SMART HELMET FOR COAL MINERS

USING ZIGBEE TECHNOLOGY

A PROJECT REPORT

Submitted by

KIRUBADHARSHINI . B **Reg. No : 13BEC074**

PAVITHRA . S **Reg. No : 13BEC099**

PUNITHA . S **Reg. No : 13BEC114**

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BONAFIDE CERTIFICATE

Certified that this project report titled **"SMART HELMET FOR COAL MINERS USING ZIGBEE TECHNOLOGY" is the bonafide work of Ms KIRUBADHARSHINI.B [13BEC074], Ms PAVITHRA.S [13BEC099] and Ms PUNITHA.S [13BEC114]** who carried out the project work under my supervision. Certified further that to the best of my knowledge the work reported herein does not form part of any other project or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

SIGNATURE
Ms.S.NAGARATHINAM ,M.E.,(Ph.D)
PROJECT SUPERVISOR
Department of ECE
Kumaraguru College of Technology
Coimbatore-641049.

SIGNATURE
Dr. K.MALARVIZHI M.E.,Ph.D.,
HEAD OF THE DEPARTMENT
Department of ECE
Kumaraguru College of Technology
Coimbatore -641049.

The candidates with Register numbers 13BEC074, 13BEC099 and 13BEC114 are examined by us in the project viva-voce examination held on …….

EXTERNAL EXAMINER **INTERNAL EXAMINER**

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ABSTRACT

In recent days coal mining has been a very dangerous activity that can result in a number of adverse effects on the environment. This project focuses on a mine supervising system which is based on the cost effective Zigbee system. Our project aims at developing a wireless sensor networks, realized realtime surveillance with early-warning intelligence on harmful gases, temperature and humidity in mining area and used Zigbee communication to reduce potential safety problems in coal production. All these three parameters are detected continuously by temperature sensor, gas sensor, humidity sensor and if they cross the pre-defined limit, then the user gets alert through speaker, which is positioned in the helmet so that a miner can have a chance to rescue his life from the hazards occurred in coal mines. The improved safety features in our system dramatically increased life expectancy of the coal miners by alerting them about the hazards. Also this hazardous information will also goes to the control station through the Zigbee transceiver and the results will be analysed through LabVIEW.

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LIST OF ABBREVATIONS

PIC	Peripheral Interface Controller
LabVIEW	Laboratory Virtual Instrument Engineering Workbench
RISC	Reduced Instruction Set Computer
CMOS	Complementary Metal Oxide Semiconductor
LED	Light Emitting Diode
LCD	Liquid Crystal Display

FIFO	First In First Out
ADC	Analog to Digital Converter
DAC	Digital to Analog Converter
SPI	Serial Peripheral Interface
LPG	Liquefied Petroleum Gas
EPROM	Erasable Programmable Read Only Memory
SSP	Synchronous Serial Port
NTC	Negative Temperature Coefficient
PTC	Positive Temperature Coefficient
PWM	Pulse Width Modulation
ICSP	In-Circuit Serial Programming
DTE	Data Terminal Equipment
DCE	Data Communication Equipment
CO	Carbon monoxide

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CHAPTER - 1

INTRODUCTION

The most important part of any type of industry is safety. Communication is the most vital key factor today, to monitor different parameters such as temperature, increasing humidity level and carbon monoxide gas continuously using sensors such as temperature sensor, gas sensor MQ6 and humidity sensor to take necessary actions accordingly to avoid any types of hazardous conditions and gives an alert using speaker. The wired communication network technology system will be not so effective. Under the mines due to uncomfortable situation the installation cost as well as maintenance cost is high for wired communication networks. For the successfully wireless data transmission, in this work a low cost Zigbee is utilized in routers.

A cost effective based wireless mine supervising system with early-warning security system on carbon monoxide, temperature, humidity in mining area is proposed. The programme adopted ZigBee wireless technology to build wireless sensor networks, realized real-time surveillance with early-warning intelligence on methane, temperature, humidity in mining area, and used speech communication to reduce potential safety problems in coal production.

The proposed system consists of two sections the first section is underground section and another section is ground section. In underground section the sensors will sense the environment conditions such as temperature, gas, humidity etc.., and this information is send to the PIC controller. PIC controller displays this information in the LCD as well as alert the miner about the hazardous situation via speaker and sends through Zigbee transmitter. In ground section Zigbee receiver take that information, displayed it in LCD and also the results were analysed using LabVIEW in PC. The information regarding the number of persons working inside the mine is also sent to the control station using IR sensor.

CHAPTER – 2

HARDWARE DESCRIPTION

2.1 PIC MICROCONTROLLER

The microcontroller that has been used for this project is from PIC series. PIC microcontroller is the first RISC based microcontroller fabricated in CMOS (complimentary metal oxide semiconductor) that uses separate bus for instruction and data allowing simultaneous access of program and data memory.

The main advantage of CMOS and RISC combination is low power consumption resulting in a very small chip size with a small pin count. The main advantage of CMOS is that it has immunity to noise than other fabrication techniques.

2.1.1 PIC (16F877A)

Various microcontrollers offer different kinds of memories. EEPROM, EPROM, FLASH etc. are some of the memories of which FLASH is the most recently developed. Technology that is used in PIC 16F877A is flash technology, so that data is retained even when the power is switched off. Easy Programming and Erasing are other features of PIC 16F877A.

2.1.2 FEATURES OF PIC

CORE FEATURES

- High-performance RISC CPU.
- Only 35 single word instructions to learn.
- All single cycle instructions except for program branches which are two cycle.
- Operating speed: DC - 20 MHz clock input.
- Up to 8K x 14 words of Flash Program Memory.

- Pin out compatible to the PIC16C73/74/76/77.
- Interrupt capability (up to 14 internal/external).
- Eight level deep hardware stack.
- Low-power, high-speed CMOS EPROM/EEPROM technology.
- In-Circuit Serial Programming (ICSP) via two pins.
- Only single 5V source needed for programming capability.
- Wide operating voltage range: 2.5V to 5.5V.
- High Sink/Source Current: 25 mA.
- Commercial and Industrial temperature ranges.
- Low-power consumption:
    - 2mA typical @ 5V, 4 MHz.
    - 20mA typical @ 3V, 32 kHz.
    - 1mA typical standby current.

PERIPHERAL FEATURES

- Timer0: 8-bit timer/counter with 8-bit prescaler.
- Timer1: 16-bit timer/counter with prescaler, can be incremented during sleep via external crystal/clock.
- Timer2: 8-bit timer/counter with 8-bit period register, prescaler and postscaler.
- Two Capture, Compare, PWM modules.
    - Capture is 16-bit, max resolution is 12.5 ns,
    - Compare is 16-bit, max resolution is 200 ns,
    - PWM max. resolution is 10-bit.
- 10-bit multi-channel Analog-to-Digital converter.
- Synchronous Serial Port (SSP) with SPI. (Master Mode) and I2C. (Master/Slave).

2.1.3 PIN DIAGRAM OF PIC

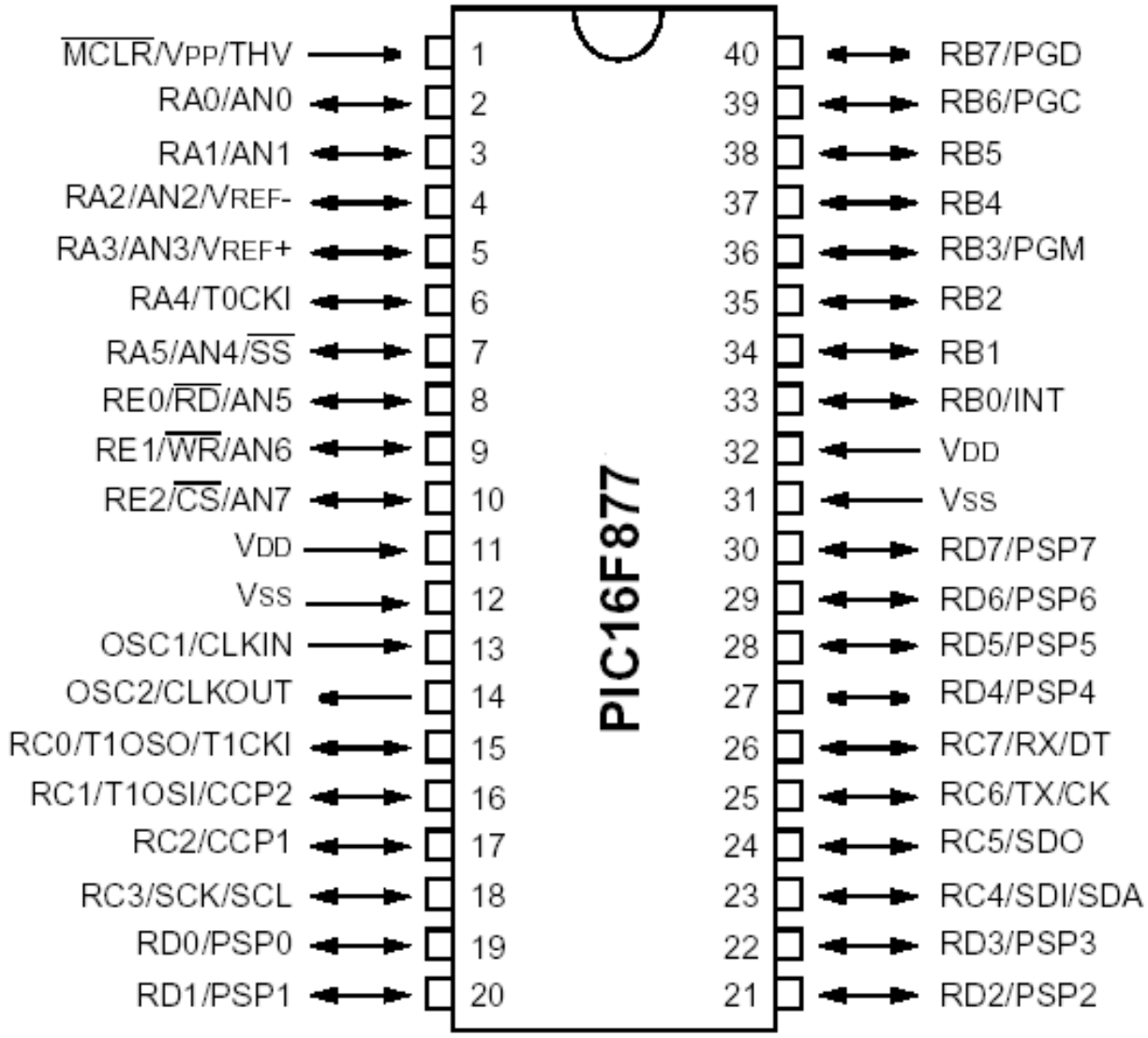


Fig.no 2.1

2.1.4 I/O PORTS

Some pins for these I/O ports are multiplexed with an alternate function for the peripheral features on the device. In general, when a peripheral is enabled, that pin may not be used as a general purpose I/O pin.

