DUAL BAND SEMI CIRCULAR DISK PATCH ANTENNA LOADED WITH L-SHAPED SLOT

Amel Boufrioua

Electronics Department, Technological Sciences Faculty,
University Constantine 1, Constantine, Algeria
boufrioua_amel@yahoo.fr

ABSTRACT

In this paper, a dual frequency resonance antenna is analysed by introducing L-shaped slot in a semi circular patch, different parametric studies have allows and the results in terms of return loss and radiation pattern are given. It is observed that various antenna parameters are obtained as a function of frequency for different value of slot length and width; it is easy to adjust the upper and the lower band by varying these different antenna parameters. The coaxial feed is used to excite the patch antenna. Theoretical results using Matlab are compared with the simulated results obtained from Ansoft HFSS and shown to be in good agreement.

KEYWORDS

L-shaped slot, semicircular patch antenna, dual band

1. INTRODUCTION

With the rapid development of wireless communications, it is desirable to design small size, low profile and wideband multi-frequency planar antennas. Over the past few years, single-patch antennas are extensively used in various communication systems due to their compactness, economical efficiency, light weight, low profile and conformability to any structure. The main drawback to implementing these antennas in many applications is their limited bandwidth. However, the most important challenge in microstrip antenna design is to increase the bandwidth and gain [1-10]. Several techniques that can be used to achieve multi-band performances such as multilayer stacked patch, multi resonator and insertion of slots and slits [2] of various shapes and sizes in the patch antennas have been proposed recently [1-10]. When a microstrip patch antenna is loaded with reactive elements such as slots, stubs or shorting pin, it gives tunable or dual frequency antenna characteristics [6]. The most popular technique for obtaining dual-frequency behavior is to introduce the slots on a single patch [1- 4].

In this paper, we present a semicircular microstrip patch antenna with L-shaped slot. The proposed antenna can completely cover two bands and provides a significant size reduction. Dual frequency is tuned by changing the dimensions of the slot. In this paper the simulation resultants and the performance analyses using Matlab and Ansoft HFSS software of the proposed semicircular microstrip patch antenna with L–shaped slot are presented, a comprehensive parametric study is carried out to investigate the effect of antenna design parameters on the return loss, the bandwidth and radiation of the proposed antenna.

David C. Wyld et al. (Eds) : SAI, CDKP, ICAITA, NeCoM, SEAS, CMCA, ASUC, Signal - 2014
pp. 189–195, 2014. © CS & IT-CSCP 2014 DOI : 10.5121/csit.2014.41118

2. L-SHAPED SLOT LOADED SEMICIRCULAR PATCH ANTENNA

The configuration of the proposed antenna is shown in Fig. 1. The semi circular microstrip patch of dimensions W × L printed on the grounded substrate, which has a uniform thickness of h and having a relative permittivity εr and the dielectric material is assumed to be nonmagnetic with permeability μ0. The analysis of the half disk patch antenna is similar to that of circular disk patch, but the effective radius changes to 50% reduction in size [6]. The L-shaped slot with dimension (Ls, Ws) is embedded in a semicircular patch (see Figure 2), the L-shaped patch semi-circular antenna features dual-band behavior.

The patch is fed by a probe coaxial (50Ω) which is easy to fabricate and has spurious radiation [11]. In this feeding technique, the inner conductor of the coaxial connector extends from ground through the substrate and is soldered to the radiating patch, while the outer conductor extends from ground up to substrate.

