General Purpose IO

- 2013/4/4

課程大綱 (Lesson Outline)

- **Cortex-M0 MCU之基本輸出/輸入原理**

- **實習範例1 : LED顯示控制**
- **實習範例 2: 按鍵+ LED顯示控制**
- **實習範例 3:按鍵+蜂鳴器控制**
- **實習範例 4:在七段顯示器顯示0000-9999**
- **實習範例 5: 3x3按鍵+七段顯示器**
- **實習範例 6: 顯示彈跳的次數**

General Purpose I/O (GPIO) Features

- NuMicro NUC140有80個通用I/O接腳，這些接腳同時具有其他功能，使用前必須先設定。
- 80個接腳分為GPIOA, GPIOB, GPIOC, GPIOD 與 GPIOE，每個PORT最多16個接腳。
- 每個接腳都是獨立的，都有對應的暫存器位元來設定接腳功能模式與資料。
- I/O接腳上的I/O類型可由軟體獨立地設定為高阻態輸入，推挽輸出，開漏輸出或准雙端模式。
- reset之後，所有接腳的I/O類型均為準雙端模式。
- 每個 I/O接腳有一個電阻值110 KΩ~300 KΩ的弱上拉電阻接到VDD上，VDD的範圍從 5.0 V 到 2.5 V。

General Purpose I/O (GPIO) Features

- 輸入模式
- [說明] 設定GPIOx_PMD[n]=00 為輸入模式，則 I/O 接腳為高阻抗，GPIOx_PIN[n]反映引腳狀態。
- [設定] GPIOx->PMD.PMDn=00b
- [查詢] (GPIOx->PIN & (1<<n))的值反映相應GPIOx[n]的狀態。

- 輸出模式
- [說明] 設定GPIOx_PMD[n]=01 為輸出模式，則 I/O 接腳支持數位輸出功能，有source/sink電流能力。
- [設定] GPIOx->PMD.PMDn=01b
- [輸出] GPIOx->DOUT &= ~(1<<n) //set GPIOx[n]=0
- GPIOx->DOUT |= (1<<n) //set GPIOx[n]=1
- [查詢] (GPIOx->PIN & (1<<n))的值反映相應GPIOx[n]的狀態。

General Purpose I/O (GPIO) 接腳模式

- 開漏模式
- [說明] 設定GPIOx_PMD[n]=10 為Open_Drain模式，則 I/O 接腳支援sink電流，需要外加上拉電阻。
- [設定] GPIOx->PMD.PMDn=10b
- [輸出] GPIOx->DOUT &= ~(1<<n) //set GPIOx[n]=0
- GPIOx->DOUT |= (1<<n) //set GPIOx[n]=1
- [查詢] (GPIOx->PIN & (1<<n))的值反映相應GPIOx[n]的狀態。

General Purpose I/O (GPIO) 接腳模式

- 準雙端模式
- [說明] 設定GPIOx_PMD[n]=11 為準雙端模式，則 I/O 接腳支持輸入/數位輸出功能，但 source 電流僅有30-200uA 。准雙端輸出是 80C51 及其系列產品共有的模式。要實現數位輸入，需要先將 GPIOx[n] 設定為1(reset後， GPIO->PMD=0xFFFFFFFF, GPIOx->DOUT =0xFFFF)。
- [設定] GPIOx->PMD.PMDn=11b
- [輸出] GPIOx->DOUT &= ~(1<<n) //set GPIOx[n]=0
- GPIOx->DOUT |= (1<<n) //set GPIOx[n]=1
- [查詢] (GPIOx->PIN & (1<<n))的值反映相應GPIOx[n]的狀態。

GPIOA Register

寄存器	偏移量	R/W	描述	復位後的值
GPIOA_PMD	GP_BA+0x000	R/W	接腳 I/O 模式控制	0xFFFF_FFFF
GPIOA_OFFD	GP_BA+0x004	R/W	接腳 OFF 數位致能	0x0000_0000
GPIOA_DOUT	GP_BA+0x008	R/W	數據輸出值	0x0000_FFFF
GPIOA_DMASK	GP_BA+0x00C	R/W	數據輸出寫屏蔽	0x0000_0000
GPIOA_PIN	GP_BA+0x010	R	接腳數值	0x0000_XXXX
GPIOA_DBEN	GP_BA+0x014	R/W	去抖動致能	0x0000_0000
GPIOA_IMD	GP_BA+0x018	R/W	中斷模式控制	0x0000_0000
GPIOA_IEN	GP_BA+0x01C	R/W	中斷致能	0x0000_0000
GPIOA_ISRC	GP_BA+0x020	R/W	中斷源標誌	0xXXXX_XXXX

GPIOA_PMD: I/O Mode Control

設定GPIO引腳的輸入/輸出模式

bit	Symbol	Descriptions
[2n+1:2n]	PMDn	**GPIOx I/O Pin[n] Mode Control**
[1:0]	PMD0	00 = GPIO port [n] pin is in INPUT mode
[3:2]	PMD1	01 = GPIO port [n] pin is in OUTPUT mode
[5:4]	PMD2	10 = GPIO port [n] pin is in Open-Drain mode
[7:6]	PMD3	11 = GPIO port [n] pin is in Quasi-bidirectional mode
…	…	After RESET, PMD=0xFFFFFFFF

GPIOA_OFFD

If input is analog signal, users can disable GPIO digital input path to avoid creepage.

bit	Symbol	Descriptions
[31:16]	OFFD	**GPIOx Pin[n] OFF 數位輸入通道致能** 用於控制 bit 對應的 GPIO 的數位輸入通道是否禁用。若輸入為類比信號，可以關閉數位輸入通道避免漏電。 1 = 禁用 IO 數位輸入通道（數位輸入拉低） 0 = 使能 IO 數位輸入通道 After RESET, OFFD=0

GPIOA_DOUT

控制引腳的輸出為0/1

bit	Symbol	Descriptions
[n] [0] [1] [2] [3] …	DOUT[n] DOUT[0] DOUT[1] DOUT[2] DOUT[3] …	**GPIOx Pin[n] Output Value** if the GPIO pin is configures as output, open-drain and quasi-mode: 1 = GPIO port [A/B/C/D/E] Pin[n] will drive High 0 = GPIO port [A/B/C/D/E] Pin[n] will drive Low After RES

GPIOA_DMASK

保護引腳的輸出，不被改變

bit	Symbol	Descriptions
[n]	DMASK[n]	**PORT[A/B/C/D/E] 數據輸出寫入遮蔽**
[0]	DMASK[0]	用於保護相應暫存器 GPIOx_DOUT bit[n]。在設置
[1]	DMASK[1]	DMASK bit[n] 為1，相應的GPIOx_DOUT[n] bit 被
[2]	DMASK[2]	保護。寫入信號會被遮蔽，不能向保護位元寫入資
[3]	DMASK[3]	料。
…	…	1 = 相應的 GPIOx_DOUT[n] bit 被保護
		0 = 相應的 GPIOx_DOUT[n] bit 能被更新
		After RESET, DMASK=0

GPIOA_PIN

查詢引腳的狀態0/1

bit	Symbol	Descriptions
[n]	PIN[n]	**Port [A/B/C/D/E] Pin Values**
[0]	PIN[0]	Each bit of the register reflects the actual status of the
[1]	PIN[1]	respective GPIO pin.
[2]	PIN[2]	Bit=1, the corresponding pin status is high,
[3]	PIN[3]	Bit=0, the pin status is low.
…	…	After RESET, PIN=0xFFFF

GPIOA_DBEN

啟用去彈跳功能

bit	Symbol	Descriptions
[n]	DBEN[n]	**Port [A/B/C/D/E] 輸入信號去抖動致能**
[0]	DBEN[0]	DBEN[n] 用於致能相應位元的去抖動功能。如果輸入信號脈衝寬度不能被兩個連續的去抖動採樣週期所採樣，則輸入信號被視為信號抖動，從而不會觸發中斷。去抖動的時鐘源由 DBNCECON[4] 控制，去抖動的採樣週期由 DBNCECON[3:0] 控制。 DBEN[n] 僅用於邊沿觸發 (edge-trigger)中斷，不能用於電平觸發 (level trigger)中斷。 1 = 致能 bit[n] 去抖動功能 0 = 禁用 bit[n] 去抖動功能 去抖動功能對邊沿觸發中斷有效，對於電平觸發中斷模式該致能位元不起作用 。 After RESET, DBEN=0
[1]	DBEN[1]	
[2]	DBEN[2]	
[3]	DBEN[3]	
…	…	

GPIOA_IMD

設定引腳中斷的觸發模式

bit	Symbol	Descriptions
[n]	IMD[n]	**Port [A/B/C/D/E]**邊沿或電平檢測中斷控制
[0]	IMD[0]	IMD[n] 用於控制中斷是電平觸發或邊沿觸發。若為邊沿觸發中斷，觸發源可由去抖動控制；若為電平觸發中斷，輸入源由一個 HCLK 時鐘採樣並產生中斷。
[1]	IMD[1]	1 = 電平觸發中斷
[2]	IMD[2]	0 = 邊沿觸發中斷
[3]	IMD[3]	如果設置管腳為電平觸發中斷，則在寄存器 GPIOx_IEN 中，只能設置一個電平。若設置了兩個電平去觸發中斷，則設置被忽略，不會產生中斷。
…	…	去抖動功能對於邊沿觸發有效，對於電平觸發中斷無效。
		After RESET, IMD=0

