Interfacing the 24LCXXB Serial EEPROMs to the PIC16C54

INTRODUCTION

The 24LCXXB Serial EEPROMs from Microchip Technology are I²C™ compatible, will operate in the standard 100kHz and the 400kHz Fast Mode. When using any serial protocol with a general microcontroller that does not have a dedicated protocol specific serial port, the designer must generate the specific code routines to accomplish the several memory access functions that the microcontroller will perform. The PIC16CXX products from Microchip are both versatile and efficient to program. This application note is a series of stand-alone programs to perform the basic I²C interface functions on a PIC16C54 running at 4MHz in XT mode. This configuration will provide a 60 kHz serial bus rate. At this speed, the interface does not meet the 100kHz specification. If a higher clock rate is desired, the HS crystal oscillator must be used, which has a maximum frequency of 20MHz. NOTE THAT THE TIMING ROUTINES MUST BE REWRITTEN TO RUN AT THESE FASTER CLOCK RATES. The user must consult all applicable data sheets for design details. These programs have been fully tested and are being made available for general use. Figure 1 demonstrates the tested configuration of PIC16C54 and the 24LCXXB device.

This application note includes the following programs.

– 2-Wire Byte Read

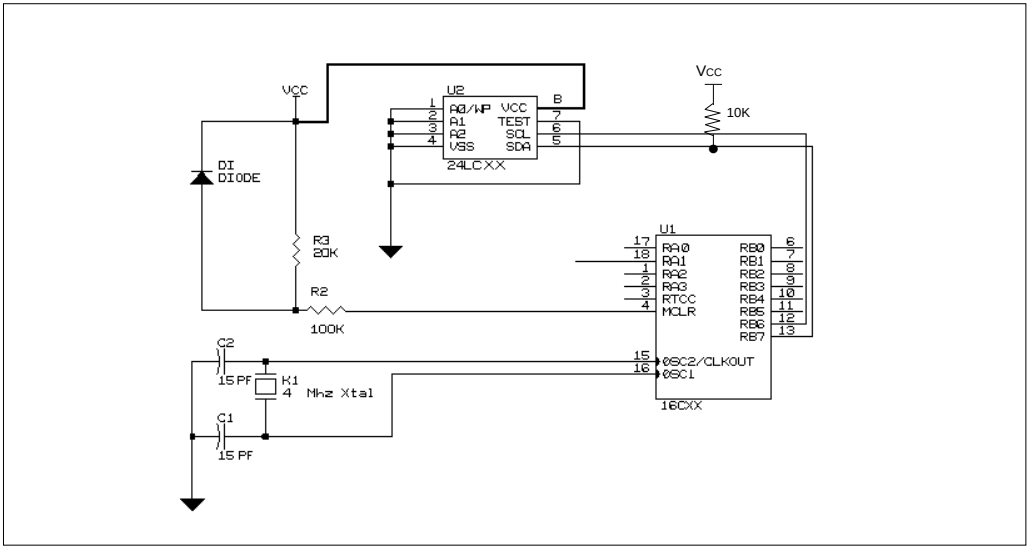
– 2-Wire Byte Write

– 2-Wire Byte Write with Data Polling

– 2-Wire Page Write

– 2-Wire Sequential Read

FIGURE 1 - TESTED CONFIGURATION OF THE PIC16C54 AND THE 24LCXXB DEVICE



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Line   PC    Opcode

0001                    LIST P=16C54,c=132
0002              ;*************************************************************
0003              ;       2-Wire Byte Read Program (118 bytes)
0004              ;
0005              ;       This program demonstrates how to interface a
0006              ;       Microchip PIC16C54 to a 24LCXX Serial EE device
0007              ;       and perform a random read operation. This program
0008              ;       will read 8 consecutive addresses in the 'random
0009              ;       read' mode.  This entails setting the address pointer
0010              ;       before doing read command for every address.
0011              ;
0012              ;       Another, more efficient method of reading consecutive
0013              ;       addresses is the 'sequential read' mode.  This involves
0014              ;       sending the control byte and address for the first byte
0015              ;       to read, then continuing to provide clocks for the next
0016              ;       addresses.  The device will automatically increment the
0017              ;       address.  An example of the sequential read mode is
0018              ;       provided in the '2wseqr.asm' file.
0019              ;
0020              ;       Timing is based on using the PIC16C54 in 'XT' mode
0021              ;       using a 4MHz crystal.  Clock speeds to the serial EE
0022              ;       will be approximately 60 kHz for this setup.
0023              ;
0024              ;       As an option, the user may connect a LED to pin 18
0025              ;       on the PIC16C54 (use about a 1K resistor in series) as an
0026              ;       acknowledge fail indicator.  This LED will come on if
0027              ;       the serial EE fails to acknowledge correctly.
0028              ;
0029              ;        PIC16C54 to Serial EE Connections:
0030              ;
0031              ;        PIC16C54       Serial EE
0032              ;       ______    ______
0033              ;       Pin 12 (RB6) —>  SCLK
0034              ;       Pin 13 (RB7) —>  SDATA
0035              ;
0036              ;       PIN 18 (RA1) —>  Acknowledge fail LED  (Optional)
0037              ;
0038              ;
0039              ;*************************************************************
0040              ;           Register Definitions
0041              ;*************************************************************
0042         0003  status  equ     3h     ; status register
0043         0005  port_a  equ     5h     ; port 5 (port a) used for LED display
0044         0006  port_b  equ     6h     ; port 6 (port b) used for data and
0045                                       ; clock lines
0046         000A  eeprom  equ    0ah     ; bit buffer
0047         000B  bycnt   equ    0bh     ; byte counter for read mode
0048         000C  addr    equ    0ch     ; address counter
0049         000D  datai   equ    0dh     ; data input register
0050         000E  datao   equ    0eh     ; data output register
0051         000F  slave   equ    0fh     ; device address 1010xxx0)

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Line   PC    Opcode

0052         0010  txbuf   equ    10h     ; transmit buffer
0053         0011  count   equ    11h     ; bit counter
0054         0012  bcount  equ    12h     ; byte counter
0055         0015  loops   equ    15h     ; delay loop counter
0056         0016  loops2  equ    16h     ; delay loop counter
0057
0058              ;*************************************************************
0059              ;           Bit Definitions
0060              ;*************************************************************
```

```
0061         0007  di      equ    7       ; eeprom input bit
0062         0006  do      equ    6       ; eeprom output bit
0063         0007  sdata   equ    7       ; serial EE data line (port_b,pin 13)
0064         0006  sclk    equ    6       ; serial EE clock line (port_b,pin 12)
0065         0001  ackf    equ    1       ; acknowledge fail LED (port_a)
0066               ;*************************************************************
0067               ;
0068         0000          org    01ffh   ; set reset vector
0069   01FF  0A5E          goto   PWRUP
0070         0000          org    000h    ;
0071   0000  0A5E          goto   PWRUP
0072               ;
0073               ;*************************************************************
0074               ;       Start Bit Subroutine
0075               ;       this routine generates a start bit
0076               ;       (Low going data line while clock is high)
0077               ;*************************************************************
0078               ;
0079               BSTART
0080   0001  05E6           bsf     port_b,sdata   ; make sure data is high
0081   0002  0C3F           movlw   b'00111111'
0082   0003  0006           tris    port_b         ; set data and clock lines for output
0083   0004  04C6           bcf     port_b,sclk    ; make sure clock is low
0084   0005  0000           nop
0085   0006  05C6           bsf     port_b,sclk    ; set clock high
0086   0007  0000           nop
0087   0008  0000           nop
0088   0009  0000           nop
0089   000A  0000           nop
0090   000B  0000           nop
0091   000C  04E6           bcf     port_b,sdata   ; data line goes low during
0092                                                ; high clock for start bit
0093   000D  0000           nop
0094   000E  0000           nop
0095   000F  0000           nop
0096   0010  0000           nop
0097   0011  0000           nop                    ; timing adjustment
0098   0012  04C6           bcf     port_b,sclk    ; start clock train
0099   0013  0000           nop
0100   0014  0000           nop
0101   0015  0800           retlw   0
0102                        ;

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Line   PC    Opcode

0103               ;*************************************************************
0104               ;       Stop Bit Subroutine
0105               ;       This routine generates a stop bit
0106               ;       (High going data line while clock is high)
0107               ;*************************************************************
0108               BSTOP
0109   0016  04E6           bcf     port_b,sdata   ; make sure data line is low
0110   0017  0C3F           movlw   b'00111111'    ;
0111   0018  0006           tris    port_b         ; set data/clock lines as outputs
0112   0019  04E6           bcf     port_b,sdata   ; make sure data line is low
0113   001A  0000           nop
0114   001B  0000           nop
0115   001C  0000           nop
0116   001D  05C6           bsf     port_b,sclk    ; set clock high
0117   001E  0000           nop
0118   001F  0000           nop
0119   0020  0000           nop
0120   0021  05E6           bsf     port_b,sdata   ; data goes high while clock high
0121                                                ; for stop bit
```

