5.8㎓ 대역용 수정된 미앤더형 마이크로스트립 안테나의 구현

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Design of a Modified Meander-Type Microstrip Patch Antenna for the 5.8㎓ Band

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요 약

본 논문은 5.8㎓ 대역에서 동작하는 수정된 미앤더형 마이크로스트립 안테나의 특성을 구현하였으며, 형식 모델은 미앤더형의 선폭과 보우 타이 형으로 설계하였다. 측정된 최대 대역폭은 약 0.505㎓(5.540-6.045㎓), 8.72%(VSWR 1:1.5)이다. 이득은 5.8㎓에서 약 7.71 dBi를 얻었으며, 통과대역에서의 원거리 필드 패턴은 매우 안정적 특성을 얻었다.

Key Words : Microstrip Antenna, Modified Meander-Type Patch, Airgap, 5.8㎓ Band

ABSTRACT

This paper presents the characteristics of a modified meander-type patch antenna for the 5.8 GHz band, which is based on a meander line width and bow tie shaped model. The maximum measured bandwidth is approximately 0.505 GHz (5.54-6.045 GHz) or about 8.72% (VSWR 1:1.5). The obtained measured gain is 7.71 dBi at 5.8 GHz, and experimental far-field patterns are stable across the pass band.

Ⅰ. Introduction

Compact antennas have been the center of interest of much research due to the increasing popularity of wireless communications [1]. Though their patch dimensions are large for wireless communications applications, microstrip antennas have become very attractive for these kinds of applications because they are low-profile, lightweight, and easy to fabricate. Further reducing the size of the microstrip antenna, however, makes it more advantageous; hence, several designs have been proposed to make it smaller [2]. Using meander antennas is an effective way of reducing the patch size of the microstrip antenna. The meandering technique is achieved by inserting slots at the non-radiating edges of the antenna's radiating patch. These meandering slits lengthen the excited patch surface current paths, which lower the antenna's resonant frequency. The result is a smallerfixed antenna with a meandered patch [3, 4]. The bow tie antenna, with a compact size for a fixed operating frequency and radiation pattern characteristics similar to those of a conventional rectangular patch antenna, has been proposed and studied [5]. Since it was first introduced, many researchers have studied it [6-13]. Dual frequency operation of the bow tie microstrip antenna with a spur-line filter technique [6], shorting pin [7], and a pair of narrow slots closeto the radiating edges [8] has been demonstrated. Moreover, the bow tie slot microstrip antenna is fed by CPW [9-10], featuring a

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tapered CPW feeding transition [11] and an orthogonal feed arrangement [12]. On the otherhand, a bow-tie-shaped meander slot antenna fed by a microstrip line is proposed [13-14]. Wide operating bandwidth is achieved by a bow-tie-shaped outline of the patch, and the size reduction is realized by meandered lines. Although this antenna is smaller by 65.5% than the conventional bow tie microstrip antenna, the 10 dB impedance bandwidth is narrow, with approximately 2.25%, as usual [14].

In this paper, modified meander-type patch antenna for the 5.8 GHz band is proposed, which is based on modified meander line technique and bow tie shaped model. The antenna is fabricated with a conventional RF-4 material, which is normally used to make printed circuit boards, making it easy to manufacture at low cost. Detailed experimental results for the broadband performance and radiation pattern are discussed as follows.

Ⅱ. Antenna Design

The schematic configuration of the proposed design for the modified meander patch antenna is shown in Figure 1. A modified design is presented with the purpose of further reducing the antenna's length, which is achieved by inserting slots on the non-radiating edges of the antenna's radiating patch. Owing to the meandering slits, the excited patch surface current paths can be lengthened, which lowers the antenna's resonant frequency. Owingto the use of a coaxial feed line and narrow width (8mm in this study) of the meander patch, the proposed antenna is very attractive to fit in any narrow space within a communicative device, for example, the narrow space between the liquid crystal display panel and the housing of a laptop

