

致尊敬的顾客

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M16C/65 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/65 群单片机。

本篇应用说明也适用于 M16C 族中与上面所述的群具有相同 SFR（特殊功能寄存器）定义的产品。关于产品功能的改进，请参看手册中的相关信息。在使用本篇应用说明的程序前，需进行详细的评价。

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-F/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：

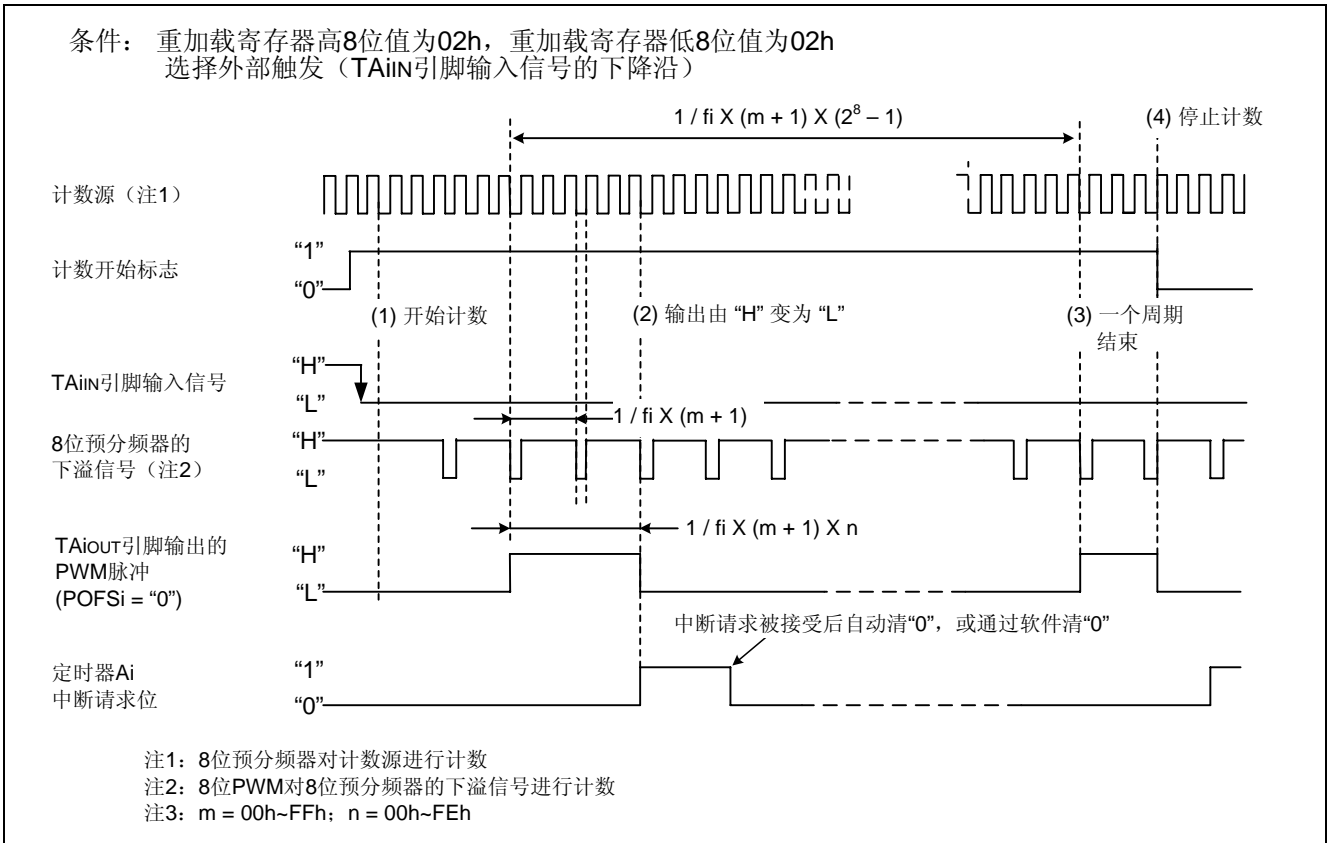


图 1. 选择 PWM 模式定时器的工作时序图

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

TCKDIVC0 寄存器 (注 1)	TACSi 寄存器 (注 2)				TAiMR 寄存器		计数源	计数源周期
	TCS3/ TCS7	TCS2/ TCS6	TCS1/ TCS5	TCS0/ TCS4	TCK1	TCK0		
TCDIV00								f(XiN):20MHz f(XciN):32.768kHz f(oco-F):约 20MHz f(oco-s):约 125kHz
0	0	-	-	-	0	0	f1TIMAB/f2TIMAB (注 3)	50ns/100ns
0	0	-	-	-	0	1	f8TIMAB	400ns
0	0	-	-	-	1	0	f32TIMAB	1600ns
0	0	-	-	-	1	1	fc32	976.56μs
0	1	0	0	0	-	-	f1TIMAB/f2TIMAB (注 3)	50ns/100ns
0	1	0	0	1	-	-	f8TIMAB	400ns
0	1	0	1	0	-	-	f32TIMAB	1600ns
0	1	0	1	1	-	-	f64TIMAB	3200ns
0	1	1	0	0	-	-	foco-F	约 50ns
0	1	1	0	1	-	-	foco-s	约 8μs
0	1	1	1	0	-	-	fc32	976.56μs
1	1	0	0	0	-	-	f1TIMAB/f2TIMAB (注 3)	约 50ns/100ns
1	1	0	0	1	-	-	f8TIMAB	约 400ns
1	1	0	1	0	-	-	f32TIMAB	约 1600ns
1	1	0	1	1	-	-	f64TIMAB	约 3200ns

