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April 1st, 2010
Renesas Electronics Corporation

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M16C/80 Group

Operation of Timer A (pulse width modulation mode, 8-bit PWM mode)

1.0 Abstract

In pulse width modulation mode, choose functions from those listed in Table 1. Operations of the circled items are described below.

Table 1. Choosed functions

Item	Set-up	
Count source	**O**	Internal count source (f_1 / f_8 / f_{32} / fc_{32})
PWM mode		16-bit PWM
	O	8-bit PWM
Count start condition	**O**	External trigger input (falling edge of input signal to the TAi_{IN} pin)
		External trigger input (rising edge of input signal to the TAi_{IN} pin)
		Timer overflow (TB2/TAj/TAk overflow)

Note: j = i – 1, but j = 4 when i = 0; k = i + 1, but k = 0 when i = 4.

2.0 Introduction

Operation (1) If the TAi_{IN} pin input level changes from “H” to “L” with the count start flag set to “1”, the counter performs a down count on the count source. Also, the TAi_{OUT} pin outputs an “H” level.

(2) The TAi_{OUT} pin output level changes from “H” to “L” when a set time period elapses. At this time, the timer Ai interrupt request bit goes to “1”.

(3) The counter reloads the content of the reload register every time PWM pulses are output for one cycle, and continues counting.

(4) Setting the count start flag to “0” causes the counter to hold its value and to stop. Also, the TAi_{OUT} pin outputs an “L” level.

Note
- The period of PWM pulses becomes (m + 1) X (2^8 – 1) / fi, and the “H” level pulse width becomes n X (m + 1) / fi. If “00_{16}” is set in the eight higher-order bits of the timer Ai register, the pulse width modulator does not work, and the the TAi_{OUT} pin output level remains at “L”. (fi : frequency of the count source f1, f8, f32, fc32; m : values set to timer Ai register's low-order address n : values set to timer Ai register's high-order address)
- When a trigger is generated, the TAiout pin outputs “L” level of same amplitude as “H” level of the set PWM pulse, after which it starts PWM pulse output.
- Set TAi_{IN} pin's function select register A to I/O port and port direction register to “0”.
- Select TAi_{OUT} output function with the function select register A and B.
- When setting the function select registers A, B, and C, sets the function select registers B and/or C first, and then sets the function select register A.

