International Journal of Innovation and Scientific Research
ISSN 2351-8014 Vol. 7 No. 1 Aug. 2014, pp. 1-4

http://www.ijisr.issr-journals.org/

Design of Square Microstrip Antenna Using T-Shaped Notch in the Ground Plane for Ultra Wideband Applications

Soufian Lakrit and Hassan Ammor

Electronic and Communication Laboratory EMI,
Mohammed V University Agdal (UM5A), Rabat, Morocco

ABSTRACT: This paper presents the design of an ultra wideband microstrip patch antenna for (UWB) communications. In this structure there is a square patch consists of a partial ground plane and fed by a 50 Ω microstrip line. The proposed antenna can achieves a wide bandwidth from 1.52 GHz to 11.19 GHz with VSWR<2 with stable and bi-directional radiation pattern. The simulation of this antenna has been performed by using Ansoft High Frequency Structure Simulator (HFSS) and Computer Simulation Technology-Microwave Studio (CST).

KEYWORDS: microstrip, Ultra-wideband (UWB), VSWR, HFSS, CST.

1 INTRODUCTION

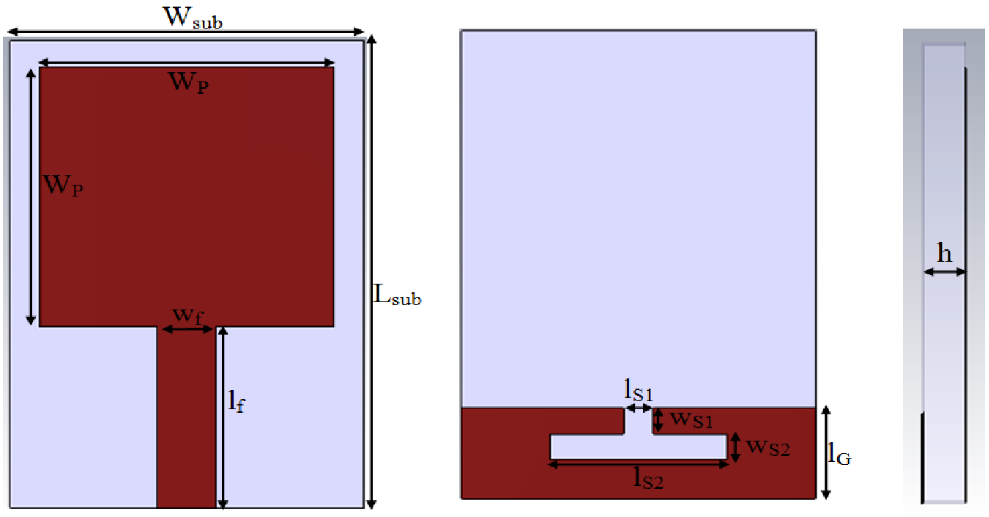
Ultra-wideband (UWB) communication systems draw great attention in the wireless world because of their advantages, like high speed data rate, extremely low spectral power density, precision, high precision ranging, low complexity and low cost since the Federal Communications Commission(FCC) allowed 3.1 to 10.6 GHz unlicensed band for UWB communication [1]. UWB also have wide applications in short range and high speed wireless systems, such as ground penetrating radars, medical imaging system, high data rate wireless local area networks WLAN (5.15–5.35 and 5.725–5.825 GHz), downlink of X-band satellite communication systems (7.25–7.75 GHz) and ITU (8.025–8.4 GHz), Various UWB microstrip antennas with single or double layer have been discussed in the literature to achieve the requirement for different applications, one of which is to increase the bandwidth [5-7],[15],[16]. Many techniques have already been applied to design wideband antennas. For example an isolated slit inside a patch, two opened slits at the top edge of a T-shaped stub, two parasitic strips and a square ring resonator embedded in a tuning stub have been reported to design band notched antenna. Embedding of various thin slots on the antenna surface, such as L-shaped slot, T-shaped slot , fractal slot and H-slot have also been reported for achieving wide-bands [8-13],[16].

