A Novel Design of Hybrid Monopole Rectangular Microstrip Antenna for WLAN and Wi-MAX Applications

Rajeshwari Biradar[1] and S. N. Mulgi[2]
[1]Research Scholar, Department of P. G. Studies and Research in Applied Electronics, Gulbarga University, Kalaburagi, Karnataka, India
[2]Research Scholar, Department of P. G. Studies and Research in Applied Electronics, Gulbarga University, Kalaburagi, Karnataka, India
[1]rajeshwarigbr@gmail.com[2]s.mulgi@rediffmail.com

Abstracts: This article describes a novel design and development of hybrid monopole rectangular microstrip antenna (HMRMSA) for WLAN and Wi-MAX applications. This antenna operates for the frequency range of2.07 to 6.72 GHz and showing a impedance bandwidth of 145%. The antenna structure consists of hybrid triangular shape model. At the bottom surface a partially ground plane is placed to achieve single wideband. The proposed antenna is fabricated using low cost FR4 substrate material. The antenna is excited through 50 Ω microstrip line. The simulated and experimental results are demonstrates which are in good agreement with each other.The proposed antenna satisfies the -10dB impedance bandwidth requirements tocovering WLAN and Wi-MAX applications.

Keywords:*Hybrid, monopole antenna, WLAN and Wi-MAX applications.*

*****

I. INTRODUCTION

Single wide band antenna with small size, low profile and simple structures are becoming increasingly attractive for wireless local area network (WLAN) and worldwide interoperability for microwave access (Wi-MAX) applications. In order to make antenna to operate the WLAN and Wi-MAX bands haying normally in the range of 3 to 6 GHz, various types of multiband monopole antennas have been proposed. However, if the antenna is working for single wide band covering the frequency range of WLAN and Wi-MAX is more advantages[1-4].Differentially shaped strips and slot antennas are another way to realize WLAN and Wi-MAX applications. The proposed antenna is designed using thin, inexpensive, low dielectric constant FR4 substrate material. The work presented in this paper clearly represents a new design method which consist of the combination of rectangular and polyline pattern forming hybridgeometry. This geometry facilitates the antenna designer to change the structure accordingly to achieve required operating frequency range. The antenna is truncatedat the bottom surface of the patch. The proposed antenna provides much better size reduction and wide bandwidth in comparison to the antennas reported in [5-10]. The proposed antenna consists of truncated ground plane. The antenna is directly fed by a simple 50 microstripline feed.This type of geometry is found to be rare in the literature.Details of the antenna design is presented and discussed.

II. Antenna Design

The proposed antenna is manufactured using a commercially available low cost glass epoxy substrate material of thickness 0.16 cm with relative permittivity is 4.2 and dielectric loss tangent is 0.02. The structure of the antenna is drawn by using Auto-CAD software.Figure 1.Showsthe geometry of HMRMSA. The geometrical parameters of the proposed antenna were obtained by using Ansoft high frequency structure simulator (HFSS). The length (L) and width (W) of the substrate is 40x60 mm. The top of the patch corners is truncated by polylines. The antenna is excited through 50 microstripline feed havingwidth Wf is 0.317 and length L_f is 2.4 mm.At the bottom surface of the ground plane a partially truncated ground plane is etched which is slightly below the radiating patch. The offset gap (g) is 0.5 mm between the radiating patch andbottom ground plane

The HMRMSA is 31.99 % compact in its physical size when compared to rectangular antenna design for the same resonant frequency. The designed parameters of the proposed antenna are as shown in Table-1.

ISSN: 2321-8169
414 – 417

TABLE: I ANTENNA PARAMETERS

Parameters	Dimensions in mm
W	40
L	60
Tl	1.94
sl	5.68
L1	0.7
W_f	3.17
L_f	24
L_g	19
g	0.5
l	3
w	5
u	17 (with an angle of 45 degree)

