DESIGN AND DEVELOPMENT OF AN AUTONOMOUS MINE CONDITION DETECTION MOBILE ROBOT SYSTEM

Project Report submitted in partial fulfillment of the requirement for the degree of

Bachelor of Technology.

in

Electronics and Communication Engineering

under the supervision of

Ms. VANITA RANA

Submitted By

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to

विद्या तत्व ज्योतिसमः

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CERTIFICATE

This is to certify that project report entitled **"Design and Development of Autonomous Mine Condition Detection Mobile Robot System"**, submitted by **Vikas Selwal , Mohit Gulati** and **Somya Sinha** in partial fulfillment for the award of degree of Bachelor of Technology in Electronics and Communication Engineering to Jaypee University of Information Technology, Waknaghat, Solan has been carried out under my supervision. This work has not been submitted partially or fully to any other University or Institute for the award of this or any other degree or diploma.

Date: 01-06-12

Ms.Vanita Rana
Senior Lecturer

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Date: 01-06-12

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LIST OF SYMBOLS AND ACRONYMS

- ADC – Analog to Digital Converter
- Op-amp – Operational Amplifier
- SCU-Signal Control Unit
- LCD-Liquid Crystal Display
- LED – Light Emitting Diode
- XTAL-Crystal Oscillator
- Vout – Output Voltage
- Vin – Input Voltage
- Vcc-Power Supply
- mV – millivolts
- V – Volts
- V+ = Voltage at positive terminal
- GND -- ground(zero potential)
- R – resistance
- C – capacitance
- W-watts
- AC-Alternating Current
- DC-Direct Current
- uA – microamperes
- Pf-pico farad
- I/O – Input / Output
- | | – parallel connection
- Rx-Receiver
- Tx-Transmitter
- mfd – microfarad
- kΩ – kilo ohms
- sw-switch

ABSTRACT

This project provides the people with a comprehensive study of developing an embedded system to create an intelligent **"Autonomous Mine Condition Detection Mobile Robot System"** that is capable of identifying fires, detecting hazardous level of gases in mines and rising temperatures, alerting fire personnel by using zigbee network and also by sending text message to mobile using GSM. It's an initiative that will help cause minimal damage to life and property in case of mine accidents. The robot is built around the interfacing of different gas, temperature and smoke sensors and robotic mechanism. The robotic mechanism consists of motors which are controlled by the microcontroller (ATmega) by relay, for movement of the robot.

The robot is controlled manually as well as takes it own fixed path as per the program in the microcontroller and keep on moving in the path. At the same times the robot is analyzing the gas around the place, temperature and smoke. When the robot detects any hazardous gas level or smoke or increase in required temperature, it will store the location in its memory and raise an alarm, so that the user can identify the place where the leakage is. This report covers a description of the components that will be used in this project, their features, description and how they function.

CHAPTER 1
INTRODUCTION

1.1 History of Accidents

Thousands of miners die from mining accidents each year, especially in the processes of coal mining and hard rock mining .Many major accidents take place in industries due to fire, leakage of gasses etc. Most of the deaths nowadays occur in developing countries, especially China and rural parts of developed countries.

- During November 2009, a **mining accident in Heilongjiang** killed at least 104 people. It is thought to have been caused by a **methane explosion** succeeded by a **coal dust explosion**. Three major officials involved with the mining company were promptly dismissed.
- **March 10, 1906:** Courrieres mine disaster in Courrieres France. 1,099 workers died, including children, in the worst mine accident ever in Europe.
- **April 26, 1942:** Benxihu Colliery disaster in Benxi, Liaoning, China. 1,549 workers died, in the worst coal mine accident ever in the world.
- **May 28, 1965:**1965 Dhanbad coal mine disaster took place in Jharkhand, India, killing over 300 miners.
- **December 3, 1984:** The **Bhopal disaster** (commonly referred to as **Bhopal gas tragedy**) in India is one of the largest industrial disasters on record. A runaway reaction in a tank containing poisonous methyl isocyanate caused the pressure relief system to vent large amounts to the atmosphere at a Union Carbide India Limited (UCIL) plant. Estimates of its death toll range from 4,000 to 20,000. The disaster caused the region's human and animal populations severe health problem to the present.
- The **Beaconsfield Mine collapse** occurred on 25 April 2006 in Beaconsfield,Tasmania, Australia. Of the 17 people who were in the mine

at the time, 14 escaped immediately following the collapse, one was killed and the remaining two were found alive using a remote-controlled device. These two miners were rescued on 9 May 2006, two weeks after being trapped nearly a kilometer below the surface.

These are few of the many mining accidents that occur all around the world every year. Historically, coal mining has been a very dangerous activity and the list of historical coal mining disasters is a long one. In the US alone, more than 100,000 coal miners were killed in accidents over the past century, with more than 3,200 dying in 1907 alone.

Firedamp explosions can trigger the much more dangerous coal dust explosions, which can engulf an entire pit. Most of these risks can be greatly reduced in modern mines, and multiple fatality incidents are now rare in some parts of the developed world.

However, in lesser developed countries and some developing countries, many miners continue to die annually, either through direct accidents in coal mines or through adverse health consequences from working under poor conditions. China, in particular, has the highest number of coal mining related deaths in the world, with official statistics claiming that 6,027 deaths occurred in 2004. Coal production in China is twice that in the US, while the number of coal miners is around 50 times that of the US, making deaths in coal mines in China 4 times as common per worker (108 times as common per unit output) as in the US.

1.2 The Need

Taking note of such hazardous conditions in mines and industries resulting in large causalities and loss of human life every year, we decided to built an autonomous mine condition detection mobile robot which would perform the following functions .

- Detect the fire on its own.
- Detect the Smoke.

- Analyze and detect the air quality & level of hazardous gases in remote areas such as coal mines.
- Sense the rising temperature levels in disaster prone areas such as mines and alert the person controlling it, before humans face the problem.
- Also alert the concerned person by sending message to its mobile.

This device can be sent into the mines before humans and can detect fire, levels of hazardous gases and rising temperatures in mines and can provide accurate information about the condition in the mine so that any human casualties and accidents can be prevented.

1.3 Existing System

The Existing system is an IEEE project earlier in same fashion.**1-4244-0527-0/06/$20.00 © 2006 IEEE** is the IEEE number of the project done on year 2006 describes the software of a terrain scanning robot capable of autonomously manipulating a typical handheld detector for remote sensing of buried landmines in a manner similar to a human operator. The autonomous manipulation of the detector on unknown terrain requires an online terrain map to generate an obstacle free path for the end effectors of the robot.

The system detects the alarming condition and stores its location and informs the condition when the data is manually fetched. It fails to inform the condition breach at the same time .The implemented model; called Deminer Robot (DR) is able to scan a minefield looking for landmines buried under ground. Less weight causes a quite safe action for Robot. After an operator independent search action, a 2D graphical map is generated with the mines located, as the output of Demining System (DS).

This system describes the design and development of a small, low-cost autonomous mine detection robot that is targeted to be used by the locals of mine-infested countries to check for the safety of their surroundings. It is targeted at solving the navigation problems that exist on other low-cost mine detection robots. It is targeted at solving the navigation problems that exist on other low-cost mine detection robots.

Path planning is carried out based on the terrain map to move the detector at a constant distance and parallel to the ground. Unlike the traditional methods, the path is generated in the non-Cartesian coordinate frame of the sensors to avoid a great deal of transformations involved in reproducing the terrain map in a Cartesian coordinate frame.

1.4 Proposed System

The proposed system has various advantages that robots hold over humans, some of which are that they do not get tired, they can never be distracted away from their duty. And in such crucial areas such as security, one cannot afford haphazardness. Taking note of such hazardous conditions in mines and industries resulting in large causalities and loss of human life every year, we built an autonomous mine condition detection mobile robot which uses ATmega microcontroller, as two synchronous communication port is required for the later technologies. It can be operated manually as well as automatically. It is based on Wireless Sensor Network Technology. It contains GSM Technology for SMS alert about the alarming condition by sending message to its mobile. It also contains the ZIGBEE Technology for PC monitoring of the hazardous condition on a subsystem. It uses the sensors to alarm the security personnel about the breach. It detects the fire and smoke. It analyzes and detects the air quality & level of hazardous gases in remote areas such as coal mines. It senses the rising temperature levels in disaster prone areas and alerts the person controlling it, before humans face the problem. All the equipment used is low cost and the robot that we have built is highly efficient and perfectly plausible in today's economy centric world

CHAPTER 2
HARDWARE DESIGN

2.1 Block Diagram

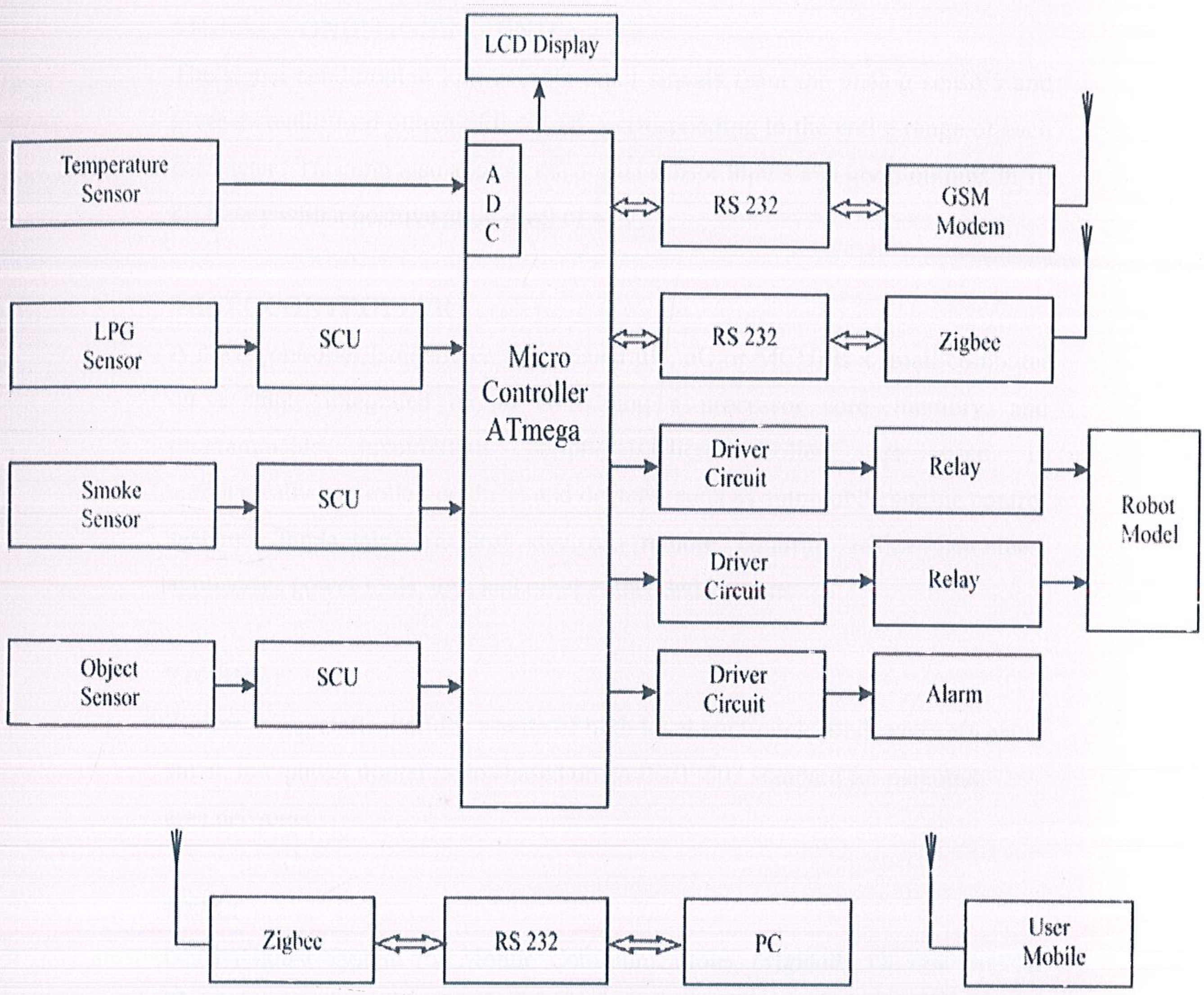

Figure 2.1 Block Diagram

SENSOR :

A sensor (also called detector) is a converter that measures a physical quantity and converts it into a signal which can be read by an observer or by an (today mostly electronic) instrument

SIGNAL CONDITIONING UNIT :

The signal conditioning unit accepts input signals from the analog sensors and gives a conditioned output of 0-5V DC corresponding to the entire range of each parameter. This unit also accepts the digital sensor inputs and gives outputs in 10 bit binary with a positive logic level of +5V.

