NIET Journal of Engineering & Technology

Volume 9, Issue 1, 2018 ISSN: 2229-5828 (Print)

Designing of Microstrip Patch Antenna for X-Band Applications

Ranjan Kumar[1], Dhananjay Singh[1], V.K. Pandey[2]

[1]AssistantProfessor, Department of Electronics& Communication Engineering, Noida Institute of Engineering & Technology, Greater Noida

[2] Professor, Department of Electronics& Communication Engineering, Noida Institute of Engineering & Technology, Greater Noida

Abstract. ***This stud introduces a microstrip patch antenna that contains radiating patch of FR-4 substrate material on the one side of microstrip antenna with dimensions 30mm×50mm×2mm, dielectric constant =4.4 and excited by microstrip line feed. HFSS is used in this research. This antenna composes of rectangular slots to improve gain and cylindrical shorted pins to enhance performance of antenna in desired band. Return loss -20.17dB, -17.82dB, -25.19dB at 8.36GHz, 9.30GHz, 11.30GHz respectively, radiation efficiency 73.6% and gain 5.9dBi in desired band***

Keywords: Return loss, gain, FR-4 substrate, X band, Radiation efficiency.

1. Introduction

Microstrip patch antenna execution is very important in wireless communicationsystems, it increases the demand of the upcoming generation to fulfill their requirements by using Antenna Technology. Microstrippatch antennas is used widely by enhance their performance and efficiency because they are easy to design and low in weight. It is easy to fabricate and can easily integrated with the circuits easily. As they are multitasking and easy to use in communication system because of these behavior it is being used in daily life[8].Due to all these properties of microstrip antenna various multi and wideband antenna is being designed for various purpose. There are various antenna that are being designed for different bands as it is important to design single antenna that operates at various frequencies for many applications. There are manytypes of multiband or wideband antennas which are being improved daily asgrowingthedemands for a mobile communication gadget which have capability to merge one communication standard into a onesystem.The improvement in range of frequency can be achieved by cutting the slots (of any shape) in ground and patch of microstrip antenna of acceptablewidth and length [7]. X-bandisveryuseful in several applications because of high frequency ranges by providing high transmission rate and shortrange features.

2. Antenna Design

The proposed multiband microstrip patch antenna is design on FR-4 substrate material in such way thatone side is patch and ground is on opposite side. There are two rectangular slots in the patch at the center which are in opposite direction and shorting pins in design at different positions. Antenna is excited by microstripline feed. The fabrication of proposed multiband microstrip patch antenna is done with following dimensions.

Substrate thickness = 2 mm Physical

dimension = 30 × 50 mm^2

Publisher: Noida Institute of Engineering & Technology,
19, Knowledge Park-II, Institutional Area, Greater Noida (UP), India.

Component	Dimensions (mm)	Material
Patch	L=10 W=29.5	Copper
Substrate	L=30 W=50 H=2	FR4 epoxy
Ground	L=30 W=50	
Shortened Pins	R=0.5 H=2	Copper
Rectangular Slot	L=4 W=1	

Table 1 Dimensions of the simulated antenna

3. SIMULATION AND RESULTS

Fig 1 shows the top and bottom view design of simulated antenna which is being designed by using HFSS.

