New Designs for WLAN Omnidirectional Antenna Array Synthesis

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Abstract: - A new design for a concave and convex polarized coplanar waveguide CPW fed 2x2 antenna arrays has been analyzed. The proposed antennas have a symmetric and uniplanar geometry with concave or convex microstrip. The basic structure consists of 4 half wavelength patches with K-form (for the concave) and D-form (for the convex), electromagnetically coupled with CPW transmission line. This antennas increase the 3dB beam width compared to a linearly polarized CPW fed 2x2 antenna around 5.6 GHz using in WLAN system. Simulations have been carried out by a program called IE3D, using the Method of Moments.

Key-Words: - Printed antennas; Omnidirectional pattern; Method of Moments.

1 Introduction

Wireless communications have demonstrated their powerful applications in many modern microwave telecommunication systems, such indoor and outdoor wireless LANs, point to multipoint, and multipoint to multipoint, as well as aircraft microwave communication systems. These applications need antennas with an omnidirectional radiation pattern, most frequently with vertical polarization. Up to now, a few numbers of papers have dealt with omnidirectional antennas. Recently, printed antennas with omnidirectional radiation pattern have been shown [1-4].

In [1,2], The antennas comprise dipoles arrays arranged back to back by coplanar printing on both sides of a dielectric substrate, and their gain is about 4 dBi, with deviation of the pure omnidirectional pattern of less than 2 dB.

In [3], the antenna consists of an array with four pairs of radiating tapes, electromagnetically coupled with three coplanar strips (TCS), a coplanar waveguide (CPW) with finite narrow strips. This antenna is very simple, low cost uniplanar antenna array with omnidirectional pattern and it is used for a frequency of about 10.5 GHz and 8 dBi

In [4], the antenna consists of a linearly polarized coplanar waveguide CPW fed 2x2 antenna arrays. It has a symmetric and uniplanar geometry; and 4 half wavelength patches electromagnetically coupled with CPW transmission line. This antenna shows a frequency band of 13% at 5.5 GHz and a maximum gain 9.9 dBi.

In this paper, we present an antenna similar to the antenna describe in [4], but with two different types of 4 half wavelength patches, one has the form of K and the other has the form of D. Geometry of the proposed antennas are shown in figure 1(a) for the K-form and (b) for the D-form.

These antennas are designed for a frequency of about 5.6 GHz, and analytically pure omnidirectional radiation pattern is obtained. Obtained results are compared with those for the antenna describe in [4].

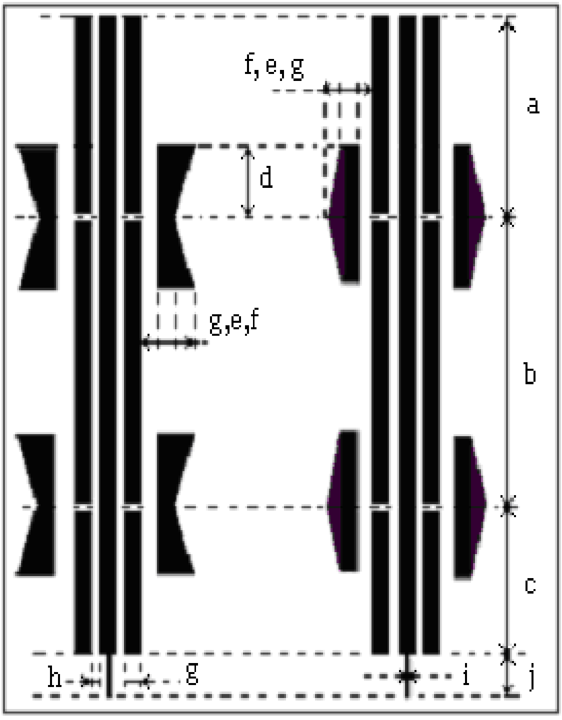
2 Concept

The proposed antenna's structures consist of a concave or convex polarized CPW fed 2x2 antenna arrays (concave microstrip figure 1.(a) K-form) and (convex microstrip figure 1.(b) D-form).

The dielectric substrate using in the realization of our antennas is the RO3000 with $\varepsilon_r = 3$, height=1.52 mm, $\mu_r = 1$, and $\tan\delta = 10^{-4}$. The RO3000 is invariant with the temperature and the frequency.

The electrical length is of about $\lambda_g = 0.78\lambda_0$ where λ_0 is the wavelength in free space. The metal using in printed circuit has a conductivity $\sigma = 5{,}8.10^7$ s/m, and a thickness equal to $17.5\mu m$. The antennas dimensions are: $a = 32.1mm$, $b = 42.6mm$, $c = 24.5mm$, $d = 8mm$, $e = 3mm$, $1.5mm < f < 3mm$, $g = 3mm$, $h = 1.5mm$, $i = 0.6mm$, and $j = 8mm$.

