How to control a HD44780-based Character-LCD

The Industry Standard Character LCD

Visitor # (unknown)

Last updated on 2005-01-21

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General info and code-examples

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1. General

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1.1. Disclaimer

THIS DOCUMENT IS PROVIDED TO THE USER "AS IS". Etc.etc.

All information in this document is to the best of my knowledge.
The 8051 PL/M51 software is used in applications using 2*16, 2*20, 4*20 and 2*40 LC-Displays.
The PIC ASM software is used in applications using 2*20, 4*20 and 2*40 LC-Displays.
So there should be no risk, but there's still Murphy.

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1.2. Usage

Tell me about your applications.
Send a postcard

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1.3. Purpose

Uuuhm..

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2. HD44780-based LCD modules

Data from *HITACHI LIQUID CRYSTAL CHARACTER DISPLAY MODULE* and *OPTREX DOT MATRIX LCD MODULE* databooks.

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2.1. Pin assignment

The pin assignment shown in *Table 2.1.* is the industry standard for character LCD-modules with a *maximum of* 80 characters.
The pin assignment shown in *Table 2.2.* is the industry standard for character LCD-modules with *more than* 80 characters.

To be sure **always** check the manufacturers datasheet!
To locate pin 1 on a module check the manufacturers datasheet!

Table 2.1., Pin assignment for <= 80 character displays

Pin number	Symbol	Level	I/O	Function
1	Vss	-	-	Power supply (GND)
2	Vcc	-	-	Power supply (+5V)
3	Vee	-	-	Contrast adjust

Pin number	Symbol	Level	I/O	Function
4	RS	0/1	I	0 = Instruction input 1 = Data input
5	R/W	0/1	I	0 = Write to LCD module 1 = Read from 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)

Table 2.2., Pin assignment for > 80 character displays

Pin number	Symbol	Level	I/O	Function
1	DB7	0/1	I/O	Data bus line 7 (MSB)
2	DB6	0/1	I/O	Data bus line 6
3	DB5	0/1	I/O	Data bus line 5
4	DB4	0/1	I/O	Data bus line 4
5	DB3	0/1	I/O	Data bus line 3
6	DB2	0/1	I/O	Data bus line 2
7	DB1	0/1	I/O	Data bus line 1
8	DB0	0/1	I/O	Data bus line 0 (LSB)
9	E1	1, 1->0	I	Enable signal for row 0 and 1 (1^{st}controller)
10	R/W	0/1	I	0 = Write to LCD module 1 = Read from LCD module
11	RS	0/1	I	0 = Instruction input 1 = Data input
12	Vee	-	-	Contrast adjust
13	Vss	-	-	Power supply (GND)
14	Vcc	-	-	Power supply (+5V)
15	E2	1, 1->0	I	Enable signal for row 2 and 3 (2^{nd}controller)
16	n.c.			

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2.2. Instruction set

Table 2.3. HD44780 instruction set

Instruction	Code										Description	Execution time**
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Clear display	0	0	0	0	0	0	0	0	0	1	Clears display and returns cursor to the home position (address 0).	1.64mS
Cursor home	0	0	0	0	0	0	0	0	1	*	Returns cursor to home position (address 0). Also returns display being shifted to the original position. DDRAM contents remains unchanged.	1.64mS
Entry mode set	0	0	0	0	0	0	0	1	I/D	S	Sets cursor move direction (I/D), specifies to shift the display (S). These operations are performed during data read/write.	40uS
Display On/Off control	0	0	0	0	0	0	1	D	C	B	Sets On/Off of all display (D), cursor On/Off (C) and blink of cursor position character (B).	40uS
Cursor/display shift	0	0	0	0	0	1	S/C	R/L	*	*	Sets cursor-move or display-shift (S/C), shift direction (R/L). DDRAM contents remains unchanged.	40uS
Function set	0	0	0	0	1	DL	N	F	*	*	Sets interface data length (DL), number of display line (N) and character font(F).	40uS
Set CGRAM address	0	0	0	1	CGRAM address						Sets the CGRAM address. CGRAM data is sent and received after this setting.	40uS
Set DDRAM address	0	0	1	DDRAM address							Sets the DDRAM address. DDRAM data is sent and received after this setting.	40uS
Read busy-flag and address counter	0	1	BF	CGRAM / DDRAM address							Reads Busy-flag (BF) indicating internal operation is being performed and reads CGRAM or DDRAM address counter contents (depending on previous instruction).	0uS
Write to CGRAM or DDRAM	1	0	write data								Writes data to CGRAM or DDRAM.	40uS
Read from CGRAM or DDRAM	1	1	read data								Reads data from CGRAM or DDRAM.	40uS

Remarks:
- DDRAM = Display Data RAM.
- CGRAM = Character Generator RAM.
- DDRAM address corresponds to cursor position.
- * = Don't care.
- ** = Based on F_{osc} = 250kHz.

Table 2.4. Bit names

Bit name	Setting / Status	
I/D	0 = Decrement cursor position	1 = Increment cursor position
S	0 = No display shift	1 = Display shift
D	0 = Display off	1 = Display on
C	0 = Cursor off	1 = Cursor on
B	0 = Cursor blink off	1 = Cursor blink on
S/C	0 = Move cursor	1 = Shift display
R/L	0 = Shift left	1 = Shift right
DL	0 = 4-bit interface	1 = 8-bit interface
N	0 = 1/8 or 1/11 Duty (1 line)	1 = 1/16 Duty (2 lines)
F	0 = 5x7 dots	1 = 5x10 dots
BF	0 = Can accept instruction	1 = Internal operation in progress

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2.3. Visible DDRAM addresses

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2.3.1. 1-line displays

Shown after reset (with N=0).

00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	← Character position (dec.)
00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F	20	21	22	23	24	25	26	27	← Row0 DDRAM address (hex)

Table 2.5. DDRAM address usage for a 1-line LCD

Display size	Visible	
	Character positions	DDRAM addresses
1*8	00..07	0x00..0x07
1*16	00..15	0x00..0x0F [1] [2] [3] [4]
1*20	00..19	0x00..0x13
1*24	00..23	0x00..0x17
1*32	00..31	0x00..0x1F
1*40	00..39	0x00..0x27

[1] Peter Bozzay:
Found DDRAM addresses 0x00..0x07 + 0x40..0x47 to be functional for a 1*16 display size.
Make/model: not mentioned / SC1601AS*B.
[2] Hendrik Abma:
Found DDRAM addresses 0x00..0x07 + 0x40..0x47 to be functional for a 1*16 display size.
Make/model: Samtron / KP-03.
[3] Luigi Candurro:
Found DDRAM addresses 0x00..0x07 + 0x40..0x47 to be functional for a 1*16 display size.
Make/model: Crystal Clear Technology / CMC116-01.
[4] Thierry Giorgetti:
Found DDRAM addresses 0x00..0x07 + 0x40..0x47 to be functional for a 1*16 display size.
Make/model: Xiamen Ocular / GDM1601c (Local copy available as zipped file, approx 278kB).

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2.3.2. 2-line displays

Shown after reset (with N=1).

