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

Timer A Operation in Pulse Width Modulation Mode (8-Bit PWM)

1. Abstract

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

$$\text{PWM "H" output width} = (\text{timer register high-order 8-bit value}) \times (\text{timer register low-order 8-bit value} + 1) \times \text{timer count source period}$$

$$\text{PWM period} = (2^8 - 1) \times (\text{timer register low-order 8-bit value} + 1) \times \text{timer count source period}$$

$$f1 = 32 \text{ MHz, } fC = 32.768 \text{ kHz}$$

Count Source	Count Source Period	“H” Width	PWM Period
f1	31.25 ns	31.25 ns to 2.032 ms	Approx. 7.97 us to 2.04 ms
f8	250 ns	250 ns to 16.256 ms	Approx. 63.75 us to 16.32 ms
f2n (n = 15)	937.5 ns	937.5 ns to 60.96 ms	Approx. 239.1 us to 61.2 ms
fC32	Approx. 0.977 ms	Approx. 0.977 ms to 63.5s	Approx. 249.0 ms to 63.75s

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 a PWM output with a 1.00 ms “H” width and a 10.20 ms period when a falling 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 “H” to “L” while the TAI S bit in the TABSR register is set to 1 (count started), the counter decrements the count source.
The output level on the TAIOUT pin becomes “H” (see NOTE below).
- (2) The output level on the TAIOUT pin changes to “H” to “L” when a set time period elapses.
Simultaneously, 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 TAI S bit 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 is set to 1 (interrupt requested).
If the TAIOUT pin output is held “L”, the output is not affected and no interrupt request is generated.

If 00h is set to the high-order 8-bits of the timer Ai register, the pulse width modulator does not run, the TAIOUT pin outputs “L” and no timer Ai interrupt request is generated.

NOTE:

After a trigger is generated, the TAIOUT pin outputs “L” whose width is the same as the set H” width of PWM pulses, and then starts outputting PWM pulses.

Figure 1 shows the Pulse Width Modulation Mode Operation, 8-Bit PWM.

