CIRCULAR PATCH ANTENNAS WITH PASSIVE CONDUCTING POSTS

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Summary

It is known [1,2] that the use of passive conducting or tuning posts within the input region of a probe-fed circular patch antenna may generally increase the resonant frequency, provide impedance matching or circularly polarized radiation. The input impedance behavior of the antenna based on modal considerations is found useful for the understanding of the performance and for the design of such antennas under various conditions.

Consider a single tuning post placed at $\rho = \rho_1$, $\phi = \phi_0$ within a circular patch antenna fed from the back with a coaxial probe located at $\rho = \rho_0$, $\phi = 0$ degrees, as shown in Fig. 1. It can be shown that in the absence of the post, the dominant (TM_{11}) mode E-field at a given ρ and variable ϕ may be considered to consist of two degenerate mode fields, referred to as the A- and B-mode, each having a resonant frequency same as that of the antenna (i.e., f_0) but the variation of each field in the ϕ-direction being orthogonal to the other. With a post present, the two modes become distinct having distinct resonant frequency f_A ($\cong f_0$) and f_B, ($f_B > f_0$), and each mode having a distinct input impedance; under these conditions, the input impedance of the antenna is the sum of the two modal impedances.

The measured input resistance vs frequency for an antenna having one post at $\phi_0 = 135$ degrees and variable ρ_1 is shown in Fig. 2 which clearly indicates that with sufficiently large ρ_1 the two modes resonate at two distinct frequencies. It is found that $f_A \cong f_0 = 1415$ MHz in the present case and $f_B > f_0$ and its value significantly depends on ρ_1. With ρ_1 fixed and ϕ_0 variable, the input resistance vs. frequency for the same antenna is shown in Fig. 3 which indicates the predominance of A-mode for $\phi_0 = 90$ degrees and that of the B-mode for $\phi_0 = 180$ degrees. These modes can be controlled by proper choice of ϕ_0, ρ_1 and the number of posts to obtain the desired characteristics

from the antenna. In general, with a single post at $\phi = \phi_c$ the modal input resistance may be represented by

$$R_{in}^A(\phi_0) = R_0^A \sin^2 \phi_0$$

$$R_{in}^B(\phi_0) = R_0^B \cos^2 \phi_0$$

where $R_0^A(\phi_0)$, $R_0^B(\phi_0)$ are the maximum (resonant) resistance of the A- and B-modes, respectively. In general, it has been found that the input resistance of the antenna depends mainly on ϕ_0, and hence such post(s) can be used for matching; location and number of posts can also be used to increase the resonant frequency of a given circular patch antenna; finally, with proper arrangement of posts a single probe-fed antenna can be used to produce circularly polarized radiation. Detailed results including far field patterns will be discussed during the presentation.

References:

[1] G-L Lan and D. L. Sengupta, "Tunable Circular Patch Antennas," Electronics Letters, Vol. 21, No. 22, pp. 1022-1023, 24th October 1985.

[2] G-L Lan and D. L. Sengupta, "Analysis of Tunable Circular Patch Antennas, Program and Abstracts, 1985 North American Radio Science Meeting, University of British Columbia, Vancouver, Canada, p. 93, June 17-21, 1985.

[3] G-L Lan and D. L. Sengupta, "Post-Tuned Single-Feed Circularly Polarized Patch Antennas,", Antennas and Propagation Symposium Digest, Vol. 1, AP-S International Symposium, University of British Columbia, Vancouver, CAnada, pp. 85-88, June 17-21, 1985.

o   FEED

•   POST
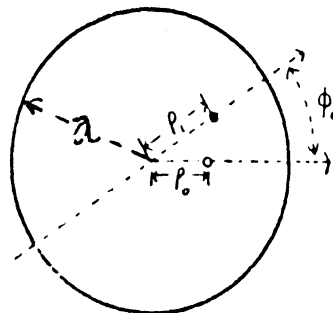
(a)

