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## M16C/65 Group

### Operation of Timer A (one-shot timer mode, external trigger)

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#### 1. Abstract

In one-shot timer mode, choose functions from those listed in Table 1. Operations of the circled items are described below.

#### 2. Introduction

This application note is applied to the M16C/65, group Microcomputers.

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

### 3. Chosen functions

**Table 1. Chosen functions**

Item	Set-up	
Count source	<input type="radio"/>	Internal count source (f1TIMAB/f2TIMAB/f8TIMAB/f32TIMAB/f64TIMAB/foco-F/foco-s/fc32)
Pulse output function	<input type="checkbox"/>	No pulse output
	<input type="radio"/>	Pulses output
Count start condition	<input type="checkbox"/>	External trigger input (falling edge of input signal to the TAIIN pin)
	<input type="radio"/>	External trigger input (rising edge of input signal to the TAIIN pin)
	<input type="checkbox"/>	Timer overflow (TB2/TAj/TAk overflow)
	<input type="checkbox"/>	Writing "1" to the one-shot start flag
Output polar control	<input type="radio"/>	Output waveform "H" active
	<input type="checkbox"/>	Output waveform "L" active (output reversed)

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

### 4. Operation

- (1) If the TAIIN pin input level changes from "L" to "H" with the count start flag set to "1", the counter performs a down count on the count source. At this time, the TAIOUT pin output level goes to "H" level.
- (2) If the value of the counter becomes "0000h", the TAIOUT pin outputs an "L" level, and the counter reloads the content of the reload register and stops counting. At this time, the timer Ai interrupt request bit goes to "1".
- (3) If a trigger occurs while a count is in progress, the counter reloads the value of the reload register again and continues counting. The reload timing is in step with the next count source input after the trigger.
- (4) Setting the count start flag to "0" causes the counter to stop and to reload the content of the reload register. Also, the TAIOUT pin outputs an "L" level. At this time, the timer Ai interrupt request bit goes to "1".

Note: When the timer Ai register is set to "0000h", the counter does not operate and the timer Ai interrupt request is not generated. When the pulse is set to output, the pulse does not output from the TAIOUT pin.

Figure 1 shows the operation timing.

