WEATHER MONITORING STATION

Design Project No. 24

Prepared for and under the guidance of

Prof. K. R. Anupama

Submitted By:

Group Number: 49

ADARSH NANDANWAR	2018A7PS0396G
VISHAL SINGH	2018AAPS0562G
CHETAN KHANNA	2017B4A70591G
PIYUSH AGARWAL	2017B4A80812G
AYUSH TEWARI	2017B4A80622G

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K K Birla Goa Campus

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USER REQUIREMENTS AND TECHNICAL SPECIFICATIONS

User Requirements

This system monitors weather parameters such as:

- Air Temperature
- Air-Humidity
- Barometric Pressure

and displays the average over regular intervals of an hour on a seven-segment display. The display is continuous. Update of the display is done once in an hour.

Technical Specifications

- Weather parameters are sensed at regular intervals of 5 minutes.
- The display is of the format: “Temperature – Value 0 C” and so on.
- Other than the regular display, the user can request the display of the weather parameters to be updated at any point of time by pressing a push button key.
- The accuracy of the parameters monitored has to be up to two decimal points.

SYSTEM DESCRIPTION

The system's analog input is received by the sensors connected to a parallel 8-bit ADC (0808). These sensor modules(leaving the pressure one) generate current values from 4 mA to 20 mA, which the MAX472 converts to equivalent 1.25 V to 6.25 V. This is again scaled to a range from 0 V to 5 Vising MAX951.

There is a programmable 8259 interrupt controller that accepts four interrupts from different sources, namely the timers, an external button and an EOC interrupt from the ADC. The IVT for the 8259 is stored in the ROM under a vector address from 80h (corresponding to a memory address 80h * 4 = 00200h).

There is a timer IC (8253) which generates an interrupt every 5 minutes and every 1 hour.
An interrupt is generated every 5 minutes, which calls an ISR in which the value of the ADC is read and the corresponding digital data is stored in RAM. It is similar to maintaining an array of 12 elements for each of the 3 sensors, with the next value being stored at the first position after the twelfth reading of the data. This means that the last 12 measured values are always retained.

An interrupt is generated after every hour, which calls an ISR that averages the values of the measured values of the last hour.In the first hour, the averaging takes place only for the number of available values. These averaged values are then scaled according to the specifications of the sensors. The resulting value after averaging and scaling is displayed on the LCD.
There is also an external interrupt button that generates an interrupt when pressed. A measured value must therefore be created and the average of the current measured value together with the last 11 measured values (a total of 12 measured values) is displayed on the LCDs.

ASSUMPTIONS AND JUSTIFICATIONS

The following assumptions are taken into account:

- The display on the LCD shows an average of the previous 12 read values which is the previous hour.
- Minimum RAM available in proteus is 2732 (4K*8) ,but we are only using its 11 address lines assuming it as 2K RAM.
- Every time the user presses the external button, the clocks are not reset, which means that the next measurement continues to take place according to the 5-minute schedule originally set. When the button is pressed, a new value is recorded, added to the data stored in the memory and then the last 12 values are used for averaging, scaling and display on the LCD monitor.
- The button press does not collide with the 5-minute interrupt in normal use. Since the probability of this is very low when using the weather monitoring station in real time, this is a fair assumption .
- In case of a collision during operation which is highly improbable and the key interrupt not being maintained, a second press ensures the maintenance of the interrupts without affecting the 5-minute interrupt maintenance.
- Separate clk generator (1MHz) used in place of an extra 8253A signal for clk to ADC.

COMPONENTS USED WITH JUSTIFICATION WHEREVER REQUIRED

ICs and devices used

Sr. No.	Components Used	Quantity	Justification
1.	6116	2	16K(2K*8) Static RAM
2.	2732	4	16K(2K*8)EPROM
3.	74LS373	3	Latching of address Bus (unidirectional)
4.	74LS245	2	Bi-Directional Buffer(for data lines)
5.	8086	1	Central Processor
6.	8259	1	Program Interrupt Controller
7.	8255	2	PPI for I/O
8.	74LS138	2	(3*8) Decoder
9.	8253	1	Programmable Interval Timer
10.	ADC 0808	1	Analog to Digital Convertor
11.	Push Button	1	Raise Manual Interrupt and for reset
12.	LM016L	3	LCD (16x2) Display
13.	Resistors (10k ohm)	1	
14.	2-input OR gate	10	
15.	8284	1	Clock Oscillator
16.	8-input OR gate	1	For absolute addressing
17.	Current to Voltage Converter	1	Circuit for converting current signal to voltage signal

