A Stacked Bidirectional Antenna

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I. Introduction

Bidirectional notch antennas used for booster relay system are arrayed in the same plane for reception / transmission and 800MHz / 1.5GHz cellular service. To obtain a compact antenna array, this paper proposes a stacked bidirectional antenna system which consists of the notch antenna for 900MHz and the monopole array for 1.5GHz inserted below the notch antenna. The notch antenna characteristics are not affected by the monopole array, however, those of the monopole array are seriously changed by this structure. To optimize the monopole array parameters, we calculate its characteristics by the moment method in this paper. We present the method to suppress the cross polarization in this antenna structure.

II. Stacked bidirectional antenna

We propose an antenna for 1.5GHz which consists of two $\lambda/4$ monopole antennas attached to the edge of a dielectric substrate with $\lambda/2$ spacing excited out of phase as shown in Fig. 1. Each monopole is excited by microstrip line on the dielectric substrate. A stacked bidirectional antenna is shown in Fig. 2. This monopole array and a notch antenna are stacked above the ground plane with its $\lambda/10$ spacing from the ground plane for each operating frequency.

We use moment method in the calculation by wire grid model. We use 5mm wire length in a monopole array and 20mm wire length in a finite ground plane and a notch antenna. This antennas includes a dielectric substrate, we do not include of its effect for simplicity in the calculation. To verify our analysis, we measured the return loss characteristics shown in Fig. 4 using the antenna as shown in Fig. 3. In the measurement, the antenna is fed at one point used a microstrip line as the transmission line. The calculated results agree with experiments, which indicate the validity of our wire grid model.

The return loss characteristics and radiation pattern of monopole array are shown in Figs. 5, and 6. The frequency band-width of return loss less than -10dB is 12.7% for the monopole array alone, 6.6% with a finite ground plane, and 4.0% when it is covered by the notch antenna with the ground plane. The resonance frequency decreases a factor of 6.0% by this stacked structure. The main polarization E_ϕ in the H-plane is tilted to $\phi = \pm 45°$ due to the effect of the finite ground plane. The cross polarization E_ϕ in the E-plane and E_θ in the H-plane are suppressed by the ground plane and the stacked structure. The radiation patterns are explained by the current distributions shown in Fig. 7. The main polarization E_ϕ in the H-plane is radiated by two monopoles, and the cross polarization E_ϕ in the E-plane is due to strong current flowing between the two probes on sheet conductor. When the position of monopole array is changed for the stacked bidirectional antenna as shown in Fig. 8, the radiation pattern of monopole array is changed as shown in Figs. 9. The optimized position to suppress the cross polarization is d= 50mm. In this case, radiation pattern of the notch antenna at 900MHz is not changed.

III. Conclusion

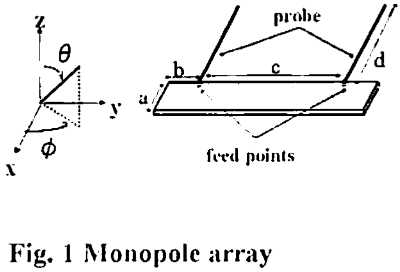
This paper presented a stacked bidirectional antenna for dual frequency use. When the monopole array is covered the notch antenna with the ground plane, its cross polarization is suppressed by -10dB. We optimized the antenna parameters to suppress the cross polarization in this structure.

IV. References

1. H.Arai, K.Kohzu, to be presented at 1996 IEEE AP-S. Int.Symp.

Acknowledgment

The authors would like to thank Dr.Ebine in NTT DoCoMo for his helpful discussions.



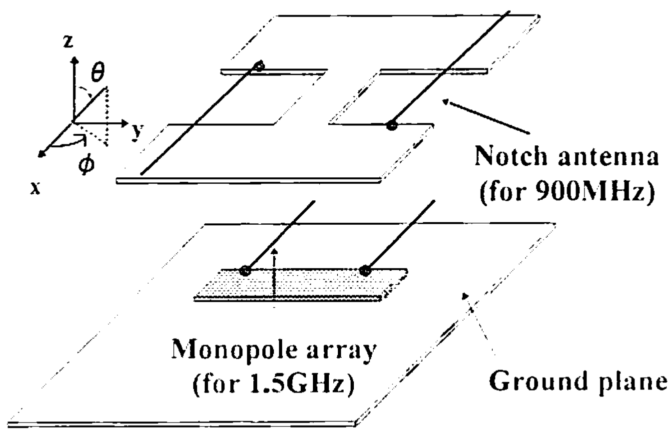


Fig. 1 Monopole array
a=20,b=20,c=100(λ /2),d=50(λ /4) [mm]

