BANDWIDTH ENHANCEMENT FOR MICROSTRIP PATCH ANTENNA USING SLOTTING TECHNIQUE FOR WIRELESS APPLICATIONS

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ABSTRACT

In the most recent days microstrip antennas are mostly used in the wireless communication due to the salient features like low cost, less weight, small size. But these antennas are having some drawbacks like narrow bandwidth, low gain etc. In this paper, a probe feed, slotted rectangular patch antenna has been proposed. Bandwidth enhancement has been improved by suitably cutting slots into the rectangular patch. Proposed antenna is suitable for various wireless applications.Representation, measurement and calculation for this new antenna has been done with the help of software IE3D.

KEYWORDS: *Bandwidth enhancement,gain,microstrip patch antenna,returnloss,VSWR.*

1. INTRODUCTION

In rapidly expanding market for wireless communication and applications, Micro strip antenna has become widely popular as it is low profile, comfortable to the hosting surfaces, light weight and can be easily integrated with the electronic circuits. Microstrip antenna is widely used in military, mobile communication, global positioning system (GPS), remote sensing etc.

Taking benefits of added processing power of today's computers, IE3D simulator is emerging to perform planer and 3Danalysis of high frequency structure. IE3D simulator has long been an essential modeling tool for RF/Microwave design. Proposed antenna is designed and simulated on IE3D simulator software.

Microstrip patch antenna in general consists of a radiating conducting patch printed on a grounded dielectric substrate. The patch is a very thin metal disk. To overcome its limitation of narrow bandwidth by generating more than one resonant frequencies, many techniques have been suggested in the past e.g. different shaped slots[2-4],stack, multilayer[6],two folded parts to the main radiated patch and use of air substrate have been proposed and investigated. In the design presented in this paper slotting of the radiating patch has been used because as compared to the other techniques slotting offers the promise of saving space while giving good performance if done appropriately.

The advantages of microstrip antenna have made them a perfect candidate for use in the wireless local area network (WLAN) applications. Though bound by certain disadvantages microstrip patch antenna can be tailored so they can be used in the new high speed broadband WLAN system. This paper concentrates on manufacture of broadband micro strip patch antennas for 4.5 GHz bandwidth.

It is now both possible and affordable to surf the web from your laptop without any wire connectivity and while enjoying cricket match on your television. A WLAN is a flexible data communication network used as an extension to or an alternative for a wired LAN in a building.

As a result the demand has been increased for broad band WLAN antenna that meets all the desired requirements. The broadband antenna are required to be compact, low profile directive for high transmission efficiency and designed to be discreet, due to these well met requirements couple with the ease of manufacture and repeatability makes the micro strip patch antennas very well suited for broadband wireless applications.

1.1 MICROSTRIP PATCH ANTENNA

Microstrip antennas are attractive due to their light weight, conformability and low cost. These antennas can be integrated with printed strip-line feed networks and active devices. This is a relatively new area of antenna engineering. The radiation properties of micro strip structures have been known since the mid 1950's.

The application of this type of antennas started in early 1970's when conformal antennas were required for missiles. Rectangular and circular micro strip resonant patches have been used extensively in a variety of array configurations. A major contributing factor for recent advances of microstrip antennas is the current revolution in electronic circuit miniaturization brought about by developments in large scale integration. As conventional antennas are often bulky and costly part of an electronic system, micro strip antennas based on photolithographic technology are seen as an engineering breakthrough.[4]

1.2 STRUCTURE

In its most fundamental form, a Microstrip Patch antenna consists of a radiating patch on one side of a dielectric substrate which has a ground plane on the other side as shown in Figure. The patch is generally made of conducting material such as copper or gold and can take any possible shape. The radiating patch and the feed lines are usually photo etched on the dielectric substrate.[1]

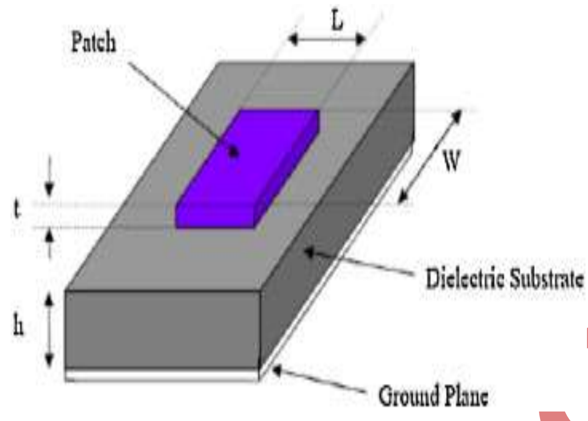

Figure 1. Structure of a Microstrip Patch Antenna

2. DESIGN AND ANALYSIS OF RECTANGULAR MICROSTRIP PATCH ANTENNA

The dimension of patch is approximated by using basic design approach described for microstrip patch antenna as listed below :-

