EXPERIMENT NO.-7

TITLE

Interfacing of LCD to PIC Microcontroller.

AIM

To Interface the LCD (8-bit Mode & 4-bit Mode).

THEORY

1. LCD Interfacing

Commonly used output peripherals in embedded systems are LEDs, seven-segment LEDs, and LCDs; The most commonly used Character based LCDs are based on Hitachi's HD44780 controller or other which are compatible with HD44580. Here we consider the character based LCDs, their interfacing with various microcontrollers, various interfaces (8-bit/4-bit), programming, special stuff and tricks you can do with these simple looking LCDs which can give a new look to your application. For Specs and technical information HD44780 controller. LCDs have become a cheap and easy way to get text display for embedded system Common displays are set up as 16 to 20 characters by 1 to 4 lines

General consideration

- Liquid Crystal Displays (LCDs)
- cheap and easy way to display text
- Used to display letters, numbers, Alphabets, Graphics
- Various configurations (1 line by 20 X char up to 8 lines X 80). [8x2,16x1, 16x2, 16x4, 20x2, 24x2,40x2, 40x4]
- Integrated controller
- The display has two register can be selected using RS register
  - Command register - Data register
- Data lines (DB7-DB0) used to transfer data and commands

1.1 LCD pin descriptions:

1.1.1 Vcc, Vss and Vee:

While Vcc and Vss provide +5V and ground, repectively, Vee is used for controlling LCD contrast. The most commonly used LCDs found in the market today are 1 Line, 2 Line or 4 Line LCDs which have only 1 controller and support at most of 80

characters, whereas LCDs supporting more than 80 characters make use of 2 HD44780 controllers.

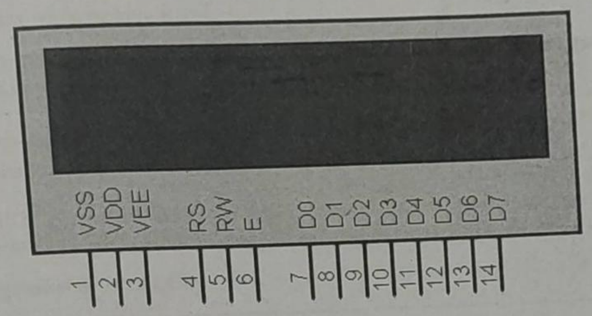


Fig (1): view of LED

1.1.2 Register Select (RS):

There are two very important registers inside the LCD. The RS pin is used for their selection as follows.

a. RS = 0: the instruction command code register is selected, allowing the user to send a command such as clear display, cursor at home.

b. RS = 1: the data register is selected, allowing the user to send the data to be displayed on the LCD.

1.1.3 Read/write (R/W):

R/W input allows the user to write information to the LCD or read information from it. R/W = 1 when reading, R/W = 0 when writing.

1.1.4 Enable (EN):

The enable pin is used by the LCD to latch information presented to its data pins. When data is supplied to data pins, a high to low pulse must be applied to the pin in order for the LCD to latch in the data present at the data pins. This pulse must be a minimum of 450ns wide.

1.1.5 Data bus (D0 – D7):

The 8-bit data pins, D0-D7 are used to send the information to the LCD or read the contents of the LCD's internal registers. To display the numbers and letters, we send ASCII codes to these pins while making RS=1.

There are also instruction command codes that can be sent to the LCD to clear the display or blink the cursor.

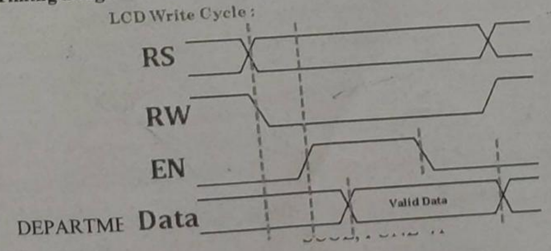
We also use RS = 0 to check the busy flag bit to see if the LCD is ready to receive information. The busy flag is D& and can be read when R/W = 1 and

RS=0. When D7 =1, the LCD is busy taking care of internal operations and will not accept any new information. When D7 = 0, the LCD is ready to receive new information.

1.2 Pin Assignment of 16x2 LCD

Pin number	Symbol	Level	I/O	Function
1	Vss	-	-	Power supply (GND)
2	Vcc	-	-	Power supply (+5V)
3	Vee	-	-	Contrast adjust
4	RS	0/1	I	0 = Instruction input
5	R/W	0/1	I	0 = Write to LCD module
6	E	1, 1->0	I	Enable signal
7	DB0	0/1	I/O	Data bus line 0 (LSB)
8	DB1	0/1	I/O	Data bus line 1
9	DB2	0/1	I/O	Data bus line 2
10	DB3	0/1	I/O	Data bus line 3
11	DB4	0/1	I/O	Data bus line 4
12	DB5	0/1	I/O	Data bus line 5
13	DB6	0/1	I/O	Data bus line 6
14	DB7	0/1	I/O	Data bus line 7 (MSB)
15	VB+	1	-	Backlight Supply