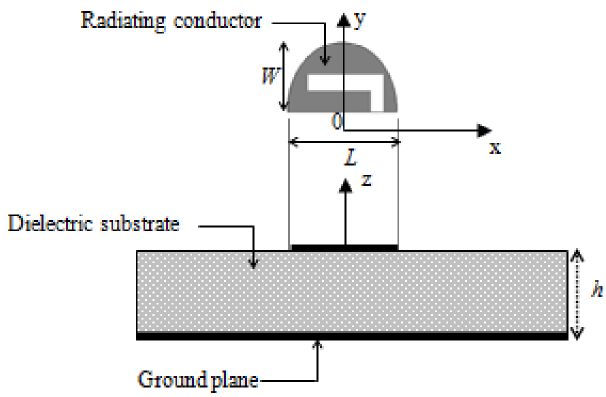


Figure 1. Geometry of L-shaped slot loaded semicircular disk patch antenna

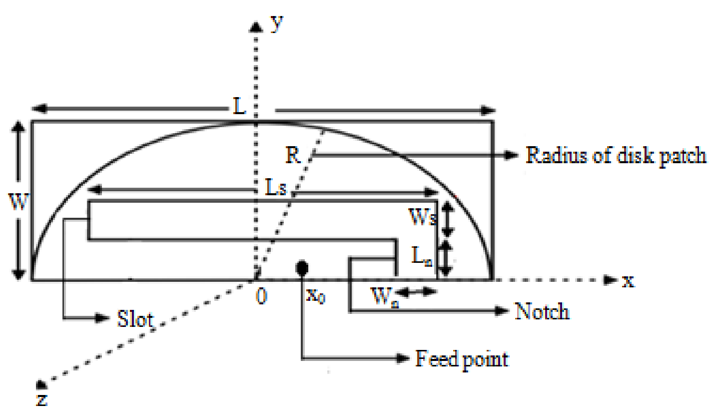


Figure 2. Dimensions of L-shaped slot loaded semicircular disk patch antenna

3. RESULTS AND DISCUSSION

Table 1 shows the different parameters of this proposed semicircular patch antenna loaded with an L-shaped slot with εr=1. It is worth noting that the feed can be placed at any desired location inside the patch. In this study the feeding is accomplished with a probe coaxial located on the axial of symmetry of the antenna in the point of coordinates x_0 and y_0.

The simulation is done through programs in Matlab and Ansoft HFSS; we compare our results with those available in the reference [6].

Table1. Design parameters of the proposed antenna.

Parameters	R	h	Ls	Ws	Wn	Ln	(x_0,y_0)
Value (mm)	40	15	46.2	6	2.5	6	(12.6, 0)

The return loss is studied in function of frequency; the effect of different physical parameters on the characteristics of the patch antenna is shown. From (figures 3a and b) given by Malab code and HFSS software respectively it is clear that the proposed antenna resonate at two frequencies with two band widths

That is seen from the (Figure3. A), given by Matlab2013 code that the lower resonant frequency fr1=1.48GHzand the upper resonant frequency fr2=2.28GHz. The -10 dB band width of lower and upper resonance frequencies are respectively BP1=14.86%, BP2=10.96%

From (Figure 3. b) obtained from HFSS14.0 software the two resonant frequencies are fr1=1.42GHz; fr2=2.23GHz. The -10 dB band width of the previous lower and upper resonance frequencies are respectively BP1=8.42%, BP2=19.74%.

The theoretical results using Matlab are found to be approximately in good agreement with the simulated results obtained with Ansoft HFSS software and with [6].

The variation of return loss S11 according to slot length “Ls” is shown by Figure 4 obtained from Matlab code, it is observed that the increase of the Ls, decreases both the lower and the upper resonance frequencies.

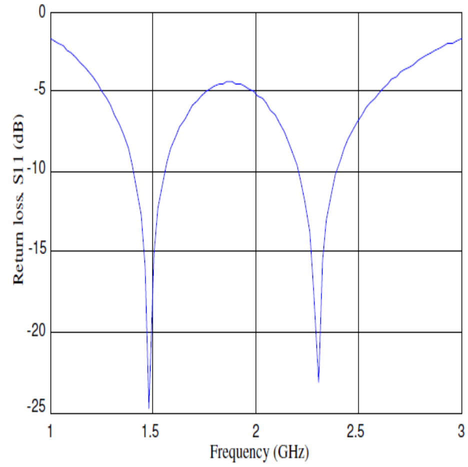
For the variation of S11 according to slot width Ws shown by Figure 5 (obtained from Matlab code), it is observed that the upper gap of the resonance frequencies decrease with increasing value of the slot width. It can be seen clearly that the slot length Ls and slot width Ws have a stronger effect on the lower resonance frequencies than the upper resonant frequencies.

