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Renesas Electronics Corporation

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M16C/Tiny Series

Operation of Timer A (Event Counter Mode, Free Run Type)

1. Abstract

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. Sample program is an example when using the Timer A0 in event counter mode and free run type.

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 Input signal to TAI _{IN} (counting falling/ rising edges)
	Timer B2 overflows/underflows
	Timer A _j (j=i-1, except j=4 if i=0) overflows/underflows
	Timer A _k (k=i+1, except k=0 if i=4) overflows/underflows
Pulse output function	Yes No pulses output
	Pulses output
Count operation type	Reload type
	Yes Free-run type
Factor for switching between up and down	Yes Content of up/down flag
	Input signal to TAI _{OUT}

4. Operation of Timer A

- (1) Setting the count start flag to “1” causes the counter to count the falling 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 timer A_i interrupt request bit goes to “1”.
- (3) If switching from an up count to a down count or from a down count to an up count while a count is in progress, the switch takes effect from the next effective edge of the count source.
- (4) Even if an overflow occurs, the content of the reload register is not reloaded, but the counter continues. At this time, the timer A_i interrupt request bit goes to “1”.

The operation timing of event counter mode, free-run type selected shows below.

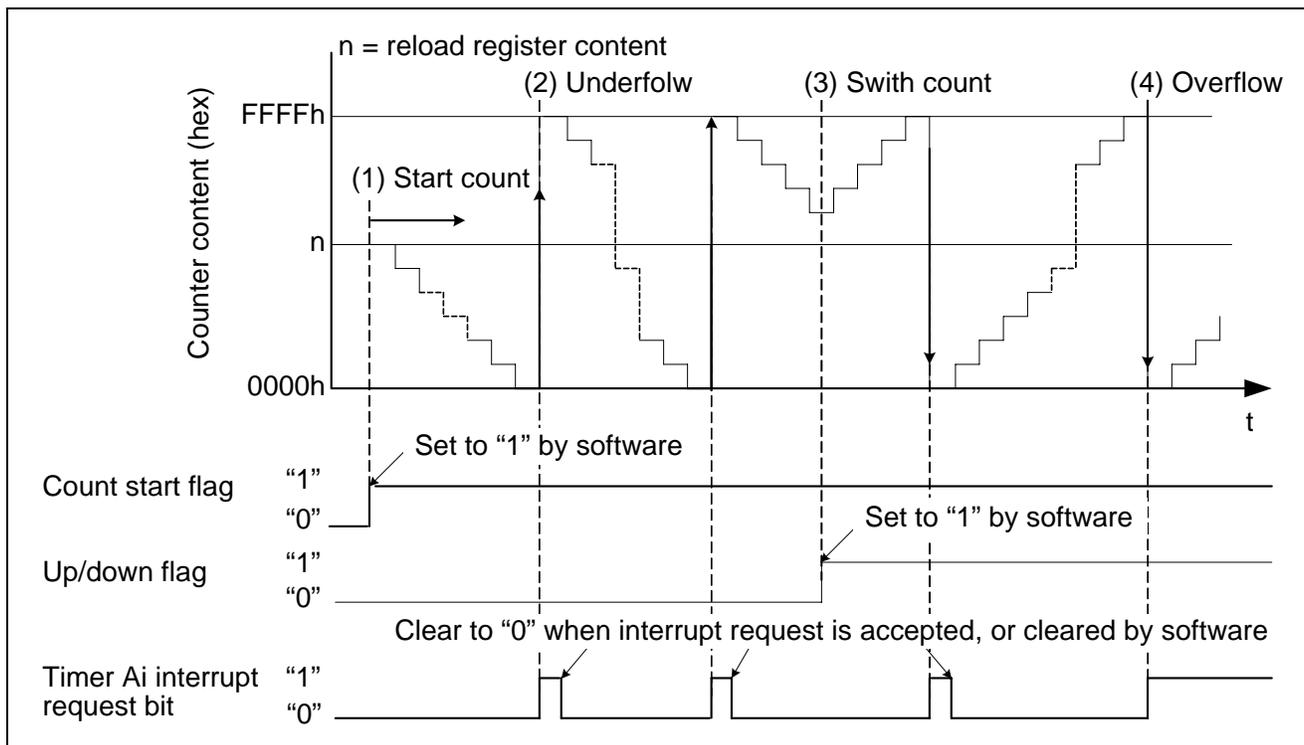
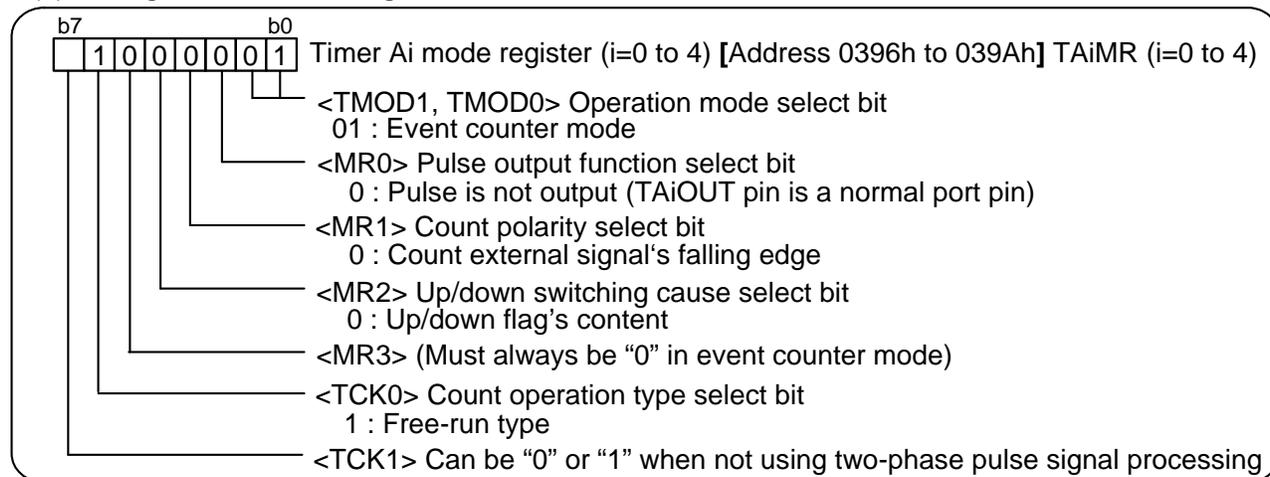


