



## Multiuser detection using BPSK modulation with Adaptive filters

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### ABSTRACT

To attain large information rates, multi user detection (MUD) is a well-built aspirant for the downlink of cell phone communications. However, while transmitting any signal over fading channel, the performance of any system is highly affected. For that reason, Multiuser detection (MUD) and channel estimation play a significant function for overcoming the interference and characterizing the channel. In previous cases, this is developed by using many kinds of algorithms. But in this Paper BPSK modulation technique was introduced for multiuser detection due to the drawbacks of those algorithm. The objective of this BPSK modulation is used to minimize the error rate of the user transmitting signal. In this, the user detection complexity and the interference of user transmitting signal are resolved. Since the detection complication and the required time are concentrated. In general, we make use of many types of filters namely, linear filters, nonlinear filters etc. here we are going to implement with adaptive filters. By using nonlinear filters we get narrow bandwidth responses and by using linear filters we get interference and BER is also high. So by using adaptive filters we overcome these drawbacks. The goal of adaptive filters is to improve synchronization and capacity by reducing interference between users. Adaptive algorithms improve the feasibility of multi user receivers.

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### Introduction

#### Generation of BPSK

Consider a sinusoidal carrier. If it is modulated by a bi-polar bit stream according to the scheme illustrated in Figure below, its polarity will be reversed every time the bit stream changes polarity. This, for a sinewave, is equivalent to a phase reversal (shift). The multiplier output is a BPSK 1 signal.

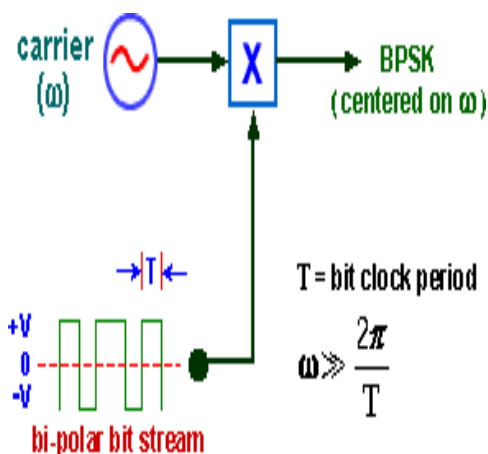


Fig.1 Generation of BPSK.

The information about the bit stream is contained in the changes of phase of the transmitted signal. A synchronous demodulator would be sensitive to these phase reversals. The appearance of a BPSK signal in the time domain is shown in Figure 2 (lower trace). The upper trace is the binary message sequence.

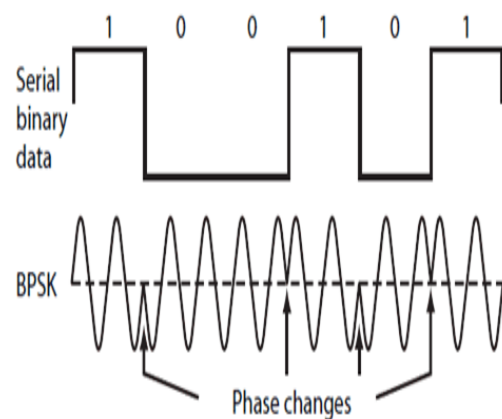


Fig. 2 Generation of BPSK waveforms.

There is something special about the waveform. The wave shape is 'symmetrical' at each phase transition. This is because the bit rate is a sub-multiple of the carrier frequency  $\omega/(2\pi)$ . In addition, the message transitions have been timed to occur at a zero-crossing of the carrier. Whilst this is referred to as 'special', it is not uncommon in practice. It offers the advantage of simplifying the bit clock recovery from a received signal. Once the carrier has been acquired then the bit clock can be derived by division.

#### Band Limiting

The basic BPSK generated by the simplified arrangement illustrated in Figure 1 will have a bandwidth in excess of that considered acceptable for efficient communications.

