Global Journal of Researches in Engineering: F
Electrical and Electronics Engineering
Volume 16 Issue 2 Version 1.0 Year 2016
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

A Planar CPW Antenna Loaded with Rectangular Slot for Triple Bands Operation

By Pooja G. Phad & Veeresh G. Kasabegoudar
MBES College of Engineering, Ambajogai, India

Abstract- In this paper a planar CPW antenna loaded with rectangular slot is presented. The proposed antenna offers three frequency bands and hence suitable for triple bands wireless applications. The proposed geometry has hexagonal shaped radiator loaded with a rectangular slot to excite three resonant frequencies in the UWB frequency range. The three resonances of triple bands obtained are at 5.9GHz, 9.9GHz, and 14.4GHz. The antenna was designed and developed on easily available low cost FR-4 glass epoxy substrate. The proposed antenna's prototype was developed for its validation and found reasonable agreement between the simulated and measured results.

Keywords: CPW fed antenna, planar antenna, triple bands antenna.

GJRE-F Classification : FOR Code: 291701

APLANARCPWANTENNALOADEDWITHRECTANGULARSLOTFORTRIPLEBANDSOPERATION

Strictly as per the compliance and regulations of :

A Planar CPW Antenna Loaded with Rectangular Slot for Triple Bands Operation

Pooja G. Phad α & Veeresh G. Kasabegoudar σ

Abstract- In this paper a planar CPW antenna loaded with rectangular slot is presented. The proposed antenna offers three frequency bands and hence suitable for triple bands wireless applications. The proposed geometry has hexagonal shaped radiator loaded with a rectangular slot to excite three resonant frequencies in the UWB frequency range. The three resonances of triple bands obtained are at 5.9GHz, 9.9GHz, and 14.4GHz. The antenna was designed and developed on easily available low cost FR-4 glass epoxy substrate. The proposed antenna's prototype was developed for its validation and found reasonable agreement between the simulated and measured results.

Keywords: CPW fed antenna, planar antenna, triple bands antenna.

I. Introduction

The Federal Communication Commission (FCC) allocated the frequency band spectrum from 3.1 to 10.6 GHz for monetary communication applications in year 2002 [1]. This resulted in the development of several antennas which operate in the ultra wideband (UWB) range. It is also expected that in this range frequency satisfactory radiation properties are required. An UWB antenna which satisfies the more requirements like a small size, consistent group delay, omnidirectional radiation patterns, and gain beyond whole band [2, 3]. There are several works reported in literature on these kinds of antennas [3-15]. By adding half wavelength V-shaped slot on radiating patch, UWB antenna achieves sharp band notched characteristics [3]. A lower pass band, 2.4 GHz Bluetooth band (2.4 – 2.484 GHz), can be realized by adding a pair of U-shaped parasitic strips bilaterally beside the feed line which covers whole UWB band [4].

In [7], by inserting an U shaped slot on radiating patch which produces band notch characteristics. The main goal in UWB antenna design is achieving the wide impedance bandwidth with high radiation efficiency. Section 2 describes the basic geometry and its operation. Geometry oprtimization procedure is covered in Section 3. Experimental validation of the proposed antenna is presented in Section 4. Finally, Section 5 concludes the work carried out and guidelines the future scope.

II. Antenna Geometry

Figure 1 shows basic geometry of the proposed antenna. The proposed antenna is having a low profile geometry with overall dimensions of 24 x 25mm x 1.6mm (*LxWxh*). The substrate used for design and fabrication is FR4 glass epoxy substrate with relative permittivity of 4.4, thickness of 1.6mm, and loss tangent equal to 0.02. The geometry is basically a CPW fed monopole antenna. An elliptical slot is etched in the ground with major axis radius of 11.55 mm and minor axis radius of 10 mm. Hexagonal stub is attached to the signal conductor of the CPW line to ensure the impedance matching. Also, a rectangular slot is made on the hexagonal stub to excite multiple bands and to enhance their bandwidths. The other dimensions are mentioned in Table 1 based on the optimization procedure discussed in Section 3.