WIDTH OF THE PATCH

$$W = \frac{c}{2f_0\sqrt{\frac{(\varepsilon_r+1)}{2}}}$$

= 20.67 mm

EFFECTIVE DIELECTRIC CONSTANT

$$\varepsilon_{r_{eff}} = \frac{(\varepsilon_r+1)}{2} + \frac{(\varepsilon_r-1)}{2}\left[1+12\frac{h}{W}\right]^{\frac{-1}{2}}$$

=3.752

EFFECTIVE LENGTH

$$L_{eff} = \frac{c}{2f_0\sqrt{\varepsilon_{reff}}}$$

= 17.2 mm

LENGTH EXTENSION

$$\Delta L = 0.412h \frac{\left(\varepsilon_{reff} + 0.3\right)\left(\frac{w}{h} + 0.264\right)}{\left(\varepsilon_{reff} - 0.258\right)\left(\frac{w}{h} + 0.8\right)}$$

=0.73 mm

ACTUAL LENGTH OF THE PATCH

$$L = L_{eff} - 2\Delta L$$

= 15.35 mm

Where,

c = velocity of the light

= 3 x 10^8 m/sec

h = height of the substrate

= 1.6 mm

ϵ_r= dielectric constant of the substrate

= 4.2 (glass epoxy)

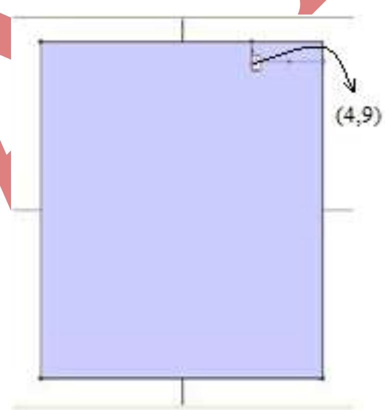

Figure 2.microstrip rectangular patch antenna

2.1 SIMULATION RESULTS

We used IE3D simulation software V.14 for the simulation purpose and got following results-

S parameter display

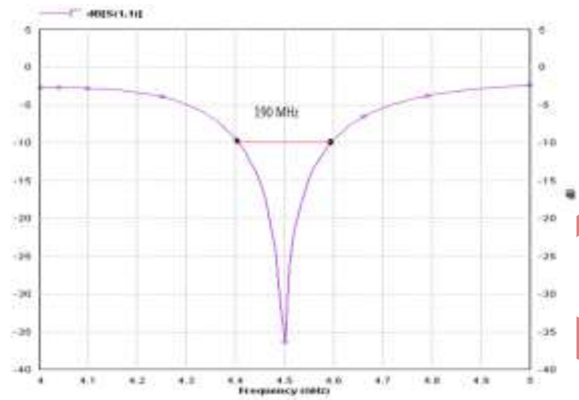

Figure3.S parameter Display of rectangular microstrip patch antenna

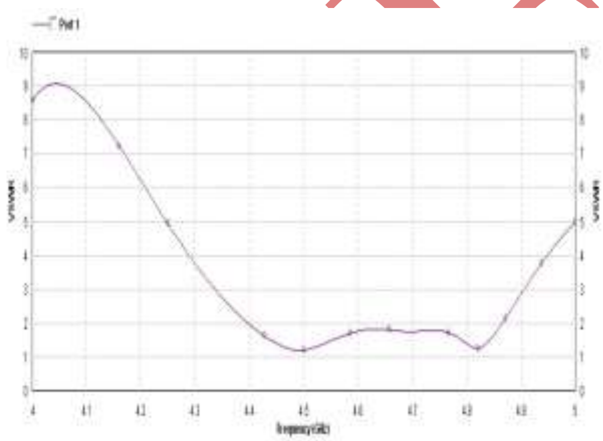

Figure4. VSWR Display of rectangular microstrip patch antenna

Figure 5.Smith chart

2.2 SIMULATION RESULT DISCUSSION

After simulation, the results which we have obtained are given below-

Bandwidth = 190 MHz

% Bandwidth = f_2-f_1/ f_{avg}

= 4.2 %

Return Loss = -37.6 db

Return Loss – return loss of microstrip antenna should be less than -10 db and here we are getting -37.6 db , which is good.

