Design of a 12×16-element Double-layer Corporate-feed Waveguide Slot Array Antenna

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***Abstract* – The plate-laminated waveguide slot array antenna is a high-efficiency and wide-band antenna in the millimeter-wave band. However, in the conventional corporate-feed circuit, the number of radiating elements is limited to be a power of two by using a cascade of T-junctions. In this paper, we propose the corporate-feed with a cross junction and an asymmetric T-junction for 12×16 elements. The bandwidth for VSWR less than 1.5 is 7.64%. Antenna efficiency of 82.6% is obtained at the design frequency of 61.5 GHz by simulation.**

***Index Terms* — waveguide slot array, corporate-feed, cross junction.**

I. INTRODUCTION

The plate-laminated waveguide slot array antenna is proposed for a high-efficiency and wide-band in the millimeter-wave band [1]. This antenna has a corporate-feed circuit in the lower layer and is fabricated by diffusion bonding of laminated etching metal plates [2]. However, in the conventional corporate-feed antenna, the element number of a power of two was able to be realized.

In this paper, we design a new feeding circuit combined with a cross junction and an asymmetric T-junction with the power division ratio of 1:2 [3] for the 12×16-element array.

II. CONFIGURATION OF THE ANTENNA

Fig. 1 shows the 12×16-element waveguide slot array antenna. It is composed of the corporate-feed circuit in the lower layer and the radiating part in the upper layer. It is fed by a standard rectangular waveguide (WR-15) from the bottom of the antenna. The end of the feeding circuit is connected with the radiating part through a coupling aperture, and the radiating slots are excited by a cavity with equal phase and amplitude.

Fig. 2 shows the top view of the feeding circuit. The feeding circuit consists of the T-junctions, the asymmetric T-junctions, the cross-junctions and the H-junctions. Because of the symmetric feeding circuit, the main beam direction does not tilt from the boresight due to the frequency variation. To excite all the subarrays with equal amplitude and phase, the asymmetric T-junction is placed in front of the cross-junction.

III. DESIGN THE CROSS JUNCTION

Fig. 3 shows the cross-junction. It is fed by Port1 and Port2 with the equal power, then the input power is equally divided to Port3 and Port4. The width of the broad iris of the waveguide *a* is 3.00 mm. At first, the irises are placed at the input ports to suppress the reflection at the design frequency of 61.5 GHz (Model 1). Then, to improve the bandwidth, irises are also added at the output ports (Model 2). Furthermore, the corners are rounded so as to reduce the discontinuity at the junction and achieve a wider bandwidth (Model 3).

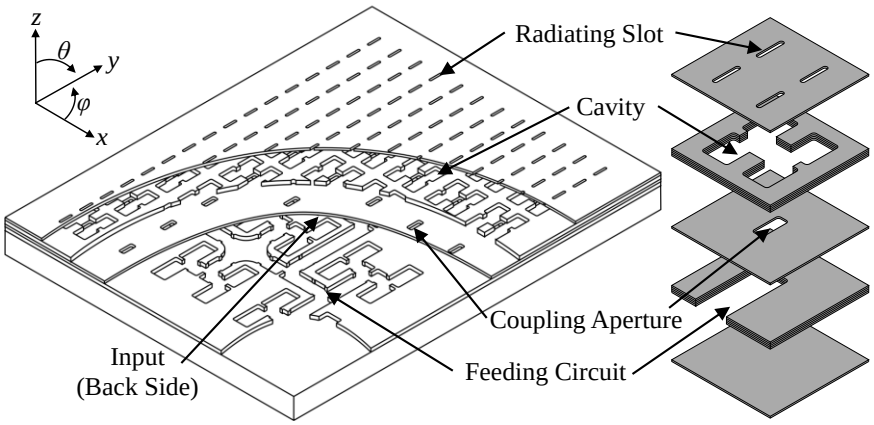

Fig. 1 12×16-element double-layer waveguide slot array antenna (left) and 2×2-element sub-array (right)

