Available online at www.sciencedirect.com

ScienceDirect

Procedia Manufacturing 22 (2018) 539–544

Procedia MANUFACTURING

www.elsevier.com/locate/procedia

11th International Conference Interdisciplinarity in Engineering, INTER-ENG 2017, 5-6 October 2017, Tirgu-Mures, Romania

A new monopole antenna in the form of double dollar-symbol for WLAN (5.1- 6 GHz) applications

Nisrin Sabbar[a,]*, Khalid Hati[b], Hassan Asselman[a], Abdellah El Hajjaji[c]

[a]*Optics and Photonics group, Faculty of Sciences, Abdelmalek Essaadi University, Tetuan, Morocco*
[b]*ISR – University of Coimbra, Rua Silvio Lima-Polo II, 3030-290 Coimbra- Portugal*
[c]*Systems of communications and Detection Laboratory, Faculty of Sciences M'hannech II,Tetuan 93002, Morocco*

Abstract

In this paper, we present a new monopole antenna design for WLAN (5.1-6 GHz) application. The proposed antenna fed by a microstrip and the radiating element is in the form of a double dolar-symbole. The antenna designed is printed on a partial ground plane, and the resulting antenna has been found to possess a compact size of 20 mm × 20 mm, and covers specific bands from the frequency spectra.
A parametrical study is performed to optimize the geometry of the antenna structure and a comparison study also will be presented for different kind of ground plane material. The designed antenna structure is simulated using the High Frequency Structural Simulator (HFSS).

Peer-review under responsibility of the scientific committee of the 11th International Conference Interdisciplinarity in Engineering.

Keywords: Monopole; Antenna; WLAN; Ground plane; Substrate.

1. Introduction

Recently, many antennas structures in literature have been presented by many authors [1 3]. Antennas are more and more used in many systems such as WLAN [4 6], RFID [7 8], WIFI application [9] and others applications [10].

* Corresponding author. Tel.: +212-659-940-966.
E-mail address: sabbar.nisrin@gmail.com

2351-9789
Peer-review under responsibility of the scientific committee of the 11th International Conference Interdisciplinarity in Engineering.
10.1016/j.promfg.2018.03.079

In the last two decades, the mobile industry and design has seen significant growth. The use of different frequencies in a multi-system needs the use of a multiband antenna. So, the multiband micro-strip patch antenna is most preferred for the wireless application. The monopole [11 13] and multiband [14 16] antennas allows a very large advantages; in particular, their simple structure, low cost, low energy consummation and the small size [17] of the system and also their easy integration into frontend circuits, suggests the use of printed technologies.

The increasing demands of wireless, short range, and high data rate transmissions, pushed to propose new wireless protocols using different bands of the frequency spectrum, in order to support high data rate wireless communications. This rapid development of short-range radio links in the mobile communications and wireless industry (especially Wi-Fi and Wireless Local Area Network (WLAN)) calls for antennas able to operate in different frequency bands simultaneously (multiband antennas), offering wideband operations covering the whole WLAN services.

The most common desirable requirement consists of providing multiband operations, and the frequency bands required to a single antenna are 2.4–2.484GHz for Bluetooth applications, 2.4GHz and 5GHz for Wi-Fi applications (following HiperLan protocol), and 2.4GHz, 5.2GHz, 5.4 and 5.8GHz for WLAN applications (following WLAN IEEE 802.11 standards). Thus, planar antennas are widely used because of their low profiles, easy design, and fabrication.

In this research work, the designed antenna structure is simulated by using the High Frequency Structural Simulator HFSS (High Frequency Structure Simulator). The simulations are carried out using the finite element method (FEM).

Nomenclature

HFSS High Frequency Structure Simulator
RFID Radio-Frequency IDentification
WLAN Wireless Local Area Network
VSWR Voltage Standing Wave Ratio

2. Antenna configuration

The antenna design is in the form of a double of dollar-symbol as shown in the Fig. 1, and the proposed antenna fed by a micro-strip with 50ohm.

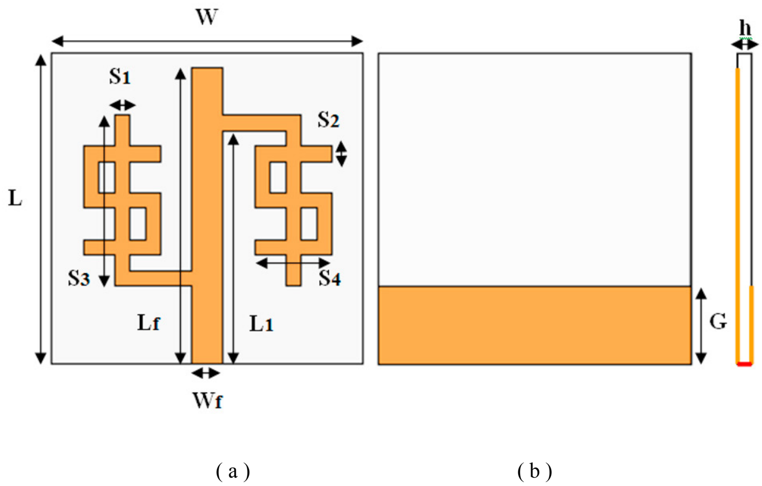


Fig. 1. Geometrical configuration of proposed antenna (a) top view; (b) bottom view.

