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Multi Band Microstrip Patch Antenna for WiMax and Bluetooth Applications

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***Abstract* — Microstrip patch antennas have been widely used in a various useful applications, due to their low weight and low profile conformability, easy and cheap realization. In this paper, an attempt has been made to investigate new microstrip antenna structure for Wimax and bluetooth Applications. CST MWS and MATLAB Softwares are used for the simulation and design calculations of the microstrip antennas. The bandwidth, gain, radiation pattern are evaluated[1]. Using CST MWS simulation software proposed antenna is designed/simulated and optimized. The antenna exhibits multiband at 2.402 GHz, 3.635 GHz, 4.333 GHz and4.737 GHz. The multi band nature of the antenna is due to I shaped slot cut in the ground and the various current paths excited in the structure.**

***Keywords* — Microstrip Antenna, Bluetooth, CST Microwave Studio, MATLAB, Multiband Antenna, Defected ground.**

I. Introduction

The microstrip antennas have a number of useful properties such as small size, low-cost fabrication, low profile, light weight, conformability, ease of installation and integration with feed networks but one of the serious limitations of these antennas have been their narrow bandwidth characteristics as it limits the frequency ranges over which the antenna can perform satisfactorily. These features are major design considerations for practical applications of microstrip antennas. Recent technologies enable wireless communication devices to become physically smaller in size.

Microstrip patch antennas have found extensive application in wireless communication system due to their advantages such as low profile, conformability, low-cost fabrication and ease of integration with feed networks.. However, the bandwidth and the size of an antenna are generally mutually conflicting properties, i.e.improvement of one of the characteristics normally results in degradation of the other.[2]

This paper presents development of microstrip antenna at different frequency ranges. An antenna is a device used to transform an RF signal, traveling on a conductor, into an electromagnetic wave in free space. Antennas demonstrate a property known as reciprocity, it means that an antenna will maintain the same characteristics regardless if it is transmitting or receiving. Most of the antennas are resonant devices, which operate efficiently over a relatively narrow frequency band. An antenna must be tuned to the same frequency band of the radio system to which it is connected; otherwise the reception and the transmission will be mismatched. When a signal is fed into an antenna, the antenna will emit radiation distributed in space in a certain way. A graphical representation of the relative distribution of the radiated power in space is called a radiation pattern. In this paper, a multiband microstrip patch antenna for Bluetooth and WiMax is designed and simulated using CST Microwave Studio. The proposed patch antenna resonates at 2.402 GHz, 3.635 GHz, 4.333 GHz and 4.737 GHz frequencies.

In this paper, a rectangular micro-strip patch antenna with Defected Ground Structure (DGS) has been analyzed and simulated for the bluetooth applications. The proposed antenna has been simulated at 2.4 GHz frequency. This compact antenna is fed by inset feeding. This type of feeding is mostly used for impedance matching purposes. The antenna is simulated by the software CST. The resultant antenna with Defected Ground Structure has improved in parameters performance.

II. Geometry Of Multi Band Microstrip Patch Antenna

In this antenna, the substrate has a thickness h=1.5 mm and a relative permittivity ε_r = 4.9. The length and width of patch are L= 26.8 mm and W=42.3888mm respectively. The length and width of ground are L=36.9494 mm and W=45.3888 mm respectively. Edges along the width are called radiating edges and that along the length are called non radiating edges.

It can be fed by different methods like microstrip line feed,inset feeding,coaxial probe feed, aperture coupling, electromagnetic coupling and coplanar waveguide (CPW)[16]. In this work, microstrip inset feeding (50 ohm) has been used. Antenna is designed for a resonating frequency of 2.4GHz and cutting a slot in I-shape in the middle of the ground to form the defected ground and by making use of optimization techniques it further resonates at 3.63GHz,4.33GHz and 4.737 GHz. It is analyzed using CST Microwave Studio software.

The dimensions of slot to be cut from ground are L=24mm and W=9.802mm.The inner dimensions of right sided slot is L=12mm and W=5mm and inner dimensions of left handed slot is L=12mm and W=5mm. For the designing of rectangular microstrip antenna, the following relationships are used to calculate the dimensions of rectangular microstrip patch antenna.

