DESIGN OF COMPOSITE CIRCULAR MICROSTRIP PATCH DUAL BAND ANTENNA FOR WIRELESS APPLICATIONS

V.Vaishnavi[1], G. Surya prabha[1], L. R. Sujithra[1], A. Gowthami[2]

[1]UG Students, Department of Electronics and Communication Engineering, Easwari Engineering College, Chennai-600089, India.
[2]Assistant professor, Department of Electronics and Communication Engineering, Easwari Engineering College, Chennai-600089, India.

Abstract: This paper presents the design of composite circular microstrip patch dual band antenna for wireless application. The composite structure of microstrip patch antenna provides better bandwidth and gain. By choosing a suitable offset feed position, a characteristic impedance of 50 Ω is obtained that improves the impedance matching. The substrate used here is FR4 which helps to improve bandwidth. The analysis has been done for the following antenna characteristics such as Bandwidth (GHz), Gain (dB), Return loss (dB) and Voltage Standing Wave Ratio (VSWR). The software which is used for design and simulation is CST Microwave Studio.

Keywords: Microstrip, Dual band antenna, FR4, Wireless application

1. INTRODUCTION

Nowadays most of the mobile phones, Wireless and communication systems uses antenna technology. The basic component which is used for communication of wireless system is antenna. The unique advantages of microstrip antennas are compactness, conformal and low cost features and so they are widely used. The main reason for the implementation of microstrip patch antennas is that they are compact and easy to fabricate .Efficient compactness in wireless system will include the following features which are innovative designs, high integration, active circuitry and active radiating elements. Compact electronic circuit design is efficient on high dielectric constant substrates and PCB, whereas the optimum patch antennas are built on low permittivity substrate for efficiency. Throughout the years, slotted microstrip patch antenna structure is used for microwave, communication purposes. The Antenna characteristics like gain, radiation pattern and polarisation should be stable within this operating range. At the same time it should be of small size, conformal, low cost and should be easily integrated into the RF circuits. Slotted microstrip patch antenna can also be printed directly onto circuit board. Since the slotted microstrip patch antenna requires few materials, it is low cost, easy to manufacture and light weight. These characteristics make slotted microstrip patch antennas ideal for use in cell phones and other small electronic devices. Slotted microstrip patch antenna consists of a dielectric substrate, with a ground plane on the other side. The reason for using FR4 material as a substrate is that it has maximum return loss,good impedance matching and high gain.The size of the slotted microstrip patch antenna is inversely proportional to its frequency. For this reason, slotted microstrip patch antennas are generally used for ultra-high frequency signals. Slotted microstrip patch antenna is capable of sensing frequencies lower than microwave would be too large to use.

2. DESIGN TOOL

CST studio suite is a software package for designing, simulating and optimising systems and networks . It is used in leading technology and engineering companies around the world. One of the core's competencies of CST software is the simulation of high frequency electromagnetic fields, ranging from RF up to optical frequencies which was founded in 1992, and also it provides the market's widest range of 3D electromagnetic field simulation tools which helps in the growth of global network of sales. The simulation of antenna design using a software in all frequency bands which has high performance can be achieved using CST, and it also supports complementary third-party products. CST includes tools for a very wide range of microwave, RF and optical applications. Antennas are designed and optimized on their own and it can also be a part of an array at a unit cell and full array level, or as installed in a device and on a larger structure such as a building, aircraft, ship, or satellite. Planar and waveguide RF components are optimized individually as part of a larger system, and increasingly the gigahertz, optical and photonic devices. CST tool helps to design both cutting-edge imaging and treatment devices, and in the analysis of exposure, tissue heating and specific absorption rate (SAR) in the biomedical field. This Complete Technology provides engineers, a powerful toolset for studying antenna and its performance. CST offers a broad range of technologies, which operates in both the time and frequency domain and also capable of using surface meshes and Cartesian, tetrahedral volume meshes. The high gain with multiple radiating elements can be achieved by using antena array and in addition to that phased array offers the possibility to shape the beam without altering the array geometry.

3. DESIGN OF PROPOSED ANTENNA

Due to its low profile, light weight, and ease to fabrication, microstrip patch antennas are widely used in many fields but also there are few disadvantages as well i.e. low gain and narrow bandwidth. To improve the impedance bandwidth, there are many techniques that can be applied. The losses can be reduced by applying different feeding technique, patch design and using FR4 substrate. Better efficiency is achieved by using dielectric and DNG (Double Negative Slab),dielectric slab and FR4 substrate. The simulation and theoretical calculation is also done and it is being compared with simulation results. It shows approximate results as in , it achieved 3.3% bandwidth 4.2 dB gain. Air is filled in spacing between the substrates and the best results can be achieved by maintaining the right decision of air gap. The conical radiation which is shown was achieved at the ISM band frequency of 5.8GHz and is greater than 5dB. Choosing the right substrate is another way to get better results and also the size of antenna can be reduced. The size of antenna has been reduced up to 80.3% by using Koch fractal shapes. Microstrip patch antenna is used at 5.8GHz as resonance is achieved at this point. Dual feeding technique is used in the design because of its feature that it is easy to obtain input matching by adjusting feed position. Input impedance matching plays an important role in achieving required bandwidth, if it doesn't occur then efficiency will be lower. "The radiating or the non-radiating edge is the point at which line fed rectangular patches can be fed. Transmission Line Model can be used to find an impedance match along the non-radiating edge. The input impedance in the non-radiating edge is lowest at the centre because of two equally high impedances at the two ends are transformed into a low value at the centre and connected in parallel with each other". The thickness of substrate tried to be kept minimum so that we can achieve maximum bandwidth with bin the limit of .003λo. The reason behind using the FR4 epoxy material is that it has Ɛr minimum as relative permittivity, which is inversely proportional to the bandwidth.

