LCD AND KEYBOARD INTERFACING

The 8051 Microcontroller and Embedded Systems: Using Assembly and C

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LCD INTERFACING

LCD Operation

- LCD is finding widespread use replacing LEDs
  - The declining prices of LCD
  - The ability to display numbers, characters, and graphics
  - Incorporation of a refreshing controller into the LCD, thereby relieving the CPU of the task of refreshing the LCD
  - Ease of programming for characters and graphics

LCD INTERFACING

LCD Pin Descriptions

- Send displayed information or instruction command codes to the LCD
- Read the contents of the LCD's internal registers

Pin Descriptions for LCD

Pin	Symbol	I/O	Descriptions
1	VSS	--	Ground
2	VCC	--	+5V power supply
3	VEE	--	Power supply to control contrast
4	RS	I	RS=0 to select command register, RS=1 to select data register
5	R/W	I	R/W=0 for write, R/W=1 for read
6	E	I/O	Enable
7	DB0	I/O	The 8-bit data bus
8	DB1	I/O	The 8-bit data bus
9	DB2	I/O	The 8-bit data bus
10	DB3	I/O	The 8-bit data bus
11	DB4	I/O	The 8-bit data bus
12	DB5	I/O	The 8-bit data bus
13	DB6	I/O	The 8-bit data bus
14	DB7	I/O	The 8-bit data bus

used by the LCD to latch information presented to its data bus

LCD INTERFACING

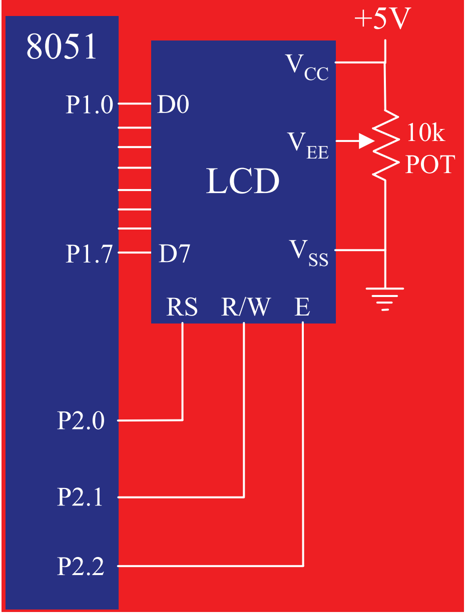
LCD Command Codes

LCD Command Codes

Code (Hex)	Command to LCD Instruction Register
1	Clear display screen
2	Return home
4	Decrement cursor (shift cursor to left)
6	Increment cursor (shift cursor to right)
5	Shift display right
7	Shift display left
8	Display off, cursor off
A	Display off, cursor on
C	Display on, cursor off
E	Display on, cursor blinking
F	Display on, cursor blinking
10	Shift cursor position to left
14	Shift cursor position to right
18	Shift the entire display to the left
1C	Shift the entire display to the right
80	Force cursor to beginning to 1st line
C0	Force cursor to beginning to 2nd line
38	2 lines and 5x7 matrix

