Experiment 7: LCD Display

14-16.11.2021
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Scarface, Brian De Palma (1983)

1 Introduction

In this experiment, you will learn how to use the 16x2 dot matrix LCD. You are given initializing configuration of the LCD at Part 0 and expected to write different programs to display dynamic strings in the later parts.

2 Part 0

There are two working modes of LCD display which require 8-bit and 4-bit connection bandwidth respectively. Connection between the LCD and the MSP430 LaunchPad is given in Figure 1. Since, the only upper nibble (D4-D7) of data bus are wired to microcontroller, we should use 4-bit working mode to utilize the LCD. Table 1 contains list of

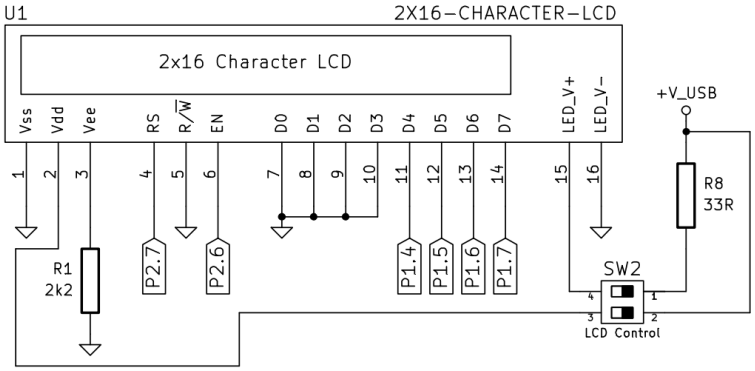


Figure 1: Connection between LCD and MSP430

commands for driving LCD.

Please, remember that the LCD works in 8-bit mode by default. To display any string on the LCD; Firstly, you should configure the LCD display in order to communicate in 4-bit mode. Secondly, you should send 8-bit ASCII characters as nibbles (4 bits) to display using the specific instruction. The flow chart that shows the steps of initialization and configuration of the LCD is given at the end of the experiment. More detail about this flow chart could be found in this link[1].

In this part, you are given "display.asm" as a solution beforehand. You should try to run & analyze the given code to write " ITU Comp Eng \n MicroLab. 2022 " and understand how the LCD initialization and display are done. You will not be given any marks based on this part.

3 Part 1

At the first part, you are asked to write a program that switches the upper and lower lines of the displayed string with a frequency of 2 Hz. You can use the clock however it is not compulsory.
string: " ITU Comp Eng \n MicroLab. 2022 "

4 Part 2

For the second part, you are asked to write a program that displays a single-line string output that moves each letter to the left repeatedly in a circular manner. You can use

[1] http://web.alfredstate.edu/faculty/weimandn/lcd/lcd_initialization/lcd_initialization_index.html

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 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

Table 1: Instruction Set of LCD, retrieved from https://mil.ufl.edu/3744/docs/lcdmanual/commands.html

a scroll speed of 2 Hz or higher if you desire.
string: " ITU Computer Engineering Microprocessor Laboratory 2022. "

5 Part 3

At the last part, you will try to merge your codes from parts 1 & 2 to simply move a dot around.

- Put a dot at the first line, left most position of the display
- Move it one character right at the below line.
- Move it back to above line with one more position at right.
- Repeat from step two w/ a period of 100ms.

string:"."

Character Mode Liquid Crystal Display Module
Initialization by Instruction - 4-bit data interface

