MICROPROCESSORS AND INTERFACING

Design Project

19/4/2015

Question – 25

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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 analog voltages ~0-5V which is connected to the ADC, which in turn, generates an 8 bit value between 0 and 255.

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.

MEMORY INTERFACING

The memory interfaced uses 6116 RAM chips and 2732 ROM chips to interface a total of 8k + 8k of ROM and 4k of RAM. Addressing starts at 00000h so that the complete memory addressing is as:

ROM1 – 00000h-01FFFh

RAM1 – 02000h-02FFFh

ROM2 – FE000h - FFFFFh

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	1	1	1	1	1	1	1	1	1	1	1	1	1

RAM1:

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	1	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	1	0	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	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	1	1	1	1	1	1	1

Hence, to decode memory, we use bits A15, A14 and A13 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 8253s (labelled 8253a and 8253b)

The addressing is:

- 8259 (Interrupt controller) - 04000h
- 8255a (for LCD operations) – 04010h
- 8255b(for ADC operations) – 04020h
- 8253a (5 min timer) – 04030h
- 8253b (1hr timer) -- 04040h

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.
- For the simulations and debugging, we have connected a faster (than 5 min) output of clock to see the output changes. In actual usage, 5 minute interrupt is used.

INTEGRATED CIRCUITS AND DEVICES USED

1) Random Access Memory UT-6116
2) Read Only Memory UT-2732
3) Two 8 bit latches 74LS373
4) 8 bit bidirectional buffer 74LS245
5) Microprocessor 8086
6) Programmable Interrupt Controller 8259
7) Programmable Peripheral Interface 8255
8) 8x1 Decoders – 74LS138
9) Programmable Interval Timer 8253
10) Analog to Digital Converter AD0808
11) External Push Button
12) Resistors – 10k ohm
13) Quad 2-input OR gate chip 7432
14) Temperature, Humidity and Pressure Sensors (using appropriate voltage generators)

SENSORS USED

Temperature:

AD8494

Sensing Temperature	5°C ~ 50°C
Output Type	Analog
Accuracy	± 1°C

Humidity:

HF 3223 / HTF 3223 Temperature and Humidity Module

Humidity Range	0% ~ 99% RH
Operating Temperature	-30°C ~ 80°C
Sensitivity	-
Accuracy	± 5% RH
Response Time	10s
Output	Linear Voltage

Pressure:

KP125 Absolute Pressure Sensor

Humidity Range	0% ~ 99% RH
Operating Pressure	5.80 ~ 16.68 PSI, 40 ~ 115 kPa
Port Size	-
Accuracy	± 1.5%
Voltage – Supply	4.5 V ~ 5.5 V
Output	0.5 V ~ 4.5 V

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:

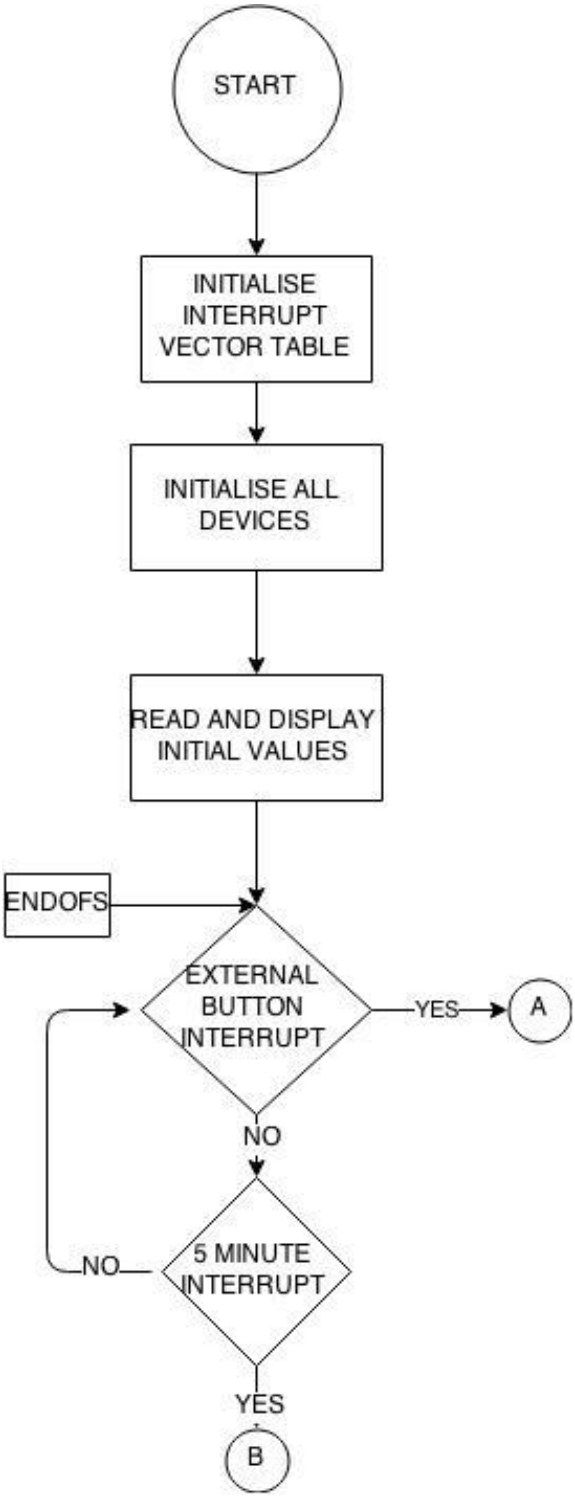
Pressure: (0-2bar)
Hex value is obtained by: ADC value *02h/FFh