00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	← Character position (dec.)
00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F	20	21	22	23	24	25	26	27	← Row0 DDRAM address (hex)
40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	50	51	52	53	54	55	56	57	58	59	5A	5B	5C	5D	5E	5F	60	61	62	63	64	65	66	67	← Row1 DDRAM address (hex)

Table 2.6. DDRAM address usage for a 2-line LCD

Display size	Visible	
	Character positions	DDRAM addresses
2*16	00..15	0x00..0x0F + 0x40..0x4F [1]
2*20	00..19	0x00..0x13 + 0x40..0x53
2*24	00..23	0x00..0x17 + 0x40..0x57
2*32	00..31	0x00..0x1F + 0x40..0x5F
2*40	00..39	0x00..0x27 + 0x40..0x67

[1] Author:
According to their datasheets DDRAM addresses 0x80..0x8F + 0xC0..0xCF are used.
Make/model: Emerging Display Technologies / EW162G0YMY (Local copy available as zipped file, approx 85kB).
Make/model: Mitsutech / EW162G0YMY (Local copy available as zipped file, approx 86kB).

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2.3.3. 4-line displays

Shown after reset (with N=1).

00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	←Character position (dec.)
00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	10	11	12	13	←Row0 DDRAM address (hex)
40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	50	51	52	53	←Row1 DDRAM address (hex)
14	15	16	17	18	19	1A	1B	1C	1D	1E	1F	20	21	22	23	24	25	26	27	←Row2 DDRAM address (hex)
54	55	56	57	58	59	5A	5B	5C	5D	5E	5F	60	61	62	63	64	65	66	67	←Row3 DDRAM address (hex)

Table 2.7. DDRAM address usage for a 4-line LCD

Display size	Visible	
	Character positions	DDRAM addresses
4*16	00..15	0x00..0x0F + 0x40..0x4F + 0x14..0x23 + 0x54..0x63 [1] [2]
4*20	00..19	0x00..0x13 + 0x40..0x53 + 0x14..0x27 + 0x54..0x67
4*40	(00..39) on 1st controller and (00..39) on 2nd controller	(0x00..0x27 + 0x40..0x67) on 1st controller and (0x00..0x27 + 0x40..0x67) on 2nd controller

[1] Rick Mann:
Found DDRAM addresses 0x00..0x0F + 0x40..0x4F + 0x10..0x1F + 0x50..0x5F to be functional for a 4*16 display size.
Make/model: Optrex / DMC16433.
Author:
This matches with the information mentioned in Dmcman_full.pdf paragraph 1.7.6.4. Local copy available as zipped file, approx 176kB.
[2] Tushar Rane:
Found DDRAM addresses 0x00..0x0F + 0x40..0x4F + 0x10..0x1F + 0x50..0x5F to be functional for a 4*16 display size.
Make/model: not mentioned / not mentioned.

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2.4. Interfacing

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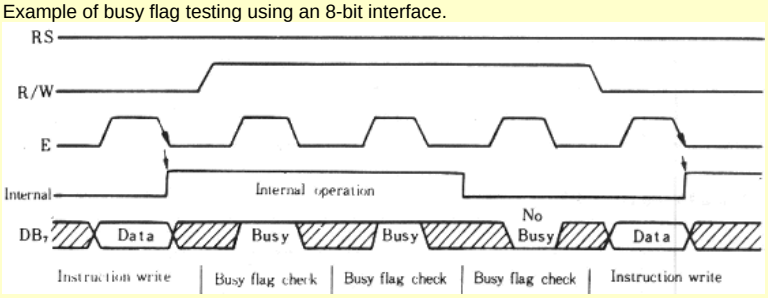
2.4.1. 8-bit interface

Example of busy flag testing using an 8-bit interface.



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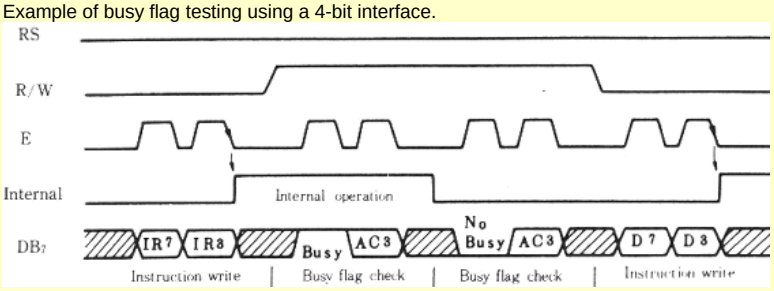
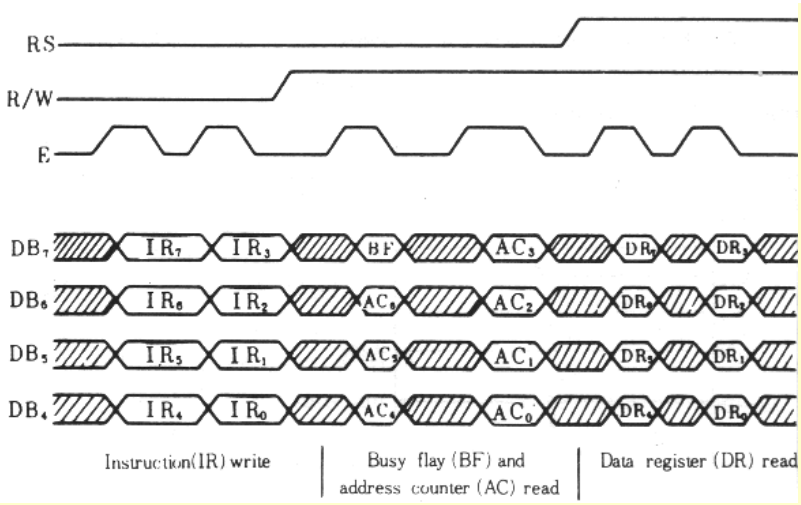
2.4.2. 4-bit interface

Example of busy flag testing using a 4-bit interface.



Example of data transfer using a 4-bit interface.



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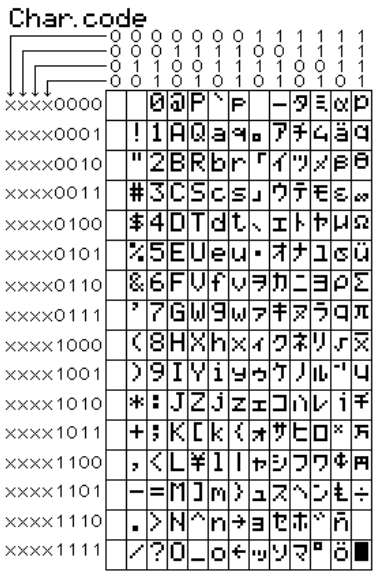
2.5. Character set

Characterset for 5x7 dot font



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2.6. Related pages

Private sites:
- Fil's FAQ-Link-In Corner: LCD Technology FAQ
- Fil's FAQ-Link-In Corner: HD44780-based LCD
- LCD Module to PC Interfacing Example
- HD44780-based LCD Modules

Commercial sites:
- LCD Intro
- HANTRONIX, Inc. Home Page
- Shelly, Inc. - LCD Engineering Application Notes

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Code examples for PIC16C84

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4. PIC example

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4.1. Basic control software

Microchip's AN587 was used as a basis for this code.
WARNING:
Microchip's AN587 has major errors in the ***read from*** LCD code sequences.
The routines on this page use the correct *read from* LCD code sequences.

