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## 32176 Group

### Application of Timer TIO (Noise Processing Input Mode)

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#### 1. Overview

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

#### 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

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### 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. Noise Processing Input Mode Sample Program

### 4.1 Outline of the sample program

In this sample program, TIO5 is used and the clock bus 0 is counted as count source.

The external capture signal inputted from TIN3 is inputted into TIO5 through input event bus 3. If “H” level remain same status more than setting time it goes interrupt processing, if it is not it stops counting as invalid. In interrupt processing P11DATA is incremented.

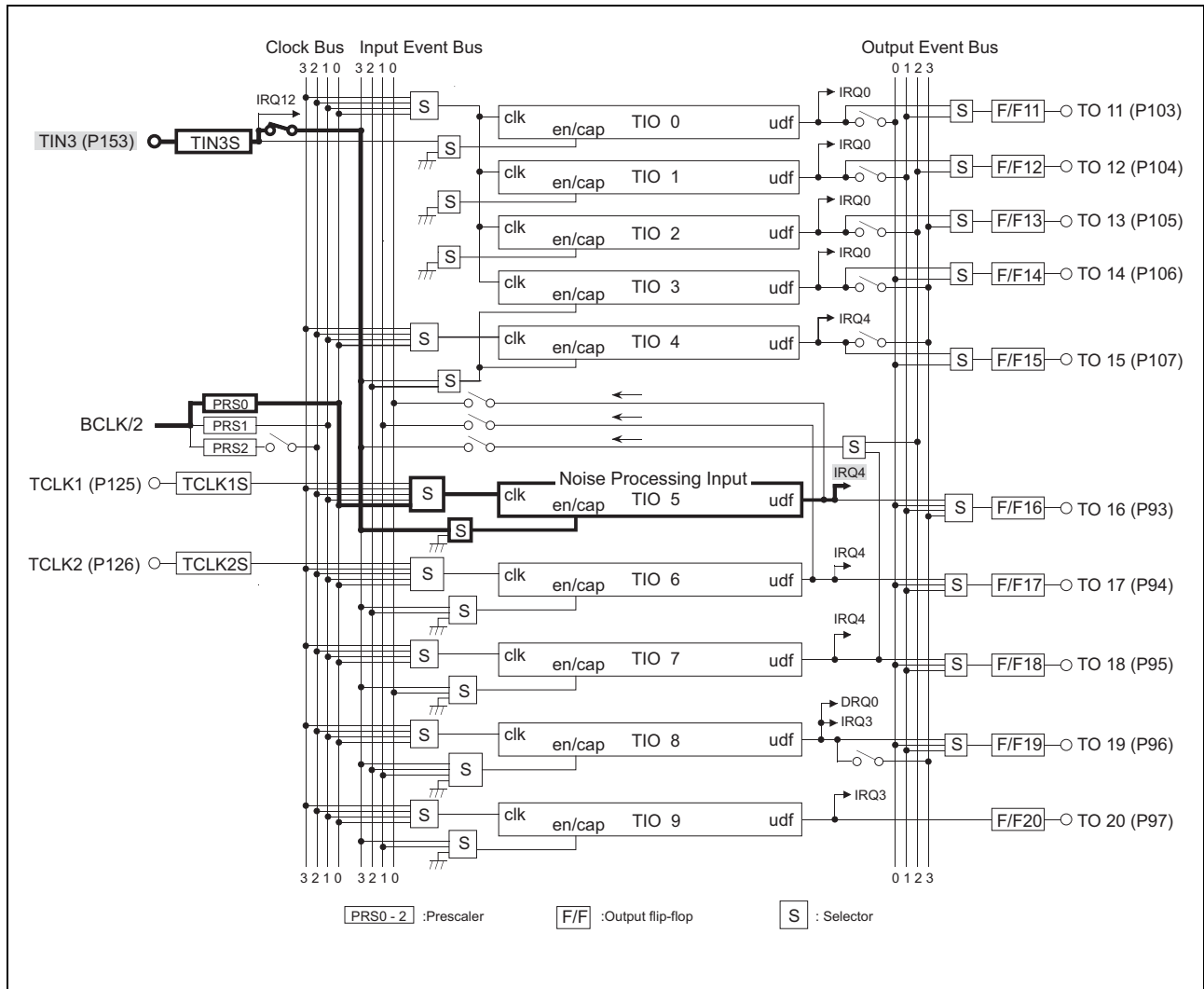


Figure 4.1.1 Configuration of TIO Noise Processing Input Timer

4.2 Processing procedure

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

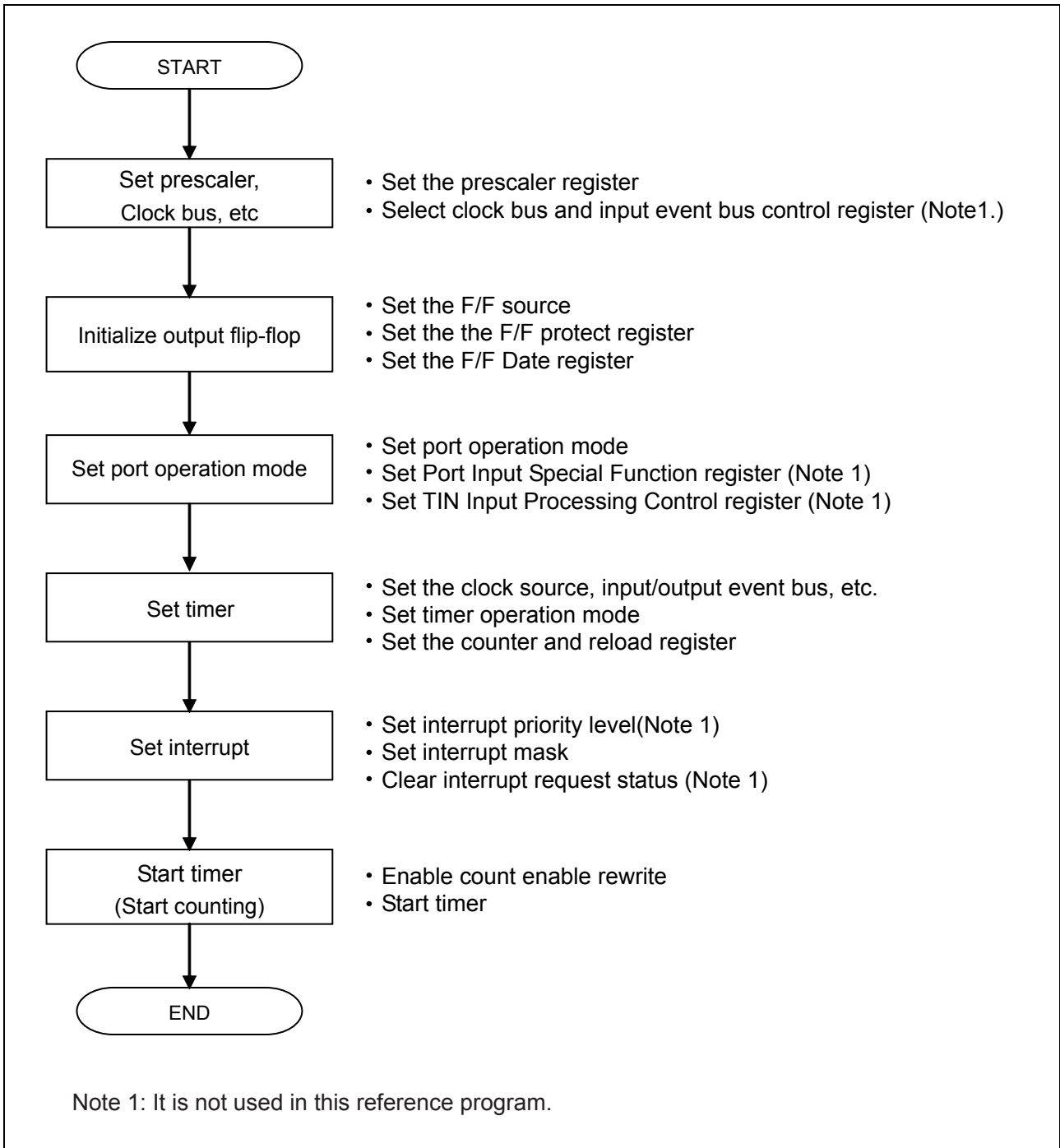


Figure 4.2.1 Basic Timer Setup Flow

### 4.3 Description of a reference program

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

#### 4.3.1 Interrupt setting function (int\_init())

(1) Set the Interrupt priority level of TIO5 Output

- Set the priority level of MJT Output Interrupt Control Register 4 (TIO4 - 7 Interrupt) as 0. (Top priority) (IMJTOCR4: ILEVEL)

