Small C-Patch Antenna for Portable Digital Television Receivers

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Abstract: - In this paper a small c-patch antenna is designed and simulated. The antenna is compatible with Digital High-Definition Television frequency assignment in North America and it is able to be used in portable cellular units. The size of the designed antenna is less than the corresponding rectangular or circular patches. Besides, the c-patch antenna can be easily tunable in order to select the resonant frequency, and the matching impedance of the antenna can be changed by setting the feeding position. The performance of the antenna and its electrical features were evaluated using the HFSS software and, the results are presented here; where antenna gain, radiation patterns and other parameters were employed.

Key-Words: - F-inverted antenna, C-Patch Antenna, DTV, Mobile units, Small Antenna, Electrical Antenna Size.

1 Introduction

The HDTV is the current standard in Mexico City since last December for terrestrial TV broadcasting systems. Many people want to watch the TV in many places or even in a transport system, but it is clear, that the large wired directional antennas are not a good solution; because they cannot be used in a handset TV. Microstrip antennas have some features that are needed in the described systems; for instance, they are lightweight, planar, low-cost and have a wide main lobe [1], [2], [3] and [4].

Antennas with rectangular or circular patches are larger in comparison with c-patch ones. In this paper, a c-patch antenna is carried out in order to be used in a portable TV receiver.

The structure of this paper is divided in four sections: The first section is an introduction, the second section is dedicated to described the model of the c-patch antenna, in the third section the main results obtained are presented; and, the fourth section are the conclusion of this article.

2 Antenna model

In this section the model of the c-patch antenna is presented and described in detail. The Figure 1 shows the layout of the antenna model, where a two copper layers are separated by a FR-4 dielectric substrate. As you can see in that figure, the Printed Circuit Board (PCB) has a patch in the Top Layer.

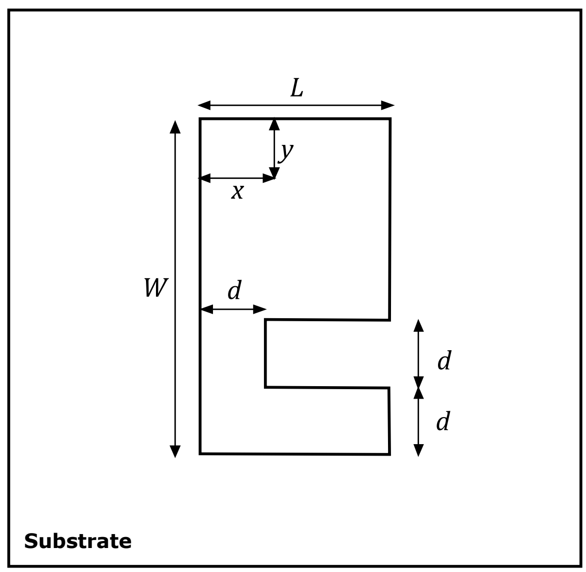

Fig. 1. C-patch antenna geometry.

The main resonant frequency of the F-inverted patch antenna can be computed by the equation (1) [1], [4].

$$f_0 = \frac{c}{4(W+L)} \tag{1}$$

Where f_0 is the resonant frequency of the F-inverted antenna, c is the phase velocity of the light in the vacuum, W is the width of the patch, L is the length of the patch.

In order to consider the dielectric constant of the substrate, in this paper a correction of this formula is introduced, see equation (2).

$$f_0 = \frac{c}{4\alpha\sqrt{\varepsilon_r}(W + L)} \quad (2)$$

Where α is an empirical constant; and, ε_r is the dielectric constant of the PCB substrate.

It is necessary to take in account the empirical constant; because there are some parameters that are not analyzed in the geometry, for example: the thickness of the substrate. Nevertheless, it is also important to create some parameters with the aim of substituting the parameter d, because d is used for some different distances in the geometry of the model; each of them has a particular effect in the structure performance.

The behavior of the structure can be modified using some of the parameters of the structure. The resonant frequency is especially sensible to W and L; but it is important to consider both, the substrate thickness and the dielectric constant. The matching of the antenna impedance is determined by the position of the antenna feed [1] and [5].

The most important parameters of the final model of the microstrip c-patch antenna are illustrated in the Table 1.

TABLE 1. MODEL PARAMETERS

1	Length of the patch	L	65 mm
2	Width of the patch	W	70 mm
3	Length of the ground plane	L_g	150 mm
4	Width of the ground plane	W_g	150 mm
5	Distances of the slot	d	14 mm
6	Position of the feed	x	12.73mm
7	Position of the feed	y	12.73mm
8	Substrate thickness	h	1.544mm
9	Patch thickness	t	0.03mm
10	Dielectric constant (FR-4)	ε_r	4.3

3 Results

The results of this work are presented in this section where antenna patterns and frequency response, are the most important results. All the results were obtained by simulation using HFSS software.

In the figure the model is illustrated in as a tridimensional model; where the cartesian coordinate system and radiation boundary are shown.

