

LCD Interfacing

LCD Interfacing

- Liquid Crystal Displays (LCDs)
- **cheap** and **easy** way to display text
- Various configurations (1 line by 20 X char upto 8 lines X 80).
- Integrated controller
- The display has two register
 - **command** register
 - **data** register
- By **RS** you can select register
- Data lines (DB7-DB0) used to transfer data and commands

Alphanumeric LCD Interfacing

Microcontroller

- Pinout

- 8 data pins D7:D0
- RS: Data or Command Register Select
- R/W: Read or Write
- E: Enable (Latch data)

- RS – Register Select

- RS = 0 → Command Register
- RS = 1 → Data Register

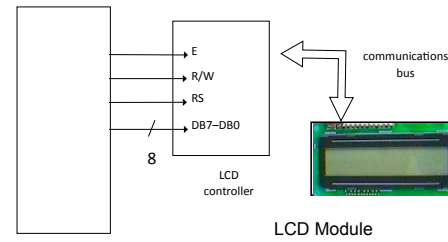
- R/W = 0 → Write , R/W = 1 → Read

- E – Enable

- Used to latch the data present on the data pins.

- D0 – D7

- Bi-directional data/command pins.
- Alphanumeric characters are sent in ASCII format.



LCD Commands

- The LCD's internal controller can accept several commands and modify the display accordingly. These commands would be things like:
 - Clear screen
 - Return home
 - Decrement/Increment cursor
- After writing to the LCD, it **takes some time** for it to complete its internal operations. During this time, it will not accept any new commands or data.
 - We need to insert time **delay** between any two commands or data sent to LCD

Pin Description

Table 4-7: Pin Descriptions for LCD

Pin	Symbol	I/O	Description
1	V _{SS}	--	Ground
2	V _{CC}	--	+5V power supply
3	V _{EE}	--	Power supply source to control contrast
4	RS	I	Register select: RS=0 to select instruction command register, RS = 1 to select data register
5	R/W	I	Read/write: R/W=0 for write, R/W=1 for read
6	E	I	Enable
7	DB0	I/O	The 8-bit data bus
8	DB1	I/O	" "
9	DB2	I/O	" "
10	DB3	I/O	" "
11	DB4	I/O	" "
12	DB5	I/O	" "
13	DB6	I/O	" "
14	DB7	I/O	" "

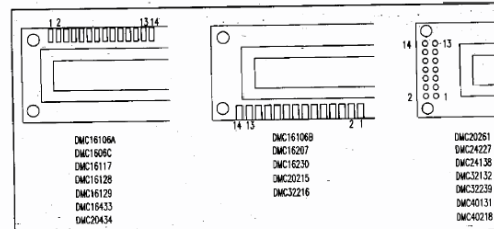


Figure 4-34. Pin Positions for Various LCDs from Optrex

Command Codes

Table 4-8: 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 on
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
C0	Force cursor to beginning of 2nd line
38	2 lines and 5x7 matrix

Note: This table is extracted from Table 4-10.

LCD Addressing

```

16 x 2 LCD
80 81 82 83 84 85 86 through 8F
C0 C1 C2 C3 C4 C5 C6 through CF
20 x 1 LCD
80 81 82 83 through 93
20 x 2 LCD
80 81 82 83 through 93
C0 C1 C2 C3 through D3
20 x 4 LCD
80 81 82 83 through 93
C0 C1 C2 C3 through D3
94 95 96 97 through A7
D4 D5 D6 D7 through E7
40 x 2 LCD
80 81 82 83 through A7
C0 C1 C2 C3 through E7
    
```

Note: All data is in hex.

Figure 4-36. Cursor Addresses for Some LCDs

Table 4-9: LCD Addressing

	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Line 1 (min)	1	0	0	0	0	0	0	0
Line 1 (max)	1	0	1	0	0	1	1	1
Line 2 (min)	1	1	0	0	0	0	0	0
Line 2 (max)	1	1	1	0	0	1	1	1

