Triple - Band Broad Bandwidth Dipole Antenna with Broadside and Side Placed Parasitic Elements

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1. Introduction

Although dual frequency resonant is easily obtained to place a parasitic element in the vicinity of a feed dipole, the bandwidth of input impedance in resonant frequency of parasitic element is narrow [1] -[3]. This paper proposes serial- arranged two parasitic elements above the feed dipole to obtain broad bandwidth in resonant frequency of parasitic element. Further, a new triple - band dipole antenna of one feed and broadside and side placed parasitic elements is proposed, and its design method using FDTD method is also presented. Next, 120-degree beamwidth of triple - band antenna(0.9/1.5/2.0GHz band) for a base station of mobile communications is developed and its characteristics of return loss and radiation patterns are indicated. Calculated values are in good agreement with measured ones.

2. Configuration

The configuration of triple - band dipole antenna is shown in Fig.1. Triple frequency is defined as f1, f2 and f3, and on the condition of $f1<f2<f3$. The feeding dipole element of P1 which is fed by parallel feedline is placed over ground plane with 1/4 wavelength height. Two parasitic elements of P2 which are same length are located at side of the feed dipole symmetrically. One parasitic element of P3 is placed above the feed dipole and the other parasitic element of P3' is arranged serially above the parasitic element of P3 to obtain broad bandwidth. Hence, only one dipole of P1 is fed by the feed line and another dipoles of different frequency are fed through proximity electromagnetic coupling from the feed dipole.

This configuration leads to achieving triple resonance with keeping a very simple feeding because a number of the feed lines of each frequency band are decreased. The major advantage of this configuration is that since higher resonant frequency of parasitic element is placed at higher position compared to lower resonant frequency of elements, input impedance and radiation characteristics are not to affect strongly from lower resonant frequency of elements.

3. Increasing bandwidth using serial - arranged two parasitic elements

Dual frequency resonant is easily obtained by using the parasitic dipole element, however, it has shortcoming of narrow bandwidth about several percentage of the input impedance in resonant frequency of the parasitic element. Even if another different length of parasitic elements are arranged around the feed dipole in parallel, only resonant frequencies corresponds to each parasitic elements, which are not broad bandwidth, are obtained. In order to overcome this problem, serial arranged two parasitic elements is addressed. By adjusting the length of P3' and distance of h2 between P3 and P3', a double-loop response with larger bandwidth can be obtained. It is significant that the length of P3' is shorter (in this case 7 %) than that of P3.

Figure 2 shows comparison of return loss for the case of one and two parasitic elements. In the case of two parasitic elements, broad bandwidth of 17% of VSWR<2 was obtained, while in the case of one parasitic element, that was only 5%. That is, more than three times of broad bandwidth can be obtained.

4. Application for base station

The triple- band (0.9/1.5/2.0GHz band [4][5]) antenna with 120 - degree beamwidth in the horizontal plane was designed for base station of 3-sector zones as shown in Fig.3. The feed dipole and parasitic elements are fabricated on printed fiberglass-reinforced substrate and wide width of elements is adopted to obtain broad bandwidth. A reflector is placed behind the elements.

Figure 4 shows comparison of calculated and measured return loss of this triple - band antenna. Three resonant frequency response and the bandwidth of 17%, 5% and 17% of VSWR<2 were obtained, respectively. Good agreement can be shown between calculated and measured values.

Measured and calculated radiation patterns in the horizontal plane at each frequency are shown in Fig. 5. Figure 5(a) shows the radiation pattern in the 0.9GHz band. Calculated -3dB beamwidth is 122 degrees, which is matches the measured value of 124 degrees. Front to back ratio (F/B) is under -15dB. Figure 5(b) shows the radiation pattern in the 1.5GHz band and calculated and measured -3dB beamwidths are 116 degrees and 121 degrees, respectively. And also the radiation pattern in the 2GHz band is shown in Fig. 5(c) . Calculated and measured -3dB beamwidths are 98 degrees and 100 degrees, respectively. This beamwidth in the 2GHz band is designed relatively narrow compared another frequencies because more communication capacity can be obtained using less than 120 degrees beam in W-CDMA system, as described in [6]. It is found that calculated values are in good agreement with measured values.

5. Conclusion

A new triple - band dipole antenna with broadside and side placed parasitic elements has been proposed and that for base station has been developed. This antenna easily realizes triple resonance by means of parasitic elements arrangement with keeping simple one feeding. In order to broaden the bandwidth, the distance and length of serial arranged two parasitic element were adjusted, and broad bandwidth of 17% of VSWR<2 has been obtained and effectiveness of this proposed method has been clarified. Calculated values of return loss and radiation patterns are in good agreement with measured ones. For application of base station antenna , 120 - degrees beamwidth in the horizontal plane for 3-sector zones has been realized in all triple frequency band.

