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DESIGN AND TESTING OF PIC MICROCONTROLLER BASED DIGITAL BAROMETER

[1] Radhika Rani L, [2] C.Aruna

[1] Assistant Professorr, [2] Assistant Professor

[1] Computer Science and Internet of Things [2] Department of Electronics

[1] Loyola Academy, Hyderabad, India, [2] Aurora Degree and PG College, Hyderabad, India

Abstract: A digital Barometer is a scientific instrument that is used to measure air pressure in a certain environment and it is a very important instrument in automotive industry, engine control and weather station applications. In the present work Pic microcontroller based digital Barometer Meter was developed. The hardware implementation of this system contains Pic 18f46k22 microcontroller, LCD screen and MPX4115A pressure sensor. The Digital Barometer measures pressure and displaying on LCD screen. The system provides easy implementation, economical and precise measurement of Pressure.

Index Terms **- PIC Microcontroller, MPX4115A pressure sensor, LCD Screen**

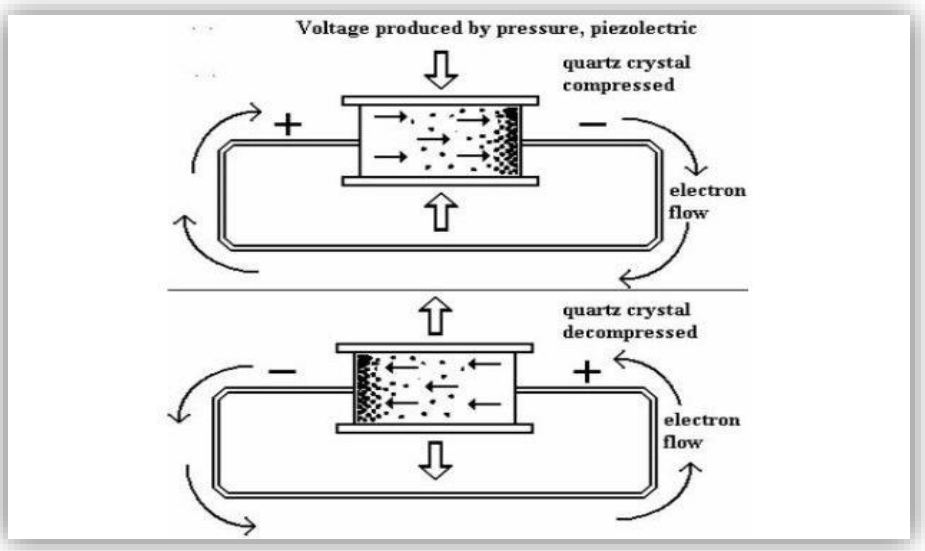
I. INTRODUCTION

A barometer is a scientific instrument which measures atmospheric pressure. Pressure is defined as the amount of force applied to a unit area, P=F/A. The unit of pressure is Pascal. The SI unit for pressure is the pascal (N/m2).There are different pressure sensors available based on measurement conditions, ranges and materials used in the construction of sensor. Often input pressure is converted to some intermediate form such as displacement then this displacement is converted into output voltage or current. The three most commonly used pressure transducers are bridge (Strain gauge), variable capacitance and piezoelectric type. In the present research paper piezoelectric type sensor is used.

Working Principle

On the theory of the piezoelectric effect, a piezoelectric transducer is based. According to the theory behind the piezoelectric effect, quartz crystal surfaces produce electrical charges when mechanical stress or forces are applied. The operating mode of a piezoelectric sensor is depicted in Figure 1.

Fig1: Working principle of Piezo electric sensor



2. Literature Survey:

Measurement of pressure can be calculated by using non- electrical methods or electrical methods.

1. Non Electrical Methods
   - Liquid column method – In this type of device pressure to be measured is balanced against the pressure exerted by a column of liquid.
   - Manometer-Instruments that employ the liquid column approach include manometers. The concept of balancing a liquid column by either another liquid column or the same column is the basis of this device.
   - Using elastic elements - Elastic element pressure measuring devices deform the elastic material being utilised in a proportional manner to the applied pressure.
   - Diaphragm type-There are two types of diaphragm elements one of which uses elastic characteristics and the second one is of spring type. One or more diaphragm capsules were joined in the first type. For pressure containment in the second kind, a flexible diaphragm is used. A spring that controls the diaphragm's deflection for a specific pressure opposes the movement of the diaphragm.
   - Bourdon pressure gauge-:This pressure sensor makes it very simple to create a digital barometer. The formula below illustrates how the sensor's output voltage and input pressure relate to one another.

