Micro-strip Slot Antenna with high Efficiency

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***Abstract*–A reduced size slotted rectangular micro strip patch antenna is introduced which exploits RT DUROID 5880 substrate from Rogers-Corp with dielectric constant of 2.2 and thickness of 0.76mm. The proposed antenna uses a finite ground plane with slotted rectangular patch to achieve an excellent impedance matching, high gain, along with operating frequency range of 3.06-3.145GHz and a radiation efficiency of 95.524%. The various simulations are provided to evaluate its performance parameters. This antenna is highly efficient for S-band (3.1-10 GHz) applications.**

***Keywords*– HFSS Simulator; Micro strip antenna; Patch dimensions; Return loss; VSWR.**

I. INTRODUCTION

Micro strip antennas became very popular in the 1970s primarily for space borne applications. Today they are used for government and commercial applications. An Antenna (aerial) is considered as a region of transition between a transmission line and space [1]. These antennas consist of a metallic patch on a grounded substrate [2]. Recently, micro strip patch antennas become the most demanding antenna based on their applications, which has some merits like low fabrications weight and cost, and operating in high frequency range [3]. At microwave frequencies Micro strip slot antenna becomes very small and light weight [4]. In spite of these advantages, it has main disadvantages of low efficiency, low Return loss, narrow bandwidth and large micro strip antenna aperture size[5].

In telecommunications, Return loss is the loss of signal power due to the reflections from discontinuities in a transmission line or coaxial cable. I t is the measure of how well devices or lines are matched. Therefore, for the efficient performance of a Micro strip antenna higher Return loss and high efficiency is desired. A patch antenna can be feed either by micro strip line, coaxial cable, aperture coupling or by proximity coupling. In this paper presents Micro strip line feed method for the simplicity of design and fabrication.

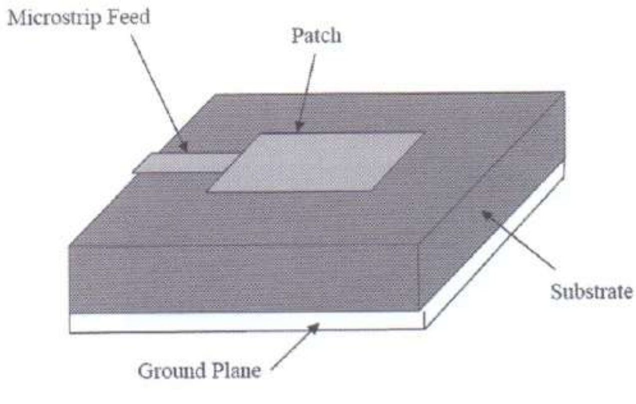

Fig. 1: Represents Micro strip line feed[6].

The narrow bandwidth can be enhanced by increasing the substrate thickness; however, this will lead to greater surface wave which will decrease the antenna efficiency and degrade the antenna pattern [5]. To overcome their drawbacks, micro strip patch antennas are incorporated with different materials used to improve the potential parameters of micro strip patch antenna.

II. METHODOLOGY

The calculation of dimensions can be obtained by the following formula:

$$W = \frac{c}{2f_0}\sqrt{\frac{2}{(\varepsilon_r + 1)}}$$

From the above formula the operating frequency can be calculated by knowing the width W and vice versa. For efficient results the effective of the dielectric constant (εreff) is considered, whose value is determined [7] by the formula given below:

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

Substituting ε_r=2.2, W=40mm and h=0.024mm then, ε_{reff}=2.1414.

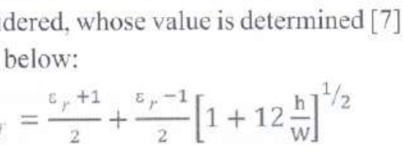

Fig.2: Represents the side view of the proposed antenna with labeling of the main parts of the antenna.

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This antenna makes use of the finite ground plane made up of copper and a dielectric substrate having dielectric constant 2.2. Micro strip antennas, consist of a very thin (t<<λ0, where λ0 is the free-space wavelength) metallic strip (patch) placed a small fraction of a wavelength (h <<λ0, usually 0.003λ0 ≤ h ≤ 0.05λ0) above a ground plane. For a rectangular patch, the length L of the element is usually λ0/03<L<λ0/2[2].

III. ANTENNA DESCRIPTION

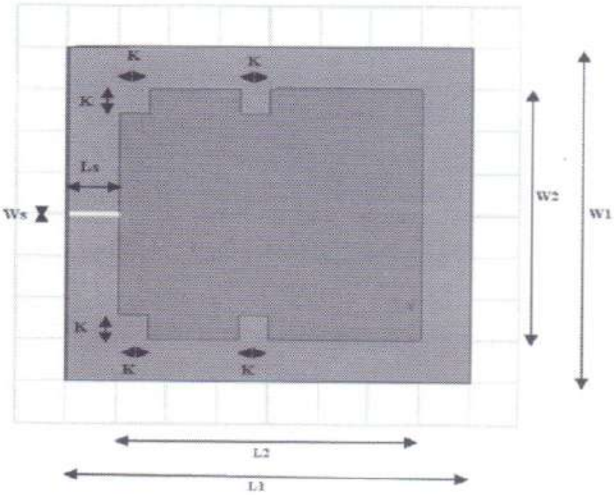

Fig. 3: Top view of the proposed antenna


Fig.4: Side View of the proposed Antenna .

