A REPORT
ON

SPIRIT LEVEL TESTER

BY

KORUKANTI SHATRUGNA RAO	**2017A7PS0118P**
SURYA SUMANTH MEESALA	**2017A7PS0119P**
BINEET CHANDRA	**2017A7PS0120P**
ROHIT JAIN	**2017A7PS0122P**

GROUP 89

BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI

ACKNOWLEDGEMENT

We would like to express our gratitude to all those who have helped us directly or indirectly to complete this report.

We would like to express our gratitude towards the Instructor-in-Charge (IC) of the course Microprocessor and Interfacing, Dr. Nitin Chaturvedi for giving us this opportunity to work on such an interesting assignment. His teachings and support during the program were greatly valuable to all of us.

We would also like to thank our Lab Instructor and the teacher assistants for the help and knowledge imparted to us related to the assembly language programming in the lab-sessions.

Thank you.

PROBLEM STATEMENT

P7: System to be designed: Spirit Level Tester System Description:

Used for testing the sobriety of a person. This system tests the sobriety of the user by giving a sequence of hexadecimal characters of varying length(6 to 12 characters) by showing it on the LCD. It records the reaction time of the user in ms and displays the same on the LCD on a successful patch. The sequence should disappear after 2 seconds. The user is given a new pattern if he/she enters a wrong pattern. The user is given a total of three chances. After three mismatches of patterns an alarm is sounded. The pattern is generated randomly by the systems.

ASSUMPTIONS

- Pseudo random numbers are generated with a cycle of 19683 and hence, in this condition, supposed to be fairly random
- Software delays are producing the same amount of delay as hardware delay.
- Simulation time is not very slow as compared to real time.
- All the port driven i/o devices are working with any voltage output from the 8255A pins
- Reaction time is being shown in microseconds irrespective of the sobriety of the person.

LIST OF COMPONENTS USED

CHIP NUMBER	QTY.	CHIP	PURPOSE
8086	1	Microprocessor	Central Processing Unit
74HC373	4	8 bit Octal Latches	Latching the Address Bus and the buzzer
74HC245	4	8 bit Octal Latches	Latching the Data Bus and the LCD Panel
74LS138	1	3:8 Decoder	Chip Select for ROM and Ram in memory interfacing
74154	1	4:16 Decoder	Chip Select for 8255A to connect the I/O devices
2732	2	ROM (4KB each)	Read Only Memory To store the code
6116	2	RAM (2KB each)	Random Access Memory To store and retrieve temporary memory
8255A	2	Programmable Peripheral Interface	Connects I/O devices to the memory
555	1	555 Timer	Generates Clock pulse to measure reaction time
LM020L	1	Liquid Crystal Display	Displays the random patterns
BUZZER	1	Buzzer	Beeps as affirmative

OTHER HARDWARE USED

- Logic Gates – Used for building decoding logic for memory interfacing
- A Hex Keypad – Used for entering patterns

MEMORY MAPPING

The System uses 4KB RAM (2KB banks of each odd and even) and 8KB ROM (4KB banks for each odd and even) thus enabling copy of 16-bit of data in one cycle.

ROM : 8KB

Even bank starting Address — 00000h
Even bank ending Address — 01FFEh
Odd bank starting address — 00001h
Odd bank ending address — 01FFFh

RAM : 4KB

Even bank starting address — 02000h
Even bank ending address — 02FFEh
Odd bank starting address — 02001h
Odd bank ending address — 02FFFh

MEMORY AND ADDRESS MAP TABLE

Chip	E/O	A19	A18	A17	A16	A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	ADD
ROM	Even	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	00000h
	Odd	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	01FFFh
RAM	Even	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	02000h
	Odd	0	0	0	0	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	02FFFh

