Microstrip Patch Antenna for WiMax/WLAN Applications

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Abstract: This paper contains microstrip patch antenna designed with Inset feed technique. The antenna is mainly intended to be used for WiMAX (2.2-3.4 GHz) & WLAN (2.40–2.48 GHz) wireless applications. Measurement shows that wide bandwidth of 88.57% is obtained covering the frequency range from 1.01 to 2.62 GHz. Next, the results of this microstrip feed line patch antenna is designed by using Zeland IE3D software.

Keywords: Line feed, Wideband, WiMAX, and WLAN

I. INTRODUCTION

Due to the advancement in the design and production range in the electronics devices and wireless technology, they have greater emphasis on the antenna designs for future development. Wideband refers to signal or system that either has a large relative bandwidth (BW) or a large absolute bandwidth. These bandwidths give some advantages with respect to signal robustness, information content and/or implementation simplicity. These systems also have some fundamental differences from the conventional narrowband systems.

Microstrip patch antennas has conformal and planar structure, compactness, low-profile, directive with high transmission efficiency, light weight, low profile, low cost and ease of integration with microwave circuit and portable communication equipments, that's why it finds place in much applications since 1970's.

Physically the microstrip antennas are small but the electrical size is large. A rectangular patch is a most commonly employed microstrip antenna. The rectangular patch antenna is approximately a one-half wavelength long section of rectangular microstrip transmission line.

We have taken ref. no. 1 as the reference paper and have tried to show that our results in this proposed paper are better than that paper. In this paper, feeding technique used is a line feed. It is easy to model and easy to match by controlling the inset position. Also easier to fabricate as it is a just conducting strip connecting to the patch and therefore can be considered as extension of patch.

The proposed antenna has been designed on glass epoxy substrate to give a wide bandwidth of 88.57%, and maximum radiating efficiency of about 99%.

II. DESIGNING THE PROPOSED ANTENNA

A microstrip antenna and its coordinate system are illustrated in Fig.1. The microstrip antenna that has the patch length *L* along the *x* -axis and the patch width *W* along the *y* -axis is located on the surface of a grounded dielectric substrate with the thickness of *h*.

The three essential parameters for the design of a Microstrip Patch Antenna are frequency of operation (f_o), dielectric constant of the substrate (ε_r) and height of dielectric substrate (h). The di-electric material of the substrate (ε_r) selected for this design is glass epoxy which has a dielectric constant of 4.4 and loss tangent equal to 0.001.

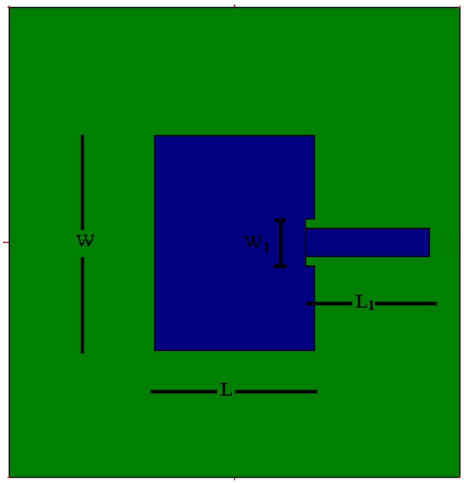

Figure 1- Geometry of proposed microstrip antenna

Low dielectric constant is used in the prototype design because it gives better efficiency and higher bandwidth, and lower quality factor Q. The low value of dielectric constant increases the fringing field at the patch periphery and thus increases the radiated power. The height of the substrate is kept small 1.6 mm is used here in the proposed design.

For a single-ended microstrip antenna, the patch width *W* and length *L* that support the operation at the required resonant frequency (or the free-space wave length $\lambda 0$) can be design using the formulas as given in [6] as.

