Design of data collector based on wireless sensor network

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Abstract: According to the application characteristics of wireless sensor network in the field of forest environment monitoring, a low-power data collector is designed in this paper. The data collector is the expansion of the sensor node. An LT1086CM-3.3 is used to provide sTable 3.3V power for the system. Environmental parameters, such as temperature and humidity, are collected by the temperature and humidity sensor, SHT11. An Analog-to-Digital Converter, MAX146, provides a low-power, 8-channel, serial 12-bit ADC interface. Different excitation sources are provided by MIC5219-2.5BM5, MIC5219-3.3BM5 and MIC5219BM5. The excitation sources have the ability to provide power source for external sensors. Besides, they can be controlled by software to enter ENABLE mode or SHUTDOWN mode. This ability greatly reduces the power consumption of sensor nodes, further improving the wireless sensor networks for forest environment monitoring.

1. Introduction

The application of wireless sensor network for forest environment monitoring has achieved initial success. But the energy consumption of sensor nodes has been being the technical focus. A large number of distributed nodes are needed by the wireless sensor networks for forest environmental monitoring, and the centralized power supply is not easy. At present, some sensor nodes are designed to use solar cells, and each node is equipped with a small solar cell. But it has a high cost. Besides, external power supply equipment may be necessary in continuous cloudy situation. It can reduce costs to use batteries as the power source. But the drawback is that manually replacing batteries is necessary. One of the ways to extended battery life and reduce the times of replacing batteries is to try to reduce nodes' power consumption. In order to reduce nodes’ power consumption, we can choose low-power devices, and improving the protocol stack is also a good idea [1-4]. However, the wireless sensor nodes used for forest environmental monitoring contains a variety of sensors, and the majority of the power consumption due to the sensors. Therefore, the key to reduce nodes' power consumption is to reduce sensors' power consumption. Taking all of above factors into consideration, a low-power data collector is designed in this paper. Cooperating with effective software, it greatly reduces the power consumption of nodes, and further improves wireless sensor nodes for forest environmental monitoring.

2. Wireless Sensor Nodes Based on CC2430

The data collector is designed for wireless sensor nodes based on CC2430. The node contains a RF board and a data collector, including a power supply module, a sensor module, a processor module and a wireless transceiver module [5-6].The power module and the sensor module compose the data collector. The processor module and the wireless transceiver module make up the RF board. TI's technical documents are perfect references to design the RF board, and its schematic is shown in Figure 1[7]. P1 and P2 are two 10-pin single connectors. All IO ports of CC2430 have been linked to the data collector. This paper mainly describes the design of data collector.

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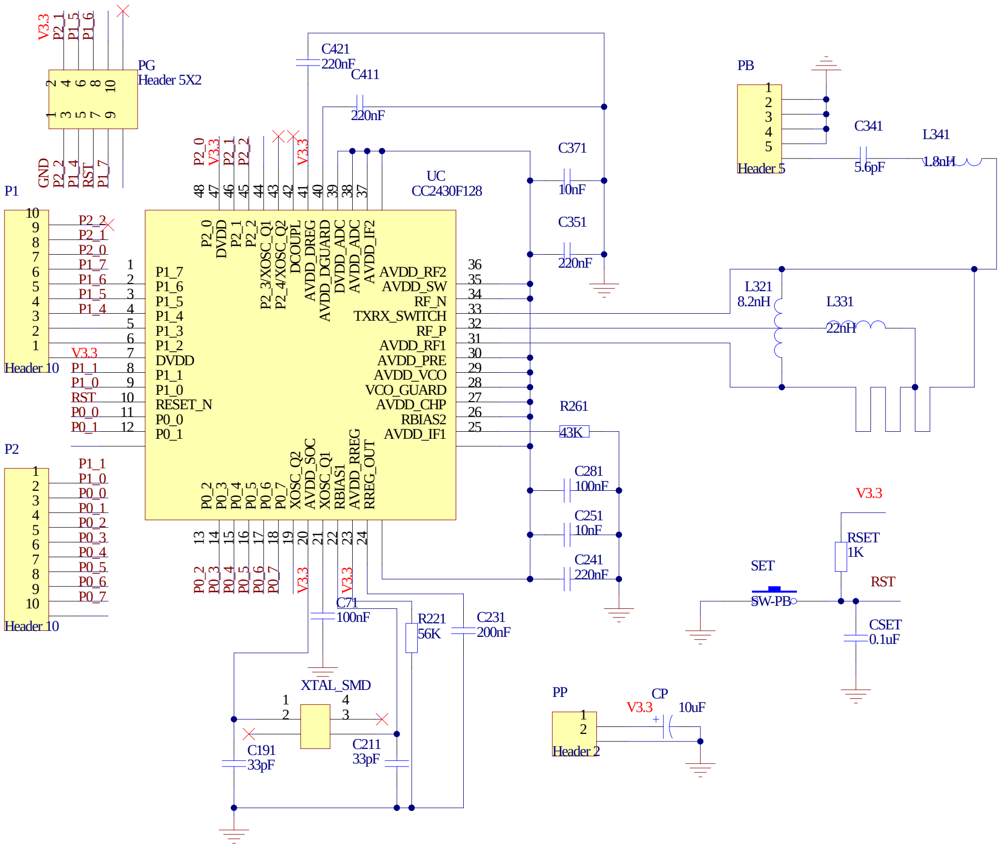