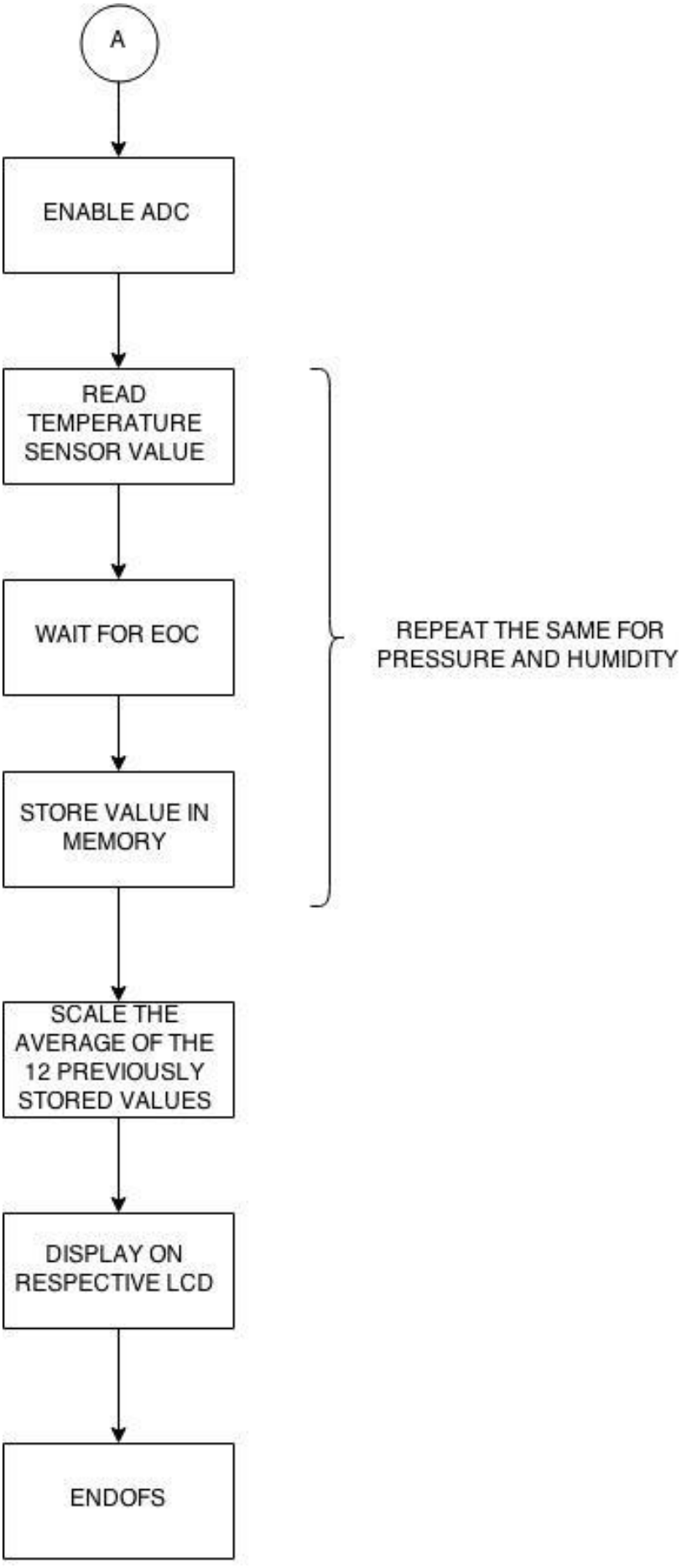
Temperature: (5-50°C): ADC value *32h/FFh

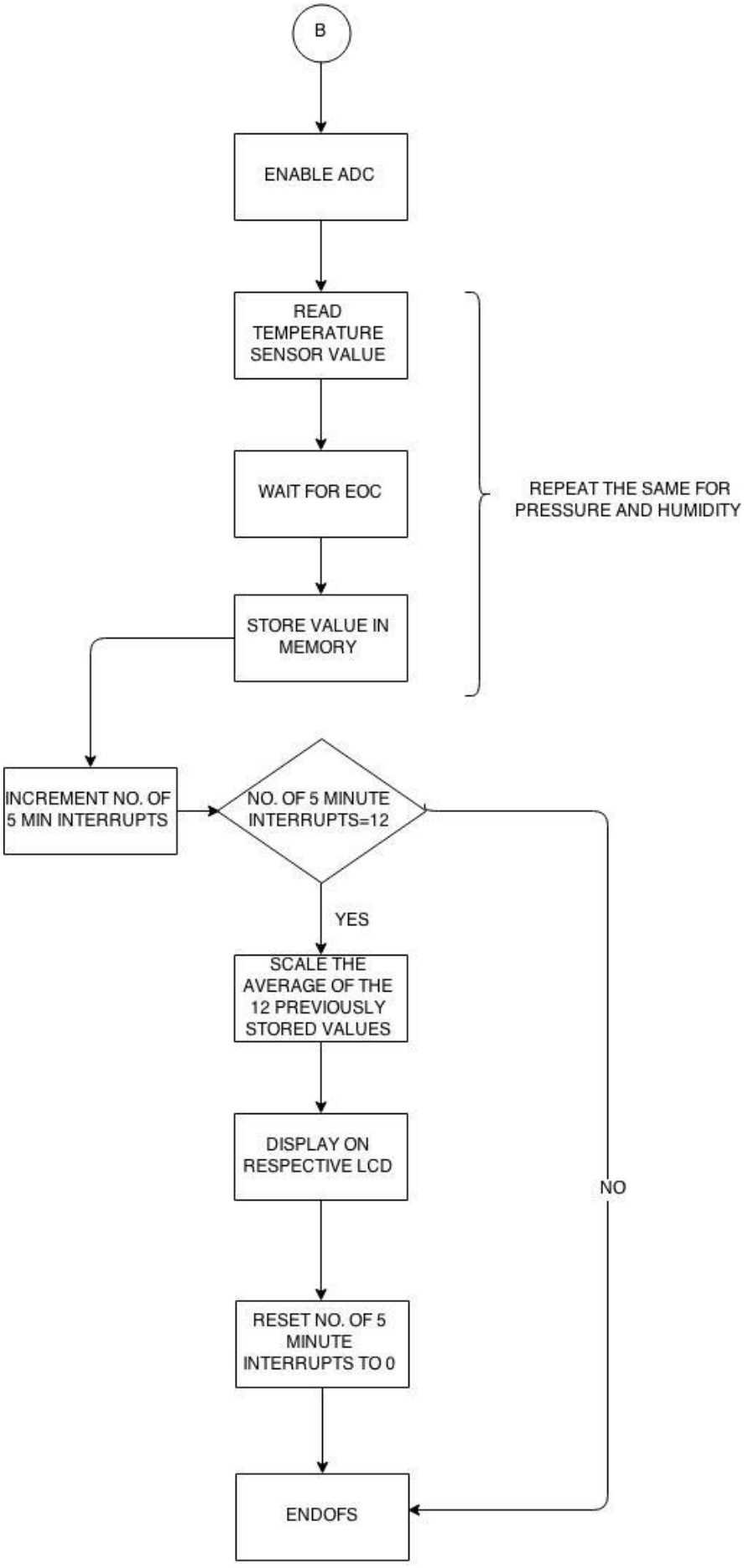
Humidity: (0-99%): ADC value *63h/FFh

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

FLOWCHART:


START
INITIALISE INTERRUPT VECTOR TABLE
INITIALISE ALL DEVICES
READ AND DISPLAY INITIAL VALUES
ENDOFS
EXTERNAL BUTTON INTERRUPT
YES
A
NO
5 MINUTE INTERRUPT
NO
YES
B