MICROCONTROLLER :

A microcontroller (sometimes abbreviated µC, uC or MCU) is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals.Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other embedded systems

ZIGBEE :

ZigBee is a specification for a suite of high level communication protocols using small, low-power digital radios based on an IEEE 802 standard for personal area networks.

GSM :

GSM (Global System for Mobile Communications, originally Groupe Spécial Mobile), is a standard set developed by the European Telecommunications Standards Institute (ETSI) to describe technologies for second generation (2G) digital cellular networks

RS232 :

In telecommunications, RS-232 is the traditional name for a series of standards for serial binary single-ended data and control signals connecting between a DTE (Data Terminal Equipment) and a DCE (Data Circuit-terminating Equipment). It is commonly used in computer serial ports

RELAYS :

A relay is an electrically operated switch. Many relays use an electromagnet to operate a switching mechanism mechanically, but other operating principles are also used. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal.

DC MOTORS :

A DC motor is an electric motor that runs on direct current (DC) electricity. DC motors were used to run machinery, often eliminating the need for a local steam engine or internal combustion engine. DC motors can operate directly from rechargeable batteries, providing the motive power for the first electric vehicles. Today DC motors are still found in applications as small as toys and disk drives, or in large sizes to operate steel rolling mills and paper machines. Modern DC motors are nearly always operated in conjunction with power electronic devices.

2.2 Thermistor Circuit

A **thermistor** is a type of resistor used to measure temperature changes, relying on the change in its resistance with changing temperature. Thermistor is a combination of the words thermal and resistor. The Thermistor was first invented by Samuel Ruben in 1930, and has U.S. Patent #2,021,491

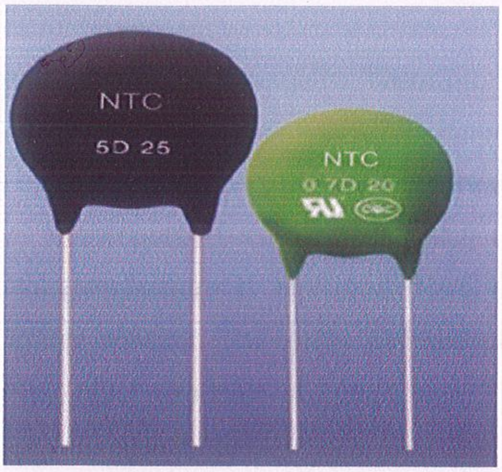

Figure 2.2 Thermistor

If we assume that the relationship between resistance and temperature is linear (i.e. we make a first-order approximation), then we can say that:

$$\Delta R = k\Delta T$$

Where

ΔR = change in resistance

ΔT = change in temperature

k = first-order temperature coefficient of resistance

Thermistors can be classified into two types depending on the sign of k. If k is positive, the resistance increases with increasing temperature, and the device is called a positive temperature coefficient (**PTC**) thermistor, **Posistor**. If k is negative, the resistance decreases with increasing temperature, and the device is called a negative temperature coefficient (**NTC**) thermistor. Resistors that are not thermistors are designed to have the smallest possible k, so that their resistance remains almost constant over a wide temperature range. Resistance values from 8 W to 150 kW and B Values are from 3000 K to5000 K.

2.2.1 Circuit Description

In this circuit the thermistor is used to measure the temperature. Thermistor is nothing but temperature sensitive resistor. There are two type of thermistor available such as positive temperature co-efficient and negative temperature co-efficient. Here we are using negative temperature co-efficient in which the resistance value is decreased when the temperature is increased. Here the thermistor is connected with resistor bridge network. The bridge terminals are connected to inverting and non-inverting input terminals of comparator. The comparator is constructed by LM 324 operational amplifier.

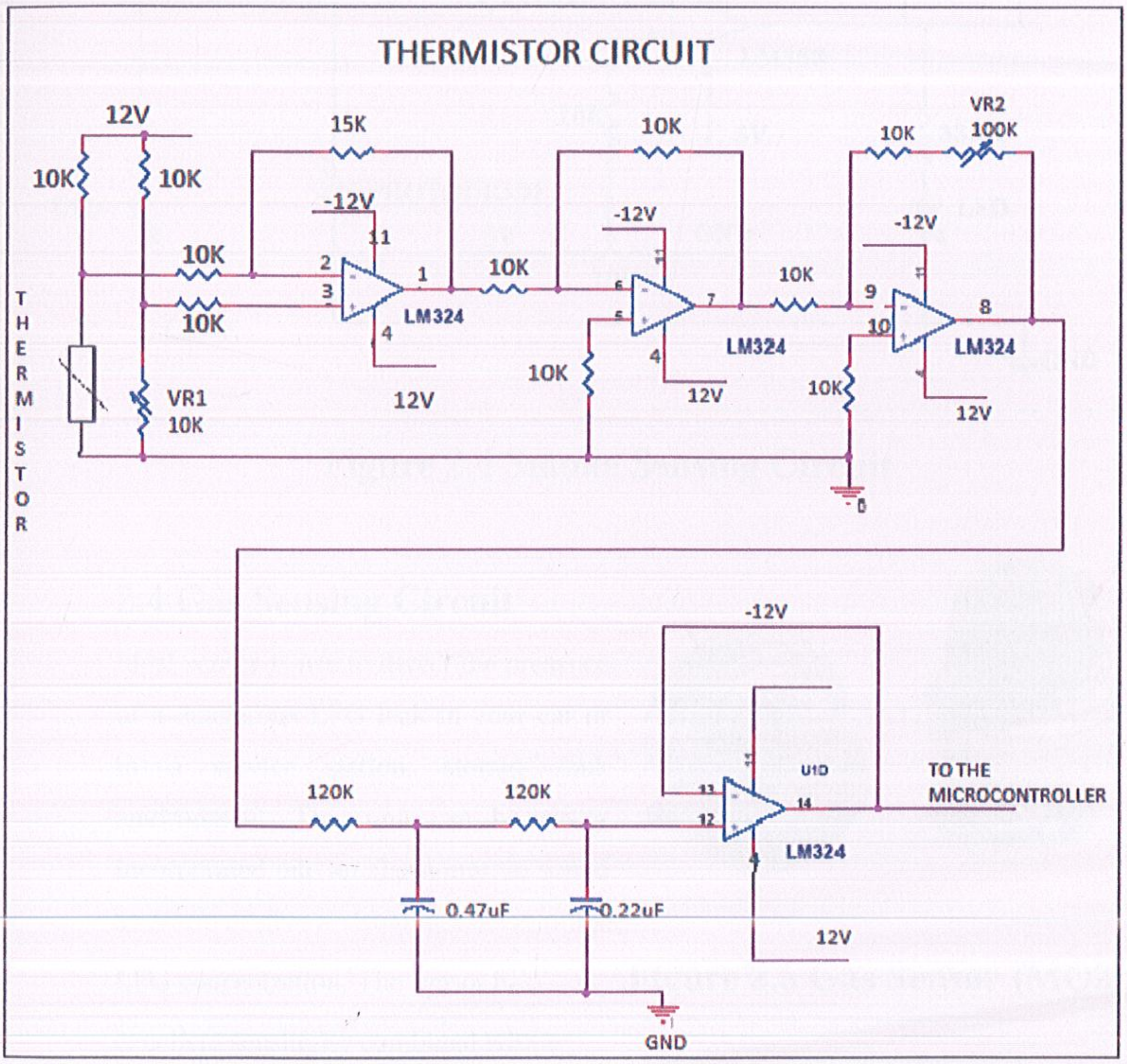

Figure 2.3 Thermistor Circuit

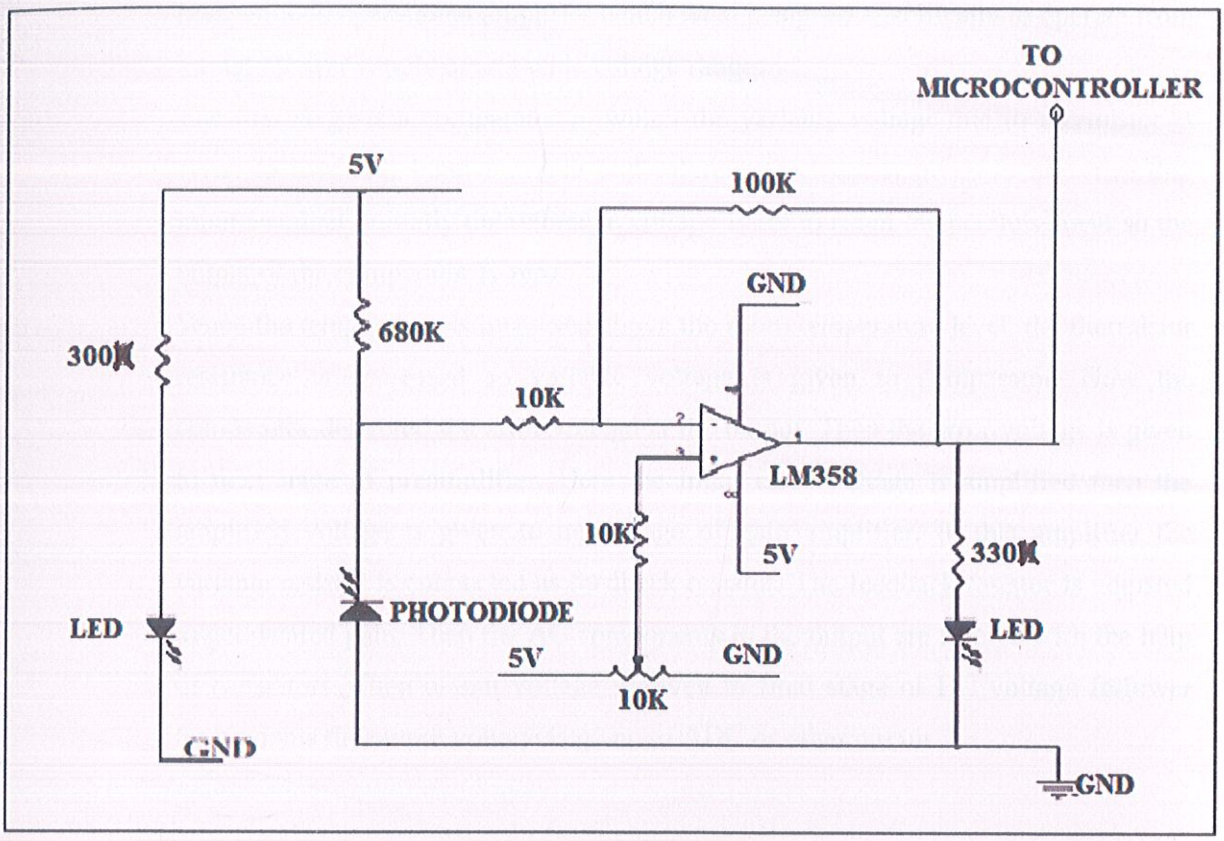

Figure 2.4 Smoke Sensing Circuit

2.4 Gas Sensing Circuit

Figure 2.5 Gas Sensor (MQ2)

Ideal sensor is use 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

The LM 324 consists of four independent, high gains, internally frequency compensated operational amplifier which were designed specifically to operate from a single power supply over a wide voltage range.

