Slot Ring Triangular Patch Antenna with Stub for MIMO 2x2 Wireless Broadband Application

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***Abstract*-A compact slot ring triangular patch antenna with stub has been designed for MIMO 2x2 wireless broadband application. This compact antenna consists of only one layer substrate; however has broadband characteristic due to the slot ring inserted to the triangular patch antenna. The MIMO 2x2 elements achieved mutual coupling suppression to lower than 25 dB by placing the single element perpendicular to each other. In addition, the maximum antenna gain obtained is 5.9 dBi.**

I. INTRODUCTION

In Indonesia, the government has regulated for wireless broadband application the frequency band from 2.3 GHz to 2.39 GHz [1] with impedance bandwidth of 90 MHz. This wireless broadband application includes Worldwide Interoperability Microwave Access (WIMAX) application which needs Multiple Input Multiple Output (MIMO) characteristic due to high capacity and reliability requirements of wireless communication systems without increasing transmitted power or bandwidth [2].

To achieve broadband characteristic, several studies have been conducted by using aperture coupled antenna [3], air filled substrate [4] and slot antenna [5].

For the mutual coupling suppression between elements in the MIMO system, [3] used defected ground structure, while [6] added slit on the ground plane and [7] added spacing of λ/4 between elements. Theses paper achieved around 20 dB mutual coupling suppression.

In this paper, a compact slot ring triangluar patch antenna with stub is designed to achieve broadband characteristic and mutual coupling suppression of more than 20 dB between elements of the MIMO antenna.

II. ANTENNA DESIGN

The proposed antenna design is depicted in Fig. 1. The antenna shape is triangular patch with insertion of slot ring to obtain broadband characteristic. Microstrip line feeding technique is used and good impedance matching is achieved by adding stub to the microstrip line. The antenna is printed on FR4-Epoxy substrate of 50 mm x 50 mm with permittivity 4.4 and height 1.6 mm.

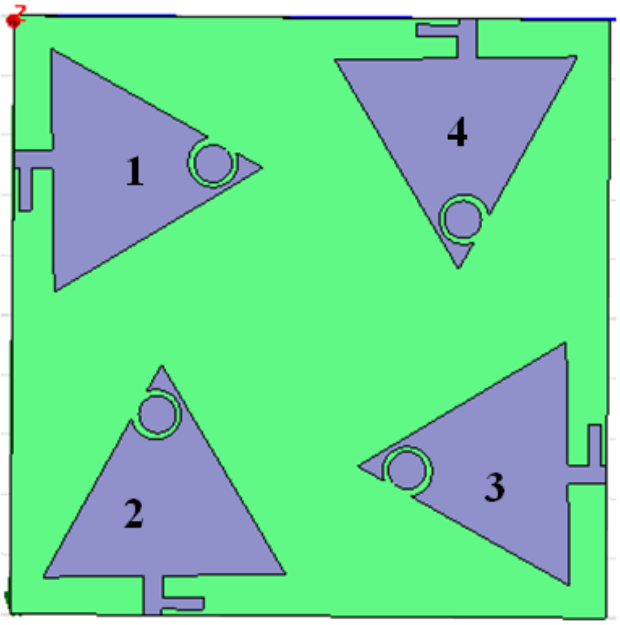


Fig.1 The proposed antenna design

The antenna consists of four elements perpendicular to each other to form the 2 x 2 MIMO configuration. Two antenna elements are for the transmitters (port 2 and port 4) and two elements for the receivers (port 1 and port 3). The antenna design is very compact because it consists of only one substrate and the elements are placed directly near to each other without any spacing.

The antenna design excites linear polarization. The polarization of port 2 is linear in the x direction, while port 1 in the y direction. Therefore, this can reduce the mutual coupling between antenna port 1 and port 2. This also occurs for the other pair of ports of the MIMO antenna.

III. SIMULATION AND MEASUREMENT RESULTS

The simulation result of the proposed antenna using HFSS software is shown in Fig. 2. All four ports show that the antenna works at the frequncy center 2.35 GHz.

Observed at return loss of -10 dB, port 1, port 2, port 3 and port 4 has impedance bandwidth of 112 MHz, 112 MHz, 113 MHz and 107 MHz, respectively.

