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Design of a Dual Frequency Circular Polarized Microstrip Antenna

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***Abstract*—Microstrip antennas have become the key of recent research and they are commonly used in wireless communications because of its mini size, low profile. This paper uses HFSS software to design a dual band circularly polarized microstrip antenna for navigation system which based on circular polarization and dual frequency/multi frequency technology. It adopts doubly fed point to realize circular polarization of the antenna and puts two different circular shaped patches on two dielectric substrates to achieve dual frequency work of antenna. This paper firstly introduces the based concept of microstrip antennas, and then describes circular polarization and dual frequency technique of antenna separately. Finally provides the design process and simulation results of dual band circularly polarized microstrip antenna.**

Keywords—microstrip antenna; circular polarization; dual-frequency technology; double feed point method

I. Introduction

With the rapid development of communication technology, the design of satellite antennas has also transitioned from receiving only a single frequency band to receiving multiple frequency bands at the same time [1, 2]. The advantages of microstrip antennas are many. For example, in terms of volume, it is relatively small, and its profile is also particularly low compared. And the advantages such as conformal with carriers are widely used in communication technology and other fields. Because of its many design and manufacturing advantages, the microstrip antenna has now occupied many places in communication. There are four kinds of global navigation and positioning systems that are currently known to everyone. Among them, in addition to China's Beidou satellites, there are several other types of navigation antennas. These navigation and positioning systems have placed circular polarization, and it can be seen that circular polarized antennas are common in the world [3]. The application of dual-frequence/multi-frequency and circular polarization to microstrip antennas is the focus of the researcher's research on the antenna [4, 5]. In this paper, two frequency bands of GPS circular polarized microstrip antennas are also studied. The two frequency bands of the GPS antenna are 1.227 GHz and 1.575 GHz.

II. Antenna Structure

The two-layer patch designed in this section implements a dual-frequency structure diagram. The upper and lower layers use circular patches, which are placed on two substrates with a dielectric constant of R = 4.4. We attach large round patches to the following slices. On, A small round patch is attached to the medium substrate above. the low-frequency segment of the antenna(L1 = 1.227 GHz) is produced by a large circular patch on the substrate of the lower medium.The high frequency segment(L2 = 1.575 GHz) is given by the small patch on the medium substrate above. Fig. 1 is a side view of the microstrip antenna structure. The bottom substrate is a feeding network. It is also equivalent to the ground of the antenna. The two probes in the figure are placed orthogonal and directly connected to the upper circular patch feed. The bottom patch is a coupled feeding method. We use the coupling method to get two signals with a phase difference of 90 degrees.

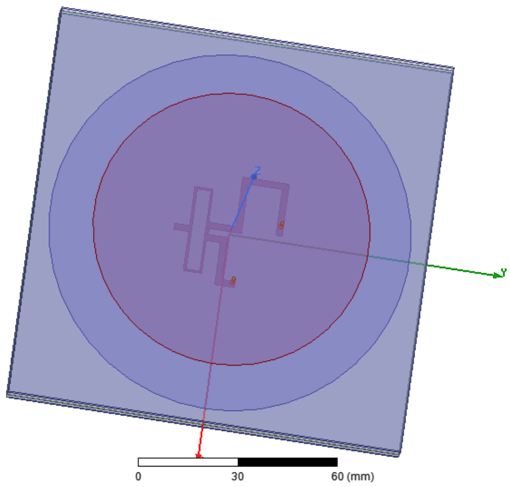


FIGURE I. ANTENNA STRUCTURE DIAGRAM

III. Simulation Results

It can be seen from Fig. 2 that at the low frequency of 1.227 GHz, the value of S11 is approximately -13.2882 dB; At 1.575 GHz in the high-frequency segment, the value of S11 is approximately -16.8267 dB. From the frequency band shown in the figure, it can be seen that the value of the microstrip antenna S11 is less than -10 dB, indicating that the performance of the antenna S11 is better than that of the design.

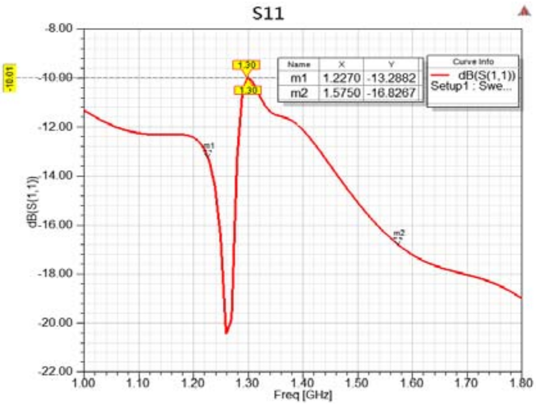


FIGURE II. ANTENNA RETURN LOSS

Figure 3 shows the voltage standing wave ratio of the antenna in this section. The voltage standing wave ratio is similar to that of the antenna S11. It represents the matching performance of the antenna. To achieve good matching performance, the voltage standing wave ratio coefficient of the antenna should be as close as possible. 1. It can be seen from the figure that at 1.227 GHz, VSWR = 1.5533; At 1.575 GHz, VSWR = 1.3367. It shows that the voltage standing wave ratio coefficient of the antenna also achieves a good goal.

