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# Architecture of Power Line Communication

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**Abstract—***Power-Line Communication (PLC), is type of communication in which the data transfer takes place on a conductor that is also use simultaneously for AC electric power transmission. In this paper we are discussing the generic system architecture of power line communication. An example interfacing with microcontroller is also shown.*

**Index terms***: System Architecture, C2000 microcontroller, Analog Front End (AFE)*

## 1. INTRODUCTION

Power-Line communication (PLC), is a type of communication in which the data transfer takes place on conductor which is also used for electric power distribution.

The superimposing of a communication signal onto a power waveform has been practiced for over a century. Recently in 1990's it started gaining momentum. The advancements in semiconductor theory and production in the last half century and associated growth of consumer electronics market, facilitated the computer and internet boom. Subsequently this set the stage for home networks and home automation. They became the ideal candidates for power line communications. This driving force for power line communication is typical for high, medium and low voltage distributions, as well as an intra building networks. Traditional applications were limited to voice and control signals over high voltage and medium voltage networks.

The first know patents for power line communication (PLC), systems were registered in Britain and Germany in 1897 and 1901 respectively. Unknown to general public utility companies have utilized the PLC for many decades to implement their own telephone systems over their own distributions lines.

In 1901 patent Loubery proposed a multi tone signaling scheme, i.e. different tone (frequencies) representing different messages. It is somewhat similar to DTMF (Dual Tone Multi Frequency) technology. Further, the patent suggests dedicated tuned filters to receive and interpret the message. It is now clear that the system can only communicate very crudely with receiver, but this technology is still used in many modern high speed PLC. The OFDM (Orthogonal Frequency Division Multiplexing) and FSK (Frequency Shift Keying), modulation techniques does the same thing by making use of multiple frequencies or frequency band to transmit data.

Currently in third world countries were telephone networks are still restricted, these power line networks are wide spread and can facilitate the desperate need for communication. It is hoped that internet over power lines will soon facilitate telephony, education, banking and even remote medical consultation in these third world countries.

In PLC, at low frequencies, close to the frequency the network was designed for, power – line cabling is not as hostile towards the communication signals. Unfortunately, bandwidth is directly limited by frequency, and only limited data rates can be achieved with low frequency PLC's. As the communication frequency is pushed up to increase bandwidth, so do the complications increases. Instead of conducting copper networks, the power line channel acts more and more like a complex antenna as frequency rises. Both from technical efficiency view point as well as environmental and interference perspectives, this potential radiated emission of the PLC signal has become an important consideration.

## 2. POWER LINE COMMUNICATION (PLC) FEATURES

**A PLC has many features.**

It has no additional wire networks. It would profitable to implement where the distribution line exists and radio based systems would not be feasible. This perquisites are meet by medium voltage cables. As they virtually span up to a long distances, they can be effectively used for communication. GSM can be used there but we need to take account of the cost associated with service. Therefore for long distances power line communication is the only alternative allowing the communication with numerous clients. Thus it makes an expensive technology a quite profitable one. An analysis shows that the coverage of distances or large area by an existing infrastructure and a greater number of users is crucial to profitable employment of power line communication.

PLC has various applications, ranging from home application to factory use. It can also be used in office.

For home application, it can used as first aid information systems, remote control switching, electric keys, interphone systems, data transmission to electrical appliances in home.

In office it can used to manage to the FAX machine, indoor telephone, and remote office appliances control. In factory, PLC can be mainly used to monitor high systems. As they are connected to voltage supply (i.e. power lines), they can be used as communication line.

## 3. SYSTEM ARCHITECTURE

The superimposing of a communication signal on a power waveform implies that communication circuitry would have to be carefully designed and interfaced for optimal compatibility between the two systems. The two different systems work at different levels. The communication work at low voltage but at high frequencies, but the power line work at high voltage and low frequency.

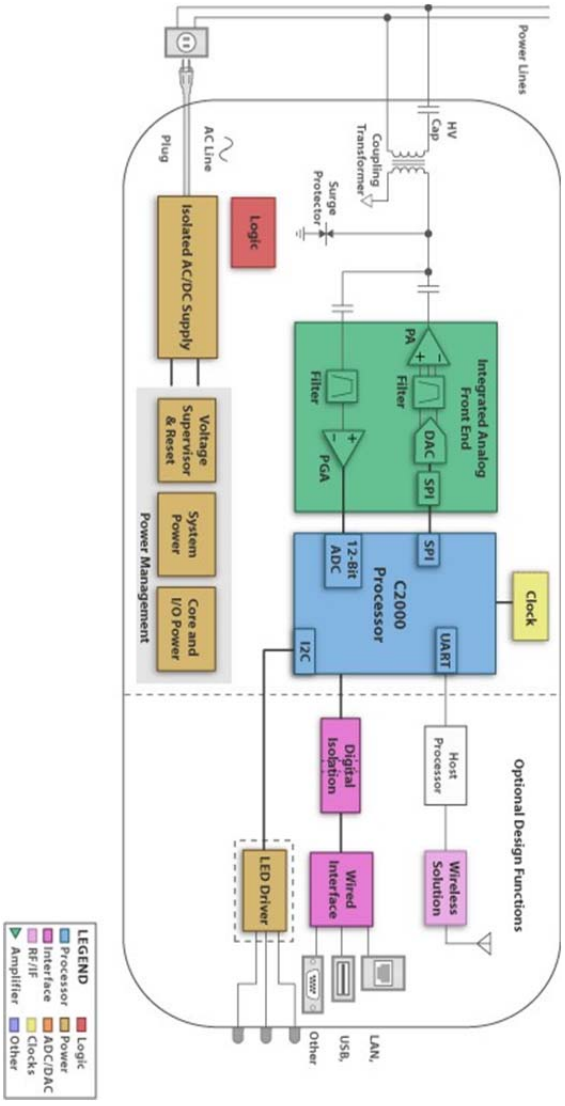


**Fig. 1: Basic Block Diagram of PLC**

The main problem arises with the design of blocking inductors, blocking capacitors and coupling transformers.

