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Multiple Signal Processing, Control and Communication

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Abstract— The paper is aimed at designing a system by means of which multiple signals could be sent by using a single carrier. In real time communication only a single signal can be sent through a carrier. Although there are many multiplexing techniques, this particular technique helps us to extract multiple signals at a single period of time and using single frequency. This problem can be approached in two different ways. In the first technique, the signal which is sampled is sent for quantization. At this stage, the quantization of the signal depends on the other digital signal which is transmitted in parallel. Whenever the digital signal is high, the sample will be quantized to an even integer and when it is low, the signal will be quantized to an odd integer. In this way multiple signals can be transmitted. In the second approach which we are using in this paper, three analog signals are taken and converted into digital signals. One of them is modulated using the amplitude modulation technique and the modulated signal is frequency modulated with the other digital signal. The resultant signal is then phase modulated with the third digital signal. Here we are using the same time, same bandwidth and same carrier to send three different signals. This is an alternative technique to process multiple signals at a time and hence increasing the efficiency. We can apply this technique in real time to simultaneously send a text message while two persons speak to each other on phone.

Index Terms- **BASK, BFSK, BPSK, Digital Communication, Multiplexing of signals.**

I. INTRODUCTION

There are many modulation techniques for sending analog signals though it is very difficult to process or do some operations on them. There has been a huge development in the field of digital signal processing. So now-a-days, almost everyone uses digital communication for a variety of reasons. There has been many techniques invented to process these digital signals efficiently and also with high speed. Some of them are *Binary Amplitude Shift Keying, Binary Frequency Shift Keying, Binary Phase Shift Keying*, etc. Every technique has its own advantages and disadvantages. So we have come up with a new *hybrid technique* where maximum signal rate can be achieved. Multiple signals can be processed simultaneously. In this technique we are transmitting three different speech signals using a single carrier wave by combining all the above mentioned techniques. The three input signals will be taken and will be modulated by using BASK, BFSK, BPSK respectively as shown in Fig.1. The final wave is transmitted and the receiver decodes it simultaneously therefore time for decoding can be reduced.

II. THE PROPOSED SYSTEM

Three analog signals are taken and converted to digital form. First the signal is amplitude modulated using a carrier. The next block frequency modulates the input with respect to the next signal. Then the third block performs phase modulation on the already amplitude and frequency modulated signal. In this way three signals are simultaneously sent using one carrier. Then on the decoder side the demodulations are simultaneously performed to recover all the signals.

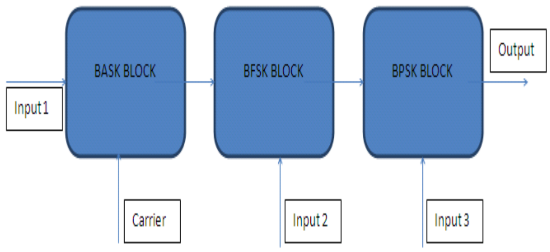

Fig.1 Transmitter Block Diagram

III. METHODOLOGY

A. Binary Amplitude Shift Keying

The first digital signal is taken and transmitted to a block where the amplitude of the carrier wave is made negative when '0' is detected and positive when the symbol '1' is detected as shown in Fig.2. The output wave from this block is fed to another block where it is frequency modulated.

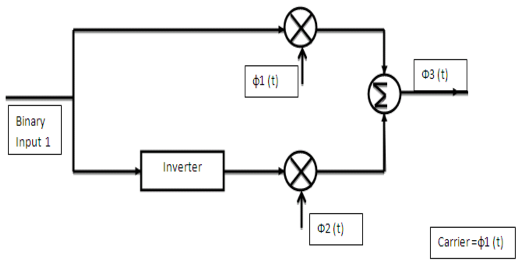

Fig. 2 BASK Block

B. Binary Frequency Shift Keying

The second input wave is given as control to this block Fig.3. The wave is modulated to low frequency when '0' is detected and high frequency when '1' is detected. The output is further sent to BPSK block.

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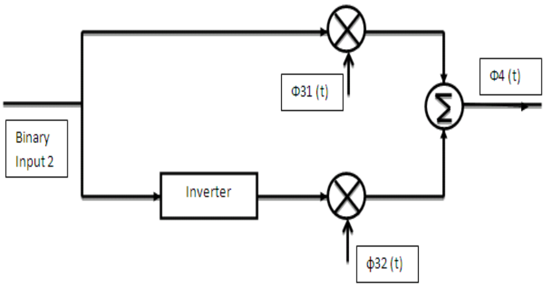

Fig. 3 BFSK Block

C. Binary Phase Shift Keying

The output of this block is sent to the third block Fig.4 where it is phase shifted according to the third input sequence. The carrier wave is not shifted when symbol '0'is detected and is given a 90deg phase shift from the original wave when symbol '1' is detected. The wave output of this block will be the final wave ready to be transmitted.

