Step By Step Initialization Flow Chart for HD44780 Based Alphanumeric LCD Modules.

(These instructions are intended to help *get up and running* quickly. More detailed timing diagrams and instructions are available elsewhere.)

The Hitachi HD44780 is long gone. The Samsung KS0066U is currently on the way out. Sitronix ST7066 is one of the current clones.

This information discusses 8-bit communication. 4-bit is similar, but the upper nibble is sent first, followed by the lower nibble. The upper nibble of the function set is %0010 to specify 4-bit operation. Use DB4 – 7, and leave DB0 – 3 open.

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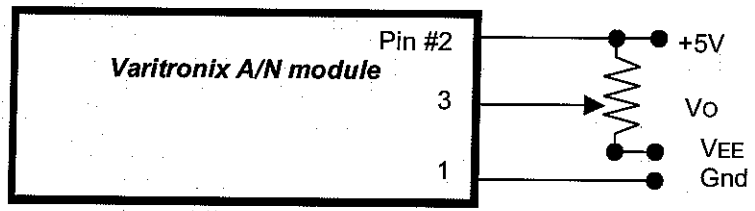
1) Connect to all data and power lines of the LCD module. Typical connections:

Table #1

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Gnd	Vdd	Vo	RS	R/W	E	DB0	DB1	DB2	DB3	DB4	DB5	DB6	DB7

2) To reduce noise, it may be desirable to tie input only pins low with a resistor. (10kΩ should work.) For I/O pins, such as DB7, a smaller value is suggested (~470Ω).
3) Ground (pin #1) is 0V and V_{DD} (pin #2) is to be +5V.
4) Allow >15ms for power to come up before applying power to pin #3 or sending data.
5) Start with Vo (pin #3) at about 0V. The value of Vo is model and temperature dependent. At room temperature, "LV" modules may need about +0.5V, wide temp modules may require approximately –4V.)



For standard temp, low voltage (LV) modules: V_{EE} = Gnd
For wide temp, high voltage (HV) modules: V_{EE} = –5V

$V_{DD} – V_O = V_{LCD}$, the voltage used to drive the LCD. So, decreasing Vo will increase V_{LCD}.

6) Enable or "E" (pin #6) starts low (0V).
7) In this initialization table, suggested or common settings for variables are in **Bold** in the *Notes* column.
8) Initialize modules per Table #2. For each instruction, configure the 10 pins shown. Then clock in the data/command by taking E from low to high and back low. Data is clocked on the falling edge of E.
9) Once initialized you can readjust Vo (pin #3) for optimum contrast at the desired viewing angle.

March 11, 2006

Ralph Sabroff

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Table #2

INSTRUCTION	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	NOTES
FUNCTION SET	0	0	0	0	1	DL	N	0	*	*	DL = **1 for 8 bit,** 0 for 4 bit N = **1 for 16:1 mux,** 0 for 8:1 or 11:1 (See "Note" below.) [Wait >5ms after this]
FUNCTION SET	Same As Above										Hit "E" two more times. [Wait >100µs after each time]
CLEAR DISPLAY	0	0	0	0	0	0	0	0	0	1	Clears DD RAM and LCD [Wait >16ms after this]
ENTER MODE	0	0	0	0	0	0	0	1	I/D	S	I/D = **1 for increment,** 0 for decrement S = **0 for no shift,** 1 shifts display [Wait >40µs after this & all subsequent]
DISPLAY ON/OFF	0	0	0	0	0	0	1	D	C	B	**1 is "ON",** 0 is "OFF" D = "DISPLAY" C = "CURSOR" B = "BLINK" the character
WRITE DATA	1	0	?	?	?	?	?	?	?	?	? = ASCII character to display

(*) = Does not matter

Note: Most all other information sources related to A/N modules say this "N" value sets the number of "display lines" (rows of characters). Actually, this sets the number of lines the controller *thinks* there are. The numbers may not match: if the controller thinks there are two lines, the LCD might actually have 1, 2, 3, or 4 rows of characters. The controller always thinks 16 level multiplex (a.k.a. 16:1 mux) LCDs have two lines and 8:1 or 11:1 mux LCDs have one line.

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OTHER HELPFUL INSTRUCTIONS:

Table #3

INSTRUCTION	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	NOTES
DISPLAY SHIFT	0	0	0	0	0	1	S/C	R/L	*	*	S/C = 1 moves the display, **0 moves the cursor** R/L = **1 shifts right,** 0 shifts left
RETURN HOME	0	0	0	0	0	0	0	0	1	*	Puts cursor at hex 00 location [Wait >16ms after this]
SPECIFY CHARACTER LOCATION	0	0	1	?	?	?	?	?	?	?	? = DDRAM's Hex location

(*) = Does not matter

Character locations:

The driver/controller can control up to 80 characters. The LCD can be configured with up to 4 rows of characters, but the total (Rows x Columns) of characters cannot exceed 80. The controller maps all characters as if 2 rows of 40 characters were being displayed.

