Design and Implementation of Dual Band Modified Biconical Antenna for Wireless LAN

Jong Dae Oh*, Ji Myoung Son*, Woon Geun Yang*
*Department of Electronics Engineering, University of Incheon
177, Dohwa 2-dong, Nam-gu, Incheon 402-749, Korea
Tel: +82-32-770-8447, Fax: +82-32-764-2371, E-mail: wgyang@incheon.ac.kr

Abstract

In this paper, we propose the dual band(2.4GHz and 5GHz) antenna for access point of WLAN(Wireless Local Area Network) which has similar radiation patterns for each band. Simulation results by using HFSS(High Frequency Structure Simulator) for the proposed antenna are presented. The electrical characteristics of the proposed antenna are measured with HP 8510C network analyzer and included. And radiation patterns are measured with rectangular anechoic far field antenna chamber. Measured results show that S_{11} is less than -14dB and VSWR(Voltage Standing Wave Ratio) is less than 1.5 for all frequency bands of interest. The measured maximum gain for elevation pattern at 2.40GHz is about 2.46dBi at theta=-78° and maximum gain for 5.825GHz is about 2.70dBi at theta=80°. And the implemented antenna has good radiation pattern characteristic, therefore, we expect that the implemented dual band antenna is applicable for access point of WLAN.

Key words : WLAN, Access Point, Dual Band, Biconical antenna

1. INTRODUCTION

Recently, wireless local area network (WLAN) has received much attention for their convenience in reconfiguration of networks and with rapidly growing demand for wireless connection. WLAN consists of LAN adapter, access point, and outdoor bridge [1].

The IEEE 802.11 WLAN has been gaining great popularity for data communications in university campuses, enterprise networks and hotspots since the baseline standard of it was approved in 1997. During the same time, the maximum raw bandwidth of the 802.11 system improved greatly, from 2Mbps (for 11 systems) to 11Mbps (for 11b systems), and now up to 54Mbps (for 11a and 11g systems)[2]. There are many commercial WLAN devices in the markets which use 802.11b system supporting the speed of 11Mbps. Now, with the demand for faster data communication, application of 2.4GHz, 5GHz band is considered in IEEE 802.11g, 802.11a standards. IEEE 802.11b is a data rate extension of the initial 802.11 standard, providing operation in the 2.4GHz band. Frequency band for IEEE 802.11b is 2.4GHz ~ 2.4835GHz. And frequency bands for 802.11a are 5.15GHz ~ 5.25GHz, 5.25GHz ~ 5.35GHz, 5.725GHz ~ 5.825GHz and each band is used for different maximum power output[3].

Always, dual or multi band antenna is of interest since it requires less space for installation and lower cost than the case that we apply different antenna for each frequency band. Furthermore, with dual or multi band antenna, we can have some flexibilities in designing wireless communication network[4].

Therefore, in this paper we propose the dual band antenna for access point of WLAN, which covers the frequency bands of 2.4GHz and 5GHz.

First, we'll describe theory of typical biconical antenna and dual band biconical antenna in chapter 2. In chapter 3, we'll explain the process of design and fabrication. Finally, conclude in chapter 4.

2. THEORY FOR DUAL BAND ANTENNA

Proposed antenna is a modification of typical biconical antenna for dual band operation. So, we first describe typical biconical antenna. And we present the structure of the proposed antenna.

2.1. Infinite biconical antenna

Broadband antennas usually require structures that do not emphasize abrupt change in the physical dimensions involved, but instead utilize materials with smooth boundaries. Smooth physical structure tends to produce patterns and input impedance that also change smoothly with frequency. This simple concept is very prominent in broadband antennas[5-7].

The bandwidth of dipole antenna can be increased by using thicker wire. This concept can be extended to further increase bandwidth if the conductors are flared to form a biconical structure. Fig. 1 shows field components and current flow for infinite biconical antenna which can be regarded as evenly tapered transmission line. And characteristic impedance of transmission line is obtained by surface current and applied time-varying voltage. These currents create an encirculating magnetic field H. If we assume a TEM transmission line mode, the electric field will be perpendicular to the magnetic field[7].

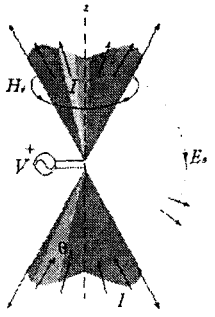


Fig. 1. Field components and current of the biconical antenna.

