Article

A Novel Design of F Shaped Multiband Antenna

Bhanu Priya Kumawat[1], Sanjeev Yadav[2], Santosh Meena[3]

Abstract

In the proposed article, F shaped multiband antenna has been designed for various wireless applications. Four F shaped slots cuts symmetrically so that multiband can occur. Main operation of a multiband antenna is to cover multiple frequencies in a single band so in this designed antenna it can efficiently support three different frequencies as 2.4GHz, 4.29GHz, and 5.57GHz. All three frequencies cover the different wireless bands such as Bluetooth, Wi-Fi, WLAN, WiMAX and some broadband applications. Design results of Return loss (S_{11}), VSWR, Surface current, Radiation pattern is also shown in this article. This design simulated on CST simulation tool.

Keywords: Frequency bands, F slots, Impedance matching, Multiband antenna, Radiation pattern, Return loss, Surface current

Introduction

In the recent years demand of wireless communication has been increased continuously. In the modern mobile communication technology design of an antenna which can cover multiband is an important issue. The device which can be used to transmit or receive wireless signals or electromagnetic signals or RF signals is known as an antenna.[1] Multiband antenna depend on different frequency bands so they are designed in such a way so that they can operate at different frequency bands such as GSM 900/1900 Global system for mobile communication) bands (890-960 MHz), UMTS (universal mobile telecommunication systems) bands (1900-2200 MHz and 2500-2700 MHz), Bluetooth band (2400 MHz), WiMAX (worldwide interoperability for microwave access) band (3800 MHz), Wi-Fi (wireless fidelity) bands (2400-2500 MHz), WLAN (wireless local area network) bands (5100-5800 MHz) and LTE (long term evolution) bands (2400-2500 MHz). These bands generally include competent designs where both part of the antenna is operated for different bands.[2]

Proposed Antenna Design

In the design of multiband antenna a simple strip line feed is used with four F shaped slots. Single F slot perform single band operation, whereas four F slots perform multiple operations and broaden the bandwidth. By increasing the number of thin F slots multiband operation is performed. The four F-shaped slots become crossly spiral and distribute symmetrically about the center.[3] Each slot of this multiband antenna is modifiable according to their shapes and sizes. It also describes the geometry of F shaped slotted antenna and simulation model of microstrip line. By using the simple strip line model we easily simulated the four F shaped multiband antenna structure.

[1,2]M.Tech Student, [3]Assistant Professor, Department of Electrical Communications and Engineering, Government Women Engineering College, Ajmer, Rajasthan, India.

Correspondence: Mr. Sanjeev Yadav, Government Women Engineering College, Ajmer, Rajasthan, India.

E-mail Id: sanjeev.mnit@gmail.com

Orcid Id: http://orcid.org/0000-0002-5199-3562

How to cite this article: Kumawat BP, Yadav S, Meena S. A Novel Design of F Shaped Multiband Antenna. *J Adv Res Electro Engi Tech 2017; 4(1&2)*: 1-4.

ISSN: 2456-1428

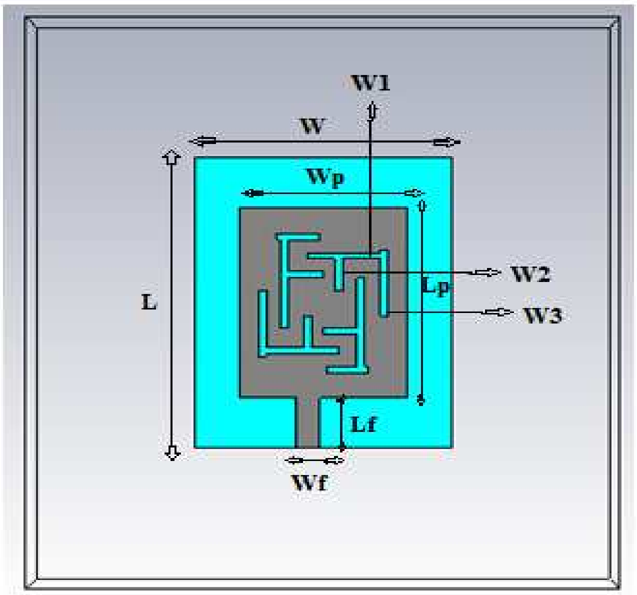

Figure 1.Design of a F slot Multiband Antenna

Table 1.Parameters of the Multiband Antenna

Name of the dimensions	Symbols	Units (mm)
Width of the substrate	W	34
Length of the substrate	L	46
Width of the patch	Wp	22
Length of the patch	Lp	30
Width of the feed	Wf	3
Length of the feed	Lf	8
Width of first slot	W1	1
Width of second slot	W2	1
Width of third slot	W3	1