GPIOA_IEN

啟用引腳中斷

bit	Symbol	Descriptions
[n+16]	IR_EN[n]	**Port [A/B/C/D/E]輸入上升沿或輸入高電平中斷致能** 當設置 IR_EN[n] 位為 1： 中斷是電平觸發模式， PIN[n] 為高電平時將產生中斷。 中斷是邊沿觸發模式，PIN[n] 由低電平上升到高電平產生中斷 1 =致能 PIN[n] 高電平或由低電平到高電平變化的中斷 0 = 禁用 PIN[n] 高電平或由低電平到高電平變化的中斷 After RESET,, IR_EN=0
[n]	IF_EN[n]	**Port [A/B/C/D/E]**輸入下降沿或輸入低電平中斷致能 當設置 IF_EN[n] 位為 1： 中斷是電平觸發模式， PIN[n] 的狀態為低電平時將產生中斷。 中斷是邊沿觸發模式，PIN[n] 的狀態由高電平到低電平變化時將產生中斷。 1 =致能 PIN[n] 低電平或由高電平到低電平變化的中斷 0 = 禁用 PIN[n] 低電平或由高電平到低電平變化的中斷 After RESET,, IF_EN=0

GPIOA_ISRC

讀取/清除引腳中斷來源

bit	Symbol	Descriptions
[n]	ISRC[n]	**Port [A/B/C/D/E]** Interrupt Source Flag
[0]	ISRC[0]	讀：
[1]	ISRC[1]	1 = 表示GPIOx[n] 產生中斷
[2]	ISRC[2]	0 = 表示GPIOx[n] 沒有中斷
[3]	ISRC[3]	寫：
…	…	1= 清除相應的未處理中斷
		0= 無動作
		After RESET=0

GPIOA_DBNCECON

讀取/清除引腳中斷來源

bit	Symbol	Descriptions
[5]	ICLK_ON	中斷用時鐘 On 模式 1 = reset後,所有I/O接腳邊緣偵測為啟用 0 = 只有I/O接腳對應的GPIOx_IEN為1,則邊緣偵測為啟用 關掉此位元，可節省耗電
[4]	DBCLKSRC	選擇去抖動計數器時鐘源 1 = 去抖動計數器時鐘源為內部 10 kHz 振蕩器 0 = 去抖動計數器時鐘源為 HCLK
[3:0]	DBCLKDEL	選擇去抖動採樣週期 0:採樣中斷輸入每 1 clocks 1 次 1:採樣中斷輸入每 2 clocks 1 次 2:採樣中斷輸入每 4 clocks 1 次 3:採樣中斷輸入每 8 clocks 1 次 4:採樣中斷輸入每 16 clocks 1 次 15:採樣中斷輸入每 2^{15} clocks 1 次

GPIO Driver

_DRVGPIO_DOUT	control I/O Bit Output/Input Control Register of the specified pin.
	_DRVGPIO_DOUT (E_GPA, 1) = 1;
	u8PinValue = _DRVGPIO_DOUT (E_GPB, 3);

GPA_[n] / GPB_[n] / GPC_[n] / GPD_[n] / GPE_[n]	same as _DRVGPIO_DOUT macro but without any parameters GPA_1 = 1; u8PinValue = GPB_3;

GPIO Driver

DrvGPIO_ Open	Set GPIO pin to operation mode. GPIOx_PMD DrvGPIO_Open (E_GPA, 0, E_IO_OUTPUT); DrvGPIO_Open (E_GPA, 1, E_IO_INPUT);
DrvGPIO_ Close	set the pin to quasi-bidirectional mode. GPIOx_PMD DrvGPIO_Close (E_GPA, 0);
DrvGPIO_ SetBit	Set GPIO pin to 1. GPIOx_DOUT DrvGPIO_SetBit (E_GPA, 0);
DrvGPIO_ GetBit	Get GPIO pin value. GPIOx_PIN i32BitValue = DrvGPIO_GetBit (E_GPA, 1);
DrvGPIO_ ClrBit	Set GPIO pin to 0. GPIOx_DOUT DrvGPIO_ClrBit (E_GPA, 0);

GPIO Driver

DrvGPIO_ SetPortBits	Set the output port value to the specified GPIO port. GPIOx_DOUT DrvGPIO_SetPortBits (E_GPA, 0x1234);
DrvGPIO_ GetPortBits	Get the input port value from the specified GPIO port. GPIOx_PIN i32PortValue = DrvGPIO_GetPortBits (E_GPA);
DrvGPIO_ GetDoutBit	Get the bit value from the specified Data Output Value Register. GPIOx_DOUT i32BitValue = DrvGPIO_GetDoutBit (E_GPA, 1);
DrvGPIO_ GetPortDoutBits	Get the port value from the specified Data Output Value Register. GPIOx_DOUT i32PortValue = DrvGPIO_GetPortDoutBits (E_GPA);

GPIO Driver

DrvGPIO_ SetPortMask	protect the write data function of the corresponding GPIO pins. GPIOx_DMASK DrvGPIO_SetPortMask (E_GPA, 0x11);
DrvGPIO_ GetPortMask	Get the port value from the specified Data Output Write Mask Register. GPIOx_DMASK i32MaskValue = DrvGPIO_GetPortMask (E_GPA);
DrvGPIO_ ClrPortMask	remove the write protect function of the corresponding GPIO pins. GPIOx_DMASK DrvGPIO_ClrPortMask (E_GPA, 0x11);

GPIO Driver

DrvGPIO_ SetBitMask	protect the write data function of the corresponding GPIO pin. GPIOx_DMASK DrvGPIO_SetBitMask (E_GPA, 0);
DrvGPIO_ GetBitMask	Get the bit value from the specified Data Output Write Mask Register. GPIOx_DMASK i32MaskValue = DrvGPIO_GetBittMask (E_GPA, 0);
DrvGPIO_ ClrBitMask	remove the write protect function of the the corresponding GPIOpin. GPIOx_DMASK DrvGPIO_ClrBitMask (E_GPA, 0);

GPIO Driver

DrvGPIO_ EnableDigitalInputBit	Enable IO digital input path of the specified GPIO input pin. GPIOx_OFFD DrvGPIO_EnableDigitalInputBit (E_GPA, 0);
DrvGPIO_ DisableDigitalInputBit	Disable IO digital input path of the specified GPIO input pin. GPIOx_OFFD DrvGPIO_DisableDigitalInputBit (E_GPA, 0);

GPIO Driver

DrvGPIO_ EnableDebounce	Enable the de-bounce function of the specified GPIO input pin. GPIOX_DBEN DrvGPIO_EnableDebounce (E_GPA, 0);
DrvGPIO_ DisableDebounce	Disable the de-bounce function of the specified GPIO input pin. GPIOX_DBEN DrvGPIO_DisableDebounce (E_GPA, 0);
DrvGPIO_ SetDebounceTime	Set the interrupt de-bounce sampling time based on the de-bounce counter clock source. DrvGPIO_SetDebounceTime (4, E_DBCLKSRC_10K); GPIOX_DBNCECON
DrvGPIO_ GetDebounceSampleCycle	get the number of de-bounce sampling cycle selection. GPIOX_DBNCECON i32CycleSelection = DrvGPIO_GetDebounceSampleCycle ();

GPIO Driver

DrvGPIO_ EnableInt	Enable the interrupt function of the specified GPIO pin. GPIOX_IEN DrvGPIO_EnableInt (E_GPB, 13, E_IO_RISING, E_MODE_EDGE);
DrvGPIO_ DisableInt	Disable the interrupt function of the specified GPIO pin. GPIOX_IEN DrvGPIO_DisableInt (E_GPB, 13);
DrvGPIO_ SetIntCallback	Install the interrupt callback function for GPA/GPB port and GPC/GPD/GPE port, DrvGPIO_SetIntCallback (GPABCallback, GPCDECallback);

