Noise In Communication System

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**What is Noise?**

* In electrical terms, noise may be defined as an unwanted form of energy that tends to interfere with the proper reception and reproduction of transmitted signals.
* For example, in receivers, several electrical disturbances produce noise and thus modifying the required signal in an unwanted form.
* In the case of [radio receivers](https://easyelectronics.co.in/radio-receivers/), noise may produce hiss-type sound in the output of loud speakers.
* Similarly, in T.V. receivers, noise may produce ‘snow’ which becomes superimposed on the picture output.
* In pulse communications, noise may produce unwanted pulses or cancel the required pulses.
* In other words, we can say that noise may limit the performance of a [communication system](https://easyelectronics.co.in/communication-system/).

**Classification of Noise in communication system**

* There are several ways of classifying the noise in communication system but conveniently noise may be classified in two broad groups as under:

|  |  |
| --- | --- |
| 1. External Noise | 2. Internal Noise |

Let’s discuss each noise classified as above in detail.

### ****(I). External Noise:****

* External Noise may be defined as that type of noise that is generated external to a communication system. i.e. whose sources are external to the communication system.
* External Noise can not be analyzed quantitatively. In addition to this, for a given geographical point or location, external noise can not be controlled.
* Thus, to reduce the effect of external noise, the only way is to shift the [communication system](https://easyelectronics.co.in/block-diagram-of-digital-communication-system/) to another place or location which has comparatively smaller external noise.
* Thus due to this reason, the satellites’ [earth stations](https://www.gartner.com/en/information-technology/glossary/earth-station#:~:text=An%20earth%20station%20is%20a,over%20one%20or%20more%20satellites.&text=Earth%20stations%20are%20part%20of,operating%20in%20a%20satellite%20system.) are generally located in noise-free valleys.
* External Noise may be classified as under:

1. Atmospheric Noise
2. Extraterrestrial Noise
3. Industrial Noise

#### ****1. Atmoshpheric Noise****

* Atmospheric noise, which is also called static, is produced by lightning discharges in thunderstorms and other natural electrical disturbances which occur in the atmosphere. These electric impulses are random in nature. Thus this energy is spread over the complete frequency spectrum used for radio communication.
* Atmospheric noise contains spurious radio signals which are disturbed over a wide frequency range.
* **It has been observed that the field strength of atmospheric noise varies approximately inversely with the frequency.**
* So, large atmospheric noise is produced in low and medium frequency bands whereas very small noise is produced in the VHF and UHF bands.
* Atmospheric noise becomes less severe at frequencies above about 30MHz

#### ****2. Extraterrestrial Noise****

There are several types of extraterrestrial noise or space noise depending upon their sources. Extraterrestrial noise may be divided into the following two sub-groups as under:

(i) Solar Noise

(ii) Cosmic Noise

* **Solar Noise:** Solar noise is the electrical noise eliminated from the sun. Under steady conditions, there is regular radiation of noise from the sun. This radiation of noise from the sun is due to the fact that the sun is a big body at an extremely high temperature and it radiates electrical energy in the form of noise over a very wide frequency spectrum including also the frequency spectrum which is occupied by radio communication. However, the condition of the sun varies and follows an eleven years cycle. Hence, at the peak of this eleven years cycle, electrical disturbances are caused.
* ince industrial or man-made noise is highly variable and hence can be analyzed only statistically.

### ****(II). Internal Noise:****

* Internal Noise is that type of noise that is generated internally or within the communication system or receiver.

**Cosmic Noise:** Distance stars can also be considered Suns. These distant stars have high temperatures and therefore radiate noise in the same manner as the sun. The noise received from these distant stars is thermal noise and is distributed almost uniformly over the entire sky. This type of noise is quite intense but since it comes from very distant sources, the angle subtended by the earth is quite small. Therefore the strength of noise received on the earth gets diminished.

