International Journal of Research in Engineering, Science and Management
Volume-3, Issue-1, January-2020
www.ijresm.com | ISSN (Online): 2581-5792

Design of AM, FM, PM, ASK, FSK, PSK Using OptiSystem Simulator

Rashmi Rekha Mishra[1], Sagupha Parween[2]
[1,2]*Assistant Professor, Department of Instrumentation & Electronics Engineering, College of Engineering & Technology, Bhubaneswar, India*

***Abstract*: Modulation contributes to the advancement of communications by increasing the quality, speed and capacity of the network. The idea of modulation is a primary factor for the reason that without a scheme of suitable modulation, it would be not possible to attain a strategic flow. The modulation is the process of encoding information in transmitted signals, while demodulation is the process of extracting of originally transmitted information from the respective transmitters. The two main categories of modulation are analog and digital. Analog communication is a data transmitting technique in a format that utilizes continuous signal to transmit the data where as digital communication uses discrete signal to transmit the data for various voice, image, videos, etc. Digital modulation techniques are used widely over analog modulation scheme due to their available bandwidth, immunity to noise and better quality of service. In this paper, different analog and digital modulation & demodulation schematic have been designed and tested using OptiSystem 16.0.**

***Keywords*: AM, FM, PM, ASK, FSK, PSK, OptiSystem**

1. Introduction

Communication uses electronic circuits to transmit, process, and receive information between two or more locations. The elementary components of a communication system comprise a source, a communication medium or channel, a destination and noise. Information is transferred into the system in analog or digital form. It is then processed and decoded by the receiver [1]. Information needs to be converted into digital form before it can be transmitted electronically. A signal is that information which has been converted into a digital format. Signals are divided into two forms; Analog signals and Digital signals. The signals have continuous variations of voltage and current. For instance, human voice is an analog signal. The signals that are transmitted via discreet stepwise values such as 0 and 1 are digital signal. Proper modulation scheme is required to transmit various signals through a media. Modulation refers to the act of accumulation of information to an electronic or optical waveform. The information may be added by modifying the amplitude, frequency and phase of the waveform. [2] Modulation is required because most of the time information is produced and transferred via signals having low frequencies. A low frequency signal is highly susceptible to attenuation and therefore it cannot be transferred to long distant locations. In order to resolve this problem, the original carrier wave having a low frequency is superimposed upon a high-frequency carrier wave. The modulation process is also needed to reduce the quantity of noise present in the communication band. There are two types of modulation analog and digital. Analog modulation deals with the voice, video and regular waves of base band signals, whereas digital modulations are with bit streams or symbols from computing devices as base band signals.

Analog modulation is the process of transferring analog low frequency baseband signal, like an audio or TV signal over a higher frequency carrier signal. Baseband signal is always analog for this modulation. There are three properties of a carrier signal amplitude, frequency and phase. The three basic types of analog modulations are Amplitude Modulation (AM), Frequency Modulation (FM), Phase modulation (PM) [2].

Digital modulation is similar to the analog modulation except base band signal is of discrete amplitude level. For binary signal it has only two level, either high or logic 1 or low or logic 0. The three types of modulation schemes are Amplitude shift Key (ASK), Frequency shift key (FSK), Phase shift key (PSK) [3].

A. Amplitude Modulation

AM is a type of modulation where the amplitude of the carrier signal is modulated (changed) in proportion to the message signal, while the frequency and phase are kept constant [4].

B. Frequency Modulation

FM is a type of modulation where the frequency of the carrier signal is modulated (changed) in proportion to the message signal while the amplitude and phase are kept constant [5].

C. Phase Modulation

PM is a type of modulation where the phase of the carrier signal is varied accordance to the low frequency of the message signal is known as phase modulation [5].

D. Amplitude-shift keying

It is a form of modulation that represents digital data as variations in the amplitude of a carrier wave. The amplitude of an analog carrier signal varies in accordance with the bit stream (modulating signal), keeping frequency and phase constant. This digital modulation scheme is used to transmit digital data over optical fiber, point to point military communication

applications, etc. [6]

E. Phase-shift keying

It is a digital modulation scheme that conveys data by changing, or modulating, the phase of a reference signal (the carrier wave). PSK uses a finite number of phases; each assigned a unique pattern of binary bits. Usually, each phase encode an equal number of bits. The simplest form of PSK is binary phase shift keying (BPSK) [6].