PORT A FUNCTIONS

Name	Bit#	Buffer	Function
RA0/AN0	bit0	TTL	Input/output or analog input
RA1/AN1	bit1	TTL	Input/output or analog input
RA2/AN2	bit2	TTL	Input/output or analog input
RA3/AN3/VREF	bit3	TTL	Input/output or analog input or VREF
RA4/T0CKI	bit4	ST	Input/output or external clock input for Timer0 Output is open drain type
RA5/$\overline{SS}$/AN4	bit5	TTL	Input/output or slave select input for synchronous serial port or analog input

Table no 1.1

PORT B FUNCTIONS

Name	Bit#	Buffer	Function
RB0/INT	bit0	TTL/ST(1)	Input/output pin or external interrupt input. Internal software programmable weak pull-up.
RB1	bit1	TTL	Input/output pin. Internal software programmable weak pull-up.
RB2	bit2	TTL	Input/output pin. Internal software programmable weak pull-up.
RB3/PGM	bit3	TTL	Input/output pin or programming pin in LVP mode. Internal software programmable weak pull-up.
RB4	bit4	TTL	Input/output pin (with interrupt on change). Internal software programmable weak pull-up.
RB5	bit5	TTL	Input/output pin (with interrupt on change). Internal software programmable weak pull-up.
RB6/PGC	bit6	TTL/ST(2)	Input/output pin (with interrupt on change) or In-Circuit Debugger pin. Internal software programmable weak pull-up. Serial programming clock.
RB7/PGD	bit7	TTL/ST(2)	Input/output pin (with interrupt on change) or In-Circuit Debugger pin. Internal software programmable weak pull-up. Serial programming data.

Legend: TTL = TTL input, ST = Schmitt Trigger input

Note 1: This buffer is a Schmitt Trigger input when configured as the external interrupt.

2: This buffer is a Schmitt Trigger input when used in serial programming mode.

Table no 1.2

PORT C FUNCTIONS

Name	Bit#	Buffer Type	Function
RC0/T1OSO/T1CKI	bit0	ST	Input/output port pin or Timer1 oscillator output/Timer1 clock input
RC1/T1OSI/CCP2	bit1	ST	Input/output port pin or Timer1 oscillator input or Capture2 input/ Compare2 output/PWM2 output
RC2/CCP1	bit2	ST	Input/output port pin or Capture1 input/Compare1 output/PWM1 output
RC3/SCK/SCL	bit3	ST	RC3 can also be the synchronous serial clock for both SPI and I^2C modes.
RC4/SDI/SDA	bit4	ST	RC4 can also be the SPI Data In (SPI mode) or data I/O (I^2C mode).
RC5/SDO	bit5	ST	Input/output port pin or Synchronous Serial Port data output
RC6/TX/CK	bit6	ST	Input/output port pin or USART Asynchronous Transmit or Synchro-nous Clock
RC7/RX/DT	bit7	ST	Input/output port pin or USART Asynchronous Receive or Synchro-nous Data

Legend: ST = Schmitt Trigger input

Table no 1.3

PORT D FUNCTIONS

Name	Bit#	Buffer Type	Function
RD0/PSP0	bit0	ST/TTL(1)	Input/output port pin or parallel slave port bit0
RD1/PSP1	bit1	ST/TTL(1)	Input/output port pin or parallel slave port bit1
RD2/PSP2	bit2	ST/TTL(1)	Input/output port pin or parallel slave port bit2
RD3/PSP3	bit3	ST/TTL(1)	Input/output port pin or parallel slave port bit3
RD4/PSP4	bit4	ST/TTL(1)	Input/output port pin or parallel slave port bit4
RD5/PSP5	bit5	ST/TTL(1)	Input/output port pin or parallel slave port bit5
RD6/PSP6	bit6	ST/TTL(1)	Input/output port pin or parallel slave port bit6
RD7/PSP7	bit7	ST/TTL(1)	Input/output port pin or parallel slave port bit7

Legend: ST = Schmitt Trigger input TTL = TTL input
Note 1: Input buffers are Schmitt Triggers when in I/O mode and TTL buffer when in Parallel Slave Port Mode.

Table no 1.4

Fig.no 2.2

PORT E FUNCTIONS

Name	Bit#	Buffer Type	Function
RE0/$\overline{RD}$/AN5	bit0	ST/TTL(1)	Input/output port pin or read control input in parallel slave port mode or analog input: $\overline{RD}$ 1 = Not a read operation 0 = Read operation. Reads PORTD register (if chip selected)
RE1/$\overline{WR}$/AN6	bit1	ST/TTL(1)	Input/output port pin or write control input in parallel slave port mode or analog input: $\overline{WR}$ 1 =Not a write operation 0 =Write operation. Writes PORTD register (if chip selected)
RE2/$\overline{CS}$/AN7	bit2	ST/TTL(1)	Input/output port pin or chip select control input in parallel slave port mode or analog input: $\overline{CS}$ 1 = Device is not selected 0 = Device is selected

Legend: ST = Schmitt Trigger input TTL = TTL input
Note 1: Input buffers are Schmitt Triggers when in I/O mode and TTL buffers when in Parallel Slave Port Mode.

Table no 1.5

2.1.5 ADVANTAGES OF PIC

- PIC microcontrollers are consistent and malfunctioning of PIC percentage is very less.
- They are reliable.
- The performance of the PIC microcontroller is very fast because of using RISC architecture.
- When comparing to other microcontrollers, power consumption is vey less and programming is also very easy.
- Interfacing of an analog device is easy without any extra circuitry.

2.1.6 APPLICATIONS OF PIC

Household appliances – washing machine, remote control, light control, video games, TV tuner, intercom and sewing machine.

Office Equipment – telephones, fax machines, printers and security systems.

Instruments – digital thermometers, level meters and multimeters.

Peripheral Devices – keyboard controllers, modems and plotters.

Motor Control – speed control of AC and DC motors, position control using servo motors and stepper motors.

Industry – process control systems and automobile applications.

2.2 TEMPERATURE SENSOR

The Thermistor is another type of temperature sensor, whose name is a combination of the words THERM-ally sensitive res-ISTOR. A thermistor is a special type of resistor which changes its physical resistance when exposed to changes in temperature. Thermistors are generally made from ceramic materials such as oxides of nickel, manganese or cobalt coated in glass which makes them easily damaged. Their main advantage over snap-action types is their speed of response to any changes in temperature, accuracy and repeatability. Most types of thermistor's have a Negative Temperature Coefficient of resistance or (NTC), that is their resistance value goes down with an increase in the temperature, and of course there are some which have a Positive Temperature Coefficient (PTC), in that their resistance value goes UP with an increase in temperature.

Thermistors are constructed from a ceramic type semiconductor material using metal oxide technology such as manganese, cobalt and nickel, etc. The semiconductor material is generally formed into small pressed discs or balls which are hermetically sealed to give a relatively fast response to any changes in temperature. Thermistors are rated by their resistive value at room temperature (usually at 25^{O} C), their time constant (the time to react to the temperature change) and their power rating with respect to the current flowing through them. Like resistors, thermistors are available with resistance values at room temperature from 10's of MO down to just a few Ohms, but for sensing purposes those types with values in the kilo-ohms are generally used. Thermistors are passive resistive devices which means it is required to pass a current through it to produce a measurable voltage output. Then thermistors are generally connected in series with a suitable biasing resistor to form a potential divider network and the choice of resistor gives a voltage output at some pre-determined temperature point .

2.2.1 VOLTAGE DIVIDER CIRCUIT

Developing more than one voltage level from a single power supply.

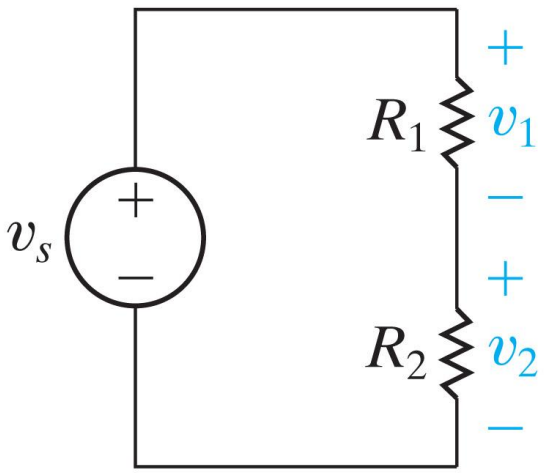


Fig.no 2.3

2.2.2 POTENTIAL DIVIDER CIRCUIT

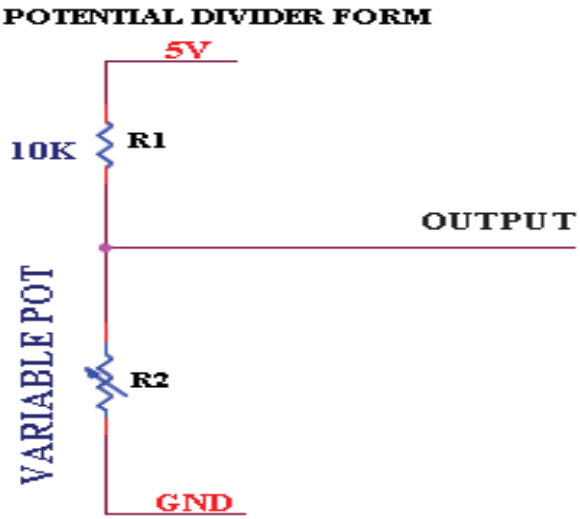


Fig.no 2.4

- If the R1 and R2 value is equal means the output is half of the VCC supply. In this circuit output is a variable one. So the output is depending upon the R2 resistance value.
- Resistance value will be varied depend upon the Temperature level. Temperature varied means the resistance value also varied.
- If resistance value increased means output also increased. The resistance value and output is a directly proportional one.
- Then the final voltage is given to ADC for convert the analog signal to digital signal. Then the corresponding digital signal is taken to process in microcontroller.

2.2.3 THERMISTOR CHARACTERSTICS

The resistance increase with increase in temperature for PTC and resistance decrease with increase in temperature for NTC. The thermistor exhibits a highly non-linear characteristic of resistance vs temperature. PTC thermistors can be used as heating elements in small temperature controlled ovens. NTC thermistors can be used as inrush current limiting devices in power supply circuits. Inrush current refers to maximum, instantaneous input current drawn by an electrical device when first turned on. Thermistors are available in variety of sizes and shapes, smallest in size are the beads with a diameter of 0.15mm to 1.25mm. There are two fundamental ways to change the temperature of thermistor internally or externally. The temperature of thermistor can be changed externally by changing the temperature of surrounding media and internally by self-heating resulting from a current flowing through the device.

