Checking the feasibility of power line communication channel with noise using OFDM Technique

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Abstract: *We know that research on digital communication has been widely developed in the past few years and offers a high quality of transmission in both the medium guided (wired) & unguided (wireless) communication environment. Coupled the devices with new modulation technique OFDM (Orthogonal Frequency Division Multiplexing) which is known as digital multicarrier communication technique and one of the most suitable method for the digital data transmission over a limited bandwidth. OFDM is a type of multichannel modulation that divides a given channel into many parallel sub channels or subcarriers, so that multiple symbols are sent in parallel. In this paper, design and analysis of OFDM system for power line channel based communication is proposed. for encode the signal convolutional encoder & for decode Viterbi decoder used. In doing so, MATLAB are used to simulate the operation of virtual transmitter and receiver. The performance of the system design is analyzed with noise occurs in the channel without reducing it. This paper results will show that for which a comparative performance studies using the Bit Error Rate (BER) plots was conducted for numerous simulations scenarios. These simulation scenarios include the use of different modulation types like BPSK, QPSK, QAM.*

Keywords: PSK, QPSK, QAM, Convolution encoder, Viterbi decoder

Introduction:

One of the most important technology that provide connectivity between one person to others at the long distance due to that they can talk to each other , they can send messages to each other , they can send videos to each other etc. these things are possible very easiest in way due to development of technologies. We know sharing the information or transmitting data from one to other is known as Communication but transmitting information or sharing information need medium, medium may be wired or wireless. It depends on the requirement or feasibility of the users, how they want to send data from one user to other users. Data or message transmitted from transmitter (source) before sending the data we encode the message using encoder ,encoder change the data from other code to binary code then use channel or medium to send the data over the network and at the receiver end data before receiving decoded using decoder, decoder converts binary data into other code. There are so many modulation techniques developed for communication like amplitude modulation, frequency modulation and phase modulation. Using modulation we can transmit data at long distance, it offers multiplexing, reduce bandwidth requirement for data transmission.

Electrical power system is used only for power transmission but recently it uses for transmitting the energy, voice, data services and internet access.Jing Lin, Marcel Nassar et all suggest an analytic model describing complex transfer functions of typical powerline networks using only a small set of parameters [4].PLC as a channel network differs in all the topologies their structures and whatever media we use like twisted pair cable, co axial, or fiber optic cable physical properties changed.if we are using the simplest topology with one branch we can identify the physical reason for observed result. In real network topologies which are always more complicated a back-tracing of measurement results to physical reasons will generally turn out to be impossible.As we use point to point connection in telephone local loop,in PLC "local loop access network" does not contain point to point connection between substation & customer's but their a bus topology present for representation. A typical access link between a substation and a customer consists of the distributor cable, or a series connection of distributor cables, and the branching house connection cables, both with real valued characteristic impedance). In multipath signal propagation propagation only doesn't take place along line of sight path between sores and destination, but additional path must also be considered, result based on multipath scenario with frequency selective fading. Cable Losses As mentioned above, the propagating signals are affected byattenuation increasing with length and frequency .The presented model offers the possibility to carry out investigations for different network topologies and to study their impact on PLC-system performance by means of simulations [4].

Literature Survey

Recently, the idea of using suboptimal clipping or blanking techniques for impulsive noise mitigation has been applied to modern OFDM. The aim of the study is proposed an analytical technique for performance assessment of OFDM with three types of memory less non linearity [10]:1. Clipping 2.Blanking 3. Combine clipping blanking. The results of this comparative study show that the blanking nonlinearity asymptotically (i.e.in highly impulsive noise) performs better than the clipping nonlinearity. On the other hand, in a weakly impulsive environment, clipping nonlinearity may slightly outperform the blanking scheme. The best solution is, however, the clipping blanking nonlinearity that combines the advantages of both techniques [10]. Asynchronous impulsive noise, periodic impulsive noise limit the performance in OFDM power line communication system. Impulsive noise in conventional OFDM degrade the performance of the system in which OFDM receiver that assumes AWGN,for removing this problem we design statical model & use the model parameter to mitigate impulsive noise to mitigate the asynchronous impulsive noise we explain in time domain and apply sparsely in time domain,also apply Bayesian learning methods to estimate & subtract the impulsive noises Typical sources of noise are brush motors, fluorescent & halogen lamps, switching power supplies. The noise in power lines can be impulsive or frequency selective in nature and, sometimes, both. Due to high attenuation over the power line, the noise is also location dependent.

