WEATHER MONITORING SYSTEM

Design Project No. 24

Prepared for and under the guidance of

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MICROPROCESSOR PROGRAMMING AND INTERFACING

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The Problem Statement (Weather Monitoring Station)

System Description:

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. Weather parameters are sensed at regular intervals of 5 minutes.

The display is of the format: “Temperature – Value 0C” 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.

SPECIFICATIONS

The analog input for the system is received from the sensors which are connected to an 8-bit parallel ADC(0808) . These sensor modules generate current values ranging from 4 mA-20 mA which is converted into equivalent 1.25 V-6.25 V using the MAX472. This can be scaled to 0 V-5 V range. MAX472 is a bidirectional high-side Current-Sense Amplifier which has a current output that can be converted into a ground referred voltage with a single resistor, allowing a wide range of battery voltages.

There is an 8259 Programmable Interrupt controller device that accepts four interrupts from various sources, namely the timers, an external button and an EOC interrupt from the ADC. The IVT for the 8259 is stored in the ROM at a vector address of 80h onwards (corresponding to a memory address 80h*4=00200h). There are two timer IC’s (8253) generating interrupts every 5 minutes and every one hour.

Every five minutes, an interrupt is generated and an ISR is invoked in which the ADC value is read and this digital data is stored in the RAM. It is as though an array of twelve elements is maintained for each sensor, where after the twelfth reading of data, the next value is stored in the first position. Therefore, the past 12 readings are always maintained.

Every one hour, there is an interrupt generated that invokes an ISR that averages the values for the past hour. For the first hour, averaging is done for only the number of values available. After averaging, the values are scaled according to the specifications of the sensors. This scaled and average value is displayed.

There is also an external button which on pressing, generates an interrupt which takes a reading and averages the past 12 readings (including the current reading i.e. the past hour). This displays value on the LCD as per the request of the external button.

ASSUMPTIONS

Some assumptions are being made in consideration for the design:

- The display on the LCD displays an average of the previous 12 values read, i.e., the previous hour.

- Each time the user presses the external button, the clocks are not reset, implying that the next reading continues to take place as per the original 5-minute scheme which is set. On the button press, a new value is taken, added to data stored in memory and then, the past 12 values are taken for averaging, scaling and displaying on the LCD monitor.

- The button press does not clash with the 5-minute interrupt in normal usage. This is a fair assumption to make as, the probability for the same is very small in real-time usage of the weather monitoring station.

- In case of clash during operation (highly unlikely), and non-servicing of button interrupt, a second press will ensure the servicing of the interrupts, without affecting the 5minute interrupt-servicing.

SENSORS USED

NOTE: We have used appropriate voltage generators in simulation for Temperature, Humidity and Pressure Sensors.

Temperature:

WE700 - This covers the required temperature range with required resolution.

Sensing Temperature	-50°C ~ 50°C
Operating Voltage	10-36 VDC
Output	4-20mA
Accuracy	±0.1°C
Warm Up Time	3 seconds minimum

Humidity:

WE600 - This covers the required humidity range with required resolution.

Humidity Range	0% ~ 100% RH
Operating Temperature	-40°C ~ 55°C
Output	4-20mA
Operating Voltage	10-36 VDC
Accuracy	± 2% RH
Warm Up Time	3 seconds minimum

Pressure:

KP125 - This covers the required pressure range with required resolution.

Humidity Range	0% ~ 99% RH
Operating Pressure	0.4 ~ 1.15 bar
Port Size	-
Accuracy	± 1.5%
Voltage-Supply	4.5 V ~ 5.5 V
Output	0.5 V ~ 4.5 V

INTEGRATED CIRCUITS AND DEVICES USED

Sr. No.	Components Used	Quantity	Purpose
1.	6116	2	RAM for the Memory
2.	2716	2	EPROM
3.	74LS373	3	Latching the Bus
4.	74LS245	2	Bi-Directional Buffer
5.	8086	1	Central Processor
6.	8259	1	Program Interrupt Controller
7.	8255A	2	PPI for LCD PPI for ADC
8.	74LS138	2	Address Decoder
9.	8254A	2	Programmable Interval Timer
10.	ADC0808	1	Analog to Digital Convertor
11.	Push Button	1	Raise Manual Interrupt
12.	LM016L	3	LCD (16x2) Display
13.	Resistors (10k ohm)	1	
14.	2-input OR gate	4	Odd even memory interfacing
15.	MAX472	1	Current to voltage convertor

