ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 12, December 2013

Design and Bandwidth Enhancement of Rectangular Microstrip Patch Antenna using Double H-Slot Technique for Broadband Applications

Arun K. Saurabh[1], Sunil Kumar[2], D. K. Srivastava[3]

M.Tech Student, ECE, Bundelkhand Institute of Engineering and Technology, Jhansi, Uttar Pradesh, India[1]

M.Tech Student, ECE, Bundelkhand Institute of Engineering and Technology, Jhansi, Uttar Pradesh, India[2]

Associate Professor, ECE, Bundelkhand Institute of Engineering and Technology, Jhansi, Uttar Pradesh, India[3]

Abstract: In this paper, the bandwidth enhancement of microstrip patch antenna is done by cutting double H slot into dimension calculated rectangular patch. The design antenna obtained good results such as bandwidth 1786MHz (70.04% fractional bandwidth), efficiency (100%), VSWR (1.159) and gain 4.032dB at calculated resonant frequency of 2.391GHz and the operating frequency range of antenna is 1.657-3.443GHz. The broadband characteristics of antenna are shown in simulated application results of design double H slot microstrip patch antenna. The designed structure and performance of antenna is simulated using IE3D Zealand simulation software. The antenna is fed by 50Ωmicrostrip line feed.

Keywords: Calculated ground plane, Calculated microstrip patch [MSP], Enhance bandwidth, Double H- Slot, IE3D simulator, 50Ωmicrostrip line feed.

INTRODUCTION

At that time the demand of microstrip patch [MSP] antenna increases day by day because antennas play an important role for broadband devices such like mobile phone, radio, laptop with wireless connection [17].

The purpose of new design antenna presents to enhance the bandwidth of double slotted H shape MSP antenna for many broadband applications such as military, wireless communication, satellite communication, global positioning system (GPS), RF devices, WLAN/WI -MAX application [8, 11]. The major drawbacks of MSP antennas in basic form are narrow bandwidth and low gain [7] and many techniques are used to enhance bandwidth and gain of MSP patch antennas. By using thick substrate with low dialectic constant and compact slotted patch can enhance the bandwidth and gain of antennas [16]. The MSP antenna have good features such as low cost, low profile, light weight, high efficiency, simply manufacture and easy to implement with circuits [8, 10, 16].The design structure components of antenna become small in size and have low processing cost [11].

In this paper transmission line method are used to analysis the rectangular MSP antenna. The design resonant frequency of rectangular MSP antenna is 2.5GHz with 50Ωmicrostrip line feed. MSP antenna is characterized by using thickness (h), dialectic constant (ε_r), and length (L_g, L), width (W_g, W) of ground plane and patch. The performances of design MSP antenna such as radiation pattern, return loss, directivity, VSWR and gain are simulated by using IE3D software.

II. MATHEMATICAL FORMULAS TO CALCULATE DIMENSIONS OF M S P ANTENNA

The mathematical formula is used to calculate the dimensions of ground plane and patch in the form of length and width.

A.

Width formula of Rectangular MSP is taken by [1, 8].

$$W = \left(\frac{c}{2f_r}\right)\left(\frac{\varepsilon_r + 1}{2}\right)^{-.5}$$

Where $c = 3\times10^8$ ms^{-1}, εr =4.2, f_r =2.5GHz

B.

ormula of effective dielectric constant is taken by [4, 15].

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 12, December 2013

$$\varepsilon_{eff} = \left(\frac{\varepsilon_r + 1}{2}\right) + \left(\frac{\varepsilon_r - 1}{2}\right)\left(1 + \frac{12W}{h}\right)^{-.5}$$

At h=1.6mm

C.

ormula of length extension is taken by [1, 4].

$$\Delta L = .412h\left(\frac{\varepsilon_{eff} + .3}{\varepsilon_{eff} - .258}\right)\left(\frac{\left(\frac{W}{h}\right) + .264}{\left(\frac{W}{h}\right) + .8}\right)$$

D.

ength formula of Rectangular MSP is taken by [5, 8].

$$L = \left(\frac{c}{2 f_r \sqrt{\varepsilon_{eff}}}\right) - 2\Delta L$$

E.

ormula of length and the width of the ground plane are taken by [1, 11].

$$L_g = L + 6h$$

$$W_g = W + 6h$$

III. ANTENNA DESIGN SPECIFICATIONS

Calculated dimensions of ground plane is constructed by using resonant frequency (f_r), dielectric constant (ε_r), substrate thickness (h) and loss tangent ($tan\ \delta$) and 50Ωmicrostrip line feed is fed into patch. Calculated dimensions are obtained by using formula and double H slot cut into the rectangular patch.

