

致尊敬的顾客

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## M16C/64 群

### 定时器 A 操作（脉宽调制模式、8 位 PWM）

#### 1. 要点

在 PWM 模式中，可以选择如表 1 中所列的各种功能。在表 1 中用符号“○”表示本篇资料所选的项目，图 1 是定时器的工作时序图。本篇资料的参考例程是定时器 A1 选择 PWM 模式的例子。

#### 2. 说明

本篇资料，适用于 M16C/64 群单片机。

本篇资料中的参考例程也适用于 M16C 族产品中与 M16C/64 群具有相同 SFR（特殊功能寄存器）定义的产品。

由于 M16C 系列产品中有些功能会有所改进，请参看用户手册。如果使用本篇资料中所列功能时，请仔细检查每一步操作。

### 3. 选定功能

表 1. 选定功能

| 设定项目   | 设定内容                  |                                                              |
|--------|-----------------------|--------------------------------------------------------------|
| 计数源    | <input type="radio"/> | 内部时钟源（f1TIMAB/f2TIMAB/f8TIMAB/f32TIMAB/f64TIMAB/fOCO-S/fc32） |
| PWM 模式 |                       | 16 位 PWM                                                     |
|        | <input type="radio"/> | 8 位 PWM                                                      |
| 计数开始条件 | <input type="radio"/> | 外部触发输入（TAiIN 引脚输入信号的下降沿）                                     |
|        |                       | 外部触发输入（TAiIN 引脚输入信号的上升沿）                                     |
|        |                       | 计数器溢出（TB2/TAj/TAk 溢出）                                        |
| 输出极性控制 | <input type="radio"/> | 输出波形“高”电平有效                                                  |
|        |                       | 输出波形“低”电平有效（输出反转）                                            |

注: j = i - 1, 在 i = 0 时 j = 4      k = i + 1, 在 i = 4 时 k = 0

### 4. 定时器 A 的操作

(1) 当 TAiIN 引脚输出电平由“高”变为“低”，并且把计数开始标志位置为“1”时，计数器开始对计数脉冲源的下降沿计数。同时，TAiOUT 引脚输出“高”电平。

(2) 计数经过预设的周期长度之后，TAiOUT 引脚输出电平从“高”变为“低”。同时，定时器 Ai 中断请求位置为“1”。

(3) 每次在 PWM 输出一个周期之后，重加载寄存器的设定值被加载到计数器，计数器继续进行计数。

(4) 把计数开始标志位置为“0”，计数器停止计数，并且保持当前值。同时，TAiOUT 输出“低”电平。

注意：

PWM 周期为  $(m + 1) \times (2^8 - 1) / f_i$ ，高电平宽度为  $n \times (m + 1) / f_i$ 。如果定时器 Ai 寄存器的高 8 位值被设定为“00h”，PWM 功能不会工作，并且 TAiOUT 引脚输出电平为“L”，因此定时器 Ai 中断请求也不会产生。

