Design of a E-Slotted Loaded Circular Microstrip Patch Antenna

Received :15/ 12 / 2016 **Accepted : 14 / 3 /2017**

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Abstract: This paper presents a design of E-slot loaded circular patch microstrip antenna used for communication purposes especially in civil and military applications.The antenna has been simulated and design on Arlon AD320A (tm) substrate with dielectric constant substrates of 3.2 and optimum dimensions of 29 × 24 × 1.7 mm^3.The design requirements for the antennas include a VSWR < 2 for 50 Ω reference impedance and return loss is less than to -10 dB. The proposed antenna simulation is carried out using Ansoft HFSS. The E-slot microstrip patch antenna was then fabricated using microstrip coaxial probe feed arrangement and to be determined its S_{11} and VSWR result. While the dual bandwidths measured for -10 dB refleection coefficient are 0.21 GHz and 0.812 GHz at range (11.9699-12.7820 GHz) or (1.6 % and 6.55%).

Keywords: VSWR, Radiation Pattern, Bandwidth, E-Shaped Slot.

1. Introduction

A simple microstrip patch antenna consists of a conducting patch and ground plane with a dielectric substrate of particular dielectric constant value. Microstrip patch antennas have recently received much attention and are used as efficient radiators in many communication systems. The microstrip antennas have been worked out extensively due to the advantages of compactness, low cost, lightweight, and low profile planner configuration [1], and disadvantages such as narrow bandwidth and efficiency. A number of experimental and

theoretical researches have been done to improve the bandwidth of this antenna [3- 4]. Loading of shorting pins and stacking of patches are some techniques to increase the bandwidth of microstrip antennas [5-6]. Different shapes of slot loading in patch fed also enhance the return loss bandwidth [7-8] . Different shapes of slot loading in patch fed also enhance the return loss bandwidth [7-8]. In this paper, circular patch loaded E-slot microstrip patch antenna using coaxial -probe feed has been studied .Both the geometries (E-slot and circular patch) microstrip antenna are using High Frequency Electromagnetic Field Simulation (Ansoft HFSS) which using numerical technique finite element [9].

2. Antenna Design

The configuration of the proposed antenna is shown in Fig. 1. in which a microstrip antenna with E- slot shape loaded circular disk patch on the dielectric substrate chosen is Arlon AD320A (tm) at dielectric constant, ε_r= 3.2 and a thickness of 1.7mm. The dimensions of the substrate are taken as ($L_s \times W_s \times h$) 29 × 24 × 1.7 mm^3 and the size of the ground plane is taken as ($L_s \times W_s$) 29 × 24 mm^2.
The E-slot configuration continue four rectangular type, three horizontally rectangular dimension are ($w_R \times t_R$) 7 mm × 2 mm, and vertical rectangular dimension is $(L_R \times t_R)$ 11 mm× 2mm. The propose antenna exaction by coaxial prop feed, the feed location is (x_f, y_f) is (0,3 mm). All dimensions of this antenna are

shown in Fig 2 and recorded in table 1.

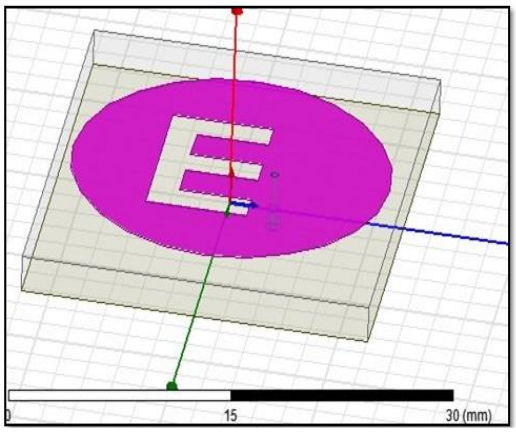

Fig.1. Geometry of E-slot loaded circular disk patch antenna design by HFSS.

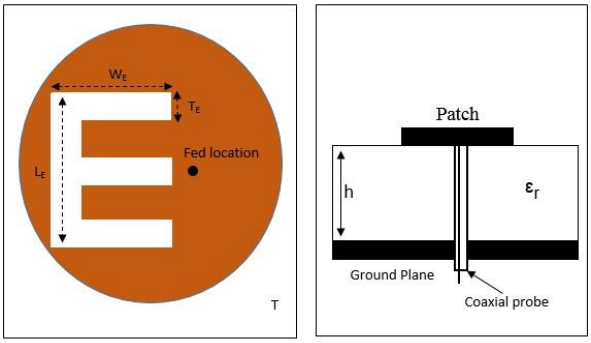

Fig.2. E-slot loaded circular microstrip antenna.

