Microprocessor and Interfacing

Design Project

Intelligent Humidistat

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Design Problem

P 23: System to be designed – Intelligent Humidistat

System Description: A humidistat is supposed to be reset according to the outside temperature - as the outside temperature falls, the humidity level inside the house should be set lower. The purpose of this project is to develop a humidistat which senses the outside temperature and adjusts the humidity accordingly. Two sensors are required: outside temperature and inside humidity. Output is provided via a simple relay with the humidifier (presumably on the furnace) being on or off. Also readings from the humidity and temperature sensors must be displayed on an LCD display

Design Specifications:

1. Measurement of external Temperature in degree Celsius.
2. Measurement of internal Relative Humidity in %.
3. Adjusting the humidity of the room based on the external temperature. This is done with the help of a humidifier.
4. The output to switch on/off the humidifier is given via a simple relay to indicate the state (on/off) of the humidifier.
5. Displaying the temperature (in deg Celsius) and Relative Humidity (in %) on the LCD.

Assumptions:

1) Range of the temperature sensor (0°C – 60°C)
2) Humidity Range (25% - 55%)
3) Assuming the room is a large one, we find the average temperature and the average humidity of the room via the help of a number of sensors.
4) The temperature sensors are located as the follows:
    - One on each outer wall (assume 4 walls = 4 sensors)
    - One on the top of the roof (1 sensor)
5) The humidity sensors are located as follows:
    - One on each corner of the ceiling.(4 sensors)
    - One on the centre of the ceiling.(1 sensor)
    - One each on a pair of opposite walls.(2 sensors)
6) Chart for optimal humidity ranges at given temperature range

Temperature (in deg C)	**Relative Humidity**
0-5	27%-30%
5-10	30%-33%
10-15	33%-35%
15-20	35%-38%
20-25	38%-40%
25-30	40%-43%
30-35	43%-45%
35-45	45%-48%
45-55	48%-50%
55-60	50%-53%

Hardware Requirements:

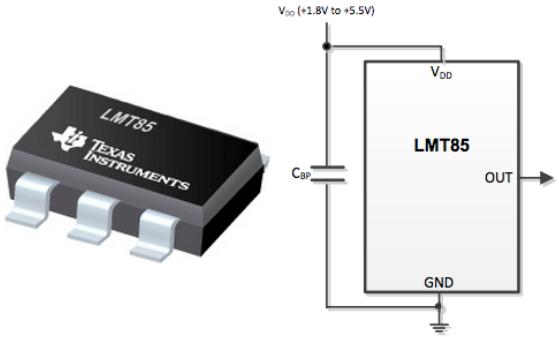
1. Microprocessor 8086
2. Octal 8 bit buffer -74LS245 (x2) [to separate data bus]
3. Octal 8 bit latch - 74LS373(x3) [to separate address bus]
4. Temperature Sensors – LMT85 (x5)
   [Highly accurate, requires limited current supply, cost effective, capable of driving heavy loads, temperature range which suits our design]
5. Humidity Sensors – HIH4030 (x7)
   [Very accurate, low response time, stable, cost effective, resistant to dust and other chemicals]
6. Humidifier (x1) [controls inside relative humidity]
7. LCD – LM016L (x1) [Displays outside temperature and inside RH]
8. Programmable Peripheral Interface – 8255(x2)
   [Interfaces ADC & LCD]
9. Decoder- 74LS138(x2) [Memory, I/O Addressing]
10. Programmable Interval Timer – 8253(x1) [provides clock to ADC]
11. OR ICs – 7432 (x2) [8 or gates used in memory interfacing]
12. ROM chips (4K each) – 2732 (x6)
    [ROM required at reset address FFFF0h and at 00000h (IVT location)]
13. RAM chips (2K each) – 6116 (x2)
    [For stack and temporary storage of data]
14. Simple Relay(x1) [Controls switching ON/OFF the humidifier]
15. Clock Generator – 8284 (x1) [Provide clock to 8086]
16. Analog to Digital Convertor – 0808 (x2)
    [Converts analog inputs from sensors to digital values]

ADC Specifications:

1) No of analog inputs = 12
2) No of ADCs used = 2
3) Size of ADC = 8
4) Resolution of ADC = 5 V / 256 = 19.532 mV

Sensor specifications

- **Temperature Sensor LMT85:**



LMT85 – Analog Temperature sensors with class-ab output

Supply Voltage = -0.3 to 6 V

Output current rating = ±7 mA

Range = −50°C to 150°C

Voltage at output pin: -0.3 V – V_{DD} + 0.5V (V_{DD}: 1.8V-5.5V)

Accuracy: 0.25-0.7 °C

Voltage V at a given temp T in °C=> V = (-8.2mV/°C)xT +1569 mV

Voltage output at assumed operating range (0-60 °C) = 1.570 – 1.118 V

- **Humidity Sensor HIH 4030/31 series:**

HIH-4030/31 Series (Honeywell) including a SMD (surface mount device)

Accuracy = ± 3.5 % RH

Response time = 5 s (average)

Settling time = 70 ms (max)

Input Voltage supply = 4 – 5.8 V (DC)

Input Current supply = 0 – 500 µA

%RH value for a given value of V_{out} = $\frac{Vout - Zero\ offset}{Slope}$ = $\frac{Vout - 0.958}{0.0307}$

