User's Manual

FOR

LCD DISPLAY INTERFACING MODULE
ET - LCD

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LCD DISPLAY INTERFACING MODULE (ET-LCD)

The LCD Display Interfacing Module (ET-LCD) will demonstrate to the student that as to how a LCD display device can be configured through I/O lines of 8255 to display the desired information.

DESCRIPTION

L C D stands for LIQUIED CRYSTAL DISPLAY and is a commonly used as O/P device for the microprocessor based system. As compared to the other commonly used O/P devices i.e. light Emitting Diode (LED) Display, they consume very less power and they don't emit their own light but use ambient light.

The LCD module used here is CTS-1612. It is a 16 character * 2 line display module, without backlight. A character is displayed using 5*7 dots format. It is compatible with both 4 and 8 bit microprocessor. This LCD module has 14 pins. The various signals on them can be classified into 3 groups, namely Power signals, Control signals & Data signals.

- Signals constituting the power signals are:

1. Vss (1) : Ground
2. Vdd (2) : Supply voltage for logic and LCD. It should be 5v +-5%
3. V0 (3) : Supply voltage for LCD. By varying this contrast can be varied.

- Signal forming the control group are :

1. RS (4): It stands for Registered selection. Depending upon its status, the contents of the data bus are treated as an instruction code or data. A High on this pin means that contents of the data bus are to be treated as the data while low on it means that their contents are to be treated as an instruction code.

2. R/W (5): Status of this pin indicates whether the MPU will read or write data, from or to, the LCD module. A high on this pin will initiate a read cycle, while a low on it will initiate a write cycle.

3. E (6): This is the Enable signal. While performing either read or writes operation, a High and then High to Low transition has to be provided on this pin.

Above-mentioned control signal can be connected to 3 I/O lines.

- Eight signals forming the data bus signal is:

1. DB0 – DB7 (7-14): These can be connected to B I/O port lines. DB0 is the LSB & DB7 is the MSB.

Dot matrix LCD controller used in this LCD module is KS 0066. It automatically initializes (reset), when power is turn on, using the internal reset ckt. However when the power supply conditions are not met, MPU will reset the LCD module by issuring a sequence of instruction show under the heading "Initialization by instruction". It has internal memory called Display Data Ram (80 * 8 bits).

HOW TO DISPLAY A STRING OF CHARACTERS

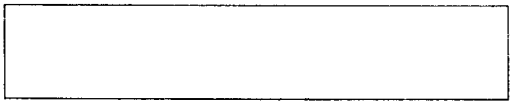
A character can be display by writing its ASCII code into the DISPLAY DATA RAM (DDRAM), which can hold a maximum of 80 character code. RAM is divided in two groups. Starting address of the 1st group is (refer to table 2) 80H while that of 2nd group is A9H. Contents of 1st 8 locations of group 1 are displayed at 1st 8-display position, while those of 2nd group are displayed at next 8-display position. Now that the display is full, if we go to the SHIFT mode, 1st 8-display position shows the character whose code is 81h-88h, after a write operation. The 2nd 8 display position now show the characters whose code are at AAh-B1h. Like this characters are shifted with each write/read operation. Through **RESTORE** command, contents of 80-87h at 1st 8-display position and A9-B0 at next 8-display position can be brought back.

Also the DDRAM is more of a sequential memory than a random memory. It is so since, memory location can be accessed serially only. For example, say we want to write something at 87h which belongs to 1st group of DDRAM. To get there we would have to initialize address counter of DDRAM at 80h (start of 1st group of DDRAM), perform 7 dummy write operation and then write what we intended to write at 87h, which is presently pointed by the address counter for the DDRAM. Same is true for the 2nd group of memory, whose starting address is A9h.

Another point to be noted is that, say presently contents of 88-8F & B1-B8 are being displayed and a write operation is performed at 80-87, the changes due to these write operation won't be visible immediately. It could be seen only if the display is restored i.e. contents of 80-87h are put on display. However if this write operation is continued till 8FH then the changes from 88-8F would be visible immediately, since their contents are currently being displayed, at 1st 8-display position.

