AN530

Interfacing 93CX6 Serial EEPROMs to PIC16C5X Microcontrollers

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INTRODUCTION

Microchip Technology Inc.'s popular 93C46/56/66 and 93LC46/56/66 Serial EEPROMs feature a three/four wire serial interface bus. The attractive price and simple interface make it the ideal device for additional memory space. This application note is intended for design engineers who wish to incorporate a pre-packaged serial EEPROM interface driver into their application.

THE HARDWARE CONNECTION

A typical 4-wire hardware connection is illustrated in Figure 1 and a typical 3-wire connection is illustrated in Figure 2. Since all I/O ports on the PIC16C5X are configurable as input and/or output, a 3-wire interface makes optimum utilization of the I/O pins by having a common connection for the DI and DO lines of the Serial EEPROM. The port pin on the PIC16C5X connected to these pins, has a default setting as an output and is configured, when needed, as an input during program execution.

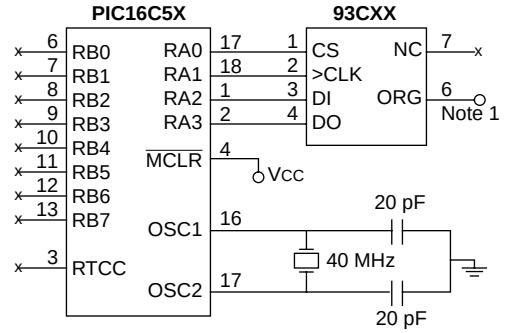
THE SOFTWARE CONNECTION

An example interface driver is listed in Appendix A. A flow diagram is given in Figure 2. The interface driver is written to minimize both overhead to the calling program as well as the program space necessary for its inclusion into the user's code. The driver has been written as a generic driver to service all 93 Series Serial EEPROMs made by Microchip. Processor resources which must be made available to the driver prior to being called are:

1. Two levels of processor stack.
2. Six register locations (four for command/data passing and two for software counters).
3. The File Select Register (FSR), which is used to pass a command/data string pointer to the driver.

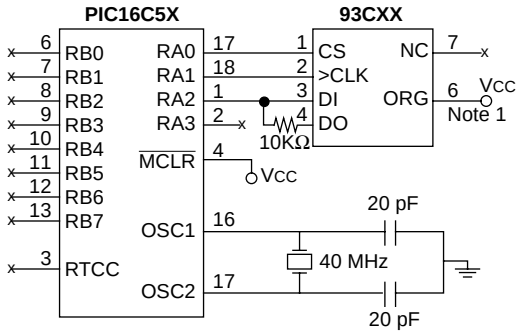
Note: The four command/data passing registers have to be defined consecutively in order for the FSR to access them successfully in the program execution.

FIGURE 1: 4-WIRE CONNECTION



Note 1: FOR 93LCXX
For 16-bit data word connect to VCC
For 8-bit data word connect to GND

FIGURE 2: 3-WIRE CONNECTION



Note 1: FOR 93LCXX
For 16-bit data word connect to VCC
For 8-bit data word connect to GND

The user should take the following steps when using the routines provided in Appendix A.

A) Specify and define a 3-/4-wire interface by defining the common connection to the DI/DO lines and setting the equate 'wire3' TRUE or FALSE (4-wire is automatically assumed if 3-wire is false).

B) Specify and define if 16-bit or 8-bit data organization is used, by setting equate 'org8' TRUE or FALSE.

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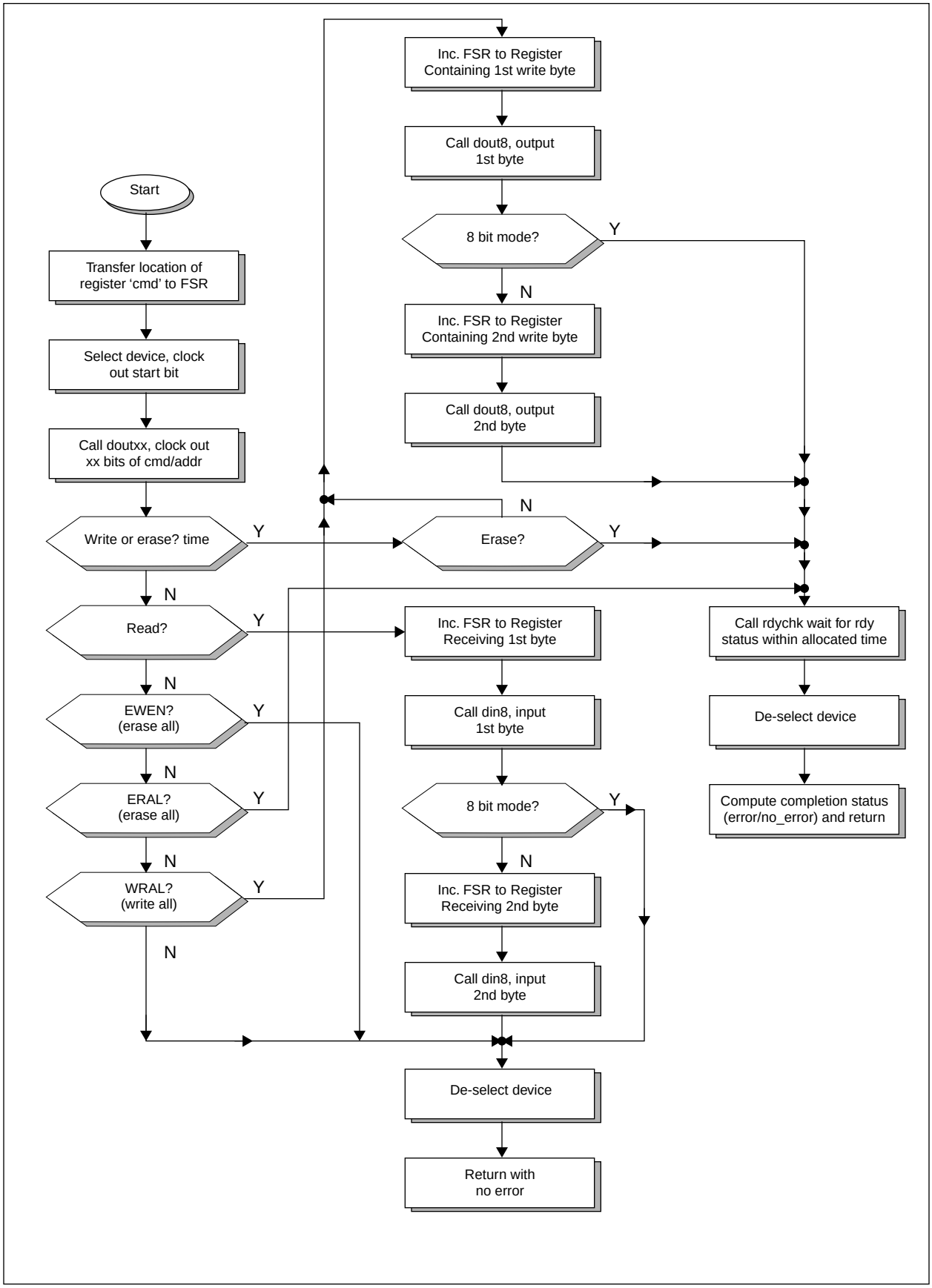
FIGURE 3: FLOW CHART



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C) The user should assemble the source file by specifying which type of serial EEPROM is being used. This is done by defining the equate S93C46, S93LC46, etc., as TRUE. Only one device can be TRUE, the rest have to be defined FALSE.

D) The user would invoke the driver as follows:

1. Load the register defined as 'cmd' with the 93CX6 Command Opcode (only the four upper bits are used in this register; see Figure 3).
2. If necessary, load the register defined 'addr' with the lower 8/7/6 bit address of the location.
3. If necessary, load the 9th bit of the address as bit 3 of the register defined as 'cmd' (Figure 3).

> **Note:** READ, WRITE and ERASE commands need to have an address associated with the command and the 9th bit of the address is only required when using the 93C56/66 or 93LC56/66 devices in the 8 bit mode (ORG tied to GND).

4. If necessary, load the register defined as 'highb' and 'lowb' with the 16 bits of data, the most significant byte loaded in 'highb'. In 8 bit mode, 'highb' should be loaded with the 8 bit data.

> **Note:** Only the WRITE and WRAL commands require data to be loaded in the 'highb', 'lowb' locations.

