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Renesas Electronics Corporation

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M16C/28, 29 Group

Pulse Width Measurement with Time Measurement Function of Timer S

1. Abstract

This application note describes the input pulse width measurement with the time measurement function of Timer S.

2. Introduction

This application note is applied to the following microcomputers.

- MCU: M16C/28 Group
- M16C/29 Group

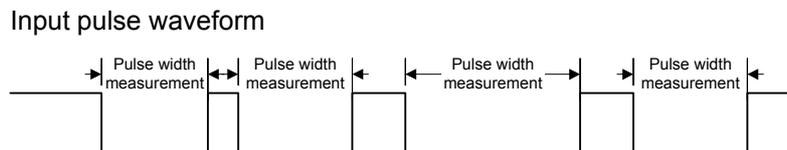
This program can also be used when operating other microcomputers within the M16C family, provided they have the same SFR (Special Function Registers) as the M16C/28, M16C/29 microcomputers. However, some functions may have been modified.

Refer to the Hardware Manual for details. Use functions covered in this Application Note only after careful evaluation.

3. Detailed Description

Timer S has one 16-bit base timer for free-run operation and eight 16-bit registers (channel 0 to 7) for the time measurement function and waveform generation function.

In this example, “L” width of the input pulse from INPC1₀ is measured with the time measurement function of the channel 0.



(1) Time Measurement Function Setting

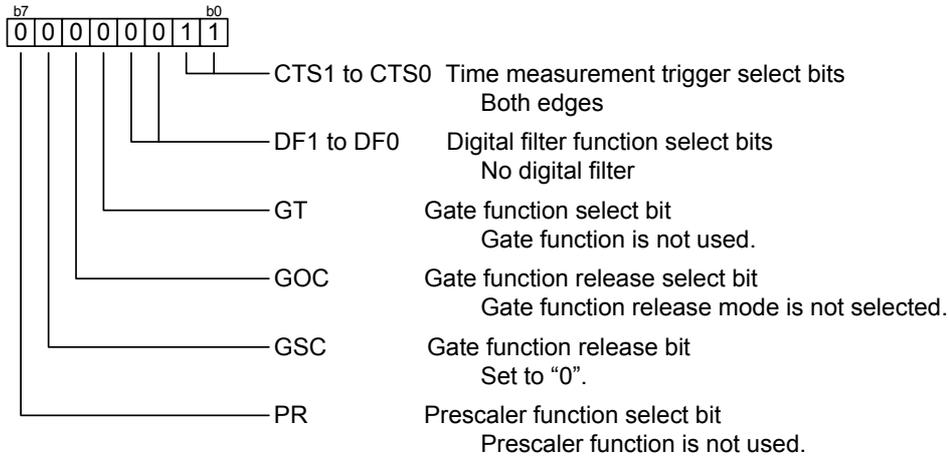
The channel 0 is used in this function. Both edges are selected for the time measurement trigger.

(2) Pulse Width Calculation

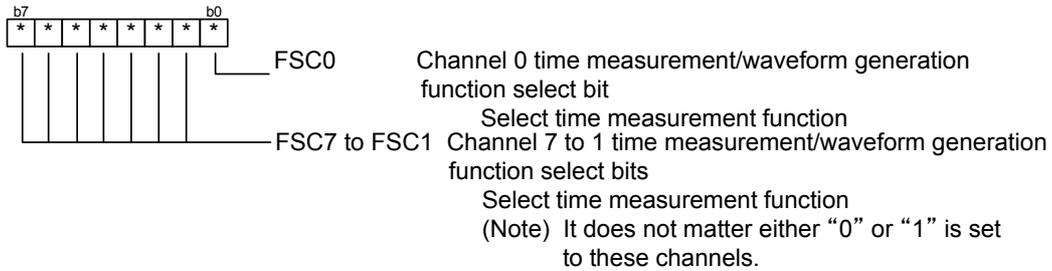
The time measurement interrupt of the channel 0 is used, and the value of channel 0 in the time measurement register (G1TM0 register) is read during the interrupt routine.

The input pulse width is the difference between the value that is measured last time and that of the channel 0.