Table No. 1: Dimensions of proposed antenna

Symbol	W1	L1	W2	L2	K
Size (in mm)	40	40	30	30	3
Symbol	Ws	Ls	H		T
Size (in mm)	0.5	5	0.76		0.024

IV. RESULTS AND DISCUSSIONS

The results of the proposed slotted rectangular micro strip patch antenna designed and verified in HFSS Simulator with optimization.

Table No. 2: Parameters of proposed antenna.

Quantity	Value
Max U	0.0532494(W/sr)
Peak Directivity	0.700714
Peak Gain	0.669348
Peak Realized Gain	0.669168
Radiated Power	0.954979(W)
Accepted Power	0.99973(W)
Incident Power	1(W)

a) Return loss

The given plot represents the different values of Return loss in the operating frequency range of the proposed antenna i.e. between 3.06-3.145GHz.The maximum Return Loss of -34.6155dB is obtained at 3.1GHz resonant frequency.

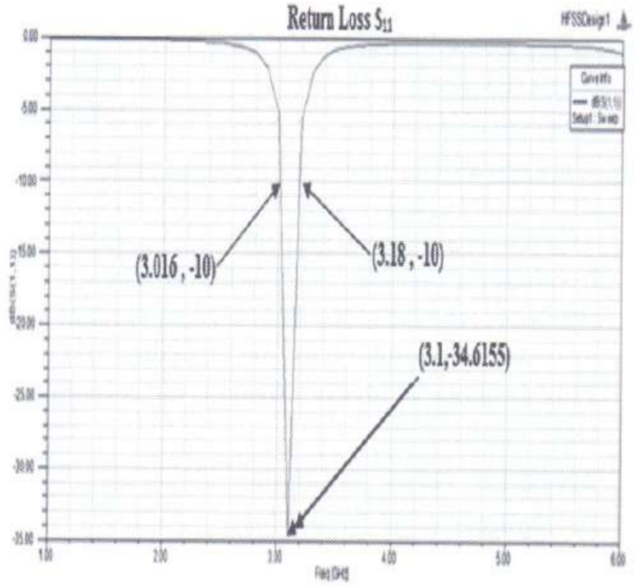

Fig.5: .Return loss of the proposed Antenna.

b) VSWR

The below plot represents that the VSWR is close to 1 between 3.06-3.145GHz.When VSWR increases the return loss of the antenna decreases.

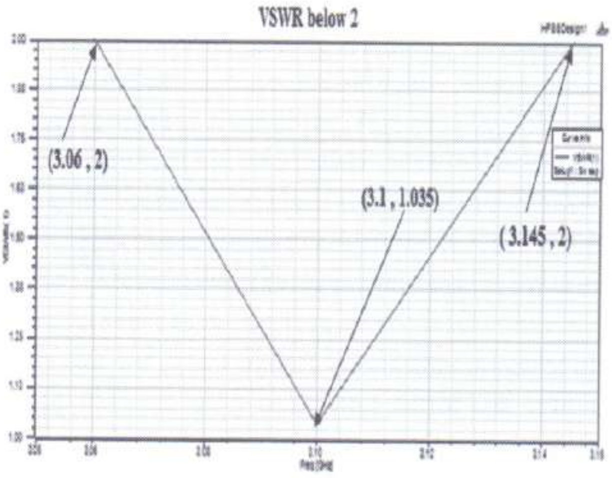

Fig.6: VSWR of proposed Antenna.

c) Directivity

The directivity represents the power radiated by an antenna in a particular direction. Since the power radiated in the backward direction is very low so we can say that this design presents a good directivity. From the below plot Directivity=0.700714dBi.

