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M16C/Tiny 系列

定时器 A 操作（事件计数模式中的二相脉冲信号处理、4 倍频方式）

1. 要点

在定时器事件计数模式中处理二相脉冲信号中，可以选择如表 1 中所列的各种功能。在表 1 中用符号“〇”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 A4 选择事件计数模式中的二相脉冲信号处理、4 倍频方式的例子。

2. 说明

本篇资料，适用于 M16C/26A、M16C/28、M16C/29 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/26A、M16C/28、M16C/29 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	
计数操作类型		重加载方式
	○	自由运行方式
二相脉冲信号处理（注 1）		正常处理方式
	○	4 倍频处理方式

注 1：只有定时器 A3 能选择二相脉冲信号的处理方式。定时器 A2 只能使用正常处理方式，而定时器 A4 只能使用 4 倍频处理方式。

4. 定时器 A 的操作

(1) 把计数开始标志位置为“1”，计数器对计数脉冲源的有效沿计数。

(2) 即使在发生下溢时，也不重新加载重加载寄存器的设定值，而是继续进行计数。同时，定时器 Ai 中断请求位置为“1”。

(3) 即使在发生上溢时，也不重新加载重加载寄存器的设定值，而是继续进行计数。同时，定时器 Ai 中断请求位置为“1”。

注意事项：

递增/递减计数的条件和有效沿如下表所示。

表 2. 递增/递减计数的条件和有效沿

	TAiOUT 引脚的输入信号	TAiIN 引脚的输入信号
递增计数	“H”电平	上升沿
	“L”电平	下降沿
	上升沿	“L”电平
	下降沿	“H”电平
递减计数	“H”电平	下降沿
	“L”电平	上升沿
	上升沿	“H”电平
	下降沿	“L”电平

