POWER LINE COMMUNICATION CONTROLLED AIRCRAFT TELEMETRY SYSTEM

A PROJECT REPORT

Submitted by

M.BASKAR (71201105009)
A.PRABAVATHY (71201105030)
P.RAJA (71201105038)
D.T. SHANTHINI (71201105054)

in partial fulfillment for the award of the degree

of

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in

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Under the guidance of
Mrs. Rani Thottungal

KUMARAGURU COLLEGE OF TECHNOLOGY,
COIMBATORE - 641006

ANNA UNIVERSITY :: CHENNAI - 600 025

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ANNA UNIVERSITY: CHENNAI-600 025

BONAFIDE CERTIFICATE

Certified that this project report titled " **POWER LINE COMMUNICATION CONTROLLED AIRCRAFT TELEMETRY SYSTEM** " is the bonafide work of

M. BASKAR	-	**Register No. 71201105009**
A. PRABAVATHY	-	**Register No. 71201105030**
P. RAJA	-	**Register No. 71201105038**
D.T. SHANTHINI	-	**Register No. 71201105054**

who carried out the project work under my supervision.

8/4/05

Signature of the Head of the Department

Prof.K.Regupathy subramanian,B.E.,M.Sc.
DEAN/EEE,
Kumaraguru college of technology

Signature of the guide

Mrs.Rani Thottungal,M.A,M.E
Senior Lecturer, EEE,
Kumaraguru college of technology

CERTIFICATE OF EVALUATION

College : **KUMARAGURU COLLEGE OF TECHNOLOGY**

Branch : **Electrical & Electronics Engineering**

Semester : **Eighth Semester**

Sl.No.	Name of the Students	Title of the Project	Name of the Supervisor with Designation
01	M. Baskar	**"Powerline Communication Controlled Aircraft Telemetry System"**	Mrs.Rani Thottungal,M.A,M.E. Senior Lecturer
02	A. Prabavathy		
03	P. Raja		
04	D.T. Shanthini		

The report of the project work submitted by the above students in partial fulfillment for the award of Bachelor of Engineering degree in Electrical & Electronics Engineering of Anna University were evaluated and confirmed to be report of the work done by the above students and then evaluated.

18/4/05

(INTERNAL EXAMINER) **(EXTERNAL EXAMINER)**

DEDICATED

TO OUR BELOVED

PARENTS

ACKNOWLEDGEMENT

The successful completion of our project can be attributed to the combined efforts made by us and the contribution made in one form or the other, by the individuals we hereby acknowledge.

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ABSTRACT

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Our project is power line carrier communication controlled aircraft telemetry system. PCATS is an Avionics based project, which is useful in Aircraft systems. There are numerous parameters to be monitored and controlled in aircraft. Presently there is individual controller for individual parameters. The objective of our project is to go in for a single control system for all measured parameters.

The objective of the project is to utilize the power lines for data transmission so as to reduce the additional cost required to lay the cables. There are sensors used for monitoring the temperature, pressure and altitude. The speed of motor is monitored as well as controlled.

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ADC – Analog to Digital Converter.

ASK – Amplitude Shift Keying

DAC – Digital To Analog Converter

FSK – Frequency Shift Keying

LCD – Liquid Crystal Display

LED – Light Emitting Diode

PIC – Peripheral Interface Controller

PLCC – Power Line Carrier Communication

PSK – Phase Shift Keying

CHAPTER 1

1.INTRODUCTION:

1.1 PROBLEM STATEMENT:

The aircraft equipped with basic automated flight control systems and displays, which forms flight management systems. In aircraft there are certain parameters that need to be monitored and kept under control at all times in order for ensure safe aviation. Presently there are individual controllers for individual parameters.

We decided to go for a controller for more than one parameter and we decided to go for the control system for all the measured parameters. The communication through wire systems involves the use of dedicated cables, which increases the cost involved. The concept of power line carrier communication enhances the mode of communication by having the power flow and the communication flow through the same network.

1.2 PRESENT SOLUTION:

Presently since there are individual controllers it occupies more space. In the aircraft the sensors are place at different location. The temperature sensor is placed at the tail of the aircraft. The pressure sensor is located at the bottom of the aircraft. We also control the speed of the DC motor. The DC motor is used in an aircraft for engine cooling purposes. Since the sensors are at different locations there have been dedicated cables connecting the sensors to the control panel, which is in the cockpit.

In our project we use the power supply lines to supply the power as well as carry the communication signals.

1.3 PRESENT MODES OF COMMUNICATION:

- Cable communication
- Fiber optic cable communication

- ❖ Microwave communication.

1.3.1 CABLE COMMUNICATION:

There are different types of cables used. Let us consider the coaxial cables. It has a single core, with an outer conductor, which acts as a shield. The signal is transmitted on the inner core. The inner core and the outer shield are separated by an insulator, either plastic or mica. The cable is enclosed in polyurethane to protect it and give it some strength.

DISADVANTAGES OF CABLE COMMUNICATION:

- ➢ The resistance of the cables is quiet large, which results in increased losses.
- ➢ The heating effects cause dielectric losses when a varying electric field passes through a dielectric (insulator).
- ➢ Radiation losses occur because the cable acts as an antenna.
- ➢ All these losses increase with frequency.

1.3.2 FIBER OPTIC COMMUNICATION:

This is cable made from fine strands of silica (glass), coated with a plastic sheath. The signals are converted to light pulses using a laser. Each fiber optic strand can support thousands of speech channels and multiple TV channels simultaneously. It is used mainly for long haul links and intercontinental links.

DISADVANTAGES OF FIBER OPTIC COMMUNICATION:

- ➢ The primary disadvantages of optical fiber are the technical difficulties associated with reliable and cheap connections.
- ➢ The development of an optical circuit technology that can match the potential data-rates of the cables is difficult.

- The difficulty of connection and high-cost of associated circuitry result in optical fibers being used only in very high bit-rate communication.
- Good phase control of an optical signal is extremely difficult.

1.3.3 Microwave Communication:

Microwave communication does not use cable as a transmission medium rather it uses the air. Using very high frequency signals, microwave can support thousands of channels on the one circuit. Microwave is a radio system, which uses very high frequencies to send and receive data. Because of the high frequencies involved, stations are located about 30 kilometers apart and in line of sight (visible to each other).

Disadvantages:

- This can prove to be economical for providing many circuits over short distances.
- Its operation is, however, limited to line of sight distances unless repeaters are used.
- This increases the cost.
- Noise interference
- Becoming outdated

1.4 Advantages Of Power Line Carrier Communication:

- No separate wires are needed for communication purposes, as the power lines themselves carry power as well as communication signals. Hence the cost of constructing separate lines is saved.
- When compared with ordinary lines the power lines have appreciably higher mechanical strength. They would normally remain unaffected

under the conditions, which might seriously affect other communication lines.

- Power lines usually provide the shortest route.
- Power lines have large cross-sectional areas resulting in very low resistance per unit length. Consequently the carrier signals suffer much less attenuation than when they travel on other lines of equal lengths.
- Power lines are well insulated to provide only negligible leakage between conductors and ground even in adverse weather conditions.
- Large spacing between conductors reduces capacitance, which results in smaller attenuation at high frequencies.

CHAPTER 2

2. POWER LINE CARRIER COMMUNICATION:

Power line carrier communications (PLCC) refers to the concept of transmitting information using the electrical power distribution network as a communication channel. This technology allows a flow of information through the same cabling that supplies electrical power. This novel idea of communication helps in bridging the gap existing between the electrical and communication network. PLCC integrates the transmission of communication signal and 50/60 Hz power signal through the same electric power cable. The major benefit is the union of two important applications on a single system. Since the existing power lines are used for signal transmission, the initial heavy cost and investment for setting up a data communications system is avoided.

2.1 HISTORY:

The idea of sending the communication signals on the same pair of wires that are used for power distribution is as old as the telegraph. In the 1920's at least two patents were issued to the American Telephone and Telegraph Company in the field of "carrier transmission over power line circuits". There were number of applications filed for patents regarding the power line carrier transmission in United States during 1924. The experts apprehended that what was required for power line communication to move into the main stream was a commercialized version of spread spectrum technology. This was needed in order to over come the harsh and erratic characteristics of power line environment. Commercial spread spectrum technology power line communication has become the focus of research of many companies during the early 1980's.

2.2 BLOCK DIAGRAM:

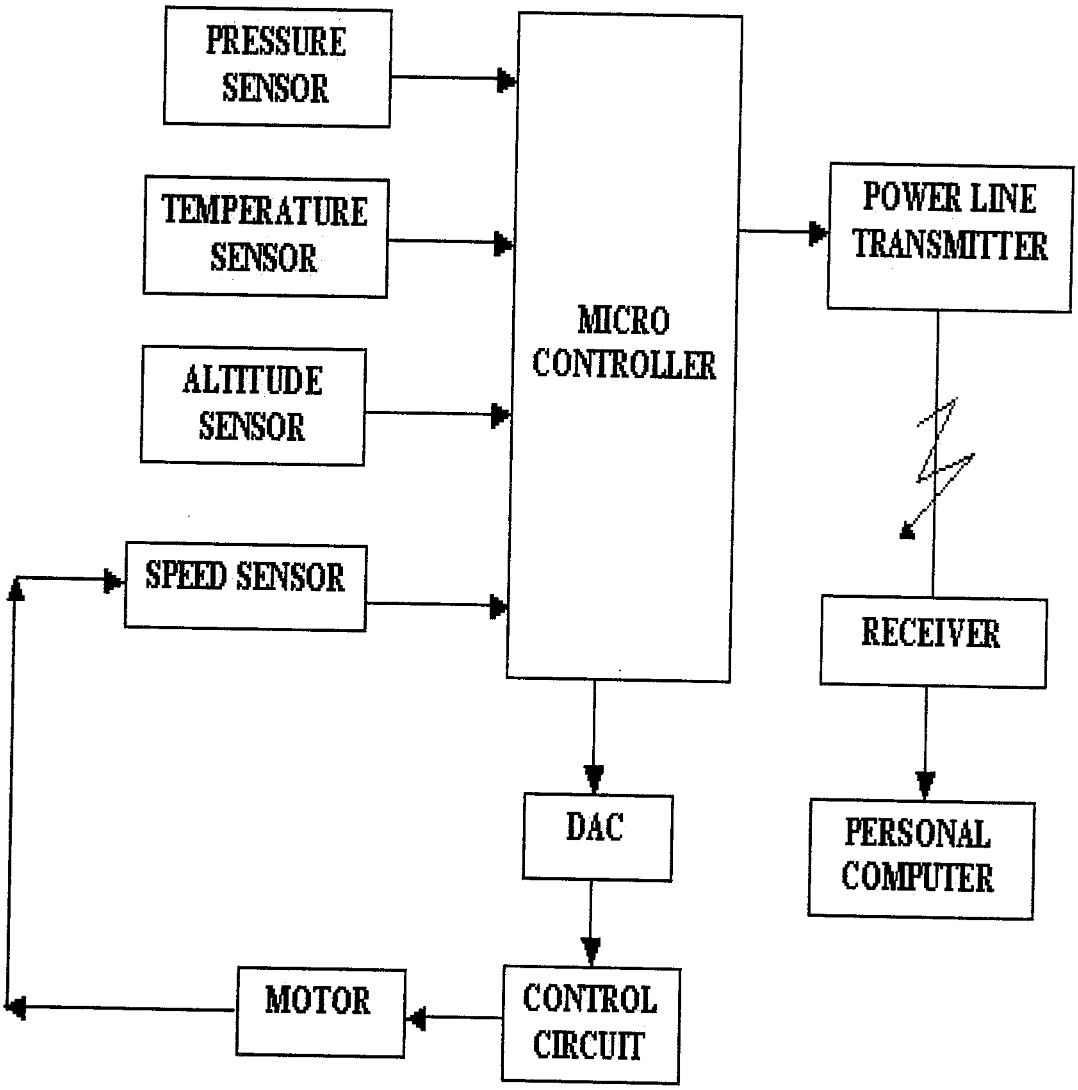


Figure 2.1

2.3 DESCRIPTION:

First parameter is temperature, the temperature is measured with the help of the thermistor; the Sensor is a resistance sensitive device, which will change the resistance of the sensor according to the temperature. The resistance change will be converted into voltage change with the help of a wheat stone bridge. Then the voltage output will be amplified with the help of a suitable amplifier up to the voltage level of 0 to 5 volts DC. Then the DC output will be fed to the analog to digital converter, and then it will give eight bit data to the PIC16F877.

Another parameter, which we are going to monitor, is pressure the differential Pressure .The Sensor used here for Differential Pressure transducer. The sensor that we are going to use is a semiconductor type and it will be suitable for measuring the differential pressure. That will produce a direct voltage output, and then it will be connected to the ADC. Thus the pressure and the temperature are monitored in the system. From the value of pressure we determine the altitude of the aircraft. The motor speed is sensed and the motor is made to run at desired speed by means of speed control circuit. All these data is fed to the PIC microcontroller and are modulated and fed to the power line. At the receiver side the signals are demodulated and monitored using a Personal Computers.

Hence the full status of the Aircraft is monitored & if at any hazardous time helps to secure passengers from any disasters.

