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소형 2중-급전 4-배열 미앤더 모노폴 안테나

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A Low Profile Dual-Microstripline-Fed 4-Arrayed Meander Monopole Antenna

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요 약

본 논문에서는 분리된 4-조각 매쉬형 반사판을 갖는 소형 이중 4-배열 미앤더 모노폴 안테나를 제안한다. 십자형 요소와 4-소각 매쉬형 반사판은 복사패턴 특성과 안테나 이득 개선에 기여했다. 제안된 안테나의 실험치는, 다이폴과 같은 복사패턴 특성을 보였다. 제작된 안테나의 최대 이득 실험치는 약 2.89dBi 로 나타났으며, 이것은 소형 안테나에서는 비교적 높은 이득 특성을 나타낸 것이다. 이 안테나는 이동통신 RFID 리더용, 의료용기기, 방송용, 홈네트워킹, 그리고 다른 소형 고이득 시스템에 응용될 수 있다.

Abstract

In this paper, we present a low profile dual-microstripline-fed double 4-arrayed meander monopole antenna with a cross-type element back by separated four-segments mesh-type reflector. The cross-type element and separated four-segments mesh-type reflector leads to enhance radiation patterns and antenna gain characteristics. The measurement value of the proposed antenna show that it has dipole-like radiation pattern characteristics. The experimental peak gain of fabricated antenna is about 2.89 dBi, which presents relatively high gain characteristics for a low profile(small-size) one. This antenna can be applied mobile RFID(radio frequency identification) readers, small medical instruments, broadcasting and home-networking operations, and other low profile high-gain systems.

Keyword : low-profile, 4-arrayed meander, high-gain, separated four-reflectors, antenna

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Ⅰ. Introduction

Monopole antennas are used in mobile communications. A monopole antenna is very simple and efficient radiating element [1]. The simple whip and monopole antenna are attractive for using in mobile handsets and repeater applications because of omni-directional characteristics, simple structure, and the inherent 2:1 size reduction over equivalent dipole designs [2]. However, this antennas suffer from the problem of a limited bandwidth and a distortion radiation characteristics. This narrow bandwidth is a major obstacle that restricts wider applications. To achieve dual-band operation in the compact monopole antenna design, some promising designs, such as using a bent fork-type monopole[3] or a planar monopole in wrapped structure [4], have been invested for cellular communication applications. It is noted that these conventionally compact monopole antennas for single-band or dual-band operation are fed using a pro-fed or a microstrip-line feed [3]. Relatively, the design of monopole antenna using the feeding scheme of a coplanar waveguide(CPW) has been reported many attractive features, such as no soldering points, easy integration with microwave devices, and a simplified configuration with a single metallic layer, thus the designs of the CPW-fed antennas have recently received much attention. A simple way has proposed in [5-6] where a meandering conductor line printed on a single-dielectric substrate is used to reduce the size of a monopole antenna but the gain characteristic of the resulting antenna was low level(approximately 1.2dBi) at 900MHz. The radiation patterns of its antenna have been showed un-uniform and null-points characteristic. The low gain and null-points characteristic for a low profile antenna is a major obstacle that restricts a built-in RFID mobile applications.

In this paper, we present a low profile microstripline-fed double 4-arrayed meander monopole antenna with a cross-type element back by separated four-segments mesh-type reflector. This antenna can be manufactured in relative simple procedure. The cross-type element and back by the four-segments mesh reflector is used to enhance the impedance matching and to increase the antenna gain. The double arrayed meander structure leads to enhance the antenna gain and to reduce the antenna profile at once. This antenna offers an uniform radiation patterns and a high-gain characteristics for antenna profile(size). The measurements show that the antenna has dipole-like radiation pattern characteristics, and the variation in the radiation patterns is slight across the frequency range interest. Details of the antenna design and structure are described, and experimental results are also presented and discussed.

