



## PWM (Pulse Width Modulation) 功能使用方法

### 1 適用產品：

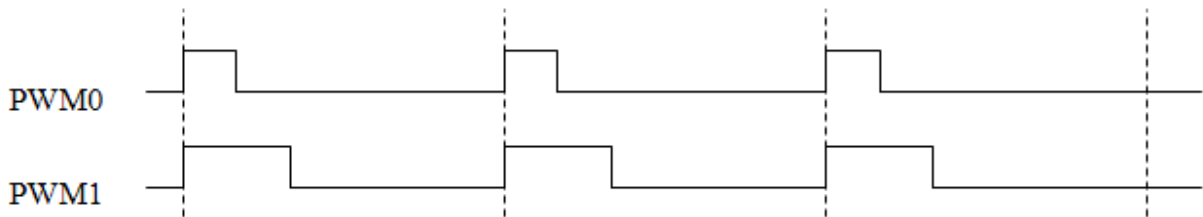
1.1 SM39R16A2/ SM39R12A2/ SM39R08A2

### 2 PWM 使用說明:

2.1 提供 2 組獨立的 PWM 信號

2.2 輸入時脈可由暫存器 PWMCS[2:0]選擇

2.3 PWM 為 10-bit 模式，但最大資料計數可由 PWMMDH 及 PWMMDL 設定為 1~1024



### 3 PWM 相關的特殊暫存器 PWM Special Function Register (SFR)

Mnemonic	Description	Direct	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	RESET
PWM											
PWMC	PWM Control register	B5h	<i>PWMCS[2:0]</i>			-	-	-	<i>PWM1EN</i>	<i>PWM0EN</i>	00H
PWMD0H	PWM 0 Data register high byte	BCh	<i>PWMP0</i>	-	-	-	-	-	<i>PWMD0[9:8]</i>		00H
PWMD0L	PWM 0 Data register low byte	BDh	<i>PWMD0[7:0]</i>								00H
PWMD1H	PWM 1 Data register high byte	BEh	<i>PWMP1</i>	-	-	-	-	-	<i>PWMD1[9:8]</i>		00H
PWMD1L	PWM 1 Data register low byte	BFh	<i>PWMD1[7:0]</i>								00H
PWMMDH	PWM Max Data register high byte	CEh	-	-	-	-	-	-	<i>PWMMD[9:8]</i>		00H
PWMMDL	PWM Max Data register low byte	CFh	<i>PWMMD[7:0]</i>								FFH

Mnemonic: PWMC

Address: B5h

7	6	5	4	3	2	1	0	Reset
<i>PWMCS[2:0]</i>			-	-	-	<i>PWM1EN</i>	<i>PWM0EN</i>	00H

PWMCS[2:0]: 時脈選擇位元(PWM clock select)

PWMCS [2:0]	Mode
000	Fosc
001	Fosc/2
010	Fosc/4

Specifications subject to change without notice, contact your sales representatives for the most recent information.



011	Fosc/6
100	Fosc/8
101	Fosc/12
110	Timer 0 overflow
111	Timer 0 external input (P3.4/T0)

PWM1EN: 通道 1 致能位元(PWM channel 1 enable control bit)

PWM1EN = 1 - PWM 通道 1 致能.

PWM1EN = 0 - PWM 通道 1 禁能.

PWM0EN: 通道 0 致能位元(PWM channel 0 enable control bit)

PWM0EN = 1 - PWM 通道 0 致能.

PWM0EN = 0 - PWM 通道 0 禁能.

**Mnemonic: PWMD0H**

**Address: BCh**

7	6	5	4	3	2	1	0	Reset
PWMP0	-	-	-	-	-	PWMD0[9:8]		00H

**Mnemonic: PWMD0L**

**Address: BDh**

7	6	5	4	3	2	1	0	Reset
PWMD0[7:0]								00h

PWMP0: 通道 0 閒置準位選擇位元(PWM channel 0 idle polarity select)

“0” –通道 0 閒置時為低準位(PWM channel 0 will idle low)

“1” –通道 0 閒置時為高準位(PWM channel 0 will idle high)

PWMD0[9:0]: 通道 0 資料暫存器(PWM channel 0 data register)

可調整 PWM 通道 0 責任週期(Duty Cycle)

