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April 1st, 2010
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Renesas Technology Corp.
Customer Support Dept.
April 1, 2003

M32C/83 Group

Pulse width measurement with the Time measurement function of Intelligent I/O Group 0 and 1

1.0 Abstract

This application note shows the pulse width measurement operation, the time measurement function of the Intelligent I/O Group 0 and 1.

2.0 Introduction

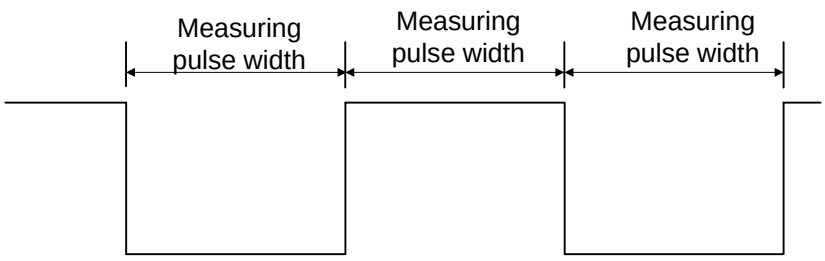
This application note is applied to the M32C/83 Group microcomputer only.

3.0 Detailed Description

Intelligent I/O Group 0 and 1 (Group 0 and Group 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.

This section shows how to measure the input pulse width applied to pin $INPCO_0$ by using the Channel 0 time measurement function.

Input pulse waveform



Intelligent I/O Group0 can measure maximum 8 channels of input pulses. And Intelligent I/O Group 1 can measure maximum 4 channels of input pulses.

(1) Time measurement function setting

This example will use Channel 0 in Group 0 for the pulse width measurement function. Select the both-edge mode for the trigger of the measurement.

(2) Pulse width calculation

Use the time measurement interrupt of Channel 0. Then, read the value of register G0TM0 during the interrupt routine.

Then calculate the difference from the value that is measured last time. This is the pulse width of the input pulse sectioned by two successive edges.

3.1 How to Set Up

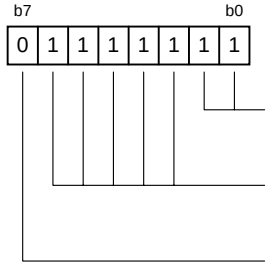
This section shows setting procedures and setting values to proceeds section "*3.0 Detailed Description*". For detail configurations of each register, please refer to *M32C/83 Group Datasheet* .

(1) Inhibiting an Interrupt

Set I flag = 0. Or set bits ILV2 - 0 = 000_2 in register IIO0IC which the interrupt request of the Intelligent I/O is assigned in.

Then proceed the following register settings step by step.

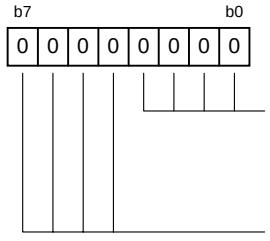
(2) G0BCR0 Register



BCK1 to 0 Count source select bits
f1
DIV4 to 0 Count source divide ratio select bits
No division
- Not used. Must be set to "0".

This setting allows using register BTSR.

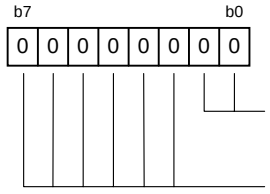
(3) BTSR Register



BT3S to BT0S Base Timer start bits
Base Timers in group 0 to 3 are reset.
- Not used. Must be set to "0".

This setting resets Base Timers in Groups 0 to 3. Base Timer of Group i starts counting from 0x0000 by selecting a count source of Base Timer with register GiBCR0 and then set bit BTS = 1 in register GiBCR1.

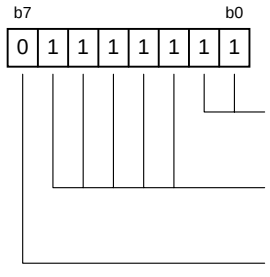
(4) GiBCR0 Register (i= 1 to 3)



BCK1 to 0 Count source select bits
Clock stop
- Not used. Must be set to "0000_2".

Set 0 to the BTSR register if Group 2 and the BTSR register is not used.

