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# M16C/Tiny 系列

## 定时器 A 操作（事件计数模式、自由运行方式）

### 1. 要点

在定时器事件计数模式中，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 A0 选择事件计数模式、自由运行方式的例子。

### 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 | |
|---|---|---|
| 计数源 | ○ | TAiIN 引脚的输入信号（下降沿/上升沿有效） |
| | | 定时器 B2 的溢出信号（上溢/下溢有效）<br>定时器 Aj (j= i-1,但当 i=0 时 j=4)的溢出信号（上溢/下溢有效）<br>定时器 Ak (k= i+1,但当 i=4 时 k=0)的溢出信号（上溢/下溢有效） |
| 脉冲输出功能 | ○ | 无脉冲输出 |
| | | 有脉冲输出 |
| 计数方式 | | 重加载方式 |
| | ○ | 自由运行方式 |
| 递增/递减计数切换触发 | ○ | 递增/递减标志寄存器的设定 |
| | | TAiOUT 端子的输入信号 |

## 4. 定时器 A 的操作

(1) 把计数开始标志位置为“1”，计数器开始对计数脉冲源的下降沿计数。
(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) 在计数过程中改变递增/递减标志寄存器的内容，从计数脉冲的下一个有效沿开始有效，即切换递增/递减计数方式。
(4) 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”。