Table 1 : Dimensions of the optimized geometry

Parameter	L_1	W_1	L_2	L_3	L_s	Ws	W_2	W_3	g_1	g_2	a	b	c
Values (mm)	24	25	2.59	3.6	7.2	7.1	5.29	2.2	0.1	1	10	11.55	5.66

III. Geometry Optimization and Discussions

This section covers the geometry optimization by varying some parameters of the antenna geometry. The parameters utilized for optimization are gap g_1, width of signal conductor (W_3) of CPW feed, length of rectangular slot (L_s), and the width of rectangular slot (W_s). High frequency structure simulator (HFSS-v.13) [16] was used to carry out the parametric optimization.

Author α σ: P. G. Dept., MBES College of Engineering, Ambajogai, India. e-mails: pooja_it_me@yahoo.com, veereshgk2002@rediffmail.com

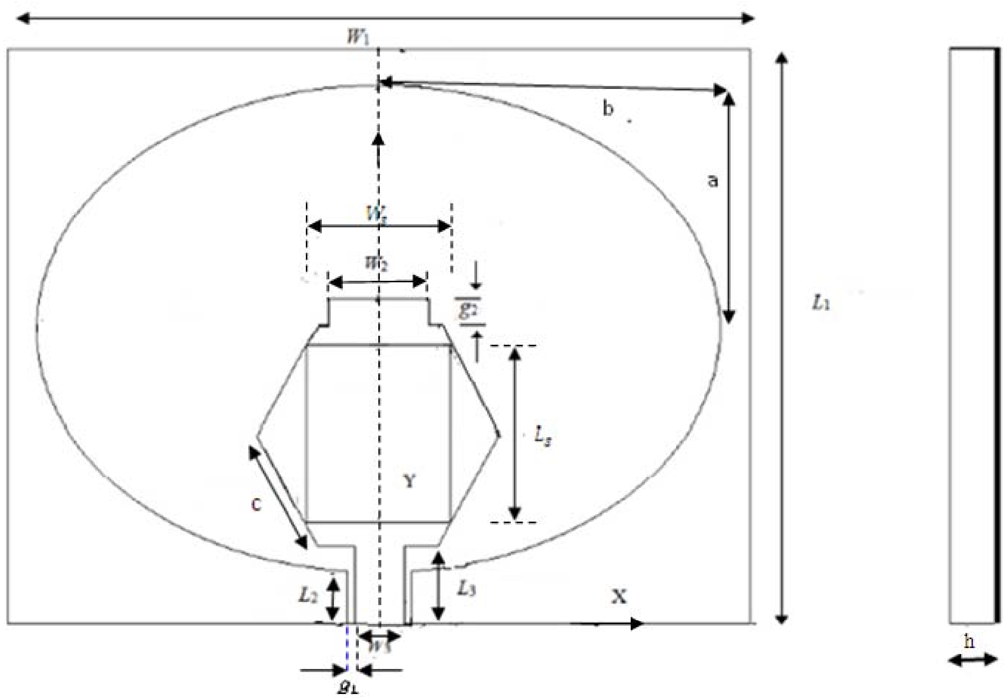


Figure 1 : Basic geometry of the proposed antenna (left: top view; right: cross sectional view).

a) Variation of Gap (g_1)

The gap between signal conductor and ground (g_1) was varied from 0.1 to 0.2 in steps of 0.05 mm by keeping all other parameters constant. Effect of g_1 on S_{11} characteristics is presented in Figure 2. From Figure 2 it may be noted that impeadance matching may be fine tuned with this parameter. From this study the gap value of $g_1 =$ 0.1mm was noted as an optimum.