Keeping these points in mind a program has been written to display contents of memory starting from 2600H till 00 is encountered.

The Sample program display the character stored in the memory location 2600H onwards of microprocessor/micro-controller kit on LCD till it encounter "00" (End of file character). The program first initializes the LCD. The LCD is set to no shift and +1 increment entry mode. It means that when one character gets display on LCD, the next character entered will be written at next LCD RAM address and display next to the previous character on LCD. The display setting are make as display = ON, cursor = ON and blinking of cursor = OFF. These setting are done by referring to table 2. The display will look like this:



The program calls a subroutine named "write 1". This routine is required since for write operation of LCD, RS & R/W signals should be low initially. Then the enable signal should go high for a period of minimum 220 n.s. After this the enable signals should go to low position again. Then the R/W signal is pulled high. HL pointer initialized to point to first character i.e. 2600H and address counter of LCD is set to first memory location i.e. 80H. This address is set by using table 2. The program display first character on LCD from 80H-87H.

```
+-------------------------------------------------------+
A B C D FE F G H
+-------------------------------------------------------+
```

The next 8 character are written at 88H-8FH location but are not displayed on LCD since, the display is set to no shift mode. The HL pointer is set to 2610H. The HL is then moved back by 8 character. These 8 characters are written at A9-B0H. Then all 16 character is display by this time.

```
80H          87H A9H          B0H
+-----------------------------------------+
  A B C D E F G H I J K L M N O P
+-----------------------------------------+
LSB          MSB LSB \        MSB
```

Now put the display in shift mode. At the end of previous operation, the pointer of LCD RAM was at B1H. The program, then moves the next character from kit memory to LCD RAM address. At this movement, the character of group1 will be shifted by 1 position. Therefore "A" character gets lost and 1 character get displayed at H position since we have copied these characters at 88H-8Fh location (refer to loop 5 in program). This same way all character is moved from kit memory to LCD RAM and is displayed one by one on LCD.

The display become:

```
 88h          8FH B1          B8
+-----------------------------------------------+
  I J K L M N O P Q R S T U V W X
+-----------------------------------------------+
```

Now to enter the next 8 character the contents from 88H-8FH are copied in 80H-87H. The contents of B1H-B8H are copied to 88H-8FH. Then a restore operation is performed which display the contents of 80H-87H & A9H-B0H. The contents at A9H-B0H location are rewritten as were written at B1H-B8H location. The program then is ready to accept next 8 character. The following procedure gives detail description.

Refer to start of loop9 for the following:

At this moment, HL points to B9H location. In the next instruction, HL is decremented by 16 so that is point to the character, which was written at 88H-8FH location. A copy of these characters is made in 80H-87H location but are not display since at present contents of 88H-8FH are being display still looks like this:

```
88H          8FH B1H          B8H
+-----------------------------------------+
  I J K L M N O P Q R S T U V W X
+-----------------------------------------+
```

A copy of B1-B8H is made in 88H to 8FH location. Since contents of 88H-8FH are presently on display, so these write operation will be seen on screen, if delay between 2 writes is increased and the display will look like this:

```
88H          8FH B1H          B8H
+-----------------------------------------+
  Q R S T U V W X Q R S T U V W X
+-----------------------------------------+
```

Now restore operation is performed. Then the display is restored to the initial memory locations, 80H-87H & A9-B0H. The memory location 80H-87H consists of copied contents of A9-B0. The memory location 80H-87H consists of copied contents of A9-B0. The display may looks like this, if the delay is increased.

```
80H          87H A9H          B0H
+-----------------------------------------+
  I J K L M N O P I J K L M N O P
+-----------------------------------------+
```

Both group of display fields display the same group of character. The next instruction write to A9-B0H so that the screen displays the same 16 characters that are was showing at the start of loop9. The LCD is now ready to accept next 8 character.

