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Renesas Electronics Corporation

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APPLICATION NOTE

Using Clock Time-Base Function to Make LED Flicker

Introduction

The clock time-base function of timer A is used to turn on and off the LED every 1 s.

Target Device

H8/300H Tiny Series H8/3664

Contents

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1. Specifications

1. The clock time-base function of timer A is used to turn on and off the LED every 1 s.
2. A timer A interrupt is generated when timer counter A (TCA) overflows, and the LED is turned on or off during the timer A interrupt handling.
3. The LED is connected to the $P7_4$ output pin of port 7.
4. A timer A interrupt is set to be generated every 1 s by clock time-base operation.

2. Description of Functions Used

In this sample task, the LED is turned on and off every 1 s by the clock time-base function of timer A. Figure 2.1 is a block diagram of the clock time-base function of timer A. The elements of the block diagram are described below.

- ϕ_w is the clock (32.768 kHz) output by the subclock pulse generator.
- Prescaler W (PSW) is a 5-bit counter with clock input of 32.768 kHz divided by four ($\phi_w/4$). The divided output is used in clock time-base operation of timer A.
- Timer mode register A (TMA) is an 8-bit readable/writable register that selects the TCA input clock source and TCA overflow cycle. In this sample task, PSW is selected as the TCA input clock source and 1 s is selected as the TCA overflow cycle.
- Timer counter A (TCA) is an 8-bit read-only up-counter that is incremented by internal clock input. When TCA overflows, the timer A interrupt request flag (IRRTA) in interrupt request register 1 (IRR1) is set to 1.
- IRRTA in IRR1 is set to 1 when TCA overflows. A timer A interrupt is accepted and timer A interrupt handling starts when the IRRTA flag is set to 1, timer A interrupt enable (IENTA) in interrupt enable register 1 (IENR1) is set to 1, and the I bit in the condition code register (CCR) is cleared to 0.

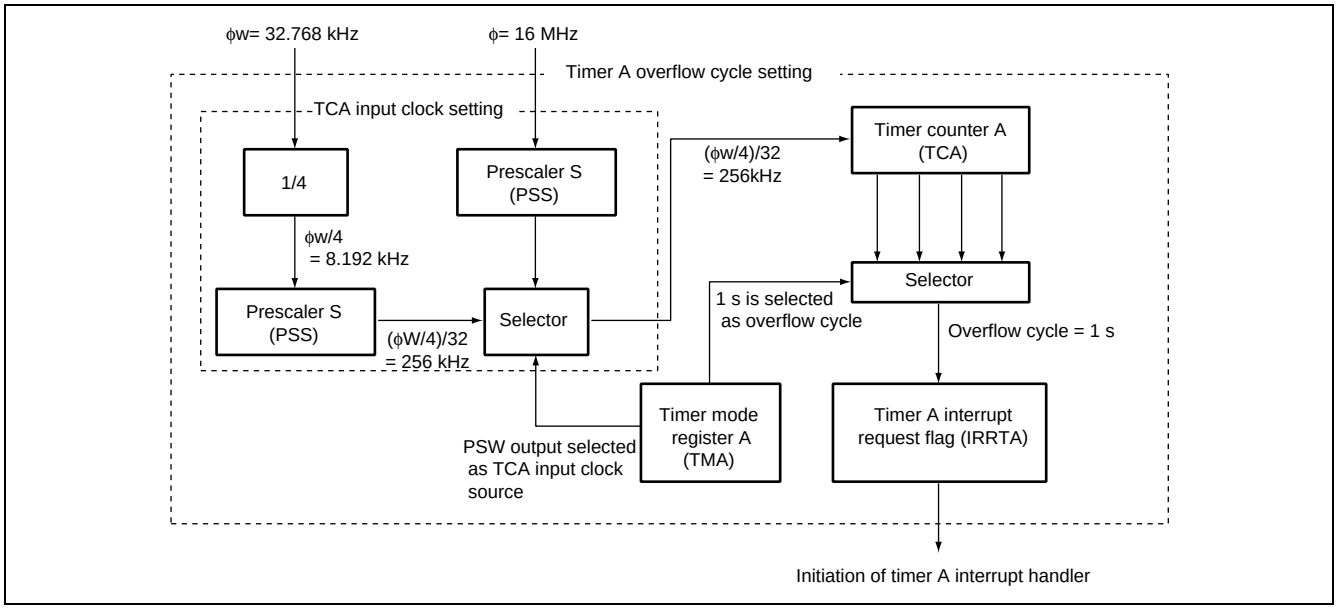

Figure 2.1 Timer A's Clock Time-Base Function

Table 2.1 lists the function allocation for this sample task. The functions listed in table 2.5 are allocated so that the LED flickers by the clock time-base function of timer A.

