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Declined Rectangular Slotted Microstrip Patch Antenna for Wi-Max and S-Band Application

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Abstract- *Low cost high performance antenna is required in communication services in areas such as wi-fi, wimax, microwave application , Ethernet etc. The electromagnetic simulation of the proposed antenna has been carried out using IE3D software which work on principle of Method of Moment. Return loss, VSWR, antenna efficiency and radiation pattern etc can be evaluated for given design.*

Keywords- *Declined rectangular slot microstrip patch antenna for 3.5 GHz, return loss VSWR, antenna efficiency.*

I. INTRODUCTION

As the technology is advancing day by day the miniaturization of the device is one of the main constraints, while maintaining the performance of the device. Same is the case with antenna technology, now a day low profile antenna structures are in high demand. e.g. in wireless communication the communicating device should be small enough to be carried out easily, so the antenna used in such devices should be small but not at the cost of the performance of the antenna. Similarly if we want to place an antenna on the surface of any aircraft, Yagi antenna or parabolic reflectors having high gain and bandwidth can be placed on the surface but due to their humungous 3D structure it will highly influence the aerodynamics of the aircraft, hence it becomes impractical to plant those antenna structure on the aircraft surface. Planer or 2D antenna configuration is the solution to such types of problem; these antennas can be easily mounted on the surface of any such equipment. In such type of scenario the micro strip patch antenna plays vital role. Significant amount of research and study is being carried out to determine the augment in gain and bandwidth of the micro strip patch antenna by using probe feed stacked antenna, slotted patch antenna and stacked shorted patches. Generally the impedance bandwidth of patch antenna is directly proportional to the antenna volume; hence, using stacked configuration of the antenna structure amplifies the impedance bandwidth. Any wireless communication needs high gain and if the bandwidth of the antenna is also increased along with the gain it will be an additional advantage, though enhancing both gain as well as bandwidth at a same time is a challenging task.

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II. ANTENNA DESIGN

The proposed antenna is designed by cutting a rectangular slot of fixed dimensions at a fixed angle. Cutting of this slot in antenna increases the current path which increases current intensity as a result efficiency is increased and desired return loss is obtained. Start off by calculating basic equation of typical rectangular patch and then convert its equivalent area to a Rectangular form. The Essential parameters of this Rectangular microstrip patch antenna are W= 33.88mm,L= 27.90mm,Length of ground plane=38.70,Width of ground plane=44.68155. The rectangular microstrip patch antenna designed on one side of glass/epoxy structure with εr = 2.2,height from the ground plane d= 1.8mm and loss tangent=0.0009.Design is being calculated taking frequency 3.5GHz and it is shown in figure (1).

Steps for calculating the dimension of patch[10]

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:

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ΔL = **0.94 mm**

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

The actual length is obtained by:

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

Substituting *Leff* = 29.79 mm and ΔL = 0.94 mm we get:

L = **27.90 mm**

Step 6: Calculation of the ground plane dimensions (*Lg* and *Wg*):

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 [9] 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:

Lg = 6*h* + L = 6(1.8) + 27.90 = 38.70 mm

Wg = 6*h* + W = 6(1.8) + 33.88 = 44.68 mm

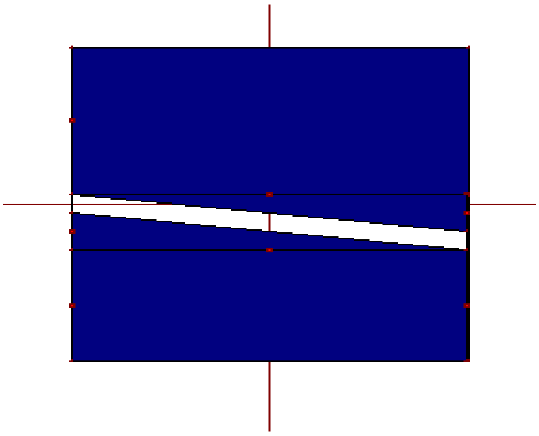

Figure (1): Proposed Rectangular Micro-strip Patch Antenna with declined rectangular shaped slots

III. ANTENNA RESULT

The simulation of micro-strip patch antenna is done by using IE3D simulation software. The VSWR graph for a declined rectangular shaped slotted 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 slotted antenna is 1. The simulated radiation pattern in 3D are shown in figure (3), the return loss graph is shown in figure (4) and it is -42.5 dB, the total field gain & frequency is shown in figure (5), the antenna efficiency & frequency is shown in figure (6),

