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Performance Evaluation of OFDM based Efficient Power Line Communication

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ABSTRACT: Power Line Communication is an integrated technology because of power and data/information signals transmitted/received simultaneously. Here we propose three different modulation schemes named as 64-QAM, QPSK, DPSK for the generation of the OFDM signal. This modulated OFDM signal transmitted through Power Line Communication (PLC) Channel, during the transmission some noises are introduces due to joint of different wires and devices. In this paper Mean Error Rate (MER) can be calculated by the simulation process. The Performance is evaluated in terms of Bit Error Rate (BER). From the Simulation result it is confirm that the 64-QAM modulation scheme is slightly better than other modulation schemes and DPSK go out of the range, so it is not suitable modulation scheme for the OFDM based PLC. This scheme can also be applied on smart grid system

KEYWORDS:-Orthogonal Frequency Division Multiplexing (OFDM), Modulation Technique QAM-64, QPSK and DPSK, Power line Communication, Receiver and Transmitter, Bit error Rate (BER).

I.INTRODUCTION

Now day's smart grid technology attract the public attention towards it. This technology provide various services such as supervisory control and data acquisition (SCADA), advanced metering infrastructure (AMI), Energy Management system and home area network(HAN)[1] by converging with IT Techniques to enhance and improve command and control system[1]. Power line Communication is leading technique for smart grid industry because of its advantages. The most important point is to use the existing power line infrastructure for communication to lower the installation cost. Because power lines have been made for electricity distribution purpose, its channel characteristics very hostile for data transmission. There are lots of devices with different value of impendences in PLC network, that's why this is caused multipath environment. Due to random joint of different electrical/electronic devices impulsive noise introduced in PLC, sometimes it exceeds the power spectral density of background noise by 50 dB because this effect the performance of the system, it needs to mitigate impulsive noise [2]. In this paper we propose different modulation schemes with coding and without coding both for evaluating the performance of PLC. Fig 1 shows a digital communication system for the power line channel.

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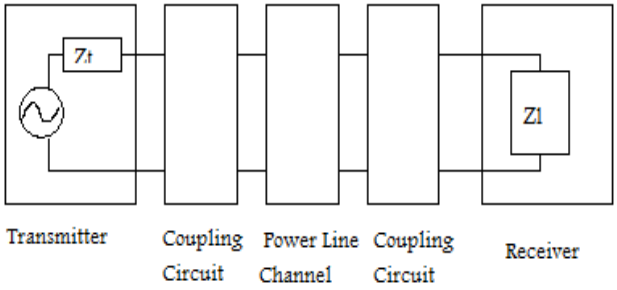

Fig.1 A digital communication system for the power-line channel

In this paper Section I describes the Introduction about the paper, Section II describes a brief about the Power Line Communication (PLC). Following that in Section III OFDM signal generation scheme is explained. In Section IV results of the simulation process is shown. Finally we draw conclusion in Section V.

II.POWER LINE COMMUNICATION SYSTEM

The model of PLC system in this paper is shown in fig.2. Due to variety of impendences occurred in PLC transmission become more adverse because of the power outlets are connected with the devices. So the impedance mismatching cause the multipath frequency selective fading. In this paper we consider the multipath channel model proposed in [4], and its impulse response is given by the formula

$$H(f) = \sum_{i=1}^{N} g_i \cdot e^{-(a_0 + a_1 f^k) d_i} \cdot e^{-j2\pi f (d_i / v_p)},$$

…..(1)

Where, $g_i$is weighting term, $e^{-(a0+a1fk)\,di}$ is attenuation term, and $e^{-j2\Pi f\,(di/vp)}$ is delay term.

In PLC system, total noise *n* can be expressed as below [1].

