International Journal of Scientific Research Engineering & Technology (IJSRET)
Volume 1 Issue7 pp 005-008 October 2012 www.ijsret.org ISSN 2278 - 0882

Multi-frequency Wideband Microstrip Patch Antenna for WLAN/ HIPERLAN/ SATELLITE Applications

Deependra Khandelwal*, Ajay Patidar**, Banwari Lal Kalwar***

*(Assistant Prof., Deptt. of EC, Jaipur Engineering college, kukas- Jaipur-India
E-mail:d.khandelwal2021@yahoo.co.in)
** (M.Tech Scholar, Arya Engineering College, Kukas-Jaipur)
*** (Deptt. of EC, JEC, Kukas-Jaipur)

ABSTRACT

In present work, a novel miniaturized design of a multi frequency rectangular microstrip patch antenna is designed and simulation results are presented in this paper with broadband behavior for WLAN and HYPERLAN and SATELLITE applications is proposed. The proposed antenna has Multi frequency bandwidth of about 385 MHz (3.282-3.672GHz), 517MHz (5.114-5.631GHz) and 1111 MHz (5.917-7.028GHz) at -10 dB return loss which is sufficient to make the antenna useful for WLAN/ HIPERLAN/ SATELLITE operation. The maximum achievable gain over the entire frequency band is close to 5 dBi. The resonance frequencies can be controlled by adjusting the dimensions of the ground plane. The proposed antenna uses a pi-shaped slot made into the ground. The key parameters like return loss, input impedance, gain are simulated, analyzed and optimized using High Frequency structure Simulator (HFSS) v11. The results show that the preference of the proposed antenna can be greatly improved compared to traditional microstrip patch antennas.

Keywords - Microstrip antenna, Microstrip feed, WLAN, HIPERLAN, & broadband behavior.

I. INTRODUCTION

Microstrip patch antennas have been widely researched in recent times due to their attractive features including light weight, low profile, easiness in integration with other circuit elements etc. In recent years, these antennas are one of the most innovative topics in antenna theory and design and are increasingly finding application in a wide range of modern communication systems. For current mobile communication, the diversity scheme has already been implemented to mitigate the fading effects of multipath scenario [1, 2]. In a multipath rich wireless channel, deploying multiple antennas at both the transmitter and receiver achieves high data rate without increasing the total transmission power [3]. The IEEE 802.11 standard was proposed in 1997 for WLANs application. After few years new standard was proposed, operating on the 2.4 GHz ISM band (2.4 - 2.484 GHz), is called 802.11b or 802.11 HR (High Rate), which provides a data rate up to 11 Mbps. The IEEE 802.11y standard was approved in 2008, operating on the 3.6 GHz frequency. The IEEE 802.11a standard was approved in 1999, operating on the 5 GHz ISM bands (5.15 - 5.35GHz and 5.725 -5.825GHz). The change of band shows that 802.11a and 802.11b products are not compatible. Therefore, the IEEE proposed 802.11g standard which is compatible with both 802.11b and 802.11a technology. The 802.11g standard was accepted in 2003.

Since 802.11b and 802.11g are using 2.4 GHz frequency band while 802.11a uses 5 GHz frequency band so a dual band antenna is requirement for WLAN applications. The size reduction, together with gain and bandwidth enhancement is becoming major design considerations for most practical applications of microstrip antennas for wireless communication. The bandwidth can be improved by various methods like adding slots into the patch, increasing the substrate height, decreasing of substrate [4], associating several patch elements to form an array antenna [5], introducing a capacitive coupling between the radiating element and the ground plane, modifying the shape of radiating element and adding a shorting pin [6,7]. The simulations of these antennas are carried out by applying Ansoft HFSS v11 software [8].

International Journal of Scientific Research Engineering & Technology (IJSRET)
Volume 1 Issue7 pp 005-008 October 2012 www.ijsret.org ISSN 2278 - 0882

II. ANTENNA GEOMETRY

The antenna is printed on Printed Circuit Board (PCB) with the dimensions of patch L x W as 18.4 mm x 45 mm. The front view geometry of proposed microstrip patch antenna is shown in fig.1. The FR4 substrate (22.83 mm x 45 mm) used has a dielectric constant of 4.4 with a loss tangent of 0.0022 and thickness of 1.6 mm. Edges along the width are called radiating edges and that along the length are called non radiating edges. The proposed antenna is excited by a microstrip feed line (2.215 mm x 6 mm). As the microstrip line feed generates Quasi-TEM mode so the dimensions of port from which the patch is excited are extended in all directions. The dimensions of the patch and feed line location for proposed antenna have been optimized so as to get the best possible impedance match to the antenna.