选择事件计数模式中的二相脉冲信号处理、4 倍频方式的定时器工作时序图如下所示：

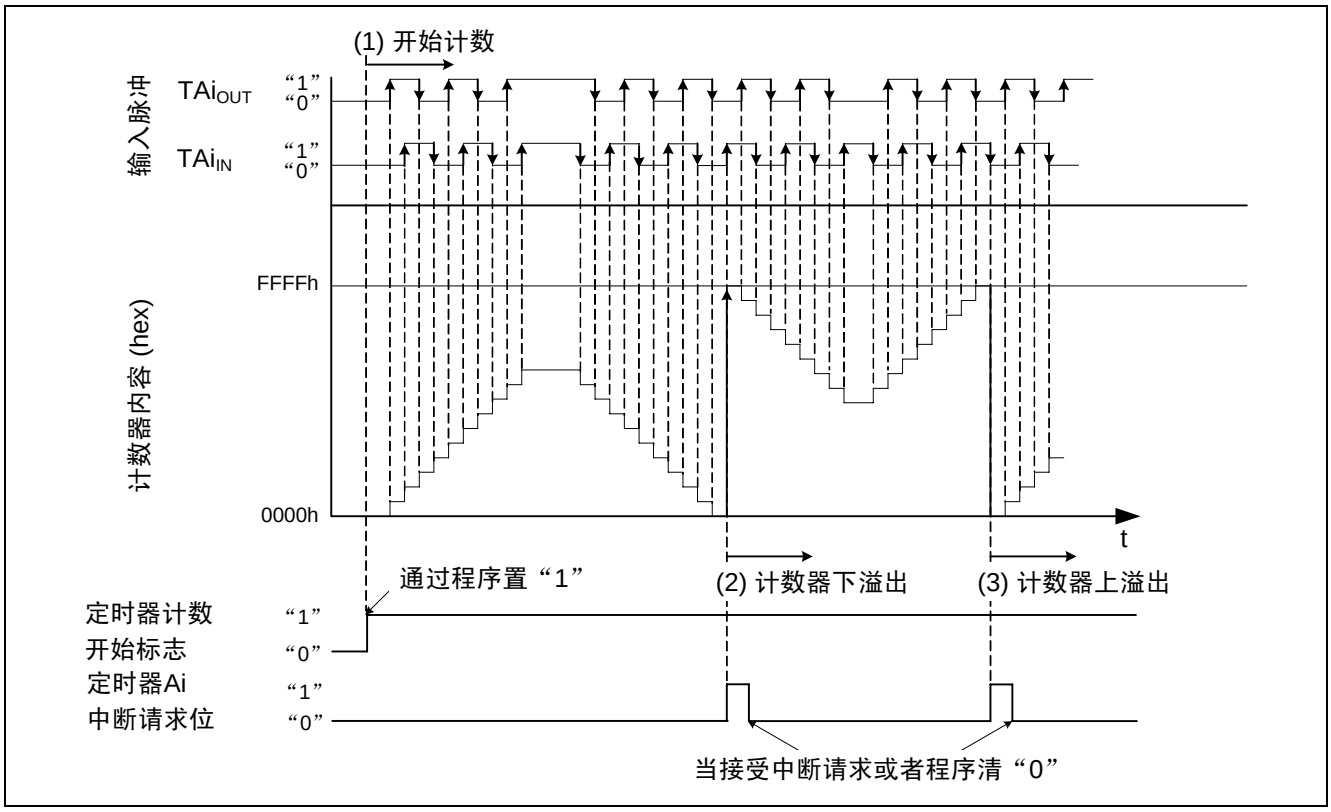


图 1. 选择事件计数模式中的二相脉冲信号处理、4 倍频方式的定时器工作时序图

5. 寄存器设置

为了能实现定义在"4. 定时器 A 的操作"的功能，下列寄存器必须按步骤进行设置。对于每个寄存器的具体结构请参考 M16C/26A 群、M16C/28 群、M16C/29 群的硬件手册。

选择事件计数模式中的二相脉冲信号处理、4 倍频方式定时器的寄存器设定如下所示：

(1) 设置定时器Ai模式寄存器

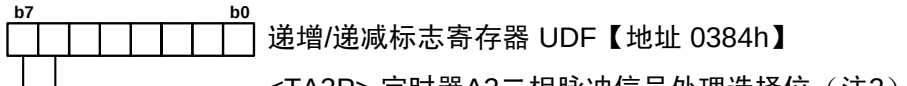
b7							b0
1	1	0	1	0	0	0	1

定时器Ai模式寄存器 TA3MR, TA4MR【地址 0399h, 039Ah】

<TMOD1, TMOD0> 工作模式选择位
01：事件计数工作模式
<MR0> 在使用二相脉冲信号处理功能时，必须置为"0"。
<MR1> 在使用二相脉冲信号处理功能时，必须置为"0"。
<MR2> 在使用二相脉冲信号处理功能时，必须置为"1"。
<MR3> 在使用二相脉冲信号处理功能时，必须置为"0"。
<TCK0> 计数操作类型选择位
1：自由运行方式
<TCK1> 二相脉冲信号处理操作选择位（注1）
1：4倍频处理操作