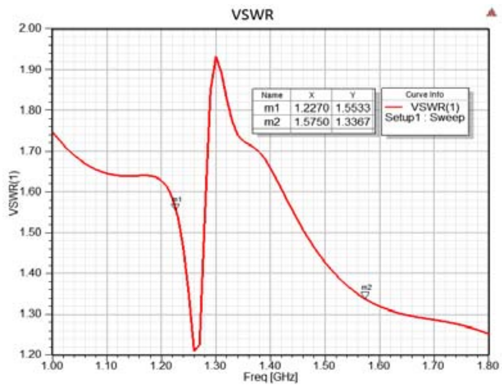


FIGURE III. ANTENNA VOLTAGE STANDING WAVE RATIO

Figure 4 shows the axis ratio of the antenna designed in this section. It can be seen that the axis ratio of the antenna is 2.1079 dB at the low frequency segment 1.227 GHz, and the axis ratio is 1.3141 dB at the high frequency segment 1.575 GHz of the antenna. Looking at the whole, since the axial ratio in these two frequency bands is less than 3dB, it can be seen that the antenna circular polarization performance designed in this section is also better.

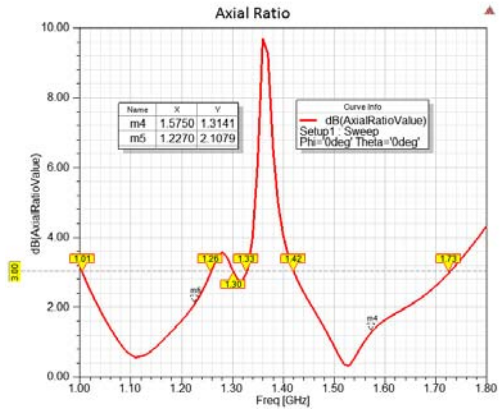


FIGURE IV. ANTENNA AXLE RATIO

See the antenna gain diagram in Fig. 5 of this article, where the gain in the entire band is greater than 2.5 dB. It can be seen from the figure that in the 1.227 GHz low frequency segment, its gain is 3.3694 dB in the figure, and when the antenna in the low frequency band has a larger gain than the set value, the bandwidth is 90 MHz. The gain in the high-frequency segment is higher. In the 1.47-1 .60 GHz, when the gain of the antenna is greater than 2.5 dB, its bandwidth is 130 MHz.

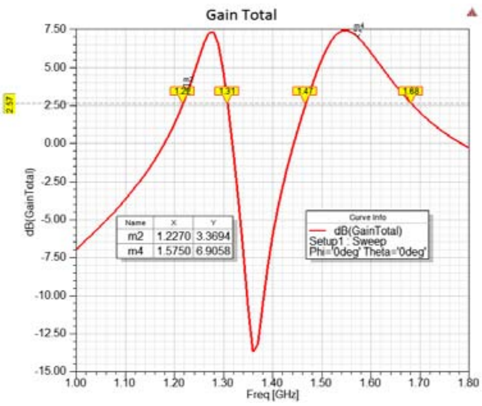
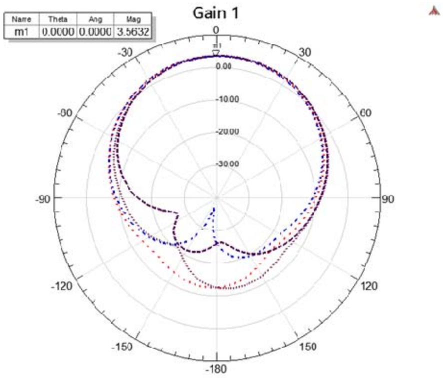
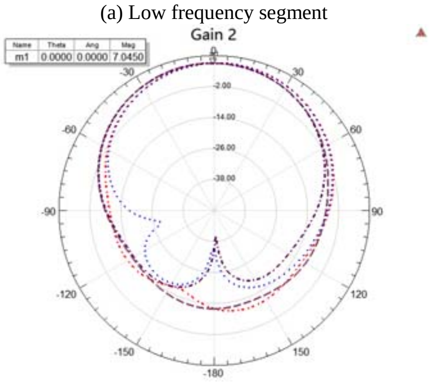


FIGURE V. ANTENNA GAIN CHART

Figure 6 is a two-dimensional gain map of the antenna, which has a gain of 3.5632 dB at low frequency bands; In the high-frequency segment, its gain is 7.0450 dB. After careful observation of the two-dimensional gain graph, the total gain is not much different from the right-handed gain curve and almost coincides with it. The result obtained by this microstrip antenna is a right-circular polarized microstrip antenna.



(a) Low frequency segment



(b) High frequency segment

FIGURE VI. TWO-DIMENSIONAL ANTENNA GAIN

IV. CONCLUSIONS

The design of layered double frequency circular polarized microstrip antenna is presented. Then the circular polarization technique and the double frequency band are put together to obtain the microstrip antenna needed in this paper. Ansoft software is used to optimize and simulate the antenna. The echo loss, axial ratio and gain of the antenna are analyzed in this paper.

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