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Design for Isolation Improvement of MIMO Antennas on WiBro and PCS band

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***Abstract*- This paper presents to improve of isolation for personal communication service(PCS) in handy terminal, which operating at 1.77~1.88 GHz band. To begin with, it is investigated for the reduction of mutual coupling between MIMO antenna elements for WiBro band. To decrease the mutual coupling, it is considered on the projected(凸) ground structure and a height of 3 mm on the ground plane of the antenna. It is proposed a planar spiral type antenna with shorting strip line. By the adoption of the projected ground plane, the proposed antenna shows very low mutual coupling and low radiation coupling. Additionally, it is designed a PCS band antenna for the multi-function of the mobile terminal. To improve the isolation between WiBro elements and PCS element, it is considered on 3-dimensional structure that the PCS element has 3 mm height from substrate. The proposed antennas are well tuned in each operating band and the mutual coupling between antenna elements is isolated under -20 dB at all design frequency band.**

***Index Terms* – MIMO, WiBro, PCS, Mutual Coupling, Radiation Pattern Coupling.**

I. INTRODUCTION

A multi-input multi-output(MIMO) antenna system is a well-known technique to enhance the performance of wireless communication systems. The channel capacity that a MIMO antenna system provides is much larger than that provided by the conventional wireless system. Thus, the MIMO antenna system can significantly enhance the performance of the wireless communication system.

In order to create a MIMO antenna system on wireless handy device, two or more antenna elements could be placed in very small space. Due to the complex and narrow structure in the mobile handy terminals, the space which is arrowed for antenna is extremely restricted. Thus, in case of a MIMO antenna in mobile handy terminal, the mutual coupling including radiation pattern coupling between closely arrayed antenna elements causes the decrease of a MIMO antenna performance. It means that we must consider not only the antenna size but also the suitable antenna array method to design the MIMO antenna system for mobile handy terminal.

The 2-channel MIMO WiBro antenna is proposed at Ref. [5]. It consists of two printed meander antennas. In this paper, the planar spiral with shorting strip line antenna of personal communication service(PCS) band is designed. These antennas are located on the inner part of mobile handy terminal. The antenna elements are employed the printed meander line antenna and planar spiral with shorting strip line antenna, due to theirs compact size, good isolation and useful space. It is proposed the method of mutual coupling suppression by the modified ground structure and examined the antenna radiation pattern coupling, isolation coefficients, and return loss.

II. PCS ANTENNA DESIGN WITH 2-CHANNEL WIBRO ANTENNA

Fig. 1 and Fig. 2 show the structure of proposed antenna and characteristics of 2-channel WiBro Antenna in Ref. [5], respectively.

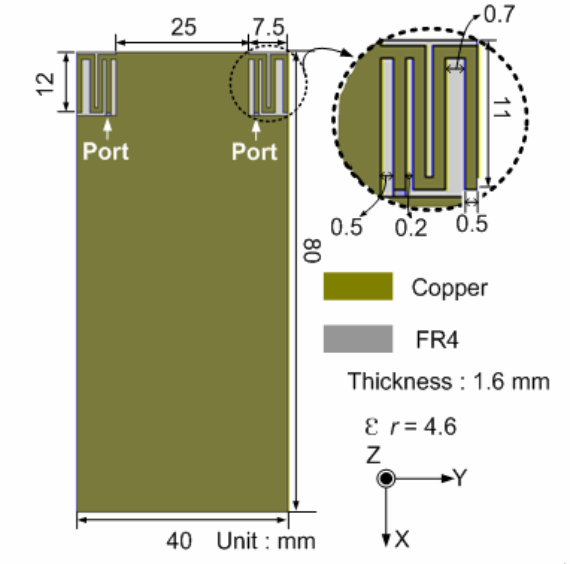
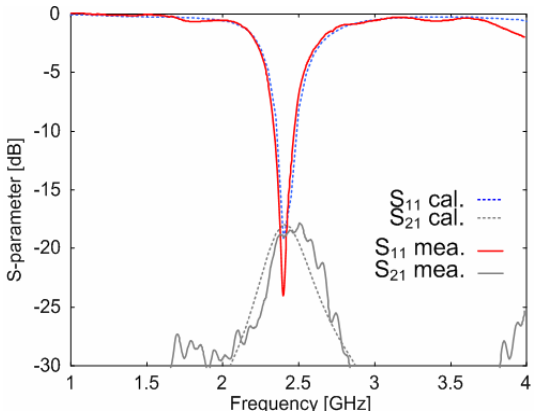


