# Dual-Polarized Antenna Based on Metal Ring and Microstrip Patch

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***Abstract*─** Based on the principle of the complementary antenna, a kind of dual-polarized antenna element is studied, which combines the metal ring and rectangular microstrip patch. The antenna separates the rectangular microstrip patch and the metal ring on a vertical space, and the metal ring is equivalent to a current radiation source. The rectangular microstrip patch is equivalent to a magnetic flux radiation source, which respectively radiates and receives two orthogonal polarized electromagnetic wave components to achieve dual polarization. A metal reflector ground is introduced to realize the uni-direction radiation pattern, and the front-to-back ratio of the pattern has been improved. The simulation results show that the isolation between two polarization ports is 22dB within the frequency range of 4.94GHz~5.06GHz. The measured results of the fabricated antenna indicate that the Voltage Standing Wave Ratio (VSWR), port isolation degree and the cross polarization level can satisfy technical requirements. And design effectiveness of the dual-polarized antenna in this paper was proved. The dual-polarized antenna studied in this paper has been suitable for some application fields such as phased array radar and the research results lay the technical foundation for the practical engineering application.

***Index Terms* ─** Cross polarization level, dipole, dual-polarized antenna, microstrip patch antenna, radiation pattern.

## I. INTRODUCTION

Phased array antenna which compares with mechanical scanning, phased array antenna, as one of the types of electro-scanning antennas, have advantages in beam scanning without inertia, fast beam scheduling and multi-beam capability [1]. The indexes of antenna element directly affect the overall performance of phased array antenna. Therefore, the design and study on phased array antenna element to be applied in engineering application is very meaningful.

Polarization is an inherently important information for radio waves. The wireless electronics with the ability to sense the polarization of electromagnetic waves have better performance than conventional single-polarization electronic devices. The polarization information has gained widespread attention in the field of radar. Dual-polarized antenna can transmit or receive two orthogonally polarized electromagnetic waves, it can be used to get amplitude and phase or other information from the scattered wave of target. Dual-polarized antennas are the key components of phased arrays and MIMO arrays, the design and implementation of dual-polarized antennas have become a hot research area in the field of antenna technology [2-3]. The research on dual-polarization antenna mainly focuses on the radiation principle, realization plan and feasibility of dual-polarization antenna [4-7]. From the radiation mechanism point of view, the dual-polarized antenna is composed of orthogonal current source and magnetic current source, the two polarized ports respectively radiate or receive the corresponding polarized electromagnetic wave. From the structure point of view, the dual-polarized antenna mainly includes the dual-polarized dipole antenna, the dual-polarized log-periodic antenna, the dual-polarized microstrip patch antenna, the dual-polarized aperture antenna and the dual-polarized vivaldi antenna, etc. For example, Qun and his team studied a dual-polarized antenna based on printed dipole and circular microstrip patch structure, the antenna was designed by a combination of a current source and a magnetic current source to explore its engineering realization technology and its radiation performance [8]. A dual-band dual-polarized log-periodic dipole array for multiple-input-multiple-output WLAN applications is proposed in [9]. The antenna has 12 antennas element: six for horizontal polarization and six for vertical polarization. The proposed array is manufactured and exhibits the characteristics of high isolation, good

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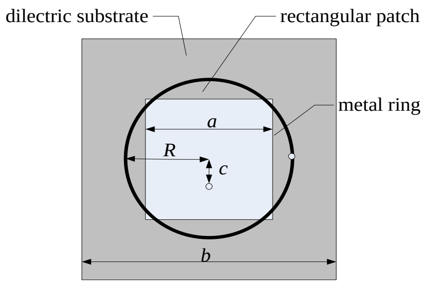
front-to-back ratio. A Ku-band dual-linear polarized broadband aperture-coupled antenna is presented based on substrate integrated waveguide technology in [10]. Experimental results indicated that the isolation is more than 40dB, the bandwidth obtains 21% of return loss less than -20dB. A cross-placed Vivaldi antenna is designed in [11], the working frequency of this antenna is 0.7GHz~7.3GHz when the return loss is less than -10dB.