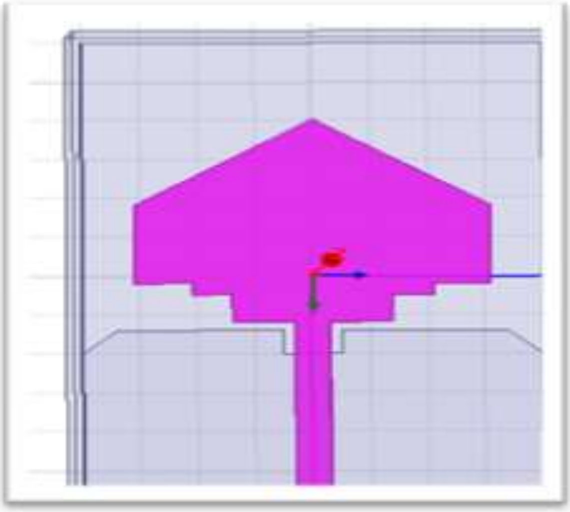
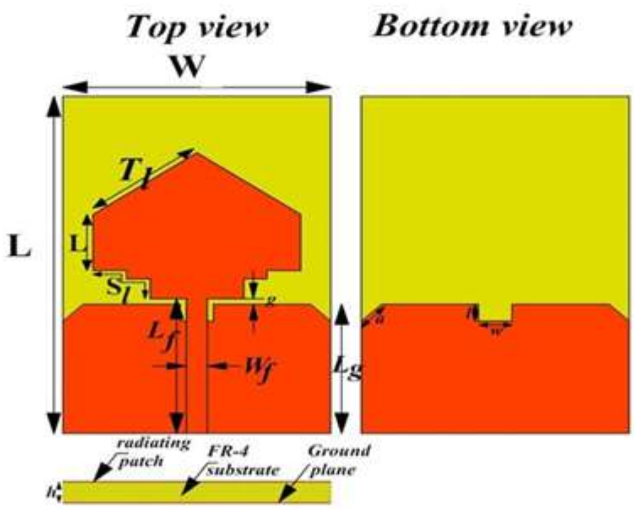


Fig. 1 Geometry of proposed HMRMSA.



a) Top view b) bottom view

Fig. 2 Photographs of HMRMSA

III. Results and Discussion

The impedance band width over return loss than -10 dB for the proposed antenna ismeasuredusingVector NetworkAnalyzer (VNA).The variation of return loss verses frequency of HMRMSA is as shown in Fig. 3. From Fig. 3 it is clear that the antenna exhibitsa singlewide band characteristic.The operating band covers the WLAN and Wi-MAX ranges.Good agreement is observed between the simulation and measured results.

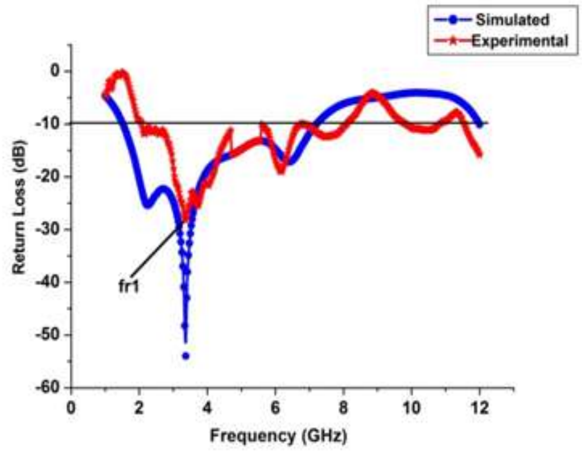


Fig.3 Return loss versus frequency of HMRMSA

To illustrate the radiation mechanismsof proposed antenna, the E and H plane radiation patterns are measuredat the resonant frequency of 3.36 GHz which is shown in Figure 4.This indicates that the antenna gives monopole radiation pattern. The surface current distribution of the proposed antenna observed at 3.36 GHz as shown in the Fig.5. From this figure it is noticed that, the current path is mainly distributing along the microstripline feed and slightly at the bottom of the radiating patch.

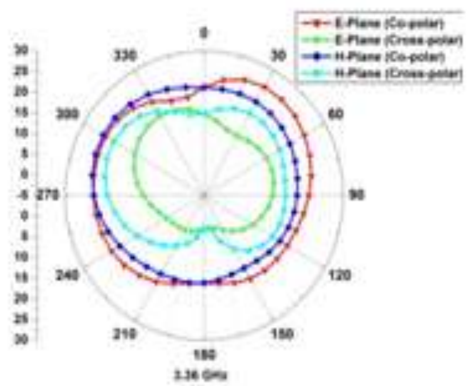


Fig. 4 Radiation pattern of HMRMSA observed at 3.36GHz.

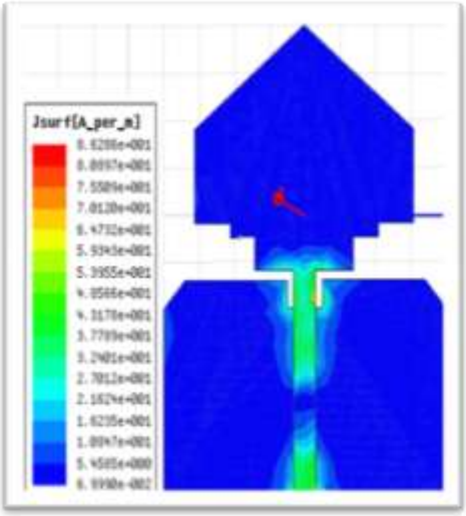


Fig. 5 Current distributions of HMRMSA observed at 3.36 GHz.

