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Research Paper

HIGH GAIN MICROSTRIP ARRAY ANTENNA FOR WLAN APPLICATIONS

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This paper describes the design of single microstrip square patch antenna and the construction of 3 × 4 array pattern to increase the efficiency of the antenna. The operating frequency of square patch is at 2.4 Ghz. Simulation result shows that 4.67 dB gain can be achieved for single microstrip patch and 14.57 dB gain can be achieved for 3 × 4 array microstrip patch antenna. Also Simulation results shows that the return loss is –27 dB at 2.4 GHz in single patch and –25 dB for 3 x 4 array microstrip antenna. The simulation is done using ADS software.

Keywords: Microstrip patch antenna, ADS

INTRODUCTION

The development of small-integrated antennas plays a significant role in the progress of the rapidly expanding military and commercial communications applications. The technology to support these applications has been made possible by recent advances in high-density RF and microwave circuit packaging [3]. As system requirements for faster data transmission in lighter compact designs drive the technology area, higher frequency design solutions with large density layouts require integration of microwave devices, circuitry, and radiating elements that offer light weight, small size, and optimum performance.. The study of microstrip patch antennas has made great progress in recent years. Compared with conventional antennas, microstrip patch antennas have more advantages and better prospects. They are lighter in weight, low volume, low cost, low profile, smaller in dimension and ease of fabrication. In its most basic form, a Microstrip patch antenna consists of a radiating patch on oneside of a dielectric substrate which has a ground plane on the other side [1, 2]. The patch is generally made of conducting material such as copper or gold and can take anypossible shape. The antenna array is the concept in which similar antenna elements are oriented similarly to improve the directivity in particular direction and increase efficiency. Many applications in

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communications and radars require circular or dual linear polarization, and the flexibility afforded by microstrip antenna technology has led to a wide variety of designs and techniques to fill this need. In recent years, the demand for compact mobile telephone handsets has grown. Handsets with size of a pocket have begun appearing in the market and, as the demand for increased electronic mobility grows, the need for small handsets will most likely increase. A small antenna size is required as one of the important factors in portable mobile communication systems. A key requirement of a WLAN system is that it should be low profile, where it is almost invisible to the user. For this reason the microstrip patch antennas are the antennas of choice for WLAN use due to their small real estate area and the ability to be designed to blend into the surroundings [4, 5].

ANTENNA PARAMETERS

Different parameter such as Return Loss, Antenna Gain, Directivity, Antenna Efficiency and Bandwidth is analyzed.

Gain

The 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. Formula for gain is *G* = 4®. *U*(¯, Φ)/Pin, where, *U*(¯, Φ) is a intensity in a given direction, *Pin* is input power.

Radiation Pattern

The radiation pattern is defined as a mathematical function or a graphical representation of the radiation properties of the antenna as a function of space coordinates.

Antenna Efficiency

It is a ratio of total power radiated by an antenna to the input power of an antenna.

Return Loss

Return loss is the reflection of signal power from the insertion of a device in a transmission line. Hence the RL is a parameter similar to the VSWR to indicate how well the matching between the transmitter and antenna has taken place. The RL is given as by as: RL = –20 $\log^{10}$ (Γ) dB. For perfect matching between the transmitter and the antenna, $\Gamma = 0$ and RL = ∞ which means no power would be reflected back, whereas a $\Gamma = 1$ has a RL = 0 dB, which implies that all incident power is reflected. For practical applications, a VSWR of 2 is acceptable, since this corresponds to a RL of –9.54 dB.

ANTENNA DESIGN METHOD

The dielectric material that is used in this design of the Microstrip Patch Antenna is FR4 with $£_r$ = 4.6. The selection of substrate depends on the type of circuit, operating frequency of operation and the amount of dissipation from the circuit [6, 7]. The properties of substrate materials should be high dielectric constant, low dissipation factor, high purity high resistivity, high stability, surface smoothness and thermal conductivity [3]. The bandwidth is directly proportional to the substrate thickness or height and directly proportional to the $£_r$. The conductor and dielectric loss is more important for thinner substrate and conductor loss increase with the frequency due to skin effect.

The width and length of the radiating surface is given by, $W = L = c/(2f * \mathrm{sqrt}(£_r))$

Dielectric substrate £$_r$ = 4.6

Velocity of light = 3 x 10^8 m/s

Operating frequency (f) = 2.4 GHz

Height of substrate (h) = 1.6 mm

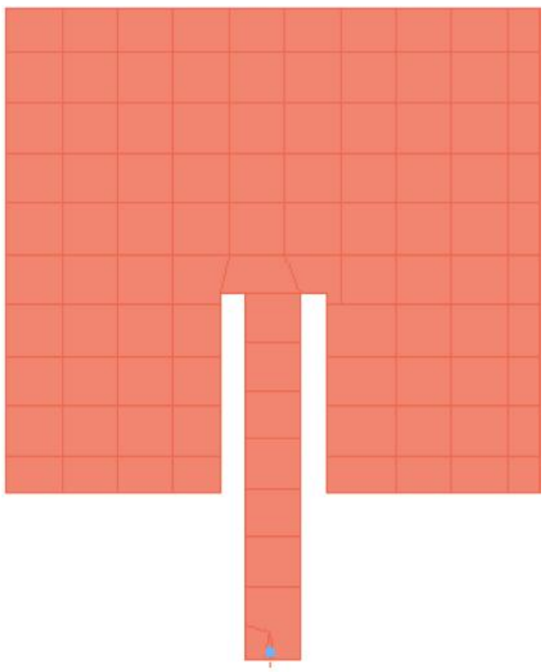
Thickness of ground plane = 35 μm

Feeding method = –microstrip line (inset feed)