注 1: TCDIV00 位是定时器 AB 分频前时钟选择位。请在设定和定时器 A 相关的其它寄存器之前设定 TCDIV00 位。在改变 TCDIV00 位后，请再次设定和定时器 A 相关的其它寄存器。

注 2: 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 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）。

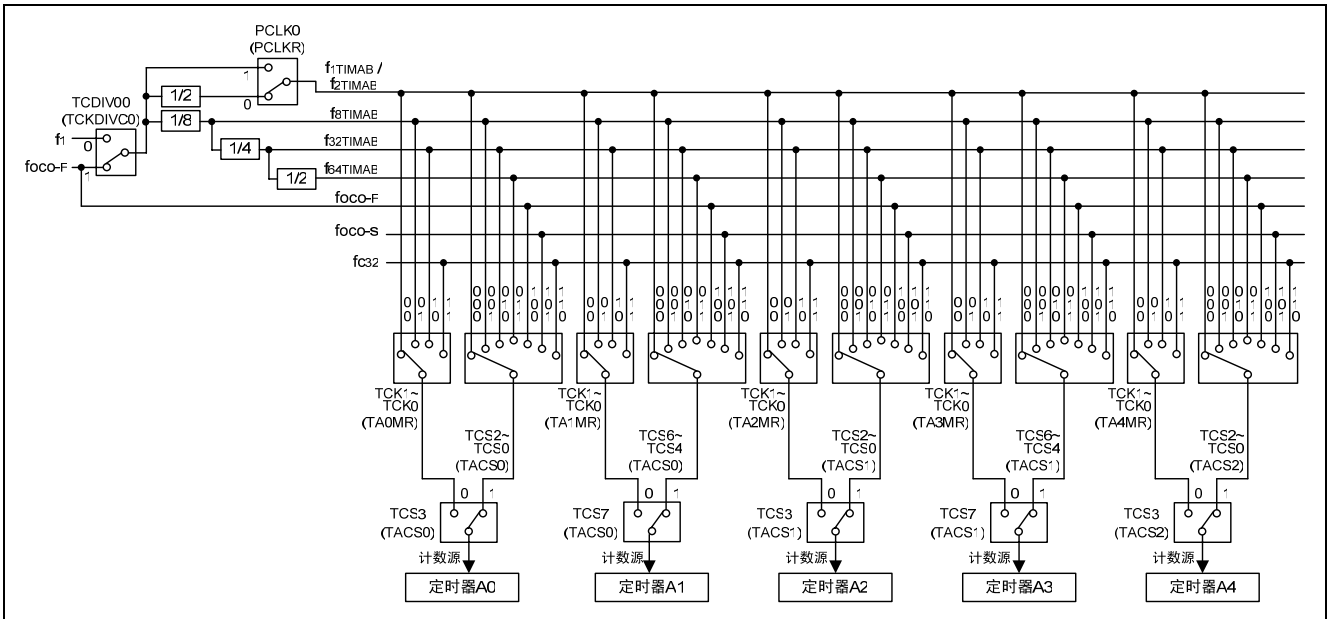


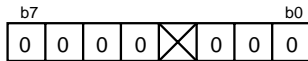
图 2. 定时器 A 的计数源

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/65 群的硬件手册。

(1) 选择定时器计数源

选择定时器 AB 分频前时钟

(请在设定和定时器 A 相关的其它寄存器之前设定 TCDIV00 位。在改变 TCDIV00 位后，请再次设定和定时器 A 相关的其它寄存器。)



定时器 AB 分频控制寄存器 0 TCKDIVC0 【地址 01CBh】

定时器 AB 分频前时钟选择位

0 : f1

保留位

设定为“0”