2.4 TRANSMISSION SIDE CIRCUIT DIAGRAM:

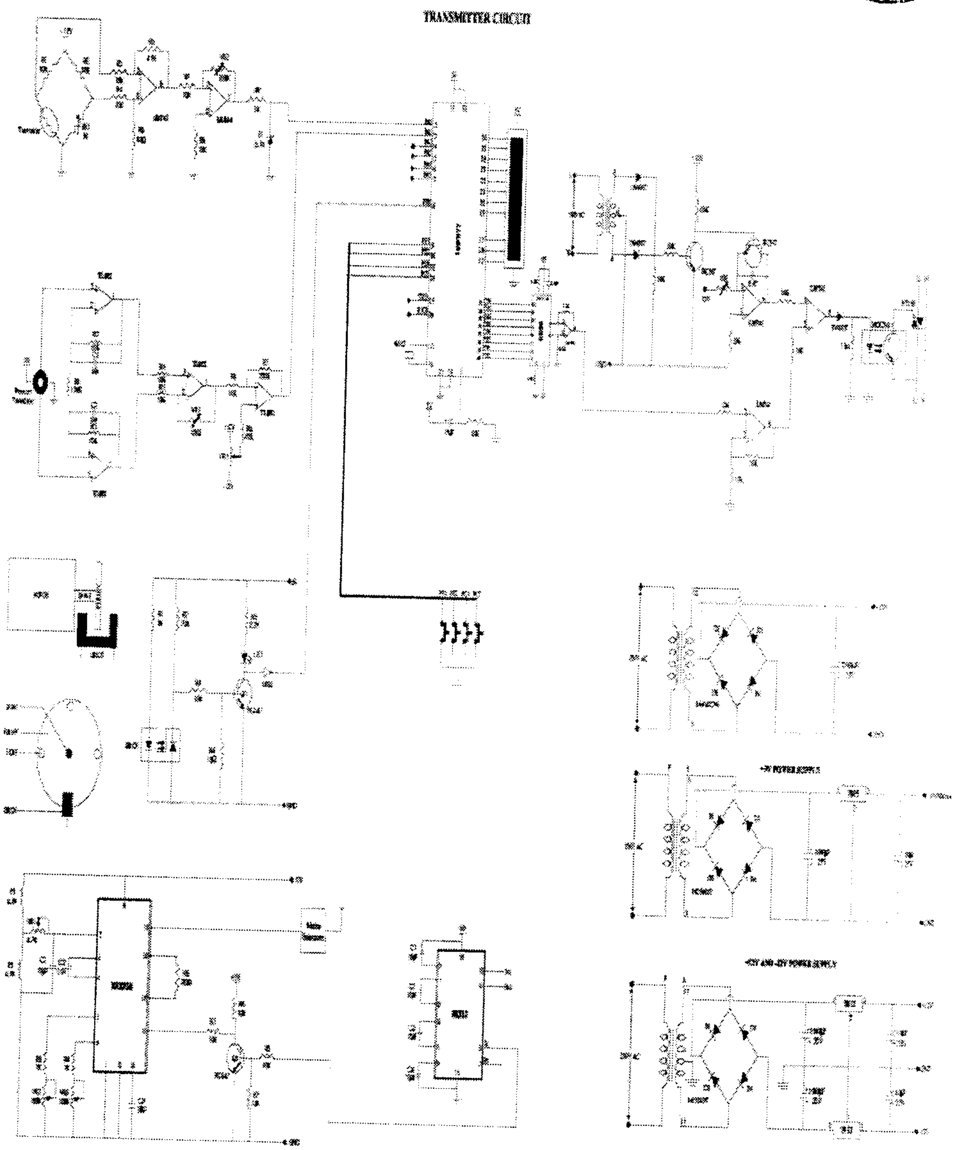


Figure 2.2

2.5 RECEIVER SIDE CIRCUIT DIAGRAM:

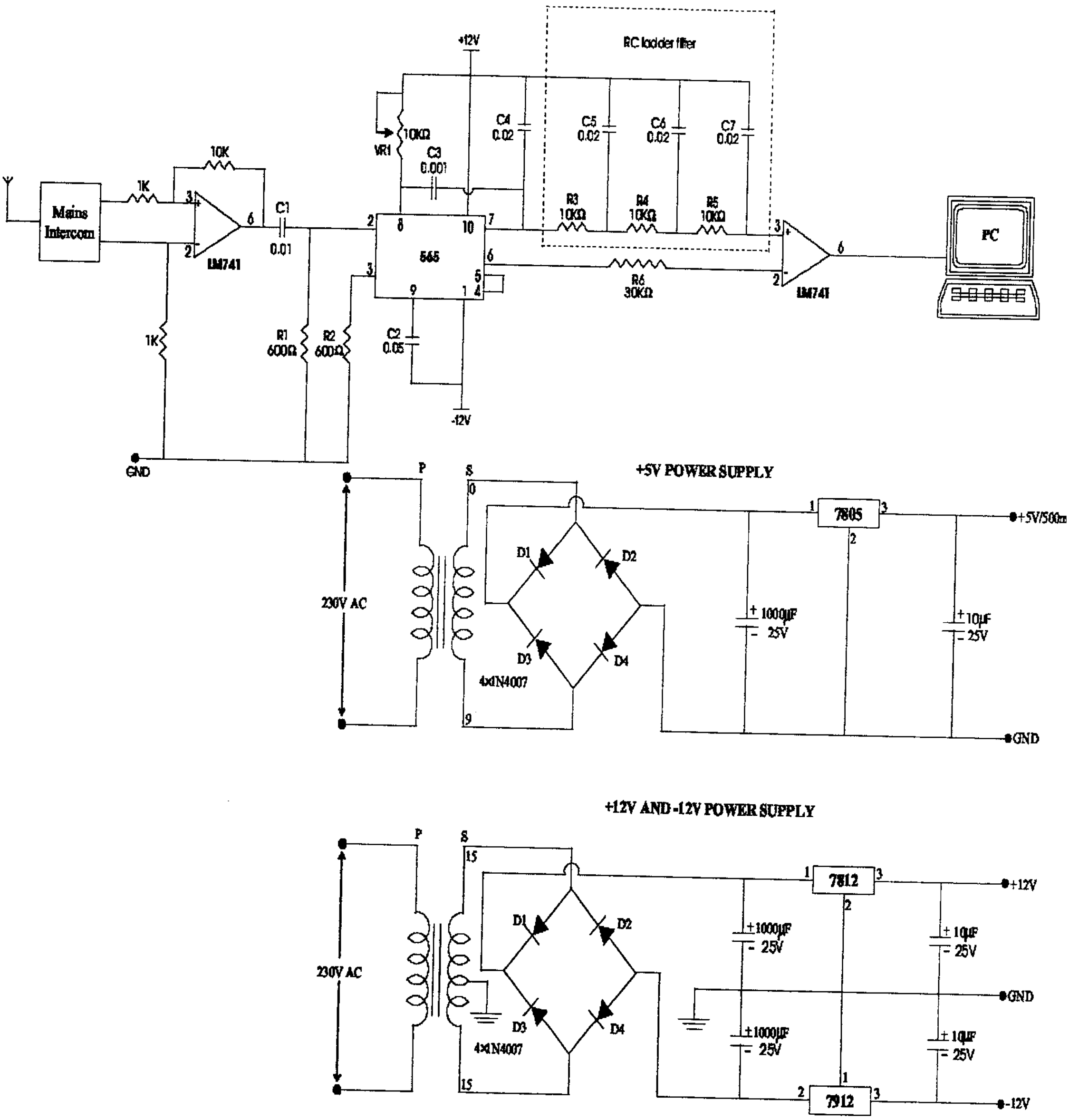


Figure 2.3

CHAPTER 3

3. PRESSURE SENSOR:

Pressure is an important parameter to be monitored in an aircraft. In an aircraft the tyre pressure, cabin pressure, pressure inside the de-icing systems, brake pressures etc have to be monitored. In our project we consider monitoring the cabin pressure. The pressure drops as the altitude increases. At higher altitudes the pressure is comparatively low. So the pressure inside the aircraft should be maintained at optimal level for safe aviation.

There are basically two different types of pressure sensors silicon pressure sensors and stainless steel pressure sensors. The silicon pressure sensors are ideal for low-cost commercial grade applications, such as printed circuit boards. Silicon-based versions in stainless steel and brass housing allow for use in harsh environmental conditions. Stainless steel pressure sensors are employed in environments like aerospace where they cannot be easily replaced. Among the stainless steel pressure sensors there are different types based on the working principle.

3.1 CAPACITANCE PRESSURE TRANSDUCERS:

Capacitance pressure transducers were originally developed for use in low vacuum research. This capacitance change results from the movement of a diaphragm element. The diaphragm is usually metal or metal-coated quartz and is exposed to the process pressure on one side and to the reference pressure on the other. Depending on the type of pressure, the capacitive transducer can be either an absolute, gauge, or differential pressure transducer.

Stainless steel is the most common diaphragm material used, but for corrosive service, high-nickel steel alloys, such as Inconel or Hastelloy, give better performance. Tantalum also is used for highly corrosive, high temperature applications. As a special case, silver diaphragms can be used to measure the pressure of chlorine, fluorine, and other halogens in their elemental state. In a capacitance-type pressure sensor, a high frequency, high-voltage oscillator is used to charge the sensing electrode elements. In a two-plate capacitor sensor design, the movement of the diaphragm between the plates is detected as an indication of the changes in process pressure.

DISADVANTAGES:

- Capacitance-type sensors are often used as secondary standards, especially in low-differential and low-absolute pressure applications.
- The distance the diaphragm must physically travel is only a few microns.
- Capacitance pressure transducers are less sensitive to stray capacitance and vibration effects.

3.2 POTENTIOMETRIC PRESSURE SENSOR:

The potentiometric pressure sensor provides a simple method for obtaining an electronic output from a mechanical pressure gauge. The device consists of a precision potentiometer, whose wiper arm is mechanically linked to a Bourdon or bellows element. The movement of the wiper arm across the potentiometer converts the mechanically detected sensor deflection into a resistance measurement, using a Wheatstone bridge circuit.

DISADVANTAGES:

- The mechanical nature of the linkages connecting the wiper arm to the Bourdon tube, bellows, or diaphragm element introduces unavoidable errors.

- Temperature effects cause additional errors because of the differences in thermal expansion coefficients of the metallic components of the system.
- Errors also will develop due to mechanical wear of the components and of the contacts.

3.3 Resonant-Wire Pressure Transducer:

The resonant-wire pressure transducer consists of a wire that is gripped by a static member at one end, and by the sensing diaphragm at the other. An oscillator circuit causes the wire to oscillate at its resonant frequency. A change in process pressure changes the wire tension, which in turn changes the resonant frequency of the wire. A digital counter circuit detects the shift. Because this change in frequency can be detected quite precisely, this type of transducer can be used for low differential pressure applications as well as to detect absolute and gauge pressures.

Disadvantages:

- Sensitivity to temperature variation
- Nonlinear output signal
- Sensitivity to shock and vibration.

3.4 Strain Gage Based Pressure Transducer:

In our project we are using strain gage based pressure transducer PX305. When a strain gage, is used to measure the deflection of an elastic diaphragm or Bourdon tube, it becomes a component in a pressure transducer. Strain-gage transducers are used for narrow-span pressure and for differential pressure measurements. Essentially, the strain gage is used to measure the displacement of an elastic diaphragm due to a difference in pressure across the diaphragm. These devices can detect gauge pressure if the low-pressure port is left open to the atmosphere.

The inside of a strain gage based pressure transducer is as given

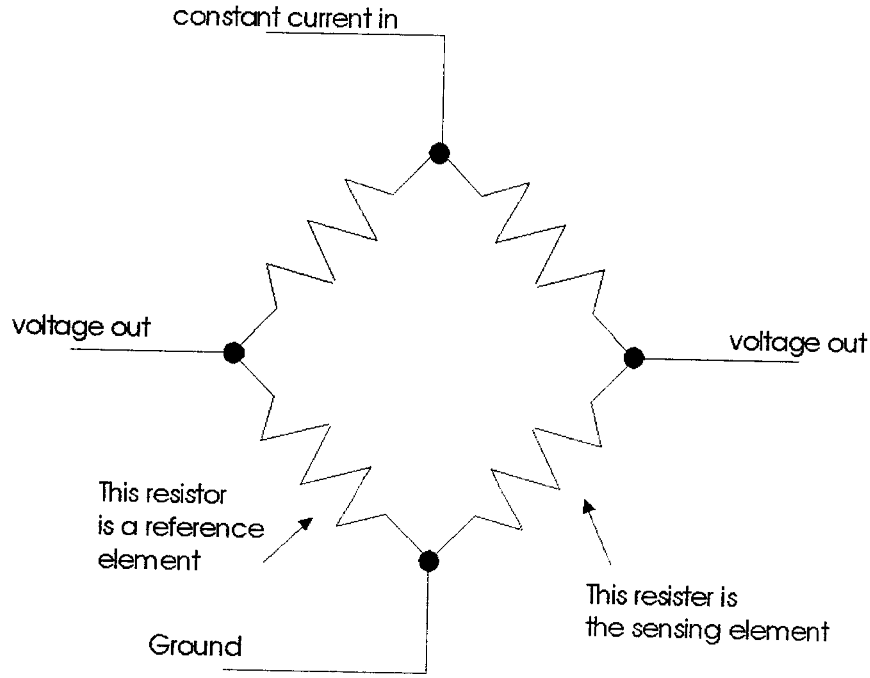


Figure 3.1

It consists of a round, tubular stainless steel body with a pipe fitting on one end and a cable coming out of the other end. Stainless is used because of its high strength and resistance to corrosion. At the pipe threaded end, the opening or port has a stainless steel diaphragm inside that protects the sensor element from the media being measured.

On the other side of the diaphragm there is a sensor element. The actual element is a strain gauge; that is, a resistive element whose resistance changes with the amount of strain placed on it. This variable resistor forms one leg of a bridge circuit. The other side of the strain element is the reference port that the measuring port is compared to. All transducers have two sides; sometimes the other side has its own pressure connection and the device is called a differential pressure transducer.

ADVANTAGES:

- Low drift.
- More accuracy.
- Not sensitive to temperature variations.
- Resistant to shock and vibrations.
- No mechanical losses.

3.5 PRESSURE CIRCUIT:

3.5.1 CIRCUIT DIAGRAM:

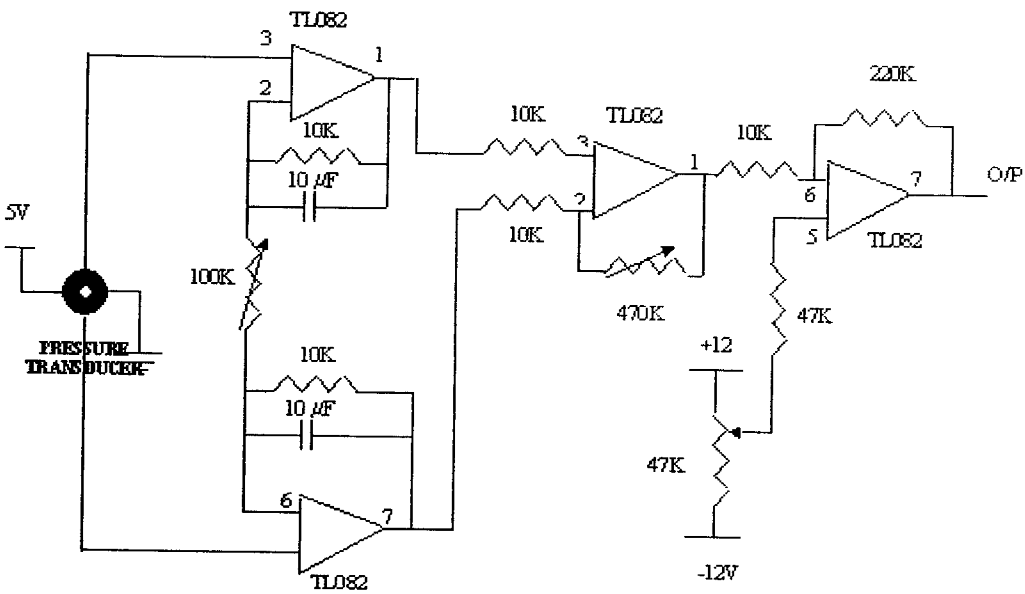


Figure 3.2

3.5.2 EXPLANATION:

The pressure circuit consists of a pressure transducer and instrumentation amplifier.

The transducer is a device that converts one form of energy into other where one of the forms of energy is electrical energy. A pressure transducer is a transducer that converts pressure into an analog electrical signal. The transducer consists of strain gages, which are bonded into the diaphragm of the pressure transducer and wired into a wheat stone bridge configuration. Pressure applied to the pressure transducer produces a deflection of the diaphragm, which introduces strain to the gages. The strain will produce an electrical resistance change proportional to the pressure.

3.5.3 INSTRUMENTATION AMPLIFIER:

The instrumentation amplifier is a dedicated differential amplifier with extremely high input impedance. A single internal or external resistor can precisely set its gain. The high common mode rejection makes this amplifier very useful in recovering small signals buried in large common mode offsets and noise. The instrumentation amplifier is a closed loop device with carefully set gain. The instrumentation amplifier basically consists of two stages. The first stage offers very high input impedance to both input signals and allows to set gain with a single resistor. The second stage is a differential amplifier with the output, negative feedback, and ground connections all brought out. In our project we use instrumentation amplifier with three-amplifier configuration. The circuit uses three operational amplifier hence is called as three-amplifier configuration. The circuit has an advantage of providing rejection against common mode signal. The voltage produced from the pressure transducer is thus amplified and fed to PIC circuit.

CHAPTER 4

4. TEMPERATURE SENSOR:

Temperature is an essential parameter in an aircraft. The temperature of engine fuel, the cabin temperature, temperature at brake pads, cylinder heads, the temperature at the inlet air ducts have to be measured and should be kept under control. In our project we monitor the cabin temperature.

There are different types of temperature sensors. Among these thermistor is used for low temperature measurements, thermocouple is used to measure high temperature and it has a low output signal, resistance transducers are linear than thermocouple but it has low sensitivity and IC sensor is the most linear measuring device.

4.1 RESISTIVE TRANSDUCERS:

The resistive transducers include strain gages and temperature sensors. The resistance of a conductor changes when its temperature is changed. This property is utilized for measurement of temperature.

DISADVANTAGES:

- For most operational ranges, the amount of resistance changes is very small (For 1degree change in temperature there is 0.385 percent change in the indicating meter which is hardly visible).
- Non-linear in operation.

4.2 THERMOCOUPLE:

When two metals having different work functions are placed together, a voltage is generated at the junction, which is generated at the junction, which is nearly proportional to the temperature. This junction is called a thermocouple. This principle is used to convert heat energy to electrical energy at the junction of two conductors. The heat at the junction is produced by the electrical current flowing in the heater element while the thermocouple produces an emf at its output terminals, which can be measured with the help of a PMMC instrument. The emf produced is proportional to the temperature and hence to the rms value of the current. Therefore the scale of PMMC instrument can be calibrated to read the current passing through the heater. The thermocouple type instruments can be used for both DC and AC applications.

DISADVANTAGES:

- Thermocouples have a low output signal.
- The resistance varies non-linearly with temperature.
- Also they need some form of reference compensation with regards to ice point.

4.3 THERMISTORS:

Thermistor is a contraction of a term "thermal resistors". Thermistors are generally composed of semi-conductor materials. Although positive temperature co-efficient of units (which exhibit an increase in the value of resistance with increase in temperature) are available, most thermistors have a negative coefficient of temperature resistance i.e. their resistance decreases with increase of temperature. The negative temperature coefficient of resistance can be as large as several percent per degree Celsius. This allows the thermistor circuits to detect very small changes in temperature. In some cases the resistance of thermistor at room temperature may decrease as much as 5 percent for each 10°C rise in temperature. This high sensitivity to temperature changes makes thermistors extremely useful for precision temperature measurements control and compensation.

Thermistors are composed of a sintered mixture of metallic oxides, such as manganese, nickel, cobalt, copper, iron, and uranium. Their resistances range from 0.5 Ω to 75 MΩ and they are available in a wide variety of shapes and sizes. Smallest in size are the beads with a diameter of 0.15 mm to 1.25 mm. Beads may be sealed in the tips of solid glass rods to form probes that are somewhat easier to mount than beads. Disks and washers are made by pressing thermistor material under high pressure into flat cylindrical shapes with diameters from 2.5 mm to 25 mm. Washers can be stacked and placed in series or in parallel for increased power dissipation.

4.3.1 CHARACTERISTICS OF THERMISTORS:

Three important characteristics of thermistors make them extremely useful in measurement and control applications:

- The resistance-temperature characteristics
- The voltage-current characteristic, and
- The current-time characteristic.

The voltage-current characteristic is such that the voltage drop across a thermistor increases with increasing current until it reaches a peak value beyond which the voltage drop decreases as the current increases. In this portion of the curve, the thermistor exhibits negative resistance characteristics. If a very small voltage is applied to the thermistor, the resulting small current does not produce sufficient heat to raise the temperature of the thermistor above ambient. Under this condition, ohm's law is followed and the current is proportional to the applied voltage. Larger currents, at larger applied voltages, produce enough heat to raise the thermistor above the ambient temperature and its resistance decreases further. The current continues to increase until the heat dissipation of the thermistor equals the power supplied to it. Therefore under any fixed ambient conditions, the resistance of a thermistor is largely a function of the power being dissipated within itself, provided that there is enough power available to raise its temperature above ambient. Under such operating conditions, the temperature of the thermistor may rise 100°C or 200°C, and its resistance may drop to one-thousandth of its value at low current.

4.3.2 ADVANTAGES:

- Thermistor control systems are inherently sensitive, stable, and fast acting, and they require relatively simple circuitry.
- This high sensitivity, together with the relatively high thermistor resistance that may be selected, makes the thermistor ideal for remote measurement or control.
- Changes in contact or transmission line resistance due to ambient temperature effects are negligible.

