Design and Fabrication of a Dual-polarization Corporate-feed Waveguide 32x32-slot Array Antenna for 120 GHz Band

Keisuke HASHIMOTO[1], Jun TAKEUCHI[2], Jiro HIROKAWA[1], Akihiko HIRATA[2], and Makoto ANDO[1]
[1]First Dept. of Electrical and Electronic Eng., Tokyo Institute of Technology, Tokyo, Japan
[2]Microsystem Integration Laboratories, NTT Corporation, Kanagawa Japan

***Abstract* – A dual-polarization corporate-feed waveguide 32x32-slot array antenna is designed for 120 GHz band in order to increase the operating frequency band and the gain. The simulation by HFSS gives the bandwidth for VSWR lower than 1.5 of 7.6% (S_{11}) and 8.8% (S_{22}), respectively, at the design frequency of 125 GHz. The isolation is achieved more than 50 dB over the bandwidth. The simulated realized gain for both polarizations is 38.5 dBi at 125 GHz with the antenna efficiency of 85%.**

***Index Terms* — millimeter wave; waveguide slot array; dual polarization; 120GHz band**

I. INTRODUCTION

A dual-polarization corporate-feed waveguide 16x16-slot array antenna was proposed and fabricated in the 60GHz band [1]. A 32x32-slot array antenna in the 120GHz band is designed to increase the operating frequency band and the gain.

II. ANTENNA STRUCTURE

A. Feeding waveguide

There are two feeding waveguides in the antenna for the dual polarization on the bottom. Each feeding waveguide has a feeding port. Layer 1 is a single layer for the lower feeding waveguide while Layers 3 and 5 are double layers for the upper feeding waveguide. A 2x2-element sub-array is connected at each end of the lower and the upper feeding waveguides. The sub-array of radiating slots is shared for the dual polarizations.

B. 2x2-element sub-array

The 2x2-element sub-array consists of six sub-layers as shown in Figure 2.

A wave is fed from the lower feeding waveguide and propagates to the cavity through the coupling slot 1. An *x*-directed magnetic current is excited at the coupling slot 1. On the other hand, another wave is fed from the upper feeding waveguide 2 and propagates to the cavity through the cross coupling slot. A *y*-directed magnetic current is excited at the cross coupling slot. It is perpendicular to the magnetic current excited by the coupling slot 1. The radiating slots on the cavity are excited by both of the magnetic currents for the dual polarizations.

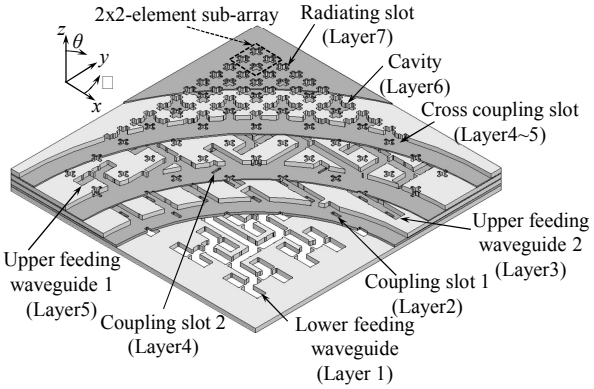

Figure 1 Antenna structure (for 16x16 elements)

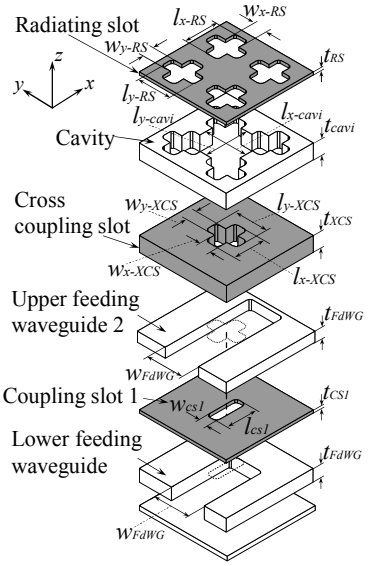

Figure 2 2x2-element sub-array structure

III. MEASUREMENT RESULTS

Use The calculated and measured frequency characteristics of the reflection and the isolation are shown in Figure 3. The bandwidth for VSWR less than 1.5 at t 125 GHz is 7.6% (S_{11} : black dashed line) and 8.8% (S_{22} : gray dashed line), respectively, in the simulation. The isolation is more than 50 dB over the above bandwidth. The solid lines show measured

results. The measured results are worse than calculated results. The reasons are under investigation.

Figure 4 shows the realized gain and the directivity. At 125GHz, 38.5 dBi realized gain is obtained with 85 % antenna efficiency for both polarizations, The directivity is 39.0dBi. The measured gain is 37.7 dBi (Port1) and 38.4 dBi (Port2), respectively.

