ANNULAR-RING MICROSTRIP ANTENNA WITH PARASITIC ELEMENT FED BY COPLANAR HYBRID COUPLER

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1.Introduction

An annular-ring microstrip antenna (ARMSA) with a parasitic element has been developed for the car-top application in a satellite communications. This antenna is made compact by putting the hybrid coupler at the inner part of the ARMSA. The loading of the parasitic element is effective for broadbanding.

2.Structure

Fig.1 shows the structure of the developed ARMSA. The antenna is fed at two points apart by 45°[1] through a branch-line type hybrid coupler placed at the inner part. At the operating frequency, the antenna is excited at TM_{21} mode and radiates the circular polarized conical beam. The isolation port is terminated with a chip resister.

3.Design Procedure

The sizes of the ARMSA and the parasitic element are determined by the cavity model analysis[2].

Fig.2 shows the measured input resistances of the ARMSA. In this figure, the dotted lines and the solid line are with and without the parasitic element respectively. The parasitic element is effective for reducing the input resistance.

Fig.3 shows the measured input impedance of the ARMSA when the resonant frequency, fp, of the parasitic element was varied. It is seen from this figure that broadbanding is achieved when $fp \simeq f_a$ (f_a : the resonant frequency of the ARMSA). In this case, the resonance occurs at two frequencies, f1 and f2, on account of the coupling of two elements.

In fig.4 the frequency difference $\Delta f/fo$ is shown with a parameter a/b when the height of the parasitic element ($h/\lambda o$) is varied, where Δf and fo are (f2-f1) and (f2+f1)/2 respectively. From this figure, the combinations of a/b and $h/\lambda o$ for desired frequency bands can be obtained.

Fig.5 shows the bandwidth (BW) that satisfies VSWR$\leqq$2 and $\Delta f/fo$ against a/b and $h/\lambda o$. From this figure, the parameters, a/b and $h/\lambda o$, that give the broadband characteristics can be obtained.

4. Experimental Results

From fig.5, to get the maximum bandwidth at $\Delta f/f=7\%$, parameters, a/b and $h/\lambda o$, are set to 0.77 and 0.025 respectively. Fig.6 shows the return loss of the circular polalization at the feed points. The broadband characreristics of more than 8% is obtained.

Fig.7 shows the measured radiation patterns in the plane $\phi=0°$ and 90°. The axial ratio less than 3dB is obtained for $30° \leqq \theta \leqq 60°$. Fig.8 shows the radiation patterns for the TM_{21} mode and the TM_{11} mode (dominant). For a TM_{11} mode antenna, a circular MSA with a parasitic element having the same frequency band was used. At a low elevation angle for $40° \leqq \theta \leqq 60°$, the gain of the TM_{21} mode was more than 1.5dB higher than that of the TM_{11} mode.

5.Conclusion

The ARMSA with the parasitic element fed by coplanar hybrid coupler has been developed. This antenna is compact because a multi-layered structure is not required. Making the resonant frequencies of the ARMSA and the parasitic element identical is found to be favorable for the broadbanding.

Reference

[1]John Huang, "Circularly Polarized Conical Patterns from Circular Microstrip Antennas", Antennas Propagat., vol.AP-32, 9, pp.991-994 (Sep.,1984)

[2]I.J.Bahl,P.Bhartia, "Microstrip Antennas", Artech House, Masachusetts (1980)