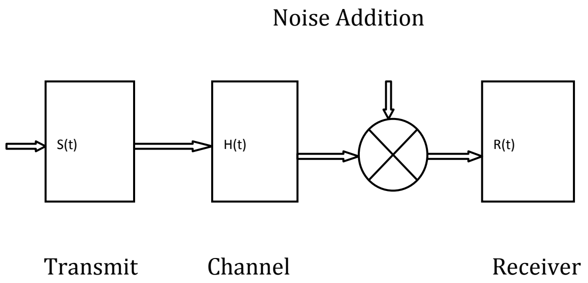


Fig1: General block diagram of PLC system

In this we have seen the evolution and potential of PLC technology and have gained someidea of the structure of the standards involved with it.High data rate communications on the medium voltage network has recently been added to the many fieldsof interest in power-line communications [7]. This paper presents a comparison of OFDM and CDMA for data communications on the medium voltage network [1].This paper evaluates the stability of CDMA &OFDM for high data rate communication on medium voltage power line cables.CDMA having robustness against interference .the possibility of multiuser access the availability of dedicated processor& inherent low power spectral density.Low PSD is advantage of CDMA as low as PSD minimum emission of EM waves. This paper provides a fair comparison between DS-CDMA (Direct Sequence Code Division Multiple Access) and OFDM (Orthogonal Frequency Division Multiplexing) systems for broadband downstream Power Lines Communications (PLCs). Considered schemes seem particularly suitable for high bit rate broadcast flexible communications on low voltage grid in order to guarantee "last mile" access network.As the number of Internet users increases and the request for multimedia communications grows, the demand forhigh-rate connections tends to become stronger and stronger, especially for the local access networks, the socalledlast mileBetween different Spread Spectrum Multiple Access (SSMA) techniques, Direct Sequence is known as anefficient scheme for communication systems due to its characteristics such as remarkable capacity, narrow-bandinterference suppression and anti-multipath capabilities: according to this technique, each bit of the signal to betransmitted is multiplied for a pseudonoise sequence whose fundamental element, called chip, is much shorterthan the informative bit; as a result, signal bandwidth occupation is increased of a factor equal to the ratiobetween bit and chip duration, the so-called Spreading Factor (SF). Conventional DS-CDMA receivers considerother users as pure interference and the Multiple Access Interference (MAI) limits the number of active users inrelation to a specified bit error rate (BER).Proposed multiple access scheme is,based on joint utilization of Orthogonal Variable Spreading Factor (OVSF) [6] and random scrambling codes: firstly, each global bit stream is divided in N parallel sub-streams,orthogonally separated each other by a channelizationopinion performed by multiplying them with anindividual orthogonal OVSF code; in the second step all the substreams composing the data flow of each userare added together andscrambled by means of a pseudonoise user code to better protect it from multipath effectsand from interference of other possible users [2].

OFDM system

Multi-carrier transmission techniques are based on the idea of partitioning the overall bandwidth in order tocreate many sub-channels, each characterized by its personal camer: this solution takes to obtain almost idealcondition of propagation for all the informative data flows even if the overall channel is characterized by colourednoise and frequency selectivity; as a consequence, since Inter-Symbol Interference (ISI) impairments arenegligible, channel equalizer block can be dramatically simplified or, ideally suppressed. Moreover, thismodulation technique permits to achieve data rate near to channel capacity if channel impulse response and noisepower density spectrum are known [2].

