Comparison of Gain Optimization Techniques on Reconfigurable Power Amplfiers with a Real-Time Varactor Tuning Network

Zachary Hays[1], Lucilia Lamers[*][1], Charles Baylis[1], Robert J. Marks II[1], Ed Viveiros[2], John Penn[2], Abigail Hedden[2], Ali Darwish[2]

(1) Wireless and Microwave Circuits and Systems Program, Department of Electrical & Computer Engineering, Baylor University, Waco, TX, USA

(2) Army Research Laboratory, Adelphi, MD, USA

Reconfigurable amplifiers are needed for operation in a spectrum sharing environment. Amplifiers must be capable of adapting to changing operating frequency and spectral mask assignments. This presentation details a comparison between optimization techniques for a varactor diode tuning network to achieve maximum gain from an amplifier. A gradient based search using the complex load reflection coefficient Γ_L as the tuning parameter is compared with a gradient based search using the varactor diode bias voltages as the tuning parameters. The varactor tuning network is a simple tee matching network with three variable capacitance varactor diodes which allow Γ_L to be tuned around the Smith Chart. The Γ_L based search requires a characterization mapping the varactor network's three bias voltages to corresponding Γ_L values.

The Γ_L optimization algorithm calculates the gradient of gain with respect to the real and imaginary parts of Γ_L, while the voltage search directly evaluates the gradient of gain with respect to the three varactor bias voltages to gain. The voltage search removes the need for a look-up table relating bias voltages to Γ_L, effectively saving computation steps. However, it is known that the gain contours plotted against Γ_L form ovular shapes on the Smith chart, which allows the gradient search in the Γ_L space to be used effectively. In contrast, the gain plotted against bias voltages creates a multimodal situation. However, the maximum gain for the amplifier can still be found because the various optima found all correspond to nearly the same gain. This is due to several different combinations of bias voltages settings resulting in a similar value for Γ_L. The results show that both searches effectively find the maximum gain for the amplifier. The search based on Γ_L search takes fewer measurements in most cases, but the search based on bias voltages saves computation time by removing the need for the search to use a large look-up table.