Design of BPSK and ASK Modulator and Demodulator

Members of Group-1:

1706066-Md. Awsafur Rahman

1706067-Abdul Mukit

1706068-Nabila Tasnim

1706069-Joyita Halder

Objectives:

- Digital signal transmission using modulation
- Signal modulation using amplitude variation in ASK and phase variation in BPSK
- Observing the effect of channel noise on the modulated signal
- Denoising the signal using Integrate and Dump Filter and Bandpass and Lowpass Filter
- Reconstruction of modulating signal
- Comparison of ASK and BPSK using bit error rate

Abstract:

This project presents the implementation of Binary Phase Shift Keying (BPSK) modulation and demodulation in MATLAB Simulink environment. The main aim of the communication system is accurate transmission and reception of data/signals. The selection of modulation and demodulation techniques depends on the low Bit Error Rate (BER), high data rate, small power requirement and design simplicity. The BPSK modulation and demodulation technique is widely used in many areas because of it satisfies most of the above criteria. The BPSK modulated signal is produced by modulating carrier according to the Bernoulli binary code generator and by noisy Additive White Gaussian Noise (AWGN) channel. The demodulation is performed in different demodulation techniques like using Integrate and Dump filter, low pass filter and BPSK Demodulator block with suitable block parameters.

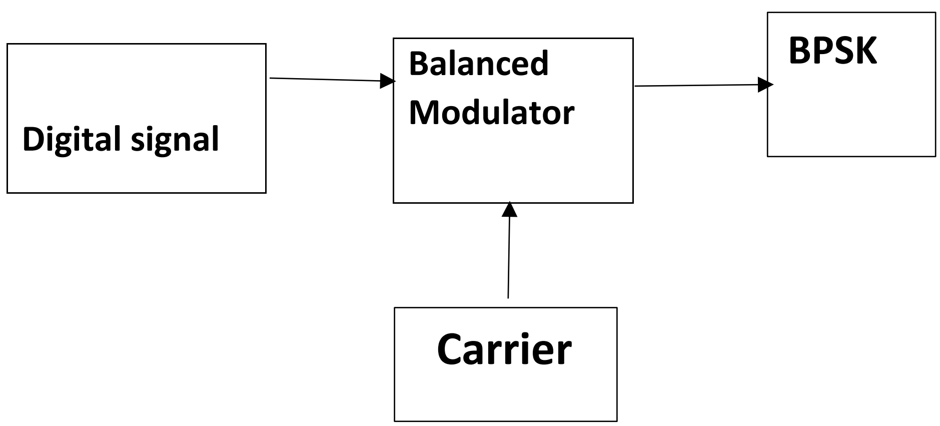
Digital modulation and demodulation system as an important part of digital communication system, its research is necessary. Based on the analysis of 2ASK digital band-pass system transmission characteristics, SIMULINK software is used to simulate the digital band-pass transmission system. Having been fully considered the possible factors affecting the 2ASK signal in the transmission process, a basic model of 2ASK digital band-pass transmission system is established, a system model which can simulate and realize the function of 2ASK digital band-pass signal transmission. Debugging and testing show that the waveforms of the system are consistent with the theoretical analysis and error-free code transmission can be achieved; the symbol error rate is rising with the increase of noise, which indicates that the system design is

effective and reasonable. It is worth reference for related research and the improvement of such system, and also provides a new way for system design and experimental teaching.

BPSK Modulation:

BPSK is the digital modulation technique which use its basic concept on PSK (phase shift keying). PSK is the digital modulation technique in which the phase of the carrier signal is changed by varying the sine and cosine inputs at a particular time. In binary phase shit keying (BPSK) the transmitted signal is a sinusoid of fixed amplitude. It has one fixed phase when the data is at one level and when the data is at the other level the phase is different by 180^0.

Methodology:



Demonstration:

Digital signal:

In digital wireless communication systems, the modulating signal which is the digital signal may be represented as a time sequence of symbols or pulses, where each symbol has m finite states. Each symbol represents n bits of information where n = log2m bits/symbol. In this project, a pulse train has been taken which has a random 0 and 1 sequence .

Modulation:

Binary Phase Shift Keying (BPSK) is a two phase modulation scheme, where the 0's and 1's in a binary message are represented by two different phase states in the carrier signal: $\theta = 0^{\circ}$ for binary 1 and $\theta = 180^{\circ}$ for binary 0.
In digital modulation techniques, a set of basis functions are chosen for a particular modulation scheme. Generally, the basis functions are orthogonal to each other. Basis functions can be derived using ***Gram Schmidt orthogonalization*** procedure. Once the basis functions are chosen, any vector in the signal space can be represented as a linear combination of them. In this project, sinusoid function is used as the basis function and it's phase is varied with the message signal for modulation.

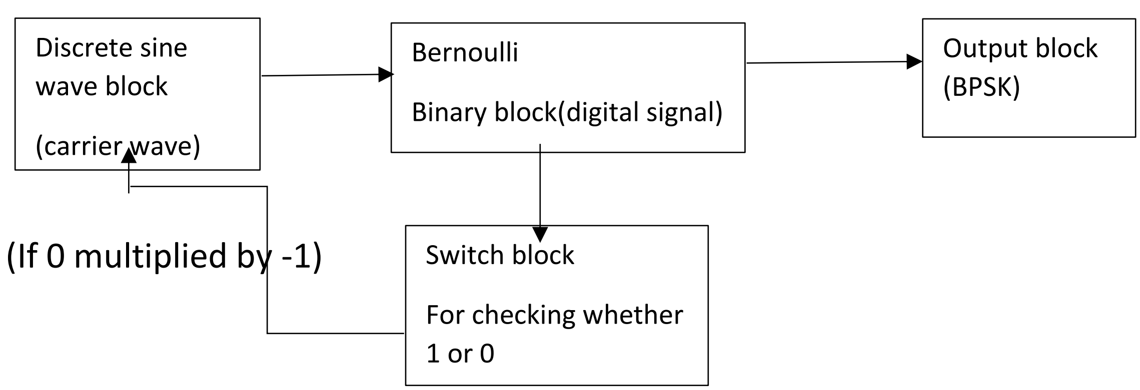
Carrier:

In BPSK, only one sinusoid is taken as the basis function. Modulation is achieved by varying the phase of the sinusoid depending on the message bits. Therefore, within a bit duration T_b, the two different phase states of the carrier signal are represented as,

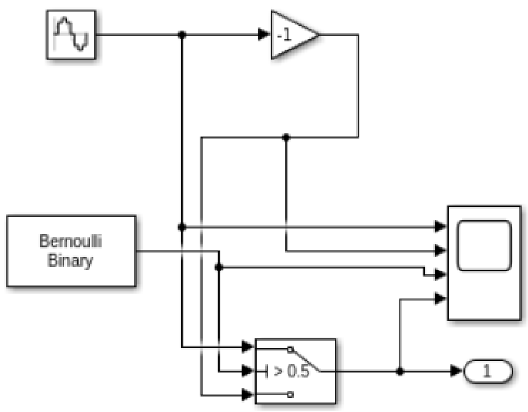
$S_1(t)=\sin(2\pi f_c t)$; $0 \leq t \leq T_b$; for binary '1'

$S_2(t)=\sin(2\pi f_c t+\pi)$; $0 \leq t \leq T_b$; for binary '0'

Simulation process:



The BPSK modulation is implemented in Matlab simulink with the use of bit sequence generator as input signal of bit stream. It is fed to the switch which compares the threshold level of signal coming with two sine wave carrier in apposite phase and same frequency. The threshold level is selected 0.5, below the threshold the carrier will be multiplied by -1 which ultimately gives the 180 degree phase shift .The output of switch is fed to the scope which shows the modulated signal.
The block diagram is shown below:



Result:

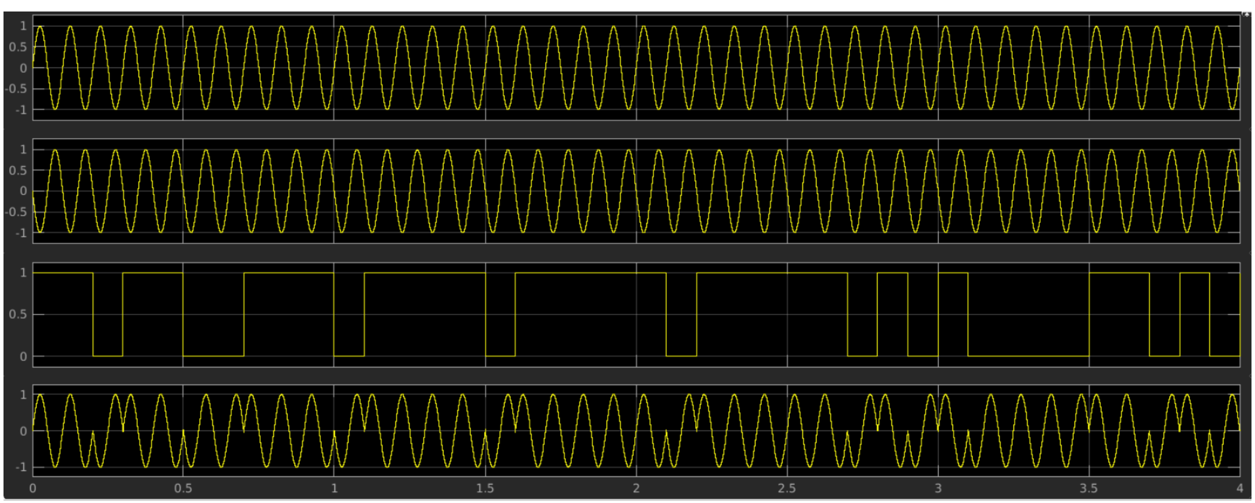


Figure: BPSK Modulation

Explanation:

From the above figure, the first plot is of the carrier wave which is the sampled sine wave and the second plot is the carrier wave with 180^0 phase shift, both signals have an amplitude of 2 V peak to peak and frequency of 10Hz and sampling frequency is 1000Hz. The third plot is the digital binary signal which has a random 1s and 0s for making it more practical rather than ideal periodic digital message signal. The fourth plot is the modulated signal. Comparing the above three plots it can be seen that whenever there is a transition from 0 to 1 or 1 to 0 , the modulated signal has a phase change of 180^0.

