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Renesas Electronics Corporation

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M32C/84, 85, 86, 87, 88 Group

Timer A Operation in Pulse Width Modulation Mode (16-Bit PWM)

1. Abstract

In pulse width modulation mode, the timer continuously outputs pulses of desired width for a fixed period. An interrupt request is generated on the falling edge of the PWM output.

PWM "H" output width = (timer register value) × timer count source period

PWM output period = $(2^{16} - 1) \times$ timer count source period

f1 = 32 MHz, fC = 32.768 kHz

Count Source	Count Source Period	"H" Width	PWM Period
f1	31.25 ns	31.25 ns to approx. 2.047 ms	2.048 ms
f8	250 ns	250 ns to approx. 16.383 ms	16.384 ms
f2n (n = 15)	937.5 ns	937.5 ns to approx. 61.43 ms	61.44 ms
fC32	Approx. 0.977 ms	Approx. 0.977 ms to approx. 63.99s	64s

2. Introduction

The application example described in this document is applied to the following MCUs and parameter(s):

MCUs: M32C/84 Group
 M32C/85 Group
 M32C/86 Group
 M32C/87 Group
 M32C/88 Group

This program can be used with other M16C Family MCUs which have the same special function registers (SFRs) as the above MCUs. Check the manual for any additions and modifications to functions. Careful evaluation is recommended before using this application note.

3. Application Example

This section describes how to perform the PWM output with a 1.00 ms “H” width and a 16.384 ms period when a rising edge is input to the TAIIN pin, using the count source f8.

3.1 Example Description

- (1) If the input signal to the TAIIN pin changes from “L” to “H” while the TAIIS bit in the TABSR register is set to 1 (count started), the counter decrements the count source.
 At the same time, the output level on the TAIOUT pin becomes “H”.
- (2) The output level on the TAIOUT pin changes to “H” to “L” when a set time period elapses.
 At the same time, the IR bit in the TAIIC register is set to 1 (interrupt requested).
- (3) The counter reloads the content of the reload register and continues counting every time PWM pulses are output for one period.
- (4) Setting the TAIIS bit in the TABSR register to 0 (count stopped) causes the counter to hold its value and to stop.
 If the TAIOUT pin output is held at “H” at this time, the timer output becomes “L” and the IR bits becomes 1 (interrupt requested). If the TAIOUT pin output is held at “L”, the output is not affected and no interrupt request is generated.

If 0000h is set to the timer Ai register, the pulse width modulator does not run, the TAIOUT pin outputs “L” and no timer Ai interrupt request is generated.

Figure 1 shows the Pulse Width Modulation Mode Operation, 16-Bit PWM.

