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Structureless Modeling of Power Amplifiers Accounting for Inertial Properties[1]

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Abstract—The paper considers various structureless inertial non-linear models of power amplifiers and methods of their identification. Based on polynomial model with memory and Volterra model the influence of different kinds of input signals, their bandwidth and average power on precision of power amplifier modeling and complexity of model implementation.

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INTRODUCTION

The development trend for modern wireless communications systems demonstrates constant improvement of data transmission rates caused by a priority shift on the user side to multimedia, business application and Internet. In order to simultaneously achieve high data rate and high spectral efficiency complex radio signal modulation methods are used which facilitate rapid changes of its envelope. Firstly these systems use a combination of 16QAM and 64QAM modulations with Orthogonal Frequency Division Multiplexing (OFDM) techniques. For such signals the ratio of peak-to-average power gets relatively large (6–9 dB), which imposes strict requirements to linear nature of the transmission path.

At the same time with increasing number of consumers leads to more base stations, hence revealing a need for decreasing power consumption. The power consumption problems appears to be even more topical for mobile devices with limited battery capacity.

As generally known, a power amplifier (PA) is the main non-linear device in the transmission path as well as the main power consumer, hence causing increased interest to its modeling aiming to improve linear nature and energy efficiency [1–8]. Typically power amplifier modeling is done either on the structure level when the device is represented by an equivalent circuit and analyzed using the circuit theory or on the structureless (behavioral) level.

Behavioral model is a model with a device represented as a black box characterized by some mathematical function to connect transformation of input signal into the output one. Output signal are obtained either in experiments or using finer models. Behavioral models are formal, i.e. are built using formal similarity in behavior of model and real object with respect to their outputs. Meanwhile the choice of behavioral functions kind primarily relies on operation efficiency and required precision of reproducing the connection between input and output signals rather than physical processes that occur in the semiconductor device.

Behavioral models are widely used in digital predistortion unit design [2, 5] that find application in power amplifier linearization due to the optimal volume-to-price ratio. Digital predistortion techniques expect connecting an additional low-power unit at power amplifier's input that introduces preliminary signal distortions to compensate for non-linear effects in the amplifier. The use of digital modulation techniques along with direct synthesis circuits allows implementing predistortion units as integrated software-hardware modules included in modulator.

Digital predistortion unit implements a transfer function which is reciprocal to the power amplifier's one, hence its realization depends on the choice of amplifier's behavioral model. Structureless power amplifier

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