

# Temperature and Humidity Detection System Based on ZigBee Protocol

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## Abstract

This design utilizes ZigBee Wireless Network and temperature sensor STH11 to finish remote temperature and humidity acquisition and do design on schematic of data acquisition module including power-supply circuit, minimum system of communication module and connection circuit of temperature and humidity sensor. ZigBee Wireless Network is built using ZICM2410 Module to do data communication and detect real-time temperature and humidity through upper-computer software. Experiment proves that temperature and humidity detection accuracy of this system is high thus keeping high application value.

Key words: WIRELESS NETWORK, ZIGBEE, DATA ACQUISITION, ZICM2410

## Introduction

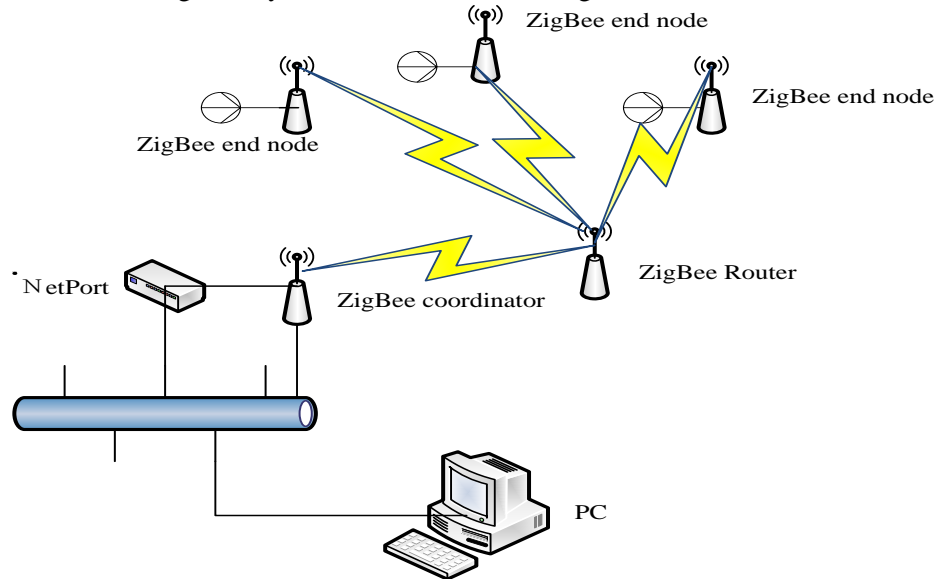
Wireless sensor network could detect, perceive and acquire real-time object data in network distribution area. Meanwhile it does processing on data to acquire accurate and detailed information. Wireless sensor network has great application and research prospect. IEEE 802.15.4 Standard is an emerging wireless communication protocol which is set aiming at Low-rate Wireless Personal Area Network. ZigBee Wireless Sensor Network is wireless data transmission network based on IEEE 802.15.4 Technical Standard and ZigBee Network Protocol [1]. ZigBee Technology keeps many advantages such as high communication efficiency, low complexity, low power consumption, low cost, high safety, etc. These advantages help perfectly exert technical features of wireless sensor network [2].

Data acquisition is an important research and application area of ZigBee

Wireless Sensor Network. With the rapid development of wireless network communication technology and embedded technology industries [3], traditional monitoring management modes and solutions could not meet market demand. Power consumption and cost of ZigBee Network is low. Its multiple distributed self-organizing sensor nodes can acquire signal data which may not be acquired by traditional monitoring methods. It overcomes many disadvantages of traditional monitoring system such as needing wired devices of cable and fiber, spending more money and maintenance being difficult. Therefore remote data acquisition system based on ZigBee and Internet is researched and designed to replace relevant traditional solutions thus reducing production and operation costs of enterprises which has important practical significance.

## Architecture Design of System

Overall structural design of system is seen in Figure 1.

