The Backscattering Characteristics of Wires Actively Loaded with Negative Impedance Elements

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This paper investigates the use of active loads to control the backscattering properties of PEC wire structures. In particular, a class of active loads known as negative impedance converters in the form of single elements, both real and reactive, as well as simple networks will be considered. The EFIE analysis technique originally developed in (K. M. Chen and V. Liepa, *IEEE Transactions on Antennas and Propagation*, **13**, 262-270, 1965) will be adapted for the purpose of this study. Results will be compared with a numerically rigorous solution technique based on the method of moments.

The electromagnetic response of a dipole actively loaded with negative resistance has been documented in (R. F. Harrington, *IRE Transactions on Microwave Theory and Techniques*, **10**, 165-174, 1962). Due to the constant gain-bandwidth product of the structure, it was demonstrated that increasing the magnitude of the negative resistance increases the backscattering cross-section at resonance while simultaneously reducing the relative bandwidth.

Here we show that negative capacitance and negative inductance loading applied separately, have complementary effects shifting the resonant frequency and altering the Q but also make no change in the system gain-bandwidth product. However, applied in combination as a series connected negative LC load leaves the resonant frequency and cross-section magnitude largely unaffected but significantly increases bandwidth as illustrated in Figure 1. Stability criteria useful in the design of networks containing active negative impedance converters will be discussed. Experimental confirmation of the stability of these circuits will also be presented.

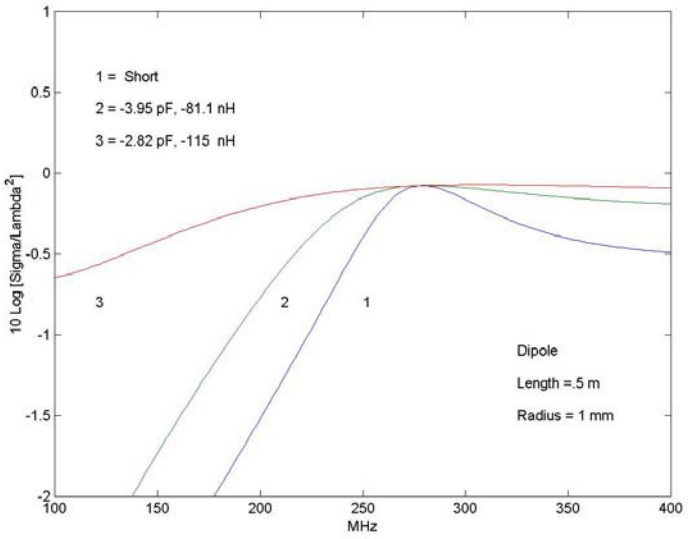

Figure 1. Dipole Backscatter with Series Negative LC Load.