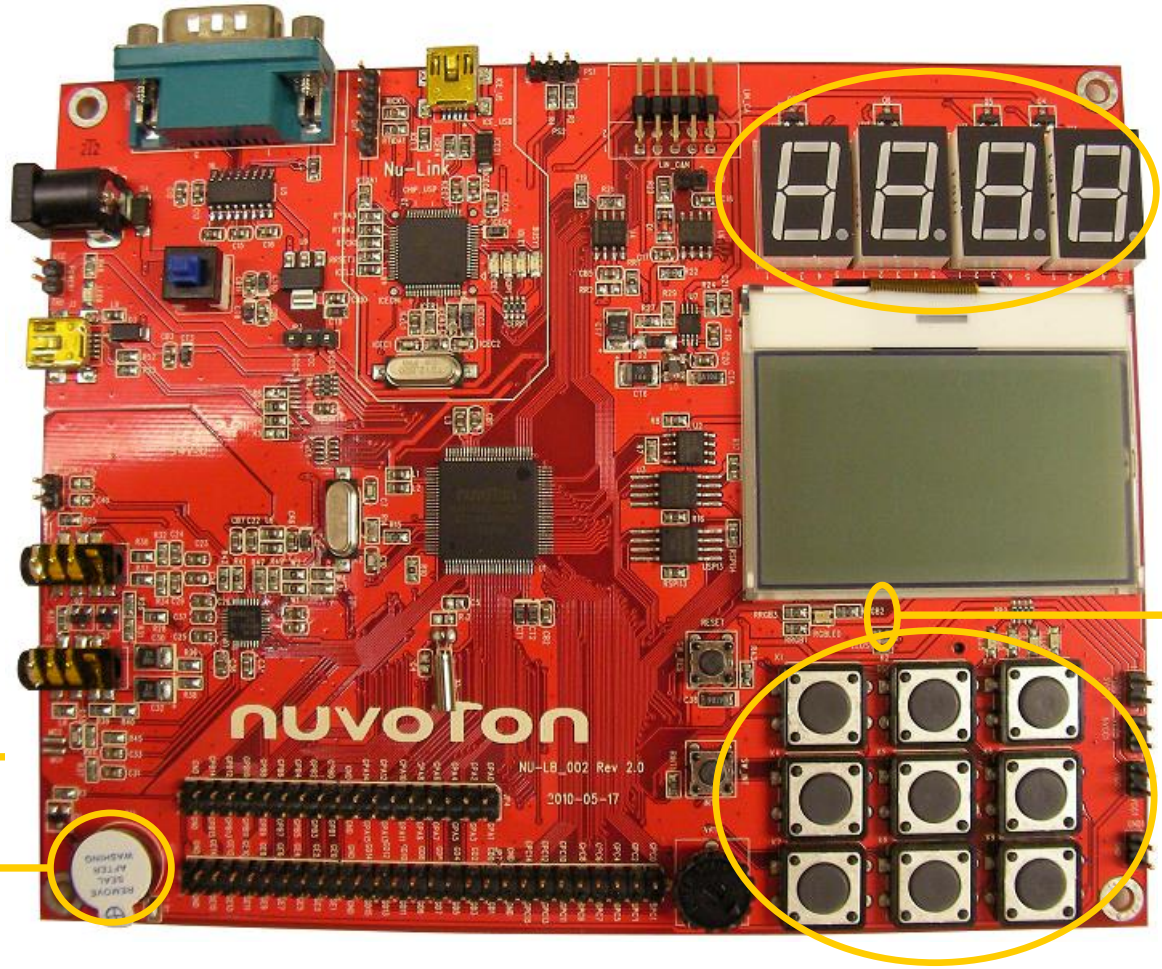
GPIO Driver

DrvGPIO_ EnableEINT0	Enable the interrupt function for external GPIO interrupt from /INT0(GPB.14) pin. GPIOx_IEN DrvGPIO_EnableEINT0 (E_IO_BOTH_EDGE, E_MODE_EDGE, EINT1Callback);
DrvGPIO_ DisableEINT0	Disable the interrupt function for external GPIO interrupt from /INT0 (GPB.14) pin. GPIOx_IEN DrvGPIO_DisableEINT0 ();
DrvGPIO_ EnableEINT1	Enable the interrupt function for external GPIO interrupt from /INT1(GPB.15) pin. GPIOx_IEN DrvGPIO_EnableEINT1 (E_IO_FALLING, E_MODE_LEVEL, EINT1Callback);
DrvGPIO_ DisableEINT1	Disable the interrupt function for external GPIO interrupt from /INT1(GPB.15) pin. GPIOx_IEN DrvGPIO_DisableEINT1 ();

GPIO Driver

DrvGPIO_ GetIntStatus	Get the port value from the specified Interrupt Trigger Source Indicator Register. GPIOx_ISRC i32INTStatus = DrvGPIO_GetIntStatus (E_GPA);
DrvGPIO_ InitFunction	Initialize the specified function and configure the relative pins for specified function used. DrvGPIO_InitFunction (E_FUNC_UART0);
DrvGPIO_ GetVersion	return the version number of GPIO driver i32GPIOVer = DrvGPIO_GetVersion ();

NU-LB-NUC140 開發板



7 segment LEDs

RGB LED
GPA12,13,14

Keypad

SW Int
GPB15

Buzzer
GPB11

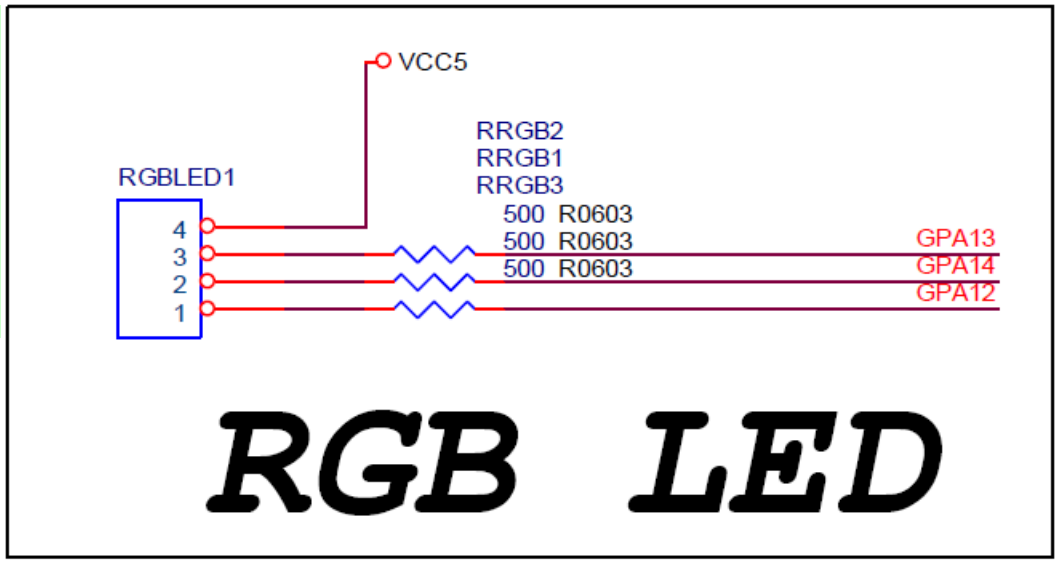
3.1Test_RGBled 學習板電路圖

- RGB LED : GPA12,13,14

GPA12 : Blue 0 = on, 1 = off

GPA13 : Green 0 = on, 1 = off

GPA14 : Red 0 = on, 1 = off



- 寫一程式，設定藍色，綠色，紅色LED依序發亮0.5秒，然後全暗0.5秒；反覆執行。LED分別由GPIO A的bit12,13,14控制，輸出0時發亮，輸出1時，不亮。

DrvGPIO_Open

- 功能：設定GPIO接腳的Input/Output，有四種模式：輸入、輸出、開漏、準雙向。
- 函數：int32_t DrvGPIO_Open(E_DRVGPIO_PORT port, int32_t i32Bit, E_DRVGPIO_IO mode)
- 參數：Port: E_DRVGPIO_PORT, specify GPIO port. It could be E_GPA(+0), E_GPB(+0x40), E_GPC(+0x80), E_GPD(+0xC0) and E_GPE(+0x100).
- 參數： i32Bit: Specify pin of the GPIO port. It could be 0~15.
- 參數： Mode: E_DRVGPIO_IO, set the specified GPIO pin to be E_IO_INPUT(00), E_IO_OUTPUT(01), E_IO_OPENDRAIN(10) or E_IO_QUASI(11) mode.
- 範例：DrvGPIO_Open(E_GPA, 12, E_IO_OUTPUT); //61states
- 與下列指令的作用相同
- GPIOA->PMD.PMD12 = 0x1; //13states

DrvGPIO_SetBit

- 功能：設定GPIO接腳的值=1。
- 函數： int32_t DrvGPIO_SetBit(E_DRVGPIO_PORT port, int32_t i32Bit)
- 參數： Port: E_DRVGPIO_PORT, specify GPIO port. It could be E_GPA(+0), E_GPB(+0x40), E_GPC(+0x80), E_GPD(+0xC0) and E_GPE(+0x100).
- 參數： i32Bit: Specify pin of the GPIO port. It could be 0~15.
- 範例：DrvGPIO_SetBit(E_GPA,13); //GPIOA_13=1 off, 35states
- 與下列指令的作用相同
- GPIOA->DOUT |= (1<<13); //10states

DrvGPIO_ClrBit

- 功能：設定GPIO接腳的值=0。
- 函數： int32_t DrvGPIO_ClrBit(E_DRVGPIO_PORT port, int32_t i32Bit)
- 參數： Port: E_DRVGPIO_PORT, specify GPIO port. It could be E_GPA(+0), E_GPB(+0x40), E_GPC(+0x80), E_GPD(+0xC0) and E_GPE(+0x100).
- 參數： i32Bit: Specify pin of the GPIO port. It could be 0~15.
- 範例：DrvGPIO_ClrBit(E_GPA,12); //GPIOA_12=0 on, 35states
- 與下列指令的作用相同
- GPIOA->DOUT &= ~(0x1<<12); //10states

DrvSYS_Delay

- 功能：generate the delay time (us)。
- 函數：void DrvSYS_Delay (uint32_t us);
- 參數： **us**: Delay time. The maximal delay time is 335000 us.
- 範例：DrvSYS_Delay (5000); //delay 5000us
- 與下列指令的作用相同
- 說明：DrvSYS_Delay使用SysTick作為計數器，最大可以設定2^{24}=16777215；時脈使用HCLK，若HCLK為22MHz，則數22次為1us。當計數器設定16777215，相當於762600us。也就是說DrvSYS_Delay(762600)是最大的設定值。
- 若HCLK=12MHz，最大值DrvSYS_Delay(1398101) 。
- 若HCLK=50MHz，最大值DrvSYS_Delay(335544) 。

3.1Test_RGBled (1/5)

```
int main (void)
{
    // Initial GPIO GPA12,13,14 to output mode
    DrvGPIO_Open(E_GPA, 12, E_IO_OUTPUT);
    //GPIOA->PMD.PMD12 = 0x01;
    DrvGPIO_Open(E_GPA, 13, E_IO_OUTPUT);
     //GPIOA->PMD.PMD13 = 0x01;
    DrvGPIO_Open(E_GPA, 14, E_IO_OUTPUT);
    //GPIOA->PMD.PMD14 = 0x01;
    while (1)
          {
```

3.1Test_RGBled (2/5)

```
// set RGBled to Blue

// GPA12 = Blue,  0 : on, 1 : off
DrvGPIO_ClrBit(E_GPA,12);
//GPIOA->DOUT &= ~(0x1<<12);

DrvGPIO_SetBit(E_GPA,13);
//GPIOA->DOUT |= (1<<13);

DrvGPIO_SetBit(E_GPA,14);
//GPIOA->DOUT |= (1<<14);

DrvSYS_Delay(500000); //delay 500000us=500ms=0.5s
```

3.1Test_RGBled (3/5)

```
// set RGBled to Green

DrvGPIO_SetBit(E_GPA,12);
//GPIOA->DOUT |= (1<<12);

// GPA13 = Green, 0 : on, 1 : off
DrvGPIO_ClrBit(E_GPA,13);
//GPIOA->DOUT &= ~(0x1<<13);

DrvGPIO_SetBit(E_GPA,14);
//GPIOA->DOUT |= (1<<14);
DrvSYS_Delay(500000); //delay 500000us=500ms=0.5s
```

3.1Test_RGBled (4/5)

