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.

H8/300H Tiny Series

Measuring the Pulse Cycle Using Input Capture Timer W

Introduction

You can use input capture timer W to measure the cycle of a pulse entered into the input capture input pin (FTIOA).

Target Device

H8/300H Tiny Series H8/36014 CPU

Contents

1. Specifications 2
2. Description of Functions 3
3. Description of Operation 5
4. Description of Software 7
5. Flowchart 10

1. Specifications

- As shown in Figure 1, you can use input capture timer W to measure the cycle of a pulse entered into the GRA input capture input pin (FTIOA).
- Input capture timer W measures the time between the leading edges of two pulses and stores it in RAM. You can determine the cycle of a pulse using the measured time.
- Since it may take some time before the leading edge of the first target pulse occurs after input capture timer W starts measurement, the measurable maximum pulse cycle changes between 32.768 and 65.535 ms. The variance is ± 0.5 µs.

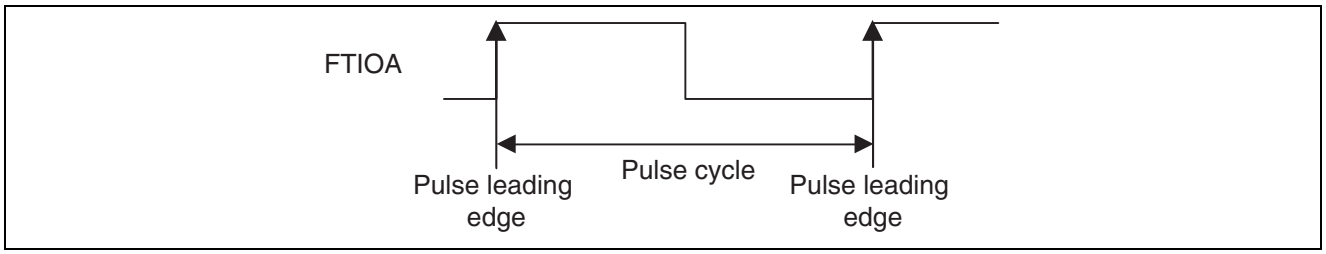
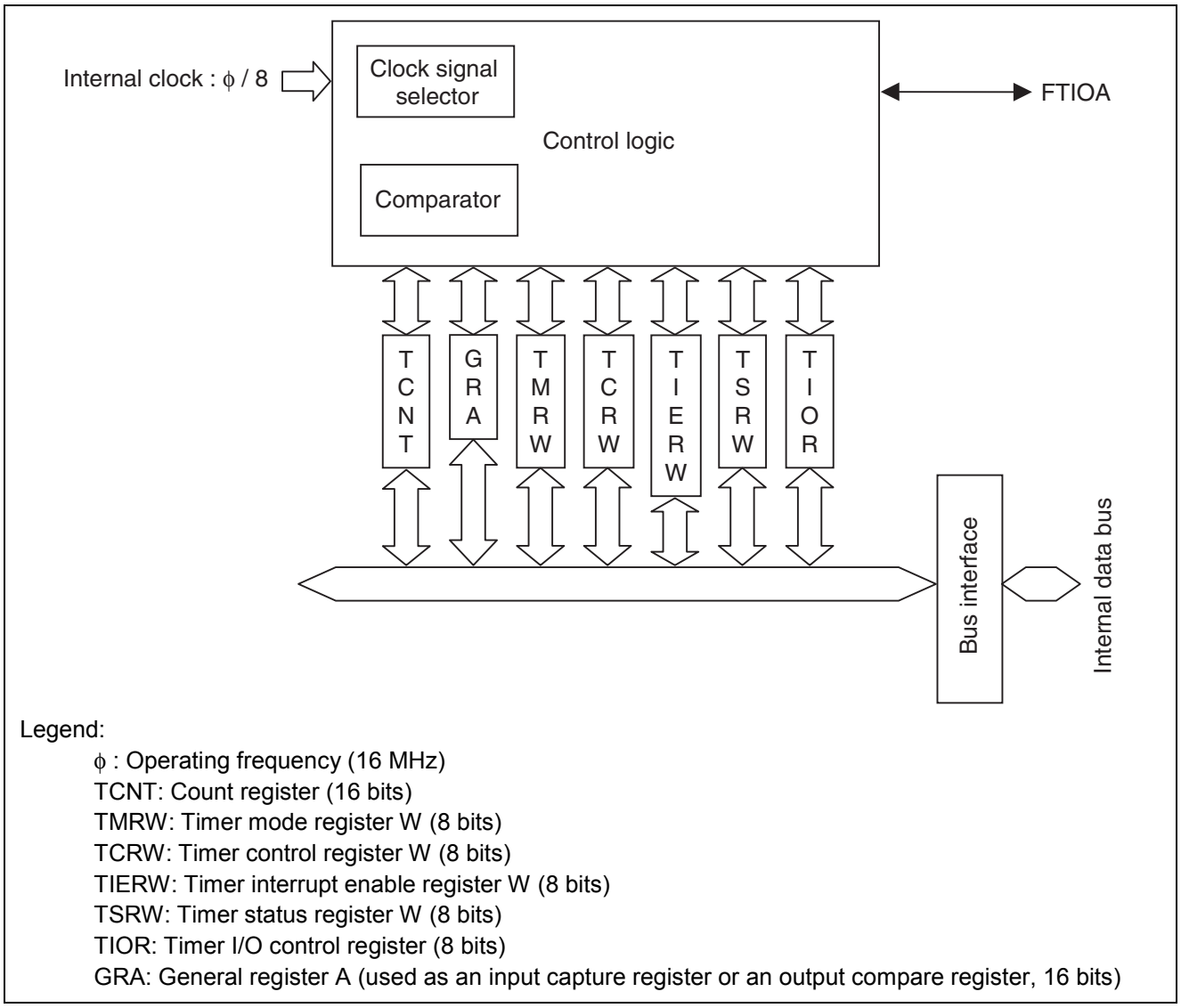


