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What Is AWGN?

As anyone who has ever lived in an apartment would know, noise is often something we'd like to reduce in our lives. Modern electrical systems don't take too kindly to noise either, however, their foe isn't obnoxious neighbors, but rather the noise that's ever-present all around us. Noise is generated by the random vibrations of conducting electrons, as well as holes that are present in the material. The collective sum of these vibrating elements can cause quite the headache for designers of electronic systems. Noise creates unwanted interference, which degrades communication signals and can even lead to signal loss. This doesn't bode well for many electronic devices, such as sensitive receivers. Oftentimes, noise isn't welcome in an electrical system – that is, unless, it was added on purpose.

A little bit of what's considered "bad" can actually be a very good thing. By generating known amounts of noise and deliberately sending those noise signals through a system, designers can better understand how the system reacts in its presence, as well as observe the noise's overall impact. Unsurprisingly, noise generators are used to generate these known amounts of noise. A noise generator produces electrical noise (i.e. a random signal) to test equipment and measure key parameters, such as noise figure, frequency response, etc. Essentially, by purposely adding noise, designers can best prepare for and measure its effect on the system.

A basic and generally accepted noise model is known as Additive White Gaussian Noise (AWGN), which imitates various random processes seen in nature. Let's break each of those words down for further clarity:

Additive – As its name suggests, noise is *added* to a signal. In other words, the signal that's received equates to the signal that's transmitted…plus some noise. Moreover, the noise is generated randomly and has an individual probability from the signal, meaning the occurrence of one does not affect the probability of occurrence of the other.

White – This refers to the idea that the noise has the same power distribution at every frequency. Therefore, white noise has a constant Power Spectral Density (the measure of a signal's power compared to frequency) across all frequencies. You may be asking, "Why choose the word 'white' to represent this idea?" Well, if I focused a beam of light for each color on the visible spectrum onto a single spot, that combination would result in a beam of white light. As a result, white light is comprised of a combination of all colors or frequencies in the visible spectrum.

Gaussian – Due to a noise source's random nature, a mathematical model is used to calculate the probability of events. Gaussian distribution, or a normal distribution, has an average of zero in the time domain, and is represented as a bell-shaped curve that is symmetrical about the mean with no left or right bias.

The random nature of noise can distort signals and the integrity of electrical systems. Therefore, noise generators can help measure a system's response to noise, using an AWGN channel to introduce an average number of errors through the system. So just remember, a little bit of a perceived "bad" occurrence can be used to help bolster designs in the long run.