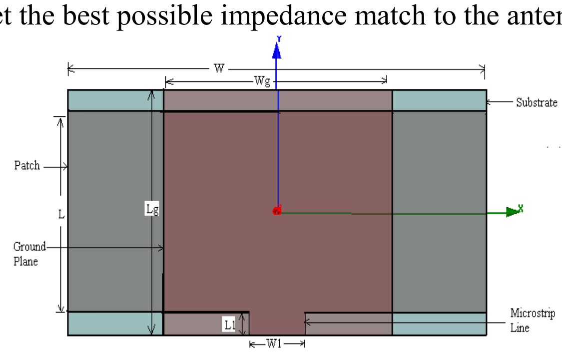

Fig.1. Geometry of proposed microstrip patch antenna

It is clearly shown From the Fig. 1 of the antenna design, that the width of patch and substrate are the same whereas the width of ground plane has been reduced for getting optimum results with enhanced bandwidth. The rectangular ground is modified in such a way so that it completely covers the complete band. The dimensions of the patch and feed line location for proposed antenna have been optimized so as to get the best possible impedance match to the antenna. The following parameters shown in Table: 1 is used for design of the proposed microstrip patch antenna.

Table 1: Design Parameters

Parameters	***Dimensions (mm)***
Patch (L x W)	18.4 x 45
Substrate (FR4)	22.83 x 45
Ground Plane (Lg x Wg)	22.83 x 24
Dielectric Constant	4.4
Loss tangent	0.0022
Substrate thickness	1.6
Feed line (L_1 x W_1)	2.215 x 6
Operational frequency band	3.282GHz-3.672 GHz, 5.114GHz-5.631GHz & 5.917GHz-7.028GHz

III. SIMULATED RESULTS

The simulation of antenna carried out with Ansoft HFSS software. The simulated variation in S11 parameter as a function of frequency for the proposed antenna is shown in Fig.2. It is apparent from this figure that antenna resonates at three frequencies 3.48 GHz, 5.35 GHz and 6.55 GHz. Antenna covers the first frequency band from 3.282GHz to 3.672GHz with resonance frequency 3.48 GHz and covers the second frequency band from 5.111GHz to 5.631GHz with resonance frequency5.35 GHz and covers the third frequency band from 5.917GHz to 7.028GHz with resonance frequency6.55 GHz at -10 dB return loss. The achieved impedance bandwidths of proposed antenna are about 11.22%, 9.62% and 17.17% at frequency 3.48 GHz, 5.35 GHz and 6.55 GHz respectively. This impedance bandwidth value is much larger than that achieved with a single layer antenna (1 – 2%). The Smith Chart shows the perfect matching as shown in the Fig. 3. VSWR for one the frequency band from 3.282GHz to 3.672GHz band is 1.03:1 and frequency band from 5.111GHz to 5.631GHz band is 1.43:1 and 1.12:1 for frequency band 5.917GHz to 7.028GHz as shown in the Fig. 4. Fig.5 shows the simulated 3-D radiation pattern at three resonant frequencies. The gain of the antenna is always more than 5dBi across the three frequency bands as shown in the Fig.5. The radiation patterns at representative frequencies are almost identical in shape and the direction of maximum radiations at all the representative frequencies is normal to patch geometry as shown in fig.6.