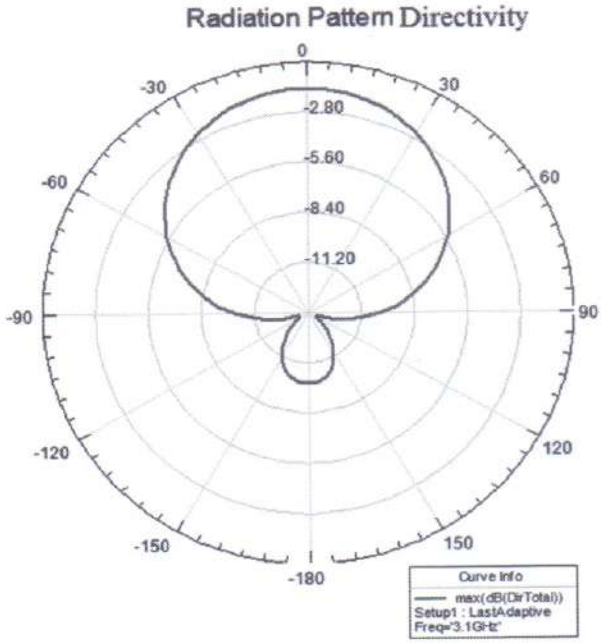

Fig.7: Represents the directivity of the proposed antenna

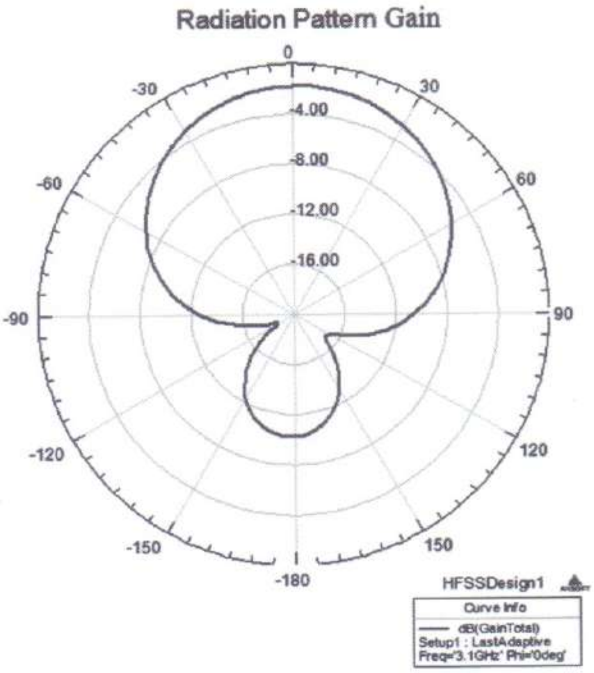

Fig.8: Gain of the proposed Antenna

d) Antenna Gain

Gain of an Antenna is defined as "the ratio of the intensity in a given direction, to the radiation intensity that would be obtained if the power accepted by the antenna were radiated isotropically. Gain=$4\pi\, U(\theta,\varphi)/P_{in}$.

The obtained Gain =0.669348

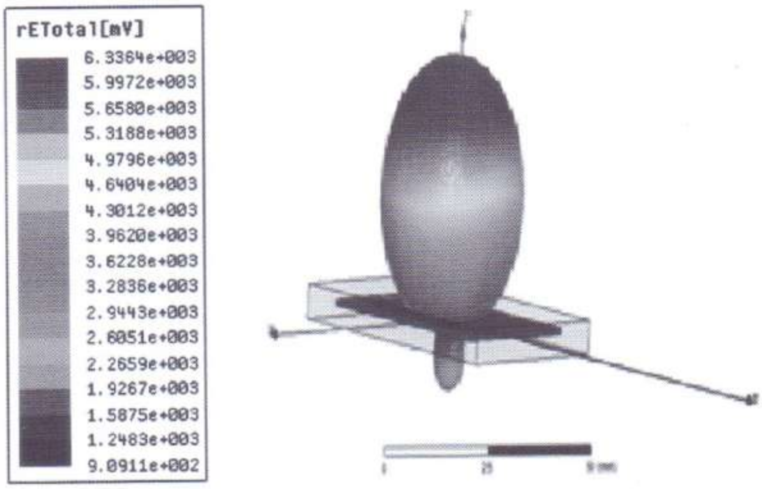

Fig.9: Represents the 3D plot of the radiation pattern.

e) Radiation Pattern

It is defined as thea mathematical function or a graphical representation of the radiation properties of the antenna as a function of space coordinates. In most cases, the radiation pattern is determined in the Far-field region.

V. CONCLUSION

A computationally easier and efficient HFSS Simulator is used to analyze the proposed antenna design. The proposed slotted rectangular micro strip patch antenna with RT DUROID 5880 substrate is designed & analyzed in 3D. The proposed antenna works in the frequency range of 3.06-3.145GHz (S Band) and better result is obtained at 3.1GHz. The return loss and efficiency of the antenna can be increased by attempting various methods such as by changing the dimensions of the patch, by changing the dimension & dielectric constant of the substrate and by changing the frequency of operation of the antenna. The simulated result of HFSS Simulator at 3.1 GHz is Return loss= -34.6155dB, VSWR=1.035, Peak

Directivity=0.70071, Peak Gain=0.66935, Peak Realized Gain=0.66917, Accepted Power=0.99973W, Incident Power=1W, Radiated Power=0.95498W, Radiation Efficiency (η) =95.524%. The operating frequency range (3.06-3.145GHz) of the proposed antenna lies inside the lower UWB (3.1GHz-5.1GHz). It can be used in Radar, Satellite Communications.

ACKNOWLEDGMENT

The Authors would like to pay sincere thanks to HOD & faculties, Department of Electronics Engineering, NIET, Greater Noida for their kind support & Encouragements and for providing fabrication facilities in the college.

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