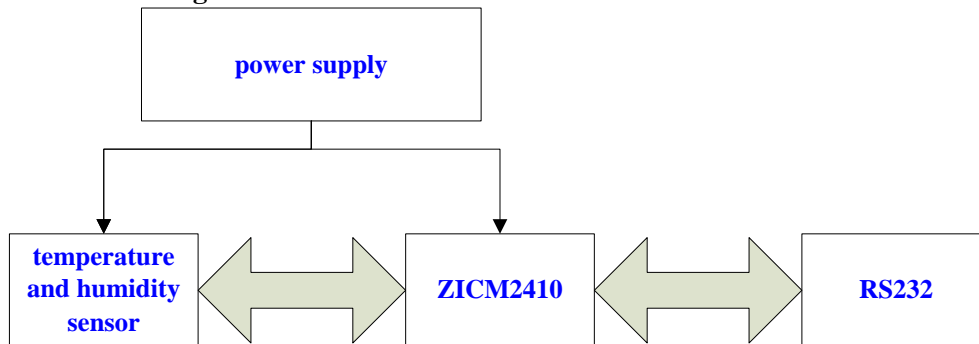


**Figure 1.** Overall structural design of system

It is seen from Fig.1 that topology structure of wireless network applies tree structure. Network includes ZigBee coordinator, ZigBee Router and ZigBee end nodes. Upper computer receives route data acquired by ZigBee coordinator through RS232 main line and uses VC Software to write upper computer interface on PC which help realize monitoring on temperature data.

### Design of Hardware Platform

#### Architecture Design of End Nodes



**Figure 2.** Architecture of end nodes

#### Introduction on ZIC2410

Wireless transceiver chip in this paper applies ZICM2410 wireless transceiver module designed by CEL Company based on ZIC2410. ZIC2410 is a true single-chip solution, compliant with ZigBee specifications and IEEE802.15.4, a complete wireless solution for all ZigBee applications. The ZIC2410 consists of an RF transceiver with base band modem, a hardwired MAC and an embedded 8051

ZigBee routing nodes and ZigBee coordinator are just used to send and receive data. ZigBee end nodes are just utilized to acquire and send data. There only exists power module and wireless transceiver module in hardware design of routing nodes and coordinator nodes. Besides power module and transmitting module, ZigBee end nodes also have sensor module used for acquiring data. Architecture of end nodes is shown in Fig.2.

microcontroller with internal flash memory. The device provides numerous general-purpose I/O pins, peripheral functions such as timers and UART and is one of the first devices to provide an embedded Voice CODEC. This chip is ideal for very low power applications [4].

The ZIC2410 consists of a 2.4GHz RF, Modem (PHY Layer), a MAC hardware engine, a Voice CODEC block, Clocks,

Peripherals, and a memory and Microcontroller (MCU) block [5]. On the basis of ZIC2410, ZICM2410 encapsulates wireless transceiver and antenna system whose electromagnetic wave coverage area could be 900m. Its application development provides us with convenience [5].

### Description of SHT11

SHT11 is Sensirion's family of surface mountable relative humidity and temperature sensors. The sensors integrate sensor elements plus signal processing on a tiny foot print and

provide a fully calibrated digital output. A unique capacitive sensor element is used for measuring relative humidity while temperature is measured by a band-gap sensor. The applied CMOSens® technology guarantees excellent reliability and long term stability. Both sensors are seamlessly coupled to a 14bit analog to digital converter and a serial interface circuit. This results in superior signal quality, a fast response time and insensitivity to external disturbances (EMC). Technical parameters of SHT11 are seen in Table 1 [6].

**Table 1.** Technical Parameter List of SHT11

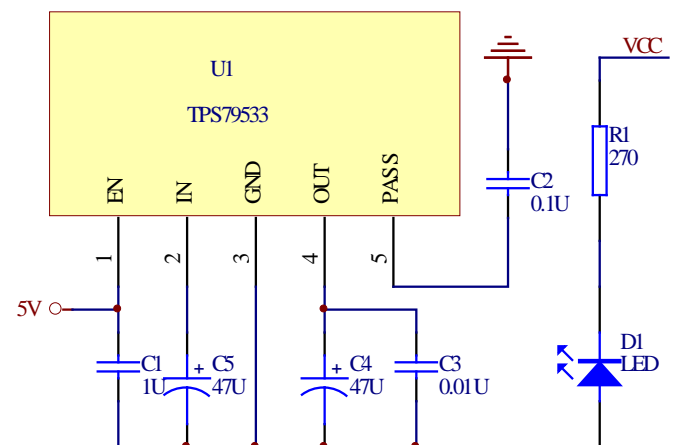
Types of sensor	Range	Accuracy	Response time/S	Resolution
Temperature sensor	-40°C -120°C	±0.9°C (0-40°C) ±0.5°C (25°C)	≤20	0.01°C
Humidity sensor	0-100%	±3%	≤4	0.3%

Temperature and humidity sensor SHT11 is a high-accuracy one with ultra low power consumption. Its temperature acquisition accuracy could be 0.5 Celsius and humidity acquisition accuracy could be 3%RH. Its measurement range of temperature would be from minus 40 degrees Celsius to 125 Celsius. The one of humidity is between 0%RH and 100%RH. Working voltage of SHT11 is from 2.4V to 5.5V. SHT11 sensor would become dormant within 11 milliseconds after operation. It means that instructions have to be sent to SHT11 before its dormancy. Energy consumption of SHT11 is just from 1uW to 30uW which may be negligible. SHT11 communicates with ZICM2410 through bi-directional two-wire serial interface.

