A REPORT ON AUTOMATED LAWN SPRINKLER SYSTEM AND ALP PROGRAM

Submitted as a design project for the course EEE F241
Microprocessor Programming and Interfacing

Submitted by

Alex Mathai	2016A7PS0339P
Aashish Singh	2016A7PS0683P
Lakshay Garg	2015A3PS0197P
Deepak Patel	2014B2A30708P

BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE PILANI,
RAJASTHAN-333031

CONTENTS

ATTACHMENTS :

Interfacing Diagram
Design File
ALP Program

System to be designed - Lawn Sprinkler System

PROBLEM STATEMENT

An average sized garden has 4 sprinklers that have to be turned on and off. A series of 8 soil moisture sensors are placed at different parts of the garden. The sprinkler system works twice in a day. Once at 9: 00 am and then at 5:00 pm. The sprinkler is turned on and off based on the time of the day and the soil moisture. The time for which the sprinkler remains on depends upon the difference between required soil moisture and actual soil moisture level. There is an overhead tank from which the system draws required water. If the water level is below a certain level, the sprinklers are not turned ON and buzzer is sounded.

HARDWARE DEVICES

CHIP NUMBER	NO. OF CHIPS	CHIP	USE
8086	1	MICROPROCESSOR	CENTRAL PROCESSING UNIT
6116	2	RAM - 2K	RANDOM ACCESS MEMORY
2732	2	ROM - 4K	READ ONLY MEMORY
74LS373	3	8-BIT LATCH	TO LATCH ADDRESS BUS
74LS245	2	8-BIT BUFFER	TO BUFFER DATA BUS (BIDIRECTIONAL)
8253	1	PROGRAMMABLE INTERVAL TIMER	TO GENERATE REGULAR CHECKS OF THE SOIL MOISTURE
8255	1	PROGRAMMABLE PERIPHERAL INTERFACE	CONNECTED TO VARIOUS I/O DEVICES
8259	1	PROGRAMMABLE INTERRUPT CONTROLLER	TO GENERATE INTERRUPTS WITH THE HELP OF TIMER
ADC0808	1	ANALOG TO DIGITAL CONVERTER	CONVERTS ANALOG VOLTAGE SIGNAL FROM MOISTURE SENSOR TO DIGITAL FORM
LOGIC GATES	-	NAND,AND,OR GATES	USED FOR VARIOUS LOGIC CIRCUITS
VH400	8	MOISTURE SENSOR	TO PRODUCE AN ANOLOG SIGNAL(VOTAGE) TO BE FED INTO THE ADC
AQUAPLUMB	1	WATER LEVEL SENSOR	TO CHECK WATER LEVEL IN OVERHEAD TANK
-	1	BUZZER	TO PRODUCE ALARM WHEN THE WATER LEVEL IN TANK FALLS BELOW A THRESHOLD VALUE
74LS138	3	DECODER	USED TO DECODE ADDRESS BUS FOR I/O DEVICES
LEDs	4	SPRINKLER	TO SPRINKLE WATER

ASSUMPTIONS

1. ALP is already stored in the ROM in executable format.

2. IVT is already present in ROM.

3. The lawn is very big, so that the moisture of one part of the lawn has no influence over the moisture of the other parts.

4. The optimal moisture level of the soil is corresponding to 2.5V output of VH400 sensor which translates to 213 by the ADC.

5. When the power is switched off, all the sprinklers are off.

6. System is started for first time at 1 AM.

ADDRESS MAPPING

MEMORY ORGANISATION:

The system uses 8KB of ROM and 4KB of RAM. Both consists of two chips of 4KB and 2KB size respectively. They are organized into odd and even bank to facilitate both byte and word size data transfers.

Read Only Memory (2732):

Starting Address: 00000h
Ending Address: 01FFFh

Random Access Memory (6116):

Starting Address: 02000h
Ending Address: 02FFFh

MEMORY INTERFACING

RAM	2 CHIPS OF 2K EACH	02000H-02FFFH
ROM	2 CHIPS OF 4K EACH	00000H-01FFFH

I/O MAPPING

8255 Programmable Peripheral Interface

PORT A- 00H

PORT B - 02H

PORT C - 04H

CR - 06H

8253 Interval Timer

CNT1 - 08H

CNT2 - 0AH

CNT3 - 0CH

CR - 0EH

8259 Programmable Interrupt Controller

Base Address – 10H

Next Address – 12H

IVT TABLE

1. The interrupt raised for refreshing the input from sensors after 0.1 sec (t_isr) is mapped at vector number 80h.

2. The interrupt raised at 9AM and 5PM (t_isr2) is mapped at vector number 81h.

ALGORITHM

1) The system is powered up automatically at 9am and 5pm.