Binary Phase Shift Keying (BPSK) Demodulation

Methodology:

The BPSK generation and demodulation parts of the set-up can be represented by the block diagram in Fig.1. The second Multiplier and the Tune-able Low-pass filter module are used to implement a product detector to recover the digital data from the BPSK.

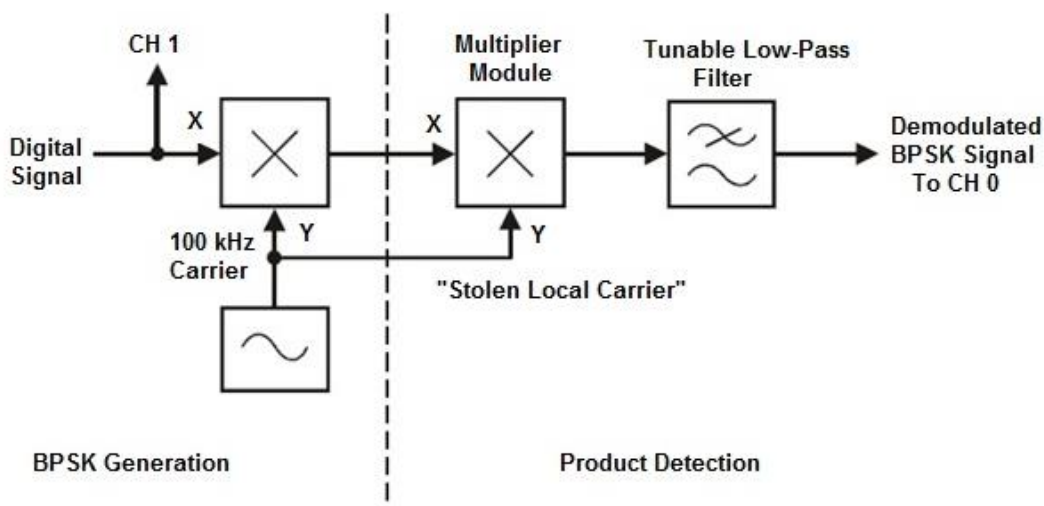


Figure: Diagram of BPSK Demodulation

The demodulation of a BPSK modulated signal, the carrier must be in phase and frequency synchronism with the carrier available at the transmitter. The carrier for the purpose of demodulation can either be transmitted along with the modulated signal or extracted from the modulated signal at the receiver. Two commonly used techniques of carrier recovery are signal squaring and Costas loop.

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

- Translation back to baseband, with recovery of the band limited message waveform

- Regeneration from the bandlimited 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. This requires a local synchronous carrier. In this experiment a stolen carrier will be used.

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.

BPSK Transmitter:

A BPSK transmitter, shown in Figure below, is implemented by coding the message bits using NRZ coding (1 represented by positive voltage and 0 represented by negative voltage) and multiplying the output by a reference oscillator running at carrier frequency f_c.

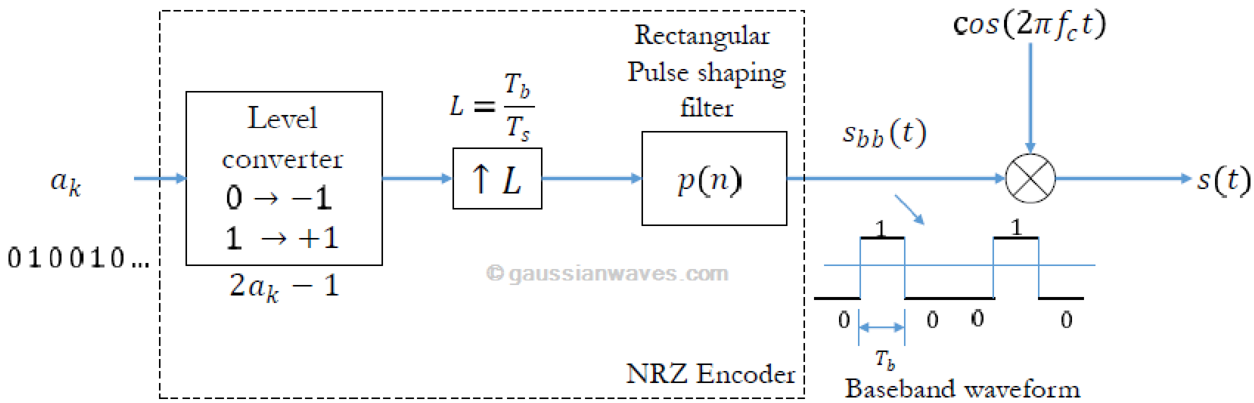


Figure: BPSK transmitter

The output of the function is in baseband and it can optionally be multiplied with the carrier frequency outside the function. In order to get nice continuous curves, the oversampling factor (L) in the simulation should be appropriately chosen. If a carrier signal is used, it is convenient to choose the oversampling factor as the ratio of sampling frequency (f_s) and the carrier frequency (f_c). The chosen sampling frequency must satisfy the Nyquist sampling theorem with respect to carrier frequency. For baseband waveform simulation, the oversampling factor can simply be chosen as the ratio of bit period (T_b) to the chosen sampling period (T_s), where the sampling period is sufficiently smaller than the bit period.

BPSK receiver:

A correlation type coherent detector, shown in Figure below, is used for receiver implementation. In coherent detection technique, the knowledge of the carrier frequency and phase must be known to the receiver. This can be achieved by using a **Costas loop** or a **Phase Lock Loop (PLL)** at the receiver. For simulation purposes, we simply assume that the carrier phase recovery was done and therefore we directly use the generated reference frequency at the receiver – $cos(2\pi f_c t)$.

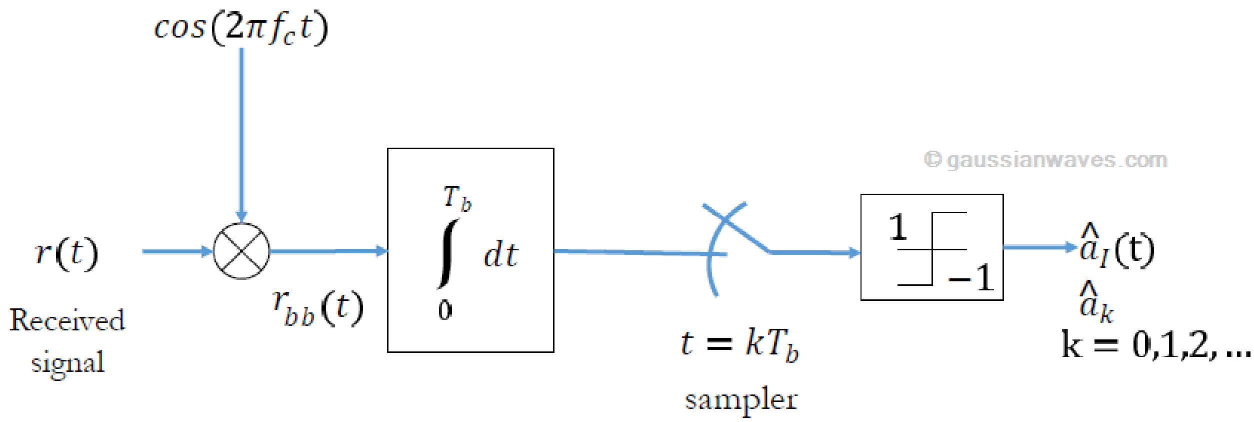


Figure: Coherent detection of BPSK (correlation type)

In the coherent receiver, the received signal is multiplied by a reference frequency signal from the carrier recovery blocks like PLL or Costas loop. Here, it is assumed that the PLL/Costas loop is present and the output is completely synchronized. The multiplied output is integrated over one bit period using an integrator. A threshold detector makes a decision on each integrated bit based on a threshold. Since, NRZ signaling format was used in the transmitter, the threshold for the detector would be set to 0.

