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32176 Group

Application of Timer TOP (Delayed 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. Delayed Single-shot Output Mode Sample Program

4.1 Outline of the sample program

In delayed Single-shot output mode, the timer outputs a pulse in width equal to “reload register set value + 1”. A finite time later which is equal to “counter set value + 1” and stops after generating said pulse once. This sample program starts the timer to output a delayed single-shot pulse by specifying the delay value and pulse width in arguments. Interrupt by Underflow and compensation function are not in used in this example.

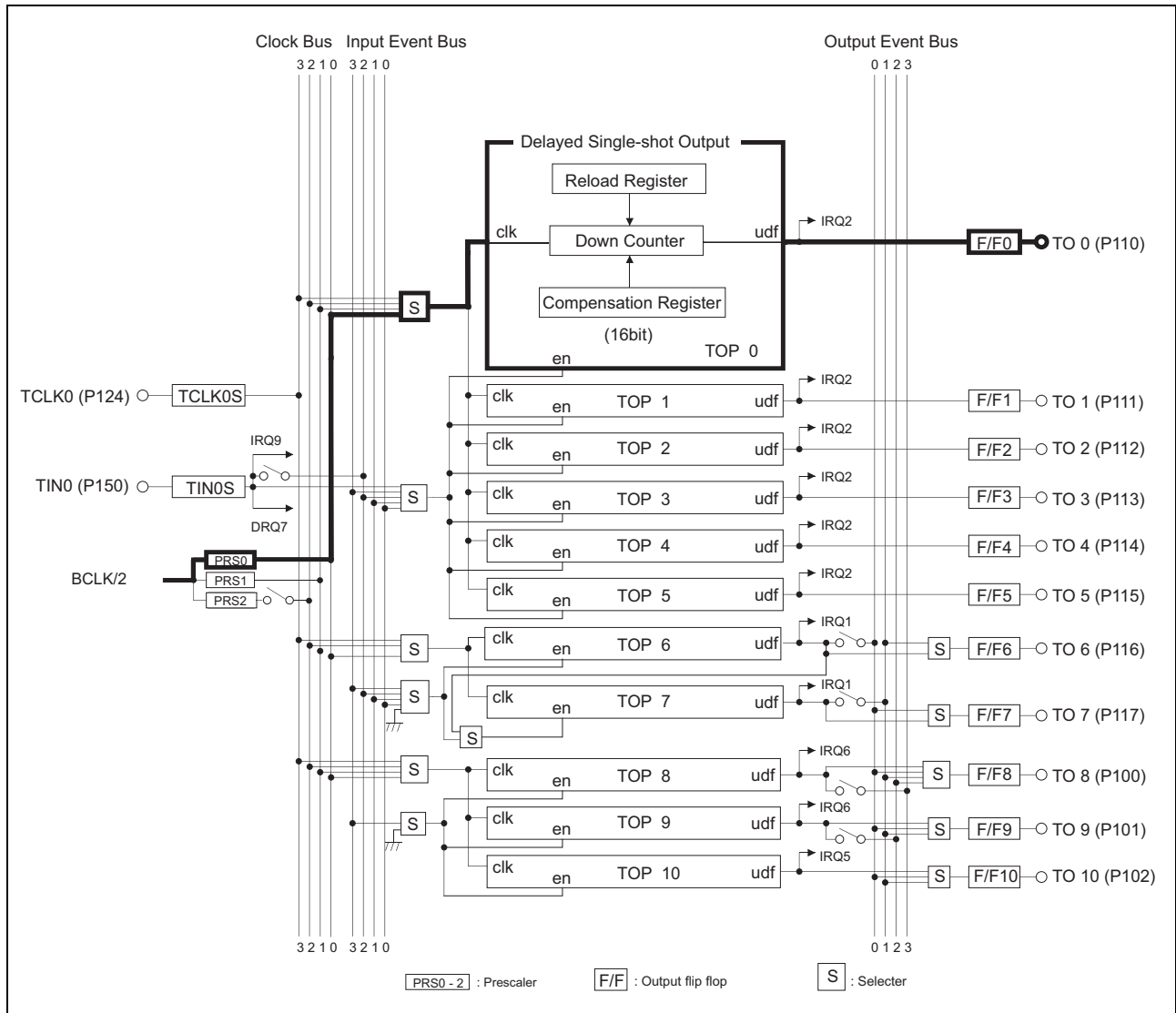


Figure 4.1.1 Configuration of TOP Single-shot Output Timer

4.2 Processing procedure

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

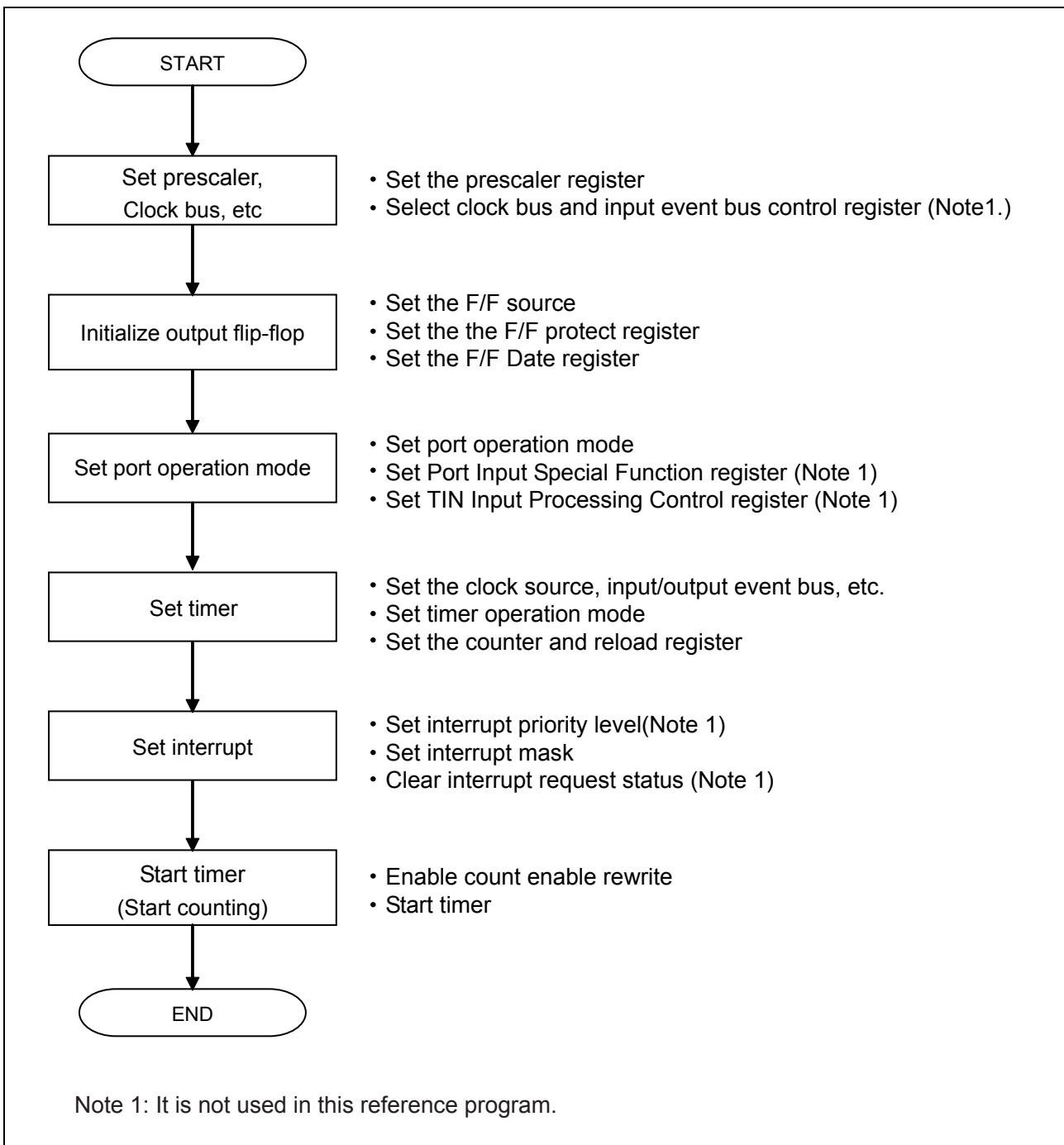


Figure 4.2.1 Basic Timer Setup Flow

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 TOP0 Delayed single-shot output mode initial setting function
- (4) Call the interrupt enable function
- (5) Call the TOP0 Delayed single-shot output start function

4.3.4 TOP0 Delayed single-shot output mode initial setting function (TOP0_DSS_init())

- (1) Initial setting of a timer output terminal
 - Set F/F0 protect bit of F/F Protect Register 0 as writing enable to output bit. (FFP0: FP0)
 - Set F/F0 output data bit of F/F Data Register 0 as output data"0". (FFD0: FD0)
 - Set the port P110 operation mode bit of P11 Operation Mode Register as TO0. (P11MOD : P110MOD).
- (2) Setting TOP0
 - Set Delayed Single-shot output mode. (TOP05CR0: TOP0M)
 - Set Clock source as clock bus 0. (TOP05CR: TOP05CKS)
