Printed Wideband Antenna for Millimeter Wave Applications

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1. Introduction

Magneto electric (ME) dipole antennas [1-3] are proposed for having wideband, stable gain and pattern across the entire passband. These antennas are simple in structure, ease of fabrication, and low cost. Some designs based on the concept of ME-dipole have suggested to be a dual-polarized antenna [4] for mobile communications, a circularly-polarized antenna [5] for satellite broadcast services, and a very wideband antenna [6] for WLAN systems, etc. All of the above mentioned [1-6] are only drawn the focus on microwave band applications. However, the recent trend of wireless communications is running to higher frequency like the instances of millimeter wave and THz frequency bands, so that the development on the antenna operating at very high frequency is popularly demanded. Among many types of millimeter wave antennas [7-8], they are expensive in manufacturing cost due to their very tiny size in radiating element and preciseness in feed mechanism. Some low-cost designs for millimeter wave antennas [9] are poor in narrow bandwidth or they do not have good radiating patterns [10] for the whole operating bandwidth. In this paper, we study and propose a new structure of millimeter wave antenna by introduction of ME-dipole fabricated on the microwave substrate. This proposed antenna is simple in the inherent architecture in the both of radiating element and feed line. The design yields advantages for wide impedance bandwidth, good directional radiation pattern across the passband and low fabrication cost.

2. Antenna Description

The proposed magneto electric dipole antenna for millimeter wave applications is shown in Fig.1. This antenna is fabricated on a microwave substrate S which is from ROGERS laminates (RT/Duroid 5880, εr=2.2, thickness H= 0.787mm). A horizontal rectangular dipole is printed on the upper layer of the substrate; while the ground plane is located at the bottom layer. For the right-sided half dipole, there are three vertically via pins built and connected between the printed dipole and the ground plane. For the left-sided half dipole, there are two vertically via pins built and connected between the printed dipole and the ground plane. These two sets of parallel shorting pins provide the formation for realizing a vertically-oriented quarter-wavelength patch antenna. For the middle via pin located at the left-sided half dipole which is chosen as a feeding pin forms a structure of GSG transmission line. Then a T-shaped coupled strip is added on the top-end of the feeding pin

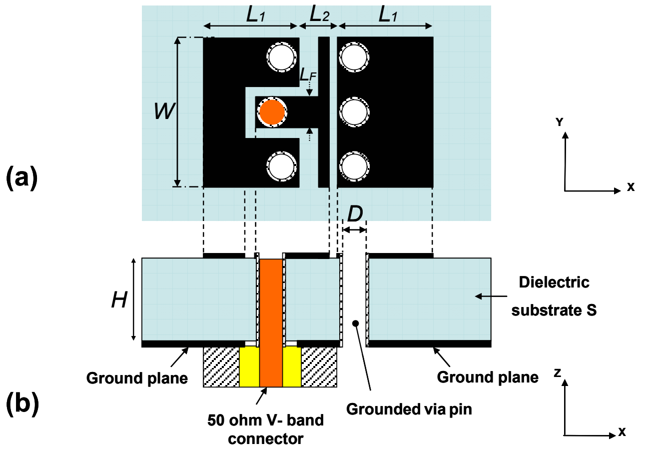

Fig. 1. The geometry of the printed EM dipole antenna.
(a) Top View (b) Side View.

to excite the planar dipole and the quarter-wavelength patch simultaneously. A V-band SMA type connector is launched underneath the ground plane. Table 1 describes the dimensions of the proposed antenna.

3. Antenna Performance

TABLE I
DIMENSIONS OF THE PROPOSED ANTENNA

Antenna Parameters	Dimension
W	1.4mm, 0.416λg
L_1	0.9mm, 0.267λg
L_2	0.4mm, 0.119λg
L_F	0.3mm, 0.089λg
D	0.3mm, 0.089λg
H	0.787mm, 0.24λg

Results presented in this paper are all simulated by an EM commercial software package HFSS. As shown in Fig. 2, the impedance bandwidth, for S11≤-10 dB is 42% from 50 to 72 GHz. The simulated antenna gain at the broadside direction varies between 6.4 dBi and 7.5 dBi, with an average value of 7.0 dBi, across the passband. Fig. 3 shows the radiation pattern at 60 GHz. For the H-plane, it is symmetric in shape and the cross-polarization level is around 22 dB below the co-polarization level within the 3dB beamwidth. Both the E- and H-planes are low back radiation. From the simulation, the radiation patterns over the operating bandwidth are stable.

4. Conclusion

This paper presents a new form of millimeter wave antenna by realizing a magneto electric (ME) dipole in a printed microwave substrate. The antenna is combined with a vertically-oriented quarter-wavelength patch and a printed horizontal electric dipole. A wideband balun comprising a vertical

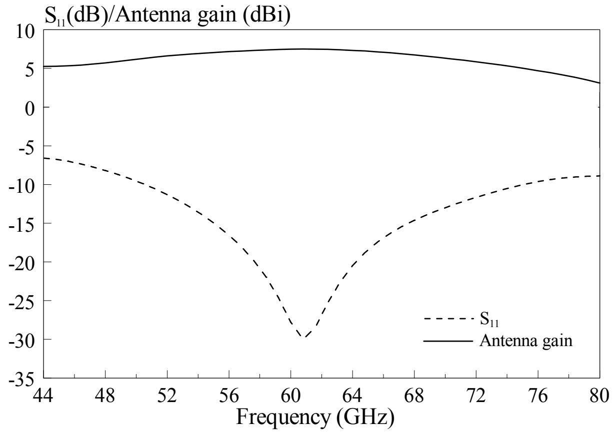

Fig. 2. Simulated antenna gain at broadside direction and return loss of the proposed antenna.

coplanar transmission line and a T-shaped coupled strip is proposed. The antenna has a wide bandwidth of 42% (50GHz to 72GHz) and with an average gain of 7.0 dBi with stable radiation patterns.

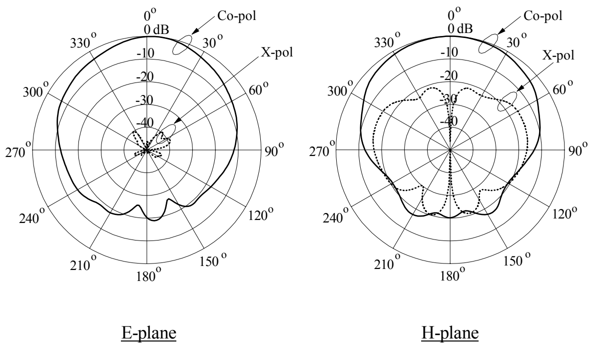

Fig. 3. Simulated radiation patterns at 60GHz.

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