International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-3 Issue-1, October 2013

Analysis of L-Slot Loaded Rectangular Patch Antenna for Dual Band Operation

Amel Boufrioua

Abstract—In this paper, a dual-band rectangular patch antenna is analysed 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, width and feed point; it is easy to adjust the upper and the lower band by varying these different antenna parameters. In the present work variation of substrate permittivity is also studied.

Index Terms—L-shaped, Slot, patch, antenna, dual band.

I. INTRODUCTION

Today, the state of the art antenna technology allows the use of different types and models of antennas, depending on the area of application considered. Microstrip antennas have its remarkable advantages over conventional antennas and have attracted a lot of attention due to rapid growth in wireless communications area, due to their compactness, economical efficiency, light weight, low profile and conformability to any structure. However, microstrip patch antenna is limited by its inherent narrow bandwidth. Therefore, this problem has been addressed by researchers and many configurations have been proposed for band width enhancement [1-3]. Several patch designs with single feed, dual frequency operation have been proposed recently [4-7]. When a patch antenna is loaded with reactive elements such as slots, stubs or shorting pin, it gives tunable or dual frequency antenna characteristics [5]. A rigorous solution to the problem of a rectangular microstrip antenna which is the most widely used configuration because its shape readily allows theoretical analysis [8]. Also it is found that the substrate permittivity is a very important factor to be determined in microstrip antenna designs [9]. In the present work variation of substrate permittivity will be studied. In this paper, a rectangular microstrip patch antenna with a pair of L-shaped slots is presented. The proposed antenna can completely cover two bands. The proposed antennaprovides a significant size reduction. Dual frequency is tuned by changing the dimensions of the slots. This paper is organized as follows. Section 2 describes the proposed rectangular patch antenna with a pair of L–shaped slots. Section 3,details the simulation resultants and the performance analyses using Matlab, different parametric studies have allows and the effect of the various antenna parameters on the return loss and the radiation of the proposed antenna are given. Finally Section 4 concludes the paper.

Manuscript published on 30 October 2013.
***** Correspondence Author (s)
Amel Boufrioua, Electronics Department, Faculty of Science, University of Constantine, 25000, Constantine, Algeria.

II. ANTENNA DESIGN

The geometry for the rectangular microstrip patch antenna with a pair of L–shaped slots is shown in Fig. 1. The rectangular patch of dimension 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 μ_0. The patch is fed by a probe coaxial (50Ω).

The dual L-shaped slots, having a narrow width of Wn are placed parallel to the center line of the rectangular patch and faced to each other with distances of d and S, (see Fig. 2). The L-shaped slot in a rectangular patch can be analysed by assuming it as a combination of horizontal slot Along X-axis denoted as “Ln” and vertical notch Y-axis denoted as “Ls” (see Fig. 2), when the notch is incorporated in the rectangular patch. 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.