 - Set interrupt request as inhibit. (TOPIR1: TOPIM0)

4.3.5 TOP0 Delayed single-shot output start function (TOP0_DSS_out())

(1) Execution judging

- If the pulse width or delay value are “0”, it goes abnormal termination.
- If it does not have a margin of time for rewriting during timer operation (during rewriting counter and reload register, it may occurs overflow) or it already starts Single-shot outputting, it goes abnormal termination.

(2) Set TOP0 counter and reload register

- Set counter. (TOP0CT)
- Set reload register. (TOP0RL)

(3) Starting TOP0 count

- Call the interrupt disable function.
- Set enable protect bit as enable for rewriting. (TOPPRO: TOP0PRO)
- Start counting. (TOPCEN: TOP0CEN)
- Wait till starting count.
(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 (TOP0_DSS_cc()) (The correction function is not used in this reference 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 operation (during rewriting counter and reload register, it does not overflow) and it already starts Single-shot outputting, set to correction register as “correction value-1”.
- If it has a margin of time for rewriting during timer operation (during rewriting counter and reload register, it does not overflow) and it does not start Single-shot outputting yet, “correction value” will be added to reload register.
- If it does not have a margin of time for rewriting during timer operation (during rewriting counter and reload register, it may occurs overflow) and it already starts Single-shot outputting, it goes abnormal termination.
- During timer operating if it almost starts outputting, it waits for starting Single-shot outputting, set to correction register as “correction value-1”.