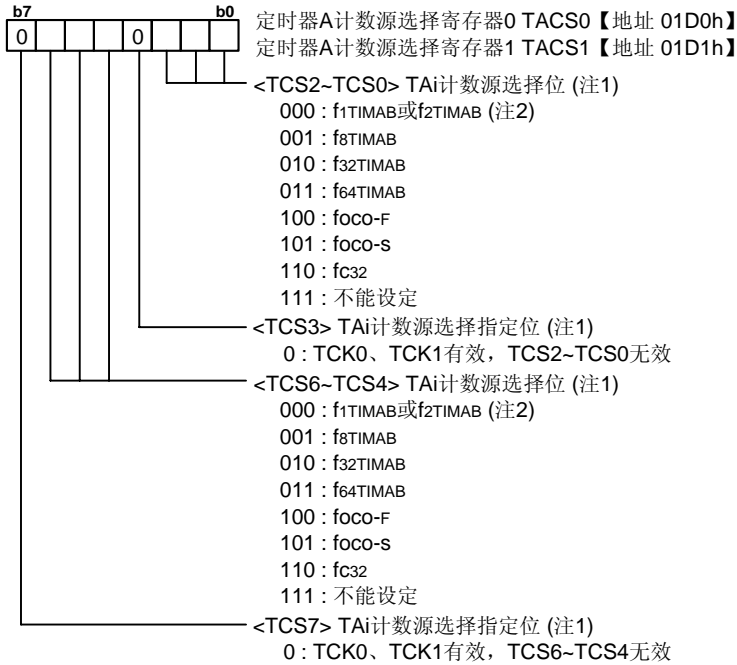
什么也不指定。只能写“0”，读时值不定

保留位

设定为“0”

⋮

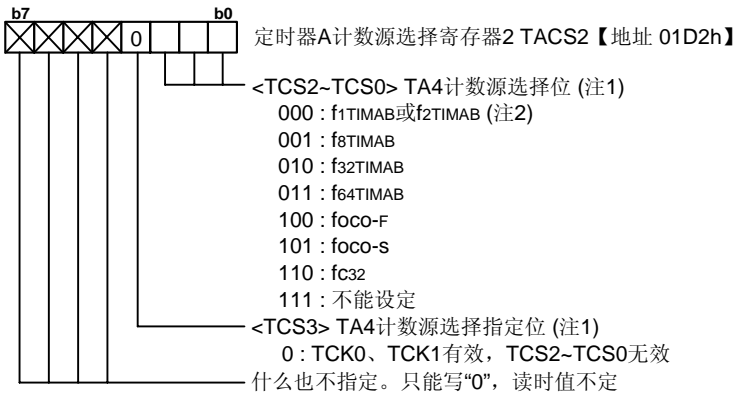
选择定时器计数源



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。

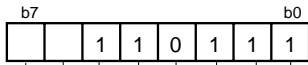
注2: 如果PCLKR寄存器中的PCLK0位为0选择f2TIMAB作为计数源, PCLK0位为1选择f1TIMAB作为计数源(复位设定值)。



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】

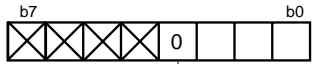
- 选择PWM工作模式
- 1 (在PWM模式下, 请置为“1”)
- 外部触发选择位
- 0: 通过TAiIn引脚输入信号的下降沿触发 (注1)
- 触发选择位
- 1: 通过事件/触发选择寄存器选择
- 16/8位 PWM 模式选择位
- 1: 8位PWM
- 计数源选择位 (注2)
- b7 b6
- 00: f1TIMAB或f2TIMAB (注3)
- 01: f8TIMAB
- 10: f32TIMAB
- 11: fc32

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)。

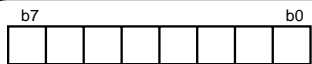
(3) 清除定时器Ai中断请求位 请参考“定时器A (PWM模式) 使用注意事项”



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】

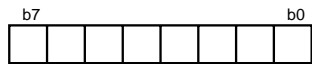
中断请求位

(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
 00: 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
 00: 选择TA1In引脚的输入(注1)

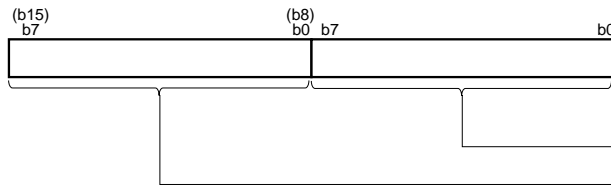
定时器A2事件/触发选择位
 b3 b2
 00: 选择TA2In引脚的输入(注1)

定时器 A3事件/触发选择位
 b5 b4
 00: 选择TA3In引脚的输入(注1)

定时器 A4事件/触发选择位
 b7 b6
 00: 选择TA4In引脚的输入(注1)

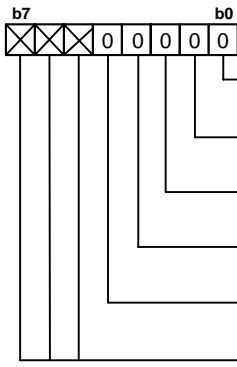
注1: 请将TA0In~TA4In引脚对应的端口方向寄存器设定为“0” (输入模式)。

(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

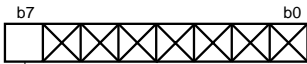
(6) 选择定时器波形输出功能



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

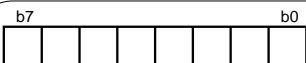
这一功能只在选择fc32作为计数源时有效，复位预分频器的目的是为了产生XCIN时钟的32分频即fc32。



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/65 群硬件手册

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