Suspended Microstrip Patch Antenna for Wireless Applications

T.Shanmuganantham, Dr. S. Raghavan

Department of Electronics & Communication Engineering
National Institute of Technology, Thiruchirappali-620015
Tamil Nadu, India.
E-mail: eck0601@nitt.edu,raghavan@nitt.edu

Abstract :- **In this paper suspended Microstrip Patch Antenna with inverted V-shaped ground plane is presented. The fundamental parameters of the antenna such as return loss, gain, radiation pattern and polarizations are simulated, measured and these parameters meets the acceptable antenna standards. The radiation patterns are bidirectional in the E-plane and H-plane. The analysis is performed numerically using method of moments simulation software (Zeland- IE3D version 12.0) and the experimental results are presented.**

Index Terms: - **Microstrip Patch, Inverted V-Shaped Ground, Probe-fed, Polarization.**

I INTRODUCTION

The rapid development of wireless communication system is bringing about a wave of a new wireless devices and systems to meet the demands of multimedia applications. Primarily, the antennas need to have high gain, small physical size, broad bandwidth, versatility, embedded installation and particularly, the bandwidth for impedance, polarization, axial ratio, radiation patterns and gain are becoming the most important factors that affect the application of antennas incontemporary and future wireless communications [1-3]. The development of a compact antenna suitable for a range of frequency bands which are widely used in modern microwave communication systems. The wireless communication industry has witnessed a drastic development in the field of low power, short range microwave communication gadgets like mobile phones. Planar antennas are the newest generation of antennas, boasting such attractive features as low profile, light weight, low cost, and ease of integration into arrays. These features make them ideal components of modern communications systems, particularly in cellular and WLAN applications. Consequently, many novel designs of planar antennas for related applications have come into being within the last two to three years. Until now these designs were only accessible to current and prospective antenna designers through journal articles, conference papers, and patent descriptions. Planar Antennas for Wireless Communications organizes today's most important planar antenna designs into one easy-to-use reference [4]. Recently, with the wireless communications, such as the wireless local area network (WLAN), having evolved at astonishing rate, it has been well known that the future communication technology pressingly demands integration of more than one communication system into a limited equipment space. In applications where size, weight, cost, performance, ease of installation, and aerodynamic profile are constrains, low profile antennas like Microstrip and printed slot antennas are required. Because Microstrip antennas inherently have narrow bandwidths and, in general, are half-wavelength structures operating at the fundamental resonant mode [5], researchers have made efforts to overcome the problem of narrow bandwidth, and various configurations have been presented to extend the bandwidth [6-9] by introducing slots in the Microstrip patch. In high-performance aircraft, spacecraft, satellite, and missile applications, where size, weight, cost, performance, ease of installation, and aerodynamic profile are constraints, and low-profile antennas may be required [10]. The characteristics of rectangular Microstrip patch antenna as a function of its ground plane size has been discussed in [11-12]. In this paper a new design of broad band probe-fed rectangular Microstrip patch antenna with a V-shaped ground plane is proposed simulated and experimental results are presented.

II ANTENNA STRUCTURE AND DESIGN

The geometry of the proposed compact broadband probe-fed inverted rectangular patch antenna with a inverted V-shaped ground plane designed for

2.0GHz center frequency is shown in figure 1.The rectangular patch having dimensions of L x W (L is along the resonant direction) is supported by spacers above the central line (y-axis) of the inverted V-shaped ground plane.

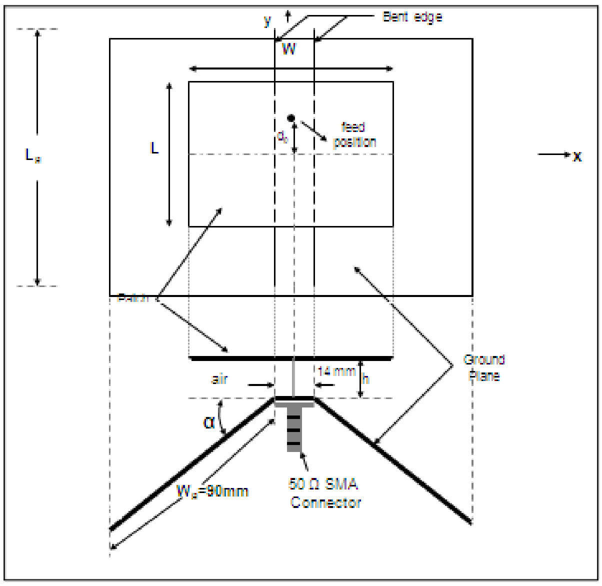

Figure 1 Geometry of the proposed probe-fed Inverted V-Shaped Ground plane with Microstrip patch antenna (L = 60 mm, W =90 mm, L_g = 120 mm, W_g = 90 mm)