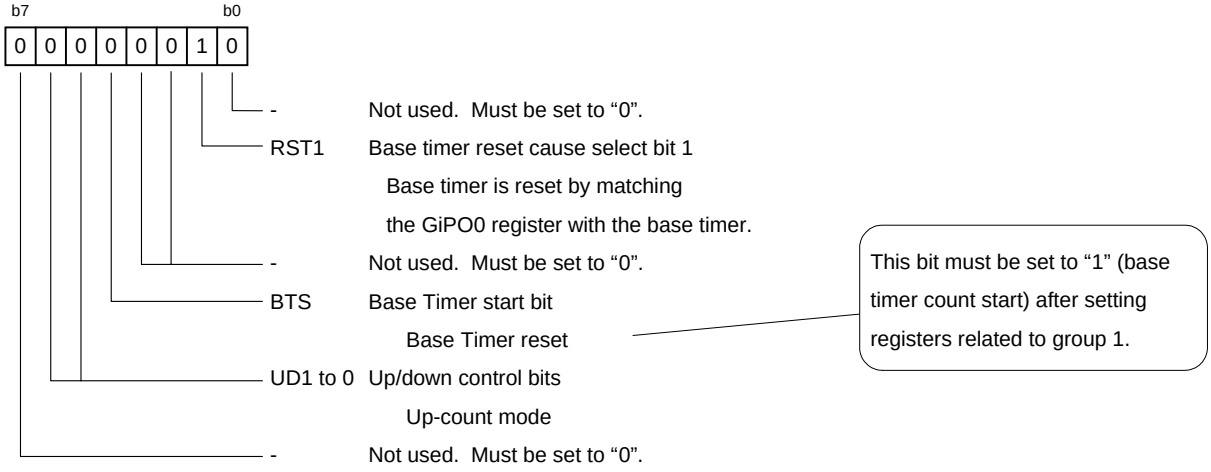
(5) G0BCR0 Register



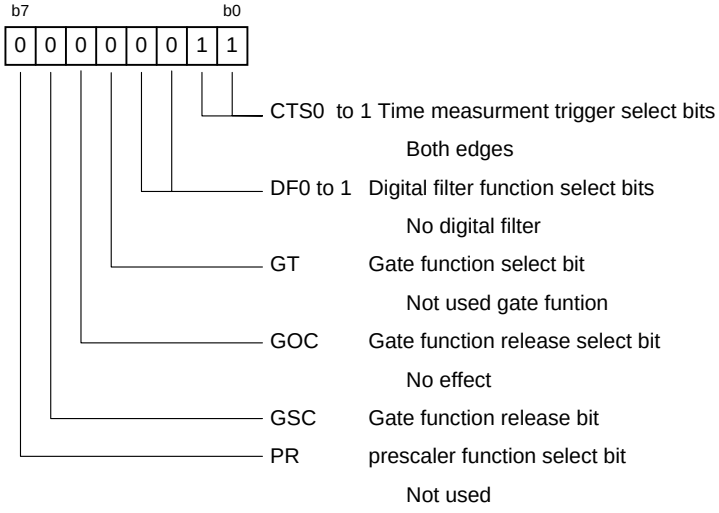
BCK1 to 0 Count source select bits
f1
DIV4 to 0 Count source divide ratio select bits
No division
- Not used. Must be set to "0".

Setting " 01111111_2" to this register enables to set registers (6) thru (13).

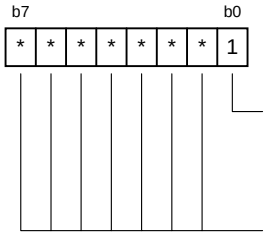
(6) G0BCR1 Register



(7) G0TMCR0 Register



(8) G0FS Register

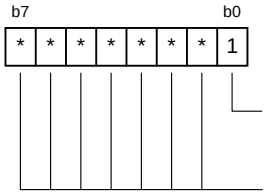


FSC0 Channel 0 time measurement function, waveform generation function select bit
Select waveform generation function for channel 0.

FSC7 to 1 Channel 7 to 1 time measurement function, waveform generation function select bits
If using channel j is used, the FSCj bit should be set “0” (waveform generation function selected).

Bit FSCj selects one from either the time measurment or wave generation functions. No error occurs if unused channels are set to either way, “0” or “1”.

(9) G0FE Register

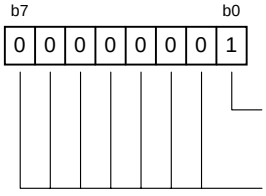


IFE0 Channel 0 function enable bit
Channel 0 function is activated.

IFE7 to 1 Channel 7 to 1 function enable bits
The IFEj bit should be set to “1” (channel j function activated) when using channel j.