TABLE 1
DESIGN SPECIFICATIONS PARAMETER OF ANTENNA

S. NO	Antenna Parameter	Data
1.	Resonant frequency (f_r)	2.5GHz
2.	Substrate thickness (h)	1.6mm
3.	Dielectric constant (ε_r)	4.2
4.	Loss Tangent ($tan\ \delta$)	.0013

IV. ANTENNA DESIGN PROCEDURE

Using the above equations and geometrical parameters, dimensions of antenna is calculated. In the design of antennas first calculate the dimensions of ground plane and patch then antenna is designed by using dimensions after that slots cut into the microstrip patch.

TABLE 2CALCULATED ANTENNA DIMENSIONS

S. NO	Antenna Dimension	Data
1.	Ground plane width (W_g)	46.8 mm
2.	Ground plane Length (L_g)	37.4 mm
3.	Patch width (W)	37.2 mm
4.	Patch length (L)	27.8 mm

The calculated design of double H slot shape MSP antenna is shown in Fig. 1.

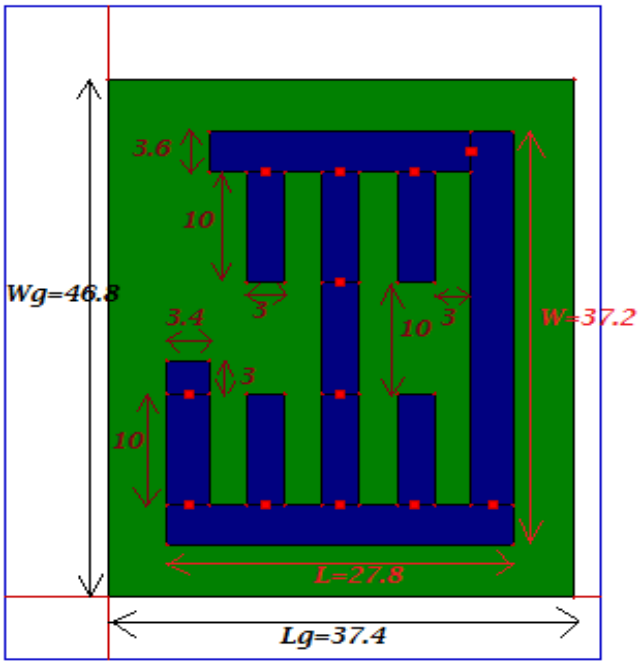

Fig. 1.Geometry of design antenna and all dimensions in mm

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 12, December 2013

V. SIMULATION RESULT AND DISCUSSION

The simulation performances of design MSP antenna is analyzed by using IE3D software at define resonant frequency of 2.5GHz and antenna successfully obtained 2.391GHz resonant frequency at peak point of return loss.

The plot graph of return loss Vs frequency is taken at the maximum frequency of 3.5GHz which is shown in Fig. 2.The enhances bandwidth 1786MHz (70.04% fractional bandwidth) of design antenna is obtained at calculated resonant frequency of 2.391GHz.

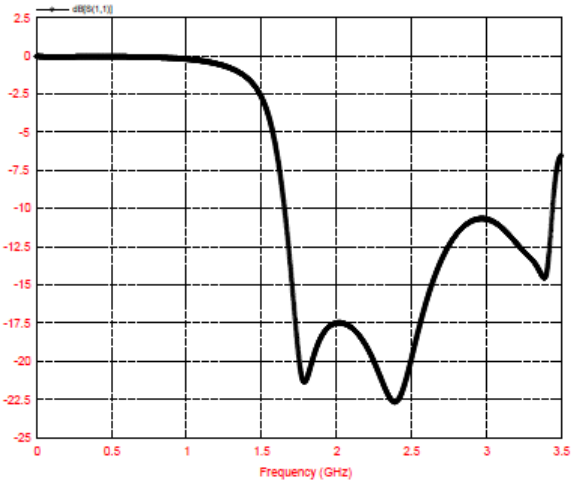

Fig. 2. Return loss vs. frequency graph

In Fig. 3, the plot graph of Gain Vs Frequency shows the total field gain of the MSP antenna and obtain maximum gain of antenna is 4.032dB at resonant frequency 2.391GHz.

