To our customers,

Old Company Name in Catalogs and Other Documents

On April 1st, 2010, NEC Electronics Corporation merged with Renesas Technology Corporation, and Renesas Electronics Corporation took over all the business of both companies. Therefore, although the old company name remains in this document, it is a valid Renesas Electronics document. We appreciate your understanding.

Renesas Electronics website: http://www.renesas.com

April 1st, 2010
Renesas Electronics Corporation

Issued by: Renesas Electronics Corporation (http://www.renesas.com)

Send any inquiries to http://www.renesas.com/inquiry.

Notice

1. All information included in this document is current as of the date this document is issued. Such information, however, is subject to change without any prior notice. Before purchasing or using any Renesas Electronics products listed herein, please confirm the latest product information with a Renesas Electronics sales office. Also, please pay regular and careful attention to additional and different information to be disclosed by Renesas Electronics such as that disclosed through our website.
2. Renesas Electronics does not assume any liability for infringement of patents, copyrights, or other intellectual property rights of third parties by or arising from the use of Renesas Electronics products or technical information described in this document. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
3. You should not alter, modify, copy, or otherwise misappropriate any Renesas Electronics product, whether in whole or in part.
4. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation of these circuits, software, and information in the design of your equipment. Renesas Electronics assumes no responsibility for any losses incurred by you or third parties arising from the use of these circuits, software, or information.
5. When exporting the products or technology described in this document, you should comply with the applicable export control laws and regulations and follow the procedures required by such laws and regulations. You should not use Renesas Electronics products or the technology described in this document for any purpose relating to military applications or use by the military, including but not limited to the development of weapons of mass destruction. Renesas Electronics products and technology may not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations.
6. Renesas Electronics has used reasonable care in preparing the information included in this document, but Renesas Electronics does not warrant that such information is error free. Renesas Electronics assumes no liability whatsoever for any damages incurred by you resulting from errors in or omissions from the information included herein.
7. Renesas Electronics products are classified according to the following three quality grades: "Standard", "High Quality", and "Specific". The recommended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below. You must check the quality grade of each Renesas Electronics product before using it in a particular application. You may not use any Renesas Electronics product for any application categorized as "Specific" without the prior written consent of Renesas Electronics. Further, you may not use any Renesas Electronics product for any application for which it is not intended without the prior written consent of Renesas Electronics. Renesas Electronics shall not be in any way liable for any damages or losses incurred by you or third parties arising from the use of any Renesas Electronics product for an application categorized as "Specific" or for which the product is not intended where you have failed to obtain the prior written consent of Renesas Electronics. The quality grade of each Renesas Electronics product is "Standard" unless otherwise expressly specified in a Renesas Electronics data sheets or data books, etc.

   "Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; and industrial robots.

   "High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control systems; anti-disaster systems; anti-crime systems; safety equipment; and medical equipment not specifically designed for life support.

   "Specific": Aircraft; aerospace equipment; submersible repeaters; nuclear reactor control systems; medical equipment or systems for life support (e.g. artificial life support devices or systems), surgical implantations, or healthcare intervention (e.g. excision, etc.), and any other applications or purposes that pose a direct threat to human life.
8. You should use the Renesas Electronics products described in this document within the range specified by Renesas Electronics, especially with respect to the maximum rating, operating supply voltage range, movement power voltage range, heat radiation characteristics, installation and other product characteristics. Renesas Electronics shall have no liability for malfunctions or damages arising out of the use of Renesas Electronics products beyond such specified ranges.
9. Although Renesas Electronics endeavors to improve the quality and reliability of its products, semiconductor products have specific characteristics such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Further, Renesas Electronics products are not subject to radiation resistance design. Please be sure to implement safety measures to guard them against the possibility of physical injury, and injury or damage caused by fire in the event of the failure of a Renesas Electronics product, such as safety design for hardware and software including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult, please evaluate the safety of the final products or system manufactured by you.
10. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. Please use Renesas Electronics products in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. Renesas Electronics assumes no liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
11. This document may not be reproduced or duplicated, in any form, in whole or in part, without prior written consent of Renesas Electronics.
12. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products, or if you have any other inquiries.

(Note 1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its majority-owned subsidiaries.

