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ASK PSK and FSK Signal Transmission through AWGN Channel

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Abstract

In this paper basic digital modulation techniques amplitude shift keying (ASK), phase shift keying (PSK) and frequency shift keying (FSK) modulation and demodulation are achieved using MATLAB. As name implies digital modulation techniques, transmitted signal should be in digital configuration. Unipolar data bit stream [1 1 0 0 1] as digital input signal for ASK and FSK, and bipolar data bit stream [1 1 0 0 1] as input signal for execution of PSK are used. The characteristics of carrier wave are modified on the basis of modulating or transmitting signal. For instance in ASK amplitude of the carrier wave is changed according to the message signal, and in PSK phase of the carrier wave is changed with message, similarly in FSK frequency of carrier is varied with message signal.

Keywords: *Amplitude Shift Keying (ASK),Frequency Shift Keying (FSK),Phase Shift Keying (PSK), Additive White Gaussian Noise (AWGN).*

INTRODUCTION

Over the past few decades, there has been appeared an enormous transformation from straightforward amplitude and angle (phase / frequency) analog modulation schemes to the leading digital modulation techniques [1-3]. In the digital modulation field there is a variation of either amplitude or angle of a high frequency sinusoidal signal known as carrier signal, correspondent to a low frequency signal normally enclose information to be transmitted [1] [4-6]. The elementary objective of this paper is to attain a modernized process of digital modulation techniques for transmission of information using AWGN channel.

In the proposed ASK, PSK and FSK modulation and demodulation process additive white Gaussian noise channel has introduced in the channel to execute the modulation and demodulation in more practical manner. AWGN channel adds white Gaussian noise to the signal or corrupt the signal that passes through the signal [6-7]. In this paper: part-2 provides primitive knowledge and block representation of fundamental digital modulation techniques ASK, PSK, FSK and AWGN channel. Part-3 this discusses about the plotted results obtained using MATLAB simulation tool, and ends with conclusion.

AMPLITUDE SHIFT KEYING

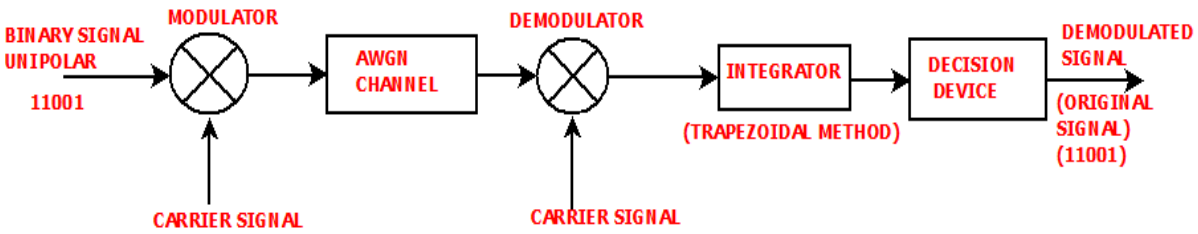


Fig.1 *Block Diagram of ASK Modulation and Demodulation*

Amplitude shift keying technique is fundamental digital modulation technique where the word 'Keying' referred to switching. In ASK technique high frequency analog carrier wave normally sinusoidal wave is modulated by discrete binary signal and also known as the On-Off keying. Block diagram of the ASK modulation and demodulation is shown in figure1. The main building blocks are balanced modulator, AWGN channel, demodulator, integrator and decision device. The modulation is executed at the transmitting end anddemodulation is performed at the receiver side. ASK is equivalent to unipolar binary modulation or amplitude modulation on an analog signal [7]. The transmitter and receiver circuit used are relatively user friendly and un-complex. In ASK modulation binary 1 is symbolized by sending a fixed amplitude carrier signal and binary 0 is represented by absence of carrier, this is accomplished by using modulator [4] [9]. AWGN channel is used to introduce the noise in ASK modulated signal with high SNR. Signal to noise ratio is defined as signal power to the noise power.And for the coherent detection correlator receiver is used i.e. receiver must has the exact knowledge of carrier's phase and frequency. The verb 'to correlate' means to 'to match'. Coherent correlator consists of modulator and integrator. At the receiver side decision device is used with preset threshold, if input to the device is greater than zero output is 1 else 0. The use of ASK is with fiber-optic data transmission, with a high light intensity representing a binary 1 and a low intensity representing a binary 0 [5].