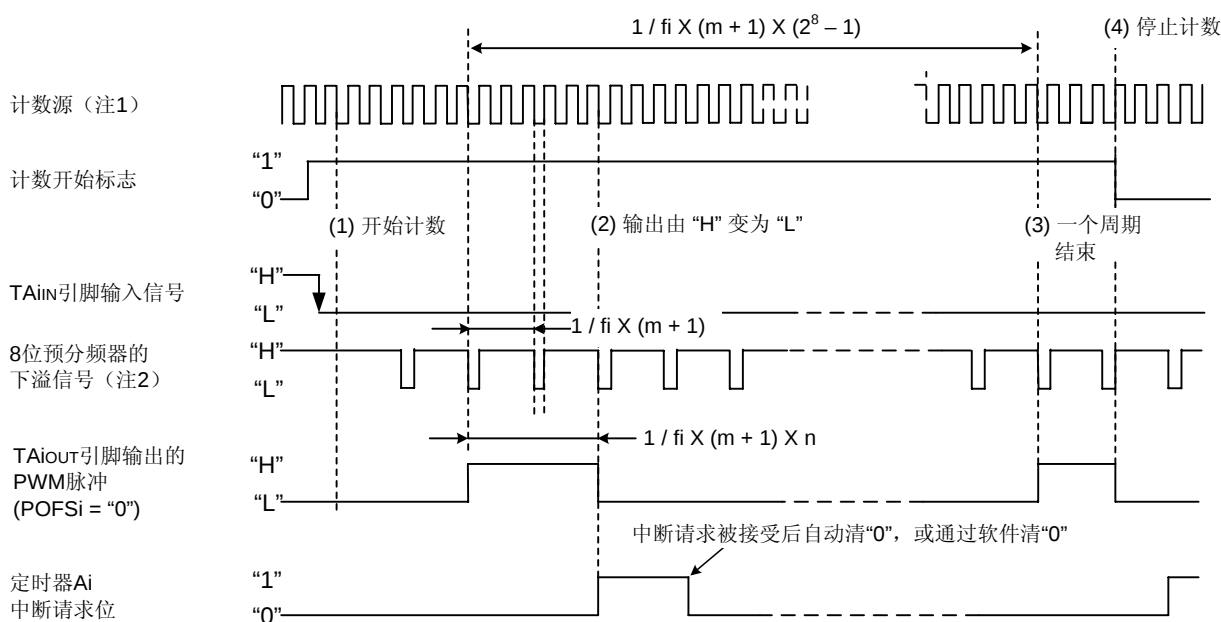
（fi: 计数源频率 f1TIMAB/f2TIMAB/f8TIMAB/f32TIMAB/f64TIMAB/fOCO-S/fc32

m: 定时器 Ai 寄存器的低 8 位值    n: 定时器 Ai 寄存器的高 8 位值）

触发发生后，TAiOUT 引脚输出一段与所设的 PWM 高电平宽度相同的低电平，然后开始 PWM 输出。

选择 PWM 模式的定时器工作时序图如下所示：

条件：重加载寄存器高8位值为02h，重加载寄存器低8位值为02h  
选择外部触发（TAiin引脚输入信号的下降沿）



注1：8位预分频器对计数源进行计数  
注2：8位PWM对8位预分频器的下溢信号进行计数  
注3：m = 00h~FFh；n = 00h~FEh

图 1. 选择 PWM 模式定时器的工作时序图

## 5. 寄存器设置

在定时器模式中，定时器 A 可以选择如表 2 中所列的各种计数源，定时器 A 计数源的结构框图如图 2 所示。

表 2. 定时器 A 计数源的选择

| TACSi 寄存器（注 1） |               |               |               | TAiMR 寄存器 |      | 计数源                      | 计数源周期                             |
|----------------|---------------|---------------|---------------|-----------|------|--------------------------|-----------------------------------|
| TCS3/<br>TCS7  | TCS2/<br>TCS6 | TCS1/<br>TCS5 | TCS0/<br>TCS4 | TCK1      | TCK0 |                          | f(PLL):24MHz<br>f(XCIN):32.768kHz |
| 0              | -             | -             | -             | 0         | 0    | f1TIMAB/f2TIMAB<br>（注 2） | 41.7ns/83.3ns                     |
| 0              | -             | -             | -             | 0         | 1    | f8TIMAB                  | 333.3ns                           |
| 0              | -             | -             | -             | 1         | 0    | f32TIMAB                 | 1333.3ns                          |
| 0              | -             | -             | -             | 1         | 1    | fc32                     | 976.56ns                          |
| 1              | 0             | 0             | 0             | -         | -    | f1TIMAB/f2TIMAB<br>（注 2） | 41.7ns/83.3ns                     |
| 1              | 0             | 0             | 1             | -         | -    | f8TIMAB                  | 333.3ns                           |
| 1              | 0             | 1             | 0             | -         | -    | f32TIMAB                 | 1333.3ns                          |
| 1              | 0             | 1             | 1             | -         | -    | f64TIMAB                 | 2666.7ns                          |
| 1              | 1             | 0             | 1             | -         | -    | foco-s                   | 约 8μs                             |
| 1              | 1             | 1             | 0             | -         | -    | fc32                     | 976.56μs                          |