Table 2.1 Function Allocation

Function	Description
PSW	5-bit counter with clock input of 32.768 kHz/4
TCA	8-bit counter with clock input of 32.768 kHz/128
TMA	Selects PSW and sets the TCA overflow cycle
IRRTA	Indicates whether or not a timer A interrupt request is issued
PCR7	Sets $P7_4$ output pin function
PDR7	Stores $P7_4$ output pin data
$P7_4$	LED output

3. Description of Operations

Figure 3.1 shows this sample task's principle of operation. The hardware and software processing shown in figure 3.1 applies the clock time-base function of timer A to make the LED flicker.

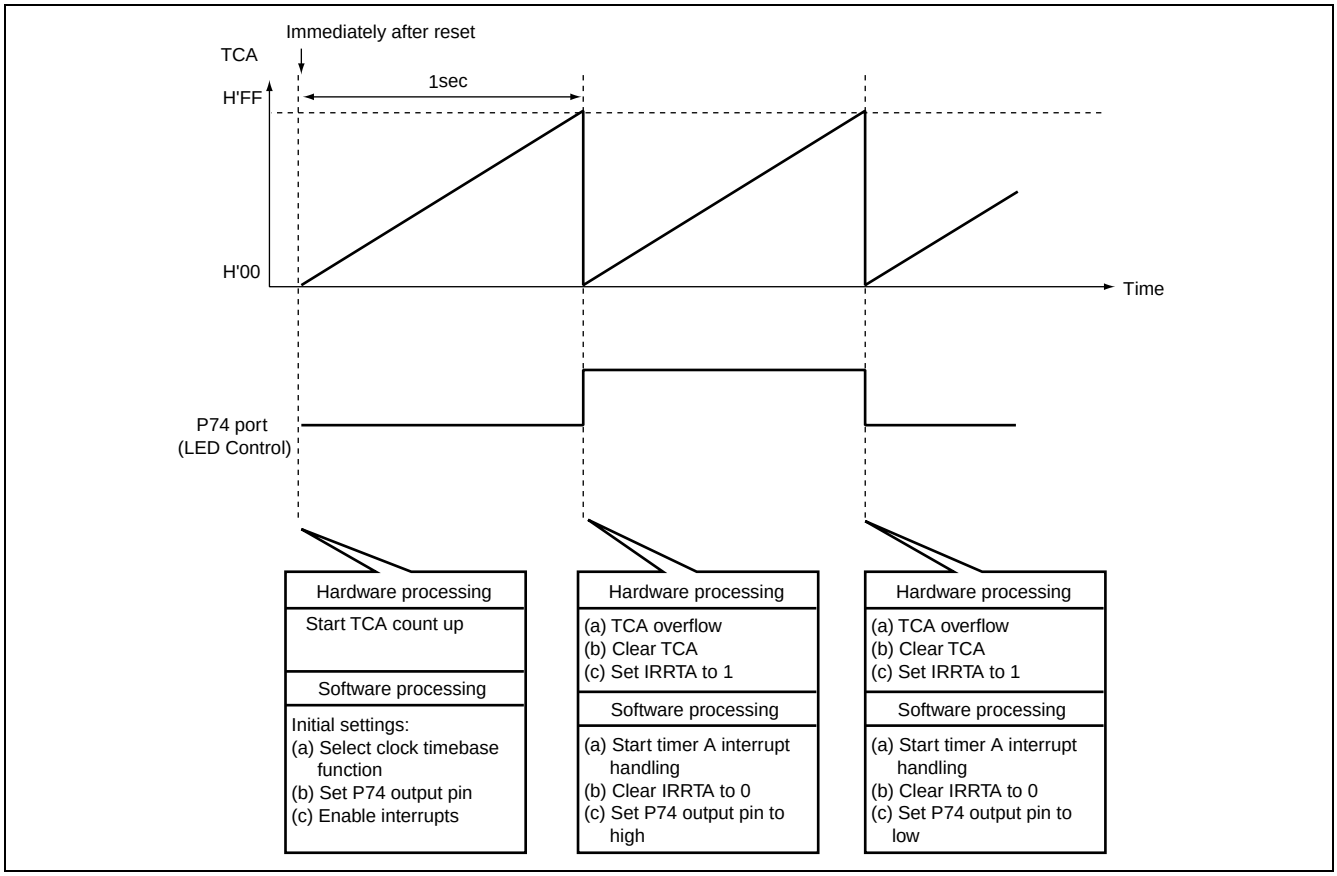

Figure 3.1 Operation Principle: Using Clock Time-Base Function of Timer A to Make LED Flicker

4. Description of Software

4.1 Description of Modules

Table 4.1 describes the software used in this sample task.

