POWER LINE CHATTING

P-1154

PROJECT REPORT

Submitted by

MAHALINGAM M. 2KIT26

PRASATH S.2KIT34

Under the best guidance of

Mr.K.R.Baskaran .,M.S.

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF BACHELOR OF ENGINEERING IN INFORMATION TECHNOLOGY BRANCH OF BHARATHIAR UNIVERSITY COIMBATORE.

DEPARTMENT OF INFORMATION TECHNOLOGY

KUMARAGURU COLLEGE OF TECHNOLOGY

COIMBATORE - 641 006

2003-2004

CERTIFICATE

Estd-1984

ISO 9001:2000 Certified

KUMARAGURU COLLEGE OF TECHNOLOGY

COIMBATORE - 641 006

DEPARTMENT OF INFORMATION TECHNOLOGY

CERTIFICATE

This is to certify that the project report entitled

POWERLINE CHATTING

has been submitted by

PRASATH S , MAHALINGAM M.

In partial fulfillment of the requirements for the Award of the Degree of Bachelor of Engineering in Information Technology Branch of Bharathiar University, Coimbatore – 641 046 during the Academic Year 2003-04

Guide **Head of the Department**

Date:

Certified that the candidate PRASATH S. MAHALINGAM M.

with University Register No. 0027S0094 , 0027S0086

was examined in Project work Viva-Voce

Examination held on 26.03.04

Internal Examiner **External Examiner**

DEDICATED TO OUR
BELOVED PARENTS

DECLARATION

DECLARATION:

We Prasath S, Mahalingam M,hereby declare that this project work entitled "**POWERLINE CHATTING**" submitted to Kumaraguru College Of Technology ,Coimbatore(Affiliated to Bharathiar University) is a record of original work done by us under the supervision and guidance of Mr.K.R.Baskaran, Assistant Professor,Department of Information Technology.

Name	**Register No**	**Sign of the candidate**
Prasath S.	0027S0094	S. Prasath
Mahalingam M.	0027S0086	M. Mahalingam

Staff Incharge:

Mr.K.R.Baskaran, Assistant Professor.
Department of Information Technology,
Kumaraguru College Of Technology,
Coimbatore-641 006

Place: COIMBATORE

Date: 26.03.04

ACKNOWLEDGEMENT

Acknowledgement:

We deem this a rare opportunity to express our sincere thanks and deep gratitude to all those who were responsible for the knowledge and experience we acquired during our project as well as our course.

We would like to thank **Dr.K.K.Padmanaban Ph.D**, Principal, Kumaraguru College Of Technology for his encouragement .

It is a great pleasure to thank our Head Of The Department **Dr.S.Thangasamy Ph.D** for being the chief motivation behind our project work .

We express our gratitude to our guide **Mr.K.R.Baskaran M.S, Assistant Professor**,for having provided us with constructive ideas and efficiently guiding us in the design and implementation of our project work.

Respectful thanks to our family members for their continued encouragement and support during the project.

Last but not the least,we would like to thank all those who were involved in this project indirectly.

INDEX

CONTENTS

3.DATA TRANSMISSION

4.DATA RECEPTION

5.HARDWARE

6.POWERLINE MODEM DESCRIPTION

7.POWER SUPPLY DESCRIPTION

SYNOPSIS

SYNOPSIS:

Computers ,the miraculous machines ,have bright future for the decades to come. to increase their power and intelligence ,they should have proper channels to communicate between them and the world. The communication of computer are sure to shrink the world to its smallest extent.

Power line communications facilitates the communication between PC's through the existing electric cables .Our project **POWERLINE CHATTING** is one way of giving the computer an effective communicating power.

The basis of carrier current communication is the transmission and reception of a carrier , modulated by data over the A.C lines .the device utilizes FSK modulation not only for its excellent impulse noise rejection but also for the simplicity of implementation in both the transmitter and receiver sections.

The carrier current communication of computers has its own versatility for their higher communication power with low cost. Due to complexity and noise interference it is not normally implied for their greater advantages.

We have succeeded in doing this PC communication through AC power lines, with higher accuracy and less complexity.

With good future developments our system might have greater impact in the forth coming years of our country .

A good software support is also with our project for making this more effective. It is certain that our project **POWERLINE CHATTING** will gain a lighting attraction with future expansion.

INTRODUCTION

INTRODUCTION

1.1. POWERLINE COMMUNICATION TECHNOLOGY:

Powerline Communication is the technology that enables the transmission of data over power line that carries and supplies electric power. PLC has long history while the concept of broadband data transmission has been recently developed. Replacing the slow data transmission rate with only one-way communication, the emerging PLC technology has brought wider bandwidth with two-way communications.

For a long time, PLC technologies have achieved very limited success in a certain vertical market. The major applications of PLC Technology have remained within the boundaries of monitoring & control of load control, low capacity data communication various automation system and remote metering system, and low speed data communication up to 9600bps as well as analog signal transfer.

1.1.1 MODES OF COMMUNICATION

There are two modes of communication parallel mode and serial mode. In short distance communication parallel mode is the general choice. In long distance, serial is the suitable mode.

In parallel mode, the interconnection cable is a bus with separate lines for all bits of the bytes, lines for handshaking signals, lines for error checking signals such as parity. Thus the interconnecting cable is expensive.

In serial mode, the interconnecting cable is a bus with two lines for receiving and transmitting the bit, lines for handshaking signals and line error checking signals.

Two types of serial transfer are in existence, asynchronous and synchronous transmission. The asynchronous format is character oriented.

Each character carries the information of the start and stop bits. This is also known as framing. This format is generally used for high-speed transmission.

Serial communication also can also be classified according to the direction and simultaneously.

In simplex transmission data are transmitted in only one direction. In duplex transmission occurs in both directions. However if the transmission goes one way at a time it is called half duplex if it goes in both ways simultaneously it is called full duplex.

The rate at which the bits are transmitted/ seconds is called a baud in serial transmission.

A modem (modulator – demodulator) is a circuit that translates digital data into audio tone for transmission over telephone lines. And convert audio frequencies into digital data for reception. The modulation technique generally used is called frequency shift keying.

1.1.2 COMPUTER NETWORKS:

A group of computer, user terminals and other system components that are linked together over long distances constitute a computer network.

A network can be a LAN – Local area network or WAN – Wide area network.

We can define a LAN to be a set of independent computers connected together by short and fast communication links. And WAN is founded to be a set of independent computers connected together by long and hence slower communication links.

Accessing of resources by LAN network is much faster than by means of WAN. Number of LAN can also be interlined to form a WAN.

1.1.3 COMPUTER PORTS:

This is an introduction to program the powerline PC's communication ports. Th basic way by which the computer communicates with the devices is through ports. O PC's its basically an 8-bit doorway. The computer communicates with other device either through serial ports or through parallel ports.

Each method has its own merits and demerits. A parallel port transfers an entir byte at time where as a serial port transfer only one bit at a time. This is the basi difference between two ports. These serial ports take eight-fold time that of a parallel por to transfer a byte. This makes us to come to a conclusion that parallel transfer is muc faster than serial transfer is. In spite of this we have selected serial port as the medium c transfer for this project.

1.1.4 SERIAL AND PARALLEL TRANSMISSION:

Historically, the need for serial port arose when mainframe become large and fas enough to share time between several program or tasks, rapidly switching between ther to give each of them an illusion of exclusive attention. The multitask facilities each use to work on an independent terminal. These works even in cases where independen terminal are at some distances form the main system and terminal as per requirements.

The main drawback of parallel communication, which forced people to use seria communication in cases of long distances, is the high cost due to the need of separat wires for each bit to be transmitted simultaneously.

Another serious drawback in cases of long distances is the speeds at which the bit travel along the different wires, which differs slightly. Thus bits reach the receiver a different times even together. Over long distances these garbles the message.

Serial communication does not require use of expensive cables. The phone line transmits the data over long distances. The extent the communication over thousands of kilometers the usage of modems at both ends are the only additional requirements.

1.1.4.1 SYNCHRONOUS SERIAL COMMUNICATION

Synchronous serial communication is efficient when high data transfer rates are required. Here synchronous or bit stream synchronization that involves sending a group of characters in a continuous bit stream is used. The data transfer is controlled by a timing signal at the originating device. This may originate from the terminal itself or it may be provided by communication components like modems, multiplexers or front-end processor channel. At the receiving end, the timing is derived from a synchronized clock to ensure synchronization.