Working conditions and comparison criteria

In this paper the considered propagation environment is wired channel communication inside the building as described in power line channel impedance is highly varying with frequency, load conditions changes and discontinuities in branch cables can cause reflection and echos. Peaks in impedance matching may occurs at certain frequencies.as a result PL channel can be considered as a multipath propagation environment with deep narrowband notches in the frequency response. In performing our simulations the following conditions have been assumed. PLC channel ranging from 1 MHz to 21.480 MHz, i.e., bandwidth occupation equal to 20.480 MHz;overall maximum bit rate equal to 10.240 MHz;coherent phase modulation and rectangular pulse shaping for all the considered signals;perfect power matching, i.e. ideal power transfer. For what concerns DS-CDMA systems the following conditions have been supposed:considered substreams bit-rate equal to 40, 160,320,640 and 2560 kbit/s;spreading through a OVSF code, followed by a random scrambling code; the spreading factor of the OVSF.On the other hand, OFDM systems are based on the following assumptions:considered subchannels number equal to 64 and 256;bit loading technique based on the utilization of constellations formed by 2, 4 and 8 symbols; besides thepower is distributed between the subchannels so that each bit has the same energy. In this paper, a fair comparison between DS-CDMA and OFDM systems for broadband downstream PLCs has been provided under same overall working conditions of bandwidthoccupation, transmitted power, global data rate. BL technique introduction allows OFDM to achieve remarkable performance and high flexibility in resources management. On the contrary, CDMA guarantees good performance and satisfactory allocation policies with low complexity receiver [2]. Power line noise can affect the performance of broadband communication significantly. In this research F/D approach used to characterise & model the statistical variation ,LC noise model contain both impulsive and coloured background noise, amount of impulsive noise reaching power line communication receiver can they be determined with consideration channel transfer characteristic between noise sources & the PLC receiver, using these model the performance of two major class of digital schemes namely single carrier modulation and multi carrier modulation are analysed and compared it is found that the multicarrier schemes performs better than the single carrier scheme when subjected to the observed PLC noise with non-Gaussian statics uses they existing power cable infrastructure for communication purposes. The communication medium of this technology, the power lines, has been designed for transmitting electrical power without any thought on communications.In this paper, a frequency-domain power-line noise model is proposed for the typical broadband PLC bandwidth of 1–30 MHz. Using this proposed model, the effect of the power-line noise on the performance of several modulation schemes is evaluated. The evaluation is based on the bit error rate (BER) of the different schemes. Although the system BER is actually dependent on both channel transfer function and noise, in this paper, only noise is considered since. Background Noise To model the background noise, long-term measurements ofnoise spectrum from 1 to 30 MHz were conducted at two sites,a laboratory and a residential house. In each measurement, forevery five minutes, one set of spectrum data was recorded andthe whole measurement lasted for one week. The results havegiven us sufficient information on how the background noisesvary with frequency and time. The Nakagami model is often used to represent wireless fading signals in multipath scattering environment with relatively large delay-time spreads, and with different clusters of reflected waves. The power lines, with many loops and joints, are likely to exhibit such multipath behavior with substantial reflections. The noise spectrums from various appliances are also obtained through measurements. The procedure to determine the appliance noise can be divided into three steps. Step one is to measure the background noise spectrum without connecting the appliance. Then in step two, the appliance is connected to the network to measure the combined background and appliance noise. Finally, subtracting the spectrum of step two from that of step one gives the noise spectrum generated by the appliance. It should be noted that the noise spectrum used in this calculation is the power spectrum. This is because noises from different sources are noncoherent and hence they combine in term of power and not amplitude.This paper proposed a frequency-domain noise modelling approach for characterising the background noise and the impulsive noise encountered in broadband PLC systems. Based on two long-term measurements, the amplitude spectrum of the background noise at frequency 1–30 MHz is found to follow the Nakagami distribution.

