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Safety Helmets For Coal Miners Using Zigbee Technology

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Abstract

This paper enlightens the concept of ZigBee, based on the IEEE 802.15.4- 2006 standard for wireless personal area network (WPANs).It is a low data rate, low cost, low power consumption, low cost wireless networking protocol mainly targeted towards automation and remote control applications. This technology is planned to be simpler and less expensive than the other WPANs, such as Bluetooth. This paper presents a study on how ZigBee is used for the transmission between the hardware circuit fitted with the coal mine workers and the ground control system through some routers.

Keywords **:** *ZigBee, WPANs , Sensors, Wireless protocol, Xbee, MAX 232*

1. Introduction

Coal as an important source of energy in industrial international standard wireless sensor network protocol production, it plays a pivotal role in the national economy. Coal mining deep underground involves a higher safety risk due primarily to problems associated with mine ventilation and the danger from gases like methane, carbon monoxide. Therefore ZigBee based wireless sensors networks are recently investigated due to their remote environment monitoring capabilities. The smart helmets used by the coal miners mobile wireless sensors that will observe the change in environment parameters and transmit them in radio frequencies. It is convenient to build a real time surveillance on environmental parameters, so the potential safety problems can be avoided as early as possible. For the successful wireless data transmission in this work we use ZigBee specifications to design a monitoring system.

2. Design Overview

Coal mines are divided into two parts. The first section is the underground section and the other section is ground section. The underground part is the main part of the coal mine. This section is use to collect data from the sensors like temperature sensor, humidity sensor and gas sensor. The three sensors will observe the change in environment parameters and will give the information to the ADC of the microcontroller. The microcontroller displays the information in the LCD board and sends through ZigBee transmitter. The ground section is generally present outside the coal mine where the control room which contains the ZigBee receiver that receives the information sent by the transmitter and gives accurate information and give time to time help when needed. The ground and the underground section is connected by a wireless link. Here we have used the ZigBee specification as a wireless link between the two sections.

2.1 Underground Section

The underground section consists of different sensor nodes, microcontroller, LCD board and ZigBee Transmitter as shown in the figure1.The sensor nodes sense the physical parameters like temperature,

pressure, humidity which are always in an analogue form. This information is then sent to the ADC first which converts it into digital form and then the information is sent to the microcontroller. The microcontroller checks these values and sends it to the ground section through the ZigBee transmitter. At the same the values will be displayed on the LCD board, if any of the received values exceeds thethreshold value then the buzzer will be turned ON giving warning to the miners.

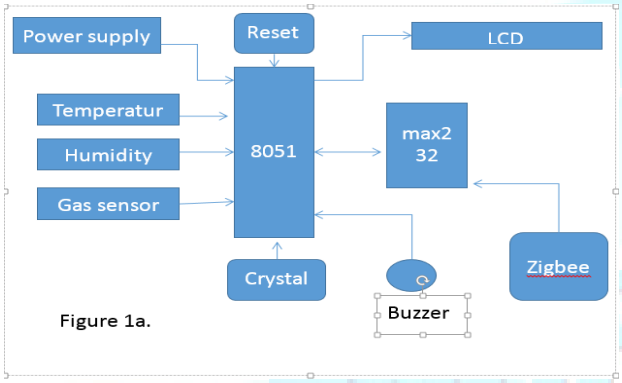


Fig 1. Transmitter section of ZigBee

2.2 Ground Section

The ground section consists of a ZigBee module, microcontroller, LCD. In this section the ZigBee receiver collects the information and sends it to the microcontroller. The LCD connected to the controller displays the information in the ground section. The officers that will be present in the control room will take proper actions according to the data displayed on the LCD board and provide immediate help if necessary.

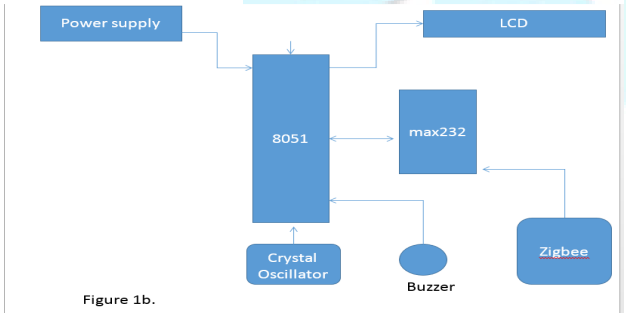


Fig 2. Receiver Section of ZigBee

3. Zigbee

ZigBee is a technological standard created for control and sensor networks. It is based on the IEEE 802.15.4 standard. It is a wireless personal area network (WPANs) which uses high level communication. It works on a frequency band of 2.4 GHz. It can vary on data rates from 20 kbps to 250 kbps. It easily supports low latency devices and works on CSMA-CA Channel access. Its range varies from 40 m (indoor range) to 120m (line of sight range). It has low power consumption as it works on 2.1-3.6V. Some of the advantages of using ZigBee is that it provides noise free communication with high security. Another important reason of using ZigBee is that it has battery life ranging from months to years. So low maintenance is required.