- 8284 - To generate 5Mhz CLK for the CPU and 2.5Mhz PCLK
- 6116 – 2 nos. Smallest RAM chip available is 2K and we need odd and even banks. RAM is used for stack and temporary storage of data
- 2716 – 4 nos. Smallest ROM chip available is 2K and as we need to have even and odd banks. ROM is required at reset address which is at $FFFF0_H$ and 00000_H - where IVT is stored.
- 74LS373 - To latch the Address Bus from 8086
- 74LS245 - To buffer the Data bus from 8086
- 74LS138 - Decoder used for memory and IO address decoding
- 7447 – BCD to Common Anode 7 – Segment converter -as values will be only numeric values
- 8255 – To interface ADC and LCD display
- ADC 0808 - For converting analog inputs from temperature, humidity and pressure sensor with voltage varying from 0-5 V to 8-bit resolution. Output can be directly connected to 8255
- LM016L - LCD Display for displaying the temperature, humidity and pressure data.
- 8253 – To generate ADC clock, 5min clock and 1hr clock for interrupts.
- 8259 – Interrupt controller to manage interrupt from EOC from ADC, button, 5 min timer and 1hr timer. Button is given higher priority than timers.
- Current to voltage converter - To convert current input to voltage output. Sensor modules(leaving the pressure one) generate current values from 4 mA to 20 mA, which the MAX472 converts to equivalent 1.25 V to 6.25 V. This is again scaled to a range from 0 V to 5 Vising MAX951.

Sensors Used

- Temperature: WE700 Temperature and Humidity Module

Sensing range	-50°C to + 50°C
Output range	4-20mA
Voltage supply	10-36V (DC)
Warm Up time	5 sec minimum
Output Type	Linear current
Accuracy	±1°C

- Humidity: WE600 Humidity Module

Humidity Range	0% ~ 100% RH
Output Range	4-20mA
Operating Temperature	-40°C ~ +55°C
WarmUp time	3 sec min
Accuracy	± 2% RH
Voltage-Supply	10-36V(DC)
Output	Linear current

- Pressure: KP229E3518 Analog Absolute Pressure Sensor

Operating Temperature	-40 ~ 140°C
Operating Pressure	50 ~ 350 kPa
Output Type	Linear voltage
Accuracy	±4kPa (0~100°C
Voltage-Supply	4.5 V ~ 5.5 V
Output	0.10 V ~ 4.85 V

ADDRESS MAPPING

Memory Mapping

ROM 1 : 00000h - 00FFFh
ROM 2 : FF000h - FFFFFh
RAM 1 : 01000h - 01FFFh

ROM 1

19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1

ROM 2

19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

RAM 1

19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1

I/O Mapping

8253 (timer) : 02000h
8259 (Interrupt controller) : 02010h
8255_1 (Display) : 02020h
8255_2 (Sensors) : 02030h

INITIALIZATION

```
a8253 equ 02000h
a8259 equ 02010h
a8255 equ 02020h
b8255 equ 02030h
```

Initializing 8259:

```
mov al, 00010011b
mov dx, a8259+00h
out dx, al

mov al, 10000000b
mov dx, a8259+02h
out dx,al

mov al, 00000011b
out dx,al

mov al, 11111110b
out dx, al
```

Initialising 8255_1:

```
mov al, 10000010b
mov dx, a8255+06h
out dx, al
```

Initialising 8255_2:

```
mov al, 10000010b
mov dx, b8255+06h
out dx, al
```

Initialising 8253:

;Counter 0: 100Hz

```
mov al, 00110100b
mov dx, a8253+06h
out dx, al
mov al, 0A8h
mov dx, a8253+00h
out dx, al
mov al, 61h
mov dx, a8253+00h
out dx, al
```

;Counter 1: 5 min

```
mov al, 01110100b
mov dx, a8253+06h
out dx, al
mov al, 30h
mov dx, a8253+02h
out dx, al
mov al, 75h
mov dx, a8253+02h
out dx, al
```