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If you can calculate the spectrum of the binary sequence then you know the bandwidth of the BPSK itself. The BPSK signal is a linearly modulated DSB, and so it has a bandwidth twice that of the baseband data signal from which it is derived. In practice there would need to be some form of bandwidth control. Band limiting can be performed either at baseband or at carrier frequency. It will be performed at baseband in this experiment.

**Bpsk Demodulation**

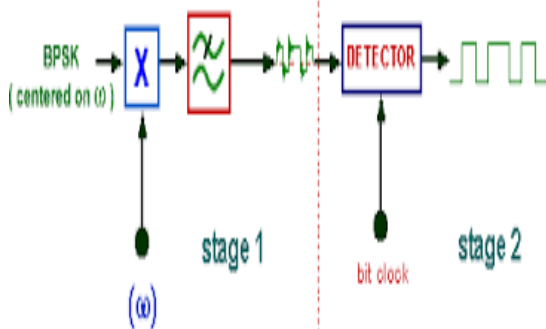
Demodulation of a BPSK signal can be considered a two-stage process.

1. Translation back to baseband, with recovery of the band limited message waveform
2. Regeneration from the band limited waveform back to the binary message bit stream. Translation back to baseband requires a local, synchronized carrier.

**Stage 1**

Translation back to baseband is achieved with a synchronous demodulator and translation back to baseband. This requires a local synchronous carrier. In this experiment a stolen carrier will be used.

Carrier acquisition will be investigated in the experiment entitled DPSK - carrier acquisition and BER



**Fig.3 synchronous demodulation of BPSK.**

**Stage 2**

The translation process does not reproduce the original binary sequence, but a band limited version of it. The original binary sequence can be regenerated with a detector. This requires information regarding the bit clock rate. If the bit rate is a sub-multiple of the carrier frequency then bit clock regeneration is simplified. In TMS the DECISION MAKER module can be used for the regenerator, and in this experiment the bit clock will be a sub-multiple of the carrier. phase ambiguity

You will see in the experiment that the sign of the phase of the demodulator carrier is important. Phase ambiguity is a problem in the demodulation of a BPSK signal. There are techniques available to overcome this. One such sends a training sequence, of known format, to enable the receiver to select the desired phase, BPSK - binary phase shift keying D1 - 73 following which the training sequence is replaced by the normal data. An alternative technique is to use differential encoding. This will be demonstrated in this experiment by selecting a different code from the line code encoder.

- One advantage is more bandwidth.
- A disadvantage is that the transmitted power is lower.

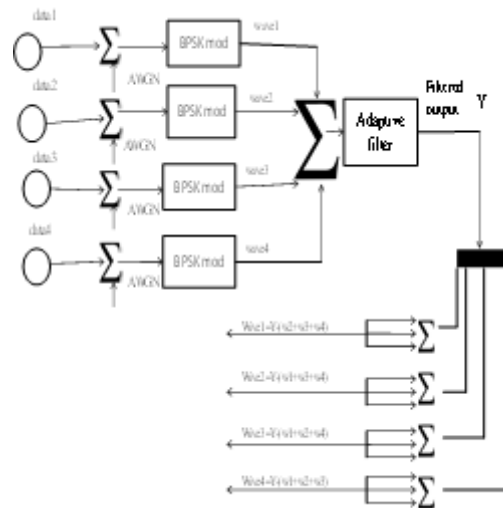
**Adaptive Filter**

An adaptive filter is a system with a linear filter that has a transfer function controlled by variable parameters and a means to adjust those parameters according to an optimization algorithm. Because of the complexity of the optimization algorithms, almost all adaptive filters are digital filters. Adaptive filters are required for some applications because

some parameters of the desired processing operation (for instance, the locations of reflective surfaces in a reverberant space) are not known in advance or are changing. The closed loop adaptive filter uses feedback in the form of an error signal to refine its transfer function.

