



# **Comparative Study of Digital Modulation Techniques Using MATLAB**

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**ABSTRACT:** 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 main objective of this paper is to give an overview of the digital modulation techniques used in wireless communication systems. This paper presents different modulation techniques with the help of MATLAB/SIMULINK that are amplitude shift keying (ASK), quadrature phase shift keying (QPSK), binary phase shift keying (BPSK), frequency shift keying (FSK) & On-off keying (OOK). Simulation models of above techniques involved in signal modulation are proposed in this paper and comparative studies of the same have been done at the later stages.

**KEYWORDS:** Digital Modulation, MATLAB/SIMULINK, ASK, FSK, QPSK, BPSK, OOK.

## **I. INTRODUCTION**

Modulation is the process of varying one or more properties of a periodic waveform, called the carrier signal, with a modulating signal that typically contains information to be transmitted. A modulator is a device that performs modulation. A demodulator (sometimes detector or demod) is a device that performed, the inverse of modulation. A modem (from **modulator–demodulator**) can perform both operations. The aim of digital modulation is to transfer a digital bit stream over an analog band pass channel, for example over the public switched telephone network (where a bandpass filter limits the frequency range to 300–3400 Hz) or over a limited radio frequency band.

The modulation of digital signal information can be transmitted by using cable, microwave system, satellite at different frequencies. As per practical implement approach several type of delay, noise in analogous waveform which is transmitted. All type of modulation techniques, as concern with practical approach considering baseband signal and carrier frequency.

Type of modulation technique classified as following.

1. Binary phase shift keying (BPSK)
2. Quadrature phase shift keying (QPSK)
3. Amplitude shift keying (ASK)
4. Frequency shift keying (FSK)
5. On-off keying (OOK)

## **II. MODULATION & DEMODULATION TECHNIQUES**

### **A. Binary Phase Shift Keying (BPSK)**

BPSK (also sometimes called PRK, phase reversal keying, or 2PSK) is the simplest form of phase shift keying (PSK). It uses two phases which are separated by 180° and so can also be termed 2-PSK. It does not particularly matter exactly where the constellation points are positioned, and in this figure they are shown on the real axis, at 0° and 180°. This modulation is the most robust of all the PSKs since it takes the highest level of noise or distortion to make the demodulator reach an incorrect decision. It is, however, only able to modulate at 1 bit/symbol (as seen in the figure) and so is unsuitable for high data-rate applications.

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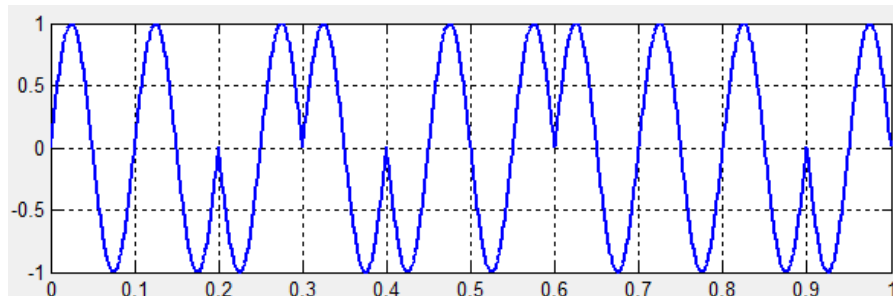


Figure1.Phase change of frequency with binary signal

## B.Quadrature phase shift keying (QPSK)

Quadrature Phase Shift Keying (QPSK) is a form of Phase Shift Keying in which two bits are modulated at once, selecting one of four possible carrier phase shifts (0, 90, 180, or 270 degrees). **QPSK** allows the signal to carry twice as much information as ordinary PSK using the same bandwidth.

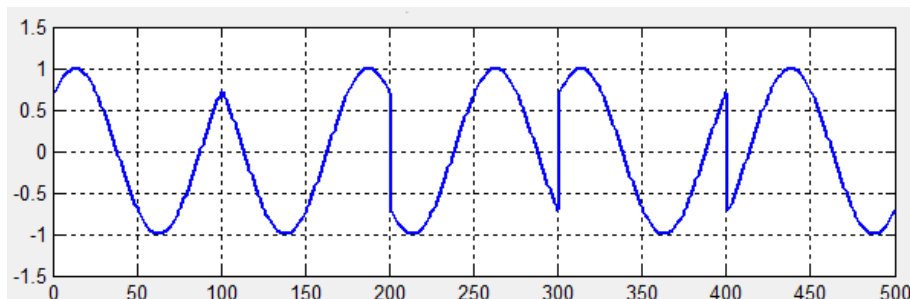


Figure2.Phase change of QPSK signal with time

## C.Amplitude shift keying (ASK)

Amplitude-shift keying (ASK) is a form of amplitude modulation that represents digital data as variations in the amplitude of a carrier wave. In an ASK system, the binary symbol 1 is represented by transmitting a fixed-amplitude carrier wave and fixed frequency for a bit duration of T seconds.

