Appears in the Proceedings of IEEE AP Society International Symposium and URSI National Radio Science Meeting, July 2001.

PRECISE ANALYSIS OF COMMERCIAL LOG-PERIODIC DIPOLE ARRAYS USING WIRE-ANTENNA ALGORITHMS

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The log-periodic dipole array (LPDA) has become the most popular commercial antenna for reception of TV signal in VHF and UHF bands in Europe. The antenna consists of two booms of a square cross section to which dipoles are attached (Figure 1). The booms play the role of the feeding two-conductor line. The dimensions of the boom are relatively large compared to the wavelength and the dipole length. Hence, this antenna cannot be accurately analyzed as a wire structure unless special precautions are taken. On the other hand, the wire-antenna computer programs are the fastest and thus the most convenient tool for interactive design. The aim of our paper is to span this gap.

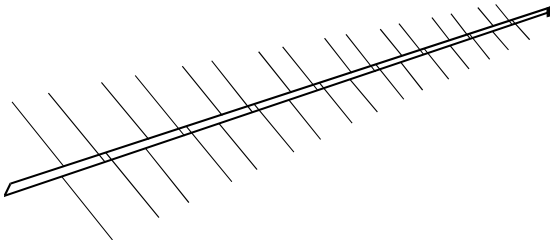

Figure 1. Commercial LPDA.

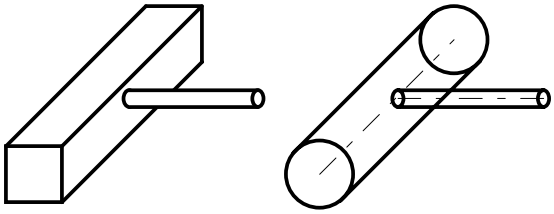

Figure 2. Exact dynamic three-dimensional model and thin-wire model of a boom and attached dipole arm.

The paper presents results that establish equivalence between transmission lines whose conductors have a square viz. a circular cross section. Two approaches to the equivalence are considered . The first is an exact approach, which rigorously takes into account the current and charge distribution over the conductors. Conditions are established for the equivalence between two transmission lines. They take into account both the characteristic impedance and coupling with the electromagnetic environment. This equivalence is considered using two-dimensional quasi-static transmission-line models.

The second approach follows from the standpoint of using the thin-wire kernel in numerical codes. The objective is to provide accurate results for the LPDA from wire-antenna programs. This equivalence is obtained by comparing three sets of results. The first set is computed using the two-dimensional models. The second set follows from a rigorous three-dimensional dynamic analysis of the boom with attached dipoles (Figure 2). The third set is obtained from wire-antenna codes (Figure 2).

In addition to the data for the transmission line, corrections are established for the end effect of dipole arms, as well as junctions between dipoles and booms. All these corrections are included in a wire-antenna model. Experimental and computed results agree remarkably well, both for the input impedance and for the radiation pattern of LPDA.