Slotted Design of Microstrip Antenna for WLAN/WiMax Applications

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Abstract: ***A wide band microstrip antenna for various wireless applications such as WLAN/WiMax having satisfactory radiation characteristics is presented. The proposed antenna has wide bandwidth of 63.81% covering the range of frequency 1.435-2.780GHz. The return loss bandwidth and radiation performance of the antenna are examined by IE3D simulation software.***

Keywords: ***Broadband, Radiation pattern, Radiation efficiency,***

I. INTRODUCTION

Printed micro strip antennas are attractive for compact wireless communication systems due to low profile, light weight and low cost. It has been only very recent in human history that the electromagnetic spectrum, outside the visible region, has been employed for communication, through the use of radio. One of humankind's greatest natural resources is the electromagnetic spectrum and the antenna has been instrumental in harnessing this resource [1-5]. The IEEE 802.11b and IEEE 802.11g standards utilizes the 2.4 GHz ISM Band. The frequency band is license free hence the WLAN equipment will suffer interference from microwave ovens, cordless phones, blue tooth devices and other applications that use this same band. Generally a Conventional microstrip antenna has a radiating patch of any planar geometry (e.g. square, rectangular, Circular, Ellipse and ring). Microstrip patch antennas are increasing in popularity for use in wireless applications [6-8]. Therefore they are extremely compatible for embedded antennas in wireless devices such as cellular phones, pagers etc. The telemetry and communication antennas on missiles need to be thin substrate. Now days Compact microstrip antennas are getting much more attention due to the increase in demands of small size antennas used in personal and commercial purposes communicational accessories. In order to design a compact microstrip antenna at a fixed operating frequency higher dielectric constant of substrate must be used [9-14].

In this paper a novel compact slotted broadband microstrip patch antenna has been designed for GPS/WLAN/WiMax communication systems. The return loss bandwidth is measured 63.81% covering a range of 1.435 to 2.780 GHz frequency band. . The maximum radiation efficiency of 97% at 1.24 GHz and maximum antenna efficiency 95% at 1.48 GHz is reported [15-20].

II. DESIGN AND LAY OUT

The length and width of rectangular patch antenna are calculated from below equations .Where c is the velocity of light, ε_r is the dielectric constant of substrate [1].

(1) Width (W) Calculation:

The width of the microstrip patch antenna can be calculated by the given equation as follows;

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

(2) Calculation of effective dielectric constant (ε_{reff}):

The following equation gives the effective dielectric constant is given by

$$\varepsilon_{reff} = \frac{(\varepsilon_r + 1)}{2} + \frac{(\varepsilon_r - 1)}{2}\left[1 + 10\frac{h}{W}\right]^{-\frac{1}{2}}$$

(3) Calculation of length extension (Δl):

The following equation gives the length extension in terms of (W/h) ratio and effective dielectric constant.

$$\frac{\Delta l}{h} = 0.412\frac{\left(\varepsilon_{reff} + 0.300\right)\left(\frac{W}{h} + 0.262\right)}{\left(\varepsilon_{reff} - 0.258\right)\left(\frac{W}{h} + 0.813\right)}$$

(4) Calculation of actual length of patch (L):

The following equation gives the length of patch as,

$$L_e = L + 2\Delta l$$

(5) Calculation of the length and width of ground plane:

Ideally the ground plane is assumed of infinite size in length and width but it is practically impossible to make a such infinite size ground plane, so to calculate the length and width of a ground plane following equations are given as,

$$L_g = L + 6h$$

$$W_g = W + 6h$$

6: Determination of feed point location (x_f,y_f):

The center of the patch is taken as the origin and feed point location is given by the coordinates (x_f ,y_f) from the origin. The feed point must be located at that point on the patch, where the input impedance is 50 ohms for the resonant frequency. Hence a trial and error method is used to locate the feed point. The resonant frequency is taken at the return loss which is the most negative point of S_{11} parameter

