International Journal of Students Research in Technology & Management
Vol 2 (02), March-April 2014, ISSN 2321-2543, pg. 78-83

# Ambience Measurement

Veera Varun, Oviya

*Department of Electronics and Instrumentation*
*Kongu Engineering College, Perundurai, Erode, Tamil Nadu, India*

veeravarun@gmail.com

oviyaeie59@gmail.com

***Abstract*— Air pollution is posing a major threat to the environment. The amount of toxic gases present in air is increasing above the permissible level. This is mainly due to emissions from various industries and automobiles. So monitoring the level of various pollutants in air is necessary to maintain air pollution within the limit. The present method consists of separate equipments for monitoring different types of gases in air. This paper says about implementation with novel sensor system for the measurement of indoor air quality for carbon monoxide, carbon dioxide, temperature and relative humidity in a single integrated circuit. It consists of four sensors for measuring carbon monoxide, carbon dioxide, temperature and relative humidity. The outputs from four sensors are given to PIC microcontroller. It performs analog to digital conversion and displays the level of values in Liquid Crystal Display. Thus the level of toxic gases, temperature and relative humidity is measured with minimum deviation using simple circuits and low cost sensors. The implementation of this system in hazardous gas emitting area is a major scope in future. Further studies can be carried over and better efficiency and accuracy can be produced.**

***Keywords*— Toxic gases, PIC microcontroller, Sensor system, Simple circuits, Low cost sensors**

## I. INTRODUCTION

In the last several years, a growing body of scientific evidence has indicated that the air within homes and other buildings can be more seriously polluted than the outdoor air in even the largest and most industrialized cities. Indoor pollution sources that 655 gases or particles into the air are the primary cause of indoor air quality problems in homes. Inadequate ventilation can increase indoor pollutant levels by limiting emission dilution. High temperature and humidity levels can also increase concentrations of some pollutants. There are many sources of indoor air pollution in any home. These include combustion sources, building materials and furnishings, asbestos-containing insulation, wet or damp carpet, outdoor sources such as radon, pesticides, and outdoor air pollution. So the need for measuring the indoor air parameters is indispensable in controlling the indoor pollution. This project aims at measuring the various pollutants such as carbon dioxide, carbon monoxide and the common indicators of pollution (temperature and humidity).

## II. HARDWARE DESCRIPTION OF AIR QUALITYMEASUREMENT

The GPS Modem will continuously give the signal The general block diagram of the process is shown in the Fig. 1. The analog signals from the sensors are given to the PIC microcontroller where the analog signal is converted into digital and the output is displayed using LCD.

*Temperature Sensor (DS 1820)*

A temperature sensor is a device that measures temperature or temperature gradient. It is a three terminal device which gives an electrical output equivalent to the measured temperature.

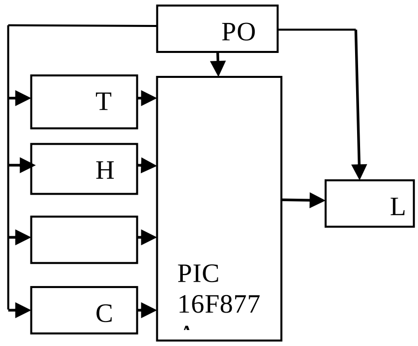



Fig. 1 Block diagram of ambience measurement

*Humidity Sensor (SY HS 220)*

A humidity sensor is a device that measures the relative humidity in a given area. It can be used in both indoors and outdoors. Humidity sensors are available in both analog and digital forms.

*Carbon Dioxide Sensor (MG 811)*

The MG811 is a gas sensor that detects the presence of carbon dioxide concentration in the environment. The sensor is easy to use and can be easily incorporated in a small portable unit.

*Carbon Monoxide Sensor (MQ 7)*

The MQ 7 sensor is a type of gas sensor suitable for sensing carbon monoxide concentrations in the air. This sensor can detect CO-gas concentrations from 20 to 2000ppm.

*PIC Microcontroller (PIC 16F877A)*

A controller is a small computer on a single Integrated Circuit containing a processor core, memory and programmable input/output peripherals. One of the most useful features of a PIC microcontroller is re-programming using flash memory. With the larger devices it is possible to drive LCDs or seven segment displays with very few control lines.