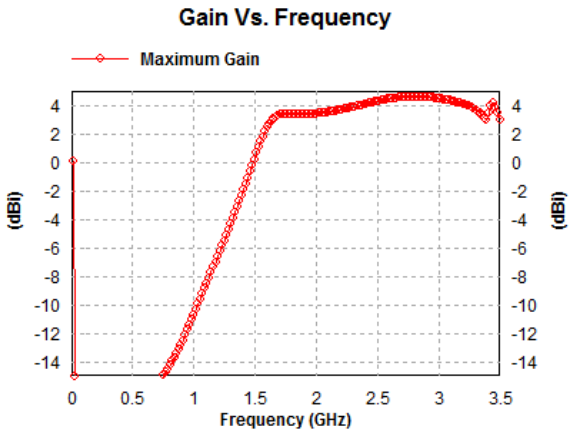

Fig. 3. Gain vs. frequency plot

In Fig. 4, the plot graph of Efficiency Vs Frequency represents radiating efficiency and antenna efficiency. The obtain percentage antenna efficiency is 100 at 2.391GHz.

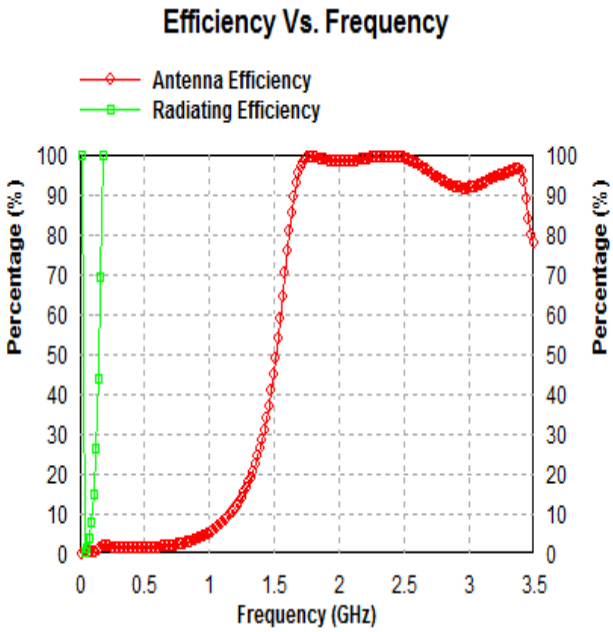

Fig. 4. Efficiency vs. frequency plot

In Fig. 5, the plot graph of VSWR Vs Frequency represents that the bandwidth of design antenna is useful or not. The obtain VSWR is 1.159 at resonant frequency of 2.391GHz.

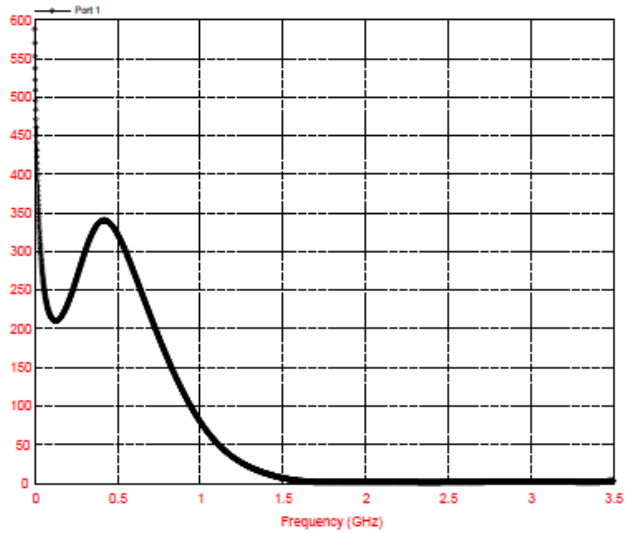

Fig. 5. VSWR vs. frequency plot

In Fig. 6, the plot graph of 2D radiation pattern of antenna represents radiating all power in one direction therefore design antenna has unidirectional radiation pattern. 2D radiation pattern of antenna is shown at resonant frequency 2.391GHz and phi=0(deg).