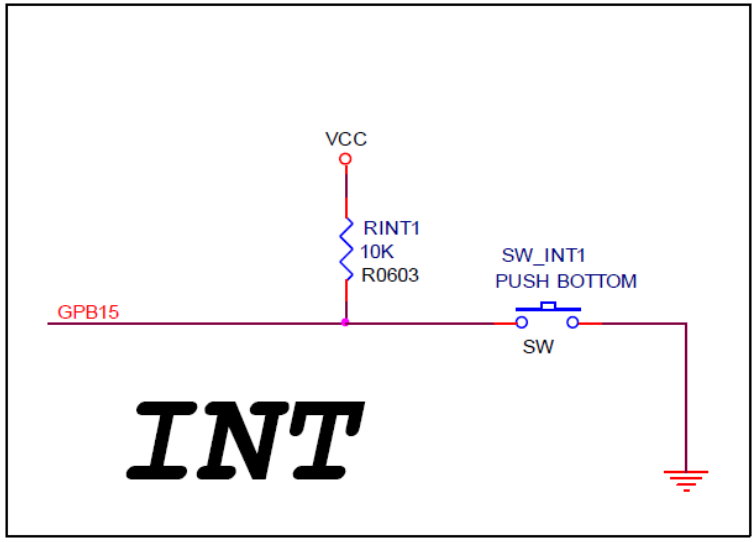
```
// set RGBled to Red

DrvGPIO_SetBit(E_GPA,12);
//GPIOA->DOUT |= (1<<12);

DrvGPIO_SetBit(E_GPA,13);
//GPIOA->DOUT |= (1<<13);

// GPA14 = Red,   0 : on, 1 : off
DrvGPIO_ClrBit(E_GPA,14);
//GPIOA->DOUT &= ~(0x1<<14);

DrvSYS_Delay(500000); //delay 500000us=500ms=0.5s
```

3.1Test_RGBled (5/5)

```
        // set RGBled to off
        DrvGPIO_SetBit(E_GPA,12); // GPA12 = Blue,  0 : on, 1 : off
        //GPIOA->DOUT |= (1<<12);

        DrvGPIO_SetBit(E_GPA,13); // GPA13 = Green, 0 : on, 1 : off
        //GPIOA->DOUT |= (1<<13);

        DrvGPIO_SetBit(E_GPA,14); // GPA14 = Red,   0 : on, 1 : off
        //GPIOA->DOUT |= (1<<14);

        DrvSYS_Delay(500000); //delay 500000us=500ms=0.5s
    }
}
```

3.2Test_SWInt_RGBled

- RGB LED : GPA12,13,14
  - **GPA12** : Blue 0 = on, 1 = off
  - **GPA13** : Green 0 = on, 1 = off
  - **GPA14** : Red 0 = on, 1 = off
- SW Int : GPB15
  - **GPB15**: 0=pressed, 1= not pressed



寫一程式，當按鍵按下時，紅色LED閃爍(on/off各0.5秒) 。鬆開則綠色LED閃爍(on/off各0.5秒)。

GPIOB bit15作為GPIO輸入

檢查GPIOB_PIN[15]=0時，表示按鍵已經按下

DrvGPIO_Open

- 功能：設定GPIO接腳的Input/Output，有四種模式：輸入、輸出、開漏、準雙向。
- 函數：int32_t DrvGPIO_Open(E_DRVGPIO_PORT port, int32_t i32Bit, E_DRVGPIO_IO mode)
- 參數：Port: E_DRVGPIO_PORT, specify GPIO port. It could be E_GPA(+0), E_GPB(+0x40), E_GPC(+0x80), E_GPD(+0xC0) and E_GPE(+0x100).
- 參數： i32Bit: Specify pin of the GPIO port. It could be 0~15.
- 參數： Mode: E_DRVGPIO_IO, set the specified GPIO pin to be E_IO_INPUT(00), E_IO_OUTPUT(01), E_IO_OPENDRAIN(10) or E_IO_QUASI(11) mode.
- 範例：DrvGPIO_Open(E_GPB, 15, E_IO_INPUT); //61states
- 與下列指令的作用相同
- GPIOB->PMD.PMD12 = 0x0; //13states

DrvGPIO_SetBit

- 功能：設定GPIO接腳的值=1。
- 函數： int32_t DrvGPIO_SetBit(E_DRVGPIO_PORT port, int32_t i32Bit)
- 參數： Port: E_DRVGPIO_PORT, specify GPIO port. It could be E_GPA(+0), E_GPB(+0x40), E_GPC(+0x80), E_GPD(+0xC0) and E_GPE(+0x100).
- 參數： i32Bit: Specify pin of the GPIO port. It could be 0~15.
- 範例：DrvGPIO_SetBit(E_GPA,13); //GPIOA_13=1 off, 35states
- 與下列指令的作用相同
- GPIOA->DOUT |= (1<<13); //10states

DrvGPIO_ClrBit

- 功能：設定GPIO接腳的值=0。
- 函數： int32_t DrvGPIO_ClrBit(E_DRVGPIO_PORT port, int32_t i32Bit)
- 參數： Port: E_DRVGPIO_PORT, specify GPIO port. It could be E_GPA(+0), E_GPB(+0x40), E_GPC(+0x80), E_GPD(+0xC0) and E_GPE(+0x100).
- 參數： i32Bit: Specify pin of the GPIO port. It could be 0~15.
- 範例：DrvGPIO_ClrBit(E_GPA,13); //GPIOA_13=0 on, 35states
- 與下列指令的作用相同
- GPIOA->DOUT &= ~(0x1<<13); //10states

DrvSYS_Delay

- 功能：generate the delay time (us)。
- 函數：void DrvSYS_Delay (uint32_t us);
- 參數： **us**: Delay time. The maximal delay time is 335000 us.
- 範例：DrvSYS_Delay (5000); //delay 5000us
- 與下列指令的作用相同
- 說明：DrvSYS_Delay使用SysTick作為計數器，最大可以設定2^{24}=16777215；時脈使用HCLK，若HCLK為22MHz，則數22次為1us。當計數器設定16777215，相當於762600us。也就是說DrvSYS_Delay(762600)是最大的設定值。
- 若HCLK=12MHz，最大值DrvSYS_Delay(1398101) 。
- 若HCLK=50MHz，最大值DrvSYS_Delay(335544) 。

DrvGPIO_GetBit

- 功能：Get the pin value from the specified input GPIO pin.
- 函數：int32_t DrvGPIO_GetBit(E_DRVGPIO_PORT port, int32_t i32Bit)
- 參數：Port: E_DRVGPIO_PORT, specify GPIO port. It could be E_GPA(+0), E_GPB(+0x40), E_GPC(+0x80), E_GPD(+0xC0) and E_GPE(+0x100).
- 參數： i32Bit: Specify pin of the GPIO port. It could be 0~15.
- 範例：DrvGPIO_GetBit(E_GPB, 15)　　//get GPIOB bit15
- 　　與下列指令的作用相同
- 　　GPIOB->PIN & (1<<15) //get GPIOB bit15

3.2Test_SWInt_RGBled (1/4)

```
int main (void)
{
        // Initial GPIO GPA13(blue LED) to output mode
        DrvGPIO_Open(E_GPA, 13, E_IO_OUTPUT);
        //GPIOA->PMD.PMD13 = 0x01;

        // Initial GPIO GPA14(red LED) to output mode
        DrvGPIO_Open(E_GPA, 14, E_IO_OUTPUT);
        //GPIOA->PMD.PMD14 = 0x01;

        // Initial GPIO GPB15(SW Int) to input mode
        DrvGPIO_Open(E_GPB, 15, E_IO_INPUT);
        //GPIOB->PMD.PMD15 = 0x00;
```

3.2Test_SWInt_RGBled (2/4)

```
while (1)
   {
        if (DrvGPIO_GetBit(E_GPB,15)==0)     // 當(按鍵按下)
        //while((GPIOB->PIN & (1<<15))==0)
        {       //關綠色LED，閃紅色LED
                // turn off green LED, bit13=1
                DrvGPIO_SetBit(E_GPA,13);
                //GPIOA->DOUT |= (1<<13);
                // turn on red LED, bit14=0
                DrvGPIO_ClrBit(E_GPA,14);
                //GPIOA->DOUT &= ~(0x1<<14);
                DrvSYS_Delay(500000);
```

3.2Test_SWInt_RGBled (3/4)

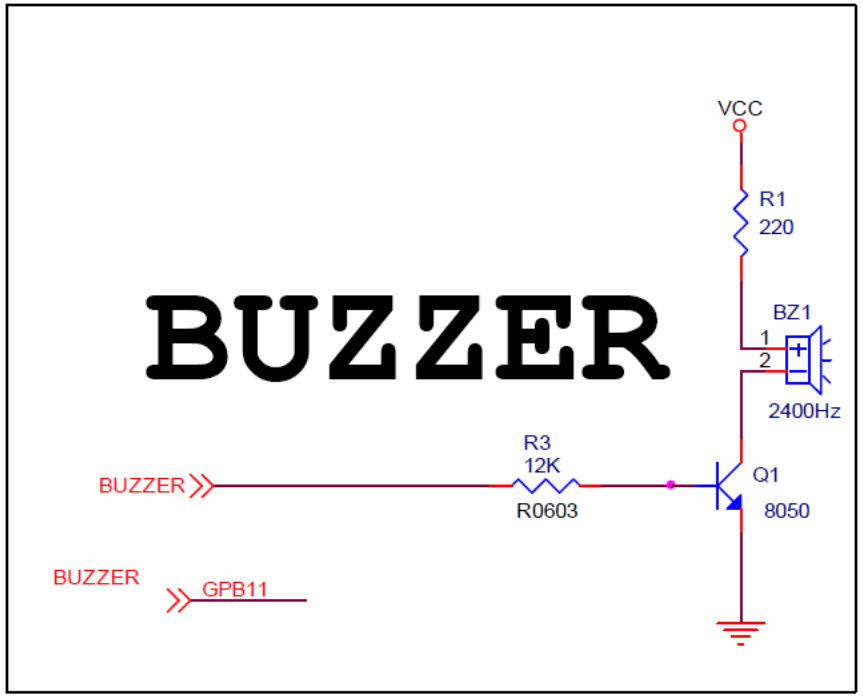
```
            // turn off red LED, bit14=1
            DrvGPIO_SetBit(E_GPA,14);
            //GPIOA->DOUT |= (1<<14);
            DrvSYS_Delay(500000);
    }
    else
    {       // set green flashing
            // turn off red LED, bit14=1
            DrvGPIO_SetBit(E_GPA,14);
            //GPIOA->DOUT |= (1<<14);
            // turn on green LED, bit13=0
```

