實習題目 - 3
液晶時鐘

溫進坤

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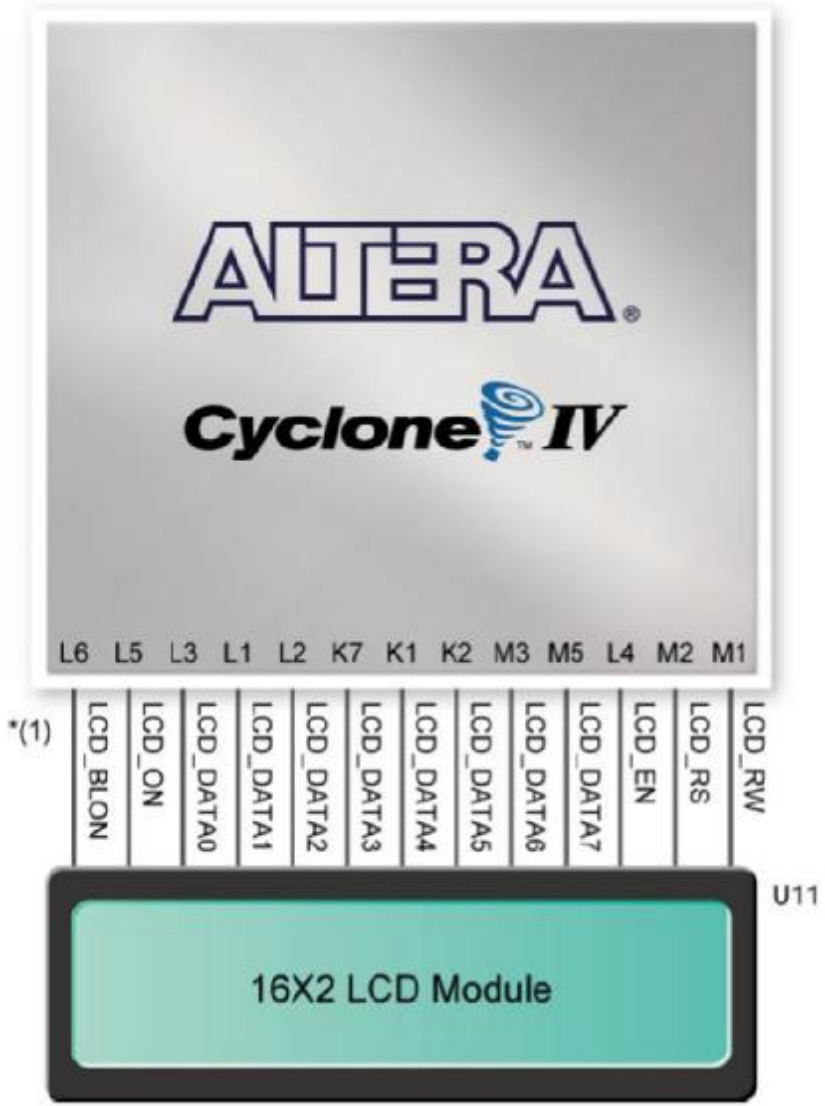
題目功能

1. 開機後在文字液晶上顯示”00:00:00”之時/分/秒後，開始計時顯示。
2. 按下KEY0後，可調整秒鐘數值+1，範圍0-59。
3. 按下KEY1後，可調整分鐘數值+1，範圍0-59。
4. 按下KEY2後，可調整小時數值+1，範圍0-23。
5. 使用同步式設計，always中不能使用CLOCK_50M或RESET以外的訊號當CLOCK使用。