In addition, the noise amplitude spectra from several typical household appliances were measured to construct a spectral density model for the impulsive noise. Together with the channel transfer function, the amount of appliance impulsive noise reaching the receiver can be determined. Summing the total appliance noise and the background noise gives the noise expected at the receiver. This receiver noise model has been verified through practical measurements.The Nakagami noise model was later used to compare the error performance of single-carrier modulation (PSK) versus multicarrier modulation (OFDM). It is found that due to the randomization effect inherent in the FFT operation in the OFDMreceiver, the OFDM performance is not affected by Nakagaminoise PDFs with different values, while the performance of single-carrier modulation schemes such as PSK and FSK degrades for channel noise having Nakagami distribution with smaller values. Since multicarrier modulation gives a more stable and predictable performance independent of the channel noise statistics [6]. Technique being used for Orthogonal frequency division multiplexing is a most promising OFDM is a promising technique being used for bandwidth efficientcommunication over thepower-line channel.It gives excellent alternative to adapt to the frequency-selectivity of the channel [3].The influence of impulsive noise on the OFDM transmission is not well analyzed so for. We chooseMiddletons Class A man-made noise model to statistically describe the impulsive interference and studythe capacity of the additive impulsive noise channel.One promising modulation scheme for data transmission over power-lines is OFDM. It provides excellentalternative to handle the colored noise, the narrowband interference and the frequency selective attenuation ofthe channel. The goal of our paper is to give more insight into the influence of impulsive noise on OFDM. In the first section, we introduce the selected impulsive noise model and give a brief review of OFDM. In order to analyze the performance of OFDM corrupted by impulsive noise a statistical model for theinterference is required. In this paper we choose Middletons canonical man-made noise model [3]. It comprisesthe influence of impulsive noise and an additionally Gaussian component. The model is known to fit very well toa broad spectrum of measured data In this section the channel capacity of Middletonsmemory less additive Class A impulsive noise channel with anaverage energy constraint on the input is studied. The channel capacity gives a general performance bound forreliable communication over a noisy channel .We are interested in comparing the capacity of the Gaussiannoise channel with the capacity of the Class A impulsive noise channel.In this paper we analysed the performance of the OFDM transmission scheme corrupted by impulsive noise.Using channel capacity arguments we showed, that using the conventional Gaussian noise OFDM receiver in animpulsive noise environment results in strong performance degradations. In the second part of our paper wedescribed a new iterative algorithm suited for mitigating the influence of the impulsive noise on the OFDMtransmission [3].OFDM systems are inherently robust to impulsive interference. This interference becomes disadvantage when impulsive noise energy exceeds a certain threshold. The impulse noise could occur due to several reasons such as circuit failure, power switching, and erasure channels.In this technique, total number of subcarriers is split into small blocks and spread the data symbols over these blocks by using unitary matrices in order to gain frequency diversity over each block. Unfortunately, this improvement comes at the cost of an increase in system computational complexity.Different approaches for impulse noise suppression are proposed. A simple method of reducing the adverse effect of impulsive noise is to precede a conventional OFDM demodulator withmemory less nonlinearity [2]. But these traditional methods provide unsatisfactory systemperformance improvement. A completely different approach is considered here to remove impulsenoise in OFDM system. A time domain interleaving (TDI) technique in conjunction with thresholdbased blanking scheme is utilized to improve the OFDM immunity over multipath fading channelsimpaired by impulsive noise without a sacrifice in bandwidth or an increase in the transmit power[2]. For the better performance of the system, interleaving is applied before and after IFFT at thetransmitter. And this will reduce the bit error rate of OFDM system.

In standard OFDM system interleaving is used before IFFT in the transmitter part and deinterleavingis used after FFT block in the receiver part. By comparing these systems, standard OFDMsystem has high bit error rate. This is due to the presence of Impulse noise in the OFDM system. Toimprove the performance of the system, interleaving is used before and after IFFT.The biterror rate performance this system is shown in .The results clearly shows that the interleavingsurely outperforms the other considered systems Bit error rate performance of proposed systemThe performance of the OFDM system has been enhanced without sacrificing bandwidth orincreasing transmits power. This enhancement was achieved by exploiting the time diversity which isensured by the use of a block interleaver of depth N samples positioned after the IFFT process at thetransmitter and a block deinterleaver located after the equalization process at the receiver. A blankingprocess has been proposed to suppress the enhanced noise and improve the overall system performance. The use of the interleaver breaks the correlated behaviour of the multipath fading channel, and spreads the impulsive noise samples over the impulse free OFDM symbols as well. The

Interleaving-OFDMsystem used before and after [12].