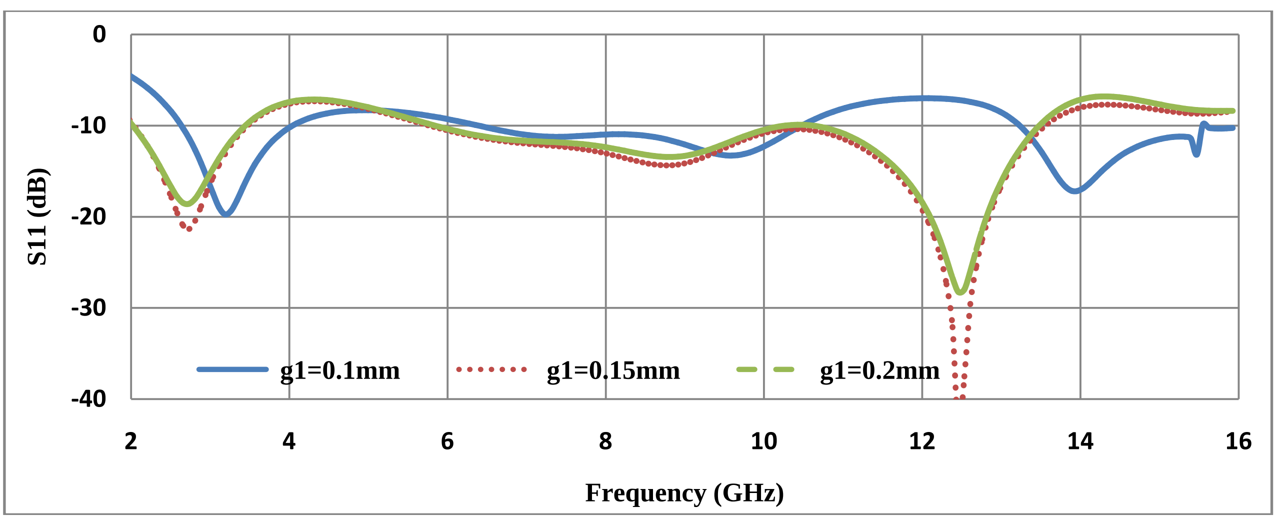


Figure 2 : The effect of the length g_1 on reflection coefficient characteristics.