Data to be sent is blocked into a group of data bits preceded by the transmission of one or more special character. These synchronizing characters have a unique bit configuration of 'zeros' and 'ones' that allows the receivers to recognize and synchronize data transfer.

Since the data is blocked into to a group of character, terminal transmitting and receiving data using this mode must have a buffer for storage of character blocks. More complex circuitry is required since the receiving terminal must remain in step with the data originally transmitted. Considering these aspects, asynchronous serial communication is used in the project. The details of asynchronous serial communication are dealt in the following paragraphs.

1.1.4.2 ASYNCHRONOUS SERIAL COMMUNICATION:

Almost all computers store and manipulate their data in parallel. This means that when bytes is send from one part of the PC to another, it is not send one bit at a time instead it is sent several bits at a time over a number of busses running in parallel. Since serial communication from a PC to another device is done serially, meaning that data are sent one bit at a time. A communication interface must be able to take data bits that are received in parallel and send out the individual bits separately.

The data lines in serial communication can only be in either mark (negative voltage) or space (positive voltage) condition. Therefore any transmitted data must first be translated into a sequence of Mark's and Space's. For the purpose of this translation, a MARK represents a "1" and SPACES represents a "0".

The above mentioned details pertain to serial communication in general and since for communication between PCs any PC can initiate transmission and terminate the transmission at any time and the length of the data transmitted varies widely, asynchronous serial transmission is preferred which does not require the two PCs to be in synchronism.

Three mode of communication are possible simplex, Half, Duplex and Full Duplex. In simplex mode, data transmission takes place from one system only. Half Duplex transmission means that communication can take place in either direction between two systems, but can occur in one direction at a time. Full Duplex means that each system can send and receive at the same time. The Half – Duplex mode is used in the project.

FRAMING:

In the case of asynchronous serial communications, the bits are representing one byte, which are known as the data bits preceded and followed any start stop and parity bits. This process is known as framing.

START BIT:

A start bit is always added at the beginning of the frame to alert the receiving device that, data rare arriving and synchronize them. The mechanism that separates out the individual start bit is a SPACE or binary zero.

DATA BITS:

These represent the actual data. They can be 7 bits or 8 bits depending upon the data to be transmitted. Text files need only seven data bits per byte of data. These bits are transmitted with least significant bit first. Binary files need 8-bit data representation.

PARITY BIT:

Parity checking is a method of testing whether the transmission is being received correctly. The sending device adds a parity bit, the value of which (0 or 1) depends on the contents of the data bits. The receiving device checks that the parity bit does indeed bear the correct relationship to the other bits. EVEN, ODD, SPACES or MARK parity schemes can also be used.

STOP BITS:

At the end of each frame, stop bits are sent. This can be 1, 1.5 or 2. More than one stop bits are generally used when the receiving device requires extra time before it can handle the next incoming character when the number of data bits is five we should always go for 1.5 stop bits.

1.2 POWER LINE COMMUNICATION:

INTRODUCTION:

In the early days of generation and utilization of electric power, the generating station was invariably a thermal one located within or very near a city having industries acting as the consumers of the power. However with the introduction of hydroelectric generating stations and extension of electricity to suburban and rural areas, the picture radically changed. The various generating stations, located at great distances among themselves, could no longer remain isolated and self-sufficient entities. On the other hand, they soon became interconnected giving rise to what is known as the power grid. This necessitated an economical and dependable means of intercommunication, between various generating stations, sub-stations, and control rooms. Among many facilities that such means of communication are expected to provide, the following are the important ones:

- Speech transmission
- Remote control and telemetering
- Power line protection
- Direct breaker tripping

ALTERNATE METHODS OF POWER SYSTEM COMMUNICATION:

Many different methods are possible for sending speech or other signals from poin to point in an interconnected power grid. Some of them are being discussed below:

- **PUBLIC TELEPHONE NETWORK:**

Circuits can be rented to provide communication between the stations of powe system. Such circuits normally pass through the public exchanges and along undergroun cable and overhead lines to provide circuits for ordinary telephone subscribers, specia precautions must be taken to guard against any possible danger to the exchang equipment or personnel due to high voltages and currents prevailing in power station Moreover, the post and telegraph department's circuits are liable to be interrupted due t faults or maintenance work. Also, the delay incurred in establishing a call an dependence on external agencies in case of a fault do not suit the requirements of powe supply systems. In addition to all these, telephone exchanges are normally located in th centers of thickly populated areas and the power system stations are normally located fa away from such centers. This would need special lines to be laid involving considerabl expenses. Depending on the distances involved, it might be better for the power suppl company to lay its own communication lines.

- **DIRECT LINES:**

Direct lines can be provided very economically when the distance between the sub stations and the control room is about a kilometer. In some cases telephone cable is put a the time of laying power cables themselves in the same trench. This costs only th telephone cable. But it would be uneconomical to dig communication purpose However, lead-covered aerial cables suspended below the power conductors have prove a practical solution. Care must be taken to guard cables against high voltage hazards.

- **RADIO CIRCUITS:**

Radio operation working in the VHF or UHF range can provide means to communicate speech, supervisory and protective signals. 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 and other complications. However, it serves a useful purpose with mobile units like line crews.

BASICS OF POWER LINE COMMUNICATIONS:

What is Power Line Communication?

Power Line Communications refers to the use of existing electricity cable infrastructure to carry voice and data signals e.g. Internet, telephony, video etc.

How does Power Line Communication function?

1.A power line modem transmits and receives data through a power line, or mains. Its use in home applications requires a duplex-mode power line modem that transmits and receives data at approximately 10 kbit/s.

2.An incoming signal is coupled to the receiving component of the modem that decodes the data and delivers it to the application through an interface.
3.The application returns data to the modem, where it's coded. The transmitter then generates an amplified signal that is coupled into the power line.

Among factors to consider in power line communications are:

1. Easy signal coupling into and out of the power line.
2. Efficient transmission through the power line and ongoing separation between the communication signal and the power line frequency.
3. Resistance to noise and interference such as electromagnetic interference (EMI) and electromagnetic compatibility (EMC).
4. A coupling transformer with high pass characteristic is a reliable solution, providing necessary galvanic isolation of the power line from the main voltage. In a one-phase operation, the transformer should be connected in parallel between one

phase and neutral for 220 V and between two of the three phases for a three-phase operation.

5. A serial connection of the coupling transformer is not recommended, because it results in a high current through the transformer that causes a magnetic saturation of the transformer core.
6. In any power line, there are several sources of noise and interference, each with individual characteristics:
   - Multiples of the main frequency; i.e., 50 Hz, 100 Hz, 150 Hz
   - High-voltage transients from flashes or switches
   - High-frequency noise of power factor corrections (PFCs), motors, and inverters.

Power Line Communication technology:

The technology has been around for a while and at a low bandwidth. It has been used by power utilities for simple control of electrical equipment in their networks. data transmission via the mains supply voltage network right through to every power socket in the building, as well as in the reverse direction at high speed is possible.

How is high bandwidth possible for every user?

The PLC technology is known as a "shared medium" technology: Several buildings with individual terminals (PCs, telephones, etc.) that are connected to the same distribution node share the available bandwidth.

Dynamic bandwidth management ensures optimal usage and hence all users have sufficient bandwidth available at all times. Compared with a point-to-point connection (the traditional telephone connection), a shared medium represents a far more economical solution.

Application areas offered by Power Line Communications:

Power Line Communications offers end-users a broad spectrum of applications and services including broadband Internet access, Voice over IP, multimedia services, home automation and energy management.

The transmission rate of the Power Line Communications:

Compared with the current 56kbps over normal telephone modem, PLC is up to 80 times faster. The transmission speed of the PLC equipment for the commercial product utilized for the Technology Trial could reach 2.25Mbps.

Advantages Power Line Communications offer as compared with other technologies:

1. No additional installation of cables necessary for voice and data transmissions – use of existing low voltage supply network/infrastructure.
2. Easy to use and uncomplicated for the user.
3. Terminals can be connected to any mains socket using a PowerLine modem, and several terminals can be used simultaneously.
4. It is an effective technology for setting up a Local Area Network in the home or building (in-house LAN).
5. Permanent access to the Internet without having to dial-up to the provider (Always On).
6. At the same time, PLC offers a high transmission rate, at present ranging from a maximum of 4.5 Mbps (a maximum of 40 times faster than an ISDN channel) up to 45 Mbps.
7. The ubiquity of the low voltage network, with every room having at least a power socket, means PLC can be simply implemented with a much smaller technical effort than for alternative access possibilities.
8. When compared with ordinary lines the power lines have appreciably highe mechanical strength. They would normally remain unaffected under th conditions, which might seriously damage telephone lines.
9. Power lines usually provide the shortest route between the power stations.
10. Power lines have large cross-sectional areas resulting in very low resistance pe unit length. Consequently the carrier signals suffer much less attenuation tha when they travel on usual telephone lines of equal lengths.
11. Power lines are well insulated to provide only negligible leakage betwee conductors and ground even in adverse weather conditions.
12. Large spacing between conductors reduces capacitance, which results in smalle attenuation at high frequencies. The large spacing also reduces the cross talk to considerable extent.

