

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.

M32C/82,83 Group

Time measurement function of Intelligent I/O Group 0 and 1 with prescaler function

1. Abstract

This application note describes the time measurement function of Intelligent I/O group 0 with prescaler function, which measures a period from the beginning of the program to input of any edge.

2. Introduction

This application note is applied to the M32C/83 group microcomputer.

This program can also be used when operating other microcomputers within M16C family, provided they have the same SFR (Special Function Registers) as the M32C/83 group. However, some functions may have been modified. Refer to the User's Manual for details. Use functions covered in this Application Note only after careful evaluation.

3. Detailed description

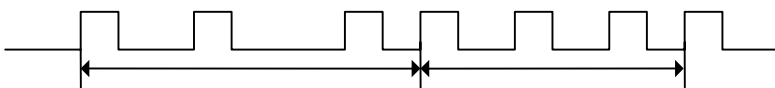
Intelligent I/O group 0 and 1 are composed of one 16-bit Base Timer for free-run operation and eight 16-bit registers for the time measurement function and waveform generation function.

Channel 6 and 7 have the prescaler function.

In this example, using the time measurement function of channel 6, a period is measured from the beginning of the program to input to INPC06 port of any rising edge.

Input pulse waveform

(Detecting a rising edge when the value of prescaler is "2")



Measuring a period from the beginning of the program to 3rd rising edge

When using prescaler function, trigger input is counted.

The period is measured every trigger input of setting value in the GTPR6 register +1.

(1) Time measurement function setting

This example will use Channel 6 in Group 0 for the time measurement function. Select the rising edge mode for the trigger of the measurement.

(2) Time measurement calculation

Use the time measurement interrupt of Channel 6. Then, read the value of register G0TM6 during the interrupt routine. Then calculate the difference from the value that is measured last time. This is the measuring time.

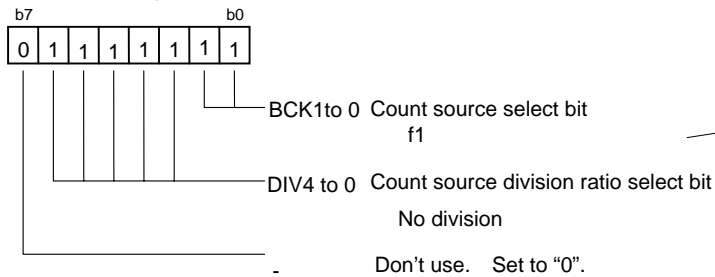
3.1 How to set up

This section shows the setting procedures and setting values to proceed section “3. Detailed Description”. For detail configuration of each register, please refer to M32C/83 Group HARDWARE MANUAL.

(1) Disabling an Interrupt

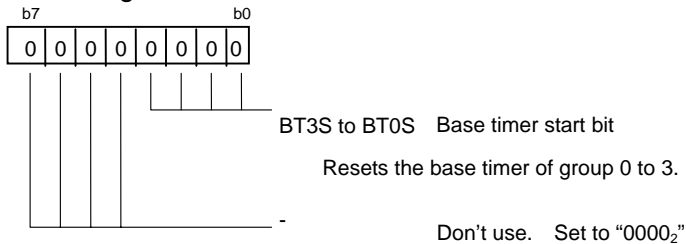
Set I flag=0. Or set bits ILV2 to 0=000₂ in register IIOkIC (k=0 to 11) where the interrupt request of the Intelligent I/O is assigned.

(2) G2BCR0 register



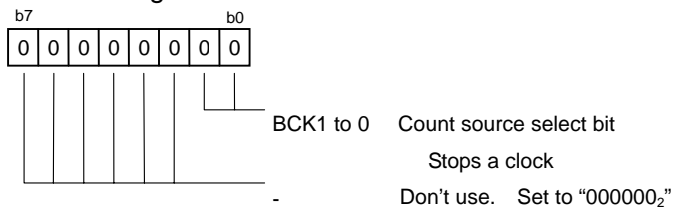
This setting supplies the BCSR register with a clock, and enables the register to be set.

