ANALYTICAL MODAL OF CIRCULAR PATCH USING FSS AT 5.8GHZ FOR WLAN APPLICATION

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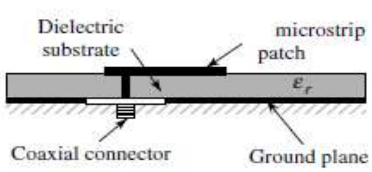
Abstract

In this letter, we describes the planning and comparative analysis of circular patch with FSS layer and without FSS which operate at 5.8GHz frequency. Dimension and the material has influence on the antenna parameter. Here the enhancement of gain upto 8.093 dB at 5.8GHz by minimizing the surface wave losses. For the simulation of design (HFSS) form 13 simulator is used for compute antenna parameters. Application of circular patch antenna above FSS is in WLAN, Bluetooth & Biomedical applications.

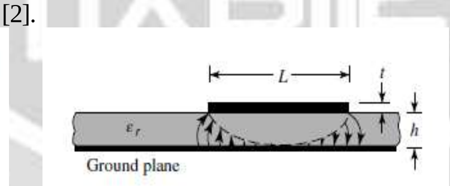
Index Terms— *Circular Patch, FSS, Coax-feed method, Return loss, Gain, HFSS 13.0 .*

I. INTRODUCTION

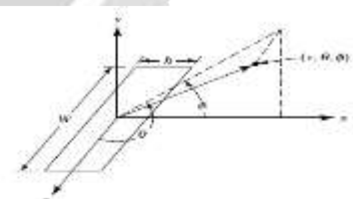
Here, gain enhancement of circular patch antenna by using FSS for remote correspondences, multi-band and wide-band patch receiving wires can turn into the necessities for precisely transmission the voice, information, video, and transmission data in remote correspondence frameworks, similar to radical wide and measuring applications, wise transportation frameworks (ITS), global situating framework (GPS) administrations, radio-recurrence distinguishing proof applications. Microstrip radio wire is main stream for low profile applications at frequencies above 100MHz. It comprises of a dainty Metallic strip put a little portion of wavelength over the ground plane. The ground plane and strip are isolated by a dielectric sheet alluded to as substrate. In superior flying machine, shuttle, satellite, and rocket applications, where size, weight, cost, execution, simplicity of establishment, and streamlined profile are imperatives, and low-profile receiving wires might be required. In the blink of an eye there are numerous other government and business applications, for example, portable radio and remote correspondences that have comparative determinations [1] and [2].



(a) Microstip Antenna



(b) Side view



(c) Coordinate systemof radiating slot

Figure 1. Microstrip patch antenna with coax feed [1].

In fig (a), here a dielectric is sandwich in between the ground plane and patch. This patch is excited by a Coax feed Method.

Fig (b) in this figure a side view of microstrip patch antenna which shows the field inside the dielectric. The maximum radiation occurs at the corner and minimum at the centre.

Fig(c)this figure shows antenna operated in spherical coordinates system i.e. (r,θ,∅). This shows the azimuthal and polar angle for microstrip patch antenna.

The surface wave existed on the patch radio wire can in any case engender till it meets a division. Once the surface wave meets the detachment, it ought to emanate and couple vitality to the partition. The surface wave can reduce reception apparatus intensity, increase, and data measure. To achieve multi-band and wide-band operation amid a patch radio wire style, the frequency selective surface (FSS) is upheld or imbedded amid a patch receiving wire as of late. For very four decades, the FSS highlights a kind of utilizations in receiving wires, spatial microwave and optical channels, safeguards, polarizers, coplanar meta-materials, and fake attractive conveyor (AMC) styles. The FSS is regularly made with occasional varieties of metal like patches of supreme geometries or openings at interims metal like screens. Commonplace FSS geometries square measure planned by dipoles, rings, square Loops, shape and shapes. As an aftereffect of the substrate thickness of a patch receiving wire is normally a great deal of littler than a half-wavelength inside the material, the base plane of the patch reception apparatus demolishes the patch radio wire execution. The FSS structure highlights an improvement with high electrical wonder surface that mirrors the plane wave in-stage and smothers surface wave. These attributes of FSS structures might be acclimated enhance the radiation power, increase, and data measure of a patch radio wire. The effect of a FSS on patch radio wire execution relies on upon the cross section immaculate arithmetic, part consistency, furthermore the electrical properties of the substrate materials. In this; Analytical modular of Circular Patch utilizing FSS at 5.8GHz for WLAN Application is anticipated to be at the inalienable drawback of the thin data measure of the microstrip patch reception apparatus. Notwithstanding, the full recurrence is likewise moved from agent recurrence furthermore the data measure is additionally limited down once a wide-band Analytical modular of Circular Patch utilizing FSS at 5.8GHz for WLAN Application changes its immaculate science and size to suit totally diverse situations. Inside the underlying a piece of this correspondence, we tend to give an account of a double band FSS comprising of standard Jerusalem cross segment that was usual study the effect on the data transmissions and full frequencies of a Two Parallel opening patch recieving wire at 5.8 GHz as shown in figure 2.1.