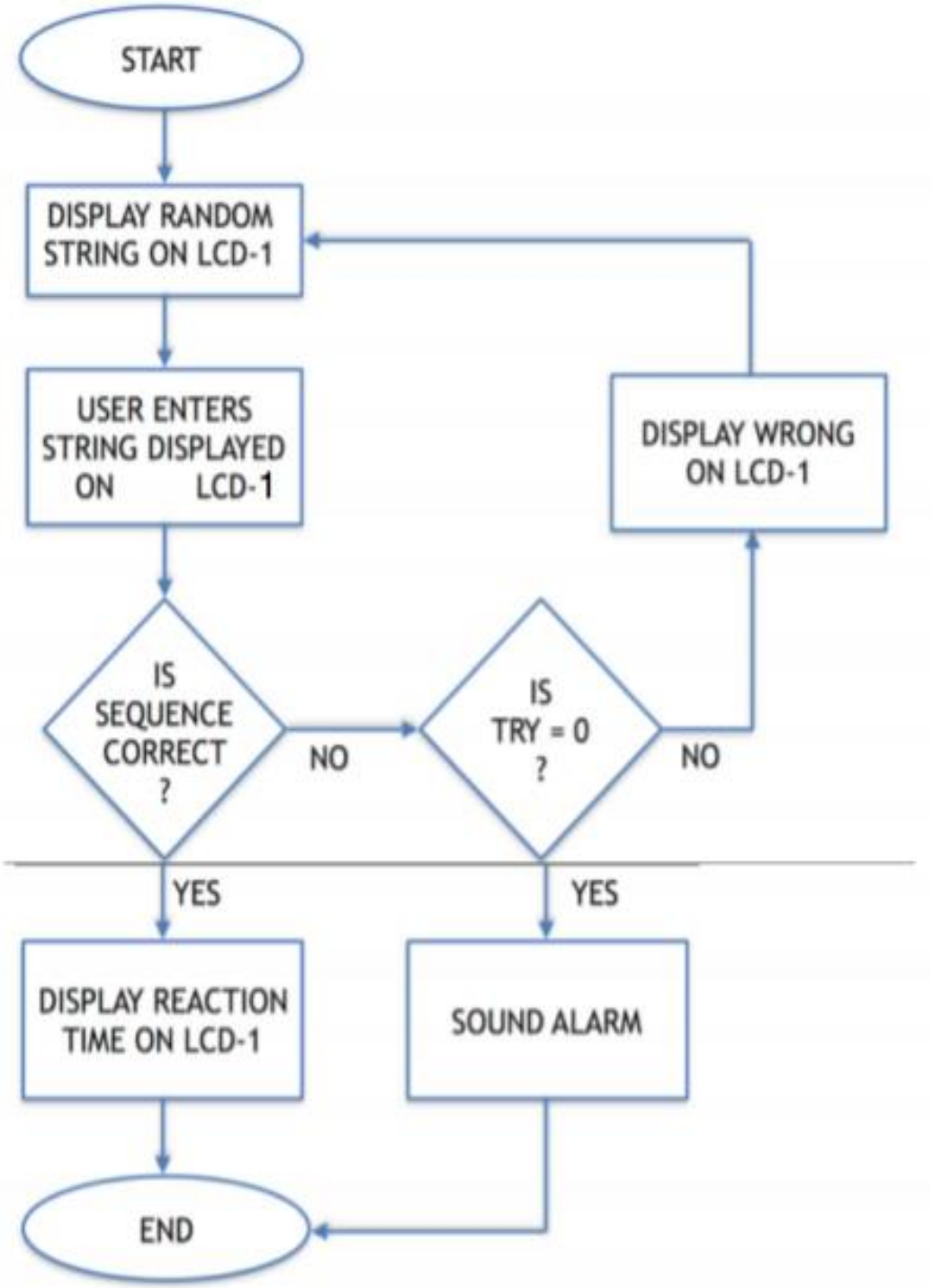
A0 and BHE' signal is used for separating even and odd banks .

I/O INTERFACING

I/O Interfacing:

I/0 Chip	A7	A6	A5	A4	A3	A2	A1	A0	Address
8255-1	0	0	0	1	0	0	0	0	10h
8255-1	0	0	0	1	0	1	1	0	16h
8255-2	0	0	1	0	0	0	0	0	20h
8255-2	0	0	1	0	0	1	1	0	26h

FLOW CHART


START
DISPLAY RANDOM STRING ON LCD-1
USER ENTERS STRING DISPLAYED ON LCD-1
IS SEQUENCE CORRECT ?
NO
IS TRY = 0 ?
NO
DISPLAY WRONG ON LCD-1
YES
YES
DISPLAY REACTION TIME ON LCD-1
SOUND ALARM
END