(Note 2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

To all our customers

Regarding the change of names mentioned in the document, such as Hitachi Electric and Hitachi XX, to Renesas Technology Corp.

The semiconductor operations of Mitsubishi Electric and Hitachi were transferred to Renesas Technology Corporation on April 1st 2003. These operations include microcomputer, logic, analog and discrete devices, and memory chips other than DRAMs (flash memory, SRAMs etc.) Accordingly, although Hitachi, Hitachi, Ltd., Hitachi Semiconductors, and other Hitachi brand names are mentioned in the document, these names have in fact all been changed to Renesas Technology Corp. Thank you for your understanding. Except for our corporate trademark, logo and corporate statement, no changes whatsoever have been made to the contents of the document, and these changes do not constitute any alteration to the contents of the document itself.

Renesas Technology Home Page: http://www.renesas.com

Renesas Technology Corp.
Customer Support Dept.
April 1, 2003

Cautions

Keep safety first in your circuit designs!

1. Renesas Technology Corporation puts the maximum effort into making semiconductor products better and more reliable, but there is always the possibility that trouble may occur with them. Trouble with semiconductors may lead to personal injury, fire or property damage.
   Remember to give due consideration to safety when making your circuit designs, with appropriate measures such as (i) placement of substitutive, auxiliary circuits, (ii) use of nonflammable material or (iii) prevention against any malfunction or mishap.

Notes regarding these materials

1. These materials are intended as a reference to assist our customers in the selection of the Renesas Technology Corporation product best suited to the customer's application; they do not convey any license under any intellectual property rights, or any other rights, belonging to Renesas Technology Corporation or a third party.
2. Renesas Technology Corporation assumes no responsibility for any damage, or infringement of any third-party's rights, originating in the use of any product data, diagrams, charts, programs, algorithms, or circuit application examples contained in these materials.
3. All information contained in these materials, including product data, diagrams, charts, programs and algorithms represents information on products at the time of publication of these materials, and are subject to change by Renesas Technology Corporation without notice due to product improvements or other reasons. It is therefore recommended that customers contact Renesas Technology Corporation or an authorized Renesas Technology Corporation product distributor for the latest product information before purchasing a product listed herein.
   The information described here may contain technical inaccuracies or typographical errors.
   Renesas Technology Corporation assumes no responsibility for any damage, liability, or other loss rising from these inaccuracies or errors.
   Please also pay attention to information published by Renesas Technology Corporation by various means, including the Renesas Technology Corporation Semiconductor home page (http://www.renesas.com).
4. When using any or all of the information contained in these materials, including product data, diagrams, charts, programs, and algorithms, please be sure to evaluate all information as a total system before making a final decision on the applicability of the information and products. Renesas Technology Corporation assumes no responsibility for any damage, liability or other loss resulting from the information contained herein.
5. Renesas Technology Corporation semiconductors are not designed or manufactured for use in a device or system that is used under circumstances in which human life is potentially at stake. Please contact Renesas Technology Corporation or an authorized Renesas Technology Corporation product distributor when considering the use of a product contained herein for any specific purposes, such as apparatus or systems for transportation, vehicular, medical, aerospace, nuclear, or undersea repeater use.
6. The prior written approval of Renesas Technology Corporation is necessary to reprint or reproduce in whole or in part these materials.
7. If these products or technologies are subject to the Japanese export control restrictions, they must be exported under a license from the Japanese government and cannot be imported into a country other than the approved destination.
   Any diversion or reexport contrary to the export control laws and regulations of Japan and/or the country of destination is prohibited.
8. Please contact Renesas Technology Corporation for further details on these materials or the products contained therein.

APPLICATION NOTE

Flickering of LEDs Connected to I/O Ports

Introduction

The two LEDs connected to the I/O ports are alternately turned on and off.