#### 4.3.2 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)

#### 4.3.3 Port initialization function (port\_init())

(1) Initial setting of output port

- Set Port input enable bit of Port Input Special Function Control Register as permit inputting. (PICNT: PIEN0)
- Initialize P11 Data Register. (P11DATA)
- Set P11 Direction Register as output mode. (P11DIR)
- Set P11 Operation Mode Register as input/output port. (P11MOD)

Note. If a Direction Register is set as output before setting up a Data Register, an unfixed value is outputted until writing will be performed to a Data Register.

#### 4.3.4 Various initialization function (init\_func())

- (1) Call the port initialization function
- (2) Call the timer initialization function
- (3) Call the Interrupt Setting function

#### 4.3.5 Main function (main())

- (1) Call the interrupt disable function
- (2) Call the various initialization function
- (3) Call the TIO5 Noise processing input mode initial setting function
- (4) Call the interrupt enable function
- (5) Infinite loop waiting for Interrupt

#### 4.3.6 Input interrupt processing function (TIO4\_7\_Int())

- (1) TIO5 Interrupt Request Status Check
  - Call the interrupt disable function.
  - Clear TIO5 Interrupt Request Status.
  - Call the interrupt enable function.
  - Call the TIO5 Noise processing input interrupt processing function.

#### 4.3.7 TIO5 Noise processing input interrupt processing function (TIO5\_noiseInt())

- (1) Increment of P11DATA
- When TIO5 interrupt occurs, increment P11DATA.

#### 4.3.8 TIO5 Noise processing input mode initial setting function (TIO5\_noise\_init())

- (1) Set Input Event Bus
- Select TIN3 when inputs in input event bus3. (CKIEBCR: IEB3S)
- (2) Initial setting TIO5
- Set Noise Processing Input Mode. (TIO5CR: TIO5M)
  - Set Clock Bus 0 to Clock sources. (TIO5CR: TIO5CKS)
  - Set Input Event Bus 3 to Measurement Input Sources. (TIO5CR: TIO5ENS)
  - Set noise judgment time in reload register 0. (TIO5RL0)
- (3) Initial setting Input terminal
- Set TIN3 as “H” level is valid. (TINCR0: TIN3S)
  - Set P153 Operation Mode bit of P15 Operation Mode register as TIN3. (P15MOD: P153MOD)
- (4) Set Interrupt
- Set TIO5 Interrupt Request as prohibition. (TIOIR1: TIOIM5)
  - Set TIN3 Interrupt Request as permission. (TINIR0: TINIM3)
- (5) Start counting TIO5
- Set Enable protect bit as enable for rewriting. (TIOPRO: TIO5PRO)
  - Start counting. (TIOCEN: TIO5CEN)

#### 4.3.9 Startup routine (startup.ms)

- (1) Set interrupt
- Set Interrupt sources of ICU Vector Table, which is MJT output interrupt 4 (H'0000 00B4), as the head address of interrupt processing function. (TIO4\_7\_Int())



## 4.4 Sample Programming Code

The sample program of TIO5 Noise Processing Input Mode is shown below.

In this example of a reference program, TIO5 is used and if valid signal level (“H” level) inputted in TIN3 is more than defined time in the program interrupt request occurs.