2.2.4 THERMISTOR APPLICATIONS

- PTC thermistors were used as timers in the degaussing coil circuit of most CRT displays. A degaussing circuit using a PTC thermistor is simple, reliable (for its simplicity), and inexpensive.
- PTC thermistors can be used as heater in automotive industry to provide additional heat inside cabin with diesel engine or to heat diesel in cold climatic conditions before engine injection.
- PTC thermistors can be used as current-limiting devices for circuit protection, as replacements for fuses.
- NTC thermistors can be used as to monitor the temperature of an incubator.
- Thermistors are also commonly used in modern digital thermostats and to monitor the temperature of battery packs while charging.

- NTC thermistors can be used in automotive applications.
- NTC thermistors are used in the Food Handling and Processing industry, especially for food storage systems and food preparation. Maintaining the correct temperature is critical to prevent food borne illness.
- NTC thermistors are used throughout the Consumer Appliance industry for measuring temperature. Toasters, coffee makers, refrigerators, freezers, hair dryers, etc. all rely on thermistors for proper temperature control.
- The Thermistors are used in the hot ends of 3D printers. They monitor the heat produced and allow the printer's control circuitry to keep a constant temperature for melting the plastic filament.
- NTC thermistors are used as resistance thermometers in low-temperature measurements of the order of 10 K.
- NTC thermistors can be used as inrush-current limiting devices in power supply circuits.

Fig.no 2.5

2.3 HUMIDITY SENSOR

Humidity is the amount of water vapor in an air sample. There are three different ways to measure humidity, absolute humidity, relative humidity, and specific humidity. Relative humidity is the most frequently

encountered measurement of humidity because it is regularly used in weather forecasts. A humidity sensor, also called a hygrometer, measures and regularly reports the relative humidity in the air. They may be used in homes for people with illnesses affected by humidity; as part of home heating, ventilating, and air conditioning systems. Humidity sensors can also be used in cars, office and industrial systems and in meteorology stations to report and predict weather.

A Humidity sensor senses relative humidity. This means that it measures both air temperature and moisture. Relative humidity, expressed as a percent, is the ratio of actual moisture in the air to the highest amount of moisture air at that temperature can hold. The warmer the air is, the more moisture it can hold, so relative humidity changes with fluctuations in temperature. The most common type of Humidity sensor uses what is called “capacitive measurement.” This system relies on electrical capacitance, or the ability of two nearby electrical conductors to create an electrical field between them. The sensor itself is composed of two metal plates with a non-conductive polymer film between them. The film collects moisture from the air, and the moisture causes minute changes in the voltage between the two plates. The changes in voltage are converted into digital readings showing the amount of moisture in the air.

Fig.no 2.6

2.3.1 HUMIDITY MEASUREMENT

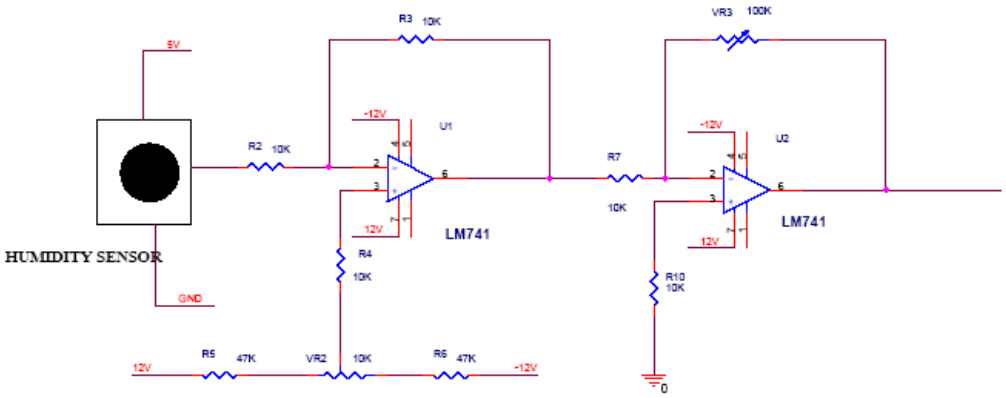


Fig.no 2.7

2.3.2 CIRCUIT DESCRIPTION

This circuit is designed to measure the humidity level in the atmospheric air. The humidity sensor is used for the measurement device. The humidity sensor is consists of astable mulitivibrator in which the capacitance is varied depends on the humidity level. So the multivibrator produce the varing pulse signal which is converted into corresponding voltage signal.

The voltage signal is given to inverting input terminal of the comparator. The reference voltage is given to non inverting input terminal. The comparator is designed by the LM 741 operational amplifier.

The comparator is compared with reference humidity level and delivered the corresponding error voltage at its output which is given to next stage of gain amplifier in which the variable resistor is connected in the feedback path by adjusting the resistor in order to get the desired gain. Then the final voltage is given to microcontroller or other circuit in order to find the humidity level in the atmosphere.

2.3.3 APPLICATIONS OF HUMIDITY SENSOR

- Used as a part of home heating, ventilating and air conditioning system.
- Used in offices, cars, humidors, museums, industrial spaces and greenhouses and are also used in meterology stations to report and predict weather.
- For measurements in complex industrial applications and under rough operating conditions.

2.4 GAS SENSOR

Electrochemical gas sensors are gas detectors that measure the concentration of a target gas by oxidizing or reducing the target gas at an electrode and measuring the resulting current.

Fig.no 2.8

Ideal sensor can be used to detect the presence of a dangerous LPG leak in your car or in a service station, storage tank environment. This unit can be easily incorporated into an alarm unit, to sound an alarm or give a visual indication of the LPG concentration. The sensor has excellent sensitivity combined with a quick response time. The sensor can also sense iso-butane, propane and cigarette smoke.

2.4.1 CIRCUIT DIAGRAM

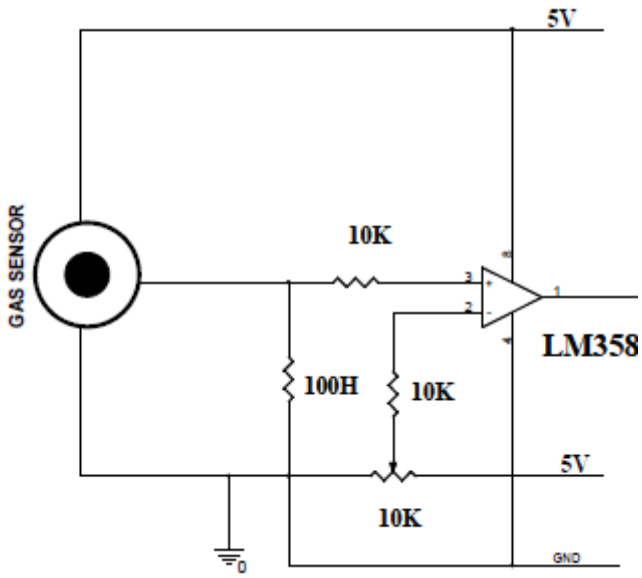


Fig.no 2.9

2.4.2 CIRCUIT DESCRIPTION

The gas sensor is the special sensor which designed for sense the gas leakage. In the gas sensor the supply voltage is given to input terminal. The gas sensor output terminals are connected to non inverting input terminal of the non inverting amplifier.

Non inverting amplifier amplifies the voltage level and sends the signal to the PIC microcontroller.

2.4.3 FEATURES OF GAS SENSOR

• High Sensitivity.
• Detection Range: 100 - 10,000 ppm.
• Fast Response Time: <10s.
• Heater Voltage: 5.0V.
• Dimensions: 18mm Diameter, 17mm High excluding pins, Pins - 6mm High.

2.4.4 APPLICATIONS OF GAS SENSOR

Safety field

- Battery operated CO alarm.
- Battery operated LP detector in a gas storage station.
- Combined fire, gas, and CO alarm; Fire (temperature) + gas leak (town gas) + incomplete combustion (CO).

Environmental field

- Battery operated air monitor built in a remote controller.
- Air conditioner with an air purifier.
- Home use air purifiers.
- Ventilation with carbon monoxide monitor.
- Air damper controller in automobiles.
- Ozone monitor.
- Odor analyser.

Health field

- Breath odor checker.
- Breath alcohol checker.
- Halitosis analyser.

Super sensitivity field

- Hydrogen sulfide analyser.
- Acetone analyser.

2.5 IR SENSOR

An Infrared sensor (IR sensor) is an electronic device that measures infrared(IR) light radiating from objects in its field of view. Apparent motion is detected when an infrared source with one temperature, such as a human, passes in front of an infrared source with another temperature, such as a wall. All objects emit what is known as black body radiation. It is usually infrared radiation that is invisible to the human eye but can be detected by electronic devices.

Infrared transmitter is one type of LED which emits infrared rays generally called as IR transmitter. Similarly IR receiver is used to receive the IR rays transmitted by the IR transmitter. IR receiver receives the signal from the transmitter if the resistance is low. When the resistance goes high, the signal will cut off. By this way the sensor works and sense the value.

2.5.1 CIRCUIT DIAGRAM

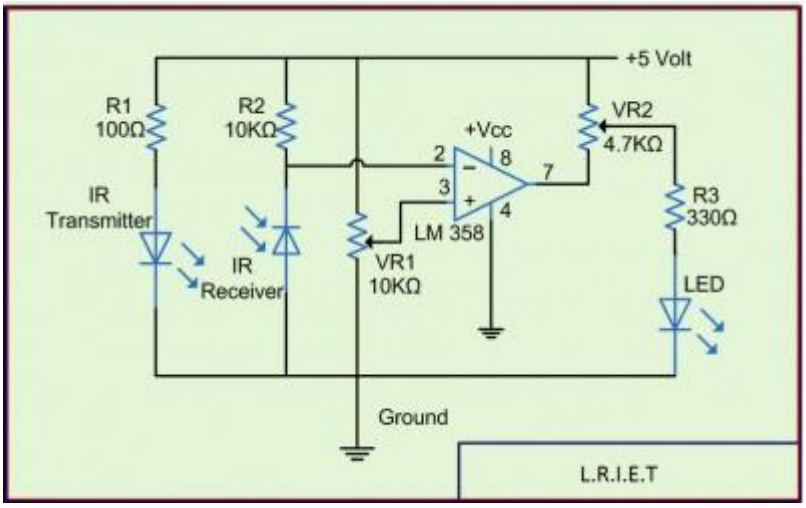


Fig.no 2.10

2.5.2 CIRCUIT DESCRIPTION

The transmitter section includes an IR sensor, which transmits continuous IR rays to be received by an IR receiver module. An IR output terminal of the receiver varies depending upon its receiving of IR rays. Since this variation cannot be analyzed as such, therefore this output can be fed to a comparator circuit. Here an operational amplifier (op-amp) of LM 339 is used as comparator circuit.