The initial character maps (DDRAM Address Counter) for various configurations are depicted on the next page. (The "Shift" feature changes this.) Notice that for displays with four rows, rows 3 & 4 are continuations of 1 & 2 respectively.

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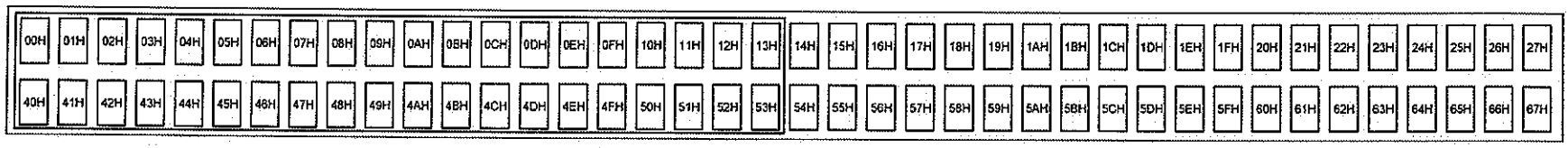
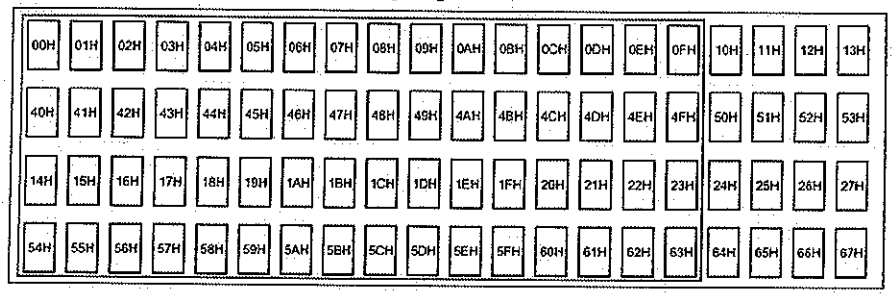
Character locations (continued):

20x2 Display

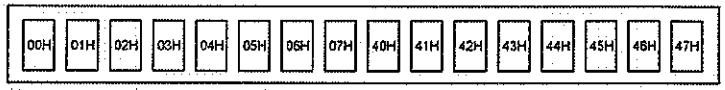


40x2 Display

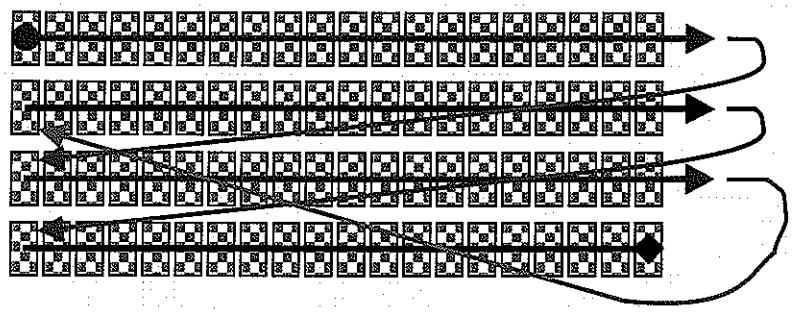
20x4 Display
16x4 Display



16x1 Display
(for a 16:1 multiplex version)



This is the path the *Increment* feature follows. (It will 'jump' automatically from 27H to 40H, and from 67H back to 00H.



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Special Characters (CGRAM):

Table #4

INSTRUCTION	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	NOTES
SET DDRAM LOCATION	0	0	0	0	0	*	?	?	?	?	Specify Hex 00 thru 07: location for special character in CGRAM
SET CGRAM	0	0	0	1	?	?	?	?	?	?	If you start with Hex 40, the address counter will automatically increment
CREATE PATTERN	1	0	*	*	*	?	?	?	?	?	Correlates to the pixels in row #1: 1 = "ON" pixel, 0 = "OFF" pixel
CREATE PATTERN	1	0	*	*	*	?	?	?	?	?	Correlates to the pixels in row #2: 1 = "ON" pixel, 0 = "OFF" pixel
CREATE PATTERN	1	0	*	*	*	?	?	?	?	?	Correlates to the pixels in row #3: 1 = "ON" pixel, 0 = "OFF" pixel
CREATE PATTERN	1	0	*	*	*	?	?	?	?	?	Correlates to the pixels in row #4: 1 = "ON" pixel, 0 = "OFF" pixel
CREATE PATTERN	1	0	*	*	*	?	?	?	?	?	Correlates to the pixels in row #5: 1 = "ON" pixel, 0 = "OFF" pixel
CREATE PATTERN	1	0	*	*	*	?	?	?	?	?	Correlates to the pixels in row #6: 1 = "ON" pixel, 0 = "OFF" pixel
CREATE PATTERN	1	0	*	*	*	?	?	?	?	?	Correlates to the pixels in row #7: 1 = "ON" pixel, 0 = "OFF" pixel

(*) = Does not matter

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