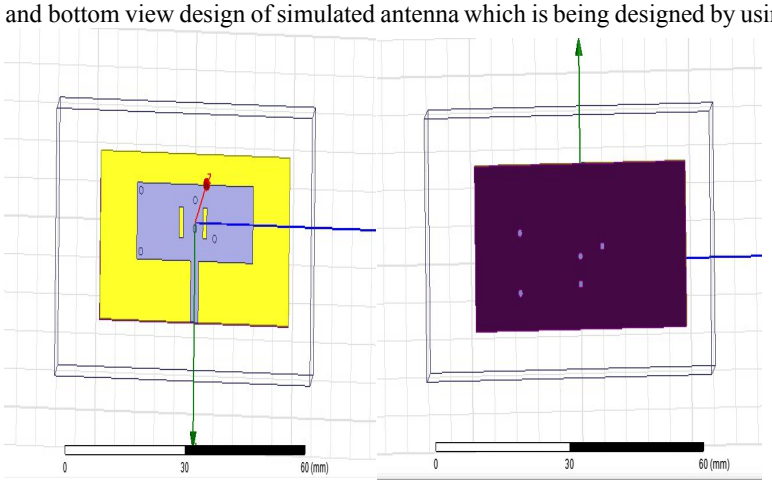

Fig 1 Top view and bottom view of simulated antenna

3.1 Return loss (S11)

S11 represents how much power is returned from the antenna, so itcalled reflection coefficient (written as gammaor return loss). From fig 2 one can easily conclude that proposed antenna resonates at three frequencies 8.3GHz, 9.3GHz, 10.2GHz, and 11.3GHz. From s11 graph return loss is calculated, return loss should be -10dB.

Publisher: Noida Institute of Engineering & Technology,
19, Knowledge Park-II, Institutional Area, Greater Noida (UP), India.

NIET Journal of Engineering & Technology
Volume 9, Issue 1, 2018 ISSN: 2229-5828 (Print)

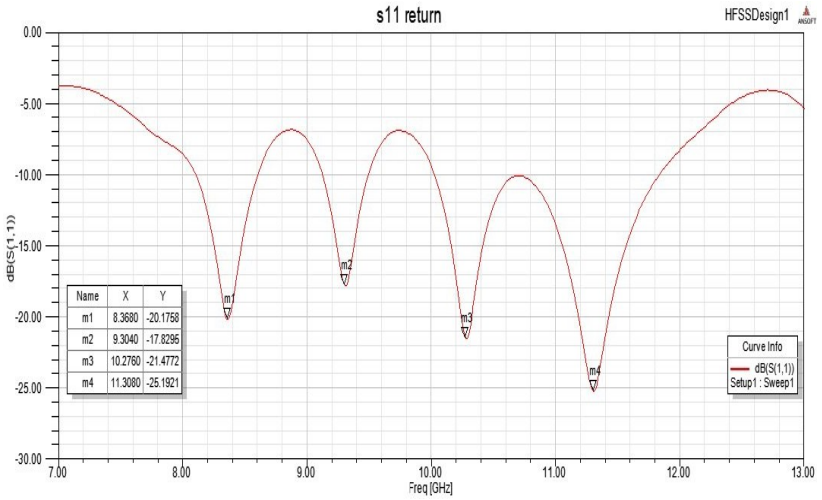

Fig. 2S11 (dB) of the Simulated Antenna

3.2 Voltage Standing Wave Ratio

VSWR is amount of mismatch impedance between an antenna and connector connecting at input port. VSWR represents how much power reflected back to the source of antenna after mismatching of impedance. Ideal value of VSWR should be 1. Practically, value of VSWR is considered between 1 and 2. In proposed design at resonating frequencies value of VSWR is 1.7, 2.04, 1.4, and 1.5.

$VSWR=V_{max} / V_{min}$

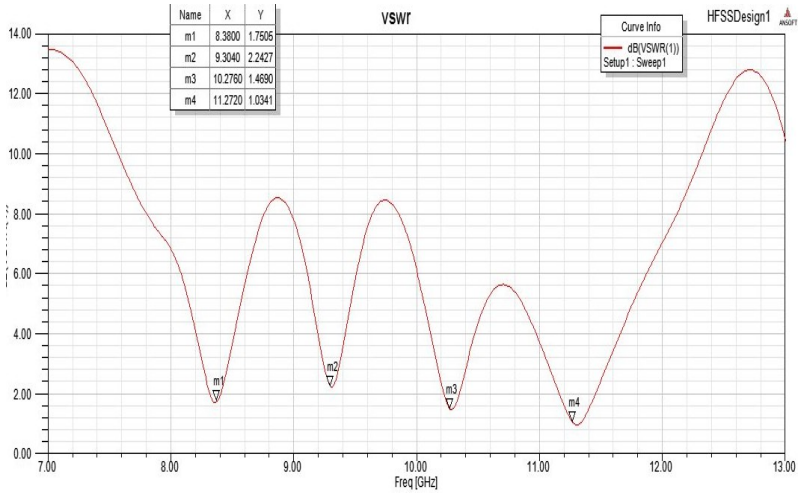

Fig. 3VSWR of theSimulated Antenna

Publisher: Noida Institute of Engineering & Technology,
19, Knowledge Park-II, Institutional Area, Greater Noida (UP), India.

