

Design of a MIMO Antenna for USB Dongle Application Using Common Grounding

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Abstract—In this paper, a MIMO antenna for USB dongle application is proposed. To obtain the wide impedance bandwidth, the beveling technique is used. The high isolation between the two radiating elements is achieved by using T-shaped common grounding element. The fabricated antenna has a return loss over 10 dB, a gain over 4.53 dBi, and an isolation between the two radiating elements higher than 20 dB over the Mobile-WiMAX band from 3.5 to 3.7 GHz. The measured ECC was less than 0.2.

Keywords— MIMO, Mobile-WiMAX, T-shaped common grounding element, beveling technique

I. Introduction

Multiple Input Multiple Output (MIMO) is a well-known technique to maximize the channel capacity and to enhance the performance of a wireless communication system by using two or more antenna elements [1]. However, it is difficult task to place multiple antennas within a limited space of a mobile terminal such as USB dongle. Especially, the mutual coupling between closely located antenna elements not only affects the radiation pattern but also deteriorates the overall performance of a communication system. Several techniques have been proposed to solve this problem, including the use of a slit and stub on the ground plane [2-3] and a decoupling network [4-6].

In this paper, a MIMO antenna utilizing a T-shaped common grounding element is proposed to obtain high isolation between the two radiating elements.

II. Antenna structure and performance

The geometry of the proposed MIMO antenna for USB dongle application using common grounding is shown in fig. 1. The proposed MIMO antenna consists of two modified inverted-L radiating elements, T-shaped common grounding elements and a ground plane. The ground plane is printed on the top of a FR4 ($\epsilon_r = 4.4$) substrate with a thickness of 1 mm and has the size of 54.5 mm x 25 mm which is a reasonable dimension for a general USB dongle. The T-shaped common grounding element is printed on the same layer of the ground plane. The two radiating elements are connected to T-shaped common grounding elements. The two radiating elements of the MIMO antenna were symmetrically printed with respect to

the center of the ground plane and were placed near the tow corners of the top edge of the ground plane.

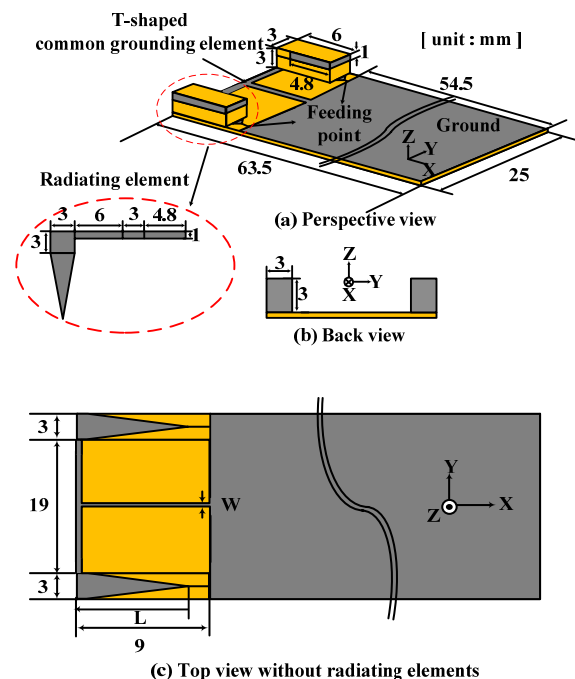


Fig. 1 Geometry of the proposed MIMO antenna

Fig. 2 shows the simulated return loss characteristics of the proposed antenna for various values of beveling length (L). The variation in the length of beveling provides tuning capability for resonance frequency. By adjusting the length of beveling, the impedance matching can be improved and wideband operation characteristics can be obtained [7]. The simulated s-parameter characteristics with and without T-shaped common grounding element are illustrated in Fig. 3. It is obvious that the addition of T-shaped common grounding elements improve the isolation characteristic. The designed antenna has an isolation of higher than 20 dB over the operating frequency. Fig. 4 shows the simulated isolation characteristics of the proposed antenna. By adjusting the width (W) of the T-shaped common grounding element, the isolation characteristic can be improved. Good isolation characteristic over the Mobile-WiMAX was achieved by adjusting the dimension of T-shaped common grounding

element. To investigate the effect of T-shaped common grounding on the isolation characteristic, the current distributions at 3.6 GHz with and without T-shaped common grounding element were calculated and shown in Fig. 5. When one of the two elements was excited, a strong current was induced at the other element in the absence of T-shaped common grounding element. After the T-shaped common grounding was added, the induced current on the non-excited element became very weak. The antenna structure was designed and analyzed using a high frequency structure simulator (HFSS V12.1) [8].

