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M16C/Tiny Series

Operation of Timer B (Pulse Width Measurement Mode)

1. Abstract

In pulse period/pulse width measurement mode, choose functions from those listed in Table 1. Operations of the selected items are described below. Figure 1 shows the operation timing. A reference program is an example when using the Timer B0 in pulse width measurement mode.

2. Introduction

The explanation of this issue is applied to the following condition:

- MCU: M16C/26A Group
  M16C/28 Group
  M16C/29 Group

This program can be operated under the condition of M16C family products with the same SFR (Special Function Register) as 26A, 28, 29 group products. Because some functions may be modified of the M16C family products, see the user's manual. When using the functions shown in this application note, evaluate them carefully for an operation.

3. Selected functions

Table 1. Selected Functions

Item	Setup	
Count source	Yes	Internal count source (f1/f2/f8/f32/fC32)
Measurement mode		Pulse period measurement (interval between measurement pulse falling edge to falling edge)
		Pulse period measurement (interval between measurement pulse rising edge to rising edge)
	Yes	Pulse width measurement (interval between measurement pulse falling edge to rising edge, and between rising edge to falling edge)

4. Operation of Timer B

(1) Setting the count start flag to "1" causes the counter to start counting the count source.
(2) If an effective edge of a pulse to be measured is input, the value of the counter goes to "0000h", and measurement is started. In this instance, an indeterminate value is transferred to the reload register. The timer Bi interrupt request does not generate.
(3) If an effective edge of a pulse to be measured is input again, the value of the counter is transferred to the reload register, and the timer Bi interrupt request bit goes to "1". Then the value of the counter becomes "0000h", and measurement is started again.

Notes:

- The timer Bi interrupt request bit goes to "1" when an effective edge of a pulse to be measured is input or timer Bi is overflow. The factor of interrupt request can be determined by use of the timer Bi overflow flag within the interrupt routine.
- The value of the counter at the beginning of a count is indeterminate. Therefore, the timer Bi overflow flag may go to "1" and timer Bi interrupt request may be generated during the interval between a count start and an effective edge input.
- The timer Bi overflow flag is indeterminate after reset. The timer Bi overflow flag goes to "0" if timer Bi mode register is written to when the count start flag is "1". This flag can not be set to "1" by software.

Operation timing of Timer B in pulse width measurement mode shows below.