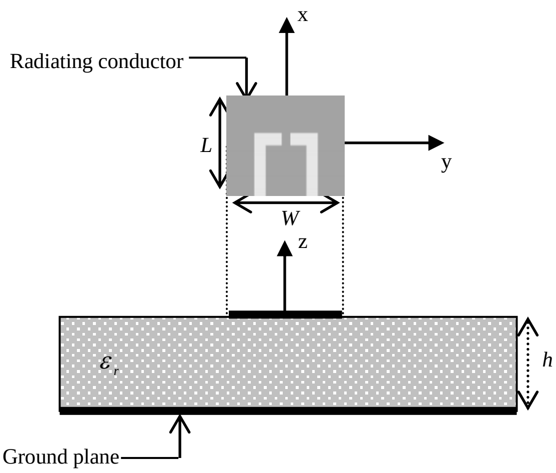

Fig. 1. Geometry of L-shaped slot loaded rectangular patch antenna

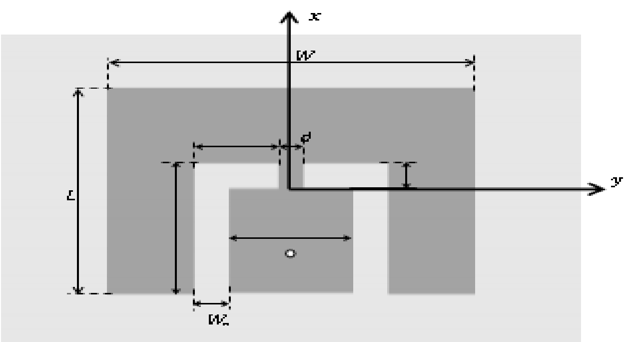

Fig. 2. Dimensions of L-shaped slot in a rectangular patch

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

III. RESULTS AND DISCUSSION

Table 1 shows the different parameters (value, mm) of this proposed rectangular microstrip patch antenna with a pair of L–shaped slots, the simulation is done through programs in Matlab.

The folowing figures show the variation of return loss S11 with frequency and the effect of the different physical parameters on the return loss S11, the resonant frequencies and the band widths of the proposed L-shaped slod loaded rectangular patch antenna.

From Fig. 3 it is clear that the antenna resonate at two frequencies (Fr1= 2.45GHz and Fr2=5.1GHz) with two band widths. The -10dB bandwidth of lower and upper resonance frequency is respectively 19.56 % and 11.76 %.

The variation of return loss S11 according to εr is shown by Fig.4, it is observed that the increase of the dielectric constant of substrate εr, decreases both the lower and the upper resonance frequencies, it is found that the variation of the upper resonance is more significant than the lower resonance.

Figure. 5 shows the variation of S11 according to Ws, it is observed that both the resonance frequency are inversely depend on slot width (Ws)

From Fig. 6, the variation of S11 according to the slot length Ls is shown, it is observed that the resonant frequencies decrease slightly with increasing value of slot length (Ls), whereas it is further observed that at both the lower and upper resonance frequencies it is almost the constant.

Figure 7 shows the variation of S11 according to Wn, it is clear that the increase of the value of notch width (Wn) decreases both the lower and the upper resonance frequencies.

For the variation of S11 according to the notch length Ln shown by Fig. 8, it is observed that both the lower and the upper gap of the resonance frequencies decrease with increasing value of the notch length Ln. It can be seen clearly that the notch length (Ln) has a stronger effect on the resonance frequencies than the length slot Ls for both lower and upper resonant frequencies; also it is observed that the notch length (Ln) has a stronger effect on the resonance frequencies than the notch width (Wn) for the lower resonant frequency.

Table 1: Design parameters of proposed antenna

W	L	d	W_s	L_s	W_n	L_n	h	εr	(x_0,y_0)
24	32	2	1	9	1	18	3.2	1	(0,-10)

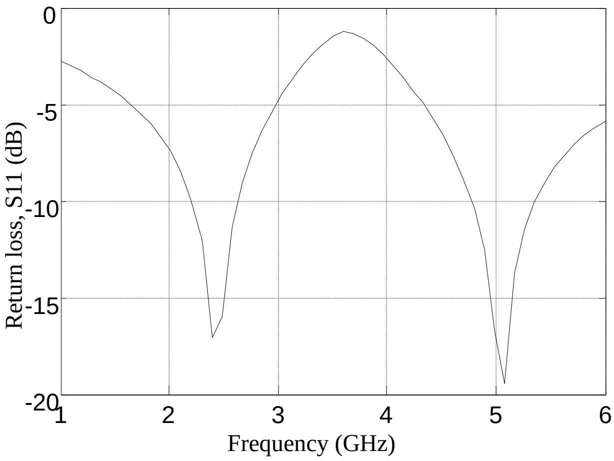

Fig. 3.Variation of return loss S11 with frequency.