On the other hand, the conventional bow tie antenna has broad characteristics, but it has very large dimensions [15, 16]. The geometrical advantages of each antenna are combined in the proposed design. Input impedance of the proposed antenna can be matched with the coaxial cable by adjusting the distance F1. The radiating patch occupies an area of 22.6 7 mm 2, and is printed on a thin FR-4 substrate 0.8 mm thick and 4.4. The antenna is fabricated with a conventional RF-4 material, which is normally used to make printed circuit boards, making it easy to manufacture at low cost. The FR-4 substrate serves as support to the radiating patch, and between the FR4 substrate and the ground plane is an air layer substrate that is 4.5 mm thick. An air-filled substrate is applied to help increase the desirable impedance bandwidth (VSWR1:1.5). A 4040mm 2 ground plane is used in this study. The line width, line length, gaps of lines, foam thickness, and position of the feeding point are varied in steps, with the bandwidth calculated at each step until the maximum bandwidth is obtained and optimized for WLAN system in the 5.8-GHz band. The optimum design parameters of the proposed antenna are set as follows: L1 = 22.9 mm, L2 = 16.1 mm , L3 = 13.1 mm, L4 = 13.1 mm, L5 = 4.6 mm, W1 = 2 mm, and W2 = W3= 1 mm, while the other meander line width = 1.0 mm, and F = 5.4 mm. The width between the meander line and the line is 1 mm. An air layer with spacing t1 = 4.5 mm between the dielectric substrate and ground plane was chosen for the experiment to minimize the return loss. Optimal parameters can be obtained with the aid of the commercially available software Ensemble 5.0 [17]. The proposed antenna is easily excited by using a 50 coaxial feed. After achieving the optimum design, the antenna was fabricated by Du-San Cooperation, using a DS-7408 T/C H/H substrate with 0.8 mm thickness and $\epsilon_r = 4.4$.

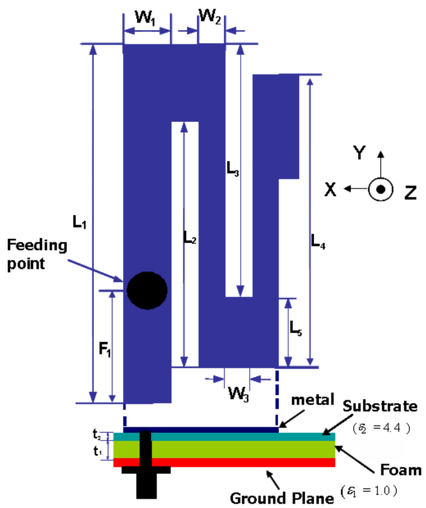


Fig. 1. Configuration of the modified meander-type antenna with short pin

Ⅲ. Measurement

Based on the proposed design described earlier, modified meander-type patch antenna for the 5.8 GHz band was designed, fabricated, and measured. The return loss and VSWR of the antenna were measured using an HP8510 network, with the far-field patterns and gain measured inside a compact range taken from the Chamber of Samsung Electron-Mechanics. Figure 2 shows the measured and simulated (by Ensemble 5.0) return loss versus frequencyfor the proposed antenna at the 4.5 GHz starting point and 6.5 GHz end point,with an interval of 200 MHz. From the results shown in Figure 2, it was found that the resonant mode was excited, with good agreement between the experimental and simulation results, and that the measured return loss at 5.81 GHz was -21.34 dB. The impedance bandwidth, defined by VSWR = 1.5, reached 0.505 GHz, thus covering the 5.8 GHz (5.725-5.875 GHz) bands for WLAN operation.

The radiation characteristics of the proposed antenna have also been studied. Fig. 3 presents the measured radiation patterns for free space at 5.6 GHz, 5.7 GHz, 5.8 GHz, 5.9 GHz, and 6.0 GHz. In Fig. 3, the red line represents the radiation pattern at 5.6 GHz, and the green, purple, black, and orange lines represent the radiation pattern at 5.7, 5.8, 5.9, and 6.0 GHz, respectively. Good broadband radiation patterns have been obtained, with slight asymmetry, however, in the radiation patterns, largely

