

實驗板程式範例：

- APP_CPLD1_MCU 範例：

https://www.microchip.com.tw/modules/tad_uploader/index.php?op=dlfile&cfsn=271&cat_sn=39&name=cpld.zip

- APP_CPLD1_ATF1502 範例：

https://www.microchip.com.tw/modules/tad_uploader/index.php?op=dlfile&cfsn=272&cat_sn=39&name=atf1502.zip

示範影片：

- 開發軟體安裝說明影片：<https://youtu.be/Dv3imDQrVos>
- CPLD 燒錄範例影片：<https://youtu.be/syg608gLVYs>
- CPLD 開發範例影片：https://youtu.be/F1s_vNdrERM

使用工具：

PCB : Microchip Taiwan office APP-CPLD01

CPLD part number : ATF1502ASV

開發環境 : WinCUPL v5.30.3, <https://www.microchip.com/en-us/products/fpgas-and-plds/spld-cplds/pld-design-resources>

燒錄器 : ATDH1150USB

燒錄軟體 : ATMISP V7.3

MCU : PIC16F18446

開發環境 : MPLAB X IDE V6.15

PIC16F1xxxx_DFP : 1.25.389

Compiler : XC8 v2.46

燒錄器 : PICkit4

, WinCUPL

範例程式功能簡介：

以 CPLD 做一個 10 進位的計數器, CPLD 的 pin 19, 22, 25 & 28 輸出點亮 LED, 輸入訊號為 clock, dir(counter 計數方向, 加 or 減), ctr(清除輸出) & ena(輸出致能), 這些

輸入訊號分別是由 MCU 的 RC0(pin 16), RC1(pin 15), RC2(pin 14) & RC3(pin 7)輸出
來完成.

安裝開發環境&燒錄軟體：

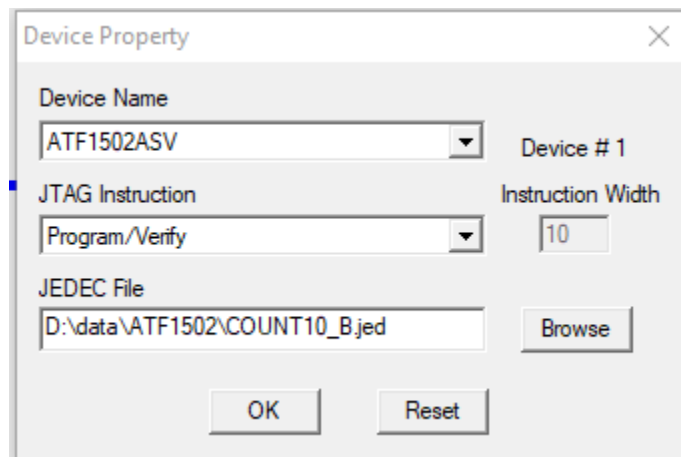
先從 Microchip 網站下載此兩軟體, WinCUPL v5.30.3 & ATMISP V7.3, 先儲存在硬碟
後,解壓縮此兩軟體, 然後安裝此兩軟體,在安裝過程中,只需按 Next or Yes 按鍵即可
順利安裝此兩個軟體. WinCUPL 預設安裝路徑 C:\Wincupl , ATMISP 安裝在
C:\ATMISP7 .

