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Performance analysis of digital modulation, bit dilation and signal level through AWGN channel

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***Abstract*— In this paper performance of digital modulations like FSK, BPSK and QPSK using CRC coded data are analyzed. These digital modulations are widely used in data transfer in mobile phone, scientific and geomagnetic instruments etc. The performance of these modulations is compared with each other. The simulation is carried out through AWGN Channel and obtains the bit error rate by varying the signal to noise ratio of the AWGN channel. The performance of these modulations is evaluated by calculating the bit error rate versus signal to noise ratio. We have also compared bit delay at receiving end with sending end of bit timing. Spectrum power levels are also measured at transmitting and receiving end. This paper may be useful for further analysis and computation of theoretical and practical result.**

Index Terms— **Frame Check Sequence, frequency-shift keying, Bi-polar Phase Shift Keying , Quadrature Phase Shift Keying**

I. INTRODUCTION

Digital modulation substitutes the analog modulation for better communication. There are several digital modulation out of which we considered three. FSK modulation is a frequency modulation scheme in which digital information is transmitted through discrete frequency changes of a carrier wave. FSK uses a pair of discrete frequencies to transmit binary (0s and 1s) information. With this scheme, the "1" is called the mark frequency and the "0" is called the space frequency. In any phase modulation scheme the information is expressed in terms of phase of the carrier. Phase of the carrier signal is shifted according to the input binary data. Two-state phase shift keying (PSK) is called BPSK where the phase of the radio carrier is set to 0 or δ according to the value of the incoming bit. Four-state or quadraphase PSK is called QPSK, in which two bits are combined and the radio carrier is phase-modulated according to the four possible patterns of two bits. Bit error rate (BER) of a communication system is defined as the ratio of number of error bits and total number of bits transmitted during a specific period. It is the likelihood that a single error bit will occur within received bits, independent of rate of transmission. In our simulations, we have considered the most commonly used channels: the Additive White Gaussian. Noise (AWGN) channel where the noise gets spread over the whole spectrum of frequencies.

II. AWGN CHANNEL

Additive white Gaussian noise (AWGN) is a channel in which the only impairment to communication is a linear addition of white noise with a constant spectral density (expressed as watts per hertz of bandwidth) and a Gaussian distribution of amplitude as shown in figure 1. The model does not account for fading, frequency selectivity, interference, nonlinearity or dispersion. However, it produces simple and tractable mathematical models which are useful for gaining insight into the underlying behavior of a system.

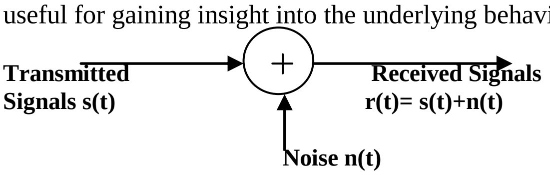

Fig -1: Block Diagram of AWGN Channel model

It is the basic communication channel model and used as a standard channel model. The transmitted signal gets disturbed by a simple additive white Gaussian noise process. AWGN channel may disturb at abnormal geomagnetic activities. At normal geomagnetic activities the magnetic field of earth is 46000+ nT at Allahabad, Uttar Pradesh. The magnetic field of earth is approximately not even but varies thousand nanao tesla low latitude to high latitude under normal geomagnetic activities.

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The transmitted waveform gets corrupted by noise n, typically referred to as Additive White Gaussian Noise (AWGN).

Additive: As the noise gets ‘added’ (and not multiplied) to the received signal

White: The spectrum of the noise if flat for all frequencies.

Gaussian: The values of the noise n follows the Gaussian probability distribution function,

$$=\frac{1}{\sqrt{2\pi\sigma}^{2}} e^{\frac{-(x-\mu)^2}{2\sigma^2}}$$

With $\mu = 0$ and $\sigma^2 = \frac{No}{2}$

III. DIGITAL MODULATION

In digital modulation, an analog carrier signal is modulated by a discrete signal. Digital modulation methods can be considered as digital-to-analog conversion, and the corresponding demodulation .The move to digital modulation provides more information capacity, compatibility with digital data services, higher data security, better quality communications, and quicker system availability. The RF spectrum must be shared, yet every day there are more users for that spectrum as demand for communications services increases. Digital modulation schemes have greater capacity to convey large amounts of information than analog modulation schemes. At low frequency more communication distance covered. In a communication system, the receiver side BER may be affected by transmission channel noise, interference, distortion, bit synchronization problems, attenuation, wireless multipath fading, etc.