AWGN channel model:

In order to simulate a specific SNR point in performance simulations, the modulated signal from the transmitter needs to be added with random noise of specific strength. The strength of the generated noise depends on the desired SNR level which usually is an input in such simulations. In practice, SNRs are specified in **dB**. Given a specific SNR point for simulation, let's see how we can simulate an AWGN channel that adds correct level of white noise to the transmitted symbols.

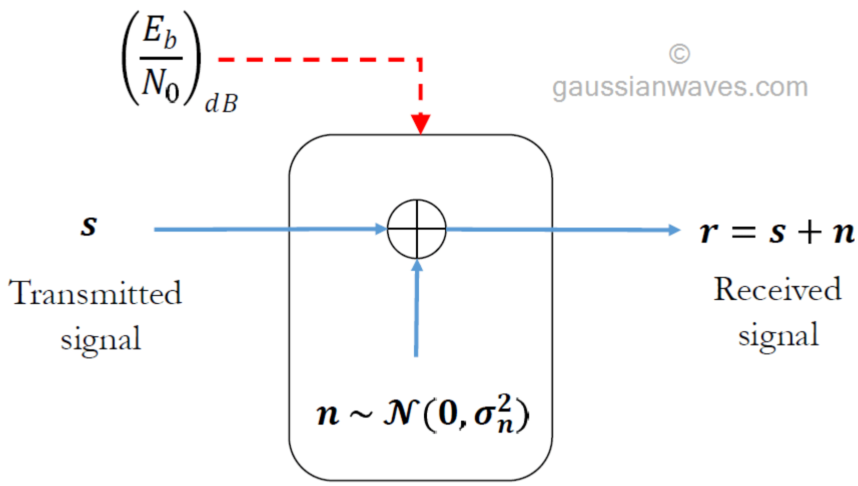


Figure: Simplified simulation model for awgn channel

Considering the AWGN channel model given in above Figure, at a given a specific SNR point to simulate, we wish to generate a white Gaussian noise vector $\mathcal{N}(0, \sigma^2)$ of appropriate strength and add it to the incoming signal. The method described can be applied for both waveform simulations and the complex baseband simulations. In following text, the term SNR (γ) refers to $\gamma_b = E_b/N_0$ when the modulation is of binary type (example: BPSK).

(1) Assume, s is a vector that represents the transmitted signal. We wish to generate a vector r that represents the signal after passing through the AWGN channel. The amount of noise added by the AWGN channel is controlled by the given SNR – γ

(2) For waveform simulation model, let the given oversampling ratio is denoted as L.

(3) Let N denotes the length of the vector s. The signal power for the vector s can be measured as,

$$P = L \times \frac{1}{N} \sum_{i=0}^{N-1} |s_i|^2$$

(4) The required power spectral density of the noise vector n is computed as

$$N_0 = \frac{signal\ power}{signal - to - noise - ratio} = \frac{P}{\gamma}$$

(5) Assuming complex IQ plane for all the digital modulations, the required noise variance (noise power) for generating Gaussian random noise is given by

$$\sigma^2 = \frac{N_0}{2}$$

(6) Generate the noise vector n drawn from normal distribution with mean set to zero and the standard deviation computed from the equation given above

$$\mathbf{n} = \begin{cases} \sigma \times \mathcal{N}_N(0,1) & \text{if } \mathbf{s} \text{ is real} \\ \sigma \times \left[\mathcal{N}_N(0,1) + j * \mathcal{N}_N(0,1)\right] & \text{if } \mathbf{s} \text{ is complex} \end{cases}$$

(7) Finally add the generated noise vector (n) to the signal (s)

$$\mathbf{r} = \mathbf{s} + \mathbf{n}$$

BPSK BER – optimum receiver in AWGN channel (Integrate & Dump Filter):

The ideal constellation diagram of a BPSK transmission (Figure 1) contains two constellation points located equidistant from the origin. Each constellation point is located at a distance $\sqrt{Es}$ from the origin, where E_s is the BPSK symbol energy. Since the number of bits in a BPSK symbol is always one, the notations – symbol energy (E_s) and bit energy (E_b) can be used interchangeably (E_s=E_b).

Assume that the BPSK symbols are transmitted through an AWGN channel characterized by variance = $N_0/2$ Watts. When 0 is transmitted, the received symbol is represented by a Gaussian random variable 'r' with mean=S_0 = $\sqrt{Es}$ and variance =$N_0/2$. When 1 is transmitted, the received symbol is represented by a Gaussian random variable – r with mean=S_1= $\sqrt{Es}$ and variance =$N_0/2$. Hence the conditional density function of the BPSK symbol (Figure 2) is given by,

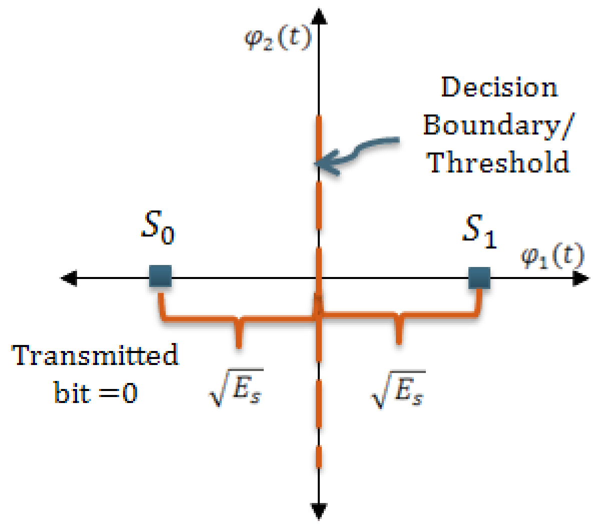


Figure: BPSK – ideal constellation

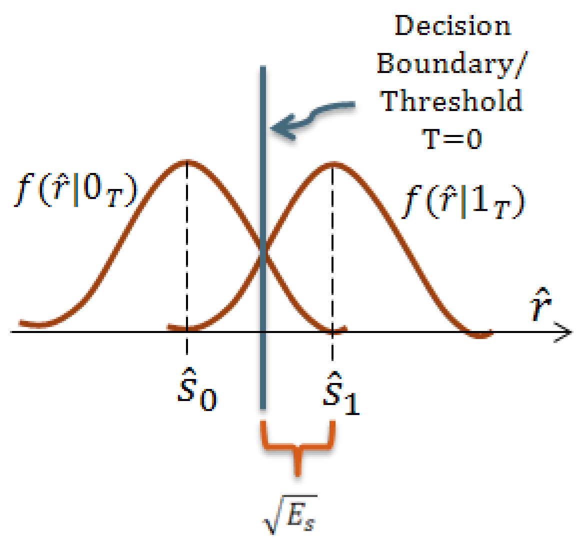


Figure: Probability density function (PDF) for BPSK Symbols

An optimum receiver for BPSK can be implemented using a correlation receiver or a matched filter receiver. Both these forms of implementations contain a decision making block that decides upon the bit/symbol that was transmitted based on the observed bits/symbols at its input.

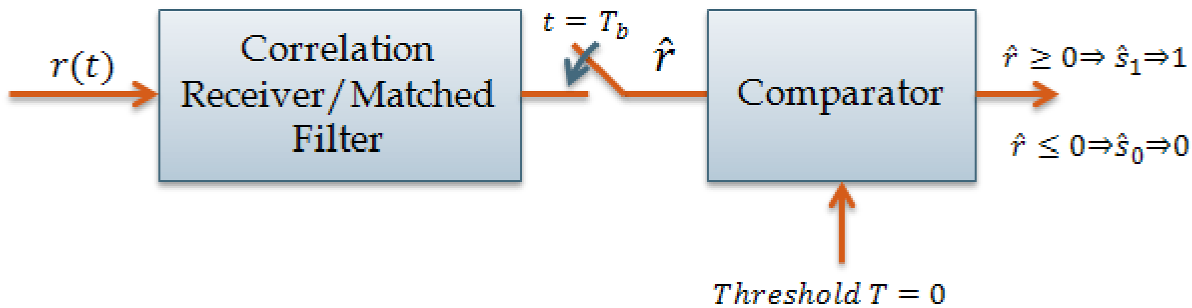


Figure: Optimum Receiver for BPSK

When the BPSK symbols are transmitted over an AWGN channel, the symbols appears smeared/distorted in the constellation depending on the SNR condition of the channel. A matched filter or that was previously used to construct the BPSK symbols at the transmitter. This process of projection is illustrated in above Figure. Since the assumed channel is of Gaussian nature, the continuous density function of the projected bits will follow a Gaussian distribution. This is illustrated in Figure 5.

