Design Of H-Shape Wideband Microstrip Patch Antenna With Slots For Wireless Communication

Bharatendra Singh Niboriya
M. Tech Scholar, Saroj Institute of Technology & Management, Lucknow, India

Chetan Choudhary
Assistant Professor, Saroj Institute of Technology & Management, Lucknow, India

Gyan Prabhakar
Assistant Professor, Saroj Institute of Technology & Management, Lucknow, India

Abstract

A wideband H-shape microstrip patch antenna is proposed in this paper. The bandwidth is further increased by a pair of slots inserted to both, left and right side of H-shape. The antenna is designed and simulated by electromagnetic field software IE3D. Results show that the designed antenna has an impedance bandwidth over 60.72% (from 4.92 GHz to 9.21 GHz) for VSWR<2, which is twelve times greater than the conventional rectangular patch antenna. Satisfactory radiation pattern is also obtained through simulation. The maximum gain in frequency band is 6 dBi. The return loss of -46 dB is also achieved.

Index Terms— H-shape patch, Microstrip antenna, bandwidth.

1. Introduction

The Microstrip antennas, for its low profile planar configuration, ease of fabrication and integration with RF devices, are being used for many applications due to key advantages over conventional antenna[1-2]. However in order to obtain a wider bandwidth, the antenna is usually enlarged. Also the practical limitations of the Microstrip antennas are low gain and low efficiency. Several techniques have been proposed to alleviate these problems recently, such as using a thicker substrate with low permittivity constant [3], parasitic patch loading on the same layer with the main patch [4], stacked multilayer patches [5], chip resistor loading [6,7], and modifying the geometry of patch antennas.

In this paper, a wideband H-shape MSA is proposed. The bandwidth of the antenna is broadened by creating the slots to both left and right side of H-shape rectangular patch. The bandwidth of 60.72% is obtained at feed point (50, 48).

2. Design Procedure

The width and length of the Microstrip antenna are determined as follow

$$W = \frac{1}{2f_r\sqrt{\mu_0\epsilon_0}}\sqrt{\frac{2}{\epsilon_r+1}} = \frac{v_0}{2f_r}\sqrt{\frac{2}{\epsilon_r+1}}$$

Where $v0$ is the free-space velocity of light

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

Where the dimensions of patch along its length have been extended on each end by a distance ΔL, which is a function of the effective dielectric constant εreff and the width-to-height ratio (*W/h*). A very popular and practical approximate relation for the normalized extension of the length is

$$\frac{\Delta L}{h} = 0.412\frac{(\epsilon_{\text{reff}}+0.3)\left(\frac{W}{h}+0.264\right)}{(\epsilon_{\text{reff}}-0.258)\left(\frac{W}{h}+0.8\right)}$$

The actual length of the patch can now be determined by

$$L = \frac{1}{2 f_r \sqrt{\epsilon_{\text{reff}}} \sqrt{\mu_0 \epsilon_0}} - 2\Delta L$$

The various design parameters of antenna are calculated using the above standard equations [1-2-9].
In Figure 2, designed parameter of H-shape Microstrip Antenna with dual slot is shown with following dimensions:
Length of ground plane (Lg) = 50 mm
Width of ground plane (Wg) = 50 mm
Length of Patch (L) = 36.33 mm
Width of Patch (W) = 38 mm
L1= 16.33 mm
W1= 28 mm
L2= 10 mm
W2= 16.5 mm