Operating humidity: 0-100% RH

Operating temperature: -40 to 85 °C

Output voltage at assumed range (25-55 %) = 1.725 – 2.645V

- **LM016L Hitachi LCD module with an inbuilt controller LSI HD44780:**

Display: 16 characters * 2 lines

Power Supply for LCD drive: 0 - 6.5V

Operating Temperature: 0 - 50 °C

Power supply current (V_{DD} = 5 V): 1 – 3 mA

Memory Interfacing

- **ADDRESSING:**

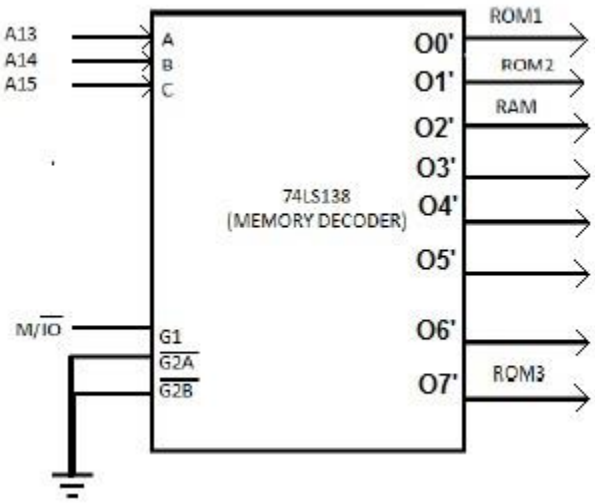
ROM 1 – 8k: 00000_H – $01FFF_H$

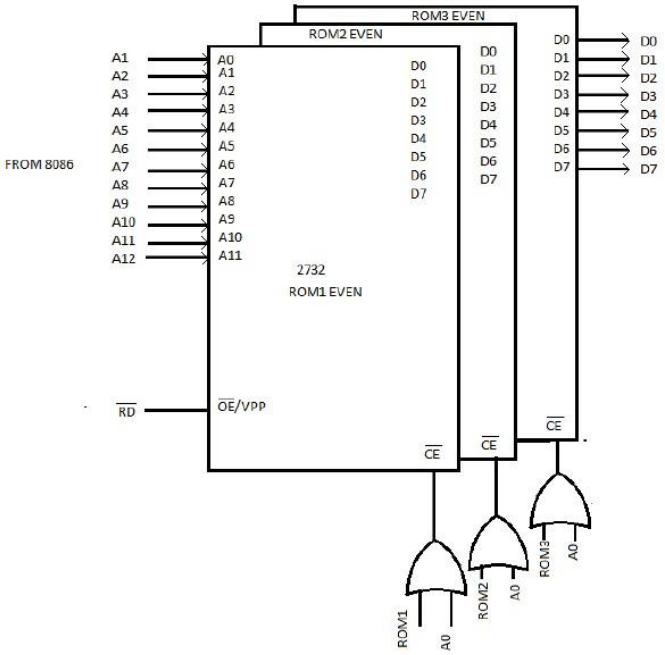
ROM 2 – 8k: 02000_H – $03FFF_H$

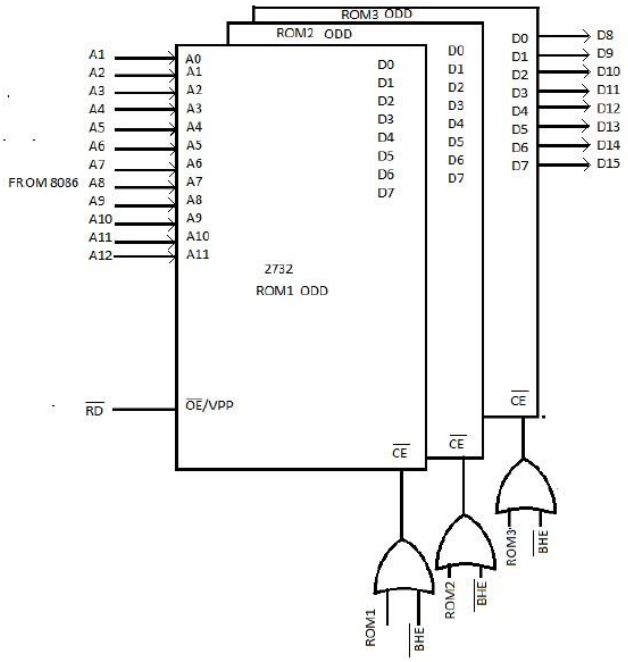
ROM 3 – 8k: $FE000_H$ – $FFFFF_H$

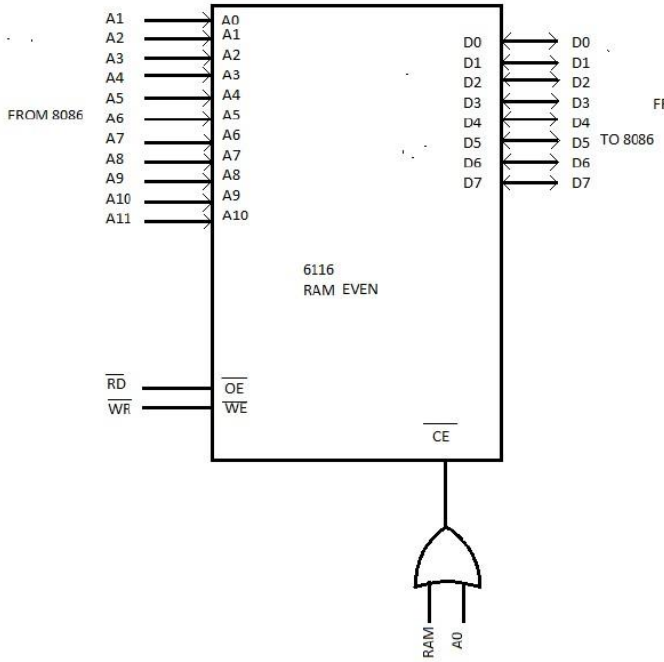
RAM – 4k: 04000_H – $04FFF_H$

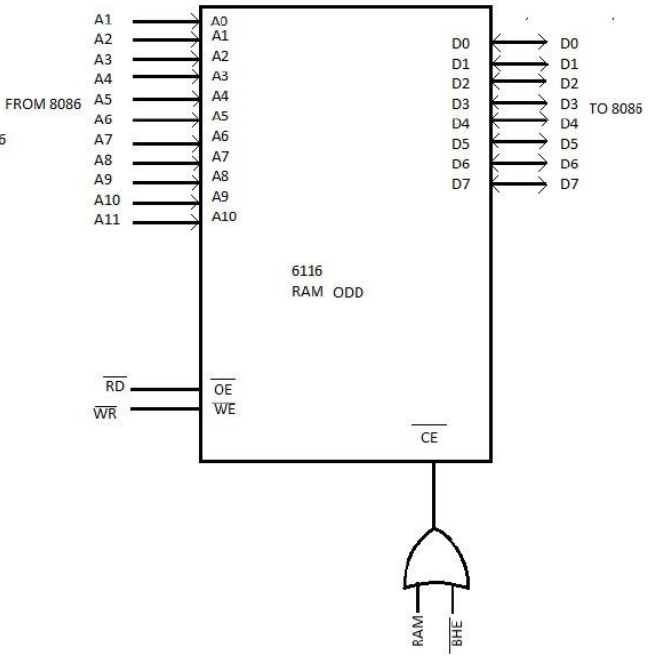
- **DECODING LOGIC:**




ROM3 EVEN
ROM2 EVEN
FROM 8086
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A11
A12
A0
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A11
2732
ROM1 EVEN
D0
D1
D2
D3
D4
D5
D6
D7
RD
OE/VPP
CE
ROM1
ROM2
ROM3
A0


ROM3 ODD
ROM2 ODD
FROM 8086
2732
ROM1 ODD
D8
D9
D10
D11
D12
D13
D14
D15
RD
OE/VPP
CE
ROM1
ROM2
ROM3
BHE


FROM 8086
6116
RAM EVEN
TO 8086
RD
WR
OE
WE
CE
RAM
A0


FROM 8086
6116
RAM ODD
TO 8086
RD
WR
OE
WE
CE
RAM
BHE

I/0 Interfacing (8255(H), 8255(T), 8253)