INITIALIZING BY INSTRUCTION

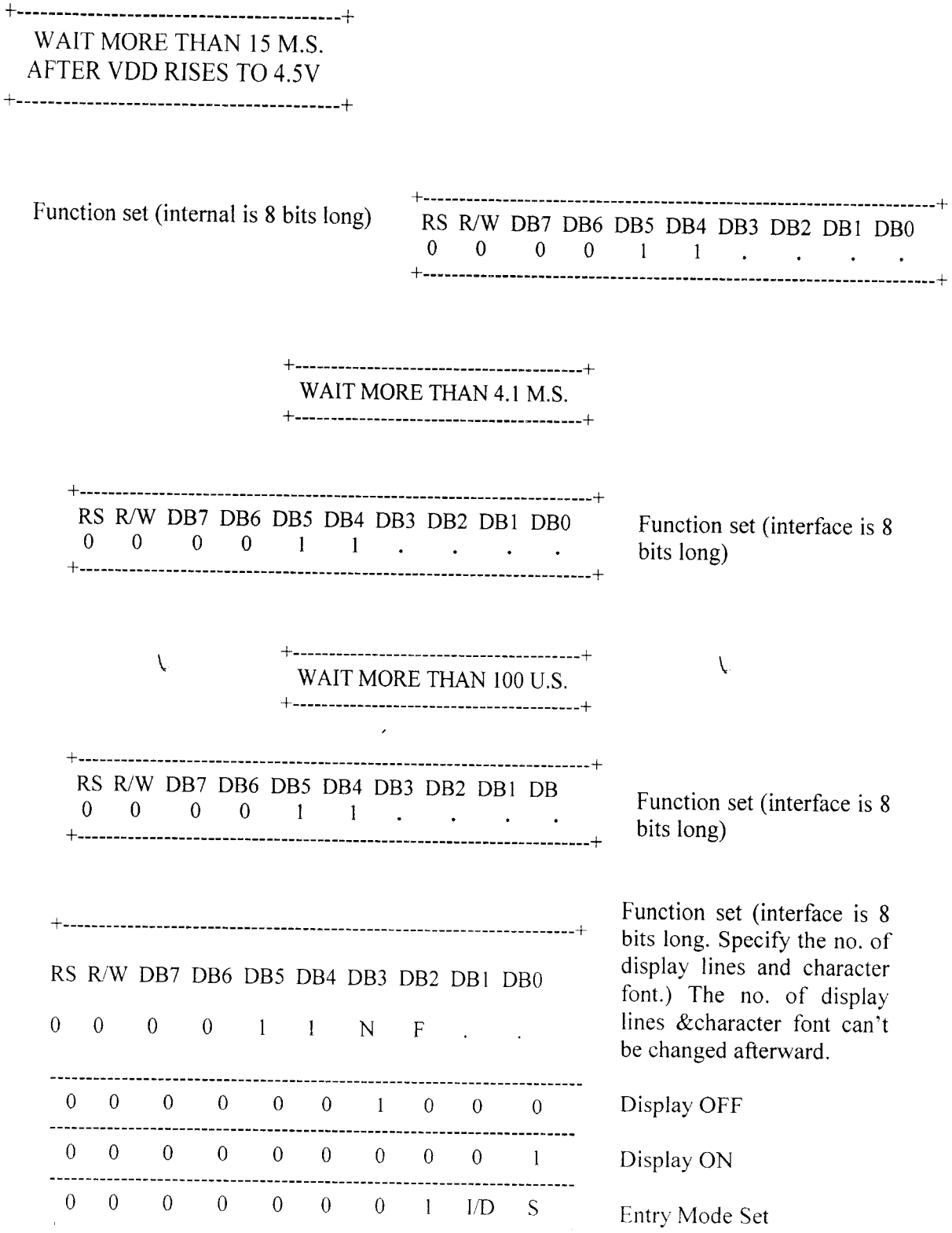
If the power supply condition for correctly operation the internal reset circuit are not met, initialization by instruction is required.

Use the following STEPS for initialization:

TABLE 1

```
+--------------------+
  POWRE ON
+--------------------+
```

When Interface is 8 bits long.



