

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.

H8S/2200 Series

Using Compare-Match Function of 16-Bit Timer Pulse Unit

Introduction

A 50%-duty cycle pulse waveform is produced using the compare-match function of the 16-bit timer pulse unit.

Target Device

H8S/2215

Contents

1. Specifications	2
2. Description of Functions	2
3. Principles of Operation.....	4
4. Description of Software.....	5
5. Flowchart.....	7

1. Specifications

- As shown in figure 1, 50%-duty cycle pulse waveform is produced by toggling the output on compare-match, which is configured through the timer settings of the 16-bit timer pulse unit.
- In 16-MHz operation, the period of the output pulses can be set in TGPA_0 within the range from 1 μ s to 32.768.

$$\text{Period } f = ((\text{TGRA}_0 \text{ setting} + 1) \times (1/(\phi/4)) \times 2) \text{ [s]}$$

In this sample task, $\phi/4$ is set with TCR_0. For details on TCR settings, refer to the hardware manual.

For reference, available clocks based on the internal clock are shown below:

$\phi/1$, $\phi/4$, $\phi/16$, $\phi/64$

ϕ = Internal clock (16 MHz)

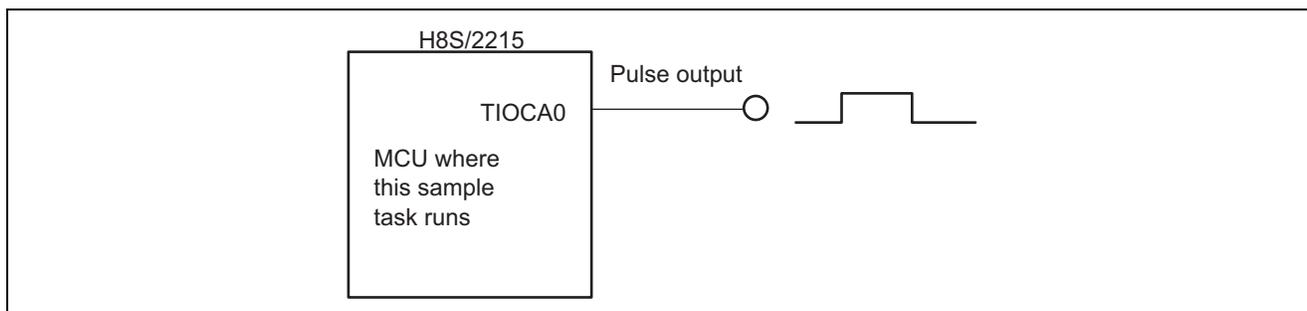


Figure 1 Example of Pulse Output

2. Description of Functions

- Figure 2 shows a block diagram of the 16-bit timer pulse unit (TPU), and the following is the description for the block diagram:
 - The timer control register (TCR) controls settings for TCNT on each channel, such as counter clearing condition based on TGRA to TGRD registers, input clock edge condition, etc.
 - The timer mode register (TMDR) sets operating mode, for example, normal operating mode and buffer operating mode, for each channel.
 - The timer I/O control register (TIOR: TIORH and TIORL) controls output signals by setting the initial output value and output value in compare-match/input-capture operation for each TGR.
 - The timer interrupt enable register (TIER) enables/disables interrupts for each channel.
 - The timer status register (TSR) indicates the status for each channel.
 - The timer counter (TCNT) is a 16-bit counter that can be read or written to. This counter is always accessed in 16-bit units.
 - The timer general registers (four registers from TGRA to TGRD) are 16-bit readable/writable registers that are used for output compare or input capture. These registers are always accessed in 16-bit units.
 - The timer start register (TSTR) selects to start or stop TCNT operation for channels 0 to 2.
 - The timer synchro register (TSYR) selects independent or synchronous operation of TCNTs on channels 0 to 2.

Note that the description above has focused on the channel 0 registers.