In our project we are using 44004 thermistor.

4.4 TEMPERATURE CIRCUIT:

4.4.1 EXPLANATION:

The temperature circuit consists of a bridge circuit. The bridge is balanced under normal conditions. One of the arms of the bridge circuit consists of the thermistor, which has negative temperature co-efficient of resistance. When the temperature changes there is an unbalance in the bridge and a voltage is generated across it. The difference in voltage across the bridge is compared, amplified and is fed to the PIC circuit.

4.4.2 CIRCUIT DIAGRAM:

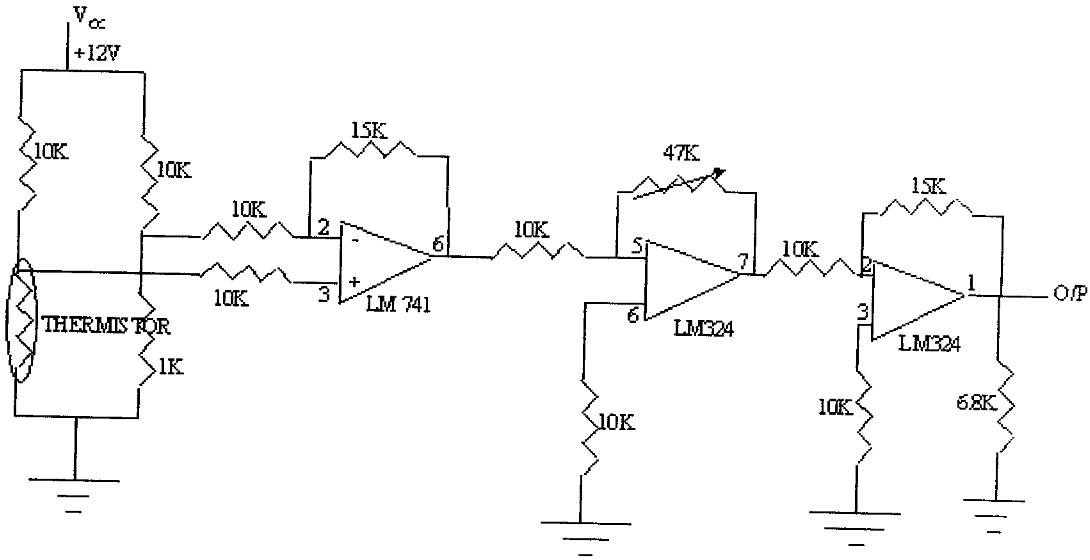


Figure 4.1

CHAPTER 5

5. ALTITUDE CALCULATION:

An aircraft configured for level flight will climb or descend only as the air through which it is flying rises or falls. The aircraft basically flies at constant altitude. The aircraft's motion is sensed and recorded. The altitude is calculated using the values of pressure, as the pressure is found to vary with altitude. Usually in an aircraft there will be two pressure-sensing devices one for calculating the pressure inside the aircraft and another outside. The pressure sensor that measures the atmospheric pressure is used in altitude calculation. The pressure sensor we use gives the value of pressure in Pounds per Square Inch (PSI).

The following table gives the altitude corresponding to the pressure.

ATMOSPHERIC PRESSURE AS A FUNCTION OF ALTITUDE	
ALTITUDE IN KILOMETERS, PRESSURE IN PSI	
ALTITUDE (KM)	**PRESSURE (PSI)**
0.0	1013.25
0.5	954.61
1.0	898.76
1.5	845.59
2.0	795.01
2.5	746.91
3.0	701.21
3.5	657.80
4.0	616.60
4.5	577.52

5.0	540.48
5.5	505.39
6.0	472.17
6.5	440.75
7.0	411.05
7.5	382.99
8.0	356.51
8.5	331.54
9.0	308.00
9.5	285.84
10.0	264.99
11.0	226.99
12.0	193.99

Table 5.1

In our project we use only one pressure transducer. These pressure details are entered in the program and the corresponding altitude is displayed.

CHAPTER 6

6. SPEED SENSING CIRCUIT:

In our project we control the speed of the DC motor. In aircraft the DC motor is used in the engine cooling fans. The engine temperature increases due to the combustion of fuels. The temperature has to be kept under control and therefore the speed control is essential. The speed of the DC motor is sensed using the u-slot circuit.

6.1 U-SLOT CIRCUIT:

6.1.1 CIRCUIT DIAGRAM:

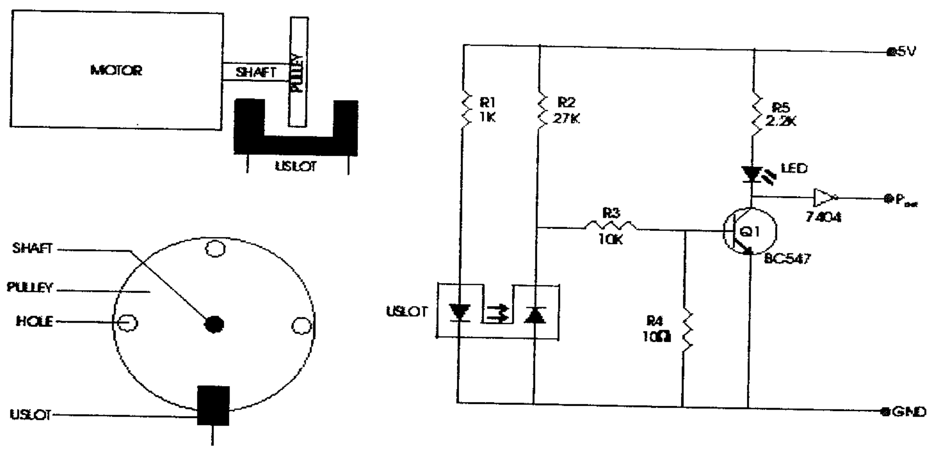


Figure 6.1

6.1.2 EXPLANATION:

The u-slot consists of a U shaped slot in which there is an infrared LED at one end and photodiode at other end. A thin disc that is coated alternately is attached to the shaft of the motor. As the disk rotates there are alternate dark and bright regions passing through the u-slot. The photodiode conducts when there is a bright region. Accordingly the transistor switches on and turns off producing 0 and 1 at the output. Thus we get pulses at the output and the frequency will depend on the speed of the rotation of the motor.

6.2 CONTROL CIRCUIT:

The speed control of the motor is achieved using TRIAC. The speed control circuit consists of the following components.

6.2.1 TRIAC:

Bilateral control may be achieved with one type of thyristor that is equivalent to two SCR'S in a single crystalline structure. It is known as triode ac semiconductor switch or TRIAC for short. It can support the flow of current in both directions. It is also regenerated and latches on once gated. Its connections are labeled main terminal 1 (MT1), main terminal (MT2) and gate (G). It is a symmetrical device. The forward and reverse turn on voltages can be greatly reduced with gate current. The TRIAC is not operated at break over.

The advantage of the triac is in AC voltage control. In normal operation, the circuit of a triac must be designed so that it only goes into conduction by action of the gate. The applied source voltage must therefore be of a value that is somewhat less than that normally needed to overcome the operating voltage. The characteristic therefore becomes a critical factor when selecting a triac to do a specific control function. Transient pulse or uncontrolled line voltage spikes must also be limited in order to avoid uncontrolled triggering of a triac.

The gate of a triac responds as a non-linear low-impedance junction similar to that of a forward biased diode. Triggering of the gate must therefore be achieved by some type of low-impedance source. The gate junction usually requires a considerable current to produce triggering.

6.2.2 OPTO ISOLATOR:

Opto isolators contain at least one emitter, which is, optically coupled to a photo detector through some sort of an insulating medium. This arrangement permits the passage of information from one circuit, which contains the emitter to the other circuits containing the detector. Because this information is passed optically across an insulating gap, the transfer is one way; that is the detector cannot affect the input circuit. This is important because a low voltage circuit utilizing logic gates may drive the emitter. While the output of the photo detector may be part of a high voltage DC or even an AC load current. The optical isolation prevents interaction or even damage to the input current to be caused by the relatively hostile output current. In the case of trigger type isolator efficiency is defined by the amount of emitter current required to trigger the output. This is known as "Forward trigger current or I".

Efficiency and isolation voltage are two of the most important operating parameters of the opto isolator.

There are several varieties of opto isolators. We are using transistor type opto coupler. In this opto isolator, LED is the light emitting device and transistor is the photo detector.

6.2.3 INTEGRATOR:

The circuit in which the output voltage waveform is the integral of the input voltage waveform is the integrator. In our project, integrator circuit is obtained using a basic inverting op-amp 741 configuration by replacing the feedback resistor Rf by a capacitor Cf of value 0.47 microfarad.

Then the output voltage will be

$$Vo = -1/R1C1\ Vi\ dt$$

The input voltage Vi given to the circuit through 22K resistor is –12V dc. The capacitor terminals are shunted with the transistors emitter and collector. The output of the integrator will be positive ramp signal.

6.2.4 AMPLIFIER:

In our circuit, the amplifier is used to amplify the output dc signal from DAC circuit of the micro controller unit. It is an op-amp 741 inverting amplifier.

The output of this amplifier is given to the comparator.

6.2.5 COMPARATOR:

A comparator is a circuit, which compares the signals applied at its inputs. In our circuit, op-amp 741 is used as comparator. The ramp signal of the integrator is given to the non-inverting terminal. The dc signal of the amplified form of output of DAC circuit is given to the inverting terminal. This circuit produces rectangular pulses as output.

6.3 SPEED CONTROL CIRCUIT:

6.3.1 EXPLANATION:

Motor speed control is achieved by varying the firing angle of TRIAC. This circuit is used for speed and on-off controlling. Single-phase 230V supply is transformed into 30V using center tapped transformer and it is given to full wave rectifier. The output of the rectifier is given to the base of the NPN transistor BC547. The collector is supplied +12V DC and the emitter is grounded. When the input to the base becomes less than 0.7V, a positive 12V pulse appears at the output and it remains when the input goes greater than 0.7V pulse appears at the output and it remains when the input goes greater than 0.7V. So the output of the transistor comprises of +12V on-off pulses of equal time period. It is given to the base of another NPN transistor BC547. Its emitter and collector are connected across the capacitor of an op-amp integrator –12V DC. The output of the integrator is a saw tooth waveform and it is given to the comparator. A dc voltage from micro controller unit is given to the amplifier and the output of the amplifier is given to the comparator. The comparator compares these two signals and produces rectangular pulses, which is given to the opto coupler. When the rectangular pulses appear, the LED in the opto coupler glows and it triggers the diac in the opto coupler. The diac output is converted to the gate of the triac to control ac voltage given to the motor. When the input of opto coupler is zero volts, there is no ac voltage at the output.

6.3.2 CIRCUIT DIAGRAM:

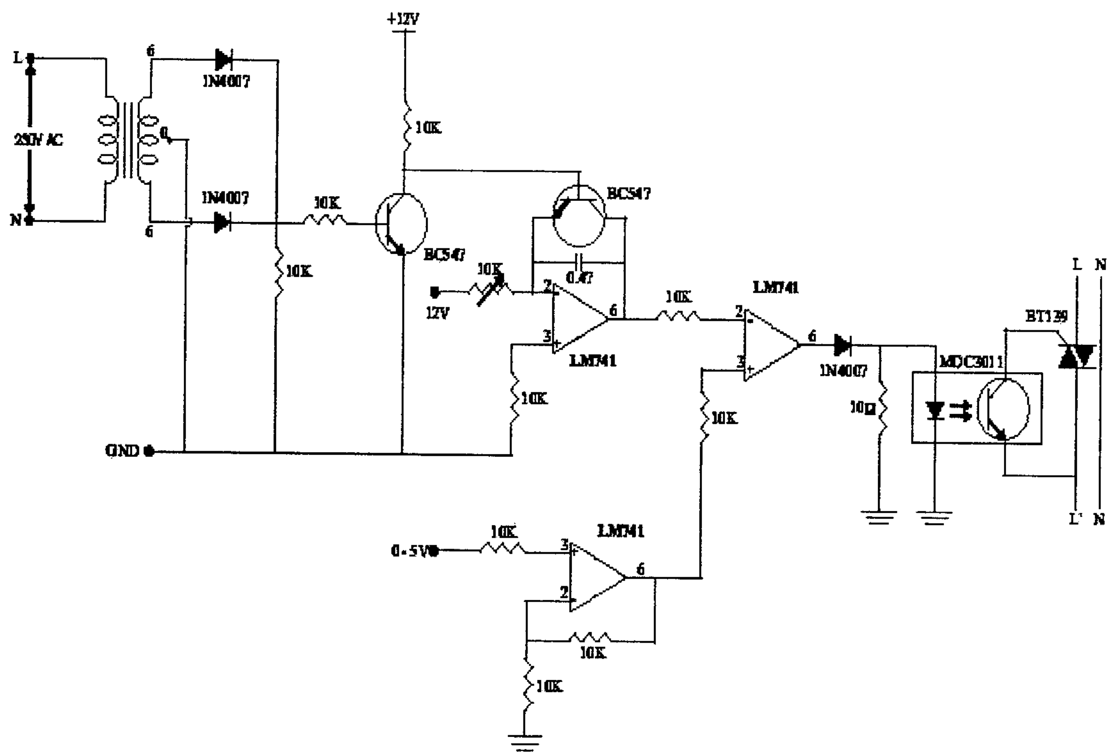


Figure 6.2

CHAPTER 7

7. MICRO CONTROLLER:

Microcontroller is a general-purpose device which has inbuilt CPU, memory and peripherals to make it as a mini computer. PIC stands for Peripheral Interface Controller. Microchip Technology Inc., USA, manufactures PIC. In our project we are using PIC 16F877.

16F877 is a high performance FLASH microcontroller that can be erased and reprogrammed without having to use a UV light source. This allows the same device to be used for prototype development as well as production. The 16F877 has 8k of code space, 368 bytes of RAM and 256 bytes of EEPROM. It has 5 analog input lines and 3 digital input lines. PIC works with 5V power supply. It has an inbuilt ADC. The output of the PIC is fed to the modulation circuit through RS232 serial interfacing.

7.1 CORE FEATURES:

- High-performance RISC CPU.
- Only 35 single word instructions to learn.
- All single cycle instructions except for program branches, which are two cycles.
- 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 PIC16C73B/74B/76/77.
- Interrupt capability (up to 14 sources).
- 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 FLASH/EEPROM technology.
- Fully static design.
- In-Circuit Serial Programming (ICSP) via two pins.
- Single 5V In-Circuit Serial Programming capability.
- In-Circuit Debugging via two pins.
- Processor read/write access to program memory.
- Wide operating voltage range: 2.0V to 5.5V.
- High Sink/Source Current: 25 mA.
- Commercial and Industrial temperature ranges.
- Low-power consumption:
  - < 2 mA typical @ 5V, 4 MHz
  - 20 mA typical @ 3V, 32 kHz
  - < 1 mA typical standby current.

7.2 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).
- Universal Synchronous Asynchronous Receiver Transmitter (USART/SCI) with 9-bit address detection.
- Parallel Slave Port (PSP) 8-bits wide, with external RD, WR and CS controls (40/44-pin only).
- Brown-out detection circuitry for Brown-out Reset (BOR).

7.3 PORTS:

PIC 16F877 has 5 ports.

PORT A is bi-directional input output port. It contains pins 2,3,4,5,6,7.

PORT B is a bi-directional input output port. PORT B can be software programmed for internal weak pull up on all inputs. It has pins 33,34,35,36,37,38,39,40.

PORT C is a bi-directional input output port. It has pins 15,16,17,18,23,24,25,26.

PORT D is a bi-directional input output port or parallel slave port when interfacing to a microprocessor bus. It has pins 19,20,21,22,27,28,29,30.

PORT E is a bi-directional input output port. It has pins 8,9,10.