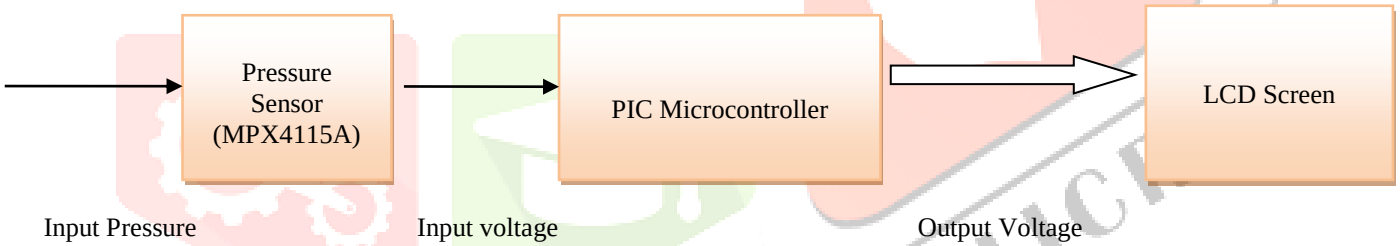
2. Electric methods
   - Strain gauge pressure transducer-A strain gauge is a device in which there will be change in its resistance when mechanical stress is applied. To convert the changes in its resistance to voltage strain gauge is connected as one of the arms of Wheatstone bridge so that changes in resistance can be measured
   - Piezoelectric pressure transducer-Piezoelectric transducer is based on piezoelectric effect. Some materials like crystals generate an electric potential in when mechanical stress is applied.

The main disadvantage of these discussed methods is there are analog type and not useful for remote sensing.

3. Methodology of the Study

Fig 2 depicts the block diagram of PIC microcontroller based Digital Barometer. The Main blocks are Pressure sensor, PIC Microcontroller, LCD Screen. The input is applied to Pressure sensor and the Pressure value is displaying on the LCD Screen

Fig 2: Block Diagram of PIC microcontroller based Digital Barometer

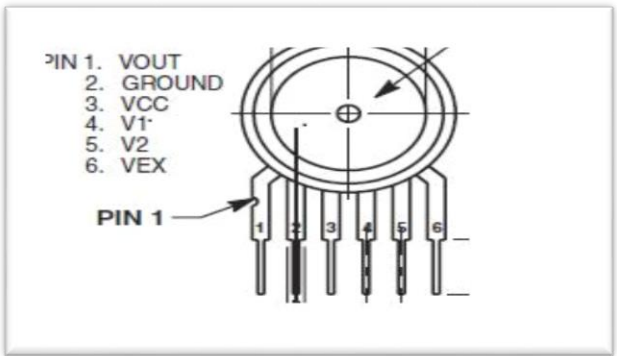


4. Hardware Design

Pressure sensor (MPX4115A):

MPX4115A is an IC pressure sensor. It comprises of piezo resistive transducer. The pressure is converted into dc voltage via this transducer. It can calculate pressure in the range of 15 kPa to 115 kPa. This sensor's output voltage ranges from 0.2 volts to 4.8 volts. This sensor is appropriate for digital, embedded and Microcontroller based circuits. This sensor can used in industrial automation, engine control systems and whether station applications. Fig 3 shows the pin diagram of MPX4115A pressure sensor.