Figure 1 Measuring the Input Pulse Cycle

2. Description of Functions

- This document describes how to measure the cycle of a pulse entered into the input capture input pin (FTIOA) using input capture timer W. Figure 2 shows the block diagram of input capture timer W. Read the following for details about the items in the block diagram.

  — Timer mode register W (TMRW)
  Starts or stops TCNT.
  — Timer control register W (TCRW)
  Selects an input clock signal for TCNT. In this document, the input clock signal is set to ϕ / 8.
  — Timer interrupt enable register W (TIERW)
  Permits or prohibits interrupt requests. In this document, TIERW permits interrupt requests raised by the OVF and IMFA flags of TSRW and prohibits other interrupts.
  — Timer status register W (TSRW)
  Shows the status of timer W. In this document, when TCNT overflows from H'FFFF to H'0000, TSRW sets the OVF flag to 1. When GRA functions as an input capture register and the input capture signal transfers the value of TCNT to GRA, TSRW sets the IMFA flag to 1.
  — Timer I/O control register 0 (TIOR0)
  Controls GRA. In this document, when GRA is used as an input capture register and the FTIOA pin is set to 1, the value of TCNT is transferred to GRA.
  — Count register (TCNT)
  A 16-bit register that is incremented and can be read and written. The register is incremented by the internal or external clock signal entered. In this document, the input clock signal is set to ϕ / 8 and the register is incremented at the rising edge of a clock signal.
  — General register A (GRA)
  A 16-bit register that can be read and written. In this document, when GRA is used as an input capture register and the FTIOA pin is set to 1, the value of TCNT is transferred to GRA.
  — Input capture/output compare A pin (FTIOA)
  Set as the input capture input pin and transfers the value of TCNT to GRA when this pin is set to 1.
  — Input pulse cycle
  = (Value of TCNT stored in prdhl) × (TCNT input clock signal cycle)
  = (Value of TCNT stored in prdhl) × (1 / (ϕ / PSS))
  = (Value of TCNT stored in prdhl) × (1 / (16 MHz / 8))
  = (Value of TCNT stored in prdhl) × 0.5 µs



Legend:
ϕ : Operating frequency (16 MHz)
TCNT: Count register (16 bits)
TMRW: Timer mode register W (8 bits)
TCRW: Timer control register W (8 bits)
TIERW: Timer interrupt enable register W (8 bits)
TSRW: Timer status register W (8 bits)
TIOR: Timer I/O control register (8 bits)
GRA: General register A (used as an input capture register or an output compare register, 16 bits)

Figure 2 Block Diagram of Timer W

- Table 1 shows the function of each item described in this document. Assign the function to each item as shown in Table 1 to measure the pulse cycle.