5. Call the driver sub-routine 'see'.
6. Upon completion, the driver will return a completion status in the W register (error/no error). Only commands requiring a status check are capable of returning a valid error/no error status, in all other cases a no error is returned.
7. If the READ command is executed, the 16/8 bit data will be loaded in the 'highb' and 'lowb' registers, where 'highb' contains the MSB in the 16 bit mode and 8 bit data in the 8-bit mode.
   The Example interface assumes a 4 MHz oscillator clock which gives us a 1 µS instruction cycle. If a higher clock speed is used, additional NOPs have to be included in the code in order to meet the minimum clock speed requirements of the 93 Series Serial EEPROMs (see data sheet for further details).

Listing in Appendix B is for an interface to 93C46 Serial EEPROM only.

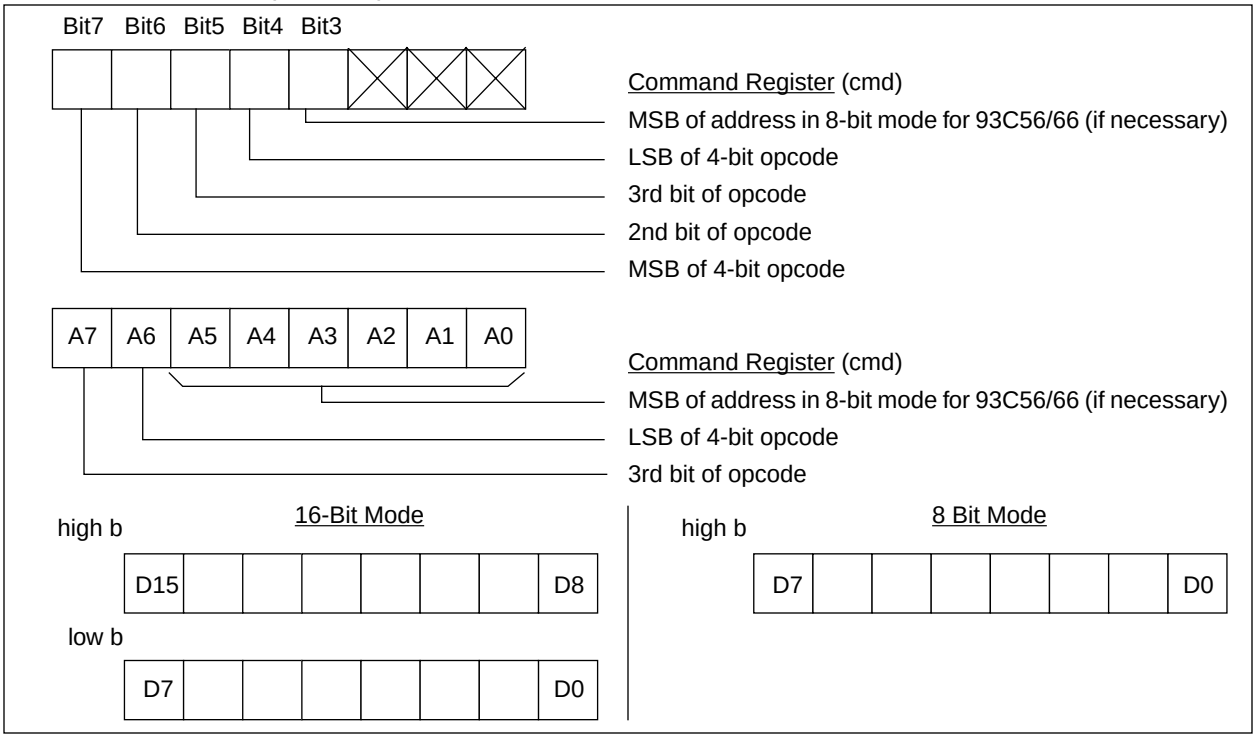
SUMMARY

The 93 Series Serial EEPROMs are a simple and versatile method of increasing read/write memory capability in a PIC16C5X application. The 'generic' code in Appendix A makes it easy to incorporate in any PIC16C5X application. Any of the 93 Series Serial EEPROMs can be applied, while at the same time using a minimal amount of I/O, code and RAM resources.

Code size: 6 bytes of RAM.

Appendix A listing:	127 bytes program code (max.) 100 bytes program code (min.)
Appendix B listing:	86 bytes program code

FIGURE 4: 'CMD', 'ADDR', DATA BYTE DEFINITION



Please check the Microchip Worldwide Website at www.microchip.com for the latest version of the source code.

APPENDIX A: 93XCXX.ASM

```
MPASM 01.40 Released           93XCXX.ASM   1-16-1997  13:13:47         PAGE  1


LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

                     00001                 TITLE        “R/W EEPROM”
                     00002      LIST  P = 16C54
                     00003 ;Serial Eprom interface to PIC16C5X.
                     00004 ;
                     00005 ;
                     00006 ;       Program:          93XCXX.ASM
                     00007 ;       Revision Date:    8/26/92
                     00008 ;                         10/31/92      Comments clarified  REV 2.0
                     00009 ;                         1-13-97       Compatibility with MPASMWIN 1.40
                     00010 ;
                     00011 ;*****************************************************************
                     00012 ;
                     00013 ;Define Equates:
                     00014 ;
  000001FF           00015 PIC54   EQU     1FFH
                     00016 ;
                     00017     PAGE
                     00018 ;
0000                 00019         ORG     0
0000                 00020 START
0000 0A7B            00021         goto    main            ;run test program
                     00022 ;
                     00023     PAGE
                     00024 ;
  00000001           00025 TRUE    EQU     1
  00000000           00026 FALSE   EQU     0
  00000001           00027 F       EQU     1
  00000000           00028 S93C46  EQU     FALSE
  00000000           00029 S93LC46 EQU     FALSE
  00000000           00030 S93C56  EQU     FALSE
  00000000           00031 S93LC56 EQU     FALSE
  00000001           00032 S93C66  EQU     TRUE
  00000000           00033 S93LC66 EQU     FALSE
  00000001           00034 wire3   equ     TRUE            ; for four-wire setup equate to FALSE
  00000000           00035 org8    EQU     FALSE
                     00036 ;
                     00037         IF      S93LC46
                     00038         IF      org8
                     00039 LC468   EQU     TRUE
                     00040 XC46    EQU     FALSE
                     00041 H16     EQU     FALSE
                     00042 H8      EQU     FALSE
                     00043         ELSE
                     00044 LC468   EQU     FALSE
                     00045 XC46    EQU     TRUE
                     00046 H16     EQU     FALSE
                     00047 H8      EQU     FALSE
                     00048         ENDIF
                     00049     ELSE
                     00050     ENDIF
                     00051     IF      S93C46
                     00052 LC468   EQU     FALSE
                     00053 XC46    EQU     TRUE
                     00054 H16     EQU     FALSE
                     00055 H8      EQU     FALSE
                     00056     ENDIF
```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```
                 00057     IF      S93C56 + S93C66 + S93LC56 + S93LC66
                 00058         IF      org8
                 00059 H8      EQU     TRUE
                 00060 H16     EQU     FALSE
                 00061 LC468   EQU     FALSE
                 00062 XC46    EQU     FALSE
                 00063         ELSE
00000001         00064 H16     EQU     TRUE
00000000         00065 H8      EQU     FALSE
00000000         00066 LC468   EQU     FALSE
00000000         00067 XC46    EQU     FALSE
                 00068         ENDIF
                 00069     ELSE
                 00070     ENDIF
                 00071
                 00072
                 00073
                 00074 ;*****************************************************************
                 00075 ;*                      Register Assignments                     *
                 00076 ;*****************************************************************
                 00077
00000000         00078 indir   equ     0       ;Use this register as source/destination
                 00079                         ;for indirect addressing.
00000002         00080 pc      equ     2       ;PIC Program Counter.
00000003         00081 status  equ     3       ;PIC Status Register.
00000004         00082 fsr     equ     4       ;File Select Register.
00000005         00083 serial  equ     5       ;Port used for 93CX6 control.
                 00084                         ;The following four registers must be
                 00085                         ;located consecutively in memory.
0000001A         00086 cmd     equ     1a      ;This register contains the 4 bit
                 00087                         ;command op code for 93CX6 as follows:
                 00088                         ;bit 7 msb of command op code
                 00089                         ;bit 6 next bit of op code
                 00090                         ;bit 5 next bit of op code
                 00091                         ;bit 4 lsb of op code
                 00092                         ;bit 3 A8 of address in case of
                 00093                         ;56/66 in 8 bit mode.
0000001B         00094 addr    equ     1b      ;memory address of lower 7/8 bits
0000001C         00095 highb   equ     1c      ;Used in read/write routines to store the
                 00096                         ;upper byte of a 16 bit data word,
                 00097                         ;or the data in a 8 bit data word
0000001D         00098 lowb    equ     1d      ;Used in read/write routines to store the
                 00099                         ;lower byte of a 16 bit data word,
                 00100                         ;or not used in 8 bit data word.
                 00101
0000001E         00102 cnthi   equ     1e      ;Used as the upper byte of a sixteen bit
                 00103                         ;loop counter in RDYCHK routine.
0000001F         00104 cnt     equ     1f      ;Used as the lower byte of a sixteen bit
                 00105                         ;loop counter in RDYCHK routine, and
                 00106                         ;elswhere as an eight bit counter.
0000001E         00107 temp_cmd equ    1e      ;doubles as a temp register for cmd
0000001F         00108 temp_addr equ   1f      ;doubles as a temp register for addr
                 00109
                 00110 ;*****************************************************************
                 00111 ;* Bit Assignments: The following assignments are for 3-wire. For
                 00112 ;* 4-wire assign din and dout to seperate pins.
                 00113
00000000         00114 carry   equ     0               ;Carry Flag of Status Register.
00000002         00115 zflag   equ     2               ;Zero Flag of Status Register.
                 00116
00000002         00117 cs      equ     2               ;Port pin tied to CS on 93CX6.
00000001         00118 din     equ     1               ;Port pin tied to DI on 93CX6. 3-wire
00000001         00119 dout    equ     1               ;Port pin tied to DO on 93CX6. 3-wire
00000003         00120 clock   equ     3               ;Port pin tied to CLK on 93CX6.
                 00121
                 00122 ;*****************************************************************
```