选择事件计数模式、自由运行方式的定时器工作时序图如下所示：

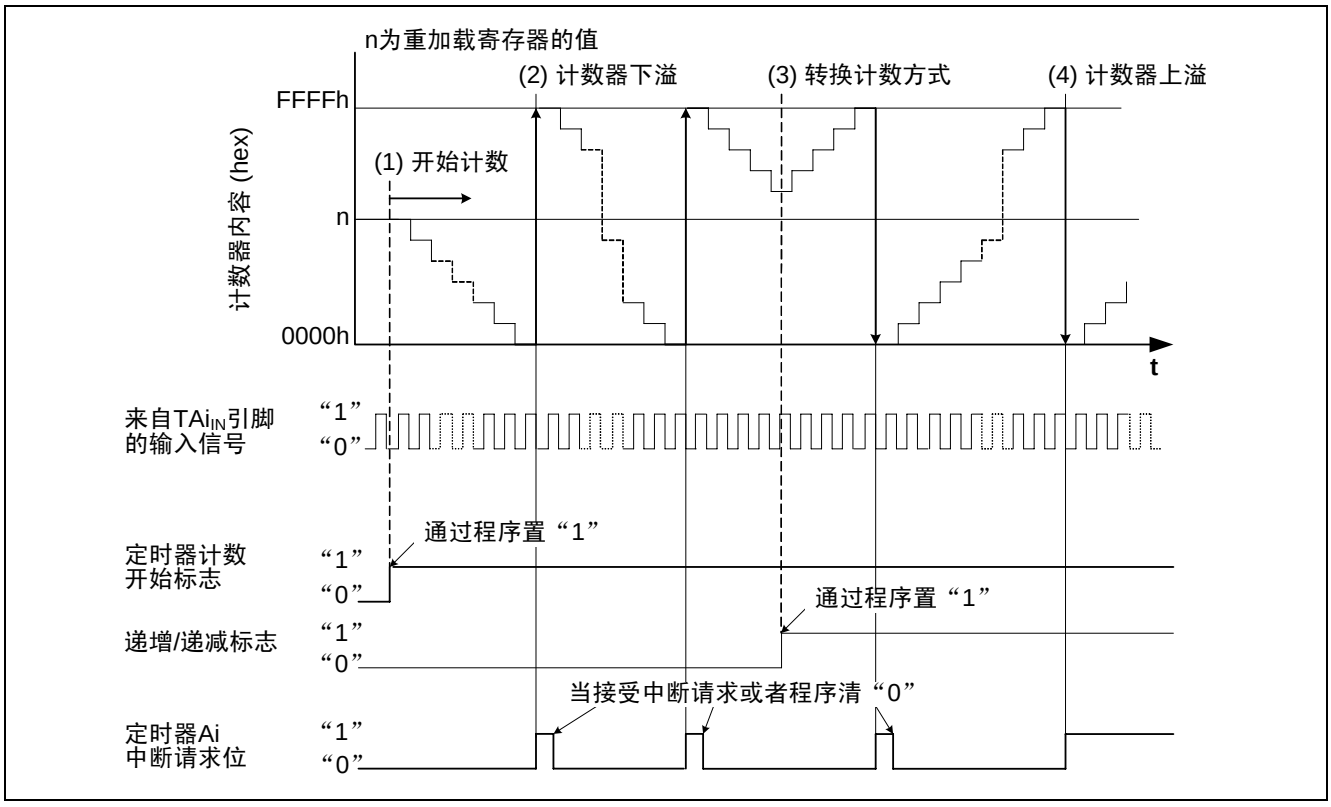


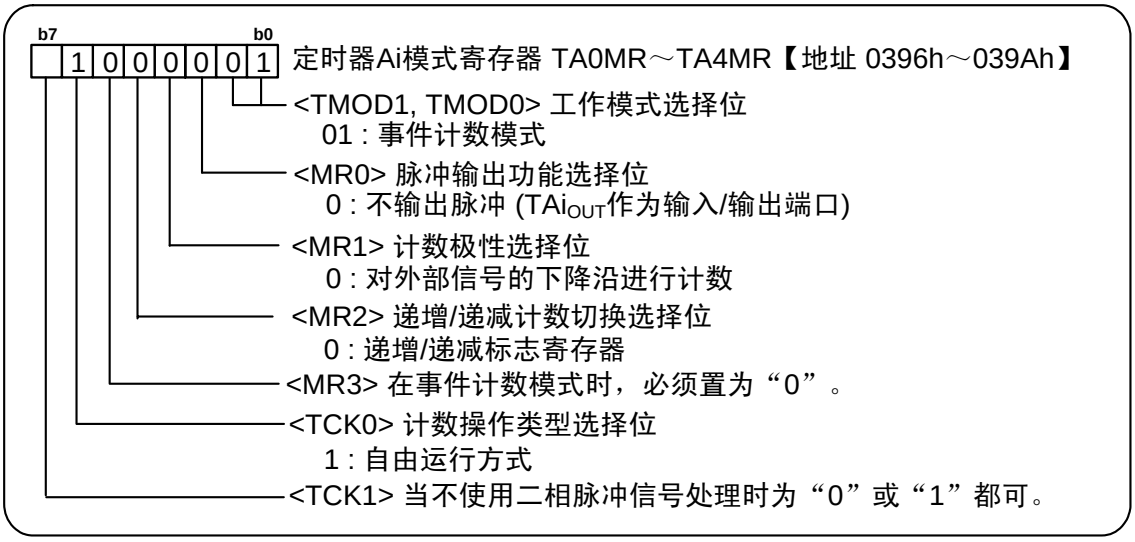

图 1. 选择事件计数模式、自由运行方式定时器的工作时序图

## 5. 寄存器设置

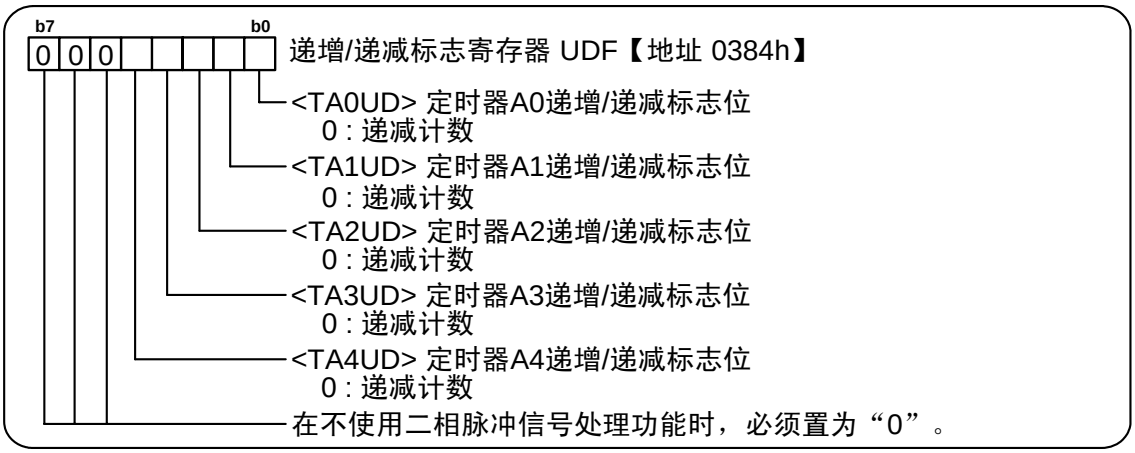
为了能实现定义在“4. 定时器 A 的操作”的功能，下列寄存器必须按步骤顺序进行设置。对于每个寄存器的具体结构，请参考 M16C/26A 群、M16C/28 群、M16C/29 群的硬件手册。

选择事件计数模式、自由运行方式时，定时器的寄存器设定如下所示：

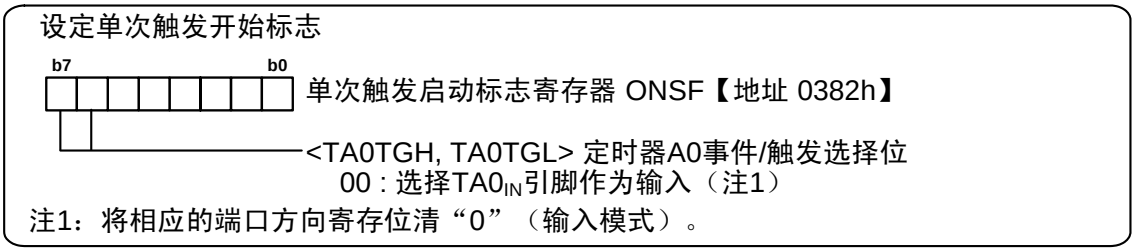
(1) 设置定时器Ai模式寄存器 (i=0～4)