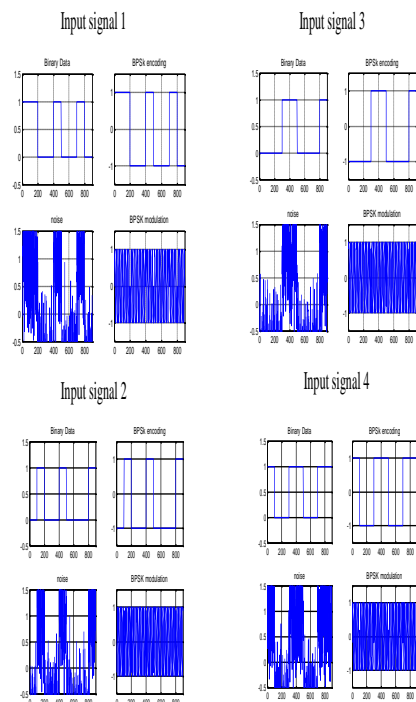
Generally speaking, the closed loop adaptive process involves the use of a cost function, which is a criterion for optimum performance of the filter, to feed an algorithm, which determines how to modify filter transfer function to minimize the cost on the next iteration. The most common cost function is the mean square of the error signal.

As the power of digital signal processors has increased, adaptive filters have become much more common and are now routinely used in devices such as mobile phones and other communication devices, camcorders and digital cameras, and medical monitoring equipment.



**Fig.4 Block Diagram**

**Simulation Results**



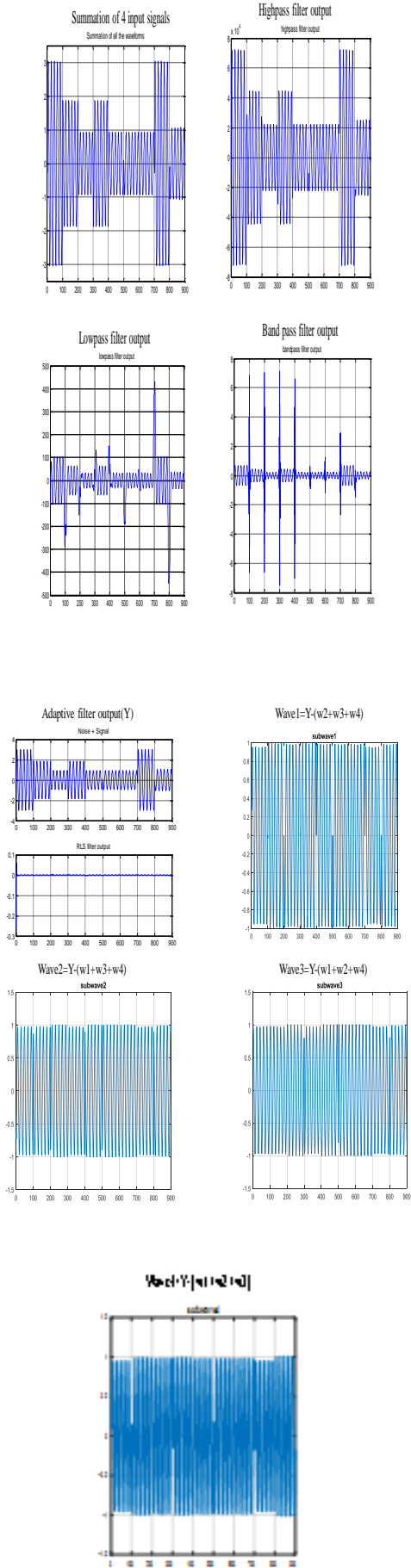


Fig.5 BER of 4users

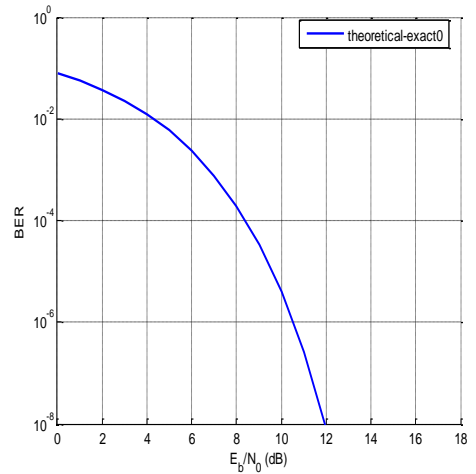


Fig. 6 BER of 3users.