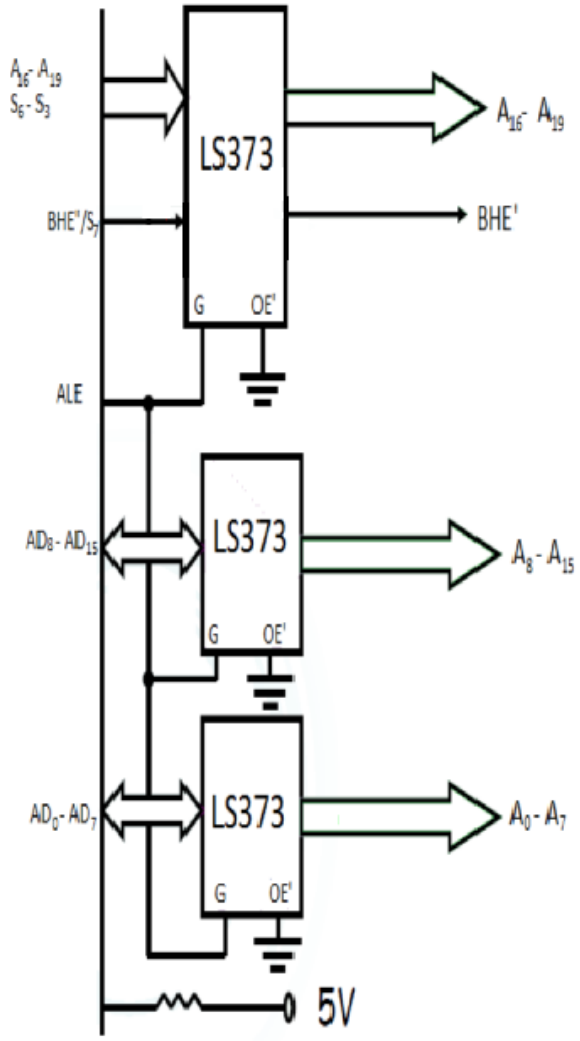

A
ENABLE ADC
READ TEMPERATURE SENSOR VALUE
WAIT FOR EOC
STORE VALUE IN MEMORY
REPEAT THE SAME FOR PRESSURE AND HUMIDITY
SCALE THE AVERAGE OF THE 12 PREVIOUSLY STORED VALUES
DISPLAY ON RESPECTIVE LCD
ENDOFS


B
ENABLE ADC
READ TEMPERATURE SENSOR VALUE
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 THE 12 PREVIOUSLY STORED VALUES
DISPLAY ON RESPECTIVE LCD
RESET NO. OF 5 MINUTE INTERRUPTS TO 0
ENDOFS

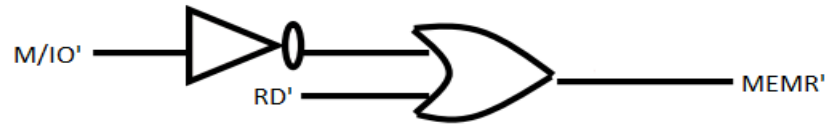
CIRCUIT DIAGRAM:

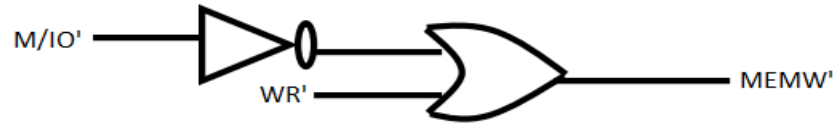
System bus (Address):`

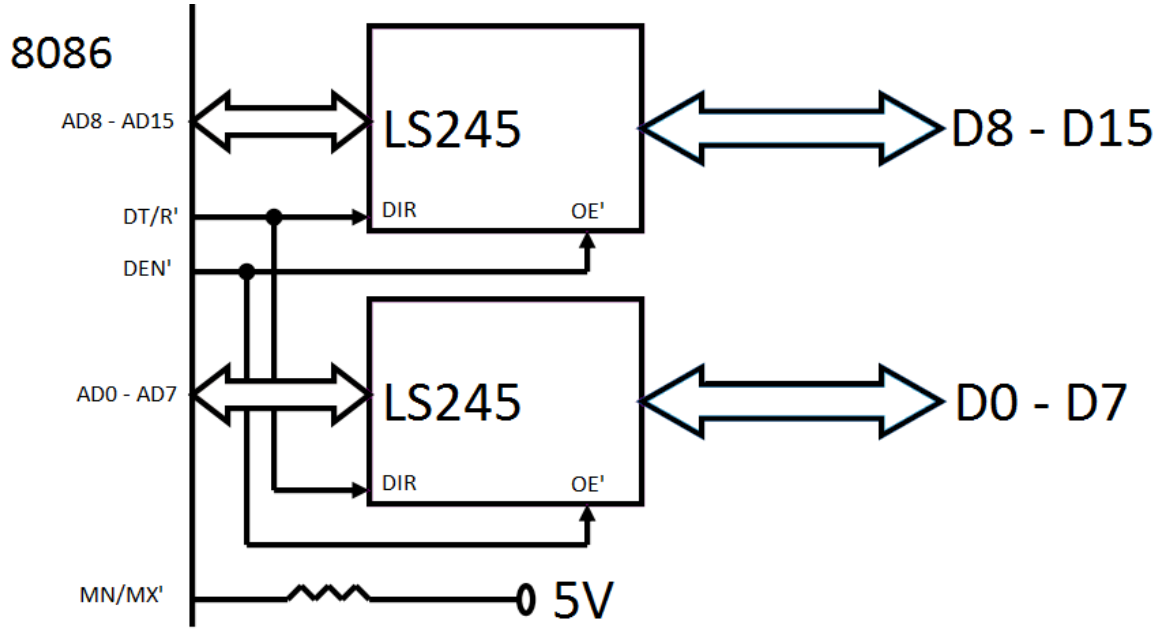
8086

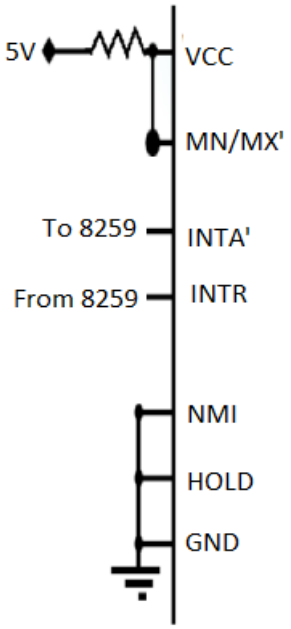


System Bus (Control and Data):