Target Device

H8/300H Tiny Series H8/3664

Contents

Cautions

1. Hitachi neither warrants nor grants licenses of any rights of Hitachi's or any third party's patent, copyright, trademark, or other intellectual property rights for information contained in this document. Hitachi bears no responsibility for problems that may arise with third party's rights, including intellectual property rights, in connection with use of the information contained in this document.
2. Products and product specifications may be subject to change without notice. Confirm that you have received the latest product standards or specifications before final design, purchase or use.
3. Hitachi makes every attempt to ensure that its products are of high quality and reliability. However, contact Hitachi's sales office before using the product in an application that demands especially high quality and reliability or where its failure or malfunction may directly threaten human life or cause risk of bodily injury, such as aerospace, aeronautics, nuclear power, combustion control, transportation, traffic, safety equipment or medical equipment for life support.
4. Design your application so that the product is used within the ranges guaranteed by Hitachi particularly for maximum rating, operating supply voltage range, heat radiation characteristics, installation conditions and other characteristics. Hitachi bears no responsibility for failure or damage when used beyond the guaranteed ranges. Even within the guaranteed ranges, consider normally foreseeable failure rates or failure modes in semiconductor devices and employ systemic measures such as fail-safes, so that the equipment incorporating Hitachi product does not cause bodily injury, fire or other consequential damage due to operation of the Hitachi product.
5. This product is not designed to be radiation resistant.
6. No one is permitted to reproduce or duplicate, in any form, the whole or part of this document without written approval from Hitachi.
7. Contact Hitachi's sales office for any questions regarding this document or Hitachi semiconductor products.

1. Specifications

1. The two LEDs connected to the I/O ports are alternately turned on and off, as shown in figure 1.1.
2. The timing for turning on and off the LEDs is set to 0.5 s using the clock time-base function of timer A.
3. LED1 is connected to the $P7_4$ output pin of port 7 and LED2 is connected to the $P8_7$ output pin of port 8.

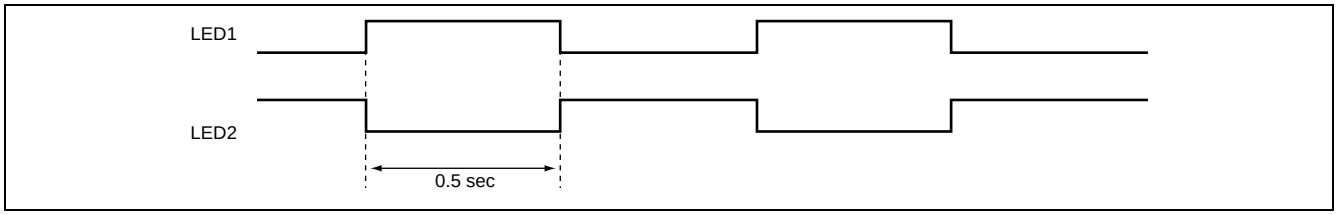


Figure 1.1 LED Flickering Operation

2. Description of Functions Used

In this sample task, the LEDs that are connected to the I/O ports are turned on and off.

Figure 2.1 is a block diagram of the I/O ports. The elements of the block diagram are described below.

- Port control register 7 (PCR7) selects inputs/outputs in bit units for pins $P7_6$ to $P7_4$ of port 7. Setting $PCR7_4$ to 1 makes the $P7_4$ pin an output port, while clearing the bit to 0 makes it an input port.
- Port data register 7 (PDR7) is an 8-bit register that stores data for port 7 pins $P7_6$ to $P7_4$. If port 7 is read while PCR7 bits are set to 1, the values stored in PDR7 are read, regardless of the actual pin states. If port 7 is read while PCR7 bits are cleared to 0, the pin states are read.
- Port control register 8 (PCR8) selects inputs/outputs in bit units for pins $P8_7$ to $P8_0$ of port 8. Setting $PCR8_7$ to 1 makes the $P8_7$ pin an output port, while clearing the bit to 0 makes it an input port.
- Port data register 8 (PDR8) is an 8-bit register that stores data for port 8 pins $P8_7$ to $P8_0$. If port 8 is read while PCR8 bits are set to 1, the values stored in PDR8 are read, regardless of the actual pin states. If port 8 is read while PCR7 bits are cleared to 0, the pin states are read.

