Research Paper

A TRIPLE-BAND CIRCULAR-SHAPED PATCH ANTENNA FOR 2.4/3.5/5.8 GHz WIRELESS COMMUNICATION SYSTEM

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ABSTRACT

In this paper a triple-band circular-shaped patch antenna for wireless communication system is designed and simulated. Proposed antenna is suitable for wireless application which uses the frequencies 2.4GHz, 3.5GHz and 5.2GHz. Proposed antenna is made up of two different types of material with silicon as substrate and copper as a patch of antenna. This proposed antenna comprises of four circular patches and one I-shaped patch to control the performance of antenna. The return loss, $S_{1,1}$ parameter, gain , current distribution and VSWR are analyzed through the simulation result and also presented as same in this paper .

KEYWORDS: MICROSTRIP PATCH ANTENNA, RETURN LOSS, GAIN, BANDWIDTH, WLAN.

1. INTRODUCTION

In the modern era communication devices are part and parcel of life. In the field of wireless communication, data transfer between the devices are done through a wireless medium; where antenna is being used to transmit and receive electromagnetic waves[1]. Antennas are available in variety [1], depending on the performance and working frequency, we use them for different applications. In the field of mobile cellular technology there are many manufacturers producing a variety of mobile phones and the other communication devices like tablet, where data transfer facilities such as 3G, 4G and WLAN are being supported. For such devices, thewidth is continuously increasing,while the thickness is decreasing. Even the Portable Computers are manufactured with smaller sizes, which incorporates antenna for accessing Wireless LAN [2].

In the early generation of wireless communication, perpendicular hardwired antennas were used on printed circuit boards, these antenna's were very bulky and used to occupy more area. The bulkier antennas were prone to breakage by some obstructions such walls, tables and other materials. This problem is solved by patch antenna, which is easily mountable on the printed circuit boards with low conformal properties [1] [3]. One of the main inventions in the field of antenna is microstrip patch antenna suitable for low energy devices. These antennas can be built on different substrate which is having variable thickness and shape [4] [5]. By creating slots or changing thickness of the patch, the performance of antenna can be enhanced. There are different types of slots like L shape, U shape and H shape that can made on the patches [5-9]. Intensive research has been done to develop a dual band, triple band and multiband antennas [10]. For WLAN many researchers have proposed an antenna with flexible substrate for dual band showing that it is easy to mount a patch antenna on RFID circuit [11]. Apart from substrate, different feeding mechanisms can be used to enhance the performance of antenna [12].

The prominent challenge faced by WLAN is the design of antenna. In WLAN, antenna should be more efficient and it should work in a certain range of frequencies [6][8]. In the past few decades E-shape micro-strip patch antenna has gained importance, due to its good gain and polarisation properties. Initially, E-shaped patch antenna were developed for the broadband application but later many researchers worked on it to improve the performance by changing its shape [9]. As per the 802.11 standards, WLAN will work in the frequencies of 5-6GHz. For WLAN and WiMax new antenna has been proposed and simulated and results are presented in the paper.

2. RELATED WORK

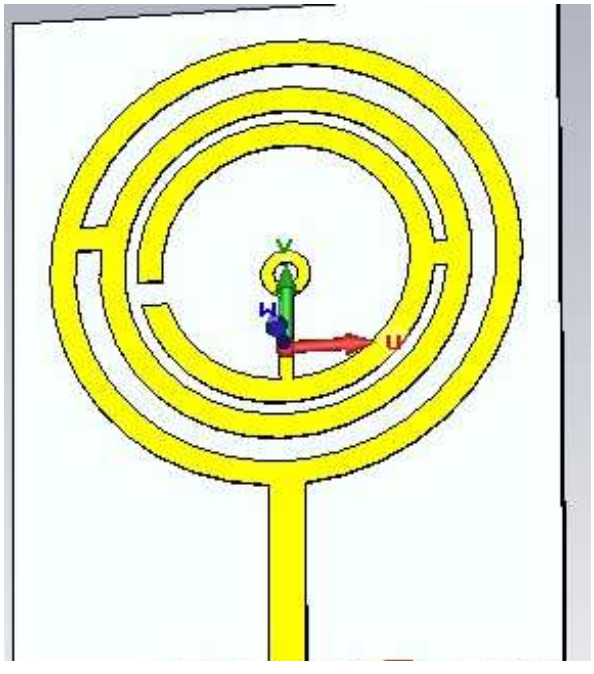
In [7] , Hussein and Luhaib, proposed a new antenna design for WLAN applications, where the design includesmultilayer of substrate silicon/glass/silicon with dielectric constant 11.9 and 4.6 respectively. The proposed antenna shows bandwidth of 920MHz with gain 2.8dB and return loss -20. There are many types of antenna that have been proposed for multiple frequency band operations like Wi-Fi, WiMax, ISM band etc. [16][17].

Authors in [13] claim that staked configuration on patch antenna can increase the bandwidth and that can be used for WiFi, WiMax.