3.2Test_SWInt_RGBled (4/4)

```
            DrvGPIO_ClrBit(E_GPA,13);       //35states
            //GPIOA->DOUT &= ~(0x1<<13);    //10 states
            DrvSYS_Delay(500000);
            // turn off green LED, bit14=0
            DrvGPIO_SetBit(E_GPA,13);       //35states
            //GPIOA->DOUT |= (1<<13);       //10 states
            DrvSYS_Delay(500000);
             }
      }
}
```

3.3Test_SWInt_Buzzer

- BUZZER : GPB11
  - **GPB11** : 0 = on, 1 = off
- R1電阻太大，聲音太小聽不到。將R1短路，可聽到聲音。
- SW Int : GPB15
  - **GPB15**: 0=pressed, 1= not pressed



寫一程式，當按鍵按下時，蜂鳴器發出聲音。鬆開則沒有聲音。

GPIO pin GPB11=0 turn on BUZZER

GPIO pin GPB11=1 turn off BUZZER

DrvGPIO_Open

- 功能：設定GPIO接腳的Input/Output，有四種模式：輸入、輸出、開漏、準雙向。
- 函數：int32_t DrvGPIO_Open(E_DRVGPIO_PORT port, int32_t i32Bit, E_DRVGPIO_IO mode)
- 參數：Port: E_DRVGPIO_PORT, specify GPIO port. It could be E_GPA(+0), E_GPB(+0x40), E_GPC(+0x80), E_GPD(+0xC0) and E_GPE(+0x100).
- 參數： i32Bit: Specify pin of the GPIO port. It could be 0~15.
- 參數： Mode: E_DRVGPIO_IO, set the specified GPIO pin to be E_IO_INPUT(00), E_IO_OUTPUT(01), E_IO_OPENDRAIN(10) or E_IO_QUASI(11) mode.
- 範例：DrvGPIO_Open(E_GPB, 15, E_IO_INPUT); //61states
- 與下列指令的作用相同
- GPIOB->PMD.PMD12 = 0x0; //13states

DrvGPIO_SetBit

- 功能：設定GPIO接腳的值=1。
- 函數： int32_t DrvGPIO_SetBit(E_DRVGPIO_PORT port, int32_t i32Bit)
- 參數： Port: E_DRVGPIO_PORT, specify GPIO port. It could be E_GPA(+0), E_GPB(+0x40), E_GPC(+0x80), E_GPD(+0xC0) and E_GPE(+0x100).
- 參數： i32Bit: Specify pin of the GPIO port. It could be 0~15.
- 範例：DrvGPIO_SetBit(E_GPB,11); //GPIOB_11=1 off, 35states
- 與下列指令的作用相同
- GPIOB->DOUT |= (1<<11); //10states

DrvGPIO_ClrBit

- 功能：設定GPIO接腳的值=0。
- 函數： int32_t DrvGPIO_ClrBit(E_DRVGPIO_PORT port, int32_t i32Bit)
- 參數： Port: E_DRVGPIO_PORT, specify GPIO port. It could be E_GPA(+0), E_GPB(+0x40), E_GPC(+0x80), E_GPD(+0xC0) and E_GPE(+0x100).
- 參數： i32Bit: Specify pin of the GPIO port. It could be 0~15.
- 範例：DrvGPIO_ClrBit(E_GPB,11); //GPIOB_11=0 on, 35states
- 與下列指令的作用相同
- GPIOB->DOUT &= ~(0x1<<11); //10states

DrvGPIO_GetBit

- 功能：Get the pin value from the specified input GPIO pin.
- 函數：int32_t DrvGPIO_GetBit(E_DRVGPIO_PORT port, int32_t i32Bit)
- 參數：Port: E_DRVGPIO_PORT, specify GPIO port. It could be E_GPA(+0), E_GPB(+0x40), E_GPC(+0x80), E_GPD(+0xC0) and E_GPE(+0x100).
- 參數： i32Bit: Specify pin of the GPIO port. It could be 0~15.
- 範例：DrvGPIO_GetBit(E_GPB, 15)　　//get GPIOB bit15
- 　　與下列指令的作用相同
- 　　GPIOB->PIN & (1<<15) //get GPIOB bit15

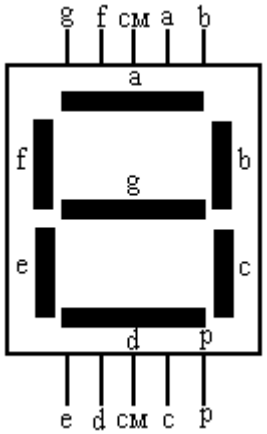
3.3Test_SWInt_Buzzer (1/2)

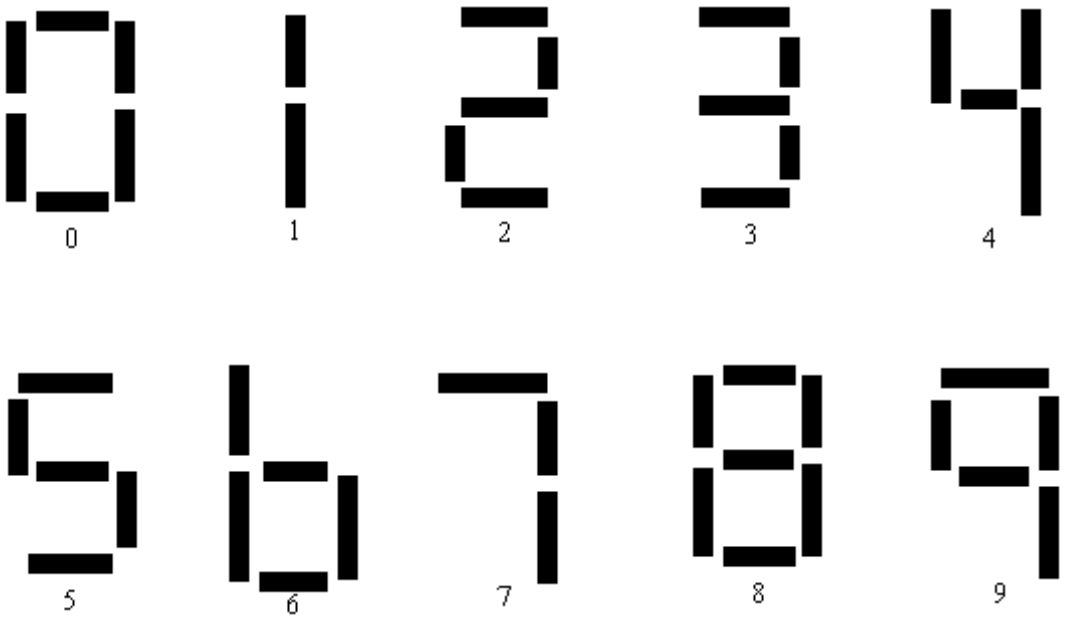
```
int main (void)
{
        // initial GPIO pin GPB15 (SW int ) to input mode
        DrvGPIO_Open(E_GPB, 15, E_IO_INPUT);
        //GPIOB->PMD.PMD15 = 0x00;

        // initial GPIO pin GPB11 for controlling Buzzer to output mode
        DrvGPIO_Open(E_GPB, 11, E_IO_OUTPUT);
        //GPIOB->PMD.PMD11 = 0x01;
```

3.3Test_SWInt_Buzzer (2/2)

```
    while (1)
    {
      if(DrvGPIO_GetBit(E_GPB,15)==0)  // if SW_INT button pressed
      //if((GPIOB->PIN & (1<<15))==0)
            {    // GPB11 = 0, turn on Buzzer
                 DrvGPIO_ClrBit(E_GPB,11);
                 //GPIOB->DOUT &= ~(0x1<<11);
            }  else
            {
                 // GPB11 = 1, turn off Buzzer
                 DrvGPIO_SetBit(E_GPB,11);
                 //GPIOB->DOUT |= (1<<11);
    }
}
```