MEMORY INTERFACING

The memory interfaced uses 6116 RAM chips and 2716 ROM chips to interface a total of 4k + 4k of ROM and 4k of RAM. Addressing starts at 00000h so that the complete memory addressing is as:

ROM1 – 00000h - 00FFFh (as 00000h is the starting address of IVT, will include entire program)

RAM – 01000h - 01FFFh (the values recorded by sensors will be stored in the RAM)

ROM2 – FF000h – FFFFFh (reset address of microprocessor is FFFF0h)

Both, even and odd banks have been incorporated in the design. The decoding logic is obtained from:

ROM1:

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

RAM:

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

ROM2:

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

Hence, to decode memory, we use bits A14, A13 and A12 of the address lines.

I/O INTERFACING

The following I/O devices need to be interfaced to address lines:

- 8259
- Two 8255s (labelled 8255a and 8255b)
- Two 8254s (labelled 8254a and 8254b)

The type of addressing used is variable addressing as follows:

- 8259 (Interrupt controller) - 04000h – 04002h
- 8255a (for LCD operations) – 04010h – 04016h
- 8255b (for ADC operations) – 04020h – 04026h
- 8254a (5 min timer) – 04030h – 04036h
- 8254b (1hr timer) -- 04040h – 04046h

CALCULATIONS FOR SCALING

The ADC used in the design produces a voltage between 0 and 255d for the sensors. To scale it to the values for Pressure, Temperature and Humidity, we use a scaling function that employs the following formulae:

Pressure: (0-2bar) Hex value is obtained by: ADC value *02h/0FFh

Temperature: (-50°C to +50°C): ADC value *64h/0FFh

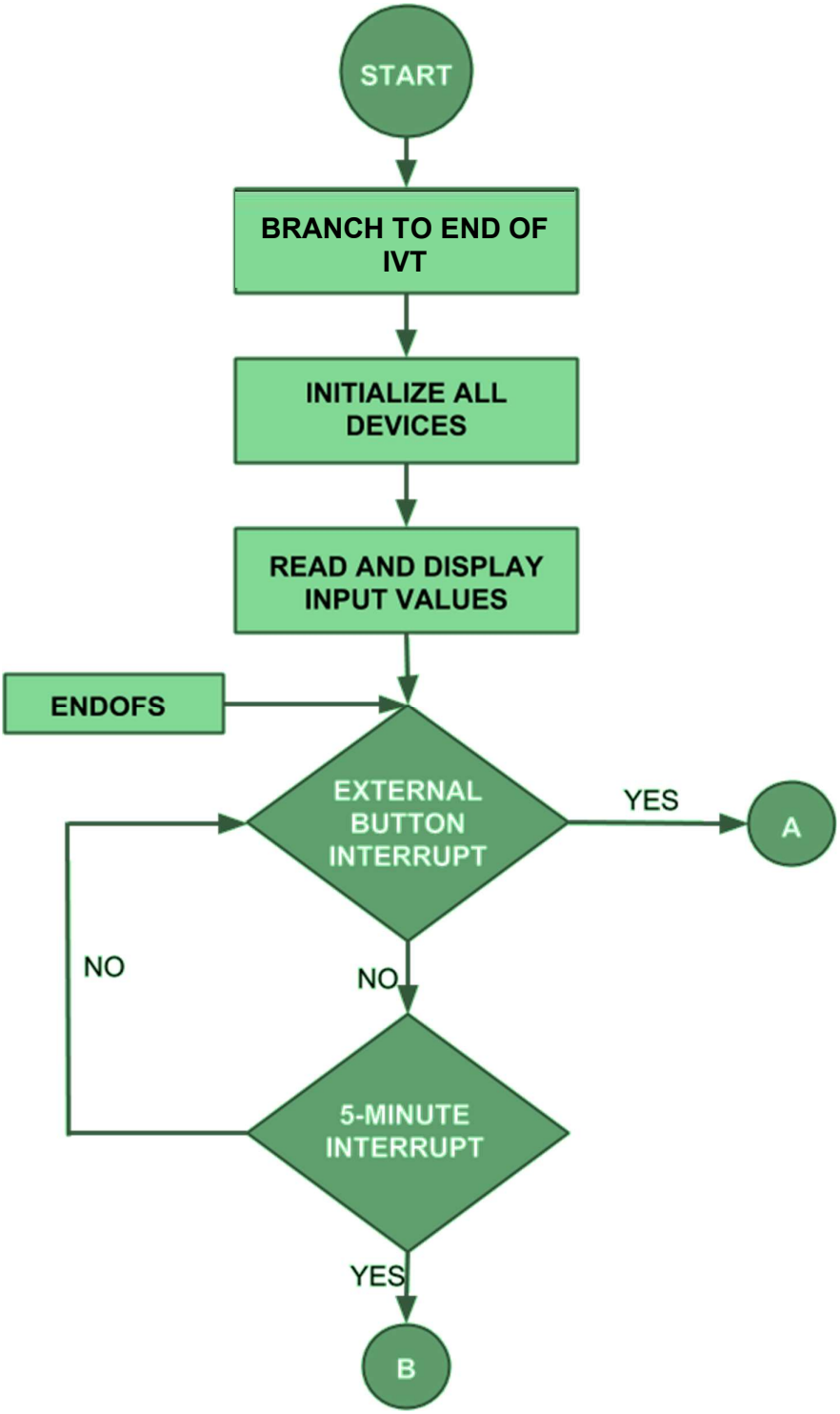
