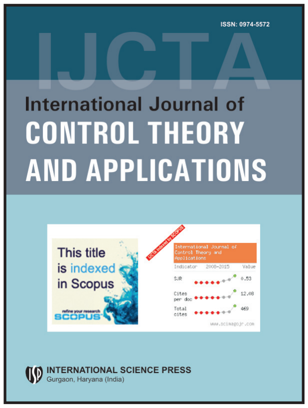

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Multipath Channel Model of Power Line Signal to Noise Ratio (SNR) Calculation using OFDM with QAM Technique

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Abstract: The aim of this Paper is focused the realization of multipath channel in power line communication model. This model is composed of communication model, model of power line and noise model. The Power line is modeled from transfer function of multipath signal environment. The paper attempt modulating the digital data with different level of QAM and simulate the interference effect QPSK with QAM. The different level of mapping the carrier frequencies in OFDM were simulated in this model and comparing error with signal to noise ratio (SNR) and the interference effect are reorganize in the constellation diagram.

Keywords: PLC, QAM, OFDM, Noise, Modulation.

1. INTRODUCTION

Communication through power line referred to power line communication. Communication technology takes the advantage of not requiring additional wiring. PLC System derived into two area broadband and narrowband PLC. Broadband PLC is widely used for data communication. The Broadband PLC Technology works up to the maximum frequency range 150 KHz to 34 MHz and theoretical maximum speed is 200 M bits/sec. The possibility of using the power network and system of narrow band PLC is the most recent development has been reported in [5]

The power network can also be used for other application including control arrangement of power consumption, tarifling, remote meter reading, commanding, remote data acquisition, electricity for the control signal, etc in [4]

The problematic area in PLC is interference the interference affect the total reliability of the system. The data transmission in the power line is always mismatched and appear reflected on the same power line in this paper focused contains error check mechanism and multipath signal reflection environment [4]

2. PLC COMMUNICATION MODEL

The PLC communication Model will be described frequency division using OFDM technique carrier frequencies are mapped with 256 state, 64 state or 32 state QAM or QPSK and BPSK Modulation are found in literature [1].

A Bernoulli binary generator used as the data source in this model, which generates random binary number according to the Bernoulli distribution.

In the real system bit allocation can be obtained from this equation,

$$b_n = \log_2\left(1 + 3/\left(Q^{-1}\frac{\text{BER}}{4}\right)^2 \text{SNR}n\right) \tag{1}$$

where,

b_n is the number of bits at n sub channel.

SN R_n is the average signal to noise ratio in Partial sub channel n.

Q^{-1} is defined

$$Q(x) = 1/\sqrt{2\pi}\int_{\pi}^{\alpha} e^{\frac{-y^2}{z}}\, dy \tag{2}$$

The channel coding block are obtained in serial flow data, this flow enters the mapping block. The bit sequences are converted to a symbol sequence in the mapping were used in [4].

3. TRANSMISSION LINE MODEL THEORY

In the literature the methods used to simulate and study the transmission line behaviour most of them we obtained from the time dependent telegrapher's equation which are elementary line cell are developed in (7, 4, 9).

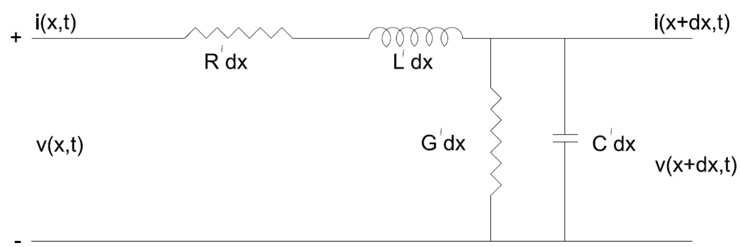

Figure 1: Transmission Line Model Theory

$$\frac{\partial v(x,t)}{\partial x} + R' i(x,t) + L'\frac{\partial i(x,t)}{\partial t} = 0 \tag{3}$$

$$\frac{\partial i(x,t)}{\partial x} + G' v(x,t) + C'\frac{\partial v(x,t)}{\partial t} = 0 \tag{4}$$

In the above equation 'x' denotes the longitudinal direction at the line and R′, L′, G′ and C′ are the per unit length resistance (Ω/m), inductance (H/m), conductance (S/m) and capacitance (F/m) respectively.