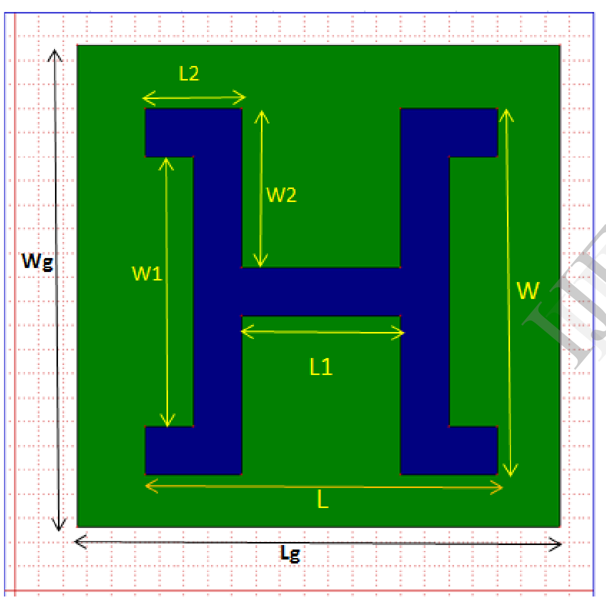

Fig 1: H-shape MSA with Slots

3. Results and Discussions

For the simulation of proposed antenna IE3D software have been used. In this simulation we have tried to obtain optimized performance of various antenna parameters such as return loss, gain, radiation pattern, directivity etc. The bandwidth percentage for designed antenna is 60.72%. It is very appreciable because Microstrip antennas are known for their poor bandwidth. With the proposed antenna we have achieved very appreciable percentage of bandwidth which could be useful for C-band wireless communication and satellite communication.

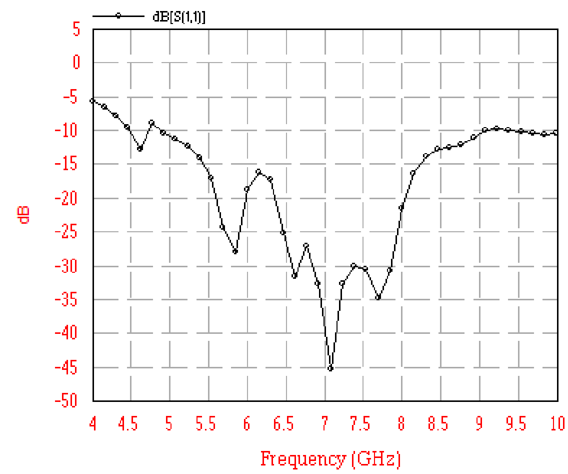

Fig 2: Return loss Vs frequency

From the plot it can be observed that return loss obtained at frequency 7.065 GHz is maximum which is near by -46 dB.
The simulated result of proposed patch antenna is obtained at the resonant frequency of 4.5 GHz and 4.92 GHz. The return loss is found to be -13 dB and -46 dB for band1 and band2 respectively from the curve shown in fig. 2.
Bandwidth for band 1 = 250 MHz &
Bandwidth for band 2 = 4.29 GHz.

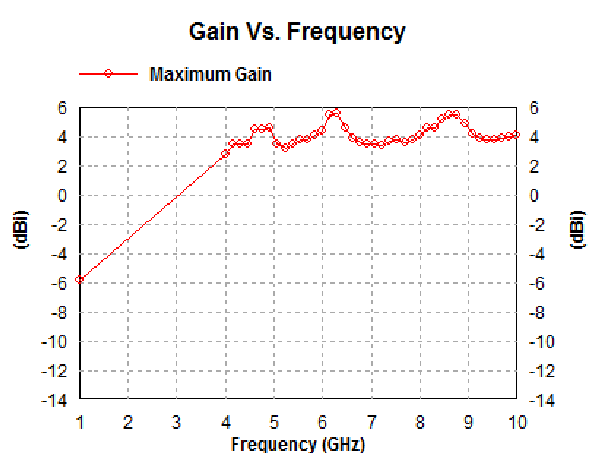

Fig 3: Gain Vs frequency

From the gain plot of antenna it is clear that maximum gain of 6 dBi is achieved by proposed antenna. The directivity curve is shown in fig. 4 which show that about 8.52 dBi is achieved by the proposed H-shape microstrip antenna.

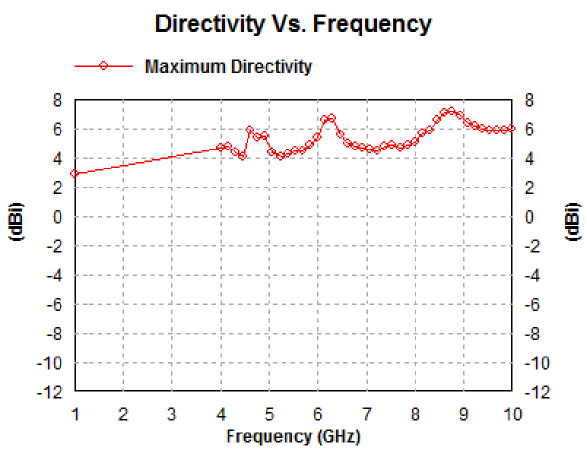

Fig 4: Directivity Vs frequency

The efficiency curve for the proposed MSA is shown in fig.5. It is observed that antenna efficiency and radiation efficiency of 89% and 99% are achieved respectively.