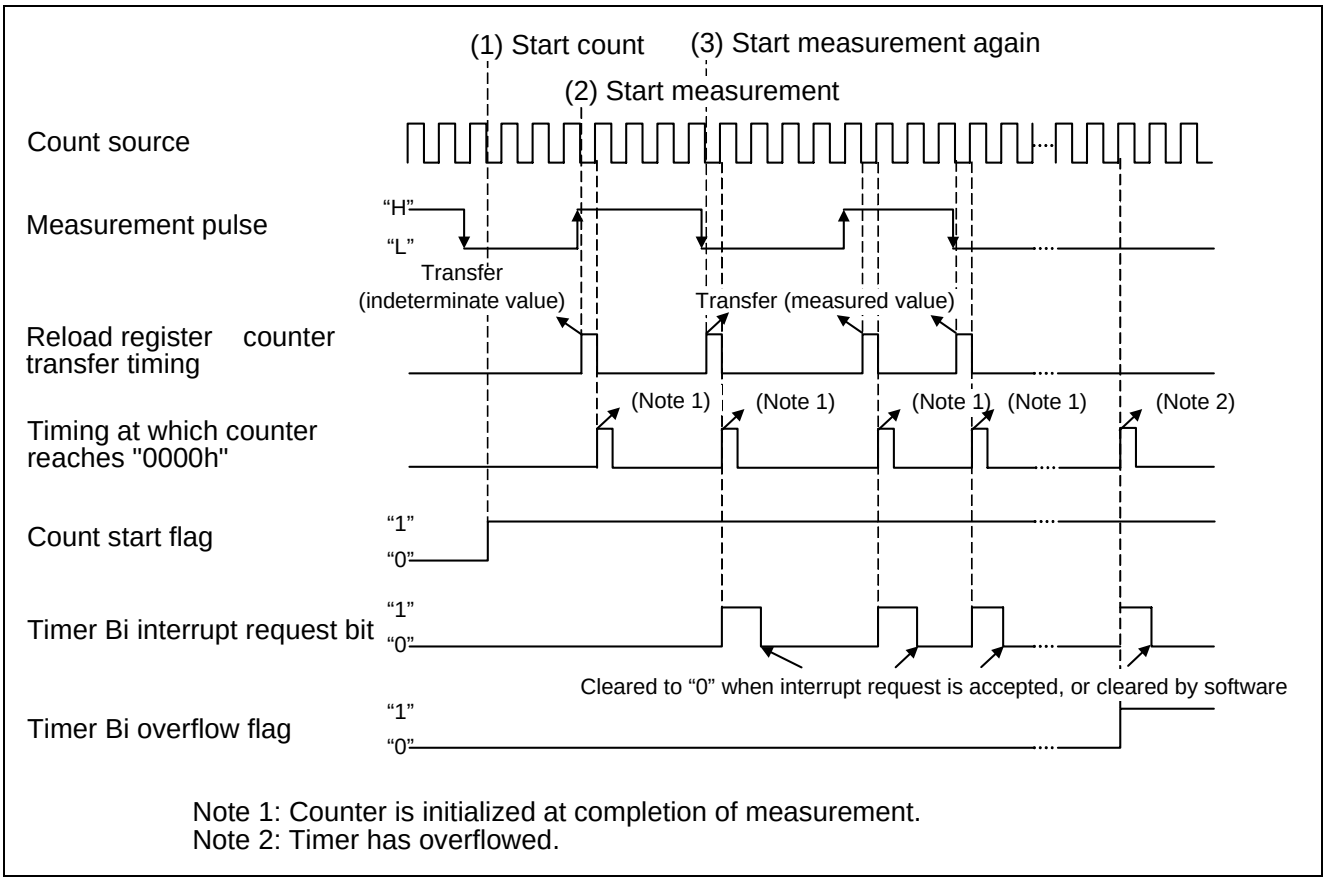
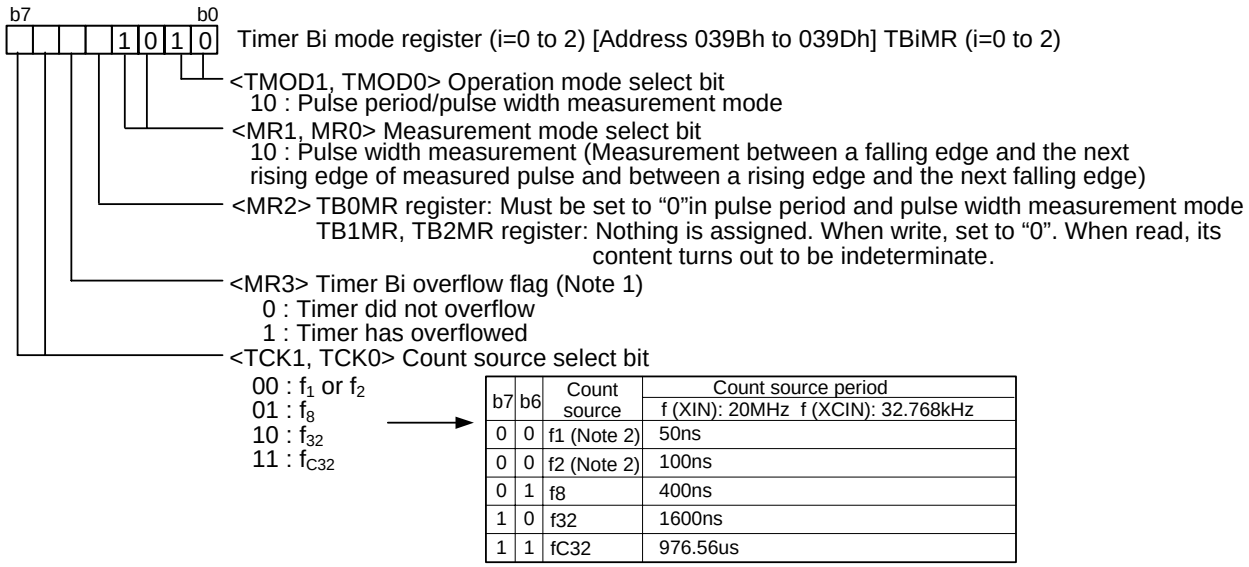


Figure 1. Operation Timing of Pulse Width Measurement Mode

5. Register setting

To enable the operation defined in "4. Operation of Timer B", the following register settings must be taken place step by step. For detail configuration of each register, please refer to M16C/26A group hardware manual, M16C/28 group hardware manual, M16C/29 group hardware manual.

