

U-Slotted Microstrip Patch Antenna

Yogesh Bhomia, Yogesh Kr. Sharma, Ramesh Bharti, Amit Kumar Jain

Abstract – A new U-slotted microstrip antenna is proposed. A patch antenna is a narrowband, wide-beam antenna. These antennas are low profile, conformal to planar and non-planar surface, simple and inexpensive to manufacture using modern printed circuit technology, mechanically robust when mounted on rigid surface, compatible with MMIC designs and when the particular shape and mode are selected they are very versatile in terms of resonant frequency, polarization, field pattern and impedance. Microstrip antenna consists of a very thin metallic strip (patch) placed a small fraction of a wavelength above a ground plane. The patch is generally made of conducting material such as copper or gold and can take any possible shape.

This paper presents a design of U-slotted microstrip patch antenna and experimentally studied on IE3D software. This design is achieved by cutting U shape in a patch. With U-slotted shapes patch antenna is designed on a FR4 substrate of thickness 1.524 mm and relative permittivity of 4.4 and mounted above the ground plane at a height of 6 mm. Bandwidth as high as 39% are achieved with stable pattern characteristics, such as gain and cross polarization, within its bandwidth. Impedance bandwidth, antenna gain and return loss are observed for the proposed antenna. Details of the measured and simulated results are presented and discussed.

Keywords – Bandwidth, U-Slot, Return Loss, Microstrip Antenna.

I. INTRODUCTION

A microstrip antenna consists of conducting patch on a ground plane separated by dielectric substrate. In the late 1970s, the rapid development of microstrip antenna technology began. By the early 1980s basic microstrip antenna elements and arrays were fairly well established in terms of design and modeling, and workers were turning their attentions to improving antenna performance features (e.g. bandwidth), and to the increased application of the technology. One of these applications involved the use of microstrip antennas for integrated phased array systems, as the printed technology of microstrip antenna seemed perfectly suited to low-cost and high-density integration with active MIC or MMIC (monolithic microwave integrated circuit) phase shifter and T/R circuitry. Low dielectric constant substrates are generally preferred for maximum radiation. The conducting patch can take any shape but rectangular and circular configurations are the most commonly used configuration [3]. Other configurations are complex to analyze and require heavy numerical computations. A microstrip antenna is characterized by its Length, Width, Input impedance, and Gain and radiation patterns. Various parameters of the patch antenna and its design considerations will be discussed in the subsequent chapters. The length of the antenna is nearly half wavelength in the dielectric; it is a very critical parameter, which governs the resonant frequency of the antenna. There are no hard and fast rules to find the width of the patch.

II. ANTENNA DESIGN

In a wide-band operation of antenna have presented to satisfy various wireless applications. In this section, we demonstrate the validity of our proposed designed antenna through the simulation results. One of the main design features that make the PCB of U-slotted antenna, simple to use is the feeding with largest element. This configuration allows you to directly attach a coaxial cable feed to the microstrip transmission line on the board without having to use a matching network.

The design idea was taken from broadband antennas to make the antenna work in a large band of frequencies of the many broadband antennas [7]. Hence the chosen shape of the patch is U-slot shape microstrip patch antenna, with an aim to achieve smaller size antenna. The U-slot shape microstrip patch antenna is presented in fig.1 with front (top) view.

