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Bandwidth Enhancement by slot loaded Patch Antenna for GPS/WLAN/WiMAX Applications

Sunil Kumar[1], N.S. Beniwal[2], D. K. Srivastava[3]

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

Assosiate Professor, 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 of rectangular microstrip patch antenna is enhanced by 'W' slotted patch antenna. It can be seen that bandwidth of microstrip antenna is increased up to great extant when antenna is loaded with multiple slots. In some applications where the increased bandwidth is needed, proposed antenna is one of the alternative solution. The frequency band of proposed antenna is in between 1.45-3.25 GHz. The fractional bandwidth of proposed antenna is 76.59%. The gain of the antenna has improved up to 5.05dB, directivity 5.32dBi and efficiency 99.89%.. Proposed antenna is suitable for WiMAX/GPS/WLAN applications. The proposed antenna has been designed on glass epoxy substrate having ϵ_r= 4.2 and the design frequency of proposed antenna is 2.2 GHz. The proposed W slotted microstrip antenna is fed by 50Ω microstrip feed line.

Keywords: Slot loaded, enhanced bandwidth, compact Microstrip (MS) Patch, radiation pattern, gain, 50Ω feed line.

I. INTRODUCTION

The progress in wireless communication assures to substitute wired communication network in the near future in which antennas plays the important role. In wireless communication microstrip patch antenna is gaining importance as a most powerful scientific trend. Its enormous potential promises major change in future of wireless application fields. Present scientific trend has focused much more attention towards microstrip antenna. Microstrip antennas are used in many applications in the field of communication systems to biomedical system, due to several attractive properties such as light weight, low production cost, low profile, reproducibility, reliability, conformability and integration with solid state devices. The disadvantages of microstrip antenna are their limited band width. Researchers investigated method to increase the bandwidth of microstrip patch antenna [2-6]. The proposed W-slotted rectangular microstrip patch antenna is proved to be one of the effective methods in enhancement of bandwidth. However, the obtained bandwidth in this case is comparatively very less when met with the requirements of the above applications [1].
Further enhancement in the antenna bandwidth is achieved by cutting rectangular slots at the edges of W fig1. The proposed antenna has been designed on glass epoxy substrate (ϵ_r= 4.2) [7, 8]. The substrate material has large influence in determining the size and bandwidth of an antenna. Increasing the dielectric constant decreases the size but lowers the bandwidth and efficiency of the antenna while decreasing the dielectric constant increases the bandwidth but with an increase in size. The design frequency of proposed antenna is 2.2 GHz. The frequency band(1.45-3.25GHz) of proposed antenna is suitable for broad band applications (1.605-3.381GHz) such as military, wireless communication, satellite communication, global positioning system (GPS), RF devices, WLAN/WI -MAX application [9, 10, 11].

II. ANTENNA DESIGN

For designing a rectangular microstrip patch antenna, the length and the width are calculated as below [10, 8, and13]

$$W = \frac{c}{2f_r}\sqrt{\frac{2}{\epsilon_r+1}}$$

Where c is the velocity of light, ϵ_r is the dielectric constant of substrate, fr is the antenna design frequency, W is the patch width, and the effective dielectric constant ϵ_{reff} is given as [7, 12]

$$\epsilon_{reff} = \frac{\epsilon_r+1}{2} + \frac{\epsilon_r-1}{2}\left[1+12\frac{h}{W}\right]^{-\frac{1}{2}}$$

At h = 1.6mm

The extension length ΔL is calculates as [7, 8 and 13].

$$\frac{\Delta L}{h} = 0.412\frac{(\epsilon_{reff}+0.3)(\frac{W}{h}+.264)}{(\epsilon_{reff}-.258)(\frac{W}{h}+0.8)}$$

By using the above mentioned equation we can find the value of actual length of the patch as, [15, 10, 13]

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$$L = \frac{c}{2f_r\sqrt{\epsilon_{reff}}} - 2\Delta L$$

The length and the width of the ground plane can be calculated as [9, 8 and 13]

$L_g = 6h+L$

$W_g = 6h+W$

III. ANTENNA PARAMETERS

The design of proposed antenna is shown in Figure1. The proposed antenna is designed by substrate which has a dielectric constant 4.2 and the design frequency is 2.2 GHz.