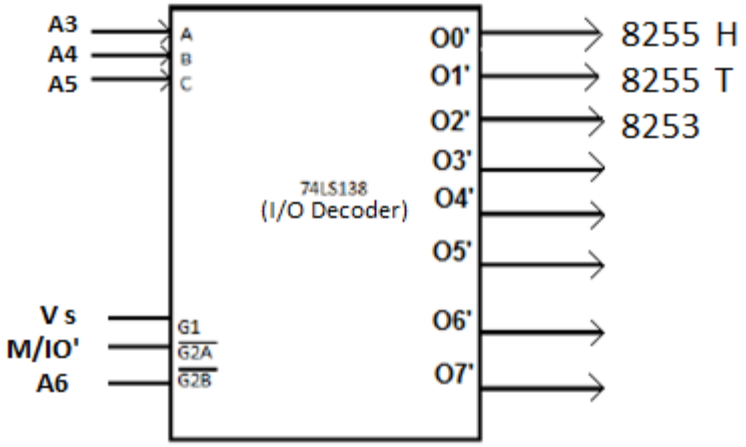
- **ADDRESSING:**

  8255(H): 00_H – 06_H

  8255(T): 08_H – $0E_H$

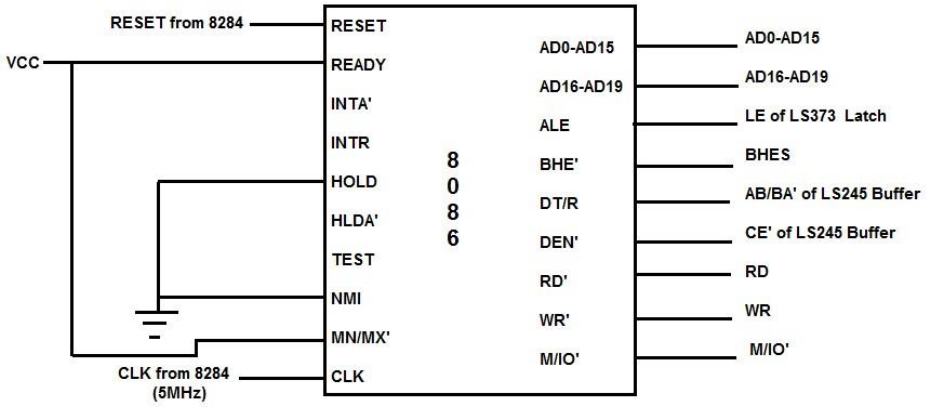
  8253: 10_H – 16_H

- **DECODING LOGIC:**

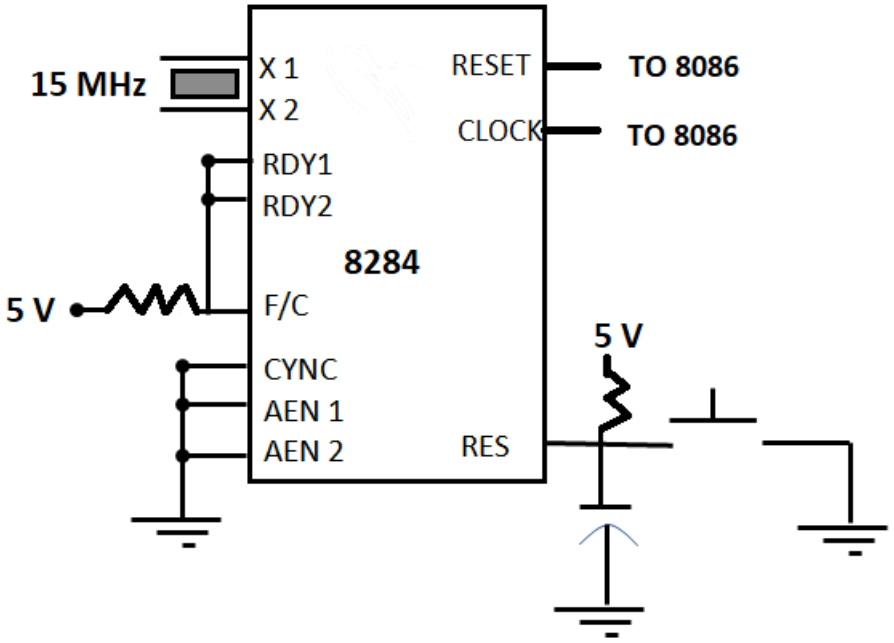