### Hardware Circuit of System

#### Power Module

TPS79533 Chip is applied because the needed voltage is 3.3V. (The TPS79533 of low-dropout low-power linear voltage regulators features high power-supply rejection power-supply rejection ratio (PSRR), ultra low noise, fast start-up, and excellent line and load transient responses in a small outline, SOT223-6, package ) offer [7]. It is shown in Fig.3.



**Figure 3.** Schematic of power module

#### Circuit Design of Main Module

The main module of system is ZICM2410 wireless module which has 56 pins. Fig.4 shows the minimum system of ZICM2410 in which pins 1-5, 7-11, 20-22 and 49-56 are all grounded. Pins 12-15 are analog circuit inputs without using AD function. Therefore they are suspended. P1\_1 and P1\_0 are DART 1 used to connect RS232. P3\_1 and P3\_0 are UART0 utilized to link serial interfaces of SHT11 module and read its data. Other ports are not applied in the system. Therefore they are suspended. As ZICM2410 module is designed according to ZIC2410 wireless transceiver chip, antenna and other wiring problems do not need considering. We

just need to connect peripheral circuit of module with minimum system according to its

instructions [5].

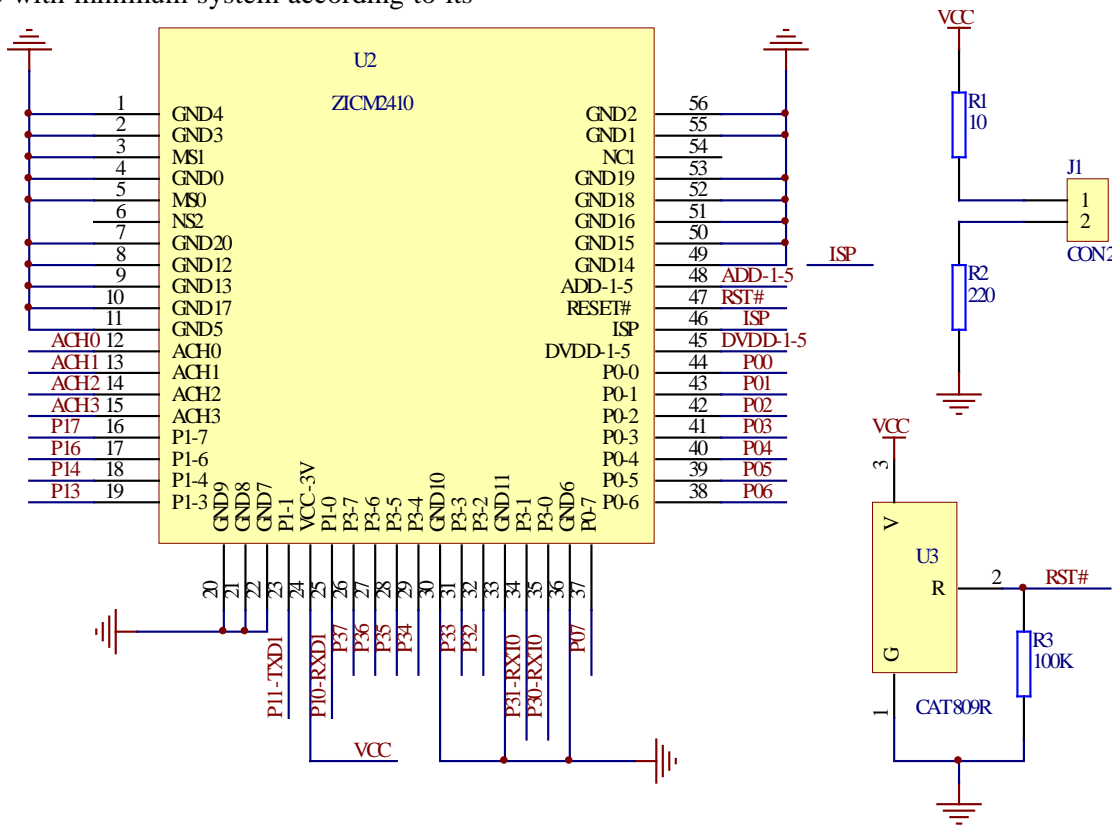


Figure 4. Minimum system of ZICM2410

### Schematic of SHT11 Module

SHT11 accesses through two-wire serial digital interface because of which its hardware interface circuit is very simple. SHT11 has four pins including SCK, DATA, VDD and GND. VDD links power and GND links earth wire. SCK connects with P3\_0 and DATA connects with P3\_1 of ZICM2410 so as to use software to read sensor data. Fig.5 is the circuit connection schematic of SHT11 Module.

