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A Base Station Antenna Element with Simple Structure but Excellent Performance

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Abstract— **A ±45° dual-polarized concentrically arranged dipole antenna is proposed for base station applications. The simple, robust antenna consists of four simple dipoles arranged in a square above a flat reflector. Two specially designed feeding networks for the two polarizations are proposed to simultaneously excite the four dipoles. Without shaping the reflector, the combination of four dipoles provides a stable radiation pattern across a wide bandwidth. Measured results show that the proposed antenna has an input reflection coefficient ≤ -14 dB from 1.71 to 2.71 GHz for both polarizations. Across this wide bandwidth (45.2%), the half-power-beamwidths (HPBWs) of the two polarizations remain very stable in the range from 60.5° to 69.5°. High port-to-port isolation ≥ 30 dB and low cross-polarization level ≤ -20 dB are achieved over the entire operating band.**

Keywords— ***base station antenna; dual polarization; stable radiation pattern; wideband.***

I. Introduction

Modern base station antennas are required to have ±45° dual-polarizations, low VSWR, low cross-polarization level, high port-to-port isolation, and stable radiation patterns across a wide operation band (1.71 GHz to 2.69 GHz). Cross-dipole antennas provide very promising solutions to meet the above-mentioned specifications [1]-[3]. They employ two sub-dipoles perpendicular to each other to obtain dual-polarizations. The configuration with only two electric dipoles intrinsically has its radiation pattern varying with frequency, thus making it difficult to maintain stable radiation patterns across a wide band [1]. To stabilize the pattern, shaped reflectors are used [2]-[3], but they inevitably increase design complexity and cost. Magneto-electric (ME) dipoles using two magnetic and two electric dipoles can achieve very stable pattern across a wide band without shaping the reflectors [4]. This is because, the radiation patterns generated by the magnetic and electric dipoles complement each other as the frequency changes. However, ME dipoles published in the literature only show moderate matching capability of VSWR<2. Stable radiation patterns as required in base station applications can also be realized by combining the radiation of four electric dipoles, such as shown in [5]. Four folded dipoles are utilized and are excited at the same time to realize the ±45° dual polarization. However, the reported work to date can only have limited impedance bandwidths < 27%, which cannot fulfill the base station antenna's requirement.

In this paper, a simple concentrically arranged dipole antenna consisting of four electric dipoles and a flat reflector is described which provides a stable radiation patterns across the target band from 1.71 to 2.69 GHz. We firstly modeled four electric dipoles without feed network to obtain the requested radiation performance, and then matched the antenna using two feed networks. Finally, a prototype was fabricated and tested. Measured results show that stable radiation patterns are achieved across the entire target band combined with excellent matching performance.

II. Configuration of the Broadband Dual-Polarized Antenna

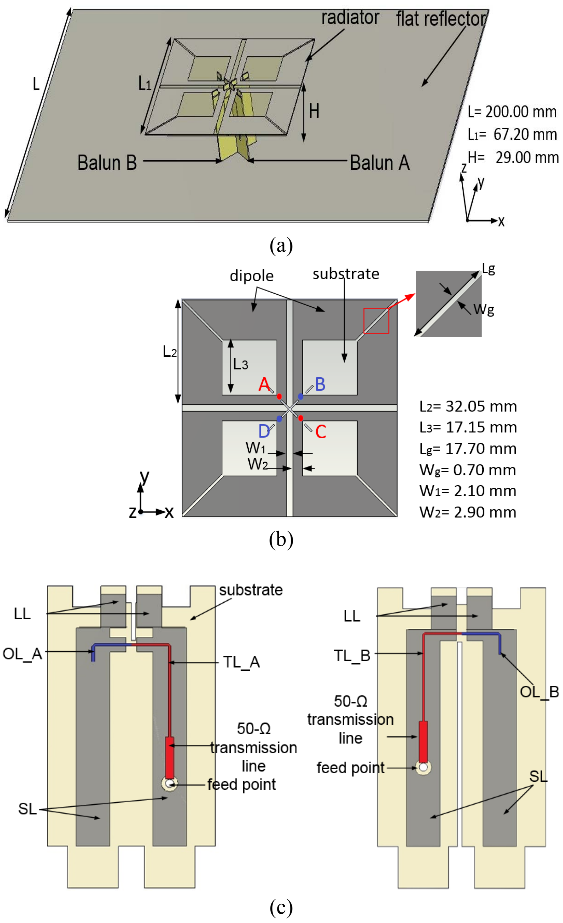


Fig. 1. Antenna configuration: (a) perspective view; (b) top view; (c) detached view of Balun A and B.

