A High Isolation Dual-Polarized Microstrip Antenna for Sub-6 GHz Base Station

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ABSTRACT

A dual-polarized microstrip antenna with high isolation for Sub-6 GHz (3.4-3.6 GHz) base station application is presented in this letter. To increase isolation between two feed ports, the stacked patches are excited by double orthogonal open-ended feed lines. The proposed antenna is simulated by HFSS18.0. The simulation results show that the isolation is better than 50 dB over the whole bandwidth from 3.23 to 3.85 GHz with the cross-polarization levels less than -30 dB when the gains are higher than 7.64 dBi for dual polarization. It’s valuable for this design method to devise mobile communication system base station antenna used in Sub-6 GHz of China Unicom and China Telecom.

KEYWORDS

Microstrip Antenna, Dual-polarization, High Isolation.

INTRODUCTION

Due to the advantage of increasing channel capacity, dual-polarization antenna is often applied in mobile communication base station, which requires good isolation in a specific operating band for a dual-polarized antenna.

Microstrip antenna is a kind of dual-polarization antenna type. However, the

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impedance band of conventional microstrip antenna is about 3%[1], which is difficult to meet the requirements of engineering application. Hence, many different methods are carried out to broaden the band of traditional microstrip antenna such as circuitous probes proximity coupling a single patch[2],[6], introducing one air layer[3],[5], two pairs of T-shaped slots on the two bowtie-shaped patches separately[4].

To reduce the mutual effect of both polarization ports, many techniques of improving isolation are put forward. For instance, short pins are inserted between patch and ground[4],[6], two slots are etched in the ground[7],[9], and two different feed methods are used [8].

However, none of antennas achieve the isolation of greater than 50 dB for Sub-6 GHz band in the above references, which is main problem to solve in this letter. Inspired by the design method in[9], using two perpendicular open-ended microstrip lines to excite stacked patches via two H-shaped slots, a dual-polarized microstrip antenna with high isolation for Sub-6 GHz is presented.

**ANTENNA STRUCTURE**

Figure 1 shows the geometry of the proposed antenna which consists of three layers of square dielectric substrates with a relative dielectric constant of 2.2 and one air layer. The upper patch is printed on the bottom of substrate 1. The lower patch separated from the upper one by an air layer to broaden the impedance band is etched on the top of substrate 2. Four plastic struts are used to support substrate 1. The ground plane in which two orthogonal H-shaped slots are etched is positioned at the top of substrate 3. Two orthogonal open-ended microstrip lines are printed on the bottom of substrate 3. When port 1 is excited, vertical polarization is obtained. Similarly, when port 2 is stimulated, horizontal polarization is generated. The distances between the center of two slots and the center of the ground plane are x1 and x2, respectively. Simulated by HFSS 18.0, the values of the antenna sizes are listed in TABLE I.
Figure 1. Configuration of the proposed antenna:(a) front view;(b) top view;(c) H-shaped slot.

| parameter | value | parameter | value | parameter | value |
|-----------|-------|-----------|-------|-----------|-------|
| L1        | 24    | g1        | 8     | tt1       | 8     |
| W1        | 2.2   | s1        | 0.5   | h1        | 0.5   |
| L2        | 32    | rr0       | 0.6   | h2        | 6.8   |
| W2        | 2.2   | rr1       | 8     | h3        | 1     |
| a0        | 56    | g2        | 5     | h4        | 0.5   |
| a1        | 29    | s2        | 0.5   | x1        | 8     |
| a2        | 24    | tt0       | 0.5   | x2        | 9     |
SIMULATION RESULTS OF ANTENNA

The simulated S-parameters are plotted in Figure 2. It is observed that the simulated bandwidth is from 3.21 to 3.85 GHz for port 1 and the bandwidth of port 2 from 3.23 to 3.87 GHz. The common bandwidth for both ports is about 17.5% (3.23-3.85 GHz). It’s also seen that the simulation isolation between two ports is higher than 50 dB over the whole band. The simulation radiation patterns are depicted in Fig.3 at 3.5 GHz. For port 1, the cross-polarization levels are lower than -40 dB both in xz-plane and yz-plane. As for port 2, the cross-polarization levels are lower than -30 dB both in xz-plane and yz-plane. The simulated gains of the proposed antenna for both ports are plotted in Fig.4. The gains for both horizontal polarization and vertical polarization are stable and greater than 7.64 dBi ranging from 3.23 to 3.85 GHz.

Finally, the key characteristics of the proposed dual-polarized microstrip antenna is compared with previous work in[10],[11],[12] and[13] which all cover Sub-6 GHz band in TABLE II. It is evident that the proposed antenna is competitive in the key characteristics, particularly for port to port isolation. Therefore, the proposed antenna is a good candidate for Sub-6 GHz band base station application.

![Figure 2. S-parameters of the proposed antenna.](image-url)
Figure 3. Radiation patterns at 3.5GHz for (a) port 1; (b) port 2.

Figure 4. Gains of the proposed antenna for two ports.

| Antennas | Common Bandwidth (GHz) | Isolation (dB) | Peak Gain (dBi) | Dimensions (mm³) |
|----------|------------------------|----------------|-----------------|------------------|
| [10]     | 3.14-3.81              | >43            | 8.1             | 82*82*13.4       |
| [11]     | 3.3-3.6                | >30            | 8.2             | 105*105*30       |
| [12]     | 3.05-4.42              | >20            | 9.36            | 51*51*18.7       |
| [13]     | 3.24-4.03              | >25            | 6.86            | 72*72*9.5        |
| proposed | 3.23-3.85              | >50            | 8.88            | 56*56*8.8        |
CONCLUSION

The design method of dual-polarized microstrip antenna with high isolation is presented in this letter. The isolation is improved through two orthogonal open-ended microstrip feed lines. The simulation results in TABLE II reveal that the proposed antenna has a clear advantage for Sub-6 GHz band, especially about isolation. Besides, the cross-polarization levels are lower than -30 dB both in xz-plane and yz-plane while the proposed antenna is simple in structure. The above simulation results prove that it’s valuable for the proposed dual-polarized microstrip antenna in the mobile communication base station applied for Sub-6 GHz of China Unicom and China Telecom.

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