Height of the dielectric substrate is 1.6 mm and loss tangent *tan* δ is 0.0013. Antenna is fed through 50Ω microstrip feed line. Antenna dimensions are given in table 1 and other parameters are given in the table 2 (lengths in mm and frequency in GHz).

TABLE 1: ANTENNA DIMENSION

S.No	ANTENNA DIMENSION	SPECIFICATION
1.	Ground plane width , a	51.88
2.	Ground plane length , b	41.36
3.	Patch width , c	47.08
4.	Patch length , d	36.56
5.	e	6
6.	f	19.08
7.	g	5
8.	h	12
9.	i	7
10.	j	18.36
11.	k	37.2
12	l	8
13	m	3.76
14	n	11.2
15	o	7.2
16	p	6.2
17	q	4
18	r	4

TABLE 2: ANTENNA PARAMETER

S.No	ANTENNA PARAMETER	SPECIFICATION
1	Dielectric constant(ϵ_r)	4.2
2	Maximum frequency	3.5 GHz
3	Height of substrate(h)	1.6 mm
4	Loss tangent(tanδ)	0.0013

IV. ANTENNA DESIGN PROCEDURE

All the dimensions of proposed antenna are calculated by using the above mentioned equation. Design frequency taken is 2.2 GHz. The rectangular patch is first grown and then it is loaded with W slot as shown in Figure1.

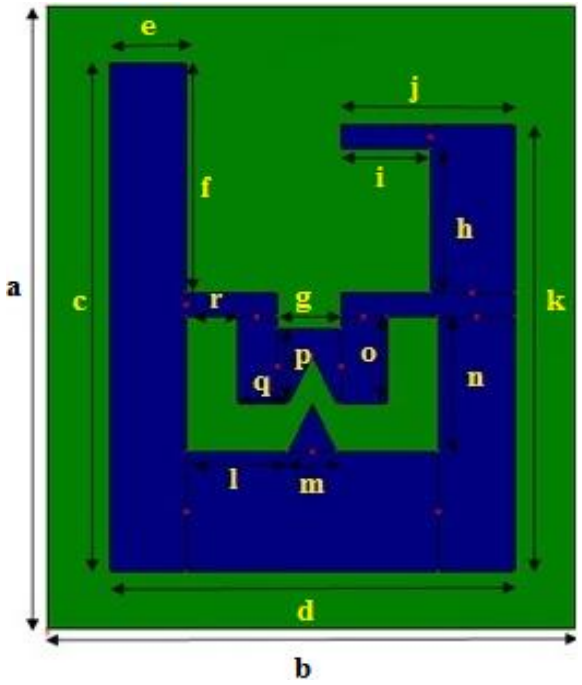

Figure 1: Geometry of proposed antenna

V. SIMULATION RESULT AND DISCUSSION

The proposed rectangular microstrip antenna studied successfully and it is found that it provides 76.59% high bandwidth and returns loss up to -38.31dBi. Proposed microstrip antenna provides high gain up to 5.05 dBi, efficiency 99.89% and good return loss up to -38.31 dBi. The narrow bandwidth of microstrip antenna is one of the important features that restrict its wide usage**.** From the above it is clear that W shaped patch antenna which provides high bandwidth and high return loss. The

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maximum gain of the antenna has been improved up to 5.05 dBi, directivity improved up to 5.32 dBi, efficiency of the antenna is found to be 99.89 %, and the VSWR of the antenna is in between 1 to 2 over the entire frequency band which shows good impedance matching.