The first stage is a comparator in which the variable voltage due to thermistor is given to inverting input terminal and reference voltage is given to non-inverting input terminal. Initially the reference voltage is set to room temperature level so the output of the comparator is zero.

When the temperature is increased above the room temperature level, the thermistor resistance is decreased so variable voltage is given to comparator. Now the comparator delivered the error voltage at the output. Then the error voltage is given to next stage of preamplifier. Here the input error voltage is amplified then the amplified voltage is given to next stage of gain amplifier. In this amplifier the variable resistor is connected as feedback resistor. The feedback resistor is adjusted to get desired gain. Then the AC components in the output are filtered with the help of capacitors. Then output voltage is given to final stage of DC voltage follower through this the output voltage is given to ADC or other circuit.

2.3 Smoke Sensing Circuit

The IR receiver is connected with comparator. The comparator is constructed with LM 358 operational amplifier. In the comparator circuit the reference voltage is given to inverting input terminal. The non inverting input terminal is connected IR receiver. When interrupt the IR rays between the IR transmitter and receiver, the IR receiver is not conducting. So the comparator non inverting input terminal voltage is higher than inverting input. Now the comparator output is in the range of +5V. This voltage is given to microcontroller or PC and led so led will glow.

When IR transmitter passes the rays to receiver, the IR receiver is conducting due to that non inverting input voltage is lower than inverting input. Now the comparator output is GND so the output is given to microcontroller or PC. This circuit is mainly used to for counting application, intruder detector etc.

quick response time. The sensor can also sense iso-butane, propane, LNG and cigarette smoke.

2.4.1 Features

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

2.4.2 Applications

- Domestic gas leakage detector
- Industrial Combustible gas detector

2.4.3 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 comparator.

Here the comparator is constructed with operational amplifier LM 358. The reference voltage is given to inverting input terminal. The reference voltage is depends on the desired gas intensity. When there is no leakage the non inverting input is greater then inverting input so the output of the comparator is positive voltage which is given to the base of the switching transistor BC 547. Hence the transistor is conducting. Here the transistor is act as switch so the collector and emitter will be closed. The output is taken from collector terminal. Now the output is zero which is given to hex inverter 40106.

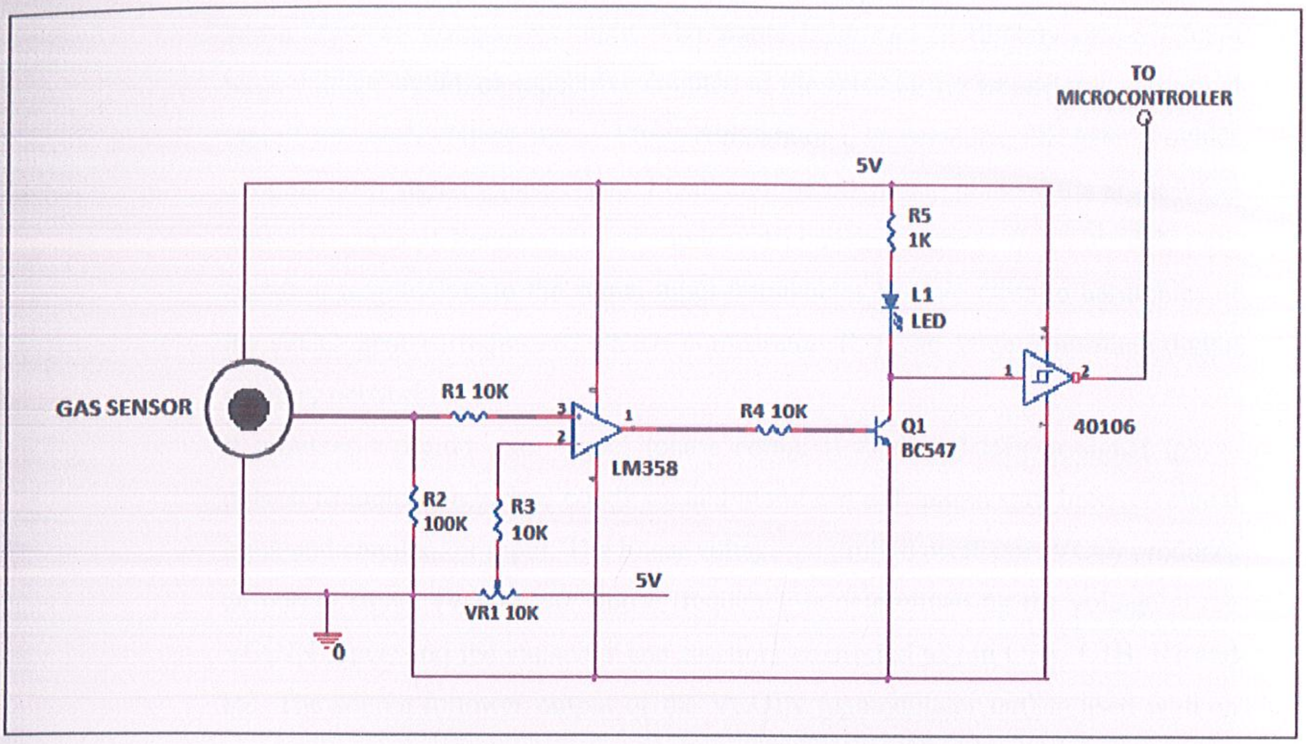

Figure 2.6 Gas Sensing Circuit

When there is gas leakage the inverting input voltage is greater than non inverting input. Now the comparator output is -12V so the transistor is cutoff region. The 5v is given to hex inverter 40106 IC. Then the final output data is directly given to microcontroller to determine the gas leakage.

2.5 Object Sensing Circuit

This circuit is used to sense the objects for different applications

2.5.1 CD4046BC (Micro power Phase-Locked Loop)

The CD4046BC micro power phase-locked loop (PLL) consists of a low power, linear, voltage controlled oscillator (VCO), a source follower, a zener diode, and two phase comparators. The two phase comparators have a common signal input and a common comparator input. The signal input can be directly coupled for a large voltage signal, or capacitive coupled to the self-biasing amplifier at the signal input for a small voltage signal. Phase comparator I, an exclusive OR gate, provides a digital error signal (phase comp. I Out) and maintains 90° phase shifts at the VCO center frequency. Between signal input and comparator input (both at 50% duty cycle), it may lock onto the signal input frequencies that are close to harmonics of the VCO center frequency. Phase comparator II is an edge-controlled digital memory network.

It provides a digital error signal (phase comp. II Out) and lock-in signal (phase pulses) to indicate a locked condition and maintains a 0° phase shift between signal input and comparator input. The linear voltage-controlled oscillator (VCO) produces an output signal (VCO Out) whose frequency is determined by the voltage at the VCOIN input, and the capacitor and resistors connected to pin C1A, C1B, R1 and R2. The source follower output of the VCOIN (demodulator out) is used with an external resistor of 10 kΩ or more. The INHIBIT input, when high, disables the VCO and source follower to minimize standby power consumption. The zener diode is provided for power supply regulation, if necessary.

2.5.1.1 Features

- Wide supply voltage range: 3.0V to 18V
- Low dynamic power consumption: 70 μW (typ.) at fo = 10 kHz, VDD = 5V
- VCO frequency: 1.3 MHz (typ.) at VDD = 10V
- Low frequency drift: 0.06%/°C at VDD = 10V with temperature
- High VCO linearity: 1% (typ.)

2.5.1.2 Applications

- FM demodulator and modulator
- Frequency synthesis and multiplication
- Frequency discrimination
- Data synchronization and conditioning

- Voltage-to-frequency conversion
- Tone decoding
- FSK modulation
- Motor speed control

2.5.1.3 Absolute Maximum Ratings

• DC Supply Voltage (VDD)	−0.5 to +18 VDC
• Input Voltage (VIN)	−0.5 to VDD +0.5 VDC
• Storage Temperature Range (TS)	−65°C to +150°C

2.5.1.4 Recommended Operating Conditions

• DC Supply Voltage (VDD)	3 to 15 VDC
• Input Voltage (VIN)	0 to VDD VDC
• Operating Temperature Range (TA)	−55°C to +125°C

2.5.2 Circuit Description

This is used to sense the object for different application. The 4046 clock generator is used to generate 38 KHZ carrier signal which is transmitted through the sensor TSOP1038. The CD4046 micro power phase locked loop consists of a low power, linear, voltage controlled oscillator, a source follower, a zener diode, and two phase comparators.

The two phase comparators have a common signal input and a common comparator input. The signal input can be directly coupled for a large voltage signal, or capacitive coupled to the self biasing amplifier at the signal input for a small voltage signal.

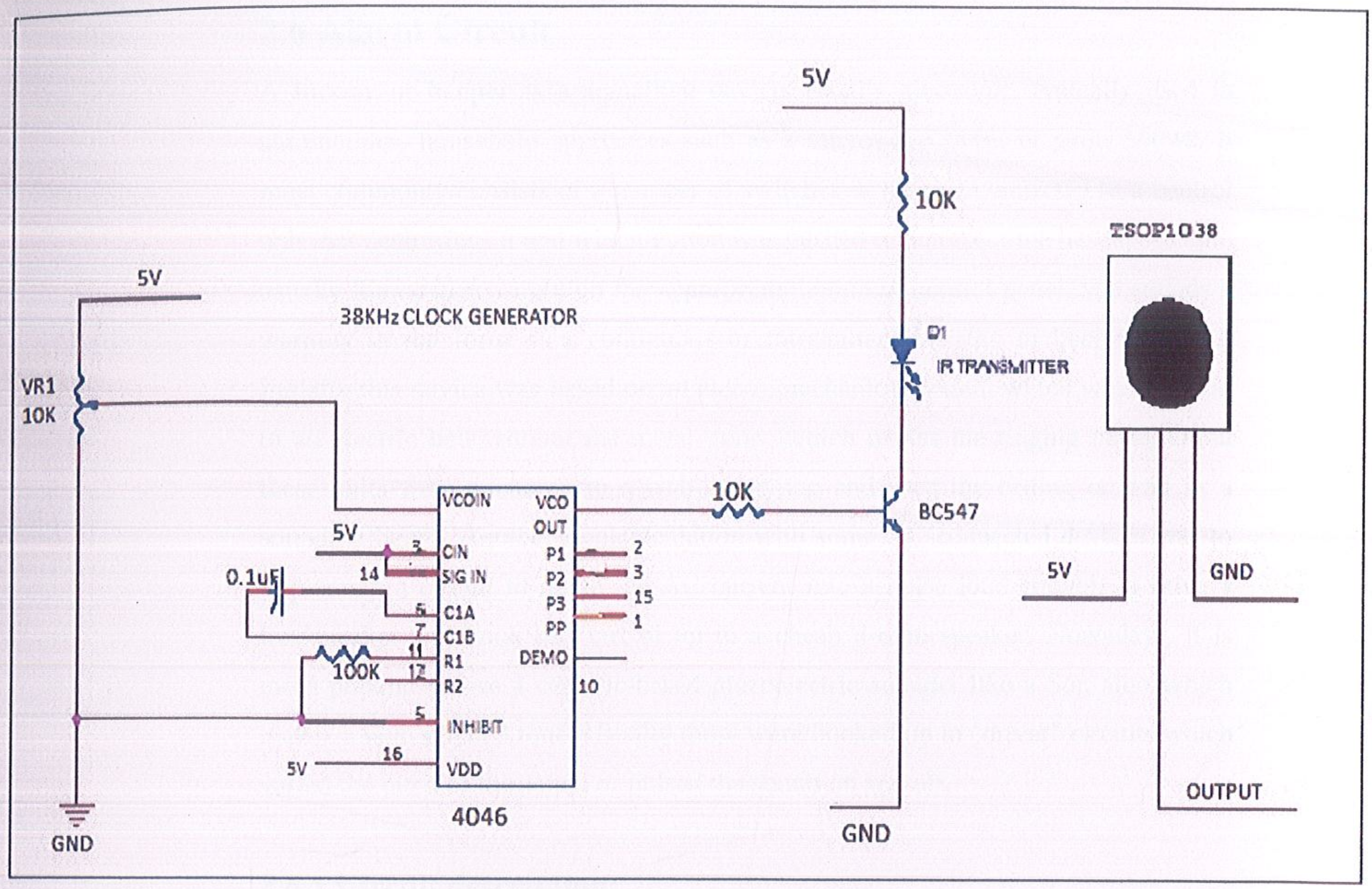

Figure 2.7 Object Sensing Circuit

Phase comparator 1, an exclusive OR gate, provides a digital error signal and maintain 90 phase shifts at the VCO center frequency between signal input and comparator input, it may lock onto the signal input frequencies that are close to harmonics of the VCO center frequency.

