SH7216 Group

Using the Compare Match Timer

R01AN0429EJ0100
Rev. 1.00
Jan. 11, 2011

Summary

This application note describes an example to use interrupts by the SH7216 Compare Match Timer.

Target Device

SH7216 MCU

Contents

1. Introduction

1.1 Specifications

Uses the SH7216 Compare Match Timer interrupts to blink an LED.

This application uses the Compare Match Timer as a 10-ms periodic timer, and generates a compare match interrupt when the compare match flag is set to 1. Every time when the number of compare match interrupts reaches 50, the SH7216 reverses the general-purpose I/O ports output value within the interrupt processing, and blinks the LED which is connected to the general-purpose I/O ports in 500-ms period.

1.2 Modules Used

- Compare Match Timer (CMT)
- Interrupt Controller (INTC)

1.3 Applicable Conditions

MCU	SH7216
Operating Frequency	Internal clock: 200 MHz Bus clock: 50 MHz Peripheral clock: 50 MHz
Integrated Development Environment	Renesas Electronics Corporation High-performance Embedded Workshop Ver.4.07.00
C Compiler	Renesas Electronics SuperH RISC engine Family C/C++ compiler package Ver.9.03 Release 00
Compiler Options	Default setting in the High-performance Embedded Workshop (-cpu=sh2afpu -fpu=single -debug -gbr=auto -global_volatile=0 -opt_range=all -infinite_loop=0 -del_vacant_loop=0 -struct_alloc=1)

1.4 Related Application Note

For more information, refer to the following application note:

- SH7216 Group Example of Initialization

2. Applications

2.1 Overview of Modules

2.1.1 Compare Match Timer

Compare Match Timer (CMT) counts values in a constant interval by the Compare match counter (CMCNT). When the Count start bit in the Compare match timer start register (CMSTR) is set to 1, the CMCNT starts counting up. When the CMCNT value matches the Compare match constant register (CMCOR) value, the CMCNT is cleared to 0, and the Compare match flag (CMF) in the Compare match timer control/status register (CMCSR) is set to 1. A compare match interrupt (CMI) occurs when the Compare match interrupt enable bit (CMIE) in the CMCSR is set to 1 at the same time. Then, the CMCNT starts counting up from 0 again.

Table 1 lists the specifications of the CMT. Figure 1 shows its block diagram. For more information, refer to the Compare Match Timer (CMT) chapter in the SH7214 Group, SH7216 Group User's Hardware Manual.

Table 1 CMT Specifications

Item	Description
Number of channels available	2
Counting	16-bit counter (only up-counter)
Pin function	None
Clock source	Pφ/8, Pφ/32, Pφ/128, Pφ/512 (Pφ: peripheral clock)
How to activate	Activated by the software
Compare match occur condition	A compare match occurs at the last state (CMCNT value is updated to H'0000) when the CMCNT and CMCOR match
Interrupt request	Compare match interrupt (CMI)