```
                    00123 ;*                      General Assignments                       *
                    00124 ;*****************************************************************
                    00125
00000000            00126 no_err  equ     0
00000001            00127 err1    equ     1
00000020            00128 tries   equ     20      ;After issuing a WRITE, ERASE, ERAL, or WRAL
                    00129                         ;command, the approximate number of machine
                    00130                         ;cycles X 256 to wait for the RDY status.
                    00131                         ;This value must be adjusted for operating
                    00132                         ;frequencies other than 4 MHz.
                    00133
00000080            00134 read    equ     b'10000000'     ;read command op code
00000040            00135 write   equ     b'01000000'     ;write command op code
000000C0            00136 erase   equ     b'11000000'     ;erase command op code
00000030            00137 ewen    equ     b'00110000'     ;erase enable command op code
00000000            00138 ewds    equ     b'00000000'     ;erase disable command op code
00000020            00139 eral    equ     b'00100000'     ;erase all command op code
00000010            00140 wral    equ     b'00010000'     ;write all command op code
                    00141
                    00142 ;*****************************************************************
                    00143 ;*                      Macro Definitions                         *
                    00144 ;*****************************************************************
                    00145
                    00146 sel     MACRO                   ;Selects the 93CX6 device.
                    00147         bsf     serial,cs       ;Chip Select (CS) = '1' to select
                    00148         ENDM                    ;the device
                    00149
                    00150 dsel    MACRO                   ;De-select the 93CX6 device.
                    00151         bcf     serial,cs       ;Chip Select (CS) = '0' to de-select
                    00152                                 ;the device.
                    00153         ENDM
                    00154
                    00155 strtbt  MACRO                   ;Issue the Start Bit to the 93CX6.
                    00156         bsf     serial,din      ;Start Bit = '1'.
                    00157         clkit                   ;Clock it out.
                    00158         ENDM
                    00159
                    00160 clkit   MACRO                   ;Clocks a serial data bit into or out
                    00161                                 ;of the 93CX6 device.
                    00162         bsf     serial,clock    ;Clock (CLK) = '1'.
                    00163
                    00164         nop             ;Adjust the number of nop instructions
                    00165                         ;between the assertion and de-assertion of
                    00166                         ;CLK in proportion to the PIC operating
                    00167                         ;frequency.  Refer to the 93CX6 data for the
                    00168                         ;minimum CLK period.
                    00169
                    00170         bcf     serial,clock    ;Clock (CLK) = '0'.
                    00171         ENDM
                    00172 ;
                    00173     PAGE
                    00174 ;*****************************************************************
                    00175 ;*                      DOUTx                                     *
                    00176 ;*****************************************************************
                    00177 ;doutxx, outputs up to 11 bits of op code/data, depending on whether
                    00178 ;a 46/56/66 serial eeprom is being used. The number of bits over 8 are
                    00179 ;saved in the cmd register and the rest in the addr register. Before
                    00180 ;calling this routine the cmd and the addr registers should be loaded
                    00181 ;as follows:
                    00182 ;cmd reg.bits 7|6|5|4|3|2|1|0
                    00183 ;--------------|-|-|-|-|-|-|-|
                    00184 ;             X|X|X|X|X|X|X|Y| --> not used
                    00185 ;             X|X|X|X|X|X|Y|X| --> mot used
                    00186 ;             X|X|X|X|X|Y|X|X| --> not used
                    00187 ;             X|X|X|X|Y|X|X|X| --> 9th bit of address if necessary
                    00188 ;             X|X|X|Y|X|X|X|X| --> lsb of command op code
```


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                 00189 ;            X|X|Y|X|X|X|X|X| --> 3rd bit of command op code
                 00190 ;            X|Y|X|X|X|X|X|X| --> 2nd bit of command op code
                 00191 ;            Y|X|X|X|X|X|X|X| --> msb of command op code
                 00192 ;
                 00193 ;addr reg. 6/7/8 bits of address if necessary.
                 00194
                 00195     IF      H8
                 00196 dout11
                 00197         bcf     serial,din
                 00198         rlf     indir           ;rotate thru carry
                 00199         btfsc   status,carry    ;set?
                 00200         bsf     serial,din      ;yes, set output to 1
                 00201         clkit                   ;clk data
                 00202     ENDIF
                 00203     IF      H16+H8
0001             00204 dout10
0001 0360        00205         rlf     indir, F        ;rotate thru carry
0002 0425        00206         bcf     serial,din      ;set output to 0
0003 0603        00207         btfsc   status,carry    ;set?
0004 0525        00208         bsf     serial,din      ;else set output to 1
                 00209         clkit                   ;clk data
                     M                                 ;of the 93CX6 device.
0005 0565            M         bsf     serial,clock    ;Clock (CLK) = '1'.
                     M
0006 0000            M         nop             ;Adjust the number of nop instructions
                     M                         ;between the assertion and de-assertion of
                     M                         ;CLK in proportion to the PIC operating
                     M                         ;frequency.  Refer to the 93CX6 data for the
                     M                         ;minimum CLK period.
                     M
0007 0465            M         bcf     serial,clock    ;Clock (CLK) = '0'.
                 00210     ENDIF
                 00211     IF      H8+H16+LC468
0008             00212 dout9
0008 0360        00213         rlf     indir, F        ;rotate thru carry
0009 0425        00214         bcf     serial,din      ;set output to 0
000A 0603        00215         btfsc   status,carry    ;set?
000B 0525        00216         bsf     serial,din      ;else set output to 1
                 00217         clkit                   ;clk data
                     M                                 ;of the 93CX6 device.
000C 0565            M         bsf     serial,clock    ;Clock (CLK) = '1'.
                     M
000D 0000            M         nop             ;Adjust the number of nop instructions
                     M                         ;between the assertion and de-assertion of
                     M                         ;CLK in proportion to the PIC operating
                     M                         ;frequency.  Refer to the 93CX6 data for the
                     M                         ;minimum CLK period.
                     M
000E 0465            M         bcf     serial,clock    ;Clock (CLK) = '0'.
000F 02A4        00218         incf    fsr, F          ;inc pointer
                 00219     ENDIF
0010             00220 dout8
0010 0C08        00221         movlw   8               ;Initialize loop counter.
0011 003F        00222         movwf   cnt
                 00223 ;
0012 0425        00224 d_o_8   bcf     serial,din      ;Assume that the bit to be transfered
                 00225                                 ;is a '0'.  Hence, de-assert DI.
0013 0360        00226         rlf     indir, F        ;Rotate the actual bit to be
                 00227                                 ;transferred into the carry bit.
0014 0603        00228         btfsc   status,carry    ;Test the carry, if our assumption was
                 00229                                 ;correct, skip the next instruction.
0015 0525        00230         bsf     serial,din      ;No, actual bit was a '1'.  Assert DI.
                 00231         clkit                   ;Clock the 93CX6.
                     M                                 ;of the 93CX6 device.
0016 0565        M         bsf    serial,clock ;Clock (CLK) = '1'.
                 M
```

```
0017 0000          M         nop                ;Adjust the number of nop instructions
                   M                            ;between the assertion and de-assertion of
                   M                            ;CLK in proportion to the PIC operating
                   M                            ;frequency.  Refer to the 93CX6 data for the
                   M                            ;minimum CLK period.
                   M
0018 0465          M         bcf    serial,clock ;Clock (CLK) = '0'.
0019 02FF       00232        decfsz cnt, F       ;Repeat until cnt = 0.
001A 0A12       00233        goto   d_o_8        ;Cnt still > 0.
001B 0360       00234        rlf    indir, F     ;Restore register to its original condition.
001C 0425       00235        bcf    serial,din   ;make sure din is low
001D 0800       00236        retlw  no_err       ;Exit with good status.
                00237
                00238 ;*****************************************************************
                00239 ;*                       DIN8                                    *
                00240 ;*****************************************************************
                00241                              ;Din8 will input 8 bits of data from the
                00242                              ;93CX6.  Before calling this routine,
                00243                              ;the FSR must point to the register
                00244                              ;being used to hold the incomming data.
001E            00245 din8
                00246     IF      wire3
                00247 ;set up the RA1 as a input before proceeding
001E 0C02       00248        movlw   b'00000010'    ;set up porta
001F 0005       00249        tris    serial         ;
                00250     ENDIF
0020 0C08       00251        movlw   8              ;Initialize loop counter.
0021 003F       00252        movwf   cnt            ;
                00253
0022            00254 d_i_8
0022 0360       00255        rlf     indir, F       ;Make room for the incomming bit in the
                00256                               ;destination register.
0023 0400       00257        bcf     indir,0        ;Assume that the incomming bit is a '0' and
                00258                               ;clear the LSB of the destination register.
                00259        clkit                  ;Clock a bit in the 93CX6.
                    M                              ;of the 93CX6 device.
0024 0565           M        bsf     serial,clock   ;Clock (CLK) = '1'.
                    M
0025 0000           M        nop                    ;Adjust the number of nop instructions
                    M                               ;between the assertion and de-assertion of
                    M                               ;CLK in proportion to the PIC operating
                    M                               ;frequency.  Refer to the 93CX6 data for the
                    M                               ;minimum CLK period.
                    M
0026 0465           M        bcf     serial,clock   ;Clock (CLK) = '0'.
0027 0625       00260        btfsc   serial,dout    ;Test the incomming bit, if our assumption
                00261                               ;was correct, skip the next instruction.
0028 0500       00262        bsf     indir,0        ;No, actual bit is a '1'.  Set the LSB of
                00263                               ;the destination register.
0029 02FF       00264        decfsz  cnt, F         ;Repeat until cnt = 0.
002A 0A22       00265        goto    d_i_8          ;Cnt still > 0.
                00266     IF      wire3
                00267 ;setup RA1 back to output
002B 0C00       00268        movlw   0              ;set RA1 as output
002C 0005       00269        tris    serial         ;      /
                00270     ENDIF
002D 0800       00271        retlw   no_err         ;Exit with good status.
                00272
                00273 ;*****************************************************************
                00274 ;*                       RDYCHK                                  *
                00275 ;*****************************************************************
                00276                             ;Rdychk will read the 93CX6 READY/BUSY status
                00277                             ;and wait for RDY status within the alloted
                00278                             ;number of processor cycles.  If RDY status
                00279                              ;is not present after this set period, the
                00280                              ;routine will return with an error status.
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                 00281
002E             00282 rdychk
                 00283     IF      wire3
                 00284 ;set up RA1 as a input before proceeding
002E 0C02        00285         movlw   b'00000010'     ;set up porta
002F 0005        00286         tris    serial          ;
                 00287     ENDIF
0030 0C20        00288         movlw   tries           ;Initialize time-out counter.
0031 003E        00289         movwf   cnthi           ;
0032 007F        00290         clrf    cnt             ;
                 00291         dsel                    ;De-select the 93CX6.
0033 0445            M         bcf     serial,cs       ;Chip Select (CS) = '0' to de-select
                     M                                 ;the device.
                 00292
                 00293 ;       nop                     ;NOTE:  Check the 93CX6 data sheet for
                 00294                                 ;minimum CS low time.  Depending upon
                 00295                                 ;processor frequency, a nop(s) may be
                 00296                                 ;between the assertion and de-assertion of
                 00297                                 ;Chip Select.
                 00298
                 00299         sel                     ;Re-select the 93CX6.
0034 0545            M         bsf     serial,cs       ;Chip Select (CS) = '1' to select
0035 0625        00300 notrdy  btfsc   serial,dout     ;If DO is a '0', 93CX6 has yet to completed
                 00301                                 ;the last operation (still busy).
0036 0A3E        00302         goto    rdynoerr        ;skip to no error
0037 02FF        00303         decfsz  cnt, F          ;No, not yet ready.  Decrement the LSB of
                 00304                                 ;our 16 bit timer and check for expiration.
0038 0A35        00305         goto    notrdy          ;Still some time left.  Try again.
0039 02FE        00306         decfsz  cnthi, F        ;Least significant byte expired - decrement
                 00307                                 ;and check for expiration of the MSB.
003A 0A35        00308         goto    notrdy          ;Still some time left.  Try again.
                 00309     IF      wire3
                 00310 ;setup RA1 back to output
003B 0C00        00311         movlw   0               ;set RA1 as output
003C 0005        00312         tris    serial          ;      /
                 00313     ENDIF
003D 0801        00314         retlw   err1            ;RDY status was not present in the alloted
                 00315                                 ;time, return with error status.
003E             00316 rdynoerr
                 00317     IF      wire3
                 00318 ;setup RA1 back to output
003E 0C00        00319         movlw   0               ;set porta as output
003F 0005        00320         tris    serial          ;      /
                 00321     ENDIF
0040 0800        00322         retlw   no_err
                 00323
                 00324 ;*****************************************************************
                 00325 ;*                      SEE                                      *
                 00326 ;*****************************************************************
                 00327
                 00328                               ;See will control the entire operation of a
                 00329                               ;93CX6 device.  Prior to calling the routine,
                 00330                               ;load a valid command/memory address into
                 00331                               ;location cmd, and for WRITE or WRAL
                 00332                               ;commands, load registers highb and lowb with
                 00333                               ;16 bits of write data.  Upon exit, the W
                 00334                               ;register will contain the completion status.
                 00335                               ;Only 93CX6 instructions which require a
                 00336                               ;status check can return with an error as the
                 00337                               ;completion status.  The values that denote
                 00338                               ;the completion status are defined as
                 00339                               ;variables 'error' and 'no_err' in the
                 00340                               ;general assignments section.
                 00341
0041                 00342 see
0041 021A            00343         movf    cmd,W           ;save cmd
```

```
0042 003E          00344         movwf   temp_cmd
0043 021B          00345         movf    addr,W          ;save addr
0044 003F          00346         movwf   temp_addr       ;
0045 0C1A          00347         movlw   cmd             ;Load W with the location of the cmd
                   00348                                 ;register.
0046 0024          00349         movwf   fsr             ;Transfer that information into the
                   00350                                 ;File Select Register. The fsr now
                   00351                                 ;points to location cmd.
                   00352         sel                     ;Select the 93CX6.
0047 0545              M         bsf     serial,cs       ;Chip Select (CS) = '1' to select
                   00353         strtbt                  ;Send a start bit.
0048 0525              M         bsf     serial,din      ;Start Bit = '1'.
                       M         clkit                   ;Clock it out.
                       M                                 ;of the 93CX6 device.
0049 0565              M         bsf     serial,clock    ;Clock (CLK) = '1'.
                       M
004A 0000              M         nop             ;Adjust the number of nop instructions
                       M                         ;between the assertion and de-assertion of
                       M                         ;CLK in proportion to the PIC operating
                       M                         ;frequency.  Refer to the 93CX6 data for the
                       M                         ;minimum CLK period.
                       M
004B 0465              M         bcf     serial,clock    ;Clock (CLK) = '0'.
                   00354 ;
004C 06FA          00355         btfsc   cmd,7           ;bit 7 = 0?
                   00356     IF      XC46
                   00357         goto    sca8            ;xfer 8 bit cmd/adr
                   00358     ENDIF
                   00359     IF      LC468
                   00360         goto    sca9            ;xfer 9 bit cmd/adr
                   00361     ENDIF
                   00362     IF      H16
004D 0A73          00363         goto    sca10           ;xfer 10 bit cmd/adr
                   00364     ENDIF
                   00365     IF      H8
                   00366         goto    sca11           ;xfer 11 bit cmd/adr
                   00367     ENDIF
                   00368
                   00369 ;        goto    set_cmd_addr   ;no then set cmd/addr
004E 07DA          00370         btfss   cmd,6           ;bit 6 = 0 ?
                   00371     IF      XC46
                   00372         goto    sc8             ;xfer 8 bit cmd/adr
                   00373     ENDIF
                   00374     IF      LC468
                   00375         goto    sc9             ;xfer 9 bit cmd/adr
                   00376     ENDIF
                   00377     IF      H16
004F 0A75          00378         goto    sc10            ;xfer 10 bit cmd/adr
                   00379     ENDIF
                   00380     IF      H8
                   00381         goto    sc11            ;xfer 11 bit cmd/adr
                   00382     ENDIF
                   00383 ;        goto    set_cmd         ;yes then set cmd
                   00384     IF      XC46
                   00385         goto    sca8            ;xfer 8 bit cmd/adr
                   00386     ENDIF
                   00387     IF      LC468
                   00388         goto    sca9            ;xfer 9 bit cmd/adr
                   00389     ENDIF
                   00390     IF      H16
0050 0A73          00391         goto    sca10           ;xfer 10 bit cmd/adr
                   00392     ENDIF
                   00393     IF      H8
                   00394         goto    sca11           ;xfer 11 bit cmd/adr
                00395     ENDIF
                00396
```


