5 세대 이동 통신을 위한 보우 타이 배열 안테나

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Bow-tie Array Dipole Antenna for Fifth Generation Mobile Communications

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Abstract

This work presents 1 x 4 array bowtie dipole antenna with a modified ground. The modified backward plane is carved with the same power divider and a bowtie driver into a ground of a printed circuit board. Also, this work proposes an exponential taper for reducing mismatching between the ground plane and the feeding lines of the power divider. Consequently, the proposed array antenna consists of two layers a forward bowtie array and a backward bowtie array. This work obtains dual operation frequency bands of 3 GHz (20.6 – 23.6 GHz) and 2.1 GHz (26.8 – 28.9 GHz). The proposed antenna achieves a gain of 7.6 dBi and 9.4 dBi at 21.8 GHz and 27.9 GHz, respectively. The proposed antenna is designed for the fifth generation (5G) communication system, we hope that it will be adopted and used widely for wireless communication.

I. Introduction

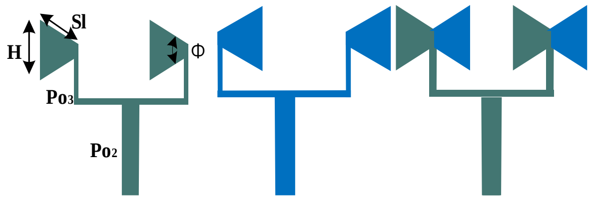
In the last few years, economic and social development is greatly influenced by advancements in the field of mobile communication. As a result, the fifth-generation (5G) technology has emerged as a pedestal of the 21st-century generation. 5G technology is an emerging technology with evolutionary and revolutionary services. Recently, economic and social development is greatly influenced by advancements in the field of mobile communication.

The intensive research in 5G technology is a realistic indication of the technological revolution to meet the ever-increasing demand and needs for high-speed communication as well as Internet of Thing (IoT) based applications. 5G will provide the foundational infrastructure for building smart cities, which will push mobile network performance and capability requirements to their extremes, such as the Internet of IoT, Gigabit wireless connectivity, and tactile internet. For IoT, the main challenge is the scalability problem. The 5G technology will be supported by not only IoT devices to provide different services but also smart buildings, smart cities, and many more which will require a 5G antenna with low latency, low path loss, and stable radiation pattern [1, 2].

Ⅱ. Design and **Description of proposed antenna**

The bow-tie dipole antennas have been designed for the 5G application. The bow-tie patch actually is the combination of an imaginary image of two triangular patches which are fabricated in a single substrate. Bow-tie dipole antennas have become attractive candidates in the present-day communication scenario due to their compact nature compared to rectangular patches. The increasing demand for compact wireless communication equipment necessitates research in compact antenna options and which sparked the interest of many researchers worldwide in the field of bow-tie microstrip antenna [3, 4].

A. Elements of Array antenna



(a) forward bowtie 1x2 elements, (b) backward bowtie 1x2 elements, (c) Join forward to backward 1x2 elements.

Fig. 1. Element of 1x 2 of array bowtie dipole.

Fig. 1 shows 1x2 elements of the proposed array bowtie dipole antenna. The proposed bowtie driver is like a triangle shape, as shown in Fig. 1. The elements of an array antenna compose forward and backward triangle drivers of a substrate. Here, H and Sl are the bottom side and a hypotenuse of a bowtie. Also, Φ is an interior angle. Fig. (a), and (b) are forward and backward bowtie elements. Also, Fig. 1 (c) shows the join elements of array bowties.

B. Power divider of Array Antenna

An array antenna needs to match impedance between array elements and feeding lines and to divide equally power to each element. Therefore, the proposed array antenna composes power divider, as shown in Fig. 2 [5, 6].

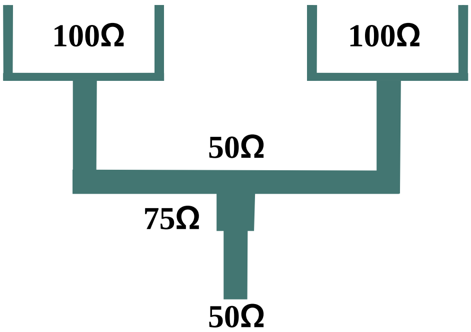
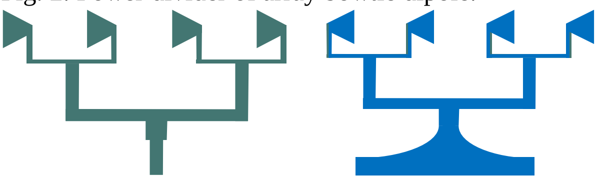


Fig. 2. Power divider of array bowtie dipole.