Fig. 1 Proposed antenna configuration for WiBro in Ref. [5].



(a) S-parameters of antenna in Ref. [5].

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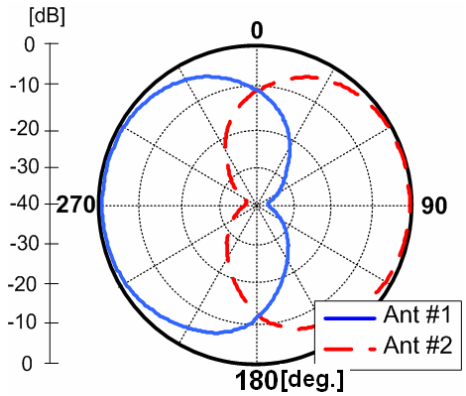


(b) Radiation patterns of antenna in Ref. [5].

Fig. 2 Characteristics of 2-channel WiBro Antenna in Ref. [5].

It is considered the PCS band antenna design including the WiBro MIMO antenna explained in Ref. [5]. Because the mobile users want to call when they are using the WiBro service simultaneously; for example, users want to call to somebody during downloading files, sending e-mail and searching information through the WiBro service. Thus it must be considered the PCS band antenna with WiBro-MIMO antenna to satisfy the user's requirement. In this research, they are employed a planar spiral with shorting strip line antenna for PCS band. To reduce the total antenna surface size which includes 3 antennas of the PCB board, we choose the space which is a projected(凸) ground area between two WiBro antenna elements for the PCS band antenna design.

Fig. 4 shows characteristics of printed IFA in Ref. [6] and the measured radiation patterns of the fabricated PCS band antenna and the WiBro antennas. The printed IFA has 140 MHz(1.74 GHz ~ 1.88 GHz) band width. The isolation between PCS band and WiBro band is observed -15 dB.

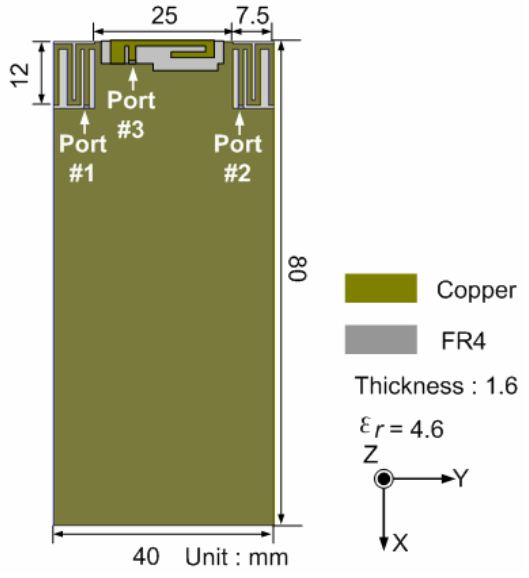
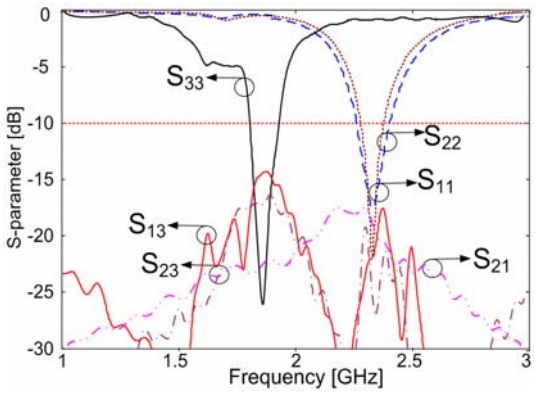
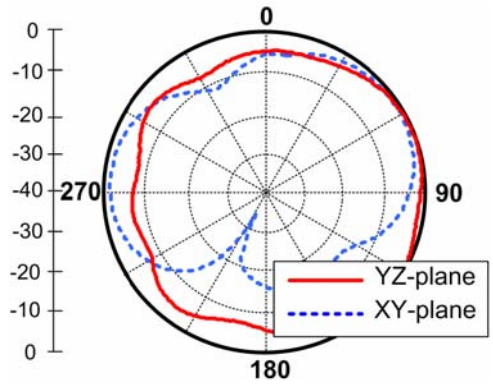