3.4Test_7seg–七段顯示器





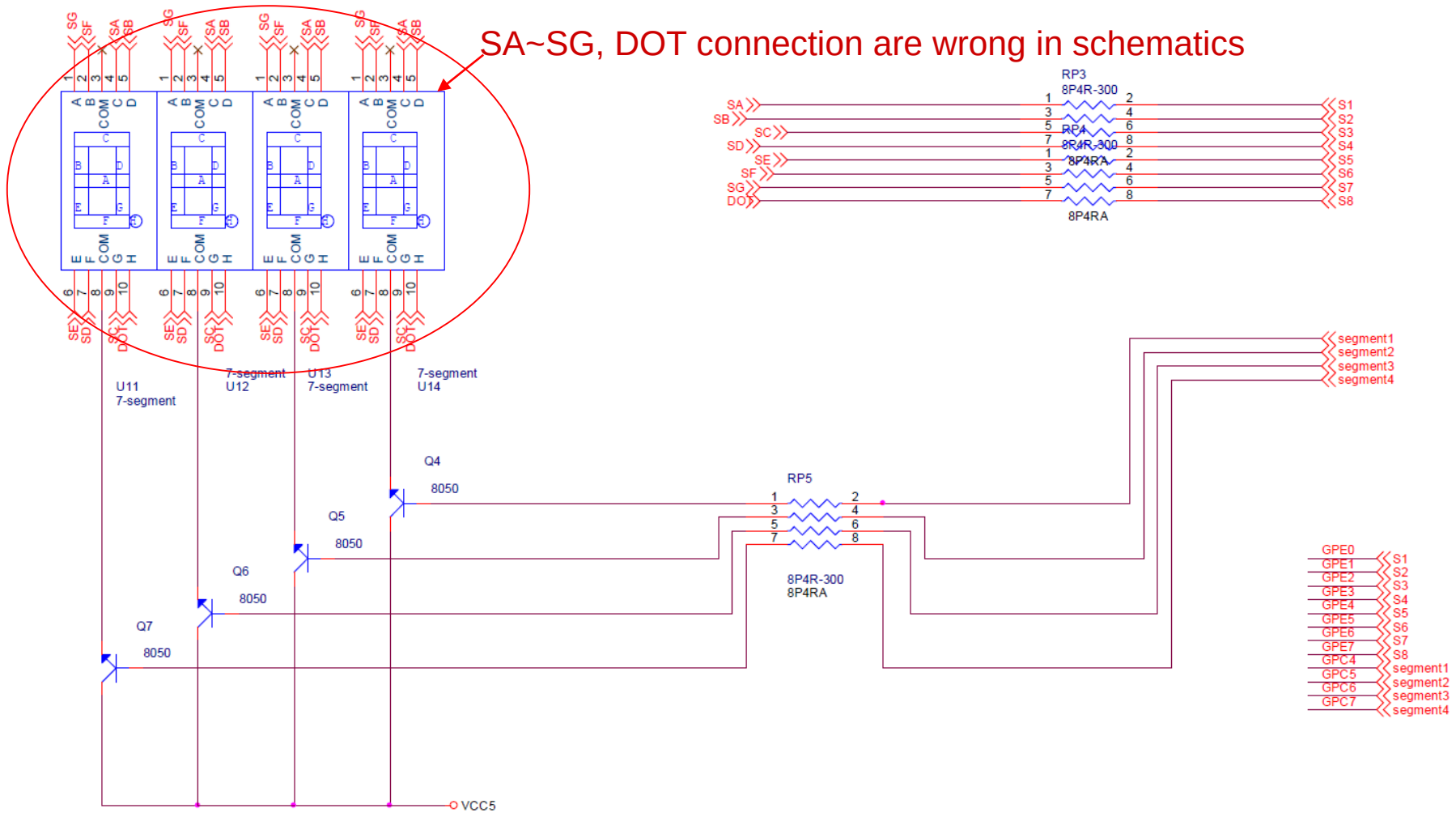
每個7段顯示器有8個LED，分別標示為a,b,c,d,e,f,g,p。

如果將a,b,c,d,e,f,g,p分別對應到GPIO的bit 0,1,2,3,4,5,6,7，則可由GPIO控制LED的明暗。

共陽極7段顯示器由低電位控制，共陰極7段顯示器由高電位控制。

寫一程式，逐一顯示0000-9999。

Test_7seg– 7 段顯示器線路圖

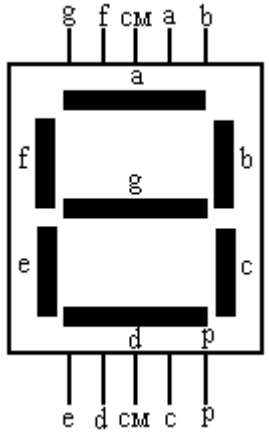


Test_7seg– Control Pins used for

GPC4~7 control which 7-segment to turn on (1 = on, 0 = off)

- GPC4 : 1st 7-segment (LSB)
- GPC5 : 2nd 7-segment
- GPC6 : 3th 7-segment
- GPC7 : 4th 7-segment (MSB)

GPE0~7 control each segment to turn on (0 = on, 1 = off)



	g	e	d	b	a	f	dp	c	
	7	6	5	4	3	2	1	0	
0	1	0	0	0	0	0	1	0	0x82
1	1	1	1	0	1	1	1	0	0xEE
2	0	0	0	0	0	1	1	1	0x07
3	0	1	0	0	0	1	1	0	0x46
4	0	1	1	0	1	0	1	0	0x6A
5	0	1	0	1	0	0	1	0	0x52

7-Segment LED Driver

NUC100SeriesBSP/NuvotonPlatform_Keil/Src/NUC1xx-LB002/Seven_Segment.c

- #define SEG_N0 0x82 // define segment led on/off for digit 0
- #define SEG_N1 0xEE // define segment led on/off for digit1
- #define SEG_N2 0x07
- #define SEG_N3 0x46
- #define SEG_N4 0x6A
- #define SEG_N5 0x52
- #define SEG_N6 0x12
- #define SEG_N7 0xE6
- #define SEG_N8 0x02
- #define SEG_N9 0x62
- // array of segment led on/off value for digit 0~9
- unsigned char SEG_BUF[10]={SEG_N0, SEG_N1, SEG_N2, SEG_N3, SEG_N4, SEG_N5, SEG_N6, SEG_N7, SEG_N8, SEG_N9};

7-Segment LED Driver - show_seven_segment

- 功能：將number顯示在第no個7段顯示器
- 函數： void show_seven_segment(unsigned char no, unsigned char number)
- 參數： no:第no個7段顯示器，(0-3)
- 參數：number: 顯示的數字，(0-9)
- 範例：show_seven_segment(3,digit)
- 與下列指令的作用相同
- GPIOE->DOUT &= ~(0xFF); //clear 7 seg., GPIOE bit0-7
- GPIOE->DOUT |= SEG_BUF[digit[3]];//show 7 seg.,
- GPIOC->DOUT |= (1<<(3+4)); //display 4th 7 seg.,GPIOC bit 7=1

7-Segment LED Driver - close_seven_segment

- 功能：關閉7段顯示器。
- 函數：void close_seven_segment(void)
- 參數：
- 範例： close_seven_segment();
- 與下列指令的作用相同
- GPIOC->DOUT &= ~(0xF<<4);

seven_segment_open

- 功能：設定7段顯示器的LED為輸出。
- 函數：void seven_segment_open(void)
- 參數：
- 範例： seven_segment_open();
- 與下列指令的作用相同

```
//Initial GPIOE [7:0] to input mode for 7-seg.
for (ith=0; ith<8; ith++)
  { DrvGPIO_Open(E_GPE, ith, E_IO_OUTPUT); }
//Initial GPIOC [7:4] to output mode for nth 7-seg.
for (ith=4; ith<8; ith++)
  { DrvGPIO_Open(E_GPC, ith, E_IO_OUTPUT); }
```

3.4Test_7seg– main() (1/x)

```
int32_t main (void)
{
    int32_t i;

    seven_segment_open();
    //GPIOE->PMD.PMD0 = 1; GPIOE[7:0]=output
    //GPIOE->PMD.PMD1 = 1; GPIOE[7:0]=output
    //GPIOC->PMD>PMD4 = 1; GPIOC[7-4]=output

    for (i=0; i<10000; i++)          // counting 0~9999
    {
       seg_display(i);       // display value to  7-segment display
    }
}
```

3.4Test_7seg– seg_display()　　(2/x)

```
void seg_display(int16_t value)
{
    int8_t digit[4];
    int32_t itimes=50;

    //將顯示在7段顯示器的值先算出來，存在陣列
    digit[3] = value / 1000;
    value = value - digit[3] * 1000;
    digit[2] = value / 100;
    value = value - digit[2] * 100;
    digit[1] = value / 10;
    value = value - digit[1] * 10;
    digit[0] = value;
```

3.4Test_7seg– seg_display() (3/x)

```
while(itimes--){
    //turn off 7-seg., clear GPIOC bit4-7
    close_seven_segment();
    //GPIOC->DOUT &= ~(0xF<<4);

    show_seven_segment(3,digit);
    //GPIOE->DOUT &= ~(0xFF); //clear 7 seg., GPIOE bit0-7
    //GPIOE->DOUT |= SEG_BUF[digit[3]];//show 7 seg.,
    //GPIOC->DOUT |= (1<<(3+4)); //display 4th 7 seg.,GPIOC bit
7=1
     DrvSYS_Delay(5000); //delay 5000us=5ms
```

3.4Test_7seg– seg_display() (4/x)

```
            close_seven_segment(); //clear GPIOC bit4-7
            show_seven_segment(2,digit[2]);
             DrvSYS_Delay(5000); //delay 5000us=5ms

            close_seven_segment(); //clear GPIOC bit4-7
            show_seven_segment(1,digit[1]);
             DrvSYS_Delay(5000); //delay 5000us=5ms

            close_seven_segment(); //clear GPIOC bit4-7
            show_seven_segment(0,digit[0]);
             DrvSYS_Delay(5000); //delay 5000us=5ms
    }
}
```