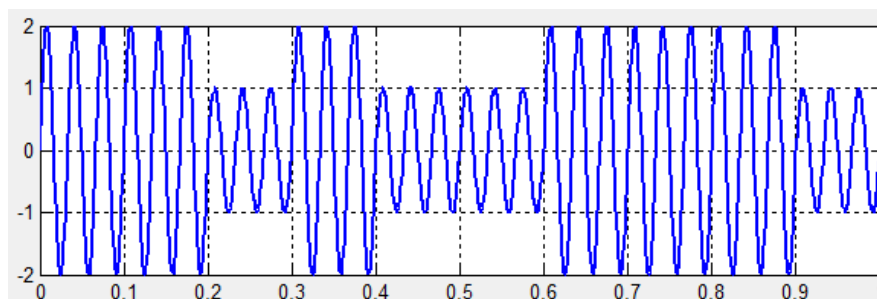


Figure3.Modulation signal of ASK

## D.Frequency shift keying (FSK)

Frequency-shift keying (FSK) 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 uses a pair of discrete frequencies to transmit binary (0s and 1s) information.

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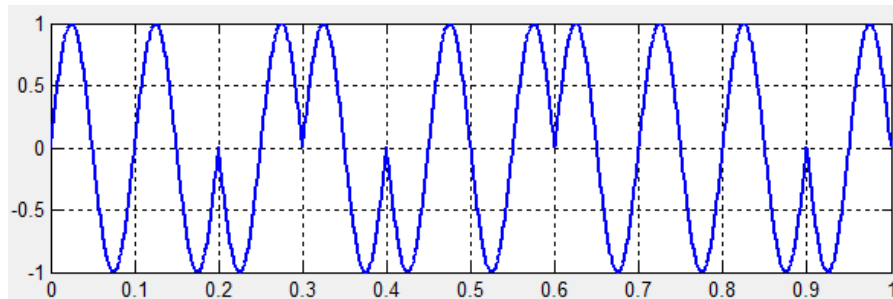


Figure4.Phase change of frequency with binary signal

## E.On-off keying (OOK)

OOK modulation (On/Off Key) is the special case of ASK (Amplitude Shift Key) modulation where no carrier is present during the transmission of a zero. FSK modulation (Frequency Shift Key) is commonly believed to perform better in the presence of interfering signals.