Humidity: (0-99%): ADC value *63h/0FFh

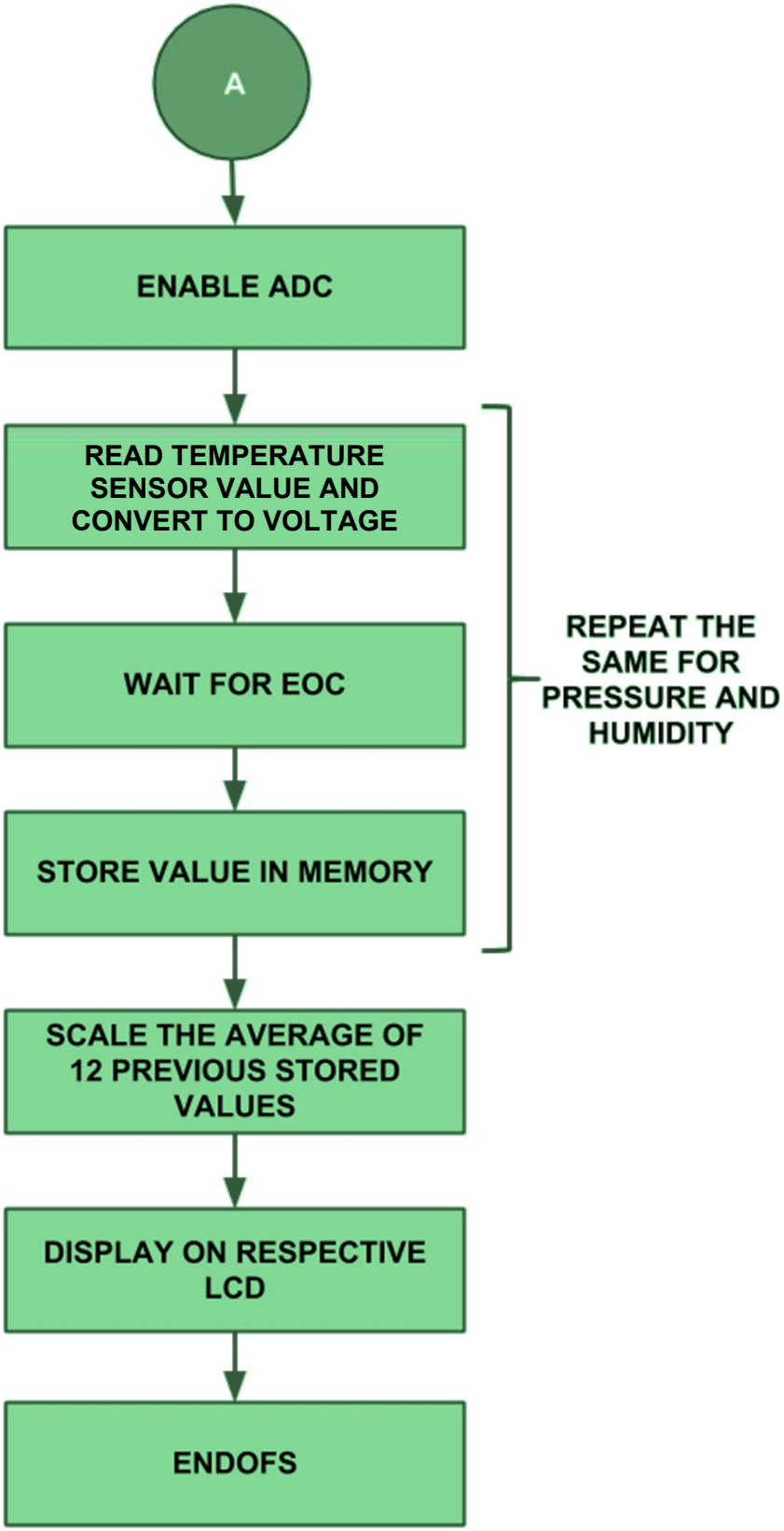
These hex values are then converted to decimal for viewing on the LCD.