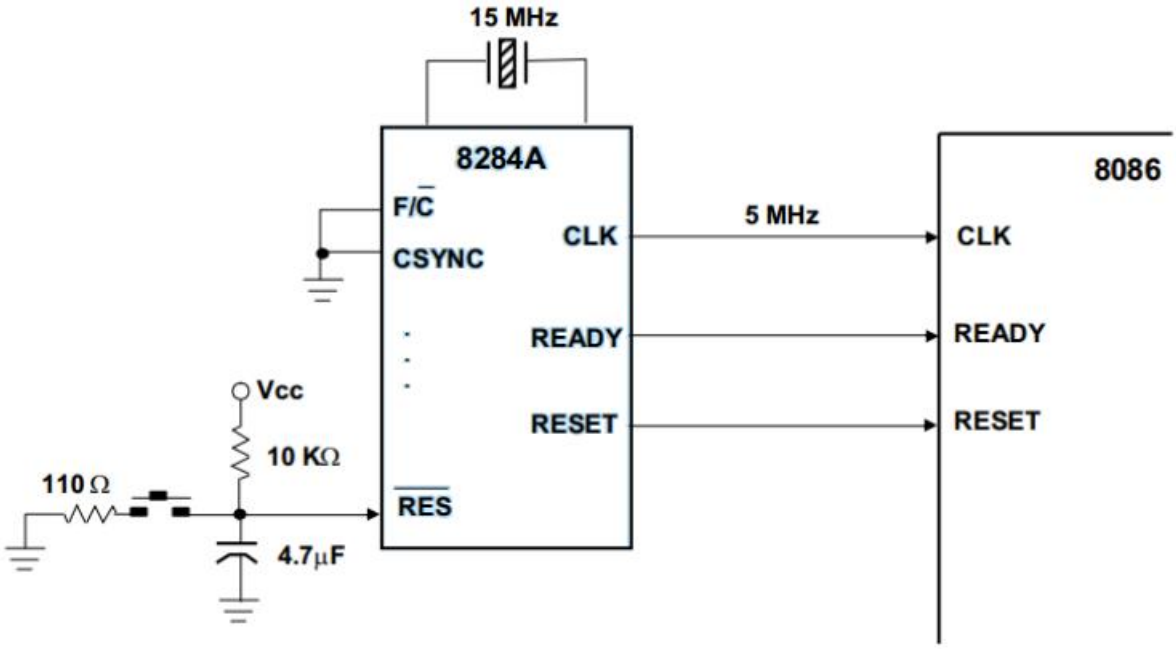






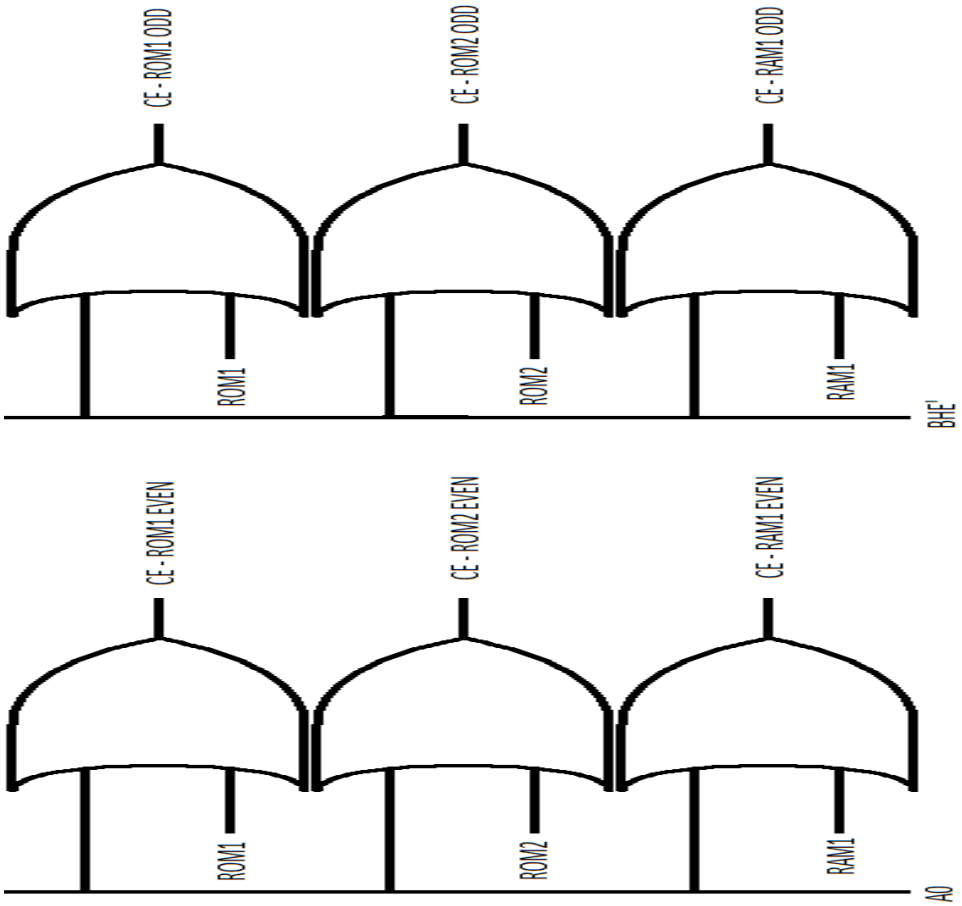


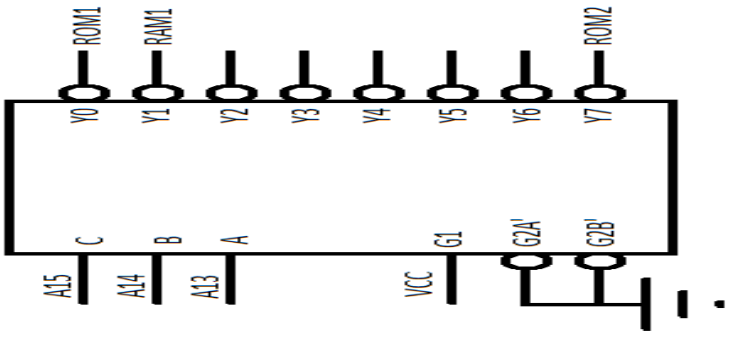
