Study on Simulation Programming for Digital Modulation System

A simulation program does not describe the real system exactly, but must represent the characteristic of system that would be simulated. By using parameter of system that will be simulated we can build a program simulation to understand the characteristic of its system and gives a several of treatment.

In Digital modulation techniques, we can start by using Binary PSK as our first system to be simulated. As we know that BPSK is a basic technique for digital modulation that used for recently digital communication system. This system is not too difficult to understand for a beginner whose want to study about digital communication system.

2.1. Understanding The Concept of BPSK System

Phase shift-keying modulation technique, which has a format one symbol, content one bit as called as binary phase shift keying or BPSK. In the BPSK output, phase of carrier signal is separated π radiant to differentiate the value modulator signal, in this case 1 or 0. Two output signal ca be expressed as

$$\begin{aligned} s_1(t) &= A\cos(2\pi f_c t) \\ s_1(t) &= A\cos(2\pi f_c t + \pi) \\ &= -A\cos(2\pi f_c t) \end{aligned} \tag{2-1}$$

Where is the $s_1(t)$ parameter is represent a modulated signal that bring an information 1 and $s_2(t)$ represent a modulated signal that bring an information 0. The parameter A is represents the signal amplitude that describes the energy signal per bit (Eb) along the T duration. In this case has a value

$$A = \sqrt{\frac{2E_b}{T}} \tag{2-2}$$

*f*c is a carrier frequency, and π is a phase that has value as a function of modulator signal.

The output signal of BPSK system as a function of modulator signal, in this case is a sequence of bit information can be described as Figure (2.1).

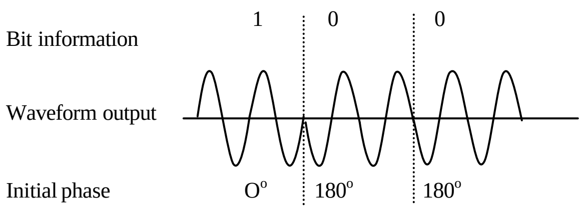


Figure (2.1) Output signal of BPSK system

Generator of BPSK signal has a block diagram as Figure (2.2). The binary data that has a NRZ format will modulate a carrier signal. After filtering process of its output signal is ready for transmission process through a channel.

The receiver part as Figure (2.3) has a similar construction with the transmitter part but has a different function. The received signal will multiply by a local carrier signal, which has synchronized to the carrier signal in the transmitter part. By using low pass filter (LPF) process, the output will be a base band signal. The decision is made by the rule:

If the received signal < 0, the information recover is 0

If the received signal is >= , the information recover is 1.

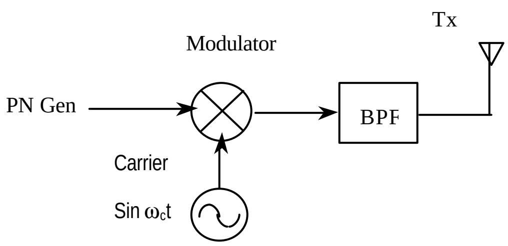


Figure (2.2) Transmitter of BPSK

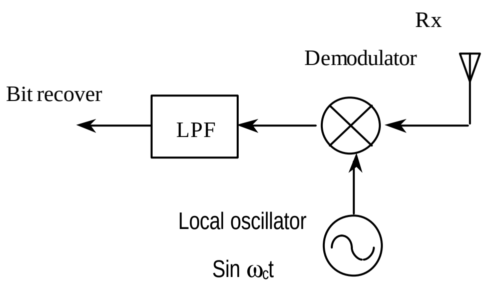


Figure (2.3) Receiver of BPSK

2. 2. AWGN Channel

Noise can be defined as an electric signal that randomly generated and cannot predicted. It can come from internal process or external process. When a value of the random variable is added to the information content of a signal, its information may be destroyed and its value tend to change, and the worst condition is that its original form of information can't understand by the receiver part. Noise can fully eliminated and as a specific case in the communication system. The basic noise in the communication system modeled as Gaussian distributed, and has a frequency spectral density in all of frequency, is like a white light. So its noise then called as white Gaussian noise. And by an addition process effected to a signal transmission, then this called as additive white Gaussian noise or AWGN. This model is only an approximation.

The output signal from transmitter part of BPSK system, after transmission process will has degradation level, which effected by AWGN channel.

$$r(t) = s(t) + n(t) \tag{2-3}$$

Where the n parameter is represent an AWGN component, which zero mean and a variants value

σ^2 = 1/2 No. At the receiver, the decision is made based on the rule of decision as like in the sub section 2.2.1. If the value of received symbol r < 0, the decision is 0 for $s_1(t)$, and if the value of received symbol r $\geq$ 0, the decision is 1 for $s_2(t)$. Clearly, the conditional probability of density function of r is:

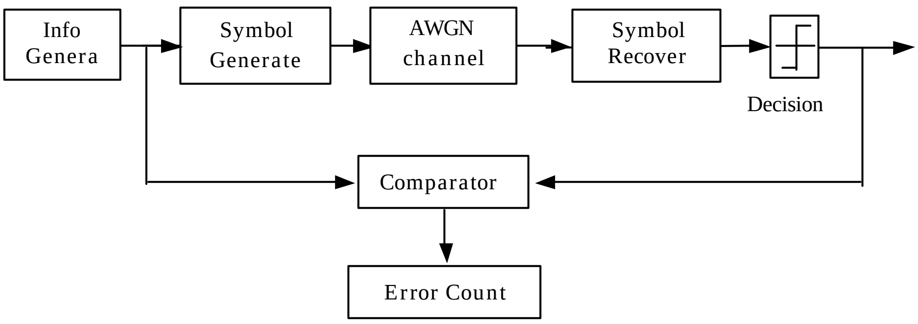
$$\left.\begin{array}{l} p(r \mid s1) = (1/sqrt(pNo))exp(-(r - sqrt(Eb))2/No) \\ p(r \mid s2) = (1/sqrt(pNo))exp(-(r - sqrt(Eb))2/No) \end{array}\right\} \qquad (2\text{-}4)$$

2. 3. Base Band Simulation

As a beginner in simulation programming for digital modulation system, its better if we make an assumption that the channel is ideal or the other words is no noise channel. Modulation, demodulation and filtering processes work perfectly. By do it a new programmer easier to understand and evaluate the program.

The second step is develops a base band simulation for BPSK system, and evaluates transmitter and receiver part work perfectly or not. In the case ideal channel the receiver part have to recover the bit information same with the information sent by the transmitter part.

The third step is develops a BPSK simulation through the AWGN channel as in the Figure (2.4).



Figurer (2.4) Block diagram of BPSK simulation

2.4. Programming

First step what we have done is how to generate the information signal, develop the symbol based on the information signal and transmitted its symbol. At the receiver part we must recover the symbol and get the value of bit recover from each the received symbol. To check if the receiving process work perfectly we use an error detector. In the ideal channel condition the bit recover must be same with the information that generated by the transmitter part.

At the transmitter part we must develop several functions:

- Info generator
- Symbol generator

At the receiver part we must develop several functions:

- Receiving symbol
- Bit recovering process
- Error detect
- Error counting

If we use AWGN channel as our transmission channel, we must develop several functions:

- Gaussian random generator
- Noise addition process

To evaluate the simulation program that we have developed, we must develop probability of error based on the theory by make a derivation of error probability of BPSK system in the AWGN channel and an approximation for program implementation.