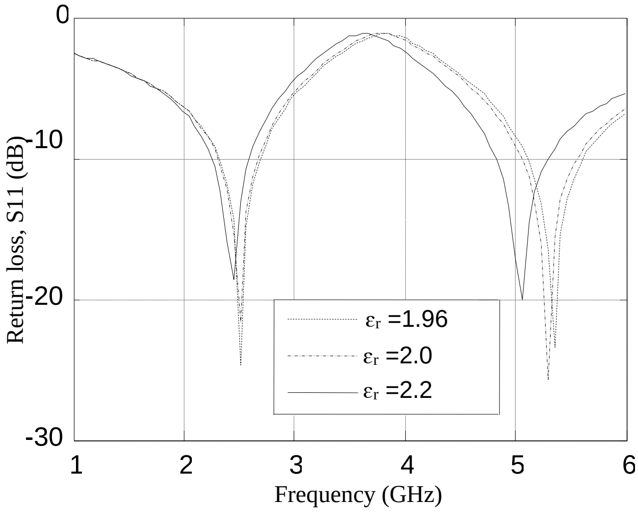

Fig. 4. Variation of return loss S11 with frequency for different substrate permittivity εr

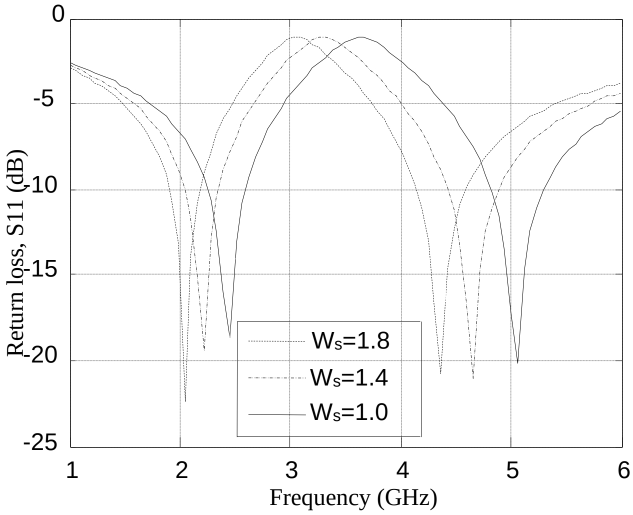

Fig. 5.Variation of return loss S11 with frequency for different value of slot width Ws (mm).

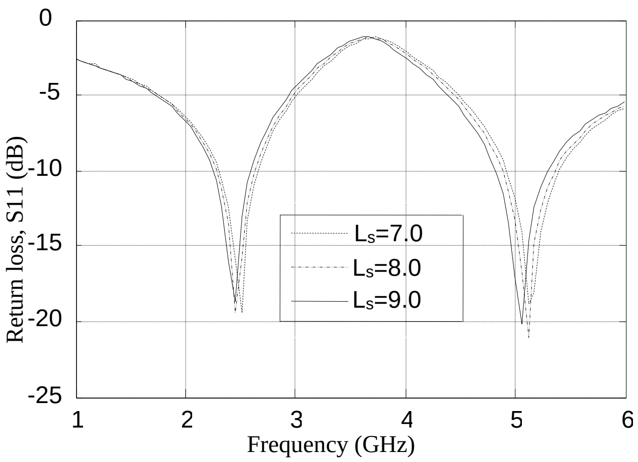

Fig. 6.Variation of return loss S11 with frequency for different value of slot length Ls (mm).

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-3 Issue-1, October 2013

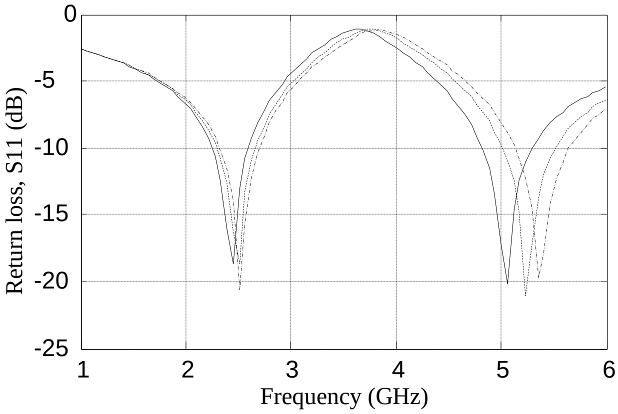

Fig. 7.Variation of return loss S11 with frequency for different value of notch width Wn (mm).

