STEPPER MOTOR GUIDED RANGE DETECTION USING ULTRASONICS

A Project Report

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ABSTRACT

Driving under poor visibility conditions is really difficult, even for an experienced driver. Thus, a system which detects obstacles on the road beforehand and alerts the driver would be of mighty help. It was decided to implement such a system using Ultrasonic sound signals. By manipulating the time taken between transmission and reception of Ultrasonic sound, the distance of the obstacle from the measurement point can be determined. The area ahead is divided into a number of sectors and the traversal from one sector to another is made possible with the help of a stepper motor. The sector and the distance are displayed to the driver.

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INTRODUCTION

1.1. INTRODUCTION

This project mainly focuses on implementing a method of obstacle detection in vehicles. During bad weather and in case of extreme driving conditions, it is difficult for the driver to watch the vehicle in front and rear sides. To enhance the safety of the travel and to assist the driver, this project focuses on detecting the obstacles that are within a range of distance from the vehicle. The aim of the project is to build an apparatus which can sense obstacles in front of it, in the direction it is positioned at. By fixing the apparatus over the body of the vehicle at those places necessary, any obstacle within a distance and at any side, can be sensed and can be used to alert the driver.

The apparatus consists of a board with a principle that, when the waves produced by the transmitter reflect off an object's surface, the receiver receives those waves. According to the time of flight principle, the time taken by the waves to be reflected and received by the receiver gives the time taken for transmittance and reflectance. Using this value of time taken, with knowledge of the speed of the waves, the distance to the obstacle can be found.

1.2. OBJECTIVE OF THE PROJECT

The project aims to attain the following:

- Division of the area in front of the vehicle into a specified number of sectors.
- Identifications of obstacles ahead, up to a range of 200 meters.
- Display the distance to the obstacle, along with the sector in which it is present.

1.3. SCOPE OF THE PROJECT

The ultrasonic range detector has a limited range as regards the transmitter-receiver circuit used. When an ultrasonic detector of higher power is used, there is a high amount of scattering of the waves. Ultrasonics being sound waves, travel in all directions and it is hard to confine them to a particular position or direction. This made the use of stepper motor and the division of sectors more difficult. When the range is increased, the step angle has to increased, and the number of sectors decreased, to ensure accuracy.

1.2. ORGANIZATION OF THE REPORT

Chapter 1 gives the introduction to the problem and the technique used to solve it.

Chapter 2 elaborates on the available sensor options and the principles of each. The range and compatibility of the sensor with the project aides the selection of the sensor used in the project.

Chapter 3 gives the introduction to ultrasonic materials and principle of ranging and distance measurement.

Chapter 4 gives the schematics of ultrasonic transmitter receiver and the working of the circuit. It also describes the flow of control in the process of obstacle detection in the form of a flowchart and algorithm.

Chapter 5 describes the working of the stepper motor and its interfacing with the rest of the circuit.

Chapter 6 gives the circuits of the miscellaneous components like power supply and relays.

Chapter 7 gives the final conclusion of the project and the recommendations for future extensions and uses of the product.

SELECTION OF SENSOR

2.1. IDENTIFICATION OF SENSOR

The first process involves the identification of a suitable sensor for this purpose. There is a host of sensors available, many of them based on how insects function. What is needed for the automatic beam traffic system is something that detects an object well ahead of impact, so tactile information will not do. We need a sensor with the ability to:

1. Look sufficiently far ahead of the beamcar to be able to discern potential obstacles
2. Scan the perimeter of the travelling direction, and allow for the fact that this travelling direction changes now and then, both vertically and horizontally
3. Scan the perimeter of the travelling direction, also because objects might approach the path from the sides or from above/below, as well as being stationary and in the path of travel
4. Evaluate what is being seen
5. Do all this in sufficiently good time for the control system to brake the car before impact.

We thus need:

1. Sufficient range to allow for high vehicle speed
2. Sufficient width, both to cover change of travelling direction and to see objects moving in from the sides
3. Quick and reliable processing of data.

2.2. AVAILABLE SENSORS

Some of the sensors that were considered include the following:

1. RADAR
   a. RADAR Microwave
   b. Ground Radar
2. LIDAR
   a. Scanning LASER
   b. Sick LASER

3. Ultrasonic Ranging
    a. Piezo Sonar Board
    b. Piezo Electric Ultrasonics
    c. Mini Polaroid SONAR
4. Infrared Ranging

2.3. TECHNOLOGIES USED

The sensors of the obstacle detection systems that are of interest to us are built on different technologies. Those that are available to us today are:

1.Infrared sensors

Infrared sensors are divided into:

Near infrared sensors (laser radar, infrared sensors) which do not offer a sensible benefit in fog.

Far infrared sensors (sensitive in the range of 8-14 mm), providing thermal images of the scenario independently from any light conditions, the enhanced visibility in fog and heavy rain condition is dependent on droplets dimensions.

Infrared sensors are not suitable for our purpose.

2. Common RADAR

Common radar might be the obvious choice, at first thought. But common radar does not have a high enough frequency to provide the details of an object that would be necessary for identification. One could of course increase this frequency, but radar still has disadvantages as compared to laser.

3. Microwave based RADAR

Microwave-based radar is a much more viable technology. It has good ability to distinguish small objects and is used in many fields, such as guiding docking ships. By using variable frequency during the sweep, one can obtain much information. Microwave range sensors (radar), operate properly in any poor visibility condition. Providing information from stationary objects require powerful signal processing to be extracted. Their functionality is limited in complex scenarios like urban road traffic.

4. Digital cameras

Digital cameras is quite an interesting option. CCD/CMOS sensors are used, and they are active in the visibility range, and thus not offering much benefit in any reduced visibility condition. The technology is based on intelligent evaluation of what is seen. An everyday example of this is "OCR"; Optical Character Recognition. The computer that evaluates the pictures has a database of characters it has to recognize. Every character has deviations in the way it looks, depending on:

a. type face
b. font
c. bold and/or cursive
d. size
e. "fuzzy borders", depending on contrasting colors between character and background and poor readability.

One practical use of this technique is traffic surveillance. Cameras mounted over traffic lanes can scan the license plates of motorcars as these come into view, from the bottom of the area in view. This information can then be used to check for stolen cars, charging toll fees, etc.

5. A combination of digital cameras and laser

This is being used today to control assembly-line manufacturing processes. It could conceivably be of use in connection with obstacle detection.

6. LASER

"RADAR" is the acronym for "Radio Detection and Ranging". If one replaces the first word with "Laser" (which in itself is an acronym), one gets the acronym "LADAR". Laser beams are eminently suitable for the task of identifying obstacles. They keep a narrow beam over long distances; the beam does not spread out at an angle like other type of beams. Thus, NASA has for instance been able to measure the distance to the moon by bouncing a Laser beam off its surface.

The device includes information processing ability, which can be programmed to:

a. report only objects above a certain size
b. report only moving objects
c. report only objects within a certain distance
d. when looking vertically down at terrain below; report only objects that do not agree with what the topology should look like, at that location
e. report the distance and even the sloping angle of objects.

A laser beam consists of light, and consequently, the beam cannot be deflected by a varying electric or magnetic field, as is done with the electron beam in a television set. Instead, the laser beam in this kind of application is made to scan across a pre-set angle by means of a fast-moving mirror. A scanning frequency of 1000 Hz is common, which indicates what demands are put on the motor that drives this mirror.

2.4. TECHNIQUES FOR DISTANCE MEASUREMENT

There are four basic techniques for distance measurement using electro magnetic radiation. These are:

All are used in practice for distance measurement depending on the particular application.

1. Pulse Timing

Pulse timing, as the name suggests, involves measuring the round time for a signal to be transmitted to a reflective surface and return.

This is the principle used in Radar, DME for aircraft, LORAN, Satellite Altimetry, Airborne RADAR Altimetry, Lunar Laser Ranging etc. Some of the newer EDM instruments used by surveyor are also using pulse timing and accuracies of +/- 5mm are possible. Most of the military range finders also use pulse timing. The GPS system uses pulse timing for coarse distance measurement. Very Long Base Interferometry (VLBI) is also a pulse timing technique where signals from pulsars are timed from two or more radio telescopes and the difference in times of arrival are converted to intercontinental distances with a precision of a few centimetres.

2. Phase Comparison

Phase difference involves the use of a carrier wave which may be modulated at different wavelengths. By measuring the difference in phase between the transmitted signal and the received signal after it has been reflected from the other end of the target, the distance can be determined as an integer number (unknown) of wavelengths plus a fraction of a wavelength which is known from the phase comparison. By using a range of modulation frequencies the ambiguity can be resolved. There are many applications of this technique. A wide range of carrier frequencies are used ranging from visible through infra red to microwave and right down to VLF. Typical instruments used by surveyors have accuracies of +/-(1to2 mm +1to3 parts per million) and use infra red as the carrier. Precise positioning using GPS can be achieved by phase comparison of the carrier wave signals of the various satellites. Accuracies in position of better than 1 part per million can be achieved.

3. Doppler Methods

Doppler techniques were used in the earlier satellite positioning systems. The received frequency of a low orbit satellite is compared with the actual transmitted signal as a function of time. The rate of change of frequency gives the slant range between the satellite and the observer while the instant when the two freqencies are the same gives the point of closest approach. By knowing the orbital parameters of the satellite which are transmitted, the observer's position can be determined.

4. Interferometry

Interferometric methods are the same as those used in the original Michelson Interferometer. It is used for metrology, high precision distance measurement over short distances (up to 60 metres) and in the definition of the metre.

ULTRASONICS

3. ULTRASONIC TRANSMITTER – RECEIVER

3.1 PIEZOELECTRIC EFFECT

Many polymers, ceramics, and molecules such as water are permanently polarized: some parts of the molecule are positively charged, while other parts of the molecule are negatively charged. This is depicted in Figure 3.1.

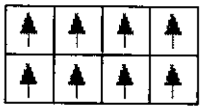


Figure 3.1

Permanent Polarization

When an electric field is applied to these materials, these polarized molecules will align themselves with the electric field, resulting in induced dipoles within the molecular or crystal structure of the material.

Furthermore, a permanently-polarized material such as quartz (SiO_2) or barium titanate ($BaTiO_3$) will produce an electric field when the material changes dimensions as a result of an imposed mechanical force. These materials are piezoelectric, and this phenomenon is known as the piezoelectric effect. This is depicted in Figure 3.2.

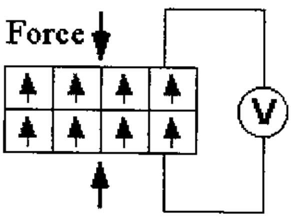


Figure 3.2

Piezoelectric effect

Conversely, an applied electric field can cause a piezoelectric material to change dimensions. This phenomenon is known as electrostriction, or the reverse piezoelectric effect. This is depicted in Figure 3.3.

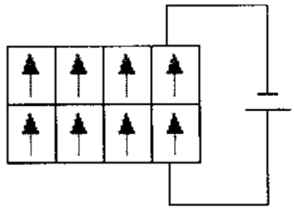


Figure 3.3

Reverse piezoelectric effect

3.2 PIEZOELECTRIC MATERIALS

Piezoelectric materials produce a voltage in response to an applied force, usually a uniaxial compressive force. Similarly, a change in dimensions can be induced by the application of a voltage to a piezoelectric material. In this way they are very similar to electro-strictive materials. These materials are usually ceramics with a perovskite structure. The perovskite structure exists in two crystallographic forms. Below the Curie temperature they have a tetragonal structure and above the Curie temperature they transform into a cubic structure. In the tetragonal state, each unit cell has an electric dipole, i.e. there is a small charge differential between each end of the unit cell. A mechanical deformation (such as a compressive force) can decrease the separation between the cations and anions which produces an internal field or voltage.

Some examples of piezoelectric materials are given in table 3.1.

Material	Piezoelectric constant (X 10^{12}m/V)
Quartz	2.3
Barium titanate	100 – 149
Lead niobate	80 – 85
Lead zirconate titanate	250 – 365

Table 3.1

Piezoelectric constants of materials

Key properties

(i) The ability to produce a voltage output in response to an applied stress. This ability is made use of in ultrasonic receiver.

(ii) The ability to produce a strain output (deformation) in response to an applied voltage. This is the principle of ultrasonic transmitter.