F. Frequency-shift keying

It is a frequency modulation scheme in which digital information is transmitted through discrete frequency changes of a carrier wave. The simplest FSK is binary FSK (BFSK). BFSK literally implies using a couple of discrete frequencies to transmit binary (0s and 1s) information [7].

The basic block diagram for communications is shown in Fig. 1. The input message signal is multiplied with the carrier signal are given to the modulator It is very much important to retrieve the originally transmitted signal at the receiver side, for which a demodulator and some filter are required [8]. Demodulation reverses modulation. It takes a modulated signal and extracts the original message out of it.

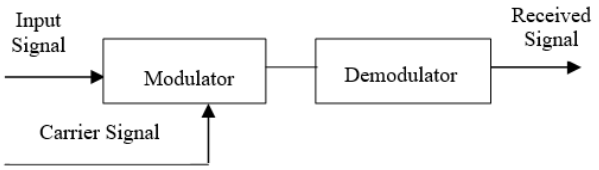

Fig. 1. Basic block diagram for communication

This paper illustrates the design of both analog modulation schemes (AM, FM, PM) and digital modulation schemes (ASK, FSK, PSK) by using analog modulators and demodulators only in OptiSystem 16.0. Section II gives the brief idea about AM, FM, PM, ASK, FSK, and PSK modulation schemes experimental layout. The input and output signal for each modulation schemes has been determined and shown in Section III. The Section IV gives the conclusion based on the experimental results.

2. Experimental layout description

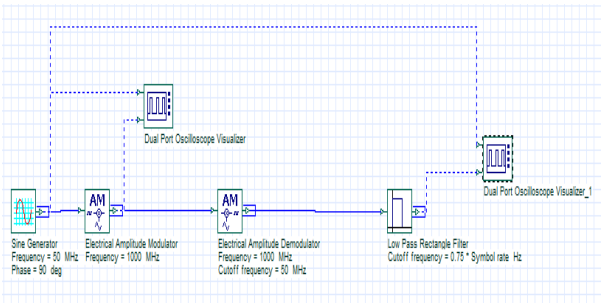

Fig. 2. Electrical amplitude modulation layout

The layouts are designed using OptiSystem 16.0. We have used analog modulators and demodulators to demonstrate both analog and digital communication schemes. AM, FM, PM, ASK, FSK, and PSK shown in Fig. 2, Fig. 3, Fig. 4, Fig. 5, Fig. 6, and Fig. 7 respectively. Table 1 gives the components description and its specifications to design the same.