CODE

```
.model tiny
.data

;_____________________________________
; assigning address for counters
; ------------------------------
count1                  db      3
count2                  dw      0
count3                  dw      0
flag            db       0
seed            dw       0deafh,0abbah,9876h,0fafah,8e34h,3847h,9218h,0fadeh

;-------------------------
; Actual and entered word
; ----------------------

randomdata              db      12      dup(0)
inputs                  db      12 dup(0)
random                          dw      0

;------------------------------
;assigning port addresses 8255-1
; ------------------------------
porta           equ     10h
portb           equ     12h
portc           equ     14h
creg            equ     16h

; ____________________________________
; assigning port addresses for 8255-2
; ----------------------------------

porta2                  equ 20h
portb2                  equ 22h
portc2                  equ 24h
creg2           equ 26h

table_keys  db      0eeh,0edh,0ebh,0e7h
                        db              0deh,0ddh,0dbh,0d7h
                        db              0beh,0bdh,0bbh,0b7h
                        db              07eh,07dh,07bh,077h

; ------------------------------------
; CODE
```

```
; -------------------------------------

.code
.startup
                call port_initialization
                call port2_initialization
                call lcd_initialization

try:    ;Attempts Left=Count1
                dec count1

                lea si,seed
                add si,count2
                mov dx,[si]
                add count2,2

                ;generating random string length
                call random_integer

                mov cx,[random]

                lea si,seed
                add si,count2
                mov dx,[si]
                add count2,2

                call random_string
                call write_pattern
                call delay
                call delay_2000
                call cls

                call keypad_interface

                call comparison
                cmp flag,1
                jz reactiontime

                cmp count1,0
                jnz try

                ;if reaches here then he/she is drunk.

        ;call buzzer
                mov al,00000001b
                out porta2,al
```

```
                mov al,00000001b
                out portb2,al
                call cls
                call write_d
                call delay_2000
                call cls
                jmp eop

reactiontime:


                mov al,00000001b
                out portb2,al


                call write_nd
                call cls

                ;display reaction time on lcd
                call delay_2000
                call delay_2000
                call delay_2000
                call delay_2000
                call delay_2000

eop:

.exit

;-----------------------------
;Initialising port 1 and port 2
;-----------------------------

; port 1

port_initialization proc near

        mov al,10001000b
        out creg,al

        ret

port_initialization endp

; port 2
```

```
port2_initialization proc near

        mov al,10000000b
        out creg2,al

        mov al,00000000b
        out porta2,al

        mov al,00000000b
        out portb2,al

        ret
port2_initialization endp

; ------------------------------
; Delay Functions
; ------------------------------

;delay in the circuit here the delay of 20 millisecond is produced

delay proc
                mov cx, 1325 ;1325*15.085 usec = 20 msec

        w1: nop
                nop
                nop
                nop
                nop

                loop w1

                ret

delay endp

;delay in the circuit here the delay of 2000 millisecond is

delay_2000 proc

                mov cx,2220
        t1: loop t1

                ret

delay_2000 endp
```

```
;----------------------------
;Input from Keyboard
;----------------------------

keypad_interface proc near

                mov al,00000001b
                out portb2,al

                ; counter 3 used for randomized counter can hold any initial value

                mov cx,12
                lea di,inputs
                mov al,00h

cl0:    stosb
                loop cl0

                mov    al,0
                lea di,count3
                stosb

                mov al,88h
                out creg,al

                mov al,0ffh
                out portb,al

                ; control word for counter0-mode2
                ; control word for counter 1- mode2
                ; control word for counter2 - mode0
                ; loading words to counters
                ; ------------------------
                ; cascaded counter 0 and 1 count till 2 seconds
                ; input frequency to clock = 5 MHZ
                ; output frequency = 0.5HZ
                ; therefore counter 0 loaded with 10000 = 2710h and counter1 with 1000 =
03E8
                ; to give final N factor of 10^(7) thus reducing frequency to 0.5 hz
                ; ------------------------------------------------------------------------

x0:     mov al,00h
           out portc,al

x1:    in  al, portc
```

```
                and al,0f0h
                cmp al,0f0h
                jnz x1

                call d20ms

                mov al,00h
                out portc ,al

x2:     in al, portc
                and al,0f0h
                cmp al,0f0h
                jz x2

                call d20ms

                mov al,00h
                out portc ,al

                in al, portc

                and al,0f0h
                cmp al,0f0h
                jz x2

                mov al, 0eh
                mov bl,al
                out portc,al

                in al,portc

                and al,0f0h
                cmp al,0f0h
                jnz x3

                mov al, 0dh
                mov bl,al
                out portc ,al

                in al,portc

                and al,0f0h
                cmp al,0f0h
                jnz x3

                mov al, 0bh
```

```
                mov bl,al
                out portc,al