*Liquid Crystal Display*

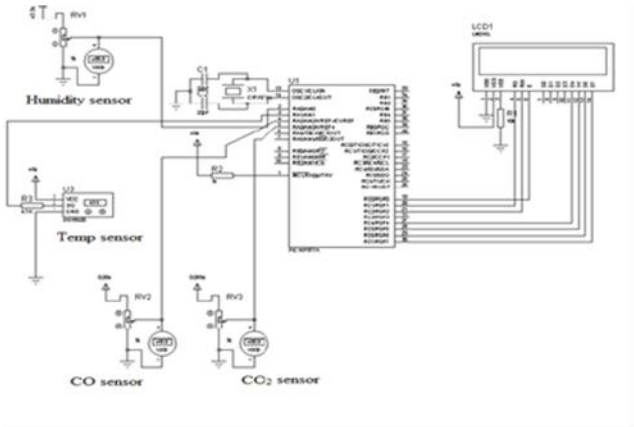
An LCD is a thin flat electronic visual display which emits light indirectly by using the modulating properties of liquid crystals. There are eight data pins (D0-D7) which will be used to display the calculated values from the controller. Also there will be three control pins to control the operations of the LCD. It also contains provision for adjusting the contrast of the LCD.

*Power Supply*

A power supply is a device that supplies electrical energy to one or more electric loads. A regulated power supply is the one that regulates the output voltage to a specific value. The controlled value is held nearly constant despite variations in either load current or voltage supplied by the power energy source. The power supply consists of a bridge rectifier and a filter capacitor.

*Circuit Diagram of Air Quality Measurement*

The circuit diagram of the project is illustrated in the Fig. 2.




## III. TECHNICAL DESCRIPTION OF AIR QUALITY MEASUREMENT

The system implementation requires temperature sensor, humidity sensor, carbon monoxide sensor, carbon dioxide sensor, PIC controller, liquid crystal display. The Fig. 3 illustrates the prototype of the hardware implementation.

### A. *Temperature Sensor (DS 1820)*

The DS18S20 digital thermometer provides 9-bit Celsius temperature measurements and has an alarm function with non-volatile user-programmable upper and lower trigger points. The DS18S20 communicates over a 1-Wire bus that by definition requires only one data line (and ground) for communication with a central microprocessor. It has an operating temperature range of –55°C to +125°C and is accurate to ±0.5°C over the range of –10°C to +85°C. In addition, the DS18S20 can derive power directly from the data line ("parasite power"), eliminating the need for an external power supply (Fig. 4).

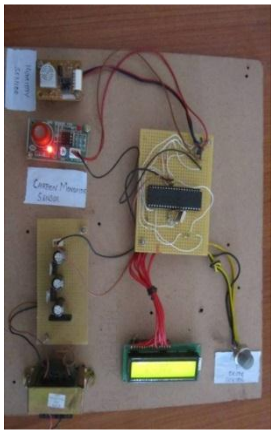


Fig. 3 Prototype of the project

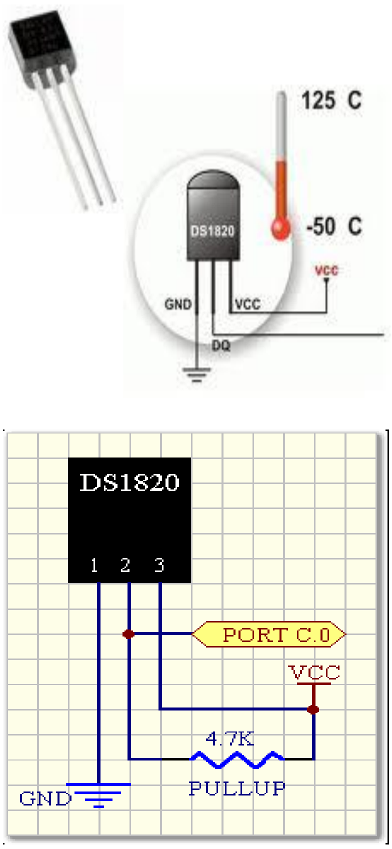



Fig. 4 Pin diagram of DS1820

*1) Pin Description of Temperature Sensor:* Pin 1 is the ground pin. Pin 2 is the data pin where the data is sent to the transmitter and the pin 3 is used as supply pin.