3.3 Gain

Antenna gain is a main parameter which unitethe directivity and electrical efficiency of antenna. Gain denotes how much designed antenna radiates in particular direction with respect to isotropic antenna. Gain of antenna should be positive. The gain of designed antenna is 5.9 dB.

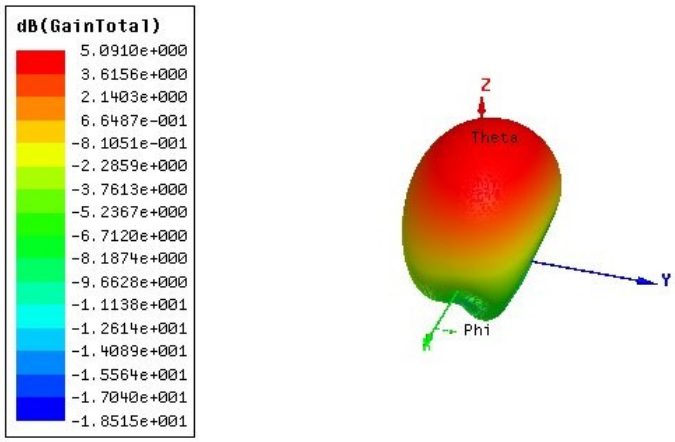

Fig. 4 Gain of theSimulatedAntenna

3.4 E-plane

The E-plane can act as reference plane for antennas and other microwave devices. E plane includes E – field and direction of maximum radiation.

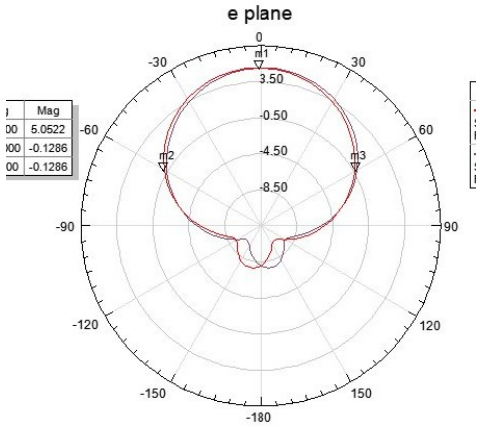

Fig. 5 E-plane of the Antenna

Publisher: Noida Institute of Engineering & Technology,
19, Knowledge Park-II, Institutional Area, Greater Noida (UP), India.

3.5 H-plane

The H-plane can acts as a reference plane for antennas and other devices. H plane have H- field (magnetic field) and direction of maximum radiation.

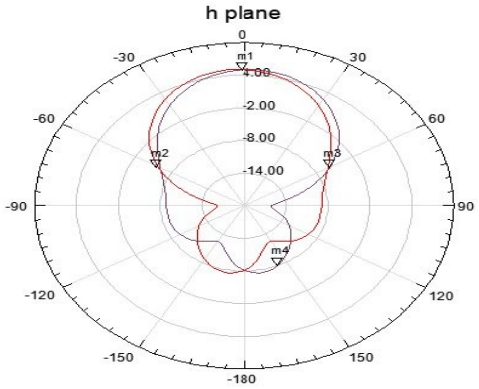

Fig. 6 H-plane of the Antenna

3.6 Smith Chart

It is a graphical instrument or alignment chart developed for electrical and electronics engineers specially used in radio frequency engineering to facilitate in solving problems of transmission lines and matching circuits.it is used for conceptualize the impedance of a transmission line and antenna system as a function of frequency.

