

Passive and Active Engineering of Metamaterial-inspired Electrically Small Radiating Systems

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A number of advances in the use of metamaterial-inspired constructs to improve the overall efficiency, directivity and bandwidth performance of electrically small antennas (ESAs) in the VHF, UHF and microwave regimes will be reviewed. Several metamaterial-inspired ESA designs have been fabricated and tested; these measurement results are in nice agreement with predictions. While initial efforts emphasized simply high overall efficiencies without using any external matching networks, more recent resonant near-field parasitic (NFRP) designs have also explored the ability to exhibit multi-functional performance, higher directivity and enhanced bandwidths. Multi-functionality is achieved by combining multiple NFRP elements in an electrically small package. Higher directivity from an electrically small system is obtained by augmenting the NFRP antenna with structured ground planes. Enhanced bandwidths are achieved in an electrically small system by augmenting the NFRP antenna internally with non-Foster (active) elements, which are implemented as negative impedance convertor (NIC)-based inductors and capacitors. The possibility to develop an electrically small system sharing all of these interesting characteristics will be discussed. Connections to similar enhanced performance characteristics of radiating systems at higher frequencies, i.e., millimeter wave, terahertz and optical systems, will also be given.