Implementing Wake-up on Key Stroke

INTRODUCTION

Microchip's PIC16CXX family of microcontrollers are ideally suited to directly interface to a keypad. The high 4-bits of PortB (RB4 - RB7) have internal pull-ups and can trigger a "change on port state" interrupt. This interrupt, if enabled, will wake the microcontroller from sleep. In most battery powered applications, a microcontroller is exercised when a key is pressed, e.g. in a remote keyless entry system. The life of the battery can be extended by using PIC16CXX microcontrollers. This can be done by putting the PIC16CXX microcontroller into sleep mode for most of the time and wake-up only when a key is pressed.

IMPLEMENTATION

Figure 1 depicts an application where four keys are connected to RB4 - RB7. Internal pull-ups are used to maintain a high level on these inputs. In this example, LEDs are connected to RB0 - RB3. When SW1 is pressed, LED1 is turned on and when SW2 is pressed, LED2 is turned on and so on. The PIC16CXX is normally in sleep mode with the "change on port state" interrupt enabled. When SW1 is pressed, RB4 goes low and triggers an interrupt. Since the PIC16CXX is in sleep, it first wakes up and starts executing code at the interrupt vector. Note that if the global interrupt is enabled, the program execution after an interrupt is at the interrupt vector, if the global interrupt is not enabled, the program starts executing right after the sleep instruction.

After waking up, a 20 - 40 msec. de-bounce delay is executed which checks the port for a key hit and, depending on which key is hit, its associated LED is turned on. The LEDs are used purely for demonstration purposes. In a remote keyless entry application, the remote code would be transmitted when the appropriate key is hit.

Figure 2 depicts a 4x4 keypad interface to the PIC16CXX. When using the PIC16CXX in a keypad application, the internal pull-ups on RB4 - RB7 can be enabled eliminating the need for external pull-up resistors. The series 100Ω resistors are used for ESD protection, and are recommended in keypad interface applications.

Author: Stan D'Souza, Logic Products Division

SUMMARY

The PIC16CXX is ideally suited to interface directly to a Keypad application. Built in pull-up resistors and very low sleep current make it a very good candidate for battery powered remote operations and applications.

Performance:

Code Size:	64 words
RAM Locations Used:	0 bytes

FIGURE 1 - 4 KEY INTERFACE TO PIC16CXX

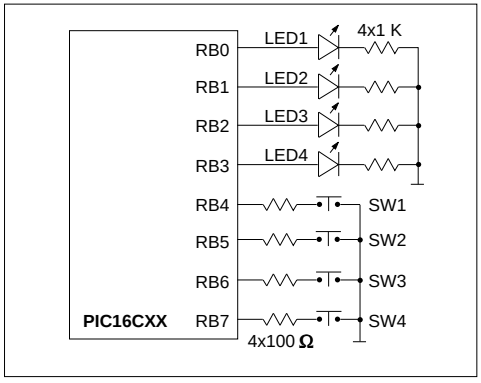
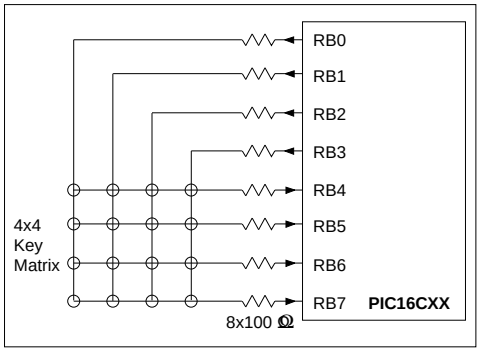


