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DESIGN AND PERFORMANCE ANALYSIS OF 2X2 RECTANGULAR MICROSTRIP PATCH ANTENNA ARRAY FOR WIRELESS LAN APPPLICATION

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ABSTRACT

2x2 rectangular micro strip patch antenna array for WLAN application is presented in this paper. Design and simulation of this antenna is done using HFSS simulator. At present in wireless communication , high performance antenna required with low profile features. As micro strip patch antenna is having low profile characteristics, so it fits for such application. WLAN is a small range communication network used for connecting more than one wireless devices that are in a short range. In this paper, antenna is designed on 1.6 mm thick RT/Duroid substrate having 2.2 relative permittivity. In this paper. Simulation results of antenna such as return loss, VSWR, gain, directivity plots and values are presented.

Keywords: Micro strip patch antenna, HFSS (High Frequency Structure Simulator), WLAN (Wireless Local Area Network), Return loss, VSWR (Voltage Standing Wave Ratio) , Gain, Directivity.

I. INTRODUCTION

Antenna used to connect the transmitter and receiver by means of wireless medium. If it is used at the transmitting section then it converts the voltage or current waves into electromagnetic waves. If antenna used at the receiver side then it converts the electromagnetic waves into voltage or current waves. All these below six papers are referred before starting the project and tried to improve the performance of the antenna by changing the dimensions and by improving the antenna parameter values. Summary of these six papers are explained briefly. Performance parameters that are achieved using this rectangular patch antenna are return loss -16.70 db and gain 2.6db.It is used for 6.5 GHz application. The main drawback of this paper is low gain is achieved and using slotted patch we can increase the gain and performance of the antenna [1]. Using FR4 epoxy substrate, circular micro strip patch antenna array designed for Wi-Fi application which was resonated at 2.45GHz frequency. Edge feed technique is used in this. The gain achieved using antenna is 5.7 db and return loss of -12.58 db. By changing the dimensions of the antenna, performance can be further improved [2]. For lower atmospheric boundary applications, circular patch antenna designed resonating at 1280 MHz . The designed antenna has the better values of VSWR, gain, return loss. Hence it can be used for wireless sensor applications also [3]. Design and Simulation of Circular Micro strip Patch Antenna with U-slot done and resonated at 1.8 GHz for LTE application. To increase the performance of the antenna air gap is inserted between the top plane and bottom plane. Due to this air gap antenna resonates at more than one frequency. Gain in this paper is observed as 3.8 db and return loss is -21.16 db. In this paper also low gain obtained [4]. For S-band applications, circular micro strip patch antenna array was designed. This antenna has advantage of circular polarization which can capture the signal under any circumstance. The gain of this antenna observed as 6.8 db and return loss -21.96 db. The main limitation of this paper is its directivity is less. It can be increased by decreasing the minor lobes [5]. For GSM Application, Rectangular micro strip patch antenna array was designed which resonates at 900 MHz frequency. Micro strip feed technique is used to feed single patch antenna. Simulated antenna has a return loss of -11.9 db and gain of 3 db. Simulated antenna has the poor results. This is main limitation of this paper. This can be rectified by introducing some slots in the patch [6].