注 1: TACS0 寄存器的 TCS3~TCS0 位和定时器 A0 计数源的选择相对应, TACS0 寄存器的 TCS7~TCS4 位和定时器 A1 计数源的选择相对应, TACS1 寄存器的 TCS3~TCS0 位和定时器 A2 计数源的选择相对应, TACS1 寄存器的 TCS7~TCS4 位和定时器 A3 计数源的选择相对应, TACS2 寄存器的 TCS3~TCS0 位和定时器 A4 计数源的选择相对应。

注 2 如果 PCLKR 寄存器中的 PCLK0 位为“0”选择 f2TIMAB 作为计数源, PCLK0 位为“1”选择 f1TIMAB 作为计数源（复位设定值）。

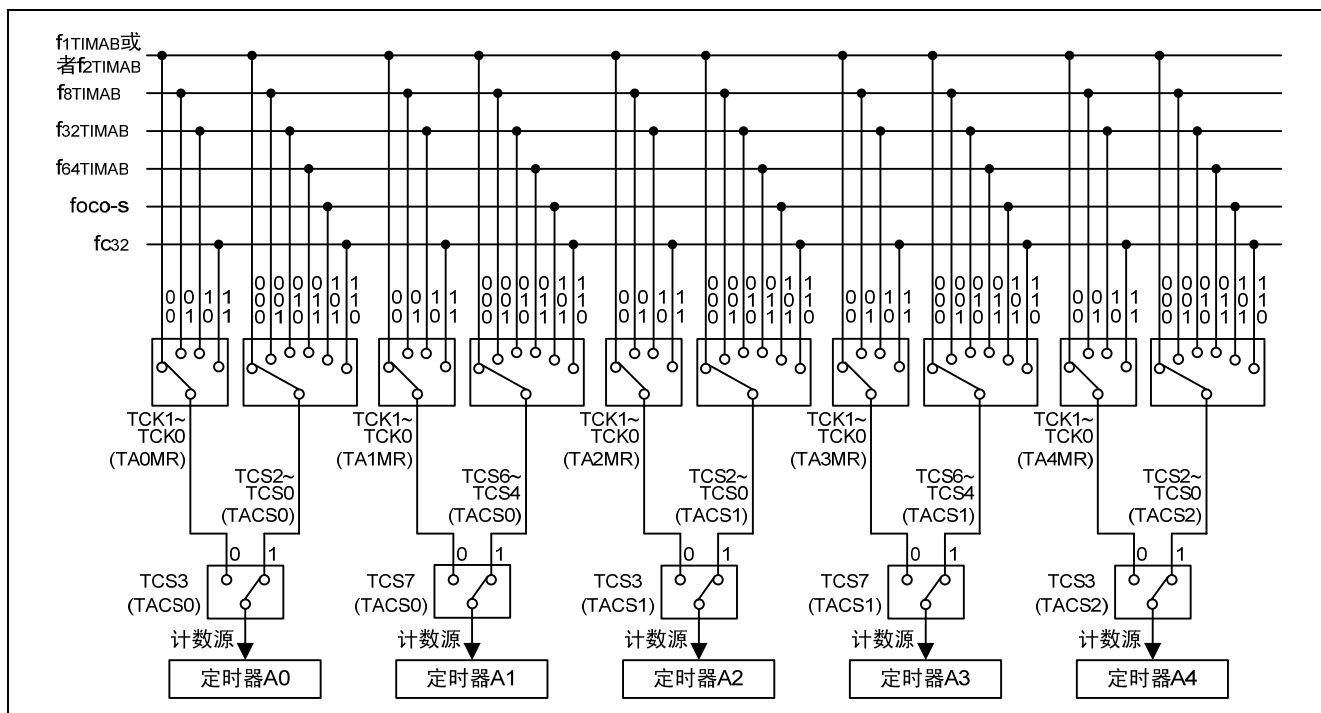
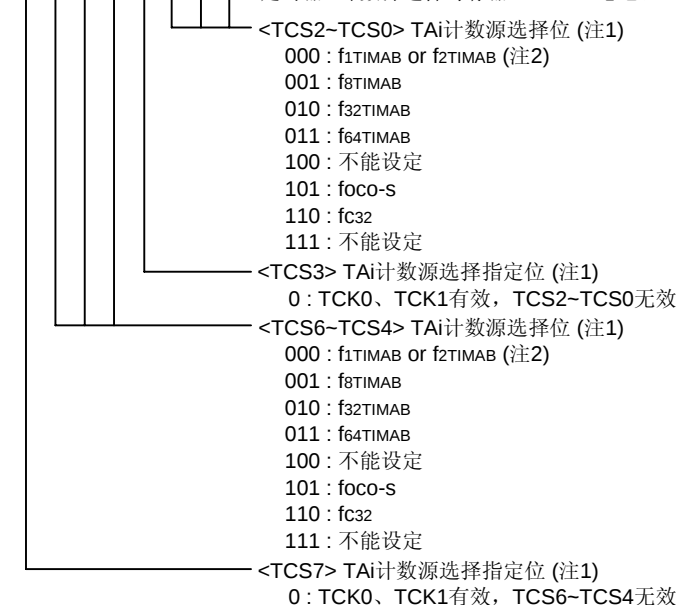


