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Four Ports Wideband Pattern Diversity MIMO Antenna

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Abstract

In this paper a broadband four ports MIMO antenna with pattern diversity is presented. To obtain pattern diversity, four microstrip feeding lines are printed on one side of the substrate where as the modified ground plane is printed on the other side. These microstrip lines generate orthogonal radiation patterns. In annular slot four shorts are placed between the microstrip lines to maintain isolation more than 25dB. The antenna operates in the range of frequencies from 2.3GHz to 12.6GHz (nearly 139

Index terms— broadband antenna, pattern diversity antenna, slot antenna and ultra wide band (UWB) antenna.

1 Introduction

ne important challenge to design a compact antenna for multiple applications is smaller and thinner terminals with increasing operating frequency bands and performance. Bandwidth enhancement is major requirement to design printed antenna for different applications, like WLAN, cellular and cordless phones. These applications are used in urban environments where multipath propagation and fading may occur.

To mitigate channel fading and improve transmission quality, antenna diversity technique is efficient. There are several types of diversity, such as pattern, polarization and space diversity has been used [1,2]. The signals are combined in several ways to optimize the output signal power or signal to noise ration. In diversity method, selection includes combining of signals, where highest SNR is selected. The signals from all branches are compared with respective received signal [3].

The correlation between received signals shows the diversity performance [4]. If correlation is high then the combining efficiency is reduced. In spatial diversity method, decoupling between signals is achieved by maintaining separation between antennas. This scheme is difficult to implement in mobile handsets because of space restriction. To overcome this drawback pattern diversity and polarization diversity schemes are investigated [5,6]. These techniques use two or more co-located antennas with different radiation patterns. To receive signal horizontally and vertically, dipole or microstrip antennas are used [7]. Microstrip antennas are widely used for diversity schemes due to their low cost. However, these suffer from narrow bandwidth. To extend bandwidth, many solutions are proposed including impedance matching networks, substrates with low dielectric constants or parasitic patches on the top of main patch [8] etc.

Slot antennas traditionally demonstrated a large bandwidth than microstrip antennas. For example in [9], slot with two feeding ports for pattern diversity applications is used. Pattern diversity antennas have been proposed in many literatures and carried out with different methods. In [10] two monopoles were used to provide pattern diversity. The T-shaped network was used to feed antenna with operating frequency range of 1790-2200 MHz, was achieved. In [11], a planar dual port diversity antenna was presented, which operates with broadside and conical radiation patterns in Hplane. In this geometry, operating bandwidth of 50% is achieved for diversity. In [12] pattern diversity is achieved by dual ports microstrip antenna with two shorts to maintain isolation above 15dB between these two ports. The annular slot is used for pattern diversity. The total bandwidth is increased up to 120%.

In this paper, we extended the work reported in [12]. Here, we designed annular ring slot with four ports. Furthermore, geometry of [12] uses air gap which makes the whole geometry as delicate and difficult to assemble.

To overcome this FR4 material is used to fabricate the proposed prototype. Also, the substrate is easy to handle as compared to air dielectric material. The simulated and measured return loss, isolation between ports, and radiation patterns are presented. Antenna geometry is presented in Section 2. Section 3 presents geometry optimization procedure. Experimental results and discussions are covered in Section 4. Finally, the work is concluded in Section 5.

2 II.

3 Antenna Design

In this section, the annular slot antenna which generates four orthogonal patterns is proposed for diversity applications in multipath fading environment. The proposed annular slot microstrip antenna, wideband behavior was achieved. To obtain wideband Year 2015 F with pattern diversity, two more ports have been inserted in [12] geometry as shown in Figure ??. Four shorts are placed in antenna, in order each shorts between feed lines. These shorts are placed to obtain high isolation between ports. Good isolation between ports is achieved when single short is placed between ports.

The proposed antenna is printed on FR4 dielectric material with thickness of 0.8 mm. The annular slot is etched on square chassis of 100 x 100 mm 2 . The antenna is fed with four microstrip lines printed on bottom side of substrate and shown in Figure ??. The microstrip feed lines terminated with sub-tuned patches to match the antenna to characteristics impedance of microstrip line.

4 Geometry Optimization and Discussions

In this section parametric study is conducted by optimizing the proposed geometry of antenna. The key design parameters used for optimization are inner radius R in , patch length L 1 , patch width W 1 , and feed width W feed . All simulations were carried out in HFSS 13 software. Here the parameters of R in, L 1 , W 1 , W feed are considered (one at a time keeping other parameters constant) to investigate the effect of each of these parameters on the antenna's performance.

