GAS DETECTION AND PATH FINDING ROBOT IN ATOMIC POWER STATIONS

Estd. 1984

PROJECT REPORT

Submitted By

Aruna .R
Ganesh Kumar .S
Rohit .S
Vidhya Sankar .V

Guided By

Mr.T.Kannan M.E.,MISTE,MSSI
Lecturer, Dept. of EEE

2002 - 2003

Sponsored By

Tamil Nadu State Council for Science and Technology,
Chennai – 25.

In partial fulfillment of the requirements for the award of the degree of Bachelor of Engineering in Electrical and Electronics branch of Bharathiar University, Coimbatore.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
KUMARAGURU
COLLEGE OF TECHNOLOGY
COIMBATORE – 641 006

Estd-1984

ISO 9001:2000 Certified

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGIINEERING

KUMARAGURU
COLLEGE OF TECHNOLOGY
COIMBATORE – 641 006

Estd-1984

CERTIFICATE

This is to certify that the Project Report entitled

"GAS DETECTION AND PATH FINDING ROBOT FOR ATOMIC POWER STATIONS"

has been submitted by

ARUNA .R	99EEE08
GANESH KUMAR .S	99EEE15
ROHIT .S	99EEE42
VIDHYA SANKAR .V	99EEE59

in partial fulfillment of the requirements for the award of the degree of Bachelor of Engineering in Electrical and Electronics branch of Bharathiar University, Coimbatore during the academic year 2002 - 2003

Project Guide

Head of the Department

Certified that the candidates were examined in project work Viva – Voce Examination on 20·03·2003

Internal Examiner

External Examiner

ACKNOWLEDGEMENT

ACKNOWLEDGEMENT

We wish to express our deep sense of gratitude and indebtedness to our project guide **Mr.T. Kannan, M.E., MISTE, MSSI.,** Lecturer, Department of Electrical and Electronics Engineering, for his invaluable guidance and constructive suggestions, the keen and constant inspiration and interest evinced by him at all stages right from the inception to the completion.

We are highly grateful to **Dr.T.M. Kameswaran, B.E, M.Sc(Engg), Ph.D , MISTE , Sr.MIEEE, FIE** Head of the Department, Electrical and Electronics Engineering, for his enthusiasm and encouragement which has been instrumental in the success of the project.

We are also indebted to **Prof.V.Duraisamy, M.E., MISTE., AMIE., MSSI.,** Assistant Professor, and **Prof.K. Rajan, M.E., MISTE,** Assistant Professor and Project Coordinator, Department of Electrical and Electronics Engineering for their cooperation.

We express our heartfelt gratitude to our principal **Dr.K.K.Padmanabhan, B.Sc., (Engg), M.Tech., Ph.D., FIE,** for providing the necessary facilities for the successful completion of the project.

We are immensely grateful to **Tamil Nadu State Council for Science and Technology Chennai,** for recognizing and partially sponsoring our project.

We also would like to express our gratitude to the **Faculty of Department of Electrical and Electronics Engineering** for their kind patronage.

Our **friends and classmates** deserve very special thanks for their continued support and encouragement during the course of the project.

Above all, we would like to add a sincere thanks to **the Lord Almighty,** without whose blessings, the project wouldn't have got completed.

DEDICATED

TO OUR

BELOVED PARENTS

SYNOPSIS

SYNOPSIS

The world is moving at a very fast pace with a rapid industrialization taking place throughout. The concept of high technology implementation is aimed at high quality production, optimum cost and userfriendly measures and with such being the prevailing situation, the top priority is for industrial safety. It is distressing to note that catastrophe caused due to the leakage of (Methyl Isocyanate) gas in the Union Carbide Factories during the 1980's, which could have been avoided if adequate safety measures were adopted. The essential components of industrial safety that are closely associated are men, materials, machines and work methods.

Though this project can be used in various industries involving combustible and poisonous gases, we here specify its major application in *atomic plants*. This is because as per the present scenario, the resources for other power plants are at a steady decline and this disadvantage of other plants is provoking the need for atomic plants in which the only big problem involved is of safety. This project aims at designing a safety system that can be used in atomic plants to sense the leakage using robots.

CONTENTS

INTRODUCTION

1.1. Enhancement from previous models

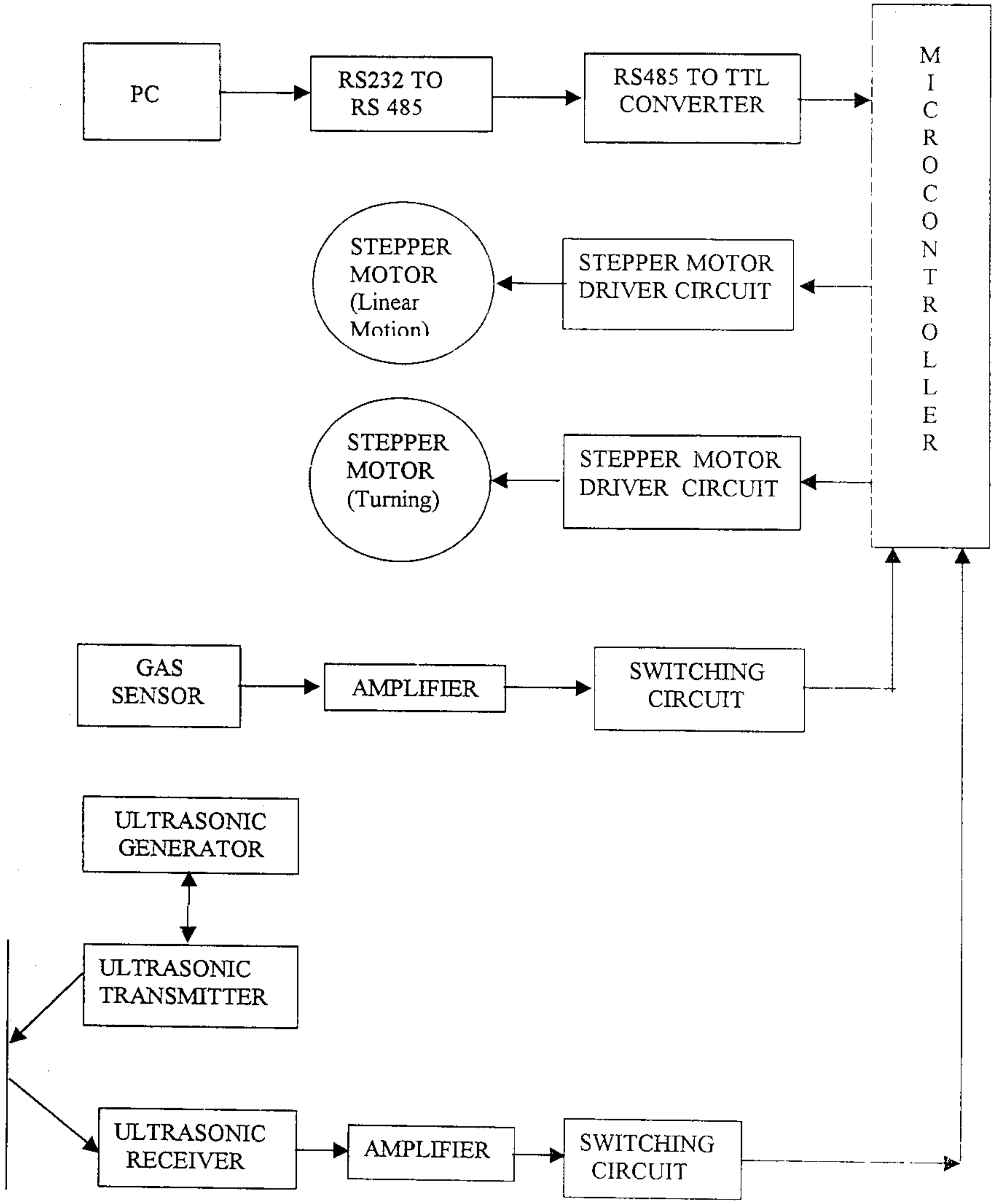
One of the most promising and exciting fields of study is artificial intelligence, which is the study of making a machine take decisions by programming it. It is a subject involving various fields like robotics, perception of vision, understanding of speech, problem solving and expert systems. This project " **Gas Detection & Path Finding Robot In Atomic Power Stations** " is designed to find out the leakage of poisonous and combustible gases in atomic stations or any other industry involving such gases and also it has some intelligence to take the predetermined path. An additional circuit is also designed and used to detect if there is any obstacle in the desired path of the robot.

This requires very large memory and is a complicated one to program. An easy method can be done by using a microcontroller. In our project, the robot performs action on receiving a command from personal computer. In earlier days the highest performance real-time control applications have employed 16 and 32 bits micros together with interrupt handle chips, programmable-timer, which can now be achieved in a single microcontroller chip. It has extensive Boolean processing capabilities.

In earlier conventional methods, a stand-alone Gas Detector with alarm was available. It was very time consuming and it required experts to keep it in correct position. Then the robot controlled through motor came into existence. Later invention was using keyboard for forecasting. We are using a *personal computer* as the machine to overcome the difficulties such as need for operators, positioning etc. By using the specially made Gas Detection and Path Finding Robot, the Atomic Station will be a most safety one regaining gas leakages. It has high security features. Life span guarantee is more for this project.

For the detection of leakage of poisonous or combustible gases, sensors with alarm may be used in industries as in few of the existing ones. But to have a highly efficient and reliable system, robots can be used for the detection of the leakage of any dangerous gases or chemical fumes in the course of manufacture. The presence of obnoxious gases can be identified by employing robots with sensors attached.

1.2 BLOCK DIAGRAM



The robot is driven using two stepper motors, one for the linear motion and the other for the turning. The exact path of movement for the robot is predetermined. The robot movement is based on the pulses given to it using a microcontroller and its speed can be altered by including required delay.

When the gas is detected by the gas sensor, it sends out a signal. This signal is amplified and passed on to the microcontroller through the switching circuit. When any obstacle comes in the path of the robot, it is detected using the ultrasonic circuit.

Thus, any obstacle or gas leakage is reported to the microcontroller which inturn sends a signal to the Personal Computer which is serially interfaced. An alarm will be energized at the same instant.

HARDWARE

2.1 ROBOT AND STEPPER MOTOR

The heart of this project is a ***robot*** which moves around the reactor. The robot has a gas sensor and an ultrasonic sensor fixed in it to sense leakage of gases and to detect any obstacle in its path.

A ***robot*** can be defined as a programmable multifunction manipulator designed to handle material parts, tools or specialized devices through variable programmed motions for the performance of variety of tasks. Today robots are fitted with a variety of sensors like vision, ranging, force-torque, touch, proximity etc, sending the sensory information to the computer which processes them subject to given objective and constraints and develops action decisions for the robot actuators. Robots are more flexible in terms of ability to perform new tasks or to carry out complex sequences of motion than other categories of automated manufacturing eguipment. Generally speaking robots are machines with some degree of intelligence and operated under the control of a minicomputer. Industrial robots can perform hazardous and monotonous tasks with tireless precision.

Reasons for using Robots

- It relieves man of hazardous or fatiguing tasks.
- It brings improvement in product consistency and quality.
- It offers opportunities for multimachine manning for multishift operation and for wholly unmanned production.
- It brings savings in labour reduction where there is a shortage of labour and increases the output without increasing the labour force.
- It will lead the way in to areas of technology where man has not entered so far.

STEPPER MOTORS

These motors are also called stepping motors or step motors. The name stepper is used because this motor rotates through a fixed angular step in response to each input current pulse received by its controller. They can be controlled directly by computers, microprocessors and programmable controllers. The stator windings are excited by electrical pulses and for each pulse, the motor advances by one angular step. Since the stepper motor can be driven by digital pulses, it is also called digital motor.