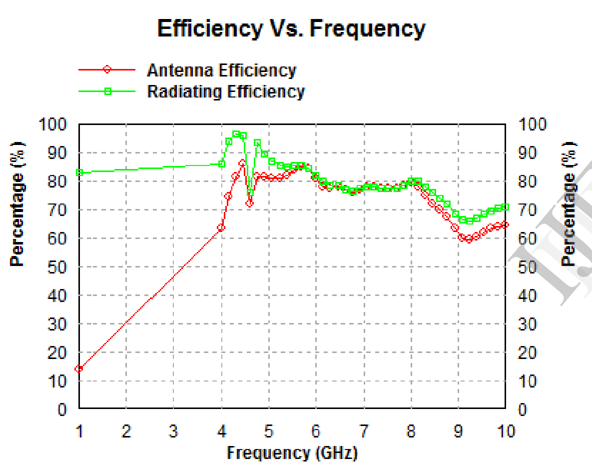

Fig 5: Efficiency Vs frequency

Another very important term which effects the performance of the antenna and is related to the antenna bandwidth is VSWR. Ideally, the VSWR should be below 2. The antenna will only operate at the frequencies where the value of VSWR is less than 2. The VSWR curve of the antenna structure is shown in fig. 6.

Smith Chart and radiation pattern for the proposed H-shape MSA is shown in fig. 7 and fig. 8 respectively. Fig.8 shows that satisfactory radiation pattern is achieved by the proposed H-shape Microstrip antenna with slots.