2) One sensor is selected at random by the ADC and its analog value is converted into an 8-bit digital value.

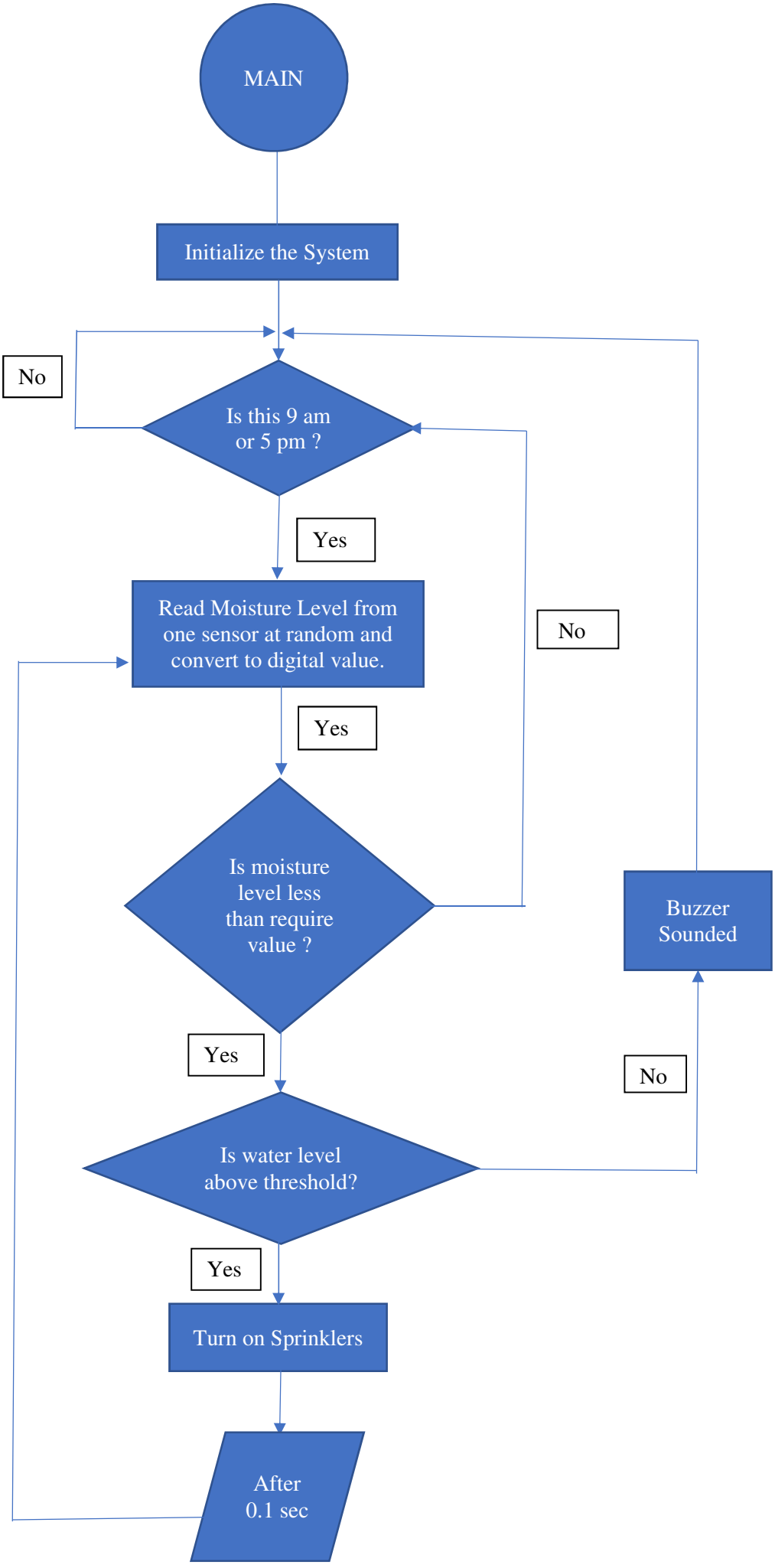
3) This value is compared with a predefined value stored in the memory.

4) If the moisture level is less than the required level and the water level in the overhead tank is above a threshold then all the sprinklers are turned on.

5) If the overhead tank's water level is below the threshold then sprinklers are not turned on and a buzzer is sounded.

6) The moisture value is read after an interval of 0.1 seconds and the process is repeated till the optimal moisture level in the soil is reached or the tank's water level drops below the threshold.