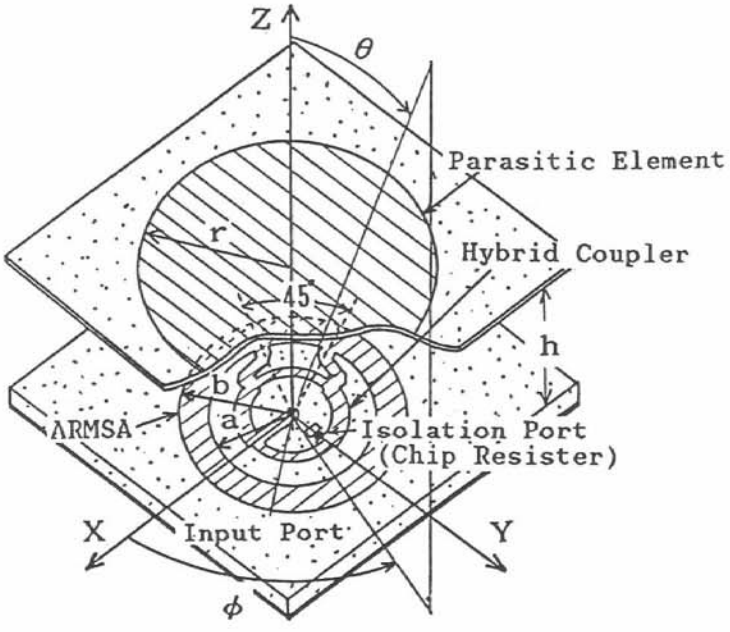


Fig.1 Structure of ARMSA with a parasitic element fed by coplanar hybrid coupler

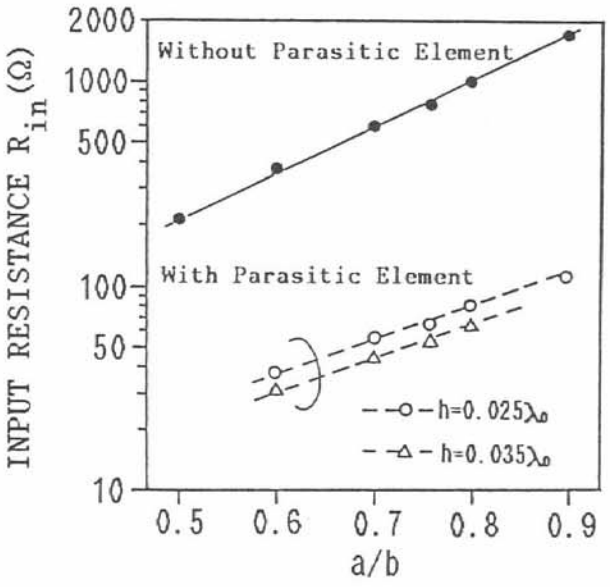
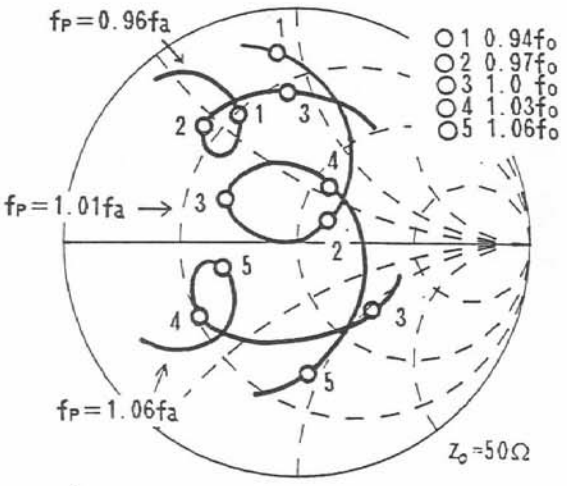


Fig.2 Input resistance of ARMSA



fa: resonant frequency of ARMSA
fp: resonant frequency of parasitic element

Fig.3 Input impedance of ARMSA with a parasitic element

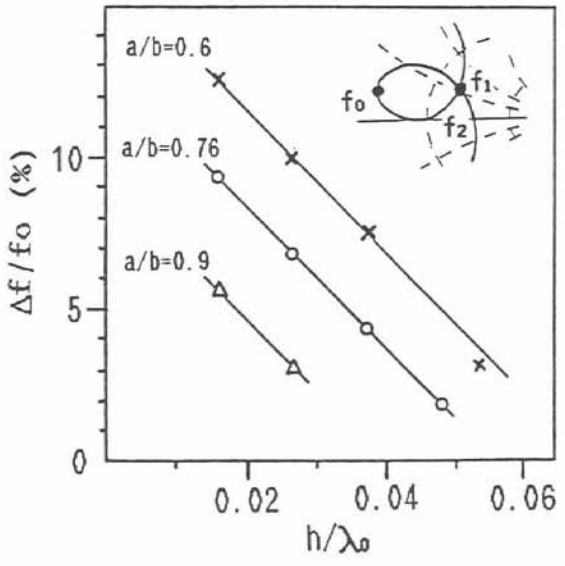


Fig.4 Δf versus h/λo for different a/b
(Δf : f2-f1
fo : (f2+f1)/2)