Table 1 Assignment of Functions

Item	Function
TMRW	Starts or stops TCNT.
TCRW	Sets the input clock signal for TCNT to ϕ / 8.
TIERW	Permits the interrupt requests enabled by OVF and IMFA flags of TSRW.
TSRW	Sets the applicable flag when GRA is used as an input capture register or when TCNT overflows.
TIOR0	Uses GRA as an input capture register and transfers the value of TCNT to GRA when the FTIOA pin is set to 1.
TCNT	A 16-bit register that counts up at a rising edge of ϕ / 8
GRA	Receives the value of TCNT when the FTIOA pin is set to 1.

3. Description of Operation

- The details about the operation are described here. Figure 3 shows the operation when no overflow occurs between the leading edge of the first pulse and the leading edge of the second pulse. Figure 4 shows the operation when an overflow occurs. The pulse cycle is measured by the hardware processing and software processing described in Figure 3 and Figure 4.

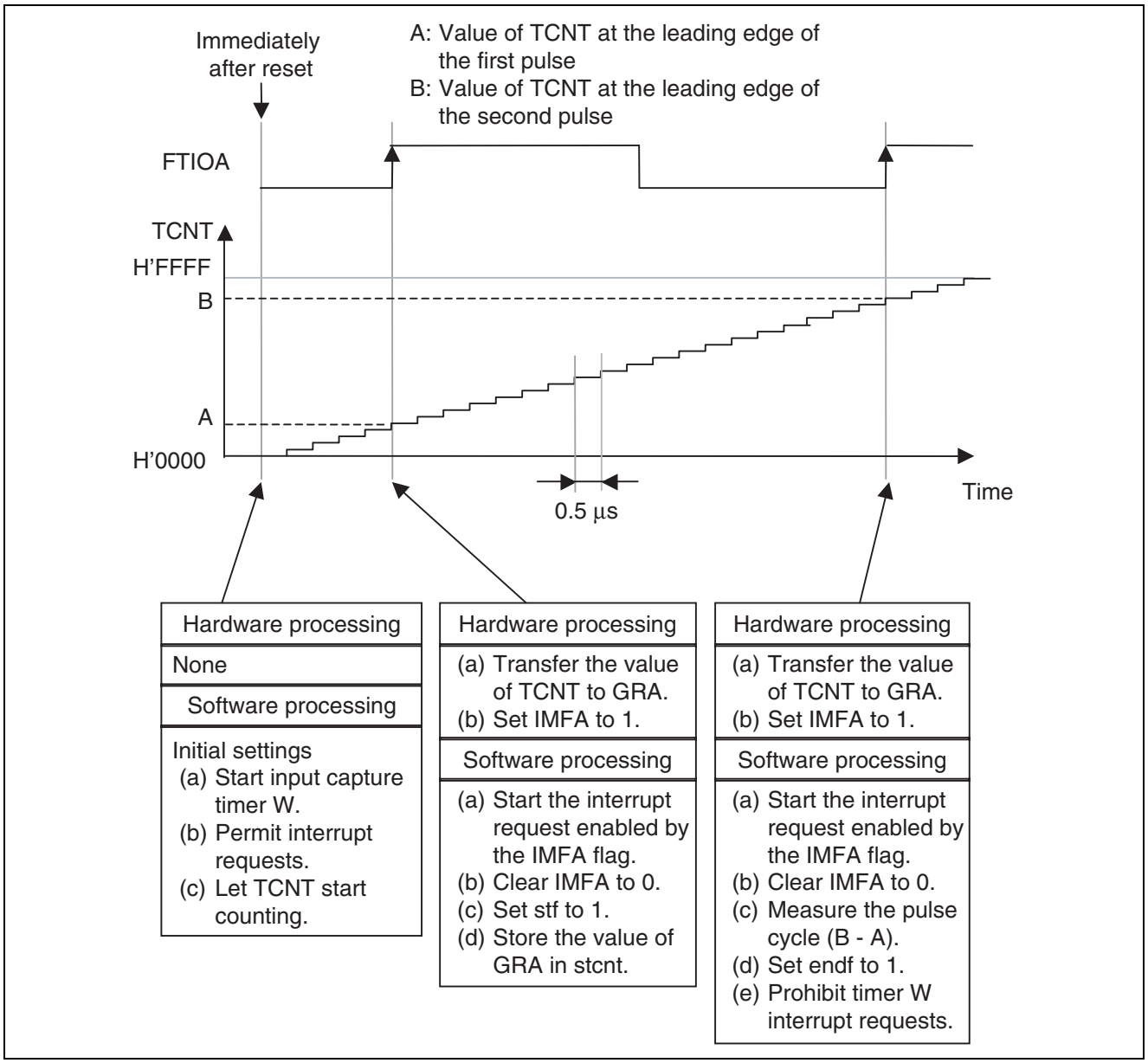


Figure 3 Operation 1

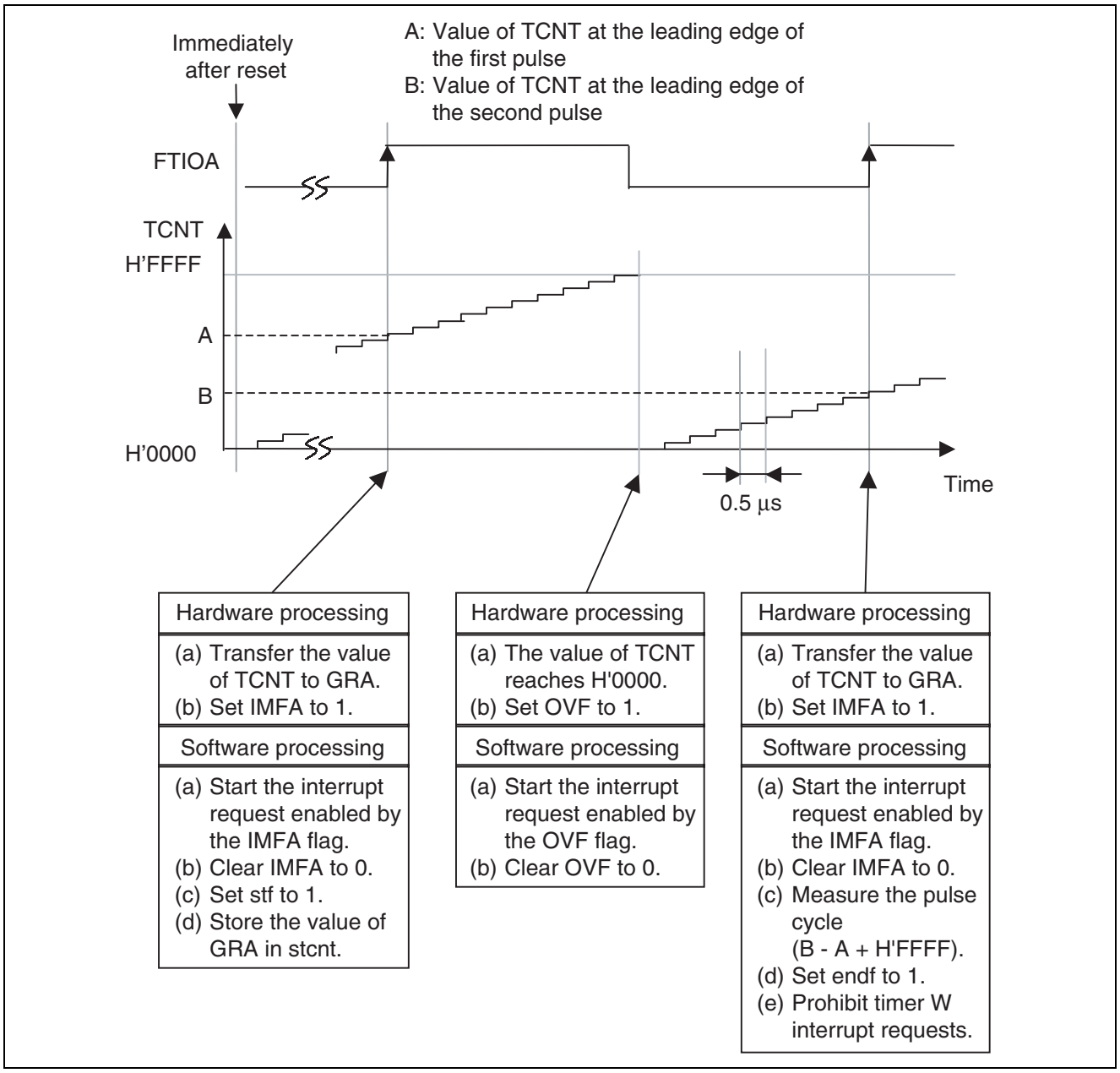


Figure 4 Operation 2

4. Description of Software

4.1 About the Modules

- Table 2 lists the modules used in this document.