SYSTEM FLOW CHART



ALP Program

```
#make_bin#



#LOAD_SEGMENT=FFFFh#
#LOAD_OFFSET=0000h#



#CS=0000h#
#IP=0000h#



#DS=0000h#
#ES=0000h#



#SS=0000h#
#SP=FFFEh#



#AX=0000h#
#BX=0000h#
#CX=0000h#
#DX=0000h#
#SI=0000h#
#DI=0000h#
#BP=0000h#



; add your code here
        jmp     st1
        db     509 dup(0)
```

```
;IVT entry for 80H

        dw     t_isr
        dw     0000
        db     508 dup(0)


;IVT entry for ///81H

        dw     t_isr2
        dw     0000
        db     508 dup(0)

        nop
        dw      0000
        dw      0000
        dw      ad_isr
        dw      0000

        db     1012 dup(0)




;main program

;---------- Start Inits-------------------------;



st1:      cli


; intialize ds, es,ss to start of RAM
          mov       ax,0200h
          mov       ds,ax
          mov       es,ax
          mov       ss,ax
          mov       sp,0FFFEH
```

```
;1st timer - 0.1 second - 8253 clock is 10 KHz-divide by 10,00d
;Mode 3 : We give 0.1 seconds to read and 0.1 seconds for a time delay in between
next read and current read
                mov     al,00110110b
                out     0Eh,al
                mov     al,0e8h
                out     08h,al
                mov     al,03h
                out     08h,al

;2nd timer - 8*3600 second - 8253 clock is 1 Hz-divide by 28800d
;Mode 0 : Divide the day into three 8 hour partitions. (1am to 9am) to (9am to 5pm)
to (5pm to 1am)
;The counter should send an interrupt once at 9am and second at 5pm so connect a
NOT gate to the output of this counter and give it as input to 8259

                mov     al,01110110b
                out     0Eh,al
                mov     al,80h
                out     08h,al
                mov     al,70h
                out     08h,al

;8259 intialize - vector no. ///80h, edge triggered
;8259 -          enable IRO alone use AEOI
                mov     al,00010011b ;edge triggered
                out     10h,al
                mov     al,80h ;starting vector number is 80h
                out     12h,al
                mov     al,03h ;automatic end of interrupt
                out     12h,al
                mov     al,0FDh
                out     12h,al
```

```
;start



;for required value of moisture content(assumed voltage :2.5v of 3v:digital 8-bit eqv->213 of 256)
  mov [00fdh],213



 ;for flag of one routine
  mov [00fbh],0



;The number of maximum interrupts in one day is 2
  mov [00feh],2




;intialise port b  as input & a & c as output
        mov       al,10000010b
                  out             06h,al
  sti

;loop till isr
x2:       jmp       x2




;------------------------- Interrupt Service Routine ---------------------------------------------;



;INTERRUPT Service Routine: Checks at 9am and 5pm
t_isr2:
        mov al,0
        cmp [00feh],0
        jnz x1

          ;if two interrupts at 9am and 5pm are already called then skip the 1 am one
        mov [00feh],2
        iret
```

```
x1:
        ;select ch0
        mov    al,00
        out    00h,al

        ;give ale
        mov    al,00100000b
        out    00h,al

        ;give soc
        mov    al,00110000b
        out    00h,al
        nop
        nop
        nop
        nop

        ;make soc 0
        mov     al,00010000b
        out     00h,al



        ;make ale 0
        mov     al,00000000b
        out     00h,al



        ;decrement value at 00feh
        mov al,1
        sub [00feh],al



        ;enable for t_isr
        mov [00fch],1



x5:   cmp    [00fbh],1
        jnz    x5



        ;disable the enable for t_isr
        mov [00fch],0
iret
```

```
;INTERRUPT Service Routine: for 0.1 sec feedback system during sprinkler
activation
t_isr:



        ;check for enable
        cmp  [00fch],1 ;Flag if it is 9am or 5 pm
        jz   x7
        iret



        x7:     mov al,1
                mov [00ffh],al
                nop ; Give slight Delay
                nop
                nop
                nop


                ;make soc 0
                mov       al,00010000b
                out       00h,al


                ;make ale 0
                mov       al,00000000b
                out       00h,al




        x4:     mov al,1
                cmp [00ffh],al
                jz x4

iret
```

