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Design and Analysis of Double layer Microstrip patch antenna

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***Abstract*— This paper presents a design of double layer microstrip patch antenna and experimentally studied on IE3D, an electromagnetic simulation package by Zeland Software Inc.. Double layers microstip patch antenna is designed on a FR4 substrate of thickness 1.524 mm and relative permittivity of 4.4 and mounted above the ground plane at a height of 1.6 mm. Bandwidth as high as 8.1 % are achieved with stable pattern characteristics, such as gain and cross polarization, within its bandwidth. Impedance bandwidth, antenna gain and return loss are observed for the proposed antenna. Details of the measured and simulated results are presented and discussed.**

***Index Terms*— Microstrip antenna, Radiation pattern, Returns loss.**

I. Introduction

In high performance aircraft, spacecraft, satellite, and missile applications where size, weight, cost, performance, ease of installation, low profile, easy integration to circuits, high efficiency antennas may be required. Presently there are many other government and commercial applications, such as mobile radio and wireless communication [1]. To meet these requirements microstrip antenna can be used. These antennas are low profile, conformal to planar and non-planar surface, simple and inexpensive to manufacture using modern printed circuit technology, mechanically robust when mounted on rigid surface; compatible with MMIC designs and when the particular shape and mode are selected they are very versatile in terms of resonant frequency, polarization, field pattern and impedance. Microstrip antenna consist of a very thin metallic strip (patch) placed a small fraction of a wavelength above a ground plane. The patch and ground plane are separated by dielectric material. Patch and ground both are fabricated by using conducting material [2].

However the major disadvantage of the microstrip patch antenna is its inherently narrow impedance bandwidth. Much intensive research has been done in recent years to develop bandwidth enhancement techniques [9]. These techniques includes the utilization of thick substrates with low dialectic constant .The use of electronically thick substrate only result in limited success because a large inductance is introduce by the increased length of the probe feed, resulting few percentage of bandwidth at resonant frequency.

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The purpose of this work is to design a microstrip patch antenna using commercial simulation software like IE3D [10]. The IE3D by Zeland Software Inc. has been recently considered as the benchmark for electromagnetic simulation packages. It is a full wave, method of moment (MOM) simulator solving the distribution on 3D and multilayered structures of general shape. The primary formulation of the IE3D is an integral equation obtained through the use of Green's functions. In the IE3D, it is possible to model both the electric current on a metallic structure and a magnetic current representing the field distribution on a metallic aperture.

In this paper, a double layer with air gap microstrip patch antenna is designed. The patch mounted on FR4 substrate (thickness=1.524mm) and above from ground plane at a height of 1.6mm. It is found that proposed design can also cause significant lowering of antennas fundamental resonant frequency due to increased length of the probe feed.

II. ANTENNA DESIGN

Designing an antenna in the Wi-max band meant that the antenna dimension could be bulky which is un-welcomed. Owing to it objective is to design a reduced size wide band microstrip antenna; the design idea was taken from broadband antennas to make the antenna work in a large band of frequencies of the many broadband antennas, square patch antenna was chosen [4]. Hence the chosen shape is double layers with air gap microstrip patch antenna, with an aim to achieve smaller size antenna [5]. The geometry of designed microstrip antenna is presented in fig.1 with front (top) view.

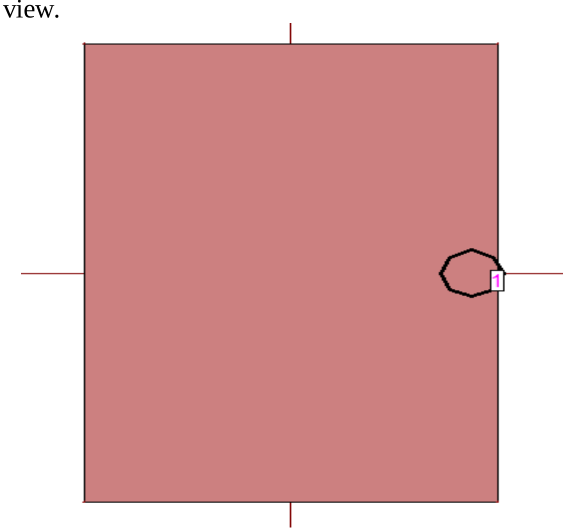

Fig.1 Geometry of proposed double layer with air gap microstrip patch antenna length= 7.09 mm and width 9.95 mm

This square microstrip patch antenna with Y-slotted circular hole is fabricated on a FR4 substrate of thickness 1.524 mm and relative permittivity of 4.4. It is mounted above the ground plane at height of 1.6 mm [6]. In this work, co-axial or probe feed technique is used as its main advantage is that, the feed can be placed at any place in the patch to match with its input impedance (usually 50 ohm). The software used to model and simulate the antenna was IE3D, it can be used to calculate and plot return loss, VSWR, radiation pattern, smith chart and various other parameters.