- Call the interrupt enable function.

4.4 Sample Programming Code

The sample program of TOP0 Delayed Single-shot output mode is shown below. Delay width is set to 10ms, 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 TOP0_dss_main.c

```

1  /*****"FILE COMMENT"*****/
2  *      M32R C Programming          Rev. 1.01
3  *      < Sample Program for 32176 >
4  *      < TOP0 delayed single-shot output (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      TOP0_DSS_init( void ); /* Initialize TOP0 delayed single-shot output
mode */
32 extern ULONG      TOP0_DSS_out( USHORT delay, USHORT PW ); /* Start TOP0 delayed single-shot output */
33 extern ULONG      TOP0_DSS_cc( USHORT 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 *****/
46 void timer_init(void)
47 {
48     PRS0 = ( 100u - 1u); /* 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 *****/
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 TOP0 in delayed single-shot output mode, this program outputs a single-shot
waveform
71 *           : from the T00 pin
72 *           : with a delay time of 10ms and in pulse width of 2ms (when the source clock frequency = 10
MHz).
73 *           :
74 *-----
75 * Argument   : -
76 *-----
77 * Returns    : -
78 *-----
79 * Notes      : -
80 *"FUNC COMMENT END"*****
81 void main(void)
82 {
83 /** Initializing microcomputer ***/
84
85     DisInt();                /* Disable interrupt */
86
87     init_func();
88
89     TOP0_DSS_init();        /* Initialize TOP0 delayed single-shot output
mode */
90
91     EnInt();                /* Enable interrupt */
92
93     TOP0_DSS_out( (USHORT)1000u, (USHORT)200u); /* Start TOP0 delayed single-shot output */
94
95     while( 1 ){
96         ;
97     }
98 }