7.4 PIC CIRCUIT:

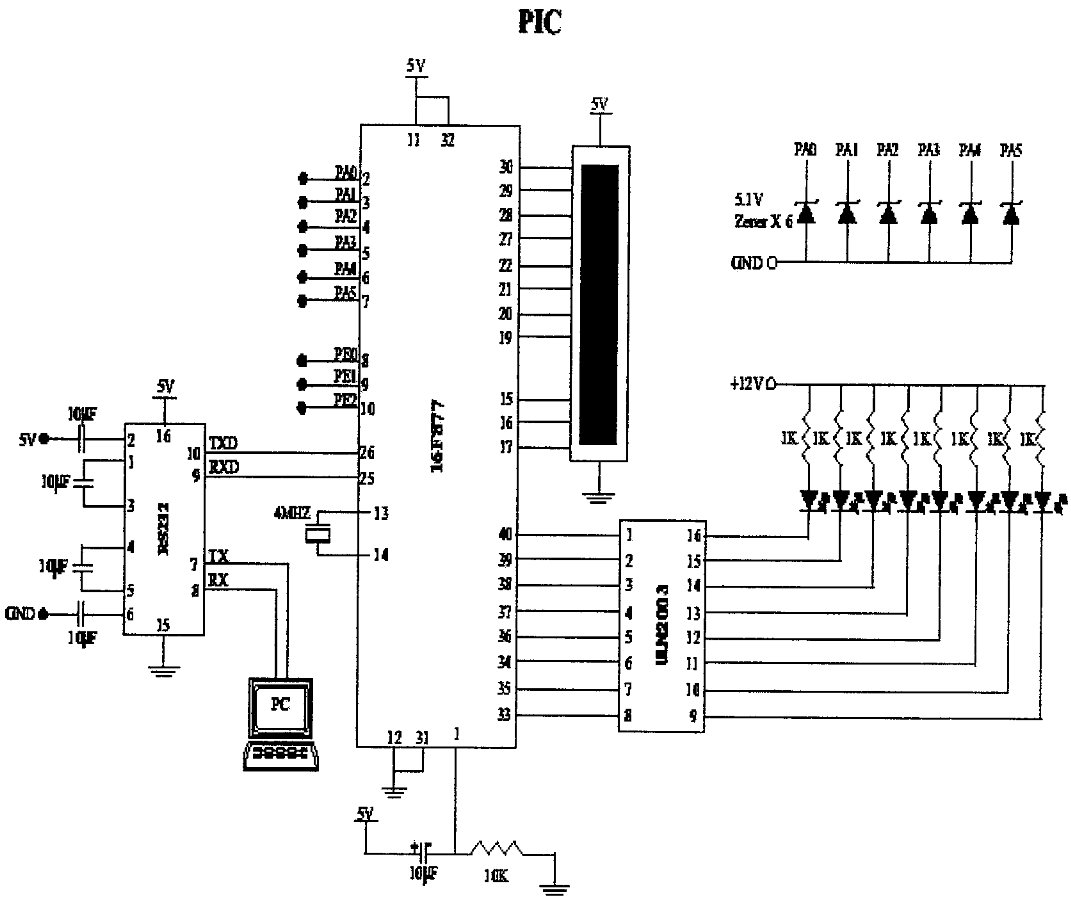


Figure 7.1

7.5 LCD DISPLAY:

The readings are obtained and shown on an LCD display. An LCD consists of two glass panels, with the liquid crystal material sandwiched between them. The inner surfaces of the glass plates are coated with transparent electrodes that define the character, symbols or patterns to be displayed. Polymeric layers are present in between the electrodes and the liquid crystal, which makes the liquid crystal molecules to maintain a defined orientation angle.

Polarizers are pasted outside the two glass panels. These polarizers would rotate the light rays passing through them to a definite angle, in a particular direction. When the LCD is in the off state, light rays are rotated by the two polarizers and the liquid crystal, such that the light rays come out of the LCD without any orientation, and hence the LCD without any orientation, and hence the LCD appears transparent.

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

CHAPTER 8

8. POWER SUPPLY UNIT:

The project consists of two modules the transmission module and the receiver module. The transmission module requires two power supplies +5V and 12V power supplies.

In an aircraft the power is generated using generators that are present in the wings. The generation is usually in the form of 115V single phase or 200V three-phase supply. In our project we use 230V single-phase supply for construction of power supply units.

The power supply unit consists of transformers, rectifiers, filters, and regulators. The input A.C supply voltage, typically 230V Rms is stepped down by means of step-down transformer to get 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. The 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 if the DC voltage varies, or when the load connected to the output DC voltage changes.

8.1 BASIC BLOCK DIAGRAM:

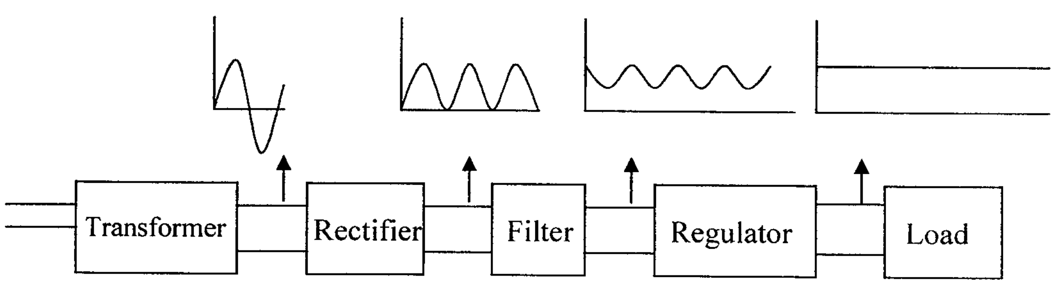


Figure 8.1

8.2 CIRCUIT DIAGRAM:

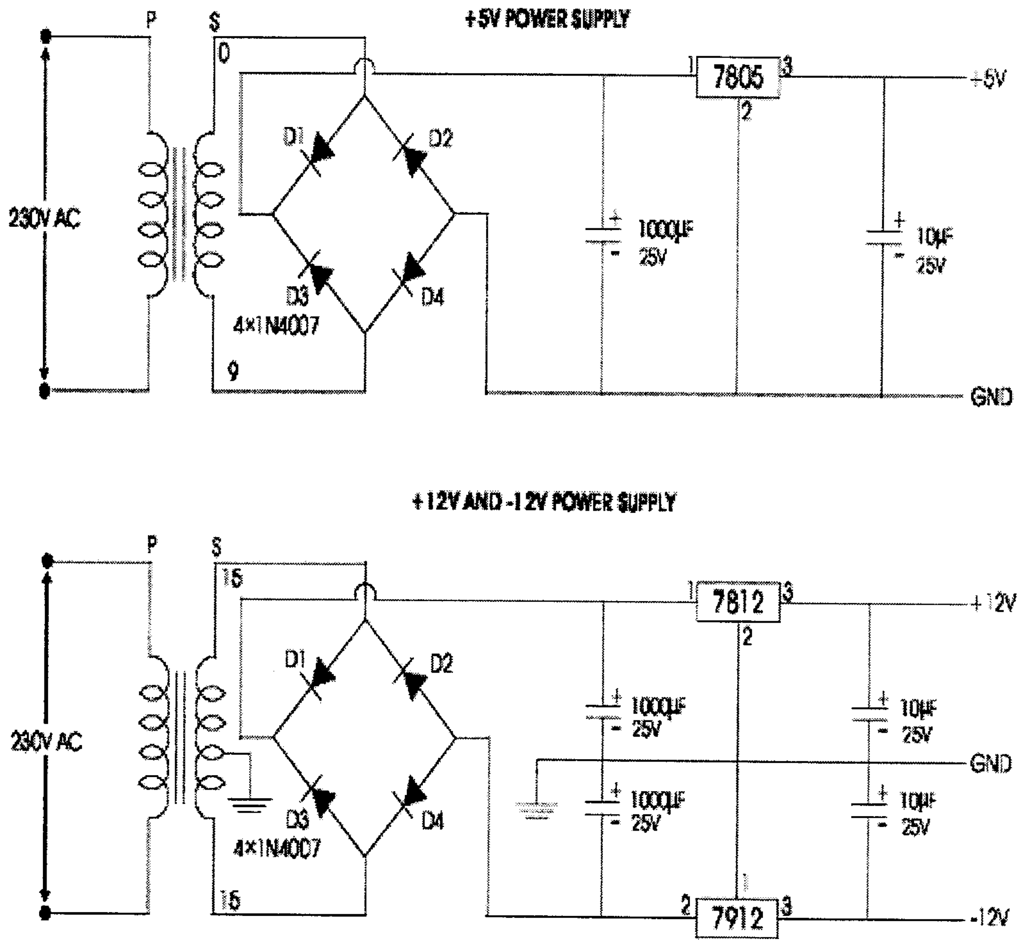


Figure 8.2

8.2.1 RECTIFIER:

The DC level obtained from a sinusoidal input can be improved 100% using a process called full-wave rectification. It uses 4 diodes in a bridge configuration. From the basis bridge configuration we see that two diodes (say D2 and D3) are conducting while the other two diodes (D1 and D4) are in "off" state during the period t=0 to T/2.

Accordingly for the negative half cycle of the input the conducting diodes are D1 and D4. Thus the polarity of the load is same.

8.2.2 FILTER:

The filter circuit used here is the capacitor filter circuit where a capacitor is connected at the rectifier output, and a DC is obtained across it. The filtered waveform is essentially a DC voltage with negligible ripples, which is fed to the load.

8.2.3 REGULATORS:

The voltage regulator is a device, which maintains constant output voltage irrespective of the change in supply variations, load variations and temperature changes. The fixed voltage regulator is a three terminal device, which has an unregulated dc input voltage, V_0, from a second terminal, with the third terminal connected to ground. For a selected regulator, IC device specification list a voltage range over which the input voltage can vary to maintain a regulated output voltage over a range of load current. The specifications also list the amount of output voltage change resulting from a change in load current or in input voltage.

CHAPTER 9

9. DAC CIRCUIT:

The DAC 0800 series are monolithic 80bit high –speed current output digital to analog converter (DAC) featuring typical setting time of 100ns. When used as a multiplying DAC, monotonic performance over 40 to 1 reference current range is possible. The DAC 0800 series also features high compliance complementary current outputs to allow differential output voltages of 20V peak to peak with simple resistor loads as shown. The reference to full scale current matching of better ±1LSB eliminates the need for full scale trims in most applications while the nonlinear ties of better than ±0.1% over temperature minimizes system error accumulations.

The noise immune inputs of the DAC0800 series will accept TTL levels with the logic threshold pin, Vlc pin 1 grounded. Simple adjustments of the Vlc potential allow direct interface to all logic families. The performance and characteristics of the device are essentially unchanged over the full ±4.5V to ±18V power supply range; power dissipation is only 33mW with ±5V supplies and is independent of the logic input states.

9.1 FEATURES:

- Fast setting output current
- Full scale error
- Non linearity over temperature
- Full scale current drift ±10ppm/°C
- High output compliance ±10V to +18V
- Complementary current outputs
- Interface directly with TL, CMOS, PMOS, and others
- 2 quadrant wide range multiplying capability

➢ Wide power supply range ±4.5V to ±18V

➢ Low power consumption 33mW to ±5V

➢ Low cost

In our project DAC is used to convert the digital output from the PIC circuit to analog signal so that it could be used to control the speed of the DC motor.

9.2 CIRCUIT DIAGRAM:

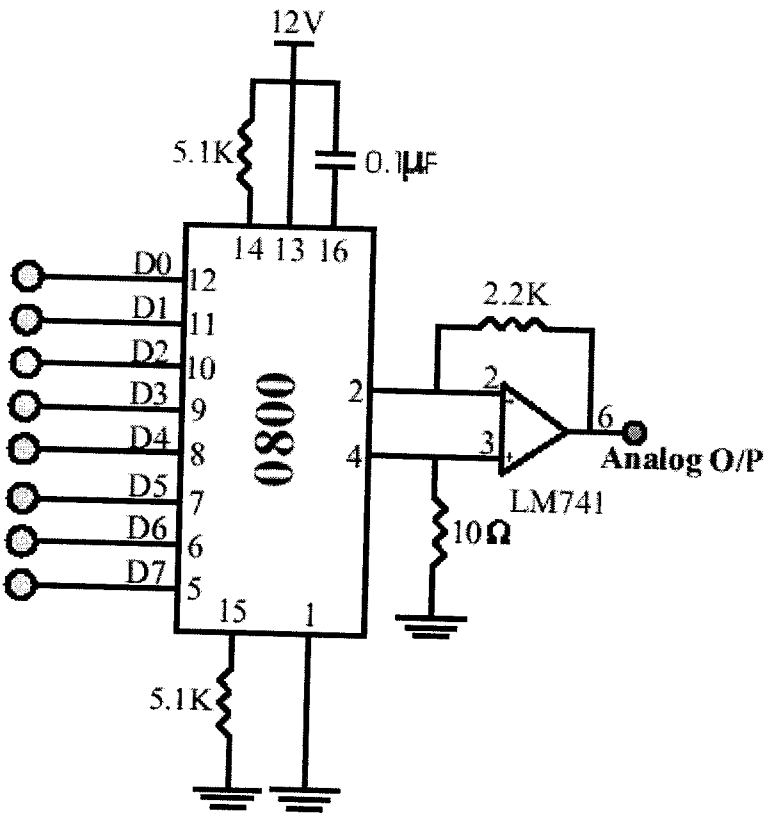


Figure 9.1

9.3 WORKING:

The DAC consists of the following major components:

- **Switches:** There are n switches, one for each bit.
- **Resistances:** The resistive network consists of n resistors. One resistor is connected in the input circuit of each bit. The resistances are weighted i.e., if the resistance in the circuit for MSB is R , the resistance in the circuit for next significant bit is 2R and so on.
- **Reference source:** The voltage of the reference source is stable.

According to the input bits the switches are connected to the reference voltage or to the ground. Now the total resistance is calculated and accordingly the output voltage of the comparator varies. Thus for the given digital input we get an analog output of 0-5V.

In practical D/A circuits the resistive network called DAC, is connected to a flip-flop register, which holds the digital number. As the divider is simply a passive network, the digital input voltage determines the output voltage. Because digital voltage levels are not usually precise as required in an analog system, level amplifiers may be placed between the flip-flop register and the divider network. These amplifiers switch the input to the divider network between ground and reference voltage supplied by a precision reference source.

CHAPTER 10

10. MODULATION CIRCUIT:

Modulation is the process of facilitating the transfer of information over a medium. Voice cannot be sent far without screaming. Thus to extend the range of the information we are trying to transfer we have to transmit it through a medium. The process of converting the information so that it can be successfully sent through a medium is called modulation.

There are different types of modulation schemes.

ASK (AMPLITUDE SHIFT KEYING) is the simplest scheme but is very rarely used, because of its relatively poor noise performance. The amplitude variations in an ASK signal becomes a source of difficulty. Such signals when amplified by nonlinear amplifiers generate spurious out-of-band spectral components, which are filtered out only with difficulty.

The phase shift keying techniques, BPSK (BINARY PHASE SHIFT KEYING) and QPSK (QUADRATURE PHASE SHIFT KEYING) generate discontinuities in the carrier phase, which are a further source of difficulty. When it is necessary to avoid such amplitude and phase discontinuities, frequency modulation is the feasible solution.

10.1 FSK MODULATION:

Frequency Shift Keying is a 'non return to zero' modulation method. This means that the non-modulated condition is between the "off" and "on" condition. In other words, the carrier should never be at the center frequency when modulation is present. The benefit here is noise immunity. Since FSK relies on frequency change, and not amplitude change, to indicate data states, an FSK receiver is inherently immune to amplitude noise. This increased noise immunity suggests a potential for higher data rates.

The Frequency Shift Keying waveform has constant amplitude and no matter how discontinuous the modulating waveform maybe, its phase is continuous. Phase delay in the power line carrier channel is expected and is also unpredictable. The reliable performance of FSK with any reasonable amount of phase delay makes it the modulation scheme of choice for power line communication techniques. So in our project we use the frequency shift keying modulation.

10.2 Circuit Diagram:

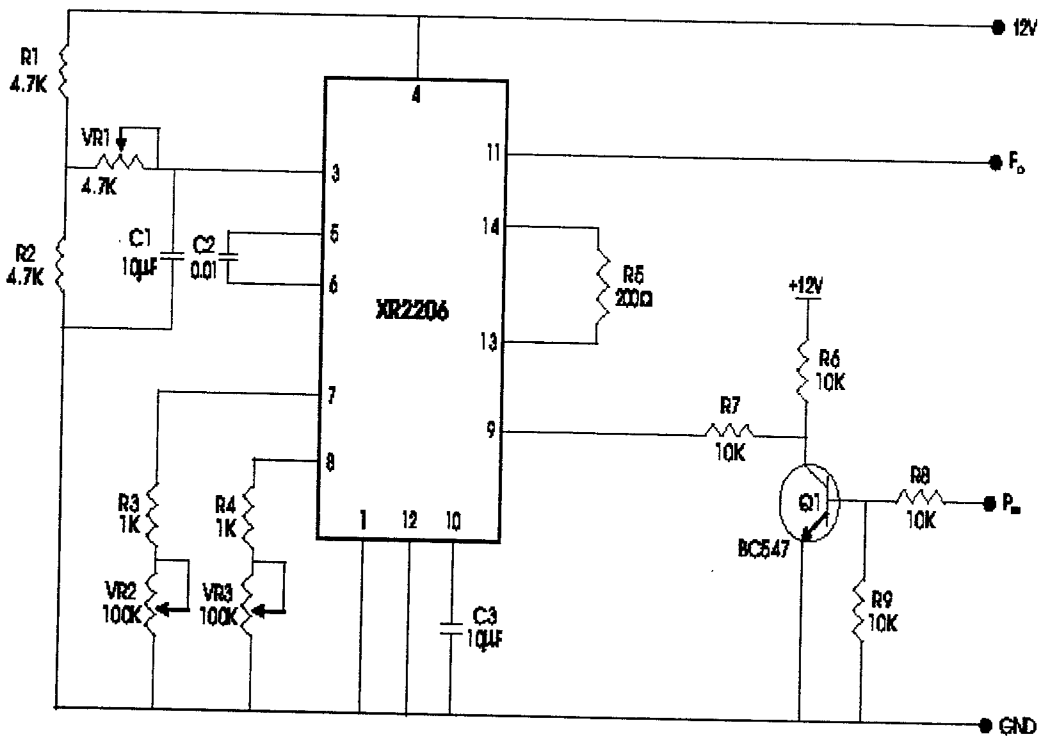


Figure 10.1

10.3 Explanation:

FSK modulation is performed by XR2206. The XR-2206 is a monolithic function generator integrated circuit capable of producing high quality sine, square, triangle, ramp, and pulse waveforms of high-stability and accuracy. The output waveforms can be both amplitude and frequency modulated by an external voltage. Frequency of operation can be selected externally over a range of 0.01Hz to more than 1MHz.

The XR-2206 is comprised of four functional blocks; a voltage-controlled oscillator (VCO), an analog multiplier and sine-shaper; a unity gain buffer amplifier; and a set of current switches. The VCO produces an output frequency proportional to an input current, which is set by a resistor from the timing terminals to ground. With two timing pins, two discrete output frequencies can be independently produced for FSK generation applications by using the FSK input control pin. This input controls the current switches, which select one of the timing resistor currents, and routes it to the VCO.