III. RESULTS AND DISCUSSION

The proposed antenna has been simulated using IE3D by Zeland software Inc. [10]. Fig.2 shows the variation of return loss with frequency. Plot result shows resonant frequency 9.14 GHz. And total available impedance band width is 8% from the proposed antenna. Minimum -34.67 db return loss is available at resonant frequency which is significant. Fig.3 shows the input impedance loci using smith chart. Figure 4 shows that the 2 dimensional radiation pattern of antenna. Figure 5 shows the VSWR plot. Figure 6 shows the relationship between Gain and Frequency. Figure 7 shows the three dimensional plot of designed double layer microstrip patch antenna.

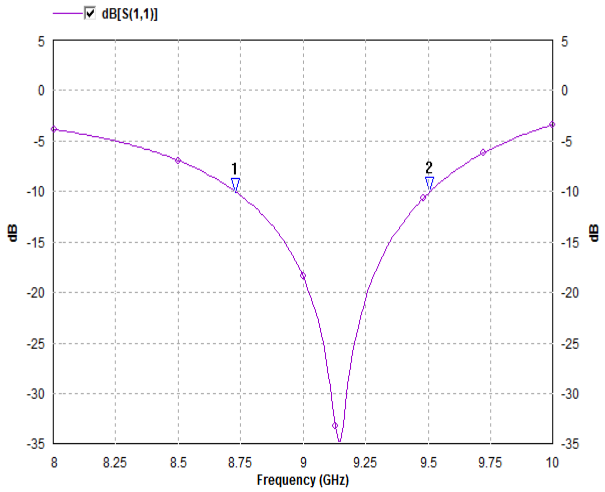

Figure 2 Return loss of double layer microstrip patch antenna is -34.67 db at 9.14 GHz frequency

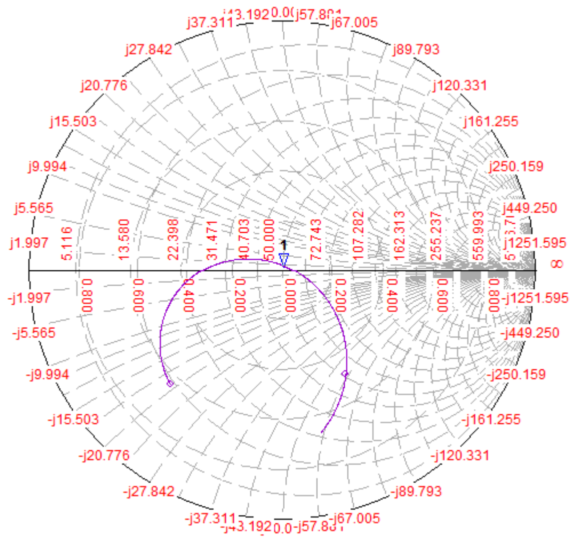

Figure 3 Smith chart of double layer microstrip patch antenna at 50 ohm

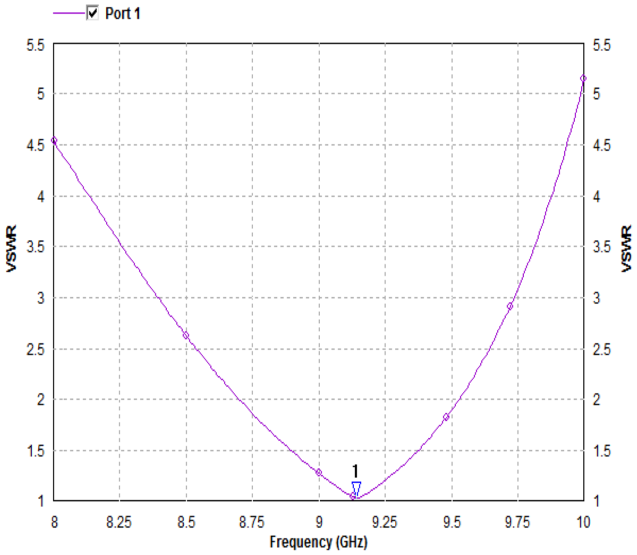

Figure 5 VSWR of double layer microstrip patch antenna at 9.14 GHz frequency is 1.03.