Table 4.1 Description of Modules

Module Name	Label Name	Function
Main routine	main	Selects the clock time-base function, sets port 7, and enables interrupts.
LED control	taint	During the timer A interrupt handling routine, turns on/off the LED.

4.2 Description of Arguments

No arguments are used in this sample task.

4.3 Description of Internal Registers

Table 4.2 describes the internal registers used in this sample task.

Table 4.2 Description of Internal Registers

Register	Name	Function	Address	Setting
IRR1	IRRTA	Interrupt request register 1 (timer A interrupt request flag):	H'FFF6	
		When IRRTA is cleared to 0, no timer A interrupt is requested.	Bit 6	0
		When IRRTA is set to 1, a timer A interrupt is requested.		
IENR1	IENTA	Interrupt enable register 1 (timer A interrupt enable):	H'FFF4	
		When IENTA is set to 1, timer A interrupt requests are enabled.	Bit 6	1
TMA		Timer mode register A:	H'FFA6	H'18
		When TMA is set to H'18, timer A is set to the clock time-base function, the TCA input clock source to PSW, and the TCA overflow cycle to 1 s.		
TCA		Timer counter A:	H'FFA7	H'00
		8-bit up-counter incremented by clock input of 32.768 (kHz)/128.		
PDR7	P74	Port data register 7 (port data register 7_4):	H'FFDA	
		When P74 is cleared to 0, the $P7_4$ pin output level is low.	Bit 4	0
		When P74 is set to 1, the $P7_4$ pin output level is high.		
PCR7	PCR74	Port control register 7 (port control register 7_4):	H'FFEA	
		When PCR74 is set to 1, the $P7_4$ pin functions as an output pin.	Bit 4	1

4.4 Description of RAM

Table 4.3 describes the RAM used in this sample task.

Table 4.3 Description of RAM

Label Name		Function	Address	Used in
USRF	LDONF	Flag for judging on/off of the LED	H'FB80 Bit 0	Main routine LED control