In engineering applications, dual-polarized microstrip patch antenna is one of the most widely used dual-polarized antenna types [12-13]. The radiation of the microstrip patch antenna can be regarded as the radiation of the gap around the patch. According to the equivalent principle of the electromagnetic field, the radiation of the slot can be understood as the radiation of the magnetic current source. The dual-polarized microstrip patch antenna adopts printed circuit technology processing with the advantages of low profile, small size, light weight and low cost. Besides, the feed method of dual-polarized microstrip antenna is flexible and easy to be achieve microstrip side-fed, microstrip corner-fed and electromagnetic coupling feed [14-15]. However, the working bandwidth of the microstrip antenna is narrow, the polarization port isolation of the dual-polarized antenna and the cross-polarization level of the radiation field are higher. Although the improvement measures can be used to extend the impedance bandwidth of the microstrip antenna and improve the antenna pole, but the structure of the dual-polarized antenna is also complicated and the difficulty of engineering is increased. Printed dipole is a common form of microwave radiators, it can achieve a larger impedance bandwidth. The shape of the metal conductor vibrator can be rectangular, circular, oval, butterfly or many other shapes. The printed dipole antenna is realized by loading the dipole structure on dielectric substrate, its feeding methods include coaxial line, coplanar waveguide (CPW), etc. It is designed to be flexible and can even achieve ultra-wideband (UWB) performance [16-19]. Dual-polarized dipole antenna is composed of two orthogonally placed dipoles, equivalent to two orthogonal current source, this antenna has been widely used in base stations, communications and other fields. A Ku-band dual polarization microstrip array antenna is presented in [20]. The microstrip patch antenna as the array element radiates orthogonally excited by approximate and slot coupling, respectively. The design by simulation indicates that the antenna has a good performance of low cross polarization level within large frequency bandwidth. A compact ultra-wideband diversity monopole antenna with tilted inverted tree branches is proposed in [21]. From the discussion above, the microstrip antenna can be seen as the radiation of the orthogonal magnetic current source, dual-polarized printed dipole antenna can be seen as the radiation of the orthogonal current source. According to the principle of duality, their radiation field structure in space is also dual. As space angle changes, the orthogonal polarization characteristics of the two types of dual-polarized antennas will change greatly, and the technical implementation is relatively mature.

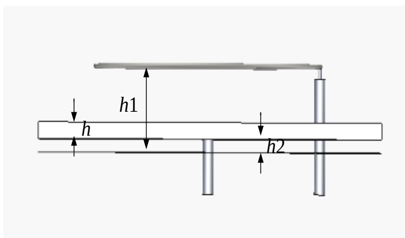
Most dual-polarized antennas are achieved by orthogonal feeding of a single type of antenna, but the freedom of design is low and the isolation is hardly to improve. Therefore, we designed a dual-polarized antenna structure based on metal ring and rectangular patch from the engineering requirements. The antenna separately places the rectangular patch and the metal ring in the vertical space and respectively radiates or receives two orthogonally polarized electromagnetic wave components to realize a dual-polarized working mode; Due to the laminated structure, the feeding of the two polarized ports is introduced from the bottom of the antenna element without affecting each other. This structure improves the isolation of the polarization ports of the antenna and is more suitable for the installation of phased array antennas. The rectangular chip can be equivalent to the radiation of the current source, while the metal ring can be equivalent to the radiation of the magnetic source. Therefore, the radiation principle of the dual-polarized antenna proposed in this paper is based on the radiation of the orthogonal electromagnetic source, which is different from the traditional dual-polarized antenna in principle and has strong innovation.

## II. ANTENNA DESIGN

According to the principle of the metal circular antenna, the metal ring can be equivalent to two half-wave dipole, while the microstrip rectangular patch antenna is equivalent to two half-wave slot antennas with equal amplitude and phase. The half-wavelength slot antenna and the half-wave dipole are complementary antennas to each other, which satisfies the duality principle. So the two complementary antennas have the same radiation pattern in the ideal case. Therefore, based on the complementary principle of the half-wave dipole and the half-wavelength slot antenna, the dual-polarzied antenna is proposed in this paper and shown in Fig. 1. The metal ring in the upper layer and the microstrip rectangular patch in the lower layer form a basic structure of antenna. The two ports of antenna are fed directly by the coaxial, so that it will facilitate the feed when the array composed. As for the antenna simulation, we use the finite difference method based on three-dimensional electromagnetic simulation software CST for rigorous numerical calculations to get the best results. The dual-polarized antenna designed is a combination of two types of antennas, so how to reduce the mutual coupling between them during the design process is a design difficulty. First, we need to determine the structure of the antenna and feeding method, then consider the influence of the size of the substrate and the dielectric constant, the size of the rectangular patch and the radius of the metal ring, etc. finally get the dual polarized antenna.