THE DISADVANTAGES ARE:

1. Proper care has to be taken to guard carrier equipment and persons using them against high voltages and currents on the lines.
2. Reflections are produced on spur lines connected to high voltage lines. This increases attenuation and creates other problems.
3. High voltage lines have transformer connections, which attenuate carrier currents. Sub-station equipments adversely affect the carrier currents.
4. Noise introduced by power lines is far more than in case of telephone lines, this is due to the noise generated by discharge across insulators, corona and switching processes.

1.3 COUPLING EQUIPMENT:

The most important technical problem in a power line carrier is to devise methods and equipments to couple the low voltage and high frequency carrier set to the high voltage and low frequency power line.

During the initial stages of carrier operation on power lines, an aerial wire of more than 300 feet length, supported on power line structure was used on one end of it, was connected the output from carrier equipment.

While the aerial coupled the signals to power lines mainly due to capacitance between them this created the following problems:

1. It was inefficient and created disturbances in nearby broadcast receivers. In its turn, it was affected by radio transmitter signals.
2. Means had to be provided against high voltages appearing on it due to its accidental contact with high voltage lines.

3. Interference resulted when more than one carrier circuits were coupled.
4. The aerial tuning depended to some extent on capacitance of line switching plan Hence undesirable detuning resulted on switching.

The modern practice is to achieve the coupling by connecting a capacitor betwee the carrier terminal and the high voltage line. The particular value of the capacitor is compromise between two conflicting requirements. Too low a value will present larg reactance to carrier currents while too high a value will be uneconomical to build an would pass large currents at 50 c/s. the typical range is between 2200 to 4400 μF.

Although coupling capacitors are exclusively used for coupling carrier signals t high voltage line, aerial coupling is still used for mobile communication equipments use by line crews.

1.4 PROPERTIES OF POWER LINES AT CARRIER FREQUENCIES:

The properties of power lines vary greatly with the frequency at which the carrie signals are transmitted over them. The factors affecting their behavior are many an mostly of a nature which do not readily yield to exact calculations. When designing new system, one has to lean rather heavily on data furnished by various authorities o existing units.

Conventional communication lines can easily be designed for definit characteristic impedance. When connected to terminal equipment proper impedanc matching is thus readily attained. Hence mismatch losses are reduced to negligibl proportions.

In power lines the situation is far more complex. The impedance presented t carrier equipment depends on switching conditions and equipments like transformers an bus bars of power stations. Mismatch at branch-off points and the lines should also b taken into consideration. However, for an initial approximation, input impedances may b

taken as 100 ohms and 400 ohms for phase-to-phase and phase-to-ground couplings respectively.

As already mentioned, noise introduced by power line is far in excess to that by telephone lines. Special attention is to be paid if power cables are used for lead-in purposes from lines to power station. These cables have much lower characteristic impedance and their attenuation is about ten times higher than that of overhead lines.

To avoid the mismatch loss at the cable joint either a special matching section should be used or the line coupling equipment should be connected before the cable joint.

1.5MODULATION METHODS:

In early stages, the communications consisted mainly of speech signals. The carrier was amplitude modulated (AM) with transmission of carrier plus the two side bands. The system was easy to design; simple in it's working, and met the purpose well. With the advent of time the number of carrier channels needed became larger and larger. The lowest and the highest value of carrier frequencies being rather closely fixed, saving of frequency band employed by a carrier channel became of great importance. Hence, single side band (SSB) transmission was used. This reduces the frequency bandwidth of a carrier channel to half and gives some advantage in signal-to-noise ratio.

If frequency modulation (FM) is used, it must be transmitted in its full. That is, we cannot suppress carrier or side band at the transmitting station and then add the carrier at the receiving station. In order that the FM spectrum is limited within the range 2fm where fm is the modulating frequency, the modulation index for the highest modulating frequency must be within 0.5.

1.6POWER LEVEL:

If the carrier power is too high, it may result in interference with radio transmission or telephone carrier systems. If it is too low, it may not produce good signal-

to-noise ratio at desired distances. Hence a compromise is carefully worked out keeping also in view the fact that a line may be a good one at power transmission but a poor one at carrier transmission. The method of modulating the carrier should also be considered. A general value is 10 W at the carrier output terminals, though lower and much higher values are also found in practice.

FREQUENCY ASSIGNMENT:

The question of frequency assignment presents many complexities. The whole power system is an extensive interconnected grid. If a carrier frequency is used for two stations in one section of it, the same cannot be used in another section, unless the sections happen to be laid wide distant apart. Intolerable interface will result if the same carrier frequency is used in nearby sections, either due to carrier energy trickling through wave traps or due to radiation.

But the operation of power line carrier may deviate from the 4kc/s bandwidth due to many reasons. The most important being the necessity of providing many channels in a limited range of frequencies. The usual frequency range for operation of power line carrier between 10kc/s to 450kc/s, although the actual range varies from country to country and sometimes from administration to administration.

Consider the problem of separating the carrier frequency from the 50 or 60c/s power frequency, the higher the carrier frequency the better it is. But the higher frequencies get more attenuated by the open wire transmission lines. Hence an upper limit at about 500c/s turns out to be workable. Moreover, if the frequency is too high then the radiation becomes a problem and it may cause interference in a nearby radio receiver. It should be seen that the frequency range adopted for power line carrier use is just below the median wave band of a commercial broadcasting system. Some spot frequencies within this band are some-times used for radio transmitter, operated by the police, air traffic and wartime communication services. The assignments are usually co-

ordinated by a central organization such as the Posts and Telegraphs Department, so tha the possibility of mutual interface is eliminated.

It is also clear that the lower the carrier frequency the greater is the loss in the coupling capacitor and a larger portion of the carrier energy gets diverted through the wave trap, only to be undesirably wasted. Thus in order to design efficient and economical coupling capacitor and wave trap, the lower limit should not be less than 10kc/s.

But due to the need of speech transmission, both-way operation is to be provided The same frequency may be used in both directions with manual or automatic changeover to transmit or receive conditions. This is 'half-duplex' working and is not in common use When carrier facilities are to be extended to many stations of the power system difficulties arise of frequency assignment and equipment needed.

One scheme is to transmit on one frequency from one central stations to many sub-stations and on another frequency from any of the sub-stations to the central station Transmission among the sub-stations is not possible in this case. Another scheme to work among several stations is to adjust all carrier terminals ready to receive at same frequency f1 while in normal conditions. When one wants to make a call his transmitter transmits a frequency f1 and his receiver tuning is changed to receive frequency f2, the transmi frequency of the distant station

The frequency changeover may be manually affected, but may be automatic by some voice-operated devices.

The various units that enter into the design of a speech channel, a telemetry channel, or a protective relaying channel are very similar to those used in the double modulation, segregation of channels by directional filters, etc. are also very common Hence the details of the block diagrams of these systems are not being included here Readers desirous to find more details may consult the literatures some of which are being listed in the references.

SYSTEM STUDY

SYSTEM STUDY:

2.1 INTERFACING:

Interface is a process where information is being converted from one to another o transported from one machine to another using FM transmitter and receiver.In the case o computer, interface made through ports.

A port is a gateway of data transformer. On PC's it is normally an 8-bit gatewa The two ways that a computer communicates with other devices are through serial an parallel ports.

The parallel ports can transfer an entire byte at once but a serial port can transfe only bit at a time. Thus parallel transfer much quicker than serial transfers.

One of the disadvantages of parallel communications over long distance is the hig cost associated with it. Because interconnecting cable must have separate wires for a many bits as are transmitted separately.

Overlong distances, there is also a problem of line noise, or cross talk between a this data wires. Serial communications at the other ends does not need the use o expensive cable. To communicate over long distances, serial cables are the answers.

The phone line allows us only a simple wire for the flow of data, so only seria transfers can take place over phone lines to communicate with a distance computer.

There are two ways this can be done. Writing a program takes each byte and spool the bits out over a single bit of the port, one at a time, or uses a serial interface.

