KTH Electrical Engineering

# Characterization and Linearization of Multi-band Multi-channel RF Power Amplifiers

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**Abstract**

The World today is deeply transformed by the advancement in wireless technology. The envision of a smart society where interactions between physical and virtual dimensions of life are intertwined and where human interaction, more often than not, takes place with or is mediated by machines, e.g., smart phones, demands increasingly more data traffic. This continual increase in data traffic requires re-designing of the wireless technologies which can accommodate multi-channel and multi-band scenarios for increased system capacity and flexibility. In this thesis, aspects related to behavioral modeling, characterization, and compensation of nonlinear distortions in the radio frequency (RF) multiple-input-multiple-output (MIMO) and concurrent dual-band power amplifiers (PAs) are discussed.

When building a model of any system, it is advantageous to take into account the knowledge of the physics of the system and incorporate this information into the model. This approach could help to improve the model performance and might reduce the number of model parameters. In this context, three novel behavioral models and digital pre-distortion (DPD) schemes for nonlinear MIMO transmitters are proposed. Different types of cross-talk in MIMO transmitter are investigated to derive simple and powerful modeling schemes. Effect of coherent and partially coherent signal generation on the performance of DPD is also evaluated.

To model and compensate nonlinear distortions in gallium nitride (GaN) based RF PAs in presence of long-term memory effects, two novel models for single-input-single-output (SISO) and three novel models for concurrent dual-band RF PAs are proposed. These models are based on a fixed pole expansion technique and have infinite impulse response. They show substantial performance improvement in comparison with the finite impulse response based behavioral models. A behavioral model based on the physical knowledge of the concurrent dual-band PA is derived, and its performance is investigated both for behavioral modeling and compensation of nonlinear distortions.

Two-tone characterization is a fingerprint method for the characterization of memory effects in dynamic nonlinear systems. In this context, two novel techniques are proposed for the characterization of concurrent dual-band and MIMO transmitters. The first technique is a dual two-tone characterization technique to characterize the individual memory effects of self- and cross-modulation products in concurrent dual-band transmitter. The second technique is for the characterization and analysis of self- and cross-Volterra kernels of nonlinear 3×3 MIMO systems using three-tone signals. In the proposed technique, the self- and cross-Volterra kernels are analyzed along certain paths in a frequency space to determine the block structures of the underlying system. By using these characterization techniques, it is shown that the knowledge extracted from the studied systems could be used to modify previously published behavioral models.

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