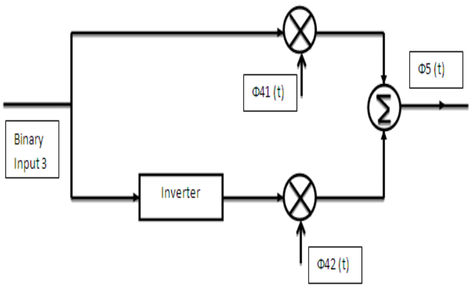

Fig. 4 BPSK Block

D. Receiver

In the receiver the wave is simultaneously sent into three different decoder blocks. Each block will act independently and do the work simultaneously so that the total amount of time for decoding can be reduced. The first, second and third block does amplitude, frequency, phase demodulation respectively.

IV. RESULTS AND SIMULATION

A carrier with frequency fc is given along with the first input as shown in Fig.5.

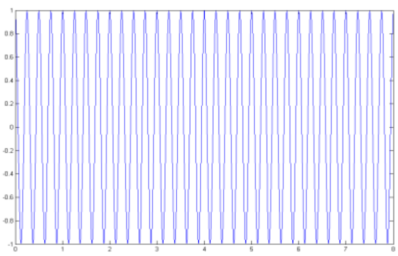

Fig. 5 Carrier Wave

The sample input binary sequences are as follows:
n1= [1 0 0 0 1 0 1 0]
n2= [1 0 1 0 1 1 1 0]
n3= [1 1 0 1 0 0 0 0]

According to whether the input (n1) to BASK block is 1 or 0 the output is ϕ1 (t) or ϕ2 (t) respectively as shown in Fig.6.

$$\phi 1\ (t) = \sqrt{\frac{2}{Tb}} * \cos(2\pi * (fc) * t) \quad \text{for } 1 \qquad (1)$$

$$\phi 2\ (t) = \sqrt{\frac{2}{Tb}} * \cos(2\pi * (fc) * t) - c \quad \text{for } 0 \qquad (2)$$

fc = carrier frequency (Hz)
Tb = bit duration (s)
c = constant

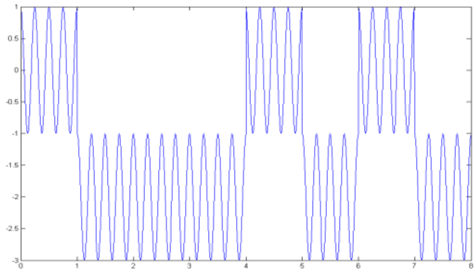

Fig. 6 Amplitude Modulated wave with first input signal.

Now when the output is fed into BFSK block depending on the 4 combinations of the inputs to BASK (n1) and BFSK (n2) block subsequently following output waves are possible. The output corresponding to the given input is shown in Fig. 7.

$$\phi 311\ (t) = \sqrt{\frac{2}{Tb}} * \cos\ (2\pi * (fc) * t) \text{ for } 11 \qquad (3)$$

$$\phi 310(t) = \sqrt{\frac{2}{Tb}} * \cos\ (2\pi * (fc + fa) * t) \text{ for } 10 \qquad (4)$$

$$\phi 321\ (t) = \sqrt{\frac{2}{Tb}} * \cos(2\pi * (fc) * t) - c \text{ for } 01 \qquad (5)$$

$$\phi 320(t) = \sqrt{\frac{2}{Tb}} * \cos(2\pi * (fc + fa) * t) - c \text{ for } 00 \qquad (6)$$

fa= Modulating Frequency (Hz)

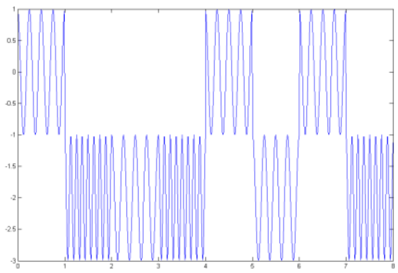

Fig. 7 The output from BASK block Frequency modulated using the second input.