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

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

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

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

$$f_r = \frac{1}{2L\sqrt{\varepsilon_r \varepsilon_O \mu_O}} = \frac{V_O}{2L\sqrt{\varepsilon_r}}$$

$$W = \frac{1}{2 f_r \sqrt{\mu_O \varepsilon_O}} \sqrt{\frac{2}{\varepsilon_r + 1}}$$

$$W_g = 6h + W$$

$$L_g = 6h + L$$

where,
h = substrate thickness
L = length of patch
L_{eff} = effective length
W = width of patch
c = speed of light
f_r = resonant frequency
ε_r = relative permittivity
ε_{reff} = effective permittivity
L_g = Length of ground plane
W_g = Width of ground plane

III. Design Parameters

Figure 1. show the front view geometry and the structure designed on CST Microwave Studio software of proposed microstrip line fed patch antenna with multiband operation for Wireless and bluetooth application. The dimensions and feed point location for proposed antenna have been optimized so as to get the best possible impedance match to the antenna. The following parameters are used for design of proposed antenna.

Design frequency = 2.4 GHz
Substrate permittivity = 4.9
Thickness of substrate = 1.5 mm
Length of patch (L) = 26.8 mm
Width of patch (W) = 42.3888 mm
Length of Ground (L_g) = 36.9494 mm
Width of Ground (W_g) = 45.3888 mm

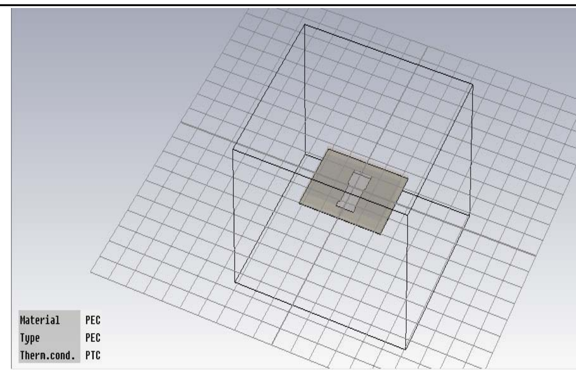

Fig.1(a) Designed Structure on CST Microwave studio

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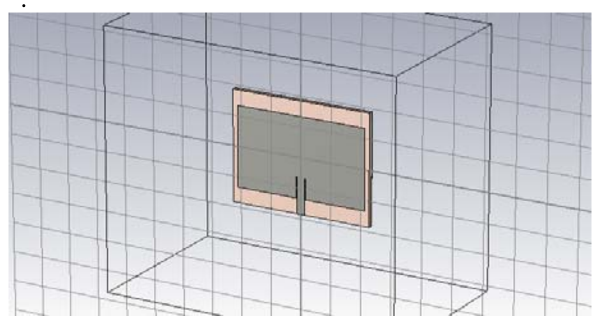

Fig.1(b) Designed Structure on CST Microwave studio

IV. Simulated Results

The parameters for the designed antenna were calculated and the simulated return loss results are shown in Figure 2. The bandwidth at the 2.4 GHz band is around 84.28 MHz with the corresponding value of return loss as -38 dB and bandwidth at the resonating frequency 3.6GHz is 81.0 MHz with the corresponding value of return loss as -22 dB. The bandwidth at the 4.3 GHz band is around 47.28 MHz with the corresponding value of return loss as -17 dB.

The bandwidths so achieved are shown in Figure 3(a),figure 3(b),figure(c) and figure 3(d). The antenna covers the bluetooth band (2.4 GHz band) and WiMax (3.6 GHz).The return loss value i.e. -38 dB suggests that there is good matching at the frequency point below the -10 dB region. The achieved antenna impedance is 50.37 ohm as shown in Figure 4(a), which is very close to the required impedance of 50 ohm. The VSWR ratio is shown in Figure 4(b), which should lie in between 1 and 2. Figure 5(a),5(b),5(c) and 5(d) shows the simulated 3-D radiation pattern at frequency of 2.4 GHz,3.6GHz,4.3GHz and 4.7GHz. It shows that proposed antenna radiates in omni-directional nature.