Stepping motors are ideally suited for situations where either precise positioning or precise speed control or both are required in automation systems. The unique feature of a stepper motor is that its output shaft rotates in a series of discrete angular intervals or steps, one step being

taken each time a command pulse is received. When a definite number of pulses are supplied, the shaft turns through a definite known angle. This fact makes the motor well suited for open-loop position control because no feedback need be taken from the output shaft. In fact, they function as decoders, transforming the digital information received in the form of electrical pulses into steps of angular position.

Stepper motors are often constructed with a multipole, multiphase stator winding similar to the conventional electrical machines. They usually have three or four phase windings wound for a number of poles determined by the desired angular displacement per input pulse. The rotors are either of the permanent magnet type or the variable reluctance type. Stepper motors are actuated by means of an external drive logic circuit. As a series of pulses of voltage is applied to the input of the drive circuit, it feeds suitable currents to the stator windings of the motor to make the axis of the magnetic field step around in synchronism with the input pulses. Depending on the pulse rate and the load torque including that of inertia, the rotor follows the axis of the magnetic field due to the torque produced due to the interaction of the magnetic field caused by the permanent magnet rotor or the variation of reluctance w.r.t. angular position of rotor.

Such motors develop torques ranging from 1 micro N-m upto 40Nm. Their Power output ranges from about 1 W to a maximum of 2500 W. The only moving part in a stepping motor is its rotor which has no windings, commutator or brushes. This feature makes the motor quite robust and reliable.

STEP ANGLE

The angle through which the motor shaft rotates for each command pulse is called the step angle. Smaller the step angle, greater the number of steps per revolution and higher the resolution or accuracy of positioning obtained. The step angles can be as small as 0.72 degrees or a large as 90 degrees. But most common step sizes are 1.8,2.5,7.5 and 15 degrees.

The value of step angle can be expressed either in terms of the rotor And stator poles (teeth) or in terms of the number of stator phases and the Number of rotor teeth. Resolution is given by the number of steps needed of steps needed to complete one revolution of the rotor shaft.

A stepping motor has the extraordinary ability to operate at very
High stepping rates and yet to remain fully in synchronism with the command pulses. When the pulse rate is high, the shaft rotation seems continuous. Operation at high speeds is called 'slewing'. Stepping motorsare designed to operate for longer periods with the rotor held in a fixed position and with rated current flowing in the stator windings.

OPERATING PRINCIPLE

Consider a stepper motor having a 4 pole stator with two phase windings. Let the rotor be made of permanent magnet with 2 poles. The stator poles are marked A , B , C and D and they are excited with pulses supplied by power transistors. The power transistors are switched by digital controllers or computers.

Each control pulse applied by the switching device causes a stepped variation of the magnitude and polarity of the voltage fed to the control windings. If the first excitation is applied to A and C, they develop the magnetic polarities indicated for step 1 and the rotor sets itself vertically. The magnetic polarity developed in the stator can be determined by the *right hand rule.*

If now A and C are switched OFF and B and D are excited in step 2, an alignment torque is developed on the rotor to turn its axis to the horizontal by a 90 degree step. With B and D OFF and A and C re-energized with reverse polarity, the rotor turns for a further 90 degree and so on.The direction of rotation is anticlockwise. The direction can be reversed by changing the current direction suitably.

FULL STEP OPERATION

Full step operation of a stepper motor consists of a movement of one full step for each input pulse.

Full step = 360 / (No. of rotor poles * No. of stator pole pairs)

Consider a two phase stepper motor with four wound poles in the stator and a 10 pole rotor. Now the step angle will be 18 degrees. The arrow on the rotor will enable us to follow the movement of the rotor. The motor is in start position. A current of Im amperes enters the phase A. the direction of this current is such that the top stator pole is a south pole and bottom stator pole is a north pole. The magnetic attraction between unlike poles will hold the rotor in the position as shown in the figure.

A current of Im enters the phase B winding and current in phase A is switched OFF. Now the right side stator pole becomes south pole and left side stator pole becomes north pole. The top and bottom stator poles are demagnetized. The magnetic attraction between opposite poles and the repulsion between like poles has caused the rotor to rotate one step in the clockwise direction.

Step	θ(deg)	Ia/Im	Ib/Im
0	0	1	0
1	18	0	1
2	36	-1	0
3	54	0	-1
4	72	1	0
5	90	0	1

HALF-STEP OPERATION

Half-steps are accomplished by applying partial currents to both phase windings to position the rotor halfway between two full step position. The first half-step is accomplished by reducing the phase A Current to 0.707 Im amperes and increasing the phase B current to 0.707 Im Amperes. Notice that all four stator coils are magnetized. The magnetic forces are such that the rotor is held in the position exactly half of a full 18 deg. Step. Table below lists the angle θ and the two phase currents for 8 half-steps.

Half Step	Q (deg)	Ia/Im	Ib/Im
0	0	1	0
1	9	0.707	0.707
2	18	0	1
3	27	-0.707	0.707
4	36	-1	0
5	45	-0.707	-0.707
6	54	0	-1
7	63	0.707	-0.707
8	72	1	0

MICRO STEP OPERATION

Microstepping uses different values of current in each phase. The microstep sizes that are most commonly used are 1/10,1/16,1/32 and 1/125 **of a full** step. It provides a much finer resolution. For example, when 125 microsteps are used in a stepper that has 200 full steps per revolution, the resolution is 25,000 microsteps per revolution.

TYPES OF STEPPER MOTOR

There is a large variety of stepper motors which can be divided into the following three basic categories:

- Variable Reluctance Stepper motor
- Permanent Magnet Stepper motor.
- Hybrid Stepper motor.

APPLICATIONS

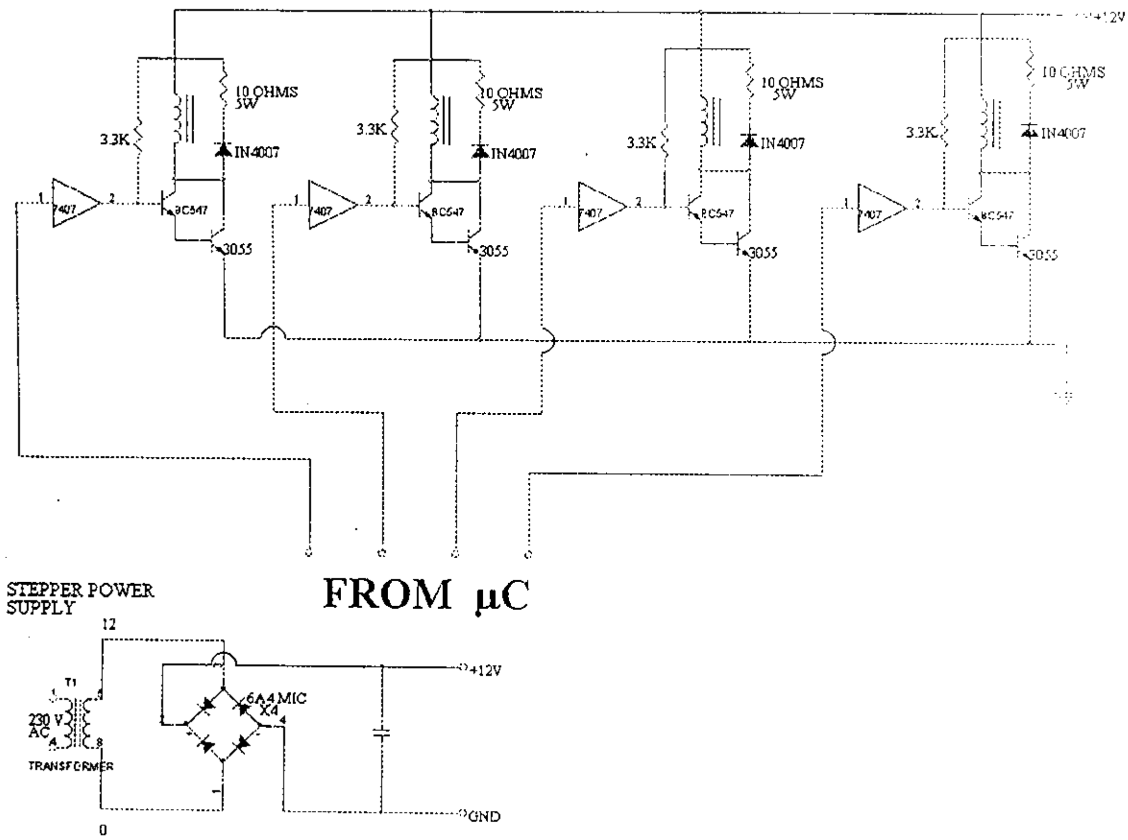
- They are used in computer peripherals, X-Y plotters, scientific instruments, robots and machine tools.
- They are used in quartz – crystal watches.
- They are used for colour registration in printing.
- They can upgrade mechanical systems by replacing cams, complex linkages and similar mechanisms to give greater precision and production rate.

STEPPER DRIVER CIRCUIT

Stepper motor is having four energizing coils. When the alternate phases of stepper motor are energised, the shaft of Stepper motor starts running in forward Direction and also energizing in opposite phases, the motor starts running in reverse direction.

Four coils of stepper motor are energized by using ports of the micro controller. We can't directly drive the coils of stepper motor from

STEPPER DRIVER CIRCUIT AND STEPPER POWER SUPPLY



a microcontroller. So by using appropriate power transistors, we can energize the coils of stepper motor. NPN transistor is switched by sending pulse from micro controller. Power transistor is switched by using NPN transistor. Resistors are used for current limiting purpose. Diodes are used for to avoid reverse current. When sending corresponding data for energizing the coils of stepper motor from micro controller, first NPN transistors are switched. Then by switching NPN transistors, we can switch on the Power transistor. By switching power transistors we can energize the coils of stepper motor. The necessary power is obtained from a power supply circuit build around a step down transformer and four power diodes.

STEPPER MOTOR SELECTION

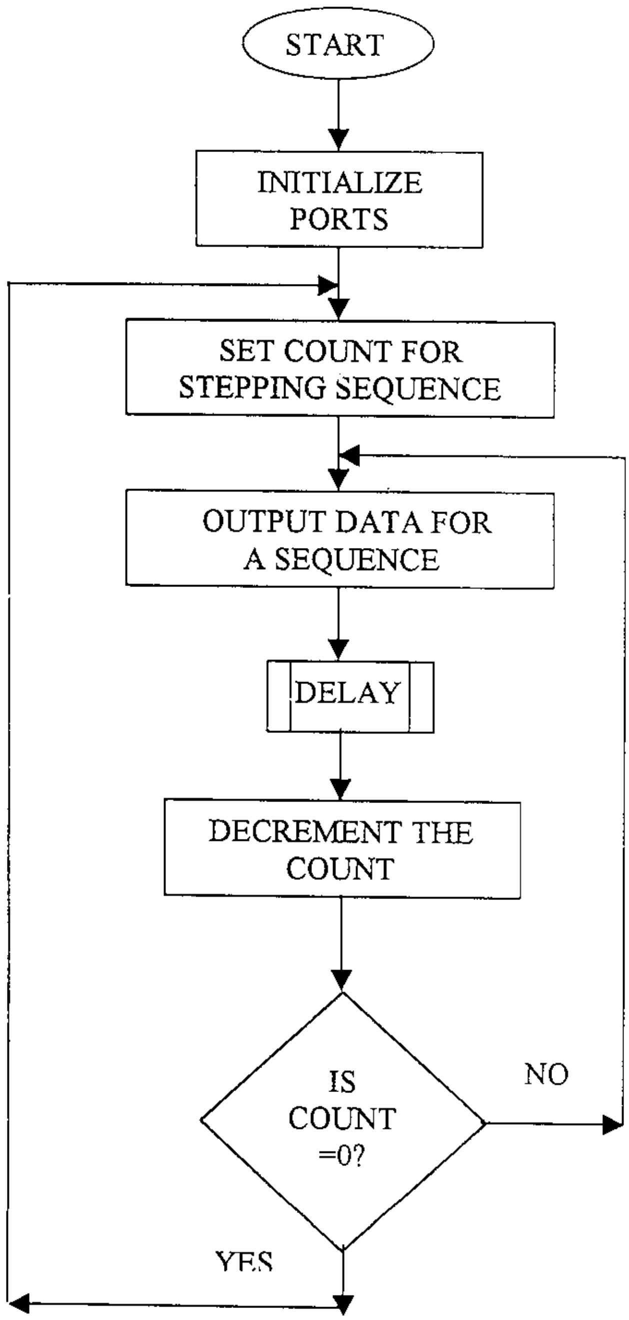
The two most important factors in selecting a stepper motor are the torque and the current requirements. A motor that can develop enough torque to overcome the frictional and inertial loads at the highest stepping rate needed should be chosen. The motor shoud be of continuous duty rating. We can certainly operate a motor at somewhat less than the rated current to reduce motor heating or to get away with a smaller driver for cost reasons. We may also overdrive a stepper motor if adequate heat sinking is available or if the operate to idle ratio (duty cycle) is relatively low and the driver produces a "current cutback at idle" capability.

