Design of Circular Microstrip MIMO Antenna for Nomadic Broadband Wireless Access (BWA) At 2,3 GHz

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Abstract - **This paper presents the design of a 2.3 GHz circular microstrip MIMO antenna for nomadic BWA which applying MIMO system in wireless communication that increasing channel capacity by employing multiple antennas in both transmitter and receiver ends without increasing SNR or signal bandwidth. For the specification of the antenna is set on the Regulation of Director General of Post and Telecommunications No. 96/DIRJEN/2008. The center frequency is designed at 2.345 GHz with bandwidth 90 MHz with VSWR ≤ 1.9. The resulting of radiation pattern is unidirectional. Coupling factor between two elements antenna is -11 dB. The polarization is vertical and it is to be used on SS section.**

Keywords - **microstrip antennas, MIMO system, radiation pattern, VSWR, coupling factor**

I. INTRODUCTION

BWA (Broadband Wireless Access) is a service that offers high data rate and wide bandwidth. Nomadic BWA is a service that implements a wireless access terminal location where the end-user can move but should not be used when moving. MIMO (Multiple Input Multiple Output) systems essentially employ multiple antennas for transmission and reception side of the signals. MIMO is one of several forms of smart antenna technology. Using more than one antenna makes coupling factor between the antennas. The coupling factor affects data rate. Higher coupling coefficient lower data rate. To reduce coupling factor by keeping two antennas at the distance until it becomes lower. The distance usually more than a half wavelength. Besides, the wavelenght depends on the antenna operating frequency.

There are a lot of forms of antenna, from large to smal size. Kinds of antennas include linear wire, loop, array, aperture, horn, microstrip, reflector, and smart antennas. Microstrip antenna has a small form with a lot of advantages such as low profile, conformable to planar and nonplanar surfaces, simple and inexpensive to manufacture using modern printed-circuit technology, mechanically robust when mounted on rigid surfaces, compatible with MMIC designs, and when the particular patch shape and mode are selected, they are very versa-tile in terms of resonant frequency, polarization, pattern, and impedance [1]. Besides, there are some disadvantages of microstrip antennas such as low efficiency, low power, high Q (sometimes inexcess of 100), poor polarizationpurity, poor scan performance, spurious feed radiation and very narrow frequency bandwidth, which is typically only a fraction of a percent or at most a few percent [1].

BWA services can be developed by MIMO systems. Currently, the government in Indonesia has had regulations regarding Nomadic BWA services at 2.3 GHz frequency band. This regulation sets BWA network that consist of BS (Base Station), SS (Subscriber Station) and antenna for each sections. The antenna for SS has to have small dimension regards to it function to be easy to carry and also constraints about weight, cost, performance, and ease of installation. So, microstrip patch antenna is suitable for its requirements.

This paper presents two elements of circular microstrip patch MIMO antenna which operates at 2.3 GHz. This antenna is designed on an FR4 substrate. Each antenna is fed with probe coaxial for each ports. CST Microwave Studio Simolator is used to simulate this MIMO antenna system.

II. ANTENNA DESIGN

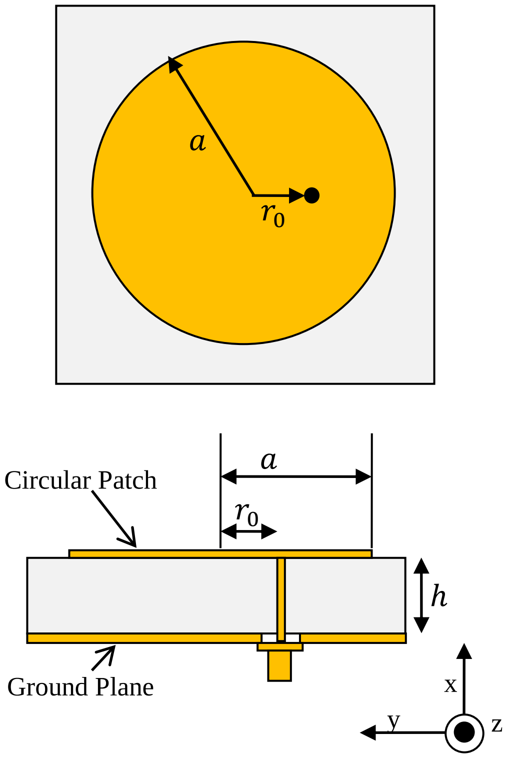


Figure 1. Geometry of circular microstrip antenna.