Simulation and Measured Results

In this design four F shaped geometry has been used to obtain the multiband performance. This propose design has been fabricated on FR4 substrate having dielectric constant of 4.4 and loss tangent of 0.0024 the overall size of antenna is 46 mm (L) × 34 mm (W) with 1.6 mm thickness.[4] The dimension of patch is 30 mm × 22 mm having perfect electric conductor (PEC) material with 0.035 mm thickness. This patch has total four F shaped slots each slot has 1 mm width and length is varies according to dimension of the patch. In this design four F shaped slots cuts symmetrically according to their length and width.[5]

Length and Width of the antenna in terms of λ is calculated by following formulas

Width of the antenna is calculated by:

$$W = \frac{c_0}{2f_r}\left(\sqrt{\frac{2}{\epsilon_r+1}}\right)$$

Length of the antenna is calculated by:

L= Leff - 2ΔL

Where, Leff is the effective length of antenna

ΔL is the extended length of antenna

Dielectric constant of antenna is calculated by:

$$\epsilon_{reff} = \frac{\epsilon_r+1}{2} + \frac{\epsilon_r-1}{2}\left[1+\frac{12h}{w}\right]^{-1/2}$$

Leff and ΔL are calculated by:

$$\Delta L = h \times 0.412 \frac{(\epsilon_{reff}+0.3)(\frac{W}{h}+0.264)}{(\epsilon_{reff}-0.258)(\frac{W}{h}+0.8)}$$

