LCD Commands

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	40uS

Command											Description	Time
											direction (R/L). DDRAM contents remains unchanged.	
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 or received after this setting.	40uS
Set DDRAM address	0	0	1	DDRAM address							Sets the DDRAM address. DDRAM data is sent or received after this setting.	40uS
Read busy-flag and address counter	0	1	BF	DDRAM address							Reads Busy-flag (BF) indicating internal operation is being performed and reads address counter contents.	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

Notes:

- DDRAM = Display Data RAM.
- CGRAM = Character Generator RAM.
- DDRAM address corresponds to cursor position.

- Address Counter is used for both DDRAM and CGRAM.
- * = Don't care.
- ** = Based on Fosc = 250KHz.

Bit names

Bit	Settings	
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

Clear Display

```
RS   R/W DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0
===  === === === === === === === === ===
 0    0   0   0   0   0   0   0   0   1
```

Clears all display and returns the cursor to the home position (Address 0).

Details
Writes space code (20h) into all DD RAM addresses. Sets address counter to DD RAM location 0. Returns display to its original state if it was shifted. In other words, the display disappears and the cursor or blink goes to the left edge of the display (the first line if 2 lines are displayed). Sets entry mode I/D to 1 (Increment Mode). Entry mode shift (S) bit remains unchanged.

Execution Time = 82µs-1.64ms / 120µs-4.9ms

Cursor Home

```
RS   R/W DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0
 0    0   0   0   0   0   0   0   1   *
```

Returns the cursor to the home position (Address 0). Returns display to its original state if it was shifted.

Details
Sets the address counter to DD RAM location 0 in the address counter. Returns display to its original state if it was shifted. DD RAM contents remain unchanged. The cursor or blink goes to the left edge of the display (the first line if 2 lines are displayed).

Execution Time = 40µs-1.6ms / 120µs-4.8ms

Entry Mode Set

```
RS   R/W DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0
=== === === === === === === === === ===
 0    0   0   0   0   0   0   1  I/D  S
```

Sets the effect of subsequent DD RAM read or write operations. Sets the cursor move direction and specifies or not to shift the display. These operations are performed during data read and write.

Details
Specifies whether to increment (I/D = 1) or decrement (I/D = 0) the address counter after subsequent DD RAM read or write operations.

If S = 1 the display will be shifted to the left (if I/D = 1) or right (if I/D = 0) on subsequent DD RAM write operations. This makes it looks as if the cursor stands still and the display moves when each character is written to the DD RAM. if S = 0 the display will not shift on subsequent DD RAM write operations.

Execution Time = 40µs / 120µs

Display ON/OFF

```
RS   R/W DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0
=== === === === === === === === === ===
 0    0   0   0   0   0   1   D   C   B
```

Controls display of characters and cursor.

Details
D: The display is ON when D = 1 and OFF when D = 0. The DD RAM contents remain unchanged.

C: The cursor is displayed when C = 1 and is not displayed when C = 0.
The cursor is displayed as 5 dots in the 8th line when the 5 x 7 dot character font is selected and as 5 dots in the 11th line when the 5 x 10 dot character font is selected.

B: The character at the the cursor position blinks when B = 1.
Blinking is performed by switching between all blank dots and the display character every 409.6 ms.

Execution Time = 40µs / 120µs

Cursor and Display Shift

```
RS   R/W DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0
=== === === === === === === === === ===
 0    0   0   0   0   1  S/C R/L  *   *
```

Moves the cursor and shifts the display without changing DD RAM contents

Details
Shifts cursor position or display to the right or left without writing or reading display data. This function is used to correct or search for the display. In a 2-line display, the cursor moves to the 2nd line when it passes the 40th digit of the 1st line. Notice that the 1st and 2nd line displays will shift at the same time. When the displayed data is shifted repeatedly each line only moves horizontally. The 2nd line of the display does not shift into the 1st line position.

```
S/C R/L
=== ===
```

```
0   0   Shifts the cursor position to the left
        (Address Counter is decremented by 1)
0   1   Shifts the cursor position to the right
        (Address Counter is incremented by 1)
1   0   Shifts the entire display to the left
        The cursor follows the display shift
1   1   Shifts the entire display to the right
        The cursor follows the display shift
```

<div align="center">Execution Time = 40μs / 120μs</div>

Function Set

```
RS  R/W DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0
=== === === === === === === === === ===
 0   0   0   0   1  DL   N   F   *   *
```

<div align="center">Sets interface data length (DL), number of display lines (N) and character font (F)</div>

Details

This command should be issued only after automatic power-on initialization has occurred, or as part of the module initialization sequence.