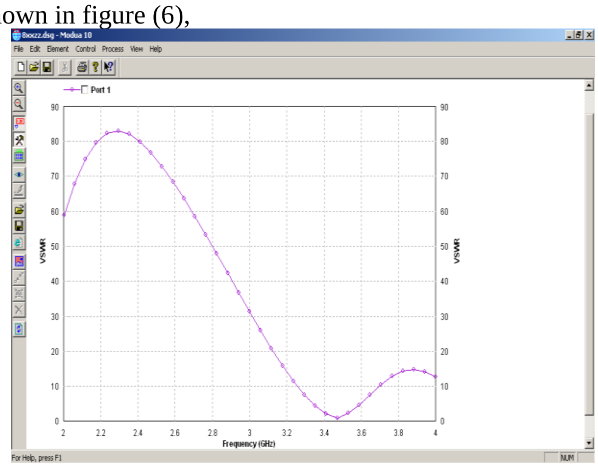

Figure (2): VSWR of the Proposed Antenna = 1.

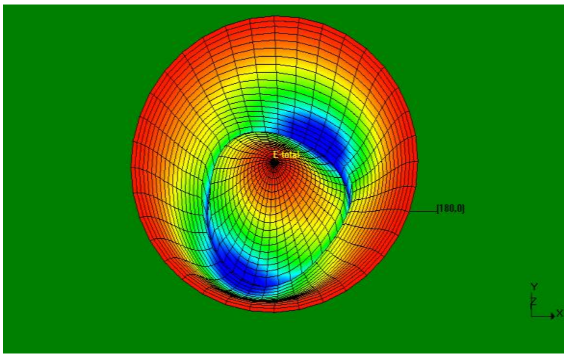

Figure (3): Radiation pattern in 3D of the Proposed Antenna

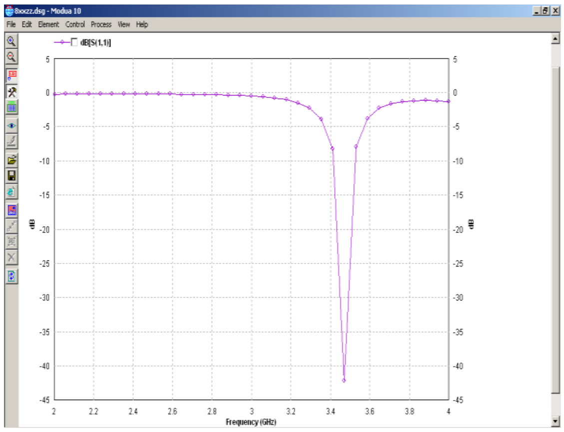

Figure (4): Return Loss of the Proposed Antenna = -42.5 db

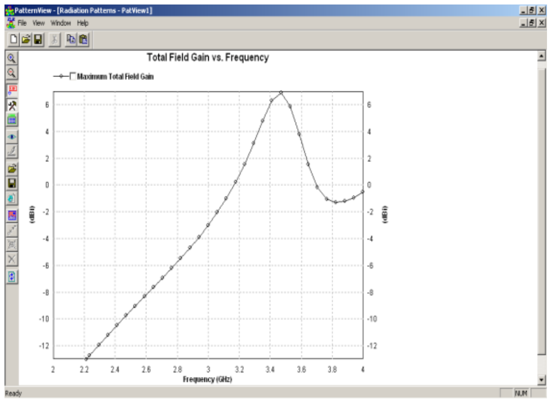

Figure (5): total field gain & frequency of proposed antenna=6.9

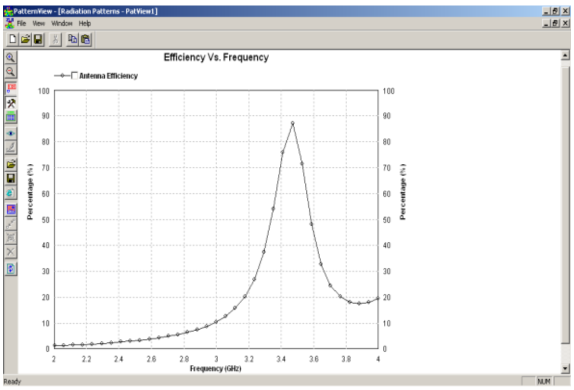

Figure (6): Antenna efficiency & frequency of proposed antenna=88

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IV. CONCLUSION

It is observed that a probe feed, declined rectangular shaped slotted 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 cover the Wireless operations like Wi-Max

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