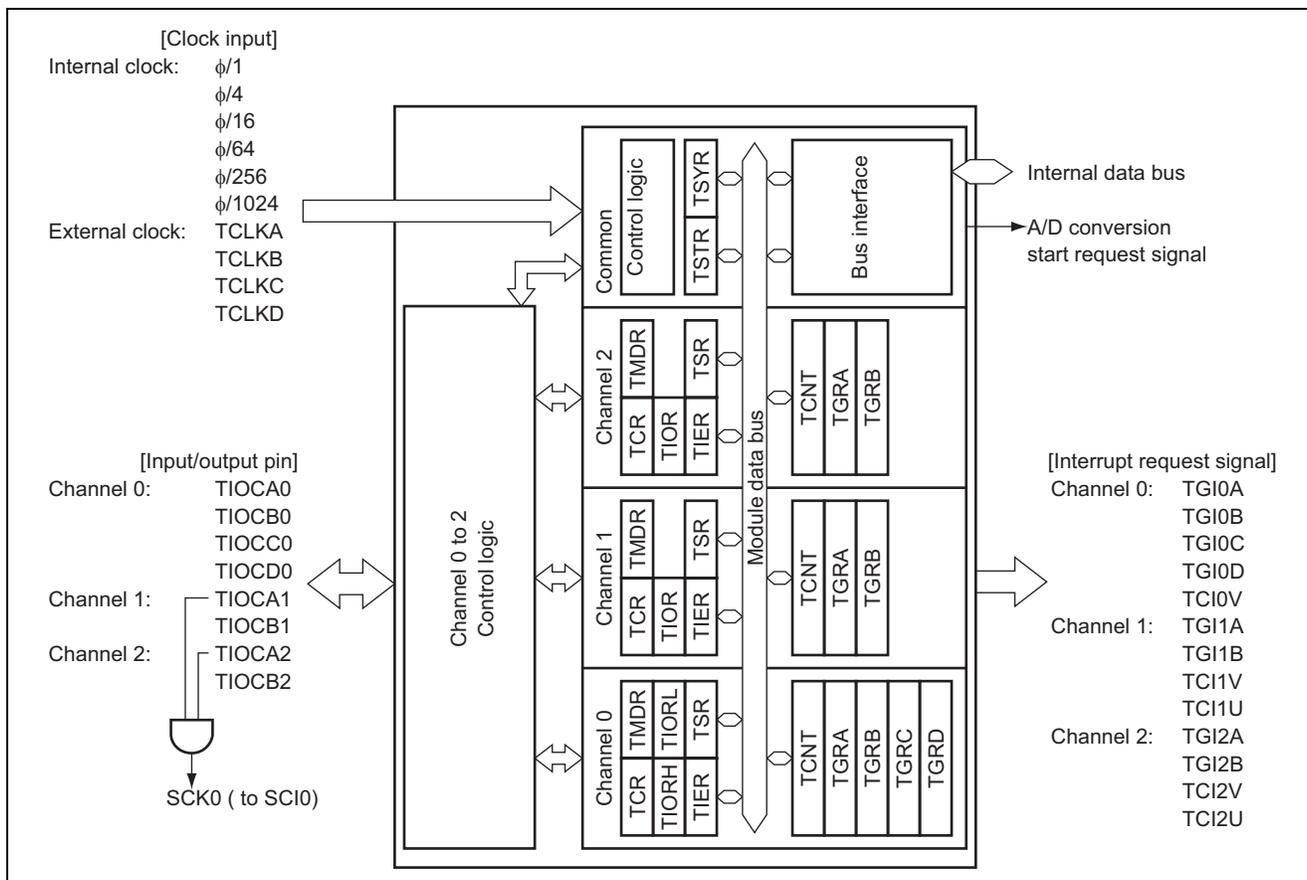


Figure 2 Block Diagram of TPU

2. Table 1 shows the assignment of functions used in this sample task.

Table 1 Assignment of Functions

Elements	Description
TCR	Controls TCNT for each channel (counter clearing condition, clock edge selection, etc.).
TMDR	Sets the operating mode for each channel: normal operation, PWM operation, etc.
TIOR	Sets output level on compare-match, etc.
TIER	Enables/disables interrupt requests.
TSR	Consists of flags indicating overflow, input capture/output compare, etc.
TCNT	16-bit counter that can be read or written to.
TGR	Registers used for input capture or output compare.
TSTR	Starts or stops counting by TCNT.
TSYR	Selects independent operation or synchronous operation of TCNTs on channels 0 to 2.

3. Principles of Operation

Figure 3 illustrates the operation of this sample task. A waveform is output based on compare-matches through the hardware and software processing shown in the figure.

1. A waveform is output from TIOCA0 using the TPU compare-match function by setting the following TPU registers:
TCR_0, TMDR_0, TIORH_0, TIORL_0, TIER_0, TSR_0, TCNT_0, TGRA_0 and TSYR
2. When TSTR is set to start counting on channel 0, compare-match operation is initiated.

