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32176 Group

Application of Timer TOP (Single-shot Output Mode)

1. Overview

The following article shows sample program of 32176 group using timer TOP.

2. Introduction

The sample task described here uses the following microcomputer, under the respective conditions.

- Microcomputer: 32176 Group (M32176FnVFP, M32176FnTFP)
- Operating frequency: 20 to 40MHz (The sample program is compiled assuming a frequency of 40 MHz.)
- Operating Board: Starter kit for 32176 Group

3. Explanation of an applied technology

3.1 Outline of Multijunction Timers

The multijunction timers (abbreviated MJT) have input event buses and output event buses. Therefore, in addition to be used as a single unit, the timers can be internally connected to each other. This capability allows for highly flexible timer configuration, making it possible to meet various applications needs. It is because the timers are connected to internal event bus at multiple points that they are called the “multijunction” timers.

MJT is detailed in 32176 Group User's Manual.

4. Single-shot Output Mode Sample Program

4.1 The Outline of Sample Program

In Single-shot output mode, the timer generates a pulse in width of “reload register set value + 1” and stops after generating said pulse once. The sample program here starts the timer to output a single-shot pulse by specifying the pulse width in an argument.

The sample program uses the TOP6 timer to count clock pulses on clock bus 0 as its count source. The single-shot pulse is forwarded to the external pin TO6.

