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Design of Dual-Band Electrically Small Micro-strip Antenna with wave type Slot as Complementary of folded-dipole antenna for C & X Bands

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Abstract:
This paper presents a new electrically small rectangular probe-fed micro-strip patch antenna loaded with material Rogers rt/duriod5880(tm). The present dissertation deals with Electrically small antenna which are electrically small compared to wave length.the performance of electrically small antenna are closely related to their electrical size, so the gain can be increased to maintain radiating efficiency. The micro-strip patch antennas have been widely used in satellite and telecommunications for their good characteristics such as light weight, in expensive, low cost and so on. Here in this design slots are placed to form folded dipole, which increases the band width of the antenna. Different parameters like returnloss,gain (2d&3d), radiation pattern in θ, Ø directions, current distribution, E&H fields and vswr are simulated in HFSS 13.0.This type of proposed patch can be used for various applications in C & X-Bands.
Keywords : Electrically small antennas, probe-fed, Dipole antenna.

I. INTRODUCTION:

Electrically small antenna are small compared to the extremely long waves lengths used at the lowest radio frequencies. There are various rules for considering an antenna to be electrically small. The large dimension of the antenna is no more the One-Tenth of a wave length. The most common structure in electrically small antenna is short dipole. The 3 basis for understanding electrically small antenna is

- Efficiency
- Impedance matching
- Radiation patterns.

In Tele communication Micro-strip patch antennas are widely used in portable electronic devices due to their compact size, low profile and low cost which can be mounted on a flat surface.The patch is generally made of conducting material such as copper or gold and can take any possible shape. Microstrip patch antennas radiate primarily because of the fringing fields between the patch edge and the ground plane. For good antenna performance, a thick dielectric substrate having a low dielectric constant is desirable since this provides better efficiency, larger bandwidth and better radiation. In order to design a compact Microstrip patch antenna, higher dielectric constants must be used which are less efficient and result in narrower bandwidth.

Microstrip patch antennas can be fed by a variety of methods. These methods can be classified into two categories

- Contacting
- 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 micro-strip line and the radiating patch.

The main purpose of this work is to investigate the miniaturization of a rectangular probe-fed micro-strip folded dipole patch antenna by inserting a number of slots one-by-one to the radiating edges. so that the slot length is a half wavelength at the desired frequency and the width is a small fraction of a wave length. The antenna is frequently compared to a conventional half wave dipole consisting of two flat metal strips. Here the design of folded dipole is presented. Generally dipole is the complementary of the slot antenna. Slot antennas are often used at UHF & Microwave frequencies

In this paper, a compact size micro-strip folded dipole slot antenna is proposed with dielectric substrate as Rogers RT/duroid 5880(tm) with εr=4.4 and dimensions are base on resonant frequency. Various attempts are made to adjust the dimensions of the patch to improve the parameters like bandwidth, return loss, gain along □, Ø directions, radiation pattern in 2-D and 3-D, E and H Field Distributions, Current Distributions using HFSS 13.0

II. DESIGN MODEL:

The basic structure of the proposed antenna is shown in figure 1. The antenna is simulated on Rogers RT/Duroid 5880 substrate with a dielectric constant εr of 4.4.The size of the antenna is 3cm. Here the rectangular probe-fed micro-strip patch was taken, rectangular slots were inserted one with a length of 0.6cm and a width of 0.1cm.The substrate thickness is 0.16cm.So we designed the slots with individual manner and applied the thickness of the substrate and then cutted from the main patch. The patch can be fed with a probe through ground plane. Placing the slots in folded dipole manner increases antenna's electrical length, without modifying the patch's global dimensions.The slot antenna consists of a radiator formed by cutting a narrow slot in a large metal surface. Such an antenna is shown in figure. The slot length is a half wavelength at the desired frequency and the width is a small fraction of a wavelength. The antenna is frequently compared to a conventional half-wave dipole consisting of two flat metal strips. The physical dimensions of the metal strips are such that they would just fit into the slot cut out of the large metal sheet.

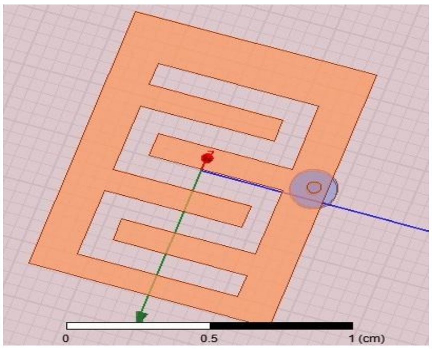

Figure 1: geometry of rectangular probe-fed with folded dipole.