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

Where **c** is the velocity of light, ε_r is the dielectric constant of substrate, ***f*** *is* the antenna working frequency, **W** is the patch non resonant width, and the effective dielectric constant is ε_{eff} given as,

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

The extension length Δ is calculated as,

$$\Delta L = 0.412h \frac{(\varepsilon_{reff} + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\varepsilon_{reff} - 0.258)\left(\frac{W}{h} + 0.8\right)} \quad \text{-(3)}$$

By using the mentioned equation we can find the value of actual length of the patch as,

$$L = L_{eff} - 2\Delta L \quad \text{-(4)}$$

The ground plane dimensions have given as 100×100 mm and patch dimension 35.4×45.6 mm. The essential parameters obtained from the previous formulation for the design are given in following table.

Table 1. Antenna design parameters

Parameters	Value
ε_r	4.4
h	1.6
W_g	100
L_g	100
L	35.4
W	45.6
L_1	27.72
W_1	10.0

Figure 2- Fabricated model of the proposed antenna

III. RESULT AND DISCUSSION

Figure 4 shows the return loss plot of proposed microstrip antenna. The proposed antenna resonates at 1.65 GHz frequency and has frequency range from 1.01 to 2.62 GHz giving a wide band width of 88.57%. Figure 5- shows the smith chart plot & figure 9- shows the 3D radiation pattern which is obtained from IE3D. Gain Vs frequency graph is shown at figure 8 and have high gain up to 6 dBi and good radiation efficiency of about 99% shown in figure 7.