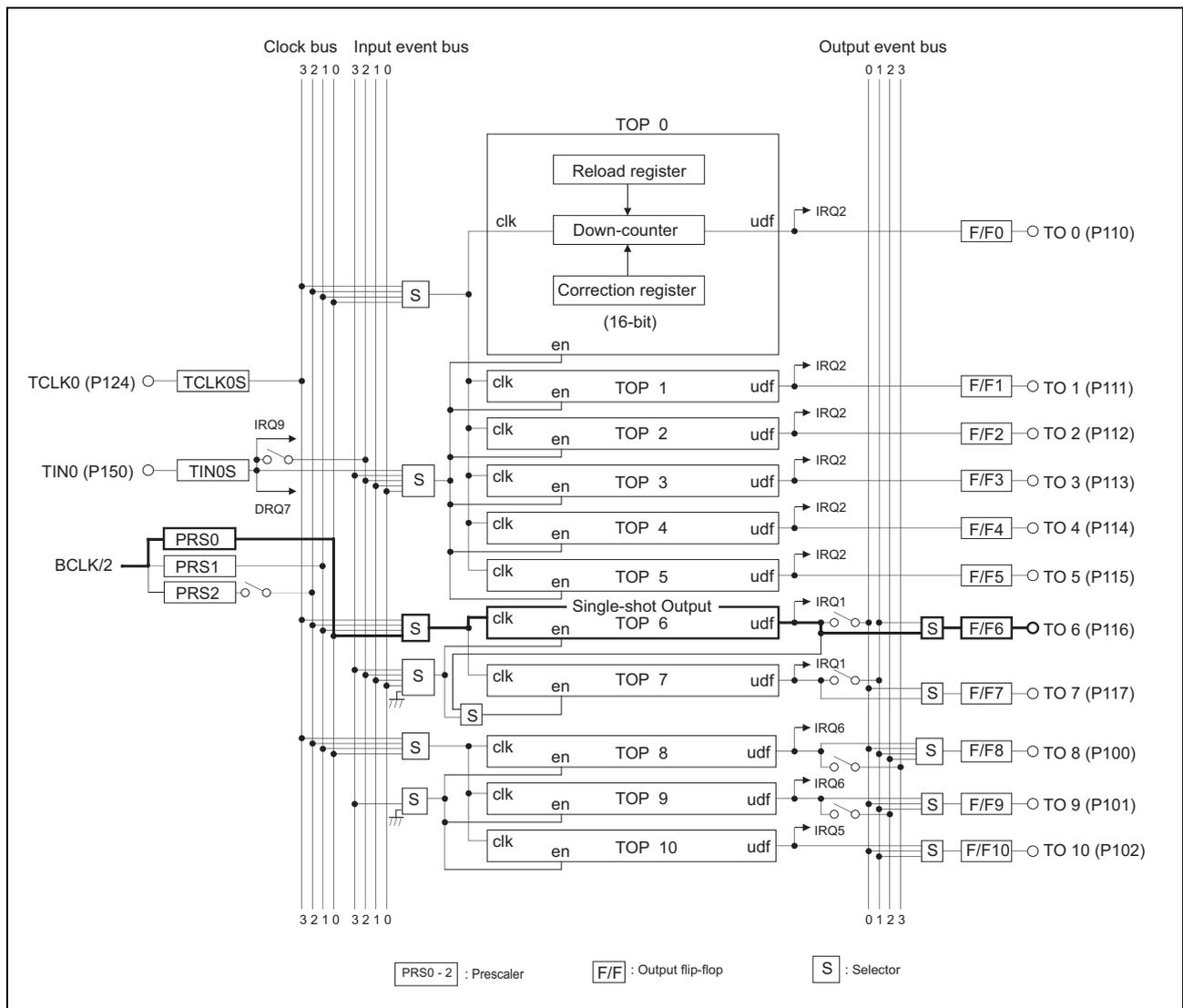


Figure 4.1.1 Configuration of TOP Single-shot Output Timer

4.2 Processing procedure

The basic processing flow of a timer setup is shown in Figure 4.2.1.

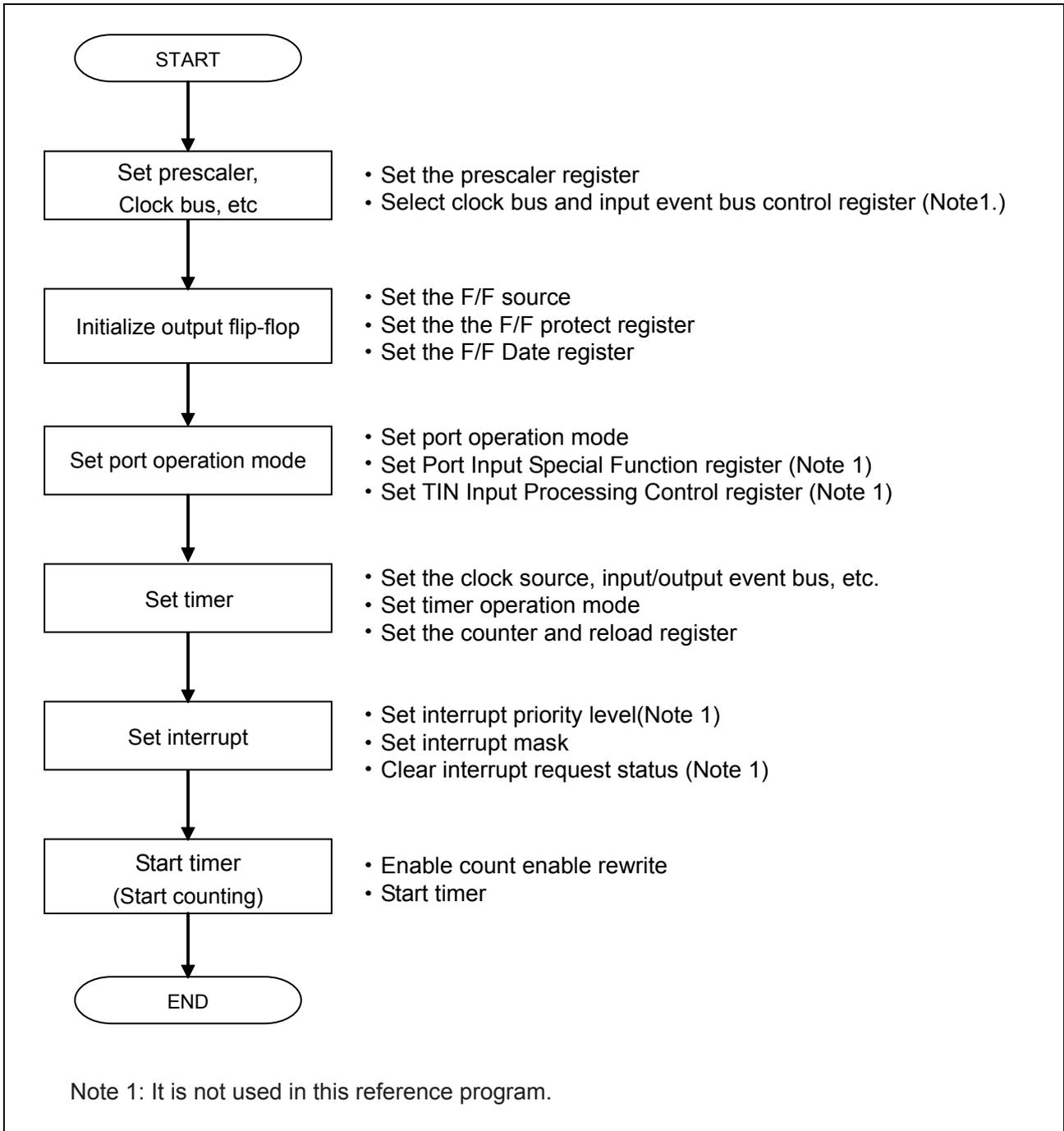


Figure 4.2.1 Basic Timer Setup Flow

4.3 Description of a reference program

Note: The registers used are indicated as (register name: bit name)

