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Design of Arrow Head Slotted Microstrip Patch Antenna for Wlan Applications

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Abstract:- ***In recent years, great interest was focused on microstrip antennas for their small volumes, low profiles, excellent integration, low costs and good performance. With the continuous growth of wireless communication service and the constant miniaturization of communication equipment, there are higher and higher demands for the volume of antennas, integration and working band. This paper presents a single layer arrow head slotted microstrip patch antenna is thoroughly simulated for wireless communications system application which are suitable for the 3.5GHz operations. A constant circular radiation pattern, for an operating frequency of 3.5GHz can be easily achieved. Configuration of an antenna is easy to design. Different parameters like VSWR which is 1.5 at 3.5GHz, gain, radiation pattern in 2D & 3D are simulated using IE3D. This type of proposed patch can be used for various applications in S band.***

Keywords:- ***Micro-strip patch antenna, Radiation pattern,Gain, Circular polarization, VSWR, Return Loss.***

I. INTRODUCTION

In recent years, demand for small antennas on wireless communication has increased the interest of research work on compact microstrip antenna design among microwave and wireless engineers [1-6]. Because of their simplicity and compatibility with printed-circuit technology microstrip antennas are widely used in the microwave frequency spectrum. Simply a microstrip antenna is a rectangular or other shape, patch of metal on top of a grounded dielectric substrate. Microstrip patch antennas are attractive in antenna applications for many reasons. They are easy and cheap to manufacture, lightweight, and planar to list just a few advantages. Also they can be manufactured either as a stand-alone element or as part of an array. However, these advantages are offset by low efficiency and limited bandwidth. In recent years much research and testing has been done to increase both the bandwidth and radiation efficiency of microstrip antennas. Due to the recent interest in broadband antennas a microstrip patch antenna was developed to meet the need for a cheap, low profile, broadband antenna. This antenna could be used in a wide range of applications such as in the communications industry for cell phones or satellite communication. Our aim is to reduce the size of the antenna as well as increase the operating bandwidth. The proposed antenna (substrate with εr = 2.2) has a gain of 6 dBi. The simulation has been carried out by IE3D [11] software which uses the MOM method. Due to the small size, low cost and low weight this antenna is a good entrant for the application of S-Band wireless communication.

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In this paper the microstrip patch antenna is designed for use in a WLAN application at 3.5 GHz. The results obtained provide a workable antenna design for incorporation in WLAN application.

II. DESIGN MODEL

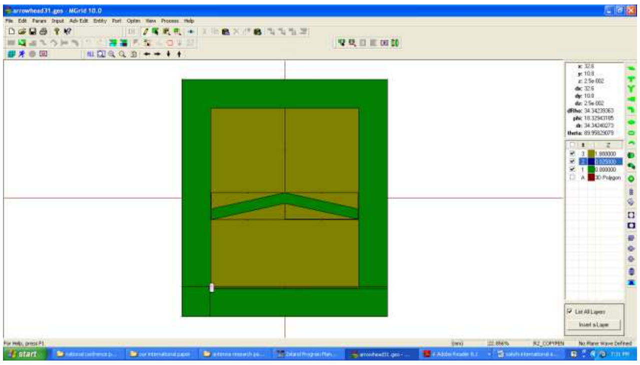

Fig:1 IE3D generated model.

The proposed structure of the antenna is shown in Fig.1. The antenna is simulated on an silicon substrate with a permittivity constant of 2.2 and a permeability of 1. The thickness of the substrate is 1.8mm. The area of the antenna is 38.70 mm*44.68 mm. Some numerical results and experimental data are presented. Here, a rectangular patch can be fed with a probe with slot placed center on the patch considered through ground plane. The ease of insetting and low radiations is advantages of probe feeding as compared to rectangular micro-strip line feeding. The dimensions of shaped patch shown in Fig.1 are L=27.90mm, W=33.88mm which are designed at operating frequency 3.5 GHz.

