# PORTABLE VETERINARY HEALTH MONITORING SYSTEM

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**Abstract**
**An animal health monitoring system for monitoring the physiological parameters, such as body temperature, and heart rate with surrounding temperature and humidity, has been developed. The developed system can also analyze the stress level corresponding to thermal humidity index. The Zigbee device and PIC16F877A microcontroller are used in the implementation of sensor module. The device is very helpful for inexpensive health care of livestock. A prototype model is developed and tested with high accuracy results.**
**Keywords: Temperature, Humidity, Zigbee and Controller**

## I. INTRODUCTION

Animal welfare is an issue of great importance in modern food production system because of consumer concerns for food safety, Food quality and the ethics of animal production. These concerns have resulted in higher public and legal demand for improved welfare standards for farmed animals. In adequate levels of animal welfare can significantly, affect the animals' growth, reproduction and survival rate, which in turn may compromise the quality and Safety of the produced food(Nardoneetal.,2004).Improving farmed animals' welfare positively affects animal pathology and disease resistance.

## II. THE SENSORS USED

### A. Humidity Sensor

Humidity is the presence of water in air. The amount of water vapor in air can affect human comfort as well as many manufacturing processes in industries. The presence of water vapor also influences various physical, chemical, and biological processes. Humidity measurement in industries is critical because it may affect the business cost of the product and the health and safety of the personnel. Hence, **humidity sensing** is very important, especially in the control systems for industrial processes and human comfort.

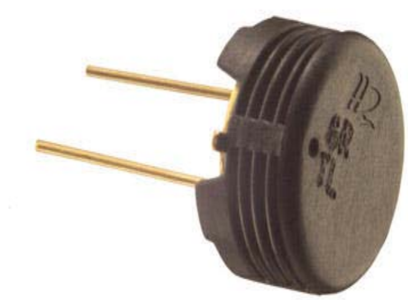


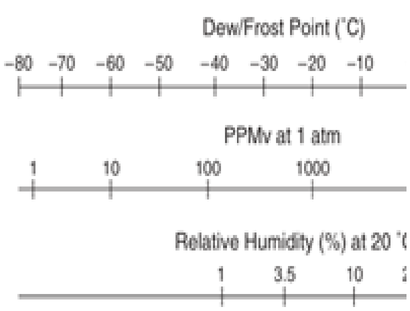
**Figure 1: Humidity Sensor**

Controlling or monitoring humidity is of paramount importance in many industrial & domestic applications. In semiconductor industry, humidity or moisture levels needs to be properly controlled & monitored during wafer processing. In medical applications, humidity control is required for respiratory equipments, sterilizers, incubators, pharmaceutical processing, and biological products. Humidity control is also necessary in chemical gas purification, dryers, ovens, film desiccation, paper and textile production, and food processing. In agriculture, measurement of humidity is important for plantation protection (dew prevention), soil moisture monitoring, etc. For domestic applications, humidity control is required for living environment in buildings, cooking control for microwave ovens, etc. In all such applications and many others, **humidity sensors** are employed to provide an indication of the moisture levels in the environment. [1-11]

## III. RELEVANT MOISTURE TERMS

To mention moisture levels, variety of terminologies are used. The study of water vapor concentration in air as a function of temperature and pressure falls under the area of psychometrics. Psychometrics deals with the thermodynamic properties of moist gases while the term "humidity' simply refers to the presence of water vapor in air or other carrier gas. Humidity measurement determines the amount of water vapor present in a gas that can be a mixture, such as air, or a pure gas, such as nitrogen or argon. Most commonly used units for humidity measurement are Relative Humidity (RH), Dew/Frost point (D/F PT) and Parts Per Million (PPM). RH is a function of temperature, and thus it is a relative measurement. Dew/Frost point is a function of the pressure of the gas but is independent of temperature and is therefore defined as absolute humidity measurement. PPM is also an absolute measurement [12-19].