The simulation performance of proposed micro strip patch antenna is analyzed by using IE3D simulation software version 9.0 at select design frequency of 2.2 GHz. The performance specifications like gain, radiation pattern etc of proposed antenna is shown in the Figures 2 to 9.

The plot graph of return loss Vs frequency is taken at the maximum frequency of 3.5GHz which is shown in Figure. 2. Bandwidth is increase to 1800MHz (76.59% fractional bandwidth) of design antenna.

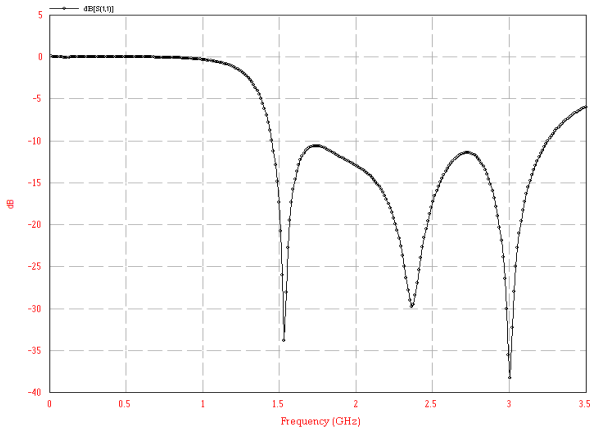

Figure 2: Return loss v/s frequency graph

Figure 3, shows the plot of 3D Radiation pattern of proposed antenna at resonant frequency 2.364 GHz.

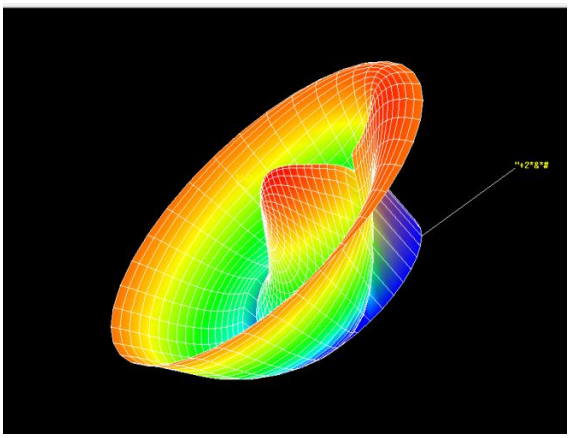

Figure 3: 3D Radiation pattern of proposed antenna

In Figure. 4, the graph of Gain Vs Frequency shows the total field gain of the MSP antenna and obtain maximum gain of antenna is 5.05 dBi.

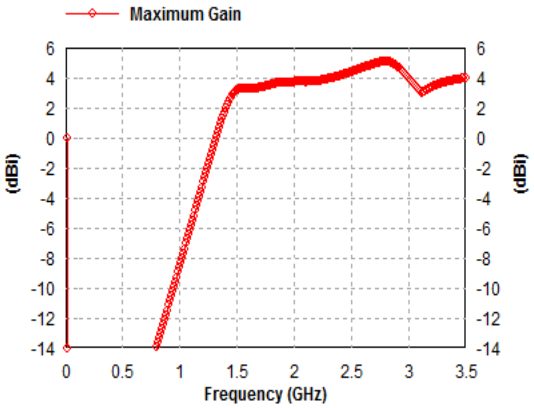

Figure 4: Gain vs. frequency plot

Figure. 5, the plot of VSWR Vs Frequency represents that the bandwidth of design antenna is useful or not. The obtain VSWR is 1.066 at resonant frequency of 2.364GHz.

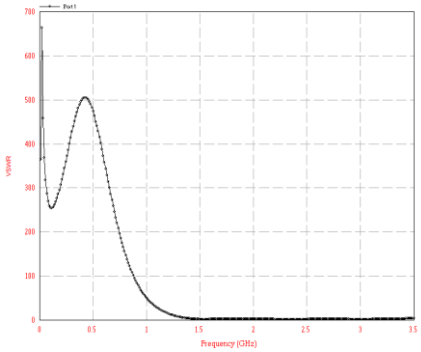

Figure 5: VSWR of proposed antenna

In Figure. 6, 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 [16]. The obtain directivity of antenna is 5.32dBi.