Figure 1. Schematic of RF board

3. Data Collector

The data collector includes a power module, a temperature and humidity sensor, a low-power, 8-channel, serial 12-bit Analog-to-Digital Converter, two 2.5V excitation sources, two 3.3V excitation sources and two 5.0V excitation sources, etc.

A low dropout positive regulator, LT1086CM-3.3, is used to supply 3.3V operating voltage for the system, and the schematic is shown in Figure 2[5, 8]. PP is a 2-pin connector, which leads the power source to the RF board.

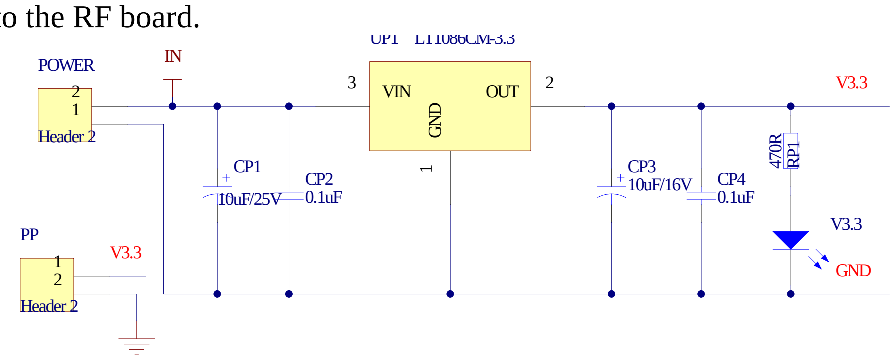

Figure 2. Schematic of power module

Temperature and humidity parameters are collected by SHT11, which is produced by Sensirion Corporation. The SHT11 is a single chip relative humidity and temperature multi-sensor module comprising a calibrated digital output. It communicates with micro-controller via I2C bus. The schematic is shown in Fig. 5. DATA is the data pin, which connects a 10KΩ pull-up resistor. SCL is the clock pin. SDA and SCL are connected to CC2430's P1.1 and P1.0.

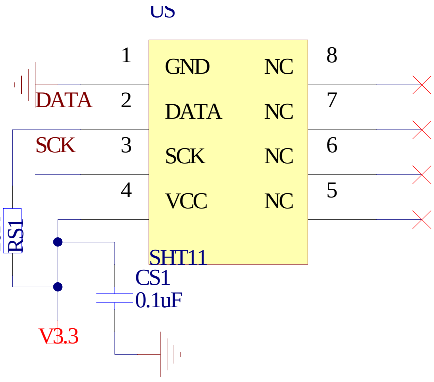

Figure 3. Schematic of temperature and humidity sensor

Data collector provides a low-power, 8-channel, serial 12-bit ADC for a variety of external sensors which can output analog signal. The schematic is shown in Figure 4. MAX146 is a low-power, 8-channel, serial 12-Bit ADC. CS is chip select signal pin. SCLK is serial clock input pin. DIN and DOUT are the serial data input and output pins. CH0~CH7 are 8 analog signal input interfaces, and the capacitors are filter capacitors.

