Effects of Time-Varying Transmit Amplifier Matching Networks in Cognitive Radar Applications

Austin Egbert*[1], Kyle Gallagher[2], Charles Baylis[1], Anthony Martone[2], Ed Viveiros[2], Robert J. Marks II[1]

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

As the available wireless spectrum becomes more congested and contested with additional applications and users, the ability to change a device's operating frequency range while maintaining critical performance parameters in real-time has become an essential method to efficiently manage and use available bandwidths. Future radar systems will be required to dynamically share spectrum.

Existing research has demonstrated the ability to optimize amplifier performance across multiple frequencies in real time through the use of fast adjustable load impedance tuners. However, these time-varying matching networks can also result in observable changes to transmitted signals when these signals pass through the network while the network is in the process of changing its configuration. In this presentation, the primary effects a signal may encounter during transmission through an actively varying network are given. Additionally, the practical impact this can have in radar applications, specifically range-Doppler processing, is described. Finally, methods for compensating for these effects are discussed.

The use of a tunable impedance matching network is intended to allow optimum amplifier performance after re-tuning. However, the tuning of this network will affect the amplitude of the transmitted signal. Achieving some optimal transmitted power is typically the goal of these applications, and as such this effect does not require some form of correction. However, this variable network may also produce a noticeable phase shift in the transmitted signal; that is, when the signal is compared at two separate impedances, two different signal phase shifts will be observed. In the range-Doppler processing, these various phase shifts do not result in any measurable impact on target resolution. However, if the network is in transition between two impedances, the varying phase shift will result in a frequency shift of the signal for the duration of the transition. In practice, this appears as an apparent Doppler shift associated with a given target.

This frequency shift is dependent on the speed of the impedance transition as the rate of change in phase shift determines the signal frequency shift. For example, if the tuner's transmission phase shifts by +180 degrees in 1 second, then a +0.5Hz frequency shift will be observed in the resulting signal. If the tuner transition speed and phase change profile is known in advance, then compensation can be made for this shift prior to transmitting the signal, allowing high-precision range and Doppler detection to be performed during the impedance tuning process.