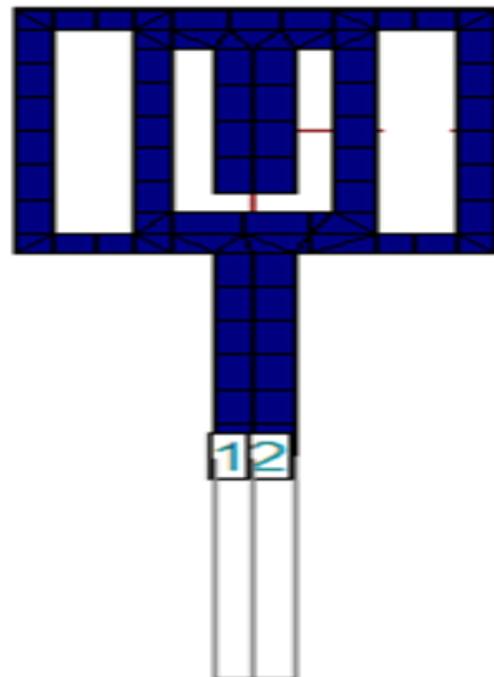


Fig.1. Geometry of proposed U-slotted shape microstrip patch antenna

This U-slotted shape microstrip patch antenna is fabricated on a FR4 substrate [5] of thickness 1.524 mm and relative permittivity of 4.4. It is mounted above the ground plane at height of 6 mm. In this work, transmission line feed technique is used as its main advantage is that, the feed can be placed at any place in the patch to match with its input impedance (usually 50 ohm) [17]. The software used to model and simulate the U-slotted shape microstrip patch antenna was IE3D, it can be used to calculate and plot return loss, VSWR, radiation pattern, smith chart and various other parameters.

III. RESULT AND DISCUSSION

The proposed antenna has been simulated using IE3D software [9]. The physical parameters of all antennas are the same, but the resonant frequency decreased as the iteration order increased, thus the electrical length of the ground plane also decreased in their resonant frequency for the proposed patch antenna.

The input characteristics of the fabricated small-size U-slotted patch antennas with different parameters are measured through a Vector Network Analyzer. Fig.2 shows the variation of return loss with frequency. Plot result shows resonant frequency 3.41 GHz. And total available impedance band width of 1340 MHz that is 39% from the proposed antenna. Minimum -39.47 dB return loss is available at resonant frequency which is significant. Fig.3 shows the input impedance loci using smith chart. Input impedance curve passing near to the 1 unit impedance circle that shows the perfect matching of input. Fig.4 shows the VSWR of the proposed antenna that is 1.32 at the resonant frequency 3.41 GHz.

In order to have a strong coupling among the element, a microstrip line is introduced between them. Then all the elements are coupled mostly by a guided wave through the microstrip line. Based on the measurement results, we can discuss the property of the proposed U-slotted patch antenna. From these results, it is observed that the proposed technique can achieve a maximum size reduction and better results that is good than the results obtained from other shapes.

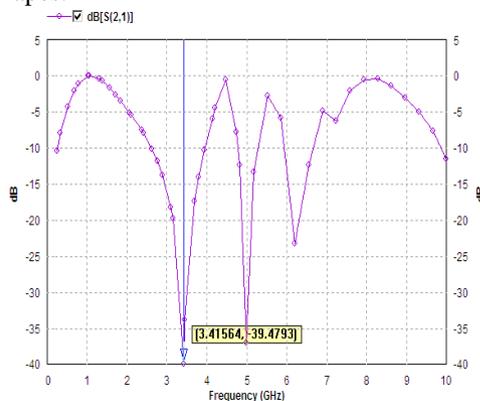


Fig. 2 Return loss vs. Frequency curve for proposed antenna

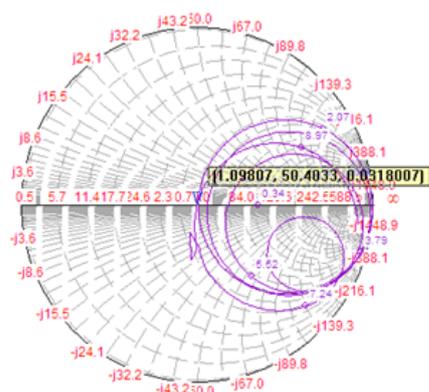


Fig.3. Input impedance loci using smith chart

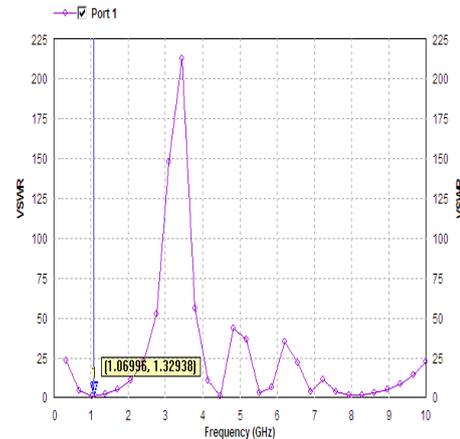


Fig.4. VSWR vs. Frequency curve for proposed antenna

IV. CONCLUSION

Microstrip patch antennas are increasing in popularity for use in wireless applications due to their low-profile structure. Therefore they are extremely compatible for embedded antennas in handheld wireless devices such as cellular phones, pagers etc. The telemetry and communication antennas on missiles need to be thin and conformal and are often in the form of Microstrip patch antennas. Another area where they have been used successfully is in Satellite communication. An Ultra Wide Band Microstrip U-slot antenna is presented. Simulation and measured results of our design show more than -39dB return loss at the resonant frequency of 3.41 GHz and VSWR less than 1.35 at this frequency.

