iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 **Issue:** VI **Month of publication:** June 2017

DOI:

Volume 5 Issue VI, June 2017
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Paper-Based Screen-Printed Multi-Band Monopole Antenna for Wireless Application

Kirti Varma[1], Jyotsna Pawane[2], Sarika Waghmode[3], Dr. S. S. Chorge[4]
[1,2,3,4]*Department of Electronics and Telecommunication Engineering*
[1,2,3,4]*Bharati Vidyapeeth's College of Engineering for Women, Pune-43*

Abstract: In this paper, we proposed design of a photo paper-based multiband antenna using screen-printing technology. The U-shape slots are achieving multiband operation of various frequencies. The antenna is fabricated through a silver metallic nanoparticle ink on a standard commercial paper. Thus, the antenna can be used for different wireless application GPS, WiMAX, HiperLAN/2, and WLAN and other also. The antenna has a compact size of 12X37:3X0:44mm^3. The S11 parameter, current distributions, radiation patterns, and VSWR of the antenna have been studied through HFSS software and by using VNA practically in antenna lab.

Index Terms: Printed antenna, multiband antenna, paper antenna, small antenna, various shape slot antenna.

I. INTRODUCTION

Antennas which can work properly in more than one frequency region either for transmitting or receiving electromagnetic (EM) waves are termed as Multi-band antennas. Such antennas are usually used for dual-band, tri-band, and penta-band applications. Multi-band antennas are much more complex than the single band antennas in their design, structures and operations.

In literature, different ways of generating multiband and wideband operations in a single antenna have been proposed, e.g., using a trapezoid conductor on the backside of the antenna [1], inductive slot [2], additional sleeve [3], shorting wall [4], U-slot antenna [5], double L-slit [6], coupled V-slot [7], split-ring monopole antenna [8], inverted-L monopole antenna [9], defected ground plane [10], and using single-cell met material loading [11].

In this paper, a compact U-slot antenna is proposed using screen printing technology. Recently printing technology is a low cost fabrication process for electronics. Screen printing allows very detailed prints that can be used to produce physically complicated structure, whereas the other fabrication methods are expensive and require more time. The antenna is fabricated using silver ink. A low cost environment friendly, biodegradable, organic and flexible material such as photo paper is used as substrate. The Antenna employs U-slot shapes to generate additional bands at low and high frequency. It is operate within the Global Positioning System (GPS), the Worldwide Interoperability of Microwave Access (WiMAX), and HiperLAN/2 applications.

II. PRINTED MONOPOLE ANTENNA DESIGN &SIMULATION

A. Structure and Dimensions

The structure of the proposed monopole antenna with mi-cro strip feed is shown in Fig. 1, which consists of a rectangular radiator, a 50ohm microstrip feed line, and a ground plane. The dielectric material selected for the design is photo paper which has dielectric constant of (3.2) and height of dielectric substrate (h = 0.44mm.) A U-shaped slot is cut on the radiator to create a longer current path to excite a narrow band for the GPS system and, at the same time, to achieve two wide bands for WiMAX, HiperLAN/2, and WLAN systems. The antenna is design using High Frequency Structure Simulator (HFSS) software with the dimensions.

Table 1

L	L1	L2	L3	L4	L5
20	13.6	9.175	2.3	1.325	3.7
W	W1	W2	W3	W4	W5
40	12	4.9	2.5	6.5	3

B. Design Steps for monopole antenna

We will design of multiband monopole antenna at a frequency of 5GHz. We will employ the following procedure for the antenna design. For an antenna to be an efficient radiator, W should be taken equal to half the wavelength corresponding to the average of the two dielectric mediums (i.e., substrate and air).

$$\omega = \frac{c}{2f_0\sqrt{\frac{\varepsilon_r + 1}{2}}}$$

where f_0 is the resonant frequency of the microstrip antenna (MSA), ε_r is the relative dielectric constant of the substrate In this design, photo paper substrate of relative permittivity of 3.2 and height h=0.44mm is used. The value of ε_e is slightly less than ε_r, because the fringing fields around the

Peripheries of the patch are not confined in the dielectric substrate but are also spread in the air.

$$\varepsilon_{reff} = \frac{\varepsilon_{r+1}}{2} + \frac{\varepsilon_{r-1}}{2}\left[1 + 12\frac{h}{\omega}\right]^{-1/2}$$

Due to the fringing fields at the two edges,

The effective length of the microstrip patch antenna is given by

$$L_{eff} = \frac{c}{2f_{0\sqrt{\varepsilon_{reff}}}}$$

Because of the fringing effects, electrically the patch of the MSA looks greater than its physical dimension (extension of □*L* on both sides). A very practical approximate relation

for the normalized extension of the length is given by

$$\Delta L = 0.421\, h \frac{\left(\varepsilon_{reff} + 0.3\right)\left(\frac{\omega}{h} + 0.264\right)}{\left(\varepsilon_{reff} - 0.258\right)\left(\frac{\omega}{h} + 0.8\right)}$$

Where h is the thickness of the substrate and it is assumed to be much smaller than the dimensions of the antenna.