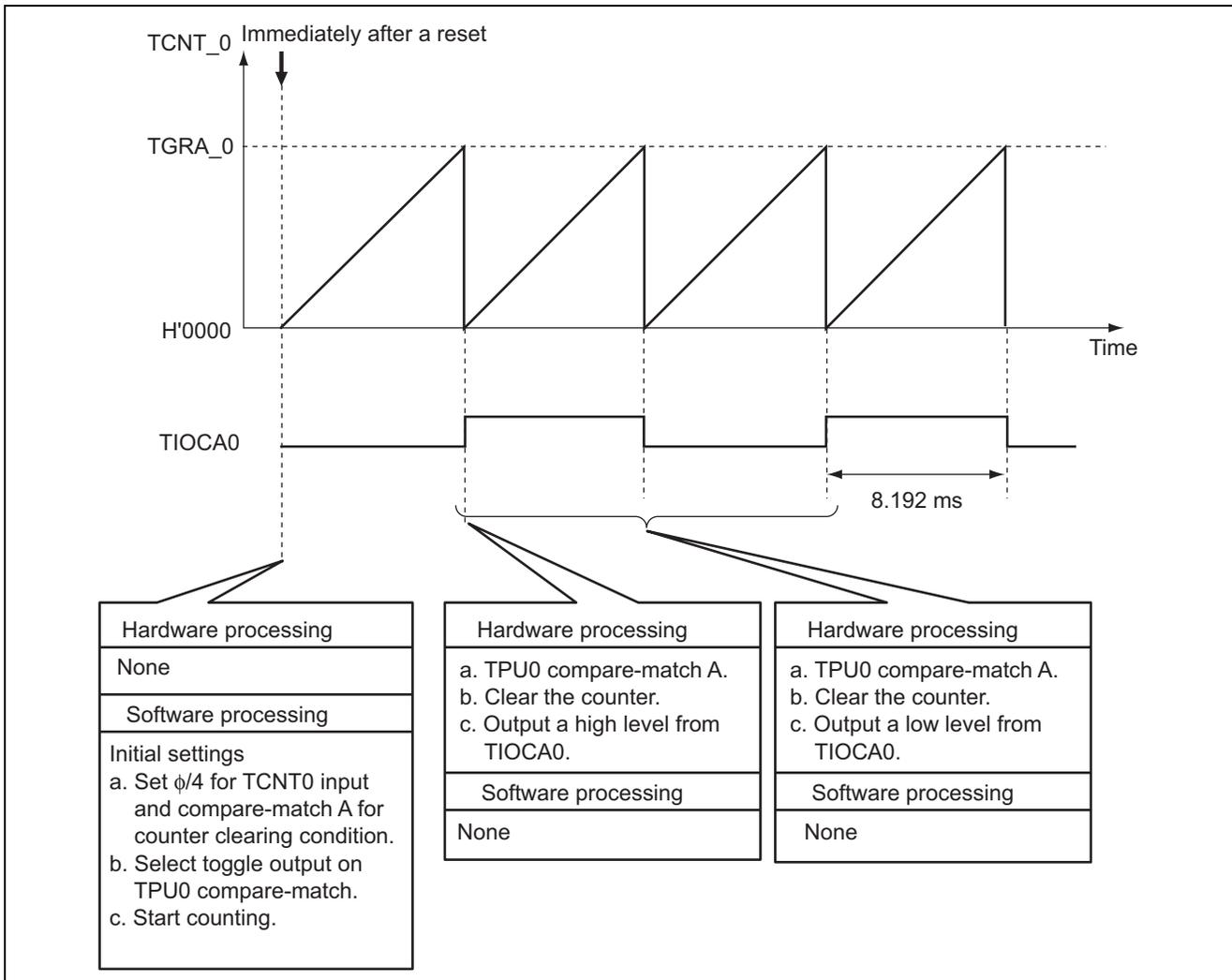


Figure 3 Waveform Output on Compare-match

4. Description of Software

4.1 Module

Table 2 describes the module used in this sample task.

Table 2 Description of Modules

Module	Label	Function
Main routine	main	Alternately outputs high-level and low-level signals from TIOCA0 every time TCNT value reaches H'7FFF, which is set in TCRA_0.

4.2 Arguments

This sample program does not use arguments.

4.3 Internal Registers

The internal registers used in this sample task are described in table 3.