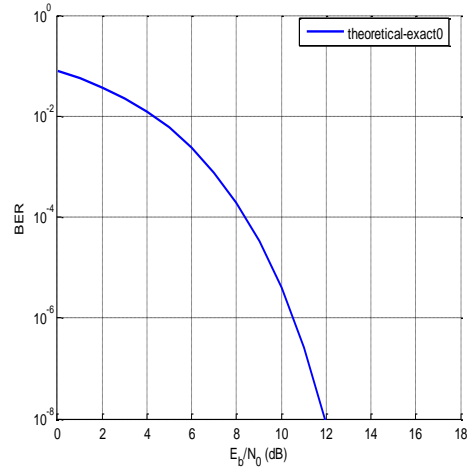
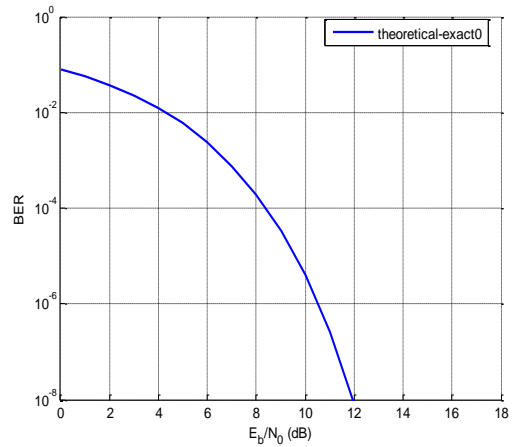


Fig.7 BER of 2users.



S.No	No: of users	BER
1.	4 users	0.07862
2.	3 users	0.07861
3.	2 users	0.07860

Fig. 8 Comparison of BER for different no: of users.  
Conclusion

The work presented in this Paper has been aimed at implementation of efficient communication system based multiuser and multicarrier communication systems with low bit error rate and low receiver complexity. Novel spreading codes with good correlation properties have been used. Earlier works in this area have ignored the effect of time varying and frequency selective channels on accuracy of data

transmission and bit error rate. Most of the researchers evaluate the performance of the multiuser communication systems proposed by them using Time Invariant Channel, which is not a realistic assumption.

The big challenge before the researchers is the problem of multiuser detection when the signal has been transmitted over multipath channel like Rayleigh fading channel and the receiver is supposed to receive the signal from multiple paths. In this Paper the parallel interference cancellation method has been used in the multipath environment when the sender and receiver has been assumed in motion (Doppler shift). Moreover in this thesis the Rayleigh fading channel has been simulated by taking into consideration the Doppler shift. The error rate of both the users have also calculated and has been found satisfactory. Various Code Division Multiple Access based communication techniques having better performance, low bit error rate, less receiver complexity, good auto and cross correlation properties. The multi-carrier and multi-user detection techniques have been verified, tested and simulated using simulation software and hardware.

The results of experimental investigation presented in this Paper, in the form of photographs and sketches of various waveforms, tables prove the efficacy of the proposed techniques for their respective applications. Though the significance of the proposed techniques have been analysed using few communication parameters, however, in many commercial applications, where the parameters are sufficient, the proposed schemes have a high market potential.

#### Scope for Future Work

In this Paper the main focus has been given on multiuser detection, multicarrier modulation, effect of channel noise, mitigation of MAI, performance evaluation of spreading codes and beam forming antenna. The work is still open for further research in terms of implementation of proposed schemes using Time Hopping Spread spectrum modulation technique. To minimize the bit error rate, channel coding is being used realized without channel coding, The multicarrier CDMA has been used in this thesis which requires two stage modulation processes; the same can be realized by using Orthogonal Frequency Division Multiplexing which can be implemented by using Inverse Fast Fourier Transform (IFFT) at transmitting end and Fast Fourier Transform (FFT) at receiving end.

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#### Author Profile



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