(a) forward array bowtie (b) backward array bowtie

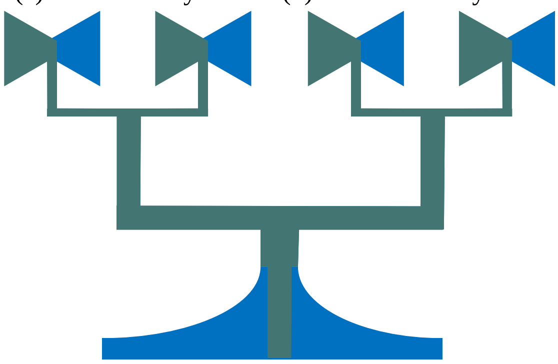


Fig. 3. Geometry of array bowtie antenna.

Fig. 3 shows the geometry of the proposed array bowtie antenna. Fig.3 (a), (b) appear a forward and a backward array bowtie. Fig. 3 (c) shows the join a forward backward array bowtie to a backward array bowtie. The backward ground plane uses an exponential taper between a ground plane and a power divider for reducing mismatching impedance. The proposed array antenna stays a distance of 0.7 λ_g between elements.

III. Analyzed and Experiment

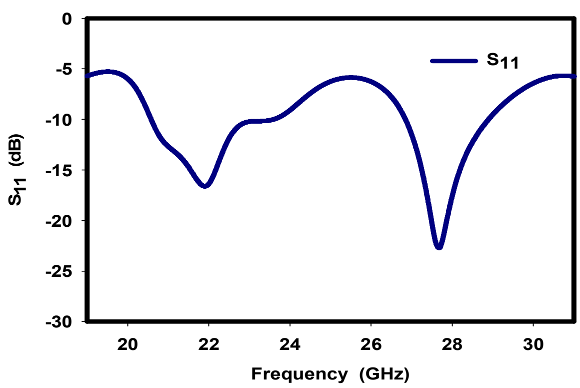


Fig. 4. Reflection coefficient.

Fig. 4 shows reflection coefficient of the proposed antenna. This work yields dual frequency bands of 20.6 – 23.6 GHz and 26.8 – 28.9 GHz.

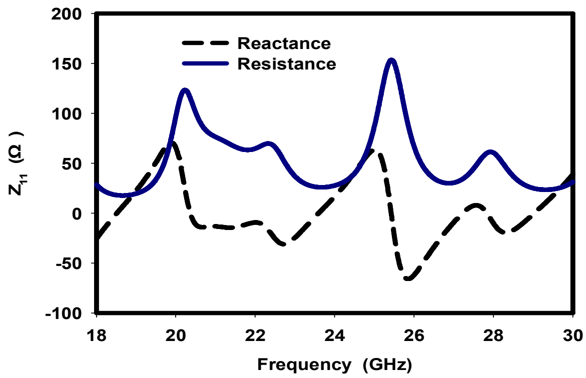


Fig. 5. Impedance of the proposed antenna.

Resistance and reactance of the proposed array antenna are shown in Fig. 5. The resistance approaches the characteristic resistance of 50 – 70 Ω and reactance of 0 – 20 Ω at both operating frequency bands of 20.6 – 23.6 GHz and 26.8 – 28.9 GHz.

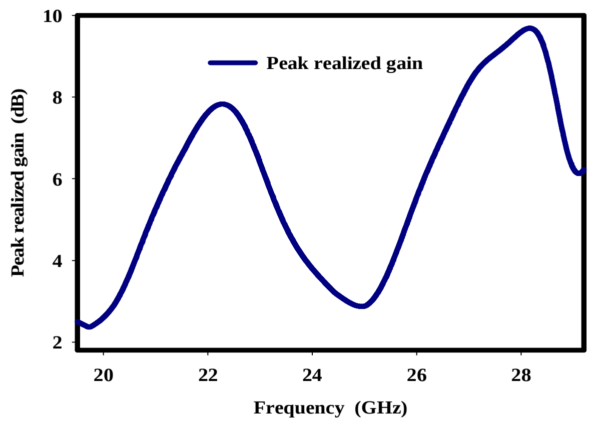
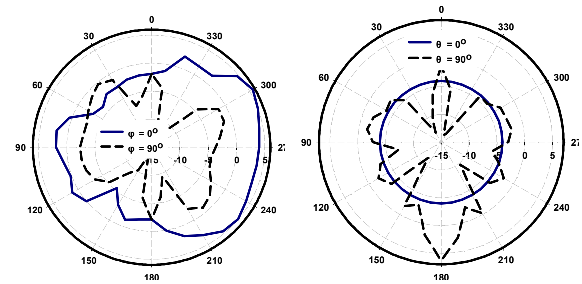
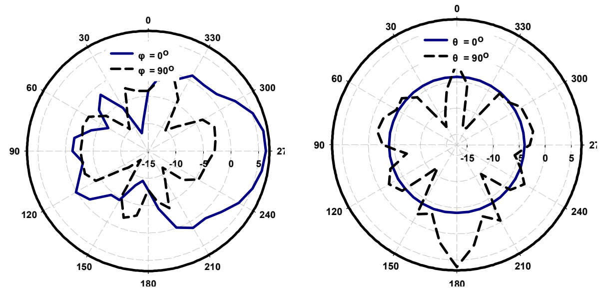


Fig. 6. Peak realized gain of the proposed array antenna.