Fig. 1. Circular patch antenna with one post. Feed at $\rho = \rho_0$, $\phi = 0°$. Post at $\rho = \rho_1$, $\phi = \phi_0$.
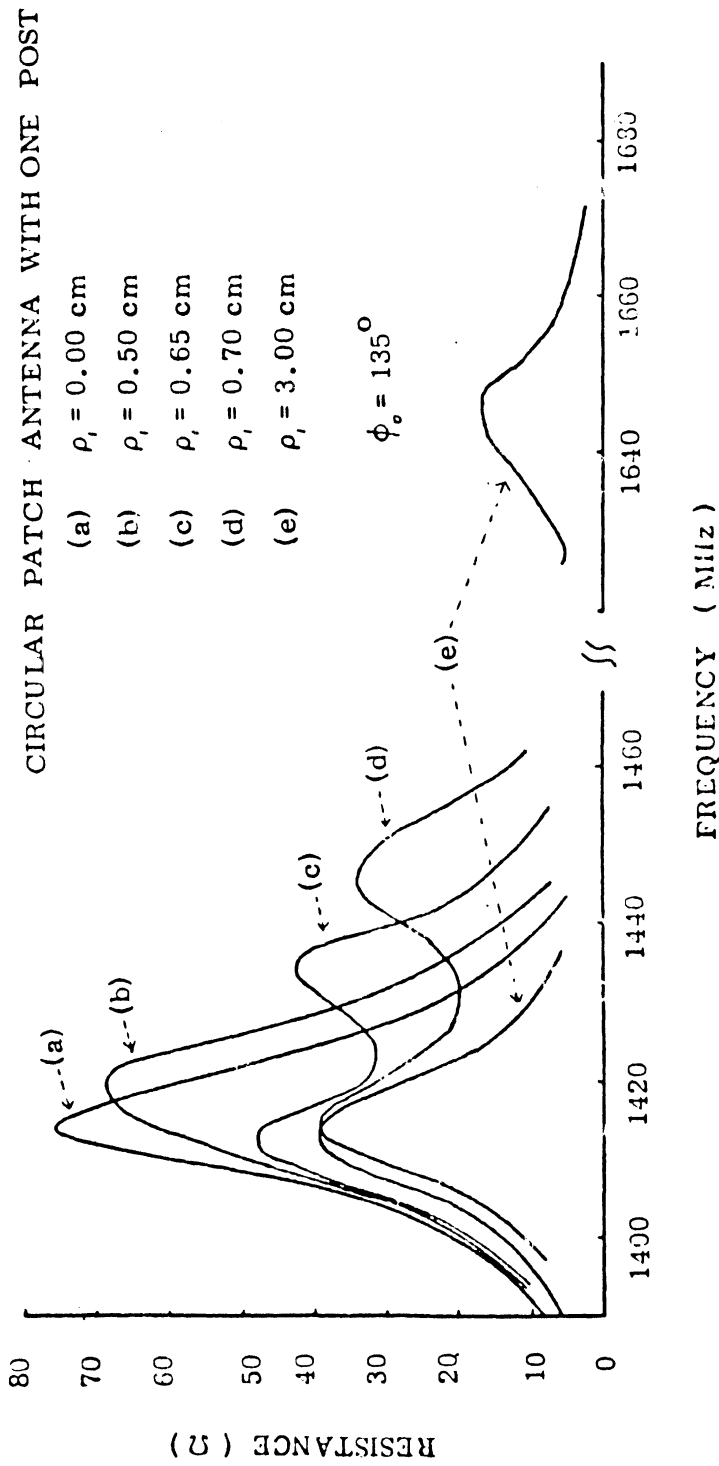
CIRCULAR PATCH ANTENNA WITH ONE POST

(a) $\rho_I = 0.00$ cm

(b) $\rho_I = 0.50$ cm

(c) $\rho_I = 0.65$ cm

(d) $\rho_I = 0.70$ cm

(e) $\rho_I = 3.00$ cm

$\phi_o = 135^o$

RESISTANCE (Ω)

FREQUENCY (MHz)

