

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.

7546/7547 Group

Operation of Timer A (Output Compare Mode)

1. Abstract

The following article introduces and shows an application example of output compare normal mode of timer A.

2. Introduction

The explanation of this issue is applied in the following condition:

- Application MCU: M37546 Group
M37547 Group
- Oscillation frequency: 8MHz

3. Contents

3.1 Description of the application example

- Description
 - Outputs Timer A underflow waveform from P02. The output level will invert when the timer A underflow. The period of timer A is 40ms.
 - Outputs compare waveform from compare channel 0. At first, the phase of the output waveform is at 0ms of one period and the pulse width is 10% period (4ms). Then the pulse width will turn longer 4ms and the phase will delay 4ms every time timer A underflow. If the positive pulse width too longer to output in one period, the waveform will change to the first status and continuously output.
- Operation
 - Selecting external oscillator and setting clock division ratio high-speed.
 - Initialize SFR.
 - Enable timer A and compare (compare 00 match) interrupt.
 - Start timer A and then output the waveform form CMP0 and P02.
 - Rewrite compare latch 00 and 01 value in the compare interrupt service routine.
 - Setting compare latch 00 and 01 reload bit (CMPR.0) to “1”, and then the compare latch will reload from the compare buffer at next timer A underflow.
 - Invert P02 output level to show timer A underflow in the timer A interrupt service routine.

The operation timing, the compare output waveform and the timer A underflow waveform are shown in Fig.1.

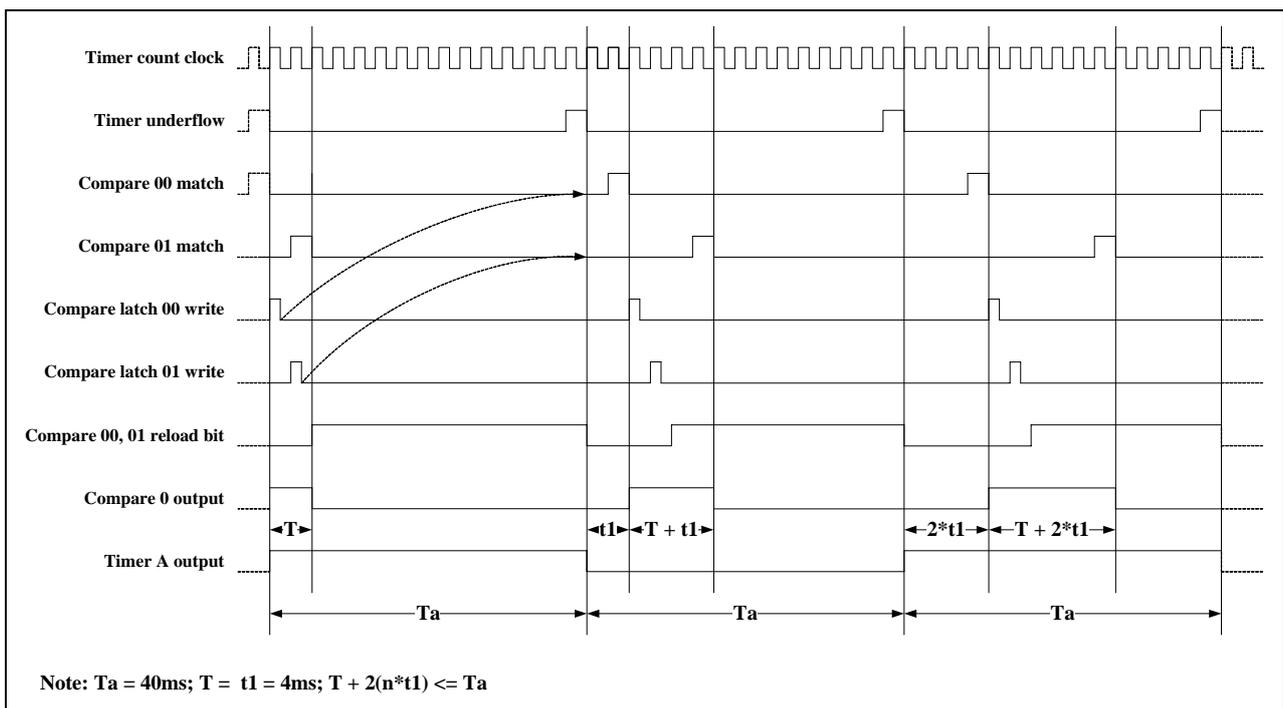
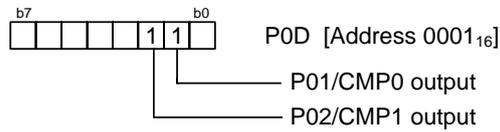


