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M16C/Tiny 系列

定时器 B 操作（脉冲宽度测量模式）

1. 要点

在脉冲周期/脉冲宽度测量模式中，可以选择如表 1 中所列的各种功能。在表 1 中用符号“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 B0 选择脉冲宽度测量模式的例子。

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	○	内部计数源（f1, f2, f8, f32, fC32）
测量模式		脉冲周期测量（从测量脉冲的下降沿到下一个下降沿之间的测量）
		脉冲周期测量（从测量脉冲的上升沿到下一个上升沿之间的测量）
	○	脉冲宽度测量（从测量脉冲的下降沿到下一个上升沿之间的测量和从测量脉冲的上升沿到下一个下降沿之间的测量）

4. 定时器 B 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进行计数。
(2) 当第一次检测到脉冲的有效沿输入时，计数器值变为“0000h”，测量开始。在这种情况下，重加载寄存器的值不定，定时器 Bi 不产生中断请求。
(3) 当再次检测到计数脉冲源的有效沿输入时，将计数器的值传送给重加载寄存器，定时器 Bi 中断请求标志位置为“1”。然后，计数器值变为“0000h”，开始下一次测量。

注意事项：

- 当检测到脉冲的有效沿输入或定时器 Bi 计数溢出时，定时器 Bi 中断请求标志置为“1”。在中断程序中通过检测 Bi 溢出标志位，对中断请求的原因进行判断。
- 在开始计数时计数器的值不定。因此，从开始计数到另一有效沿输入时间间隔内，定时器 Bi 溢出标志位可能为“1”，并有可能产生定时器 Bi 中断请求。
- 复位后，定时器 Bi 溢出标志的值不定。在计数开始标志位为“1”的状态下，若进行定时器 Bi 模式寄存器的写入操作，定时器 Bi 溢出标志位变为“0”，并且该标志位不能通过程序置“1”。