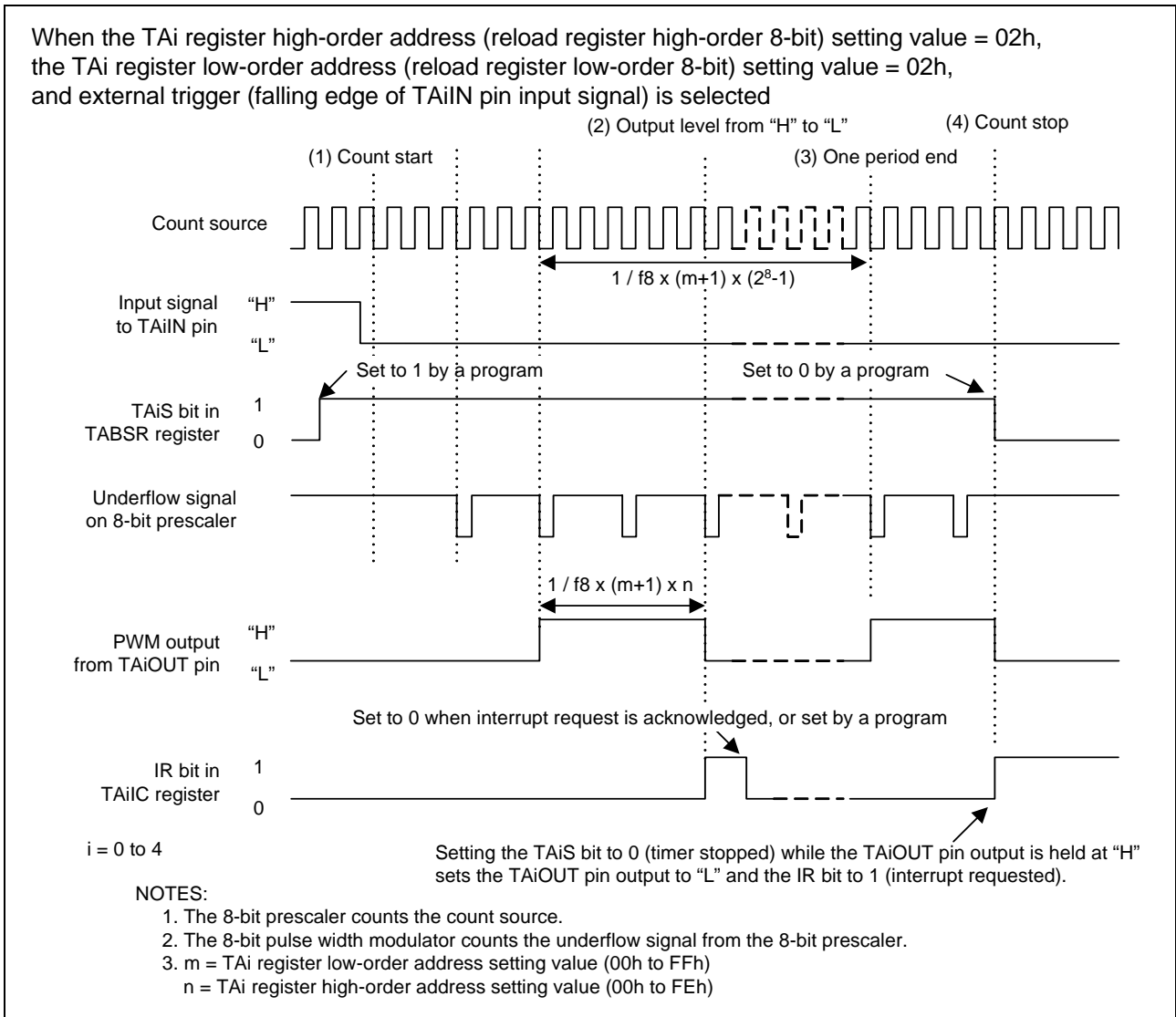


Figure 1 Pulse Width Modulation Mode Operation, 8-Bit PWM

3.2 Setup

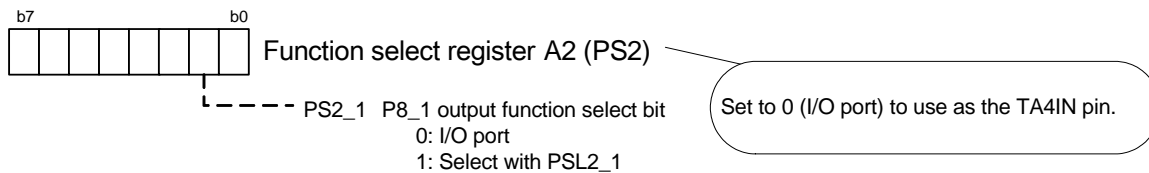
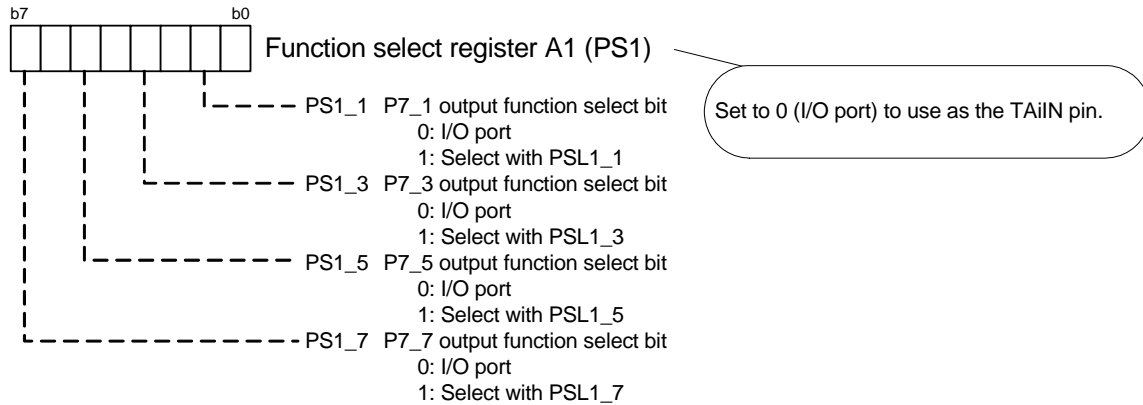
This section shows the setting steps and values to perform the application example described in