Fig.1: The Operate Timing and Output Waveform of Output Compare Mode

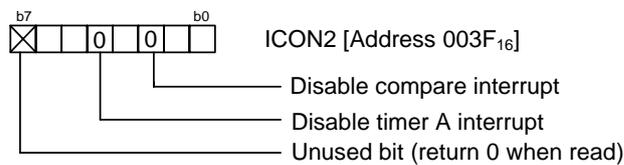
3.2 Register setting

The setup procedures of output compare 0 are shown as follow. When use compare 1~3, the procedures are same as these.

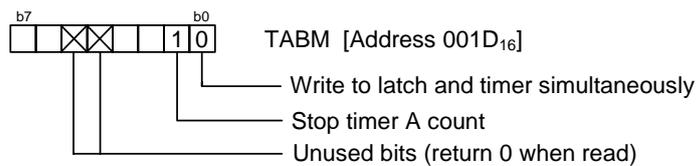
(1) Setting Port P0 direction register



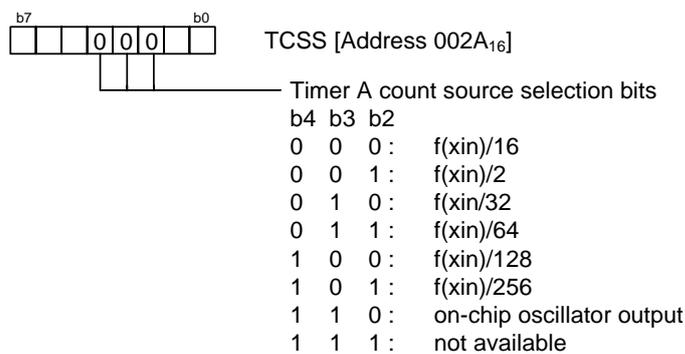
(2) Setting interrupt control register 2



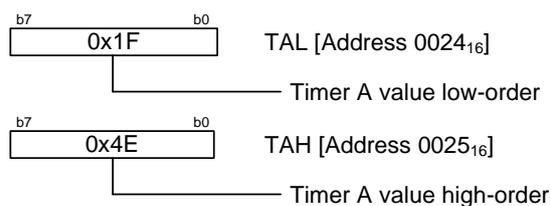
(3) Setting timer A,B mode register



(4) Setting timer count source set register

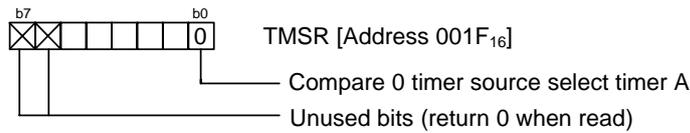


(5) Setting timer A register

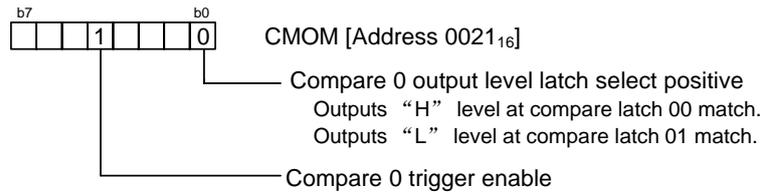


Note: Write to the low-order of timer A first, and the high-order of timer A next and be sure to write both low-order and high-order.