Correlation among RH, Dew/Frost point and $PPM_V$ is shown below:




Various terms used to indicate moisture levels are tabulated in the table below:

| S.No | Term | Definition | Unit |
|---|---|---|---|
| 1 | Absolute Humidity (Vapor Concentration) | Ratio of mass (vapour) to volume. | grams/ $m^3$ |
| 2 | Mixing Ratio OR Mass Ratio | Ratio of mass (vapour) to mass(dry gas) | grams/ $m^3$ |
| 3 | Relative Humidity | Ratio of mass (vapour) to mass (saturated vapour) OR ratio of actual vapor pressure to saturation vapor pressure. | % |
| 4 | Specific Humidity | Ratio of mass (vapour) to total mass. | % |
| 5 | Dew Point | Temperature (above 0°C) at which the water vapor in a gas condenses to liquid water) | °C |
| 6 | Frost Point | Temperature (below 0°C) at which the water vapor in a gas condenses to ice | |
| 7 | Volume Ratio | Ratio of partial pressure (vapour) to partial pressure (dry gas) | % by volume |
| 8 | PPM by Volume | Ratio of volume (vapour) X $10^6$ to volume (dry gas) | $PPM_V$ |
| 9 | PPM by Weight | $PPM_V$ X | $PPM_W$ |

Dew points and frost points are often used when the dryness of the gas is important. Dew point is also used as an indicator of water vapor in high temperature processes, such as industrial drying. Mixing ratios, volume percent, and specific humidity are usually used when water vapor is either an impurity or a defined component of a process gas mixture used in manufacturing.

## IV. HUMIDITY SENSING – CLASSIFICATION & PRINCIPLES

According to the measurement units, humidity sensors are divided into two types: Relative humidity (RH) sensors and absolute humidity (moisture) sensors. Most humidity sensors are relative humidity sensors and use different sensing principles.

### Sensing Principle

Humidity measurement can be done using dry and wet bulb hygrometers, dew point hygrometers, and electronic hygrometers. There has been a surge in the demand of electronic hygrometers, often called humidity sensors [20-26]. Electronic type hygrometers or humidity sensors can be broadly divided into two categories: one employs capacitive sensing principle, while other use resistive effects

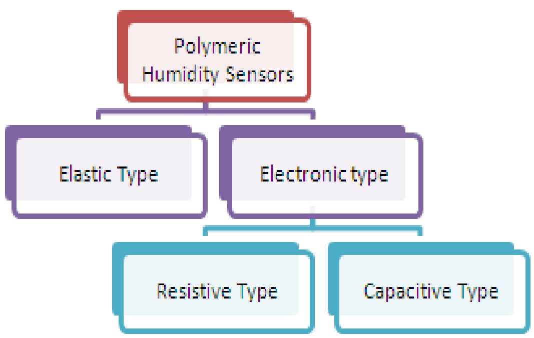



**Figure 2: Types of humidity sensors**

### Sensors based on capacitive effect

Humidity sensors relying on this principle consists of a hygroscopic dielectric material sandwiched between a pair of electrodes forming a small capacitor. Most capacitive sensors use a plastic or polymer as the dielectric material, with a typical dielectric constant ranging from 2 to 15. In absence of moisture, the dielectric constant of the hygroscopic dielectric material and the sensor geometry determine the value of capacitance.

At normal room temperature, the dielectric constant of water vapor has a value of about 80, a value much larger than the constant of the sensor dielectric material. Therefore, absorption of water vapor by the sensor results in an increase in sensor capacitance.

At equilibrium conditions, the amount of moisture present in a hygroscopic material depends on both the ambient temperature and the ambient water vapor pressure. This is true also for the hygroscopic dielectric material used on the sensor.

By definition, relative humidity is a function of both the ambient temperature and water vapor pressure. Therefore there is a relationship between relative humidity, the amount of moisture present in the sensor, and sensor capacitance. This relationship governs the operation of a capacitive humidity instrument.

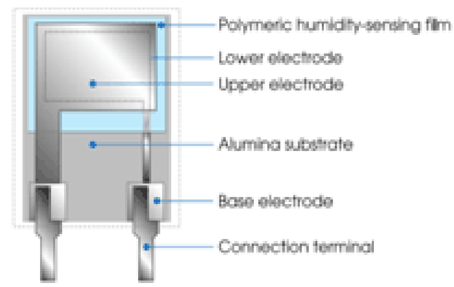



**Figure 3: Basic structure of capacitive type humidity sensor**

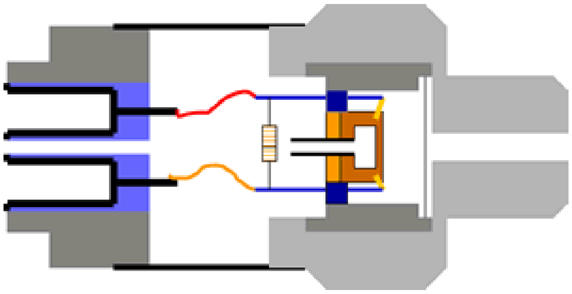
### Pressure sensor

A pressure sensor is a device which senses pressure and converts it into an analog electric signal whose magnitude depends upon the pressure applied. Since they convert pressure into an electrical signal, they are also termed as pressure transducers.