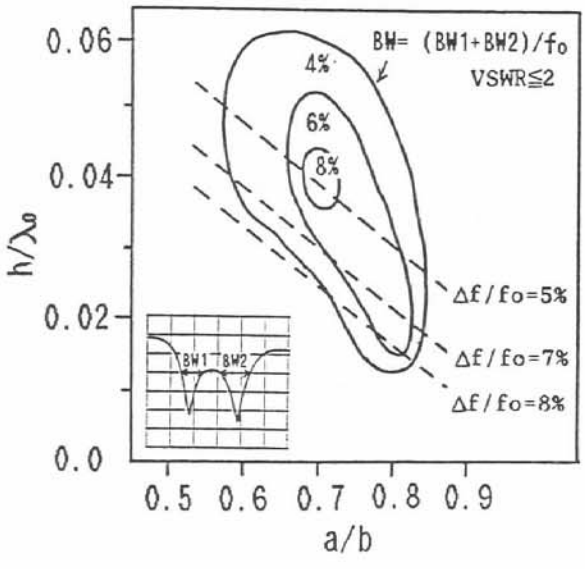


Fig.5 Bandwidth that satisfy VSWR≦2 and Δf/fo against a/b and h/λo

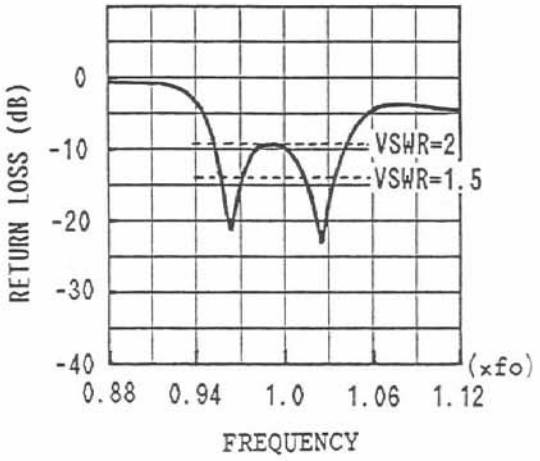


Fig.6 Return loss of circular polarization

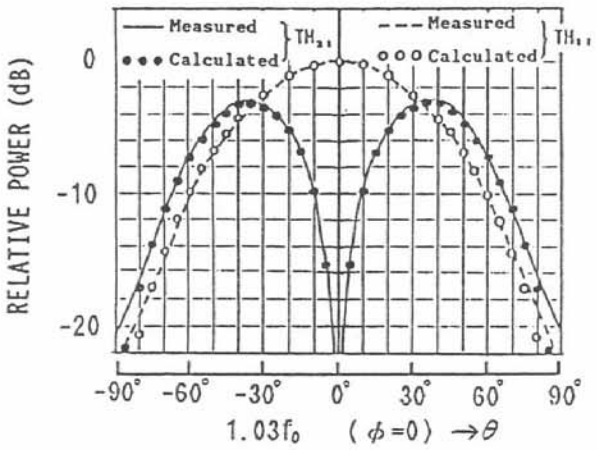


Fig.8 Radiation pattern of TM_{21} and TM_{11} mode

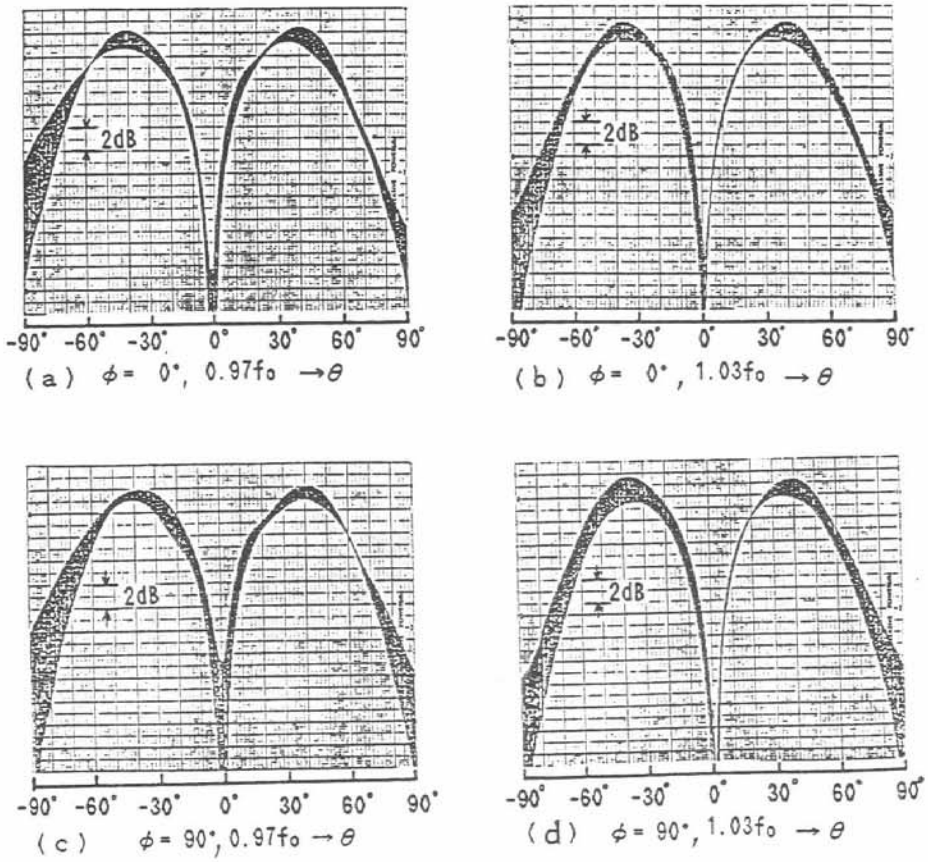


Fig.7 Circular polarized radiation patterns of ARMSA with the parasitic element fed by coplanar hybrid coupler