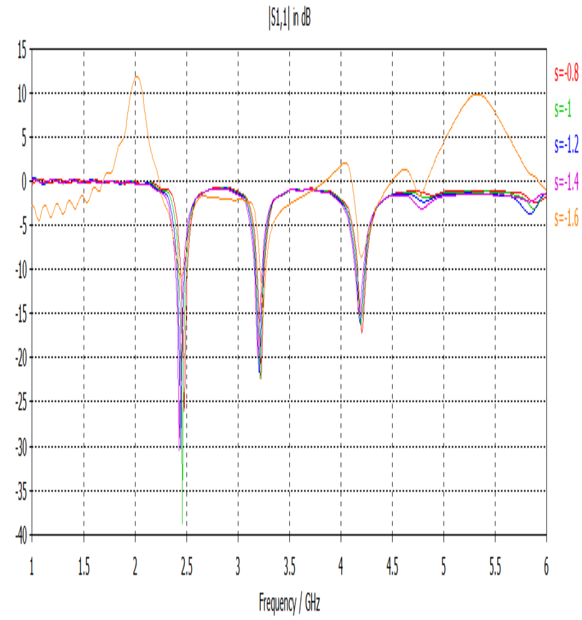

Fig.2. Simulated Return loss curve

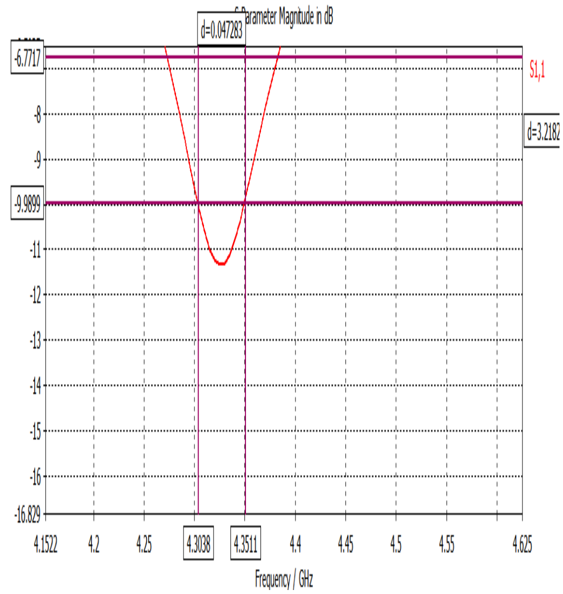

Fig.3.c Bandwidth plot for 4.3GHz.