An feeding method is an approach to supply radio waves into the antenna structure. Number of feeding strategy is being used in the innovations, it can contact and Non reaching. The criteria of division is immediate and round about availability of RF (radio Frequency) power supply with the reception apparatus. Microstrip line and coaxial are reaching sustaining strategy while gap and vicinity is non reaching feeding.

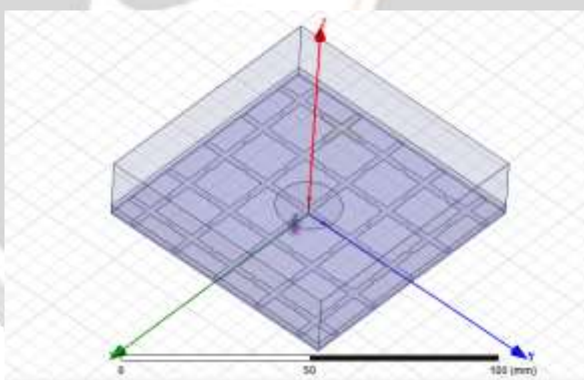


Figure 2.1.FSS layer with Circular patch

II. RELATED WORK

A. Objective

Our objective of this design to enhance and analyst the parameter of antenna to be using mathematically define equation with simulated result for hardware optimization.

B. Existing system

By using microstrip patch antenna have larger application in different sectors (as medical, telecommunication, etc.) because of low profile, smaller weight and many others also easy to fabrication but with this there are few disadvantages as well i.e. low gain and narrow bandwidth. There are various technique is implement for enhance bandwidth, impedance, gain, directivity and so forth. Use of FSS layer is a way of overcome the losses induce in antenna and increase efficiency. With the simulation theoretical calculation is also done and being compared with simulation results. It shows nearby results as in [4] it achieve 6.87 dB gain.

Dividing (gap) of substrate is filled with Rogers RT/duroid 5880™ to maintain to achieve best results. At the ISM band frequency 5.8GHz which achieved greater than 5 dB and showed conical radiation [4]. Similarly, another paper has demonstrated antenna at same frequency which achieved bandwidth 12.8% and gain of 5.7 dB [5].

III. ANTENNA THEORY AND ANALYSIS

Before designing we need parameters for analysis is made in two ways as: theoretical and mathematical analysis as shown table 1 after calculating. But this analysis is based on comparison the antenna is designed with only circular patch and after with using FSS layer because for comparative optimization to reduce the surface wave loss to be circular patch antenna, hence the results of antenna with comparative analysis has discussed in section IV.

A. Theoretical analysis

In theoretically, we are taking resonance frequency or operating frequency for beginning of our project at 5.8GHz. it also include coaxial feeding technique because it ease to obtain enhanced bandwidth, input matching with impedance matching. The spacing of substrate tried to be kept minimum so that we can reach maximum bandwidth with bin the limit of $.003\lambda o < h < .05\ \lambda o$.
As we know, FSS has a property that it reflect plane in phase and suppress the surface wave. FSS can be used as filter, reflector, absorber, polarizer it. Here in our first design dielectric is sandwich in between the circular patch and ground plane illustrate in figure 3.3(b). In second design, we are using a layer of FSS which is sandwich in between the two dielectric & circular patch for reducing the surface wave loss illustrate in figure 3.3.

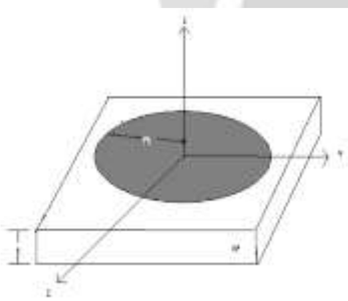


Figure 3.1. Geometry of Circular Patch Antenna.

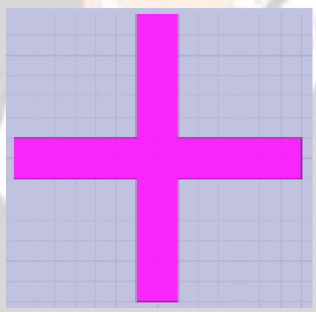


Figure 3.29(a). Unit cell of FSS.