2.2. Basic structure for dual band biconical antenna

One design method for dual or multi band operation is using two or multi elements which have different resonance frequencies[4,8]. And we should consider geometrical structure of the antenna, for symmetrical azimuth pattern.

Fig. 2 shows proposed antenna structure for dual band operation. The proposed antenna is based typical biconical antenna. The whole structure corresponds to low frequency band and we hollow out a groove for high frequency band.

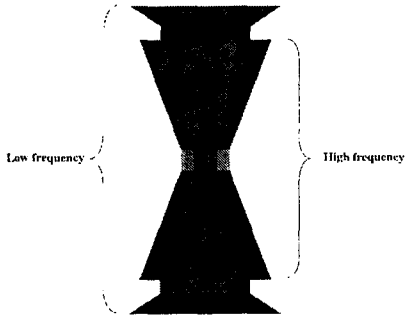


Fig. 2. Structure of the proposed antenna.

3. SIMULATION, IMPLEMENTATION AND MEASUREMENT

We are interested in dual band antenna which covers 2.4GHz and 5GHz frequency bands for WLAN. By using simulation software, HFSS, we got the suitable results for the required electrical characteristics and radiation properties. And we measured implemented antenna by using HP 8510C network analyzer and rectangular anechoic far field antenna chamber.

3.1. Simulation for proposed antenna

Fig. 3 shows the drawing of the proposed dual band antenna. The antenna is fed by coaxial cable. Dimensions of the proposed antenna are L_1=3mm, L_2=6mm, L_3=10mm, L_4=2mm, L5=3mm, D_1=3.5mm, D_2=9.5mm, D_3=6.5mm, D_4=11mm, H_1=2mm and H_2=6mm. D_x and H_x are radii. Characteristics are sensitive to the space between cone, and a hole size. We dug a hole, to get the similar azimuth pattern at two frequency bands.

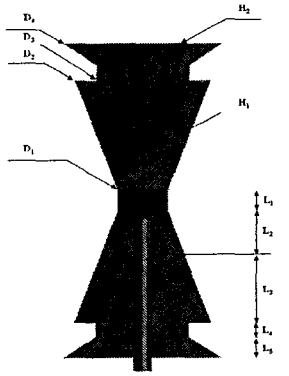


Fig. 3. Parameters of the proposed antenna.

Fig. 4 shows simulated electrical characteristics. Fig. 4(a) shows that S_{11} is less than −10.97dB. Fig. 4(b) shows that VSWR is less than 1.79 for all frequency bands of interest, and Fig. 4(c) is impedance loci of simulated dual band antenna.

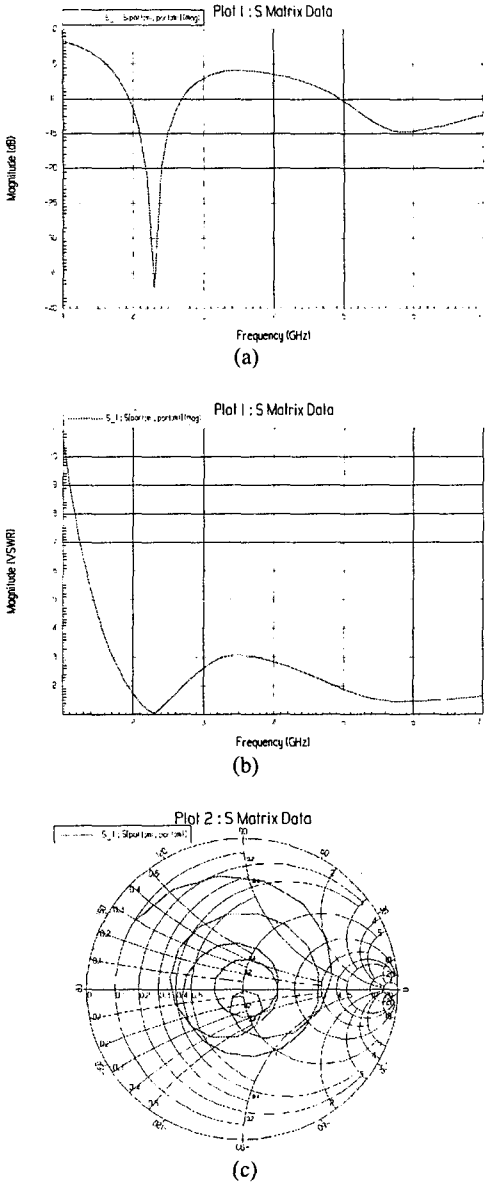
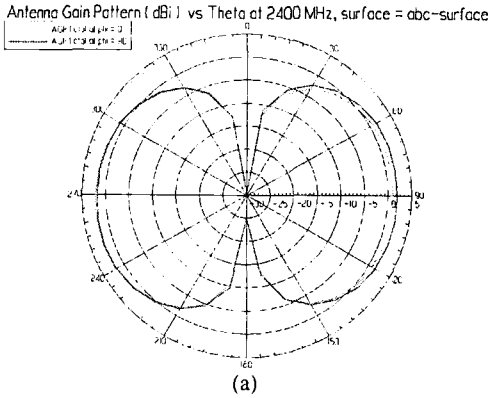
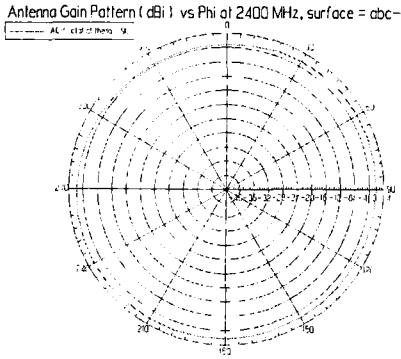


