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Design and simulation of circular microstrip patch antenna with cross-shaped slot

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Abstract

A design of circular microstrip patch antenna were proposed . The aim of this design to improve the performances of circular microstip antenna for Ultra Wide Band (UWB) applications . A cross- shaped slot is etched on the circular patch to improving characteristics of antenna such as return loss, bandwidth , vswr, radiation pattern , and antenna gain . The designed circular patch antenna shows return loss value -27dB and a band width equal to 18% . Also, a the value of vswr is 1.09 and antenna avarage gain equal to 5.2 dB. The circular microstrip patch antenna is designed at 9.2 GHz frequency by using coaxial feeding technique and Arlon substrate with dielectric constant εr = 3.2 and thickness is 1.7mm . Antenna design and simulation of proposed antenna carried out in Finite Element Method (FEM) based High Frequency Structural Simulation (HFSS) tool.

Keyword: Circular Microstrip Antenna, FEM , HFSS, UWB , cross- shaped slot .

1- Introduction

The principal advantages of microstrip antenna include, small size , light weight , low fabrication cost , low profile planar, and can be manufa-ctured either as a separate component or part of array [1]. Some of disadvantages of microstrip antenna are: narrow bandwidth; low efficiency; low Gain ; and thicker substrate results in excitation of surface waves [2] . Basic microstrip antenna consist of two thin metallic layers ($t << \lambda_0$) separated by dielectric substrate of thickness ($h << \lambda_0$) usually $0.003\ \lambda_0 \leq h \leq 0.05\ \lambda_0$ [3]. The radiating element can be take several shapes such as a rectangular , square, monopole , circular, triangular, circular ring, , and elliptical , or other configuretion. There are special features for each shape, but the rectangular , circular and square shapes are the most common configu-rations [4]. Microstrip patch antennas can be fed by a variety of methods. These methods can be classified to contacting and non-contacting. In the contacting method, the RF power is fed directly to the radiating patch using a connecting element such as a microstrip line. In the non-contacting scheme, electromagnetic field coupling is done to transfer power between the microstrip line and the radiating patch. The four most popular feed techniques used are the microstrip line, coaxial probe (both contacting schemes), aperture coupling and proximity coupling (both non-contacting schemes) [5].

To improving bandwidth of microstrip antennas can be use different techniqes, such as increasing the height of the substrate, microstrip slot antenna loaded approach on the patch and using different shapes of microstrip patch [6]. By increases thickness of substrate increases the band width, but may lead to surface wave excitation which decrease efficiency [7]. Different shapes of slot loading in radiated patch to improving the antenna bandwidth [8]. In this study, a cross-shaped slot in circular patch antenna were designed with coaxial probe feed .The software which is the industry standard for simulating high frequency electromagnetic structure (HFSS). In this paper, a microstrip antenna with higher gain and wider bandwidth were proposed .The configuration of the initial antenna at resonance frequency at 8.8 GHz, Arlon material has been used as substrate with thickness of 1.7mm, and the dielectric constant of substrate is 3.2, with radius of the patch is 11 mm and the dimension of ground plane 29x24mm^2.The return loss of initial antenna is about -37.45dB, and the band width is 4.8% GHz , and the vswr is 1.02 at 8.8 GHz. and the average gain is 3.8 dB .

2- Antenna design

The design of the antenna is a circular microstrip antenna with radius of patch 11mm ,the dimension of ground plane 29x24 mm^2. The substrate chosen for the proposed antenna is Arlon with dielectric constant of 3.2 and a thickness 1.7 mm , the feed position is (-3.5,0) .

The slot techniques etched in the circular patch is used here to improving the band width of the antenna .The cross-shaped slot was to be etched in the circular patch of the proposed antenna as shown in figure (1) , The dimensions of the slot, are shown in figure (2).