(a) Top view




(b) Side view

Fig. 1. Schematic view of antenna.

Choosing wavelength ring to be the metal ring. At first, we use a copper wire with a diameter of 0.4mm as the material of the metal ring, and then according to the principle of the wavelength ring, the radius of the ring can be approximated by the formula $r = \lambda / 2\pi$ at the center frequency of 5GHz and finely adjusted considering the influence between the antennas.

The length of rectangular patch ($\boldsymbol{a}$) can be approximated by the formula:

$$\boldsymbol{a} = \frac{c}{2f}\left(\frac{\varepsilon_r+1}{2}\right)^{-\frac{1}{2}}, \tag{1}$$

$$\boldsymbol{a} = \frac{c}{2f\sqrt{\varepsilon_e}} - 2\Delta \boldsymbol{l}, \tag{2}$$

$$\Delta \boldsymbol{l} = \mathbf{0.412}\boldsymbol{h}\frac{(\varepsilon_e+0.3)(a/h+0.264)}{(\varepsilon_e+0.258)(a/h+0.8)}. \tag{3}$$

At modeling, the size of the antenna can be calculated by the formula, but the calculated sizes are theoretical value. In fact, those calculated antenna sizes need be optimized by the simulation software.

In this paper we use the commonly FR4 dielectric substrate with $\varepsilon_r$=4.3. In order to reduce the workload of the rectangular patch in the simulation, we set the height and width of the dielectric substrate is 35mm×35mm.

When the rectangular patch is fed by the coaxial, the antenna's input impedance consists of two parts, the impedance $Z_R$ is caused by the main transmission mode in the antenna, and the probe impedance $X_L$ is caused by higher order mode, so the input impedance of the antenna $Z_{in}=Z_R+jX_L$.

By adjusting the distance c from the feeding point to the center, the square patch can achieve 50Ω matching to reduce the return loss of the port. The changing curve of return loss of rectangular patch port with feed distance *c* is shown in Fig. 2. It can be clearly seen from the figure that the return loss of the rectangular patch port is the smallest when the feeding point is 3mm away from the center of the patch, and the best resonance effect is obtained. However, the matching effect of the distance too close or too far are not very good.

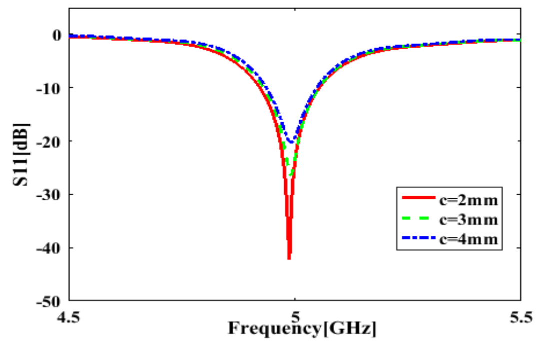



Fig. 2. The change curve of return loss of rectangular patch port with feed position.

The rectangular microstrip patch has resonant characteristics, which can be used as an antenna, but its working frequency band is only about 1%. The main methods to increase the microstrip antenna working frequency band include: (1) Increase the thickness of the dielectric substrate *h*, which is equivalent to increase the width of the radiation slot or reduce characteristic impedance of the microstrip structure, so that the input impedance of the antenna decreases with the frequency changes. But the effect of this method is limited, which is not conducive to the miniaturization of the microstrip antenna, and the requirements of increasing the thickness and decreasing the height are conflicting. This problem can be solved by using substrate with higher relative permittivity, but it will also increase the loss of the antenna. (2) By changing the form of radiation patch, for example, increasing the number of radiation patches and adopting special patches such as E-type, they can be respectively resonated at different frequencies, so that the total working frequency band can be widened.

