ISSN:0975-9646

Ram Singh Kushwaha et al, / (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 3 (2) , 2012,3523-3525

A Multi-Slotted Wide Microstrip Patch Antenna for Dual Frequency

Ram Singh Kushwaha[1], D.K.Srivastava[2], J.P.Saini[3]
[1]*Department of Electronics and Communication Engineering, BIET Jhansi, INDIA*
[2]*Department of Electronics and Communication Engineering, BIET Jhansi, INDIA*
[3]*Madan Mohan Malviya College of Engineering, Gorakhpur, INDIA*

Abstract— This paper presents a compact, wideband microstrip patch antenna with a E-shape slot for dual frequency. The proposed antenna operates at 1.95 GHz and 2.93 GHz bands. The antenna size is very compact (40 mm x 60 mm x 1.6 mm) and is fed from a 50 Ω microstrip line. Using IE3D software package of Zeland, according to the set size, the antenna is simulated. The computer simulation results show that the antenna can realize wide band characters. The two operating bands exhibit broad impedance bandwidths (VSWR ≤ 2) of about 25% and 15%.
Keywords— Microstrip antenna, E-shape slot, dual frequency, microstrip line, IE3D.

1. INTRODUCTION

The rapid development of wireless communication technology has increased the demand for compact microstrip antennas with high gain and wideband operating frequencies. Microstrip patch antennas are very advantageous because of their low cost, low profile, light weight and simple realization process. However, the general microstrip patch antennas have some disadvantages such as narrow bandwidth etc. Enhancement of the performance to meet the demanding bandwidth is necessary [1]. There are numerous and well-known methods to increase the bandwidth of antennas, including increase of the substrate thickness, the use of a low dielectric substrate, slotted patch antenna, the use of various impedance matching and feeding techniques [2-17].

This paper presents a new E-shaped slot loaded patch antenna that is investigating for enhancing the impedance bandwidth. By choosing the suitable slot shape, selecting a proper feed and tuning their dimensions, a large operating bandwidth is obtained. The design employs 50 Ω microstrip line feeding. The antenna is simulated using IE3D software package of Zealand. The results show that the impedance bandwidth has achieved a good match.

II. ANTENNA GEOMETRY

The dielectric constant of the substrate is closely related to the size and the bandwidth of the microstrip antenna. Low dielectric constant of the substrate produces larger bandwidth, while the high dielectric constant of the substrate results in smaller size of antenna. A trade-off relationship exists between antenna size and bandwidth [18].

The resonant frequency of microstrip antenna and the size of the radiation patch can be similar to the following formulas [19].

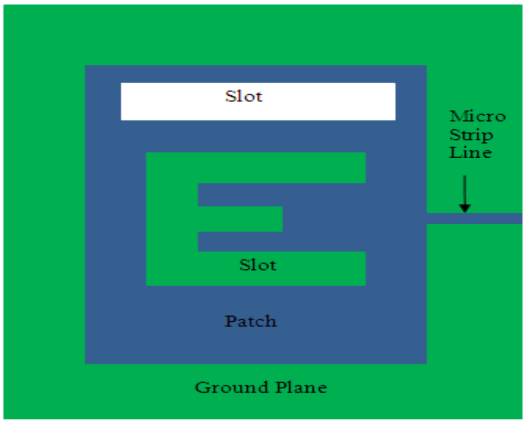
$$f \cong \frac{c}{2L\sqrt{\varepsilon_r}} \quad (1)$$

$$W = \frac{2}{f_r}\left(\frac{\varepsilon_r + 1}{2}\right)^{\frac{1}{2}} \quad (2)$$

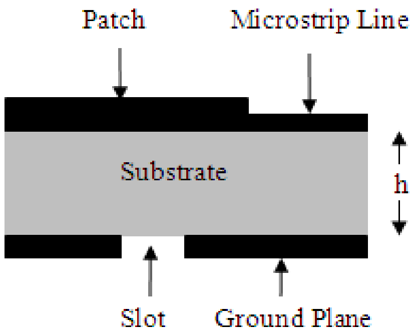
$$L = \frac{c}{2 f_r \sqrt{\varepsilon_r}} - 2\Delta l \quad (3)$$

Where f is the resonant frequency of the antenna, c is the free space velocity of the light, L is the actual length of the current, ε_r is the effective dielectric constant of the substrate and Δl is the length of equivalent radiation gap.