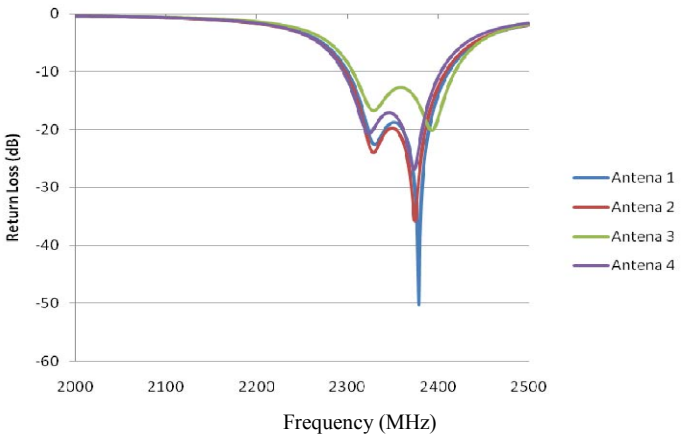


Fig.2. Return loss simulation result

The perpendicular position of the antenna plays an important role towards the mutual coupling reduction of the antenna. Focusing on the port as the tranmitter, the mutual coupling of the port 2 and port 4 towards the nearest port is shown in Fig. 3. The simulated mutual coupling suppression of S21, S41, S23 and S43 at center frequency 2.35 GHz is -33.1 dB, -40.1 dB, -32.9 dB and -34.9 dB, respectively. This mutual coupling result is suppressed well below -20 dB.

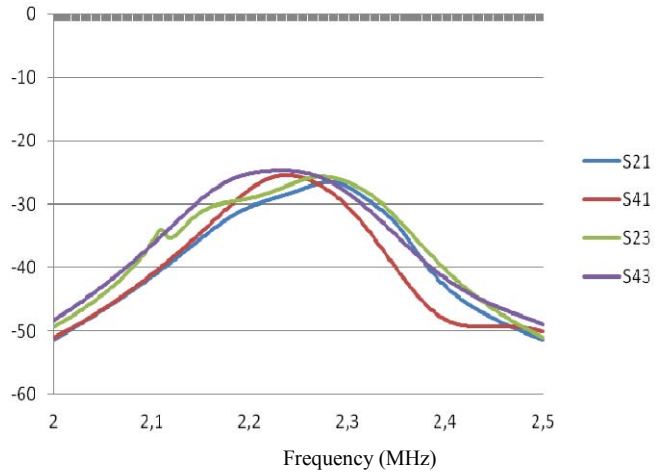


Fig.3. Mutual coupling simulation result

The simulation results show that the antenna design fulfills the aforementioned parameters, therefore the antenna design is fabricated and measured in an anechoic chamber.

The measurement result of the return loss is depicted in Fig. 4 for all of the antenna elements. At return loss of -10 dB, port 1, port 2, port 3 and port 4 has impedance bandwidth of 105 MHz, 108 MHz, 110 MHz and 120 MHz, respectively.

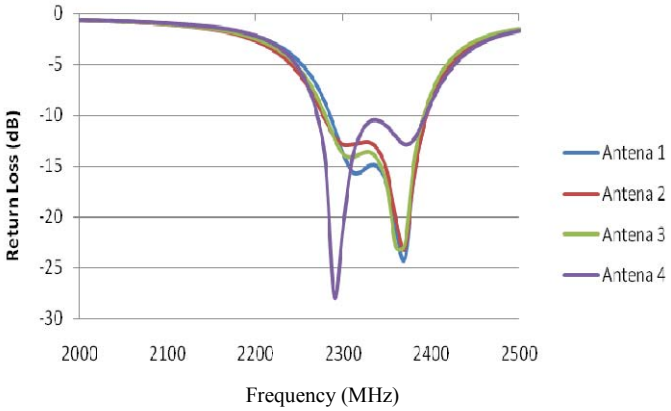


Fig.4. Return loss measurement result

The measured mutual coupling was also measured at the center frequency 2.35 GHz and shows the S21, S23, S41 and S43 is -25.31 dB, -25.22 dB, -25.17 dB and -25.6 dB, respectively.

In addition, the maximum antenna gain obtained at center frequency 2.35 GHz is 5.9 dB.