IV. DIGITAL MODULATION COMMUNICATION SYSTEM ARRANGEMENT

In this Digital modulation communication system arrangement each block is connected as shown in figure 2**.** At the sending end CRC N-generator coding is used and at the receiving end of communication CRC N-Syndrome detector is used. The simulation of Bit error rate through AWGN channel with FSK / BPSK / QPSK modulation is carried out using simulink Matlab. At a time one digital modulation out of three is used at a sending side and same corresponding digital demodulation out of three is used at a receiving side. The FSK / BPSK / QPSK schematic diagram is shown in figure 2. For the input signal 1000000 bits are generated randomly using Bernoulli Binary bit generator. At the receiving end, the bit error rate is calculated over the ($\frac{Eb}{No}$) ranging 0 to 30 dB. The result obtained. A graph between ($\frac{Eb}{No}$) and bit error rate is shown in figure 3 for the FSK, BPSK and QPSK modulation performance. In this experiment with CRC coded data are used. In this Digital modulation communication system the oscilloscope graph is obtain to show the delay of bits at the receiving end as shown in figure 4. Both bit spectrum are compared. The bit spectrum shows that bit in the communication transmission delay few micro second in AWGN channel. Signal amplitude is measured as shown in figure 4. 70db signal is transmitted through AWGN channel and it is measured at the receiving end. Both signal level is evaluated; received signal spectrum in AWGN channel has approximately the same power level as transmitted signal. It is observed that the both end the signal level are approximately same of 70db in the spectrum. In figure 5 above scope shows sending end signal amplitude in db, below scope shows receiving end signal amplitude in db. Table 1 show the different parameters used in Bernoulli Binary Bit Generator, CRC Code Generator and modulations.

	Bernoulli Binary Bit Generator	
1	Probability of Zero	0.5
2	Sample Time	1/50000
3	Data type	Framed, Unframmed
4	Sample per frame	1
5	Output data type	double
	CRC Code Generator	
6	Generator Polynomials	[1000100000010000]
7	Initial states	[0]
8	Checksum per frame	1
	FSK Modulation	
9	M-ary Number	8

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10	Frequency Separation	6 Hz
11	Phase Continuity	Continuous
12	Output data type	Double
	BPSK Modulation	
13	Phase offset (rad)	0
14	Output Data type	Double
	QPSK Modulation	
15	Constellation Ordering	Binary
16	Phase offset (rad)	Pi/4
17	Output Data type	Double

Table No.: 1

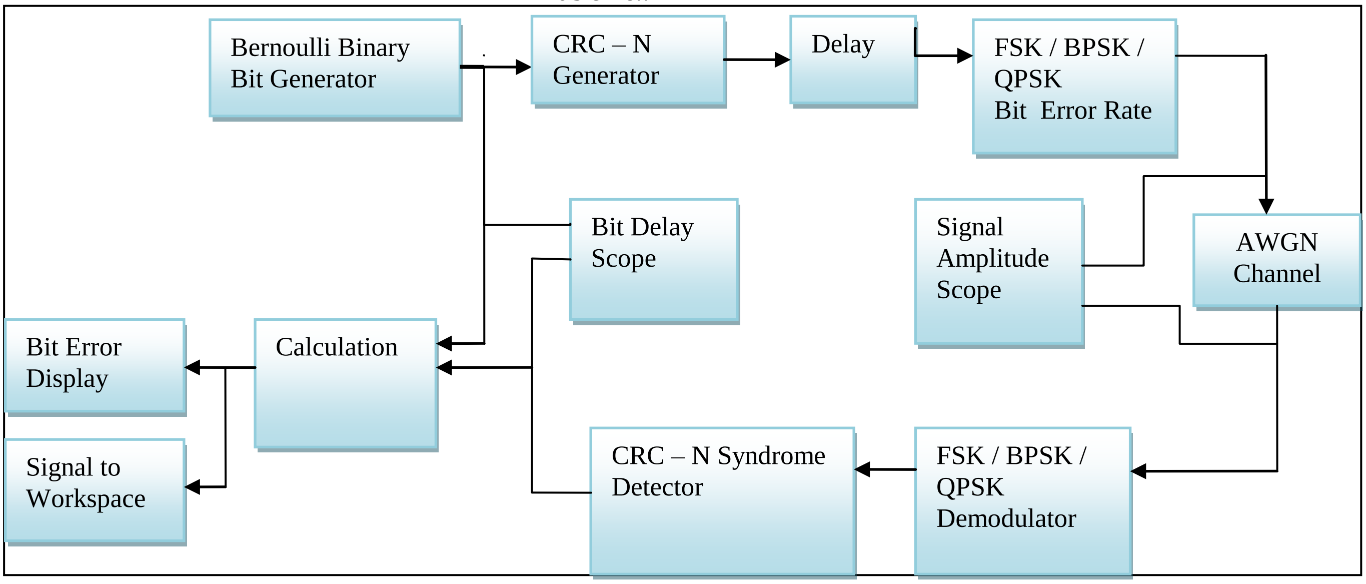

Fig-2: Block diagram of digital modulation communication system.