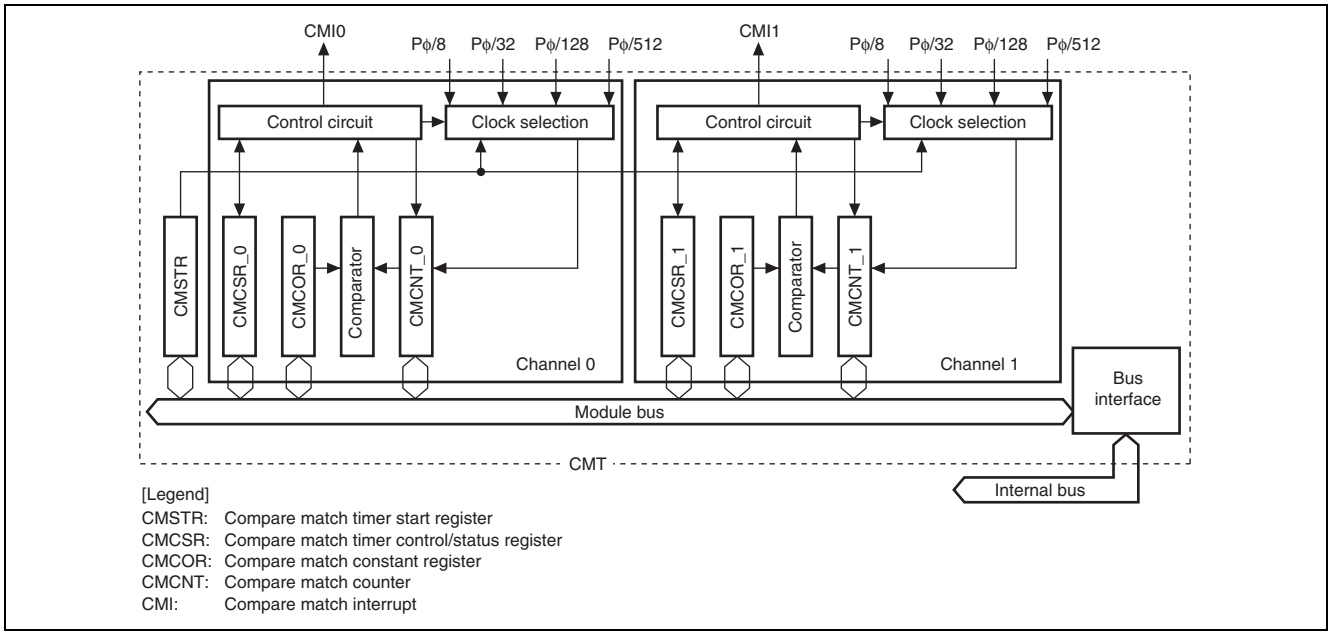


Figure 1 CMT Block Diagram

2.1.2 Interrupt Controller

The Interrupt Controller (INTC) detects the priority of interrupt sources, and controls interrupt requests to the CPU. INTC has registers to set interrupt priorities, and it handles interrupt requests according to the priority which is set to the INTC register by user.

Figure 2 shows the INTC block diagram. For more information, refer to the Interrupt Controller (INTC) chapter in the SH7214 Group, SH7216 Group User's Hardware Manual.

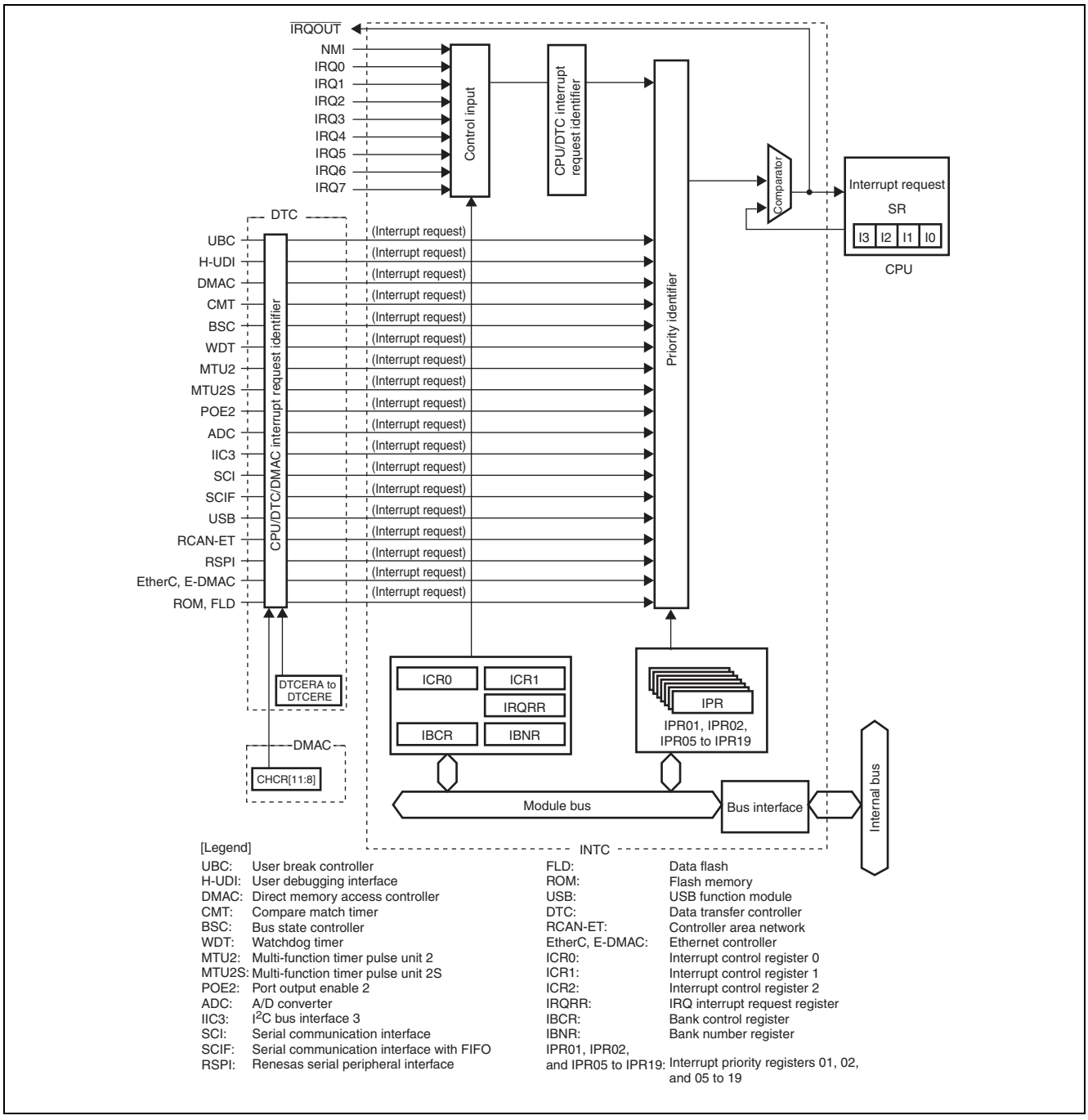


Figure 2 INTC Block Diagram

2.2 Configuration Procedure

This section describes how to configure the CMT (channel 0) periodic count operation.

