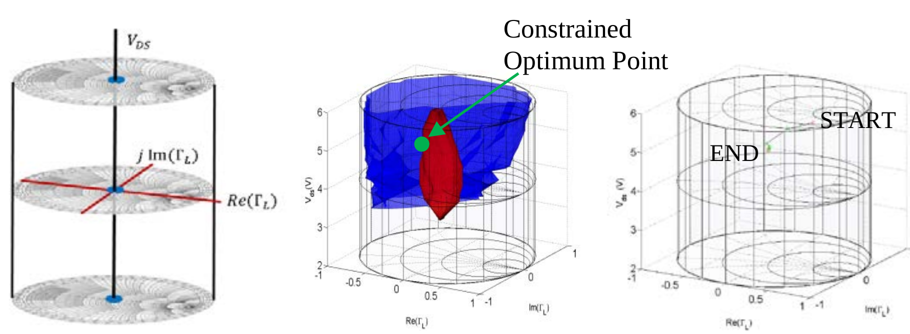
Joint Optimization of Load Impedance and Bias Voltage for Power-Added Efficiency and Adjacent-Channel Power Ratio Using the Bias Smith Tube

Matthew Fellows[(1)], Sarvin Rezayat[(1)], Lucilia Lamers[(1)], Joseph Barkate[(1)],
Charles Baylis[*(1)], Lawrence Cohen[(2)], and Robert J. Marks II[(1)]
(1) Wireless and Microwave Circuits and Systems Program, Department of Electrical & Computer Engineering, Baylor University, Waco, TX, USA
(2) Naval Research Laboratory, Washington, DC, USA

Shortage of available radio spectrum is requiring the innovation of new designs for next generation radar and communication transmitters. The advent of dynamic spectrum allocation continues to require that more systems be capable of changing their operating frequency and spectral output bandwidth. Reconfigurable power amplifiers will allow transmitters to maintain their spectral regrowth under dynamically changing limits while optimizing performance such as power delivered and power-added efficiency (PAE). In this presentation, we discuss an algorithm to jointly and quickly optimize the power amplifier device's load impedance and bias voltage. Figure 1(a) shows the Bias Smith Tube, which has been proposed as a method for visualizing joint optimization of these two parameters (Fellows *et al.*, submitted July 2015 to *IEEE Radio and Wireless Symposium*, 2016). In this presentation, we describe the Bias Smith Tube and the constrained optimization problem, followed by a description of a fast algorithm that searches directly for the constrained optimum. In the example shown, the algorithm is designed to find the combination of load reflection coefficient Γ_L and bias voltage V_{DS} to provide the largest PAE under a maximum constraint on the adjacent-channel power ratio (ACPR). Figure 1(b) shows the measured constant-ACPR surface for the ACPR constraint value with the constant-PAE surface for the constrained optimum PAE.

Simulation and measurement results are presented for this search algorithm. A vector-based search algorithm based on gradient estimations is used. The algorithm required an average of 34.8 measurement points, which is a much lower number of points than required by multiple full load-pulls to fill out the Bias Smith Tube. Figure 1(c) shows measured algorithm results for starting point $\Gamma_L = 0.8\underline{/90.0°}$, V_{DS}= 5 V. This work is expected to find application in reconfigurable radar and communication transmitter power amplifiers, as well as in improved computer-aided design and measurement based power amplifier design.



(a) (b) (c)

Fig. 1. (a) The Bias Smith Tube, (b) plot of surfaces from MWT-173 transistor measurements demonstrating PAE (power-added efficiency) = 32.19% and ACPR (adjacent-channel power ratio) = -28.5 dBc, in a Smith Tube with power as the vertical axis, (c) algorithm results for starting point $\Gamma_L = 0.8\underline{/90.0°}$, $V_{DS} = 5$ V, obtaining PAE = 27.24% with 28 measurements.