A Comparison of Fixed Broadband and Tunable Narrowband Output Matching Networks in a Power Amplifier for Improvements in Radar Range

Justin Roessler *[1], Adam Goad[1], Austin Egbert[1], Charles Baylis[1], Anthony Martone[2], Ben Kirk[2], Robert J. Marks II[1]

[1]Baylor University, Waco, TX
[2]CCDC Army Research Laboratory, Adelphi, MD

With the recent S-band radar reallocations for spectrum sharing in the United States, radar systems must be capable of fast operating-frequency changes to share the band with wireless communications users. The radar transmitters will need to be able to quickly change operating frequency while maintaining optimum range. A present best-practice approach is to design a broadband power amplifier that provides good impedance matching for output power over a band of frequencies which allows similar performance as the operating frequency is varied. However, the design of broadband matching for amplifiers is fundamentally limited by the Bode-Fano Criterion, which states that the gain-bandwidth product is constant. Thus, as the bandwidth is increased, the achievable gain decreases. As such, the design of a fixed amplifier for broadband performance limits the output power and range. However, implementing a narrowband, reconfigurable amplifier permits re-matching at each operating frequency for higher output power. While the device requires time to reconfigure "on the fly" upon changes in operating frequency, the payoff is increased radar detection range over the entire designed frequency range of operation.

In this presentation, a simulation-based design comparison is shown that demonstrates the advantages of using a reconfigurable matching network over a fixed, broadband matching network in a power-amplifier. Two amplifier scenarios for operation between 3.1 and 3.5 GHz are presented: a fixed, broadband design and a reconfigurable design. For the fixed, broadband amplifier, the amplifier load matching network is designed to operate consistently over the entire 400 MHz bandwidth. A gain match is used on the input of the transistor, and harmonic load terminations are selected to optimize performance. For the reconfigurable amplifier, the simulation model of a high-power tunable matching network designed by Semnani (Semnani, *Microwaves, Antennas & Propagation*, 2019) is used for the load matching network. The source match and ideal harmonic terminations are fixed to optimize performance at the center of the band (3.3 GHz), and only the fundamental load impedance is reconfigured. Results will show that the reconfigurable amplifier significantly outperforms the fixed, broadband amplifier in terms of output power and radar range. The simulations also show that, while the performance of the fixed, broadband amplifier can be improved if more in-band ripple in output power is tolerated, the reconfigurable narrowband amplifier still provides the best output power performance. The use of the reconfigurable matching network can allow operation over a significant band of frequencies while maintaining optimal detection range in spectrum-sharing scenarios. This study proves that reconfigurable amplifiers can provide greater output power and radar range over a range of frequencies than a fixed broadband amplifier.