(3) BCSR register



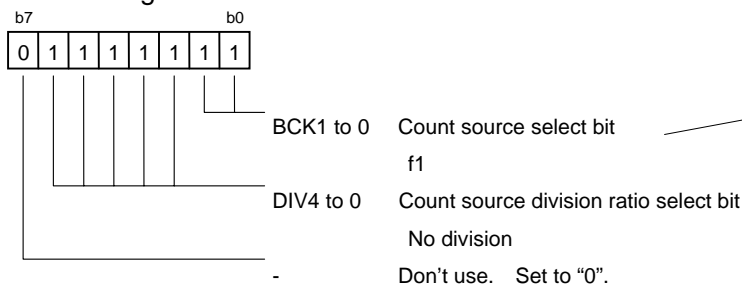
This setting resets Base Timers in Groups 0 to 3. Base Timer of Group i starts counting from 0000₁₆ by setting the BTS bit in the register GiBCR1 to "1" after the operation clock of Base Timer is set in GiBCR0 register.

(4) G2BCR0 register



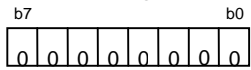
Stop a clock supplied to Group 2 when Group 2 and BCSR register are not used.

(5) GiBCR0 register



This setting supplies the registers (6) –(13) with a clock. Set each register to "0111111₂" in order to be effective after setting.

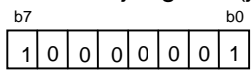
(6) GiBCR1 register



- Don't use. Set to "0".
- RST1 Base timer reset cause select bit 1
Base timer is not reset by matching the GiPO0 with the Base timer.
- Don't use. Set to "00₂".
- BTS Base timer start bit
Resets the base timer
- UD1 to 0 Up down control bit
Up count mode
- Don't use. Set to "0".

Set the bit to "1" (starts base timer count) after setting intelligent I/O related register.

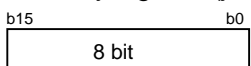
(7) G0TMCRj register (j = 6,7)



- CTS1 to 0 Timer measurement triaquer select bit
Rising edge
- DF1 to 0 Digital filter function select bit
No digital filter
- GT Gate function select bit
Don't use Gate function
- GOC Gate function release select bit
Don't select gate function release mode.
- GSC Gate function release bit
- PR Prescaler function select bit
Select prescaler function mode.

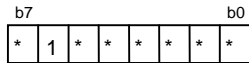
Set to use prescaler function.

(8) G0TPRj register (j =6,7)



- Set a prescaler value.
- When the setting value is n, time measurement is performed every n+1 count of trigger input.

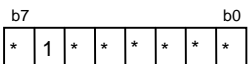
(9) GiFS register



- FSC5 to 0 Channel 5-1 time measurement, waveform generation function select bit
When Channel j is used, set the bit FSCj to "1" (select time measurement function)
- FSC6 Channel 6 time measurement, waveform generation function select bit
Channel 6 selects time measurement function
- FSC7 Channel 7 time measurement, waveform generation function select bit
When Channel 7 is used, set the bit FSC7 to "1" (select time measurement function)

The bit FSCj is a bit to select time measurement function or waveform generation function. It doesn't matter either "0" or "1" is set to unused Channel.

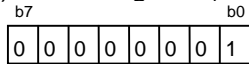
(10) GiFE register



- IFE5 to 0 Channel 5 to 1 function enable bit
When Channel j is used, set the bit IFEj to "1" (operate channel j function).
- IFE6 Channel 6 function enable bit
Operate Channel 6 function
- IFE7 Channel 7 function enable bit
When Channel 7 is used, set the bit IFE7 to "1" (operate channel 7 function).

Set the bit IFEj of unused channel j to "0".

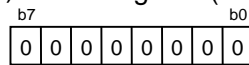
(11) IIOkIE register (k = 0 to 11)



- IRLT Interrupt Request select bit
Uses interrupt request for an interrupt
- bit7 to 1 Interrupt enable bit 7 to 1
Set to "000000₂"

Don't set the bit IRLT and the bit 7-1 to "1" at the same time.

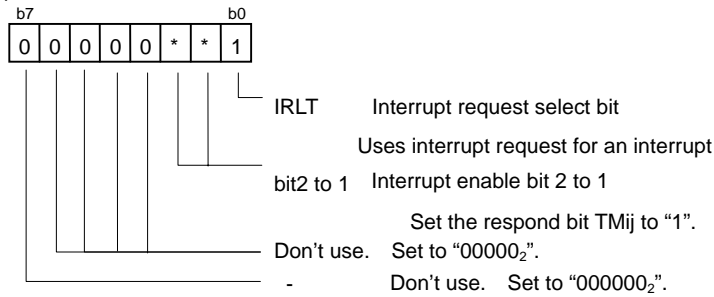
(12) IIOkIR register (k = 0 to 11)



- Don't use. Set to "0".
- Initializes interrupt request register..