Figure 3 shows the flow chart for configuring the CMT periodic counter. For more information on register settings, refer to the SH7214 Group, SH7216 Group User's Hardware Manual.

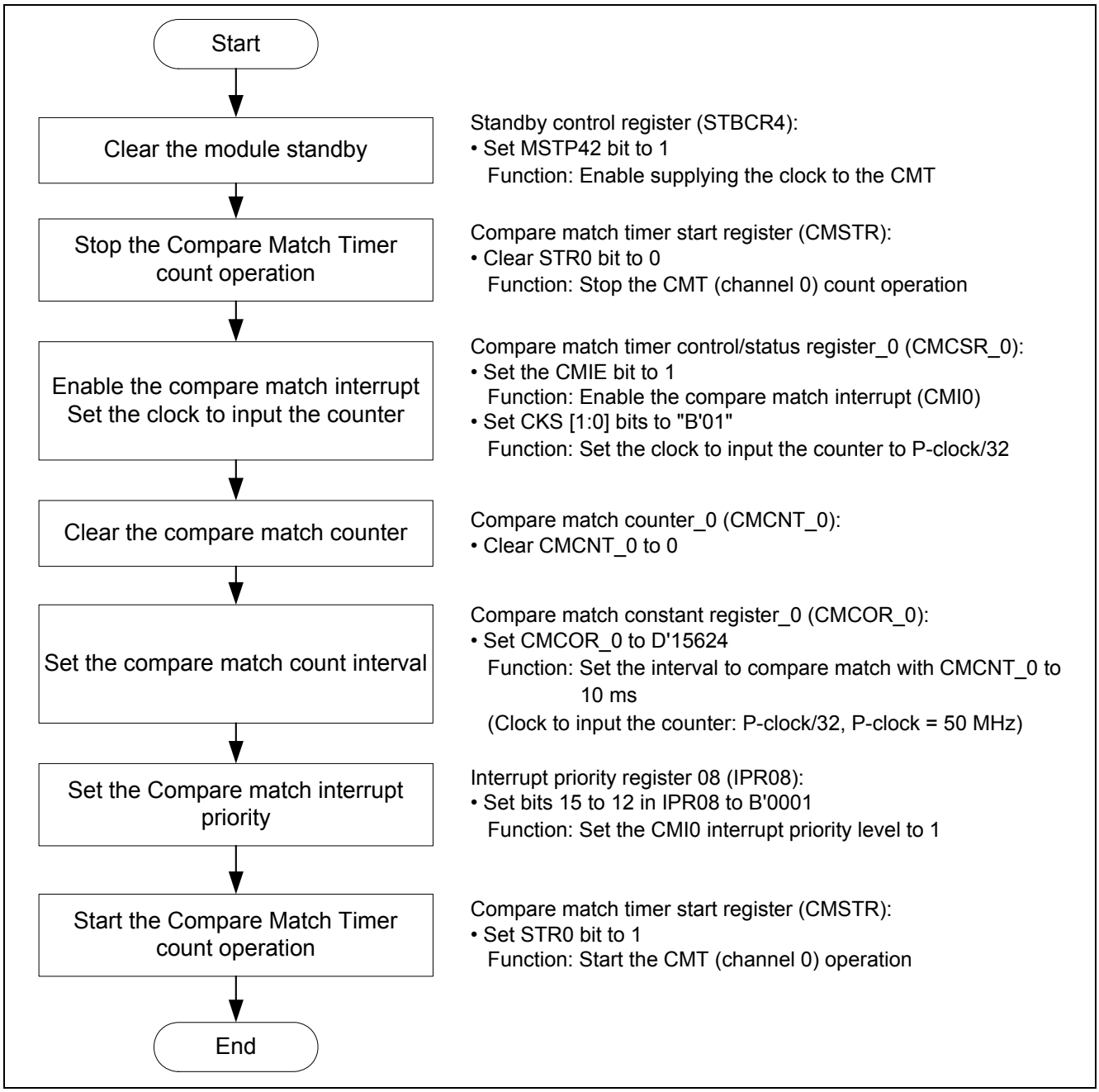


Figure 3 Flow Chart for Configuring the CMT Periodic Count Operation

2.3 Sample Program Operation

The sample program uses the CMT (channel 0) interrupt (CMT0). Every time when the number of times of CMI0 reaches 50, the sample program reverses the general-purpose I/O ports (PE) output value, and blinks the LED which is connected to the PE.

Figure 4 shows the operation timing of the sample program.