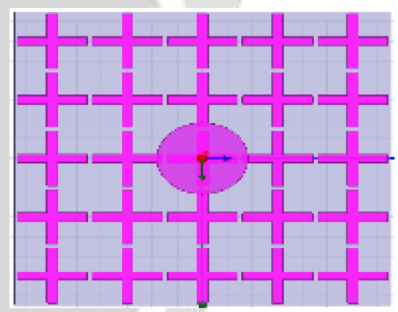


Figure 3.3(b). FSS sandwich with circular patch

B. Mathematical analysis

Through, the mathematical analysis we are calculating parameters of antenna as length, width, spacing between two layer as FSS layer, patch layer respectively by defined equation.

- To determine the radius of circular patch:

$$a = \frac{F}{\left\{1 + \frac{2h}{\pi \varepsilon_r F}\left[\ln\left(\frac{\pi F}{2h}\right) + 1.7726\right]\right\}^{1/2}}$$

$$(f_r)_{110} = \frac{1.8412 v_0}{2\pi a_e \sqrt{\varepsilon_r}}$$

- Effective radius of circular patch:

$$a_e = a\left\{1 + \frac{2h}{\pi \varepsilon_r a}\left[\ln\left(\frac{\pi a}{2h}\right) + 1.7726\right]\right\}^{1/2}$$

TABLE 1
CALCULATED ANTENNA PARAMETERS

PARAMETER	VALUES
Operating frequency	5.8GHz
Wavelength in free space/ vacuum	51.72mm
Radius of circular patch	9.3mm
Substrate dielectric material	RT-Duroid 5880™
Substrate dielectric constant	2.2
Substrate thickness	2mm
FSS surface used in substrate layer above direction	RT duroid 5880™
Feeding technique	Coaxial feeding
Feed point location from centre	3.55mm
Air gap	16
Ground plane	L=75mm, W=75mm
FSS thickness	0.762mm

IV. RESULT AND DISCUSSION

A. *Results of antenna without FSS layer*

1) Gain total: as shown in figure 4.1
Operating frequency: 5.8GHz
Value of Gain Total (in dB): 6.870
Peak point of operating frequency: 5.804GHz

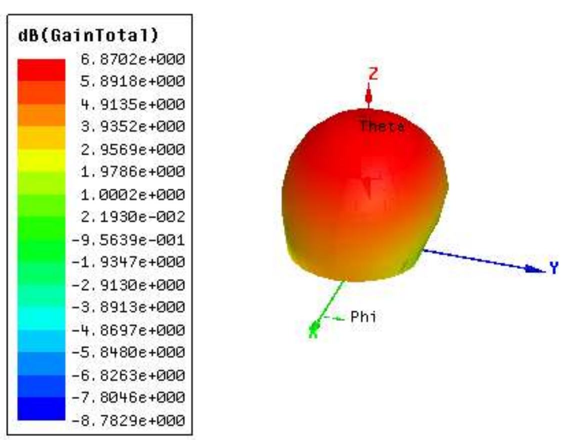


Figure 4.1:Illustrate the total gain without FSS.

2) Return loss: as shown in figure 4.2
Operating frequency: 5.8Ghz
Setup 1: sweep 1
Peak point of operating frequency : 5.804GHz

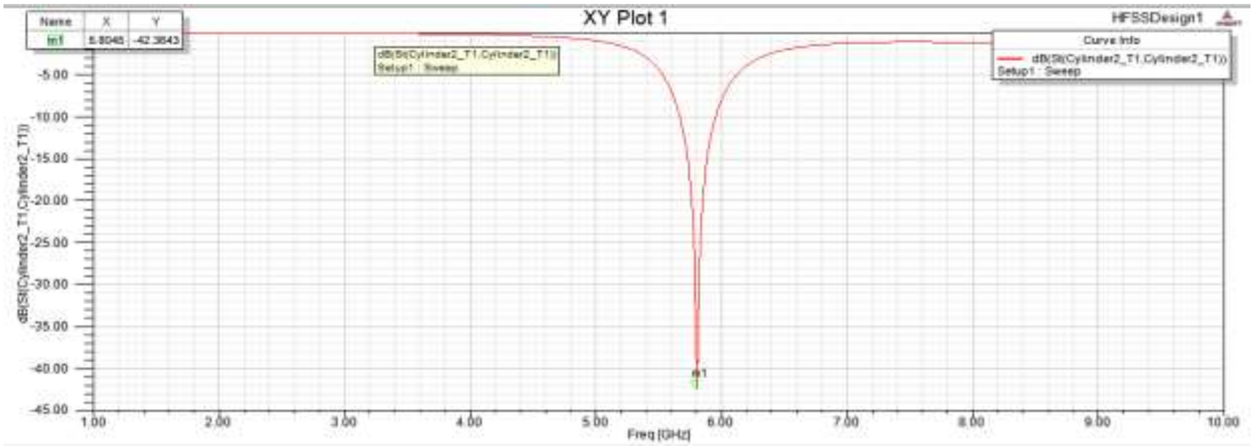


Figure 4.2:Illustrate return loss at 5.8Ghz without FSS.

