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A Wideband Dielectric Resonator Antenna with a Double Port Inverted L-shaped Feeder

Linlin Cheng[1,2, a], Wusheng Ji[1,2, b], Xinyue Liu[1,2, c], Jinfeng Gan[1,2, d]

[1] Institute of Antenna and Microwave Techniques, Tianjin University of Technology and Education, Tianjin 300222, China

[2] School of Electronic Engineering, Tianjin University of Technology and Education, Tianjin 300222, China

[a]chenglinlin@tute.edu.cn, [b]937754602@qq.com, [c]liuxinyue810401@163.com, [d]ganjf@tute.edu.cn

Abstract

A wideband dielectric resonator antenna with double-port inverted L-shaped feeders is designed. The antenna consists of two cylindrical dielectric resonators, two inverted L-shaped microstrip lines, a dielectric substrate, and a ground surface. Two inverted L-shaped microstrip lines are etched with a rectangular groove to improve the isolation. The antenna is fed by two inverted L-shaped microstrip lines connected by two ports to excite two cylindrical dielectric resonators respectively to radiate energy. According to the ANSYS20 simulation results, the reflection coefficient S11<-10dB, the antenna center frequency is 28.35GHz, the impedance bandwidth reaches 59.6% (18.78GHz-35.7GHz), the gain reaches 7.3dBi, and the isolation in the passband is less than -10dB. The passband of the antenna covers the millimeter wave frequency band and has a good application prospect.

Keywords

Broadband; Dual Port; Millimeter Wave; Dielectric Resonator Antenna.

1. Introduction

With the growing demand for modern wireless communication services, dielectric resonator (DR) antennas (DRA) have been extensively studied due to their small size, high radiation efficiency, high gain, low cost, and ease of excitation [1]-[3]. In addition, antennas with broadband performance are of interest in various fields, for example, as reference antennas in EMC measurements [4], ground penetrating radar for mine detection [5], and many military systems [6]. A major challenge in the design of DRA is to improve its impedance bandwidth. By utilizing the resonance of the feed structure [7]-[11], hybrid DRA can achieve broadband/dual frequency performance.

In this paper, a double-port inverted L-shaped microstrip line-fed cylindrical wideband dielectric resonator antenna is designed to enhance the bandwidth by coupling the microstrip line and slot feeding. The impedance bandwidth of the antenna reaches 59.6%, and the passband covers the 5G millimeter wave planning frequency band, which has a good application prospect in the millimeter wave communication system.

Volume 8 Issue 9, 2022
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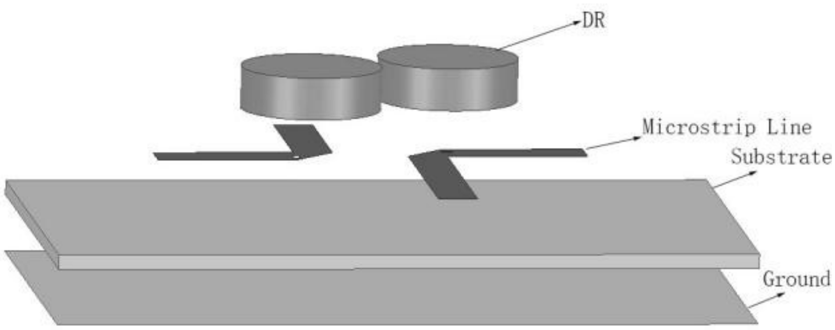
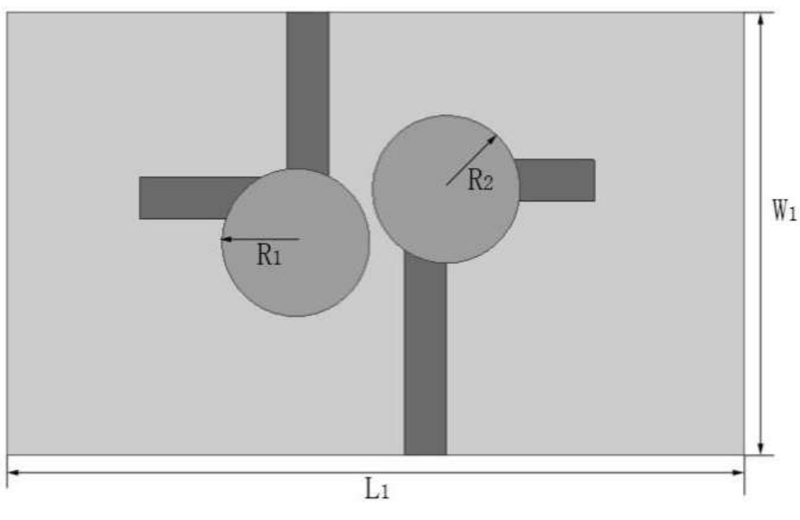
2. Antenna Design Theory