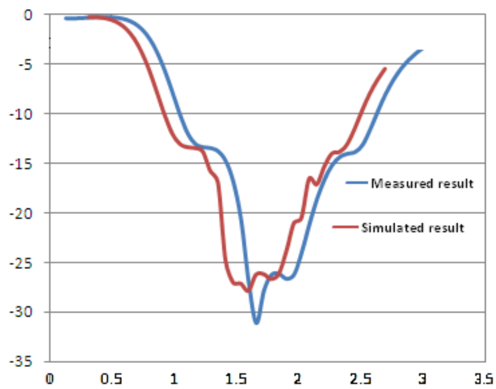

Figure 3 Measured Return loss Vs frequency of proposed microstrip antenna

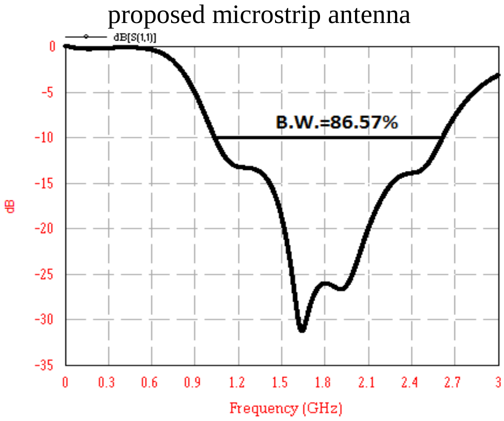

Figure 4- Return loss Vs frequency of proposed microstrip antenna

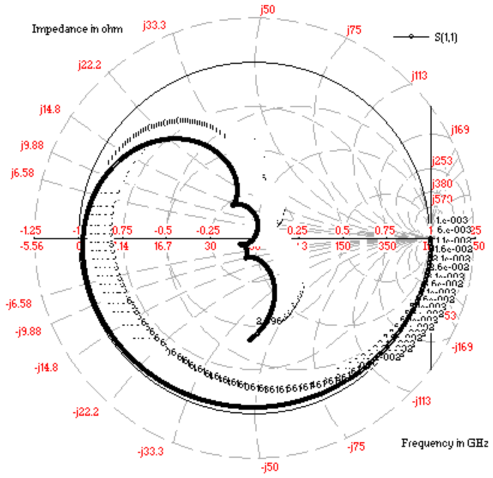

Figure 5- Smith chart plot of the proposed microstrip antenna

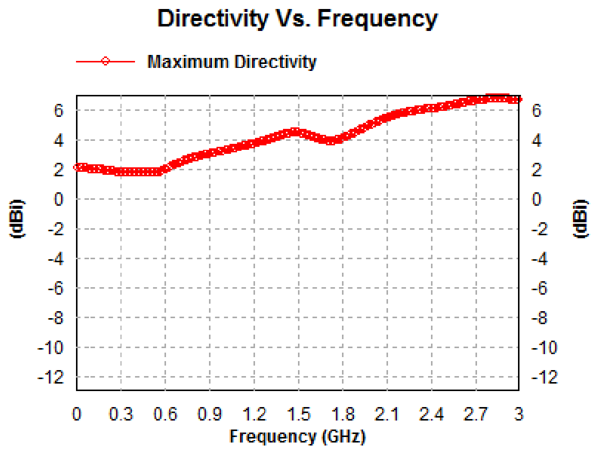

Figure 6- Directivity vs frequency graph of the proposed antenna

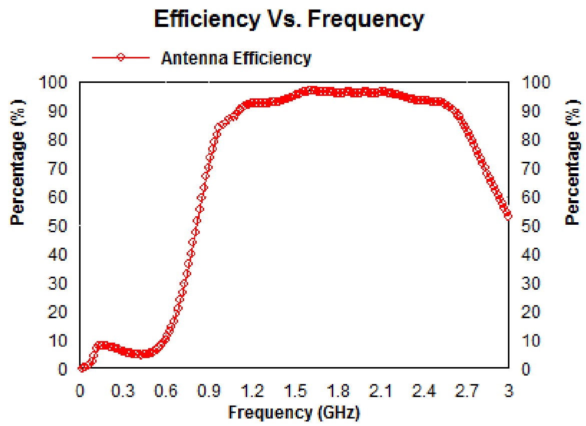

Figure 7- Efficiency vs frequency graph

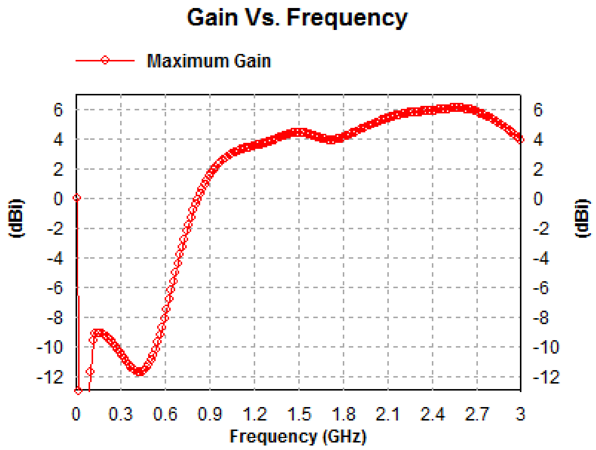

Figure 8- Gain Vs frequency graph of the proposed antenna

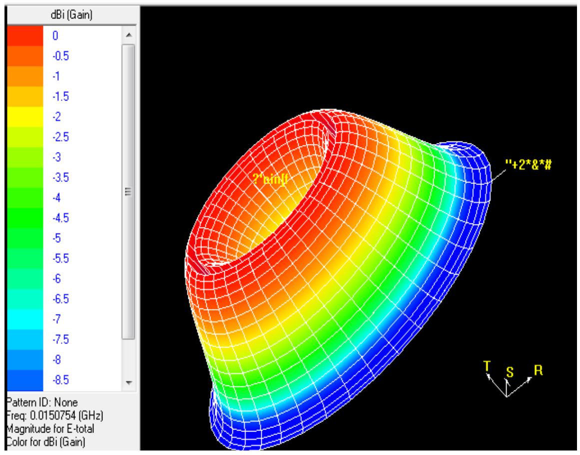

Figure 9- 3D radiation pattern

IV-CONCLUSION

This paper presents a design of a microstrip patch antenna with Inset feed connector for use in WiMAX & WLAN application. Glass epoxy substrate with dielectric constant 4.4 is used which gives a wide bandwidth of 88.57% and maximum radiating efficiency of about 99%. In this proposed antenna Inset feed used enhances the parameters. The characteristics of small patch antenna are simulated and studied in this paper.

