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Embedded low Cost Solution of Remotely Sensing Humidity

Saima Shaikh[1]*, M. Shahid Shaikh[2], Pinial Khan Butt[1], Farah Naveen Issani[1] and Kehkahan Asma[2]

[1]Information Technology Centre, Sindh Agriculture University Tandojam, Pakistan;
Ss2kcs@gmail.com, pinial@sau.edu.pk, farahnaveenissani@gmail.com
[2]Department of Electronics, Mehran University of Engineering and Technology, Jamshoro, Pakistan;
m.shsahid.2k6@gmail.com, kehkashan@faculty.muet.edu.pk

Abstract

Objectives: To design a system capable of remotely measuring the Relative Humidity of the high voltage devices so that the risks involved with human physically interaction can be avoided, and the levels of humidity can be conveniently maintained at a remote location. **Methods/Statistical Analysis:** Variations in the humidity cause many major problems for human beings, electronic components, industrial machines etc. Hence to measure and maintain the humidity has become a non-trivial issue. However, in certain situations the manual methods of measuring humidity are not always convenient, in fact, hazardous. For instance, measuring and monitoring the humidity level of high voltage transformers can be very dangerous. The proposed system is the low cost and low complex implementation of embedded system and does not require Analog to Digital Conversion or vice versa to interface the Humidity sensing circuit with the microcontroller. The design provides the wireless transmission of the data, that makes easiness for the engineers (at industry) or for any other person (at home or any other place) to get humidity information of any remote and hazards locations. **Findings:** High power electrical devices such as transformers and transmission lines are severely affected by the humidity. Typically, the affordable levels of humidity are in the range of 45 to 65%. The rapid fluctuations in the levels of relative humidity can lead to a range of problems. The risks of physical damage, such as warping, cracking and splitting, chemical deterioration, and insect or mold attack are all increased when relative humidity is too high or too low. Also these fluctuations can damage collections that are experienced in many museums, galleries and libraries. Therefore, maintaining an appropriate level of humidity is imperative, as much as for hygienic reasons as well as for energy efficiency. **Application / Improvement:** The proposed design may find useful applications in Industries, agriculture fields, educational labs, Food storage places, Drying production industries, Blood banks, Coal mines, Sprinkler etc.

Keywords: Humidity sensor HS1101, Microcontroller, Relative Humidity, RF Transmitter

1. Introduction

Humidity is the quantity of water which vaporizes in the air. Humidity shows the probability of precipitation, dew, or fog. Humidity is usually calculated as Relative Humidity (RH). RH is a percentage that shows the amount of water vaporize in the air at a particular temperature matched to the maximum amount of water that is vaporize at the particular temperature is capable to hold without the water condensing. For example, the air at a set temperature comprises the entire vapor it can hold at that temperature, it takes a RH of 100 percent. If the humidity exceeds 100 percent, moisture will start to condense from the air. Variations in the humidity cause many major problems for human beings, electronic components, industrial machines etc. Hence to measure and maintain the humidity has become a non-trivial issue. However, in certain situations the manual methods of measuring humidity are not always convenient, in fact, hazardous.

**Author for correspondence*

For instance, measuring and monitoring the humidity level of high voltage transformers can be very dangerous. To solve this problem, we propose an embedded low cost solution of measuring humidity and wirelessly transmitting it to any remote location. The block diagram overall system is shown in Figure 1, and is controlled by the AT89C52 Microcontroller[1,2].

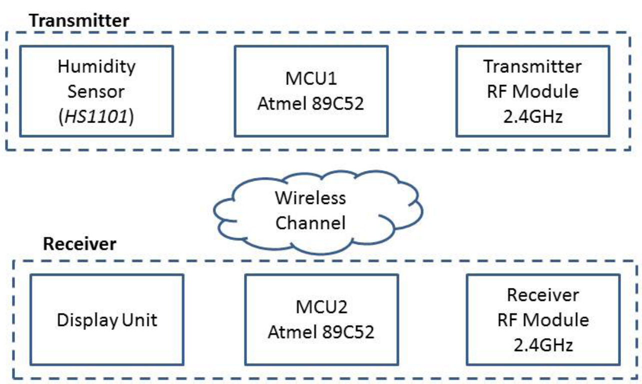

Figure 1. System block diagram.