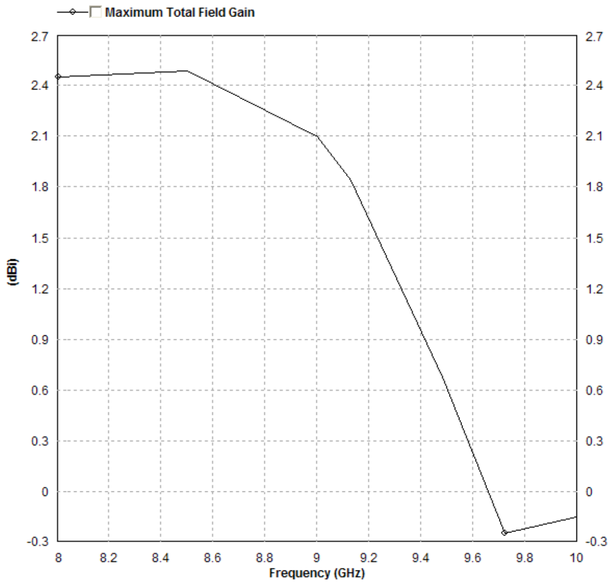

Figure 6 shows the relation between gain and frequency.

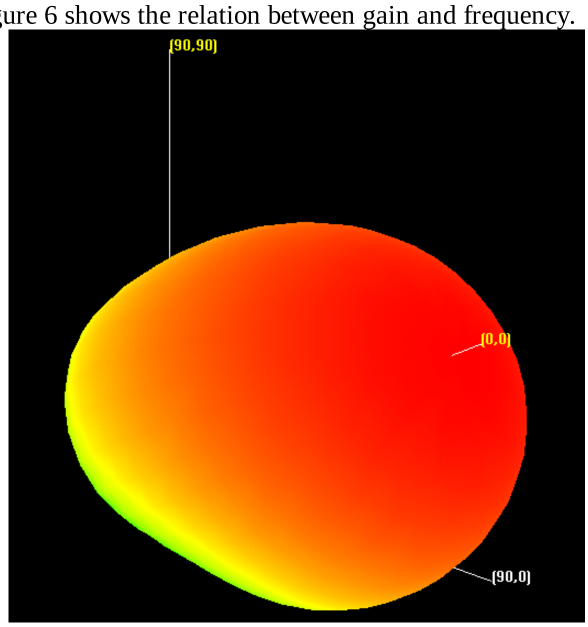

Figure 7 shows that the three dimensional plot of Double layer microstrip patch antenna

IV. Conclusion

The design has demonstrated that a single probe feed double layer with air gap microstrip patch antenna can be used to form an antenna with impedance bandwidth of 8% working in Wi-max wireless communication system with resonant frequency 9.14 GHz. These modern communication systems require antennas with broadband and/or multi-frequency operation modes. These goals have been accomplished employing slotted patch for the radiating element, with the aim to preserve compactness requirements and to maintain the overall layout as simply as possible and keeping the realization cost very low. In future by cutting slots on square microstrip antenna reduced patch size and improved bandwidth can be achieved.

References

[1] James, J.R. and Hall, P.S.: 'Handbook of Microstrip Antennas' (Peter Peregrinus)

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

[3] Lu JH, Tang CL, Wong KL, 'Novel dual-frequency and broadband designs of the slot-loaded equilateral Triangular Microstrip Antenna' IEEE Trans. Antennas Propag. 2000;48;1048-54.

[4] Row JS. 'Dual-frequency triangular planar inverted-f Antenna' IEEE Tran Antennas Propag 2005;53;874-6.

[5] Kai-Fong Lee, Kwai- Man Luk, Jashwant S. Dahele, 'Characteristics of the Equilateral Triangular Patch Antenna ' IEEE Tran. Antennas Propag.1988;36;1510.

[6] C. L. Mak, K. M. Luk, K. F. Lee, ' Wideband Triangular Patch Antenna' IEEE. Proc. Microwave Antennas Propag. 1999.

[7] Shan-Cheng Pan and Kin- Lu Wong, ' Dual Frequency Triangular Microstrip Antenna with Shorting Pin' IEEE Tran. Antennas Propag.1997;45;1889

[8] D.M. Pozar and D. H. Shaubert, 'Microstrip Antennas : The Analysis and Design of Microstrip Antenna and Array' IEEE Press,Inc., 1980.

[9] I. J. Bahl and P. Bhartia, 'Microstrip Antennas, Artech House, Dedham, MA, 1980.

[10] IE3D User's Manual, Release 9, Zeland Software, Inc.