In this paper, a novel square patch antenna is proposed, This structure present a wide bandwidth and miniaturized dimensions, sufficient impedance bandwidth and highly stable bi-directional radiation pattern is obtained. The planar antenna consists of a square shaped radiating patch and partial ground plane with a T-shaped slot on the upper edge to cause a broad bandwidth from 1.52GHz to 11.19GHz frequency. The antenna structure is flat, and its design is simple and straightforward. Details of the proposed design are presented and discussed in this paper. The proposed antenna design and performances are analyzed by using Ansoft High Frequency Structure Simulator (HFSS) and Computer Simulation Technology-Microwave Studio (CST).

2 ANTENNA GEOMETRY AND DESIGN

Figure 1 illustrated the configuration of the proposed antenna, which consist of a squarer patch, a partial ground plane and a T-shaped slot on the ground plane. The antenna, which has a compact dimension of 10×10 mm^2 , is printed in the front of a FR4-epoxy substrate of thickness 1.58 mm and relative permittivity 4.4. The dimension of partial ground plane which is printed in the back side of the substrate is chosen to be 12×3.5 mm^2 in this study. The bottom of the patch is connected by a microstrip line, which is fed by a 50Ω coaxial probe from the side of the antenna. The microstrip line was etched on the same side of the substrate as the radiator. The antenna has the following parameters: L_{sub}= 18mm,

W_{sub} = 12mm, WP = 10mm, W_f = 2mm, l_f = 7mm, Lg = 3.5mm, w_{S1} = l_{S1} = w_{S2} = 1mm, l_{S2} = 6mm and h = 1.58mm.



Top view *Bottom view* *side view*

Fig. 1. Geometry of proposed antenna with inverted T-shaped notch

3 RESULTS AND DISCUSSION

In this section, the square patch antenna with various design parameters is constructed, and the numerical results of the input impedance and radiation characteristics are presented and discussed. The simulated results are obtained using the Ansoft simulation software high frequency structure simulator (HFSS) and Computer Simulation Technology- Microwave Studio (CST).

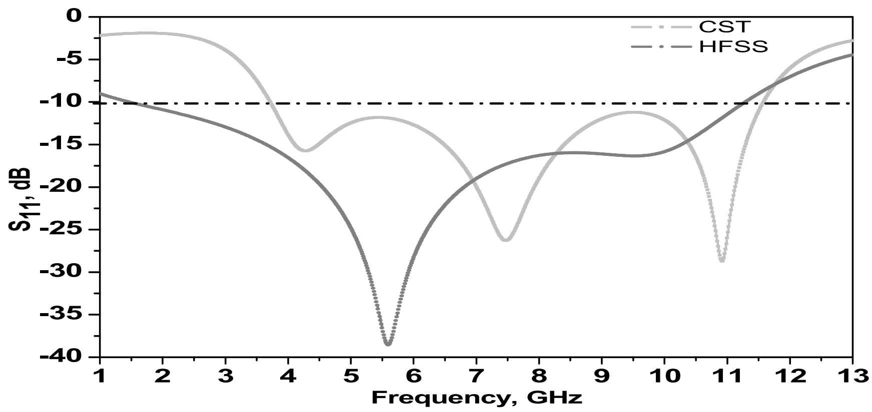


Fig. 2. Comparison between the simulated S_{11} for the microstrip square antennas with HFSS and CST

Figure 2 shows the simulated S_{11} characteristics of the proposed antenna obtained by the two tools for simulation. We notice good agreement between the simulated results. There exist some differences if one considers the frequencies of resonance; however, in terms of band-width the results remain very comparable.

Figure 3 shows the simulated VSWR characteristics of the proposed antenna obtained by the two tools for double layer antenna. We notice good agreement between the simulated results. There exist some differences if we consider the frequencies of resonance; however, in terms of bandwidth the results remain very comparable.