Ⅱ. Antenna structure and experimental results

Figure 1 shows the geometry of microstripline-fed double meander 4-arrayed monopole antenna with a cross-type

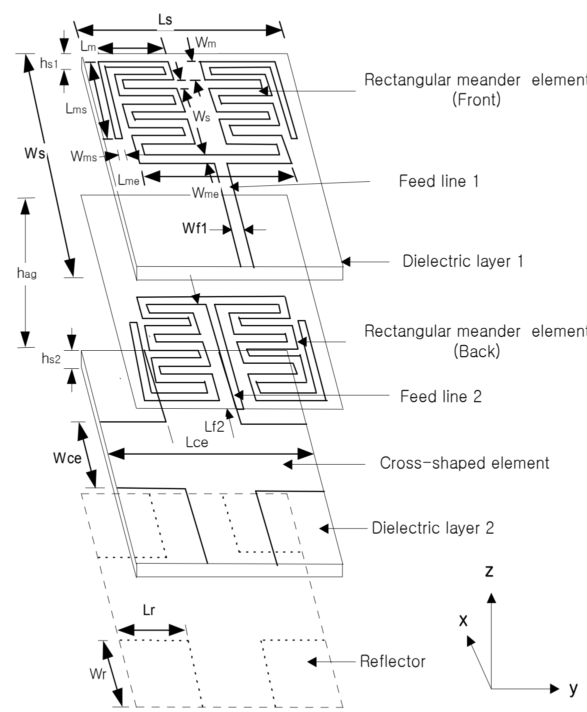
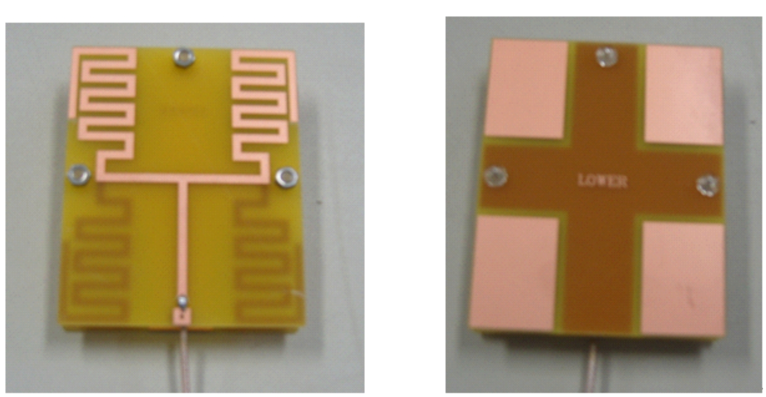


그림 1. 안테나 구조와 설계 파라메타
Fig. 1. Antenna structure and design parameters

element back by separated four-segments mesh-type reflector. The proposed antenna is fed by double microstripline-fed and the rectangular meander is printed in two metal layers and a cross-type element and back by the four-segments mesh reflector. A cross-type element and back by the four-segments mesh reflector is used to enhance the impedance matching and to increase the antenna gain. The double arrayed meander structure leads to enhance the antenna gain and to reduce the antenna profile(size) at once. This antenna can be manufactured in relative simple procedure. It consists of double 2-arrayed rectangular meander elements, a cross-type element, and the separated four-segments mesh, dual microstrip feed line and 50W coaxial cable with N-type connector. The upper dielectric layer is placed between the front 2-arrayed rectangular meander element with feed line and the back 2-arrayed rectangular meander element with feed line, improving the coupling. The lower dielectric layer is placed between the cross-shaped element and the separated four-segments mesh reflector. The radiators and micrstrip feed line are etched on the FR-4 substrate(εr=4.3, 1mm thick), and the cross-shaped element and the four-segments reflector are also etched on the FR-4 substrate(εr=4.3, 1mm thick). The 50W coaxial cable is attached to the lower microstrip feedline, through a small hole in the dielectric layer 1. The cross-shaped element is located on the dielectric layer 2. And four-separated mesh reflectors are attached under four-segments mesh reflector. Ls,Ws are the lengths and the width of the substrate, respectively. Lm,Wm are the lengths and the width of a rectangular meander, respectively. Lms,,Wms are the lengths and the width of a meander stub, respectively. Lme,Wme are the lengths and the width of a central meander element, respectively. Lme,Wme are the lengths and the width of a central meander element, respectively. Lr,Wr are the lengths and the width of the separated reflector, respectively, hag is the air gap between the layer of the lower 2-arrayed rectangular meander element and the layer of the cross-shaped element. Lr,Wr are the lengths and the width of the separated reflector, respectively. The cross-type element and back by the four-segments mesh reflector is used to enhance the impedance matching and to increase the antenna gain. The double arrayed meander structure leads to enhance the antenna gain and to reduce the antenna profile at once.