Fig 3: Pin diagram of MPX4115A pressure sensor

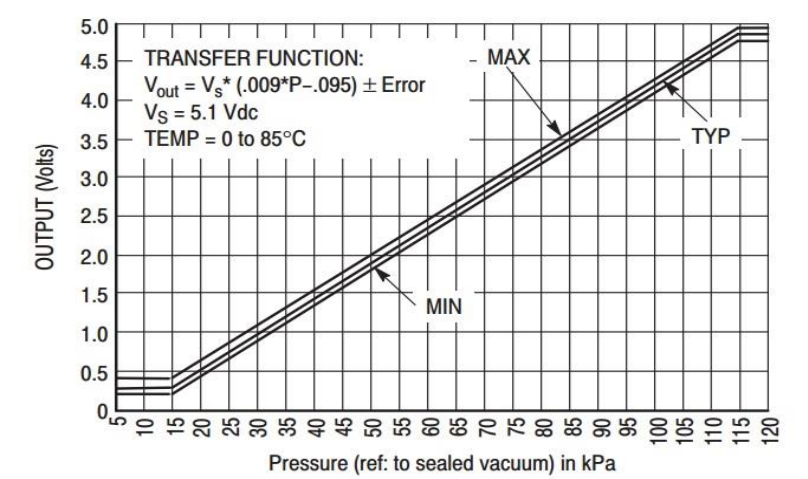


Graph 1 explains the relationship between output voltage and input pressure. According to this graph, the sensor monitors a minimum pressure of 15 KPa and a maximum pressure of 115 KPa; its output voltage is zero below 15 KPa and constant above 115 KPa. This pressure sensor makes it very simple to create a digital barometer. The formula below illustrates how the sensor's output voltage and input pressure relate to one another.

Vout = Vs x ((0.009 x P) – 0.095) ± Error

Graph1 shows the relationship between input pressure and output voltage. From this graph we can conclude that a linear relationship is existing between 15KPa to 115Kpa.

Graph1: Input pressure Vs output voltage



PIC Microcontroller PIC16F877A:

The PIC microcontroller PIC16f877 is from Microchip Technology it is one of most popular microcontrollers' in industry. It is an 8 bit Microcontroller. It comes in 44 pin DIP package. One of the main advantages is that it uses FLASH memory technology. It has 8channel 10bit ADC

Few important features are:

It has a smaller 35 instructions set.

It can operate up to 20MHz frequency.

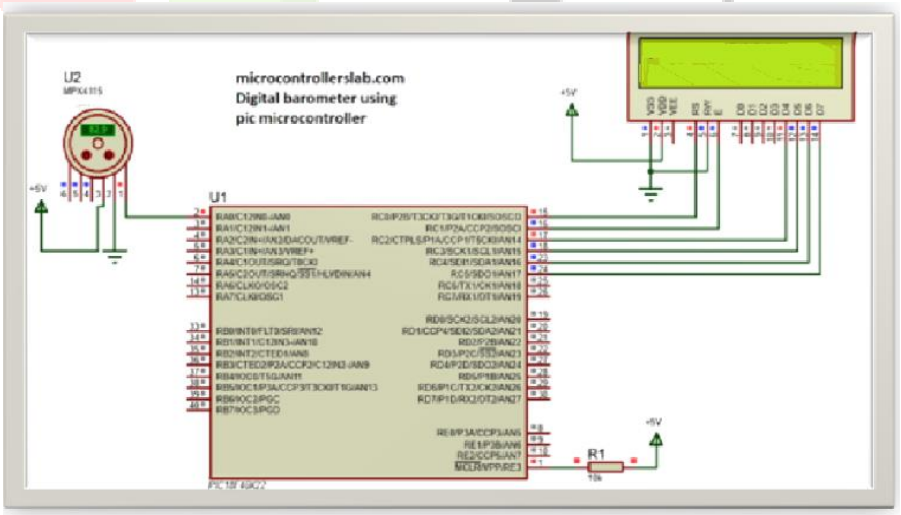
The operating voltage is between 4.2 volts to 5.5 volts.

LCD Screen:

LM016L has 14 pins displays output in 2 lines and 5X7 matrix. The data to be displayed must be sent digit by digit. Each digit to be displayed must be in ASCII format and a delay must be provided between each digit display.

The Hard ware circuit of Digital Barometer using PIC Microcontroller is shown in the above fig.4.The working of each bock is described below.