Design Components

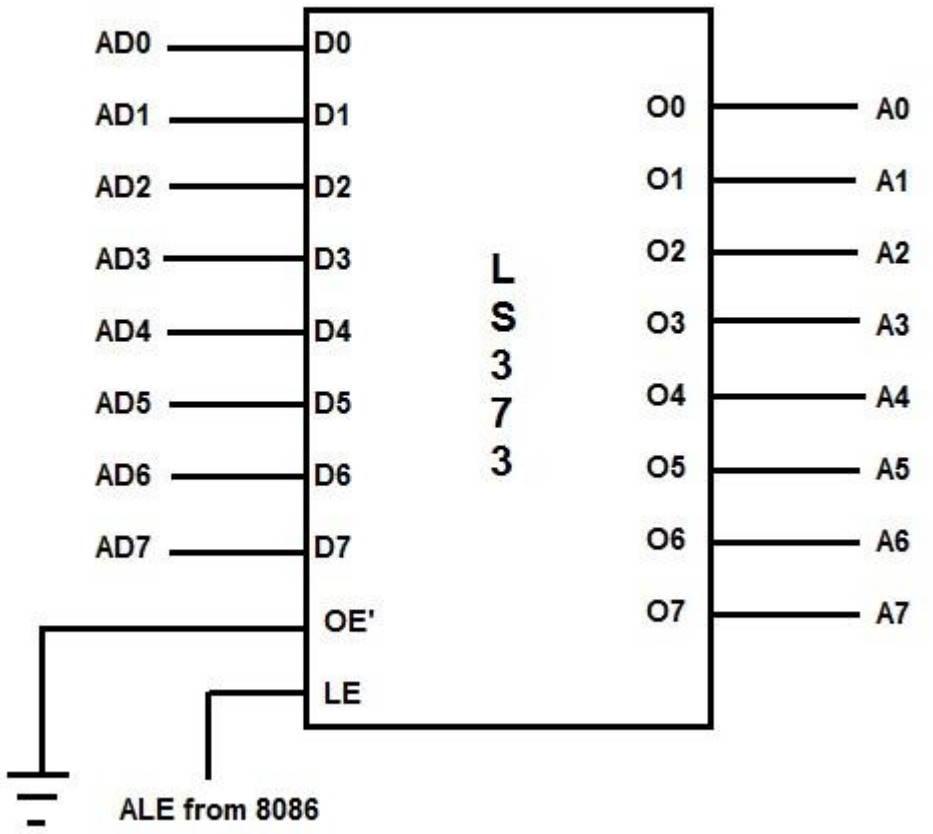
- **Connections to 8086 microprocessor**

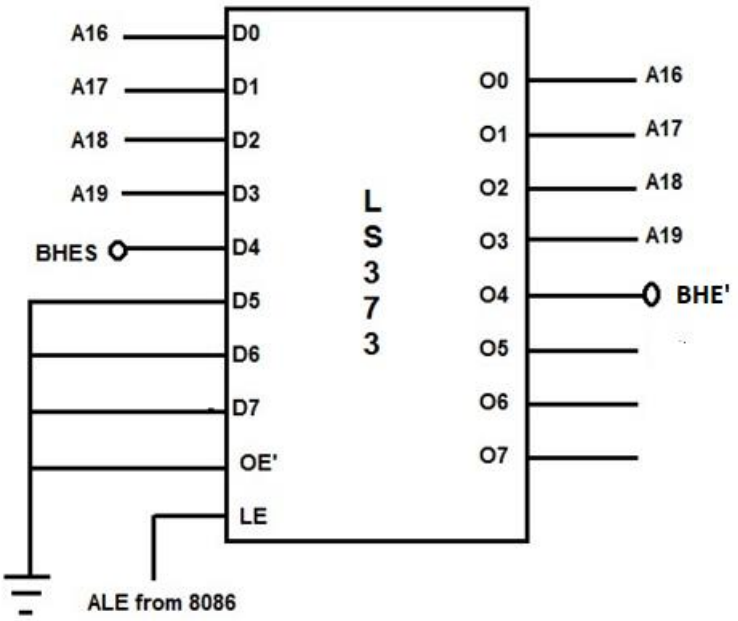


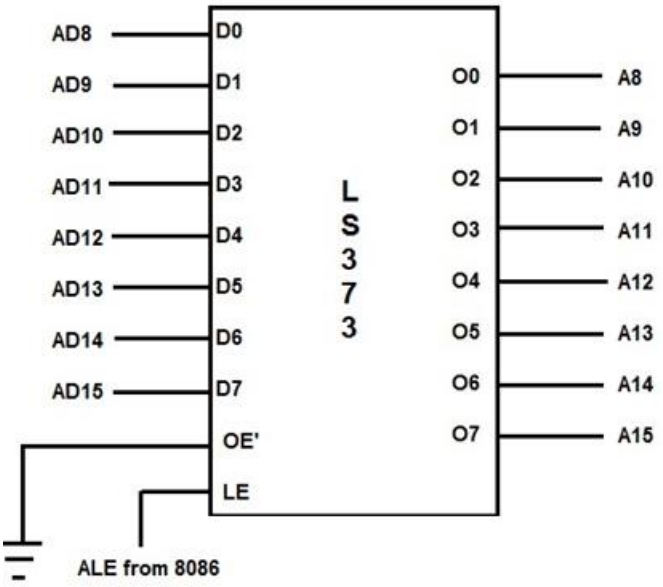
- **Connections to 8284 Clock generator**