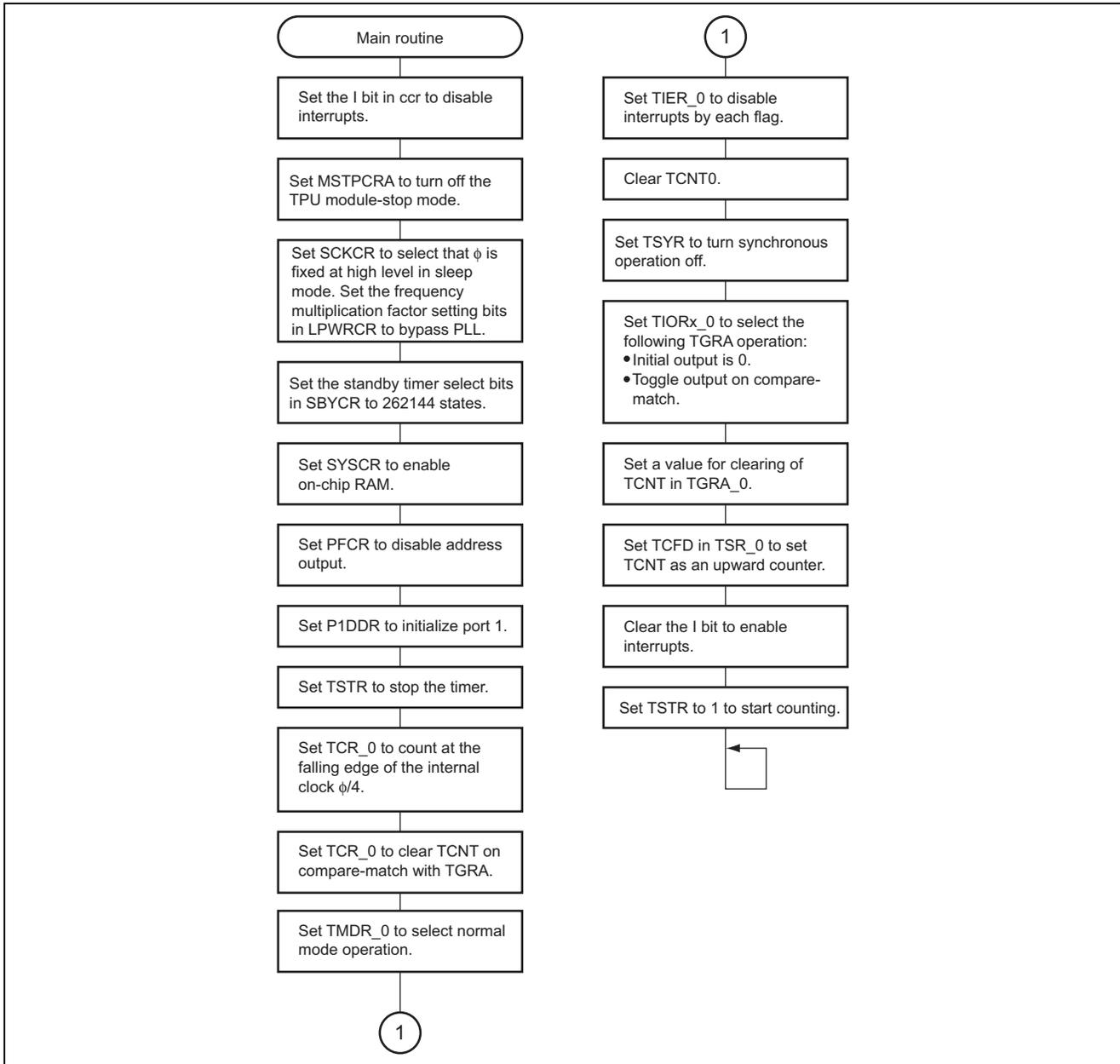
Table 3 Description of Internal Registers

Register	Function	Address	Setting
TCR_0	CCLR2	Timer Control Register_0 (Counter Clear 2 to 0)	H'FFFF10 0, 0, 1
	CCLR1	When CCLR2, CCLR1 and CCLR0 = 001, TCNT is cleared on	Bits 7 to 5
	CCLR0	TGRA compare-match or input capture.	
CKEG1	CKEG1	Timer Control Register_0 (Clock Edge 1, 0)	H'FFFF10 0, 1
	CKEG0	When CKEG1 and CKEG0 = 00, TCNT is incremented at the rising edge.	Bit 4
		When CKEG1 and CKEG0 = 01, TCNT is incremented at the falling edge.	Bit 3
		When CKEG1 and CKEG0 = 1X, TCNT is incremented at both edges (X: Don't care).	
TPSC2	TPSC2	Timer Control Register_0 (Timer Prescaler 2 to 0)	H'FFFF10 0, 0, 1
	TPSC1	When TPSC2 to TPSC0 = 001, TCNT is incremented by the	Bits 2 to 0
		TPSC0	
TMDR_0	BF8	Timer Mode Register_0 (Buffer Operation B)	H'FFFF11 0
		When BFB = 0, TGRB performs normal operation.	Bit 5
		When BFB = 1, TGRB and TGRD perform buffer operation.	
BFA	BFA	Timer Mode Register_0 (Buffer Operation A)	H'FFFF11 0
		When BFA = 0, TGRA performs normal operation.	Bit 4
		When BFA = 1, TGRA and TGRC perform buffer operation.	
MD3	MD3	Timer Mode Register_0 (Mode 3 to 0)	H'FFFF11 0, 0, 0, 0
	MD2	When MD3 to MD0 = 0000, the timer operates in normal mode.	Bits 3 to 0
	MD1	Note: MD3 is a reserved bit. Only 0 should be written to this bit.	
	MD0		
TIORH_0	IOA3	Timer I/O Control Register H_0 (I/O Control A3 to A0)	H'FFFF12 0, 0, 1, 1
	IOA2	When IOA3 to IOA0 = 0011, the initial output is 0 and the	Bits 3 to 0
	IOA1	output is toggled on compare-match.	
	IOA0		

