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Application of Manifold Sensors in Wireless Digital Thermometer

S. S. Shende[1], M. J. Hedau[1], K. Y. Rokde[2]

[1]Assistant Professor, Department of Electronics, Shivaji Science College, Nagpur, Maharashtra, India

[2]Assistant Professor, Department of Electronics, K. R. Pandav, Mahavidyalaya, Nagpur Maharashtra, India

ABSTRACT

This paper describes the application of a manifold sensors in wireless digital thermometer for measuring temperature from different sensors using single wireless digital thermometer. In this paper primarily temperature sensor LM35 is used. ADC0808 is used to convert analog signal obtained from temperature sensor into digital format so that the special parallel to serial encoder will transmit the signal using Tx module to remote receiving end. At the receiving end the transmitted signal is received by receiver module. Reverse action is carried out on the signal to what happed at the transmitting end and temperature detected by sensor is displayed on digital multi-meter on mV scale.

Keywords: Temperature Sensor, ADC, Encoder

I. INTRODUCTION

Temperature is certainly among the most commonly measured parameters in industry, science, and academia. Recently, the growth of wireless instrumentation technology, along with some clever innovations, has provided new ways to apply temperature measurement sensors combined with personal computers to collect, tabulate, and analyse the data obtained.

Wireless monitoring system is, as their name suggests, monitoring systems that can be installed without the need to run cabling or wires. Wireless monitoring systems are the ultimate in quick, easy and neat monitoring installation solutions. Because they are wireless they are very discreet and unobtrusive, there is no buildings' decoration spoiling nor is there an unsightly wire highway on wall surfaces. Wireless monitoring systems are more convenient than hard wired systems and it means that even the most unlikely places can have a wireless monitoring a system installed and in a fraction of the time.

Temperature measurement in today's industrial environment encompasses a wide variety of needs and applications. To meet this wide array of needs the process controls industry has developed a large number of sensors and devices to handle this demand. Temperature is a very critical and widely measured variable for most applications. Many processes must have either a monitored or controlled temperature. The paper deals with measurement of temperature using temperature sensor LM35. In all eight LM 35 sensors are been used in the current work.

II. METHODOLOGY

Temperature measurement can be done using temperature sensor LM35 but the problem arises when one has to measure more than one temperature at a time. To overcome this problem an approach has been shown in the paper to sense temperature from eight sensors at a time.

At the transmitting end, we have temperature sensor LM35, ADC 0808, Encoder HT12E2, Sequential Data Selector and Transmitter Module. An 8 bit ADC continuously scans and converts signals from eight different temperature sensors. The sensors are selected sequentially by a 3 bit binary addressing system. At any instant of time an 8 bit ADC generates an 8 bit binary number equivalent to the analog signal obtained at the output of a particular temperature sensor, being selected by 3 bit binary addressing system. By using special parallel-to-serial encoders, this 8-bit data, along with the binary address of the sensor, is sent serially to the remote receiving end. Communication between the two ends are met with the help of a pair of 433MHz UHF transmitter and receiver modules operating in ASK/OOK mode. At the receiving end, the transmitted signal is received by a 433MHz ASK/OOK RF receiver module. The received 8-bit serial signal is then converted back to its original parallel form, by using special data decoders HT 12E. An equivalent analogue signal is then developed from this data by an 8-bit digital-to-analogue converter (DAC). A digital multimeter connected at the output of the DAC is used to show the temperature on mV scale.

III. EXPERIMENTAL SETUP & WORKING

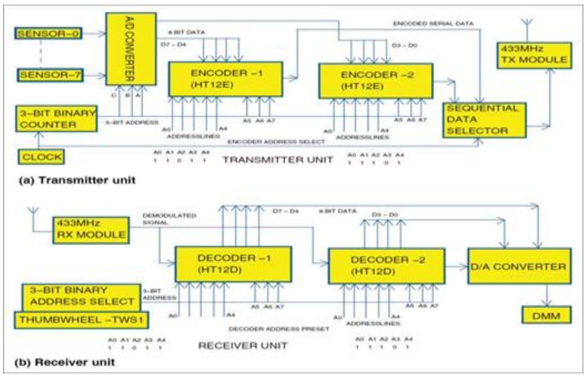

Figure 1. Block Diagram Of Manifold Sensors In Wireless Digital Thermometer

Figure **1.a** shows the block diagram of the transmitter unit for the wireless addressable digital thermometer. Eight LM35 IC temperature sensors are connected to ADC 0808. Although the ADC is capable of accepting a total number of eight sensors through its eight input lines, less number of sensors could be used as well as, whenever desired. IC 7404 configured as a CMOS oscillator with the help of resistors and capacitor feeds the ADC with necessary clock pulses required for conversion processes.

Output voltage of LM35 series IC temperature sensors follows linearly (@10mV/°C) the centigrade temperature of its surroundings, taking 0mV at 0°C temperature. The ADC continuously scans its eight input lines. The scanning process is governed by a 3-bit binary up counter built around CD4029. The counter places a continuously-changing 3-bit binary number on A-B-C input lines of the ADC. Scanning rate is dependent upon the clock constructed around timer NE555, and is 8Hz, approximately. Hence, each of the eight sensors is allowed to send data to the ADC for approximately one-eighth of a second, irrespective of whether all sensors are connected or not.