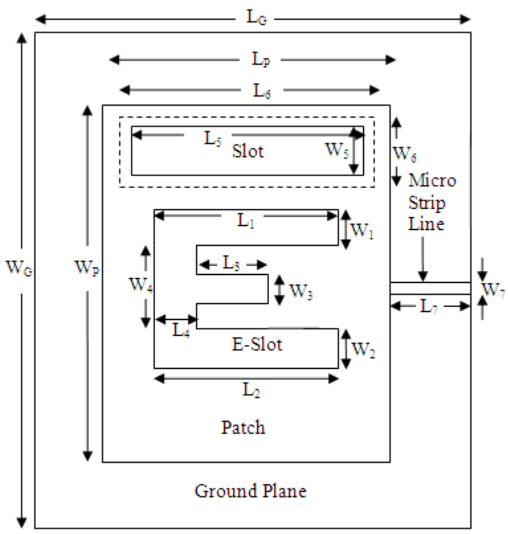
The geometries of the E-shaped slot antenna are shown in figure 1. The antenna is built on a glass epoxy substrate with dielectric constant 4.2 and height h of 1.6 mm. A substrate of low dielectric constant is selected to obtain a compact radiating structure that meets the demanding bandwidth specification. For the given design the slot and the feeding line are printed on the same side of the dielectric substrate. The geometry of the top view and side view of the proposed antenna is shown in figure 1 (a) and (b) respectively. The dimensions of the slotted patch are shown in figure (c). Here L_G and W_G represent the length and width of the ground plane which is finite whereas L_P and W_P are those of the patch. The lengths of the horizontal arms of the E-shape slot are defined by L_1, L_2 and L_3 where as W_1, W_2 and W_3 define the widths. The length and width of the vertical arm are defined by L_4 and W_4 respectively. The patch is also loaded with a horizontal slot at center coordinates (20, 50). The length and width of the slot are shown by L_5 and W_5 respectively. An additional horizontal slot is cut on the ground plane, whose length and width are shown by L_6 and W_6 respectively. The patch is fed by a 50 Ω microstrip line whose length and width are defined by L_7 and W_7 respectively. The use of microstrip line feeding technique provides the bandwidth enhancement. Table 1 shows the optimized design parameters for the proposed antenna.



(a) Top view of the antenna.



(b) Side view of the antenna.



(c) Dimensions of the antenna.

Fig.1. Geometry of the proposed antenna.

Table 1. The proposed patch antenna design parameters.

Parameter	Value [mm]	Parameter	Value [mm]
W_G	60	L_3	10
L_G	40	W_4	10
W_P	50	L_4	5
L_P	30	W_5	8
W_1	5	L_5	25
L_1	20	W_6	9
W_2	5	L_6	30
L_2	20	W_7	2
W_3	5	L_7	5

Reducing the size of the antenna is one of the key factors to miniaturize the wireless communication devices. However, reducing the antenna size will usually reduce its impedance bandwidth as well. Therefore designing a small antenna operating with a wide impedance bandwidth which satisfies future generation wireless application is a challenging work, especially having stable radiation patterns across the operating frequency band [20-21]. In this paper microstrip line feeding, slots on the patch as well as on ground plane provide the wide bandwidth and gain enhancement.

III. RESULTS AND DISCUSSIONS

The proposed antenna was simulated and optimized by IE3D software package of Zealand. This was used to calculate the return loss, impedance bandwidth and radiation pattern.

