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How Is Noise Generated?

Noise – a word often met with dread for designers of sensitive electrical systems. Noise is generated by the random vibrations of conducting electrons, as well as holes that are present in the material, and its collective sum can disrupt communication signals. However, noise isn't always a negative pest to designs. In fact, when it's generated and sent through a particular system on purpose, noise can help designers better understand and measure the effects of real-world interference. This is where noise generators come in, which are devices that generate known amounts of noise. Furthermore, a basic and generally accepted noise model is known as Additive White Gaussian Noise (AWGN), which imitates various random processes that are observed in nature. An AWGN channel adds randomly generated white noise into a system over a normal distribution.

So, now that we're all on board that noise can be used for the greater good in wireless design, that leads us to our next inquiry: how is noise generated?

First, a diode is used – a Zener diode to be more exact – in a reversed-biased circuit. Touching on a few of the basics, a diode is defined as a semiconductor device or component that essentially acts as a one-way current switch. Since it's a semiconductor material, diodes can conduct or oppose the flow of current. In other words, diodes can allow the flow of current easily in one direction, but severely restrict the flow of current in the other direction. In the case where diodes allow the current to flow, that is known as a forward-biased circuit. On the other hand, when a diode is preventing the current from flowing, it is referred to a reversed-biased circuit.

However, AWGN is generated using a Zener diode. When in forward-biased mode, a Zener diode acts like any other typical diode, business as usual. However, when in reversed-biased mode, Zener diodes work almost like a standard diode, but the key word there is "almost." They do have one exception – the diode will prevent the current from flowing, but it will only do so up to a certain voltage. Once the Zener diode's breakdown voltage has been exceeded, the current will start to flow through the circuit once again.

In a reversed-biased p-n diode, a type of electrical breakdown can occur when the electric field allows electron tunneling from valence electrons to a semiconductor's conduction band. This ultimately leads to the reverse current suddenly increasing, known as the Zener effect (below 7 volts). In this case, the Zener breakdown and noise generated is shot noise. A breakdown above that threshold is known as avalanche noise, which is more complicated and has a flat frequency spectrum (i.e. white noise). It is possible to use these diodes that exhibit these effect as noise generators for test applications.

Noisecom's noise diodes, for example, are sorted for performance characteristics that enhance their broadband noise output and flat spectral response, all of which deliver symmetrical white Gaussian noise and flat output power versus frequency. In the end, noise diodes are the fundamental building blocks for analog noise systems. Now armed with this knowledge, your systems better prepare themselves for some noise signals headed their way.