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, εr = 2.2 and *fo* = 3.5 GHz, we get: *W* **= 0.03388 m = 33.88 mm**

Step 2: Calculation of Effective dielectric constant ($\varepsilon reff$**):**

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 εr = 2.2, *W* = 33.88 mm and *h* = 1.8 mm we get: $\varepsilon reff$ = **2.0688**

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

The effective length is:

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

Substituting $\varepsilon reff$ = 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 (ΔL):
The length extension is:

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

Substituting $\varepsilon reff$ = 2.0688, W = 33.88 mm and h = 1.8 mm we get: 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 [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:

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

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

III. RESULT AND DISCUSSION

Simulated (using IE3D[11]) results of return loss in conventional , slotted antenna and antenna with defected ground structure are shown in Figure2-12. The simulation of micro-strip patch antenna is done by using IE3D simulation software. The VSWR graph for arrow head 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. In this design the VSWR is 2 at 3.5 GHz frequency. 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 -31dB at resonant frequency 3.5 GHz, 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) and it is 88 % at 3.5 GHz frequency, the radiating efficiency & frequency is shown in figure (10) and it is 90 % at 3.5 GHz frequency, the elevation pattern gain is shown in figure (11) and the 3D radiation pattern for 3.5 GHz frequency for the narrow head shaped Slotted rectangular micro-strip patch antenna.

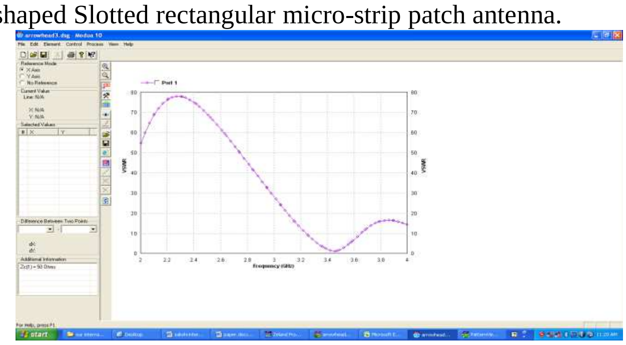

Figure (2): VSWR of the Proposed Rectangular Microstrip Patch Antenna with arrow head shaped slots

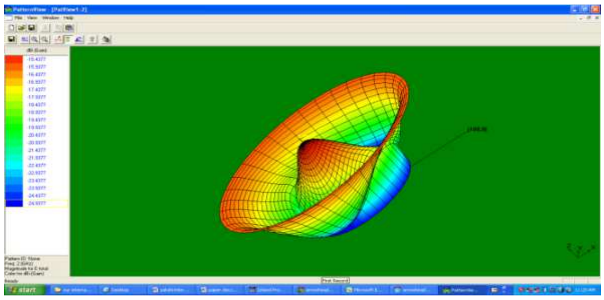

Figure (3): Radiation pattern in 3D of the Proposed Rectangular Micro-strip Patch Antenna with arrow head shaped slots

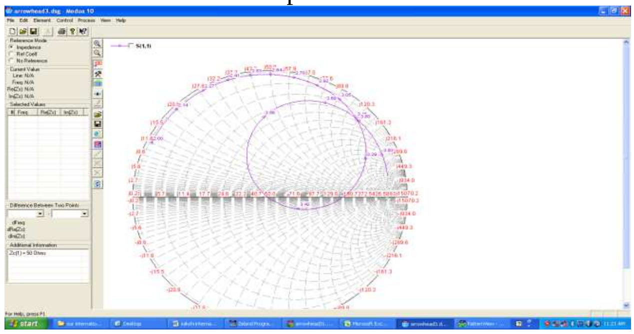

Figure (4): Smith chart of the Proposed Rectangular Micro-strip Patch Antenna with arrow head shaped slots

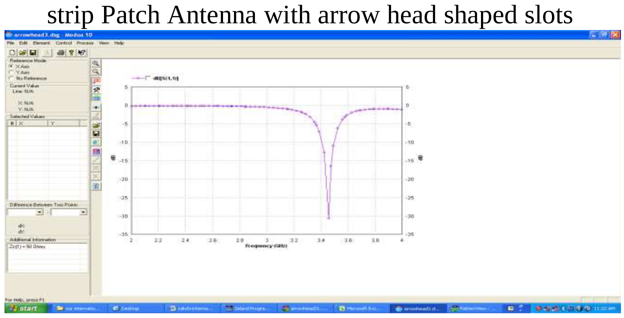

Figure (5): Return Loss of the Proposed Rectangular Microstrip Patch Antenna with arrow head shaped slots

