DESN2000
(Computer Engineering)

HD44780 LCD Controller

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- First see the lecture video for what was covered on the whiteboard

Pinouts

| Pin	Description
Vss	Power Supply Ground
Vcc	Power Supply (+3.3 or +5 V depending on module)
Vee	Contrast Adjustment (analogue input)
RS	Register Select (0 = command, 1 = data)
R/W	Read/Write (0 = write to display module, 1 = read from display module)
E	Clock Enable (falling-edge triggered)
DB0- DB3	Data Bit 0 to 3 (grounded in 4-bit operation)
DB4-DB7	Data Bit 4 to 7
LED+	Backlight +
LED–	Backlight –

HD44780 LCD Controller Block Diagram
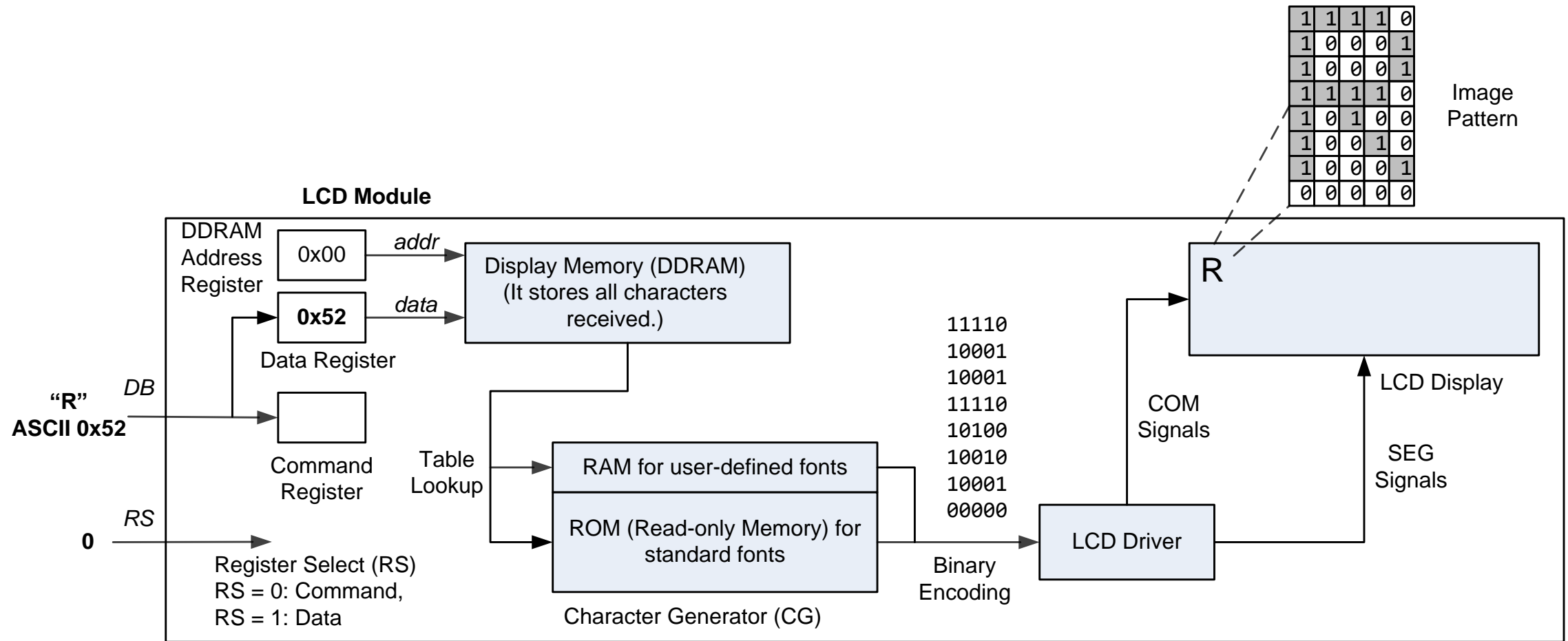
Figure adapted from: Yifeng Zhu, Embedded Systems with ARM Cortex-M Microcontrollers in Assembly Language and C