Here both probe fed & edge fed electrically small micro-strip folded dipole antennas are measured in order to validate the results of the simulations.From the results obtained, the simulated returnloss & gain values of electrically small microstrip probe fed folded dipole antenna are better than the values obtained using edge fed. Micro-strip probe fed folded dipole antenna was simulated and the numerical return loss and radiation patterns were shown. The purpose of this paper is to discuss the microstrip probe-fed folded dipole patch antenna and to present the experimental results. In particular, the dimensions of the patch are given along with the feed network. Discussion of the dimensions and how they were obtained are presented. The experimental return loss and the experimental E and H-plane radiation patterns are compared with the Ansoft HFSS 13.0 results.

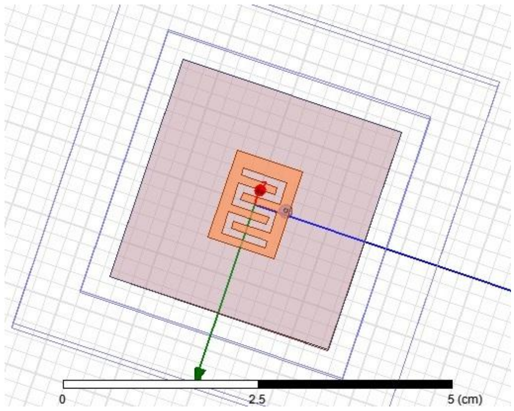

Figure 2: Ansoft HFSS generated model.

III. SIMULATION RESULTS:

A.Return loss:

It is defined as the signal attenuation caused by impedance variations in the structure of a cable or associated connection parts.

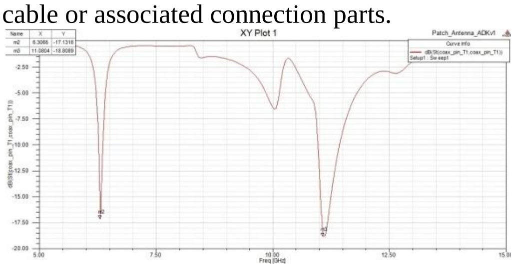

Figure 3: Return Loss

From the figure 3, the return losses of the proposed antenna at 6.3065GHz and 11.0804GHz are -17.1318dB and -18.8089dB.

B. Gain:

It is defined as the ratio of the radiation intensity in the peak intensity direction to the intensity that would be obtained if the power accepted by the antenna were radiated isotropically.

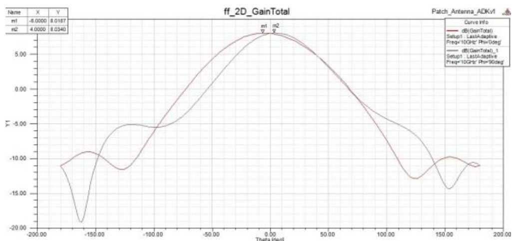

Figure 4: 2D gain total

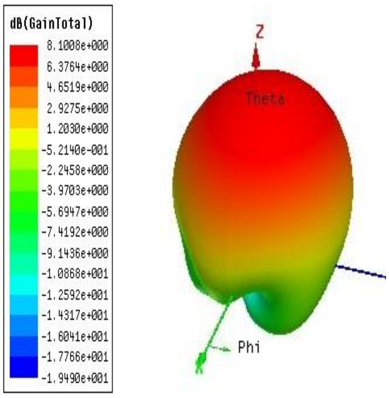

Figure 5: 3D gain total

Figure 4 & 5 shows the gain of the antenna in 2D & 3D patterns. The gain of the proposed antenna is 8.1008 dB.

C. Radiation patterns:

The radiation pattern of an antenna is a plot of the far-field radiation properties of antenna as a function of the spatial co-ordinates which are specified by the elevation angle □ **and** Ø and the azimuth angle. It is a plot of the power radiated from an antenna per unit solid angle which is nothing but the radiation intensity.