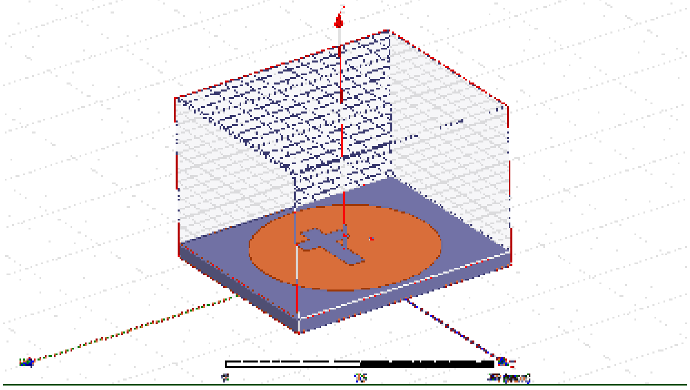


Figure (1) :The circular microstrip antenna with cross slot

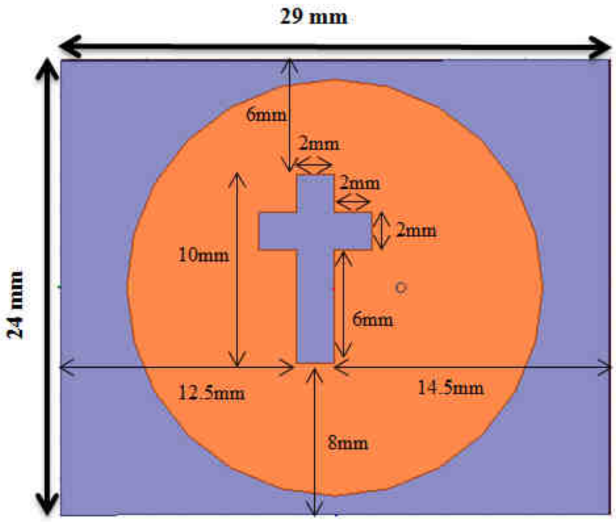


Figure (2): Optimum dimension of proposed antenna

3. Simulation results and Discussion

According to the optimum dimensions in figure (2), the return loss of cross -slot antenna shown as in figure (3) , bandwidth for -10 dB return loss equal to 18 % at 9.2 GHz .

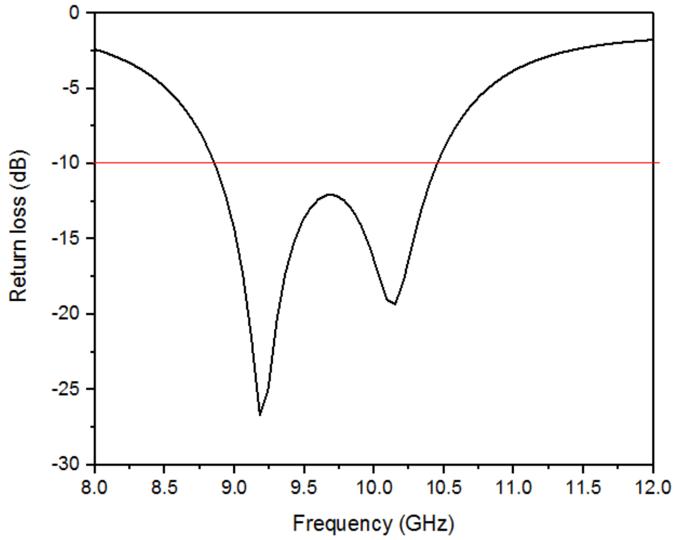


Figure (3): Return loss of the proposed antenna

The value of VSWR is 1.09 for the antenna at resonant frequency at 9.2 GHz as shown in figure (4) **.**

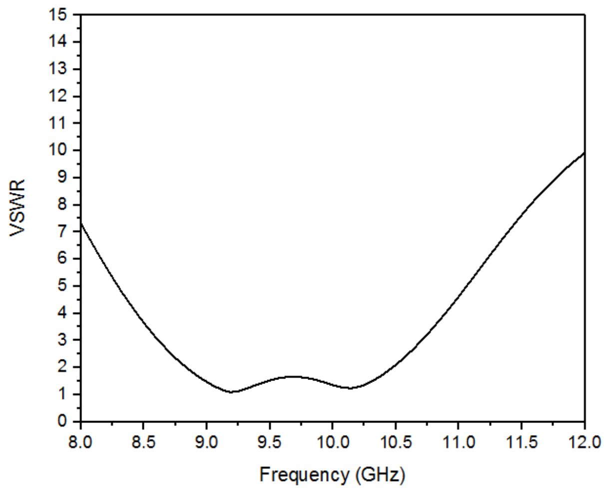


Figure (4): VSWR of the proposed antenna.

The input impedance at 9.2 GHz as shown in figure (5) , the real part of impedance is approximately 50 Ω and the imaginary part is zero .