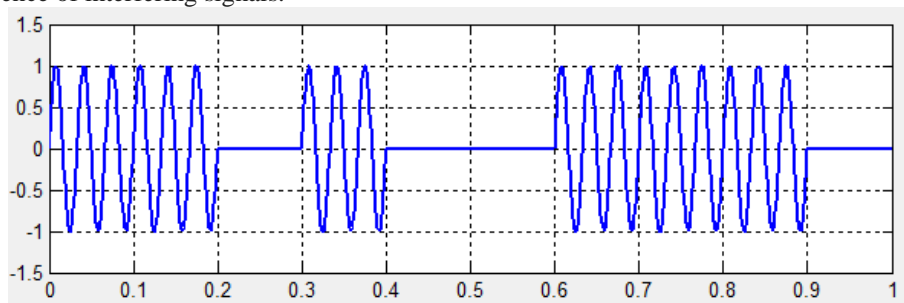


Figure5.Phase change of frequency with binary signal

## III.IMPLEMENTATION OF MODULATION TECHNIQUE IN MATLAB

### 1. Binary phase shift keying (BPSK)

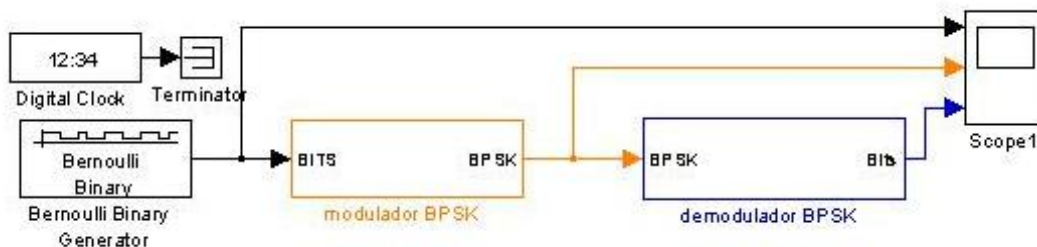


Figure6.BPSK Modulator and Demodulator

We can use MATLAB for the implementation of BPSK modulator and demodulator.MATLAB is fully based on experimental work. We represent here with SIMULINK block eg. binary generator.Output waveform is shown below .

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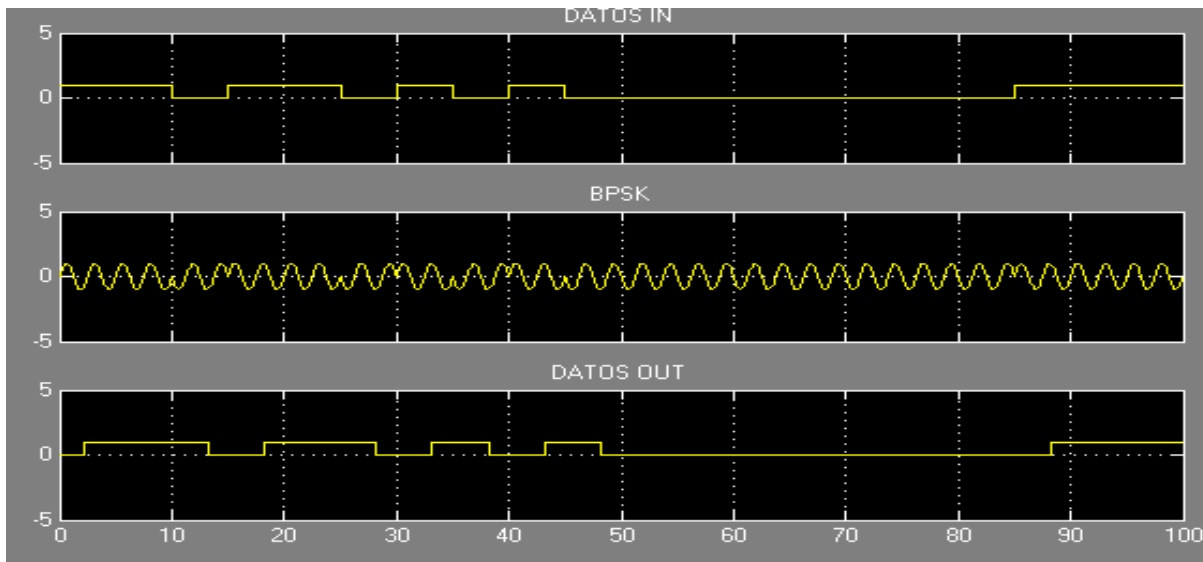


Figure7.Output of BPSK Modulator and Demodulator

System does not have 100% performance capability because of some delay. Output of BPSK modulator and demodulator shown above. Three axis respectively as shown above, in the first axis binary bit or information bit then second axis in which modulated waveform of BPSK and finally third axis show demodulated data.