5 a) Effect of Inner Radius

The inner radius (R in) of the circle is varied in steps of 1 mm from 10 mm to 13 mm by keeping all other parameters constant. The simulated results of reflection coefficient of antenna with varying R in are shown in Figure 2. From these characteristics it may be noticed that the good bandwidth of antenna is obtained for R in = 12 mm. In this study, keeping inner radius (R in) constant, the patch length L 1 was varied (9mm to 9.8mm in step of 0.2mm) to investigate its effect on the antenna geometry. Results of this study are presented in Figure ??. These results indicate that the geometry offers good bandwidth for L 1 =9.4 mm.

6 c) Effect of Patch Width

In another effort, the patch width W 1 is varied (6.8mm to 7.6mm) in steps of 0.2mm. The simulated reflection coefficient characteristics of this study are shown in Figure ??. From these simulated results, it may be noticed that optimum bandwidth can achieved for W 1 =7.2mm. Finally, keeping all parameters discussed in earlier subsections constant, feed width (W feed) of antenna was varied from 1mm to 1.4mm in steps of 0.2mm. The simulated characteristics for various feed widths are presented in Figure 5. By observing these characteristics it may be noted that the bandwidth of antenna is optimum for feed width equal to 1.2mm. From the parametric study conducted, it may be noted that the geometry with its dimensions listed in Table ?? offers optimum performance. The reflection coefficient characteristics and mutual coupling coefficients of the proposed optimum geometry are depicted in Figure 6. From these results it may be noted that the antenna offers 139% impedance bandwidth. Also, the mutual coupling is well below -20dB throughout the band of operation.

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8 Experimental Validation of the Geometry and Discussions

The proposed geometry shown in Figure ?? with its optimized dimensions listed in Table ?? is fabricated on FR4 substrate having dielectric constant of 4.4 and thickness of 0.8mm. The photograph of fabricated prototype is shown in Figure ??. In Figure ??, the setup of measurement of reflection coefficient of antenna in real environment is shown. Reflection coefficient characteristics of measured results are compared with simulated values in Figure ??. In Figure ?? only S 11 is presented as all ports are symmetrical. The measured results slightly mismatch with the simulated values which may be due to inaccuracies in the fabricated prototype. Simulated radiation patterns at different frequencies in the operating band are presented in Figure ??0. From these patterns it may be noted that the patterns remain nearly stable across the band of operation. Also, omni-directional patterns are obtained in the H-plane suitable for broadcasting applications. [1]

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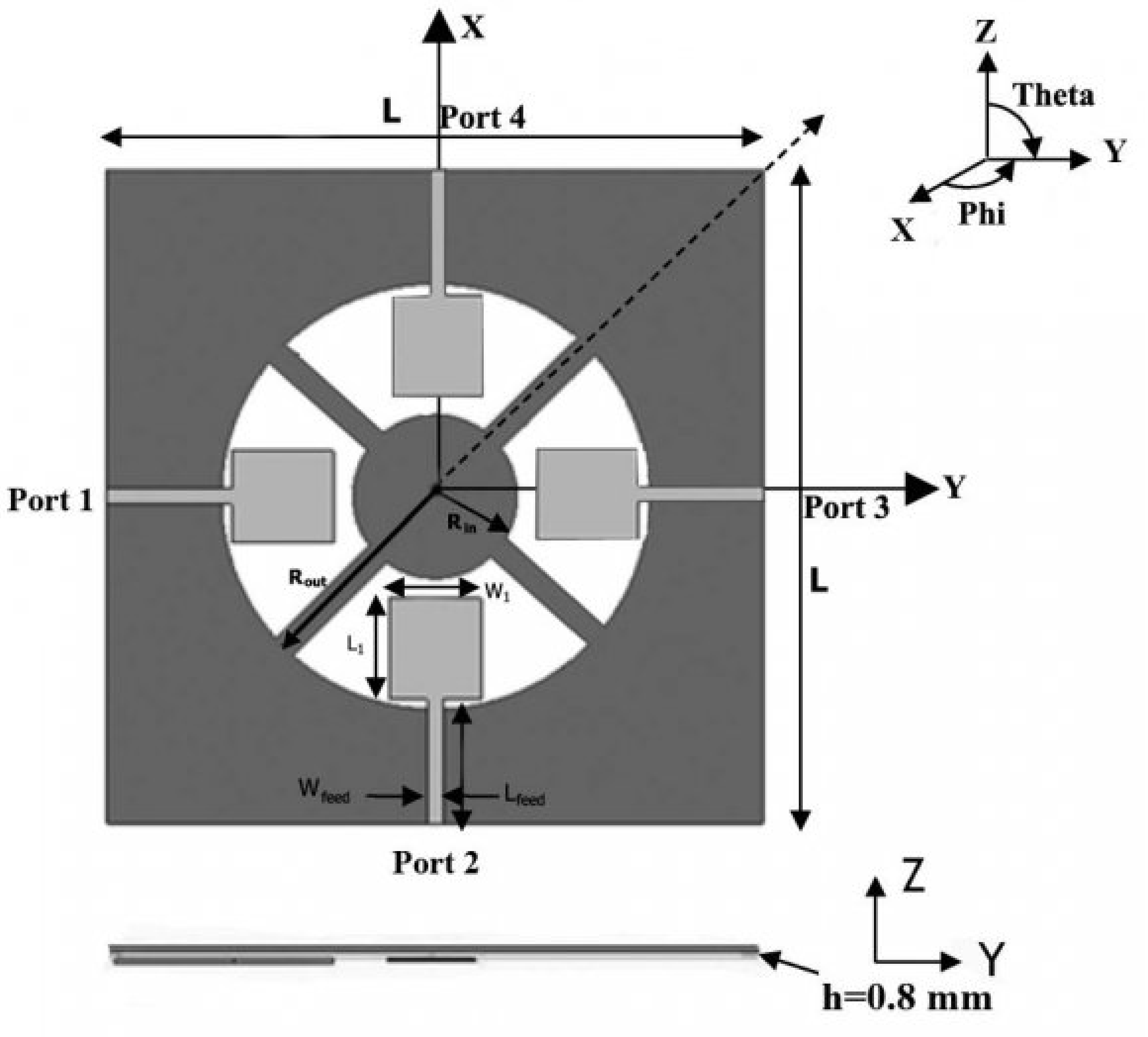
Figure 1: Table 1 : 2 Figure 1 :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Port 3
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Figure 2: Fe