Finally the output from the BFSK block is fed into BPSK block where phase modulation is done using the third input (n3).Now there will be total 8 combinations of inputs which results in 8 possible output equations as given below. The final output which contains the information related to all the three inputs is shown in Fig.8.

$$\Phi 411\ (t) = \sqrt{\frac{2}{Tb}} * \cos\ (2\pi * (fc) * t) \text{ for } 111 \qquad (7)$$

$$\Phi 410\ (t) = -\sqrt{\frac{2}{Tb}} * \sin\ (2\pi * (fc) * t) \text{ for } 011 \qquad (8)$$

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$$\Phi 421\ (t) = \sqrt{\frac{2}{Tb}} * \cos\left(2\pi * (fc + fa) * t\right) \text{ for } 101 \tag{9}$$

$$\Phi 420\ (t) = -\sqrt{\frac{2}{Tb}} * \sin\left(2\pi * (fc + fa) * t\right) \text{ for } 001 \tag{10}$$

$$\Phi 431\ (t) = \sqrt{\frac{2}{Tb}} * \cos\left(2\pi * (fc) * t\right) - c \text{ for } 110 \tag{11}$$

$$\Phi 430\ (t) = -\sqrt{\frac{2}{Tb}} * \sin\left(2\pi * (fc) * t\right) - c \text{ for } 010 \tag{12}$$

$$\Phi 441\ (t) = \sqrt{\frac{2}{Tb}} * \cos\left(2\pi * (fc + fa) * t\right) - c \text{ for } 100 \tag{13}$$

$$\Phi 440\ (t) = -\sqrt{\frac{2}{Tb}} * \sin\left(2\pi * (fc + fa) * t\right) - c \text{ for } 000 \tag{14}$$

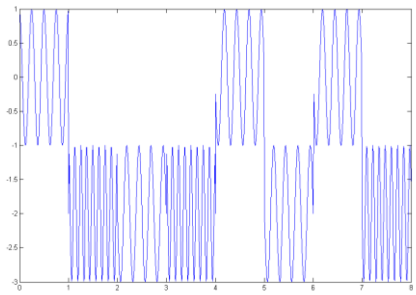

Fig. 8 The output from BFSK block Phase modulated using the third input.

The final output can now be transmitted over any channel and at the receiver side all the inputs can be recovered by demodulation processes. First the amplitude demodulation is performed wherever the amplitude of the hybrid signal is greater than -1, 1 is recovered and 0 elsewhere. The sample input recovered by this process is shown in Fig.9.

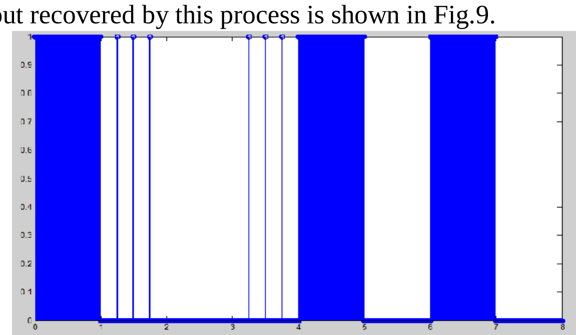

Fig.9 First input recovered n1 = [1 0 0 0 1 0 1 0]

Next the frequency demodulation recovers the second input. Wherever the frequency is equal to the carrier frequency 1 is recovered and 0 otherwise. The recovered output is shown in Fig.10.

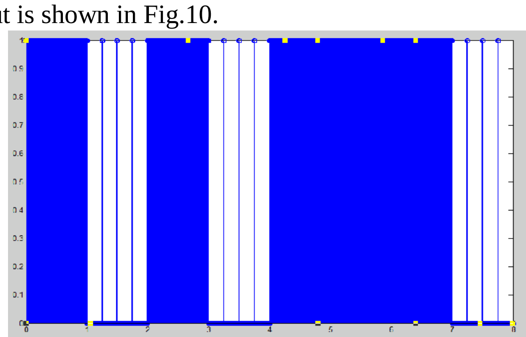

Fig.10 Second input recovered n2 = [1 0 1 0 1 1 1 0]

Last step is to perform phase demodulation due to which the third input is recovered as shown in Fig.11.

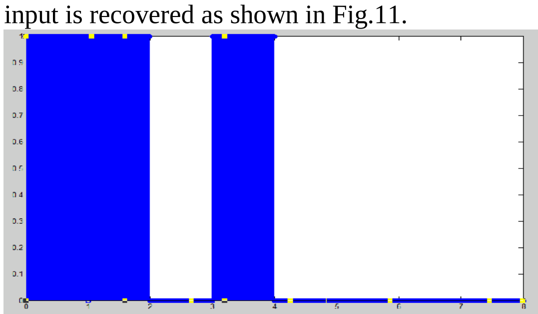

Fig.11 Third input recovered n3 = [1 1 0 1 0 0 0 0]

V. CONCLUSION

The present study shows that through a single carrier multiple signals can be processed and the bit rate can be increased. It can be applied in the speech processing, image processing and in all other digital communications.

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