The antenna designed is printed on a partial ground plane, and the resulting antenna has been found to possess a compact size of 20 mm × 20 mm, and covers specific bands from the frequency spectra.

In the first part, a parametric study is performed to satisfy a good resonance and gain of the proposed antenna. In the second part, many types of substrate (Rogers RT/duroid5880-5870, RO 4003, Ultralam 2000 and FR4) have been used for a comparison study.

The dimensions of the proposed structure are given in the Table 1.

Table 1. Geometrical parameters of the proposed antenna.

Parameters	Value (mm)
W	20
L	20
Wf	2
G	7
Lf	19
L1	15
S1	1
S2	1
S3	11
S4	5
H	1.6

3. Results and discussions

The return loss is another way of expressing mismatch. It is a logarithmic ratio measured in dB that compares the power reflected by the antenna to the power that is fed into the antenna from the transmission line.

In the first part, a parametric study was performed to optimize the obtained a resonance at the WLAN frequency band. The effect of the thickness H of substrate is presented. As shown in the figure 2, and for different values of the parameter H, the optimize value obtained is for the small one H=0.794 mm with a good adaptation -65 dB.

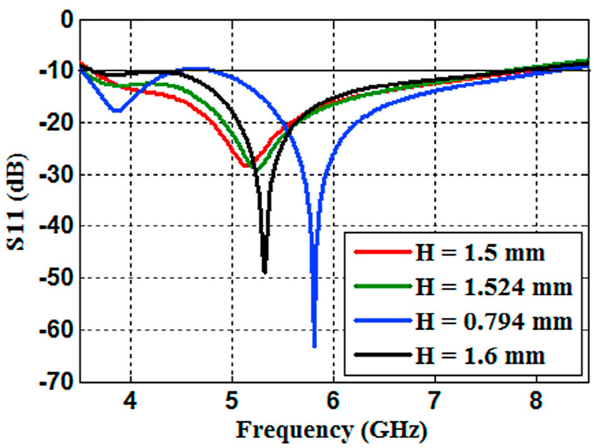


Fig. 2. Simulated return loss for different values of thickness H.

In the second part, a comparison study of a numerous types of substrate is performed to optimize the side effect of the return loss. The figure 3 shows the reflection coefficient of the proposed antenna for many different substrates. It is clear that the optimize structure is made by the substrate duroid5870.

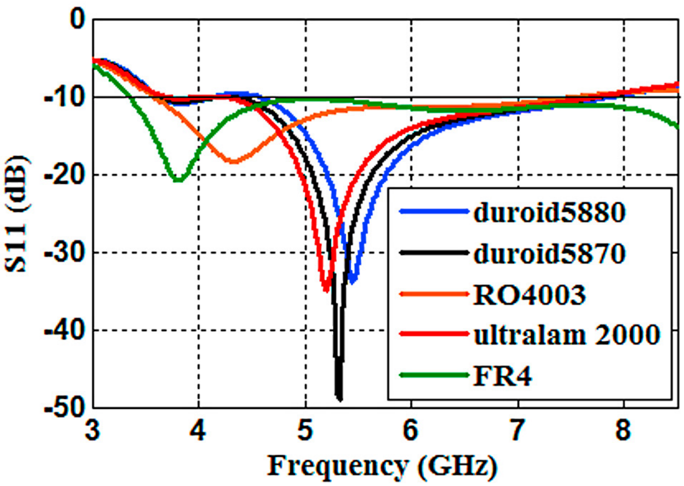


Fig. 3. Simulated return losses of different substrates.

As shown in the Fig. 4, the VSWR is less than 2 dB at band of frequencies (5 GHz-5.7 GHz). The simulating results show that the proposed antenna is suitable for wireless communication system application WLAN.