Phase comparator 2 is an edge controlled digital memory network. It provides a digital error signal to indicate a locked condition and maintain the a 0 phase shift between signal input and comparator input.

The linear voltage controlled oscillator produce an output signal whose frequency is determined by the voltage at the VCO input, and the capacitor and resistors at the VCO input and the capacitor and resistors connected to pin C1a, C1b, R1 and R2.

2.6 Alarm Circuit

A **buzzer** or **beeper** is a signalling device, usually electronic, typically used in automobiles, household appliances such as a microwave oven, or game shows. It most commonly consists of a number of switches or sensors connected to a control unit that determines if and which button was pushed or a preset time has lapsed, and usually illuminates a light on the appropriate button or control panel, and sounds a warning in the form of a continuous or intermittent buzzing or beeping sound. Initially this device was based on an electromechanical system which was identical to an electric bell without the metal gong (which makes the ringing noise).Often these units were anchored to a wall or ceiling and used the ceiling or wall as a sounding board. Another implementation with some AC-connected devices was to implement a circuit to make the AC current into a noise loud enough to drive a loudspeaker and hook this circuit up to a cheap 8-ohm speaker. Nowadays, it is more popular to use a ceramic-based piezoelectric sounder like a Son alert which makes a high-pitched tone. Usually these were hooked up to "driver" circuits which varied the pitch of the sound or pulsed the sound on and off.

2.6.1 Circuit description:

The circuit is designed to control the buzzer. The buzzer ON and OFF is controlled by the pair of switching transistors (BC 547). The buzzer is connected in the Q2 transistor collector terminal.

When high pulse signal is given to base of the Q1 transistors, the transistor is conducting and close the collector and emitter terminal so zero signals is given to base of the Q2 transistor. Hence Q2 transistor and buzzer is turned OFF state.

When low pulse is given to base of transistor Q1 transistor, the transistor is turned OFF. Now 12v is given to base of Q2 transistor so the transistor is conducting and buzzer is energized and produces the sound signal.

Voltage Signal from Microcontroller or PC	Transistor Q1	Transistor Q2	Buzzer
1	on	off	off
0	off	on	on

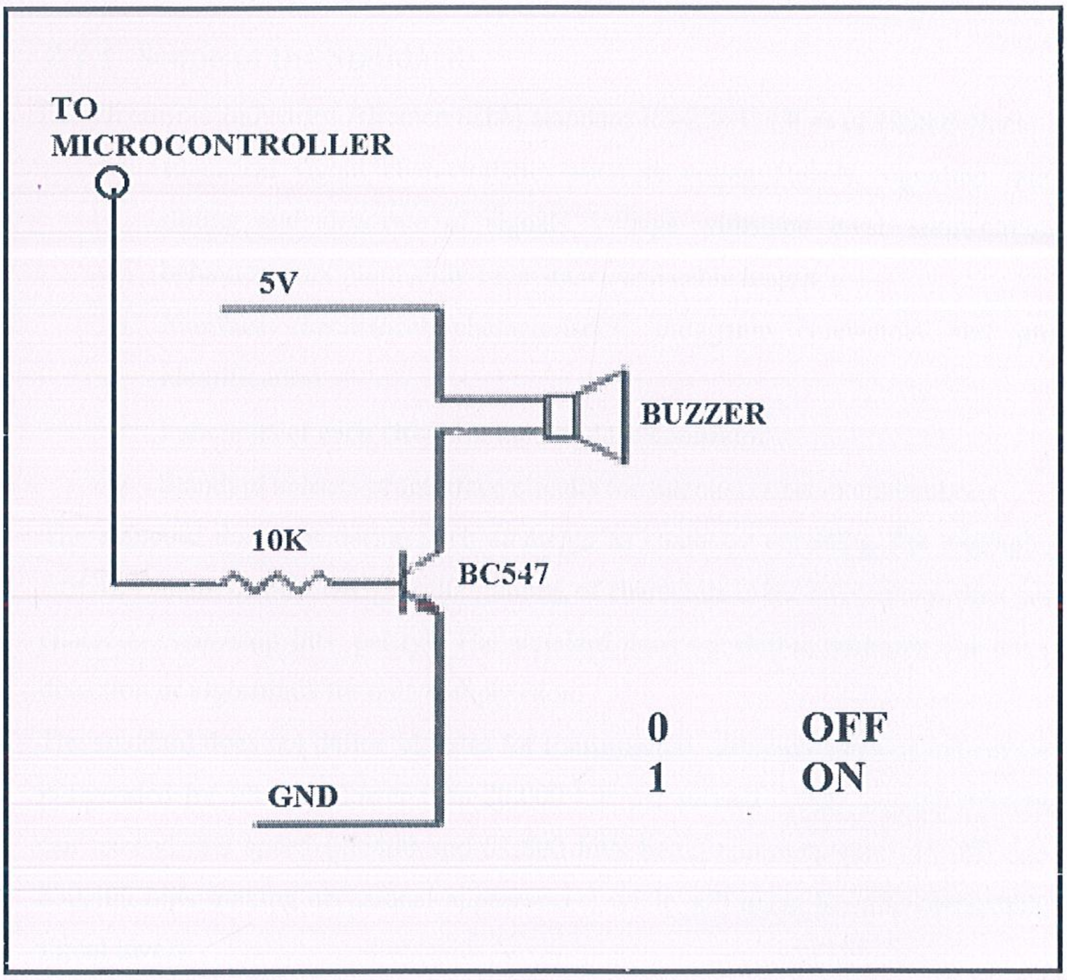

Figure 2.8 Alarm Circuit

2.7 RS-232 Communication

RS232: In telecommunications, **RS-232** is a standard for serial binary data interconnection between a *DTE* (Data terminal equipment) and a *DCE* (Data Circuit-terminating Equipment). It is commonly used in computer serial ports.

2.7.1 Scope of the Standard:

The Electronic Industries Alliance (EIA) standard RS-232-C [3] as of 1969 defines:

- Electrical signal characteristics such as voltage levels, signaling rate, timing and slew-rate of signals, voltage withstand level, short-circuit behavior, maximum stray capacitance and cable length
- Interface mechanical characteristics, pluggable connectors and pin identification
- Functions of each circuit in the interface connector
- Standard subsets of interface circuits for selected telecom applications

The standard does not define such elements as character encoding (for example, ASCII, Baudot or EBCDIC), or the framing of characters in the data stream (bits per character, start/stop bits, parity). The standard does not define protocols for error detection or algorithms for data compression.

The standard does not define bit rates for transmission, although the standard says it is intended for bit rates lower than 20,000 bits per second. Many modern devices can exceed this speed (38,400 and 57,600 bit/s being common, and 115,200 and 230,400 bit/s making occasional appearances) while still using RS-232 compatible signal levels.

Details of character format and transmission bit rate are controlled by the serial port hardware, often a single integrated circuit called a UART that converts data from parallel to serial form. A typical serial port includes specialized driver and receiver integrated circuits to convert between internal logic levels and RS-232 compatible signal levels.

2.7.2 MAX 232 IC

MAX 232 Features

- Meet or Exceed TIA/EIA-232-F and ITU.
- Recommendation V.28.
- Operate With Single 5-V Power Supply.
- ±30-V Input Levels.
- Low Supply Current . . . 8 mA Typical.
- Designed to be Interchangeable With Maxim MAX232.
- ESD Protection Exceeds JESD 22
  – 2000-V Human-Body Model (A114-A)

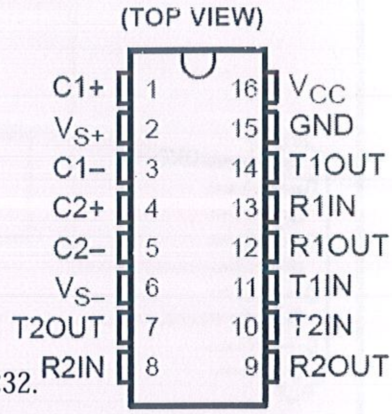

Fig 2.9 IC MAX 232

2.7.3 Circuit Description

In this circuit the MAX 232 IC used as level logic converter. The MAX232 is a dual driver/receiver that includes a capacitive voltage generator to supply EIA 232 voltage levels from a single 5v supply. Each receiver converts EIA-232 to 5v TTL/CMOS levels. Each driver converts TLL/CMOS input levels into EIA-232 levels.

Function Table

Table 2.1 : Function Table

EACH DRIVER | EACH RECEIVER

INPUT TIN	**OUTPUT TOUT**		**INPUT RIN**	**OUTPUT TOUT**
Low Level	High Level		Low Level	High Level
High Level	Low Level		High Level	Low Level