Bit spooling needs a very precise timing scheme on both transmit and receivin ends and a half-crazed programmer to write the program. Obliviously the serial interfac is the solution. The PC uses an RS232 serial interface for serial data transfers. It is th serial interface circuit that does the bit spooling.

The PC sends a byte to a CPU port connected to the serial interface, spools the bits over the modem cable to the modem. The modem converts each bit into a sound frequency on the phone line. That's why we hear that high-pitched squeal. Receiving data is just the reverse process. Using a serial interface standardizes communications and simplifies the programming.

If we have been using a communication program to dial up other computer we have everything we need.

A modem is optional and is necessary only if we wish to communicate over phone lines without a modem, two computers or other device, can communicate over a direct cable connection. This is a connection between serial parts of each device.

2.2 RS232C SERIAL DATA STANDARD

In 1960's as the use of time-share computer terminals became more widespread, modems were developed. So that terminals could use phone lines to communicate with distant computer.

As we stated earlier, modems and other devices used to send serial data transferred to as data communication equipment or DCE. The terminal or computers that are sending or receiving data referred to as data terminal equipments or DTE.

In response to the need for signal and handshake standards between DTE and DCE, the Electronics Industries Association developed EIA standard R-232c. This standard describes the function of 25 signal and handshake pins for serial data transfer. It also describes voltage levels, impedance levels, rise and fall times, maximum nit rate and maximum capacitance levels for the signal lines. Before we work our through the 25 pin functions we will take a brief look at some other hardware aspects of RS232.

RS232C specifies 25 signals pins and it specifies that the DTE connector should be a male and the DCE connector should be a female. A specific connector is not given, but

the most commonly used connectors are the DB-25S females. When you are writing up these connectors, it is important to note the order in which the pins are numbered.

The voltage levels for all RS-232C signals are as follows. Logic high or marks is a voltage between -3V to -15V under load (-25V no load). A logic low or space is a voltage between +3V and +15V under load (+25V under no load). Voltages such as + or -12V are commonly used.

2.3 RS-232 INTERFACE:

RS 232 is what is known as a "Serial" interface. It transfers data between devices on a single wire, byte by byte being sent one bit at a time.

RS 232 JOBS

Let us turn attention to basic areas to successfully solve an RS 232 interface problem.

CABLING

Getting the appropriate connector pins at one end connected to appropriate pins at the other end. This job is the most obvious task associated with RS 232, but is only one third of the journey.

DB 9

This is the style of connector generally used with RS 232. It is a D shaped and it has 9 pins in two rows. The connector in male as well as in female types.

OPTIONS

Baud is the unit name for measuring speed of communication in bits per second (bps). The data rate of serial channel is equal to the number of characters send in one second.

CHOICE OF BAUD RATES

50, 110, 300, 600, 1200, 4800, 9600 and 19200 baud. The two communicating devices must agree on this

Out these 300, 1200, 4800 and 9600 are commonly preferred baud rates

NUMBER OF BITS OR DATA LENGTH

Our choice of data bits will be from 5 to 8, with 8 being the most common for newer equipment and 5 or 6 bits were used with ancient teletypes. Both machine should agree, but many (at least essentially) even without agreement.

PARITY

Parity is an error-checking scheme, so it is most useful where the communication path is of dubious quality.

Our choice will be none, even or odd. Choose none on both machines if possible, otherwise select an agreeing choice.

Check whether each byte is followed by a parity bit, and if so whether "even" or "odd" parity is to be used.

STOP BITS

After each byte, the line must be "at rest" for a pre specified amount of time. This parity to make sure both sides are synchronized and parity to allow slower device time to recover. This "stop bit" is a set of 1 or 1.5 or 2 bits time. 1.5 is usually used with 5-bit character length.

The first is software at each end to equalize this parameter. With PC's we are often provided with the manufacture software for setting up many options including the configuration of the serial ports.

2.4 RS-232C SIGNAL PINS

RS-232C has 25 pins out of which only few pins are used. First note that the sign direction is specified with respect to the DCE. This conversion is part of the standard. W have found it very helpful to put arrowheads on all signal lines as shown in figure.

Next observe that there is both a chassis ground signal ground. To prevent larg AC induced currents in the signal grounds this two should be connected together only a the power supply in the terminal or the computer. The TxD, RxD and the handshake th signal shown with common names in figure are the once most often is used for simpl systems.

This signal control what is called the primary or forward communication channe of the modem? Some modem communication over secondary or backward channe which operates in the reverse direction from the forward channel and at a much lowe baud rate. Pin 12, 13, 14, 16 and 19 are the data and handshake lines for these backwar channel pins 15, 17, 21 and 24 are used for synchronous data communication.

DATA TRANSMISSION

DATA TRANSMISSION :

The digital signal from the computer cannot be transmitted directly, as they do not have much power with them. The RS 232C signals that are coming from the USART are bipolar and have both positive and negative voltage levels. Transmitting such a discrete bipolar signal may cause loss of data.

So these signals have to be modulated properly on a carrier before transmission The fundamental concepts of modulation and demodulation are discussed in this chapter At the end of the chapter the use of frequency shift keying (FSK-FM) as the modulation scheme for wireless data transmission is justified.

3.1 MODULATION TECHNIQUES

Before going into the various details of various modulation techniques, let us get acquainted with the concept of modulation. Modulation is the process where in some parameter of a high frequency signal, termed as carrier is varied in accordance with the signal to be transmitted.

The signal to be transmitted is known as the modulating signal. Various modulation methods have been developed for transmission of signals with minimum possible distortion.

The various modulation techniques that are available for signal transmission are given below.

1. Amplitude modulation
2. Frequency modulation
3. Phase modulation
4. Pulse modulation

First three modulations come under Analogue Modulation where as in digit modulation a pulse train is used as a carrier.

3.1.1 ANALOGUE MODULATION

Analogue modulation may be divided into three parts

1. Amplitude modulation
2. Phase modulation
3. Frequency modulation

AMPLITUDE MODULATION

The process of amplitude modulation consists of varying the peak amplitude of th modulating signal in proportion to the instantaneous amplitude of the modulating signa The signal to noise ratio (S/N) is comparatively less in amplitude modulation. This mean that the data transmitted using amplitude modulation is more prone to noise. Also th power required for AM is more prone to noise. Also the power required AM is mor when compared with FM. So we should select a modulation scheme, which consume less power and is less prone to noise

PHASE MODULATION

Phase shift keying (PSK) is also called as phase modulation. The signal differs b phase shift instead of frequency or amplitude. Typically, a signal's phase shift i measured relative to the previous signal. In such case, the term differential phase shif keying (DPSK) is often used. Here n bits can be assigned a signal having one of 2^n phas shifts, giving a technique in which the bit rate is n times the baud rate.

FREQUENCY MODULATION

In frequency modulation, the frequency of the carrier signal is varied in accordance with the instantaneous amplitude of the modulating signal, without any variations ion the amplitude of the carrier wave.

These factors when taken into consideration, gives frequency modulation a priority over AM. We will discuss in detail about the frequency modulation technique in the following section.

WHY PREFERRED FM TO AM?

- FM gives a noiseless reception. Noise being a form of amplitude variations, FM receivers will reject such signals
- FM operates for a wide bandwidth
- Fm provides high quality reception
- FM provides adjacent channel or side band rejection by providing a guard band

3.1.2 FM – AN ANALYTICAL APPROACH

We have been talking about eh theory of frequency modulation as an analytical approach for the technique that will provide us with details about its feature. When the modulating frequency is zero, the output frequency equals f_c (center frequency). When the modulating signal reaches its positive peak, the frequency of the modulated signal is maximum and equals ($f_c + f_m$). At the negative peaks for the modulating signal, the frequency of FM wave becomes minimum ($f_c - f_m$). Thus, the process of frequency modulation makes the frequency of FM wave to deviate from the centre frequency by an amount (Δf – frequency deviation). The analytical approach is given below.

Assume modulating signal to be represented by

$$e_m = E_m \cos(\varpi_m t)$$

The carrier wave being represented by

$e_c = E_c \sin(\varpi_c t)$

Where $(\varpi_c t + \theta)$ represents total phase angle θ at time t and represents the initial phase angle. Thus,

$\phi = (\varpi_c t + \theta)$

The angular velocity may be determined by finding the rate of change of phase angle.

