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Performance of NBPE in Rectangular Microstrip Patch Antenna

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ABSTRACT
In this paper we use a rectangular microstrip patch antenna with fed patch contains four notches of equal Length and width (L×W) and having one parasitic patch, to achieve dual band operation of proposed microstrip patch antenna, is analyzed using circuit theory concept. The theoretical and simulated results of proposed antenna are compared. The return loss of NBPE using rectangular microstrip patch antenna decreased and bandwidth at dual operating frequency 1.44 GHz & 1.80 GHz are increased at a substrate height of 1.6 mm. This paper shows the decreased in return loss & improves in Gain as well as bandwidth using NBPE. These structures are simulated using IE3D version 12.29 Zeland software incorporation.
Keywords – NBPE, patch antenna, return loss, gain, bandwidth

I. INTRODUCTION

It is found that the input impedance varies significantly with the size and position of the parasitic patch. The result is important for bandwidth enhancement and impedance matching of the microstrip antenna. The microstrip patch antennas are commonly used in the wireless devices. Therefore, the miniaturization of the antenna has become an important issue in reducing the volume of entire communication system [1].To meet these requirements, microstrip antennas can be used. Microstrip antennas are largely used in many wireless communication systems because of their low profile and light weight [2]. In spite of having a lot of advantages (low profile, low cost and Omni directional radiation patterns etc.), it has some drawbacks like narrow bandwidth and low gain [9].These antennas is conformable to planar and non-planar surfaces, simple and inexpensive to manufacture using modern printed-circuit technology electrically & mechanically robust when mounted on rigid surfaces, compatible designs, and when the particular patch shape and mode are selected, they are very versatile in terms of resonant frequency. The currently popular antenna designs suitable for the applications of wireless local area network and world-wide interoperability for Wi-Fi & Wi-Max microwave access [3].

II. DESIGN SPECIFICATIONS

The Coaxial feed or probe feed is a very common technique used for feeding Microstrip patch antennas. As seen from Fig.1 the inner conductor of the coaxial connector extends through the dielectric and is soldered to the radiating patch, while the outer conductor is connected to the ground plane [10]. The length and width of patch is respectively, L = 37.7 mm, W = 28.4 mm [11]. Rectangular Microstrip Patch Antenna is etched on FR4 (Lossy) substrate of thickness h = 1.6mm and dielectric constant ε_r = 4.4 by using PEC [6] (Perfect Electric conductor) as the conducting plane. Hence, the essential parameters for the design are dielectric constant of the substrate ε_r = 4.4 & height of dielectric substrate h = 1.6 mm. Length of the notch is 12 mm & width of the notch is 1 mm. The distance between feed & parasitic patch is 1 mm by the simulation through IE3D software shown in figure 1. In this type of antenna design, patch is placed near the edge of original patch. These new patches may be coupled to the main patch electro-magnetically or through the direct coupling technique. Each patch can be designed in a similar manner to the original patch. The lengths of the parasitic patches will determine their resonant frequency and their width will determine the bandwidth.

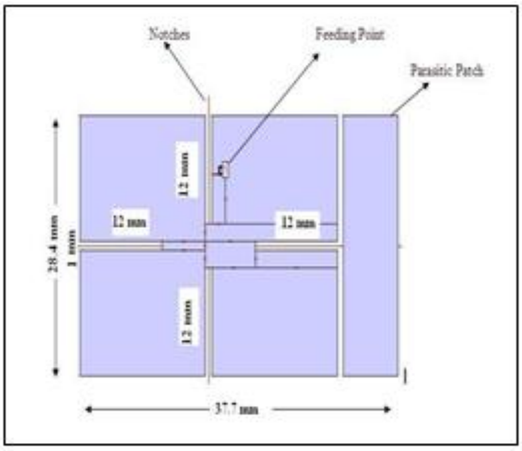

Fig.1 Microstrip rectangular patch antenna using Notch based parasitic element

III. INDENTATIONS AND EQUATIONS

The main advantage of this type of feeding scheme is that the feed can be placed at any desired location inside the patch in order to match with its input impedance. This feed method is easy to fabricate and has low spurious radiation. The Rectangular microstrip patch antenna parameters are calculated from the following formulas. Desired Parametric Analysis [4] [5].