图 2. 定时器 A 的计数源

为了能够实现定义在“4. 定时器 A 的操作”的功能，下列寄存器必须按步骤顺序进行设置。对于每个寄存器的具体结构，请参考 M16C/64 群的硬件手册。

### (1) 选择定时器计数源

定时器A计数源选择寄存器0 TACS0【地址 01D0h】  
定时器A计数源选择寄存器1 TACS1【地址 01D1h】

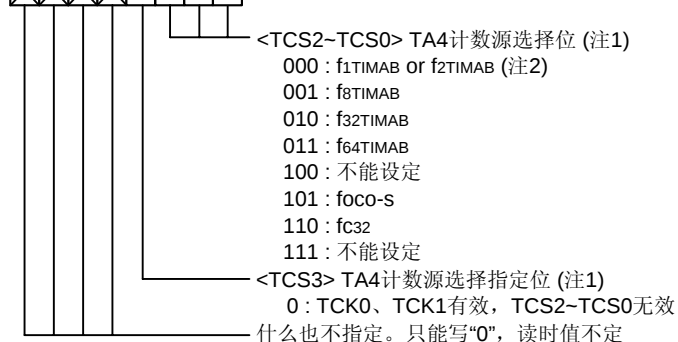


TACS0寄存器: i = 0、j = 1, TACS1寄存器: i = 2、j = 3

注1: 关于各种设定情况下的计数源周期，请参考表2。

注2: 如果PCLKR寄存器中的PCLK0位为0选择f2TIMAB作为计数源，PCLK0位为1选择f1TIMAB作为计数源（复位设定值）。

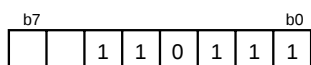
定时器A计数源选择寄存器2 TACS2【地址 01D2h】



注1: 关于各种设定情况下的计数源周期，请参考表2。

注2: 如果PCLKR寄存器中的PCLK0位为0选择f2TIMAB作为计数源，PCLK0位为1选择f1TIMAB作为计数源（复位设定值）。

### (2) 选择PWM模式和功能



定时器A0模式寄存器 TA0MR 【地址 0336h】  
 定时器A1模式寄存器 TA1MR 【地址 0337h】  
 定时器A2模式寄存器 TA2MR 【地址 0338h】  
 定时器A3模式寄存器 TA3MR 【地址 0339h】  
 定时器A4模式寄存器 TA4MR 【地址 033Ah】

选择PWM工作模式

1 (在PWM模式下，必须设定为“1”)

外部触发选择位

0: 通过TAiIN引脚输入信号的下降沿触发（注1）

触发选择位

1: 通过事件/触发选择寄存器选择

16/8位 PWM 模式选择位

1: 8位PWM

计数源选择位（注2）

b7 b6

00 : f1TIMAB OR f2TIMAB（注3）

01 : f8TIMAB

10 : f32TIMAB

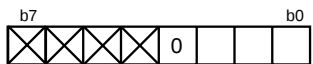
11 : fC32

注1: 当ONSF寄存器或TRGSR寄存器中，相应的TAiTGH位和TAiTGL位为0（TAiIN引脚为输入）时有效。请将TAiIN引脚对应的端口方向寄存器设定为“0”（输入模式）。