LCM Connection



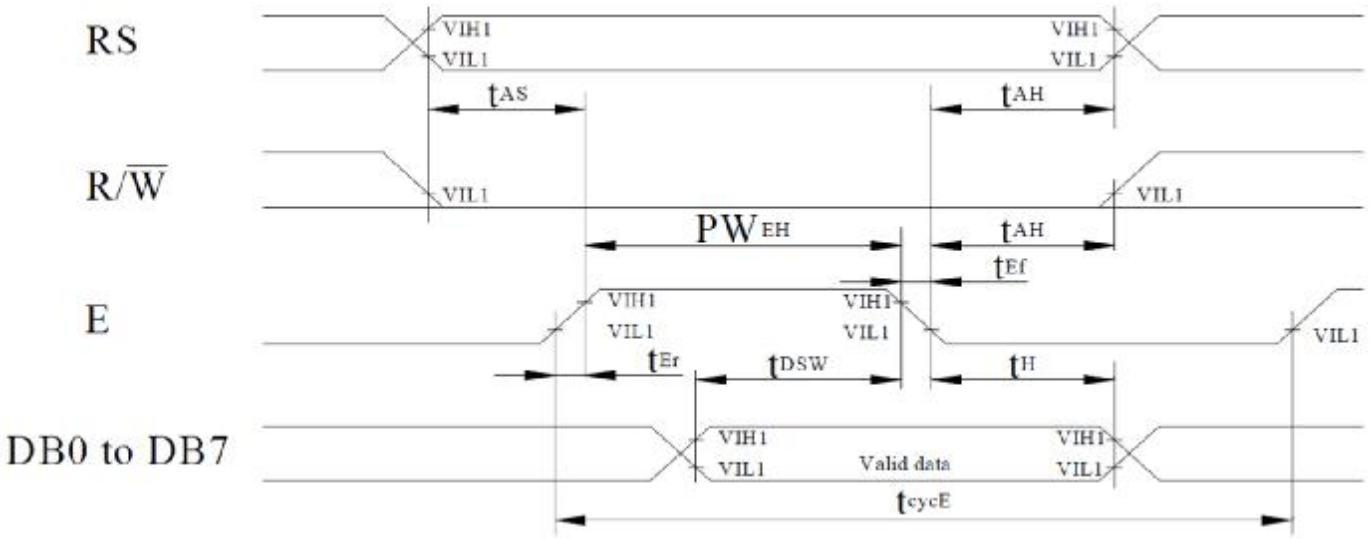
LCM Pin Define

Signal Name	*FPGA Pin No.*	*Description*	*I/O Standard*
LCD_DATA[7]	PIN_M5	LCD Data[7]	3.3V
LCD_DATA[6]	PIN_M3	LCD Data[6]	3.3V
LCD_DATA[5]	PIN_K2	LCD Data[5]	3.3V
LCD_DATA[4]	PIN_K1	LCD Data[4]	3.3V
LCD_DATA[3]	PIN_K7	LCD Data[3]	3.3V
LCD_DATA[2]	PIN_L2	LCD Data[2]	3.3V
LCD_DATA[1]	PIN_L1	LCD Data[1]	3.3V
LCD_DATA[0]	PIN_L3	LCD Data[0]	3.3V
LCD_EN	PIN_L4	LCD Enable	3.3V
LCD_RW	PIN_M1	LCD Read/Write Select, 0 = Write, 1 = Read	3.3V
LCD_RS	PIN_M2	LCD Command/Data Select, 0 = Command, 1 = Data	3.3V
LCD_ON	PIN_L5	LCD Power ON/OFF	3.3V
LCD_BLON	PIN_L6	LCD Back Light ON/OFF	3.3V

LCD_ON : Turn On LCM Power, 1: LCM power on, 0: LCM power off

LCD_BLON : Turn On LCM Backlight, 1:LCM backlight on, 0:LCM backlight off

LCM Control Timing



1:Data,0:Instruction

1:Read,0:Write

1:Enable

Item	Symbol	Min	Typ	Max	Unit
Enable cycle time	t_{cycE}	500	–	–	ns
Enable pulse width (high level)	PW_{EH}	230	–	–	ns
Enable rise/fall time	t_{Er},t_{Ef}	–	–	20	ns
Address set-up time (RS, R/W to E)	t_{AS}	40	–	–	ns
Address hold time	t_{AH}	10	–	–	ns
Data set-up time	t_{DSW}	80	–	–	ns
Data hold time	t_{H}	10	–	–	ns