The XR-2206 can be operated with two separate timing resistors, R3 and R4, connected to the timing Pin 7 and 8, respectively. Depending on the polarity of the logic signal at Pin 9, either one or the other of these timing resistors is activated. If Pin 9 is open-circuited or connected to a bias voltage -2V, only R3 is activated. Similarly, if the voltage level at Pin 9 is 1V, only R4 is activated. Thus, the output frequency can be keyed between two levels. f1 and f2, as:

$$\mathbf{f_1 = 1/R_3C_2} \text{ and}$$

$$\mathbf{f_2 = 1/R_4C_2}$$

For split-supply operation, the keying voltage at Pin 9 is referenced to V-.

The frequency of oscillation, fo, is determined by the external timing capacitor, C2, across Pin 5 and 6, and by the timing resistor, R3 and R4, connected to either Pin 7 or 8. The frequency is given as:

$$f_1 = 1/R_3C_2 \text{ and}$$

$$f_2 = 1/R_4C_2$$

And can be adjusted by varying either R3 and R4 or C2. Temperature stability is optimum for 4k < R < 200k. Recommended values of C2 are from 1000pF to 100F. The output is taken across pin 11.

CHAPTER 11

11. RS232 INTERFACING:

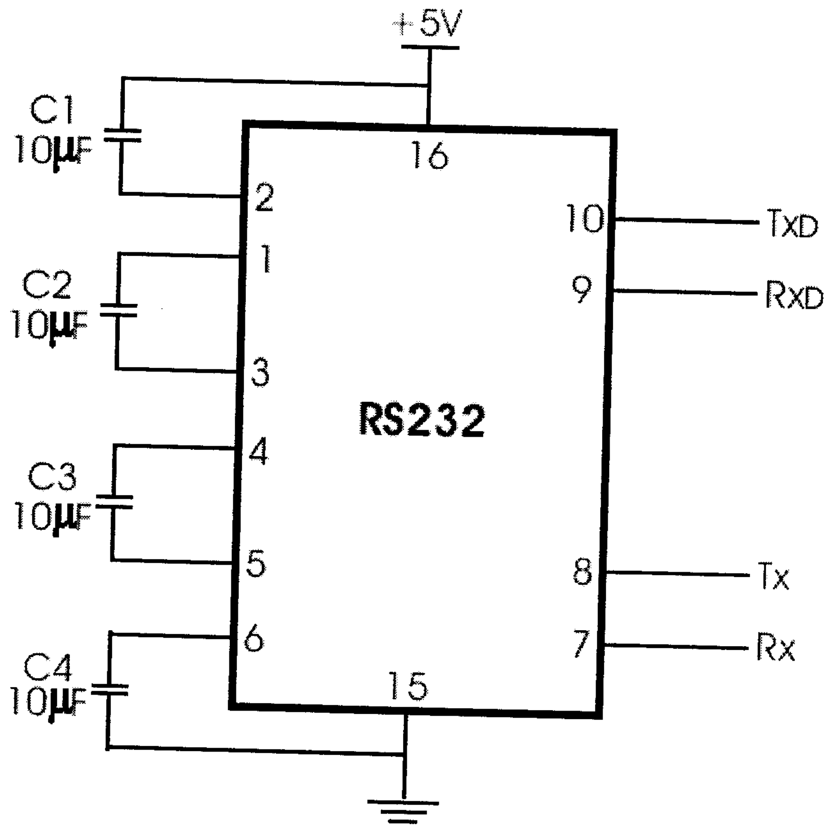


Figure 11.1

RS 232 is used for interfacing the PIC circuit with the FSK modulation circuit. The RS232 is used for serial data transmission.

The Serial Port is harder to interface than the Parallel Port. In most cases the serial transmission needs to be converted back to parallel so that it can be used. This can be done using a UART (*Universal Asynchronous Receiver / Transmitter*).

The advantages of using serial data transfer rather than parallel are:

- Serial Cables can be longer than Parallel cables. 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.

- The cable loss is not a problem for serial cables as they are for parallel.
- The number of wires needed is less. Therefore the cost is less.
- Micro controllers 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 Micro Processor Units.
- Only two pins are commonly used, Transmit Data (TXD) and Receive Data (RXD) compared with at least 8 pins as used in 8 bit parallel.

The DS14C232 is the commercial IC available for interfacing. The DS14C232 is a low power dual driver/receiver featuring an onboard DC-to-DC converter, eliminating the need for ±12V power supplies. The device only requires a +5V power supply. The device is ideal for battery and power conscious applications. The drivers' slew rate is set internally and the receivers feature internal noise filtering, eliminating the need for external slew rate and filter capacitors. The device is designed to interface data terminal equipment (DTE) with data circuit-terminating equipment (DCE). The driver inputs and receiver outputs are TTL and CMOS compatible. DS14C232C driver outputs and receiver inputs meet RS-232 standards.

CHAPTER 12

12. POWER LINE CARRIER COMMUNICATION CIRCUIT:

12.1 MAINS TRANSMITTER:

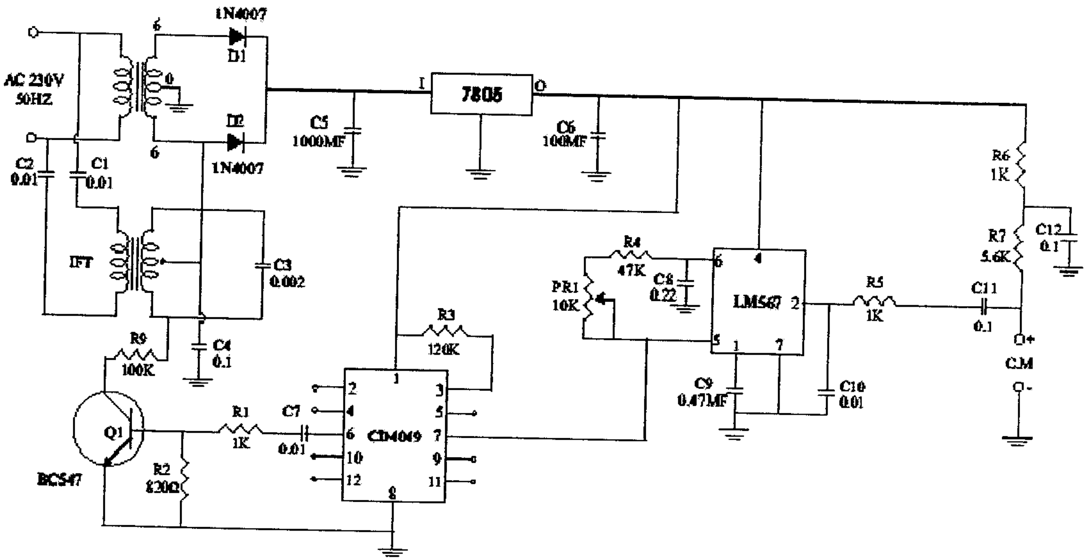


Figure 12.1

12.2 EXPLANATION:

The transmitter side consists of a transformer, rectifier, coupling network, current boosting driver circuit, frequency modulation and amplifier circuit.

The frequencies generated by the FSK modulation circuits are fed to the amplifier circuit. The signals are then frequency modulated to a frequency of around 3KHZ and is fed to the current booster circuit. The signals are then fed to switching transistor, which produces an output of 0 and 1 according to the signals. This produces oscillation in the inter frequency transformer which forms the coupling network.

The coupler employs an inductive coupling of the signal to the power line using differential mode coupling. A capacitor that has sufficient impedance to block the 50 Hz power frequencies is connected as shown in the circuit diagram. Resonance between the coupling capacitor and the inductance of the primary winding of toroid gives the suitable low characteristic impedance.

Thus the modulated signal is superimposed over the mains 50HZ signal.

CHAPTER 13

13. MAINS RECEIVER:

13.1 CIRCUIT DIAGRAM:

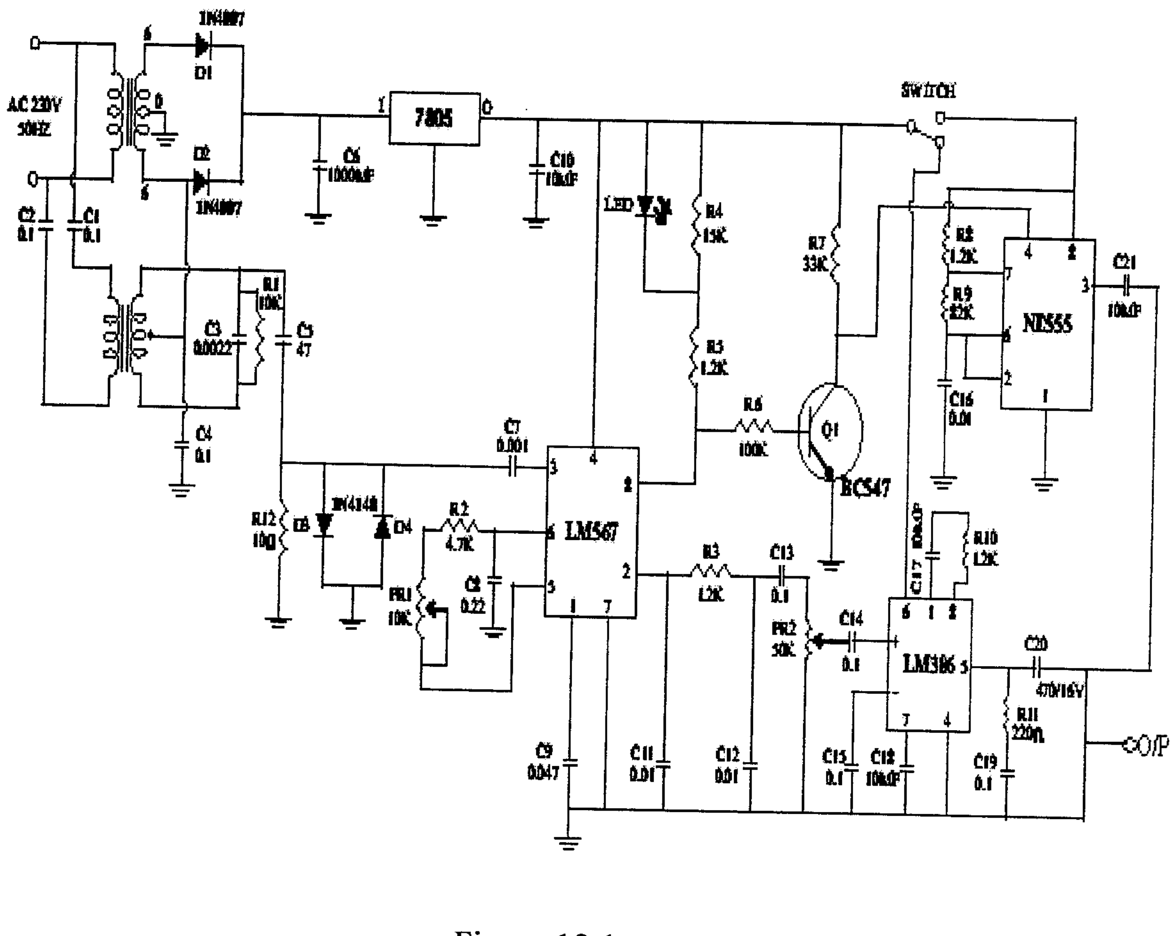


Figure 13.1

13.2 EXPLANATION:

The receiver side also contains the coupling network along with the inter frequency transformer. The capacitors are used to filter out the mains 50HZ, 230V signal. The capacitor C1 and the self-inductance, L1, of the transformer, T1, form a series resonance circuit, a high pass filter to effectively remove the 50 Hz signal and its harmonics, but also other spectral components with low frequencies. Capacitor C2 prevents the transformer from shorting out the DC offset of the transmitter and has not been mounted when the filter has been used as a receiver. The carrier signal is demodulated, amplified and fed to the audio amplifier circuit from which the output signals can be obtained.

CHAPTER 14

14. FSK DEMODULATION:

14.1 CIRCUIT DIAGRAM:

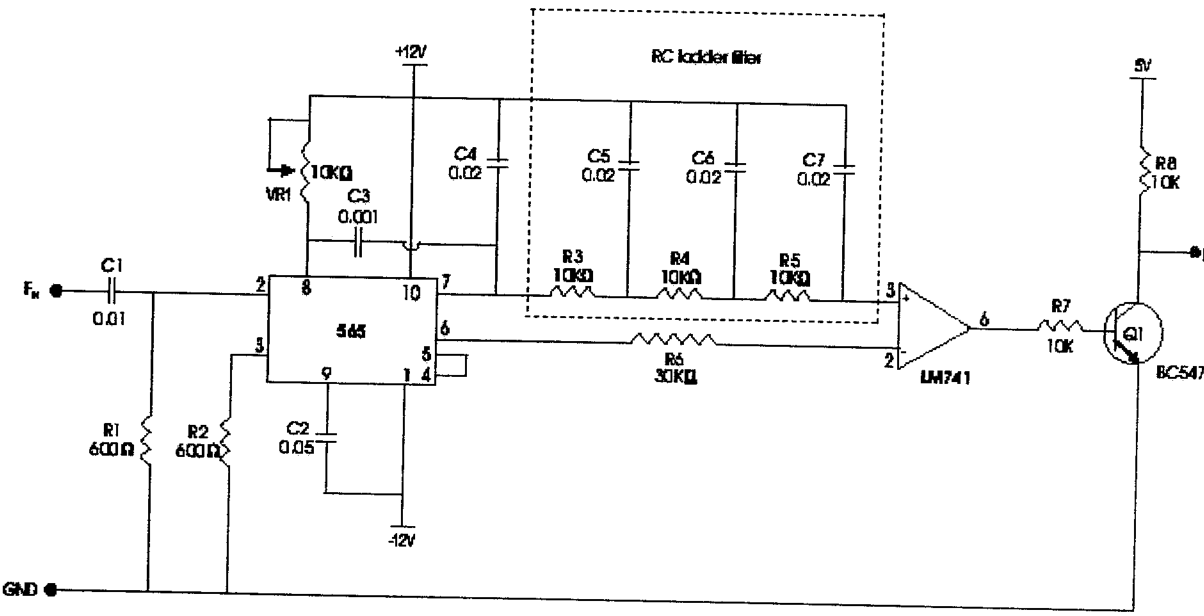


Figure 14.1

14.2 EXPLANATION:

The FSK demodulation is performed by the application of a Phase Locked Loop (PLL). A phase locked loop attempts to maintain a lock on its input frequency. When the input waveform changes frequencies, an error signal occurs at the phase locked loop, causing it to also change frequencies, attempting to match the input frequency. By carefully tuning the phase locked loop to the middle of the FSK mark and space frequencies, we can use its error signal for FSK demodulation. The design for the FSK demodulator used a LM565 phase locked loop.

The operation of this circuit can be explained as: As can be seen from the circuit diagram capacitive coupling is used at the input to remove any dc level. R1 and C1 determine the free running frequency of the VCO. A three stage RC ladder (low pass) filter is used to remove the carrier component from the output. The output signal is made logic compatible by connecting a voltage comparator between the output of the ladder filter and pin 6 of the PLL.

This output is fed to the personal computer by RS232 interface.

CHAPTER 15

15. FABRICATION AND TESTING:

15.1 FABRICATION:

The circuits were initially simulated and the outputs were verified. The PCB (printed circuit board) was then designed for each circuit and the fabrication was done. The electronic components were soldered into the PCB. The transformers, displays, switches etc were fixed to the main board along with the PCB. The connections were established as given in figure ii.

15.2 TESTING:

The testing of pressure circuit was carried out using a cathode ray oscilloscope. The input voltage is +5V and the output voltage varies between 0 to +5V depending on the pressure. The input voltage to the bridge in the temperature circuit is 12V DC. The output is analog voltage depending on the change in resistance of the thermistor. The testing is carried out using the CRO. The speed control circuit is also tested using the CRO.

In the FSK modulation circuit the actual frequency shifts could be observed only in terms of the capacitor voltage. Testing the FSK demodulation section involved passing an FSK input into the demodulator, and tuning the phase locked loop parameters until a stable binary output was obtained.

After successfully constructing and individually testing a PLCC-FSK communications system, we tested the total system performance at this level by using the input square wave (from a function generator). This square wave was modulated into an FSK waveform, passed through the coupling network onto the power line. On the other side the second coupler network passed the received signal through to the FSK demodulator, and this demodulator output was observed on an oscilloscope. Satisfactory results were obtained.

Now we passed the actual signals from the sensors and control circuits and they were effectively received and monitored at the receiver side.

CHAPTER 16

16. CONCLUSION:

Thus an alternate control system has been developed to replace all the individual control systems. This enhances the visibility and provides the flight crew with an accurate indication of an aircraft's height, pressure and temperature in the cabin and other details essential for flight safety. Since the communication is carried out through power line carrier communication the additional cost of laying cables is reduced.

Power line carrier communication technology is definitely an exciting alternative to the existing methods of communication used. The project work realized the concept of PLCC with the transmission of data from different locations. This technology promises to be a viable concept for domestic and industrial automation, multiple drive speed control etc.

In this section we would also like to discuss some major applications driving the Power Line Communication (PLCC) technology. They are:

- Automatic Meter Reading (AMR)
- Home Bus
- Distribution Automation, and Supervisory Control and Distribution Automation (DA and SCADA)
- Rural Communication Applications.