Applications

Piezoelectric materials are used in acoustic transducers, which convert acoustic (sound) waves into electric fields, and electric fields into acoustic waves.

ULTRASONIC DISTANCE METER

4.1. BLOCK DIAGRAM

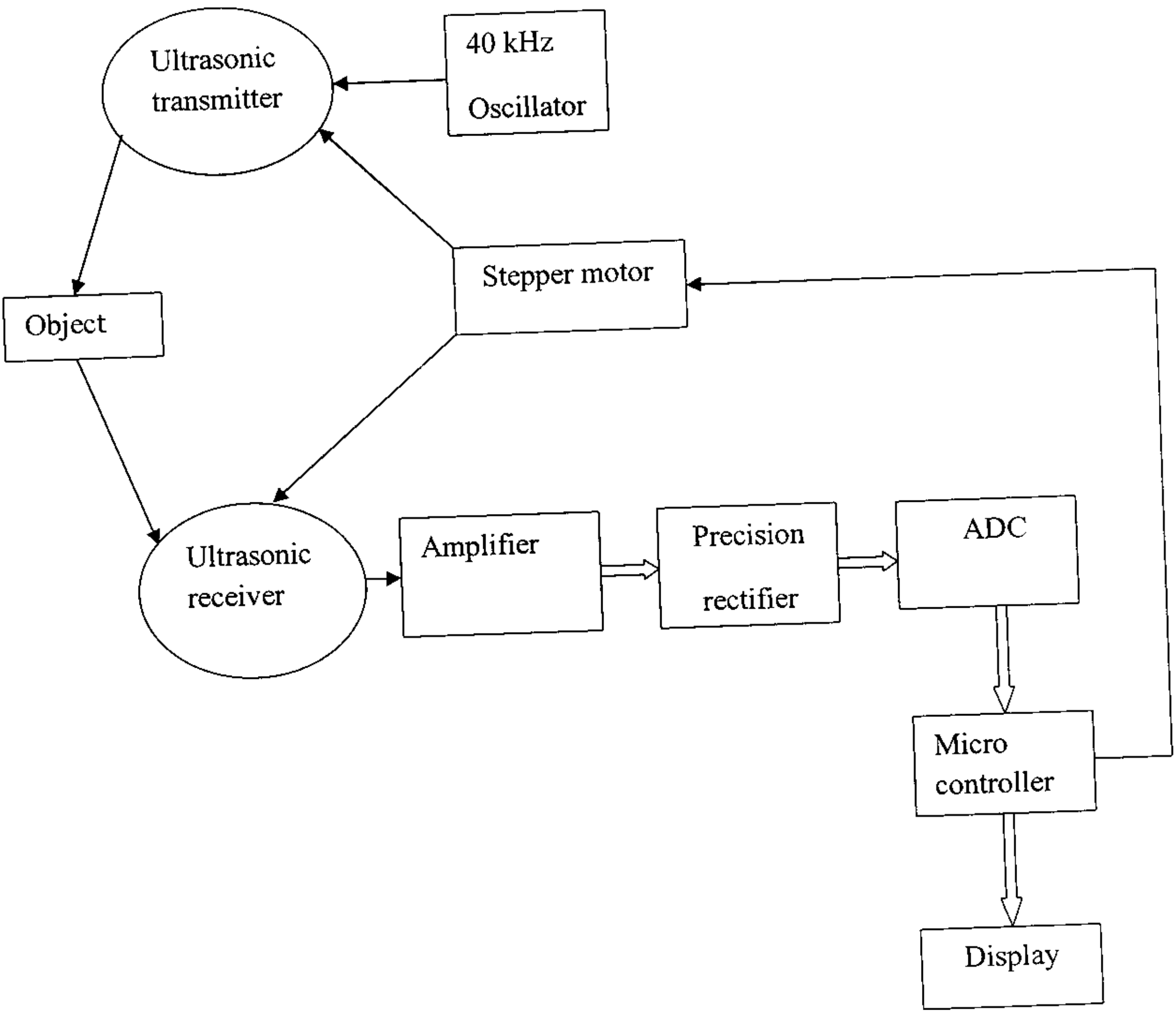


Figure 4.1

Block Diagram – Ultrasonic Distance Meter

4.2. ALGORITHM

Step 1: The stepper motor is initially positioned in a particular sector.

Step 2: A signal of frequency 40 kHz is generated using PIC 12F675.

Step 3: The TTL logic is converted to +12 and −12 Volts signal using MAX232 Level Logic Controller.

Step 4: This 40 kHz signal is used to drive the ultrasonic transmitter.

Step 5: When an obstacle hinders the transmitted ultrasonic signal, it reflects back towards the receiver.

Step 6: The receiver receives the signal and sends it to the non-inverting amplifier.

Step 7: This signal is amplified and sent to the zero adjustment amplifier.

Step 8: The zero adjustment amplifier converts this signal to one below 6V.

Step 9: This wave signal is converted into square wave signal using a comparator.

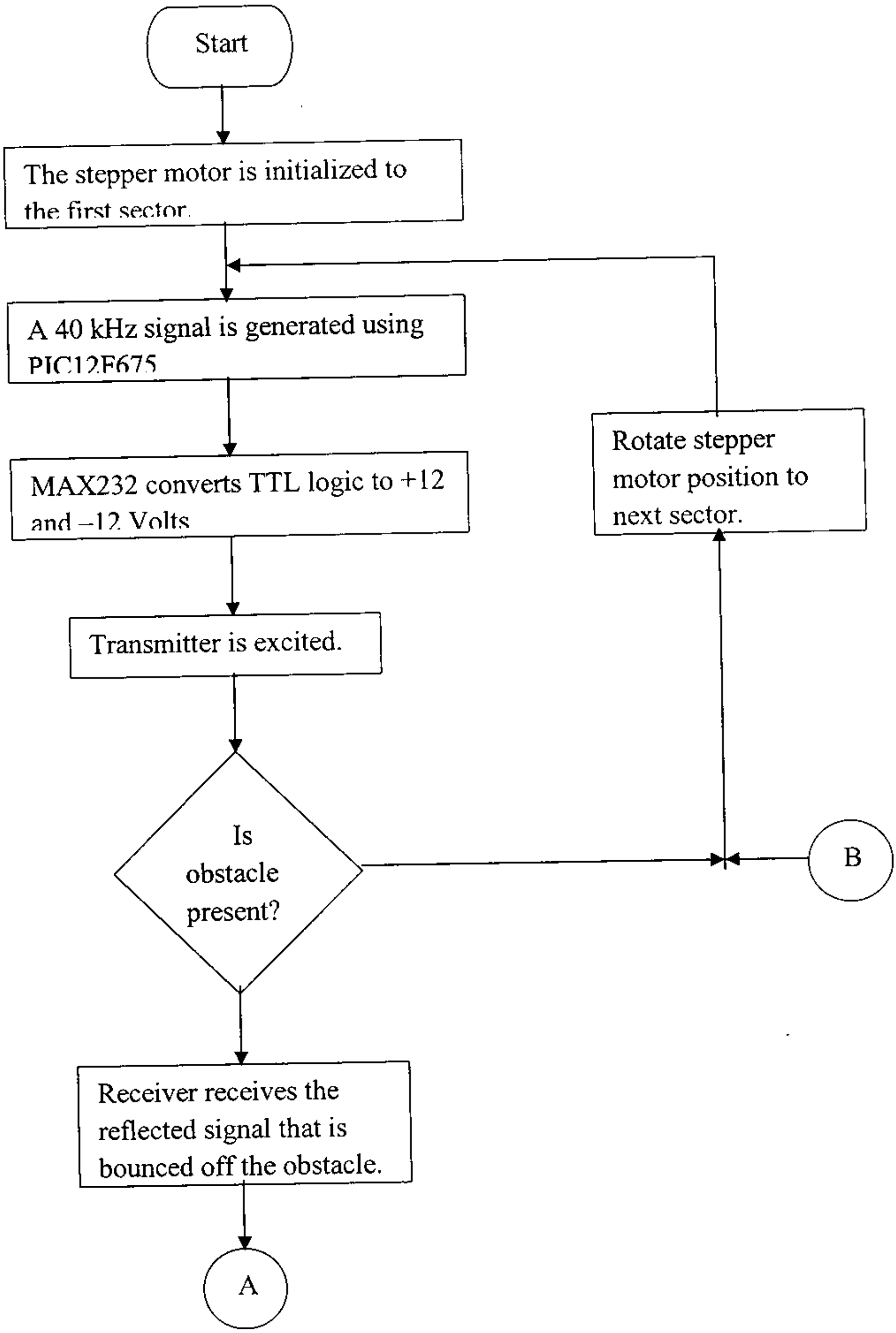
Step 10: This square wave signal is sent as input to the microcontroller, which compares it with the transmitted signal to give the time difference between the two.

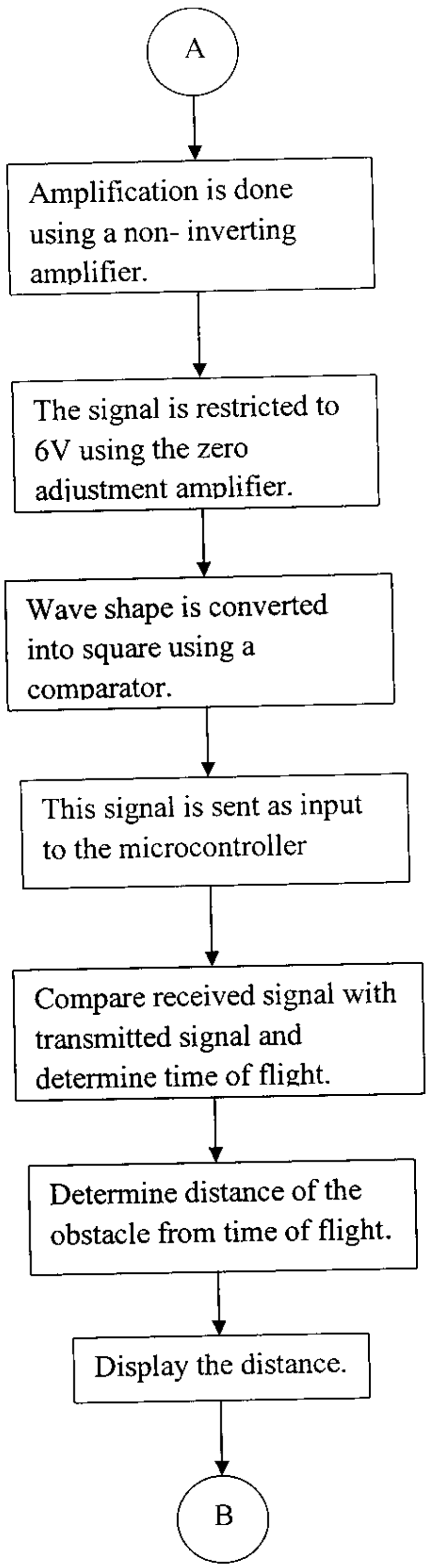
Step 11: From this time difference and the speed of sound, the distance to the obstacle is determined.

Step 12: The stepper motor is rotated to the next sector and the same process of transmission and reception is carried out.

Step 13: Each time the value of distance is displayed using an LCD display.

