Implementation of FSK and PSK Using On-Off Keying with MATLAB

[1]Mrs. Rekha Chahar, [2] Himani, [3]Mr. Sanjeev Yadav
[1][3] Assistant Professor, [2] M.Tech scholar, Govt. Women Engineering College, Ajmer
[1]rekhachahar@gweca.ac.in, [2]himmiiim27@gmail.com, [3]sanjeev.yadav@gweca.ac.in

Abstract
Frequency shift keying (FSK) and Phase shift keying (PSK) are executed and investigated in this paper. FSK and PSK modulated signals are produced using On-Off Keying (OOK) which is a special case of Amplitude Shift Keying (ASK).This paper describes the relation between digital modulation technique ASK, FSK and PSK in the simplest manner.These are digital modulation techniques so the input signal should be in binary form means either 0 or 1. For ASK amplitude of carrier signal is varied to represent binary 1 and 0 respectively, FSK frequency of carrier signal is varied according to the message signal and for PSK phase of the carrier signal is varied according to the message signal. In this paper square wave as message signal data and a high frequency carrier signal have been used. First ASK signal is executed by simple multiplication process of data stream with carrier and then FSK through invert data stream with changing frequency of the carrier also. PSK is implemented by change data stream in bi-polar NRZ (Non return to Zero) form and then multiplication process. To execute the coding system generator version 8.5 are used under MATLAB version (R2015a.)

Keywords: *Amplitude Shift Keying (ASK),Frequency Shift Keying (FSK), On-Off Keying (OOK),Phase Shift Keying (PSK).*

INTRODUCTION

Today digital communication system is required almost in every area and increasing its application in many fields. Communication system means dealing with transmission of information from transmitter to receiver. That means transmitter required to convert information in one form to another from so channel can easily carry information from source to destination and receiver required converting back information to original form so destination could faithfully understand the information. When we transmit digital signal over a long distance than continuous wave modulation is needed. In this modulation process the parameters of the carrier is changed for example amplitude, frequency and phase.

There are a number of digital modulation techniques, available for digital communication. The most fundamental digital modulation techniques are shift keying techniques:

- ASK (amplitude-shift keying) - a finite number of amplitudes are used.
- FSK (frequency-shift keying) -a finite number of frequencies are used.
- PSK (phase-shift keying) - a finite number of phases are used.

The digital communication means digital modulated signal can be transmitted through cable, microwave system, satellite at different frequencies. Because of the constant amplitude of FSK and PSK the effect of non- linearity, noise interference is minimum on signal detection. In digital modulation instead of transmitting one bit at a time, we can also transmit two or more bits at a time. This is known as the M-ary transmission. The factors affecting the modulation schemes are as- 1) maximum data rate, 2) minimum probability of symbol error, 3) minimum transmitted power, 4) maximum channel bandwidth, 5) maximumresistanceto interfering signals, 6) minimum circuit complexity [1–5].

AMPLITUDE SHIFT KEYING

This technique is the simplest digital modulation technique. Amplitude-shift keying (ASK) modulation technique represents digital data as variations in the amplitude of a carrier wave. In an ASK binary symbol ‘1’ is represented by transmitting a high amplitude of carrier signal and binary symbol ‘0’ is represented by transmitting a low amplitude carrier signal.

