Low-Profile Proximity Coupled Cavity-less Magneto-electric Dipole Antenna

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***Abstract* – The modern communication system imposes high specification antennas. Magento-electric dipole antenna has a wide impedance bandwidth, high gain and unidirectional pattern. This work presents a new low-profile magneto-electric dipole which is proximity-fed. The antenna has a wide impedance bandwidth of 45% and a high gain of 9.8 dBi with 1.7 dB in-band variation.**

***Index Terms* – magneto-electric dipole, proximity coupled feeding.**

I. Introduction

Antenna with high specification attracted the interest of researchers in academia and the wireless communications industry. Many wireless commutation systems impose antennas with wide impedance bandwidth, high gain, high directivity, low back lobe radiation, and stable unidirectional radiation patterns in the E- and H-planes to meet the high demand in wireless communication. Various types of antennas, such as microstrip patch antennas, horn antennas, log periodic antennas, and antenna arrays, have been proposed in the literature to address some of these requirements. However, these solutions often have drawbacks, such as limited impedance bandwidth or bulkiness. Additionally, achieving identical radiation patterns in both E- and H-planes may require antenna arrays in each plane [1, 2]. Magneto-electric (ME) dipole antenna operates in the principle of exciting both electric dipole and the magnetic dipole with equal magnitude and phase. The resulting antenna will have a wide impedance bandwidth and a unidirectional radiation pattern in the E and H planes.

In [3], the authors introduced the ME dipole concept using a Γ-shaped feed to excite the two orthogonal modes with equal magnitude and phase. The resultant radiation patterns are identical in the E and H planes. The antenna has a wide bandwidth of 43.8% and a high gain 8 dBi. In [4], the authors introduced a dual polarized ME dipole antenna fed by Γ-shaped feeding system to excite the two modes. The ME dipole achieved a wide impedance bandwidth of 66%, high gain of 9.5 dBi and high isolation of 36 dB, but the thickness was about $0.23\lambda_o$. In [5], the author proposed a simple low-profile cavity-less ME dipole antenna fed by a coaxial cable. The antenna has a wide impedance bandwidth of 41% and high gain of 9.7 dBi with 2 dB in-band variation. Several methods and techniques were proposed in the literature to reduce the overall size of the antenna [2, 6]. Using bending cavity walls or a tilted coaxial feeding system to reduce the height of the antenna, however, the size of the ground reflector is usually larger than $1\lambda_o$

In this paper, a simple cavity-less magneto-electric dipole antenna using proximity coupled feed is proposed. The proposed feeding method allows the antenna ground reflector to be reduced $0.78\lambda_o$ while maintaining a wide impedance bandwidth and a high gain of 8 dBi with a low profile. The antenna has a wide impedance bandwidth of 45% and a high gain of 9.8 dBi with 1.7 dB in-band variation.

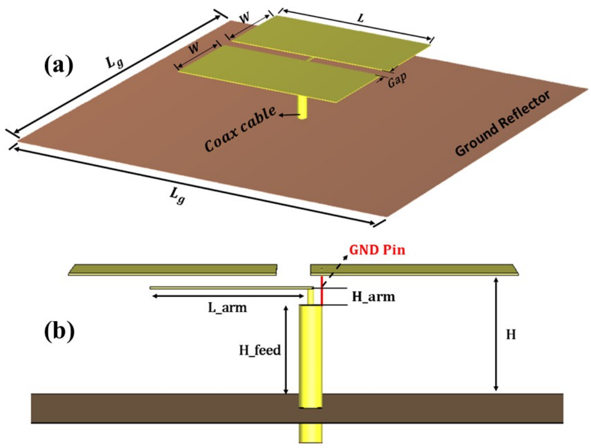

Fig. 1. Geometry proximity coupled fed cavity-less magneto-electric dipole antenna (a) prospective view (b) side view.

TABLE I
Dimensions of the Proposed Antenna

Parameter	Lg	L	W	Gap
Value (mm)	120 ($0.97\lambda_0$)	60 ($0.5\lambda_0$)	30 ($0.25\lambda_0$)	3 ($0.02\lambda_0$)
Parameter	H	H_feed	L_arm	H_arm
Value (mm)	20 ($0.16\lambda_0$)	18 ($0.14\lambda_0$)	22 ($0.18\lambda_0$)	1 ($0.008\lambda_0$)

II. Antenna Geometry and Design

The proposed ME dipole consists of two metallic patches fed by a horizontally oriented probe arm which is connected to a coaxial cable (RG402, 50Ω, diameter = 3.58 mm) and a square ground reflector, as shown in Fig. 1. The inner conductor of the coaxial cable is connected to the probe to feed the ME-dipole through the proximity coupling. The outer conductor of the coaxial cable is connected to one of the metallic patches through a ground pin. The detailed parameter dimensions are listed in Table 1.

III. Result and Discussion

As shown in the simulation results, the proximity coupled feeding method allows the reduction of the ground reflector while maintaining the radiation characteristics. The impedance bandwidth of the proposed antenna with different ground reflector L_g is shown in Fig. 2. The antenna bandwidth is maintained a large bandwidth of 40% and a high gain of 8 dBi across the operational bandwidth as shown in Fig. 3. The radiation patterns at 2 GHz, 2.5 GHz and 3 GHz are shown in Fig. 4. It can be observed that the antenna has a unidirectional stable radiation pattern with low back-lobe of (≤ -12 dB). To demonstrate the E-dipole and M-dipole modes of the antenna, E-field distributions at different time, i.e. t = 0, T/4, T/2 and 3T/4 are shown in Fig. 5.