*2) Operation of the Sensor:* The core functionality of the DS18S20 is its direct-to-digital temperature sensor. The temperature sensor output has 9-bit resolution, which corresponds to 0.5°C steps. The DS18S20 powers-up in a low-power idle state, to initiate a temperature measurement and A-to-D conversion, the master must issue a convert T [44h] command. Following the conversion, the resulting thermal data is stored in the 2-byte temperature register in the scratchpad memory and the DS18S20 returns to its idle state. If the DS18S20 is powered by an external supply, the master can issue "read-time slots" after the Convert T command and the DS18S20 will respond by transmitting 0 while the temperature conversion is in progress and 1 when the conversion is done. If the DS18S20 is powered with parasite power, this notification technique cannot be used since the bus must be pulled high by a strong pull-up during the entire temperature conversion. DS18S20 output data is calibrated in degrees centigrade. The temperature data is stored as a 16-bit sign-extended two's complement number in the temperature register. The sign bits (S) indicate if the temperature is positive or negative: for positive numbers S = 0 and for negative numbers S = 1 (Fig. 5).

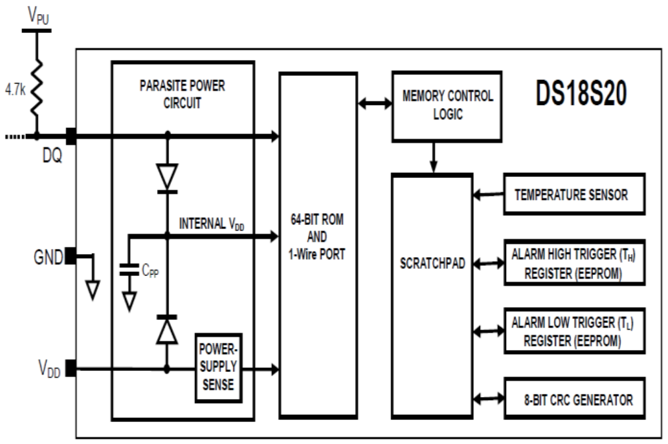



Fig. 5 Block diagram of DS1820

Resolutions greater than 9 bits can be calculated using the data from the temperature, COUNT REMAIN and COUNT PER °C registers in the scratchpad. COUNT PER °C register is hard-wired to 16 (10h). After reading the scratchpad, the TEMP_READ value is obtained by truncating the 0.5°C bit (bit 0) from the temperature data. The extended resolution temperature can then be calculated using the following equation,

Temperature = temp_read-0.25+
count_per_c_count_remain/count_per_c

### *B. Humidity Sensor (SY HS 220)*

Humidity sensors measure the amount of water vapour in the atmosphere. Absolute humidity is the percentage of water vapour per volume of air. The dew point is the temperature at which water vapour condenses into liquid, given the current air pressure and humidity. The oldest type of instrument used a chilled mirror to measure when condensation occurred. Relative humidity compares the moisture content in the air with the saturated moisture at the same temperature and pressure (Fig. 6).

Fig. 6 Humidity sensor (SY HS 220)

*1) Working of Humidity Sensor:* An analog humidity sensor gauges the humidity of the air relatively using a capacitor-based system. The sensor is made out of a film usually made of either glass or ceramics. The insulator material which absorbs the water is made out of a polymer which takes in and releases water based on the relative humidity of the given area. This changes the level of charge in the capacitor of the on board electrical circuit.

*2) Specifications of SY HS 220:* It works with the rated DC voltage 5V. It operates in the temperature range of 0-60oC. It works in the condition where relative humidity should be 30%-90%. It delivers an output voltage of 33mv for a rise of one percentage of relative humidity. At ambient room conditions it has an accuracy of about 0-5%.

*3) Characteristics of SY HS 220:* The characteristics of the sensor are determined from the Fig. 7.