When the IR receiver does not receive a signal, the potential at the inverting input goes higher than that non-inverting input of the comparator IC (LM339). Thus the output of the comparator goes low, but the LED does not glow. When the IR receiver module receives signal , the potential at the inverting input goes low. Thus the output of the comparator (LM 339) goes high and the LED starts glowing. Resistor R1 (100), R2 (10k) and R3 (330) are used to ensure that minimum 10 mA current passes through the IR LED Devices like Photodiode and normal LEDs respectively. Resistor VR2 (preset=5k) is used to adjust the output terminals. Resistor VR1 (preset=10k) is used to set the sensitivity of the circuit .

2.5.3 APPLICATIONS

Radiation Thermometers

IR sensors are used in radiation thermometers to measure the temperature depend upon the temperature and the material of the object and these thermometers have some of the following features

- Measurement without direct contact with the object.
- Faster response.

- Easy pattern measurements.

Flame Monitors

These types of devices are used for detecting the light emitted from the flames and to monitor how the flames are burning. The Light emitted from flames extend from UV to IR region types. PbS, PbSe, Two-color detector, pyro electric detector are some of the commonly employed detector used in flame monitors.

Moisture analyzers

It use wavelengths which are absorbed by the moisture in the IR region. Objects are irradiated with light having these wavelengths (1.1 µm, 1.4 µm, 1.9 µm, and 2.7µm) and also with reference wavelengths. The Lights reflected from the objects depend upon the moisture content and is detected by analyzer to measure moisture (ratio of reflected light at these wavelengths to the reflected light at reference wavelength). In GaAs PIN photodiodes, Pbs photoconductive detectors are employed in moisture analyzer circuits.

IR Imaging Devices

IR image device is one of the major applications of IR waves, primarily by virtue of its property that is not visible. It is used for thermal imagers, night vision devices, etc.

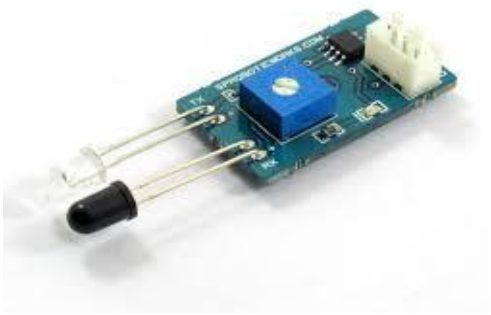


Fig.no 2.11

2.6 ZIGBEE MODULE

The mission of the ZigBee Working Group is to bring about the existence of a broad range of interoperable consumer devices by establishing open industry specifications for unlicensed, untethered peripheral, control and entertainment devices requiring the lowest cost and lowest power consumption communications between compliant devices anywhere in and around the home.

The ZigBee specification is a combination of HomeRF Lite and the 802.15.4 specification. This operates in the 2.4GHz radio band - the same band as 802.11b standard, Bluetooth, microwaves and some other devices. It is capable of connecting 255 devices per network. It also supports data transmission rates of up to 250 Kbps at a range of up to 30 meters. ZigBee's technology is slower than 802.11b (11 Mbps) and Bluetooth (1 Mbps) but it consumes significantly less power.

2.6.1 CIRCUIT DIAGRAM

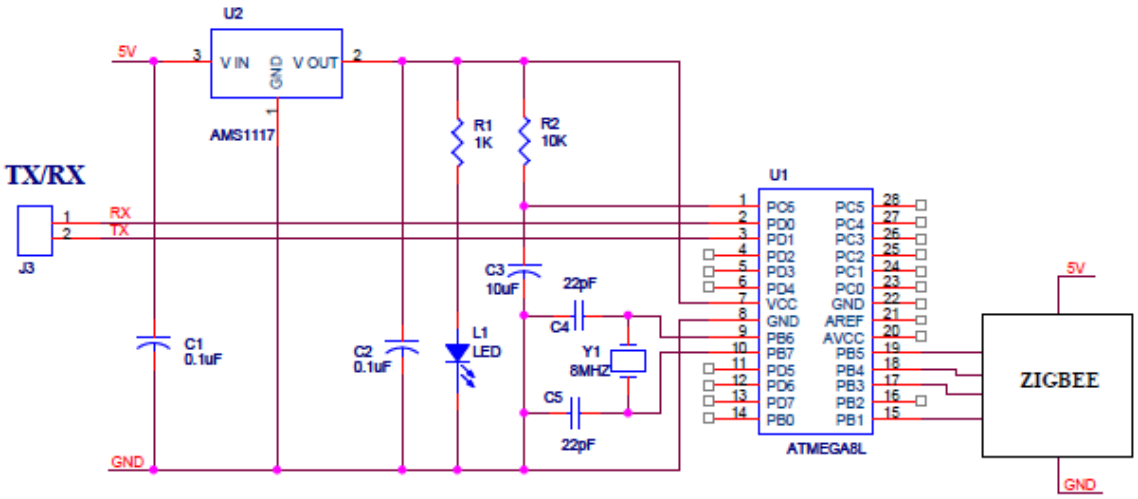


Fig.no 2.12

2.6.2 CIRCUIT DESCRIPTION

CC2500 is wireless transmitter receiver developed by Texas instruments which is used in 2400-2483.5 MHz ISM/SRD band systems. The input present at PORTD of transmitter atmega8 is transmitted wirelessly to the PORTD of receiver atmega8. The CC2500 RF module is a low-cost 2.4 GHz transceiver used in very low power wireless applications. The RF transceiver is integrated with a highly configurable baseband modem. It works in voltage range of 1.8 - 3.6V. Two AA batteries are enough to power it. It has 30m range with onboard antenna. It is always used with microcontroller which supports SPI communication.

Programming CC2500:

SPI interface: CC2500 is configured via a simple 4-wire SPI compatible interface (SI, SO, SCLK and CSn) where CC2500 is the slave and microcontroller (here atmega8) is used as master.

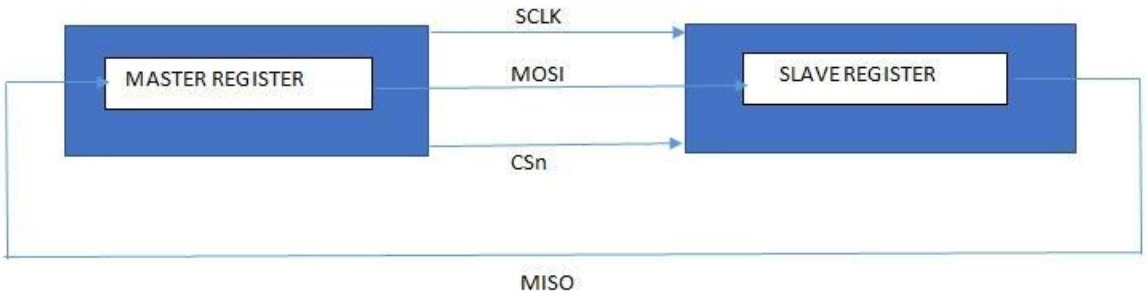


Fig.no 2.13

Register access and commands are given serially to CC2500 by atmega8 with SPI interface. In SPI, master generate clock and chip select signal. SPI communication involves two shift registers. One in master and other in slave. Data is shifted from master to slave and slave to master in circular manner in

synchronous with clock generated by master and at the end of shift operation, data in master register and slave register is exchanged.

In CC2500, all transfers on the SPI interface are done in most significant bit first. All transactions on the SPI interface start with a header byte containing a R/W bit, a burst access bit (B), and a 6-bit address (A5 – A0). The CSn pin must be kept low during transfers on the SPI bus. If CSn goes high during the transfer of a header byte or during read/write from/to a register, the transfer will be cancelled.

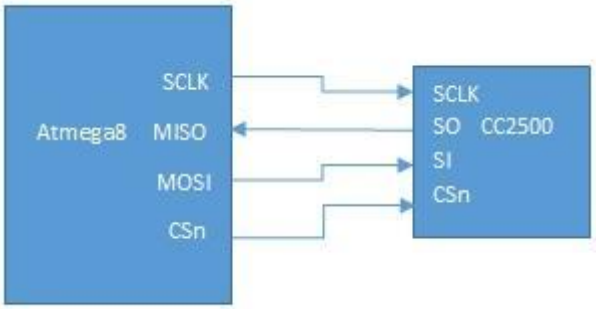


Fig.no 2.14

Initialize/configure CC2500:

There are total 47 configuration registers in CC2500 which has to be programmed with SPI interface after each time the chip is reset. CC2500 can enter into transmitter or receiver mode or decide data transmission rate and type of modulation by programming these registers.

The optimum configuration data based on selected system parameters can be most easily found in CC2500 datasheet by using Smart RF Studio software. The configuration registers starts from address 0x00 and end at 0x2F. To write data into configuration register Atmega8 sends two bytes to CC2500 through SPI interface.

The two bytes are as follow:

1st byte (address byte)

r/w=0	Burst= 0	A5	A4	A3	A2	A1	A0

2nd byte (data byte)

D7	D6	D5	D4	D3	D2	D1	D0

These two bytes are sent one after the other. The last five bits (A5-A0) of byte one gives CC2500 the address of register and next byte give data to be written into the registers. SPI interface is exchange of data between master and slave, when atmega8(master) sends these two bytes it get two bytes in exchange which gives status of the CC2500. This way CC2500 program its configuration registers. Now CC2500 is ready to transmit or receive data wirelessly.

Transmit or receive data:

Similar to the configuration register there are tx and rx FIFO registers. To transmit data wirelessly, data has to be written into tx FIFO in similar way as data must be written in config register. Address byte and data byte are given to CC and CC will write data in its tx FIFO. The 'STX' command is given for sending the data in the tx FIFO wirelessly. The address for tx FIFO is 0x3F. So A5-A0=111111. Since it is in burst mode, 3 bytes of data has been sent, so 6th bit of address byte will be 1. Hence address byte is 01111111= 0x7F.