Angular velocity $= d\phi/dt = \varpi_c$

After the frequency modulation, angular velocity of the carrier wave varies in proportion to the instantaneous amplitude of the modulating signal. The instantaneous angular velocity ϖ_i is given by

$$\varpi_i = \varpi_c + Ke_m$$
$$= \varpi_c \pm K E_m \cos(\varpi_i t)$$

Where K is the constant of proportionality

Maximum frequency shift or deviation occurs when the cosine term in equation has a value of ± 1. Under this condition, the instantaneous angular velocity if given by

$$\varpi_i = \varpi_c \pm K E_m$$

So that the maximum frequency deviation is given by

$\Delta f = KE_m/2\pi$

This gives $KE_m = 2\pi \cdot \Delta f$

Therefore, $\varpi_i = \varpi_c + 2\pi \cdot \Delta f \cos(\varpi_c t)$

Integrating instantaneous frequency gives the instantaneous phase angle of the FM wave

$$\phi_I = \int \varpi_i \, dt$$
$$= \int (\varpi_c + 2\pi \cdot \Delta f / (\varpi_m \sin \varpi_c t) + \theta)$$

Where θ is constant of integration representing a constant phase angle and may be neglected in the following analysis.

The instantaneous amplitude of the modulated waves is given by

$$e_{mod} = E_c \sin \phi_i$$

$$= E_c \sin (\varpi_c t + \Delta f/\varpi_m \sin \varpi_m t)$$

The ratio $(\Delta f/\varpi_m)$ is termed as the modulating index of the frequency modulated wave and is denoted by fm. Thus, we find that the instantaneous frequency of the carrier is change in proportional to the modulating signal amplitude.

3.2 FSK MODULATION

Frequency shift keying (FSK) is most commonly used method for transmitting digital data over Telecommunication links. In order to use FSK, a modem (Modulator Demodulator) is needed to translat3e digital 1's & 0's into their respective frequencies and back again.

In FSK modulation the carrier frequency is shifted in steps or levels corresponding to the levels of digital modulating signal. In case of a binary signal, two carrier frequencies are used, one corresponding to binary '0' other to binary '1'.

Frequency shift keying employs two different carrier frequencies which are switched ON and OFF by the mark and space signal. A mark signal switches ON one carrier while the other carrier remains OFF. Under the space conditions, the first carrier is switched OFF and the second carrier is switched ON. By applying the FSK signal before it is allowed to modulate a high frequency carrier, the noise problem can be improved drastically. The data communication becomes very reliable, but the data transfer rate comes down if FSK is used because FSK standard supports a maximum baud rate of 1.2 KBPS. Each frequency change conveys two bits of data; that is. The bit rate is twice the baud rate.

FILTERS

The filters are used to obtain the desired band of frequency and to suppress the unwanted signals and noise. Filters are of different types. But the ceramic filters are most commonly used for carrier frequency generation and band selection. The ceramic filters are used because of their accurate frequency tuning.

DATA RECEPTION

DATA RECEPTION:

4.1 DEMODULATION

The process of recovering the original modulation signal from a modulated wave i termed as demodulation or detection. Basically, the demodulation or detection is process of frequency translation that requires a non-linear device in which the signa lying at a higher frequency in the frequency spectrum are converted to a lower frequenc converter circuits are also termed as detectors.

HARDWARE

HARDWARE:

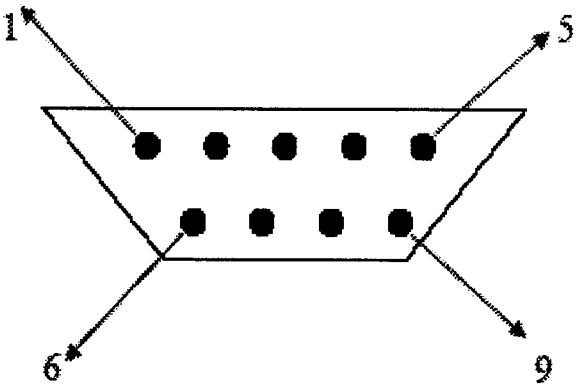
5.1 RS-232C SERIAL DATA STANDARD

In the 1960s as the use of time-share computer terminals became more widespread, modems were developed so that terminals could use phone lines to communicate with distant computers. As we stated earlier, modems and other devices used to send serial data are often referred to as data communication equipment or DCE. The terminals or computers that are sending or receiving the data are referred to as data terminal equipment or DTE. In response to the need for signal and handshake standards between DTE and DCE, the Electronic Industries Association (EIA) developed EIA standard RS-232C. This standard describes the functions of 25 signal and handshake pins for serial data transfer. It also describes the voltage levels. Impedance levels, rise and fall times, maximum bit rate, and maximum capacitance for these signal lines.

Before we work our way through the 25 pin functions, we will take a brief look at some of the other hardware aspects of RS-232C. RS-232C specifies 25 signal pins and it specifies that the DTE connector should be a male, and the DCE connector should be a female. A specific connector is not given, but the most commonly used connectors are the DB-25P male and the DB-25S female shown in figure. When you are wiring up these connectors. It is important to note the order in which the pins are numbered. The voltage levels for all RS-232C signals are as follows. A logic high, or mark, is a voltage between –3V and –15 V under load (-25 V no load). A logic low or space is a voltage between +3 V and +15 under load (+25 V no load). Voltages such as ±12 V are commonly used.

The output signal level usually swings between +12V and -12V. The "dead area" between +3v and -3v is designed to absorb line noise. In the various RS-232-like definitions this dead area may vary. For instance, the definition for V.10 has a dead area from +0.3v to -0.3v. Many receivers designed for RS-232 are sensitive to differentials of 1v or less.

5.2DB9PINCONNECTOR



DB9 PC signals set:

RS232 Pin Assignments	
Pin 1	Received Line Signal Detector (Data Carrier Detect)
Pin 2	Received Data
Pin 3	Transmit Data
Pin 4	Data Terminal Ready
Pin 5	Signal Ground
Pin 6	Data Set Ready
Pin 7	Request To Send
Pin 8	Clear To Send
Pin 9	Ring Indicator

5.3 PIN DESCRIPTION

1. DTR (Data terminal ready):

When the terminal is turned on, after going through a self-test, it sends ou signal DTR to indicate that it is ready for communication.

2. DSR (Data set ready):

When DCE is turned on and has gone through the self-test, it asserts DSR to indicate that it is ready to communicate.

3. RTS (Request to send):

When the DTE device (such as a pc) has a byte to transmit, it asserts RTS to signal the modem that it has a byte of data to transmit.

4. CTS (clear to send):

In response to RTS when the modem has room for storing the data it is to receive, it sends out signal CTS to the DTE (PC) to indicate that it can receive the data now.

5. DCD (data carrier detect):

The modem assert signal DCD to inform the DTE (PC) that a valid carrier has been detected and that contact between it and the other modem is established.

6.RI (ring indicator):

An output from the modem (DCE) and an input to a pc (DTE) indicates that the telephone is ringing. It goes on and off in synchronization with the ringing sound.

While signals DTR and DSR are used by the pc and modem respectively, to indicate that they are alive and well, it is RTS and CTS that actually control the flow of data. RTS and CTS are also referred to as hardware control flow signals.

This concludes the description of the 9 most important pins of the RS232 handshake signals plus TxD, RxD and ground. Ground is also referred to as SG (signal ground)