;Counter 2: 1hr

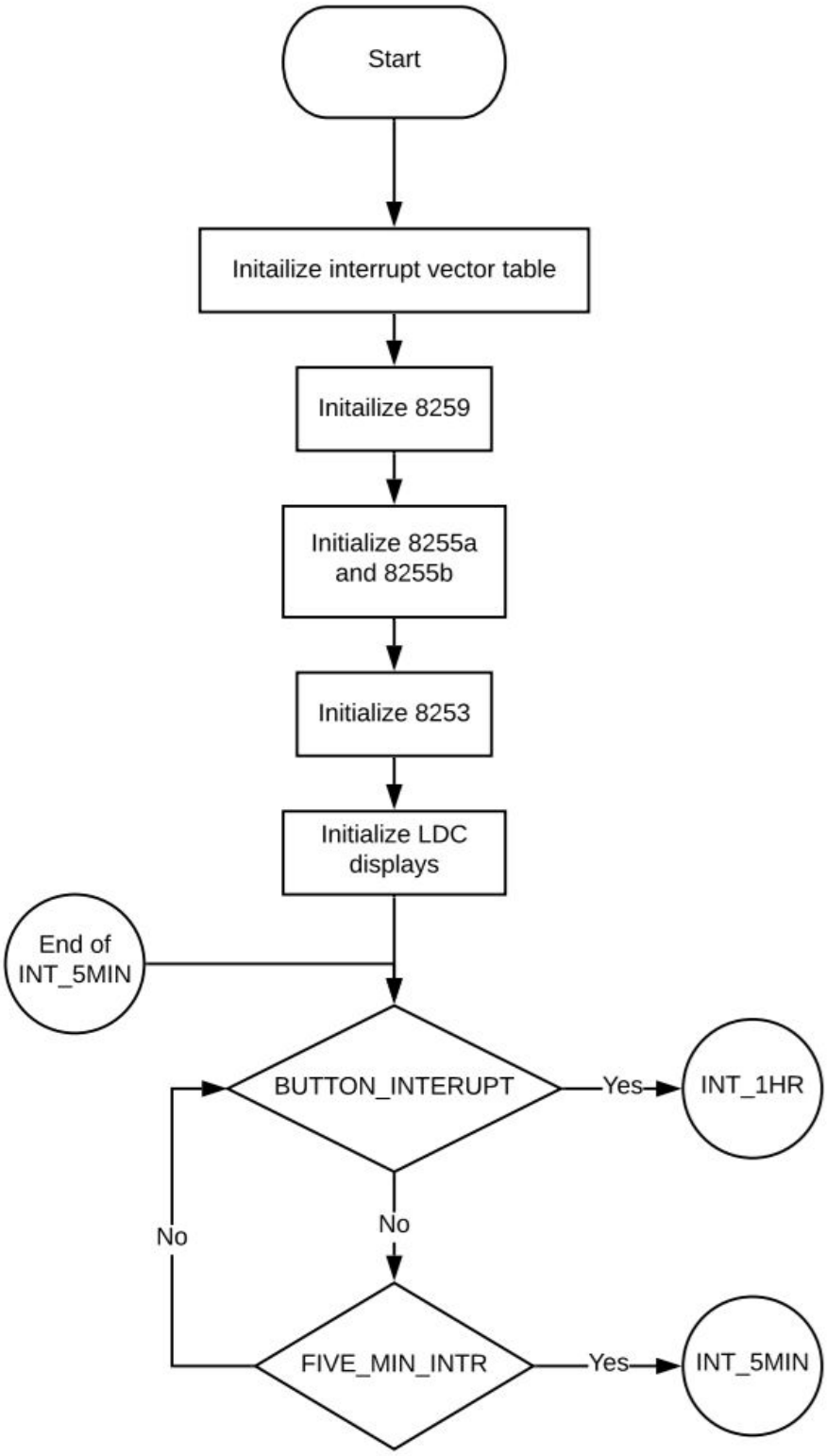
```
mov al, 10010100b
mov dx, a8253+06h
out dx, al
mov al, 0ch
mov dx, a8253+04h
out dx, al
```

