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Fabrication and Measurement of a Microstrip Antenna with Triple U-Shape Slots in the HiperLAN /2 Band

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Abstract: In this paper, a triple U-shaped slot microstrip patch antenna for HiperLAN/2 application is designed and fabricated. For the HiperLAN/2 application, a new model is presented by adding two U-slots to the basic U-shaped slot antenna. To obtain sufficient bandwidth in the operating band, the foam layer is inserted between the ground plane and substrate. The coaxial probe source is used. The measured results for the bandwidth and radiation patterns are obtained, with the result of the fabricated antenna satisfying the conditions of VSWR<2.0 in the HiperLAN /2 band (5.15~5.35/5.47~5.725GHz), gain of 6.27 ~ 9.82 dBi, and broad radiation pattern.

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1. Introduction

Today's wireless local area networks are designed to support mobile computing in small areas such as buildings, parks, airports, or office complex. The main attraction of WLANs is their flexibility. They can extend access to local area networks, such as corporate intranet, as well as support broadband access to the Internet particularly at "hot spots," which are public venues where people tend to gather. WLANs can provide quick, easy wireless connectivity to computers, machinery, or systems in a local environment where a fixed communications infrastructure does not exist, or where such access is not permitted [1].

For the 2.4GHz WLAN system, the frequency ranges from 2400 to 2484MHz for IEEE 802.11b. For the 5GHz WLAN system, the frequency is 5150-5350/5725-5825MHz for IEEE 802.11a and 5150-5350/5470-5725MHz for HIPERLAN/2. Currently, the 2.4GHz band is widely used for WLAN application. Because of the shortage of frequency band, miniaturization of the system, the interfere of the adjacent frequency and high-speed data transmission, the market estimate suggests a strong shift from 2.4 to 5GHz in the future. Therefore, an antenna should be able to cover 5GHz (5150-5825MHz) bands. To date, various 5.2-GHz band antenna designs for WLAN applications have been reported [2-5].

Microstrip patch antennas have been receiving increasing interest in various mobile communication systems because they have advantages over traditional whip and helix antennas in terms of high efficiency, low EM coupling to human head, and increased mechanical reliability [6]. Nonetheless, their limited bandwidth is a primary barrier to their implementation in many applications. Thus, much work has been devoted to increasing the bandwidth of microstrip antennas, including increasing the thickness of substrate or substrates with low dielectric constant using the physical structure and composing the structure of the antenna through stacked geometry or coplanar geometry using parasitic patches [7]. Another method is the U-slot patch antenna, which uses the resonance of the main patch and additional resonance according to the current distribution in the edges of the U-slot [8]. Since the patch antenna with a U-shaped slot is first reported, many published results have confirmed its broadband characteristic [9-15].

In this study, a triple U-shaped slot microstrip patch antenna is designed and fabricated in the HiperLAN/2 band. The proposed antenna had sufficiently wide bandwidth and small size. The two U-slots are injected in the single U-slot patch antenna used in the HiperLAN/2 band. The antenna configuration is given, and some results illustrating its characteristics are presented and discussed.

2. Antenna Configuration and Results

Figure 1 shows the configuration of the triple U-shaped slot antenna. A prototype design is done using Ensemble 5.0 from Ansoft, Inc., based on the method of moment in frequency domain. The antenna is designed to work in the 5GHz frequency band, with VSWR of 2:1 over the designated frequency range. A radiating patch occupying an area of $41.4 \times 26.8\ mm^2$ is printed on a thin Taconic TLY-5A-0620-C1/C1 substrate with thickness of 1.57mm and relative permittivity of 2.17. The ground plane has a size of $50 \times 35\ mm^2$. Table 1 lists the optimum parameters. An airgap is inserted between the substrate and the ground to improve bandwidth. For manufacturing convenience, a coaxial cable feed is used. Through simulation, the antenna is designed using optimal conditions.

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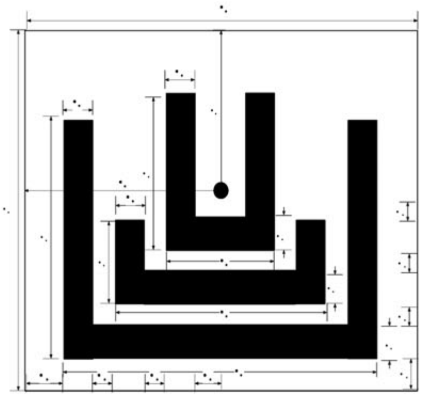
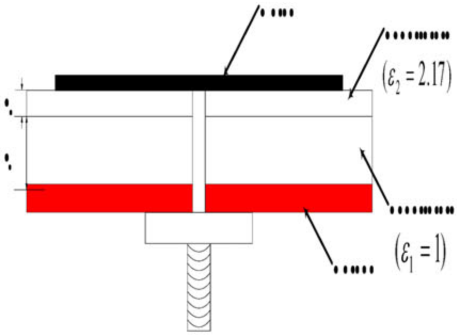


(a) Top view of the proposed U-shaped slot antenna



(b) Side view of the proposed U-shaped slot antenna

. *[for consistency, please capitalize "metal"]*

Figure 1. Geometry of the triple U-shaped slot antenna.

