International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

A Compact Broadband Rectangular Microstrip Antenna with Slotted Ground

Rathod Pratik[1], Sanyog Rawat[2]

[1, 2]ASET-ECE, Amity University, Kant Kalwar, NH-11C, Jaipur Delhi Highway, Jaipur, Rajasthan 303007, India

Abstract: ***This paper presents a compact new design of broadband microstrip antenna. The proposed antenna has a compact dimension of 30mm×30mm×1.66mm. The simulation of this antenna has been done by CST MICROWAVE STUDIO. The simulation result of the antenna exhibits wider bandwidth of 68.83% ranging from 2.435GHz -4.77GHz, constant gain throughout the range more than 3 dB as well as the omnidirectional radiation pattern.***

Keywords: Broadband slotted ground, Rectangular MSA.

1. Introduction

In the current scenario rapid enhancement and need for compact multifunctional wireless communication system has laid the development of broadband and multiband antenna with compact size. Microstrip patch antenna is widely used in this aspect as it provides various advantages. However the narrow operating bandwidth is its limitation.

As we know that MSA suffers from narrow bandwidth, there are several known techniques to increase the bandwidth of the MSA including increment of substrate thickness [1], parasitic patch can be used for bandwidth enhancement of the microstrip antenna [2-8], by using various feeding and impedance matching techniques [9], and use of slot geometry [10]. Design of wide band antenna for wireless technology is presented in [9, 10].

In this paper, a novel design for various microwave S-band applications such as Direct-to-Home Television, Airport Surveillance Radars, Amateur Radios, Amateur Satellite, WiMAX Standards of 3.5-GHz and IEEE 802.11y Standard have been designed and simulated using CST Simulation tool. The integral element is rectangular patch and the slotted line in the ground for obtaining the broadband operation of the antenna. The simulated result of the proposed antenna is presented and discussed.

The analysis and design of the proposed antenna have been done by CST MICROWAVE STUDIO simulator, which is based on the finite-element method (FEM). The FEM is a well-known technique which is capable of modeling 3D complex structures with inhomogeneity [9].

2. Antenna Design

The antenna design is as shown in figure-1. The antenna geometry consists of a compact dimension as 30mm×30mm×1.66mm. The rectangular patch is mounted on FR-4 dielectric substrate thickness of 1.59mm with dielectric constant (i.e. εr-4.4).Several simulations were carried out to get optimized design as well as result of the antenna by simulator and the resultant optimize parameter are as below.

W=30mm, L=30mm, W1=8mm, L1=14mm, L2=3mm, Wf=2mm, W2=22mm, W3=3mm, l=5mm, l1=l3=2mm, l2=14mm.

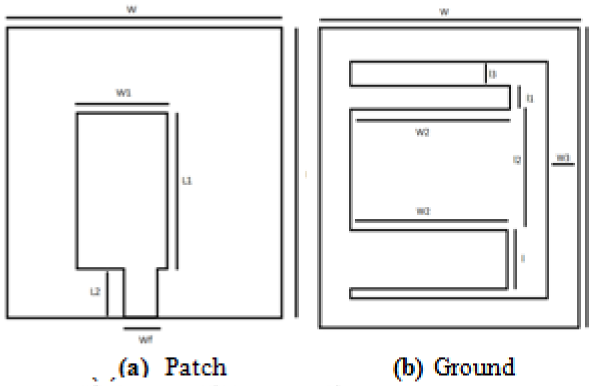

Figure-1: Antenna Design

3. Antenna Simulation and Results

Initially the antenna is simulated without two rectangular slots with same dimension of patch and rectangular ring of width W3 as ground structure and result of the initial simulation depicts in the below figure-2.

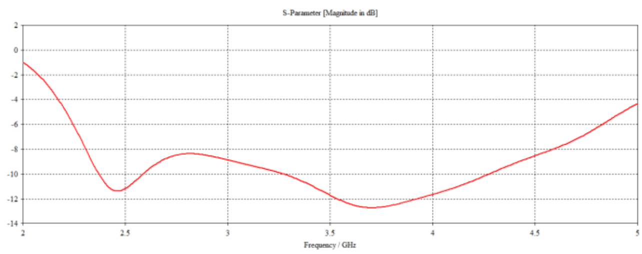

Figure 2: Initial simulation result.

The overall proposed antenna geometry as shown in figure-1 has been simulated for the broadband performance. By simulating the proposed antenna geometry we get the resonant frequencies are 2.595 GHz and 4.21 GHz with the return losses of -13.44dB and -30.55dB respectively and the resultant impedance bandwidth below -10dB return loss of the proposed antenna is 2.335 GHz which is shown in Figure-3.

