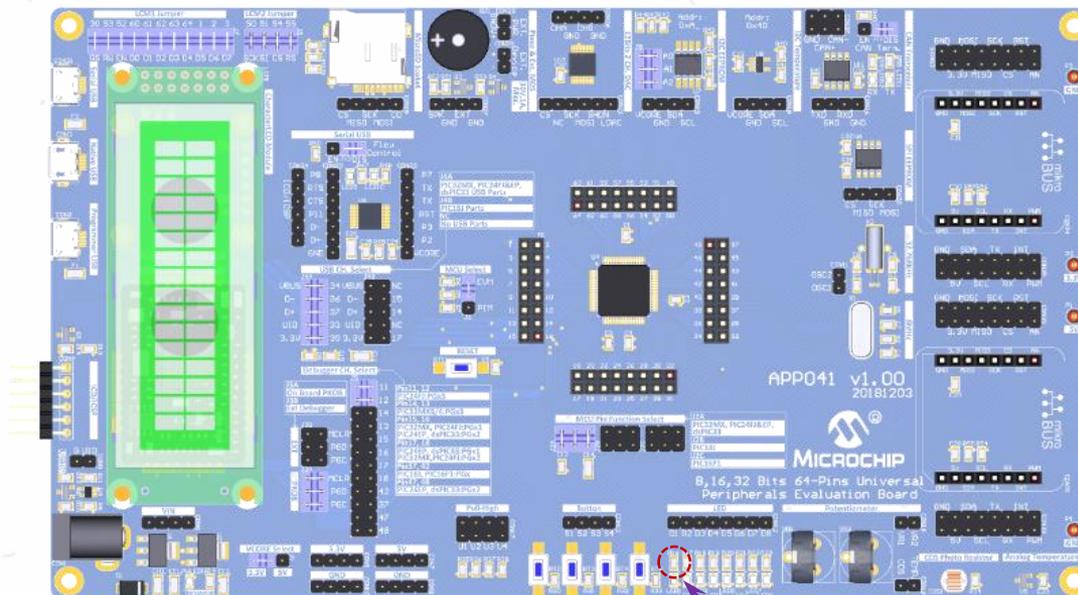
Add header file  
automatically.



# Lab1 GPIO Output

## Step 9 & Result

- Try to program your code to your target board.  
Select **Make and Program Device Main Project** icon   
Make sure Programming/Verify complete
- Please connect **RB7** to **LED(D1)** to observe LED status.



LED1 Toggle !

# Lab1 – GPIO Output

## MCC's Setting & Code Example

Pin Module - Editor

Pin Module

Pin Module

Easy Setup Registers

Selected Package : QFN64

Pin Name	Module	Function	Custom N...	Start High	Analog	Output	WPU	WPD	OD	IOC
RB0	ICD	PGED1		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	no...
RB1	ICD	PGEC1		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	no...
RB7	Pin Module	GPIO	D1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	no...

```
#include "mcc_generated_files/system.h"
#include "mcc_generated_files/pin_manager.h"

unsigned long i = 0;

int main(void)
{
    // initialize the device
    SYSTEM_Initialize();

    while (1)
    {
        // Add your application code
        D1_Toggle();
        for (i = 0; i < 80000; i++);
    }
    return -1;
}
```

Pin Manager: Grid View - Editor

Pin Manager: Grid View

Package: QFN64 Pin No: 16 15 14

Module	Function	Direction	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Clock	CLKI	input																															
	CLKO	output																															
	OSCI	input																															
	OSCO	output																															
	SOSCI	input																															
ICD	SOSCO	output																															
	PGCx	input																															
Pin Module	BGDx	input																															
	GPIO	input																															
TMR1	GPIO	output																															
	T1CK	input																															
TMR2	T1CK	input																															
	T2CK	input																															

# Lab1 GPIO Output

## Review

- ❏ Open `pin_manager.h` & `pin_manager.c`
- ❏ Try to find D1xxxx relate function & definition at `pin_manager.h`

```
114 @Returns
115 None.
116
117 @Param
118 None.
119
120
121 @Example
122 <code>
123 // Toggle RB7
124 D1_Toggle();
125 </code>
126
127
128 #define D1_Toggle() _LATB7 ^= 1
129
130 @Summary
131 Reads the value of the GPIO pin, RB7.
132
133 @Description
134 Reads the value of the GPIO pin, RB7.
135
136 @Preconditions
137 None.
138
139 @Returns
140 None.
141
142 @Param
143 None.
```

```
56 Section: Driver Interface Function Definitions
57 */
58 void PIN_MANAGER_Initialize (void)
59 {
60
61     /* Setting the Output Latch SFR(s)
62     .....
63     LATB = 0x0080;
64     LATC = 0x0000;
65     LATD = 0x0000;
66     LA TE = 0x0000;
67     LATF = 0x0000;
68     LATG = 0x0000;
69
70     .....
71     * Setting the GPIO Direction SFR(s)
72     .....
73     TRISB = 0xFF7F;
74     TRISC = 0x7000;
75     TRISD = 0x00FF;
76     TRISE = 0x00FF;
77     TRISF = 0x003B;
78     TRISG = 0x03CC;
79
80     .....
81     * Setting the Weak Pull Up and Weak Pull Down SFR(s)
82     .....
83     CNPD1 = 0x0000;
84     CNPD2 = 0x0000;
85     CNPD3 = 0x0000;
```