There are three further basic considerations for selecting stepper motors for a particular application. These are: (a) positioning accuracy (δ) – expressed in degrees or minutes of arc (rotary motion) – mm or microns (linear motion); (b) speed of operation (V) – specified in degrees or rad/sec, or rpm (rotary motion) –mm or m per sec.(linear motion); and (c) acceleration (α) – specified indirectly in terms of the time Δt required to attain operating speed V.

It is possible to determine the step angle θ_s of the motor from the positioning accuracy. Stepping rate Fs can similarly be determined from the operating speed V. Acceleration in rad/sec^2 is computed from the ratio V/ Δt, where V is the time required to attain it from rest.

The load determines the total inertia J_T reflected to the motor shaft and the drive used to couple it to the motor. Knowledge of J_T and α enables us to compute accelerating torque $J\alpha$. Adding friction and load torques yields the total torque T_M that must be developed by the motor.Once these basic data are available, we may proceed to select a stepper motor of proper size .

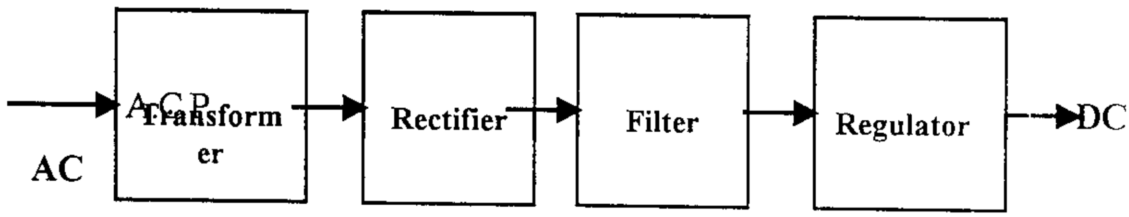
STEPPER MOTOR CONTROL FLOW CHART



2.2 POWER SUPPLY

All electronic circuits work only with low D.C. voltage. Hence we need a power supply unit to provide the appropriate voltage supply. This unit consists of transformer, rectifier, filter and regulator. The transformer steps that AC voltage down to the level to the desired AC voltage. 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 variations. A regulator circuit can use this DC input to provide DC voltage that not only has much less ripple voltage but also remains the same DC value even the DC voltage varies some what, or the load connected to the output DC voltages changes.

BLOCK DIAGRAM



The voltage regulator is a device, which maintains the output voltage constant irrespective of the change in supply variations, load variation and temperature changes. Here we use two fixed voltage regulators namely LM 7812, LM 7805 and LM7912. The IC 7812 is a +12V regulator, IC 7912 is a -12V regulator and IC 7805 is a +5V regulator. The series 78 regulators provide fixed regulated voltages from

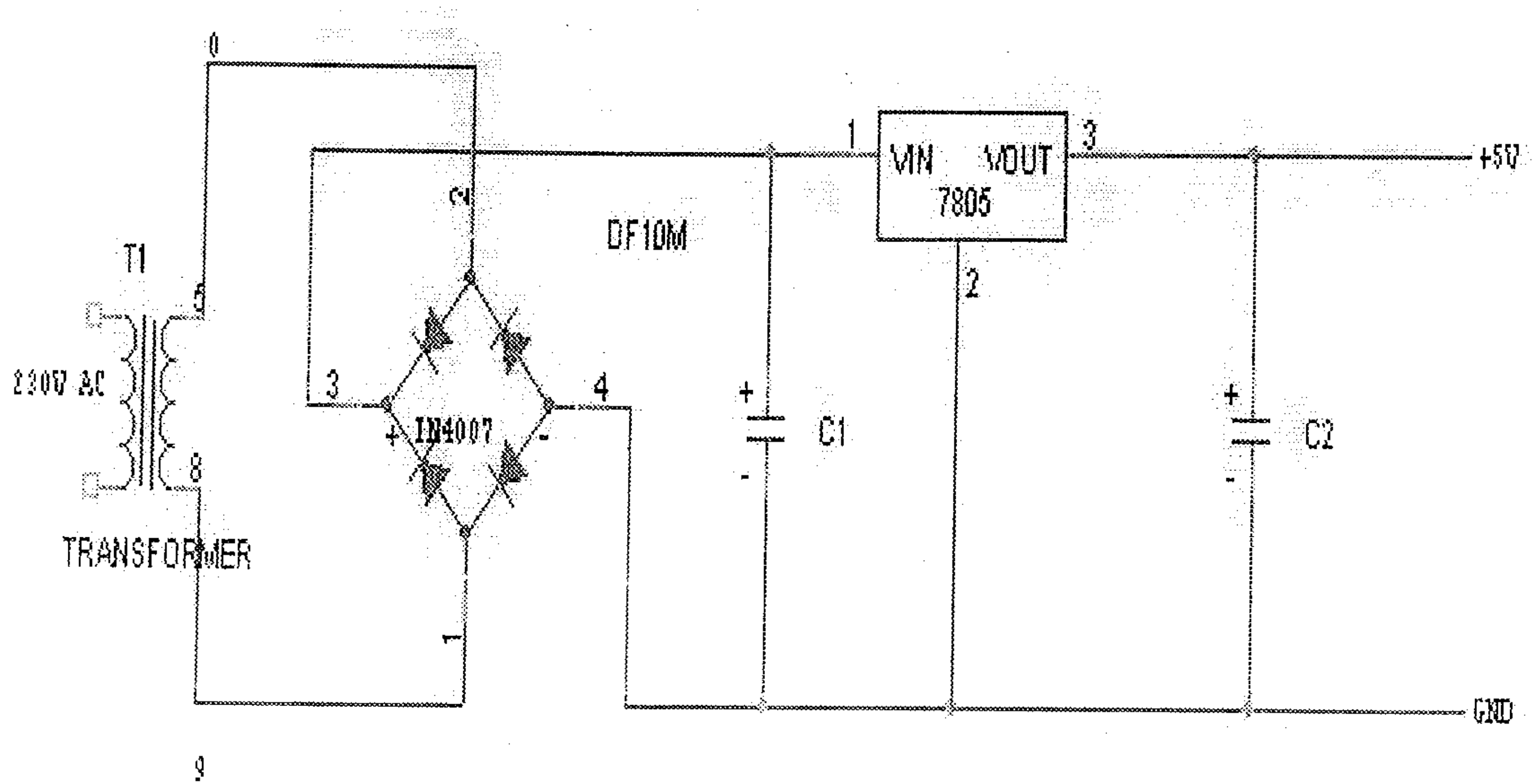


Fig 1(a) +5V supply

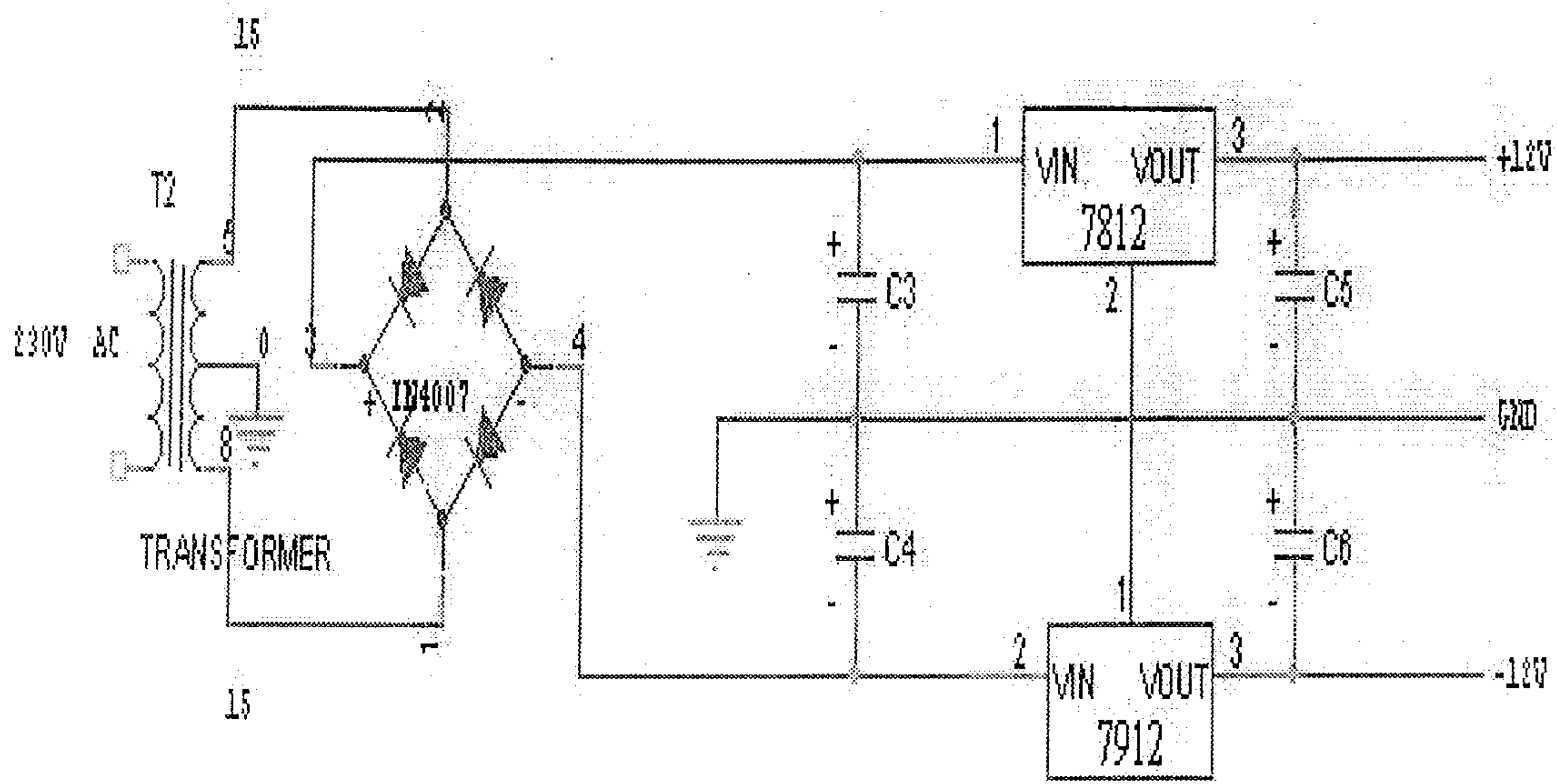


Fig 1(b) +12V and -12V supply

5 to 24 V. Similarly the series 79 regulators provide regulated voltages from -5 to -24 V.