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```
                 00397 ;       goto    set_cmd_addr    ;else set cmd/addr
0051             00398 see1
0051 021E        00399         movf    temp_cmd,W      ;retore cmd
0052 003A        00400         movwf   cmd             ;       /
0053 021F        00401         movf    temp_addr,W     ;restore addr
0054 003B        00402         movwf   addr            ;       /
0055 06DA        00403         btfsc   cmd,6           ;Check for a WRITE or ERASE command.
0056 0A5F        00404         goto    see2            ;Yes, parse the command further.
0057 06FA        00405         btfsc   cmd,7           ;Check for a READ command.
0058 0A69        00406         goto    read_           ;Yes, process READ command.
0059 06BA        00407         btfsc   cmd,5           ;Check for a EWEN or ERAL command.
005A 0A66        00408         goto    see3            ;Yes, parse the command further.
005B 069A        00409         btfsc   cmd,4           ;Check for a WRAL command.
005C 0A6E        00410         goto    write_          ;Yes, process WRITE/WRAL command.
                 00411
                 00412 exit_   dsel                    ;No further processing required; 93CX6
005D 0445            M         bcf     serial,cs       ;Chip Select (CS) = '0' to de-select
                     M                                 ;the device.
                 00413                                 ;command completed.
                 00414 ;
005E 0800        00415         retlw   no_err          ;Return with good completion status.
                 00416
005F 07FA        00417 see2    btfss   cmd,7           ;Check for a ERASE command.
0060 0A6E        00418         goto    write_          ;No, process WRITE command.
0061 092E        00419 exit2_  call    rdychk          ;ERASE command requires a status check.
                 00420         dsel                    ;De-select the 93CX6.
0062 0445            M         bcf     serial,cs       ;Chip Select (CS) = '0' to de-select
                     M                                 ;the device.
0063 01E2        00421         addwf   pc, F           ;Compute completion status from
                 00422                                 ;results of status check.
0064 0800        00423         retlw   no_err          ;Return with good completion status.
0065 0801        00424         retlw   err1            ;Return with bad completion status.
                 00425
0066 069A        00426 see3    btfsc   cmd,4           ;Check for a EWEN command.
0067 0A5D        00427         goto    exit_           ;Yes, no further processing required,
                 00428                                 ;exit now.
0068 0A61        00429         goto    exit2_          ;No, ERAL command which requires a
                 00430                                 ;status check.
                 00431
0069 02A4        00432 read_   incf    fsr, F          ;Increment the File Select Register to
                 00433                                 ;point to the register receiving the upper
                 00434                                 ;byte of the incomming 93CX6 data word.
006A 091E        00435         call    din8            ;Input the upper byte.
                 00436     IF      org8
                 00437     ELSE
006B 02A4        00438         incf    fsr, F          ;Increment the File Select Register to point
                 00439                                 ;to the register receiving the lower byte.
006C 091E        00440         call    din8            ;Input 8 more bits.
                 00441     ENDIF
006D 0A5D        00442         goto    exit_           ;No further processing required, exit now.
                 00443
006E 02A4        00444 write_  incf    fsr, F          ;Increment the File Select Register to point
                 00445                                 ;to the upper byte of the 16 bit 93CX6 data
                 00446                                 ;word to be transmitted.
006F 0910        00447         call    dout8           ;Output that byte.
                 00448     IF      org8
                 00449     ELSE
0070 02A4        00450         incf    fsr, F          ;Increment the File Select Register to point
                 00451                                 ;to the lower byte.
0071 0910        00452         call    dout8           ;Output the lower byte of the 16 bit 93CX6
                 00453                                 ;data word.
                 00454     ENDIF
0072 0A61        00455         goto    exit2_          ;Exit with a status check.
                 00456
                     00457 ;
                     00458 ;
```