The measured radiation patterns in the E-plane and H-plane for Port 1 at 125GHz are shown in Figure 5 and Figure 6, respectively (the black line is for the measured result, the gray dashed line is for the calculated one). The 3 dB-down bandwidth is 1.9 degrees. We confirm the measured radiation patterns for Port2 are almost the same to those for port1.

Figure 7 shows the fabricated antenna by the diffusion bonding of 19 plates with 0.2mm thickness.

IV. CONCLUSION

We have presented the measured results of the dual-polarization 32x32-element plate-laminated-waveguide slot array antenna. The bandwidth for VSWR less than 1.5 at 125 GHz is 3.7% (S_{11}) and 3.0% (S_{22}), respectively. At the design frequency, 37.7 and 38.4 dBi gain with 69% and 82% antenna efficiency are achieved for the both polarization.

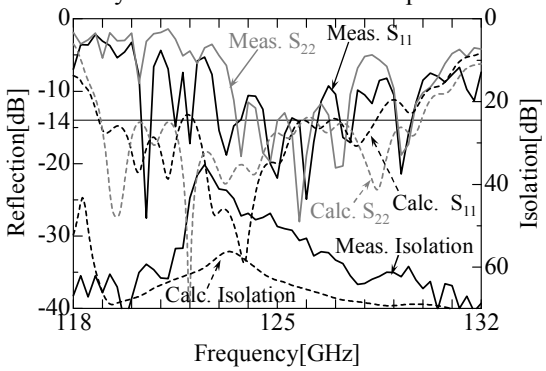

Figure 3 Frequency characteristics of the reflection and the isolation

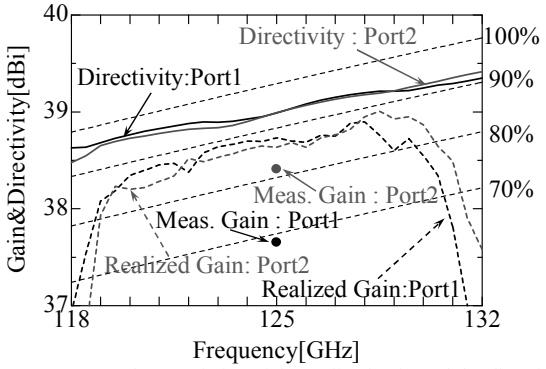

Figure 4 Frequency characteristics of the realized gain and the directivity

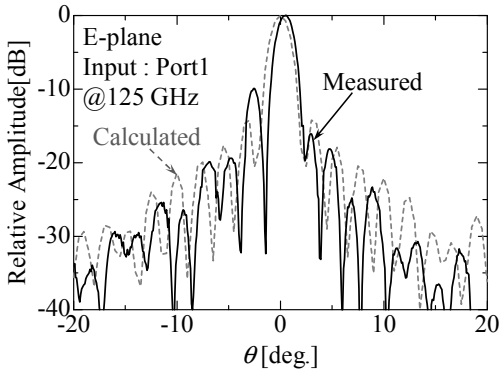

Figure 5 E-plane patterns at 125 GHz (Port1)

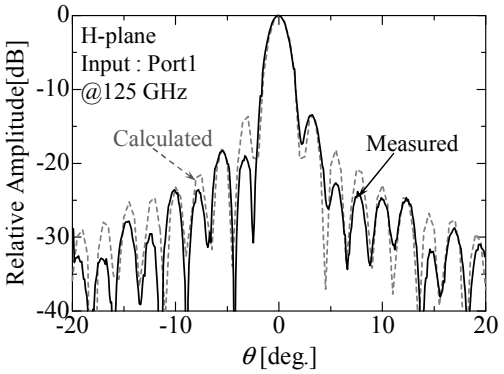

Figure 6 H-plane patterns at 125 GHz (Port1)

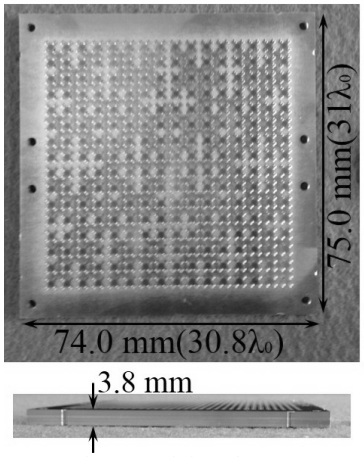

Figure 7 Fabricated antenna

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[1] D. Kim, M.Zhang, J.Hirokawa and M.Ando, "Dual-polarized Corporate-feed Plate-laminated Waveguide Slot Array Antenna for 60 GHz-band," Proc. of Intl. Symp. on Antennas and Propagat., 1B3-4, Oct. 2012