A Multiple Nonagon Void Slotted Rectangular Micro-Strip Patch Antenna

Jitesh Kumar,Sakshi Singh, Sarthak Singh, Arvind Gaur

Abstract-In this paper we present a proposed design for Rectangular micro-strip patch antenna by cutting multiple nonagon void shaped slots in the Rectangular patch. Using proposed antenna design and probe feeding at proper position we find the resultant return loss, VSWR and bandwidth. We are using IE3D simulation software for designing and analysis. We have observed that using slotted patch antenna and using probe feed at proper location we can get better VSWR and bandwidth.

Keywords- Slotted Nonagon void shaped rectangular micro-strip patch antenna, VSWR, radiation pattern.

I. INTRODUCTION

Antenna is a key building in wireless communication and global positioning system(GPS) since it was first demonstrate in 1886 by Heinrich Hertz and its practical application by Guglielmo Marconi in 1901. Future trend in communication design is towards compact devices. Low cost of fabrication and low profile features attract many researches to investigate the performance of a micro-strip patch antenna in various ways. Micro-strip antenna was first proposed by G.A. Deschamps in 1953. Micro-strip patch antennas are often uses where thickness and conformability to the host surfaces are the key requirements. Since patch antennas can be directly printed onto a circuit board, these are becoming increasingly popular within the mobile phone market.

They are low cost, have a low profile and are easily fabricated. One of the key drawbacks of such device is their narrow bandwidth. Micro-strip patch antenna is widely considered to be suitable for many wireless applications, even though it usually has a narrow bandwidth. The bandwidth limitation can be addressed by using thick substrates, cutting slots in the metallic patch, using aperture coupled stacked patch antenna. The stacked patch antenna have multilayer structure consisting of several parasitic radiating elements placed one above the other and above the driven element. However this approach has the inherent disadvantage of increased overall thickness and issues related on aligning various precisely. In this paper we design a rectangular micro-strip patch antenna in which 12 nonagon shaped slots are cut. By cutting a slot in micro-strip patch enhance its bandwidth.

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II. ANTENNA DESIGN

The proposed antenna design by cutting twelve hexagon shaped slots in Rectangular patch as shown in fig. (1). Cutting of theses slots in antenna increases the current path which increases current intensity as a result efficiency is increased. The dimension of the patch are L=27.9mm and W=33.88mm. Inside this rectangular patch three C shaped slots are cut. The antenna is fabricated on a substrate of dielectric constant 2.2 and thickness h=1.8 mm. The probe feeding is used for optimum results.

Steps for calculating the dimension of patch

Step 1: Calculation of the Width (*W*):

The width of the Microstrip patch antenna is given as:

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

Substituting *c* = 3.00e+008 m/s, ε*r* = 2.2 and *fo* = 3.5 GHz, we get:

W **= 0.03388 m = 33.88 mm**

Step 2: Calculation of Effective dielectric constant (ε*reff*):

The effective dielectric constant is:

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

Substituting ε*r* = 2.2, *W* = 33.88 mm and *h* = 1.8 mm we get:

ε*reff* = **2.0688**

Step 3: Calculation of the Effective length (*Leff*):

The effective length is:

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

Substituting ε*reff* = 2.0688, *c* = 3.00e+008 m/s and *fo* = 3.5 GHz we get:

Leff **= 0.02979 m = 29.79 mm**

Step 4: Calculation of the length extension (Δ*L*):

The length extension is:

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

Substituting ε*reff* = 2.0688, *W* = 33.88 mm and *h* = 1.8 mm we get:

Δ*L* = **0.94 mm**

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

The actual length is obtained by:

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

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Substituting L_{eff} = 29.79 mm and ΔL = 0.94 mm we get:
L = 27.90 mm

Step 6: Calculation of the ground plane dimensions (L_g and W_g):