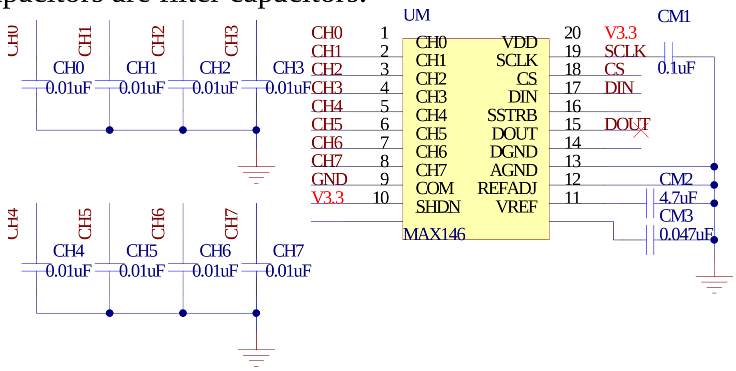

Figure 4. Schmatic of analog signal acquisition circuit

The sensors are the majority of energy consumption devices of the sensor nodes. In order to reduce the sensors' power consumption, this design provides several programmable power supplies for sensors, three different levels of excitation sources. The schematic is shown in Figure 5. IN is the voltage input, OUT is the output of the excitation source, EN is the control side. The opening or closing of the excitation sources can be controlled by CC2430's IO ports as needed, greatly reducing the sensor's power consumption.

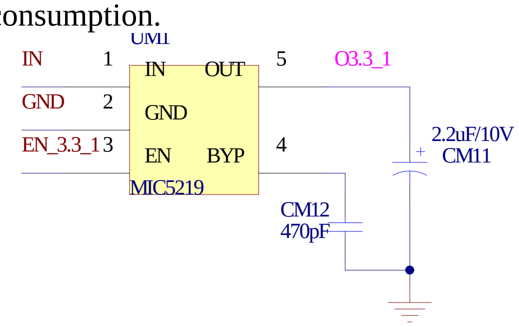

Figure 5. Schematic of excitation source

In addition, the data collector also provides two LEDs and five IO ports. P0.6, P0.7 and P2.0~P2.2 of CC2430 are leaded to the data collector via connectors. The IO ports can be reused as external interrupt input, counter input, and 16-bit high precision ADC. Two LEDs are under the control of P1.6 and P1.7. The schematic is shown in Figure 6.

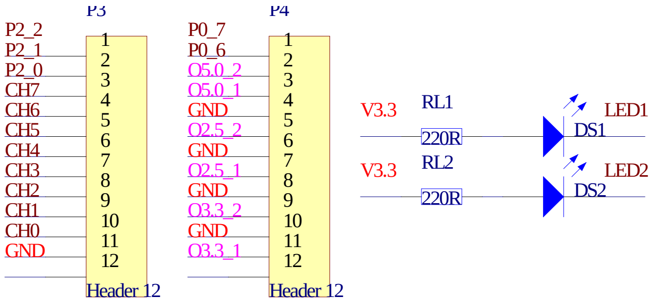

Figure 6. Schematic of peripheral interfaces and LEDs

4. Performance Test

Every sensor node cooperates with an external smoke sensor, MS5100, a flame sensor, SGL101 and a test circuit for light intensity, and their powers are provided by the excitation sources of the data collector. The power of the system is provided by three batteries. Adjust the time interval between two outputs of the excitation source and record the battery life in different time intervals. The test result is shown in Table 1.

Table 1. Test Result

Time interval (minutes)	Battery life (days)
0.5	11
1	21
2	30
5	37
10	43

5. Conclusions

A great progress is made in the field of forest environment monitoring because of the application of wireless sensors. But the energy consumption of wireless sensor nodes has been being a concern as a technical difficulty, especially, the multi-sensor nodes. In this paper, a low-power data collector is designed. A low dropout positive regulator, LT1086CM-3.3, is used to supply 3.3V operating voltage for the system. Temperature and humidity parameters are collected by SHT11. An MAX146 is used to provide a low-power, 8-channel, serial 12-Bit ADC. Several excitation sources are provided by MIC5219s. The time of ENABLE mode can be controlled by software. This feature greatly reduces the energy consumption of wireless sensor nodes, further improving the wireless sensor networks for forest environmental monitoring.

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