AMCAD Engineering

White Paper

STAN Tool: A Unique Solution for the Stability Analysis of RF & Microwave Circuits

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Introduction

The next generation of cellular communications (5G) requires communication networks with higher capabilities in bandwidth, speed, and reliability. This fast evolution of connectivity involves developing more complex communication structures to attain the new, highly demanding specifications.

In wireless communication networks, the most restrictive element is the base station, where the power amplifier (PA) is the component that consumes the highest amount of energy. To achieve maximum power efficiency, PAs work near their saturation region, risking the presence of nonlinear distortion [1]. Moreover, power amplifiers at RF and microwave frequencies often present undesired behavior due to the presence of feedback loops, such as frequency division by two, oscillations at incommensurate frequencies, or hysteresis [2]-[4]. This undesired behavior may appear in linear conditions, depending on the device's bias, and in nonlinear conditions where the input power increase may lead to a qualitative change of the solution's stability.

The detection of instabilities at the design stage enables a reduction of fabrication costs: the circuit can be perfectly characterized without delaying the fabrication process. Moreover, if designs are made for MMIC (Monolithic Microwave Integrated Circuits), the stability analysis gains importance due to the impossibility of adjusting the design after fabrication. Thus, the use of reliable tools allowing rigorous detection of circuit instabilities in both small and large signals is essential at the design stage.

Problematic

Nowadays, the circuit behavior can be predicted using commercial CAD (Computer-Aided Design) Tools, where different simulation methods try to provide more insight into the circuit dynamics. The available methodologies are based on time-domain and frequency-domain integration [5]. When using the time-domain integration, the transient is considered in the analysis. Large time constants are necessary to account for the system dynamics, making it unsuitable at microwave frequencies. On the other hand, frequency-domain methods such as Harmonic Balance (HB) only provide steady-state solutions without giving information about their stability. Note that only stable solutions can be observed physically. Therefore, further analyses are necessary after getting a solution.

Stability Analysis:

Available methodologies in CAD tools are either **not complete** or **too complex** to be practically implemented.

Small-signal stability analysis (K, μ) are widely used. However, **instabilities** may arise in **large signal** when increasing the input power.

Commercial simulators have implemented different tools to simplify the stability analysis of a circuit. In linear conditions, the Rollet factor [6]-[7], *K*, and the μ factor [8] are widely used. However, they are only

This document features:

1. Identification Methodologies
2. Extraction of the frequency response H0(jωS)
3. STAN Tool Analyses
4. Plotting the Resonant Poles
5. Stability Analysis using STAN Tool
6. Conclusion

If you want to get more details

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