$n = n_G + n_I$ ….. (2)

Where n_G – background noise, n_I –impulsive noise

There are various factors that affect the transmission, that factors are impedance matching inductance of power line, capacitance of power line, coupling factors. There are two main coupling schemes in PLC named (1) Phase to Phase coupling (2) Phase to Ground coupling. There are many home appliances are connected with PLC at different-different coupling parameters that also introduces impulsive noise in the signal [5]. From the equation $n_{G,}$ can be modelled as White Gaussian noise nI is modelledas Class A interference model [7]

$$f_z(z) = \sum_{m=0}^{\infty} \frac{\alpha_m}{2\pi\sigma_m^2} e^{\left(-\frac{z^2}{2\sigma_m^2}\right)} \quad \text{….(3)}$$

$$\alpha_m = e^{-A} \frac{A^m}{m!} \quad \text{……...(4)}$$

M denotes how many times noise occurs and A is called impulsive index.

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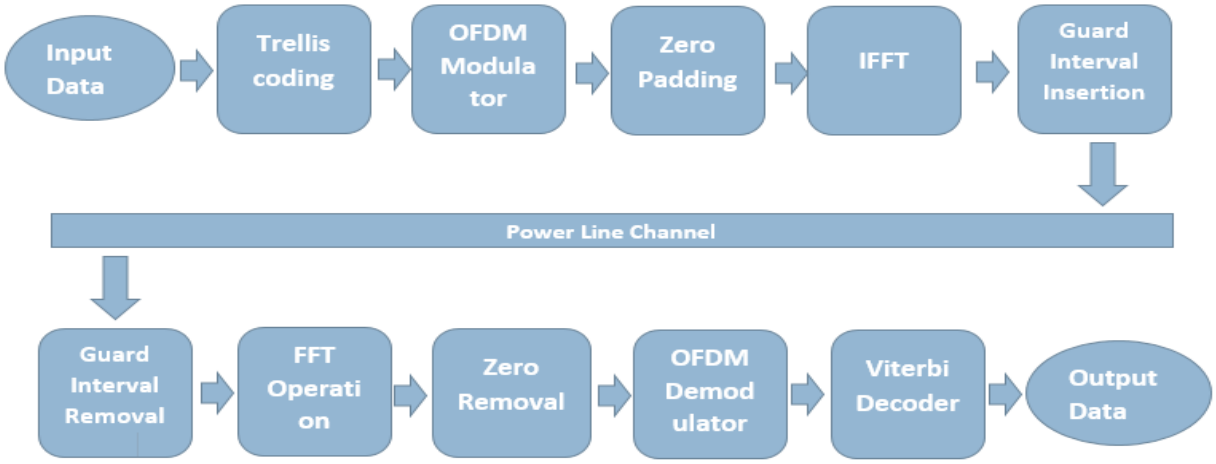

Fig.2 Block diagram of proposed PLC system model.

III.OFDM SIGNAL AND ITS GENERATIONUSING MATLAB

Orthogonal Frequency Division Multiplexing (OFDM) is nothing but a specialized FDM technique. In OFDM, all the carrier signals are orthogonal to each other, that means inter-carrier guard bands are not required and cross-talk between the sub-channels is eliminated. OFDM can be combined with multiple access using time and frequency or coding separation of the consumer. In the OFDMA, frequency-division multiple access is achieved by assigning different OFDM sub-channels for different users.

Fig.3 OFDM signal generation system [1]

OFDM is the best modulation scheme for power line communication. Fig.4 shows the OFDM signal that simulated on MATLAB and it is used in the Power Transmission Line.

