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Comparitive analysis of data transmission through Power Line Carrier Communication using different modulation technique with MATLAB

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Abstract: In the modern world the usage of PLCC is spreading as it is cheap, simple, and easy to deployment. Using the existing power transmission line and infrastructure this can be achieved at lower cost but the main hurdle is noise insertion and data loss for long distance transmission. This paper provides a development of PLCC in AMR system by employing different modulation technique to decrease signal distortion. In this paper PSK is being implemented for modulation/demodulation at transmitting/ receiving end. Simulation of all the circuits is being done on ORCAD/MAT LAB. Also a comparative study of SNR and BER is represented in this paper.

Keywords: PLCC, AMR, Modulations, PSK, MATLAB.

Introduction

In the last decade, a number of networking technologies are invented which purely concentrates on home networks. But users are limited due to its nature of high cost. Some are over engineered or difficult to install in pre-existing buildings. This report is based on one such communication medium, which has a very high potential growth. i.e. the power line, which give rise to power line carrier communication.Power line carrier communication refers to the concept of transmitting information usingthe mains power line as a communications channel Our project mainly aims at applicability of power line carrier communication techniques towards home networking i.e., Automatic meter reading (AMR).Automatic meter reading system is a technology which is used to gather data from energy, water and gas metering devices and transfer it to central station in order to analyze it for billingpurposes. It is an effective mean of data collection that allow substantial saving through meter re-read, greater data accuracy, allow frequent meter reading, improved billing and consumer service, more timely energy profiles and consumption trends update and better deployment of human resource.

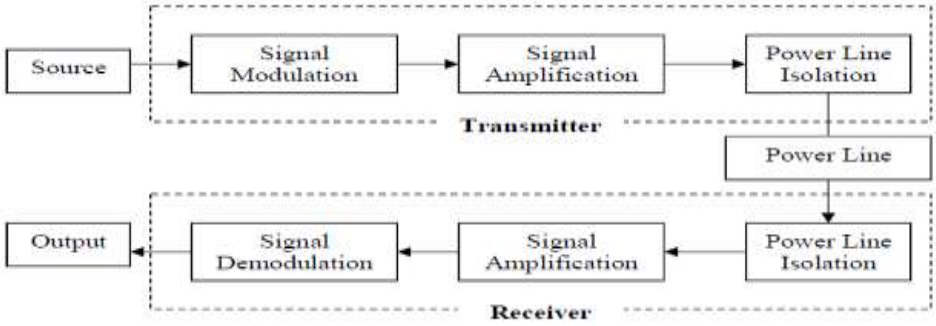
In this project Power line Communications (PLC), or sometimes also referred as Power line Telecommunication (PLT) technology is used that utilizes the existing electrical power distribution network as a transmission medium for communication purpose. By using this existing cable infrastructure it obviates the need for installation and maintenance of dedicated communication links. The main objective is to successfully transmit the meter reading using the power line without any noise or signal distortion. The basic process involves three steps:

1) Modulate the data so that it can be sent over the transmission medium.
2) Transmit the signal in such a manner to reduce signal distortion.
3) Receive and demodulate the signal to extract the data.

Since power lines are designed to send power, they are not optimized as transmission medium for data. Power lines typically have high amounts of noise, which causes signal distortion. This signal distortion increases the bit error rate (BER). The BER is defined as the ratio of incorrect bits demodulated by the receiver to the number of total bits received. Furthermore, power line signals are also subject to high amounts of attenuation. These factors are the primary reasons why power lines have not been adopted for mainstream data delivery. To overcome these shortcomings of the power line, we can employ various methods to decrease the BER. The current prototype uses FSK to modulate the message signal. All existing modulation techniques have deteriorated performance under the presence of interference, but there exist techniques that have slightly better performance than FSK in noise. A technique called PSK (Phase Shift Keying) has better performance than FSK under noise.

Frequency Shift Keying (FSK): In this form of modulation carrier wave frequency is varied by a binary input stream. As the binary input signal changes from logic '0' to logic '1' and vice-versa, the FSK output shifts between two frequencies. Phase Shift Keying (PSK): In this form of modulation phase of the carrier wave is varied by a binary input stream. As the binary input signal changes from logic '0' to logic '1', and vice-versa, the PSK output shifts between two angles that are 180 degrees out of phase while keeping the frequency a constant. Amplitude Shift Keying (ASK): In an ASK system, binary symbol 1 is represented by transmitting carrier wave of fixed amplitude and fixed frequency for the bit duration T seconds. If the signal value is 1 then the carrier signal will be transmit and when signal value is 0 then not. In order to decide the method of modulation to be used in power line communication it is important to keep in mind the hostile environment in which it operates. It is difficult to say which method to use, whether FSK or PSK. Phase delay in the PLC channel is expected and unpredictable in the case of PSK technique. The reliable performance of PSK with any reasonable amount of phase delay makes it the modulation scheme of choice for PLCC techniques.