```

4.4.2 TOP0_dss.c

```

1  /*****FILE COMMENT*****/
2  *      M32R C Programming          Rev. 1.01
3  *      < Sample Program for 32176 >
4  *      < TOP0 delayed 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            TOP0_DSS_init( void );    /* Initialize TOP0 delayed single-shot output
mode */
28          ULONG          TOP0_DSS_out( USHORT delay, USHORT PW ); /* Start TOP0 delayed single-shot output */
29          ULONG          TOP0_DSS_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 /*** Delayed single-shot(TOP0) ***/
39
40                                /* 0123 4567 89AB CDEF
*/
41 #define TOP0_MASK          0x0373u          /* 0000 0011 0111 0011B
*/
42 #define TOP0_DSS          0x0100u          /* 0000 0001 0000 0000B
*/
43                                /*      || |||  +-+ Select clock bus 0
*/
44                                /*      || +++----- don't care
*/
45                                /*      +-+----- Set TOP0 delayed single-shot
output mode */
46
47 /*****FUNC COMMENT*****/
48 *      Function name: TOP0_DSS_init()
49 *-----
50 *      Description   : Set TOP0 delayed single-shot output modeInitial settings necessary to drive TOP0 in
51 *                    : delayed single-shot mode
52 *                    : - While using TOP0 in delayed single-shot mode, this function outputs a single-shot
waveform from
53 *                    : the T00 pin
54 *                    : - The count source used for this operation is clock bus 0
55 *-----
56 *      Argument     : -
57 *-----
58 *      Returns      : -
59 *-----
60 *      Notes        : The prescaler, clock bus, etc. are set separately from the above
61 *                    : Must be executed while interrupts are disabled
62 *****/
63 void TOP0_DSS_init( void )
64 {
65     USHORT top05CR0;
66
67 /*** Initializing P110 (T00) output(low level output) ***/
68
69     FFP0 = (~FP0) & 0xFFFFu;          /* Enable F/F0 rewrite */
70     FFD0 = 0x0000u;          /* F/F0 low(0) output (inverted to high during single-
shot output) */
71     P11MOD |= 0x80u;          /* Select T00 (TOP0 output) for output */
72
73 /*** Setting delayed single-shot(TOP0) ***/
74
75     top05CR0 = TOP05CR0;

