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Rectangular Based Circular Slot Antenna for Ku Band Applications

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Abstract

Microstrip antenna plays a vital role in wide range of communication systems applications. microstrip antenna is the equipment connecting two are more devices by means of wireless connecting medium. in this manuscript, rectangular patch with circular slot antenna is presented, for ku band applications. Analysis of proposed antenna is carried out on HFSS 13.0 Simulator. Proposed antenna is designed on FR4 Epoxy substrate. The experimental result confirms the proposed antenna operates over the frequency of 13.99GHz to 16.61GHz with the impedance bandwidth of 18.3%.far field of proposed radiator are stable and confirms its better performance in this frequency range.

Keywords: microstrip antenna, ku band applications, FR4 epoxy, HFSS13.0.

1. Introduction

Now a days, the microstrip antenna are used in various applications like, WLAN, WiMAX, Satellite communication, aircraft, remote control and telemetry. microstrip antenna is highly known to light weight, size,low cost and low profile.microstrip antenna consists of three parts named by a radiating element known to be microstrip patch, dielectric substrate, and ground plane.an all antenna elements with geometrical arrangement for improving of antenna gain, return loss,VSWR and highly directive radiation pattern for microwave antenna field. Although conventional microstrip antenna is highly advantage in terms of size and cost.it is unable to create omnidirectional radiation pattern in all planes as well as impedance bandwidth that is very less than 3%.To overcome both these drawbacks slot antenna comes in to role.slot antenna works on the principle of magnetic dipole.it provides wider impedance bandwidth as compared to conventional microstrip antenna. A pair of c shaped at conductor backed plane is used for impedance matching. This antenna consists of square shaped patch as a radiator and slotted conductor backed plane. By adjusting the positions and lengths of these structures of slots on the conductor for backed plane.in this article triple slot antenna is designed and analyzed. In the proposed antenna design circular ring slot with C shaped slot is used. Fair fields features of proposed antenna is stable in operating frequency. for better understanding of complete design procedure, Entire manuscript is divided in to five segments I) Introduction, II) Antenna geometry, III) Results and discussion, IV) conclusion, V) References. [1−4]

2. Antenna Geometry

The top and bottom view geometry of the

proposed antenna is shown in figure 1 and 2 respectively.

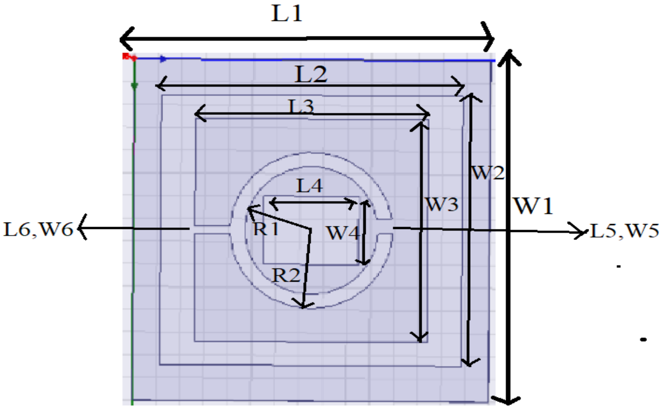

Fig.1 Top view geometry of proposed antenna

Rectangular slot along with C shaped slot is etching over FR4 substrate. The thickness of FR4 substrate is 0.8mm. its dielectric constant is 4.4 and loss tangent is 0.0148 respectively. on one side of the substrate rectangular patch of dimensions (L1,W1) is printed and then rectangular slots (L2,W2,L3,W3) and C shaped slots inner and outer side radius (R1,R2,R3,R4) is etched. The C shaped slot is formed by combining a rectangular shaped slot. The length of connecting square patch is (L5,W5).The length and width of centre rectangular slot is (L4,W4). [5–9] A rectangular microstrip feed line is formed beneath the dielectric substrates. The dimension of the feed line is (L7,W7).the various dimensions of proposed radiator and location of feed line have been optimized using parametric analyses.Table 2.1 shows the every optimized dimension of proposed antenna. [10–12]

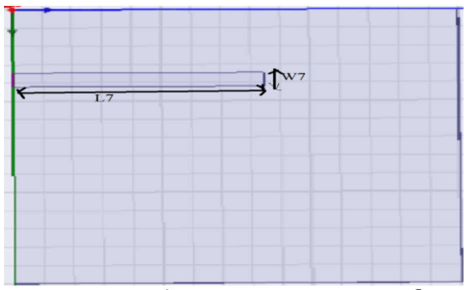

Fig.2 Bottom view geometry of proposed antenna

3. RESULT AND DISCUSSION

The simulation analysis has been performed using HFSS software (Ansoft's HFSS, version 13.0). HFSS is a finite element method based solver for electromagnetic structures.