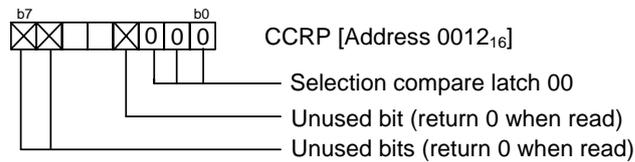
(6) Setting Timer source selection register



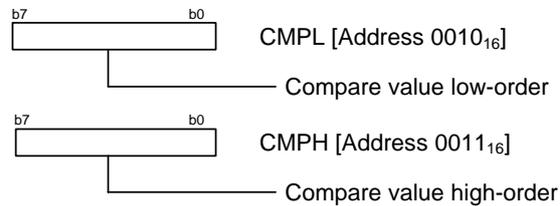
(7) Setting compare output mode register



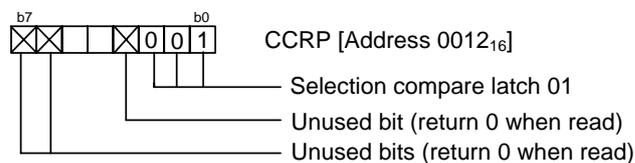
(8) Setting capture/compare register R/W pointer



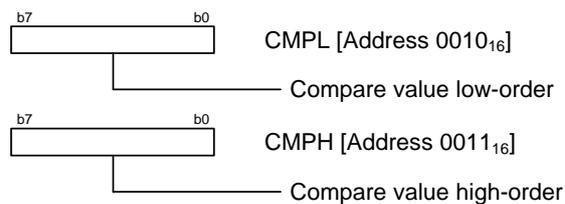
(9) Setting compare latch 00



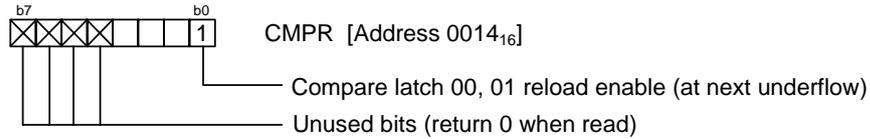
(10) Setting capture/compare register R/W pointer



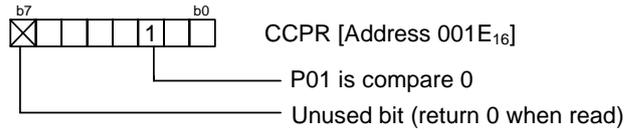
(11) Setting compare latch 01



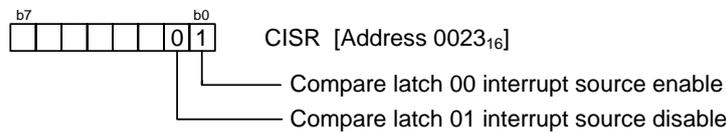
(12) Setting compare register re-load register



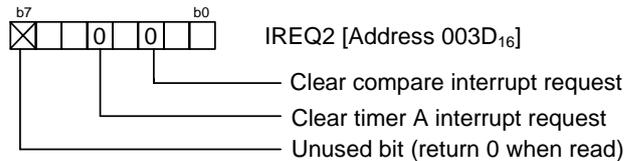
(13) Setting capture/compare port register



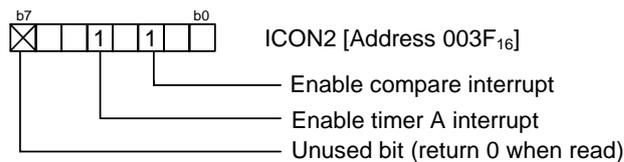
(14) Setting compare interrupt source register



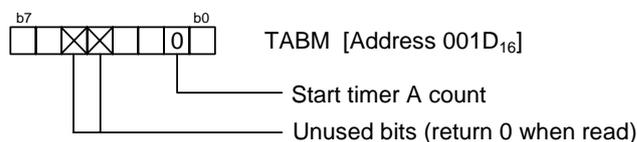
(15) Setting interrupt request register 2