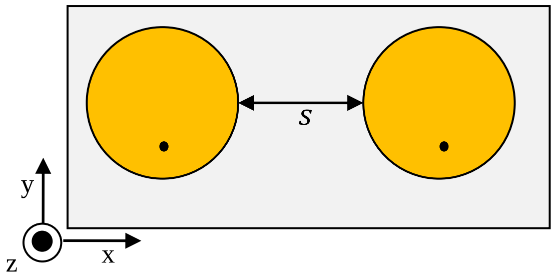


Figure 2. Geometry of two elements MIMO antenna.

In this paper, a MIMO antenna consists of two circular elements has been examined (Figures 1 and 2). In figure 2, the way of arranging circular patches and feeding the antenna is shown. For antenna design, it is assumed that the dielectric constant of the substrate (ε_r), the height of the substrate h (in mm), and the resonant frequency (f_r in Hz) are known. The design of microstrip patch antenna has done. Two circular patch elements of dimension $a =$ 17 mm printed on the surface of FR4 substrate with a dimension of 80mm x 40mm x 1.5 mm, and is fed by 50 ohm coaxial probe feed. The material of circular patch and ground plane are from copper from lossy metal type which have 0.05 mm thick. The feeding distance from center of the circular patch is $r_0 = 4.9\ mm$ [3].

The distance s between each MIMO antenna elements related with the result of mutual coupling between its elements. The mutual coupling is represented from the S-parameter S_{12} and S_{21}. With the distance $s = 11\ mm$ the S-parameter S_{12} and S_{21} which are under -60dB.

III. RESULTS

The aim of this project is to design a MIMO antenna with the specification based on Indonesia government regulation of Director General of Post and Telecommunications No. 96/DIRJEN/2008.

- ☐ Antenna type : antenna Subscriber Station
- ☐ Frequency range : (2,3 – 2,39) GHz
- ☐ Gain : maximum15 dBi
- ☐ Impedance : 50 Ω
- ☐ Polarization : vertical
- ☐ VSWR : maximum1,9:1
- ☐ Maximum input power : 50 W
- ☐ XPD : minimum 20 dB
- ☐ Connector : SMA-female

The circular MIMO antenna was simulated by CST Microwave Studio 2010.

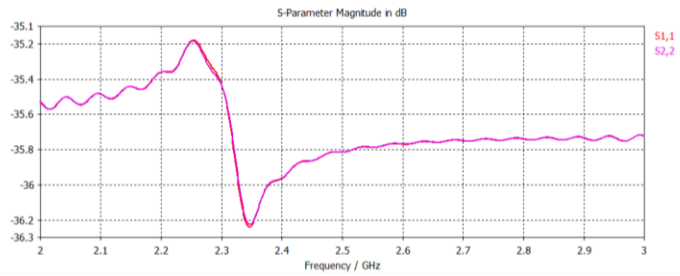


Figure 3. S-Parameter Magnitude (S_{11} and S_{22})

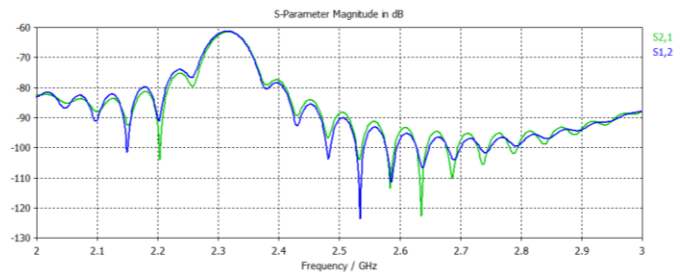
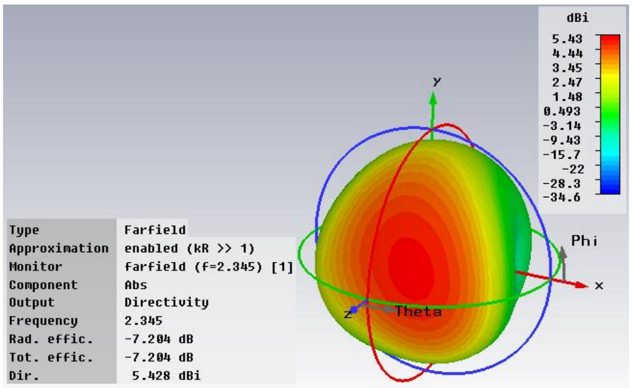
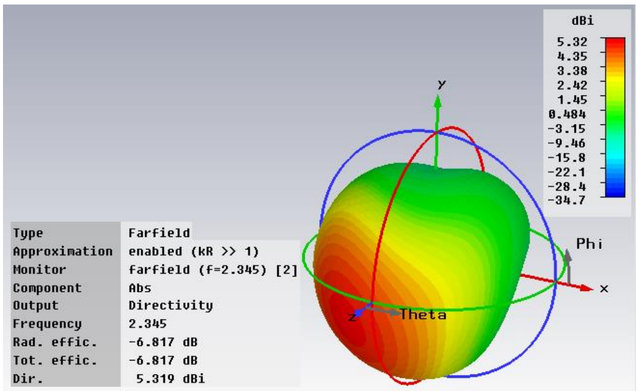