(1) Selecting pulse period/pulse width measurement mode

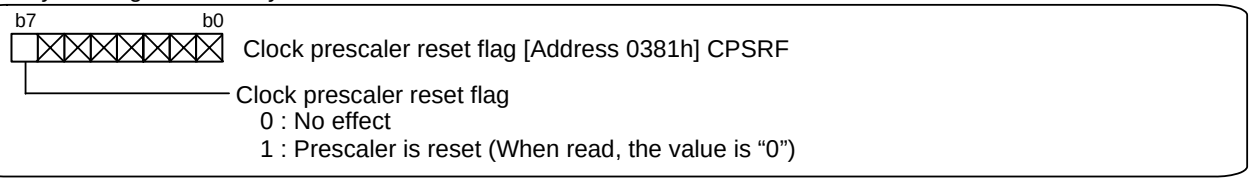


b7	b6	Count source	Count source period f (XIN): 20MHz f (XCIN): 32.768kHz
0	0	f1 (Note 2)	50ns
0	0	f2 (Note 2)	100ns
0	1	f8	400ns
1	0	f32	1600ns
1	1	fC32	976.56us

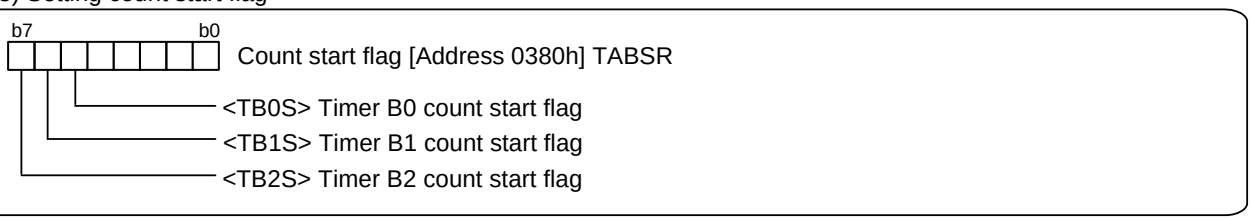
Notes:
1. This flag is indeterminate after reset. When the TBiS bit = 1 (start counting), the MR3 bit is cleared to "0" (no overflow) by writing to the TBiMR register at the next count timing or later after the MR3 bit was set to "1" (overflowed). The MR3 bit can not be set to "1" in a program. The TB0S to TB2S bits are assigned to the TABSR register's bit 5 to bit 7.
2. When the PCLK0 bit in the PCLKR register is "1", the selected clock source is f1. When the PCLK0 bit is "0", the selected clock source is f2.

(2) Setting clock prescaler reset flag

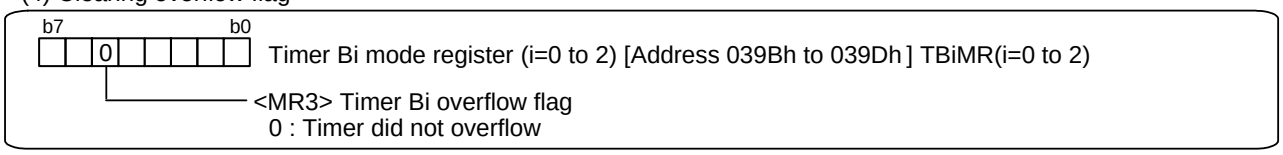
This function is effective when fC32 is selected as the count source. Reset the prescaler for generating fC32 by dividing the XCIN by 32.



(3) Setting count start flag



(4) Clearing overflow flag



6. Sample program code

```
/************************************************************/
/*                                                          */
/* M16C/Tiny Series Program Collection                      */
/*                                                          */
/* File name   : rec05b0010-0101_src.c                      */
/* CPU         : M16C/Tiny Series                           */
/* Function    : Operation of Timer B                       */
/*             (pulse width measurement mode)               */
/* Version     : 2006.04.13 Ver 1.01                        */
/*                                                          */
/* Copyright (C) 2006. Renesas Technology Corp.             */
/* All right reserved.                                      */
/*                                                          */
/************************************************************/

/************************************************************/
/*    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-L0> : Interrupt priority level (011: Level 3)
}

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

In order for this program to run properly, the Timer B0 interrupt vector needs to point to the service routines for the interrupt. The interrupt vector table information is included in the startup file "sect30.inc". Add the interrupt vectors listed below.

Software interrupt number 26 (Timer B0 interrupt)

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

7. Reference

Renesas web-site
http://www.renesas.com/

Inquires
http://www.renesas.com/inquiry
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Hardware manual
M16C/26A (M16C/26A, M16C/26T) Group Hardware Manual Rev.1.00
M16C/28 Group Hardware Manual Rev.1.01
M16C/28 Group (T-ver./V-ver.) Hardware Manual Rev.1.00
M16C/29 Group Hardware Manual Rev.1.00
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Revision

Rev.	Date	Description	
		Page	Summary
1.00	Jan.25.06	-	First edition issued
1.01	Apr.14.06	-	Modified function “wait_10ms” in sample program

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