2.3 GAS SENSING

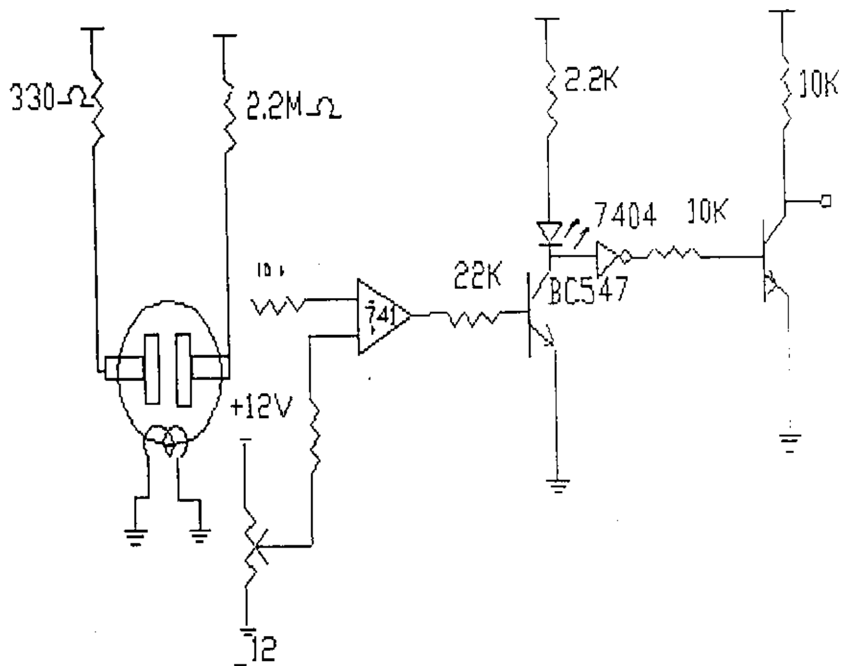
In the gas sensing circuit of the project ,we are using gas sensors.Gas sensors are available for a variety of gases .The gases are either combustible or non-combustible.Combustible gases are more dangerous with regard to industrial safety.We are using TGS 813- for the detection of combustible gases.

REMARKABLE FEATURES OF TGS 813

- General purpose sensor with sensitivity to a wide range of combustible gases
- High sensitivity to methane, propane and butane
- Long life and low cost
- uses simple electrical circuit

The sensing element of this gas sensor is a tin dioxide (SnO_2) semiconductor which has low conductivity in clean air. In the presence of a detectable gas, the sensor's conductivity increases depending on the gas concentration in the air. This change in conductivity can be converted to an output signal using a simple electrical circuit.

GAS SENSING CIRCUIT



The TGS 813 has high sensitivity to methane, propane, and butane, making it ideal for natural gas and LPG monitoring. The sensor can detect a wide range of gases, making it an excellent, low cost sensor for a wide variety of applications.

The sensitivity of the sensor is measured in terms of sensor resistance ratio (R_s/R_o) which is defined as

R_s = Sensor resistance of the gas at various concentration

R_o = Sensor resistance in 1000 ppm of methane

2.4 OBSTACLE SENSING

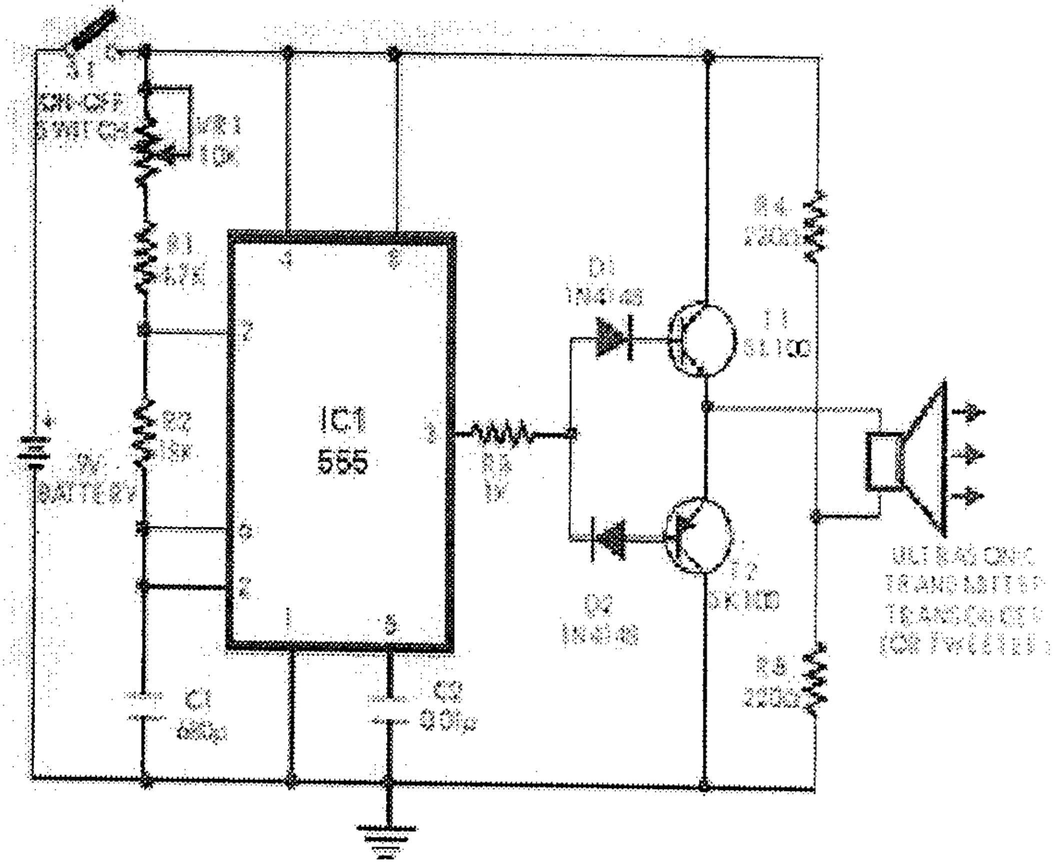
Ultrasonic Transmitter

The various parts involved in the ultrasonic transmitter are

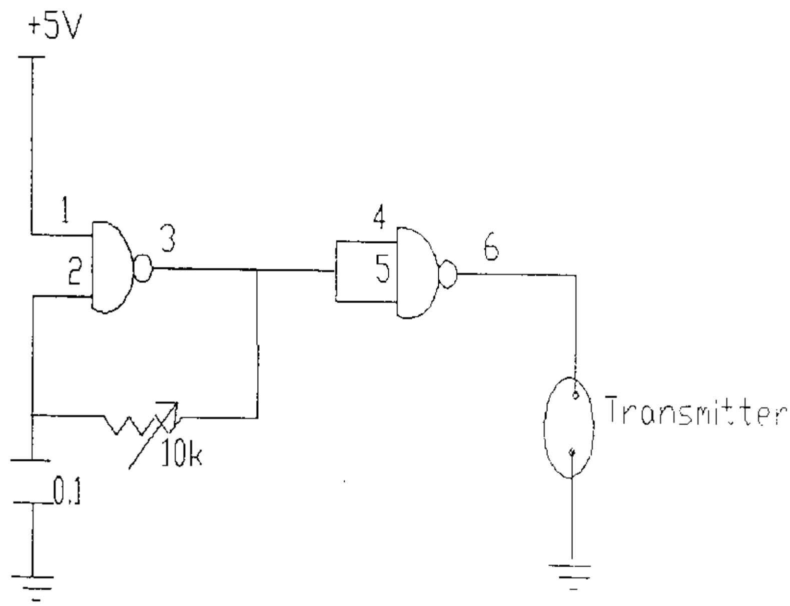
- IC1 NE555 timer IC
- VR1 10k variable resistor
- R1 4.7k resistor
- R2 18k potentiometer
- R3 1k resistor
- R4, R5 220 ohm resistor
- C1 680 picofarad capacitor
- C2 0.01uf capacitor
- D1, D2 1N4148 Diode
- T1 SL100 NPN transistor
- T2 SK100 PNP transistor
- S1 SPST momentary contact switch
- XMTR ultrasonic transmitter 40-50khz

The ultrasonic transmitter uses a 555 based astable multivibrator. It oscillates at a frequency of 40-50 kHz. An ultrasonic transmitter transducer is used here to transmit ultrasonic sound very effectively. The transmitter is powered from a 9-volt PP3 single cell. When switch S1 of transmitter is pressed, it generates ultrasonic sound. Frequency of ultrasonic sound generated can be varied from 40 to 50 kHz range by adjusting VR1. It should be adjusted to achieve maximum performance. Ultrasonic sounds are highly directional. So when operating the switch, the ultrasonic transmitter transducer of transmitter should be placed

INTERNAL CIRCUIT OF ULTRASONIC TRANSMITER



ULTRASONIC TRANSMITTER



towards ultrasonic receiver transducer of receiver circuit for proper functioning. A 9-volt PP3 battery is used for transmitter.

Circuit Description

The ultrasonic transmitter circuit consists of NAND gate. Two NAND gates are used in this circuit. One of the inputs to the NAND gate is +5V. Consider the other input to the NAND is 0. The output will be 1. When the output is 1, the capacitor gates charged. During the next cycle both the inputs to the NAND gate is 1 and the output goes to 0. The output of the first NAND gate is given to the second NAND gate. The two inputs to the NAND gate are tied together. The output of this second NAND gate is used for transmission using ultrasonic sensor.

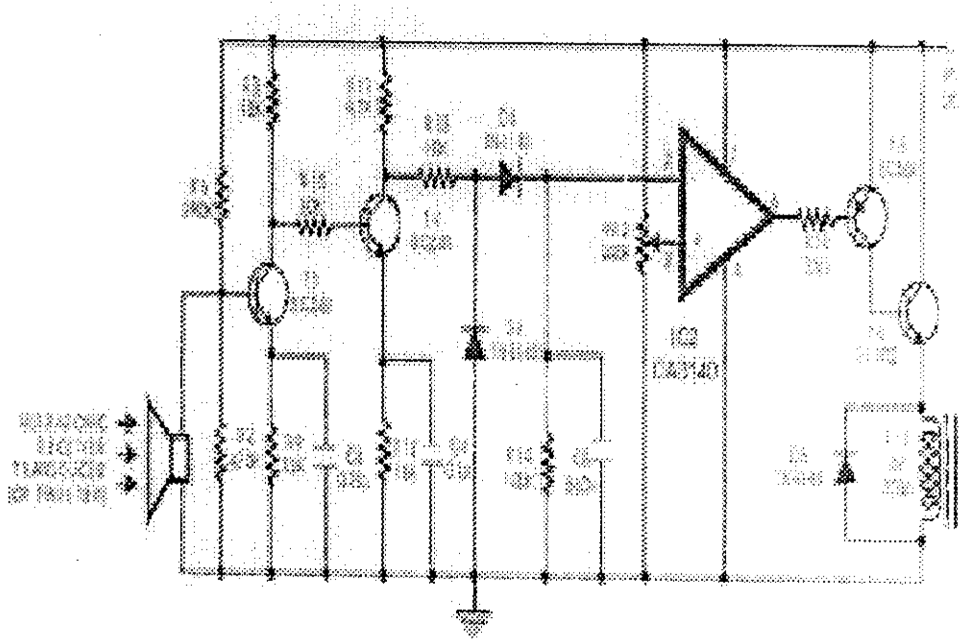
Ultrasonic Receiver

The major parts of the ultrasonic receiver are:

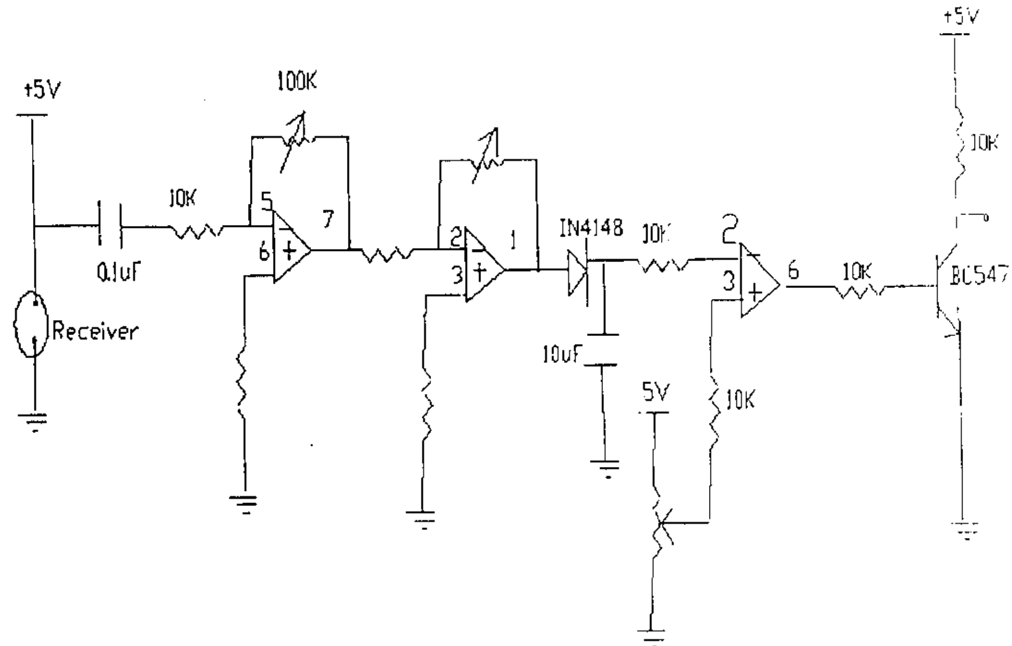
- RCVR Ultrasonic Receiver 40-50khz
- RL1 6volt 200ohm resistor
- IC2 CA3140
- VR2 250k Variable Resistor
- R6 390k Resistor
- R7 470k Resistor
- R8, R12 15k Resistor
- R9 12k
- R10, R13 10k
- R11 4.7k
- R14 100k Resistor
- R15 33 ohm Resistor
- C3 0.22uf ceramic capacitor
- C4 0.1uf ceramic capacitor
- C5 560n ceramic capacitor
- T3, T4 BC548 NPN Transistor
- T5 BC558 PNP Transistor
- T6 SL100 NPN Transistor
- D3, D4, D5 1N4148 Diode

The ultrasonic receiver circuit uses an ultrasonic receiver transducer to sense ultrasonic signals. It also uses a two-stage amplifier, a rectifier stage, and an operational amplifier in inverting mode. Output of op-amp is connected to a relay through a complimentary relay driver stage. A 9-volt battery eliminator can be used for receiver circuit, if required. When

INTERNAL CIRCUIT OF ULTRASONIC RECEIVER



ULTRASONIC RECEIVER



switch S1 of transmitter is pressed, it generates ultrasonic sound. The sound is received by ultrasonic receiver transducer. It converts it to electrical variations of the same frequency. These signals are amplified by transistors T3 and T4. The amplified signals are then rectified and filtered. The filtered DC voltage is given to inverting pin of op-amp IC2. The non- inverting pin of IC2 is connected to a variable DC voltage via preset VR2 which determines the threshold value of ultrasonic signal received by receiver for operation of relay RL1. The inverted output of IC2 is used to bias transistor T5. When transistor T5 conducts, it supplies base bias to transistor T6. When transistor T6 conducts, it actuates the relay. The relay can be used to control any electrical or electronic equipment.

Circuit Description

At the receiving side, ultrasonic sensor is used to receive the transmitted signal. The received signal is used as input to the inverting amplifier. The amplified signal is rectified and filtered and given as input to the comparator. The other input to the comparator is the reference voltage. The comparator compares these two voltages and the output of the comparator is +12 or -12 V. The output of the comparator is given to the switching circuit. Here, the transistor acts as a switch.. When the voltage across the B-E junction of the transistor is less than 0.7 V, the transistor is in OFF condition. The output voltage taken across the collector of the transistor is 0V.

MICROCONTROLLER

MICROCONTROLLER

The robot of our project has been programmed to take a particular path and detect the presence of gas leakage and obstacle.For this purpose, we are using microcontroller which inturn is interfaced with the personal computer. For our application, we are using PIC16F877.

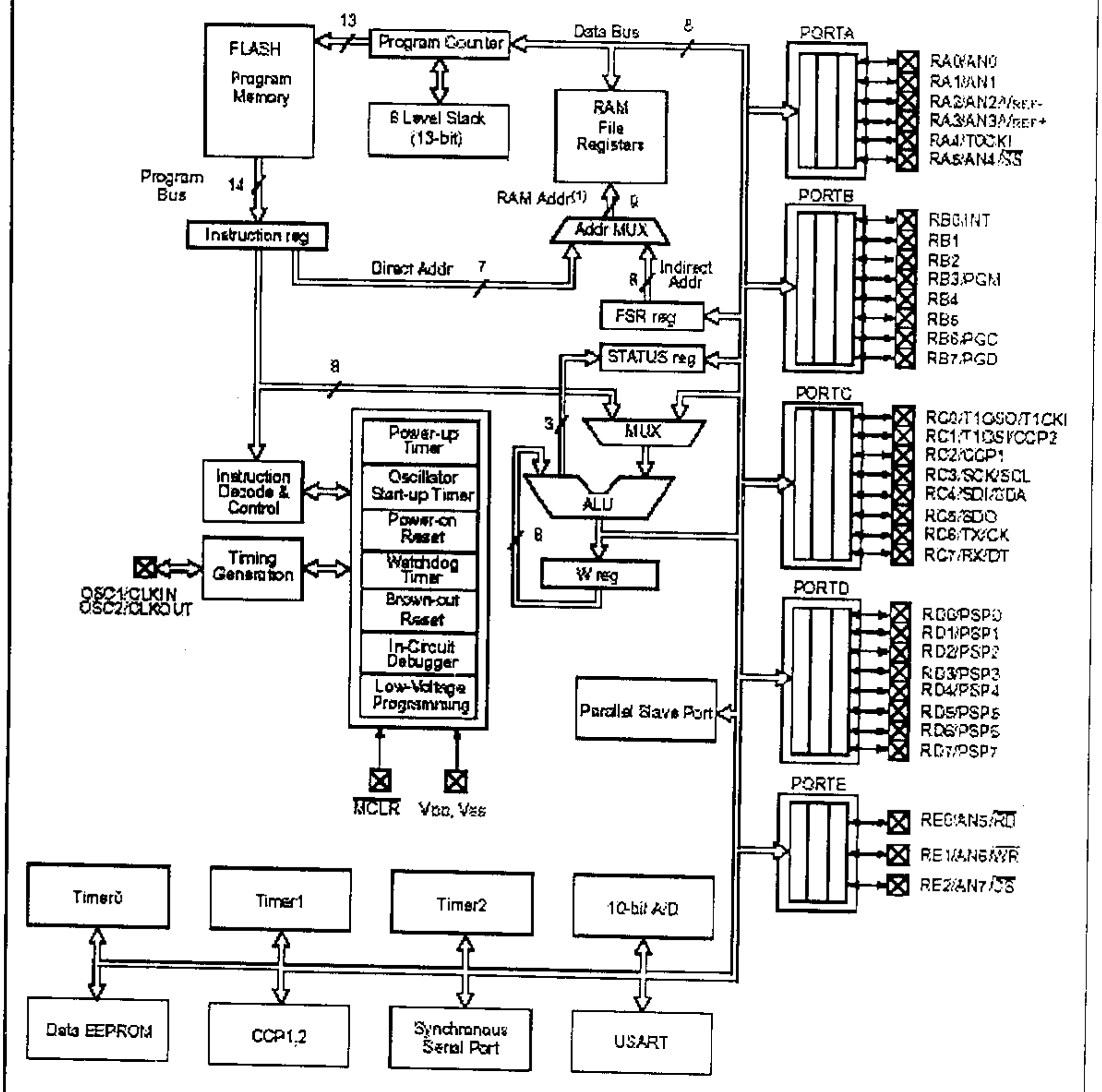
PIC 16F877

3.1 PIC 16F877 Architecture

The PIC 16 series comprises of PIC16F873, PIC16F874, PIC16F876 and PIC16F877. Out of this PIC 16F873 and PIC16F874 are 28-pin packages. In our Project we have used the PIC16F877 for its outstanding features like

- High performance RISC CPU
- Only 35 single word instructions
- Up to 8K x 14 words of FLASH Program Memory,
- Up to 368 x 8 bytes of Data Memory (RAM)
- Up to 256 x 8 bytes of EEPROM Data Memory
- Interrupt capability (up to 14 sources)
- Power saving SLEEP mode
- Low power, high speed CMOS FLASH/EEPROM technology
- Processor read/write access to program memory
- Wide operating voltage range: 2.0V to 5.5V
- High Sink/Source Current: 25 mA

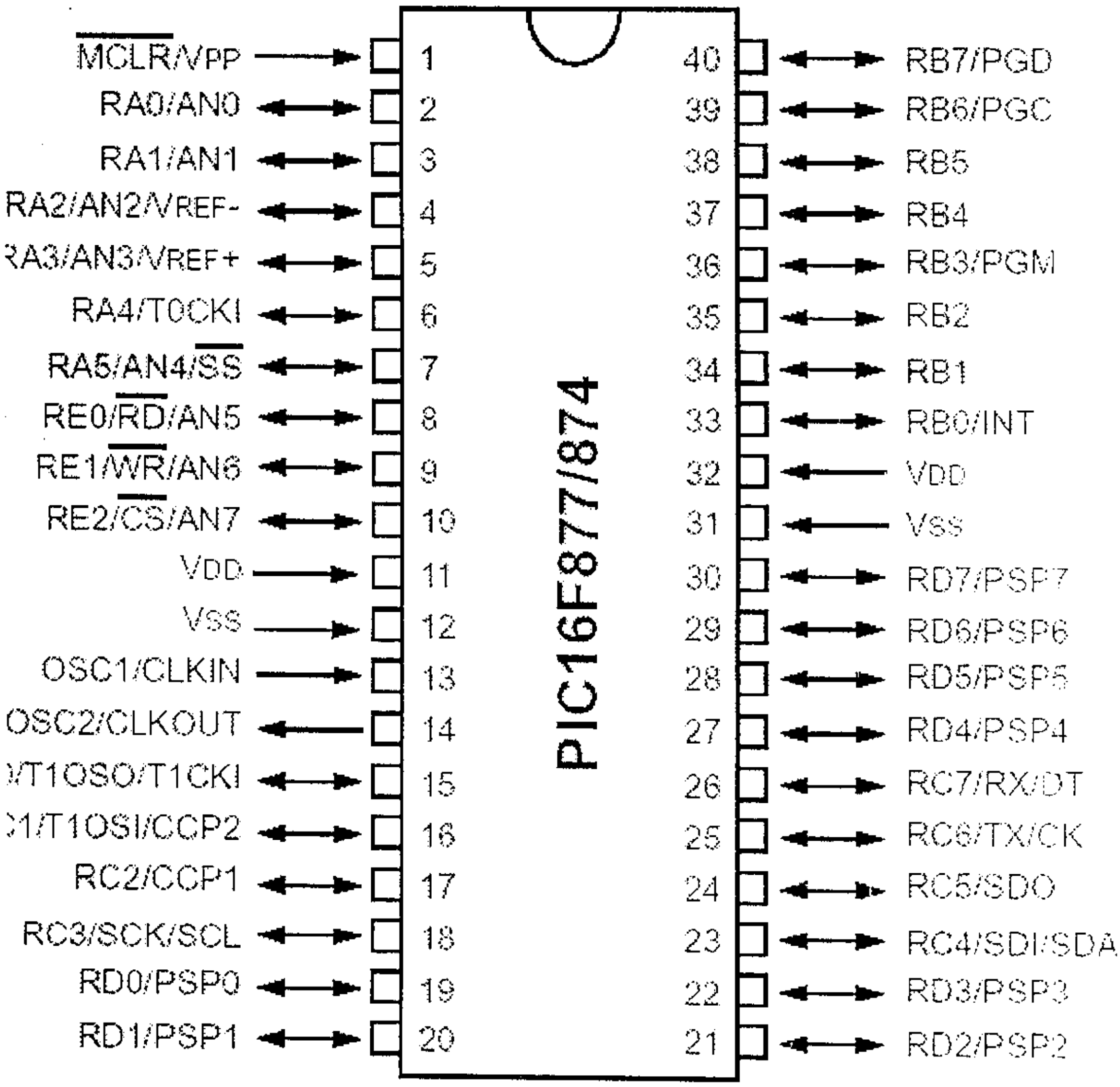
Device	Program FLASH	Data Memory	Data EEPROM
PIC16F874	4K	192 Bytes	128 Bytes
PIC16F877	8K	368 Bytes	256 Bytes



Note 1: Higher order bits are from the STATUS register.