Fig. 3 Proposed antenna in Ref. [6].



(a) S-parameters of antenna in Ref. [6].



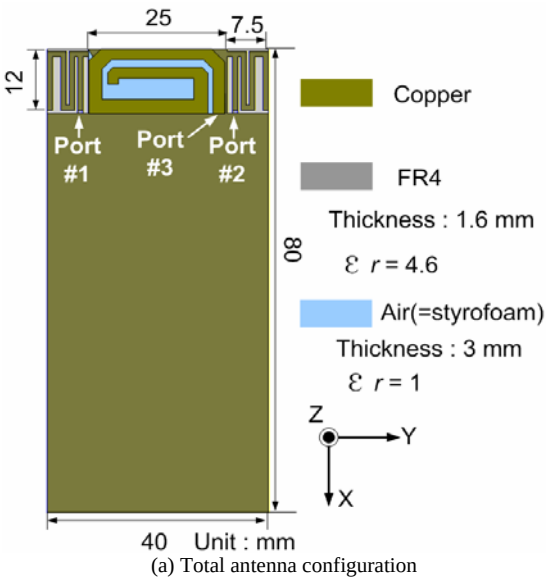
(b) Radiation patterns of antenna in Ref. [6].

Fig. 4 Characteristics of printed IFA in Ref. [6].

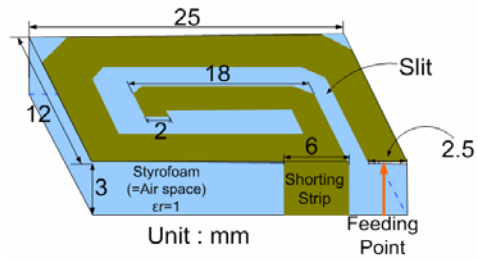
Fig. 5 shows the multi-band antenna configuration which includes the PCS band antenna with the 2-channel WiBro-MIMO antenna band. The antenna for PCS is designed planar spiral antenna with shorting strip line between two WiBro antenna elements. Due to the restricted space, the antenna used a bent microstrip line like a spiral and shorting strip line for good resonance in PCS frequency band.

Generally the bandwidth of planar inverted F antenna(PIFA) is determined according to the distance between antenna and ground plane. The proposed antenna is designed of 3-dimension structure on the ground between 2-channel WiBro MiMO antenna. Thus, it is used a slit on the antenna plane to good resonance frequency and easy tuning use to middle microstrip line. The antenna used an air space to increase the isolation and bent microstrip line like a spiral turned to inner for good isolation in PCS frequency band. Fig. 5(b) shows the antenna structure for PCS band. As shown in the Fig. 5(b), the structure is considered for increase of isolation of each antenna. The slit is applied to expand the physical electric length of antenna as shown Fig. (6). An air space is employed between PCS band antenna and ground could be placed electronic components of mobile terminal. Thus the antenna is easy to tune by length of middle microstrip line. We examined antenna bandwidth with various height of the space and length of the slit. Finally, we decided 3 mm in the antenna because of the its

good Isolation and bandwidth, and round off the corner for the current flow smoothly.