Also during the last years the use of Internet has increased. If it would be possible to supply such a kind of network communication over the power-line, it would bring this technology out of the embedded systems area right to the personal computer industry.

APPENDIX

APPENDIX A

SOFTWARE CODING:

```
#include<pic.h>
static bit  rs  @((unsigned) &PORTC*8+0);   // for control lines of LED display
static bit  rw  @((unsigned) &PORTC*8+1);
static bit  en  @((unsigned) &PORTC*8+2);

static bit  pulse @((unsigned) &PORTE*8+0);  // from uslot

static bit  key1 @((unsigned) &PORTE*8+1);  // for set point switches
static bit  key2 @((unsigned) &PORTE*8+2);
static bit  key3 @((unsigned) &PORTC*8+4);
static bit  key4 @((unsigned) &PORTC*8+5);

void lcd_init();
void command(unsigned char);
void lcd_disp(unsigned char);
void lcd_condis(const unsigned char*,unsigned int);
void hex_dec(unsigned char); //4bit data
void hex_dec_rpm(unsigned int);

void setpt_disp(unsigned char,unsigned char,unsigned char,unsigned char);

void ser_txn(unsigned char);
void ser_contxn(const unsigned char*,unsigned int);
```

```
void delay(unsigned int);
void eeprom_wr(unsigned char,unsigned char); //to write set point in
EEPROM
char eeprom_rd(unsigned char); //to read the already written set point

unsigned char d1,d2,d3,d4,a,reg,n,q;
unsigned char i,h,hr,t,o,c,tem1;
unsigned char err,sy,dac,l,b;
unsigned int s,rps,rpm,th,thr,sp,pre;
bit z,k,k1,k2,k3,k4,j,p;

void interrupt timer1(void)  // for setting interrupts (to count the no of
instructions // executed)
{
 if(TMR1IF==1)
 {
  b++;        //for every instruction b gets incremented
  if(b==4)     // for every 4 instructions b is reinitialised
  {
   b=0;
   j=1;
  }
 TMR1IF=0;
 }
}
```

```
main()
{
 ADCON1=0x02;
 dac=28;
 TRISD=0x00;
 TRISC=0xf0;
 TRISB=0x00;
 TRISE=0x07;
 reg=0xc0;

 lcd_init();
 lcd_condis("   AIRCRAFT    ",16);
 command(0xc0);
 lcd_condis("  MONITORING   ",16);
 delay(30000);
 command(0x01);

 GIE=1;
 PEIE=1;
 TMR1IE=1;
 d1=d2=d3=d4=0;
 while(1)
 {
  ADCON1=0x02;
  TRISE=0x07;
```

```
TRISC=0xf0;
if(key1==0 && k==0) k=1;
if(key1==1 && k==1)
{
 k=0;
 command(0x01);
 command(0x80);
 lcd_condis("  ENTER SPEED   ",16);
 command(0xc0);
 setpt_disp(d1,d2,d3,d4);
 while(1)
 {
  if(key1==0 && k1==0)   k1=1;
  if(key1==1 && k1==1)
  {
   k1=0;
   reg++;
   if(reg>=0xc4) reg=0xc0;
  }
  if(key2==0 && k2==0)  k2=1;
  if(key2==1 && k2==1)
  {
   k2=0;
   if(reg==0xc0) a=d1;
   if(reg==0xc1) a=d2;
   if(reg==0xc2) a=d3;
```

```
 if(reg==0xc3) a=d4;

 a++;

 if(a>=10) a=0;
 if(reg==0xc0) d1=a;
 if(reg==0xc1) d2=a;
 if(reg==0xc2) d3=a;
 if(reg==0xc3) d4=a;

 command(0x01);
 command(0xc0);
 setpt_disp(d1,d2,d3,d4);
}

if(key3==0 && k3==0)  k3=1;
if(key3==1 && k3==1)
{
 k3=0;
 if(reg==0xc0) a=d1;
 if(reg==0xc1) a=d2;
 if(reg==0xc2) a=d3;
 if(reg==0xc3) a=d4;

 a--;
```

```
    if(a==0xff)  a=9;
    if(a>=10) a=0;
    if(reg==0xc0) d1=a;
    if(reg==0xc1) d2=a;
    if(reg==0xc2) d3=a;
    if(reg==0xc3) d4=a;

    command(0x01);
    command(0xc0);
    setpt_disp(d1,d2,d3,d4);
   }
   if(key4==0 && k4==0)  k4=1;
   if(key4==1 && k4==1)
   {
    k4=0;
    setpt_disp(d1,d2,d3,d4);
    sp=(d1*1000+d2*100+d3*10+d4);
    eeprom_wr(0x00,d1);
    eeprom_wr(0x01,d2);
    eeprom_wr(0x02,d3);
    eeprom_wr(0x03,d4);
    command(0x01);
    break;
   }
  }
 }
```

```
/*EEADR=0x05;      //select memory location to store set point
EEPGD=0;          //access EEPROM data memory
RD=1;
sp=EEDATA;        //read the set point */

eeprom_rd(0x00);
d1=q;
eeprom_rd(0x01);
d2=q;
eeprom_rd(0x02);
d3=q;
eeprom_rd(0x03);
d4=q;
sp=(d1*1000+d2*100+d3*10+d4);
command(0x80);
lcd_condis("SP:",3);
hex_dec_rpm(sp);

TMR1ON=0;
TMR1L=0x00;
TMR1H=0x00;
j=rps=0;
TMR1ON=1;

while(!j)
```

```
{
 TRISE=0x07;
 if(pulse==0 && p==0) p=1;
 if(pulse==1 && p==1)
 {
  p=0;
  rps++;
 }
}

rpm=rps*2;
command(0x87);
lcd_condis(" RPM:",4);
hex_dec_rpm(rpm);

ser_contxn("SPEED:",6);
ser_txn(th+0x30);
ser_txn(h+0x30);
ser_txn(t+0x30);
ser_txn(o+0x30);
ser_contxn("RPM",3);
ser_contxn("         ",9);

if(rpm<sp)
{
 dac++;
```

```
  if(dac==255) dac=254;
  PORTB=dac;
 }

 if(rpm>sp)
 {
  dac--;
  if(dac<=29) dac=30;
  PORTB=dac;
 }

ADCON1=0x02; //TO SELECT 5 ANALOG & 3 DIGITAL PORTS
TRISA=0x1f;

ADCON0=0x00; // CONFIGURE OR CLEAR ADCON REG
ADON=1; // SWITCH on ADC
delay(50);
ADCON0=0x05; // Start conversion
while(ADCON0!=0x01); //Proceed till the conversion gets over
tem1=ADRESH; //Store in the reg

command(0xc0); //Send to LCD
lcd_condis("TEM:",4);
hex_dec(tem1);

ser_contxn("Temperature:",11);
```

```
ser_txn(h+0x30);
ser_txn(t+0x30);
ser_txn(o+0x30);
ser_contxn("         ",9);

ADON=0; //shut off ADC
ADCON0=0x08; //Select channel 1
ADON=1; // Switch on ADC
delay(50);
ADCON0=0x0d; //Start conversion
while(ADCON0!=0x09); //Check for end of conversion
pre=ADRESH; //Store in reg
pre=pre*4; //multiply pre by 4
command(0xc8); //Send to LCD second position
lcd_condis("PR:",3);
hex_dec_rpm(pre);

ser_contxn("Pressure:",9);
ser_txn(th+0x30);
ser_txn(h+0x30);
ser_txn(t+0x30);
ser_txn(o+0x30);
ser_contxn("         ",9);
// ALTITUDE CALCULATION
if(pre>=954 && pre<=1020)   ser_contxn("  ALTITUDE:0.5 Km ",18);
else if(pre>=898  && pre<954)   ser_contxn("  ALTITUDE:1.0 Km ",18);
```

```
else if(pre>=845  && pre<898)   ser_contxn("  ALTITUDE:1.5 Km ",18);
else if(pre>=795  && pre<845)   ser_contxn("  ALTITUDE:2.0 Km ",18);
else if(pre>=746  && pre<795)   ser_contxn("  ALTITUDE:2.5 Km ",18);
else if(pre>=701  && pre<746)   ser_contxn("  ALTITUDE:3.0 Km ",18);
else if(pre>=657  && pre<701)   ser_contxn("  ALTITUDE:2.5 Km ",18);
else if(pre>=616  && pre<657)   ser_contxn("  ALTITUDE:4.0 Km ",18);
else if(pre>=577  && pre<616)   ser_contxn("  ALTITUDE:4.5 Km ",18);
else if(pre>=540  && pre<577)   ser_contxn("  ALTITUDE:5.0 Km ",18);
else if(pre>=505  && pre<540)   ser_contxn("  ALTITUDE:5.5 Km ",18);
else if(pre>=472  && pre<505)   ser_contxn("  ALTITUDE:6.0 Km ",18);
else if(pre>=440  && pre<472)   ser_contxn("  ALTITUDE:6.5 Km ",18);
else if(pre>=411  && pre<440)   ser_contxn("  ALTITUDE:7.0 Km ",18);
else if(pre>=382  && pre<411)   ser_contxn("  ALTITUDE:7.5 Km ",18);
else if(pre>=356  && pre<382)   ser_contxn("  ALTITUDE:8.0 Km ",18);
else if(pre>=331  && pre<356)   ser_contxn("  ALTITUDE:8.5 Km ",18);
else if(pre>=308  && pre<331)   ser_contxn("  ALTITUDE:9.0 Km ",18);
else if(pre>=285  && pre<308)   ser_contxn("  ALTITUDE:9.5 Km ",18);
else if(pre>=264   && pre<285)      ser_contxn("   ALTITUDE:10.0  Km
",19);
else if(pre>=226   && pre<264)      ser_contxn("   ALTITUDE:11.0  Km
",19);
else if(pre>=193   && pre<226)      ser_contxn("   ALTITUDE:12.0  Km
",19);
else if(pre<193)    ser_contxn(" ALTITUDE IS >12.0 Km ",22);

}
```

```
}

void lcd_init()
{
 TRISC=0xf0;
 TRISD=0;

 command(0x38);//to select function set
 command(0x06);//entry mode set
 command(0x0c);//display on
 command(0x01);//clear display
 command(0x80);//select the display position
}

void command(unsigned char com)
{
  PORTD=com;
  en=1;
  rs=rw=0;
  delay(70);
  en=0;
  delay(70);
}

void lcd_disp(unsigned char lr)
{
```

```
 PORTD=lr;
 en=1;
 rs=1;
 rw=0;
 delay(70);
 en=0;
 delay(70);
}

void lcd_condis(const unsigned char *word,unsigned int n)
{
 for(i=0;i<n;i++)
 {
  lcd_disp(word[i]);
 }
}

void hex_dec(unsigned char val)
{
h=val/100;
hr=val%100;
t=hr/10;
o=hr%10;

lcd_disp(h+0x30);
lcd_disp(t+0x30);
```

```
 lcd_disp(o+0x30);
}

void hex_dec_rpm(unsigned int val)
{
 th=val/1000;
 thr=val%1000;
 h=thr/100;
 hr=thr%100;
 t=hr/10;
 o=hr%10;
 lcd_disp(th+0x30);
 lcd_disp(h+0x30);
 lcd_disp(t+0x30);
 lcd_disp(o+0x30);
}
void ser_txn(unsigned char te)
{
 SPBRG=141;        //for 110 baud rate for 1MHZ crystal
 BRGH=0;          //for low baud rate
 SYNC=0;          //asynchronous mode
 SPEN=1;          //Enable the serial port
 TX9=1;           //enable the ninth data bit
 TXEN=1;          //enable TXion
 TXREG=te;
 delay(2500);
```

```
  TXIF=0;
}

void ser_contxn(const unsigned char *dat,unsigned int m)
{
 unsigned int j;

 for(j=0;j<m;j++)
 {
  TXREG=dat[j];
  delay(1500);
 }
}
void eeprom_wr(unsigned char addr,unsigned char wlr)
{
 GIE=0;          //desable all interrupts
 EEPGD=0;        //access EEPROM data memory
 EEADR=addr;     //select memory location to store setpoint
 EEDATA=wlr;
 WREN=1;
 EECON2=0x55;    //for enable write cycle
 EECON2=0xaa;    //      ,,
 WR=1;           //start write operation
 while(!EEIF);   //wait until write is finished
 EEIF=0;
 WREN=0;
```

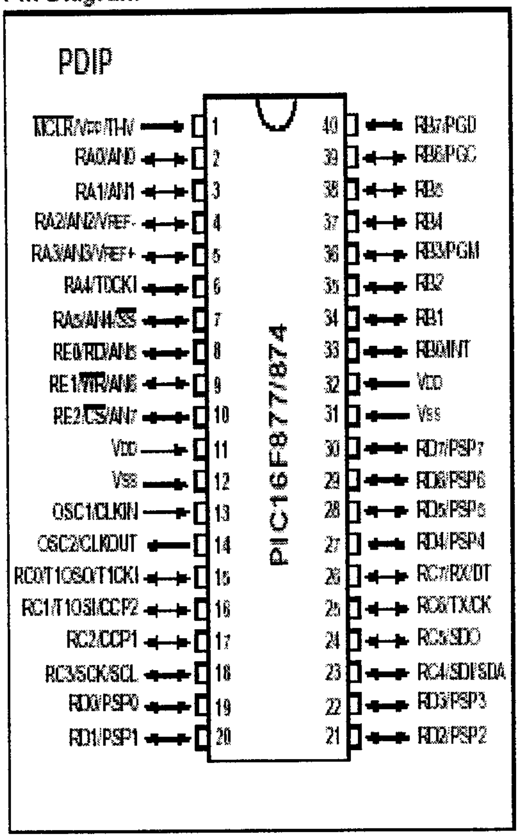
```
 GIE=1;
}

char eeprom_rd(unsigned char radd)
{
 EEADR=radd;      //select memory location to store setpoint
 EEPGD=0;         //access EEPROM data memory
 RD=1;
 q=EEDATA;        //read the setpoint
 return(q);
}
void setpt_disp(unsigned char p,unsigned char q,unsigned char r,unsigned
char s)
{
 lcd_disp(p+0x30);
 lcd_disp(q+0x30);
 lcd_disp(r+0x30);
 lcd_disp(s+0x30);
}
void delay(unsigned int del)
{
 wh
```

APPENDIX B

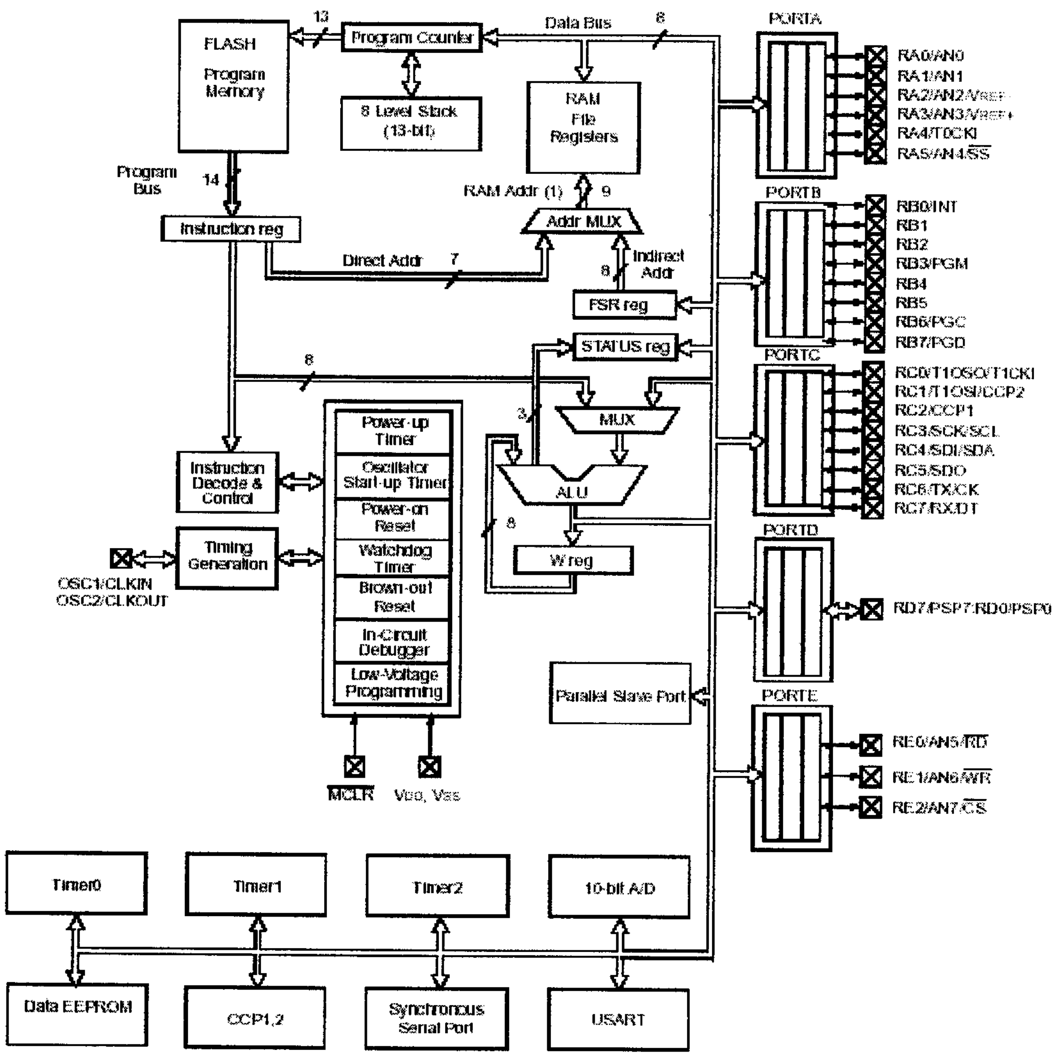
PIC DETAILS:

Pin Diagram



ARCHITECTURE:

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.