Table 1: List of design parameters of Antenna.

Parameters	Values
Substrate material	Arlon AD320A (tm)
substrate thickness h	1.7mm
dielectric constant ε_r	3.2
Radius of the disk patch (a)	11.0mm
substrate size ($Ls \times Ws \times h$)	29×24×1.7 mm^3
Radius of the disk patch (a)	$(11\ mm)$
Length of the vertical slot (L_E)	$(11\ mm)$
Length of the horizontal slot (W_E)	$(7\ mm)$
Thickness of the slot (T_E)	$(2\ mm)$
Feed location (x_f, y_f)	$(0, 3\ mm)$

3. Results and Discussion

Figure.3 shows the simulated and measured return loss of the E-slot loaded circular disc patch. The measured dual impedance bandwidths for -10 dB return loss is 210 MHz, ranging from 5.9850 to 6.1955 GHz, and 812 MHz, ranging from 11.9699 to 12.7820, with a return loss of -23.97 dB, -17.37 dB respectively.

The VSWR values are 1.135 and 1.183 for the corresponding dual resonant frequencies indicating the good matching conditions with impedance shown in Fig (4).The rectangular and 3D radiation patterns at 12.39 GHz frequency for $E\&H\ \ Plane$ are shown in Figs. 5 and 6. Figure (7) shows that the real part of Z_{in} at resonant frequency (12.39 GHz) is approximately equal to 50 Ω, and the imaginary part is approximately equal to zero.

Fig .8 shows that the effect of variation of S_{11} parameter with different thickness of substrate clarify an increasing in the bandwidth at (h = 1.7 mm). Fig (9) shows the electric current distribution on the circular patch loaded with E-slot.

4. Conclusions

The simulation design of E-slot loaded circular disk microstrip patch antenna by using Ansoft HFSS Microsoft was presented , The design requirements for the antennas include a VSWR < 2 for 50 Ω reference impedance and return loss is less than to -10 dB . The proposed antenna was then fabricated using coaxial probe feed arrangement with VSWR values of 1.135 and 1.183 corresponding to the two resonance frequencies $(6.27, 12.39)\ GHz$ .The bandwidths values for -10 dB refleection coefficient are 0.21 GHz and 0.812 GHz or 1.6 % and 6.55% at resonant frequency.

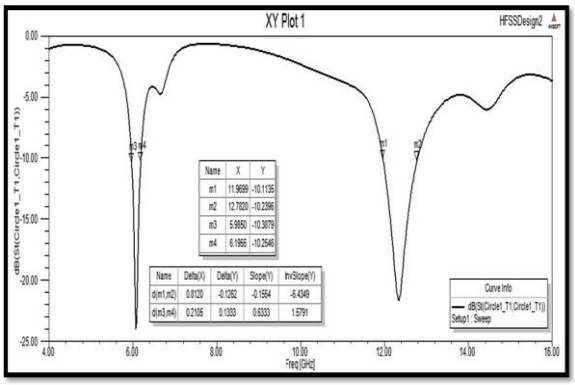

Fig.3.Return loss of proposed antenna.

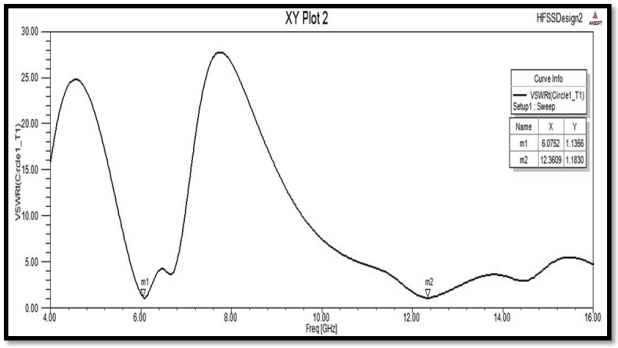

Fig.4. VSWR of the proposed antenna.

