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Design and Analysis of Triband Microstrip Patch Antenna for S Band Applications

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Abstract*: This paper presents a novel design of 2 shaped patch antennas. Recently the demand for the multiband antennas has increased due to its advantages. Here 2 shaped patch of dimension 50*46 mm is analyzed using full wave simulation system software. This design resonates at three frequencies cantered on 2.44 GHz, 2.92 and 3.92 GHz. Gain and Return loss results are presented.

Keywords*: Multiband, Antenna, WLAN Antenna, patch antenna

I. INTRODUCTION

Microstrip antennas have extremely broad applications as of late as a result of its light weight, little size, conformity [1]. The fast advancement in the wireless field prompted incredible interest for remote gadgets that can work at various models, for example, the widespread portable media communications framework UMTS, Bluetooth, the wireless local area network (WLAN) and furthermore satellite communication[2]. Many advances in electronic field such as smartphones, smart watch and wearable gadgets have increased the demand for the small conformal antennas. The Internet of things recently have gained lot of popularity where most of the gadgets and things will be able to communicate with each other, which will lead to increase in number of wireless devices working at different frequencies. This requirement leads to the research in the antenna which can work at multiple bands in order to connect with gadgets working at different operating frequencies. Microstrip antenna is broadly utilized in light of their numerous benefits, for example, the low profile, lightweight and congruity. Notwithstanding, antenna have the fundamental weakness: narrow bandwith leading to limited data transfer capacity. Scientists have tried numerous endeavours to beat this issue and numerous configurations have been displayed to broaden the transmission capacity.

Microstrip patch antennas are widely utilized as a part of remote gadgets and other smaller sizes wearable electronic devices with the multiband antenna operation. The strategies for decreasing the size of Microstrip patch antenna is accounted for widely and incorporate, LC resonator [3] and capacitive stacking [4].Moreover, these procedures more often compromise on antenna bandwidth or antenna efficiency in order to reduce the antenna size. There is a trade off between the multiband operation required and the antenna size [5]. Diverse methods for making multiband Microstrip patch antenna with metamaterial have been proposed [6].Negative refractive index material load patch antenna for ultra wideband application was proposed in [7].Tunable dual band metamaterial antenna based on stacked split ring resonator (SRR) was proposed in [8].

II. PROPOSED DESIGN AND MODEL

This section introduces the design of the proposed 2 shaped antenna. Firstly the traditional rectangular patch antenna was designed based on the design equation for the desired WLAN application, then in order to obtain the multiband operation two slots were taken out from the design in such a way that patch resembled the letter 2. Here the patch was excited using the microstrip feed line. Following design equation were used to designing the proposed antenna. [9]

$$w = \frac{c}{2f_o\sqrt{\frac{\epsilon_r + 1}{2}}} \qquad (1)$$

The width of the rectangular patch was decided from the design equation (1), here **w** represent width of the patch.

$$L_{eff} = \frac{c}{2f_o\sqrt{\epsilon_{eff}}} \qquad (2)$$

$$\epsilon_{eff} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r + 1}{2}\left(\frac{1}{\sqrt{1 + \frac{12t}{w}}}\right) \quad (3)$$

$$L = L_{eff} - 2\Delta L \quad (4)$$

$$\Delta L = 0.412 * t * \frac{(\epsilon_{eff} + 0.3)\left(\frac{w}{t} + 0.264\right)}{(\epsilon_{eff} - 0.258)\left(\frac{w}{t} + 0.8\right)} \quad (5)$$

