Compact UWB Co-axial Fed Low Expensive Microstrip Antenna for WLAN Applications

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***Abstract* - In this paper a compact UWB microstrip antenna is proposed. Simulation studies o f the proposed structure are studied and analysed using Computer Simulation Technology (CST) microwave studio. The radiating patch is placed on a FR-4 dielectric substrate (εr = 4.3, tanδ = 0.025) with conducting ground. The Co-axial feeding technique is used. In the operating frequency range of 5.2 to 5.4 GHz -10 dB return loss is achieved for WLAN applications. Effective return loss of -40 dB is achieved at 5.25 GHz for application of earth satellite services. The fabricated antenna results very nearby to results of simulation.**

Keywords: Patch antenna, UWB, WLAN, Return loss.

I. INTRODUCTION

In [1] 2002, Federal Communication Commission announced that the 3.1 to 10.6 GHz range for ultra wide band applications. This led to lot of research in UWB. The antennas are having sound importance in wireless communication transmitters and receivers. As UWB is higher frequency spectrum, the microstrip patch antennas are very much suitable due to their lesser dimensions (i.e. λ=c/f), because size of the antennas are proportional to wavelength.

In microstrip structure, the narrow conducting patch produces inductance, and the entire structure gives amount of capacitance. As impedance due to these parameters varies with frequency [$Z_L=j\omega L$ and $Z_C=\frac{1}{j\omega C}$], a single microstrip line will produce different impedance for different frequency levels.

By creating discontinuities in conducting patch, the microstrip line will be made to radiate the EM energy. In antenna point of view, if microstrip line produces low impedance, we get high return loss (in negative scale), if it produces high impedance, we get low return loss. For propagation, antenna should deliver high return loss and for elimination low return loss to be delivered.

The radiating gain of the microstrip antenna depends on the dimension and discontinuities on the patch and the type of the dielectric substrate used.

Monopole antennas [2] were developed for UWB range with different notch functions. There are six monopole antennas performances were compared and studied in [3]. The characteristics of UWB antennas were analyzed in [4]. In [5], [6] &[7] different UWB microstrip antennas were developed with different notch functions.

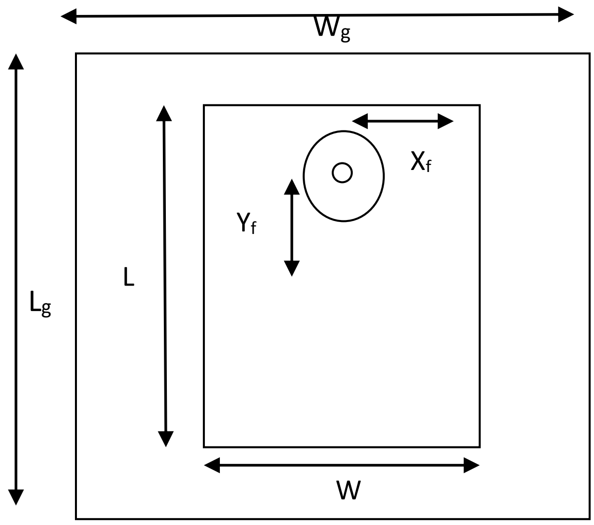


Fig. 1. Proposed Microstrip Patch Antenna

II. THE DESIGN OF RECTANGULAR MICROSTRIP PATCH ANTENNA

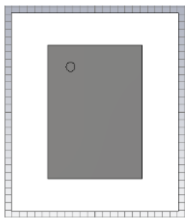
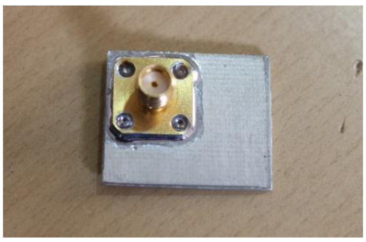


Fig. 2. Simulated Microstrip antenna (Top view)



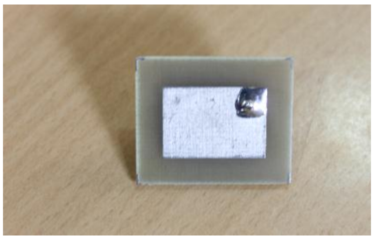


Fig. 3. Photograph of fabricated antenna (Top and Bottom sides).

The design of rectangular microstrip patch antenna is based on L and W of the patch and height of the dielectric substrate. For fabrication convenience the height of the substrate (FR4-lossy) is fixed to 1.6 mm.