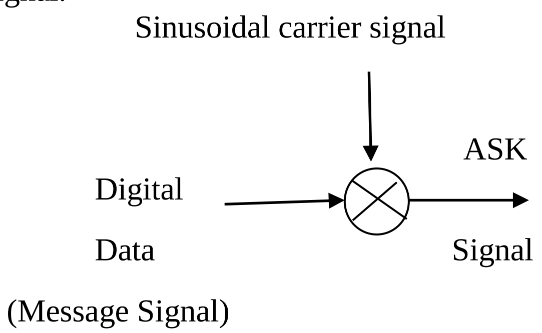


***Fig 1:** Block diagram of generation of ASK signal.*

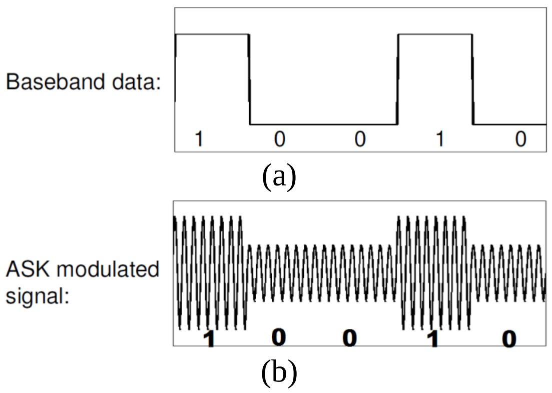


***Fig 2:** Input data (a) and ASK modulated signal (b)*

ON-OFF KEYING (OOK)

OOK is a form of amplitude modulation, in this there is only one unit energy carrier depending upon the input binary sequence. In an OOK system, the binary symbol ‘1’ is represented by transmitting a fixed-amplitude carrier wave and fixed frequency for a bit duration of T seconds. If there will no amplitude value then data value of ‘0’ will be transmitted.

In OOK technique modulated signal can be expressed as

$$s(t)= \begin{cases} \sqrt{2P}\cos(2\pi f_c t) & \text{for bit } 1 \\ 0 & \text{for bit } 0 \end{cases} \quad \text{............(1)}$$

where, f_c =>carrier frequency

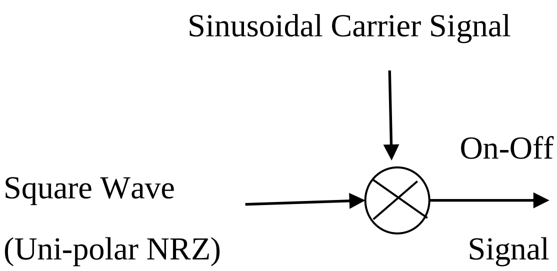


***Fig 3:** Block diagram of generation of OOK signal.*

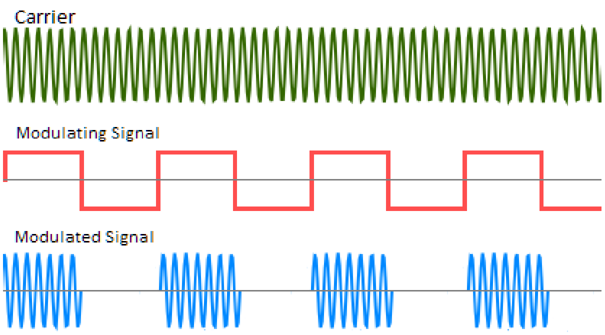


***Fig 4:** Carrier, Input data and OOK modulated signal*

It can be said that modulated signal is in the form of ON means some amplitude level and OFF means zero amplitude level. Thus ASK is also known as ON-OFF KEYING (OOK).

FREQUENCY SHIFT KEYING

Frequency Shift keying (FSK) is a frequency digital modulation technique in which digital message signal is transmitted through discrete frequency changes of a carrier wave. The basic FSK is binary Frequency Shift Keying(BFSK) uses a pair of two discrete frequencies to transmit binary (0s and 1s) information. In this scheme the frequency for binary "1" is known as the mark frequency and the frequency for binary "0" is known as the space frequency [6–11].

In binary FSK signal with message symbol 1 and 0 are distinguished from each other by transmitting one of the two sinusoidal carrier waves that differ in frequency by a fixed amount. It is generated by adding two ask modulated signals in which we have to use two carriers and message signals. One of the carriers has user defined frequency and other one is multiple frequency components of one with inverted message signal respectively.