II. COMPONENTS USED

Micro strip patch antenna has four main components

1.Ground plane

2.Dielectric substrate

3.Patch

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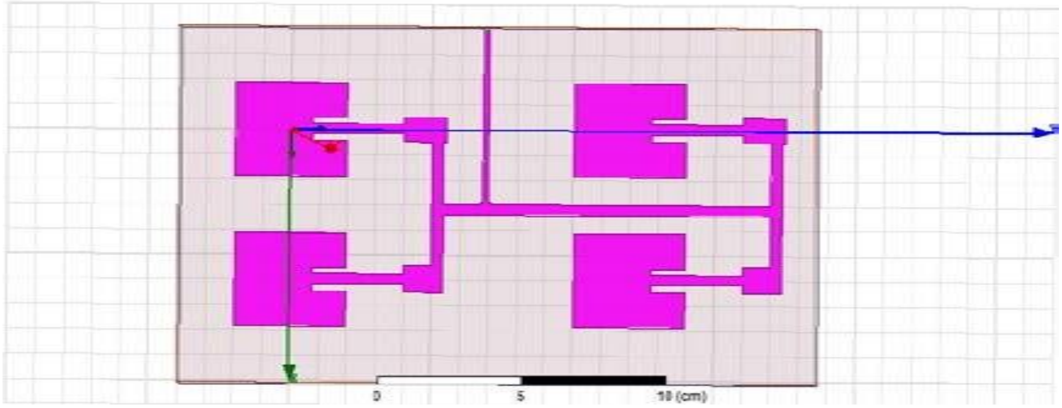
4.Feedline



III. EQUATIONS USED

Using the expressions of widths and lengths given below, various widths and lengths of antenna are calculated for different relative permittivity of substrates such as epoxy Bakelite, Duroid.

$$Width = \frac{c}{2f_o\sqrt{\frac{\varepsilon_R+1}{2}}}; \quad \varepsilon_{eff} = \frac{\varepsilon_R+1}{2} + \frac{\varepsilon_R-1}{2}\left[\frac{1}{\sqrt{1+12\left(\frac{h}{W}\right)}}\right]$$

$$Length = \frac{c}{2f_o\sqrt{\varepsilon_{eff}}} - 0.824h\left(\frac{(\varepsilon_{eff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\varepsilon_{eff}-0.258)\left(\frac{W}{h}+0.8\right)}\right)$$

Antenna performance changes by changing the dimensions of antenna so till we achieve desired antenna parameter values we change the dimensions.

IV. METHODOLOGY

Above algorithm is followed for designing the 2x2 rectangular micro strip patch antenna array for 2.45 GHz application.

Source selection :

As we know antenna can take input as electromagnetic wave or voltage wave . If it is acting as transmitting antenna, then it take input as voltage wave and if it is acting as receiving antenna, then it take input as electromagnetic wave. In our project we using antenna as transmitting antenna, so it takes voltage wave through an input port which is connected to feed line.

Frequency band :

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Depending on operating frequency, the type of application changes. In our project we are using antenna for WLAN application. WLAN operating frequency is 2.45GHz. so 2.45 GHz selected for rectangular micro strip patch antenna array.

Reflection coefficient and VSWR Calculation :

From the return loss plot and VSWR plot, these are calculated. In the two plots, in the frequency axis at the resonating frequency or near to it cusp will be present. Corresponding to that frequency, vertical axis values is VSWR nd reflection coefficient values calculated.

Array design :

As we are designing 2x2 antenna array, so antennas are arranged in two rows and two columns. Feed lines of four antennas are different but the input for all that antennas are given from the single source.

Final modeling and Simulation of antenna ;

This is done after the design of antenna array. When complete 2x2 antenna design is done, we do analysis set up. If all tests are cleared then it indicates simulation is completed successfully. After we will go for result analysis. In that we observe various plots of antenna that has 2D plots and 3D plots.