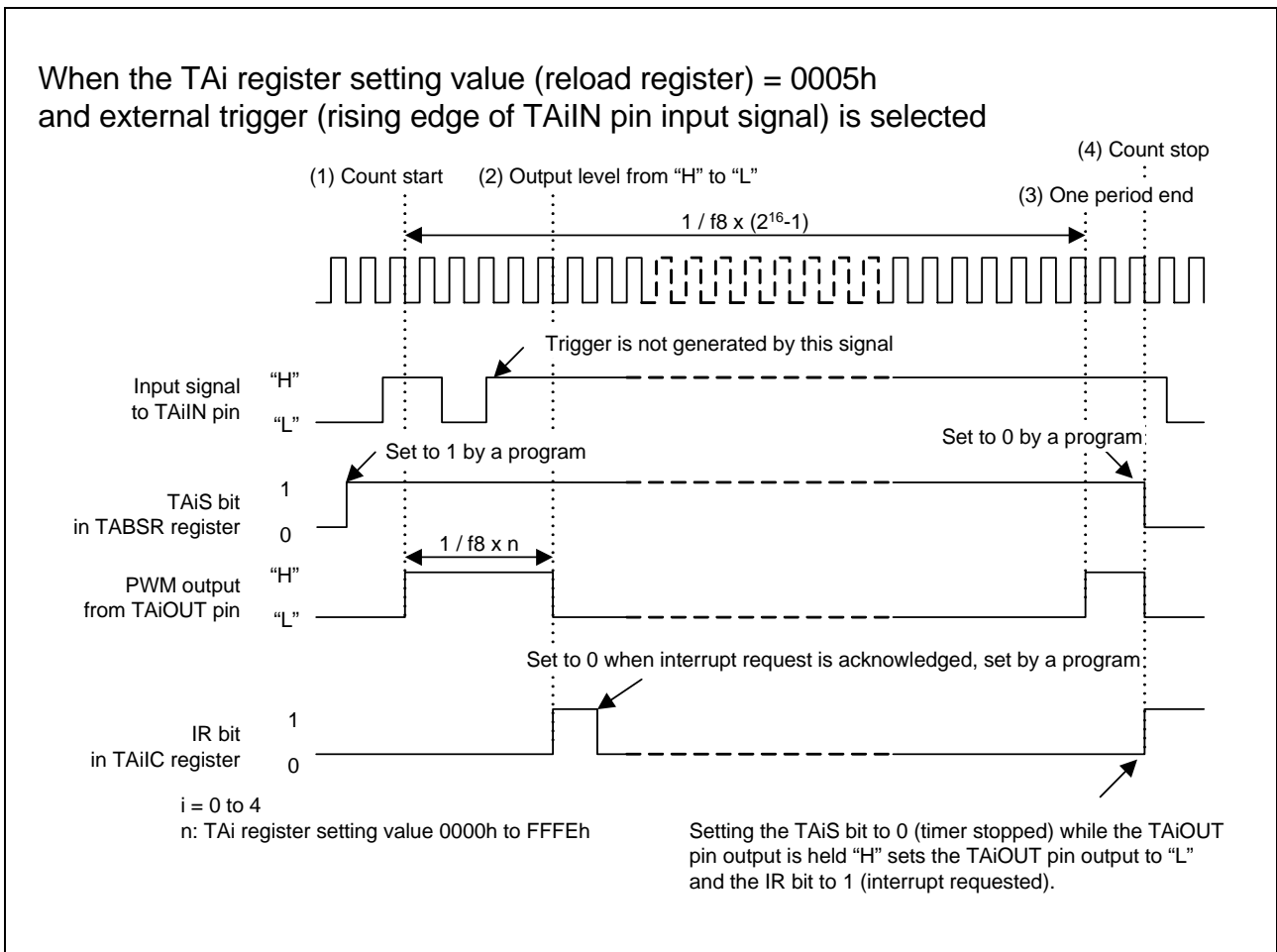


Figure 1 Pulse Width Modulation Mode Operation, 16-Bit PWM

3.2 Setup

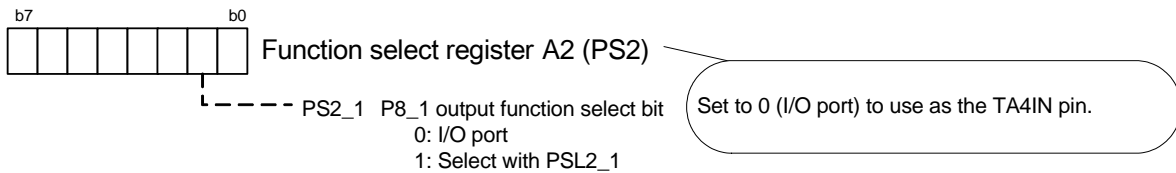
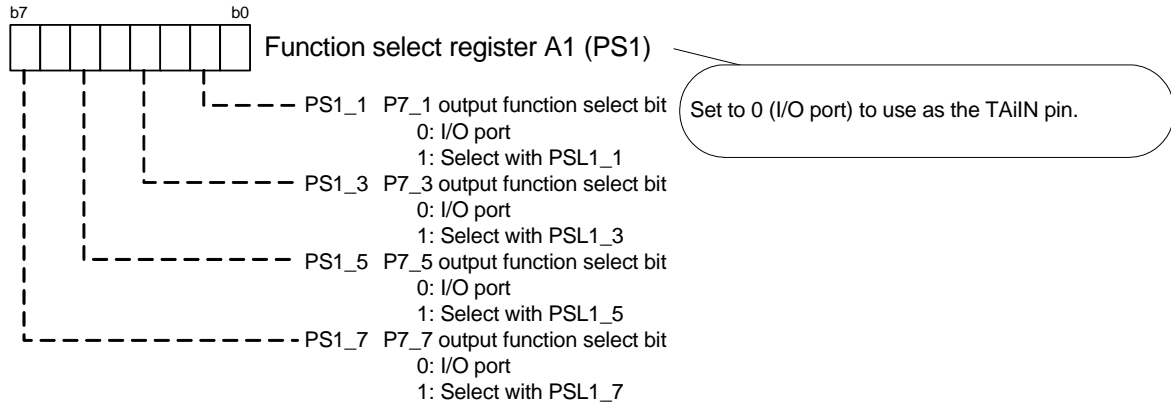
This section shows the setting steps and values to perform the application example described in