2

Figure 3: (FFigure 2 :

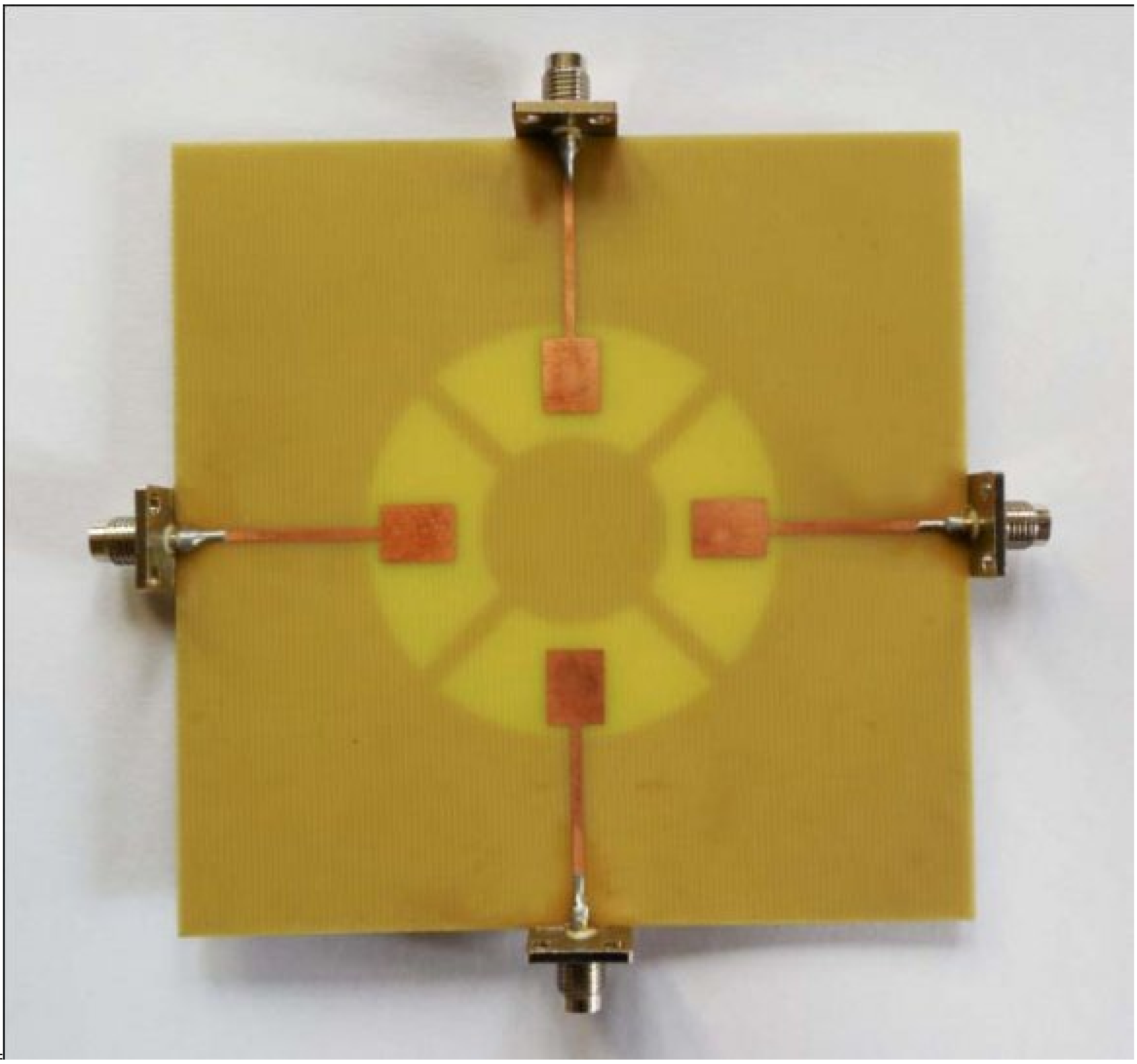

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Figure 4: Figure 3 :Figure 4 :

