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Renesas Electronics Corporation

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M16C/Tiny Series

Operation of Timer A

(2-Phase Pulse Signal Process in Event Counter Mode, Multiply-by-4 Mode)

1. Abstract

In processing 2-phase pulse signals in event counter 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 A2 in multiply-by-4 mode of 2-phase pulse signal process in event counter 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 operation type		Reload type
	Yes	Free run type
2-phase pulse process (Note)		Normal processing
	Yes	4-multiplication processing

Note: Only Timer A3 can be selected. Timer A2 is solely used for normal processes, and Timer A4 is solely used for 4-multiplication processes.

4. Operation of Timer A

(1) Setting the count start flag to "1" causes the counter to count effective edges of the count source.
(2) Even if an underflow occurs, the content of the reload register is not reloaded, but the counter continues. At this time, the interrupt request bit goes to "1".
(3) Even if an overflow occurs, the content of the reload register is not reloaded, but the counter continues. At this time, the interrupt request bit goes to "1".

Notes:

- The conditions and effective edges of up count or down count are as follows:

Table 2. The Conditions and Effective Edges of Up Count or Down Count

	Input signal to the TAiOUT pin	Input signal to the TAiIN pin
Up count	"H" level	Rising
	"L" level	Falling
	Rising	"L" level
	Falling	"H" level
Down count	"H" level	Falling
	"L" level	Rising
	Rising	"H" level
	Falling	"L" level

Operation timing of Timer A in multiply by 4 mode of 2-phase pulse signal process in event counter mode shows below.