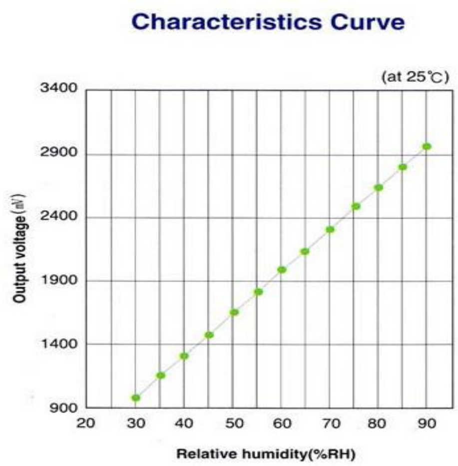



Fig. 7 Characteristics curve of SY HS 220

*B. Carbon Monoxide Sensor (MQ 7)*

The MQ-7 can detect CO-gas concentrations anywhere from 20 to 2000ppm. This sensor has a high sensitivity and fast response time. The sensor's output is an analog resistance. This sensor comes in a package similar to our MQ-3 alcohol sensor, and can be used with the breakout board. The sensor can operate at temperatures from -10 to 50°C and consumes less than 150 mA at 5 V. The pictorial representation of MQ 7 is shown in the Fig. 8.

Fig. 8 Carbon monoxide sensor (MQ 7)

*1) Operation Principle of the Sensor:* The surface resistance of the sensor Rs is obtained through effected voltage signal output of the load resistance RL which series-wound. The relationship between them is described in the following equation

Rs\RL = (Vc-VRL) / VRL

*2) Standard Test Circuit of MQ 7:* The standard measuring circuit of MQ 7 sensitive components consists of two parts. One is the heating circuit having the time control function (the high voltage and low voltage work circularly). The second is the signal output circuit, which can accurately respond to the changes in the surface resistance of the sensor. Sensitive layer of MQ-7 gas sensitive components is made of SnO2 with stability. So, it has an excellent long term stability. Its service life can reach 5 years under using condition.

The Fig. 9 shows the basic testing circuit of the sensor.

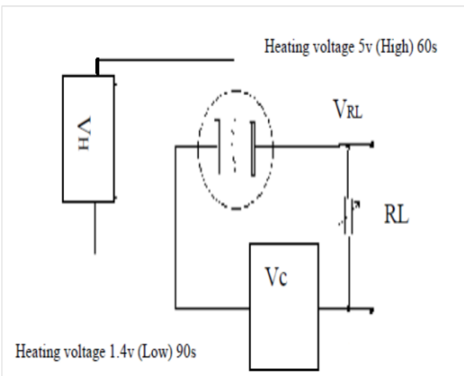



Fig. 9 Basic test circuit of MQ 7

*3) Connection of the Sensor:* Connecting five volts across the heating (H) pins keeps the sensor hot enough to function correctly. Connecting five volts at supply pins causes the sensor to emit an analog voltage on the other pins. A resistive load between the output pins and ground sets the sensitivity of the detector. The resistive load should be calibrated for the particular application. They are used in gas detecting equipment for carbon monoxide (CO) in industry or car.

*D. Carbon Dioxide Sensor (MG 811)*

The measurement of carbon dioxide concentration in the air is done by using MG 811 gas sensor. It has good selectivity and sensitivity to $CO_2$. This sensor has long stability and reproducibility. The dependency on temperature and humidity is very low when compared to other gas sensors. The pictorial representation of MG 811 is shown in the Fig. 10.

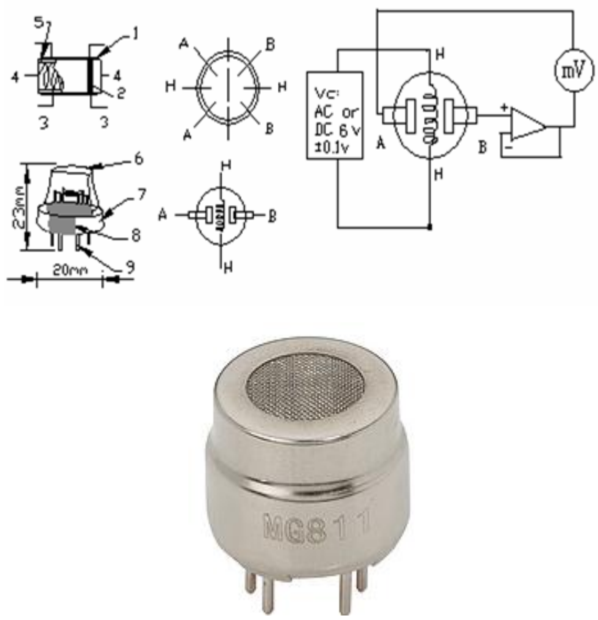



Fig. 10 Carbon dioxide sensor (MG 811)