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 TIO5\_noise\_main.c

```

1  /*"FILE COMMENT"*****
2  *      M32R C Programming          Rev. 1.01
3  *      < Sample Program for 32176 >
4  *      < TIO5 noise processing input 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          port_init(void);     /* Initialize port */
23 void          timer_init(void);    /* Timer initialization */
24 void          int_init(void);      /* ICU initialization */
25 void          TIO4_7_Int(void);    /* Process TIO4-7 output interrupt */
26 void          TIO5_noiseInt(void); /* Process TIO5 interrupt */
27
28 /******/
29 /*      Definition of external reference */
30 /******/
31
32 extern void   DisInt( void );      /* Interrupt disable function */
33 extern void   EnInt( void );      /* Interrupt enable function */
34
35 extern void   TIO5_noise_init(void); /* Initialize TIO5 noise processing input
mode */
36
37 /*"FUNC COMMENT"*****
38 * Function name: int_init()
39 *-----
40 * Description  : ICU initialization
41 *-----
42 * Argument    : -
43 *-----
44 * Returns     : -
45 *-----
46 * Notes      :
47 *"FUNC COMMENT END"*****/
48 void int_init(void)
49 {
50     IMJTOCR4 = 0x00;          /* TIO4-7 ILEVEL = 0 */
51 }
52
53 /*"FUNC COMMENT"*****
54 * Function name: timer_init()
55 *-----
56 * Description  : Timer initialization
57 *-----
58 * Argument    : -
59 *-----
60 * Returns     : -
61 *-----
62 * Notes      :
63 *"FUNC COMMENT END"*****/
64 void timer_init(void)
65 {
66     PRS0 = ( 100 - 1);      /* Set prescaler(10us@10MHz) */
67 }
68
69 /*"FUNC COMMENT"*****

```

```

70  * Function name: port_init()
71  *-----
72  * Description  : Port initialization
73  *-----
74  * Argument    : -
75  *-----
76  * Returns     : -
77  *-----
78  * Notes      :
79  *"FUNC COMMENT END"*****/
80 void port_init(void)
81 {
82     PICNT = PIEN0;                               /* Enable port input */
83
84     P11DATA = 0x00;                               /* Output data (must be set prior to mode) */
85     P11DIR  = 0xff;                               /* P110-P117 : Output mode */
86     P11MOD  = 0x00;                               /* P110-P117 : Input/output port */
87 }
88
89 /*"FUNC COMMENT"*****
90 * Function name: init_func()
91 *-----
92 * Description  : Call various initialization functions
93 *-----
94 * Argument    : -
95 *-----
96 * Returns     : -
97 *-----
98 * Notes      :
99 *"FUNC COMMENT END"*****/
100 void init_func(void)
101 {
102     port_init();                                 /* Initialize those related to port */
103     timer_init();                               /* Initialize those related to timer */
104     int_init();                                 /* Initialize those related to port */
105 }
106
107 /*"FUNC COMMENT"*****
108 * Function name: main()
109 *-----
110 * Description  : Initialize those related to portWhile using TIO5 in noise processing input mode, this
function
111 *             : performs interrupt processing when the high-level duration of TIN3 is 1 ms or more (when the
112 *             : source clock frequency = 10 MHz).
113 *             : It increments the LED (port 11) in each interrupt generated.
114 *-----
115 * Argument    : -
116 *-----
117 * Returns     : -
118 *-----
119 * Notes      :
120 *"FUNC COMMENT END"*****/
121 void main(void)
122 {
123     DisInt();                                   /* Disable interrupt */
124
125     init_func();
126
127     TIO5_noise_init();                           /* Start TIO5 count */
128
129     EnInt();                                     /* Enable interrupt */
130
131     while(1){
132         ;
133     }
134 }
135
136 /*"FUNC COMMENT"*****
137 * Function name: TIO4_7_Int()
138 *-----
139 * Description  : Enable interruptProcess TIO4-7 output interrupt
140 *             : - If a TIO5 interrupt, clear request status and process the TIO5 interrupt
141 *-----
142 * Argument    : -
143 *-----
144 * Returns     : -
145 *-----
146 * Notes      :
147 *"FUNC COMMENT END"*****/
148 void TIO4_7_Int(void)
149 {
150     UCHAR temp;
151
152     /**/ Interrupt judgment(TIO5) /**/
153
154     if(( TIOIR1 & TIOIS5) != 0u) {
155         DisInt();                               /* Disable interrupt */