Proposed Model& Implementation:

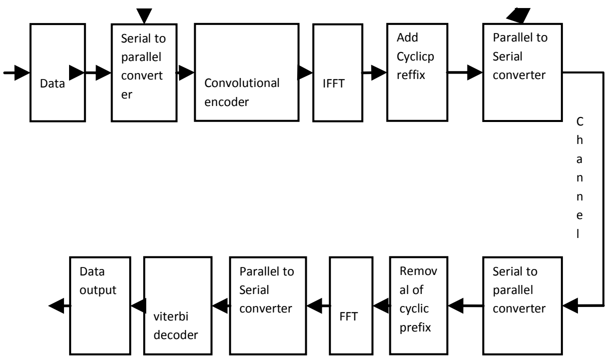


Fig2: Block diagram of OFDM with PLC Channel

Algorithm for OFDM

The mathematical representation of the modulation system formulates the signal generation and defines the terminology in which the receiver operates. As discussed above, OFDM transmits a large number of narrowband carriers, closely spaced in the frequency domain. In order to avoid a large number of modulators and filters at the transmitter and complementary filters and demodulators at the receiver, it is desirable to be able to use modern digital signal processing techniques, such as fast Fourier transform (FFT) [30].Mathematically, each carrier can be described as a complex wave:

$$S_C(t) = A_C(t)\exp\ j[\omega_c t + \phi_c(t)] \qquad (1)$$

The real signal is the real part of $S_C(t)$. Both Ac(t) and fc(t), the amplitude and phase of the carrier, canvary on a symbol by symbol basis. The values of the parameters are constant over the symbol duration period τ .OFDM is similar to conventional Frequency Division Multiplexing (FDM) inthatthemultiple user access is achieved by subdividing the available bandwidth into multiple channels, that are then allocated to users. The difference lies in the way in which the signals are modulated anddemodulated.However, OFDM usesthe spectrum much more efficiently by spacing the channels much closer together.

