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Two Parallel Slot Microstrip Antenna over Frequency Selective Surface with Jerusalem Cross Components

Geeta, Ramit Kirti Saran, Amit Kirti Saran

Assistant Professor, Dept. of Electronics and Communication Engineering, AIT, Rampur, Uttar-Pradesh, India

B. Tech Student, Dept. of Electronics and Communication Engineering,Apex Institute of Technology, APJ Abdul KalamTechnical University, Lucknow, U.P, India

B. Tech Student, Dept. of Electronics and Communication Engineering,Apex Institute of Technology, APJ Abdul KalamTechnical University, Lucknow, U.P, India

ABSTRACT: FSS consisting of standard Jerusalem cross components was initial accustomed study its impact on the bandwidth and resonant frequencies of a U-slot patch antenna. Supported the simulation expertise of the primary partial study, another FSS with Jerusalem cross components was projected to enhance the bandwidths, antenna gains, and return losses of a smaller Two Parallel slot patch antenna at 5.8 GHz frequency for Bluetooth and local area network applications ,severally .Measured information of the return loss , radiation diagram, and antenna gain of this smaller E slot patch antenna were conjointly bestowed. It’s tried that the smaller U-slot patch antenna established with a FSS consisting of Jerusalem cross components feature a smart performance with comfortable information measure and better gain. Here microstrip patch antenna is placed over the layer of FSS. The objective in such design to analyze the return loss, gain, efficiency and VSWR for microstrip patch antenna which operate at 5.8 GHz.

KEYWORDS: ***FSS***, Jerusalem cross, Microstrip patch antenna , Coax-feed method,Return loss,Gain.

I. INTRODUCTION

For wireless communications, multi-band and wide-band patch antennas can become the necessities for accurately transmission the voice, data, video, and transmission info in wireless communication systems, like extremist wide and measuring applications, intelligent transportation systems (ITS) , , international positioning system (GPS) services , radio-frequency identification (RFID) applications. Microstrip patch antenna is that the natural favorite attributable to its inherent blessings of tiny size, low profile, light-weight, cost-effect, and its easy integration with alternative circuits. However, it's well-know that a patch antenna on a material substrate might have an awfully slender information measure attributable to surface wave losses. The surface wave existed on the patch antenna can still propagate till it meets a separation. Once the surface wave meets the separation, it should radiate and couple energy to the separation. The surface wave can cut back antenna potency, gain, and information measure. To attain multi-band and wide-band operation during a patch antenna style, the frequency selective surface (FSS) is enforced or imbedded during a patch antenna in recent years. For quite four decades, the FSS features a sort of applications in antennas, spatial microwave and optical filters, absorbers, polarizers, coplanar meta-materials, and artificial magnetic conductor (AMC) styles. The FSS is typically created with periodic arrays of metal like patches of absolute geometries or slots at intervals metal like screens. Typical FSS geometries square measure designed by dipoles, rings, square Loops, shape and shapes. As a result of the substrate thickness of a patch antenna is typically a lot of smaller than a half-wavelength within the material, the bottom plane of the patch antenna destroys the patch antenna performance. The FSS structure features a development with high electrical phenomenon surface that reflects the plane wave in-phase and suppresses surface

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wave. These characteristics of FSS structures may be accustomed improve the radiation potency, gain, and information measure of a patch antenna. The impact of a FSS on patch antenna performance depends on the lattice pure mathematics, component regularity, and also the electrical properties of the substrate materials .In this; the Two Parallel slot patch antenna is projected to be at the inherent downside of the slender information measure of the microstrip patch antenna. However, the resonant frequency is also shifted from operative frequency and also the information measure is also narrowed down once a wide-band Two Parallel slot patch antenna changes its pure mathematics and size to suit completely different environments. Within the initial a part of this communication, we tend to report on a dual-band FSS consisting of standard Jerusalem cross component that was accustomed study the impact on the bandwidths and resonant frequencies of a Two Parallel slot patch antenna at 5.8 GHz. For Bluetooth and local area network applications , severally .Supported the simulation expertise of the primary partial study, another FSS with changed Jerusalem cross components established during a new Two Parallel slot patch antenna with a smaller size was used for more studies to enhance the antenna bandwidths, antenna gains, and resonant frequencies at a pair of.45 and 5.8 GHz, severally. In simulations, the characteristics of Two Parallel patch antennas were obtained by exploitation the Ansoft high-frequency structure simulator (HFSS).Simulation results of the return loss , radiation pattern diagram, and gain of this new Two Parallel patch antenna were valid by measuring information.