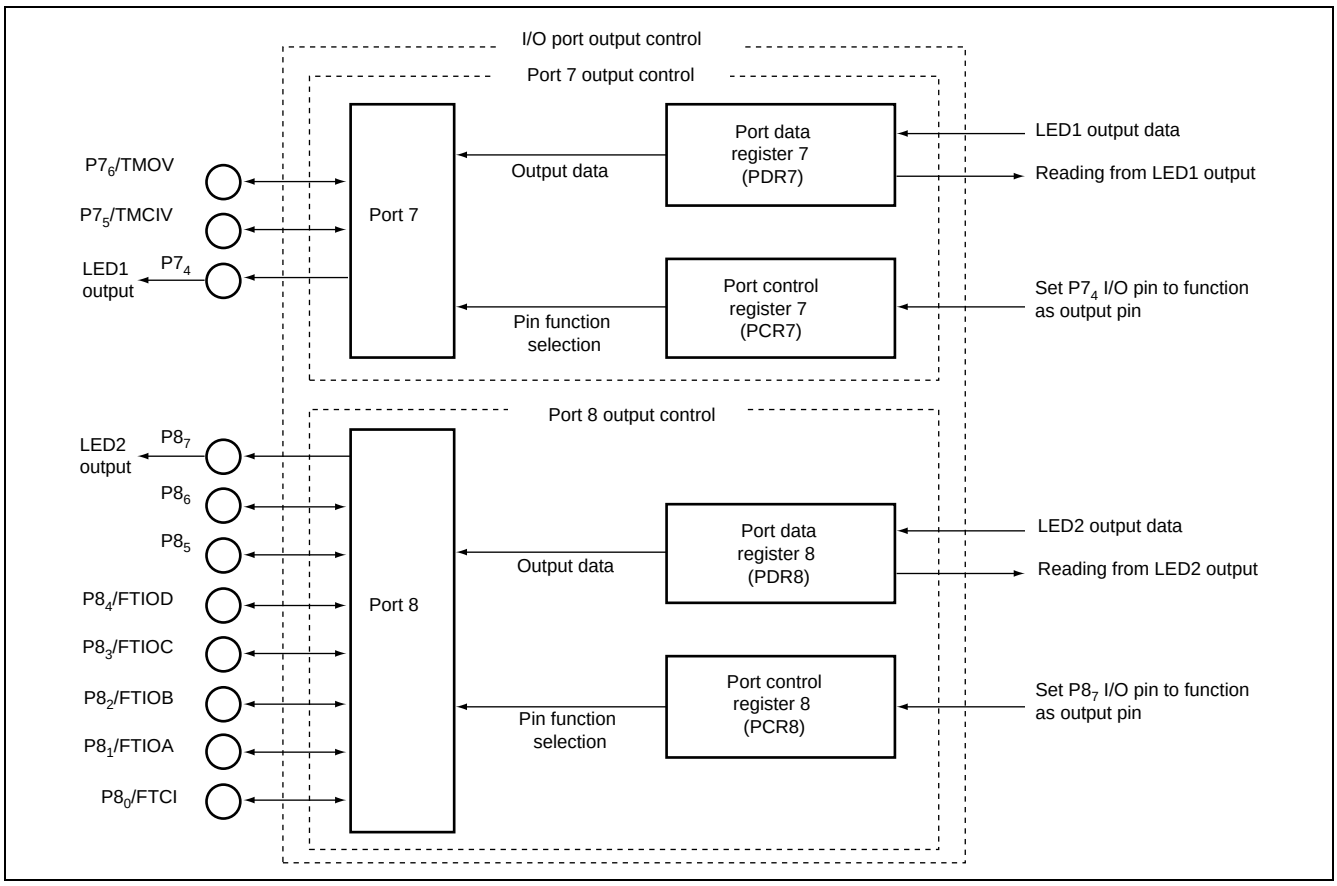


Figure 2.1 I/O Ports

Table 2.1 lists the function allocation for this sample task. The functions listed in table 2.1 are allocated so that the LEDs connected to the I/O ports can be made to flicker.

Table 2.1 Function Allocation

Function	Description
PDR7	Stores data output from pins P7$_6$ to P7$_4$ of port 7
PDR8	Stores data output from pins P8$_7$ to P8$_0$ of port 8
PCR7	Sets functions of I/O pins P7$_6$ to P7$_4$ of port 7
PCR8	Sets functions of I/O pins P8$_7$ to P8$_0$ of port 8
P7$_4$	LED1 output pin
P8$_7$	LED2 output pin
PSW	5-bit counter with clock input of 32.768 kHz/4
TCA	8-bit counter with clock input of the PSW output clock
TMA	Selects the clock time-base function of timer A and sets the TCA overflow cycle to 0.5 s

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 makes the LEDs connected to the I/O ports flicker.