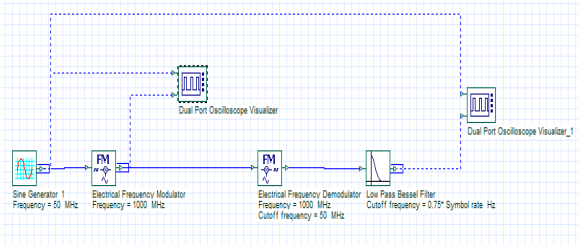

Fig. 3. Electrical frequency modulation layout

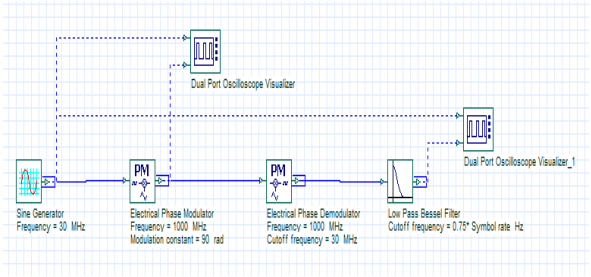

Fig. 4. Electrical phase modulation layout

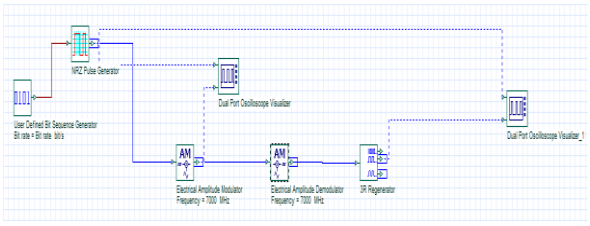

Fig. 5. Electrical ASK layout

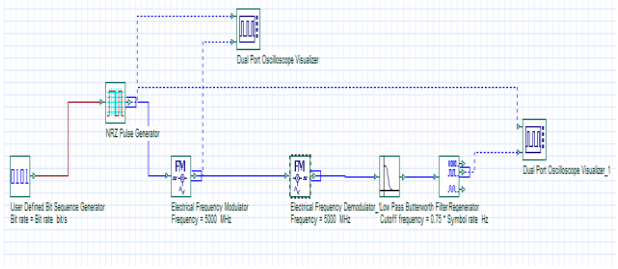

Fig. 6. Electrical FSK layout

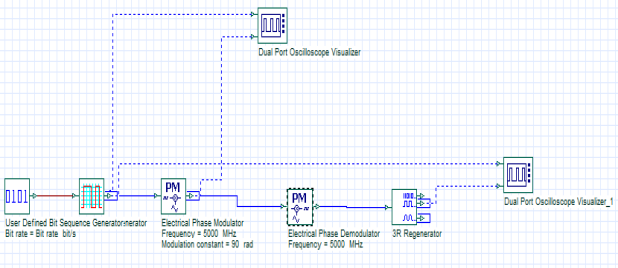

Fig. 7. Electrical PSK layout

Table 1
Components and Specifications summary

Modulation Techniques	Components and Specifications
AM	1. Message Signals: Sine Generators i. Frequency-50MHz 2. Modulator: Electrical Amplitude Modulator i. Frequency-1000MHz ii. Gain-1dB 3. Demodulator: Electrical Amplitude Demodulator i. Frequency:1000MHz ii. Cut-off frequency-50MHz 4. Filter: Low Pass Rectangular Filter 5. Dual Port Oscilloscope visualizer
FM	1. Message Signals: Sine Generators i. Frequency-50MHz 2. Modulator: Electrical Frequency Modulator i. Frequency-1000MHz 3. Demodulator: Electrical Frequency Demodulator i. Frequency:1000MHz ii. Cut-off frequency-50MHz 4. Filter: Low Pass Bessel Filter 5. Dual Port Oscilloscope visualizer
PM	1. Message Signals: Sine Generators i. Frequency-30MHz 2. Modulator: Electrical Phase Modulator i. Frequency-1000MHz ii. Modulation Constant-90 rad 3. Demodulator: Electrical Phase Demodulator i. Frequency:1000MHz ii. Cut-off frequency-30MHz 4. Filter: Low Pass Bessel Filter 5. Dual Port Oscilloscope visualizer
Modulation Techniques	Components and Specifications
ASK	1. Message Signals: User defined Bit sequence Generator i. Bit Sequence:0101101110 2. Encoding: NRZ Pulse Generator 3. Modulator: Electrical Amplitude Modulator i. Frequency-7000MHz 4. Demodulator: Electrical Amplitude Demodulator i. Frequency:7000MHz ii. Cut-off frequency-1MHz 5. 3R Generator 6. Dual Port Oscilloscope visualizer
PSK	1. Message Signals: User defined Bit sequence Generator i. Bit Sequence:0101101110 2. Encoding: NRZ Pulse Generator 3. Modulator: Electrical Frequency Modulator i. Frequency-5000MHz 4. Demodulator: Electrical Frequency Demodulator i. Frequency:5000MHz ii. Cut-off frequency-5000MHz 5. 3R Generator 6. Filter: Low Pass Butterworth Filter Generator 7. Dual Port Oscilloscope visualizer
PSK	1. Message Signals: User defined Bit Sequence Generator i. Bit Sequence:111100101000 2. Encoding: NRZ Pulse Generator 3. Modulator: Electrical Phase Modulator i. Frequency-5000MHz ii. Modulation constant-90rad.
	4. Demodulator: Electrical Phase Demodulator i. Frequency:5000MHz ii. Cut-off frequency-5000MHz 5. 3R Generator 6. Dual Port Oscilloscope visualizer

At the receiver side, we have used some filters like Low pass Rectangular filter, Low pass Bessel filter, and Low pass Butterworth filter to remove the unwanted signals. For ASK, FSK, and PSK schemes, a 3R Regenerator is used for Reshaping, Retiming, and Reamplification of data pulse.

