

## INDUSTRIAL AUTOMATION SYSTEM USING POWER LINE COMMUNICATION AND ANDROID DEVICE

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**Abstract**— In this paper we present a feasible Industrial Automation System in which ubiquitous power lines are mode of transmitting data over 220V/50Hz (440V/50Hz Also) to control the electrical devices. A power line communication modem is used in which FSK [Frequency shift keying] is used for modulating the signal. An Android device is connected to microcontroller via Wi-Fi and this android device sends the data and in turn controls the devices. There are Multiple receivers which contain the power line modem can be connected through the power line to the devices.

**Keywords**—Power line communication, Wi-Fi, Microcontroller, Frequency shift keying, Android

### I. INTRODUCTION

Automation is the need of the hour from developed countries to the developing countries in order to suffice their ever increasing demand of the population. For this speed matters and that comes from Automation. It simplifies things without involving physical work for managing various sectors like hospitals, public edifices, private houses and so on.

In Industries there are widespread of electrical network, we can use this network in a convenient and low cost way to control appliances remotely because industries are very massive and things should be controlled very rapid otherwise there will be some loss. In Industries, Device switches normally located at a distance far from the working area. In Industries, too it becomes tedious to physically switch on and off appliances from working area.

The purpose of the system is to provide convenience to the user interaction system and to make things around us smarter and interactive and to reduce power consumption and save energy. This system requires no modification to the appliances, and it works for all appliances using electricity since electricity to the socket is controlled and not the appliance directly. The number of appliances needed to be controlled can be easily increased by increasing the range of addresses of the receiver units. Also the hardware and software used to build the system are licensed under open source license, unlike commercial systems which are proprietary in nature, thus lowering the cost of the system significantly.

With increasing amounts of electrical appliances in residential homes, power usage is becoming a larger concern. Home owners require a more convenient system to monitor power usage so they can make decisions to use power more efficiently. Since there is already a wired network in most homes, the power line mains, it is unnecessary to add additional wiring for a power monitoring system. Therefore, the mains should be used for such a power monitoring and control system, increasing the convenience for the home owner.

The design of a Wireless Home Automation System Using PLC (Power Line Communication) was undertaken because of a need for users to efficiently manage the consumption of power in their homes. Costs will be kept to a minimum using existing home wiring. The PLC (Power Line Communication) over the low voltage grid has interested several researchers and utilities during the last decade. They are trying to achieve higher bit-rates and more reliable communication over the power lines. A power line communication (PLC) system superimposes a signal on the mains. It is the usage of power lines as a transmission channel for the exchange of data.

Each PLC unit can send or receive commands and data using this communication channel. The power usage of a load is monitored by a PLC unit, and the resulting data is sent back to the home owner over the power lines. The user can then reduce the power going into the load with a dimmer circuit on the PLC unit.

PLC is a technology which uses power lines as physical media for data transmission. PLC system signals were sent and received on household and industrial 50Hz current bearing power lines. PLC offers a no new wires solution because the infrastructure has already been established. PLC modems are used for transmitting data at a rapid speed through a power line in a house, an office, a building, and a factory, etc. Here, the existing alternating current (AC) power wires serve as a transmission medium by which information is relayed from a transmitter or control station to one or more receivers. It is because power line is a relatively cheaper and more robust communication channel used throughout the world except wireless channel. It is used more commonly than any other communication channel.

## II. THE PLC

**Power-line communication (PLC)** uses communication protocol that is electrical wiring to carry both data, and Alternating Current (AC) simultaneously electric power transmission or electric power distribution.

It is also known as power-line carrier, power-line digital subscriber line (PDSL), mains communication, power-line telecommunications, or power-line networking (PLN).

Power Line Communication (PLC) is a communication technology that enables sending data over existing power cables. This means that, with just power cables running to an electronic device (for example) one can both power it up and at the same time control/retrieve data from it in a half-duplex manner.

**For understanding, PLC can be broadly viewed as:**

1. Narrowband PLC
2. Broadband PLC

**Narrowband PLC** works at lower frequencies (3-500 kHz), lower data rates (up to 100s of kbps), and has longer range (up to several kilometres), which can be extended using repeaters. Broadband PLC works at higher frequencies (1.8-250 MHz), high data rates (up to 100s of Mbps) and is used in shorter-range applications.