燒錄程序：若想先試試看 CPLD 的工作狀況,則可先做燒錄的動作

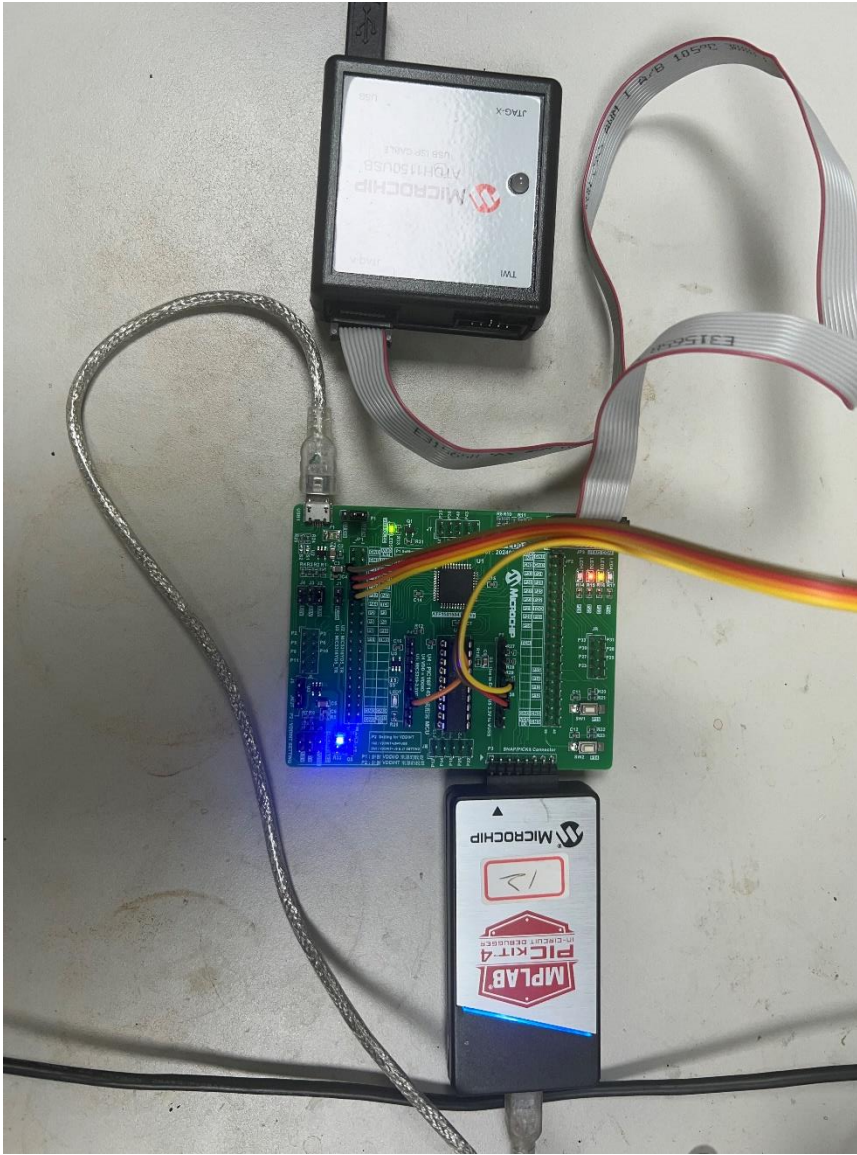
1. APP-CPLD01 jump 設定：P1 & P2：2&3 pin 短路, J1, J3, J4, J5 & J7：空接, J2 &
J6：短路
2. 將燒錄器 ATDH1150USB 先連接到電腦的 USB 埠
3. 開啟 ATMISP
4. 設定燒錄程序的 project, File→New→1 →OK