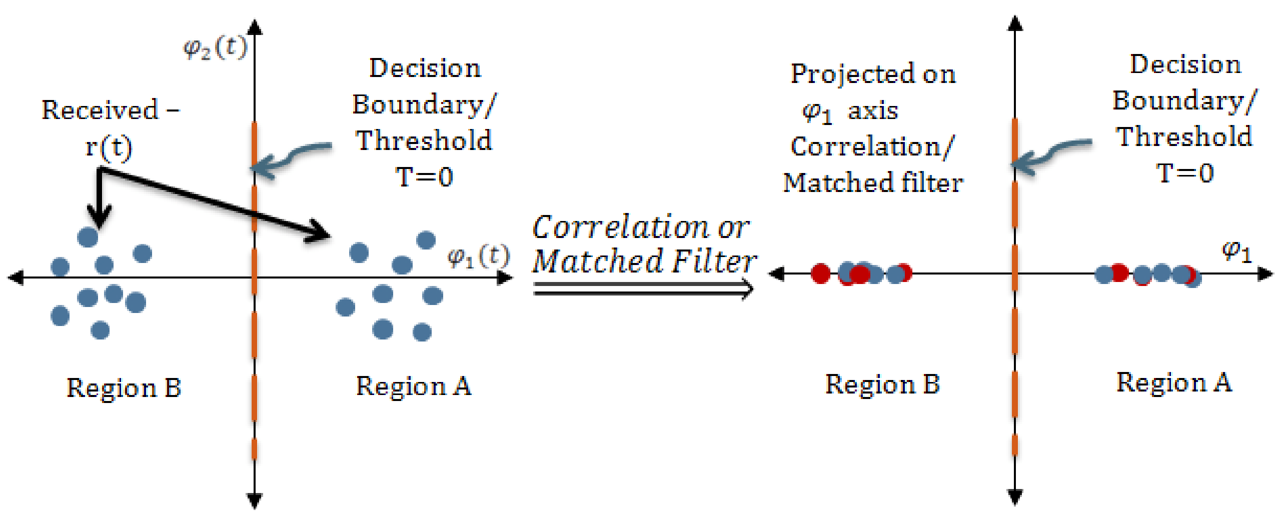


Figure: Role of correlation/Matched Filter

After the signal points are projected on the basis function axis, a decision maker/comparator acts on those projected bits and decides on the fate of those bits based on the threshold set. For a BPSK receiver, if the a-prior probabilities of transmitted 0's and 1's are equal (P=0.5), then the decision boundary or threshold will pass through the origin. If the apriori probabilities are not equal, then the optimum threshold boundary will shift away from the origin.

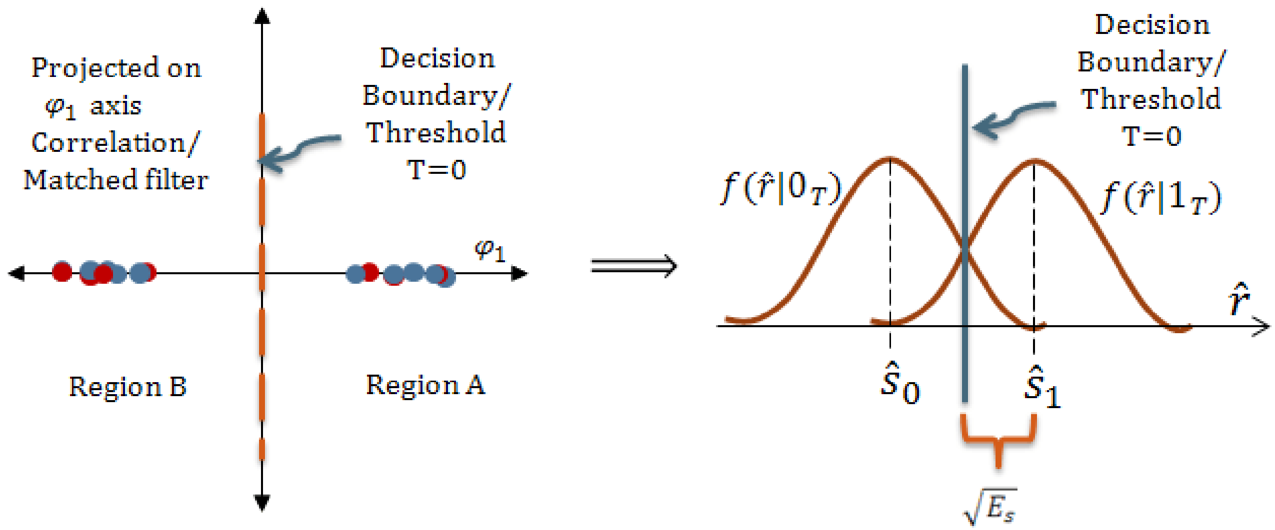


Figure: Distribution of received symbols

Considering a binary symmetric channel, where the apriori probabilities of 0's and 1's are equal, the decision threshold can be conveniently set to T=0. The comparator, decides whether the projected symbols are falling in region A or region B (see Figure 4). If the symbols fall in region A, then it will decide that 1 was transmitted. It they fall in region B, the decision will be in favor of '0'.

For deriving the performance of the receiver, the decision process made by the comparator is applied to the underlying distribution model (Figure 5). The symbols projected on the ϕ axis will follow a Gaussian distribution. The threshold for decision is set to T=0. A received bit is in error, if the transmitted bit is '0' & the decision output is '1' and if the transmitted bit is '1' & the decision output is '0'.

This is expressed in terms of probability of error as,

$$P(error) = P(1\ decided, 0\ transmitted) + P(0\ decided, 1\ transmitted) \rightarrow (2)$$

Or equivalently,

$$P(error) = P(1_D, 0_T) + P(0_D, 1_T) \qquad \rightarrow (3)$$

By applying Bayes Theorem , the above equation is expressed in terms of conditional probabilities as given below,

$$P(error) = P(0_T)P(1_D \mid 0_T) + P(1_T)P(0_D \mid 1_T) \quad \rightarrow (4)$$

Since a-prior probabilities are equal $P(0_T)= P(1_T) =0.5$, the equation can be re-written as

Intuitively, the integrals represent the area of shaded curves as shown in Figure 6. From the previous article, we know that the area of the shaded region is given by Q function.

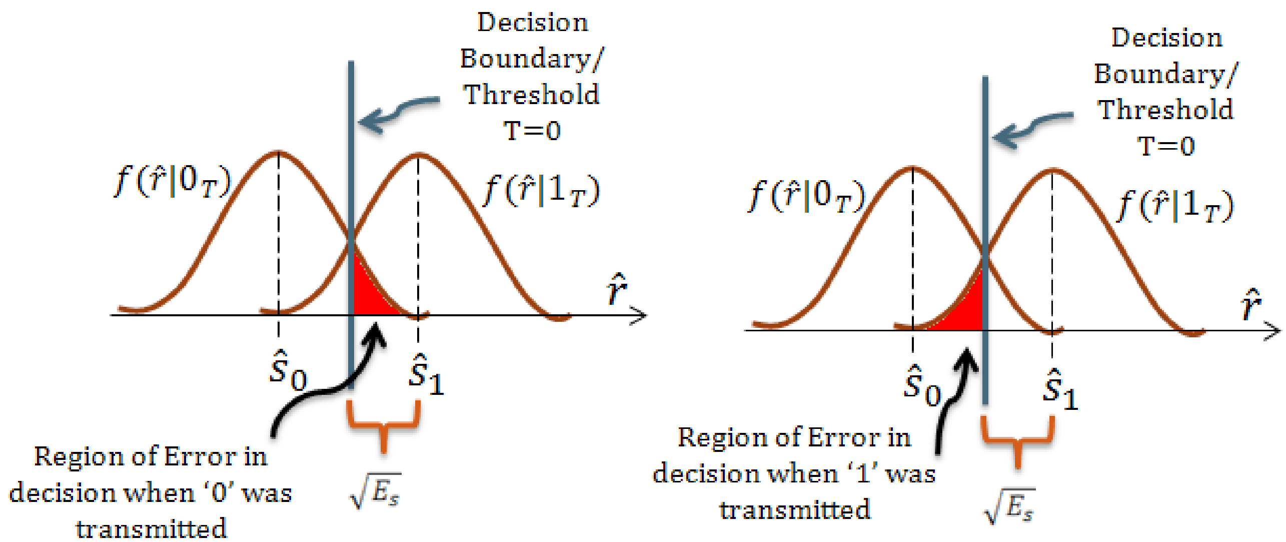


Figure: Calculating Error Probability

$$P(1_D \mid 0_T) = Q\left(\sqrt{\frac{E_s}{N_0/2}}\right) \qquad \rightarrow (7)$$

Similarly,

$$P(0_D \mid 1_T) = Q\left(\sqrt{\frac{E_s}{N_0/2}}\right) \qquad \rightarrow (8)$$

From (4), (6), (7) and (8),

For BPSK, since $E_s=E_b$, the probability of symbol error (P_s) and the probability of bit error (P_b) are same. Therefore, expressing the P_s and P_b in terms of Q function and also in terms of complementary error function :

Simulation Process:

The modulated signal is transmitted through Additive White Gaussian Noise (AWGN) channel where a noise is added to signal. The noisy signal is fed to the saturation block. The saturation block imposes upper and lower bounds on signal This saturated signal is then multiplied a synchronous carrier with same phase and frequency as that of received signal, then fed to integrate and dump filter block with suitable parameters which create a cumulative sum of the discrete-time input signal, fed to the control input to compare with data inputs of switch block. Criteria for passing the first or third input the control input condition sets as required output of modulating signal of binary sequence. The simulation block diagram is shown below:

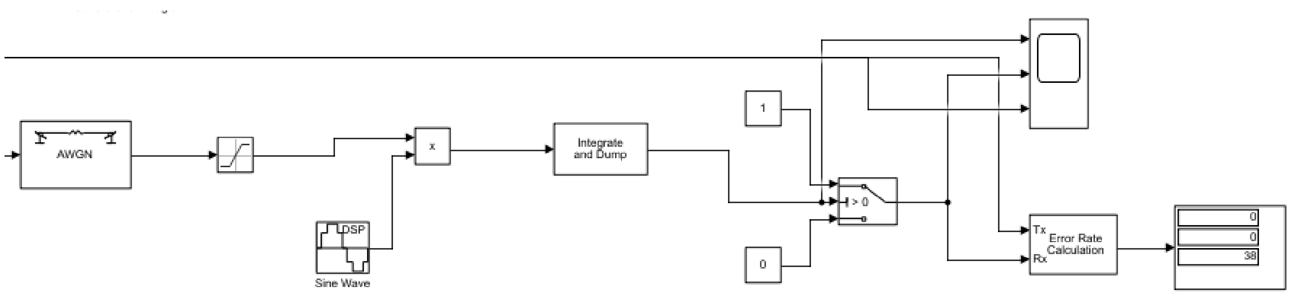


Figure: Simulation Diagram

Result:

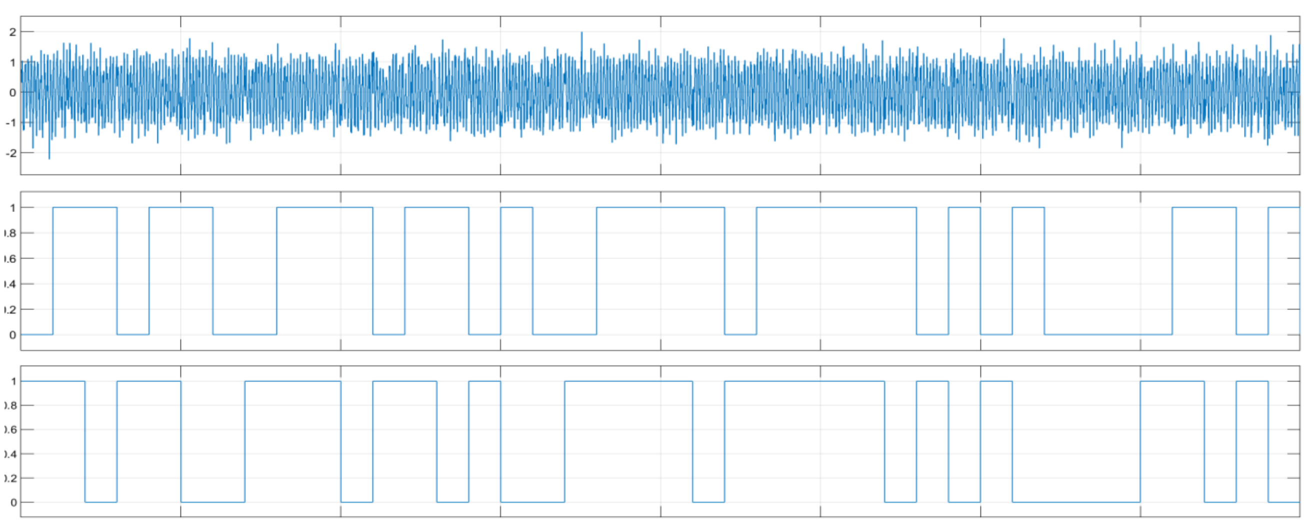


Figure: Simulated Result

Explanation:

From the above figure, the first plot is the modulated signal with noise. The second plot is the input signal the last plot is the output signal.

ASK Modulation Principle and Methodology:

In order for the digital signal to be transmitted in the bandpass channel, the digital baseband signal must be used to modulate the carrier to match the characteristics of the channel to the channel. Digital modulation is typically performed using keying, such as the amplitude, frequency, and phase of the carrier. Amplitude-shift keying is a type of Amplitude Modulation which represents the binary data in the form of variations in the amplitude of a signal. In the ASK modulation, the amplitude of the carrier only changes in the two states, that is, the use of digital information "0" or "1" baseband rectangular pulse to a continuous carrier wave, the carrier intermittent output. "1" is output when a carrier wave is output, and "0" is transmitted when no carrier wave is output. ASK signal can be expressed as:

$e(t) = s(t) * A\cos(w_c t)$

Where A is the amplitude of carrier and w_c is the angular frequency. s(t) is the unipolar NRZ rectangular pulse train.

$s(t) = \sum a_n g(t - nT_b)$

Where s(t) is a rectangular pulse of duration Tb and height 1, and is often called a gate function.

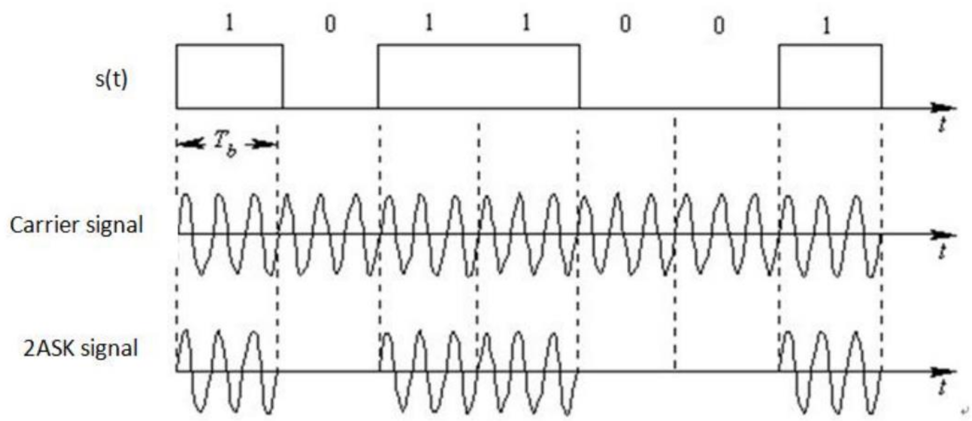
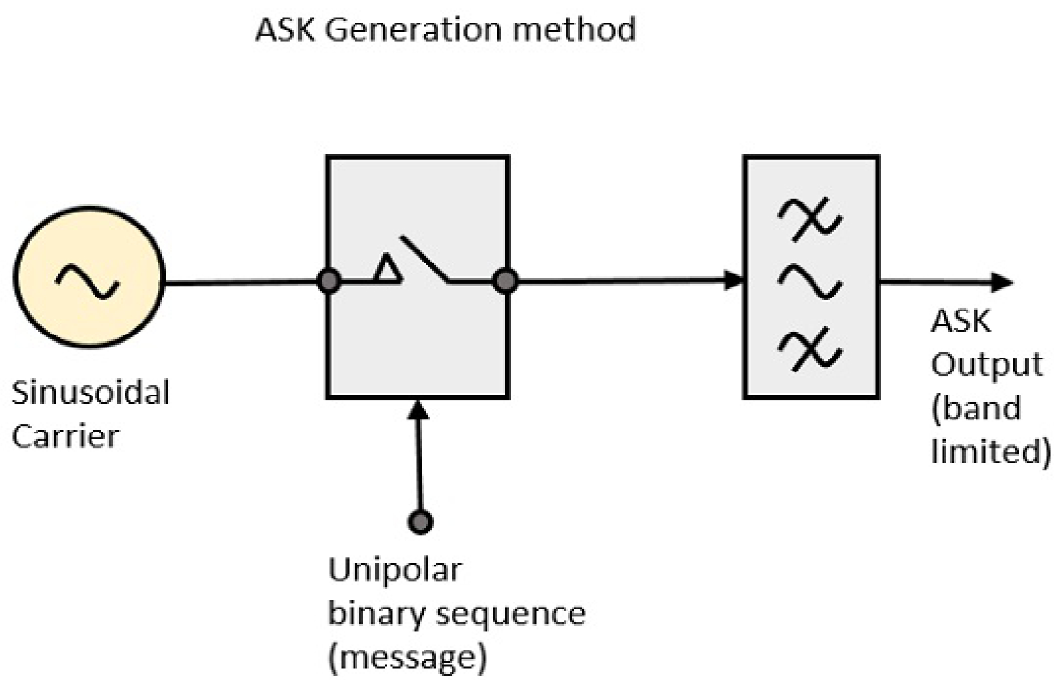