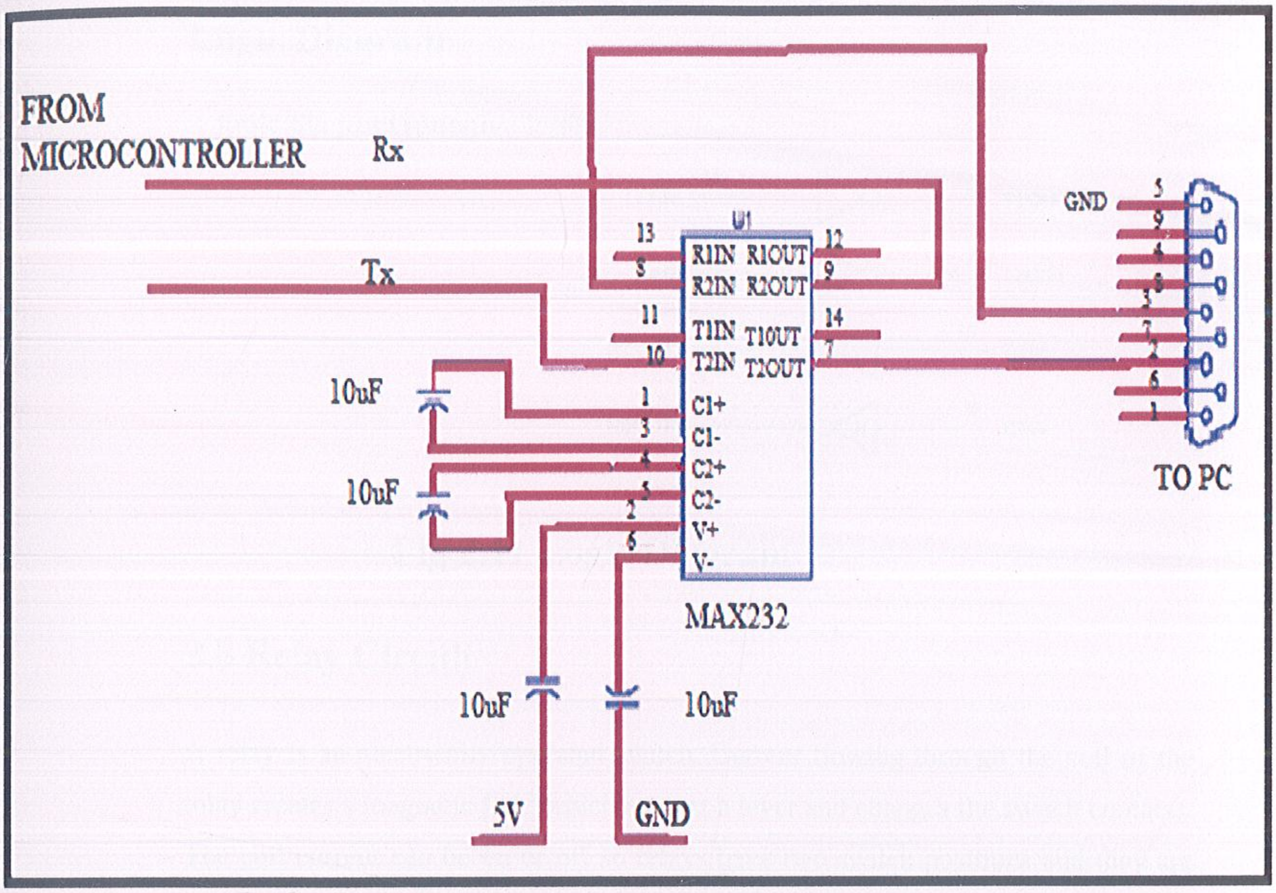

Figure 2.10 Circuit Diagram of RS232

Here the microcontroller transmitter pin is connected in the MAX232 T2IN pin which converts input 5v TTL/CMOS level to RS232 level. Then T2OUT pin is connected to reviver pin of 9 pin D type serial connector which is directly connected to PC.

In PC the transmitting data is given to R2IN of MAX232 through transmitting pin of 9 pin D type connector which converts the RS232 level to 5v TTL/CMOS level. The R2OUT pin is connected to receiver pin of the microcontroller. Likewise the data is transmitted and received between the microcontroller and PC or other device vice versa.

Logic Diagram

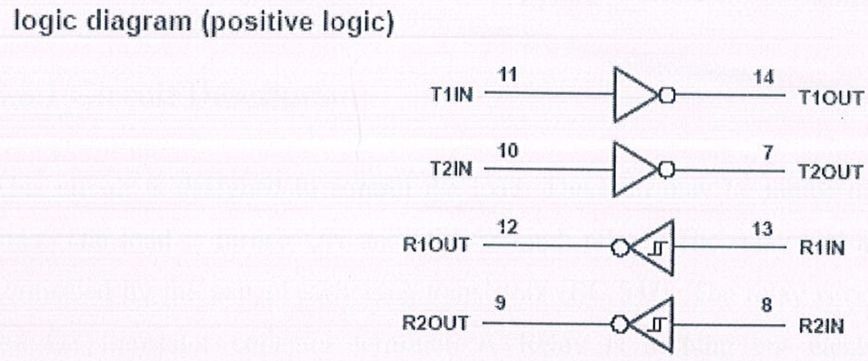

Fig 2.11 Logic Diagram

2.8 Relay Circuit

A relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and they are double throw (changeover) switches. Relays allow one circuit to switch a second circuit which can be completely separate from the first. For example a low voltage battery circuit can use a relay to switch a 230V AC mains circuit. There is no electrical connection inside the relay between the two circuits; the link is magnetic and mechanical.

The coil of a relay passes a relatively large current, typically 30mA for a 12V relay, but it can be as much as 100mA for relays designed to operate from lower voltages. Most ICs (chips) cannot provide this current and a transistor is usually used to amplify the small IC current to the larger value required for the relay coil. The maximum output current for the popular 555 timer IC is 200mA so these devices can supply relay coils directly without amplification.

Relays are usually SPDT or DPDT but they can have many more sets of switch contacts, for example relays with 4 sets of changeover contacts are readily available.

Most relays are designed for PCB mounting but you can solder wires directly to the pins providing you take care to avoid melting the plastic case of the relay.

2.8.1 Circuit Description

This circuit is designed to control the load. The load may be motor or any other load. The load is turned ON and OFF through relay. The relay ON and OFF is controlled by the pair of switching transistors (BC 547). The relay is connected in the Q2 transistor collector terminal. A Relay is nothing but electromagnetic switching device which consists of three pins. They are Common, Normally close (NC) and Normally open (NO). The relay common pin is connected to supply voltage. The normally open (NO) pin connected to load. When high pulse signal is given to base of the Q1 transistors, the transistor is conducting and shorts the collector and emitter terminal and zero signals is given to base of the Q2 transistor. So the relay is turned OFF state.

When low pulse is given to base of transistor Q1 transistor, the transistor is turned OFF. Now 12v is given to base of Q2 transistor so the transistor is conducting and relay is turned ON. Hence the common terminal and NO terminal of relay are shorted. Now load gets the supply voltage through relay.

Voltage Signal from Microcontroller or PC	Transistor Q1	Transistor Q2	Relay
1	on	off	off
0	off	on	on

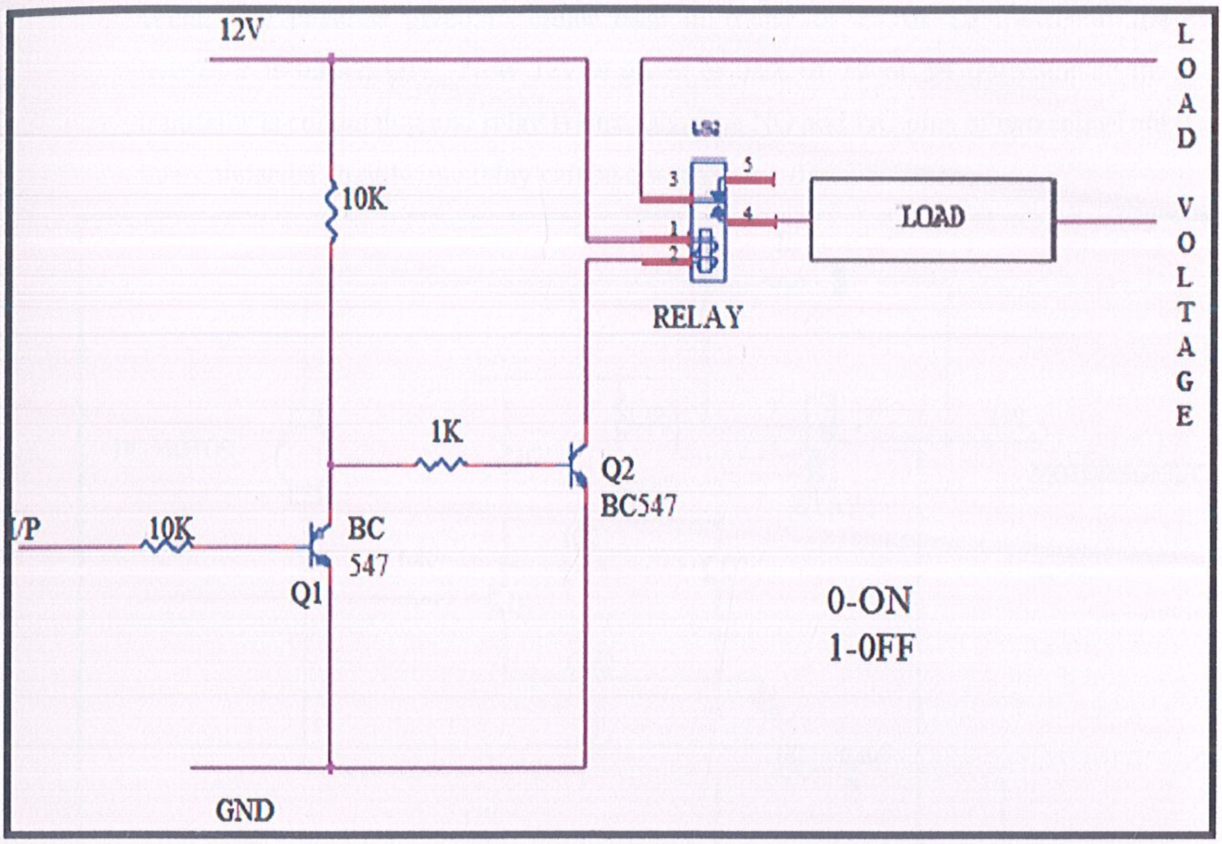

Figure 2.12 Relay Circuit

2.9 DC Motor Forward-Reverse Control

This circuit is designed to control the motor in the forward and reverse direction. It consists of two relays named as relay1, relay2. The relay ON and OFF is controlled by the pair of switching transistors. A Relay is nothing but electromagnetic switching device which consists of three pins. They are Common, Normally close (NC) and normally open (NO). The common pin of two relay is connected to positive and negative terminal of motor through snubber circuit respectively. The relays are connected in the collector terminal of the transistors T2 and T4.

When high pulse signal is given to either base of the T1 or T3 transistors, the transistor is conducting and shorts the collector and emitter terminal and zero signals is given to base of the T2 or T4 transistor. So the relay is turned OFF state.

When low pulse is given to either base of transistor T1 or T3 transistor, the transistor is turned OFF. Now 12v is given to base of T2 or T4 transistor so the transistor is conducting and relay is turn ON. The NO and NC pins of two relays are interconnected so only one relay can be operated at a time.

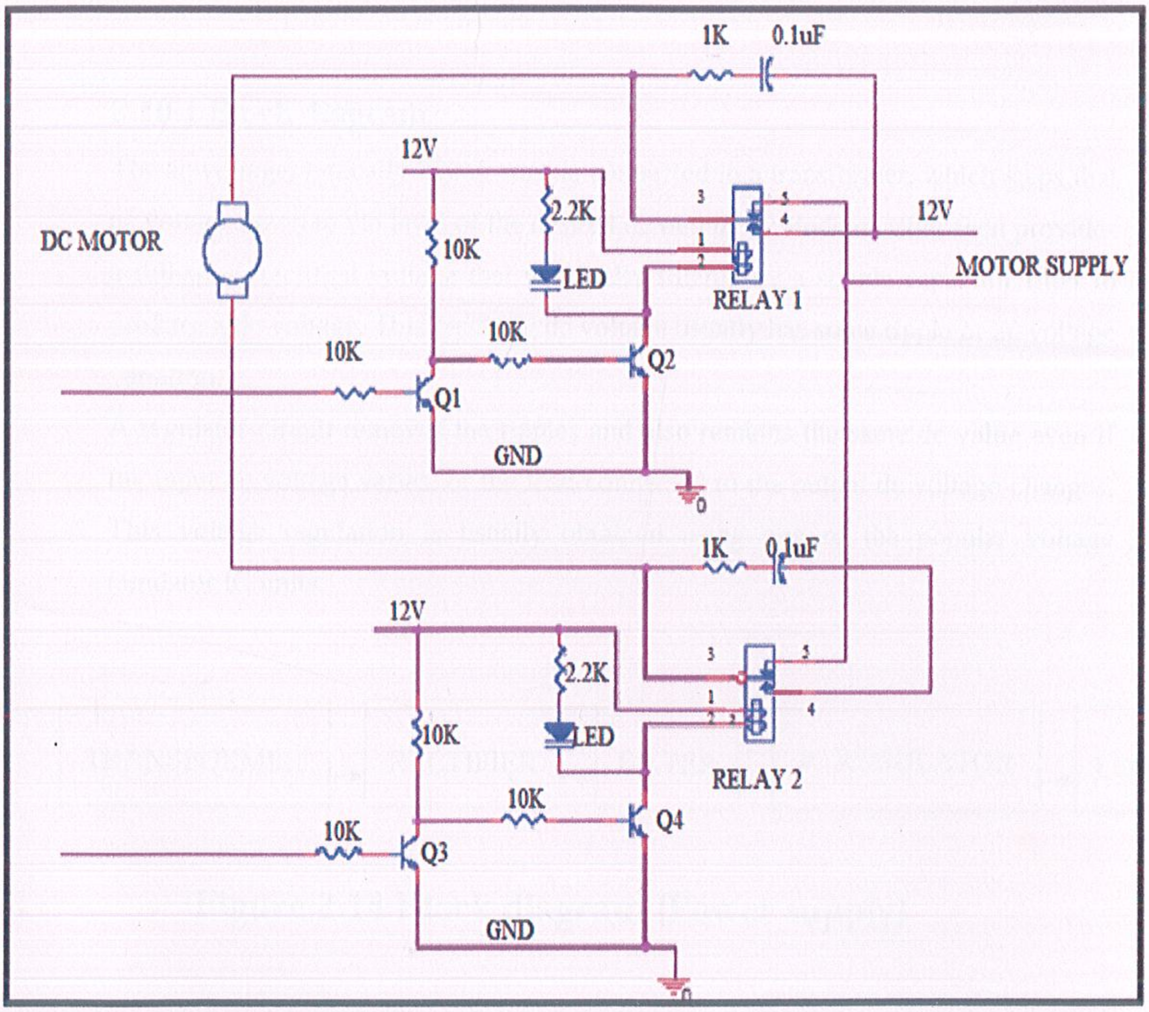

Figure 2.13 DC Motor Circuit

The series combination of resistor and capacitor is called as snubber circuit. When the relay is turn ON and turn OFF continuously, the back emf may fault the relays. So the back emf is grounded through the snubber circuit.