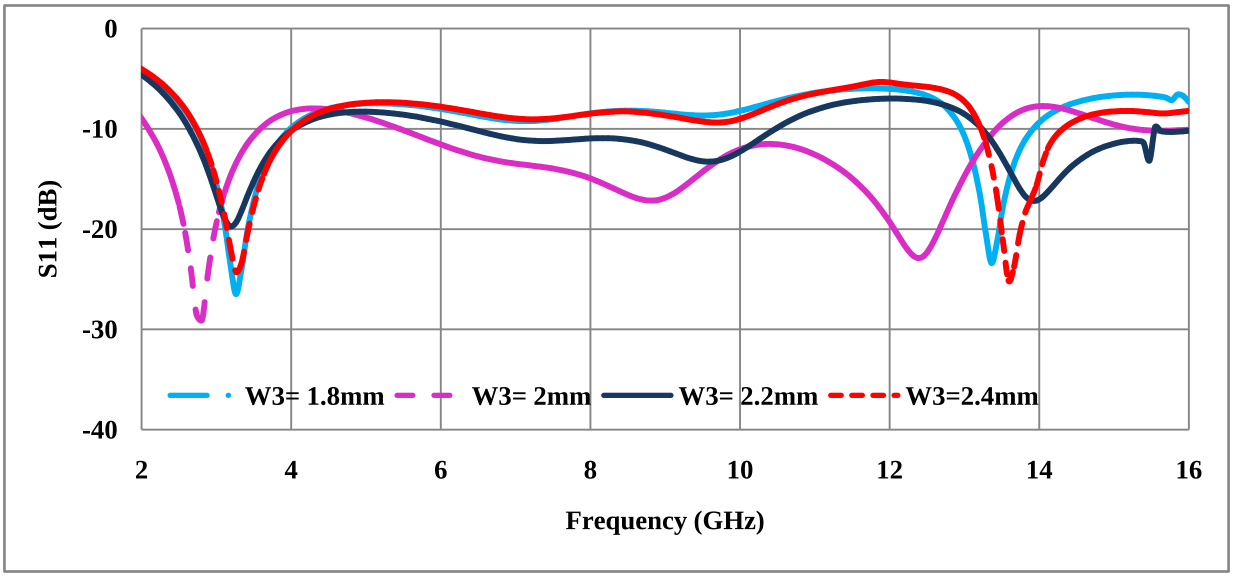


Figure 3 : The effect of the signal conductor width W_3 on reflection coefficient characteristics.

b) Effect of Length of Rectangular Slot (L_s)

In anoter effort, rectangular slot length (L_s) was varied from 5.7 mm to 7.2 mm in steps of 0.5mm with all other parameters kept constant. Effect of variation of rectangular slot's length on reflection coefficient characteristics are presented in Figure 4. In this observation, a slot value of L_s = 7.2 mm offered the optimum impedance bandwidth. It may be noted that slot length beyond 7.2mm cuts the edges of the hexagonal signal conductor stub.

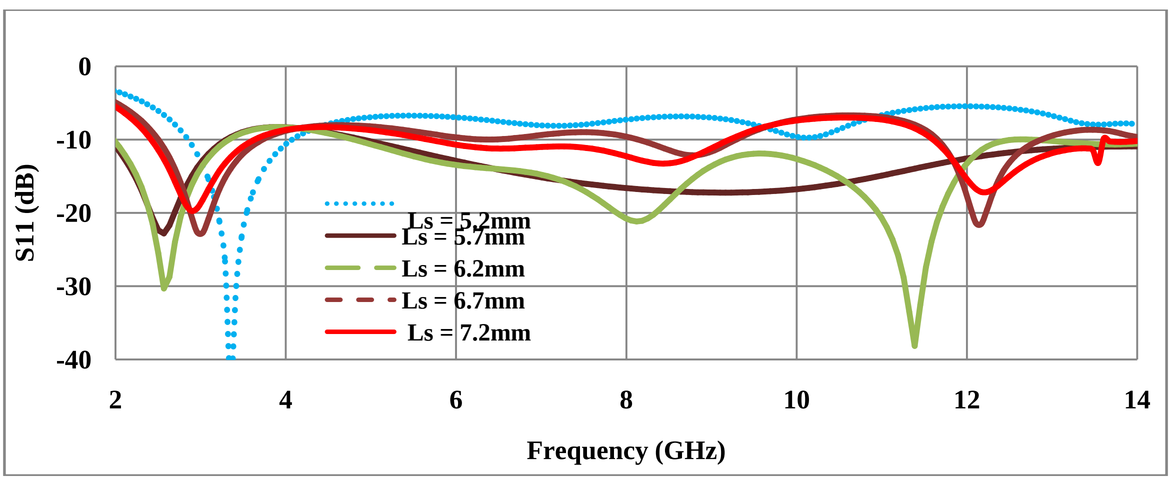


Figure 4 : The effect of the length of rectangular slot L_s on reflection coefficient characteristics.

c) Effect of Width of Rectangular Slot (W_s)

Finally, the width of rectangular slot was varied from 5.1 mm to 7.1 mm in steps of 0.5 mm by keeping all other parameters constant. The effect of variation of W_s on the antenna's input characteristics are presented in Figure 5. These characteristics indicate that a rectangular slot width of W_s = 7.1 mm offers the optimum performance.