(16) Setting interrupt control register 2



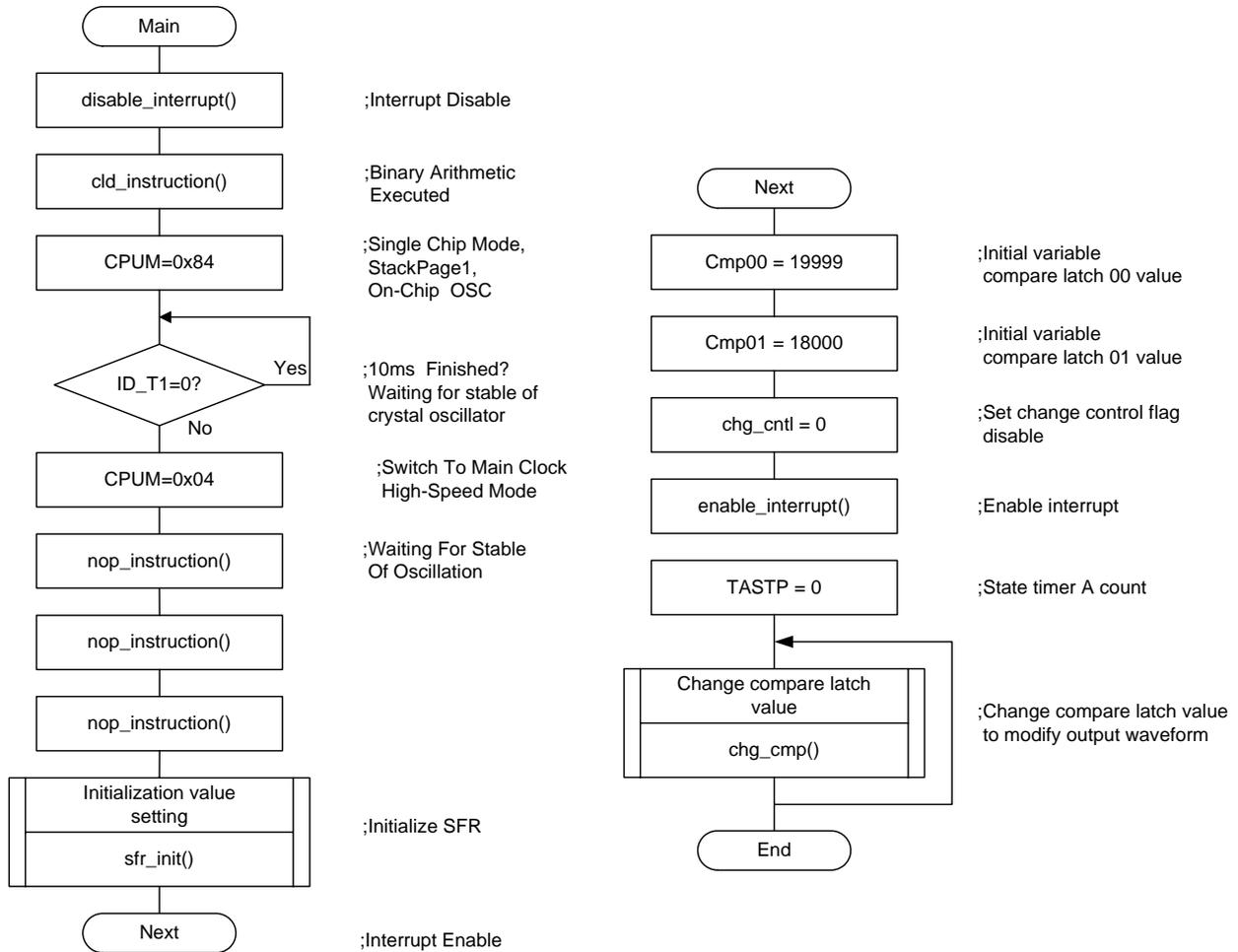
(17) Setting timer A,B mode register



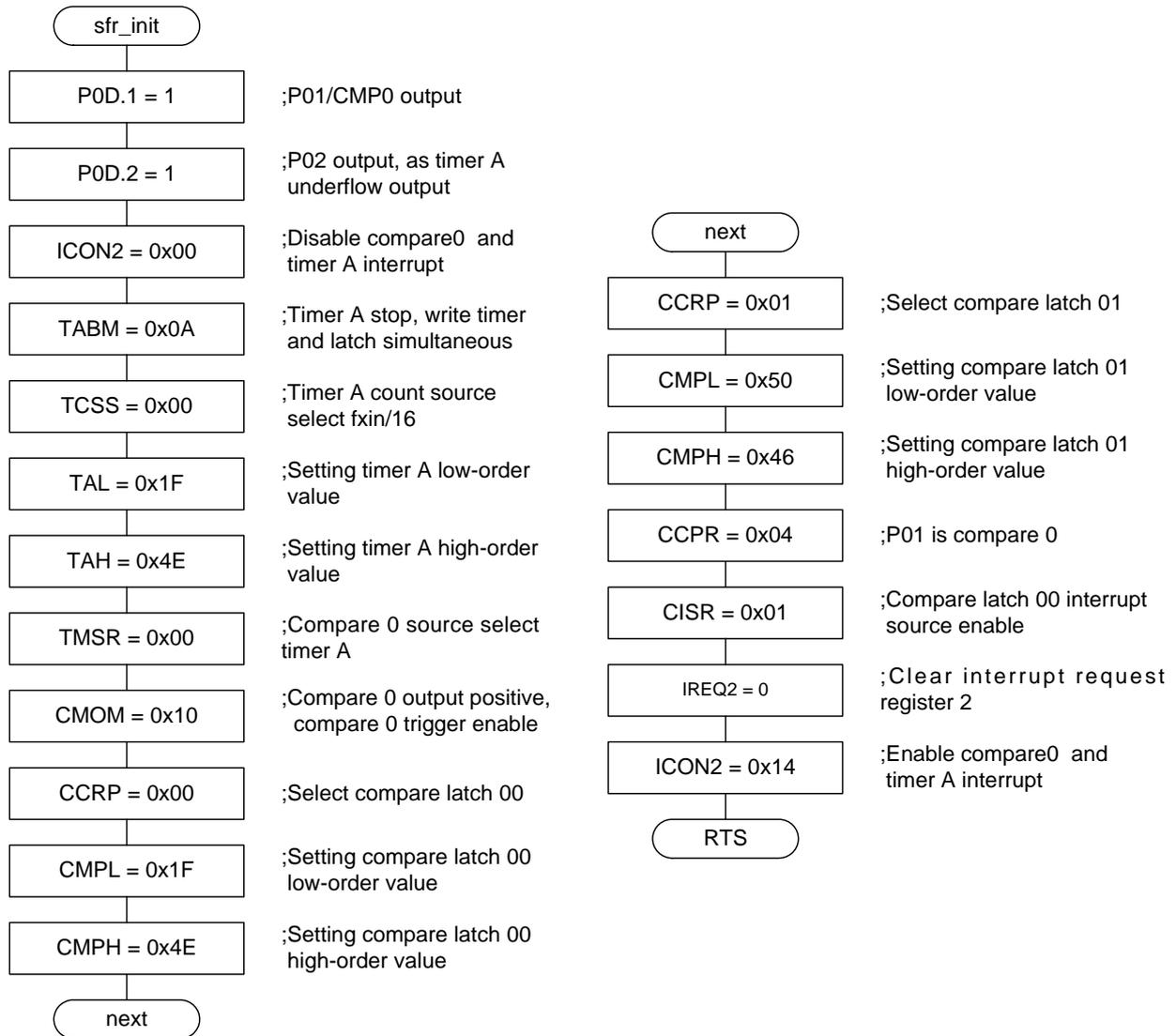
Note: To change compare 0 output waveform when timer A is running, repeat procedures from step (8) to step (12). Must set compare latch 00, 01 reload bit to “1” (reload at next underflow). The compare latch value will be written from compare buffer at next timer underflow. And the output waveform will be changed.