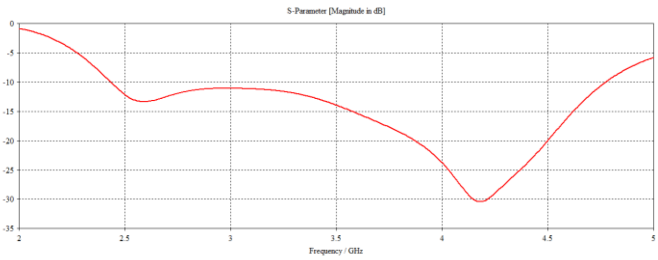

Figure 3: Return loss of proposed antenna.

Figure-4 shows the variation in the inserted rectangular slot's width "l" and "l1" as shown in figure-1. From the graph we can notice that as we decrease the width of the rectangular slots the bandwidth is increasing.

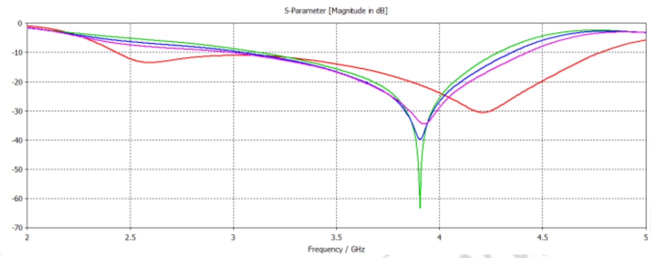

Figure 4: Variation in proposed antenna.

Figure-5 and Figure-6 shows the fairly good omnidirectional characteristics of radiation pattern at the resonant frequencies at 2.595 GHz and 4.21 GHz respectively.

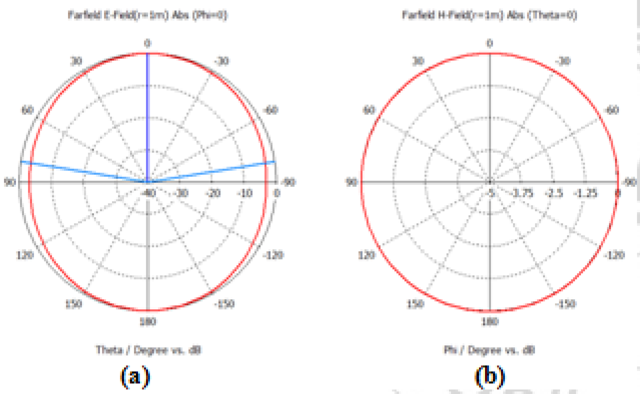

Figure 5: (a) E-Field (b) H-field radiation Pattern at 2.595 GHz.

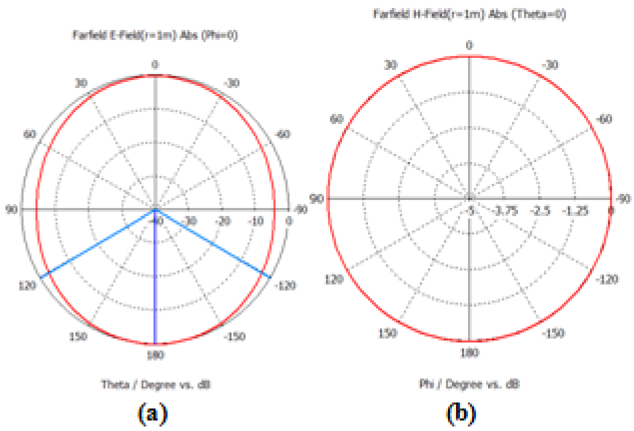

Figure 6: (a) E-Field (b) H-field Radiation pattern at 4.21GHz.

While the average 3dB gain through entire bandwidth of the proposed antenna is shown in figure-7 as well as the surface current at resonant both resonant frequency is given in figure-8.