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4.1.1. Requirements / features

- HD44780-based (industry-standard) character-LCD, all software in this chapter is based on it's instruction-set.
- PIC16C84 running on a 4MHz crystal, some code is based on this frequency.

- 8-bit interface between microcontroller and LCD-module.

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4.1.2. Global declarations

To get things working.

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4.1.2.1. Register declarations

Purpose:

```
- Tells MPASM which ports and registers (files) to use.
```

Code:

```
LCD_DATA        EQU     PORTB           ; LCD data lines interface
LCD_DATA_TRIS   EQU     TRISB
LCD_CTRL        EQU     PORTA           ; LCD control lines interface

LCD_TEMP        EQU     0x020           ; LCD subroutines internal use

DELAY           EQU     0x023           ; Used in DELAYxxx routines
X_DELAY         EQU     0x024           ; Used in X_DELAYxxx routines
```

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4.1.2.2. Literal declarations

Purpose:

```
- Literal declarations (Equates) used in the code.
```

Code:

```
; PORTA control bits
LCD_E           EQU     2               ; LCD Enable control line
LCD_RW          EQU     1               ; LCD Read/Write control line
LCD_RS          EQU     0               ; LCD Register-Select control line
```

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4.1.2.3. Procedure declarations / library interface

Since MPLIB and MPLINK are not yet available, no declarations are needed.

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4.1.3. Code

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4.1.3.1. LCD initialisation

Purpose:

```
- LCD initialisiation code to be executed after power-up (i.e.: before any other subroutin
- Should be modified to your needs (i.e. display type, cursor on/off, etc.)
```

Code:

```
LCDINIT
                                ; Busy-flag is not yet valid
    CLRF        LCD_CTRL        ; ALL PORT output should output Low.
                                ; power-up delay
    MOVLW       0x01E
    CALL        X_DELAY500      ; 30 * 0.5mS = 15mS
                                ; Busy Flag should be valid from here
```

```
    MOVLW       0x038               ; 8-bit-interface, 2-lines
    CALL        LCDPUTCMD
    MOVLW       0x000               ; disp.off, curs.off, no-blink
    CALL        LCDDMODE
    CALL        LCDCLEAR
    MOVLW       0x004               ; disp.on, curs.off
    CALL        LCDDMODE
    MOVLW       0x002               ; auto-inc (shift-cursor)
    CALL        LCDEMODE
    RETURN
```

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4.1.3.2. Busy flag

Purpose:

```
- Tests if the LCD is busy. Returns when LCD busy-flag is inactive.
```

Code:

```
LCDBUSY
    BSF         STATUS,RP0          ; Select Register page 1
    MOVLW       0x0FF               ; Set PORTB for input
    MOVWF       LCD_DATA_TRIS
    BCF         STATUS, RP0         ; Select Register page 0
    BCF         LCD_CTRL, LCD_RS    ; Set LCD for command mode
    BSF         LCD_CTRL, LCD_RW    ; Setup to read busy flag
    BSF         LCD_CTRL, LCD_E     ; LCD E-line High

    MOVF        LCD_DATA, W         ; Read busy flag + DDram address
    BCF         LCD_CTRL, LCD_E     ; LCD E-line Low
    ANDLW       0x80                ; Check Busy flag, High = Busy
    BTFSS       STATUS, Z
    GOTO        LCDBUSY
LCDNOTBUSY
    BCF         LCD_CTRL, LCD_RW
    BSF         STATUS, RP0         ; Select Register page 1
    MOVLW       0x000
    MOVWF       LCD_DATA_TRIS       ; Set PORTB for output
    BCF         STATUS, RP0         ; Select Register page 0
    RETURN
```

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4.1.3.3. Clear display

Purpose:

```
- Clears display and returns cursor to home position (upper-left corner).
```

Code:

```
LCDCLEAR
    MOVLW       0x001
    CALL        LCDPUTCMD
    RETURN
```

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4.1.3.4. Cursor home

Purpose:

```
- Returns cursor to home position.
- Returns display to original position (when shifted).
```

Code:

```
LCDHOME
    MOVLW       0x002
    CALL        LCDPUTCMD
    RETURN
```

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4.1.3.5. Entry mode

Purpose:

```
- Sets entry mode of the LCD
- Required entry mode must be set in W
  b0    : 0 = no display shift, 1 = display shift
  b1    : 0 = auto-decrement, 1 = auto-increment
  b2-b7 : don't care
```

Code:

```
LCDEMODE
    ANDLW       0x003               ; Strip upper bits
    IORLW       0x004               ; Function set
    CALL        LCDPUTCMD
    RETURN
```

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4.1.3.6. Display mode

Purpose:

```
- Sets display control
- Required entry mode must be set in W
  b0    : 0 = cursor blink off, 1 = cursor blink on (if b1 = 1)
  b1    : 0 = cursor off,  1 = cursor on
  b2    : 0 = display off, 1 = display on (display data remains in DD-RAM)
  b3-b7 : don't care
```

Code:

```
LCDDMODE
    ANDLW       0x007               ; Strip upper bits
    IORLW       0x008               ; Function set
    CALL        LCDPUTCMD
    RETURN
```

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4.1.3.7. Set character generator RAM address

Purpose:

```
- Sets the Character-Generator-RAM address. CGRAM data is read/written after this setting.
- Required CGRAM address must be set in W
   b0-5 : required CGRAM address
   b6-7 : don't care
```

Code:

```
LCDSCGA
    ANDLW       0x03F               ; Strip upper bits
    IORLW       0x040               ; Function set
    CALL        LCDPUTCMD
    RETURN
```

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4.1.3.8. Set display data RAM address

Purpose:

```
- Sets the Display-Data-RAM address. DDRAM data is read/written after this setting.
- Required entry mode must be set in W
   b0-6 : required DDRAM address
   b7   : don't care
```

Code:

```
LCDSDDA
    IORLW       0x080               ; Function set
    CALL        LCDPUTCMD
    RETURN
```

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4.1.3.9. Get address counter contents

Purpose:

```
- Returns address counter contents, used for both DDRAM and CGRAM.
- RAM address is returned in W
```

Code:

```
LCDGADDR
    BSF         STATUS,RP0          ; Select Register page 1
    MOVLW       0x0FF               ; Set PORTB for input
    MOVWF       LCD_DATA_TRIS
    BCF         STATUS, RP0         ; Select Register page 0
    BCF         LCD_CTRL, LCD_RS    ; Set LCD for command mode
    BSF         LCD_CTRL, LCD_RW    ; Setup to read busy flag
    BSF         LCD_CTRL, LCD_E     ; LCD E-line High
    MOVF        LCD_DATA, W         ; Read busy flag + RAM address
    BCF         LCD_CTRL, LCD_E     ; LCD E-line Low
    ANDLW       0x07F               ; Strip upper bit
    BCF         LCD_CTRL, LCD_RW
    BSF         STATUS, RP0         ; Select Register page 1
    MOVLW       0x000
    MOVWF       LCD_DATA_TRIS       ; Set PORTB for output
    BCF         STATUS, RP0         ; Select Register page 0
    RETURN
```