Figure 1 shows the operation timing

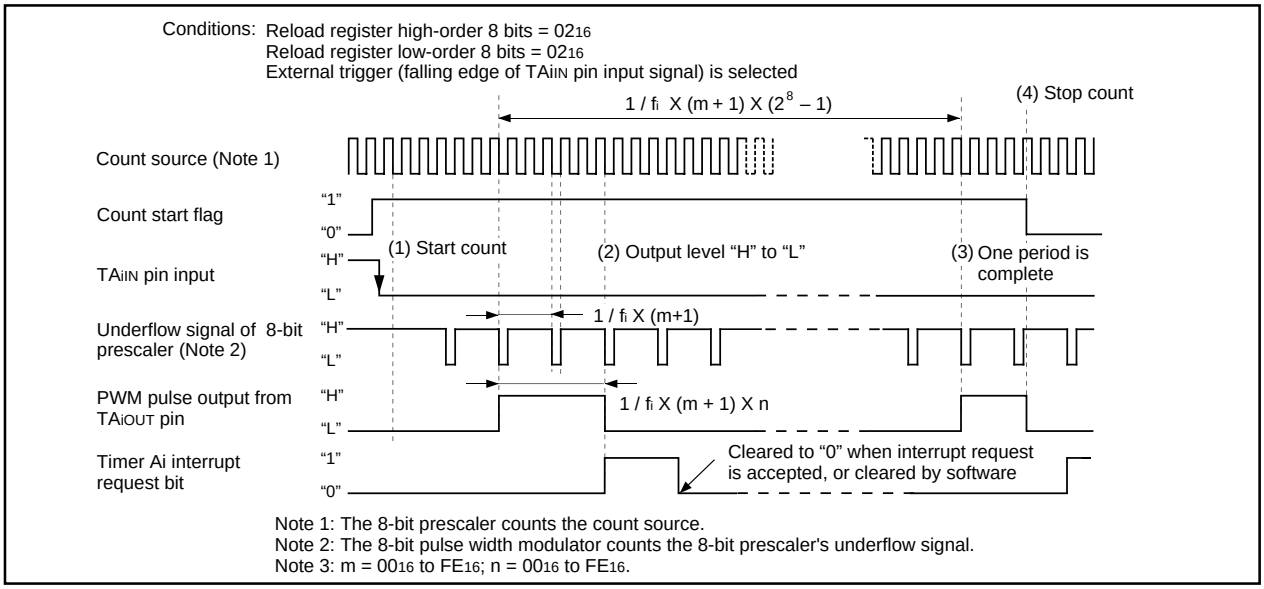


Figure 1. Operation timing of pulse width modulation mode, with 8-bit PWM mode

3.0 Set-up procedure

Selecting PWM mode and functions

b7 b6 b5 b4 b3 b2 b1 b0 = 1 1 0 1 1

Timer Ai mode register (i=0 to 4) [Address 0356$_{16}$ to 035A$_{16}$]
TAiMR (i=0 to 4)

Selection of PWM mode

External trigger select bit
0 : Falling edge of TAiIN pin's input signal (Note)

Trigger select bit
1 : Selected by event/trigger select register

16/8-bit PWM mode select bit
1 : Functions as a 8-bit pulse width modulator

Count source select bit
b7 b6
0 0 : f_1
0 1 : f_8
1 0 : f_{32}
1 1 : fc_{32}

b7	b6	Count source	Count source period f(X_{IN}):20MHz f(X_{CIN}):32.768kHz
0	0	f_1	50ns
0	1	f_8	400ns
1	0	f_{32}	1.6µs
1	1	fc_{32}	976.56µs

Note: Set the corresponding function select register A to I/O port and port direction register to “0”.

Setting function select register A and B

Function select register A1
[Address 03B1$_{16}$]
PS1

Port 7$_0$ output function select bit
0 : I/O port
1 : Peripheral function output (PSL1_0 enabled)

Port P7$_2$ output function select bit
0 : I/O port
1 : Peripheral function output (PSL1_2, PSC_0 enabled)

Port P7$_4$ function select bit
0 : I/O port
1 : Peripheral function output (PSL1_4 enabled)

Port P7$_6$ output function select bit
0 : I/O port
1 : TA3$_{OUT}$ output

Function select register A2
[Address 03B4$_{16}$]
PS2

Port 8$_0$ output function select bit
0 : I/O port
1 : Peripheral function output (PSL2_0 enabled)

Function select register B1
[Address 03B3$_{16}$]
PSL1

Port P7$_0$ output peripheral function select bit
0 : TxD$_2$(SDA$_2$) port
1 : TA0$_{OUT}$ output

Port P7$_2$ output peripheral function select bit
0 : Port P7$_2$ output peripheral subfunction select bit
1 : TA1$_{OUT}$ output

Port P7$_4$ output peripheral function select bit
0 : TA2$_{OUT}$ port
1 : W phase output

Function select register B2
[Address 03B6$_{16}$]
PSL2

Port P8$_0$ output peripheral function select bit
0 : TA4$_{OUT}$ output
1 : U phase output

Function select register C [Address 03AF$_{16}$]
PSC

Port P7$_2$ output peripheral subfunction select bit
0 : Must set "0" in selecting TA1$_{OUT}$ output

Clearing timer Ai interrupt request bit

(Please refer to the notes on the pulse width modulation mode of Timer A in the User's manual.)