### Pressure Sensors Explained

Typically, a pressure sensor is used to measure the pressure of fluids (gases or liquids). Pressure is an expression of the force required to stop a fluid from expanding, and is usually stated in terms of force per unit area. A pressure sensor generates an electrical signal relating to the pressure imposed. Such a signal is normally digital or analogue, although optical, visual and auditory signals are also common.

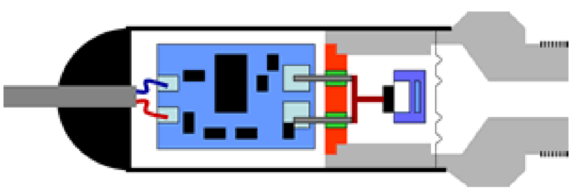
Industrial pressure sensors also referred to as pressure transducers, pressure transmitters, pressure indicators and pressure switches, normally have a diaphragm type design that uses strain gauges, which are either bonded to, or diffused into it, with the strain gauges acting as resistive elements. Under the pressure-induced strain, the resistive values change. In capacitive technology, the pressure diaphragm is a single plate of a capacitor that changes its value under pressure-induced displacement.



The Basic Pressure Sensor Design

Pressure sensing using diaphragm technology measures the difference in pressure of the two sides of the diaphragm. Depending on the relevant pressure, the terms ‘Absolute’ is used when the reference is vacuum; ‘Gauge’ is used where the reference is atmospheric pressure; and ‘Differential’ is used where the sensor has two ports for the measurement of two different pressures.

Pressure sensors are used in a wide variety of applications for control and monitoring purposes. Pressure sensors can also be used to indirectly measure other variables such as fluid flow, speed, water level and altitude.



The Pressure Transmitter Design

Pressure sensors vary considerably in their design, technology used, performance, application and cost. World-wide, there are hundreds of different technologies used in pressure sensor designs and thousands of different suppliers of pressure sensors.

Certain types of pressure sensor are designed to measure dynamically and are able to capture very high speed changes in pressure. Example applications here are in the measurement of combustion pressures in engine cylinders or gas turbines. These sensors are normally manufactured using piezoelectric materials such as quartz.

Some pressure sensors operate using a binary method. In this design, when pressure is applied to a pressure sensor, the sensor completes or breaks an electrical circuit. These types of sensors are also referred to as pressure switches.

Pressure sensors can be classified in terms of the pressure range they are measuring, operating temperature range, or the type of pressure they are measuring. In terms of pressure types, pressure sensors can be divided into several main categories:

**Absolute Pressure Sensors**: An absolute pressure sensor measures the pressure relative to perfect vacuum pressure (0 PSI or no pressure). Atmospheric pressure is 101.325 kPa (14.7 PSI) at sea level with reference to vacuum.

**Gauge Pressure Sensors:** A gauge pressure sensor is used in different applications because it can be calibrated to measure the pressure relative to a given atmospheric pressure at a given location. A tyre pressure gauge is an example of gauge pressure indication.

**Vacuum Pressure Sensors**: A vacuum pressure sensor is used to measure pressure less than the atmospheric pressure at a given location. Differential Pressure Sensors: A differential pressure sensor or transmitter measures the difference between two or more pressures introduced as inputs to the sensing unit. For example, measuring the pressure drop across an oil filter. Differential pressure is also used to measure flow or level in pressurized vessels.

**Sealed Pressure Sensors:** A sealed pressure sensor is similar to the gauge pressure sensor, except that it has already been calibrated by the manufacturer to measure pressure relative to sea level pressure.

**Need for Pressure Sensors**

Since a long time, pressure sensors have been widely used in fields like automobile, manufacturing, aviation, bio medical measurements, air conditioning, hydraulic measurements etc. A few prominent areas where the use of pressure sensors is inevitable are:

1. **Touch Screen Devices**: The computer devices and smart phones that have touch screen displays come with pressure sensors. Whenever slight pressure is applied on the touch screen through a finger or the stylus, the sensor determines where it has been applied and accordingly generates an electric signal that informs the processor. Usually, these sensors are located at the corners of the screen. So when the pressure is applied, usually two or more such sensors act to give precise location information of the location.