PHASE SHIFT KEYING

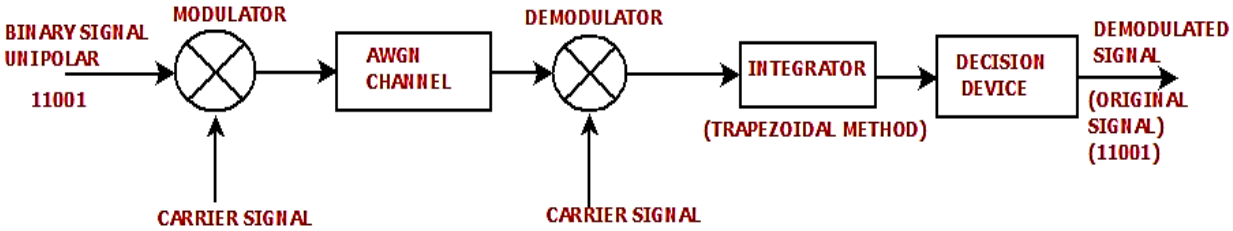


Fig.2 *Block Diagram of PSK Modulation and Demodulation*

Phase shift keying consists of a shifting the phase of a sinusoidal carrier 0 degree or 180 degree with a bipolar binary signal keeping amplitude and frequency remain unchanged throughout the data transmission, it is identical to phase modulation with a digital signal and also to modulating an analog message signal with a polar digital signal [7]. Block diagram of the PSK modulation and demodulation is shown in figure2.PSK is widely used in both military and commercial communications systems. In this technique transmission of binary 1 is represented bycarrier wave with 0 degree phase shift alternatively transmission of binary 0 means the carrier signal with 180 degree phase shift with same amplitude [9]. For the coherent detection of noisy PSK modulated signal with correlation receiver (product integrator) same carrier wave is needed [5]. The last step of the binary detection is decision device with preset threshold, detected binary symbol is 1. If input to the device is greater than zero else detected symbol is zero. Thus the output of the decision device is original data bit stream. BPSK treated to be vigorous among all modulation techniques because of 180 degree difference between two constellation points and is widely used in OFDM for channel control [10] [11].