Fig. 2 Stacked bidirectional antenna

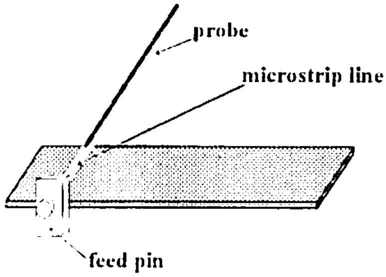


Fig. 3 Experimental antenna

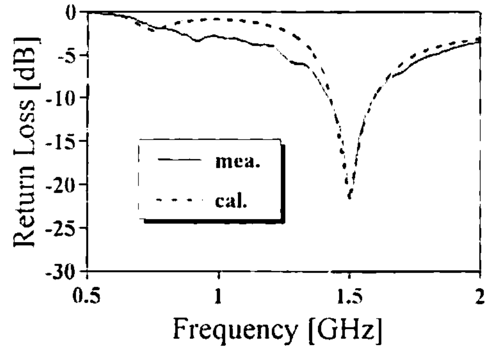


Fig. 4 Return loss characteristics

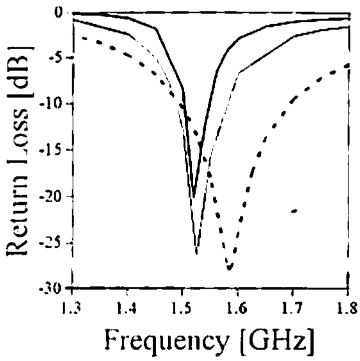
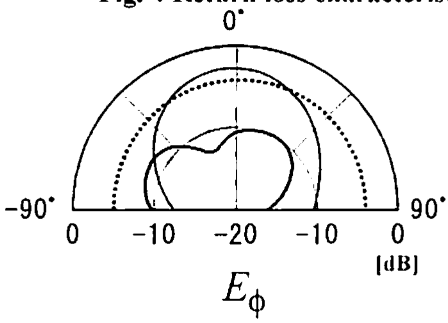
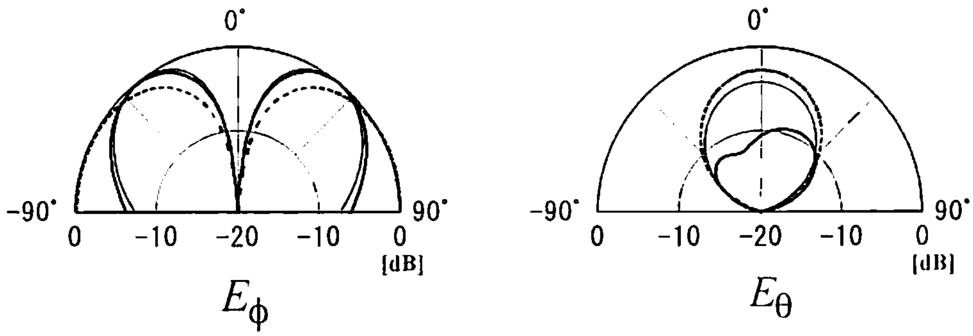


Fig. 5 Return loss characteristics



(a) E-plane(z-x plane)



(b) H-plane(y-z plane)

Fig. 6 Radiation pattern

- - - -without ground plane ——with ground plane——stacked antenna with ground plane

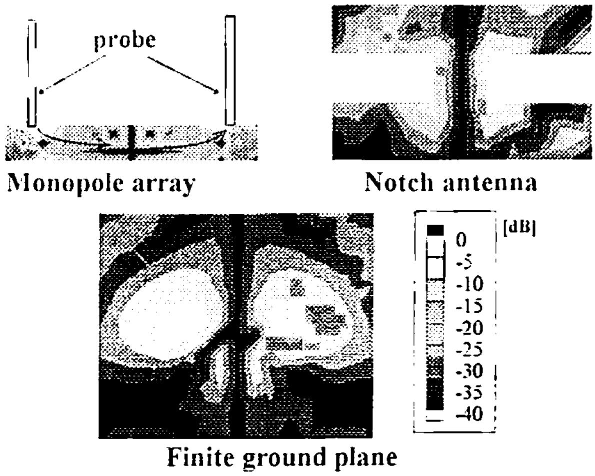


Fig. 7 Current distribution

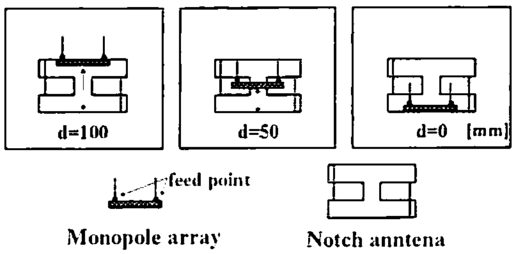
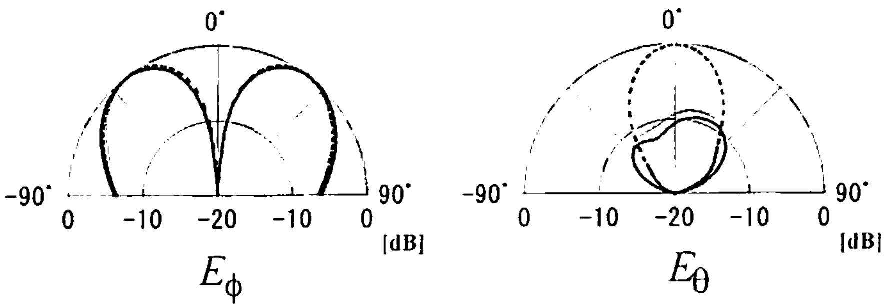
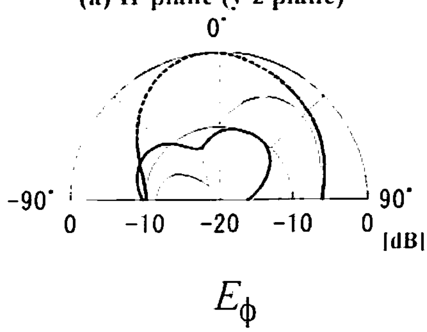


Fig. 8 The position of monopole array in a stacked antenna



(a) H-plane (y-z plane)



(b) E-plane (z-x plane)

Fig. 9 Radiational pattern

····· d=100 ——— d=50 –— d=0 [mm]