INITIALIZATION ENDS

1. Display Clear

2. Function Set

DL = 1 : 8 bit interface data
DL = 0 : 4 bit
F = 0 : 5 * 7 dot character font
N = 1 : 1/16 Duty
N = 0 : 1/18 Duty, 1/11 Duty

3. Display ON/OFF Control
   D = 0 : Display OFF
   C = 0 : Cursor OFF
   B = 0 : Blink OFF

4. Entry Mode Set
   I/D = 1 : +1 (increment)
   S = 0 : No shift

INSTRUCTIONS

TABLE-2

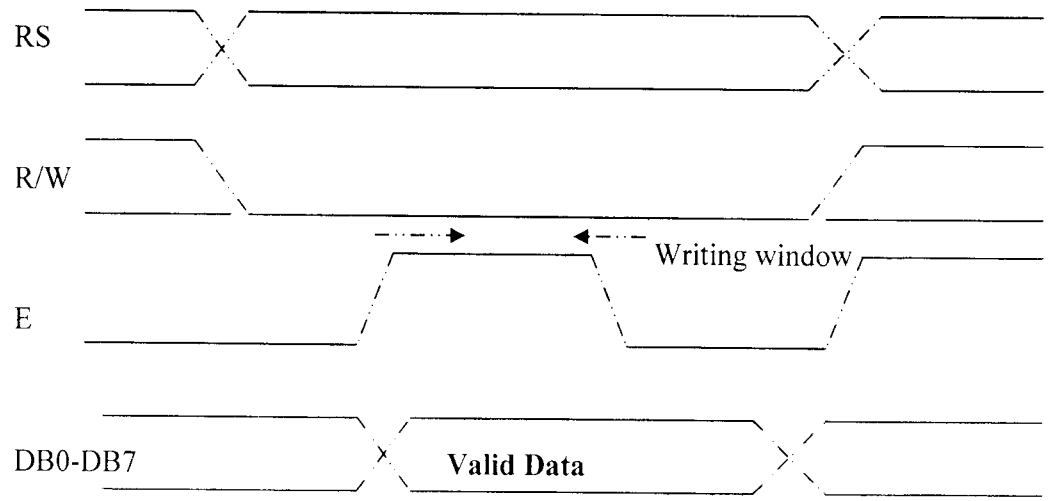
Instruction	Code										Description
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	
Clear Display	0	0	0	0	0	0	0	0	0	1	Clear all display and returns the cursor to the home position (Address 0)
Entry mode set	0	0	0	0	0	0	0	1	I/D	1	Sets the cursor move direction and specifies or not to shift the display. These operation are performed during data write and read.
Display On/Off Control	0	0	0	0	0	0	1	D	C	B	Sets On/Off all display (D) cursor On/Off (C), and blink of cursor position character (B).
Cursor/ Display Shift	0	0	0	0	0	0	S/C	R/L	.	.	Moves the cursor and shifts the display without changing DDRAM contents.

Function Set	0	0	0	0	1	DL	N	F	.	.	Sets interface data length (DL) number of display lines (L) and character font (F).
DDRAM Address Set	0	0	1			ADD					Sets the DDRAM address, DDRAM data is sent and received after this setting.
DDRAM Data Write	1	0				Write Data					Write data into DDRAM or CGRAM.

CODE

I/D = 1 : Increment
I/D = 0 : Decrement
S = 1 : With display shift
ADD DDRAM Address Corresponds to Cursor Address

FIG .1 WRITE CYCLE



PROGRAM LISTING

A: 8085.TBL		CPU	8085	
2000		ORG	2000h	

0000 =		Port A:	Equ	00h
0002 =		Port C:	Equ	02h
0003 =		Cwr:	Equ	03h

### LCD MODULE ###				
Interfacing to 8255 (P P I)				
			DBO	PA0
			DB7	PA7
			RS	PC0
			R/W	PC1
			E	PC2

NOTE: -Listing of program for various models of Microprocessor and Micro controller kits is given below. Please select the model of kit being used before entering the program into the kit.

SETUP FOR THE EXPERIMENT

This explanation as well as the explanation of the Program under the heading " Description of the Program" is for 8085 LED Kit. However if you are interfacing the LCD Module to other Kits, then also refer to the specific instruction before the program listing for that particular Kit also

1) Connect the ET-LCD interfacing module to the 8255-1 port connector **J1** of the kit using 26-pin flat FRC cable. The pin No.1 of the connector on the module as well as the kit is marked. Please ensure that the pin no. 1 of the connector is connected to pin no. 1 of the module.