Practical Implementation



1. Transmitter

One of the most important parts of our power line transmitter and receiver is the Power Line Interface. Because our circuit has to connect to the 220V 50 Hz power line.The ideal isolation circuit should completely block the 50Hz signal, and pass the information signal. The information signal in our case is the frequency modulated signal which is achieved by employing a ring modulator composed of four diodes DIN4934 in order to have PSK modulated signal.

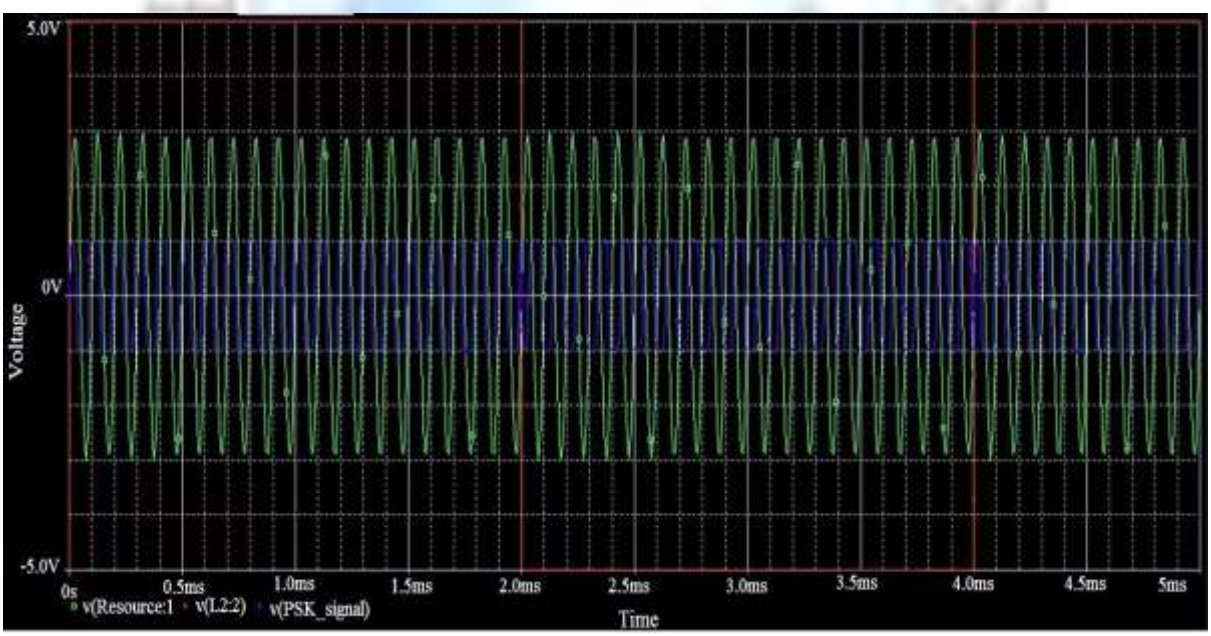


Fig 1. Simulation Result of Modulation Circuit

2. Amplifier

The signal from the source is usually very small. Even after modulation, it is not strong enough for the receiver to receive because of the high inference of the power line noise. So, the modulated signal needs to be amplified before being sent through the power line.The UA741 chip was chosen as the operational amplifier.