3. Results and analysis

All the simulations are done using OptiSystem 16.0 software. For the analysis of analog and digital communication system, it is required to receive the originally transmitted signals at the receiver side without any alteration in the transmitted signal. Amplitude modulated and demodulated signals are shown in Fig. 8 and Fig. 9 respectively.

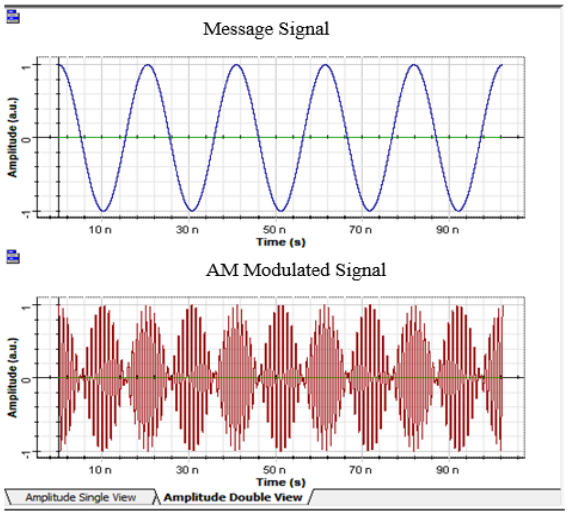

Fig. 8. Message signal and AM modulated signal

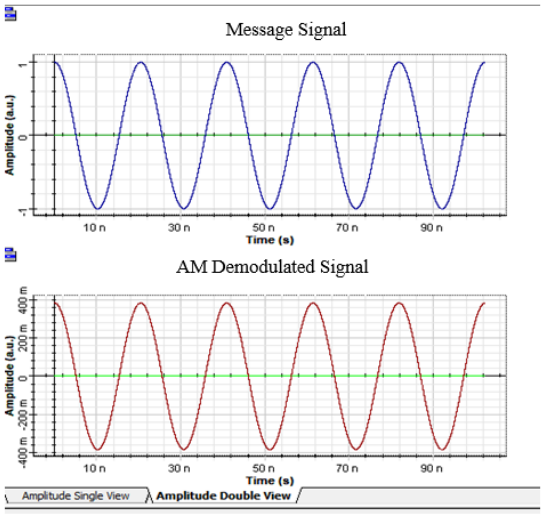

Fig. 9. Message signal and AM demodulated signal

Frequency modulated and demodulated signals are shown in Fig. 10 and Fig. 11 respectively.