Table 2 Modules

Module name	Label	Function
Main routine	main	Starts input capture timer W, lets TCNT start counting, and generates interrupts.
Timer W interrupt routine	tw0int	Controls the output of interrupt requests from timer W, stores the measured pulse cycle in RAM, and clears the OVF and IMFA flags.

4.2 About the Arguments

- No arguments are used in this document.

4.3 About the Internal Registers Used

- The following internal registers are used in this document.

— TMRW (timer mode register W) address: H'FF80

Bit	Bit name	Set value	R/W	Function
7	CTS	0	R/W	Determines whether to allow TCNT to start counting. CTS = 0: TCNT stops counting. CTS = 1: TCNT starts counting.

— TCRW (timer control register W) address: H'FF81

Bit	Bit name	Set value	R/W	Function
6	CKS2	0	R/W	Selects the input clock signal for TCNT.
5	CKS1	1	R/W	TCNT counts up when it receives internal clock signal ϕ / 8.
4	CKS0	1	R/W	

— TIERW (timer interrupt enable register W) address: H'FF82

Bit	Bit name	Set value	R/W	Function
7	OVIE	1	R/W	Permits or prohibits the output of interrupt requests when TCNT overflows. OVIE = 0: Prohibits interrupt requests using the OVF flag of TSRW. OVIE = 1: Permits interrupt requests using the OVF flag of TSRW.
0	IMIEA	1	R/W	Permits or prohibits the output of interrupt requests when GRA is used as an input capture register. IMIEA = 0: Prohibits interrupt requests using the IMFA flag of TSRW. IMIEA = 1: Permits interrupt requests using the IMFA flag of TSRW.

— TSRW (timer status register W) address: H'FF83

Bit	Bit name	Set value	R/W	Function
7	OVF	0	R/W	Flag for indicating whether an overflow has occurred OVF = 0: TCNT has not overflowed. OVF = 1: TCNT has overflowed.
0	IMFA	0	R/W	Indicates whether the value of TCNT is transferred to GRA using the input capture signal when GRA works as an input capture register. IMFA = 0: The value of TCNT is not transferred to GRA. IMFA = 1: The value of TCNT is transferred to GRA.

— TIOR0 (timer I/O control register 0) address: H'FF84

Bit	Bit name	Set value	R/W	Function
2	IOA2	1	R/W	Controls I/O. Sets the function of GRA. GRA = 0: GRA functions as an output compare register. GRA = 1: GRA functions as an input capture register.
1	IOA1	0	R/W	Controls I/O.
0	IOA0	0	R/W	When IOA2 = 1 00: The value of TCNT is transferred to GRA when the FTIOA pin is set to 1. 01: The value of TCNT is transferred to GRA when the FTIOA pin is set to 0. 1X: The value of TCNT is transferred to GRA when the FTIOA pin is set to 1 or 0.

X: Can be any.

— TCNT (count register) address: H'FF86
Function: A 16-bit register that counts up at a rising edge of ϕ / 8.
Set value: H'0000

— GRA (general register A) address: H'FF88
Function: Receives the value of TCNT when the FTIOA pin is set to 1 when GRA functions as an input capture register.
Set value: -