注2: TACS0~TACS2寄存器的TCS3位和TCS7位设置为0（TCK0位、TCK1位有效）。关于各种设定情况下的计数源周期，请参考表2。

注3: 如果PCLKR寄存器中的PCLK0位为0选择f2TIMAB作为计数源，PCLK0位为1选择f1TIMAB作为计数源（复位设定值）。

### (3) 清除定时器Ai中断请求位 请参考“定时器A（PWM模式）使用注意事项”



定时器A0中断控制寄存器 TA0IC 【地址 0055h】

定时器A1中断控制寄存器 TA1IC 【地址 0056h】

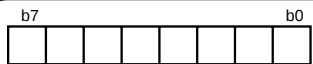
定时器A2中断控制寄存器 TA2IC 【地址 0057h】

定时器A3中断控制寄存器 TA3IC 【地址 0058h】

定时器A4中断控制寄存器 TA4IC 【地址 0059h】

中断请求位

### (4) 设定事件/触发选择位



单次触发启动标志ONSF 【地址0322h】

定时器A0 事件/触发选择位

b7 b6

0 0 : 选择 TA0IN引脚的输入 (注1)

触发选择寄存器TRGSR 【Address 0323h】

定时器A1事件/触发选择位

b1 b0

0 0 : 选择TA1IN引脚的输入(注1)

定时器A2事件/触发选择位

b3 b2

0 0 : 选择TA2IN引脚的输入(注1)

定时器 A3事件/触发选择位

b5 b4

0 0 : 选择TA3IN引脚的输入(注1)

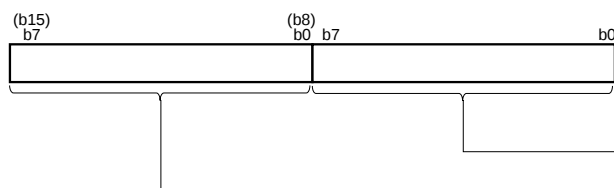
定时器 A4事件/触发选择位

b7 b6

0 0 : 选择TA4IN引脚的输入(注1)

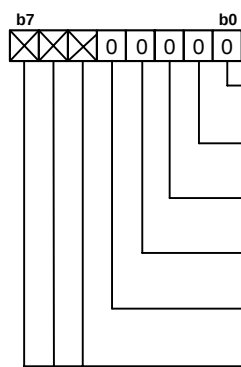
注1: 请将TA0IN~TA4IN引脚对应的端口方向寄存器设定为“0”（输入模式）。

(5) 设定PWM脉冲周期和高电平宽度



定时器A0寄存器 TA0【地址 0327h~0326h】  
 定时器A1寄存器 TA1【地址 0329h~0328h】  
 定时器A2寄存器 TA2【地址 032Bh~032Ah】  
 定时器A3寄存器 TA3【地址 032Dh~032Ch】  
 定时器A4寄存器 TA4【地址 032Fh~032Eh】  
 设定范围为00h到FFh: m  
 设定范围为00h到FEh: n

(6) 选择定时器波形输出功能



定时器A波形输出功能选择寄存器 TAPOFS【地址 01D5h】

<POFS0> TA0out输出极性控制位  
 0: 输出波形“高”电平有效  
 <POFS1> TA1out输出极性控制位  
 0: 输出波形“高”电平有效  
 <POFS2> TA2out输出极性控制位  
 0: 输出波形“高”电平有效  
 <POFS3> TA3out输出极性控制位  
 0: 输出波形“高”电平有效  
 <POFS4> TA4out输出极性控制位  
 0: 输出波形“高”电平有效  
 什么也不指定。只能写“0”，读时值不定

(7) 设置时钟预分频器复位标志位

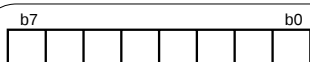
这一功能只在选择fc32作为计数源时有效，复位预分频器的目的是为了产生XCIN时钟的32分频即fc32。



时钟预分频器复位标志 CPSRF【地址 0015h】

时钟预分频器复位标志  
 0: 没有影响  
 1: 复位预分频器（读时值为“0”）

(8) 设置定时器计数开始标志位



计数开始标志 TABSR【地址 0320h】

定时器A0计数开始标志  
 定时器A1计数开始标志  
 定时器A2计数开始标志  
 定时器A3计数开始标志  
 定时器A4计数开始标志

开始计数

## 6. 参考文献

数据手册

M16C/64 群硬件手册

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