```

```

156         temp = TIOIR1;
157         temp |= ( TIOIS4 | TIOIS6 | TIOIS7);
158         temp &= ~TIOIS5;
159         TIOIR1 = temp;
160         EnInt();
161
162         TIO5_noiseInt();
163     }
164 }
165 /*"FUNC COMMENT"*****
166 * Function name: TIO5_noiseInt()
167 *-----
168 * Description   : Process TIO5 interrupt
169 *-----
170 * Argument      : -
171 *-----
172 * Returns       : -
173 *-----
174 * Notes         :
175 *"FUNC COMMENT END"*****/
176 void TIO5_noiseInt( void )
177 {
178     P11DATA++;
179 }

```

### 4.4.2 TIO5\_noise.c

```

1  /*****FILE COMMENT*****/
2  *      M32R C Programming          Rev. 1.01
3  *      < Sample Program for 32176 >
4  *      < TIO5 noise processing input 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 /*      Function prototype declaration */
18 /*****/
19
20 void          TIO5_noise_init( void );          /* Initialize TIO5 noise processing input
mode */
21 void          TIO5_noiseInt( void ); /* Process TIO5 noise processing input interrupt (user
processing) */
22
23 /*****/
24 /*      Define macro                */
25 /*****/
26
27 /*** Noise processing input (TIO5) ***/
28
29 /*          /* 0123 4567
30 #define IEB3_MASK          0xc0u          /* 1100 0000B
31 #define IEB3_Tin3          0x00u          /* 0000 0000B
32 /*          /* ++----- Input event bus 3 : TIN3
33
34 /*          /* 0123 4567 89AB CDEF
35 #define TIN3_MASK          0x0700u          /* 0000 0111 0000 0000B
36 #define TIN3_HLevel          0x0600u          /* 0000 0110 0000 0000B
37 /*          /*          +++----- Set high on TIN3 to be the
active level */
38
39 /*          /* 0123 4567
40 #define TIO5_Noise          0x9eu          /* 1001 1110B
41 /*          /* ||| |++---- Set TIO5 noise processing input mode
42 /*          /* |||++----- Measurement input source :
43 /*          /* |||          Input event bus 3 selected
44 /*          /* ++----- Select clock bus 0
45
46 #define TIO5_NoiseTime          100 - 1          /* Count value for noise judgment time
47
48 /*****FUNC COMMENT*****/
49 * Function name: TIO5_noise_init()
50 *-----
51 * Description : Count value for noise judgment timeInitial settings for TIO5 noise processing input mode
52 *              : - While using TIO5 in noise processing input mode,
53 *              : this function detects high level on TIN3 via input event 3
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 *        : ICU's interrupt control related registers are set separately from the above
62 *        : Port input function must be enabled
63 *        : This function must be executed while interrupts are disabled
64 *****/
65 void          TIO5_noise_init( void )
66 {
67     UCHAR          temp;

```

```

68     USHORT  temp16;
69
70  /**/ Setting input event bus 3 ***/
71
72     temp = CKIEBCR;
73     CKIEBCR = ( temp & ~IEB3_MASK) | IEB3_Tin3;          /* Select input event bus 3 for input */
74
75  /**/ Setting noise processing input mode (TIO5) ***/
76
77     TIO5CR = TIO5_Noise;                                /* Set TIO5 noise processing input mode */
78     TIO5RL0 = TIO5_NoiseTime;                          /* Set TIO5 noise judgment time */
79
80  /**/ Setting P153 (TIN3) high level active ***/
81
82     temp16 = TINCRO;
83     TINCRO = ( temp16 & ~TIN3_MASK) | TIN3_HLevel;      /* Set high on TIN3 to be the active level */
84     P15MOD |= 0x10u;                                    /* Select P153 for TIN3 */
85
86  /**/ Setting interrupt (TIO5) ***/
87
88     temp = TIOIR1;
89     temp |= ( TIOIS7 | TIOIS6 | TIOIS4);
90     temp &= ~( TIOIS5 | TIOIM5);                       /* Enable TIO5 interrupt */
91     TIOIR1 = temp;
92
93  /**/ Setting interrupt (TIN3) ***/
94
95     TINIR1 |= TINIM3;                                    /* Disable TIN3 interrupt */
96
97  /**/ Starting count ***/
98
99     TIOPRO = (~TIO5PRO) & 0xFFFFu;                    /* Enable TIO5 enable protect rewrite */
100    TIOCEN = 0xffffu;                                    /* Starting count TIO5 */
101 }
102