The transmission line model is applicable to infinite ground planes only. However, for practical considerations, it is essential to have a finite ground plane. It has been shown by [11] that similar results for finite and infinite ground plane can be obtained if the size of the ground plane is greater than the patch dimensions by approximately six times the substrate thickness all around the periphery. Hence, for this design, the ground plane dimensions would be given as:

$L_g = 6h + L = 6(1.8) + 27.90 = 38.70$ mm

$W_g = 6h + W = 6(1.8) + 33.88 = 44.68$ mm

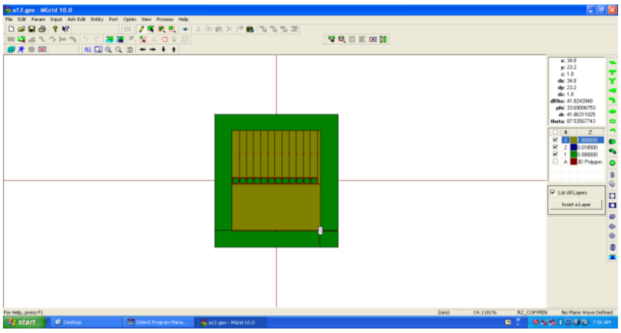

Figure (1): Proposed Rectangular Micro-strip Patch Antenna with multiple nonagon shaped slots

III. ANTENNA RESULT

The simulation of micro-strip patch antenna is done by using IE3D simulation software. The VSWR graph for a twelve nonagon shaped slotted rectangular patch antenna is shown in figure (2) . The VSWR indicates the mismatch between the antenna and the transmission line. For perfect matching the VSWR value should be close to unity. The VSWR for this multiple nonagon void shaped slotted antenna is 1. The simulated radiation pattern in 3D are shown in figure (3), the Smith chart is shown in figure (4), the return loss graph is shown in figure (5) and it is -19 dB, the total field gain & frequency is shown in figure (6), the total field directivity & frequency graph is shown in figure (7), the axial ratio & frequency is shown in figure (8), the antenna efficiency & frequency is shown in figure (9), the radiating efficiency & frequency is shown in figure (10), the elevation pattern gain is shown in figure (11) and the 3D radiation pattern for 3.5 GHz frequency for the multiple nonagon void shaped Slotted rectangular micro-strip patch antenna is shown in figure (12).

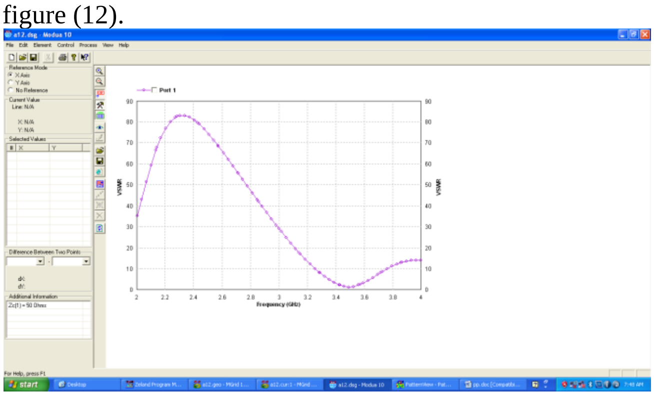

Figure (2): VSWR of the Proposed Rectangular Microstrip Patch Antenna with Multiple nonagon void shaped slots

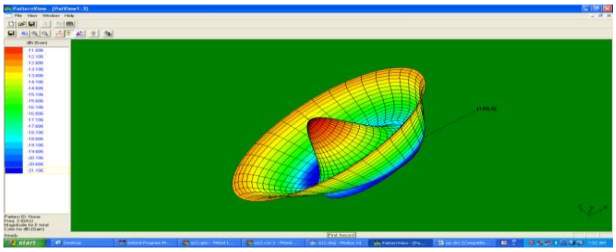

Figure (3): Radiation pattern in 3D of the Proposed Rectangular Micro-strip Patch Antenna with Multiple nonagon void shaped slots