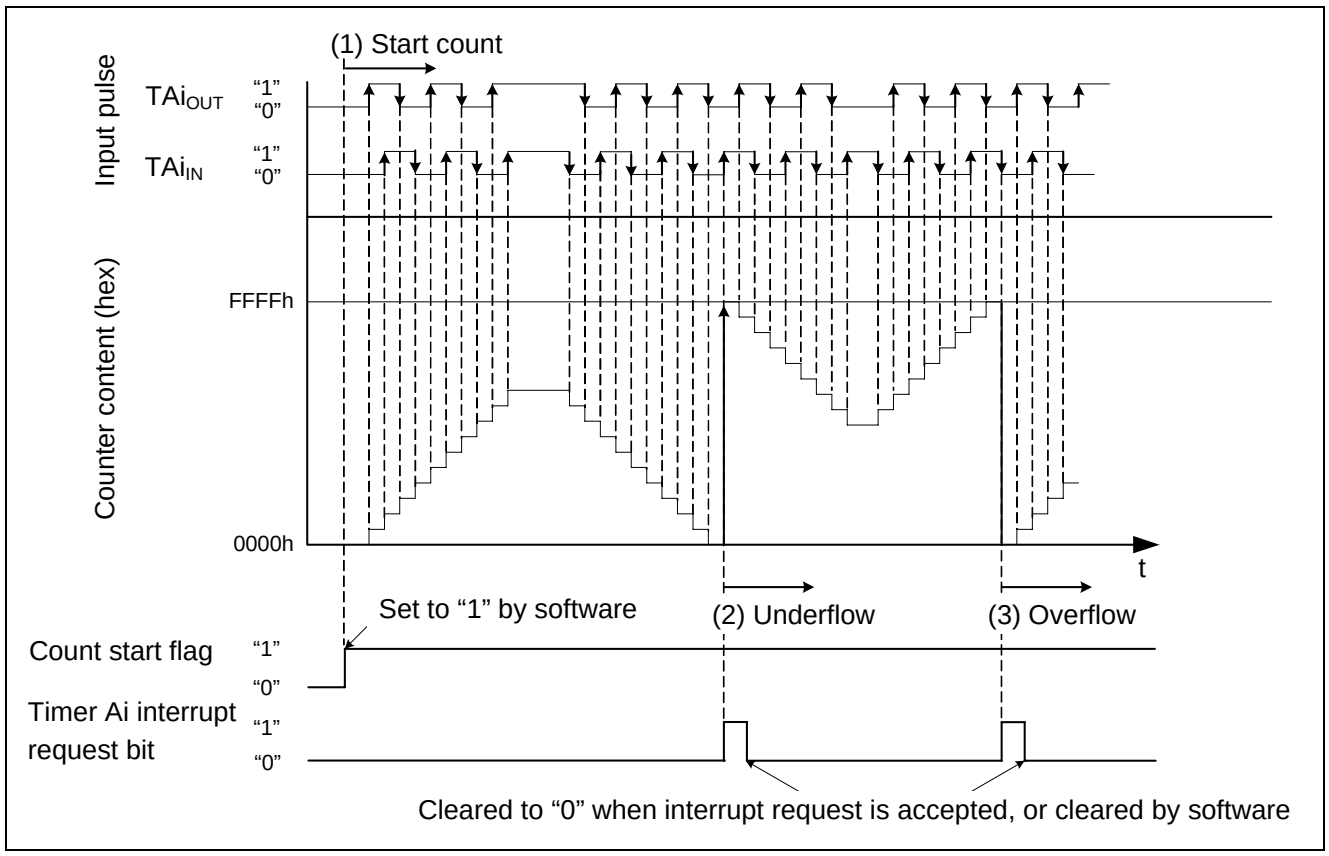
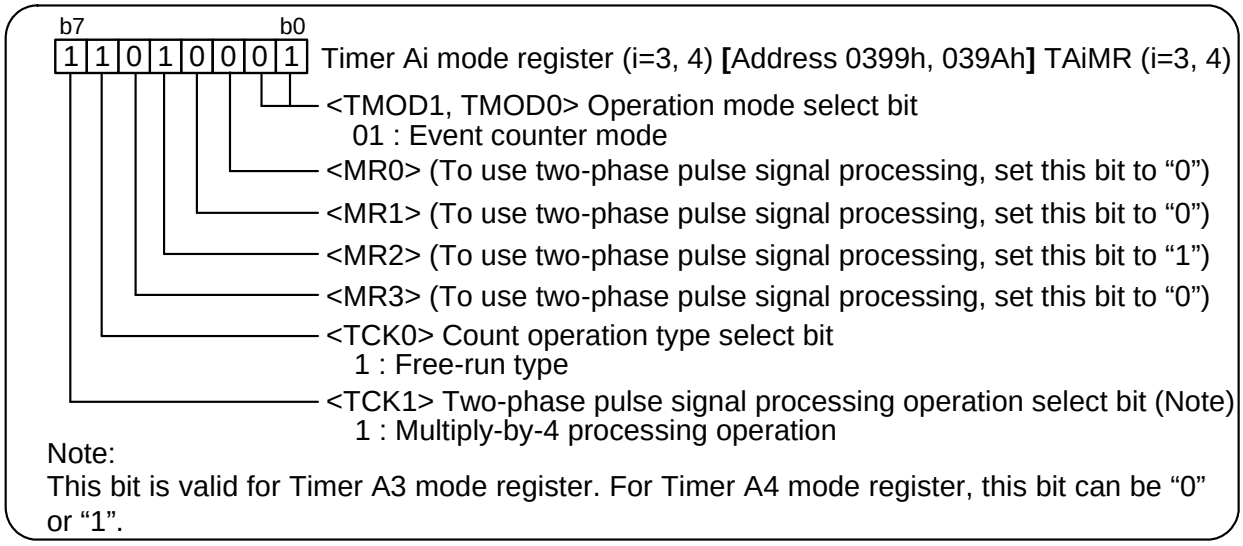


Figure 1. Operation Timing of 2-Phase Pulse Signal Process in Event Counter Mode, Multiply-by-4 Mode

5. Register setting

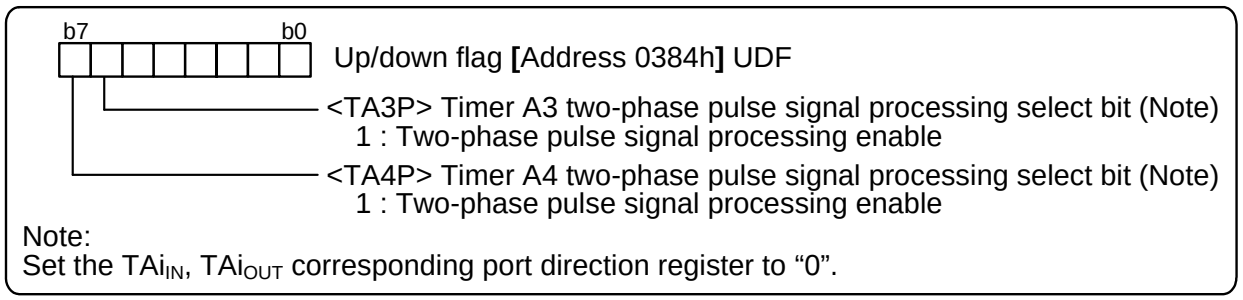
To enable the operation defined in "4. Operation of Timer A", the following register settings must be taken place step by step. For detail configuration of each register, please refer to M16C/26A group hardware manual, M16C/28 group hardware manual, M16C/29 group hardware manual.