POWERLINE MODEM DESCRIPTION

POWERLINE MODEM DESCRIPTION

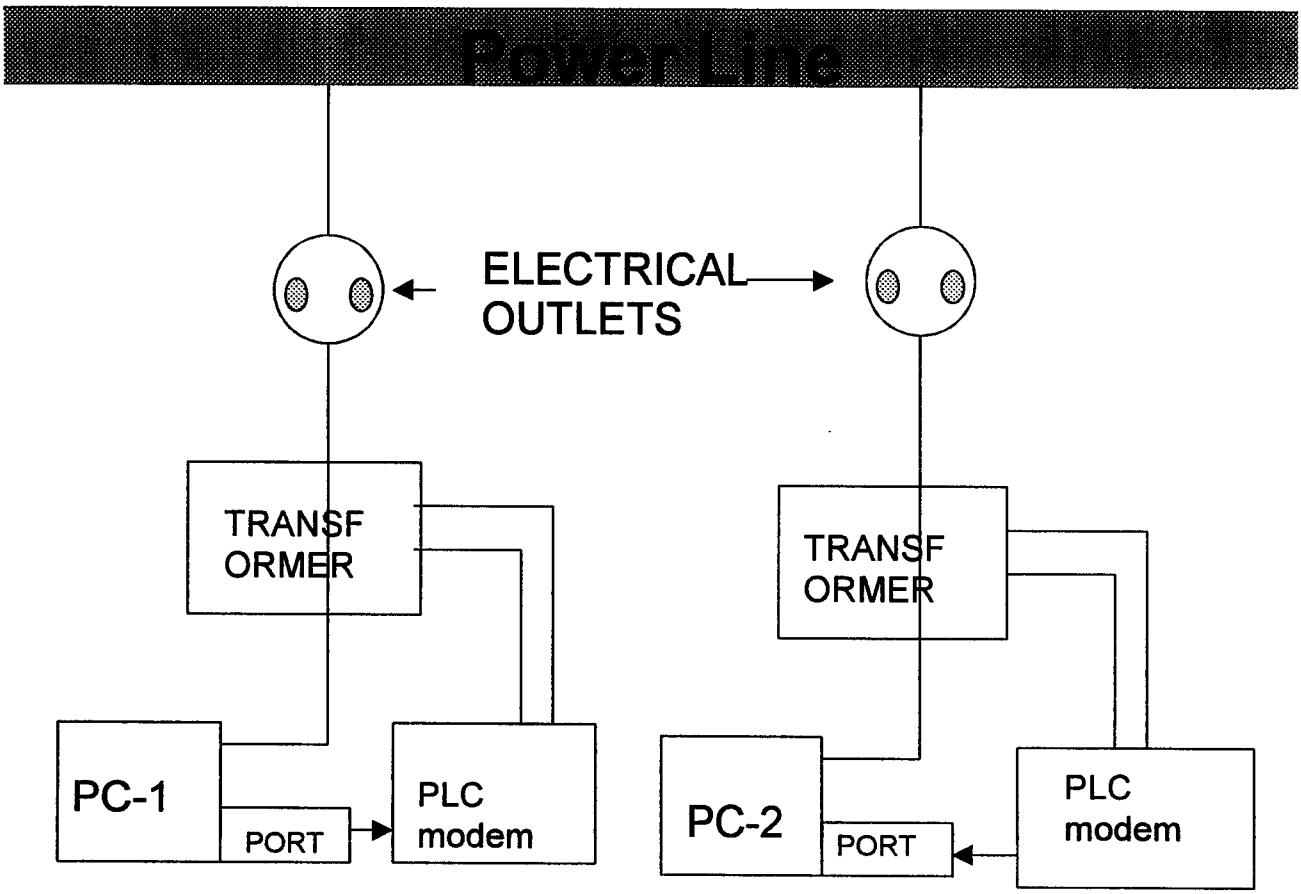
6.1 ATL90120

The ATL90120 is capable of transferring data over the power cable at the low voltage end of the power transformer of a 3-phase/ 4-wire distribution network. A pair of ATL90120 connected on the power line can provide low speed bi-directional data communication at a baud rate of 600 bps. It is built in a small form factor that can be easily integrated into and become part of the user's power line data communication system. The ATL90120 device is based on the FSK Technology, which ensures high noise immunity and reliable data communication.

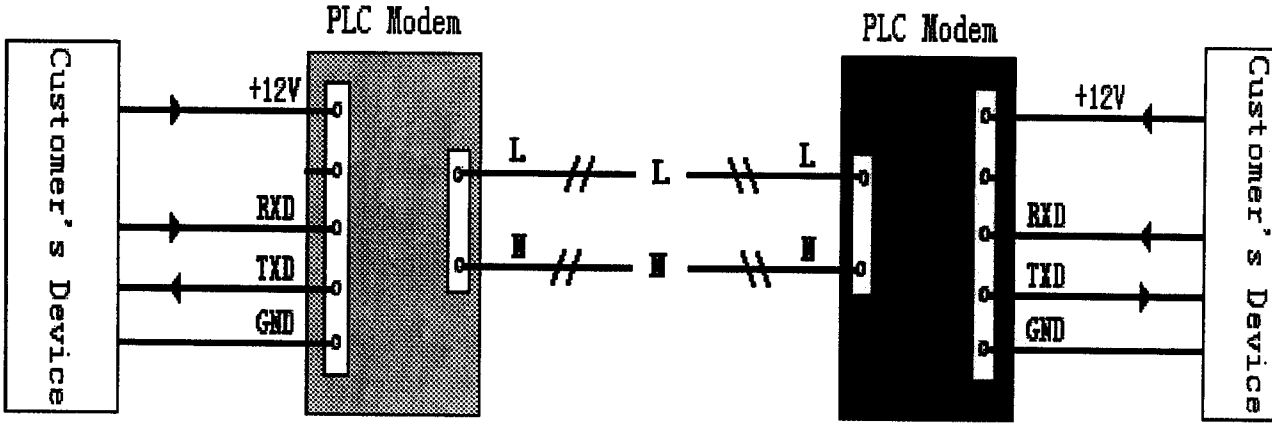
The ATL90120 provides bi-directional half-duplex data communication over the mains of any voltage up to 250v a. c., and for frequency of 50 or 60 Hz. The ATL90120 is a physical layer communication device. It does not require any protocol to function and therefore is protocol independent. Data flow through module as if it is a channel and therefore it is transparent to the Data Devices. As a result, with user's proper addressing and communication protocol, multiple units can be connected to the mains without affecting the operation of one another. There is no hassle of building interface circuits. It has a built-in on board AC coupling circuit, which allows direct and simple connection to the mains. Interface to user's data devices is a simple data-in and data-out serial link. Power to the PLC circuit module is a single +12V DC supply.

Applications of the Power Line Modem include status monitoring, control and data communication of devices connected on the power line, such Home Automation, Lighting Control, HVAC control, Low Speed Data Networks, Automatic Meter Reading, Signs and Information Display, Fire and Security Alarm, … and so on.

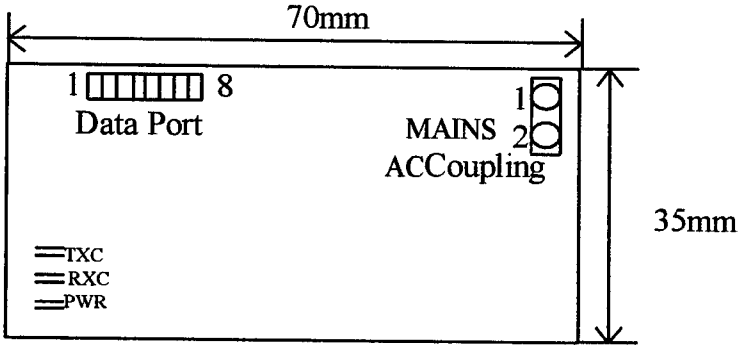
6.2 OUTLINE OF THE CONNECTION



6.3 ATL90120 APPLCATION DIAGRAM



CONNECTOR AND INDICATOR LAYOUT



DATA PORT PIN OUT ASSIGNMENT

Pin	Symbol	Description	Direction
1	+12V	+12v in	Input
2	GND	Ground	Input
3	GND	Ground	Output
4	RXD-232	RS232C level Data in	Input
5	TXD-232	RS232C level Data out	Output
6	RXD-TTL	TTL level Data in	Input
7	TXD-TTL	TTL level Data out	Output
8	NC	No Connection	-

