Passive and Active Circuit Matching for VHF Antennas

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Antennas' minimization at VHF and UHF frequencies is of particular interest due to their much larger size and often non-conformal installations. Typically, miniaturization is achieved by loading the antenna with dielectric/magnetic materials and by using lumped circuits, all aimed to achieve wave slow down. Impedance matching over broad frequencies is also necessary and may be accomplished using antenna shaping and matching circuits at the antenna feed. In terms of matching circuits at the feed, the goal is to cancel the antenna reactance and possibly transform the antenna resistance to that of the matching network.

Matching networks are typically designed via an optimization process of the circuit elements. The optimized circuit values can then be fitted to commercially available lumped circuits. An obvious problem, of course, is the sensitivity of the matching network to variations in the circuit elements and the inevitable statistical variations of commercial impedance values. Active circuits and networks (or negative impedance converters), can possibly avoid issues with multi-stage passive matching networks. Moreover, they can theoretically offer more broadband matching performance. However, active matching circuits and elements (transistors, LNA's, amplifiers, operational amplifiers, etc) may be non linear, and may lead to instability.

In this paper we will consider the potential of both passive and active matching circuits for lowering the operation frequency of VHF antennas. An optimization technique is used to find the optimum topology and values of passive elements (with the minimum number of segments) used for matching circuits. Specifically, we demonstrate how the passive matching network can give an additional 20% minimization for a broadband planar dipole. The implementation of active networks is also investigated and discussed. In both cases, efforts are focused on manufacturable circuits that can be tested and verified.