V. MODELING AND ANALYSIS

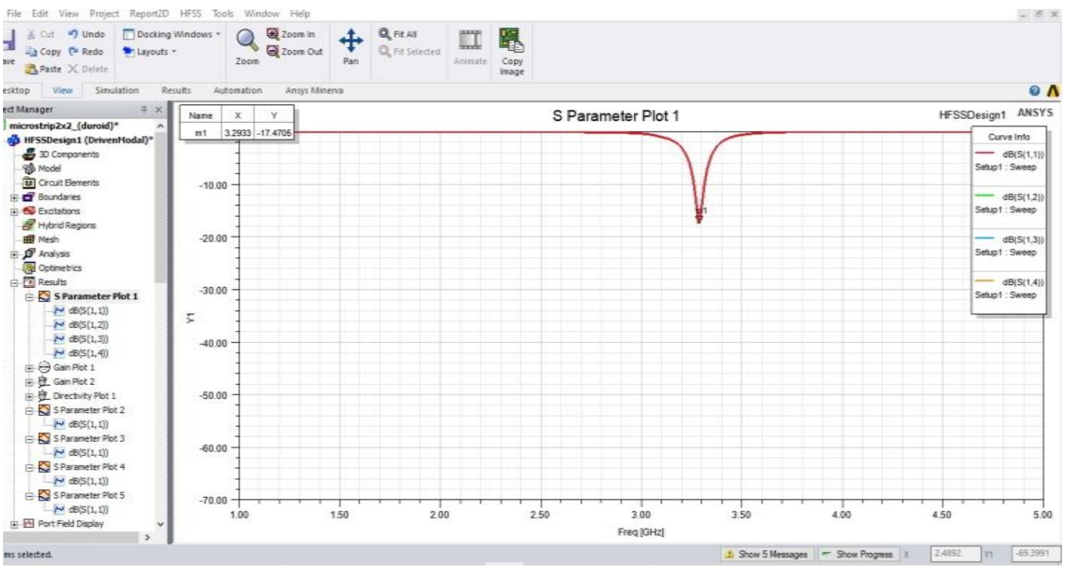
In our project, 2x2 antenna design done for three substrates .In that we obtained better results for Duroid substrate.

Comparison Table

	1x1 Single patch	2x2 FR4 Epoxy	2x2 Bakelite	2x2 Duroid
Return loss (db)	-27.69	-14.34	-4.60	-17.47
VSWR (db)	0.71	3.37	-5.17	2.303
Gain (db)	3.3	4.8	8.8	9.5
Directivity (db)	6.4	9.0	9.4	9.7

VI. RESULTS AND DISCUSSION

Return loss S11 Vs freq



In the graph, corresponding to 2.45 GHz frequency no cusp is observed so near to that frequency one cusp is present. So that vertical value is measured which is reflection coefficient which was observed as -17.47 db. It is

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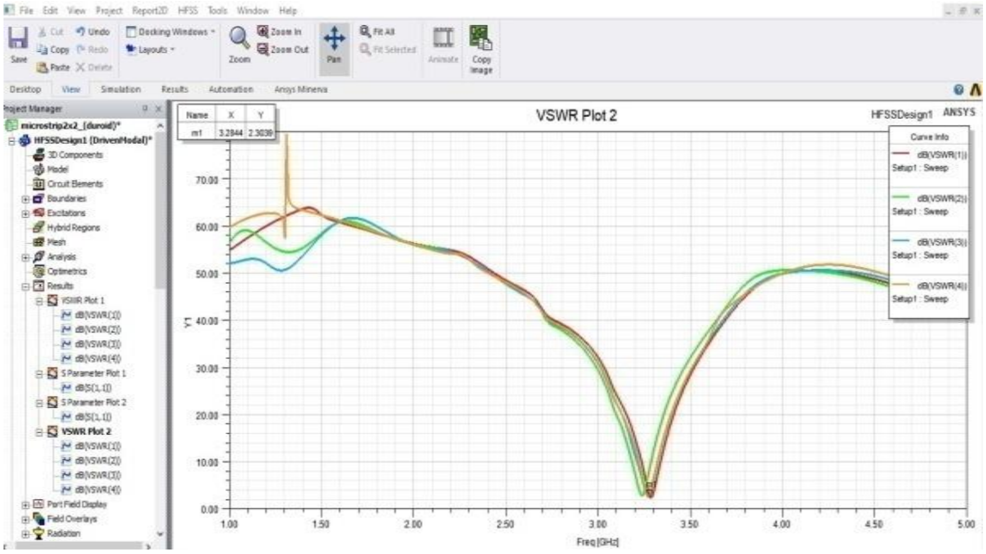
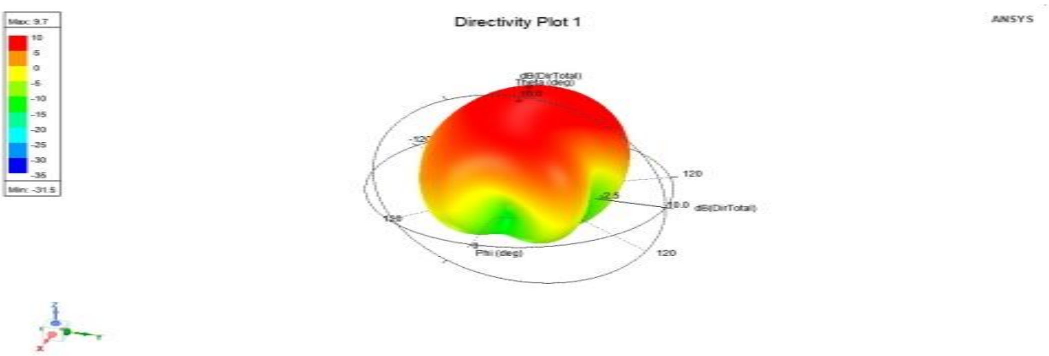
close to that ideal reflection coefficient value. So Antenna radiation is good.