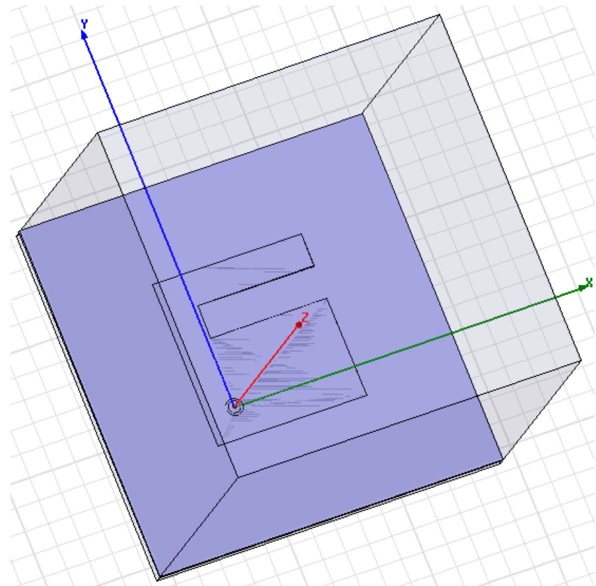

Fig. 2. Tridimensional model of the c-patch antenna.

The resonant frequency of the antenna is 480 MHz approximately that is near to the center frequency in the interval used in the terrestrial HDTV broadcasting system in Mexico City. The Figure 3 shows the frequency response of the c-patch antenna.

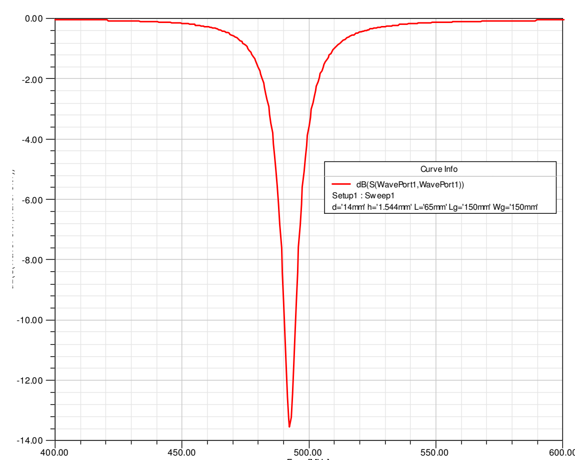

Fig. 3. S11 Parameter of the c-patch antenna.

The radiation pattern of the antenna is wide in order to provide mobility in the city; but the antenna gain is reduced to -1 dB approximately, that is a normal value in this kind of systems.

The antenna pattern for the elevation plane (where ϕ equal to 0 degrees) that was computed by the mentioned computational tool is presented in the figure 4.

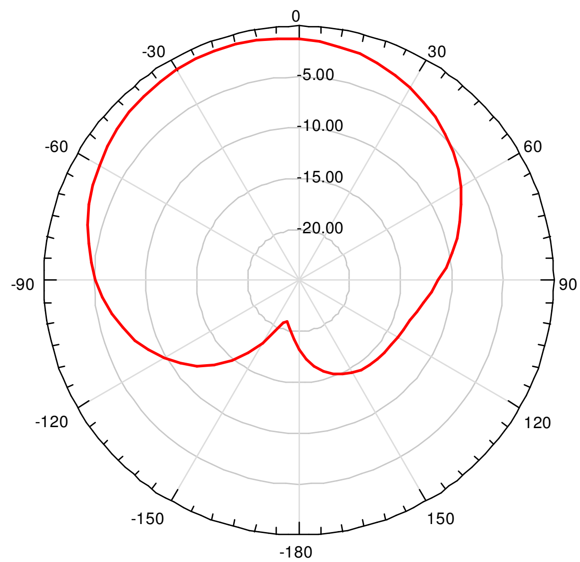

Fig. 4. Radation pattern of the c-patch antenna.

Finally, the tridimensional antenna pattern of the antenna is shown in the figure 5; where it is easy to see that the main lobe is asymmetric in the elevation plane. In despite of this feature, this asymmetry is not a problem in this case; because the main lobe is very wide above the top layer. The origin of this aspect is the asymmetry of the c-patch.

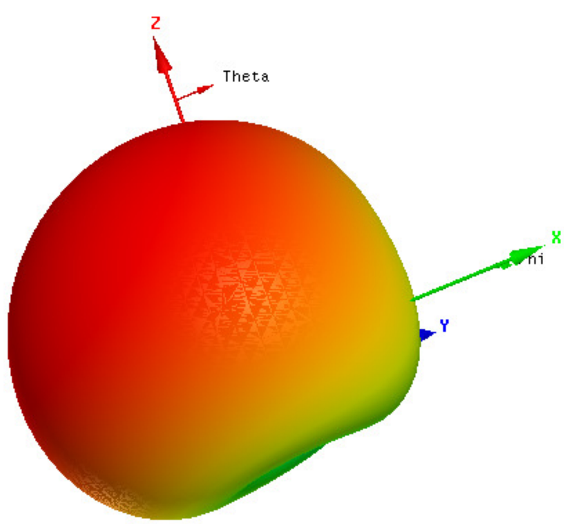

Fig. 5. Tridimensional radiation pattern of the c-patch antenna.

4 Conclusion

The microstrip c-patch antenna was carried out for HDTV receivers employed in terrestrial DTV in Mexico City.

The antenna is smaller in comparison with other ones where their patches have rectangular or circular shapes; in this case: 4,900 mm^2 for the c-patch antenna and 10,000 mm^2 or higher for the other ones.

It is important to emphasize that this sort of structure is quite easy to computed; but it is very good option for systems where the antenna can be set on the top of a conducting surface like cars, buses, trains, and other transport systems.

The structure can be analyzed if the distance *d* is divided in three parameters in order to separate the effect of each distance in the model; because where this distance is changed the tuning of the antenna is modified in a very complex way.

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