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Design and Analysis of Triple Band Quarter wave Microstrip Patch Antenna

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Abstract*: This paper presents a design of quarter wave patch antenna. Now a day the multiband antennas are very popular due to its advantages. The proposed antenna has dimensions of 70mm*70mm. This antenna is analyzed using High Frequency Structure Simulator software. Simulated results show three bands of frequencies at 2.17 GHz, 3.74 GHz and 4.63 GHz. Gain and Return loss are measured at these frequencies.

Keywords*: Triple band, Antenna, Quarter wave, patch antenna

I. INTRODUCTION

Wireless communication system requires low profile, light weight, high gain, and simple structure antennas to assure reliability, mobility, and high efficiency characteristics [1]-[2]. And the main advantage of these antennas is that they can be produced in mass with very nominal cost. One of the main disadvantage of these antennas is having narrow bandwidth and large size. Many advances in electronic field such as smart phones, 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. To solve this problem, different techniques are used. Different techniques like using Frequency Selective Surface [3]-[4], use of thick profile for folded shorted patch antennas [5], using slots [6], using thick substrate[7], E-shaped patch antenna [8], E-shaped using compatible feeding [9] and feeding techniques like L-probe feed [10] are used to enhance bandwidth of microstrip patch antenna. While designing antenna, care should be taken in selecting the size of feeding patch and thickness of dielectric. Wideband microstrip E shaped patch antenna and microstrip patch antennas for WLAN applications are discussed in [11]-[12]

II. DESIGN EQUATION AND PROPOSED ANTENNA

This section introduces the design of the proposed antenna. First the rectangular patch antenna is designed based on the design equation. The antenna is fed with quarter wavelength transmission line. Then one slot is created in patch to obtain triple band operation of proposed antenna. Material used for proposed antenna is FR4 having thickness 1.6 mm and dielectric constant 4.4. Following design equation are used to design the proposed antenna. [13]

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

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

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

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

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

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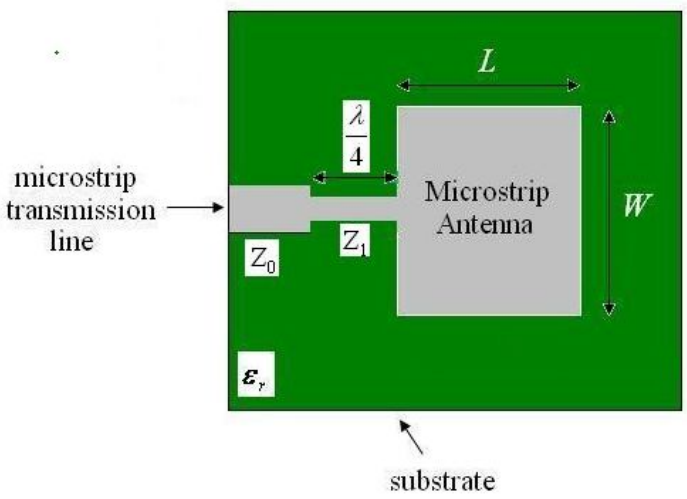

Fig. 1 Quarter Wavelength Microstrip Patch Antenna

Here L represent the length of the patch, L_{eff} represent the effective length. And the main objective is input impedance (Zin) matching with the transmission line (Z0). If the antenna impedance is ZA, then the input impedance seen from the beginning of the quarter-wavelength line is

$$Z_{in} = Z_0 = \frac{Z_1^2}{Z_A} \quad (6)$$

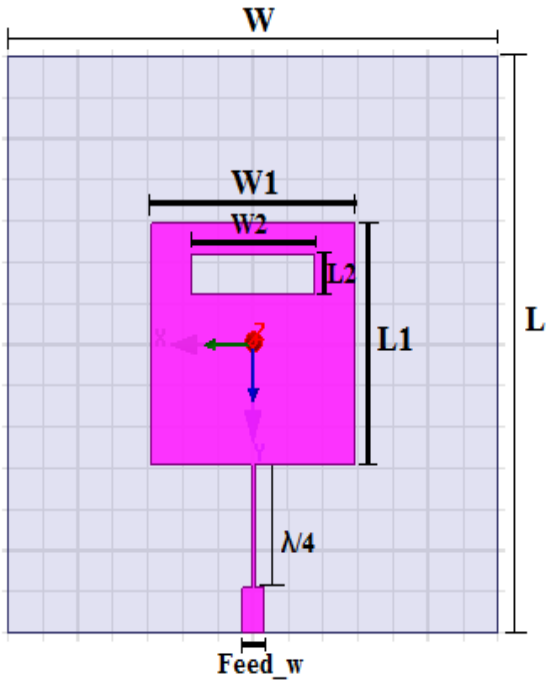

Fig. 2 Design of proposed antenna in HFSS.