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Instructions

	RS	R/$\overline{W}$	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Function set Code	0	0	0	0	1	DL	N	F	*	*
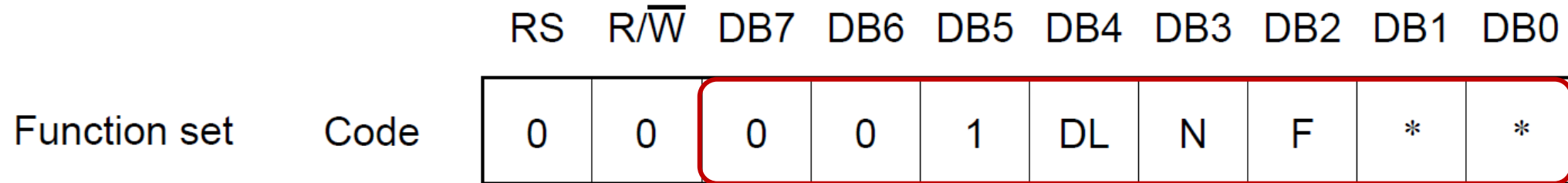
- Sets the interface data length, the number of lines, and the character font.
  - DL: interface data length
    - DL = 0: 4 bits
    - DL = 1: 8 bits
  - N: Sets the number of lines
    - N = 0: 1 line display
    - N = 1: 2 line display
  - F: Sets character font.
    - F = 0: 5 x 8 dots
    - F = 1: 5 x 10 dots

Taken from the HD44780 datasheet

Instructions

		RS	R/W̄	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Clear display	Code	0	0	0	0	0	0	0	0	0	1

- The display clears and the cursor or blink moves to the upper left edge of the display.
- The execution of clear display instruction sets entry mode to increment mode.

		RS	R/W̄	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Return home	Code	0	0	0	0	0	0	0	0	1	*

Note: * Don't care.

- The cursor or the blink moves to the upper left edge of the display. Text on the display remains unchanged.

Taken from the HD44780 datasheet

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Instructions

		RS	R/$\overline{W}$	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Entry mode set	Code	0	0	0	0	0	0	0	1	I/D	S
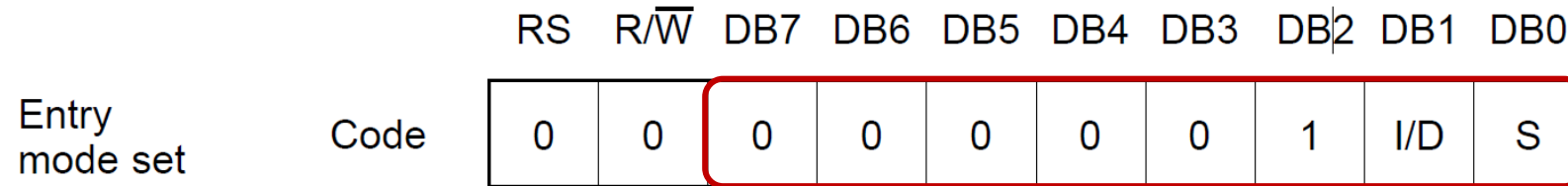
- Sets the Increment/Decrement and Shift modes to the desired settings.

  - I/D: Increments (I/D = 1) or decrements (I/D = 0) the DDRAM address by 1 when a character code is written into or read from DDRAM
    - The cursor or blinking moves to the right when incremented by 1 and to the left when decremented by 1.
    - The same applies to writing and reading of CGRAM.

  - **S:** Shifts the entire display either to the right (I/D = 0) or to the left (I/D = 1) when S is 1. The display does not shift if S is 0.

Instructions

		RS	R/W̄	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Display on/off control	Code	0	0	0	0	0	0	1	D	C	B

- Controls the display ON/OFF status, Cursor ON/OFF and Cursor Blink function.
  - D: The display is ON when D = 1 and OFF when D = 0.
  - C: The cursor displays when C = 1 and does not display when C = 0.
  - B: The character indicated by the cursor blinks when B=1.

Taken from the HD44780 datasheet

Instructions

		RS	R/W̄	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	
Cursor or display shift	Code	0	0	0	0	0	1	S/C	R/L	*	*	Note: * Don't care.