Table.1. Parameters for proposed antenna

PARAMETERS	UNITS (mm)
Length of the substrate/patch (L1)	15
Width of the substrate/patch (W1)	15
Length of the outer rectangle (L2)	12.7
Width of the outer rectangle (w2)	11.875
Length of the inner square (L3)	9.8
Width of the inner square (w3)	9.8
Length of the inner rectangle (L4)	4
Width of the inner rectangle (W4)	3
Length of the gap (L5)	0.668
Width of the gap (W5)	0.625
Length of the connecting slot (L6)	1.46
Width of the connecting slot (W6)	0.3125
Length of the microstrip line (L7)	8.4375
Width of the microstrip line (W7)	0.78125
Radius of the inner circle (R1)	2.8125
Radius of the outer circle (R2)	3.4375
Height of the substrate (H)	0.8

3.1 RETURN LOSS

Return loss is for mismatched load ,if load is mismatched then energies losses concern with no better quality so all power is not transfer to load from source is called return loss.The peak return loss is founded to be -37.2 dB at 14.45GHz

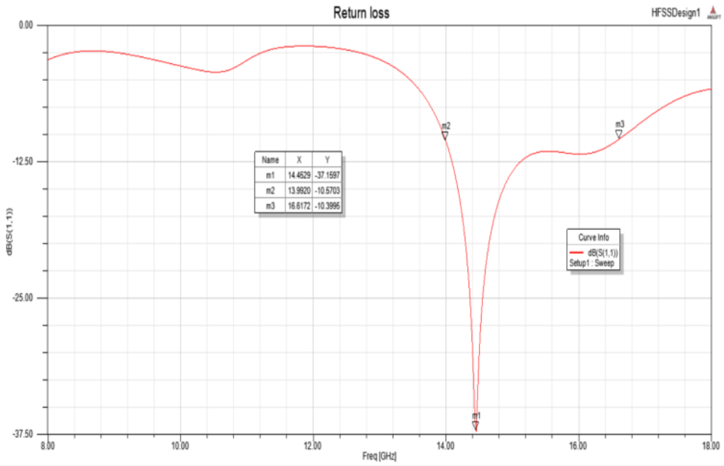

Fig.3. Return loss or S11 parameter for proposed antenna

The reflection coefficient of S11 parameter bandwidth are achieved (S11 <-10 dB) from 13.99 to 16.62 GHz (18.3%).Table.2 shows the return loss in dB versus frequency of S11 parameter.

Table.2 Return loss in dB versus frequency of reflection coefficient.

Freq [GHz]	dB(S(1,1)) []
13.9060403	-9.1913766
13.9731544	-10.242057
14.0402685	-11.492855
14.1073826	-13.015229
14.1744966	-14.929393
14.2416107	-17.454875
14.3087248	-21.044083
14.3758389	-26.89794
14.442953	-37.438944
14.5100671	-28.461789
14.5771812	-23.109015
14.6442953	-20.028631
14.7114094	-17.930129
14.7785235	-16.384031
14.8456376	-15.199934
14.9127517	-14.275873
14.9798658	-13.549626
15.0469799	-12.979607
15.114094	-12.536147
15.1812081	-12.197005
15.2483221	-11.944812
15.3154362	-11.765495
15.3825503	-11.647234
15.4496644	-11.579731
15.5167785	-11.553668
15.5838926	-11.560301
15.6510067	-11.591152
15.7181208	-11.637792
16.657718	-10.2197

3.2 VSWR

VSWR is function of reflection coefficient it shows reflected power from antenna.it always real and positive number of antenna.Smaller the VSWR then the design is perfectly matched with transmission line to antenna and no power is reflected from antenna.

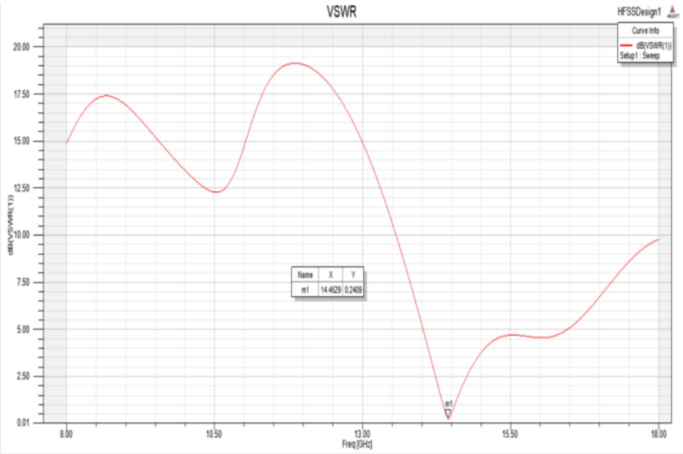

Fig.4.VSWR analysis for proposed antenna

VSWR for proposed antenna is 0.2409,therefore reflection coefficient will be 0.8058.