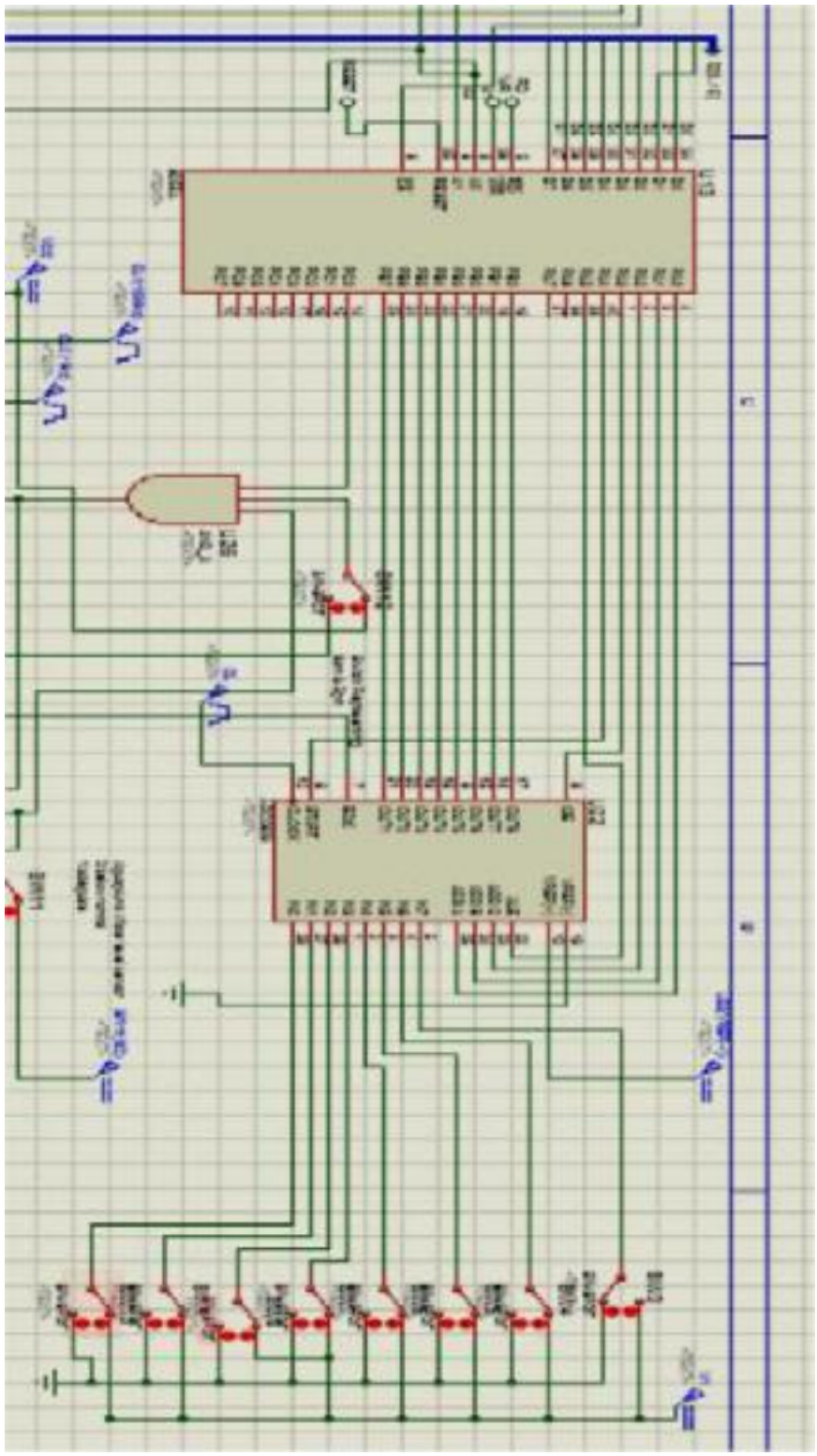
```
;NMI of EOC
ad_isr:
        mov     al,00001000b   ;oe enable
        out      00h,al
        in      al,02h
        cmp     al,[0ffdh]
        jge     x3
        mov     al,0ffh
        out     06h,al

       ;setting flag to be 1 to show that routine is over
        x3:     mov   [00fbh],1

        ; for single execution of nmi in 0.1 s interrupt
        x6:     mov   [00ffh],0
iret
```