For a lossless line ($R' = G' = 0$)

The voltage and current are

$$v(x, t) = f(x - ct) + g(x + ct) \tag{5}$$

$$i(x, t) = 1/z_c\,[f(x - ct) - g(x + ct)] \tag{6}$$

The physical interpretation of $f(x - ct)$ is a wave travelling velocity c in forward direction and $g(x + ct)$ is a wave travelling velocity c in backward direction.

Where 'f' and 'g' are arbitrary function of the variable $x = ct$ and $x - ct$ and $c = 1/\sqrt{L'C}$ is the phase velocity.

$z_c = \sqrt{L'C}$ is the line characteristics impedance.

$$z_c = \sqrt{\frac{R' + j\omega X_L}{G' + j\omega C'}} \tag{7}$$

$$\gamma = \alpha + j\beta$$

$$\gamma = \sqrt{(R' + j\omega X_L)(G' + j\omega C')} \tag{8}$$

The transfer function of a line with the length 'l' can be expressed as

$$H(f) = \frac{v(x = l)}{v(x = 0)} \tag{9}$$

$$H(f) = \frac{v(x = l)}{v(x = 0)} = e^{-\gamma l} = e^{-\alpha(f)l} e^{-\beta(f)l} \tag{10}$$

4. MULTIPATH PROPAGATION ALONG THE LINE

Multipath propagation along with multiple reflection at impedance for simplified consideration "A" and "B" are matched which mean that $Z_A = Z_{L1}$, $Z_c = Z_{L2}$ each path has weighing factor g_i respectively. The product of the reflection and transmission factor along the path. The time delay τ_i of a path can be calculated from the length d_i and the phase velocity v_p.

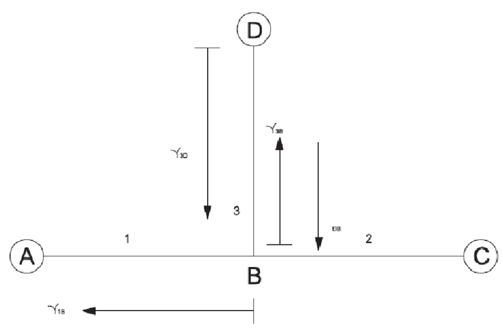

Figure 2: Multipath Propagation along the Line

Table 1
Multipath propagation

Path No.	*Signal path way*	*Weighing factor (g_i)*	*Length of the path (d_i)*
1.	A –> B –> C	t_{1b}	L1 + L2
2.	A –> B –> D –> B –> C	t_{1b}, r_{3d}, t_{3b}	L1 + 2L3 + L2
.	.	.	.
.	.	.	.
N.	A –> (–> D –> B)$^{N-1}$ –> E	$t_{1b}, r_{3d}, (r_{3d} \cdot r_{3d})^{N-1} t_{3b}$	L1 + 2(N – 1)L3 + L2

$$\tau_i = \frac{d_i}{v_p}$$

where,

d_i is length of the path

v_p is phase velocity

The loss of the real cable cause an attenuation (f, d), increasing with the cable length and frequency.(8,4) and the transfer function of the signal component path A-C can be expressed as

$$H(f) = \underbrace{\sum_{i=1}^{N} |g_i(f)|^{\phi_{g1}(f)}}_{\text{Weighing factor}} \cdot \underbrace{e^{-(a_0 + a_1 f^k)^{d_1}}}_{\text{attenuation term}} \cdot \underbrace{e^{-j2\pi f \tau_1}}_{\text{delay term}} \tag{11}$$

Combines multipath propagation, frequency and length depending attenuation term leads

$$H(f) = \sum_{i=1}^{N} |g_i(f)|^{\phi_{g1}(f)} \cdot e^{-(a_0 + a_1 f^k)^{d_1}} \cdot e^{-j2\pi \frac{d_i}{v_p}} \tag{12}$$

Equation (10) describing the complex transfer function of typical power line channels. Using this model the characteristics of power line channel the frequency range from 500 KHz to 40 MHz increasing the number of path allows the control of the precision of the model from (7, 4, 1)