```
0122   0022  0000           nop
0123   0023  0000           nop
0124   0024  04C6           bcf     port_b,sclk     ; set clock low again
0125   0025  0000           nop
0126   0026  0000           nop
0127   0027  0000           nop
0128   0028  0800           retlw   0
0129                ;
0130                ;*************************************************************
0131                ;       BITOUT routine takes the bit of data in 'do' and
0132                ;       transmits it to the serial EE device
0133                ;*************************************************************
0134                BITOUT
0135   0029  0C3F           movlw   b'00111111'     ; set data,clock as outputs
0136   002A  0006           tris    port_b
0137   002B  07CA           btfss   eeprom,do       ; check for state of data bit to xmit
0138   002C  0A2F           goto    bitlow          ; low? go set data line low
0139   002D  05E6           bsf     port_b,sdata    ; high? set data line high
0140   002E  0A30           goto    clkout          ; go toggle the clock
0141
0142   002F  04E6  bitlow   bcf     port_b,sdata    ; output a low bit
0143   0030  05C6  clkout   bsf     port_b,sclk     ; set clock line high
0144   0031  0000           nop
0145   0032  0000           nop
0146   0033  0000           nop
0147   0034  0000           nop
0148   0035  04C6           bcf     port_b,sclk     ; return clock line low
0149   0036  0800           retlw   0
0150                ;
0151                ;*************************************************************
0152                ;       BITIN routine reads one bit of data from the
0153                ;       serial EE device and stores it in the bit 'di'

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Line   PC    Opcode

0154                ;*************************************************************
0155                BITIN
0156   0037  05EA           bsf     eeprom,di       ; assume input bit is high
0157   0038  0CBF           movlw   b'10111111'     ; make sdata an input line
0158   0039  0006           tris    port_b
0159   003A  05C6           bsf     port_b,sclk     ; set clock line high
0160   003B  0000           nop                     ; just sit here a sec
0161   003C  0000           nop
0162   003D  0000           nop
0163   003E  0000           nop
0164   003F  0000           nop                     ;
0165   0040  07E6           btfss   port_b,sdata    ; read the data bit
0166   0041  04EA           bcf     eeprom,di       ; input bit was low, set 'di' accordingly
0167   0042  04C6           bcf     port_b,sclk     ; set clock line low
0168                                                ;
0169   0043  0800           retlw   0               ;
0170                ;
0171                ;*************************************************************
0172                ;       Transmit Data Subroutine
0173                ;       This routine takes the byte of data stored in the
0174                ;       'datao' register and transmits it to the serial EE device.
0175                ;       It will then send 1 more clock to the serial EE for the
0176                ;       acknowledge bit.  If the ack bit from the part was low
0177                ;       then the transmission was successful.  If it is high, then
0178                ;       the device did not send a proper ack bit and the ack
0179                ;       fail LED will be turned on.
0180                ;*************************************************************
0181                TX
0182   0044  0C08           movlw   .8
0183   0045  0031           movwf   count           ; set the #bits to 8
0184                        ;
0185                TXLP
```

```
0186   0046  04CA           bcf     eeprom,do      ; assume bit out is low
0187   0047  06F0           btfsc   txbuf,7        ; is bit out really low?
0188   0048  05CA           bsf     eeprom,do      ; no, set it high
0189   0049  0929           call    BITOUT         ; send the bit to serial EE
0190   004A  0370           rlf     txbuf          ; rotate txbuf left
0191   004B  02F1           decfsz  count          ; 8 bits done?
0192   004C  0A46           goto    TXLP           ; no - go again
0193   004D  0937           call    BITIN          ; read ack bit
0194   004E  06EA           btfsc   eeprom,di      ; check ack bit
0195   004F  0525           bsf     port_a,ackf    ; set acknowledge fail LED if the
0196                                                ; device did not pull data low
0197                        ;
0198   0050  0800           retlw   0
0199                ;
0200                ;*****************************************************************
0201                ;       Receive data routine
0202                ;       This routine reads one byte of data from the part
0203                ;       into the 'datai' register.  It then sends a high
0204                ;       ack bit to indicate that no more data is to be read

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Line   PC    Opcode

0205                ;*****************************************************************
0206                RX
0207   0051  006D           clrf    datai          ; clear input buffer
0208   0052  0C08           movlw   .8             ; set # bits to 8
0209   0053  0031           movwf   count
0210   0054  0403           bcf     status,0       ; make sure carry bit is low
0211   0055  036D  RXLP     rlf     datai          ; rotate datai 1 bit left
0212   0056  0937           call    BITIN          ; read a bit
0213   0057  06EA           btfsc   eeprom,di
0214   0058  050D           bsf     datai,0        ; set bit 0 if necessary
0215   0059  02F1           decfsz  count          ; 8 bits done?
0216   005A  0A55           goto    RXLP           ; no, do another
0217   005B  05CA           bsf     eeprom,do      ; set ack bit = 1
0218   005C  0929           call    BITOUT         ; to finish transmission
0219   005D  0800           retlw   0
0220                ;
0221                ;*****************************************************************
022          0000   END
```

```
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Line   PC    Opcode

0001                     LIST P=16C54,c=132
0002               ;*************************************************************
0003               ;       2-Wire Byte Write Program (123 bytes)
0004               ;
0005               ;       This program demonstrates how to interface a
0006               ;       Microchip PIC16C54 to a 24LCXX Serial EE device
0007               ;       and perform a byte write operation on 8 consecutive
0008               ;       addresses.
0009               ;
0010               ;       This routine waits approximately 10mS for the write
0011               ;       cycle time, which is enough time for any of the
0012               ;       24LCxx devices to complete a write.  A more efficient
0013               ;       method of determining when the write cycle is complete
0014               ;       is called “data polling.”  The data polling method is
0015               ;       explained in the program “2wdpoll.asm.”  That
0016               ;       particular program uses data polling in a byte write
0017               ;       mode but it can be used in exactly the same way for
0018               ;       a page mode write.
0019               ;
0020               ;       As an option, the user may connect a LED to pin 18
0021               ;       on the PIC16C54 (use about a 1K resistor in series) as an
0022               ;       acknowledge fail indicator.  This LED will come on if
0023               ;       the serial EE fails to acknowledge correctly.
0024               ;
0025               ;       Timing is based on using the PIC16C54 in ‘XT’ mode
0026               ;       using a 4Mhz crystal.  Clock speeds to the serial EE
0027               ;       will be approximately 60 kHz for this setup.
0028               ;
0029               ;        PIC16C54 to Serial EE Connections:
0030               ;
0031               ;        PIC16C54        Serial EE
0032               ;       ______    ______
0033               ;       Pin 12 (RB6) —>  SCLK
0034               ;       Pin 13 (RB7) —>  SDATA
0035               ;
0036               ;       PIN 18 (RA1) —>  Acknowledge fail LED  (Optional)
0037               ;
0038               ;*************************************************************
0039               ;           Register Definitions
0040               ;*************************************************************
0041         0005  port_a  equ     5h     ; port 5 (port_a) used for LEDs
0042         0006  port_b  equ     6h     ; port 6 (port b) used for data and
0043                                       ; clock lines
0044         000A  eeprom  equ    0ah     ; bit buffer
0045         000B  bycnt   equ    0bh     ; byte counter for read mode
0046         000C  addr    equ    0ch     ; address counter
0047         000D  datai   equ    0dh     ; data input register
0048         000E  datao   equ    0eh     ; data output register
0049         000F  slave   equ    0fh     ; device address
0050                                       ; (1010xxx0)
0051         0010  txbuf   equ    10h     ; transmit buffer


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Line   PC    Opcode

0052         0011  count   equ    11h     ; bit counter
0053         0012  bcount  equ    12h     ; byte counter
0054         0015  loops   equ    15h     ; delay loop counter
0055         0016  loops2  equ    16h     ; delay loop counter
0056               ;*************************************************************
0057               ;           Bit Definitions
0058               ;*************************************************************
0059         0007  di      equ    7       ; eeprom input bit
```