II. THE TWO PARALLEL PATCH ANTENNA WITH A FSS

The Two Parallel patch antenna and its dimensions are given below. In my work, a concentric line with a characteristic electrical phenomenon of fifty ohms is employed because the feed of the Two Parallel patch antenna. The inner conductor of the concentric line is connected to the patch material substrate, and also the outer conductor is shorted to the metal like plate on the opposite aspect of the patch antenna. The FR4 material is employed for the material substrate with a thickness of four.4 mm. The relative material constant and electrical loss tangent of the substrate square measure adopted to be four (.4) and 0.02 at frequencies a pair of to six rate, severally. This Two Parallel patch antenna established with a FSS consisting of standard Jerusalem cross components is shown in Fig. 2. The FR4 material is additionally used for the higher and lower material substrates of the U-slot patch antenna with a FSS. The thickness of the higher and lower material substrate is unbroken at 4.40mm, whereas the thickness of the lower material substrate H , might vary from a pair of .2 to 3.2 mm.The Frequency Selective Surfaces (FSS) created with regular Jerusalem cross components is employed to enhance the antenna performance. The thickness of the highest metal like patch, the FSS, and also the bottom metal like plate is .035 mm. Fig. 3 shows an regular Jerusalem cross component. Therefore, the structure of the FSS may be viewed as behaving sort of a tuned network of equivalent LC circuits. By fixing the Jerusalem cross component pure mathematics the values for L and C may be changed, and also the resonant frequency is modified consequently. Comparisons of simulation results of return losses for the U-slot patch antenna established with and while not a FSS square measure studied. Simulation results were investigated by checking the impedance matching with higher than 10 dB return losses. From observations, the resonant frequencies of the U-slot patch antenna established with and while not a FSS square measure found to be close to the two resonant frequencies of 2.5GHz and 5.6 GHz rate for the impedance matching with higher than 10dB return loss.

III. ANTENNA THEORY

In this we tend to discuss the vital parameters through that we tend to style our structure for a specific application. First selection of substrate as in several styles the various materials is accustomed style the structure. The material constant of substrate affects the antenna performance as a thick material substrate that features low materialconstant can offer higher radiation then the substrate features a high material constant as second selection of Feed .The antenna may be excited by mainly two methods one is that the Contacting feed and another is Non Contacting feed. In contacting feed there are two sorts that is. Microstrip feed and concentric feed in these the Rf Power is fed on to the patch by connect the feed and also the diverging patch on alternative hand the non-contacting feed even have the two sort Proximity feed and Aperture coupled feed in these feed the RF Power is fed by coupling the feed and also the radiating patch. In our design we tend to use the microstrip feed attributable to its advantage that it's engraved on constant substrate to produce planar E structure. A Characterics electrical phenomenon of slot .Recently, with the growing number of wireless applications, there has been an increasing worldwide interest in low profile, low-cost, wideband system designs. One of the most intrinsic components of wireless systems is their antenna. Microstrip patch antenna is the natural favorite due to its inherent advantages of small size, low profile, lightweight, cost-effect, and its ease of integration with other