Fig. 2. Input resistance versus frequency for different distances ρ_1.
(ρ_1 is the distance between the post and the center line.)
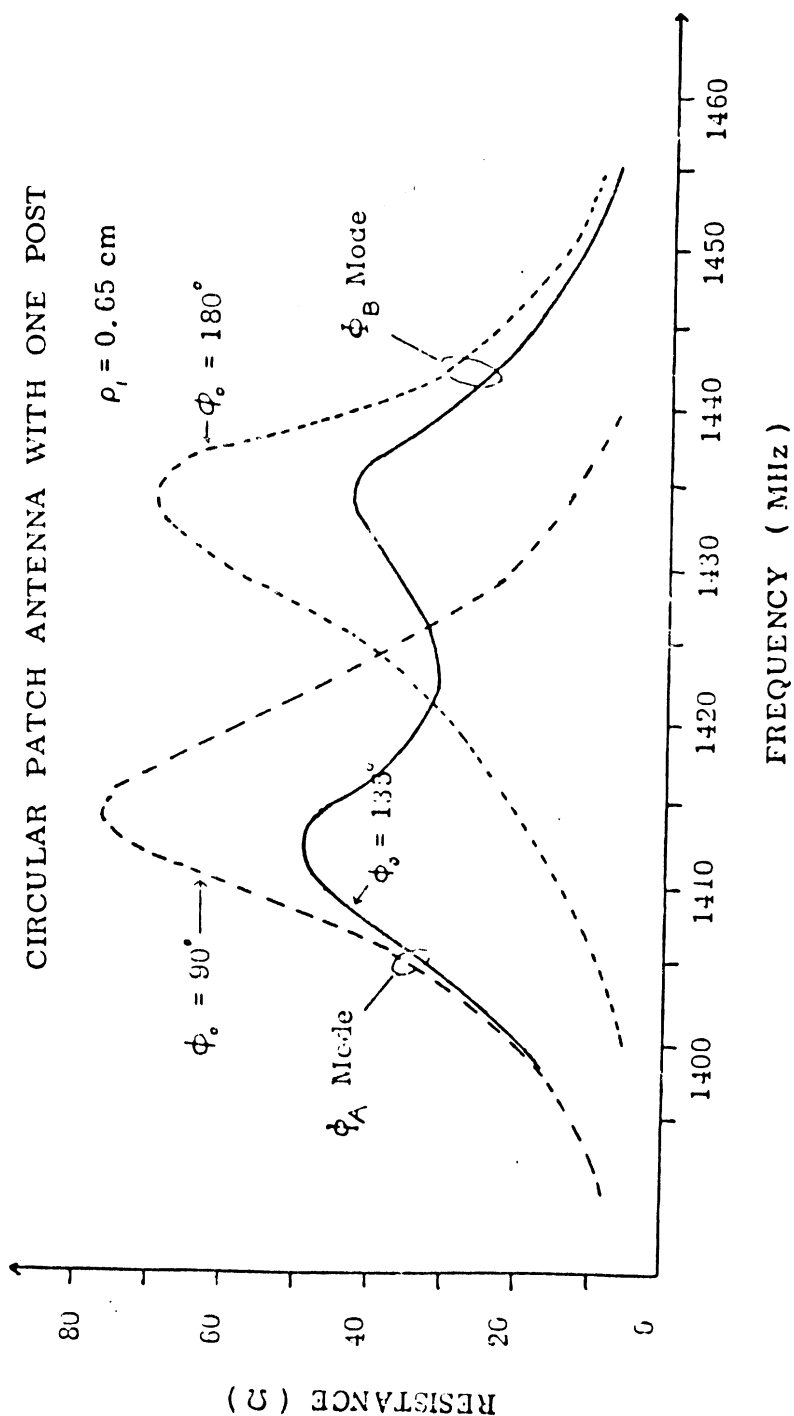$\rho_o = 1.2$ cm, a = 3.8 cm.

Fig. 3. Input resistance versus frequency for varying angular separation ϕ_0. (ρ_0 is the angle between the feed and the post.) ρ_0 = 1.2 cm, a = 3.8 cm.