1.3 Timing Diagram for 16x2 LCD



DEPARTME ENGINEERING

LCD Writing: Condition RS=0, R/W=0, EN= L-H short pulse timing diagram for LCD writing is shown in fig(3)

1.4 LCD command codes

- 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

Command codes are shown in table 1

BIT	RS	R/W	D7	D6	D5	D4	D3	D2	D1	D0	Function
	0	0	0	0	0	0	0	0	0	1	Clear LCD and memory, home cursor
	0	0	0	0	0	0	0	0	1	0	Clear and home cursor only
	0	0	0	0	0	0	0	1	I/O	S	Screen action as display character written S = 1/0: Shift screen/cursor I/0 = 1/0: Cursor R/L, screen L/R
	0	0	0	0	0	0	1	D	C	B	D = 1/0: Screen on/off C = 1/0: Cursor on/off B = 1/0: Cursor Blink/Noblink
	0	0	0	0	0	1	S/C	R/L	0	0	S/C = 1/0: Screen/Cursor R/L = 1/0: Shift one space R/L
	0	0	0	0	1	DL	N	F	0	0	DL = 1/0: 8/4 Bits per character N = 1/0; 2/1 Rows of characters F = 1/0; 5X10/5X7 Dots/Character
	0	0	0	1	Character address						Write to character RAM Address after this
	0	0	1	Display data address							Write to display RAM Address after this
	0	1	BF	Current address							BF = 1/0: Busy/Notbusy
	1	0		Character byte							Write byte to last RAM chosen
	1	1		Character byte							Read byte from last RAM chosen

Sr. No.	Command to LCD instruction	Code (Hex)
01	Clear display screen	01
02	Return home	02
03	Decrement cursor (shift cursor to left)	04
04	Increment cursor (shift cursor to right)	06
05	Shift display right	05
06	Shift display left	07
07	Display off, cursor off	08
08	Display off, cursor on	0A
09	Display on, cursor off	0C

10	Display on cursor blinking	0E
11	Shift cursor position to left	10
12	Shift cursor position to right	14
13	Shift the entire display to left	18
14	Shift the entire display to right	1C
15	Force cursor to beginning of 1st line.	80
16	Force cursor to beginning of 2nd line.	C0
17	2 lines and 5x7 matrixes.	38

LCD Addressing: The starting address for line one and line two are given in table 2

Table 2: 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	0	0

INTERFACING DIAGRAM

ALGORITHM

General steps for programming of LCD

1. **Initialize LCD using format – function set**
2. **Command word for display on Blinking/no blinking**
3. **Command word for clear LCD screen**
4. **Command for cursor shift (Right or Left)**
5. **Command for position of cursor 80+ for line 1 & C0+ for line 2**
6. **load characters to be displayed**
7. **While writing each command be sure that RS=0, R/W=0 E=1 H-L pulse, E=0 Latch in**

IMP

Before start writing LCD for Display of information it is necessary to check for busy flag.

- **Check for busy flag (D7) bit**
  - **RS=0, and R/W=1, D7=1 – LCD is busy taking care of internal operations and not accept any data.**
  - **RS=0, and R/W=1, D7=0 – LCD is ready to accept any data.**
- **For command RS=0 is passed through port line**
- **For Data RS=1 is passed through port line**
- **Send high to low pulse to 'E' pin to enable the internal latch of LCD**
- **Call delay for completion of internal operations**
- **Send different command words**
- **Pass data to be displayed [On any line]]**

Algorithm for Checking the Busy Flag

You can use subroutine for checking busy flag or just a big (and safe) delay.

1. Set R/W Pin of the LCD HIGH(read from the LCD)
2. Select the instruction register by setting RS pin LOW
3. Enable the LCD by Setting the enable pin HIGH
4. The most significant bit of the LCD data bus is the state of the busy flag(1=Busy,0=ready to accept instructions/data). The other bits hold the current value of the address counter.

If the LCD never come out from"busy" status because of some problems, The program will"hang," waiting for DB7 to go low. So in real applications it would be wise to put some kind of time limit on the delay--for example, a maximum of 100 attempts to wait for the busy signal to go low. This would guarantee that even if the LCD hardware fails, the program would not lock up.

Algorithm for Command word

1. Select the instruction register by setting RS pin LOW
2. Set R/W Pin of the LCD low(write to LCD)
3. Enable the LCD by Setting the enable pin HIGH
4. Delay
5. Latch the data E=0

Algorithm for Data write to LCD

1. Select the instruction register by setting RS pin high
2. Set R/W Pin of the LCD low (write to LCD)
3. Enable the LCD by Setting the enable pin HIGH
4. Delay
5. Latch the data E=0

FLOWCHART

CONLCLUSION

In this practical we have studied about interfacing of LCD to PIC microcontroller.

2 Draw and explain interfacing diagram of key with PIC18F microcontroller.

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