Figures 6 and 7 show the variation of the return loss with frequency for different value of notch length and width respectively, it is observed that the notch length Ln and notch width Wn have a stronger effect on the upper resonance frequencies which increase with the increasing value of the notch length and width length than the lower ones which slightly increases with the increase of these parameters (Ln and Wn).

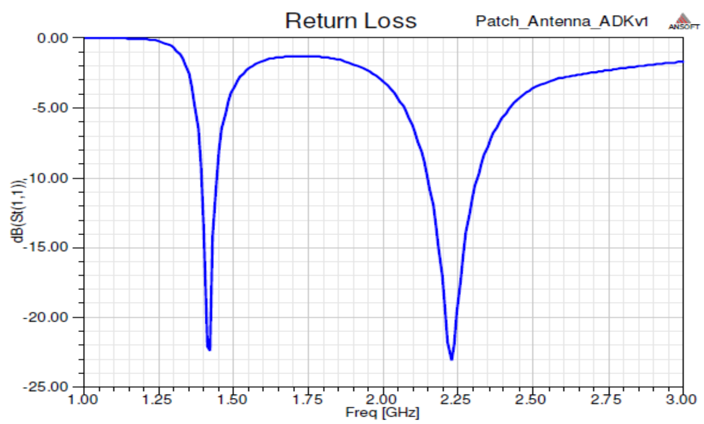
In Figure 8, it is shown that the feed locations have a stronger effect on both the lower and the upper resonance frequencies; furthermore the obtained results show that the lower resonance

frequencies vary more significantly when the x_0 change compared to the upper resonance frequencies as well as the other physical parameters of the proposed antenna.

Radiation pattern of the antenna is shown in Figure 9 and 10 for both upper and lower resonance in both principal planes E and H.



(a)



(b)

Figure 3. Comparative plot of return loss with frequency along with theoretical results obtained from Matlab code (a) and simulated results obtained from Ansoft HFSS software (b).

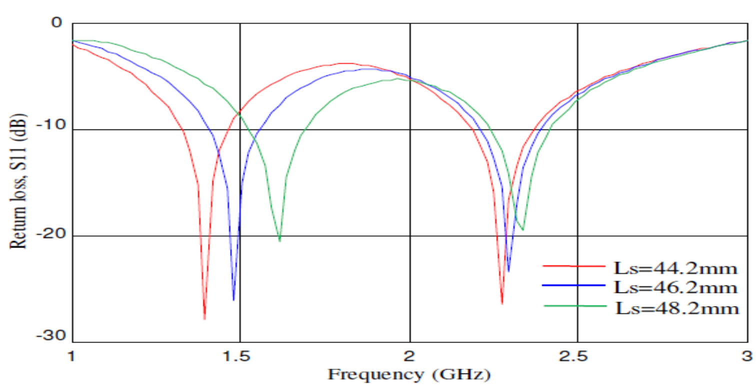


Figure 4. Variation of return loss S11 with frequency obtained from Matlab code for different value of slot length Ls.

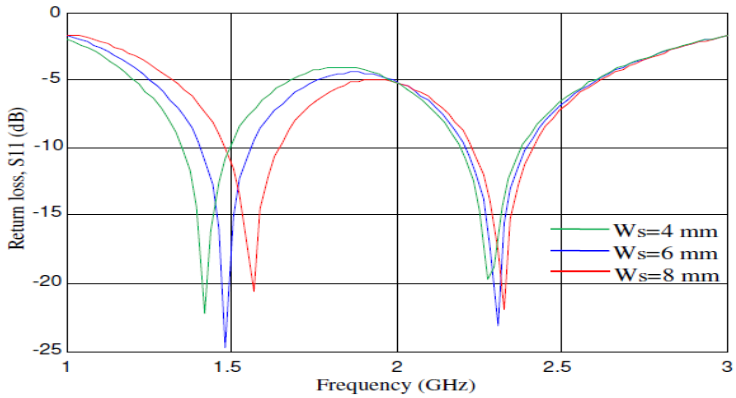


Figure 5. Variation of return loss S11 with frequency obtained from Matlab code for different value of slot width Ws.