5. SIMULATION OF INTERFERENCE EFFECT BY QPSK AND QAM

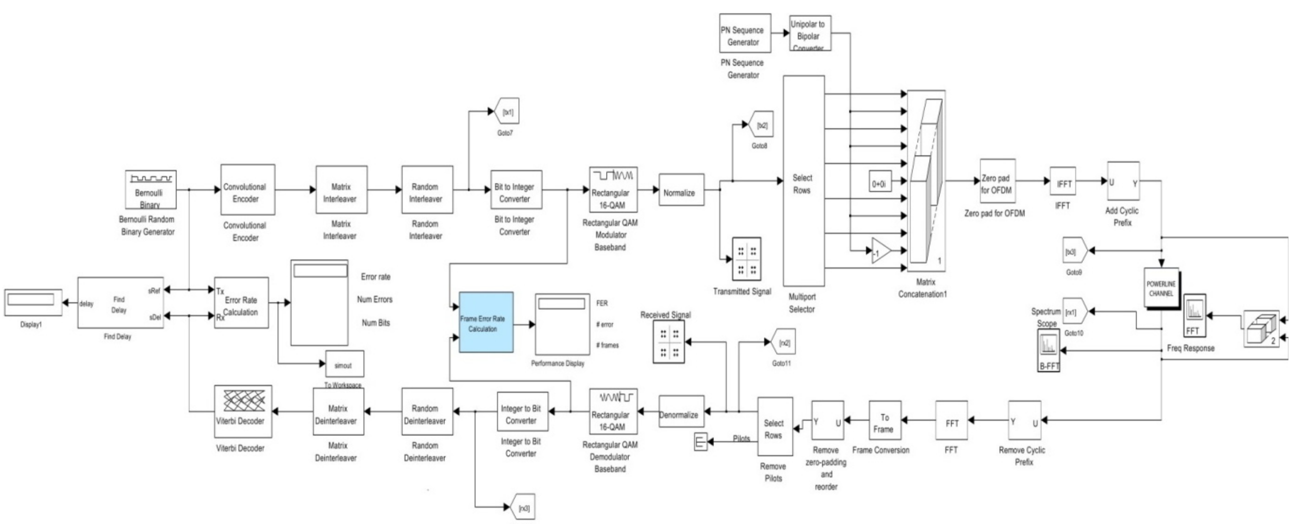

Figure 3: Simulation of Interference Effect by QPSK and QAM

6. QPSK WITH PSK

Psk that use phase shift 90 degree = $\pi/2 = 4$ ie four different signal are generated and each signal are represented two bits when the four psk easily extended to 8 psk i.e., nPSK. However higher rate of PSK are limited by ability of equipment to distinguish small difference in phase are developed in this context

$$S(t) = \{A\cos(2\omega_c t) - \text{binary } 00\}, \{A\cos(2\omega_c t + \pi/2) - \text{binary } 01\}, \{A\cos(2\omega_c t + \pi) - \text{binary } 10\},$$
$$\{A\cos(2\omega_c t + 3\pi/2) - \text{binary } 11\}$$

7. MODULATION OF DIGITAL DATA – QAM

QAM using two dimensional signaling the original information stream split in to two sequences consists of ODD and EVEN system (B_k and A_k)

A_k sequences modulated by Cos $(2\pi f_c t)$

B_k sequences modulated by Sin $(2\pi f_c t)$

The composite signal is A $\cos(2\omega_c t) + B_k \sin(2\pi f_c t)$ sent through the channel