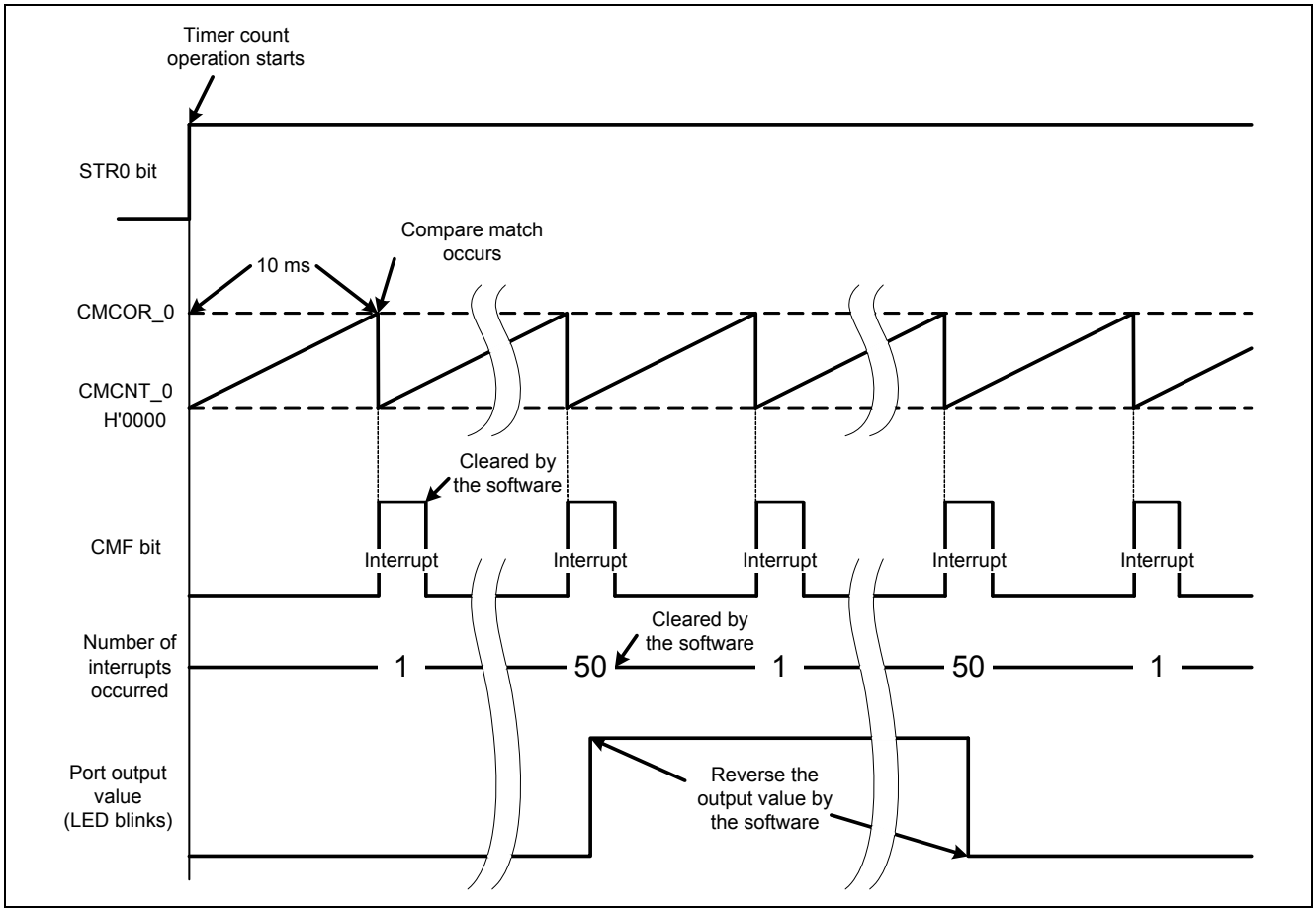


Figure 4 Sample Program Operation Timing

2.4 Sample Program Procedure

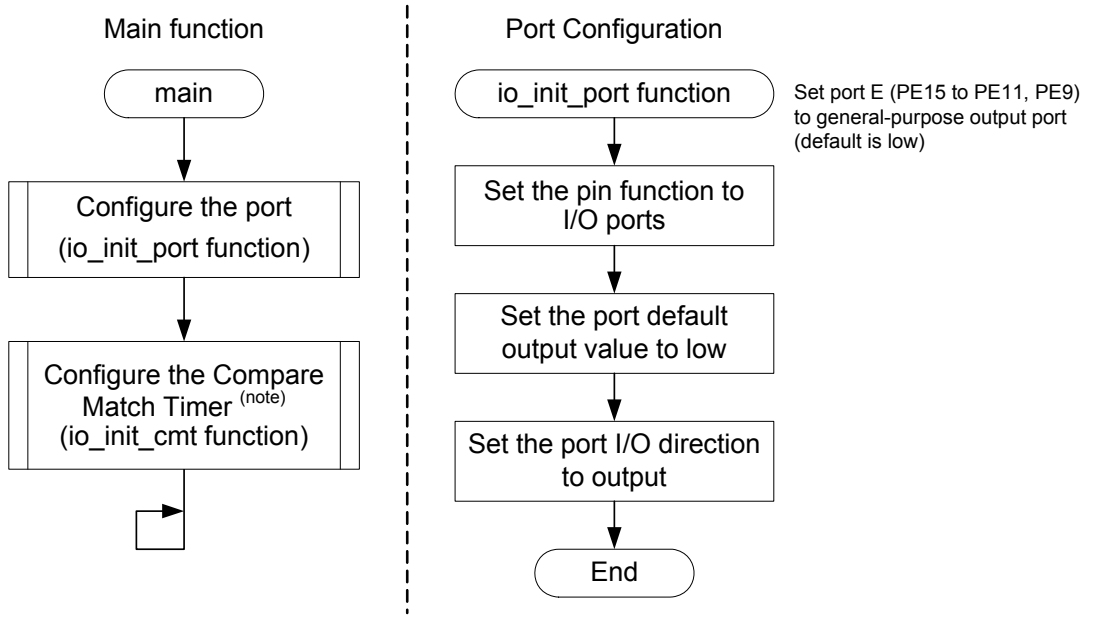
Table 2 lists the register settings for the CMT (channel 0). Table 3 lists the register settings for the INTC. Figure 5 and Figure 6 show sample program flow charts.