(2) 设置递增/递减标志寄存器

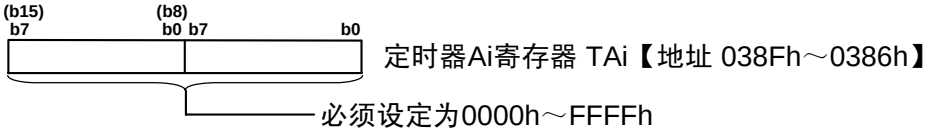



(3) 设置单次触发启动标志和触发选择寄存器

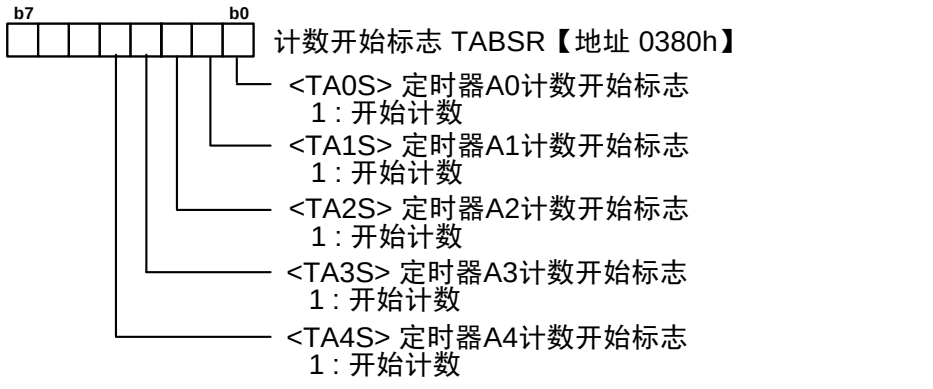


设定触发选择寄存器


(4) 设置定时器Ai寄存器 (i=0～4)




(5) 设置定时器计数开始标志位



## 6. 参考例程

```
/*****************************************************************/
/*                                                               */
/* M16C/Tiny Series Program Collection                           */
/*                                                               */
/* File name   : rec05b0007-0101_src.c                           */
/* CPU         : M16C/29 Group                                   */
/* Function    : Operation of Timer A                            */
/*              (event counter mode, free run type)              */
/* 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 ta0_int

/*****************************************************************/
/*    Function Declaration                                       */
/*****************************************************************/
void mcu_init(void);        // MCU initialize routine
void timerA0_init(void);    // Timer A0 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

   timerA0_init();   // Timer A0 initialize routine

   tabsr = 0x01;     // Setting count start flag
                     // <TA0S>  : TimerA0 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 A0 Initialize Routine                                */
/*    (Event Count Mode, Free Run Type)                          */
/*****************************************************************/
void timerA0_init(void) {
   ta0mr = 0x41;  // Timer A0 mode register
                  // <TMOD1-0>  : Operation mode select bit (01: Event counter
                  // mode)
                  // <MR0>   : Pulse output function select bit (0: Pulse is not
                  // output, TA0OUT pin functions as I/O port)
                  // <MR1>   : Count polarity select bit (0: Counts external
                  // signal's falling edge)
                  // <MR2>   : Up/down switching cause select bit (0: UDF register)
                  // <MR3>   : Must be set to "0" in event counter mode
                  // <TCK0>  : Count operation type select bit (1: Free-run type)
                  // <TCK1>  : Can be "0" or "1" when not using two-phase pulse
                  // signal processing

   udf = 0x00;    // Up/down flag register
                  // <TA0UD> : Timer A0 up/down flag (0: Down count)

   onsf = 0x00;   // One-shot start flag register
                  // <TA0TGH-L> : Timer A0 event/trigger select bit (00: Input on
                  // TA0IN is selected)

   ta0 = 0x7FFF;  // Count value on event counter mode (down count)

   ta0ic = 0x03;  // Interrupt control register
                  // <ILVL2-0>  : Interrupt priority level (011: Level 3)
}
```

```
/************************************************************/
/*    Timer A0 Interrupt Program                            */
/************************************************************/
void ta0_int(void) {
                  // TA0 interrupt routine
}
```

如下所示，为使程序正常运行，需定义定时器 A0 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 A0 的中断程序地址“_ta0_int”。

序号为 21 的软件中断（定时器 A0 中断）

```
.glb  _ta0_int
.lword   _ta0_int  ; timer A0(for user)(vector 21)
```

## 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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