Figure 4. S-Parameter Magnitude (S_{12} and S_{21})

Figure 3 is shown the simulation results of S_{11} and S_{22}, which are under -35dB over 2.3 to 2.39 GHz. The isolation of MIMO antenna can be achived by adding space between each elements, and the results are shown in figure 4. With coaxial probe feeding, the isolation of MIMO antenna can be strong enough even the distance between each elements is close, it is under a half wavelength.



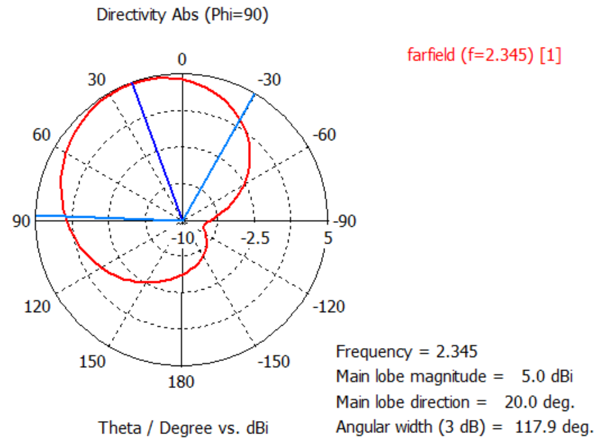
(a)



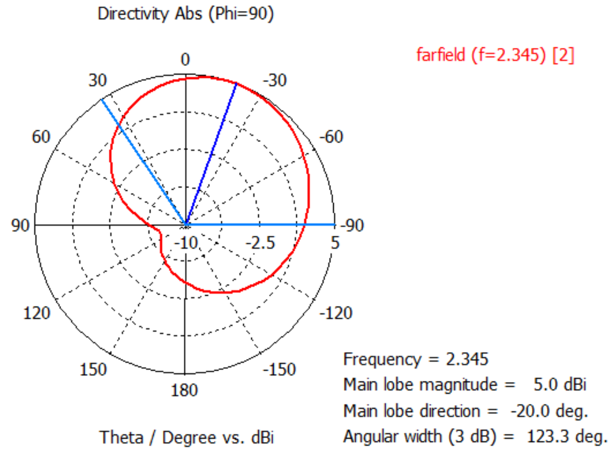
(b)

Figure 5. 3D pattern of directivity absolute result from farfield : (a) at port 1 and (b) at port 2)

Figure 5 is shown the simulation results of three-dimentional pattern of directivity absolute results from farfield at 2.345 GHz. The simulation results of two-dimentional pattern of directivity absolute (Phi=90) results at port 1 and port 2 are shown in figure 6. Figure 7 is shown the simulation results of two-dimentional pattern of directivity absolute (Theta=90) at port 1 and port 2.