Fig. 4. Simulated electrical characteristics of the proposed antenna.
(a) S_{11}, (b) VSWR, (c) Impedance loci.

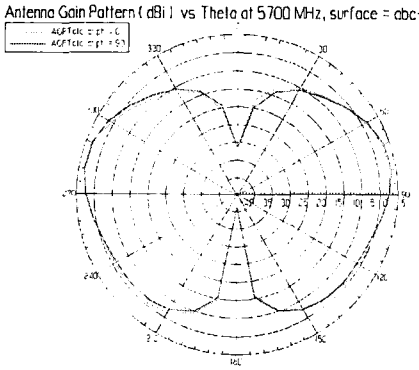
Fig. 5 shows radiation patterns of the proposed antenna. Fig. 5(a) is elevation pattern at 2.4GHz, and Fig. 5(b) is azimuth pattern at 2.4GHz. Fig. 5(c) is elevation pattern at 5.7GHz, and Fig. 5(d) is azimuth pattern at 5.7GHz. Fig. 5(b) and (d) display omni-directional azimuth patterns. The simulated maximum gain for 2.40GHz elevation pattern is about 2.27dBi at theta=250°. And azimuth pattern is about 2.33dBi at phi=40°. The simulated maximum gain for 5.70GHz elevation pattern is about 3.50dBi at theta=80°. And azimuth pattern is about 2.60dBi at phi=70°.



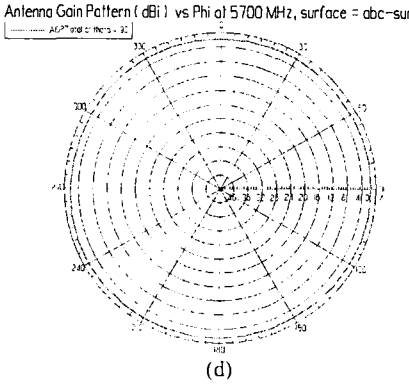
(a)



(b)



(c)



(d)

Fig. 5. Simulated radiation patterns of the proposed antenna.
(a) Elevation pattern at 2.4GHz,
(b) Azimuth pattern at 2.4GHz,
(c) Elevation pattern at 5.7GHz,
(d) Azimuth pattern at 5.7GHz.

3.2. Implementation and measurement

Fig. 6 is a photograph of the implemented antenna.

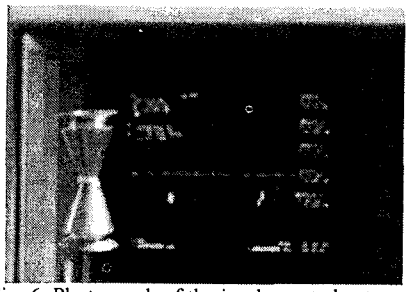
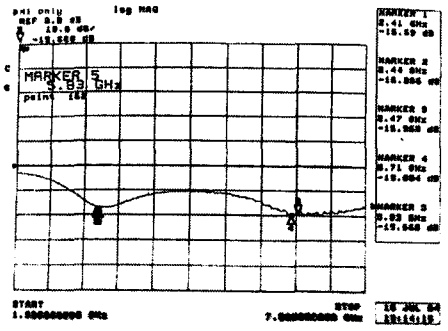
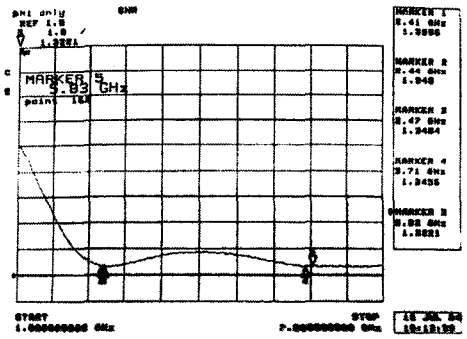


Fig. 6. Photograph of the implemented antenna.