Set 0 to bit IFEj if the respective channel j is not used.

(10) IIOkIE Register (k=0 to 11)

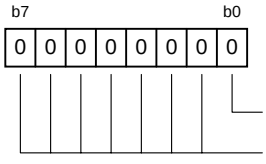


IRLT Interrupt request latch bit
Interrupt request is not latch.

Bits 7 to 1 Interrupt enable bits 7 to 1
Should set to “0000000$_2$”.

Do not set 1 to bit IRLT and bits 7 - 1 at the same time.

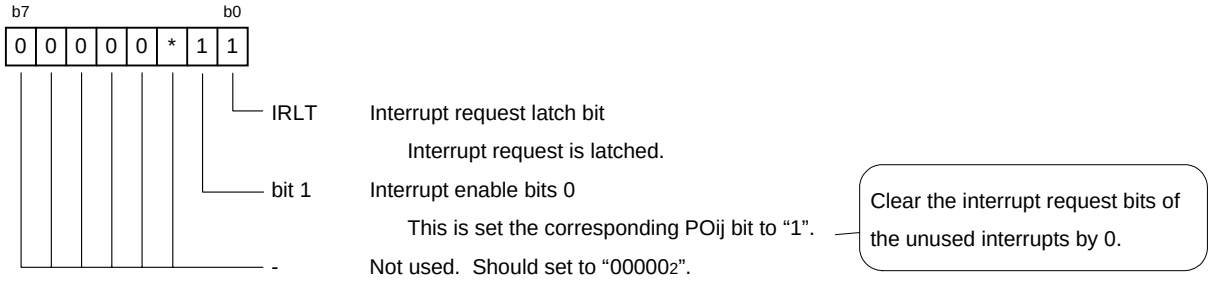
(11) IIOkIR Register (K=0 to 11)



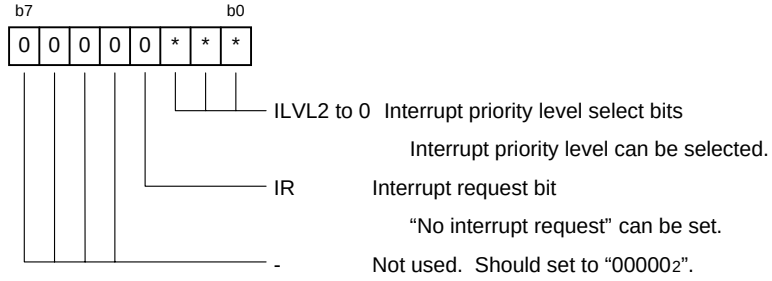
Not used. Must be set to “0”.
Interrupt request flag is initialized.

00_{16} must be set to register IIOkR.

(12) IIOkIE Register (k=0 to 11)



(13) IIOkIC Register (k=0 to 11)

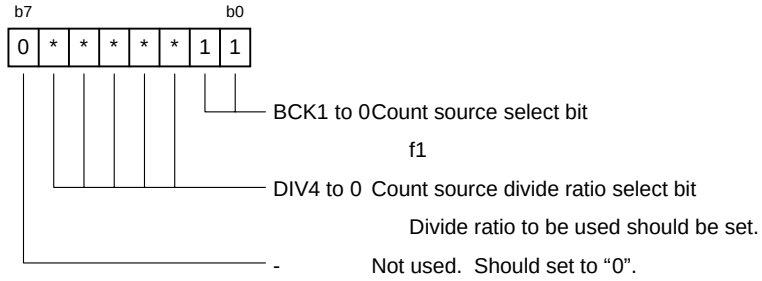


(14) PSC Register, PSLa(a=0 to 3) Register, PSb Register(b=0 to 9) IPS register

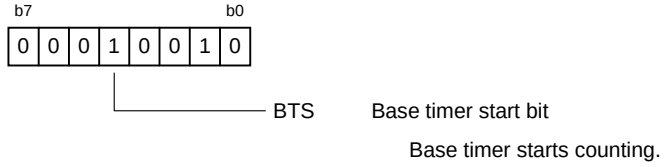
Ports to be used as the INPCij pin can be set by these registers.