3.5Test_7seg_Keypad–學習板電路圖

Control Pins used for 3x3 Keypad

Column control : GPA2, 1, 0

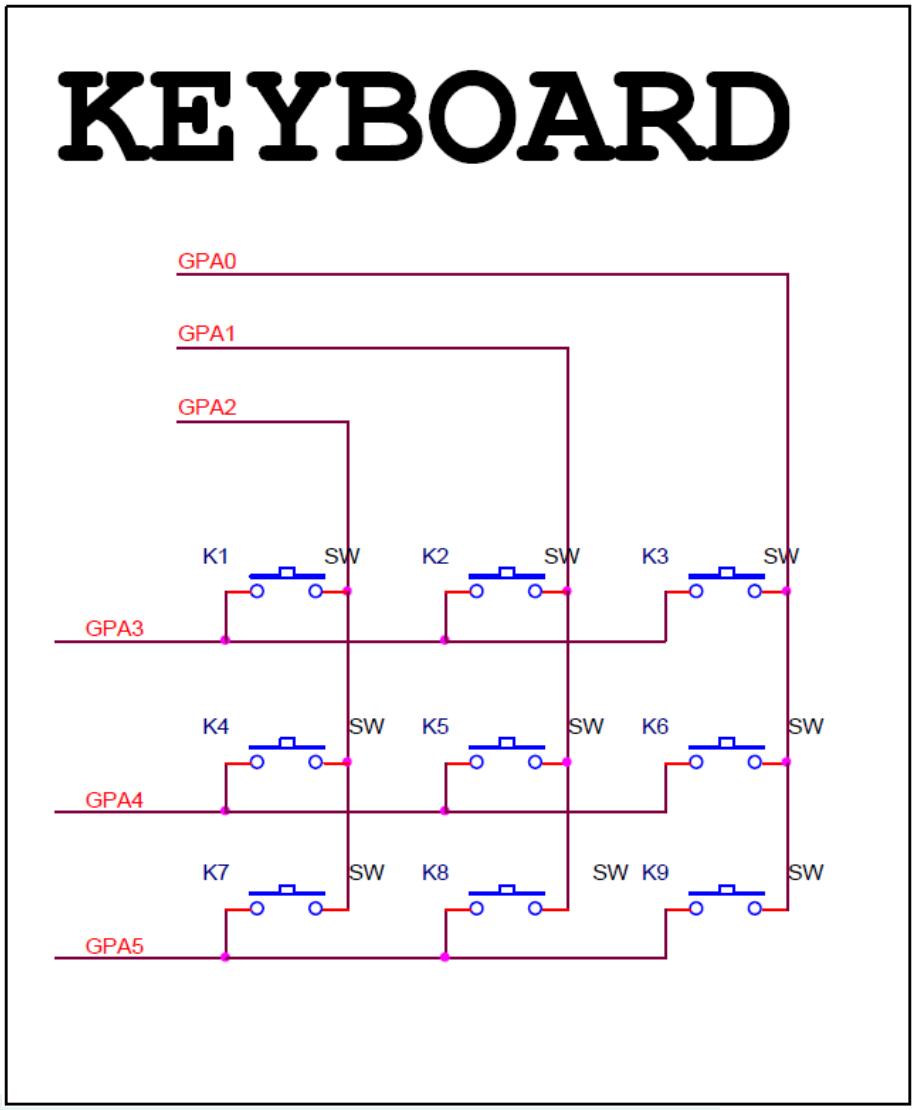
Raw control : GPA 3, 4, 5

- Key1 = GPA3 + GPA2
- Key2 = GPA3 + GPA1
- Key3 = GPA3 + GPA0
- Key4 = GPA4 + GPA2
- Key5 = GPA4 + GPA1
- Key6 = GPA4 + GPA0
- Key7 = GPA5 + GPA2
- Key8 = GPA5 + GPA1
- Key9 = GPA5 + GPA0

寫一程式，當按鍵按下時，顯示對應的數字0-9。

GPA[2:0]依序輸出低電位(011, 101, 110)供按鍵讀取

GPA[5:3]讀取低電位

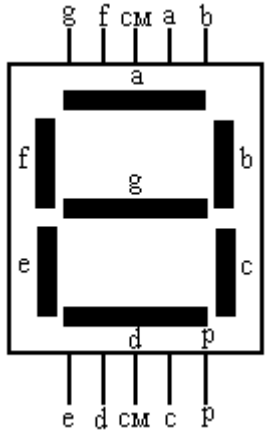


Test_7seg_Keypad– 7-seg. Control Pins

GPC4~7 control which 7-segment to turn on (1 = on, 0 = off)

- GPC4 : 1st 7-segment (LSB)
- GPC5 : 2nd 7-segment
- GPC6 : 3th 7-segment
- GPC7 : 4th 7-segment (MSB)

GPE0~7 control each segment to turn on (0 = on, 1 = off)



	g	e	d	b	a	f	dp	c	
	7	6	5	4	3	2	1	0	
0	1	0	0	0	0	0	1	0	0x82
1	1	1	1	0	1	1	1	0	0xEE
2	0	0	0	0	0	1	1	1	0x07
3	0	1	0	0	0	1	1	0	0x46
4	0	1	1	0	1	0	1	0	0x6A
5	0	1	0	1	0	0	1	0	0x52

ScanKeyDriver - OpenKeyPad

- 功能：將ScanKey的控制GPIOA[5:0]設定為雙向
- 函數： void OpenKeyPad()
- 範例：OpenKeyPad ()
- 與下列指令的作用相同
- GPIOA->PMD.PMD0 = 0x03;
- GPIOA->PMD.PMD1 = 0x03;
- GPIOA->PMD.PMD2 = 0x03;
- GPIOA->PMD.PMD3 = 0x03;
- GPIOA->PMD.PMD4 = 0x03;
- GPIOA->PMD.PMD5 = 0x03;

ScanKeyDriver - Scankey

- 功能：讀取按鍵對應的值1-9
- 函數： void ScanKey (void)
- 範例：ScanKey ()
-

ScanKeyDriver - CloseKeyPad

- 功能：將ScanKey的控制GPIOA[5:0]設定為雙向
- 函數： void CloseKeyPad ()
- 範例：CloseKeyPad()
- 與下列指令的作用相同
- GPIOA->PMD.PMD0 = 0x03;
- GPIOA->PMD.PMD1 = 0x03;
- GPIOA->PMD.PMD2 = 0x03;
- GPIOA->PMD.PMD3 = 0x03;
- GPIOA->PMD.PMD4 = 0x03;
- GPIOA->PMD.PMD5 = 0x03;

KeyPadOpen

- 功能：將ScanKey的控制GPIOA[2:0]設定為輸出，GPIOA[5:3]設定為輸入
- 函數： void KeyPadOpen (void)
- 範例：KeyPadOpen ()
- 與下列指令的作用相同
- GPIOA->PMDPMD0 = 0x01;
- GPIOA->PMDPMD1 = 0x01;
- GPIOA->PMDPMD2 = 0x01;
- GPIOA->PMDPMD3 = 0x00;
- GPIOA->PMDPMD4 = 0x00;
- GPIOA->PMDPMD5 = 0x00;

Scankey_GetKey

- 功能：讀取按鍵對應的值1-9
- 函數： void ScanKey_GetKey (void)
- 範例：ScanKey_GetKey ()
- 與下列指令的作用相同

```
number = 0;
for (irow=1; irow <4; irow++)
{
        GPIOA->DOUT |= (0x7);          //xxxx-x111
        GPIOA->DOUT &= ~(1<<(3-irow));  //011, 101, 110
        if((GPIOA->PIN & (0x1<<3)) == 0)number = irow;
        if((GPIOA->PIN & (0x1<<4)) == 0)number = irow+3;
        if((GPIOA->PIN & (0x1<<5)) == 0)number = irow+6;
}
return number;
```

7-Segment LED Driver - show_seven_segment

- 功能：將number顯示在第no個7段顯示器
- 函數： void show_seven_segment(unsigned char no, unsigned char number)
- 參數： no:第no個7段顯示器，(0-3)
- 參數：number: 顯示的數字，(0-9)
- 範例：show_seven_segment(3,digit)
- 與下列指令的作用相同
- GPIOE->DOUT &= ~(0xFF); //clear 7 seg., GPIOE bit0-7
- GPIOE->DOUT |= SEG_BUF[digit[3]];//show 7 seg.,
- GPIOC->DOUT |= (1<<(3+4)); //display 4th 7 seg.,GPIOC bit 7=1

7-Segment LED Driver - close_seven_segment

- 功能：關閉7段顯示器。
- 函數：void close_seven_segment(void)
- 參數：
- 範例： close_seven_segment();
- 與下列指令的作用相同
- GPIOC->DOUT &= ~(0xF<<4);

seven_segment_open

- 功能：設定7段顯示器的LED為輸出。
- 函數：void seven_segment_open(void)
- 參數：
- 範例： seven_segment_open();
- 與下列指令的作用相同
- GPIOE->PMD.PMD0 = 1;
- …
- GPIOE->PMD.PMD7 = 1;
- GPIOC->PMD.PMD4 = 1;
- …
- GPIOC->PMD.PMD7 = 1;

3.5Test_7seg_Keypad– (1/x)

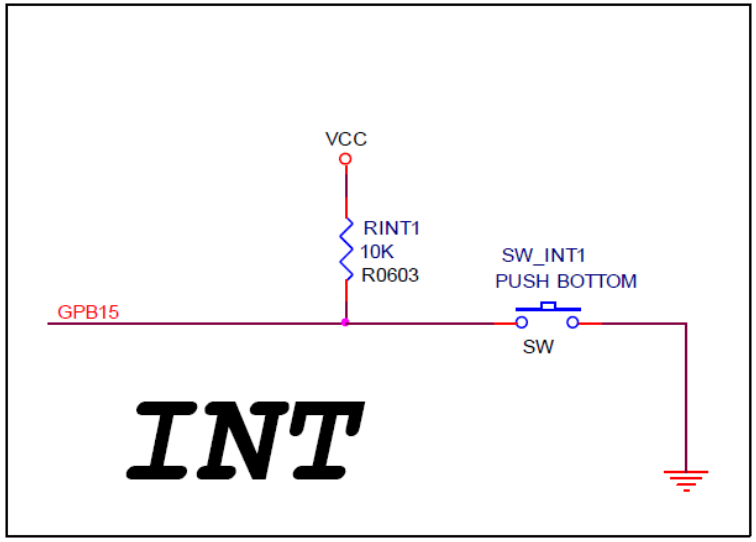
```
int32_t main (void)
{
    //Initial GPIOC [7:4] to output mode
    seven_segment_open();  //set GPIOC_PMD[7:4] //743 states

    close_seven_segment();  //tuen off 7-seg. GPIOC[7:4] //157 states
    //GPIOC->DOUT &= ~(0xF<<4);

    //Initial GPIOA [5:0]=11,QUASI mode
    OpenKeyPad(); //383 states
    //GPIOA->PMD.PMD0 = (0x3);
    //GPIOA->PMD.PMD1 = (0x3);
    //GPIOA->PMD.PMD2 = (0x3);
    //GPIOA->PMD.PMD3 = (0x3);
    //GPIOA->PMD.PMD4 = (0x3);
    //GPIOA->PMD.PMD5 = (0x3);
```