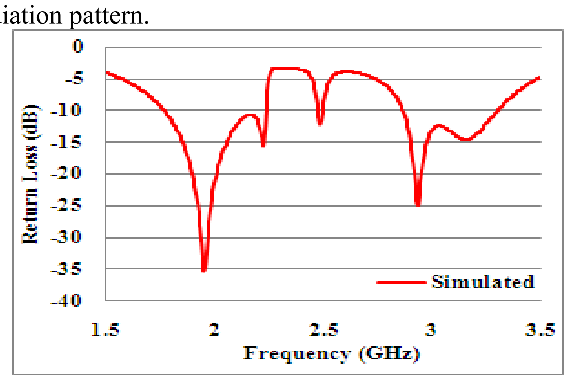
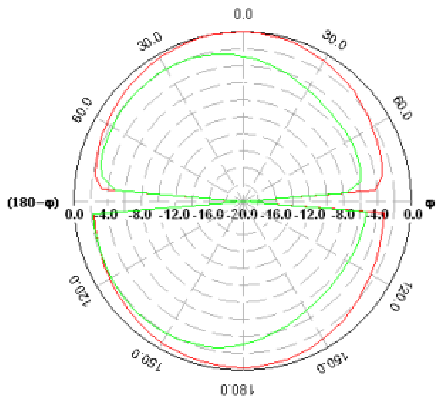
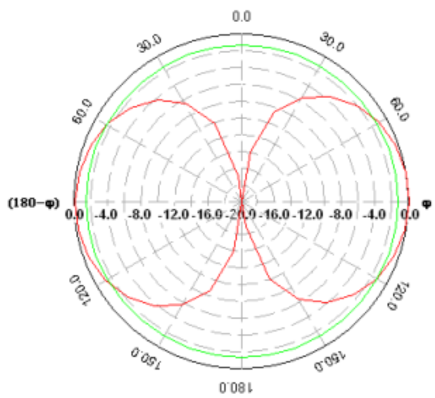


Fig.2. Simulated return loss of the proposed antenna.



(a)



(b)

Fig.3. Radiation pattern of the proposed antenna. (a) Elevation and (b) Azimuth.

The simulated -10 dB return loss of the proposed antenna is shown in the figure 2. The simulated result shows that the first band resonant frequency locates at about 1.95 GHz with the -10 dB impedance bandwidth from about 1.765 GHz to 2.238 GHz. The second band resonant frequency locates at about 2.93 GHz with the impedance bandwidth from about 2.865 GHz to 3.303 GHz. The -10 dB return loss impedance bandwidths for first and second band are 25% and 15% respectively. The simulated radiation patterns of the elevation and azimuth of the proposed antenna are shown in figure 3. It can be observed that the proposed antenna have the same radiation patterns over the entire frequency band.

IV. CONCLUSION

A novel compact dual-band slot microstrip antenna for 1.76/3.30 GHz is presented. The proposed antenna has a compact size of (40 mm x 60 mm x 1.6 mm) and it can effectively cover the AMPS, GSM and WLAN applications**.** Good antenna performance and impedance matching can be realized by adjusting the length and width of microstrip line. The two operating bands exhibit broad impedance bandwidths (VSWR ≤ 2) of about 25% and 15%. It can be concluded from the results that the designed antenna has satisfactory performance and hence can be used for indoor wireless applications.

REFERENCES

[1] Ramadan, A., K. Y. Kabalan, A. El-Hajj, S. Khoury, and M. Al-usseini, *"A reconfigurable U-Koch microstrip antenna for wireless applications,"* Progress In Electromagnetics Research, PIER 93, 355-367, 2009.

[2] Kawei Qian and Xiaohong Tang, "*Compact LTCC dual-band circularly polarized perturbed hexagonal microstrip antenna,*" IEEE Antennas and Wireless Propagation Letters, Vol. 10 pp. 1212-1215,2011.

[3] K. Kumar and N. Gunasekaran, "*A novel wideband slotted mm wave microstrip patch antenna,*" Proc. IEEE Vol. 987-1, pp. 10-14, 2011.

[4] Aliakbar Dastranj and Habibollah Abiri, "*Bandwidth enhancement of printed E-shaped slot antennas fed by CPW and microstrip line,*" IEEE Transactions on Antennas and Propagation, Vol. 58 No. 4, 2010.

[5] Ayesha Aslam and F. A. Bhatti, "*Novel inset feed design technique for microstrip patch antenna,*" Proc. IEEE Vol. 978-1, pp. 215-219, 2010.

[6] A. Sen, J. S. Roy and S.R. Bhadra Chaudhuri, "Investigation on a dual-frequency microstrip antenna for wireless applications," Proc. IEEE. Vol. 978-1, 2009.

[7] M. T. Islam, M. N. Shakib and N. Misran, "*Broadband E-H shaped microstrip patch antenna for wireless systems,*" Progress In Electromagnetics Research, PIER 98, 163-173, 2009.