LCD Timing

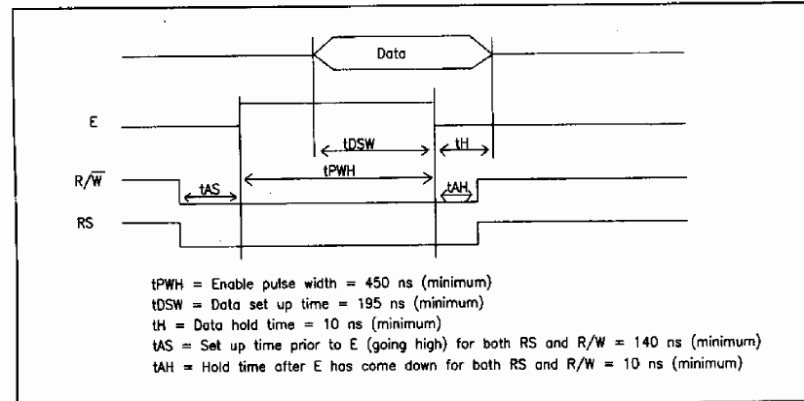
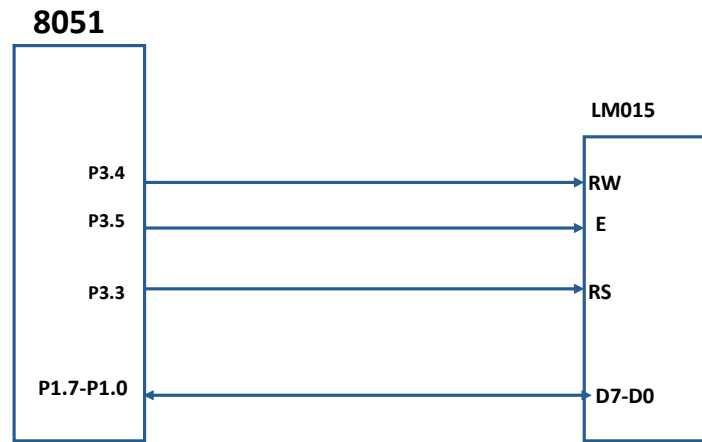


Figure 4-37. LCD Timing

Table 4-10: List of Instructions (Courtesy of Optrex Corporation)

Instruction	Code										Description	Execution Time (max)
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Clear Display	0	0	0	0	0	0	0	0	0	1	Clears entire display and sets DD RAM address 0 in address counter.	1.64 ms
Return Home	0	0	0	0	0	0	0	0	0	1	Sets DD RAM address 0 as address counter. Also returns display being shifted to original position. DD RAM contents remain unchanged.	1.64 ms
Entry Mode Set	0	0	0	0	0	0	0	1	1/D	S	Sets cursor move direction and specifies shift of display. These operations are performed during data write and read.	40 μs
Display ON/OFF Control	0	0	0	0	0	0	1	D	C	B	Sets ON/OFF of entire display (D), cursor ON/OFF (C), and blink of cursor position character (b).	40 μs
Cursor or Display Shift	0	0	0	0	0	1	S/C	R/L	--	--	Moves cursor and shifts display without changing DD RAM contents.	40 μs
Function Set	0	0	0	0	1	DL	N	F	--	--	Sets interface data length (DL), number of display lines (L) and character font (F).	40 μs
Set CG RAM Address	0	0	0	1	AGC						Sets CG RAM address. CG RAM data is sent and received after this setting.	40 μs
Set DD RAM Address	0	0	1	ADD							Sets DD RAM address. DD RAM data is sent and received after this setting.	40 μs
Read Busy Flag & Address	0	1	BF	AC							Reads Busy flag (BF) indicating internal operation is being performed and reads address counter contents.	40 μs
Write Data to CG or DD RAM	1	0	Write Data								Writes data into DD RAM or CG RAM.	40 μs
Read Data from CG or DD RAM	1	1	Read Data								Reads data from DD RAM or CG RAM.	40 μs

Interfacing LCD with 8051



Interfacing LCD with 8051

```
mov A, command
call cmd
delay
mov A, another_cmd
call cmd
delay
mov A, #'A'
call data
delay
mov A, #'B'
call data
delay
...
Command and Data Write Routines
data:mov P1, A      ;A is ascii data
      setb P3.3     ;RS=1 data
      clr P3.4      ;RW=0 for write
      setb P3.5     ;H->L pulse on E
      clr P3.5
      ret
cmd:mov P1,A       ;A has the cmd word
      clr P3.3     ;RS=0 for cmd
      clr P3.4      ;RW=0 for write
      setb P3.5     ;H->L pulse on E
      clr P3.5
      ret
```

Example

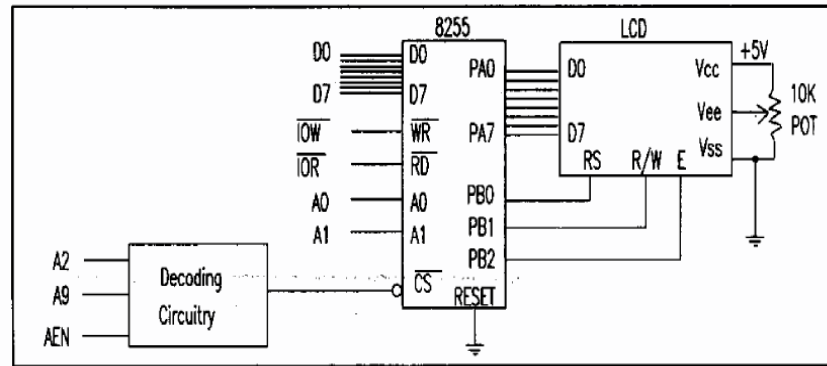


Figure 4-35. 8255-to-PC Interface Connection to LCD