5. Flowcharts

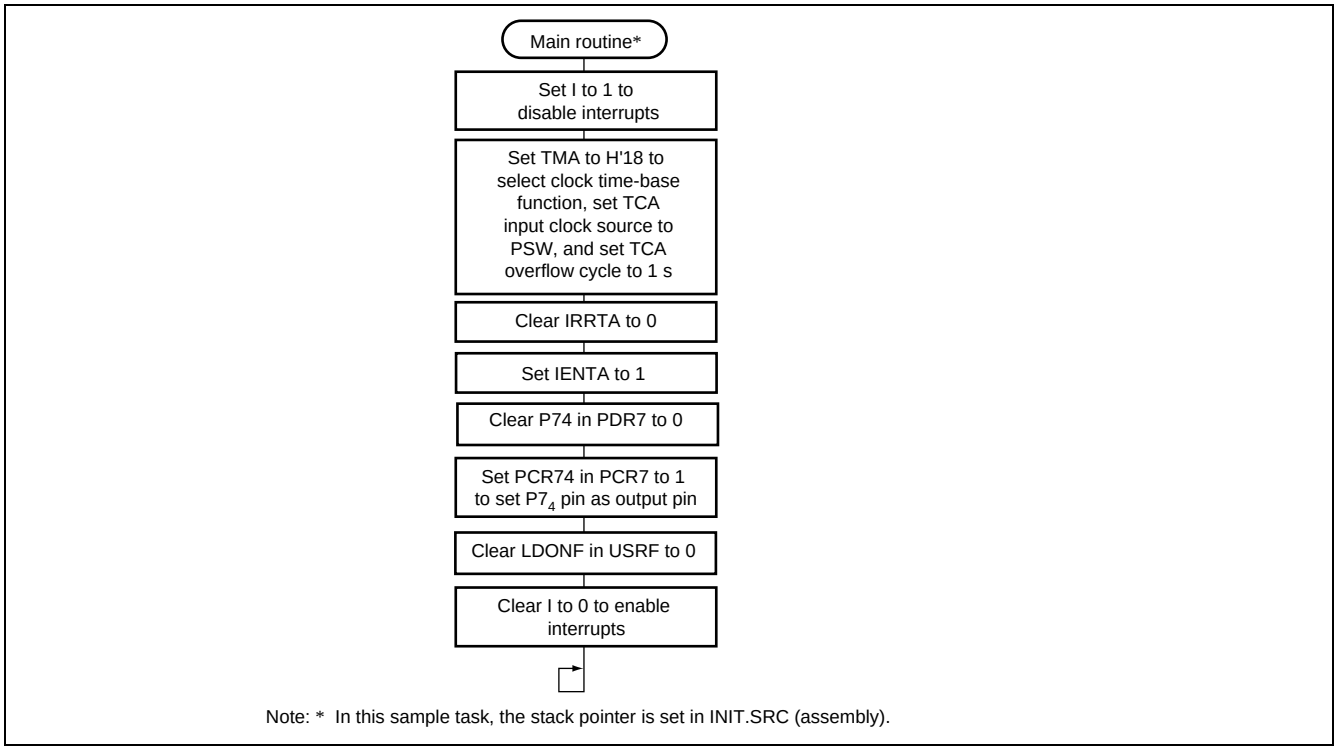

Figure 5.1 Flowchart for Main Routine

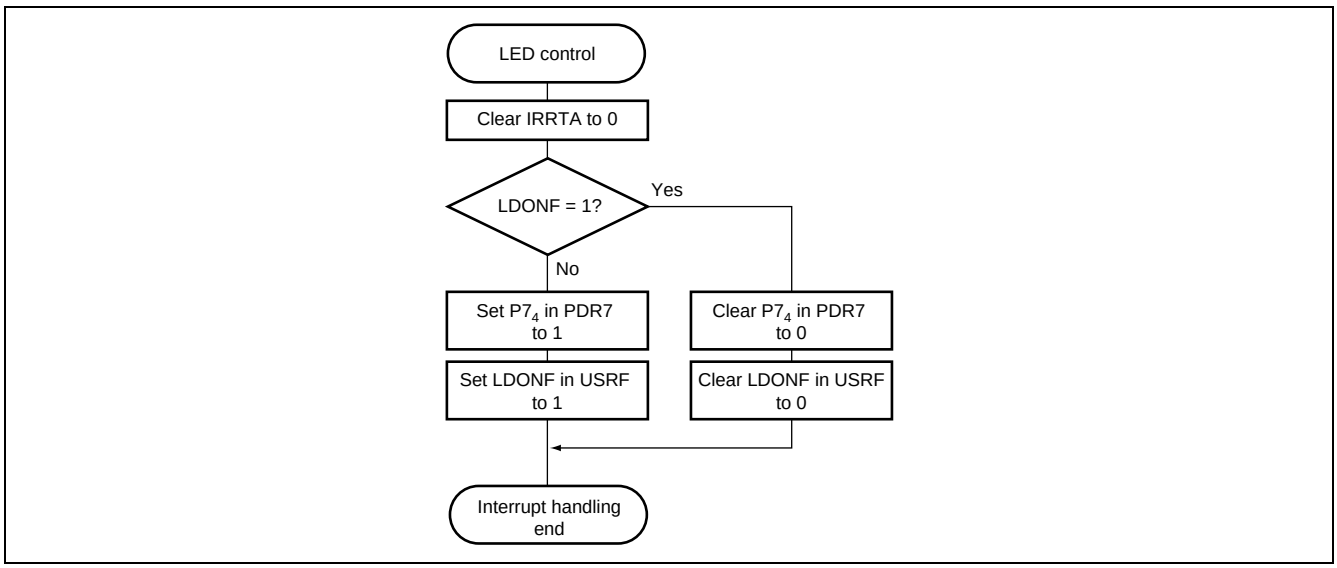

Figure 5.2 Flowchart for Timer A Interrupt Handling Routine

6. Program Listing

INIT.SRC (Program listing)

```
.EXPORT_INIT
  .IMPORT_main
  ;
  .SECTION    P,CODE
  _INIT:
  MOV.W#H'FF80,R7
  LDC.B#B'10000000,CCR
  JMP@_main
  ;
.END
```

```
/************************************************************/
/*                                                          */
/*    H8/300H Tiny Series -H8/3664-                         */
/*    Application Note                                      */
/*                                                          */
/*    'LED Flickering by Clock Time-Based Function'         */
/*                                                          */
/*    Function                                              */
/*    : Timer A Clock Time Base                             */
/*                                                          */
/*    External Clock : 16MHz                                */
/*    Internal Clock : 16MHz                                */
/*    Sub Clock      : 32.768kHz                            */
/*                                                          */
/************************************************************/

#include    <machine.h>
```

```
/************************************************************/
/*    Symbol Defnition                                      */
/************************************************************/
struct BIT {
    unsigned char    b7:1;      /* bit7 */
    unsigned char    b6:1;      /* bit6 */
    unsigned char    b5:1;      /* bit5 */
    unsigned char    b4:1;      /* bit4 */
    unsigned char    b3:1;      /* bit3 */
    unsigned char    b2:1;      /* bit2 */
    unsigned char    b1:1;      /* bit1 */
    unsigned char    b0:1;      /* bit0 */
};

#define        TMA         *(volatile unsigned char *)0xFFA6   /* Timer Mode Register A          */
#define        TCA         *(volatile unsigned char *)0xFFA7   /* Timer Counter A                */
#define        PDR7_BIT    (*(struct BIT *)0xFFDA)             /* Port Data Register 7           */
#define        P74         PDR7_BIT.b4                         /* Port Data Register 74          */
#define        PCR7_BIT    (*(struct BIT *)0xFFEA)             /* Port Control Register 7        */
#define        PCR4        PCR7_BIT.b4                         /* Port Control Register 74       */
#define        IENR1_BIT   (*(struct BIT *)0xFFF4)             /* Interrupt Enable Register 1    */
#define        IENTA       IENR1_BIT.b6                        /* Timer A Interrupt Enable       */
#define        IRR1_BIT    (*(struct BIT *)0xFFF6)             /* Interrupt Request Register 1   */
#define        IRRTA       IRR1_BIT.b6                         /* Timer A Interrupt Request Flag */

#pragma        interrupt    (taint)
/************************************************************/
/*     Function Definition                                  */
/************************************************************/