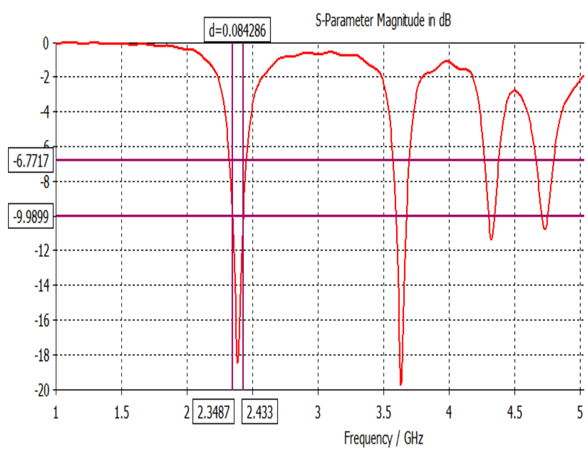

Fig.3.a. Bandwidth plot for Bluetooth Band

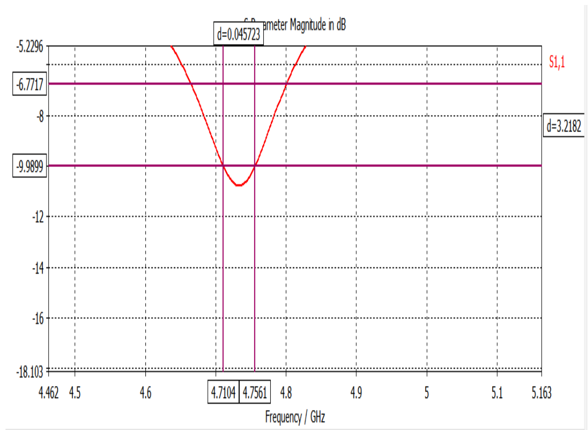

Fig.3.d Bandwidth plot for 4.7GHz

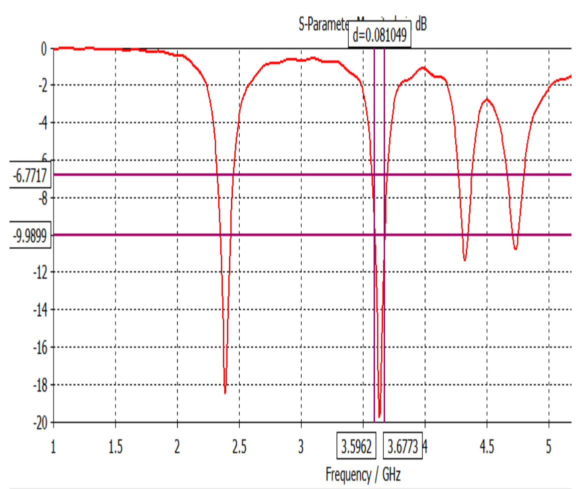

Fig.3.b. Bandwidth plot for WiMax

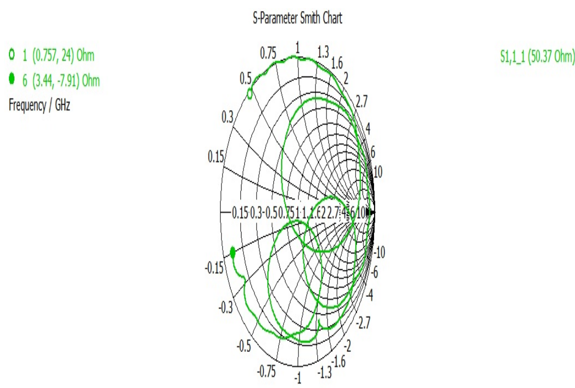

Fig.4(a) Curves showing Antenna characterictic Impedance.

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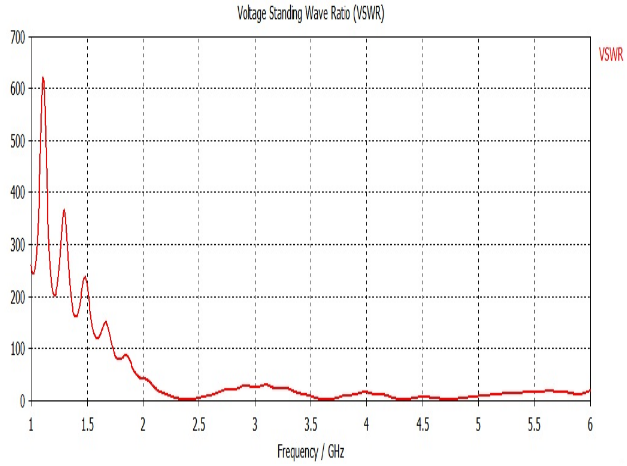

Fig.4(b): VSWR Curve

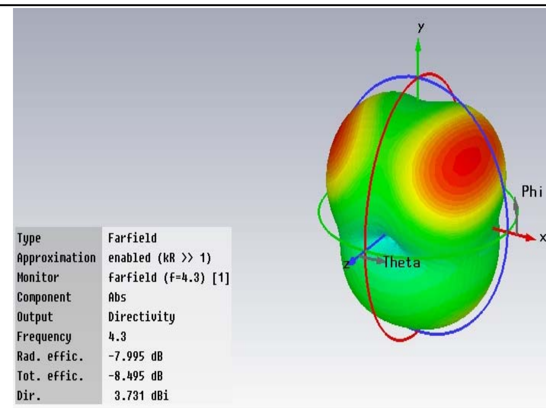

Fig.5.c 3-D Radiation Pattern of patch Antenna at 4.3 GHz

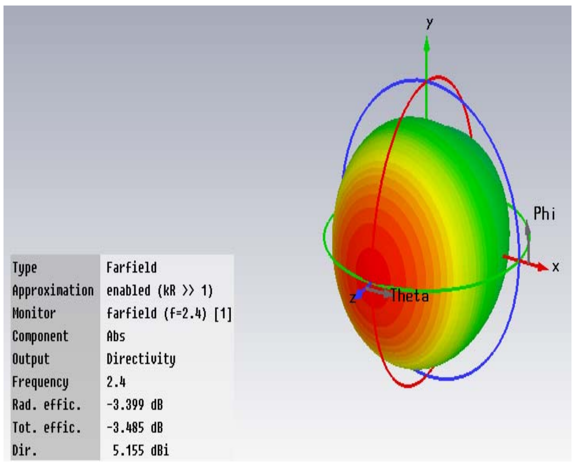

Fig.5.a 3-D Radiation Pattern of patch Antenna at 2.4 GHz.

