

Warning Message Regarding Frequency Band Crossing DC

Problem

Why does the warning message "Caution: Frequency band crosses DC. Noise power will appear to be doubled where negative frequencies are folded." appear?

Solution

In a sampled Complex Envelope (CE) simulation, as in VSS, the signal is centered around a center frequency F_c , and sampled at a rate (sampling frequency) of F_s (in samples per second). This results in the operational bandwidth of the signal being the aforementioned F_s , centered around F_c . In other words, the "frequency universe" of the simulation at any given point in a chain is the frequency interval $[F_c - F_s/2, F_c + F_s/2]$.

Given the above, it can happen that the "frequency universe" of a signal includes the zero frequency (DC), for example when (say, the IF) $F_c = 1\text{GHz}$ and $F_s = 4\text{GHz}$ (the sampling frequency). If one uses a graph with a PWR_SPEC measurement to plot the spectrum of the above signal, there are two (among other) options:

1. Set the "Frequencies Displayed" option (second from last, bottom right) in the PWR_SPEC measurement to "All", in which case one will see all frequencies, i.e. from -1GHz to 3GHz .
2. Set the "Frequencies Displayed" option to "Spectrum Analyzer Style" (the default), in which case only positive frequencies are displayed, not because the negative ones are eliminated, but because they are folded conjugately back onto the positive ones, much like a real world spectrum analyzer would do.

In the second case above, if pure white noise centered at $F_c = 1\text{GHz}$ and sampled at $F_s = 4\text{GHz}$ was the signal in question, and if "Spectrum Analyzer Style" is selected, what one would see (from the folding) is 3dB higher noise spectrum from 0 to 1GHz (because of the original noise there, plus the conjugated spectrum of the noise in the negative frequencies from -1GHz to 0 GHz), and, of course, the regular noise spectral level from 1GHz to 3GHz. So, the noise spectrum would appear to have a knee at 1GHz, being 3dB higher below 1GHz, and 3dB lower above 1GHz, when in fact the internal noise is being generated flat, with the same spectrum everywhere. So, the warning is there to alert the user to the fact that, while the noise (and everything else) is being generated correctly without error, one could be fooled by folded frequency plots into thinking the noise actually doubles close to DC. This is the meaning of the warning message.