Step 1: Calculation of the Width (W):

$$W = \frac{c}{2f_o\sqrt{\frac{(\varepsilon_r+1)}{2}}}$$

Step 2: Calculation of Effective dielectric constant (ε_{reff}):

$$\varepsilon_{reff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[1+12\frac{h}{W}\right]^{-\frac{1}{2}}$$

Step 3: Calculation of the Effective length (L_{eff}):

$$L_{eff} = \frac{c}{2f_o\sqrt{\varepsilon_{reff}}}$$

Step 4: Calculation of the length extension (ΔL):

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

Step 5: Calculation of actual length of patch (L):

$$L = L_{eff} - 2\Delta L$$

Where, ε_r = relative permittivity
c = speed of light
W = width of antenna patch
h = height of antenna patch
f_o = resonant frequency of antenna

IV. FIGURES AND TABLES

After simulation of NBPE rectangular microstrip patch antenna return loss is -15.387 dB at 1.44 GHz & -14.013 dB at 1.80 GHz are obtained. The return loss graph at corresponding frequency is shown by the Fig.2.

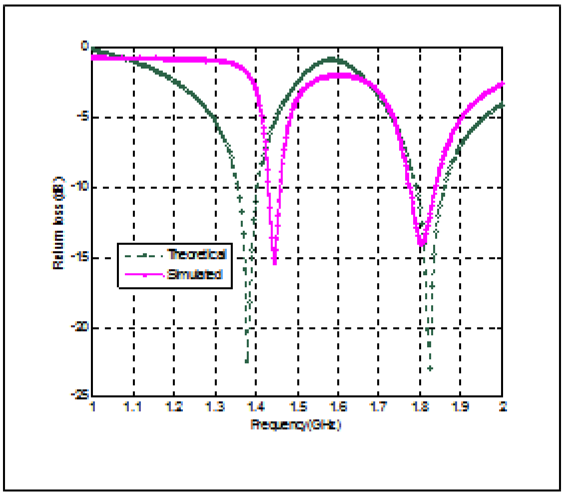

Fig.2 Return loss versus frequency graph of Microstrip rectangular patch antenna using Notch based parasitic element

If we take a different height of substrate like 1.60 mm, 1.65 mm, 1.75 mm & 1.80 mm then their corresponding graph between return loss & frequency is shown in figure 3.It is clear from the graph, the reduction in return loss is depend on the height of substrate. As much as the height increases, corresponding return loss will reduce. There will be much interconnecting and hence the heat loss as well as unwanted radiation will be reduced. The parasitic elements have the effect of widening the bandwidth, with the result that the array will have a larger bandwidth than the case when each patch is fed. These arrays are relatively simple to manufacture. In order to meet the miniaturization requirements of portable communications equipment, researchers have given much attention recently to compact Microstrip antennas. Many techniques have been reported to reduce the size of Microstrip antennas at a fixed operating frequency. So we can enhance the bandwidth of microstrip patch antennas, either by obtaining a wider bandwidth or performing a dual-band operation.

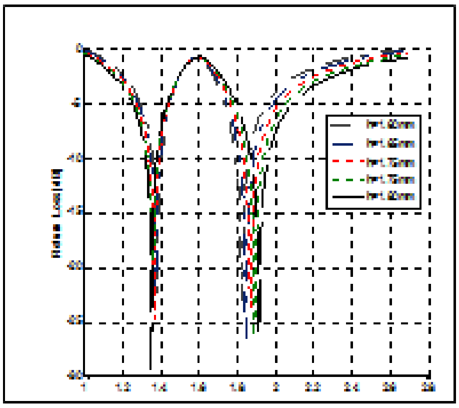

Fig.3 Graph between return loss & frequency at different height of substrate

By the simulation of NBPE rectangular microstrip patch antenna gain is 4.2 dBi is obtained. The Gain graph at corresponding frequency is shown by the Fig.4.