Table 2 CMT (channel 0) Register Setting

Register Name	Address	Setting	Description
Standby control register 4 (STBCR4)	H'FFFE 040C	H'F7	• MSTP42 = "0": CMT is operating
Compare match timer start register (CMSTR)	H'FFFE C000	H'0000	• STR0 = "0": Stops the count operation
		H'0001	• STR0 = "1": Starts the count operation
Compare match timer control/status register_0 (CMCSR_0)	H'FFFE C002	H'0041	• CMIE = "1": Enables the compare match interrupt • CKS [1:0] = "B'01": Clock to input the counter = Pφ/32
Compare match counter_0 (CMCNT_0)	H'FFFE C004	H'0000	Clears the timer counter
Compare match constant register_0 (CMCOR_0)	H'FFFE C006	D'15624	Compare match interval: 10 ms Note: When the clock to input the counter = Pφ/32, and Pφ = 50 MHz

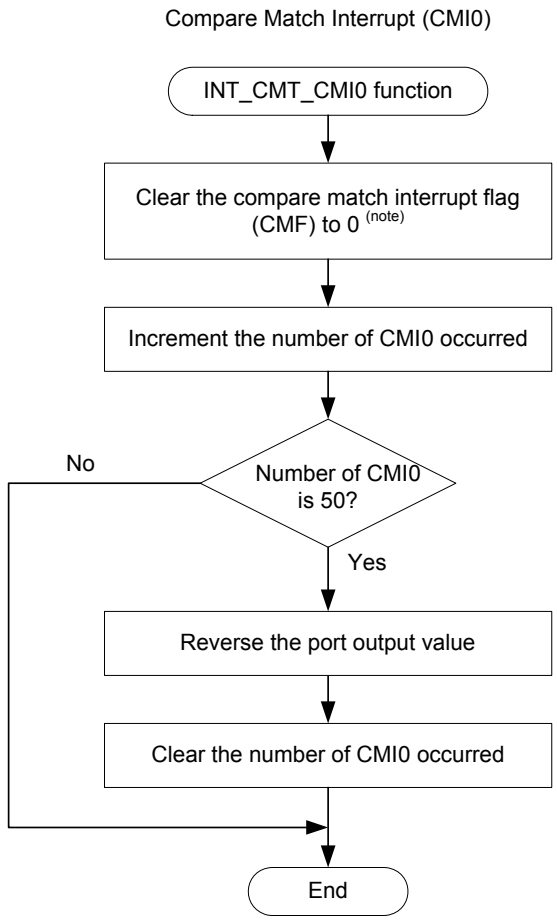
Table 3 INTC Register Setting

Register Name	Address	Setting	Description
Interrupt priority register 08 (IPR08)	H'FFFE 0C04	H'1000	CMT0 interrupt priority level = 1



Note: Refer to Figure 3 for the flow chart to configure the Compare Match Timer (io_init_cmt function).

Figure 5 Main Function and Port Configuration (io_init_port function) Flow Chart



Note: The sample program reads the compare match flag (CMF) after clearing the flag to avoid accepting the interrupt source which is already cleared.