HARDWARE DESIGN

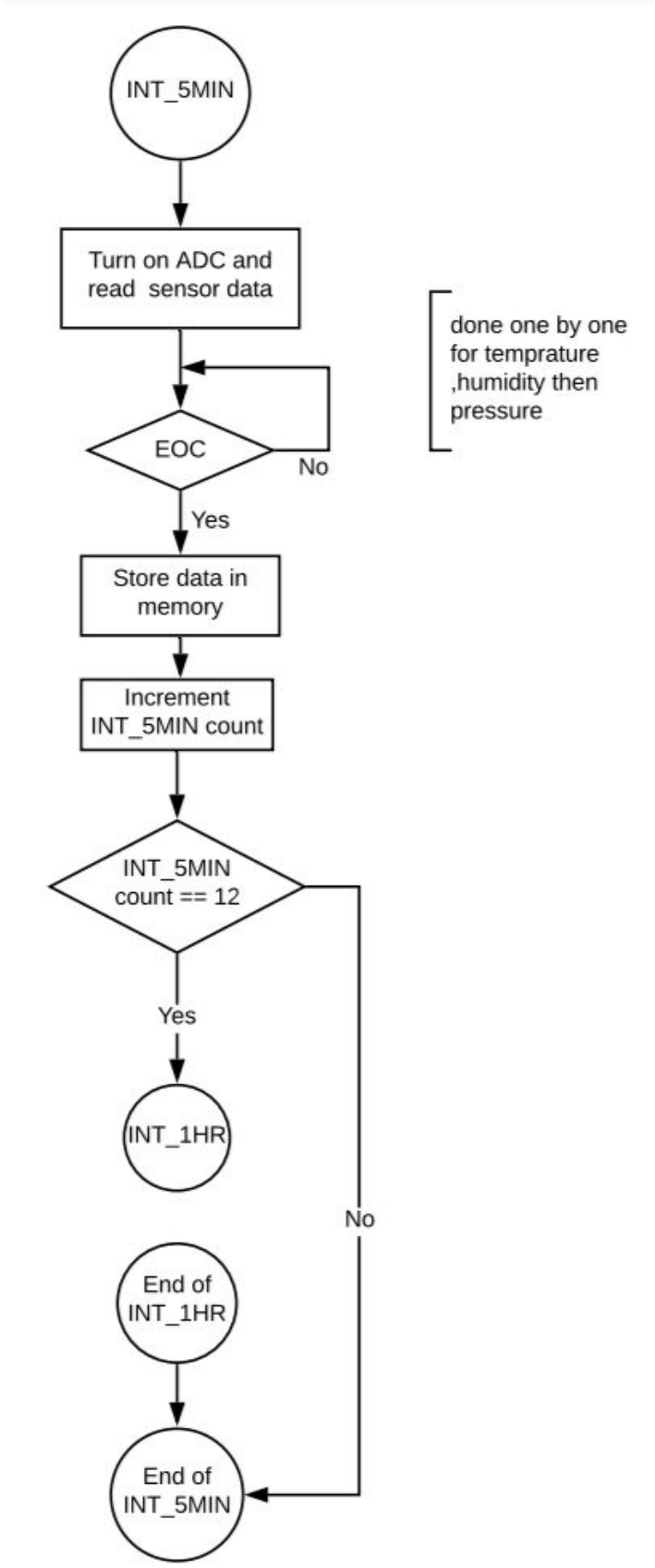
Complete Hardware Design attached in the submission (hardware_design.pdf)

FLOW CHARTS

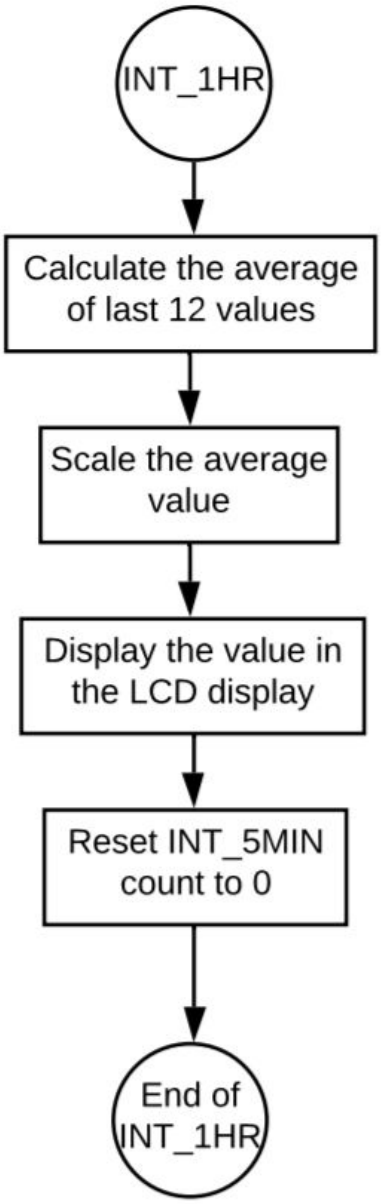
Main program



INT_5MIN ISR


INT_5MIN
Turn on ADC and read sensor data
done one by one for temprature ,humidity then pressure
EOC
No
Yes
Store data in memory
Increment INT_5MIN count
INT_5MIN count == 12
Yes
INT_1HR
No
End of INT_1HR
End of INT_5MIN

INT_1HR ISR


INT_1HR
Calculate the average of last 12 values
Scale the average value
Display the value in the LCD display
Reset INT_5MIN count to 0
End of INT_1HR

VARIATIONS IN PROTEUS IMPLEMENTATION WITH JUSTIFICATION

1) ROM is only 00000 – as proteus allows to change reset address.
2) Using 8253A – as 8254 not available in Proteus.
3) As 8284 is not present in proteus CLK(5MHz) and PCLK(2.5MHz) taken from the clk generator.
4) Temperature,Pressure and Humidity Sensor – replaced by DC voltage potentiometer giving voltage between 0 – 5 as none of these sensors are there in Proteus

FIRMWARE

Implemented using emu8086 attached.

LIST OF ATTACHMENTS

1. Complete hardware real world design: hardware_design.pdf
2. Manuals:
3. WE700 and WE600: WE700B.pdf
4. KP229E3518: KP229E3518.pdf
5. Proteus File: design.pdsprj
6. EMU8086 ASM File: assembly_code.asm
7. Binary file after assembly: assembly_code.bin