Electrically Small Antennas Augmented with Internal Non-Foster Elements

Richard W. Ziolkowski and Ning Zhu
Department of Electrical and Computer Engineering, University of Arizona
Tucson, AZ 85721-0104

Electrically small antennas (ESAs) have been a topic of great research interest for many years because of their utility for a wide variety of wireless applications. However, because of their compact size, ESAs are generally not efficient radiators and they have narrow bandwidths. There have been many efforts to overcome the conflicting performance characteristics of ESAs, including their efficiencies, bandwidths, and directivities, using various meta-structures.

To overcome one of the fundamental bounds, the impedance bandwidth, we have introduced non-Foster elements into the near-field resonant parasitic elements of two classes of metamaterial-inspired designs: the protractor and Egyptian axe dipole (EAD) antennas. The active non-Foster element is realized with negative impedance convertor (NIC) circuit. In the case of the protractor antenna, a NIC-based capacitor element, a C-NIC, is introduced, while in the EAD antenna a NIC-based inductor element, an L-NIC, is introduced. These general design concepts and their possible alternatives are graphically represented in the figure below. In both cases, this non-Foster element approach leads to nearly complete impedance matching to a 50 Ω source without any external matching network over an extended, large frequency range. Both of these NIC-augmented near-field resonant parasitic ESAs have been simulated, fabricated and tested. Comparisons of the simulation and experiment results are very favorable and will be highlighted in our presentation. The experimental results confirm impedance bandwidths exceeding the fundamental passive bounds. We will also discuss a variety of details about the design procedure, antenna characteristic performance analysis, trade-offs in any practical NIC-based antenna design, sensitivity issues, stability issues and future work.

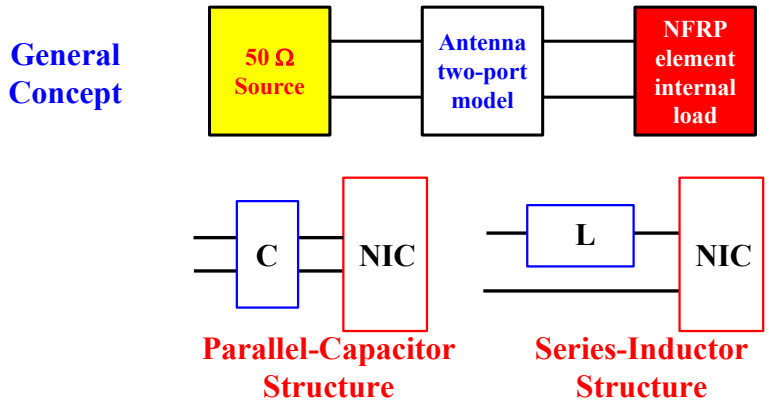

Fig. 1. The NIC-augmented near-field resonant parasitic antenna paradigm.