The ground plane with a length of L_g along the resonant direction is bent with a bend angle of α leaving a small flat section of 14 mm in width and L_g in length to set the 50Ω SMA connector used in this design. The distance between the radiating patch and the small flat section is h, which is chosen to be small to reduce the probe length for feeding the patch antenna. The probe feed is placed along the central line of the patch to provide good impedance matching across a wide operating bandwidth. The distance between optimal feed position and the patch center is d_p. In this proposed design, it is seen that the effective average substrate thickness increases with increasing value of α, i.e., the antenna's operating bandwidth can be increased with an increase in α. The width of the bent section of the V-shaped ground is W_g . The inverted V-shaped lead to longer excited current path in the rectangular patch and increased capacitive fringing effect which makes the fundamental resonant frequency of the proposed antenna greatly lowered because of increased radiating edge length.

The photograph of this fabricated prototype antenna is shown in figure 2.

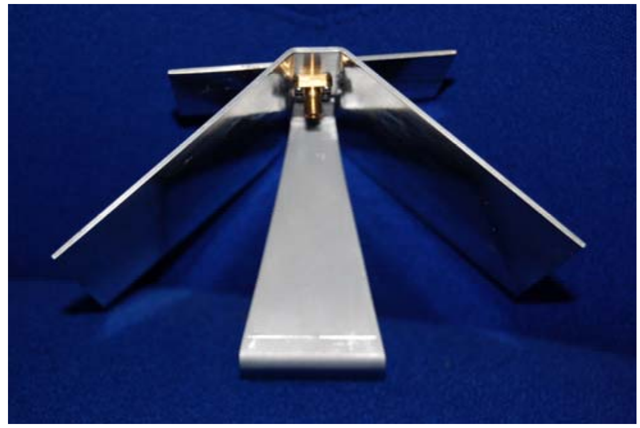

Figure 2 Photograph of the proposed Antenna

III EXPERIMENTAL RESULTS AND DISCUSSION

The return loss is measured using HP vector network analyzer-E5062A and this graph is shown in figure 3. The simulated return loss is -21.12 dB and measured return loss is -23.75 dB for the center frequency 2.0 GHz. In particular, the proposed antenna shows great frequency reduction at the same time maintaining the larger bandwidth.

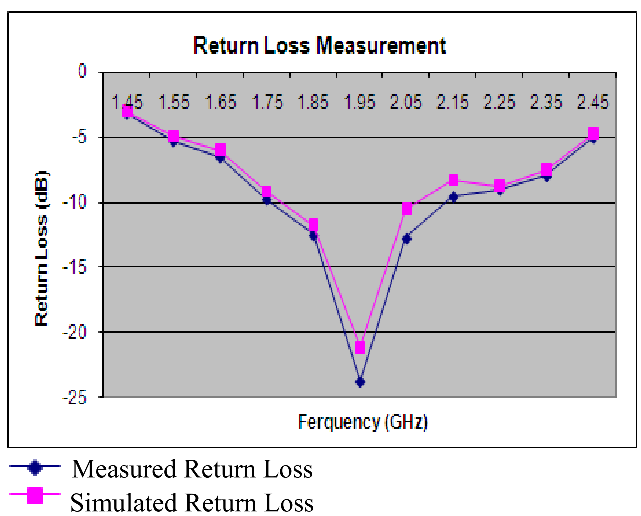

Figure 3 Measured and Simulated Return Loss for the proposed antenna

The simulated an measured radiation patterns for E-plane and H-plane with co-polarization and cross-polarizations are shown in figure 4.