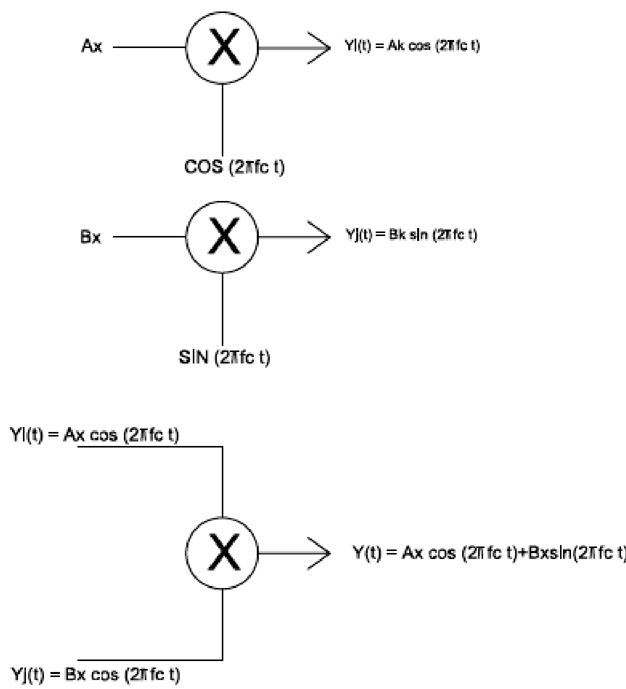

Figure 4: Modulation channel of digital data – QAM

8. OFDM WITH QPSK

Modulation of OFDM subcarrier is analogous to the modulation in conventional serial systems. The modulation schemes of the subcarriers are generally QAM or PSK in conjunction with both coherent and noncoherent detection. As the additive white Gaussian noise (AWGN) in the time domain channel corresponds to AWGN of the same average power in the frequency domain, an OFDM system performance in an AWGN channel is identical to that of a serial system. Analogously to a serial system, the bit error rate (BER) verses signal-to-noise rate (SNR) characteristics are determined by the modulation scheme used. Modulation of OFDM subcarrier is analogous to the modulation in conventional serial systems. The modulation schemes of the subcarriers are generally QAM or PSK in conjunction with both coherent and noncoherent detection. As the additive white Gaussian noise (AWGN) in the time domain channel corresponds to AWGN of the same average power in the frequency domain, an OFDM system performance in an AWGN channel is identical to that of a serial system. Analogously to a serial system, the bit error rate (BER) verses signal-to-noise rate (SNR) characteristics are determined by the modulation scheme used.

The constellation diagram and its behavior for various level of noise ratio (SNR) is shown in OFDM with QPSK modulation. Simulation of the interference Effect through constellation diagram will be better understanding of the problematic of data transmission over power line. The model described with frequency division of spectrum using the OFDM technique and particular carrier frequency are mapped with 256 states; 64 state; (or) 32 state

QAM (or) QPSK and BPSK. It can be seen that the more distance of the SNR is reduced the more symbols are dispressed the constellation diagram.in [5]

The effect of SNR on constellation diagram of OFDM with QPSK for SNR = 30, 15 and 5dB.

Simulation diagram (7)

The effect of SNR on constellation diagram of OFDM with 64 QAM for SNR = 30, 20 and 17db

Simulation diagram (8)

The effect of SNR on constellation diagram of OFDM with256 QAM for SNR = 30, 20 and 17db

Simulation diagram (9)

9. OFDM WITH 64 QAM

The basic symbol with constellation diagram and its behaviour for different level of SNR is shown for the OFDM. It can be seen that the more distance of the SNR is reduced the more symbols are dispressed the constellation diagram. In the modulation of 64 QAM is very susceptible to interference.