The fabricated antenna dimensions are as follow: Ls=59mm Ws,=73mm, Lm, =21.5mm, Wm=6.5 mm, Lms=20 mm,,Wms,=1.94mm,Lme,=mm, Wme= mm, Wmes=1.94mm, Lce=59mm, Wce=16mm,Lr, =19mm, W r, =21mm, ,Lf2,=25mm, Wf1=1.9 4mm, hag= 8 mm,. hs1= hs2=1.0 mm. The front face photo of fabricated an-



(a) (b)

그림 2. 제작된 안테나 사진 (a) 전면, (b) 후면
Fig. 2. Photo of fabricated antenna. (a) Front, (b) Back

tenna is shown in Figure 2(a). The back face photo of fabricated antenna is also presented in Figure 2(b).

This proposed antenna is designed by using commercial program based on the CST Microwave Studio[6]. To verify its performance, the proposed antenna was fabricated and measured. The antenna was fabricated using FR-4(h=1.0 mm), and the overall size of the proposed antenna is 59 mm×73 mm×2 mm. The VSWR of the proposed antenna was measured with an HP8510B network analyzer.

In Figure 3, the simulated and the measured VSWR (Voltage Standing Wave Ratio) of the proposed antenna are compared. The experimental result is relatively good agreement with the calculated result. The measured bandwidth of the antenna is 0.885 GHz ~ 0.945 GHz for a VSWR of less than 2.0. The simulated bandwidth of this antenna is 0.897 GHz ~ 0.923 GHz for a VSWR of less than 2.0. The obtained bandwidths cover both the RFID(0.908-0.914 MHz) and other mobile communication operations. An investigation of the radiation pattern characteristic of this antenna shows the characteristics to be similar to a conventional monopole. In Figure 4, the measured x-z plane radiation patterns of the proposed antenna is a bi-conical radiation pattern. The y-z plane radiation pattern is omni-directional, as illustrated in Figure 5. In addition, it is expected that, in general, the smaller CPW-fed, or microstripline-fed structure can affect the radiation patterns less than the other existing approaches. The measurements show that the antenna has dipole-like radiation pattern characteristics, and the variation in the radiation patterns is slight across the frequency range interest. Measured gain against frequency of RFID, mobile system is shown in Figure 6. The gain is relatively higher over most of the band, and this is most probably due to the effect of the finite size of the antenna substrate, i.e. power in the surface wave is not confined to the substrate but diffracted by the substrate edge, an ef

