WIDEBAND CIRCULARLY-POLARIZED ANNULAR SLOT ANTENNA

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Introduction

Characteristics of a cavity-backed annular slot antenna with one point shorted are investigated. Resonance frequencies, bandwidths and radiation patterns with respect to a slot width, a slot shorting position and a cavity dimension are analyzed experimentally . By selecting the slot shorting position, the bandwidth can become more than 10% and circular polarization for a wide bandwidth is also obtained.

Antenna structure

The antenna structure is shown in Fig.1, where the antenna parameters are shown. A square ground plane with a side length of 103cm is used. The annular slot is formed on a printed circuit board of a thickness of 1.5mm and a dielectric constant of 2.5. One point on a slot is shorted with a copper sheet of a width of 3mm. The antenna was fed by a coaxial cable as shown in Fig.1. A cavity is employed as a resonator. The resonance frequency of the slot antenna is determined by both the slot and the cavity dimensions. The slot radius is fixed to make the circumference of the slot $1.5\lambda_r$(λ_r:a resonance wavelength).

Antenna Characteristics

The VSWR characteristics against frequency are shown in Fig.2, where α , the shorting position in terms of the angle from the x-axis, is taken as the parameter. The resonance frequency f_r(the frequency for the local minimum VSWR here) and the bandwidth(VSWR$\leqq$ 2.0 in this paper) vary with α . The tendency of these variations is similar to this figure when the parameters of the slot width b or the cavity depth t is varied. Shorting one point in the slot makes the dual-resonance antenna. The resonance frequency f_r for $\alpha=0°$ (no shorted point) exists between a low and an upper resonance frequency. As α is increased from 0° to 105°, the two resonance frequencies approach each other. When α is about 105°, the VSWR characteristics become similar to those for $\alpha=0°$. This implies that the magnetic current distribution on the slot for $\alpha=105°$ becomes the same as that for $\alpha=0°$. As α is increased from 105°, the two resonance frequencies part each other. As a result, by adjusting α, the separation of the two minimum points of the VSWR becomes small and the bandwidth can be increased. When α is around 90°, the bandwidth becomes maximum.

The input impedance characteristics are shown in Fig.3, where two cases of b=0.75 and 1.0cm are given. The impedance locus with b=1.0cm shows a case where the antenna radiates a circularly polarized wave. Fig.4 shows the measured radiation patterns for cases where α =0° and 90°. When α =90°, the radiation is circularly polarized and the axial ratio is 1.1dB and the gain is 12dBic.

The resonance frequency f_r and the bandwidth ratio $\Delta f/f_r$ are studied with respect to a slot width b and a cavity depth t and Figs.5 and 6 illustrate the relations of these parameters. Fig.5(a) gives the variation of f_r with t and also shows the influence of b upon f_r. The resonance frequency greatly depends on both the slot width and the cavity depth. Fig.5(b) expresses the variation of $\Delta f/f_r$ against t. It shows that $\Delta f/f_r$ is not varied very much against t and b, when α is set to 0°.

The variation of f_r is large against b and α as can be seen in Fig.6. The increase of the slot width b makes the resonance frequency higher and does not always make the bandwidth wider.

Conclusion

A cavity-backed annular slot antenna with one point shorted has been introduced and by means of selecting the slot shorting position, the wideband and circular polarization are achieved. The resonance frequency, bandwidth and radiation pattern of this antenna are investigated experimentally. Based on these results, design parameters can be determined to set the resonance frequency and to obtain the wide bandwidth and circular polarization.