[8] Kasabegoudar, V. G. and K. J. Vinoy, *"A broadband suspended microstrip antenna for circular polarization,"* Progress In Electromagnetics Research, PIER 90, 353-368, 2009.

[9] Bai-wen Tian, Jin-ming, *"A Design of Dual-Band H-shaped Microstrip-Line-Fed Printed Wide-Slot Antenna,*" Proc. IEEE, vol. 978-1, pp. 201 - 203, 2008.

[10] Lin S-, Row J-, "*Bandwidth enhancement for dual-frequency microstrip antenna with conical radiation,''* Electronics Letters. 2008; 44(1): 2-3.

[11] Albooyeh, M. N. Kamjani, and M. Shobeyri, "*A novel cross-slot geometry to improve impedance bandwidth of microstrip antennas,*" Progress In Electromagnetics Research Letters, Vol. 4, 63-72, 2008.

[12] G. M. Zhang, J. S. Hong and B. Z. Wang, "*Two novel band-notched UWB slot antennas fed by microstrip line,*" Progress In Electromagnetics Research, PIER 78, 209-218, 2008.

[13] Ren, W., J. Y. Deng, and K. S. Chen, *"Compact PCB monopole antenna for UWB applications,"* Journal of Electromagnetic Wave and Applications, Vol. 21, No. 10, 1411-1420, 2007.

[14] B. K. Ang and B. K. Chung, "*A Wideband E-shaped microstrip patch antenna for 5–6 GHz wireless Communications,*" Progress In Electromagnetics Research, PIER 75, 397-407, 2007.

[15] Ravi Pratap Singh Kushwaha," *Bow-shape single layer with single probe feed microstrip patch antenna,*" Proc. IEEE, 2005.

[16] Y. F. Liu, K. L. Lau, Q. Xue, C. H. Chan. "*Experimental Studies of Printed Wide-Slot Antenna for Wide-Band Applications,*" IEEE Antennas and Wireless Propagation Letters, Vol. 3, pp. 273-275, 2004.

[17] Yu, A. and X. X. Zhang, "*A method to enhance the bandwidth of microstrip antennas using a modified E-shaped patch,"* Proceedings of Radio and Wireless Conference, 261–264, Aug. 10–13, 2003.

[18] D. M. Pozar, "*Microstrip Antennas,*" Proc. IEEE, vol. 80, No. 1, pp. 79-81, January 1992.

[19] Xiaofei Shi, Zhihong Wang, Hua Su, Yun Zhao, *"A H-type Microstrip Slot Antenna in Ku-band Using LTCC Technology with MultipleLayerSubstrates,*" Proc. IEEE, Vol. 978-1, pp. 7104 - 7106, 2011.

[20] Mohammad Tariqul Islam, Mohammed Nazbus, Shakib, Norbahiah Misran, Baharudin Yatim, *"Analysis of Broadband Microstrip Patch Antenna,*" Proc. IEEE, pp. 758-761, Dec. - 2008.

[21] W. Ren," *Compact dual-band slot antenna for 2.4/5 GHz WLAN applications,*" Progress In Electromagnetics Research, B, Vol. 8, 319-327, 2008.

Biographical notes

Mr. Ram Singh Kushwaha is a lecturer in the Department of Electronics and Communication Engineering, Bundelkhand Institute of Engineering and Technology Jhansi, India. He has about 7 years of experience in teaching and research work.

Dr. D.K.Srivastava is a Reader in the Department of Electronics and Communication Engineering, Bundelkhand Institute of Engineering and Technology Jhansi, India. He has more than 14 years of experience in teaching, research and administrative work. His current area of research includes Microwaves and Optical communication. He has published around five papers in referred international journals. He has also presented more than twenty research articles in national and international conferences. He is Member IEEE.

Dr. J. P. Saini is a Professor in the Department of Electronics and Communication Engineering, Bundelkhand Institute of Engineering and Technology Jhansi, India. He has more than 25 years of experience in teaching, research and administrative work. His current area of research includes Multi-criteria Decision-Making, Neural Networks, and Optical and photonic waveguides. He has published more than twenty papers in referred international journals. He has also presented nearly fifty research articles in national and international conferences. He is currently working as a Principal of Madan Mohan Malviya Engineering College, Gorakhpur, India on deputation. He is life Member IETE and ISTE and Member IEEE (Ex.).