Let the carrier be

$c(t) = \sqrt{2P}\ Cos(2\pi f_c t)$………………..(2)

For symbol'l'the FSK modulated signal can be given as

$s_1(t) = \sqrt{2P}\ Cos[2\pi(f_c + \Delta f)t]$………...(3)

For symbol '0' the FSK modulated signal can be given as

$s_2(t) = \sqrt{2P}\ Cos[2\pi(f_c - \Delta f)t]$…………(4)

Where Δf => change in carrier frequency

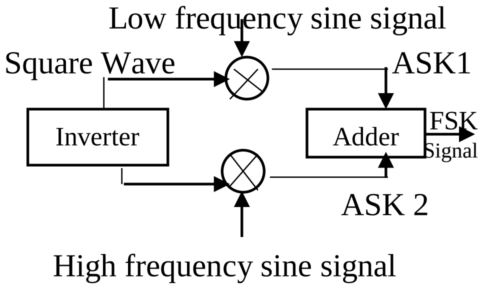


Fig 5: *Block diagram of generation of FSK signal*

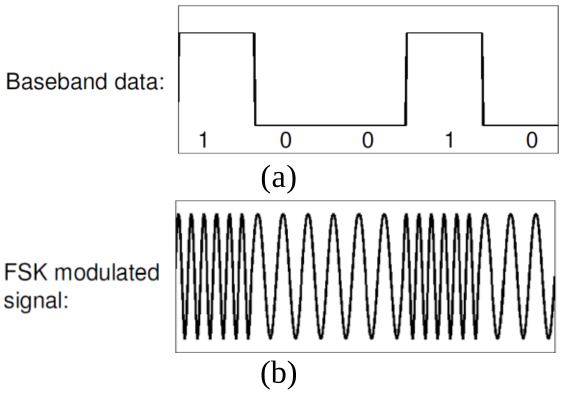


Fig 6: *Input data (a) and FSK modulated signal (b)*

PHASE SHIFT KEYING

Phase-shift keying (PSK) 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 and each assigned a unique pattern of binary digits. Usually each phase encodes an equal number of bits. Each pattern of bits forms the symbol that is represented by the particular phase.

In binary PSK signal with message symbol 1and 0 are transmitted by two different phases. Symbol '0' is transmitted with 0 phase change in carrier signal and symbol '1' is transmitted with π phase shift in carrier. The input signal is a square wave signal. Then PSK signal is generated by convert the square wave signal in Bipolar NRZ form of data. Let the carrier be

$c(t) = \sqrt{2P}\ Cos(2\pi f_c t)$……………(1)

For Symbol '1' the PSK modulated signal can be given as

$s_1(t) = \sqrt{2P}\ Cos(2\pi f_c t)$…………….. (2)

For Symbol '0' the PSK modulated signal can be given as

$s_2(t) = \sqrt{2P}\ Cos(2\pi f_c t + \pi)$………….. (3)

Since Cos $(\theta + \pi) = -Cos\theta$, we can write above equation as

$s_2(t) = -\sqrt{2P}\ Cos(2\pi f_c t)$…………….. (4)

we can define PSK signal combine as,

$s(t) = b(t)\sqrt{2P}\ Cos(2\pi f_c t)$………… (5)

Here, b(t)= +1 when binary '1' is to be transmitted and b(t)= -1 when binary '0' is to be transmitted

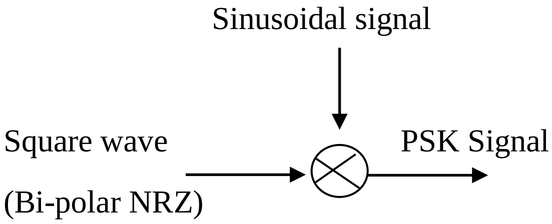
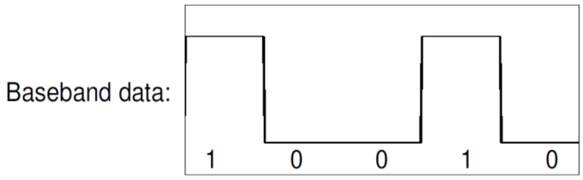
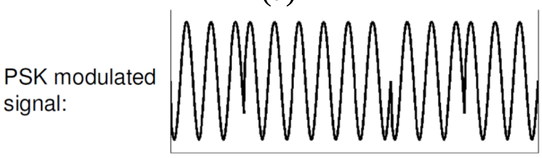