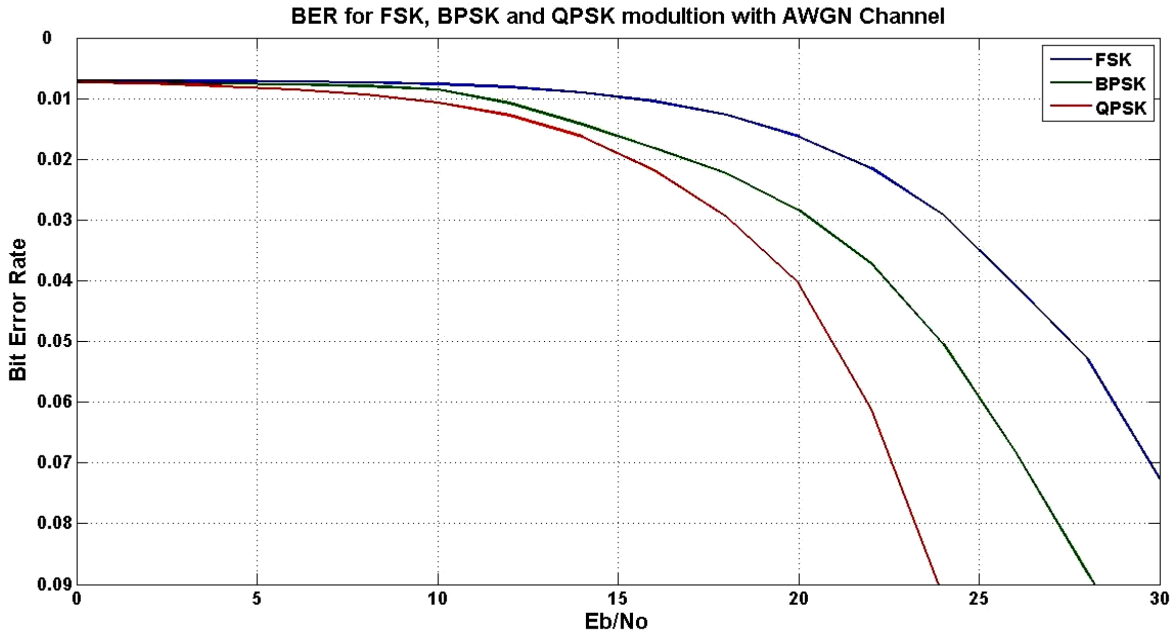

Fig-3: FSK, BPSK and QPSK digital modulation performance graph using coded frame data.

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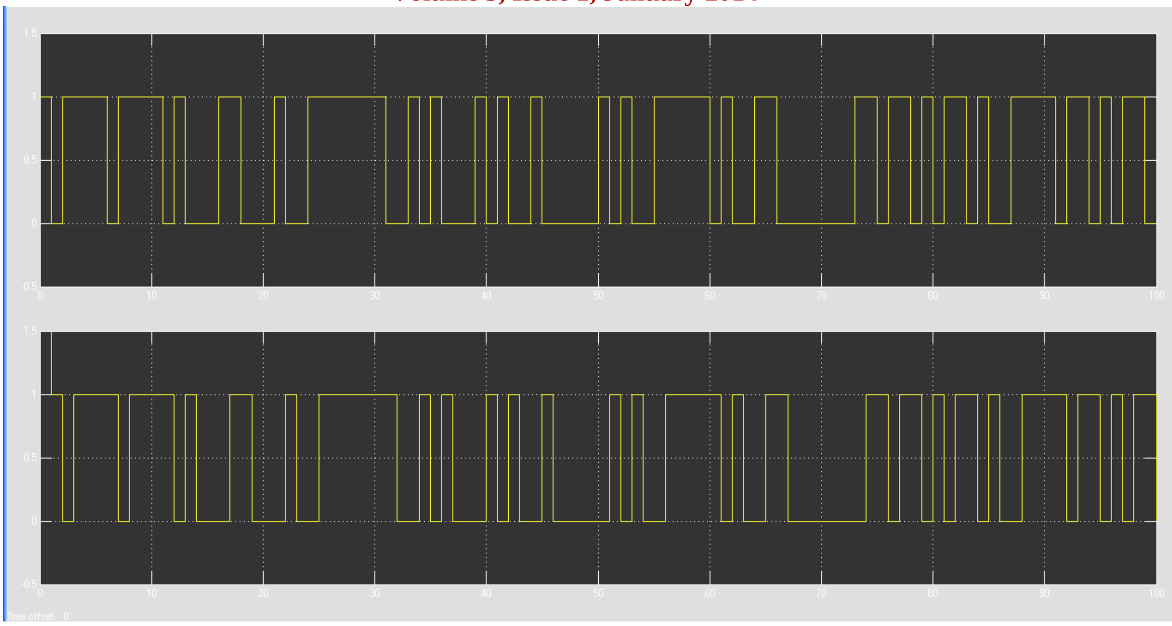