(a) Total antenna configuration



(b) Configuration of PCS band antenna

Fig. 5 Proposed antenna configuration for PCS band.

Fig. 6 shows the calculated S-parameters of the proposed PCS band antenna. The proposed antenna is well tuned in the PCS. The bandwidth of antenna for PCS band has 110 MHz (1.77 GHz ~ 1.88 GHz) which requiring on PCS system. The 2-channel WiBro antenna operated at 2.35 GHz. On the other hand, because the isolation between two frequencies bands are good performance, the WiBro antenna characteristic is not much affected by the PCS antenna. The mutual coupling(S_{ij}) between three antennas are calculated -20 dB below at all frequency bands.

Fig. 7 shows the calculated radiation patterns of the PCS band antenna. The solid line shows the YZ-plane (H-plane) of antenna, and it shows the typical H-plane radiation pattern of the antenna. However, the antenna tilted to Y-direction because the bent microstrip line leans to the Y-direction. The dotted line shows the XY-plane (E-plane) radiation pattern of each antenna, it also shows the typical E-plane radiation pattern of IFA. Due to the shorting strip line of the antenna, the back lobe of the E-plane is tilted to X-direction. The planar IFA tilted to X-direction because the shorting strip line located on the X-direction. General radiation patterns of the antenna are shown in Fig. 7 because turned to the inside and leaned to the left. It is proposed a height of 3 mm for good isolation and new type like a spiral. Even though the bent microstrip line and PCB board effect to the antenna radiation patterns, PCS band antennas show good radiation pattern for communication.

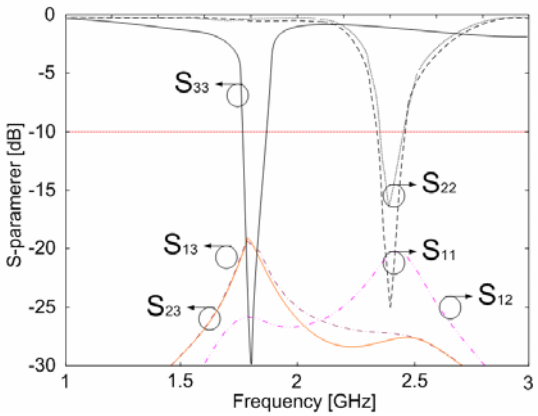


Fig. 6 Calculated S-parameters of the proposed antenna.

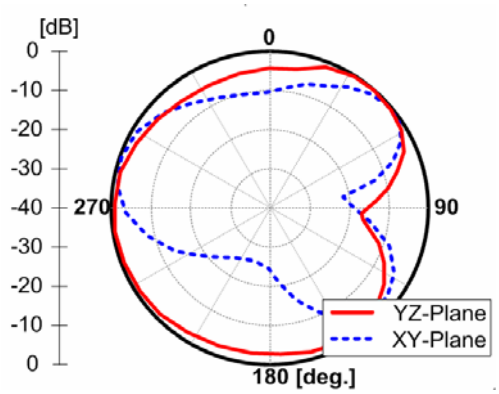


Fig. 7 Calculated radiation patterns of PCS band antenna at 1.8 GHz.

IV. Experimental Results and Discussion

Fig. 8 shows photographs of fabricated antennas for PCS and WiBro band.

Fig. 8 A photograph of the fabricated antenna.

Fig. 9 shows the measured S-parameters of the fabricated antenna. They show the reasonable agreement comparing with calculated ones. Only due to the effect of the connector and coaxial cables of the each antenna for feeding the radiation pattern tilted to X-direction.