```
0060         0006  do      equ    6       ; eeprom output bit
0061         0007  sdata   equ    7       ; serial EE data line (port_b,pin 13)
0062         0006  sclk    equ    6       ; serial EE clock line (port_b,pin 12)
0063         0001  ackf    equ    1       ; acknowledge fail LED (port_a,pin 18)
0064               ;*************************************************************
0065               ;
0066               ;
0067         0000          org    01ffh   ; set reset vector
0068   01FF  0A5E          goto   PWRUP
0069         0000          org    000h    ;
0070   0000  0A5E          goto   PWRUP
0071               ;
0072               ;*************************************************************
0073               ;       DELAY ROUTINE
0074               ;       This routine takes the value in 'loops'
0075               ;       and multiplies it times 1 millisecond to
0076               ;       determine delay time.
0077               ;*************************************************************
0078               WAIT
0079               ;
0080   0001  0C6E  top      movlw   .110           ; timing adjustment variable
0081   0002  0036           movwf   loops2
0082   0003  0000  top2     nop                    ; sit and wait
0083   0004  0000           nop
0084   0005  0000           nop
0085   0006  0000           nop
0086   0007  0000           nop
0087   0008  0000           nop
0088   0009  02F6           decfsz  loops2         ; inner loops complete?
0089   000A  0A03           goto    top2           ; no, go again
0090                                               ;
0091   000B  02F5           decfsz  loops          ; outer loops complete?
0092   000C  0A01           goto    top            ; no, go again
0093   000D  0800           retlw   0              ; yes, return from sub
0094               ;
0095               ;*************************************************************
0096               ;       Start Bit Subroutine
0097               ;       this routine generates a start bit
0098               ;       (Low going data line while clock is high)
0099               ;*************************************************************
0100               ;
0101               BSTART
0102   000E  05E6           bsf     port_b,sdata   ; make sure data is high


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Line   PC    Opcode

0103   000F  0C3F           movlw   b'00111111'
0104   0010  0006           tris    port_b         ; set data and clock lines for output
0105   0011  04C6           bcf     port_b,sclk    ; make sure clock is low
0106   0012  0000           nop
0107   0013  05C6           bsf     port_b,sclk    ; set clock high
0108   0014  0000           nop
0109   0015  0000           nop
0110   0016  0000           nop
0111   0017  0000           nop
0112   0018  0000           nop
0113   0019  04E6           bcf     port_b,sdata   ; data line goes low during
0114                                               ; high clock for start bit
0115   001A  0000           nop
0116   001B  0000           nop
0117   001C  0000           nop
0118   001D  0000           nop
0119   001E  0000           nop                    ; timing adjustment
0120   001F  04C6           bcf     port_b,sclk    ; start clock train
0121   0020  0000           nop
0122   0021  0000           nop
```



```
0123   0022  0800           retlw   0
0124                        ;
0125                        ;    End of Subroutine
0126                ;*************************************************************
0127                ;       Stop Bit Subroutine
0128                ;       This routine generates a stop bit
0129                ;       (High going data line while clock is high)
0130                ;*************************************************************
0131                BSTOP
0132   0023  0C3F           movlw   b'00111111'    ;
0133   0024  0006           tris    port_b         ; set data/clock lines as outputs
0134   0025  04E6           bcf     port_b,sdata   ; make sure data line is low
0135   0026  0000           nop
0136   0027  0000           nop
0137   0028  0000           nop
0138   0029  05C6           bsf     port_b,sclk    ; set clock high
0139   002A  0000           nop
0140   002B  0000           nop
0141   002C  0000           nop
0142   002D  05E6           bsf     port_b,sdata   ; data goes high while clock high
0143                                                ; for stop bit
0144   002E  0000           nop
0145   002F  0000           nop
0146   0030  04C6           bcf     port_b,sclk    ; set clock low again
0147   0031  0000           nop
0148   0032  0000           nop
0149   0033  0000           nop
0150   0034  0800           retlw   0
0151                ;
0152                ;           End of Subroutine
0153                ;*************************************************************


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Line   PC    Opcode

0154                ;       BITOUT routine takes one bit of data in 'do' and
0155                ;       transmits it to the serial EE device
0156                ;*************************************************************
0157                BITOUT
0158   0035  0C3F           movlw   b'00111111'    ; set data,clock as outputs
0159   0036  0006           tris    port_b
0160   0037  07CA           btfss   eeprom,do      ; check for state of data bit to xmit
0161   0038  0A3B           goto    bitlow         ;
0162   0039  05E6           bsf     port_b,sdata   ; set data line high
0163   003A  0A3C           goto    clkout         ; go toggle the clock
0164
0165   003B  04E6  bitlow   bcf     port_b,sdata   ; output a low bit
0166   003C  05C6  clkout   bsf     port_b,sclk    ; set clock line high
0167   003D  0000           nop
0168   003E  0000           nop
0169   003F  0000           nop
0170   0040  0000           nop
0171   0041  04C6           bcf     port_b,sclk    ; return clock line low
0172   0042  0800           retlw   0
0173                ;
0174                ;                   End of Subroutine
0175                ;
0176                ;*************************************************************
0177                ;       BITIN routine reads one bit of data from the
0178                ;       serial EE device and stores it in 'di'
0179                ;*************************************************************
0180                BITIN
0181   0043  05EA           bsf     eeprom,di      ; assume input bit is high
0182   0044  0CBF           movlw   b'10111111'    ; make sdata an input line
0183   0045  0006           tris    port_b
0184   0046  05E6           bsf     port_b,sdata   ; set sdata line for input
0185   0047  05C6           bsf     port_b,sclk    ; set clock line high
```

```
0186   0048  0000          nop                   ; just sit here a sec
0187   0049  0000          nop
0188   004A  0000          nop
0189   004B  0000          nop
0190   004C  0000          nop                   ;
0191   004D  07E6          btfss   port_b,sdata  ; read the data bit
0192   004E  04EA          bcf     eeprom,di     ; input bit was low
0193   004F  04C6          bcf     port_b,sclk   ; set clock line low
0194                                             ;
0195   0050  0800          retlw   0             ;
0196               ;
0197               ;*****************************************************************
0198               ;       Transmit Data Subroutine
0199               ;       This routine takes the byte of data stored in the
0200               ;       'datao' register and transmits it to the serial EE device.
0201               ;       It will then send 1 more clock to the serial EE for the
0202               ;       acknowledge bit.  If the ack bit from the part was low
0203               ;       then the transmission was successful.  If it is high, then
0204               ;       the device did not send a proper ack bit and the ack


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Line   PC    Opcode

0205               ;       fail LED will be turned on.
0206               ;*****************************************************************
0207               TX
0208   0051  0C08          movlw   .8
0209   0052  0031          movwf   count         ; set the #bits to 8
0210                       ;
0211               TXLP
0212   0053  04CA          bcf     eeprom,do     ; assume bit out is low
0213   0054  06F0          btfsc   txbuf,7       ; is bit out really low?
0214   0055  05CA          bsf     eeprom,do     ; otherwise data bit =1
0215   0056  0935          call    BITOUT        ; serial data out
0216   0057  0370          rlf     txbuf         ; rotate txbuf left
0217   0058  02F1          decfsz  count         ; 8 bits done?
0218   0059  0A53          goto    TXLP          ; no - go again
0219   005A  0943          call    BITIN         ; read ack bit
0220   005B  06EA          btfsc   eeprom,di     ; check ack bit
0221   005C  0525          bsf     port_a,ackf   ; set acknowledge fail LED if the
0222                       ;
0223   005D  0800          retlw   0
0224               ;
0225               ;*****************************************************************
0226               ;       Power up routine
0227               ;       This is the program entry point, which in this case simply
0228               ;       sets the port_a I/O lines and directs control to the
0229               ;       byte write routine.
0230               ;*****************************************************************
0231               PWRUP
0232   005E  0C00            movlw  b'00000000'
0233   005F  0005            tris   port_a         ; set port A as all output
0234   0060  0065            clrf   port_a         ; all output lines low
0235   0061  0A62            goto   WRBYTE
0236
0237               ;*****************************************************************
0238               ;       Byte Write Routine
0239               ;       This routine writes the data in "datao" to
0240               ;       8 consecutive bytes in the serial EE device starting
0241               ;       at address 00.  This routine waits 10mS after every
0242               ;       byte to give the device time to do the write.  This
0243               ;       program repeats forever.
0244               ;*****************************************************************
0245               ;
0246               WRBYTE
0247               ;
0248   0062  0065          clrf    port_a      ; clear all LEDs
```



```
0249   0063  0CA0           movlw   b'10100000' ; set slave address and write mode
0250   0064  002F           movwf   slave
0251   0065  0C55           movlw   b'01010101' ; set data to write as 55h
0252   0066  002E           movwf   datao
0253                ;
0254   0067  0C08           movlw   .8          ; set number of bytes
0255   0068  0032           movwf   bcount      ; to write as to 8