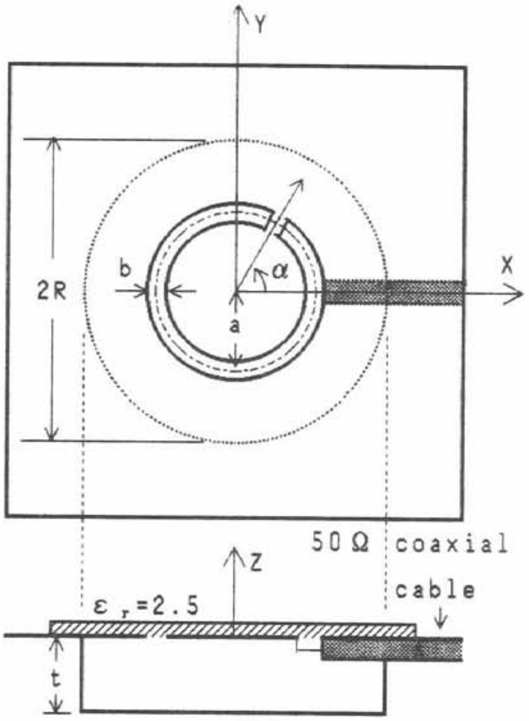


Fig.1 Antenna structure

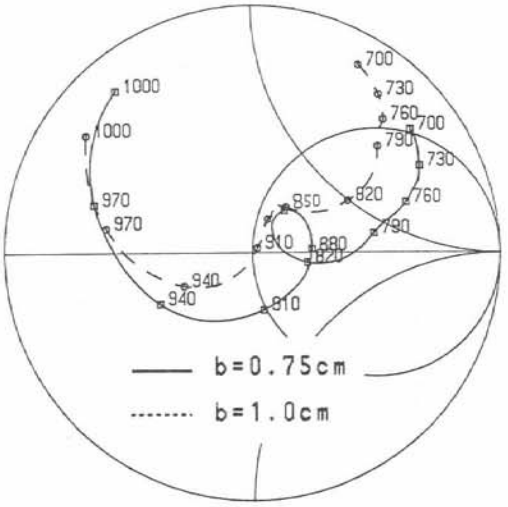


Fig.3 Input impedance characteristics

a=7.7cm,R=12.35cm,t=3.0cm, α=90°

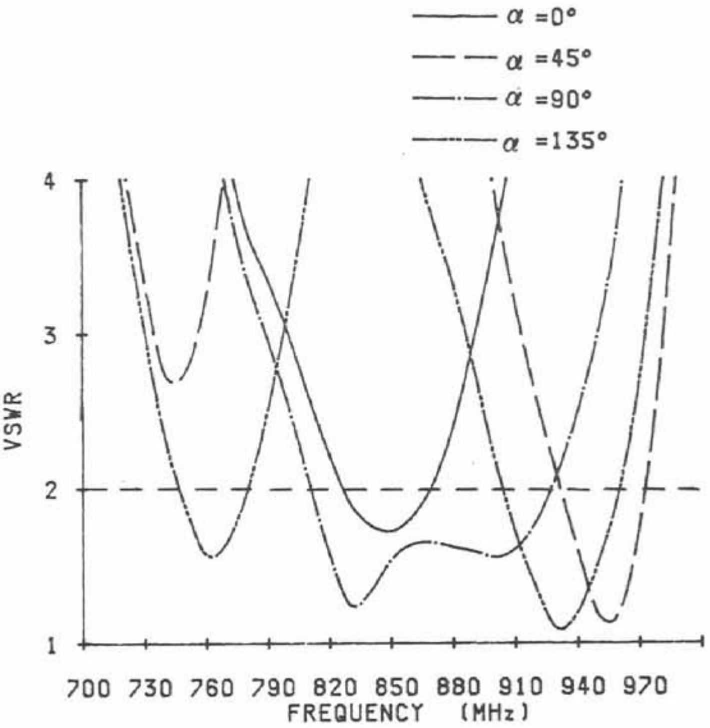
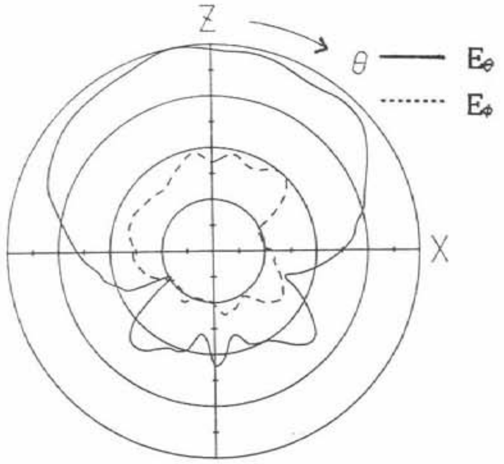