FIGURE 2 - 4X4 KEYPAD INTERFACE TO PIC16CXX



```
MPASM 1.00 Released     WAKUP.ASM   7-15-1994  13:24:29                PAGE  1


LOC  OBJECT CODE     LINE SOURCE TEXT

                     0001 ;This program demonstrates the wake-up on Keystroke feature of the
                     0002 ;PIC16C71. Port B pins RB4 - RB7 can be configured as inputs with
internal
                     0003 ;pull up resistors, also the interrupt associated with the change on
input
                     0004 ;on RB4 - RB7 can be set up to wake the chip from sleep. If the
                     0005 ;global interrupt is enabled just before sleep, the program will vector
to
                     0006 ;the interrupt vector (0004). If not the chip will continue execution
                     0007 ;just after the next instruction following sleep.
                     0008 ;In this example code, the port B is initalized to input 4 push-buttons
at
                     0009 ;RB4 - RB7. RB0 - RB3 are configured to drive LEDs corresponding to
                     0010 ;which push-button is hit (LED on RB0 when RB4 is hit and so on).
                     0011 ;Sleep is executed. When any keys is hit, the processor wakes
                     0012 ;up and jumps to the interrupt vector. The corresponding LED is
                     0013 ;turned on and after the key is released, the whole process is re-
peated.
                     0014 ;
                     0015         LIST P=16C71, F=INHX8M
                     0016 ;
0002                 0017 z       equ     2
0007                 0018 RBPU    equ     7
0010                 0019 temp    equ     10h
0001                 0020 OptionReg  equ     1h
                     0021     include “picreg.equ”
                     0083
                     0084
                     0021
                     0022 ;
                     0023         org     0
0000 2805            0024         goto    start
                     0025 ;
                     0026         org     4
0004 2808            0027         goto    ServiceInterrupt
                     0028 ;
                     0029 ;
                     0030 start
0005 2024            0031         call    InitPortB       ;initalize port B
                     0032 loop
                     0033 ;        sleep                    ;sleep till key is hit
0006 0000            0034         nop
0007 2806            0035         goto    loop
                     0036 ;
                     0037 ServiceInterrupt
0008 180B            0038         btfsc   INTCON,RBIF     ;change on rb int?
0009 280D            0039         goto    ServiceWakup    ;yes then service
000A 128B            0040         bcf     INTCON,RTIE     ;clear RTCC int mask
000B 110B            0041         bcf     INTCON,RTIF     ;clear flag
000C 0008            0042         return
                     0043 ;
                     0044 ;This routine checks which keys is hit and lights up the
                     0045 ;corresponding LED associated with it. eg. RB0’s LED when
                     0046 ;RB4’s key is pressed. Finally it waits till all keys have
                     0047 ;been released before returning form the service routine.
                     0048 ServiceWakup
000D 118B            0049         bcf     INTCON,RBIE     ;clear mask
000E 0906            0050         comf    PORT_B,w        ;read PORT_B

000F 100B            0051         bcf     INTCON,RBIF     ;clear flag
0010 2035            0052         call    delay16         ;do de-bounce for 16mSecs
0011 0906            0053         comf    PORT_B,w        ;read port B again
0012 39F0            0054         andlw   B’11110000'     ;mask outputs
0013 0090            0055         movwf   temp            ;save in temp
```

```
0014 0E10           0056         swapf   temp,w          ;switch low and high
0015 0086           0057         movwf   PORT_B          ;send as outputs.
0016 2018           0058         call    KeyRelease      ;check for key release
0017 0009           0059         retfie
                    0060 ;
                    0061 ;This sub-routine, waits till all key have been released
                    0062 ;In order to save power, the chip is in sleep mode till
                    0063 ;all keys are released.
                    0064 KeyRelease
0018 2035           0065         call    delay16         ;do debounce
0019 0906           0066         comf    PORT_B,w        ;read PORT_B
001A 100B           0067         bcf     INTCON,RBIF     ;clear flag
001B 158B           0068         bsf     INTCON,RBIE     ;enable mask
001C 39F0           0069         andlw   B'11110000'     ;clear outputs
001D 1903           0070         btfsc   STATUS,z        ;key still pressed?
001E 0008           0071         return                  ;no then return
001F 0063           0072         sleep                   ;else save power
0020 118B           0073         bcf     INTCON,RBIE     ;on wake up clear mask
0021 0906           0074         comf    PORT_B,w
0022 100B           0075         bcf     INTCON,RBIF     ;clear flag
0023 2818           0076         goto    KeyRelease      ;try again
                    0077 ;
                    0078 ;
                    0079 ;This sub-routine, initializes PortB.
                    0080 InitPortB
0024 1683           0081         bsf     STATUS,RP0      ;select bank 1
0025 3003           0082         movlw   B'00000011'     ;Port_A digital I/O
0026 0088           0083         movwf   ADCON1          ;               /
0027 3000           0084         movlw   0               ;
0028 0085           0085         movwf   PORT_A          ;set port a as outputs
0029 30F0           0086         movlw   B'11110000'     ;RB0-RB3 outputs
002A 0086           0087         movwf   PORT_B          ;RB4-RB7 inputs
002B 1381           0088         bcf     OptionReg,RBPU  ;enable pull up
002C 1283           0089         bcf     STATUS,RP0      ;select page 0
002D 0186           0090         clrf    PORT_B          ;init port B
002E 0185           0091         clrf    PORT_A          ;make port a all low
002F 1405           0092         bsf     PORT_A,0        ;make first bit high
0030 118B           0093         bcf     INTCON,RBIE     ;disable mask
0031 0806           0094         movf    PORT_B,w        ;read port
0032 100B           0095         bcf     INTCON,RBIF     ;clear flag
0033 158B           0096         bsf     INTCON,RBIE     ;enable mask
0034 0009           0097         retfie                  ;enable global and return
                    0098 ;
                    0099 ;delay16 waits for approx 16.4mSecs using RTCC interrupts
                    0100 ;fosc speed is 4Mhz.
                    0101 delay16
0035 1683           0102         bsf     STATUS,RP0      ;select page 1
0036 3007           0103         movlw   B'00000111'     ;fosc/256 –> RTCC
0037 0081           0104         movwf   OptionReg       ;       /
0038 1283           0105         bcf     STATUS,RP0      ;select page 0
0039 0181           0106         clrf    RTCC
003A 110B           0107         bcf     INTCON,RTIF     ;clear flag
003B 168B           0108         bsf     INTCON,RTIE     ;enable mask
                    0109 CheckAgain
003C 1D0B           0110         btfss   INTCON,RTIF     ;timer overflowed?
003D 283C           0111         goto    CheckAgain      ;no check again
003E 128B           0112         bcf     INTCON,RTIE     ;else clear mask
003F 110B           0113         bcf     INTCON,RTIF     ;clear flag
0040 0008           0114         return
                    0115 ;
                    0116         end
                    0117
                    0118
                    0119
                    0120
                    0121
                    0122
                    0123
                    0124
```

```
MEMORY USAGE MAP ('X' = Used,  '-' = Unused)

0000 : X—XXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
0040 : X——————— ———————— ———————— ————————

All other memory blocks unused.


Errors   :    0
Warnings :    0
```