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Line   PC    Opcode

0256   0069  006C           clrf    addr        ; set starting address to 00
0257                                            ;
0258   006A  090E  byte     call    BSTART      ; generate start bit
0259   006B  020F           movf    slave,w     ; move slave address
0260   006C  0030           movwf   txbuf       ; into transmit buffer
0261   006D  0951           call    TX          ; and send it
0262   006E  020C           movf    addr,w      ; move word address
0263   006F  0030           movwf   txbuf       ; into transmit buffer
0264   0070  0951           call    TX          ; and send it
0265   0071  020E           movf    datao,w     ; move data byte
0266   0072  0030           movwf   txbuf       ; to tranmit buffer
0267   0073  0951           call    TX          ; and transmit it
0268   0074  0923           call    BSTOP       ; generate stop bit
0269                                            ;
0270   0075  0C0A           movlw   .10
0271   0076  0035           movwf   loops       ; set delay time to give
0272   0077  0901           call    WAIT        ; 10 ms wait after every byte
0273   0078  02AC           incf    addr        ; add 1 to address counter
0274   0079  02F2           decfsz  bcount      ; all 8 bytes written?
0275   007A  0A6A           goto    byte        ; no, do another byte
0276                                            ;
0277   007B  0A62           goto    wrbyte      ; start over
0278                ;
0279                ;
0280          0000  END
```

```
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Line   PC    Opcode

0001                     LIST P=16C54,c=132
0002              ;*************************************************************
0003              ;       2-Wire Byte Write With Data Polling Program (129 bytes)
0004              ;
0005              ;       This program demonstrates how to interface a
0006              ;       Microchip PIC16C54 to a 24LCXX Serial EE device.
0007              ;       This program performs a byte write operation on 8
0008              ;       consecutive addresses using the data polling method
0009              ;       to determine when the write cycle is complete.
0010              ;
0011              ;       When writing to a serial E≤ device, there are 2
0012              ;       ways to handle the internal timed write cycle
0013              ;       time of the device.  The simplest method is
0014              ;       simply to wait until the maximum cycle time
0015              ;       is exceeded before attempting another command.
0016              ;       The other, more efficient method is known as “data
0017              ;       polling.”  Data polling is done by sending a start
0018              ;       bit and control byte to the part after the write
0019              ;       cycle has been initiated by a stop bit.  If the ack bit
0020              ;       is low, then the device is through writing, otherwise
0021              ;       the the sequence is repeated.  If no low acknowledge
0022              ;       is found within 40 attempts (about 10 milliseconds)
0023              ;       then the routine times out and sets the timeout
0024              ;       LED (pin 1) high.
0025              ;
0026              ;       As an option, the user can connect a LED to pin 1
0027              ;       on the PIC16C54 (use about a 1K resistor in series) as a
0028              ;       timeout indicator.  This LED will come on if the
0029              ;       data polling is unsuccessful and the device being
0030              ;       programmed does not respond.  This can be tested by
0031              ;       simply running the program with no part in the socket.
0032              ;
0033              ;       Timing is based on using the PIC16C54 in ‘XT’ mode
0034              ;       using a 4MHz crystal.  Clock speeds to the serial EE
0035              ;       will be approximately 40 kHz for this setup.
0036              ;
0037              ;        PIC16C54 to Serial EE Connections:
0038              ;
0039              ;        PIC16C54          Serial EE
0040              ;       ______    ______
0041              ;       Pin 12 (RB6) –>  SCLK
0042              ;       Pin 13 (RB7) –>  SDATA
0043              ;
0044              ;       Pin 1  (RA2) –>  Write cycle timeout fail LED (optional)
0045              ;
0046              ;*************************************************************
0047              ;           Register Definitions
0048              ;*************************************************************
0049         0005  port_a  equ     5h     ; port 5 (port_a) used LEDs
0050         0006  port_b  equ     6h     ; port 6 (port_b) used for data and
0051                                       ; clock lines

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Line   PC    Opcode

0052         000A  eeprom  equ    0ah     ; bit buffer
0053         000B  bycnt   equ    0bh     ; byte counter for read mode
0054         000C  addr    equ    0ch     ; address counter
0055         000D  datai   equ    0dh     ; data input register
0056         000E  datao   equ    0eh     ; data output register
0057         000F  slave   equ    0fh     ; device address (1010xxx0)
0058         0010  txbuf   equ    10h     ; transmit buffer
0059         0011  count   equ    11h     ; bit counter
0060         0012  bcount  equ    12h     ; byte counter
```

```
0061         0015  loops   equ    15h     ; delay loop counter
0062         0016  loops2  equ    16h     ; delay loop counter
0063         0017  pollcnt equ    17h     ; data polling counter
0064               ;*************************************************************
0065               ;           Bit Definitions
0066               ;*************************************************************
0067         0007  di      equ    7       ; eeprom input bit
0068         0006  do      equ    6       ; eeprom output bit
0069         0007  sdata   equ    7       ; serial EE data line (port_b,pin 13)
0070         0006  sclk    equ    6       ; serial EE clock line (port_b,pin 12)
0071         0002  timeout equ    2       ; write cycle timeout fail LED, port_a (pin 1)
0072         0001  ackf    equ    1       ; acknowledge fail LED, port_a (pin 18)
0073               ;*************************************************************
0074               ;
0075         0000          org    01ffh   ; set reset vector
0076   01FF  0A5C          goto   PWRUP
0077         0000          org    000h    ;
0078   0000  0A5C          goto   PWRUP
0079               ;
0080               ;*************************************************************
0081               ;       DELAY ROUTINE
0082               ;       This routine takes the value in 'loops'
0083               ;       and multiplies it times 1 millisecond to
0084               ;       determine delay time.
0085               ;*************************************************************
0086               WAIT
0087               ;
0088   0001  0C6E  top       movlw   .110            ; timing adjustment variable
0089   0002  0036            movwf   loops2
0090   0003  0000  top2      nop                     ; sit and wait
0091   0004  0000            nop
0092   0005  0000            nop
0093   0006  0000            nop
0094   0007  0000            nop
0095   0008  0000            nop
0096   0009  02F6            decfsz  loops2          ; inner loops complete?
0097   000A  0A03            goto    top2            ; no, go again
0098                                                 ;
0099   000B  02F5            decfsz  loops           ; outer loops complete?
0100   000C  0A01            goto    top             ; no, go again
0101   000D  0800            retlw   0               ; yes, return from sub
0102               ;

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Line   PC    Opcode

0103               ;*************************************************************
0104               ;       Start Bit Subroutine
0105               ;       this routine generates a start bit
0106               ;       (Low going data line while clock is high)
0107               ;*************************************************************
0108               ;
0109               BSTART
0110   000E  05E6            bsf     port_b,sdata    ; make sure data is high
0111   000F  0C3F            movlw   b'00111111'
0112   0010  0006            tris    port_b          ; set data and clock lines for output
0113   0011  04C6            bcf     port_b,sclk     ; make sure clock is low
0114   0012  0000            nop
0115   0013  05C6            bsf     port_b,sclk     ; set clock high
0116   0014  0000            nop
0117   0015  0000            nop
0118   0016  0000            nop
0119   0017  0000            nop
0120   0018  0000            nop
0121   0019  04E6            bcf     port_b,sdata    ; data line goes low during
0122                                                 ; high clock for start bit
0123   001A  0000            nop
0124   001B  0000            nop
```

```
0125   001C  0000           nop
0126   001D  0000           nop
0127   001E  0000           nop                     ; timing adjustment
0128   001F  04C6           bcf     port_b,sclk     ; start clock train
0129   0020  0000           nop
0130   0021  0000           nop
0131   0022  0800           retlw   0
0132                         ;
0133                 ;*************************************************************
0134                 ;       Stop Bit Subroutine
0135                 ;       This routine generates a stop bit
0136                 ;       (High going data line while clock is high)
0137                 ;*************************************************************
0138                 BSTOP
0139   0023  0C3F           movlw   b'00111111'     ;
0140   0024  0006           tris    port_b          ; set data/clock lines as outputs
0141   0025  04E6           bcf     port_b,sdata    ; make sure data line is low
0142   0026  0000           nop
0143   0027  0000           nop
0144   0028  0000           nop
0145   0029  05C6           bsf     port_b,sclk     ; set clock high
0146   002A  0000           nop
0147   002B  0000           nop
0148   002C  0000           nop
0149   002D  05E6           bsf     port_b,sdata    ; data goes high while clock high
0150                                                 ; for stop bit
0151   002E  0000           nop
0152   002F  0000           nop
0153   0030  04C6           bcf     port_b,sclk     ; set clock low again