4.4 About RAM

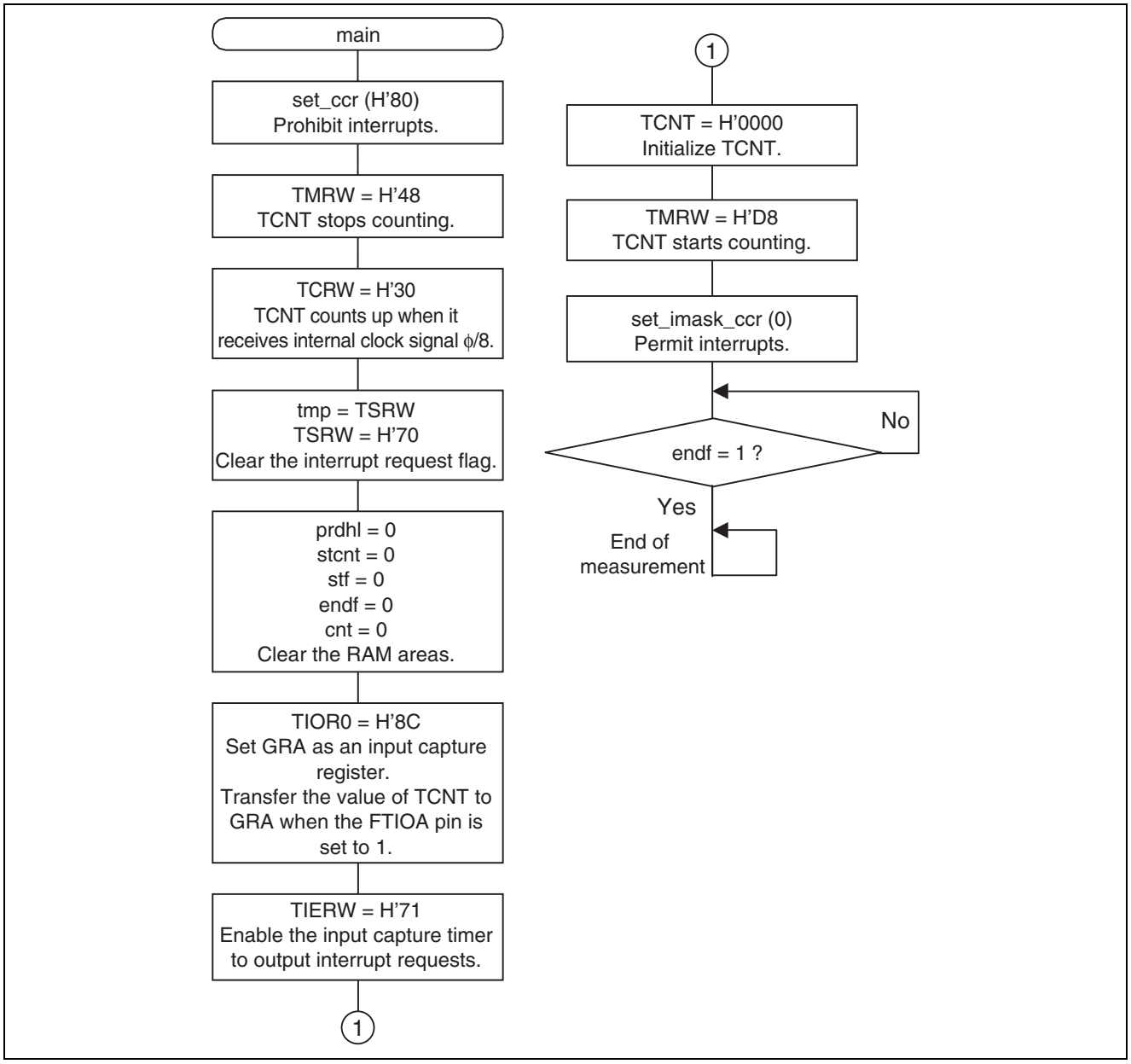
- Table 3 shows how RAM is used in this document.