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4.1.3.10. Write character

Purpose:

```
- Sends character to LCD
- Required character must be in W
```

Code:

```
LCDPUTCHAR
    MOVWF       LCD_TEMP            ; Character to send is in W
    CALL        LCDBUSY             ; Wait for LCD to be ready
    BCF         LCD_CTRL, LCD_RW    ; Set LCD in read mode
    BSF         LCD_CTRL, LCD_RS    ; Set LCD in data mode
    BSF         LCD_CTRL, LCD_E     ; LCD E-line High
    MOVF        LCD_TEMP, W
    MOVWF       LCD_DATA            ; Send data to LCD
    BCF         LCD_CTRL, LCD_E     ; LCD E-line Low
    RETURN
```

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4.1.3.11. Write command

Purpose:

```
- Sends command to LCD
- Required command must be in W
```

Code:

```
LCDPUTCMD
    MOVWF       LCD_TEMP            ; Command to send is in W
    CALL        LCDBUSY             ; Wait for LCD to be ready
    BCF         LCD_CTRL, LCD_RW    ; Set LCD in read mode
    BCF         LCD_CTRL, LCD_RS    ; Set LCD in command mode
    BSF         LCD_CTRL, LCD_E     ; LCD E-line High
    MOVF        LCD_TEMP, W
    MOVWF       LCD_DATA            ; Send data to LCD
    BCF         LCD_CTRL, LCD_E     ; LCD E-line Low
    RETURN
```

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4.1.3.12. Delay loops

Purpose:

```
- Used in LCDINIT subroutine
- Required delay factor must be in W
  (Could be coded more efficient, but this approach gives more flexibility)
```

Code:

```
;*********************************  a 500uS delay @ 4MHz X-tal
DELAY500
    MOVLW       D'165'              ; +1        1 cycle
    MOVWF       DELAY               ; +2        1 cycle
DELAY500_LOOP
    DECFSZ      DELAY, F            ; step1     1 cycle
    GOTO        DELAY500_LOOP       ; step2     2 cycles
DELAY500_END
    RETURN                          ; +3        2 cycles

;*********************************  a delay of 'W' * 500mS
X_DELAY500
    MOVWF       X_DELAY             ; +1        1 cycle
X_DELAY500_LOOP
    CALL        DELAY500            ; step1     wait 500uSec
    DECFSZ      X_DELAY, F          ; step2     1 cycle
    GOTO        X_DELAY500_LOOP     ; step3     2 cycles
X_DELAY500_END
    RETURN                          ; +2        2 cycles
```

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4.2. Advanced control software

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4.2.1. User defined characters

Purpose:

```
After several requests a quick explanation on how to implement
user-defined characters:

First you'll need to make a pixel definition for the characters
you want to use.  This is the pixel definition for an underlined
'0' (char code 0x30) based on a 5x7 dots character definition:
```

```
       |   bits    | byte
  row  | 76543210  | value
  ----------------------
  000  |     xxx   | 0x0E
  001  |    x   x  | 0x11
  010  |    x  xx  | 0x13
  011  |    x x x  | 0x15
  100  |    xx  x  | 0x19
  101  |    x   x  | 0x11
  110  |     xxx   | 0x0E
  111  |    xxxxx  | 0x1F


The byte values need to be loaded into CGRAM address 00cccrrr
(binary), where:
-  ccc = user-defined character number (0...7)
-  rrr = row number of the user defined character (0...7)

Once that's done you can write character codes 0...7 to the
desired LCD character position, just like you do with
'normal' characters.

User-defined character definitions may be changed 'on-the-fly'.

While defining a 5x7 dots character:
- Character code bits (DDRAM) 2..0 correspond to CGRAM address bits 5..3
  (i.e. 8 possible user defined characters).
While defining a 5x10 dots character:
- Character code bits (DDRAM) 2..1 correspond to CGRAM address bits 5..4
  (i.e. 4 possible user defined characters).
It's best to switch off the cursor while writing to CGRAM.
```

Code:

```
(More detailed code may be published some day)
```

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4.3. Availability

LCD-PIC.ZIP (17,796 bytes): an example using some of the above subroutines (all subroutines are included).
Source is coded for a 4*20 LCD, adjust it to your needs!

Shows the following screen on a 4*20 LCD:

```
    ----------------------
    |This is on line :  0|
    |This is on line :  1|
    |This is on line :  2|
    |This is on line :  3|
    ----------------------
```

Picture of the above (296K).

Shows the following screen on a 2*40 LCD:

```
    ----------------------------------------
    |This is on line :  0This is on line :  2|
    |This is on line :  1This is on line :  3|
    ----------------------------------------
```

Shows the following screen on a 2*20 LCD:

```
    ----------------------
    |This is on line :  0|
    |This is on line :  1|
```

```
    ----------------------
```

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4.4. Used hardware

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4.4.1 Controller

- A PIC16C84 is used to control the LCD.
- 8-bit data interface between controller and LCD.

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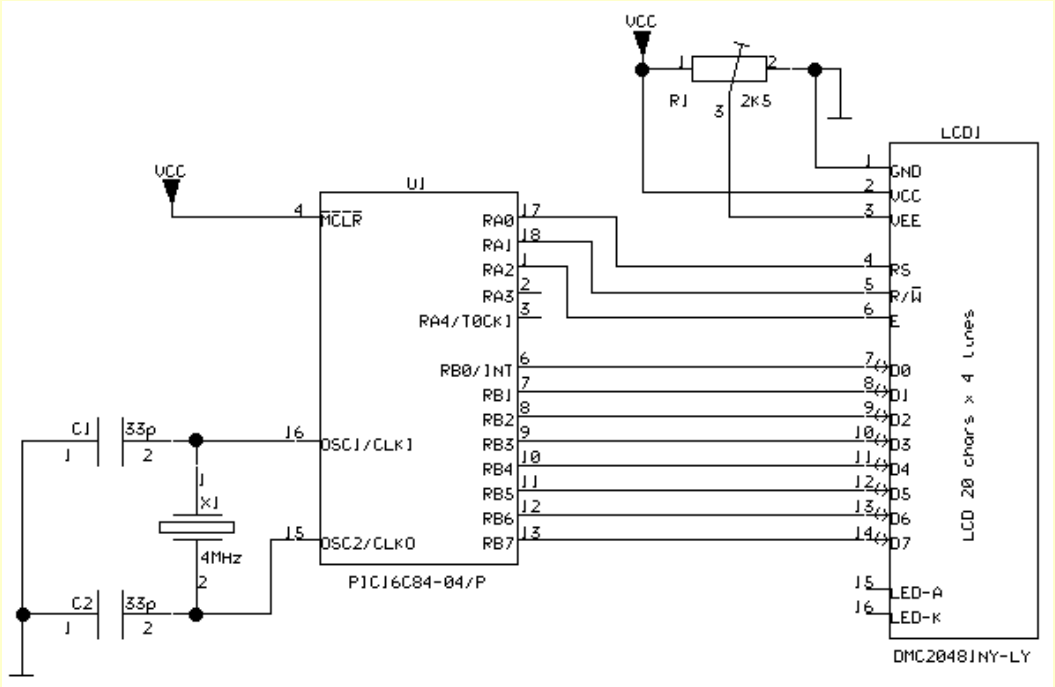
4.4.2 Interface



