Design of a low profile microstrip antenna for Beidou RDSS application

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Abstract: This paper presents a low profile circular polarization microstrip antenna for Beidou RDSS (Radio Determination Satellite Service) application. The antenna comprises two radiation patches which correspond to the centre operation frequency of 1.616 GHz and 2.492 GHz respectively. The total thickness of the antenna which contains two layers of dielectric substrate is 1.6mm. The proposed antenna shows good impedance bandwidth, gain and circular polarization characteristics, and is suitable for Beidou navigation terminal applications.

Keywords: microstrip antenna, circular polarization, impedance bandwidth, axial ratio bandwidth

I. INTRODUCTION

Due to the emerging need for Chinese Beidou navigation terminal, low profile antennas are of great demand. Though monopole antennas are thin, the gain is small and it is difficult to achieve circular polarization[1,2]. Helical antennas are easy to achieve circular polarization and a better gain, but they have high profile[3,4]. Planar spiral antennas have a low profile and wideband circular polarization characteristics, but the gain is small and not suitable for Beidou terminals applications[5,6]. Microstrip antennas have been popular for decades because they exhibit a low profile, small size, lightweight, conformity, low manufacturing cost and an easy method of fabrication and installation[7-10]. Therefore, microstrip antennas are the best choice for low-profile antenna requirements on Beidou terminal applications. In this paper, a low-profile microstrip antenna is designed.

II. DEFINITION OF THE ANTENNA

The proposed antenna is described in this section. Fig. 1 shows the top and side views of the antenna which has two layers of substrate. The radiating face of patch_1 in Fig.1 (a) is square copper plane which some slots are incorporated into this patch for miniaturization and circular polarization. The radiating face of patch_2 is a conventional square copper plane with a truncated angle. The antenna is fed by two probes, shown in Fig.1 (b). Both the two layer substrates of the proposed antenna have the same thickness and relative permittivity.

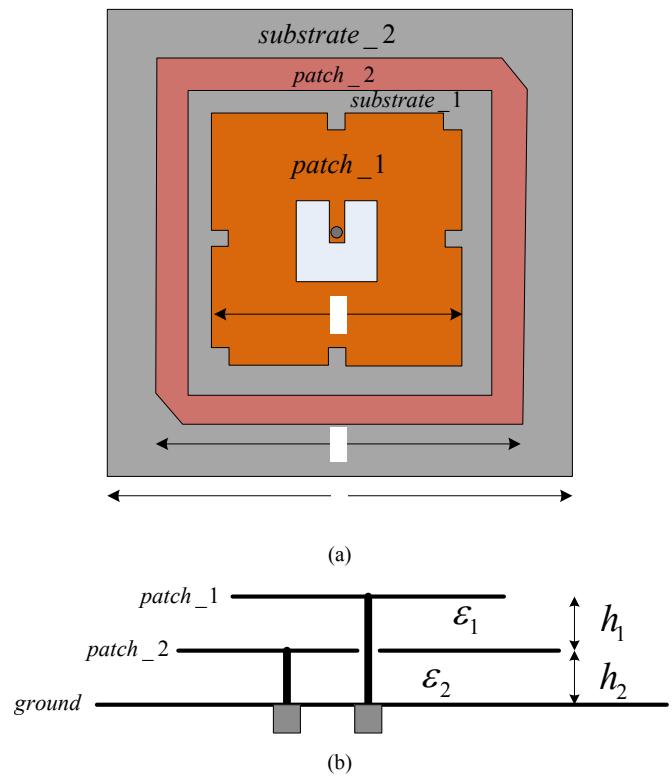
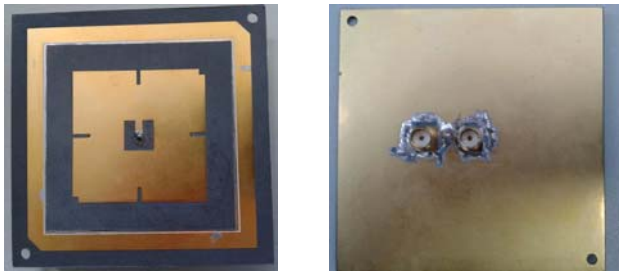


Fig. 1. Antenna configuration proposed. (a) the top view; (b) the side view.

III SIMULATIONS AND MEASUREMENTS

The effects of the different structural parameters on the proposed antenna characteristics are studied. The results are obtained by simulations and verified by measurements. A particular example of fabricated prototype will be studied in terms of reflection coefficient, gain and axial ratio. The selected dimensions shown in Fig.1 for this example are as

follow: the height of the substrate is $h_1 = h_2 = 0.8mm$; the substrate relative permittivity is $\varepsilon_{1r} = \varepsilon_{2r} = 2.2$; the side length of patch_1 and patch_2 are $l_1 = 36mm$, $l_2 = 61.4mm$ respectively; the ground plane size is $l_3 \times l_3$ of $70mm \times 70mm$. A photo of the manufactured prototype is shown in Fig. 2.



(a) (b)

Fig.2 A photo of the manufactured prototype. (a) top view, (b) back view.

Fig.3 shows the S_{11} at centre frequency of 1.616G for both simulation and measured results, and it can be found that the simulation results agree well with the measured results. The S_{11} was measured with an Agilent E5071C network analyzer and is illustrated in Fig. 3, in which the resonant frequency is tuned from 1.607 GHz to 1.624GHz with better than -10dB reflection coefficient. Similarly, Fig.4 shows the S_{11} at centre frequency of 2.492G for both simulation and measured results. The measured resonant frequency is tuned from 2.478 GHz to 2.501GHz with better than -10dB reflection coefficient, which achieve the Beidou terminal application requirements.