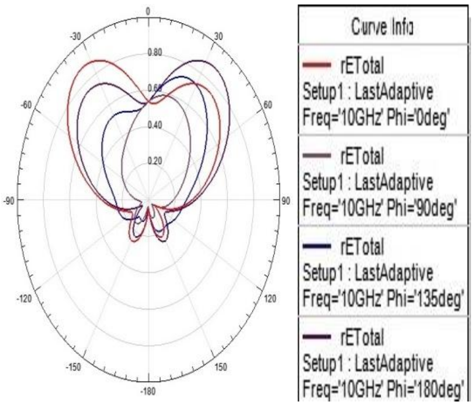

Figure 6: Radiation Pattern total

Figure 6 shows the radiation pattern total (E-total) plotted at 10GHz.

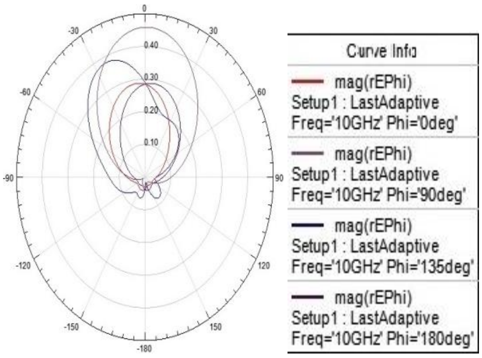

Figure 7:Radiation pattern phi

Figure 7 shows the radiation pattern phi (E - Phi) plotted at 10Ghz.

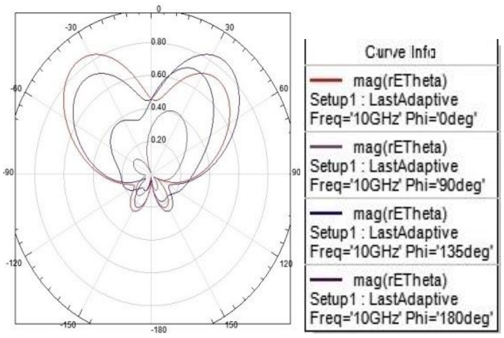

Figure 8: Radiation pattern theta

Figure 8 shows the radiation pattern theta (E-Theta) plotted at 10GHz.

D. E-Feild distribution:

The effect produced by an electric charge that exerts a force on charged objects is the E-field and its distribution in the patch is as shown in figs 9 & 10

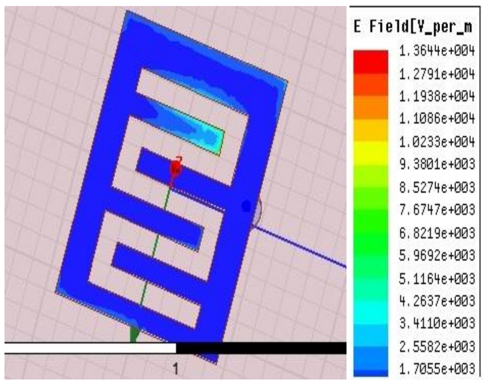

Figure 9 : Electric field at mag_E

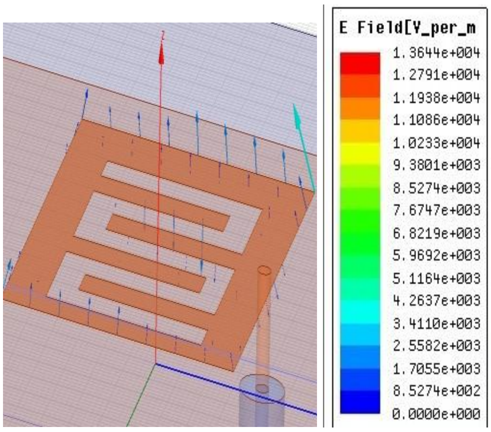

Figure 10: electric field at vector_E

The value obtained from the figures 9 & 10 is 1.3644e+004 at 10GHz frequency.