Figure.6. shows the variation of gain versus frequency of HMRMSA. From this figure it is clear that the antenna gives a peak gain more than 5.5dB in its operating band.

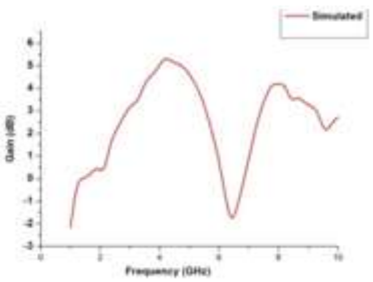


Fig. 6 Variation of gain verses frequency of HMRMSA.

CONCLUSION

In this article, a single wide band antenna has been proposed.The structure of antenna ishybrid in nature. The hybrid geometry is having more freedom in changing the dimensions of radiating patch which in turn gives desired radiation requirements of an antenna.The proposed antenna compact in its structureby 31.99 % when compared to the size of rectangular microstrip antenna designed for the same resonant frequency. The antenna has been realized by using low cost FR4 substrate material. The antenna isfed by a simple 50 Ω microstripline feed. The simulated and measured results are in good agreement with each other. The antenna shows goodomnidirectional radiation pattern in both E and H planeand gives a peak gain morethan 5.5dB in its operating band. Hence this antenna is more useful for both WLAN and Wi-MAX applications.

ACKNOWLEDGMENT

The authors would like to thank the authorities of Dept. of Science and Tech. (DST), Govt. of India, New Delhi, for sanctioning the Vector Network Analyzer under the FIST Project to the Department of Applied Electronics, Gulbarga University, Kalaburagi.

References:

[1] Zahir Jordan, M., et al., “Wideband radar cross-section reduction of patch array antenna with miniaturized hexagonal loop frequency selective surface,” *Electron. Lett*. Vol. 52. No. 9, 767–768, 2016.

[2] Volakis, J. L., et al., “Broadband RCS reduction of rectangular patch by using distributed loading,” *Electron. Lett.* Vol. 28, No. 25, 2322–2323, 1992.

[3] Vaughan, R. G. and J. B. Andersen, “Antenna diversity in mobile communication,”*IEEETrans.Veh. Technol.*, Vol. 36, No. 4, 149–172, Nov. 1987.

[4] Thomas, K. G. and M. Sreenivasan, “A simple ultra wideband planar rectangular printed antenna with band dispensation,”*IEEE Trans. Antennas Propagate.* Vol. 58, No. 1, 27–34, Jan. 2010.

[5] Li, W. T., Y. Q. Hei, W. Feng, and X. W. Shi, “Planar antenna for 3G/Bluetooth/WiMAX and UWB applications with dual band-notched characteristics,”*IEEE Antennas Wireless Propagation Letters*, Vol. 11, 61–64, 2012.

[6] Chu, Q. X. and Y. Y. Yang, “3.5/5.5 GHz dual band-notch ultra-wide-band antenna,”*Electronics Letters*, Vol. 44, No. 3, 172–174,2008.

[7] Shen, W., X.-W. Sun, and W.-Y. Yin, “A novel microstrip filter using three-mode stepped impedance resonator (TSIR),”*IEEE Microwave and Wireless Components Letters*, Vol. 19, No. 2, 774–776, 2009.

[8] CST Microwave Studio, 2011.

[9] Dhakal, R. and N. Y. Kim, “A compact systematic microstrip filter based on a rectangular meandered line stepped impedance resonator with a triple band band stop response,” *The Scientific World Journal*, Vol. 2013, Article ID 457693, 2013.

[10] Chiou, H. K. and C. F. Tai, “Dual-band microstrip band stop filter using dual-mode loop resonator,”*Electronic Lett*., Vol. 45, No. 10, 507–509, May 2009.

ISSN: 2321-8169
414 – 417

BIOGRAPHIES

Rajeshwar Biradar received her M.Sc. degree in Department of Applied Electronics, from Gulbarga University, Gulbarga in the year 2002 and M. Phil degree from Vinayak Mission University, from Salem in the year 2007. Presently she is pursuing for Ph. D degree under the guidance of Dr. S. N. Mulgi, Professor in the Department of P. G. Studies and Research in Applied Electronics, Gulbarga University, Kalaburgi, Her fields of interest include Microwave Electronics.

Dr. S. N. Mulgi received his M.Sc., M.Phil. and Ph.D. degrees in Applied Electronics, from Gulbarga University Gulbarga in the year 1986, 1989 and 2004 respectively. He is working as a Professor in Department of P. G. Studies and Research in Applied Electronics, Gulbarga University, Kalaburagi. He is an active researcher in the field of Microwave Electronics. He has published more than seventy five reputed peer reviewed International Journals and more than 30 in National Journals. He has presented several papers in International and National Conferences.