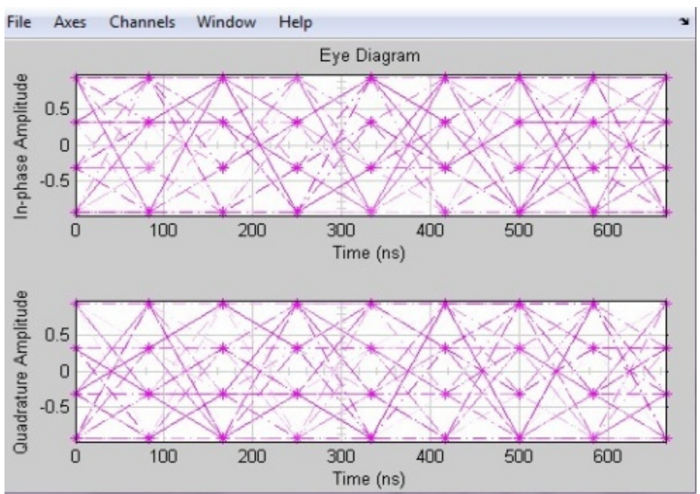

Figure 5: Eye Diagram

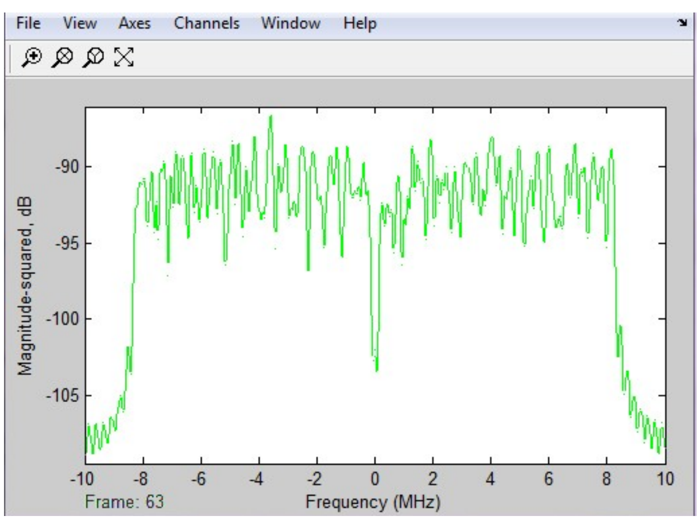

Figure 6: Output waveform of magnitude square vs Frequency

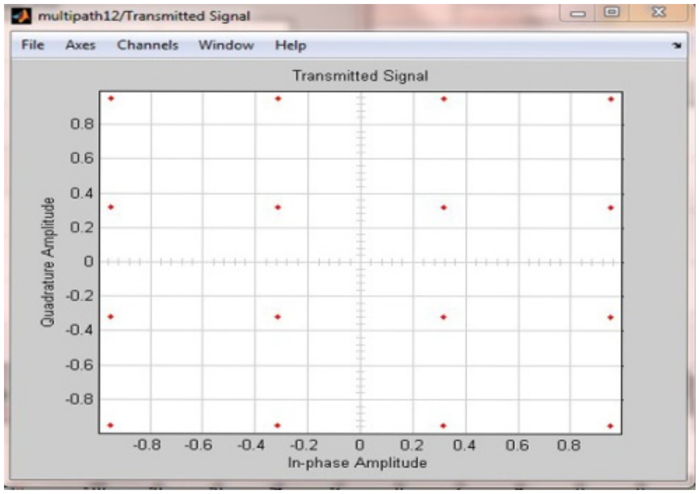

Figure 7: Output waveform of Quadrature vs inphase Amplitude (Transmitted Signal)

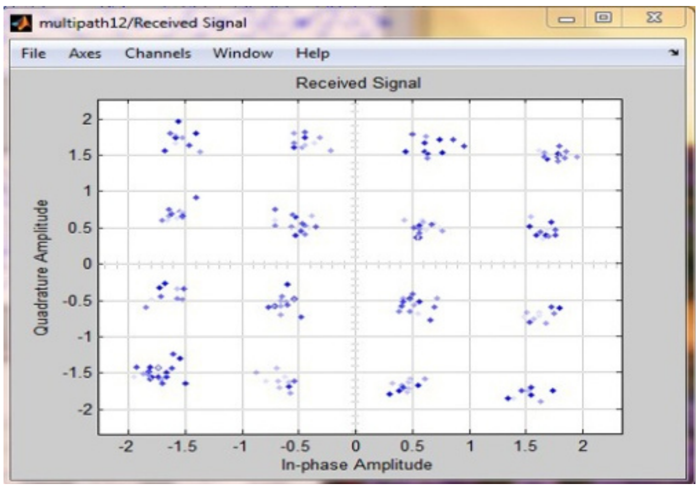

Figure 8: Output waveform of Quadrature vs inphase Amplitude (Received Signal)

