Design and Implementation of High Performance 2×2 Array Antenna for WLAN Applications

J.Vignan, III B-Tech Department of ECE,

IARE,Dundigal,Hyderabad

20955a0421@iare.ac.in

Dr.D.Srikar, Assistant professor, Department of ECE,

IARE,Dundigal,Hyderabad

d.srikar@iare.ac.in

ABSTRACT

In this paper, a high-gain multilayer 2 × 2 antenna array for the application of WLAN (wireless local area network) AP (access point) is presented. The antenna array consists of four square patch antenna elements fabricated on FR4 substrate. The FR4 substrate is with air gap to the ground plane. By adjusting the thickness of FR4 substrate and geometry of antenna array the maximum gain of array can be achieved. The proposed antenna is designed, fabricated and tested. The measured -18.4 dB return loss impedance bandwidth is around 14.2% (2.24 - 2.62 GHz). The peak gain of simulated and tested antenna array is about 9.09 dB. The radiation efficiency for 2.4, 2.5 and 2.6 GHz are all larger than 92.3% at 2.4 GHz band. The 3 dB beamwidth for E-plane and H-plane is about 30 • . The test results of power gain and return loss are agreed with that of simulation.

Keywords— dielectric substrate, microstrip antenna, bandwidth, feed line,WLAN, microstrip patch, waveport.

INTRODUCTION

The whole generations are hooked to new technologies. One of the wireless communication technology is playing a main role, so every day they try to improve their status [1]. Even then microstrip patch antenna guarantees low profile, compact and affordable manufacturing for real time applications. An antenna array is a set of individual antennas used for transmitting and receiving radio waves, connected together in such a way that their individual currents are in specified amplitude and phase relationship. So comparing of these antennas, array antenna is highly used for improving gain and it does easily handle the more powers

Microstrip patch antenna in wireless communication is gaining importance as a most powerful technological trend. Its immense potential promises significant change in near term future of wireless application fields. Current technological trend has focused much more attention towards microstrip patch antenna. Single microstrip patch antenna has some advantages (low cost, light weight, conformal & low profile), but it has little disadvantages too- like low gain, low efficiency, low directivity and narrow bandwidth. These disadvantages can be overcome by implementation of many patch antennas in array configuration. Here term array stands for geometrical and electrical arrangements of patch elements. As we increase number of patch elements to form an array, improvement in performance is observed.

Wave port represents the surface through which a signal enters or exits the geometry. Hence 2 ports are required to be defined. HFSS assumes that each wave port you define is connected to a semi-infinitely long waveguide that has the same cross-section and material properties as the port. coaxial probe to give the RF signal in HFSS, only waveport is supported at the coaxial probe to account the even and odd property of a signal (which is not included in Lumped port) hence, draw wave port at the end of your coaxial probe. In order to increase the antenna's gain performance, a 1.8 mm air gap thickness was added in between the radiating patch element and the ground layer. Dielectric constant of air is 1.0006

By adjusting the thickness of FR4 substrate and geometry of antenna array the maximum gain of array can be achieved. The measured 10 dB return loss impedance bandwidth is around 2.65 GHz. The gain of simulated and tested antenna array is about 13 dBi. The radiation efficiency for 2.4, 2.5 and 2.6 GHz are all larger than 65% at 2.4 GHz band. The 3 dB beamwidth.

LITERATE SURVEY

Resonance characteristics of microstrip antenna as a function of substrate thickness RitikaTandon1, Alpana Singh2, Saurabh Khanna3, states that A slight variation in resonance frequency is also noticed which can be neglected for wideband application by using different substrate thicknesses.

Effect of Substrate dielectric constant on Bandwidth characteristics of Line feed on Patch Antenna Amita Thakur, Manoj Chauhan, Mithilesh Kumar, states that, when we increase the substratedielectric constant in antenna design The performance characteristics of antenna-like antenna bandwidth, gain andS11(Return loss) parameter are reduced.

Review and Analysis of Microstrip Patch Array Antenna with different configurations Kuldeep Kumar Singh, Dr. S.C.Gupta

Investigation on the effect of Substrate on the performance of Microstrip antenna Sant SharanShukla, Rahul Kumar Verma, Gurpreet Singh Gohir, states that, As we change the value of relative permittivity with the substrate material, we get a better result on patch antenna.

Design and analysis of microstrip patch array antenna for wlan applications b. ramya, c. supratha and s. robinson

Effect of the dimension of feed line on enhanchment of bandwidth and square microstrip antenna R.KChausaria, Ranjan Mishra, states that, broadband is obtained by increasing the width of feeding line.