Here, IC 0808 is configured in continuous operational mode. So, whenever a particular sensor is addressed, output lines of the ADC reflect the present analogue output status of the sensor. Output of the ADC goes to data input lines of special encoders HT12E; higher nibble to first HT12E and lower nibble to second HT12E, respectively. As TE input of encoders is permanently grounded, the encoders are configured to produce encoded data continuously. These two encoded digital outputs are alternately steered to TX1 (TX-433MHz), a UHF RF transmitter module, to modulate UHF carrier wave generated by the module.

Encoder output: Whenever IC 555 output pulse goes high, output of HT12E is steered to TX1 through diode. At the same time, due to the presence of transistor inverter, output of HT12E is inhibited to reach TX1 through the gate. As soon as the clock pulse returns to logic 0, output of HT12E gets its passage to TX1 through gate of 7408.

So, in essence, analogue data of a sensor is converted and the resultant 8-bit digital data is sent to the remote end using ASK/OOK modulation, in a complete clock cycle of IC 555.

Modulated signal is radiated into space through a wire, acting as an antenna, connected at the antenna point of the module.

Figure **1.b** shows the receiving unit of the wireless addressable digital thermometer. RX1, a 433MHz RF receiver module, is used to receive and demodulate ASK-modulated RF signal transmitted by TX1 of the transmitter unit. Demodulated output is a train of rectangular pulses comprising a 4-bit data nibble and destined for a particular decoder as explained earlier.
Transistor BC547 is used as a pulse amplifier to amplify the signal output from RX1 and, hence, raises the pulse height to CMOS compatible logic -1 (>3.5V at 5V). This compatible output is then fed to CMOS NAND gate 4011. NAND gate helps to get pulses of perfect rectangular-wave shape. Output of IC 4011 is fed to decoders HT12D. Address lines of the decoders are preset to receive data from two encoders HT12E, respectively.
LEDs connected at their outputs flicker to indicate reception of valid data. Decoding speed is 200kHz (approximately). Decoded data is then fed to DAC 0808. Analogue current output of the DAC is loaded. Voltage developed across it is fed to a digital multimeter, which shows the temperature on mV scale. A thumbwheel switch is used to change the preset address of the decoders. The switch changes the last three LSB of the address.

III. RESULT AND DISCUSSION

Table 1. Temperature recorded by different techniques and deviation

Sr. No	Actual	Experimental	Deviation
1.	37.4	37.2	0.2
2.	37.6	37.3	0.3
3.	37	37.1	-0.1
4.	36.8	36.9	-0.1
5.	37	36.8	0.2
6.	36.5	36.3	0.2
7.	37.5	37.3	0.2
8.	36.7	36.4	0.3
9.	37.5	37.3	0.2
10.	36.9	37	-0.1
11.	37.2	37	0.2
12.	37.6	37.4	0.2
13.	36.7	36.9	-0.2
14.	36.8	36.5	0.3
15.	37.5	37.3	0.2
16.	36.9	37	-0.1
17.	37	37.2	-0.2
18.	37.3	37.1	0.2
19.	37.4	37.2	0.2
20.	36.5	36.3	0.2

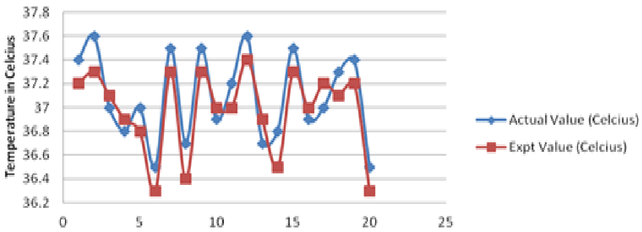

Figure 2. Graph representing the comparison of data for Temperature by different techniques.

For proper operation of this wireless thermometer, reference current (to pin 4 of DAC0808) of the receiver unit should be pre-adjusted. To do this, follow the steps below:

Connect a known voltage source (not exceeding +5V) to any input of the ADC, say, at pin 4 of the ADC.

Switch on the transmitter unit. Connect a DMM across Resistor of the receiver unit. Set the range switch to DC 200mV range, positive lead to ground and negative lead to top of Resistor. Switch on the receiver unit. LEDs at decoder outputs should start glowing to indicate the received voltage data. If source voltage is 1.5V, status of LEDs should be as listed in Table I. So, received voltage = (D× 5)/256 = (76×5)/256 = 1.50

where D is the weight of the binary numbers represented by LED7 through LED14. Now, adjust trim potmeter to get 150.00mV on the dial of the multimeter. Connect another voltage source at the input and see that the multimeter shows it correctly. If required, re-adjust the trim potmeter. After proper calibration, enclose the circuit in two separate boxes with suitable connections of input and LED indicators.

STATUS OF LEDS IN THE RECEIVER UNIT								
LED	7	8	9	10	11	12	13	14
Data	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Weight	128	64	32	16	8	4	2	1
Status	OFF	ON	OFF	OFF	ON	ON	OFF	OFF

IV. CONCLUSION

Although the system can be used best to measure temperatures in hazardous or inaccessible areas (like a radioactive zone), the same can also be used by a hospital doctor to monitor, from a fixed location, the body temperatures of multiple patients lying in different rooms without visiting each patient in person.

A hotel control room can monitor temperatures of all the rooms at the same time by using multiple units. The unit can also be used (with certain modifications) as a wireless digital voltmeter.

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