**Microprocessor Lab-work #8**

**Use of an LCD 16x2 Display** 100-11-14

[1] **Subject and goals**

(a) Control for accessing a 16x2 LDC display.

(b) I/O interface of a typical stand-alone IO-chip device.

(c) Typical interactions between CPU and IO-device for data exchange.

[2] **Preparations**

(a) **Refer to the ckt schematic diagram**:

(a.1) control interface and data path between 51CPU and the LCD module

(b) **Datasheets reading**:

(b.1) supplemental technical data of the LCD module

(c) **Readiness-evaluation:**

Can you or can you not

(c.1) write a text line on the top line of the LCD unit from the left to the right (the normal writing)? And write from the right to the left (the opposite writing)? Insert a character into an existent text line at any position? Shift a text line left or right as desired?

(c.2) do all works in (c.1) on the bottom line of the LCD unit?

(c.3) access DD-RAM of the LCD unit for data write-in or read-back?

(c.4) access CG-RAM of the LCD unit for generating user-defined character/pattern?

(c.5) , in all, create dynamic sequence of text display as required on the screen of the LCD unit?

[3] **Lab-work for all:**

(a) **Operating Procedure**

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| **TASK 1** general requirements   * 1. on the bottom line display the message, left-to-right and starting from Home position, “Hello!! Welcome to Microlab.” And then shift the texts back and forth for 3 rounds;   2. after (1.1) is done, on the top line display the message, right-to-left and starting from the end of line position, “.balorciM ot emocleW !!olleH.” And then shift the texts back and forth for 3 rounds;   \*\* wiring for proper setup of all modules \*\* code preparation \*\* code executing with ICE51  **TASK2** write codes for fulfilling the specifications described below  (2.1) creating two locomotive patterns as shown below, each may consist of 3 or 4 CG-pattern (5x10 pixs.)  (2.2) dynamic sequence on the display running in proper rate  phase1:   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- 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(a.1) jumper-wiring for the target module setup

Refer to the schematic circuit diagram, do all jumper-wiring necessary for setting up the circuitry as required below.

SW19

**INT0**

SW20

**INT1**

**51μ*p***

8

**P1**  **D0-7**

Hello!! Welcome

**EA P2** **RS**  DD-RAM 40x2

**R/W**

3 **EN** CG-RAM (16)

(a.2) code preparation:

\*\* invoke IDE51 for editing the following sample 51 assembly code

\*\* get the code ready for execution under IDE51 emulation

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| **; TASK1 exercise on using LCD unit**  ; ============================  ; using LCD unit for two text lines  ; display;  ; 1] .balorciM ot emocleW !!olleH  ; 2] Hello!! Welcome to Microlab.  ; =============================  ; P1 D7-0 of LCD unit  ; P2.0  RS  ; P2.1  R/W  ; P2.2  EN  LCD\_RS REG P2.0  LCD\_RW REG P2.1  LCD\_EN REG P2.2  LCD\_DATA REG P1  org 0  start: mov SP, #60H  mov A, #38H  call WT\_cmmd ; ???  ; ===========================  ; phase I  ; ===========================  repeat:  mov A, #01H  call WT\_cmmd ; ???  mov A, #0EH  call WT\_cmmd ; ???  mov A, #06H  call WT\_cmmd ; ???  mov A, #0A8H  call WT\_cmmd ; ???  mov DPTR, #string  call print\_string2  mov R1, #28 ; why 28?  T2\_Rshift:  mov A, #1cH  call WT\_cmmd ; ???  mov A, #30  call delay\_10ms  djnz R1, T2\_Rshift  mov R1, #28  T2\_Lshift:  mov A, #18H  call WT\_cmmd ; ???  mov A, #30  call delay\_10ms  djnz R1, T2\_Lshift  ; ==========================  ; phase II  ; ==========================  mov A, #1 ; xxxxx  call WT\_cmmd ; ???  mov A, #0EH  call WT\_cmmd ; ???  mov A, #04H  call WT\_cmmd ; ???  mov A, #9CH ; #8FH???  call WT\_cmmd  mov R1, #27  screen\_mv:  ; mov A, #14H ; cursor ->  mov A, #1CH ; screen->  call WT\_cmmd  djnz R1, screen\_mv  mov DPTR, #string  call print\_string1  mov R1, #28  T1\_Lshift:  mov A, #18H  call WT\_cmmd ; ???  mov A, #30  call delay\_10ms  djnz R1, T1\_Lshift  mov R1, #28  T1\_Rshift:  mov A, #1cH  call WT\_cmmd ; ???  mov A, #30  call delay\_10ms  djnz R1, T1\_Rshift  jmp repeat  string:  DB "Hello!! Welcome to Microlab.",0  WT\_cmmd:  push A  RDY\_check:  call RD\_cmmd  jb A.7, RDY\_check  pop A  clr LCD\_RS  clr LCD\_RW  setb LCD\_EN  mov LCD\_DATA, A  clr LCD\_EN  setb LCD\_RW  anl A, #0FCH  jz delay\_40ms  mov A, #1  call delay\_40microsec  ret  delay\_40ms:  mov A, #40  call delay\_40microsec  ret  RD\_cmmd:  clr LCD\_RS  setb LCD\_RW  setb LCD\_EN  mov A, LCD\_DATA  clr LCD\_EN  push A  mov A, #1  call delay\_40microsec  pop A  ret  WT\_data:  push A  RDY2WT:  call RD\_cmmd  jb A.7, RDY2WT  pop A  setb LCD\_RS  clr LCD\_RW  setb LCD\_EN  mov LCD\_DATA, A  clr LCD\_EN  setb LCD\_RW  mov A, #1  call delay\_40microsec  ret  print\_string2:  push A  push 1  mov R1, #0  next\_char2:  clr A  movc A, @A+DPTR  jz end\_print2  call WT\_data  push A  mov A, #40  call delay\_10ms  pop A  inc DPTR  inc R1  cjne R1, #16, next\_char2  mov A, #18H  call WT\_cmmd ; ???  mov A, #07H  call WT\_cmmd ; ???  mov A, #40  call delay\_10ms  jmp next\_char2  end\_print2:  pop 1  pop A  ret  print\_string1:  push A  push 1  mov R1, #0  next\_char1:  clr A  movc A, @A+DPTR  jz end\_print1  call WT\_data  push A  mov A, #40  call delay\_10ms  pop A  inc DPTR  inc R1  cjne R1, #16, next\_char1  mov A, #1CH  call WT\_cmmd ; ???  mov A, #05H  call WT\_cmmd ; ???  mov A, #40  call delay\_10ms  jmp next\_char1  end\_print1:  pop 1  pop A  ret  delay\_40microsec:  push 7  dd40: mov R7, #20  djnz R7, $  djnz A, dd40  pop 7  ret  delay\_10ms:  push 6  push 7  dd10: mov R6, #100  loop: mov R7, #48  djnz R7, $  djnz R6, loop  djnz A, dd10  pop 7  pop 6  ret  end  ;===============================  ; TASK2:  ; about time to define a set of  ; specifications on your own and  ; write coding accordingly…  ; . . .GOOD LUCK! |

(a.3) task execution:

\*\* start the execution and observe circuit behaviors

\*\* start trouble-shooting if necessary

**Key**: (1) checking along the data path in a stage by stage manner, from the start: inside of 89c51 to the end: the target module

(2) test the codes module by module, when things are getting somewhat ugly and messy, by masking irrelevant modules out, e.g., \*\*) test print\_string2 first

\*\*) test print\_string1 then

1. **Observations**

(b.1) Is the sample code running well? If so, it’s too bad that nothing you could learn about from it.

If not, congratulate you that you have a chance for getting more experience in trouble-shooting.

(b.2) Please describe the execution flow structure if you will.

(b.3) Describe the responses of the LCD unit to the commands issued by the instructions marked with “**???**”**.**

(b.4) Describe how the LCD interface signals **RS**-**WR**-**EN** are generated and removed.

(b.5) Describe the defects lurking in the module **delay\_10ms** and **delay\_40microsec**.

(b.6) Describe the command sequence that must be issued to the LCD unit, in general, before it can start displaying text string.

(b.7) Prior to the calling of print\_string1 and print\_string2, two different LCD entry-modes were deployed. Describe the difference in

between and the purposes of the two.

(b.8) In the module **print\_string1**,

\*\* why is there a counting test against 16?

\*\* why is there a change in the LCD entry-mode setting after passing the counting test?

\*\* what’s the effect to the subsequent characters sent to LCD after passing the test?

(b.9) In the module **print\_string2**,

\*\* why is there a counting test against 16?

\*\* why is there a change in the LCD entry-mode setting after passing the counting test?

\*\* what’s the effect to the subsequent characters sent to LCD after passing the test?

(b.10) Why is there a successive rightward moving of the screen for 27 times before the start of **print\_string1** in phase II operation?

(b.11) Could you visualize the contents of DD-RAM in the LCD module during phase I operation? And during phase II operation?

[ the key for answering lots of the questions concerning the operations in phase I and II ]

(b.12) Replace the code line marked with **; xxxxx** with “**mov A, #2**” and see what the difference it causes. Explain.

[4] **Comprehension evaluation**

(a) Try rewriting the codes so that it is shorter and cleaner in code structure and less complicated in execution.

(b) If the goal of TASK2 is revised as follows, what would be the challenge in attempt of revising the codes for the original TASK2?

phase 1:

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