After calculation of the dimensions of the patch, the design process is continued with the matching of the antenna resistance to50Ω of the input line. For impedance

Matching with the microstrip feed line, inset feeding

Technique is generally used. Feed width is calculated by

$$z = \frac{377}{\sqrt{\epsilon r(\frac{w}{t}+2)}}$$

C. simulation results

The proposed monopole antenna is working in 5 frequency bands. A simple monopole antenna without slot with mi-crostrip feed operate in a single band at approximately 2:8 3 GHz and optimized S11 parameter is -12.95db.

A large U-shaped slot is cut on the radiator to create higher frequency band operation above 4GHz. A small U-shaped slot is cut on the radiator that cutting a smaller slot adds another band at 1.18GHz in addition with three more frequency bands at around 2.8,4.4,4.9and 6.3 GHz, with significantly better matching without requiring to increase the antenna size. The antenna now has five frequency bands, one narrow band at 1.18 GHz and other are wide bands. The S11 parameters of their bands are -12.95dB,-17.65dB,-12.32dB and -12.41dB respectively.

The simulated and measured (S11 < (10dB)) for the multi-band are summarized in Table II. These frequency bands cover the GPS WiMAX WLAN IEEE 802.11a/n, and HiperLAN/2 the discrepancy between the simulation and measurements could be due to the effect of connector and manufacturing tolerance. Since the size of the antenna is small, the coupling between the connector and various parts of the antenna may slightly affect the performance.

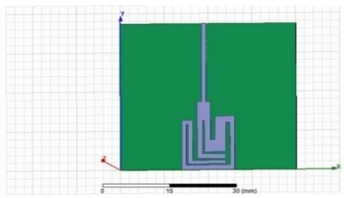


Fig 1: Top view of antenna

Volume 5 Issue VI, June 2017
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

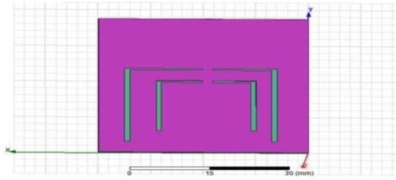


Fig 2:Ground plane of antenna

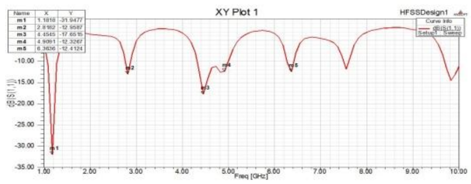


Fig 3:S11

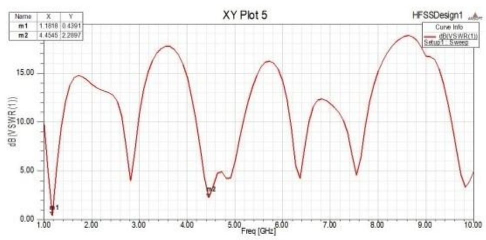


Fig 4:VSWR

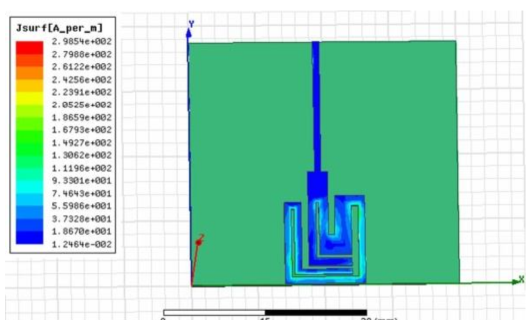


Fig 5:Current distribution

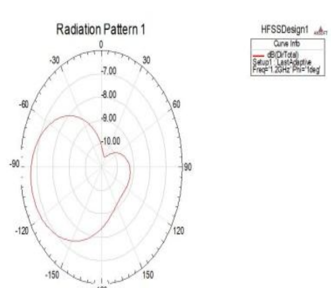


Fig 6: Radiation pattern

III. MEASURED RESULT

The simulated and measured S11 parameters of the antenna are shown in figure. The simulated and measured results show good agreement. It can be seen that the antenna can operate in multiple frequency bands centred at 1.18, 2.8, 4.4, 4.9 and 6.3 GHz.