- Shifts the cursor position or display to the right or left without writing or reading display data.

S/C	R/L	
0	0	Shifts cursor position to the left
0	1	Shifts cursor position to the right
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.

Taken from the HD44780 datasheet

Instructions

Set DDRAM Address

	RS	R/W̄	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Code	0	0	1	A	A	A	A	A	A	A

← Higher order bit   Lower order bit →
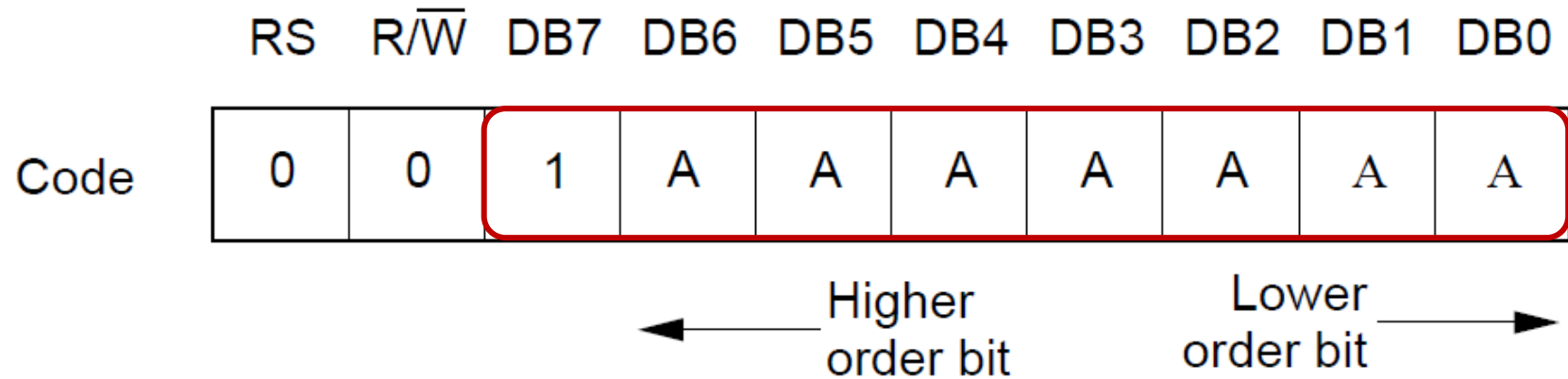
- ~~1100 000~~ will take to the start of the second line

Correct this to be 1100 0000

4-bit Mode Initialisation

Power on

Wait for more than 15 ms
after V_{CC} rises to 4.5 V

(Wait for more than 40 ms
after V_{CC} rises to 2.7 V)

RS	R/W̄	DB7	DB6	DB5	DB4
0	0	0	0	1	1

BF cannot be checked before this instruction.

Function set (Interface is 8 bits long.)

Wait for more than 4.1 ms

RS	R/W̄	DB7	DB6	DB5	DB4
0	0	0	0	1	1

BF cannot be checked before this instruction.

Function set (Interface is 8 bits long.)

Wait for more than 100 µs

Taken from the HD44780 datasheet

4-bit Mode Initialisation

RS	R/W̅	DB7	DB6	DB5	DB4
0	0	0	0	1	1

BF cannot be checked before this instruction.

Function set (Interface is 8 bits long.)

RS	R/W̅	DB7	DB6	DB5	DB4
0	0	0	0	1	0
0	0	0	0	1	0
0	0	N	F	*	*
0	0	0	0	0	0
0	0	1	0	0	0
0	0	0	0	0	0
0	0	0	0	0	1
0	0	0	0	0	0
0	0	0	1	I/D	S

Initialization ends

BF can be checked after the following instructions. When BF is not checked, the waiting time between instructions is longer than the execution instuction time. (See Table 6.)

Function set (Set interface to be 4 bits long.) Interface is 8 bits in length.

Function set (Interface is 4 bits long. Specify the number of display lines and character font.) The number of display lines and character font cannot be changed after this point.

Display off

Display clear

Entry mode set

Taken from the HD44780 datasheet