4.3. FLOWCHART OF OPERATION




A
Amplification is done using a non- inverting amplifier.
The signal is restricted to 6V using the zero adjustment amplifier.
Wave shape is converted into square using a comparator.
This signal is sent as input to the microcontroller
Compare received signal with transmitted signal and determine time of flight.
Determine distance of the obstacle from time of flight.
Display the distance.
B

4.4. SCHEMATIC – ULTRASONIC DISTANCE METER

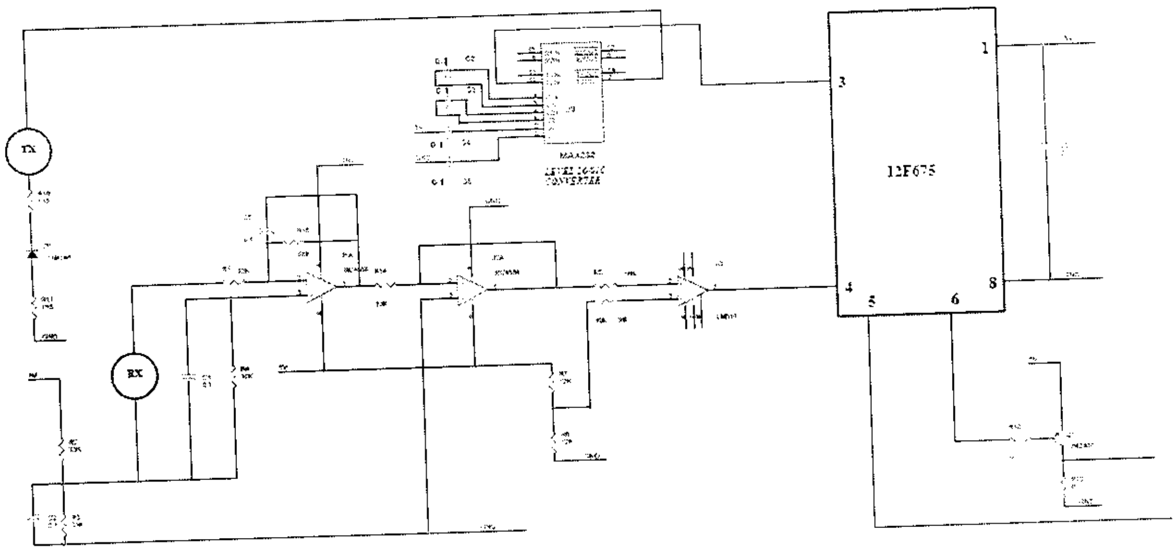


Figure 4.2

Ultrasonic distance meter

4.5. SCHEMATIC DESCRIPTION

This circuit is designed to measure the distance of the object with the help of ultrasonic waves. The 12F675 microcontroller is used to generate the 40 KHz frequency signal, which is used o drive the 40 KHz synchronized ultrasonic transmitter. This signal is given to level logic converter (MAX232) in order to convert to TTL output pulse to +12v and -12v pulse. Then this pulse is transmitted through ultrasonic transmitter.

The ultrasonic wave is spread in the air and hit the nearest object and reflected from the object which is received by the ultrasonic receiver. The received wave is given to amplifier in order to amplify the received weak signal. With the increase of amplification, the minimum range of the module reduces. After the amplification the amplified wave is given to zero adjustment amplifier because the amplified wave is in the range of above 6V level. Then the output is given to comparator in which the wave signal is converted into corresponding square wave signal. Then the square wave signal is given to input of the microcontroller. Now the microcontroller compares the time between the transmitted signal and received signal and generates the corresponding pulse output which is equal to distance of the object. Then the pulse signal is given to input of transistor.

4.6. OVERALL CIRCUIT DIAGRAM

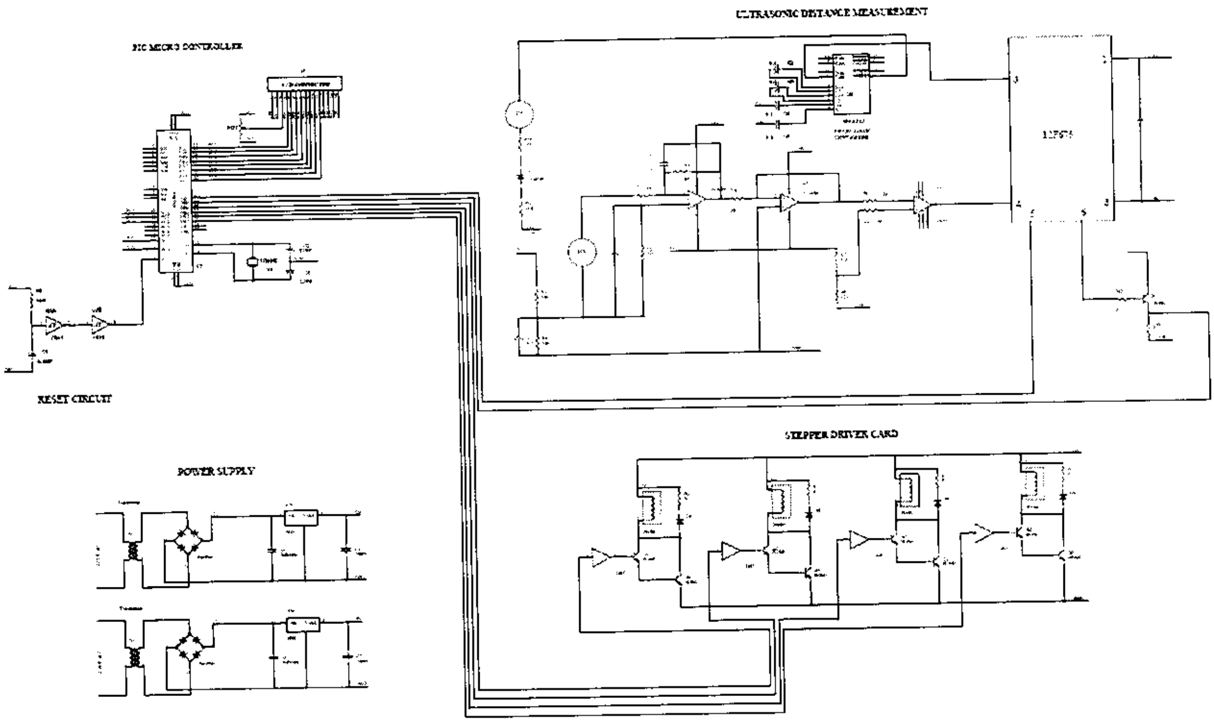


Figure 4.3

Overall Circuit Diagram

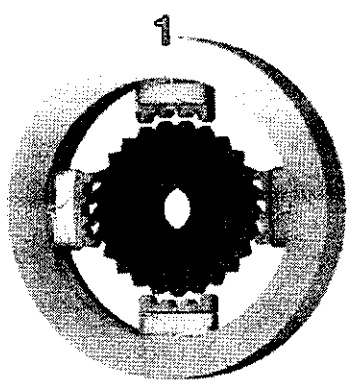
STEPPER MOTOR AND INTERFACING

5.1. STEPPER MOTOR

A stepper motor is a brushless, synchronous electric motor that can divide a full rotation into a large number of steps. Thus the motor can be turned to a precise angle.

5.1.1. FUNDAMENTALS OF OPERATION

Stepper motors operate much differently from normal DC motors, which simply spin when voltage is applied to their terminals. Stepper motors, on the other hand, effectively have multiple "toothed" electromagnets arranged around a central metal gear, as shown at right. To make the motor shaft turn, first one electromagnet is given power, which makes the gear's teeth magnetically attracted to the electromagnet's teeth. When the gear's teeth are thus aligned to the first electromagnet, they are slightly offset from the next electromagnet. So when the next electromagnet is turned on and the first is turned off, the gear rotates slightly to align with the next one, and from there the process is repeated. Each of those slight rotations is called a "step." In that way, the motor can be turned a precise angle. There are two basic arrangements for the electromagnetic coils: bipolar and unipolar.



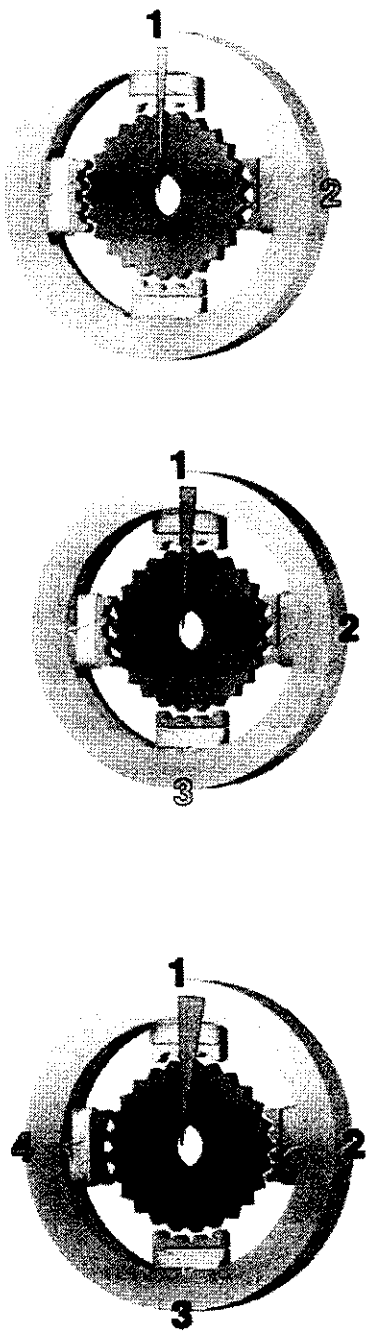


Figure 5.1

Stepper Motor – Fundamentals of Operation

A step motor can be viewed as a DC motor with the number of poles (on both rotor and stator) increased, taking care that they have no common denominator. Additionally, soft magnetic material with many teeth on the rotor and stator cheaply multiplies the number of poles (reluctance motor). Like an AC synchronous motor, it is ideally driven by sinusoidal current, allowing a stepless operation, but this puts some burden on the controller. When using an 8-bit digital controller, 256 microsteps per step are possible. As a digital-to-analog converter produces unwanted ohmic heat in the controller, pulse-width modulation is used instead to regulate the mean current. Simpler models switch voltage only for doing a step, thus needing an extra current limiter: for every step, they switch a single cable to the motor. Bipolar controllers can switch between supply voltage, ground, and unconnected. Unipolar controllers can only connect or disconnect a cable, because the voltage is already hard wired. Unipolar controllers need center-tapped windings.

It is possible to drive unipolar stepper motors with bipolar drivers. The idea is to connect the output pins of the driver to 4 transistors. The transistor must be grounded at the emitter and the driver pin must be connected to the base. Collector is connected to the coil wire of the motor.

Stepper motors are rated by the torque they produce. Synchronous electric motors using soft magnetic materials (having a core) have the ability to provide position holding torque (called detent torque, and sometimes included in the specifications) while not driven electrically. To achieve full rated torque, the coils in a stepper motor must reach their full rated current during each step. The voltage rating (if there is one) is almost meaningless. The motors also suffer from EMF, which means that once the coil is turned off it starts to generate current because the motor is still rotating. There needs to be an explicit way to handle this extra current in a circuit otherwise it can cause damage and affect performance of the motor.

5.1.2. STEPPER MOTOR DRIVER CARD

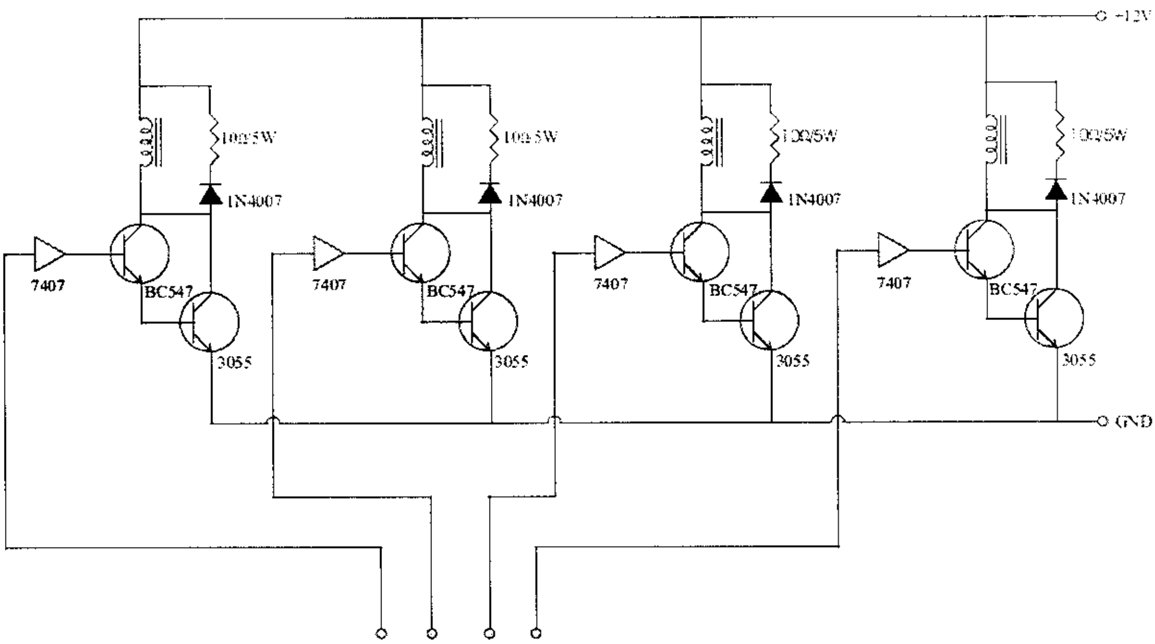


Figure 5.2

Stepper Motor Driver Card

5.1.3. APPLICATIONS

Computer-controlled stepper motors are one of the most versatile forms of positioning systems, particularly when digitally controlled as part of a servo system. Stepper motors are used in floppy disk drives, flatbed scanners, printers, plotters and many more devices. Note that hard drives no longer use stepper motors to position the read/write heads, instead utilizing a voice coil and servo feedback for head positioning. Stepper motors can also be used for positioning of valve pilot stages, for fluid control systems.