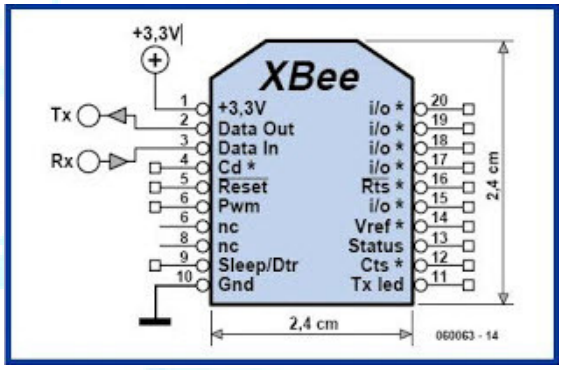


Fig 3. Xbee PIN Diagram

4. Sensors

A sensor is a transducer which detects some characteristics of the surroundings. Here we are using three types of sensors:

4.1 Temperature Sensor

We are using LM35 as a temperature sensor here which is a precision integrated circuit sensor that measures temperature with an electrical output proportional to the temperature in Celsius. It is more accurate than Thermistor and has a sealed sensor circuitry which prevents it from oxidation.

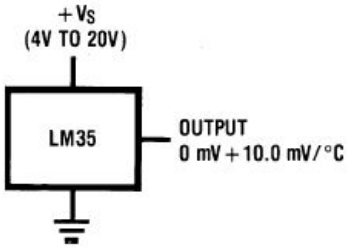


Fig 4.1 Temperature Sensor

4.2 Humidity Sensor

It measures and reports the relative humidity in the air periodically. We are using DHT11 which is a basic, ultra low-cost digital tem humidity sensor. It uses a capacitive humidity sensor and has an operating range 0 to 60 degrees. It is very easy to use and is less expensive.

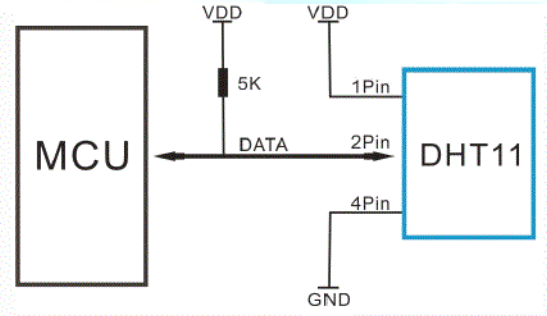


Fig 4.2 Humidity Sensor

4.3 Smoke Sensor

We use MQ-7 sensor, suitable for sensing carbon monoxide at concentration from 10 to 10,000 ppm. The sensor has a high sensitivity and a fast response time. The sensor's output is an analog resistance. The circuitry is simple, all we need to do is power the heater coil with 5V, add a load resistance and connect the output to an ADC.

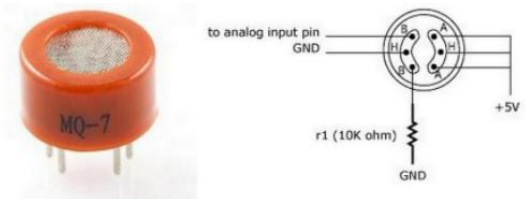


Fig 4.3 Smoke Sensor

5. MAX232

It is one of the drivers/receivers used for interfacing the ZigBee module with the 8051 primer board. It is an integrated circuit that is used to convert the TTL/CMOS logic levels to RS-232 logic levels during serial communications of microcontrollers with PC. The advantage is that the driver provides the RS-232 voltage level outputs from a single +5V supply via external capacitors whereas the receiver reduce RS-232 inputs to standard TTL logic levels.

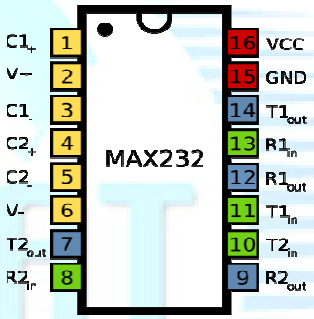
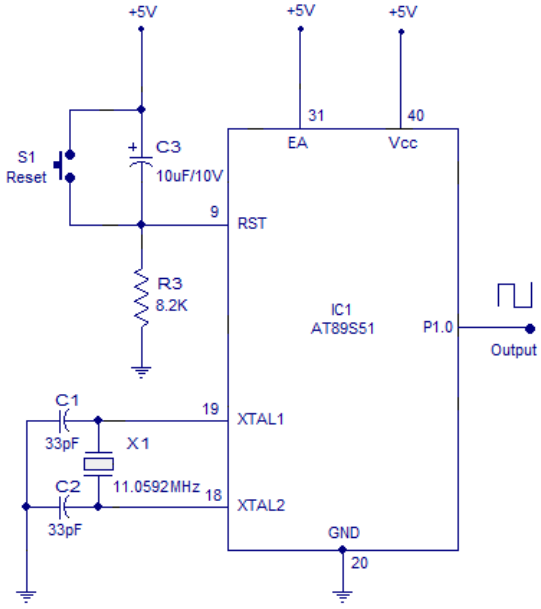


Fig 5. Max232 PIN Diagram

6. Microcontroller

The 8051 microcontroller is the most general purpose microcontroller today. We are using an 8-bit dual inline package that has 40 pins and is popularly known as DIP and works at +5 Volts DC. The microcontroller has 128 bytes of RAM and 4K bytes of on-chip ROM, two timers, one serial port, four ports all on single chip. The basic pins include Pin.9 called the rest pin which is required to initialize the microcontroller. Pin.18 & Pin.19 are for the system clock system from the crystal clock circuit.V_{cc} and ground is provided by Pin.40 and Pin.20 respectively.



7. Conclusion

Thus, the paper here presented covers all the hardware components and software requirement for the project "Safety helmet for coal miners using ZigBee technology" and as well as they are tested. Each component used is decided after a thorough research on project and used to produce best efficiency of the project with least amount of expenditure. Therefore system is reliable and supports even in versatile environment smoothly. It is easy to apply on larger level and best advantage is light weight and easily portable. With easy installation system can be easily extended too, using ZigBee Wireless positioning devices in future we can locate every miner inside mines and track their movement

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