$$L = \frac{c_0}{2f_r\sqrt{\epsilon_{reff}}} - 2\Delta L$$

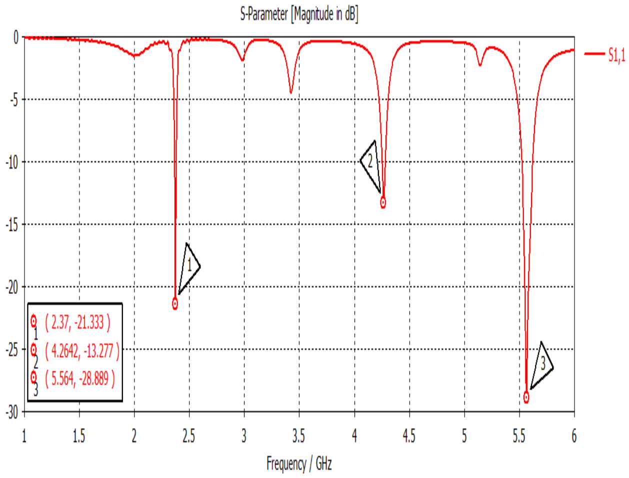

Figure 2.Parameters of Multiband Antenna

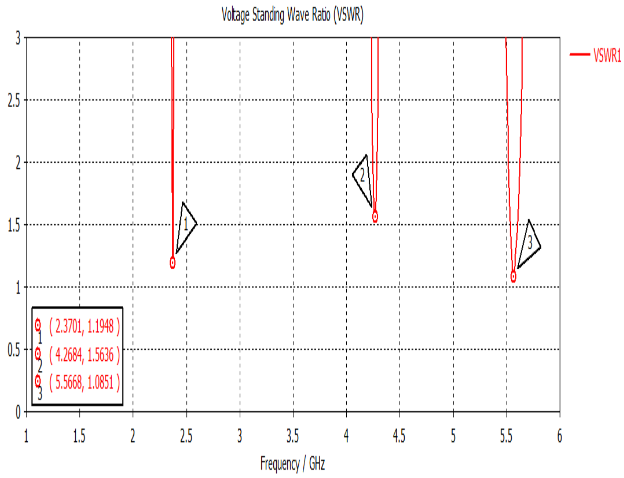

Figure 3.VSWR Measurement

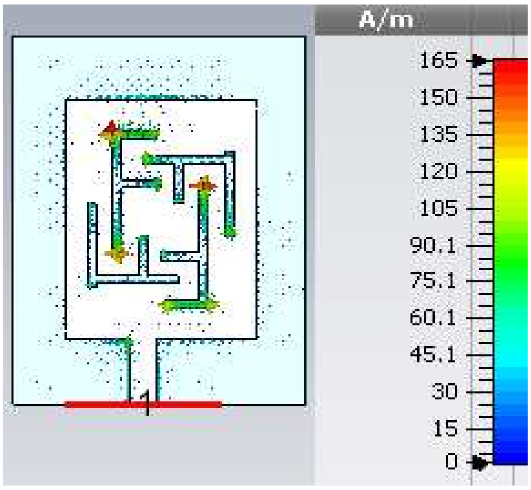

Figure 4.Surface Current at 2.4GHz

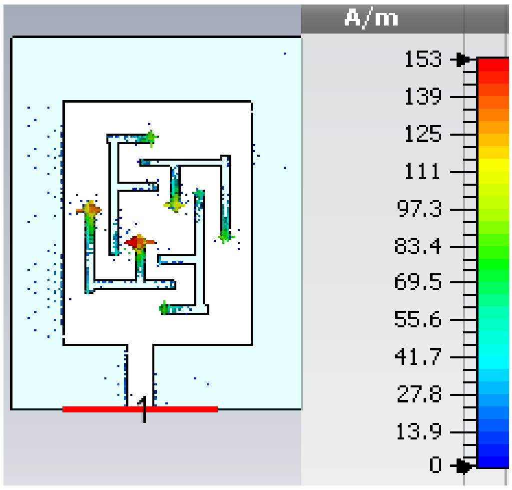

Figure 5.Surface Current at 4.29GHz

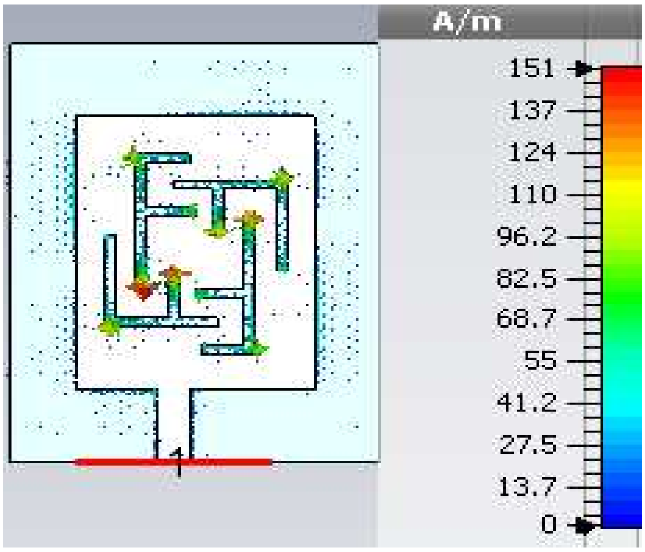

Figure 6.Surface Current at 5.57GHz

In Fig. 2 Reflection coefficient (S_{11}) shows the return loss. The simulated VSWR plots of this antenna is shown in Fig. 3, the frequency range for VSWR will always be less than or equal to 2. Figure 4, 5 and 6 shows the surface current of the proposed antenna at three different frequencies. Radiation pattern shows the lobes (Major lobe, Minor lobe, Side lobe, Back lobe) and beam width.