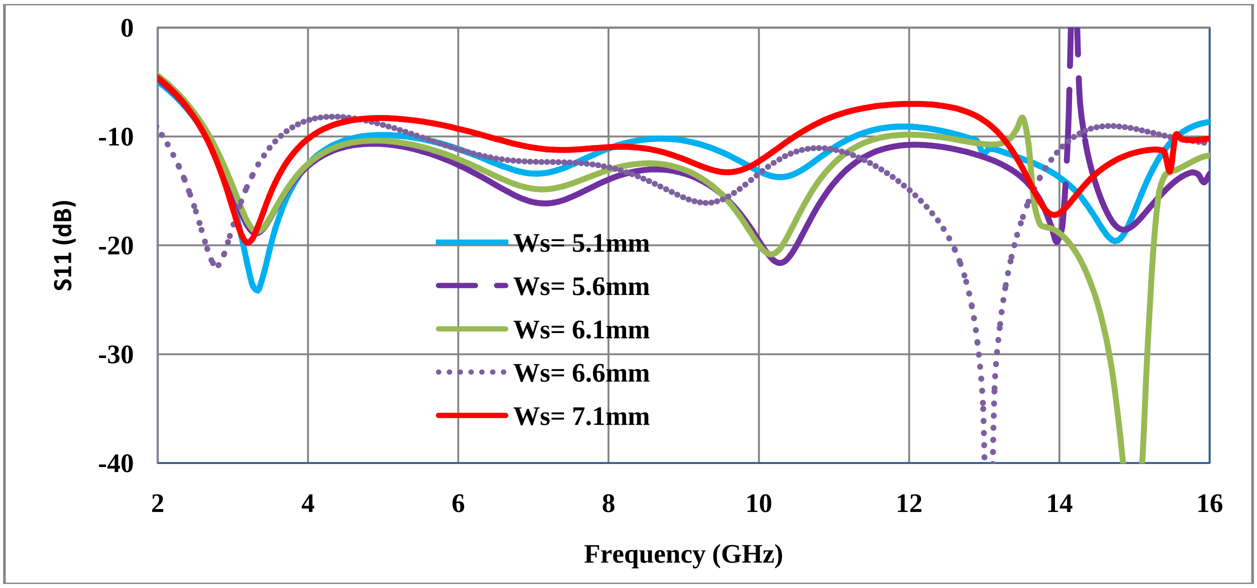


Figure 5 : The effect of the Width of rectangular slot W_S on reflection coefficient characteristics.

IV. Experimental Validation of the Geometry and Discussions

The prototype of antenna geometry shown in Figure 1 was fabricated and tested experimentally for its validation. The dimensions used for prototype development are as listed in Table 1. Substrte used for development is an FR4 glass epoxy material whose height is 1.6mm and having a relative permitivity of 4.4 with dielectric loss tangent of 0.02. The photograph of the fabricated design is as shown in Figure 6. Antenna's reflection coefficient parameters were measured using Agilent's network analyzer. Measured characteristics are compared with simulated values and presented in Figure 7. Although, a mismatch was observed due to fabrication inaccuracies, tri band operation was observed. Three resonances are obtained at 5.9GHz, 9.9GHz, and at 14.4GHz.