5.2. STEPPER MOTOR CONTROL USING ULN 2803

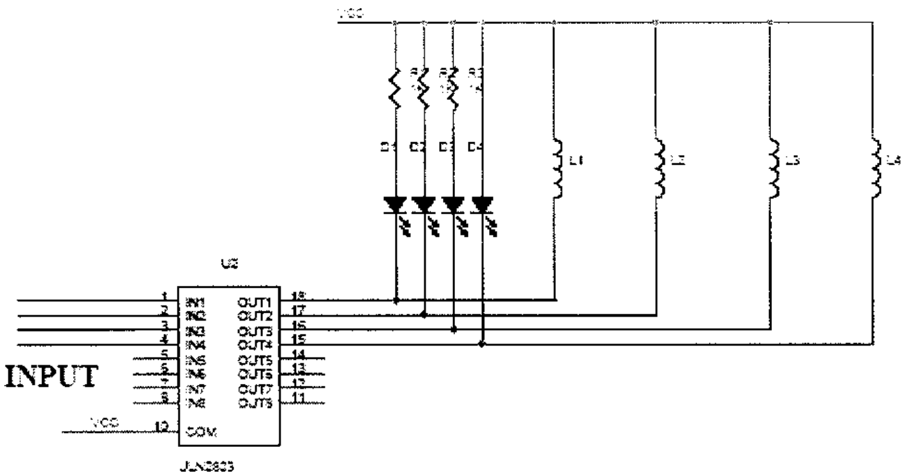


Figure 5.3

Stepper Motor Interfacing

The stepper motor is having four windings named as A, B, C, D, which are energized by the ULN2803 high current transistor driver. The ULN2803 is the eight NPN Darlington connected transistor in this family of arrays are ideally suited for interfacing between low logic level digital circuitry. The ULN2803 is designed to be compatible with standard TTL families.

The stepper motor windings are energized sequentially which is controlled by the microcontroller. If the microcontroller sends the binary data in the order of 5, 9, A, and 6 the stepper motor is rotating in the forward direction. If the microcontroller sends the binary data in the order of 6, A, 9, and 5 the stepper motor is rotating in the reverse direction. For an example if the binary data 5 (0101) given to driver circuit, the winding A and C are energized.

PROGRAMMING THE PIC

6.1 MPLAB IDE

The PIC is programmed using MPLAB IDE.

MPLAB IDE is a software program that runs on a PC to develop applications for Microchip microcontrollers. It is called an Integrated Development Environment, or IDE, because it provides a single integrated "environment" to develop code for embedded microcontrollers.

The MPLAB IDE project manager organizes the files to be edited and other associated files so they can be sent to the language tools for assembly or compilation, and ultimately to a linker. The linker has the task of placing the object code fragments from the assembler, compiler and libraries into the proper memory areas of the embedded controller, and ensure that the modules function with each other (or are "linked"). This entire operation from assembly and compilation through the link process is called a project "build".

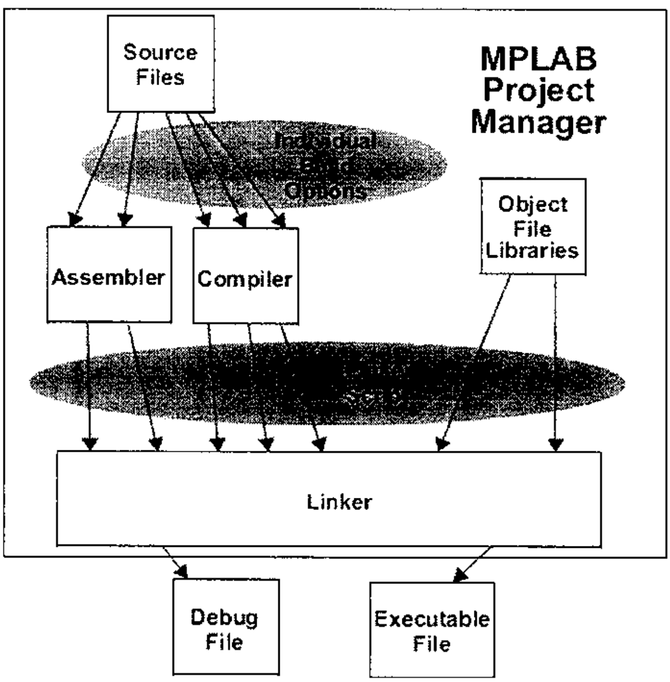


Figure 6.1

MPLAB IDE Project Manager

The source files are text files that are written conforming to the rules of the assembler or compiler. The assembler and compiler convert them into intermediate modules machine code and placeholders for references to functions and data storage. The linker resolves these placeholders and combines all the modules into a file of executable machine code. The linker also produces a debug file which allows MPLAB IDE to relate the executing machine codes back to the source files.

Language tools are programs such as cross-assemblers and cross-compilers. The language tool used here is HI-TECH's PICC LITE. This converts the source code produced by MPLAB to machine instructions that can be loaded into the PIC.

6.2 DEVICE PROGRAMMING

MPLAB ICD 2 is a low cost, real-time debugger and programmer. Using Microchip Technology's proprietary In-Circuit Debug functions, programs can be downloaded, executed in real time and examined in detail with the debug functions of MPLAB. MPLAB ICD 2 can also be used as a development programmer for supported microcontrollers. In Circuit Debugging works on two dedicated hardware lines (microcontroller pins used only during debugging mode) that control In Circuit Serial Programming (ICSP) of the device and afterwards, debugging through proprietary, on-chip firmware. The ICD 2 debug features are built into the microcontroller and activated by programming the debug code into the target processor. There is some shared overhead expense that includes one stack level, some general purpose file registers and a small area of program memory when in the debug mode.

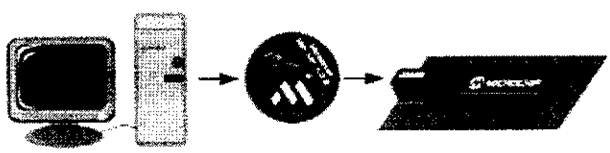


Figure 6.2

MPLAB ICD2

The MPLAB ICD 2 connects using USB or RS-232 between the PC operating with MPLAB IDE and the product board being developed. It acts as an intelligent interface/translator between the two, allows us to look into the active target board's microcontroller, viewing variables and registers at breakpoints with MPLAB watch windows. A breakpoint can be set to halt the program at a specific location. The program can be single-stepped or run at full speed. At breakpoints, data and program memory can be read and modified. Additionally, the MPLAB ICD 2 can be used to program or reprogram the Flash-based microcontroller while installed on the board.

6.2.1 ICD2 Connector Pin out

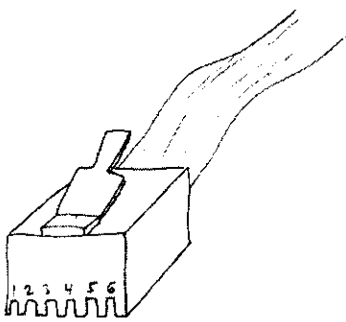


Figure 6.3

ICD2 Connector Pin out

The standard ICD2 cable is wired so that the pins are flipped between the ends. In other words, pin 1 on one end is connected to pin 6 on the other end, pin 2 to pin 5, etc. The pin out of each end is:

Signal	ICD2 end pin	Target end pin
Vpp	6	1
Vdd	5	2
GND	4	3
PGD	3	4
PGC	2	5
not connected	1	6

Table 6.1- ICD 2 Pin Connections

- **GND**-Negative power input to the PIC and the ground reference for the remaining signals.
- **Vdd** - This is the positive power input to the PIC.
- **Vpp** - Programming mode voltage. This is connected to the MCLR pin of the target PIC
- **PGC** - Clock line of the serial data interface. This line swings from GND to Vdd and is always driven by the programmer. Data is transferred on the falling edge.
- **PGD** - Serial data line. The serial interface is bi-directional, so this line can be driven by either the programmer or the PIC depending on the current operation. In either case this line swings from GND to Vdd. A bit is transferred on the falling edge of PGC.

POWER SUPPLY AND RELAY

7.1. POWER SUPPLY

7.1.1. 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 7.1

Power Supply Block Diagram

7.1.2 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.

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.

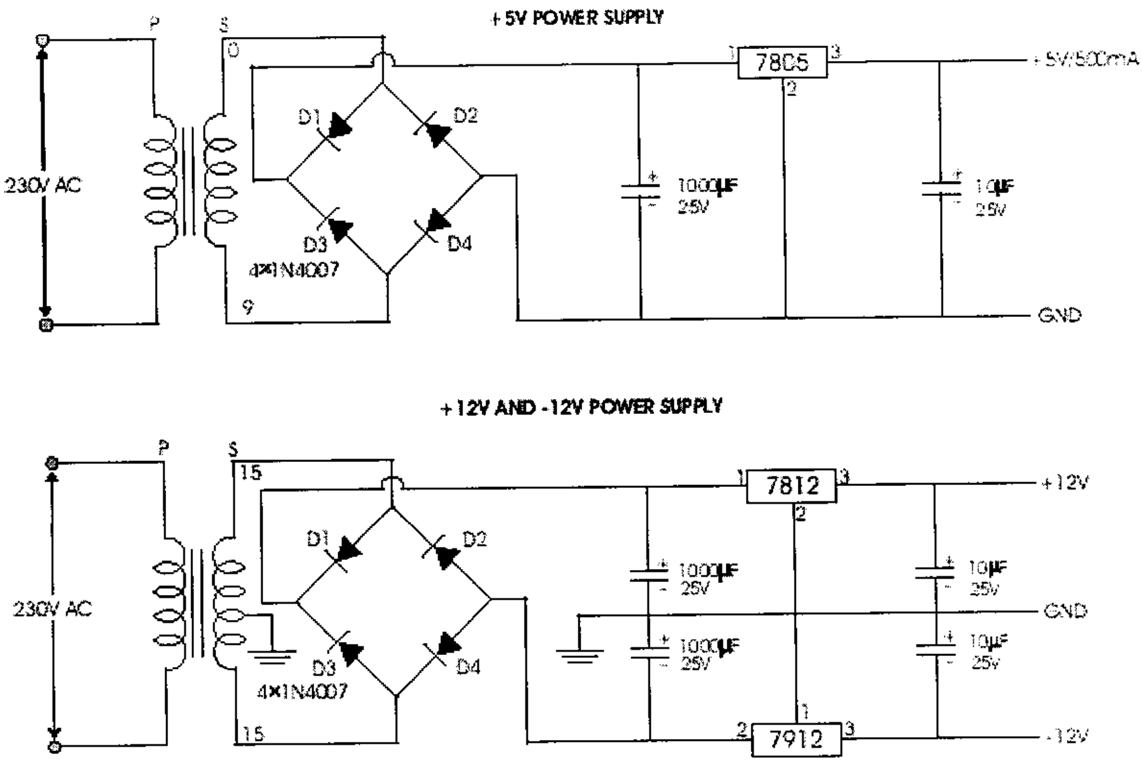


Figure 7.2

Power Supply Circuit Diagram

IC VOLTAGE REGULATORS

Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustably set voltage. The regulators can be selected for operation with load currents from hundreds of milli amperes to tens of amperes, corresponding to power ratings from milli watts to tens of watts.