Name of Substrate metal = FR4

In this paper a square patch antenna with dimension 29.2 x 29.2 mm is designed. The layout of the single patch is shown in the Figure 1. The 3 x4 Antenna Array of individual Micro strip patch antenna is designed to achieve higher gain, better efficiency.

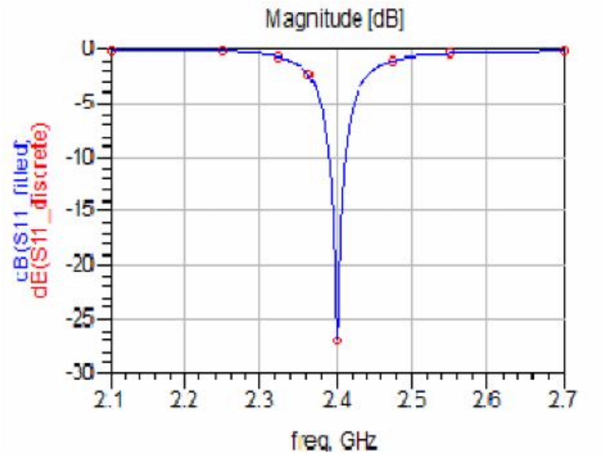
Figure 1: Single Patch



The return loss curve for the single square patch is shown in the Figure 2.

The above figure shows a return loss of –27 dB for single patch.

Figure 2: Return Loss Curve for Single Square Patch



The radiation pattern of the 3 x 4 array pattern is shown in the Figure 3.

Figure 3: Radiation Pattern of Single Patch

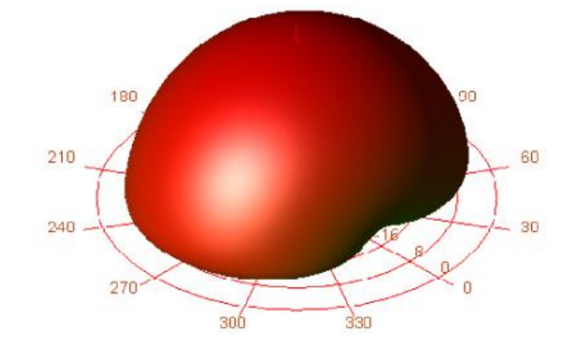
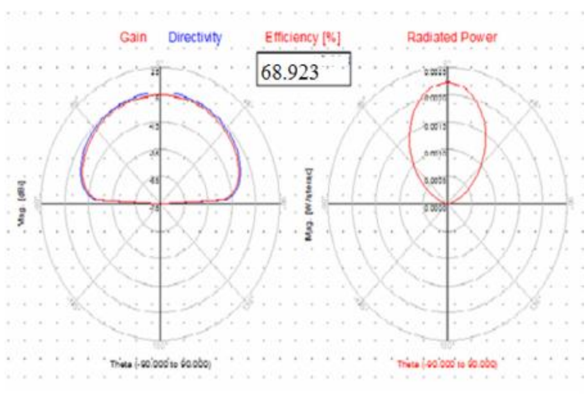


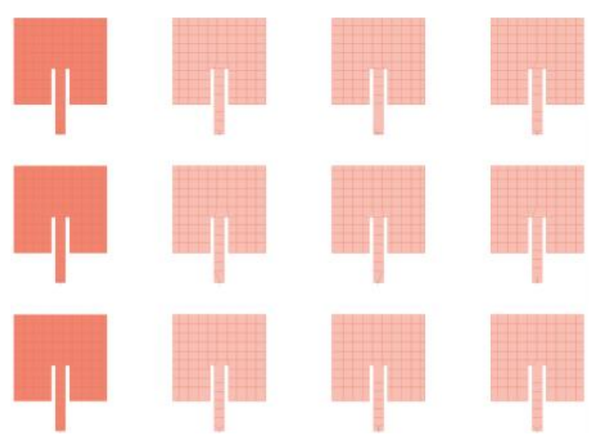
Figure 4: Efficiency of Single Patch



The above figure shows that the efficiency of a single microstrip patch antenna is 68.92%.