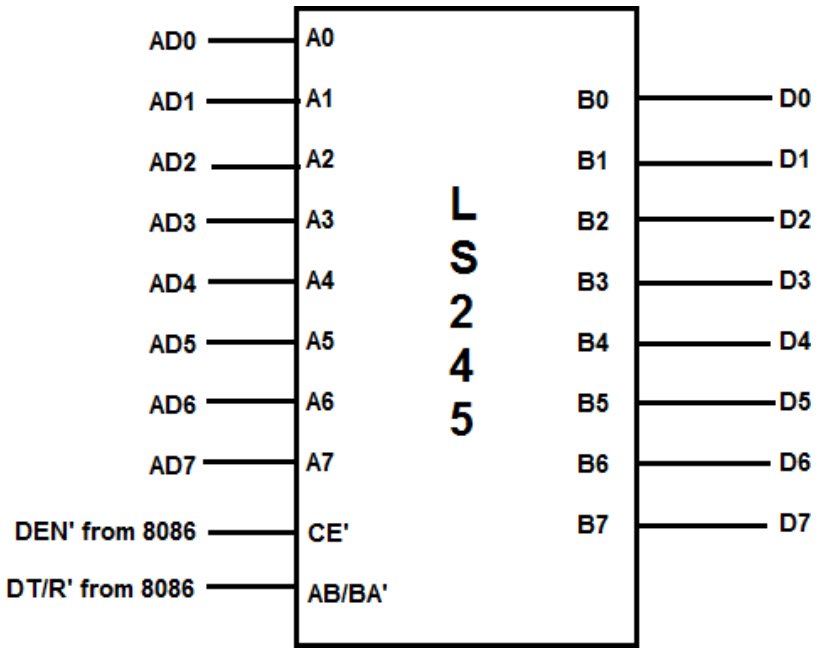
- **Connections to 74LS373 Octal Latches**

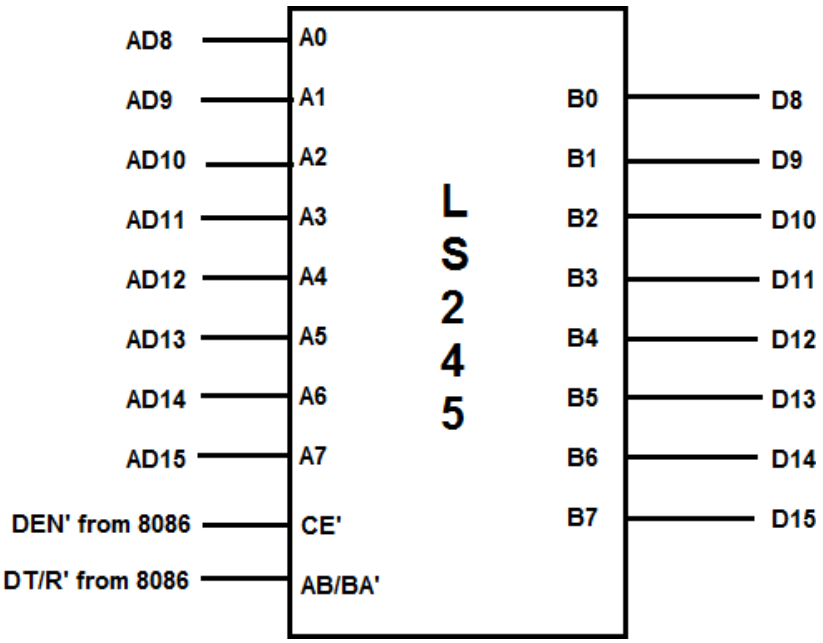



A16
A17
A18
A19
BHES
D0
D1
D2
D3
D4
D5
D6
D7
OE'
LE
LS373
O0
O1
O2
O3
O4
O5
O6
O7
A16
A17
A18
A19
BHE'
ALE from 8086

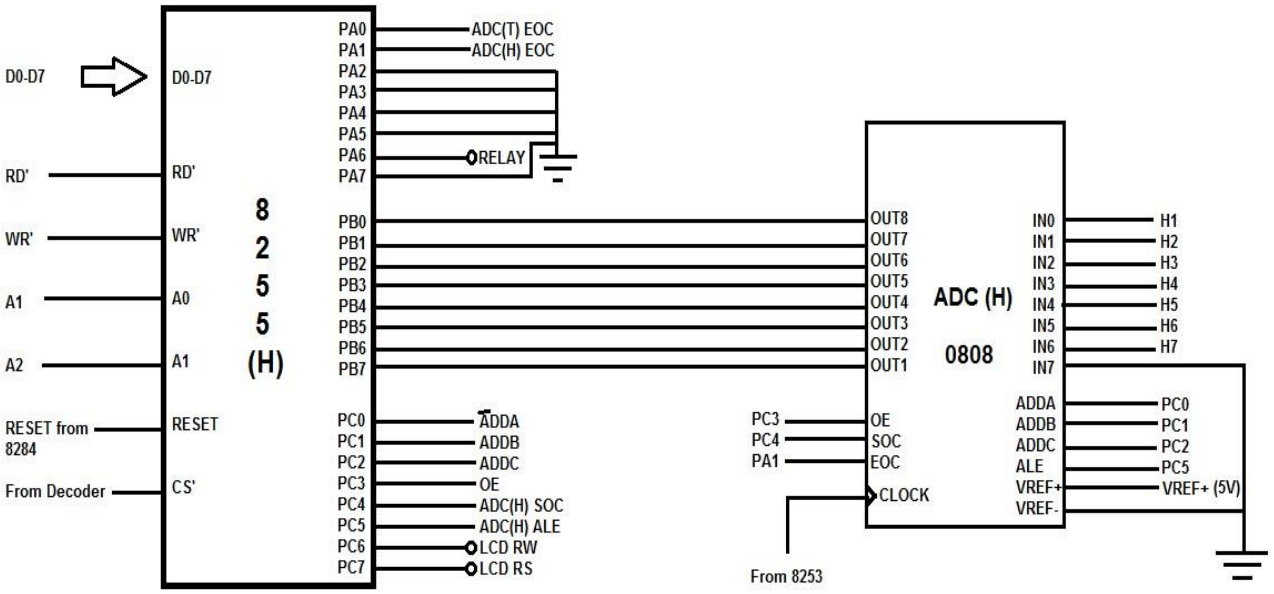

AD8
AD9
AD10
AD11
AD12
AD13
AD14
AD15
D0
D1
D2
D3
D4
D5
D6
D7
OE'
LE
LS373
O0
O1
O2
O3
O4
O5
O6
O7
A8
A9
A10
A11
A12
A13
A14
A15
ALE from 8086