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4.5. Development environment

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4.5.1. Software

- Assembler: MPASM V1.30
- Programmer software: PICSTART 16B1 V5.00.00

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4.5.2. Hardware

- Programmer PICSTART 16B1 (firmware V2.00)

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Miscellaneous examples

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5. Miscellaneous examples

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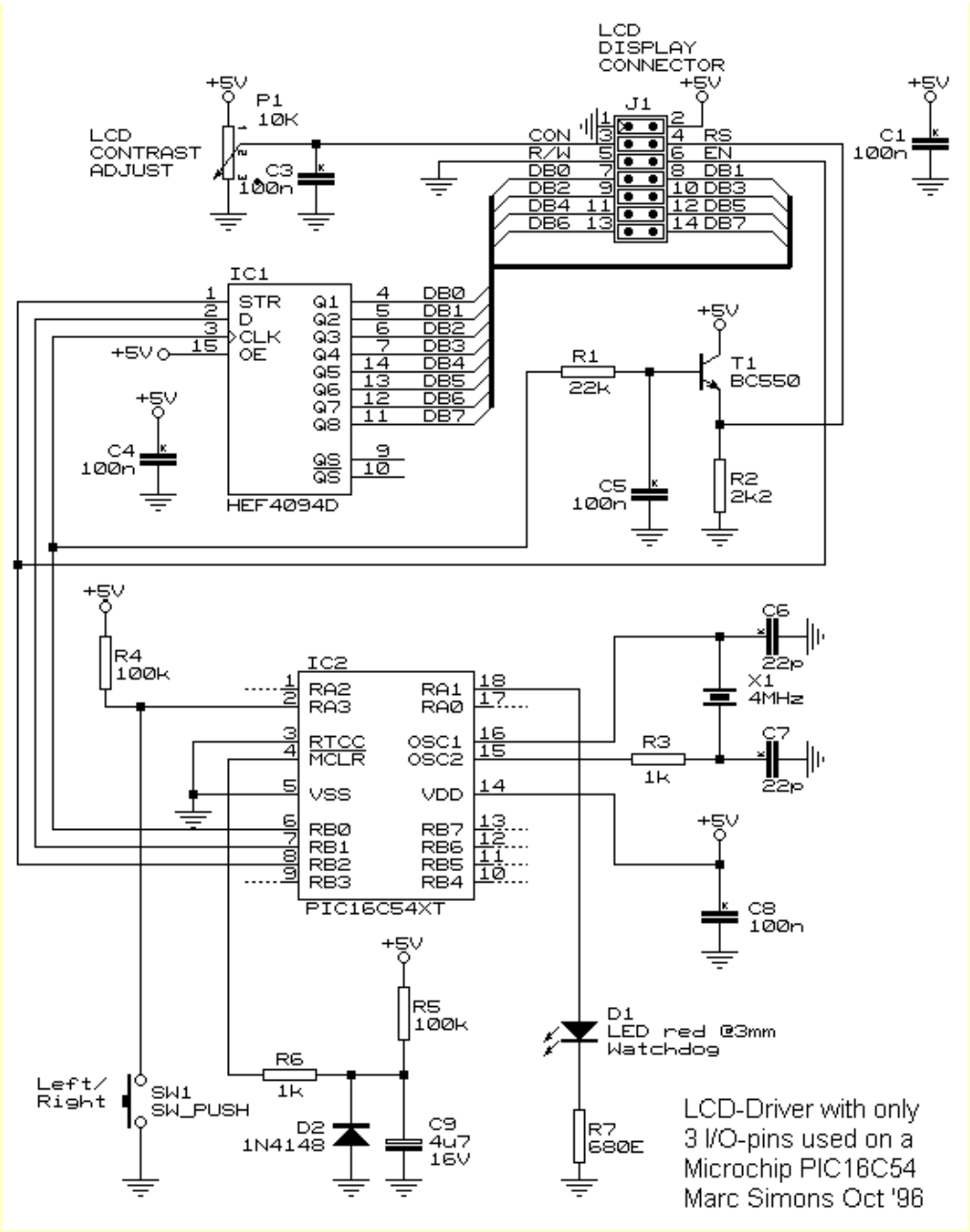
5.1. PIC16C54 using only 3 lines

This example is donated by Marc Simons.
If you have any questions/comments please send e-mail to msimons@IAEhv.nl.



Brief description:

Pins RB0, RB1 and RB2 are used for controlling AND driving text to the LCD display. Most of the time the PIC's are sufficient enough for most applications, except when it comes to more I/O. This simply cannot be expanded, except when you go to the BIG GUYS like the PIC16C74 etc. where I have done some applications with too. Observe the schematics: An PIC16C54 is the heart of the whole thing. It drives the HEF4094 CMOS serial2parallel converter. This gives us the databus towards the LCD display. Since the HEF4094 strobe is activated at the rising edge, and the LCD display on the falling edge, these can be shared. So, on the rising edge the 4094 spits out it's new byte, and on the falling edge the LCD reads it in. By the way, this concept cannot read out info from the LCD display. (Personal opinion: It is useless anyway!) Now the hard part comes: How to derive 'text' from 'commands'?? The LCD has a pin for it: The RS-pin. When it is clear, commands are accepted. when set, text is accepted. How is it solved?

Before I spit out a character to the HEF4094, I set the clock for 500uSec. Resistor R1 will load capacitor C5. Then, I spit the text character towards the 4094 as soon as possible. Therefore the capacitor simply does not have the time to discharge: The LCD will accept it as text. For commands it is the same, however, of course the other way around: The capacitor must be discharged. T1 forms an emitter follower to buffer the R/C network. The reason for this is that

the LCD RS input is an TTL input, so without proper buffering it will not work.

The code contains a few basic routines to handle the LCD display. The switch that I added is purely for fun: To be able to toggle rotation of the text. I used an 16 characters / 2 lines LCD display from an old security keypad. (Go to a surplus electronics store, they always have some!)

P.S. Any suggestions for good code from YOUR side are always welcome! Best Regards from msimons@IAEhv.nl, your PIC Scueezer Weezel!

MSIMONS.ZIP (27,140 bytes) includes the schematics, source code and include file needed for this example.

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5.2. ATMEL AT90S2313-10PI C-demo

This demo is donated by Jon Wackley (VE3JTN).
If you have any questions/comments please send e-mail to jwackley@mountaincable.net.

