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# Dual-Band Dipole Antenna with Dual Flat Reflectors

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***Abstract* – A dipole antenna with a flat reflector can achieve unidirectional radiation pattern with a simple structure. However, the distance between a reflector and an dipole element is required 1/4 wavelength. In order to use in two or more frequency bands, it is necessary to use individual dipole element for each frequency band.**

**This paper proposes a dipole antenna with dual flat reflectors. In addition, effect of the reflector structure on the beamwidth in dual frequency bands is clarified. Moreover, the effects of parasitic elements arranged close to the dipole element on the band characteristic of the VSWR is considered. Furthermore, it is shown that an impedance matching is realized in dual bands.**

***Index Terms* — Dipole antenna with reflector, Dual flat reflector, Dual band, Beamwidth.**

## I. Introduction

A dipole antenna with a flat reflector has a uni-directional radiation pattern. Therefore it is widely used for base station antennas in mobile communications[1]. By development of the latest mobile communication systems, the base station which can be used by two or more frequency bands is demanded.

An antenna which realizes broadband characteristics by arranging the broad patch type parasitic element close to the dipole element on antenna with reflector is reported[2]. However, when the frequency of the very wide range is shared, the antenna should be a multi-band. In that case, it is necessary to place many excitation elements.

This paper proposes a dipole antenna with dual flat reflectors. In addition, it is shown that the impedance matching and the same beamwidth can be realized in the dual bands.

## II. Structure of Antenna with Dual Flat Reflectors

Figure 1 shows the structure of the dipole antenna with dual flat reflectors. Wavelength of the lower frequency $f_1$ and the higher frequency $f_2$ are $\lambda_1$ and $\lambda_2$, respectively.

The 1st flat reflector with the side length $L_1$ is arranged at distance of $0.25\lambda_1$ from the half wavelength dipole antenna. In addition, the 2nd flat reflector with the side length $L_2$ is arranged between the dipole antenna and the 1st reflector. The distance from the dipole antenna to the 2nd reflector is $h$. The 1st and the 2nd reflectors are squares. Moreover, two parasitic elements are arranged on the same plane with the dipole antenna for impedance matching in dual bands[3].

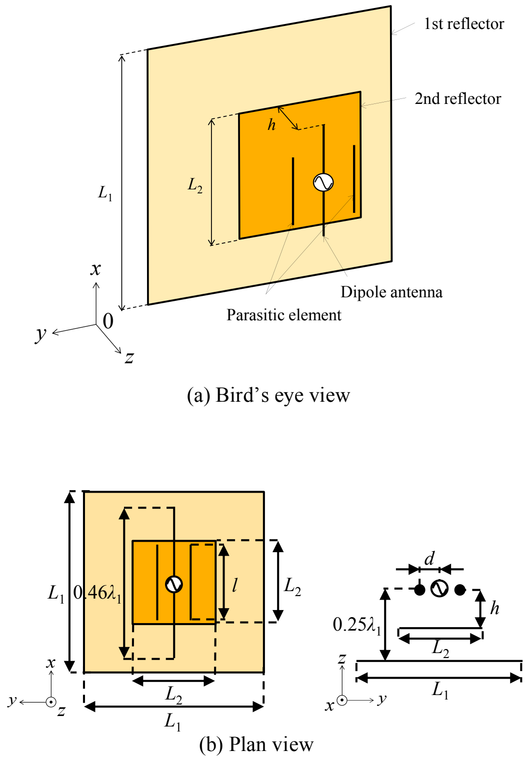


Fig. 1. Structure of dual reflectors dipole antenna.

The length of the parasitic elements is $l$, and the distance between the dipole antenna and the parasitic element is $d$.

## III. Effect of Dual Flat Reflectors on Beamwidth

### A. *Effect of Side Length of 2nd Reflector*

Figure 2 shows the relationship between the side length of 2nd reflector $L_2$ and beamwidth in $yz$-plane, when $h/\lambda_1$ =0.15, $l/\lambda_2$ = 0.45, $d/\lambda_1$ = 0.025 and $f_2/f_1$ = 1.75. From Fig. 2, it can be seen that the beamwdth in $f_1$ is not affected by $L_2$. However, $f_2$ is decreased as the side length $L_2$ is increased.

### B. *Effect of Distance Between Dipole Antenna and 2nd Reflector*

Figure 3 shows the relationship between distance $h$ and beamwidth in $yz$-plane, when $L_2/\lambda_1$= 0.65, $l/\lambda_2$ = 0.45, $d/\lambda_1$ = 0.025 and $f_2/f_1$ = 1.75. From Fig. 3, it can be seen that the beamwdth in $f_1$ is not affected by $h$. However, $f_2$ is increased as the distance $h$ is increased.