PIN DETAILS:

PIN 1 MCLR/VPP/THV Master clear (reset) input or programming voltage input or high voltage test mode control. This pin is an active low reset to the device.

PIN 12,31 VSS Ground reference for logic and I/O pins.

PIN 11,32 VDD Positive supply for logic and I/O pins.

PIN 13 OSC1/CLKIN Oscillator crystal input/external clock source input.

PIN 14 OSC2/CLKOUT Oscillator crystal output. Connects to crystal or resonator in crystal oscillator mode. In RC mode, OSC2 pin outputs CLKOUT which has 1/4 the frequency of OSC1, and denotes the instruction cycle rate.

PIN 33 TO 40:

PIN NO	PIN NAME	DESCRIPTION
33	RB0/INT	RB0 can also be the external interrupt pin.
34	RB1	
35	RB2	
36	RB3/PGM	RB3 can also be the low voltage programming input.
37	RB4	Interrupt on change pin.
38	RB5	Interrupt on change pin.
39	RB6/PGC	Interrupt on change pin or In-Circuit Debugger pin. Serial programming clock.

40	RB7/PGD	Interrupt on change pin or In-Circuit Debugger pin. Serial programming data.

PORTB is a bi-directional I/O port.

PORTB can be software programmed for internal weak pull-up on all inputs.

PIN 15,16,17:

PIN NO	PIN NAME	DESCRIPTION
15	RC0/T1OSO/T1CKI	RC0 can also be the Timer1 oscillator output or a Timer1clock input.
16	RC1/T1OSI/CCP2	RC1 can also be the Timer1 oscillator input or Capture2 input/Compare2 output/PWM2 output.
17	RC2/CCP1	RC2 can also be the Capture1 input/Compare1 output/ PWM1 output.

PIN 19 TO 22 AND 27 TO 30:

PORTD is a bi-directional I/O port or parallel slave port when interfacing to a microprocessor bus.

PIN NUMBER	PIN NAME
19	RD0/PSP0

20	RD1/PSP1
21	RD2/PSP2
22	RD3/PSP3
27	RD4/PSP4
28	RD5/PSP5
29	RD6/PSP6
30	RD7/PSP7

PIN 25 **RC6/TX/CK** RC6 can also be the USART Asynchronous Transmit or Synchronous Clock.

PIN 26 **RC7/RX/DT** RC7 can also be the USART Asynchronous Receive or Synchronous Data.

PIN 23 **RC4/SDI/SDA** RC4 can also be the SPI Data In (SPI mode) or data I/O (I^2C mode).

PIN 24 **RC5/SDO** RC5 can also be the SPI Data Out (SPI mode).

PIN 8 TO 10:

PORTE is a bi-directional I/O port.

PIN NUMBER	PIN NAME	DESCRIPTION
8	RE0/$\overline{RD}$/AN5	RE0 can also be read control for the parallel slave port, or analog input5.
9	RE1/$\overline{WR}$/AN6	RE1 can also be write control for the parallel slave port, or analog input6.
10	RE2/$\overline{CS}$/AN7	RE2 can also be select control for the parallel slave port, or analog input7.

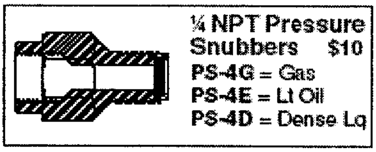
PIN 2 TO 7:

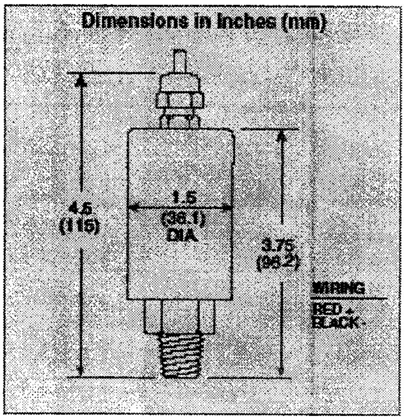
PORT A is a bi-directional I/O port.

PIN NUMBER	PIN NAME	DESCRIPTION
2	RA0/AN0	RA0 can also be analog input0
3	RA1/AN1	RA1 can also be analog input1
4	RA2/AN2/VREF-	RA2 can also be analog input2 or negative analog reference voltage
5	RA3/AN3/VREF+	RA3 can also be analog input3 or positive analog reference voltage
6	RA4/TOCK1	RA4 can also be the clock input to the Timer0 timer/ counter. Output is open drain type.
7	RA5/SS/AN4	RA5 can also be analog input4 or the slave select for the synchronous serial port.

APPENDIX C

PRESSURE SENSOR DETAILS:





SPECIFICATIONS:

Excitation: 6 to 30 Vdc unregulated

Output: 4 to 20 mA (2 wire reverse polarity protected)

Max Loop Resistance: (Vpower–Vmax) x 50

Accuracy: 0.25% FS (linearity, hysteresis, repeatability)

Zero Balance: 4 mA ±0.2%

Span: 16 mA ±0.4% FS

Long Term Stability: ±0.5% FS

Operating Temperature: 0 to 160°F (-18 to 71°C)

Compensated Temperature: 30 to 160°F (-1 to 71°C)

Total Thermal Effects: 1% FS max over compensated range

Proof Pressure: 200% or 13000 psi max, whichever is less

Gage Type: Stainless steel diaphragm, silicone oil filled semiconductor sensor

Shock: 50 g @ 11mS

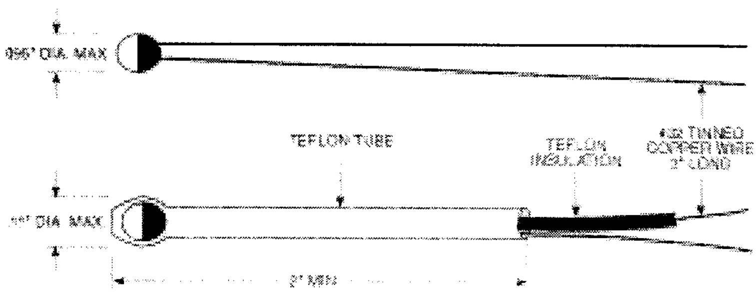
Wetted Parts: 17-4 PH and 300 Series Stainless Steel

Pressure Port: 1⁄4 NPT Male

Electrical Conn: 2 cond, 22 awg, PVC shielded cable, 3 ft (1 m) long with integral strain relief and ground

Weight: 9.4 oz max (266 grams)

TEMPERATURE SENSOR:



CHARACTERISTICS:

- Epoxy encapsulated
- High stability.

CONSTRUCTION:

Thermistors are manufactured from oxides of nickel, manganese, iron, cobalt, magnesium, titanium and other metals. All are available epoxy encapsulated and color coded, with two 3" leads.Thermistors with 0.2°C interchangeability also are available encased in a 2" long waterproof Teflon® tube; order by adding 100 to the part number. For example: 44005 is a standard 3000 ohm thermistor; 44105 is a Teflon® encased thermistor with the same temperature/resistance values. Stiff wire is placed in the tube so that, with slight finger pressure, it can be bent to any configuration. For Teflon® encased thermistors, consult the factory.

STABILITY:

Finished thermistors are chemically stable and not significantly affected by aging or exposure to strong fields of hard nuclear radiation. Time Constant -The time required for a thermistor to indicate 63% of a newly impressed temperature is called the time constant. For a thermistor suspended by its leads in a "well stirred" oil bath, it is 1 sec. max., or 2.5 sec. max. for Teflon® encased thermistors, and in still air it is 10 sec. max., or 25 sec. max.forTeflon®units.

DISSIPATION CONSTANT:

The power in milliwatts required to raise a thermistor 1°C above the surrounding temperature is the dissipation constant. For all thermistors suspended by their leads in a "well stirred" oil bath, it is 8 mw/ °C min., or 1 mw/°C min. in still air. Operating Temperature -Maximum operating temperature is 150°C. Long-term stability studies show that extended operation or continued cycling above 90°C will cause thermistors with values less than 2252 ohms at 25°C to exceed tolerances eventually. Thermistors 44030, 44031, 44032 and 44033 are designed for operation below 75°C. They will operate safely up to 100°C, but extended use above 75°C may cause a change in resistance. Storage temperature for thermistors is from -80 to 120°C.

DATA SHEETS:

TL082:

WIDE BANDWIDTH DUAL JFET INPUT OPERATIONAL AMPLIFIER

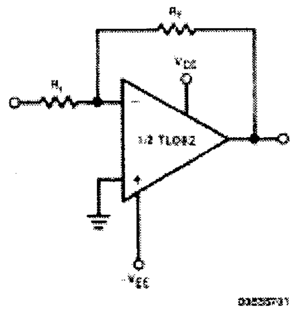
GENERAL DESCRIPTION

These devices are low cost, high speed, dual JFET input operational amplifiers with an internally trimmed input offset voltage (BI-FET II™ technology). They require low supply current yet maintain a large gain bandwidth product and fast slew rate. In addition, well-matched high voltage JFET input devices provide very low input bias and offset currents. The TL082 is pin compatible with the standard LM1558 allowing designers to immediately upgrade the overall performance of existing LM1558 and most LM358 designs. These amplifiers may be used in applications such as high speed integrators, fast D/A converters, sample and hold circuits and many other circuits requiring low input offset voltage, low input bias current, high input impedance, high slew rate and wide bandwidth. The devices also exhibit low noise and offset voltage drift.

FEATURES

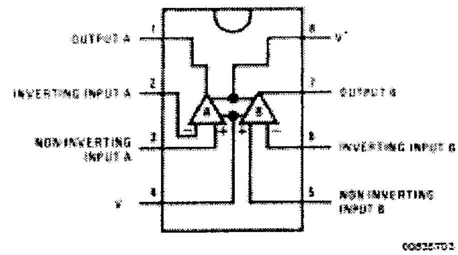
- Internally trimmed offset voltage: 15 mV
- Low input bias current: 50 pA
- Low input noise voltage: 16nV/√Hz
- Low input noise current: 0.01 pA/√Hz
- Wide gain bandwidth: 4 MHz
- High slew rate: 13 V/μs
- Low supply current: 3.6 mA
- High input impedance: 1012Ω
- Low total harmonic distortion: ≤0.02%
- Low 1/f noise corner: 50 Hz
- Fast settling time to 0.01%: 2 μs

Typical Connection



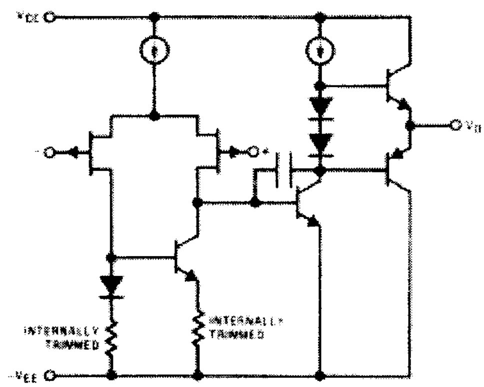
Connection Diagram

DIP/SO Package (Top View)



Order Number TL082CM or TL082CP
See NS Package Number M08A or N08E

Simplified Schematic



DC CHARACTERISTICS:

Symbol	Parameter	Conditions	TL082C			Units
			Min	Typ	Max	
V_{OS}	Input Offset Voltage	R_S = 10 kΩ, T_A = 25°C		5	15	mV
		Over Temperature			20	mV
$\Delta V_{OS}/\Delta T$	Average TC of Input Offset Voltage	R_S = 10 kΩ		10		μV/°C
I_{OS}	Input Offset Current	T_j = 25°C, (Notes 5, 6)		25	200	pA
		$T_j \le 70$°C			4	nA
I_B	Input Bias Current	T_j = 25°C, (Notes 5, 6)		50	400	pA
		$T_j \le 70$°C			8	nA
R_{IN}	Input Resistance	T_j = 25°C		10^{12}		Ω
A_{VOL}	Large Signal Voltage Gain	V_S = ±15V, T_A = 25°C V_O = ±10V, R_L = 2 kΩ	25	100		V/mV
		Over Temperature	15			V/mV
V_O	Output Voltage Swing	V_S = ±15V, R_L = 10 kΩ	±12	±13.5		V
V_{CM}	Input Common-Mode Voltage Range	V_S = ±15V	±11	+15		V
				−12		V
CMRR	Common-Mode Rejection Ratio	$R_S \le 10$ kΩ	70	100		dB
PSRR	Supply Voltage Rejection Ratio	(Note 7)	70	100		dB
I_S	Supply Current			3.6	5.6	mA

DAC0800/DAC0802:

8-Bit Digital-to-Analog Converters

General Description

The DAC0800 series are monolithic 8-bit high-speed current-output digital-to-analog converters (DAC) featuring typical settling times of 100 ns. When used as a multiplying DAC, monotonic performance over a 40 to 1 reference current range is possible. The DAC0800 series also features high compliance complementary current outputs to allow differential output voltages of 20 Vp-p with simple resistor loads as shown in Figure 1. The reference-to-full-scale current matching of better than ±1 LSB eliminates the need for full-scale trims in most applications while the nonlinearities of better than ±0.1% over temperature minimizes system error accumulations. The noise immune inputs of the DAC0800 series will accept TTL levels with the logic threshold pin, VLC, grounded. Changing the VLC potential will allow direct interface to other logic families. The performance and characteristics of the

device are essentially unchanged over the full ±4.5V to ±18V power supply range; power dissipation is only 33 mW with ±5V supplies and is independent of the logic input states.

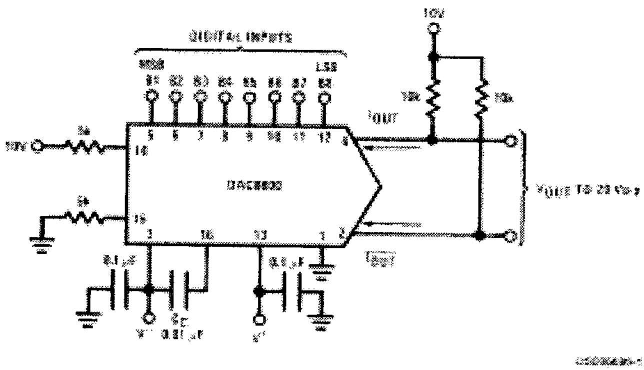
The DAC0800, DAC0802, DAC0800C and DAC0802C are a direct replacement for the DAC-08, DAC-08A, DAC-08C, and DAC-08H, respectively.

Features

- Fast settling output current: 100 ns
- Full scale error: ±1 LSB
- Nonlinearity over temperature: ±0.1%
- Full scale current drift: ±10 ppm/°C

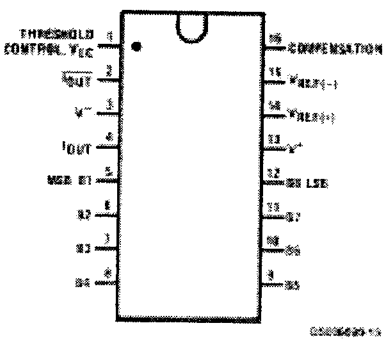
- High output compliance: −10V to +18V
- Complementary current outputs
- Interface directly with TTL, CMOS, PMOS and others
- 2 quadrant wide range multiplying capability
- Wide power supply range: ±4.5V to ±18V
- Low power consumption: 33 mW at ±5V
- Low cost

Typical Applications



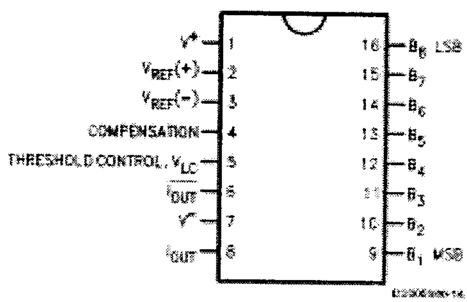
Connection Diagrams

Dual-In-Line Package



Top View

Small Outline Package



Top View

LM386:

LOW VOLTAGE AUDIO POWER AMPLIFIER

GENERAL DESCRIPTION

The LM386 is a power amplifier designed for use in low voltage consumer applications. The gain is internally set to 20 to keep external part count low, but the addition of an external resistor and capacitor between pins 1 and 8 will increase the gain to any value from 20 to 200. The inputs are ground referenced while the output automatically biases to one-half the supply voltage. The quiescent power drain is only 24 mill watts when operating from a 6-volt supply, making the LM386 ideal for battery operation. **FEATURES**

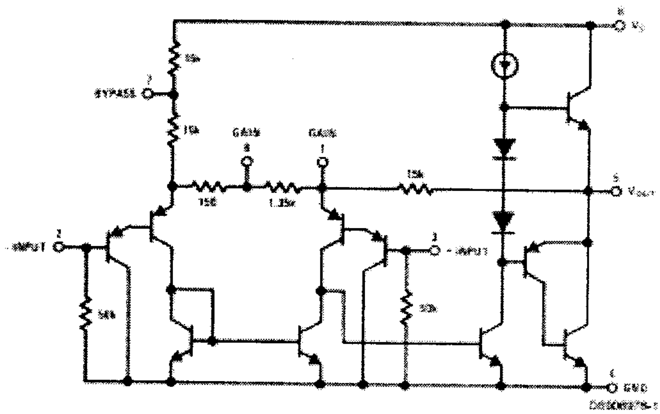
- Battery operation
- Minimum external parts
- Wide supply voltage range: 4V–12V or 5V–18V
- Low quiescent current drain: 4mA
- Voltage gains from 20 to 200
- Ground referenced input
- Self-centering output quiescent voltage
- Low distortion: 0.2% (AV = 20, VS = 6V, RL = 8W, PO = 125mW, f = 1kHz)
- Available in 8 pin MSOP package

Applications

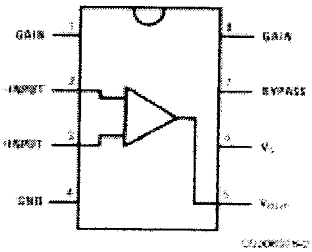
- AM-FM radio amplifiers
- Portable tape player amplifiers
- Intercoms
- TV sound systems

- Line drivers
- Ultrasonic drivers
- Small servo drivers
- Power converters

Equivalent Schematic and Connection Diagrams



Small Outline,
Molded Mini Small Outline,
and Dual-In-Line Packages



Top View
Order Number LM386M-1,
LM386MM-1, LM386N-1,
LM386N-3 or LM386N-4
See NS Package Number
M08A, MUA08A or N08E

LM565/LM565C:

Phase Locked Loop

General Description

The LM565 and LM565C are general-purpose phase locked loops containing a stable, highly linear voltage controlled oscillator for low distortion FM demodulation, and a double balanced phase detector with good carrier suppression. The VCO frequency is set with an external resistor and capacitor, and a tuning range of 10:1 can be obtained with the same capacitor. The characteristics of the closed loop system—bandwidth, response speed, capture and pull in range—may be adjusted over a wide range with an external resistor and capacitor. The loop may be broken between the VCO and the phase detector for insertion of a digital frequency divider to obtain frequency multiplication. The LM565H is specified for operation over the −55°C to +125°C military temperature range. The LM565CN is specified for operation over the 0°C to +70°C temperature range.