FREQUENCY SHIFT KEYING

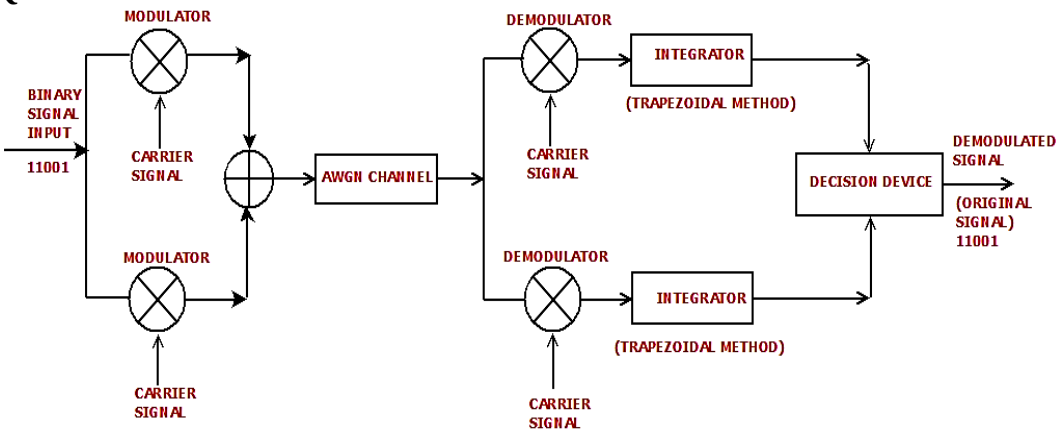


Fig.3 *Block Diagram of FSK Modulation and Demodulation*

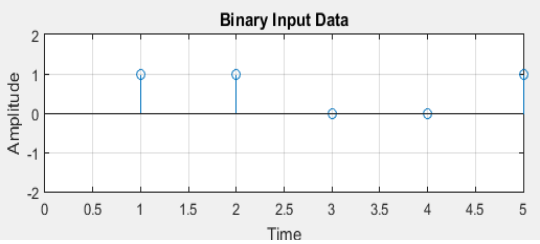
Frequency shift keyingdeviates the frequency of the sinusoidal carrier from a mark frequency (correspondent, to sending a binary 1) to a space frequency (correspondent, to sending a binary 0) with respect to the baseband digital signal. Block diagram of the FSK modulation and demodulation is shown in figure3. FSK is analogous to the frequency modulation with a binary digital signal [7]. It is characterized by the information being contained in the frequency of the carrier with amplitude and phase is kept constant. Two carrier signals are used with different frequencies and frequency for first carrier signal is always high as compared to that of the second carrier signal [3] [12-17]. Modulated signal is same as carrier wave, for transmission of binary 1 it is carrier signal with high frequency and for the transmission of binary 0 it is lower carrier frequency [9]. FSK signal can be detected using coherent correlation receiver with two carrier waves same as that have used at the transmission end. The concept used in the correlator detector is the maximum likelihood detector, with assumptions that all symbols are equi-probable and process AWGN channel with zero mean and power spectral density of No/2 where No is average noise power [8-11][16-20]. At the end of demodulation decision device detect whether the binary symbol 1 or 0 was transmitted with the help of preset threshold, if threshold exceeded the receiver output is symbol 1 else it is 0 [4] [21-22].

RESULTS

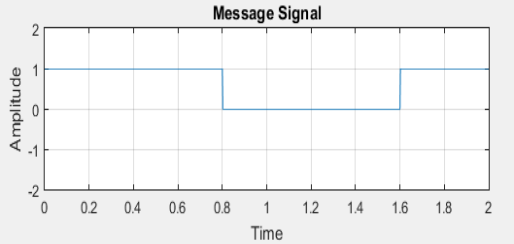
ASK Modulation and Demodulation:

For the implementation of coding R2015a version of MATLAB has been used. For the implementation of ASK signal one carrier signal and message signal is required, sinusoidal signal with unit amplitude and 5Hz frequency as carrier signal and Binary data 1 1 0 0 1 are used as message signal.Carrier signal and message signal are product modulated thus resulting signal is ASK modulated signal as shown in fig 1(d). ASK signal is passed through Additive White Gaussian Noise (AWGN) channel with SNR (signal to noise ratio) 10.Resulting distorted ASK signal is demodulated by passing it through correlator (comprises the product modulator with same carrier signal used for modulation and integrator). The integral is calculated using the trapezoidal rulealso known as thetrapezium rule. Trapezoidal rule is one of the numerical integration methods.This method approximates the integration over an interval by breaking the integral into trapezoids with more easily computable integral.Output of correlator is given to the decision making device, if input to the device is greater than 0, output is binary 1

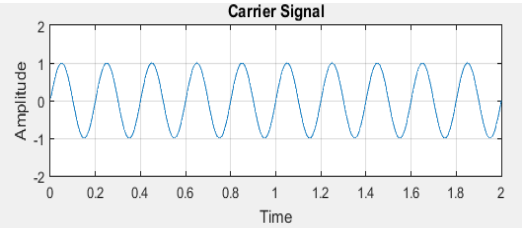
otherwise it makes a decision in favor of binary symbol 0. The resulting signal is ASK demodulated signal. As shown in Fig. 1(f).