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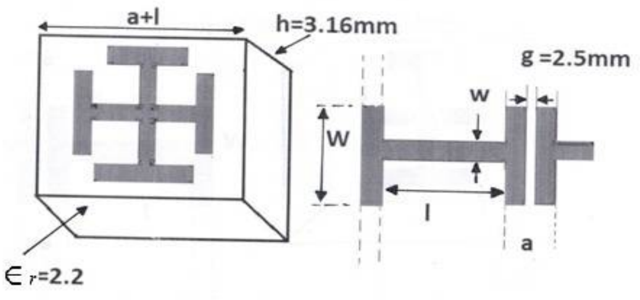
circuits. However, it is well-know that a patch antenna on a dielectric substrate may have a very narrow bandwidth due to surface wave losses. The surface wave existed on the patch antenna will continue to propagate until it meets a discontinuity. When the surface wave meets the discontinuity, it may radiate and couple energy to the discontinuity. The surface wave will reduce antenna efficiency, gain, and bandwidth .To achieve multi-band and wide-band operation in a patch antenna design, the frequency selective surface (FSS) is implemented or imbedded in a patch antenna in recent years.FSS can be used as a filter, substrate and superstrate. In this designed FSS is used as a substrate.

IV. MICROSTRIO PATCH ANTENNA WITH FSS

The dielectric material used for both the substrate is RT Duroid 5880 (the relative dielectric constant is 2.2) and the thickness chosen to be 3.16 mm for the lower substrate and for upper substrate is 1.58mm .There is layer of jerusalem cross element in between the two substrate ,this whole structure is known as frequency selective surface. All the parameters (a, l, w, W) depicted in Figure 1. Except g, are used as optimization variables. Where W and (a-g)/2 are length and width of the edge parts while l and w indicate the length and width of the straight portion of cross respectively.



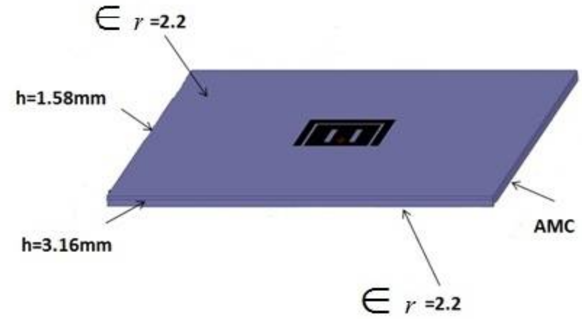


Figure 1. The unit cell geometry for the JC –FSSFigure 2. Patch antenna on FSS

The length Lp, width Wp and the location of the feed probe yf of the patch antenna as well as dimensions of JC-FSS (w,W,a,l).Geometrical parameters of the antenna-AMC structure.
Lp=12.8,yf=5.5,Wp=15.08,w=0.55,W=8.5,a=4.31,l=11.64. We observe that when an FSS ground plane is employed, with the same resonant frequency, we have nearly equal to 67% increase in bandwidth.The height of patch is divided or segregated in two section one is upper and other is lower both of RT duroid 5870 and the height of these substrate is considered by it's ratio which is either half of one or twice the other. The lower section is always thick then the upper section.

Sub1/Sub2 = 1.58mm/3.16mm

Hence, total height is 4.74 mm is considered for Microstrip patch antenna for optimization.

A. Analytical Model

The effect of changing the geometrical parameters of the JC- FSS element on the antenna performance was outlined and quantified. We observed that on increasing W and decreasing w the good matching characteristics shift to lower frequencies.

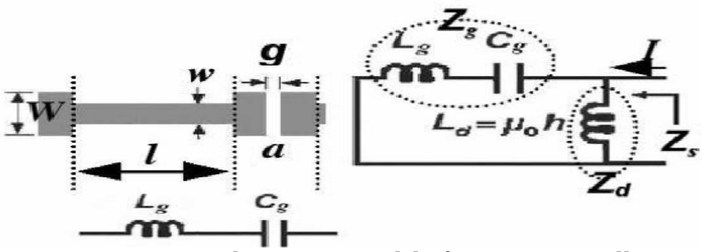


Figure 3.Equivalent circuit model of JC-FSS unit cell

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B. Equations

$$f_r = \frac{1}{2\pi\sqrt{(L_g + L_d)C_g}} \qquad (1)$$

$$BW = \frac{\pi}{8\eta_0}\sqrt{\frac{L_g + L_d}{C_g}} \times \left(\frac{L_d}{L_g + L_d}\right)^2 \qquad (2)$$

Where Lg is the grid effective inductance and Cg is the effective capacitance .There is shift down in resonant frequency by changing (increasing the width of strip) the value of W. There is also effect on return loss and the gain of the antenna .On increasing the value of w ,increase in resonant frequency will be there.