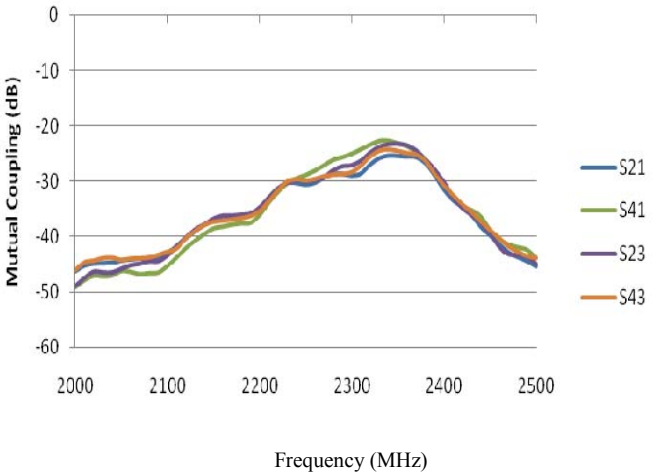
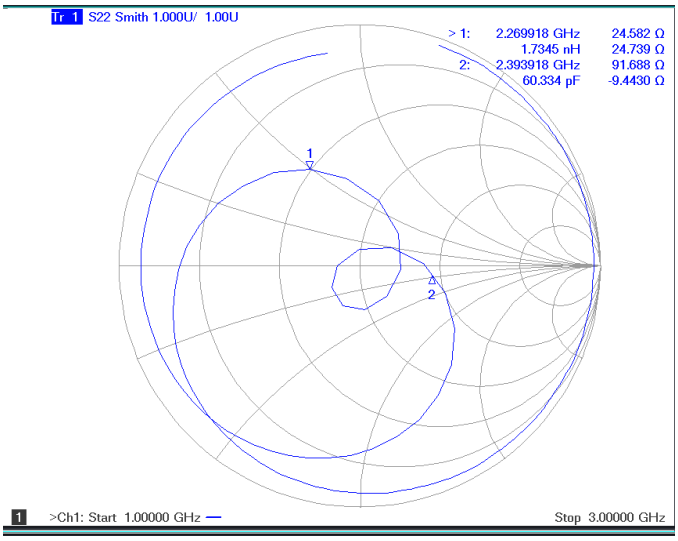


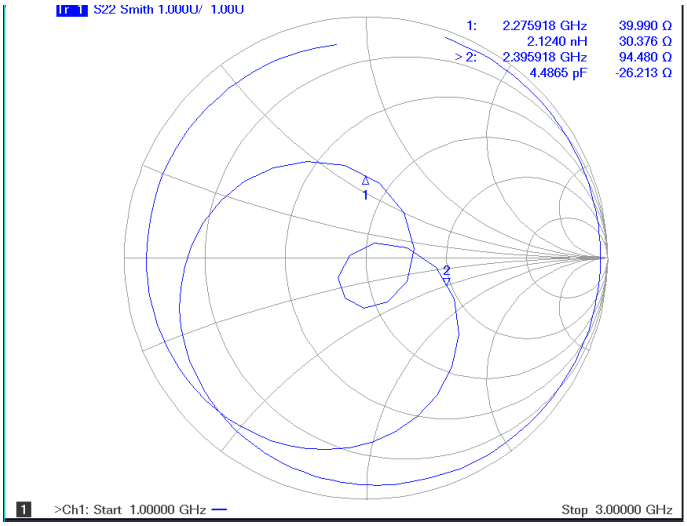
Fig.5. Mutual coupling measurement result

Moreover, the input impedance of the antenna was also measured and the results is shown in Fig. 6(a) for the port 1 Fig. 6(b) for port 3.

The input impedance for port 2 and port 4 was also measured at 2.35 GHz, therefore the impedance for port 1, port 2, port 3 and port 4 is 40.35-j11.07 Ω; 37.59-j7.37 Ω; 40.27-j9.6 Ω and 37.94-j21.23 Ω, respectively.



(a)



(b)

Fig.6. Input impedance measurement result
(a) port 1 (b) port 2

The measured and simulated results show good agreement with similar results. A slight discrepancy between simulation and measurement results are due to imperfect fabrication of the antenna. The slot ring inserted in the triangular patch is very small and the connection of the antenna with sma connector was not designed with the HFSS software, therefore these causes are mostly possible to be the cause of the discrepancy.

A slight difference of dimension between the design and fabrication can cause a slight shift of frequency when the antenna works at high frequencies.

IV. Conclusion

The compact slot ring triangular patch antenna with stub has been designed, fabricated and measured for MIMO 2x2 wireless broadband applications. The measured impedance bandwidth of the antenna for all ports is more than 100 MHz while the mutual coupling effect is suppressed to lower than -25 dB. In addition, the maximum antenna gain obtained is 5.9 dBi.

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