4.3.1 Timer initialization function (timer_init())

- (1) Set the prescaler's divide-by value
 - Set Prescaler Register 0 as "the prescaler's divide-by value-1" (PRS0)

4.3.2 Various initialization function (init_func())

- (1) Call the timer initialization function

4.3.3 Main function (main())

- (1) Call the interrupt disable function
- (2) Call the various initialization function
- (3) Call the TOP6 Single-shot output mode initial setting function
- (4) Call the interrupt enable function
- (5) Call the TOP6 Single-shot output start function

4.3.4 TOP6 Single-shot output mode initial setting function (TOP6_SS_init())

- (1) Initial setting of a timer output terminal
 - Set F/F6 source select bit of F/F6 Source Select Register 0 as TOP6 output. (FFS0: FF6)
 - Set F/F6 protect bit of F/F6 Protect Register 0 as write enable to output bit. (FFP0: FP6)
 - Set F/F6 output data bit of F/F6 Data Register 0 as output data "0". (FFD0: FD6)
 - Set the port P116 operation mode bit of P11 Operation Mode Register as TO6. (P11MOD: P116MOD)
- (2) Setting TOP6
 - Set Single-shot output mode. (TOP67CR: TOP6M)
 - Set Clock source as clock bus 0. (TOP67CR: TOP67CKS)
 - Set interrupt demand as disable. (TOPIR2: TOPIM6)

4.3.5 TOP6 Single-shot output start function (TOP6_SS_out())

- (1) Execution judging
 - If the pulse width is “0”, it goes abnormal termination.
 - If timer is moving, it goes abnormal termination.
- (2) Set TOP6 reload register
 - Set counter value to reload register. (TOP6RL)
- (3) Starting TOP6 count
 - Call the interrupt disable function.
 - Set enable protect bit as enable for rewriting. (TOPPRO: TOP6PRO)
 - Start counting. (TOPCEN: TOP6CEN)
 - Wait till starting count down. (Inversion of F/F6)
(After start counting, the period of count clock generating waits for generating here, because the compensation function does not become effective)
 - Call the interrupt enable function.

4.3.6 Single-shot output time of the correction function (TOP6_SS_cc()) (The correction function is not used in this sample program.)

- (1) Execution judging
 - If time of correction is “0”, it goes abnormal termination.
- (2) Correction
 - Call the interrupt disable function.
 - If timer is stopping, “correction value” will be added to reload register.
 - If it has a margin of time for rewriting during timer operating, set correction register as “correction value”.
 - If it does not have a margin of time for rewriting during timer operating, it goes abnormal termination.
 - Call the interrupt enable function.

4.4 Sample Programming Code

The sample program of TOP6 Single-shot output mode is shown below. Pulse width is set to 2ms in here.

Note that the sample program below requires the SFR definition file. The latest SFR definition file can be downloaded from Renesas Technology website. When using the SFR definitions file, adjust the path setting to match the operating computer environment.