Figure 1. 2ASK signal waveform

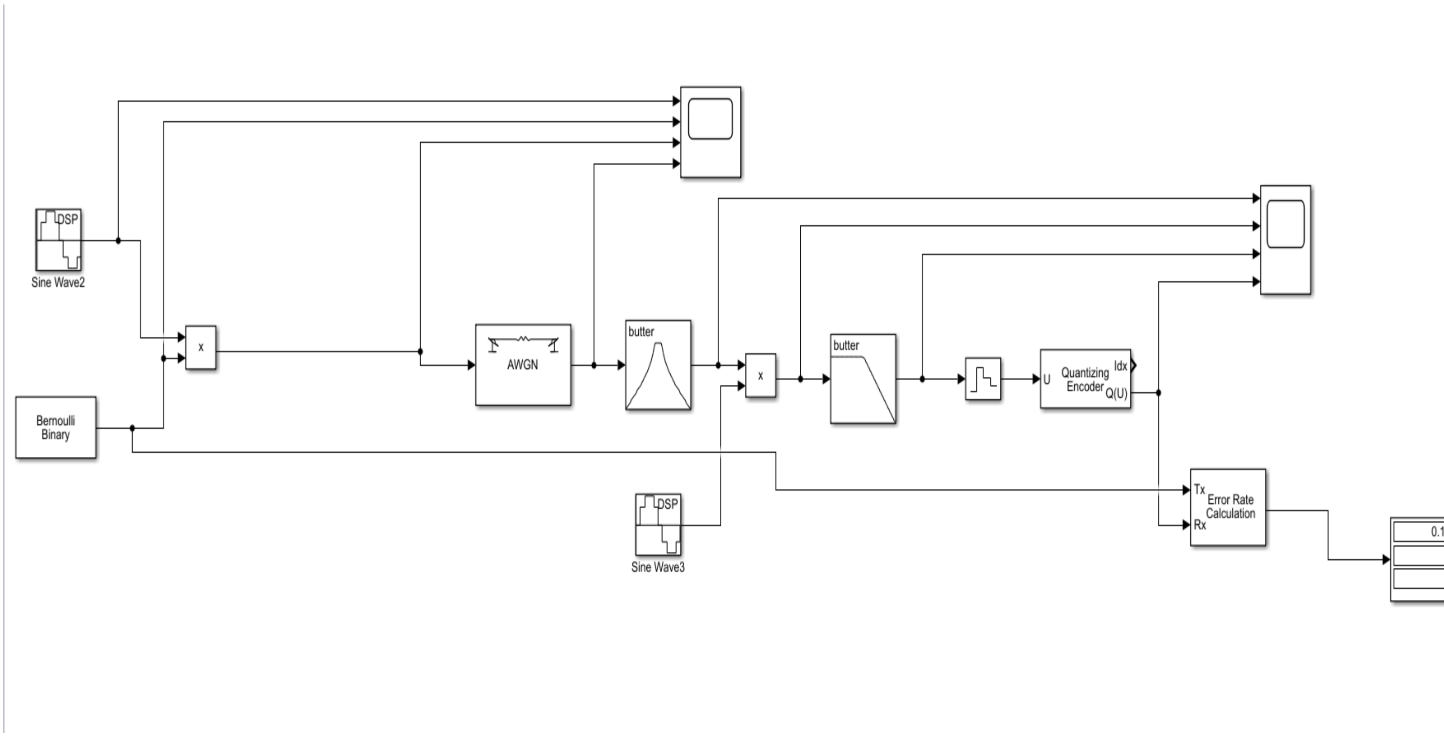
The keying method is another method of generating the ASK signal. Binary ASK is also known as on-off control (OOK). The most typical implementation is achieved by using a key to control the output of the carrier oscillator.



The carrier generator, sends a continuous high-frequency carrier. The binary sequence from the message signal makes the unipolar input to be either High or Low. The high signal closes the switch, allowing a carrier wave. Hence, the output will be the carrier signal at high input. When there is low input, the switch opens, allowing no voltage to appear. Hence, the output will be low.

Simulation Process:

The schematics of the total ASK modulation and demodulation system is as follows:

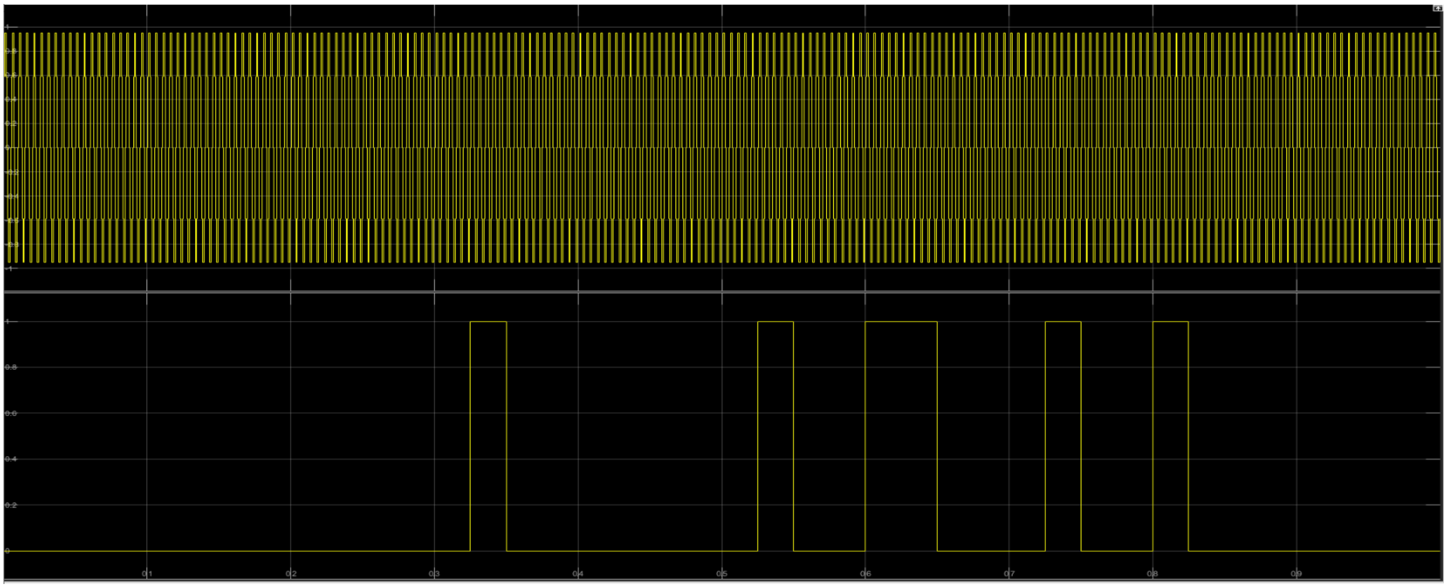


The output signal of the signal source (Binary Data Generator) and the carrier (sine wave) are multiplied by the multiplier.

The multiplied signal is then transmitted into the additive white Gaussian noise (AWGN) channel. In a modem system, the carrier signal frequency is generally greater than the frequency of the signal source. The signal source frequency is 40 Hz, so the carrier frequency is set to 200 Hz i.e. angular frequency of 2*200*pi rad/sec.

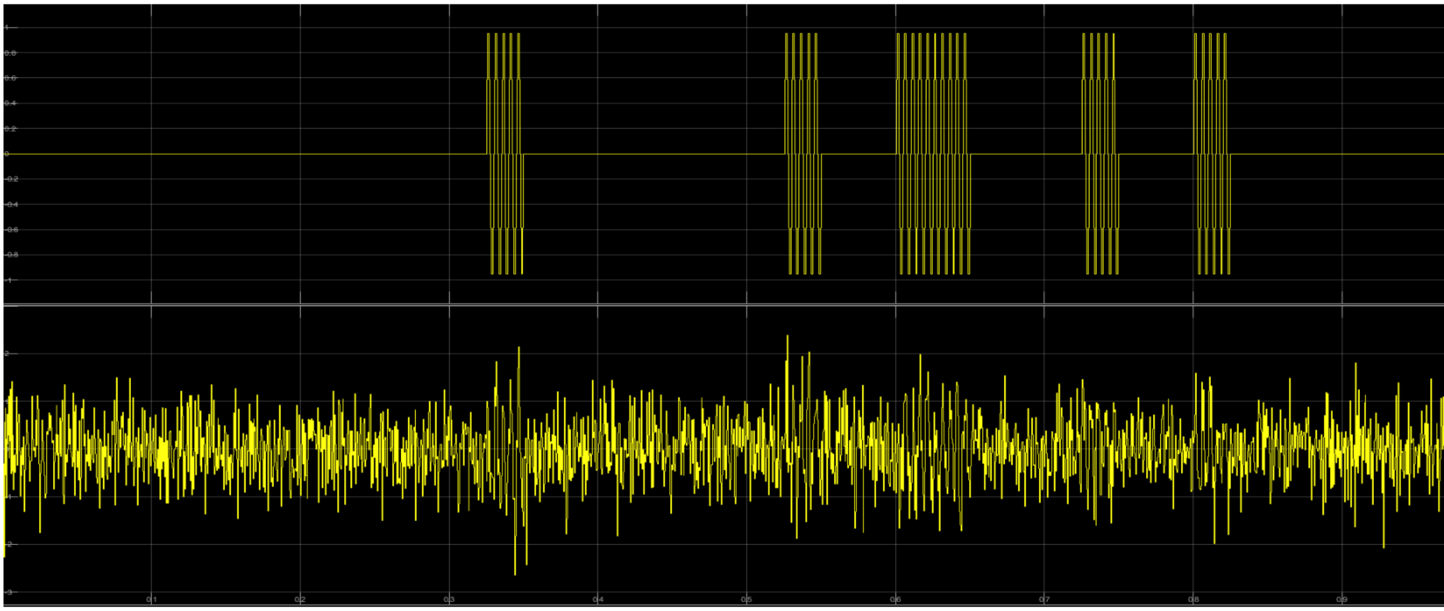
The transmission channel adds white gaussian noise to the signal.