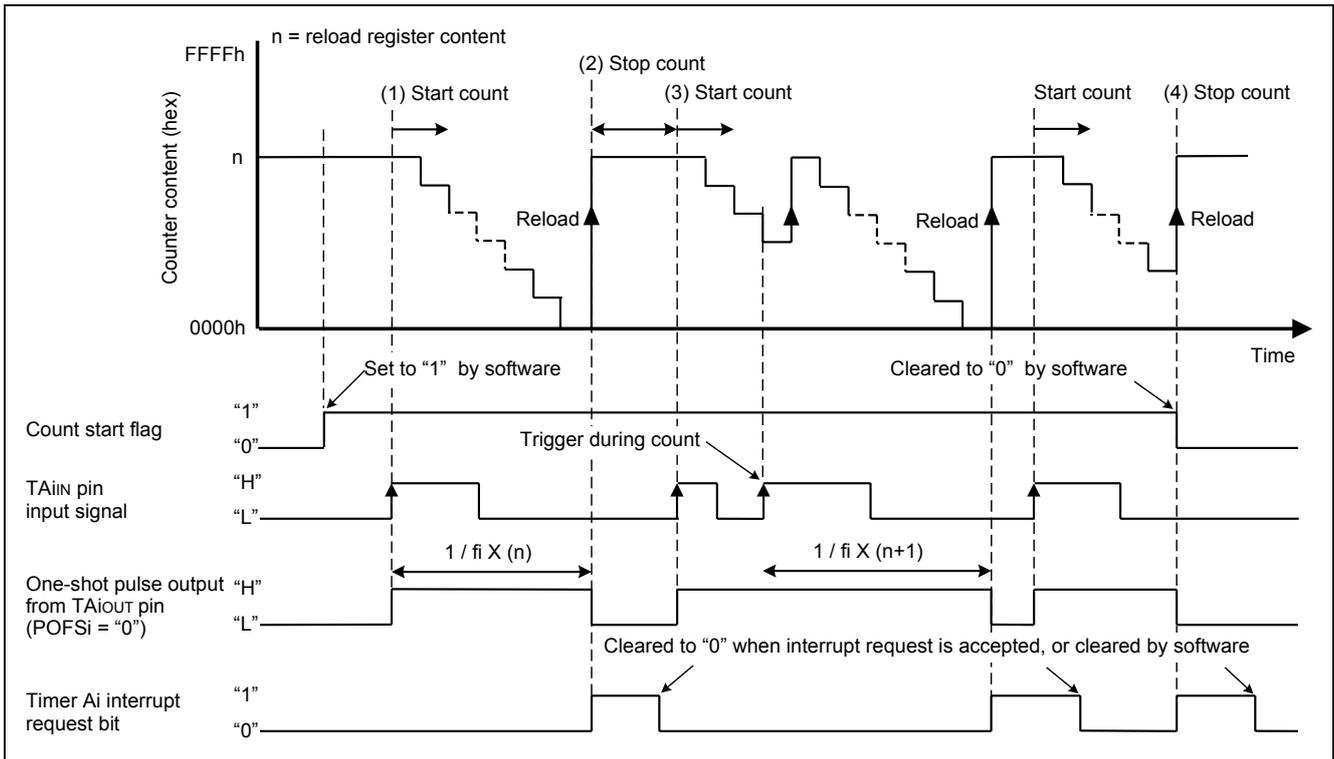


Figure 1. Operation timing of one-shot

**5. Set-up procedure**

Table 2 shows Timer A count source, Figure 2 shows block diagram of Timer A count source in timer mode.

**Table 2. Count Source Selection of Timer A**

TCKDIV00 register (Note 1)	TACSj register (Note 2)				TAiMR register		Count source	Count source period
	TCS3/ TCS7	TCS2/ TCS6	TCS1/ TCS5	TCS0/ TCS4	TCK1	TCK0		f(X <sub>IN</sub> ):20MHz f(X <sub>CIN</sub> ):32.768kHz f(oco-F):about 20MHz f(oco-s):about 125kHz
0	0	-	-	-	0	0	f <sub>1</sub> TIMAB/ f <sub>2</sub> TIMAB (Note 3)	50ns/100ns
0	0	-	-	-	0	1	f <sub>8</sub> TIMAB	400ns
0	0	-	-	-	1	0	f <sub>32</sub> TIMAB	1600ns
0	0	-	-	-	1	1	fc <sub>32</sub>	976.56μs
0	1	0	0	0	-	-	f <sub>1</sub> TIMAB/ f <sub>2</sub> TIMAB (Note 3)	50ns/100ns
0	1	0	0	1	-	-	f <sub>8</sub> TIMAB	400ns
0	1	0	1	0	-	-	f <sub>32</sub> TIMAB	1600ns
0	1	0	1	1	-	-	f <sub>64</sub> TIMAB	3200ns
0	1	1	0	0	-	-	foco-F	about 50ns
0	1	1	0	1	-	-	foco-s	about 8μs
0	1	1	1	0	-	-	fc <sub>32</sub>	976.56μs
1	1	0	0	0	-	-	f <sub>1</sub> TIMAB/ f <sub>2</sub> TIMAB (Note 3)	about 50ns/100ns
1	1	0	0	1	-	-	f <sub>8</sub> TIMAB	about 400ns
1	1	0	1	0	-	-	f <sub>32</sub> TIMAB	about 1600ns
1	1	0	1	1	-	-	f <sub>64</sub> TIMAB	about 3200ns

Note 1: TCDIV00 bit is clock select prior to timer AB division bit. Set the TCDIV00 bit before setting other registers associated with timer A. After changing the TCDIV00 bit, set other registers associated with timer A again.

Note 2: TCS3~TCS0 bits of TACS0 register correspond to Timer A0 count source selection, TCS7~TCS4 bits of TACS0 register correspond to Timer A1 count source selection, TCS3~TCS0 bits of TACS1 register correspond to Timer A2 count source selection, TCS7~TCS4 bits of TACS1 register correspond to Timer A3 count source selection, and TCS3~TCS0 bits of TACS2 register correspond to Timer A4 count source selection.

Note 3: When the PCLK0 bit in the PCLKR register is "1", the selected clock source is f<sub>1</sub>TIMAB. When the PCLK0 bit is "0", the selected clock source is f<sub>2</sub>TIMAB.