LCD INTERFACING

Sending Data/ Commands to LCDs w/ Time Delay

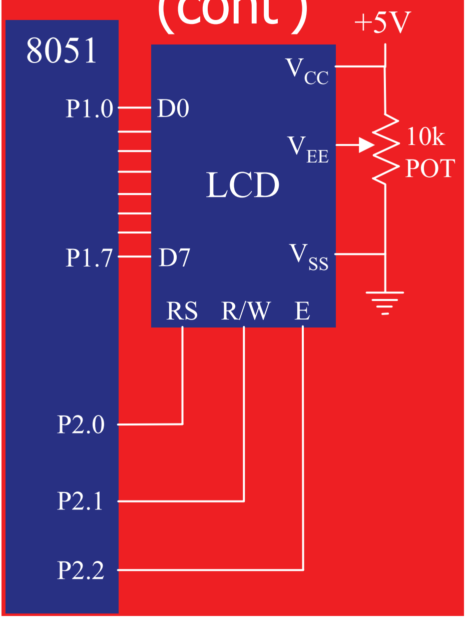


To send any of the commands to the LCD, make pin RS=0. For data, make RS=1. Then send a high-to-low pulse to the E pin to enable the internal latch of the LCD. This is shown in the code below.

```
;calls a time delay before sending next data/command
;P1.0-P1.7 are connected to LCD data pins D0-D7
;P2.0 is connected to RS pin of LCD
;P2.1 is connected to R/W pin of LCD
;P2.2 is connected to E pin of LCD
        ORG   0H
        MOV   A,#38H  ;INIT. LCD 2 LINES, 5X7 MATRIX
        ACALL COMNWRT ;call command subroutine
        ACALL DELAY   ;give LCD some time
        MOV   A,#0EH  ;display on, cursor on
        ACALL COMNWRT ;call command subroutine
        ACALL DELAY   ;give LCD some time
        MOV   A,#01   ;clear LCD
        ACALL COMNWRT ;call command subroutine
        ACALL DELAY   ;give LCD some time
        MOV   A,#06H  ;shift cursor right
        ACALL COMNWRT ;call command subroutine
        ACALL DELAY   ;give LCD some time
        MOV   A,#84H  ;cursor at line 1, pos. 4
        ACALL COMNWRT ;call command subroutine
        ACALL DELAY   ;give LCD some time
.....
```

LCD INTERFACING

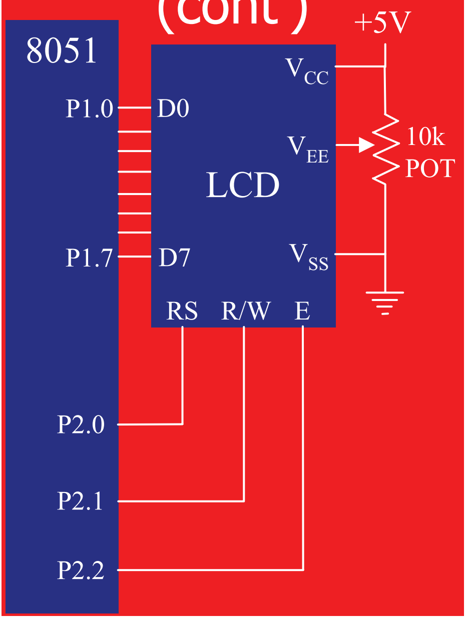
Sending Data/ Commands to LCDs w/ Time Delay (cont')



```
.....
        MOV   A,#'N'    ;display letter N
        ACALL DATAWRT   ;call display subroutine
        ACALL DELAY     ;give LCD some time
        MOV   A,#'O'     ;display letter O
        ACALL DATAWRT   ;call display subroutine
AGAIN:  SJMP  AGAIN     ;stay here
COMNWRT:                ;send command to LCD
        MOV   P1,A      ;copy reg A to port 1
        CLR   P2.0      ;RS=0 for command
        CLR   P2.1      ;R/W=0 for write
        SETB  P2.2      ;E=1 for high pulse
        ACALL DELAY     ;give LCD some time
        CLR   P2.2      ;E=0 for H-to-L pulse
        RET
DATAWRT:                ;write data to LCD
        MOV   P1,A      ;copy reg A to port 1
        SETB  P2.0      ;RS=1 for data
        CLR   P2.1      ;R/W=0 for write
        SETB  P2.2      ;E=1 for high pulse
        ACALL DELAY     ;give LCD some time
        CLR   P2.2      ;E=0 for H-to-L pulse
        RET
DELAY:  MOV   R3,#50    ;50 or higher for fast CPUs
HERE2:  MOV   R4,#255   ;R4 = 255
HERE:   DJNZ  R4,HERE   ;stay until R4 becomes 0
        DJNZ  R3,HERE2
        RET
        END
```