The proposed antenna is shown in Fig. 1(a). It consists of four dipoles, two microstrip baluns, and a flat square metallic plate as reflector. The two baluns are perpendicular to each other and mounted between the radiators and the reflector. Fig. 1(b) gives the detailed view of the radiators. The four dipoles are printed on a FR4 substrate and arranged in a square loop. Gaps of width *Wg* and length *Lg* are left between the adjacent dipoles for tuning. The dipoles are linked together by coupled lines as illustrated in Fig. 1(b), so that they can be excited together. Baluns A and B are employed to provide balance feeds at AC and BD to have different polarizations. The baluns have similar configurations as shown in Fig. 1(c). Each balun consists of four essential parts: a link line (LL), a transmission line (TL), an open line (OL), and a short line (SL). In addition, a segment of 50-Ω microstrip line is added at the end of the TL and is connected to a standard coaxial cable at the feed point. LL and SL that are located on the back of the substrate, while OL, TL, and 50-Ω microstrip lines are located on the front side of the substrate. The slots and rectangle tabs on the baluns are designed for antenna assembling. A flat metallic plate is placed under the dipoles to act as a reflector. All the substrates employed in Fig. 1 are FR4 substrate with dielectric constant of 4.3 and thickness of 0.5 mm.

III. Simulation and Measurement Results

To verify the performance of the proposed antenna, a prototype was fabricated and tested. Fig. 2 gives the simulated and measured S-parameters of the two ports. Within the target band (1.71 GHz to 2.69 GHz), the measured reflection coefficient $|S_{11}|/|S_{22}|$ are all ≤ -14 dB. The port-to-port isolations of the simulation and measurement results are > 30 dB over the entire operating frequency band. The simulated and measured radiation patterns at 1.7 GHz and 2.7 GHz in the horizontal plane are shown in Fig. 3. These results are seen to be in good agreement. The measured cross-polarization level is < -20 dB within the coverage. Fig. 4 shows the simulated and measured HPBWs and gains of the dipole antenna for both the two polarizations. The measured HPBW is 64.0°±4.5° and 65.3°±4.2° for port 1 and port 2, respectively. The measured gain varies from 8.8 dBi to 10.1 dBi for port 1, and from 8.6 dBi to 9.9 dBi for port 2. The measured results demonstrate that this simple antenna achieves a stable radiation pattern over a wide bandwidth without reflector shaping.

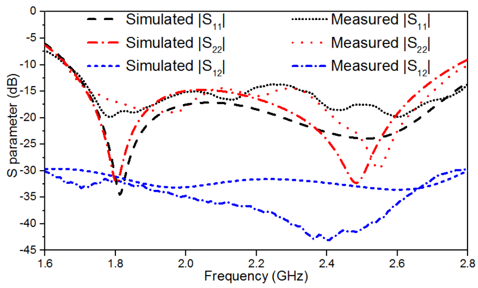
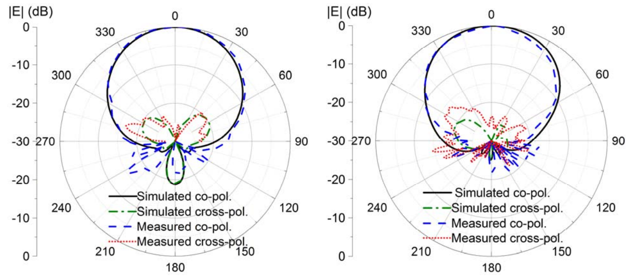


Fig. 2. Simulated and measured S-parameters of the proposed antenna.



(a) (b)

Fig. 3. Simulated and measured radiation patterns of the proposed antenna at (a) 1.7 GHz and (b) 2.7 GHz.

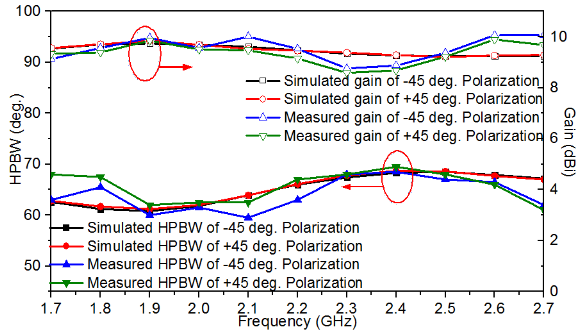


Fig. 4. Simulated and measured HPBWs and gains.

IV. Conclusion

A broadband ±45° dual-polarized concentrically arranged dipole antenna has been designed, fabricated, and tested. It utilizes four electric dipoles arranged in a square circle and is fed by two baluns, featuring a simple structure and low profile. Stable radiation patterns are achieved over a wide band by a concentrica arrangement of four dipoles mounted above a flat reflector that achieves a very good match (VSWR < 1.5) across the entire targeted band. Due to its simple structure and excellent performance, it is a potential candidate for commercial use.

References

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