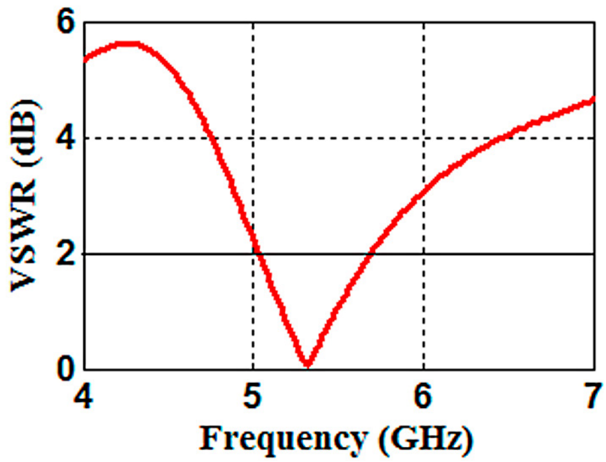
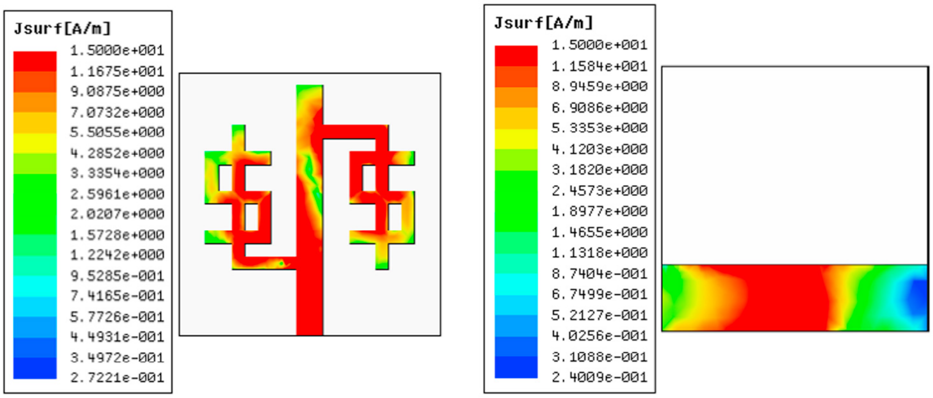


Fig. 4. The VSWR of proposed antenna.

The figure 5 below shows the areal current distribution of the proposed antenna.

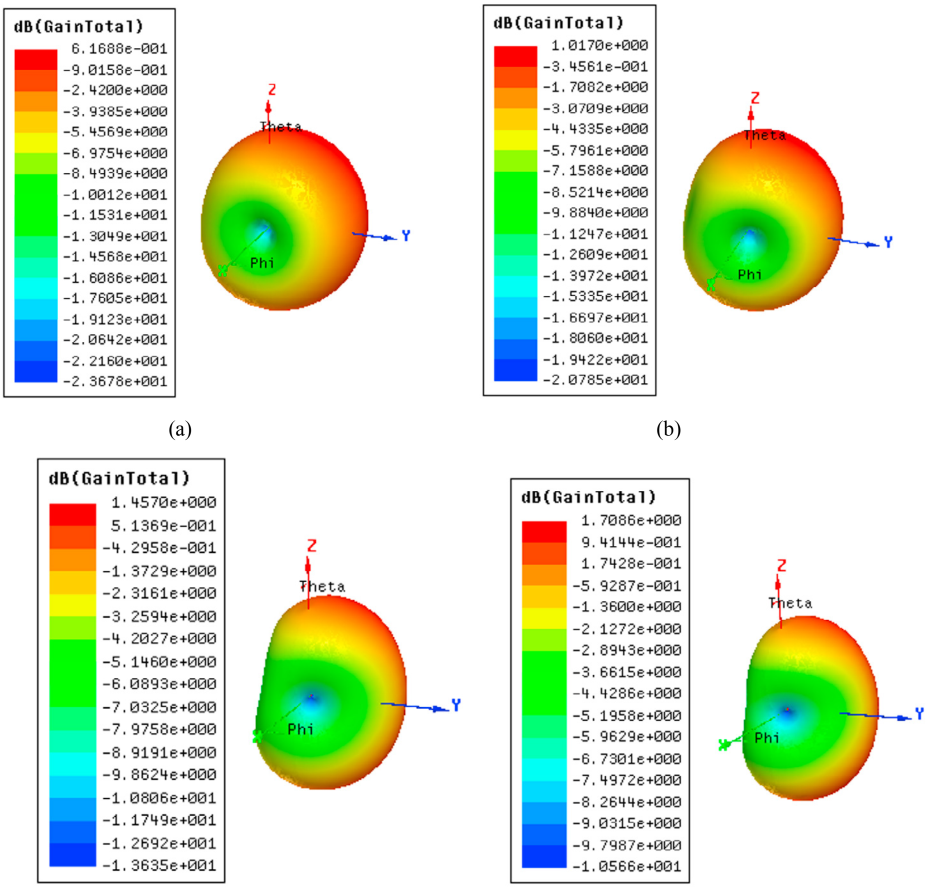
We can observe that the current distribution is concentrated at the alimentation line for the resonance frequency (5.3 GHz).