3.1 Example Description.

Refer to the each MCUs Hardware Manual for the details of individual registers.

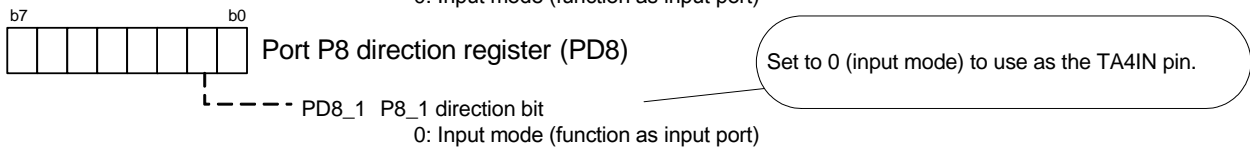
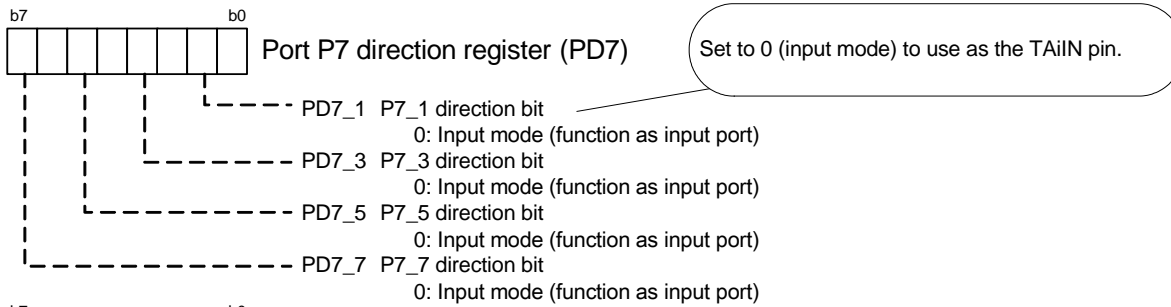
(1) Set the function select registers

The TAIIN pins are assigned to P7_1 (TA0IN), P7_3 (TA1IN), P7_5 (TA2IN), P7_7 (TA3IN), and P8_1 (TA4IN).
 Select I/O ports using the function select registers.



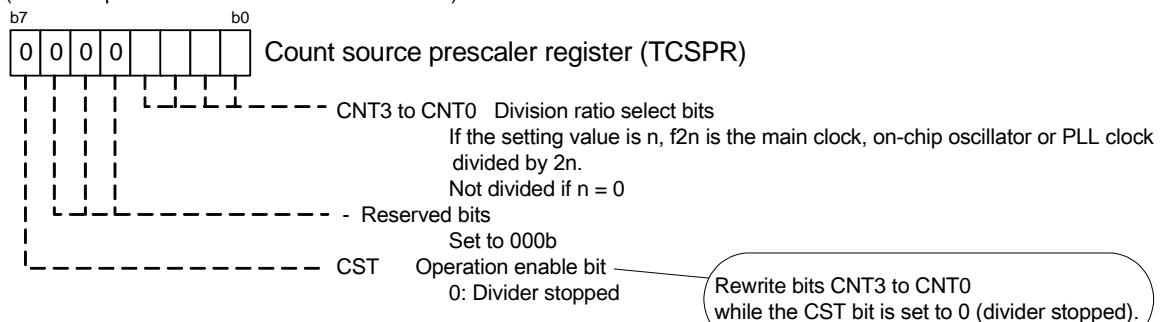
(2) Set the port P7 register and the port P8 direction register

Set the pin to use as the TAIIN pin to an input port.