8086 Inputs

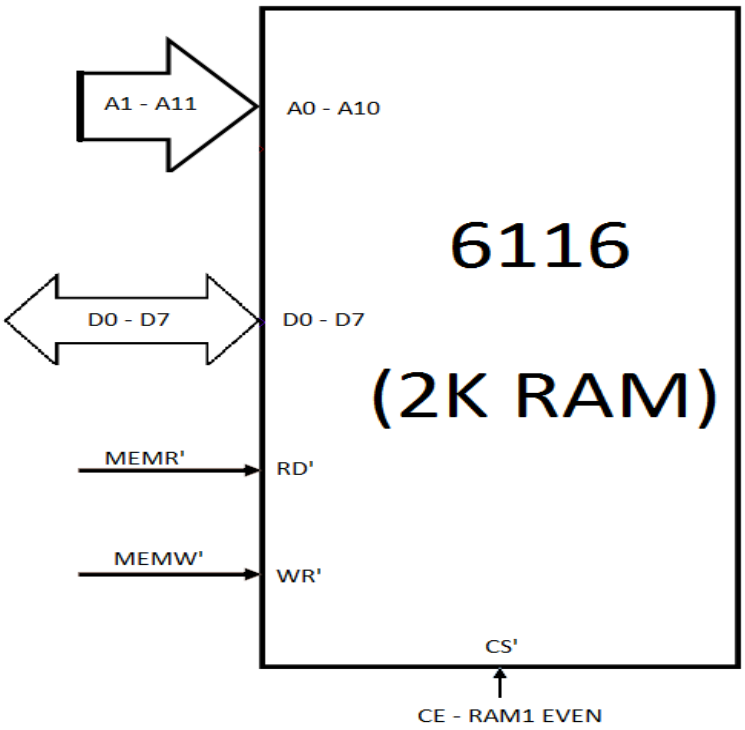


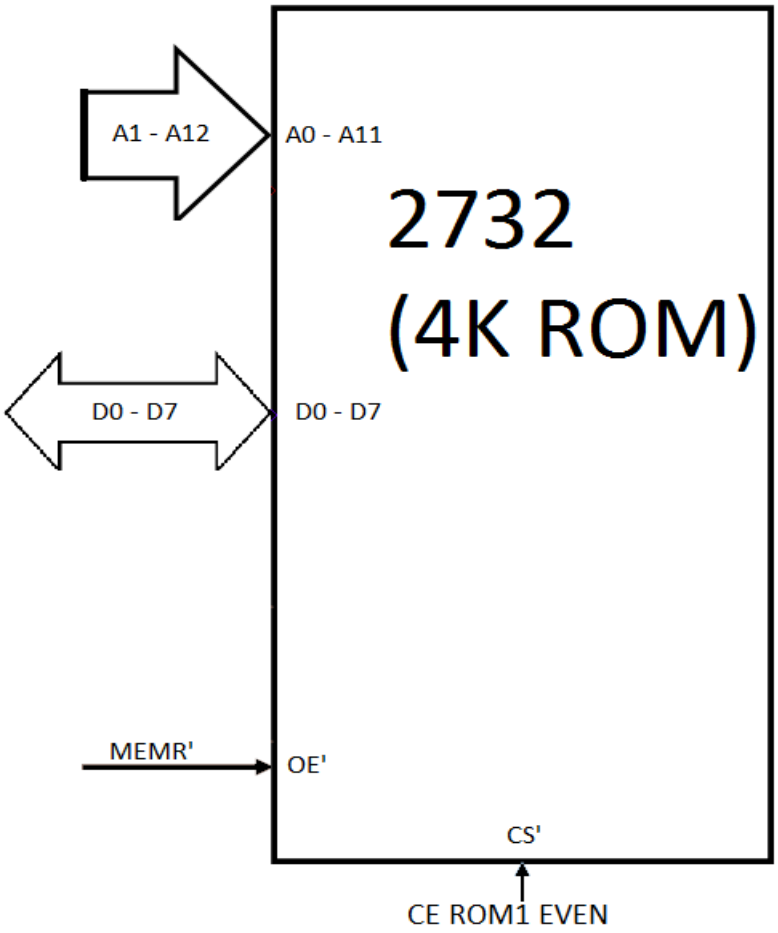
Clock Generator (8284)

Memory Interfacing:

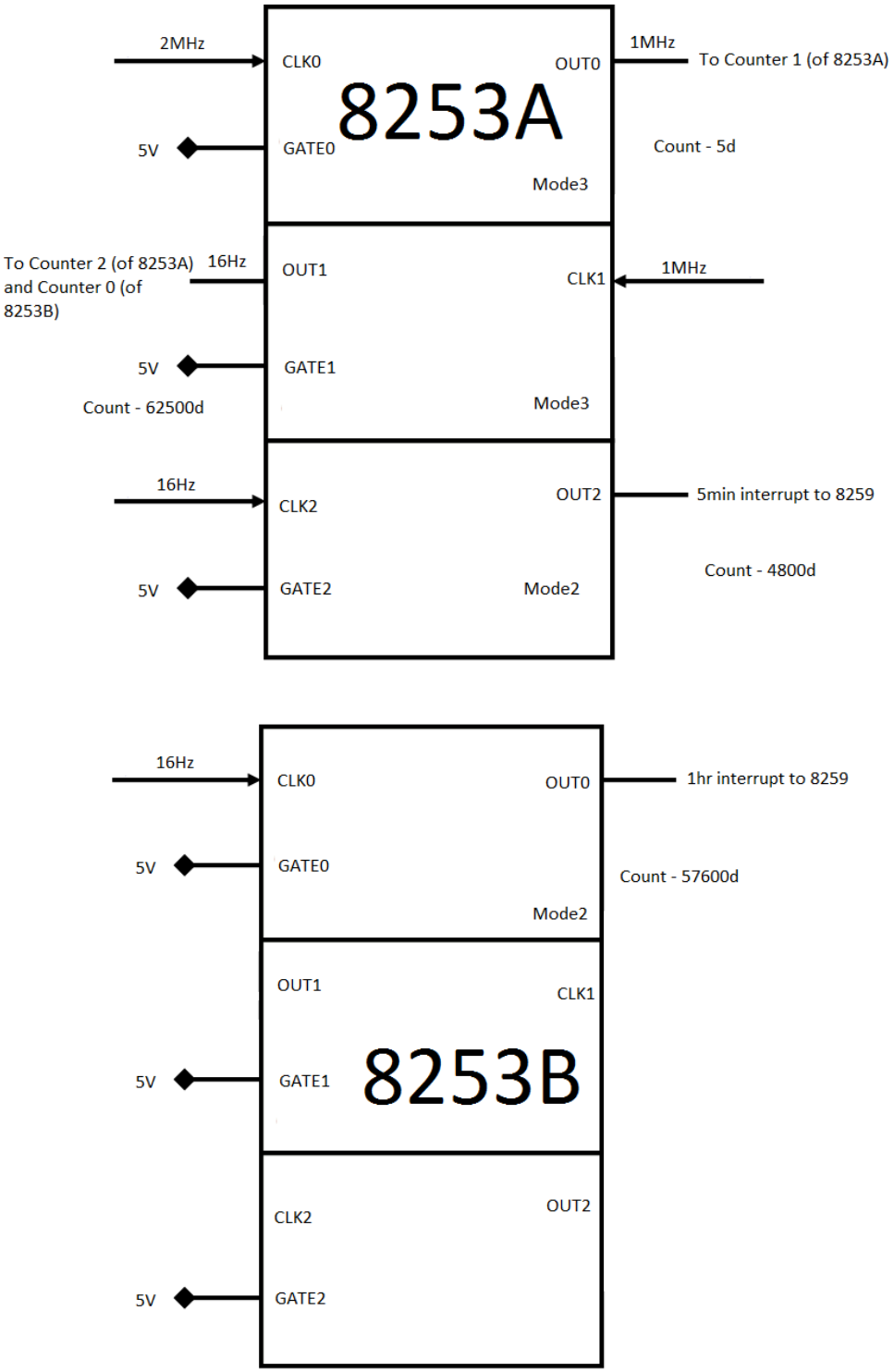




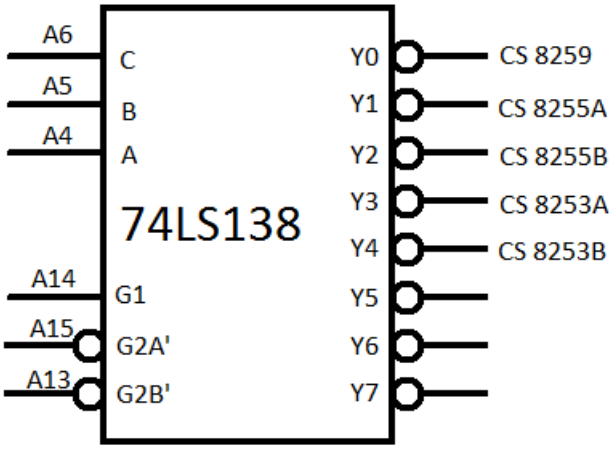

A1 - A11
A0 - A10
6116
D0 - D7
D0 - D7
(2K RAM)
MEMR'
RD'
MEMW'
WR'
CS'
CE - RAM1 EVEN


A1 - A12
A0 - A11
2732
(4K ROM)
D0 - D7
D0 - D7
MEMR'
OE'
CS'
CE ROM1 EVEN

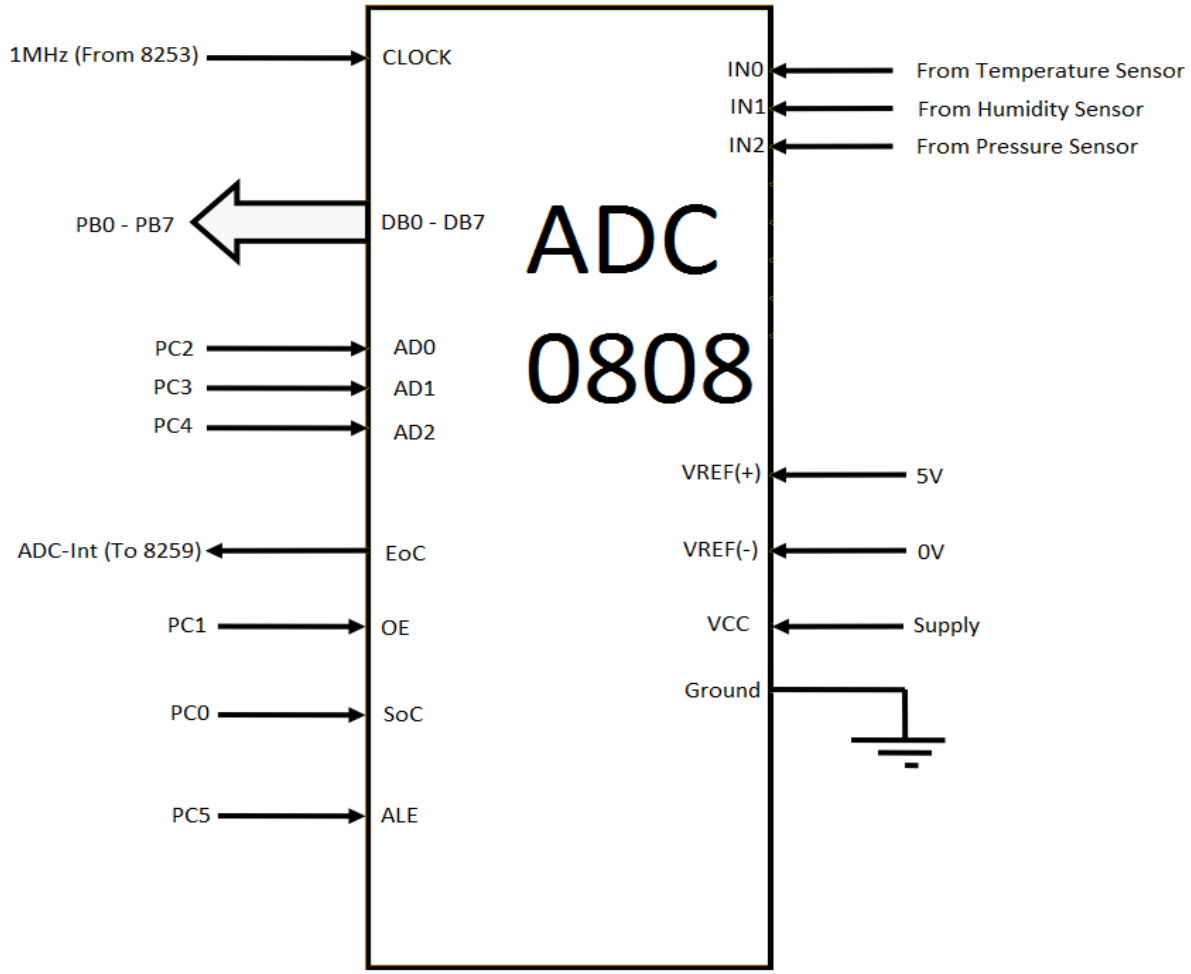
8253-Timer:


2MHz
CLK0
OUT0
1MHz
To Counter 1 (of 8253A)
8253A
5V
GATE0
Count - 5d
Mode3
To Counter 2 (of 8253A) and Counter 0 (of 8253B)
16Hz
OUT1
CLK1
1MHz
5V
GATE1
Count - 62500d
Mode3
16Hz
CLK2
OUT2
5min interrupt to 8259
Count - 4800d
5V
GATE2
Mode2
16Hz
CLK0
OUT0
1hr interrupt to 8259
5V
GATE0
Count - 57600d
Mode2
OUT1
CLK1
5V
GATE1
8253B
CLK2
OUT2
5V
GATE2