2. System Design

In this section the overall system design is explained in detail.

2.1 Transmitter

The transmitting system consists of a capacitive humidity sensor HS1101[3], 555 timer and TRW 2.4G module[2] configured as transmitter. The whole system is controlled by AT89C52 Microcontroller. The humidity sensor is used as a variable capacitor whose capacitance value depends on the humidity in the air. The sensor is connected to the stable design of NE555 IC which provides a frequency output with 50% duty cycle. The output frequency of the NE555 IC varies in inverse proportion to the capacitance of sensor. As the humidity increases the sensor's capacitance also increases and the output frequency of 555 IC decreases as shown in Table 1. This frequency is measured by the microcontroller, after measuring the frequency of NE555 IC the microcontroller performs the programmed calculations and convert the frequency into the relative humidity value. Microcontroller drives the 16x2 Top way LMB162A LCD[4,5] which displays the current relative humidity. The data is then supplied to RF transmitter module which transmits it wirelessly to a remote location.

The HS1100/HS1101 humidity sensor, used as changeable capacitor, is connected to the pin 2 (TRG) Trigger and pin 6 Threshold (THR) of 555 IC. Pin 7 as a short circuit pin for resistor R_4 as shown in the Figure 2. The HS1100/HS1101 equivalent capacitor is charged through resistors R_2 and R_4 to the threshold voltage of approximately 0.67 Vcc and discharged through R_2 only to the trigger level of approximately 0.33 Vcc. The charge and discharge of the sensor run through resistors R_2 and R_4. The output frequency response of the humidity sensing circuits can be analyzed from the Figure 3. The output pin (pin#3) of LM555 is connected to the INT0 (pin# 12 or P3.2) of the microcontroller. Microcontroller measures the frequency that is generated by the LM555. After getting the current humidity values from sensing circuit, the data is then transferred to the ports of microcontroller that are initialized as the output ports. Port 2 of AT89C52 is configured as the output port and it is assigned to send the output data (RH value) from microcontroller to the Liquid Crystal Display (LCD). Two pins of Port 3 (P3.0 and P3.1) of the Micro Controller Unit (MCU) are connected to the control lines (RS and EN) of the LCD through which the control commands are exchanged between microcontroller and LCD. The readings of humidity sensors are then displayed on LCD.

TRW 2.4G is the RF transceiver[3] module which is used to transmit and receive the information. Its single module can be used as both transmitter as well as receiver. The humidity that was measured by the microcontroller from sensing circuitry is then sent to the transmitter module via the output port of microcontroller. TRW 2.4G modulates the data using Gaussian Frequency Shift Keying (GFSK) modulation technique in order to transmit it wirelessly to a remote location through a built-in antenna. It transmits the RF signal at the frequency range of 2.4 GHZ and at the data rate of 1Mbps[2]. TRW 2.4G contains 10 pins. Two

Table 1. 555 Timer frequency response table

RH (%)	0	10	20	30	40	50	60	70	80	90	100
Frequency (Hz)	7351	7224	7100	6976	6853	6728	6600	6468	6330	6186	6033

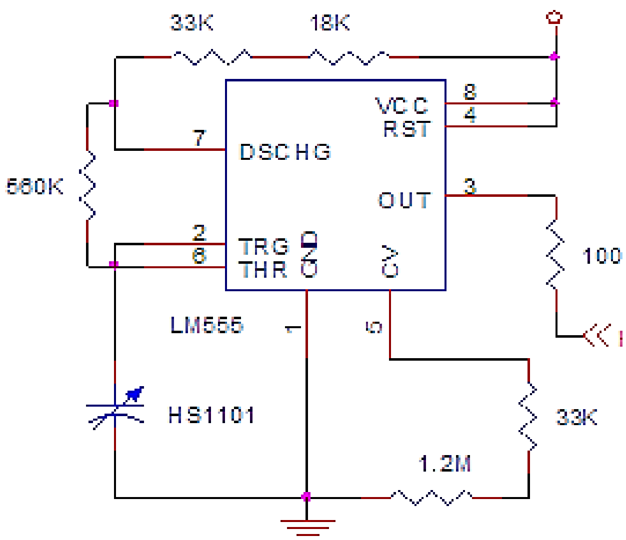

Figure 2. Driver circuit of HS1101 using LM555 IC.