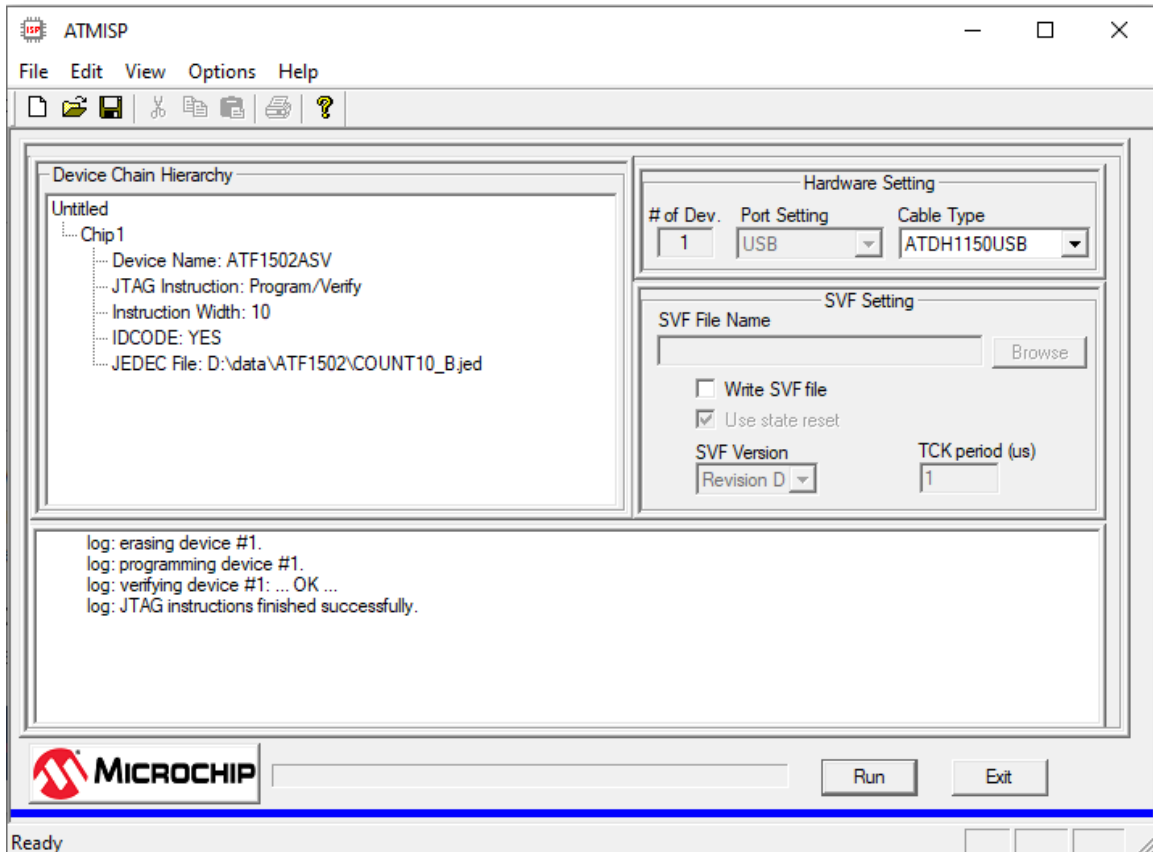
5. Device Name 選擇 ATF1502ASV, JTAG Instruction 選擇 Program/Verify, JEDEC
File 選擇 COUNT10_B.jed, →OK



6. 從 USB 埠連接電源至 APP-CPLD01 USB1, 並且將燒錄器 ATDH1150USB 連接至 APP-CPLD01 的 JTAG ISP Header, 接線如下圖



7. 按 Run 按鍵,稍等一點時間即可看到以下畫面,表示燒錄成功



8. 目前支援 Microchip SPLD/CPLD 的台灣本地廠商分別是研儀 LABTOOL-48UXP, 崇貿 SG8000, 岱鐸 NuProg-E2

有關 MCU 的開發&燒錄請參考 Microchip MCU 的相關資料,在此不再贅述, 為此 demo board 上的 MCU 燒錄檔案名稱為 CPLD.X.production.hex

接下來我們就要討論如何開發 CPLD 的程式

1. 開啟 WinCUPL
2. File → New → Project, 然後輸入以下資訊,然後按 OK

Design Properties

Name:	Count10_B	OK
PartNo:	ATF1502ASV	Cancel
Date:	2024/4/24	
Revision:	01	
Designer:	Richard Hsu	
Company:	Microchip Taiwan office	
Assembly:	None	
Location:		
Device:	f1502isptqfp44	