FEATURES

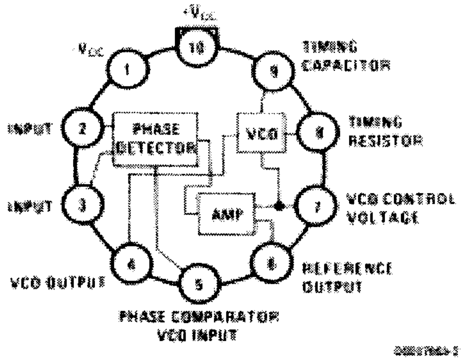
- 200 ppm/°C frequency stability of the VCO
- Power supply range of ±5 to ±12 volts with 100 ppm/% typical n 0.2% linearity of demodulated output
- Linear triangle wave with in phase zero crossings available
- TTL and DTL compatible phase detector input and square wave output
- Adjustable hold in range from ±1% to > ±60%

APPLICATIONS

- Data and tape synchronization
- Modems
- FSK demodulation
- FM demodulation
- Frequency synthesizer
- Tone decoding
- Frequency multiplication and division
- SCA demodulators
- Telemetry receivers
- Signal regeneration
- Coherent demodulators

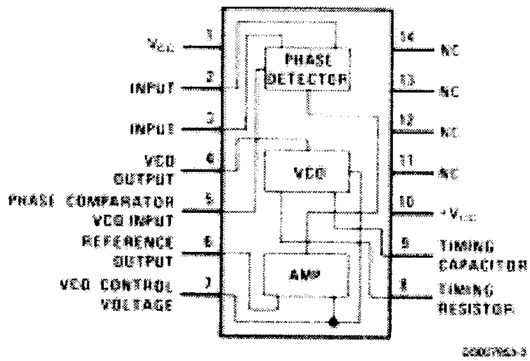
Connection Diagrams

Metal Can Package



Order Number LM565H
See NS Package Number H10C

Dual-In-Line Package



Order Number LM565CN
See NS Package Number N14A

LM567/LM567C:

TONE DECODER

GENERAL DESCRIPTION

The LM567 and LM567C are general-purpose tone decoders designed to provide a saturated transistor switch to ground when an input signal is present within the pass band. The circuit consists have an I and Q detector driven by a voltage controlled oscillator which determines the center frequency of the decoder. External components are used to independently set center frequency, bandwidth and output delay.

FEATURES

- 20 to 1 frequency range with an external resistor
- Logic compatible output with 100 mA current sinking capability
- Bandwidth adjustable from 0 to 14%
- High rejection of out of band signals and noise
- Immunity to false signals
- Highly stable center frequency

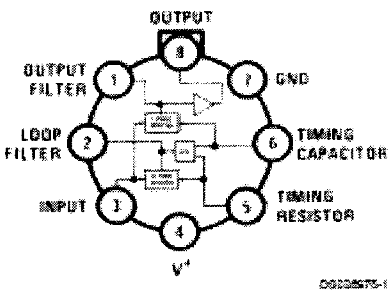
- ➢ Center frequency adjustable from 0.01 Hz to 500 kHz

APPLICATIONS

- ➢ Touch tone decoding
- ➢ Precision oscillator
- ➢ Frequency monitoring and control
- ➢ Wide band FSK demodulation
- ➢ Ultrasonic controls
- ➢ Carrier current remote controls
- ➢ Communications paging decoders

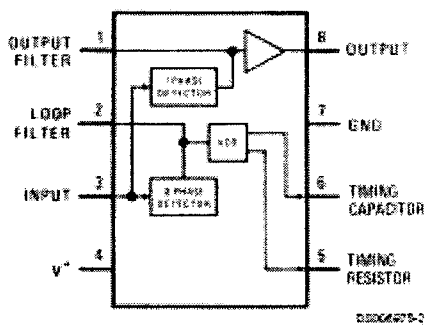
Connection Diagrams

Metal Can Package



Top View
Order Number LM567H or LM567CH
See NS Package Number H08C

Dual-In-Line and Small Outline Packages



Top View
Order Number LM567CM
See NS Package Number M08A
Order Number LM567CN
See NS Package Number N08E

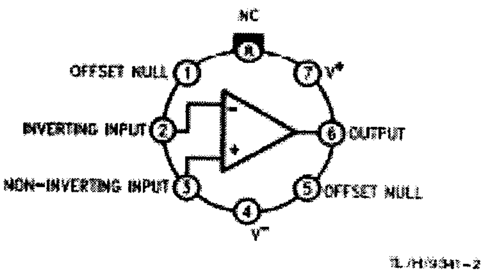
LM741 OPERATIONAL AMPLIFIER:

GENERAL DESCRIPTION

The LM741 series are general-purpose operational amplifiers which feature improved performance over industry standards like the LM709. They are direct, plug-in replacements for the 709C, LM201, MC1439 and 748 in most applications. The amplifiers offer many features, which make their application nearly foolproof: overload protection on the input and output, no latch-up when the common mode range is exceeded, as well as freedom from oscillations.

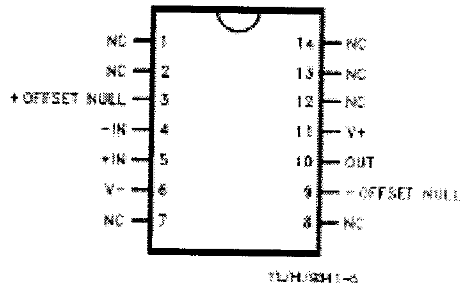
Connection Diagrams

Metal Can Package



Order Number LM741H, LM741H/883*, LM741AH/883 or LM741CH
See NS Package Number H08C

Ceramic Dual-In-Line Package



Order Number LM741J-14/883*, LM741AJ-14/883*
See NS Package Number J14A

*also available per JM38510/10101

**also available per JM38510/10102

NE555:

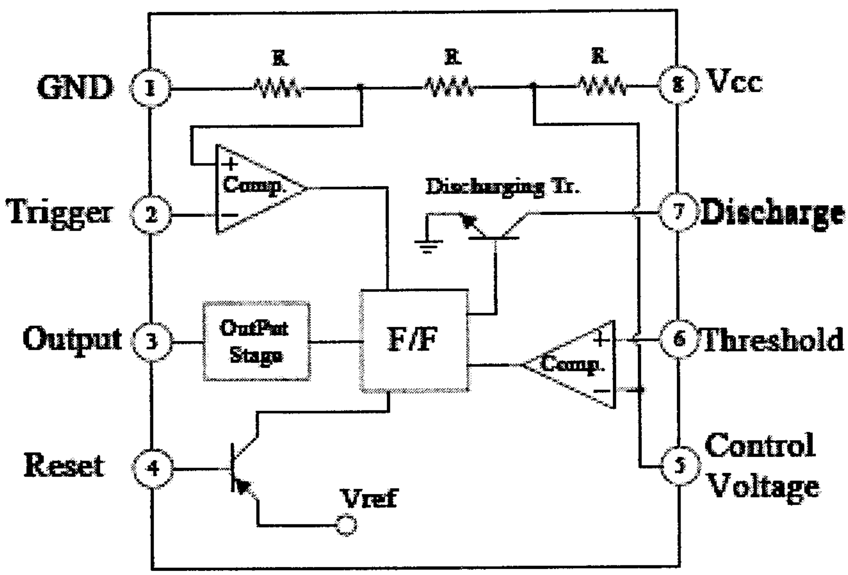
FEATURES

- High Current Drive Capability (200mA)
- Adjustable Duty Cycle
- Temperature Stability of 0.005%/□C
- Timing From μSec to Hours
- Turn off Time Less Than 2μSec Applications
- Precision Timing
- Pulse Generation
- Time Delay Generation
- Sequential Timing

DESCRIPTION

The LM555/NE555/SA555 is a highly stable controller capable of producing accurate timing pulses. With a monostable operation, the time delay is controlled by one external resistor and one capacitor. With an astable operation, two external resistors and one capacitor accurately control the frequency and duty cycle.

Internal Block Diagram



XR2206:

FEATURES

- Low-Sine Wave Distortion, 0.5%, Typical
- Excellent Temperature Stability, 20ppm/°C, Typ.
- Low-Supply Sensitivity, 0.01%V, Typ.
- Linear Amplitude Modulation
- TTL Compatible FSK Controls
- Wide Supply Range, 10V to 26V

- Adjustable Duty Cycle, 1% TO 99%

APPLICATIONS

- Waveform Generation
- AM/FM Generation
- V/F Conversion
- FSK Generation
- Phase-Locked Loops (VCO)

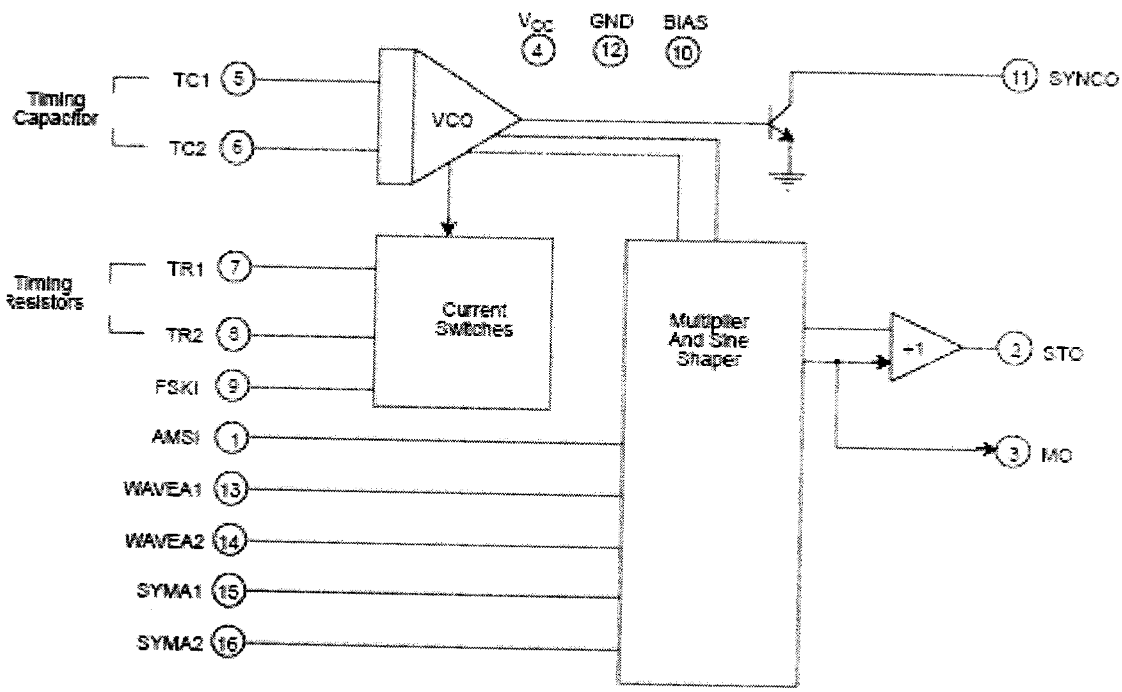


Figure 1. XR-2206 Block Diagram

GENERAL DESCRIPTION

The XR-2206 is a monolithic function generator integrated circuit capable of producing high quality sine, square, triangle, ramp, and pulse waveforms of high-stability and accuracy. The output waveforms can be both amplitude and frequency modulated by an external voltage. Frequency of operation can be selected externally over a range of 0.01Hz to more than 1MHz. The circuit is ideally suited for communications, instrumentation, and function generator applications requiring sinusoidal tone, AM, FM, or FSK generation. It has a typical drift specification of 20ppm/°C. The oscillator frequency can be linearly swept over a 2000:1 frequency range with an external control voltage, while maintaining low distortion.

CD4049:

CMOS HEX BUFFER/CONVERTERS

The CD4049UB and CD4050B devices are inverting and non-inverting hex buffers, respectively, and feature logiclevel conversion using only one supply voltage (VCC). The input-signal high level (VIH) can exceed the VCC supply voltage when these devices are used for logic-level conversions. These devices are intended for use as CMOS to DTL/TTL converters and can drive directly two DTL/TTL loads. (VCC = 5V, VOL £ 0.4V, and IOL ³ 3.3mA.) The CD4049UB and CD4050B are designated as replacements for CD4009UB and CD4010B, respectively. Because the CD4049UB and CD4050B require only one power supply, they are preferred over the CD4009UB and CD4010B and should be used in place of the CD4009UB and CD4010B in all inverter, current driver, or logic-level conversion applications. In these applications the CD4049UB and CD4050B are pin compatible with the CD4009UB and CD4010B respectively, and can be substituted for these devices in existing as well as in new designs. Terminal No. 16 is not connected internally on the CD4049UB or CD4050B, therefore, connection to this terminal is of no consequence to circuit operation. For applications not requiring high sink-current or voltage conversion, the CD4069UB Hex Inverter is recommended.

FEATURES

- CD4049UB Inverting
- CD4050B Non-Inverting
- High Sink Current for Driving 2 TTL Loads
- High-To-Low Level Logic Conversion
- 100% Tested for Quiescent Current at 20V
- Maximum Input Current of 1mA at 18V Over Full Package
- Temperature Range; 100nA at 18V and 25oC
- 5V, 10V and 15V Parametric Ratings

APPLICATIONS

- CMOS to DTL/TTL Hex Converter
- CMOS Current "Sink" or "Source" Driver
- CMOS High-To-Low Logic Level Converter

Schematic Diagrams

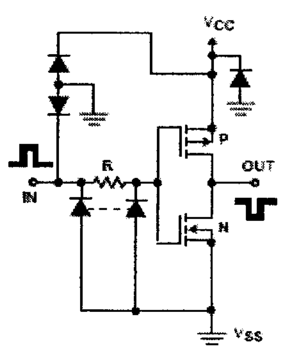


FIGURE 1A. SCHEMATIC DIAGRAM OF CD4049UB, 1 OF 6 IDENTICAL UNITS

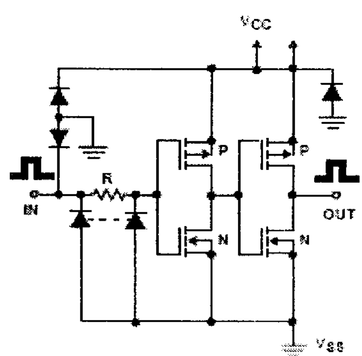
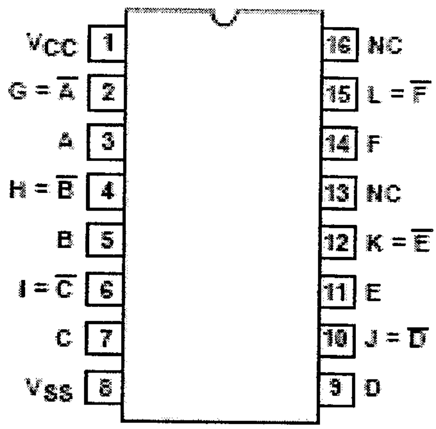


FIGURE 1B. SCHEMATIC DIAGRAM OF CD4050B, 1 OF 6 IDENTICAL UNITS

Pinouts

CD4049UB (PDIP, CERDIP)
TOP VIEW

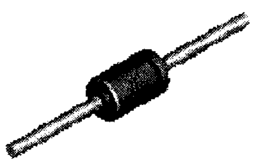


IN4004 -4007

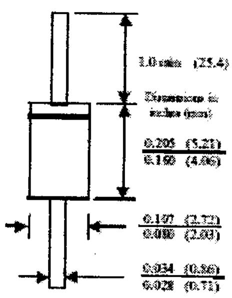
FEATURES

- ➢ Low forward voltage drop.
- ➢ High surge current capability.

1N4001 - 1N4007



DO-41
COLOR BAND DENOTES CATHODE



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