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OPTIMIZATION OF RESONANT FREQUENCY OF SHORTED ELLIPTICAL PATCH

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ABSTRACT: In this paper, a parametric study on the resonant frequency of shorted elliptical microstrip antenna is done and optimization of feed probe location for optimum radiation efficiency is carried out. A feed probe is located off-axis to generate closely spaced dual resonances for weakly elliptical patch. Using multiple shorting posts, the resonant frequencies of these modes are selectively tuned. Measured results are compared with simulation studies (IE3D) for validation.

INTRODUCTION

Elliptical resonators have potential to operate as compact and tunable antenna. Small impedance bandwidth is inherent property of microstrip antenna and to improve it a number of procedures have evolved over the years, which display an increase in bandwidth [1,2]. For increasing the effective bandwidth, a microstrip antenna of a small instantaneous bandwidth is electronically tuned over a large frequency range. For a fixed dimension of microstrip antenna tunability is obtained by connecting a variable reactive load to the patch. The reactive loading can be varied by changing the number or positions of the shorting posts. When the shorting post is placed between the patch and the ground plane, it changes the field distribution and provides inductive loading to the patch and hence changes its resonance frequency. The characteristics of shorted annular elliptical patch [3] is considered, where Mathiew functions is approximated by Bessel function for weakly elliptical structure. The annular elliptical patch radiator [4] with inner border shorted to ground is also considered where both numerical simulations and measurements results of annular shorted elliptical patch and its characteristics are studied. Here studies on elliptical patch with multiple shorts located in off-centred positions are done. An elliptical patch loaded with multiple shorts has not been presented before in literature. Here a general study on the impact of shorts on the resonant frequencies of elliptical patch is carried out theoretically and validation is done by simulation and measurements, thereby generalizing its potentiality for different application areas. Finally optimization of feed probe location for maximum radiation efficiency is done using ANN-GA algorithm.

II. PATCH CONFIGURATION

A single feed elliptical microstrip resonator is shown in Figure 1, the coaxial feed being placed at approximately 45^0 from the major axis. Its location is optimized theoretically to excite TM_{11} modes with proper impedance matching. For a=33.0 mm, b= 27.0 mm, e_r =2.2,h = 0.787 mm, the input VSWR for the feed (12.0, 12.0) is measured.

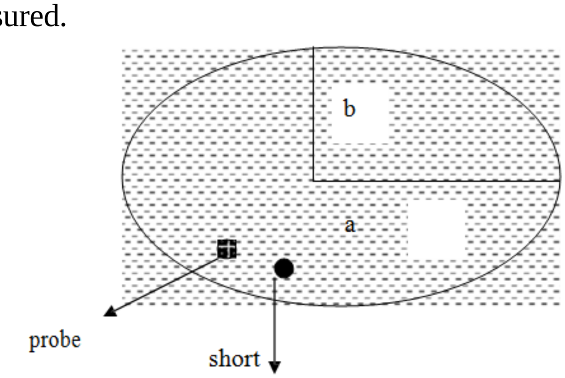

Fig. 1 : Geometry of shorted elliptical patch

The lower and higher resonance frequencies are 1.79 GHz. and 2.12 GHz respectively. The ratio of the two resonance frequencies is approximately the same as that of the effective radii in the two orthogonal planes. It is seen that by locating the probe along the diagonal, the degeneracy of the patch is enhanced. A single shorting post of radius 1.0 mm. is placed between the patch and the ground plane at radial distance r_2. The shorting post can be modeled as an inductive load. This inductive impedance per unit length is loading the patch can be represented as parallel R-L-C resonator. The net effect observed is reduction of primary resonance and tunability of higher order resonances. For a circular patch, a detailed analysis has been carried out for short loaded patch [5]. In the following section, the parametric results for short loaded elliptical patch are presented.

RESULTS

The above mentioned elliptical patch is measured and compared with simulated results where resonant frequencies are calculated using MoM based commercial solver (IE3D). For theoretical analysis of improving the tunability, an imaginary line through the probe location and the center of the patch is drawn. The angular location of short is measured in counter-clockwise direction from the probe location. The measured results for first three resonant modes for a shorted elliptical patch is presented in Figure 2. Like a shorted circular patch [5], a shorted elliptical patch also displays a non-zero resonance which is lower in frequency as compared to unperturbed patch. In Figure 2, the results for shorting post locations along the primary axis, is shown. It is observed that as the short is pushed towards the outer periphery of patch, the lowest unperturbed mode (f_2) increases in frequency, whereas the higher unperturbed mode (f_3) does not vary.