 ISSN: 2456-1428

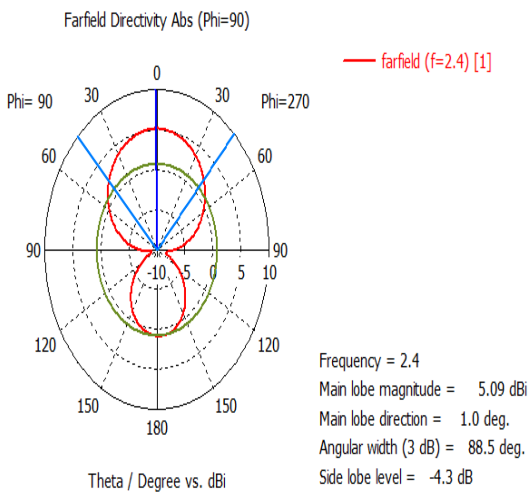

Figure 7.Radiation Pattern at 2.4GHz

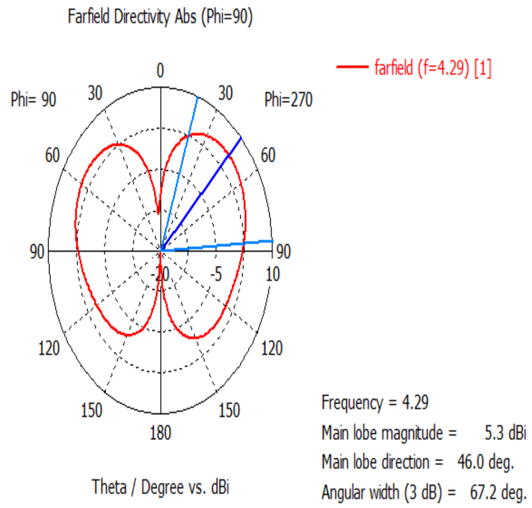

Figure 8.Radiation Pattern at 4.29GHz

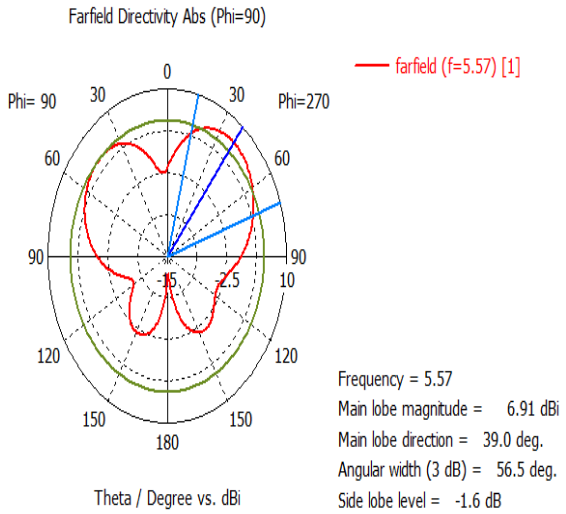

Figure 9.Radiation Pattern at 5.57GHz

Conclusion

An F shaped multiband antenna with a simple strip line feed is designed in this article. Simulation and results are obtained using CST Microwave Studio Simulation tool. The obtained result shows the various operations at multiple frequency bands. Modifiable feeding techniques, dimensions of antenna and slots of the antenna made it possible to obtained frequency bands of 2.4GHz, 4.29GHz and 5.57GHz in various wireless broadband applications. Reflection coefficient (S11), VSWR pattern, Surface current and radiation pattern are analyzed.[6]

References

1. Rappaport TS. Wireless Communications: Principals and practice. 2nd ed. Prentice Hall, 2002.
2. Best SR. Electrically Small Multiband Antennas, In: Multiband Integrated Antennas for 4G Terminals. Sanchez-Hemandez DA (ed.)., Boston, USA. pp. 1-32. 2008. Available from: http://www.sae.org/images/books/toc_pdfs/BART023.pdf.
3. Lee KF, Yang SLS, Kishk A, et al. The versatile U-slot patch antenna. *Antennas and Propagation Magazine* 2010; 52(1): 71-88.
4. Lee KF, Yang SLS, Kishk A. Dual and multiband U-slot patch antennas. *Antennas Wireless Communications Letters* 2002; 7: 645-8.
5. Ali M, Okoniewski M, Stuchly MA, et al. Dual Frequency Strip-Sleeve Monopole for Laptop Computers. *Transactions on Antennas and Propagation* 1999; 47(2): 317-23.
6. Nashaat D, Elsadek H, Ghali H. Multiband Miniaturized PIFA for Compact Wireless Communication Applications. *Microwave antenna Optical Technology Letters* 2004; 42(3): 230-5.