اسم المادة: أساسيات الاتصالات

قسم تقنيات المعلومات والاتصالات

المرحلة الثانية

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NOISE

Introduction

Noise is a general term which is used to describe an unwanted signal which affects a wanted signal. 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)*
- *Naturally occurring random noise*

- **Interference**

Interference arises for example, from other communication systems (cross talk), 50 Hz supplies (hum) and harmonics, switched mode power supplies, thyristor circuits, ignition (car spark plugs) motors … etc.

- **Natural Noise**

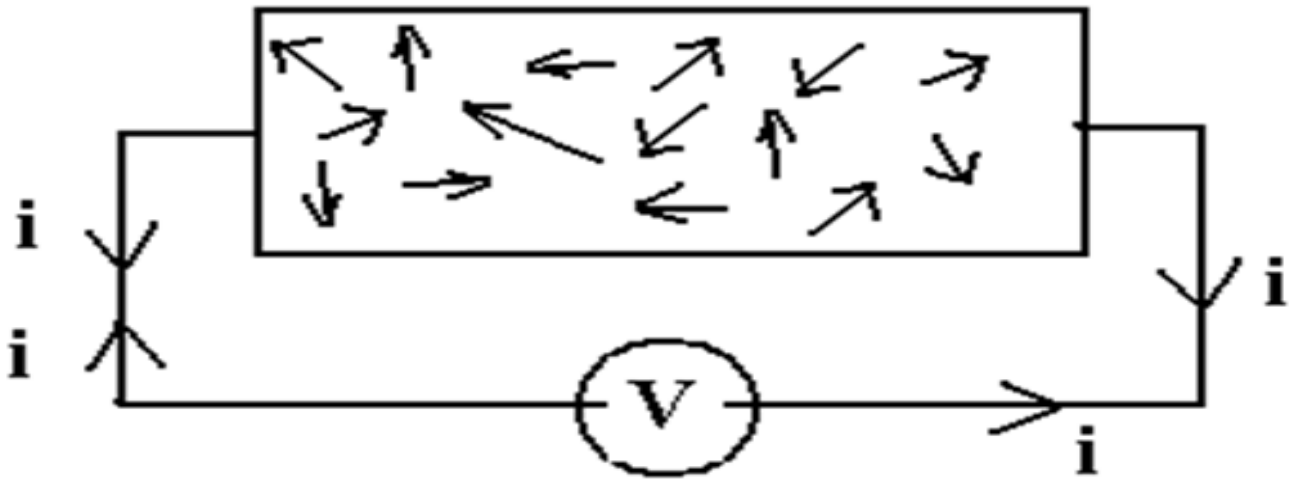
Naturally occurring external noise sources include atmosphere disturbance (e.g. electric storms, lighting, ionospheres effect etc), so called ‘Sky Noise’ or Cosmic noise which includes noise from galaxy, solar noise and ‘hot spot’ due to oxygen and water vapour resonance in the earth’s atmosphere.

Types of noise

1. Thermal Noise
2. Shot Noise
3. Low Frequency or Flicker Noise
4. Excess Resister Noise
5. Burst or Popcorn Noise

1- Thermal Noise (Johnson Noise)

This type of noise is generated by all resistances (e.g. a resistor, semiconductor, the resistance of a resonant circuit, i.e. the real part of the impedance, cable etc).



Experimental results (by Johnson) and theoretical studies (by Nyquist) give the mean square noise voltage as

$$\bar{V}^2 = 4kTBR \ (volt^2)$$

Where k = Boltzmann's constant = 1.38 x 10^{-23} Joules per K

T = absolute temperature

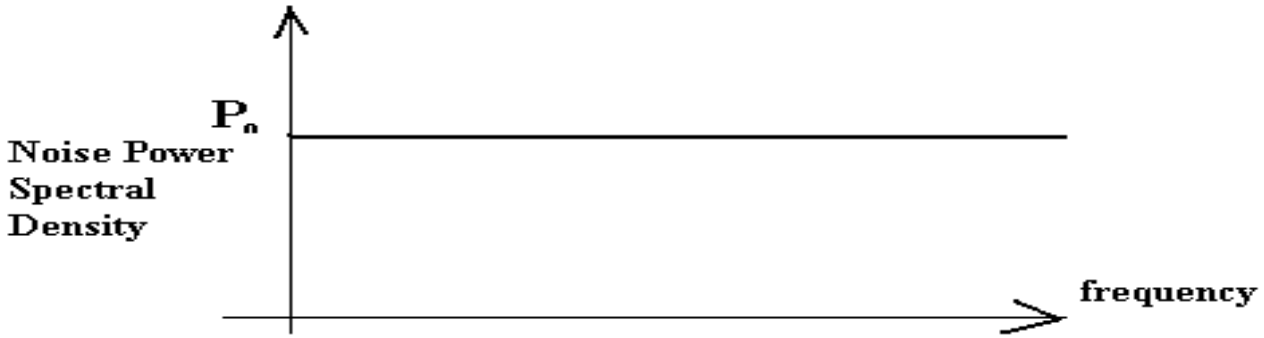
B = bandwidth noise measured in (Hz)

R = resistance (ohms)

The law relating noise power, N, to the temperature and bandwidth is

N = k TB watts

Thermal noise is often referred to as 'white noise' because it has a uniform 'spectral density'.



Uniform Noise Power Spectral Density

2- Shot Noise

• Shot noise was originally used to describe noise due to random fluctuations in electron emission from cathodes in vacuum tubes.

• Shot noise also occurs in semiconductors due to the liberation of charge carriers.

3- Low Frequency or Flicker Noise

Active devices, integrated circuit, diodes, transistors etc also exhibits a low frequency noise, which is frequency dependent (i.e. non uniform) known as flicker noise.

4- Excess Resistor Noise

Thermal noise in resistors does not vary with frequency, as previously noted, by many resistors also generates as additional frequency dependent noise referred to as excess noise.

5- Burst Noise or Popcorn Noise

Some semiconductors also produce burst or popcorn noise with a spectral density which is proportional to $\left(1/f\right)^2$

Signal power to Noise power ratio (SNR)

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

$$\left(\frac{S}{N}\right)_{ratio} = \frac{S}{N}$$

$$\left(\frac{S}{N}\right)_{dB} = 10 \log_{10}\left(\frac{S}{N}\right)$$

$$i.e.\ \left(\frac{S}{N}\right)_{dB} = 10 \log_{10} S - 10 \log_{10} N$$

$$\left(\frac{S}{N}\right)_{dB} = S_{dBm} - N_{dBm}$$