注1：
TCK1位对于定时器A3模式寄存器有效；对于定时器A4模式寄存器，TCK1位可以设置为"0"或"1"。

(2) 设置二相脉冲信号处理选择位



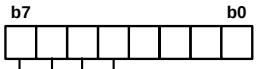
递增/递减标志寄存器 UDF【地址 0384h】

<TA3P> 定时器A3二相脉冲信号处理选择位（注2）
1：允许二相脉冲信号处理

<TA4P> 定时器A4二相脉冲信号处理选择位（注2）
1：允许二相脉冲信号处理

注2：
将TAi_{IN}、TAi_{OUT}相应的端口方向位清“0”（输入模式）。

(3) 设置触发选择寄存器



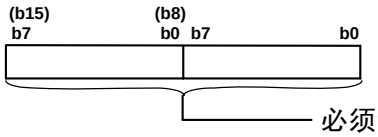
触发选择寄存器 TRGSR【地址 0383号】

<TA3TGH, TA3TGL> 定时器A3事件/触发选择位
00：选择$TA3_{IN}$作为输入（注3）

<TA4TGH, TA4TGL> 定时器A4事件/触发选择位
00：选择$TA4_{IN}$作为输入（注3）

注3：
将相应的端口方向位清“0”（TAi_{IN}引脚输入）。

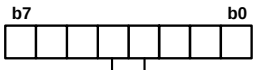
(4) 设置定时器Ai寄存器



定时器A3寄存器 TA3【地址 038Dh, 038Ch】
定时器A4寄存器 TA4【地址 038Fh, 038Eh】

必须设定为0000h～FFFFh

(5) 设置定时器计数开始标志位



计数开始标志 TABSR【地址 0380h】

<TA3S> 定时器A3计数开始标志
1：开始计数

<TA4S> 定时器A4计数开始标志
1：开始计数

6. 参考例程

```
/*****************************************************************/
/*                                                               */
/* M16C/Tiny Series Program Collection                           */
/*                                                               */
/* File name   : rec05b0009-0101_src.c                           */
/* CPU         : M16C/Tiny series                                */
/* Function    : Operation of Timer A                            */
/*             (2-phase pulse signal process in event            */
/*             counter mode, multiply-by-4 mode)                 */
/* Version     : 2006.04.13 Ver 1.01                             */
/*                                                               */
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/*                                                               */
/*****************************************************************/

/*****************************************************************/
/*    Include File                                               */
/*****************************************************************/
#include "sfr29.h"          // Special function register header file

/*****************************************************************/
/*    Definition Interrupt                                       */
/*****************************************************************/
#pragma interrupt ta4_int

/*****************************************************************/
/*    Function Declaration                                       */
/*****************************************************************/
void mcu_init(void);        // MCU initialize routine
void timerA4_init(void);    // Timer A4 initialize routine
void wait_10ms(void);       // Main clock oscillation stable wait routine

/*****************************************************************/
/*    Define Label                                               */
/*****************************************************************/
#define PRODUCT_TYPE 0   // 28,29 group: 0   26A group: 1
#define PIN_TYPE 0       // 80 pin: 0       64 pin: 1 (28,29 group)
                         // 48 pin: 0       42 pin: 1 (26A group)

/*****************************************************************/
/*    Main Program                                               */
/*****************************************************************/
void main(void) {
   mcu_init();       // MCU initialize routine

   timerA4_init();   // Timer A4 initialize routine

   tabsr = 0x10;     // Setting count start flag
                     // <TA4S>  : TimerA4 Starts counting

   asm("fset i");    // Interrupt enabled

   while (1);
}
```

```
/************************************************************/
/*    MCU Initialize Routine                                */
/************************************************************/
void mcu_init(void) {
   prcr = 0x03;      // Protect register
                     // <PRC0>  : Protect bit 0 (Enable write to CM0, CM1, CM2,
                     // ROCR, PLC0, PCLKR and CCLKR registers)
                     // <PRC1>  : Protect bit 1 (Enable write to PM0, PM1, PM2,
                     // TB2SC, INVC0 and INVC1 registers)

   pm0 = 0x00;       // Processor mode register 0
                     // Single-chip mode

   pm1 = 0x08;       // Processor mode register 1
                     // <PM10>  : Flash data block access bit (0: Disable)
                     // <PM17>  : Wait bit (0: No wait state)

   wait_10ms();      // Waiting for main clock oscillation stable

   cm2 = 0x00;       // System clock select Main clock or PLL clock

   cm1 = 0x20;       // System clock control register 1
                     // <CM11>  : System clock select bit 1 (0: Main clock)
                     // <CM15>  : Xin-Xout drive capacity select bit (1: High)
                     // <CM17-16>  : Main clock division select bits (00: No
                     // division mode)