References

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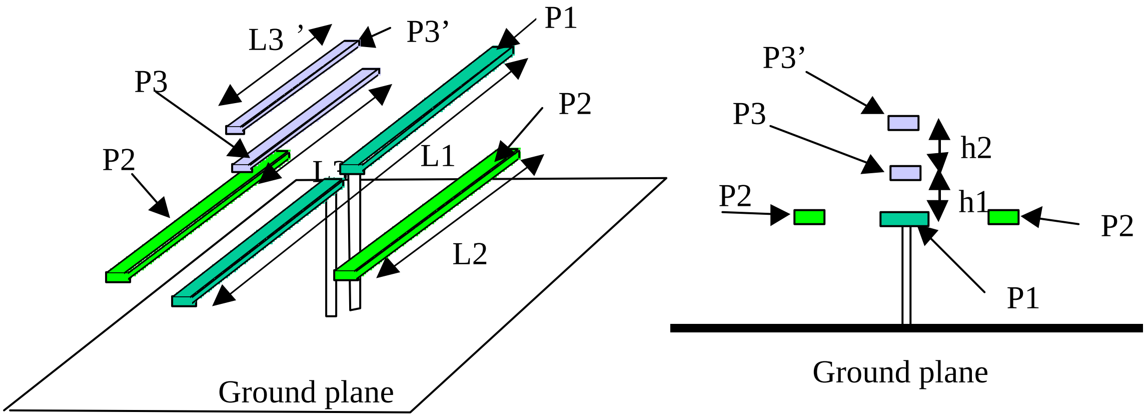