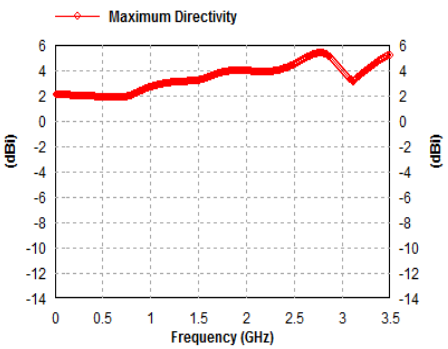

Figure 6: Directivity v/s frequency plot

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In Figure. 7, Smith chart of proposed antenna is shown.

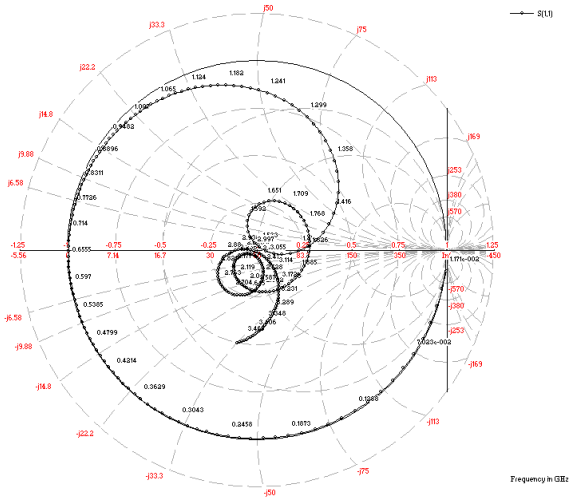
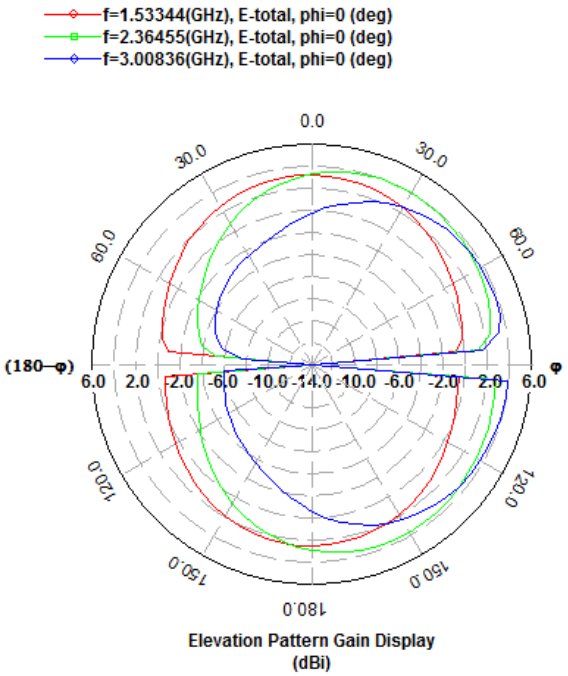


Figure 7: Smith chart

In Figure. 8, 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 2.364GHz and phi=0(deg).



Figur e 8: 2D radiation pattern of antenna

In Figure. 9, the plot graph of Efficiency Vs Frequency represents antenna efficiency. The obtain percentage antenna efficiency is 99.89% at 2.364GHz.