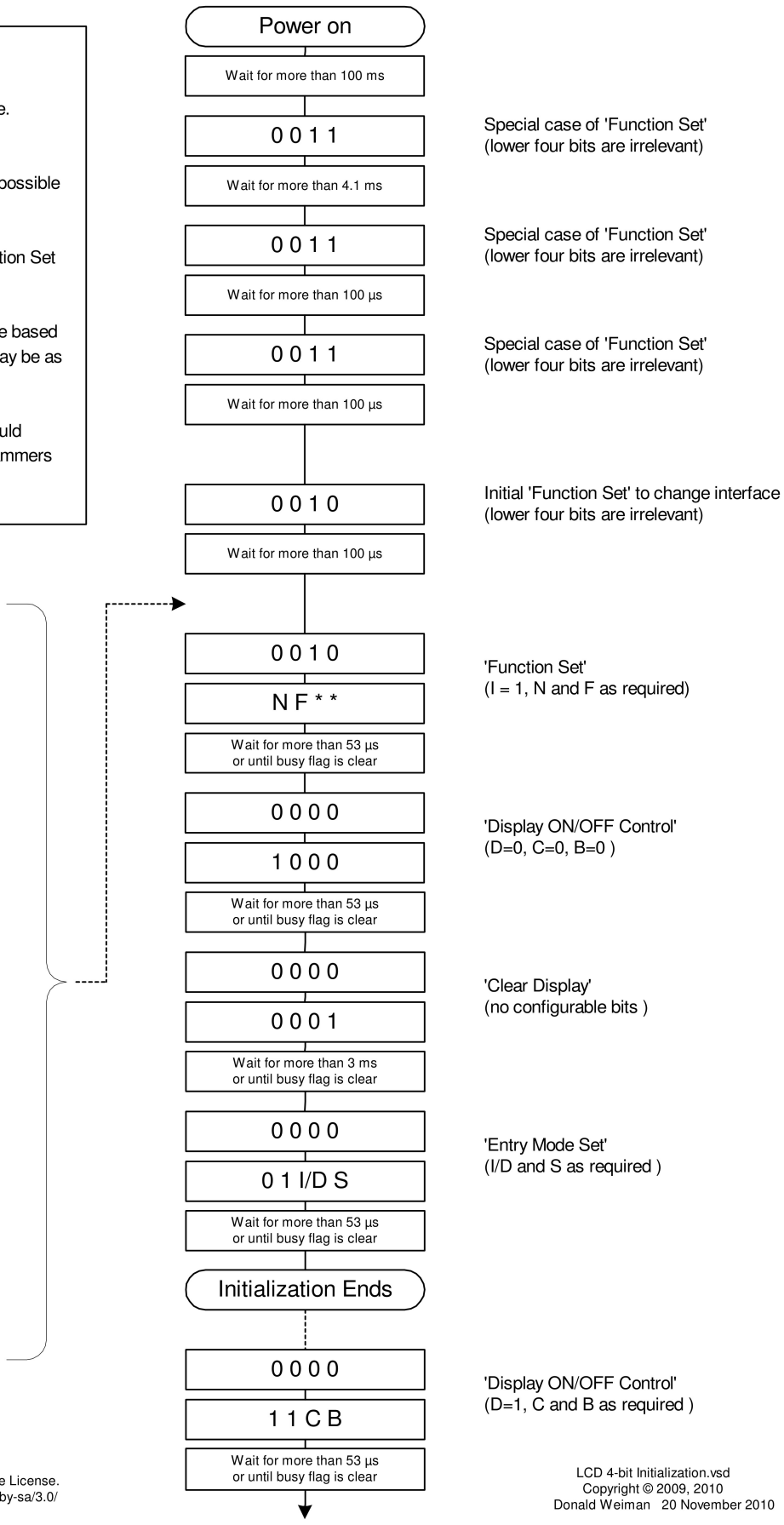
Notes:
RS = 0 to select the Instruction register.
R/W = 0 so that data is written to the LCD module.

The second and third 100 µs time delays are not documented, this figure is speculation, it may be possible to check the busy flag here.

N and F must be set in the first non-special Function Set instruction and cannot be changed subsequently

All time delays specified after the Function Set are based on worst case instruction execution time (clock may be as low as 190 kHz).

The first Display ON/OFF Control instruction should probably be performed as specified (some programmers set D, C, and B here).



The device is in 8-bit mode when powered-up, and it remains in that mode until this point.

Up to this point the device reads all eight data pins each time the enable pin is pulsed.

The four bits shown in the flowchart are the relevant ones and they should be placed on the upper four data lines.

The lower four inputs are supposed to be grounded but they will be ignored in any case.

At this point the device switches to the 4-bit mode.

Beyond this point the device reads only the upper four data pins each time the enable pin is pulsed.

The device will temporarily store the first group of four data bits that it receives. After it receives the second group of four data bits it will reassemble them and execute the resulting instruction.

No time delay is required between the sending of the two groups of bits.