- Blocking inductor has to be designed to prevent

Saturation (Power frequency) and to prevent voltage drop (power current). But blocking inductor have to function properly for modulation frequency. Air-core and gapped-core inductor are well suited for this application.

- Coupling capacitors carry the communication

Current and thus have to be high frequency capacitors and also, they have to filter the power voltage as well as surges and therefore need to be high voltage capacitors.

- The main use of coupling transformers is to

Provide galvanic isolation and impedance adaptation, but they have to freely pass the high-frequency communication signal

### 3.1 Integrated Analog Front End (AFE).

Integrated Analog front-end transceiver provides two main paths: Transmit (TX) path and Receive (Rx) path. It also provides the means of establishing communication between processor and the power line.

MAX 2991 (Maxim Integrated) is an Integrated Circuit (IC) which can be used here as an analog front end in the power line communication. It is the state-of-the-art integrated circuit that delivers high integration and superb performance, while reducing the total system cost. It is specially designed for OFDM (Orthogonal Frequency Division Multiplexing) modulated signal transmission over power line. Operating in the 10 KHz to 490 KHz band, the programmable filters allow compliance with CENELEC, FCC and ARIB standards using the same device.

The transmit path injects an OFDM modulated signal into the power line. The transmit path is composed of a digital IIR filter, digital-to-analog (DAC) converter, followed by a low pass and pre line driver.

The receiver path is for the signal enhancement, filtering, digitization of the received signal. The signal is composed of low pass and high filter, a two stage automatic gain controller (AGC) and an analog to digital converter (ADC). The integrated AGC maximizes the dynamic range of the signal up to 60 dB, while the low pass filter removes only out-of-band noises, and selects the desired frequency band. The ADC converts the enhanced and amplified input signal to a digital format. An integrated offset cancellation loop minimizes the DC offset.

### 3.2 Microcontroller

Microcontroller is special Integrated circuit (IC) containing a processor core and programmable input output peripherals. Here microcontroller is used to interface with the Analog Front End (AFE) and user peripherals. The user peripherals includes Wi-Fi connectivity, wired interface with LAN, USB's

etc. The microcontroller basically sends the data to AFE given by the user to be send over the power line (i.e. microcontroller is transmitting TX) and also receives the data given by AFE and then it transmits to intended receiver (i.e. microcontroller is receiving RX).

C 2000 is a 32-bit microcontroller with advanced peripherals, analog integration and its package size is from 32 to 256 pin. It enhances the performance of Power line communication (PLC) and real-time control in a variety of applications.

### 3.3 Noise

A power line communication network is made up off, a wired link and a wireless link. A wired link is made up off a pear-to-pear fiber optical network, with attenuation and its normal noise. The wireless part of it is mainly affected by all the alternation and noises of free space/atmosphere.

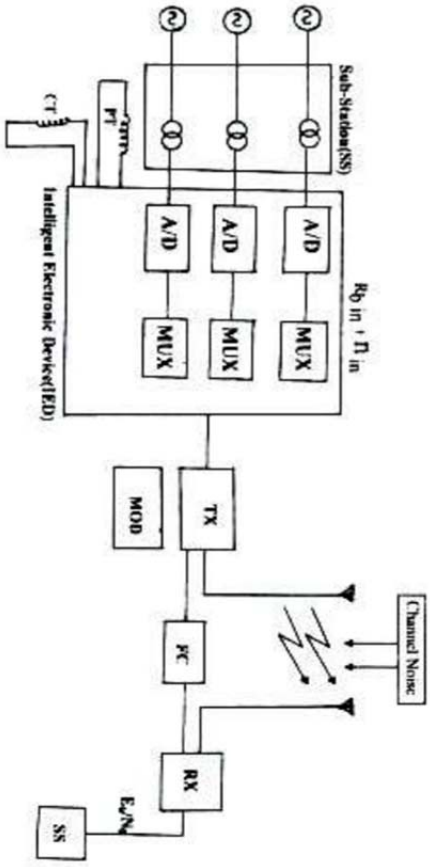


**Fig. 2: A Power line network with associate noise**

### 3.4 Interference

The extensive signal processing will be used to make the transmitted signal as robust as possible to impairments to power grid and local power distribution in the houses. In the HF band (3-30 MHz), communication system could not be affected by it. It would interfere with HF broadcasting, radio-communication services. Services such as low VHF band and TV will also be affected.

## 4. UTILIZATION OF POWER LINE COMMUNICATION (PLC)

There are many proposed ideas dealing with the Power Line Communication (PLC). Some of them are discussed here as follows:

- Power line communication in electricity

Infrastructure for data transmission, is also been used in context with smart grid.

- Power line communication can also be used

Indoor. Indoor use like intercommunication (Inter Comm.) use, electrical appliances control etc.
It can also be used in offices. In the offices Examples such as connecting printer to the computer using power line, thereby reducing the cost and space of extra cable.

- Outdoor or use of power line communication

Include the use by railways, use in smart grid etc.

- The optimization of such system for electrical

Utilities to decrease the power consumption in the peak hours can low load hours. The power line communication systems links consumer and electrical utilities to improve the load distribution.

## 5. CONCLUSION

The Power Line communication system can be realize with help of some combination of fiber optics, CATV and the public subscriber telephone system. We are continuously trying to find better solution hence the BEST SOLUTION one that gives the variety of transmission of electricity and data signals. While studying technical possibilities. We are going to build up those business scenarios which useful for commercial purposes.

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