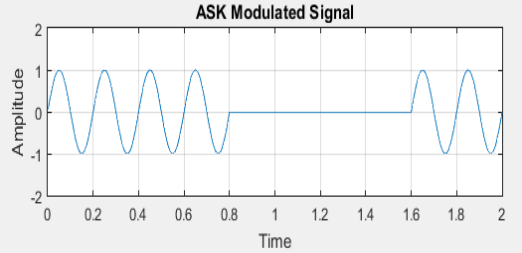
(a)



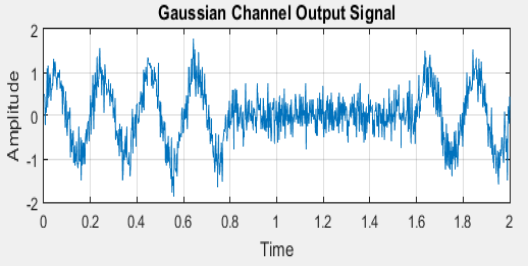
(b)



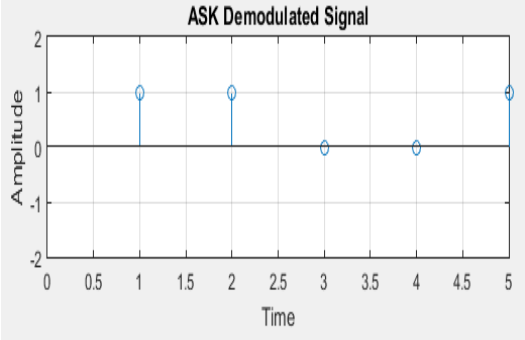
(c)



(d)



(e)

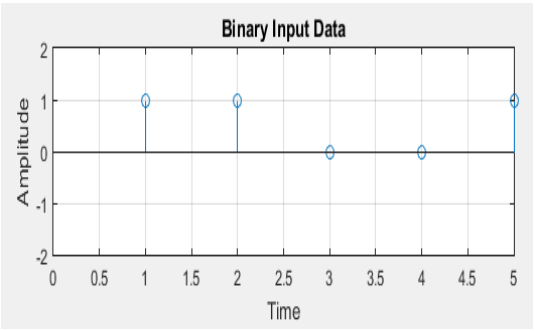


(f)

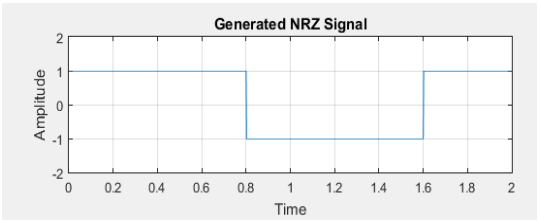
***Fig. 4** : Binary Input Data(a), Message Signal(b), Carrier Signal (c), ASK Modulated Signal(d), ASK Modulated Signal Passing Through AWGN Channel(e), ASK Demodulated Signal(f)*

PSK Modulation and Demodulation:

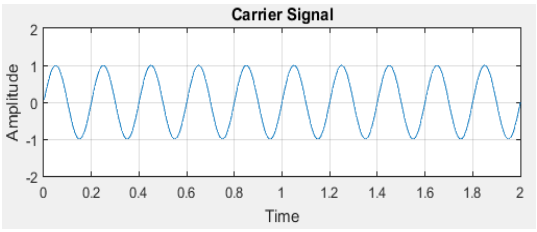
For the generation of PSK signal input binary data stream 1 1 0 0 1 is converted into bipolar NRZ signal. Sinusoidal signal with unit amplitude and 5Hz frequency as carrier signal is used. Output is then applied to the product modulator whose other input is carrier signal. As in PSK phase of the sinusoidal carrier is varied in accordance with the value of the binary input data ,for binary symbol 1 PSK signal is inphase with respect to carrier signal and for binary symbol 0 PSK signal is 180 degree ot of phase with respect to carrier signal.Thus resultant signal is PSK modulated signal, as shown in Fig. 2(d).Modulated signal is passed through the AWGN channel with SNR 10.The incoming distorted PSK signal is applied to the correlator which consists of a product modulator and an integertor.