2.1 Antenna Structure

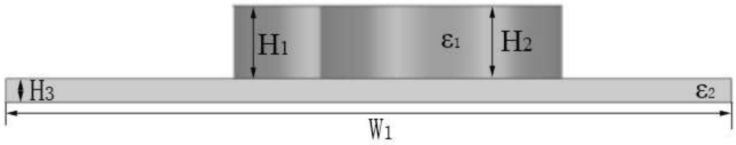
In this paper, a wideband dielectric resonator antenna with a double-port inverted L-shaped feeder is designed. The antenna contains two cylindrical dielectric resonators, which are excited by two inverted L-shaped microstrip lines. The antenna structure diagram is shown in Figure 1, where (a) diagram of the structure of each layer of the antenna, (b) diagram of the top view of the antenna, (c) diagram of the side view of the antenna, and (d) diagram of the top surface of the substrate, according to Figure 1 (a), you can see that the upper layer of the antenna is two cylindrical Dielectric Resonator, The lower layer is a dielectric substrate, in which two inverted L-shaped microstrip lines are etched on the upper surface of the dielectric substrate, and the ground surface is placed on the lower surface of the dielectric substrate. A rectangular groove is etched on the two inverted L-shaped microstrip lines to increase the isolation between the two resonators. The two cylindrical dielectric resonators are identical, using Rogers RT/ Duroid 6010LM material, dielectric constant $\varepsilon r1$= 10.2, radius R1=R2=2.5mm, height H1=H2=1.5mm; Rogers5880 dielectric substrate, dielectric constant $\varepsilon r2$ =2.2, substrate length L1=25mm, width W1=15mm, height H3=0.508mm; The two inverted L-shaped microstrip lines have the same width, W2=W3=1.4mm, and their lengths are L2=5mm, L3=7mm, L4=10mm, and L5=5mm, respectively. The lengths and widths of the two rectangular slots etched on the microstrip lines are L6=0.2mm, L7=0.4mm, W4=0.4mm, and W5=0.2mm, respectively. The length and width of the ground surface are the same as the medium substrate.



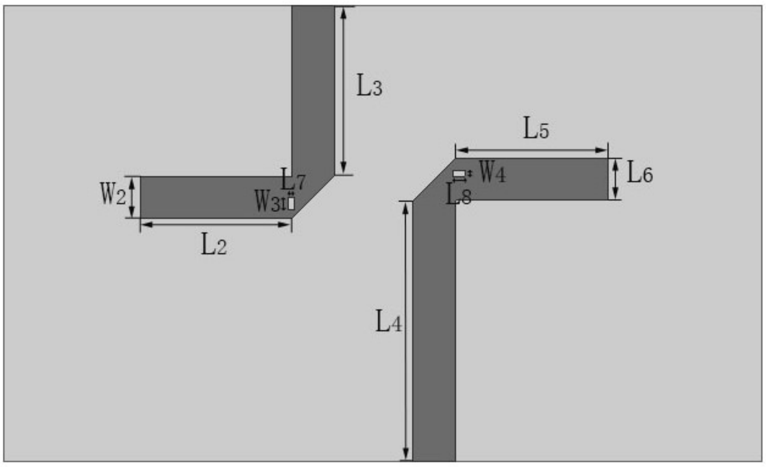
(a) Structure diagram of each layer



(b) Antenna top view



(c) Antenna side view



(d) The upper surface of the antenna substrate

Fig. 1 Antenna structure

2.2 The Simulation Results

ANSYS20 simulation software is used to establish the dielectric resonator antenna model and perform simulation analysis. The simulation results of antenna reflection coefficient S11, isolation degree S12, gain, and cross-polarization can be obtained. The simulation results of antenna reflection coefficient S11 are shown in Figure 2. The antenna center frequency is 28.35GHz, the passband is 18.78GHz-35.7GHz, and the impedance bandwidth reaches 59.6%. According to Figure 2, there are four resonant frequencies in the passband. The simulation results of the isolation degree are shown in Figure 3. The isolation degree in the antenna passband is less than -10dB, and the isolation degree in the 18.78GHz-29.8GHz band is less than -20dB. The antenna gain simulation results are shown in Figure 4. The maximum antenna gain is 7.3dBi, and the antenna gain amplitude in the passband is stable. The cross-polarization simulation results are shown in Figure 5.