3.5Test_7seg_Keypad– (2/x)

```
while(1)
    {
        number = Scankey(); //7380 states

        if(number)show_seven_segment(0,number);//448 states
        //GPIOE->DOUT &= ~(0xFF); //clear 7 seg., GPIOE bit0-7=0000000
        //GPIOE->DOUT |= SEG_BUF[number];//show 7 seg.,GPIOE bit0-7=
        //GPIOC->DOUT |= (1<<(0+4));     //display 1st 7 seg.,GPIOC bit 7=1

        //Delay(5000);                  //30013 states
    }

}
```

3.6Test_7seg_SWInt_Bounce–計算彈跳的次數

- SW Int: GPB15
  - **GPB15**: 0=pressed, 1= not pressed

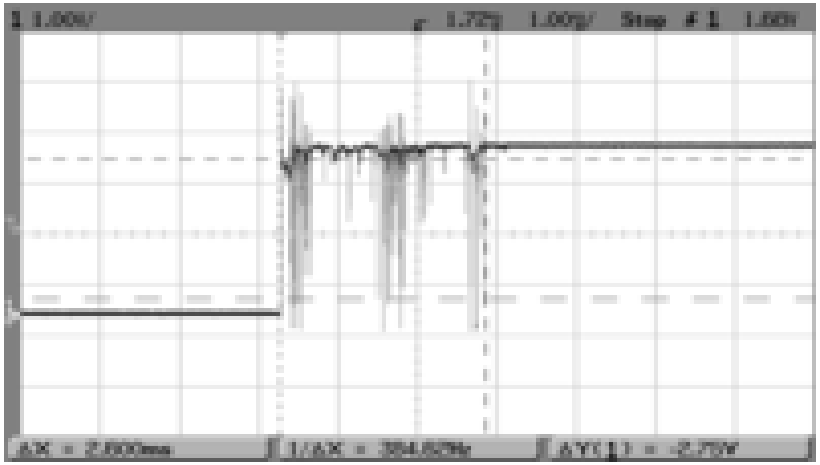


寫一程式，當按鍵按下時，計算彈跳(bounce)的次數。然後將次數顯示在7段顯示器。

設定為GPIO，檢查GPIOB_DOUT[15]=0時，表示按鍵已經按下

3.6Test_7seg_SWInt_Bounce–計算彈跳的次數

- 接觸彈跳(bounce)是機械開關常見的問題。當開關接觸時，由於動量和彈性造成彈跳。
- 彈跳時間通常在10ms以內。
- 彈跳可以藉由硬體電路消除，或使用軟體處理。



- 按下時，會有彈跳發生，通常在10ms內結束。一般延遲20ms。
- 鬆開時，也會有彈跳現象。一般延遲10ms就足夠處理。
- 按鍵主要的接觸時間約60ms-150ms，或更長。這是較難處理的地方。

http://www.embedded.com/electronics-blogs/break-points/4024944/The-secret-life-of-switches

3.6Test_7seg_SWInt_Bounce–計算彈跳的次數

- 軟體處理1：
- 第一次偵測到低電位，延遲20ms，再檢測一次是否為低電位?
- 若是高電位表示一個雜訊。若是低電位，表示一個有效的按鍵。
- 等待按鍵鬆開，出現高電位，延遲10ms。若是低電位，表示雜訊。

- 軟體處理2：
- 使用TIMER計時，每5ms測量一次按鍵。
- 若連續出現4次低電位，表示按鍵已經按下。
- 等待連續出現4次高電位， 表示按鍵已經鬆開。

- 軟體處理3：
- 使用TIMER計時，每5ms測量一次按鍵。
- 若連續出現2次低電位，間格2次，再出現2次高電位，表示已經完成一次按鍵。缺點是必須等按鍵鬆開(可能很久)，才能判斷出來。

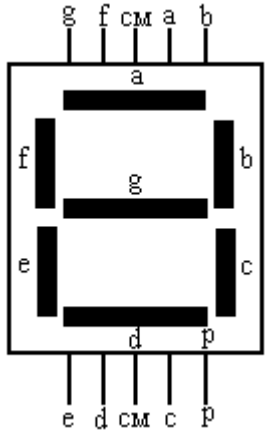
http://www.embedded.com/electronics-blogs/break-points/4024944/The-secret-life-of-switches

Test_7seg_SWInt_Bounce– Control Pins used for

GPC4~7 control which 7-segment to turn on (1 = on, 0 = off)

- GPC4 : 1st 7-segment (LSB)
- GPC5 : 2nd 7-segment
- GPC6 : 3th 7-segment
- GPC7 : 4th 7-segment (MSB)

GPE0~7 control each segment to turn on (0 = on, 1 = off)



	g	e	d	b	a	f	dp	c	
	7	6	5	4	3	2	1	0	
0	1	0	0	0	0	0	1	0	0x82
1	1	1	1	0	1	1	1	0	0xEE
2	0	0	0	0	0	1	1	1	0x07
3	0	1	0	0	0	1	1	0	0x46
4	0	1	1	0	1	0	1	0	0x6A
5	0	1	0	1	0	0	1	0	0x52

seven_segment_open

- 功能：設定7段顯示器的LED為輸出。
- 函數：void seven_segment_open(void)
- 參數：
- 範例： seven_segment_open();
- 與下列指令的作用相同
- GPIOE->PMD.PMD0 = 1;
- …
- GPIOE->PMD.PMD7 = 1;
- GPIOC->PMD.PMD4 = 1;
- …
- GPIOC->PMD.PMD7 = 1;

7-Segment LED Driver - close_seven_segment

- 功能：關閉7段顯示器。
- 函數：void close_seven_segment(void)
- 參數：
- 範例： close_seven_segment();
- 與下列指令的作用相同
- GPIOC->DOUT &= ~(0xF<<4);

7-Segment LED Driver - show_seven_segment

- 功能：將number顯示在第no個7段顯示器
- 函數： void show_seven_segment(unsigned char no, unsigned char number)
- 參數： no:第no個7段顯示器，(0-3)
- 參數：number: 顯示的數字，(0-9)
- 範例：show_seven_segment(3,digit)
- 與下列指令的作用相同
- GPIOE->DOUT &= ~(0xFF); //clear 7 seg., GPIOE bit0-7
- GPIOE->DOUT |= SEG_BUF[digit[3]];//show 7 seg.,
- GPIOC->DOUT |= (1<<(3+4)); //display 4th 7 seg.,GPIOC bit 7=1

3.6Test_7seg_SWInt_Bounce (1/x)

```
int main (void)
{
    int32_t  value;

    //: SYST_RVR=SysTick reload value, max=2^24=16M
    SysTick->LOAD = 10000 * CyclesPerUs; //: 10000us=10ms
    //: SYST_CVR=SysTick current value=0 always
    SysTick->VAL  = 0;                          //: (core_cm0.h) always be 0
    //: enable SysTick and clock source,
    SysTick->CTRL = (1<<2) | (1); //: (core_cm0.h)

     seven_segment_open(); //set GPIO pin output for 7-seg. LED
    close_seven_segment(); //clear GPIOC[7:0]

    // Initial GPIO GPB15(SW Int) to input mode
    DrvGPIO_Open(E_GPB, 15, E_IO_INPUT);
```

3.6Test_7seg_SWInt_Bounce (2/x)

```
while (1)
{
    //set SysTick 10000us=10ms
    SysTick->LOAD = 10000 * CyclesPerUs;
    // wait for key pressed
    while(DrvGPIO_GetBit(E_GPB,15)!=0) ;
    // press first time
    value=1;
    // wait for key released
    while(DrvGPIO_GetBit(E_GPB,15)==0)
```

3.6Test_7seg_SWInt_Bounce (3/x)

```
while (1)
{       //: reset SysTick time=0
        SysTick->VAL  = (0x00);
        //wait key not pressed and not time limit
        while(((GPIOB->PIN & (1<<15))!=0)  && (!(SysTick->CTRL
& (1 << 16))));
        //if time limited, the  key did not press
        if((GPIOB->PIN & (1<<15))==0)
        {           // key pressed, increase times
                    value++;
                    //wait for key release
                    while((GPIOB->PIN & (1<<15))==0);
        } else   // time limit, break
        {           break;
        }
}
```

3.6Test_7seg_SWInt_Bounce (4/x)

```
            show_seven_segment(0,value);
            DrvSYS_Delay(700000);
    //700000us=700ms=0.7sec.,nax=762600
            close_seven_segment(); //clear GPIOC bit4-7
    }
}
```

3.6Test_7seg_SWInt_Bounce (5/x)

```
void seven_segment_open(void)
{
    //Initial GPIOE [7:0] to output mode for 7-seg.
    DrvGPIO_Open(E_GPE, 0, E_IO_OUTPUT);
    DrvGPIO_Open(E_GPE, 1, E_IO_OUTPUT);
    DrvGPIO_Open(E_GPE, 2, E_IO_OUTPUT);
    DrvGPIO_Open(E_GPE, 3, E_IO_OUTPUT);
    DrvGPIO_Open(E_GPE, 4, E_IO_OUTPUT);
    DrvGPIO_Open(E_GPE, 5, E_IO_OUTPUT);
    DrvGPIO_Open(E_GPE, 6, E_IO_OUTPUT);
    DrvGPIO_Open(E_GPE, 7, E_IO_OUTPUT);
    //Initial GPIOC [7:4] to output mode for nth 7-seg.
    DrvGPIO_Open(E_GPC, 4, E_IO_OUTPUT);
    DrvGPIO_Open(E_GPC, 5, E_IO_OUTPUT);
    DrvGPIO_Open(E_GPC, 6, E_IO_OUTPUT);
    DrvGPIO_Open(E_GPC, 7, E_IO_OUTPUT);
}
```

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數據類型相關的編程風格

- 必須用typedef顯式標識出各數據類型的長度和符號特性，避免直接使用標準數據類型。
- 一個32位的整數係統，可定義如下：
- typedef char chat_t；
- typedef sigrled char int8_t；
- typedef signed short intl6_t；
- typedef signed int int32_t；
- typedef signed long int64_t；
- typedef unsitgned chat uint8_t；
- typedef unsigned short uint16_t;
- typedef unsigned int uint32_t;
- typedef unsigned 1ong uint64_t；