These dimensions are chosen to have a frequency of about 5.6 GHz.



(a) (b)

Fig.1 Sketches of the proposed antennas with omnidirectional pattern

3 Simulation and results

Simulations and optimization of the described antennas structures shown in figure 1(a) and (b) have been performed using the software packages for electromagnetic simulation IE3D from Zeland Software [6] and matlab version 6.1.

Our studies consist firstly to analyze and simulate the K-form and D-form antennas for tow values of f (f=1,5mm and f=3mm), secondly to compare the obtained results with those simulated and measured by [4], and finally to comment these obtained results.

Figure 2 presents the VSWR of the linearly polarized coplanar waveguide and of the K-form antenna for two different values of f (f=1.5mm and f=3mm).

Figure 3 shows clearly the minimum value of S_{11}: it's at 5.65 GHz. The directivity is equal to 10.84 dBi and its 3dB beam width is (21.67, 33.25) degrees.

Figure 4 shows the VSWR of the linearly polarized coplanar waveguide and of the D-form antenna for two different values of f (f=1.5mm and f=3mm). The minimum value of VSWR is at 5.6 GHz for f=1.5mm and 5.65 GHz for f=3mm. These VSWR are very clear in figure 5. Figure 5 shows the S_{11} in dB for the D-form using here.

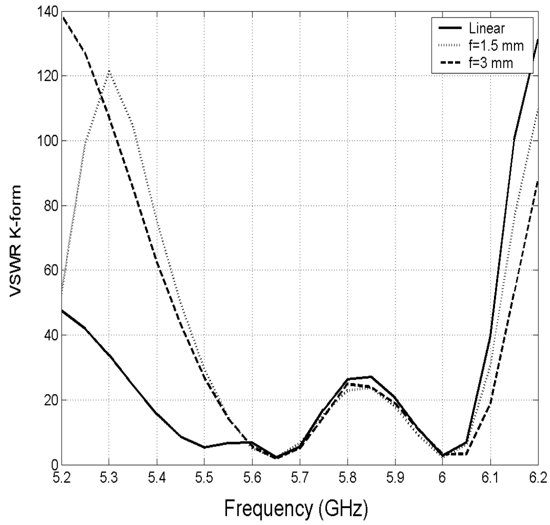


Fig.2 VSWR for K-form

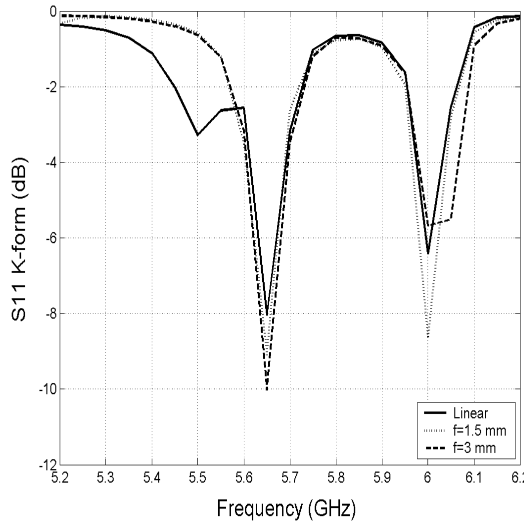


Fig.3: Magnitude of S_{11} for K-form

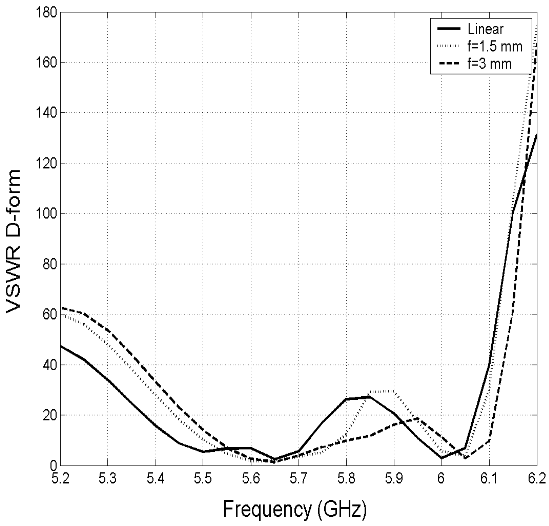


Fig.4 VSWR for D-form

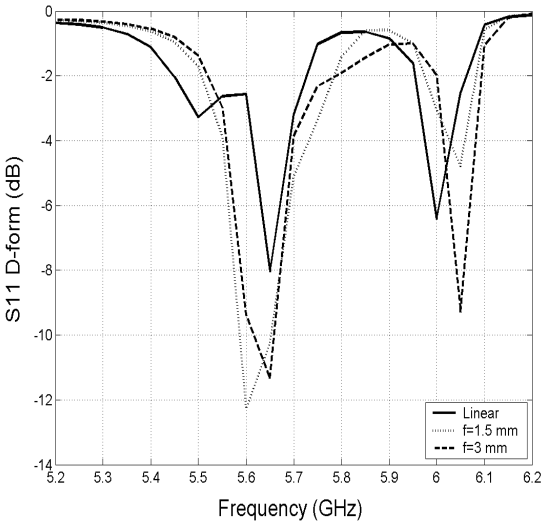


Fig.5: Magnitude of S_{11} for D-form

We conclude that, for all antenna types using in this paper, the frequency at the minimum of VSWR stay invariant, but the E-field and the 3dB beam width change as shown as on the table 1.