```
                    00459     IF      XC46
                    00460 sca8
                    00461         movlw   b'11000000'     ;clr all but hi 2
                    00462         andwf   cmd,W           ;save in w
                    00463         iorwf   addr            ;mask in addr.
                    00464         incf    fsr             ;inc FSR
                    00465         call    dout8           ;output
                    00466         goto    see1            ;return
                    00467     ENDIF
                    00468     IF      LC468
                    00469 ;
                    00470 sca9
                    00471         bcf     addr,7          ;clr hi of addr
                    00472         btfsc   cmd,6           ;xfer cmd's bit 6
                    00473         bsf     addr,7          ;to addr's bit 7
                    00474         call    dout9           ;output
                    00475         goto    see1            ;return
                    00476     ENDIF
                    00477     IF      H16
                    00478 ;
0073                00479 sca10
0073 0901           00480         call    dout10          ;output cmd reg
0074 0A51           00481         goto    see1            ;return
                    00482     ENDIF
                    00483 ;
                    00484     IF      H8
                    00485 sca11
                    00486         bcf     cmd,5           ;xfer cmd's bit 3 to
                    00487         btfsc   cmd,3           ;cmd's bit 5
                    00488         bsf     cmd,5           ;       /
                    00489         call    dout11          ;output
                    00490         goto    see1            ;return
                    00491 ;
                    00492     ENDIF
                    00493 ;
                    00494 ;
                    00495 ;
                    00496     IF      XC46
                    00497 sc8
                    00498         movf    cmd,W           ;get command
                    00499         movwf   addr            ;save in addr
                    00500         incf    fsr             ;inc pointer
                    00501         call    dout8           ;output
                    00502         goto    see1            ;return
                    00503 ;
                    00504     ENDIF
                    00505     IF      LC468
                    00506 sc9
                    00507         rlf     cmd,W           ;rotate cmd left
                    00508         movwf   addr            ;save in addr
                    00509         call    dout9           ;xfer 9 bits
                    00510         goto    see1            ;return
                    00511     ENDIF
                    00512     IF      H16
                    00513 ;
0075                00514 sc10
0075 037A           00515         rlf     cmd, F          ;rotate cmd
0076 035A           00516         rlf     cmd,W           ;left twice
0077 003B           00517         movwf   addr            ;save in addr
0078 007A           00518         clrf    cmd             ;clear command
0079 0901           00519         call    dout10          ;xfer 10 bits
007A 0A51           00520         goto    see1            ;return
                    00521     ENDIF
                    00522 ;
                00523     IF      H8
                00524 sc11
```


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```
                00525         bcf     addr,7          ;xfer cmd's bit 4
                00526         btfsc   cmd,4           ;to addr's bit 7
                00527         bsf     addr,7          ;       /
                00528         call    dout11          ;xfer 11 bits
                00529         goto    see1            ;return
                00530     ENDIF
                00531 ;*****************************************************************
                00532 ;*                      Test Program                             *
                00533 ;*****************************************************************
                00534 ;
007B            00535 main                            ;We've include a sample program to
                00536                                 ;exercise the PIC to 93C66 interface
                00537                                 ;using a simple erase, write and verify
                00538                                 ;routine.8 bit organization has been
                00539                                 ;used with a 3 wire interface.
                00540
007B 0065       00541         clrf    serial          ;Clear the port tied to the 93C66 device.
007C 0CF0       00542         movlw   b'11110000'     ;Intialize the data direction register
007D 0005       00543         tris    serial          ;for that port.
                00544
007E 0C30       00545         movlw   ewen            ;Load W with the Erase/Write Enable command.
007F 003A       00546         movwf   cmd             ;Transfer W into cmd register.
0080 0941       00547         call    see             ;Enable the 93C66 device.
                00548
0081 0C20       00549         movlw   eral            ;Load W with the Erase All command.
0082 003A       00550         movwf   cmd             ;Transfer W into cmd register.
0083 0941       00551         call    see             ;Erase the 93C66.
0084 0F01       00552         xorlw   err1            ;Check completion status.
0085 0643       00553         btfsc   status, zflag   ;Test for error condition.
0086 0AA6       00554         goto    errloop         ;Yes, bad completion status, error-out.
                00555
                00556                                 ;Write loop:
  000000AA      00557 tstptrn equ     0xAA            ;Define the test pattern to be written.
                00558
0087 0C40       00559         movlw   write           ;Load W with the Write command.
0088 003A       00560         movwf   cmd             ;Transfer W into cmd register.
0089 0CAA       00561         movlw   tstptrn         ;Intialize the 93C66 data registers with
                00562                                 ;write data.
008A 003C       00563         movwf   highb           ;load in high byte only
                00564                                 ;since 8 bit low byte is ignored
008B 007B       00565         clrf    addr            ;start at addr 0
008C 0941       00566 test1   call    see             ;Write data word into 93C66 device.
008D 0F01       00567         xorlw   err1            ;Check completion status.
008E 0643       00568         btfsc   status,zflag    ;Test for error condition.
008F 0AA6       00569         goto    errloop         ;Yes, bad completion status, error-out.
0090 03FB       00570         incfsz  addr, F         ;No, increment the 8 bit memory address
                00571                                 ;field.
0091 0A8C       00572         goto    test1           ;write another location
0092 077A       00573         btfss   cmd,3           ;see if all done
0093 0A95       00574         goto    wrt_nxt_pg      ;no then write next page
0094 0A97       00575         goto    read_tst        ;read written data
0095            00576 wrt_nxt_pg
0095 057A       00577         bsf     cmd,3           ;set page bit
0096 0A8C       00578         goto    test1           ;No, write another location.
                00579
                00580                                 ;Read loop:
0097            00581 read_tst
0097 0C80       00582         movlw   read            ;Load W with the Read command.
0098 003A       00583         movwf   cmd             ;Transfer W into cmd register.
0099 0941       00584 test2   call    see             ;Read addressed data word from 93C66 device.
009A 0CAA       00585         movlw   tstptrn         ;Load W with the pattern written.
009B 009C       00586         subwf   highb,W         ;Verify the data read against what was
                00587                                 ;written.
009C 0743       00588         btfss   status,zflag    ;Same?
009D 0AA6       00589         goto    errloop         ;No, error-out.
009E 03FB       00590         incfsz  addr, F         ;Yes, both byte correct, increment the 8 bit
```

```
                00591                                   ;memory address field.
009F 0A99       00592           goto    test2           ;do next byte
00A0 077A       00593           btfss   cmd,3           ;check page bit
00A1 0AA3       00594           goto    rd_nxt_pg       ;no then chk next page
00A2 0AA5       00595           goto    allok           ;all done!!!
00A3            00596 rd_nxt_pg
00A3 057A       00597           bsf     cmd,3           ;set page bit
00A4 0A99       00598           goto    test2           ;No, read another location.
                00599
00A5 0AA5       00600 allok     goto    allok           ;Home safe!
                00601 ;
                00602 ;
00A6            00603 errloop
00A6 0AA6       00604           goto    errloop
                00605 ;
                00606 ;
                00607 ;
                00608 ;KEY DEFINITIONS
                00609 ;
01FF            00610           ORG     PIC54
01FF            00611 SYS_RESET
01FF 0A00       00612           GOTO    START
                00613 ;
                00614           END
MEMORY USAGE MAP ('X' = Used,  '-' = Unused)

0000 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
0040 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
0080 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXX--------- ----------------
01C0 : ---------------- ---------------- ---------------- ---------------X

All other memory blocks unused.

Program Memory Words Used:   168
Program Memory Words Free:   344


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


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APPENDIX B: 93C46.ASM