4. Flow chart

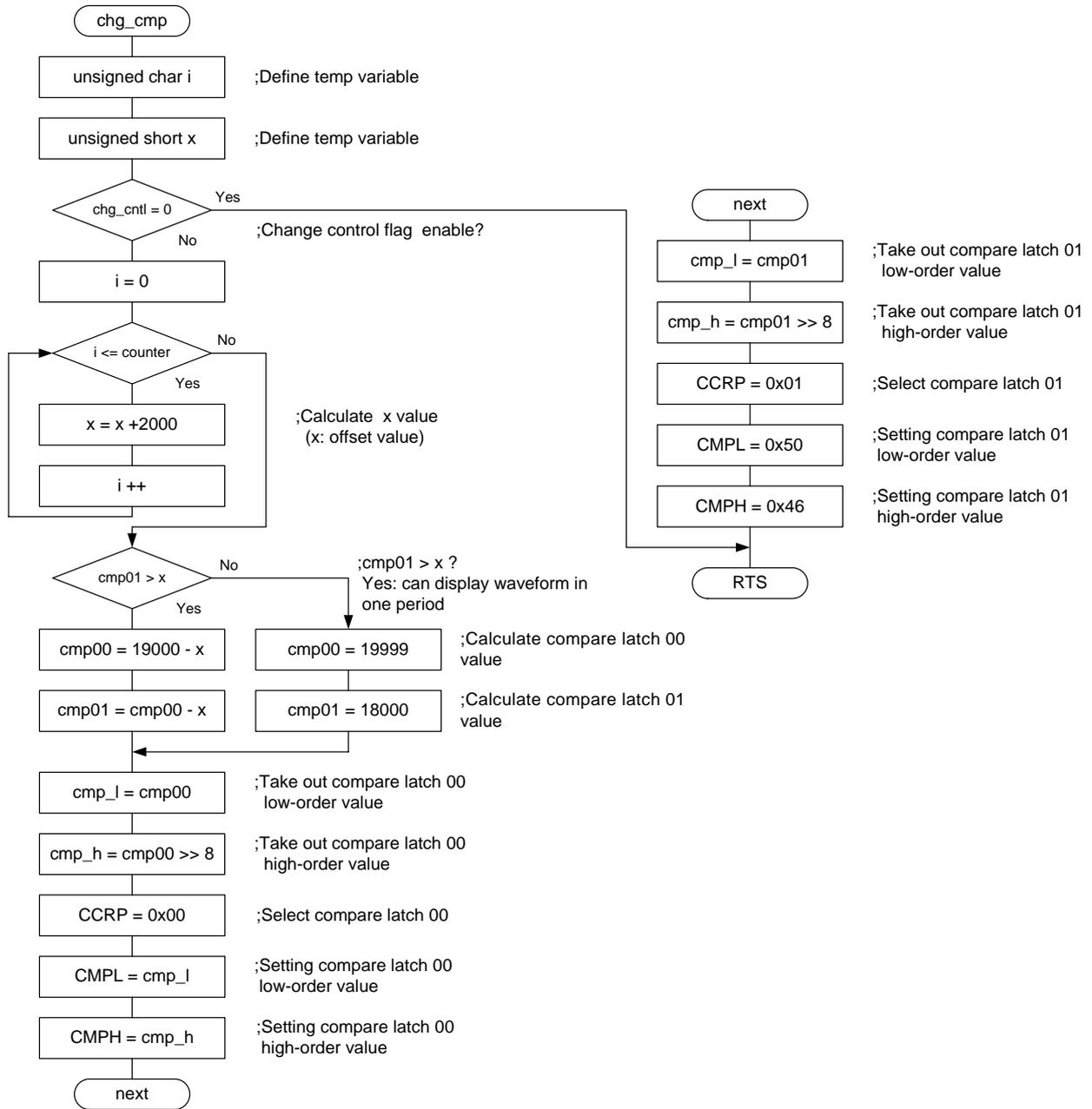
4.1 Flowing is the main loop program chart:



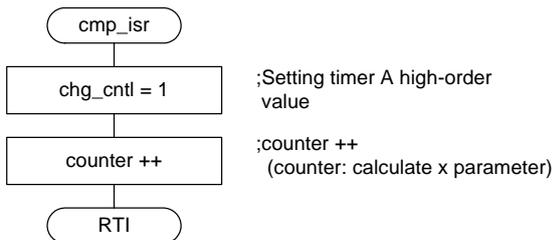
4.2 Flowing is the chart of initial setting subroutine (sfr_init):



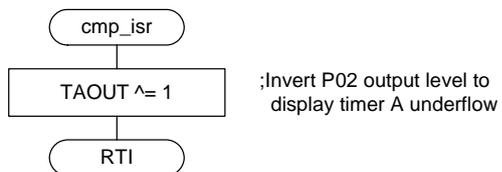
4.3 Flowing is the chart of change compare latch value subroutine (chg_cmp):