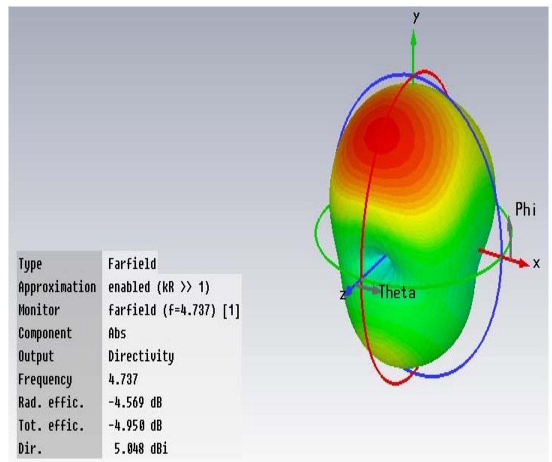

Fig.5.d 3-D Radiation Pattern of patch Antenna at 4.7 GHz

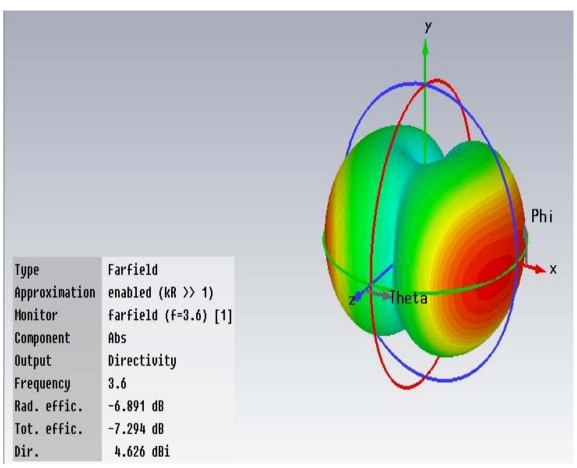

Fig.5.b 3-D Radiation Pattern of patch Antenna at 3.6 GHz.

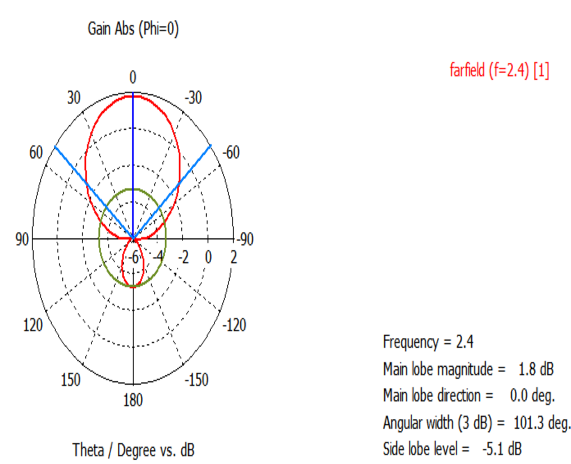

Fig.6.a Elevation Radiation Pattern of proposed patch Antenna at 2.4 GHz.

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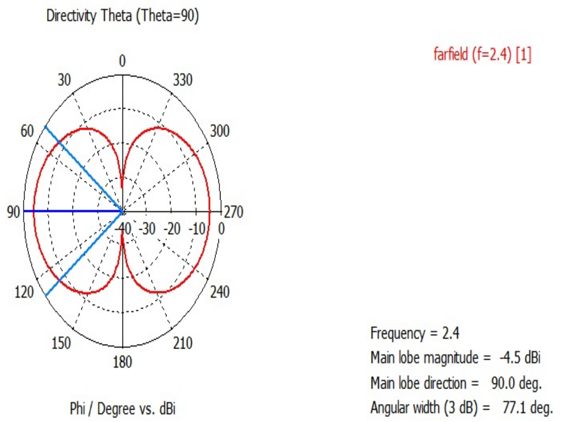

Fig.6.b Azimuthal Radiation Pattern of proposed patch antenna at 2.4 GHz.

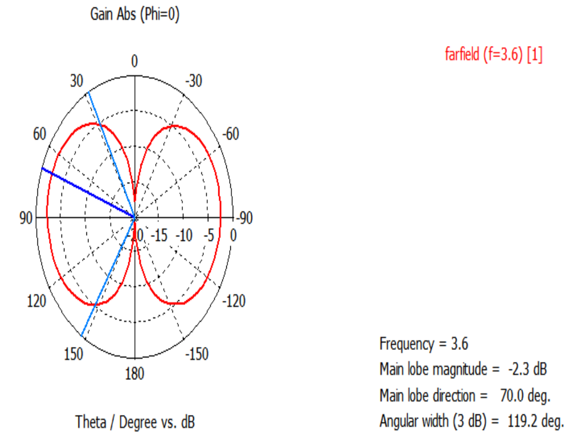

Fig.6.c Elevation Radiation Pattern of proposed patch antenna at 3.6 GHz.