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 12, December 2013

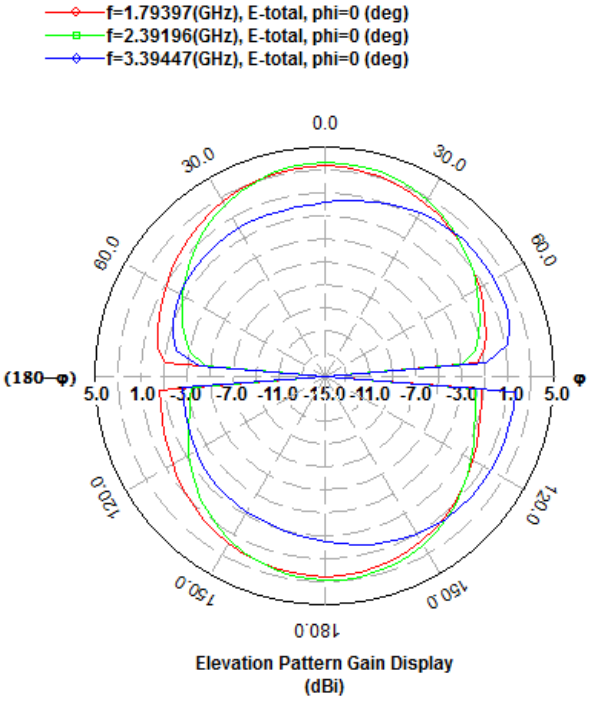

Fig. 6. 2D radiation pattern of antenna

In Fig. 7, the plot graph of total field Directivity Vs Frequency represents the ratio of radiation intensity in a given direction from the antenna to the radiation intensity averaged over all direction [14]. The obtain directivity of antenna is 3.92dB at resonant frequency 2.391GHz.

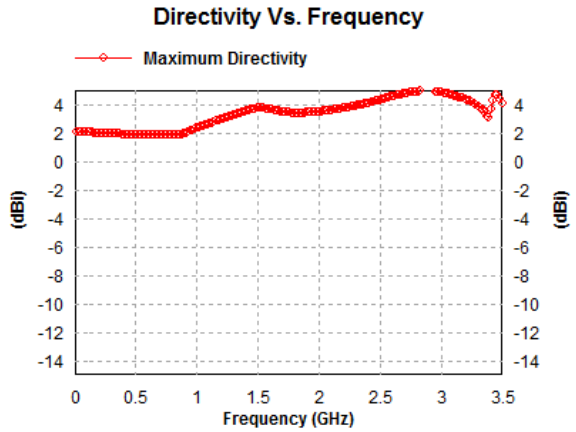

Fig. 7. Directivity vs. frequency plot

In Fig. 8, the plot graph of Axial-Ratio Vs Frequency represents the ratio of the major axis to the minor axis of the polarization ellipse and the resulting pattern shows an oscillating pattern [9].

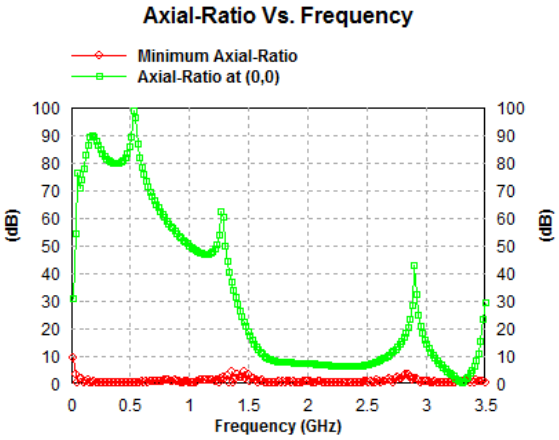

Fig. 8. Axial-ratio vs. frequency plot

VI. CONCLUSION

In this paper, the simulated results of double H slot rectangular MSP antenna with 50Ωmicristrip line feed are obtained. The obtain results of design antenna are enhance bandwidth 1786MHz (70.03% fractional bandwidth), operating frequency range 1.657-3.443GHz, gain (4.032dB), efficiency (100%), return loss (-22.6dB), VSWR (1.159) at resonant frequency of 2.391GHz.The obtain good performance results of design antenna can be used as various broadband applications such as missile, wireless, satellite, mobile communication, and military.

ACKNOWLEDGMENT

The authors gratefully acknowledge the support to carry out this study and work from Electronic and Comm. Engineering department of Bundelkhand Institute of Engineering and Technology, Jhansi, Uttar Pradesh, India

REFERENCES

[1] Constantine A., Balanis ‘‘Antenna Theory, Analysis and Design,” John Wiley & Sons, Inc., Hoboken, New Jersey, 2005.
[2] D. G. Fang, ‘‘Antenna Theory and Microstrip Antenna”.
[3] Chuan-Ling Hu, Chang-Fa Yang and Shun-Tian Lin, “A Compact Inverted-F Antenna to be Embedded in Ultra-thin Laptop Computer for LTE/WWAN/WI-MAX/WLAN Applications,” IEEE Trans. AP-S/USRT, 978-1-4244-9561, 2011.
[4] T. Jayanthy, M. Sugadev, J. Mohamed Ismaeel, and G. Jegan, “Design and Simulation of Microstrip M-Patch Antenna with Double Layer,” IEEE Trans. AP- 978-1-4244-2690-4444, 2008.
[5] Mohammad Tariqul Islam, Mohammed Nazmus Shakib, Norbahiah Misran, and Baharudin Yatim, “Analysis of Broadband Slotted Microstrip Patch Antenna,” IEEE Trans. AP-1-4244-2136, 2008.
[6] C. L. Mak, K. M. Luk, K. F. Lee, and Y. L. Chow, “Experimental Study of Microstrip Patch Antenna with an L-Shaped Probe,” IEEE Trans. AP-48(2000)777-783.
[7] Karim A. Hamad, “Design and Enhancement Bandwidth of Rectangular Patch Antenna Using Single Trapezoidal Slot Technique,” ARPN-JEAC, ISSN: 1819-6608, Vol. 7, No. 3, March – 2012.
[8] D. Bhattacharya, and R. Prasanna, “Bandwidth Enrichment for Micro-strip Patch Antenna Using Pendant Techniques,” IJER, ISSN: 2319-6890, Volume No.2, Issue No. 4, pp. 286-289, Aug. – 2013.