*1) Testing Circuit of MG 811:* The standard test circuit is shown in the Fig. 11.

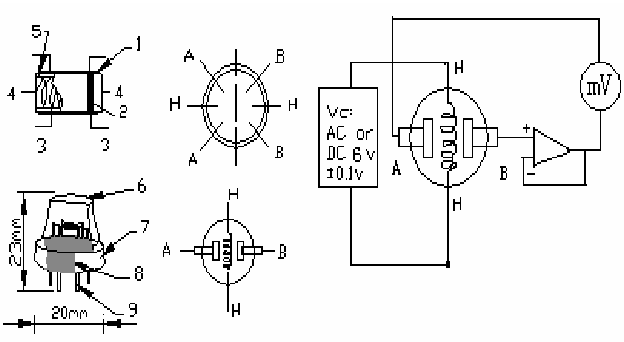



Fig. 11 Test circuit of MG 811

The test circuit contains heater coils, supply coils and a buffer circuit. It is composed by solid electrolyte layer(1), Gold electrodes(2), Platinum Lead(3), Heater(4), Porcelain Tube(5),100m double-layer steel less net(6),Nickel and copper plated ring(7),Bakelite (8),Nickel and copper plated pin.

*2) Working Principle Of MG 811:* Sensor adopts solid electrolyte cell principle. It is composed by the following solid cells.

Air, Au |NASICON|| carbonate |Au, air, $CO_2$

When the sensor exposed to $CO_2$, the following electrodes reaction occurs:

Cathodic reaction: $2Li + CO_2 + 1/2O_2 + 2e^- \rightarrow Li_2CO_3$

Anodic reaction: 2Na+ + 1/2O2 + 2e- → Na2O

Overall chemical reaction : Li2CO3 + 2Na → Na2O + 2Li + CO.

The Electromotive force（EMF） result from the above electrode reaction, accord with according to Nernst's equation:

EMF = Ec - (R x T) / (2F) ln (P(CO2))

$P(CO_2)$—$CO_2$--- partial Pressure Ec—Constant Volume R—Gas Constant volume

T—Absolute Temperature （K）F—Faraday constant

*3) PIC Microcontroller:* PIC16F877A is an 8-bit microcontroller based on Reduced Instruction Set Computer (RISC) architecture. It has 8k * 14-bits flash program memory, 368 bytes of SRAM, 256 bytes of EEPROM and Self-reprogrammable under software control. One of the main advantages is that each pin is only shared between two or three functions so it's easier to decide what the pin function.

## IV. LCD INTERFACING

In LCD, Pin 1 and 2 are the power supply pins. Pin1 is connected to ground and pin2 is connected to +5V power supply. Pin 3 is the contrast adjusting pin. Pins 7 to 14 are the Data pins of the LCD. Pin 7 is the Least Significant Bit (LSB) and pin 14 is the Most Significant Bit (MSB). Pins 15 and 16 are respectively used for backlight adjustment. The 3 control pins used in LCD are: R/S, R/W and E. Depending on the status of Register Select pin, the data on the 8 data pins (D0-D7) is treated as either an instruction or as character data. The enable pin has a very simple function. It is just the clock input for the LCD. For all practical purposes, the R/W pin has to be permanently connected to GND.

The interfacing of LCD with PIC 16F877A is shown in the Fig. 12.