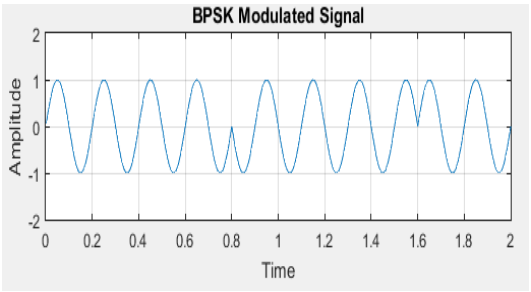
(a)



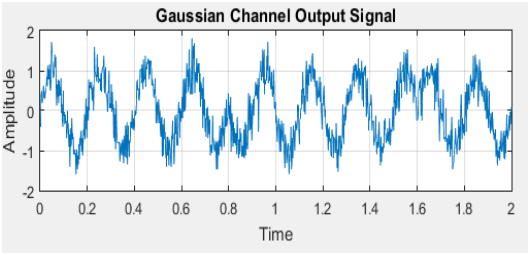
(b)



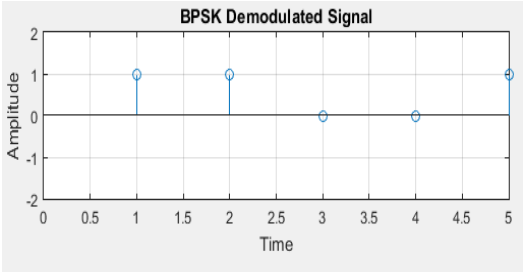
(c)



(d)



(e)



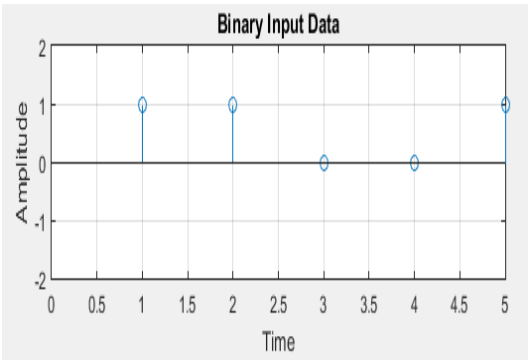
(f)

Fig 5 : *Message Signal(a), Generated NRZ Signal(b) Carrier Signal (c) , PSK Modulated Signal(d), PSK Modulated Signal Passing Through AWGN Channel(e), PSK Demodulated Signal(f)*

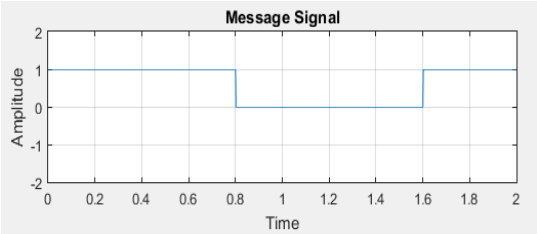
Other input to the product modulator is carrier signal for integration trapezoidal numerical integration method is used. Correlator output is passes through decision making device, if input to the device is greater than 0, output is binary 1 otherwise it makes a decision in favor of binary symbol 0. The resulting signal is PSK demodulated signal. As shown in Fig. 2(f).

FSK Modulation and Demodulation:

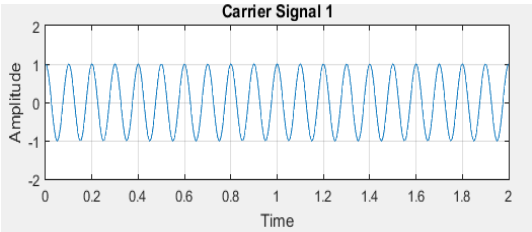
To generate FSK signal two carrier signals with different frequencies 10Hz and 5Hz are needed. Thus in FSK modulation frequency of the carrier signal is varied in accordance with the binary input data 1 1 0 0 1. Input data stream is applied to the two independent product modulators, other inputs to the two independent product modulators are carrier signals of different frequencies. The output of the product modulators are added together. The resultant signal is FSK modulated signal, as shown in Fig. 3(h). Modulated signal is passes through the AWGN channel with SNR 10.The received FSK signal is applied to the two independent correlators. The correlator comprises of a product modulator, followed by an integrator. Other input to the two independent product modulators are carrier signals with different frequencies (same as used for modulation) for integration trapezoidal numerical integration method is used.