Without changing the antenna feeding method and the overall structure, the bandwidth of the rectangular microstrip patch antenna is increased by adding slot below the dielectric substrate. The slot structure can make the antenna have close but different resonant frequencies, so the impedance bandwidth is widened. The change curve of S11 with the slot width is shown in Fig. 3.

The bandwidth of rectangular patch has increased nearly double by using slot structure, and the rectangular patch antenna can get the optimal resonance effect by adjust the slot width h2.

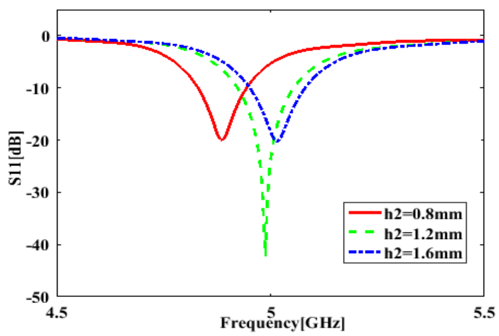



Fig. 3. The change curve of return loss of rectangular patch with the slot width.

The rectangular patch and the metal ring composed the dual-Polarized antenna. When the antenna is working, there are some coupling effect between the rectangular patch and the metal ring. Those coupling effect can cause S-parameters worsen, and radiation 3dB beam width narrowing.

## III. SIMULATION AND ANALYSIS

In this paper, the full wave electromagnetic simulation software is used to optimize the performance and structure of the antenna. A set of parameters were obtained to meet the design requirements: $a$=17.8mm, $b$=35mm, $c$=3mm, $R$=11.5mm, $h$=1.5mm, $h1$=6.7mm, $h2$=1.2mm. The simulated curves of S-parameters are obtained by using CST. Figure 4 shows that port 1 is rectangular patch port and port 2 is metal ring port. When the return loss of the dual-polarized antenna is less than -10dB, the working frequency band of the metal ring port is 4.87GHz~5.11GHz and the working frequency band of the rectangular patch port is 4.94GHz~5.06GHz. The overall bandwidth of the antenna is 4.94GHz~5.06GHz. The isolation between ports is less than -22dB within the bandwid.

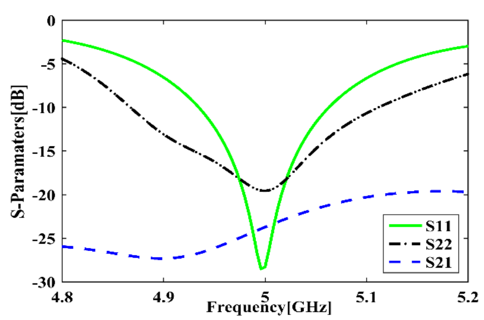



Fig. 4. S-parameter curve of dual-polarized antenna based on metal ring and rectangular patch.

Figure 5 shows the far-field radiation pattern of the two ports of the dual-polarized antenna at the center frequency of 5GHz. As can be seen from the figure, the radiation pattern of the rectangular patch is very regular, and the maximum gain of the radiation far-field is 7.17dB. The 3dB beam width of the $\varphi = 0^\circ$ plane is 83.7°. The 3dB beam width of the $\varphi = 90^\circ$ plane is 82.2°. The maximum gain of the metal ring part is 7.31 dB in the radiation far-field. The 3dB beam width of the $\varphi = 0^\circ$ plane is 56.5°, and the 3dB beam width of the $\varphi = 90^\circ$ plane is 80.2°. The gain of the two polarized antennas is relatively close, but the difference of the beam width is large. This is because there is a certain difference in the binary half-wave oscillator spacing between that equivalent by the rectangular patch and metal ring.