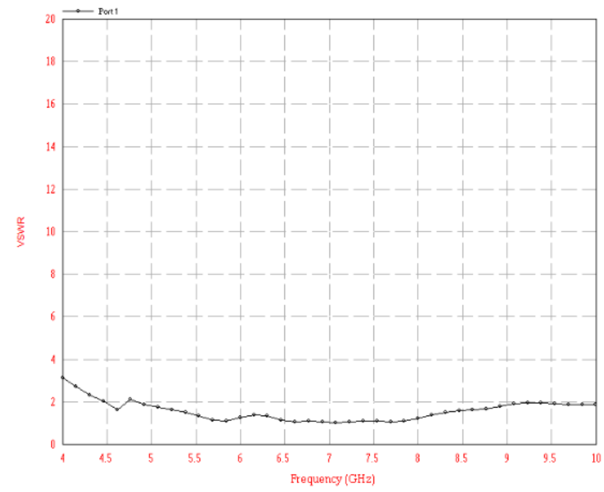

Fig 6: VSWR Vs frequency

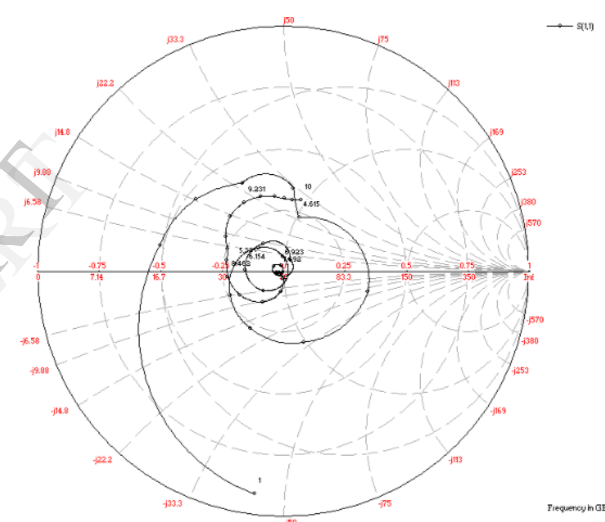

Fig 7: Smith Chart

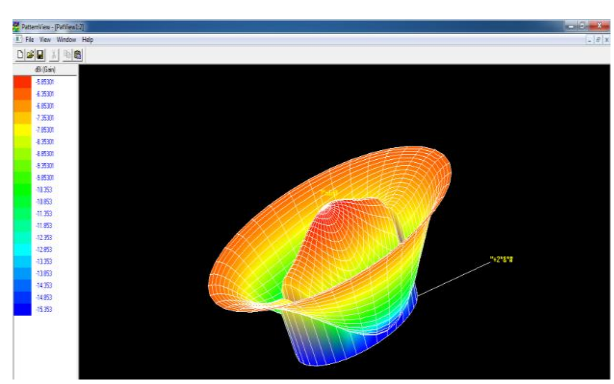

Fig 8: Radiation pattern

Table 1. Summary of Results

S. No.	Center Frequency	Return loss	Bandwidth
1	4.625 GHz	-13 dB	250 MHz
2	7.065 GHz	-46 dB	4.29 GHz

4. Conclusion

From the simulation analysis of the proposed antenna it can be easily observed that designed H-shape antenna can operate in two bands with bandwidth of 250 MHz and 4.29 GHz. The bandwidth of the antenna is broadened by creating two slots on left and right edge of H-shape. It is observed that a good return loss of -46 dB is also achieved. The maximum gain in C-band is 6 dBi. By varying the feed point position, different performance parameters can be optimized. The proposed MSA has achieved 89% and 99% of antenna efficiency and radiation efficiency respectively. Designed antenna can be used in different applications such as satellite communication, mobile phones, wireless communication, etc.

5. References

[1] Kaizhong Zhan, Qinggong Qou and Kama Huang, "A novel kind of Bluetooth and UWB antenna" Microwave and Millimeter Wave Technology (ICMMT), 2010, International Conference on, pp. 1038-1041, 2010.

[2] Y. T. Lo, D. Solomon, W.F. Richards,"Theory and experiment on Microstrip antennas," IEEE Transactions on Antennas and Propagation, Vol. 27 no. 2, pp. 137-145, 1979.

[3] R. Garg, P. Bhartia, I. Bahl, A. Ittipiboon, Microstrip Antenna Design Handbook, Artech House, Boston London, 2001, pp. 534-538.

[4] G. Kumar and K. C. Gupta, "Directly coupled multiple resonator wideband Microstrip antenna," IEEE Trans. Antennas Propagation, vol. AP-33, pp. 588-593, Jun. 1985.

[5] D. M. Pozar, "Microstrip antenna coupled to a Microstrip line," Electronics Letter, vol. 21, no. 2, pp. 49-50, Jan. 1985.

[6] K. L. Wong and Y. F. Lin, "Small broadband rectangular Microstrip antenna with chip resistor loading," Electron. Lett., vol. 39, pp. 1593-1594, 1997.

[7] V. Srinivasan, S. Malhotra, and G. Kumar, "Multiport network model for chip resistor loaded rectangular Microstrip antennas," Microwave opt. Technol. Lett., vol. 24, no. 1, pp. 11-13, 2000.

[8] Thana Pakkiam. K, J. S. Mandeep and M.T Islam, "Design of Microstrip Antenna for Modern Wireless Communication," 1st IEEE International Symposium on Telecommunication Technologies, 2012.

[9] Ali Foudazi, Hamid Reza, Hassani and Sajad Mohammad Ali Nezhad,"Small UWB Planar Monopole Antenna with added GPS/GSM/WLAN Bands," IEEE Transactions on Antenna & Propagation, vol 60, No.6, Jun. 2012.

[10] B.K. Ang and B. K. Chung, "A Wideband E-Shaped Microstrip Patch Antenna for 5–6 GHz Wireless Communications," Progress in Electromagnetic Research, PIER 75, p.p. 397–407, 2007.

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

[12] Ram Singh Kushwaha, D.K.Srivastava, J.P.Saini, "A Design of H-shape Slot loaded Wideband Microstrip Patch Antenna," International Journal of Electronics and Computer Science Engineering, Vol. 1 no. 2, pp. 533-537, 2012.

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

[14] C. A. Balanis, Antenna Theory: Analysis and Design, 3rd Ed. Wiley, 2005.

[15] IE3D, Zeland Software Inc, Fremont, CA, USA, 2000.