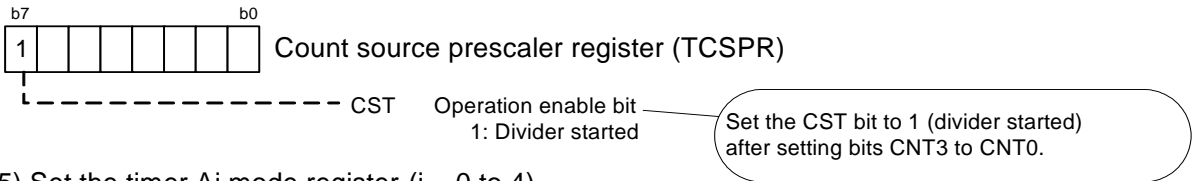


(3) Set the count source prescaler register

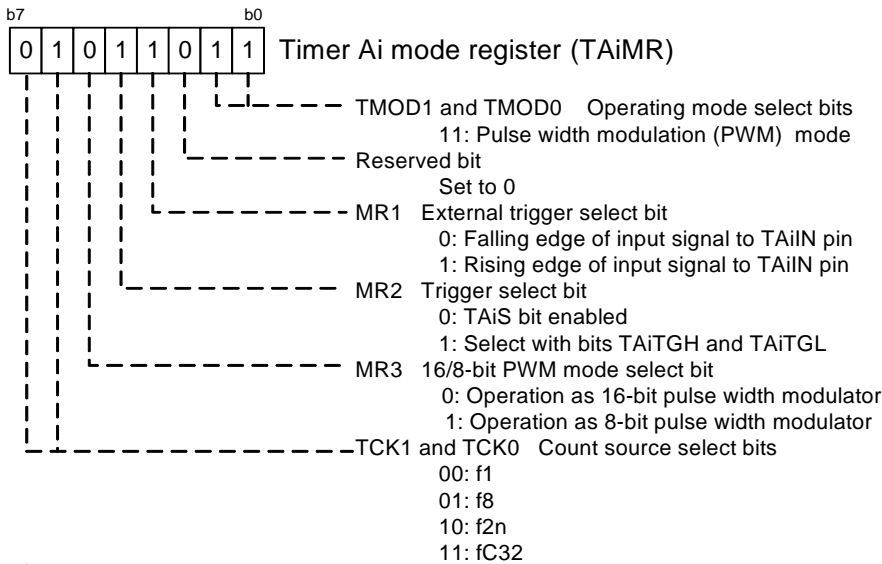
(This is required to use f2n as the count source.)



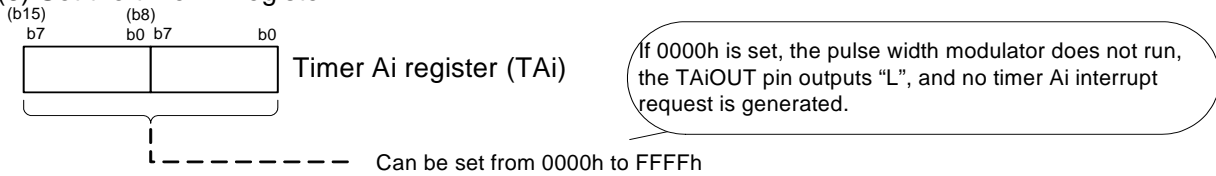
(4) Set the count source prescaler register (divider operation)
 (This is required to use f_{2n} as the count source.)