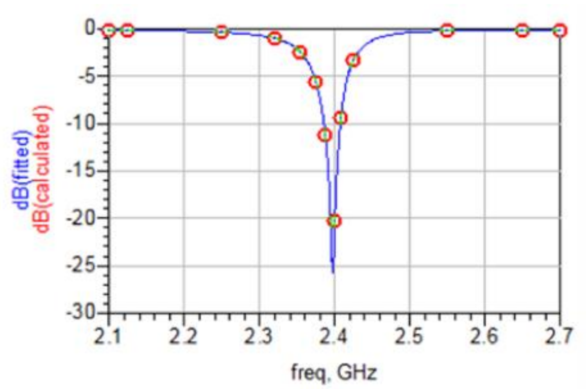
In order to increase the efficiency of the microstrip antenna, array pattern is constructed. Here 3 x 4 array pattern is designed and the layout is shown in the Figure 5.

Figure 5: 3 x 4 Array Pattern



The return loss curve for the 3 x 4 Array antenna is shown in the Figure 6.

Figure 6: Return Loss Curve for 3 x 4 Array Antenna



The above figure shows a return loss of –25 dB for single patch.

The radiation pattern of the 3 x 4 array pattern is shown in the Figure 7.

Figure 7: Radiation Pattern of the 3 x 4 Array Pattern

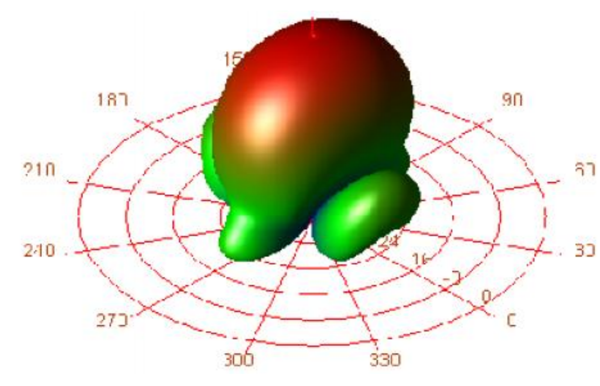
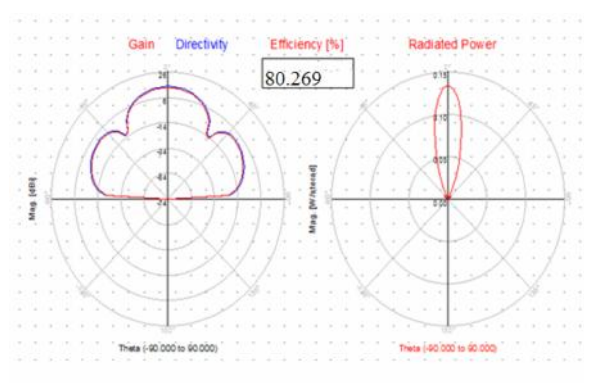


Figure 8: Efficiency of 3 x 4 Array Antenna



The above figure shows that the efficiency of a single microstrip patch antenna is 80.26%.

SOFTWARE AND ITS DESCRIPTION

Advanced Design System is the world's leading electronic design automation software for RF, microwave, and high speed digital applications. In a powerful and easy-to-use interface, ADS pioneers the most innovative and commercially successful technologies, such as X-parameters and 3D EM simulators, used by leading companies in the wireless communication and networking and aerospace and defense industries.

KEY BENEFITS OF ADS

Complete, integrated set of fast, accurate and easy-to-use system, circuit and EM simulators enable first-pass design success in a complete desktop flow. Application-specific Design Guides encapsulate years of expertise in an easy-to-use interface.ADS is supported by leading industry and foundry partners.

Table 1: Comparison of Antenna Parameters

Parameter	Single Antenna	3 x 4 Antenna Array
Power radiated (watts)	0.0065	0.08592
Effective angle (steradians)	2.952	0.3536
Directivity (dBi)	6.28	15.5058
Gain (dBi)	4.67	14.5746
Maximum intensity (watts/steradians)	0.0022	0.2429
Angle of U max (theta/phi)	0(0)	0(0)
E (theta) max (mag, phase)	0.505(145.3)	13.5(164.04)
E (phi) max (mag, phase)	1.190(–34.62)	0.46(–15.56)
E (x) max (mag, phase)	0.0007(97.82)	0.004(123.4)
E (y) max (mag, phase)	1.29(–34.6)	13.52(–15.95)
E (z) max (mag, phase)	0(0)	0(0)

RESULTS AND DISCUSSION

The 3 x 4 microstrip patch antenna array are simulated using Simulation method of ADS. The return loss of the 3x4 microstrip patch antenna is 25 dB when resonance frequency is 2.4 GHz. The gains of single microstrip antenna and 3x4 antenna array are 4.7 dB and 14.67 dB and the directivity of single microstrip antenna and 3 x 4 antenna array are 6.28 dB and 15.50 Db.

CONCLUSION

Thus a microstrip patch antenna for 2.4 GHz is designed using ADS software using FR4 substrate. A single microstrip layout is designed and simulated, it shows a return loss of –27 dB, then the 3D radiation pattern is observed. The antenna efficiency of 68.2% is achieved.In order to increase the efficiency array antenna is designed. The efficiency of array antenna is increased to 80.2%. Hence the 3D radiation pattern, current distribution and 2D cut out radiation pattern and also the return loss of single patch and 3 x 4 array antenna are studied effectively using ADS software.

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