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April 1\textsuperscript{st}, 2010
Renesas Electronics Corporation

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1.0 Abstract
In this process, Timer A0 and Timer A1 are connected to make a 16-bit timer with a 16-bit prescaler.
Use the following peripheral functions:
• Timer mode of timer A
• Event counter mode of timer A

2.0 Introduction
Specifications
(1) Set timer A0 to timer mode, and set timer A1 to event counter mode.
(2) Perform a count on count source \( f \) using timer A0 to count for 1 ms, and perform a count on timer A0 using timer A1 to count for 1 second.
(3) Connect a 20-MHz oscillator to \( X_{IN} \).
(4) The formula for calculating the Long-Period becomes as follows.
\[
\text{Long-Period} = (\text{Count source period of Timer A0}) \times (\text{Timer A0 register +1}) \times (\text{Timer A1 register +1})
\]
Setting example for 1 sec period
\[
(1 \text{ sec}) = (50\text{ns}) \times (19999+1) \times (999+1)
\]
Operation
(1) Setting the count start flag to “1” causes the counter to begin counting. The counter of timer A0 performs a down count on count source \( f \).
(2) If the counter of timer A0 underflows, the counter reloads the content of the reload register and continues counting. At this time, the timer A0 interrupt request bit goes to “1”. The counter of timer A1 performs a down count on underflows in timer A0.
(3) If the counter of timer A1 underflows, the counter reloads the content of the reload register and continues counting. At this time, the timer A1 interrupt request bit goes to “1”.

Figure 1 shows the operation timing.
Figure 2 shows the connection diagram of long-period timers.

Figure 2. Connection diagram of long-period timers
3.0 Set-up procedure

Setting timer A0

Selecting 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>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Timer A0 mode register [Address 035616]

TA0MR

Selection of timer mode

Gate function select bit

b4 b3

0 0 : Gate function not available (TA0IN pin is a normal port pin)

0 (Must always be “0” in timer mode)

Count source select bit

b7 b6

0 0 : f1

Setting divide ratio

<table>
<thead>
<tr>
<th>b7</th>
<th>b6</th>
<th>Count source period</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>f1 : 50ns</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>f8 : 400ns</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>f32 : 1.6µs</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>fC32 : 976.56µs</td>
</tr>
</tbody>
</table>

Setting timer A1

Selecting event counter mode and each function

<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>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Timer A1 mode register [Address 035716]

TA1MR

Selection of event counter mode

Count polarity select bit

Up/down switching cause select bit

0 : Up/down flag content

0 (Must always be “0” in event counter mode)

Count operation type select bit

0 : Reload type

When not using two-phase pulse signal processing, set this bit to “0”

Continued to the next page
Continued from the previous page

**Setting up/down flag**

<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>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>UDF</td>
<td>Timer A1 up/down flag</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0 : Down count</td>
<td></td>
</tr>
</tbody>
</table>

When not using the 2-phase pulse signal processing function, set the select bit to “0”.

*Note1: Use MOV instruction to write to this register.*

**Setting trigger select register**

<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>TRGSR</td>
<td>Trigger select register [Address 034316]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Timer A1 event/trigger select bit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b1 b0</td>
<td>1 0 : TA0 overflow is selected</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Setting divide ratio**

<table>
<thead>
<tr>
<th>b15</th>
<th>b14</th>
<th>b13</th>
<th>b12</th>
<th>b11</th>
<th>b10</th>
<th>b9</th>
<th>b8</th>
<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>0316</td>
<td>E716</td>
<td>Timer A1 register [Address 034916, 034816]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Setting count start flag**

<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>TABSR</td>
<td>Count start flag [Address 034016]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Timer A0 count start flag</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 : Starts counting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Timer A1 count start flag</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 : Starts counting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Start counting*
4.0 Programming Code

;************************************************************************************
;                      M16C/80 Program Collection
;                      FILE NAME : rjj05b0505.src.a30
;                      CPU       : M16C/80 Group
;                      FUNCTION  : Timer A Applications
;                                      (Long-Period Timers)
;                      HISTORY   : 2004.03.15  Ver 1.00
;                      Copyright(C)2003, Renesas Technology Corp.
;                      Copyright(C)2003, Renesas Solutions Corp.
;                      All rights reserved.
;************************************************************************************
; 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
;************************************************************************************
RAM_TOP     .EQU    000400H    ;Start address of RAM
RAM_END     .EQU    002BFFH    ;End address of RAM
ROM_TOP     .EQU    0FFC000H   ;Start address of ROM
FIXED_VECT_TOP .EQU    0FFFFDCH   ;Start address of fixed vector

;************************************************************************************
; Program area
;************************************************************************************

.RESET:
LDC      #RAM_END+1, ISP   ;Sets initial value in stack pointer
; 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
}
LONG-PERIOD TIMERS

;--------------------------------------------------------------------------
; TimerA (Long-Period Timers)
;--------------------------------------------------------------------------

; Setting Timer A0 (Timer mode, 1ms)
;--------------------------------------------------------------------------

; Selecting timer mode and functions
MOV.B #00000000B, ta0mr
; |++++++|Selection of timer mode
; | |-----|This bit is invalid in M16C/80 series
; | |++++|Gate function select bit
; | | |++++|Must always be "0" in timer mode
; | | |++++|Count source select bit (00: f1)

; Setting divide ratio
MOV.W #04E1FH, ta0      ; (1msec @20MHz, f1)

;--------------------------------------------------------------------------
; Setting Timer A1 (Event counter mode, count underflows of Timer A0)
;--------------------------------------------------------------------------

; Setting event counter mode and functions
MOV.B #00000001B, ta1mr
; |++++++|Selection of event counter mode
; | |-----|This bit is invalid in M16C/80 series
; | |++++|Count polarity select bit
; | | |++++|Up/down switching cause select bit (0: Up/down flag's content)
; | | |++++|Must always be "0" in event counter mode
; | | |++++|Count operation type select bit (0: Reload type)

; Setting up/down flag
MOV.B #00000000B, udf
; |++++++|Timer A1 up/down flag (0: Down count)
; | |-----|When not using the 2-phase pulse signal processing function,
; | | |++++|set the select bit to "0"

; Setting trigger select register
MOV.B #00000010B, trgsr
; ++---------|Timer A1 event/trigger select bit
; (10: TA0 overflow is selected)

; Setting divide ratio
MOV.W #03E7H, ta1      ; (1msec * 1000 = 1sec)

; Setting count start flag
MOV.B #00000011B, tabsr
; |+---------|TimerA0 count start flag (1: Starts counting)
; |++++++|TimerA1 count start flag (1: Starts counting)

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/

Technical Support
E-mail: support_apl@renesas.com

Data Sheet
M16C/80 group Rev. E3
(Use the latest version on the Home page: http://www.renesas.com/)

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