Fig. 7 shows measured electrical characteristics, such as S_{11}, VSWR, impedance loci on the smith chart for the implemented antenna.



(a)



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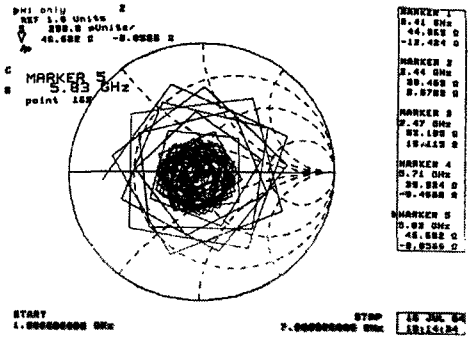
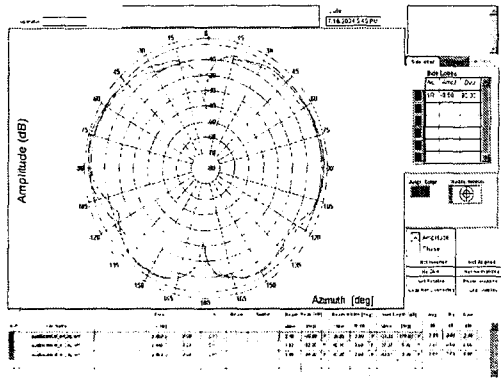


(c)

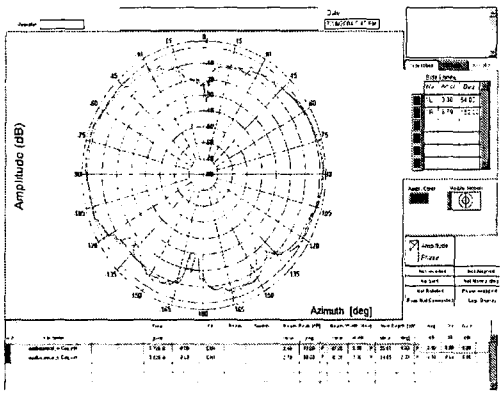
Fig. 7. Measured electrical characteristics of the implemented antenna.
(a) S_{11}, (b) VSWR, (c) Impedance loci.

Measured electrical characteristics of the implemented antenna are similar to simulated results and they are suitable for access point antenna of WLAN. Measured results of S_{11} and VSWR are less then -14dB and 1.5 for all frequency bands of interest.

Fig. 8 shows radiation patterns of the implemented antenna. Fig. 8(a) is elevation pattern at 2.4GHz, and Fig. 8(b) is elevation pattern at 5GHz. And measured maximum gain for 2.40GHz and 5.825GHz are 2.46dBi and 2.70dBi.



(a)



(b)

Fig. 8. Measured radiation patterns of the implemented antenna.
(a) Elevation pattern at 2.4GHz,
(b) Elevation pattern at 5.7GHz.

4. CONCLUSION

We proposed the 2.4GHz and 5GHz dual band antenna for access point of WLAN in the form of the modified biconical antenna.

Measured and simulated results show proper characteristics for dual band application. The simulated maximum gain for 2.40GHz elevation pattern is about 2.27dBi at theta=250° and maximum gain for 5.70GHz elevation pattern is about 3.50dBi at theta=80°. The measured maximum gain for 2.40GHz elevation pattern is about 2.46dBi at theta=-78° and maximum gain for 5.825GHz elevation pattern is about 2.70dBi at theta=80°. The implemented antenna for access point of WLAN has similar radiation patterns for all bands. Measured VSWR is less than 1.5 which is suitable for commercial application.

The implemented dual band modified biconical antenna has a good radiation pattern characteristic, therefore, we expect that the dual band modified biconical antenna is applicable for access point of WLAN.

ACKNOWLEDGEMENT

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