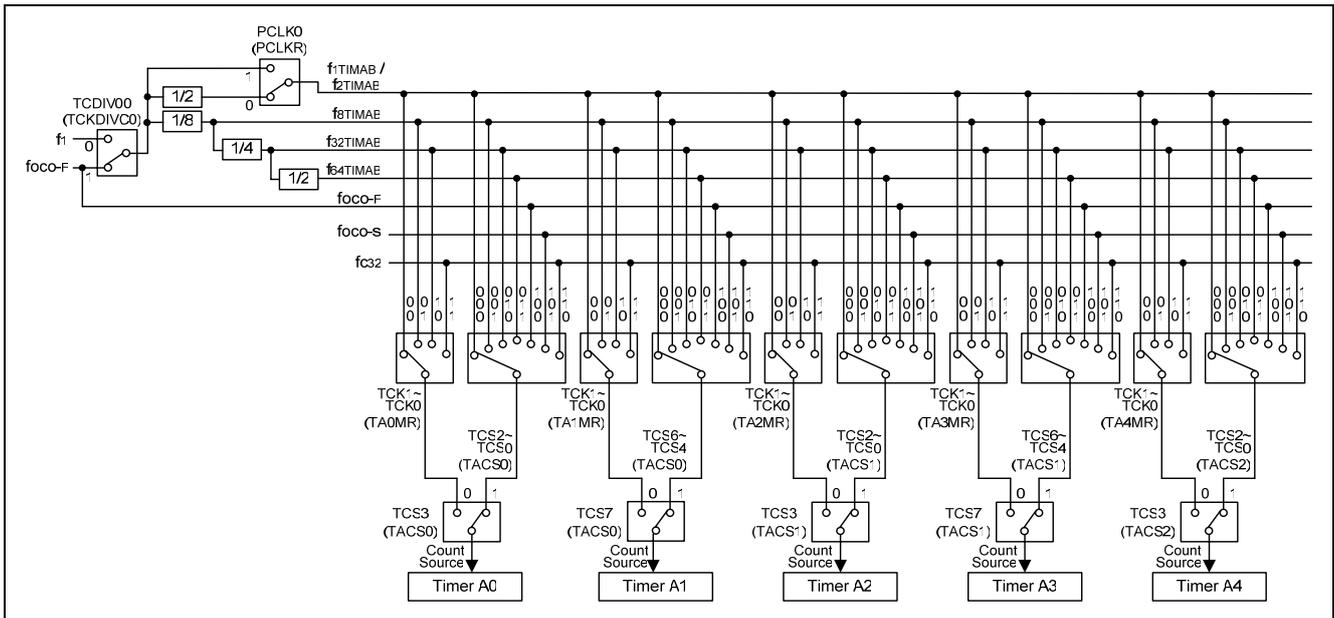
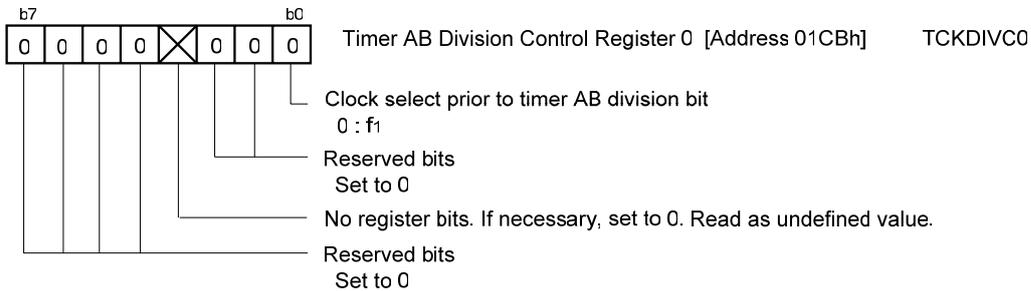


Figure 2. Count source of Timer A

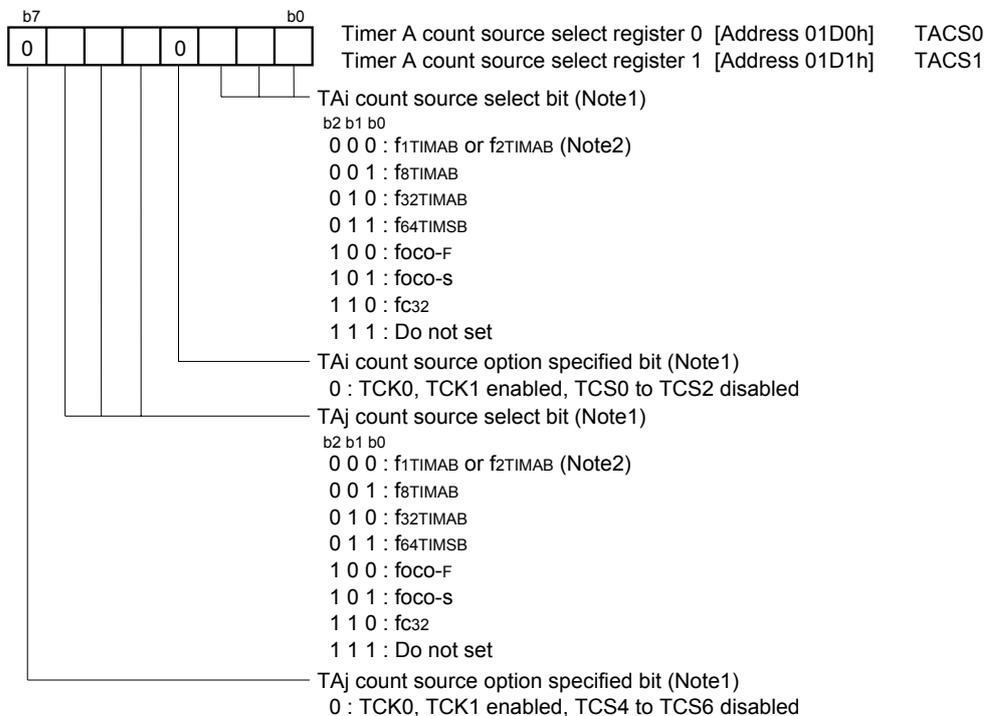
#### Selecting a clock used prior to timer AB frequency dividing

