致尊敬的顾客

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2010年4月1日
瑞萨电子公司

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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

<table>
<thead>
<tr>
<th>设定项目</th>
<th>设定内容</th>
</tr>
</thead>
<tbody>
<tr>
<td>计数操作类型</td>
<td>重加载方式</td>
</tr>
<tr>
<td>Ｏ  自由运行方式</td>
<td></td>
</tr>
<tr>
<td>二相脉冲信号处理（注 1）</td>
<td>正常处理方式</td>
</tr>
<tr>
<td>Ｏ  4 倍频处理方式</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th></th>
<th>TAIOUT 引脚的输入信号</th>
<th>TAIN 引脚的输入信号</th>
</tr>
</thead>
<tbody>
<tr>
<td>递增计数</td>
<td>“H”电平</td>
<td>上升沿</td>
</tr>
<tr>
<td></td>
<td>“L”电平</td>
<td>下降沿</td>
</tr>
<tr>
<td></td>
<td>上升沿</td>
<td>“L”电平</td>
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<tr>
<td></td>
<td>下降沿</td>
<td>“H”电平</td>
</tr>
<tr>
<td>递减计数</td>
<td>“H”电平</td>
<td>下降沿</td>
</tr>
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<td></td>
<td>“L”电平</td>
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</tr>
<tr>
<td></td>
<td>下降沿</td>
<td>“L”电平</td>
</tr>
</tbody>
</table>
选择事件计数模式的二相脉冲信号处理、4倍频方式的定时器时序图如下所示:

图 1. 选择事件计数模式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

<table>
<thead>
<tr>
<th>b7</th>
<th>b6</th>
<th>b5</th>
<th>b4</th>
<th>b3</th>
<th>b2</th>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

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”
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）

(2) 设置二相脉冲信号处理选择位

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<thead>
<tr>
<th>b7</th>
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<th>b3</th>
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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

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<th>b7</th>
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触发选择寄存器 TRGSR【地址 0383h】

<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

<table>
<thead>
<tr>
<th>b15</th>
<th>b14</th>
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<th>b12</th>
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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

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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

```c
#include "sfr29.h" // Special function register header file

#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)

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

void main(void) {
    mcu_init();   // MCU initialize routine
    timerA4_init(); // Timer A4 initialize routine
    tabsr = 0x10;  // Setting count start flag
    asm("fset i"); // TimerA4 Starts counting
    while (1);
}
```
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")
#endif
    prcr = 0x04; // Protect register off
#if PIN_TYPE // Port setting
    pacr = 0x01; // 42pin type
#else
    pacr = 0x04; // 48pin type
#endif
#else // Product selection: 28,29 group
    ifsr2a = 0; // Interrupt request cause select register2 IFSR2A
    // <IFSR20> : Reserved bit (Must be set to "0")
#endif
    prcr = 0x04; // Protect register off
#if PIN_TYPE // Port setting
    pacr = 0x02; // 64pin type
#endif
#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)
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
.1word _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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