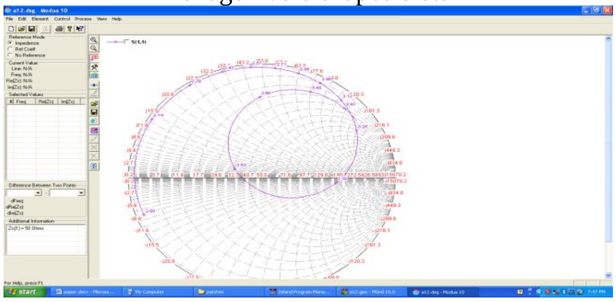

Figure (4): Smith chart of the Proposed Rectangular Micro-strip Patch Antenna with Multiple nonagon void shaped slots

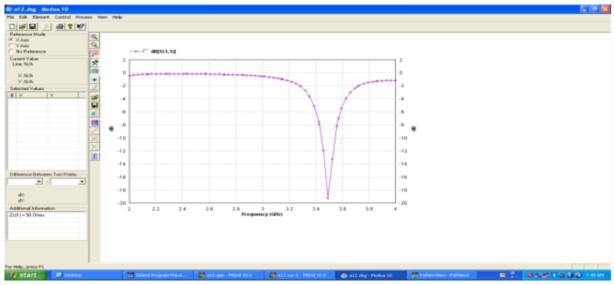

Figure (5): Return Loss of the Proposed Rectangular Microstrip Patch Antenna with Multiple nonagon void shaped slots

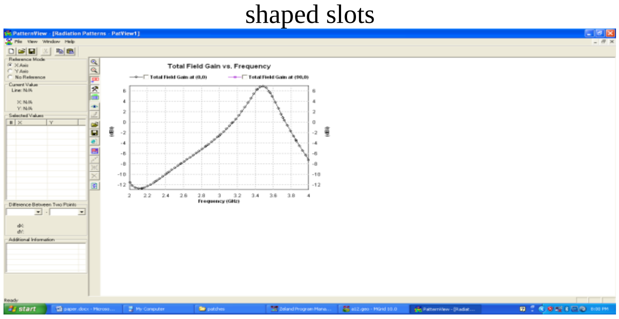

Figure (6): total field gain & frequency of Rectangular Micro-strip Patch Antenna with Multiple nonagon void shaped slots

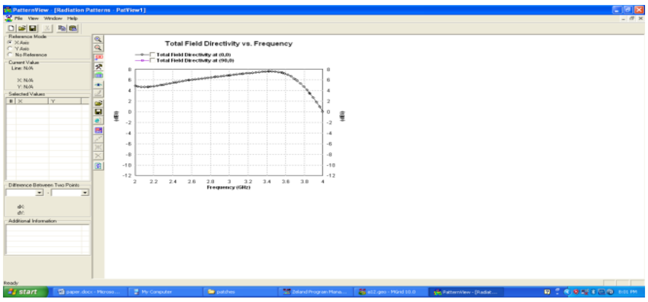

Figure (7): total field directivity & frequency of Rectangular Micro-strip Patch Antenna with Multiple nonagon void shaped slots

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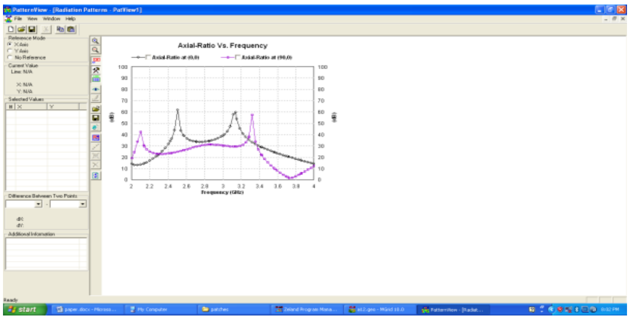

Figure (8): Axial ratio & frequency of Rectangular Micro-strip Patch Antenna with Multiple nonagon void shaped slots