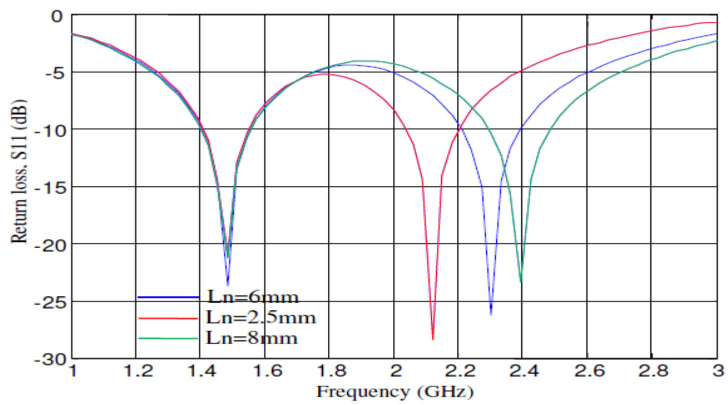


Figure 6. Variation of return loss with frequency for different value of notch length “L

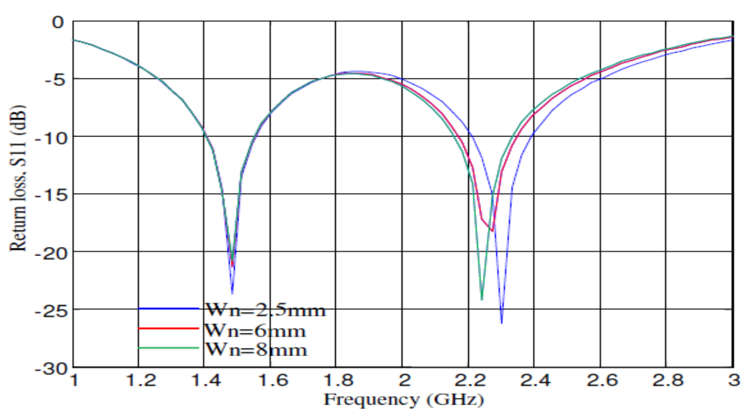


Figure 7. Variation of return loss with frequency for different value of notch width “Wn”

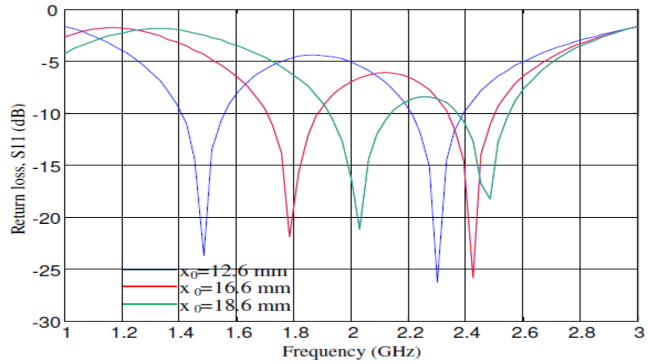


Figure 8. Variation of return loss with frequency for different value of feed point "x_0"

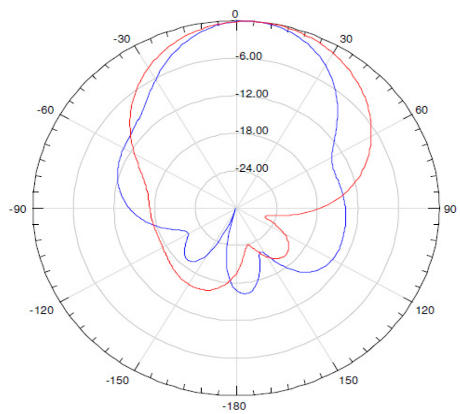


Figure 9. Radiation pattern of L-shaped slot loaded semicircular patch antenna for both upper resonant frequency (blue line) and lower resonant frequency (red line) at E plane

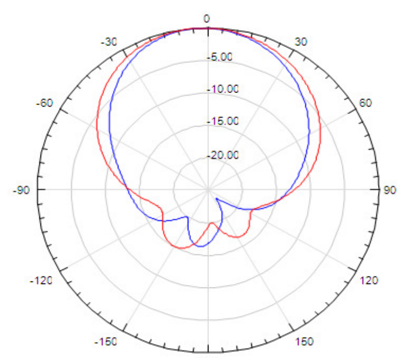


Figure 10. Radiation pattern of L-shaped slot loaded semicircular patch antenna for both upper resonant frequency (blue line) and lower resonant frequency (red line) at H plane