3. 選填輸入 pin 數量, 因 demo board 輸入訊號有四個, 故輸入 4, →OK

INPUT PINS

How many input pins are there

OK

Cancel

4

4. 選填輸出 pin 數量, 因 demo board 輸入訊號有五個, 故輸入 5, →OK

OUTPUT PINS

How many output pins are there

OK

Cancel

5

5. 此程式中沒有用到 pinnode, 故保留為 0, →OK



6. 至此 project 表頭就建立好了

```
Name      Count10_B ;
PartNo    ATF1502ASV ;
Date      2024/4/24 ;
Revision  01 ;
Designer  Richard Hsu ;
Company   Microchip Taiwan office ;
Assembly  None ;
Location  ;
Device    f1502isptqfp44 ;

/* ***** INPUT PINS ***** */
PIN      =          ; /* */
PIN      =          ; /* */
PIN      =          ; /* */
PIN      =          ; /* */

/* ***** OUTPUT PINS ***** */
PIN      =          ; /* */
PIN      =          ; /* */
PIN      =          ; /* */
PIN      =          ; /* */
PIN      =          ; /* */
```

7. 現在就依線路圖將輸出入 pin 定義寫入

```
/** Inputs **/
Pin 37 = clk;
Pin 39 = clr;
Pin 38 = dir;
Pin 40 = !ena;

/** Outputs **/
Pin 28 = Q0;
Pin 25 = Q1;
Pin 22 = Q2;
Pin 19 = Q3;
Pin 18 = carry;
```

8. 接下來輸入程式本體

```


/** Declarations and Intermediate Variable Definitions */
field count = [Q3..0];          /* declare counter bit field */
#define S0 'b'0000              /* define counter states */
#define S1 'b'0001
#define S2 'b'0010
#define S3 'b'0011
#define S4 'b'0100
#define S5 'b'0101
#define S6 'b'0110
#define S7 'b'0111
#define S8 'b'1000
#define S9 'b'1001

count.ck = clk;
count.oe = ena;

field mode = [clr,dir];        /* declare mode control field */
up = mode:0;                  /* define count up mode */
down = mode:1;                /* define count down mode */
clear = mode:[2..3];          /* define count clear mode */

/** Logic Equations */
Sequenced count {            /* free running counter */
present S0      if up        next S1;
                  if down     next S9;
                  if clear    next S0;
                  if down     out carry;
present S1      if up        next S2;
                  if down     next S0;
                  if clear    next S0;
present S2      if up        next S3;
                  if down     next S1;
                  if clear    next S0;
present S3      if up        next S4;
                  if down     next S2;
                  if clear    next S0;
present S4      if up        next S5;
                  if down     next S3;
                  if clear    next S0;
present S5      if up        next S6;
                  if down     next S4;
                  if clear    next S0;
present S6      if up        next S7;
                  if down     next S5;
                  if clear    next S0;
present S7      if up        next S8;
                  if down     next S6;
                  if clear    next S0;
present S8      if up        next S9;
                  if down     next S7;
                  if clear    next S0;
present S9      if up        next S0;
                  if down     next S8;
                  if clear    next S0;
                  if up        out carry;          /* assert carry output */
}


```


9. 儲存此 project, File → Save As, 請自行選擇檔案名稱 & 儲存路徑, 選擇 project 的副檔名為.pld, 然後選擇 Save.
10. 接下來要建立 simulation file, File → New → Text File
11. 首先 copy Project file 的表頭至此新檔案

```
Name      Count10_B ;
PartNo    ATF1502ASV ;
Date      2024/4/24 ;
Revision  01 ;
Designer  Richard Hsu ;
Company   Microchip Taiwan office ;
Assembly  None ;
Location  ;
Device    f1502isptqfp44 ;
```