- **Connections to 74LS245 Octal Buffers**

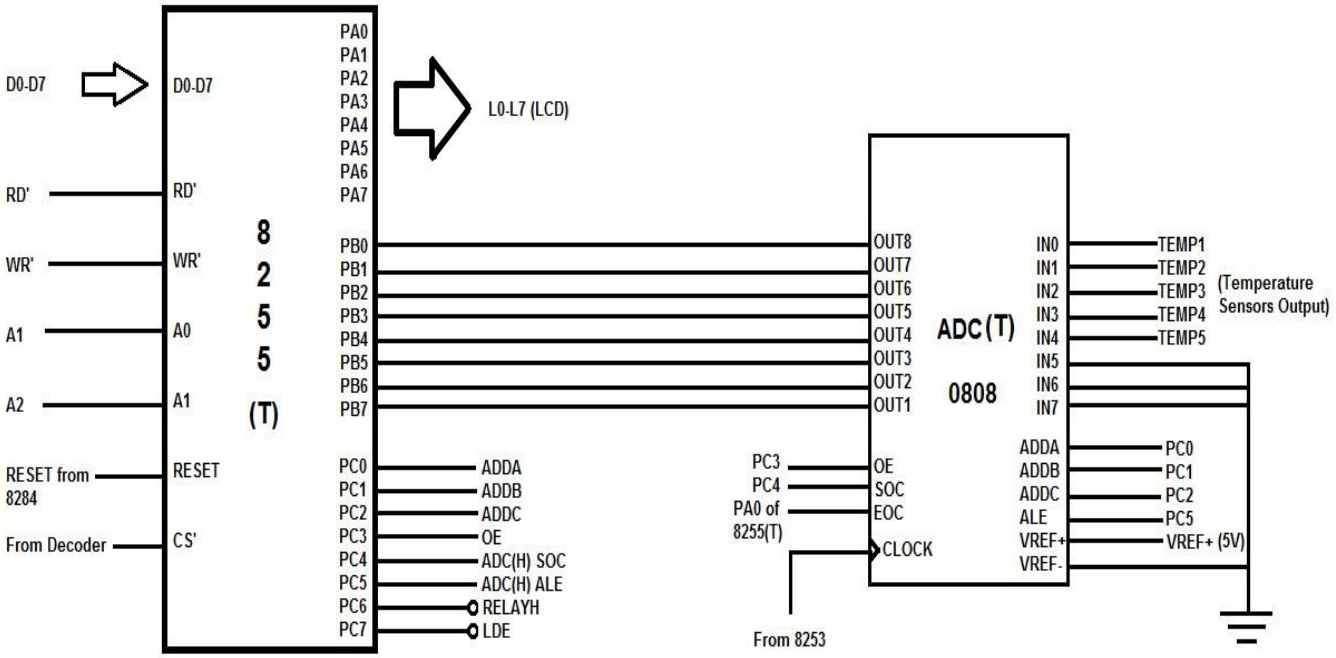




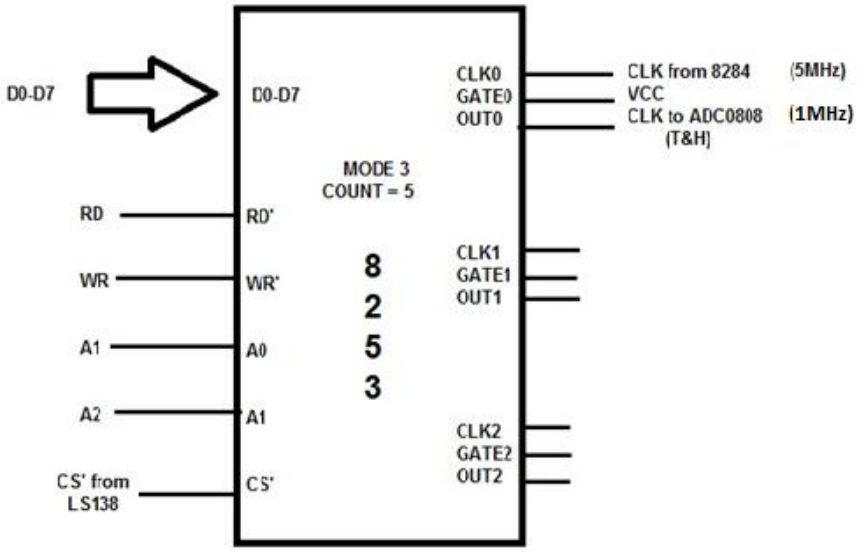
- **Interfacing of ADC(H) with 8255(H)**



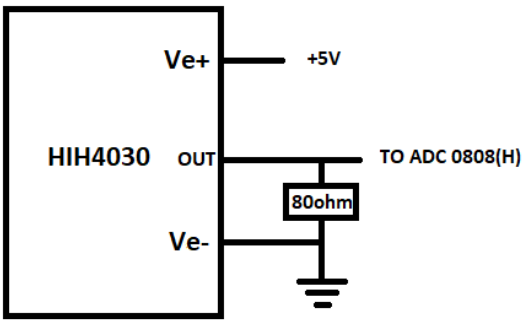
- **Interfacing of ADC(T) with 8255(T)**