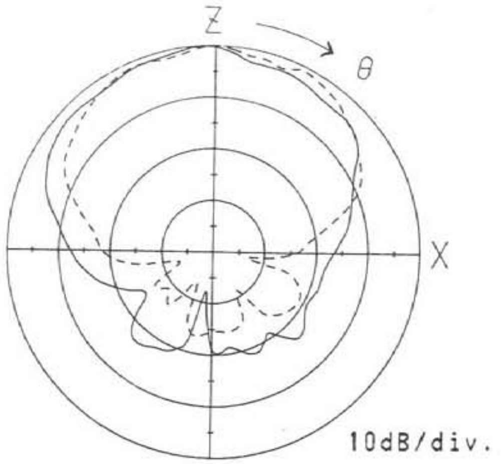
Fig.2 VSWR characteristics

a=7.7cm,b=0.75cm,

R=12.35cm,t=3.0cm



(a) α=0°,850MHz

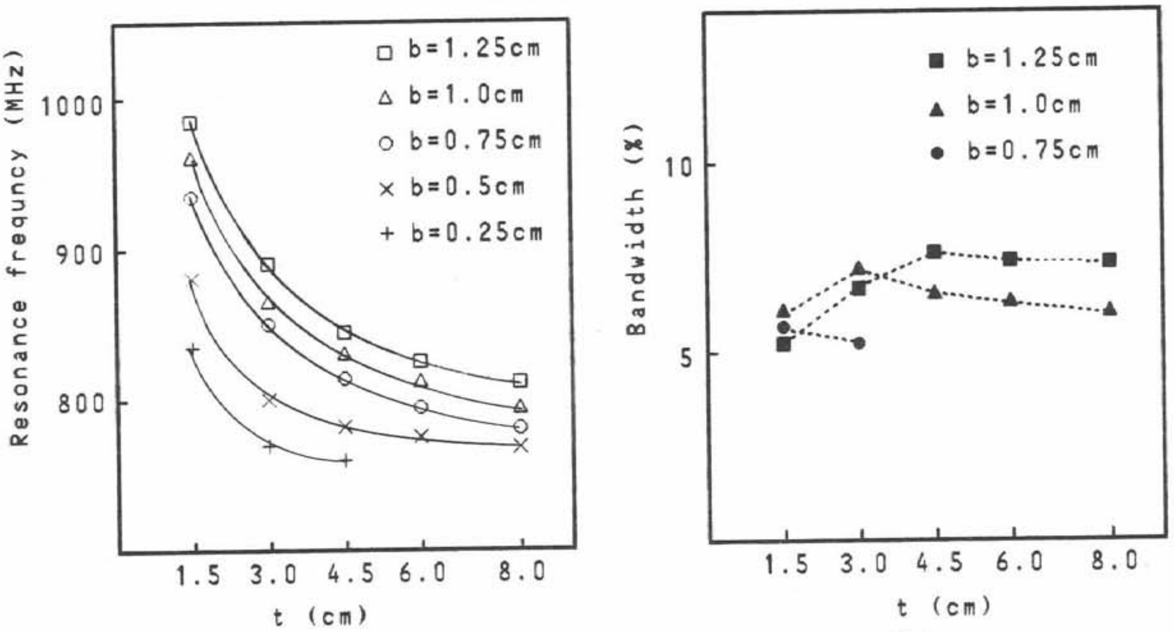


(b) α=90°,860MHz

Fig.4 Radiations patterns

a=7.7cm,b=1.0cm,

R=12.35cm,t=3.0cm



(a) (b)

Fig.5 Resonance frequency and bandwidth versus cavity depth t
a=7.7cm, R=12.35cm, $\alpha=0°$

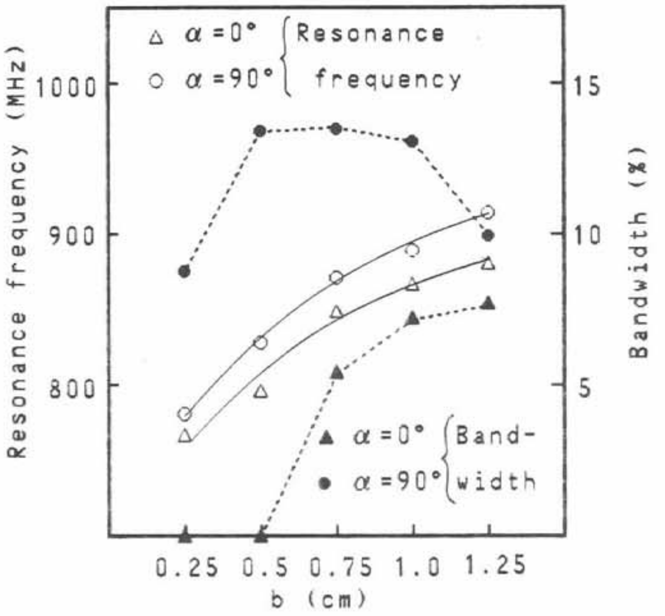


Fig.6 Resonance frequency and bandwidth versus slot width b
a=7.7cm, R=12.35cm, t=3.0cm