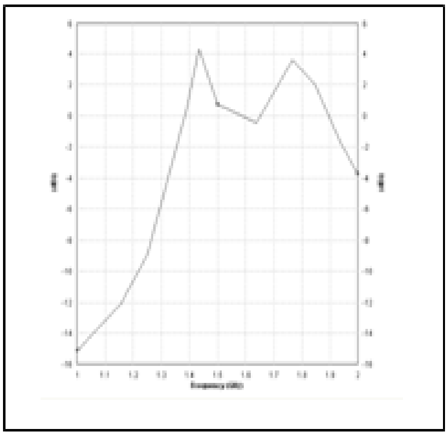

Fig.4 Graph between Gain & frequency for NBPE rectangular microstrip patch antenna

By the simulation of NBPE rectangular microstrip patch antenna, Efficiency is found to be 57% at corresponding frequency is shown by the Fig.5

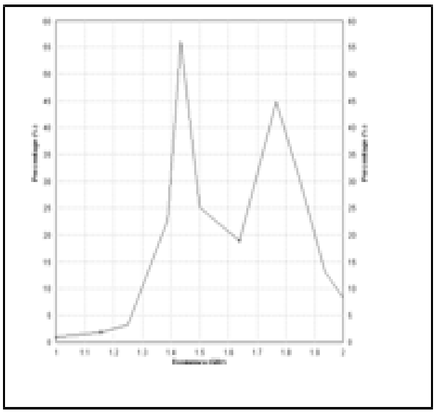

Fig.5 Graph between efficiency & frequency for NBPE rectangular microstrip patch antenna

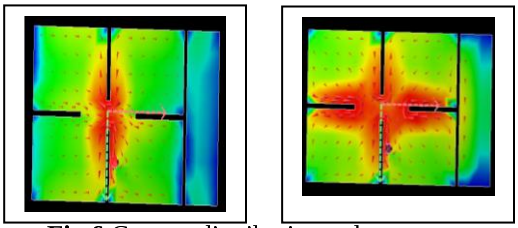

Fig.6 Current distribution at lower resonant frequency and upper resonant frequency at 1.44GHz & 1.80 GHz.

V. RESULT & DISCUSSION

The Monopole antenna used for both type of polarization. Number of notch can be increased to get circular polarization. Different feeding techniques can be used to improve the antenna performance.3G Antenna design, Array Antenna, Helical antenna and Proximity coupling. The bandwidth of proposed antenna is found to be 2.17% at 1.38 GHz and 3.33% at 1.84 GHz. Frequency ratios is found to be 1.75 and Gain is found to be 4.2dBi.Bandwidth increases using parasitic elements. The radiation edges of the driven element and parasitic element are adjacent to each other therefore capacitive coupling occurs between them.

VI. CONCLUSION

We analyze from the above results that the NBPE of rectangular microstrip patch antenna operate at dual band frequency i.e. 1.44 & 1.80 GHz. The Theoretical Bandwidth ≈ 2.17% at lower resonant frequency 1.38 GHz and ≈ 3.33% at upper resonant frequency 1.84 GHz & Simulated Bandwidth □ 4.38% at lower resonant frequency 1.45GHz and □ 4.26% at upper resonant frequency 1.80 GHz. We know that the dual band operating frequency improves the gain of antenna. Hence here NBPE of rectangular microstrip patch antenna has been designed for the wireless communication. Power radiation by a driven parasitic element increases the bandwidth of the antenna. Hence the simulated results provide better bandwidth as compare to theoretical bandwidth while theoretical return loss gives the better result as compare to simulated return loss as shown in figure2.

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