Figure 6 INT_CMT_CMI0 Flow Chart

3. Sample Program Listing

3.1 Sample Program Listing "main.c" (1/3)

```
1    /***********************************************************************
2    *   DISCLAIMER
3    *
4    *   This software is supplied by Renesas Electronics Corporation and is only
5    *   intended for use with Renesas products.  No other uses are authorized.
6    *
7    *   This software is owned by Renesas Electronics Corporation and is protected under
8    *   all applicable laws, including copyright laws.
9    *
10   *   THIS SOFTWARE IS PROVIDED "AS IS" AND RENESAS MAKES NO WARRANTIES
11   *   REGARDING THIS SOFTWARE, WHETHER EXPRESS, IMPLIED OR STATUTORY,
12   *   INCLUDING BUT NOT LIMITED TO WARRANTIES OF MERCHANTABILITY, FITNESS FOR A
13   *   PARTICULAR PURPOSE AND NON-INFRINGEMENT.  ALL SUCH WARRANTIES ARE EXPRESSLY
14   *   DISCLAIMED.
15   *
16   *   TO THE MAXIMUM EXTENT PERMITTED NOT PROHIBITED BY LAW, NEITHER RENESAS
17   *   ELECTRONICS CORPORATION NOR ANY OF ITS AFFILIATED COMPANIES SHALL BE LIABLE
18   *   FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES
19   *   FOR ANY REASON RELATED TO THIS SOFTWARE, EVEN IF RENESAS OR ITS
20   *   AFFILIATES HAVE BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.
21   *
22   *   Renesas reserves the right, without notice, to make changes to this
23   *   software and to discontinue the availability of this software.
24   *   By using this software, you agree to the additional terms and
25   *   conditions found by accessing the following link:
26   *   http://www.renesas.com/disclaimer
27   ***********************************************************************
28   *   Copyright (C) 2010 Renesas Electronics Corporation. All rights reserved.
29   ***********************************************************************/
30   /*""FILE COMMENT""************ Technical reference data ************************
31   *   System Name : SH7216 Sample Program
32   *   File Name   : main.c
33   *   Abstract    : Using the Compare Match Timer
34   *   Version     : 1.00.00
35   *   Device      : SH7216
36   *   Tool-Chain  : High-performance Embedded Workshop (Ver.4.07.00).
37   *               : C/C++ compiler package for the SuperH RISC engine family
38   *               :                             (Ver.9.03 Release00).
39   *   OS          : None
40   *   H/W Platform: R0K572167 (CPU board)
41   *   Description :
42   ***********************************************************************
43   *   History     : Oct.21,2010 Ver.1.00.00
44   *""FILE COMMENT END""*********************************************************/
45   #include "iodefine.h"
46
```

3.2 Sample Program Listing "main.c" (2/3)

```
47   /* ==== Prototype declaration ==== */
48   void main(void);
49   void io_init_port(void);
50   void io_init_cmt(void);
51
52   /*""FUNC COMMENT""*****************************************************************
53    * ID           :
54    * Outline      : Sample program main
55    *-------------------------------------------------------------------------------
56    * Include      :
57    *-------------------------------------------------------------------------------
58    * Declaration  : void main(void);
59    *-------------------------------------------------------------------------------
60    * Description  : Sample program main
61    *-------------------------------------------------------------------------------
62    * Argument     : void
63    *-------------------------------------------------------------------------------
64    * Return Value : void
65    *-------------------------------------------------------------------------------
66    * Note         : None
67    *""FUNC COMMENT END""*************************************************************/
68   void main(void)
69   {
70     /* ==== Configures the port ==== */
71     io_init_port();
72     /* ==== Configures the Compare Match Timer ==== */
73     io_init_cmt();
74
75     while(1){
76     }
77   }
78
79   /*""FUNC COMMENT""*****************************************************************
80    * ID           :
81    * Outline      : Port Configuration
82    *-------------------------------------------------------------------------------
83    * Include      : "iodefine.h"
84    *-------------------------------------------------------------------------------
85    * Declaration  : void io_init_port(void);
86    *-------------------------------------------------------------------------------
87    * Description  : Configures port E (PE15 to PE11, PE9).
88    *-------------------------------------------------------------------------------
89    * Argument     : void
90    *-------------------------------------------------------------------------------
91    * Return Value : void
92    *-------------------------------------------------------------------------------
93    * Note         : None
94    *""FUNC COMMENT END""*************************************************************/
95   void io_init_port(void)
96   {
```

3.3 Sample Program Listing "main.c" (3/3)

```
97      /* ---- Sets the pin function ---- */
98      PFC.PECRL4.WORD = 0x0000;       /* PE15 to 12: I/O ports */
99      PFC.PECRL3.BIT.PE11MD = 0;      /* PE11: I/O ports */
100     PFC.PECRL3.BIT.PE9MD = 0;       /* PE9: I/O ports */
101     /* ---- Sets the default data ---- */
102     PE.DR.WORD = 0x0000;        /* PE15 to PE11, PE9: Default value is low */
103     /* ---- Sets the I/O direction ---- */
104     PFC.PEIORL.WORD |= 0xfa00;      /* PE15 to PE11, PE9: Output */
105   }
106
107   /*""FUNC COMMENT""*****************************************************************
108    * ID           :
109    * Outline      : CMT configuration
110    *-------------------------------------------------------------------------------
111    * Include      : "iodefine.h"
112    *-------------------------------------------------------------------------------
113    * Declaration  : void io_init_cmt(void);
114    *-------------------------------------------------------------------------------
115    * Description  : Sets CMT channel 0 as a 10-ms periodic timer.
116    *-------------------------------------------------------------------------------
117    * Argument     : void
118    *-------------------------------------------------------------------------------
119    * Return Value : void
120    *-------------------------------------------------------------------------------
121    * Note         : None
122    *""FUNC COMMENT END""*************************************************************/
123   void io_init_cmt(void)
124   {
125     /* ---- Module standby clear ---- */
126     STB.CR4.BIT._CMT = 0;           /* Supplies the clock to the CMT */
127
128     /* ---- Stops the count operation ---- */
129     CMT.CMSTR.BIT.STR0 = 0;
130     /* ---- Enables interrupts/sets the clock to input the counter ---- */
131     CMT0.CMCSR.WORD = 0x0041;       /* Enables CMI0, the clock to input the counter is */
132                                 /* P-clock/32 */
133     /* ---- Clears the counter ---- */
134     CMT0.CMCNT = 0x0000;
135     /* ---- Sets the count operation interval ---- */
136     CMT0.CMCOR = 15625 - 1;         /* 10 ms (P-clock/32, P-clock = 50 MHz) */
137
138     /* ---- Sets the interrupt priority level---- */
139     INTC.IPR08.BIT._CMT0 = 1;       /* CMI0 priority = 1 */
140
141     /* ---- Starts the count operation ---- */
142     CMT.CMSTR.BIT.STR0 = 1;
143   }
144
145   /* End of File */
```