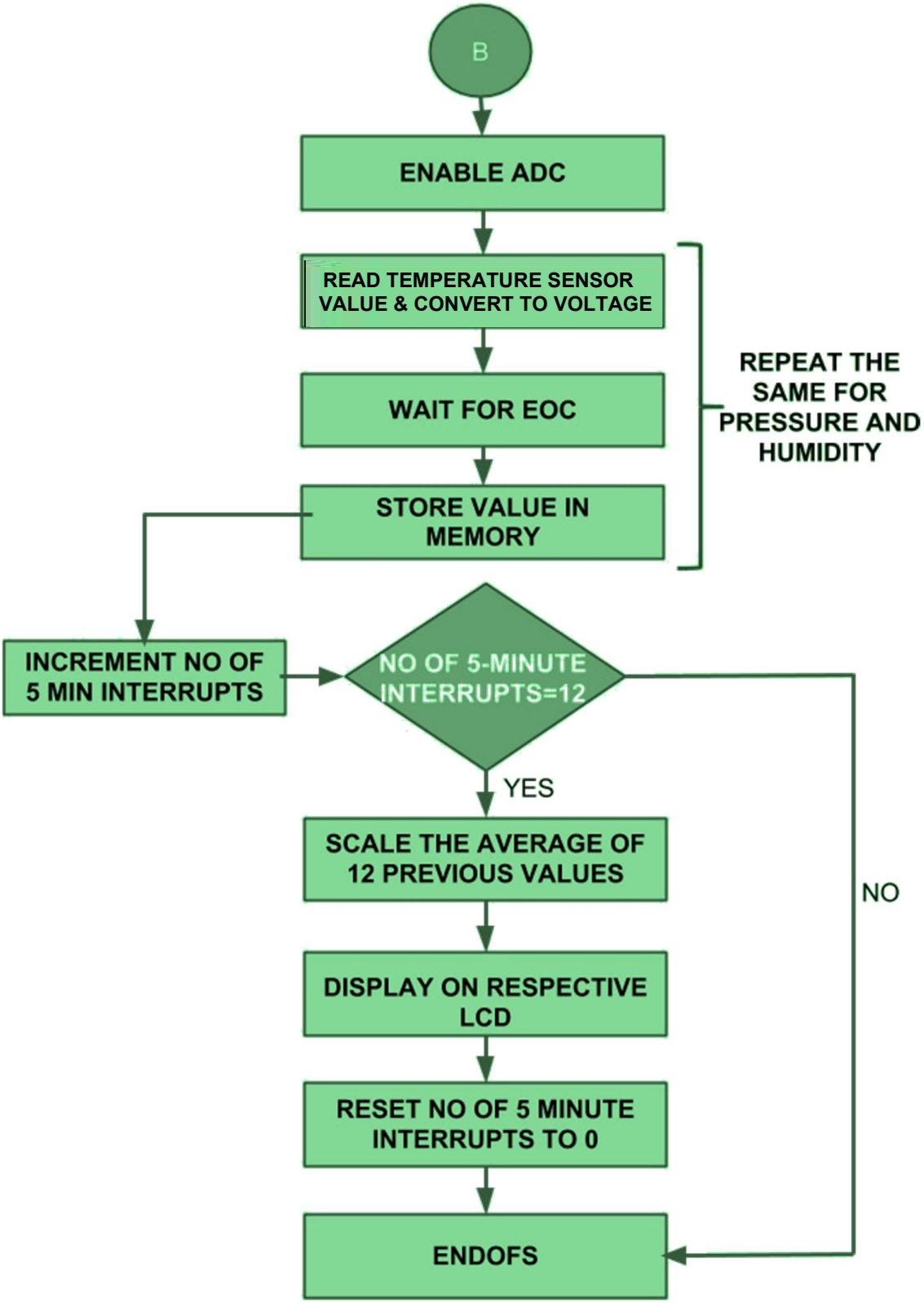
DESIGN

Complete design shown with proper labelling (design attached)

FLOWCHART


START
BRANCH TO END OF IVT
INITIALIZE ALL DEVICES
READ AND DISPLAY INPUT VALUES
ENDOFS
EXTERNAL BUTTON INTERRUPT
YES
A
NO
NO
5-MINUTE INTERRUPT
YES
B


A
ENABLE ADC
READ TEMPERATURE SENSOR VALUE AND CONVERT TO VOLTAGE
WAIT FOR EOC
STORE VALUE IN MEMORY
REPEAT THE SAME FOR PRESSURE AND HUMIDITY
SCALE THE AVERAGE OF 12 PREVIOUS STORED VALUES
DISPLAY ON RESPECTIVE LCD
ENDOFS


B
ENABLE ADC
READ TEMPERATURE SENSOR VALUE & CONVERT TO VOLTAGE
WAIT FOR EOC
STORE VALUE IN MEMORY
REPEAT THE SAME FOR PRESSURE AND HUMIDITY
INCREMENT NO OF 5 MIN INTERRUPTS
NO OF 5-MINUTE INTERRUPTS=12
YES
NO
SCALE THE AVERAGE OF 12 PREVIOUS VALUES
DISPLAY ON RESPECTIVE LCD
RESET NO OF 5 MINUTE INTERRUPTS TO 0
ENDOFS

VARIATION IN PROTEUS IMPLEMENTATION

1. Using 5 Min delay as 8259 does not work in proteus – EOC is used as NMI and the Timer Int replaced by software delay as 5 Minutes.
2. ROM in only 00000 – as proteus allows to change reset address.
3. Using 8253 – as 8254 not available in Proteus.
4. 2732 is used as 2716 – not available in Proteus.
5. Using a gate-based circuit for memory – does the same as LS 138 here
6. All Sensors – replaced by DC voltage source giving voltage between 0 – 5 V – as all sensors not there in Proteus.
7. Key debounce delay is 20ms.
8. We have connected a 2 second (rather than 5 min) output of clock to see the output changes. Hence, the values are shown every 24 seconds. In actual usage, 5- minute interrupt is used.

FIRMWARE

Implemented using emu8086 attached.

LIST OF ATTACHMENTS:

1. Manuals:
    a. ADC 0808
    b. WE600B (contains Temperature and humidity sensors)
    c. KP125 (contains pressure sensor)
    d. MAX472
    e. LM016L
2. Complete Hardware Real World Design – Hardware_design.pdf
3. Proteus File – Final_Design.dsn
4. EMU8086 ASM File – code.asm
5. Binary File after assembly – code.bin