Table I. Proposed antenna design parameters

Parameters	Values
Design frequency	2.9GHz
Height of substrate	1.6 mm
Ground length(L_g)	40 mm
Ground width (W_g)	60 mm
L	14 mm
W	32 mm
L_1	10.8 mm
W_1	4 mm
L_2	2 mm
W_2	2 mm

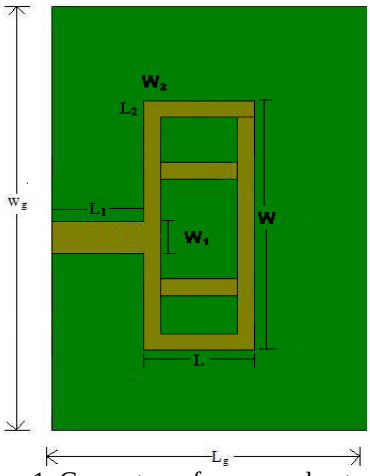

Figure 1. Geometry of proposed antenna

Figure 1. Photograph of proposed antenna

III. RESULTS AND DISCUSSION

Various results from the analysis of the patch are shown in figures. Fig 2 shows the graph of return loss Vs frequency. The total bandwidth is calculated 63.81% at operating range 1.435 to 2.780 GHz. Fig 3 shows the antenna and radiation efficiency. The maximum radiation efficiency is occurred 97% at 1.24 GHz and maximum antenna efficiency is obtained 95% at 1.48 GHz. Fig 4 shows the Smith chart Vs frequency plot which is used to determine the input impedance. Fig 5 shows the 3D radiation pattern. Fig 6 shows the 3D view of proposed antenna.