extern    void    INIT ( void );                          /* SP Set                         */
void      main      ( void );
void      taint     ( void );
```

```
/************************************************************/
/*    RAM define                                            */
/************************************************************/

unsigned char    USRF;                                      /* User Flag Erea                */

#define        USRF_BIT    (*(struct BIT *)&USRF)
#define        LDONF        USRF_BIT.b0                     /* Led On Flag                   */

/************************************************************/
/*    Vector Address                                        */
/************************************************************/
#pragma    section        V1                                /* VECTOR SECTOIN SET            */
void (*const VEC_TBL1[])(void) = {
/* 0x00 - 0x0f */
    INIT                                                   /* 00 Reset                      */
};
#pragma    section        V2                                /* VECTOR SECTOIN SET            */
void (*const VEC_TBL2[])(void) = {
    taint                                                  /* 26 Timer A Interrupt          */
};
#pragma    section                                           /* P                             */
/************************************************************/
/*    Main Program                                          */
/************************************************************/
void main ( void )
{
    set_imask_ccr(1);                                      /* Interrupt Disable             */

    TMA = 0x18;                  /* Initialize Timer A Function & TCA overflow Period       */

    IRRTA = 0;                                             /* Clear IRRTA                   */
    IENTA = 1;                                             /* Timer A Interrupt Enable      */

    P74 = 0;                                               /* Clear P74                     */
    PCR4 = 1;                                              /* Initialize P74 Output Port    */

    LDONF = 0;                                             /* Clear LDONF                   */

    set_imask_ccr(0);                                      /* Interrupt Enable              */
```

```
    while(1)    {
        ;
    }
}

/*********************************************************/
/*    Timer A Interrupt                                  */
/*********************************************************/
void taint ( void )
{

    IRRTA = 0;                                  /* Clear IRRTA              */
    if ( LDONF == 1 )    {                      /* LDONF == 1?              */
        P74 = 0;                                /* Turn Off LED             */
        LDONF = 0;                              /* Clear LDONF              */
    }
    else    {
        P74 = 1;                                /* Turn On LED              */
        LDONF = 1;                              /* Set LDONF                */
    }
}
```

Link address specification:

Section Name	Address
CV1	H'0000
CV2	H'0026
P	H'0100
B	H'FB80