- When relay 1 is in the ON state and relay 2 is in the OFF state, the motor is running in the forward direction.

- When relay 2 is in the ON state and relay 1 is in the OFF state, the motor is running in the reverse direction.

2.10 POWER SUPPLY

2.10.1 Block diagram

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, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.

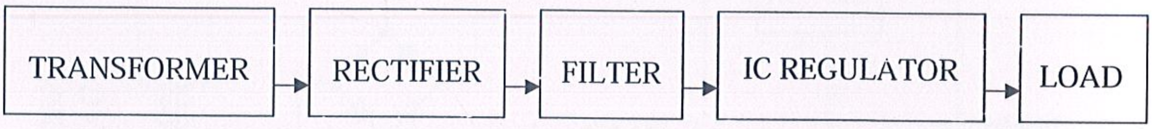

Figure 2.14 Block diagram (Power supply)

2.10.2 Working principle

Transformer

The potential transformer will step down the power supply voltage (0-230V) to (0-6V)level. Then the secondary of the potential transformer will be connected to the precision rectifier, which is constructed with the help of op–amp. The advantages of using precision rectifier are it will give peak voltage output as DC, rest of the circuits will give only RMS output.

Bridge rectifier

When four diodes are connected as shown in figure, the circuit is called as bridge rectifier. The input to the circuit is applied to the diagonally opposite corners of the network, and the output is taken from the remaining two corners.

Let us assume that the transformer is working properly and there is a positive potential, at point A and a negative potential at point B. the positive potential at point A will forward bias D3 and reverse bias D4.

The negative potential at point B will forward bias D1 and reverse D2. At this time D3 and D1 are forward biased and will allow current flow to pass through them; D4 and D2 are reverse biased and will block current flow.

The path for current flow is from point B through D1, up through RL, through D3, through the secondary of the transformer back to point B. this path is indicated by the solid arrows. Waveforms (1) and (2) can be observed across D1 and D3.

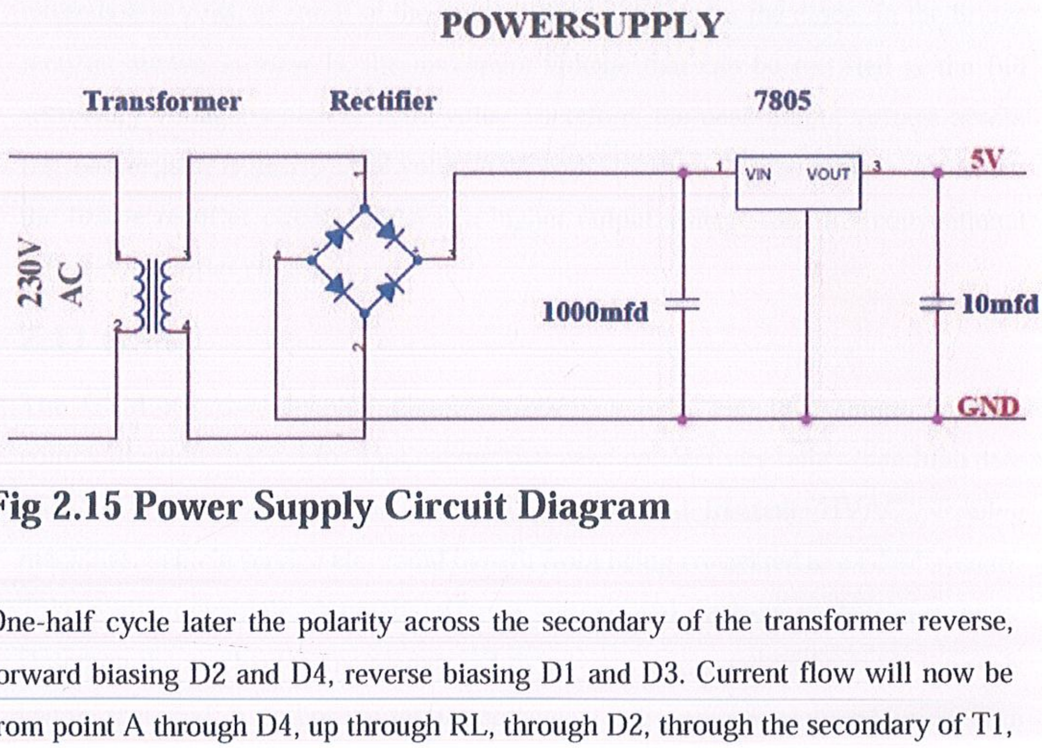

Fig 2.15 Power Supply Circuit Diagram

One-half cycle later the polarity across the secondary of the transformer reverse, forward biasing D2 and D4, reverse biasing D1 and D3. Current flow will now be from point A through D4, up through RL, through D2, through the secondary of T1, and back to point A. This path is indicated by the broken arrows. Waveforms (3) and (4) can be observed across D2 and D4. The current flow through RL is always in the same direction. In flowing through RL this current develops a voltage corresponding to that shown waveform (5). Since current flows through the load (RL) during both half cycles of the applied voltage, this bridge rectifier is a full-wave rectifier.

One advantage of a bridge rectifier over a conventional full-wave rectifier is that with a given transformer the bridge rectifier produces a voltage output that is nearly twice that of the conventional full-wave circuit.

This may be shown by assigning values to some of the components shown in views A and B. assume that the same transformer is used in both circuits. The peak voltage developed between points X and y is 1000 volts in both circuits. In the conventional full-wave circuit shown—in view A, the peak voltage from the center tap to either X or Y is 500 volts. Since only one diode can conduct at any instant, the maximum voltage that can be rectified at any instant is 500 volts.

The maximum voltage that appears across the load resistor is nearly-but never exceeds-500 vOlts, as result of the small voltage drop across the diode. In the bridge rectifier shown in view B, the maximum voltage that can be rectified is the full secondary voltage, which is 1000 volts. Therefore, the peak output voltage across the load resistor is nearly 1000 volts. With both circuits using the same transformer, the bridge rectifier circuit produces a higher output voltage than the conventional full-wave rectifier circuit.

2.11 GSM

The GSM net used by cell phones provides a low cost, long range, wireless communication channel for applications that need connectivity rather than high data rates. Machinery such as industrial refrigerators and freezers, HVAC, vending machines, vehicle service etc. could benefit from being connected to a GSM system. Take a given example. A garage offers a very special package to their customers. Based on the mechanics knowledge and the given vehicle, tailored service intervals can be specified. A part of the service agreement is installation of a GSM modem in the vehicle. An onboard service application can then notify the garage when the vehicle approaches its service interval. The garage will schedule an appointment and inform the customer.

The customer will benefit from a reliable and well-serviced vehicle at a minimum cost. The garage on the other hand can provide excellent customer support, vehicle statistics, efficient work scheduling, and minimum stocks. This application note describes how to use an AVR to control a GSM modem in a cellular phone. The interface between modem and host is a textual protocol called Hayes AT-Commands. These commands enable phone setup, dialing, text messaging etc. This particular application connects an AVR Butterfly and Siemens® M65 cellular phone using a RS232 based data cable. Most cellular phones could be used, except Nokia® phones using F or M-bus.

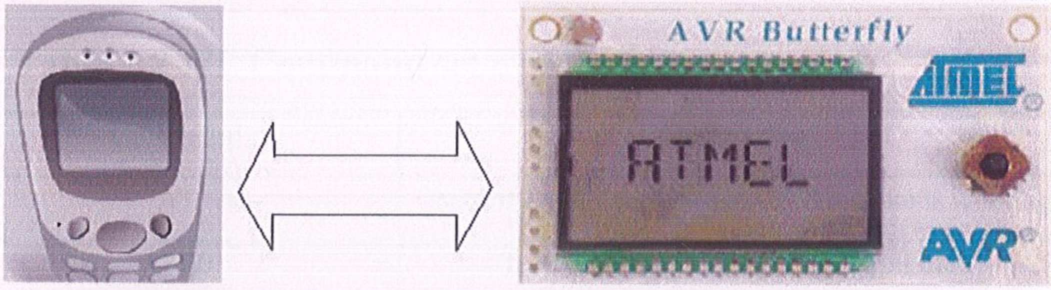

Fig 2.16 Interconnection of phone with AVR

2.11.1 Theory of operation

The protocol used by GSM modems for setup and control is based on the Hayes AT-Command set. The GSM modem specific commands are adapted to the services offered by a GSM modem such as: text messaging, calling a given Phone number, deleting memory locations etc. Since the main objective for this application note is to show how to send and receive text messages, only a subset of the AT-Command set needs to be implemented.

The European Telecommunication Standard Institute (ETSI) GSM 07.05 defines the AT-Command interface for GSM compatible modems. From this document some selected commands are chosen, and presented briefly in this section. This command subset will enable the modem to send and receive SMS messages. For further details, please consult GSM 07.05.

2.11.2 AT-Command set

The following section describes the AT-Command set. The commands can be tried out by connecting a GSM modem to one of the PC's COM ports. Type in the test-command, adding CR + LF (Carriage return + Line feed = \r\n) before executing. Also see chapters for further details.

Table 2.2 gives an overview of the implemented AT-Commands in this application. The use of the commands is described in the later sections.

Table 2.2 AT-Command set overview

Command	Description
AT	Check if serial interface and GSM modem is working.
ATE0	Turn echo off, less traffic on serial line.
AT+CNMI	Display of new incoming SMS.
AT+CPMS	Selection of SMS memory.
AT+CMGF	SMS string format, how they are compressed.
AT+CMGR	Read new message from a given memory location.
AT+CMGS	Send message to a given recipient.
AT+CMGD	Delete message.

2.11.3 Error codes

Many of the commands in the implemented subset can terminate with an error message related to the modem or network. These could be errors such as:

- Memory failure.
- Invalid recipient number.

- Network timeout.
- SIM busy or wrong.
- Operation not allowed.
- No network service.

These error messages can be useful, and could be implemented as a part of the application. It is possible to extend the handling of the error codes, but this is beyond the scope of this application note. We will just catch the ERROR message, and repeat the command.

