

## Implementing Wake-up on Key Stroke

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### INTRODUCTION

Microchip's PIC16CXXX microcontroller family are ideally suited to directly interface to a keypad. The high 4-bits of PORTB (RB7:RB4) have internal pull-ups and can trigger a "change on 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 PIC16CXXX microcontrollers. This is done by putting the PIC16CXXX 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 RB7:RB4. Internal pull-ups are used to maintain a high level on these inputs. In this example, LEDs are connected to RB3:RB0. When SW1 is pressed, LED1 is turned on and when SW2 is pressed, LED2 is turned on and so on. The PIC16CXXX is normally in SLEEP mode with the "change on state" interrupt enabled. When SW1 is pressed, RB4 goes low and triggers an interrupt. Since the PIC16CXXX 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 the first line of code right after the SLEEP instruction.

After waking up, a 20 - 40 ms 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 a PIC16CXXX microcontroller. When using the PIC16CXXX in a keypad application, the internal pull-ups on RB7:RB4 can be enabled, eliminating the need for external pull-up resistors. The series 100Ω resistors are used for Electrostatic Discharge (ESD) protection, and are recommended in keypad interface applications.

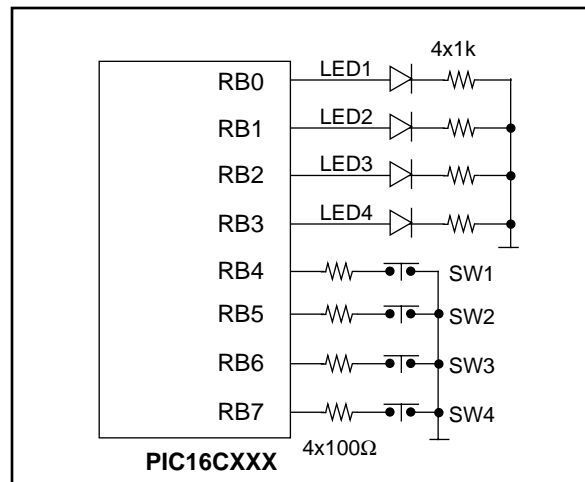
### SUMMARY

The PIC16CXXX is ideally suited to interface directly to a keypad application. Built in pull-up resistors and very low current consumption during sleep make it a very good candidate for battery powered remote operations and applications. Appendix A provides an example of the code.

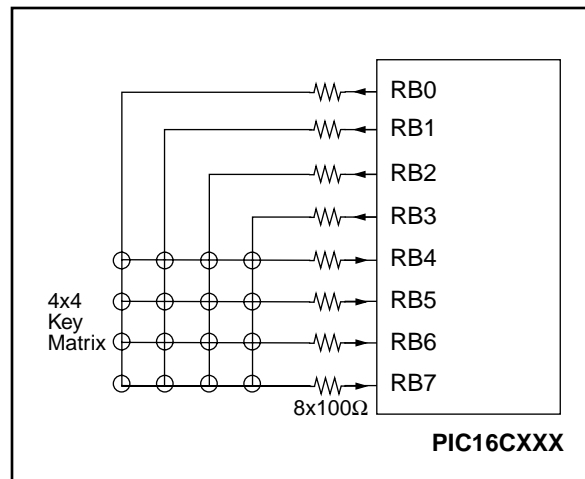
Performance:

Code Size - 64 words  
RAM Used - 0 bytes

**FIGURE 1: 4 KEY INTERFACE TO PIC16CXXX**



**FIGURE 2: 4x4 KEYPAD INTERFACE TO PIC16CXXX**



# AN552

Please check the Microchip BBS for the latest version of the source code. Microchip's Worldwide Web Address: [www.microchip.com](http://www.microchip.com); Bulletin Board Support: MCHIPBBS using CompuServe® (CompuServe membership not required).