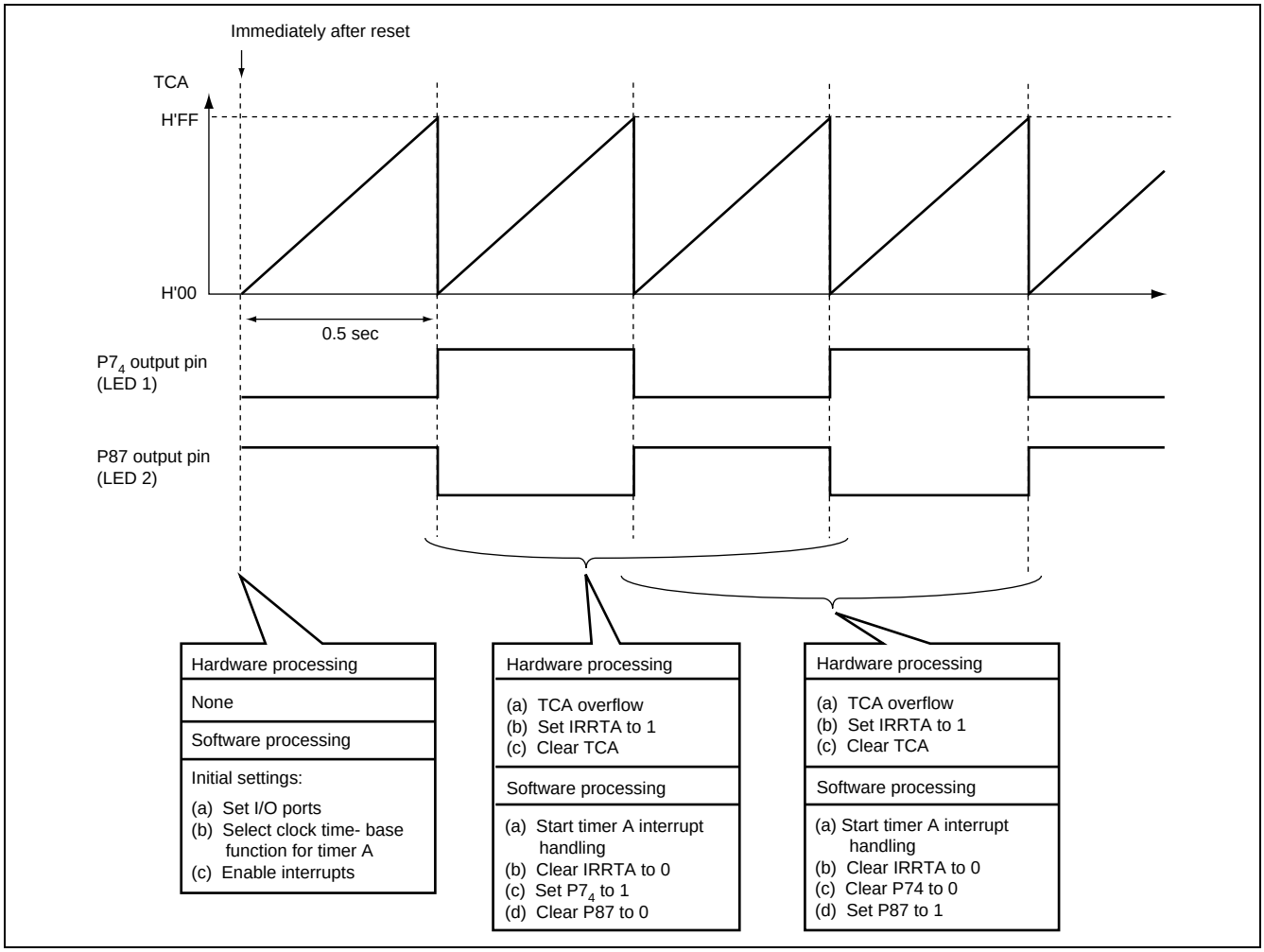


Figure 3.1 Operation Principle: Making LEDs Connected to I/O Ports Flicker

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 for timer A, sets I/O ports, and enables interrupts.
Port output	taint	During the timer A interrupt handling routine, judges the LED1 and LED2 outputs and controls output.