#### ****3. Industrial Noise****

* Industrial noise or man-made noise is that type of noise which is produced by such sources as automobiles and aircraft ignition, electrical motors, switch gears and leakage from high voltages transmission line and several other heavy electrical equipment.
* Such a type of noise is produced by the arc discharge taking place during the operation of all these machines or equipment.
* Industrial noise is quite intensive in industrial areas, densely populated urban areas.
* Internal noise may be treated quantitatively and can also be reduced or minimized by proper system design.
* Since internal noise is randomly distributed over the entire frequency spectrum, the noise present in a given bandwidth B is the same at any frequency in the frequency spectrum.
* Hence, this random noise power is proportional to the bandwidth over which it is measured.
* Internal noise may be classified as under:

1. Shot Noise
2. Partition Noise
3. Low freqeuncy or Flicker Noise
4. High frequency or Transit time Noise
5. Thermal Noise

#### ****Shot Noise:****

* Shot noise arises in active devices due to the random behavior of charge carriers.
* In electron tubes, shot noise is generated due to the random emission of electrons from cathodes, whereas in semiconductor devices shot noise is generated due to the random diffusion of minority carriers or simply random generation and recombination of electron-hole pairs.
* In fact, the current in electron devices (i.e. tubes or solid-state devices) flows in the form of discrete pulses, every time a charge carrier moves from one point to the other (i.e. cathode to plate).
* Hence, although the current appears to be continuous, it is still a discrete phenomenon.

#### ****Partition Noise:****

* Partition noise is generated in a circuit when a current has to divide between two or more paths.
* This means that the partition noise results from the random fluctuations in the division. Hence, it is expected that a diode must be less noisy than a transistor, all else being equal.
* Due to this reason, the inputs of microwave receivers are generally taken directly to the diode mixers.
* For partition noise, the spectrum is a flat spectrum.
* Also, the active three-terminal components in which the control terminal draws less current are less noisy.
* In recent time, Metal- Oxide Semiconductor Field Effect Transistors have been developed which draws almost zero gate bias current.
* Due to this reason, these devices have low partition noise and therefore finds applications in low noise microwave amplification.

#### ****Flicker Noise or Low Frequency Noise****

* At low frequencies (below a few kHz), a particular type of noise appears.
* The power spectral density of this noise increases as the frequency decreases.
* This noise is called flicker noise or (1/f) noise.
* In the case of Vaccum tubes, the main causes of flicker noise are slow changes that take place in the oxide structure of oxide-coated cathodes and the migration of impurity ions.
* In semiconductor devices, flicker noise is generated from the fluctuations in the carr density and creates more problems in semiconductor amplifying devices than in Vaccum tubes at low frequencies.
* Actually, the fluctuations in the carrier density generate fluctuations in the conductivity of the material. This produces a fluctuating voltage drop when a direct current flows. This fluctuating voltage drop is called the flicker-noise voltage.
* The power density spectrum of the flicker noise is inversely proportional to frequency. Mathematically,

\boxed{S(w) \propto \frac{1}{f}}*S*(*w*)∝*f*1​​

* Therefore, the flicker noise becomes significant at very low frequencies, generally below a few kHz.

#### ****4. Transit Time Noise or High Frequency Noise:****

* It is generally observed in semiconductor devices, when the transit-time of charge carriers crossing a junction is comparable with the time period of the signal, some charge-carriers diffuse back to the source or emitters.
* This process gives rise to an input admittance in which the conductance component increases with frequency.

#### This conductance has a noise current source that is associated with it in parallel. Because this conductance increases with frequency, the power spectral density will also increase.Advertisements ****. Thermal Noise:****

* Thermal noise is random and is often referred to as white noise or Johnson noise.
* The thermal noise or white noise or Johnson noise is the random noise that is generated in a resistor or the resistive component of a complex impedance due to rapid and random motion of the molecules, atoms, and electrons.
* According to the kinetic theory of thermodynamics, the temperature of a particle denotes its internal kinetic energy.
* This means that the temperature of a body expresses the RMS value of the velocity of motion of the particles in the body. As per this kinetic theory, the kinetic energy of these particles becomes approximately zero (i.e. zero velocity) at absolute zero.
* Therefore, the noise power produced in a resistor is proportional to its absolute temperature. Also, the noise power is proportional to the bandwidth over which the noise is measured.
* Therefore the expression for the maximum noise power output of a resistor may be given as,

*Pn*​∝*T*.*B*

P\_n = K.T.B*Pn*​=*K*.*T*.*B*

* Where,

K = Boltzmann’s constant

T = absolute temperature

* B = Bandwidth of interest in Hz.