                in al,portc

                and al,0f0h
                cmp al,0f0h
                jnz x3

                mov al, 07h
                mov bl,al
                out portc,al

                in al,portc

                and al,0f0h
                cmp al,0f0h
                jz x2

x3:     or al,bl
                mov cx,0fh
                mov di,00h

x4:     cmp al,table_keys[di]
                jz x5

                inc di
                loop x4

x5:             mov ax,di
                and ax,000ffh

                cmp al,0ah
                jae atofkey

                add al,48
                jmp display

atofkey:
                add al,55
                jmp display

display:
                lea di,inputs
                add di,count3
                stosb
```

```
                mov al,[di-1]

                call datwrit

                inc count3

                mov bx,count3
                cmp bx,random
                jz donewithinput

                jmp x0

d20ms:  ;delay generated will be approx 0.45 secs
                mov cx,220

xn:     loop xn

donewithinput:
                mov al,00000000b
                out portb2,al

          ret

keypad_interface endp


comparison proc near

                lea si,randomdata
                lea di,inputs
                mov cx,random

c1:             mov al,[si]
                mov bl,[di]
                cmp al,bl
                jnz eoproc

                inc si
                inc di
                loop c1

                mov flag,1

eoproc:
                ret
```

```
comparison endp

;-------------------------
;Random Generatoor
;-------------------------


;random no generator, value of 'n' is in cx, dx value should also be initialized with a
different seed everytime

random_integer proc

        lea di,random
        mov ax,dx
        mov bx,31
        mul bx

        add ax,13
        mov bx,19683
        div bx
        mov ax,dx

        mov cl,07h
        and ax,00ffh
        div cl

        mov al,ah
        add al,6

        stosb
        ret

random_integer endp



random_string proc

                mov cx,random
                lea di,randomdata

r1:             mov ax,dx
                mov bx,31
                mul bx
                add ax,13
```

```
                mov bx,19683
                div bx

                mov bx,dx
                and bx,000fh
                mov al,bl

                cmp al,0ah
                jae atof

                add al,48
                jmp store

atof:   add al,55

store:  stosb
                loop r1

        ret

random_string endp

;---------------------------------------
;LCD Functions
;---------------------------------------

;Initialise

lcd_initialization proc near

        mov al, 38h             ;initialize lcd for 2 lines & 5*7 matrix

        call comndwrt                   ;write the command to lcd
        call delay                      ;wait before issuing the next command
        call delay                      ;this command needs lots of delay
        call delay

        mov al, 0eh             ;send command for lcd on, cursor on

        call comndwrt
        call delay

        mov al, 01              ;clear lcd

        call comndwrt
        call delay
```

```
        mov al, 06                  ;command for shifting cursor right

        call comndwrt
        call delay

        ret

lcd_initialization endp

; Clear

cls proc
        mov al, 01

        call comndwrt
        call delay
        call delay

        ret

cls endp

; Writing a command

comndwrt proc

        mov dx, porta
        out dx, al                  ;send the code to port a

        mov dx, portb
        mov al, 00000100b           ;rs=0,r/w=0,e=1 for h-to-l pulse
        out dx, al

        nop
        nop

        mov al, 00000000b           ;rs=0,r/w=0,e=0 for h-to-l pulse
        out dx, al

        ret

comndwrt endp

; Write drunk
```

```
write_d proc near

        call cls

        mov al, 'd'
        call datwrit
        call delay
        call delay

        mov al, 'r'
        call datwrit
        call delay
        call delay

        mov al, 'u'
        call datwrit
        call delay
        call delay

        mov al, 'n'
        call datwrit
        call delay
        call delay

        mov al, 'k'
        call datwrit
        call delay
        call delay

        ret

write_d endp

; Write not drunk

write_nd proc near
        call cls
        mov al, 'n'
        call datwrit
        call delay
        call delay

        mov al, 'o'
        call datwrit
        call delay
        call delay
```

```
        mov al, 't'
        call datwrit
        call delay
        call delay

        mov al, 'd'
        call datwrit
        call delay
        call delay

        mov al, 'r'
        call datwrit
        call delay
        call delay

        mov al, 'u'
        call datwrit
        call delay
        call delay

        mov al, 'n'
        call datwrit
        call delay
        call delay

        mov al, 'k'
        call datwrit
        call delay
        call delay

        ret

write_nd endp

; --------------------------------
; Other Functions
; --------------------------------

write_pattern proc near

                lea di,randomdata
                call cls

                mov cx,random
                mov si,cx
```

```
x10:    mov al, [di]

                call datwrit
                call delay
                call delay

                inc di
                dec si

                jnz x10

        ret

write_pattern endp


datwrit proc

        push dx                         ;save dx

        mov dx,porta                    ;dx=port a address
        out dx, al                      ;issue the char to lcd

        mov al, 00000101b       ;rs=1, r/w=0, e=1 for h-to-l pulse
        mov dx, portb                   ;port b address
        out dx, al              ;make enable high

        mov al, 00000001b       ;rs=1,r/w=0 and e=0 for h-to-l pulse
        out dx, al

        pop dx

        ret

datwrit endp ;writing on the lcd ends


end
```

CIRCUIT DIAGRAM