4.4.1 TOP6_ss_main.c

```

1  /*"FILE COMMENT"*****
2  *      M32R C Programming          Rev. 1.01
3  *      < Sample Program for 32176 >
4  *      < TOP6 single-shot output mode (main routine) >
5  *
6  *      Copyright (c) 2004 Renesas Technology Corporation
7  *      All Rights Reserved
8  *      *****/
9
10 /*****/
11 /*      Include file                      */
12 /*****/
13
14 #include          "..\inc\sfr32176_pragma.h"
15
16 /*****/
17 /*      Function prototype declaration    */
18 /*****/
19
20     void          main(void);              /* Main function */
21     void          init_func(void);        /* Initial setup function */
22     void          timer_init(void);       /* Timer initialization */
23
24 /*****/
25 /*      Definition of external reference  */
26 /*****/
27
28 extern void      DisInt( void );         /* Interrupt disable function */
29 extern void      EnInt( void );         /* Interrupt enable function */
30
31 extern void      TOP6_SS_init( void );   /* Initialize TOP6 single-shot output mode */
32 extern ULONG     TOP6_SS_out( USHORT PW ); /* Start TOP6 single-shot output */
33 extern ULONG     TOP6_SS_cc( SSHORT cc ); /* Correct single-shot output time */
34
35 /*"FUNC COMMENT"*****
36 * Function name: timer_init()
37 *-----
38 * Description   : Initialize timer
39 *-----
40 * Argument      : -
41 *-----
42 * Returns       : -
43 *-----
44 * Notes         : -
45 *"FUNC COMMENT END"*****
46 void timer_init(void)
47 {
48     PRS0 = ( 100 - 1);                    /* Set prescaler(10us@10MHz) */
49 }
50
51 /*"FUNC COMMENT"*****
52 * Function name: init_func()
53 *-----
54 * Description   : Call various initialization functions
55 *-----
56 * Argument      : -
57 *-----
58 * Returns       : -
59 *-----
60 * Notes         : -
61 *"FUNC COMMENT END"*****
62 void init_func(void)
63 {
64     timer_init();                          /* Initialize those related to timer */
65 }
66
67 /*"FUNC COMMENT"*****
68 * Function name: main()
69 *-----
70 * Description   : While using TOP6 in single-shot output mode, this program outputs a single-shot waveform
71 *               : from the TO6 pin pulse width of 2ms(when the source clock frequency = 10 MHz).
72 *-----
73 * Argument      : -

```

```

74  *-----
75  * Returns      : -
76  *-----
77  * Notes       : -
78  *"FUNC COMMENT END"*****/
79 void main(void)
80 {
81     DisInt();                               /* Disable interrupt */
82
83     init_func();
84
85     TOP6_SS_init();                         /* Initialize TOP6 single-shot output mode */
86
87     EnInt();                                 /* Enable interrupt */
88
89     TOP6_SS_out( (USHORT)200);             /* Start TOP6 single-shot output */
90
91     while( 1 ){
92         ;
93     }
94 }

```

4.4.2 TOP6_ss.c

```

1  /*"FILE COMMENT"*****
2  *      M32R C Programming          Rev. 1.01
3  *      < Sample Program for 32176 >
4  *      < TOP6 single-shot output mode >
5  *
6  *      Copyright (c) 2004 Renesas Technology Corporation
7  *      All Rights Reserved
8  *      *****/
9
10 *****/
11 /*      Include file                      */
12 *****/
13
14 #include          "..\inc\sfr32176_pragma.h"
15
16 *****/
17 /*      Definition of external reference    */
18 *****/
19
20 extern void      DisInt( void );          /* Interrupt disable function */
21 extern void      EnInt( void );          /* Interrupt enable function */
22
23 *****/
24 /*      Function prototype declaration      */
25 *****/
26
27 void            TOP6_SS_init( void );     /* Initialize TOP6 single-shot output mode */
28 ULONG          TOP6_SS_out( USHORT PW ); /* Start TOP6 single-shot output */
29 ULONG          TOP6_SS_cc( USHORT cc );  /* Correct single-shot output time */
30
31 *****/
32 /*      Define macro                      */
33 *****/
34
35 #define OK      1ul
36 #define NG      0ul
37
38 /*** single-shot(TOP6) ***/
39
40                                /* 0123 4567 89AB CDEF
*/
41 #define TOP6_MASK          0x0373u    /* 0000 0011 0111 0011B
*/
42 #define TOP6_SS           0x0010u    /* 0000 0000 0000 0000B
*/
43                                /*      ||  |||  ++-- Select clock bus 0
*/
44                                /*      ||  +++----- Does not select enable source
*/
45                                /*      ++----- Set TOP6 single-shot output
mode */
46
47                                /* 0123 4567 89AB CDEF
*/
48 #define FF6_TOP6M          0x0001u    /* 0000 0000 0000 0001B
*/
49                                /*      +- FF6 source : TOP6 unselected
*/
50
51 /*"FUNC COMMENT"*****
52 * Function name: TOP6_SS_init()
53 *
54 * Description : FF6 source: TOP6 unselectedInitial settings necessary to drive TOP6 in single-shot mode
55 *             : - While using TOP6 in single-shot output mode, this program function a single-shot pulse
from TO6
56 *             : - The count source used for this operation is clock bus 0.
57 *-----
58 * Argument   : -
59 *-----
60 * Returns   : -
61 *-----
62 * Notes     : The prescaler, clock bus, etc. are set separately from the above
63 *             : Must be executed while interrupts are disabled
64 *"FUNC COMMENT END"*****/
65 void TOP6_SS_init( void )
66 {
67
68     UCHAR temp;
69     USHORT top67cr;
70
71 /*** Setting P116(TO6) output Initializ("L"output) ***/
72
73     FFS0 &= (~FF6_TOP6M) & 0xFFFFu;          /* FF6 source: TOP6 selected */
74