LCM Instruction Table

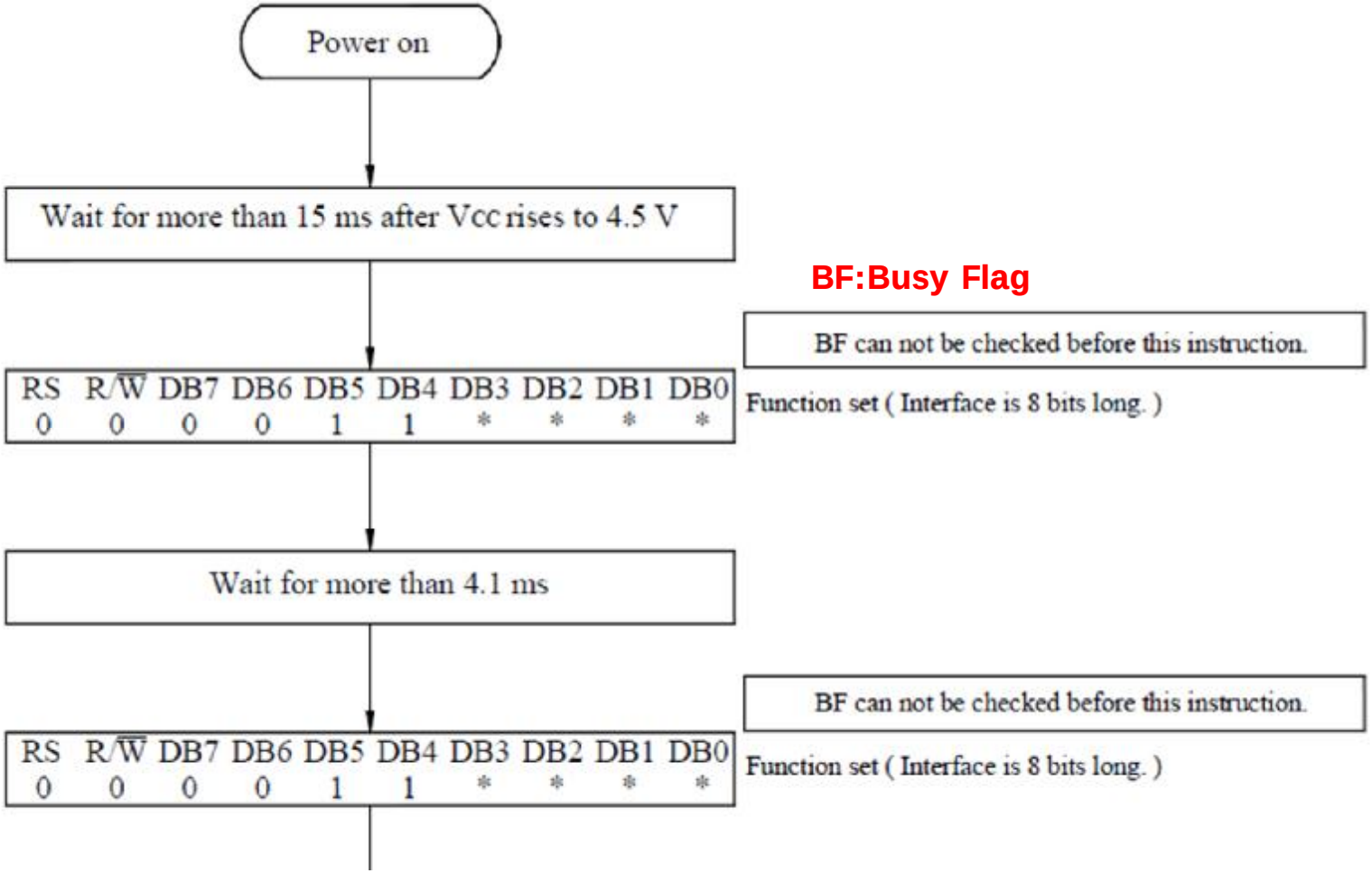
Instruction	Instruction Code										Description	Execution time (fosc=270Khz)
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Clear Display	0	0	0	0	0	0	0	0	0	1	Write "00H" to DDRAM and set DDRAM address to "00H" from AC	1.53ms
Return Home	0	0	0	0	0	0	0	0	1	—	Set DDRAM address to "00H" from AC and return cursor to its original position if shifted. The contents of DDRAM are not changed.	1.53ms
Entry Mode Set	0	0	0	0	0	0	0	1	I/D	SH	Assign cursor moving direction and enable the shift of entire display.	39 μs
Display ON/OFF Control	0	0	0	0	0	0	1	D	C	B	Set display (D), cursor (C), and blinking of cursor (B) on/off control bit.	39 μs
Cursor or Display Shift	0	0	0	0	0	1	S/C	R/L	—	—	Set cursor moving and display shift control bit, and the direction, without changing of DDRAM data.	39 μs

