

National Instruments

ABSTRACT

Aku Wilenius

May 4, 2009

Tel: +358 400 726 060

Email: aku.wilenius@ni.com

The Effect of Synthesizer Phase Noise on Measurement Device Performance

Presenter: Leif Johansson, National Instruments Sweden Ab

This presentation describes how the synthesizer phase noise affects the performance of your measurement device. We give an overview of the technology options and their performance and explain how to measure the phase noise and what technology gives the best overall performance for a synthesizer.

In a non-ideal world a sinusoidal waveform at some carrier frequency is modulated by noise; there are both phase and amplitude modulation. Amplitude modulation by noise dominates the noise floor of the signal, which is known as the "far out (spectral region away from the carrier) thermal noise floor". On the other hand, phase modulation by noise dominates in the spectral region close to the carrier; typically out to an offset frequency of few MHz for carrier frequencies in the GHz. This close-in noise due to phase modulation is commonly known as phase noise. While thermal noise generally has a flat spectrum, phase noise spectrally increases at a rate of 20 dB per decade or more as the noise frequency approaches 0 Hz offset from the carrier.

Phase noise from a system mostly originates from the oscillators and synthesizers employed. In oscillators the dominant cause for phase noise is amplitude-to-phase conversion of thermal, flicker, and pop-corn noises of components. In addition to the phase noise of oscillators, synthesizers add to it phase noise arising from amplifiers, dividers, multipliers, and PLL components.

Phase noise affects many communication systems; both digital and analog systems. In analog systems such as a FM system, high phase noise levels causes loss of audio fidelity, and signal surveillance systems phase noise could hide a low level alien signal close to the carrier. In digital communication systems phase noise affects the phase component of symbols causing an increase in error-vector-magnitude measurements. It is thus important to keep the phase noise low enough as to not significantly affect the outcome of the system. If a synthesizer is well designed phase noise could be kept low despite tuning speed and frequency step size. However, phase noise can generally be improved if the tuning speed is slower and frequency step size is larger. The physical size and power consumption of a system are two other factors that affect phase noise performance. Having more room and power to work with opens up more options for better performing components and additional optimization circuitry, which in return provides a better performing system.