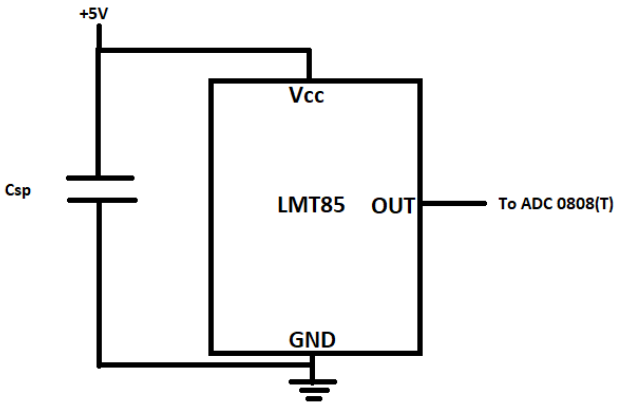


- **Interfacing of 8253 with ADC0808(T) and ADC0808(H)**

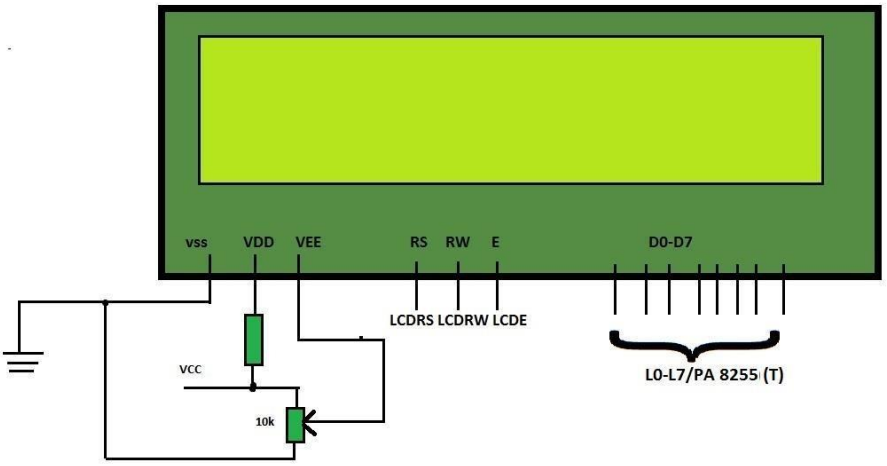


- **Connections to Temperature sensor LMT85 and Humidity sensor HIH4030**

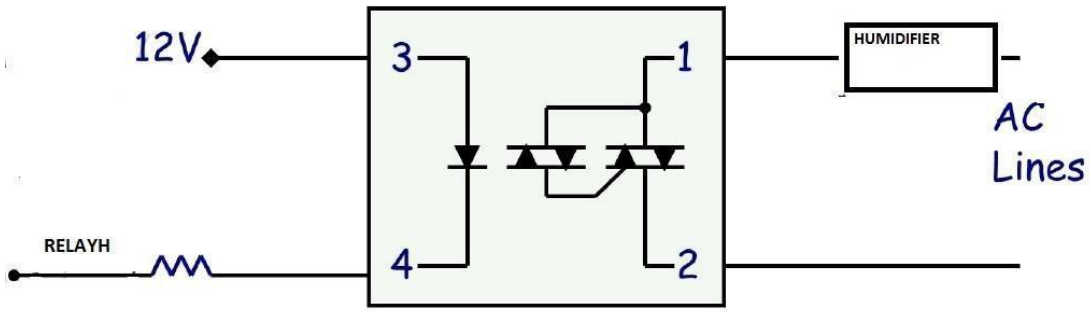




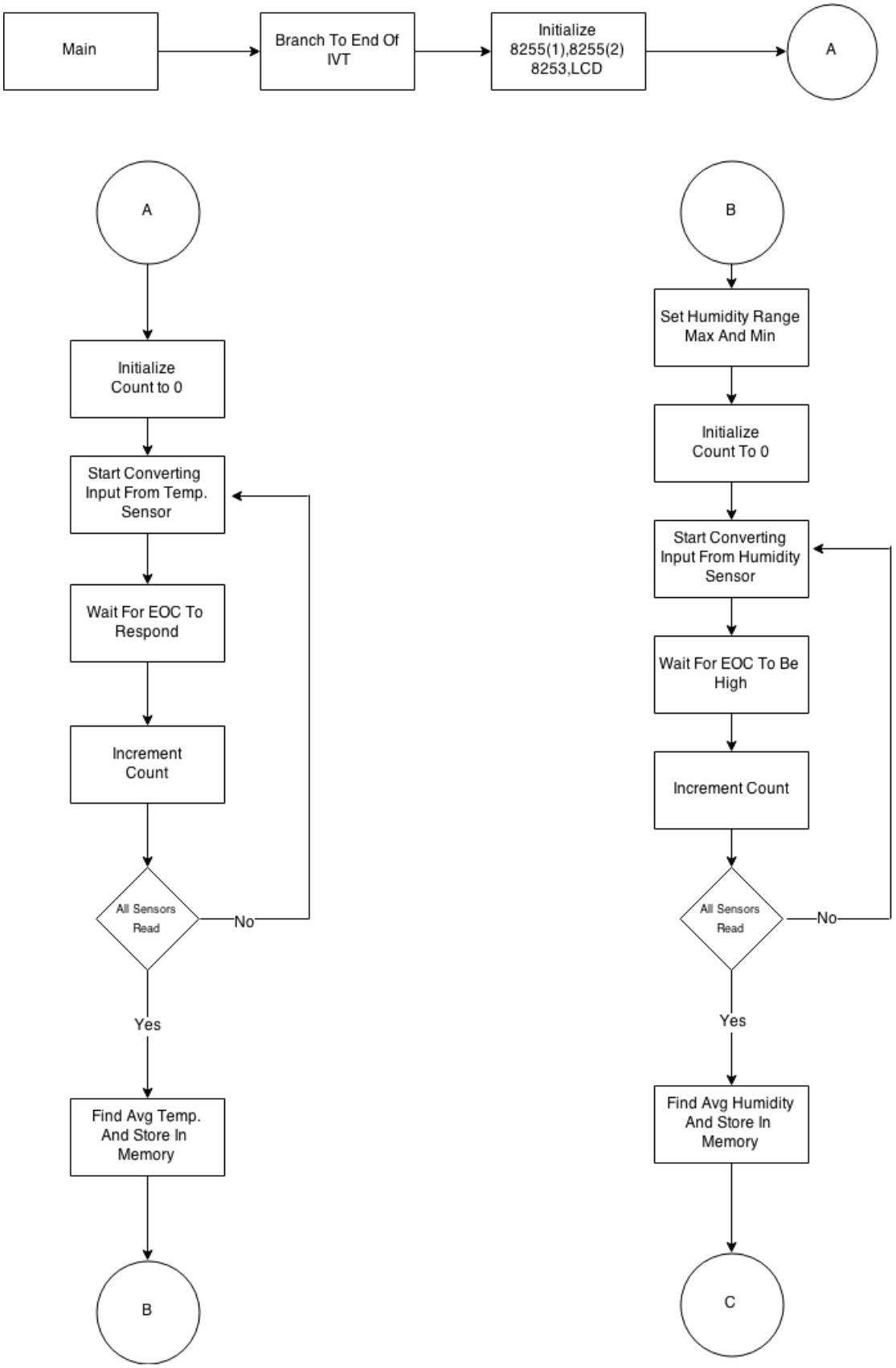
- **Interfacing of LCD with 8255(H) and 8255 (T)**