Fig -4: Bit delay, above transmit end bit scope, below receive end bit scope. Time is in micro second.

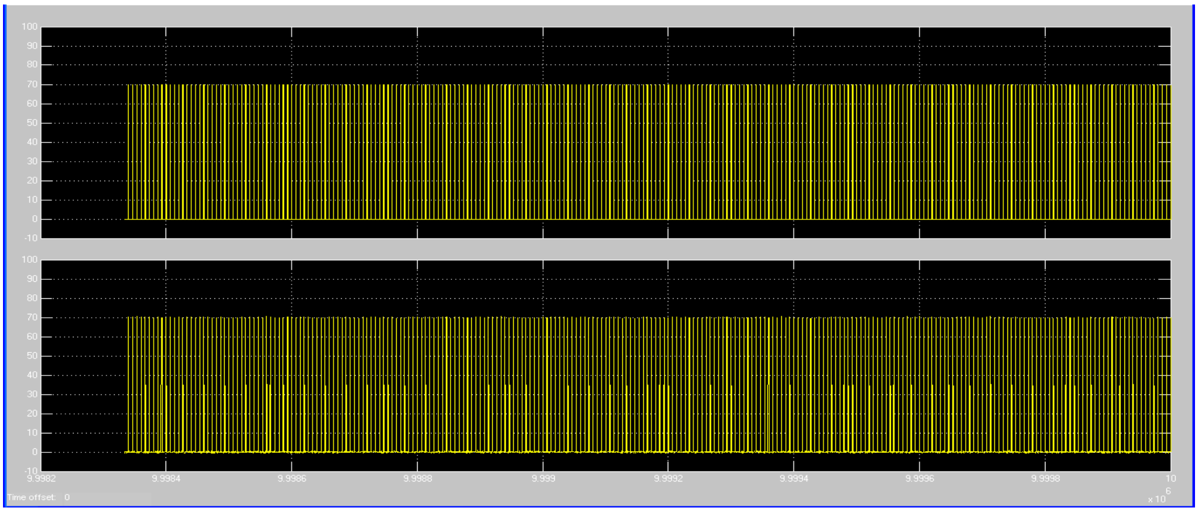

Fig -5: Signal amplitude measurement above scope shows sending end amplitude in db, below scope shows receiving end amplitude in db.

V. RESULTS

The results are represented in terms of bit energy to noise power spectral density ratio ($\frac{Eb}{No}$) and bit error rate (BER) for practical values of system without coded data. By varying the ($\frac{Eb}{No}$) vs. BER, plot is drawn. The Bit Error Rate (BER) plot obtained in the performance analysis showed that QPSK modulation has 5 db better SNR with respect to BPSK modulation. And the BPSK modulation has 4 db better SNR with respect to FSK modulation as shown in figure 3.Bits at the receiving end may delayed by few microsecond due to abnormal channel condition shown in figure 4. The amplitude of signal receiving and sending end are the approximate same. Figure 5 reveals that received signal spectrum in AWGN channel has approximately the same power level as transmitted signal. This paper may be useful for researcher in further analysis.

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VI. CONCLUSION

In this paper, the performance of FSK, BPSK, and QPSK modulation with AWGN channel is evaluated. From the simulation results, the Bit Error Ratio of a digital communication system is an important figure of merit used to quantify the integrity of data transmitted through the system. By implementing the different modulation techniques and parameters, the criterions comparison of the variation of BER for different SNR. Graphical results show the QPSK modulation is better compared with BPSK for its performance in AWGN channel and BPSK modulation is better compared with FSK for its performance in AWGN channel. Spectrum in AWGN channel has approximately the same power level as transmitted signal. Matlab simulations are interactive and parameters are easily changeable, immediately results are available.

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