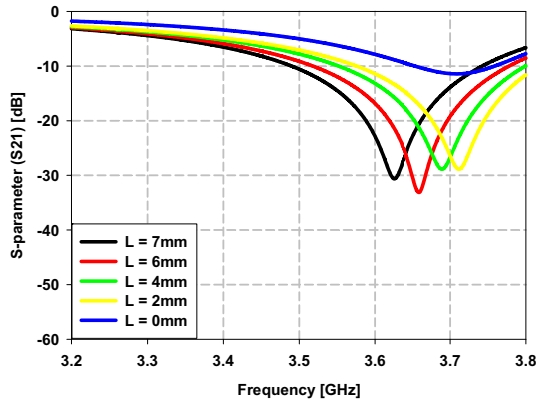


Fig. 2 Simulated return loss characteristics for various values of L

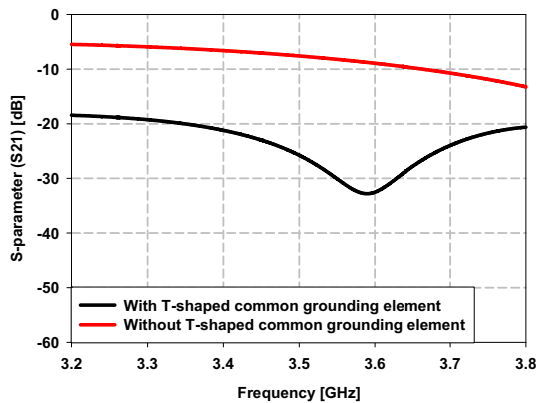


Fig. 3 S-parameter characteristics with and without

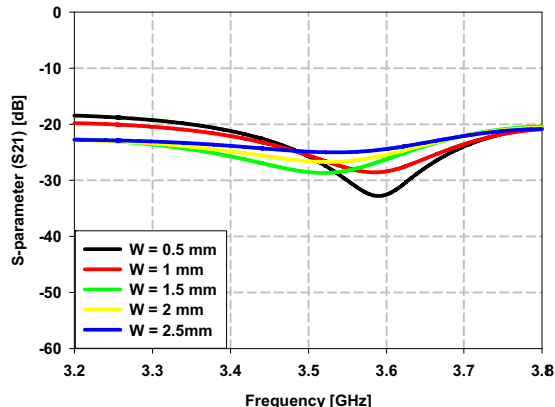
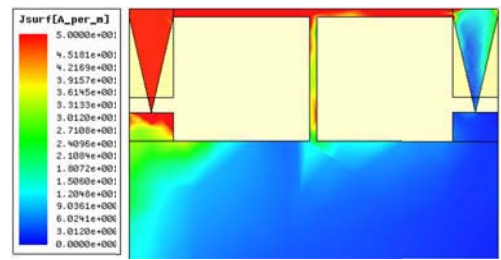
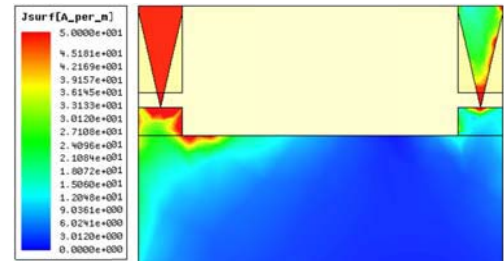


Fig. 4 Simulated return loss characteristics for different values of width (W)



(a) current distribution
with T-shaped common grounding element



(b) current distribution
without T-shaped common grounding element

Fig. 5 Current distributions of the proposed MIMO antenna (3.6GHz)

III. Results

Measured and simulated S-parameter characteristics for the proposed MIMO antenna are shown in Fig 6.

The measured results were very similar to the simulated results. The fabricated antenna has a return loss greater than 10 dB and an isolation between the two radiating elements higher than 20 dB over the Mobile-WiMAX band (3.5 ~ 3.7 GHz). The measured radiation patterns of the two radiating elements of the designed MIMO antenna are shown in Fig. 7. Fig. 8 shows the measured envelop correlation coefficient (ECC) of the fabricated antenna. The ECC value is less than 0.2 over the entire Mobile-WiMAX band and satisfies the general guideline for a mobile terminal [1]. The measured antenna gain is shown in fig. 9. The peak gain of the proposed MIMO antenna is 4.53 dBi at 3.6 GHz.

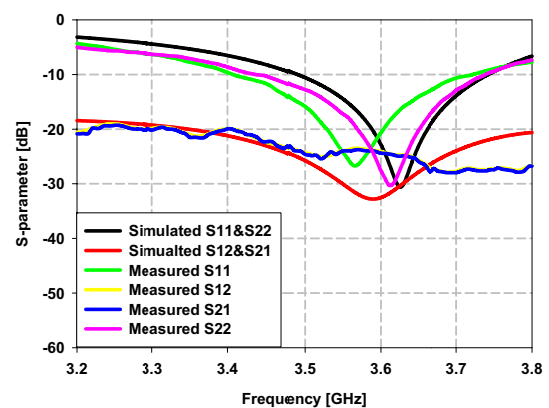


Fig. 6 Measured and simulated S-parameter characteristics for the proposed MIMO antenna