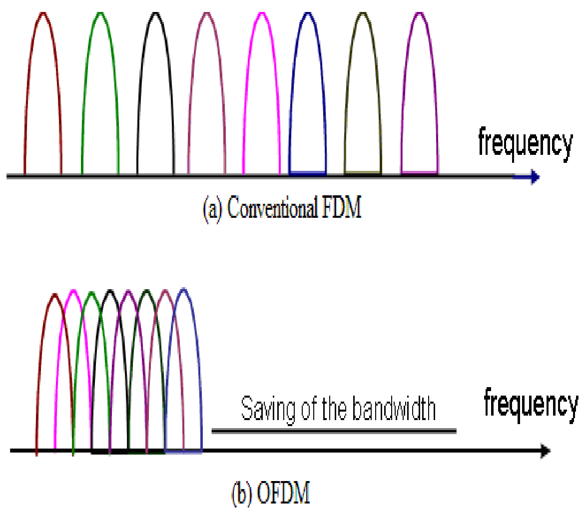


Figure 3. Comparison between the conventional FDM and OFDM

To generate OFDM successfully the relationship between all the carriers must be carefully controlled to maintain the orthogonality of the carriers. For this reason, OFDM is generated by firstly choosing the spectrum required, based on the input data, and modulation scheme used. Each carrier to be produced is assigned some data to transmit. The required amplitude and phase of the carrier is then calculated based on the modulation scheme (typically differential BPSK, QPSK, or QAM). In QAM, the constellation points are usually arranged in a square grid with equal vertical and horizontal spacing. In QAM, the amplitude of two waves, 90 degrees out-of-phase with each other (in quadrature) is modulated to represent the data signal. In the present work, 64- QAM is used as a mapping. The required spectrum is then converted back to its time domain signal using an Inverse Fourier Transform. In the OFDM system, Inverse Fast Fourier Transform/Fast Fourier Transform (IFFT/FFT) algorithms are used in the modulation and demodulation of the signal. The IFFT transforms a spectrum into a time domain signal whereas FFT performs a reverse operation by transforming a cyclic time domain signal into its equivalent frequency spectrum. The amplitude and phase of the sinusoidal components represent the frequency spectrum of the time domain signal.An IFFT converts a number of complex data points, of length which is a power of 2, into the time domain signal of the same number of points. Each data point in frequency spectrum used for an FFT or IFFT is called a bin. The IFFT performs the transformation very efficiently, and provides a simple way of ensuring the carrier signals produced are orthogonal. The orthogonal carriers required for the OFDM signal can be easily generated by setting the amplitude and phase of each bin, then performing the IFFT. Since each bin of an IFFT corresponds to the amplitude and phase of a set of orthogonal sinusoids, the reverse process guarantees that the carriers generated are orthogonal. After performing IFFT, a guard period is added to generate the OFDM signal.This section has shown that the generation of the OFDM signal can be realized through the IFFT/FFT processing block to which the mapped original data is applied. However, several complementary operations have to achieved and applied to the information bits before they are submitted to the IFFT processing, The OFDM model consists of transmitter and receiver. Convolutional encoder used for encoding it consist of shift register and adder this combination generate the output sequence, at receiver Viterbi decoder used that decode the signal. The receiver basically does the reverse operation to that of transmitter. Coding for signal generation is as follows:

```
N =2048;
M1 = 64;
k1 = log2(M1);
numof zeros  = N/4+1;
GI = 1/8;
BW = 20e6;
Tu=112e-6;
T=Tu/2048;
tt=0:T/2:Tu;
TD  =randint(4*256,1);
trel = poly2trellis([5 4],[23 35 0;0 5 13]);
code = convenc (TD,trel);
figure(1)
stairs(tt(1:30),TD(1:30));
TDM  =qammod(code,M1);
figure(2)
subplot(211);
stem(tt(1:30),real(TDM(1:30)),'filled');
xlabel('Time(sec)');
ylabel('Amplitude');
title('Inphase modulated data');
subplot(212);
stem(tt(1:30),imag(TDM(1:30)),'filled');
xlabel('Time(sec)');
ylabel('Amplitude');
title('Quadrature modulated data');
TDZ = [TDM((N-numOfZeros+1)/2:end,:);...
zeros(numOfZeros,1);...
TDM(1:(N-numOfZeros+1)/2,:)];
TDZIFFT = sqrt(N)*ifft(TDZ,N);
TGI = [TDZIFFT((1-GI)*N+1:end,:);TDZIFFT];
figure(3)
plot(tt(1:100),(TGI(1:100)));
xlabel('Time(sec)');
ylabel('Amplitude');
title('OFDM signal ');
```

Simulation & Result:

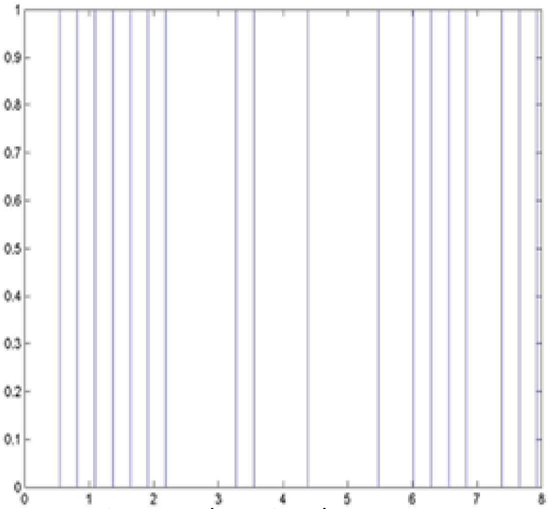


Fig 1 Randam signal

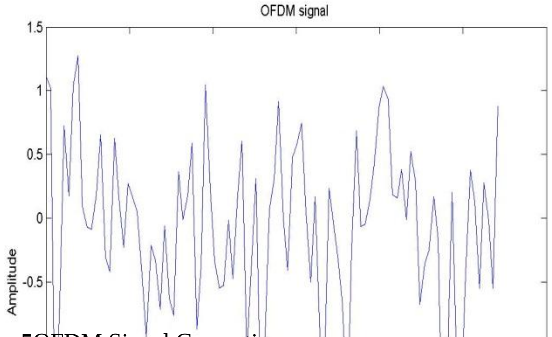


Fig:5OFDM Signal Generation

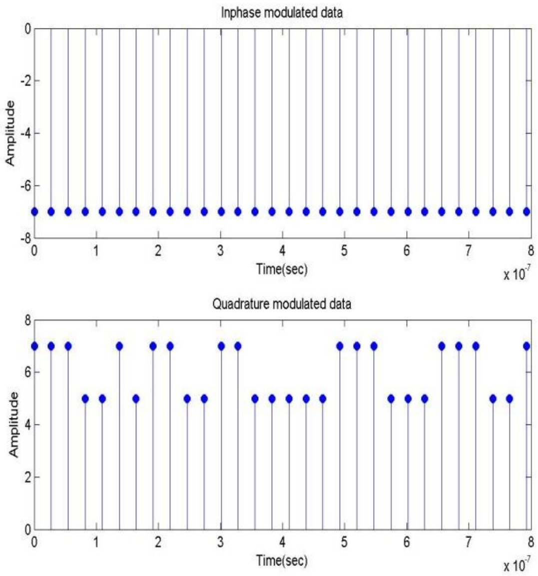
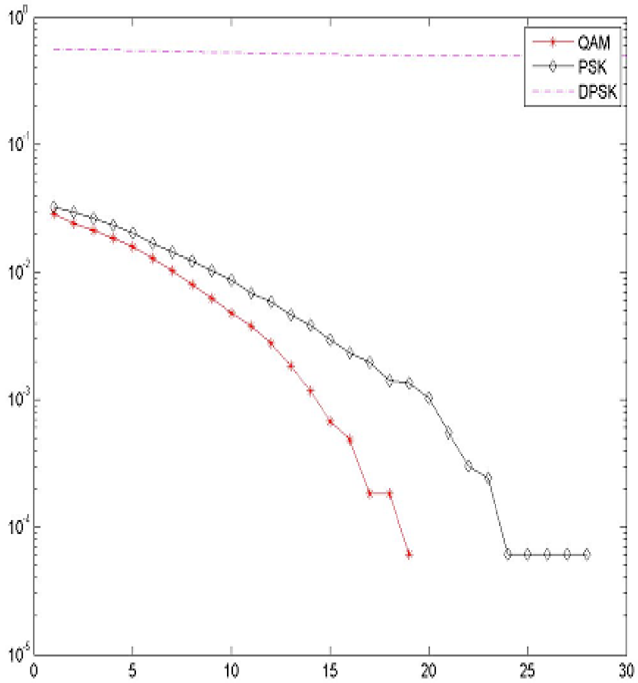


Fig.2 Inphase& Quadrature



In the simulation we take random signal as fig:3 and Inphase data with quadrature modulated data Fig 4 combined to generate OFDM signal as shown in fig:5.We will transmit OFDM signal over the communication channel (PLC). As the we know channel data effected with noise we analysis the noise generated on communication channel with different modulation technique i.e QAM, PSK, BPSK as fig: 6 and we say that QAM is better than other two.

Conclusion and Future Scope:

As per our finding during the research of various paper and work done by different researchers they work on difference modulation technique with PLC and try to reduce noise by using different method but their main course of action to remove noise with the help of different hardware devices they didn't focus on any simulated coded technique. In future we can develop coded modulation technique with the help of simulation framework like MATLAB and can analyse the performance of PLC system with noise using Plot like BER (bit error rate).

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