VSWR plot



In the graph, corresponding to 2.45 GHz frequency no cusp is observed so near to that frequency one cusp is present. So that vertical value is measured which is VSWR. That value was observed as 2.303 db. It is also close to the ideal value. Mathematically it is calculated from the reflection coefficient.

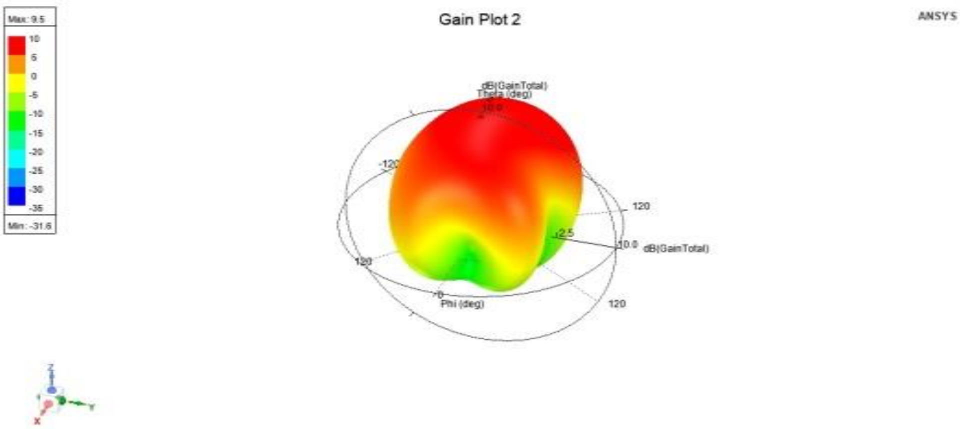
Directivity plot



From the directivity plot, directivity is calculated. It is a spherical coordinate system. From the 3D plot directivity is observed as 9.7 db. This good directivity is obtained because it has no minor lobes and has only major lobes.

Gain plot

It is also 3D plot In this spherical coordinate system, gain is calculated by observing at the z-axis. Gain is observed as 9.5 db. These are various results calculated from the graphs.



VII. CONCLUSION

The 2x2 rectangular microstrip patch antenna array was designed and simulated successfully using the HFSS and we obtained VSWR and return loss values close to the ideal values. In the radiation pattern also main lobe is broad and no minor lobe which indicates that antenna array is directive and resonated at a frequency of 2.45 GHz. The future work is to design 4x4 rectangular microstrip patch antenna array for WLAN application at 2.45 Ghz frequency. In that future work, we try to obtain improved results than this work. In order to improve the antenna performance, we should increase order of antenna array, change the dimensions and introducing some slots. As it has compact size, so it is best suitable for wireless communication applications.

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