E. H-Field distribution:

The measured intensity of a magnetic field in the patch is shown in figure 11 & 12

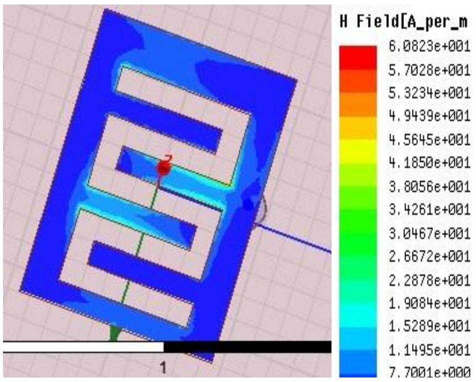

Figure 11: Magnetic field at mag_H

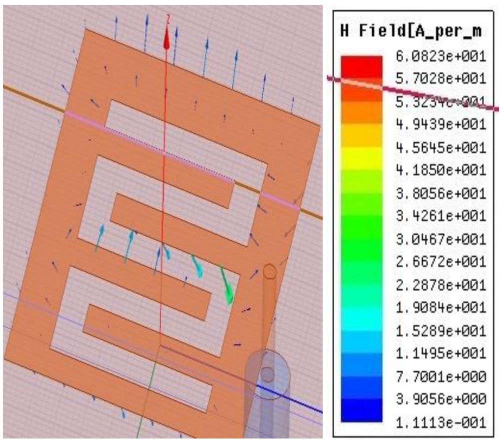

Figure 12: Magnetic field at vector_H

The value obtained from the figures 11 & 12 is 6.0823e+001 at 10GHz.

F. Current distribution:

The distribution which establishes itself when the influence of over potential is negligilble.

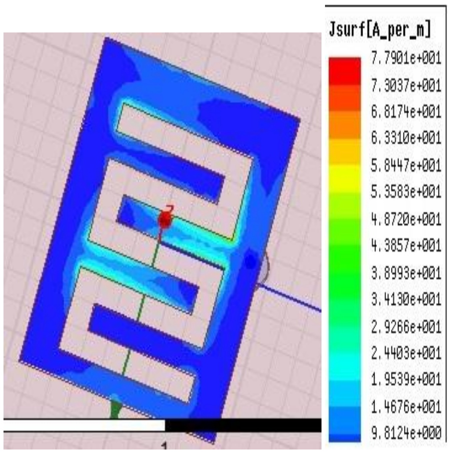

Figure 13: Current distribution at mag_Jsurf

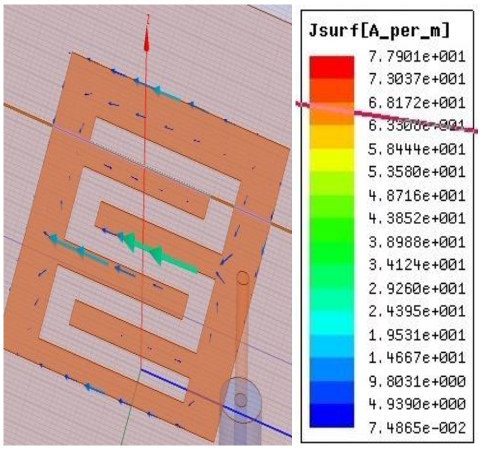

Figure 14: Current distribution at vector_Jsurf

The measured value obtained from the figure 13 & 14 is 7.7901e+001 at 10GHz.

G.Mesh plot:

It can be said by the rectangles which defines the current distribution.current distribution on the patch and from the figure it is clear that current distribution is more on the patch when compared to the substrate.

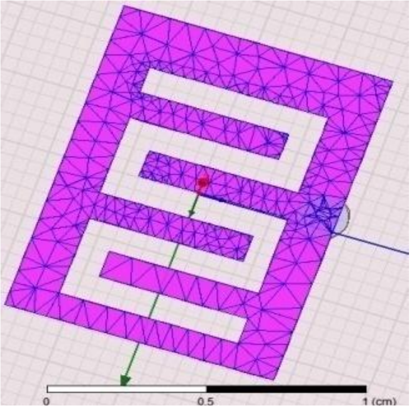

Figure 15: Mesh Plot

H.VSWR:

It is a function of reflection coefficient, which describes the power reflected from the antenna.

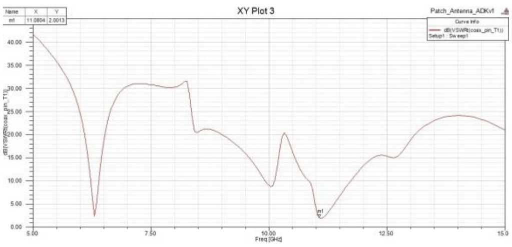

Figure 16: Terminal VSWR

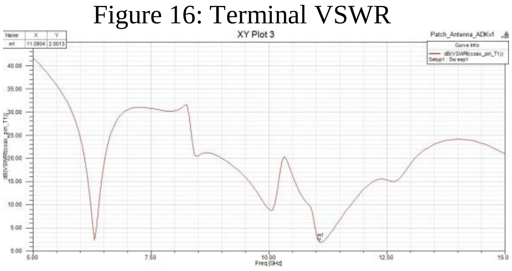

Figure 17: Active VSWR

Figure 16 & 17 shows Terminal and Active VSWR plotted at 10GHz.The VSWR obtains 2.0013 at 11.0804GHz frequency.