Figures 6 and 7 show respectively the polar elevation pattern of K-form and D-form for f=1.5mm.

The maximum of the total E-field of the linear antenna is at ($\theta = 15$, ϕ=270) degrees, the 3dB Beam Width is (21.6773, 33.2582) degrees, and the directivity is 10.8128 dB.

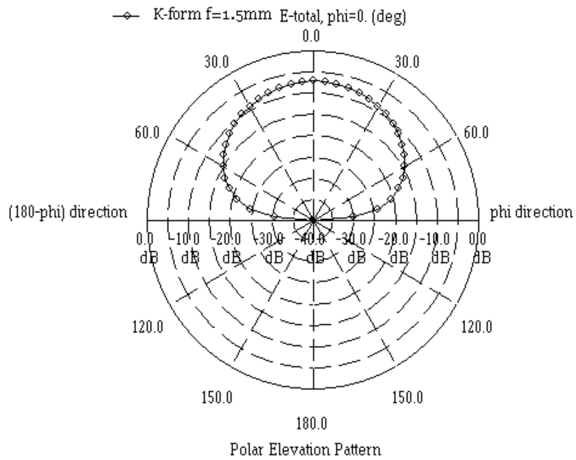


Fig.6 Radiation pattern of K-form (f=1.5 mm)

Table 1 shows the maximum of the total E-field, the 3dB beam width and the directivity for all types of antennas analyzed here.

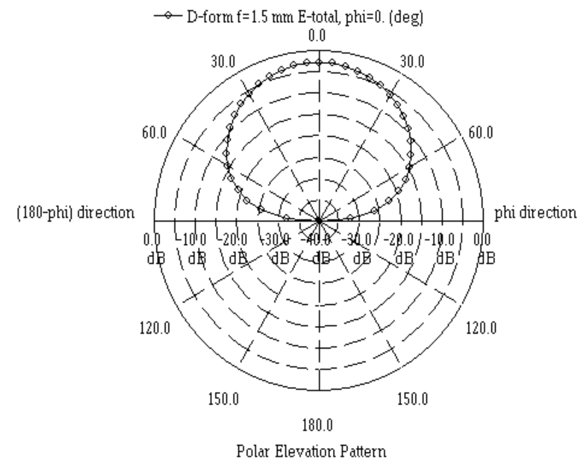


Fig.7 Pattern radiation of D-form (f=1.5 mm)

	Max field (degrees)	3dB beam width	Directivity (dB)
K-form f=1.5mm	θ=55° ϕ=90°	35.25° 53.86°	8.520
K-form f=3mm	θ=55° ϕ=90°	39.11° 54.30°	8.786
D-form f=1.5mm	θ=50° ϕ=90°	41.53° 54.82°	9.41
D-form f=3mm	θ=50° ϕ=90°	44.81° 54.37°	9.276

Table 1: Antennas parameters

The K-form antennas increase the 3dB beam width compared to linear one a 13.58° for f=1.5mm and 26.61° for f=3mm. They decrease the directivity 2.29 dB for f=1.5mm and 2.02 dB for f=3mm. For the D-form, the 3dB beam width and the directivity are bigger than the case of K-form. We can conclude that, D-form antennas are more important than the K-form for the omnidirectional pattern.

4 Conclusion

A new form of uniplanar printed antenna array with more omnidirectional radiation pattern has been introduced. An antenna array with concave and convex polarized coplanar waveguide CPW fed 2x2 has been analyzed and simulated. The K-form and the D-form of the four microstrip increase 3dB beam width compared to linearly polarized coplanar waveguide CPW fed 2x2 antenna arrays with a less gain about 1.3 dB.

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