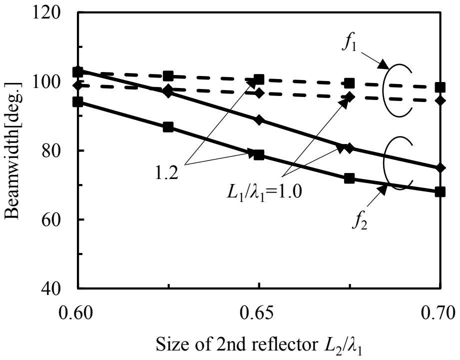


Fig. 2 Relationship between side length of the 2nd reflector and beamwidth on *yz*-plane.
($h/\lambda_1$ =0.15, $l/\lambda_2$ = 0.45, $d/\lambda_1$ = 0.025 and $f_2/f_1$ = 1.75)

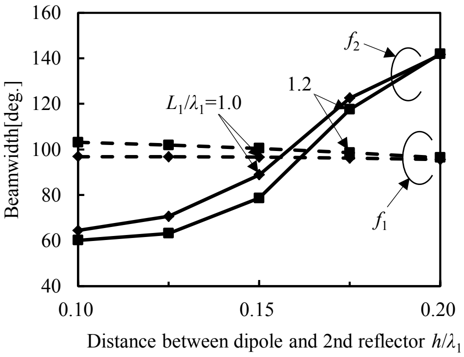


Fig. 3 Relationship between distance of the 2nd reflector and beamwidth.
($L_2/\lambda_1$= 0.65, $l/\lambda_2$ = 0.45, $d/\lambda_1$ = 0.025 and $f_2/f_1$ = 1.75)

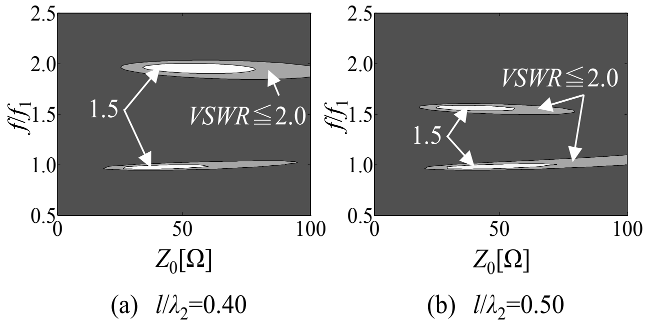


Fig. 4 Effect on the band characteristics by length of the parasitic elements.

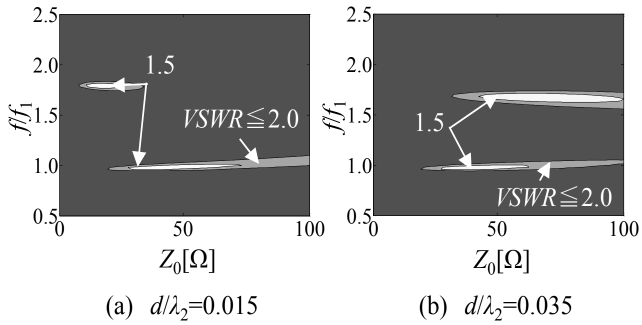


Fig. 5 Effect on the band characteristics by distance of the parasitic elements.

From the above discussion, it is expected that the same beamwidth can be obtained in dual bands by optimizing the 2nd reflector.

## IV. Effect of Parasitic Elements on Band Characteristics of VSWR

### A. *Effect of Length of Parasitic Elements*

Figure 4 shows the variation of the band characteristics of the VSWR when the length of the parasitic elements $l$ is changed. The horizontal axis is the characteristic impedance of the feeding line $Z_0$, the vertical axis is the normalized frequency, and the bright color in Fig.4 means low VSWR.

From fig. 4, it can be seen that the upper resonant frequency is decreased as the length of the parasitic elements is increased. Therefore, it is possible to control the frequency of $f_2$ by adjusting the length of parasitic elements.

### B. *Effect of Distance of Parasitic Elements*

Figure 5 shows the variation of the band characteristics of the VSWR when the distance between the dipole antenna and the parasitic elements $h$ is changed. The axes of Fig.5 are the same as Fig.4.

From Fig. 5, it can be seen that the characteristic impedance at the upper resonant frequency is shifted to higher one.

Therefore, it is possible to control the input impedance in the $f_2$ by adjusting the distance of parasitic elements.

## V. Conclusion

The dual-band dipole antenna with dual flat reflectors was proposed. First, it was clarified that the effects of the 2nd reflector on beamwidth of the dual-band. It was shown that the same beamwidth could be obtained in dual band by optimizing the size of the 2nd reflector.

Moreover, it was also clarified that the effects of the parasitic elements on the band characteristics of VSWR. It was shown that the impedance matching could be obtained in dual bands by optimizing the size of the parasitic elements.

## References

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