PIC 16F877 Block Diagram

PIC PIN DETAILS

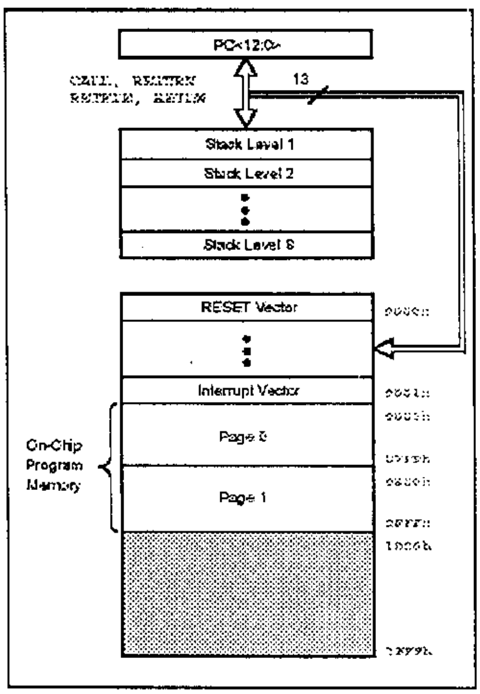


3.2 Memory Organization

There are three memory blocks in the PIC16F877 Microcontroller. The Program Memory and Data Memory have separate buses so that concurrent access can occur in both.

Program Memory Organization

The PIC16F87X devices have a 13-bit program counter capable of addressing an 8K x 14 program memory space. The PIC16F877 device has 8K x 14 words of FLASH program memory. Accessing a location above the physically implemented address will cause a wraparound. The RESET vector is at 0000h and the interrupt vector is at 0004h. The program memory map and stack organization of 16F877 is shown.



Data Memory Organization

The data memory is partitioned into multiple banks which contain the General Purpose Registers and the Special Function Registers. Bits RP1 and RP0 are the bank select bits.

RP1	RP0	BANK
0	0	0
0	1	1
1	0	2
1	1	3

Each bank extends up to 7Fh (128 bytes). The lower locations of each bank are reserved for the Special Function Registers. Above the Special Function Registers are General Purpose Registers, implemented as static RAM. All implemented banks contain Special Function Registers. Some frequently used Special Function Registers from one bank may be mirrored in another bank for code reduction and quicker access.

The General Purpose Register file can be accessed either directly, or indirectly through the File Select Register (FSR). The Special Function Registers are registers used by the CPU and peripheral modules for controlling the desired operation of the device. These registers are implemented as static RAM. The Special Function Registers can be classified into two sets: core (CPU) and peripheral. The registers present in Special Function Registers are explained in brief.

The **STATUS** register contains the arithmetic status of the ALU, the RESET status and the bank select bits for data memory.

The **OPTION_REG** Register is a readable and writable register, which contains various control bits to configure the TMR0 prescaler/WDT postscaler, the External INT Interrupt, TMR0 and the weak pull-ups on PORTB.

The **INTCON** Register is a readable and writable register, which contains various enable and flag bits for the TMR0 register overflow, RB Port change and External RB0/INT pin interrupts.

The **PIE1** register contains the individual enable bits for the peripheral interrupts.

The **PIR1** register contains the individual flag bits for the peripheral interrupts.

The **PIE2** register contains the individual enable bits for the CCP2 peripheral interrupt, the SSP bus collision interrupt, and the EEPROM write operation interrupt.

The **PIR2** register contains the flag bits for the CCP2 interrupt, the SSP bus collision interrupt and the EEPROM write operation interrupt.

The **Power Control** (PCON) Register contains flag bits to allow differentiation between a Power-on Reset (POR), a Brown-out Reset (BOR), a Watchdog Reset (WDT), and an external MCLR Reset.

3.3 I/O Ports

There are totally 6 ports present in PIC 16F877. They are Port A, Port B, Port C, Port D, Port E and Parallel Slave Port

PORT A is a 6-bit wide, bi-directional port. The corresponding data direction register is TRISA. Setting a TRISA bit (= 1) will make the corresponding PORTA pin an input (i.e., put the corresponding output driver in a Hi-Impedance mode). Clearing a TRISA bit (= 0) will make the corresponding PORTA pin an output (i.e., put the contents of the output latch on the selected pin).

PORT B is an 8-bit wide, bi-directional port. The corresponding data direction register is TRISB. Setting a TRISB bit (= 1) will make the corresponding PORTB pin an input (i.e., put the corresponding output driver in a Hi-Impedance mode). Clearing a TRISB bit (= 0) will make the corresponding PORTB pin an output (i.e., put the contents of the output latch on the selected pin).

PORT C is an 8-bit wide, bi-directional port. The corresponding data direction register is TRISC. Setting a TRISC bit (= 1) will make the corresponding PORTC pin an input (i.e., put the corresponding output driver in a Hi-Impedance mode). Clearing a TRISC bit (= 0) will make the corresponding PORTC pin an output (i.e., put the contents of the output latch on the selected pin).

PORT D is an 8-bit port with Schmitt Trigger input buffers. Each pin is individually configurable as an input or output. PORTD can be configured as an 8-bit wide microprocessor port (parallel slave port) by setting control bit PSPMODE (TRISE<4>). In this mode, the input buffers are TTL.

PORT E has three pins (RE0/RD/AN5, RE1/WR/AN6, and RE2/CS/AN7) which are individually configurable as inputs or outputs. These pins have Schmitt Trigger input buffers. The PORTE pins become the I/O control inputs for the microprocessor port when bit PSPMODE (TRISE<4>) is set.

PORTD operates as an 8-bit wide **Parallel Slave Port** or microprocessor port, when control bit PSPMODE (TRISE<4>) is set. In Slave mode, it is asynchronously readable and writable by the external world through RD control input pin RE0/RD and WR control input pin RE1/WR.

3.4 Timers

Timer 0 Module

The Timer0 module timer/counter has the following features:

- 8-bit timer/counter
- Readable and writable
- 8-bit software programmable prescaler
- Internal or external clock select
- Interrupt on overflow from FFh to 00h
- Edge select for external clock

The TMR0 interrupt is generated when the TMR0 register overflows from FFh to 00h. This overflow sets bit T0IF (INTCON<2>). The interrupt can be masked by clearing bit T0IE (INTCON<5>). Bit T0IF must be cleared in software by the Timer0 module Interrupt Service Routine before re-enabling this interrupt. The TMR0 interrupt cannot awaken the processor from SLEEP, since the timer is shut-off during SLEEP.

Timer 1 Module

The Timer1 module is a 16-bit timer/counter consisting of two 8-bit registers (TMR1H and TMR1L), which are readable and writable. The TMR1 Register pair (TMR1H:TMR1L) increments from 0000h to FFFFh and rolls over to 0000h. The TMR1 Interrupt, if enabled, is generated on overflow, which is latched in interrupt flag bit TMR1IF (PIR1<0>). This interrupt can be enabled/disabled by setting/clearing TMR1 interrupt enable bit TMR1IE (PIE1<0>). Timer1 can operate in one of two modes:

- As a timer
- As a counter

The operating mode is determined by the clock select bit, TMR1CS (T1CON<1>). In Timer mode, Timer1 increments every instruction cycle. In Counter mode, it increments on every rising edge of the external clock input. Timer1 can be enabled/disabled by setting/clearing control bit TMR1ON (T1CON<0>).

Timer 2 Module

Timer2 is an 8-bit timer with a prescaler and a postscaler. It can be used as the PWM time-base for the PWM mode of the CCP module(s). The TMR2 register is readable and writable, and is cleared on any device RESET.

The Timer2 module has an 8-bit period register, PR2. Timer2 increments from 00h until it matches PR2 and then resets to 00h on the next increment cycle. PR2 is a readable and writable register. The PR2 register is initialized to FFh upon RESET.

SERIAL COMMUNICATION

SERIAL COMMUNICATION

4.1 Serial Data Transmission

The need to send and receive data from one location to another is of vital importance. The most cost-effective way to meet this demand is to send the data as a serial stream of bits in order to reduce the cost (and bulk) of multiple conductor cable. Optical fiber bundles, which are physically small, can be used for the parallel data transmission. However, the cost incurred for the fibers, the terminations, and the optical interface are so high.

So the optimum way of transmitting data is by serial data transmission. Special integrated circuits dedicated solely to serial data transmission and reception appeared commercially in the early 1970s. These chips, commonly called universal asynchronous receiver transmitters or USARTS, perform all the serial data transmission and reception timing tasks. The most popular data communication scheme still in use today is the transmission of serial 8-bit ASCII-coded characters at predefined bit rates of 300 to 19,200 bits per second.

The serial port transmits a '1' as -3 to -25 volts and a '0' as +3 to +25 volts where as a parallel port transmits a '0' as 0v and a '1' as 5v. Therefore the serial port can have a maximum swing of 50V compared to the parallel port which has a maximum swing of 5 Volts.

Therefore cable loss is not going to be as much of a problem for serial cables than they are for parallel.

It requires less number of wires than parallel transmission. If the device needs to be mounted a far distance away from the computer then 3 core cable (Null Modem Configuration) is cheaper than running 19 or 25 core cable. Many of the Microcontrollers have in built SCI (Serial Communications Interfaces) which can be used to talk to the outside world. Serial Communication reduces the pin count of these Microcontrollers. Only two pins are commonly used, Transmit Data (TXD) and Receive Data (RXD) compared with at least 8 pins if you use a 8 bit Parallel method.

4.2Electrical Specification

The electrical Specifications of Serial Port are given as follows

- A "Space" (logic 0) will be between +3 and +25 Volts.
- A "Mark" (Logic 1) will be between -3 and -25 Volts.
- The region between +3 and -3 volts is undefined.
- An open circuit voltage should never exceed 25 volts. (In Reference to GND)
- A short circuit current should not exceed 500mA. The driver should be able to handle this without damage.

Name	Address	IRQ
COM 1	3F8	4
COM 2	2F8	3
COM 3	3E8	4
COM 4	2E8	3

Standard Port Addresses

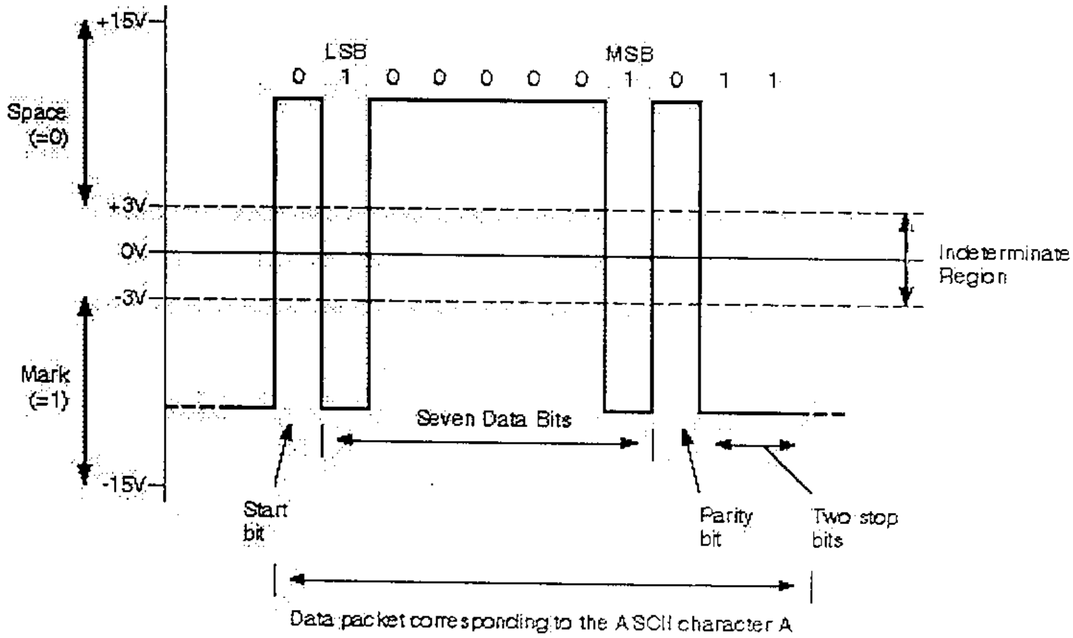
Above is the standard port addresses. These should work for most P.C s. The base addresses for the COM ports can be read from the BIOS Data Area.