A fixed three-terminal voltage regulator has an unregulated dc input voltage, Vi, applied to one input terminal, a regulated dc output voltage, Vo, from a second terminal, with the third terminal connected to ground. In this project fixed output regulators 78XX is used. In 78XX the last two numbers (XX) indicates the output voltage. This project uses LM 7805 which is a 5V regulator and LM7812 which is a 12V regulator.

IC Part	**Output Voltage (V)**	**Minimum Input (V)**
7805	+5	7.3
7806	+6	8.3
7808	+8	10.5
7810	+10	12.5
7812	+12	14.6
7815	+15	17.7
7818	+18	21.0
7824	+24	27.1

Table 7.1 Positive Voltage Regulators in 7800 series

- For ICs, microcontroller, LCD --------- 5 volts
- For op-amp, relay circuits ---------- 12 volts

7.2. RELAY

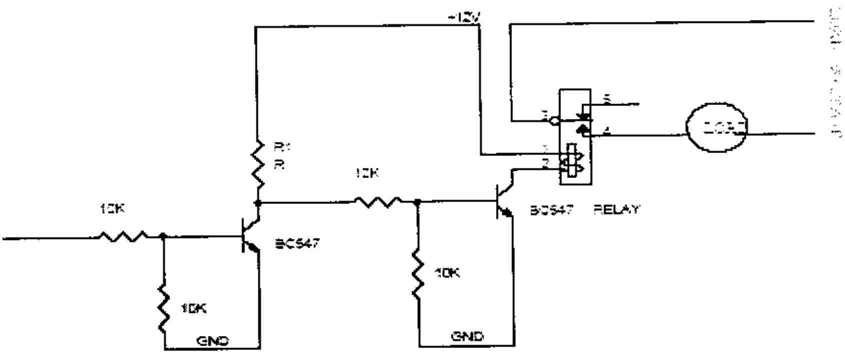


Figure 7.3

Relay

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 T2 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 T1 transistors, the transistor is conducting and shorts the collector and emitter terminal and zero signals is given to base of the T2 transistor. So the relay is turned OFF state.

When low pulse is given to base of transistor T1 transistor, the transistor is turned OFF. Now 12v is given to base of T2 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.

When the controlling current flows through the coil, the soft iron core is magnetized and attracts the L-shaped soft iron armature. This rocks on its pivot and opens, closes or changes over, the electrical contacts in the circuit being controlled it closes the contacts.

The current needed to operate a relay is called the pull-in current and the dropout current in the coil when the relay just stops working. If the coil resistance R of a relay is 185 Ω and its operating voltage V is 12V, the pull-in current I is given by:

$$I = \frac{V}{R} = \frac{12}{185} = 0.065A = 65mA$$

CONCLUSIONS AND RECOMMENDATIONS

8.1. CONCLUSION

Our project has been successfully tested as a range detector, which would detect obstacles in front of the vehicle on which it is mounted and display its range, with the desired accuracy. The usage of stepper motor ensures the extensive coverage of the area in front of the vehicle. The usage of microcontroller along with mechanical equipment guarantees accurate working of the mechanism and high speed of response. This range detector is useful in night driving and conditions of poor visibility like fog, mist etc.

8.2. FUTURE DEVELOPMENTS

The usage of high power LASERs, which can traverse high distances, can increase the range of the obstacle detector. The number of sectors can be increased to give more details on the obstacle position. The speed of scanning can be increased by using a DC motor. Further, an approaching obstacle can be displayed in the form of dots on an LCD monitor placed on the console of the vehicle. This type of obstacle detector can be used in AGV (Automatic Guided Vehicle), by increasing the span of the apparatus.

APPENDIX A

CODING

```
#include <pic.h>

#include <lcd.h>


static bit pulse2 @((unsigned)&PORTC*8+0);

static bit pulse1 @((unsigned)&PORTC*8+1);

static bit alarm @((unsigned)&PORTC*8+2);


unsigned long int count1;

unsigned int time,count,distance,mes_count;

unsigned char d1,d2,d3,d4,i;

void ultra_dis();

void display();

void del();


void mot_rev(unsigned int yy);

void mot_for(unsigned int y);

void scan();

void first_scan();

unsigned char da[4]={0x01,0x02,0x04,0x08};


unsigned char d1,d2,d3,d4,dd,i,j;

unsigned int aa,data1,data2,data3,data4,data5,data6,data7,data8;

void disp(unsigned int la_val,unsigned int cu_val);
```

```
void error();
void main()
{
 TRISC=0x01; //0b1100 0001
 TRISB=0x00;
 lcd_init();
// alarm=0;  //off
 GIE=1;
 PEIE=1;
 TMR1IE=1;
 TMR1ON=0;
 TMR1L=TMR1H=0x00;
 read(0x01);
 read(0x80);
 lcd_condis("   ULTRASONIC   ",16);
 read(0xc0);
 lcd_condis("   MONITORING   ",16);
 del();  del();
 read(0x01);
 read(0x80);
 lcd_condis("D:000incL.D:000 ",16);
 first_scan();
 mot_rev(1050);
 while(1)
 {
```

```
 scan();
 mot_rev(1050);
 }
}

void scan()
{
    mot_for(263);
          read(0xca);
          write('S');write('.');write('N');write('o');write('.');write('1');
          dd=0;
          while(dd<2)
          {
                   ultra_dis();
                   dd++;
                   disp(data1,distance);
                   if((data1<distance+10)&&(data1>distance-10)){read(0xc0);lcd_condis("
 ",9);}
                   else error();
                   delay(50);
          }

     mot_for(263);
          read(0xca);
          write('S');write('.');write('N');write('o');write('.');write('2');
```

```
dd=0;
while(dd<2)
{
        ultra_dis();
        dd++;
        disp(data2,distance);
        if((data2<distance+10)&&(data2>distance-10)){read(0xc0);lcd_condis("
",9);}
        else error();
        delay(50);
}
mot_for(263);
read(0xca);
write('S');write('.');write('N');write('o');write('.');write('3');
dd=0;
while(dd<2)
{
        ultra_dis();
        dd++;
        disp(data3,distance);
        if((data3<distance+10)&&(data3>distance-10)){read(0xc0);lcd_condis("
",9);}
        else error();
        delay(50);
}
```

```
 mot_for(263);
        read(0xca);
        write('S');write('.');write('N');write('o');write('.');write('4');
        dd=0;
        while(dd<2)
        {
                ultra_dis();
                dd++;
                disp(data4,distance);
                if((data4<distance+10)&&(data4>distance-10)){read(0xc0);lcd_condis("
",9);}
                else error();
                delay(50);
         }
}

void first_scan()
{
    mot_for(263);
        read(0xca);
        write('S');write('.');write('N');write('o');write('.');write('1');
        dd=0;
        while(dd<3)
        {
```

```
            ultra_dis();
            disp(data1,distance);
            delay(50);
            dd++;
      }
      data1=distance;

mot_for(263);
      read(0xca);
      write('S');write('.');write('N');write('o');write('.');write('2');
      dd=0;
      while(dd<2)
      {
            ultra_dis();
            disp(data2,distance);
            delay(50);
            dd++;
      }
      data2=distance;
mot_for(263);
      read(0xca);
      write('S');write('.');write('N');write('o');write('.');write('3');
      dd=0;
      while(dd<2)
      {
```

```
}
            ultra_dis();
            disp(data3,distance);
            delay(50);
            dd++;
    }
    data3=distance;

mot_for(263);
    read(0xca);
    write('S');write('.');write('N');write('o');write('.');write('4');
    dd=0;

    while(dd<2)
    {
            ultra_dis();
            disp(data4,distance);
            delay(50);
            dd++;
    }
    data4=distance;
}

void error()
{
  alarm=1;  // on
```

```
        read(0xc0);
        lcd_condis("NEW ENTRY",9);
        delay(45000);
        lcd_condis("         ",9);
  alarm=0;  // off
}
void disp(unsigned int la_val,unsigned int cu_val)
{
 read(0x82);
 write(cu_val/100+0x30);
 write(cu_val%100/10+0x30);
// write('.');
 write(cu_val%10+0x30);
 read(0x8c);
 write(la_val/100+0x30);
 write(la_val%100/10+0x30);
// write('.');
 write(la_val%10+0x30);
 }
 void mot_for(unsigned int y)
 {
     for(aa=0;aa<y;aa++)
           {
       PORTB=da[j];
                  delay(400);
```

```
            j++; if(j>3) j=0;
        }
}
void mot_rev(unsigned int yy)
{
 read(0xc0);
 lcd_condis("                ",16);

   for(aa=0;aa<yy;aa++)
        {
     PORTB=da[j];
                delay(250);
                j--;if(j==0xff) j=3;
        }
 }
 void ultra_dis()
 {
        count1=count=0;
        TMR1H=TMR1L=0x00;
        for(i=0;i<5;i++)
        {
                pulse1 = 0;
                delay(1000);
                pulse1=1;
                delay(10);
```

```
}          pulse1=0;
           while(pulse2==0);
           TMR1ON=1;
           while(pulse2==1);
           TMR1ON=0;
           count=TMR1H<<8;
           count=count|TMR1L;
           TMR1H=TMR1L=0x00;
           count1=count1+count;
           delay(5000);
      }
      count1=count1/5;
      count=count1;
      display();
}
void interrupt timer(void)
{
 if(TMR1IF==1)
 {
  TMR1IF=0;
  TMR1H=0x00;
  TMR1L=0x00;
 }
 }
```

```
void display()
{
        d4=(count/10000);
        d3=(count%10000/1000);
        d2=(count%1000/100);
//      mes_count= ((d4*1000)+(d3*100)+(d2*10)+d1);
//      mes_count=mes_count*25;
//      d3=(mes_count/10000);
//      d2=(mes_count%10000/1000);
//      d1=(mes_count%1000/100);
        distance=((d4*100)+(d3*10)+d2);
    read(0x82);
        write(distance/100+0x30);
        write(distance%100/10+0x30);
//      write('.');
    write(distance%10+0x30);
  }

  void del()
  {
  delay(65000);delay(45000);
  }
```

APPENDIX B

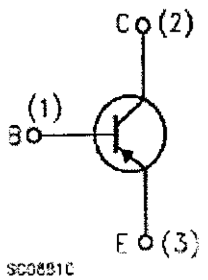
1. 2N2907

GENERAL PURPOSE AMPLIFIERS AND SWITCHES

DESCRIPTION

The 2N2905 and 2N2907 are silicon planar epitaxial PNP transistors in Jedec TO-39 (for 2N2905) and in Jedec TO-18 (for 2N2907) metal case. They are designed for high speed saturated switching and general purpose application.