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Line   PC    Opcode

0154   0031  0000           nop
0155   0032  0000           nop
0156   0033  0000           nop
0157   0034  0800           retlw   0
0158                 ;
0159                 ;*************************************************************
0160                 ;       BITOUT routine takes one bit of data in 'do' and
0161                 ;       transmits it to the serial EE device
0162                 ;*************************************************************
0163                 BITOUT
0164   0035  0C3F           movlw   b'00111111'     ; set data,clock as outputs
0165   0036  0006           tris    port_b
0166   0037  07CA           btfss   eeprom,do       ; check for state of data bit to xmit
0167   0038  0A3B           goto    bitlow          ;
0168   0039  05E6           bsf     port_b,sdata    ; set data line high
0169   003A  0A3C           goto    clkout          ; go toggle the clock
0170                                                ;
0171   003B  04E6   bitlow   bcf     port_b,sdata    ; output a low bit
0172   003C  05C6   clkout   bsf     port_b,sclk     ; set clock line high
0173   003D  0000           nop
0174   003E  0000           nop
0175   003F  0000           nop
0176   0040  0000           nop
0177   0041  04C6           bcf     port_b,sclk     ; return clock line low
0178   0042  0800           retlw   0
0179                 ;
0180                 ;                  End of Subroutine
0181                 ;
0182                 ;*************************************************************
0183                 ;       BITIN routine reads one bit of data from the
0184                 ;       serial EE device and stores it in 'di'
0185                 ;*************************************************************
0186                 BITIN
0187   0043  05EA           bsf     eeprom,di       ; assume input bit is high
0188   0044  0CBF           movlw   b'10111111'     ; make sdata an input line
```



```
0189   0045  0006          tris    port_b
0190   0046  05E6          bsf     port_b,sdata   ; set sdata line for input
0191   0047  05C6          bsf     port_b,sclk    ; set clock line high
0192   0048  0000          nop                    ; just sit here a sec
0193   0049  0000          nop
0194   004A  0000          nop
0195   004B  0000          nop
0196   004C  0000          nop                    ;
0197   004D  07E6          btfss   port_b,sdata   ; read the data bit
0198   004E  04EA          bcf     eeprom,di      ; input bit was low
0199   004F  04C6          bcf     port_b,sclk    ; set clock line low
0200                                              ;
0201   0050  0800          retlw   0              ;
0202               ;
0203               ;*****************************************************************
0204               ;       Transmit Data Subroutine

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Line   PC    Opcode

0205               ;       This routine takes the byte of data stored in the
0206               ;       'datao' register and transmits it to the serial EE device.
0207               ;       It will then send 1 more clock to the serial EE for the
0208               ;       acknowledge bit.  If the ack bit from the part was low
0209               ;       then the transmission was successful.  If it is high, then
0210               ;       the device did not send a proper ack bit and the ack
0211               ;       fail LED will be turned on.
0212               ;*****************************************************************
0213               TX
0214   0051  0C08           movlw   .8
0215   0052  0031           movwf   count          ; set the #bits to 8
0216                        ;
0217               TXLP
0218   0053  04CA           bcf     eeprom,do      ; assume bit out is low
0219   0054  06F0           btfsc   txbuf,7        ; is bit out really low?
0220   0055  05CA           bsf     eeprom,do      ; otherwise data bit =1
0221   0056  0935           call    BITOUT         ; serial data out
0222   0057  0370           rlf     txbuf          ; rotate txbuf left
0223   0058  02F1           decfsz  count          ; 8 bits done?
0224   0059  0A53           goto    TXLP           ; no - go again
0225   005A  0943           call    BITIN          ; read ack bit
0226                        ;
0227   005B  0800           retlw   0
0228               ;                  ;
0229               ;*****************************************************************
0230               ;       Power up routine
0231               ;       This is the program entry point, which in this case simply
0232               ;       sets the port_a I/O lines and directs control to the
0233               ;       write routine.
0234               ;*****************************************************************
0235               PWRUP
0236   005C  0C00            movlw  b'00000000'
0237   005D  0005            tris   port_a          ; set port A as all output
0238   005E  0065            clrf   port_a          ; all output lines low
0239   005F  0A60            goto   WRBYTE
0240
0241               ;*****************************************************************
0242               ;       Byte Write Routine with data polling technique
0243               ;
0244               ;       This routine writes the data in "datao" to
0245               ;       8 consecutive bytes in the serial EE device starting
0246               ;       at address 00. To determine when the write cycle time
0247               ;       of the device, the 'data polling' method is used.  This
0248               ;       involves sending a start bit and control byte to the part
0249               ;       and checking for an acknowledge.  If the ack bit is low, then
0250               ;       the device is through writing, otherwise the the sequence
0251               ;       is repeated.  If no low acknowledge is found within 40
0252               ;       attempts (about 10 milliseconds) then the routine times
```

```
0253                ;       out and sets the timeout LED (pin 18) high.  This program
0254                ;       will repeat forever.
0255                ;

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Line   PC    Opcode

0256                ;*****************************************************************
0257                ;
0258                WRBYTE
0259                ;
0260   0060  0065           clrf    port_a          ; all LEDs off
0261   0061  0CA0           movlw   b'10100000'     ; set slave address and write mode
0262   0062  002F           movwf   slave
0263   0063  0CAA           movlw   b'10101010'     ; set data to write as AAh
0264   0064  002E           movwf   datao
0265   0065  0C08           movlw   .8              ; set number of bytes
0266   0066  0032           movwf   bcount          ; to write as to 8
0267   0067  006C           clrf    addr            ; set starting address to 00
0268                                                 ;
0269   0068  090E  byte      call    BSTART          ; generate start bit
0270   0069  020F           movf    slave,w         ; move slave address
0271   006A  0030           movwf   txbuf           ; into transmit buffer
0272   006B  0951           call    TX              ; and send it
0273   006C  020C           movf    addr,w          ; move word address
0274   006D  0030           movwf   txbuf           ; into transmit buffer
0275   006E  0951           call    TX              ; and send it
0276   006F  020E           movf    datao,w         ; move data byte
0277   0070  0030           movwf   txbuf           ; to tranmit buffer
0278   0071  0951           call    TX              ; and transmit it
0279   0072  0923           call    BSTOP           ; generate stop bit
0280                                                 ;
0281                                                 ; now start polling for a low ack bit
0282                                                 ;
0283   0073  0C28           movlw   .40             ;
0284   0074  0037           movwf   pollcnt         ; set max number of times to poll as 40
0285   0075  090E  poll      call    BSTART          ; generate start bit
0286   0076  0CA0           movlw   b'10100000'     ; move slave address (write mode)
0287   0077  0030           movwf   txbuf           ; into transmit buffer
0288   0078  0951           call    TX              ; and send it
0289   0079  07EA           btfss   eeprom,di       ; was the ack bit low?
0290   007A  0A7E           goto    exitpoll        ; yes, do another byte
0291   007B  02F7           decfsz  pollcnt         ; is poll counter down to zero?
0292   007C  0A75           goto    poll            ; no, poll again.  Other wise the part is
0293   007D  0545           bsf     port_a,timeout  ; not responding in time so set timeout
0294                                                 ; LED and continue on
0295                                                 ;
0296   007E  02AC  exitpoll incf    addr            ; add 1 to address counter
0297   007F  02F2           decfsz  bcount          ; all 8 bytes written?
0298   0080  0A68           goto    byte            ; no, do another byte
0299   0081  0A60           goto    WRBYTE          ; yes, start over
0300                ;
0301                ;
0302         0000  END
```

8

```
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Line   PC    Opcode

0001                     LIST P=16C54,c=132
0002              ;*************************************************************
0003              ;       2-Wire Page Write Program (122 bytes)
0004              ;
0005              ;       This program demonstrates how to interface a
0006              ;       Microchip PIC16C54 to a 24LCXX Serial EE device
0007              ;       and perform a page write operation on 8 consecutive
0008              ;       addresses.
0009              ;
0010              ;       All of Microchip's 2-wire serial E≤ devices have a
0011              ;       buffer or 'page' that can be used as a more efficient
0012              ;       method of writing to consecutive addresses.  Some
0013              ;       devices have page lengths of 2 bytes, others have
0014              ;       page lengths of 4,8,16 or 64 bytes.  Please consult
0015              ;       the databook for the page length of the device you
0016              ;       are using.  THIS ROUTINE IS WRITTEN FOR A DEVICE
0017              ;       WITH A PAGE LENGTH OF 8 OR MORE BYTES.
0018              ;
0019              ;       When using page mode, the control byte and address
0020              ;       are sent for the first address only.  After the data
0021              ;       byte for the first address is sent, the data for the
0022              ;       next consecutive address is clocked in.  This is
0023              ;       repeated as many times as needed (as long as the page
0024              ;       length is not exceeded) and then a stop bit is sent.
0025              ;       The device will still acknowledge between every byte of
0026              ;       data.  After the stop bit is sent, the part will
0027              ;       initiate the self timed write cycle.  For all of
0028              ;       Microchip's 24LCxx devices, the cycle time for
0029              ;       a byte write and a page write is the same.  Therefore,
0030              ;       writing 8 bytes in byte mode with a typical 5ms write
0031              ;       cycle consumes 40ms of wait time, while the same data
0032              ;       written in page mode would consume only 5ms of wait time.
0033              ;
0034              ;       This routine waits approximately 10mS for the write
0035              ;       cycle time, which is enough time for any of the
0036              ;       24LCxx devices to complete a write.  A more efficient
0037              ;       method of determining when the write cycle is complete
0038              ;       is called "data polling."  The data polling method is
0039              ;       explained in the program "2wdpoll.asm."  That
0040              ;       particular program uses data polling in a byte write
0041              ;       mode but it can be used in exactly the same way for
0042              ;       a page mode write.
0043              ;
0044              ;       As an option, the user can connect a LED to pin 18
0045              ;       on the PIC16C54 (use about a 1K resistor in series) as a
0046              ;       acknowledge fail indicator.  This LED will come on
0047              ;       if the device being programmed does not send a low
0048              ;       acknowledge bit at the proper times.  This can be
0049              ;       tested by simply running the program with no part
0050              ;       in the socket.
0051              ;