```
MPASM 01.40 Released            93C46.ASM   1-16-1997  13:13:14         PAGE  1


LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

                     00001 ;*****************************************************************
                     00002 ;*                      PICALC Directives Section                *
                     00003 ;*****************************************************************
                     00004
                     00005         SUBTITL “93C46 3 WIRE INTERFACE ROUTINE”
                     00006         LIST     P=16C54,N=40,C=132
                     00007
                     00008 ;*****************************************************************************
                     00009 ;
                     00010 ;
                     00011 ;       Program:          93C46.ASM
                     00012 ;       Revision Date:
                     00013 ;                         1-13-97      Compatibility with MPASMWIN 1.40
                     00014 ;
                     00015 ;*****************************************************************************
                     00016 ;
                     00017
                     00018 ;*****************************************************************
                     00019 ;*                      Register Assignments                     *
                     00020 ;*****************************************************************
                     00021
  00000000           00022 indir   equ     0x00          ;Use this register as source/destination for
                     00023                               ;indirect addressing.
  00000002           00024 pc      equ     0x02          ;PIC Program Counter.
  00000003           00025 status  equ     0x03          ;PIC Status Register.
  00000004           00026 fsr     equ     0x04          ;File Select Register.
  00000005           00027 serial  equ     0x05          ;Port used for 93C46 control. Port A is
                     00028                               ;4 bits wide, we’ll use 3 or 4 of Port A.
  00000001           00029 F       EQU     1
                     00030                               ;The following three registers must be
                     00031                               ;located consecutively in memory.
  00000010           00032 cmd     equ     0x10          ;This register contains the 2 bit 93C46
                     00033                               ;command is the upper 2 bit positions and
                     00034                               ;memory address in the lower 6.
  00000011           00035 highb   equ     0x11          ;Used in read/write routines to store the
                     00036                               ;upper byte of a 16 bit 93C46 data word.
  00000012           00037 lowb    equ     0x12          ;Used in read/write routines to store the
                     00038                               ;lower byte of a 16 bit 93C46 data word.
                     00039
  00000013           00040 cnthi   equ     0x13          ;Used as the upper byte of a sixteen bit loop
                     00041                               ;counter in RDYCHK routine.
  00000014           00042 cnt     equ     0x14          ;Used as the lower byte of a sixteen bit loop
                     00043                               ;counter in RDYCHK routine, and elsewhere as
                     00044                               ;an eight bit counter.
                     00045
                     00046 ;*****************************************************************
                     00047 ;* Bit Assignments: The following assignment is for 3-wire setup.
                     00048 ;* For 4-wire setup assign din and dout to seperate pins.
                     00049
  00000000           00050 carry   equ     0             ;Carry Flag of Status Register.
  00000002           00051 zflag   equ     2             ;Zero Flag of Status Register.
                     00052
                     00053 ;For the 3 wire interface, connect the din and dout to the same
                     00054 ;i/o line of the PIC16C5X.
  00000000           00055 cs      equ     0             ;Port pin tied to CS on 93C46.
  00000001           00056 din     equ     1             ;Port pin tied to DI on 93C46. 3-wire
```