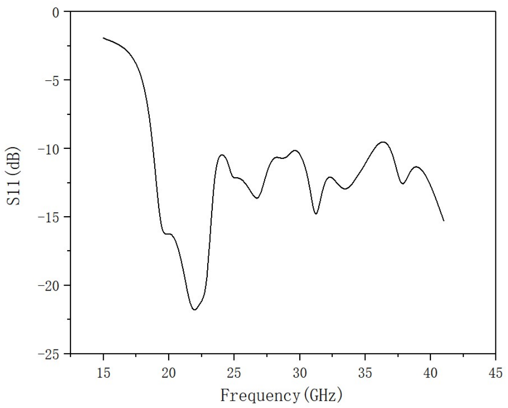


Fig. 2 S11 simulation result

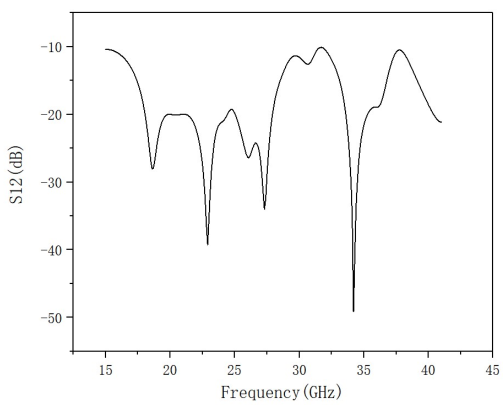


Fig. 3 S12 simulation result

Volume 8 Issue 9, 2022
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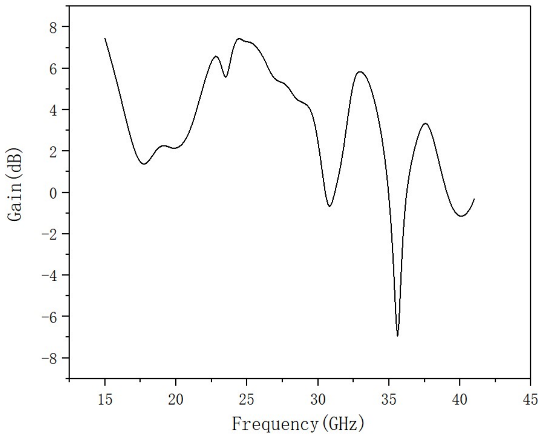

Fig.4 Gain simulation result

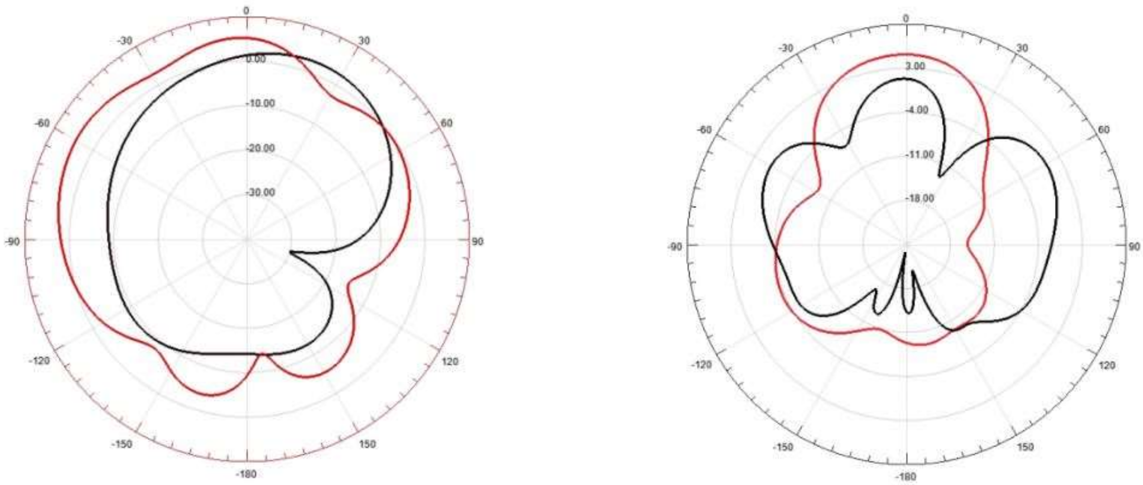

Fig.5 Simulation results of cross-polarization

3. Conclusion

A wideband dielectric resonator antenna with double-port inverted L-shaped feeders is designed. The antenna contains two identical cylindrical dielectric resonators. The two cylindrical dielectric resonators are excited by two inverted L-shaped microstrip lines connected by two ports to radiate energy. According to the ANSYS20 simulation results, the reflection coefficient S11<-10dB, the center frequency of the antenna is 28.35GHz, and the impedance bandwidth reaches 59.6% (18.78GHz-35.7GHz), the gain reaches 7.3dBi, and the isolation degree is less than -10dB. The antenna covers the 5G millimeter wave frequency band and has a good application prospect. However, the antenna still has some shortcomings, such as the isolation degree is not good enough. The antenna isolation degree will be improved later.

Acknowledgments

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