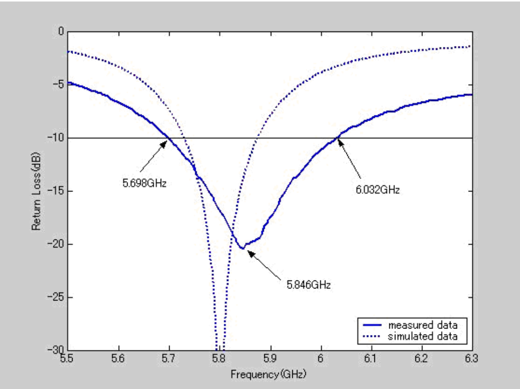
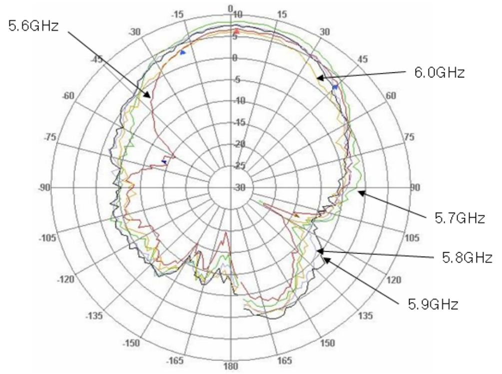


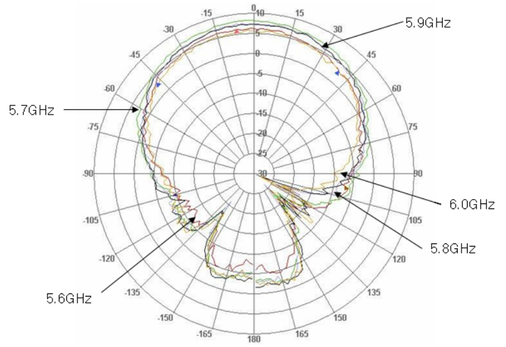
Fig. 2. Simulated and measured return loss vs. frequency for the proposed antenna

due to the finite ground plane and conductor loss. The 3 dB beam width (HPBW) on the x-z plane is 58.72 and on the y-z plane, 81.52, both at 5.8 GHz.

In addition, a good peak antenna gain of about 3.64-8.46 dBi for operating frequencies across the 5.8 GHz band is obtained for the proposed half-bow-tie-shaped meander-type patch antenna (see the simulated gain and measured peak gain in Fig. 4). If the frequency is 5.8 GHz, the maximum gain is 7.71 dBi for the x-z plane and 7.52 dBi for the y-z plane.



(a)



(b)

Fig. 3. Radiation patterns of the proposed antenna at 5.6, 5.7, 5.8, 5.9, 6.0 GHz in the operating band on the (a) x-z plane, and (b) y-z plane

Ⅳ. Conclusion

A half-bow-tie-shaped meander-type patch antenna is proposed for the 5.8 GHz band. Optimum parameters are produced by varying the meander line width and length, the gap between the lines, a number of meander sections, the thickness of the foam, and the posi-

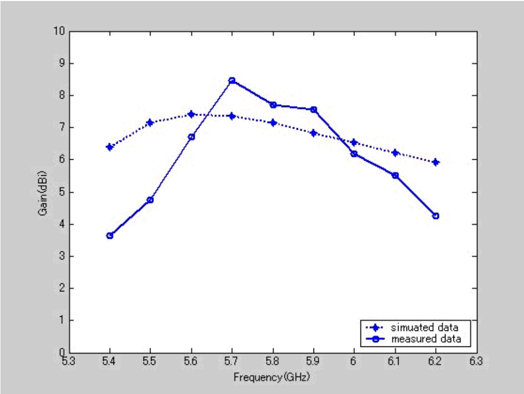


Fig. 4. Simulated and measured antenna gain for operatingfrequencies across the 5.8 GHz band.

tion of the feeding point. The proposed antenna was constructed and tested in the 5.8 GHz band. This proposed antenna has an impedance bandwidth (VSWR 1:1.5) of about 0.505 GHz or 8.72% of the bandwidth. The proposed antenna has also shown good broadside radiation characteristics, and has exhibited anantenna gain of about 7.71 dBi at 5.8 GHz.

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