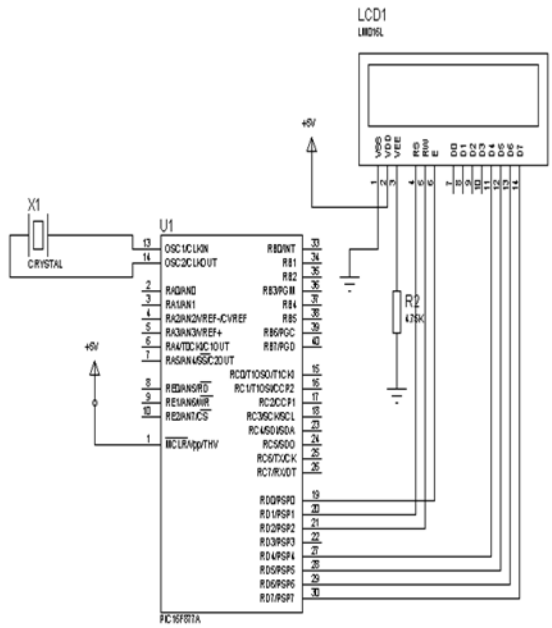



Fig. 12 LCD Interfacing Circuit

*1) Power Supply:* The 230 V AC supply is converted to required DC supply using the power supply circuit shown in the Fig. 13. The first step is to step down the input voltage by using a step down transformer. Immediately after the transformer a bridge rectifier circuit is used to convert the alternating current into unidirectional pulsating current. Then the output of the bridge rectifier circuit is given to the filter where the ripples are filtered to get DC output voltage. In the regulation unit an IC7812 is used to get the regulated positive 12V supply. Then this is regulated to positive 5V supply using IC7805.This is required for sensors, microcontroller and LCD circuitry.

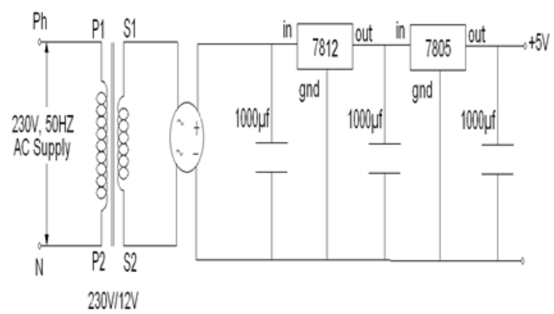



Fig. 13 Power Supply Circuit

## V. CONCLUSION

Ambient air quality monitoring carried out at various cities/towns in the country under National Air Monitoring Programme (NAMP) provide air quality data that form the basis for identification of areas with high air pollution levels and in planning the strategies and development of action plans for control and abatement of air pollution.

A simple technique to measure the concentration of CO, $CO_2$, relative humidity and temperature in a surrounding air has been made available in this project. In this model the difficulty of measuring the composition of CO and $CO_2$ is eliminated. It is eliminated by integrating a single circuit. The constituents are measured and displayed continuously so that the deviation above the permissible level can be detected instantaneously. The system is simple and cheap so that it can be installed in every place. The implementation of this project in hazardous gas emitting area is a major scope in future. Further studies can be carried over and better efficiency and accuracy can be produced.

## VI. FUTURE SCOPE

The proposed project can be developed and used to record data using data logging system. It can also be developed into a portable, integrated quality meter.

## REFERENCES

[1] John B. Peatman, *Design with PIC Microcontrollers*, Pearson Education, 6th Edition, 2003.
[2] Jack Ganssle, *Art of Programming Embedded Systems*, San Diego: Academic Press, 1992.
[3] Raj Kamal, *Embedded Systems*, McGraw-Hill Education, 2nd Edition, 2010.
[4] D. Patranbis, *Sensors and Transducers*, published by Ashok k Ghosh, PHL Learning Private Ltd., 2009.
[5] Daniel D. Gajski, Frank Vahid, Sanjiv Narayan, *Specification and Design of Embedded Systems*, PTR Prentice Hall, 1994.
[6] Marianah Masrie, Anuar Ahmed and Ramli Adnan, A novel integrated sensor system for indoor air quality measurement, *5th International Colloquium on Signal Processing & Its Applications (CSPA)*, 2009.
[7] http://sites.google.com/site/projectsof8051/datasheets/Humidity-Sensor-SY- HS-220.pdf?attredirects=0.
[8] http://www.idph.state.il.us/envhealth/factsheets/indoorairqualityguide_fs.html.