2.12 Zigbee Network

The XBee and XBee-PRO OEM RF Modules were engineered to meet IEEE 802.15.4 standards and support the unique needs of low-cost, low-power wireless sensor networks. The modules require minimal power and provide reliable delivery of data between devices. The modules operate within the ISM 2.4 GHz frequency band and are pin-for-pin compatible with each other.

2.12.1 Key Features

Long Range Data Integrity

XBee

- Indoor/Urban: up to 100' (30 m).
- Outdoor line-of-sight: up to 300' (100 m).
- Transmit Power: 1 mW (0 dBm).
- Receiver Sensitivity: -92 dBm.

XBee-PRO

- Indoor/Urban: up to 300' (100 m).
- Outdoor line-of-sight: up to 1 mile (1500 m).

- Transmit Power: 100 mW (20 dBm) EIRP.
- Receiver Sensitivity: -100 dBmRF.
- Data Rate: 250,000 bps.

Low Power XBee

- TX Current: 45 mA (@3.3 V).
- RX Current: 50 mA (@3.3 V).
- Power-down Current: < 10 μA.

XBee-PRO

- TX Current: 215 mA (@3.3 V)
- RX Current: 55 mA (@3.3 V)
- Power-down Current: < 10 μA

ADC and I/O line support

- Analog-to-digital conversion.
- Digital I/OI/O Line Passing.

Advanced Networking & Security

- Retries and Acknowledgements.
- DSSS (Direct Sequence Spread Spectrum).
- Each direct sequence channels has over 65,000 unique network addresses available.
- Source/Destination Addressing.
- Unicast & Broadcast Communications.
- Point-to-point, point-to-multipoint and peer-to-peer topologies supported.
- Coordinator/End Device operations.

Easy-to-Use

- No configuration necessary for out-of box RF communications.
- Free X-CTU Software (Testing and configuration software).
- AT and API Command Modes for configuring module parameters.
- Extensive command set.
- Small form factor.

CHAPTER 3

SOFTWARE DESIGN

3.1OrCAD

OrCAD is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly to create electronic prints for manufacturing of printed circuit boards, by electronic design engineers and electronic technicians to create electronic schematics.

OrCAD® PCB Designer contains a fully integrated design flow that includes a constraint manager, design capture technology, component tools, a PCB editor, an Auto/interactive router, and interfaces for manufacturing and mechanical CAD.

At the heart of OrCAD PCB Designer is OrCAD PCB Editor, an interactive environment for creating and editing simple to complex multi-layer PCBs. The extensive feature set addresses a wide range of design and manufacturability challenges. OrCAD PCB Designer and OrCAD PCB Designer with PSpice both include Cadence SPECCTRA® for OrCAD, the market-leading PCB solution for automatic and interactive interconnect routing. Designed to handle routing challenges requiring complex design rules, it uses powerful shape-based algorithms for speed and efficient use of the routing area. Optionai PSpice® circuit analysis and simulation capabilities integrated with the included Capture facilitates rapid design-and-simulate cycles, allowing engineers to explore various design configurations before committing to a specific circuit implementation.

A common database architecture, use model, and library offer truly scalable PCB solutions for both OrCAD and Allegro products, allowing engineers the ability to migrate to the Allegro PCB technologies as their designs and design challenges increase in complexity.

3.1.1 Features/Benefits

- It offers a proven, scalable, easy-to-use PCB editing and routing solution that grows as needed.
- Tight, front-to-back application integration increases productivity and ensures data integrity.
- A comprehensive feature set and a seamless PCB design environment delivers a complete solution to take a design from concept to production.

3.2 Keil C51 C Compiler

The Keil C51 C Compiler for the 8051 microcontroller is the most popular 8051 C compiler in the world. It provides more features than any other 8051 C compiler available today.

The C51 Compiler allows you to write 8051 microcontroller applications in C that, once compiled, have the efficiency and speed of assembly language. Language extensions in the C51 Compiler give you full access to all resources of the 8051.

The C51 Compiler translates C source files into relocatable object modules which contain full symbolic information for debugging with the µVision Debugger or an in-circuit emulator. In addition to the object file, the compiler generates a listing file which may optionally include symbol table and cross reference information.

3.2.1 Features

- Nine basic data types, including 32-bit IEEE floating-point,
- Flexible variable allocation with **bit**, **data**, **bdata**, **idata**, **xdata**, and **pdata** memory types.
- Interrupt functions may be written in C,
- Full use of the 8051 register banks,
- Complete symbol and type information for source-level debugging,

Use of **AJMP** and **ACALL** instructions,

- Bit-addressable data objects,
- Built-in interface for the RTX51 Real-Time Kernel,

- Support for dual data pointers on Atmel, AMD, Cypress, Dallas Semiconductor, Infineon, Philips, and Triscend microcontrollers,
- Support for the Philips 8xC750, 8xC751, and 8xC752 limited instruction sets,
- Support for the Infineon 80C517 arithmetic unit.

3.3 Microsoft Visual Basic

Visual Basic (VB) is a third-generation event-driven programming language and integrated development environment (IDE) from Microsoft for its COM programming model first released in 1991. Visual Basic is designed to be relatively easy to learn and use. Visual Basic was derived from BASIC and enables the rapid application development (RAD) of graphical user interface (GUI) applications, access to databases using Objects, Remote, or ActiveX Data Objects, and creation of ActiveX controls and objects. Scripting languages such as VBA and VBScript are syntactically similar to Visual Basic, but perform differently.

A programmer can put together an application using the components provided with Visual Basic itself. Programs written in Visual Basic can also use the Windows API, but doing so requires external function declarations. Though the program has received criticism for its perceived faults, from version 3 Visual Basic was a runaway commercial success, and many companies offered third party controls greatly extending its functionality.

3.3.1 Characteristics

Visual Basic has the following traits which differ from C-derived languages:

- Statements tend to be terminated with keywords such as "End If", instead of using "{}"s to group statements.

- Multiple variable assignments is not possible. A = B = C does not imply that the values of A, B and C are equal. The Boolean result of "Is B = C?" is stored in A. The result stored in A would therefore be either false or true.
- Logical and bitwise operators are unified. This is unlike some C-derived languages (such as Perl), which have separate logical and bitwise operators. This again is a traditional feature of BASIC.
- Relatively strong integration with the Windows operating system and the Component Object Model. The native types for strings and arrays are the dedicated COM types, BSTR and SAFEARRAY.
- Banker's rounding as the default behavior when converting real numbers to integers with the Round function. ? Round (2.5, 0) gives 2,? Round (3.5, 0) gives 4.
- Integers are automatically promoted to real in expressions involving the normal division operator (/) so that division of one integer by another produces the intuitively correct result. There is a specific integer divide operator (\) which does truncate.