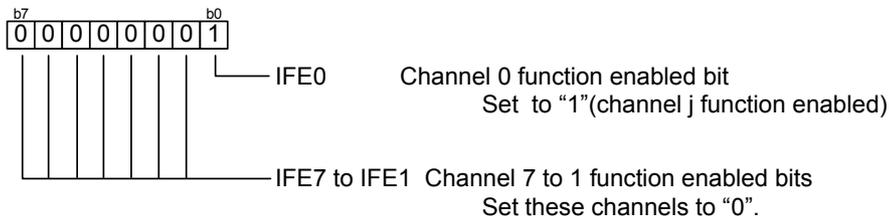
(5) G1TMCR0 register



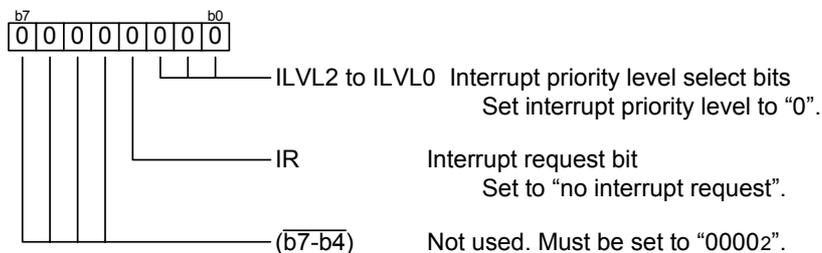
(6) G1FS register



(7) G1FE register



(8) ICOC0IC register (interrupt disable setting /interrupt request bit clear)



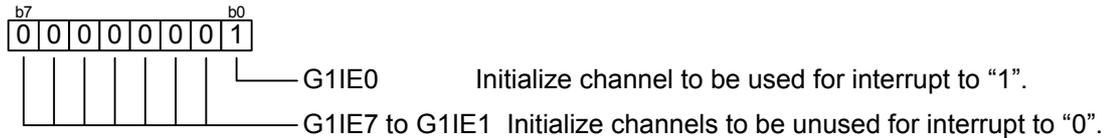
(9) G1IE0 register (interrupt enabled register reset)



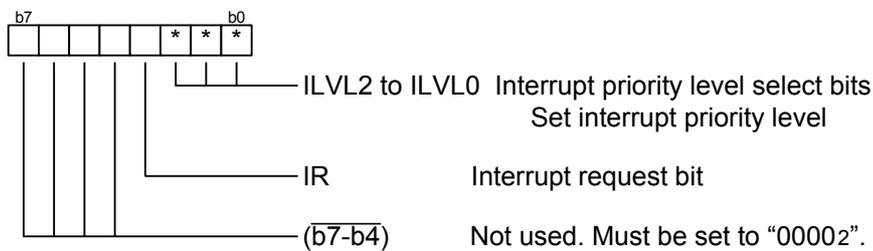
(10) G1IR register



(11) G1IE0 register

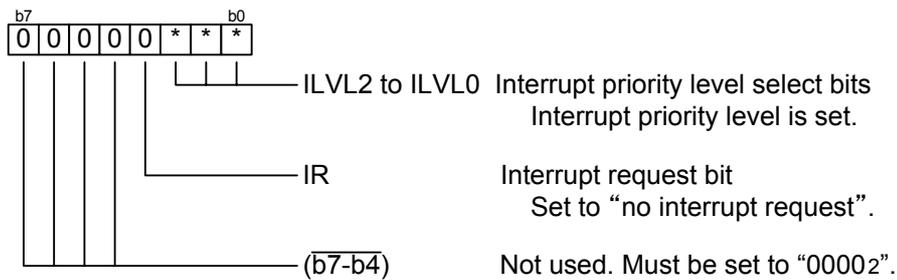


(10) ICOC0IC register (interrupt priority level setting)^(*)



(*) Use "OR" instruction so that the interrupt request bit is not changed when setting the interrupt priority level.

(11) BTIC register



3.2 Precaution on Interrupt

In the process of Timer S interrupt, the description varies depending on the interrupt routine by the base timer or by each channel.

In the case of the base timer interrupt, interrupt request bit is “0” when the request is accepted. (It is not necessary to set to “0” by the program.)

In the case of interrupt by each channel, interrupt requests for each channel are set in the interrupt request register (G1IR Register). When an interrupt request in the channel *i* occurs, the bit *i* in the G1IR Register is set to “1”.

If the bit *i* in the interrupt enable register 0 (G1IE0 Register) is “1”, the interrupt request bit in the IC/OC0 interrupt control register (ICOC0IC Register) is set to “1”.

If the bit *i* in the G1IE1 register is “1”, the interrupt request bit in the IC/OC1 interrupt control register (ICOC1IC Register) is set to “1”.