```

### 4.4.3 startup.ms (A part is extracted.)

(abbreviation)

```

69 ;*****
70 ; ICU Vector Table
71 ;*****
72 ;
73         .SECTION          ICUVECT, DATA, ALIGN=4
74 ;
75         .IMPORT           $TIO4_7_Int
76 ;
77 vectbl:
78         .DATA.W           EIT_reset          ; H'0000 0094  MJT Input Interrupt 4:TIN3-TIN6
79         .DATA.W           EIT_reset          ; H'0000 0098  MJT Input Interrupt 3:TIN20-TIN23
80         .DATA.W           EIT_reset          ; H'0000 009C  MJT Input Interrupt 2:TIN12-TIN19
81         .DATA.W           EIT_reset          ; H'0000 00A0  MJT Input Interrupt 1:TIN0-TIN2
82         .DATA.W           EIT_reset          ; H'0000 00A4  MJT Input Interrupt 0:TIN7-TIN11
83         .DATA.W           EIT_reset          ; H'0000 00A8  MJT Output Interrupt 7:TMS0,TMS1
84         .DATA.W           EIT_reset          ; H'0000 00AC  MJT Output Interrupt 6:TOP8,TOP9
85         .DATA.W           EIT_reset          ; H'0000 00B0  MJT Output Interrupt 5:TOP10
86         .DATA.W           $TIO4_7_Int       ; H'0000 00B4  MJT Output Interrupt 4:TIO4-TIO7
87         .DATA.W           EIT_reset          ; H'0000 00B8  MJT Output Interrupt 3:TIO8,TIO9
88         .DATA.W           EIT_reset          ; H'0000 00BC  MJT Output Interrupt 2:TOP0-TOP5
89         .DATA.W           EIT_reset          ; H'0000 00C0  MJT Output Interrupt 1:TOP6,TOP7
90         .DATA.W           EIT_reset          ; H'0000 00C4  MJT Output Interrupt 0:TIO0-TIO3
91         .DATA.W           EIT_reset          ; H'0000 00C8  DMAC0-4 Interrupt:DMA0-DMA4
92         .DATA.W           EIT_reset          ; H'0000 00CC  SIO1 Receive Interrupt
93         .DATA.W           EIT_reset          ; H'0000 00D0  SIO1 Transmit Interrupt
94         .DATA.W           EIT_reset          ; H'0000 00D4  SIO0 Receive Interrupt
95         .DATA.W           EIT_reset          ; H'0000 00D8  SIO0 Transmit Interrupt
96         .DATA.W           EIT_reset          ; H'0000 00DC  A-D0 Conversion Interrupt
97         .DATA.W           EIT_reset          ; H'0000 00E0  TID0 Output Interrupt
98         .DATA.W           EIT_reset          ; H'0000 00E4  TOD0 Output Interrupt
99         .DATA.W           EIT_reset          ; H'0000 00E8  DMAC5-9 Interrupt:DMA5-DMA9
100        .DATA.W           EIT_reset          ; H'0000 00EC  SIO2,3 Transmit/Receive Interrupt
101        .DATA.W           EIT_reset          ; H'0000 00F0  RTD Interrupt
102        .DATA.W           EIT_reset          ; H'0000 00F4  TID1 Output Interrupt
103        .DATA.W           EIT_reset          ; H'0000 00F8  TOD1,TOM0 Output Interrupt
104        .DATA.W           EIT_reset          ; H'0000 00FC  SIO4,5 Transmit/Receive Interrupt
105        .DATA.W           EIT_reset          ; H'0000 0100  A-D1 Conversion Interrupt
106        .DATA.W           EIT_reset          ; H'0000 0104  TID2 Output Interrupt
107        .DATA.W           EIT_reset          ; H'0000 0108  TML1 Input Interrupt
108        .DATA.W           EIT_reset          ; H'0000 010C  CAN0 Transmit/Receive & Error Interrupt
109        .DATA.W           EIT_reset          ; H'0000 0110  CAN1 Transmit/Receive & Error Interrupt

```

(abbreviation)