12. 輸入訊號的排列順序,如以下例子

```
ORDER: clk, clr, dir, !ena, %2, Q3..Q0, %1, carry;
```

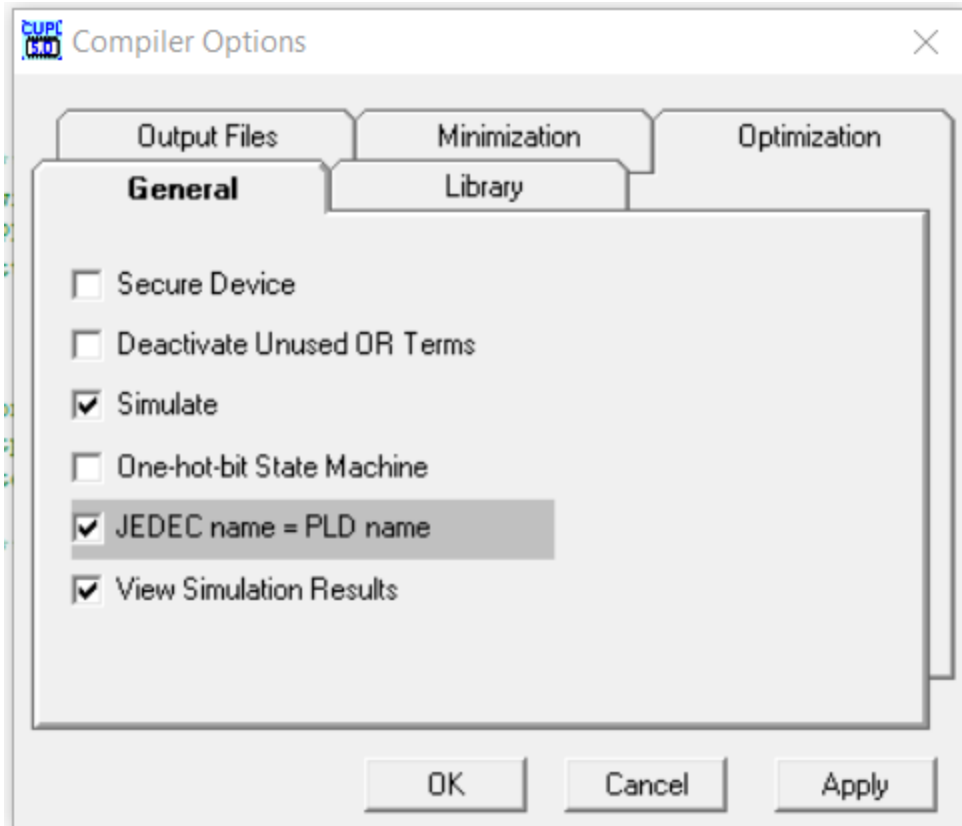
13. 再輸入各訊號之間的 high or low 關係,如以下例子

```

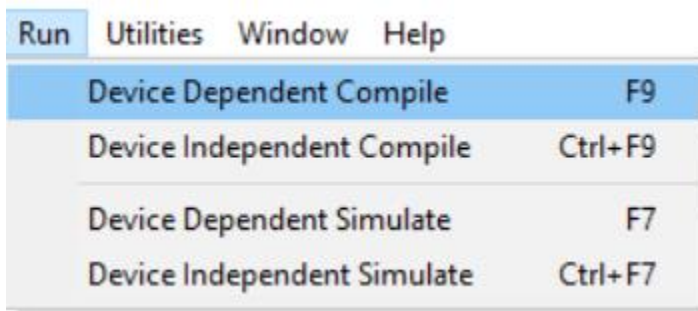
VECTORS:
C100 "0" L /* synchronous clear to state 0 */
C000 "1" L /* count up to state 1 */
C000 "2" L /* count up to state 2 */
C000 "3" L /* count up to state 3 */
C000 "4" L /* count up to state 4 */
C000 "5" L /* count up to state 5 */
C000 "6" L /* count up to state 6 */
C000 "7" L /* count up to state 7 */
C000 "8" L /* count up to state 8 */
C000 "9" H /* count up to state 9 - carry */
C000 "0" L /* count up to state 0 */
C010 "9" L /* count down to state 9 */
C010 "8" L /* count down to state 8 */
C010 "7" L /* count down to state 7 */
C010 "6" L /* count down to state 6 */
C010 "5" L /* count down to state 5 */
C010 "4" L /* count down to state 4 */
C010 "3" L /* count down to state 3 */
C010 "2" L /* count down to state 2 */
C010 "1" L /* count down to state 1 */
C010 "0" H /* count down to state 0 - carry*/
C001ZZZZL /* test tri-state */
C000 "2" L /* count up to state 2 */
C100 "0" L /* synchronous clear to state 0 */