C. Streamlining aim

Best impedance matching and enhancing gain at operating frequency of 5.8GHz.

V. RESULT AND DISCUSSION

After calculating, optimization and parametric study of Two Parallel Slot Microstrip Antenna over Frequency Selective Surface with Jerusalem Cross components using High Frequency Structural Simulator (HFSS) software with version 13 respectively. We have obtained S-parametric graph versus frequency of this antenna system in figure 4 with the value S-matrix loss at 5.7194 GHz is -58.9786. Return is the loss of power which is due to mismatching of the transmission line or feed point. The accepted value of the return loss for patch antenna is less then -10dB because on above power losses are more, but in the obtained result it is -58.97dB. Which shows matching of feed is proper to its approximate value. And hence we can operate this patch antenna within range of 5.5324 GHz to 5.9970 GHz.
Return loss occur just because of the Reflection due to the mismatching of source to load. As the return loss increases in negative, it shows the matching is improving at the resonant frequency.
The obtained bandwidth is 8.62% over the range of 5.5324 GHz to 5.9970 GHz .

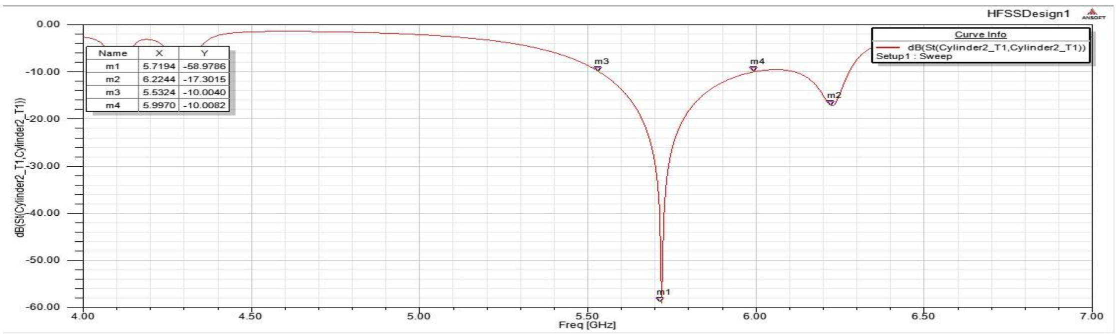

Figure 4. S_{11} Characteristics of antenna

And peak gain is 6.4050 dB and it is constant over the entire bandwidth of 8.62% at 5.8 GHz as shown in figure 5 whereas the efficiency is 98%.

