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Phase and Amplitude Noise Measurements: Fundamentals and Best Practices

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Accurate phase and amplitude noise measurements are substantial for the advancement of, and academic exchange on low-level RF, (laser) timing synchronization and timing diagnostic systems. However, the notion of phase, timing and amplitude noise, and their various representations can be quite overwhelming for scientists and newcomers to the field without a deep background in electrical engineering and statistics. This, in turn, easily can lead to misunderstandings and can also quickly cause falsification of gathered results due to incorrect measurement setups or inaccurate mathematical processing of collected data. We aim to aid good scientific practice by providing an essential and concise introduction to the art of PM and AM noise measurements, introducing the mathematical foundations that link time domain data and power spectral density estimations, the units involved, as well as standard representation of noise plots. We discuss the operation, settings, and limitations of industry standard phase noise analyzers and common pitfalls in measurement setups for RF and optical systems, covering oscillator stability as well as timing link stability. The discussion also extends to baseband measurements using custom, external timing detectors such as balanced optical cross-correlators.

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