## 2. Quadrature phase shift keying (QPSK)

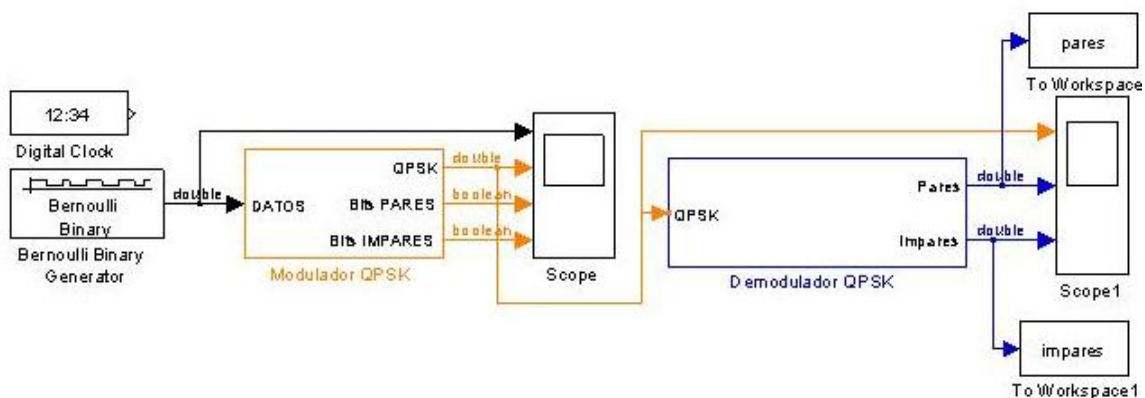


Figure8.QPSK modulator and demodulator

Information bit carry according to the frequency without changing analog signal,  $2 \cdot \pi \cdot 4$  frequency to carry the information bit as shown in the SIMULINK model of QPSK modulator and demodulator. Waveform shown below in accordance with scope.

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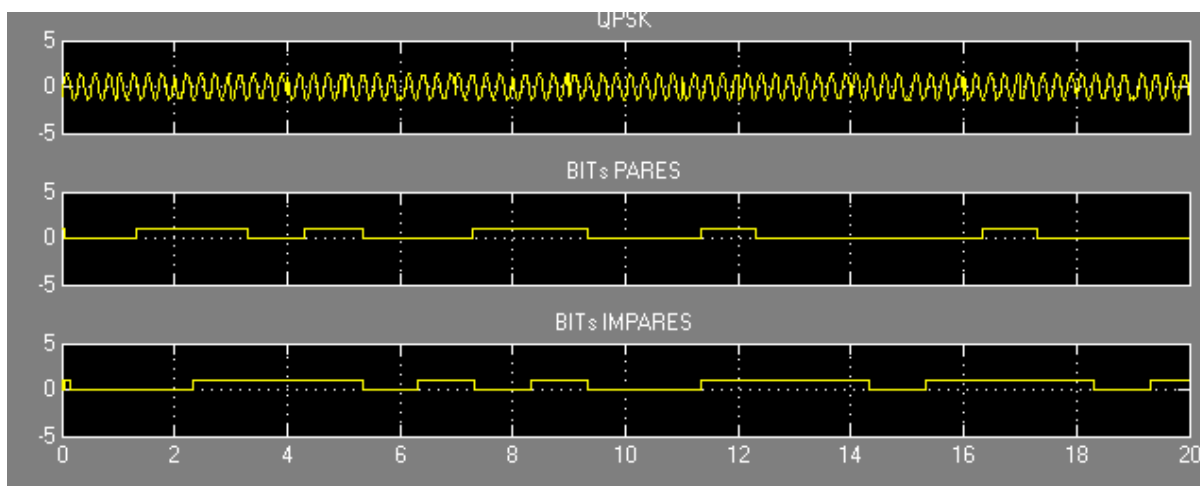


Figure9.Output of QPSK modulator and demodulator

First axis shows reception of bits during demodulation process as shown in above output waveform. Finally QPSK modulated waveform as mentioned in the theory.

### 3. Amplitude shift keying (ASK)

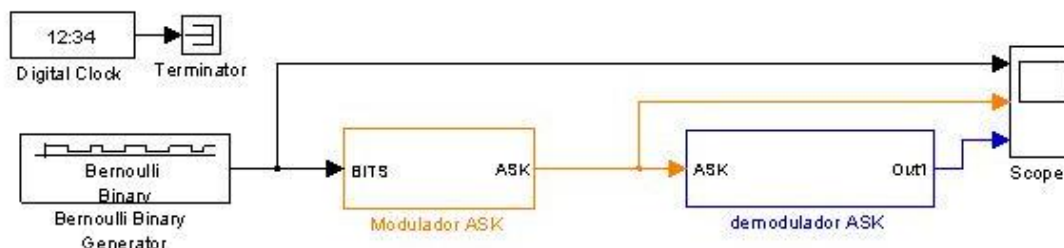


Figure10.ASK Modulator and Demodulator

Data can vary according to amplitude of desirable signal. At the same instant binary signal can change according to frequency which is mentioned in ASK the bandwidth of signal is minimum so we can go for above technique. Reception of signal has delay and has possible error occur in sequence of bit same as in BPSK and QPSK. This technique performs well in short communication but fail for long communication.