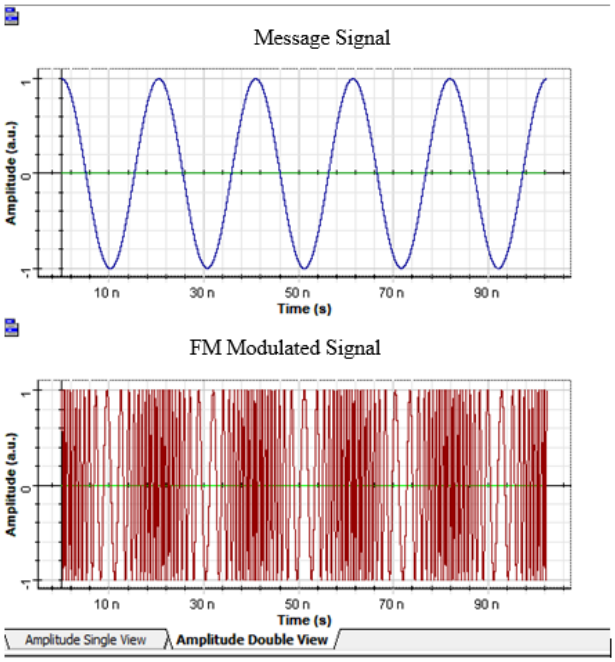

Fig. 10. Message signal and FM modulated signal

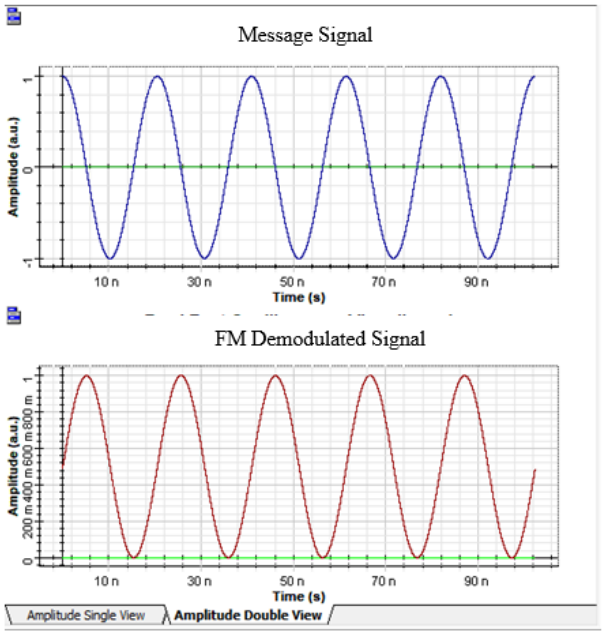

Fig. 11. Message signal and FM demodulated signal

Phase modulated and demodulated signals are shown in Fig. 12 and Fig. 13 respectively.

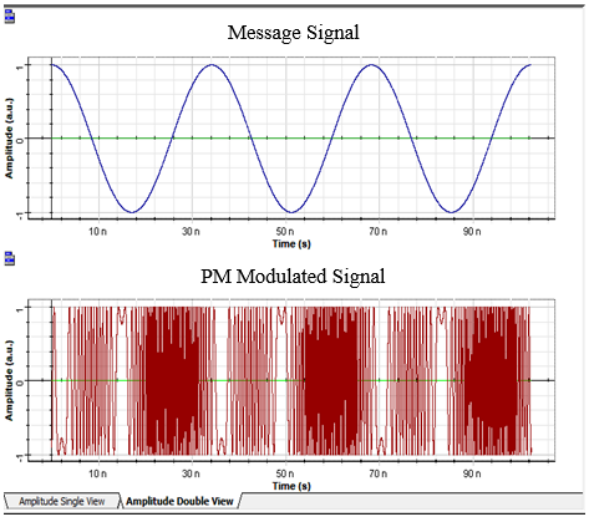

Fig. 12. Message signal and PM modulated signal

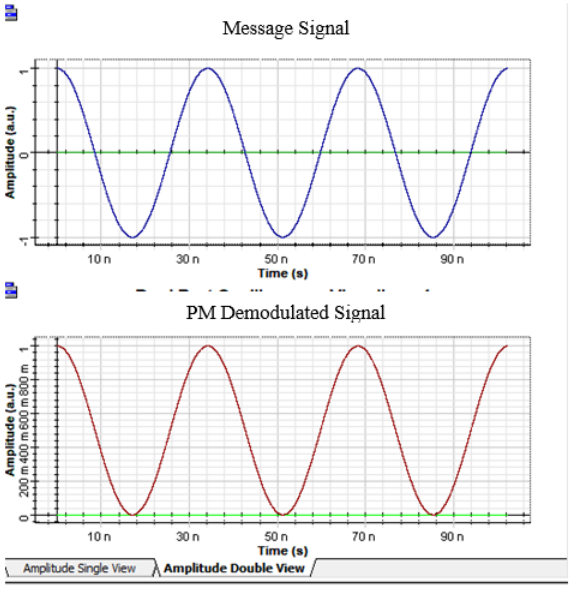

Fig. 13. Message signal and PM demodulated signal

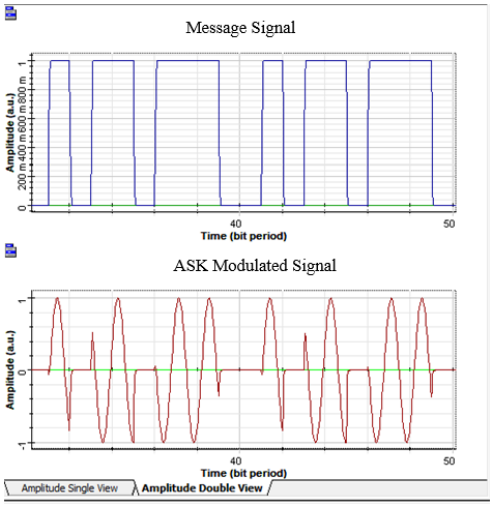

Fig. 14. Message signal and ASK Modulated signal

We have designed the ASK, FSK, PSK modulation and demodulation is designed using same AM, FM and PM modulator and demodulator respectively. ASK modulated and demodulated signals are shown in Fig. 14 and Fig.15 respectively. The input is given by user defined bit sequence generator.