3.1 Example Description.

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

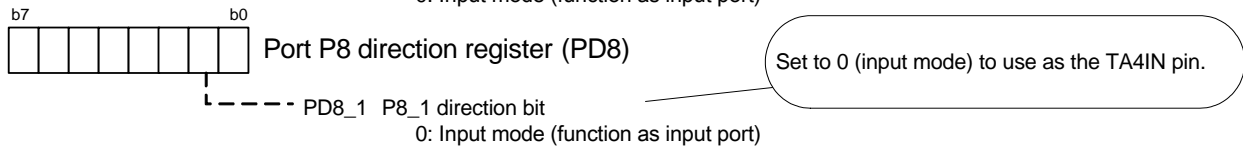
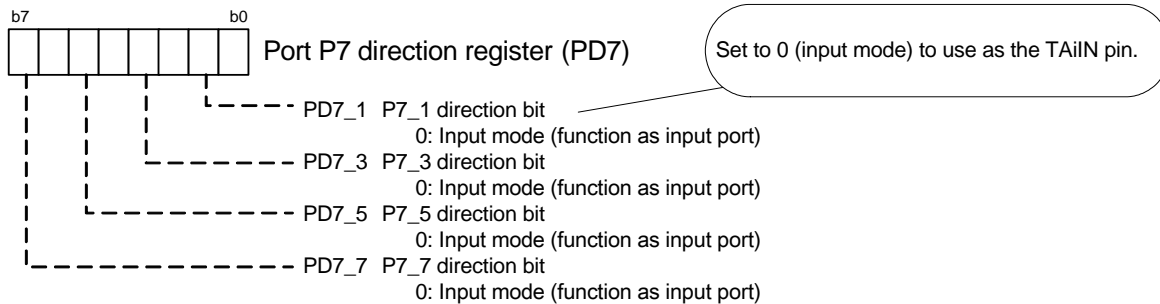
(1) Set the function select registers

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.



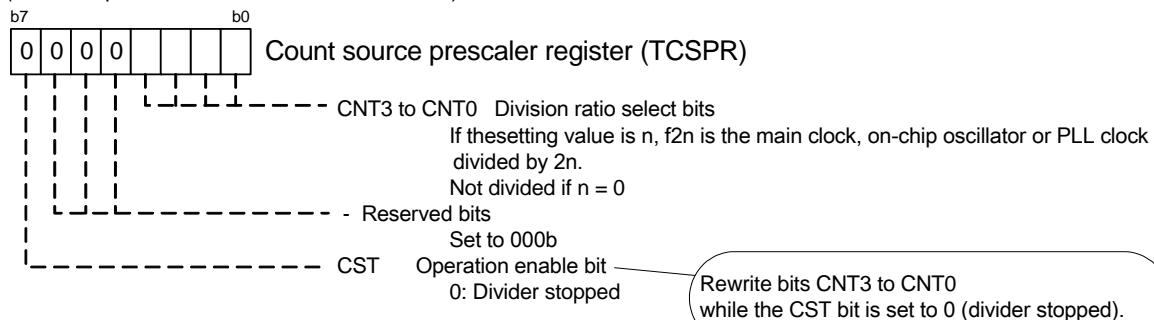
(2) Set the port P7 register and the port P8 direction register

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



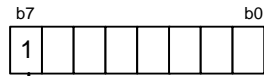
(3) Set the count source prescaler register

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



(4) Set the count source prescaler register (divider operation)

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

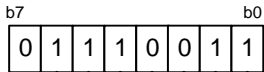


Count source prescaler register (TCSPR)

CST Operation enable bit
 1: Divider started

Set the CST bit to 1 (divider started) after setting bits CNT3 to CNT0.

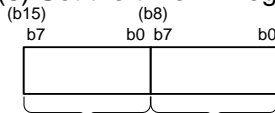
(5) Set the timer Ai mode register (i = 0 to 4)



Timer Ai mode register (TAiMR)

TMOD1 and TMOD0 Operating mode select bits
 11: PWM mode
 Reserved bit
 Set to 0.
 MR1 External trigger select bit
 0: Falling edge of input signal to TAiIN pin
 1: Rising edge of input signal to TAiIN pin
 MR2 Trigger select bit
 0: TAiS bit enabled
 1: Select with bits TAiTGH and TAiTGL
 MR3 16/8-bit PWM mode select bit
 0: Operation as 16-bit pulse width modulator
 1: Operation as 8-bit pulse width modulator
 TCK1 and TCK0 Count source select bits
 00: f1
 01: f8
 10: f2n
 11: fC32

(6) Set the timer Ai register



Timer Ai register (TAi)

Low-order 8 bits: Can be set from 00h to FFh
 High-order 8 bits: Can be set from 00h to FEh

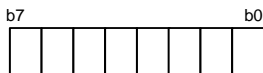
If 00h is set to the high-order 8 bits, the pulse width modulator does not run, the TAiOUT pin outputs "L", and no timer Ai interrupt request is generated.