Register	Function	Address	Setting	
TSR_0	TCFD	Timer Status Register (Count Direction Flag) TCFD = 0 indicates that TCNT is a downward counter. TCFD = 1 indicates that TCNT is an upward counter.	H'FFFF15 1 Bit 7	
	TCFU	Timer Status Register (Underflow Flag) TCFU = 0 indicates that a TCNT underflow has not occurred. TCFU = 1 indicates that a TCNT underflow has occurred.	H'FFFF15 0 Bit 5	
	TCFV	Timer Status Register (Overflow Flag) TCFU = 0 indicates that a TCNT overflow has not occurred. TCFU = 1 indicates that a TCNT overflow has occurred.	H'FFFF15 0 Bit 4	
	TGFA	Timer Status Register (Interrupt Capture/Output Compare Flag A) TGFA = 0 indicates that TCNT value does not match TGFA value. TGFA = 1 indicates that TCNT value matches TGFA value.	H'FFFF15 0 Bit 0	
TCNT	Timer Counter 16-bit counter that can be read or written to	H'FFFF16	H'0000	
TGRA_0	Timer General Register A_0 16-bit readable/writable register that is used for output compare or input capture.	H'FFFF18	H'7FFF	
TSTR	CST2	Timer Start Register (Counter Start 2 to 0) When CSTn = 0, count operation of the corresponding TCNT is stopped. When CSTn = 1, count operation of the corresponding TCNT is performed. Note: Bits 7 to 3 are reserved. Only 0 should be written to these bits.	H'FFFE00	0, 0, 0
	CST1			
	CST0			
TSYR	SYNC2	Timer Synchro Register (Timer Synchronization 2 to 0) When SYNCn = 0, the corresponding TCNTn operates independently. When SYNCn = 1, the corresponding TCNTn operates synchronously.	H'FFFE01	0, 0, 0
	SYNC1			
	SYNC0			
TIER_0	TCIEU	Timer Interrupt Enable Register (Underflow Interrupt Enable) When TCIEU = 0, an interrupt request (TCIU) by the TCFU flag is disabled. When TCIEU = 1, an interrupt request (TCIU) by the TCFU flag is enabled.	H'FFFF14	0
	TCIEV	Timer Interrupt Enable Register (Overflow Interrupt Enable) When TCIEV = 0, an interrupt request (TCIV) by the TCFV flag is disabled. When TCIEV = 1, an interrupt request (TCIV) by the TCFV flag is enabled.	H'FFFF14	0
	TGIEA	Timer Interrupt Enable Register (TGR Interrupt Enable A) When TGIEA = 0, an interrupt request (TGIA) by the TGFA flag is disabled. When TGIEA = 1, an interrupt request (TGIA) by the TGFA flag is enabled.	H'FFFF14	0

5. Flowchart

1. Main routine



Revision Record

Rev.	Date	Description	
		Page	Summary
1.00	Mar.16, 2004	—	First edition issued

Keep safety first in your circuit designs!

1. Renesas Technology Corp. 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 Corp. 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 Corp. or a third party.
2. Renesas Technology Corp. 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 Corp. without notice due to product improvements or other reasons. It is therefore recommended that customers contact Renesas Technology Corp. or an authorized Renesas Technology Corp. 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 Corp. 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 Corp. by various means, including the Renesas Technology Corp. 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 Corp. assumes no responsibility for any damage, liability or other loss resulting from the information contained herein.
5. Renesas Technology Corp. 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 Corp. or an authorized Renesas Technology Corp. 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 Corp. 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 Corp. for further details on these materials or the products contained therein.