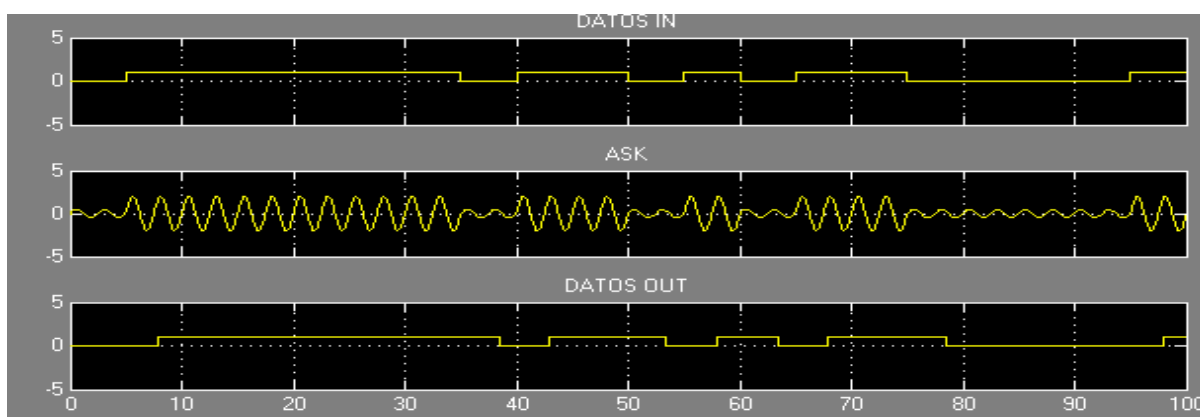


Figure11.Output waveform of ASK modulator and demodulator.

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Information bit, ASK modulated waveform and reception bit respectively shown in the above mention three axis output of ASK modulator and demodulator.

## 4. Frequency shift keying (FSK)

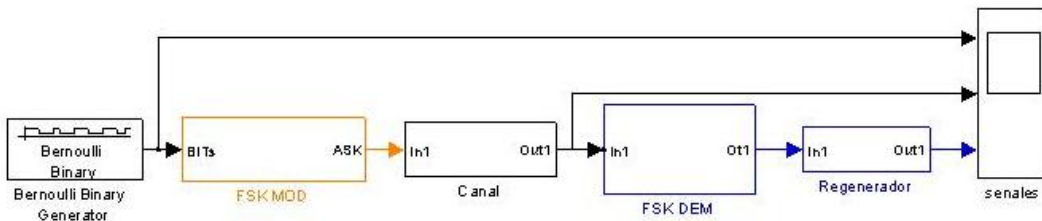


Figure12. Output of FSK modulator and demodulator

Above diagram shows implementation of FSK using MATLAB. Output shown below shows the implementation of FSK module. Information bit in first axis then modulated waveform of FSK at last reception bits having some delay.

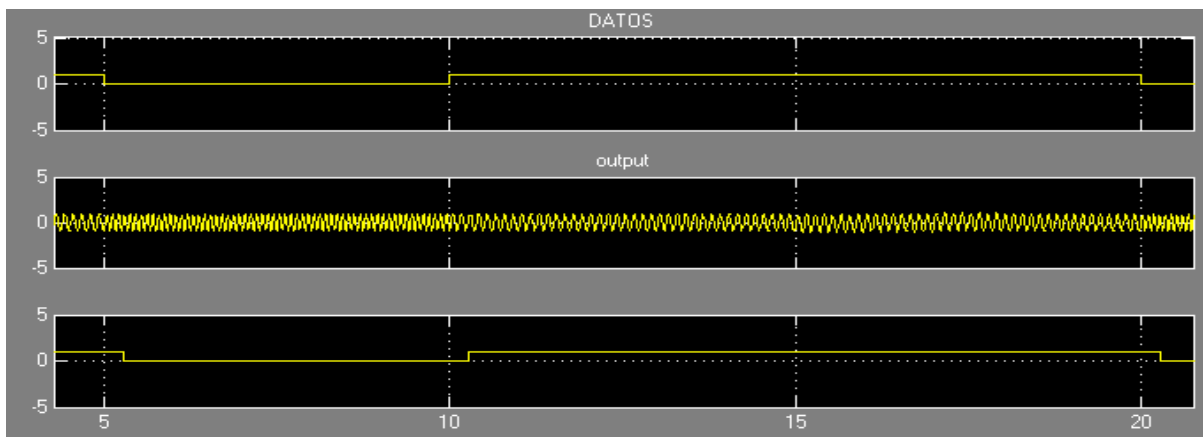


Figure13. Output of FSK modulator and demodulator.