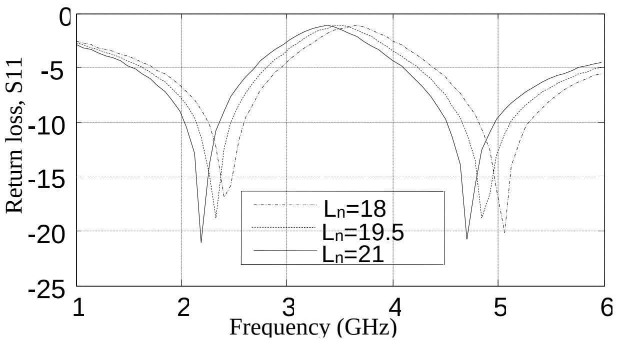

Fig. 8.Variation of return loss S11 with frequency for different value of notch depth Ln.

The variation of S11 according to y_0 is shown in Fig. 9. The obtained results show that the lower and the upper resonance frequencies increase with increasing value of y_0. Themaximum increase of both resonance frequencies is obtained in the centre of the axle of symmetry of structure. Also it should be noted that the feeding coordinates points has a stronger effect on the resonant frequencies as well as on the band widths, also the obtained results show that the upper resonant frequency varies more significantly when the x_0 change compared to the other physical parameters of the proposed antenna.

Radiation pattern of the antenna is shown in Fig. 10 and 11 for both upper and lower resonance. It is found that radiated power at lower resonance frequency is higher than the upper resonance frequency. These figures show also that the radiation pattern is unidirectional in both principal planes E and H.

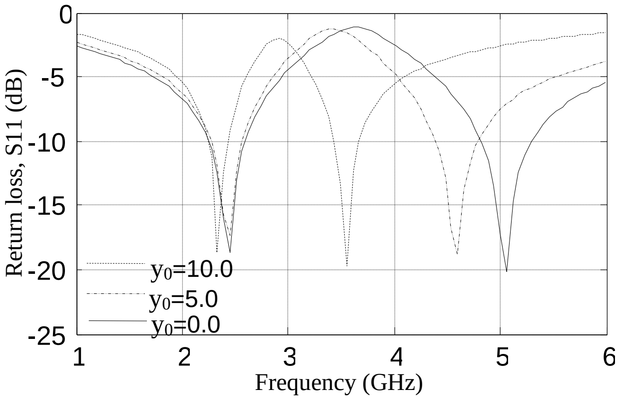

Fig. 9.Variation of return loss S11 with frequency for different feed locations y_0 (mm).

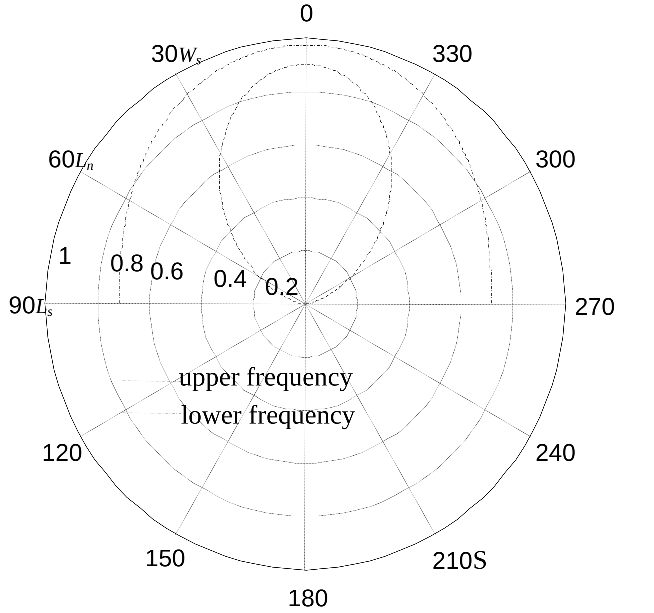

Fig. 10. Radiation pattern of L-shaped slot loaded rectangular patch antenna for both upper and lower resonant frequencies at E plane