AC COUPLING PIN OUT ASSIGNMENT

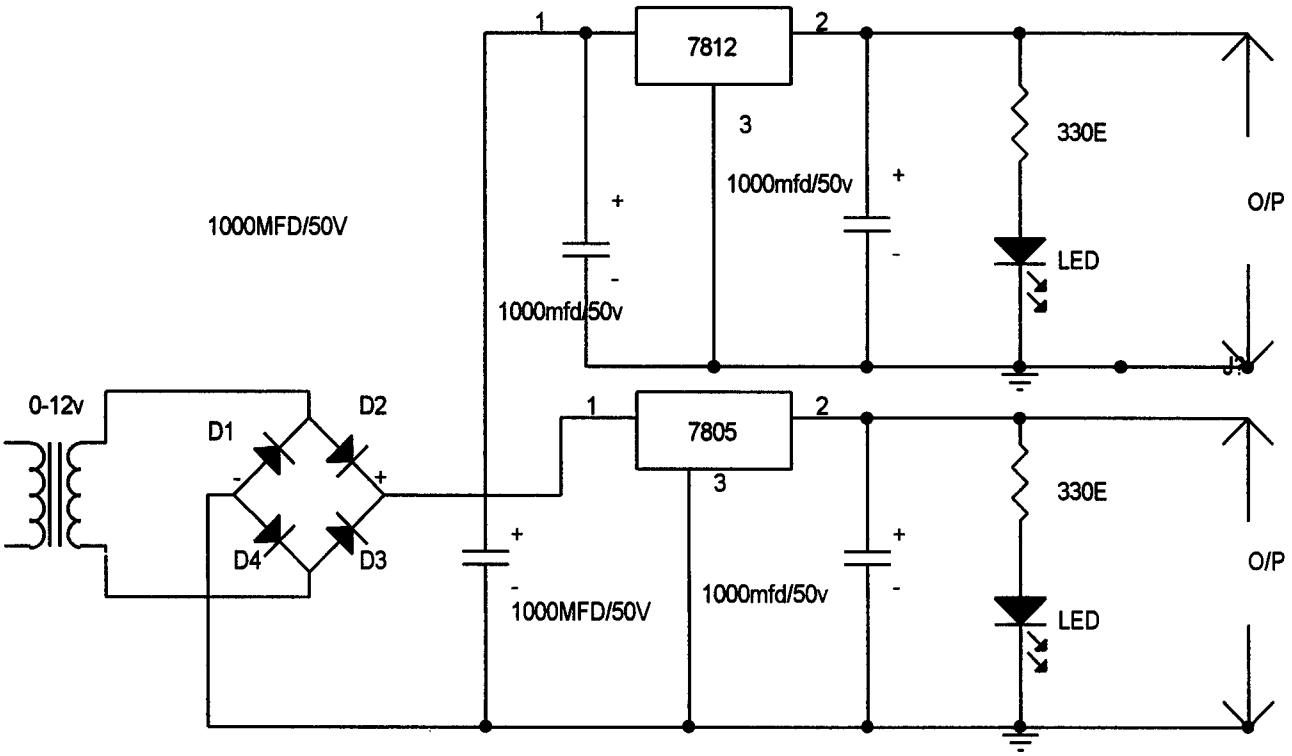
Pin	Symbol	Description	Direction
1	L	AC mains in	Input
2	N	Neutral in	Input

FEATURES

- Embedded ready-to-go Power Line Carrier Modem module with SMT components.
- Small form factor for easy of system integration
- Bi-directional half-duplex data communication over the mains
- Applicable to universal mains voltage and frequency up to 250V, 50 – 60 Hz
- Protocol independent, data transfer transparent to user's data terminals
- High noise immunity and reliable data communication
- Simple serial interface to user's data devices
- Built-in on board AC coupling circuit with direct connection to mains
- Built-in carrier generation and detection
- Multiple units can be connected to the power line of the distribution transformer
- Baud rate of 600 bps
- Selectable TTL and RS232C level serial interface to user's data devices
- Built with industrial grade components for operation under harsh environment
- Complies with EN50065-1:

6.4 BLOCK DIAGRAM – POWER SUPPLY UNIT

Power supply unit:



BLOCK DIAGRAM EXPLANATION:

It uses a mini transmitter to generate a carrier frequency, which can be varie between 70 KHz to 500 KHz. The carrier frequency is frequency modulated. Frequenc modulation is characterized by a narrow bandwidth. This narrow bandwidth has th advantage that a large number of channels can be accommodated on a single pair of line without causing interference between them. A frequency separation of 5 KHz betwee the channels is considered adequate. The signals are first amplified, limited and filtered t get rid of noise and other interfacing signals and then used to frequency modulate a oscillator. After amplification the FM signal is fed into the mains wires via an isolatio transformer. Signals transmitted from other stations are picked by the transformer and fe to the receiver section. After amplification, the received signal is demodulated.

POWER SUPPLY:

This unit needs two separate sources of DC power supply. A voltage of 7.5 Volts needed for all the stages except for the output stage of the transmitter and the A amplifier stage in the receiver, which requires a 24 Volt supply.

POWERSUPPLY

DESCRIPTION

POWER SUPPLY DESCRIPTION

7.1 INTRODUCTION

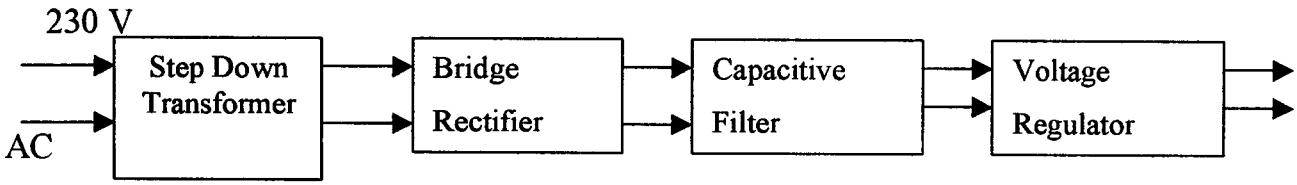
Power supplies are extensively used in all industrial applications. They are required to meet all or most of the following specifications:

- Isolation between the source and the load.
- High power density for reduction of size and weight.
- Controlled direction of power flow.
- High conversion efficiency.
- Controlled power factor if the source is an AC voltage
- Provides regulated ripple free input and output waveforms.

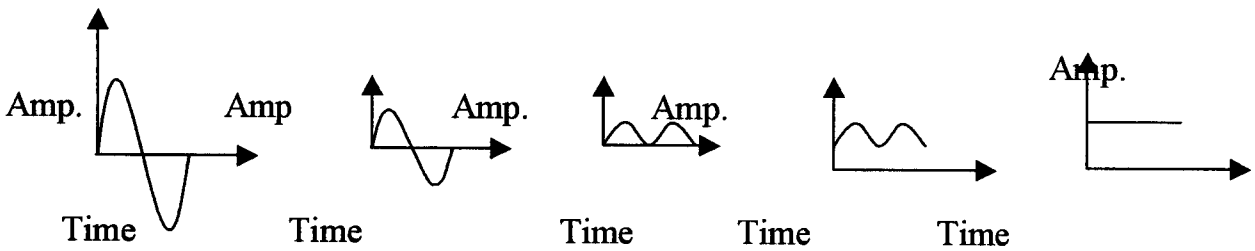
7.2 CIRCUIT DESCRIPTION

Since all electronic circuits work only with low D.C.voltage we need a power supply unit to provide the appropriate voltage supply. This unit consists of transformer, rectifier, filter and regulator. A.C. voltage typically 230V rms is connected to a transformer which steps that AC voltage down to the level to the desired AC voltage. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a DC voltage. This resulting DC voltage usually has some ripple or AC voltage variations. A regulator circuit can use this DC input to provide DC voltage that not only has much less ripple voltage but also remains the same DC value even the DC voltage varies some what, or the load connected to the output DC voltages changes.

7.3 BLOCK DIAGRAM



Output



TRANSFORMER

A transformer is a static (or stationary) piece of which electric power in one circuit is transformed into electric power of the same frequency in another circuit It can raise or lower the voltage in a circuit but with a corresponding decrease o increase in current. It works with the principle of mutual induction. In our projec we are using step down transformer for providing a necessary supply for the electronic circuits. In our project we are using a transformer with 15-0-15V center tapped secondary.

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 basic bridge configuration we see that two diodes (say D2 & D3) are

conducting while the other two diodes (D1 & D4) are in "off" state during the period t =0 to T/2. Accordingly for the negative of the input the conducting diodes are D1 & D4. Thus the polarity across the load is the same.

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 ultimately fed to the load.

REGULATOR

The output voltage from the capacitor is more filtered and finally regulated.

