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Small Antennas bandwidth enhancement Using Network Characteristic Modes

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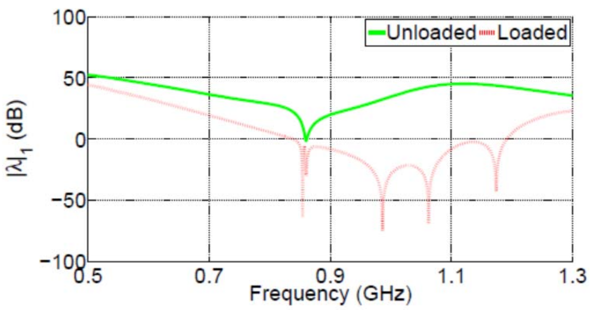
With the rapid development of wireless communication, antenna miniaturization is still a field of intense research activities with remarkable achievements, where nowadays a wireless device is supposed to carry multiple antennas operating at different frequencies and standards. Extensive studies were conducted to miniaturize and enhance the performance of small antennas, by designing complex structures addressing the issue of enhancing the bandwidth/ efficiency of small antennas. In this context, input matching networks were adapted to match the antenna in a specified bandwidth. Nevertheless, these networks are passive and are limited by the gain and bandwidth [1,2].

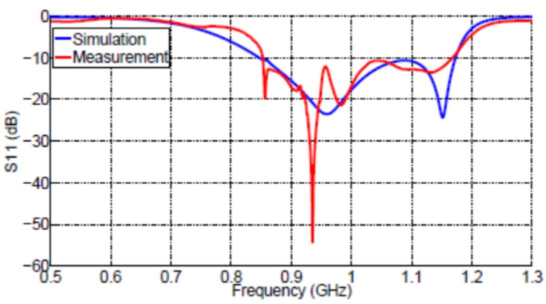
Multiport antenna systems can be regarded as N-port networks, which can be analyzed using the theory of network characteristic modes (NCMs). Due to the profound physical insights provided by an NCM, a desired antenna performance can be achieved by properly manipulating the modes through reactive loading at specified ports.

This paper presents a new matching technique for an N-port internally loaded small antenna. By combining the NCM with the differential evolution algorithm, optimal reactive load values can be calculated. Then the narrow bandwidth of a monopole antenna is optimized to have a wider range after internally loading the antenna with several reactive loads at specified loading positions. The loads are then optimized based on the methodology presented in [3]. Defining load positions inside the antenna is a critical step to insure a successful design. A proper port position insures that a reactive load placed at this position can effectively manipulate the NCMs in order to match the antenna in a wideband. In general, the load position is chosen in a location where the antenna exhibits a high surface current distribution.

The fabricated antenna was measured showing a good agreement with the simulation, where it achieved a wideband impedance matching of 32% and a total efficiency higher than 80%



Eigen value spectrum of mode 1 for the unloaded and loaded cases.



Simulation and measurement of the loaded antenna. Input reflection coefficient

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3. H. Jaafar, S. Collardey and A. Sharaiha, “Optimized Manipulation of the Network Characteristic Modes for Wideband Small Antenna Matching,” IEEE Transactions on Antennas and Propagation, , vol. 65, no. 11, pp. 5757-5767, Nov. 2017