A microstrip antenna array on a narrow wall of a rectangular waveguide for linear polarization perpendicular to the axis

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Abstract - **This paper presents a microstrip antenna (MSA) array on a narrow wall of a rectangular waveguide for linear polarization perpendicular to the axis. A two-element MSA array on a dielectric substrate fed by a longitudinal slot on the narrow wall of the rectangular waveguide is used as an element of the proposed array for grating lobe suppression due to the slot array arranged at a spacing of one guided wavelength. In this paper, a basic configuration of the novel planar array on the narrow wall for linear polarization perpendicular to the axis is described. Then, a two-element MSA array fed by a longitudinal slot on the narrow wall is designed as a sub array of the proposed array by using ANSYS HFSS. The simulated radiation pattern of the sub array reveals that the grading lobes due to the narrow wall slot array arranged at a spacing of on guided wavelength can be suppressed well.**

Index Terms — **Waveguide slot array, Microstrip patch antenna, Planar antenna, Narrow wall, Grating lobe suppression.**

1. Introduction

Waveguide slot arrays are widely used for various applications such as radar systems and communication systems [1]. A longitudinal slot array on a broad wall of the rectangular waveguide is one of the typical designs for linear polarization perpendicular to the waveguide axis. Another typical design of waveguide slot arrays is an edge slot array on a narrow wall of the rectangular waveguide for linear polarization parallel to the axis.

In order to design a slot array on the broad wall of the waveguide for linear polarization parallel to the axis, transverse slots are arranged on the broad wall of the waveguide at a spacing of approximately one guided wavelength for in-phase excitation. However it results in appearance of grating lobes because the guided wavelength of the waveguide is usually larger than that in free space. Suppression of grating lobes always becomes a problem for the transverse slot array. In order to shorten the slot spacing, a dielectric-filled waveguide or slow wave structures in a waveguide are utilized for the transverse slot arrays [2]. Another solution to reduce the guided wavelength is to use a ridged waveguide. T-shaped slot array arranged on the ridged waveguide for linear polarization parallel to the axis is reported [3]. On the other hand, the authors have proposed a novel planar array structure on a broad wall of the waveguide for linear polarization parallel to the axis [4]-[14]. A two-element series-fed microstrip antenna (MSA) array on a dielectric substrate fed by a transverse slot on the broad wall is used as an element of the array. The proposed arrays with standing-wave excitation and with traveling-wave excitation are successfully designed.

In order to design a slot array on a narrow wall of the waveguide for linear polarization perpendicular to the axis, longitudinal slots are arranged on the narrow wall of the waveguide at a spacing of approximately one guided wavelength for in-phase excitation, which faces the grating lobe problem similarly. In this paper, a novel planar array structure on the narrow wall of the waveguide for linear polarization perpendicular to the axis is proposed. A two-element MSA array on a dielectric substrate fed by a longitudinal slot on the narrow wall of the rectangular waveguide is used as a sub array of the proposed array. The sub array is designed by using ANSYS HFSS [15]. The simulated results reveal that the sub array can suppress the grating lobes due to the narrow wall slot array arranged at a spacing of on guided wavelength.

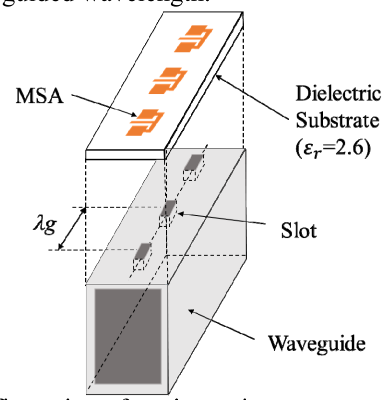

Fig. 1. Configuration of a microstrip antenna array fed by longitudinal slots on a narrow wall of the rectangular waveguide for linear polarization perpendicular to the axis.

2. Structure of the proposed array on the narrow wall

Figure 1 presents configuration of the proposed MSA array. Longitudinal slots are arranged on a narrow wall of a rectangular waveguide at a spacing of one guided wavelength and. microstrip antennas (MSAs) arrayed on a dielectric substrate are placed on the narrow wall. Two patches are excited by the longitudinal slot through a microstrip line. The two-element MSA array fed by the narrow wall slot works as a sub array of the proposed array. The spacing of the two patches can be a half of the guided wavelength. Therefore, the grating lobes of the longitudinal narrow wall slot array can be suppressed. Polarization of the proposed array is perpendicular to the waveguide axis.

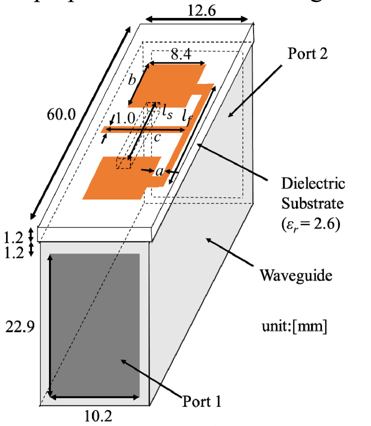

Fig. 2. Structure of the sub array.

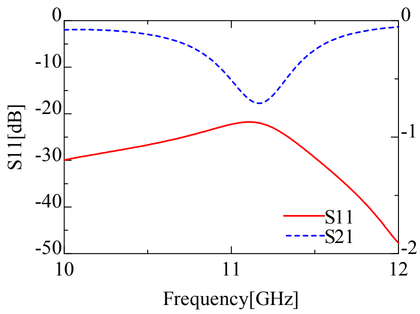

Fig. 3. Simulated S11 and S21 of the sub array.

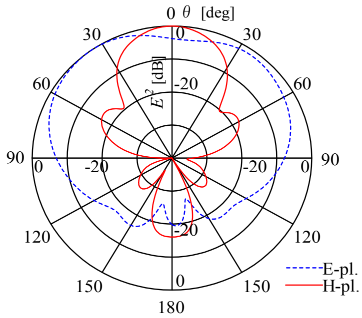

Fig. 4. Simulated radiation pattern of the sub array.

3. Simulated results of the sub array

Figure 2 presents an analysis model of the sub arra. ANSYSt HFSS is used for simulation. Waveguide ports are set on the both ends of the waveguide and radiation boundary is assumed for the external region. The relative dielectric constant of the substrate is 2.6 and the thickness is 1.2 mm. Figure 3 presents frequency response of the reflection (S11) and transmission (S21) coefficients, where the parameters are l_s = 10.6 mm, l_f = 25.6 mm, a = 0.5 mm, b = 8.4 mm, and c = 9.4 mm. The sub array resonates in the vicinity of 11.2 GHz. Figure 4 presents simulated radiation patterns of the sub array at 11.2 GHz. Nulls in the H-plane pattern are observed at around 50 degree directions, where the slots at a spacing of one guided wavelength produce grating lobes. In this design, radiated power ratio of the sub array is 14%.

4. Conclusion

A novel MSA array fed by longitudinal slots on a narrow wall of the rectangular waveguide for linear polarization perpendicular to the axis is proposed. It is confirmed by the simulation that the sub array can suppress the grating lobes due to the narrow wall slots at a spacing of on guided wavelength. Radiation power control of the sub array should be studied in the future for array design of the proposed array.

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