Thin Printed Dipole Arrays Simulation Using Integral Equation Method

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Abstract – **This paper describes the integral equation method application for calculation of thin printed dipole array characteristics and parameters.**

Keywords – **Antenna array, printed dipole, integral equation method.**

I. Introduction

This article describes the method destined for numerical simulation of flat equidistant microstrip antenna arrays of thin symmetrical dipoles. The classical integral equation method is used for simulation of antenna array characteristics.

II. Main part

A great computational load on PC system hardware during simulation of large number of radiators in universal EDA software is the main challenge. To significantly reduce a task time calculation we suggest to use the classical integral equation method for thin conductors.

The array represents a system of thin printed dipoles, placed on dielectric substrate and infinite conducting ground plane (Fig.1).

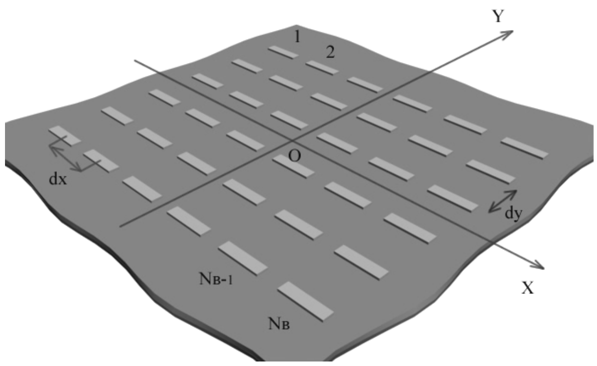

Fig.1 Microstrip dipole array model

The right part of system of linear equations is formed proceeding from a required amplitude-phase distribution at array elements. Later this system is solved using integral equation method for thin-wire dipoles.

Flat thin dipoles are replaced by equivalent cylindrical dipoles, which are placed in homogeneous dielectric with the effective permittivity the effective permittivity:

$$e_{Ý} = \frac{e+1}{2} + \frac{(e-1)\left(1+\frac{10h}{w}\right)^{-\frac{1}{2}}}{2}, \qquad (1)$$

where ε – relative permittivity of substrate;
h - substrate thickness;
w – printed dipole width (is selected equal to four radiuses of its cross section).

According to computer system resource economy purpose the Harrington [1] integral equation, piecewise sinusoidal basis functions and weight functions are selected.

Using obtained current distribution on dipoles the following main characteristics and parameters of an array are calculated: dipole input impedance; array antenna pattern for “θ” and “φ” components of electrical field in defined spatial cross section; maximum directivity.

Based on described method the program for calculation main antenna array characteristics was developed. The input parameters for this program are wavelength in free space, number of columns and rows in array, element spacing, the length of dipole arm, radius of dipole basis, relative permittivity of substrate and its thickness, amplitude-phase distribution parameters, scan angles θ˚, φ˚ for antenna pattern calculation. An example of calculated antenna pattern of 8-element linear array is presented in Fig.2.

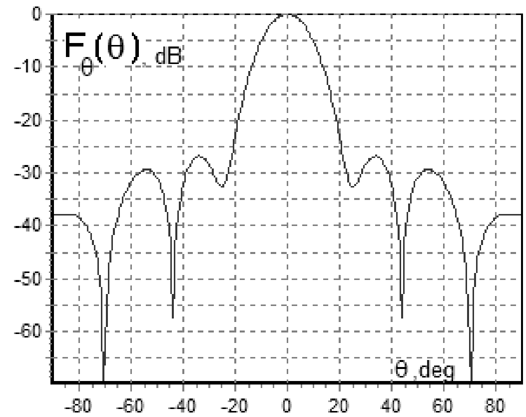

Fig.2 Antenna pattern of linear array

III. Conclusion

Testing of developed method and program was performed calculating identical constructions of printed antenna arrays using own program and commercial software AWR Microwave Office.

Comparison of the results allows to tell, that the developed program can calculate all main characteristics and parameters of printed symmetric dipole antenna array enough simply and accurately.

References

[1] R. Mittra. Computer techniques for electromagnetics. Pergamon Press, Oxford, 1973.

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