The microstrip patch antenna, is to operate in the frequency of 5.25 GHz effectively, the f_r is chosen as it. So the width of the patch is selected from equation (1).

$$W = C/2f_r\sqrt{(\varepsilon r + 1)/2} \quad (1)$$

As the inclusion, the dielectric property of the air present in substrate, the ε_{eff} is calculated.

$$\varepsilon_{eff} = \frac{\varepsilon r+1}{2} + \frac{\varepsilon r-1}{2}\sqrt{\frac{1}{1+12h/w}} \quad (2)$$

For radiation purpose, the length of the rectangular patch will be adjusted to ΔL.

$$\Delta L = 0.412h\,\frac{(\varepsilon eff+3)\left(\left(\frac{W}{h}\right)+0.264\right)}{(\varepsilon eff-0.258)\left(\left(\frac{W}{h}\right)+0.813\right)} \quad (3)$$

$$L_{eff} = C/2f_r\sqrt{\varepsilon eff} \quad (4)$$

Then, the finalized length of the rectangular patch is,

$$L = L_{eff} - 2\Delta L \quad (5)$$

The width and length of the ground will be,

$$W_g = W+6h \quad (6)$$

$$L_g = L+6h \quad (7)$$

By making these calculations, the dimensions of the rectangular microstrip antenna are finalized as in table-1 after the trial and error methods in simulation. (Ref. Fig.2)

TABLE-1. Designed Microstrip Antenna Parameters

Parameters	Dimensions in mm
W_g	26.33
L_g	22.148
W	16.73
L	12.548
H	1.6
X_f	3.2257
Y_f	8.365

III. FEEDING TECHNIQUE

Although the numbers of feeding techniques are available for microstrip patch antenna, the coaxial feed is selected to achieve the good impedance matching to 50Ω. The feeding points are selected from the following equations:

$$X_f = L/2\sqrt{\varepsilon_{eff}} \quad (8)$$

$$Y_f = W/2 \quad (9)$$

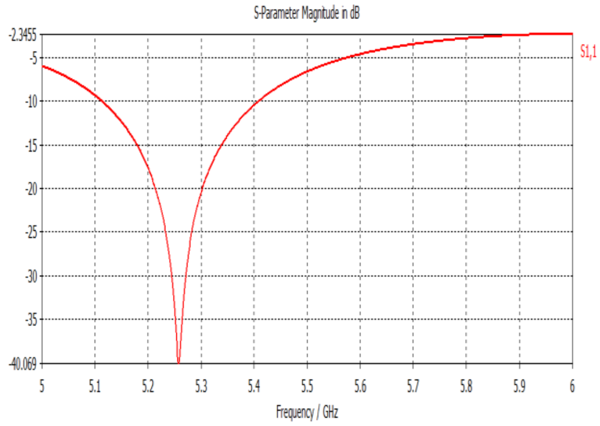


Fig 4a. Simulation Result for Return Loss

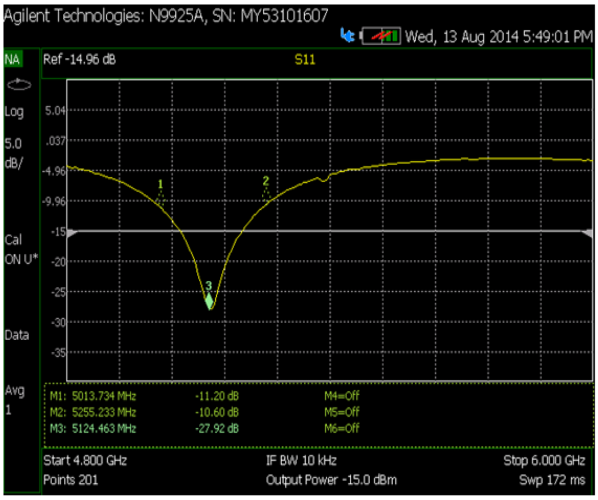


Fig. 4b.Tested Result for Return Loss

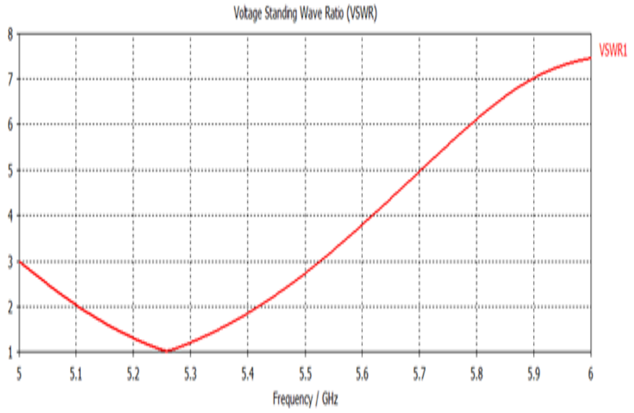


Fig 5a.Simulation Result for VSWR

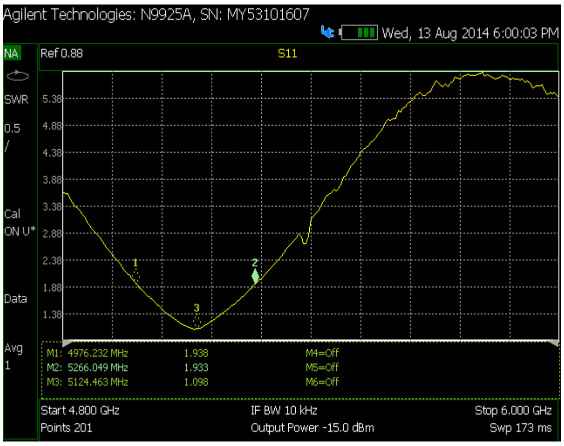


Fig. 5b. Tested Result for VSWR

IV. SIMULATION AND RESULTS

In order to investigate the performance of the microstrip antenna for frequency of 5.2 to 5.4 GHz range is used to simulate and measure for performance in detail. The dimension of the antenna is given in Table-1 and the simulated and fabricated antenna's are shown in fig. 2 and fig. 3. Using the network analyser, the measured returned loss of the proposed antenna is obtained. It was shown -10 dB return loss in simulated and tested results from 5.2 to 5.4 GHz and achieved the peak value at 5.25 GHz. Where VSWR < 2 is achieved throughout the band of 5.2 to 5.4 GHz.

V. CONCLUSION

In this paper, we designed a low-cost UWB microstrip patch antenna is fabricated on FR4 (lossy) substrate (Fig.3) and measured with vector network analyser. The measured results (Fig.4b and Fig.5b) have good agreement with simulation. Thus, this antenna can be very much used in UWB WLAN applications.

REFERENCES

[1] Federal Communications Commission, Washington, DC, "FCC report and order on ultra wideband technology", 2002.
[2] Jana Jilkova, Zbynek Raida, "Ultra-wideband coplanar-fed monopoles: A comparative study," Radioengineering, vol.17, no.1, April 2007.
[3] G.P. Pochanin, P.V.Kholod, T.N. Ogurtsova," The uwb receiving loop antenna," International Conference on Antenna Theory and Techniques, 9-12 September, 2003, Sevastopol, Ukraine pp. 546-548.
[4] Guan-yu chen, Jwo-shiun, Sheng-yi huang, YD Chen and Cheng-hung lin,"Characteristics of uwb antenna and wave Propagation," Hong Kong, December 13-16, 2005.
[5] Young Jun Cho, Ki Hak Kilm, Dong Hyuk Choi, Seung Sik Lee, and Seong-Ook Park," A miniature uwb planar monopole antenna with 5-ghz band-rejection filter and the time- domain characteristics," IEEE Trans. Antennas Propag., vol.54, no.5, May 2006.
[6] Tzyh-Ghuang Ma and Sung-Jung Wu,"A new band-notched u-shape folded monopole antenna for uwb applications," IEEE 2006.
[7] Yingqing Xia, D.J,Edwards,"Optimization of uwb Pyramidal Horn Antenna with Load," IEEE AP Int. Symp, 2007.
[8] Saber Soltani, Mohammadnaghi Azarmanesh, Gholamreza, "Two novel very small monopole antennas having frequency band notch function using DGS for UWB application," Int. J. Electron. Commun. (AEU) 65 (2011) 87-94.
[9] J. Q. Howell, *Microstrip antennas*, IEEE AP-S International Symposium Digest, 1972, pp. 177-180.
[10] Pradeep K. Agarwal and M. C. Bailey, *An analysis technique for microstrip antennas*, IEEE Tran. On antennas and propagation, Vol. AP-25, No.6 November 1977.
[11] Y. T. Lo, D. Solomon and W. F. Richards, *Theory and experiment on microstrip antennas*, IEEE transactions on antennas and propagation, Vol. AP-27, No.2, March 1979, pp.137-145.
[12] K.R. Carver, and J. W. Mink, *Microstrip Antenna Technology*, IEEE Trans.Antennas Propagation, Vol. AP-29, January 1981, pp. 2–24.
[13] J. R. James, P. S. Hall and C. Wood, *Microstrip antennas: Theory and design*, Peter Peregrinus, London, UK, 1981.
[14] Bharath Kelothu, K.R. Subhashini, *IEEE* Transactions 2012. "A compact high-gain microstrip patch antenna for dual band WLAN application".
[15] Kamerman and G. Aben, "Throughput performance of wireless LANs operating at 2.4 and 5 GHz," in *The 11th IEEE International Symposium on Personal, Indoor and Mobile Radio Communications, 2000. PIMRC 2000*, 2000, vol. 1, pp. 190–195 vol.1.
[16] Gijo Augustin, P. C. Bybi, V. P. Sarin, P. Mohanan, C. K. Aanandan, and K. Vasudevan, "A Compact Dual-Band Planar Antenna for DCS-1900/PCS/PHS, WCDMA/IMT-2000, and WLAN Applications", *IEEE Antennas WirelessPropag. Lett.*, vol. 7, pp. 108-111,2008

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