Here L represent the length of the patch, L_{eff} represent the effective length

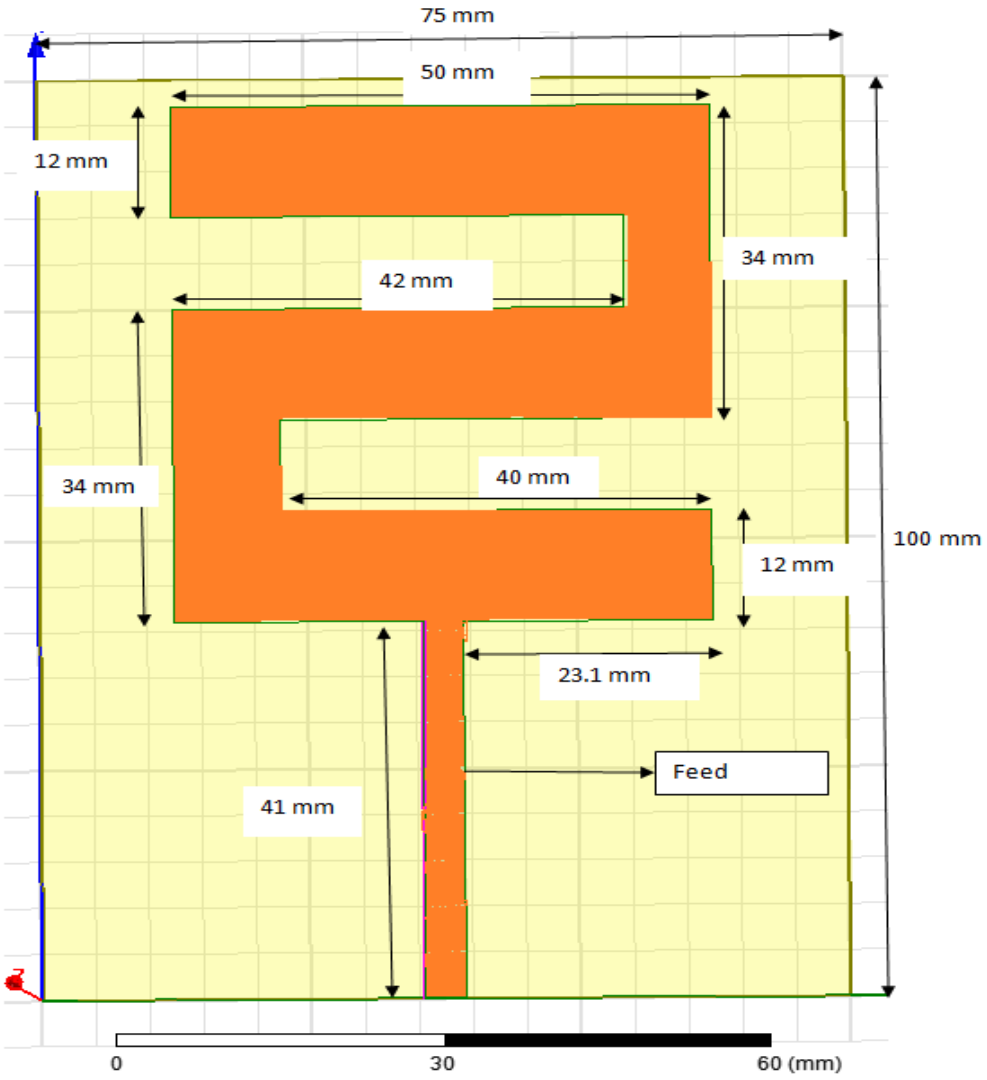

Fig. 1 Design of proposed 2 shaped patch in HFSS.

Design equation (2 to 5) helps us in deciding the length of the rectangular patch. Then a upper slot of 12*42 mm and the lower slot of 12*40 mm was removed from the rectangular slot [10] in order to optimize the design to operate at multiband which is 2.44 GHz, 2.92 and 3.92 GHz for the proposed 2 shaped antenna and hence this antenna can be used for Wireless local area network application. The design of the proposed 2 shaped antenna designed and analyzed using HFSS is shown in figure (1).

TABLE I
Material used for patch antenna

	Material Selected
Patch	Copper
Substrate	Rogers RT Duroid 5880

Table 1 depicts the material selected for patch and substrate. The material used for patch and ground is copper while for the substrate Rogers RT Duroid 5880 having relative permeability of 2.2 and loss tangent of 0.0009.

III.DISCUSSION ON SIMULATION RESULTS

Full wave simulation system software was used for the designing and simulation purpose, which provides accurate results for RF antennas. Simulation results obtained after analysing the design are as follows. Figure 2 depicts the Return Loss (S11) versus the frequency (in GHz) plot of the proposed design. Table 2 displays the values of Return Loss (S11) in dB for different operating frequency band. The minimum return loss which we are getting for the proposed design is -16 dB for the third band centered around 3.88 GHz.

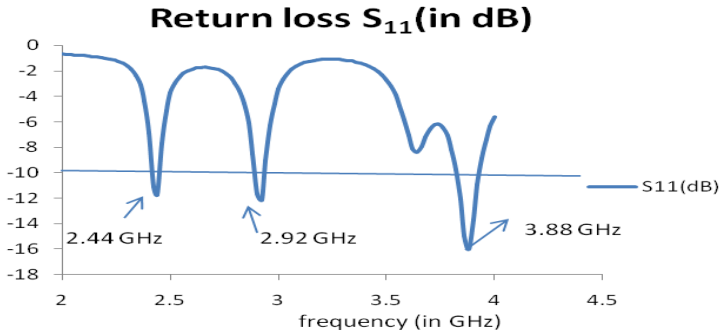

Fig. 2 Return Loss (S_{11}) versus the frequency for the proposed 2 shaped microstrip patch antenna

TABLE III
Return Loss obtained at different centre frequency

Band	Centre operating frequency	Return Loss obtained
1st	2.44 GHz	-12 dB
2nd	2.92 GHz	-12 dB
3rd	3.88 GHz	-16 dB

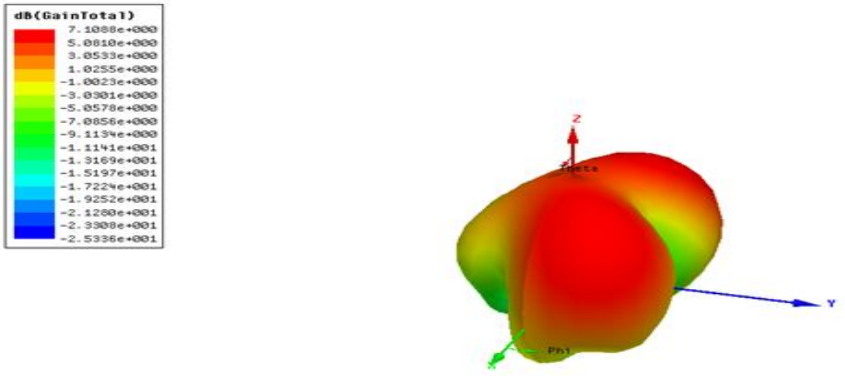

Fig. 3 3D Radiation pattern of the proposed antenna

Figure 3 represents the 3D radiation pattern of the proposed 2 shaped antenna. The figure clearly depict that the proposed design is a directional antenna. It can be observed that the maximum gain obtained is 7.1dB which is very good for a microstrip patch antenna.