3.PROPOSED SLOT ANTENNA

For designing our slot antenna, we used current density distribution method , which is given in IE3D simulator. According to this method, the slots are cut at that places in the rectangular patch antenna , where maximum current density was obtained.

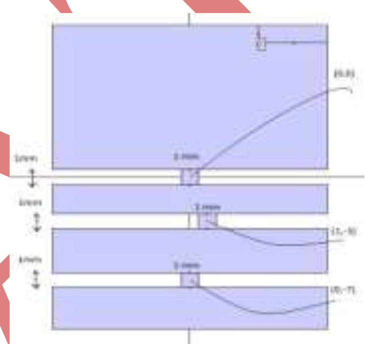

Figure 6. Proposed slot antenna

3.1 SIMULATION RESULTS.

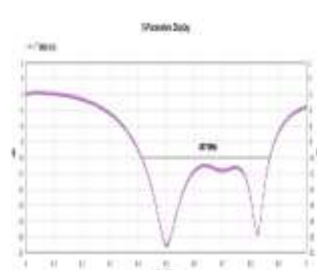

Figure7. S parameter

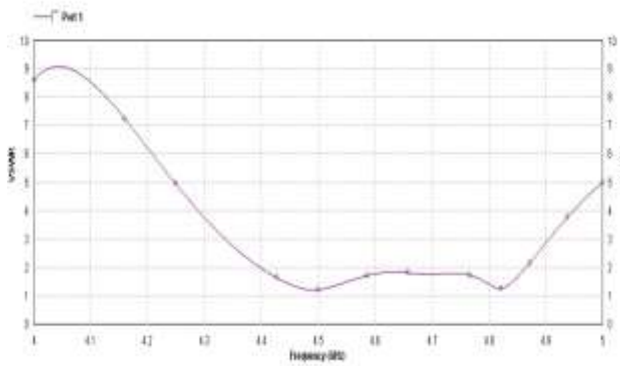

Figure 8.VSWR Display of slot antenna

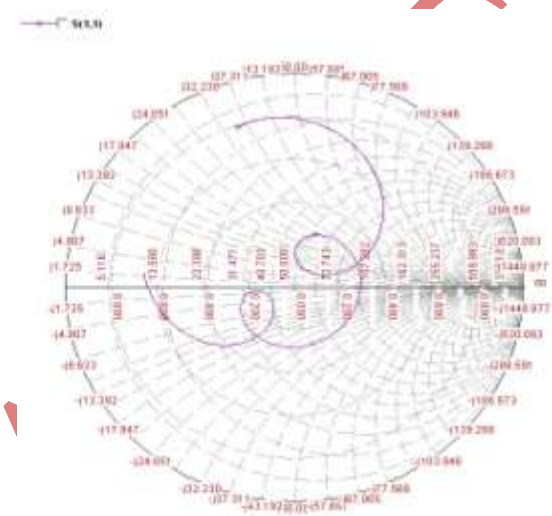

Figure 9. Smith chart

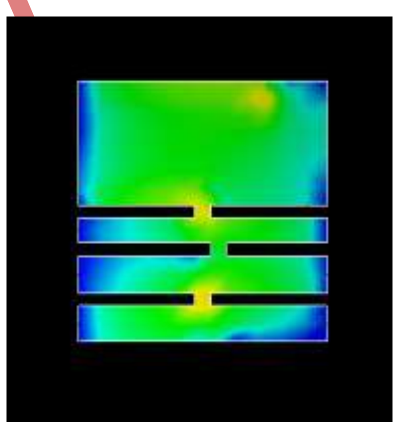

Figure 10. Current density distribution of slot antenna

3.2 SIMULATION RESULT DISCUSSION

After the designing of reference antenna, we used slotting technique for increasing the bandwith of MSA, which is our ultimate goal. After simulation of our slot antenna structure we got these results-

Bandwidth= 457 MHz

% Bandwidth = 9.9 %

Return loss = -21.3 db

Thus , we can see that the % bandwidth that we have obtained is 5 % more as compared to our reference antenna.