(1) Setting Timer Ai mode register



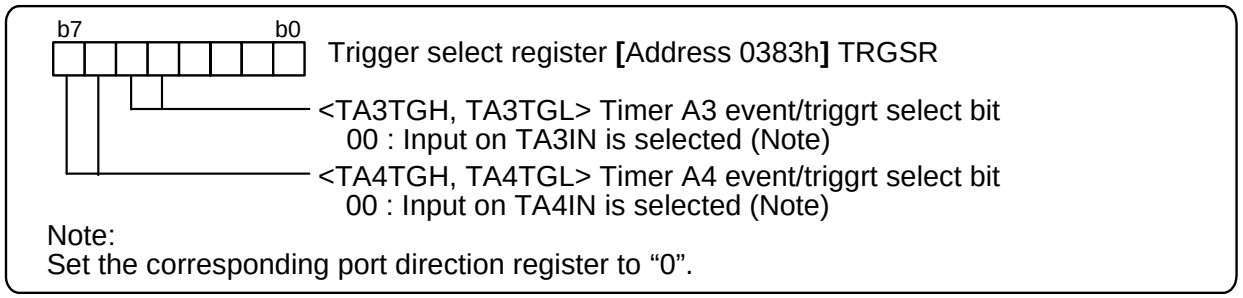
Note:
This bit is valid for Timer A3 mode register. For Timer A4 mode register, this bit can be "0" or "1".

(2) Setting two-phase pulse signal processing select bit



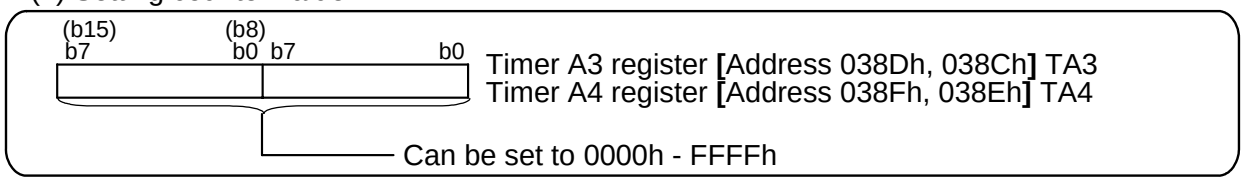
Note:
Set the TAi_{IN}, TAi_{OUT} corresponding port direction register to "0".

(3) Setting trigger select register

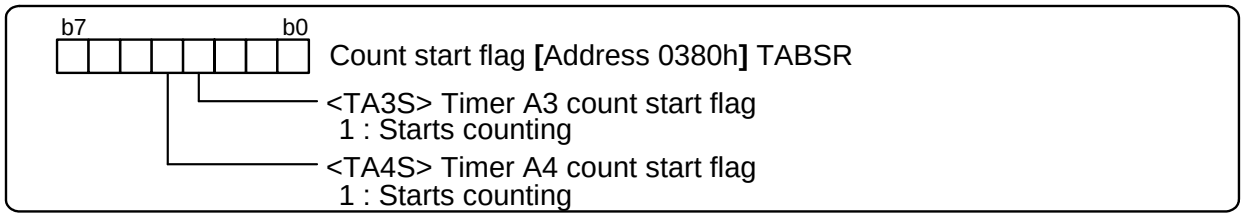


Note:
Set the corresponding port direction register to "0".

(4) Setting counter value



(5) Setting count start flag



6. Sample program code

```
/************************************************************/
/*                                                          */
/* 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                        */
/*                                                          */
/* Copyright (C) 2006, Renesas Technology Corp.             */
/* All right reserved.                                      */
/*                                                          */
/************************************************************/

/************************************************************/
/*    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
}
```

In order for this program to run properly, the Timer A4 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 25 (Timer A4 interrupt)

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

7. Reference

Renesas web-site

http://www.renesas.com/

Inquires

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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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Technical update/Technical news

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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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