选择脉冲宽度测量模式的定时器工作时序图如下所示：

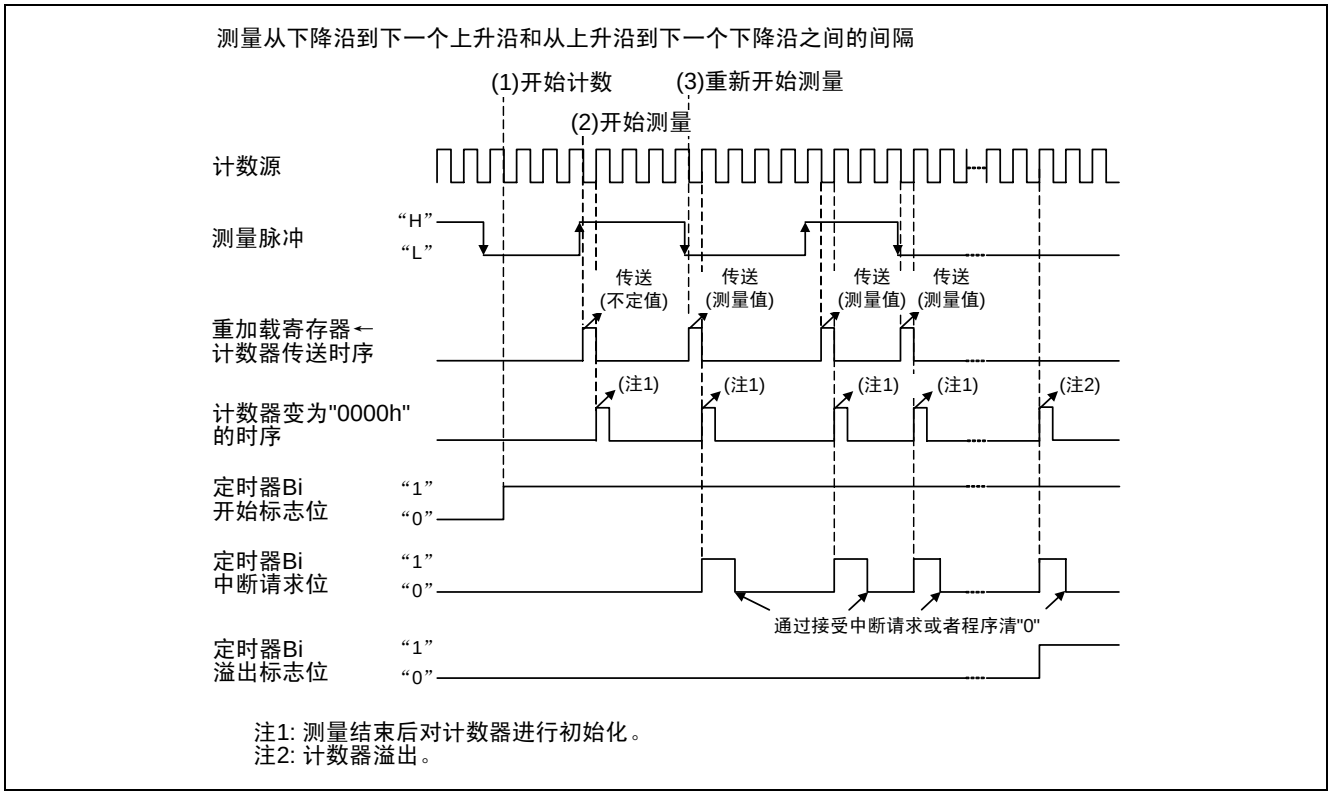
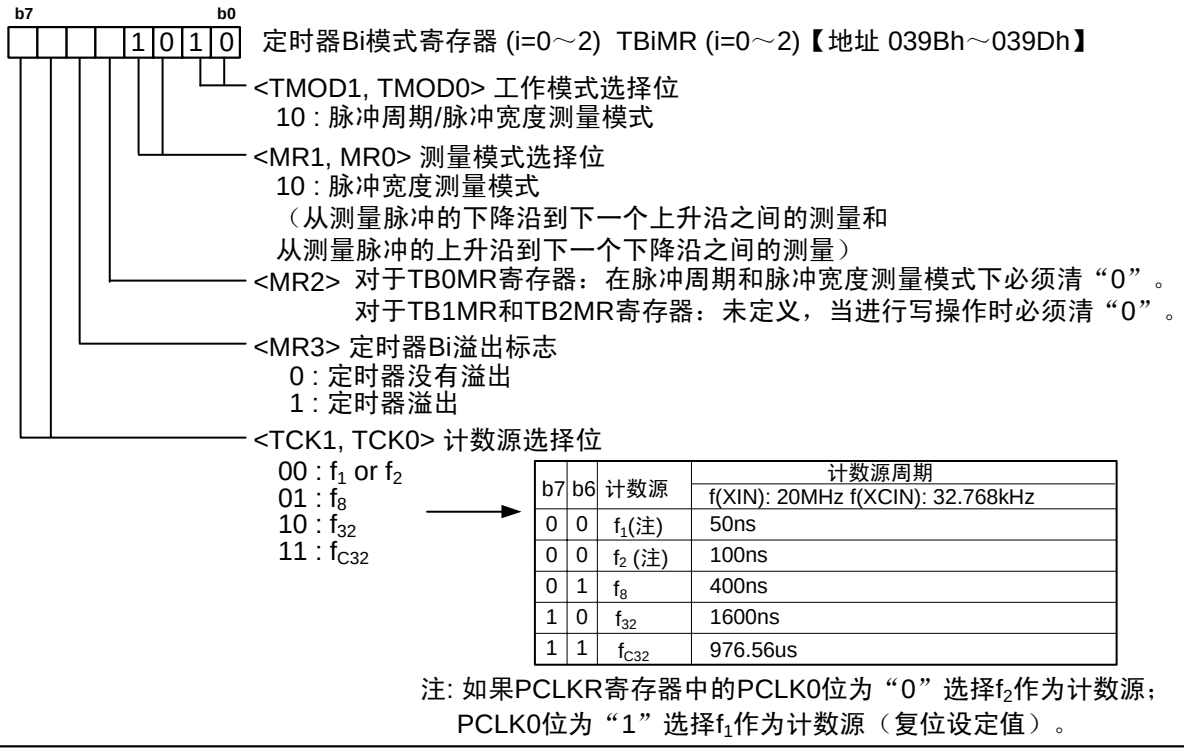


图 1. 脉冲宽度测量模式工作时序图

5. 寄存器设置

为了能实现定义在“4. 定时器 B 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。

(1) 选择脉冲周期/脉冲宽度测量模式

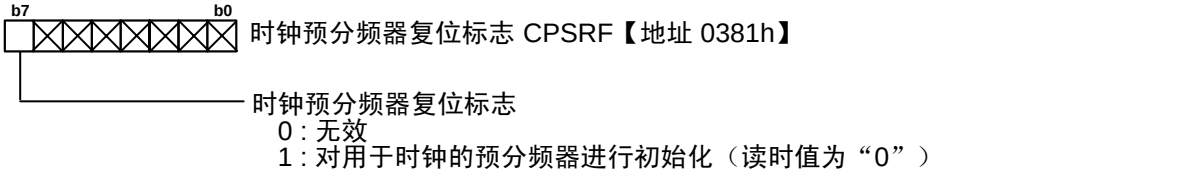


b7	b6	计数源	计数源周期 f(XIN): 20MHz f(XCIN): 32.768kHz
0	0	f_1(注)	50ns
0	0	f_2 (注)	100ns
0	1	f_8	400ns
1	0	f_{32}	1600ns
1	1	f_{C32}	976.56us