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Line   PC    Opcode

0052              ;       Timing is based on using the PIC16C5x in 'XT' mode
```

```
0053                ;       using a 4MHz crystal.  Clock speeds to the serial EE
0054                ;       will be approximately 40 kHz for this setup.
0055                ;
0056                ;
0057                ;        PIC16C54 to Serial EE Connections:
0058                ;
0059                ;         PIC16C54      Serial EE
0060                ;        ______    ______
0061                ;       Pin 12 (RB6) –>  SCLK
0062                ;       Pin 13 (RB7) –>  SDATA
0063                ;
0064                ;       PIN 18 (RA1) –>  Acknowledge fail LED  (Optional)
0065                ;
0066                ;
0067                ;*************************************************************
0068                ;           Register Definitions
0069                ;*************************************************************
0070         0005   port_a  equ     5h      ; port 5 (port a) used for LED outputs
0071         0006   port_b  equ     6h      ; port 6 (port b) used for data and
0072                                         ; clock lines
0073         000A   eeprom  equ    0ah      ; bit buffer
0074         000C   addr    equ    0ch      ; address counter
0075         000E   datao   equ    0eh      ; data output register
0076         000F   slave   equ    0fh      ; device address (1010xxx0)
0077         0010   txbuf   equ    10h      ; transmit buffer
0078         0011   count   equ    11h      ; bit counter
0079         0012   bcount  equ    12h      ; byte counter
0080         0015   loops   equ    15h      ; delay loop counter
0081         0016   loops2  equ    16h      ; delay loop counter
0082                ;*************************************************************
0083                ;           Bit Definitions
0084                ;*************************************************************
0085         0007   di      equ    7        ; eeprom input bit
0086         0006   do      equ    6        ; eeprom output bit
0087         0007   sdata   equ    7        ; serial EE data line (port_b,pin 13)
0088         0006   sclk    equ    6        ; serial EE clock line (port_b,pin 12)
0089         0001   ackf    equ    1        ; acknowledge fail LED, port_a (pin 18)
0090                ;*************************************************************
0091                ;
0092                ;
0093         0000           org    01ffh    ; set reset vector
0094   01FF  0A5E           goto   PWRUP
0095         0000           org    000h     ;
0096   0000  0A5E           goto   PWRUP
0097                ;
0098                ;*************************************************************
0099                ;       DELAY ROUTINE
0100                ;       This routine takes the value in 'loops'
0101                ;       and multiplies it times 1 millisecond to
0102                ;       determine delay time.

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Line   PC    Opcode

0103                ;*************************************************************
0104                WAIT
0105                ;
0106   0001  0C6E   top      movlw   .110            ; timing adjustment variable
0107   0002  0036           movwf   loops2
0108   0003  0000   top2     nop                     ; sit and wait
```

8

```
0109   0004  0000           nop
0110   0005  0000           nop
0111   0006  0000           nop
0112   0007  0000           nop
0113   0008  0000           nop
0114   0009  02F6           decfsz  loops2         ; inner loops complete?
0115   000A  0A03           goto    top2           ; no, go again
0116                                                ;
0117   000B  02F5           decfsz  loops          ; outer loops complete?
0118   000C  0A01           goto    top            ; no, go again
0119   000D  0800           retlw   0              ; yes, return from sub
0120                ;
0121                ;*************************************************************
0122                ;       Start Bit Subroutine
0123                ;       this routine generates a start bit
0124                ;       (Low going data line while clock is high)
0125                ;*************************************************************
0126                ;
0127                BSTART
0128   000E  05E6           bsf     port_b,sdata   ; make sure data is high
0129   000F  0C3F           movlw   b'00111111'
0130   0010  0006           tris    port_b         ; set data and clock lines for
output
0131   0011  04C6           bcf     port_b,sclk    ; make sure clock is low
0132   0012  0000           nop
0133   0013  05C6           bsf     port_b,sclk    ; set clock high
0134   0014  0000           nop
0135   0015  0000           nop
0136   0016  0000           nop
0137   0017  0000           nop
0138   0018  0000           nop
0139   0019  04E6           bcf     port_b,sdata   ; data line goes low during
0140                                                ; high clock for start bit
0141   001A  0000           nop
0142   001B  0000           nop
0143   001C  0000           nop
0144   001D  0000           nop
0145   001E  0000           nop                    ; timing adjustment
0146   001F  04C6           bcf     port_b,sclk    ; start clock train
0147   0020  0000           nop
0148   0021  0000           nop
0149   0022  0800           retlw   0
0150                        ;
0151                        ;    End of Subroutine
0152                ;*************************************************************
0153                ;       Stop Bit Subroutine

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Line   PC    Opcode

0154                ;       This routine generates a stop bit
0155                ;       (High going data line while clock is high)
0156                ;*************************************************************
0157                BSTOP
0158   0023  0C3F           movlw   b'00111111'    ;
0159   0024  0006           tris    port_b         ; set data/clock lines as outputs
0160   0025  04E6           bcf     port_b,sdata   ; make sure data line is low
0161   0026  0000           nop
0162   0027  0000           nop
0163   0028  0000           nop
```

```
0164   0029  05C6           bsf     port_b,sclk    ; set clock high
0165   002A  0000           nop
0166   002B  0000           nop
0167   002C  0000           nop
0168   002D  05E6           bsf     port_b,sdata   ; data goes high while clock high
0169                                                ; for stop bit
0170   002E  0000           nop
0171   002F  0000           nop
0172   0030  04C6           bcf     port_b,sclk    ; set clock low again
0173   0031  0000           nop
0174   0032  0000           nop
0175   0033  0000           nop
0176   0034  0800           retlw   0
0177                ;
0178                ;           End of Subroutine
0179                ;************************************************************
0180                ;       BITOUT routine
0181                ;       This routine takes one bit of data in 'do' and
0182                ;       transmits it to the serial EE device
0183                ;************************************************************
0184                BITOUT
0185   0035  0C3F            movlw   b'00111111'    ; set data,clock as outputs
0186   0036  0006            tris    port_b
0187   0037  07CA            btfss   eeprom,do      ; check for state of data bit to
xmit
0188   0038  0A3B            goto    bitlow         ;
0189   0039  05E6            bsf     port_b,sdata   ; set data line high
0190   003A  0A3C            goto    clkout         ; go toggle the clock
0191
0192   003B  04E6  bitlow    bcf     port_b,sdata   ; output a low bit
0193   003C  05C6  clkout    bsf     port_b,sclk    ; set clock line high
0194   003D  0000            nop
0195   003E  0000            nop
0196   003F  0000            nop
0197   0040  0000            nop
0198   0041  04C6            bcf     port_b,sclk    ; return clock line low
0199   0042  0800            retlw   0
0200                ;
0201                ;                  End of Subroutine
0202                ;
0203                ;************************************************************
0204                ;       BITIN routine reads one bit of data from the

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Line   PC    Opcode

0205                ;       serial EE device and stores it in 'di'
0206                ;************************************************************
0207                BITIN
0208   0043  05EA            bsf     eeprom,di      ; assume input bit is high
0209   0044  0CBF            movlw   b'10111111'    ; make sdata an input line
0210   0045  0006            tris    port_b
0211   0046  05E6            bsf     port_b,sdata   ; set sdata line for input
0212   0047  05C6            bsf     port_b,sclk    ; set clock line high
0213   0048  0000            nop                    ; just sit here a sec
0214   0049  0000            nop
0215   004A  0000            nop
0216   004B  0000            nop
0217   004C  0000            nop                    ;
0218   004D  07E6            btfss   port_b,sdata   ; read the data bit
```

