Journal of Engineering and Applied Sciences 13 (17): 7253-7255, 2018
ISSN: 1816-949X

Slot Loaded Multi Band Rectangular Microstrip Patch Antenna for Wireless Applications

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Abstract: This study present a simple and slotted muti band rectangular microstrip patch antenna for wireless communication system. A inverted U-shape slot and inverted L-shape notch has been loaded for design of the rectangular microstrip antenna. Doing this the antenna is resonating with multi band frequency range and fractional bandwidth of multi band proposed antenna is 6.09% (lower band), 23.11% (middle band) and 12.29% (upper band) and antenna is resonating at 2.461, 3.938 and 5.579 GHz, respectively. The multi band frequency of the proposed antenna design lie in the range of 1.97-2.24, 3.30-3.65 and 4.55-5.36 GHz, respectively. This frequency band is suitable for wireless communication applications. The maximum gain of this designed antenna has been enhanced up to 4.803 dBi and antenna efficiency is 99.87%. A microstrip line feed of 50 Ω has been used in this proposed slotted microstrip antenna. The simulation process has been done by IE3D simulation software tool.

Key words: Inverted, slot, bandwidth, notch, microstrip, patch, microstrip line feed

INTRODUCTION

The demand of compact microstrip antennas with high gain and wideband operating frequencies has been increased for development of wireless communication system. Microstrip patch antenna possesses many advantages such as low profile, light weight, small volume and compatibility with Microwave Integrated Circuit (MIC) (Balanis, 2005). The narrow bandwidth and small gain are the major disadvantages of microstrip antenna. The bandwidth of microstrip antenna can be enhanced by loading inverted U slot and inverted L notch in radiating patch (Khan and Chatterjee, 2016; Chen and Chen, 2009). The antenna radiating patch is directly feed through 50 Ω microstrip line feed. The frequency band of proposed antenna is lies in between 1.97-2.24, 3.30-3.65 and 4.55-5.36 GHz, respectively which is suitable for wireless communication applications (Zade and Choudhary, 2011; Roy and Bhunia, 2012; Hu *et al*., 2011). The size and bandwidth of microstrip antenna also depends on substrate material. On increasing the dielectric constant, the size of antenna decreases as well as bandwidth and efficiency also decreases (Pozar, 1992).

MATERIALS AND METHODS

Antenna design specifications: The proposed antenna design is shown in Fig. 1. A glass epoxy used as substrate of a dielectric constant 4.4 is used in this antenna design (Balanis, 2005). The patch width and length are 24 and 32 mm, respectively. The design has ground plane width 34 mm and length 42 mm. The dielectric substrate height is 1.6 mm and 0.01 is used as loss tangent. Radiating patch is fed through 50 Ω microstrip line feed. IE3D simulation software tool has been used for simulation work. All the specifications are given in Table 1.

Table 1: Antenna design specifications

Parameters	Value (mm)
Dielectric constant (ε_r)	4.4
Substrate height (h)	1.6
Patch width (Wp)	24
Patch length (Lp)	32
Ground plane width (Wg)	34
Ground plane length (Lg)	42

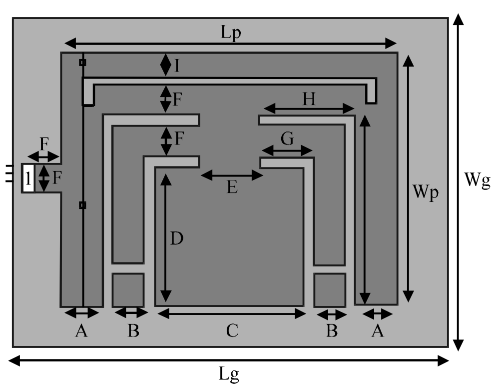

Fig. 1: Geometry of proposed microstrip antenna

Antenna design procedure: Figure 1shows the design of proposed inverted U slot and inverted L notch loaded

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microstrip antenna. The inverted U slot outer length and inner length is 28 and 26 mm, respectively. The slotting and notching strip width is 1 mm. In designing of proposed antenna on IE3D tool ground plane is selected from (0, 0) at lower left corner. The microstrip line feed of 50 Ω is placed at left middle of the patch through a strip of length 3 mm and width 3 mm to achieve maximum bandwidth.