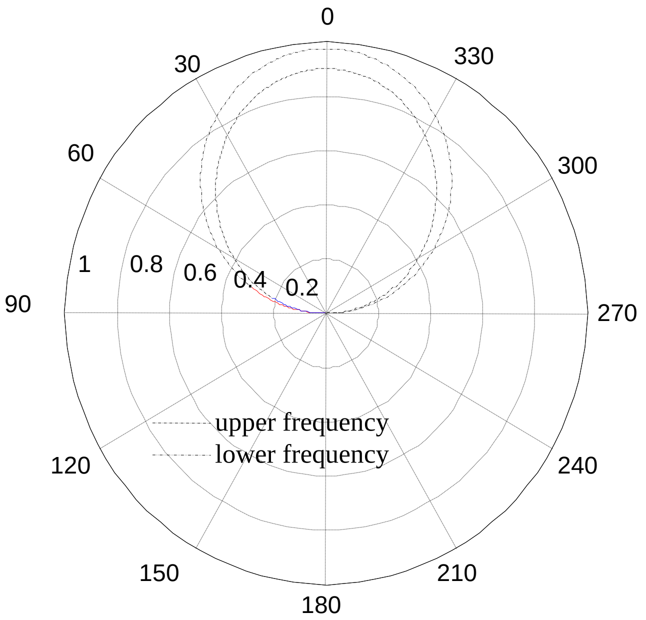

Fig. 11. Radiation pattern of L-shaped slot loaded rectangular patch antenna for both upper and lower resonant frequenciesat H plane

IV. CONCLUSION

The L-shaped slot loaded rectangular patch has been treated in this paper, it is found that this structure can operate at two resonance frequencies and consequently this antenna can be used for dual band operation, also the effects of different physical parameters on the characteristics of this structure are investigated. Numerical results indicate that both the upper and lower resonant frequencies and the band widths depend on the size of slot and highly dependent on the notch dimensions as well as feed locations.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

Also the radiation pattern of both upper and lower resonant frequency of the proposed antenna is presented in the principal planes E and H.

REFERENCES

[1] N. G. Alexopoulos, D. R. Jackson., "Fundamental superstrate (cover) effects on printed circuit antennas," IEEE Trans. Antennas Propagat., vol. 32, 1987, pp. 807–815.

[2] M. K. Meshram, B. R. Vishvakarma, "Gap-coupled microstrip array antenna for wide-band operation," International Journal of Electronics, vol. 88, 2001, pp. 1161-1175.

[3] J-S. Row, K. L, Wong, "'Resonance in a superstrate-loaded rectangular microstrip structure," IEEE Trans. Antennas Propagat, vol. 29, 1993, pp. 1349–1355.

[4] J. A. Ansari, S. K. Dubey, P. Singh, R. U. Khan, B. R. Vishvakarma, "Analysis of U-slot loaded patch for dualband operation," International Journal of Microwave and Optical Technology, vol. 3, 2008, pp. 80-84.

[5] J. A. Ansari, A.Mishra, "Half U-slot loaded semicircular disk patch antenna for GSM mobile phone and optical communications," Progress In Electromagnetics Research C, vol. 18, 2011, pp. 31-45.

[6] D. K. Srivastava, J. P. Saini, D. S.Chauhan, "Broadband stacked H-shaped patch antenna," International Journal of Recent Trends in Engineering, vol. 2, 2009, pp. 385-389.

[7] E. Wang, J. Zheng., "A novel dual-band patch antenna for WLAN communication," Progress In Electromagnetics Research C, vol. 6, 2009, pp. 93-102.

[8] A. Boufrioua, A. Benghalia, "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," AST Aerospace Science and Technology, vol.10, 2006, pp. 217-221.

[9] A. Boufrioua, "Resistive rectangular patch antenna with uniaxial substrate", in Antennas: Parameters, Models and Applications. Chapter 6, Ed. Albert I. Ferrero, Inc. New York: Nova Publishers, 2009, pp. 163-190.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)