```

```

76     TOP05CR0 = ( top05CR0 & ~TOP0_MASK) | TOP0_DSS;          /* Set TOP0 delayed single-shot */
77     TOPIR1 |= TOPIMO;                                       /* Disable TOP0 interrupt */
78 }
79
80 /*****"FUNC COMMENT"*****
81 * Function name: TOP0_DSS_out()
82 *-----
83 * Description  : Drive TOP0 in delayed single-shot mode
84 *-----
85 * Argument    : unsigned short delay  delay time
86 *              : unsigned short PW   pulse width
87 *-----
88 * Returns     : Terminated normally      1
89 *              : Terminated abnormally   0
90 *              :       - delay time = 0
91 *              :       - pulse width = 0
92 *              :       - Immediately before single-shot output or during output
93 *-----
94 * Notes       : The rewrite timing judgment value needs to be calculated according to the count source
95 ****"FUNC COMMENT END"*****
96 ULONG TOP0_DSS_out( USHORT delay, USHORT PW)
97 {
98     USHORT work;
99     ULONG  ret_c;
100    USHORT top0ct;
101    USHORT ffd0;
102
103    ret_c = OK;
104
105    top0ct = TOP0CT;
106    ffd0   = FFD0;
107
108    if(( delay == 0u) || ( PW == 0u)) {                       /* Determine delay time and pulse width */
109        ret_c = NG;
110    }
111    else if((( TOPPCEN & TOP0CEN) != 0u)                    /* Determine rewrite timing */
112        && (( top0ct <= 1u) || (( ffd0 & FFD0) != 0u))) {   /* Multiple startup or immediately before
end */
113        ret_c = NG;
114    }
115    else{
116
117    /**** Setting counter and reload register ****/
118
119        work = delay - 1u;
120        TOP0CT = work;
121        TOP0RL = PW - 1u;
122
123    /**** Starting count (even while counting) ****/
124
125        DisInt();                                           /* Disable interrupt */
126
127        TOPPRO = (~TOP0PRO) & 0xFFFFu;                    /* Enable TOP0 enable protect rewrite */
128        TOPPCEN = 0xffffu;                                  /* Start TOP0 count */
129
130        while( TOP0CT == work){                             /* Wait until count start */
131            ;
132        }
133
134        EnInt();                                           /* Enable interrupt */
135    }
136
137    return( ret_c );
138 }
139
140 /*****"FUNC COMMENT"*****
141 * Function name: TOP0_DSS_cc()
142 *-----
143 * Description  : Correct TOP0 single-shot output time
144 *-----
145 * Argument    : unsigned short cc    correction time
146 *-----
147 * Returns     : Terminated normally      1
148 *              : Terminated abnormally   0
149 *              :       - correction time = 0
150 *              :       - No sufficient time for correction (immediately before end of single-shot output)
151 *              :       - Timing at (5) below
152 *              :
153 *              :       (1)      (2)  (3)   (4)   (5)
154 *              :       :       |  |   |  |   |  |
155 *              :       :       |  |   |  |   |  |
156 *              :       :       |  |   |  |   |  |
157 *              :       :       |  |   |  |   |  |
158 *              :       :       |  |   |  |   |  |
159 *              :       :       |  |   |  |   |  |
160 *              :       :       |  |   |  |   |  |
161 * Notes       : The rewrite timing judgment value needs to be calculated according to the count source

```

```

162 *           : (Note that correction is made synchronously with the next active clock transition)
163 *           : Overflow after correction is not taken into consideration
164 *""FUNC COMMENT END""*****
165 ULONG   TOP0_DSS_cc( USHORT cc)
166 {
167     ULONG   ret_c;
168
169     ret_c = OK;
170
171     if( cc == 0) {
172         ret_c = NG;
173     }
174     else{
175
176         DisInt();                               /* Disable interrupt */
177
178         if(( TOPCEN & TOPOCEN) == 0u) {         /* Count halted? */
179             TOP0RL += cc;                       /* Timing at (1) */
180         } else if( TOP0CT >= 2u) {
181             if(( FFD0 & FD0) != 0u) {          /* During delay? */
182                 TOP0CC = cc - 1u;             /* Timing at (4) */
183             } else {
184                 TOP0RL += cc;                 /* Timing at (2) */
185             }
186         } else {
187             if(( FFD0 & FD0) != 0u) {          /* During delay? */
188                 ret_c = NG;                   /* Timing at (5) */
189             } else {
190                 while(( FFD0 & FD0) == 0u){   /* Wait for end of delay, timing at (3) */
191                     ;
192                 }
193                 TOP0CC = cc - 1u;
194             }
195         }
196         EnInt();                               /* Enable interrupt */
197     }
198
199     return( ret_c );
200 }

```

4.5 Timing of operation

Timing of operation in this reference program is shown below.
(In the program, it is considering as delay=(1000-1), PW=(200-1))