Result:



Here, the graph shows the output attached to of the carrier wave (above) and Binary Data (message signal).

The binary data is generated Randomly from Bernoulli Binary Generator and it is unipolar not return to zero. The carrier wave is a sine wave with peak to peak voltage of 2V and it has a frequency of 200Hz.

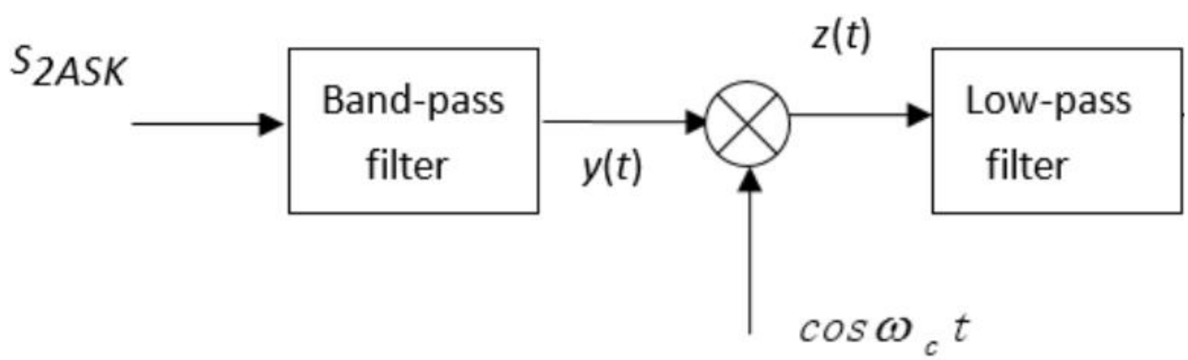


Here, the graphs show the modulated wave after the multiplier (above) and the modulated wave at the receiving end after crossing the channel (below).

Demodulation:

Demodulation is the process of reconstructing the original signal at the receiver level. And it is defined as, whatever the modulated signal received from the channel at the receiver side by implementing the proper demodulated techniques to recover/reproduce the original input signal at the output stage of the receiver. We will start the demodulation process with coherent detection which is also called as synchronous ASK detection.

ASK demodulation in two ways: 1. envelope detection method 2. Coherent demodulation. Synchronous demodulation, also known as coherent demodulation, the signal through the band-pass filter to suppress out-of-band interference from the channel, the multiplier to reverse the removal of the spectrum to restore the baseband signal. The low-pass filter is used to suppress high-order harmonics generated by the multiplier. Since the envelope of the AM signal waveform is proportional to the input baseband signal ***m(t)***, it is also possible to recover the original modulated signal by envelope detection. Envelope detector generally consists of half-wave or full-wave



rectifier and low-pass filter. Coherent detection method block diagram shown in Figure.

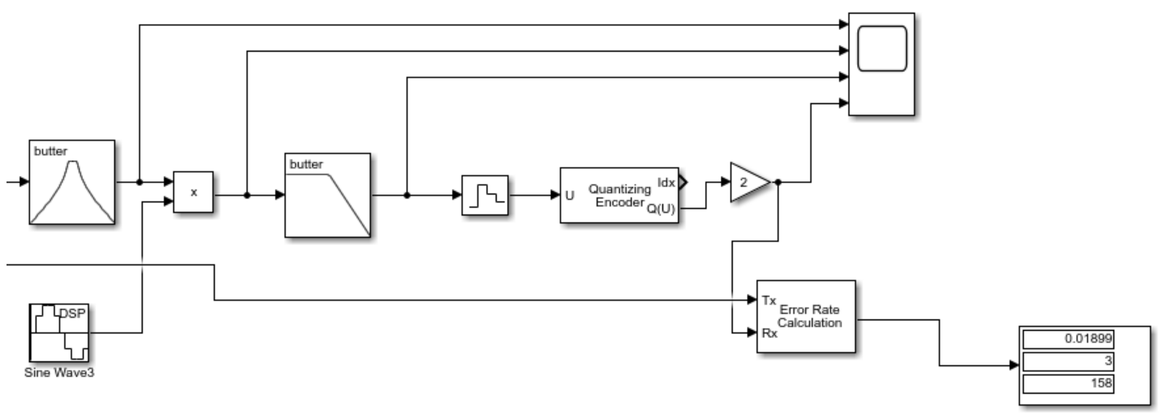
Coherent detection is synchronous mediation, requiring the receiver to generate a carrier wave with the carrier frequency in phase with the local carrier signal, called

$$z(t) = y(t)\cos\omega_c t = s(t)\cos^2\omega_c t = \frac{1}{2}s(t) + (1 + \cos 2\omega_c t)$$

synchronous carrier or coherent carrier. This carrier is multiplied with the received modulated signal and the output is

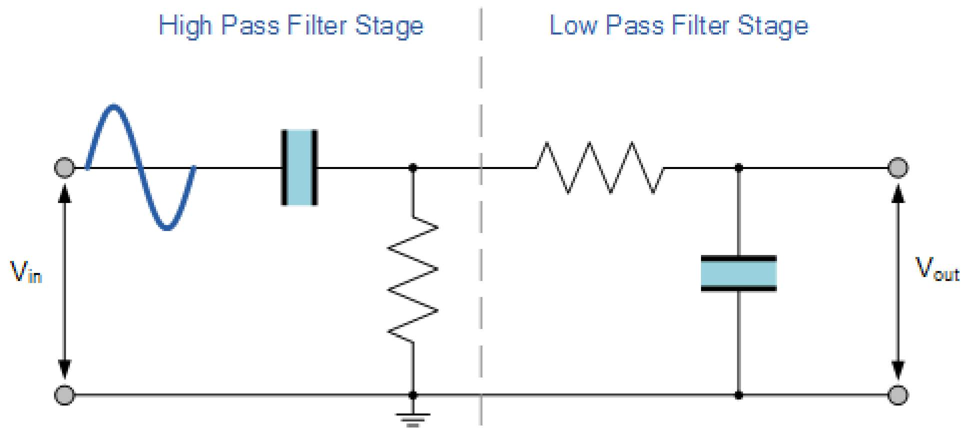
ASK Digital Band-pass Transmission System Simulation:

The modulation and demodulation process of the ASK simulation system is as follows: the output signal of the signal source and the carrier are multiplied by the multiplier and transmitted into the additive white Gaussian noise (AWGN) channel. The receiver through the band-pass filter and then multiplied by the carrier, and then through the low-pass filter, sampling judge, and finally by the oscilloscope shows the various stages of waveform, and the error rate observed with the error code.



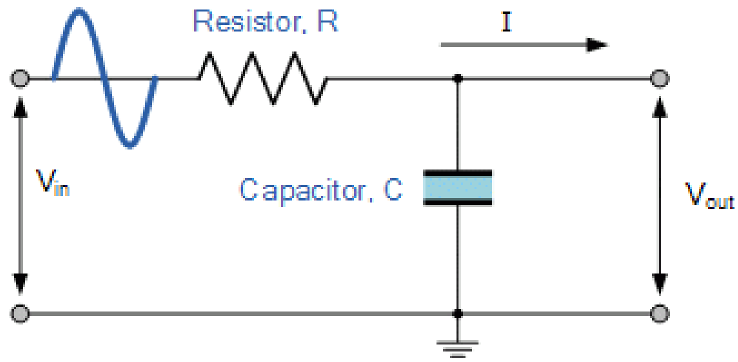
In the MATLAB Simulink simulation platform to build the ASK modulation and demodulation simulation circuit shown in Figure In a modem system, the carrier signal frequency is generally greater than the frequency of the signal source. The signal source frequency is *40 Hz*, so the carrier frequency is set to *200 Hz*, since in the carrier parameter setting, the unit of the frequency is *rad / sec*, so it is *400 * pi*. The lower frequency of the bandpass filter should equal the difference between the carrier frequency and the modulation signal frequency. The upper frequency should be equal to the sum of the carrier frequency and the modulation signal frequency. In front of the signal source has been set to *40Hz* frequency, carrier frequency is *200Hz*, calculated for the upper and lower cut-off frequency of *160Hz, 240Hz*, converted to *rads / sec* for the unit is *320 * pi, 480 * pi*. Set the parameters, the simulation, the output waveform from the oscilloscope shows that the signal modulation and demodulation is successful, but there is a delay of *0.01* seconds, that is, the signal delay of *2 bits* (with the delay time sampling multiplied by the sampling frequency of the sampling encoder)