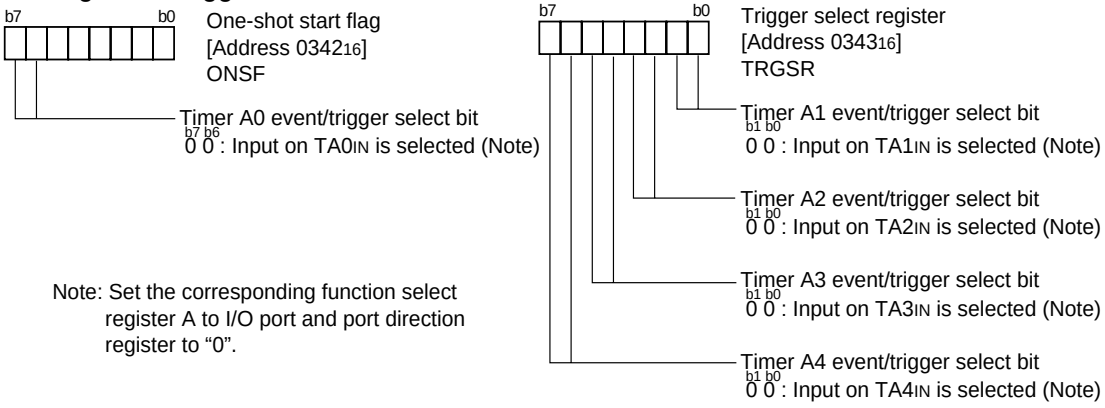
Timer Ai interrupt control register
[Addresses 006C$_{16}$, 008C$_{16}$, 006E$_{16}$, 008E$_{16}$, 0070$_{16}$]
TAiIC (i=0 to 4)

Interrupt request bit

Continued to the next page

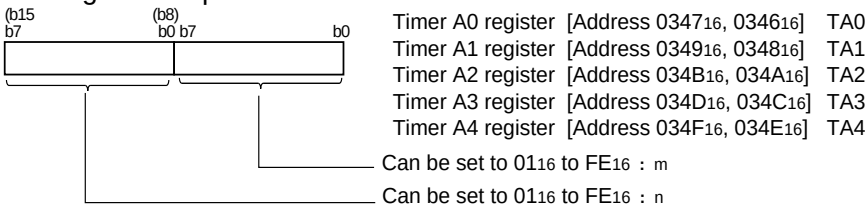
Continued from the previous page

Setting event/trigger select bit



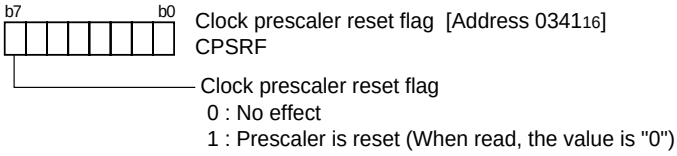
Note: Set the corresponding function select register A to I/O port and port direction register to “0”.

