

LCD Interfacing

Introduction

- 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 Pin Description

Pin Descriptions for LCD

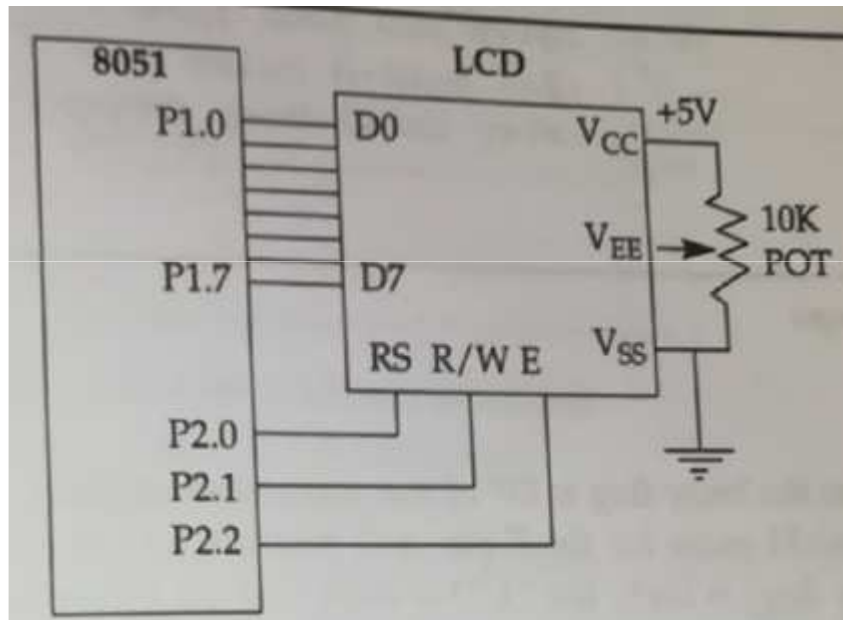
Pin	Symbol	I/O	Descriptions
1	VSS	--	Ground
2	VCC	--	+5V power supply
3	VEE	--	Power supply to control contrast
4	RS	I	RS=0 to select command register, RS=1 to select data register
5	R/W	I	R/W=0 for write, R/W=1 for read
6	E	I/O	Enable
7	DB0	I/O	The 8-bit data bus
8	DB1	I/O	The 8-bit data bus
9	DB2	I/O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

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

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

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

Sending Data/ Commands to LCDs with a 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
```

.....

Sending Data/ Commands to LCDs with a Time Delay

```
.....  
      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:  
      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:  
      MOV    P1,A        ;write data to LCD  
      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
```


Sending code/data to the LCD with checking busy flag

```
;Check busy flag before sending data, command to LCD
;pl=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
.....
```

Sending code/data to the LCD with checking busy flag

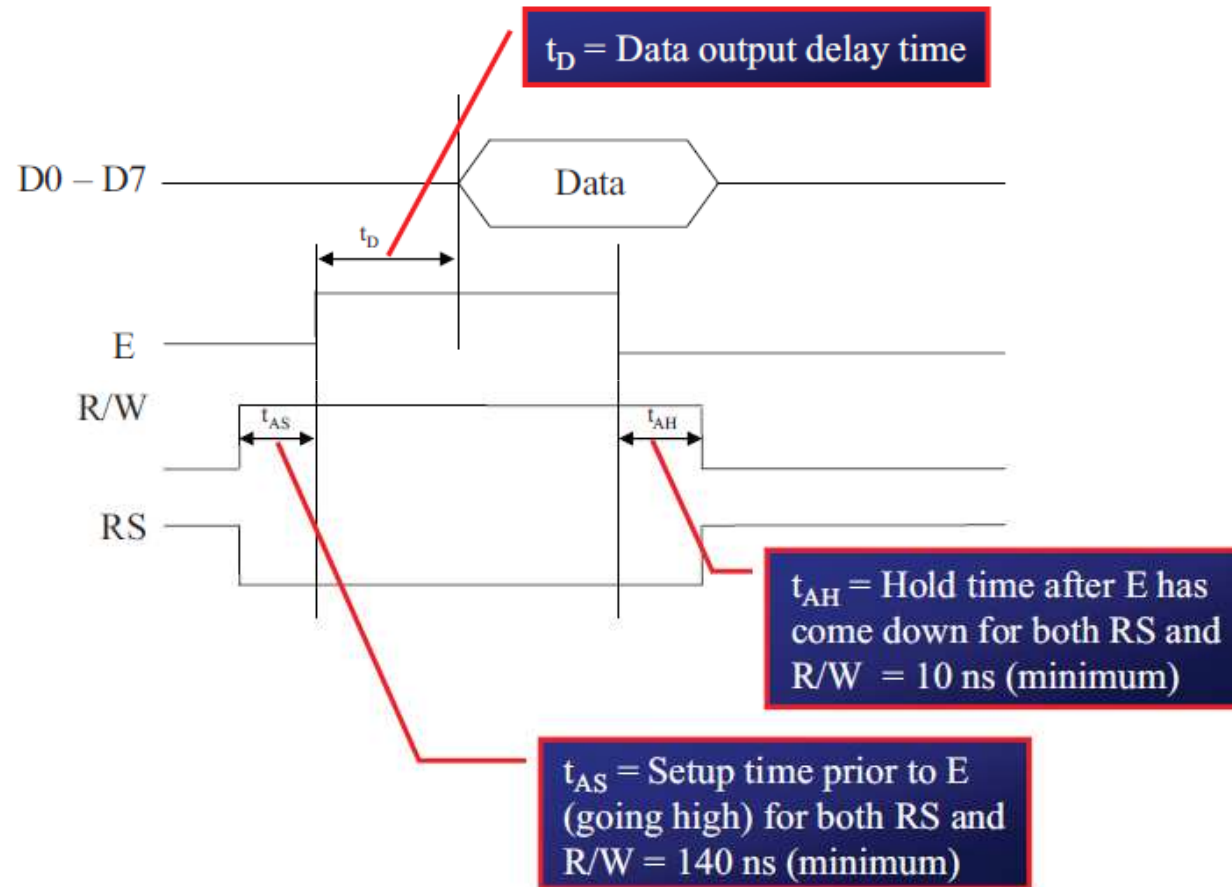
```
.....  
COMMAND:  
    ACALL READY          ;is LCD ready?  
    MOV    P1,A          ;issue command code  
    CLR    P2.0          ;RS=0 for command  
    CLR    P2.1          ;R/W=0 to write to LCD  
    SETB   P2.2          ;E=1 for H-to-L pulse  
    CLR    P2.2          ;E=0,latch in  
    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.