Gain Enhancement of Rectangular Microstrip Patch Antenna using Air Gap at 2.4 GHz

EXISTING METHOD

Parameters Symbols	Details of Parameters	Value(mm)
W_s	Width of Substrate	161
L_S	Length of Substrate	184
Pw	Width of Patch	54
P_l	Length of Patch	71
W_F	Width of Microstrip line feed	1

	Gap between ground and substrate	1.8
h	Height of Substrate	1.5

The rectangular microstrip patch antenna has the configuration and choosing the electric substrate with dielectric constant 4.4, they have used FR4 substrate materials with substrate height of 1.5 mm with dielectric loss tangent of 0.013. Next, we found out the length and width of the patchfrom the equation and lastly selecting the best resonance frequency from the millimeter-waveband and authorshave selected 2.6GHz. The parameters used to design the microstrip patch antenna are shown.

PROBLEM IDENTIFICATION

The reflection coefficient is also called return loss and is denoted by (S11). The performance of the antenna generally depends upon a good reflection coefficient or return loss should be as high as possible because return loss in the antenna is a ratio of incident power to that of reflected power. Considerthat the reflection coefficient is 0 dB then nothing has radiated as all the power have reflected from the antenna.

This bounce back reflection is called “return”. Smaller return loss is bad, and means less energy is going into our antenna. RF engineers often measure return loss on a “dB” logarithmic scale, which can make it seem more complicated than it really is. However, just remember better return loss is indicated by bigger return loss numbers, and that is better for your antenna. Here are some examples of the logarithmic scale, or loss in decibels:

Return loss in dB	**What it means**	**VSWR**
8dB	16% reflection, 84% power into the antenna	2.3
10dB	10% reflection, 90% power into the antenna	2
15dB	3% reflection, 97% power into the antenna	1.4
20dB	1% reflection, 99% power into the antenna	1.2

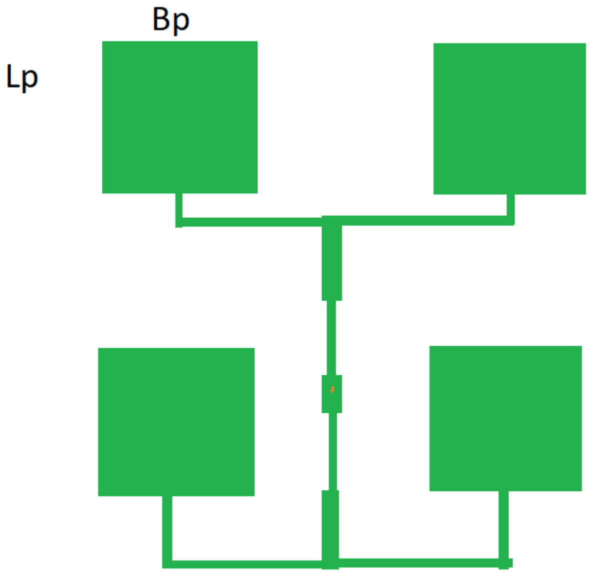
PROPOSED METHOD

By adjusting the thickness of FR4 substrate and geometry of antenna array the maximum gain of array can be achieved. The proposed antenna is designed, fabricated and tested.

The new dimensions of the antenna is:

Parameters	**Details of Parameter**	**Value**
Ws	Width of substrate	162
Ls	Length of substrate	184
W	Width of patch	54

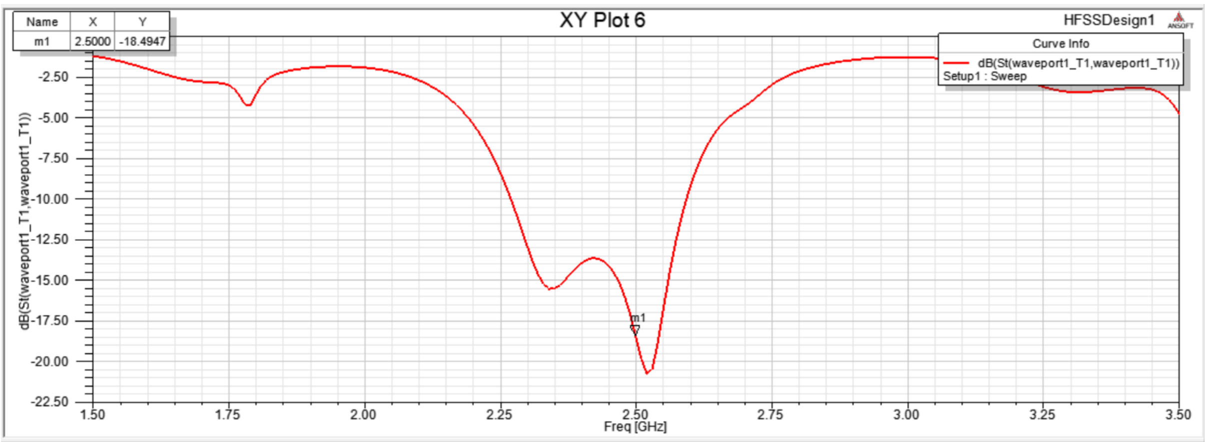
L	Length of patch	71
Wf	width of microstrip feed line	1
Lf	Gap between ground and substrate	1.8
h	Height of substrate	1.6