# Lab2 Multi-GPIO Output

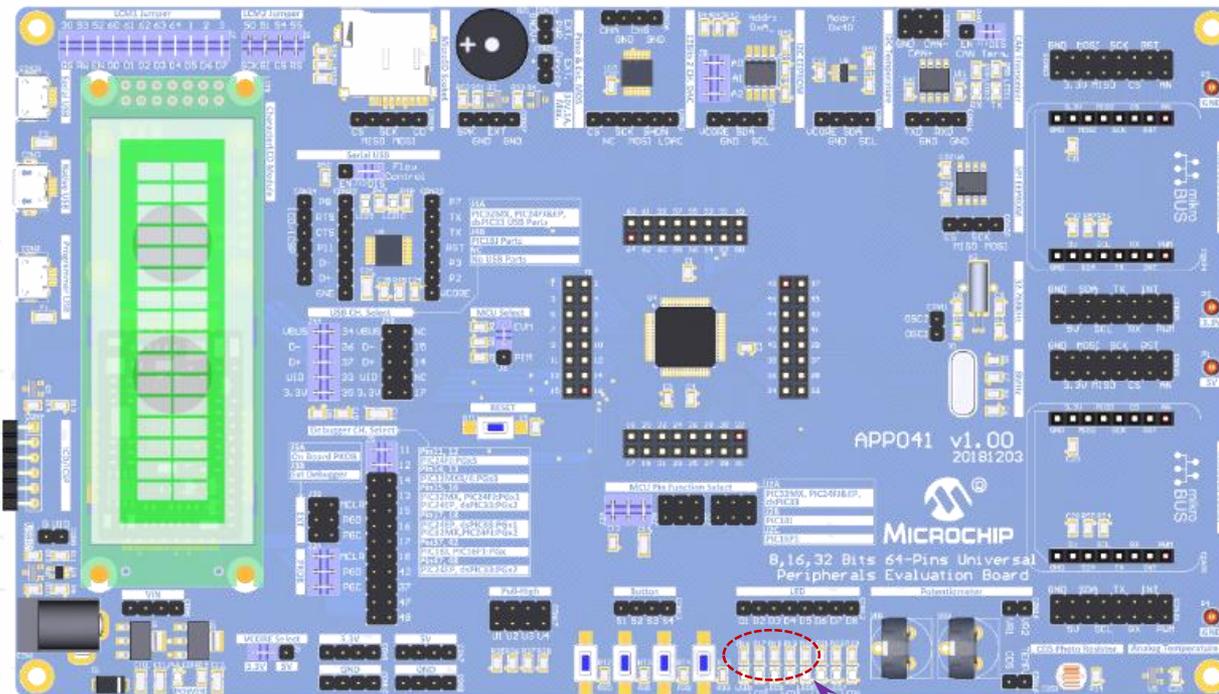


# Lab2 Multi-GPIO Output

- ◆ Try to set more GPIO pins to digital output mode and toggle levels (period around 500ms ~ 1S), individually.
- ◆ RB7 -> LED1(D1)  
RB8 -> LED2(D2)  
RB9 -> LED3(D3)  
RB10 -> LED4(D4)

◆ **Let's go!**

# Lab2 Multi-GPIO Output Result



LEDs Control by Software Delay.



# Lab2 Multi-GPIO Output MCC's Setting & Code Example

Pin Module - Editor

Pin Module

Pin Module

Easy Setup Registers

Selected Package : QFN64

Pin Name	Module	Function	Custom N...	Start High	Analog	Output	WPU	WPD	OD	IOC
RB0	ICD	PGED1		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	no...
RB1	ICD	PGEC1		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	no...
RB7	Pin Module	GPIO	D1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	no...
RB8	Pin Module	GPIO	D2	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	no...
RB9	Pin Module	GPIO	D3	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	no...
RB10	Pin Module	GPIO	D4	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	no...

```
#include "mcc_generated_files/system.h"
#include "mcc_generated_files/pin_manager.h"

int main(void)
{
    // initialize the device
    SYSTEM_Initialize();

    while (1)
    {
        // Add your application code
        D1_Toggle();
        D2_Toggle();
        D3_Toggle();
        D4_Toggle();
        for (i = 0; i < 80000; i++);
    }
    return -1;
}
```

Pin Manager: Grid View - Editor

Pin Manager: Grid View

Package: QFN64 Pin No: 16 15 14

Module	Function	Direction	0	1	2
Clock	CLKI	input			
	CLKO	output			
	OSCI	input			
	OSCO	output			
	SOSCI	input			
	SOSCO	output			
ICD	PGCx	input			
	PGDx	input			
Pin Module	GPIO	input			
	GPIO	output			
TMR1	T1CK	input			
TMR2	T2CK	input			