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
TMA		Timer mode register A (internal clock select):	H'FFA6	
	TMA3	When TMA3 and TMA0 are both set to 1 and TMA2 and TMA1 are both cleared to 0, timer A is set to the clock time-base function, the prescaler is set to PSW, and the TCA overflow cycle is set to 0.5 s.	Bit 3	TMA3 = 1
	TMA2		Bit 2	TMA2 = 0
	TMA1		Bit 1	TMA1 = 0
	TMA0		Bit 0	TMA0 = 1
TCA		Timer counter A:	H'FFA7	H'00
		8-bit up-counter incremented by clock input of PSW output clock and overflows every 0.5 s.		
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.		
PDR8	P87	Port data register 8 (port data register 8_7):	H'FFDB	
		When P87 is cleared to 0, the $P8_7$ pin output level is low.	Bit 7	1
		When P87 is set to 1, the $P8_7$ pin output level is high.		
PCR7	PCR74	Port control register 7 (port control register 7_4):	H'FFEA	
		When PCR74is set to 1, the $P7_4$ pin functions as an output pin.	Bit 4	1

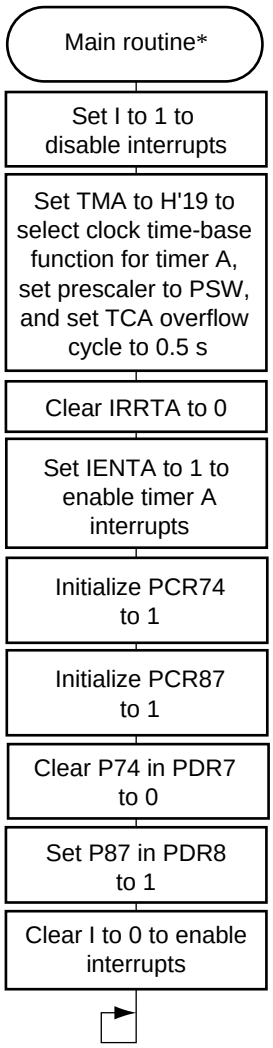
Table 4.2 Description of Internal Registers (cont)

Register Name		Function	Address	Setting
PCR8	PC87	Port control register 8 (port control register 8_7):	H'FFEB	
		When PC87 is set to 1, the $P8_7$ pin functions as an output pin.	Bit 7	1
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
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.		

4.4 Description of RAM

RAM is not used in this sample task.

5. Flowcharts



Note: * In this sample task, the stack pointer is set in INIT.SRC (assembly).