Table 3 RAM Areas to be Used

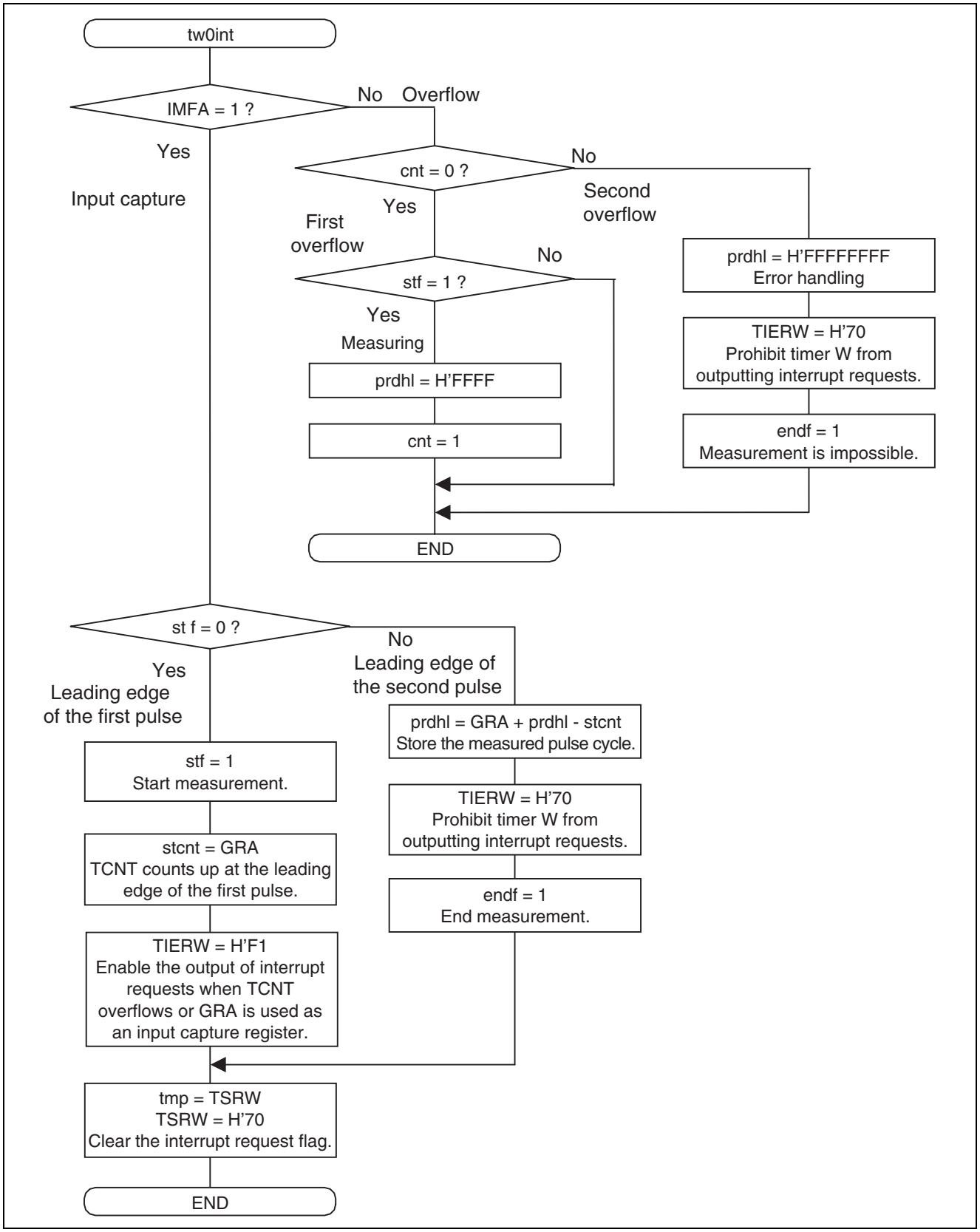
RAM area name	Description	Size of memory used	Used by:
prdhl	Stores the measured pulse cycle.	4 bytes	Main routine Timer W interrupt routine
stcnt	Stores the count of TCNT at the beginning of measurement.	2 bytes	Main routine Timer W interrupt routine
stf	stf = 0: The input capture timer has not output an interrupt request. stf = 1: The leading edge of the first pulse is detected. Measurement starts.	1 byte	Main routine Timer W interrupt routine
endf	endf = 0: The leading edge of the second pulse is not detected. endf = 1: The leading edge of the second pulse is detected or more than one overflows occurred when stf was 1. Measurement ends.	1 byte	Main routine Timer W interrupt routine
cnt	Set to 1 if an overflow occurs when stf = 1.	1 byte	Main routine Timer W interrupt routine

5. Flowchart

5.1 Main Routine



5.2 Timer W Interrupt Routine



- Link addresses

Section name	Address
CV1	H'0000
CV2	H'002A
P	H'0100
B	H'FB80

Revision Record

		Description	
Rev.	Date	Page	Summary
1.00	Dec.20.03	—	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.