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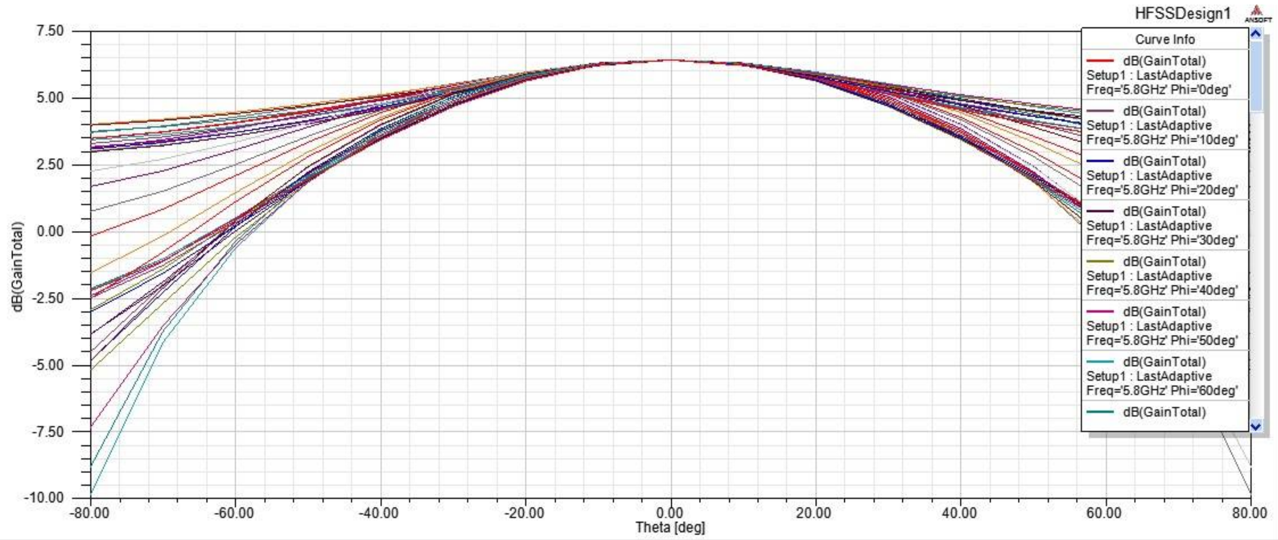

Figure 5. Comparison of optimized gain versus Frequency

For voltage standing wave ratio of reflected wave upon incident wave shown in figure 6. It is acceptable value for patch antenna is generally in of 0 to 2 but it will be as lower as possible. Here, we observed the value of VSWR is 0.0195 for resonant frequency is 5.8 GHz which shows the proper matching between JC-FSS and Microstrip patch, it is much desirable for any antenna operation.

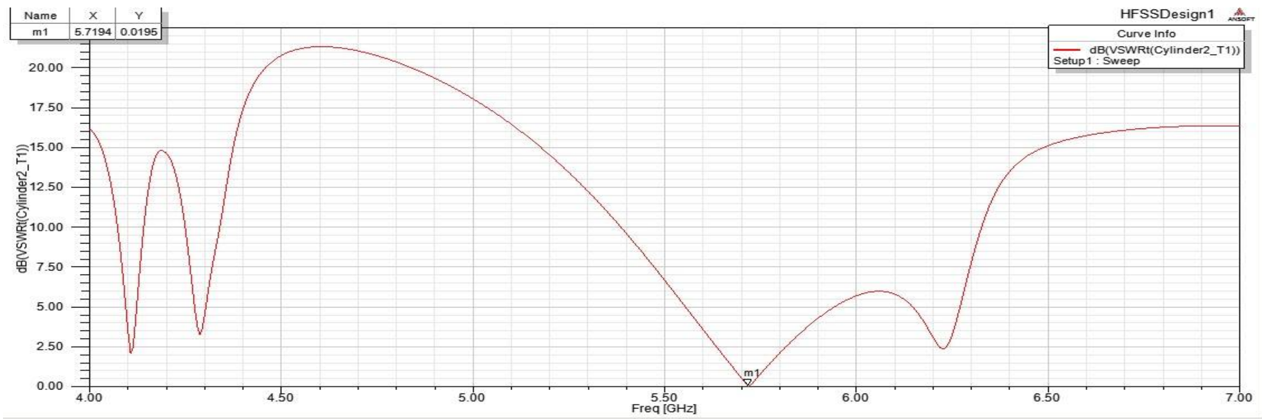

Figure 6. VSWR graph for JC-FSS over ground plane versus frequency.

Radiation pattern is a 3D representation in spherical co-ordinates system.this radiation pattern shows the direction where it give the radiation (in X,Y and Z direction or omni directional) and maximum value of gain by formula $10\log_{10}$ (peak realized gain) and the obtained value is 6.4050.