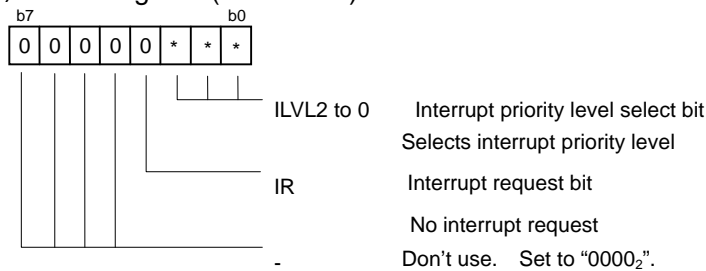
Set the register IIOkIR to "00₂".

(13) IIOkIE register (k = 0 to 11)



Set interrupt request bit not used for an interrupt to "0".

(14) IIOkIC register (k = 0 to 11)

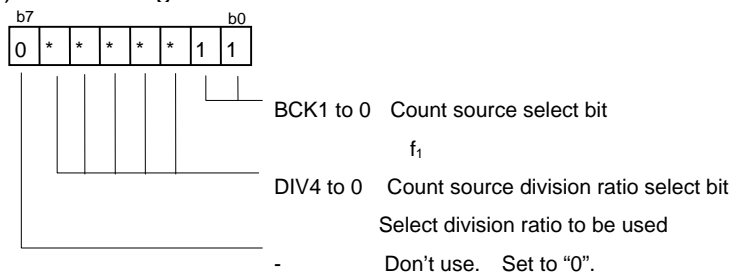


(15) PSC register, PSLa register (a=0 to 3), PSb register (b=0 to 9), IPS register

Set the port INPCij

(16) Interrupt enable flag (I flag = "1")