4.4 Flowing is the chart of compare interrupt service handle (cmp_isr):



4.5 Flowing is the chart of timer A service handle (ta_isr):



5. Sample program code

```

/*****
 *   File Name : rec05b0014_0100_source.c
 *   CPU       : M37546/47 Group
 *   Function  : Operation of timer A
 *              (Output compare normal mode)
 *   Version   : 1.00 (2006-03-13)
 *   Copyright (C) 2006, Renesas Technology Corp. All right reserved.
 *****/

/*****
 *   Include File
 *****/
#include <intr740.h>
#include "sfr_7546.h"

/*****
 *   Define Macro
 *****/
#define TAOUT    P0_2    /* P02 use as timer A output pin */
#define CMP00_L  0x1F    /* Define compare latch00 (L&H) value 19999 */
#define CMP00_H  0x4E
#define CMP01_L  0x50    /* Define compare latch01 (L&H) value 18000 */
#define CMP01_H  0x46

/*****
 *   Define Variable
 *****/
unsigned char chg_cntl  =0;    /* Change compare waveform enable flag */
unsigned char counter  =0;    /* Software counter */
unsigned short cmp00   =0;    /* Compare latch 00 value */
unsigned short cmp01   =0;    /* Compare latch 01 value */
unsigned char cmp_l    =0;    /* Compare latch low-order value */
unsigned char cmp_h    =0;    /* Compare latch high-order value */

/*****
 *   Function Declaration
 *****/
void sfr_init(void);    /* SFR initialization process */
void chg_cmp(void);    /* Change output waveform */

/*****
Name      : Main
 *****/

void main(void)
{

    disable_interrupt();    /* Interrupt disalbe */
    cld_instruction();    /* Binary arithmetic executed */

    CPUM = 0x84;    /* Single chip mode, stack page1, on-chip OSC */

```

```

ID_T1 = 0;          /* Clear timer 1 interrupt discrimination bit */
PRE1  = 0x31;      /* T = 25*50*16/2000000 = 10ms */
T1    = 0x18;
while (!ID_T1) {}  /* Waiting 10ms For Stable Of Oscillation */

CPUM = 0x04;       /* Switch To Main Clock, High-Speed Mode */
nop_instruction();
nop_instruction();
nop_instruction();

sfr_init();        /* SFR Initialize */

IREQ1 = 0x00;      /* All interrupt request bit is cleared */
IREQ2 = 0x00;
INTDIS = 0x00;

chg_cntl = 0;      /* Set change compare control flag disable */
cmp00 = 19999;     /* Compare latch 00 value */
cmp01 = 18000;     /* Compare latch 01 value */

enable_interrupt(); /* Interrupt Enable */

TASTP = 0;         /* timerA start */

while(1){
    chg_cmp();      /* Change compare output waveform */
}
}

/*****
Name      : chg_cmp
Function   : Write compare latch
*****/
void chg_cmp(void){

    unsigned char i;      /* Define temp variable */
    unsigned short x = 0; /* Define temp variable */

    if (!chg_cntl){return;} /* If chg_cntl disable, quit routine */
    chg_cntl = 0;         /* Clear change enable flag */

    for (i=0;i<=counter;i++){
        x = x + 2000;     /* Calculate offset */
    }

    if (cmp01 > x){
        cmp00 = 19999 - x; /* Compare latch 00 value */
        cmp01 = cmp00 - x; /* Compare latch 01 value */
    }
    else {
        cmp00 = 19999;     /* Compare latch 00 value */
        cmp01 = 18000;     /* Compare latch 01 value */
        counter = 0;      /* Clear software counter */
    }
}