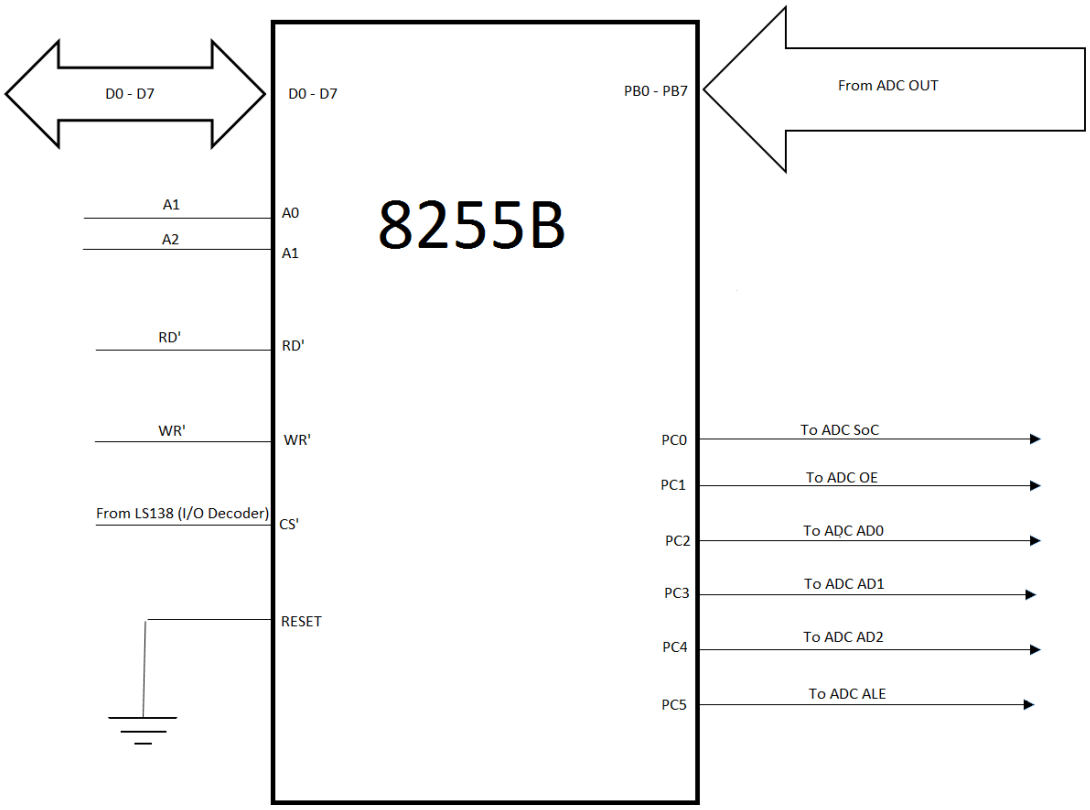
IO-decoder



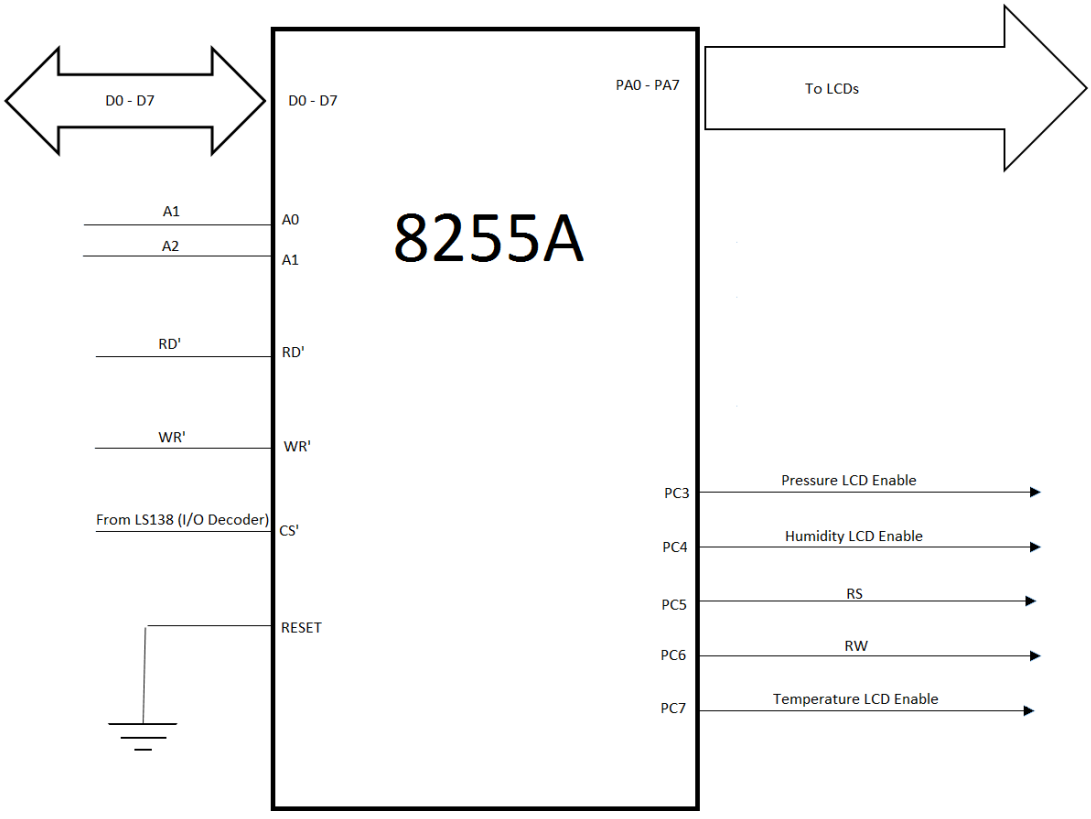
ADC:



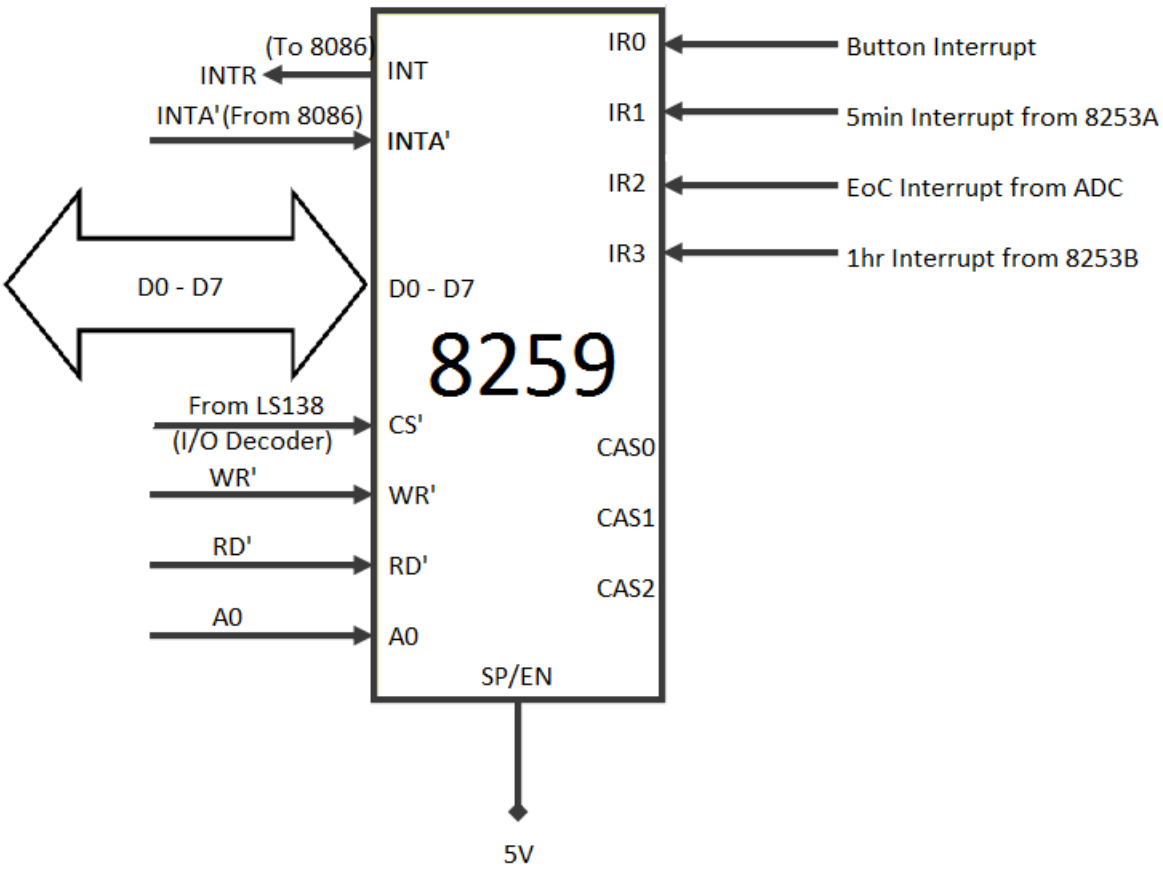
8255-B: (For the ADC)



