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# Design of Metal Supports for Corporate-feed Layer in a 60 GHz-Band Plate-laminated Waveguide Slot Array Antenna

60 GHz 帯積層薄板導波管スロットアレーアンテナにおける並列給電支持構造の設計

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## 1. Introduction

As part of the mission for broadening the user base and achieving higher transmission rates in communication devices, the plate-laminated corporate-feed slot array antenna consisting of five vertical parts has been proposed for millimeter-wave bands [1] as shown in Fig. 1. To enhance the directivity by achieving a further integration of arrays, this research focuses on the insertion and the design of pairs of supports fabricated by half-etching technique within the feeding waveguide layer overcoming problems during fabrication process.

## 2. Problem on Fabrication Process

Even if satisfying designs and simulated results have been made, issues of experimental results with regard to increasing the arrays were existing as in [2]. It is possibly attributed to the fact that the feeding layer with cavities could not bear the pressure and heat during the diffusion-bonding process. That is, this could be led to distortion of the copper walls between the cavities that worsens on account of the greater size and complexity possibly resulting from structural imbalance of the antenna.

## 3. Unit Design and Insertion of Metal Supports

To address this problem, original feeding waveguides composed of four layers were replaced with other four half-etched layers with copper supports. Fig. 2 specifies the design of a linear path of rectangular waveguide within these of which width and height are 3 mm and 1.2 mm (4 layers that of 0.3 mm) each. Here, each support is 3 mm long and 1 mm wide. Not only do these serve as strong buttresses against heat and pressure, but using pairs, each $\lambda_g/4$ ($\lambda_g$ at 61.5 GHz) apart, would cancel out the reflected waves. However, these entails of more reflection as multiple supports would block the waves. Still, it was possible to minimize additional reflection by applying the concept of a multiple resonance among four supports. With a distance of $5\lambda_g'/4$ ($\lambda_g'$ at 66.5 GHz) apart from each of abovementioned pairs, a model with the value of reflection under -30dB in the range of 55.7 GHz to 67.3 GHz as in Fig.3 was found and installed into the full 64×64-elements model as shown in Fig.4.

## 4. Expectation and Future Consideration

To acquire specific results, fabrication of an actual antenna with metal supports is required. for the full model of 64×64-elements, it is expected not to be different between simulation results of original and suggested model, whereas there will be between actual models. Additionally, it is thought to be feasible to place other support models with shorter length into further stems of 8×8-elements as well as models for other frequency bands such as 120 GHz.

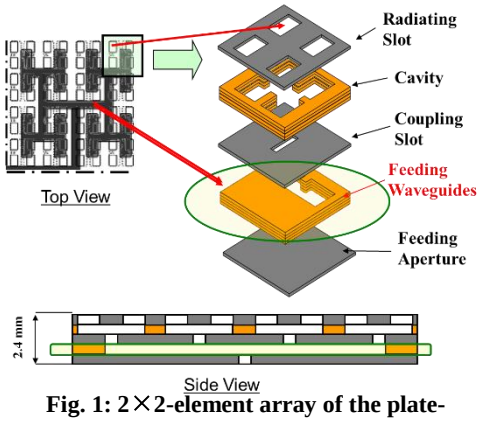


**Fig. 1: 2×2-element array of the plate-laminated corporate-feed slot array antenna**

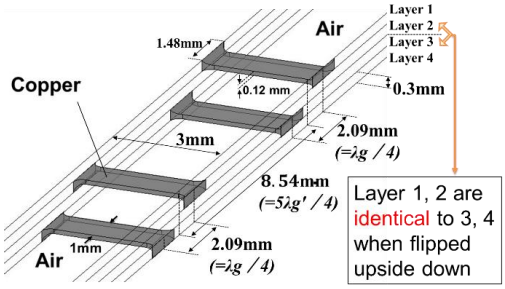


**Fig. 2: Design of two pairs of supports**

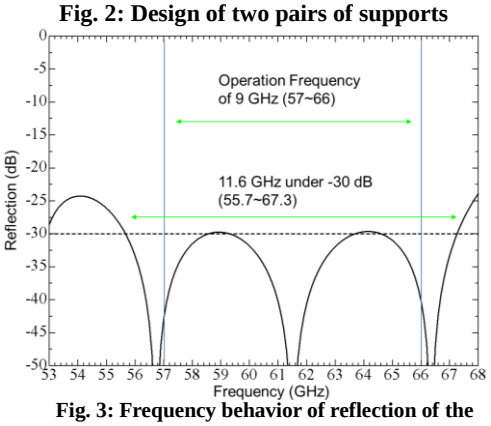


**Fig. 3: Frequency behavior of reflection of the model designed in Fig.2 (Simulation)**

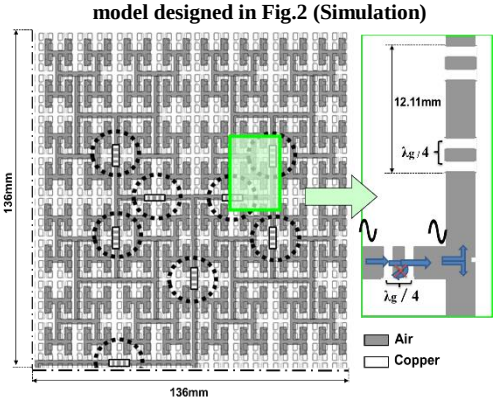


**Fig. 4: Insertion of supports into circled spots of the quarter part (32×32) of the full model**

**References**
[1] Y. Miura et al., IEICE Tech. Report, AP2009-106, Oct. 2009.
[2] D. Kim et al., IEICE Tech. Report, AP2013-29, May. 2013.