Fig. 1 Configuration of triple band antenna

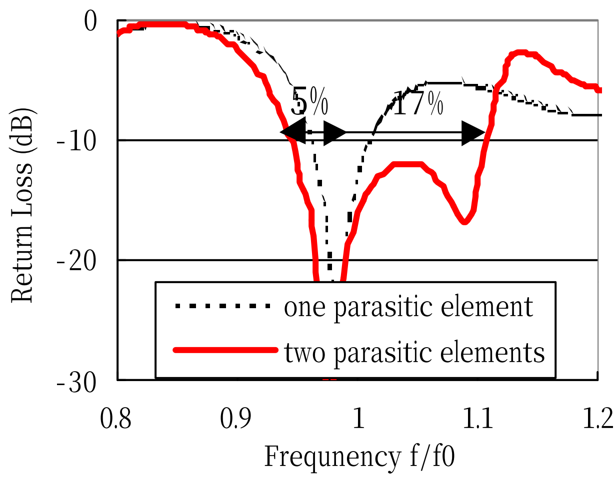


Fig. 2 Comparison of return loss with one and two parasitic elements

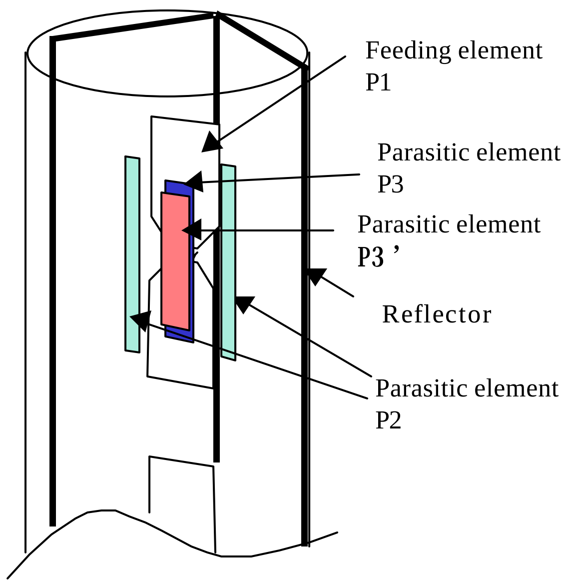


Fig. 3 Configuration of triple -band antenna with a reflector for base station

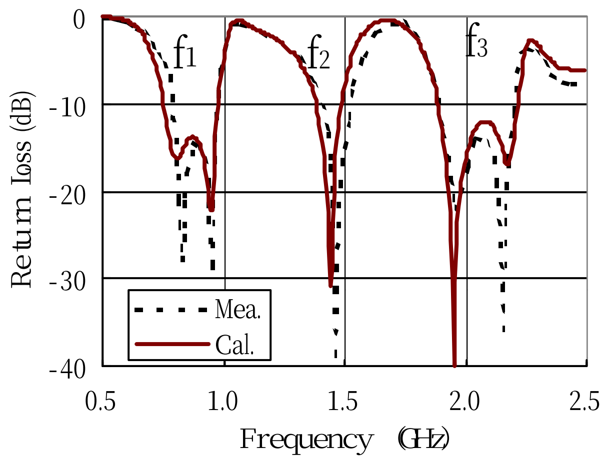
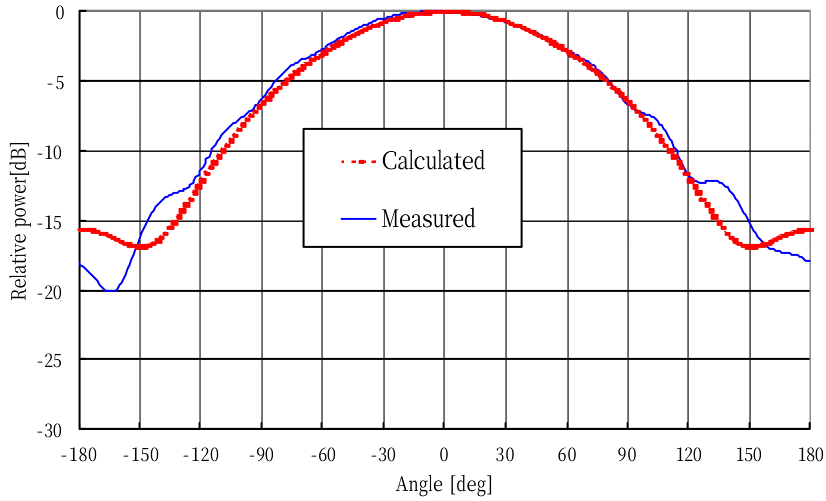
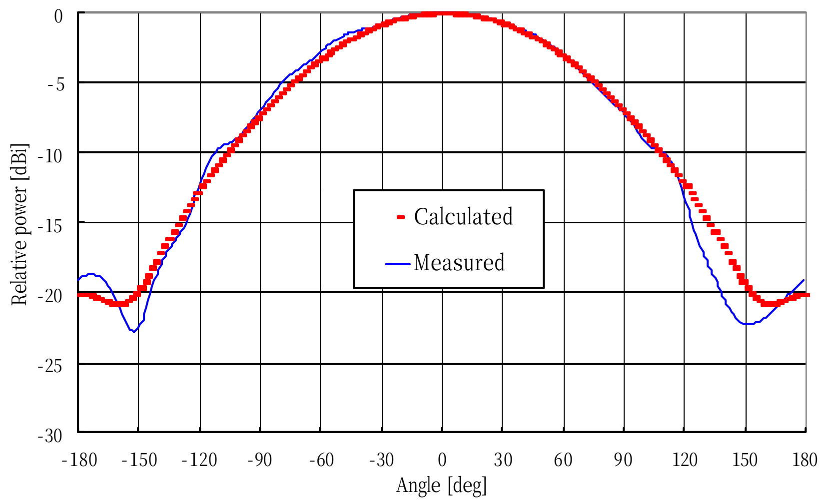


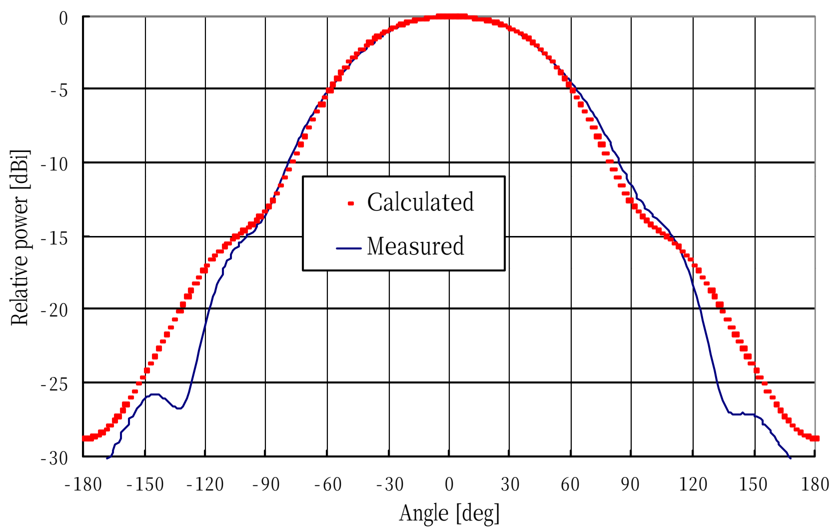
Fig. 4 Calculated and measured return loss characteristics



(a) f1



(b) f2



(c) f3

Fig. 5 Calculated and measured radiation patterns in horizontal plane