Investigation of nonlinear modeling for active antenna design

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Active antennas, such as active metamaterial antennas, reconfigurable antennas and non-foster antennas, have received increasing attention over the last several years. One of the most important factors influencing the performance of active antennas is the nonlinear behaviors generated from the incorporated active devices including diodes, transistors and switches. Therefore, it would be invaluable to develop an effective and practical method to accurately model and analyze the nonlinear behaviors of these active radiators. In this work, a hybrid EM-circuit simulation method with Ansoft designer and HFSS are used in the nonlinear analysis. The discussion will be focused on the power capacity, harmonic radiations, and efficiency of active antennas.

Two types of active antennas are taken as examples to discuss the method of nonlinearity analysis. One example is an active metamaterial antenna design. The idea of the design is indicated in the previous work in (K. Chang, Q. Tang, H. Xin, "Balanced and symmetric design of active composite right- / left-handed transmission line with gain," in *2012 IEEE/MTT-S International Microwave Symposium Digest*, p.1–3). The active metamaterial antenna consists of a passive metamaterial antenna and a built-in tunneling diode for improving the efficiency. A large-signal circuit model of tunnel diode is used in the analysis. A harmonic balance simulation is conducted to analyze the harmonic radiations. The second example is the non-foster monopole design. A typical Linvill's NIC circuit is applied for matching a 0.5 meter monopole working from 30MHz to 80MHz. The power efficiency and capacity of the non-foster antenna is analyzed.

The results demonstrate a better understanding of nonlinear behavior of active antennas. The radiation efficiency, power capacity and harmonics radiation can be analyzed by using such method.