Figure 5.1 Flowchart for Main Routine

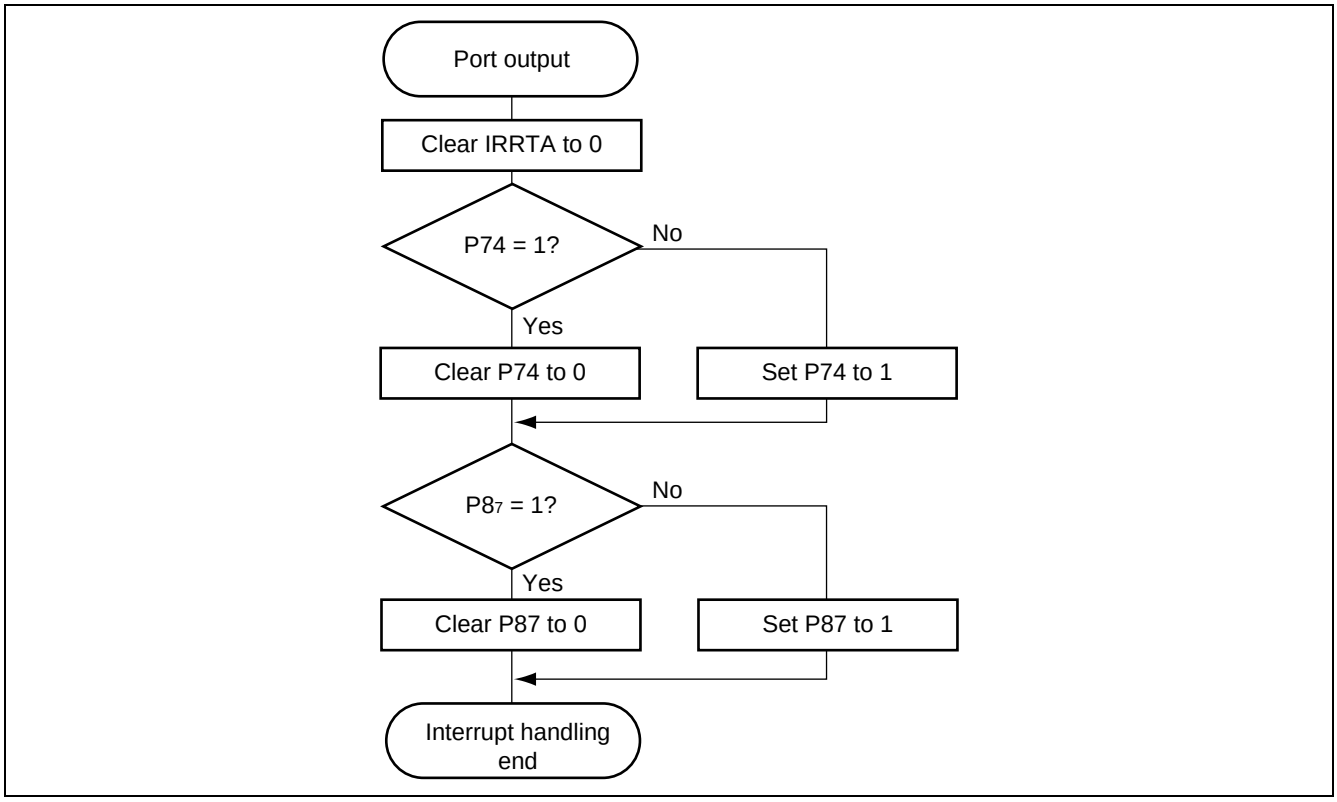


Figure 5.2 Flowchart for Timer A Interrupt Handling Routine

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                                   */
/*                                                       */
/*    'Flickering of LEDs Connected to I/O Port'         */
/*                                                       */
/*    Function                                           */
/*    : I/O Port                                         */
/*                                                       */
/*    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     PDR8_BIT   (*(struct BIT *)0xFFDB)           /* Port Data Register 8           */
#define     P87        PDR8_BIT.b7                       /* Port Data Register 87          */
#define     PCR7_BIT   (*(struct BIT *)0xFFEA)           /* Port Control Register 7        */
#define     PCR74      PCR7_BIT.b4                       /* Port Control Register 74       */
#define     PCR8_BIT   (*(struct BIT *)0xFFEB)           /* Port Control Register 8        */
#define     PCR87      PCR8_BIT.b7                       /* Port Control Register 87       */
#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 );
```

```
/************************************************************/
/*    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 = 0x19;                                              /* Initialize TCA Overflow Period */

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

    PCR74 = 1;                                               /* Initialize P74 Output Terminal Function */
    PCR87 = 1;                                               /* Initialize P87 Output Terminal Function */

    P74 = 1;                                                 /* Initialize P74 Terminal Output */
    P87 = 0;                                                 /* Initialize P87 Terminal Output */

    set_imask_ccr(0);                                        /* Interrupt Enable               */

    while(1)    {
       ;
    }
}
```

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

    IRRTA = 0;                                          /* Clear IRRTA    */
    if ( P74 == 1 )    {                                /* Turn on LED1 ? */
        P74 = 0;                                        /* Turn off LED1  */
    }
        else{
             P74 = 1;                                   /* Turn on LED1   */
        }

    if ( P87 == 1 ){                                    /* Turn on LED2 ? */
        P87 = 0;                                        /* Turn off LED2  */
    }
        else{
            P87 = 1;                                    /* Turn on LED2   */
        }
}
```

Link Address Setting:

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