Direct Tuning of Cavity Position Numbers for Circuit Optimization Using an Evanescent-Mode Cavity Tuner Designed for Reconfigurable Radar Transmission

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To overcome the challenges of an increasingly contested and congested spectral environment, the next generation radar must be adaptive and reconfigurable in real time. Therefore, fast real-time RF circuit reconfigurability is crucial. Since the radar transmitter power amplifier of a radar system is a large consumer of power and needs to be operating efficiently, the power amplifier must be equipped with the hardware and software necessary to reconfigure in response to the spectrum environment while still operating efficiently. Previous work has shown that a gradient-based optimization of load reflection coefficient can identify the ideal load impedance for a circuit using traditional load-pull tuners. Now, an evanescent-mode cavity impedance tuner been developed that is faster, has better power handling capabilities, and has a bandwidth on the order of 30%. Instead of optimizing based on the reflection coefficient, optimization can be performed directly using the position numbers of the resonant cavities. This approach avoids issues with characterization drift; however, the variation of power-added efficiency with the cavity position numbers is non-convex, which introduces difficulty using a standard gradient optimization when the starting point is not carefully chosen. This presentation describes candidate search techniques that can be used for direct optimization of the resonant cavity position numbers.

When using the position numbers directly, the search space is a two-dimensional grid in which combinations of the two position numbers can be visualized. This presentation describes two new algorithms; each of which is tested on two different devices. One algorithm uses a modified gradient search. Before the start of each search, the points are tested and the point with the highest PAE is selected as the start location of the search. With this method, the gradient search works consistently by always converging to the correct optimum for every operating frequency. Moreover, the modified search results in less measurements on average than starting randomly, and they show that consistent search parameters can be used regardless of the operating frequency. A second algorithm demonstrated in this presentation uses a Simplex-based search of resonant cavity position numbers for circuit optimization. The algorithm quickly tunes the circuit for optimum power added efficiency (PAE) within a given spectral mask constraint, quantified using a spectral mask metric (S_m). Measurement results for algorithm executed using the different device's locations are consistent. PAE and S_m measurements taken over the entire range of resonant cavity position numbers verify that the searches do indeed converge at the true optimum. The differences between the direct tuning of cavity position numbers and optimization of the characterized load reflection coefficients are discussed, and advantages of cavity position-number tuning are presented. The significance of this algorithm in the reconfiguration of future tunable radar power amplifiers is explored.