The antenna performance can be improved by inset feeding mechanism and substrate materials play major role in it [14]. For example 'Rogers' which is used as substrate material of an antenna has higher possibilities of good results like s11

parameters gain and return loss [15]. Electromagnetic waves are scattered by many ways so it is very important to have good transmitter and receiver. Itneeds to consider the polarization and other QoS parameters of antenna [19].

3. Proposed Design



The proposed antenna has a thickness of 0.618mm, width 22mm and height 29mm as shown in fig1. The antenna comprises of material silicon with dielectric constant 11.9.

Width of patch antenna will be $$w = \frac{c}{2f0\sqrt{\frac{(\varepsilon r+1)}{2}}} \quad (1)$$

The effective of the dielectric constant $$\varepsilon ref = \frac{\varepsilon r+1}{2} + \frac{\varepsilon r-1}{2}\left(1+\frac{12h}{w}\right)^{\frac{-1}{2}} \quad (2)$$

The effective length (L eff) is given by $$L_{eff} = \frac{c}{2f0\sqrt{\varepsilon ref}} \quad (3)$$

The length extension (?L) is given by $$\Delta L = 0.412h\frac{(\varepsilon reff+0.3)(\frac{W}{h}+0.264)}{(\varepsilon reff+0.258)(\frac{W}{h}+0.8)} \quad (4)$$

The actual length (L) of patch is obtained by: $$L = L_{eff} - 2 \quad (5)$$

The proposed antenna has a thickness of 0.618mm, width 22mm and height 29mm as shown in fig1. The antenna comprises of material silicon with dielectric constant 11.9.

Three circular Patch each having thickness 0.1mm and width 1mm separated by 0.1mm gap are used. Feed to the antenna is given through I shaped patch with thickness 1mm and length of 3mm constructed on the substrate 0.508mm.

4. Simulation And Result

Simulation results are displayed in fig 2. It shows that return loss is -15dB at frequency 2.4GHz, -20dB at frequency 3.5GHz and -18dB at frequency 5.8GHz that shows antenna is suitable for ISM band 2.4GHz/5.8GHz.

The proposed antenna has the gain of 3.0dB. The radiation pattern is shown in fig 3.

Radiation pattern (2D) is shown in fig 4. It shows that radiation will be distributed on the upper and lower side of the antenna. Directivity of the antenna is one of the important parameters which are used for the WLAN. In this case, directional antenna may lead to more collision because of the hidden terminal problem [18].

VSWR is the voltage standing wave ratio. Here VSWR of the antenna should be less than 2V for safety purpose and the proposed antenna has VSWR ~1.03V.

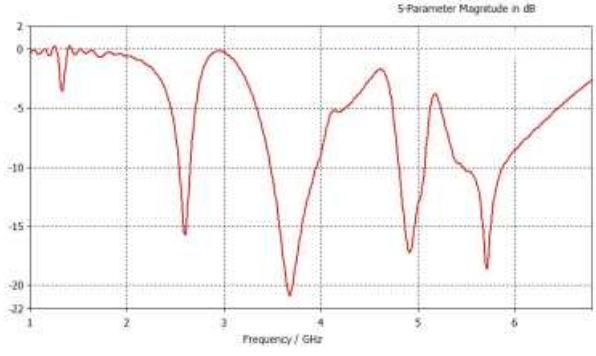


Fig.2 Simulation result showing $S_{1,1}$ parameter

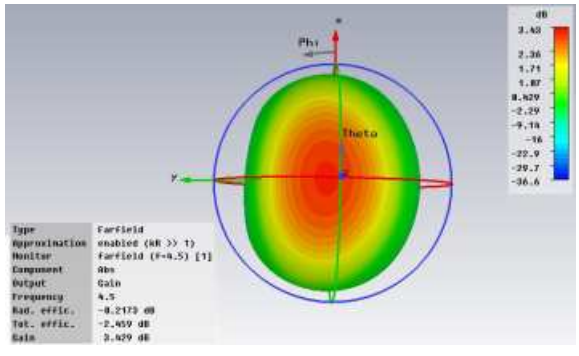


Fig.4 Simulation results of the radiation pattern (3D)

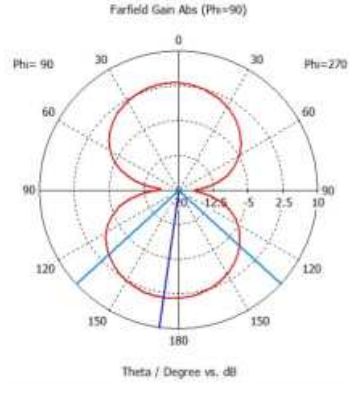


Fig.5 Simulation results of the radiation pattern (2D)

5. CONCLUSION

In this paper a triple band antenna has been designed and simulated which works in the frequencies 2.4/3.5/5.8 GHz. Proposed antenna shows a gain of 3.5dB, and it is suitable for ISM band.

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