Brief description:

Chip:	ATMEL AT90S2313-10PI
Clock:	9.420 MHz
Compiler:	avr-gcc
Written by:	Jon Wackley (VE3JTN)
Date:	November 3rd 2002
Availability:	ATMEL_AT90S2313-10PI.zip (2,559 bytes) which contains the C-source

Table 5.1. Hardware interface

ATMEL PIN	LCD PIN
PD0(2)	RS(4)
PD1(3)	R/W(5)
PD6(11)	E(6)
PB0(12)	D0(7)
PB1(13)	D1(8)
PB2(14)	D2(9)
PB3(15)	D3(10)
PB4(16)	D4(11)
PB5(17)	D5(12)
PB6(18)	D6(13)
PB7(19)	D7(14)

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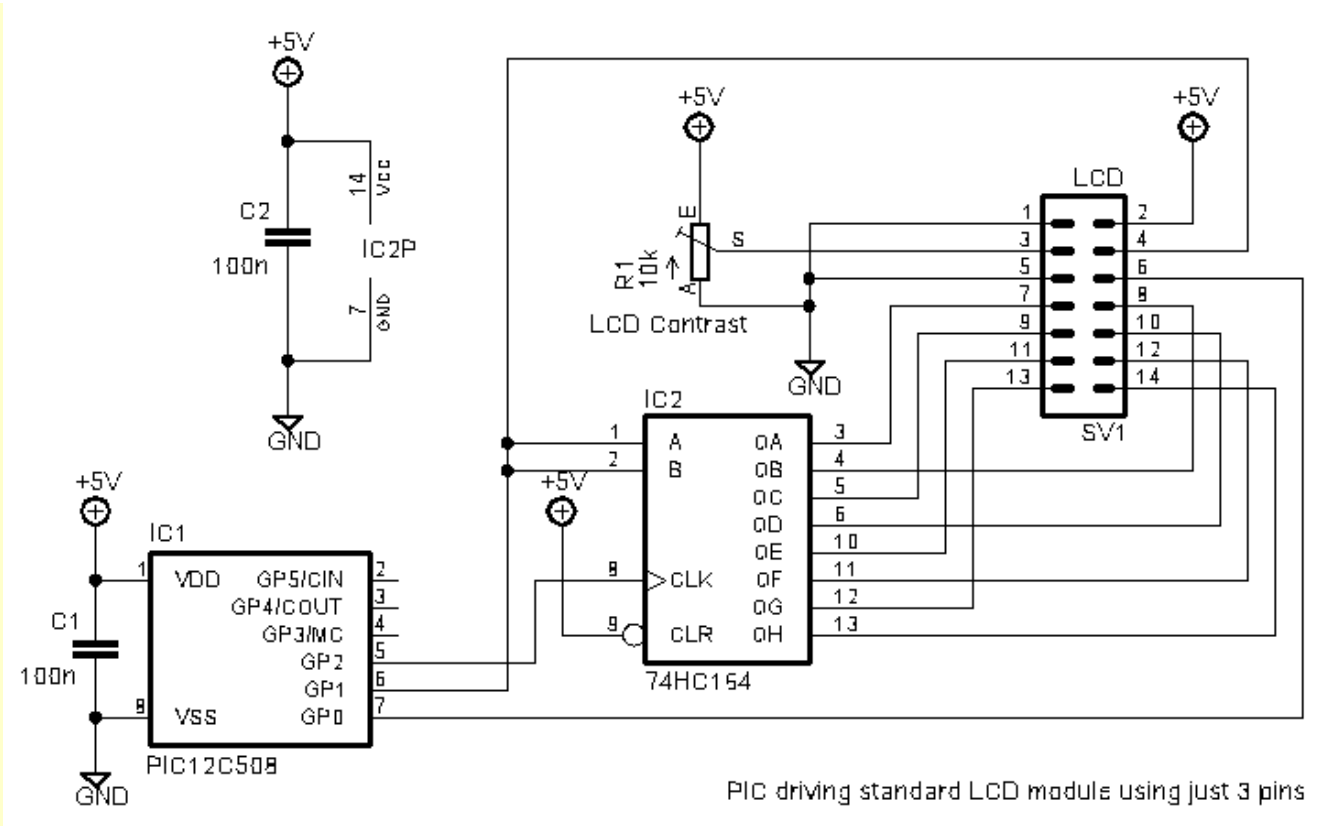
5.3. Variant on PIC16C54 using only 3 lines

This example is donated by Stefan Heinzmann.
If you have any questions/comments please send e-mail to Stefan Heinzmann.



Brief description:

I just came across the schematics for driving an LCD module with just 3 lines on the PIC (http://home.iae.nl/users/pouweha/lcd/lcd.shtml). I just wanted to show you an even simpler (and slightly cheaper) way:

- Replace the HEF4094D with a plain 8-bit shift register like the 74HC164 (it will be slightly cheaper). It has no STR input, so the PIC's RB3 just connects to the LCD module's EN signal.

- Connect RB1 to the RS signal of the LCD module, and to the two data inputs of the 74HC164. After having shifted out a byte into the 74HC164, you can put the state of the RS signal on this line.

You don't need a transistor and such, and the timing isn't critical.

You operate it like this:
With EN inactive, you shift out a byte into the shift register in the same way as you did before. This byte defines what's on the DB0-7 signals. Of course, DB0-7 will wiggle while you're shifting, but the LCD will not care as long as EN is inactive. Then, with EN still inactive, you put the state of RS on the PIC's RB1 pin, but you don't toggle the clock line (RB0). Then, you pulse the EN line (RB2) to make the LCD module accept the byte.

It should also be possible to use this technique with a hardware SPI port, which is available in some PICs (or other controllers).

Cheers Stefan

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5.4. Other information sources

america.renesas.com/products/supportdocs/hd44780.pdf (Local copy available as zipped file, approx 318kB)
www.repairfaq.org/filipg/LINK/F_LCD_menu.html
www.repairfaq.org/filipg/LINK/F_Tech_LCD.html
members.optushome.com.au/donmck/dtait/testlcd.c

www.rentron.com/Myke1.htm
www.oopic.com/lcd.htm
ee.cleversoul.com/lcd_project.html
ee.cleversoul.com/hotsheet_opto.html#lcds

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Manufacturer and Distributor Info

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6. Manufacturers and Distributors

In case you have any "HD44780-based Character-LCD"-related manufacturer and/or distributor information to add to the list, please fill in the form below.

These pages are not supported by any manufacturer/distributor. So, please, take into account the following notes:

Note 1: Do not use the form below to ask for any datasheets etc., I cannot supply you with such information.

Note 2: The information on this page is supplied 'as is' by users/manufacturers/distributors, see also section 1.1. Disclaimer.

Note 3: For all submitted entries it is mandatory to supply a corresponding/valid/reachable homepage. All entries *without* a corresponding/valid/reachable homepage will be ignored, i.e. just submitting a phone/fax number and/or e-mail address and/or bogus homepage will be ignored.

Note 4: In case you feel an entry is no longer relevant/functional please let me know using "Please check/remove: <entry_description> Reason: <your_reason>" in the Comments field below. In case I am convinced the entry is no longer relevant/functional it will be removed from this page.

Note 5: In case you, manufacturer/distributor/user, want to share datasheets/applications/<related stuff> on this site: let me know. I will evaluate and, when concidered relevant and non-copyrighted (else: supply a hyperlink), publish it on here.

Your name

Your E-Mail address

Manufacturer/Distributor/Reseller information

```
Country           :
Manufacturer name :
Distributor name  :
Phone             : +
Fax               : +
E-mail            :
Homepage          : http://
Comments          :
```

Your choice

Ok, send it! Forget about it

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6.1. Europe

Table 6.1.