Sending code/data to the LCD with checking busy flag

LCD Timing for Read

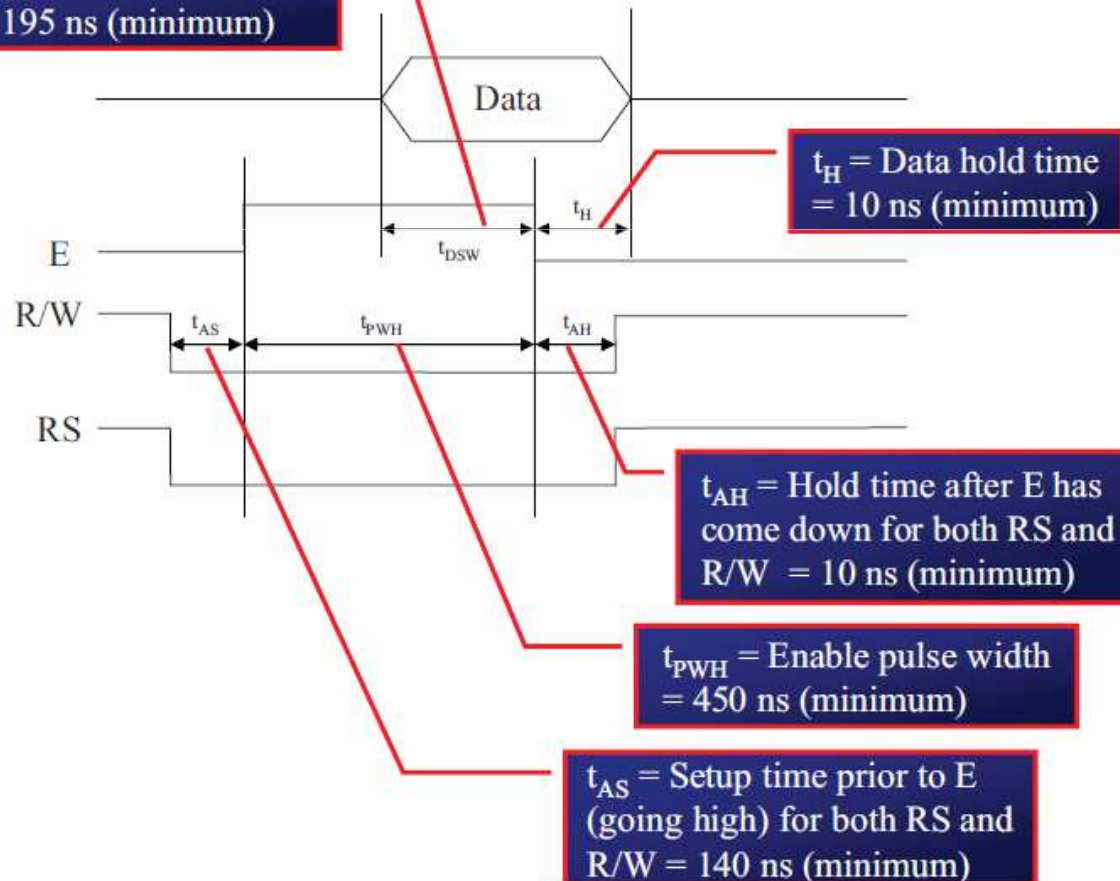


Note : Read requires an L-to-H pulse for the E pin

Sending code/data to the LCD with checking busy flag

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 Datasheet and Addressing

- ❑ 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

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

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

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