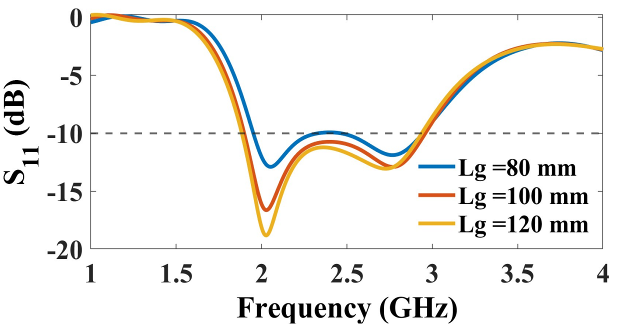

Fig. 2. S_{11} of the proposed antenna with different ground reflector size L_g.

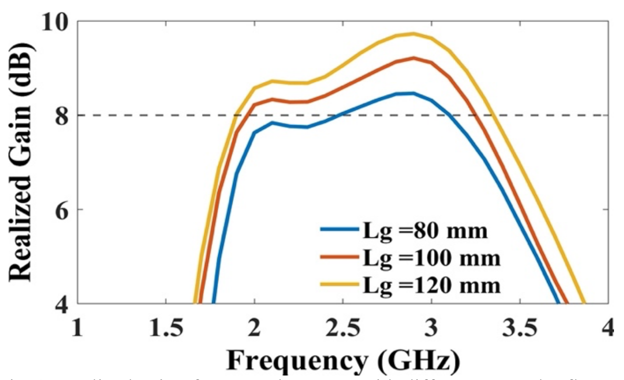

Fig. 3. Realized gain of proposed antenna with different ground reflector size L_g.

IV. Conclusion

A cavity-less magneto-electric dipole antenna using proximity coupled feed is proposed. The antenna achieved a wide impedance bandwidth of 45% and a high gain of 9.8 dBi with 1.7 dB in-band variation. The proposed feeding method allows the antenna ground reflector to be reduced below $1\lambda_o$ while maintaining a wide impedance bandwidth and a high gain of 8 dBi across the operational bandwidth.

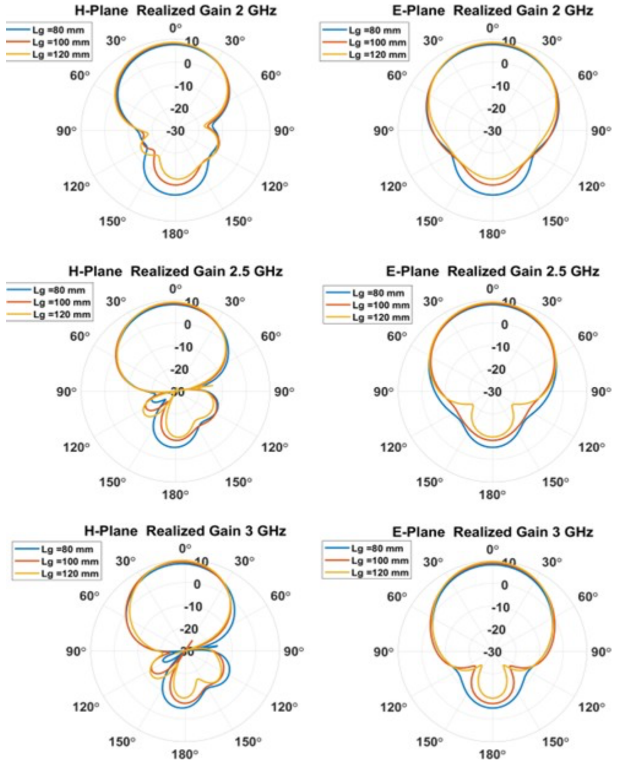

Fig. 4. The radiation patterns in both E and H planes of the proposed antenna with different GND reflector size Lg.

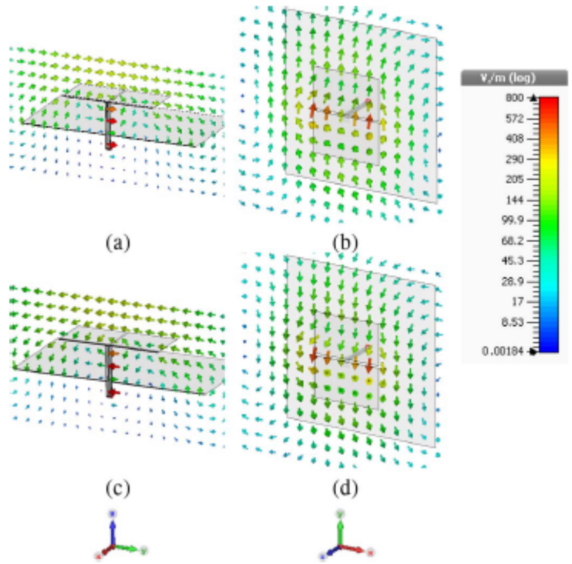

Fig. 5 E-field distributions of the ME-dipole antenna at different time, (a) t = 0, (b) t = T/4, (c) t = T/2 and (d) t = 3T/4.

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