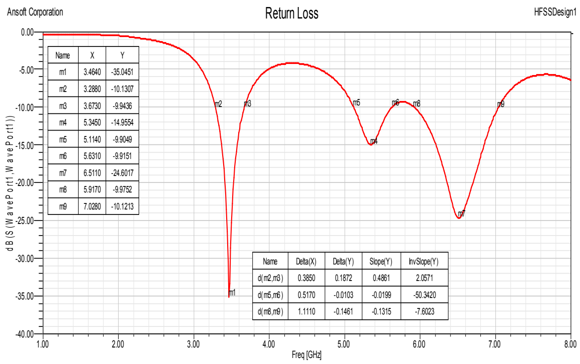

Fig.2. S11 Vs Frequency of the proposed antenna structure

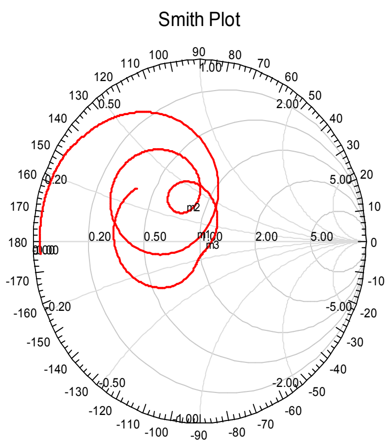

Fig.3. Smith Chart of the proposed antenna structure

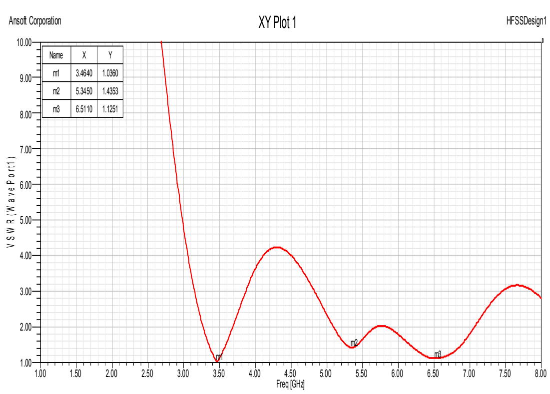

Fig.4. VSWR Vs Frequency of the proposed antenna structure

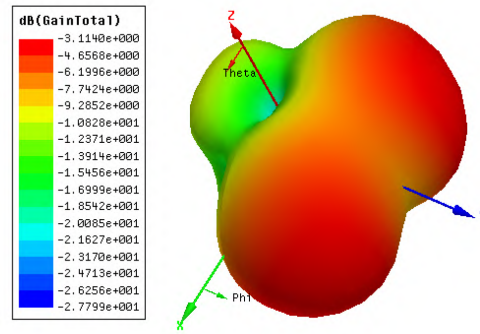

Fig.5. 3-D radiation pattern of proposed patch antenna

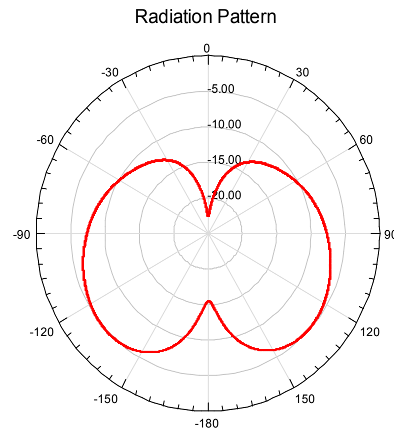

Fig.6. far-field radiation pattern of proposed patch antenna

IV. CONCLUSION

In this paper, a novel design of multi-frequency wideband microstrip patch antenna is proposed. The simulation is carried out using Ansoft HFSS v11 software. The proposed antenna operates at three bands, first frequency band from 3.282GHz to 3.672GHz with resonance frequency 3.48 GHz and covers the second frequency band from 5.111GHz to 5.631GHz with resonance frequency5.35 GHz and covers the third frequency band from 5.917GHz to 7.028GHz with resonance frequency6.55 GHz at -10 dB return loss. Good Results have been found at three frequencies 3.48 GHz, 5.35 GHz and 6.55 GHz which can be applicable to WLAN, HIPERLAN and satellite communication system. VSWR is obtained less than 2 for the three bands and Gain is always greater than 5dBi.

Volume 1 Issue7 pp 005-008 October 2012 www.ijsret.org ISSN 2278 - 0882

REFERENCES

[1] Bahl, J. and P. Bhartia, *Microstrip Antennas*, Artech House, Inc., London, 1980.

[2] C.A. Balanis, "Antenna Theory Analysis and Design", third edition, Wiley, New Jersey, 2005.

[3] James, J. R. and P. S. Hall, *Handbook of Microstrip Antennas*, Peter Peregronic Ltd., London, 1989.

[4] Richards, W. F., S. E. Davidson, and S. A. Long, "Dual band reactively loaded microstrip antenna," *IEEE Trans. Ant. Prop.*, Vol. AP-33, No. 5, 556–561, 1985.

[5] Davidson, S. E., S. A. Long, and W. F. Richards, "Dual band microstrip antennas with monolithic reactive loading," *Elec.Letters*, Vol. 21, No. 20, 936–937, 1985.

[6] Nakano, H. and K. Vichien, "Dual frequency square patch antenna with rectangular notch," *Elec. Letters*, Vol. 25, No. 16, 1067–1068, 1989.

[7] Zhong, S. S. and Y. T. Lo, "Single element rectangular microstrip antenna for dual-frequency operation," *Elec. Letters*, Vol. 19, No. 8, 298–300, 1983.

[8] Ansoft HFSS Version 11 Online Help.