(15) Interrupt enabled (I flag="1")

(16) G0BCR0 Register



(17) G0BCR1 Register

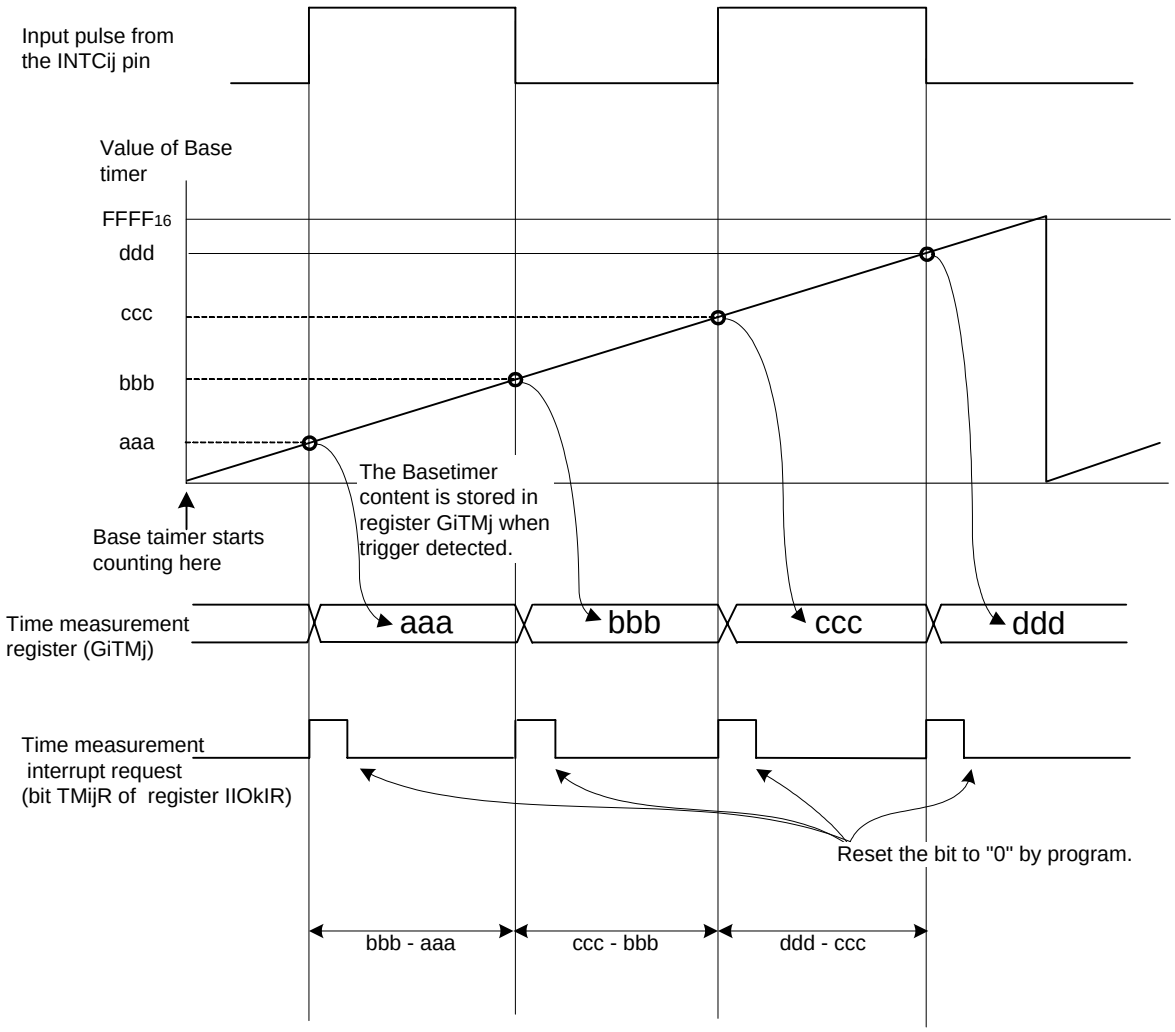


3.2 Precaution on Interrupts

During the Intelligent I/O interrupt routine, the IIOkIR register corresponding to this interrupt must be set to "00$_{16}$" (initialized). 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 settings according to the section 3.1 and 3.2.