4.FABRICATED SLOT ANTENNA

Figure 11.Fabricated slot antenna

4.1 HARDWARE TESTING RESULTS

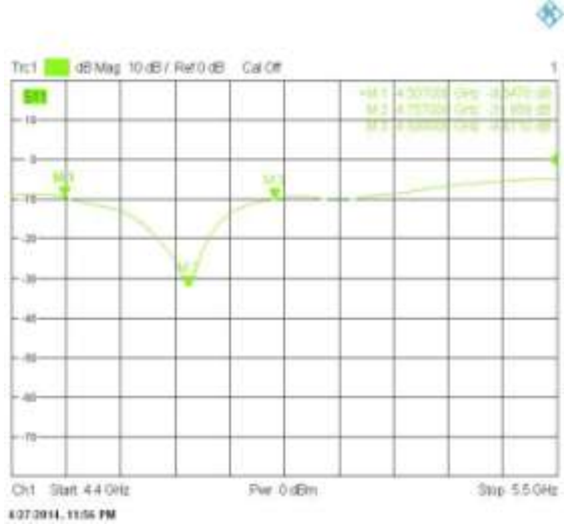

Figure12. S parameter Display of fabricated slot antenna

Figure 13. VSWR Display of fabricated slot antenna

Figure 14. Smith chart of fabricated slot antenna

5. RESULT COMPARISON

PARAMETER	REFERENCE ANTENNA	SIMULATED RESULTS	MEASURED RESULTS (SLOT ANTENNA)
Bandwidth	**190 MHz**	**457 MHz**	**423 MHz**
% Banswidth	**4.2**	**9.9**	**9.2**
Resonating frequency	**4.5 GHz**	**4.5 GHz**	**4.75 GHz**
Return loss	**-37.6 db**	**-21.3 db**	**-31.9 db**

Vector network analyser (VNA, frequency range- 10 MHz to 40 GHZ) was used to measure the various parameters of fabricated antenna. On comparing the measured and simulated results, we see that there is a little difference in both the results. We get some variations from our simulated results, like resonating frequency shifts to 4.75 GHz from 4.5 GHz. This is due to the fact that in slotting technique when we cut slots , some material is lost and we know the return loss of antenna should be less than -10 db , so for maintain this characteristics , a slight shift occurs in resonating frequency.

6. CONCLUSION

With the help of IE3D software simulator (V.14),amicrostrip slot antenna is designed.Slots are incorporated on rectangular patch. The designed antenna successfully matches the desired characterstics(like return loss should be less than -10 db). The simulated and measured results show that antenna exhibit good electrical performance and thus can be considered as a suitable candidate for various wireless applications.

In our research work, we studied different aspects related to microstrip patch antenna and we have made a microstrip slot antenna at 4.5 GHz frequency with bandwidth 430 MHz and % bandwidth up to9.2 %. The banswidth of reference antenna was 190 MHz , thus we can say that we have enhanced the bandwidth by 240 MHz.

7. ACKNOWLEDGEMENT

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8. REFERENCES

[1] User manual guide IE3D V.14

[2] Ray, K. P ,"Broadband Microstrip Antennas", Artech House antennas and propagation library,2003.

[3]C.A. Balanis, "Antenna Theory, Analysis and Design," John Wiley &Sons, New York,1997.

[4] R.Garg, P.Bhartia ,I.Bahl, and A.Ittipiboon ,Microstrip Antenna Design Handbook Antennas, John Wiley, 1997.

[5] C. Vishnu Vardhana Reddy, Rahul Rana, of NIT Rourkela, "Design Of Linearly Polarized Rectangular Microstrip patch Antenna sing IE3d/pso" Thesis, 2009.

[6] Lindsay Young of The University of Auckland, project on "Microstrip Patch Antennas for Broadband Indoor Wireless Systems", 2003.

[7] International Journal of Engineering and Innovative Technology (IJEIT) Volume 2, Issue 7, January 2013.

[8] International Journal of Electronics and Computer Science Engineering Available Online at www.ijecse.org ISSN: 2277 1956.

[9] ARPN Journal of Engineering and Applied Sciences,VOL. 7, NO. 3, MARCH 2012, ISSN 1819-6608

[10] International Journal of Advancements in Research & Technology, Volume 2, Issue5, May-2013 ISSN 2278-7763

[11] KIN-LU WONG, "Compact and Broadband Microstrip Antennas" A WILEY INTERSCIENCE PUBLICATION JOHN WILEY & SONS, INC. 2002

[12] Global Journal of Research Engineering Volume 11 Issue 2 Version 1.0 March 2011 ISSN 0975-58

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