Start Address	Function
0000:0400	COM1's Base Address
0000:0402	COM2's Base Address
0000:0404	COM3's Base Address
0000:0406	COM4's Base Address

COM Port Addresses in the BIOS Data Area

There are two basic types of serial communications, Synchronous and Asynchronous. Asynchronous means "no synchronization", and thus does not require sending and receiving idle characters. However, the beginning and end of each byte of data must be identified by start and stop bits. The start bit indicate when the data byte is about to begin and the stop bit signals when it ends. The requirement to send these additional two bits cause asynchronous communications to be slightly slower than synchronous however it has the advantage that the processor does not have to deal with the additional idle characters.

An asynchronous line that is idle is identified with a value of 1, (also called a mark state). By using this value to indicate that no data is currently being sent, the devices are able to distinguish between an idle state and a disconnected line. When a character is about to be transmitted, a start bit is sent. A start bit has a value of 0, (also called a space state). Thus, when the line switches from a value of 1 to a value of 0, the receiver is alerted that a data character is about to come down the line. An example serial data transmission through Asynchronous mode is shown in Fig 8. Here a data packet corresponding to ASCII character 'A' is sent through the wires. Here we have one start bit, seven data bits, one parity bit and two stop bits.

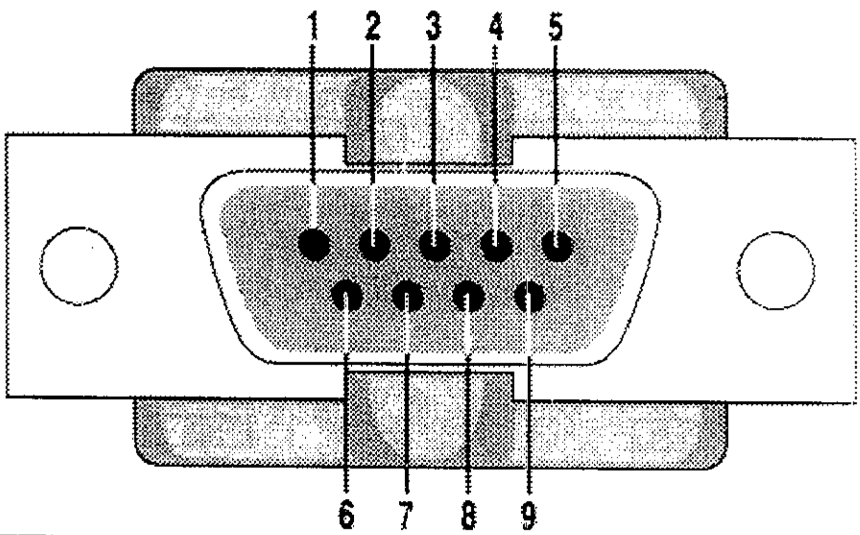


4.3 RS232-C Standard

The serial port to which the mouse connects is to the EIA RS232-C standard. This standard defines the output voltage for a 'logic-high' to be -3 to -15 volts. A 'logic-low' is to be in the range +3 to +15 volts. Common values are -/+ 5V and -/+12V. Because a logical true is represented by a negative voltage, the start bits are at the high voltage level, the and stop bits are at the low voltage level, and data bits that are logically true are transmitted at the negative voltage level as well. However, all of the handshake lines coming out of or into the PC are complimented which means that setting, for example, RTS to true in software results in the compliment of RTS which appears at the output port being at the positive voltage level.

4.4 RS232-C Pinouts

Two connectors are normally used for RS232-C, 25-pin D-type and 9-pin D-type, the 9-pin variety being most common. The DTE end (computer end) should have the pins (male) and the DCE end (mouse end) should have the sockets into which the pins fit (female). The pinout diagram for the 9-pin D-type connector is shown in Fig 9



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		

RS232-C pinouts

The below tabular column shows the names, direction of data transfer and the description of each pin

Pin Number	**Name**	**Direction**	**Description**
1	NCD	PC<-Peripheral	Carrier Detect
2	RXD	PC<- Peripheral	Received Data
3	TXD	PC->Peripheral	Transmitted Data
4	NDTR	PC->Peripheral	DataTerminalReady
5	SGND	na	Signal Ground
6	NDSR	PC<- Peripheral	Data Set Ready
7	NRTS	PC->Peripheral	Request to Send
8	NCTS	PC<- Peripheral	Clear to Send
9	NRI	PC<- Peripheral	Ring Indicator

na = not applicable

Prefix of n means signal is inverse-logic (in this case high output voltage for logical true.)

TEST RESULTS AND DISCUSSION

TEST RESULTS AND DISCUSSIONS

This project aims at the detection of leakage of poisonous gas in atomic power stations .For this, a robot is kept in constant movement around the *reactor plant* which on sensing gas leakage sends a signal to the personal computer.

Reactor

The reactor is generally a natural uranium fuelled, horizontal pressure tube reactor. The principal parts are the calandria, dump tank, moderator and cover gas connections, coolant channel assemblies, end shields and coolant feeder pipes and headers. The end shields support the coolant tubes in which the fuel resides. When heavy water acts as both moderator and reflector, is contained in the vessel. Helium occupies the space above heavy water. Dump tanks has dump ports, which are shaped to provide a gas-liquid interface. This permits the helium, which is maintained at a higher pressure in the dump tank during reactor operation, to support heavy water. The dump tank is provided with over-pressure rupture discs to protect against over pressure. Shielding from direct radiation from the reactor is provided mainly by heavy concrete construction of the vault and by the steel and water in the end shields. A major opening in the vault is filled with a removable shield tank containing light water. When gas coolants are used, there is a danger of leakage of high pressure gases also.

Fuel for the reactor is in the form of bundles consisting of sealed elements of compacted and sintered pellets of Uranium dioxide. Loading of new fuel into or removing spent fuel from the reactor is carried out by remotely controlled fuelling machines.

The primary function of the coolant channel assemblies is to house the reactor fuel and to contain the pressurized heavy water and direct the flow of coolant past the fuel to remove the nuclear heat. The coolant tube is rolled on to the end fittings with a grooved joint. Shielding plugs that latch within each end fitting assembly provide longitudinal stops for reduce the radiation passing fuel string and through the shield.

Adjuster rods form part of the overall reactor regulating system and are essential for reactivity control and flux tilt control. Non-availability or failure of an adjuster rods drive movement due to reasons such as loss of lubricating oil supply, insufficient cooling flow, etc., could result in flux distortions in the reactor core and power peaking may occur forcing the reactor power to be lowered.

Shielding

Shielding prevents radiation from the radioactive fuel and products of the nuclear reaction getting outside of the reactor. In addition it is designed to contain the products of an explosion or accident.

A thick steel pressure vessel surrounds the nuclear pile. In turn a concrete liner that acts as a radiation shield surrounds this pressure vessel.

Outside of this is a larger steel containment vessel. This vessel contains the machinery with which workers raise and lower control rods and replace the fuel elements. The steel containment vessel also helps prevent leakage of any radioactive gases or fluids from the plant.

The final and outer protection is provided by a concrete enclosure that is strong enough to survive such things as crashing jet airliners and earthquakes. This may be several metres thick.

The purposes of internal shielding are :

- To limit the radiation to an acceptable level in the accessible areas during operation
- To reduce the radiation to the dome
- To permit limited access during shutdown to the fuelling machine vaults.

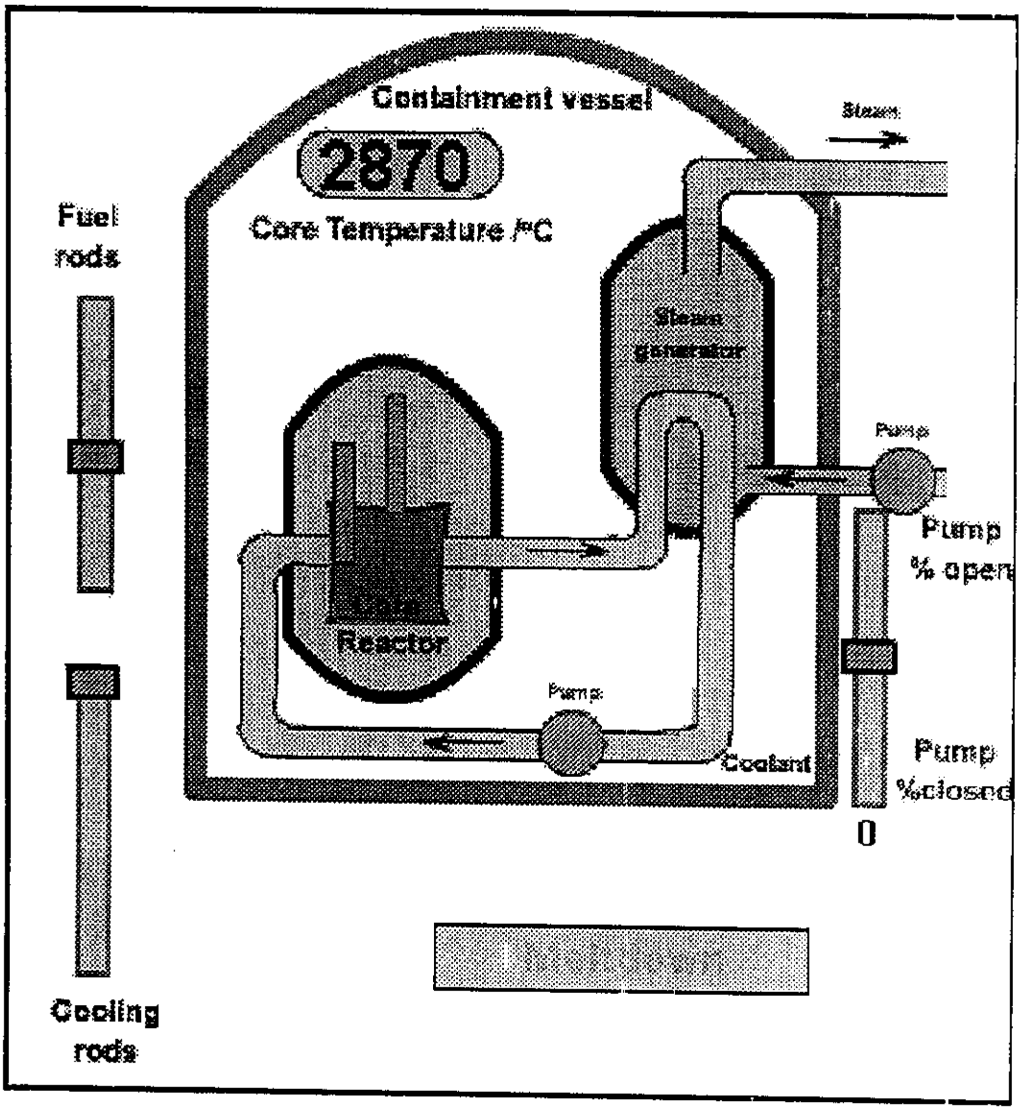
As the shielding materials are heated up due to radiation, shield cooling systems have been provided to preserve the integrity of the shielding structures by removing the radiation heat.