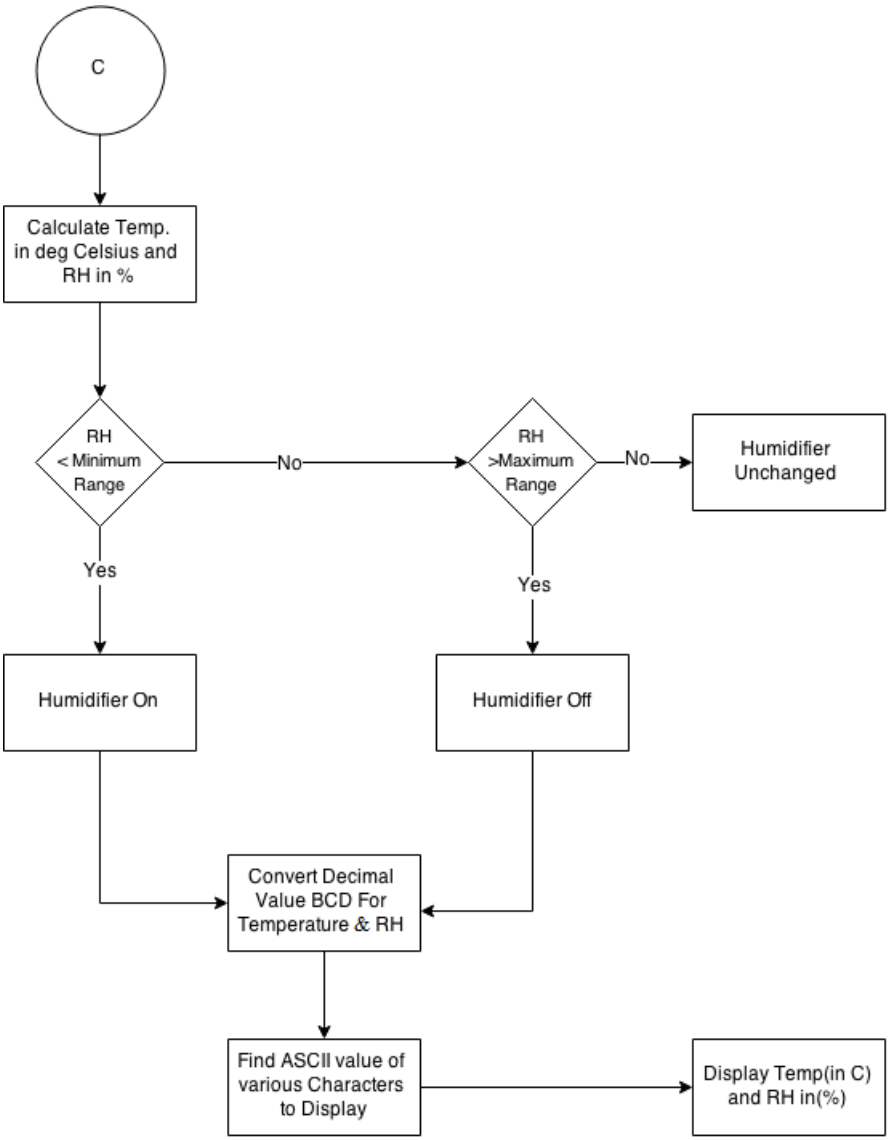


- **Simple Relay Interfaced with RELAYH(PC6) from 8255 (T)**



Software Flowchart




C
Calculate Temp. in deg Celsius and RH in %
RH < Minimum Range
No
RH >Maximum Range
No
Humidifier Unchanged
Yes
Yes
Humidifier On
Humidifier Off
Convert Decimal Value BCD For Temperature & RH
Find ASCII value of various Characters to Display
Display Temp(in C) and RH in(%)

Variations in Proteus implementation

1. Potentiometers are used to simulate input from the sensors due to unavailability of required temperature and humidity sensors.

2. As 8284 is unavailable in Proteus, the clock feature of 8086 is used to provide clock frequency to the microprocessor.

3. The Humidifier is shown as a green LED which would glow only when it is ON, as humidifier cannot be shown on Proteus.

List of attachments

1. Complete hardware design on multiple pages – Design.pdf

2. Manuals:
   - LMT85
   - HIH4030
   - ADC0808

3. Proteus file - IH.dsn

4. EMU8086 ASM file – IH.asm

5. Binary file after assembly – IH.bin

6. Output on LCD and LED - OUTPUT.jpeg