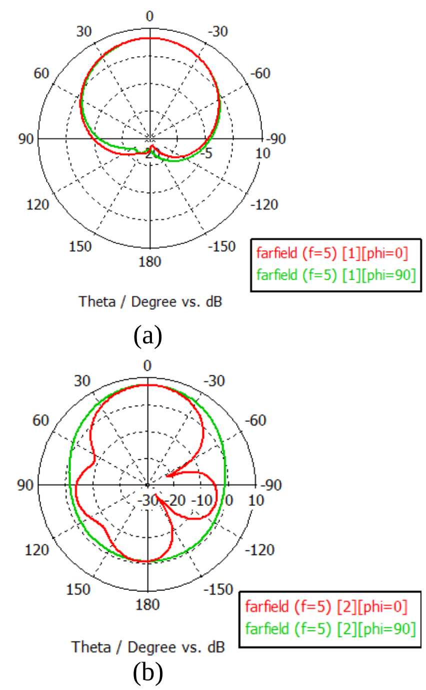
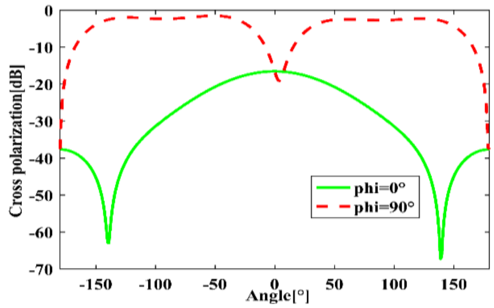
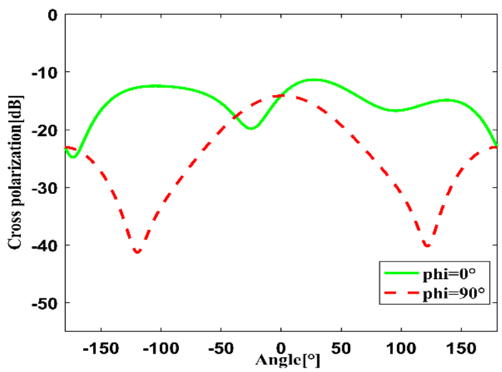



Fig. 5. Radiation pattern of dual-polarized antenna at a frequency of 5GHz: (a) rectangular microstrip patch, and (b) metal ring.

The cross polarization level of the antenna is also a very important performance parameter for dual-polarized antennas. The general communication system requires that the absolute value of the cross polarization level should be greater than 15dB. It can be seen from Fig. 6 that the cross polarization level of the two ports is less than -15dB at the main radiation direction.




(a) The cross polarization level of metal rings




(b) The cross polarization level of rectangular patch

Fig. 6. Simulation results of cross polarization level of dual-polarized antenna.

## IV. MEASUREMENT RESULTS

According to the design of the antenna structure and size, the dual-polarized antenna based on metal ring and microstrip patch is processed, assembled and tested.

Figure 7 shows the physical photos after antenna processing. We use the second substrate with little influence on antenna. Therefore, the second layer substrate has little effect on the processed antenna performance.

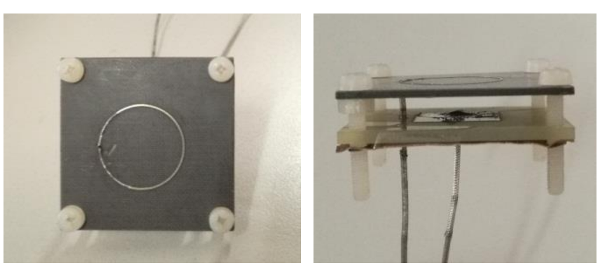
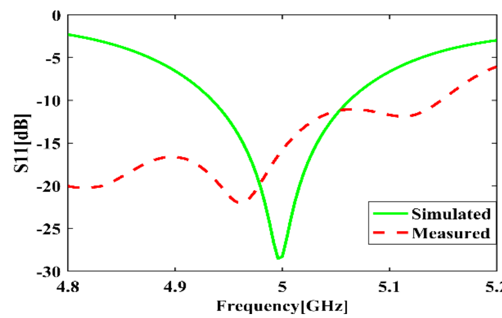
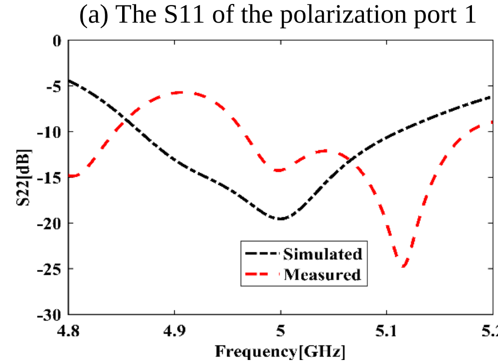


Fig. 7. Prototype of the dual-polarized antenna based on metal ring and microstrip patch.

