Design of Lightweight Fabry Perot Antenna based on ISM Application

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Abstract

This article proposes a lightweight Fabry Perot resonant cavity antenna (FPRA) for ISM communication. Compared with the traditional FPRA, its two metal surfaces are replaced by copper paper pasted on the foam dielectric plate, and the dipole antenna etched on the dielectric substrate is used as the feed, so it is more portable. The available impedance bandwidth is 2.86% (23.79-24.48GHz), with a maximum gain of 11.2dBi, suitable for ISM communication in the 24GHz frequency band.

Keywords

Millimeter Wave Antenna; Lightweight Design; Fabry Perot Antenna; ISM Communication.

1. Introduction

With the continuous development of mobile communication technology, the available microwave spectrum resources are approaching depletion, so millimeter wave applications have entered the public's field of vision. However, due to the short wavelength of millimeter waves, the designed antenna size is very small, and its resonant matching is very sensitive to size changes. Therefore, the emergence of Fabry Perot antennas (FPRA) is important and can be designed according to practical application needs.

FPRA is a classic microwave antenna structure developed from the design concept of Fabry Perot interferometer. It uses a pair of parallel metal plates with small gaps between them, forming a cavity for air medium. This cavity can introduce the effect of Fabry Perot interference, thereby achieving control over the reflection and transmission of incident waves. Compared to common antenna structures, Fabry Perot antennas have many advantages, such as high gain, broadband characteristics, compactness, adjustability, etc. With the continuous development of microwave communication and radar technology, Fabry Perot antennas will continue to play an important role in applications such as wireless communication, array antennas, and antenna gain.

There are many feeding methods for Fabry Perot antennas. The feeding antenna of FPRA can be wave-guide horn [1], co-planar wave-guide [2], microstrip patch/array [3], slotted patch [4], magneto-electric dipole antenna [5], lens antenna [6], etc. It can also be directly placed between two metal plates with an inverted L-shaped probe [7], or two L-shaped probes with a 180 ° phase difference can be used to provide a more stable radiation mode [8], However, it is heavy and difficult to integrate in general communication equipment.

This article designs a more lightweight parallel plate FPRA, with two polyamide substrates parallel to the ground and copper paper pasted on the opposite side of the two plates. The two copper walls form a Fabry resonant cavity with the ground. The antenna is fed by a dipole antenna etched on the PCB board at the center, with a lightweight and simple structure. The center frequency is 24.15GHz,

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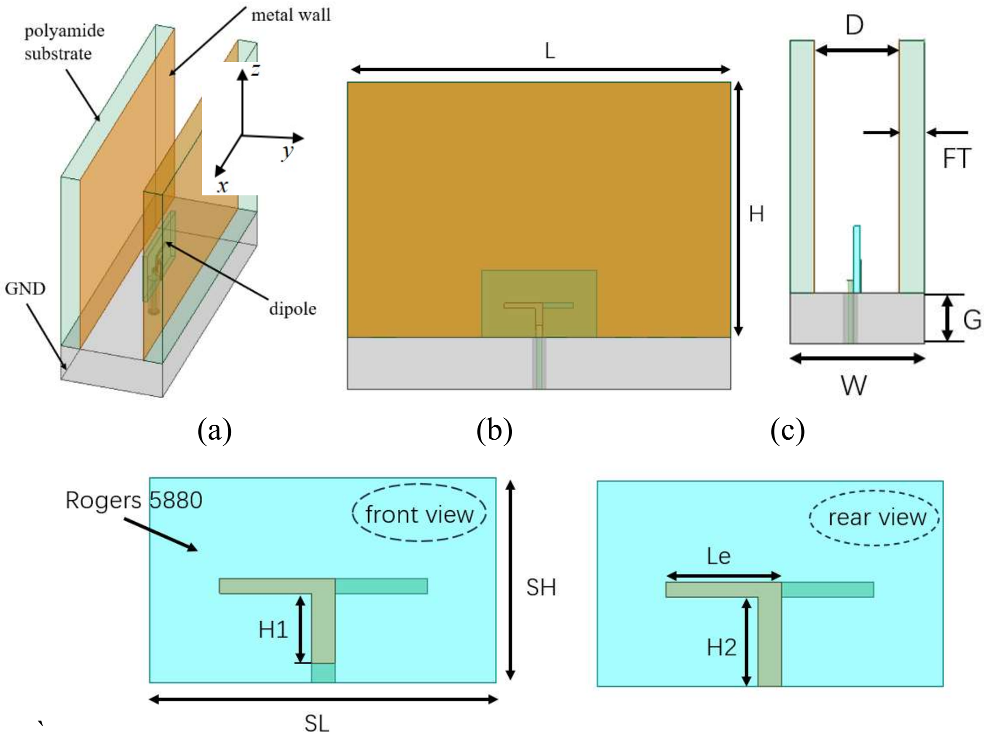
and it can achieve an impedance bandwidth of 2.86%, making it another ideal choice for ISM communication.