Setting PWM's pulse's "H" level width

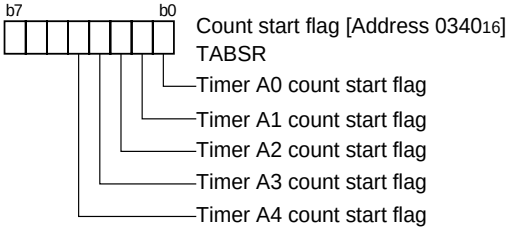


Setting clock prescaler reset flag

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



Setting count start flag



Start count

4.0 Programming Code

```
;***********************************************************************************
;
;   M16C/80 Program Collection
;
;   FILE NAME : rjj05b0133_src.a30
;   CPU       : M16C/80 Group
;   FUNCTION  : Operation of Timer A
;               (pulse width modulation mode, 8-bit PWM mode)
;   HISTORY   : 2003.06.16  Ver 1.00
;
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;
;***********************************************************************************
;***********************************************************************************
;       Include
;***********************************************************************************
        .LIST       OFF             ;Stops outputting lines to the assembler list file
        .INCLUDE    sfr80100.inc    ;Reads the file that defined SFR
        .LIST       ON              ;Starts outputting lines to the assembler list file
;
;***********************************************************************************
;       Symbol definition
;***********************************************************************************
ROM_TOP         .EQU    0FFC000H    ;Start address of ROM
FIXED_VECT_TOP  .EQU    0FFFFDCH    ;Start address of fixed vector
;
;***********************************************************************************
;       Program area
;***********************************************************************************
;=================================================================================
;       Start up
;=================================================================================
        .SECTION    PROGRAM, CODE  ;Declares section name and section type
        .ORG        ROM_TOP        ;Declares start address
RESET:
        ; Sets Processor mode, System clock and Main clock division
        MOV.B    #03H, prcr        ;Removes protect
        MOV.B    #10000000B, pm0   ; Single-chip mode
        MOV.B    #11000000B, pm1   ; Flash memory version
        MOV.B    #00001000B, cm0   ; Xcin-Xcout High
        MOV.B    #00100000B, cm1   ; Xin-Xout High
        MOV.B    #00010010B, mcd   ; No division mode
        MOV.B    #00H, prcr        ;Protects all registers
;
```

```
;===============================================================================
;       TimerA (pulse width modulation mode,8-bit PWM mode selected)
;===============================================================================
        ; Selecting PWM mode and function
        MOV.B    #01110011B, ta1mr
;                 ||||||++---------;Selection of PWM mode
;                 |||||+-----------;This bit is invalid in M16C/80 series
;                 ||||+------------;External trigger select bit
;                 ||||              (0:Falling edge of TA1IN pin's input signal) (Note)
;                 |||+-------------;Trigger select bit
;                 |||               (1:Selected by event/trigger select register)
;                 ||+--------------;16/8-bit PWM mode select bit
;                 ||                (1:Functions as an 8-bit pulse width modulator)
;                ++---------------;Count source (01:f8)
        ; Clearing timer A1 interrupt request bit
        MOV.B    #00000000B, ta1ic
;                    +------------;Interrupt request bit
        ; Setting function select register A and B (Setting pulse output function)
        BSET     psl1_2            ;Port P72 peripheral function select bit (TA1OUT output)
        BCLR     psc_0             ;Must set "0" in selecting TA1OUT output
        BSET     ps1_2             ;Port P72 function select bit (peripheral function output)
        ; Setting event/trigger select bit
        MOV.B    #00000000B, trgsr
;                      ++---------;Input on TA1IN is selected (Note)
        ; (Note) Set the corresponding function select register A to I/O port
        ; and port direction register to "0"
        BCLR     pd7_3             ;Port P73 direction register
        BCLR     ps1_3             ;Port P73 is I/O port
        ; Setting PWM pulse's period and "H" level width
        MOV.W    #6463H, ta1
;                 ||++-------------;m = timer Ai register's low-order address
;                 ++---------------;n = timer Ai register's high-order address
;                                   PWM pulse's period: 10.2(msec), @20MHz,f8
;                                   "H" level width: 4(msec), @20MHz,f8
        ; Setting clock prescaler reset flag
        ; (This function is effective when fC32 is selected as the count source)
        MOV.B    #00000000B, cpsrf
;                 +---------------;Clock prescaler reset flag (0:No effect)
        ; Setting count starts flag
        MOV.B    #00000010B, tabsr
;                      +----------;Timer A1 count start flag
;
MAIN:
        JMP      MAIN
;
;===============================================================================
;       Dummy interrupt processing program
;===============================================================================
dummy:
        REIT
;
;*******************************************************************************
;       Setting of fixed vector
;*******************************************************************************
        .SECTION    F_VECT, ROMDATA
        .ORG        FIXED_VECT_TOP
;
        .LWORD    dummy    ;Undefined instruction
        .LWORD    dummy    ;Overflow
        .LWORD    dummy    ;BRK instruction execution
        .LWORD    dummy    ;Address match
        .LWORD    dummy    ;
        .LWORD    dummy    ;Watchdog timer
        .LWORD    dummy    ;
        .LWORD    dummy    ;NMI
        .LWORD    RESET    ;Reset
;
        .END
```

5.0 Reference

Renesas Technology Corporation Semiconductor Home page

http://www.renesas.com/

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E-mail: support_apl@renesas.com

Data Sheet

M16C/80 group Rev. E3
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User's Manual

M16C/80 group Rev. B
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