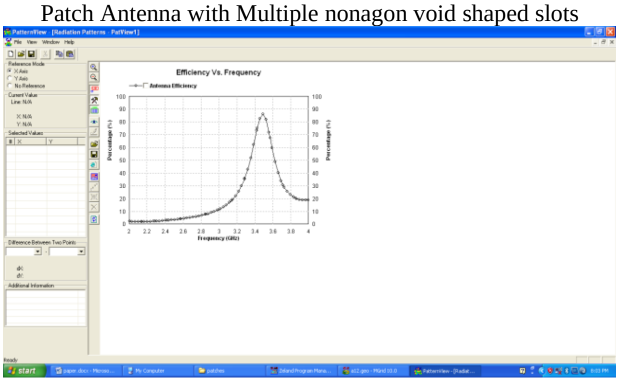

Figure (9): Antenna efficiency & frequency of Rectangular Micro-strip Patch Antenna with Multiple nonagon void shaped slots

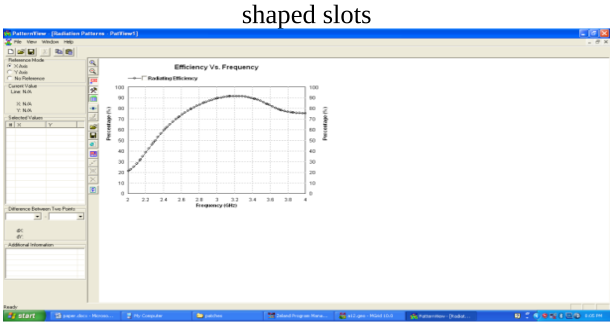

Figure (10): Radiating efficiency & frequency of Rectangular Micro-strip Patch Antenna with Multiple nonagon void shaped slots

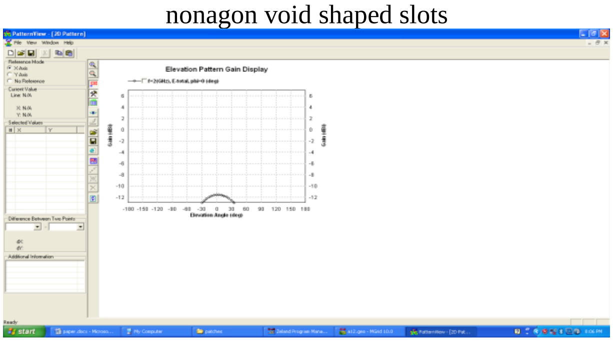

Figure (11): Elevation pattern gain of Rectangular Micro-strip Patch Antenna with Multiple nonagon void shaped slots

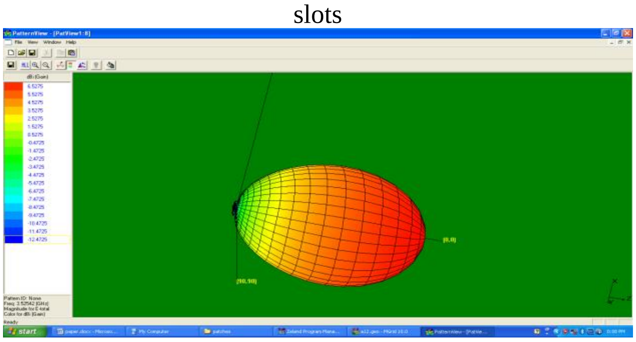
Figure (12): 3D radiation pattern for 3.5 GHz frequency of Rectangular Micro-strip Patch Antenna with Multiple nonagon void shaped slots

IV. CONCLUSION

It is observed that a probe feed, twelve nonagon void shaped slotted rectangular micro-strip patch antennas is presented. The proposed antenna has a compact size of (27.9 x 33.88 x1.8) and it can effectively covers the Wireless network, WLAN and Bluetooth application and it can also use other wireless communication system.

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