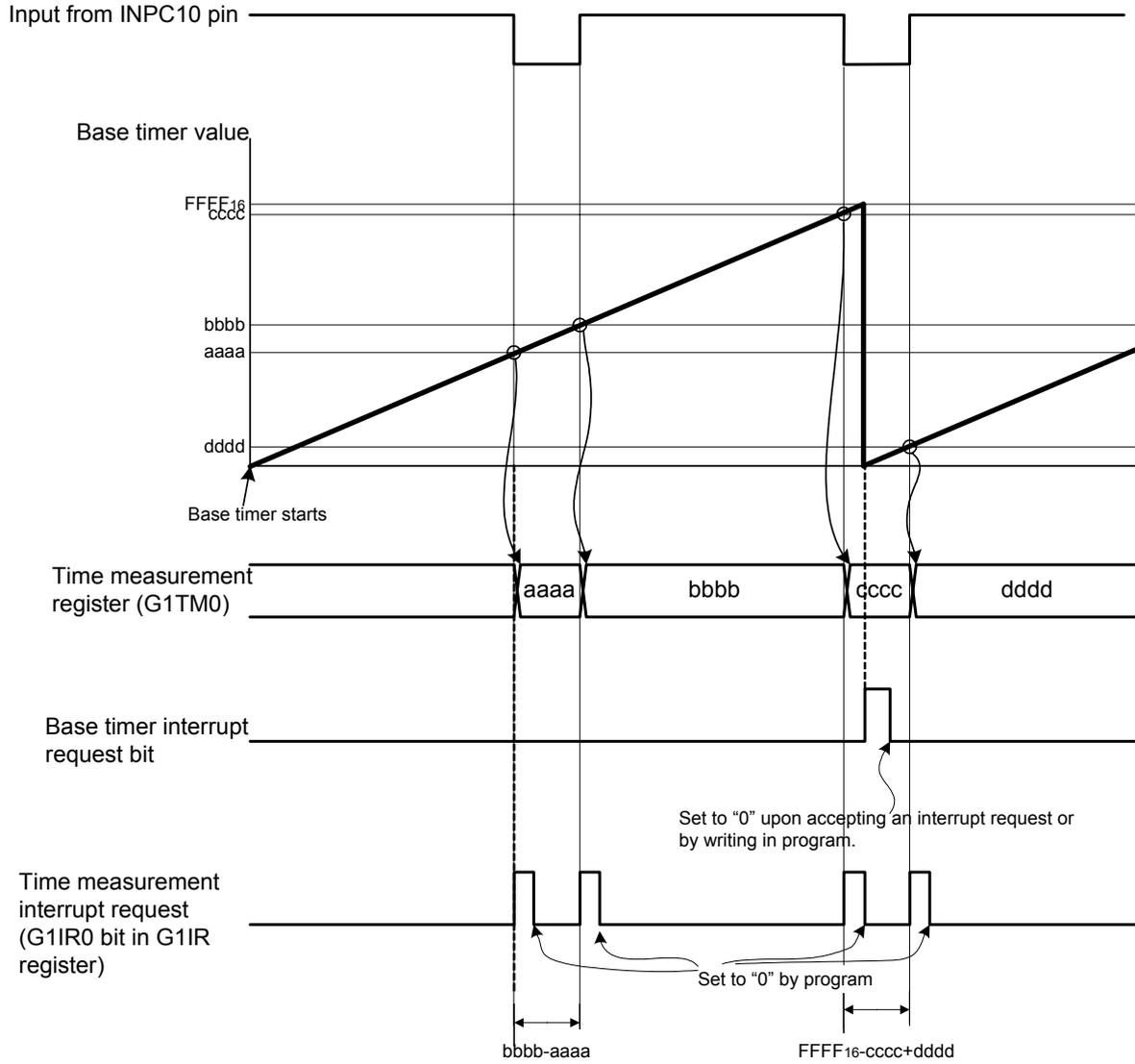
Interrupt request bits in the IC/OC0 and IC/OC1 interrupt control register are set to “0” automatically when they receive the interrupt request. However the interrupt request bits of each channel in the G1IR register are not set to “0” automatically, so set to “0” (no interrupt request) by the program.

Use the following instructions when writing “0” to each bit in the G1IR register.

AND, BCLR

3.3 Timing Diagram

The following shows a timing diagram according to the section “3.1” and “3.2”.



4. Sample Program

```

/*****
 *
 * FILE NAME :
 * Version   : 1.10
 * Function   : Pulse width measurement by Timer_S
 *
 * Copyright (C)2004, Renesas Technology Corp.
 * Copyright (C)2004, Renesas Solutions Corp.
 *
 *****/
/*****
 * include file
 *****/
#include "sfr28.h"

/*****
 * Function Definition
 *****/
void      bt_int(void);
#pragma INTERRUPT bt_int

void      icoc0_int(void);
#pragma INTERRUPT icoc0_int

void      port_init(void);
void      icoc_init(void);
/*****
 * Global variable
 *****/

static unsigned short pluse;
static unsigned short new_tr;
static unsigned short old_tr;

/*****
 * main
 *****/
void main(void) {

    port_init();
    icoc_init();

    pluse = 0;
    new_tr = 0;
    old_tr = 0;

    bts_g1bcr1 = 1;          /* Base Timer Start */
    asm (" fset I");
    while (1) {
    }
}

void port_init() {
    p0 = 0;
    p1 = 0;
    p2 = 0;
    p3 = 0;

    p7 = 0;
    p8 = 0;
    p9 = 0;
    p10 = 0;

    pd0 = 0xff;
    pd1 = 0xff;
    pd2 = 0x00;
}