```

```

}

/* Rewrite compare 00 register */
cmp_l = cmp00;      /* compare lath 00 low-order value */
cmp_h = cmp00 >> 8; /* compare lath 00 high-order value */
CCRP  = 0x00;      /* Selecte Latch 00 */
CMPL  = cmp_l;     /* Write low-order of compare 00 */
CMPH  = cmp_h;     /* Write high-order of compare 00 */

/* Rewrite compare 01 register */
cmp_l = cmp01;      /* compare lath 01 low-order value */
cmp_h = cmp01 >> 8; /* compare lath 01 high-order value */
CCRP  = 0x01;      /* Selecte Latch 01 */
CMPL  = cmp_l;     /* Write low-order of compare 01 */
CMPH  = cmp_h;     /* Write high-order of compare 01 */

CMPR  = 0x01;      /* Compare latch 00, 01 reload at next underflow */

}

/*****
Name      : cmp_isr
Function  : Compare interrupt service routine
*****/
interrupt void cmp_isr(void){

    chg_cntl = 1;      /* Set change waveform flag to enable */
    counter ++;      /* Software counter */
}

/*****
Name      : ta_isr
Function  : Timer A interrupt service routine
*****/
interrupt void ta_isr(void){

    TAOUT ^= 1;      /* Output timer A underflow waveform */
}

/*****
Name      : sfr_init
Function  : Initialize SFR
*****/
void sfr_init(void)
{
    POD.1 = 1;      /* P01/CMP0 output */
    POD.2 = 1;      /* P02 output, as timer A output */

    ICON1 = 0x00;   /* All interrupt is disable */
    ICON2 = 0x00;
    INTSET = 0x00;

    TABM  = 0x0A;   /* TimerA stop, write timer and latch simultaneous */
}

```

Operation of Timer A (Output Compare Mode)

```

TCSS  = 0x00;          /* timerA select fxin/16 */
TAL   = 0x1F;          /* TAH&L = 19999 */
TAH   = 0x4E;          /* f = 8000000/16/20000 = 25Hz */

TMSR  = 0x00;          /* Compare 0 source select timer A */
CMOM  = 0x10;          /* Compare 0 output positive, trigger enable */

CCRP  = 0x00;          /* Selecte Latch 00 */
Cmpl  = CMP00_L;       /* Write low-order of compare 00 */
CmpH  = CMP00_H;       /* Write high-order of compare 00 */

CCRP  = 0x01;          /* Selecte Latch 01 */
Cmpl  = CMP01_L;       /* Write low-order of compare 01 */
CmpH  = CMP01_H;       /* Write high-order of compare 01 */

CCPR  = 0x04;          /* P01 is compare 0 */
CISR  = 0x01;          /* Compare latch 00 interrupt source enable */

ICON2 = 0x14;          /* Enable timer A and compare interrupt */

}

```

In order to run properly for this program, the timer A interrupt vector and compare interrupt vector need to point to the service routines for the interrupt. The interrupt vector table information is included in the startup file "cstartup.s31".

```

EXTERN ta_isr, cmp_isr ; EXTERN directive
COMMON INTVEC          ; FFDC - FFFB, FFFC - FFFD
?CSTARTUP_INTVEC
WORD init_C            ; FFDC : BRK (use with E8 Emulator Program)
WORD init_C            ; FFDE : AD, Timer1
WORD init_C            ; FFE0 : TimerB
WORD ta_isr            ; FFE2 : TimerA
WORD init_C            ; FFE4 : TimerX
WORD cmp_isr           ; FFE6 : Compare
WORD init_C            ; FFE8 : Capture 1
WORD init_C            ; FFEA : Capture 0
WORD init_C            ; FFEC : CNTR0
WORD init_C            ; FFEE : Key-on wake-up, UART1 bus collision detection
WORD init_C            ; FFF0 : INT1
WORD init_C            ; FFF2 : INT0
WORD init_C            ; FFF4 : Serial I/O2 transmit
WORD init_C            ; FFF6 : Serial I/O2 receive (use with E8 Emulator
Program)
WORD init_C            ; FFF8 : Serial I/O1 transmit
WORD init_C            ; FFFA : Serial I/O1 receive
?CSTARTUP_RESETVEC
WORD init_C            ; FFFC : RESET (use with E8 Emulator Program)
ENDMOD init_C

```

6. Reference

Renesas web-site

<http://www.renesas.com/>

Inquires

<http://www.renesas.com/inquiry>

csc@renesas.com

Hardware manual

M37546 Group datasheet

M37547 Group datasheet

(Use the latest version on the home page: <http://www.renesas.com>)

Technical update/Technical news

(Use the latest information on the home page: <http://www.renesas.com>)

Revision

Rev.	Date	Description	
		Page	Summary
1.00	Mar.15.06	-	First edition issued

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.