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 12, December 2013

[9] Alak Majumder, "Design of an H-shaped Microstrip Patch Antenna for Bluetooth Applications," IJIAS, ISSN: 2028-9324, Vol. 3, No. 4, pp. 987-994, Aug. – 2013.
[10] D. Pavithra, and K .R. Dharani, "A Design of H-Shape Microstrip Patch Antenna for WLAN Applications," IJESI, ISSN: 2319-6734, Vol. 2, pp.71-74, Issue 6, June - 2013.
[11] Sukhbir Kumar, and Hitender Gupta, "Design and Study of Compact and Wideband Microstrip U-Slot Patch Antenna for WI-Max Application," IOSR-JECE, ISSN: 2278-2834, Vol. 5, Issue 2, pp. 45-48, (Mar. – Apr. - 2013).
[12] Akanksha Gupta, and Archana Sharma, "Design of probe feed multi slotted 8-shaped microstrip antenna," IJARECE, ISSN: 2278 – 909X, Volume 2, Issue 2, February 2013.
[13] Praveen Kumar Kancherla, Sanjeeva Rao Kunchala, Shaik, Abdul Salam, and B. Madhavi, "Band width Enhancement of Co-axial Feed Rectangular Micro strip Patch Antenna," IJERT, ISSN: 2278-0181, Vol. 2 Issue 2, February- 2013.
[14] Prabhaker Singh, G.S. Tripathi, and Amit Kumar Gupta, "Design of Small Size Extended T-Shaped Patch Microstrip Antenna," VSRD International Journals, e-ISSN: 2231-3346, p-ISSN: 2319-2232, Vol. No 3, 1 January-2013.
[15] Parminder Singh, Anjali Chandel, and Divya Naina, "Bandwidth Enhancement of Probe Fed Microstrip Patch Antenna," IJECCT, ISSN: 2249-7838, Vol. 3, Issue 1, January - 2013.
[16] Parikshit Vasisht ,and Taruna Gautam, " Design of V-Slotted Trapezoidal Patch Antenna in WI-MAX Band Using Optimized Feed Location Method," IJETAE, ISSN: 2250-2459, Vol. 2,Issue 6,June - 2012.
[17] Avisankar Roy, and Sunandan Bhunia, "Compact Broad Band Dual Frequency Slot Loaded Microstrip Patch antenna with Defecting Ground Plane for WI-MAX and WLAN," IJSCE, ISSN: 2231-2307, Vol.1, Issue-6, January -2012.
[18] Thakur O.P., Dwari S., and Kushwaha A.K., "Enhancement of Bandwidth by Using Photonic Band Gap Structure in Microstrip Antenna," IJCIT, ISSN: 0976-0474, Vol. 3, pp. 112-113, issue 2, 2012.

BIOGRAPHIES

Arun K. Saurabh received his B.Tech (ECE) from Anand Engg. College, Agra, Uttar Pradesh, India and M.Tech (Digital Comm.) student in ECE department of Bundelkhand Institute of Engineering and Technology, Jhansi, Uttar Pradesh, India. His area of interest lies in the field of Microstrip Antenna designing, Frequency selective surfaces and Microwave engineering.

Sunil Kumar received his B.Tech (ECE) from Anand Engg. College, Agra, Uttar Pradesh, India and M.Tech (Digital Comm.) student in ECE department of Bundelkhand Institute of Engineering and Technology, Jhansi, Uttar Pradesh, India. His area of interest lies in the field of Antenna designing and Microwave engineering.

D.K.Srivastava is an Associate Professor in the ECE department of Institute of Engineering and Technology, Jhansi, Uttar Pradesh India. He has more than 14 years of experience in teaching and research work. He has published around forty papers in reputed international journals and also he has presented more than thirty research articles in national and international conferences. His current area of research includes Microwaves and Optical communication. He is Member IEEE.