EQUIVALENT SOURCE ANALYSIS OF CURVED EDGE TAPERED SLOT-LINE ANTENNAS

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Abstract

An equivalent source model for the analysis of curved edge tapered slot-line antenna is developed, which employs effective filamentary currents along the conductor edges of the slot, but forces the electric field produced by the currents to satisfy the boundary condition on the whole conductor surface. This idea is implemented by method of moments with collocation technique, and applied to analyze a tapered slot-line antenna with arbitrarily curved edge.

Keywords

Equivalent source, slot-line antenna, filamentary current, method of moments, collocation technique.

Introduction

The tapered slot-line antenna (TSA) acting as an endfire traveling-wave antenna has been applied to microwave and millimeter wave systems. Its advantages involve appropriate directivity and low side-lobes, impedance matching in a wideband, low profile and the possibility of integration in MMICs. In addition, the TSA used as a
feed of reflector antenna or the element of array may be integrated with the front-end of the system. Three typical taper configurations shown in Fig. 1 were named as Linearly Tapered Slot-line Antenna (LTSA), Vivaldi antenna, and Constant Width Slot-line Antenna (CWSA) respectively [1]. In a general sense, they can be summarized as curved edge tapered slot-line antenna.

The properties of the TSA have been studied by many researchers [1-10]. The primary studies were mostly experimental [1-5], dealing mostly with the characterization of the TSA and derivation of some empirical design formulas. Successively, several theoretical analyses were published involving:

1) The transmission line method (TEM-mode) [6] based on the conformal mapping of the coplanar-fin structure and the two-step procedure of transmission along slot line and radiation from end;
2) The spectral domain method (SDM) [7] based on the analysis of uniform slot line and the two-step procedure;
3) The method of moments (MoM) [8-10] based on the numerical solution of integral equation defined over the whole metal plate.

However, these methods have the following restrictions:

1) The two-step procedure assumes that the slot does not radiate;
2) Both the TEM-mode and the SDM are based on the slot line with infinite width of metal plate;
3) The TEM-mode method is limited to analyze the LTSA without dielectric substrate;
4) The MoM is numerically accurate, but needs lengthy computing time.

In this paper, an equivalent source model for solving the TSA is presented by modeling the edge filamentary currents and forcing the fields satisfy the boundary condition on the metal plates of the TSA. Furthermore, this model may take the effect of end truncation of the TSA into account. Numerous examples compared with the literature demonstrate the validity of this method. The equivalent source model may be used to analyze the TSA with dielectric substrate too, if employing the dyadic Green's function in dielectric substrate to substitute that in free space and using the SDM.

![Fig. 1. Three typical taper configurations of the TSA](image_url)