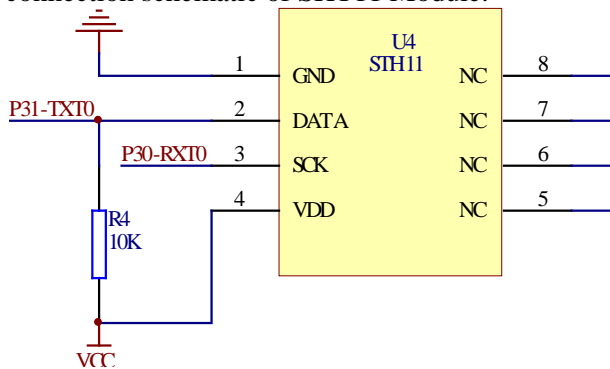


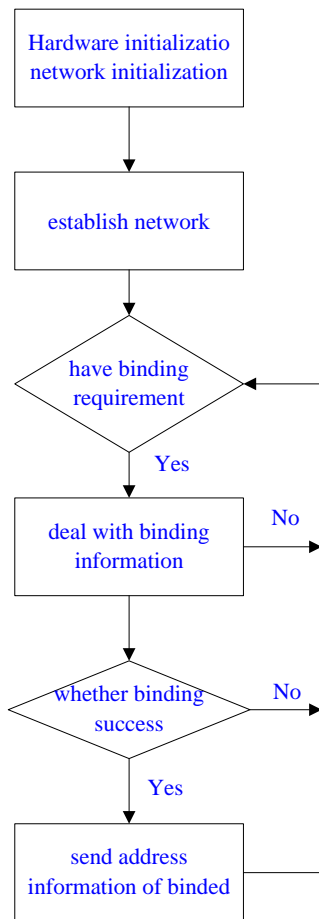
Figure 5. Circuit connection schematic of SHT11 module

### System Software Design

Development software of ZigBee Network operation system is Portal Software.

This software uses SNAPpy scripting language which is developed for SNAP Network operation system by Synapse Company. When its own hardware platform is used to develop software, the application of this software helps identify SNAP operation system on hardware after firmware is programmed on hardware platform [8-9].

The main functions of coordinator in ZigBee Network are establishing network, dealing with binding information, processing the received data, etc. Flow chart of coordinator routine is shown in Figure 6.



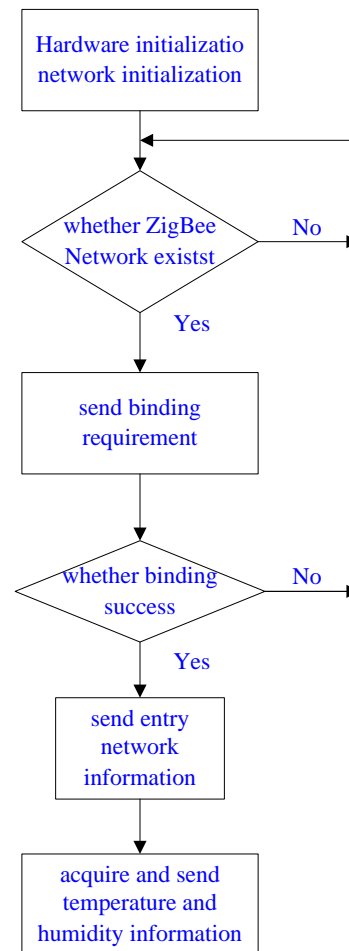
**Figure 6.** Flow chart of coordinator routine

Main functions of sensor nodes are acquiring temperature and humidity information, joining in ZigBee Network and sending information to upper computer through coordinator. Fig.7 is flow chart of sensor nodes' routine.

### Conclusions

ZigBee technology keeps advantages of low power consumption, low complexity, low cost and high networking capability. Utilizing these advantages, wireless temperature and humidity monitoring system based on ZICM2410 overcomes disadvantages of traditional monitoring system including needing wired devices of cable and fiber, high construction cost and difficult maintenance. Experiments prove that this system could do stable and efficient real-time monitoring on temperature and humidity. Meanwhile this acquisition system would monitor corresponding physical parameters as long as it accesses to relevant sensor. Therefore it keeps excellent generality and expansibility. This helps it better replace relevant traditional

solutions thus reducing enterprises' production and operation costs which have important practical significance.



**Figure 7.** Flow chart of sensor nodes' routine

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