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M16C/26

Using Key Input Interrupts

1.0 Abstract

The following article introduces and shows how to setup key input interrupt on the M16C/26 (M30262) Flash microcontroller (MCU). A sample program was written for the MSV-Mini26-SKP for evaluation purposes.

2.0 Introduction

The Renesas M16C/26 is a 16-bit MCU with multiple peripheral functions including handling interrupts generated by several sources. One of the interrupt sources is the key input interrupt.

Key input interrupts can be used to 'wake-up' the M16C/26 from Wait or Stop Mode. Key input interrupts can be used as alternative to monitor changes in the input pins (i.e. use an interrupt instead of polling the input pins for changes). It can be used as additional external interrupt pins for applications with interrupt sources more than the five external interrupt pins available on the M16C/26.

3.0 Key Input Interrupt Pins

The M16C/26 has four available key input pins that can be found on the upper four bits of Port 10 (P10_7, P10_6, P10_5, & P10_4). These four pins have other functions: GPIO (General Purpose Input/Output) and analog inputs to the internal AD converter. A block diagram of Port 10 is shown in Figure 1.

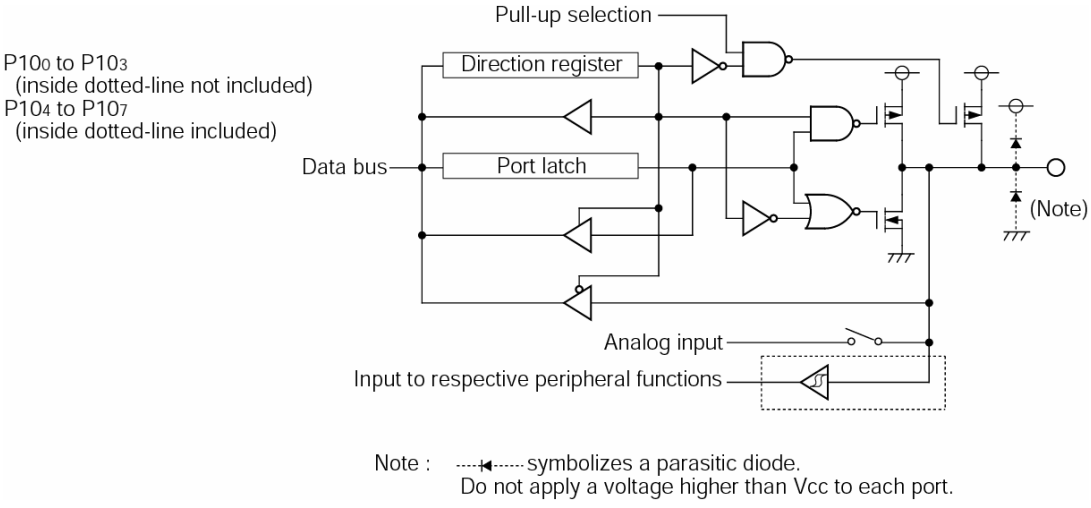

Figure 1 Port 10 Block

How the pins function is defined by setting special function registers in the M16C/26. We will focus on how to setup and use these pins to generate key input interrupts. The two registers, Port 10 Direction Register (pd10 – 0x3F5) and Key Input Interrupt Control Register (kupic – 0x04D), needed to setup key input interrupts are shown in Figure 2 and Figure 3. A diagram of key input interrupt block is shown in Figure 4.

Port Pi direction register

b7	b6	b5	b4	b3	b2	b1	b0

Symbol	Address	When reset
PDi (i = 6, 7, 10)	03EE16, 03EF16, 03F616	0016

Bit symbol	Bit name	Function	R	W
PDi_0	Port Pi0 direction register	0 : Input mode (Functions as an input port) 1 : Output mode (Functions as an output port) (i = 6, 7, 10)	○	○
PDi_1	Port Pi1 direction register		○	○
PDi_2	Port Pi2 direction register		○	○
PDi_3	Port Pi3 direction register		○	○
PDi_4	Port Pi4 direction register		○	○
PDi_5	Port Pi5 direction register		○	○
PDi_6	Port Pi6 direction register		○	○
PDi_7	Port Pi7 direction register		○	○

Figure 2 Port 10 Direction Register, *PD10*

Interrupt control register (Note 2)

Symbol	Address	When reset
BCNIC	004A 16	XXXXX0002
DMiIC(i=0, 1)	004B16, 004C 16	XXXXX0002
KUPIC	004D 16	XXXXX0002
ADIC	004E 16	XXXXX0002
SiTIC(i=0 to 2)	005116, 005316, 004F16	XXXXX0002
SiRIC(i=0 to 2)	005216, 005416, 005016	XXXXX0002
TAiIC(i=0 to 4)	005516 to 005916	XXXXX0002
TBiIC(i=0 to 2)	005A16 to 005C16	XXXXX0002

b7	b6	b5	b4	b3	b2	b1	b0
X	X	X	X				

Bit symbol	Bit name	Function	R	W
ILVL0	Interrupt priority level select bit	b2 b1 b0 0 0 0 : Level 0 (interrupt disabled) 0 0 1 : Level 1 0 1 0 : Level 2 0 1 1 : Level 3 1 0 0 : Level 4 1 0 1 : Level 5 1 1 0 : Level 6 1 1 1 : Level 7	○	○
ILVL1			○	○
ILVL2			○	○
IR	Interrupt request bit	0 : Interrupt not requested 1 : Interrupt requested	○	○ (Note 1)
Nothing is assigned. In an attempt to write to these bits, write 0 . The value, if read, turns out to be indeterminate.			–	–