## APPENDIX A : WAKUP.ASM

MPASM 01.40 Released

WAKUP.ASM 1-16-1997 16:04:19

PAGE 1

```
LOC OBJECT CODE      LINE SOURCE TEXT
VALUE

00001 ;This program demonstrates the wake-up on Keystroke feature of
00002 ;the PIC16C71. Port B pins RB4 - RB7 can be configured as inputs with
00003 ;internal pull up resistors, also the interrupt associated with the
00004 ;change on input on RB4 - RB7 can be set up to wake the chip from
00005 ;sleep. If the global interrupt is enabled just before sleep, the
00006 ;program will vector to the interrupt vector (0004). If not, the chip
00007 ;will continue execution just after the next instruction following
00008 ;sleep. In this example code, port B is initialized to input 4
00009 ;push-buttons at RB4 - RB7. RB0 - RB3 are configured to drive LEDs
00010 ;corresponding to which pushbutton is hit (LED on RB0 when RB4 is
00011 ;hit and so on). Sleep is executed. When any key is hit, the
00012 ;processor wakes up and jumps to the interrupt vector. The
00013 ;corresponding LED is turned on and after the key is released, the
00014 ;whole process is repeated.
00015 ;
00016 ;      Program:          WAKEUP.ASM
00017 ;      Revision Date:
00018 ;                      1-16-97      Compatibility with MPASMWIN 1.40
00019 ;
00020 ;*****
00021 ;
00022      LIST P=16C71
00023 ;
00000002      00024 z          equ      2
00000007      00025 RBPU      equ      7
00000010      00026 temp      equ      10h
00000001      00027 OptionReg equ      1h
00000001      00028 F          EQU      1
00029 ;
00030      include "p16c71.inc"
00001      LIST
00002 ;P16C71.INC Standard Header File, Version 1.00 Microchip Technology
00142      LIST
00031 ;
0000      00032      org      0
0000 2805      00033      goto    start
00034 ;
0004      00035      org      4
0004 2808      00036      goto    ServiceInterrupt
00037 ;
00038 ;
0005      00039 start
0005 2024      00040      call    InitPortB      ;initialize port B
0006      00041 loop
00042      00042      sleep          ;sleep till key is hit
0006 0000      00043      nop
0007 2806      00044      goto    loop
00045 ;
0008      00046 ServiceInterrupt
0008 180B      00047      btfs    INTCON,RBIF      ;change on rb int?
0009 280D      00048      goto    ServiceWakup    ;yes then service
000A 128B      00049      bcf    INTCON,T0IE      ;clear TMR0 int mask
000B 110B      00050      bcf    INTCON,T0IF      ;clear flag
000C 0008      00051      return
```

```

00052 ;
00053 ;This routine checks which key is hit and lights up the
00054 ;corresponding LED associated with it. eg. RB0's LED when
00055 ;RB4's key is pressed. Finally it waits till all keys have
00056 ;been released before returning form the service routine.
000D      00057 ServiceWakup
000D 118B      00058         bcf     INTCON,RBIE      ;clear mask
000E 0906      00059         comf    PORTB,W          ;read PORTB
000F 100B      00060         bcf     INTCON,RBIF      ;clear flag
0010 2035      00061         call   delay16        ;do de-bounce for 16mSecs
0011 0906      00062         comf    PORTB,W          ;read port B again
0012 39F0      00063         andlw  B'11110000'     ;mask outputs
0013 0090      00064         movwf  temp           ;save in temp
0014 0E10      00065         swapf  temp,W        ;switch low and high
0015 0086      00066         movwf  PORTB         ;send as outputs.
0016 2018      00067         call   KeyRelease    ;check for key release
0017 0009      00068         retfie
00069 ;
00070 ;This sub-routine, waits till all key have been released
00071 ;In order to save power, the chip is in sleep mode till
00072 ;all keys are released.
0018      00073 KeyRelease
0018 2035      00074         call   delay16        ;do debounce
0019 0906      00075         comf    PORTB,W          ;read PORTB
001A 100B      00076         bcf     INTCON,RBIF      ;clear flag
001B 158B      00077         bsf     INTCON,RBIE      ;enable mask
001C 39F0      00078         andlw  B'11110000'     ;clear outputs
001D 1903      00079         btfsc  STATUS,z       ;key still pressed?
001E 0008      00080         return                ;no then return
001F 0063      00081         sleep                ;else save power
0020 118B      00082         bcf     INTCON,RBIE      ;on wake up clear mask
0021 0906      00083         comf    PORTB,W          ;read PORTB
0022 100B      00084         bcf     INTCON,RBIF      ;clear flag
0023 2818      00085         goto   KeyRelease    ;try again
00086 ;
00087 ;
00088 ;This sub-routine, initializes PortB.
0024      00089 InitPortB
0024 1683      00090         bsf     STATUS,RP0      ;select bank1
0025 3003      00091         movlw  B'00000011'     ;Port_A digital I/O
Message[302]: Register in operand not in bank 0. Ensure that bank bits are correct.
0026 0088      00092         movwf  ADCON1          ;
0027 3000      00093         movlw  0               ;
0028 0085      00094         movwf  PORTA           ;set port a as outputs
0029 30F0      00095         movlw  B'11110000'     ;RB0-RB3 outputs
002A 0086      00096         movwf  PORTB           ;RB4-RB7 inputs
002B 1381      00097         bcf     OptionReg,RBPU ;enable pull up
002C 1283      00098         bcf     STATUS,RP0      ;select page 0
002D 0186      00099         clrfs  PORTB           ;init port B
002E 0185      00100         clrfs  PORTA           ;make port a all low
002F 1405      00101         bsf     PORTA,0         ;make first bit high
0030 118B      00102         bcf     INTCON,RBIE      ;disable mask
0031 0806      00103         movf   PORTB,W         ;read port
0032 100B      00104         bcf     INTCON,RBIF      ;clear flag
0033 158B      00105         bsf     INTCON,RBIE      ;enable mask
0034 0009      00106         retfie                ;enable global and return
00107 ;
00108 ;delay16 waits for approx 16.4mSecs using TMR0 interrupts
00109 ;fosc speed is 4Mhz.
0035      00110 delay16
0035 1683      00111         bsf     STATUS,RP0      ;select Bank1
0036 3007      00112         movlw  B'00000111'     ;fosc/256 --> TMR0
0037 0081      00113         movwf  OptionReg       ;
0038 1283      00114         bcf     STATUS,RP0      ;select Bank0
0039 0181      00115         clrfs  TMR0            ;
003A 110B      00116         bcf     INTCON,T0IF     ;clear flag

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# AN552

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```
003B 168B      00117      bsf      INTCON,T0IE      ;enable mask
003C           00118      CheckAgain
003C 1D0B      00119      btfss   INTCON,T0IF      ;timer overflowed?
003D 283C      00120      goto    CheckAgain      ;no check again
003E 128B      00121      bcf      INTCON,T0IE      ;else clear mask
003F 110B      00122      bcf      INTCON,T0IF      ;clear flag
0040 0008      00123      return
                00124 ;
                00125      end
```

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

```
0000 : X---XXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXX
0040 : X-----
```

All other memory blocks unused.

```
Program Memory Words Used:    62
Program Memory Words Free:   962
```

```
Errors      :    0
Warnings    :    0 reported,    0 suppressed
Messages    :    1 reported,    0 suppressed
```

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