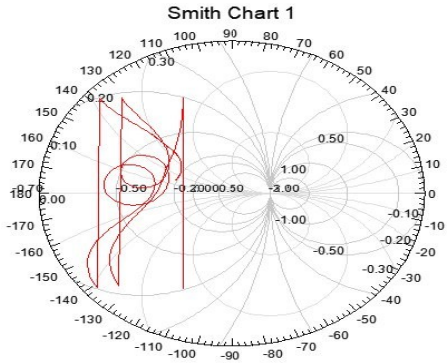

Fig. 7 Smith Chart of the Antenna

Publisher: Noida Institute of Engineering & Technology,
19, Knowledge Park-II, Institutional Area, Greater Noida (UP), India.

3.7 Radiation efficiency

It is defined as the ratio of the power of radiation emitted in an antenna to the total power receivedby the antenna. The radiation efficiency of designed antenna is 78.6%.

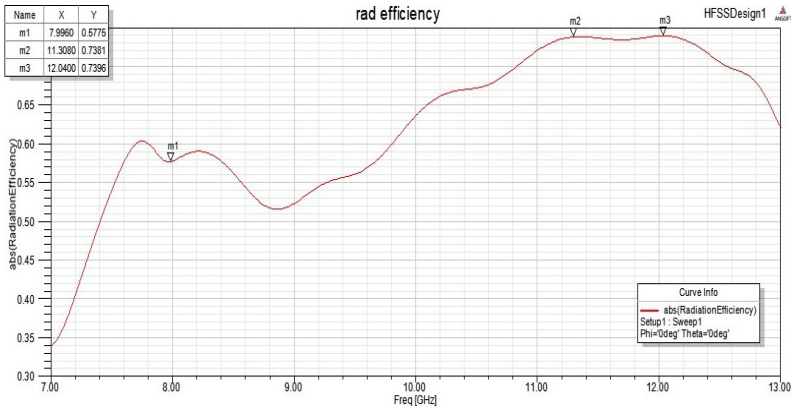

Fig. 8 Radiation Efficiency of the Simulated Antenna

4. Conclusion

This paper includes the analysis which shows that theMultibandmicrostrip patch antenna with microstrip line feed at rectangular patch with ground plane by using FR-4 substratematerialis used. This Antenna is designed, simulated, and can be usedfor various applications under X band frequency (8 – 12) GHz.

References

[1] Antennas for all Applications by John D. Kraus & Ronald J. Marhefka 3rd Ed.

[2] Jafargholi, Amir &Jafargholi, Ali &Ghalamkari, Behbod. (2018). Dual-Band Slim Microstrip Patch Antennas. IEEE Transactions on Antennas and Propagation. 66. 6818-6825. 10.1109/TAP.2018.2871964.

[3] V. S. Bharath, N. V. S. S. A. Varma and R. Sheeba, "Design and analysis of H shaped microstrip antenna with different feed position and number of slots for multiband applications," 2017 IEEE International Conference on Power, Control, Signals and Instrumentation Engineering (ICPCSI), 2017, pp. 1130-1135, doi: 10.1109/ICPCSI.2017.8391886.

[4] W. C. Mok, S. H. Wong, K. M. Luk and K. F. Lee, "Single-Layer Single-Patch Dual-Band and Triple-Band Patch Antennas," in IEEE Transactions on Antennas and Propagation, vol. 61, no. 8, pp. 4341-4344, Aug. 2013, doi: 10.1109/TAP.2013.2260516.

[5] Alaadesherfarhood, Mahamkamilnaji, Dr.Sehamahmedhashem "A Microstrip-Fed UWB Antenna for WCDMA and X-Band Applications". International Journal of Computer Trends and Technology (IJCTT) V48(1):5-10, June 2017. ISSN:2231-2803. www.ijcttjournal.org. Published by Seventh Sense Research Group.