Horizontal Axis Length of the U-shaped Slot		Ordinates Axis Length of the U-shaped Slot		Interval of the Horizontal Axis		Interval of the Ordinates Axis		Probe Position	
X_1	27.6	Y_1	18.0	D_1	6.90	H_1	1.90	F_1	20.7
X_2	2.00	Y_2	2.00	D_2	2.40	H_2	1.75	F_2	11.9
X_3	18.8	Y_3	4.90	D_3	2.40	H	1.75		
X_4	2.00	Y_4	2.00	D_4	3.00	H_4	3.50		
X_5	10.0	Y_5	15.0						
X_6	2.00	Y_6	2.00						

Table 1. Optimized parameters of the triple U-shaped slot antenna (in mm).

The antenna is measured using an HP8510 network analyzer, with the far-field patterns and gain measured inside an available compact range at the RFIC Center of Kwangwoon University. Figure 2 shows the measured return loss of the proposed antenna.

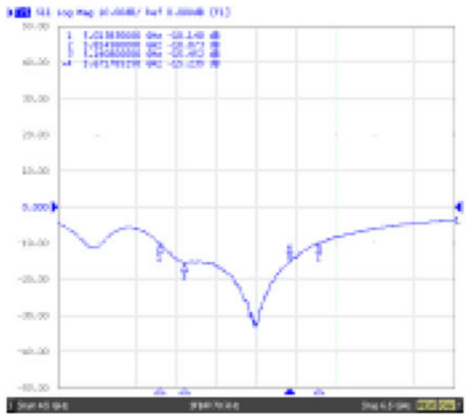


Figure 2. Measured return loss vs. frequency for the proposed antenna.

The measurement range is from 4.5GHz to 6.5GHz, with the interval of one blank set to 200MHz. The bandwidth, which is lower than -10dB, was from 5.00GHz to 5.84GHz. Figure 3 illustrates the measured VSWR. Good impedance performance is obtained, with bandwidth measuring 840MHz (15.5%) in VSWR < 2.0. The radiation pattern measures from 5.1GHz to 5.9GHz per 0.2GHz interval in the azimuth and elevation. Figures 4(a) and 4(b) present the measured radiation pattern in the azimuth and elevation. The 3-dB beamwidth measures 53.87˚ and 64.18˚ in the azimuth and elevation, respectively. The radiation pattern exhibits stability in the frequency bandwidth. Figure 5 shows the measures gain. A gain of 6.27 ~ 9.82dBi is obtained.

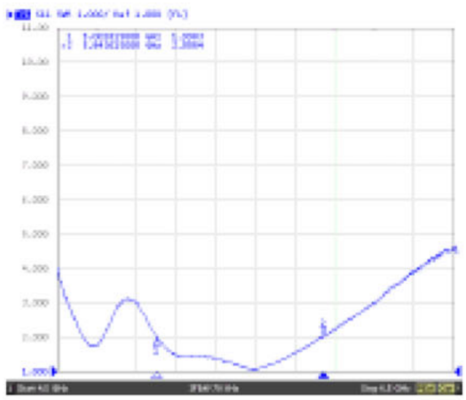
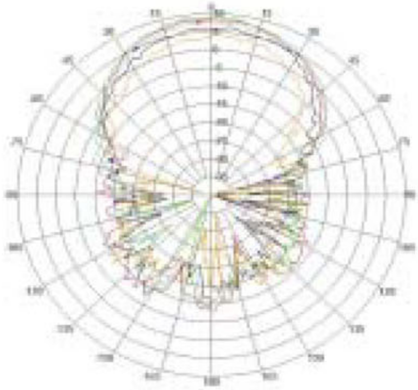
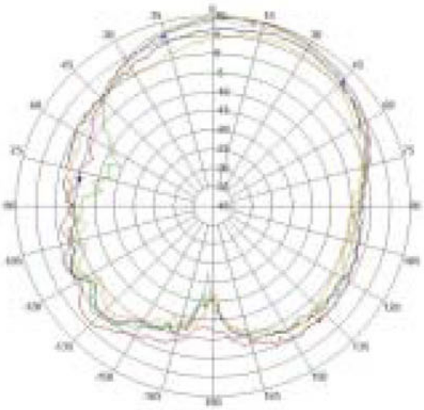


Figure 3. Measured VSWR vs. frequency for the proposed antenna.



(a) Azimuth.



(b) Elevation.

Figure 4. Radiation pattern. (a) Azimuth; (b) Elevation.

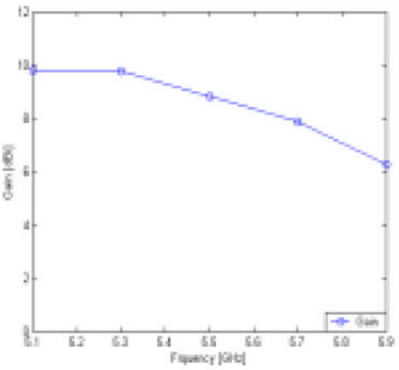


Figure 5. Measured antenna gain for the operating frequencies.

3. Conclusion

In this paper, a triple U-shaped slot antenna is proposed, designed, and fabricated for HiperLAN /2 applications. The impedance bandwidth was 840MHz (15.5%) in VSWR < 2.0 covering the required HiperLAN /2 band. The gain is 6.27 ~ 9.82dBi, and the proposed antenna is found to have a suitable bandwidth for HiperLAN /2 specification. Likewise, the proposed antenna is relatively easy to fabricate. The 3-dB beamwidth is 53.87˚ and 64.18˚ in the azimuth and elevation, respectively. The radiation pattern exhibits stability in the frequency bandwidth. Results show that the proposed antenna can be applied to the practical antenna system.

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