INTERNAL SCHEMATIC DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{CBO}	Collector-Base Voltage ($I_E = 0$)	-60	V
V_{CEO}	Collector-Emitter Voltage ($I_B = 0$)	-40	V
V_{EBO}	Emitter-Base Voltage ($I_C = 0$)	-5	V
I_C	Collector Current	-0.6	A
P_{tot}	Total Dissipation at $T_{amb} \leq 25$ °C for **2N2905** for **2N2907** at $T_{case} \leq 25$ °C for **2N2905** for **2N2907**	 0.6 0.4 3 1.8	 W W W W
T_{stg}	Storage Temperature	-65 to 200	°C
T_j	Max. Operating Junction Temperature	200	°C

ELECTRICAL CHARACTERISTICS (Tcase = 25 oC unless otherwise specified)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector Cut-off Current (I_E = 0)	V_{CB} = -50 V V_{CB} = -50 V T_{case} = 150 °C			-20 -20	nA µA
I_{CEX}	Collector Cut-off Current (V_{BE} = -0.5V)	V_{CE} = -30 V			-50	nA
I_{BEX}	Base Cut-off Current (V_{BE} = -0.5V)	V_{CE} = -30 V			-50	nA
$V_{(BR)CBO}$*	Collector-Base Breakdown Voltage (I_E = 0)	I_C = -10 µA	-60			V
$V_{(BR)CEO}$*	Collector-Emitter Breakdown Voltage (I_B = 0)	I_C = -10 mA	-40			V
$V_{(BR)EBO}$*	Emitter-Base Breakdown Voltage (I_C = 0)	I_E = -10 µA	-5			V
$V_{CE(sat)}$*	Collector-Emitter Saturation Voltage	I_C = -150 mA I_B = -15 mA I_C = -500 mA I_B = -50 mA			-0.4 -1.6	V V
$V_{BE(sat)}$*	Base-Emitter Saturation Voltage	I_C = -150 mA I_B = -15 mA I_C = -500 mA I_B = -50 mA			-1.3 -2.6	V V
h_{FE}*	DC Current Gain	I_C = -0.1 mA V_{CE} = -10 V I_C = -1 mA V_{CE} = -10 V I_C = -10 mA V_{CE} = -10 V I_C = -150 mA V_{CE} = -10 V I_C = -500 mA V_{CE} = -10 V	35 50 75 100 30		 300 	
f_T	Transition Frequency	V_{CE} = -20 V f = 100 MHz I_C = -50 mA	200			MHz
C_{EBO}	Emitter Base Capacitance	I_C = 0 V_{EB} = -2 V f = 1MHz			30	pF
C_{CBO}	Collector Base Capacitance	I_E = 0 V_{CB} = -10 V f = 1MHz			8	pF
t_d	Delay Time	V_{CC} = -30 V I_C = -150 mA I_{B1} = -15 mA			10	ns
t_r	Rise Time	V_{CC} = -30 V I_C = -150 mA I_{B1} = -15 mA			40	ns
t_s	Storage Time	V_{CC} = -6 V I_C = -150 mA I_{B1} = -I_{B2} = -15 mA			80	ns
t_f	Fall Time	V_{CC} = -6 V I_C = -150 mA I_{B1} = -I_{B2} = -15 mA			30	ns

* Pulsed: Pulse duration = 300 µs, duty cycle ≤ 1 %

ELECTRICAL CHARACTERISTICS

Symbol	Parameter	Conditions	Min	Typ (Note 3)	Max	Units
$_I$	Input Clamp Voltage	V_{CC} = Min, I_I = −15 mA			−1.5	V
$_{OH}$	HIGH Level Output Voltage	V_{CC} = Min, I_{OH} = Max, V_{IL} = Max	2.7	3.4		V
$_{OL}$	LOW Level Output Voltage	V_{CC} = Min, I_{OL} = Max, V_{IH} = Min		0.35	0.5	V
		V_{CC} = Min, I_{OL} = 4 mA		0.25	0.4	
$_{T+}$	Input Current at Positive-Going Threshold	V_{CC} = 5V, $V_I = V_{T+}$		−0.14		mA
$_{T-}$	Input Current at Negative-Going Threshold	V_{CC} = 5V, $V_I = V_{T-}$		−0.18		mA
	Input Current @ Max Input Voltage	V_{CC} = Max, V_I = 7V			0.1	mA
$_{IH}$	HIGH Level Input Current	V_{CC} = Max, V_I = 2.7V			20	µA
$_{IL}$	LOW Level Input Current	V_{CC} = Max, V_I = 0.4V			−0.4	mA
$_{OS}$	Short Circuit Output Current	V_{CC} = Max (Note 4)	−20		−100	mA
$_{CCH}$	Supply Current with Outputs HIGH	V_{CC} = Max		8.6	16	mA
$_{CCL}$	Supply Current with Outputs LOW	V_{CC} = Max		12	21	mA

3. LM78XX

SERIES VOLTAGE REGULATORS

GENERAL DESCRIPTION

The LM78XX series of three terminal regulators is available with several fixed output voltages making them useful in a wide range of applications. One of these is local on card regulation, eliminating the distribution problems associated with single point regulation. The voltages available allow these regulators to be used in logic systems, instrumentation, HiFi, and other solid state electronic equipment. Although designed primarily as fixed voltage regulators these devices can be used with external components to obtain adjustable voltages and currents.

The LM78XX series is available in an aluminum TO-3 package which will allow over 1.0A load current if adequate heat sinking is provided. Current limiting is included to limit the peak output current to a safe value. Safe area protection for the output transistor is provided to limit internal power dissipation. If internal power dissipation becomes too high for the heat sinking provided, the thermal shutdown circuit takes over preventing the IC from overheating. Considerable effort was expanded to make the LM78XX series of regulators easy to use and minimize the number of
external components. It is not necessary to bypass the output, although this does improve transient response. Input bypassing is needed only if the regulator is located far from the filter capacitor of the power supply. For output voltage other than 5V, 12V and 15V the LM117
series provides an output voltage range from 1.2V to 57V.

FEATURES

n Output current in excess of 1A

n Internal thermal overload protection

n No external components required

n Output transistor safe area protection ıternal short circuit current limit

ʌvailable in the aluminum TO-3 package

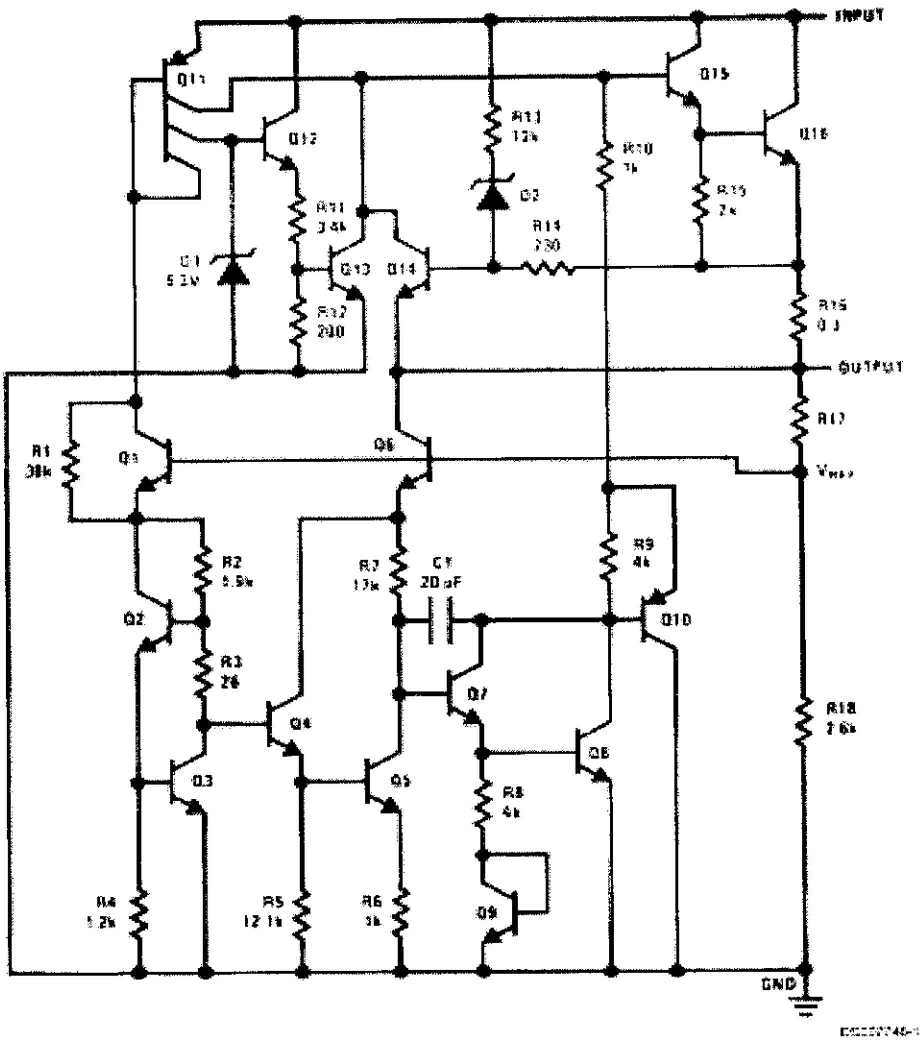
)LTAGE RANGE

ʌ17805C 5V

ʌ17812C 12V

ʌ17815C 15V

ːHEMATIC



.M311

NGLE COMPARATOR

ATURES

ow input bias current : 250nA (Max)

ow input offset current : 50nA (Max)

ifferential Input Voltage : ? 30V

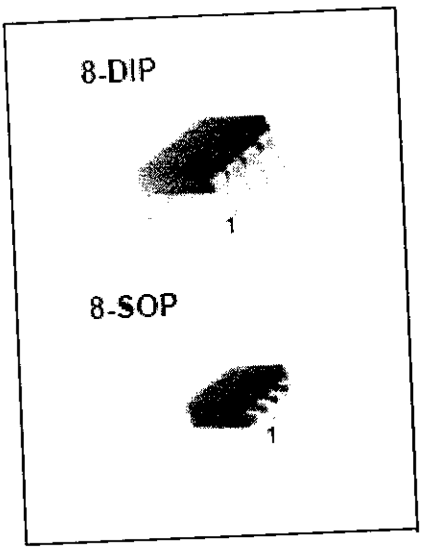
ower supply voltage : single 5.0V supply to ? 15V.

)ffset voltage null capability.

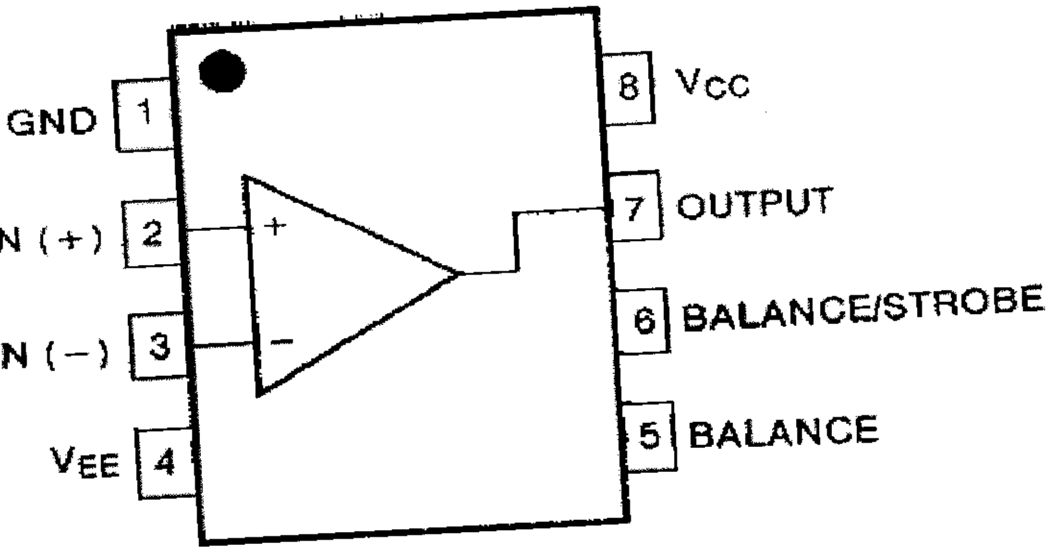
strobe capability.

ESCRIPTION

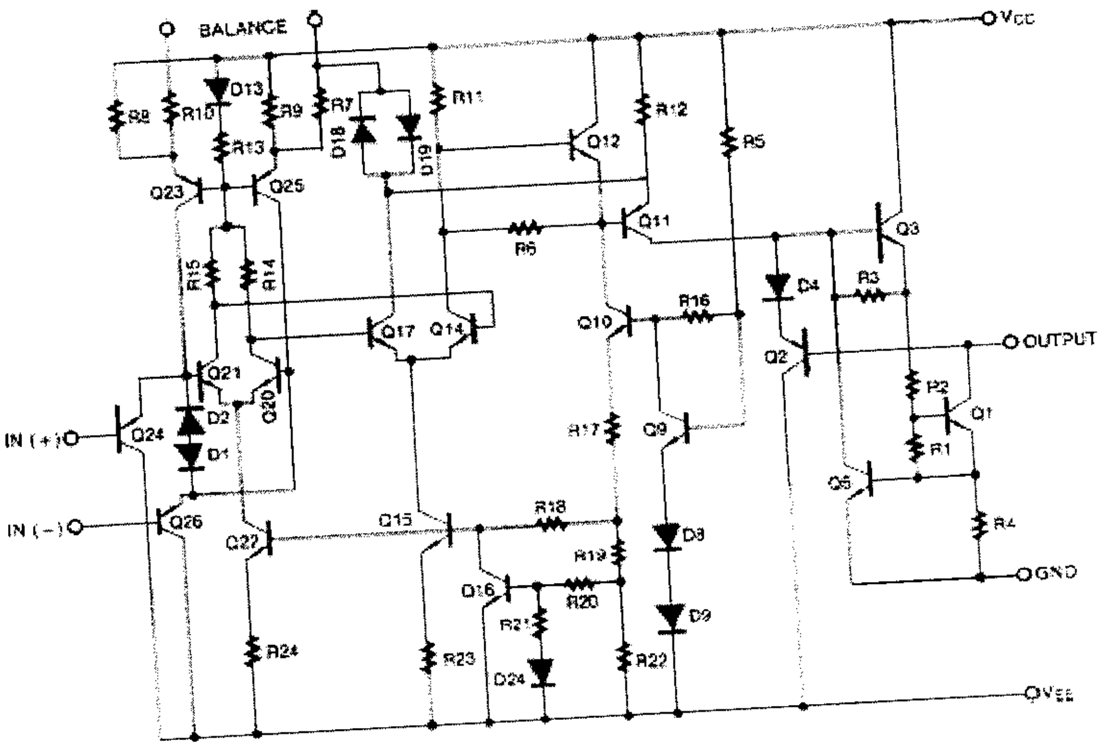
ne LM311 series is a monolithic, low input current voltage comparator. The device is also esigned to operate from dual or single supply voltage.