Note 1: This bit can only be accessed for reset (= 0), but cannot be accessed for set (= 1).
Note 2: To rewrite the interrupt control register, do so at a point that does not generate the interrupt request for that register. For details, see the precautions for interrupts.

Figure 3 Key Input Interrupt Control Register, *kupic*

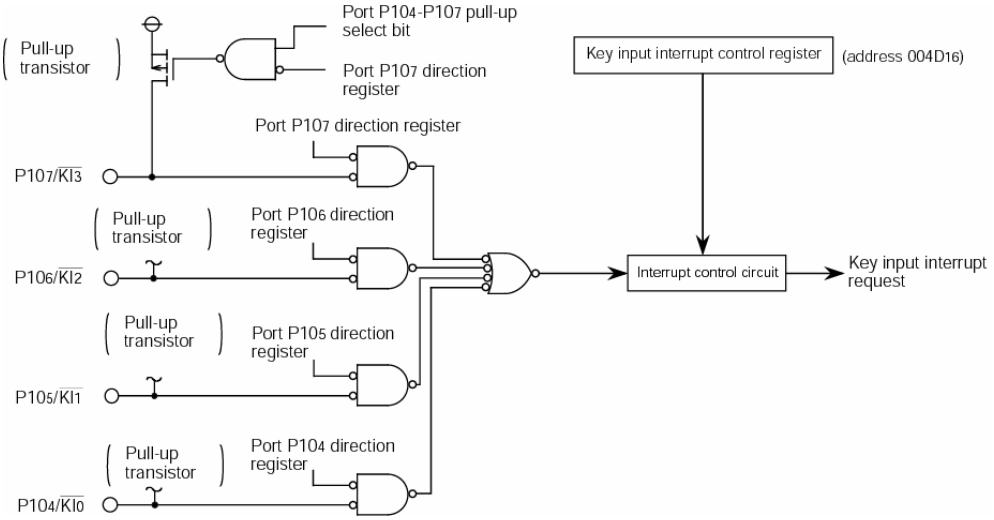

Figure 4 Key Input Interrupt Block

3.1 Key Input Interrupt Setup

As described earlier, M16C/26 registers are set to define how the upper four pins of Port 10 will function. To setup the pins for key input interrupt function, the following must be set:

- The pins used for the key input interrupt must be set as inputs in the Port 10 direction register, PD10.
- The key input interrupt (and global interrupt) must be enabled.

If the key input interrupt (or the global interrupt) is disabled, the pins become general purpose inputs. To enable it, an interrupt priority level (from 1 to 7) must be given to key input interrupt control register, kupic. The FSET I instruction must be executed to enable global interrupts. Take note that interrupts are disabled by default after reset. Refer to Interrupt Handler application note for details (see Reference).

3.2 Notes on Using the Key Input Interrupt Function

Setting up and using key input interrupts can be implemented easily. However, we need to mention a few notes when using it.

The default state of key inputs is high (at least 0.8Vcc according to M16C/26 datasheet). A key input interrupt is generated on the falling edge (high -> low transition) of one of the inputs. If one of the key inputs is always low, a key input interrupt will not be generated.

As with any interrupt, the vector address for the key input interrupt must also be set so the MCU knows the routine to process when the interrupt occurs. The interrupt vector is set in the sect30.inc startup file during firmware development. Refer to Interrupt Handler application note for details (see Reference).

4.0 Key Input Interrupt Sample Program

A sample program was written for the MSV-Mini26-SKP Board as an example. The Red and Green LED's are turned on every time a key input interrupt is generated (i.e. when pushbutton S2 is pressed). Releasing the pushbutton switch turns off the LED's. To get a copy of the sample program, contact your Renesas representative.

5.0 Conclusion

Key input interrupts can be used in a lot of applications. Setting up and using the function can be easily implemented on the M16C/26.