4. CONCLUSION

It is found that the proposed L-shaped slot loaded semicircular patch structure can operate at two resonance frequencies and consequently this proposed antenna can be used for dual band operation, also the effects of different physical parameters on the characteristics of this structure are investigated, the proposed structure can be scaled to meet different frequencies of wireless communication systems just by changing the dimension of the main antenna. Numerical results indicate that both the upper and lower resonant frequencies and the band widths depend on the size of the slot dimensions, by properly choosing the location of feed point and the slots two bands can be achieved and controlled. Furthermore, the lower resonant frequencies and band widths are highly dependent on the slot dimensions as well as feed locations, however the upper resonant frequencies and band widths are highly dependent on the notch dimensions. In addition, the radiation pattern of both upper and lower resonant frequencies of the proposed antennas are presented in the principal planes E and H.

REFERENCES

[1] J. A. Ansari, P. Singh and S. K. Dubey, (2008) "H-shaped stacked patch antenna for dual band operation," Progress In Electromagnetics Research B, Vol. 5, pp. 291–302.
[2] A. A. Razzaqi, M. Mustaqim and B. A. Khawaja, (2013) "Wideband E-Shaped Antenna Design for WLAN Applications," (ICET), IEEE 9th International Conference on Emerging Technologies, 9-10.
[3] S. Maci and G. B. Gentili, (1997) "Dual-Frequency Patch Antennas "IEEE Antennas & Propagation Magazine, Vol. 39, No. 6.
[4] I-F. Chen, C. M. Peng, and S-C. Liang, (2005) "Single Layer Printed Monopole Antenna for Dual ISM-Band Operation," IEEE Trans. On Antennas and Propaga., Vol.53, N. 4. pp. 1270–1273.
[5] J A. Ansari, S. K. Dubey, P. Singh, R. U. Khan, B. R.Vishvakarma, (2008) "Analysis of U-slot loaded patch for dualband operation," International Journal of Microwave and Optical Technology, Vol. 3, pp. 80-84.
[6] J. A. Ansari, A. Mishra, (2011) "Half U-slot loaded semicircular disk patch antenna for GSM mobile phone and optical communications," Progress In Electromagnetics Research C, Vol. 18, pp. 31-4.
[7] D. K. Srivastava, J. P. Saini, D. S. Chauhan, (2009) "Broadband stacked H-shaped patch antenna," International Journal of Recent Trends in Engineering, Vol. 2, pp. 385-389.
[8] E. Wang, J. Zheng, (2009) "A novel dual-band patch antenna for WLAN communication," Progress In Electromagnetics Research C, Vol. 6, pp. 93-102.
[9] A. Boufrioua, A. Benghalia, (2006) "Effects of the resistive patch and the uniaxial anisotropic substrate on the resonant frequency and the scattering radar cross section of a rectangular microstrip antenna" Elsevier, AST, Aerospace Science and Technology, Vol. 10, pp. 217-221.
[10] A. Boufrioua, (2014) "Bilayer microstrip patch antenna with loaded with U and half U-shaped slots," (ICMCS), IEEE International Conference on multimedia computing and systems, 14-16.
[11] I. J. Bahl and P. Bhartia, (1980) Microstrip antennas, Edited by M. A Dedham, Artech House.

AUTHORS

Amel Boufrioua was born in Constantine, Algeria; she received the B.S. degree in Electronic Engineering in 1996, the M.S. and Ph.D. degrees in Microwave from Electronics Department, Constantine University, Algeria, in 2000 and 2006 respectively. From February 2002 to December 2003, she was a Research Assistant with Space Instrumentation Laboratory at the National Centre of Space Techniques "CNTS" (Oran, Algeria), and then in November 2003, she was an Assistant Professor at the Electronic Engineering Department (Constantine University). Since 2008, she is a Lecturer with the electronic department, University Constantine 1; her area of interest is microwave and microstrip antennas. Dr. Amel Boufrioua is the corresponding author and can be contacted at: boufrioua_amel@yahoo.fr