Figure 1. Operation Timing of Event Counter Mode, Free-run Type Selected

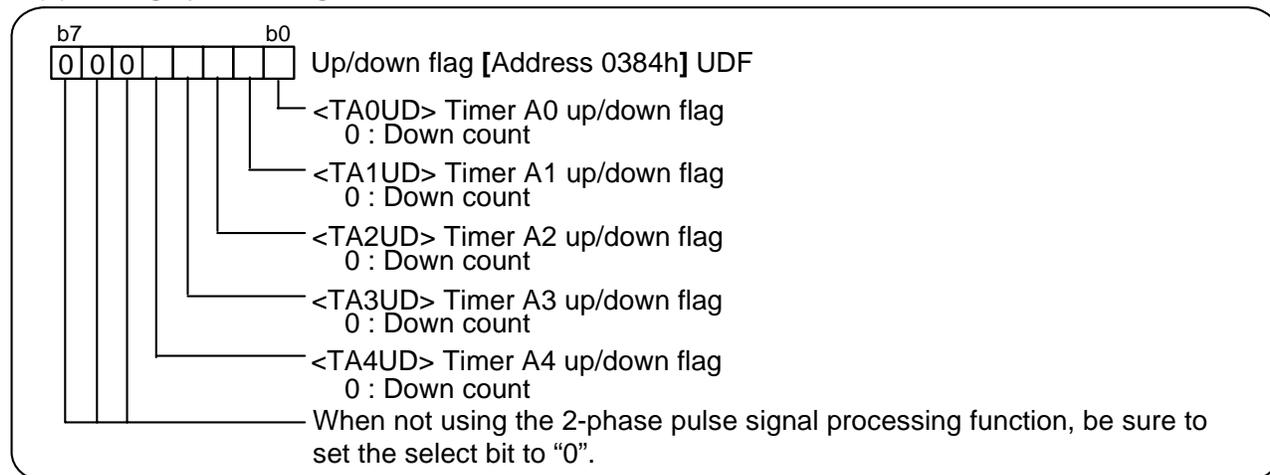
5. Register setting

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.