RESULTS

Reflection coefficient

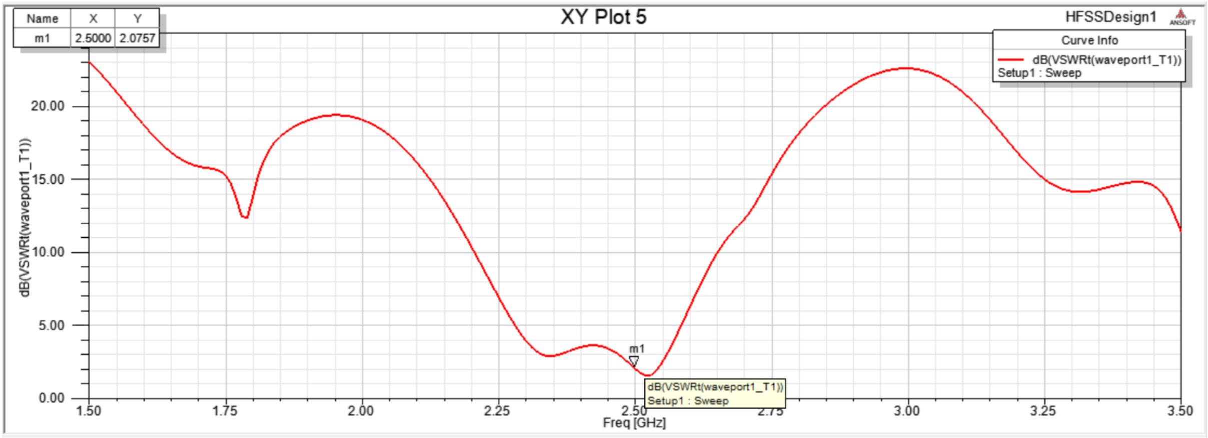
Return loss is a function of the reflection coefficient. It is denoted by s(1,1). The performance of the antenna depends on a good reflection coefficient or return loss because return loss in the antenna is a ratio of incident power to that of reflected power. If the reflection coefficient is 0 dB then nothing has radiated as all the powerhas been reflected from the antenna. The return loss is -18.7 dB and the bandwidth is 2.5 GHz analyzed that with this high bandwidth and good return loss one can have good applications for WLAN.



Return loss S(1,1)

Voltage Standing Wave Ratio

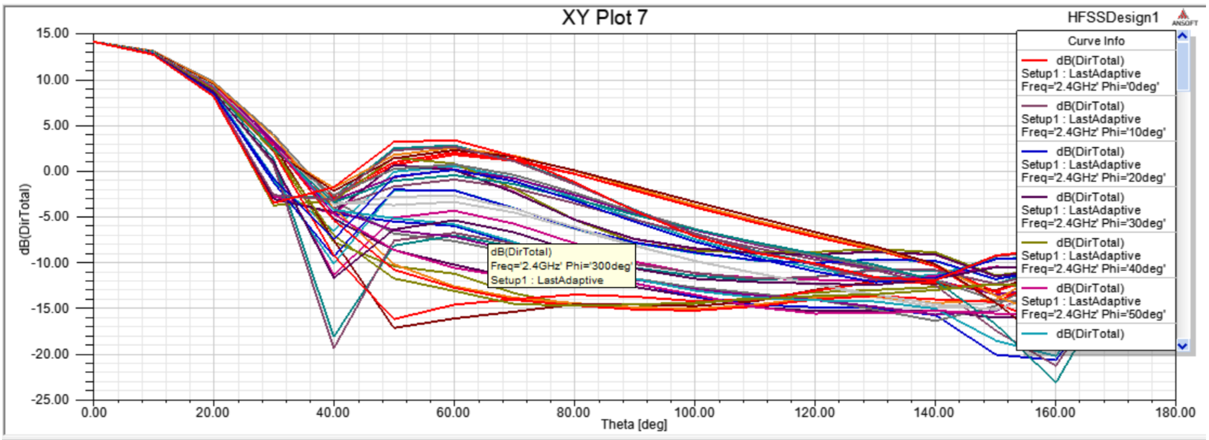
The voltage standing wave ratio is also called as standing wave ratio. For microstrip patch antenna design to be used for WLAN applications, this ratio should be as low as possible. This ratio is always will be a real and positive real number. Higher the value of VSWR means there is a greater mismatch. Therefore, the authors proposed a microstrip rectangular patch antenna that has avalue of 2.5 at 2.5 GHz.