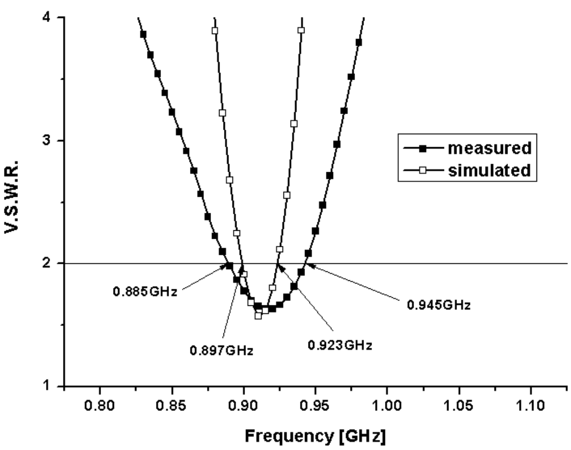


그림 3. 제안된 안테나의 정재파비
Fig. 3. VSWR of proposed antenna

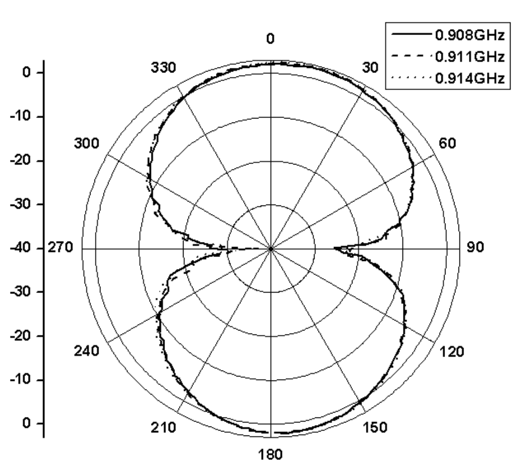


그림 4. x-z 면에서의 복사패턴 측정치
Fig. 4. Measured radiation pattern in x-z

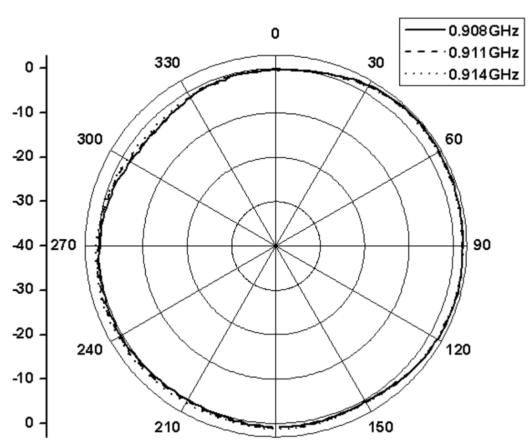


그림 5. y-z 면에서의 복사패턴 측정치
Fig. 5. Measured radiation pattern in y-z

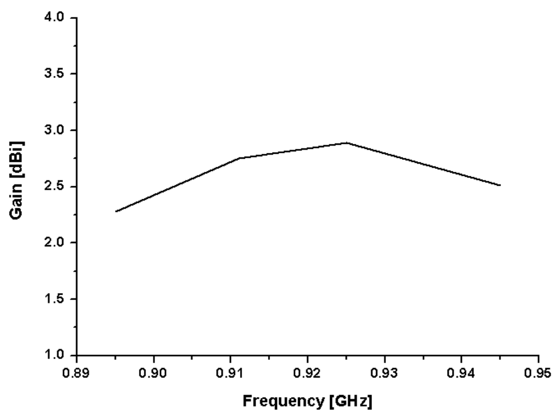


그림 6. 안테나 이득 측정치
Fig. 6. Measured antenna gain

fect which is not taken into account in analysis. The measured gain is 2.3 dBi over the entire band in the usable frequency band, but drops off rapidly past the band edges. This is due to impedance mismatchand pattern degradation, as the back radiation level increases rapidly at these frequencies. The maximum gain is most important to evaluate the communication possibility. The measured peak gain is 2.89 dBi, which presents relatively high gain for the antenna profile(size).

표 1. 안테나 성능 비교
Table 1. Comparison of antenna performance

	Antenna size[mm]	Bandwith (VSWR≥2.0)	Radiation pattern(x-z plane)	Gain[dBi]
This paper	58×73×10	0.897 GHz ~ 0.923 GHz	a bi-conical pattern	2.89
Conventional paper, Ref.[6]	50×75×3	0.897 GHz ~0.930 GHz	a bi-conical pattern	2.3

In Table 1, the characteristics of this paper and conventional paper are compared. We obtain the experimental antenna peak gain of this paper and the conventional paper is about 2.89 dBi, 2.3 dBi in respectively.

III. Conclusion

In this paper, we present a new design of a double micrstripline-fed meander 4-arrayed monopole antenna with a cross-shaped element and separated four-segments mesh-type reflector. The proposed antenna is fed by double micrstripline-fed and the rectangular meander is printed in two metal layers with cross-typed element back by the separated four-segments mesh reflector. A cross-shaped element and separated four-segments mesh-type reflector is used to enhance the impedance matching and to increase the antenna gain. The double arrayed meander structure leads to enhance the antenna gain and to reduce the antenna profile at once. The experimental values of antenna offer an uniform radiation patterns and a high-gain characteristics. The experimental peak gain of fabricated antenna is about 2.89 dBi, which presents relatively high gain characteristics for a low profile(small-size). The proposed antenna can be also applied to wide-band and high-gain built-in RFID fields, cellular and broadcasting, and other low profile and high-gain mobile systems.

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