LCD INTERFACING

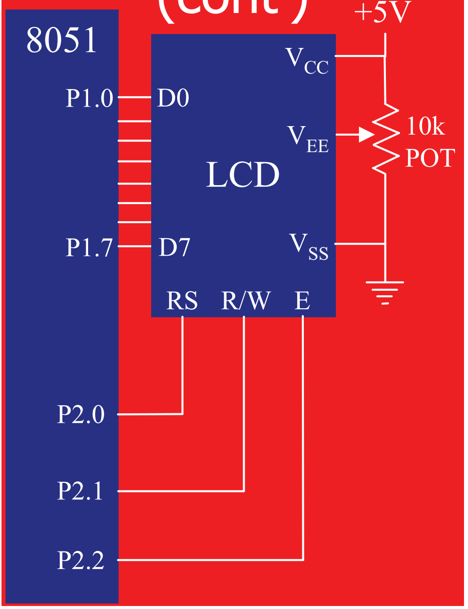
Sending Data/ Commands to LCDs w/ Time Delay (cont')



```
;Check busy flag before sending data, command to LCD
;p1=data pin
;P2.0 connected to RS pin
;P2.1 connected to R/W pin
;P2.2 connected to E pin
     ORG   0H
     MOV   A,#38H      ;init. LCD 2 lines ,5x7 matrix
     ACALL COMMAND     ;issue command
     MOV   A,#0EH      ;LCD on, cursor on
     ACALL COMMAND     ;issue command
     MOV   A,#01H      ;clear LCD command
     ACALL COMMAND     ;issue command
     MOV   A,#06H      ;shift cursor right
     ACALL COMMAND     ;issue command
     MOV   A,#86H      ;cursor: line 1, pos. 6
     ACALL COMMAND     ;command subroutine
     MOV   A,#'N'      ;display letter N
     ACALL DATA_DISPLAY
     MOV   A,#'O'      ;display letter O
     ACALL DATA_DISPLAY
HERE:SJMP  HERE        ;STAY HERE
.....
```

LCD INTERFACING

Sending Codes and Data to LCDs w/ Busy Flag (cont')



```
.....
COMMAND:
     ACALL READY            ;is LCD ready?
     MOV   P1,A             ;issue command code
     CLR   P2.0             ;RS=0 for command
     CLR   P2.1             ;R/W=0 to write to LCD
     SETB  P2.2             ;E=1 for H-to-L pulse
     CLR   P2.2             ;E=0,latch in
     RET
DATA_DISPLAY:
     ACALL READY            ;is LCD ready?
     MOV   P1,A             ;issue data
     SETB  P2.0             ;RS=1 for data
     CLR   P2.1             ;R/W =0 to write to LCD
     SETB  P2.2             ;E=1 for H-to-L pulse
     CLR   P2.2             ;E=0,latch in
     RET
READY:
     SETB  P1.7             ;make P1.7 input port
     CLR   P2.0             ;RS=0 access command reg
     SETB  P2.1             ;R/W=1 read command reg
;read command reg and check busy flag
BACK:SETB  P2.2             ;E=1 for H-to-L pulse
     CLR   P2.2             ;E=0 H-to-L pulse
     JB    P1.7,BACK        ;stay until busy flag=0
     RET
     END
```

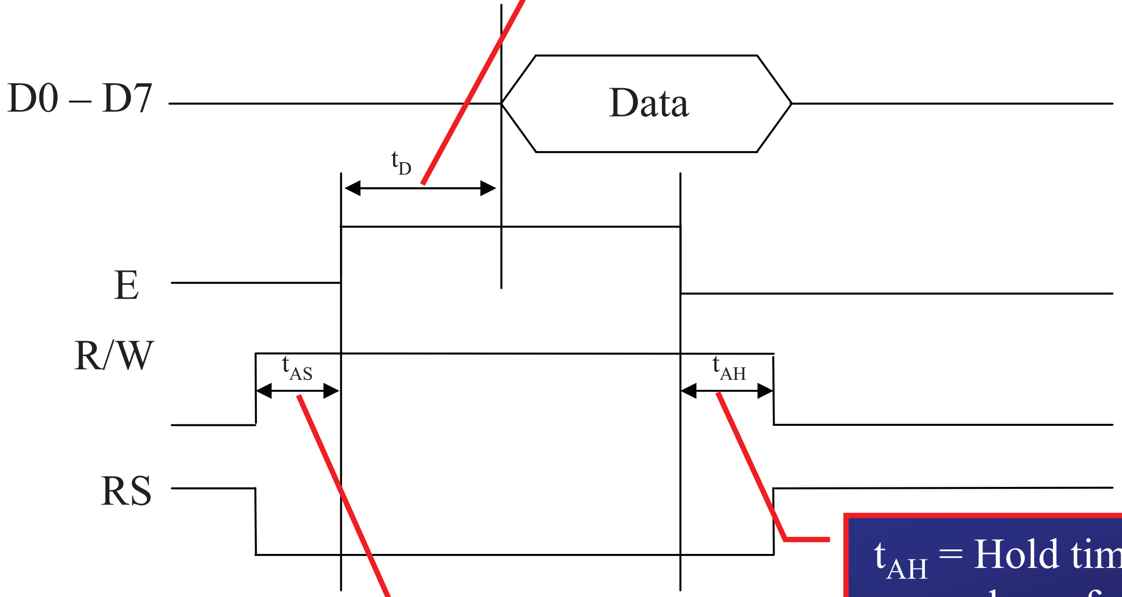
To read the command register, we make R/W=1, RS=0, and a H-to-L pulse for the E pin.