# Lab3 GPIO Input



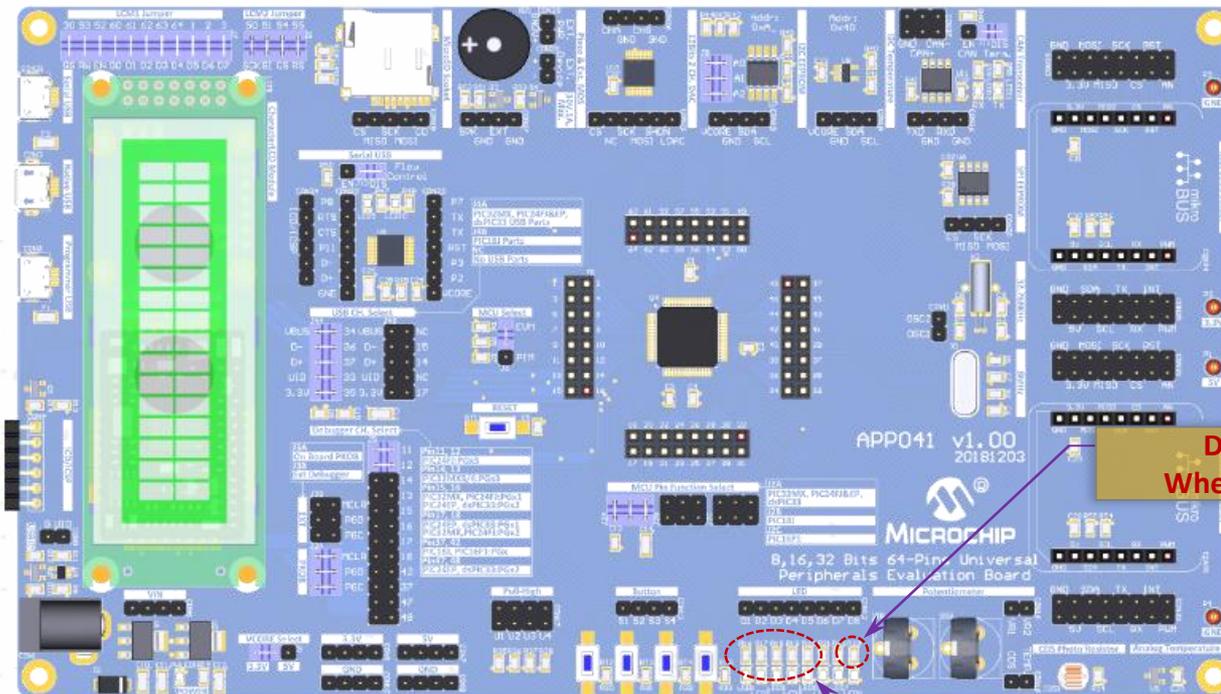
# Lab3 GPIO Input

- ◆ Try to set **RC13** to digital input to get button status.
- ◆ Try to do that to get button status then control another led status.  
S1 Pressed -> D8 Light  
S1 Released -> D8 Dark
- ◆ Please connect **RC13** to **Button(S1)**, **RB14** to **LED(D8)**.

◆ **Let's go!**

# Lab3 GPIO Input

## Result



D8 Turn On,  
When S1 Pressed.

LEDs Control by Software Delay.



# Lab3 GPIO Input

## MCC's Setting & Code Example

Pin Module - Editor

Pin Module \*

Pin Module

Easy Setup Registers

Selected Package : QFN64

Pin Name	Module	Function	Custom N...	Start High	Analog	Output	WPU	WPD	OD	IOC
RB0	ICD	PGED1		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	no...
RB1	ICD	PGEC1		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	no...
RB7	Pin Module	GPIO	D1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	no...
RB8	Pin Module	GPIO	D2	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	no...
RB9	Pin Module	GPIO	D3	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	no...
RB10	Pin Module	GPIO	D4	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	no...
RB14	Pin Module	GPIO	D8	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	no...
RC13	Pin Module	GPIO	S1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	no...

Pin Manager: Grid View - Editor

Pin Manager: Grid View \*

Module	Function	Direction	0	1	2
Clock	CLKI	input			
	CLKO	output			
	OSCI	input			
	OSCO	output			
	SOSCI	input			
	SOSCO	output			
ICD	PGCx	input	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	PGDx	input	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Pin Module	GPIO	input	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	GPIO	output	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
TMR1	T1CK	input			
TMR2	T2CK	input			
TMR3	T3CK	input			

```
int main(void)
{
    // initialize the device
    SYSTEM_Initialize();

    while (1)
    {
        // Add your application code
        if(i++>80000)
        {
            D1_Toggle();

            ..
            i = 0;
        }

        if(S1_GetValue())
            D8_SetLow();
        else
            D8_SetHigh();
    }
    return -1;
}
```