   cm0 = 0x08;       // System clock control register 0
                     // <CM03>  : Xcin-Xcout drive capacity select bit (1: High)
                     // <CM06>  : Main clock division select bit 0 (0: CM16 and
                     // CM17 valid)
                     // <CM07>  : Main clock division select bit 0 (0: Main clock,
                     // PLL clock, or on-chip oscillator clock)

   pclkr = 0x03;  // Peripheral clock select register
                  // <PCLK0> : Timer A/B clock select bit (1: f1)
                  // <PCLK1> : SI/O clock select bit (1: f1SIO)

   prcr = 0x00;   // Protects registers
                  // Protect all registers

   #if PRODUCT_TYPE      // Product selection: 26A group
      ifsr2a = 1;        // Interrupt request cause select register2 IFSR2A
                         // <IFSR20>   : Reserved bit (Must be set to "1")
      prcr = 0x04;       // Protect register off
      #if PIN_TYPE       // Port setting
         pacr = 0x01;    // 42pin type
      #else
         pacr = 0x04;    // 48pin type
      #endif
      prcr = 0x00;       // Protect register on
   #else                 // Product selection: 28,29 group
      ifsr2a = 0;        // Interrupt request cause select register2 IFSR2A
                         // <IFSR20>   : Reserved bit (Must be set to "0")
      prcr = 0x04;       // Protect register off
      #if PIN_TYPE       // Port setting
         pacr = 0x02;    // 64pin type
```

```
      #else
         pacr = 0x03;     // 80pin type
      #endif
      prcr = 0x00;        // Protect register on
   #endif
}

/************************************************************/
/*    Main Clock Oscillation Stable Wait 10ms Routine       */
/************************************************************/
void wait_10ms(void) {
   ta0mr = 0x00;     // Set Timer A0 mode register (Timer mode, count source: f1)

   ta0 = 20000-1;    // Setting counter value (10msec @4MHz/2, f1)

   ta0ic = 0x00;     // Clear interrupt request bit

   tabsr = 0x01;     // Timer A0 start counting

   while (ir_ta0ic == 0){   }

   ir_ta0ic = 0;     // Clear interrupt request bit

   tabsr = 0x00;     // Timer A0 stops counting
}

/************************************************************/
/*    Timer A4 Initialize Routine (2-Phase Pulse Signal     */
/*    Process in Event Counter Mode, Multiply-by-4 Mode)    */
/************************************************************/
void timerA4_init(void) {
   ta4mr = 0xD1;  // Timer A4 mode register
                  // <TMOD1-0>  : Operation mode select bit (01: Event counter
                  // mode)
                  // <MR0>   : To use two-phase pulse signal processing, set this
                  // bit to "0".
                  // <MR1>   : To use two-phase pulse signal processing, set this
                  // bit to "0".
                  // <MR2>   : To use two-phase pulse signal processing, set this
                  // bit to "1".
                  // <MR3>   : To use two-phase pulse signal processing, set this
                  // bit to "0".
                  // <TCK0>  : Count operation type select bit (1: Free-run type)
                  // <TCK1>  : Two-phase pulse signal processing operation select
                  // bit (1: Multiply-by-4 processing operation)

   udf = 0x80;    // Up/down flag register
                  // <TA4P>  : Timer A4 two-phase pulse signal processing select
                  // bit (1: two-phase pulse signal processing enabled)

   pd8_0 = 0;     // Set the corresponding port direction register to "0" (TA4OUT)

   pd8_1 = 0;     // Set the corresponding port direction register to "0" (TA4IN)

   trgsr = 0x00;  // Trigger select register
                  // <TA4TGH-L> : Timer A4 event/trigger select bit (00: Input on
                  // TA4IN is selected)
```

```
    ta4 = 0;        // Timer A4 register

    ta4ic = 0x03;   // Interrupt control register
                    // <ILVL2-0>  : Interrupt priority level (011: Level 3)
}

/************************************************************/
/*    Timer A4 Interrupt Program                            */
/************************************************************/
void ta4_int(void) {
                // TA4 interrupt routine
}
```

如下所示，为使程序正常运行，需定义定时器 A4 的中断向量地址，使之指向中断服务程序。必须在启动文件“sect30.inc”的中断向量表中，定义定时器 A4 的中断程序地址“_ta4_int”。

序号为 25 的软件中断（定时器 A4 中断）

```
    .glb  _ta4_int
    .lword   _ta4_int  ; timer A4(for user)(vector 25)
```

7. 参考文献

数据手册

M16C/26A 群（M16C/26A、M16C/26T）硬件手册 Rev.1.00

M16C/28 群硬件手册 Rev.1.01

M16C/29 群硬件手册 Rev.1.00

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1.00	2006.04.14	—	初版发行

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