4.0 Sample Programming Code

```
/*****************************************************************************
/*          FILENAME: apmc_80.c                                              *
/*          Ver       : 1.00                                                 *
/*          CPU       : M32C/83                                              *
/*          FUNCTION: Intelligent I/O pulse width measuring                  *
/*---------------------------------------------------------------------------*
/*    Copyright (C) 2001 Mitsubishi Electric Corporation and                 *
/*    Mitsubishi Electric Semiconductor Application                          *
/*    Engineering Corporation                                                *
/*    All rights reserved.                                                   *
/*****************************************************************************/
/*******************************/
/*    include file             */
/*******************************/
#include <stdio.h>
#include "sfr83v101.h"

/*******************************/
/*    Function Definition      */
/*******************************/
void ch_int(void);
#pragma INTERRUPT ch0_int

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

/*******************************/
/*    Main                     */
/*******************************/
void main(void){
    /*   main clock set      */
    prc0 = 1;                   /*   protect off   */
    mcd = 0x12;                 /*   Main clock: not divided   */
    prc0 = 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-b6: divided rate: not divided*/
    g0bcr1 = 0x00;

    g0tmcr0 = 0x03;             /*   measuring trigger: both edge */
    g0fs = 0x01;                /*   ch0 select the time measuring function   */
    g0fe = 0x01;                /*   ch0 work the function   */
```

```
    /*   iio Group0 interrupt initial set   */
    iio1ie = 0x01;                  /*   Interrupt request is used for an interrupt     */
    iio1ir = 0x00;                  /*   Clear a flag for interrupt request   */
    iio1ie = 0x03;                  /*   Enables corresponding interrupt from interrupt request flag   */
    iio1ic = 0x03;                  /*   Sets interrupt priority level   */

    /*   port set   */
    ps1 = 0x00;
    pd7 = 0x00;

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

    /*   iio Group0 Base Timer start   */
    bts_g0bcr1 = 1;

    while(1);

}

/*   iio ch0 interrupt     */
void ch0_int(void){
        static signed short old_tr = 0;
        short signed now_tr;
        iio1ir = 0x00;                  /*   Clear the interrupt request   */
        now_tr = (signed short)g0tm0;   /*   Read time measurmentregister   */
        palse = now_tr - old_tr;        /*   Calculate the pulse width   */
        old_tr = now_tr;                /*   Save the latest register value */

}
/*---------------------------------------------------------------------- program end */
```

5.0 Example Waveform and Result

The following example shows measuring a pulse width at pin INPC0 by using the Intelligent I/O Group 0.

Conditions: Supply voltage = 5V

Main clock (X_{IN}) = 30MHz

Base Timer operation clock (f_{BT}) = 30MHz

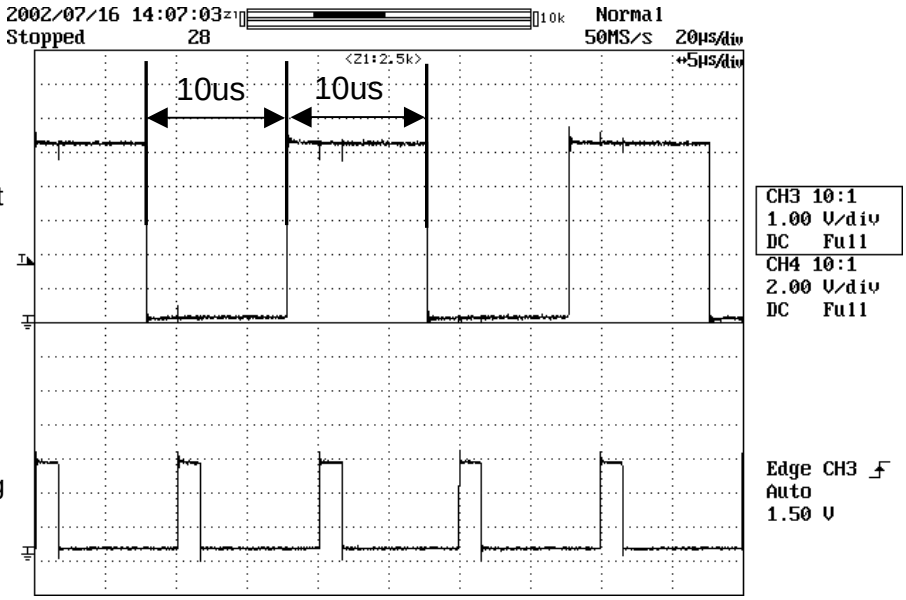
Input pulse = 50KHz

Result counts: 300

(300 / 30MHz = 10us)

Waveform at pin INPCO0

Interrupt timing



Input pulse waveform and interrupt timing

6.0 Reference

Data Sheet

M32C/83 Group Rev. B3

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