An Extremely Low-profile MF Monopole Antenna Design and Measurement

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For long-distance communication such as ground-based radio broadcasting and maritime radio in the medium frequency (MF) band, monopole antennas which show vertical polarization with omnidirectional radiation pattern are widely used. However, in the MF band, physical dimensions of the quarter-wave antennas are too large to fabricate and handle (25 to 250 meters). In order to meet the increasing demand of small-size antennas and their better mobility, the miniaturized multi-element monopole antenna incorporating air-core inductors has been studied. For designing the proposed antenna, a short-circuited $\lambda_0/2$ transmission line resonator connected to two vertical pins which can radiate vertically polarized field is introduced (J. Oh and K. Sarabandi, General Assembly and Scientific Symposium, 2011 XXXth URSI, Aug.13-20, 2011). Since the $\lambda_0/2$ transmission line is too long at MF band, the size reduction of the transmission line is the key consideration in designing the two in-phase elements.

In this paper, the long lateral dimension of the $\lambda_0/2$ transmission line is reduced significantly by using the modified T-type 180 degree phase shifter that replaces its lumped capacitor with an open-stub. Based on the equivalent circuit model using this modified T-type 180 degree phase shifter, the extremely low-profile miniaturized monopole antenna with two in-phase radiating vertical elements is designed. In-phase radiated fields from the two short vertical pins result in increased effective height of the short dipole and thus enhances the gain compared to the short monopole having the same height. In this way, significant size reduction can be realized and the input impedance can be matched to 50Ω without the use of external matching networks. The lateral dimension and the height of the proposed antenna including the ground plane are 100cm ($\lambda_0/150$) and 50cm ($\lambda_0/300$) at 2MHz, respectively. For gain enhancement, optimized air-core inductors with high quality factor ($Q >> 3000$) by minimizing the proximity effect are used in the phase shifter. Details of the proposed design approach, antenna geometry, and the simulated and measured results will be presented during the symposium.