Fig4: Circuit diagram Digital Barometer using PIC Microcontroller

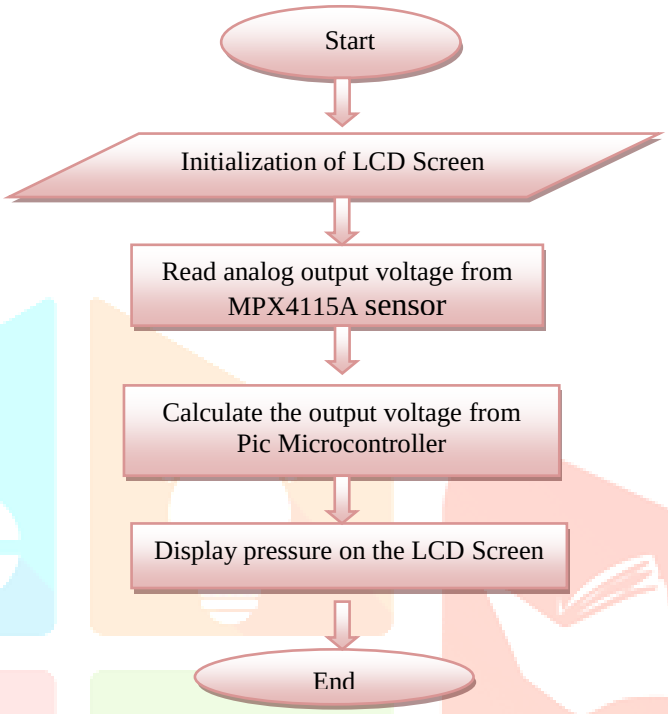


5. Software Implementation

MPX4115A pressure sensor interfacing with PIC microcontroller

In the present work digital Barometer was designed using MPX4115A pressure sensor along with **PIC** 18f46k22 microcontroller and LCD Screen. To calculate the pressure output pin of MPX4115A sensor should be connect analog input pin to **PIC** microcontroller. In the present work analog pin zero of **PIC** 18f46k22 with output pin of barometer sensor. **PIC** 18f46k22 microcontroller is connected to LCD display to measure the value of pressure. A 16X2 LCD is used to display the pressure. Port D of PIC Microcontroller is interfaced to LCD screen. The software code will read analog data, converts to digital form and converts each voltage to pressure and displays on LCD screen. Fig: 5 show the Flow chart for calculation of pressure in Proteous simulation software.

Fig5: Flow chart for calculation of pressure



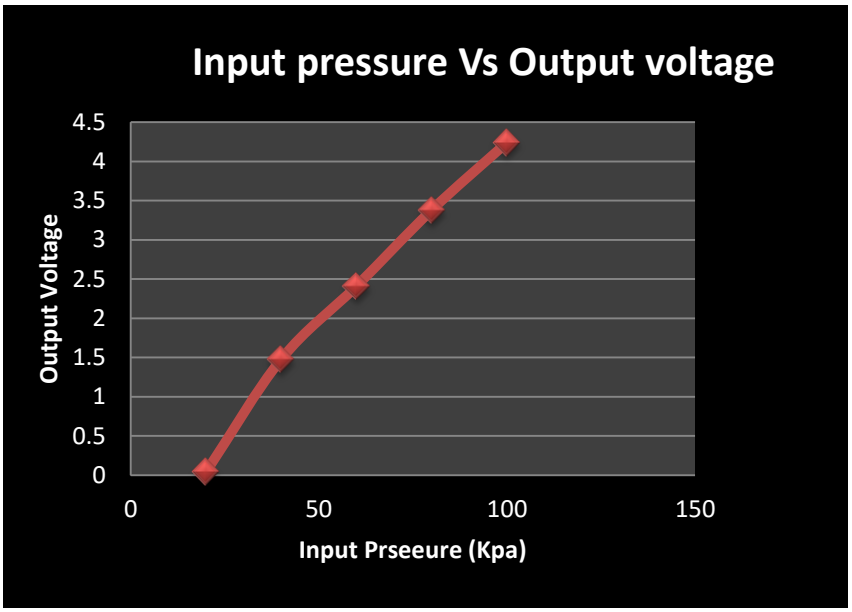
IV. RESULTS AND DISCUSSION

The table.1 shows the experimental results. Input pressure in the rage of 20kp to 100kp is applied and corresponding output of both pressure sensor and LCD Screen is shown in table below. The results are compared with the standard values and it is observed the there is an error of 1.5%. This shows that the device has good accuracy in the measuring pressure. The device is calibrated with standards inputs.