[6] Savochkin, A. A. and A. Nudga. “The multiband antenna.” 2011 VIII International Conference on Antenna Theory and Techniques (2011): 182-184.

[7] Faruque, , M. R. I., Islam, , M. T., & Misran, , N. (2010). Evaluation of Specific Absorption Rate (SAR) Reduction for PIFA antenna Using Metamaterials, Frequenz, 64(7-8), 144-149

Publisher: Noida Institute of Engineering & Technology,
19, Knowledge Park-II, Institutional Area, Greater Noida (UP), India.

[8] V. S. Bharath, N. V. S. S. A. Varma and R. Sheeba, "Design and analysis of H shaped microstrip antenna with different feed position and number of slots for multiband applications," 2017 IEEE International Conference on Power, Control, Signals and Instrumentation Engineering (ICPCSI), 2017, pp. 1130-1135, doi: 10.1109/ICPCSI.2017.8391886.

[9] K. F. Lee, K. M. Luk, K. M. Mak, and S. L. S. Yang, "On the use of U-slots in the design of dual-and triple-band patch antennas," IEEE Antennas Propag. Mag., vol. 53, pp. 60–74, Jun. 2011.

[10] M. Geethananda, Z. C. Alex and K. Shambavi, "Design of planar multi-ring monopole antenna for UWB applications," 2015 2nd International Conference on Electronics and Communication Systems (ICECS), Coimbatore, 2015, pp. 661-664, doi: 10.1109/ECS.2015.7124991

[11] A. Dadhich, J. K. Deegwal and M. M. Sharma, "Multiband Slotted Microstrip Patch Antenna for TD-LTE, ITU and X-band Applications," 2018 5th International Conference on Signal Processing and Integrated Networks (SPIN), 2018, pp. 745-748, doi: 10.1109/SPIN.2018.8474185.

[12] Kumar, Alok& Gupta, Nancy. (2016). Gain and Bandwidth Enhancement Techniques in Microstrip Patch Antennas - A Review. International Journal of Computer Applications. 148. 9-14. 10.5120/ijca2016911207.

[13] M. Samsuzzaman and M.T. Islam (2014) Inverted S- Shaped Compact Antenna For X- Band Applications on the Scientific World Journal 456-765-23.567/ytjh562256.

[14] Devendra Pratap, Satyendra Sharma; 'Planning and Modelling of Indoor WLAN Through Field Measurement at 2.437 GHz Frequency',Volume No.2,Issue No.2,2014,PP.015-019,ISSN :2229-5828

[15] Verma, Garima; 'Agile Software Development : An Alternative Approach to Software Development',Volume No.2,Issue No.2,2014,PP.020-023,ISSN :2229-5828

[16] H.S. Pali, N.kumar; 'Biodiesal Production from Sal (Shorea Robusta) Seed Oil',Volume No.2,Issue No.2,2014,PP.024-029,ISSN :2229-5828

[17] Maneesh Kumar , Rajdev Tiwari, Rajeev; 'Automated Test Case Genration on the Basis of Branch Coverage Using Teaching Learning Based Optimization',Volume No.2,Issue No.2,2014,PP.030-036,ISSN :2229-5828

[18] Meenakshi Saini,Nitin Kathuria, V.K.Pandey; 'L Slot Circularly Polarized Broadband Antenna',Volume No.2,Issue No.2,2014,PP.037-041,ISSN :2229-5828

[19] Patro, B.Narasingh; 'Content Based Image Retrival Thro-ugh Features Like Color ,Texture and Shape',Volume No.2,Issue No.2,2014,PP.042-046,ISSN :2229-5828

[20] Prabhaker Agarwal , S.P.Singh, V.K.Pandey; 'Spectrum Shaping Analysis Using Tunable Parameter of Fractional Based Dirichlet Window',Volume No.2,Issue No.2,2014,PP.047-051,ISSN :2229-5828

Publisher: Noida Institute of Engineering & Technology,
19, Knowledge Park-II, Institutional Area, Greater Noida (UP), India.