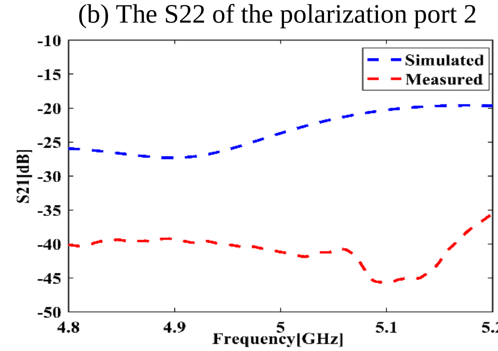
The measured and simulated results are depicted in Fig. 8. In Fig. 8 (a), at the center frequency of 5GHz, the measured and simulated S11 are less than -15dB. Figure 8 (a) also shows that the measured resonance frequency is less than the simulated resonance frequency. In Fig. 8 (b), at the center frequency of 5GHz, the measured and simulated S22 are less than -13dB. Figure 8 (b) also shows that the measured resonance frequency is greater than the simulated resonance frequency. From the above comparison, we can see that the measured S-Parameters of the two polarized ports are slightly larger than the simulation results. In Fig. 8 (c), at the center frequency of 5GHz, the measured and simulated S21 are less than -20dB. Figure 8 (b) also shows that the measured result is less than the simulated result. According to the analysis, the difference between the measured results and the simulation results is mainly caused by the machining accuracy and assembly error.




(a) The S11 of the polarization port 1




(b) The S22 of the polarization port 2

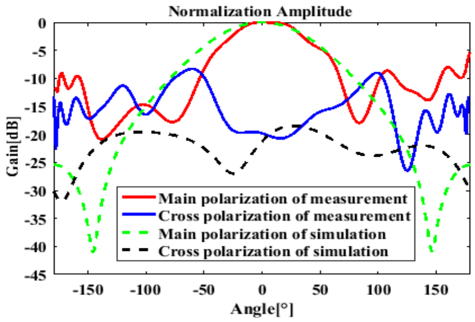



(c) The isolation between two polarization ports

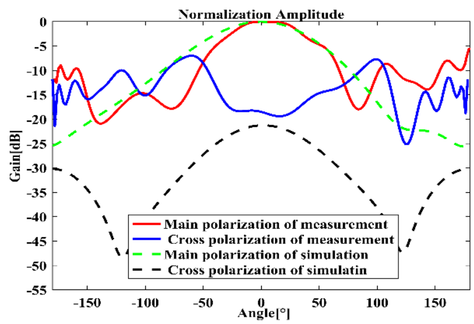
Fig. 8. The circuit characteristics of the machined dual-polarized antenna.

In the microwave darkroom, the radiation pattern of the dual-polarized antenna based on metal ring and microstrip patch is measured. Figure 9 and Fig. 10 show the measured and simulated results of the polarized port

1 (rectangular patch port) and the polarized port 2 (metal ring port) at the center frequency of 5GHz respectively.

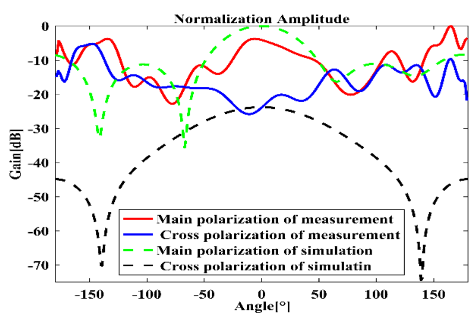



(a) The E-plane pattern of port 1

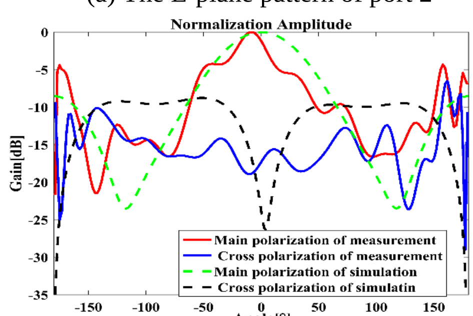



(b) The H-plane pattern of port 1

Fig. 9. The measured pattern of rectangular patch port at 5GHz.