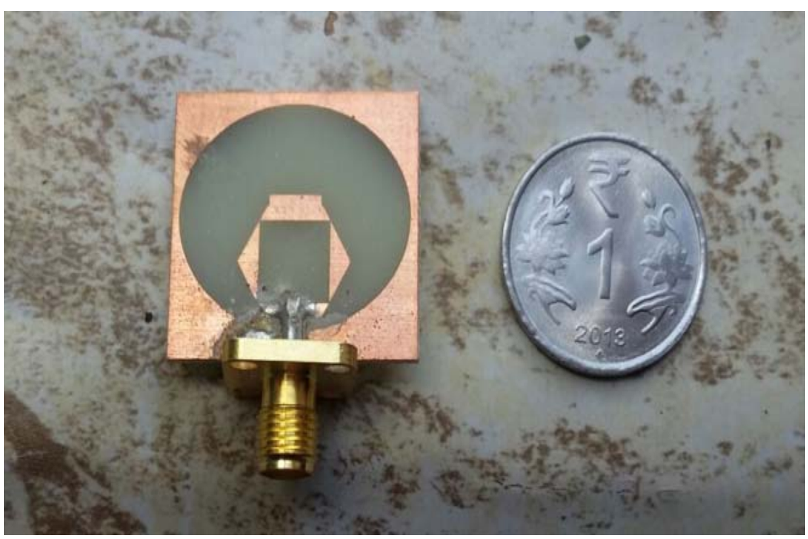


Figure 6 : Photograph of the fabricated prototype.

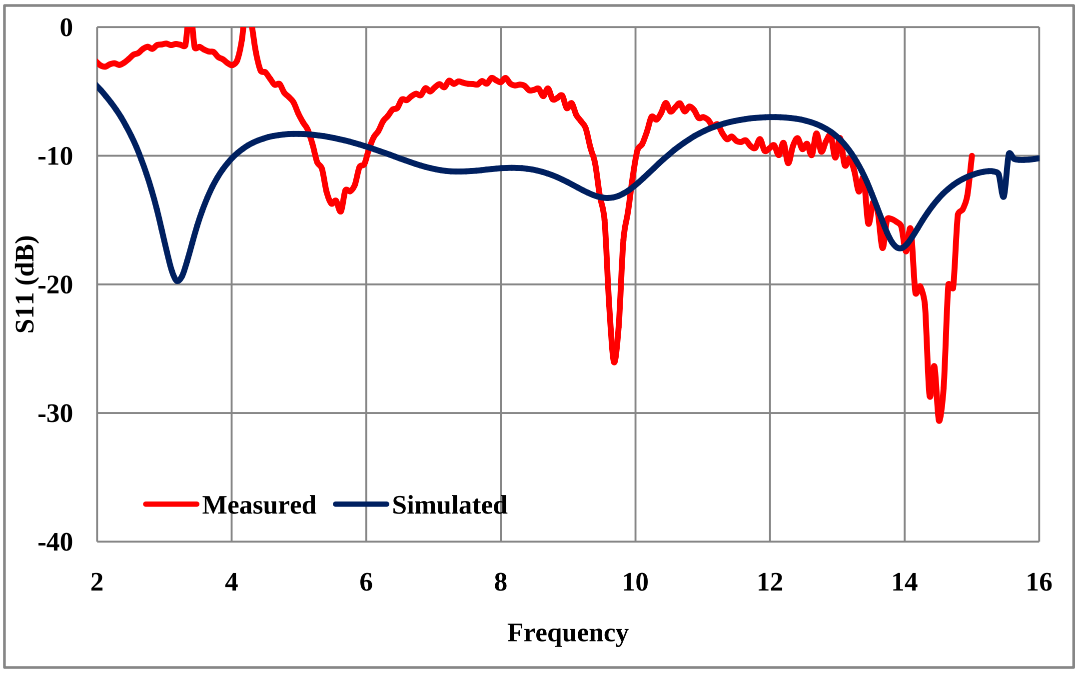
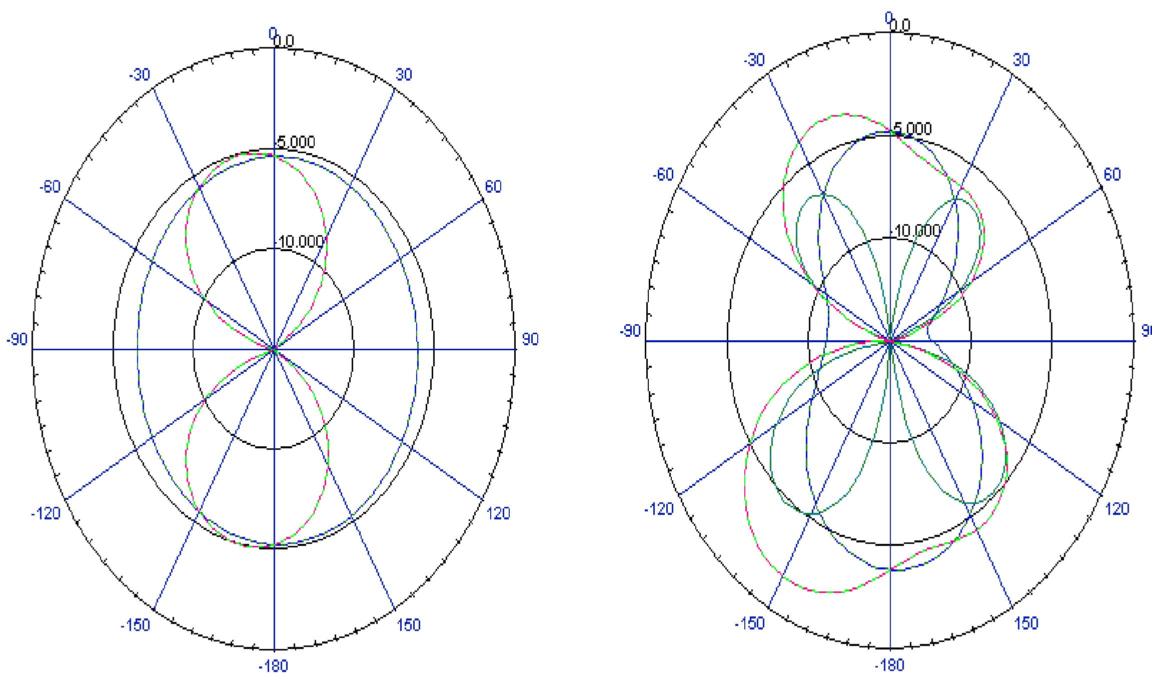