RESULTS AND DISCUSSION

This study shows the multi band rectangular microstrip patch antenna by loading inverted U-slot and inverted L-notch (Chakraborty *et al*., 2014). The fractional bandwidth of multi band proposed antenna is 6.09% (lower band), 23.11% (middle band) and 12.29% (upper band) and antenna is resonating at 2.461, 3.938 and 5.579 GHz with return loss -21.968, -28.747 and -27.076 dBi, respectively. The experimental bandwidth of multi band microstrip antenna is 12.83, 10.07 and 16.35% in the frequency range 1.97-2.24, 3.30-3.65 and 4.55-5.36 GHz, respectively.

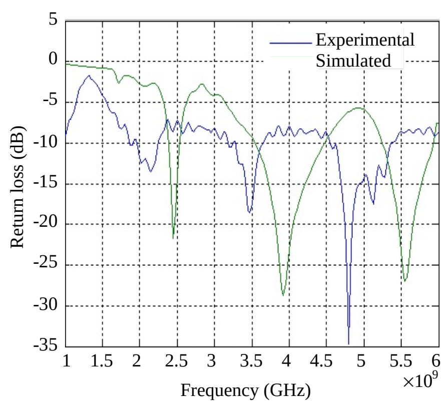

Fig. 2: Return loss v/s frequency graph

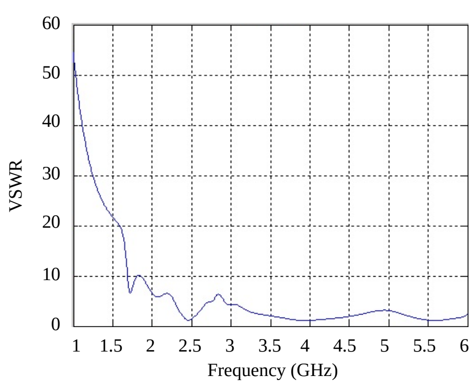

Fig. 3: VSWR of proposed antenna

The efficiency of proposed antenna is found to be 99.866% at 3.939 Ghz. The directivity of the antenna is 5.361 dBi at 4.969 GHz. The maximum gain of the antenna has been improved up to 4.803 dBi at 3.688 GHz and the VSWR of the antenna is in between 1-2 in entire resonance frequency band. The simulation analysis of design patch antenna has been used by IE3D software tool. The performance specifications of return loss, VSWR, gain, antenna efficiency and directivity of proposed antenna is shown in Fig. 2-6.