## 5. On-off keying (OOK)

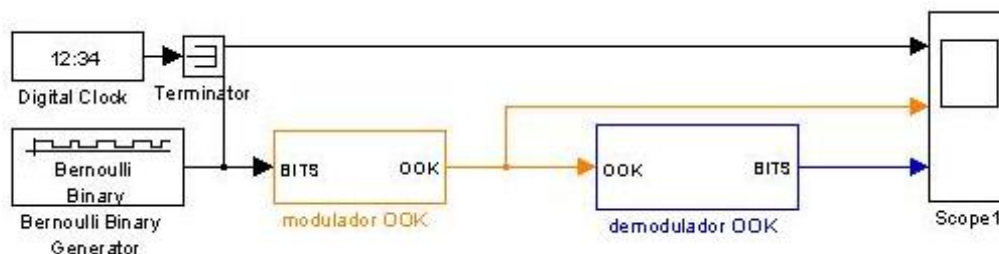


Figure14. OOK modulator and demodulator

As shown above the block diagram of OOK modulator and demodulator implemented using MATLAB. Output of OOK modulator and demodulator as shown below.

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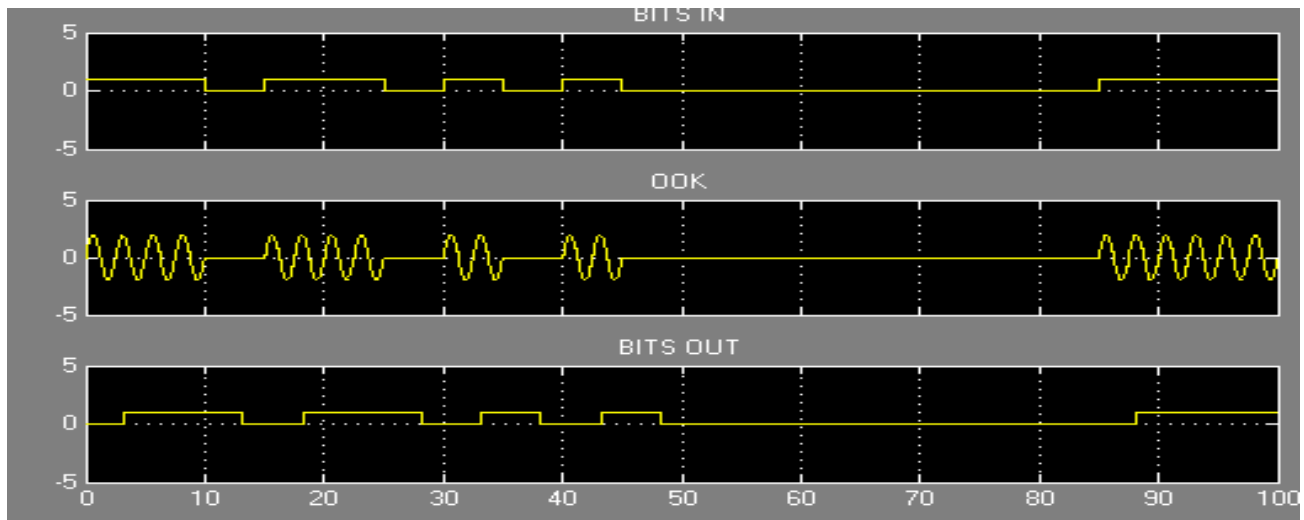


Figure15.Output of Modulator and demodulator.

## IV.RESULT & CONCLUSION

As related to digital modulation techniques, we can implement the basic digital modulation techniques with the help of theoretical concept. After the analysis we can observe that experimental result have some delay and by using the observations we can calculate the delay.

A comparative study have been done of digital modulation techniques used in wireless communication system. The simulation model and the output waveform of the different digital modulation techniques have been discussed in this paper. Hence this paper emphasises on a comparative modulation techniques i.e. Amplitude shift keying(ASK),quadrature phase shift keying(QPSK),binary phase shift keying(BPSK),frequency shift keying(FSK),on-off keying(OOK).

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