```

```

75         FFP0 = (~FP6) & 0xFFFFFu;                               /* Enable F/F6 rewrite */
76         FFD0 = 0x0000;                                           /* F/F6 low(0) output (inverted to high during single-shot
output) */
77         P11MOD |= 0x02u;                                         /* Select TO6(TOP6 output) for output) */
78
79 /**/ Setting single-shot mode (TOP6) ***/
80
81         top67cr = TOP67CR;
82         TOP67CR = ( top67cr & ~TOP6_MASK) | TOP6_SS;             /* Setting single-shot mode(TOP6) */
83         temp = TOPIR2;
84         temp |= ( TOPIR7 | TOPIM6);                               /* Disable TOP6 interrupt */
85         TOFIR2 = temp;
86     }
87
88 /**"FUNC COMMENT"*****
89 * Function name: TOP6_SS_out()
90 *-----
91 * Description   : Drive TOP6 in single-shot mode
92 *-----
93 * Argument      : unsigned short      PW      pulse width
94 *-----
95 * Returns       : Terminated normally      1
96 *               : Terminated abnormally    0
97 *               :       - Pulse width = 0
98 *               :       - Timer in operation
99 *-----
100 * Notes         : The rewrite timing judgment value needs to be calculated according to the count source
101 * "FUNC COMMENT END"*****
102 ULONG TOP6_SS_out( USHORT PW)
103 {
104     ULONG work;
105     ULONG ret_c;
106
107     ret_c = OK;
108
109     if( PW == 0u) {                                               /* Determine pulse width */
110         ret_c = NG;
111     }
112     else if(( TOPCEN & TOP6CEN) != 0u) {                         /* Determine rewrite timing */
113         ret_c = NG;
114     }
115     else{
116
117 /**/ Setting reload register ***/
118
119         TOP6RL = PW - 1u;
120
121 /**/ Starting count ***/
122
123         DisInt();                                               /* Disable interrupt */
124
125         TOPPRO = (~TOP6PRO) & 0xFFFFFu;                         /* Enable TOP6 enable protect rewrite */
126         TOPCEN = 0xffff;                                         /* Start TOP6 count */
127
128         while(( FFD0 & FD6) == 0u){                               /* Wait until count start */
129             ;
130         }
131
132         EnInt();                                               /* Enable interrupt */
133     }
134
135     return( ret_c );
136 }
137
138 /**"FUNC COMMENT"*****
139 * Function name: TOP6_SS_cc()
140 *-----
141 * Description   : Correct TOP6 single-shot output time
142 *-----
143 * Argument      : signed short cc      Correction time
144 *-----
145 * Returns       : Terminated normally      1
146 *               : Terminated abnormally    0
147 *               :       - Pulse width = 0
148 *               :       - No sufficient time for correction (immediately before end of single-shot output)
149 *               :       - Timing at (3) below
150 *               :
151 *               :       (1)          (2)          (3)
152 *               :       |           | |
153 *               :       Starting count | |
154 *               :       +-----+
155 *               :       |           |
156 *               :       +-----+ +-----+
157 *               :
158 *-----
159 * Notes         : Starting countThe rewrite timing judgment value needs to be calculated according to the
count source

```

```

160 *           : (Note that correction is made synchronously with the next active clock transition)
161 *           : Overflow after correction is not taken into consideration
162 *"FUNC COMMENT END"*/
163 ULONG TOP6_SS_cc( SSHORT cc)
164 {
165     ULONG ret_c;
166
167     ret_c = OK;
168
169     if( cc == 0) {
170         ret_c = NG;
171     }
172     else {
173
174         DisInt();                               /* Disable interrupt */
175
176         if(( TOPCEN & TOP6CEN) == 0u) {         /* Count halted? */
177             TOP6RL += cc;                       /* Timing at (1) */
178         } else if( TOP6CT >= 2) {
179             TOP6CC = cc - 1u;                   /* Timing at (2) */
180         } else {
181             ret_c = NG;
182         }
183         EnInt();                               /* Enable interrupt */
184     }
185
186     return( ret_c );
187 }