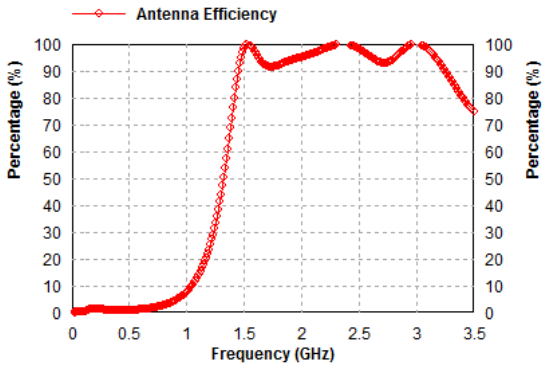


Figure 9: Efficiency graph of proposed antenna

VI. CONCLUSION

A novel technique for enhancing bandwidth of a microstrip patch antenna with single band characteristics and wide bandwidth capability for broad band applications is successfully designed and discussed. Microstrip patch antenna for broad band applications covering 1.45 to 3.25 GHz frequency has been presented. The proposed rectangular microstrip antenna it provides 76.59% high bandwidth, return loss up to -38.31dBi and efficiency 99.89%. The simulated result of design antenna shows good performance and thus can be used as various broadband applications such as missile, wireless, satellite, mobile communication, and military.

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REFERENCES

[1] Mohammed Nazmus Shakib, Mohammad Tariqul Islam, Norbahiah Misran, "Design of a Broadband Low Cross-polarization W-shape Microstrip Patch Antenna for MIMO System." 2008 IEEE INTERNATIONAL RF AND MICROWAVE CONFERENCE PROCEEDINGS December 2, 2008

[2] et al., Garg. Ramesh, Microstrip Antenna design Hand book, 2001 Artech house, Inc., 2005

[3] J.F.Aurcher, A.K. Skrivervik, O staub and J.R. Mosig., PCS Antenna Design: The challenge of miniaturization, IEEE Antennas and propagation Magazine,V0l,43,Issue 4,PP12-27,Aug-2001

[4] P.S. Hall., P, Gardner and D.Sing Miniaturized microstrip antenna for MMIC Applications, Electronic Letters.Vol.33, No22, PP-1930-1, October1997.

[5] K sarbndi and Bendad, N, "A Multiresonent single element wideband slot antenna" IEEE Trans. Antennas & wireless propagation let. Vol 3, 5-8, 2004.

[6] Size, K-L.Wing and J-Y, "Bandwidth enhancement of a microtrip-line fed printed wide slot antenna" IEEE Trans. Antennas and propagate, Vol49, No7, 1020-1024, July 2001

[7] T.Jayanthy, M.Sugadev, J.M. Ismaeel and G.Jegan, "Design and Simulation of Microstrip M- Patch Antenna with Double Layer", IEEE Trans., AP- 978-1-4244-2690-4444, 2008.

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

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 3, Issue 1, January 2014

[8] Constantine A. Balanis, ‘‘Antenna theory, Analysis and Design”, John Wiley & Sons, Inc Hoboken, New Jersey, 2005.
[9] 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).
[10] 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.
[11] 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.
[12] 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.
[13] K. V. Rop, D. B. O. Konditi, H. A. Ouma and S. M. Musyoki, “Parameter optimization in design of a rectangular microstrip patch antenna using adaptive neuro-fuzzy inference system technique”, IJTPE Journal, ISSN 2077-3528, September 2012.
[14] 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.
[15] M. T. Islam, M. N. Shakib, N. Misran and B. Yatim, “Analysis of Broadband Slotted Microstrip Patch Antenna”, IEEE Trans. AP-1-4244-2136, 2008.
[16] 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

BIOGRAPHIES

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

N.S. Beniwal is an associate professor in the ECE department of Bundelkhand Institute of Engineering and Technology, Jhansi, Uttar Pradesh India. He has more than
10 years of experience. He has published around twelve papers in reputed international journals and also he has presented many research articles in national and international conferences. His Field of specialization are Control Systems and Transformers.

D.K.Srivastava is Associate Professor in the ECE department of Bundelkhand Institute of Engineering and Technology, Jhansi, Uttar Pradesh India. He has more than 18 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 of IEEE.