If bit 7 (busy flag) is high, the LCD is busy and no information should be issued to it.

LCD INTERFACING

Sending Codes and Data to LCDs w/ Busy Flag
(cont')

LCD Timing for Read



t_D = Data output delay time

t_{AH} = Hold time after E has come down for both RS and R/W = 10 ns (minimum)

t_{AS} = Setup time prior to E (going high) for both RS and R/W = 140 ns (minimum)

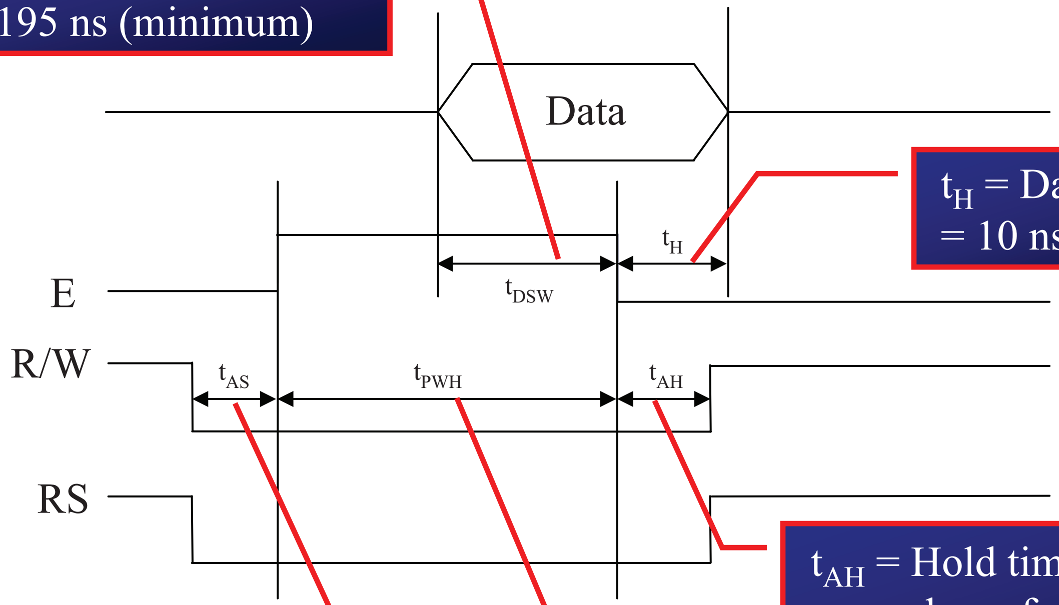
Note : Read requires an L-to-H pulse for the E pin

LCD INTERFACING

Sending Codes and Data to LCDs w/ Busy Flag (cont')

LCD Timing for Write

t_{DSW} = Data set up time = 195 ns (minimum)



t_H = Data hold time = 10 ns (minimum)

t_{AH} = Hold time after E has come down for both RS and R/W = 10 ns (minimum)

t_{PWH} = Enable pulse width = 450 ns (minimum)

t_{AS} = Setup time prior to E (going high) for both RS and R/W = 140 ns (minimum)

LCD
INTERFACING

LCD Data Sheet

- One can put data at any location in the LCD and the following shows address locations and how they are accessed

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	A	A	A	A	A	A	A

- AAAAAAA=000_0000 to 010_0111 for line1
- AAAAAAA=100_0000 to 110_0111 for line2

The upper address range can go as high as 0100111 for the 40-character-wide LCD, which corresponds to locations 0 to 39

LCD Addressing for the LCDs of 40×2 size

	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Line1 (min)	1	0	0	0	0	0	0	0
Line1 (max)	1	0	1	0	0	1	1	1
Line2 (min)	1	1	0	0	0	0	0	0
Line2 (max)	1	1	1	0	0	1	1	1