IV. Tabular form:

Typical dimensions for the antenna designed for 10GHz.

S.NO	Parameter	Magnitude	Units
1.	Gain	1.0000	dB
2.	Directivity	0.9975	No units
3.	Realized Gain	0.9849	dB
4.	Polarization Ratio	1.0000	dB
5.	Axial Ratio	1.0000	dB

V. Conclusion:

A basic rectangular probe-fed micro-strip patch antenna can be miniature by inserting a number of slots placing one-by-one to the radiating edges with short range tracking, satellite, weather radar systems and Wi-Fi applications. The resultant antennas with slots can be characterized as small antennas. In this design the proposed antenna can operate at 10GHz with return loss <-10dB.Good return loss and radiation pattern characteristics are obtained in the frequency band of interest. The antenna is successfully designed and optimized. The performance properties are analyzed for the optimized dimensions and the proposed antenna works well at C & X-band. Finally, the measurements of rectangular micro-strip probe-fed patch antenna on Rogers RT/duroid 5880(tm) substrate for satellite, military, short range tracking, missile guidance and marine radar applications have been investigated.

VI. ACKNOWLEDGEMENT

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REFERENCES:

[1] A. D. Yaghjian and S. R. Best, "Impedance, Bandwidth, and Q of Antennas," IEEE Transactions on Antennas and Propagation, AP-53 , 4, April 2005, pp. 1 298- 1 324.

[2]. Constantine A. Balanis: “Antenna Theory, Analysis and Design” (John Wiley & Sons).

[3]. N. Herscovici, “New considerations in the design of microstrip antennas.” IEEE Transactions on Antennas and Propagation, AP- 46, 6, June 1998, pp. 807-812.

[4]. S. R. Best, "Low Q Electrically Small Linear and Elliptical Polarized Spherical Dipole Antennas," IEEE Transactions on Antennas and Propagation, AP-53, 3, March 2005, pp. 1 047-1 053.

[5] S. R. Best, "A Discussion on Quality Factor of Impedance Matched Electrically Small Wire Antennas," IEEE Transactions on Antennas and Propagation, AP-53, 1 , January 2005 , pp. 502-508.

[6] S . R. Best and A. D . Yaghjian, "The Lower Bounds on Q for Lossy Electric and Magnetic Dipole Antennas," IEEE Antennas and Wireless Propagation Letters, 3, December 2004, pp. 3 1 4-3 1 6.

[7] L. J. Chu, "Physical Limitations of Omni-directional Antennas," Journal of Applied Physics, 19, December 1 948, pp. 1 1 63- 1 1 75 .

[8] R. E. Collin and R. Rothchild, "Evaluation of Antenna Q," IEEE Transactions on Antennas and Propagation, AP-12, January 1 964, pp. 23-27.
[9] H. A. Wheeler, "Fundamental Limitations of Small Antennas," Proceedings IRE, 35, December 1 947, pp. 1 479- 1 484.
[10] H. A. Wheeler, "The Radiansphere Around a Small Antenna," Proceedings IRE, 47, August 1 959, pp. 1 325- 1 33 1 .
[11] H . A. Wheeler, "Small Antennas," IEEE Transactions on Antennas and Propagation, AP-23 , December 1 975, pp. 462- 469.
[12] S . McLean, "A Re-Examination of the Fundamental Limits on the Radiation Q of Electrically Small Antennas," IEEE Transactions on Antennas and Propagation, AP-44, 5 , May 1 996, pp. 672-676.
[13] R. C. Hansen, "Fundamental Limitations in Antennas," Proceedings IEEE, 69, February 1 98 1 , pp. 1 70- 1 82.
[14] Sanad, M. "Microstrip Antennas on Very Small Ground Planes for Portable Communication Systems". *Proceedings of the IEEE Antennas and Propagation Society Symposium*, June 1994, pp. 810-813.

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