$$\mathrm{VSWR} = \frac{1+\tau}{1-\tau}$$

$$\tau = Reflection\ Coefficient$$

$$S = \frac{1+\tau}{1-\tau}$$

$$S\,(1-\tau) = 1+\tau$$

$$\tau = \frac{S-1}{S+1}$$

VSWR = 0.2409

$$|\tau| = 0.8058$$

3.3 RADIATION PATTERN

Radiation pattern of an antenna represent energy radiates or reflects by antenna in free space.Radiation pattern are representation of the distributed radiated energy in to space as function of direction. The radiation characteristics of antenna is investigated. The simulation result shows antenna exhibited good radiation pattern at operating frequency.

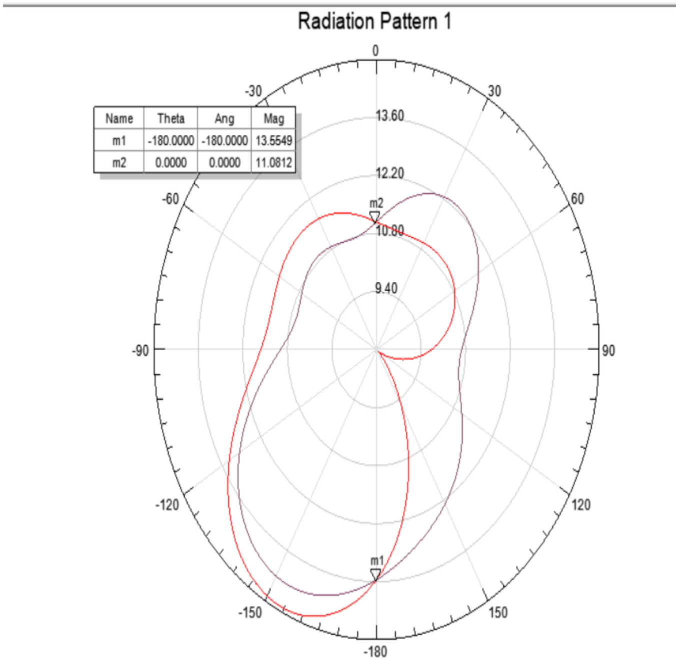

Fig.5.Radiation pattern for proposed antenna

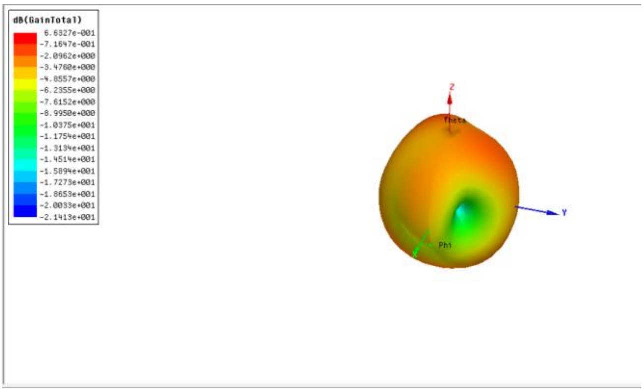

Fig.6. 3D Radiation pattern for proposed antenna

3.4 PEAK DIRECTIVITY

Peak Directivity is the measure of the concentration of an antenna"s radiation pattern in a particular direction. If the Directivity is high the designed antenna is more concentrated on beam, the proposed antenna directivity is measured to be 1.2986 dB.

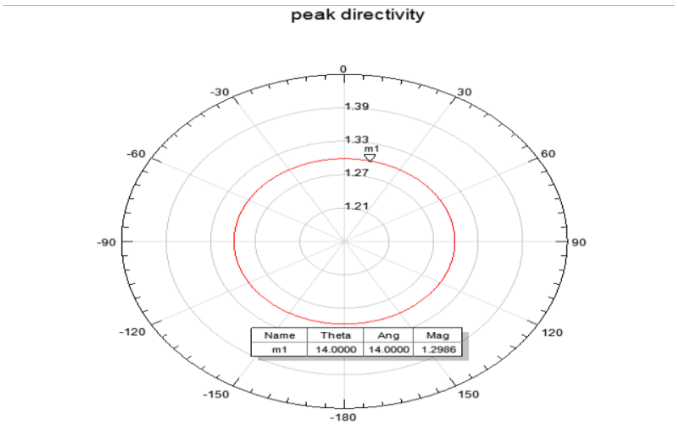

Fig.7.Peak Directivity for proposed antenna

3.5 PEAK GAIN

Peak gain shows how much power is transmitted in the direction of peak radiation to that of isotropic source.