```

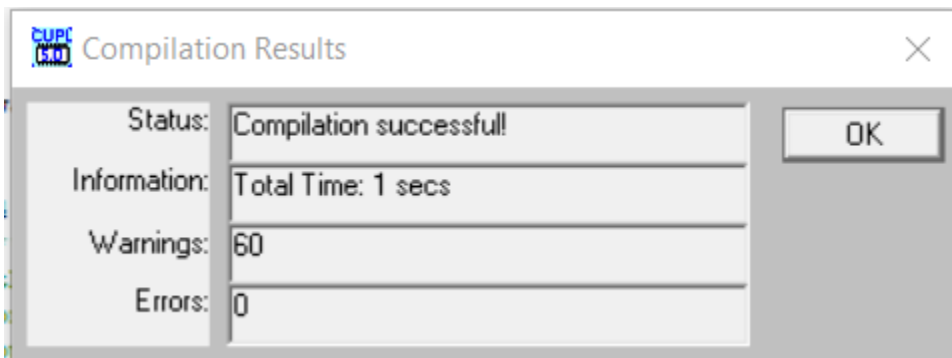
14. 儲存此 simulation file, File → Save As, 請將檔案與 project 儲存在同一路徑,並且使用相同的檔案名稱,但附檔案選擇.si, 然後選擇 Save.
15. 至此,整個 project 已經完整建立
16. 接下來,我們要 compile & simulate 整個程式,看是否有錯誤,並產生燒錄檔案.jed
17. Options→Compiler →General,請勾選"JEDEC name = PLD name" & "View Simulation Results", → Apply → OK.

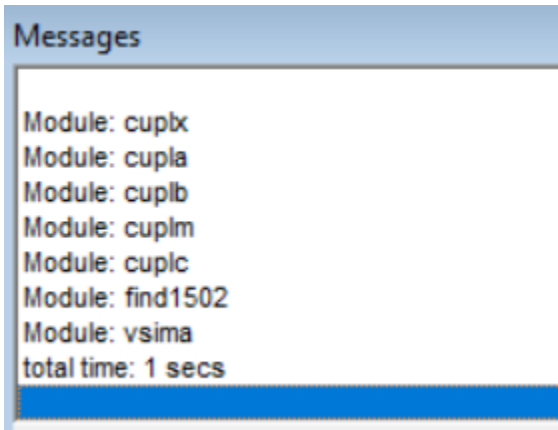


18. Compile & simulation, Run → Device Dependent Compile

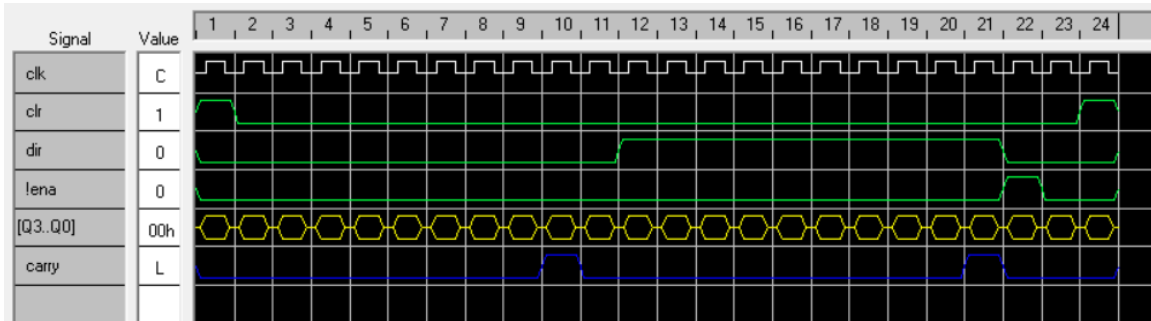


19. 可以看到以下 compile 訊息





20. 按 OK 後就會看到 simulation 的結果



21. 此時燒錄檔案.jed 也產生了,可用此檔案燒錄到 ATF1502ASV