**Mnemonic: PWMD1H**

**Address: BEh**

7	6	5	4	3	2	1	0	Reset
PWMP1	-	-	-	-	-	PWMD1[9:8]		00H

**Mnemonic: PWMD1L**

**Address: BFh**

7	6	5	4	3	2	1	0	Reset
PWMD1[7:0]								00H

PWMP1: 通道 1 閒置準位選擇位元(PWM channel 1 idle polarity select)

“0” –通道 1 閒置時為低準位(PWM channel 1 will idle low)

“1” –通道 1 閒置時為高準位(PWM channel 1 will idle high)

PWMD1[9:0]: 通道 1 資料暫存器(PWM channel 1 data register)

可調整 PWM 通道 1 Duty Cycle

**Mnemonic: PWMDH**

**Address: CEh**

7	6	5	4	3	2	1	0	Reset
-	-	-	-	-	-	PWMDH[9:8]		00H



Mnemonic: PWMMDL							Address: CFh	
7	6	5	4	3	2	1	0	Reset
PWMMD[7:0]								FFh

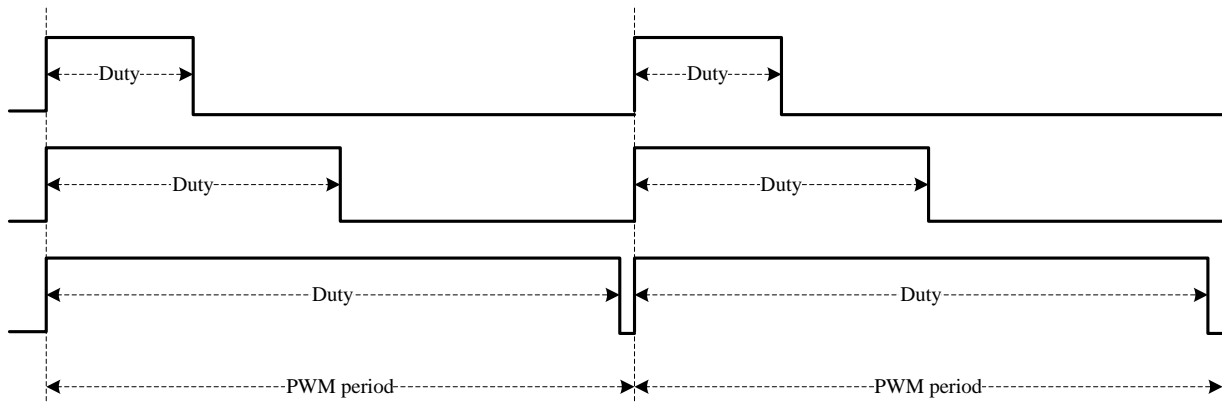
PWMMD[9:0]: 最大資料設定暫存器(PWM Max Data register)

PWM 由 0000 計數至 PWMMD[9:0]，當計數等於 PWMMD[9:0]時會產生溢位。

PWMPx = 0

Duty = PWMDx[9:0]

Period = PWMMD[9:0]



$$\text{PWM period} = \frac{\text{PWMMD} + 1}{\text{PWM clock}}$$

$$\text{Leader pulse} = \frac{\text{PWMDx}}{\text{PWM clock}}$$

## 4 PWM 中斷

### 4.1 向量表(Interrupt vectors table)

Interrupt Request Flags	Interrupt Vector Address	Interrupt Number *(use Keil C Tool)
IE0 – External interrupt 0	0003h	0
TF0 – Timer 0 interrupt	000Bh	1
IE1 – External interrupt 1	0013h	2
TF1 – Timer 1 interrupt	001Bh	3
RI0/TI0 – Serial channel 0 interrupt	0023h	4
TF2/EXF2 – Timer 2 interrupt	002Bh	5
<b>PWMIF – PWM interrupt</b>	<b>0043h</b>	<b>8</b>
SPIIF – SPI interrupt	004Bh	9



ADCIF – A/D converter interrupt	0053h	10
KBIIF – keyboard Interface interrupt	005Bh	11
LVIIIF – Low Voltage Interrupt	0063h	12
IICIF – IIC interrupt	006Bh	13
RI1/TI1 – Serial channel 1 interrupt	0083h	16