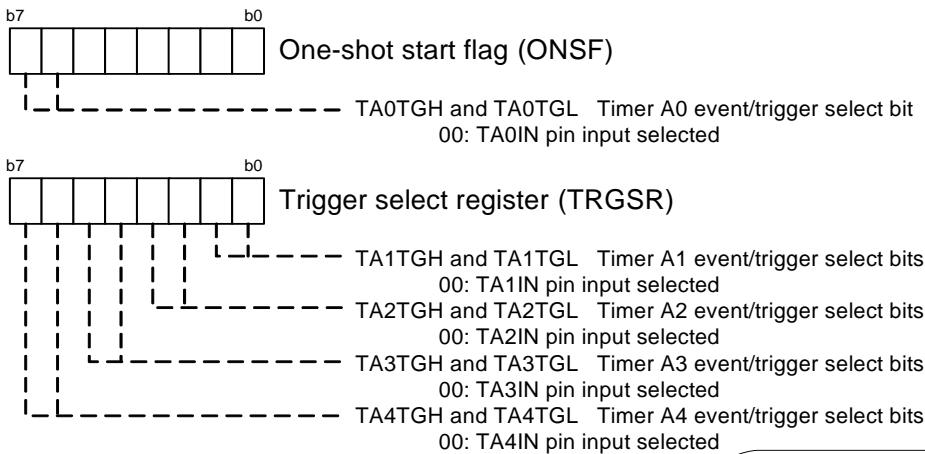
(5) Set the timer Ai mode register (i = 0 to 4)



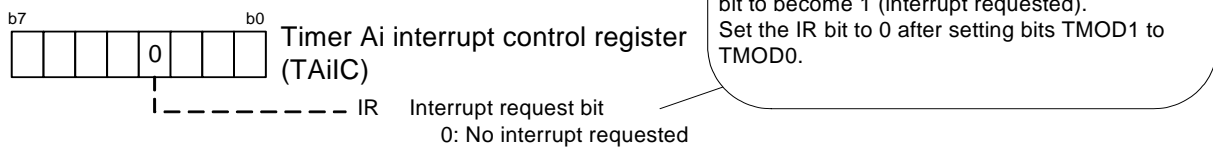
(6) Set the timer Ai register



(7) Set the one-shot start flag and the trigger select register

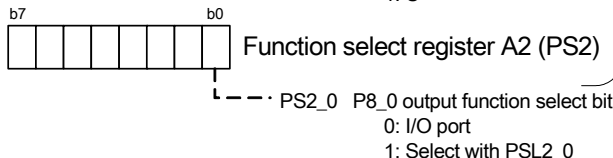
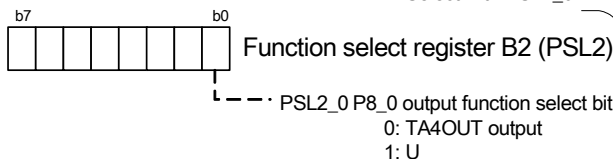
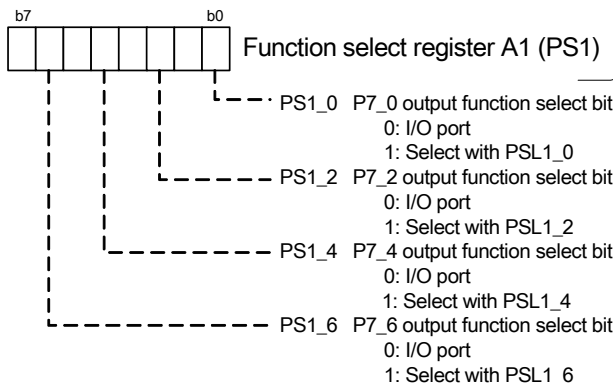
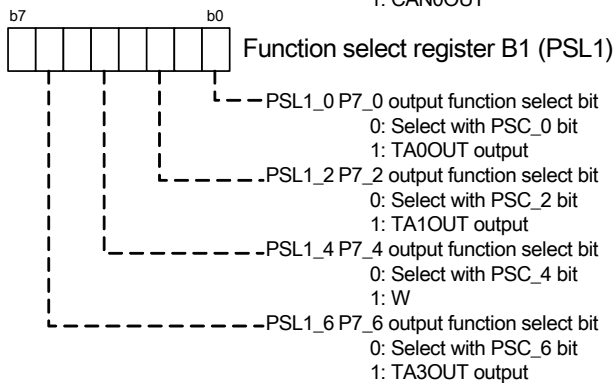
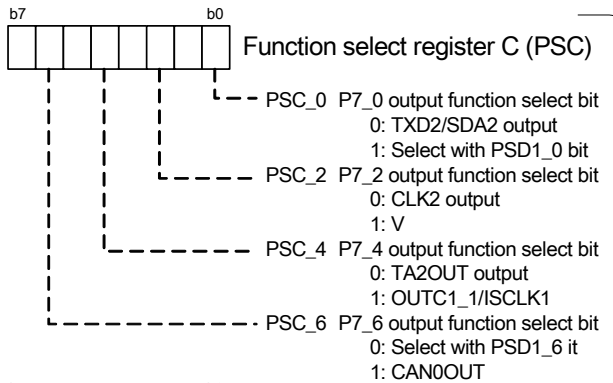


