Fast Load-Impedance Optimization to Reduce Spectral Spreading and Maximize Efficiency in Radar Transmitter Amplifiers

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This presentation demonstrates a peak-search algorithm to quickly and precisely optimize the load impedance of radar transmitter amplifiers for the joint criteria of reduced spectral spreading and high power efficiency. Radar systems are being required to operate under tighter spectral constraints, opening examination of waveform and circuit design and optimization issues. Furthermore, the advent of new protocols under development, such as dynamic spectrum access, may cause future radar systems the need to reconfigure to different frequency bands and adapt to meet changing spectral mask criteria. Significant spectral spreading from radar transmitters is generated by third-order and other odd order intermodulation nonlinearities in the power amplifier. The nonlinearity is itself a function of the amplifier load impedance, so the adjustment of the load impedance can improve the linearity of the system and reduce the spectral spreading. Similarly, the power efficiency of the radar system, which must be preserved to the best extent possible, is also a function of the load impedance. These impedances can be Pareto optimized to achieve the highest efficiency possible while meeting spectral mask constraints.

We demonstrate the use of a steepest-ascent search on the Smith chart to first locate the impedance providing maximum power-added efficiency (PAE), and then a second search approximates the Pareto front to walk toward the impedance that minimizes spectral spreading as measured by the adjacent-channel power ratio (ACPR). Once measurements reveal that the ACPR is below the spectral-mask specified maximum, the impedance is selected as the impedance providing maximum PAE while meeting ACPR requirements. Our nonlinear circuit simulation and bench-top measurement results show that excellent correspondence is obtained between our new algorithm and traditionally-acquired load-pull measurements. The optimum termination impedances, PAE values, and ACPR values resulting from our search correspond nicely to traditionally measured results; however, our search demonstrates high precision with a significantly smaller number of measurements.

This algorithm has been designed for use in adaptive radar transmitter amplifiers, and can also be used for bench-top or simulation tuning and design of amplifier load impedance to meet spectral constraints while optimizing efficiency.