Microprocessor Lab-work #3uVision

4x4 Keypad Scanning 100-11-14

[1] **Subject and goals**

(a) interconnecting structure of a 4x4 keypad, together with scanning and encoding process

(b) balance among several IO-control tasks that have to be executed in order repetitively

[2] **Preparations**

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

(a.1) how the DIP switch, 4x1 switch, and 4x4 keypad module(s) would be scanned.

(a.2) data path(s) from 51CPU to the target switch module(s)?

(b) **Datasheets reading**:

(b.1) none

(c) **Readiness-evaluation:**

Can you or can you not

(c.1) check if the target module (i.e., any switch and any 7-seg LED digit) is working properly or not by manually wiring the circuitry?

(c.2) carry out trouble shooting along the path way when the lab-work isn't going as expected? How will you do that?

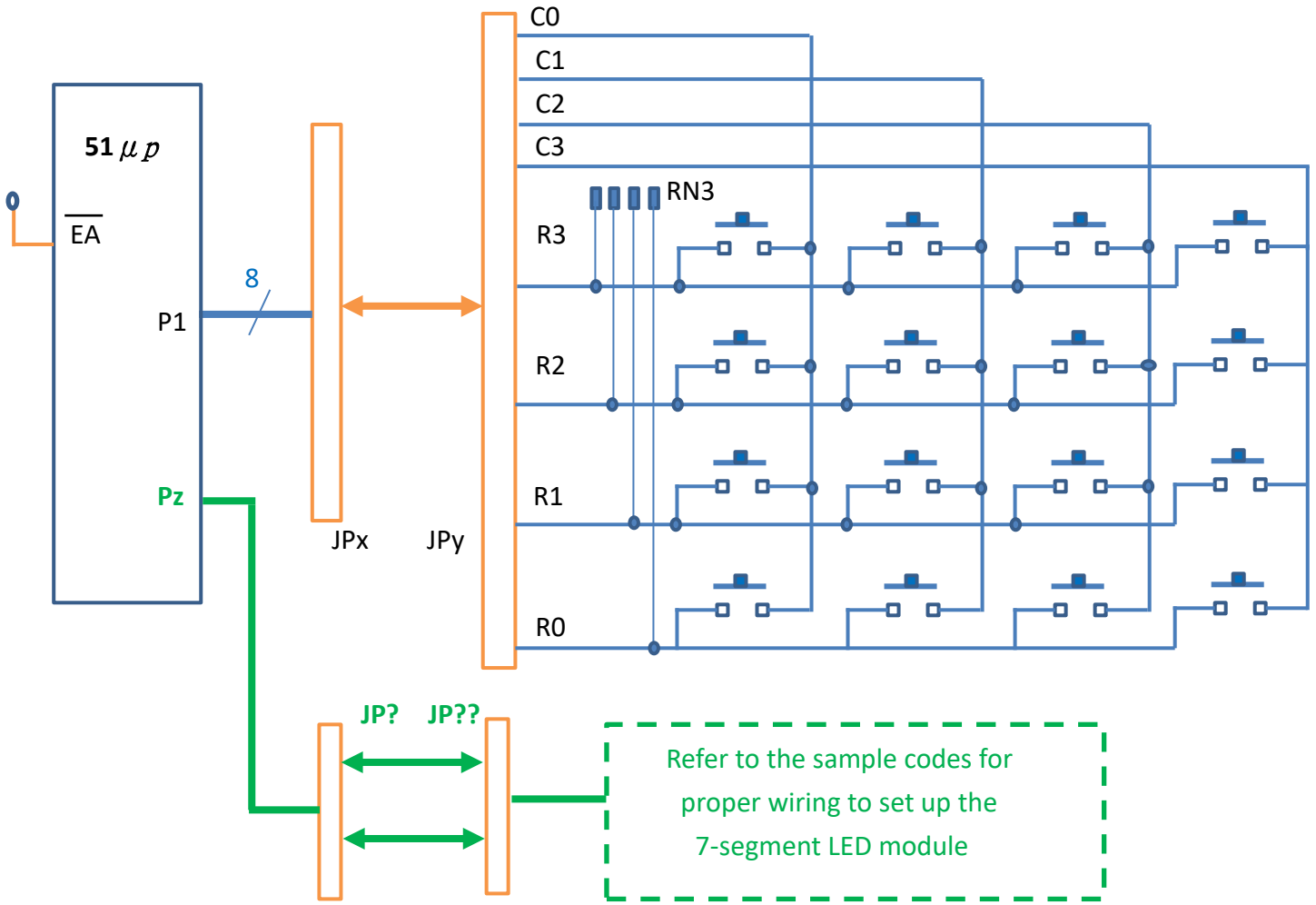
[3] **Lab-work for all:**

(a) **Operating Procedure**

TASK 1 encoding for any single key entry during 4x4 keypad scanning and then displaying the key-code on the 7-seg LED module, respectively with one and two 7-seg digit(s) ** 4x4 keypad set up ** code preparation ** code executing under IDE51 emulation

(a.1) jumper-wiring for 4x4 keypad module setup

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



(a.2) code preparation:

** edit the following sample 51 assembly codes, …two versions

** get version1 codes ready for execution first, then version2

```
; ================================
; version 1 key-code display on one 7-seg
;              digit
;               x   x   x   x
;               8   9   x   x
;               4   5   6   7
;               0   1   2   3
;      Xs: non-decimal 7-seg patterns
; ================================
; port 1 for keypad scanning
;     P1: 0-3 output for column scanning
;     P1: 4-7 input for row reading
; port 2 for using one digit of 7-seg LED
                org     0
                mov     sp, #50H
                mov     P2, #0FFH
       col0:    mov     R6, #0
                mov     P1, #0FEH
                mov     A, P1
                orl     A, #0FH
                swap    A
                cpl     A
                jnz     keycoding
       col1:    mov     R6, #1
                mov     P1, #0FDH
                mov     A, P1
                orl     A, #0FH
                swap    A
                cpl     A
                jnz     keycoding
       col2:    mov     R6, #2
                mov     P1, #0FBH
                mov     A, P1
                orl     A, #0FH
                swap    A
                cpl     A
                jnz     keycoding
       col3:    mov     R6, #3
                mov     P1, #0F7H
                mov     A, P1
                orl     A, #0FH
                swap    A
                cpl     A
                jz      col0
keycoding:              ; A: 0-9,A,B,C,D,E F
                rr      A
                anl     #0FH
                jnb     A.2, cont
                mov     A, #3
cont:           jz      cont2
                mov     R7, A
                clr     A
cont1:          add     A, #4
                djnz    R7, cont1
cont2:          add     A, R6
display:                ; when A>9 ???
                oal     A, #0E0H
```

```
                mov     P2, A                           end
                jmp     col0                ; ============================
```

```
; ================================
; version 2 key-code display on two 7-seg
;           digits
;             12   13   14   15
;             08   09   10   11
;             04   05   06   07
;             00   01   02   03
; ================================
; port 1 for keypad scanning
;     P1: 0-3 output for column scanning
;     P1: 4-7 input for row reading
; port 2 for using two digits of 7-seg LED
                org     0
                mov     sp, #50H
                mov     R7, #15
                mov     P2, #0FFH
      col0:     mov     R6, #0
                mov     P1, #0FEH
                mov     A, P1
                cpl     A
                jnz     keycoding
                call    display     ; ==??==
      col1:     mov     R6, #1
                mov     P1, #0FDH
                mov     A, P1
                orl     A, #0FH
                swap    A
                cpl     A
                jnz     keycoding
                call    display     ; ==??==
      col2:     mov     R6, #2
                mov     P1, #0FBH
                mov     A, P1
                orl     A, #0FH
                swap    A
                cpl     A
                jnz     keycoding
                call    display     ; ==??==
      col3:     mov     R6, #3
                mov     P1, #0F7H
                mov     A, P1
                orl     A, #0FH
                swap    A
                cpl     A
                jz      col0
      kecoding:         ; A: 0-9,A,B,C,D,E F
                rr      A
                anl     #0FH
                jnb     A.2, cont
                mov     A, #3
      cont:     jz      cont2
                mov     R7, A
                clr     A
      cont1:    add     A, #4
```

```
        djnz    R7, cont1
cont2:  add     A, R6
        mov     R7, A
        call    display    ; ==??==
        jmp     col0
display:
        push    PSW
        push    A
        push    F0H    ; push B??
        mov     A, R7
        mov     B, #10
        div     A, B
        anl     A, #0FH
        orl     A, #0D0H
        mov     P2, A
        call    delay
        mov     A, B
        anl     A, #0FH
        orl     A, #0E0H
        mov     P2, A
        call    delay
        pop     F0H
        pop     A
        pop     PSW
        ret
delay:  push    2
        push    3
        mov     R2, #20
xxx:    mov     R3, #250
        djnz    r3, $
        djnz    r2, xxx
        pop     3
        pop     2
        ret

end
; ============================
```

(a.3) task execution:

** start IDE51 emulator for the execution of code version1 and observe circuit behaviors

** start IDE51 emulator for the execution of code version2 and observe circuit behaviors

** start trouble-shooting if necessary

[**Key**: checking along the data path in a stage by stage manner, from the start: inside of 89c51 to the end: the target modules.]

(b) **Observations**

(b.1) Is code version 1 or version 2 running well? If so, it's a night of yours.

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

(b.2) While running version 1 sample code, one 7-seg LED will show the key-code when a key is entered and the display would remain so until the next entry of a key. For each key-code display, how many times does 89c51 access the 7-seg LED digit? And how many

times of accesses occur in between two key entries? What does that tell about the output nature of P2?

(b.3) Consider the limits imposed by the 7-seg LED module, what could you say regarding the issue of handling both keypad scanning and the display of two 7-seg LEDs concurrently?

(b.4) Instead of jumping to the label **display** as done in version 1 sample, version 2 sample code deals with two 7-segment LED digits showing different patterns by calling the subroutine **display**. Why? Is there batter approach to placing the call instructions other than at the lines marked by **==??==** in version2 code lines?

(b.5) Without **RN3** pull-up resistor array, will the keypad module still function properly? Why or why not?

(b.6) As the code of version 2 starts up, "15" appears on the two 7-seg LED digits even before key entry. Fix the problem!

(b.7) Elongate the duration of **delay** in version2 sample code by 10 times of its original setting. What do you see regarding the change in circuit behaviors? Explain.

[4] **Comprehension evaluation**

(a) Could you modify version-1 codes for a shorter code length or a better coding structure (e.g., handling 4-column scanning with a loop-body)?

(b) How could the version-2 codes be revised in such a way that the handling of the display of two 7-seg LEDs and keypad scanning would be resolved somewhat more elegantly?

(c) Consider the duration of a typical key entry from the moment of key pressing to that of key releasing, how long would it be? When a key is entered while executing either version of the sample codes, how many times the CPU would have detected this very same key entry? What are the issues to be tackled in coding such that one-detection for one-entry could be achieved?

(d) Consider the case of multiple key entry in which more than one keys are pressed at one time. Could you write the codes using the 4x1 switch module, where each switch is assigned an value, say 1, 2, 3 and 4 respectively, for summing up values resulting from multiple key entry and displaying the sum on any of the 3 LED modules on the circuit board?