Country	Manufacturer	Distributor/Reseller		
		Name	Phone	Fax
Austria	Data Vision	Conrad Electronic	+	+
Austria	Jinghua LC Displays	Kentec GmbH mail.at@kentec.net	+41 41 763 03 03	+41 41 763 03 05
Austria		Drau Electronic office@drauelectronic.com	+43 4242 311800	+43 4242 311800 9
Austria		Ribu Elektronik Versand office@ribu.at	+43 3172 64800	+43 3172 64806
Belgium	Hyundai, Sharp, Wintek	RATO Electronics	+	+
Denmark	Optrex	Brinck Elektronik sales@brinck.dk	+45 33 11 15 700	+45 33 91 15 700
Denmark	Solomon	Berendsen Electronic	+45 39 57 72 00	+45 39 57 72 02
Denmark	Winstar	Chippen	+45 28 92 10 07	+45
Denmark	Vikay	EVJ Elektronik	+45 35 86 90 22	+45 35 86 90 00
Denmark	Emerging Display Technologies	EE kit info@eekit.dk	+45 44 480 766	+45 44 480 767
Europe	Vikay	Vikay Europe Rep. Office (UK)	+44 276-686022	+44 276-29471
France	Samsung	Selectronic	+33	+33
Germany	Andi	Andi	+49 41-9250070	+49 41-92500711
Germany	DIGUANG	Smart Electronic Components info@smart-e-comp.de	+49 2154-4848-0	+49 2154-4848-0
Germany	ALPS, ANAG VISION, DATA VISION, DATA IMAGE	DST info@dst-gmbh.de	+49 89 89979764	+49 89 89979765
Germany	Jinghua LC Displays	Kentec GmbH mail.de@kentec.net	+49 (7751) 897 130	+49 (7751) 897 131
Germany	Seiko Instruments		+49 6102-297-0	+49 6102-297-320
Germany	Vikay,Hitech, div.	Display Elektronik displayel@aol.com we support best service and avaiability of standard-lcd and custom lcd. We can support TN,STN,FSTN,DSTN. We support technologies like: COB,COF,COFlex,COG.	+49 6043-511	+49 6043-3010
Germany		Conrad Elektronik	+49 180-5312111	+49 180-5312110
Germany		Electronic Assembly	+49 89-8541991	+49 89-8541721
Germany		Reichelt info@reichelt.de	+49-4422-955-0	+49-4422-955-111
Italy	Winstar	Skylab S.r.l. skylab@skylab.it Specialized on Display & Touch Screen	+39 039 666718	+39 039 691 8209
Macedonia	"Elektro Soft"- Skopje		+389 91-114212	+389 91-115380
Netherlands	aM-tec Microtips Optrex Tianma NEC Samsung	DiBis, Digital Business contact@dibis.nl distributor of LCD, TFT, ELD, touchscreens and embedded PC for the Benelux	+31-320-250860	+31-320-240091
Netherlands	Clover, Densitron, Solomon, Picvue, Sharp, Winstar	Eurodis Texim Electronics TeLinteloR@Texim.Eurodis.nl	+31 53-5733324	+31 53-5733240
Netherlands	Epson, Seiko, Vikay	Alcom Electronics B.V.	+31 10-4519533	+31 10-4586482
Netherlands	Matrix Orbital	Antratek info@antratek.nl	+31 10-4504949	+31 10-4514955

Country	Manufacturer	Distributor/Reseller		
		Name	Phone	Fax
Netherlands	Optrex	Nijkerk Electronics ne@nijkerk.nl (page doesn't display correctly in Netscape 7.yy)	+31 20 5041424	+31 20 6423948
Netherlands	Optrex	VAN DIJKEN ELEKTRONICA lcd@vandijkenelektronica.nl Large selection of lcd character and graphic displays from different manufacturers.	+31 50 5515354	+31 50 5565717
Netherlands	Philips	Conrad Nederland	+31	+31
Sweden	Solomon	Berendsen Electronic	+46	+46
Sweden	Optrex	ELFA AB order@elfa.se	+46 20-758000	+46 20-758010
Sweden	TRULY	LAWICEL info@lawicel.com Also serial LCD (TRULY + SLI-OEM)	+46 451-59877	+46 451-59878
Sweden		U.S Electronics AB uselec@algonet.se	+46 11-105077	+46
Switzerland	Jinghua LC Displays	Kentec GmbH mail.de@kentec.net	+41 41 763 03 03	+41 41 763 03 05
Ukraine		Melnichuk Pavel	+380 432-3506699	+380 432-4383477
United Kingdom	China	Crownhill Associates Limited sales@crownhill.co.uk Very high quality super twist displays, in green blue and yellow.	+44 1353-666709	+44 1353-666710
United Kingdom	Densitron International PLC sales@densitron.co.uk manufacturer of a wide range of standard and custom LCDs, industrial PCs and electro-mechanical components		+44 1959-700100	+44 1959-700300
United Kingdom	Orient Display	Maplin Electronics sales@maplin.co.uk	+44 1226 751155	+44 1226 272499
United Kingdom	Varitronix, Toshiba, IBM, Acer	Trident Displays Ltd. sales@tridentdisplays.co.uk	+44 1737-780790	+44 1737-771908

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6.2. North America

Table 6.2.

Country	Manufacturer	Distributor/Reseller		
		Name	Phone	Fax
Canada	Matrix Orbital Corp. rhansen@matrix-orbital.com Serial and parallel LCDs. Single to large volume orders accepted through our online order system (Visa/Mastercard).		+1 403-229-2737	+1 403-229-1963
Canada	Optrex	CMSS Josh Bensadon	+1 416-620-5000	+1
Canada	Orient Display(N.America)Ltd services@orientdisplay.com We produce LCD panels,alphanumeric,character and graphic LCD modules, COG,TAB,COB,SMT types.		+1 416-290-1166	+1 416-290-1165

Country	Manufacturer	Distributor/Reseller		
		Name	Phone	Fax
Canada	Tri-T Company Limited	Hitech-gadgets sales@hitech-gadgets.com provide cost effective and innovative solutions to meet LCD display modules design requirements. We carry a line of character display modules (alphanumeric displays) and graphical display modules (LCM Liquid Crystal Modules).	+1 778-772-3811	+1 604-298-6007
Canada	Sharp	Active electronics Sharp LCD using HD44780A00	+1 514-731-7441	+1 514-256-4890
Canada	Varitronix Limited	Varitronix (Canada) Ltd.	+1 905-415-0023	+1 905-415-0094
Canada	WIRZ	CANTronics kits@rzsoft.com Low cost SERIAL LCD interfaces to be used with HD44780 LCD panels.	+1 403-278-5895	+1 403-278-5895
Canada		HVW Technologies info@hvwtech.com RS-232 and I2C Serial LCD and VFD modules as well as eoconomy serial LCD kits for hobbyists and experimenters. Singles to production quantities.	+1 403-730-8603	+1 403-730-8903
USA	AZ Displays, Inc. sale@azdisplays.com		+1 949-360-5830	+1 949-360-5839
USA	Data International sales@datainternational.com Phone: +1 407-380-2242 Fax: +1 407-380-0778	Arrow	+1	+1
USA	Data International sales@datainternational.com Phone: +1 407-380-2242 Fax: +1 407-380-0778	Bell Microproducts	+1	+1
USA	Crystalfontz	Crystalfontz - Direct brent@crystalfontz.com Serial and parallel LCDs. Small orders and international orders accepted through the online order system (Visa/Mastercard).	+1 509 291-3514 888 206-9720	+1
USA	Densitron		+1 562-941-5000	+1 562-941-5757
USA	Emerging Display Technologies corp. edtc@ix.netcom.com Manufactures everything from 1 line by 8 characters to 640x480 LCD panels.		+1 714-508-2555	+1 714-508-2557
USA	Excel Technology International Corp sales@lcdexceltech.com Excel has been manufacturing Excelix brand LCDs and LCMs for over 20 years.	Excel Technology International Corp	+1 908-874-4747	+1 908-874-3278
USA	Fema Electronics Corp fema@femacorp.com	Call Fema	+1 609-409-1720	+1 609-409-1721
USA		Hantronix Lots of PDF.	+1 408-252-1100	+1 408-252-1123