The rectangular patch is designed using equations 2 to 5. While the feed line dimensions are determined using equation 6.Then the slot of size 5*17.6 mm is removed from patch to optimize the design to operate at triple bands which is at 2.17 GHz, 3.74 GHz and 4.63 GHz for the proposed antenna. This antenna can be used for Wireless local area network application. Dimensions of projected antenna are given in Table 1.

TABLE I
Dimensions of Projected Antenna

Substrate length(L)	70mm
Substrate width(W)	70mm
Patch length(L1)	29.44mm
Patch Width(W2)	29.05mm
Slot length(L2)	5mm
Slot width(W2)	17.6mm
Feed line width(Feed_w)	3.05mm

III. RESULTS AND DISCUSSION

The projected antenna is simulated using High Frequency Structure Simulator (HFSS).The simulated reflection coefficient at three different frequencies is shown in Fig 3.It can be seen that three bands of frequencies are obtained with proposed antenna. The value of S_{11} at 2.12 GHz is -12.28 dB, S_{11}at 3.74 GHz is -15.50 dB and S_{11} at 4.63 GHz is -10.93 dB. The simulated radiation pattern is shown in Fig 4. Maximum Gain of proposed antenna is 8.18 dB which is a good value of gain for microstrip patch antenna.

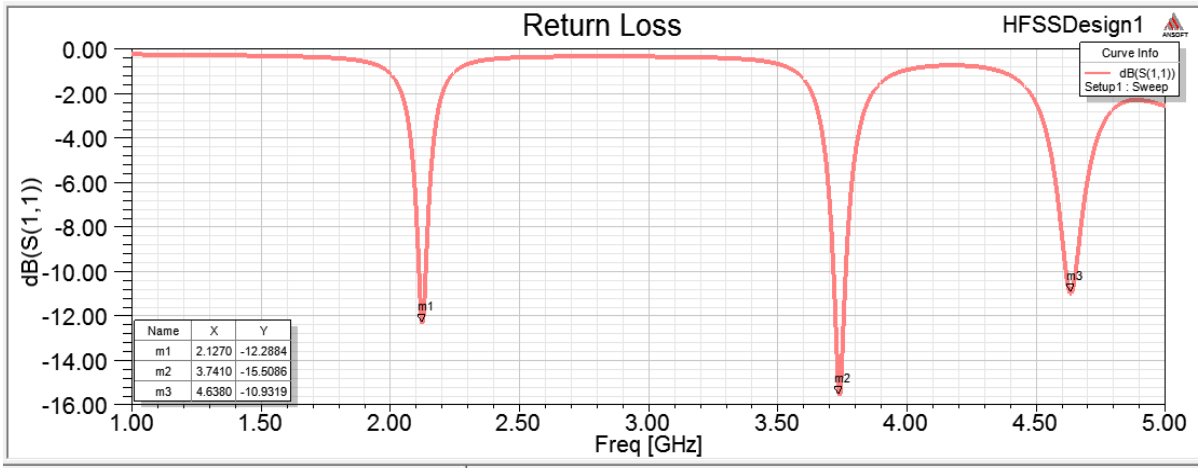

Fig. 3 Simulated Return Loss (S_{11}) of projected antenna.

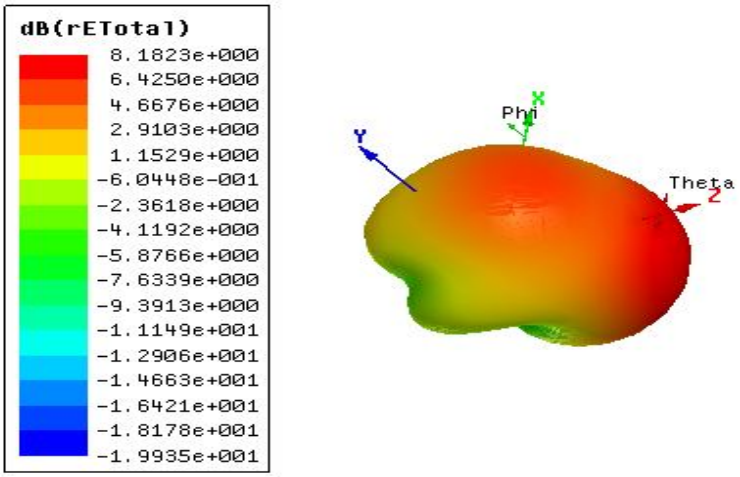

Fig. 4 Radiation Pattern of projected antenna in HFSS.