4.5 Timing of operation

Timing of operation in this reference program is shown below.  
(In the program, it is considering as  $n = (100-1)$ )

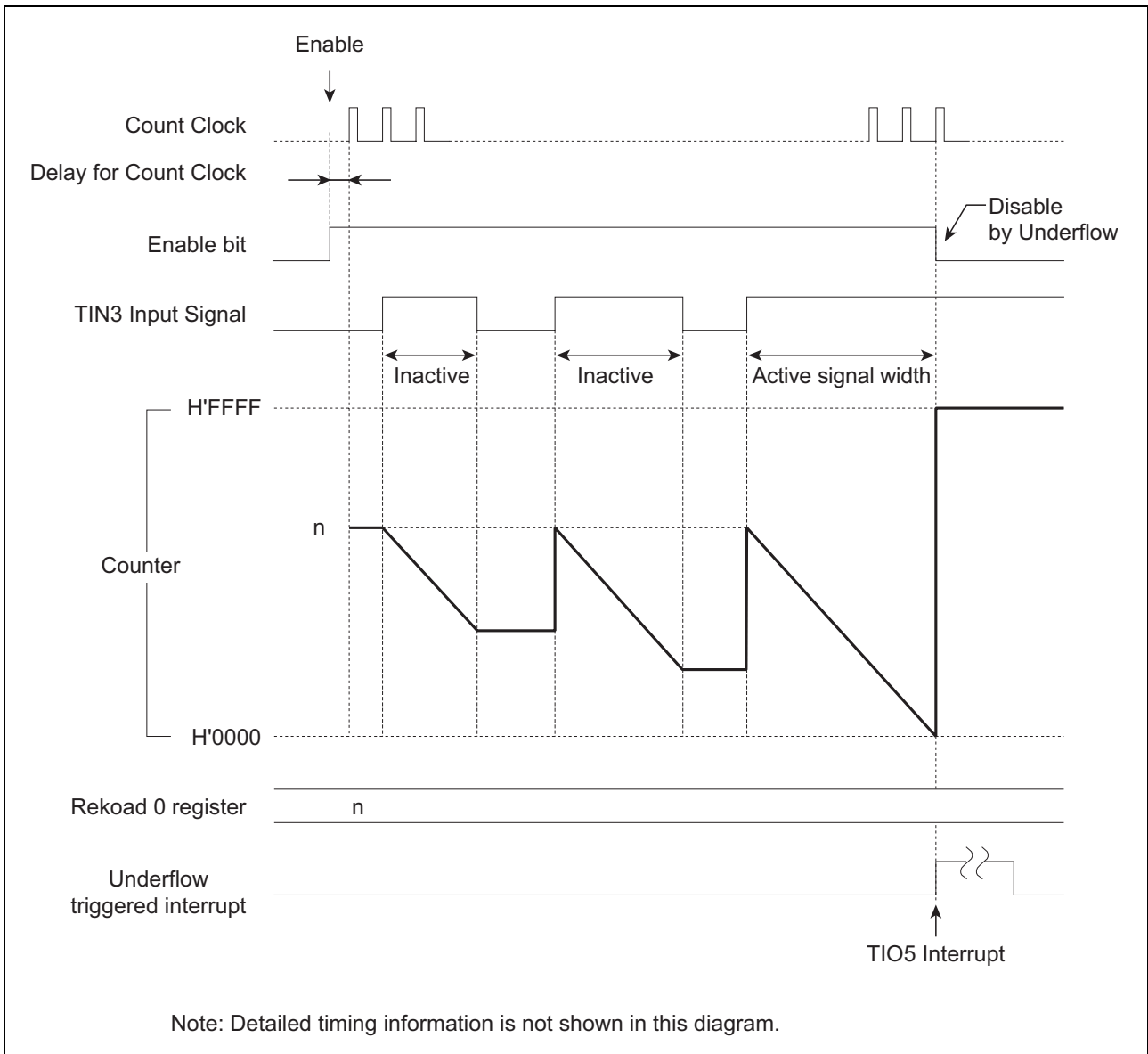


Figure 4.5.1 Timing Diagram for TIO Noise Processing Input

## 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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Rev.	Date	Description	
		Page	Summary
1.00	Jan 13, 2006	-	First Edition issued

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