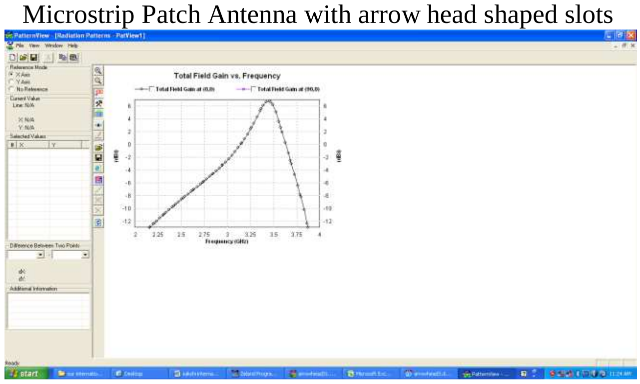

Figure (6): total field gain & frequency of Rectangular Micro-strip Patch Antenna with arrow head shaped slots

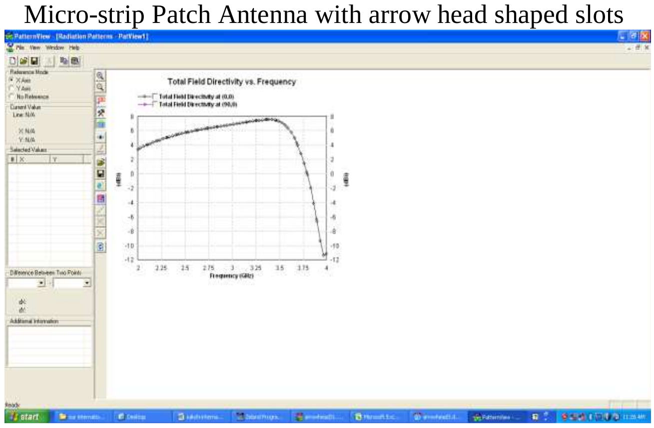

Figure (7): total field directivity & frequency of Rectangular Micro-strip Patch Antenna with arrow head shaped slots

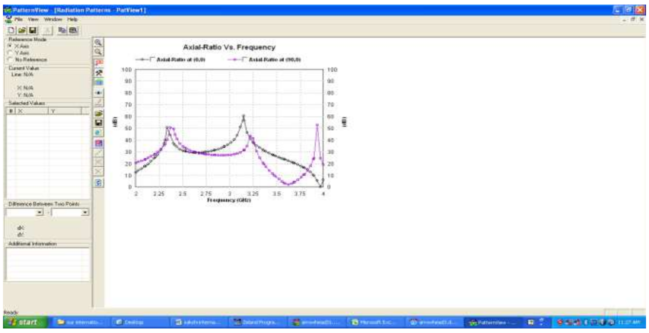

Figure (8): Axial ratio & frequency of Rectangular Micro-strip Patch Antenna with arrow head shaped slots

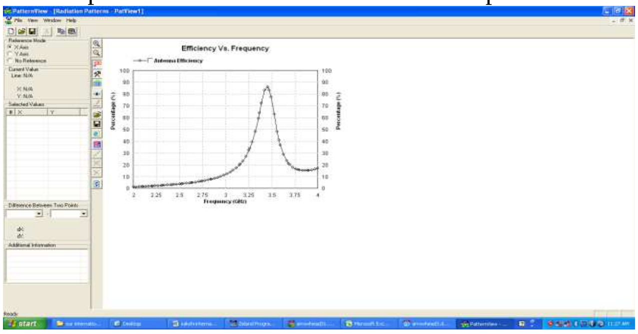

Figure (9): Antenna efficiency & frequency of Rectangular Micro-strip Patch Antenna with arrow head shaped slots

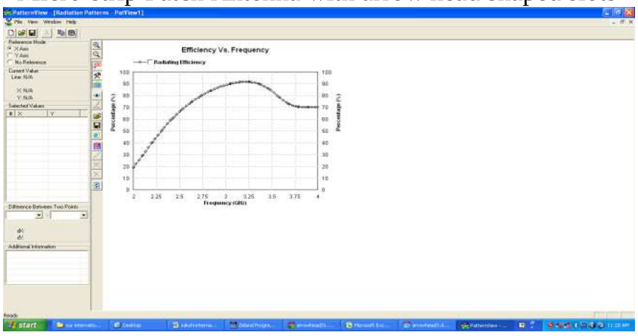

Figure (10): Radiating efficiency & frequency of Rectangular Micro-strip Patch Antenna with arrow head shaped slots