(17) GiBCR0 register



(18) GiBCR1 register

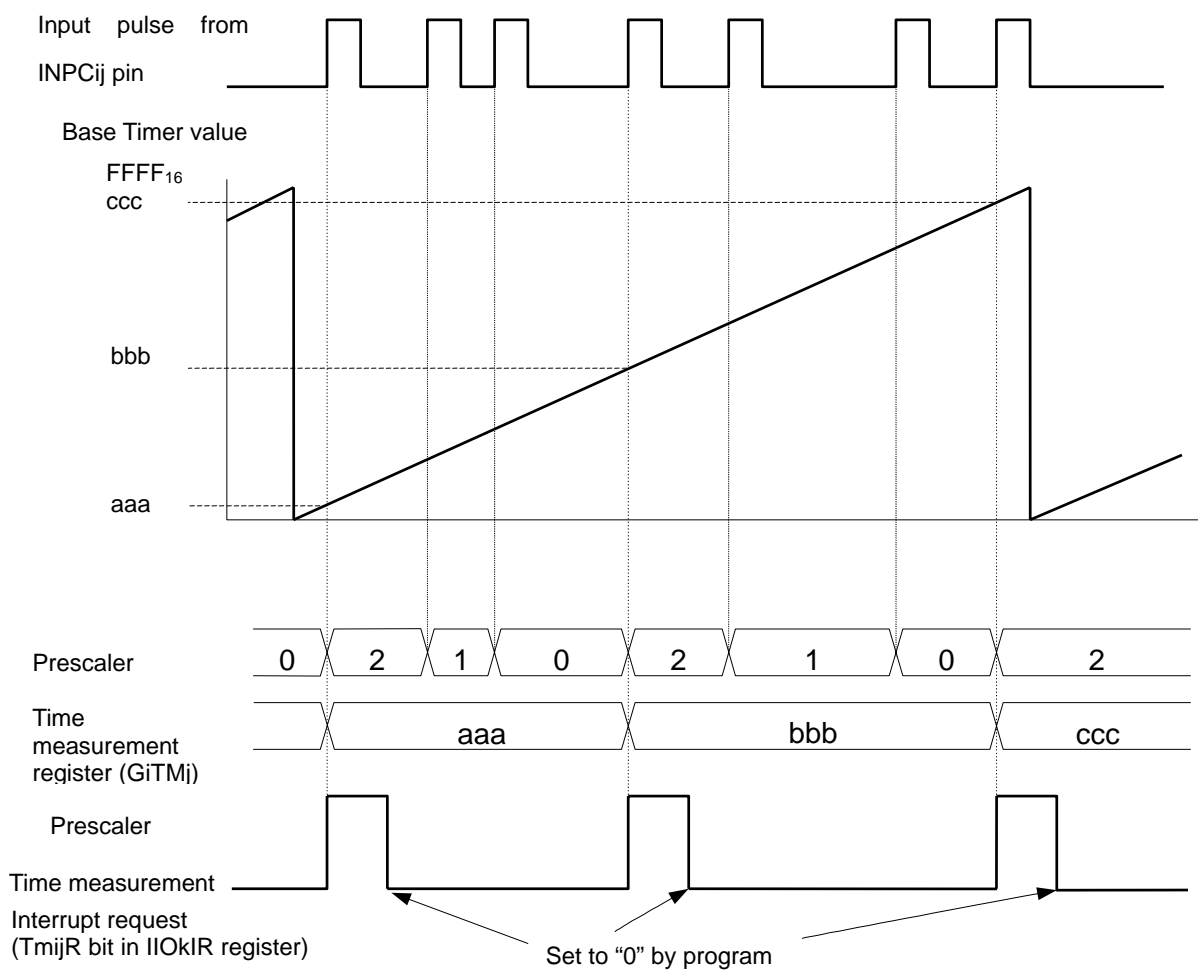


3.2 Precaution on Interrupts

During the Intelligent I/O interrupt routine, the IIOkIR register corresponding to this interrupt must be set to "00₁₆" (initialize). If this setting is missing, the IR bit in the IIOkIC register is not set to "1" regardless of the Intelligent I/O interrupt request. (No interrupt occurs.)

3.3 Timing chart

The below is a timing diagram with setting according to the section 3.1 and 3.2.



Note : In this diagram, PR bit in GiTMCRj register is set to "1". (Use prescaler function.)

4. The example of a reference program

```

/*****
/*FILENAME: rej05b0394_src.c          *
/*Ver      : 1.00                    *
/*FUNCTION : Time measurement function */
/* Intelligent I/O Group 0 and 1 with prescaler function */
/*****/
/*****/
/*      include file                */
/*****/
#include <stdio.h>
#include "sfr32c83.h"

/*****/
/*      Function Definition          */
/*****/
void ch6_int();                      /* Interrupt function */
#pragma INTERRUPT ch6_int

/*****/
/*      Global variable Definition   */
/*****/
static short pause;

/*****/
/*      main                        */
/*****/
void main()
{
    /* main clock set */
    prc0 = 1;                /* protect off */
    mcd   = 0x12;            /* Main clock : No division */
    prc1 = 0;                /* protect on */

    /* iio group0 initial set */
    g2bcr0 = 0x7f;
    btsr   = 0x00;          /* all base timer stop */
    g2bcr0 = 0x00;          /* group2 clock stop */
    g0bcr0 = 0x7f;          /* b0,b1: count source:f1
                               b2 to b6:count source division ratio: No division */

    g0bcr1 = 0x00;
    g0tmcr6 = 0x81;        /* b0,b1: rising edge
                               b2,b3: No digital filter
                               b4: Don't use gate function
                               b5: Don't select function release mode
                               b6: Gate function release bit
                               b7: Use prescaler function */

    g0tpr6 = 0x02;        /*      Set prescaler period */

    g0fs   = 0x40;        /*      ch6 : Time measurement function */
    g0fe   = 0x40;        /*      ch0,6 : Operate function */

    /* iio group0 interrupt initial set */
    iio6ie = 0x01;        /* Latch interrupt request */
    iio6ir = 0x00;        /* Clear interrupt request flag */
    iio6ie = 0x03;        /* Enable interrupt of request flag corresponding to interrupt */
    iio6ic = 0x03;        /* Select interrupt priority level */

    /* port set */

```

```

pd15 = 0x00;                                /* INPC0_6 input */
ps2   = 0;

/* interrupt enable */
_asm("fset i");

/* iio group0 basetimer start */
bts_g0bcr1 = 1;

while(1);

}

/* iio ch6 interrupt */
void ch6_int()
{
    static signed short old_tr = 0;
    short signed now_tr;
    iio6ir = 0x00;                            /* Clear interrupt request */
    now_tr = (signed short)g0tm6;             /* Read time measurement register */
    palse = now_tr - old_tr;                  /* Pulse width measurement */
    old_tr = now_tr;                          /* Store the value of current register */
}
/*----- program end */

```

5. Example Waveform and Result

The following example shows measuring a pulse width at pin INPC06 by using the Intelligent I/O Group 0.