REFERENCES

[1] Kuldeep K. Parashar, V. K. Singh, Manoj Jakheniya, Zakir Ali, Shahanaz Ayub, “Compact Band Width Enhanced Microstrip Antenna for WLAN Applications”, International Journal of Networks and Systems, Volume 2, No.1, December 2012 – January 2013

[2] Ali, Zakir; Singh, Vinod Kumar; Singh, Ashutosh Kumar; Ayub, Shahanaz; “E shaped Microstrip Antenna on Rogers substrate for WLAN applications” Proc.IEEE,pp342-345,Oct. 2011.

[3] Ansari, J. A. and R. B. Ram, “E shaped patch symmetrically loaded with tunnel diodes for

frequency agile/broadband operation", Progress In Electromagnetics Research B, Vol. 1, 29-42, 2008.

[4] Ang, B. K. and B. K. Chung, "A wideband E-shaped microstrip patch antenna for 5-6 GHz wireless communications, "Progress In Electromagnetics Research, PIER 75, 397-407, 2007.

[5] Liton Chandra Paul, Nahid Sultan, "Design, simulation and performance analysis of a line feed rectangular microstrip patch antenna", IJESET, Feb 2013.

[6] Y. X. Guo, L. Bian and X. Q. Shi, "Broadband Circularly Polarized Annular-Ring Microstrip Antenna,"IEEE Transactions on Antennas and Propagation, AP-57, 8, pp. 2474-2477, August 2008.

[7] Islam M.T., M.N.Shakib and N.Misran, "Multi-Slotted Microstrip Patch Antenna for Wireless Communication "Progress In Electromagnetics Research Letters,Vol.10,11-18,2009.

[8] Ramu Pillalamani, G Sasi Bhusana Rao, S. Srinivasa Kumar, "Novel printed rectangular patch monopole antennas with slit ground plane for UWB applications:, The NEHU Journal, vol VII, no.1 , January 2010.

[9] Islam M.T., Shakib M.N., Misran N. "Design Analysis of High Gain Wideband L-Probe Fed Microstrip Patch Antenna" Progress In Electromagnetics Research, PIER 95, 397-407, 2009

[10] Singh, V. K. and Z. Ali, "Dual band U-shaped microstrip antenna for wireless communication", International Journal of Engineering Science and Technology, Vol. 2, No. 6, 1623-1628, 2010.

[11] Vinod K. Singh, Zakir Ali "Design of Compact Triple Band Microstrip Antenna for Wireless Communication" International Journal of Electronics and Communication Engineering. ISSN 0974-2166 Volume 3, Number 1 (2010), pp. 323-330.

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

[13] Vinod K. Singh, Zakir Ali, "Dual Band U-shaped microstrip antenna for wireless Communication" International Journal of Engineering Science Technology, India, VOL 2 (6), pp 1623-1628, June,2010

[14] B. K. Ang and B. K. Chung, "A Wideband E-shaped microstrip patch antenna for 5–6 GHz wireless Communications," Progress In Electromagnetic Research, PIER75, 397-407, 2007.

[15] Mohammad Tariqul Islam, Mohammed Nazbus, Shakib, Norbahiah Misran, Baharudin Yatim, "Analysis of Broadband Microstrip Patch Antenna," Proc. IEEE,pp758-761,Dec.2008.

[16] Girish Kumar and K.P. Ray, Broadband Microstrip antennas, Norwood: Artech House 2003.

[17] Ramesh Garg, P. Bhartia, Inder Bahl, A. Ittipiboon, Microstip Antenna Design Handbook, Artech House, 2000.

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