3.4 Sample Program Listing "intprg.c" (1/2)

```
1   /***********************************************************************
2   *   DISCLAIMER
3   *
4   *   This software is supplied by Renesas Electronics Corporation and is only
5   *   intended for use with Renesas products.  No other uses are authorized.
6   *
7   *   This software is owned by Renesas Electronics Corporation and is protected under
8   *   all applicable laws, including copyright laws.
9   *
10  *   THIS SOFTWARE IS PROVIDED "AS IS" AND RENESAS MAKES NO WARRANTIES
11  *   REGARDING THIS SOFTWARE, WHETHER EXPRESS, IMPLIED OR STATUTORY,
12  *   INCLUDING BUT NOT LIMITED TO WARRANTIES OF MERCHANTABILITY, FITNESS FOR A
13  *   PARTICULAR PURPOSE AND NON-INFRINGEMENT.  ALL SUCH WARRANTIES ARE EXPRESSLY
14  *   DISCLAIMED.
15  *
16  *   TO THE MAXIMUM EXTENT PERMITTED NOT PROHIBITED BY LAW, NEITHER RENESAS
17  *   ELECTRONICS CORPORATION NOR ANY OF ITS AFFILIATED COMPANIES SHALL BE LIABLE
18  *   FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES
19  *   FOR ANY REASON RELATED TO THIS SOFTWARE, EVEN IF RENESAS OR ITS
20  *   AFFILIATES HAVE BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.
21  *
22  *   Renesas reserves the right, without notice, to make changes to this
23  *   software and to discontinue the availability of this software.
24  *   By using this software, you agree to the additional terms and
25  *   conditions found by accessing the following link:
26  *   http://www.renesas.com/disclaimer
27  ***********************************************************************
28  *   Copyright (C) 2010 Renesas Electronics Corporation. All rights reserved.
29  ***********************************************************************/
30  /*""FILE COMMENT""*********** Technical reference data ************************
31  *   System Name : SH7216 Sample Program
32  *   File Name   : intprg.c
33  *   Abstract    : Interrupt Functions
34  *   Version     : 1.00.00
35  *   Device      : SH7216
36  *   Tool-Chain  : High-performance Embedded Workshop (Ver.4.07.00).
37  *               : C/C++ compiler package for the SuperH RISC engine family
38  *               :                               (Ver.9.03 Release00).
39  *   OS          : None
40  *   H/W Platform: R0K572167 (CPU board)
41  *   Description :
42  ***********************************************************************
43  *   History     : Oct.21,2010 Ver.1.00.00
44  *""FILE COMMENT END""*****************************************************/
45  #include <machine.h>
46  #include "vect.h"
47  #include "iodefine.h"
48
49  /* ==== CMI0 occur counter ==== */
50  int cmi0_count = 0;
51
```

3.5 Sample Program Listing "intprg.c" (2/2)

```
52    #pragma section IntPRG
53
54    // 4 Illegal code
55    void INT_Illegal_code(void){/* sleep(); */}

...   (omitted)

326   // 140 CMT CMI0
327   /*""FUNC COMMENT""*****************************************************************
328    * ID           :
329    * Outline      : Compare match interrupt (CMI0).
330    *-------------------------------------------------------------------------------
331    * Include      : "vect.h" and "iodefine.h"
332    *-------------------------------------------------------------------------------
333    * Declaration  : void INT_CMT_CMI0(void);
334    *-------------------------------------------------------------------------------
335    * Description  : Counts the number of CMI0 occurred. Every time when the number
336    *              : reaches 50, it reverses port E (PE15 to PE11, PE9) output data
337    *              : and changes the LED display pattern.
338    *-------------------------------------------------------------------------------
339    * Argument     : void
340    *-------------------------------------------------------------------------------
341    * Return Value : void
342    *-------------------------------------------------------------------------------
343    * Note         : None
344    *""FUNC COMMENT END""*************************************************************/
345   void INT_CMT_CMI0(void)
346   {
347     CMT0.CMCSR.BIT.CMF = 0;         /* Clears the compare match flag (CMF) */
348     CMT0.CMCSR.BIT.CMF;             /* Dummy read the CMF */
349
350     cmi0_count++;                   /* Increments the number of CMI0 occurred */
351
352     /* ==== LED blinking ==== */
353     if(cmi0_count == 50){           /* Number of CMI0 is 50? */
354       PE.DR.WORD ^= 0xfa00;      /* Reverses PE15 to PE11, PE9 output data */
355       cmi0_count = 0;            /* Initializes CMI0 occur counter (clear to 0) */
356     }
357   }

...   (omitted)

592   /* End of File */
```