WORLDWIDE SALES & SERVICE

AMERICAS

Corporate Office
Microchip Technology Inc.
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 602 786-7200 Fax: 602 786-7277
Technical Support: 602 786-7627
Web: http://www.mchip.com/microhip

Atlanta
Microchip Technology Inc.
500 Sugar Mill Road, Suite 200B
Atlanta, GA 30350
Tel: 770 640-0034 Fax: 770 640-0307

Boston
Microchip Technology Inc.
5 Mount Royal Avenue
Marlborough, MA 01752
Tel: 508 480-9990 Fax: 508 480-8575

Chicago
Microchip Technology Inc.
333 Pierce Road, Suite 180
Itasca, IL 60143
Tel: 708 285-0071 Fax: 708 285-0075

Dallas
Microchip Technology Inc.
14651 Dallas Parkway, Suite 816
Dallas, TX 75240-8809
Tel: 214 991-7177 Fax: 214 991-8588

Dayton
Microchip Technology Inc.
35 Rockridge Road
Englewood, OH 45322
Tel: 513 832-2543 Fax: 513 832-2841

Los Angeles
Microchip Technology Inc.
18201 Von Karman, Suite 455
Irvine, CA 92715
Tel: 714 263-1888 Fax: 714 263-1338

New York
Microchip Technology Inc.
150 Motor Parkway, Suite 416
Hauppauge, NY 11788
Tel: 516 273-5305 Fax: 516 273-5335

AMERICAS (continued)

San Jose
Microchip Technology Inc.
2107 North First Street, Suite 590
San Jose, CA 95131
Tel: 408 436-7950 Fax: 408 436-7955

ASIA/PACIFIC

Hong Kong
Microchip Technology
Unit No. 3002-3004, Tower 1
Metroplaza
223 Hing Fong Road
Kwai Fong, N.T. Hong Kong
Tel: 852 2 401 1200 Fax: 852 2 401 3431

Korea
Microchip Technology
168-1, Youngbo Bldg. 3 Floor
Samsung-Dong, Kangnam-Ku,
Seoul, Korea
Tel: 82 2 554 7200 Fax: 82 2 558 5934

Singapore
Microchip Technology
200 Middle Road
#10-03 Prime Centre
Singapore 188980
Tel: 65 334 8870 Fax: 65 334 8850

Taiwan
Microchip Technology
10F-1C 207
Tung Hua North Road
Taipei, Taiwan, ROC
Tel: 886 2 717 7175 Fax: 886 2 545 0139

EUROPE

United Kingdom
Arizona Microchip Technology Ltd.
Unit 6, The Courtyard
Meadow Bank, Furlong Road
Bourne End, Buckinghamshire SL8 5AJ
Tel: 44 0 1628 851077 Fax: 44 0 1628 850259

France
Arizona Microchip Technology SARL
2 Rue du Buisson aux Fraises
91300 Massy - France
Tel: 33 1 69 53 63 20 Fax: 33 1 69 30 90 79

Germany
Arizona Microchip Technology GmbH
Gustav-Heinemann-Ring 125
D-81739 Muenchen, Germany
Tel: 49 89 627 144 0 Fax: 49 89 627 144 44

Italy
Arizona Microchip Technology SRL
Centro Direzionale Colleoni
Palazzo Pegaso Ingresso No. 2
Via Paracelso 23, 20041
Agrate Brianza (MI) Italy
Tel: 39 039 689 9939 Fax: 39 039 689 9883

JAPAN

Microchip Technology Intl. Inc.
Benex S-1 6F
3-18-20, Shin Yokohama
Kohoku-Ku, Yokohama
Kanagawa 222 Japan
Tel: 81 45 471 6166 Fax: 81 45 471 6122

9/22/95