I/D:1
SH:0

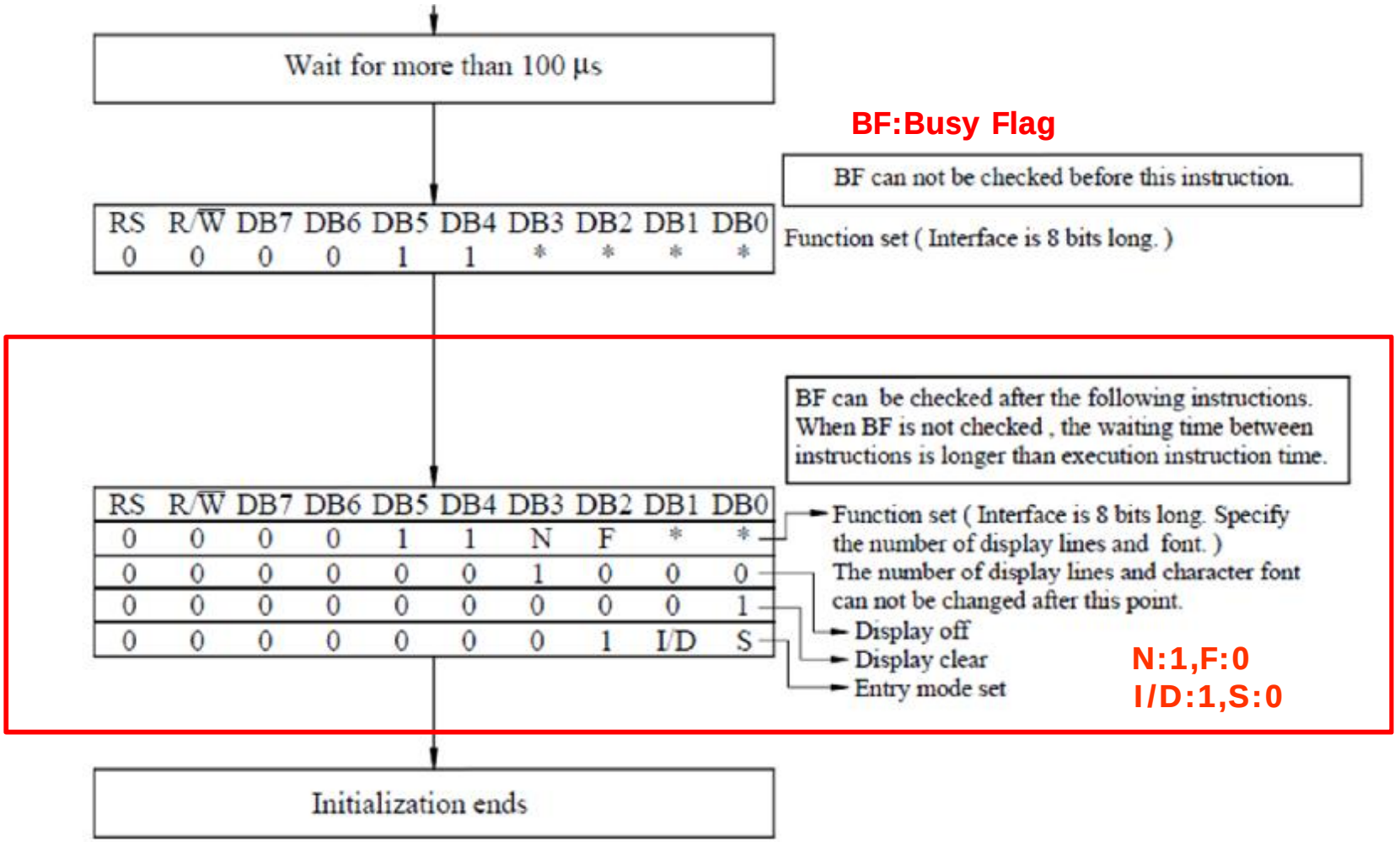
LCM Instruction Table..

Function Set	0	0	0	0	1	DL	N	F	—	—	Set interface data length (DL:8-bit/4-bit), numbers of display line (N:2-line/1-line)and, display font type (F:5× 11 dots/5× 8 dots)	39μs
Set CGRAM Address	0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0	Set CGRAM address in address counter.	39μs
Set DDRAM Address	0	0	1	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Set DDRAM address in address counter.	39μs
Read Busy Flag and Address	0	1	BF	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Whether during internal operation or not can be known by reading BF. The contents of address counter can also be read.	0μs
Write Data to RAM	1	0	D7	D6	D5	D4	D3	D2	D1	D0	Write data into internal RAM (DDRAM/CGRAM).	43μs
Read Data from RAM	1	1	D7	D6	D5	D4	D3	D2	D1	D0	Read data from internal RAM (DDRAM/CGRAM).	43μs