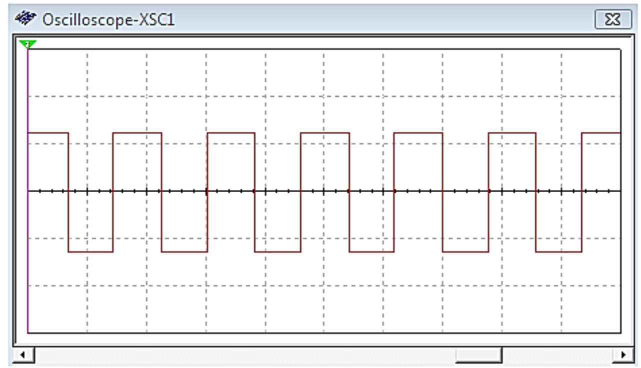

Figure 3. Output frequency response of humidity sensing circuit.

pins are used for Vcc and Ground purpose. If it is used as transmitter then only one clock pin will be used. CE and CS are the control lines. The working voltage of TRW 2.4G is just 3V so it can only be connected to the port 0 of microcontroller which provides the 3V by the help of pull up resistors. The overall design of the transmitter section is shown in Figure 4.

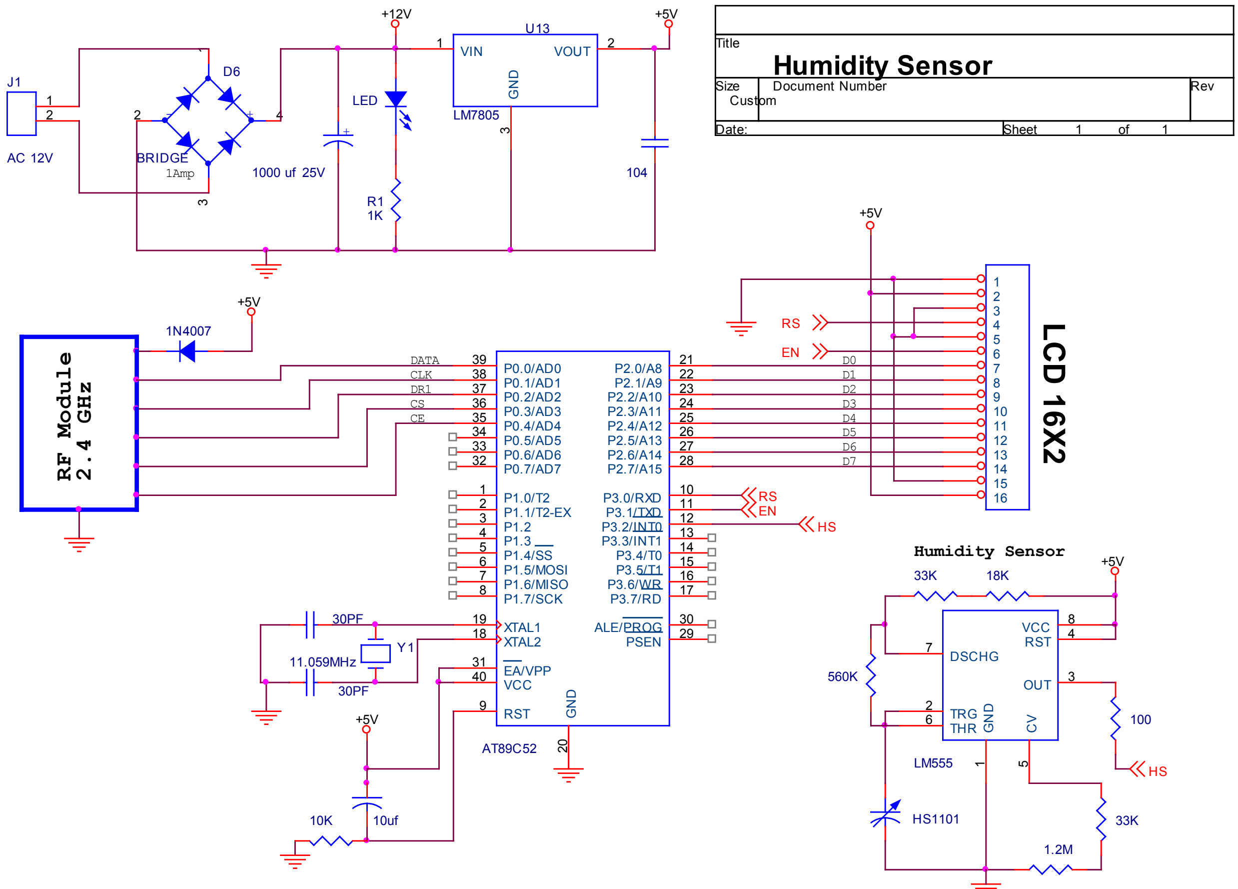

Figure 4. Transmitter section of the humidity sensing system.

2.2 Receiver

The receiving system consists of a TRW 2.4G module configured as receiver which receives the RF signal that was transmitted and convert it into the IF signal and demodulates it in order to deliver it to the microcontroller. The demodulated data is sent to the port 0 of the microcontroller. Microcontroller then sends the processed data serially to the computer. To make the serial communication between the computer using RS232 protocol and microcontroller which works on TTL logic, MAX 232 IC is used. Finally the received data can be displayed on to the computer or LCD. The system design is actually represent the wireless data gaining. The system recorded the all fluctuation including physical conditions and environmental and wirelessly displayed on the monitor at receiving the receiving side. The overall design of the receiver section is shown in Figure 5.

3. Performance Analysis

In this section the performance of the designed system is analyzed in terms of accuracy and transmission quality.

3.1 Accuracy

The accuracy of measuring instruments depends upon the parameters such as sensitivity, calibration, tolerance etc. it is imperative to properly calibrate the device and operate it with have high sensitivity and tolerance. HS1101 has much high sensitivity as to a small variation in the amount of water vapors in air (Humidity) affects the capacitive dielectric of the sensor which immediately causes the capacitance variation in the capacitance which further causes frequency variation. Accuracy also relies on the age of sensor; the HS1101 sensor that is used in the project is a fresh piece and has never been used before. So