```
  00000001      00057 dout    equ     1             ;Port pin tied to DO on 93C46. 3-wire
  00000002      00058 clock   equ     2             ;Port pin tied to CLK on 93C46.
                00059
                00060 ;*****************************************************************
                00061 ;*                       General Assignments                     *
                00062 ;*****************************************************************
                00063
  00000000      00064 no_err  equ     0             ;
  00000001      00065 err1    equ     1             ;
  00000004      00066 tries   equ     0x04          ;After issuing a WRITE, ERASE, ERAL, or WRAL
                00067                               ;command, the approximate number of machine
                00068                               ;cycles X 256 to wait for the RDY status.
                00069                               ;This value must be adjusted for operating
                00070                               ;frequencies other than 4 MHz.
                00071
  00000080      00072 read    equ     0x80          ;93C46 Read command.
  00000040      00073 write   equ     0x40          ;93C46 Write command.
  000000C0      00074 erase   equ     0xC0          ;93C46 Erase command.
  00000030      00075 ewen    equ     0x30          ;93C46 Erase/Write Enable command.
  00000000      00076 ewds    equ     0x00          ;93C46 Erase/Write Disable command.
  00000020      00077 eral    equ     0x20          ;92CXX Erase All command.
  00000010      00078 wral    equ     0x10          ;92CXX Write All command.
                00079
                00080 ;*****************************************************************
                00081 ;*                       Macro Definitions                       *
                00082 ;*****************************************************************
                00083
                00084 sel     MACRO                 ;Selects the 93C46 device.
                00085         bsf     serial,cs     ;Chip Select (CS) = ‘1’ to select the device.
                00086         ENDM
                00087
                00088 dsel    MACRO                 ;De-select the 93C46 device.
                00089         bcf     serial,cs     ;Chip Select (CS) = ‘0’ to de-select the
                00090                               ;device.
                00091         ENDM
                00092
                00093 strtbt  MACRO                 ;Issue the Start Bit to the 93C46.
                00094         bsf     serial,din    ;Start Bit = ‘1’.
                00095         clkit                 ;Clock it out.
                00096         ENDM
                00097
                00098 clkit   MACRO                 ;Clocks a serial data bit into or out of the
                00099                               ;93C46 device.
                00100         bsf     serial,clock  ;Clock (CLK) = ‘1’.
                00101
                00102         nop                   ;Adjust the number of nop instructions
                00103                               ;between the assertion and de-assertion of
                00104                               ;CLK in proportion to the PIC operating
                00105                               ;frequency.  Refer to the 93C46 data for the
                00106                               ;minimum CLK period.
                00107
                00108         bcf     serial,clock  ;Clock (CLK) = ‘0’.
                00109         ENDM
                00110
                00111 ;*****************************************************************
                00112 ;*                    Power-On/Reset Entry Point                 *
                00113 ;*****************************************************************
                00114
01FF            00115 reset_  org     0x1FF
01FF 0A56       00116         goto    main
                00117
                00118 ;*****************************************************************
                00119 ;*                       93C46 Routines                          *
                00120 ;*****************************************************************
0000            00121         org     0x000         ;Locate all subroutines in the lower half of
                00122                               ;a Program Memory Page.
```


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```
                  00123
                  00124 ;*******************************************************************
                  00125 ;*                         DOUT8                                   *
                  00126 ;*******************************************************************
                  00127                               ;Dout8 will output 8 bits of data to the
                  00128                               ;93C46.  Before calling this routine, the FSR
                  00129                               ;must point to the byte being transmitted.
                  00130
0000 0C08         00131 dout8   movlw   0x08          ;Initialize loop counter.
0001 0034         00132         movwf   cnt           ;
                  00133
0002 0425         00134 d_o_8   bcf     serial,din    ;Assume that the bit to be transfered is a
                  00135                               ;'0'.  Hence, de-assert DI.
0003 0360         00136         rlf     indir, F      ;Rotate the actual bit to be transferred into
                  00137                               ;the carry bit.
0004 0603         00138         btfsc   status,carry  ;Test the carry, if our assumption was
                  00139                               ;correct, skip the next instruction.
0005 0525         00140         bsf     serial,din    ;No, actual bit was a '1'.  Assert DI.
                  00141         clkit                 ;Clock the 93C46.
                      M                               ;93C46 device.
0006 0545             M         bsf     serial,clock  ;Clock (CLK) = '1'.
                      M
0007 0000             M         nop                   ;Adjust the number of nop instructions
                      M                               ;between the assertion and de-assertion of
                      M                               ;CLK in proportion to the PIC operating
                      M                               ;frequency.  Refer to the 93C46 data for the
                      M                               ;minimum CLK period.
                      M
0008 0445             M         bcf     serial,clock  ;Clock (CLK) = '0'.
0009 02F4         00142         decfsz  cnt, F        ;Repeat until cnt = 0.
000A 0A02         00143         goto    d_o_8         ;Cnt still > 0.
000B 0360         00144         rlf     indir, F      ;Restore register to its original condition.
000C 0800         00145         retlw   no_err        ;Exit with good status.
                  00146
                  00147 ;*******************************************************************
                  00148 ;*                         DIN8                                    *
                  00149 ;*******************************************************************
                  00150                               ;Din8 will input 8 bits of data from the
                  00151                               ;93C46.  Before calling this routine, the FSR
                  00152                               ;must point to the register being used to
                  00153                               ;hold the incomming data.
000D 0C08         00154 din8    movlw   0x08          ;Initialize loop counter.
000E 0034         00155         movwf   cnt           ;
                  00156 ;for the 3 wire interface the direction of the i/o line connected to
                  00157 ;din and dout has to converted from an output to an input.
000F 0C02         00158         movlw   b'00000010'   ;convert RA1 to an input
0010 0005         00159         tris    serial        ;       /
                  00160
                  00161 d_i_8   clkit                 ;Clock a bit out of the 93C46.
                      M                               ;93C46 device.
0011 0545             M         bsf     serial,clock  ;Clock (CLK) = '1'.
                      M
0012 0000             M         nop                   ;Adjust the number of nop instructions
                      M                               ;between the assertion and de-assertion of
                      M                               ;CLK in proportion to the PIC operating
                      M                               ;frequency.  Refer to the 93C46 data for the
                      M                               ;minimum CLK period.
                      M
0013 0445             M         bcf     serial,clock  ;Clock (CLK) = '0'.
0014 0360         00162         rlf     indir, F      ;Make room for the incomming bit in the
                  00163                               ;destination register.
0015 0400         00164         bcf     indir,0       ;Assume that the incomming bit is a '0' and
                  00165                               ;clear the LSB of the destination register.
0016 0625         00166         btfsc   serial,dout   ;Test the incomming bit, if our assumption
                  00167                               ;was correct, skip the next instruction.
0017 0500         00168         bsf     indir,0       ;No, actual bit is a '1'.  Set the LSB of the
```

```
                00169                               ;destination register.
0018 02F4       00170           decfsz  cnt, F      ;Repeat until cnt = 0.
0019 0A11       00171           goto    d_i_8       ;Cnt still > 0
                00172 ;for a 3 wire interface, convert the RA1 line back to an output
001A 0C00       00173           movlw   0           ;make RA1 to an output
001B 0005       00174           tris    serial      ;       /
001C 0800       00175           retlw   no_err      ;Exit with good status.
                00176
                00177 ;*****************************************************************
                00178 ;*                       RDYCHK                                  *
                00179 ;*****************************************************************
                00180                               ;Rdychk will read the 93C46 READY/BUSY status
                00181                               ;and wait for RDY status within the alloted
                00182                               ;number of processor cycles.  If RDY status
                00183                               ;is not present after this set period, the
                00184                               ;routine will return with an error status.
                00185
001D 0C04       00186 rdychk    movlw   tries       ;Initialize time-out counter.
001E 0033       00187           movwf   cnthi       ;
001F 0074       00188           clrf    cnt         ;
                00189 ;for a 3 wire interface, make the RA1 line an input
0020 0C02       00190           movlw   b'00000010' ;
0021 0005       00191           tris    serial
                00192           dsel                ;De-select the 93C46.
0022 0405           M           bcf     serial,cs   ;Chip Select (CS) = '0' to de-select the
                    M                               ;device.
                00193
                00194 ;         nop                 ;NOTE:  Check the 93C46 data sheet for
                00195                               ;minimum CS low time.  Depending upon
                00196                               ;processor frequency, a nop(s) may be
                00197                               ;between the assertion and de-assertion of
                00198                               ;Chip Select.
                00199
                00200           sel                 ;Re-select the 93C46.
0023 0505           M           bsf     serial,cs   ;Chip Select (CS) = '1' to select the device.
0024 0625       00201 notrdy    btfsc   serial,dout ;If DO is a '0', 93C46 has yet to completed
                00202                               ;the last operation (still busy).
0025 0A2D       00203           goto    no_error    ;Otherwise RDY status is present within the
                00204                               ;alloted time, and return with good status.
0026 02F4       00205           decfsz  cnt, F      ;No, not yet ready.  Decrement the LSB of our
                00206                               ;16 bit timer and check for expiration.
0027 0A24       00207           goto    notrdy      ;Still some time left.  Try again.
0028 02F3       00208           decfsz  cnthi, F    ;Least significant byte expired - decrement
                00209                               ;and check for expiration of the MSB.
0029 0A24       00210           goto    notrdy      ;Still some time left.  Try again.
                00211 ;for a 3 wire interface, convert RA1 line back to an ouput
002A 0C00       00212           movlw   0           ;convert RA1 to an output
002B 0005       00213           tris    serial      ;       /
002C 0801       00214           retlw   err1        ;RDY status was not present in the alloted
                00215                               ;time, return with error status.
002D            00216 no_error
                00217 ;for a 3 wire interface, convert RA1 line back to an ouput
002D 0C00       00218           movlw   0           ;convert RA1 to an output
002E 0005       00219           tris    serial      ;       /
002F 0800       00220           retlw   no_err
                00221
                00222
                00223 ;*****************************************************************
                00224 ;*                       SEE                                     *
                00225 ;*****************************************************************
                00226
                00227                               ;See will control the entire operation of a
                00228                               ;93C46 device.  Prior to calling the routine,
                00229                               ;load a valid command/memory address into
                00230                               ;location cmd, and for WRITE or WRAL
                00231                               ;commands, load registers highb and lowb with
```