2) Connect the +5V,GND to the Module either through the Kit or Externally.

3) Enter the program given below from the memory location mentioned in the program.

4) Execute the program.
5) A message " EXCEL " will be displayed on the LCD on the first line and a message " WELCOME" will be displayed on the 2nd line

LISTING OF THE PROGRAM OF LCD MODULE TO INTERFACE WITH 8085 KITS HAVING LED AND LCD DISPLAY)

ADDRESS	OP-CODE	LABEL	MNEN\MONIC	REMARKS
2000	3E 80	START	MVI A 80	DEFINE ALL PORTS OF 8255 AS OUTPUT
2002	D3 03		OUT 03	
2004	3E 38		MVI 38	Refer to the LCD data sheet for the initialization sequence of the 16*2 LCD display with 8 bit data, 5*7 matrix dots
2006	CD 48 20		CALL WR_CMD	
2009	3E 38		MVI A 38	
200B	CD 48 20		CALL WR_CMD	
200E	3E 38		MVI A 38	
2010	CD 48 20		CALL WR_CMD	
2013	3E 0C		MVI A 0C	
2015	CD 48 20		CALL WR_CMD	
2018	3E 06		MVI A 06	
201A	CD 48 20		CALL WR_CMD	
201D	3E 85		MVI A 85	Set address to 85 (6^{th} position of first line of the display
201F	CD 48 20		CALL WR_CMD	
2022	21 72 20		LXI H,MSG1	Start writing character to the first line of the LCD
2025	7E	LINE1	MOV A,M	
2026	FE 00		CPI 00	
2028	CA 32 20		JZ NEXT_LINE	
202B	CD 56 20		CALL WR_CHAR	
202E	23		INX H	
202F	C3 25 20		JMP LINE1	
2032	3E C4	NEXT_LINE	MVI A C4	Set address to C4 (5^{th} position of the 2^{nd} line of the display)
2034	CD 48 20		CALL WR_CMD	
2037	21 78 20		LXI H,MSG2	Start writing character to the 2nd line of the LCD
203A	7E	LINE2	MOV A,M	
203B	FE 00		CPI 00	
203D	CA 47 20		JZ EXIT	
2040	CD 56 20		CALL WR_CHAR	
2043	23		INX H	
2044	C3 3A 20		JMP LINE2	

2047	EF	EXIT	RST 5	Break Point to Restart the monitor Program
2048	D3 00	WR_CMD	OUT 03	
204A	3E 04		MVI A 04	Send Instruction code Data through portA; RS=0, R/W=0, E=1
204C	D3 02		OUT 02	
204E	3E 00		MVI A 00	Send Instruction code Data through portA; RS=0, R/W=0, E=0
2050	D3 02		OUT 02	
2052	CD 6B 20		CALL DELAY2	Wait due to internal Execution time of LCD
2055	C9		RET	
2056	D3 00	WR_CHAR	OUT 00	
2058	3E 05		MVI A 05	Send Character through portA; RS=1, R/W=0, E=1
205A	D3 02		OUT 02	
205C	3E 01		MVI A 01	Send Character through portA; RS=1, R/W=0, E=0
205E	D3 02		OUT 02	
2060	CD 64 20		CALL DELAY1	Wait due to internal Execution time of LCD
2063	C9		RET	
2064	0E 40	DELAY1	MVI C 40	
2066	0D	LOOP_1	DCR C	
2067	C2 66 20		JNZ LOOP_1	
206A	C9		RET	
206B	0E FF	DELAY2	MVI C FF	
206D	0D	LOOP_2	DCR C	
206E	C2 6D 20		JNZ LOOP_2	
2071	C9		RET	
2072	45 58 43 45 4C 00	MSG1	DFB "EXCEL",0	
2078	57 45 4C 43 4F 4D 45 00	MSG2	DFB "WELCOME",0	

NOTE: On executing the program a message will be displayed on the two lines of the LCD Display of the module.