Containment

Reactor building containment serves the functions of :

- Protecting the environment against the release of radioactive products during normal operating condition of the reactor as well as in the case of accident.
- Withstanding the maximum pressure that may be encountered during an accident condition to maintain the structural integrity.

- In order to have a low leakage rate through the building containment envelope during a design based accident condition, the peak containment pressure has to be limited and this is achieved by vapour suppression system.



TESTING

In the hardware model of our project, since it is not feasible to deal with poisonous gases, a domestic gas sensor is used and LPG is detected using it. For test purposes, the robot is programmed to take a rectangular path and LPG is brought near it. As soon as it senses the gas, the information appears on the screen of the personal computer and an alarm rings indicating leakage of gas and the robot comes to a temporary halt. Similarly, when an obstacle is sensed, the for information appears on the screen of the personal computer and an alarm rings.

Scope for future development

The robot in our project is being controlled through a microcontroller, which inturn is interfaced with personal computer. All the interfacing and connections have been done through wiring in our project. All the wiring may be converted to wireless control in the future.

In this project, the robot is designed such that on detecting a gas leakage or an obstacle, in addition to giving a signal to the personal computer, it comes to a temporary halt. But if the obstacle is not removed immediately on account of some difficulties, the robot will not get into motion. In the near future, it may be so designed as to take an alternate path in case of an obstacle.

Another important expansion with respect to our project could be to calculate the dimensional details of the obstacle that is detected. Also, the point at which the leakage or obstacle is detected, may be sent to the personal computer.

Other applications

The same robot can be used in various process industries such as sugar, aluminium, and chemical industries.

CONCLUSION

CHAPTER 6

CONCLUSION

The Microcontroller based GAS DETECTION & PATH FINDING ROBOT has been designed, fabricated and tested and its operation is found to be satisfactory. In practice, the detectors present are mostly stand alone devices and were time consuming & expensive. With the adaptation of a *robot*, the above said discrepancies can be overcome.

The gas sensed are also transmitted through the Microcontroller to the Personal Computer and henceforth, gas leaked at a distant location is readily available at the personal computer. This will pave way for a more sophisticated and simple way of gas detection in the near future.

APPENDIX

ALGORITHM

STEP 1: Initialize timer

STEP 2: Initialize ports and flags

STEP 3: Send pulse to stepper motor to set robot into motion

STEP 4: If any change of pulse (gas or obstacle detected}, stop Movement.

STEP 5: If initial condition achieved(removal of gas or obstacle), then go to step 3

PIC PROGRAM

STEPPER MOTOR INTERFACING

```
LIST P=PIC16F877

INCLUDE "P16F877.INC"

ORG 0X00
GOTO      MAIN

ORG 0X04
CALL      INT
RETFIE


INT: BTFSS     PIR1,TMR1IF
GOTO      XXX
```

```
        BCF  PIR1,TMR1IF
        INCF 0X30,1
        MOVF     0X30,0
        SUBLW    .10
        BTFSS    STATUS,Z
        GOTO     ZZZ
        CLRF     0X30              ;1SEC CHECKING
        INCF 0X31,1
        MOVF     0X31,0            ;HOW MANY SEC IT
 ROTATE
        SUBLW    .5                ;5SEC  FORWARD
        BTFSS    STATUS,Z
        GOTO     $+3
        MOVLW    .1
        MOVWF    0X21
        MOVF     0X31,0
        SUBLW    .6                ;1SEC RIGHT AND
 FORWARD
        BTFSS    STATUS,Z
        GOTO     $+3
        MOVLW    .2
        MOVWF    0X21
        MOVF     0X31,0
        SUBLW    .7                ;1SEC LEFT AND FOR
        BTFSS    STATUS,Z
        GOTO     ZZZ
        CLRF     0X31
        CLRF     0X21




ZZZ:
        MOVLW    0X37
        MOVWF    TMR1H
        MOVLW    0X05
        MOVWF    TMR1L

XXX:
        CLRF     INTCON
        CLRF     PIR1
        RETURN
```

```
MAIN:
        CLRF        0X21
        CLRF        0X30
        CLRF        0X31
        BSF  STATUS,RP0
        CLRF        TRISB
        CLRF        TRISD
        BSF  TRISC,0
        BSF  TRISC,1
        BCF  TRISC,2
        BCF  OPTION_REG,6
        BCF  OPTION_REG,7
        BCF  OPTION_REG,PSA
        BCF  STATUS,RP0

        CLRF        PORTD
        CLRF        PORTB
        BSF  PORTB,5
        BCF  PORTC,2
        BSF  PORTC,0
        BSF  PORTC,1

        CALL        SERCOM
        CALL        TIMERINIT
        BSF  T1CON,0

LOOP:
        BSF  STATUS,RP0
        BSF  PIE1,TXIE
        BCF  STATUS,RP0
        BSF  INTCON,PEIE
        BSF  INTCON,GIE

XX1:
        BTFSC       PORTC,0
        GOTO        $+3
        CALL        DIST1
        GOTO        LOOP
        BCF  PORTC,2
```

```
XX2:
        BTFSC    PORTC,1
        GOTO     $+3
        CALL     DIST2
        GOTO     LOOP
        BCF  PORTC,2


FOR1:
        MOVF     0X21,0
        BTFSS    STATUS,Z
        GOTO     $+2
        CALL     FORWARD  ;LSB   FORWARD AND
BACKWORD

        MOVF     0X21,0
        SUBLW    .1
        BTFSS    STATUS,Z
        GOTO     $+2
        CALL     RIGHTANDFOR

        MOVF     0X21,0
        SUBLW    .2
        BTFSS    STATUS,Z
        GOTO     $+2
        CALL     LEFTANDFOR

        GOTO     LOOP

FORWARD:
        MOVLW    0X50
        MOVWF    PORTD
        CALL     DIS
        CALL     SLOW
        MOVLW    0X90
        MOVWF    PORTD
        CALL     DIS
        CALL     SLOW
        MOVLW    0XA0
        MOVWF    PORTD
        CALL     DIS
        CALL     SLOW
```

```
        MOVLW   0X60
        MOVWF   PORTD
        CALL    DIS
        CALL    SLOW
        RETURN

RIGHTANDFOR:

        MOVLW   0X55
        MOVWF   PORTD
        CALL    DIS
        CALL    SLOW
        MOVLW   0X99
        MOVWF   PORTD
        CALL    DIS
        CALL    SLOW
        MOVLW   0XAA
        MOVWF   PORTD
        CALL    DIS
        CALL    SLOW
        MOVLW   0X66
        MOVWF   PORTD
        CALL    DIS
        CALL    SLOW
        RETURN

LEFTANDFOR:
        MOVLW   0X56
        MOVWF   PORTD
        CALL    DIS
        CALL    SLOW
        MOVLW   0X9A
        MOVWF   PORTD
        CALL    DIS
        CALL    SLOW
        MOVLW   0XA9
        MOVWF   PORTD
        CALL    DIS
        CALL    SLOW
        MOVLW   0X65
        MOVWF   PORTD
        CALL    DIS
        CALL    SLOW
```

```
        RETURN

DIST1:
        BSF   STATUS,RP0
        BSF   TXSTA,TXEN
        BCF   STATUS,RP0
        MOVLW   .0
        MOVWF   TXREG
        BSF   STATUS,RP0
        BTFSS       TXSTA,TRMT
        GOTO        $-1
        BCF   STATUS,RP0
        BSF   PORTC,2
        CALL        SLOW
        RETURN

DIST2:
        BSF   STATUS,RP0
        BSF   TXSTA,TXEN
        BCF   STATUS,RP0
        MOVLW   .255
        MOVWF   TXREG
        BSF   STATUS,RP0
        BTFSS       TXSTA,TRMT
        GOTO        $-1
        BCF   STATUS,RP0
        BSF   PORTC,2
        CALL        SLOW
        RETURN
SERCOM:
        BSF   STATUS,RP0
        MOVLW   0X33
        MOVWF   SPBRG
        BCF   TXSTA,BRGH
        BCF   TXSTA,SYNC
        BCF   STATUS,RP0
        BSF   RCSTA,SPEN
        BSF   STATUS,RP0
        BSF   PIE1,TXIE
        BCF   STATUS,RP0
        BSF   INTCON,PEIE
        BSF   INTCON,GIE
        BSF   STATUS,RP0
```

```
        BSF  TXSTA,TXEN
        BCF  STATUS,RP0
        RETURN

TIMERINIT:
        BSF STATUS,5
        BSF PIE1,TMR1IE
        BCF STATUS,5


        BSF INTCON,PEIE
        BCF PIR1,TMR1IF
        BCF T1CON,TMR1CS    ;T1SYNC
        BSF  T1CON,4
        BCF  T1CON,5

        MOVLW 0X05          ;0XDC
        MOVWF TMR1L
        MOVLW 0X37          ;0X0B
        MOVWF TMR1H
        RETURN

DIS:
        BSF  PORTB,5
        BSF  PORTB,1
        BCF  PORTB,2
        BCF  PORTB,4
        BCF  PORTB,5
        BSF  PORTB,5
        RETURN



SLOW:
        MOVLW   0xFA
        MOVWF   0X45
SS1:    MOVLW   .255
        MOVWF   0X46
        DECFSZ  0X46,1
        GOTO    $-1
        DECFSZ  0X45,1
        GOTO    SS1
```

```
        RETURN
SLOW1:
        MOVLW   0xFE
        MOVWF   0X45
SS2:    MOVLW   .255
        MOVWF   0X46
        DECFSZ  0X46,1
        GOTO    $-1
        DECFSZ  0X45,1
        GOTO    SS2
        RETURN

        END
```

C PROGRAM

```
#include<stdio.h>
#include<conio.h>
#include<dos.h>
#include<process.h>
void main()
{
	int a,b,ah,al,ab,e;
	char c,n;
	clrscr();
	a=system("mode com1,1200,n,8,1");
	if(a!=0)
	printf("\n err com init");
	getch();
	printf("\n\n1-Transmit\n\n2-Receive");
	a=getch();
	if(a=='1')
	{
		_AH=0x00;
		_AL=0x83;
		_DX=0x00;
		geninterrupt(0x14);
		ah=_AH;
		al=_AL;
		printf("\nAH = %x",ah);
		printf("\t\tAL = %x",al);
		printf("\n\nintr init ok");
		getch();
		printf("\n\ntype to transmit. 'q' to quit\n\n");
			while(1)
		{
			printf("Enter the value:");
			scanf("%d",&e);
//			n=getche();
			outport(0x3f8,e);
			if(n=='q')
			break;
		}

	}

	else
```

```
        {
                printf("\n\npress any key to quit");
                _AH=0x00;
                _AL=0x83;
                _DX=0x00;
                geninterrupt(0x14);
                ah=_AH;
                al=_AL;
                printf("\nAH = %x",ah);
                printf("\t\tAL = %x",al);
                printf("\n\nintr init ok");
                getch();
                while(!kbhit())
                {
                while(1)
                {       _AH=0x03;
                        _DX=0x00;
                        geninterrupt(0x14);
                        ah=_AH;
                        al=_AL;
//              printf("\nAH = %x",a h);
//          printf("rec");
                        if( (ah & 0x01) == 0x01)
                        {
                                b=inport(0x3f8);
                                printf("%d\n",b);
                  //    break;
//                              delay(5);
//                      getch();
                        }
                     }
                }
}
}
```

BIBLIOGRAPHY

BIBLIOGRAPHY

1.Control Systems
By Nagoorkani

2.Electrical Technology
By B.L.Thereja and A.K.Thereja

3.Technical Reference For Trainees – Atomic Power stations

WEBSITES

1.www.sixth_sense.com

2.www.microchip.com

3.www.robotics.com