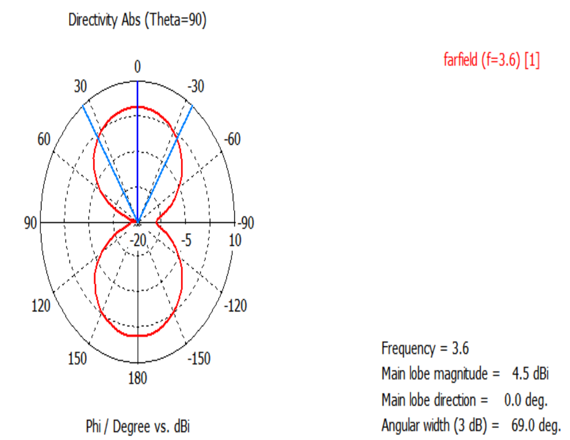

Fig.6.d Azimuthal Radiation Pattern of proposed patch antenna at 3.6 GHz.

V. Conclusion

An inset feeding multiband frequency microstrip patch antenna has been designed and simulated using CST Microwave Studio software. This is operating in the frequency band of 2.34GHz-2.433GHz covering Bluetooth Applications and 3.597GHz to 3.6778 GHz covering WiMax communication standard. The simulated impedance bandwidth at the 2.4GHz band is around 84 MHz with the corresponding value of return loss as -38 dB and simulated impedance bandwidth at the 3.6GHz is 80.1 MHz with the corresponding value of return loss as -22 dB. The bandwidth at the 4.3 GHz band is around 47.8 MHz with the corresponding value of return loss as -17 dB. This return loss value i.e. -38 dB suggests that there is good impedance matching at the frequency point below the -10 dB region.

An omni-directional radiation pattern result has been obtained which seems to be adequate for the envisaged applications. Work is going on to achieve even better results with good axial ratio over a wide bandwidth.

VI. References

[1] R.Garg, P.Bhartia, I.Bahl, A.Itipiboon, 2000. “Microstrip antenna design handbook”, Artech House, Boston – London.

[2] Constantine A. Balanis “Antenna Theory Analysis and Design”, Third edition: A JOHN WILEY & SONS, inc publication.

[3] K.D.Prasad “Antenna and Wave Propagation,Satya Prakashan,New Delhi.

[4] Randy Bancroft “Microstrip and Printed Antenna Design.” Prentice-Hall of India pvt Lmtd, New Delhi.

[5] Stutzman And Thiele’s Antenna Theory and Design.

[6] M A Matin, M.P Saha, H. M. Hasan “Design of Broadband Patch Antenna for WiMax And WLAN ICMMT 2010 Proceedings.

[7] Kraus, J. D.(1988) . Antennas. 2nd editor. McGraw Hill: New York

[8] H. F. AbuTarboush, H. S. Al-Raweshidy, and R.Nilavalan, Triple band double U-slots patch antenna for WiMAx mobile applications,” in Proc. Of APCC, Tokyo,Feb. 2008.

[9] Kin-Lu Wong, “Compact and Broadband Microstrip Antennas”, Copyright 2002 John Wiley & Sons, Inc.

[10] Milligan, T. A. (1985) , Modern Antenna Design, McGraw Hill:New York.

[11] James, J. R., P. S. Hall, “Handbook of Microstrip Antennas”, Peter Peregrinus, London, UK, 1989.

[12] http://amanogawa.com

[13] http://www.cst.com/content/products/mws/overview.aspx © 2012 CST Computer Simulation Technology AG.

[14] D.M.Pozar “Microwave Engineering” Third Edition, New York,Wiley 2005.

[15] JR James & P S Hall, “Handbook of Microstrip Antennas”, Peter Peregrinus Ltd.,1989.

[16] Mohammad Tariqul Islam, Mohammad Nazmus Shakib Norbahiah Misran Baharudin Yatim “Analysis of Braodband Slotted Microstrip Patch Antenna,” Proceedings Of The International Conference on Computer And Information Technology,December 2008,pp.758-761

[17] G. Sharma, D. Sharma and A. Katariya “An Approach to Design and Optimization of WLAN Patch Antennas for Wi-Fi Applications” IJECCT 2012, Vol. 2 (2) 18.

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