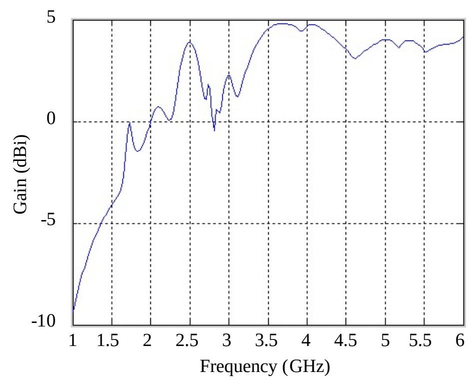

Fig. 4: Gain vs. frequency graph

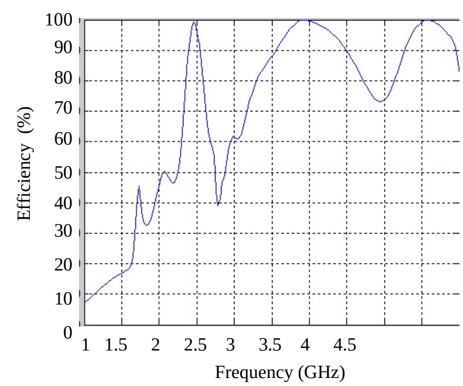

Fig. 5: Efficiency vs. frequency graph

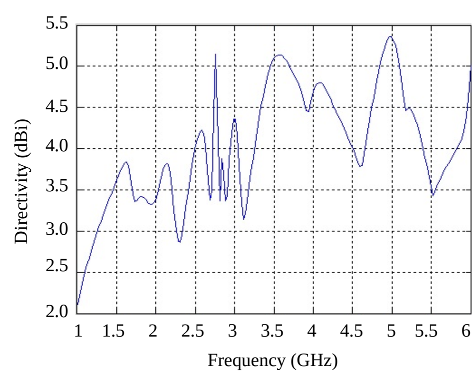

Fig. 6: Directivity vs. frequency graph

Table 2: Antenna parameters

Parameters	Value (mm)
A	4
B	3
C	14
D	13
E	6
F	3
G	6
H	11
I	2

CONCLUSION

The different characteristics of designed inverted U-slot with inverted L-notch antenna has been studied. The proposed antenna shows multi band frequency. The fractional bandwidth of the designed antenna has been observed 6.09% (lower band), 23.11% (middle band) and 12.29% (upper band) and antenna is resonating at 2.461, 3.938 and 5.579 GHz with return loss -21.968, -28.747 and -27.076 dBi, respectively. At resonance frequency 2.461, 3.938 and 5.579 GHz, the VSWR of designed antenna is 1.173, 1.076 and 1.093, respectively which is lie between 1 and 2 which indicates the impedance matching of the proposed antenna is as per requirement (Garg *et al*., 2001). The maximum antenna efficiency and gain is about 99.87% and 4.803 dBi, respectively. This proposed antenna can be used in wireless communication system.

REFERENCES

Balanis, C.A., 2005. Antenna Theory, Analysis and Design. 3rd Edn., John Wiley & Sons, Hoboken, New Jersey, USA., Pages: 431.

Chakraborty, U., A. Kundu, S.K. Chowdhury and A.K. Bhattacharjee, 2014. Compact dual-band microstrip antenna for IEEE 802.11 a WLAN application. IEEE. Antennas Wireless Propag. Lett., 13: 407-410.

Chen, C.C. and F.S. Chen, 2009. A novel compact quad-band narrow strip-loaded printed monopole antenna. IEEE. Antennas Wireless Propag. Lett., 8: 974-976.

Garg, R., P. Bhartia, I. Bahl and A. Ittipiboon, 2001. Microstrip Antenna Design Handbook. Artech House, Boston, Massachusetts, ISBN:0-89006-513-6, Pages: 817.

Hu, C.L., C.F. Yang and S.T. Lin, 2011. A compact inverted-F antenna to be embedded in ultra-thin laptop computer for LTE/WWAN/WiMAX/WLAN applications. Proceedings of the 2011 IEEE International Symposium on Antennas and Propagation (APSURSI'11), July 3-8, 2011, IEEE, Spokane, Washington, ISBN:978-1-4244-9562-7, pp: 426-429.

Khan, M. and D. Chatterjee, 2016. Characteristic mode analysis of a class of empirical design techniques for probe-fed, U-slot microstrip patch antennas. IEEE. Trans. Antennas Propag., 64: 2758-2770.

Pozar, D.M., 1992. Microstrip antennas. Proc. IEEE, 80: 79-91.

Roy, A. and S. Bhunia, 2012. Compact broad band dual frequency slot loaded microstrip patch antenna with defecting ground plane for WI-MAX and WLAN. Intl. J. Soft Comput. Eng., 11: 154-157.

Zade, P.L. and N.K. Choudhary, 2011. Design and implementation of a broadband equilateral triangular parasitic patch microstrip antenna array for wireless applications. Intl. J. Comput. Appl., 28: 36-40.