(a) (b)

Fig. 5. Simulated results of the surface current distributions for the antenna: (a). Radiating element (b). Ground plan.

Finally, the figure 6 shows the simulated 3D gain of the antenna structure. The optimum value of the gain is given at 6GHz, and it growth from 1 dB to 1.7 dB between the 5 GHz and 6 GHz bandwidth.



(a) (b) (c) (d)

Fig. 6. 3D Gain of the proposed antenna at (a) f=5.1 GHz; (b) f=5.3 GHz; (c) f=5.7 GHz; (d) f=6 GHz.

4. Conclusion

In this paper, a new monopole antenna structure in the form of a double dollar-symbol was presented. A parametrical study was performed to optimize the final configuration. The proposed structure resonates at frequency 5.3 GHz and is suitable for WLAN application and presents a good surface current distribution.

Acknowledgements

The authors would like to acknowledge funding support from Erasmus Mendus Program (Europ). The authors would like to thank the University of Coimbra for supporting this work.

References

[1] V. Rajeshkumar, S. Raghvan, A compact metamaterial inspired triple band antenna for reconfigurable WLAN/WiMAX applications, Int. J. Electron. Commun. (AEÜ) 69 (2015) 274–280
[2] Anil K. Gautam, Aditi Bisht, Binod Kr Kanaujia, A wideband antenna with defected ground plane for WLAN/WiMAX applications, Int. J. Electron. Commun. (AEÜ) 70 (2016) 354–358.
[3] D. M. Pozar, S. M. Duffy, A dual-band circularly polarized aperture-coupled stacked microstrip antenna for global positioning satellite, IEEE Transactions on Antennas and Propagation. 45(11) (1997) 1618-1625.
[4] R. Rajkumar, K.U. Kiran, A compact metamaterial multiband antenna for WLAN/WiMAX/ITU band applications, Int. J. Electron. Commun. (AEÜ) 70 (2016) 599–604
[5] R. Kashyap, R. Khanna, and J. Kaur, Novel dual-band CPW-fed monopole antenna for WLAN/WiMAX applications, Iternational Journal of Emerging Trends in Electrical and Electronics. 3(2) (2013) 73–77.
[6] Y.L. Kuo, K.L. Wong, Priented Double-T Monople Antenna For 2.4-5.2 Ghz Dual-Band WLAN Operations, IEEE trans .Antennas propagation. 51 (2003) 2187- 2192.
[7] Y. Kim, B. Lee, S. Yang, I. Byun, I. Jeong, S.M. Cho, Use of copper ink for fabricating conductive electrodes and RFID antenna tags by screen printing, Current Applied Physics. 12(2) 2012 473-478.
[8] T. Alkhdour, E. Shakshuki, Optimal Placement of RFID Antennas for Outdoor Applications, Procedia Computer Science. 34 (2014) 236-241.
[9] P. Callaghan and J. C. Batchelor, Dual-band pin-patch antenna for Wi-Fi applications, IEEE Antennas and Wireless Propagation Letters. 7 (2008) 757–760.
[10] B. Kapilevich, B. Litvak, Application of resonant monopole antenna for determination of complex permitivity of liquids, powdered and granular materials, Measurment. 46(6) (2013) 1964-1969.
[11] J.H. Lu, B.J. Huang, Planar multi-band monopole antenna with L-shaped parasitic strip for WiMAX application, Electronics Letters. 46(10) (2010) 671–672.
[12] C.Y. Pan, T.S. Horng, W.S. Chen, C.H. Huang, Dual Wideband Printed Monopole Antenna for WLAN/WiMAX Applications, IEEE Antennas Wirel. Propag. Lett. 6 (2007) 149–151.
[13] S. De, P. P. Sarkar, A high ultra-wideband monopole antenna, AEU-International Journal of Electronics and Communications. 69(8) (2015) 1113-1117.
[14] J.H. Lu, W.C. Chou, Planar dual U-shaped monopole antenna with multiband operation for IEEE 802.16e, Antennas and Wireless Propagation Letters. 9 (2010) 1006–1009.
[15] N. Prema, Anil Kumar, Design of multiband microstrip patch antenna for C and X band, Optik – International Journal of Light and Electron Optics. 127(20) (2016) 8812-8818.
[16] H. Lee, R. Heung-Gyoon, Compensation of RF impairment in multi-band receive based on RF sub-sampling, International J. Electron? Commun. (AEU). 66(8) (2012) 613-618.
[17] S.-S. Zhong, J.-H. Cui, Compact Dual frequency microstrip Antenna, IEEE Antennas Propagation Society International Symposium. 4 (2000) p. 2196.