```

```

pd3 = 0xff;

pd7 = 0xff;
pd8 = 0xff;
prcr = 4;
pd9 = 0xff;
pd10 = 0xff;
}

void icoc_init() {

    g1dv = 0;                /* fBT is 20MHz */
    g1bcr0 = 0x03;
    g1bcr1 = 0x00;

    g1tmcr0 = 0x03;        /* Both edge select and No digital filter */

    g1fs = 0x01;          /* ch-0   Time measurement function select */
    g1fe = 0x01;          /* ch-0   function enable */

    ifsr2a = 1;

    icoc0ic = 0;           /* IC/OC 0 Interrupt control register set to 0 */

    g1ie0 = 0;            /* Interrupt enable register 0 set to 0 */

    g1ir = 0;             /* Interrupt request register initialize */

    g1ie0 = 0x01;        /* Interrupt enable register 0 set */

    icoc0ic |= 0x03;     /* IC/OC 0 Interrupt control register set */

    btic = 0x04;         /* Base Timer Interrupt control register set */
}

void      bt_int() {

    p10_7 = 1;           /* for Base timer over flow detection */
}

void      icoc0_int() {

    p10_4 = 1;           /*Interrupt proces start */
    g1ir0 = 0;

    if ( p2_0 == 1 ) {
        new_tr =(unsigned short)g1tm0;
        if ( p10_7 == 1 ) {
            pluse = 0xFFFF -old_tr;
            pluse = pluse + new_tr;
            p10_7 = 0;
        } else {
            pluse = new_tr - old_tr;
        }
    } else {
        p10_7 = 0;
        old_tr =(unsigned short)g1tm0;
    }
    p10_4 = 0;           /*Interrupt process end */
}

```

5. Example

The following shows an example of the input signal pulse width (“L” width) from INPC1₀ pin of Timer S.

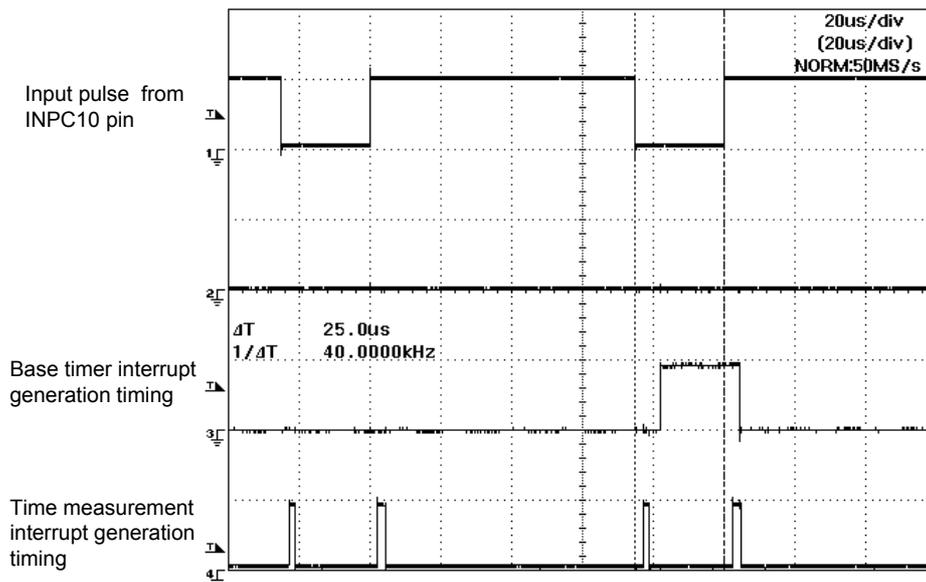
Conditions: Supply voltage = 5V

Main clock (X_{IN}) = 20MHz

Base timer operation clock (f_{BT1}) = 20MHz

Input pulse width = 25 μs

Result: 500 (25000 ns/50ns =500)



6. Reference

Hardware Manual

M16C/28 Group Hardware Manual

M16C/29 Group Hardware Manual

(The latest version is available on the website: <http://www.renesas.com>)

7. Website and Contact for Support

Renesas Website

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

For technical information related to M16C family

E-mail: support_apl@renesas.com

REVISION HISTORY

Rev.	Date	Description	
		Page	Summary
1.10	2004.10.15	-	First edition issued

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