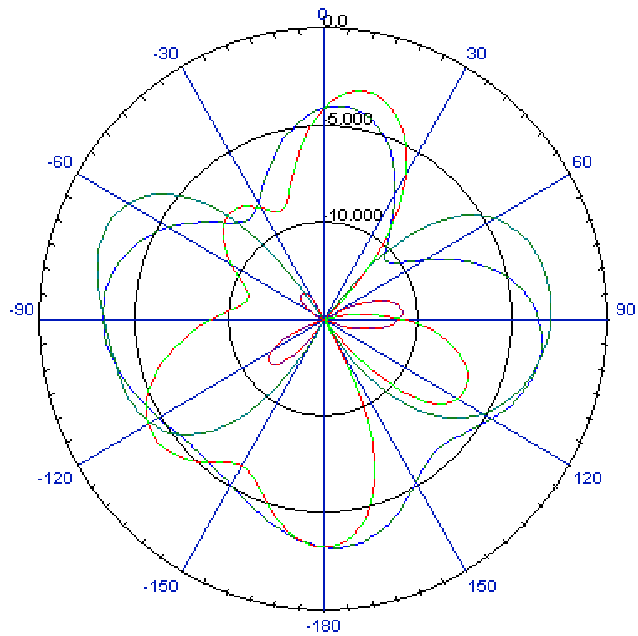
Figure 7 : Comparison of measured and simulated reflection coefficients.

Radiation patterns are plotted at three different frequencies are depicted (Figure 8) to demonstrate the proper working of antenna.



(a) *f*=3.189GHz

(b) *f*= 9.66GHz



(c) *f*=13.96 GHz

Figure 8 : Radiation patterns at three resonances of the antenna.

V. Conclusions

A planar patch antenna fed with CPW feed has been presented for tribands operation. Proposed antenna is basically a monopole antenna. A rectangular slot was loaded to excite three resonance bands. Slot and hexagonal dimensions are tuned for impedance matching of antenna. Three resonances obtained are at 5.9GHz, 9.9GHz, and at 14.4GHz. Stable radiation patterns have been obtained across the bands of operation. The proposed antenna is suitable for tri-bands applications. The future work includes the bandwidth optimization of the three frequency bands.