Similarly, whenever CC2500 receives some data, it gets stored in Rx FIFO and CC generates interrupt on GD0 pin. Atmega8 continuously check GD0 pin by polling method. Whenever interrupt is generated on GD0 pin, Atmega8 reads data from Rx FIFO. To read data from CC2500 register again two bytes are sent by atmega8. One is address byte and second one is data byte. But now atmega8

will send data byte as 0x00 and in exchange CC2500 will send the value in register to atmega8. For read operation, MSB of address byte will be '1' and to receive continuous three bytes of data, burst mode is being used and also the address of TX and RX FIFO are same. Thus address byte is 0xFF.

2.6.3 CHARACTERISTICS OF ZIGBEE

- Data rates of 250 kbps (@2.4 GHz), 40 kbps (@ 915 MHz), and 20 kbps (@868 MHz).
- Optimized for low duty-cycle applications (<0.1%).
- Low power (battery life multi-month to years).
- Multiple topologies: star, peer-to-peer, mesh.
- Optional guaranteed time slot for applications requiring low latency.
- Fully hand-shaked protocol for transfer reliability.
- Range: 50m typical (5-500m based on environment).

2.6.4 FEATURES OF ZIGBEE

- Low current consumption. (rx:13. 3ma,tx:21. 2ma @0dbm output power).
- Efficient SPI interface.
- Operating voltage :1. 8~ 3. 6 volts.
- Vailable frequency at : 2. 4-2. 483 Ghz.
- Programmable output power (up to +1dbm).
- Small footprint. In a 17x17mm,8pin pinout.
- Powerful digital features allow building a high-performance RF system.
- Using an inexpensive microcontroller.
- Burst mode data transmission with high over-the-air datarate.
- Reduces current consumption.
- Programmable data rate from1. 2-500kbps.

- Robust solution with excellent selectivity and blocking performance.
- Ideal for multi-channels operation (50-800KHz channels).

2.6.5 APPLICATIONS OF ZIGBEE

Industrial Automation

In manufacturing and production industries, a communication link continually monitors various parameters and critical equipments. Hence Zigbee considerably reduce this communication cost as well as optimizes the control process for greater reliability.

Home Automation

Zigbee is perfectly suited for controlling home appliances remotely as a lighting system control, appliance control, heating and cooling system control, safety equipment operations and control, surveillance, and so on.

Smart Metering

Zigbee remote operations in smart metering include energy consumption response, pricing support, security over power theft, etc.

Smart Grid monitoring

Zigbee operations in this smart grid involve remote temperature monitoring, fault locating, reactive power management, and so on.

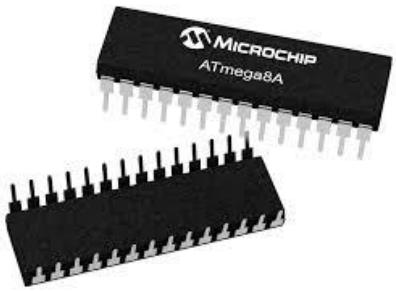


Fig.no 2.15

2.7 VOICE IC APR33A3

The APR33A series are powerful audio processor along with high performance audioanalog-to-digital converters (ADCs) and digital-to-analog converters (DACs). The APR33A series are a fully integrated solution offering high performance and unparalleled integration with analog input, digital processing and analog output functionality. The APR33A series incorporates all the functionality required to perform demanding audio/voice applications. High quality audio/voice systems with lower bill-of-material costs can be implemented with the APR33A series because of its integrated analog data converters and full suite of quality-enhancing features such as sample-rate convertor.

The APR33A series C2.0 is specially designed for simple key trigger, user can record and playback the message averagely for 1, 2, 4 or 8 voice message(s) by switch. It is suitable in simple interface or need to limit the length of single message, e.g. toys, leave messages system, answering machine etc. Meanwhile, this mode provides the power-management system. Users can let the chip enter power-down mode when unused. It can effectively reduce electric current consuming to 15uA and increase the using time in any projects powered by batteries.

2.7.1 RECORDING DURATION

WTV-SR using SPI-FLASH to store voice messages . Duration is in connection with the storage of SPI -FLASH. The latest version support up to 64M SPI-FLASH.

Specific as following table, the table data is from audio recording at 10KHz sample rate (unit: sec).

SPI-FLASH	4Mbit	8Mbit	16Mbit	32Mbit	64Mbit
Recording time (seconds)	101	206	416	836	1600

Table no 1.6

Record Mode (Level-Activated)

A single voice message of up to 20 second can be recorded. The LED pin will go low during the actual recording process to provide a visual indication if an LED light is connected to this pin. The chip is in record mode as long as the RecL pin stays low (level-activated). If the message lasts longer than 20 seconds, recording will terminate automatically after the last available memory cell is written. If the message is shorter than 20 seconds, the recording operation will stop when the RecL pin goes high. The speaker driver is automatically tristated during the recording operation. Messages of up to 30 seconds can be recorded.

Playback Mode (Edge-Activated)

Playback always starts from the beginning of the message. The chip is in playback mode after the PlayE pin pulses low (edge-activated). Playback will stop immediately when the PlayE pin pulses low a second time. If the newly recorded message is shorter than the previously recorded message, the remaining

portion of the previous message will not be played after the new message is played back during playback.

Standby Mode (CE = '0')

The chip will automatically return to the standby state after recording or playback operation is completed.

Power Down Mode (CE = '1')

The chip is always in standby state. No recording or playback is allowed. Current consumption is typically less than 1uA.

2.7.2 FEATURES OF VOICE IC

- Operating Voltage Range: 3V ~ 6.5V.
- Single Chip, High Quality Audio/Voice Recording & Playback Solution.
- No External ICs Required.
- Minimum External Components.
- Programming & Development Systems Not Required.
- Powerful 16-Bits Digital Audio Processor.
- Nonvolatile Flash Memory Technology.
- Very Low Standby Current: 1uA.
- Low Power-Down Current: 15uA.
- Averagely 1,2,4 or 8 voice messages record & playback.

2.8 POWER SUPPLY

Fig.no 2.16

The ac voltage, typically 220V rms, is connected to a transformer, which steps that ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation.

A regulator circuit removes the ripples and also remains the same dc value even if the input dc voltage varies. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.

2.8.1 CIRCUIT DIAGRAM

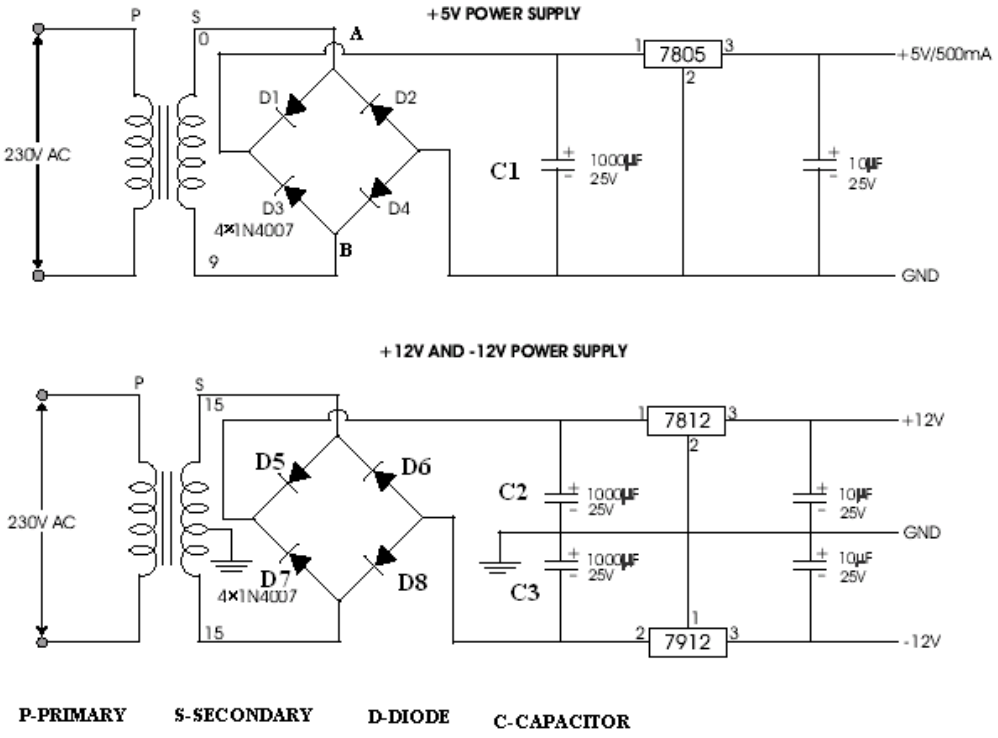


Fig.no 2.17

2.9 LIQUID CRYSTAL DISPLAY

An LCD consists of two glass panels, with the liquid crystal material sand witched in between them. The inner surface of the glass plates are coated with

transparent electrodes which define the character, symbols or patterns to be displayed polymeric layers are present in between the electrodes and the liquid crystal, which makes the liquid crystal molecules to maintain a defined orientation angle.

One each polarisers are pasted outside the two glass panels. These polarisers would rotate the light rays passing through them to a definite angle, in a particular direction.

When the LCD is in the off state, light rays are rotated by the two polarisers and the liquid crystal, such that the light rays come out of the LCD without any orientation, and hence the LCD appears transparent.

When sufficient voltage is applied to the electrodes, the liquid crystal molecules would be aligned in a specific direction. The light rays passing through the LCD would be rotated by the polarisers, which would result in activating / highlighting the desired characters.

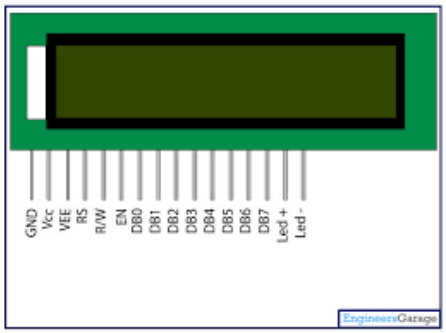


Fig.no 2.18

2.9.1 FEATURES OF LCD

- 5 x 8 dots with cursor.
- Built-in controller (KS 0066 or Equivalent).
- + 5V power supply (Also available for + 3V).
- 1/16 duty cycle.
- B/L to be driven by pin 1, pin 2 or pin 15, pin 16 or A.K (LED).
- N.V. optional for + 3V power supply.

2.9.2 ADVANTAGES

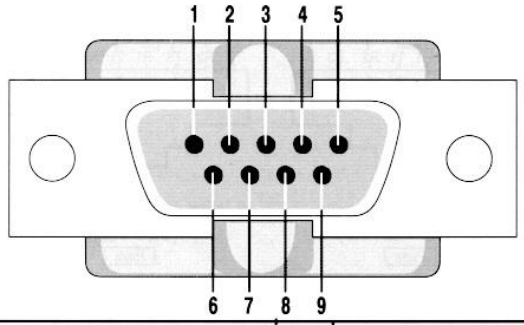
- Very compact, thin and light, especially in comparison with bulky, heavy CRT displays.
- Low power consumption.
- Little heat emitted during operation, due to low power consumption.
- No geometric distortion.
- The possible ability to have little or no "flicker" depending on backlight technology.
- Usually no refresh-rate flicker, because the LCD pixels hold their state between refreshes (which are usually done at 200 Hz or faster, regardless of the input refresh rate).