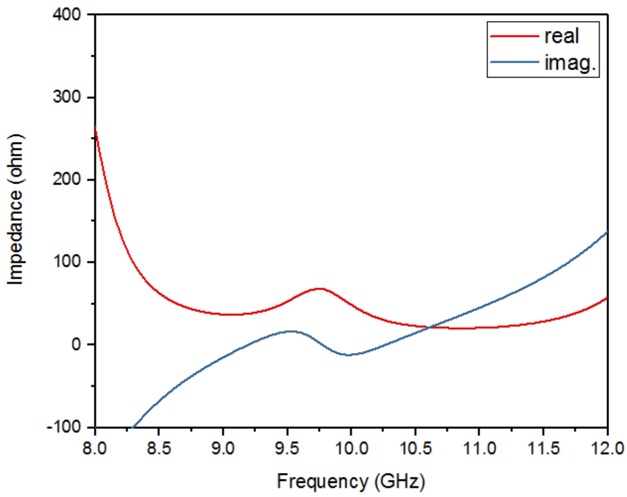
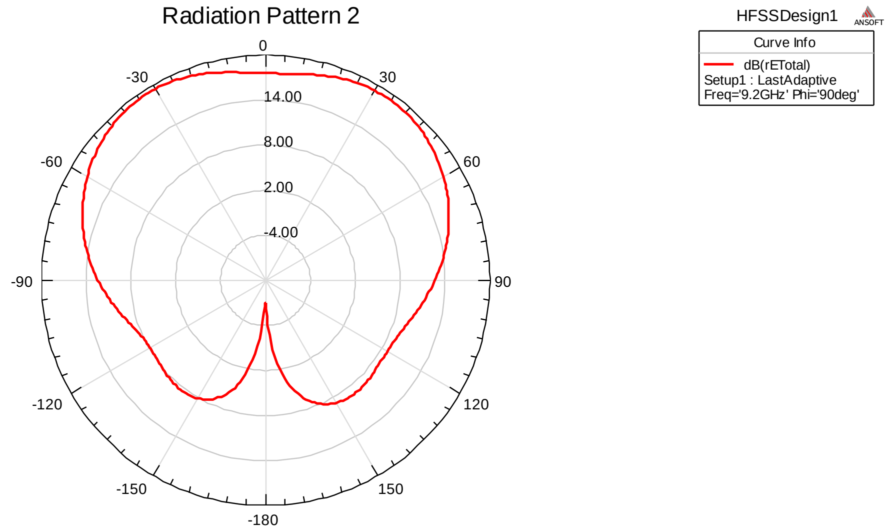
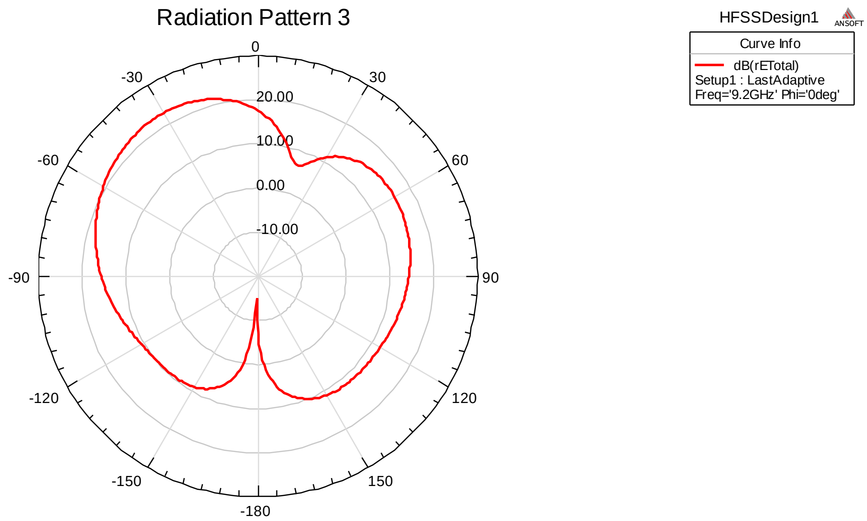


Figure (5): the real and imaginary part of the input impedance vis. frequency .

The radiation patterns of proposed antenna are shown in figures (7a) and (7b) in the E-plane and H-plane at 9.2GHz, and the figure (8) shows the 3D pattern of the proposed antenna at the same frequency.



a



b

Figure (7): (a) E-Plane and (b) H-Plane of proposed antenna at 9.2 GHz

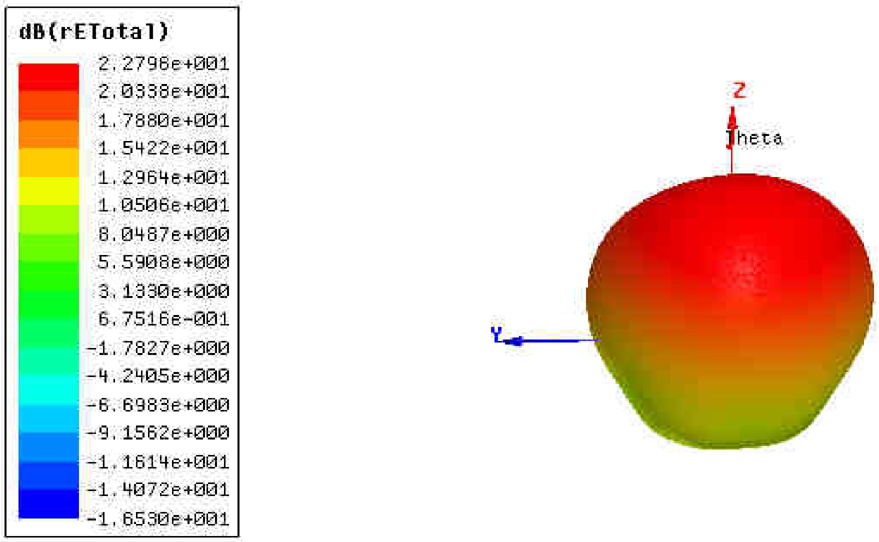


Figure (8): 3-D radiation pattern of the proposed antenna at 9.2 GHz

3- Conclusion

In this work we proposed a circular microstrip patch antenna with cross-shaped slot to improving the parameters of circular microstrip antenna . The proposed antenna was designed at 9.2 GHz with wider bandwidth and high gain. Hence this antenna used widely in different applications of UWB system .

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