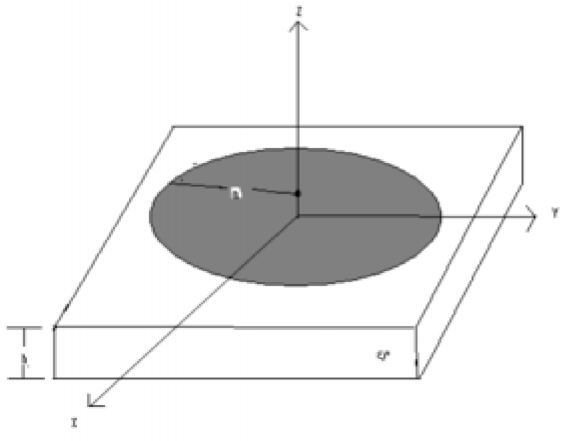

Fig1 Geometry of circular patch antenna

$$(f_r)_{mn0} = \frac{1}{2\pi\sqrt{\mu\varepsilon}}\left(\frac{X'_{mn}}{a}\right)$$

Circular patch radius:

$$a = \frac{F}{\left\{1+\frac{2h}{\pi\varepsilon_r F}\left[\ln\left(\frac{\pi F}{2h}\right)+1.7726\right]\right\}^{1/2}}$$

$$(f_r)_{110} = \frac{1.8412 v_0}{2\pi a_e\sqrt{\varepsilon_r}}$$

Effective radius of circular patch:

$$a_e = a\left\{1+\frac{2h}{\pi\varepsilon_r a}\left[\ln\left(\frac{\pi a}{2h}\right)+1.7726\right]\right\}^{1/2}$$

The proposed antenna dimensions and its operating frequency range and its design are given in Table 1.

Table 1

PARAMETER	VALUES
Frequency band used	ISM band
Operating frequency	5.8GHz
Wavelength in free space/vaccum	51.72mm
Radius of circular patch	9.8mm
Substrate dielectric material	FR-4 epoxy
Substrate dielectric constant	4.4
Substrate thickness	0.762mm
Feeding technique	Dual feeding
Feed point location from center	3.1mm
Air gap	28.96(0.56*51.72mm)
Ground plane	l=75mm,W=75mm