2. **Automotive Industry**: In automotive industry, pressure sensors form an integral part of the engine and its safety. In the engine, these sensors monitor the oil and coolant pressure and regulate the power that the engine should deliver to achieve suitable speeds whenever accelerator is pressed or the brakes are applied to the car.

For the purpose of safety, pressure sensors constitute an important part of anti-lock braking system (ABS). This system adapts to the road terrain and makes sure that in case of braking at high speeds, the tires don't lock and the vehicle doesn't skid. Pressure sensors in the ABS detail the processor with the conditions of the road as well as the speed with which the vehicle is moving. Air bag systems also use pressure sensors so that the bags get activated to ensure the safety of the passengers whenever high amount of pressure is experienced by the vehicle.

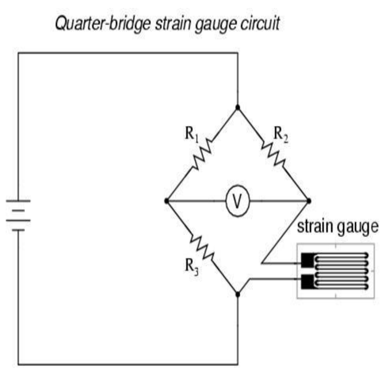



**Figure 4: Circuit Configuration**

*A. Heart beat sensor*

Heart beat sensor heart beat sensor is designed to give digital output of heat beat when a finger is placed on it. When the heart beat detector is working, the beat LED flashes in unison with each heart beat. This digital output can be connected to microcontroller directly to measure the Beats Per Minute (BPM) rate. It works on the principle of light modulation by blood flow through finger at each pulse.

**Features**

- ✓ Heat beat indication by LED
- ✓ Instant output digital signal for directly connecting to microcontroller
- ✓ Compact Size
- ✓ Working Voltage +5V DC

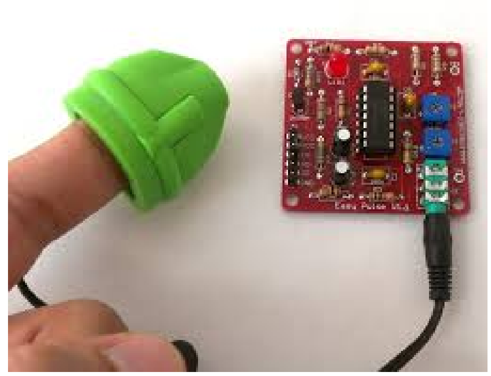


**Figure 5: PC connected heart beat sensor**

| S.NO | SPECIFICATION | VALUE |
|---|---|---|
| 1 | Operating voltage | +5V DC regulated |
| 2 | Operating Current | 100 mA |
| 3 | Output data level | 5V TTL level |
| 4 | Heart Beat detection Indicated by | LED and Output High pulse |
| 5 | Light source | 660 nm Super Red LED |

**Pin Details:**

| PIN | NAME | DETAILS |
|---|---|---|
| 1 | +5V | Supply positive input |
| 2 | OUT | Active High Input |
| 3 | GND | Power Supply Ground |

**USING THE SENSOR:**

- ✓ Connect regulated DC power supply of 5 Volts. Black wire is Ground, Next middle wire is Brown which is output and Red wire is positive supply. These wires are also marked on PCB.
- ✓ To test sensor you only need power the sensor by connect two wires +5V and GND. You can .leave the output wire as it is. When Beat LED is off the output is at 0V.
- ✓ ·Put finger on the marked position, and you can view the beat LED blinking on each heart beat.

## V. BLOCK DIAGRAM

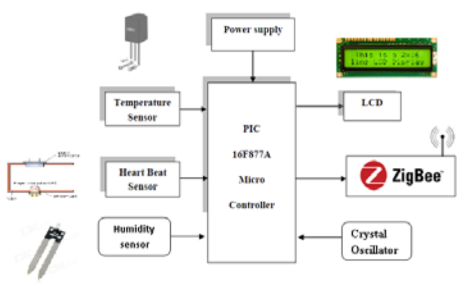



**Figure 6: Block diagram transmitter**

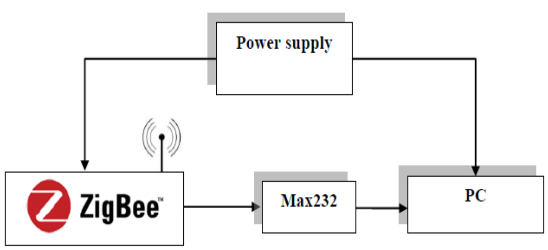



**Figure 7: Block diagram of Monitoring system**

## VI. CONTROLLER

In 40-pin and 44-pin packages. All devices in the PIC16F87XA family share common architecture with the following differences:

- The PIC16F873A and PIC16F874A have one-half of the total on-chip memory of the PIC16F876A And PIC16F877A
- The 28-pin devices have three I/O ports, while the 40/44-pin devices have five
- The 28-pin devices have fourteen interrupts, while The 40/44-pin devices have fifteen
- The 28-pin devices have five A/D input channels, While the 40/44-pin devices have eight
- The Parallel Slave Port is implemented only on The 40/44-pin devices
- The available features are summarized in Table 1-1. Block diagrams of the PIC16F873A/876A and PIC16F874A/877A devices are provided in Figure 1-1 and Figure 1-2, respectively. The pin outs for these device families are listed in Table 1-2 and Table 1-3. Additional information may be found in the PIC micro Mid-Range Reference Manual (DS33023), which may be obtained from your local Microchip Sales Representative or downloaded from the Microchip web site. The Reference Manual should be considered a complementary document to this data sheet and is highly recommended reading for a better understanding of the device architecture and operation of the peripheral modules.

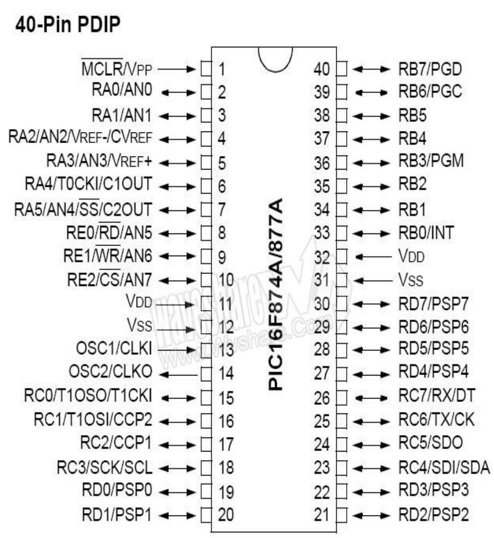



**Figure 8: Pin diagram for PIC16F877A**

***PORT A***

PORT A is a 6-bit wide, bidirectional port. The corresponding data direction register is TRISA. Setting a TRISA bit (= 1) will make the corresponding PORTA pin an input (i.e., put the corresponding output driver in a High-Impedance mode). Clearing a TRISA bit (= 0) will make the corresponding PORTA pin an output (i.e., put the contents of the output latch on the selected pin). Reading the PORTA register reads the status of the pins, whereas writing to it will write to the port latch. All write operations are read-modify-write operations. Therefore, a write to a port implies that the port pins are read, the value is modified and then written to the port data latch. Pin RA4 is multiplexed with the Timer0 module clock input to become the RA4/T0CKI pin. The RA4/T0CKI pin is a Schmitt Trigger input and an open-drain output. All other PORTA pins have TTL input levels and full CMOS output drivers. Other PORTA pins are multiplexed with analog inputs and the analog VREF input for both the A/D converters and the comparators. The operation of each pin is selected by clearing/setting the appropriate control bits in the ADCON1 and/or CMCON registers. The TRISA register controls the direction of the port pins even when they are being used as analog inputs. The user must ensure the bits in the TRISA register are maintained set when using them as analog inputs.

## VII. CONCLUSION

In this paper we have presented a prototype of a portable animal health monitoring system. The system consist of the sensor module and sink module. These modules were abundantly urbanize according to the IEEE1451.2, IEEE802.15.4 and IEEE 1451.1 standard. This Prototype system tested for the monitoring of physiological parameter such as body temperature, pressure, heart rate and humidity. We have used the low power electronic components to minimize the power consumption and the device can run continuously. The major cost of the developed system is comes from the use of Zigbee module.

## VIII.FUTURE WORK

The design of $I^2C$ master controller has immense applications in future as the number of devices connected to a system is only going to increase. So there is always a need for a system which supports multiple protocols. The drawback of designed $I^2C$ is that the bounded I/O utilization will be more when compared it with existing design. By dumping the Verilog code to FPGA to verify the code coverage and realize the exact hardware of the circuit. The verification of $I^2C$ bus using system Verilog based open verification methodology is to be performed. The Interfacing of several $I^2C$ components like ADC/DAC, RTC & EEPROM with SD (Secure Digital) host controller through $I^2C$ bus at a time and the performance to be evaluated.

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