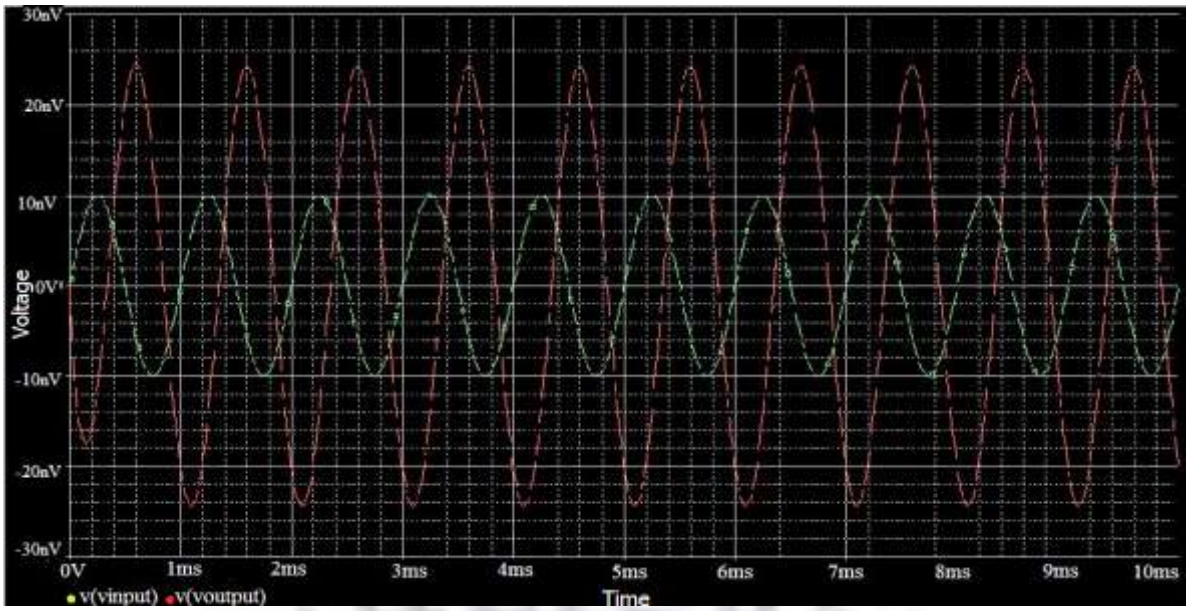


Fig 2. Simulation Result of Amplification

3. Reciever

The demodulator, which is designed specifically for the symbol-set used by the modulator, determines the phase of the received signal and maps it back to the symbol it represents thus recovering the original data.

