A Non-Resonant Short Monopole Antenna with Lumped Circuit for Wideband Impedance Matching

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In this paper, a new technique for wideband impedance matching of short monopole antennas in the HF-VHF bands is proposed. This technique is motivated by the challenge of obtaining low VSWR values in small and low frequency antennas.

The common way to compensate for the capacitive behavior of short antennas is using passive elements with inductive behavior. Standard narrowband impedance matching techniques include introducing some sections of reactive lumped circuit elements, which are cascaded with some resistive elements. However, typically this is not sufficient to obtain VSWR values below 3.5 and these standard approaches are not applicable when the bandwidth required is 20% or higher.

Therefore, in order to achieve lower values of VSWR over a large bandwidth, a simple network based on a fixed topology is proposed, rather than constructing a different network topology for every particular antenna. The proposed network topology consists of two lumped elements: an inductor cascaded with a transformer. An analytical model is provided to obtain the proper values of these lumped elements. In addition, it is shown that the proposed matching network performs close to the theoretical limit for impedance matching according to the Bode-Fano theory. Then, a small monopole antenna is designed, fabricated, and tested in the VHF band and a good agreement between the simulated and measured results is achieved. Moreover, it is also shown that a critical improvement of the antenna matching is obtained by adding a pure resistor in the middle of the antenna, without significantly reducing the antenna gain. This antenna can handle high RF power (about 80 W) because there is no active element for the matching network and may find its application in the design of small and low frequency antennas.