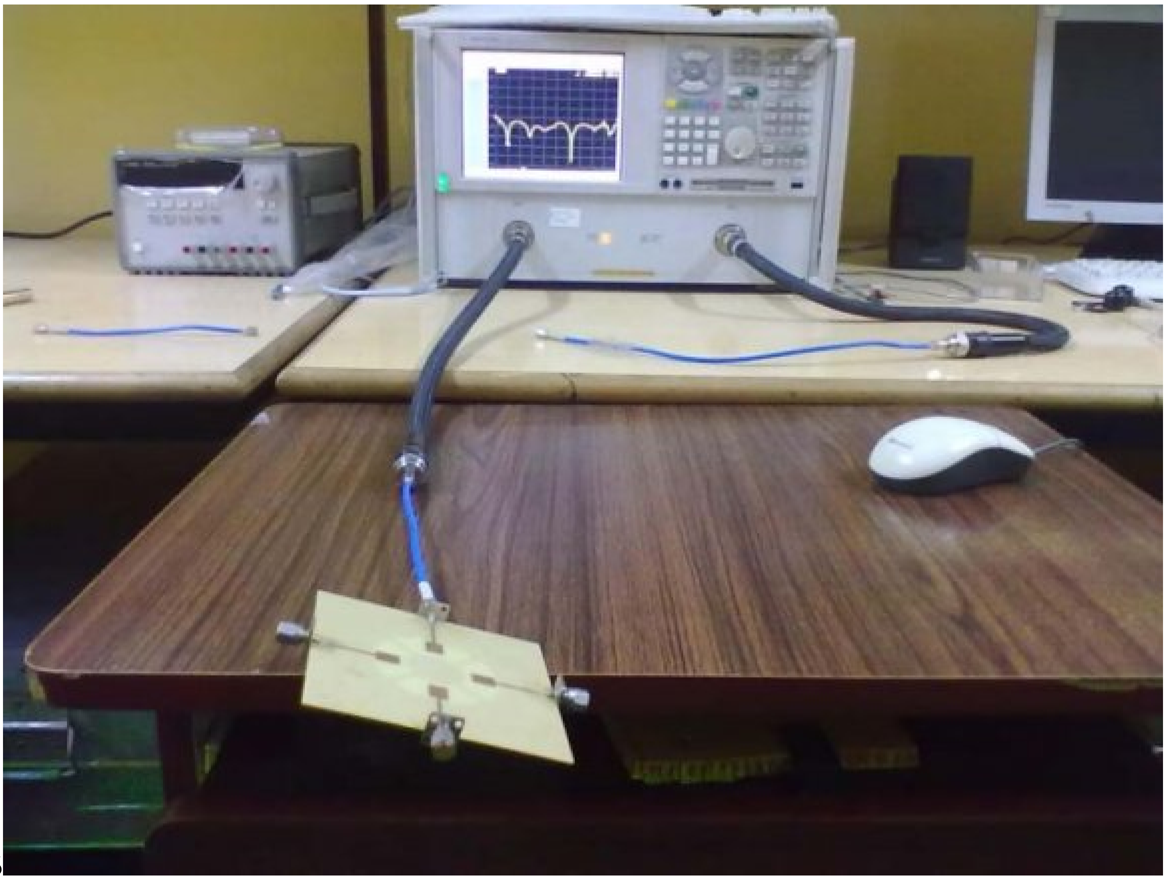
5 

Figure 5: Figure 5 :

.1 Conclusions

Four ports wideband pattern diversity antenna has been presented. The antenna is etched on chassis of 100x100mm 2 fed with four microstrip lines printed on backside of the substrate. Four shorts are inserted to increase the isolation between the ports & to improve the performance of antenna. Various characteristics of the antenna are presented and satisfactory performance was achieved. The antenna covers the FCC defined UWB band of frequencies. The proposed antenna offers an impedance bandwidth of 139% in the frequency range of 2.3GHz to 12.6GHz. Also, the geometry produces stable and omni-directional patterns with good gain over the band of operation. Besides this the antenna exhibits good performance for all four ports, and hence the geometry is suitable for diversity applications.

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