Recently, narrowband Power Line Communication has been receiving widespread attention due to its applications in the Smart Grid. Another application that narrowband PLC has been used in is smart energy generation, particularly in micro-inverters for solar panels.

**Broadband PLC**, in contrast, has mainly found acceptance as a last-mile solution for Internet distribution and home networking. With its high data rates and no additional wiring, broadband PLC is an exciting and effective technology for multimedia distribution within homes. This optimism in the market is reflected by the recent acquisitions of Intel Lon by Atheros, Copper gate by Sigma, DS2 by Marvell, and Gigle by Broadcom, all in the Home Area Networking (HAN) segment.

There is another way to classify Power Line Communication and that is:

1. PLC over AC lines
2. PLC over DC lines

While most companies are currently geared towards providing AC-PLC solutions, PLC in DC lines also has applications. Two such applications are PLC over the DC-bus in distributed energy generation, and PLC in transportation (electronic controls in airplanes, automobiles and trains). This use reduces wiring complexity, weight, and ultimately cost of communications inside vehicles. However, in this article, we will be dealing mostly with narrowband PLC over AC lines.

### **B.PLC Technology: How does it work?**

PLC is like any other communication technology whereby a sender modulates the data to be sent, injects it onto medium, and the receiver de-modulates the data to read it. The major difference

is that PLC does not need extra cabling, it re-uses existing wiring. Considering the pervasiveness of power lines, this means with PLC, virtually all line- powered devices can be controlled or monitored!

When discussing communication technology, it is often useful to refer to the 7-layer OSI model. Some PLC chips can implement only the Physical Layer of the OSI model, while others integrate all seven layers. One could use a Digital Signal Processor (DSP) with a pure software realization of the MAC and an external PHY circuit, or an optimized System-on-Chip (SoC) solution, which includes the complete PLC – MAC and PHY. The Cypress CY8CPLCXX series is an example of the latter, with a ready-to-use Physical and Network layer, and a user-programmable application layer. Before moving on to the applications of PLC, let’s first understand the various aspects of the Physical layer by viewing it as three segments based on data rate.

	Low Data Rate	Medium Data Rate	High Data Rate
Data	0-10kbps	10kbps-1Mbps	>1Mbps
Modulation	BPSK,FSK,SFSK,QAM	PSK+OFDM	PSK+OFDM
Standards	IEC 61334,ANSI/EIA 709.1,.2,UPB	PRIME,G3,P1901.2	G.hn,IEEE 1901
Frequency range	Upto 500kHz	Upto 500kHz	In MHz
Applications	Control and Command	Control and Command, Voice	Broadband over powerline,home Networking

### C. Modulation Schemes

A variety of modulation schemes can be used in PLC. Some of these are Orthogonal Frequency Division Multiplexing (OFDM), Binary Phase Shift Keying (BPSK), Frequency Shift Keying (FSK), Spread-FSK (S-FSK) and proprietary schemes too (for example Differential Code Shift Keying (DCSK) from Yitran). In the table below, BPSK, FSK, SFSK and OFDM are compared based on two important criteria – bandwidth efficiency and complexity (cost).

Modulation Scheme	Bandwidth Efficiency	Complexity
BPSK	Medium	Low
FSK	Medium	Low
SFSK	Low	Medium
OFDM	High	High

OFDM offers high data rates, but requires computational horsepower to churn out Fast Fourier Transforms (FFT) and Inverse-FFT (IFFT), as required by the scheme. On the other hand, BPSK, FSK are robust and simple but offer lower data rates. The current trend is to move towards OFDM with PSK modulation (G3 and probably P1901.2). Such heavy computation will require DSP capability, whereas FSK, PSK and SFSK can be accomplished by a microcontroller.

### D. Standards

Various standards have been developed to ensure reliable communications and interoperability, especially for the smart grid and home networking. Examples of such standards are:

Standard	Technology	Frequency band	Bit rate(kbps)
G3-PLC	OFDM	36-90.6kHz	5.6-45
PRIME	OFDM	42-89kHz	21.4-128.6
IEEE P1901.2	OFDM	9-500kHz	

ANSI/EIA 709.1.2	BPSK	6,131kHz	3.6-5.4
KNX	S-FSK	125-140kHz	1.2
IEC61334	S-FSK	CENELEC-A	2.4

These, along with the organizations that govern them like CENELEC, FCC, ARIB, Homeplug Power Alliance specify ranges for operation of PLC. If a worldwide standard for PLC were to be established, this would have a positive impact on adoption of PLC. So far, the G3-PLC standard is touted as the most robust scheme available, and the IEEE 1901.2 working group is committed to developing a universally acceptable standard.