(Set the TCDIV00 bit before setting other registers associated with timer A. After changing the TCDIV00 bit, set other registers associated with timer A again.)



#### Selecting timer count source

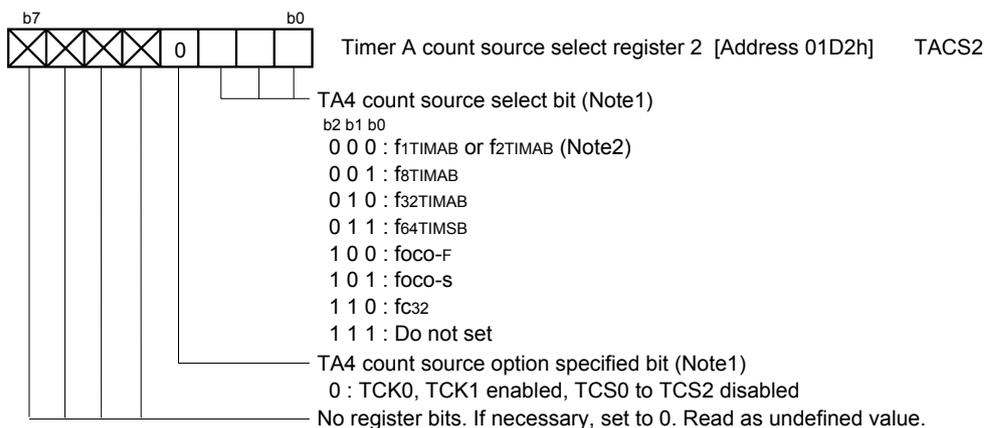
TACS0 register can select Timer A0 and Timer A1 count source, TACS1 can select Timer A2 and Timer A3 count source, and TACS2 can select Timer A4 count source.



TACS0 register: i = 0, j = 1, TACS1 register: i = 2, j = 3

Note 1: About the count source period, please refer to Table 2.

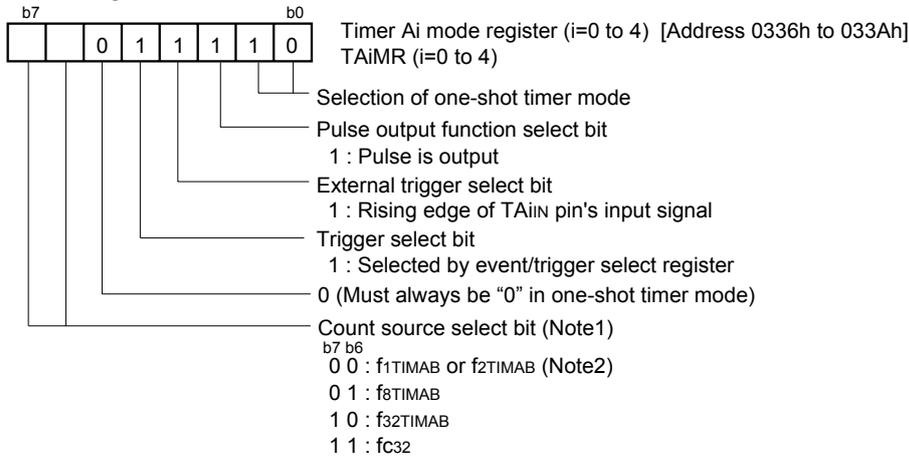
Note 2: When the PCLK0 bit in the PCLKR register is "1", the selected clock source is f1TIMAB. When the PCLK0 bit is "0", the selected clock source is f2TIMAB.