4. References

- Software Manual
  SH-2A/SH2A-FPU Software Manual Rev. 3.00
  The latest version of the software manual can be downloaded from the Renesas Electronics website.

- Hardware Manual
  SH7214 Group, Group User's Hardware Manual Rev. 2.00
  The latest version of the hardware manual can be downloaded from the Renesas Electronics website.

Website and Support

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

Inquiries
http://www.renesas.com/inquiry

Revision Record

Rev.	Date	Description	
		Page	Summary
1.00	Jan.11.11	—	First edition issued

General Precautions in the Handling of MPU/MCU Products

The following usage notes are applicable to all MPU/MCU products from Renesas. For detailed usage notes on the products covered by this manual, refer to the relevant sections of the manual. If the descriptions under General Precautions in the Handling of MPU/MCU Products and in the body of the manual differ from each other, the description in the body of the manual takes precedence.

1. Handling of Unused Pins
   Handle unused pins in accord with the directions given under Handling of Unused Pins in the manual.
   — The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible. Unused pins should be handled as described under Handling of Unused Pins in the manual.
2. Processing at Power-on
   The state of the product is undefined at the moment when power is supplied.
   — The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the moment when power is supplied.
   In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the moment when power is supplied until the reset process is completed.
   In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the moment when power is supplied until the power reaches the level at which resetting has been specified.
3. Prohibition of Access to Reserved Addresses
   Access to reserved addresses is prohibited.
   — The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.
4. Clock Signals
   After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has stabilized.
   — When the clock signal is generated with an external resonator (or from an external oscillator) during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Moreover, when switching to a clock signal produced with an external resonator (or by an external oscillator) while program execution is in progress, wait until the target clock signal is stable.
5. Differences between Products
   Before changing from one product to another, i.e. to one with a different type number, confirm that the change will not lead to problems.
   — The characteristics of MPU/MCU in the same group but having different type numbers may differ because of the differences in internal memory capacity and layout pattern. When changing to products of different type numbers, implement a system-evaluation test for each of the products.

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.

RENESAS

SALES OFFICES Renesas Electronics Corporation http://www.renesas.com

Refer to "http://www.renesas.com/" for the latest and detailed information.

Renesas Electronics America Inc.
2880 Scott Boulevard Santa Clara, CA 95050-2554, U.S.A.
Tel: +1-408-588-6000, Fax: +1-408-588-6130

Renesas Electronics Canada Limited
1101 Nicholson Road, Newmarket, Ontario L3Y 9C3, Canada
Tel: +1-905-898-5441, Fax: +1-905-898-3220

Renesas Electronics Europe Limited
Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K
Tel: +44-1628-585-100, Fax: +44-1628-585-900

Renesas Electronics Europe GmbH
Arcadiastrasse 10, 40472 Düsseldorf, Germany
Tel: +49-211-6503-0, Fax: +49-211-6503-1327

Renesas Electronics (China) Co., Ltd.
7th Floor, Quantum Plaza, No.27 ZhiChunLu Haidian District, Beijing 100083, P.R.China
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

Renesas Electronics (Shanghai) Co., Ltd.
Unit 204, 205, AZIA Center, No.1233 Lujiazui Ring Rd., Pudong District, Shanghai 200120, China
Tel: +86-21-5877-1818, Fax: +86-21-6887-7858 / -7898

Renesas Electronics Hong Kong Limited
Unit 1601-1613, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong
Tel: +852-2886-9318, Fax: +852 2886-9022/9044

Renesas Electronics Taiwan Co., Ltd.
7F, No. 363 Fu Shing North Road Taipei, Taiwan, R.O.C.
Tel: +886-2-8175-9600, Fax: +886 2-8175-9670

Renesas Electronics Singapore Pte. Ltd.
1 harbourFront Avenue, #06-10, keppel Bay Tower, Singapore 098632
Tel: +65-6213-0200, Fax: +65-6278-8001

Renesas Electronics Malaysia Sdn.Bhd.
Unit 906, Block B, Menara Amcorp, Amcorp Trade Centre, No. 18, Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia
Tel: +60-3-7955-9390, Fax: +60-3-7955-9510

Renesas Electronics Korea Co., Ltd.
11F., Samik Lavied' or Bldg., 720-2 Yeoksam-Dong, Kangnam-Ku, Seoul 135-080, Korea
Tel: +82-2-558-3737, Fax: +82-2-558-5141

Colophon 1.0