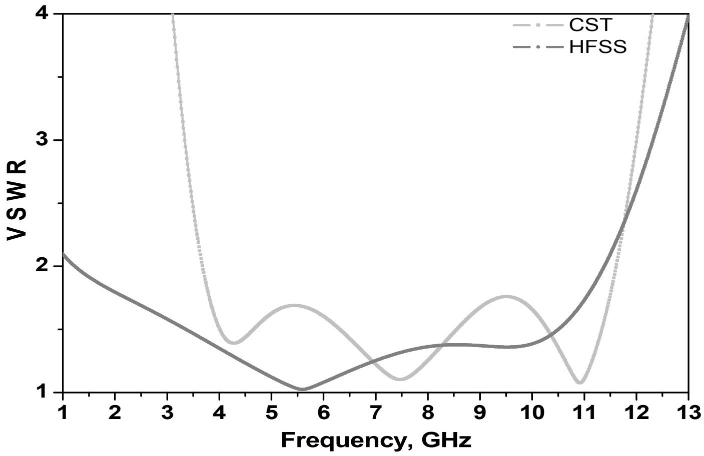
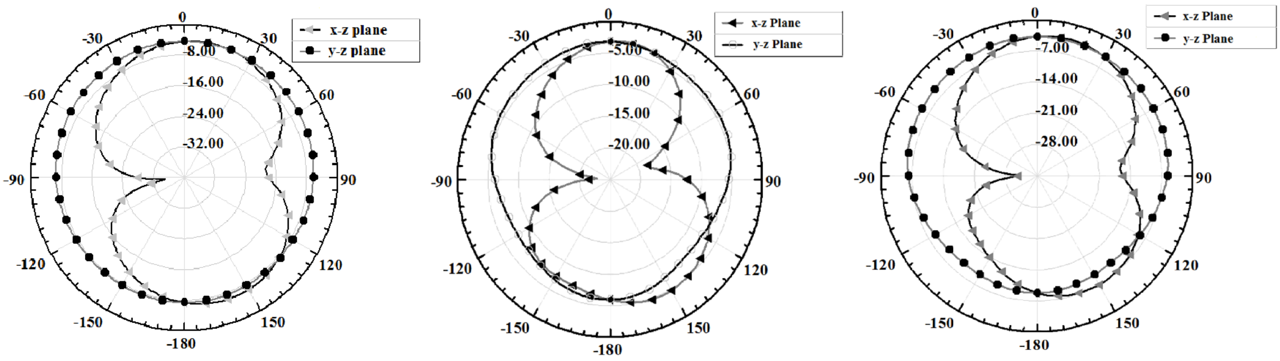


Fig. 3. Comparison between the simulated VSWR for the microstrip square antennas with HFSS and CST



(a) (b) (c)

Fig. 4. E- and H-field patterns at different frequencies a-6GHz, b-7.38GHz and c-10.52GHz

Figure 4 shows the radiation patterns of the proposed antenna at three frequencies of 6 GHz, 7.38 GHz and 10.52GHz. It is observed that at lower frequencies both the E-plane and H-plane field patterns are approximately bidirectional and the antenna has a main beam in the broadside direction. As the frequency increases, higher order current modes are excited and the radiation patterns becomes slightly directional. However a stable and symmetric the radiation patterns are observed over the entire operating band of the proposed antenna which is similar to a typical monopole antenna [13].

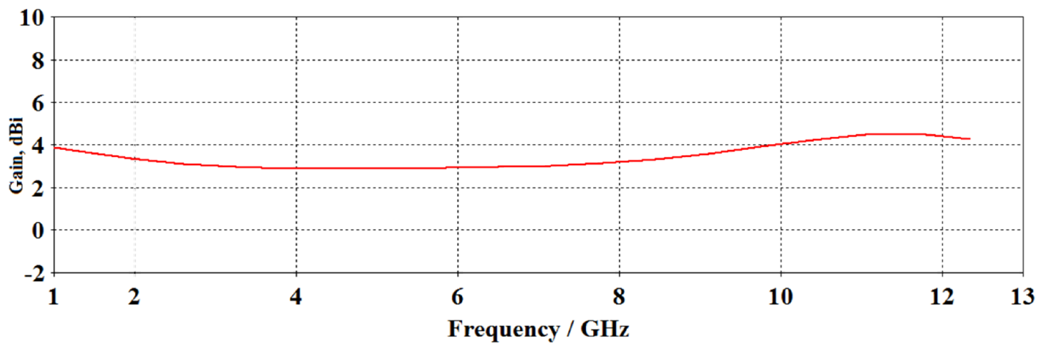


Fig. 5. Gain in dBi of square patch antennas against frequency

Figure 5 shows the antenna gain in a frequency range from 1 GHz to 12 GHz. The maximum gain is 4.55 dBi with an average of 3.7dBi.