DL: Sets interface data length

Data sent or received in 8 bit lengths (DB7-DB0) when DL = 1

Data sent or received in 4 bit lengths (DB7-DB4) when DL = 0

When the 4 bit length is selected, data must be sent or received in pairs of 4-bits each. The most-significant 4 bits are sent or received first.

N: Sets number of display lines

F: Sets character font

```
    display Character  Duty
N F lines     Font    Factor Remarks
=== ======= ========= ====== =======
0 0    1    5x 7 dots  1/8    -
0 1    1    5x10 dots  1/11   -
1 *    2    5x 7 dots  1/16  Cannot display 2 lines with
                             5x10 dot character font
```

Note that a 1 line x 16 character display is treated as a 2 line x 8 character display. The first `line' is the left eight character positions on the display and the second `line' is the right eight character positions. This also means that the 16 characters on the display do not occupy 16 sequential DD RAM locations.

<div align="center">Execution Time = 40μs / 120μs</div>

Set CG RAM Address

```
RS  R/W DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0
=== === === === === === === === === ===
 0   0   0   1   A   A   A   A   A   A
```

<div align="center">Sets the CG RAM address. Subsequent read or write operations refer to the CG RAM.</div>

Details

Sets the specified value (AAAAAA) into the address counter. Subsequent read or write operations transfer data from, or to, the character generator RAM.

Execution Time = 40µs / 120µs

Set DDRAM Address

```
RS  R/W DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0
=== === === === === === === === === ===
 0   0   1   A   A   A   A   A   A   A
```

Sets the DD RAM address. Subsequent read or writes refer to the DD RAM.

Details
Sets the specified value (AAAAAA) into the address counter. Subsequent read or write operations transfer data from, or to, the display RAM. Note: Adjacent display RAM locations do not necessarily refer to adjacent display positions.

Execution Time = 40µs / 120µs

Read busy flag and address counter

```
RS  R/W DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0
=== === === === === === === === === ===
 0   1  BF   A   A   A   A   A   A   A
```

Reads the state of the busy flag (BF) and the contents of the address counter.

Details
Reads the busy flag (BF) that indicates the state of the LCD module. BF = 1 indicates that the module is busy processing the previous command. BF = 0 indicates that the module is ready to perform another command.

The value of the address counter is also returned. The same address counter is used for both CG and DD RAM transfers.

This command can be issued at any time. It is the only command which the LCD module will accept while a previous command is still being processed.

Execution Time = 1µs

Write data to CG or DD RAM

```
RS  R/W DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0
=== === === === === === === === === ===
 1   0   D   D   D   D   D   D   D   D
```

Writes data into DD RAM or CG RAM

Details
Writes a byte (DDDDDDDD) to the CG or the DD RAM. The destination (CG RAM or DD RAM) is determined by the most recent `Set RAM Address' command. The location to which the byte will be written is the current value of the address counter. After the byte is written the address counter is automatically incremented or decremented according to the entry mode. The entry mode also determines whether or not the display will shift.

Execution Time = 40µs / 120µs

Read data from CG or DD RAM

```
RS  R/W DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0
=== === === === === === === === === ===
 1   1   D   D   D   D   D   D   D   D
```

Reads data from DD RAM or CG RAM.

Details
Reads a byte (DDDDDDDD) from the CG or DD RAM. The source (CG RAM or DD RAM) is
determined by the most recent `Set RAM Address' command. The location from which the
byte will be read is the current value of the address counter. After the byte is reda the address
counter is automatically incremented or decremented according to the entry mode.

Execution Time = 40µs / 120µs