Fig. 6 shows a peak realized gain of frequency bands of 20.6 – 23.6 GHz and 26.8 – 28.9 GHz. They are obtained a gain of 7.6 dBi and 9.4 dBi.



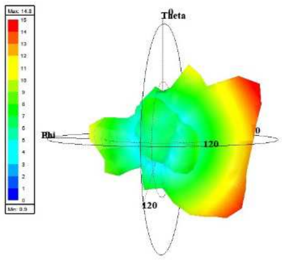
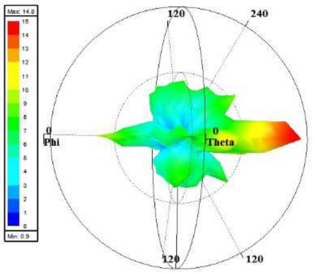
(a) Elevation and azimuth-plane at 21.9 GHz.



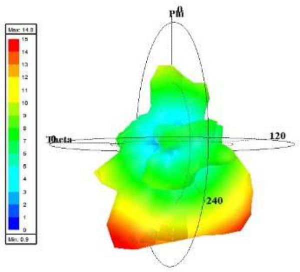
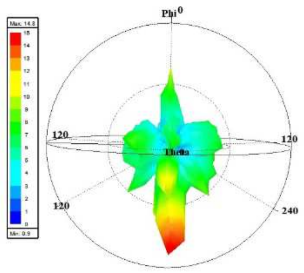
(b) Elevation and azimuth-plane at 27.9 GHz.

Fig. 7. Radiation pattern at 21.8 and 27.9 GHz.

Radiation patterns of an elevation plane and an azimuth plane at 21.8 and 27.9 GHz are shown in Fig. 7. The peak gains are 7.5 dB at each frequency band. As shown in Fig. 7, electric and magnetic fields are identified in the XZ and XY planes, respectively.

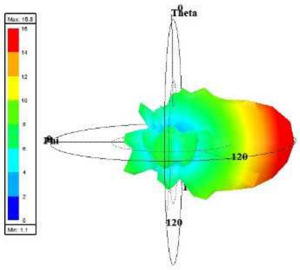
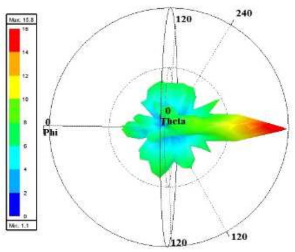



i) xz-plane ii) xy-plane

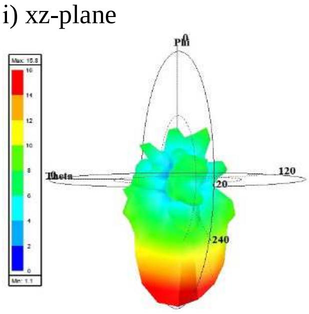
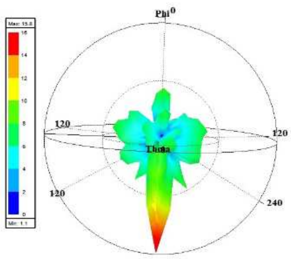



iii) yz-plane iv) xy-plane

a) 3D radiation patterns at 21.9 GHz

i) xz-plane ii) xy-plane

iii) yz-plane iv) xy-plane

b) 3D radiation patterns at 27.9 GHz

Fig. 8. 3D radiation pattern at 21.8 and 27.9 GHz.

3D radiation patterns of an elevation plane and an azimuth plane at 21.8 and 27.9 GHz are shown in Fig. 8. They show characteristics of end-fire radiation patterns.

IV. Conclusion

This work presented 1 x4 array bow-tie dipole antenna. The proposed array antenna modified a backward plane of a dielectric substrate that was carved a power divider into such as a forward power divider. The proposed array antenna consists of two layers a forward bowtie array and a backward bowtie array. Also, the proposed exponential taper played a role of balun in matching impedance between the ground plane and the feeding lines of the power divider. This work was able to obtain the high gains that are desperately required in 5G communication. This work obtains dual operation frequency bands of 3 GHz (20.6 – 23.6 GHz) and 2.1 GHz (26.8 – 28.9 GHz). The proposed antenna achieves a gain of 7.6 dBi and 9.4 dBi at 21.8 GHz and 27.9 GHz, respectively.

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