4 CONCLUSION

A novel compact microstrip-fed printed patch antenna has been proposed for UWB applications. We showed that by embedding a pair of T-shaped slots with a proper dimension and position in the partial ground plane, a wide impedance bandwidth from 1.52 GHz to 11.19 GHz (9.67 GHz) with VSWR ≤ 2 is achieved. Also the antenna is compact and can cover the whole frequency band of 5.8 GHz-band RFID systems, WLAN, ITU, X-band satellite communication systems and European-standard UWB systems, it should be a promising candidate for such applications.

REFERENCES

[1] "Federal Communications Commission Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission System from 3.1 to 10.6 GHz," in FEDERAL Communications Commission. Washington, DC: ET-Docket, pp. 98–153, FCC, 2002.

[2] Cai, L.Y., Li, Y., Zeng, G., and Yang, H.C.: "Compact wideband antenna with double-fed structure having band-notched characteristics", *Electron.Lett.*, vol 46, (23), pp. 1534–1536, 2010.

[3] D. C. Chang, J. C. Liu, and M. Y. Liu, "A novel tulip-shaped monopole antenna for UWB applications," *Microw. Opt. Technol. Lett*., vol. 48, pp. 307–312, 2006.

[4] X. H. Wu and Z. N. Chen, "Comparison of planar dipoles in UWB applications,"*IEEE Trans. Antennas Propag.*, vol. 53, pp. 1973–1983, 2005.

[5] X. H.Wu and A. A. Kishk, "Study of an ultrawideband omnidirectional rolled monopole antenna with trapezoidal cuts,"*IEEE Trans. Antennas Propag*., vol. 56, pp. 259–263, 2008.

[6] X. H. Wu, Z. N. Chen, and N. Yang, "Optimization of planar diamond antenna for single-based and multiband UWB wireless communications,"*Microw. Opt. Technol. Lett*., vol. 42, pp. 451–455, 2004.

[7] Azim R., Islam M. T., Misran N., Mobashsher A. T., "Compact UWB planar antenna for broadband applications*", Informacije MIDEM,* vol 41, No.1, pp. 37-40,2011.

[8] Lui W., Cheng C., Zhu H., Improved frequency notched ultra wideband slot antenna using square ring resonator, *IEEE Trans. Antennas Propag*., vol 55, No. 9, pp. 2445–2450, 2007.

[9] H.AMMOR, R.KARLI, "Conception d'une nouvelle antenne en technologie micro-ruban pour usage spatiale et pour l'évaluation des changements climatiques", CITS, IAV-Rabat, 30-31octobre, 2013.

[10] Zaker R., Ghobadi C., Nourinia J., "Bandwidth enhancement of novel compact single and dual band-notched printed monopole antenna with a pair of L-shaped slots", *IEEE Trans. Antennas Propag*., vol 57, No. 12, pp. 3978–3983, 2009.

[11] Ojaroudi M., Ghobadi C., Nourinia J., "Small square monopole antenna with inverted T-shaped notch in the ground plane for UWB application", *IEEE Antennas Wireless Propag. Lett*., vol 8, pp. 728–731,2009.

[12] Zhao Y. L., Jiao Y. C., Zhao G., Zhang L., Song Y., Wong Z. B., "Compact planar monopole UWB antenna with band-notched charac-teristic", *Microw. Opt. Technol. Lett.,* vol 50, No. 10, pp. 2656-2658, 2008.

[13] Lui W. J., Cheng C. H., Zhu H. B., "Compact frequency notched Ultra-wideband fractal printed slot antenna*", IEEE Microw. Wireless Compon. Lett.,* vol 16, No. 4,pp. 224-226, 2006.

[14] Azim R., Islam M. T., Misran N., " Ground modified doublesided printed compact UWB antenna " , *Electron. Lett*., vol 47, No. 1, pp .9-11 , 2011.

[15] Weerathep K., Noppin A., Chawalit B., Jintana N., and Toshio W., " Controllable Band- Notched Slot Antenna for UWB Communication Systems ", *ETRI Journal*, Vol 34, No. 5, pp.674-683, 2012.

[16] Soufian, Lakrit., Hassan, Ammor., Jaouad, Terhzaz., "Design of H-slot Patch Antenna for Ultra Wideband ", *European Journal of Scientific Research*, Vol 106, No. 2,pp.224-228, 2013.