VSWR

Directivity

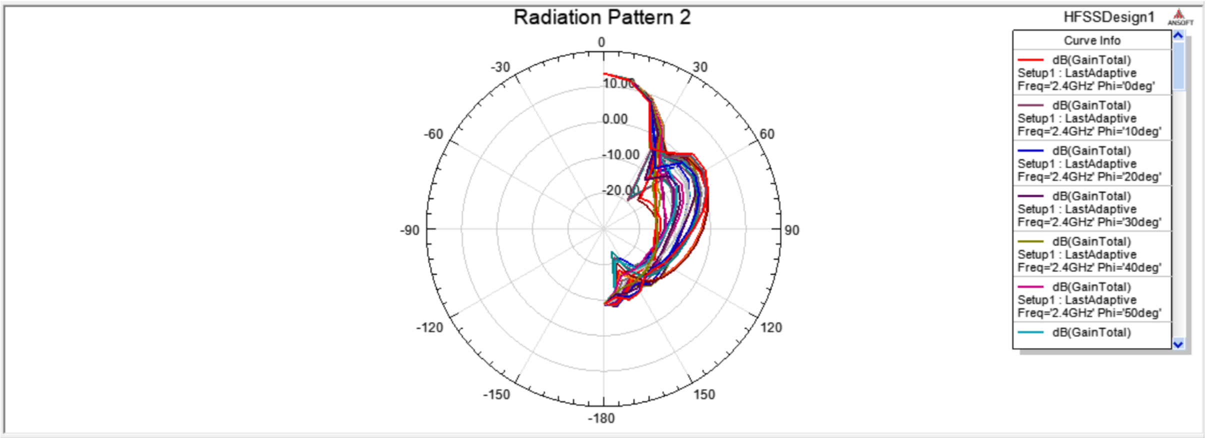
The directivity of the antenna we obtained is 18db. The higher the directivity the more concentrated the wave radiates. Higher directivity means the signal travels far distances. This can be used for data transmission.



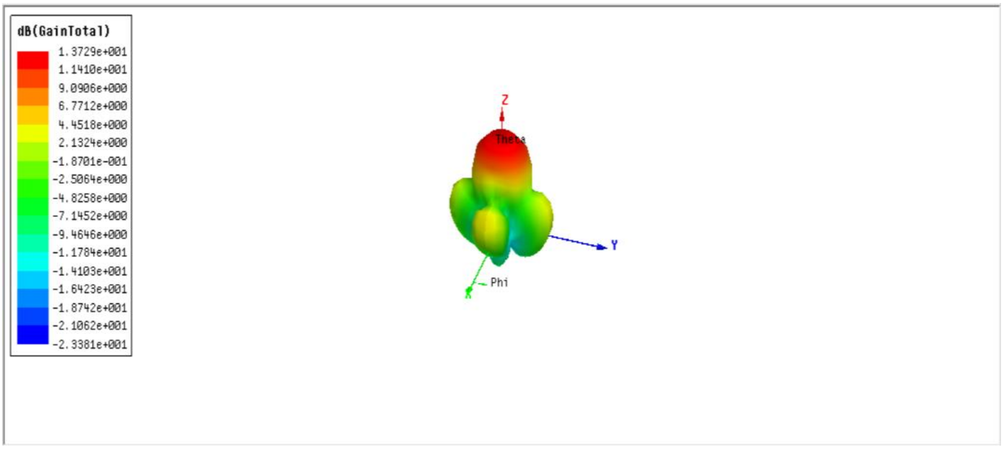
Directivity

Radiation Pattern

The below figures shows the 3D and 2D radiation pattern of the microstrip patch antenna of gain 9.09db at 2.5GHz. This can be used for WLAN.