ERNAL BLOCK DIAGRAM



CHEMATIC DIAGRAM



OLUTE MAXIMUM RATINGS

Parameter	Symbol	Value	Unit
Total Supply Voltage	VCC	36	V
Output to Negative Supply Voltage LM311	VO - VEE	40	V
Ground to Negative voltage	VEE	-30	V
Differential Input Voltage	$V_{I(DIFF)}$	30	V
Input Voltage	V_I	±15	V
Output Short Circuit Duration	-	10	sec
Power Dissipation	PD	500	mW
Operating Temperature Range	TOPR	0 ~ +70	°C
Storage Temperature Range	TSTG	- 65 ~ +150	°C

CTRICAL CHARACTERISTICS

C = 15V, TA = 25? C, unless otherwise specified)

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Input Offset Voltage	VIO	$R_S \le 50K\Omega$		-	1.0	7.5	mV
			Note 1	-	-	10	
Input Offset Current	IIO			-	6	50	nA
			Note 1	-	-	70	
Input Bias Current	IBIAS			-	100	250	nA
			Note 1	-	-	300	
Voltage Gain	GV	-		40	200	-	V/mV
Response Time	TRES		Note 2	-	200	-	ns
Saturation Voltage	VSAT	IO =50mA, $V_I \le$ -10mV		-	0.75	1.5	V
		VCC ≥ 4.5V, VEE =0V IO =8mA, $V_I \le$ -10mV,	Note 1	-	0.23	0.4	
Strobe "ON" Current	ISTR(ON)	-		-	3	-	mA
Output Leakage Current	ISINK	ISTR =3mA, $V_I \ge$ 10mV VO =15V, VCC=±15V		-	0.2	50	nA
Input Voltage Range	VI(R)	Note 1		-14.5 to 13.0	-14.7 to 13.8	-	V
Positive Supply Current	ICC	-		-	3.0	7.5	mA
Negative Supply Current	IEE	-		-	-2.2	-5.0	mA
Strobe Current	ISTR	-		-	3	-	mA

MAX232, MAX232I

AL EIA-232 DRIVERS/RECEIVERS

ATURES

- Meet or Exceed TIA/EIA-232-F and ITU Recommendation V.28
- Operate With Single 5-V Power Supply
- Operate Up to 120 kbit/s
- Two Drivers and Two Receivers
- ±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)
- Applications

  TIA/EIA-232-F

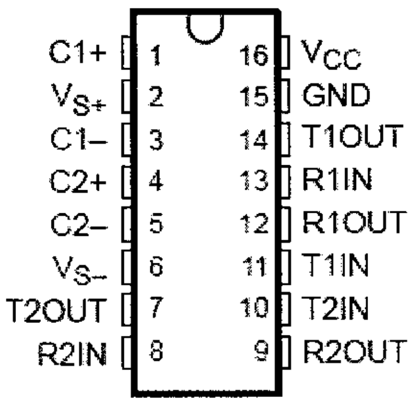
  Battery-Powered Systems

  Terminals

  Modems

  Computers

MAX232 . . . D, DW, N, OR NS PACKAGE
MAX232I . . . D, DW, OR N PACKAGE
(TOP VIEW)



CRIPTION

MAX232 is a dual driver/receiver that includes a capacitive voltage generator to supply -232 voltage levels from a single 5-V supply. Each receiver converts EIA-232 inputs to TTL/CMOS levels. These receivers have a typical threshold of 1.3 V and a typical eresis of 0.5 V, and can accept ±30-V inputs. Each driver converts TTL/CMOS input ls into EIA-232 levels. The driver, receiver, and voltage-generator functions are available ells in the Texas Instruments LinASIC□ library.

NCTION TABLES

EACH DRIVER

INPUT TIN	OUTPUT TOUT
L	H
H	L

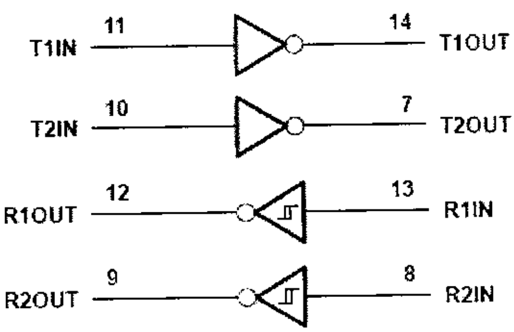
H = high level, L = low level

EACH RECEIVER

INPUT RIN	OUTPUT ROUT
L	H
H	L

H = high level, L = low level

GIC DIAGRAM (POSITIVE LOGIC)



SOLUTE MAXIMUM RATINGS OVER OPERATING FREE-AIR MPERATURE RANGE (UNLESS OTHERWISE NOTED)†

ut supply voltage range, VCC (see Note 1) .... –0.3 V to

sitive output supply voltage range, VS.. VCC – 0.3 V to

V

gative output supply voltage range, VS...–0.3 V to –

V

put voltage range, VI: Driver ....-0.3 V to VCC +

3 V

eceiver...±3

V

utput voltage range, VO: T1OUT, T2OUT ....VS– – 0.3 V to VS+ +

.3 V

1OUT, R2OUT.. –0.3 V to VCC +

.3 V

Short-circuit duration: T1OUT, T2OUT.. . . . . .

Unlimited

Package thermal impedance, ?JA (see Note 2): D package.................................. . . . .

73°C/W

DW package . . . .

....................................57°C/W

....

N package . . . .

67°C/W

NS package . . . .

64°C/W

Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds.......................... . . .

260°C

Storage temperature range, Tstg .... –65°C to

150°C

† Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and

functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not

implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

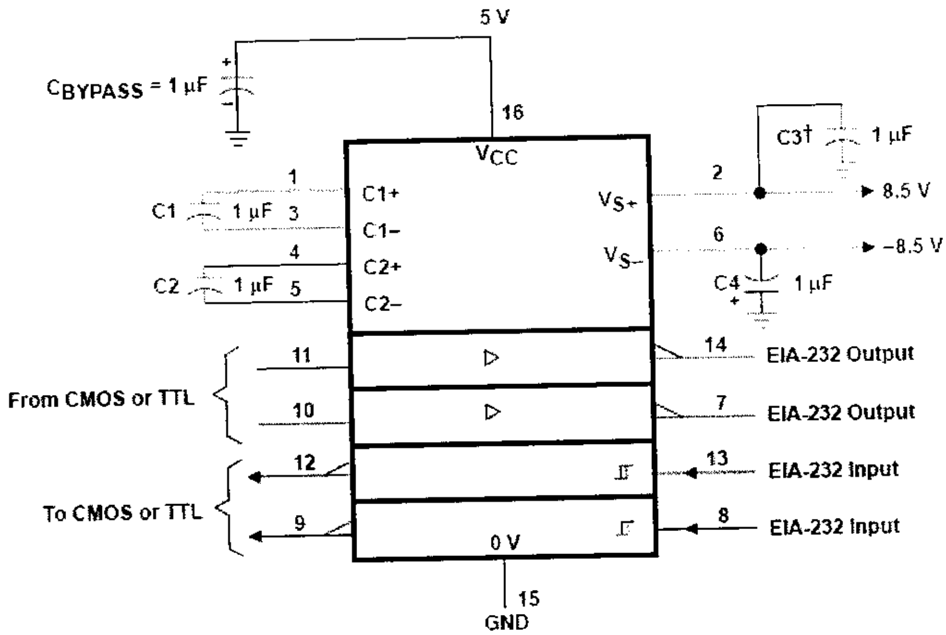
NOTE 1: All voltage values are with respect to network ground terminal.

2. The package thermal impedance is calculated in accordance with JESD 51-7.

recommended operating conditions

			MIN	NOM	MAX	UNIT
V_{CC}	Supply voltage		4.5	5	5.5	V
V_{IH}	High-level input voltage (T1IN,T2IN)		2			V
V_{IL}	Low-level input voltage (T1IN, T2IN)				0.8	V
R1IN, R2IN	Receiver input voltage				±30	V
T_A	Operating free-air temperature	MAX232	0		70	°C
		MAX232I	−40		85	

TYPICAL OPERATING CIRCUIT



5. PIC 16F877

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

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

PIC (16F877)

Various microcontrollers offer different kinds of memories. EEPROM, EPROM, FLASH etc. are some of the memories of which FLASH is the most recently developed. Technology that is used in pic16F877 is flash technology, so that data is retained even when the power is switched off. Easy Programming and Erasing are other features of PIC 16F877.

PIC START PLUS PROGRAMMER:

The PIC start plus development system from microchip technology provides the product development engineer with a highly flexible low cost microcontroller design tool set for all microchip PIC micro devices. The picstart plus development system includes PIC start plus development programmer and mplab ide.

The PIC start plus programmer gives the product developer ability to program user software in to any of the supported microcontrollers. The PIC start plus software running under mplab provides for full interactive control over the programmer.

SPECIAL FEATURES OF PIC MICROCONTROLLER:

CORE FEATURES:

- High-performance RISC CPU
- Only 35 single word instructions to learn
- All single cycle instructions except for program branches which are two cycle
- Operating speed: DC - 20 MHz clock input

  DC - 200 ns instruction cycle
- 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
- Pin out compatible to the PIC16C73/74/76/77
- Interrupt capability (up to 14 internal/external)
- Eight level deep hardware stack
- Direct, indirect, and relative addressing modes

• Power-on Reset (POR)

• Power-up Timer (PWRT) and Oscillator Start-up Timer (OST)

• Watchdog Timer (WDT) with its own on-chip RC Oscillator for reliable operation

• Programmable code-protection

• Power saving SLEEP mode

• Selectable oscillator options

• Low-power, high-speed CMOS EPROM/EEPROM technology

• Fully static design

• In-Circuit Serial Programming (ICSP) via two pins

• Only single 5V source needed for programming capability

• In-Circuit Debugging via two pins

• Processor read/write access to program memory

• Wide operating voltage range: 2.5V to 5.5V

• High Sink/Source Current: 25mA

• Commercial and Industrial temperature ranges

• Low-power consumption:

< 2mA typical @ 5V, 4 MHz

20mA typical @ 3V, 32 kHz

< 1mA typical standby current

PERIPHERAL FEATURES:

- Timer0: 8-bit timer/counter with 8-bit prescaler
- Timer1: 16-bit timer/counter with prescaler, can be incremented during sleep

  via external crystal/clock
- Timer2: 8-bit timer/counter with 8-bit period register, prescaler and postscaler
- Two Capture, Compare, PWM modules

  Capture is 16-bit, max resolution is 12.5 ns,

  Compare is 16-bit, max resolution is 200 ns,

  PWM max. resolution is 10-bit
- 10-bit multi-channel Analog-to-Digital converter
- Synchronous Serial Port (SSP) with SPI. (Master Mode) and I2C. (Master/Slave)
- Universal Synchronous Asynchronous Receiver Transmitter (USART/SCI) with

  9- bit address detection.
- Brown-out detection circuitry **for Brown-out Reset (BOR)**