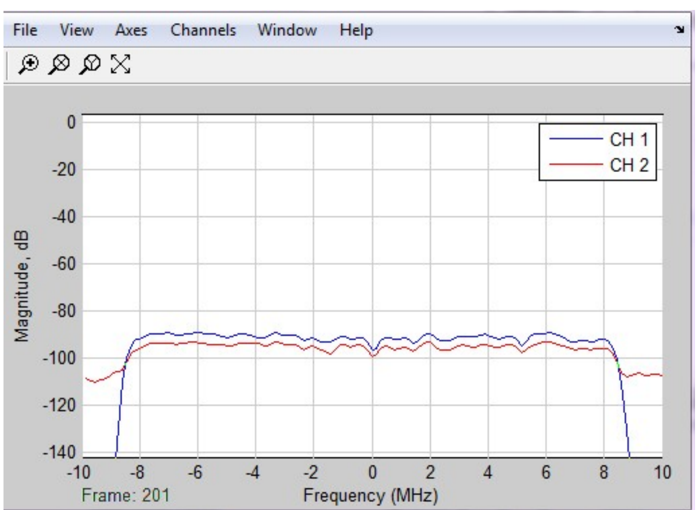

Figure 9: Output waveform of magnitude vs frequency

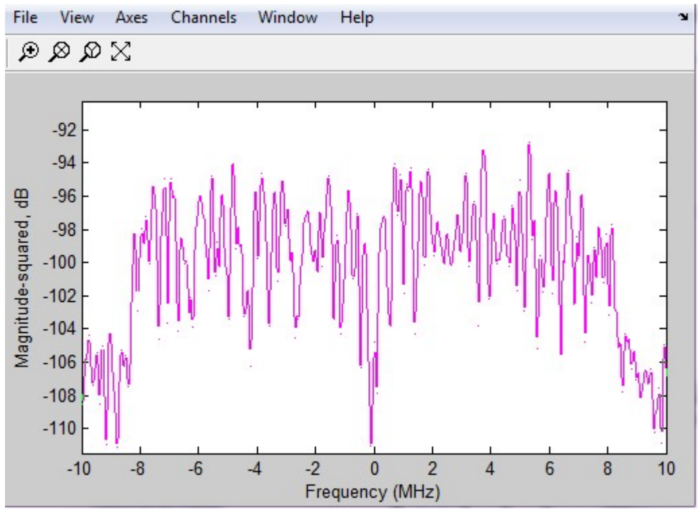

Figure 10: Output waveform of magnitude square vs frequency

10. DISCUSSIONS AND CONCLUSION

The PLC communication technology is seemed alternate data channel for remote data acquisition in this paper deals with design the PLC communication technology the model is composed with OFDM technique. The OFDM technique divide into multiple sub carrier in the sub carrier are closely spaced to each other with causing interference. In this paper compare the effect on constellation diagram of OFDM modulation with QPSK for different level of noise ratio (SNR) and the effect on constellation diagram of OFDM modulation with 16QAM, 32QAM for different level of noise ratio (SNR) is shown in Figure [7, 8, 9] All the sub carrier are orthogonal to each other and a very high data rate stream is divide into multipath parallel to low data stream. The smaller data stream are mapped individually sub carrier and modulated using QAM.

REFERENCES

[1] Peter Mlynek, Jiri Misurec, Martin Koutny, Milos Orgon, "Power line cable transfer function for modeling of power line communication" journal of electrical engineering, Vol. 62, No. 2, 2011, 104-108.

[2] P. Mlynek, Mkoutny and J. Misurec, "power line modeling for creating PLC communication system" international journal of communication, Issue 1, Volume 4, 2010.

[3] Abdullah alwadie "efficient algorithms for noise estimation in electrical power line communication" wseas transation on communication, Volume 11, November 2012.

[4] Peter Mlynek, Jiri Misurec, Martin Koutny "multipath channel model of power line'' elekroevlie, Vol. 1, No. 2, June 2010.

[5] Martin kounty, petr mlynek, onder krajsa "modeling of PLC communication for supply network" 13 wseas international conference on communication.

[6] Jose Antonio Cortes Luis Dies Francisco Javier Canete And Jesus Lopez "Analysis Of The Periodic Impulsive Noise Asynchronous With The Mains In Indoor Plc Channels" ieee xplore 2009.

[7] Antonio cataliotti, alfredo daidone, and Giovanni tine, "A medium voltage cable model for power line communication" ieee transation power delivery, Vol. 24, No. 1, January 2009.

[8] Sameer A. Dawood, F. Malek, M.S. Anuar and Suha Q. Hadi "Performance Comparison of OFDM system based on DMWTCS, DWT, and FFT using QAM Modulation Technique" ARPN Journal of Engineering and Applied Sciences, Vol. 9, No. 12, December 2014.

[9] S.K. Mydhili and A. Rajeswari "Analysis and Implementation of OFDM System and Channel Estimation based IEEE 802.11A" ARPN Journal of Engineering and Applied Sciences, Vol. 10, No. 12, July 2015.