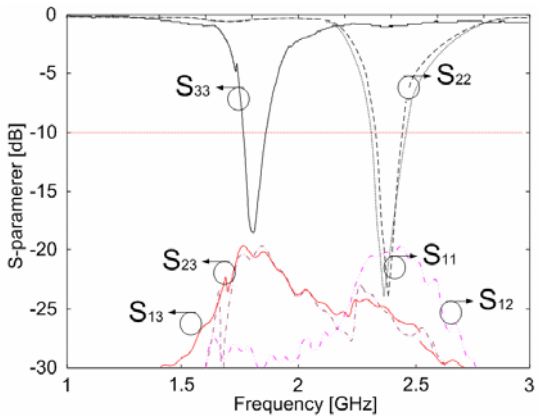


Fig. 9 Measured S-parameters of the multi-band antenna.

Fig. 10 and Fig. 11 show the measured radiation patterns of the fabricated PCS band antenna and the WiBro antennas, respectively.

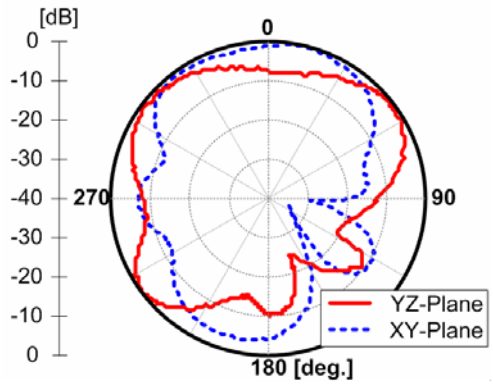


Fig. 10 Measured radiation patterns at 1.8 GHz.
(PCS band antenna,)

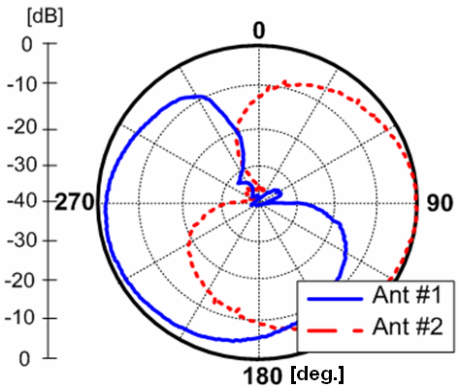


Fig. 11 Measured radiation patterns at 2.35 GHz.
(WiBro band antenna)

They show nearly similar calculated ones. However, tilted radiation pattern of the antenna in Fig. 10 and the back lobes in Fig.10 are considered by the effect of the connector and the coaxial cables as shown in Fig. 8. Additionally, made lobes to X-direction in Fig. 10 is considered by the effect of cable near the shorting-strip line.

Finally, the printed IFA has wide bandwidth than planar IFA and easy to manufacture. Additionally, the antenna size is compact than planar IFA[6]. However, it is proposed new type of antenna and isolation of the planar spiral antenna with shorting-strip line is better than printed IFA. Thus the antenna can use space to put some parts. So we can decide to application and make good use of antenna.

V. Conclusion

A compact multi-channel MIMO antenna operating in the WiBro band and PCS band is proposed. The proposed antenna which has compact size and easy tenability consists of two printed meander antennas and the planar spiral antenna with shorting-strip line. It is proposed new type and good isolation of the planar spiral antenna with shorting-strip line. The mutual coupling between WiBro antenna elements and PCS element is very low because of the projected ground structure and height of 3 mm. 3-dimensional space can provide use for put on small devices such as camera lens or IC chip. Resonance frequency of the antenna is controlled by length of middle microstrip line easily. Also the radiation pattern coupling is remarkably low due to the projected ground structure operated as an antenna reflector which can separate the radiation patterns of two antenna elements.

The S-parameters and radiation patterns are examined and they show reasonable agreements with the simulated results. The isolation between PCS band and WiBro band is observed -20 dB below. The proposed antennas have a suitable compact size for mobile handy terminal. It is realized reasonable radiation pattern coupling, and enough bandwidth for WiBro and PCS communication.

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