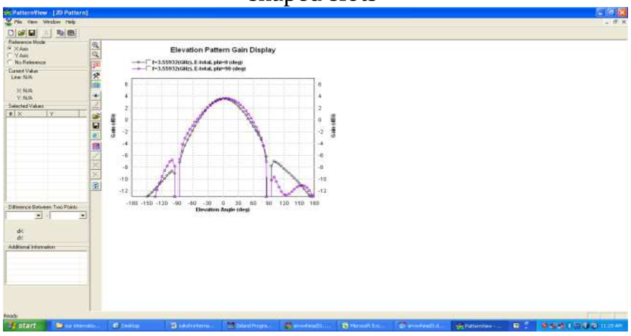

Figure (11): Elevation pattern gain of Rectangular Micro-strip Patch Antenna with arrow head shaped slots

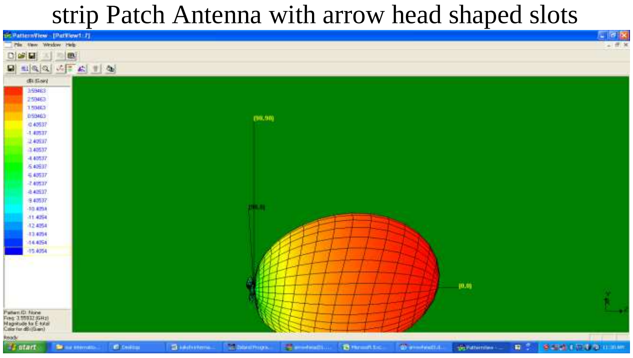
Figure (12): 3D radiation pattern for 3.5 GHz frequency of Rectangular Micro-strip Patch Antenna with arrow head shaped slots

IV. CONCLUSION

It is observed that a probe feed, arrow head 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.

REFERENCES

[1]. Ram Singh Kushwaha , D.K.Srivastava , J.P.Saini " A Design of H-shape Slot loaded Wideband Microstrip Patch Antenna" International Journal of Electronics and Computer Science Engineering (IJECSE), ISSN-2277-1956/V1N2-533-537.

[2]. Ramadan, A., K. Y. Kabalan, A. El-Hajj, S. Khoury, and M. Al-usseini, "A reconfigurable U-Koch microstrip antenna for wireless applications," Progress In Electromagnetics Research, PIER 93, 355-367, 2009.

[3]. Md. Mahabub Alam, Rifat Ahmmed Aoni, Md. Toufikul Islam " Gain Improvement of Micro Strip Antenna Using Dual Patch Array Micro Strip Antenna" Journal of Emerging Trends in Computing and Information Sciences , VOL. 3, NO.12 Dec, 2012 ISSN 2079-8407

[4]. Mayank Dwivedi1, Vinod Kumar Singh2, Mandeep singh Saini "Compact Dual Band Slotted Microstrip Antenna for IEEE802.11b Applications" International Journal of Advanced Research in Computer Science and Software Engineering(IJARCSSE)" Volume 2, Issue 10, October 2012 ISSN: 2277 128X

[5]. Mohammad A. A. Subhi H. Ahmad A. K. and Juma S. M. "Cavity model analysis of rectangular microstrip antenna operating in TM03 mode", IEEE proc. pp. 0-2218-2223, 2006..

[6]. K. L. Wong and W. H. Hsu, "A broadband rectangular patch antenna with a pair of wide slits," IEEE Transactions on Antennas and Propagation, vol. 49, pp. 1345-1347,September 2001.

[7]. Balanis, C.A., Advanced Engineering Electromagnetics, John Wiley & Sons, New York, 1989.

[8]. C. J. Prior and P. S. Hall, "Micro strip disk antenna with short-circuited annular ring",Electronics Letters, Vol.21, pp. 719-721, 1985.

[10]. Vinod K. Singh, Zakir Ali, "Dual Band U- shaped microstrip antenna for wireless Communication" International Journal of Engineering Science Technology, India, VOL 2 (6), pp 1623-1628, June,2010.

[11]. Zeland Software Inc. IE3D: MoM-Based EM Simulator. Web: http://www.zeland.com/