TABLE 2

Frequency	Simulated	Measured
1.18	-31.94	-28.12
2.8	-12.95	-13.40
4.4	-17.65	4.9
4.9	-12.32	-
6.3	-12.41	-

The simulated and measured (S11 < 10dB) for the multi-band are summarized in Table II. These frequency bands cover the GPS WiMAX WLAN IEEE 802.11a/n, and HiperLAN/2 the discrepancy between the simulation and measurements could be due to the effect of connector and manufacturing tolerance. Since the size of the antenna is small, the coupling between the connector and various parts of the antenna may slightly affect the performance.

IV. CONCLUSION

The design of an screen-printed multiband monopole an-tenna with a compact size of only 12X37:3X0:44mm^3 has been presented. U-shaped slot cut on the main radiator is used to generate a low-frequency band for GPS and other high-frequency bands with much wider bandwidths for many other applications. Although the proposed antenna is optimized to operate at 1.18, 2,8, 4.4, 4.9 and 6.3 GHz, other applications are also possible to be obtained by changing the structural parameters of the U-slot. The specific challenges encountered during this work are: 1) using multi layers of papers where alignment is of great concern; 2) realizing consistent smaller feature sizes and gaps with screen printing process for a specific substrate; 3) achieving high ink conductivity through thickness of layers and sintering process; 4) attaining good performance on a lossy paper substrate; and 5) mounting SMA on paper (with soldering) and characterizing these antennas [1]. The small size, light weight, and the cost effectiveness

of the proposed antenna makes it suitable for small and slim wireless devices and wearable sensors also. Wideband has achieved by inserting slot on ground plane