Conditions: Supply voltage = 5V,

Main clock (Xin) = 10MHz

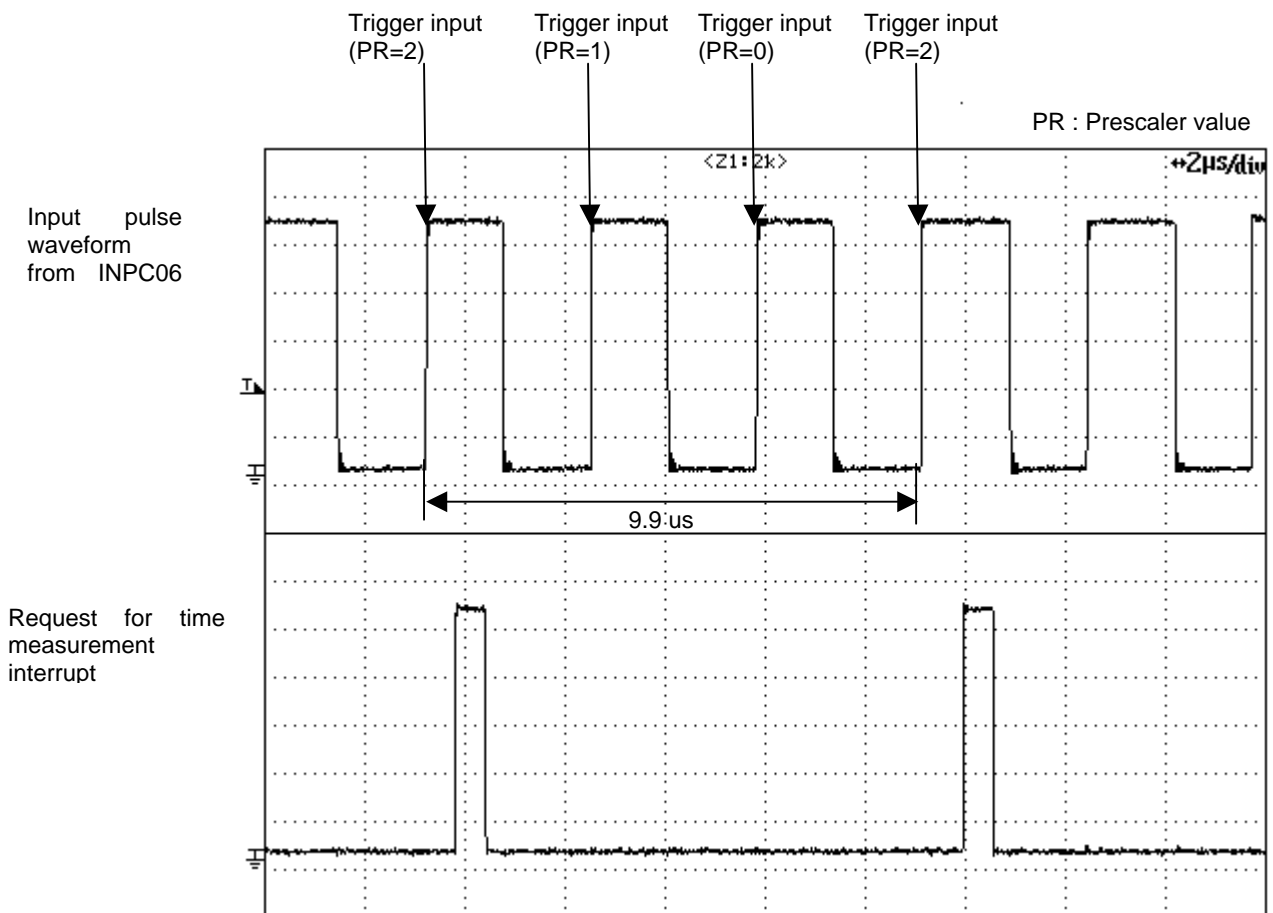
Base Timer operation clock (fBT) = 10MHz

Input pulse = 300kHz

Prescaler = 2

Result counts : 99

(99 / 10MHz = 9.9 μ s)



Measurement result from oscilloscope

6. Reference

HADWARE MANUAL

Refer to the M32C/ 83 group HARDWARE MANUAL.

7. Web-site and contact for support

Renesas Web-site

<http://www.renesas.com>

Contact for Renesas technical support

Mail to : support_apl@renesas.com

REVISION HISTORY

Rev.	Issue date		Revised
		Page	Point
1.00	Jan.30, 2004	-	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.