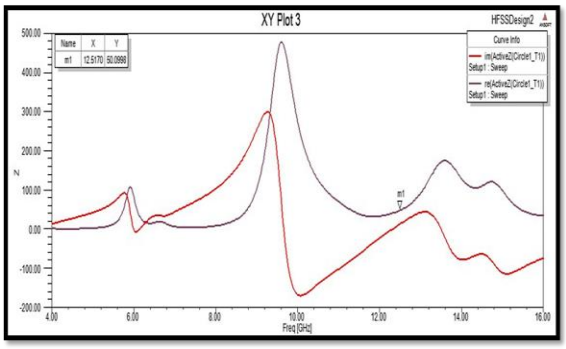

Fig. 7. The real and imaginary part of input impedance with the frequency.

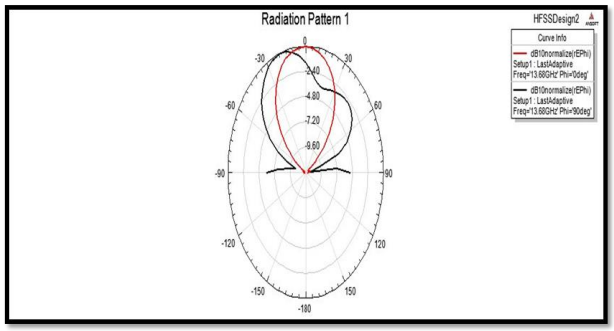

Fig.5. Radiation pattern of the E-slot loaded circular patch antenna at 12.39 GHz.

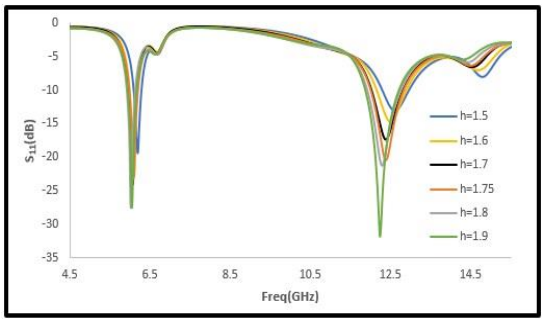

Fig. 8. The dielectric substrate thickness effected on the proposed antenna.

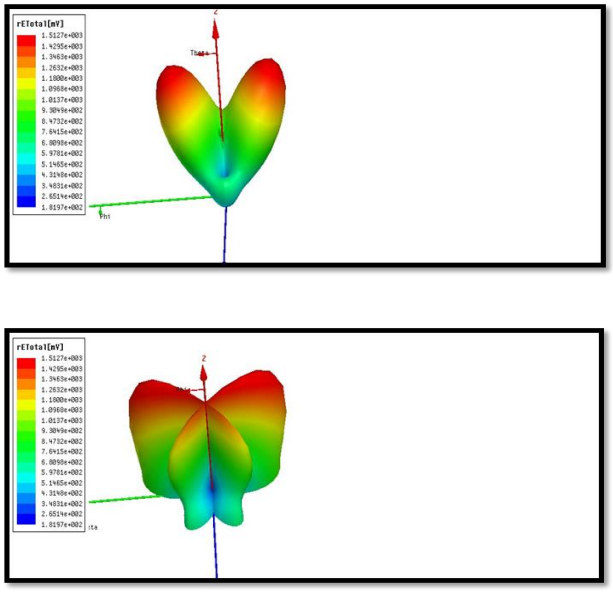

Fig. 6. 3-D radiation pattern of the E-slot patch antenna at 12.39 GHz.

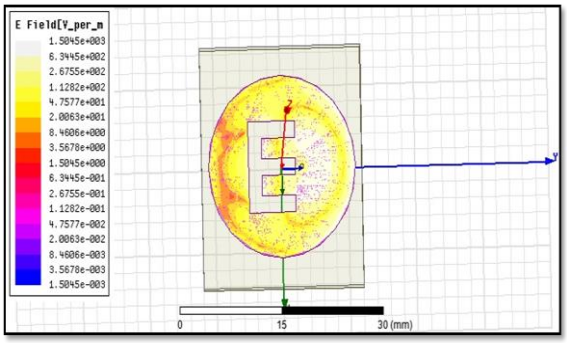

Fig. 9. Electric current distribution on the circular patch with E-slot of the antenna.

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