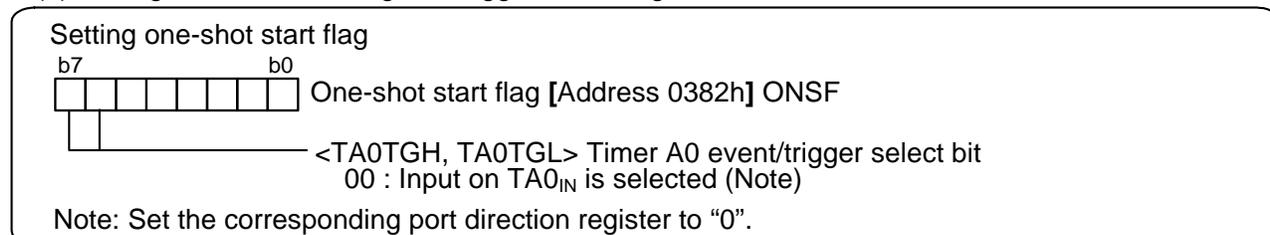
(1) Setting Timer Ai mode register



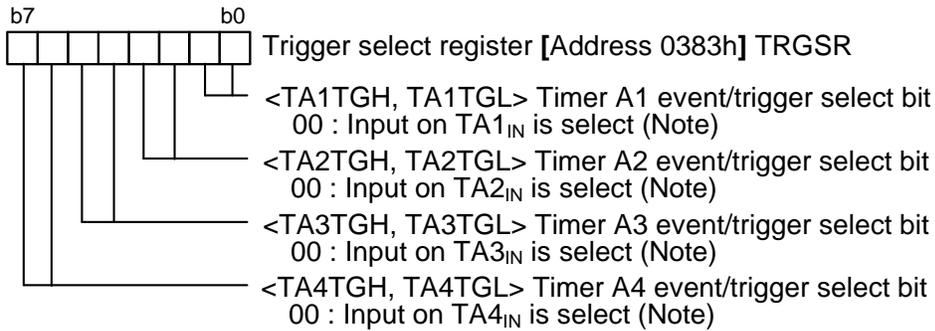
(2) Setting up/down flag



(3) Setting one-shot start flag and trigger select register

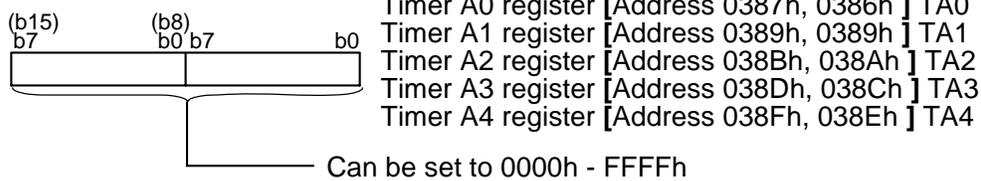


Setting trigger select register

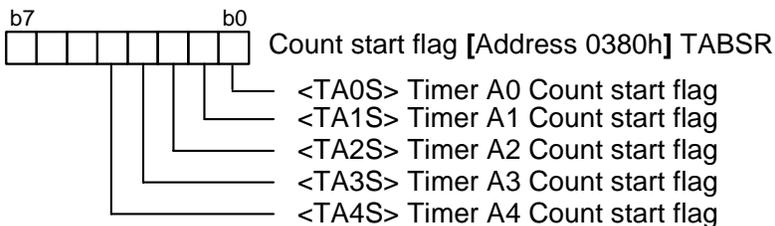


Note: Set the corresponding port direction register to "0".

(4) Setting count value



(5) Setting count start flag



6. Sample program code

```

/*****/
/*
/* M16C/Tiny Series Program Collection
/*
/* File name : rec05b0007-0101_src.c
/* CPU : M16C/Tiny series
/* Function : Operation of Timer A
/* (event counter mode, free run type)
/* 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 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
                // <TAOS> : 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)

    pclkcr = 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
        #endif
    #endif
}

```

```

        #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)

```

Operation of Timer A (Event Counter Mode, 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
}

```

In order for this program to run properly, the Timer A0 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 21 (Timer A0 interrupt)

```

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

```

7. Reference

Renesas web-site

<http://www.renesas.com/>

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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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