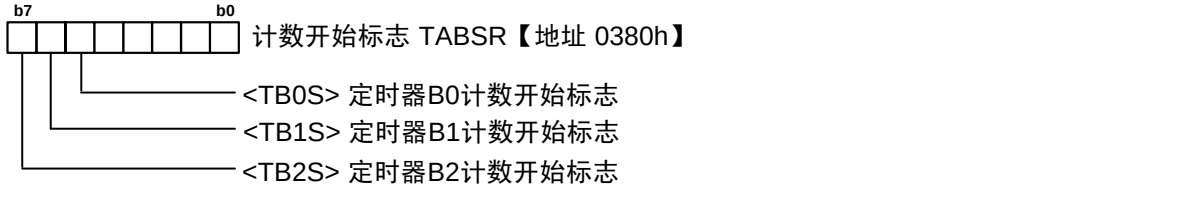
注: 如果PCLKR寄存器中的PCLK0位为“0”选择f_2作为计数源；
PCLK0位为“1”选择f_1作为计数源（复位设定值）。

(2) 设置时钟预分频器复位标志

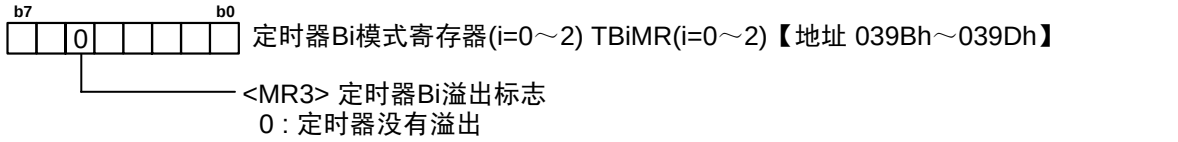
（这一功能只在选择f_{C32}作为计数源时有效。复位预分频器是为了产生XCIN时钟的32分频即f_{C32}）



(3) 设置定时器计数开始启动标志



(4) 清除溢出标志



6. 参考例程

```
/************************************************************/
/*                                                          */
/* M16C/Tiny Series Program Collection                      */
/*                                                          */
/* File name   : rec05b0010-0101_src.c                      */
/* CPU         : M16C/29 Group                              */
/* Function    : Operation of Timer B                       */
/*             (pulse width measurement 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 tb0_int

/************************************************************/
/*    Function Declaration                                  */
/************************************************************/
void mcu_init(void);        // MCU initialize routine
void timerB0_init(void);    // Timer B0 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

   timerB0_init();   // Timer B0 initialize routine

   tabsr = 0x20;     // Setting count start flag
                     // <TB0S>  : TimerB0 starts counting

   asm("nop");       // Wait next count timing
   asm("nop");
   asm("nop");
   asm("nop");
   asm("nop");
```

```
    mr3_tb0mr = 0;     // This flag is indeterminate after reset. When the TB0S bit=1,
                       // the MR3 bit is cleared to "0" by writing to the TB0MR register
                       // at the next count timing or later after the MR3 bit was
                       // set to "1".

    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 B0 Initialize Routine                                */
/*****************************************************************/
void timerB0_init(void) {
   tb0mr = 0x4a;  // Timer B0 mode register
                  // <TMOD1-0>  : Operation mode select bit (10: Pulse period/pulse
                  // width measurement mode)
                  // <MR1-0> : Measurement mode select bit (10: Pulse width
                  // measurement, measurement between a falling edge and the next
                  // rising edge of measured pulse and between a rising edge and
                  // the next falling edge)
                  // <MR2>   : Must be set to "0" in pulse period and pulse width
                  // measurement mode
                  // <MR3>   : Timer B0 overflow (0: Timer did not overflow)
                  // <TCK1-0>   : Count source select bit (01: f8)

   tb0ic = 0x03;  // Interrupt control register
                  // <ILVL2-0>  : Interrupt priority level (011: Level 3)
}
```

```
/************************************************************/
/*    Timer B0 Interrupt Program                            */
/************************************************************/
void tb0_int(void) {
                  // TB0 interrupt routine
}
```

如下所示，为使程序正常运行，需定义定时器 B0 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 B0 的中断程序地址“_tb0_int”。

序号为 26 的软件中断（定时器 B0 中断）

```
   .glb  _tb0_int
   .lword   _tb0_int  ; timer B0(for user)(vector 26)
```

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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