Fig 7: *Block diagram of generation of PSK signal.*



(a)

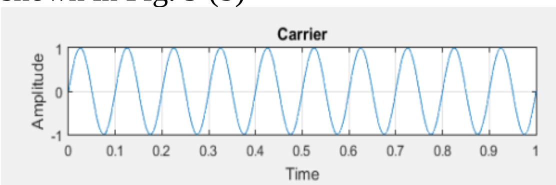


(b)

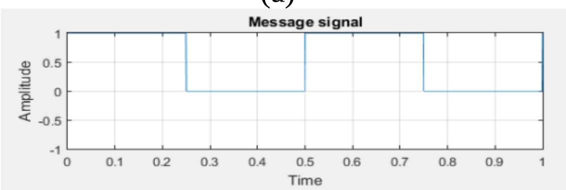
Fig 8: *Input data (a) and PSK modulated signal (b).*

RESULTS

To generate ASK signal, continuous carrier and digital message signal is required which is a square wave here. In this paper we have input continuous carrier frequency with frequency10 Hz shown in Fig.9 (a) and input square wave as message signal with frequency 2 Hz shown in Fig. 9 (b)



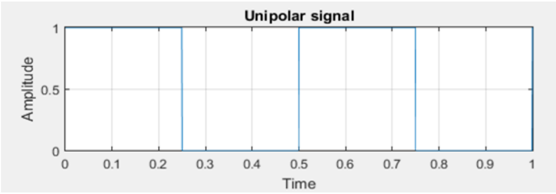
(a)



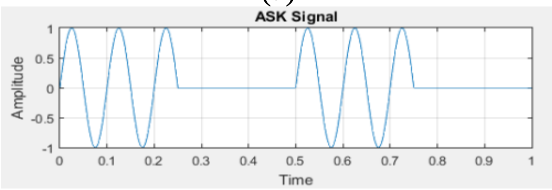
(b)

Fig 9: *Input Carrier (a) andSquare Wave (b)*

ASK Modulated Signal : This result is received when we apply continuous carrier and digital message signal (square wave) at the input of modulater as shown above in Fig. 3, then we generate ASK signal.To generate OOK signal as shown in Fig.10 (b), it require a Uni-polar form of input digital message signal as shown in Fig. 10. (a).



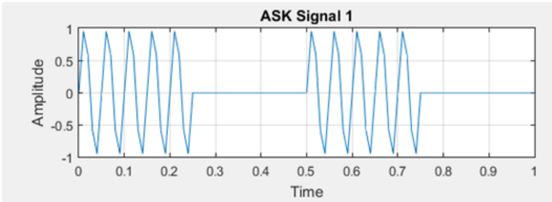
(a)



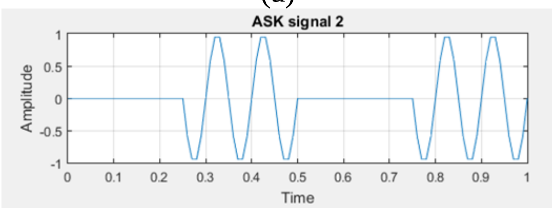
(b)

Fig 10: *Uni-polar data signal (a) and ASK signal (b)*

FSK Modulated Signal: Two different frequencies ASK modulated signals are used to generate FSK signal as shown in Fig 5. ASK signal 1 Fig.11 (a) is generated for symbol '1' and ASK signal 2 Fig. 11 (b) is for symbol '0' means in FSK modulated signal Fig. 11 (c), high frequency represents symbol '1' and low frequency represents symbol '0'.