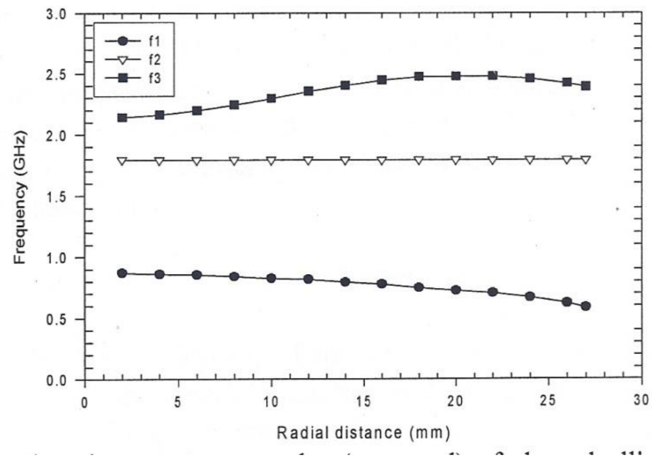

Figure 2.

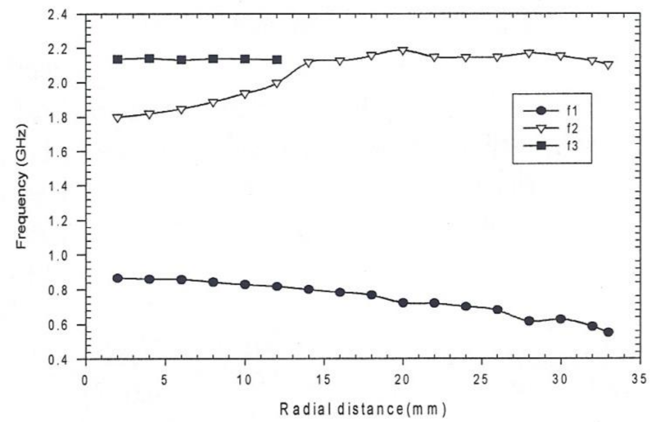

Figure 3.

In Figure 3, the reverse trend is shown, when the short is located along secondary axis. For both cases, the lowest perturbed mode (f_1) decreases with increasing radial distance of short from the center of the patch.

When the short is located diametrically opposite to probe location the resonant frequencies f_2 and f_3 are tuned up . Tunability of resonant modes is studied and can be further increased by increasing the number of posts loading the patch at a given radial distance from centre of patch. Table 1 presents the results for a typical radial distance. It is clearly seen that f_1 resonant mode is tuned up in frequency by a significant margin (more than 100% as compared to single post) while f_2 and f_3 are tuned up by much less margin. It is also seen that by indefinitely increasing the number of posts,

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it is not possible to keep on increasing the resonant frequency.

Table 1. Tunability of resonant modes with increase in number of shorting posts. (a=33.0 mm, b= 27.0 mm, e_r =2.2 ,h = 0.787 mm, delta =1.0mm, r_2 = 8mm)

No of posts	Angular location	f_1 (GHz) Simulated	f_1 (GHz) Measured	f_2(GHz) Simulated	f_2 (GHz) Measured	f_3(GHz) Simulated	f_3(GHz) Measured
1	180^0	0.818	0.829	1.813	1.815	2.26	2.22
2	0^0/ 180^0	1.23	1.14	1.86	1.87	2.37	2.29
4	0^0 / 180^0 / 90^0 /	1.67	1.54	2.055	2.01	2.505	2.43
8	Uniform	1.75	1.8	2.1	2.15	2.52	2.56

IV. CONCLUSION.

In this paper, A comprehensive parametric analysis of frequency tunability of shorting post loaded elliptical patch is presented. Such detailed study based on measured results and validated by IE3D has not been presented before. The shorting post loaded patch can be used as a compact resonator. It has been shown that unlike a circular patch degeneracy is lifted as soon as probe is suitably located. Then the post location has multiple effects on the resonant frequencies of the resonant modes.

REFERENCES

(1) R. Garg., P. Bhartia, I. Bahl and A. Ittipiboon, "Microstrip antenna design handbook", Artech House, Norwood, MA 2000
(2) K. L. Wong.., "Compact and broadband microstrip antenna", John Wiley & Sons Inc., New York, 2002
(3) L. Boccia,Amendola, G., DiMassa,G, " A shorted elliptical patch antenna for GPS applications", IEEE Antennas and Wireless Propagation Letters, Vol.2, (1), 2003, pp 6-8
(4) G. Amendola, Boccia,L., DiMassa,G, " Shorted eeliptical patch antennas with reduced surface waves on two frequency bands", IEEE Trans., Antennas Propag., Vol. 53 (6), June 2005, pp. 1946-1956
(5) T. Chakravarty and A. De, "Design of tunable modes and dual-band circular patch antenna using shorting posts," IEE Proc-Microw. Antennas Propag., Vol 146, no. 3, 1999, pp 224-228.