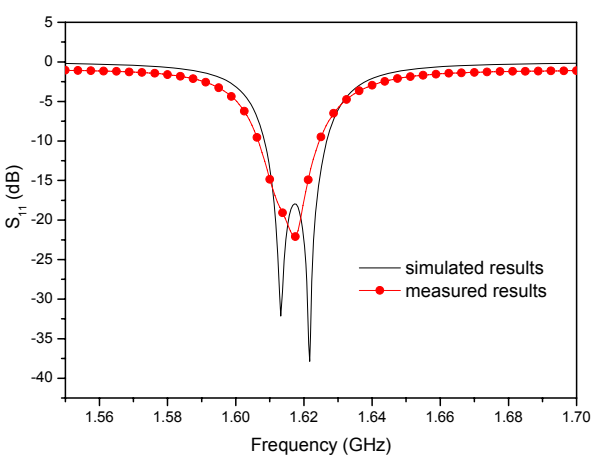


Fig.3 Simulation and measured results of the S_{11} at centre operating frequency of 1.616GHz.

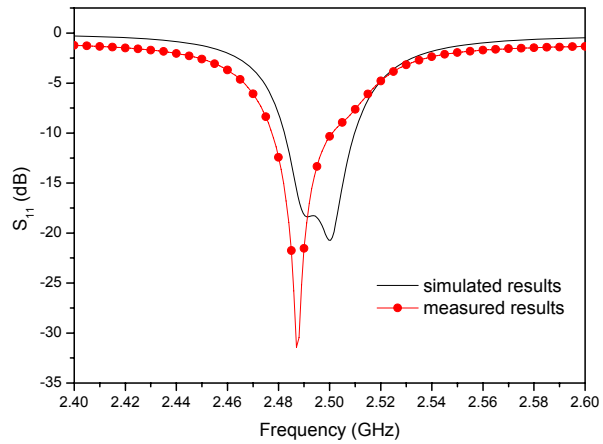


Fig.4 Simulation and measured results of the S_{11} at centre operating frequency of 2.492GHz.

Fig.5 shows the Simulation results of the axial ratio (AR) bandwidth. An acceptable axial ratio ($AR < 2$) is obtained in a broad angular range from -90 to 90 degrees from the boresight at azimuth of phi=0° and phi=90° for both centre frequency of 1.616GHz and 2.492GHz. From Fig.5, it can be observed that the proposed antenna has a good circular polarization characteristic.

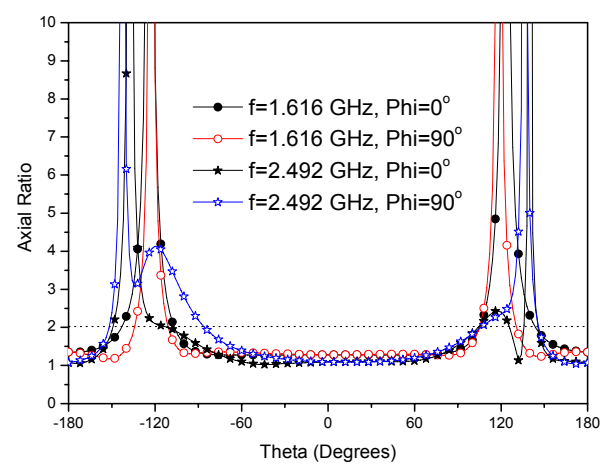


Fig.5 axial ratio of the angular range at azimuth of phi=0° and phi=90° for both centre frequency of 1.616GHz and 2.492GHz.

Fig.6 shows the simulation results of the gain of the proposed antenna at azimuth of phi=0° and phi=90° for both centre frequency of 1.616GHz and 2.492GHz. From Fig.6, it is found that the gain at the resonances is 5.2dBi and 7.3dBi, respectively.

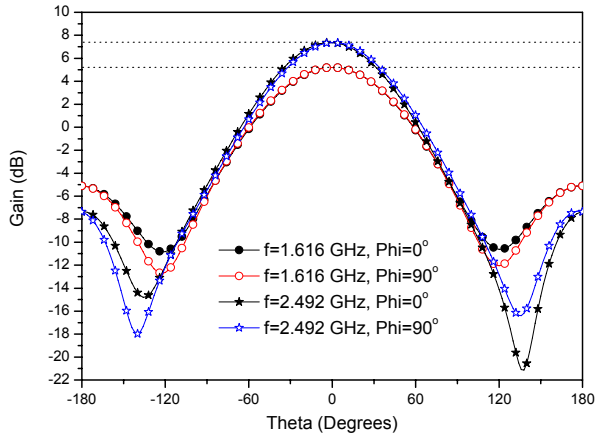


Fig.6 simulations results of the gain of the proposed antenna at azimuth of phi=0° and phi=90° for both centre frequency of 1.616GHz and 2.492GHz.

IV. CONCLUSION

A low profile microstrip antenna with total thickness of 1.6mm for Beidou terminal application is presented in this paper. The proposed antenna has dual frequency with centre operating frequency of 1.616GHz and 2.492GHz, respectively. An acceptable axial ratio is obtained in a broad angular range from -90 to 90 degrees from boresight. The total gain at the frequency point of 1.616GHz and 2.492GHz are more than 5.2 dBi and 7.3dBi, respectively. The proposed patch antenna has the attractive features of low profile, high gain, simplicity and good circular polarization characterization, which make it a good candidate for Beidou RDSS application in specific area.

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