**E. Frequencies**

Different regions of the world have different frequency bands allocated to narrowband PLC. The table below summarizes the different frequencies available for narrowband PLC communication in the respective region

Region	Regularity Body	Frequency Band	Note
Europe	CENELEC	3-95kHz 95-125kHz 125-140kHz 140-148.5kHz	A-Energy providers B-Reserved for users c-Reserved for users, regulated CSMA access d-Reserved for users
Japan	ARIB	10-450kHz	
China	EPRI	3-90kHz 3-500kHz	Not Regulated
USA	FCC	10-490kHz	

Where:

CENELEC - European Committee for Electrotechnical Standardization.

ARIB – Association of Radio Industries & Businesses

EPRI – Electric Power Research Institute

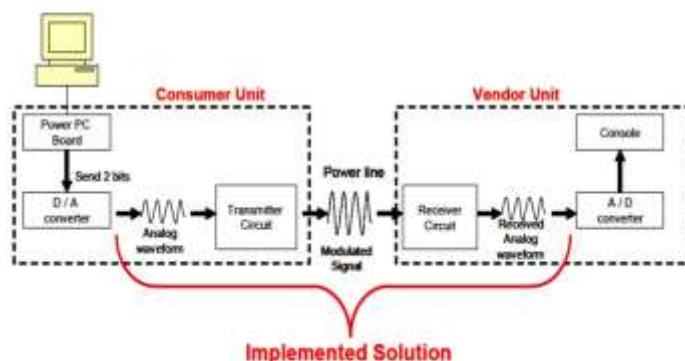
FCC – Federal Communications Commission

**III. LITERATURE REVIEW STAGE**

**A. Meter Man**

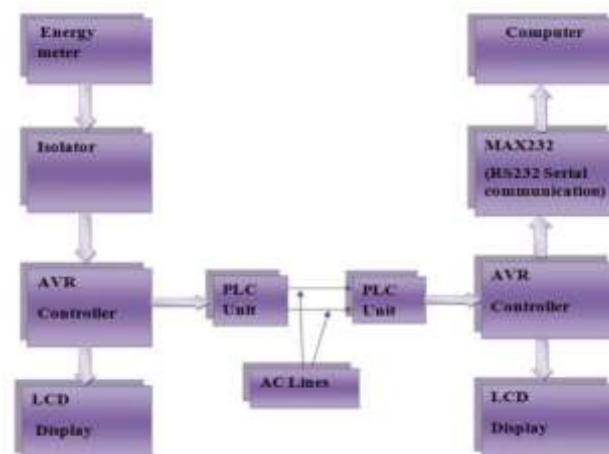


Figure 1. Meter Man Concept



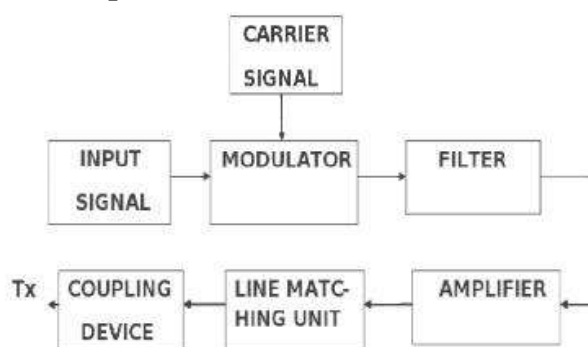
In existing system, the consumer would go to Meter Man's Graphical User Interface and choose to adjust his power consumption level that is he will increase or decrease the amount by which he needs power, and Meter Man will send a signal to the electric company inculcating them of the change in demand. Overall, this implementation will be perfect for the distribution of power between two electric grids so that power outages could be avoided. They invented device that would allow communication between the power Supplier Company and their large industrial clients in the hope that their communication would lower the probability of power failures and that it communicates solely through Powerlines. It has 2 circuits, transmitter and receiver. It uses FSK modulating chips and power amplifiers.

### B. Automatic Meter Reading



This system is Automatic meter reading (AMR). It is the modern Power measuring device. It is being used in measuring electricity, gas, water consumption in many countries since it has a lot of advantages that the old analog meters don't have. It has benefits in safety, real time measuring and time saving as well as it has a better user interface and digital data analysis. Data is send over existing carrier(Powerline) that reduces the complexity and cost of system.