Note 1: About the count source period, please refer to Table 2.

Note 2: When the PCLK0 bit in the PCLKR register is "1", the selected clock source is f1TIMAB. When the PCLK0 bit is "0", the selected clock source is f2TIMAB.

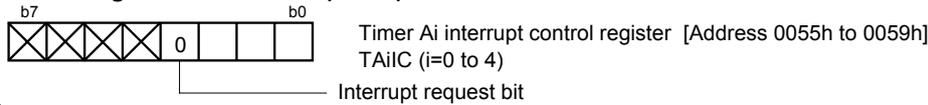
### Selecting one-shot timer mode and functions



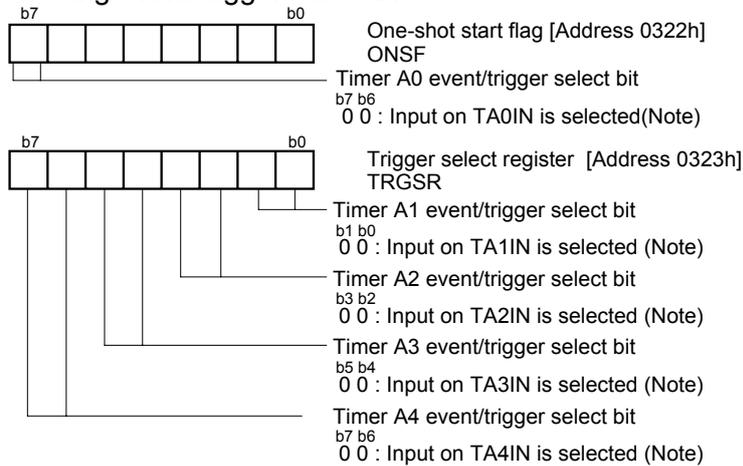
Note 1: Valid when the TCS3 bit or TCS7 bit in registers TACS0 to TACS2 is set to 0 (TCK0, TCK1 enabled). About the count source period, please refer to Table 2.

Note 2: When the PCLK0 bit in the PCLKR register is "1", the selected clock source is f1TIMAB. When the PCLK0 bit is "0", the selected clock source is f2TIMAB.

### Clearing timer Ai interrupt request bit Refer to 'Precaution for Timer A (one shot timer mode)'

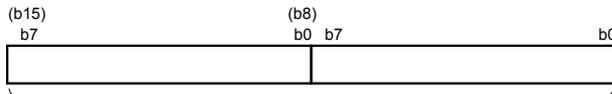


### Setting event/trigger select bit



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

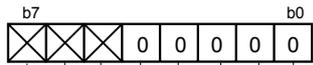
#### Setting one-shot timer's time



Timer A0 register	[Address 0327h, 0326h]	TA0
Timer A1 register	[Address 0329h, 0328h]	TA1
Timer A2 register	[Address 032Bh, 032Ah]	TA2
Timer A3 register	[Address 032Dh, 032Ch]	TA3
Timer A4 register	[Address 032Fh, 032Eh]	TA4

Can be set to 0001h to FFFFh

#### Selecting waveform output function



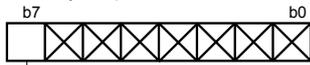
Timer A waveform output function select register [Address 01D5h]  
TAPOFS

- TA0OUT output polar control bit  
0 : Output waveform "H" active
- TA1OUT output polar control bit  
0 : Output waveform "H" active
- TA2OUT output polar control bit  
0 : Output waveform "H" active
- TA3OUT output polar control bit  
0 : Output waveform "H" active
- TA4OUT output polar control bit  
0 : Output waveform "H" active

No register bits. If necessary, set to 0. Read as undefined value.

#### Setting clock prescaler reset flag

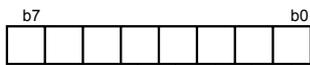
(This function is effective when fc32 is selected as the count source. Reset the prescaler for generating fc32 by dividing the X<sub>CIN</sub> by 32.)



Count prescaler reset flag [Address 0015h]  
CPSRF

- Clock prescaler reset flag  
0 : No effect  
1 : Prescale is reset (When read, the value is "0")

#### Setting count start flag



Count start flag [Address 0320h]  
TABSR

- Timer A0 count start flag
- Timer A1 count start flag
- Timer A2 count start flag
- Timer A3 count start flag
- Timer A4 count start flag

Start count

## 6. Reference

### Hardware manual

M16C/65 Group Hardware Manual

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**Revision**

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