3.4 CODE

```
#include<avr/io.h>
#include<util/delay.h>
#include<avr/interrupt.h>
#include<avr/eeprom.h>
#include<inttypes.h>
#include"ATM_LCD4.h"
#include"ATM_Serial.h"
#include"Adc_Atmega.h"

#define right_backward1 PORTB |= 0x01
#define right_backward0 PORTB &= ~0x01
#define right_forward1  PORTB |= 0x02
#define right_forward0 PORTB &= ~0x02
#define left_forward1 PORTB |= 0x04
#define left_forward0 PORTB &= ~0x04
#define left_backward1 PORTB |= 0x08
#define left_backward0 PORTB &= ~0x08
#define alr_on  PORTB |= 0x10
#define alr_off PORTB &= ~0x10
#define gas (PINB & 0x20)
#define ldr (PINB & 0x40)
#define obj (PINB & 0x80)

void send();
void enter();
void init();
void send_pc();
void enter_1();
void fun();
void right();
```

```
void left();
void backward();
void forward();
void stop();

volatile unsigned int temp,nummm=20;

volatile unsigned char
count=0,sec=0,n[10],p[10],a2[10],h,num[10],numm[10],o,x,add,mv,y,l,set_temp=2
55,cc=255,dd=255,a[60],a1[30],i,j,s,k=1,w=1;
unsigned char f,e,q,r,bit_gas,bit_obj,bit_ldr,xx,d,aa,bi,jk=0;
ISR(USART0_RX_vect)
{
   a[i]=UDR0;
   a2[h]=UDR0;
   if(a[0]=='#') i++;
   else i=0;
   if(a2[0]=='@') h++;
   else h=0;
   sei();
}

/*ISR(USART1_RX_vect)
{
   a1[j]=UDR1;
   if(a1[0]=='*') j++;
   else j=0;
   sei();
}*/
```

```
void main()
{
   cli();
   MCUCR=0<<PUD;
   DDRA=0X00;
   DDRB=0X1F;
   DDRC=0XFF;
   DDRD=0XFF;
   PORTA=0X00;
   PORTB=0XFF;
   PORTC=0XFF;
   PORTD=0XFF;
   sei();

   Lcd4_Init();
   Lcd4_Display(0x80," MINE CONDITION ",16);
   Lcd4_Display(0xC0,"DETECTION ROBOT ",16);
   _delay_ms(500);
   Serial0_Init(9600); Receive0(1);_delay_ms(500);
   Serial1_Init(9600); Receive1(0);_delay_ms(500);
   alr_off;
   Adc_Init();
   _delay_ms(500);
   init();
   _delay_ms(200);
   init();
   _delay_ms(200);
   for(o=0;o<10;o++) {n[o]=eeprom_read_byte(o); _delay_ms(100);}
// for(o=0;o<10;o++) {p[o]=eeprom_read_byte(o+10); _delay_ms(100);}
   _delay_ms(1000);
   Lcd4_Display(0x80,"TEMP:          ",16);
```

```
Lcd4_Display(0xC0,"                ",16);

a[0]=a1[0]=a1[0]=0;
i=j=h=0;
while(1)
{
        while(xx==0)
    {
                Lcd4_Decimal2(0x8e,xx);
                Lcd4_Decimal2(0x8e,h);
                fun();
        if(h>1)
        {
                        Lcd4_Write(0xc0,a2[0]);
                        Lcd4_Write(0xc1,a2[1]);
                Receive0(0);

                if(a2[1]=='R')
                {right(); Lcd4_Display(0xc0,"     RIGHT      ",16);
                }
                else if(a2[1]=='L')
                {left(); Lcd4_Display(0xc0,"     LEFT       ",16);
                }
                else if(a2[1]=='B')
                {backward(); Lcd4_Display(0xc0,"    BACKWARD    ",16);
                }
                else if(a2[1]=='F')
                {forward(); Lcd4_Display(0xc0,"    FORWARD     ",16);
                }
                else if(a2[1]=='S')
                {stop(); Lcd4_Display(0xc0,"     STOP       ",16);
```

```
                    }
                    else if(a2[1]=='A')
                    {xx=1; bi=1; Lcd4_Display(0xc0,"    AUTO MODE   ",16);
                    }
              ///for(d=0;d<=49;d++) a2[d]=0;
              h=0;
              Receive0(1);
            }
        }
        while(xx)
        {
                    fun();
//          aa++;
//          Lcd4_Decimal3(0x8e,aa);

//          if(aa>150) {right(); aa=0; while(nummm--) fun(); nummm=20;  bi=1;}
//          if(bi)
//          {
              forward();
//              bi=0;
//          }
                    if(jk==1)
                    {
                          jk=0;
                          right();
                          _delay_ms(2500);
                          forward();
                    }
          if(h>1)
          {
                          Lcd4_Write(0xc0,a2[0]);
```

```
                    Lcd4_Write(0xc1,a2[1]);
        stop();

              if(a2[1]=='M')
              {
              xx=0;   Lcd4_Display(0x80," MANULE MODE   ",16);
              }
        for(d=0;d<=49;d++) a2[d]=0;
        h=0;
      }
    }
  }
}

void fun()
{
  temp=Adc_Cha10(0);
  temp=temp/4-70;
  Lcd4_Decimal3(0x87,temp);
  if(!gas && !bit_gas) { bit_gas=1; s=2;  Serial0_Conout("%GY",3);
  send();Lcd4_Display(0xC0,"                ",16);}
  if(gas && bit_gas)
        {
        bit_gas=0; Serial0_Conout("%GN",3); Lcd4_Display(0xC0," GAS NOT
        SENSED ",16);
        }
  if(!ldr && !bit_ldr)
        {
        bit_ldr=1; s=3; Serial0_Conout("%LY",3); send();Lcd4_Display(0xC0,"
        SMOKE SENSED   ",16);
```

```
        }
if(ldr && bit_ldr)
        {
        bit_ldr=0; Serial0_Conout("%LN",3); Lcd4_Display(0xC0,"
      ",16);
        }
if(obj && !bit_obj)
        {
        bit_obj=1;jk=1; s=4; Serial0_Conout("%OY",3); Lcd4_Display(0xC0,"
        ",16);
        }
if(!obj && bit_obj)
        {
        bit_obj=0; Serial0_Conout("%ON",3); Lcd4_Display(0xC0,"
      ",16);
        }
send_pc();
if(i>13)
{
        Lcd4_Display(0x80,"VALUES  RECEIVED",16);
        Receive0(0);_delay_ms(500);
        Lcd4_Command(0x01);
        set_temp=((a[1]-0x30)*100) + ((a[2]-0x30)*10) + ((a[3]-0x30));
        _delay_ms(200);
        Lcd4_Decimal3(0x8c,set_temp);
        for(o=0;o<10;o++)
        {
                num[o]=a[o+4]; _delay_ms(100);
                eeprom_write_byte(o,num[o]); _delay_ms(100);
                n[o]=eeprom_read_byte(o); _delay_ms(100);
                Lcd4_Write(0xc0+o,n[o]); _delay_ms(100);
```

```
                /*numm[o]=a[o+20]; _delay_ms(100);
                eeprom_write_byte(o+10,numm[o]); _delay_ms(100);
                p[o]=eeprom_read_byte(o+10); _delay_ms(100);
                Lcd4_Write(0x80+o,p[o]); _delay_ms(100); */
            }
            _delay_ms(2000);
            for(e=0;e<=59;e++) a[0]=0;
            i=0;
            Lcd4_Display(0x80,"TEMP:           ",16);
            Lcd4_Display(0xC0,"                ",16);
            Receive0(1);
        }
        if(temp>set_temp && w)
        {
            w=0;
            s=1;
            Serial0_Conout("%TY",3);
            send();
        }
        else if(temp<=set_temp && !w)
        {
            w=1;
            Serial0_Conout("%TN",3);
        }
        if(temp>set_temp) alr_on;
        else if(!gas) alr_on;
        else if(!ldr) alr_on;
        else alr_off;
    }
    void send_pc()
    {
```

```
    //Lcd4_Display(0x80,"     ZIGBEE     ",16);
    Serial0_Out('$');
    Serial0_Out((temp%1000)/100+48);
    Serial0_Out((temp%100)/10+48);
    Serial0_Out(temp%10+48);
}
void send()
{
    for(q=0;q<=0;q++)
    {
            Lcd4_Display(0xc0,"Message sending ",16);
            _delay_ms(500);      _delay_ms(500);
            Serial1_Conout("AT+CMGS=",8);
            Serial1_Out('"');_delay_ms(500);
//          Serial1_Conout("9488713208",10);
            if(q==0)
            {
                    for(l=0;l<=9;l++) {Serial1_Out(n[l]);_delay_ms(50);}
            }
            Serial1_Out('"');_delay_ms(500);
            enter();
            _delay_ms(500);
            if(s==0)
            {
                    Serial1_Conout("TEMPERATURE ",12); _delay_ms(30);
                    Serial1_Out((temp%1000)/100+48); _delay_ms(30);
                    Serial1_Out((temp%100)/10+48); _delay_ms(30);
                Serial1_Out(temp%10+48); _delay_ms(30);
                    enter();
            }
```

```
            else if(s==1) {Serial1_Conout("TEMPERATURE ABNORMAL",20);
_delay_ms(30); }
            else if(s==2) {Serial1_Conout("GAS SENSED          ",20);
_delay_ms(30); }
            else if(s==3) {Serial1_Conout("SMOKE SENSED        ",20);
_delay_ms(30); }
            else if(s==4) {Serial1_Conout("OBJECT SENSED       ",20);
_delay_ms(30); }
            _delay_ms(300);
            Serial1_Out(0x1a);
            _delay_ms(500);              _delay_ms(500);
  Lcd4_Display(0xc0,"Message sended  ",16);_delay_ms(500);
  _delay_ms(500);
  }
}

void init()
{
  Serial1_Conout("AT",2);
  enter();_delay_ms(650);_delay_ms(650);

  Serial1_Conout("AT+CMGF=1",9);
  enter();_delay_ms(650);_delay_ms(650);

  Serial1_Conout("AT+CNMI=2,2,0,0,0",17);
  enter();_delay_ms(650);_delay_ms(650);
}

void enter()
{
```

```
    Serial1_Out(0x0d);
    Serial1_Out(0x0a);
}

void stop()
{
    right_backward1;
    right_forward1;
    left_forward1;
    left_backward1;
}

void left()
{
    right_backward1;
    right_forward0;
    left_forward1;
    left_backward0;
}

void right()
{
    right_backward0;
    right_forward1;
    left_forward0;
    left_backward1;
}

void forward()
{
    right_backward1;
```

```
    right_forward0;
    left_forward0;
    left_backward1;
}

void backward()
{
    right_backward0;
    right_forward1;
    left_forward1;
  left_backward0 ;
 }
```

CONCLUSION

After testing the robot, we can assert with confidence that such a robot could be used in mines and industries where human are not able to reach easily. We believe that there is definitely a place on the market for our proposed system since it has wide range of application. It can be successfully used in mines, industries, laboratories, electrical power grid and nuclear power plant and many more. The GSM and Zigbee network has enhanced the system performance and also provided a better security option

The market for wireless sensor network is expected to grow rapidly in the near future. Our developed designed system will help to reduce major accidents which generally occur in mines and industries. It will save the life of people and serve the people with an easy control

There is always a need of modification and adding features for growing technology. We know there is always profitability for modifying the technology to compete the market .Even though there are certain disadvantages and limitations to these robots, they can be overcome by making certain changes and enhancements to our current design.

FUTURE ENHANCEMENT

There are certain enhancements which would increase the efficiency of these mine condition detection robots. Firstly, self rechargeable batteries which convert the kinetic energy produced by the motion of the robot into charge can be used. This would obviate the need to charge the robot. This reduces the idle time of the robots radically. Also, intruder alarms and gas sensors which could sense various other gases can be used. A wireless camera can be installed on robot for getting the accurate position of the robot and also including a GPS system on it. In future we can also include robotic arm which has capabilities of not only detecting but also it can fix small leakages in gas furnaces. These additions would make the robot a more complete life saving intelligent robot with multiple capabilities.

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APPENDIX

ATmega PIN Configuration

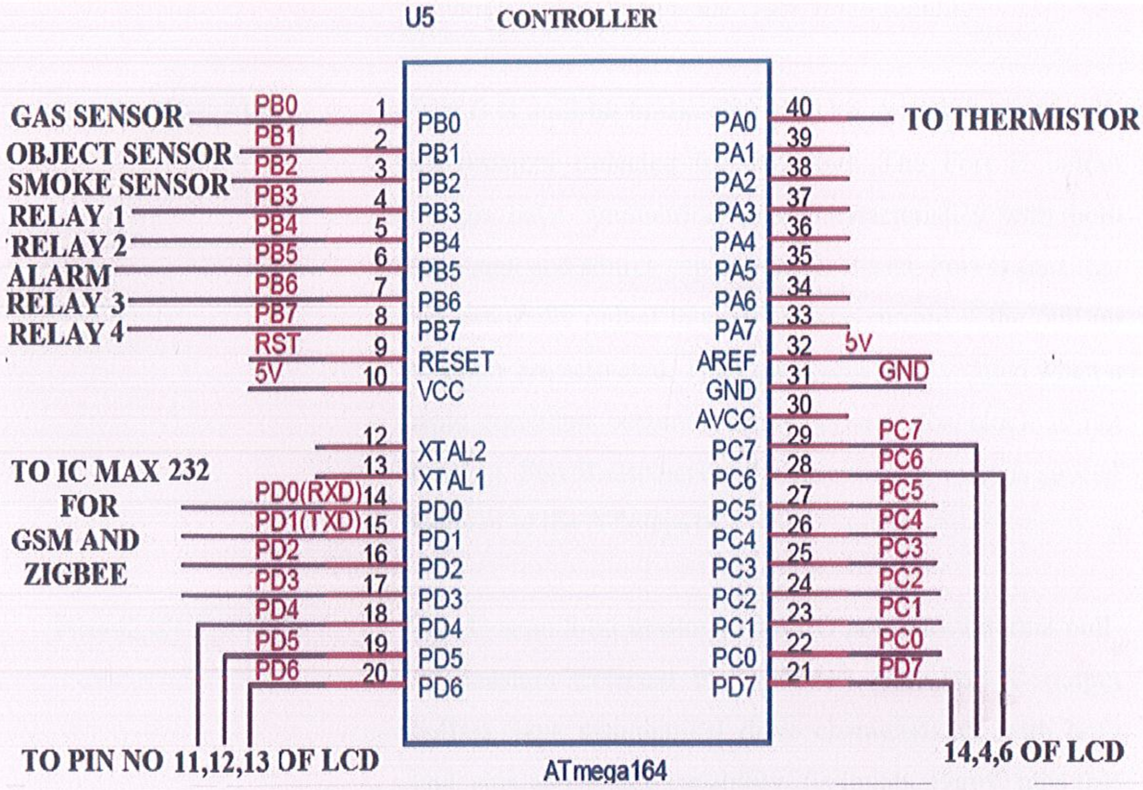

Figure A.1 ATmega pin diagram

VCC	Digital supply voltage.
GND	Ground.
Port A (PA7..PA0)	Port A serves as the analog inputs to the A/D Converter. Port A also serves as an 8-bit bi-directional I/O port, if the A/D Converter is not used. Port pins can provide internal pull-up resistors (selected for each bit). The Port A output buffers have symmetrical drive characteristics with both

high sink and source capability When pins PA0 to PA7 are used as inputs and are externally pulled low, they will source current if the internal pull-up resistors are activated. The Port A pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Port B (PB7..PB0)

Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes active, even if the clock is not running. Port B also serves the functions of various special features of the ATmega16.

Port C (PC7..PC0)

Port C is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port C output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tri-stated when a reset condition becomes active, even if the clock is not running. If the JTAG interface is enabled, the pull-up resistors on pins PC5(TDI), PC3(TMS) and PC2(TCK) will be activated even if a reset occurs. Port C also serves the functions of the JTAG interface and other special features of the ATmega16 as listed on page 59.

Port D (PD7..PD0)

Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port D output

	buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port D pins that are externally pulled low will source current if the pull-up resistors are activated. The Port D pins are tri-stated when a reset condition becomes active, even if the clock is not running. Port D also serves the functions of various special features of the ATmega16.
RESET	Reset Input. A low level on this pin for longer than the minimum pulse length will generate a reset, even if the clock is not running. The minimum pulse length is given in Table 15 on page 36. Shorter pulses are not guaranteed to generate a reset.
XTAL1	Input to the inverting Oscillator amplifier and input to the internal clock operating circuit.
XTAL2	Output from the inverting Oscillator amplifier.
AVCC	AVCC is the supply voltage pin for Port A and the A/D Converter. It should be externally connected to VCC, even if the ADC is not used. If the ADC is used, it should be connected to VCC through a low-pass filter.
AREF	AREF is the analog reference pin for the A/D Converter.