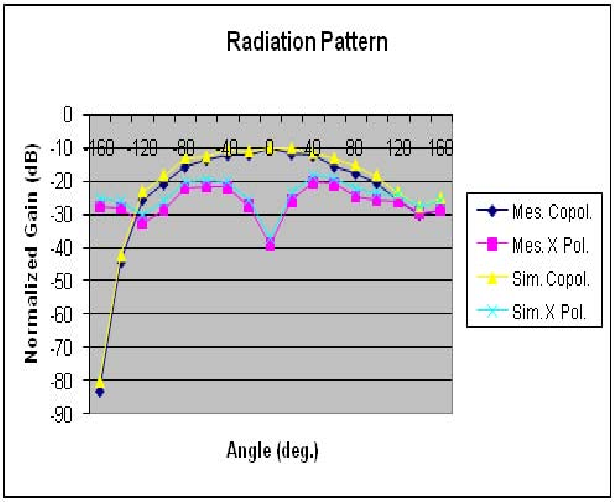

Figure 4 Proposed Antenna Radiation Pattern for E-Plane

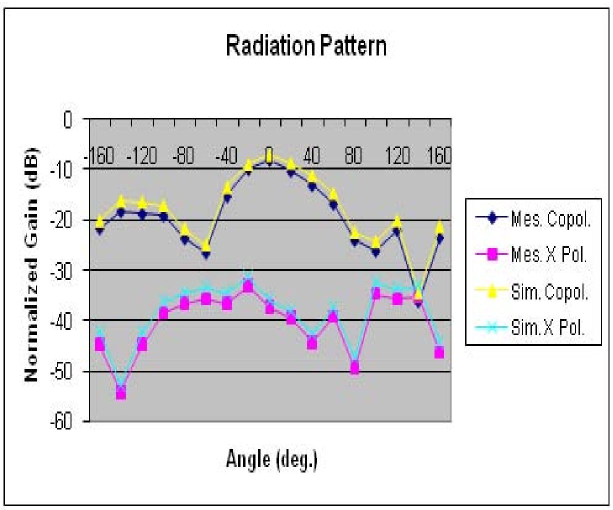

Figure 5 Proposed Antenna Radiation Pattern for H-Plane

The simulated and measured radiation patterns of H-Plane is shown in figure 5.The peak value of E-plane measured and simulated co- polarization is -10.2 dB , -9.97 dB measured and simulated cross-polarization is -39 dB , -37.12 dB and the peak value of H-plane measured and simulated co-polarization is -8.17 dB ,-7.12 measured and simulated cross- polarization is -37.17, -35.84 dB and measured gain of an antenna is shown in figure 6. The measured peak gain is 9 dBi.

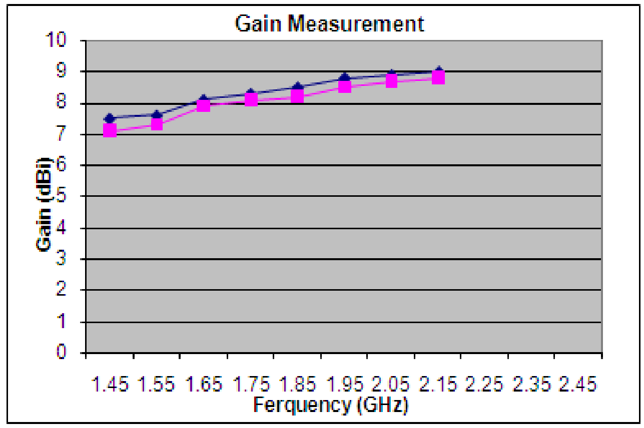

Figure 6 Measured Gain for the proposed antenna

IV CONCLUSION

A new broad-band design of probe-fed Rectangular patch antenna with a V- shaped ground plane has been proposed and experimentally studied. The antenna model with 2:1 VSWR bandwidth of 27% has been chosen for further experimentation on frequency reduction. The combined antenna model provided maximum of 39% frequency reduction and 24.5% of 2:1 VSWR bandwidth. The proposed antenna shows great frequency reduction at the same time maintaining the larger bandwidth and also provides good cross polarization performance. The proposed antenna suitable for Wireless Communications, Space applications and WLAN applications.

ACKNOWLEDGEMENT

The authors gratefully acknowledge **Indian Space Research Organization** (ISRO), Bangalore, India for the help of an antenna measurements and the useful comments by **Prof. Bharathi Bhat,** Professor (Rtd), CARE, Indian Institute of Technology, New Delhi, India.

REFERENCES

[1] Randy Bancroft, "Microstrip and Printed Antenna Design", Second Edition, SciTech Publishing, 2009.
[2] John L. Volakis, " Antenna Engineering Handbook ", McGraw-Hill , 2007.