3) VSWR: as shown in figure 4.3
Operating frequency: 5.8GHz
Value of VSWR: 0.1323
Peak point of operating frequency:5.804GHz

Figure 4.3: VSWR at 5.8GHz without FSS.

B. Results with FSS layer

1) Gain total: as shown in figure 4.4
Operating frequency: 5.8GHz
Value of Gain Total (in dB): 8.09
Peak point of operating frequency: 5.804GHz

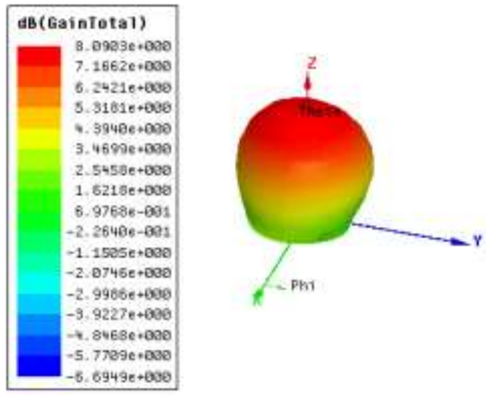


Figure 4.4: illustrate the total gain with FSS layer.

2) *Return loss: as shown in figure 4.5*

Operating frequency:5.8GHz

Values of return loss: -36.6616

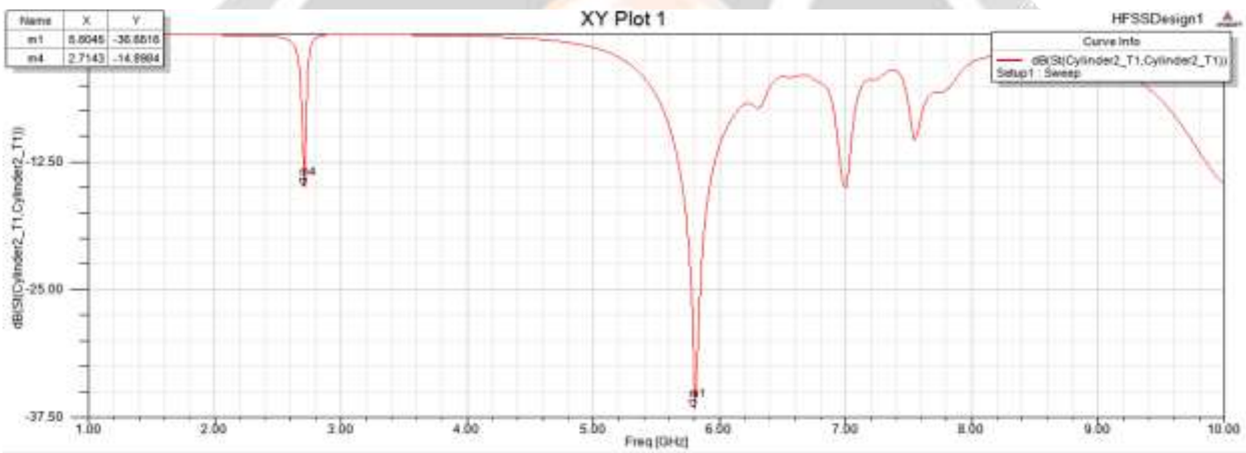


Figure 4.5: Return loss with FSS layer.

3) *VSWR*

Operating frequency: 5.8GHz

Optimum value is: 0.2554

Figure 4.6: Graph of VSWR for f_o = 5.8GHz.

V. CONCLUSION

As analytical modal of circular patch placed above the FSS layer gives the better result as compare to circular patch without FSS at 5.8GHz frequency for the WLAN application. The gain of the circular patch without FSS is 6.8dB at 5.8GHz. for the circular patch antenna using FSS. The gain of the antenna is 8.093dB at 5.8045GHz and the return loss is -36.651db at 5.8045GHz. the value of VSWR is 0.2554 at 5.8GHz frequency.

In future these antenna parameters can be enhanced by parametric studies furthermore enhanced data transmission with gain, impedance.

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