Table.1 experimental results of pressure

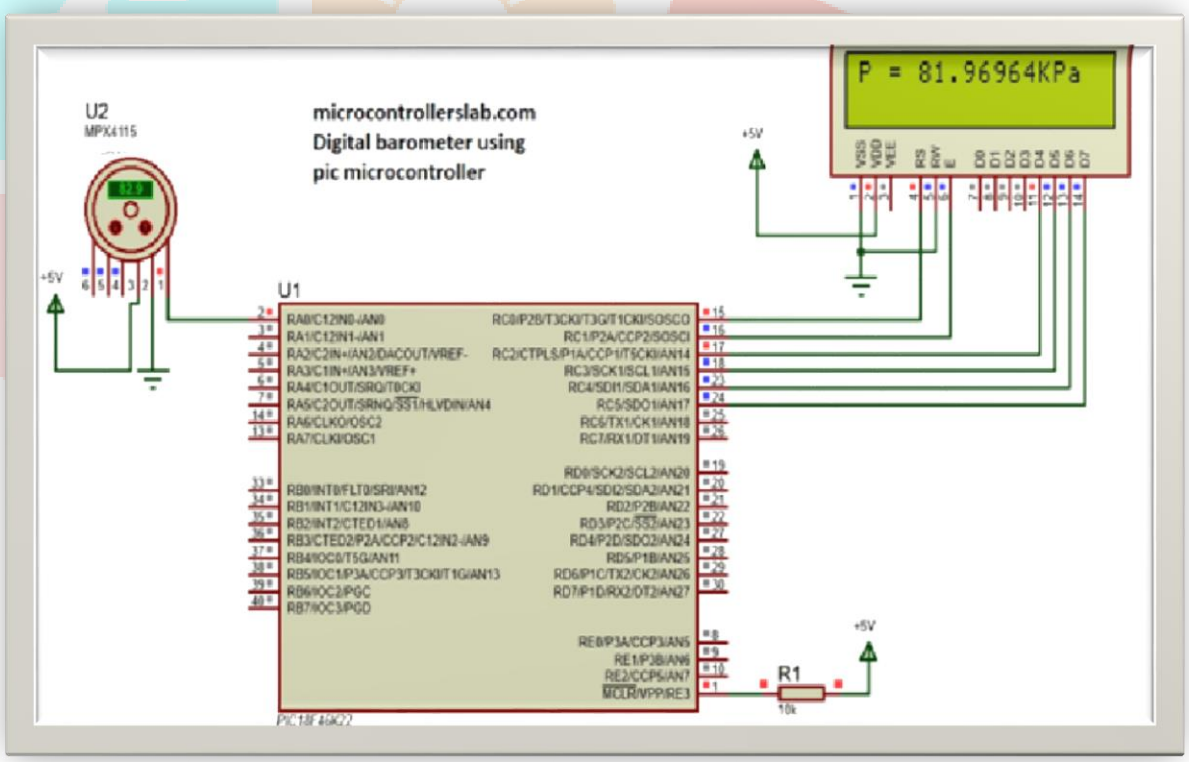
S. No	Input pressure (KPa)	Output Voltage of Pressure Sensor	Out pressure on LCD Screen (KPa)
1.	20	0.0425	19.55
2	40	1.48	41.15
3	60	2.41	60.73
4	80	3.38	81.96
5	100	4.24	100.52

Graph2: Input pressure Vs output voltage



The circuit diagram of digital barometer using PIC Microcontroller with Proteus software after simulation is shown in fig 5.

Fig: 5 PIC Microcontroller with Proteus software after simulation



The PIC Microcontroller based Digital barometer was successfully constructed and also tested using Proteus simulation software. When it was tested we found out that the system was able to detect the sense even a slight changes in pressure which shows the device has high sensitivity. It provides accuracy up to 1.5%and resolution of 0.001p. By proper programming the resolution can be increased up to 0.001p. The device is very economical and portable.

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