IV. CONCLUSIONS

Microstrip antenna is very popular now a day due to its advantages and it is a developing area of research. Their applications are boundless, in view of their less weight, small size, and simplicity of assembling. In this paper microstrip patch antenna is projected that gives triple band which can be used for S band applications. The simulated result shows that proposed antenna resonates at three frequencies centered on 2.17 GHz, 3.74 GHz and 4.63 GHz, hence can used for S band applications. The maximum gain is 8.18 dB in simulation.

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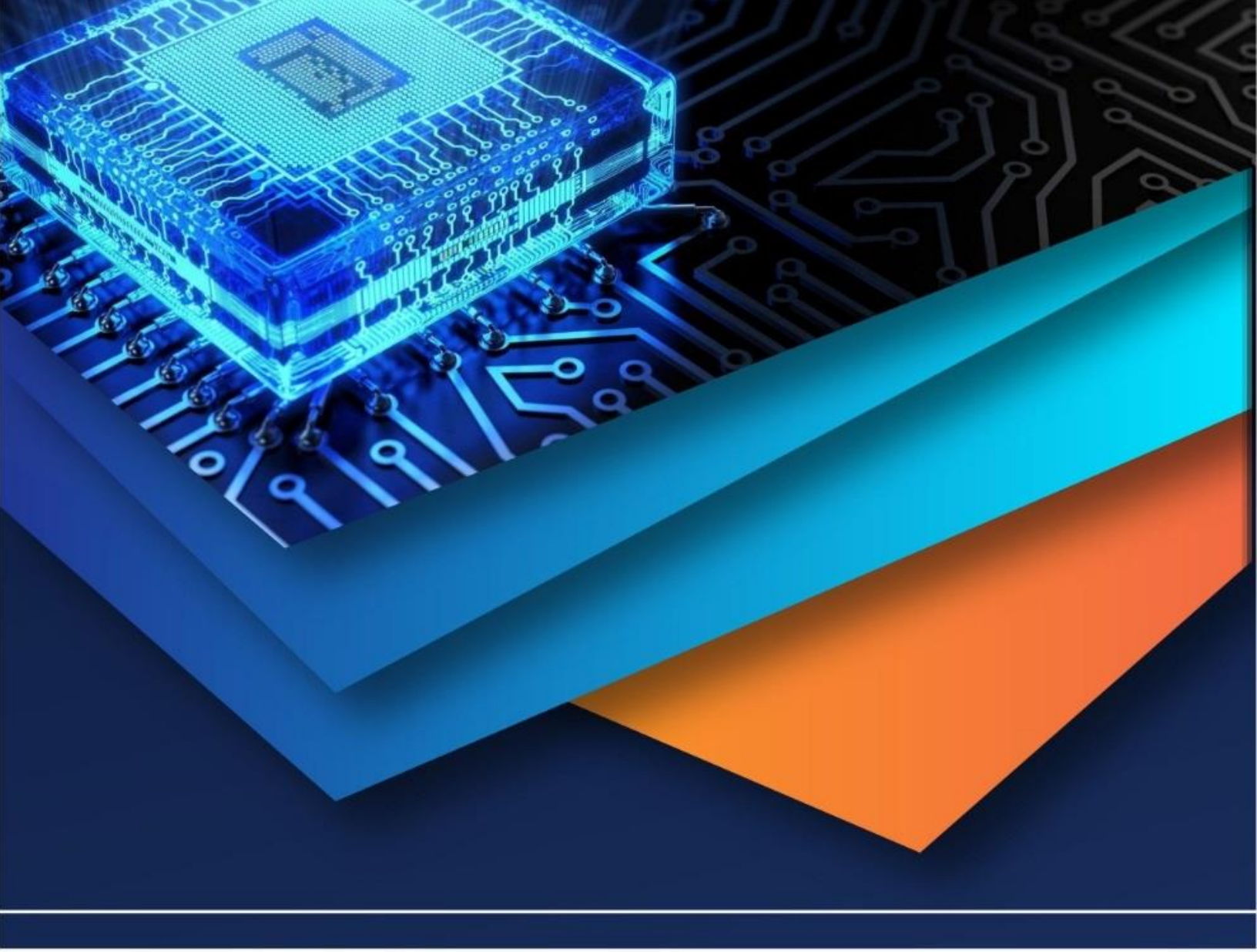

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