2.10 RS -232

In telecommunications, RS-232 is a standard for serial communication transmission of data. It formally defines the signals connecting between a DTE (data terminal equipment) such as a computer terminal, and a DCE (data circuit-terminating equipment or data communication equipment), such as a modem. The RS-232 standard is commonly used in computer serial ports. This standard defines the electrical characteristics and timing of signals, the meaning of signals, and the physical size and pinout of connectors. The current version of

the standard is TIA-232-F Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange, issued in 1997.

An RS-232 serial port was once a standard feature of a personal computer, used for connections to modems, printers, mice, data storage, uninterruptible power supplies and other peripheral devices. However, RS-232 is hampered by low transmission speed, large voltage swing, and large standard connectors. In modern personal computers, USB has displaced RS-232 from most of its peripheral interface roles. Many computers no longer come equipped with RS-232 ports and must use either an external USB-to-RS-232 converter or an internal expansion card with one or more serial ports to connect to RS-232 peripherals. Nevertheless, RS-232 devices are still used, especially in industrial machines, networking equipment, and scientific instruments.



Pin	Signal	Pin	Signal
1	Data Carrier Detect	6	Data Set Ready
2	Received Data	7	Request to Send
3	Transmitted Data	8	Clear to Send
4	Data Terminal Ready	9	Ring Indicator
5	Signal Ground		

Fig no.2.19

2.11 BLOCK DIAGRAM

In this project there are two sections. The first section is underground section and another section is ground section. The designed systems are placed in different parts of the mine and connected by means of Zigbee. In underground section the sensors will sense the environment conditions such as temperature,

humidity, gas etc.., and this information is send to ADC of the micro controller, the number of members inside the coal mine is also obtained by means of IR sensor.

Microcontroller displays this information in the Liquid Crystal Display and sends through Zigbee transmitter. In ground section Zigbee receiver take that information and send to the controller and controller sends the information to PC and as well as displaying on the LCD. Here datas can be viewed in PC using LabVIEW.

2.11.1 UNDER GROUND SECTION

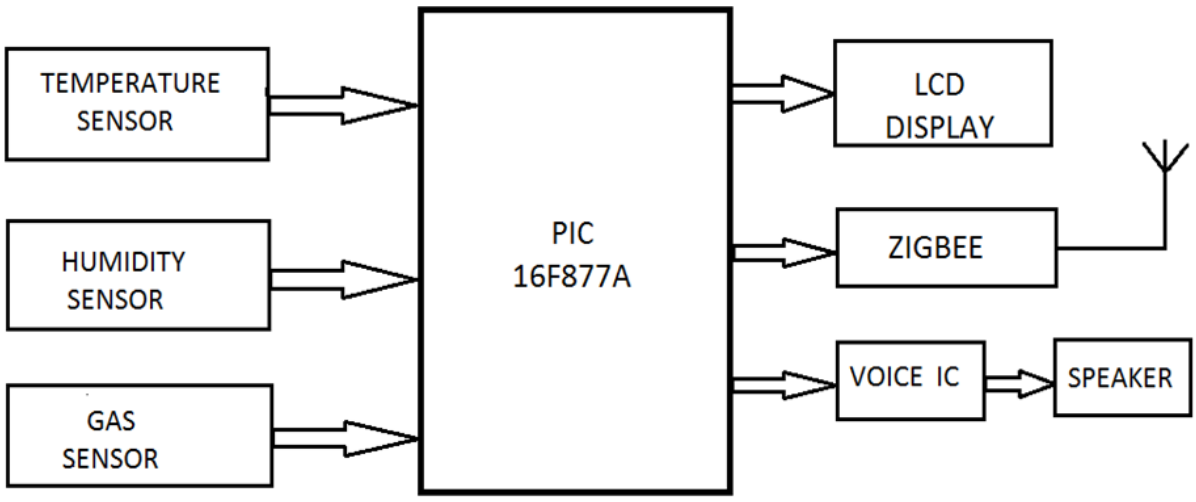


Fig.no 2.20

In the underground section, the parameters temperature, humidity and gas are measured by means of respective sensors and the output voltage measured by them is directly connected to the ADC of the PIC.

Information regarding the safety measures like wearing oxygen helmets etc., will be already given to the workers so that they can save their life. If any of the received parameters are beyond the ultra limit, then a speaker will be ON, giving

warning to the people. The parameters are displayed on the LCD screen and as well as transmitted to the Ground Section through the zigbee transceiver.

2.11.2 GROUND SECTION

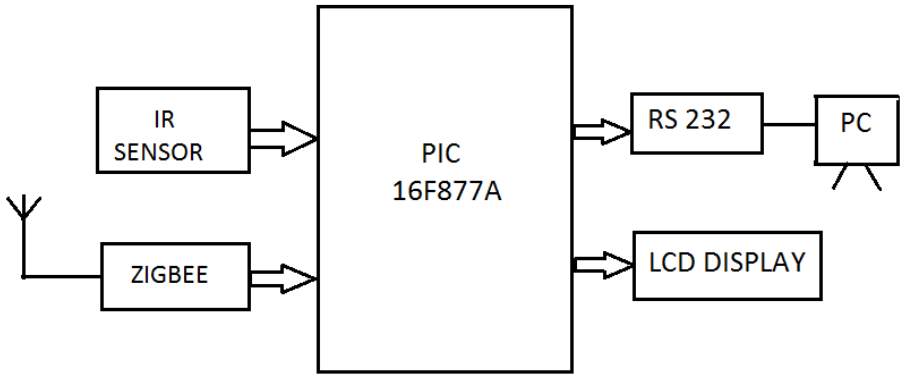


Fig.no 2.21

In the Ground Section, the Zigbee Transceiver receives the information and sends to the ARM controller. The LCD connected to the controller displays the information in the Ground Section.The number of people inside the coalmine is monitored by the help of IR sensor. During a hazard this information will be useful to know whether there are any people remained inside the coal mine. The controller is connected to PC through RS232. The measured values are continuously displayed via LabVIEW and stored in the PC for future use.

2.12 CIRCUIT DIAGRAM

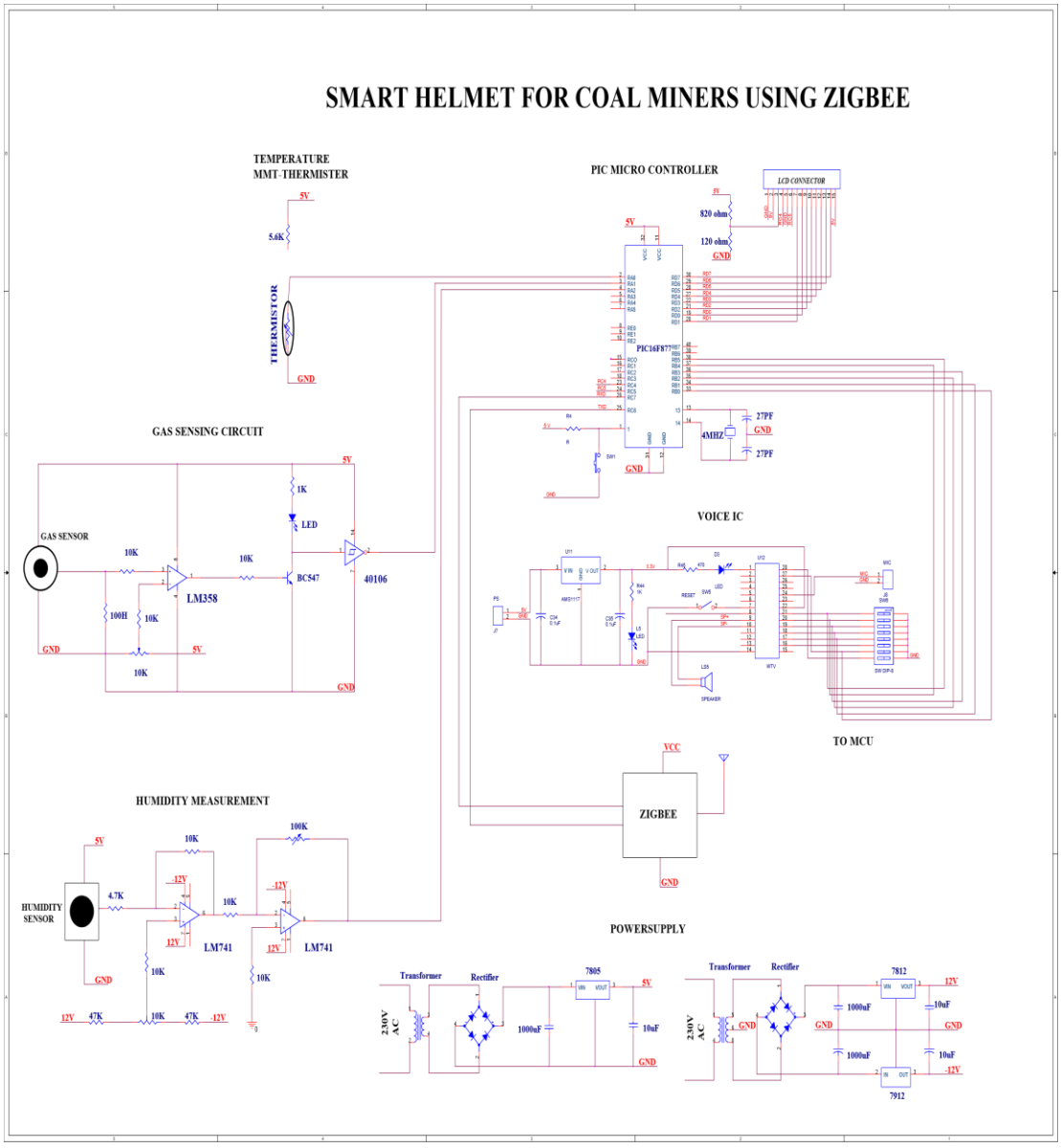


Fig.no.2.22

- The sensors available in the helmet collects the temperature, humidity and gas information and send this to the controlling unit.
- The code is been compiled and converted into hex file using MPLAB.
- Once the hex is created ,it can be loaded into the PIC16F877A by using PIC kit programmer.
- Display these values in the LCD module .

