Experiment 9

Communication Channel and Noise

Objectives:

By the end of this experiment, the student should be able to:

1. Set up a noisy band limited channel.
2. Measure the signal-to-noise ratio (SNR).

Introduction:

Communication channel is a connection between a transmitter and a receiver through which data can be transmitted. Communication channel also called as communication media or transmission media. Figure 1 shows the main three components for any communication system.

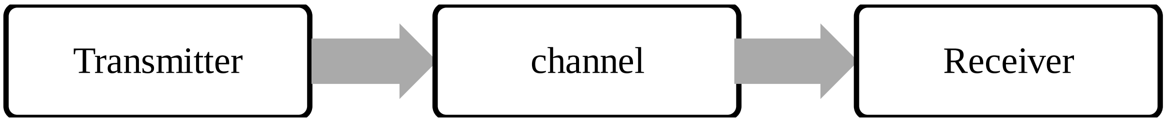

Figure .1 Communication System General Model

Channel types:

There are two types of communication channels:

1. **Baseband Channel (Low pass)**

A lowpass channel by definition should have a bandwidth ranging from zero frequency (DC level) to some upper frequency limit. Thus, it would have the characteristics of a lowpass filter. A speech channel; which is a channel dedicated to transmit human voice signal, is often referred to as a lowpass channel, although it does not necessarily extend down to DC. More commonly it is called a baseband channel.

2. ***Baseband channel***

bandpass channel by definition should have a bandwidth covering a range of frequencies not including DC. Thus it would have the characteristics of a bandpass filter

Noise:

Noise is often described as the limiting factor in communication systems. In communication systems, noise is a general term which is used to describe an unwanted signal which affects a desired signal in a communication channel.

These unwanted signals arise from a variety of sources which may be considered in one of two main categories:

- Interference, usually from a human source (Man Made).
- Natural random noise.

Noise Evaluation

The essence of calculations and measurements is to determine the signal to noise power ratio, i.e. the (SNR) ratio or (S/N) measured in dB.

Mathematically:

$$\textbf{SNR} = \frac{S}{N} = \frac{Signal\ Power}{Noise\ Power} \quad \ldots\ldots (1)$$

If the signal and the noise are measured across the same impedance, then the SNR can be obtained by calculating the square of the amplitude ratio:

$$\textbf{SNR} = \left(\frac{A_{Signal}}{A_{Noise}}\right)^2 \quad \ldots\ldots (2)$$

Where A is the root mean square (RMS) amplitude (for example, RMS voltage). Because many signals have a very wide dynamic range, SNRs are often expressed using the logarithmic decibel scale. In decibels, the SNR is defined as:

$$\textbf{SNR(dB)} = 10 \log \left(\frac{Signal\ Power}{Noise\ Power}\right) \quad \ldots\ldots (3)$$

The SNR at various stages in a communication system gives an indication of system quality and performance in terms of error rate in digital data communication systems and 'fidelity' in case of analogue communication systems.

Obviously, the larger SNR gives better system Noise, which accompanies the signal is usually considered to be additive (in terms of powers) and its often described as Additive White Gaussian Noise (**AWGN**) see figure 2.

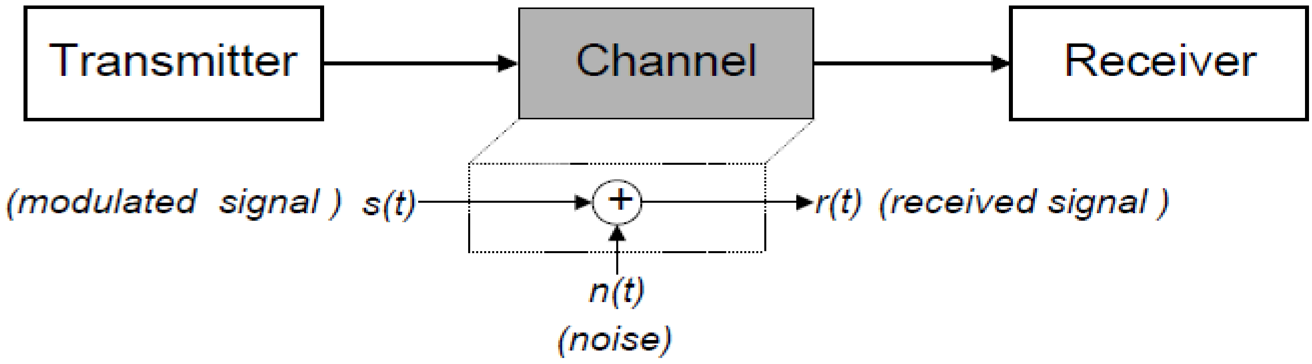

Figure .2 Noisy Channel Model.

Lab Work :

This experiment consists from one part which aims at measuring the SNR.

Modules

The following plug in modules are needed for this experiment: Audio Oscillator, Noise Generator, Baseband Channel Filter, Adder, Wideband True RMS Meter

Procedure:

1. Construct the following TIMS Model

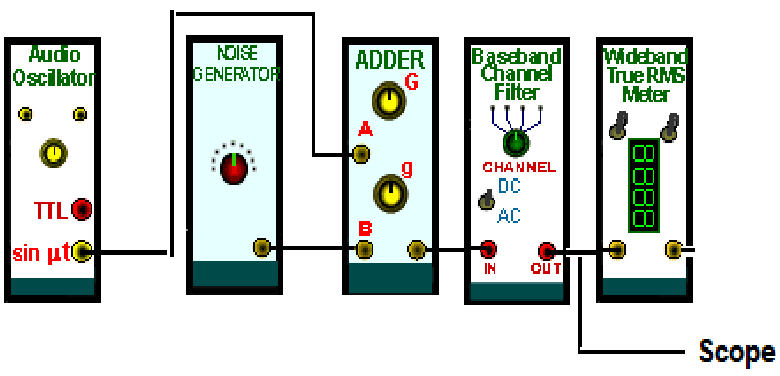

Figure 3. Noisy Channel Model

2. Use the Frequency Counter to set the Audio Oscillator to about 1 kHz.
3. Set the Adder gain (**g**) fully clockwise and the other gain (**G**) about 50% from its maximum value.
4. Set the baseband channel filter to channel 4.
5. Set the noise level to the maximum value (around 22dB).
6. Measure the SNR (dB) using wideband RMS true meter.
7. Observe the original signal and the attenuated signal in time simultaneously.
8. Increase the signal power level. What happens to the attenuated signal?
9. Describe the effect of increasing the signal power on the attenuated signal.
10. Increase the audio oscillator frequency. What happens to the attenuated signal?
11. Describe the effect of increasing the frequency on the attenuated signal.