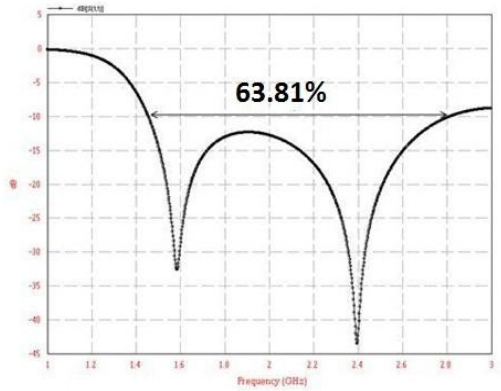

Fig. 2 Return loss Vs Frequency of proposed antenna

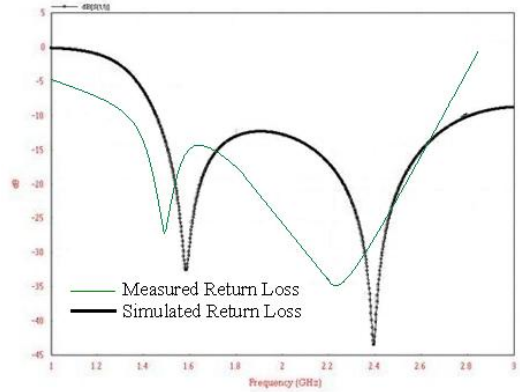

Fig. 2 Measured & Simulated Return loss Vs Frequency of proposed antenna

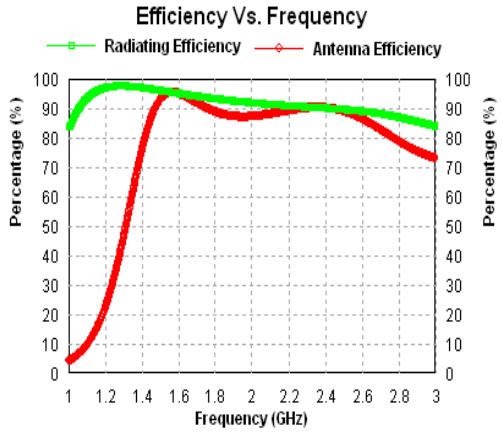

Fig. 3 Radiation and antenna efficiency Vs Frequency

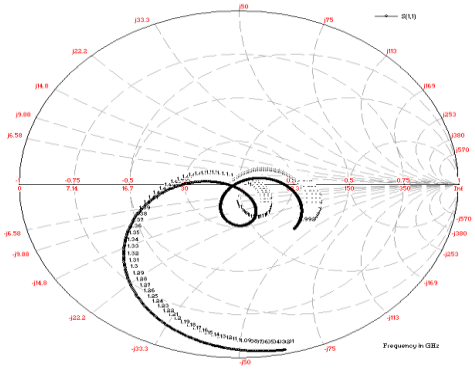

Fig. 4 Smith chart of proposed antenna

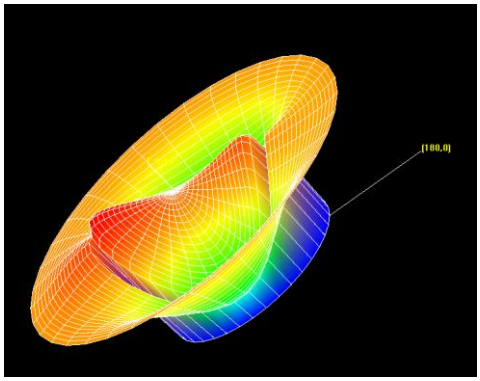

Fig. 5 3D Radiation pattern of proposed antenna

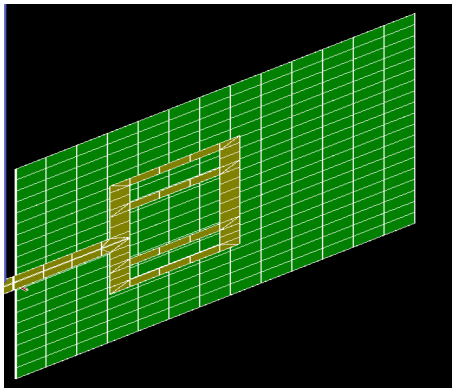

Fig.6 3D view of proposed antenna

IV. CONCLUSION

A Novel compact slotted broadband microstrip patch antenna has been designed for GPS/WLAN/WiMax communication systems. The return loss bandwidth is measured 63.81% covering a range of 1.435 to 2.780 GHz frequency band. The proposed geometry is designed using glass epoxy as a dielectric substrate between the ground plane and patch. A broadband double slit loaded microstrip antenna suitable for wireless communications has been developed and studied. The proposed antenna is compact, occupies small space and has easy structure compared to other antenna designs. The antenna offers excellent radiation efficiency exhibiting good radiation patterns and gain. The proposed antenna can be used in wireless communication systems where fabricated antennas covering both WLAN and WiMAX bands are required.

REFERENCES

[1] K. L. Wong, Design of Non planar Microstrip Antennas and Transmission Lines, Wiley, New York, 1999

[2] Compact and Broadband Microstrip Antennas. Kin-Lu Wong Copyright © 2002 John Wiley & Sons, Inc. ISBN: 0-471-41717-3 (Hardback); 0-471-22111-2 (Electronic).

[3] Shivnarayan and Babau R. Vishvakarma, "Microstrip Patch Antenna with Inclined Slot for Dual-Band Operation", Electronic letters, Vol. 33, No. 22, February 2006, PP.1833-1834.

[4] Zakir Ali, Vinod Kumar Singh, Ashutosh Kumar, Ayub Shahanaz, "E shaped Microstrip Antenna on Rogers Substrate for WLAN applications" Proc. IEEE, pp.342- 345, Oct. 2011.

[5] C.Y. Chiu, C.H. Chan and K.M. Luke, "Study of slotted microstrip patch antennas with folded patch feed", Microwave Antennas propagation, vol. 152, No. 5, October 2005.

[6] Amit Kumar Rawat, Vinod Kumar Singh, Shahanaz Ayub "Compact Wide band Microstrip Antenna for GPS/WLAN/WiMax Applications**"** International Journal of Emerging Trends in Engineering and Development(ISSN:2249-6149),Issue2 Vol.7,pp140 -145,November 2012.