SPECIFICATIONS

DEVICE	PROGRAM FLASH	DATA MEMORY	DATA EEPROM
PIC 16F877	8K	368 Bytes	256 Bytes

Table 4.1.2

PIN DIAGRAM:

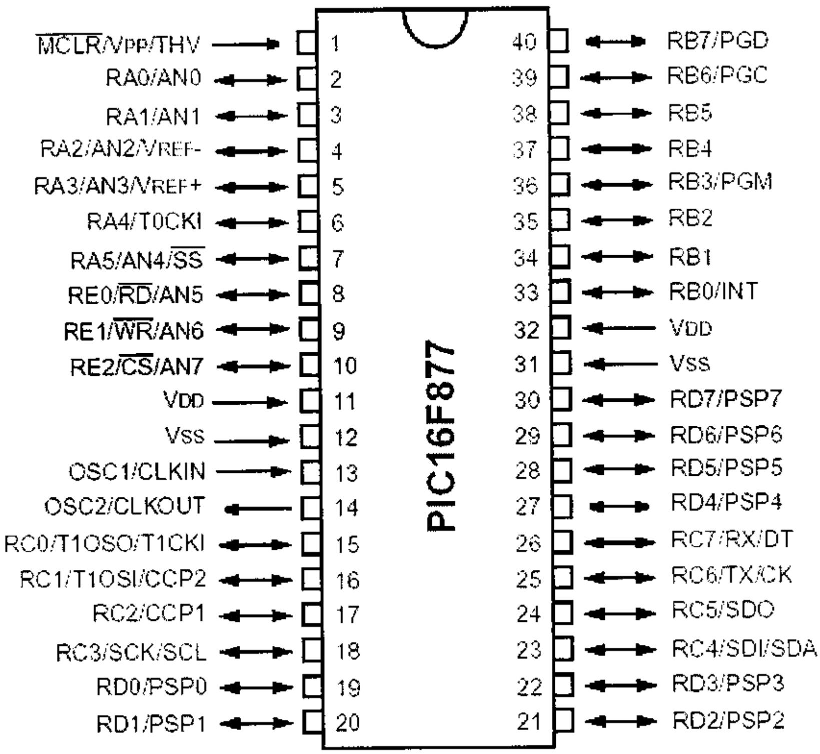


Fig 4.1.4PIN DIAGRAM OF PIC 16F877

I/O PORTS:

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

PORTA AND THE TRISA REGISTER:

PORTA 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. Reading the PORTA register reads the status of the pins whereas writing to it will write to the port latch. All write operations are read-modify-write operations. Therefore a write to a port implies that the port pins are read; this value is modified, and then written to the port data latch. Pin RA4 is multiplexed with the Timer0 module clock input to become the RA4/T0CKI pin. The RA4/T0CKI pin is a Schmitt Trigger input and an open drain output. All other RA port pins have TTL input levels and full CMOS output drivers. Other PORTA pins are multiplexed with analog inputs and analog VREF input. The operation of each pin is selected by clearing/setting the control bits in the ADCON1 register (A/D Control Register1).

The TRISA register controls the direction of the RA pins, even when they are being used as analog inputs. The user must ensure the bits in the TRISA register are maintained set when using them as analog inputs.

PORTB AND TRISB REGISTER:

PORTB 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. Three pins of PORTB are multiplexed with the Low Voltage Programming function; RB3/PGM, RB6/PGC and RB7/PGD. The alternate functions of these pins are described in the Special Features Section. Each of the PORTB pins has a weak internal pull-up. A single control bit can turn on all the pull-ups.

This is performed by clearing bit RBPU (OPTION_REG<7>). The weak pull-up is automatically turned off when the port pin is configured as an output. The pull-ups are disabled on a Power-on Reset.

Four of PORT B's pins, RB7:RB4, have an interrupt on change feature. Only pins configured as inputs can cause this interrupt to occur (i.e. any RB7:RB4 pin configured as an output is excluded from the interrupt on change comparison). The input pins (of RB7:RB4) are compared with the old value latched on the last read of PORTB. The "mismatch" outputs of RB7:RB4 are OR'ed together to generate the RB Port Change Interrupt with flag bit RBIF (INTCON<0>). This interrupt can wake the device from SLEEP. The user, in the interrupt service routine, can clear the interrupt in the following manner:

a) Any read or write of PORTB. This will end the mismatch condition.

b) Clear flag bit RBIF. A mismatch condition will continue to set flag bit RBIF. Reading PORTB will end the mismatch condition, and allow flag bit RBIF to be cleared. The interrupt on change feature is recommended for wake-up on key depression operation and operations where PORTB is only used for the interrupt on change feature. Polling of PORTB is not recommended while using the interrupt on change feature. This interrupt on mismatch feature, together with software configurable pull-ups on these four pins, allow easy interface to a keypad and make it possible for wake-up on key depression.

PORTC AND THE TRISC REGISTER:

PORTC 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. PORTC is multiplexed with several peripheral functions. PORTC pins have Schmitt Trigger input buffers.

When the I2C module is enabled, the PORTC (3:4) pins can be configured with normal I2C levels or with SMBUS levels by using the CKE bit (SSPSTAT <6>). When enabling peripheral functions, care should be taken in defining TRIS bits for each PORTC pin. Some peripherals override the TRIS bit to make a pin an output, while other peripherals override the TRIS bit to make a pin an input. Since the TRIS bit override is in effect while the peripheral is enabled, read-modify write instructions (BSF, BCF, XORWF) with TRISC as destination should be avoided. The user should refer to the corresponding peripheral section for the correct TRIS bit settings.

PORTD AND TRISD REGISTERS:

This section is not applicable to the 28-pin devices. PORTD 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.

PORTE AND TRISE REGISTER:

PORTE 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 control inputs for the microprocessor port when bit PSPMODE (TRISE<4>) is set. In this mode, the user must make sure that the TRISE<2:0> bits are set (pins are configured as digital inputs). Ensure ADCON1 is configured for digital I/O. In this mode the input buffers are TTL.

PORTE pins are multiplexed with analog inputs. When selected as an analog input, these pins will read as '0's. TRISE controls the direction of the RE pins, even when they are being used as analog inputs. The user must make sure to keep the pins configured as inputs when using them as analog inputs.

MEMORY ORGANISATION:

There are three memory blocks in each of the PIC16F877 MUC's. The program memory and Data Memory have separate buses so that concurrent access can occur.

PROGRAM MEMORY ORGANISATION:

The PIC16f877 devices have a 13-bit program counter capable of addressing 8K *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.

DATA MEMORY ORGANISTION:

The data memory is partitioned into multiple banks which contain the General Purpose Registers and the special functions Registers. Bits RP1 (STATUS<6) and RP0 (STATUS<5>) are the bank selected bits.

RP1:RP0	Banks
00	0
01	1
10	2
11	3

4.1.3 REGISTER BANK SELECTION

Each bank extends up to 7Fh (1238 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.

GENERAL PURPOSE REGISTER :

The register file can be accessed either directly or indirectly through the File Selected Register (FSR). There are some Special Function 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. Those registers associated with the core functions.

Fig.4.1.5PIC16F877 REGISTER FILE MAP

Bank 0	File Address	Bank 1	File Address	Bank 2	File Address	Bank 3	File Address
Indirect addr.(*)	00h	Indirect addr.(*)	80h	Indirect addr.(*)	100h	Indirect addr.(*)	180h
TMR0	01h	OPTION_REG	81h	TMR0	101h	OPTION_REG	181h
PCL	02h	PCL	82h	PCL	102h	PCL	182h
STATUS	03h	STATUS	83h	STATUS	103h	STATUS	183h
FSR	04h	FSR	84h	FSR	104h	FSR	184h
PORTA	05h	TRISA	85h		105h		185h
PORTB	06h	TRISB	86h	PORTB	106h	TRISB	186h
PORTC	07h	TRISC	87h		107h		187h
PORTD (1)	08h	TRISD (1)	88h		108h		188h
PORTE (1)	09h	TRISE (1)	89h		109h		189h
PCLATH	0Ah	PCLATH	8Ah	PCLATH	10Ah	PCLATH	18Ah
INTCON	0Bh	INTCON	8Bh	INTCON	10Bh	INTCON	18Bh
PIR1	0Ch	PIE1	8Ch	EEDATA	10Ch	EECON1	18Ch
PIR2	0Dh	PIE2	8Dh	EEADR	10Dh	EECON2	18Dh
TMR1L	0Eh	PCON	8Eh	EEDATH	10Eh	Reserved(2)	18Eh
TMR1H	0Fh		8Fh	EEADRH	10Fh	Reserved(2)	18Fh
T1CON	10h		90h	General Purpose Register 16 Bytes	110h–11Fh	General Purpose Register 16 Bytes	190h–19Fh
TMR2	11h	SSPCON2	91h				
T2CON	12h	PR2	92h				
SSPBUF	13h	SSPADD	93h				
SSPCON	14h	SSPSTAT	94h				
CCPR1L	15h		95h				
CCPR1H	16h		96h				
CCP1CON	17h		97h				
RCSTA	18h	TXSTA	98h				
TXREG	19h	SPBRG	99h				
RCREG	1Ah		9Ah				
CCPR2L	1Bh		9Bh				
CCPR2H	1Ch		9Ch				
CCP2CON	1Dh		9Dh				
ADRESH	1Eh	ADRESL	9Eh				
ADCON0	1Fh	ADCON1	9Fh				
General Purpose Register 96 Bytes	20h–7Fh	General Purpose Register 80 Bytes	A0h–EFh	General Purpose Register 80 Bytes	120h–16Fh	General Purpose Register 80 Bytes	1A0h–1EFh
		accesses 70h-7Fh	F0h–FFh	accesses 70h-7Fh	170h–17Fh	accesses 70h - 7Fh	1F0h–1FFh

Unimplemented data memory locations, read as '0'.

* Not a physical register.

PCB DESIGN

DESIGN AND FABRICATION OF PRINTED CIRCUIT BOARDS

INTRODUCTION:

Printed circuit boards, or PCBs, form the core of electronic equipment domestic and industrial. Some of the areas where PCBs are intensively used are computers, process control, telecommunications and instrumentation.

MANUFACTURING:

The manufacturing process consists of two methods; print and etch, and print, plate and etch.The single sided PCBs are usually made using the print and etch method. The double sided plate through – hole (PTH) boards are made by the print plate and etch method.

The production of multi layer boards uses both the methods. The inner layers are printed and etch while the outer layers are produced by print, plate and etch after pressing the inner layers.

SOFTWARE:

The software used in our project to obtain the schematic layout is MICROSIM.

PANELISATION:

Here the schematic transformed in to the working positive/negative films. The circuit is repeated conveniently to accommodate economically as many circuits as possible in a panel, which can be operated in every sequence of subsequent steps in the PCB process. This is called penalization. For the PTH boards, the next operation is drilling.

DRILLING:

PCB drilling is a state of the art operation. Very small holes are drilled with high speed CNC drilling machines, giving a wall finish with less or no smear or epoxy, required for void free through hole plating.

PLATING:

The heart of the PCB manufacturing process. The holes drilled in the board are treated both mechanically and chemically before depositing the copper by the electro less copper platting process.

ETCHING:

Once a multiplayer board is drilled and electro less copper deposited, the image available in the form of a film is transferred on to the out side by photo printing using a dry film printing process. The boards are then electrolyticaly plated on to the circuit pattern with copper and tin. The tin-plated deposit serves an etch resist when copper in the unwanted area is removed by the conveyorised spray etching machines with chemical etchants. The etching machines are attached to an automatic dosing equipment, which analyses and controls etchants concentrations.

SOLDERMASK:

Since a PCB design may call for very close spacing between conductors, a solder mask has to be applied on the both sides of the circuitry to avoid the bridging of conductors. The solder mask ink is applied by screening. The ink is dried, exposed to UV, developed in a mild alkaline solution and finally cured by both UV and thermal energy.

HOT AIR LEVELLING:

After applying the solder mask, the circuit pads are soldered using the hot air leveling process. The bare bodies fluxed and dipped in to a molten solder bath. While removing the board from the solder bath, hot air is blown on both sides of the board through air knives in the machines, leaving the board soldered and leveled. This is one of the common finishes given to the boards. Thus the double sided plated through whole printed circuit board is manufactured and is now ready for the components to be soldered.

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