[3] K.L. Wong, *Compact and Broadband Microstrip Antennas*. New York, NY: John Wiley and Sons Inc., 2002.

[4] Reena Pant, Pradyot Kala1, S. S. Pattnaik and R. C. Saraswat, "A Circularly Polarized Rectangular Patch Antenna on a Cylindrical Surface", International Journal of Microwave and Optical Technology, pp.443-444, Sep'2008.

[5] Dr. S. Raghavan, D. Sriram Kumar, M.S. Kishore Kumar, "Reconfigurable Patch Slot Antenna for Circular Polarization Diversity", International Journal of Microwave and Optical Technology, pp.419-425, Sep'2008.

[6] K P Ray, S Nikhil, A Nair, "Compact Tunable and Dual band Circular Microstrip Antenna for GSM and Bluetooth Applications", International Journal of Microwave and Optical Technology, pp.205-210, July 2009.

[7] Amit A Deshmukh, K P Ray, A. Mainkar, J. Gohil and P. Mahale, "Dual Polarized Stub Loaded Compact Microstrip Antennas", International Journal of Microwave and Optical Technology, pp.153-159, May 2009.

[8] Vidya Sagar chintakindi, Dr. Shyam Sundar Pattnaik, Dr.O.P.Bajpai, S.Devi,P.K.Patra , K.M.Bakwad, "PSO driven RBF NN to calculate Microstrip patch Antenna parameter, International Journal of Microwave and Optical Technology, pp.90-94, March 2009.

[9] K. L. Wong and W. H. Hsu, "Broadband triangular Microstrip antenna with U-shaped slot," *Electron. Letters,* vol. 33, pp. 2085- 2087, 1997.

[10] S.Raghavan, T.Shanmuganantham, and M.S.Kishore Kumar, "Reconfigurable Patch Antenna with Switchable L- shaped Slots for circular polarization diversity", Microwave and Optical Technology Letters, vol.50, Sep. 2008.

[11] K. F. Tong, K. M. Luk, K. F. Lee, and R. Q. Lee, "A broad-band U-slot rectangular patch antenna on a microwave substrate," *IEEE Trans. on Antennas Prop.*, vol. AP-48, no. 6, pp. 954-960, June 2000.

[12] K. L. Wong, C. L. Tang and J. Y. Chiou, "Broad band Probe-fed Patch Antenna with a W-shaped Ground Plane", IEEE Trans. on Antennas and Propagation, Vol.AP-50, No.6, pp. 827-831, June 2002.

BIBLIOGRAPHY

T.Shanmuganantham received B.E. degree in Electronics and Communication Engineering from University of Madras, M.E. degree in Communication Systems from Madurai Kamaraj University and pursuing Ph.D. degree in the area of MIC Antennas under the guidance of **Dr.S.Raghavan** from Department of Electronics and Communication Engineering, National Institute of Technology, Tiruchirappalli, India. He has 12 years of teaching experience in various reputed Engineering colleges such as SSN College of Engineering, National Institute of Technology and Science. His research interest includes Antennas, Microwave Integrated Circuits, Computational Electromagnetics, Numerical Techniques of Microwave and Millimeter wave transmission lines and CAD of MICs . He has published 30 research papers in various national and International level Conferences and Journals. He is a member in IEEE, Life Member in IETE , Institution of Engineers, Society of EMC and ISTE.

Dr.S.Raghavan having 30 years of Teaching (U.G., P.G. and Research) experience in the National Institute of technology, Tiruchirappalli, India as a Senior Professor. Developed Microwave and Microwave Integrated Circuits Lab. Obtained B.E.(Electronics and Communication Engineering) degree from College of Engineering , Guindy. M.Sc.(ENGG.)Microwave Engineering from College of Engineering, Trivandrum and Ph.D.(Microwave Integrated Circuits) from I.I.T., Delhi, India under the guidance of **Prof.Baharathi Bhat and Prof.S.K.Koul**. Senior Member of IEEE in MTT and EMBS. Life Fellow in BES. Fellow in IETE and IE, Life member in ISSS, MRSI, ISTE, EMC/EMI, IELTS and ILA. Referee for MTT journal. Carried out two Research and Development projects of Coplanar Waveguide and RF-MEMS. Has contributed more than 100 papers in international Conferences and five international Journals. Conducted more than 10 tutorials in IEEE preconference tutorials.