2. Antenna Design

As shown in Fig. 1, the antenna is designed on a ground with a length of L and a width of W, and the thickness of the floor is Gh. Place two identical rectangular plastic dielectric plates (with a dielectric constant of 2.1) parallel to the metal ground, with the plastic plates D apart. Copper stickers are applied to the two opposite faces of the plastic plates. The copper sticker and metal ground together form a Fabry Perot resonant cavity, and FPRA provides excitation through dipole antennas. The dipole antenna is designed on a Rogers 5880 dielectric substrate (ε= 2.2 and thickness = 0.5mm). The two metal arms of the dipole are etched on the upper and lower surfaces of the dielectric plate, and fed through parallel dual wires.Specific size parameters of the antenna:L=30mm,H=20mm,D=6.7 mm,W=10.7mm,FT =2mm,Gh=4mm,H1=1.8mm,H2=2.3mm,Le=2.7mm,SL=9mm,SH=5.3mm.



(a) (b) (c)

(d)

Fig.1. Configuration of FPRA.

(a) Perspective view (b)side view(c) Front view(d)Dipole structure diagram.

3. Simulation Result

Fig. 2 shows the electric field vector diagram of the E-plane (xoz plane) of FPRA, from which a unidirectional electric field parallel to the x-axis can be clearly observed, which conforms to the Fabry Perot resonance mode. Fig. 3 shows the antenna S parameter results, with an impedance bandwidth(| S11 |<-10dB) of 2.86% , covering a frequency range of 23.79 GHz to 24.48 GHz. Fig. 4 shows the gain of the antenna, with a maximum gain of 11.2 dBi within the frequency band.Fig.5 shows the directional pattern of the antenna operating at 24.1GHz on the E-plane and H-plane, reflecting the antenna's good directionality and low cross polarization.

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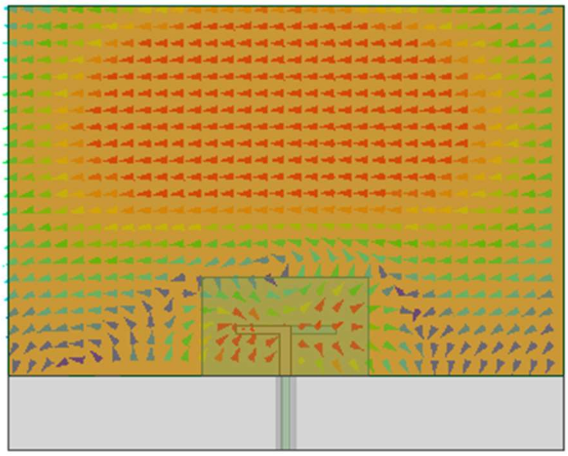