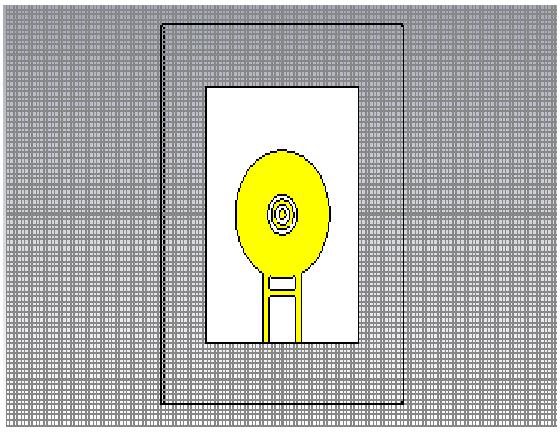

Fig2 Front view

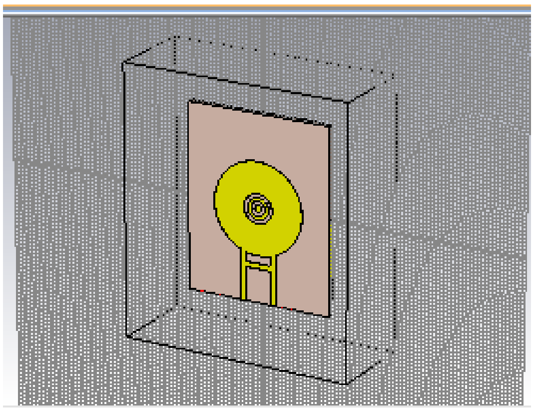

Fig3 Perspective view

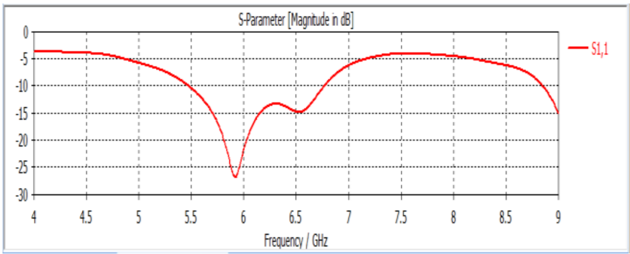

Fig4 Return loss s11

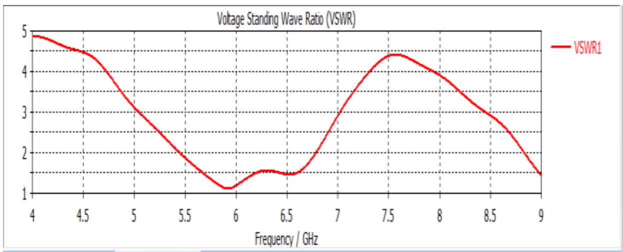

Fig5 VSWR

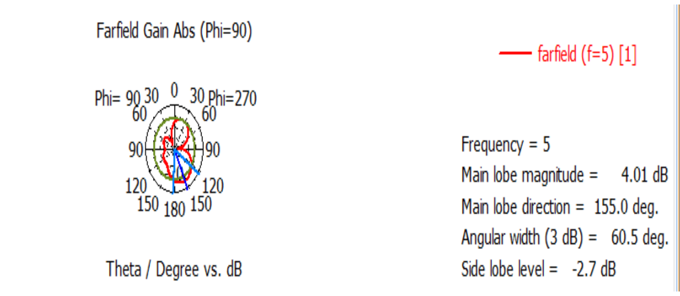

Fig6 Radiation pattern (f=5)

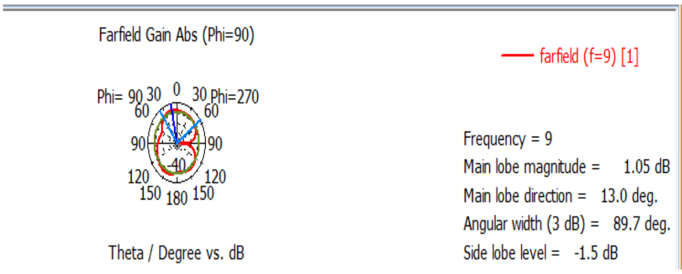

Fig7 Radiation pattern (f=9)

CONCLUSION

In this paper, a composite circular microstrip patch dual band antenna with FR4 as a substrate material capable of operating frequency up to 5.8GHz has been proposed. The gain and directivity of the proposed antenna are 4.2 dB and 3.3 dB. The overall reference impedance and VSWR are nearly 50 Ω and 1. The minimal return loss of the simulated antenna is observed to be -27 dB at corresponding resonant frequency of 5.8 GHz. The substrate variation of the proposed antenna results in minimum return loss and reduced impedance bandwidth, which helps for effective performance in wireless applications.

REFERENCES:

[1] J.F. Li et al, A compact wideband MIMO antenna with two novel bent slits, IEEE Trans. On Ant. & Prop. 60 (2)(2012)482-489.

[2] D. Mittal, A. Kaur , L. Singh, A. Sharma, E. Sidhu, Performance analysis of microstrip patch antenna using CSRR and PSRR techniques for WLAN, WiMAX, Wi-Fi and IMT applications, 2016 Int. Conf. Wirel. Commun. Signal Process. Netw., IEEE (2016) 2085–2089, http://dx.doi.org/10.1109/WiSPNET.2016.7566509

[3] Xiu Yin Zhang, Yao Zhang, Yong-Mei Pan, Wen Duan, Low-profile dual-band filtering patch antenna and its application to LTE MIMOn system, IEEE Trans. Ant. Prop. 65(1)(2017)103-113.

[4] Yuandan Dong, Jun Choi, Tatsuo Itoh, Folded Strip/Slot Antenna With Extended Bandwidth for WLAN Application, IEEE Ant. Wireless Prop. Lett. 16(2016)673-676.

[5] M.S. Rabbani, H.G. Shiraz, "Improvement of microstrip patch antenna gain and bandwidth at 60 GHz and X bands for wireless applications" IET Microwaves, Ant. Prop. 10(11)(2016)1167-1173.

[6] Alameddine K, Chahine S Abou, Rammal M, Osman Z. Wideband patch antennas for mobile communications. Int J Electron Commun 2006;60 (8):596–8

[7] Tekin Ibrahim, Knox Michael. Reconfigurable microstrip patch antenna for WLAN software defined radio applications. In: Proc ICWITS, Honolulu, HI. p. 1–4.

[8] Garg Ramesh, Bhartia Prakash, Bahl Inder, Ittipihoon Apisak. Circularly polarized microstrip antennas and techniques in microstrip antenna design handbook. Norwood (MA): Artech House; 2001. p. 505–9.

[9] Qing X, Chen ZN. A wideband circularly polarized stacked slotted microstrip patch antenna. IEEE Antennas Propag Mag 2013;55(6):84–99.