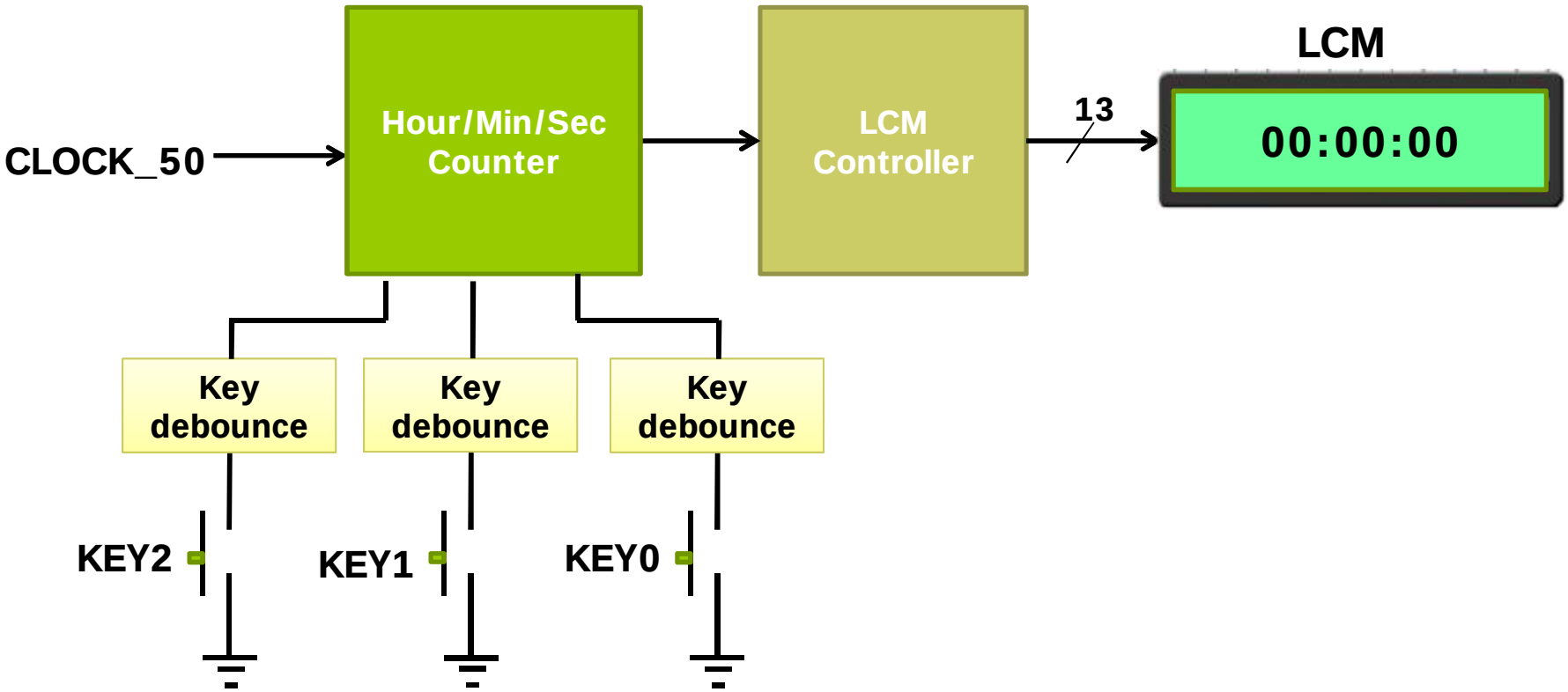
LCM Initial Flow



LCM Initial Flow..



系統方塊圖


CLOCK_50
Hour/Min/Sec Counter
LCM Controller
13
LCM
00:00:00
Key debounce
Key debounce
Key debounce
KEY2
KEY1
KEY0

計分方式

1. 程式完成後請助教確認功能是否正確，並給予完成順序號。
2. 將全部的Verilog程式壓縮後上傳至Moodle[繳交作業]，並在檔名依序寫上實習題目號碼、完成順序號、學號。(檔名:Lab_3_No_xx_學號.zip)
3. 計分標準依完成順序及程式內容給分，若發現程式有互相抄襲狀況，該員分數皆為0分。

參考資料

- **DE2-115_mb_schematic.pdf**
- **DE2_115_pin_assignments.csv**
- **CFAH1602BTMCJP.pdf**