6.0 Reference

Renesas Technology Corporation Semiconductor Home Page

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E-mail Support

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Data Sheets

- M16C/26 datasheets, M30262eds.pdf

User's Manual

- M16C/20/60 C Language Programming Manual, 6020c.pdf
- M16C/20/60 Software Manual, 6020software.pdf
- Interrupt Handler App Note, M16C26_Interrupt_Handlers_in_C.doc
- MSV30262-SKP Users Manual, Users_Manual_Mini26B.pdf

7.0 Software Code

The key input interrupt sample program is shown below. The complete project, written in C, can be compiled/linked using KNC30 Compiler and will be provided upon request. Please contact your Renesas representative for details.

```
/***************************************
 * Mini 26 Rev. B Key Input Irq Program  *
 * main.c                                *
 * v1.0 03/06/2003                       *
 ***************************************/

/*************************************************************************
 * This Key Input Irq Program shows how to setup key input interrupts   *
 * on the M16C/26. The program was written for the Mini 26 board.       *
 *                                                                        *
 * The program is simple: blink LEDs every time an interrupt occurs.     *
 *************************************************************************/

/* Include the required header files */
#include "..\common\sfr262.h"  // M16C/26 special function register definitions

/* Interrupt routines used for this demo must be defined with #pragma INTERRUPT as
   shown below. Vectors must also be set in sect30_keyinirq.inc startup file to
   point to the interrupt routine. */

#pragma INTERRUPT ki_irq

/* Function prototypes */
void ki_irq(void);

/* General definitions */
#define ON  0
#define OFF 1

/*************************************************************************
Name:           Main - main program loop
Parameters:     None
Returns:        None
Description: Handles processing and contains the infinite loop while waiting for
                key input interrupt.
*************************************************************************/
main(){

        /* To use key input interrupts, the port direction where the key inputs
           are must be configured as inputs. The M16C/26 has 4 key inputs which can
           be found on the upper 4 bits of port 10 (P10_7, P10_6, P10_5, P10_4).
           We will set the direction for these 4 pins as inputs by setting it to 0.

           On the Mini 26 Board, only P10_7 is used. P10_7 is connected to
           pushbutton S2. The other 3 pins (P10_6, P10_5, & P10_4) are unused.
```

```
        On the MSV30262 SKP Board, P10_7, P10_6, & P10_5 are
        connected to S4, S3, & S2 respectively. P10_4 is not used.

        The lower 4 bits are don't cares and can be set to inputs or outputs
        depending on your hardware connection to these 4 pins. In our example,
        P10_0 & P10_1 are set as inputs because on the Mini 26 and MSV30262
        SKP Boards, these are used as ADC inputs. Ports P10_2 & P10_3 are unused
        and we set these as outputs. */

    pd10 = 0x0C;
            /* 00001100;           Ports 10_7, 10_6, 10_5, 10_4 as inputs, where the
               ||||||||            key inputs are. Ports 10_3, 10_2, 10_1, 10_0 are
               ||||||||            don't cares. In our example, we set these to outputs.
               ||||||||
               ||||||||______P10_0, don't care - set to 0 (input)
               |||||||_______P10_1, don't care - set to 0 (input)
               ||||||________P10_2, don't care - set to 1 (output)
               |||||_________P10_3, don't care - set to 1 (output)
               ||||__________P10_4 (key input 0), set to 0 (input)
               |||___________P10_5 (key input 1), set to 0 (input)
               ||____________P10_6 (key input 2), set to 0 (input)
               |_____________P10_7 (key input 3), set to 0 (input) */

    /* The next program step is not necessary as long as the pins are held at
       a high level when not generating a key input irq.

       On the MSV30262-SKP, the 3 inputs are held high with external pull-up
       resistors and so, the step can be omitted.

       On the Mini 26 Board, there is no external pull-up for pushbutton S2, and
       so enable the internal pull-up for the upper bits of port 10.  Again this
       is only for the Mini 26 Board.                                          */

    pu25 = 1;       // enable internal pull-up for upper 4 bits of P10

    /* We need to enable the key input interrupt. To accomplish this, we set
       the key input interrupt control register to a non-zero value ranging from
       1 to 7. The value you set controls the software interrupt priority level
       - 1 (lowest) and 7 (highest).                                           */

    /* Initialize LED ports so we can use it for this demo */
    pd7 |= 0x07;            // initialize LED's ports to outputs
    p7 |= 0x07;             // turn off LED's

    asm("FCLR I");          // disable interrupts before changing irq registers
    kupic = 2;              // enable key input irq by setting to non-zero value,
                            // 2 (interrupt priority level 2)
    asm("FSET I");          // enable interrupts

    while(1){               // infinite loop
            p7 |= 0x07;     // turn off LED's while waiting for key input irq
    }
}
```

```
/***********************************************************************
Name:           ki_irq
Parameters:     None
Returns:        None
Description: This is an key input interrupt routine - processing when a key
             interrupt is generated. A key input interrupt is generated when
             one of the 4 pins goes to a low level.

          NOTE: If one of the 4 inputs is always low, a key input interrupt
                is NOT generated. It is generated by the falling edge (high->low)
                of one of the key inputs.

                For this demo on the Mini 26 Board, the key input interrupt is
                generated when pushbutton S2 is pressed.

                The routine turns Red and Green LEDs.
***********************************************************************/
void ki_irq(void){
        p7 = 0x02;              // turn on Red and Green LEDs
        while(p10_7==0);        // wait here until pushbutton is released
}
```

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