\*See Keil C about C51 User's Guide about Interrupt Function description

#### 4.2 中斷相關暫存器(Interrupt SFR)

Mnemonic	Description	Direct	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	RESET
<b>Interrupt</b>											
IEN1	Interrupt Enable 1 register	B8h	EXEN2	-	IEIIC	IELVI	IEKBI	IEADC	IESPI	<i>IEPWM</i>	00h
IRCON	Interrupt request register	C0H	EXF2	TF2	IICIF	LVIIIF	KBIIF	ADCIF	SPIIF	<i>PWMIF</i>	00H
IP0	Interrupt priority level 0	A9h	-	-	IP0.5	IP0.4	IP0.3	IP0.2	IP0.1	<i>IP0.0</i>	00h
IP1	Interrupt priority level 1	B9h	-	-	IP1.5	IP1.4	IP1.3	IP1.2	IP1.1	<i>IP1.0</i>	00h

Table: Priority levels

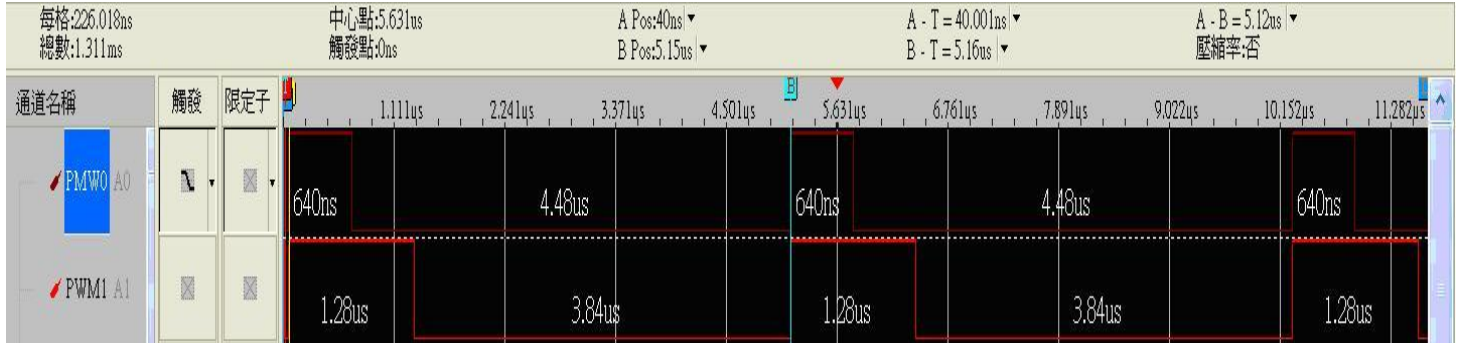
IP1.x	IP0.x	Priority Level
0	0	Level0 (lowest)
0	1	Level1
1	0	Level2
1	1	Level3 (highest)

Table: Groups of priority

Bit	Group		
IP1.0, IP0.0	External interrupt 0	-	<i>PWM interrupt</i>
IP1.1, IP0.1	Timer 0 interrupt	-	SPI interrupt
IP1.2, IP0.2	External interrupt 1	Comparator interrupt	ADC interrupt
IP1.3, IP0.3	Timer 1 interrupt	-	KBI interrupt
IP1.4, IP0.4	Serial channel 0 interrupt	-	LVI interrupt
IP1.5, IP0.5	Timer 2 interrupt	-	IIC interrupt



