Frequency-Agile Power Amplifier Matching Network Reconfiguration Using a Hybrid Real-Time Search

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Increasing spectral congestion will require next generation radar systems to be frequency-agile and adaptive. A significant challenge of radar design is that the high-power transmitter circuitry for these radars will need to quickly reconfigure to enable real-time changes in operating frequency and spectral requirements, providing high power efficiency while meeting changing spectral constraints. In this presentation, fast real-time optimization of an adaptive amplifier matching network to changes in operating frequency is demonstrated. This will allow radars to be able to successfully operate in a dynamic spectrum access environment, successfully coexisting with other wireless devices in a contested and congested spectral environment.

Measurement demonstration of the algorithm is provided using a GaAs field-effect transistor (FET) as the amplifier device, in conjunction with a 90-W evanescent-cavity tunable matching network. The device and associated optimization system allow the user to change the operating frequency and linearity constraints on the fly. Once the user specifies a new operating condition, the circuit begins optimizing to obtain maximum power-added efficiency (PAE) while meeting constraints on the adjacent-channel power ratio (ACPR). Prior to the tuning operations, a sparse characterization mapping load reflection coefficient to the tuner cavity position numbers of the matching network is performed at operating frequencies of interest. As the first step of the real-time optimization, a modified vector-based steepest ascent search is used to find the best reflection coefficient within the characterized values. To further optimize, the second stage of the search utilizes a modified gradient ascent technique to directly optimize the cavity position numbers. The second step does not require a characterization, as the fundamental tuning variables are directly optimized. The first step allows the search to be guided into the right vicinity of cavity position numbers, and the second step allows fine tuning of the cavity position numbers to provide the maximum PAE possible while meeting the ACPR requirements. This approach lowers the dependence on the characterization's accuracy, while increasing the resilience of the search in avoiding local optima.

Measurement results are presented that demonstrate the re-optimization of the tuner in response to changing operating frequencies, such as might result from a dynamic spectrum access command to the radar. These results demonstrate that a radar transmitter amplifier can be reconfigured for changing operating frequencies and spectral requirements in a dynamic spectrum access environment.