This novel design can be adjusted to work in higher frequencies which make it possible to add more slots and thus get higher gains. With the aim to preserve compactness requirements and to maintain the overall layout as simply as possible and keeping the realization cost very low.

REFERENCES

- [1] Bhattacharyya, A. K., and R. Garg, "Generalized Transmission Line Model for Microstrip Patches," *IEE Proc.*, Vol. 132, Pt. H, 1985, pp. 93-98.
- [2] S. Silver, "*Microwave Antenna Theory and Design*", McGRAW-HILL BOOK COMPANY, INC, New York 1949.
- [3] C. A. Balanis, "*Antenna Theory, Analysis and Design*", JOHN WILEY & SONS, INC, New York 1997.
- [4] K. F. Lee, Ed., "*Advances in Microstrip and Printed Antennas*", John Wiley, 1997.
- [5] Anzar Khan, Rajesh Nema, "Analysis of Five Different Dielectric Substrates on Microstrip Patch Antenna," *International Journal of Computer Applications* ISSN 0975 – 8887, Volume 55, No.18, October 2012.
- [6] R. Garg, P. Bhartia, I. Bahl, A. Ittipiboon, "*Microstrip Antenna Design Handbook*", ARTECH HOUSE, Boston 2001.
- [7] Nenad Hecimovic and Zdenko Marincic, "The improvement of the antenna parameters in ultra-wideband communications".
- [8] Ansoft Designer, www.ansoft.com.
- [9] IE3D Software Release 9 and developed by M/S Zeland Software, Inc.
- [10] Nazish Irfan, Mustapha C. E. Yagoub, and Khelifa Hettak, "Design of a Microstrip-Line-Fed Inset Patch Antenna for RFID Applications," *IACSIT International Journal of Engineering and Technology*, Vol. 4, No. 5, October 2012, pp. 558-561.

- [11] Indrasen Singh, V.S. Tripathi, "Micro strip Patch Antenna and its Applications: a Survey;" in *IJCTA.*, Sep-Oct, 2011, vol. 2, No. 5, ISSN 2229-6093, pp.1595-1599.
- [12] D. M. Pozar, "Input impedance and mutual coupling of rectangular microstrip antennas," *IEEE Trans. Antennas and Propagation*, vol. AP-30, pp. 1191-1196, Nov. 1982.
- [13] James, J.R. and Hall, P.S.: '*Handbook of Microstrip Antennas*' (Peter Peregrinus).
- [14] Douglas H. Werner, Randy L. Haupt and Pingjuan L. Werner, "Fractal antenna engineering: The theory and design of fractal antenna array", *IEEE antennas and propagation magazine*, Vol. 41, No. 5, pp. 37-59, October 1999.
- [15] F. E. Gardiol, "*Broadband Patch Antennas*," Artech House.
- [16] D. M. Pozar and D. H. Schaubert, *Microstrip Antennas: The Analysis and Design of Microstrip Antennas and Arrays*, *IEEE Press*, 1995.
- [17] H. F. Pues and A. R. Van de Capelle, "An Impedance Matching Technique for Increasing the Bandwidth of Microstrip Antennas," *IEEE Trans. on Antennas and Propagation.*, Vol. AP-37, pp. 1345 - 1354, November 1989.

AUTHOR'S PROFILE



Yogesh bhomia

received the B.E. degree from IETE, New Delhi in Electronics & telecommunication and M.E. in digital communication from M.B.M. College, Jodhpur and also received Ph.D. degree from Bhagwant University, Ajmer, Rajasthan, India.

He is currently working as a Professor & Vice-principal with the Electronics & Communication Engineering Department in Arya Institute of Engineering Technology, Jaipur, Rajasthan. He has been published more than 15 papers in International Journals. He is reviewer of various Journals and also member of various IEEE technical Committees. He has written a book on Electro Magnetic Field Theory.



Amit Kumar Jain

received the B.Tech. degree from Rajasthan Technical University, Kota in Electronics & communication and pursuing M.Tech. in digital communication from JNIT University, Jaipur, Rajasthan.