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



One-shot start flag (ONSF)

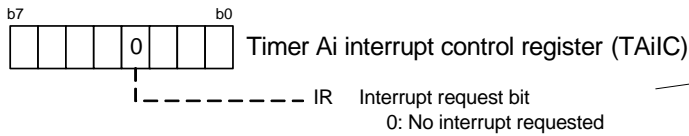
TA0TGH and TA0TGL Timer A0 event/trigger select bit
 00: TA0IN pin input selected



Trigger select register (TRGSR)

TA1TGH and TA1TGL Timer A1 event/trigger select bits
 00: TA1IN pin input selected
 TA2TGH and TA2TGL Timer A2 event/trigger select bits
 00: TA2IN pin input selected
 TA3TGH and TA3TGL Timer A3 event/trigger select bits
 00: TA3IN pin input selected
 TA4TGH and TA4TGL Timer A4 event/trigger select bits
 00: TA4IN pin input selected

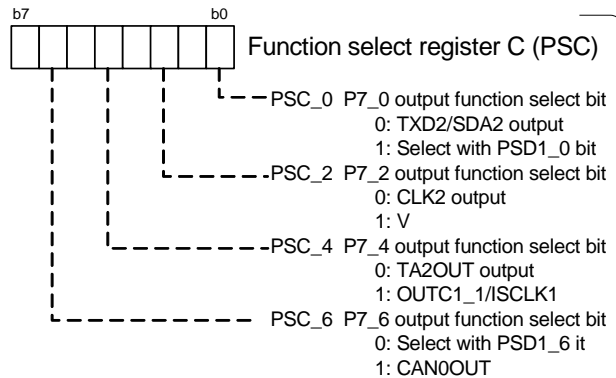
(8) Clear the interrupt request bit



Setting bits TMOD1 to TMOD0 in the TAIMR register to 11b (PWM mode) may cause the IR bit to become 1 (interrupt requested). Set the IR bit to 0 after setting bits TMOD1 to TMOD0.

(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.

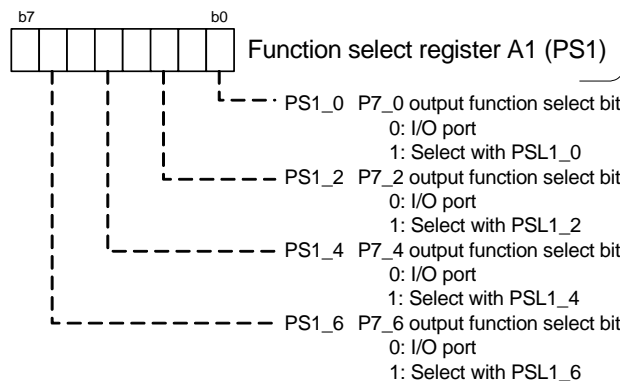
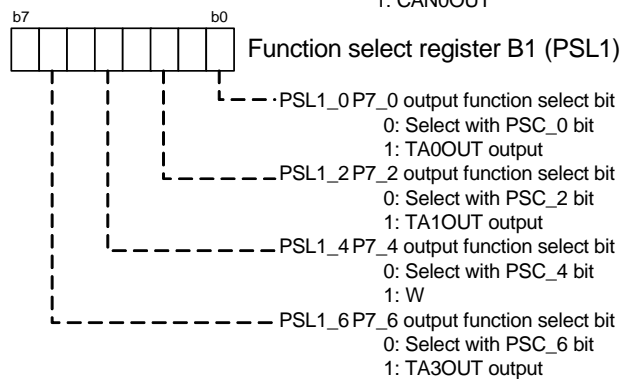


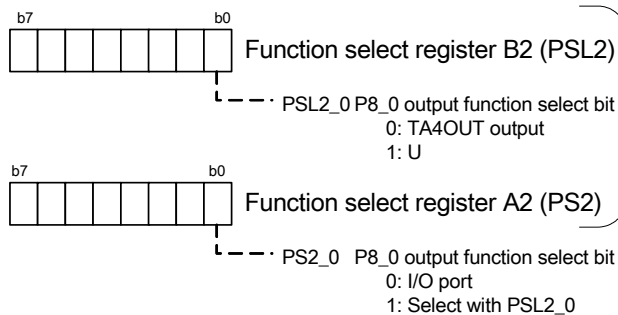
The P7 function can be selected with registers PS1, PSL1, and PSC. When the TAIOUT pin (i = 0 to 3) is used for the output function, the settings are as follows:

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.



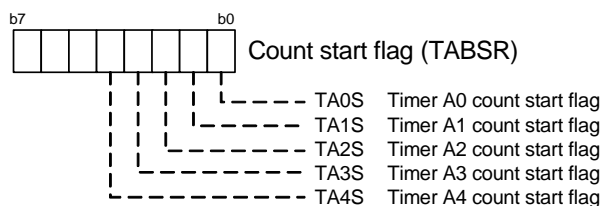


The P8 function can be selected by registers PS2 and PSL2. When the TA4OUT pin is used for the output function, the settings are follows:

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

NOTE:
 3. 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 (8-Bit PWM)
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Rev.	Date	Description	
		Page	Summary
1.00	Sep.10, 2006	-	First Edition issued

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