### C. Data Transmission and Reception

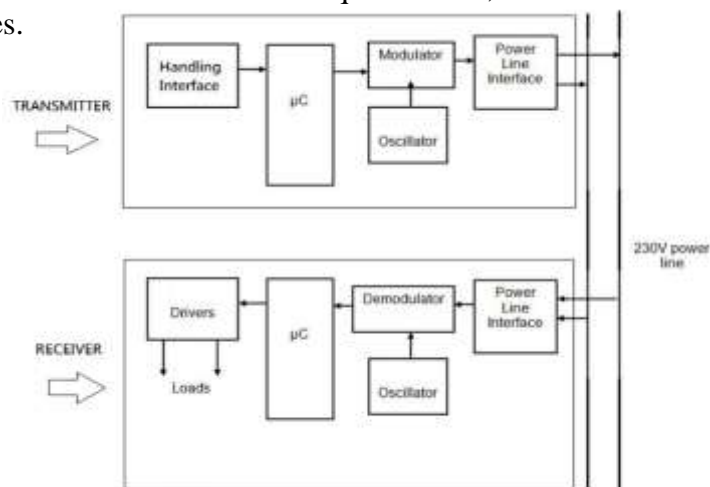


Data Transmission and Reception using Power Line Communication is the simplest method of using power line technology, in this project the existing electrical layout is used to transmit the data or command from one point towards other without any interference in the electrical signal within the same house. The system can be used to transmit a data signal in the frequency range of 3 KHz to 148.5 KHz. The data code generated is modulated using modulation technique such as FSK, QPSK and after that it is fed to the amplifier then the signal is carried through power line and then at other end the signal is demodulated using the same technique and message is received which was transferred.

#### IV. PROPOSED SYSTEM

In our project, we have applied the concept of powerline communication to control the electrical devices in industries via an android powered device.

**Transmission Part:** Data from android device is sent via Wi-Fi to the microcontroller, this data is modulated which modulation technique of FSK, it is modulated so that it can be transmitted through Powerlines.



**Medium of communication:** Data is transferred to receiver using Powerline

**Reception Part:** This data is received on the receiver power line modem (which is demodulated) and sent to the microcontroller (which is on the receiver side) and the microcontroller then decides which device is to be controlled (depending upon which option is selected in the android application).

**Android Device:** All the options are present on the android application that which appliance should be controlled

**Wi-Fi Module:** The Wi-Fi module is connected through the UART of the microcontroller.

**Modulation:** The power line modem used is PLC1187 which is connected to the microcontroller through another UART is used for modulation of the data, modulation output provides signal which can be directly connected to Powerline.

#### V. ADVANTAGES

- When compared to other communication mediums like routers which will be required in more number in an Industry to cover large areas in acres and to remove Black spots where PLC will provide one stop solution and will limit the cost.
- There will be no need to implement extra infrastructure as PLC will use existing Powerlines.
- It provides Flexibility & Stability.
- It's easy to install.
- PLC solution is a complementary solution to traditional fixed line networks, wireless networks.
- Power line communication can be used for many applications like Remote control, Emergency alarms, Security purpose, overall Industrial Automation.

#### VI. FUTURE SCOPE

To extend the project in near future voice recognition system and Internet of things can be implemented with a RF master unit which can serve as more user-friendly interface, web based can be implemented which will be useful for data logging purposes.

#### VII. CONCLUSION & DISCUSSION

As it is emerging technology, the next few years will decide whether PLC can compete in the automation market. Therefore, the use of existing power lines in any infrastructures can be used to

send data to control electrical devices. This is a low-cost mode of converting the analog means to digital, as the world is on the verge of the full time digital era. Thus, in this project we will initially control two lamps and a fan. To switch ON the lamp, we will use high voltage levels in terms of binary bits whereas we will use low voltage level to switch OFF the lamp. We will use PWM duty cycle to control the speed of the fan.

- PLC solutions may be seen as complementary or alternative solutions to traditional fixed line networks, wireless networks and VDSL networks.
- According to existing network architectures, buildings or technical constraints, either solution can be chosen, but one can also consider one solution to complement another.
- PLC bandwidths are set to increase, the Homeplug AV standard is being considered for broadcasting digital television.
- Many research projects are ongoing into these solutions and their applications, it is all to come, and one should pay close attention to news about this technology.

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