Loop-Type Electrically Small Antenna Loaded with Non-Foster Circuit

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Although electrically small antennas (ESAs) have gotten an increase attention because of their wide applications in wireless communications, they are not efficient radiators because of their high quality factor (Q). Therefore, matching networks are required to improve their input impedance and radiation characteristics. However, due to gain-bandwidth restrictions, wideband matching cannot be achieved using passive networks. Non-Foster circuits (NFCs), such as negative capacitors, negative inductors, or some of their combinations, are attractive because they can be used in matching ESAs since they violate the gain-bandwidth limitation. Although NFCs are very attractive for microwave and antenna applications, they are active nonlinear circuits and therefore suffer from many issues including losses, difficulty in achieving good performance in the gigahertz frequency range, and most important, stability.

The objective of this work is to design stable negative inductor to load a loop-type antenna. Since the input reactance of the antenna is inductive up to its first resonance, it can be loaded with a negative inductor designed by implementing a negative impedance inverter topology. The non-Foster load is added at only one of two ports located at the extremities of the loop. The antenna is loaded with a NFC to improve its bandwidth in terms of input impedance and radiation pattern because the load can also modify the currents on the antenna. Since the major issue in designing non-Foster circuits is stability, the stability of non-Foster circuits will be discussed in detail to ensure the implementation of stable networks.

Simulated input impedance and radiation pattern results as well as stability analysis of the antenna system (antenna and NFC) will be presented. The measured input impedance, realized gain, and stability observations will also be presented to show that the measured data validate the design methods proposed here.