(a)



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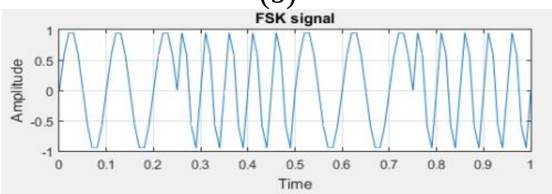
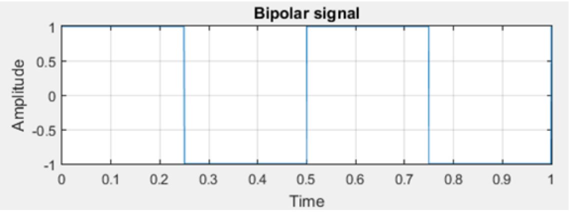


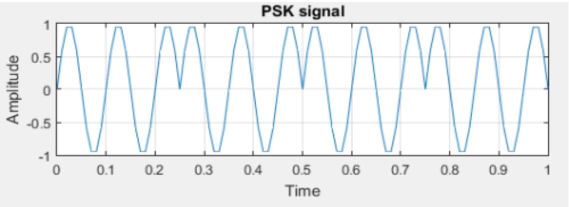
(c)

Fig 11: *ASK 1 (a), ASK 2 (b) and FSK signal (c)*

PSK Modulated Signal: PSK signal is generated as shown in Fig. 12 (b) by applying Bi-polar signal shown in Fig. 12 (a), with continuous carrier shown in Fig. 9 (a) at the input of modulator asshown in Fig. 7.



(a)



(b)

***Fig 12:** Bi-polar signal (a) and PSK signal (b)*

CONCLUSION

As related to digital modulation techniques, can be implemented the basic digital modulation techniques with the help of theoretical concept. After the analysis of different digital modulation technique it is concluded that other modulation technique like PSK and FSK are implemented through simplest digital modulation technique ASK as On-Off Keying. Experimental results show that it may be very useful method for application which have only ASK signal implementation property.

This square wave input shows the output uniformity in amplitude, frequency and phase with respect to ASK, FSK and PSK. FSK is better technique of Digital Communication as compared to PSK and ASK. As the signals generated with this technique are more faithfully regenerated at the receiver and ASK contain more bit error when regenerated. Future extension is also possible for any digital message signal as input.

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ABOUT AUTHORS

Mrs. Rekha Chahar received B. Tech degree from Mody Institute of Technology and Science (MITS), Lakshmangarh (Rajasthan) in 2006 and M.Tech from

Jaipur National University (JNU), Jaipur (Rajasthan) in 2010. She is now working as Assistant Professor in Department of Electronics and Communication Engineering at Govt. Mahila Engineering College, Ajmer (Rajasthan). Her fields of interests are Digital Communication and Artificial Intelligence.

Ms. Himani completed her B.Tech degree from Govt. Mahila Engineering College, Ajmer (Rajasthan) and currently pursing M.Tech degree in Digital Communication.

Sanjeev Yadav received B.Tech in Electronics and Communication Engineering from Uttar Pradesh Technical University, India (2007) and M.Tech. degree in Communication Stream from Malaviya National Institute of Technology, Jaipur, India (2010). He is pursuing PhD degree from Rajasthan Technical University. He is working as an Assistant Professor in Department of Electronics and Communication Engineering at Government Mahila Engineering College, Ajmer, India since 2012. He is a senior member of IEEE including IEEE-MTT-S, Antenna and Propagation Society and Life Member of IETE (India). He is the author/co-author of more than 100 research papers published in the refereed international/national journals and conferences. His research interest includes Planar Antennas, Frequency Selective Surfaces, and Microwave Absorber etc.