[7] Z. L. Dafalla, W. T. Y. Kuan, A. M. Abdel Rahman, and S. C. Shudakar, "Design of a Rectangular Microstrip Patch Antenna at 1 GHz", RF and Microwave Conference, October 5 - 6-2004, Subang, Selangor, Malaysia.

[8] A. K. Singh, R.A. Kabeer, V. K. Singh, Z. Ali **"**Performance Analysis of First Iteration Koch Curve Fractal Log Periodic Antenna of Varying Angles "Central European Journal of

Engineering,(ISSN: 1896-1541), Springer. Volume 3, Issue1, pp-51-57, March 2013.

[9] Amit A. Deshmukh and K. P. Ray, "Compact Broadband Slotted Rectangular Microstrip Antenna", IEEE antennas and wireless propagation letters, vol. 8, No. 3, March 2009, PP.377-382.

[10] Kuldeep Kumar Parashar, V.K.Singh, R. S. Pathak, "Compact Inset Fed Microstrip Patch Antenna for Dual Band Application" International Journal of Engineering and Technical Research (ISSN: 2321-0869) pp 47-49 April-2014.

[11] Vinod Kumar Singh, Zakir Ali, Shahanaz Ayub, "Bandwidth Optimization of Compact Microstrip Antenna for PCS/DCS/Bluetooth Application" Central European Journal of Engineering (ISSN: 1896-1541), Springer, Volume 4, Issue 3, pp-281-286, September 2014

[12] Nikhil Kumar Singh, Vinod Kumar Singh, Ashish Kumar Singhal, "Modelling and Analysis of Grid Connected PV System" International Journal of Engineering and Technical Research (ISSN: 2321-0869) pp 53-56 April-2014.

[13] A. M. Hadian, H.R. Hassani, "Wideband Rectangular Microstrip Patch Antenna with U-Slot", IEEE, Electronics letters, vol. 33, No. 25, April. 2009.

[14] Vinod Kumar Singh, Zakir Ali, Shahanaz Ayub, Ashutosh Kumar Singh, "A wide band Compact Microstrip Antenna for GPS/DCS/PCS/WLAN Applications", a book chapter in the book entitled "Intelligent Computing, Networking, and Informatics", (Book ISBN: 978-81-322-1664-3) Chapter 113, pp: 183–204 in Springer

[15] Saurabh Jain, Vinod Kumar Singh, Shahanaz Ayub, "Bandwidth and Gain Optimization of a Wide Band Gap Coupled Patch Antenna",IJESRT, ISSN: 2277-9655, March 2013.

[16] Vinod Kumar Singh, Zakir Ali, A. K. Singh, Shahanaz Ayub "Dual band triangular slotted stacked microstrip antenna for wireless applications" Central European Journal of Engineering (CEJE), Springer ISSN: 1896 1541Volume 3, Issue 2, pp 221-225 June, 2013.

[17] Stuti Srivastava, Vinod Kumar Singh,Zakir Ali, Ashutosh Kumar Singh,"Duo Triangle Shaped Microstrip Patch Antenna Analysis for WiMAX lower band Application" Procedia Technology Elsevier 10 pp-554 – 563, 2013

[18] Sarvesh Kumar Bhartiya, Vinod Kumar Singh, Rajeev Shankar Pathak, "Design of broadband circular patch microstrip antenna with plus slot for WLAN and WiMAX Application" International Journal of Applied Physics Letter, ISSN (Online) : 2349-1108, Vol 1, Issue 1,pp-57-60, 2014.

[19] Janabeg Loni, Vinod Kumar Singh, Shahanaz Ayub, "Bandwidth Improvement of Microstrip Patch Antenna for WLAN Application" International Journal of Engineering and Technical Research (ISSN: 2321-0869) pp 44-46 April-2014.

[20] Saurabh Jain, Vinod Kumar Singh, Shahanaz Ayub, "Design of Slotted Microstrip Antenna having high efficiency and gain" International Journal of Engineering and Technical Research (ISSN: 2321-0869) pp 50-52 April-2014.

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