Fig. 2 FPRA E-plane electric field diagram

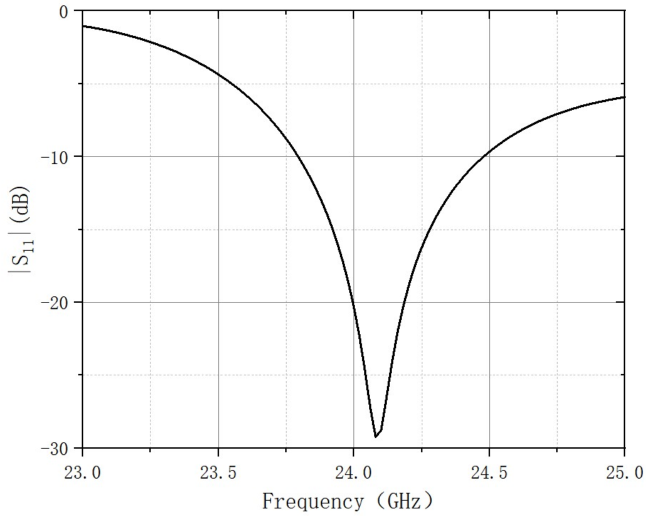

Fig. 3 Antenna return loss curve

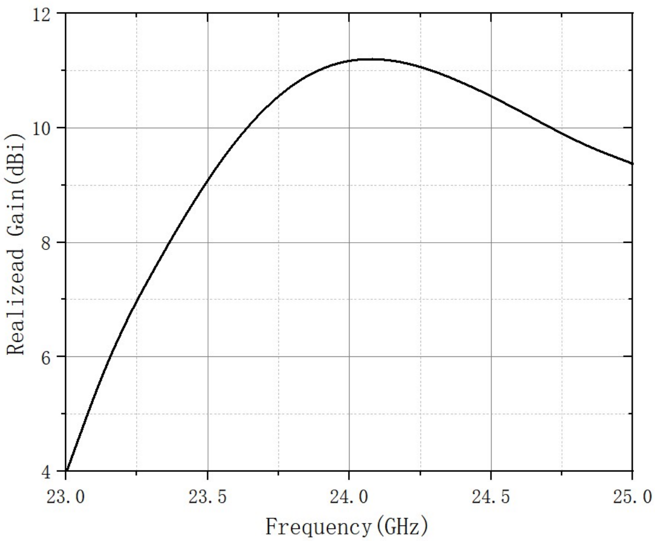

Fig. 4 Realizead Gain of antenna

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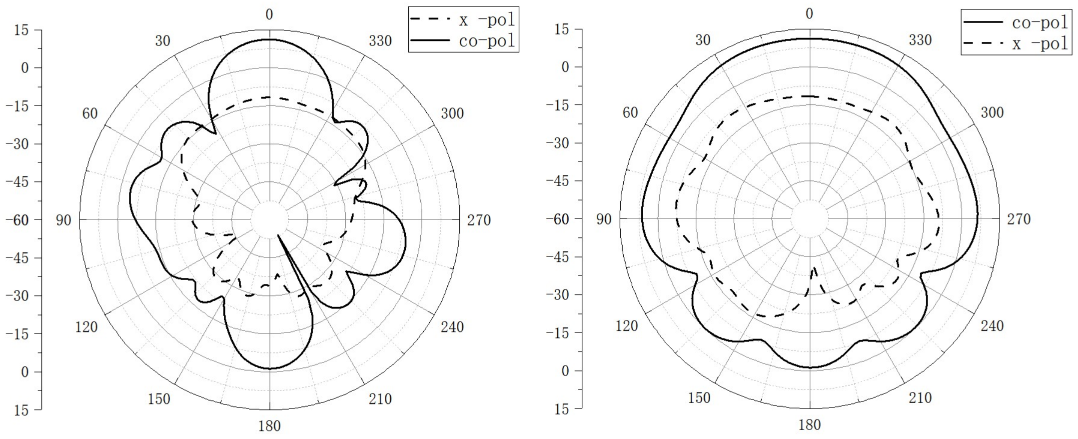

(a) (b)

Fig.5. Simulated radiation patterns of FPRA at 24.1 GHz.

(a) E-Plane radiation pattern (b) H-plane radiation pattern.

4. Conclusion

This article designs a lightweight FPRA with a simple structure, using plastic media as the base and copper paper as the adhesive, which is lightweight. Through simulation software, an impedance bandwidth of 2.86% (23.79-24.48GHz) was obtained, with a maximum gain of 11.2dBi within the bandwidth, suitable for ISM communication in the 24 GHz frequency band.

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