

## **An Evanescent-Mode Cavity-Based High-Power Impedance Tuner for Adaptive Radar Applications**

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Electronically-controllable, high-power impedance tuners play an important role in load-pull characterization and in implementing reconfigurable matching networks for power amplifiers in adaptive RF systems. These tuners must provide low insertion loss, high level of linearity, wide coverage on the Smith chart and very stable performance for such applications. In this presentation, a new high-power and highly-linear impedance tuner, based on evanescent-mode cavity resonator technology, is discussed. The tuner was implemented using substrate-integrated waveguide structure and includes also an integrated closed-loop control system for stabilization. This tuner is composed of a two-pole structure, in which, each resonator is controlled individually by changing the gap over the resonator post in the range of 10-40  $\mu\text{m}$ , using piezoelectric actuators. Due to the high- $Q$  characteristics of evanescent-mode resonators, the measured loss is less than 1 dB in the  $S$ -band. A prototype tuner at 3.3 GHz covered more than 90% of Smith chart while handling up to 90-W of input power. The measured third-order input intermodulation point is equal to +64.3 dBm and the tuner provided 25% frequency bandwidth for covering at least half of the Smith chart. The closed-loop control system provides a relatively stable performance for the tuner, with magnitude and phase drift of less than 0.1 and 3 degrees over five hours, respectively.

Fast adaptive impedance matching is also demonstrated for this high-power tuner, using search algorithms to optimize the power-added efficiency (PAE) while maintaining acceptable adjacent-channel power ratio (ACPR) in real time. A vector-based modified gradient search is used to optimize the load reflection coefficient, allowing the search to quickly enter a Smith Chart region of high efficiency and good linearity performance. Multiple-point estimations of the gradients have been shown to improve the consistency of search convergence across several Smith Chart starting locations. The reflection-coefficient search requires pre-characterization of the tuner and characterization lookup during the optimization. To avoid the time expense required for the lookup process, the resonant cavity position numbers of the tuner can be directly tuned in some circumstances. Tuning options are compared through measurement algorithm results based on the technology. Measurement results show that this high-power tuner is feasible for fast reconfiguration of radar transmitter power amplifiers.