- If Temp > 60 , then display “TEMPERATURE IS HIGH”
- If Humidity > 20 ,then display “HUMIDITY IS HIGH ”
- If GAS >200 , then display “GAS LEAKED”
- These information will also be indicated in the form of voice using speaker .

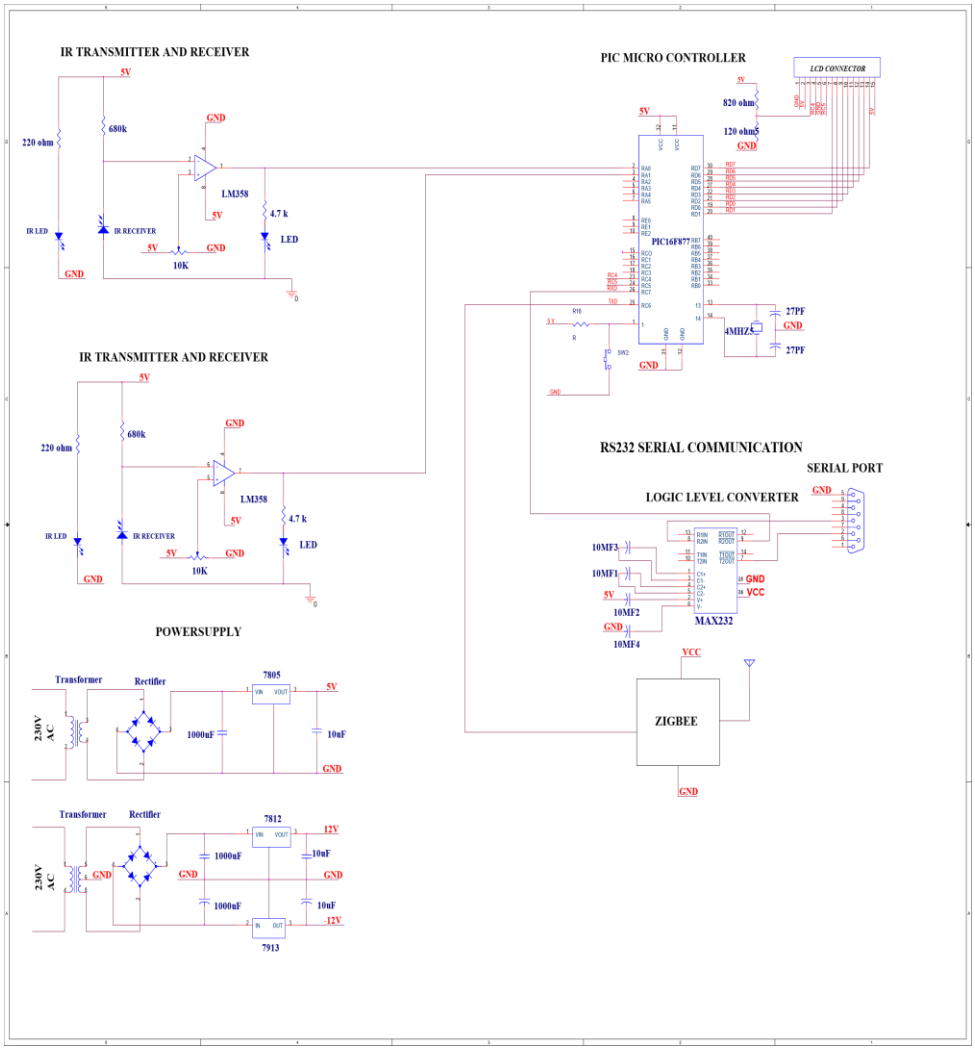


Fig.no 2.23

- The resultant information is also passed to the ground station through ZigBee .
- In addition to these , the number of members inside the coal mine is also obtained by means of IR sensor.

- The results were analysed using LabVIEW and also the values will be displayed in the LCD module.

2.13 FLOW CHART

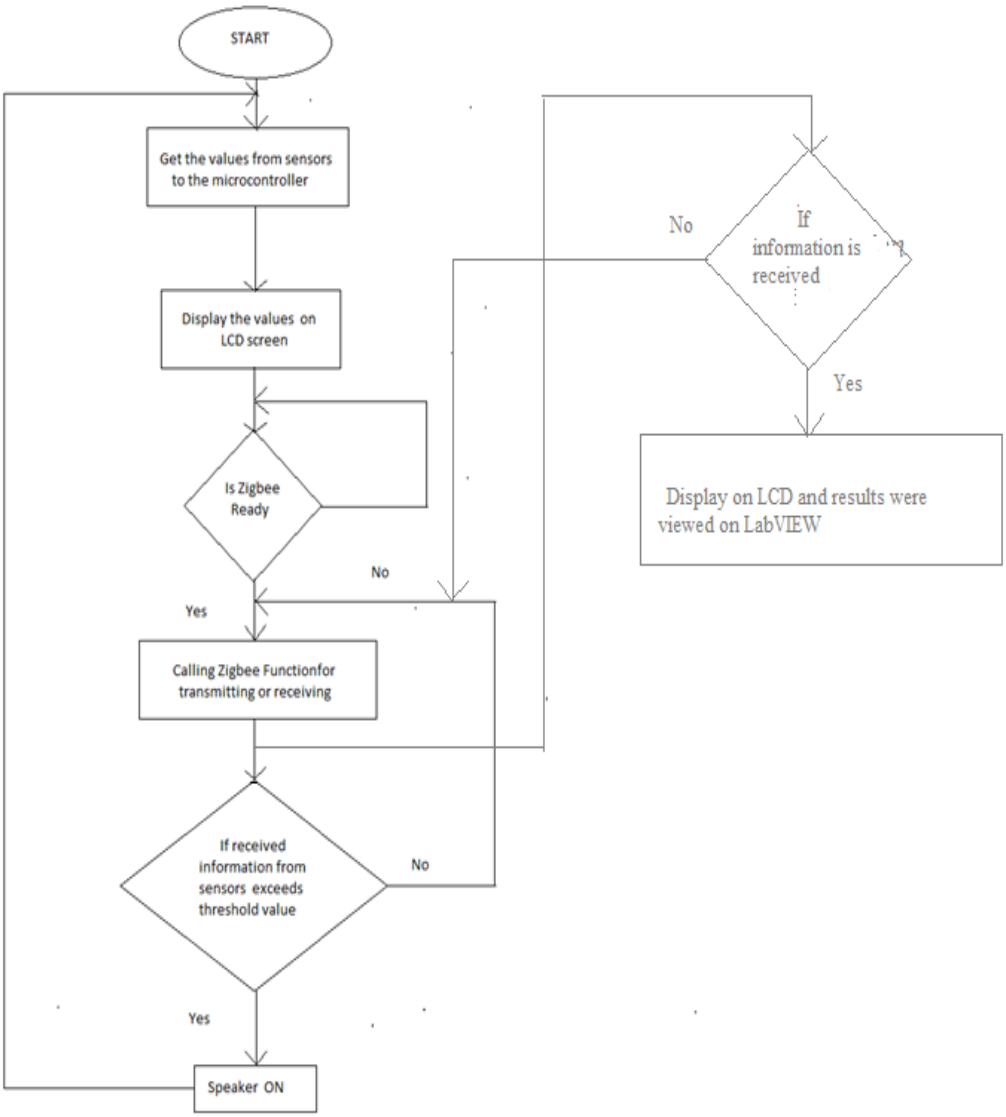


Fig.no2.24

CHAPTER – 3

SOFTWARE DESCRIPTION

3.1 MPLAB

MPLAB IDE is a software program that runs on your development environment for your embedded microcontroller design. It is a proprietary freeware integrated development environment for the development of embedded applications on PIC microcontrollers and is developed by Microchip Technology.

MPLAB supports project management, editing, debugging and programming of Microchip 8-bit, 16-bit and 32-bit PIC microcontrollers. MPLAB only works on Microsoft Windows .

3.1.1 DESIGN

The design cycle for developing an embedded controller application is:

- Select the PIC micro device to design the associated hardware circuitry.
- Knowing which peripherals and pins control the hardware, write the software. Use either assembly language, which is directly translatable into machine code, or using a compiler that allows a more natural language for creating programs.
- Compile or assemble the software using a Language Tool to convert the code into machine code for the PIC micro device. This machine code will eventually becomes firmware, the code programmed into the microcontroller.
- Test the code. Bugs need to be removed from the design to get it to act properly.

- "Burn" the code into a microcontroller and verify that it executes correctly in the finished application .

3.1.2 FEATURES

- MPLAB IDE supports "one-click".
- Provides a new call graph for navigating complex codes.
- Supports multiple versions of the same compiler.
- Supports for multiple debug tools of the same type.
- MPLAB user can configure their own.
- Provides a software call stack window with function arguments.
- Supports a fully customizable workspace, and multiple screen support.
- Provides a navigation window which allows fast easy access to code.

3.2 LabVIEW

Laboratory Virtual Instrument Engineering Workbench (LabVIEW) is a system design platform and development environment for a visual programming language from National Instruments .

The LabVIEW program development environment is different from standard C or Java development systems in one important respect. While other programming systems use text-based languages to create lines of code, this is totally a graphical programming language **.**

3.2.1 FEATURES OF LABVIEW

- LabVIEW can share data within an application or across a network.
- It can access the objects,properties,methods and events associated with other window applications like .NET or ACTIVEX.
- It is used to communicate with applications written in a text-based programming language, such as C or C++.
- It can use various nodes to perform mathematical operations on the block diagram.
- It includes extensive support for interfacing to devices, instruments, cameras, and other devices.
- It is an inherently concurrent_language, so it is very easy to program multiple tasks that are performed in parallel via multithreading.
- It includes a compiler that produces native code for the CPU platform. The graphical code is translated into executable machine code by interpreting the syntax and by compiling.
- It includes a text-based programming component named MathScript with added functions for signal processing, analysis, and mathematics.