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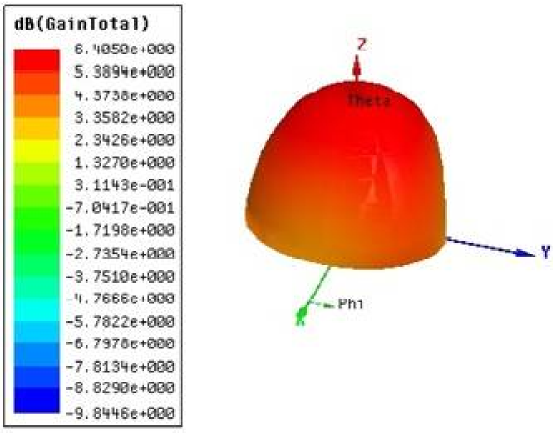

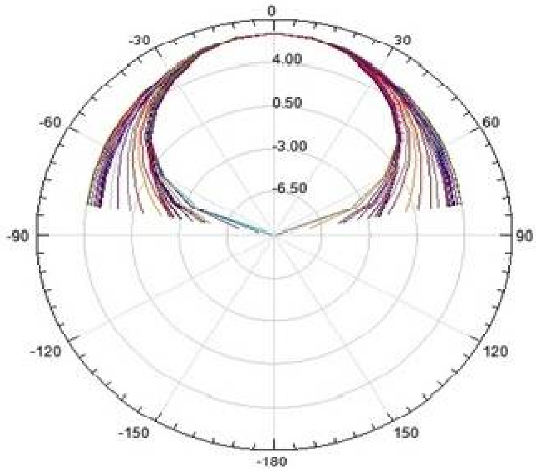

Figure 7. Radiation in 3D with peak gainFigure 8. Radiation pattern

The 2D representation of radiation pattern is also given in which we ind that there is no radiation in the back direction which shows no front to back ration is applicable.

VI. PARAMETRIC SPECIFICATION

Here, parameters are optimized which are obtained after simulation of this structure i.e. shows the peak realized gain is 4.3702, incident power is about 0.0096949 W, radiated power is 0.009431 W, accepted power is 0.0095611 W, Max U or radiatio intensity of antenna is about 0.003325 W/Sr and the efficiency is very good about 98.639% in table 1 below and it is very use full for every antenna system.

Quantity	Value	Units
Max U	0.003325	W/sr
Peak Directivity	4.4305	
Radiated Power	0.009431	W
Accepted Power	0.0095611	W
Incident Power	0.0096949	W
VSWR	0.0195	
Peak Gain	4.3702	
Efficiency (η_o)	0.98639	

Table 1:Parametric specificaton

VII. CONCLUSION

The conclusion drawn from optimization of two parallel slot microstrip antenna over FSS with Jerusalem Cross is done on high frequency structural simulation (HFSS) version 13 with determining the length, width, height of two plane

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dielectrics over ground plane for the best impedance matching then the dielectric substrate of 2.2 is used to simulate the antenna results and enhance bandwidth also increase gain of antenna.
In future these antenna parameters can be improved by parametric studies and also improved bandwidth with gain, impedance.

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BIOGRAPHY

Ms. Geeta, She is M.Tech by Qualification and currently working as Assistant Professor cum Coordinator at Apex Institute of Technology, Rampur, Uttar-Pradesh, Her area of interest is microwave, antenna designing and radar system. She has published two Paper in International Journals. She has attended two national conferences.

Amit Kirti Saran presently studying B.Tech degree in Department of ECE, under APJ Abdul Kalam Technical University at Apex Institute of Technology, Rampur, Uttar-Pradesh, India. His research interest research areas include Antennas, Communication systems and Embedded System. He has published one Paper in International Journals.

Ramit Kirti Saran presently studying B.Tech degree in Department of ECE, under APJ Abdul Kalam Technical University at Apex Institute of Technology, Rampur, Uttar-Pradesh, India. His area of interest is signal systems and microwave communications. He has published one Paper in International Journal.