----------End of Code----------

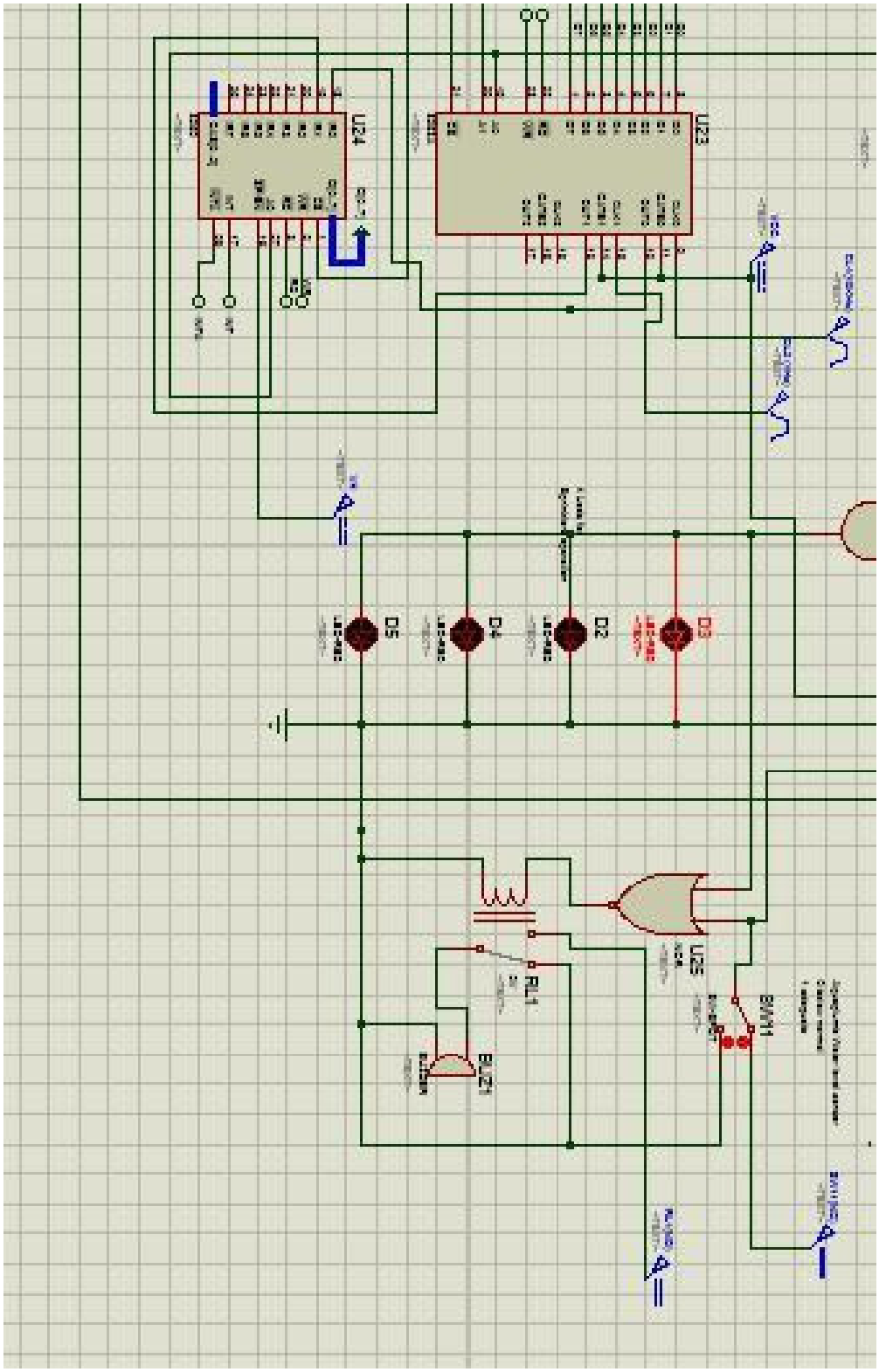
Circuit Diagram

z

1. Input sensors and PID



2. **Output Sprinkler and Buzzer**



Sensor Specifications

Soil Moisture Sensor Probe Specifications

VH400 Sensor	
Power consumption	< 7mA
Supply Voltage	3.5V to 20 VDC.
Dimensions	See drawing below.
Power on to Output stable	400 ms
Output Impedance	10K ohms
Operational Temperature	-40°C to 85°C
Accuracy at 25°C	2%
Output	0 to 3V related to moisture content
Shell Color	Red
Voltage Output Curves	Curves, Piecewise linear equations

Water Level Sensor Probe Specifications

AquaPlumb®	
Power consumption (Normal Mode)	1.2 mA
Power consumption (Calibration Mode)	20 mA
Supply Voltage	3.5V to 20 VDC.
Dimensions	See drawing below.
Power on to Output Stable	400 ms
Output Impedance	10K ohms
Operational Temperature	-40C to 85°C
Accuracy at 25°C	2%
Output>Output	0 to 3V linear with fluid level.

Please find the attached Data Sheet for VH400 in the Zip Folder for additional information.