References Références Referencias

1. Federal Communications Commission (FCC), Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems First Rep. and Order, ET Docket 98-153, FCC 02-48, and Adopted: Feb. 2002; Released, Apr. 2002.
2. C.A. Balanis, *Antenna Theory and Analysis*, 2nd Edn., Wiley & Sons, New York, 1997.
3. T. G. Ma and S. K. Jeng, "A printed dipole antenna with tapered slot feed for ultrawide- band applications," *IEEE Trans. Antennas Propag.,* vol. 53, pp. 3833-3836, Nov. 2005.
4. Q. X. Chu and T. G. Huang, "Compact UWB antenna with sharp band-notched characteristics for lower WLAN band," *Electron. Lett.*, vol. 47, pp. 838-839, Jul. 2011.
5. M. M. S. Taheri, H. R. Hassani, and S. M. A. Nezhad," UWB printed slot antenna with bluetooth and dual notch bands," *IEEE Antennas Wireless Propag. Lett.*, vol. 10, pp. 255-258, 2011.
6. C.-C. Lin, P. Jin, and R. W. Ziolkowski, "Single, dual and tri-band-notched ultrawideband (UWB) antennas using capacitively loaded loop (CLL) resonators," *IEEE Trans. Antennas Propag.*, vol. 60, pp. 102-109, Jan. 2012.
7. S. K. Mishra, R. K. Gupta, A. Vaidya, and J. Mukherjee, "A compact dual-band fork-shaped monopole antenna for Bluetooth and UWB applications," *IEEE Antennas Wireless Propag. Lett.*, vol. 10, pp. 627-630, 2011.
8. W. S. Lee, D. Z. Kim, K. Z. Kim, and J. W. Yu, "Wideband planar monopole antennas with dual band-notched characteristics," *IEEE Trans. MTT*, vol. 54, pp. 2800-2806, Jun. 2006.
9. J. J. Liu, S. S. Zhong, and K. P. Esselle, "A printed elliptical monopole antenna with modified feeding structure for bandwidth enhancement," *IEEE Trans. Antennas Propag.,* vol. 59, pp. 667- 670, Feb. 2011.
10. Y. Luo, L. Xu, Z. Xin, and S. He, "A compact CPW fed UWB antenna with GSM, GPS, bluetooth and dual notch bands applications," *Progress in Electromagnetics Research C*, vol. 35, pp. 205-219, 2013.
11. R. Chair, A.A. Kishk, and K. F. Lee, "Ultra-wideband coplanar waveguide fed rectangular slot antenna," *IEEE Antennas and Wireless Propagation Letters*, vol. 3, pp. 227-229, 2004.
12. A. Sompan, S. Sewattanapon, C. Mahatthanajatuphat, and P. Akkaraekthalin, "An

elliptical dipole antenna with rectangular slot reflector for wideband applications," IEEE *ECTI*, pp. 200-203, 2011.
13. S. Sadek and Z. Katbay, "Ultra wideband bow tie antenna," *IEEE Trans. Antennas Propag.*, pp. 262-263, 2009.
14. R. K. Yadav, J. Kishor and R. L. Yadava, "Design of hexagonal patch antenna for mobile wireless system," *IEEE IJSTM*, vol. 2, issue 4, December 2011.
15. X. L. Liang, T. A. Denidni, L-N Zhang, R-H Jin, J-P Geng, and Q. Yu , " Printed binomial curved slot antennas for wideband applications," *IEEE Trans. Microwave Theory and Techniques,* vol. 59, no. 4, pp. 1058-1065, 2011.
16. HFSS 10.0 user's manual, Ansoft Corporation, Pittsburgh.

This page is intentionally left blank