REFERENCES

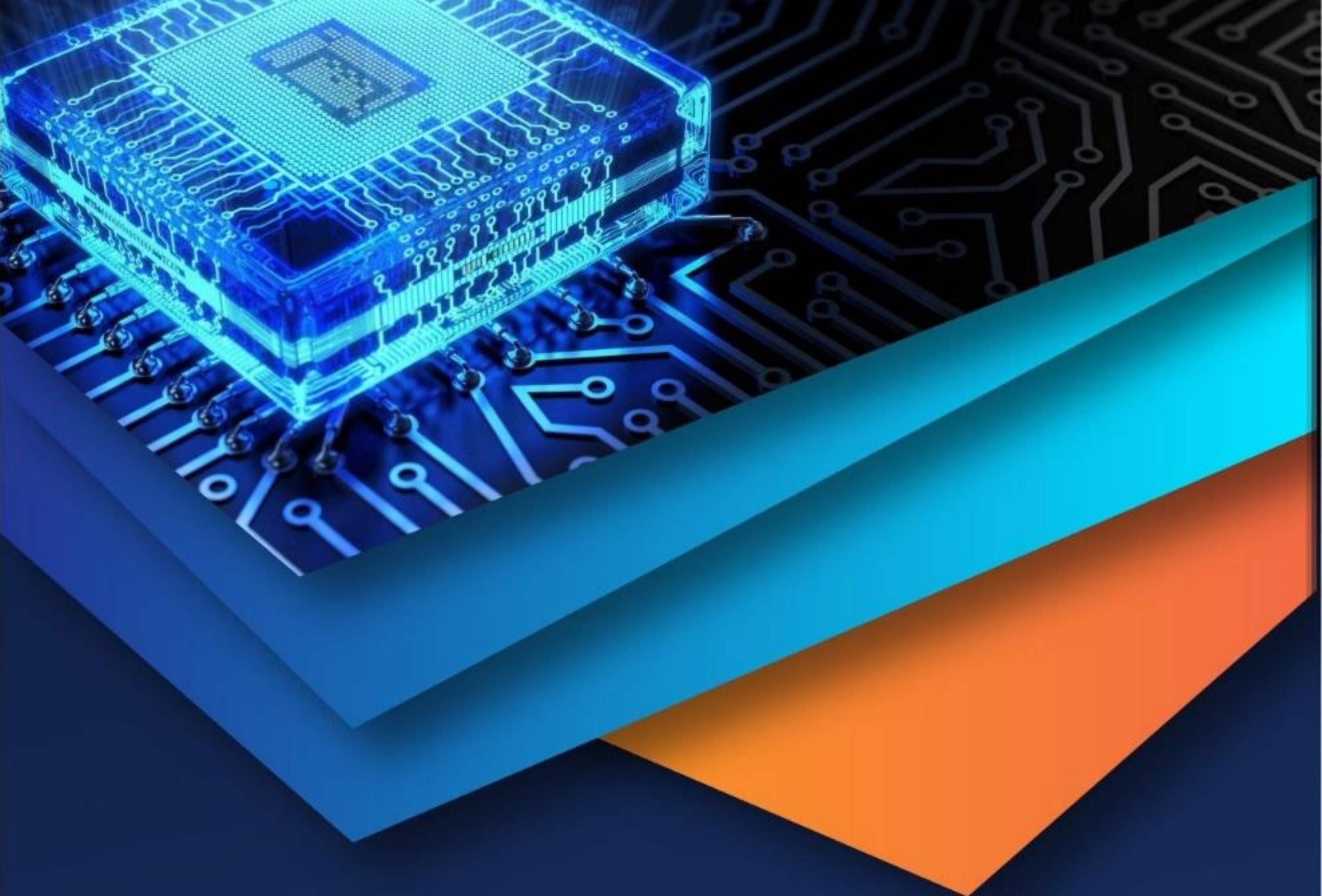
[1] C. Pan, T. Horng, W. Chen, and C. Huang, Dual wideband printed monopole antenna for WLAN/WiMAX applications, IEEE Antennas Wireless Propag. Lett., vol. 6, pp. 149151, 2007;
[2] X.-C. Lin and C.-C. Yu, A dual-band CPW-fed inductive slot-monopole hybrid antenna, IEEE Trans. Antennas Propag. vol. 56, no. 1, pp. 282285, Jan. 2008;
[3] G. Augustin, P. Bybi, V. Sarin, P. Mohanan, C. Aanandan, and K. Vasudevan, A compact dual-band planar antenna for DCS-1900/PCS/ PHS, WCDMA/IMT-2000, and WLAN applications, IEEE Antennas Wireless Propag. Lett., vol. 7, pp. 108111, 2008;
[4] C. Y. Chiu, C. H. Chan, and K. M. Luk, Study of a small wide-band patch antenna with double shorting walls, IEEE Antennas Wireless Propag. Lett., vol. 3, pp. 230231, 2004;
[5] H. F. Abutarboush, R. Nilavalan, D. Budimir, and H. Al-Raweshidy, Double U-slots patch antenna for tri-band wireless systems, Int. J. RF Microw. Comput.-Aided Eng., vol. 20, no. 3, pp. 279285, May 2010;
[6] T.-H. Kim and D.-C. Park, Compact dual-band antenna with double L-slits for WLAN operations, IEEE Antennas Wireless Propag. Lett., vol. 4, pp. 249252, 2005;
[7] S.-W. Qu and Q. Xue, A Y-shaped stub proximity coupled V-slot microstrip patch antenna, IEEE Antennas Wireless Propag. Lett., vol. 6, pp. 4042, 2007;
[8] S. Basaran, Dual wideband CPW-fed split-ring monopole antenna for WLAN applications, in Proc. MMS, Aug. 2010, pp. 174177;
[9] W. Ni and N. Nakajima, Small printed inverted-L monopole antenna for worldwide interoperability for microwave access wideband operation, Microw., Antennas Propag., vol. 4, no. 11, pp. 17141719, Nov. 2010;
[10] M. A. Antoniades and G. V. Eleftheriades, A compact multiband monopole antenna with a defected ground plane, IEEE Antennas Wire-less Propag. Lett., vol. 7, pp. 652655, 2008;
[11] J. Zhu,M. A. Antoniades, and G. V. Eleftheriades, A compact tri-band monopole antenna with single-cellmetamaterial loading, IEEE Trans. Antennas Propag., vol. 58, no. 4, pp. 10311038, Apr. 2010;
[12] H. F. Abutarboush, R. Nilavalan, S. W. Cheung, K. Nasr, T. Peter, and D. Budimir, A reconfigurable wideband and multiband antenna using dual-patch elements for compact wireless devices, IEEE Trans. Antennas Propag., vol. 60, no. 1, pp. 3643, Jan. 2012;
[13] H. F. Abutarboush, R. Nilavalan, T. Peter, and S. W. Cheung, Multiband inverted-F antenna with independent bands for small and slimcellular mobile handsets, IEEE Trans. Antennas Propag., vol. 59, no.7, pp. 26362645, Jul. 2011;
[14] H. F. Abutarboush, R. Nilavalan, S. W. Cheung, and K. Nasr, Compact printed multiband antenna with independent setting suitable for fixed and

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

reconfigurable wireless communication systems, IEEE Trans. Antennas Propag., 2012, to be published;

[15] Satimo, Villebon-sur-Yvette, France, StarLab, 2012 [Online]. Available: http://www.satimo.com C. A. Balanis, Antenna TheoryAnalysis and Design, 3rd ed. Hoboken, NJ: Wiley, 2005;

[16] www.ripbulication.com/irph/volume/ijwncv7n1.htm



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089 (24*7 Support on Whatsapp)