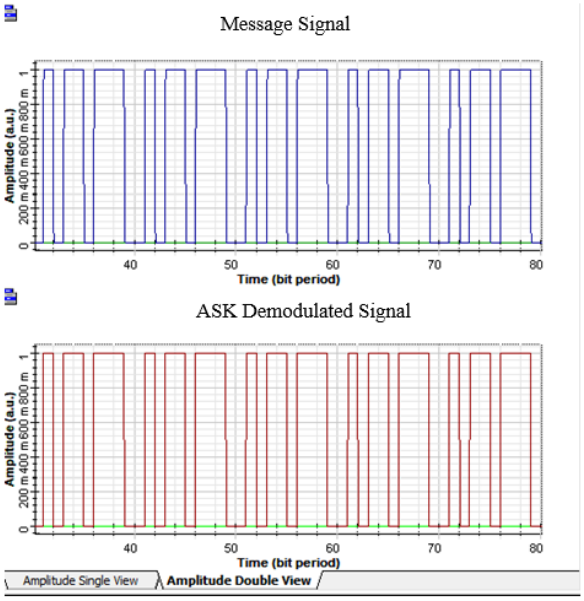

Fig. 15. Message signal and ASK modulated signal

FSK modulated and demodulated signals are shown in Fig. 16 and Fig.17 respectively. Here message signal with binary values encoded a two distinct voltage levels '1' and '0' are applied as a control to the FSK module. FSK modulated waveform is accomplished without using a complicated frequency acquisition method.