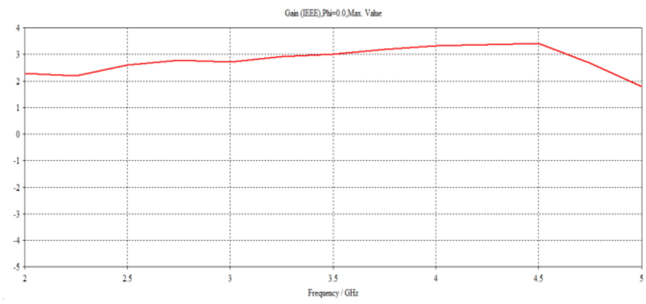

Figure 7: Final Gain of the proposed antenna

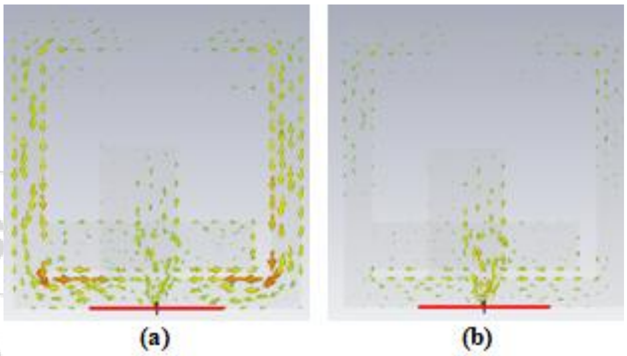

Figure 8: Surface current (a) 2.595 GHz, (b) 4.21 GHz

4. Conclusion

We can observe from the simulation result that proposed antenna is very well suited for the various microwave S-band applications. We have broadband simulated bandwidth of 68.83% ranging from 2.435GHz -4.77GHz. This is applicable for Direct-to-Home Television (2.5 GHz-2.7 GHz), Airport Surveillance Radars (2.7 GHz-2.9GHz), Amateur Radios (3.3GHz-3.5 GHz), Amateur Satellite (3.4GHz-3.475GHz), WiMAX Standards of 3.5-GHz (3.3–3.6 GHz) and IEEE 802.11y Standard (3.62GHz-3.7 GHz). Proposed antenna has balanced radiation pattern as well as stable gain over the entire range of bandwidth.

References

[1] D.H.Schaubert, D.M.Pozar, and A. Adrian,"Effect of microstrip antenna substrate thickness and permittivity: Comparison of theories and experiment," IEEE Trans. Antenna Propag., vol. AP-37,pp.677-682.

[2] Sand-Hyuk Wi, Yong-Shik Lee, Jong-gwan Yook, "Wideband Microstrip Patch Antenna with U-shapedParasitic Element" IEEE Transaction on Anennas And Propagation, Vol.55, No. 4, pp. 1196-1199, April-2007.

[3] C.-F. Tseng, C.L. Huang, C.H. Hsu, "Microstrip Fed Monopole Antenna with A Shorted Parasitic Element for Wideband Application", Progress in Electromagnetics Research Letters Vol. 7, pp.115-125, 2009.

[4] Deshmukh, A.A.; Joshi, A.A.; Tirodkar, T.A.; Ray, K.P., "Broadband Gap-Coupled Slot Cut Rectangular Microstrip Antennas," India Conference (INDICON), 2013 Annual IEEE, Mumbai.

[5] Wood, C.; "Improved Bandwidth of Microstrip Antennas using Parasitic Elements" Microwaves, Optics and Antennas, IEEE Proceedings H (Volume: 127, Issue: 4).

[6] Oraizi, H.; Hamidkhani, M., "Wide-Band Microstrip Patch Antennas using Parasitic Elements and Defected Ground Structures on Different Substrates", 2010 IEEE Middle East Conference on Antennas and Propagation (MECAP)

[7] Bharat Rochani , Rajesh Kumar Raj. "Design of Broadband Microstrip Patch Antenna with Parasitic Elements"IJAREEIE Vol. 3, Issue 6, pp.9953-9957, June-2014

[8] S.J. Vaughan-Nicolls, "Achieving wireless Broadband with WiMax",Computer, pp10-13, Jun. 2004.

[9] H. F. Pues and A.R. van de Capelle, "An impedence-matching technique for increasing bandwidth of microstrip antennas," IEEE Trans. Antenna Propag., vol. AP-37, no. 11, pp. 1345-1354, Nov.1989.

[10] S.-H.Wi, J.-M. Kim, T.-H.Yoo, H.-J. Lee,J.-Y.Park, J.-G.Yook and H.-K. Park,"Bow-tie-shaped meander slot antenn for 5 GHz application," in Proc. IEEE Int. Symp. Antenna and Propagation,Jun.2002, vol. 2, pp. 456-459.

[11] M. Amina, N. Saman, and H. AbdEl-Raouf, "Simulation and Design of Wide-Band Patch antennas for Wireless technology", Proc. 'EuCAP 2006', Nice, France, 6-10 November 2006.

[12] J. L. Bolakis, A. Chatterjee, and L. C. Kempel, Finite Element Method for Electromagnetic , IEEE Press and Oxford University Press, New York, 1998.

Author Profile

Rathod Pratik pursuing his M.Tech in Electronics and Communication Engineering from Amity University Rajasthan. He did his master's dissertation work at RRCAT, Indore for six months as a project trainee in Pulsed High Power Microwave Section (PHPMS). He received his graduation in Electronics and Telecommunication Engineering in 2010.