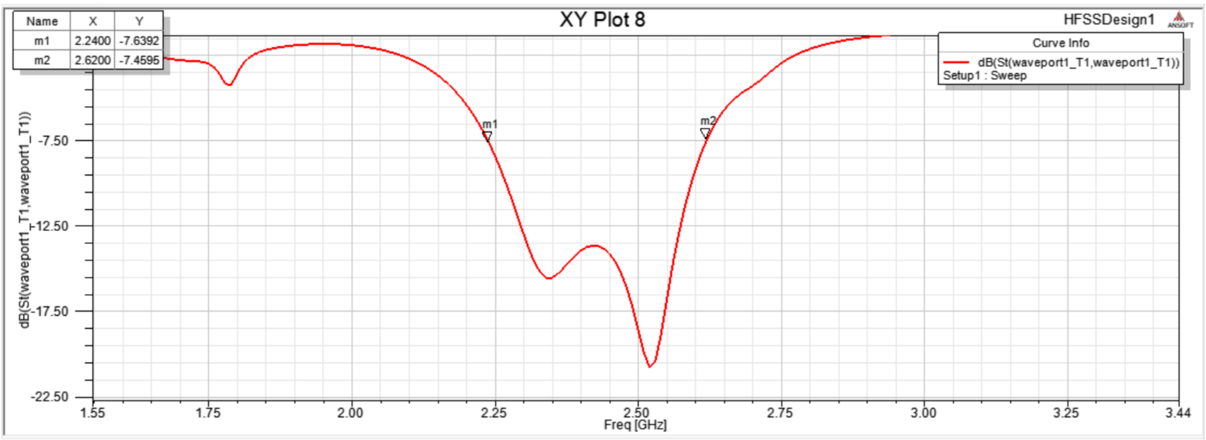
Radiation pattern at all angles



3D plot of radiation pattern

Bandwidth

Bandwidth is acquired around 14.2% (2.24 - 2.62 GHz). The bandwidth of 3.8GHz.



bandwidth

	Quantity	Value	Units
	Max U	0.018198	W/sr
	Peak Directivity	25.544	
	Peak Gain	23.601	
	Peak Realized Gain	22.597	
	Radiated Power	0.0089524	W
	Accepted Power	0.0096893	W
	Incident Power	0.01012	W
	Radiation Efficiency	0.92394	
	Front to Back Ratio	177.39	
	Decay Factor	0	

Antenna Parameters

CONCLUSION

Our proposed microstrip 2×2 array rectangular patch antenna is designed and successfully implemented at the resonance frequency of 2.6 GHz using HFSS software which is more reliable to design and view high-quality results especially 3D radiation patterns than other antenna design software. As shown above, from our simulation results and comparison table, the proposed design of Microstrip patch antenna has a higher gain of 9.09 dB for good signal strength, increased bandwidth of 3.8 GHz for high-quality video transmission for WLAN (Wireless Local Area Network) applications. We achieved a better and good return loss of –18.7 dB, voltage standing wave ratio of 2.5. However, the shortcoming of this proposed antenna is that efficiency and bandwidth are slightly less.

REFERENCES

1. Resonance Characteristics Of Microstrip Antenna As A Function Of Substrate Thickness Ritikatandon1,Alpana Singh2, Saurabh Khanna3
2. Effect Of Substrate Dielectric Constant On Bandwidth Characteristics Of Line Feed On Patch AntennaAmita Thakur, Manoj Chauhan, Mithilesh Kumar
3. Investigation On The Effect Of Substrate On The Performance Of Microstrip Antenna Sant SharanShukla,Rahul Kumar Verma, Gurpreet Singh Gohir
4. Effect Of Dimension, Spacing, And Shape On Resonant Frequency And Bandwidth Of 2× 2 Antenna Array Nayana Chaskar, Sneha Dalvi, Sandip Rathod, Anjali A. Chaudhari, And Rajiv K. Gupta,
5. Effect Of The Dimension Of Feed Line On Enhanchment Of Bandwidth And Square Microstrip AntennaR.KChausaria, Ranjan Mishra
6. Https://Www.Miwv.Com/5g-Radio-Frequency/
7. Http://Www.Antenna-Theory.Com/Antennas/Patches/Antenna.Php
8. Mohammad Faisal, Abdul Gafur, Syed Zahidur Rashid, Md.Omarfaruk Shawon, Kazi Ishtiak Hasan And Md.Bakey Billah, "Return Loss And Gain Improvement For 5g Wireless Communication Based On SingleBand Microstrip Square Patch Antenna", 1st International Conference On Advances In Science, Engineering And Robotics Technology (Icasert 2019), Dhaka, Bangladesh, 2019.
9. Gain Enhancement of Rectangular Microstrip Patch Antenna using Air Gap at 2.4 GHz K. W. S. Al Kharusi, N. Ramli, S. Khan, M. T. Ali and M. H. Abdul Halim