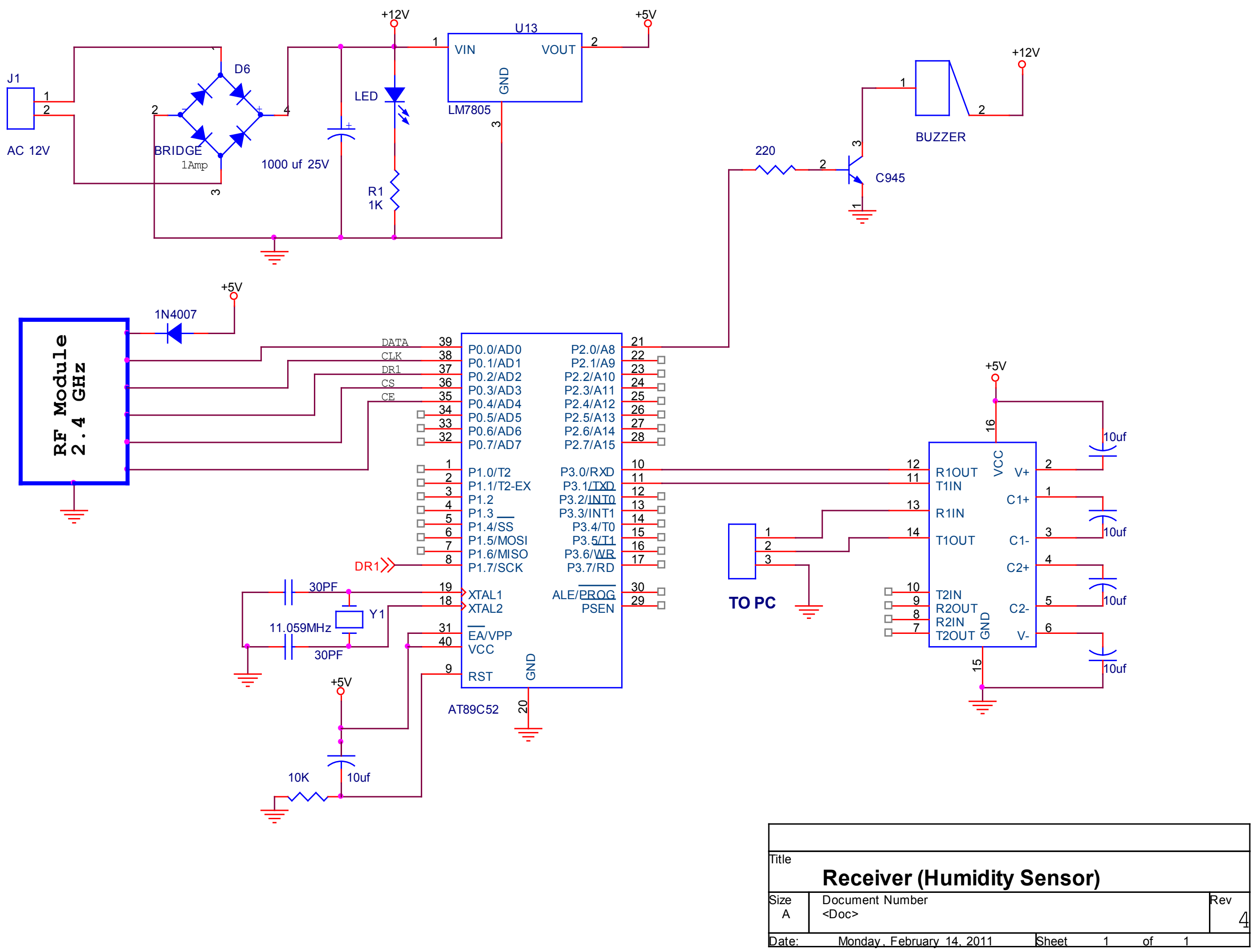

Figure 5. Receiver section of humidity sensing system.

it works much accurately according to the expectations. The accuracy of the humidity measurement of this project design can also be analyzed in this way that while operating the system whenever we put any wet thing near sensor its output frequency changes immediately and because of it RH changes as well.

3.2 Transmission Quality

The quality of a transmission and reception of the designed system within the range of 10s of meter (up to 150 meters) is fairly accurate without Line of Sight concern and can be further improved by using amplifiers and also some error reducing technique. In TRW 2.4G the data is transmitted at the rate of 1 Mbps[3] in the frequency range of 2.4~2.527 GHz. The TRW-24G provide the 8 to 16 bits Cyclic Redundancy Check (CRC)[3] capability designed to detect accidental changes to raw signals. For continuous monitoring of a very high range application we may have to use some repeaters to accomplish the task. The designed system is the low cost and low complex implementation of embedded system and does not require Analog to Digital Conversion or vice versa to interface the Humidity sensing circuit with the microcontroller. The design provides the wireless transmission of the data, that makes easiness for the engineers (at industry) or for any other person (at home or any other place) to get humidity information of any remote and hazards locations.

4. Conclusion

In this work a low cost embedded system based on AT89C52 MCU is designed which measure the relative humidity of the surroundings using HS1101 sensor. The transmitter TRW 2.4G gets the recorded data from MCU and transmits it wirelessly to a remote location. Receiver detects the data accurately and transfers it to the MCU then after serial transmission; the data can be displayed on the computer or LCD with the help of user interface developed. The proposed design may find useful applications in Industries, agriculture fields, educational labs, Food storage places, Drying production industries, Blood banks, Coal mines, Sprinkler etc.

5. References

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