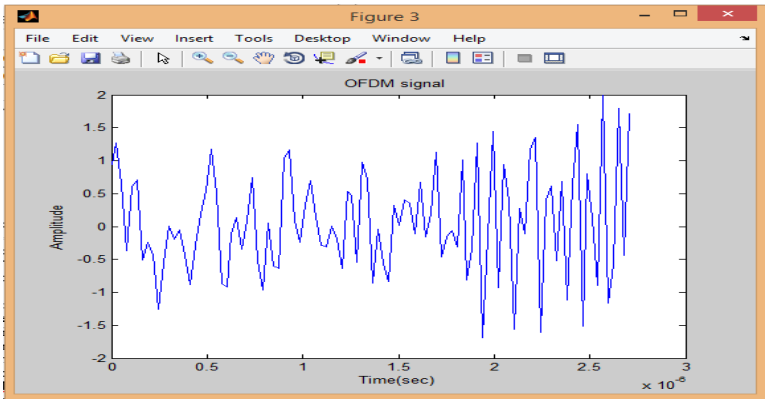

Fig.4Generated OFDM signal

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VI.SIMULATION RESULTS

In this paper the size of data frame and the cyclic prefix length (CP) is 2048 and 256 samples each and 20 packets are transmitted. We consider the power line having length l=500m. In this we employ three modulation schemes 64-QAM, QPSK, DPSK. In this we simulate the PLC, with channel coding and without coding.

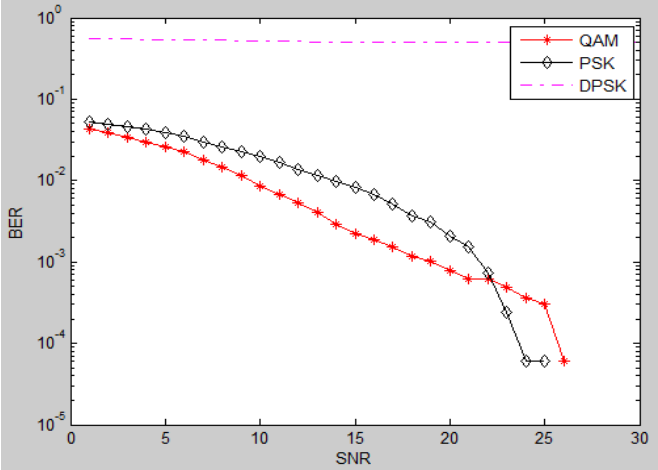

Fig .5.Performance of the un-coded PLC system

Fig.5 shows the BER vs SNR graph with channel coding and fig.6 show the BER vs SNR graph without channel coding in this we use trellis channel coding scheme and Viterbi decoding scheme.

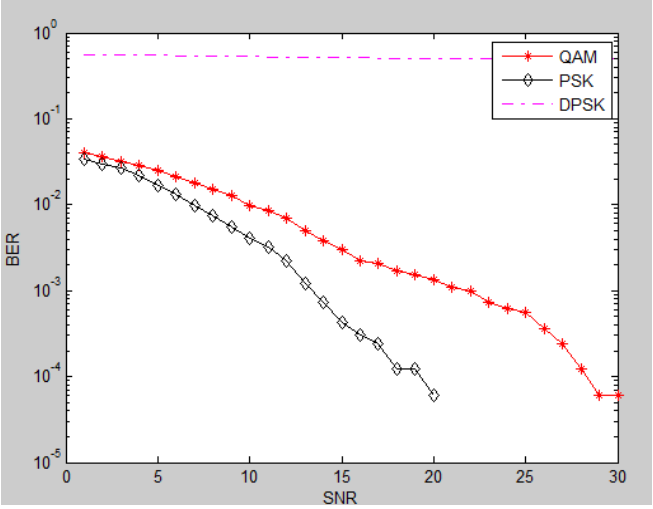

Fig.6 Performance of the coded PLC system

Fig .6 shows the BER performance in the case of applying coding to PLC system [8] at the bit Error Rate 10^{-3} the performance is improved approximately 5.2 dB, there are Bit Error Performance for QAM-64, QPSK and DPSK is 2dB, 1.2 dB & 0 dB at the above point respectively.

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V.CONLUSION

In this paper we analyse the different modulation schemes at different – different data frames. We confirm that the BER performance of QAM-64 is slightly better than the other modulation schemes. The performance improvement also demonstrated in the case of applying trellis coding. As we see in the simulation result DPSK modulation scheme is not better for OFDM based PLC. General overview on power line communication, different coupling methods and Circuit designing have also been discussed. MATLAB tools have been used to generate the BER vs SNR .in the PLC [9].

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