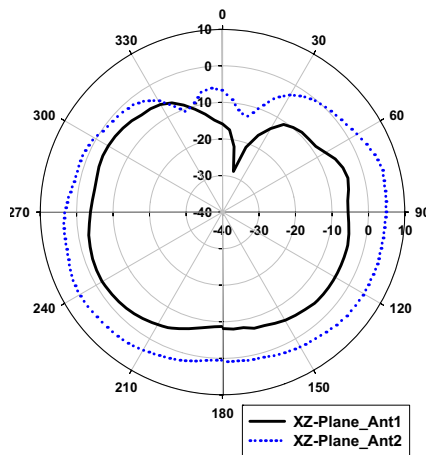
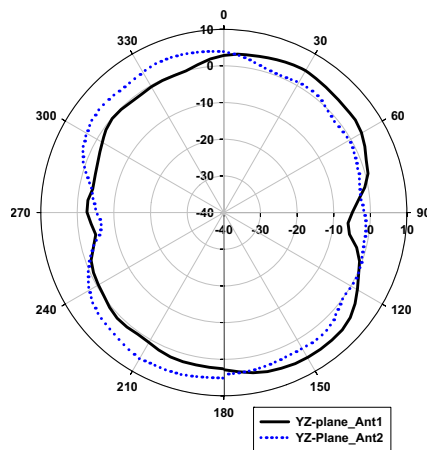
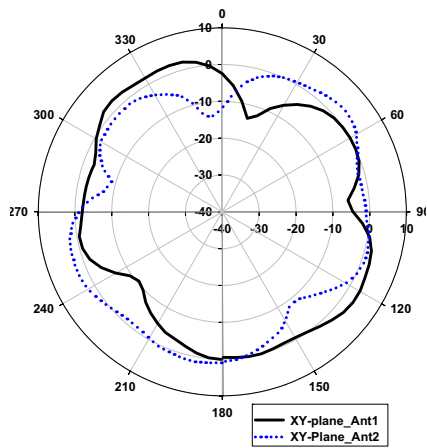


Fig. 7 Measured radiation pattern characteristics (3.6GHz)

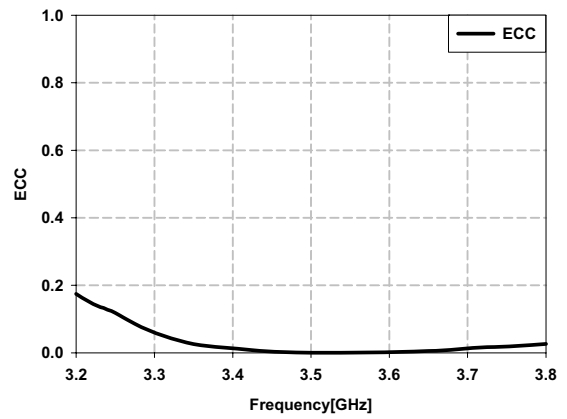


Fig. 8 Measured ECC characteristic (S-parameter)

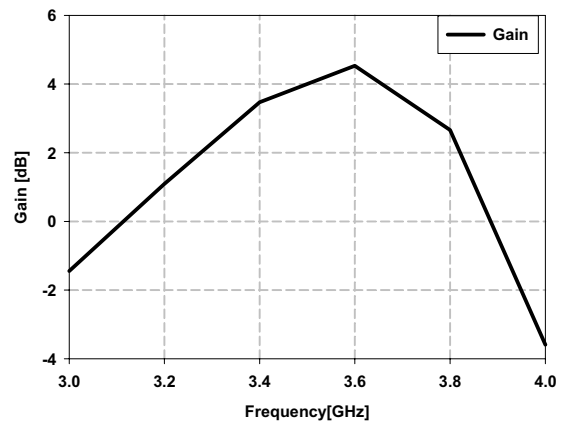


Fig. 9 Measured gain of the proposed MIMO antenna

IV. Conclusion

In this paper, we proposed a MIMO antenna using a T-shaped common grounding element. The proposed MIMO antenna consists of two radiating elements for Mobile-WiMAX (3.5 GHz ~ 3.7 GHz) service. The structure of T-shaped common grounding element was added between the two modified inverted-L radiating elements to improve the isolation characteristic. The return loss was higher than 10 dB and the isolation characteristic was higher than 20 dB over the whole Mobile-WiMAX band. The measured peak gain was 4.53 dBi at 3.6 GHz. The measured ECC was less than 0.2. Therefore, the proposed MIMO antenna using T-shaped common grounding element can be used in MIMO antenna systems to obtain the high isolation characteristic necessary for mobile applications

Acknowledgement

This research was supported by the MKE (Ministry of Knowledge Economy), Korea, under the ITRC (Information Technology Research Center) support program supervised by the IITA (Institute of information technology Assessment).

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