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April 1st, 2010
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M16C/65 Group
Operation of Timer A (one-shot timer mode, external trigger)

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

<table>
<thead>
<tr>
<th>Item</th>
<th>Set-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count source</td>
<td>O Internal count source (f1TIMAB/f2TIMAB/f8TIMAB/f32TIMAB/f64TIMAB/fOCO-F/fOCO-S/fC32)</td>
</tr>
<tr>
<td>Pulse output function</td>
<td>No pulse output</td>
</tr>
<tr>
<td>Count start condition</td>
<td>External trigger input (falling edge of input signal to the TAIiN pin)</td>
</tr>
<tr>
<td></td>
<td>O External trigger input (rising edge of input signal to the TAIiN pin)</td>
</tr>
<tr>
<td></td>
<td>Timer overflow (TB2/TAj/TAk overflow)</td>
</tr>
<tr>
<td></td>
<td>Writing “1” to the one-shot start flag</td>
</tr>
<tr>
<td>Output polar control</td>
<td>O Output waveform “H” active</td>
</tr>
<tr>
<td></td>
<td>Output waveform “L” active (output reversed)</td>
</tr>
</tbody>
</table>

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 TAIiOUT pin output level goes to “H” level.

(2) If the value of the counter becomes “0000h”, the TAIiOUT 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 TAIiOUT 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 TAIiOUT pin.

Figure 1 shows the operation timing.
Operation of Timer A (one-shot timer mode, external trigger)

**Figure 1. Operation timing of one-shot**

- **Counter content (hex):**
  - Time: $0000h$ to $FFFFh$

- **n = reload register content**

- **Count start flag:**
  - Set to "1" by software

- **TAi input pin:**
  - "H" (High)
  - "L" (Low)

- **One-shot pulse output from TAi output pin (POFSi = "0")**
  - "H" (High)
  - "L" (Low)

- **Timer Ai interrupt request bit:**
  - "1"
  - "0"

- **Trigger during count**
  - Cleared to "0" when interrupt request is accepted, or cleared by software

- **Reload**
  - Start count

- **Stop count**
  - (1) Start count
  - (2) Stop count
  - (3) Start count
  - (4) Stop count

---

**Notes:**
- Count start flag cleared to "0" by software.
- Timer Ai interrupt request bit is cleared to "0" when interrupt request is accepted, or cleared by software.
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

<table>
<thead>
<tr>
<th>TCKDIVC0 register (Note 1)</th>
<th>TACSj register (Note 2)</th>
<th>TAiMR register</th>
<th>Count source</th>
<th>Count source period</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCDIV00</td>
<td>TCS3/TCS7</td>
<td>TCS2/TCS6</td>
<td>TCS1/TCS5</td>
<td>TCS0/TCS4</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
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<td>1</td>
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<td>1</td>
<td>0</td>
<td>1</td>
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<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

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 f1TIMAB. When the PCLK0 bit is “0”, the selected clock source is f2TIMAB.
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.)

<table>
<thead>
<tr>
<th>Bit 7</th>
<th>Bit 6</th>
<th>Timer AB Division Control Register 0 [Address 01CBh]</th>
<th>TCKDIVC0</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>Clock select prior to timer AB division bit</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0: f1</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>Reserved bits</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>Set to 0</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>No register bits. If necessary, set to 0. Read as undefined value.</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>Reserved bits</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>Set to 0</td>
<td></td>
</tr>
</tbody>
</table>
### 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.

<table>
<thead>
<tr>
<th>Register</th>
<th>Address</th>
<th>TAi Count Source Select Bit (Note 1)</th>
<th>TAi Count Source Option Specified Bit (Note 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TACS0</td>
<td>01D0h</td>
<td>b7 b6 b5 b4 b3 b2 b1 b0</td>
<td>0 : TCK0, TCK1 enabled, TCS0 to TCS2 disabled</td>
</tr>
<tr>
<td>TACS1</td>
<td>01D1h</td>
<td>b7 b6 b5 b4 b3 b2 b1 b0</td>
<td>0 : TCK0, TCK1 enabled, TCS0 to TCS2 disabled</td>
</tr>
<tr>
<td>TACS2</td>
<td>01D2h</td>
<td>b7 b6 b5 b4 b3 b2 b1 b0</td>
<td>0 : TCK0, TCK1 enabled, TCS4 to TCS6 disabled</td>
</tr>
</tbody>
</table>

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 \( f_{TIMAB} \). When the PCLK0 bit is "0", the selected clock source is \( f_{TIMAB} \).
Selecting one-shot timer mode and functions

<table>
<thead>
<tr>
<th>b7</th>
<th>b6</th>
<th>b5</th>
<th>b4</th>
<th>b3</th>
<th>b2</th>
<th>b1</th>
<th>b0</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Timer Ai mode register (i=0 to 4) [Address 0336h to 033Ah]

TAiMR (i=0 to 4)

Selection of one-shot timer mode

Pulse output function select bit
1 : Pulse is output

External trigger select bit
1 : Rising edge of TAiIN pin’s input signal

Trigger select bit
1 : Selected by event/trigger select register
0 (Must always be “0” in one-shot timer mode)

Count source select bit (Note1)

0 0 : fTIMAB or f2TIMAB (Note2)
0 1 : fTIMAB
1 0 : f32TIMAB
1 1 : f32

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 fTIMAB. When the PCLK0 bit is “0”, the selected clock source is f2TIMAB.

Clearing timer Ai interrupt request bit

<table>
<thead>
<tr>
<th>b7</th>
<th>b6</th>
<th>b5</th>
<th>b4</th>
<th>b3</th>
<th>b2</th>
<th>b1</th>
<th>b0</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Timer Ai interrupt control register [Address 0055h to 0059h]

TAiIC (i=0 to 4)

Interrupt request bit

Setting event/trigger select bit

<table>
<thead>
<tr>
<th>b7</th>
<th>b6</th>
<th>b5</th>
<th>b4</th>
<th>b3</th>
<th>b2</th>
<th>b1</th>
<th>b0</th>
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</tbody>
</table>

One-shot start flag [Address 0322h]

ONSF

Timer A0 event/trigger select bit
0 0 : Input on TA0IN is selected (Note)

Trigger select register [Address 0323h]

TRGSR

Timer A1 event/trigger select bit
0 0 : Input on TA1IN is selected (Note)

Timer A2 event/trigger select bit
0 0 : Input on TA2IN is selected (Note)

Timer A3 event/trigger select bit
0 0 : Input on TA3IN is selected (Note)

Timer A4 event/trigger select bit
0 0 : Input on TA4IN is selected (Note)

Note: Set the corresponding port direction register to “0”
Operation of Timer A (one-shot timer mode, external trigger)

Setting one-shot timer's time

Can be set to 0001h to FFFFh

Selecting waveform output function

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

Setting clock prescaler reset flag

(This function is effective when f\textsubscript{C32} is selected as the count source. Reset the prescaler for generating f\textsubscript{C32} by dividing the X\textsubscript{IN} by 32.)

Setting count start flag

Start count
6. Reference

Hardware manual
M16C/65 Group Hardware Manual
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