(a) The E-plane pattern of port 2




(b) The H-plane pattern of port 2

Fig. 10. The measured pattern of metal ring port at 5GHz.

It can be seen from Fig. 10 that the measured main polarization cure is similar to the simulated results, but the measured cross polarization curve and the simulated cross polarization curve are not slightly similar.

Table 1: Measured 3dB beam width and simulated 3dB beam width at co polarization

| | | | **Simulation** | **Measurement** |
|---|---|---|---|---|
| **Port1** | E-plane | Main | 83.1° | 82° |
| | | Cross | 66° | 44° |
| | H-plane | Main | 82.3° | 82° |
| | | Cross | 72.1° | 72° |
| **Port2** | E-plane | Main | 56.4° | 55° |
| | | Cross | 83.9° | 82° |
| | H-plane | Main | 68.8° | 68° |
| | | Cross | 132.2° | 17° |

Table 1 shows that the measured main polarization beam width is similar to the simulated polarization beam width.

The measured results of the antenna indicate that the two polarization ports of the dual-polarized antenna have wide beam performance and a wide polarization pattern, which is suitable for practical applications. At the same time, the design of the dual-polarized antenna based on electromagnetic radiation source is correct. The measured result is slightly different to the simulation result, which is caused by the antenna machining and testing error.

## V. CONCLUSION

As an important part of dual-polarized phased array radar, the technical indicators of dual-polarized antenna element directly influences the performance of the whole system. Based on the principle of complementary antenna radiation, this paper presents a dual-polarized antenna design based on a combination of a current source and a magnetic current source, which provides a new technical approach for the design of a dual-polarized antenna. According to the equivalent principle of the electromagnetic field, the metal ring and the rectangular microstrip patch are respectively equivalent to the current radiation source and the magnetic current radiation source. Both polarized ports of the antenna are introduced from the bottom of the antenna structure, which is suitable for phased array antenna elements. The electromagnetic simulation and optimization design of the dual-polarized antenna are carried out by using the full wave electromagnetic simulation software. In the bandwidth of 4.94GHz~5.06GHz range, the technical indicators such as port isolation degree, cross polarization level and beam width of the antenna can meet the requirements of general dual-polarized antenna, especially the dual-polarized antenna which has a wide directional pattern. That is to say, the two polarization channels have good orthogonality over a wide range of spatial angles and can be used in phased array radar and communications systems. Through the processing and testing of the designed dual-polarized antenna, the measured results verify the effectiveness of the scheme.

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## REFERENCES

[1] M. I. Ibrahim, M. G. Ahmed, M. El-Nozahi, A. M. E. Safwat, and H. El-Hennawy, "Design and performance analysis of a miniature, dual-frequency, millimeter wave linear phased array antenna," *IEEE Transactions on Antennas and Propagation*, vol. 65, no. 12, pp. 7029-7037, Dec. 2017.

[2] H. Zhai, L. Xi, Y. Zang, and L. Li, " A low-profile dual-polarized high-isolation MIMO antenna arrays for wideband base-station applications," *IEEE Transactions on Antennas and Propagation*, vol. 66, no. 1, pp. 191-202, Jan. 2018.

[3] A. Elsherbini, J. Wu, and K. Sarabandi, "Dual polarized wideband directional coupled sectorial loop antennas for radar and mobile base-station applications," *IEEE Transactions on Antennas and Propagation*, vol. 63, no. 4, pp. 1505-1513, Apr. 2015.

[4] Y. Wang and Z. Du, "Dual-polarized slot-coupled microstrip antenna array with stable active element pattern," *IEEE Transactions on Antennas and Propagation*, 63(9): 4239-4244, 2015.