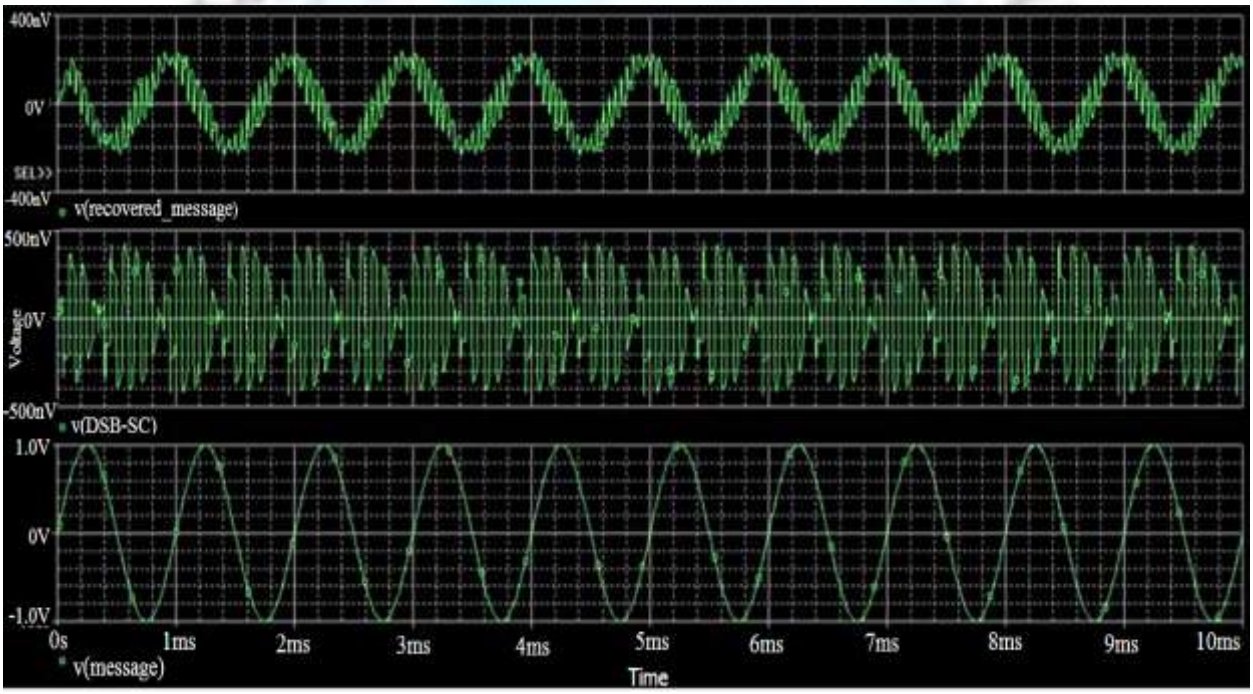


Fig 3.: Simulation of Demodulator

Comparison

Since power lines are designed to send power, they are not optimized as transmission medium for data. Power lines typically have high amounts of noise, which causes signal distortion. This signal distortion increases the bit error rate (BER). To overcome these shortcomings of the power line, we can employ various techniques of modulation to decrease the BER.

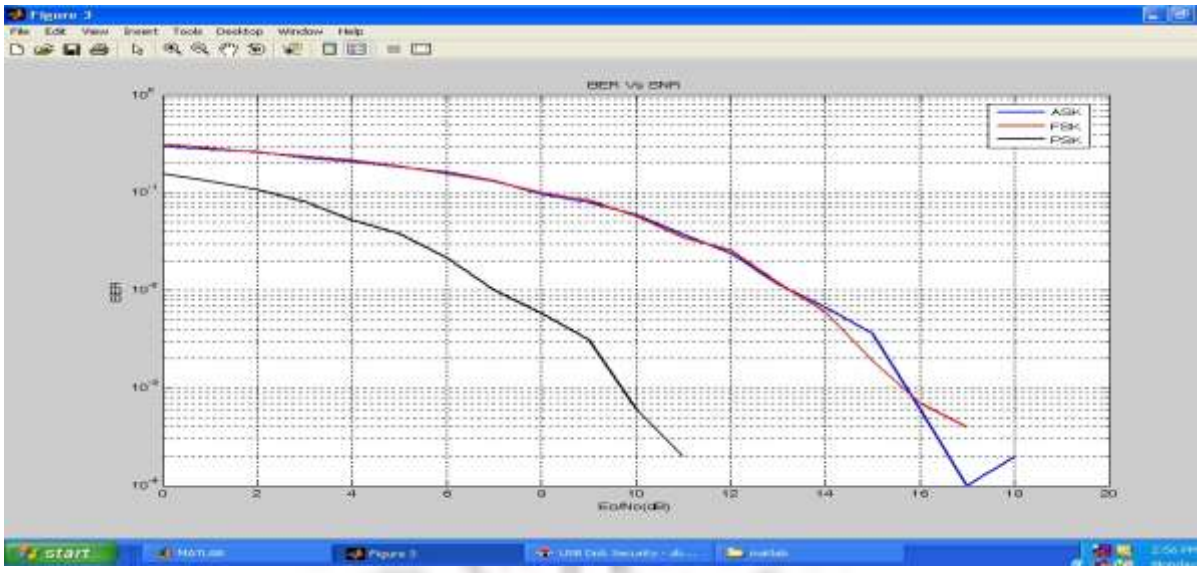


Fig 4.: BER vs. Signal to Noise ratio of different modulation techniques

In order to decide the method of modulation to be used in power line communication it is important to keep in mind the hostile environment in which it operates. From the graph above we can easily analyze which modulation technique suitable for PLCC according to their responses under noise.

S/N ratio (db)	BER of ASK (db)	BER of FSK (db)	BER of PSK (db)
0	$10^{-0.8}$	$10^{-0.79}$	$10^{-0.9}$
4	$10^{-0.9}$	$10^{-0.89}$	$10^{-1.5}$
8	$10^{-1.12}$	$10^{-1.0}$	$10^{-2.4}$
12	$10^{-1.86}$	$10^{-1.85}$	0
16	$10^{-3.4}$	$10^{-3.2}$	0
18	$10^{-3.9}$	$10^{-3.3}$	0

Table 1

From Table 1. it is concluded that the performance of PSK is much better than ASK and FSK under noise as for given SNR, PSK has lower BER than ASK and FSK.

Conclusion

This project has been a successful one with all project aims and goals are met. Addressing the individual project goals, a number of conclusion are made:

a. Meter reading or information signal in the form of modulating signal is successfully transmitted over the power line and received at the receiver.
b. Comparison in BER and signal to noise ratio of different modulation technique is made using MATLAB.
c. After comparing, it is concluded that performance of PSK modulation is better than ASK and FSK under noise so this is best modulation scheme for the system.

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Bibliography

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