```
0219   004E  04EA           bcf     eeprom,di      ; input bit was low
0220   004F  04C6           bcf     port_b,sclk    ; set clock line low
0221                                                ;
0222   0050  0800           retlw   0              ;
0223                ;
0224                ;*****************************************************************
0225                ;       Transmit Data Subroutine
0226                ;       This routine takes the byte of data stored in the
0227                ;       'datao' register and transmits it to the serial EE device.
0228                ;       It will then send 1 more clock to the serial EE for the
0229                ;       acknowledge bit.  If the ack bit from the part was low
0230                ;       then the transmission was successful.  If it is high, then
0231                ;       the device did not send a proper ack bit and the ack
0232                ;       fail LED will be turned on.
0233                ;*****************************************************************
0234                TX
0235   0051  0C08           movlw   .8
0236   0052  0031           movwf   count          ; set the #bits to 8
0237                        ;
0238                TXLP
0239   0053  04CA           bcf     eeprom,do      ; assume bit out is low
0240   0054  06F0           btfsc   txbuf,7        ; is bit out really low?
0241   0055  05CA           bsf     eeprom,do      ; otherwise data bit =1
0242   0056  0935           call    BITOUT         ; serial data out
0243   0057  0370           rlf     txbuf          ; rotate txbuf left
0244   0058  02F1           decfsz  count          ; 8 bits done?
0245   0059  0A53           goto    TXLP           ; no - go again
0246   005A  0943           call    BITIN          ; read ack bit
0247   005B  06EA           btfsc   eeprom,di      ; check ack bit
0248   005C  0525           bsf     port_a,ackf    ; set acknowledge fail LED if the
0249                                                ; device did not pull data low
0250                        ;
0251   005D  0800           retlw   0
0252                ;
0253                ;*****************************************************************
0254                ;       Power up routine
0255                ;       This is the program entry point, which in this case simply

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Line   PC    Opcode

0256                ;       sets the port_a I/O lines and directs control to the Page
0257                ;       write routine.
0258                ;*****************************************************************
0259                PWRUP
0260   005E  0C00            movlw  b'00000000'
0261   005F  0005            tris   port_a         ; set port A as all output
0262   0060  0065            clrf   port_a         ; all output lines low
0263   0061  0A62            goto   WRPAGE
0264
0265                ;*****************************************************************
0266                ;       Page Write Routine
0267                ;
0268                ;       This routine uses page mode to write the data in "datao" to
0269                ;       8 consecutive bytes in the serial EE device starting
0270                ;       at address 00. This routine waits 10mS after every
0271                ;       page to give the device time to do the write.  This
0272                ;       routine executes forever
0273                ;*****************************************************************
0274                ;
```

```
0275                WRPAGE
0276                ;
0277   0062  0065           clrf    port_a          ; clear all LEDs
0278   0063  0CA0           movlw   b'10100000'     ; set slave address and write mode
0279   0064  002F           movwf   slave
0280   0065  0C55           movlw   b'01010101'     ; set data to write as 55h
0281   0066  002E           movwf   datao
0282                                                 ;
0283   0067  0C08           movlw   .8              ; set number of bytes
0284   0068  0032           movwf   bcount          ; to write as to 8
0285   0069  006C           clrf    addr            ; set starting address to 00
0286                                                 ;
0287   006A  090E           call    BSTART          ; generate start bit
0288   006B  020F           movf    slave,w         ; move slave address
0289   006C  0030           movwf   txbuf           ; into transmit buffer
0290   006D  0951           call    TX              ; and send it
0291
0292   006E  020C           movf    addr,w          ; move word address
0293   006F  0030           movwf   txbuf           ; into transmit buffer
0294   0070  0951           call    TX              ; and send it
0295
0296   0071  020E  byte     movf    datao,w         ; move data byte
0297   0072  0030           movwf   txbuf           ; to tranmit buffer
0298   0073  0951           call    TX              ; and transmit it
0299   0074  02F2           decfsz  bcount          ; all 8 bytes written?
0300   0075  0A71           goto    byte            ; no, do another
0301   0076  0923           call    BSTOP           ; yes,generate stop bit
0302                                                 ;
0303   0077  0C0A           movlw   .10
0304   0078  0035           movwf   loops           ; set delay time to give
0305   0079  0901           call    WAIT            ; 10 ms wait after every byte
0306                                                 ;

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Line   PC    Opcode

0307   007A  0A62           goto    wrpage          ; start over
0308                ;
0309                ;
0310          0000  END
```

```
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Line   PC    Opcode

0001                     LIST P=16C54,c=132
0002               ;*************************************************************
0003               ;       2-Wire Sequential Read Program (120 bytes)
0004               ;
0005               ;       This program demonstrates how to interface a
0006               ;       Microchip PIC16C54 to a 24LCXX Serial EE device
0007               ;       and perform a sequential read operation.  A sequential
0008               ;       read involves setting the address pointer once and then
0009               ;       using the auto-increment ability of the part to read
0010               ;       consecutive addresses by simply providing more clocks.
0011               ;
0012               ;       Timing is based on using the PIC16C54 in 'XT' mode
0013               ;       using a 4MHz crystal.  Clock speeds to the serial EE
0014               ;       will be approximately 60 kHz for this setup.
0015               ;
0016               ;       As an option, the user may connect a LED to pin 18
0017               ;       on the PIC16C54 (use about a 1K resistor in series) as an
0018               ;       acknowledge fail indicator.  This LED will come on if
0019               ;       the serial EE fails to acknowledge correctly.
0020               ;
0021               ;        PIC16C54 to Serial EE Connections:
0022               ;
0023               ;          PIC16C54       Serial EE
0024               ;         ______    ______
0025               ;       Pin 12 (RB6) —>  SCLK
0026               ;       Pin 13 (RB7) —>  SDATA
0027               ;
0028               ;       PIN 18 (RA1) —>  Acknowledge fail LED  (Optional)
0029               ;
0030               ;*************************************************************
0031               ;           Register Definitions
0032               ;*************************************************************
0033         0003  status  equ     3h     ; status register
0034         0005  port_a  equ     5h     ; port 5 (port_a) used for LEDs
0035         0006  port_b  equ     6h     ; port 6 (port b) used for data and
0036                                       ; clock lines
0037         000A  eeprom  equ    0ah     ; bit buffer
0038         000B  bycnt   equ    0bh     ; byte counter for read mode
0039         000C  addr    equ    0ch     ; address counter
0040         000D  datai   equ    0dh     ; data input register
0041         000E  datao   equ    0eh     ; data output register
0042         000F  slave   equ    0fh     ; device address (1010xxx0)
0043         0010  txbuf   equ    10h     ; transmit buffer
0044         0011  count   equ    11h     ; bit counter
0045         0012  bcount  equ    12h     ; byte counter
0046         0015  loops   equ    15h     ; delay loop counter
0047         0016  loops2  equ    16h     ; delay loop counter
0048               ;*************************************************************
0049               ;           Bit Definitions
0050               ;*************************************************************
0051         0007  di      equ    7       ; eeprom input bit

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Line   PC    Opcode

0052         0006  do      equ    6       ; eeprom output bit
0053         0007  sdata   equ    7       ; serial EE data line (port_b,pin 13)
0054         0006  sclk    equ    6       ; serial EE clock line (port_b,pin 12)
0055         0001  ackf    equ    1       ; acknowledge fail LED, port_a
0056               ;*************************************************************
0057               ;
0058               ;
0059         0000          org    01ffh   ; set reset vector
0060   01FF  0A5B          goto   PWRUP
```

```
0061        0000          org    000h    ;
0062   0000 0A5B          goto   PWRUP
0063               ;
0064               ;*************************************************************
0065               ;       Start Bit Subroutine
0066               ;       this routine generates a start bit
0067               ;       (Low going data line while clock is high)
0068               ;*************************************************************
0069               ;
0070               BSTART
0071   0001 05E6           bsf     port_b,sdata   ; make sure data is high
0072   0002 0C3F           movlw   b'00111111'
0073   0003 0006           tris    port_b         ; set data and clock lines for output
0074   0004 04C6           bcf     port_b,sclk    ; make sure clock is low
0075   0005 0000           nop
0076   0006 05C6           bsf     port_b,sclk    ; set clock high
0077   0007 0000           nop
0078   0008 0000           nop
0079   0009 0000           nop
0080   000A 0000           nop
0081   000B 0000           nop
0082   000C 04E6           bcf     port_b,sdata   ; data line goes low during
0083                                              ; high clock for start bit
0084   000D 0000           nop
0085   000E 0000           nop
0086   000F 0000           nop
0087   0010 0000           nop
0088   0011 0000           nop                    ; timing adjustment
0089   0012 04C6           bcf     port_b,sclk    ; start clock train
0090   0013 0000           nop
0091   0014 0000           nop
0092   0015 0800           retlw   0
0093                       ;
0094                       ;    End of Subroutine
0095               ;*************************************************************
0096               ;       Stop Bit Subroutine
0097               ;       This routine generates a stop bit
0098               ;       (High going data line while clock is high)
0099               ;*************************************************************
0100               BSTOP
0101   0016 0C3F           movlw   b'00111111'    ;
0102   0017 0006           tris    port_b         ; set data/clock lines as outputs