IV. CONCLUSIONS

Microstrip antenna has turned into a quickly developing region of research. Their applications are boundless, in view of their less weight, small size, and simplicity of assembling. This paper proposes 2-shaped microstrip patch antenna intended for Triband applications. The simulation of the proposed model was carried out at the centre frequency of 4GHz. The results obtained depicts that the proposed 2 shaped microstrip patch antenna resonates at three frequencies centered on 2.44 GHz, 2.92 and 3.92 GHz, hence can used for S band applications. The Gain obtained is 7.1 dB. The outcomes are in great concurrence with the industry standards.

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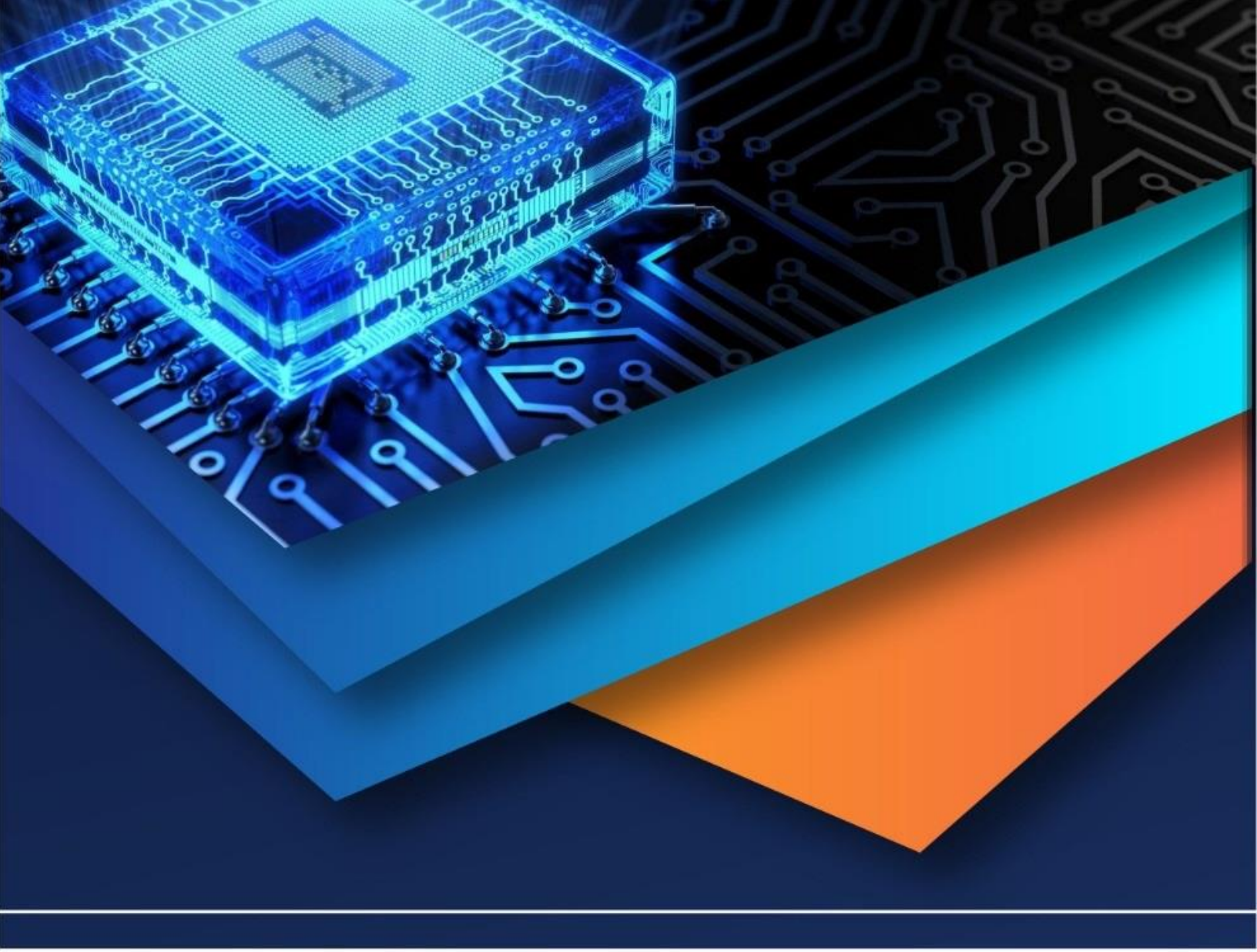

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