CHAPTER - 4

RESULTS

4.1 PROTEUS OUTPUT

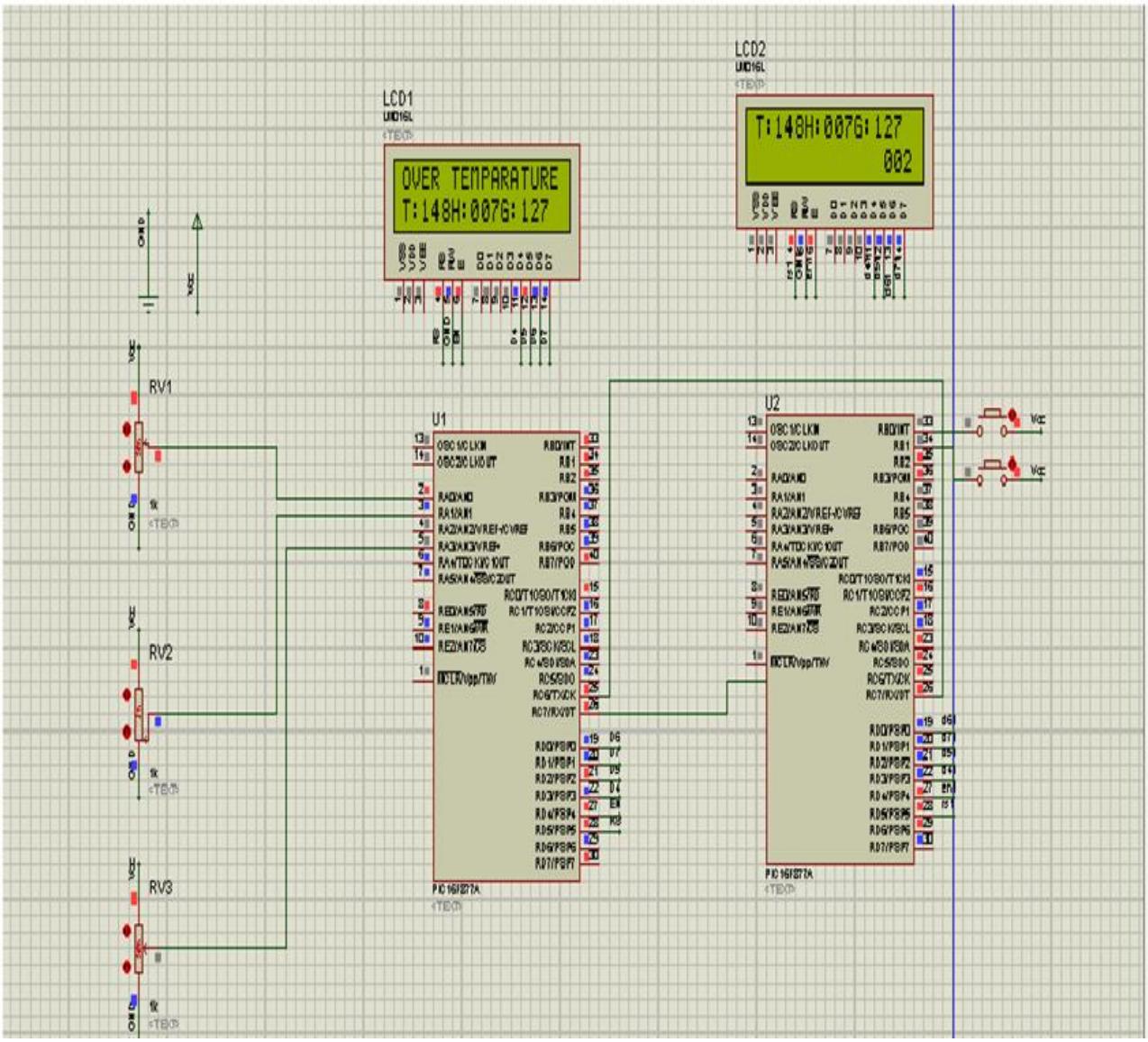


Fig.no 2.25

4.2 LABVIEW OUTPUT

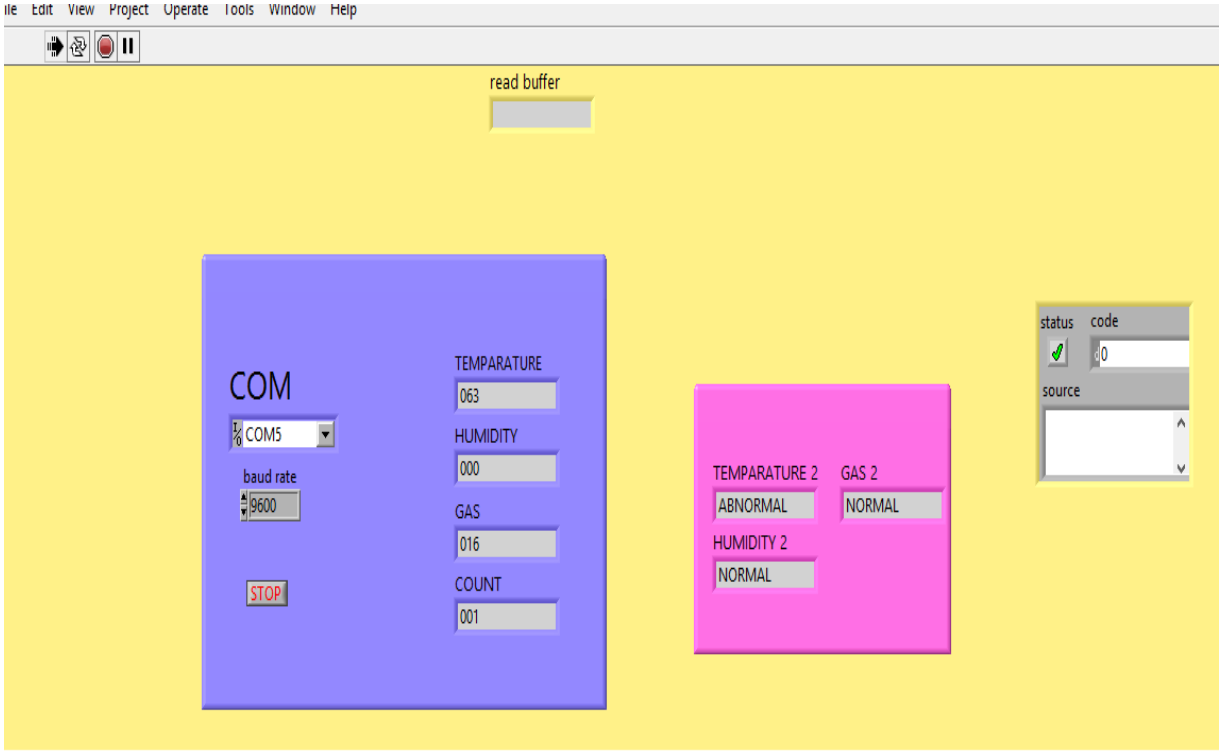


Fig.no 2.26

CHAPTER – 5

WORKING MODEL

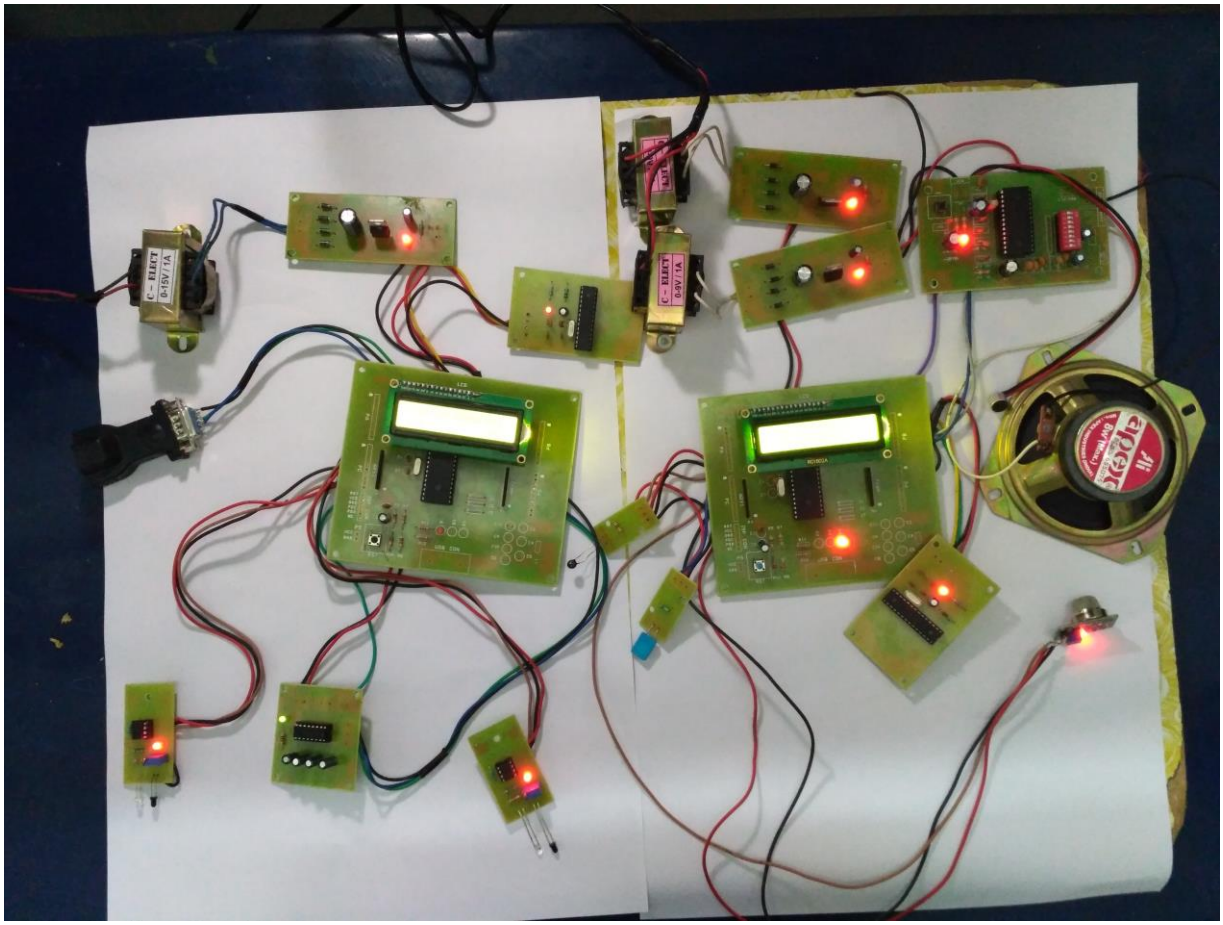


Fig.no 2.27

CHAPTER – 6

CONCLUSION

As the system requirement and the required components can be easily made available this project can be implemented easily. It will provide the safety to coal miners and change the way of their working as well as system controlling the various environmental changes in mines. It has been presented the original design of the low power ZigBee wireless sensor system with an extremely reduced cost. It is reliable system with quick and easy installation. The system might be easily extended. With ZigBee wireless positioning devices, it will improve system scalability and extend accurate position of underground miners in future. A safety system is developed for Coal mine workers using wireless sensor networks. A larger area and more depth inside hazardous underground mines are now can be covered and potential accidents can be controlled effectively. The system might be easily extended. With ZigBee wireless positioning devices, it will improve system scalability and extend accurate position of underground miners in future.

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