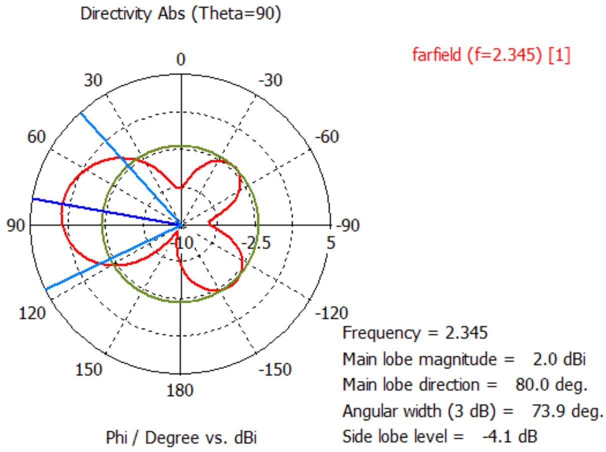


(a)



(b)

Figure 6. 2 D pattern of directivity absolute (Phi=90) result from Farfield : (a) at port 1 and (b) at port 2



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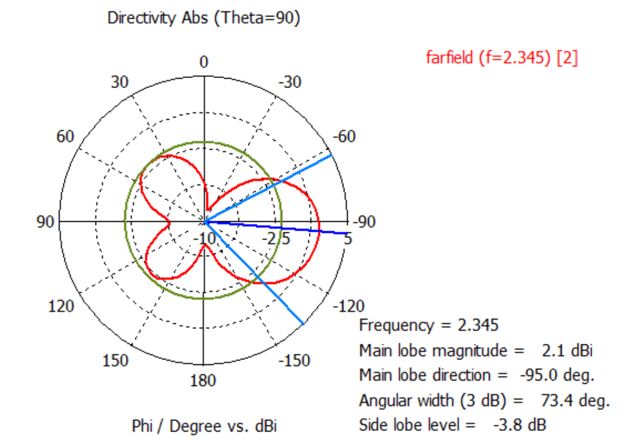
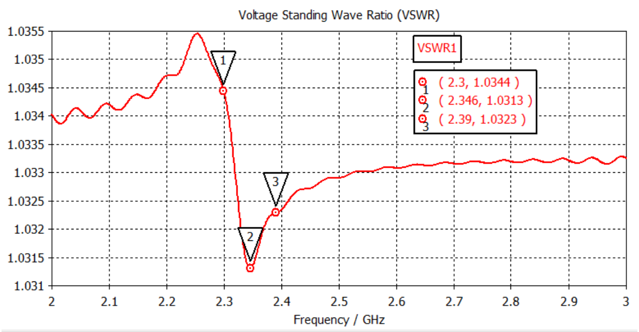
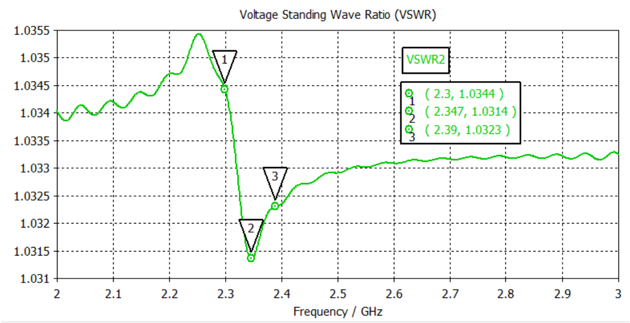


(b)

Figure 7. 2 D pattern of directivity absolute (Theta=90) result from Farfield : (a) at port 1 and (b) at port 2



(a)



(b)

Figure 8. VSWR as a function of frequency : (a) at port 1 and (b) at port 2

The value of VSWR for this antenna that is obtained by CST Microwave 2010 software is shown in figure 8. The best VSWR performane of MIMO antenna at port 1 is at 2.346 GHz, that is 1.0313 and at port 2, the best VSWR result 1.0314 is at 2.347 GHz.

IV. DISCUSSION

The concern disussion in MIMO antenna system is about the isolation between each elements. The isolation can be strong enough if the MIMO antena has a small correllation coefficient. If the correllation coefficient is high, it cause slower data rate. In addition, the coupling factor can be reduced by keeping each elements antenna at the distance until it becomes lower. In this paper, the MIMO antenna is using coaxial probe for feeding it and can reduce the distance of a half wavelength but still have strong isolation.

V. CONCLUSION

A small circular microstrip patch MIMO antenna has been presented. The antenna has been designed to be used for Nomadic BWA service at 2.3 GHz. In fact, this antenna was designed for 2.3-2.39 GHz and less than 15 dBi Gain. But the frequency under 2.3 GHz and above 2.39 GHz also has good pattern and proper VSWR. The design has been accomplished simulation results from CST Microwave Studio 2010 software.

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