4×4 Magneto-Electric Dipole Array with Single-Layer Corporate-Feed Ridge Gap Waveguide for mmWave Applications

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***Abstract*—This paper presents simulations results of a 4×4 magneto-electric dipole (MED) array antenna fed by a single-layer corporate-feed ridge gap waveguide (RGW) for millimeter wave applications. The designed antenna model consists of two unconnected metal layers: the top radiating layer and the bottom corporate-feed RGW layer. Hence, the antenna profile can be lowered since no intermediate cavity layer is required. The MED radiating element shows a larger impedance bandwidth compared to the conventional single layer array antenna. The $S_{11} \leq -10$ dB bandwidth of the simulated antenna is from $24 - 29$ GHz, resulting in a 18.9% impedance bandwidth. The realized antenna gain is greater than approximately 19.6 dBi.**

***Keywords*—Array antenna, AMC, single-layer, gap waveguide, metamaterial, millimeter wave**

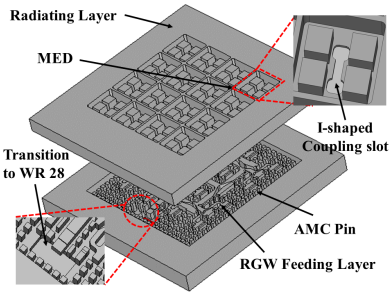

Fig. 1: Distributed view of the proposed 4×4 MED array antenna fed by single-layer corporate-fed RGW.

I. Introduction

The gap waveguide (GW) technology offers promising performance in the design of millimeter wave (mmWave) high gain array antennas due to its low losses, simple assembling and self-packaging properties. To date, a number of antennas have been built based on the GW technology [1]–[3]. In order to obtain wideband performance, and have ample space for the distribution networks and AMC pins, these antennas are often backed with cavities where four slots are excited using one cavity [1]. Although these antennas provide sufficient bandwidth performance, still production costs and design complexity can be reduced by reducing the number of layers. In addition, compact antenna structures are preferred in many applications due to obvious reasons. Single-layer-feed array antennas based on serial-feed networks have been suggested to address these issues. However, the studies presented so far show poor bandwidth performance with a -10dB impedance bandwidth around 10% [4]. Recently, few models of GW-based single-layer corporate-feed array antennas have been successfully implemented . Also, the design proposed in [5] shows limited bandwidth performance, i.e., 5%. To address the narrow bandwidth performance, [6] proposed to modify the traditional slot into an "8-shaped" slot with a bandwidth of around 17%. Thus far, many of these GW-based array antenna have proposed designs utilizing conventional slots as the radiating element, which has restricted the bandwidth performance the GW-based array antennas. In this paper, we suggest an alternative approach for the design of wide-band single-layer corporate-feed array antennas based on the ridge gap-waveguide (RGW). Moreover, the magneto-electric dipole (MED) is proposed as the radiating element. In the proposed design, there is no need for backed-cavities for excitation, while maintaining a similar bandwidth to the cavity-backed array designs. The proposed MED antenna is realized using two pairs of pins and is surrounded by a cavity forming a radiating structure with a wider bandwidth compared to single-layer corporate-feed antennas.

II. MED Array Antenna Design and Simulation Results

As can be seen from Fig 1 the proposed 4×4 MED array antenna fed by RGW comprises two layers: the radiating layer and the feeding layer. The radiating layer contains the MED antenna elements consisting of four metallic pins surrounded by a rectangular cavity, and connected to the ground. To avoid grating lobes, while providing sufficient spacing for the corporate-feed network, the proposed unit cell antenna is $0.9\lambda_0 \times 0.9\lambda_0$ in size, where λ_0 is the free-space wavelength at 29 GHz. To achieve effective radiation from the electric dipole, the height of the pin dipole is approximately a quarter-wavelength at 26 GHz. In addition