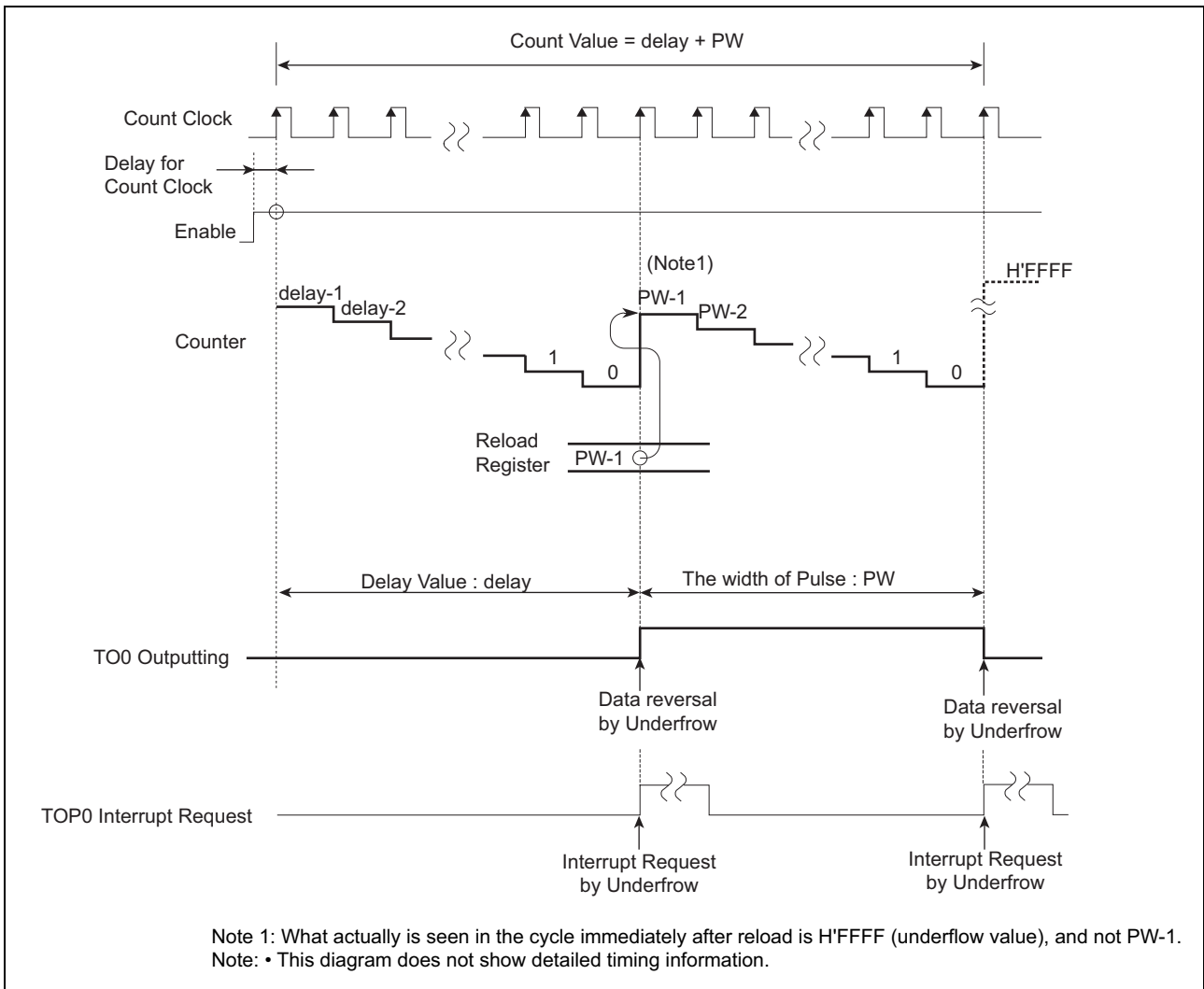


Figure 4.5.1 Timing Diagram for TOP Delayed Single-shot Pulse Output

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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