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```
                    00232                           ;16 bits of write data.  Upon exit, the W
                    00233                           ;register will contain the completion status.
                    00234                           ;Only 93C46 instructions which require a
                    00235                           ;status check can return with an error as the
                    00236                           ;completion status.  The values that denote
                    00237                           ;the completion status are defined as
                    00238                           ;variables 'error' and 'no_err' in the
                    00239                           ;general assignments section.
                    00240
0030 0C10           00241 see     movlw   cmd       ;Load W with the location of the cmd
                    00242                           ;register.
0031 0024           00243         movwf   fsr       ;Transfer that information into the File
                    00244                           ;Select Register.  The fsr now points to
                    00245                           ;location cmd.
                    00246         sel               ;Select the 93C46.
0032 0505               M         bsf     serial,cs ;Chip Select (CS) = '1' to select the device.
                    00247         strtbt            ;Send a start bit.
0033 0525               M         bsf     serial,din;Start Bit = '1'.
                        M         clkit             ;Clock it out.
                        M                           ;93C46 device.
0034 0545               M         bsf     serial,clock;Clock (CLK) = '1'.
                        M
0035 0000               M         nop               ;Adjust the number of nop instructions
                        M                           ;between the assertion and de-assertion of
                        M                           ;CLK in proportion to the PIC operating
                        M                           ;frequency.  Refer to the 93C46 data for the
                        M                           ;minimum CLK period.
                        M
0036 0445               M         bcf     serial,clock;Clock (CLK) = '0'.
0037 0900           00248         call dout8        ;Transmit the 2 bit command and six bit
                    00249                           ;address.
0038 06D0           00250         btfsc   cmd,6     ;Check for a WRITE or ERASE command.
0039 0A42           00251         goto    see2      ;Yes, parse the command further.
003A 06F0           00252         btfsc   cmd,7     ;Check for a READ command.
003B 0A4C           00253         goto    read_     ;Yes, process READ command.
003C 06B0           00254         btfsc   cmd,5     ;Check for a EWEN or ERAL command.
003D 0A49           00255         goto    see3      ;Yes, parse the command further.
003E 0690           00256         btfsc   cmd,4     ;Check for a WRAL command.
003F 0A51           00257         goto    write_    ;Yes, process WRITE/WRAL command.
                    00258
                    00259 exit_   dsel              ;No further processing required; 93C46
0040 0405               M         bcf     serial,cs ;Chip Select (CS) = '0' to de-select the
                        M                           ;device.
                    00260                           ;command completed.
0041 0800           00261         retlw   no_err    ;Return with good completion status.
                    00262
0042 07F0           00263 see2    btfss   cmd,7     ;Check for a ERASE command.
0043 0A51           00264         goto    write_    ;No, process WRITE command.
0044 091D           00265 exit2_  call    rdychk    ;ERASE command requires a status check.
                    00266         dsel              ;De-select the 93C46.
0045 0405               M         bcf     serial,cs ;Chip Select (CS) = '0' to de-select the
                        M                           ;device.
0046 01E2           00267         addwf   pc, F     ;Compute completion status from results of
                    00268                           ;status check.
0047 0800           00269         retlw   no_err    ;Return with good completion status.
0048 0801           00270         retlw   err1      ;Return with bad completion status.
                    00271
0049 0690           00272 see3    btfsc   cmd,4     ;Check for a EWEN command.
004A 0A40           00273         goto    exit_     ;Yes, no further processing required, exit
                    00274                           ;now.
004B 0A44           00275         goto    exit2_    ;No, ERAL command which requires a status
                    00276                           ;check.
                    00277
004C 02A4           00278 read_   incf    fsr, F    ;Increment the File Select Register to point
                    00279                           ;to the register receiving the upper byte of
                    00280                           ;the incomming 93C46 data word.
```

```
004D 090D       00281         call    din8          ;Input the upper byte.
004E 02A4       00282         incf    fsr, F        ;Increment the File Select Register to point
                00283                               ;to the register receiving the lower byte.
004F 090D       00284         call    din8          ;Input 8 more bits.
0050 0A40       00285         goto    exit_         ;No further processing required, exit now.
                00286
0051 02A4       00287 write_  incf    fsr, F        ;Increment the File Select Register to point
                00288                               ;to the upper byte of the 16 bit 93C46 data
                00289                               ;word to be transmitted.
0052 0900       00290         call    dout8         ;Output that byte.
0053 02A4       00291         incf    fsr, F        ;Increment the File Select Register to point
                00292                               ;to the lower byte.
0054 0900       00293         call    dout8         ;Output the lower byte of the 16 bit 93C46
                00294                               ;data word.
0055 0A44       00295         goto    exit2_        ;Exit with a status check.
                00296
                00297 ;*****************************************************************
                00298 ;*                      Test Program                             *
                00299 ;*****************************************************************
                00300 ;
0056            00301 main                          ;We've include a sample program to exercise
                00302                               ;the PIC to 93C46 interface using a simple
                00303                               ;erase, write and varify routine.
                00304
0056 0065       00305         clrf    serial        ;Clear the port tied to the 93C46 device.
0057 0CF4       00306         movlw   b'11110100'   ;Intialize the data direction register for
0058 0005       00307         tris    serial        ;that port.
                00308
0059 0C30       00309         movlw   ewen          ;Load W with the Erase/Write Enable command.
005A 0030       00310         movwf   cmd           ;Transfer W into cmd register.
005B 0930       00311         call    see           ;Enable the 93C46 device.
                00312
005C 0C20       00313         movlw   eral          ;Load W with the Erase All command.
005D 0030       00314         movwf   cmd           ;Transfer W into cmd register.
005E 0930       00315         call    see           ;Erase the 93C46.
005F 0F01       00316         xorlw   err1          ;Check completion status.
0060 0643       00317         btfsc   status, zflag ;Test for error condition.
0061 0A81       00318         goto    errloop       ;Yes, bad completion status, error-out.
                00319
                00320                               ;Write loop:
  0000001F      00321 loopcnt equ     0x1F          ;Define an unused location for our test
                00322                               ;program loop counter.
  000000AA      00323 tstptrn equ     0xAA          ;Define the test pattern to be written.
                00324
0062 0C40       00325         movlw   .64           ;Initialize that counter.
0063 003F       00326         movwf   loopcnt       ;
0064 0C40       00327         movlw   write         ;Load W with the Write command.
0065 0030       00328         movwf   cmd           ;Transfer W into cmd register.
0066 0CAA       00329         movlw   tstptrn       ;Intialize the 93C46 data registers with
                00330                               ;write data.
0067 0031       00331         movwf   highb         ;
0068 0032       00332         movwf   lowb          ;
0069 0930       00333 test1   call    see           ;Write data word into 93C46 device.
006A 0F01       00334         xorlw   err1          ;Check completion status.
006B 0643       00335         btfsc   status,zflag  ;Test for error condition.
006C 0A81       00336         goto    errloop       ;Yes, bad completion status, error-out.
006D 02B0       00337         incf    cmd, F        ;No, increment the 6 bit memory address
                00338                               ;field.
006E 02FF       00339         decfsz  loopcnt, F    ;Have we written all 64 locations?
006F 0A69       00340         goto    test1         ;No, write another location.
                00341
                00342                               ;Read loop:
                00343
0070 0C40       00344         movlw   .64           ;Initialize loop counter.
0071 003F       00345         movwf   loopcnt       ;
0072 0C80       00346         movlw   read          ;Load W with the Read command.
```


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```
0073 0030       00347         movwf   cmd           ;Transfer W into cmd register.
0074 0930       00348 test2   call    see           ;Read addressed data word from 93C46 device.
0075 0CAA       00349         movlw   tstptrn       ;Load W with the pattern written.
0076 0091       00350         subwf   highb,0       ;Verify the data read against what was
                00351                               ;written.
0077 0743       00352         btfss   status,zflag  ;Same?
0078 0A81       00353         goto    errloop       ;No, error-out.
0079 0CAA       00354         movlw   tstptrn       ;Repeat with the lower byte read.
007A 0092       00355         subwf   lowb,0        ;
007B 0743       00356         btfss   status,zflag  ;Same?
007C 0A81       00357         goto    errloop       ;No, error-out.
007D 02B0       00358         incf    cmd, F        ;Yes, both byte correct, increment the 6 bit
                00359                               ;memory address field.
007E 02FF       00360         decfsz  loopcnt, F    ;Have we read all 64 locations?
007F 0A74       00361         goto    test2         ;No, read another location.
                00362
0080 0A80       00363 allok   goto    allok         ;Home safe!
                00364
0081 0A81       00365 errloop goto    errloop       ;Bad news!
                00366
                00367         END                   ;Thats all folks!
MEMORY USAGE MAP ('X' = Used,  '-' = Unused)

0000 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
0040 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
0080 : XX-------------- ---------------- ---------------- ----------------
93C46 3 WIRE INTERFACE ROUTINE
MEMORY USAGE MAP ('X' = Used,  '-' = Unused)


01C0 : ---------------- ---------------- ---------------- ---------------X

All other memory blocks unused.

Program Memory Words Used:   131
Program Memory Words Free:   381


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

NOTES:

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NOTES:

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