```

4.5 Timing of operation

Timing of operation in this sample program is shown below.
(In the program, it is considering as $PW = (200-1)$)

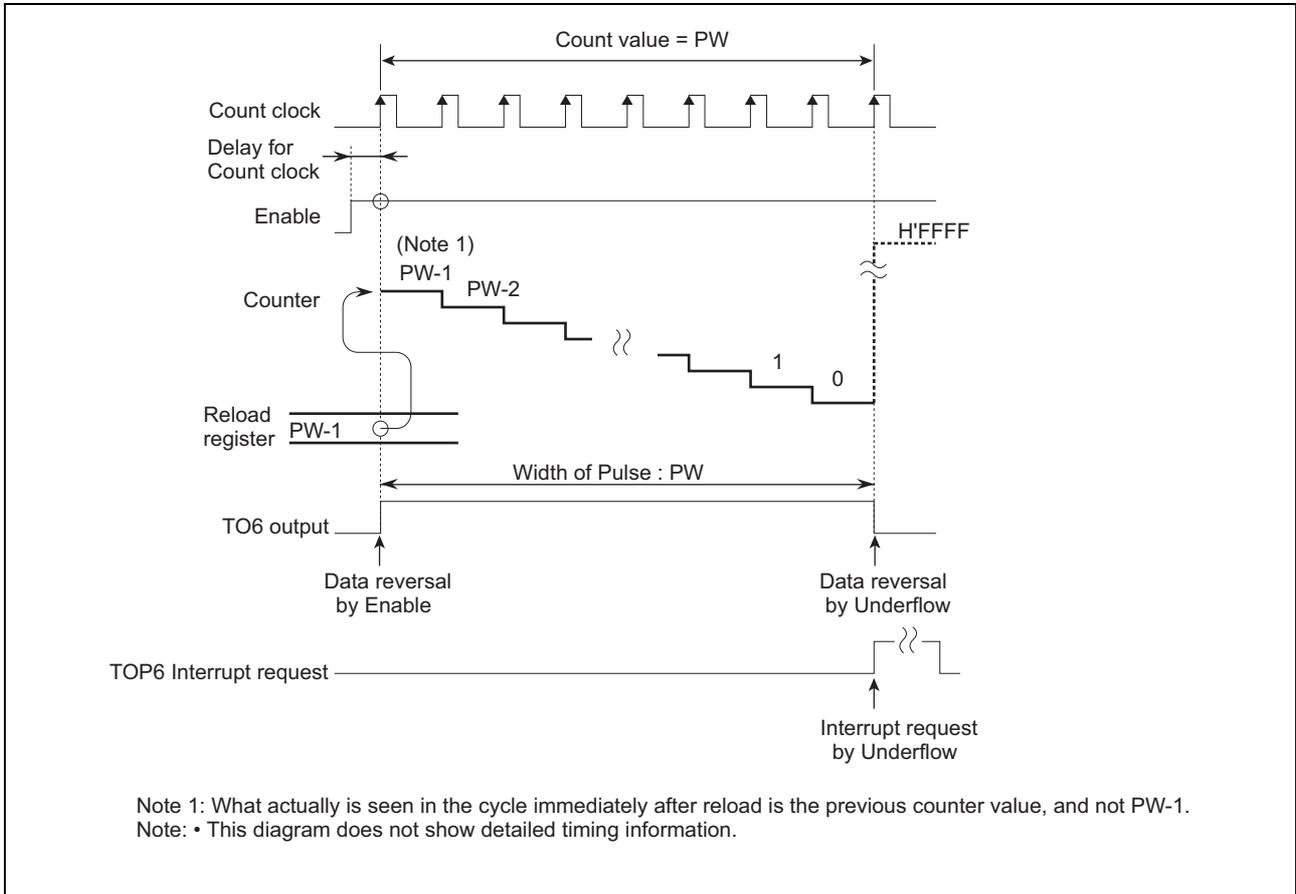


Figure 4.5.1 Timing Diagram for TOP Single-shot Pulse Output

5. Reference of Document

- 32176 Group User's Manual Rev.1.01
- M32R Family Software Manual Rev.1.20
- M3T-CC32R V.4.30 User's Manual (Compiler)
- M3T-AS32R V.4.30 User's Manual (Assembler)

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