SOFTWARE LISTING

SOFTWARE LISTING

SOURCE CODE:

```
Dim outputbuffer, u, v, rcv, comp As Variant
Dim outdata As Variant
Dim i1 As Byte
Dim device As Byte
Dim outa, enbl As Byte

Dim dataout()  As Byte
Dim counter, tim As Long
Dim sendmesg As Variant
Dim numcount  As Integer

Dim vc, dv1, dv2, dv3, lcd, dat, dat1, pri As Variant
Dim devic1, devic2, devic3 As Boolean
Dim d1, d2, d3 As Boolean
Dim txt1 As String


Private Sub CLEAR_Click()
        Text4.Text = " "
End Sub


Private Sub Command2_Click()
        Text1.Text = ""
End Sub


Private Sub Command5_Click()

        "counter = 0
        "outdata(0) = &HDD
        "serialsend
        'Text4.Text = ""
        'i1 = 0
        'If i1 <= 25 Then
        'outdata (i1)
```

```
        'i1 = i1 + 1

        'Text4.Text = Val(Text4.Text) + outdata(i1)
        'End If
        "out &H37A, &HC0
        "outa = &H1
        "out &H378, outa

        counter = 0
        outdata = Text4.Text
        outputbuffer = outdata
        MSComm1.Output = outputbuffer
        For n = 1 To 90000000 Step 1
        Next n
        MsgBox ("sent")
        'serialsend
        'lcd = 1
        'dat = dat1 = 0

End Sub


Private Sub Command6_Click()
        End
End Sub


Private Sub Dir1_Change()
        File1.Path = Dir1.Path
        Text2.Text = Dir1.Path
End Sub


Private Sub Drive1_Change()
        Dir1.Path = Drive1.Drive
End Sub


Private Sub File1_Click()
        Text2.Text = Dir1.Path & "\" & File1.FileName
```

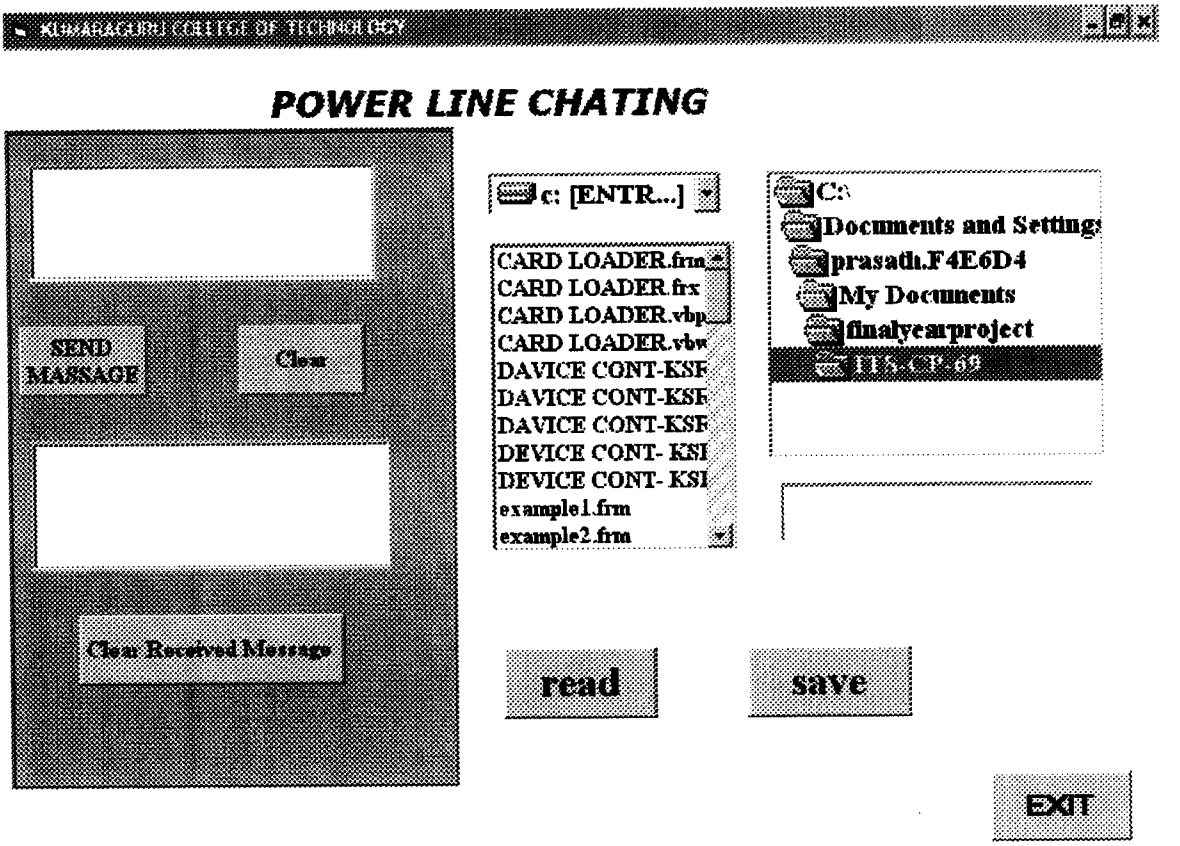
```
        txt1 = Text2.Text
End Sub


Private Sub MSComm1_OnComm()
        Dim bytesin As Integer, bytecount As Integer
        Select Case MSComm1.CommEvent
                Case comEvReceive
                dataout() = MSComm1.Input
                vc = dataout(0)
                Text1.Text = Text1.Text + Chr(dataout(0))
        End Select
End Sub


Private Sub Form_load()
        Form1.Caption = "KUMARAGURU COLLEGE OF TECHNOLOGY"
        Label1.Caption = "                    POWER LINE CHATING  "
        numcount = 1

        MSComm1.CommPort = 1
        MSComm1.Settings = "300,n,8,1"
        MSComm1.InputLen = 0
        MSComm1.OutBufferSize = 256

        MSComm1.InBufferSize = 256
        MSComm1.Handshaking = comNone
        MSComm1.EOFEnable = False
        MSComm1.RThreshold = 1

        MSComm1.SThreshold = 0
        MSComm1.InputMode = comInputModeBinary
        MSComm1.ParityReplace = " "

          If MSComm1.PortOpen = True Then
          MSComm1.PortOpen = False
          End If

          MSComm1.PortOpen = True
          dv1 = dv2 = dv3 = lcd = numcount = pri = tim = enbl = 0
```

```
        i1 = 0
End Sub


Private Sub read_Click()
        Dim nextline As String
        Open txt1 For Binary As #1
        Do Until EOF(1)
                Line Input #1, nextline
                Text4.Text = Text4.Text + nextline + vbCrLf
        Loop
End Sub


Private Sub save_Click()
        Open txt1 For Append As #1
        Write #1, Text1.Text
Close #1

End Sub


Private Sub Text4_Change()
        'Cls
        sendmesg = Mid$(Text4.Text, 1, 32)
        'Print sendmesg
        'outdata(0) = numcount
        'serialsend
        numcount = numcount + 1  'total number of data
End Sub


Private Sub serialsend()
        'MSComm1.PortOpen = True
        outputbuffer = outdata()
        MSComm1.Output = outputbuffer
End Sub

Private Sub delay()
        Dim p, r As Integer
```

```
        For p = 1 To 200 Step 1
        For r = 1 To 30000 Step 1
        Next r
        Next p
End Sub


Private Sub Timer1_Timer()
''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''
        If (vc = &H1) Then
                out &H37A, &HC0
                outa = &H1
                out &H378, outa
        GoTo ElseIf (vc = &H2) Then

                out &H37A, &HC0
                outa = &H2
                out &H378, outa
        GoTo adx

        ElseIf (vc = &H3) Then
                out &H37A, &HC0
                outa = &H4
                out &H378, outa
        GoTo adx

        ElseIf (vc = &H4) Then
                out &H37A, &HC0
                outa = &H0
                out &H378, outa
        GoTo adx

        ElseIf (enbl = &H1) Then
                Text4.Text = Text4.Text + Chr(vc)
adx:
        End If
End Sub
```

/* end of coding*/

SAMPLE OUTPUT


KUMARAGURU COLLEGE OF TECHNOLOGY
POWER LINE CHATING
SEND MASSAGE
Clear
Clear Received Massage
c: [ENTR...]
CARD LOADER.frm
CARD LOADER.frx
CARD LOADER.vbp
CARD LOADER.vbw
DAVICE CONT-KSF
DAVICE CONT-KSF
DAVICE CONT-KSF
DEVICE CONT- KSI
DEVICE CONT- KSI
example1.frm
example2.frm
C:\
Documents and Settings
prasath.F4E6D4
My Documents
finalyearproject
read
save
EXIT

CONCLUSION

CONCLUSION

Thus the **CHAT APPLICATION** is implemented using the powerline communication technology.

This telecommunications model has multiple advantages over others including speed, an established local loop, and dedicated connections. These advantages make PowerLine technology an attractive alternative for telecommunications systems.

Dedicated, multipurpose communication lines make the PowerLine model an attractive option for the information age.

PowerLine technology is an exciting alternative to connecting to the Internet via phone and modem. Though this technology is not commercially available yet, it should be available before other broadband technologies due to the relatively low cost of its local loop.

Customers want cheaper, faster, and more reliable access to the Internet right now. Not only can PowerLine provide that type of service, but it will be available before other broadband access technologies. Therefore PowerLine has both a time to market and cost advantage. This maybe too much for the other broadband access technologies

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BIBLIOGRAPHY

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