Bandpass Filter:



In electronics and signal processing, a filter is usually a two-port circuit or device which removes frequency components of a signal (an alternating voltage or current). A band-pass filter allows through components in a specified band of frequencies, called its passband but blocks components with frequencies above or below this band. This contrasts with a high-pass filter, which allows through components with frequencies above a specific frequency, and a low-pass filter, which allows through components with frequencies below a specific frequency. In digital signal processing, in which signals represented by digital numbers are processed by computer programs, a band-pass filter is a computer algorithm that performs the same function. The term band-pass filter is also used for optical filters, sheets of colored material which allow through a specific band of light frequencies, and acoustic filters which allow through sound waves of a specific band of frequencies. An example of an analogue electronic band-pass filter is an RLC circuit (a resistor–inductor–capacitor circuit). These filters can also be created by combining a low-pass filter with a high-pass filter. A bandpass signal is a signal containing a band of frequencies not adjacent to zero frequency, such as a signal that comes out of a bandpass filter. An ideal bandpass filter would have a completely flat passband: all frequencies within the passband would be passed to the output without amplification or attenuation, and would completely attenuate all frequencies outside the passband.

Low Pass Filter:



A low-pass filter is a filter that passes signals with a frequency lower than a selected cutoff frequency and attenuates signals with frequencies higher than the cutoff frequency. The exact frequency response of the filter depends on the filter design. The filter is sometimes called a high-cut filter, or treble-cut filter in audio applications. A low-pass filter is the complement of a high-pass filter. High-pass frequency filters would act as low-pass wavelength filters, and vice versa. For this reason it is a good practice to refer to wavelength filters as short-pass and long-pass to avoid confusion, which would correspond to high-pass and low-pass frequencies. Low-pass filters provide a smoother form of a signal, removing the short-term fluctuations and leaving the longer-term trend.

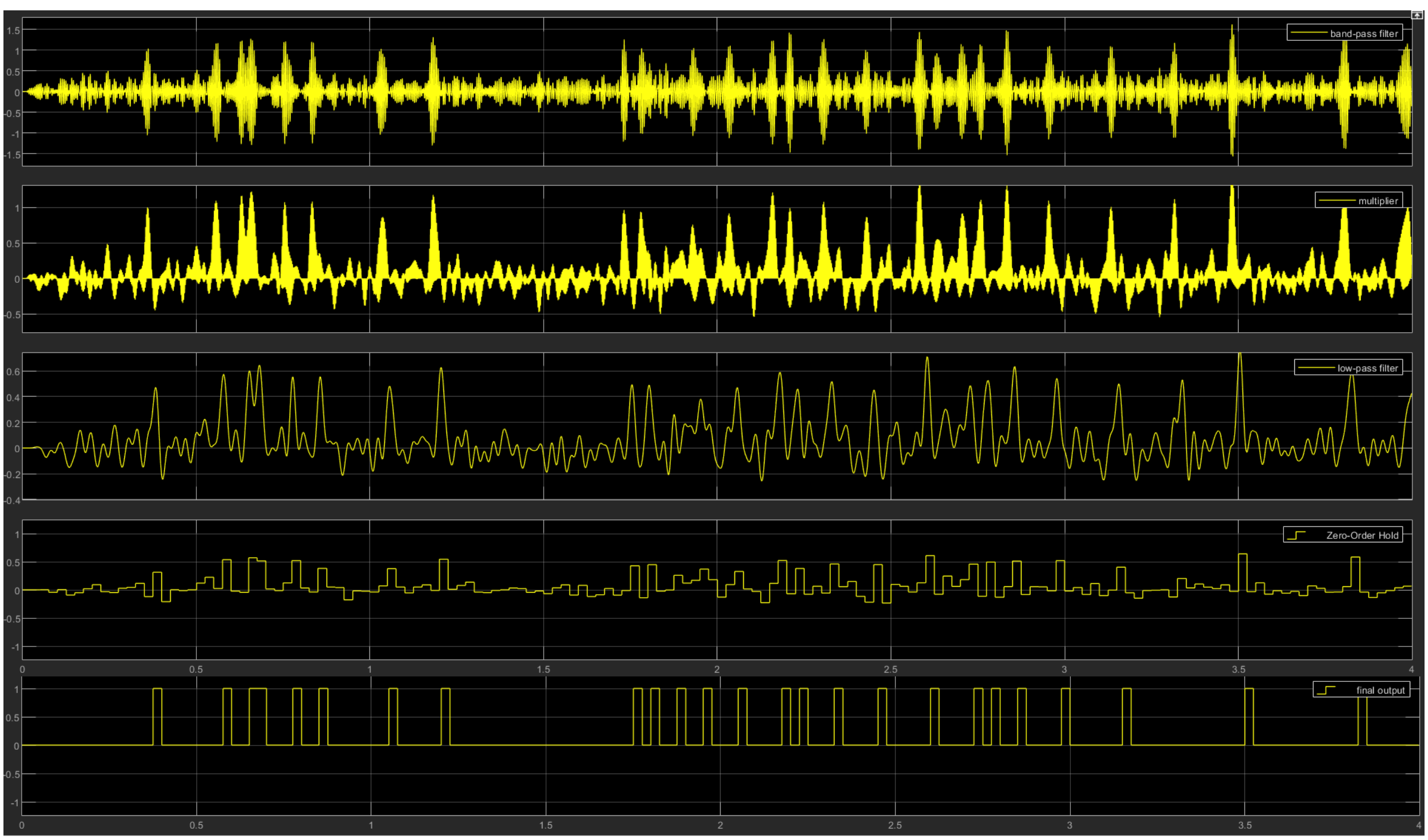
Discretize Signal:

To discretize filtered signal we have used Zero-Order Hold block. The Zero-Order Hold block samples and holds its input for the specified sample period. The block accepts one input and generates one output, both of which can be scalar or vector. If the input is a vector, all elements of the vector are held for the same sample period. One specifies the time between samples with the Sample time parameter. A setting of -1 means the Sample time is inherited. This block provides a mechanism for discretizing one or more signals in time, or resampling the signal at a different rate. If your model contains multirate transitions, you must add Zero-Order Hold blocks between the fast-to-slow transitions. The sample rate of the Zero-Order Hold must be set to that of the slower block.

Binarize Signal:

To binarize the value between 0 and 1 we have used Quantizing Encoder Block. The Quantizing Encoder block quantizes the input signal according to the Partition vector and encodes the input signal according to the Codebook vector. This block processes each vector element independently. The input must be a discrete-time signal. This block processes each vector element independently. The first output is the quantization index. The second output is the quantized signal. The values for the quantized signal are taken from the Codebook vector. The Quantization partition parameter, P, is a real vector of length n whose entries are in strictly ascending order. The Quantization codebook parameter, whose length is n+1, prescribes a value for each partition in the quantization. The first element of Quantization codebook is the value for the interval between negative infinity and the first element of P. The second output signal from this block contains the quantization of the input signal based on the quantization indices and prescribed values.

Output:



Conclusion:

This project presents the MATLAB Simulation of BPSK modulation and plotted all the wave shapes with AWGN channel of 10 dB SNR and demodulated by using three different demodulation techniques ie. Integrate and dump, Low pass filter and BPSK demodulator block. It is found that the coherent detection of base band binary sequence is delayed by about 1 micro seconds and the bit error rate of about 0.5%. But by using BPSK demodulator block of Matlab it is found that there is no delayed output and bit error is found 11 bits in 1e8 no. of symbols. In figure 7 it is seen that the plot of theoretical and Monte Carlo simulation graph of BER Vs Signal to Noise ratio are found same.

Also, it completes the simulation design of 2ASK transmission system based on MATLAB / Simulink. By adjusting the experimental parameters and comparing the experimental results, we can get or verify the required or existing conclusions in a vivid way so that the experimental results can be more clear, so that students can better understand the basic concepts and principles of communication systems. MATLAB / Simulink to a number of complex procedures become very intuitive, easy to operate, and easy to modify and later maintenance, can be used as a teacher classroom teaching auxiliary teaching software, the abstract concept of concrete, visualization, to deepen understanding, memory , To improve the effect of teaching quality, so as to mobilize the enthusiasm of students and improve students' innovative ability, with practical significance.

Future Work:

ASK Applications

- Low-frequency RF applications.
- Home automation devices.
- Industrial networks devices.
- Wireless base stations.
- Tire pressuring monitoring systems.

BPSK Applications

- This method is broadly used for bio-metric, wireless LAN along with wireless communications like Bluetooth and RFID.
- Local Oscillator
- Optical Communications
- Multi-channel WDM
- Delay & add demodulator
- Nonlinear effects for WDM transmission