[5] K. Ding, C. Gao, Y. Wu, D. Qu, B. Zhang, and Y. Wang, "Dual-band and dual-polarized antenna with endfire radiation," *IET Microwaves, Antennas & Propagation*, vol. 11, no. 13, pp. 1823-1828, Oct. 20, 2017.

[6] W. Li, Z. Zeng, B. You, L. Ye, Y. Liu, and Q. H. Liu, "Compact dual-polarized printed slot antenna," *IEEE Antennas and Wireless Propagation Letters*, vol. 16, pp. 2816-2819, 2017.

[7] H. Lee and B. Lee, "Compact broadband dual-polarized antenna for indoor MIMO wireless communication systems, "*IEEE Transactions on Antennas and Propagation*, vol. 64, no. 2, pp. 766-770, Feb. 2016.

[8] Q. Xu, S. Liu, Y. Wang, L. Song, and H. Cao, "Dual-polarized antenna based on printed dipole and microstrip patch," *Journal of Electronics & Information Technology*, vol. 39, no. 7, pp. 1764-1768, July 2017.

[9] J. J. Liang, J. S. Hong, J. B. Zhao, and W. Wu, "Dual-band dual-polarized compact log-periodic dipole array for MIMO WLAN applications," *IEEE Antennas and Wireless Propagation Letters*, vol. 14, pp. 751-754, 2015.

[10] S. J. Li, J. Gao, X. Cao, Z. Zhang, and D. Zhang, "Broadband and high-isolation dual-polarized microstrip antenna with low radar cross section," *IEEE Antennas and Wireless Propagation Letters*, vol. 13, pp. 1413-1416, 2014.

[11] F. Lin, Y. Qi, J. Fan, and Y.-C. Jiao, "0.7-20GHz dual-polarized bilateral tapered slot antenna for EMC measurements," *IEEE Transactions on Electromagnetic Compatibility*, 56(6):1271-1275, 2014.

[12] D.-L. Wen, D.-Z. Zheng, and Q.-X. Chu, "A dual-polarized planar antenna using four folded dipoles and its array for base stations," *IEEE Transactions on Antennas and Propagation*, 64(12):5536-5542, 2016.

[13] H. Nawaz and I. Tekin, "Dual-polarized, differential fed microstrip patch antennas with very high interport isolation for full-duplex communication," *IEEE Transactions on Antennas and Propagation*, vol. 65, no. 12, pp. 7355-7360, Dec. 2017.

[14] Y. Wang and Z. Du, "Dual-polarized slot-coupled microstrip antenna array with stable active element pattern," *IEEE Transactions on Antennas and Propagation*, 63(9):4239- 4244, 2015.

[15] X. Chen, P. Y. Qin, Y. J. Guo, and G. Fu, "Low-profile and wide-beamwidth dual-polarized distributed microstrip antenna," *IEEE Access*, vol. 5, pp. 2272-2280, 2017.

[16] J. Oh and K. Sarabandi, "Low profile, miniaturized, inductively coupled capacitively loaded monopole antenna," *IEEE Transactions on Antennas and Propagation*, 60(3):1206-1213, 2012.

[17] D. Hua, S. S. Qi, W. Wu, and D. G. Fang, "CPW-fed printed antenna array with conical beam," *IEEE Transactions on Antennas and Propagation*, vol. 64, no. 3, pp. 1096-1100, Mar. 2016.

[18] A. Dastranj, "Very small planar broadband monopole antenna with hybrid trapezoidal–elliptical radiator," *IET Microwaves, Antennas & Propagation*, 11(4):542-547, 2017.

[19] S. X. Ta, H. Choo, and I. Park, "Broadband Printed-Dipole Antenna and Its Arrays for 5G Applications," *IEEE Antennas and Wireless Propagation Letters*, vol. 16, pp. 2183-2186, 2017.

[20] Y. Chong, L. Juan, W. Yang, and Y. Daixu, "Design of a Ku-band dual polarized microstrip array antenna," *Journal of Microwaves*, 2014.

[21] R. Kumar and N. Pazare, "Compact printed ultra-wideband diversity monopole antenna with slant inverted tree-shaped stub," *IET Microwaves, Antennas & Propagation*, 9(14): 1595-1604, 2015.

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