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Line   PC    Opcode

0103   0018 04E6           bcf     port_b,sdata   ; make sure data line is low
0104   0019 0000           nop
0105   001A 0000           nop
0106   001B 0000           nop
0107   001C 05C6           bsf     port_b,sclk    ; set clock high
0108   001D 0000           nop
0109   001E 0000           nop
0110   001F 0000           nop
0111   0020 05E6           bsf     port_b,sdata   ; data goes high while clock high
0112                                              ; for stop bit
0113   0021 0000           nop
0114   0022 0000           nop
0115   0023 04C6           bcf     port_b,sclk    ; set clock low again
0116   0024 0000           nop
0117   0025 0000           nop
0118   0026 0000           nop
0119   0027 0800           retlw   0
0120               ;
0121               ;           End of Subroutine
0122               ;*************************************************************
0123               ;       BITOUT routine takes one bit of data in 'do' and
0124               ;       transmits it to the serial EE device
```

```
0125                ;*************************************************************
0126                BITOUT
0127   0028  0C3F          movlw   b'00111111'    ; set data,clock as outputs
0128   0029  0006          tris    port_b
0129   002A  07CA          btfss   eeprom,do      ; check for state of data bit to xmit
0130   002B  0A2E          goto    bitlow         ;
0131   002C  05E6          bsf     port_b,sdata   ; set data line high
0132   002D  0A2F          goto    clkout         ; go toggle the clock
0133
0134   002E  04E6  bitlow   bcf     port_b,sdata   ; output a low bit
0135   002F  05C6  clkout   bsf     port_b,sclk    ; set clock line high
0136   0030  0000          nop
0137   0031  0000          nop
0138   0032  0000          nop
0139   0033  0000          nop
0140   0034  04C6          bcf     port_b,sclk    ; return clock line low
0141   0035  0800          retlw   0
0142                ;
0143                ;                  End of Subroutine
0144                ;
0145                ;*************************************************************
0146                ;       BITIN routine reads one bit of data from the
0147                ;       serial EE device and stores it in 'di'
0148                ;*************************************************************
0149                BITIN
0150   0036  05EA          bsf     eeprom,di      ; assume input bit is high
0151   0037  0CBF          movlw   b'10111111'    ; make sdata an input line
0152   0038  0006          tris    port_b
0153   0039  05C6          bsf     port_b,sclk    ; set clock line high

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Line   PC    Opcode

0154   003A  0000          nop                    ; just sit here a sec
0155   003B  0000          nop
0156   003C  0000          nop
0157   003D  0000          nop
0158   003E  0000          nop                    ;
0159   003F  07E6          btfss   port_b,sdata   ; read the data bit
0160   0040  04EA          bcf     eeprom,di      ; input bit was low, set 'di' accordingly
0161   0041  04C6          bcf     port_b,sclk    ; set clock line low
0162                                              ;
0163   0042  0800          retlw   0
0164                ;
0165                ;*************************************************************
0166                ;       Transmit Data Subroutine
0167                ;       This routine takes the byte of data stored in the
0168                ;       'datao' register and transmits it to the serial EE device.
0169                ;       It will then send 1 more clock to the serial EE for the
0170                ;       acknowledge bit.  If the ack bit from the part was low
0171                ;       then the transmission was successful.  If it is high, then
0172                ;       the device did not send a proper ack bit and the ack
0173                ;       fail LED will be turned on.
0174                ;*************************************************************
0175                TX
0176   0043  0C08          movlw   .8
0177   0044  0031          movwf   count          ; set the #bits to 8
0178                       ;
0179                TXLP
0180   0045  04CA          bcf     eeprom,do      ; assume bit out is low
0181   0046  06F0          btfsc   txbuf,7        ; is bit out really low?
0182   0047  05CA          bsf     eeprom,do      ; no, set it high
0183   0048  0928          call    BITOUT         ; send the bit to serial EE
0184   0049  0370          rlf     txbuf          ; rotate txbuf left
0185   004A  02F1          decfsz  count          ; 8 bits done?
0186   004B  0A45          goto    TXLP           ; no - go again
0187   004C  0936          call    BITIN          ; read ack bit
0188   004D  06EA          btfsc   eeprom,di      ; check ack bit
```

```
0189   004E  0525           bsf     port_a,ackf    ; set acknowledge fail LED if the
0190                                                ; device did not pull data low
0191                         ;
0192   004F  0800           retlw   0
0193                ;
0194                ;*****************************************************************
0195                ;       Receive data Routine
0196                ;       This routine reads one byte of data from the part
0197                ;       into the 'datai' register.  It then sends a high
0198                ;       ack bit to indicate that no more data is to be read
0199                ;*****************************************************************
0200                RX
0201   0050  0C08           movlw   .8             ; set # bits to 8
0202   0051  0031           movwf   count
0203   0052  006D           clrf    datai          ; clear input register
0204   0053  0403           bcf     status,0       ; make sure carry bit is low

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Line   PC    Opcode

0205   0054  036D  RXLP     rlf     datai          ; rotate datai 1 bit left
0206   0055  0936           call    BITIN          ; read a bit
0207   0056  06EA           btfsc   eeprom,di
0208   0057  050D           bsf     datai,0        ; set bit 0 if necessary
0209   0058  02F1           decfsz  count          ; 8 bits done?
0210   0059  0A54           goto    RXLP           ; no, do another
0211   005A  0800           retlw   0
0212                ;
0213                ;*****************************************************************
0214                ;       Power up routine
0215                ;       This is the program entry point, which in this case simply
0216                ;       sets the port_a I/O lines and directs control to the
0217                ;       Read routine.
0218                ;*****************************************************************
0219                PWRUP
0220   005B  0C00            movlw  b'00000000'
0221   005C  0005            tris   port_a         ; set port A as all output
0222   005D  0065            clrf   port_a         ; all output lines low
0223   005E  0A5F            goto   READ
0224
0225                ;
0226                ;*****************************************************************
0227                ;       READ (sequential read routine)
0228                ;
0229                ;       This routine reads 8 consecutive addresses of the
0230                ;       serial EE device starting at address 00 in the
0231                ;       sequential read mode. Reading in this mode is more
0232                ;       efficient than the random read mode as the control byte
0233                ;       and address have to be sent only once at the beginning
0234                ;       of the sequence.  As many consecutive addresses as
0235                ;       needed can then be read from the part until a stop bit is
0236                ;       sent.  In the read mode, the PIC16C54 must send the acknowledge
0237                ;       bit after every 8 data bits from the device.  When the
0238                ;       last byte needed has been read, then the controller will
0239                ;       send a high acknowledge bit and then a stop bit to halt
0240                ;       transmission from the device.
0241                ;*****************************************************************
0242                READ
0243                                              ;
0244   005F  0425           bcf     port_a,ackf ; clear the ack fail LED if on
0245   0060  0C08           movlw   .8
0246   0061  0032           movwf   bcount      ; set number of bytes to read as 8
0247   0062  0CA0           movlw   b'10100000' ; set slave address and write mode
0248   0063  002F           movwf   slave
0249   0064  006C           clrf    addr        ; set starting address to 00
0250                                              ;
0251   0065  0901           call    BSTART      ; generate start bit
0252   0066  020F           movf    slave,w     ; get slave address
```

```
0253   0067  0030           movwf   txbuf       ; into transmit buffer
0254   0068  0943           call    TX          ; and send it
0255   0069  020C           movf    addr,w      ; get word address

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Line   PC    Opcode

0256   006A  0030           movwf   txbuf       ; into transmit buffer
0257   006B  0943           call    TX          ; and send it
0258   006C  0901           call    BSTART      ; generate start bit
0259   006D  0CA1           movlw   b'10100001' ; get slave address and read mode
0260   006E  0030           movwf   txbuf       ; into transmit buffer
0261   006F  0943           call    TX          ; and transmit it
0262                                            ;
0263   0070  0950  rbyte     call    RX          ; read 1 byte from device
0264   0071  02F2           decfsz  bcount      ; are all 8 bytes read?
0265   0072  0A77           goto    lowack      ; no, send low ack and do another
0266   0073  05CA           bsf     eeprom,do   ; yes, send high ack bit
0267   0074  0928           call    BITOUT      ; to stop transmission
0268   0075  0916           call    BSTOP       ; and send a stop bit
0269   0076  0A5F           goto    READ        ; start all over
0270
0271   0077  04CA  lowack    bcf     eeprom,do   ; send low ack bit
0272   0078  0928           call    BITOUT      ; to continue transmission
0273   0079  0A70           goto    rbyte       ; and read another byte
0274               ;
0275         0000  END
```

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