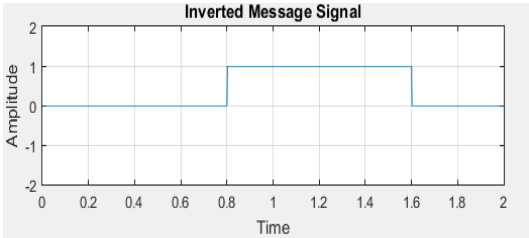
(a)



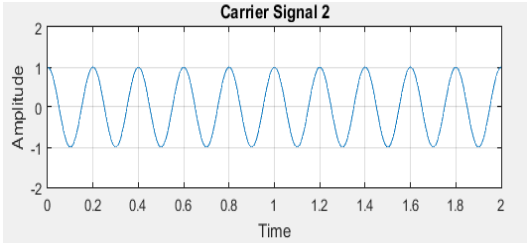
(b)



(c)



(d)



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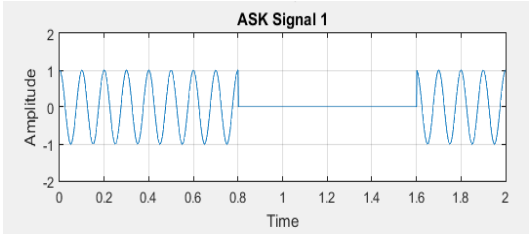

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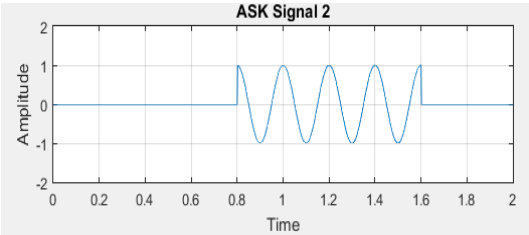
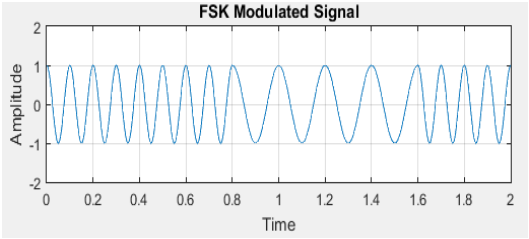
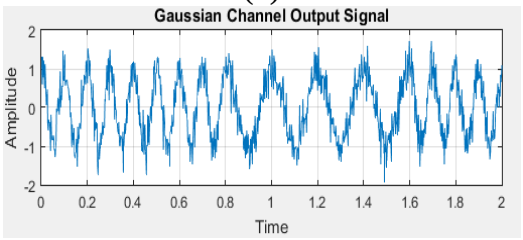


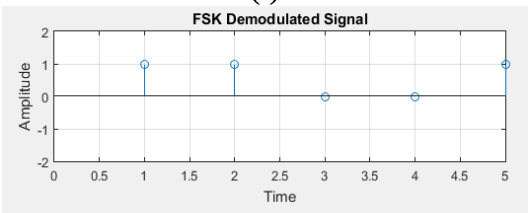
(g)



(h)



(i)



(j)

Fig 6 *: Input Binary Data(a), Message Signal(b), Carrier Signal 1(c), Inverted Message Signal(d), Carrier Signal 2(e) , ASK Modulated Signal 1(f), ASK Modulated Signal 2(g), FSK Modulated Signal(h), FSK Modulated Signal Passing Through AWGN Channel (i), FSK Demodulated Signal (j)*

Output of the correlators are then subtracted which is then applied to the decision device, if input to the device is greater than 0, output is binary 1 otherwise it makes a decision in favor of binary symbol 0. The resulting signal is FSK demodulated signal. As shown in Fig. 3(j).

CONCLUSION

In this paper we had explored and plotted modulated wave, noisy wave and demodulated waves for significant digital modulation techniques ASK, PSK and FSK which are broadly used in wireless communication system using Matlab as simulation tool. The features of these schemes can also be expanded by increasing SNR value. The future

extension is also possible in which we can calculate the probability of error and bit error rate for ASK, PSK and FSK.

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