Theoretical Investigations of Radiation and Impedance Characteristics of a Probe Excited Rectangular Cavity-Backed Slot Antenna

Titipong Lertwiriyaprapa
Department of Teacher Training in Electrical Engineering, Faculty of Technical Education,
King Mongkut's Institute of Technology North Bangkok, Bangkok 10800 Thailand

Chuwong Phongcharoenpanich and Monai Krairiksh
Faculty of Engineering and Research Center for Communications and Information Technology,
King Mongkut's Institute of Technology Ladkrabang, Bangkok 10520 Thailand

Abstract

Radiation and impedance characteristics of a probe excited rectangular cavity-backed slot antenna is theoretically investigated in this paper. The antenna structure is simple, and it is suitable for performing as the element of the small aperture array antenna. The integral equations for the analysis model are constructed by applying the Field Equivalent Principle and enforcing the boundary conditions i.e., the tangential magnetic fields are continuous through the slot aperture and the delta gap source is considered at the bottom of the probe. Dyadic Green's function is derived to fulfill the integral equations. Method of moments is a powerful tool for solving the integral equations of the unknown magnetic current over the slot and electric current on the probe. The edge effect of the ground plane is taken into account to yield more accurate results of the radiation pattern. The numerical results of currents, input impedance and radiation pattern of the antenna are demonstrated. These results are very useful in the design of the small aperture array antenna.

1. Introduction

Historically, the slot cut on a conductor; both on flat plate and curved surface has been widely and continuously investigated. The slots backed by a conducting flat plate such as parallel plate waveguide [1], rectangular waveguide [2], rectangular cavity [3], radial line waveguide [4] and many others [5] are very attractive since they belong to the flush-mounted structure which makes them low profile. Research on the rectangular slotted-waveguide antennas has been extensively conducted because they are very useful to model as the array element of very large aperture antennas such as planar slot array antenna [6] and radial line slot antenna [4] with a large number of elements. When the ends of the waveguide are shorted by the conductor, it becomes the cavity. Therefore, the effect at the shorted ends must be taken into account. The cavity-backed slot antenna is suitable for utilizing in the investigation of the characteristics of the slot on the bounded region particularly for the small aperture antennas for which the slotted-waveguide model cannot be accurately applied. To excite the cavity-backed slot antenna, there are several techniques such as microstrip feed and coaxial feed at the center of the slot aperture. It is found that the microstrip feeder suffers from conduction and dielectric loss while the directly coaxial feeder is not appropriate for applying to the slot array antenna. This paper presents an analysis of the linear electric probe excited rectangular cavity-backed slot antenna. The feeding structure is simple, free from conduction and dielectric loss, has high power handling and is suitable for slot array applications. The integral equations for the rectangular cavity-backed slot antenna fed by probe inside the cavity are established with the infinite ground plane assumed to be outside the