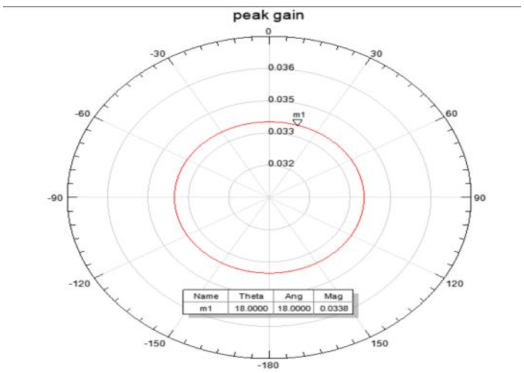

Fig.8.Peak Gain for proposed antenna

3.6 RADIATION EFFICIENCY

Radiation efficiency shows how effectively antenna radiates to a particular distance.

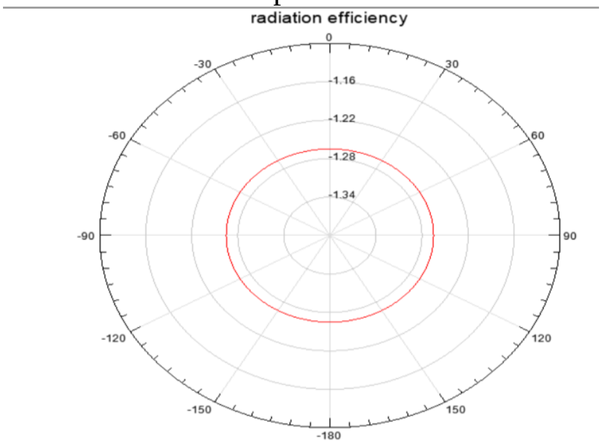

Fig.9.Radiated efficiency for proposed antenna

3.7 E AND H FIELD PATTERN

In E field and H field pattern that red and orange color shows maximum radiation of antenna.

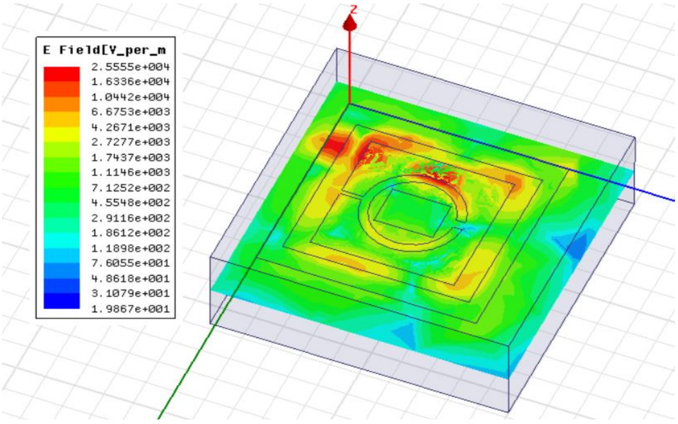

Fig.10 E Field for proposed antenna

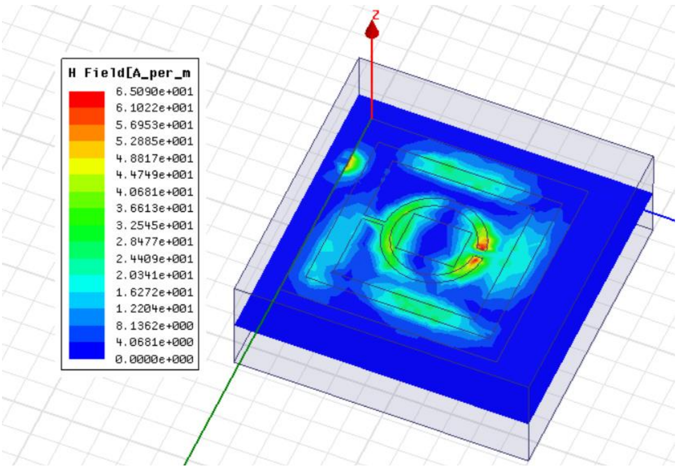

Fig.11 H Field for proposed antenna

Table.3.Overall parameter

Parameters	Values
Resonance frequency	14.45 GHz
Return loss	-37.1597 dB
Gain	11.0812 dB
VSWR	0.2409
Directivity	1.2986 dB

Conclusion

This manuscript describes the design and radiation performance of an rectangular based circular slot antenna for ku band applications.Frequency band 14 GHz is due to an rectangular slot coupling with an C shaped slots.after evaluating all the performance parameters, it can be said that the proposed antenna radiation is suitable for an KU band applications.In future by inserting an circular ring shaped slot along with an U shaped slot provides a dual band frequencies because wireless communication system widely requires a radiator, which can be capable of supporting multiple frequency ranges as well as it can provide high SNR without demanding requirement of extra power level.

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