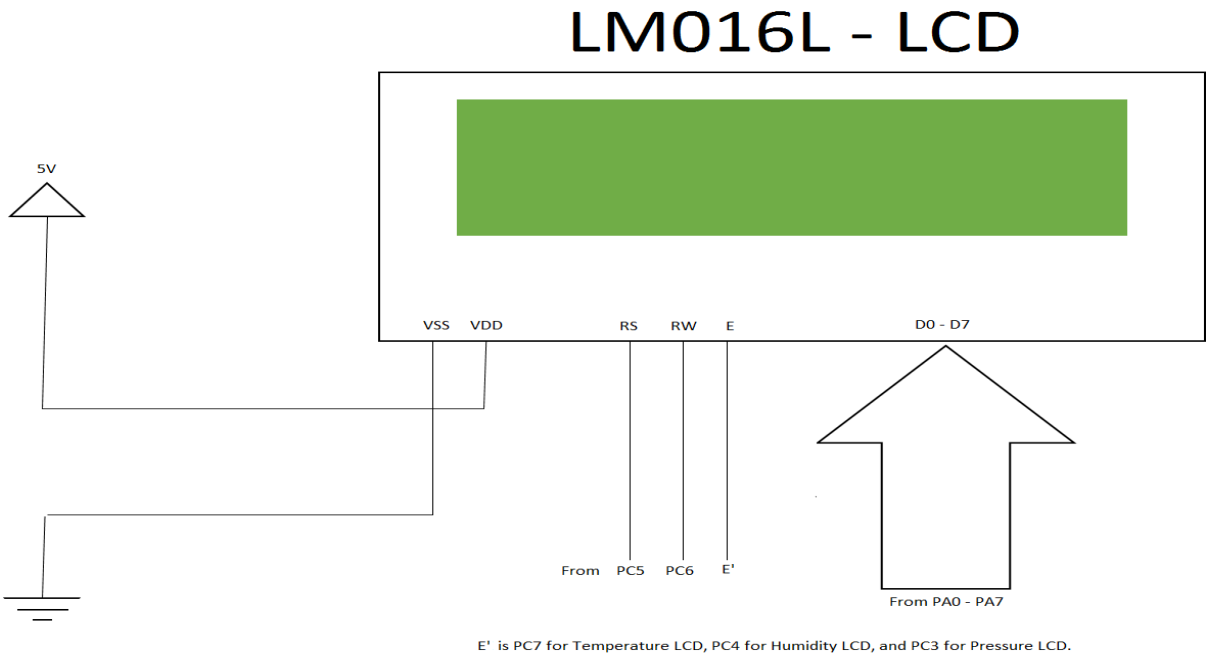
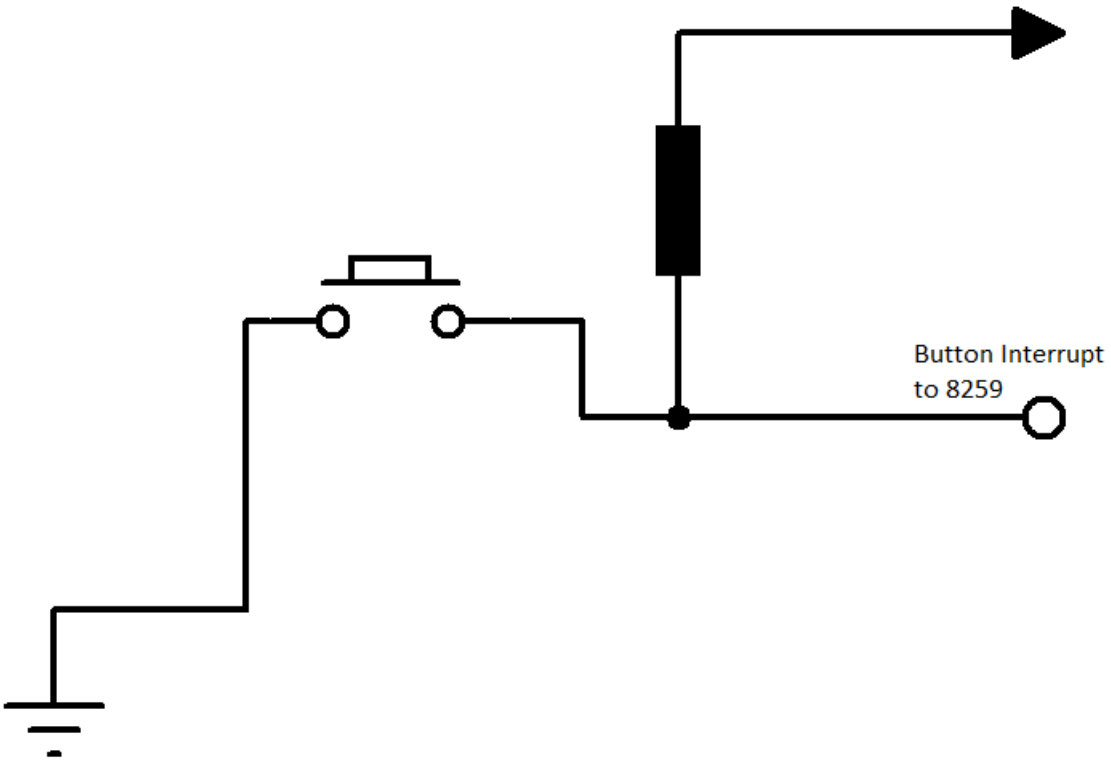
8255-A: (For display)



8259:



Display:



Button