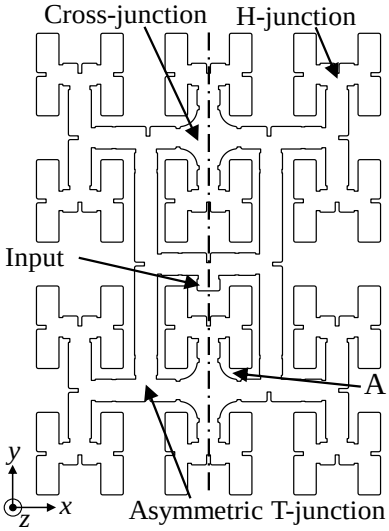

Fig. 2 Feeding circuit for the 12×16-element array

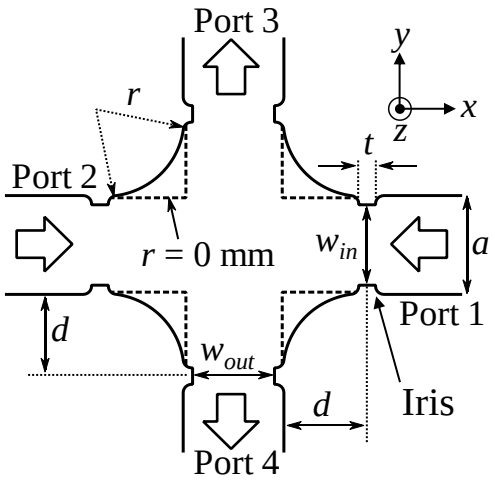

Fig. 3 Cross junction

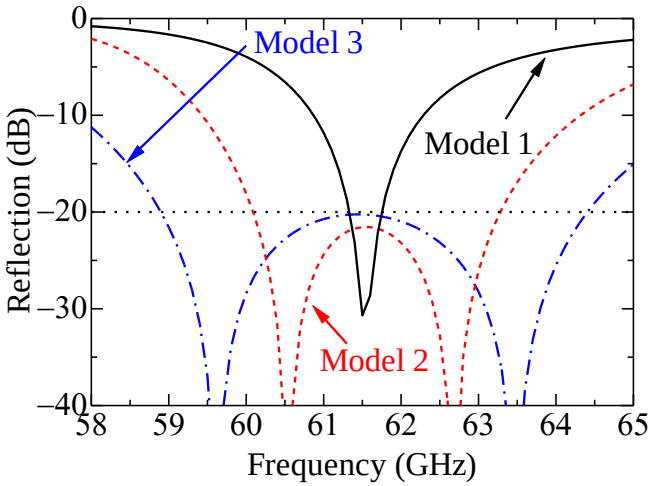

Fig. 4 Reflection of the cross junctions

Fig. 4 shows the frequency characteristics of the reflection of the cross junction. The bandwidth for the reflection less than –20 dB is enhanced to 8.94% by placing the irises at both input and output ports and rounding the corners.

IV. Analysis of the 12×16-element array

The designed corporate-feed circuit with the cross-junction and the asymmetric T-junction [3] and the radiating part [1] are combined to form a 12×16-element array. The 12×16-element array is analyzed. Fig. 5 shows the frequency characteristics of the overall reflection. The bandwidth for the VSWR less than 1.5 is 7.64%. Fig. 6 shows the frequency characteristics of the directivity and realized gain. The aperture efficiency of 87.2% and antenna efficiency of 82.6% are obtained at 61.5 GHz.

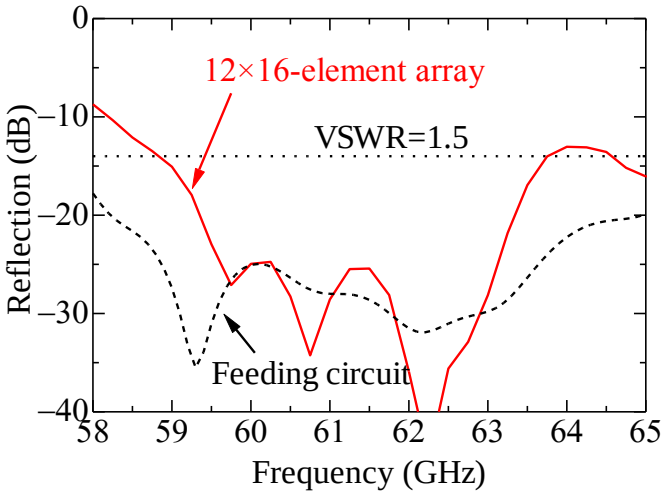

Fig. 2 Reflection of the 12×16-element array

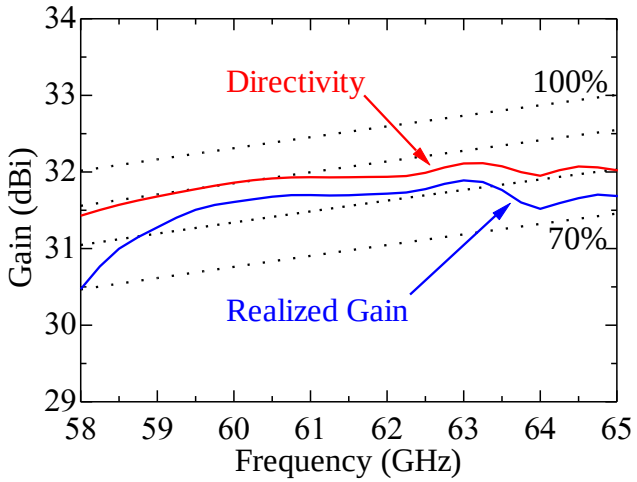

Fig. 2 Realized gain and directivity of the 12×16-element array

V. Conclusion

The 12×16-element array with the cross junctions and the asymmetric T-junctions has been designed. The bandwidth for the VSWR less than 1.5 is 7.64% and the antenna efficiency of 82.6% is obtained at 61.5 GHz.

We are now fabricating the antenna. The measured results will be shown in the conference. As future works, we will consider other number of elements by changing the configuration of the corporate-feed circuit with the cross junctions.

References

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