Measurement of a Perpendicular-Corporate Feed in a Three-Layered Parallel-Plate Slot Array

Hisanori IRIE, Takashi TOMURA, and Jiro HIROKAWA
Tokyo Institute of Technology, S3-20, 2-12-1 O-okayama, Tokyo 152-8552, Japan, irie.h@antenna.ee.titech.ac.jp

This paper presents the measurement of a perpendicular-corporate feed in a three-layered parallel-plate slot array (H. Irie, and J. Hirokawa, IEEE Trans. Antennas Propag., vol. 65, no. 11, pp. 5829 - 5836, Nov. 2017). We place dielectric with proper permittivity in the region between the coupling-aperture layer and the radiating-slot layer to excite a standing wave. The proposed structure can provide each 2×2-element subarray with a uniform excitation. In addition, we add a parasitic-slot layer on the top to improve the bandwidth.

Fig. 1 shows the structure. The antenna consists of a parasitic-slot layer, a radiating-slot layer with dielectric (ε_r:1.28, tan δ: 0.002) and a coupling-aperture layer including a planar feeding circuit. These layers are described with a distance to show the internal structure in Fig.1. However, in the actual antenna, they are stacked with a spacing among the layers. The antenna is fed by a feed aperture, which is the same size as the standard waveguide WR-15. The feeding circuit is a planar corporate feed composed of H-planes and T-junctions. The coupling-aperture layer is placed between the feeding circuit and the dielectric. The radiating-slot layer is mounted on the dielectric. The parasitic-slot layer is placed on the top of the radiating-slot layer. The spacing between the radiating- and parasitic-slot layer is hollow. For these two layers, each slot spacing is constant: $0.86\lambda_0$ (4.20 mm) in the *x* and *y* directions. In the fabrication in the 60GHz band, the periphery of the three-layered parallel plates is terminated by copper (conductivity: 5.8×10^7 S/m) to keep the flatness. Each slot layer is the thin copper plate of 0.20 mm thickness. All the plates including the feeding circuit are connected by fixing screws at four corners. The edges as PMC of the parallel plates are extended by 1.20 mm ($\approx 0.25\lambda_0$) and terminated by a conductor only in the *y* direction. The dimension of the antenna in the *xy*-plane is 81.0 mm × 79.0 mm.

Fig.2 describes the measured-, and simulated- realized gain, gain and directivity. The realized gain, which includes the reflection loss, and conductor and dielectric losses, is measured by comparing with a standard gain horn antenna in an anechoic chamber. The directivity is derived from the measured near-field distribution by Fourier transform. The measured gain is calculated by adding the measured reflection loss into the measured realized gain. The measured realized gain degrades comparing to the simulated one because of the reflection loss. Then, the measured gain is also degraded due to the same reason. However, the measured directivity is in good agreement with the simulated one. The aperture efficiency greater than 90 % is achieved over 5-GHz bandwidth. At the design frequency, the measured directivity is 33.5 dBi with the aperture efficiency of 90.6 % and the realized gain is 31.7 dBi with the antenna efficiency of 61.0 %.

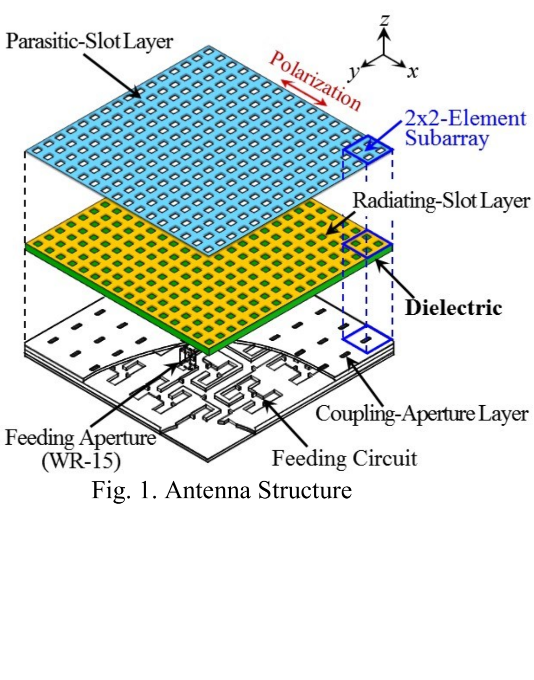

Fig. 1. Antenna Structure

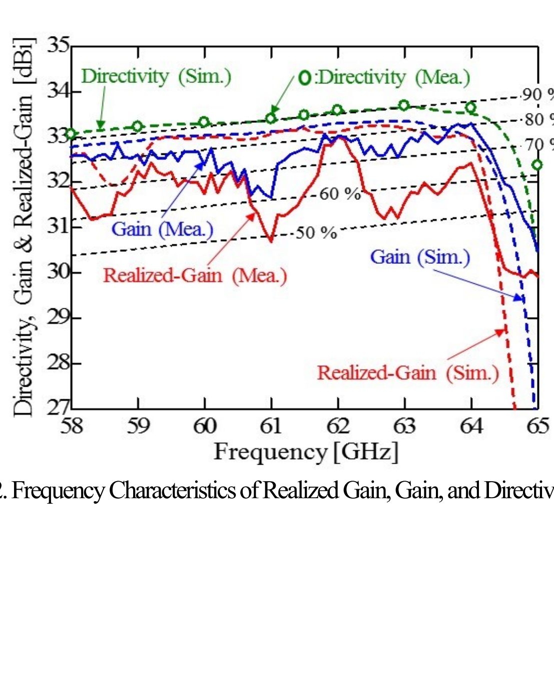

Fig. 2. Frequency Characteristics of Realized Gain, Gain, and Directivity