4.3 PWM C 語言程式範例，各通道產生的時序圖，Fosc=25MHz：



5 PWM 中斷應用範例程式

Description	<ol style="list-style-type: none"> <li>PWM 通道 0/1 全部致能，Ch.0 閒置高準位輸出 Ch.1 閒置低準位輸出</li> <li>Period: 1024 階(10bit) Duty cycle: Ch.0 512 階 / Ch.1 256 階</li> </ol>
C 語言	<pre> //===== //                SYNCMOS TECHNOLOGY //===== #include "SM39R16A2.h" #include "PWM.h"  #define PWM_VECTOR 8 //PWM Interrupt Vevtor #define d_PWMCS 0x00 //PWMCS[2:0] (PWM clock select 0~7) #define d_PWMXEN 0x03 //PWM Channel Enable (0~F) #define d_PWMP0 0x01 //PWM0 Channel idle polarity select #define d_PWMP1 0x00 //PWM1 Channel idle polarity select #define d_PWMIE 0x01 //PWM Interrupt Enable bit unsigned int PWMMD = 0x03FF; //PWMMD[9:0]=Period (PWM Max Data Register 0~1023) unsigned int PWMD0 = 0x01FF; //PWMD0[9:0]=Duty (PWM Channel 0 Data Register 0~1023) unsigned int PWMD1 = 0xFF; //PWMD1[9:0]=Duty (PWM Channel 1 Data Register 0~1023) //-----// void PWM_initialize(void) //Initialize PWM {     EA = 0; //Disable All Interrupt Function     IEPWM = (d_PWMIE); //Enable PWM Interrupt Function     PWMMDH = PWMMD &gt;&gt; 8;     PWMMDL = PWMMD;     EA=1; //Enable All Interrupt     </pre>



```

}
//-----//
void PWM_Output(unsigned int PWMD0,unsigned int PWMD1) //PWM Output Set
{
    PWMD0H = (PWMD0>>8) | (d_PWMP0<<7);
    PWMD0L = (PWMD0);
    PWMD1H = (PWMD1>>8) | (d_PWMP1<<7);
    PWMD1L = (PWMD1);
    PWMC = PWMC|(d_PWMCS<<5)|(d_PWMXEN);
}
//-----//
void PWM_Disable(void)
{
    IEPWM = 0;    //Disable PWM Interrupt
    PWMC = 0;    //Disable PWM Function
}
//-----//
void PWM_ISR(void) interrupt PWM_VECTOR //PWM Interrupt Subroutine
{
    while(PWMIF)
    {
        PWMIF = 0; //Clear PWM Flag
    }
}
//-----//
void main(void) //Main Function Start
{
    PWM_initialize();    //Call PWM Initial Subroutine
    PWM_Output(PWMD0, PWMD1);
    while(1)
    {
        ;
    }
    //PWM_Disable();
}

```

**Description**

3. PWM 通道 0/1 全部致能，Ch.0 閉置高準位輸出 Ch.1 閉置高準位輸出 不進 PWM 中斷
4. Period: 1024 階(10bit) Duty cycle: Ch.0 256 階 / Ch.1 512 階



匯編	<pre> //===== //          SYNCMOS  TECHNOLOGY //=====  #include " SM39R16A2.h "  #define d_Fosc          0x00 #define d_Fosc_div2    0x20 #define d_Fosc_div4    0x40 #define d_Fosc_div6    0x60 #define d_Fosc_div8    0x80 #define d_Fosc_div12   0xA0 #define d_T0_overflow  0xC0 #define d_T0_EX        0xE0 #define d_PWMCS        d_Fosc_div12    //PWMCS[2:0] (PWM clock select 0~7) #define d_PWMXEN        0x03           //PWM0~1 Channel Enable (0~3) #define d_IDLE_HI      0x80 #define d_IDLE_LO      0x00 #define d_PWMP0        d_IDLE_HI      //PWM0 Channel idle polarity select #define d_PWMP1        d_IDLE_HI      //PWM1 Channel idle polarity select #define d_PWMIE        0x00           //PWM Interrupt Enable bit      org    0000h        //Start     call   PWM_initialize  Start:     jmp    Start PWM_initialize:     mov    PWMMDH, #000           //set pwm max period     mov    PWMDL, #100     mov    PWMD0H, #d_PWMP0      //set idle polarity     orl    PWMD0H, #0           //set pwm0 duty cycle     mov    PWMD0L, #10     mov    PWMD1H, #d_PWMP1      //set idle polarity     orl    PWMD1H, #0           //set pwm1 duty cycle     mov    PWMD1L, #20     mov    PWMC, #d_PWMCS        //PWM CLK select     orl    PWMC, #d_PWMXEN      //PWM channel enable     ret  PWM_Disable:     //mov    IEPWM, #0           //Disable PWM Interrupt     mov    PWMC, #0             //Disable PWM Function     ret  end </pre>
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新茂國際科技希望能為客戶減少開發的時間及辛勞，故提供“Codzard 範例程式產生器”  
可於 新茂網站首頁>下載專區> 軟體下載 內下載此軟體，如有任何建議，請來信告知，謝謝!  
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