(8) Clear the interrupt request bit



(9) Set the function select registers

The timer output pins are assigned to P7_0 (TA0OUT), P7_2 (TA1OUT), P7_4 (TA2OUT), P7_6 (TA3_OUT), and P8_0 (TA4OUT). To perform the pulse output using the timer function, select timer output for the pin function by setting the function select registers.



The P7 function can be selected with registers PS1, PSL1, and PSC. When the TAiOUT pin (i = 0 to 3) is used for the output function, the settings are follows:

Pin	Bit and Setting Value		
	PS1 register ⁽²⁾	PSL1 register	PSC register
P7_0 (TA0OUT) ⁽¹⁾	PS1_0 = 1	PSL1_0 = 1	PSC_0 = 0
P7_2 (TA1OUT)	PS1_2 = 1	PSL1_2 = 1	PSC_2 = 0
P7_4 (TA2OUT)	PS1_4 = 1	PSL1_4 = 0	PSC_4 = 0
P7_6 (TA3OUT)	PS1_6 = 1	PSL1_6 = 1	PSC_6 = 0

NOTES:

- The P7_0 (TA0OUT) pin is for N-channel open drain output.
- Set the PS1 register last for the bit setting order.

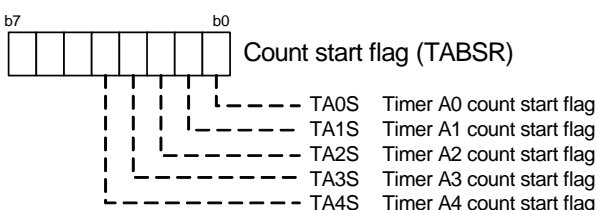
The P8 function can be selected with registers PS2 and PSL2. When the TA4OUT pin is used for the output function, the settings are follows:

Pin	Bit and Setting Value	
	PS2 register ⁽³⁾	PSL2 register
P8_0 (TA4OUT)	PS2_0 = 1	PSL2_0 = 0

NOTE:

- Set the PS2 register last for the bit setting order.

(10) Set the count start flag



4. Sample Programming Code

A sample program can be downloaded from the Renesas Technology website.
For download, click “Application Notes” in the left-hand side menu of the M16C Family page.

5. Reference Documents

Hardware Manuals

M32C/84 Group Hardware Manual

M32C/85 Group Hardware Manual

M32C/86 Group Hardware Manual

M32C/87 Group Hardware Manual

M32C/88 Group Hardware Manual

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REVISION HISTORY	M32C/84, 85, 86, 87, 88 Group Timer A Operation in Pulse Width Modulation Mode (16-Bit PWM)
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Rev.	Date	Description	
		Page	Summary
1.00	Sep.10, 2006	-	First Edition issued

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