Country	Manufacturer	Distributor/Reseller		
		Name	Phone	Fax
USA	KENT Displays Inc.	KENT Displays Inc. Large Matrix LCD Modules.	+1 330-673-8784	+1 330-673-4408
USA	Luna Labs	CIE Bookstore LCD Commander teaching tool uses a HD44780 controller.	+1 800-321-2155	n/a
USA	Nan Ya Plastics (Taiwan)	Mark Products Corp. info@mark-products.com Medium-to-high volume, high quality character and graphics modules. Excellent pricing and leadtimes. On-shore technical and design-in support.	+1 630-787-9089	+1 630-787-9015
USA	Optrex	Apollo Display Technologies, Inc. apollodisplays@erols.com	+1 516-654-1143	+1 516-654-1496
USA	Optrex	Digi-Key Corporation	+1 218-681-6674 +1 800-344-4539	+1 218-681-3380
USA	Optrex	Sager Electronics	+1 800-SAGER-800 +1 800-724-3780	+1 800-268-8001
USA	Optrex compatible	Walter Dunckel wdunckel@ix.netcom.com	+1	+1
USA	Powertip Technology Corp.	Powertip Technology Corp. sales@powertipusa.com	+1 949-585-9888	+1 949-585-9889
USA	Real-Time Controlsystems	Real-Time Controlsystems abelisle@rtcsystems.com Serial LCD uaing 2 wire control great for assembly code programing of small microcontroller. No comport used.	+1 323-893-5202	+1 323-727-7739
USA	Purdy Electronics	Allied Electronics, Inc. ftw$manager@alliedelec.com Low cost AND (tm) Intelligent LCD Displays based on Hitachi HD44780 controllers	+1 817-595-3500	+1 817-595-6444
USA	Standish Industries		+1 414-648-1000	+1 414-648-1001
USA	Standard and Custom Design	Micro Electronics Corp	+1 408-988-1101	+1 408-988-7626
USA		Surplus Traders ted@73.com	+1 514-739-9328	+1 514-345-8303
USA	TIANMA Microelectronics Co., Ltd.	TNG Industry (U.S.A.), Inc. joy@tngusa.com jwindham@tngusa.com ISO 9001 & 9002 certified. Great quality with very competitive pricing and lead times.	+1 909-590-5465	+1 909-590-5469
USA	Vikay	VGI Inc. Head Office	+1 916-783-7878	+1 916-783-7845
USA	Vikay	VGI Inc. NorthEast Sales Office	+1 203-521-0602	+1 203-521-8864
USA	Vikay	VGI Inc. SouthEast Sales Office	+1 919-832-4288	+1 919-832-6089

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6.3. Asia

Table 6.3.

Country	Manufacturer	Distributor/Reseller		
		Name	Phone	Fax
China	FORDATA ELECTORNIC CO.,LTD	FORDATA ELECTORNIC CO.,LTDp	+86-592-5528029	+86-592-5519491
China	Hainan Qinghua Lcd Technology Limited info@hnqhlcd.com.hk TN,HTN,STN,FSTN LCD and LCM		+852 26723466	+852 24286463
China	Hebei Jiya Electronics Co., Ltd hbjy@public.sj.he.cn		+86-311-7757912-8002	+86-311-7757927
China	hebei jiya electronics co., ltd lhqiang2002@yahoo.com.cn	looking for lcd lcm agent	+86-311-7726194	+86-311-7757911
China	Nely Tech Co.,Ltd. simon@nelytech.com contact@nelytech.com NELY is leading LCD and LCM manufacturer in mainland China. It is famous for its quality, price, speed and service, especially the R&D ability. You can find every standard LCD modules from 8X2 to 320X240 in NELY, We have over 300 customers all over the world.		+86 755-82261330 +86 755 8226 9458	+86 755-82429568
China	Shantou Goworld Display Co., Ltd we are LCD manufacturer,main products:TN,STN,FSTN,COG,COB,TAB,COF and other standard products.		+86-754-8628581	+86-754-8256157
China	Silicon Tek Co.,Ltd sales@stekcn.com	Seeking the agent in western atmosphere.	+86-769-3623728	+86-769-3630806
China	Wincom Electronics Co.,Ltd win_com@vip.163.com We are LCD module manufacturer in China.		+86-755-26154265	+86-755-26418649
Hong kong	Casil Semiconductor LTD	Casil Group mkt@casil-module.com.hk 12*1,16*1,16*2,20*2,20*4 LCM	+852 2356-3252	+852 2467-4998
Hong Kong	Casil Optoelectronic Product Dev. Ltd.		+852 2333-6111	+852 2467-4998
Hong Kong	DDT sales@dragonlcd.com standard / custom graphic / character module		+852 3104 8255	+852 3104 8256
Hong Kong	Tovics Technology (HK) Ltd. sales@perfectlcd.com LCD and LCM manufacturer with good technical support. Support low to high volume modules with competitive price.		+852 2121 0231	+852 2121 0230
Hong Kong	Varitronix Limited		+852 2197-6000	+852 2343-9555
Hong Kong	Vikay	Vikay Industrial (HK) LTD	+852 614-2505	+852 614-5559
India	Lampex Electronics Pvt. Ltd. lampex@hd1.vsnl.net.in		+91 40-886850 +91 40-886851	+91 40-887905
India	Oriole Electronics Pvt Ltd oriole@vsnl.com		+91 22 25094241-46	+91 22 25115810
Japan	Optrex			
Malaysia	Aiwa Electronics (M) Sdn.Bhd.		+60 7-3502472	+60 7-3502466
Vietnam	VTC Company	VTC Company ncptvtc@hn.vnn.vn	+84 04-8210315	+84 04-6362512

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6.4. Australia

Table 6.4.

Country	Manufacturer	Distributor/Reseller		
		Name	Phone	Fax
Australia		Ricom Electronics info sales	+61	+61
Australia	Ampire	Computronics Corporation Ltd info Mainly for manufacturing qty's, but can sell low qty for prototyping.	+61 8 9470 1177	+61 8 9470 2844
Australia	VL Electronics	Farnells	+61 9-2-645-8888	+61 9-2-644-7898

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6.5. South America

Table 6.5.

Country	Manufacturer	Distributor/Reseller		
		Name	Phone	Fax
Argentina	Industrial controls		+54	+54 61-304119

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6.6. Africa

Table 6.6.

Country	Manufacturer	Distributor/Reseller		
		Name	Phone	Fax
South Africa	HLM	PDE South Africa	+27 11-614-9511	+27 11-614-9511

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