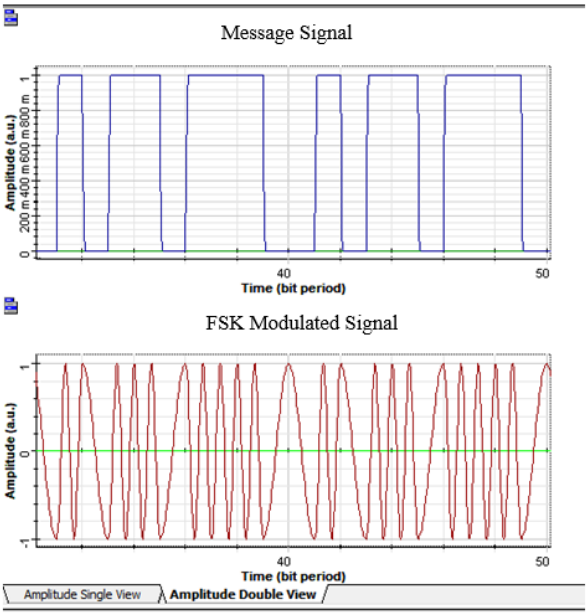

Fig. 16. Message signal and FSK modulated signal

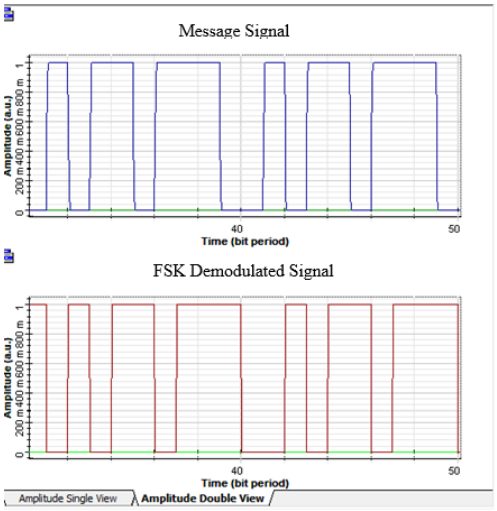

Fig. 17. Message signal and FSK demodulated signal

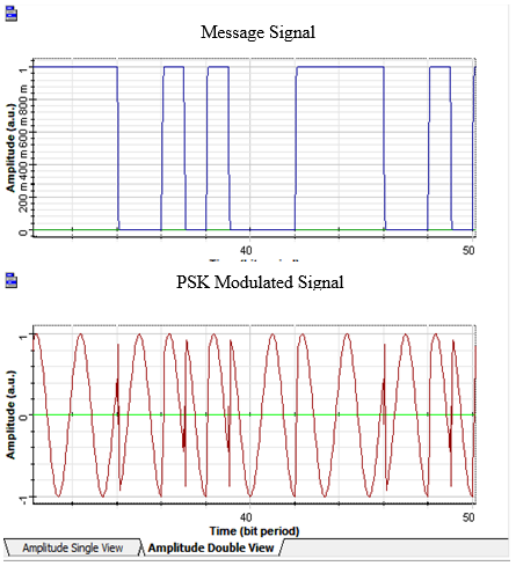

Fig. 18. Message signal and PSK modulated signal

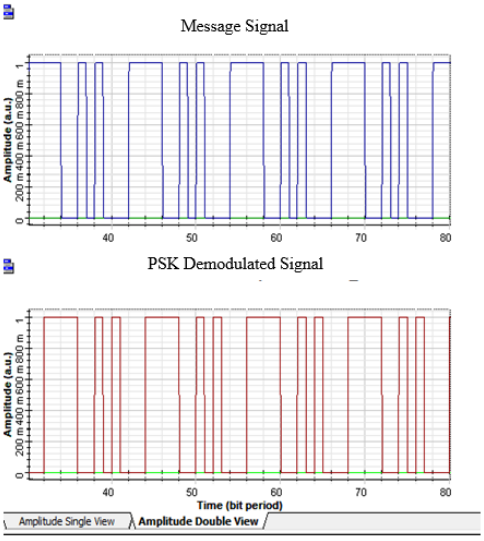

Fig. 19. Message signal and PSK demodulated signal

PSK modulated and demodulated signals are shown in Fig. 18 and Fig. 19 respectively. Whenever there is a change in the edge of binary message signal, a phase shift of 180o can be seen in PSK modulated signal.

4. Conclusion

In this paper, analysis of analog and digital communication is done using AM, FM, PM, ASK, FSK, and PSK modulation techniques. The original transmitted signal is successfully retrieved at the receiver side for all the modulation techniques, but in FSK and PSK the demodulated signal is slight shifted in comparison to its respective original transmitted signals. The shift is due to the effect of some parameters of different components that has been used for designing the schematic. The Digital modulation techniques has also been examined by using RZ encoding technique but NRZ gives the wider range for communication as compare to RZ. These techniques can be tested by adding an AWGN noise block to it, which can give a more realistic view to the schematic.

References

[1] Basic terminologies in Electronic communication; online http://www.circuitstoday.com/basic-terminologies-electronic-communication.
[2] G. Peng, D. Cai, Z. He, Z. Huang, “Modulation Index Estimation of Frequency and Phase Modulated Signals”, International Journal of Communications, Network and System Sciences, Vol. 3, pp. 773-778, September 2010.
[3] H. K. Channi, “A Comparative Study of Various Digital Modulation Techniques”, International Journal in IT and Engineering, Impact Factor, Vol.04, pp. 39-49, March 2016.
[4] S. S. Oberoi, S. Kumar, “Amplitude Modulation”, International Journal of Innovative Research in Technology, Vol. 1, pp. 106-108, 2015.
[5] M. T. Sarker, M.T. Rahman, M.A.M Rahman, M. Kamruzzaman, M.N. Uddin, V. K. Sarker, S Islam, “International Journal for Research in Applied Science & Engineering Technology, Vol. 5, pp. 367-373, January 2017.
[6] A Tarniceriu, B. Iordache, S. Spiridon, “An Analysis On Digital Modulation Techniques for Software Defined Radio Applications”, pp. 571-574, IEEE, October 2007.
[7] R. W. Middlestead, “Digital Communications with Emphasis on Data Modems: Theory, Analysis, Design, Simulation, Testing, and Applications”, First Edition, John Wiley & Sons, Inc. Published 2017 by John Wiley & Sons, 2017.
[8] S. Jain, S Yadav, “A Survey Paper on Digital Modulation Techniques”, International Journal of Computer Sciences and Engineering, Vol. 3, pp. 107-111, December 2015.