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Tuesday, January 19, 2021
9:45 am – 11:15 am ET

Session A: Nonlinear Measurements and Modeling

Modulation Analysis – A Novel Way to Characterize Components under Modulated Operating Conditions (Invited Talk) 40 minutes

Jan Verspecht (Keysight Technologies)

This presentation describes "modulation analysis", a new method to accurately and efficiently characterize modulation quality at the component level as well as at the system level. In contrast with existing methods of error-vector-magnitude and noise-power-ratio, modulation error analysis does not require demodulation and can be applied to any modulation format. As a result, the new method is universal and is well suited for metrological purposes in the context of applications like 5G, 6G and aerospace. Modulation analysis provides a unified approach to the concepts of error-vector-magnitude (EVM), noise-power-ratio (NPR) and effective-number-of-bits (ENOB). The method is based on Shannon`s theorem and uses channel capacity and channel capacity density as the fundamental measurands. The analysis is based on the concept of cross-spectral density between input and output signals, whereby these signals can be analog as well as digital. As a consequence the method can be used across a wide range of applications, from individual components like amplifiers, mixers and frequency convertors, to complete receiver and transmitter systems.

Linearity Measurement of 6G Receiver with One Transmission Frequency Extender Operating at 330 GHz

Marko E. Leinonen (University of Oulu); Klaus Nevala (University of Oulu); Nuutti Tervo (University of Oulu); Aarno Pärssinen (University of Oulu)*

The future sixth-generation (6G) is envisioned to support data rates up to 1 Tbps. The operational frequencies of the 6G system will be expanded towards the sub-mmW and THz regions. The 6G systems will utilize directive beams, as well, to compensate increased signal attenuation between link ends. The linearity of a receiver (Rx) is one of the most significant parameters for any radio system. Traditional Rx linearity measurement relies on a two-tone measurement technique, which requires two dedicated RF signals and combining them to the test signal. The generation of two independent RF signals at a 300 GHz frequency band leads to a costly and bulky solution.

This paper proposes a linearity measurement method for 6G Rx, which uses only one continuous wave transmission frequency extender. A method is proposed where the RF input signal of frequency extender is narrowband amplitude modulated (AM), generating side tones around continuous wave carrier. The carrier frequency and first side tones are used as test signals, and the linearity test is like a traditional two-tone test with unequal signals. It is shown that the carrier level can be modified by back-offing the RF input power in the frequency extender input. By varying the AM modulation index, the side tones' levels can be varied, enabling the sweep of the tone input power to perform Rx linearity measurements.

Surrogate Modeling-Based Acceleration of Multi-Harmonic Near-Field Measurements

Jonas Urbonas (Maury Microwave); Haris Votsi (University of Cyprus); Alexander Shakouri (Microsanj); Peter Aaen (Colorado School of Mines)*

In this paper, a surrogate modeling-based acceleration technique for multi-harmonic phase-coherent electrooptic near-field measurements is presented. The implementation uses an adaptive sampling and modeling algorithm instead of the conventional raster scanning approach, which reduces the measurement time by a factor of 9, from 7 hours to 45 minutes, and the number of samples by a factor of 23, from 10556 to 464, while maintaining the average measurement error under 5%. The reduction in measurement time helps to preserve the accuracy of the multi-harmonic near-field measurements, as the electro-optic measurement system response can drift over time, due to thermal fluctuations in the measurement environment.

Emulation of a Multi-Stage Differential Amplifier Using One Single-Ended Device-Under-Test

Koen Buisman (Chalmers University of Technology); Jose-Ramon Perez-Cisneros (Chalmers University of Technology); William Hallberg (Qamcom IPR); Dhecha Nopchinda (Chalmers University of Technology); Peter Zampardi (Qorvo, Inc.)*

A method to emulate multi-stage power amplifier (PA) architectures is presented. The technique predicts multistage PA performance. The method is based on an iterative procedure using transistor/branch PA active load-pull measurements to include inter-stage interaction. As a benefit, real world performance of a multi-stage PA can be evaluated early in the design process. Compared to previous published work, the method requires only a single representative device-undertest to embody multi-stage architectures. Thus, a compelling measurement method for PA designers is presented. The method is demonstrated by emulating a two-stage differential amplifier at 2.14 GHz using single-tone signals.

Estimation of the Coverage Probability of S-Parameters for Safety-Critical Systems with Hotelling's T2 Distribution

*Franz G. Aletsee (Augsburg University of Applied Sciences)**

Safety-critical systems, such as medical products, industrial safety functions, or autonomous driving systems, rely not only on the knowledge of the actual system parameters, but it is imperative to also take statistic properties into account. Besides measurement uncertainties, sample variation can play an extraordinary role in the evaluation of the overall variation of a certain parameter. S-parameters are used to describe the linear behavior of high-frequency devices, such as cables. This paper focuses on the quantification of sample variation to satisfy predefined safety margins. First, statistic relations are deduced and presented. Afterwards, these results are verified by means of Monte Carlo simulations. It can be shown, that even for moderate sample sizes of about 50 observations, the Hotelling's T2 distribution needs to be used to account for the uncertainty of the sample covariance matrix estimation. These general findings are adapted to S-parameter measurements and an application based on 9 cable measurements is presented.